Immingham Green Energy Terminal

9.3 Applicant's Responses to the Examining Authority's First Written Questions

(Responses to "Q1.6. Habitats Regulation Assessment")

Infrastructure Planning (Examination Procedure) Rules 2010

Volume 9

March 2024

Planning Inspectorate Scheme Ref: TR030008

Document Reference: TR030008/EXAM/9.3

Table of contents

Chapter **Pages**

1 Introduction

Overview

1.1 This document has been prepared to accompany an application made to the Secretary of State for Transport (the Application") under section 37 of the Planning Act 2008 ("PA 2008") for a development consent order ("DCO") to authorise the construction and operation of the proposed Immingham Green Energy Terminal ("the Project").

1.2 The Application is submitted by Associated British Ports ("the Applicant"). The Applicant was established in 1981 following the privatisation of the British Transport Docks Board. **The Funding Statement [APP-010]** provides further information.

1.3 The Project as proposed by the Applicant falls within the definition of a Nationally Significant Infrastructure Project ("NSIP") as set out in Sections 14(1)(j), 24(2) and 24(3)(c) of the PA 2008.

The Project

1.4 The Applicant is seeking to construct, operate and maintain the Immingham Green Energy Terminal, comprising a new multi-user liquid bulk green energy terminal located on the eastern side of the Port of Immingham (the "Port").

1.5 The Project includes the construction and operation of a green hydrogen production facility, which would be delivered and operated by Air Products (BR) Limited ("Air Products"). Air Products will be the first customer of the new terminal, whereby green ammonia will be imported via the jetty and converted on-site into green hydrogen, making a positive contribution to the UK's net zero agenda by helping to decarbonise the United Kingdom's (UK) industrial activities and in particular the heavy transport sector.

1.6 A detailed description of the Project is included in **Chapter 2: The Project** of the Environmental Statement ("ES") **[APP-044]**.

Purpose and Structure of this Document

1.7 This document contains the Applicant's responses to those of the Examining Authority's Written Questions 1 **[PD-008]** grouped under the theme "Q1.6. Habitats Regulation Assessment". It represents one of a collection of eighteen such documents, each of which addresses a different theme.

1.8 Responses are ordered ascendingly by reference number, replicating the structure of the Examining Authority's Written Questions 1.

1.9 Responses are provided in a table. The text of the question appears on the lefthand side, with the Applicant's answer to its right.

1.10 Further materials pertinent to the Applicant's response are included at the end of the document as appendices where necessary.

2 Applicant's Responses to the Examining Authority's First Round of Written Questions

Q1.6. Habitats Regulation Assessment	
Q1.6.1 General	
Q1.6.1.1	
Question	**Response**
Responding to NE Representation NE has raised a series of concerns relating to the assessment of European sites. [RR-019]. Respond to the issues marked as Amber and Yellow and provide a revised HRA Report that includes the additional information requested, or justify in each instance why this is not necessary.	The Applicant can confirm that it has responded to all concerns raised by Natural England in their Relevant Representation [**RR-019**]. These responses have been submitted at Deadline 1 [TR030008/EXAM/9.2]. An updated **Shadow Habitats Regulations Assessment ("HRA")** which includes all of the requested information has also been submitted at Deadline 1 **[TR030008/APP/7.6 (2)]**.
Q1.6.1.2	
Question	**Response**
Case Law The Judgement in Case C-323/17 People Over Wind and Sweetman v Coillte Teoranta ruled that mitigation measures could not be taken into account at the screening stage of an appropriate assessment. Provide a copy of the People Over Wind and Sweetman v Coillte Teoranta judgement for the purposes of the Examination.	A copy of the Judgment of the Court of Justice (Seventh Chamber) - 12 April 2018 People Over Wind v Teoranta Case C-323/17 is provided as **Appendix 1** to this document.

Q1.6.1.3	
Question	**Response**
IROPI Case Given that the Applicant's IROPI case places emphasis on green energy, the green credentials of the site and the role that the Proposed Development would play towards meeting the Government's net zero targets, the ExA requires further evidence from the Applicant to demonstrate how the Proposed Development would meet these credentials to satisfy the IROPI tests. Further to the discussion at ISH3 [EV5-006] [EV5-007] and the Action Point noted, provide copies of the Court Case judgements mentioned that reference the certainty of benefits and how these are weighted.	This question was addressed by the Applicant at both Issue Specific Hearing ("ISH") sessions 1 and 3. The Applicant's primary case is that its submitted evidence demonstrates that the Project will not result in an Adverse Effect on Integrity of any European Site, either alone or in-combination with other plans and projects. However, if, contrary to the evidence provided, the Secretary of State concludes that an adverse effect on the integrity of European Sites from the Project cannot be ruled out and, therefore, (in the absence of alternatives) it is necessary to demonstrate that the Project has to proceed for Imperative Reasons of Overriding Public Interest ("IROPI"), then it is important to understand that such reasons go beyond just the green credentials of the Project or matters relating to net zero referred to in the question. These other reasons relate to the need for substantial additional port capacity which is established in the NPSfP and which is identified as a compelling and urgent need the meeting of which is strongly in the public interest. The meeting of this compelling and urgent need is in itself, therefore, sufficient to establish IROPI for the Project. Despite the existence of these reasons, each of the separate reasons relating to green and net zero matters that have also been identified by the Applicant are each, in the Applicant's view, also sufficient in their own right to constitute IROPI.

	To assist the ExA in respect of these matters following the relevant discussions at ISH1 and ISH3, the Applicant has taken the opportunity to further clarify the position summarised above within its amendments to its Without Prejudice HRA Derogation Report that are being submitted at Deadline 1. In terms of specific green credentials and net zero related matters, the Applicant submits the following: (a) The Project would – as explained at ISH1 (see **[TR03008/EXAM/9.29]**) and in response to Q1.3.2.5 and Q1.3.3.4 – meet relevant low carbon hydrogen standards. (b) Against the background context of the legally binding targets requiring the UK to bring all greenhouse gas emissions to net zero by 2050 and the very clear Government recognition that low carbon hydrogen - including the scaling up of the production of such hydrogen - plays a critical part in the overall strategy to achieving net zero, the Project once constructed and in operation will provide 300MW of low carbon hydrogen production. For context, this equates to 3% of the Government's 2030 target of 10GW of low carbon hydrogen production which is set out in the British Energy Security Strategy (April 2022) at page 22 and 23. Although, as far as the Applicant is aware, there is not yet any specific hydrogen production target beyond 2030, the importance of low carbon hydrogen as a component of the overall energy mix and means by which net zero will be achieved will not stop in 2030. Even assuming the Government's target for 2030 is met (which would require this Project and many other similar projects to be consented and built in short order) it is highly likely that further growth in low carbon hydrogen production will be required beyond 2030 to achieve net zero and energy security.

	Furthermore, the 2030 target is just that – a target. It should not be considered or viewed as a limit on what is desirable in the public interest. If the market for hydrogen were to grow faster than expected and the target exceeded, that would deliver yet greater reductions in CO_2 emissions. This matter is without doubt, therefore, of itself an Imperative Reason of Overriding Public Interest. (c) Against the background context of the legally binding UK net zero 2050 targets and the very clear Government recognition that carbon capture, usage and storage plays a critical part in the overall strategy of achieving net zero, the Project has the potential to play a significant role in facilitating the import of up to10Mt of carbon dioxide per Annum for onward storage or use. By way of context, this would be the equivalent of one third of the Government's ambition to use CCUS technology to capture 20-30MT of carbon dioxide per year by 2030 (see Net Zero Strategy Build Back Greener (October 2021) page 126 paragraph 25). Furthermore, this document also indicates that the Government's ambition is for this to grow to at least 50MT per year by the mid 2030's (see same document page 82). Having regard to the policy position clearly set out within the Overarching National Policy Statement for Energy (EN-1), the need for carbon capture and storage infrastructure is imperative. Even if the circa 10Mt level of carbon dioxide throughput is not achieved at the facility, the scale and significance of the need for such infrastructure from a net zero perspective is such that, in the Applicant's view, any measurable contribution which the facility would make in this regard would be a benefit clearly in the public interest. The Applicant's position is that in

	view of the level of the Government's ambition, it is highly likely that a significant proportion of that available capacity will be utilised. As with hydrogen production the importance of carbon capture and storage as a component of the overall means by which net zero will be achieved will not stop by the mid 2030s. Rather it is likely that further growth in carbon capture and storage beyond this date will be required to achieve net zero. Similarly, the ambitions set by Government do not comprise a limit on what is desirable in the public interest or what could potentially occur in respect of carbon capture and storage with the right infrastructure in place in the period up to the mid 2030s. This matter is without doubt, therefore, of itself also an Imperative Reason of Overriding Public Interest. It is clear, therefore, that the various green / net zero reasons identified as to why the Project is needed are both individually and collectively: (i) reasons which are clearly in the public interest; (ii) reasons which are clearly imperative, and (iii) reasons which clearly override the relevant harm that would be caused by the Project to any European site – which in any event is extremely limited and, as the Applicant's evidence demonstrates robustly, does not result in an adverse effect on the integrity of any European Sites.

	In relation to the court judgment referenced at the ISHs 1 and 3 (R (Substation Action Save East Suffolk Ltd) v Secretary of State For Business, Energy And Industrial Strategy [2022] EWHC 3177),), this has been provided as **Appendix C** of **Appendix 2** of the response to Q1.2.1.14. The case confirms that the potential benefits of a project do not need to be legally secured in order to be treated as material considerations by the decision-maker. In addition, matters relating to the weight to be given to benefits are also discussed in the response to Q1.2.1.8, which refers to the policy of importance on such matters contained within the Overarching National Policy Statement for Energy (EN-1).
Q1.6.1. General	
Q1.6.1.4	
Question	**Response**
Bat Emergence Survey The ES Appendix 8C: Bat Survey Report [APP-182, Paragraph 5.1.1] states that further surveys of woodland trees with moderate and high bat roost potential were to be carried out to establish whether there are any additional roosting sites, and what the status of these roosts are. Further to the Action Point noted at ISH2 [EV4-007] [EV4-008], provide the results of the completed Bat Emergence Survey, including any implications for the Proposed Development.	Bat emergence and re-entry surveys which were completed between July and September 2023 found no evidence of bats roosting within 19 woodland trees which had been previously identified as having moderate-high suitability for roosting bats. Likewise, no evidence of bat foraging was identified within the proximity of the 19 surveyed trees, including one tree which had previously been found to support a bat roost, likely to be common pipistrelle (*Pipistrellus pipistrellus*). This confirms the conclusion in the **Environmental Statement** within **Chapter 8: Nature Conservation (Terrestrial Ecology) [APP-050]**, in relation to bats, that the impact of removing trees would be minor adverse and not significant.

	Further details on the additional bat emergence and re-entry surveys undertaken between July and September 2023 are included within **Environmental Statement Survey Updates [TR030008/APP/9.9]** being submitted into the Application at Deadline 1.
Q1.6.2 Clarification Required	
Q1.6.2.1	
Question	**Response**
Greater Wash SPA [APP-238, Table 2] concludes that the qualifying features of the Greater Wash SPA would not be relevant to the assessment, suggesting that it is outside of the scope of the HRA. However, Paragraph 3.3.3 states that Greater Wash SPA was screened out of Stage 2. a) Applicant - Confirm whether the Greater Wash SPA has been included in Stage 1: Screening of the HRA or whether it is outside the scope of the assessment? b) Natural England - Are you satisfied that the Applicant has correctly identified and assessed the relevant European sites and qualifying features /criteria in its HRA Report? Please confirm whether you consider that the Greater Wash SPA is of relevance to the assessment (to be included in Stage 1: Screening for LSE).	To clarify, the Greater Wash Special Protection Area ("SPA") was screened out at Stage 1 on the basis of the rationale provided in **Table 2** of the **Shadow Habitats Regulations Assessment [APP-238]**. In summary, none of the qualifying features were considered to overlap with any potential direct or indirect changes resulting from the construction and operational activities associated with the Project which are limited to within the vicinity of the Port of Immingham area.
Q1.6.2.2	

Question	Response
Conservation Status of European Sites The Conservation Objectives for the sites considered for AEoI are provided in [APP-238, Table 6]. Confirm the conservation status of the European sites carried forward to stage 2.	Natural England has advised that they do not currently undertake a specific condition assessment of the Humber Estuary European sites. Instead, Natural England advised that the condition assessment for the Humber Estuary Site of Special Scientific Interest ("SSSI") should be used where the SSSI features are the same as the European Marine Site features to give the conservation status. On this basis, the conservation status of the features screened into the assessment at Stage 2 of the **Shadow Habitats Regulations Assessment ("HRA") [APP-238]** is as follows: *Waterbird features* • Black-tailed Godwit-Favourable • Shelduck-Favourable • Oystercatcher-Favourable • Teal-Favourable • Curlew-Unfavourable (Declining) • Redshank-Unfavourable (Declining) • Turnstone-Unfavourable (Declining) • Dunlin-Unfavourable (No change) *Habitat features* • Estuaries-Not Recorded • Intertidal mudflats and sandflats-Not Recorded • Subtidal sandbanks-Not Recorded • Saltmarsh habitats-Not Recorded

	Fish and marine mammal features • Grey seal-Not Recorded • Sea lamprey-Not Recorded • River lamprey-Not Recorded With respect to the harbour (common) seal feature of The Wash and North Norfolk Coast Special Area of Conservation, this feature is not assessed at the site level but is considered to be in "*Unfavourable-Inadequate*" condition at a UK wide scale[1].
Q1.6.2.3	
Question	**Response**
Operational Activities [APP-238] does not provide a description of the operational activities of the Proposed Development. Explain what parameters, scenarios and assumptions underpin the assessment of the operational phase.	During operation, the Terminal would operate 24 hours a day, seven days a week and 365 days a year and would be able to accommodate up to 292 vessel calls per year. The hydrogen production facility is intended to be a continuous operation, although this would be dependent upon shipping frequency. The intention is therefore that the facility will operate 24 hours a day, seven days a week and 365 day a year. The facility would have a planned preventive maintenance programme during the operational phase. The flare stacks proposed as part of the Project are relatively small in scale (as compared to those associated with offshore oil and gas platforms or refineries), with the flame largely enclosed as a result of shrouding. Furthermore, they are only required to be used during start up, shut down and emergency use (typically less than 5% of the time annually).

[1] https://jncc.gov.uk/jncc-assets/Art17/S1365-UK-Habitats-Directive-Art17-2019.pdf

	Heavy Goods Vehicles ("HGVs") would use the A1173 to access the Site. Operational traffic movements are detailed in **Environmental Statement ("ES") Chapter 11: Traffic & Transport [APP-053]**. In summary, it is anticipated that during the operational phase of the Project, total HGV movements at the Site would be approximately 96 movements (48 in and 48 out) per day. These figures include movements associated with the delivery of consumables and removal of waste products. During operation of the Project, maintenance dredging will potentially be required in the same way as currently occurs at the Port. The modelling of the Project (as reported in **ES Chapter 16: Physical Processes [APP-058]**) indicates that the berth pocket, once dredged, will remain swept clear of deposited material by the flood and ebb tidal flows (in much the same way the existing Immingham Oil Terminal berths are). Consequently, the need for future maintenance dredging within the new berth pocket is expected to be very limited (if required at all). Should maintenance dredging be required, it is proposed to be incorporated within the maintenance dredge licence for Immingham (L/2014/00429/1) as part of the renewal of the licence at the end of 2025. Engineering and maintenance works in Work No. 1, is expected to be limited and only required occasionally. Further information on the operational phase of the Project is provided in **Section 2.6** of **ES Chapter 2: The Project [APP-044]**. These are the parameters that have underpinned the assessment; however, additional information on operational activities of the Project has also been provided in the updated **Shadow Habitats Regulations Assessment** which has been submitted at Deadline 1 **[TR030008/APP/7.6 (2)]**.

Q1.6.2.4	
Question	**Response**
Decommissioning effects The Shadow HRA [APP-238, Paragraph 4.1.4] indicates the guidance that it is desirable to following relation to identifying all the European sites and qualifying features as each phase of the project. This information has been provided in Tabular form in Appendix C. However, the Table does not address decommissioning. Provide the potential for LSE to arise on the designated sites resulting from the decommissioning of the Hydrogen Production Facility.	The DCO application does not make any provision for the decommissioning of the approach jetty, jetty head, jetty access ramp and the jetty access road. This is because these elements would, once constructed, become part of the fabric of the Immingham port estate and would, in simple terms, continue to be maintained so that they can be used for port-related activities to meet a long-term need (see response to Q1.15.1.3 for further detail). On this basis there was considered no requirement for decommissioning of these elements to be considered in the **Shadow Habitats Regulations Assessment ("HRA") [APP-238]**. There is no 'maximum point in time' by which the hydrogen production facility or jetty topside infrastructure and piperacks need to be or will be decommissioned. Elements of the facility would be maintained, replaced and/or refurbished as necessary but, for the purposes of the Environmental Statement assessment, at some point in the future, when appropriate, it has been assumed that the infrastructure associated with the hydrogen production facility may be decommissioned. The majority of the proposed landside decommissioning works are well in excess of 200m from the foreshore (located within Work No. 5). Similarly, there are no areas of terrestrial habitat within or adjacent to the Project boundary that are considered functionally linked land (and as such do not provide important habitat for Special Protection Area ("SPA") species). On this basis, marine ornithology receptors (i.e. coastal waterbirds) are considered to be out of the zone of potential effects associated with most decommissioning elements. The exception to this will be the removal of piperacks within Work No. 2 (the jetty access road) and plant and

	equipment on the approach jetty topside associated with hydrogen production (within Work Area 1). Due to the uncertainty associated with the techniques that will be used to undertake the decommissioning works within Work No. 1 and 2, a commitment has been made to undertake decommissioning within these areas outside of the overwintering period (October to March inclusive) where the works are located within 200m of exposed intertidal foreshore. This commitment will be secured within the Deemed Marine Licence and will avoid the potential for an adverse effect on integrity ("AEOI") of the protected sites. This clarifying information has been provided in the updated **Shadow HRA** submitted at Deadline 1 **[TR030008/APP/7.6 (2)]**. This includes updating the table in **Appendix C** of the **Shadow HRA [APP-238]** (which is now **Appendix D** in the **updated Shadow HRA**) to also consider decommissioning.
Q1.6.3 In-combination Assessment	
Q1.6.3.1	
Question	**Response**

Assessment Methodology [APP-238, Paragraph 4.14.3] states that proposed plans or projects in the Humber Estuary which have the potential to cause potential cumulative/ in-combination effects with the Proposed Development are described in detail in the ES [APP-067]. [APP-238, Tables 3, 4 and 5] state that there is no potential for LSE for a number of impact pathways from the Proposed Development alone. Also, there is no evidence of any consideration in the screening assessment of the potential for LSE arising from the Proposed Development in combination with other plans and projects. a) Applicant – Provide a further column which considers in-combination effects for the impact pathways where no LSE are identified for the Proposed Development alone [APP-238, Tables 3, 4 and 5]. b) NE – Aside from the concerns raised in your RR related to the screening distances applied for the in-combination assessment of underwater noise on grey seal (NE Issue 37) are you satisfied with the projects and plans that have been included within the in-combination assessment in Stage 2: Appropriate Assessment of the Shadow HRA report? c) MMO – Are you satisfied with the projects and plans that have been included within the incombination assessment in Stage 2: Appropriate Assessment of the shadow HRA report, noting in particular the issue raised by NE relating to the scope of the in-combination underwater noise assessment (see NE Issue 37 in RR [RR-019])?	a) **Tables 3, 4 and 5** of the **Shadow Habitats Regulations Assessment ("HRA") [APP-238]** have been revised with the 'Potential for LSE' column now considering projects alone and in-combination clearly stated. The 'Justification' column also now considers projects in-combination for effects considered small and not significant (i.e. those not resulting in likely significant effect ("LSE") alone). The in-combination assessment is then presented in **Section 4.14** of the **updated Shadow HRA** which has been provided at Deadline 1 **[TR030008/APP/7.6 (2)]**. Given the already very large size of the tables, this was considered the best approach to provide the information requested rather than adding an extra column

Q1.6.3.2	
Question	**Response**
Grey Seal Impacts With respect to underwater noise impacts to grey seal, consider whether there are any additional plans/ projects within the boundary of the Humber Estuary SAC and Ramsar site, likely to impact the grey seal feature (noting NE's advice that the scope of the in-combination assessment be expanded to encompass a wider screening distance for marine mammals).	The Spurn Peninsula on the Outer Humber Estuary and the promontory of Grimsby Docks means that much of the underwater noise will be limited by these hard constraints and will not propagate to the outer part of the estuary and beyond. In addition, the upstream bend in the estuary at Salt End will mean that elevated underwater noise levels will not be able to propagate beyond this point. Therefore, potential behavioural responses and/or displacement effects for Grey Seals are primarily limited to the section of the estuary between Salt End (upstream) and Grimsby to Spurn Bight (downstream). On this basis, the zone of influence with respect to potential disturbance effects on grey seal features is constrained by the shape of the estuary and largely limited to between Salt End (upstream) and Grimsby to Spurn Bight (downstream). The approximate distance from the Project to the upstream limit of potential underwater noise effects (Salt End) is 15km. The downstream limit (Grimsby to Spurn Bight) is also approximately 15km away. This is the same screening distance as was used for the Immingham Eastern Ro-Ro Terminal ("IERRT") assessment which was considered suitable by Natural England for screening cumulative and in-combination effects after further consultation with the Centre for Environment, Fisheries and Aquaculture Science. The Applicant can confirm that no additional plans or projects are required to be included within the in-combination assessment.
Q1.6.4 Compensatory Habitat	

Q1.6.4.1	
Question	**Response**
Previously Consented Compensatory Habitat [APP-235, Paragraph 4.3.10] explains that the physical delivery of the compensation scheme does not form part of the Proposed Development and it has already been consented. Therefore, a) Explain, with examples, how the compensatory measures are providing additional habitat. b) Confirm that there is no double counting of compensatory habitat from other developments.	a) The Applicant maintains that the intertidal losses predicted from the Project are not of a scale that would result in an adverse effect on integrity ("AEOI") on any of the European Sites. However, in case the Secretary of State is minded to disagree with this conclusion the Applicant has identified compensatory habitat at the Outstrays to Skeffling Managed Realignment Scheme on a without prejudice basis. A **Without Prejudice Report to Inform Habitats Regulations Assessment Derogation [APP-235]** outlining this case was submitted as part of the application for the Project. The Outstrays to Skeffling Managed Realignment Scheme (consented in August 2019) is a joint initiative developed by the Environment Agency and the Applicant using a managed realignment approach to create new compensatory habitats for wildlife on the north bank of the Humber Estuary. The intertidal habitats that are being created at the Outstrays to Skeffling Managed Realignment Scheme are principally mudflat, saltmarsh and transitional grassland. This has been established through site-specific surveys, numerical modelling and robust environmental assessments as well as lessons learned from the immediately adjacent Welwick Managed Realignment Scheme (which is ABP owned and was provided as compensation for Immingham Outer Harbour and Green Port Hull). Compensation for the intertidal loss associated with the Project would be provided through the allocation of an area of Skeffling predicted to be intertidal mudflat. This is the same habitat type that will be lost through the

	Project. Furthermore, the Outstrays to Skeffling Managed Realignment Scheme is immediately adjacent to the Humber Estuary Special Area of Conservation, Ramsar and Special Protection Area. It is therefore suitably located to provide contiguous compensatory habitat for the loss of qualifying features of the European sites. b) The Applicant owns approximately 80ha of the site which has been designed to create new intertidal habitat to compensate for future anticipated habitat losses at its port complexes due to future port developments. To date only 1ha of the ABP owned area has been allocated for this purpose for Immingham Eastern Ro-Ro Terminal ("IERRT") as enhancement, or compensation if needed (subject to the respective Development Consent Order being granted). As identified within **Paragraph 4.6.3** of the **Without Prejudice Report to Inform Habitats Regulations Assessment Derogation [APP-235]** the compensation area identified is intended to be allocated to the Project and secured through a separate legal agreement. This could take the form of a section 106 unilateral undertaking from the Applicant to the relevant planning authority for the Outstrays to Skeffling Managed Realignment Scheme site (East Riding of Yorkshire Authority) covenanting to allocate 1ha of intertidal habitat at the Outstrays to Skeffling Managed Realignment Scheme site to the Project, identifying its location and providing for its ongoing monitoring and management.
Q1.6.4.2	
Question	**Response**

Creation of Intertidal Habitats [APP-235] explains that the compensatory scheme was granted consent in August 2019, construction commenced in 2021, and breaching of the site is proposed for 2024 allowing inundation with seawater, expecting transition towards full intertidal habitats in 2026. This timeline would mean that that the habitat would be fully functional one year later than the commencement of the Proposed Development, as suggested in ES [APP-044, paragraph 2.4.78], which states that the construction of the jetty could start as early as early 2025. a) Explain how the coherence of the National Site Network would be maintained if the habitat would not be fully functional until a year after the start of construction. b) Further to the Action Point noted at ISH3 [EV5-006] [EV5-007], provide a copy of the Outstrays to Skeffling Managed Realignment Scheme (OtSMRS) Management Plan (agreement with EA required) c) Further to the Action Point noted at ISH3 [EV5-006] [EV5-007], provide a copy of the Environmental Statement provided with the original application for the OtSMRS.	a) The Outstrays to Skeffling Managed Realignment Scheme was granted planning consent in August 2019. Construction commenced in the summer of 2021 and breaching of the site is planned for 2024, allowing seawater to inundate the site and intertidal habitats to develop (see the **Without Prejudice Report to inform Habitats Regulations Assessment Derogation [APP-235]** for more details). The peak of marine construction works for the Project is expected to occur in 2025–2026 (Years 1–2). Habitat loss associated with the footprint of the piles is likely to occur over a 13-month period with peak losses occurring in 2026, once piling is complete. It is therefore predicted, with high confidence, that the Outstrays to Skeffling Managed Realignment Scheme will be transitioning towards a mosaic of intertidal habitats prior to the losses occurring. By the time habitat loss is incurred by the Project, the Outstrays to Skeffling Managed Realignment Scheme should be functional and as such there will be no loss of habitat associated with the Project. For context, monitoring data from other managed realignment schemes on the Humber Estuary, and elsewhere around the UK, has demonstrated that where land elevations are suitable, and an appropriate tidal connection with an adjacent estuary can be made, then intertidal habitats will establish quickly and easily. Managed realignment sites can be of substantial value to birds and fish, often within a few months of a site first being inundated. For example, the accretion of marine sediment started to occur immediately following the breaching of Welwick, resulting in the creation of mudflat within the site (Welwick is immediately adjacent to the

	Outstrays to Skeffling Managed Realignment Scheme). Within one year of the breach this mudflat supported all of the target invertebrate species that were predicted to occur at the site based on local reference conditions. Similar rapid development of such sites has also been demonstrated at Chowder Ness and Paull Holme Strays which are both managed realignments on the Humber Estuary. A total of 29 different waterbird species were counted during the September 2006 to March 2007 surveys at Welwick, the first winter post inundation. The realignment site had already developed as a major roosting and feeding site for a number of wading birds at high water throughout the 2006/2007 count season. Wildfowl species were also well represented in the realignment site, especially common Shelduck present from high to low water. Given the ecologically inconsequential effect of the project on the Humber Estuary, it is therefore considered that the compensatory habitat will maintain the coherence of the National Site Network, through the creation of functional intertidal bird habitat within one year, and this will continue to develop over the lifetime of the Project. b) As noted in **Paragraph 4.8.6** of the **Without Prejudice Report to Inform Habitats Regulations Assessment Derogation [APP-235]** the preparation of a management plan remains ongoing. The preparation of the management plan is intrinsically linked with the appointment of a site manager which will be broadly timed to coincide with the inundation of the site later in 2024.

	c) A copy of the **Outstrays to Skeffling Managed Realignment Scheme – Environmental Statement (Parts 1 and 2)** has been provided as **Appendix 2** of this document.
Q1.6.5 Alternative Solutions	
Q1.6.5.1	
Question	**Response**
Alternative Solutions [APP-235] provides little context or description to the jetty design options presented. a) Explain what the alternative options in Table 1 comprise. b) Explain how they compare in relation to the four factors listed at paragraph 2.6.2.	a) As part of the design phase for the Project, the Applicant held a design workshop involving engineers, construction specialists, designers and marine ecologists with the purpose of reducing the impact of the Jetty on the Humber Special Area of Conservation ("SAC"). The workshop reviewed the Jetty layouts and modelling results to determine if they were true alternatives as part of the Habitats Regulations Assessment ("HRA") derogation process and examined whether: • The design meets the Project objectives • The design is technically feasible • The design has a lesser environmental footprint when compared against the other design options which meet the other two requirements identified above The options in **Table 1** of the **Without Prejudice Report to Inform Habitats Regulations Assessment Derogation [APP-235]** provide an overview of the Jetty designs reviewed. These options show the design

	refinement process where the layout of the approach Jetty was modified. Where a design option was considered to meet the Project objectives and be technically feasible, then modelling was completed to determine the indirect loss of intertidal mudflat (SAC feature). This modelling identified the elements of the design that lead to increased intertidal loss (position of the dogleg on the intertidal and orientation of the pile bent to the flow) which were then refined and tested to reduce loss. **Table 1** in the **Without Prejudice Report to Inform Habitats Regulations Assessment Derogation [APP-235]** provides the output of this workshop and the details of each of the options that were tested. The design chosen was that which met the objectives, had the lowest impact on the SAC habitat and was preferred in terms of technical feasibility and construction. b) The **Without Prejudice Report to Inform Habitats Regulations Assessment Derogation** has been updated to provide further clarity on what has been assessed and will be submitted at Deadline 1 **[TR030008/APP/7.3 (2)]**. **Table 1** now outlines the features of each of the design alternatives and how the compare to the submitted design.
Q1.6.6 Mitigation	
Q1.6.6.1	
Question	**Response**
Non-Native Species	a)

The assessment of effects presented in the [APP-238, Sections 4.2 to 4.11] sets out where relevant mitigation measures are required to avoid or minimise the effects from each impact pathway included in Stage 2. Additional mitigation measures for the potential effects of the introduction and spread of non-native species during construction and operation are not proposed. However, the assessment relies on the implementation of standard best practice measures in the form of "robust biosecurity management procedures". These procedures would be secured in the CEMP [APP-221], but it is not clear how they would be secured during operation. a) Provide a description of the relevant standard best practice measures that would be implemented to manage potential effects of the introduction and spread of non-native species on qualifying habitats during operation of the Proposed Development. b) Identify how these measures would be secured?	ABP's Humber ports operate in accordance with a Biosecurity Plan originally developed in consultation with Natural England in 2016/2017. The Biosecurity Plan for the port is a live document and is updated as required. A copy of the current version of the Plan has been provided as **Appendix 3** of this response. b) The Biosecurity Plan is meant for use in accordance with day-to-day activities at ABP sites and to highlight where one-off events increase the risk of introduction of non-native species. The approach being taken within this plan is primarily to identify the highest risk pathways for introduction of non-native species and introduce measures that allow for the management of those risks as far as reasonably practicable. This allows management measures to be put in place without detailed knowledge of species present. There is space within the Biosecurity Plan to include species known to be present to facilitate the inclusion of any specific measures needed, although if a specific management plan is already in place (for example, a Japanese Knotweed plan) it can simply be referenced with any day-to-day actions required. There is also scope to include reference to non-routine activities, which may be better served by a project- or event-specific plan. Reference to adherence with the Biosecurity Plan during the operational phase is included in the **Schedule of Mitigation and Monitoring [APP-234]**. It is not considered necessary to secure biosecurity measures within

	the Development Consent Order as these processes are already embedded within normal operational controls employed at the port.
Q1.6.6.2	
Question	**Response**
Benthic habitats Where the impact pathway of changes in water and sediment quality impacting on benthic habitats and species has been screened out in [APP-238, Tables 3 & 5], reference has been made to "established industry guidance and protocols" and "standard measures". However, no explicit section on mitigation measures is provided. a) Explain whether these measures have been proposed to constitute relevant mitigation? If so, b) Identify where these measures have been secured in the dDCO and how they would be delivered. c) How would any mitigation proposed be consistent with the People Over Wind and Sweetman v Coillte Teoranta (Case C-323/17) judgement.	a) These measures are considered standard practice for any project with respect to reducing water quality effects rather than additional mitigation that is required specifically for this Project to reduce potential effects on benthic features. Even without these measures, the highlighted impact pathways are not considered to result in a Likely Significant Effect. b) These measures are secured within the **Outline Construction Environmental Management Plan [APP-221]** which is, in turn, secured by **condition 8** of the **Deemed Marine Licence [PDA-004]**. c) The proposed approach is consistent with the People Over Wind and Sweetman v Coillte Teoranta (Case C-323/17) judgment. In that case the screening report identified the risk of a negative impact if the mitigation measures in question were not in place (paragraph 17). That is the factual context for the finding that the fact those measures were taken into account when determining the need for appropriate assessment presupposed that it was likely that the site would be affected significantly (paragraph 35). As explained above in response to part a), in this case even without these measures, the highlighted impact pathways are not considered to result in a Likely Significant Effect. The measures in

	question here are not specifically mitigation which is required to reduce residual effects on any particular feature. These measures are standard industry practice and not required specifically for this Project to avoid an adverse effect on integrity.

3 Appendices to the Applicant's Responses to the Examining Authority's First Round of Written Questions

Appendix 1 - Judgment of the Court of Justice (Seventh Chamber) - 12 April 2018 People Over Wind v Teoranta Case C-323/17

Reports of Cases

JUDGMENT OF THE COURT (Seventh Chamber)

12 April 2018*

(Reference for a preliminary ruling — Environment — Directive 92/43/EEC — Conservation of natural habitats — Special areas of conservation — Article 6(3) — Screening in order to determine whether or not it is necessary to carry out an assessment of the implications, for a special area of conservation, of a plan or project — Measures that may be taken into account for that purpose)

In Case C-323/17,

REQUEST for a preliminary ruling under Article 267 TFEU from the High Court (Ireland), made by decision of 10 May 2017, received at the Court on 30 May 2017, in the proceedings

People Over Wind,

Peter Sweetman

v

Coillte Teoranta,

THE COURT (Seventh Chamber),

composed of A. Rosas, President of the Chamber, C. Toader (Rapporteur) and E. Jarašiūnas, Judges,

Advocate General: J. Kokott,

Registrar: A. Calot Escobar,

having regard to the written procedure,

after considering the observations submitted on behalf of:

– People Over Wind and Mr Sweetman, by O. Clarke, Solicitor, O. Collins, Barrister-at-Law, and J. Devlin, Senior Counsel,

– Coillte Teoranta, by J. Conway, Solicitor, S. Murray, Barrister-at-Law, and D. McGrath, Senior Counsel,

– the European Commission, by C. Hermes and E. Manhaeve, acting as Agents,

having decided, after hearing the Advocate General, to proceed to judgment without an Opinion,

gives the following

* Language of the case: English.

Judgment

1 This request for a preliminary ruling concerns the interpretation of Article 6(3) of Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (OJ 1992 L 206, p. 7; 'the Habitats Directive').

2 The request has been made in proceedings brought by People Over Wind, an environmental NGO, and by Peter Sweetman against Coillte Teoranta ('Coillte'), a company owned by the Irish State that operates in the forestry sector, relating to the works necessary to lay the cable connecting a wind farm to the electricity grid.

Legal context

EU law

3 The 10th recital of the Habitats Directive states:

'… an appropriate assessment must be made of any plan or programme likely to have a significant effect on the conservation objectives of a site which has been designated or is designated in future'.

4 Article 2 of the Habitats Directive provides:

'1. The aim of this Directive shall be to contribute towards ensuring bio-diversity through the conservation of natural habitats and of wild fauna and flora in the European territory of the Member States to which the Treaty applies.

2. Measures taken pursuant to this Directive shall be designed to maintain or restore, at favourable conservation status, natural habitats and species of wild fauna and flora of Community interest.

3. Measures taken pursuant to this Directive shall take account of economic, social and cultural requirements and regional and local characteristics.'

5 Article 3(1) of the Habitats Directive is worded as follows:

'A coherent European ecological network of special areas of conservation shall be set up under the title Natura 2000. This network, composed of sites hosting the natural habitat types listed in Annex I and habitats of the species listed in Annex II, shall enable the natural habitat types and the species' habitats concerned to be maintained or, where appropriate, restored at a favourable conservation status in their natural range.

…'

6 Article 6 of the Habitats Directive states:

'1. For special areas of conservation, Member States shall establish the necessary conservation measures involving, if need be, appropriate management plans specifically designed for the sites or integrated into other development plans, and appropriate statutory, administrative or contractual measures which correspond to the ecological requirements of the natural habitat types in Annex I and the species in Annex II present on the sites.

2. Member States shall take appropriate steps to avoid, in the special areas of conservation, the deterioration of natural habitats and the habitats of species as well as disturbance of the species for which the areas have been designated, in so far as such disturbance could be significant in relation to the objectives of this Directive.

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

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

Where the site concerned hosts a priority natural habitat type and/or a priority species, the only considerations which may be raised are those relating to human health or public safety, to beneficial consequences of primary importance for the environment or, further to an opinion from the Commission, to other imperative reasons of overriding public interest.'

Irish law

7 The High Court (Ireland) explains that development consent is regulated by the Planning and Development Acts and regulations made thereunder. The competent authority is the local planning authority and an appeal lies to An Bord Pleanála (the Irish Planning Board).

8 Certain types of development are classified as 'exempted development' and, subject to certain exceptions, do not require consent under the Planning and Development Acts. Thus, an example of exempted development is 'the carrying out by any undertaker authorised to provide an electricity service of development consisting of the laying underground of mains, pipes, cables or other apparatus for the purposes of the undertaking'.

9 Nevertheless, 'exempted development' projects may be subject to other types of consent or a process of adoption. The European Communities (Birds and Natural Habitats) Regulations 2011 ('the 2011 Regulations') apply to projects other than developments requiring development consent within the meaning of the Planning and Development Acts. Furthermore, a development which comes within 'exempted development' must nevertheless be subject to consent under the Planning and Development Acts where appropriate assessment under Article 6(3) of the Habitats Directive is required.

10 Regulation 42 of the 2011 Regulations provides:

'1. A screening for Appropriate Assessment of a plan or project for which an application for consent is received, or which a public authority wishes to undertake or adopt, and which is not directly connected with or necessary to the management of the site as a European Site, shall be carried out by the public authority to assess, in view of best scientific knowledge and in view of the conservation objectives of the site, if that plan or project, individually or in combination with other plans or projects is likely to have a significant effect on the European site.

2. A public authority shall carry out a screening for Appropriate Assessment under paragraph (1) before consent for a plan or project is given, or a decision to undertake or adopt a plan or project is taken.

...

6. The public authority shall determine that an Appropriate Assessment of a plan or project is required where the plan or project is not directly connected with or necessary to the management of the site as a European Site and if it cannot be excluded, on the basis of objective scientific information following screening under this Regulation, that the plan or project, individually or in combination with other plans or projects, will have a significant effect on a European site.

7. The public authority shall determine that an Appropriate Assessment of a plan or project is not required where the plan or project is not directly connected with or necessary to the management of the site as a European Site and if it can be excluded on the basis of objective scientific information following screening under this Regulation, that the plan or project, individually or in combination with other plans or projects, will have a significant effect on a European site.'

The dispute in the main proceedings and the question referred for a preliminary ruling

11 The main proceedings relate to the assessment of the effects that the laying of the cable connecting a wind farm to the electricity grid potentially has on two special areas of conservation under the European ecological network Natura 2000, one of which is that of the River Barrow and River Nore (Ireland). That river constitutes a habitat for the Irish subspecies of the freshwater pearl mussel (*margaritifera durrovensis*; 'the Nore pearl mussel'), which is included in Annex II to the Habitats Directive. The extant adult population of this pearl mussel is, according to the estimates mentioned by the referring court, as low as 300 individuals, having been as high as 20 000 individuals in 1991. The life span of each individual is said to be between 70 and 100 years, but the Nore pearl mussel is said not to have reproduced itself since 1970. According to the referring court, it is apparent from recent monitoring surveys that this species is threatened with extinction, on account of the high level of sedimentation of the bed of the River Nore, to which the species is particularly vulnerable, sedimentation which inhibits the successful restocking of the river by juveniles.

12 The consent required for developing the wind farm at issue in the main proceedings, with the exception of its connection to the grid, was dealt with in previous procedures. The consent granted by An Bord Pleanála in 2013 was subject to various conditions. Thus, according to condition 17 of that planning permission, 'the construction of the development shall be managed in accordance with a Construction Management Plan, which shall be submitted to, and agreed in writing with, the planning authority prior to commencement of development. This plan shall provide details of intended construction practice for the development, including ... (k) means to ensure that surface water run-off is controlled such that no silt or other pollutants enter watercourses ...'.

13 Following the grant of that permission, the developer addressed the question of connecting the wind farm concerned to the electricity grid by means of a cable. The dispute in the main proceedings concerns that connection.

14 The applicants in the main proceedings submit that river pollutants resulting from the laying of the connection cable, such as silt and sediment, will have a harmful effect on the Nore pearl mussel.

15 Coillte contends that the cable laying at issue in the main proceedings is 'exempted development' not requiring consent, within the meaning of the applicable national planning legislation. However, it accepts that, if the project were to require appropriate assessment of the environmental implications, planning permission would have to be obtained from the local planning authority.

16 In order to determine whether it was necessary to carry out such appropriate assessment, Coillte instructed consultants to conduct the examination ('screening').

17 The screening report drawn up by those consultants concluded, inter alia, as follows:

'(a) In the absence of protective measures, there is potential for the release of suspended solids into waterbodies along the proposed route, including directional drilling locations.

(b) With regards to [the Nore pearl mussel], if the construction of the proposed cable works was to result in the release of silt or pollutants such as concrete into the pearl mussel population area of river through the pathway of smaller streams or rivers, there would be a negative impact on the pearl mussel population. Sedimentation of gravels can prevent sufficient water flow through the gravels, starving juvenile [Nore pearl mussels] of oxygen.'

18 It is apparent from the file before the Court that 'protective measures' were also analysed by that report.

19 Subsequently, on the basis of that report, the following recommendation was drawn up for Coillte by the 'programme manager':

'As set out in detail in the … appropriate assessment screening report, on the basis of the findings of that report and in light of the best scientific knowledge, the grid connection works will not have a significant effect on the relevant European sites in light of the conservation objectives of the European sites, alone or in combination with the Cullenagh wind farm and other plans or projects, and an appropriate assessment is not required. This conclusion was reached on the basis of the distance between the proposed Cullenagh grid connection and the European sites, and the protective measures that have been built into the works design of the project.'

20 Adopting the above reasons and recommendation, Coillte, as a public authority referred to in Regulation 42 of the 2011 Regulations, determined that no appropriate assessment, within the meaning of Article 6(3) of the Habitats Directive, was required in this instance.

21 The referring court considers that the decision that appropriate assessment was not required is based on the 'protective measures' referred to in the screening report. That court makes clear that the protective measures proposed and taken into account by the authors of that report are not as stringent as those required in condition 17(k) of the planning permission for the wind farm concerned.

22 In the light of the foregoing, the High Court decided to stay the proceedings and to refer the following question to the Court of Justice for a preliminary ruling:

'Whether, or in what circumstances, mitigation measures can be considered when carrying out screening for appropriate assessment under Article 6(3) of the Habitats Directive?'

Consideration of the question referred

23 First of all, it should be noted that Article 6 of the Habitats Directive imposes upon the Member States a series of specific obligations and procedures designed, as is clear from Article 2(2) of the directive, to maintain, or as the case may be restore, at a favourable conservation status natural habitats and, in particular, special areas of conservation (judgments of 11 April 2013, *Sweetman and Others*, C-258/11, EU:C:2013:220, paragraph 36 and the case-law cited, and of 21 July 2016, *Orleans and Others*, C-387/15 and C-388/15, EU:C:2016:583, paragraph 31).

24 According to the Court's case-law, the provisions of Article 6 of the Habitats Directive must be construed as a coherent whole in the light of the conservation objectives pursued by the directive. Indeed, Article 6(2) and Article 6(3) are designed to ensure the same level of protection of natural habitats and habitats of species, whilst Article 6(4) merely derogates from the second sentence of Article 6(3) (see, to that effect, judgment of 14 January 2016, *Grüne Liga Sachsen and Others*, C-399/14, EU:C:2016:10, paragraph 52 and the case-law cited).

25 Thus, Article 6 of the Habitats Directive divides measures into three categories, namely conservation measures, preventive measures and compensatory measures, provided for in Article 6(1), (2) and (4) respectively. It is clear from the wording of Article 6 of the Habitats Directive that that provision contains no reference to any concept of 'mitigating measure' (see, to that effect, judgment of 21 July 2016, *Orleans and Others*, C-387/15 and C-388/15, EU:C:2016:583, paragraphs 57 and 58 and the case-law cited).

26 It follows that, as is apparent from the reasoning of the request for a preliminary ruling, that the measures which the referring court describes as 'mitigating measures', and which Coillte refers to as 'protective measures', should be understood as denoting measures that are intended to avoid or reduce the harmful effects of the envisaged project on the site concerned.

27 Thus, by its question, the referring court asks, in essence, whether Article 6(3) of the Habitats Directive must be interpreted as meaning that, in order to determine whether or not it is necessary to carry out subsequently an appropriate assessment of a project's implications for a site concerned, it is possible, at the screening stage, to take account of the measures intended to avoid or reduce the project's harmful effects on that site.

28 The 10th recital of the Habitats Directive states that an appropriate assessment must be made of any plan or programme likely to have a significant effect on the conservation objectives of a site which has been designated or is designated in future. That recital finds expression in Article 6(3) of the directive, which provides inter alia that a plan or project likely to have a significant effect on the site concerned cannot be authorised without a prior assessment of its implications for that site (judgment of 7 September 2004, *Waddenvereniging and Vogelbeschermingsvereniging*, C-127/02, EU:C:2004:482, paragraph 22).

29 As the Court has pointed out, Article 6(3) of the Habitats Directive refers to two stages. The first, envisaged in the provision's first sentence, requires the Member States to carry out an appropriate assessment of the implications for a protected site of a plan or project when there is a likelihood that the plan or project will have a significant effect on that site. The second stage, which is envisaged in the second sentence of Article 6(3) and occurs following the aforesaid appropriate assessment, allows such a plan or project to be authorised only if it will not adversely affect the integrity of the site concerned, subject to the provisions of Article 6(4) of the directive (judgment of 21 July 2016, *Orleans and Others*, C-387/15 and C-388/15, EU:C:2016:583, paragraphs 44 and 46 and the case-law cited).

30 It should be added that Article 6(3) of the Habitats Directive also integrates the precautionary principle and makes it possible to prevent in an effective manner adverse effects on the integrity of protected sites, resulting from the plans or projects envisaged. A less stringent authorisation criterion than that set out in that provision could not ensure as effectively the fulfilment of the objective of site protection intended under that provision (judgment of 26 April 2017, *Commission* v *Germany*, C-142/16, EU:C:2017:301, paragraph 40 and the case-law cited).

31 In the present instance, as the parties to the main proceedings and the Commission agree, the uncertainty of the referring court concerns only the screening stage. More specifically, the referring court asks whether measures intended to avoid or reduce the harmful effects of a plan or project on

the site concerned can be taken into consideration at the screening stage, in order to determine whether it is necessary to carry out an appropriate assessment of the implications, for the site, of that plan or project.

32 Article 6(3) of the Habitats Directive sets out clearly that the obligation to carry out an assessment is dependent on both of the following conditions being met: the plan or project in question must not be connected with or necessary to the management of the site, and it must be likely to have a significant effect on the site.

33 It is apparent from the file before the Court that the referring court considers the first of those conditions to be met.

34 As regards the second condition, it is settled case-law that Article 6(3) of the Habitats Directive makes the requirement for an appropriate assessment of the implications of a plan or project conditional on there being a probability or a risk that the plan or project in question will have a significant effect on the site concerned. In the light, in particular, of the precautionary principle, such a risk exists if it cannot be excluded on the basis of objective information that the plan or project will have a significant effect on the site concerned (judgment of 26 May 2011, *Commission* v *Belgium*, C-538/09, EU:C:2011:349, paragraph 39 and the case-law cited). The assessment of that risk must be made in the light inter alia of the characteristics and specific environmental conditions of the site concerned by such a plan or project (see, to that effect, judgment of 21 July 2016, *Orleans and Others*, C-387/15 and C-388/15, EU:C:2016:583, paragraph 45 and the case-law cited).

35 As the applicants in the main proceedings and the Commission submit, the fact that, as the referring court has observed, measures intended to avoid or reduce the harmful effects of a plan or project on the site concerned are taken into consideration when determining whether it is necessary to carry out an appropriate assessment presupposes that it is likely that the site is affected significantly and that, consequently, such an assessment should be carried out.

36 That conclusion is supported by the fact that a full and precise analysis of the measures capable of avoiding or reducing any significant effects on the site concerned must be carried out not at the screening stage, but specifically at the stage of the appropriate assessment.

37 Taking account of such measures at the screening stage would be liable to compromise the practical effect of the Habitats Directive in general, and the assessment stage in particular, as the latter stage would be deprived of its purpose and there would be a risk of circumvention of that stage, which constitutes, however, an essential safeguard provided for by the directive.

38 In that regard, the Court's case-law emphasises the fact that the assessment carried out under Article 6(3) of the Habitats Directive may not have lacunae and must contain complete, precise and definitive findings and conclusions capable of removing all reasonable scientific doubt as to the effects of the proposed works on the protected site concerned (judgment of 21 July 2016, *Orleans and Others*, C-387/15 and C-388/15, EU:C:2016:583, paragraph 50 and the case-law cited).

39 It is, moreover, from Article 6(3) of the Habitats Directive that persons such as the applicants in the main proceedings derive in particular a right to participate in a procedure for the adoption of a decision relating to an application for authorisation of a plan or project likely to have a significant effect on the environment (see, to that effect, judgment of 8 November 2016, *Lesoochranárske zoskupenie VLK*, C-243/15, EU:C:2016:838, paragraph 49).

40 In the light of all the foregoing considerations, the answer to the question referred is that Article 6(3) of the Habitats Directive must be interpreted as meaning that, in order to determine whether it is necessary to carry out, subsequently, an appropriate assessment of the implications, for a site concerned, of a plan or project, it is not appropriate, at the screening stage, to take account of the measures intended to avoid or reduce the harmful effects of the plan or project on that site.

Costs

41 Since these proceedings are, for the parties to the main proceedings, a step in the action pending before the national court, the decision on costs is a matter for that court. Costs incurred in submitting observations to the Court, other than the costs of those parties, are not recoverable.

On those grounds, the Court (Seventh Chamber) hereby rules:

Article 6(3) of Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora must be interpreted as meaning that, in order to determine whether it is necessary to carry out, subsequently, an appropriate assessment of the implications, for a site concerned, of a plan or project, it is not appropriate, at the screening stage, to take account of the measures intended to avoid or reduce the harmful effects of the plan or project on that site.

Rosas Toader Jarašiūnas

Delivered in open court in Luxembourg on 12 April 2018.

A. Calot Escobar
Registrar

A. Rosas
President of the Seventh Chamber

Appendix 2 – Outstrays to Skeffling Managed Realignment Scheme: Environmental Statement, Parts 1 and 2

ASSOCIATED BRITISH PORTS

Environment Agency

Outstrays to Skeffling Managed Realignment Scheme

Environmental Statement

Version 3, 25th February 2019

We are the Environment Agency. We protect and improve the environment and make it a better place for people and wildlife.

We operate at the place where environmental change has its greatest impact on people's lives. We reduce the risks to people and properties from flooding; make sure there is enough water for people and wildlife; protect and improve air, land and water quality and apply the environmental standards within which industry can operate.

Acting to reduce climate change and helping people and wildlife adapt to its consequences are at the heart of all that we do.

We cannot do this alone. We work closely with a wide range of partners including government, business, local authorities, other agencies, civil society groups and the communities we serve.

Published by:

Environment Agency
Horizon house, Deanery Road
Bristol BS1 5AH
Email: enquiries@environment-agency.gov.uk
www.environment-agency.gov.uk

Further copies of this report are available from our publications catalogue: http://publications.environment-agency.gov.uk or our National Customer Contact Centre: T: 03708 506506

Email: enquiries@environment-agency.gov.uk.

Quality Assurance

Project name	Outstrays to Skeffling Managed Realignment Scheme		
Project 1B1S reference	ENVIMNE000195		
Date	25/02/2019		
Version number	3		
Author	**Chapter**	**Author(s)**	**Reviewer(s)**
	Chapters 1 - 4	L Stephenson, D Keneghan	K Born, S Isaac
	Chapter 5	M Lalldin	G Wilson, L Stephenson, S Isaac
	Chapter 6	H Cooper	P Carr, L Stephenson, K Born
	Chapter 7	P Whitehead	N Frost, K Born
	Chapter 8	T Walsh	S Coverdale, L Stephenson, K Born
	Chapter 9	C Frost, D Honey	N Frost, M Barker, L Stephenson, K Born
	Chapter 10	N Westerman	J Cullis, L Stephenson, K Born
	Chapter 11	N Goldsmith	N Frost, L Stephenson, K Born
	Chapter 12	M Waddicor	M Johnson, L Stephenson, K Born
	Chapter 13	A Mulcahy	S Griffin, L Stephenson, S Isaac
	Chapter 14	S Minton	R Edwards, L Stephenson, K Born
	Chapter 15	M Bentham	P Smith, L Stephenson, K Born
	Chapter 16	S Ripoll	R Stait, L Stephenson, K Born
	Chapter 17	M Beacon	L Stephenson, K Born
	Chapter 18	L Stephenson	S Isaac, K Born
	Chapter 19	L Stephenson	K Born

This report has been produced and reviewed by staff competent in the preparation of Environmental Assessments, including Damien Keneghan (MIEMA CEnv), Katie Born (MIEMA CEnv) and Steve Isaac (MIEM CEnv)

EIA Quality Mark

This Environmental Statement, and the Environmental Impact Assessment (EIA) carried out to identify the significant environmental effects of the proposed development, was undertaken in line with the EIA Quality Mark Commitments.

The EIA Quality Mark is a voluntary scheme, operated by the Institute of Environmental Management and Assessment (IEMA), through which EIA activity is independently reviewed, on an annual basis, to ensure it delivers excellence in the following areas:

EIA Management

EIA Team Capabilities

EIA Regulatory Compliance

EIA Context & Influence

EIA Content

EIA Presentation

Improving EIA practice

To find out more about the EIA Quality Mark please visit:

www.iema.net/qmark

Non-Technical Summary

See separate document.

Contents

Appendices

Glossary

Abbreviation / Term	Definition
AA	Appropriate Assessment
ABP	Associated British Ports
AEP	Annual Exceedance Probability
AOD	Above Ordnance Datum
CHaMP	Humber Coastal Habitat Management Plan
Defra	Department for Environment, Food and Rural Affairs
EAP	Environmental Action Plan
EIA	Environmental Impact Assessment
ERYC	East Riding of Yorkshire Council
ES	Environmental Statement
FDGiA	Flood Defence Grant in Aid
FRMS	Flood Risk Management Strategy
HGV	Heavy Goods Vehicle
HRA	Habitats Regulations Assessment
IDB	Internal Drainage Board
LSE	Likely Significant Effects
LWS	Local Wildlife Site
MHWS	Mean High Water Springs
MMO	Marine Management Organisation
MR	Managed Realignment
MRS	Managed Realignment Scheme
PEIR	Preliminary Environmental Information Report
PRoW	Public Right of Way
PS	Pumping Station
RSPB	Royal Society for the Protection of Birds
RTE	Regulated Tidal Exchange
SAC	Special Area of Conservation
SEA	Strategic Environmental Assessment
SMP	Shoreline Management Plan
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
WFD	Water Framework Directive
Breach	In this ES, 'breach' refers to a gap or hole in a flood defence, which is made by removing a section of the bank to allow water from the estuary to flow behind the defence.
Coastal squeeze	Coastal squeeze is intertidal habitat loss which arises due to the high-water mark being fixed by a defence and the low water mark migrating landwards in response to sea level rise.
Environmental Impact Assessment	Environmental assessment is the assessment of the environmental consequences of a project, prior to the decision to move forward with the proposed plan.
Estuarine Habitat	Estuarine habitats occur where fresh water from rivers and streams mixes with the salty ocean water
European Site	A European Site is an area, designated by the European Union for its value.
Flood Defence Level	The chosen level for flood defences in order to protect from flooding
Heavy Goods Vehicle	A large, heavy motor vehicle used for transporting cargo
Hydrodynamic Environment	A branch of physics that deals with the motion of fluids and the forces acting on solid bodies immersed in fluids and in motion relative to them.
Intertidal habitats	The intertidal zone, in marine aquatic environments is the area of the foreshore and seabed that is exposed to the air at low tide and submerged at high tide. Therefore, it is the area between tide marks.

Abbreviation / Term	Definition
Ramsar Site	A Ramsar site is a wetland site designated to be of international importance under the Ramsar Convention. The Convention on Wetlands, known as the Ramsar Convention, is an intergovernmental environmental treaty established in 1971 by UNESCO, which came into force in 1975.
Regulated Tidal Exchange	Installing structures such as sluices, gates or pipes in a fixed defence to allow seawater to flow into an area behind the defence in a regulated, controlled way.

1 Background

1.1 Purpose of this report

We (the Environment Agency) are responsible for the management of flood risk throughout England and Wales. Together with Associated British Ports (ABP), we are proposing a managed realignment scheme on the north bank of the Humber Estuary, East Riding of Yorkshire, in order to create intertidal habitat and improve protection from tidal flooding to the local area in line with future climate change projections. The Outstrays to Skeffling Managed Realignment Scheme (the Scheme) is presented as two sites: Outstrays Managed Realignment (western site) and Welwick to Skeffling Managed Realignment (eastern site). At both sites we propose to construct new earth embankments set back from the existing coastal flood defences and insert controlled breaches in the existing defences to create new habitat.

The creation of intertidal habitat is a legal requirement under the Habitat Regulations to enable:

- The Environment Agency's ongoing flood risk management activities around the Humber Estuary in accordance with the Humber Flood Risk Management Strategy (FRMS) approved by Defra in 2007 and published in 2008; and
- ABP to continue their activities around the estuary.

The purpose of this Environmental Statement (ES) is to document the Environmental Impact Assessment (EIA) process undertaken for the Scheme, which consists of both the Outstrays Managed Realignment and the Welwick to Skeffling Managed Realignment sites. It presents details of the environmental baseline, key receptors, and likely significant effects of the proposed Scheme on the environment and people during construction and operation phases, sets out the proposed mitigation measures, and any residual effects. It addresses issues raised during the environmental scoping of the potential options in 2017 and wider consultation with stakeholders.

1.2 Legislative and Regulatory Requirements

1.2.1 EIA, planning and permitting

The works for the Scheme at both the eastern and western sites are governed by the following regulations:

- Town and Country Planning (Environmental Impact Assessment) Regulations 2017 (SI No. 571), which govern the requirement for the scope and the process of EIA; and
- Marine Works (Environmental Impact Assessment) Regulations 2017 for parts of the works that are below mean high water spring tide, under the requirements of the Marine Management Organisation (MMO).

Following an internal screening exercise, we determined that the location, size and nature of the works at both sites are likely to give rise to significant environmental effects and therefore require a statutory EIA, supported by an ES. The proposal is anticipated to fall within Schedule 2 of the Town and Country Planning (EIA)

Regulations 2017 and within Schedule A2 The Marine Works (Environmental Impact Assessment) Regulations 2007, as amended.

This was confirmed via a scoping opinion from East Riding of Yorkshire Council and MMO on the 4th August 2017 and 3rd October 2017. Since August 2017, the design has evolved to include additional lengths of defence within the Outstrays Managed Realignment and other associated flood defence works. Update letters were prepared and submitted to the MMO and ERYC in October 2018, with both the MMO and ERYC confirming that the scope agreed in August 2017 was still appropriate (Appendix 1.3).

In line with the EIA Regulations, this ES has been produced to document the EIA process. The potential effects of the Scheme's two sites (Outstrays Managed Realignment and the Welwick to Skeffling Managed Realignment) are assessed in this single document, clearly showing the effects of the sites individually and cumulatively. This ES will accompany the full planning applications and marine licence applications being submitted separately for the two sites to East Riding of Yorkshire Council (ERYC), the local planning authority, under the Town and Country Planning Act 1990 (as amended) and the MMO under the Marine Works (Environmental Impact Assessment) Regulations 2017.

1.2.2 The Habitats Regulations

The Habitats Directive (92/43/EEC) and the Wild Birds Directive (2009/147/EC) are the key components of the EU's policy on nature conservation. They are transcribed into English law by The Conservation of Habitats and Species Regulations 2017 (known as the 'Habitats Regulations').

The Habitats Regulations are important in the context of the Scheme because they drive the requirement for the Environment Agency and ABP to create the proposed intertidal habitat.

Also, under Regulation 24(1), an 'appropriate assessment' (AA) must be undertaken by the competent authority(ies) in respect of any plan or project which:

- Either alone, or in combination with other plans or projects, is likely to have a significant effect on a European Site, and;
- Is not directly connected with, or necessary to, the management of that site.

As the Scheme falls partly within a European Site (the Humber Estuary Special Area of Conservation (SAC) and Special Protection Area (SPA)), is not connected to the conservation management of the sites and has the potential to generate significant effects, Habitat Regulations Assessment (HRA) and AA information to inform the competent authority's determination has been prepared for each site (Appendix 10.2).

These regulations are discussed further in relation to the Humber Estuary and the legislative driver for the Scheme's proposed habitat creation in section 1.4.6.

1.2.3 Water Framework Directive

The Water Framework Directive (WFD) is transposed into law in England and Wales by the Water Environment (Water Framework Directive) (England and Wales) Regulations 2003. This legislation requires all waterbodies (rivers, lakes, canals, groundwater, transitional and coastal waters) to have a 'good' status for a range of physical, chemical and ecological parameters by 2027, except where it is agreed that this is not possible or realistic. Any actions which could affect this aim need to demonstrate that they will not affect the achievement of a 'good' status.

In England, the Environment Agency publishes regional River Basin Management Plans every six years, which describe the current condition of waterbodies and the actions required to achieve 'good' condition. The Humber falls under the Humber River Basin District - River Basin Management Plan.

A WFD assessment has been developed for the Scheme (see Appendix 8.1). This assessment considers the potential impacts of the proposed option on hydro-morphological, physico-chemical quality and biological quality elements and identifies, where practical, any WFD improvements that could be delivered as part of the Scheme.

1.2.4 Other regulations and consents

Various additional consents are required for the Scheme, including:

- An environmental permit for 'Flood Risk Activities' will be required for the construction of the Scheme, under the Environmental Permitting (England and Wales) Regulations 2016;
- Land Drainage Consent from the Internal Drainage Board;
- A marine licence will be obtained from the MMO for works taking place below Mean High Water Springs (MHWS), under the Marine and Coastal Access Act 2009;
- Permanent diversion orders for Public Rights of Way (PRoW) (WELWF03, SKEFF04 and SKEFF02) will be required, under the Town and Country Planning Act 1990 (as amended);
- Highways stopping up orders of two public highways with the Welwick to Skeffling Managed Realignment;
- Closure of PRoWs within the site during the construction period will need to be agreed with ERYC as there is no suitable route for a temporary diversion;
- A SSSI assent will be required for site clearance and mobilisation before planning permission is agreed, under the Countryside and Rights of Way Act 2000; this will be agreed during the planning application consultation with Natural England; and
- Protected species licences may be required to commence the works. Consultation with Natural England is being undertaken.

1.3 Planning and policy context

The national, regional and local planning policy framework for the Scheme are listed below and described more fully in Appendix 1.4. A separate Planning Statement forms part of the planning applications to EYRC and includes an appraisal of the Scheme's compliance with the relevant legal and policy framework.

The policies that are relevant to the Scheme include:

- National Planning Policy Framework (2018);
- National Planning Practice Guidance (2014);
- UK Marine Policy Statement (2011);
- East Inshore Marine Plan (2014);
- The East Riding of Yorkshire Local Planning Framework, including the Local Plan Strategy Document (2016), Allocations Document, Policies Map, Joint Minerals

Local Plan, Joint Waste Local Plan, Bridlington Town Centre Area Action Plan and various Supplementary Planning Documents; and

- Non-statutory plans, including the UK Biodiversity Action Plan (1994) and UK Post-2010 Biodiversity Framework, East Riding Biodiversity Action Plan (2010), the Government's 25 year Environment Plan (2018), and Future Water (2008) – the Government's water strategy for England (2008).

The key flood risk management plan which the Scheme falls under is the Humber FRMS, approved by Defra in 2007 and published in 2008. The strategic context of this and other relevant flood risk management plans are given in section 1.4.6 below.

1.4 The problem

1.4.1 Scheme location

1.4.1.1 The Humber Estuary

The Humber Estuary is the largest coastal plain estuary on the British North Sea and one of the largest and most dynamic estuaries in the UK. The Estuary has the second highest tidal range in Britain (7.2 m), and approximately one third of the estuary is exposed as mud or sand flats at low tide. The Estuary has sea defences along almost its entire length, which protect approximately 115,000 ha of low-lying land and 400,000 people from flooding. Approximately 85% of the land included in the Humber FRMS administrative area is farmed, and much of this is among the best and most versatile agricultural land in England. Three percent of the land is used for other commercial or industrial purposes and 8% is occupied by housing and urban areas.

The Humber Estuary is a designated Special Protect Area (SPA), Special Area Conservation (SAC), Ramsar site and Site of Special Scientific Interest (SSSI). It is also important for industry and trade, and is home to the country's largest port complex.

1.4.1.2 The Outstrays to Skeffling site

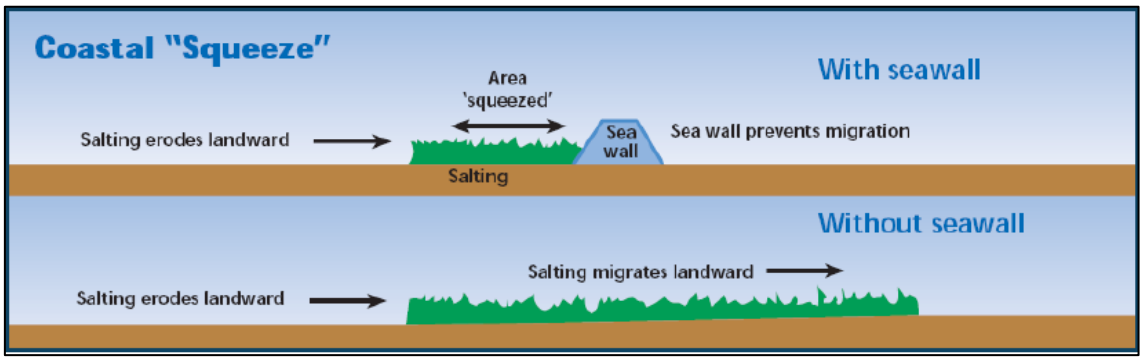
The site of the Scheme is located on the north bank of the Humber Estuary, approximately 25 km east of Hull (see Plate 1.1). The site is in a rural location, partially situated on an area known as Sunk Island. It is south of Patrington Haven and Patrington, and southwest of Welwick, Weeton and Skeffling. Most of the site is agricultural land, but the area also includes Haverfield Quarry Local Wildlife Site (LWS), an area of ponds and scrub of ecological importance.

Plate 1.1: Location of the Scheme within the Humber Estuary

1.4.2 Environment Agency habitat requirements

Under 'natural' conditions in the absence of tidal/flood defences, intertidal habitats (such as saltmarsh and mudflats) migrate inland in response to sea level rise. However, where this migration is prevented by existing defences (such embankments and walls), intertidal habitats reduce in area due to the resultant coastal "squeeze" (see Plate 1.2). Under the Habitat Regulations, the area of designated intertidal habitat within European Sites needs to be maintained. There is therefore a need to mitigate the effect of coastal "squeeze" by the provision of replacement habitat or removal of hard defences so that habitat migration can continue.

Plate 1.2: Illustration of the concept of coastal squeeze



The Environment Agency is required to compensate for intertidal habitat likely to be lost within European Sites due to its flood risk management activities. The Environment Agency's main objective of the Scheme is to compensate for intertidal habitats likely to be lost from the Humber Estuary as a result of implementing the Humber FRMS (2008) (see section 1.4.6). These habitat losses are the result of a rising sea level against existing flood defences and from works to maintain and improve existing defences as set out in the Strategy's programme.

The creation of intertidal habitat at Outstrays to Skeffling is to meet the legal requirement for compensation of such habitat loss in the middle and outer north part of the Humber Estuary.

1.4.3 Associated British Ports habitat requirements

ABP have a legal and corporate responsibility to protect and preserve the valuable and safeguarded Humber environment. ABP's four Humber ports - Hull, Goole, Grimsby and Immingham - offer an unrivalled mix of facilities and together handle up to 60 million tonnes of cargo annually. The Humber Ports contribute £2.2 billion to the UK economy every year and support 23,000 jobs in the Humber region. Due to the potential business growth opportunities within ABP's port areas, it is important and legally required for ABP to be able to consider ways to enhance existing ecological opportunities and offset potential environmental losses.

ABP wish to create new intertidal habitat, with the aim of using this habitat to compensate for future anticipated habitat losses at their port complexes. The estuarine habitats created are legally required to be of a similar composition to those of the Humber Estuary being lost.

1.4.4 Existing formal defences and current flood risk

Sunk Island (see Plate 1.3) is protected by 11.8 km of earth embankments of which approximately 4.5 km are within the Scheme boundary. These embankments prevent 6733 ha of land behind from flooding. There are 668 properties at risk from estuary flooding. The current standard of protection varies; it is generally about 10% Annual Exceedance Probability (AEP[1]) or better but is 50% AEP in places.

The Welwick to Skeffling area is protected by 4.8 km of earth embankments, which prevents 411 ha of land behind from flooding (see Plate 1.3).

There are 10 properties at risk from estuary flooding, mainly in Weeton (at the edge of the floodplain). The current standard of protection varies; it is generally about 5% AEP but is 50% AEP in places. The Humber FRMS (2008) stated that the defences were generally in good condition but were expected to need minor repairs every few years and major improvement in about 20/30 years.

[1] Annual Exceedance Probability (AEP) refers to the probability of a flood event occurring in any year. The probability is expressed as a percentage. For example, a large flood which may be calculated to have a 1% chance to occur in any one year, is described as 1% AEP.

Plate 1.3: Existing floodplain and flood defence locations (source: Humber FRMS, 2008)

1.4.5 History of flooding

On 5th December 2013, a serious tidal surge moved across along the UK coastline. A deep low pressure weather system raised water levels and combined with strong winds and high spring astronomical tides to cause a tidal surge. Widespread flooding was experienced by a number of coastal communities, but the most serious impact was felt along England's east coast between the Humber and the Wash. A section of defence south of Welwick breached, causing agricultural land behind to flood. In total, approximately 7,000 ha land was flooded adjacent to the Humber Estuary (see Plate 1.4 and Plate 1.5).

Plate 1.4: Flooding south of Weeton village in December 2013

Plate 1.5: Land flooded in 2013 from the tidal surge, including a breach at Welwick

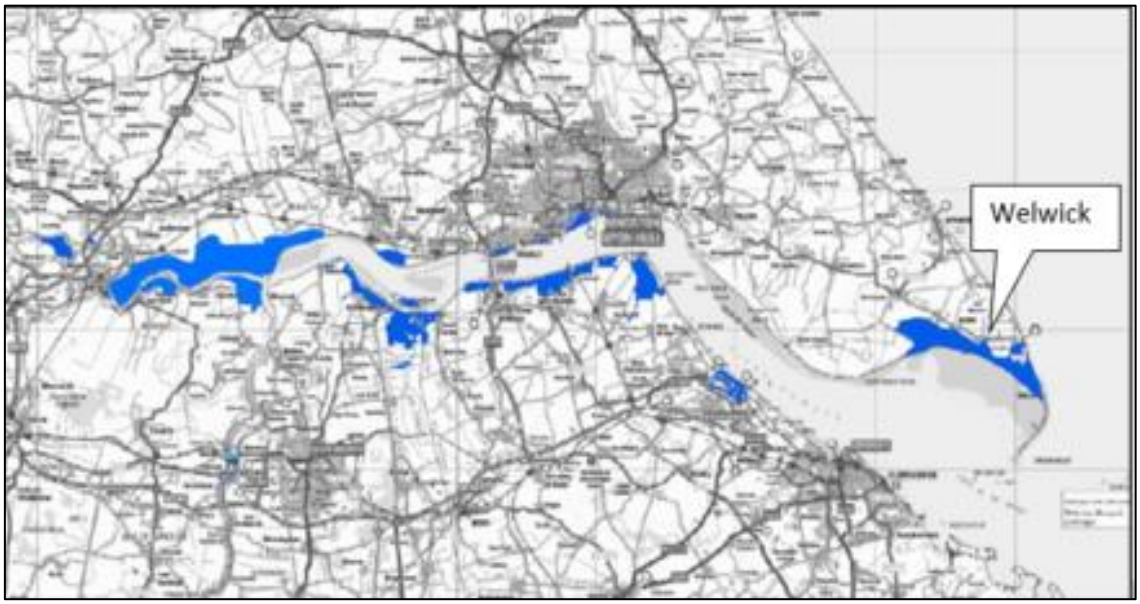


Plate 1.6 presents the current flood risk in the Outstrays to Skeffling area and shows that the site is within an area benefiting from flood defences.

Plate 1.6: Current flood risk at Outstrays to Skeffling (source: Environment Agency, 2018[2])

1.4.6 Strategic context

1.4.6.1 Humber Estuary nature conservation status

The Humber Estuary's intertidal areas provide a complex and highly productive ecosystem that supports a wide range of habitats and species. The estuary is recognised as one of the most important estuaries in Europe for wildlife and is designated as a site of nature conservation under national and international legislation.

The Humber Estuary is designated as:

- SAC under the EC Habitats Directive (92/43/EEC):
- SPA under the EC Wild Birds Directive (79/409/EEC);
- 'Wetlands of International Importance' under the Ramsar Convention; and
- Site of Special Scientific Interest (SSSI) under the Wildlife and Countryside Act 1981, as amended and the Countryside Rights of Way (CRoW) Act (2000).

The SPA and SAC together form the Humber Estuary European Marine Site, also known as a Natura 2000 site.

EU member states are required to take appropriate steps to avoid the deterioration of natural habitats and the habitats of species for which Natura 2000 sites have been designated (EC, 2000). These measures may be proactive (e.g. planning for the future

[2] https://flood-map-for-planning.service.gov.uk/, accessed 02/11/2018.

management of Natura 2000 sites) or preventative (e.g. assessing the impacts of proposed developments on Natura 2000 sites).

The Conservation of Habitats and Species Regulations 2017 (known as the 'Habitat Regulations') (see section 1.2.2) require that, where it is not feasible to prevent the deterioration of a Natura 2000 site, i.e. where a scheme will result in adverse effects on the integrity of the site, but where there are no feasible alternatives and there are reasons of overriding public interest for the scheme to take place, compensatory measures should be taken to maintain or enhance the overall coherence of the Natura 2000 network. Compensatory measures can include recreating a habitat on a new or enlarged site, to be incorporated into the Natura 2000 network (EC, 2000). The competent authority would need to set this out in an "Appropriate Assessment".

The provision of such compensatory habitat is a key driver for the Scheme (see Humber FRMS below).

Information on the Likely Significant Effects (LSE) of the Scheme on the Natura 2000 site is included in the Habitat Regulations Assessments in Appendix 10.2 and information to inform the competent authority's(ies) Appropriate Assessment of the potential adverse effects on the integrity of the site is included in Appendix 10.2.

1.4.6.2 Plans to manage flood risk in the Humber Estuary

In 1997 the Environment Agency began developing a long-term strategy for managing flood risk around the Humber Estuary and the lower reaches of its main tributaries. A number of management plans were produced to enable the Environment Agency to manage flood risk around the estuary into the future. These are outlined below.

Flamborough Head to Gibraltar Point Shoreline Management Plan

The Flamborough Head to Gibraltar Point Shoreline Management Plan (SMP) (Humber Estuary Coastal Authorities Group, 2010) presents the long-term policy framework for managing this section of coast, which includes the Outer Humber. The section is divided into policy units. The Outstrays to Skeffling Managed Realignment Scheme is located within Policy Unit K: Easington Road to Stone Creek. The overarching policy for this unit is to Hold the Line and maintain the standard of flood protection up to 2105 (the end of the period that the SMP covers). However, the SMP notes that managed realignment of defences my occur in order to comply with the Habitats Regulations and sustain the current level of flood risk (responding to climate change-related sea level rise). The SMP refers to the Humber Flood Risk Management Strategy (see below) in the identification of suitable sites, and states that these should be in the order of 100 ha can be identified for the period up to 2055, and should not adversely affect property or known designated and significant historic environment assets.

Humber Estuary Coastal Habitat Management Plan

The Humber Coastal Habitat Management Plan (CHaMP) (Environment Agency, 2005) was produced to inform the development of a more detailed strategy to manage the risk of flooding around the Humber Estuary. Taking 2000 as its base date, it assessed the amount of intertidal habitat likely to be lost due to coastal squeeze and the construction of new or improved flood defences over the following 50 years. It also set out the rate at which replacement habitat should be provided to meet the requirements of the Habitats Regulations.

Humber River Basin District Flood Risk Management Plan

The Humber River Basin District Flood Risk Management Plan was published in March 2016 and is a statutory plan under the Flood Risk Regulations 2009 which transpose the EU Floods Directive into UK law. With regard to the Outstrays to Skeffling area, its key conclusion is that flood risk management should follow the Humber Flood Risk Management Strategy described below. It notes that an update is being developed.

Humber Flood Risk Management Strategy

The Outstrays to Skeffling Managed Realignment Scheme sits within the approved Humber Flood Risk Management Strategy (Humber FRMS), which is the Environment Agency's long-term plan for managing flood risk around the Humber Estuary. The strategy drew up a programme of work needed to maintain the estuary defences for the next one hundred years. The first 25 years of the Humber FRMS was approved by Defra in 2007.

Approval of the Humber FRMS was conditional upon the delivery of a programme of habitat replacement as identified in the strategic Habitats Regulations Assessment (initially called a "Shadow AA" produced in 2005, and then the final HRA agreed in 2011). The Humber FRMS and the strategic HRA detail the compensatory habitat needs for impacts resulting from both sea level rise and the implementation of Humber FRMS schemes and maintenance works on the estuary.

The Humber FRMS Strategic Environmental Assessment (SEA) and strategic HRA (2011) identified Outstrays and Skeffling as suitable areas to create compensatory habitat to replace losses in the middle and outer estuary.

If the Environment Agency fails to meet its obligation for compensatory habitat under the Habitat Regulations, it may not be permitted to maintain or improve defences adjacent to the Humber Estuary in the future.

1.4.7 Scheme objectives

1.4.7.1 Overarching objectives

Managed realignment involves creating a new line of flood defences inland from the existing defences and allowing the land between the new and existing defences to flood, creating new intertidal habitat. The overarching objectives for the Outstrays to Skeffling Managed Realignment Scheme are to:

1. Create habitat to provide compensation (under the Habitat Regulations) for habitat losses in the middle and outer-north parts of the Humber Estuary resulting from coastal squeeze, flood risk management activities and future ABP port development; and
2. Support the WFD objective for the Humber Estuary of reaching good ecological potential.

1.4.7.2 Primary objectives for the Environment Agency

The primary objectives for the Environment Agency are to:

1. Create Humber Estuary SAC intertidal habitat (saltmarsh and mudflat) that supports an invertebrate community and Humber Estuary SPA bird species typical of the middle estuary, to compensate for coastal squeeze losses and direct losses in the middle and outer north estuary. The site should specifically provide:

a. an area of intertidal habitat that allows for the natural migration of inter-tidal habitats in response to sea level rise to compensate for habitat loss due to coastal squeeze;

b. an area of intertidal habitat to compensate for direct losses which need to be replaced by the same habitat type; and

c. Freshwater habitat (likely to be mainly wet grassland, approx. 75 ha) that will support the function of the inter-tidal area for wetland birds and provide mitigation for protected species.

2. Create specific habitat:

    a. For middle estuary birds, to allow the site and the middle estuary to sustain a characteristic assemblage of birds;

    b. At least 19 ha of open landscape to act as (extreme) high tide roost to support populations of redshank, knot and dunlin to compensate for losses at Easington Lagoons;

    c. 0.87 ha of SAC saltmarsh habitat to compensate for terrestrial/intertidal habitat loss at Kilnsea (2014 flood recovery scheme); and

    d. Mudflat to compensate for losses on the Humber Hull Frontages, currently expected to be 0.6 ha.

1.4.7.3 Primary objective for ABP

The primary objective for ABP is to create habitat to compensate for losses associated with future port development in the Humber Estuary, most likely along the Hull, Grimsby, and Immingham frontages. The habitat required is expected to be 40 ha of mudflat.

1.4.7.4 Secondary objectives

The secondary objectives shared by the Environment Agency and ABP are that the Scheme should not have an adverse effect on, and where feasible, benefit flood risk, drainage and biodiversity, and should promote socio-economic benefits, for example relating to recreation, access, amenity and landscape.

Specific habitat and bird numbers will also form part of the objectives and will be finalised as the Scheme progresses and as habitat losses that require compensation are identified.

1.5 Scoping methodology

A scoping exercise was undertaken to ensure that all potential significant environmental issues have been identified, to enable the EIA work to focus on aspects that require further assessment, whilst scoping out aspects unlikely to be significantly affected by the Scheme. By taking these potential effects into account at an early stage of the Scheme, any potential significant effects can be investigated, predicted and assessed, and where necessary and practicable, means to avoid or reduce them can be built into the design.

The study area for the EIA has been defined as the area of potential influence. It therefore varies for different environmental issues and is set out in each topic chapter.

The Scheme is part of the programme of projects that were subject to a SEA in the Humber FRMS. Extensive data gathering and consultation was undertaken with a wide

range of stakeholders, including local residents, businesses, non-statutory and statutory consultees during the preparation of the Strategy. The EIA scoping process for the Scheme was based on the SEA's information, supplemented by additional desk-based research, site-specific surveys, results of ongoing annual ecological monitoring across the estuary, further consultation with statutory and key consultees and experience of scoping similar schemes.

This scoping process was documented in the Preliminary Environmental Information Report (PEIR), which was submitted to EYRC and the MMO as part of a request for a formal scoping opinion on 13th June 2017. This is provided in Appendix 1.3.

Details of the scoping consultation responses are summarised in section 2.5, along with the main issues raised by consultees, how these have been addressed, and which issues have been scoped into or out of the EIA.

1.6 Structure of the Environmental Statement

Table 1.1 sets out the structure of this ES. Copies of the ES will be publicly available during the planning application determination period.

Table 1.1: Structure of the Environmental Statement

Chapter	Title	Description
-	Non-Technical Summary	Summary of the ES in non-technical language. Provided as a separate document.
1	Background	Information on the purpose of the ES, the strategic, legislative and consenting framework, habitat compensation requirements, site location and description, scheme objectives and scoping methodology.
2	Project development	An overview of how the Scheme has evolved, including alternatives considered, option selection and stakeholder consultation.
3	The preferred option	Detailed description of the preferred option, including location and layout, proposed design and construction and operation details.
4	Methodology	The EIA methodology used for assessing likely significant effects.
5	Socio-economics and land use	Results of the technical assessment of the two managed realignment sites, including a description of the current and future environmental baseline, any specific assessment methodologies used, assessment of likely significant effects (both adverse and beneficial), any mitigation proposed, residual effects, post-construction monitoring requirements and any limitations and uncertainties in the assessment.
6	Population and recreation	
7	Physical processes and the hydrodynamic environment	
8	Water environment	
9	Geology, soils and hydrogeology	
10	Terrestrial biodiversity	
11	Marine biodiversity	
12	Landscape and visual amenity	
13	Historic environment	
14	Traffic and transport	
15	Air quality	
16	Noise and vibration	
17	Other issues	Assessment of effects relating to artificial lighting, litter, vermin control and explanation of environmental monitoring and management.
18	Cumulative effects	Assessment of potential in-combination effects arising from the proposals for each site, cumulative effects resulting from the interaction of each site with other proposed developments in the vicinity, and cumulative effects resulting from the interaction of the two sites together.
19	Summary	A summary of beneficial and adverse effects.
-	References	Documents referred to in the ES.
-	Appendices	Including the Environmental Action Plan, HRA, WFD, FRA, figures and other supporting documents.

2 Project development

2.1 Introduction

Various alternatives were considered for the Scheme in relation to the location of the managed realignment and the Scheme design. These are consecutively summarised below, along with an explanation of the evolution of the preferred option design and the influence of consultation on the proposal.

2.2 Site selection alternatives

Site selection studies were undertaken to choose an appropriate location for this Scheme, as documented below.

2.2.1 Environment Agency site selection

The strategy for managing coastal defences and creating compensatory habitat in the Humber Estuary has evolved over the last 20 years, prior to the initiation of the Outstrays Managed Realignment and Welwick to Skeffling Managed Realignment projects. The process has been iterative, drawing upon extensive studies, reviews and strategies, including the SMP, CHaMP and the Humber FRMS. The work has been informed by policies and guidance which have emerged during the period, and by the feedback from the extensive public and stakeholder engagement activities that the Environment Agency has initiated and managed.

In summary, the process that led to selection of the Outstrays to Skeffling site for compensatory habitat creation encompassed broadly four phases of work:

- preliminary screening;
- detailed assessment and selection of preferred realignment sites;
- review of the selection of realignment sites; and
- identification of the preferred implementation programme.

2.2.1.1 Phase 1- Preliminary screening

Preliminary screening involved the assessment of the whole estuary and adjacent areas against the aims, objectives and criteria documented in the SMP, the Humber FRMS and the CHaMP. The process was informed principally by three studies:

- Urgent Works Review of the condition of existing coastal defences;
- A Habitat Migration Study; and
- Geomorphology studies.

The results of the Habitat Migration Study and Urgent Works Review were used to identify locations where setting back the defences in a managed realignment scheme would not affect inhabited areas and a new set-back defence line might provide some flood defence benefit.

The preliminary screening process was completed in spring 2001 and generated a long list of 28 possible sites that may be suitable for intertidal habitat creation.

As the Humber FRMS specifically identifies the need for compensatory intertidal habitat in the middle and outer part of the estuary, only sites in those locations were considered.

2.2.1.2 Phase 2 – Detailed assessment and selection of preferred realignment sites

A detailed assessment of the long list began in early 2002. The sites on the long list were reviewed and modified in light of the results of estuary-wide coastal geomorphology modelling studies that became available at that time. As a result, some of the site options were subdivided or modified.

The sites were visited and assessed against the site selection criteria detailed below:

- Geomorphology
- Environment
- Assets
- Habitats
- Community
- Engineering

The criteria were developed specifically for the purpose of identifying suitable sites for managed realignment within the Humber Estuary.

As a result of this assessment, the Outstrays to Skeffling sites were selected for managed realignment and became part of the compensation programme stated in the Humber FRMS and HRA.

2.2.1.3 Phase 3 – Review of the selection of realignment sites

In 2009 the Environment Agency revisited the site selection process. The reassessment confirmed that the Outstrays to Skeffling sites were still the preferred option for managed realignment.

2.2.1.4 Phase 4 – Identification of the preferred implementation programme

The implementation programme, set out in the Humber FRMS for managed realignment in the Humber Estuary, has been based on the Environment Agency's current predictions (HFRMS, 2011) of where and when intertidal habitat will be lost from within the Humber Estuary from coastal squeeze effects and flood risk management schemes.

2.2.2 Associated British Ports site selection

As part of ABPs' assessment of ways to offset potential environmental losses due to their activities and potential business growth opportunities within ABP port areas on the Humber Estuary, ABP searched for land to purchase adjacent to the estuary. Such land would need to meet ABP's economic, technical and environmental needs – to deliver the specific habitat types required to compensate for their activities under the Habitat Regulations.

An opportunity arose to buy land in the Skeffling area, which was anticipated to be suitable for creating the compensatory habitat required for ABP to progress future port expansion at one of their facilities.

The Environment Agency and ABP are working in partnership to deliver this habitat compensation and creation site at Outstrays to Skeffling in order to take full advantage of the land owned by both organisations at the preferred site. The majority of the land

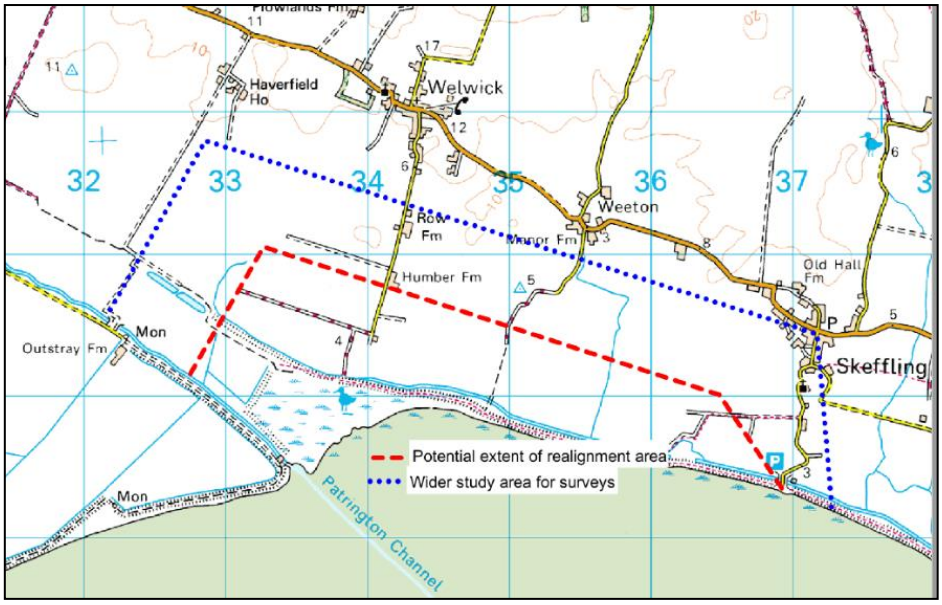
within the site is owned by the two organisations; the Environment Agency is in the process of acquiring the remaining land through negotiations with landowners.

2.2.3 Scheme evolution

The size and timing of the creation of compensatory managed realignment sites is governed by practical issues such as the availability and size of land. Consultation with relevant landowners and tenants formed an integral part of the site selection process.

In May 2015, we, the Environment Agency and ABP, sent out a letter to the local community and interested stakeholders describing the principles behind the originally named Welwick to Skeffling Managed Realignment Scheme (see Plate 2.1).

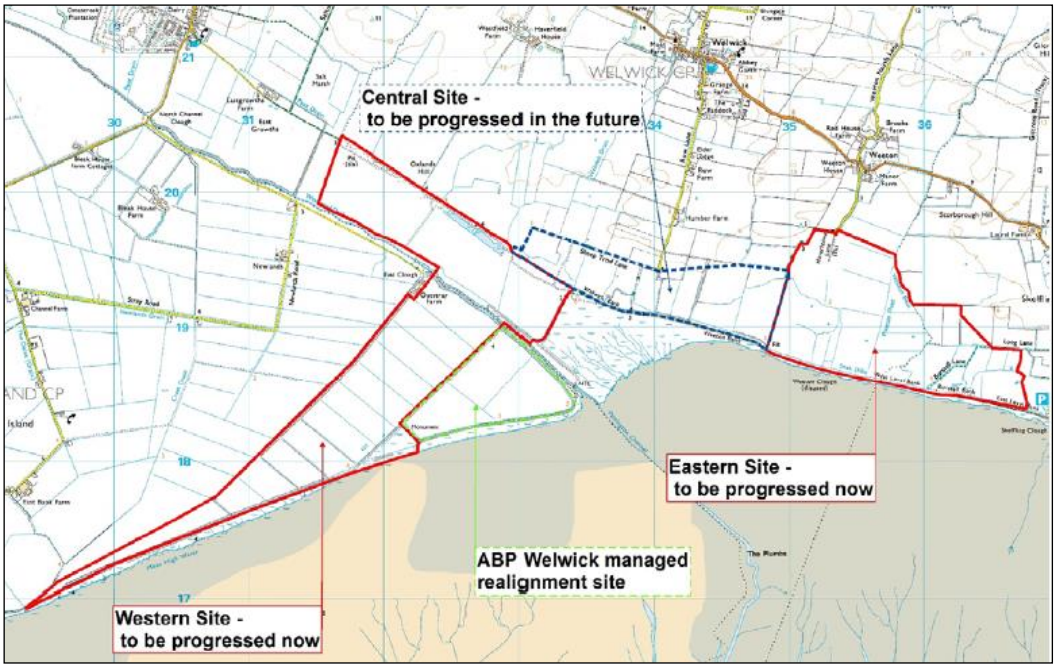
Plate 2.1: Initial scheme area considered for managed realignment



As a result of additional land becoming available locally, land south of Weeton, the Environment Agency were in a position to bring all its land holdings locally together. This allowed the Environment Agency to bring forward plans identified in the Humber FRMS to create compensatory habitat on Sunk Island (Outstrays) in conjunction with habitat creation at Welwick to Skeffling.

In July 2016 the scheme boundary changed, due to the land south of Welwick, identified in the Humber FRMS, not being available to purchase for habitat creation. The scheme boundary was revised to include land owned by the Environment Agency to the west of the original site (see Plate 2.2). It was anticipated that the land south of Welwick (known as the central site) would be included in the Scheme in the future.

Plate 2.2: Scheme boundary presented in the July 2016 newsletter



The central site land was later identified for the Environment Agency to purchase through negotiation, allowing for a larger habitat creation site to be developed. The addition of this land will allow the Environment Agency to address deficiencies in sections of the flood defences, especially south of Welwick that failed in 2013, and provide more compensatory habitat area needed to comply with the Humber FRMS HRA (2011) as stated in Section 1.4.6. The scheme name was changed to the Outstrays to Skeffling Managed Realignment Scheme in recognition of the expanded site.

The final Scheme boundary is presented in Plate 2.3, divided into two sites and five sections, namely:

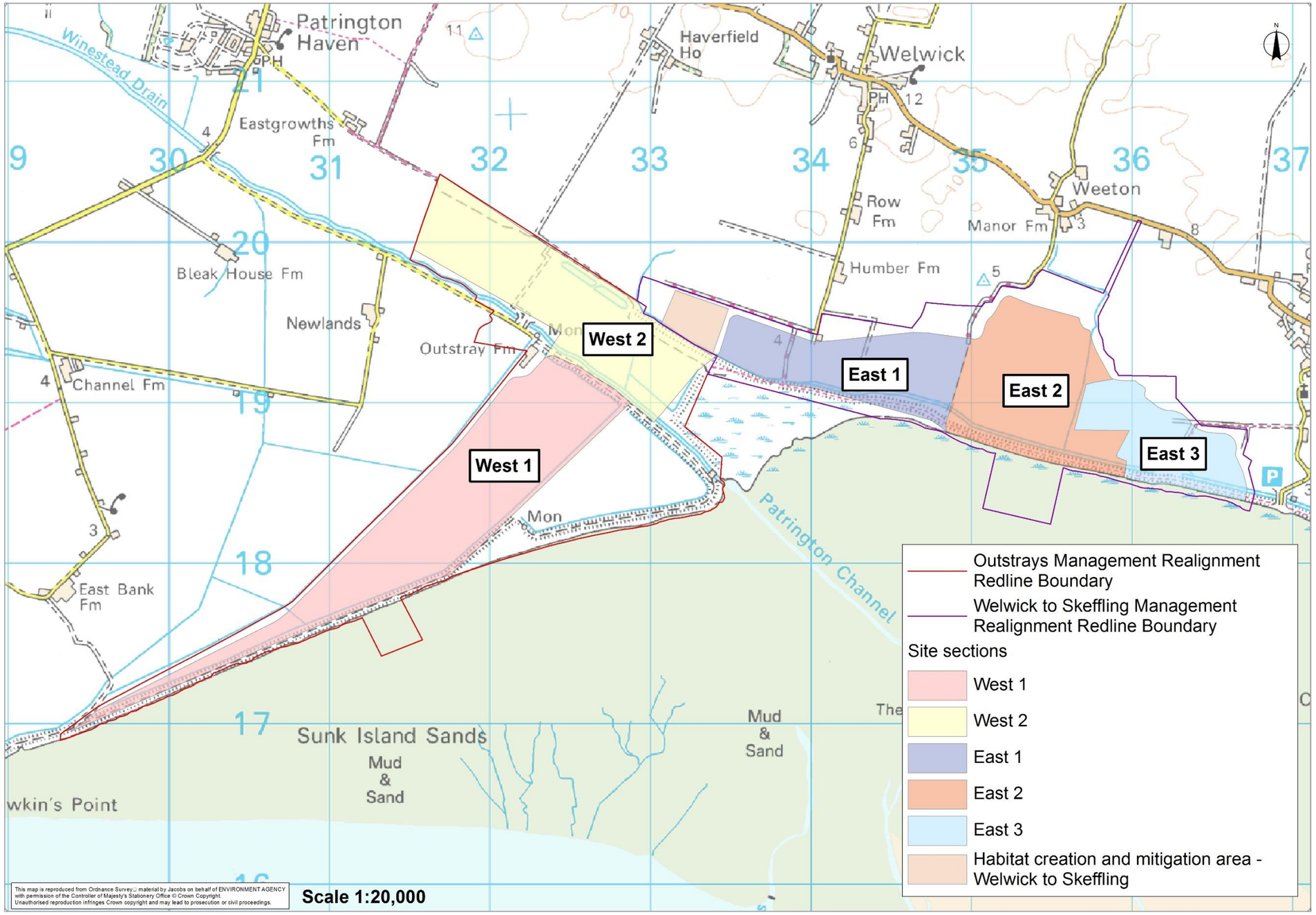
Outstrays Managed Realignment site:

- West 1 (land south of Outstrays Farm); and
- West 2 (land north of Outstrays Farm).

Welwick to Skeffling Managed Realignment site:

- East 1 (Land south of Welwick);
- East 2 (Land south out of Weeton); and
- East 3 (Land south of Skeffling).

Plate 2.3: Division of the managed realignment sites



2.3 Design alternatives

As the scheme area evolved, a number of design options were considered during the option appraisal process. The following main options were investigated:

- Do Nothing;
- Do Minimum;
- Welwick to Skeffling (the original site): various breach scenarios; and
- Outstrays to Skeffling (the final site): 13 long list of options, five on the short list of options (see Table 2.1).

2.3.1 Do Nothing

This option consists of undertaking no improvement works and ceasing all operational and maintenance activities. It would result in the progressive deterioration of the existing defences in the Outstrays and Skeffling area, leading to an increase in future breaches and failure of defences. The current flood protection would deteriorate due to climate change factors. This option would also not provide the legally required intertidal habitat to compensate for losses adjacent to the Humber Estuary. The 'Do Nothing' option does not support the strategic objectives (Humber FRMS, 2011) or the project specific objectives (section 1.4.7) but provides an economic baseline against which the other options are compared.

2.3.2 Do Minimum

This option assumes that the existing operation and maintenance regime is continued on all of the Environment Agency's assets and existing structures. Allowance is made for the replacement of existing structures on a 'like for like' basis at the end of their life to maintain the existing level of flood protection. The 'Do Minimum' option would provide some improvement from the 'Do Nothing' option but its performance would decline over time due to climate change.

The 'Do Minimum' option (along with other options with a "Hold the Line" approach i.e. retaining the current alignment of flood defences) would be difficult to fund in the Outstrays to Skeffling area under current FRM funding rules, as there are only a small number of houses at risk and few other assets in the vicinity. This funding shortfall is identified in the Humber FRMS. Therefore, "Hold the Line" options (including Do Minimum) have not been considered further. In order to improve the defences in this area, a link with habitat creation was considered necessary, as it would allow the Environment Agency to meet their compensatory habitat requirements while improving flood resilience in the area.

2.3.3 Welwick to Skeffling design alternatives

The option appraisal process for the original scheme (identified in 2015) built on the option appraisal work undertaken by the Humber FRMS and added information on the land acquisitions and ABP's requirement for creating specific habitat types (prioritising mudflat).

Consideration of the Welwick to Skeffling site started in 2015, with a review of its habitat creation potential (CH2M & ABPmer, 2015). This work was completed to inform decisions on site design that could maximise the habitat creation potential of the site in relation to delivering intertidal habitat and meeting wider environmental objectives. This review concluded that the site could provide the habitat required, through managed realignment of the existing defences.

A project review of the existing constraints and opportunities at the site was undertaken to inform the development of the long list of design options (See Appendix 2.1), including:

- Technical /engineering/asset issues;
- Economics;
- Connection with the estuary;
- Carbon;
- Archaeology;
- Habitat creation feasibility (particularly given the relatively high elevations of the existing topography);
- Existing terrestrial ecology;
- Contaminated land;
- Designated sites;
- Landscape and visual;
- Services and infrastructure; and
- Access/land ownership.

Following an initial workshop, three preliminary managed realignment design options were selected for short listing and high-level feasibility coastal geomorphological modelling for the Welwick to Skeffling site (CH2M and ABPmer, 2016a).
These were:

- A single breach with site lowering;
- Two breaches with site lowering; and
- Regulated Tidal Exchange (RTE) with no site lowering.

The assessment of the initial managed realignment options demonstrated that both the single and double breach scenarios produced a stable breach condition and functioned over a mean spring tidal range. The assessment of the RTE showed that this approach functioned over a neap tide. However, the area of inundation achieved by the RTE was significantly less than under the breach scenarios. Further details on each of these options are presented in the report on Welwick to Skeffling Managed Realignment: Modelling Options (CH2M and ABPmer, 2016a). As stated previously in July 2016, the Outstrays site became part of the overall scheme, requiring further modelling and assessment.

2.3.4 Outstrays to Skeffling design alternatives

2.3.4.1 Long list of options

Building on the original site option appraisal work, a long list of 13 design options was developed when the site boundary was expanded to become the Outstrays to Skeffling Managed Realignment Scheme (the final Scheme, see Plate 2.3). The focus of the option development was on effectiveness of moving water onto and off the site.

Further hydraulic modelling was undertaken for the 13 design options, which comprised different numbers, locations and widths of possible breaches to the existing banks (to enable water onto the site), drainage solutions, and channel/creeks. More details are provided in Appendix 2.1.

Each hydraulic option for the Scheme was appraised against a number of expanded criteria to what is presented in section 2.3.3, to determine which option best meets the objectives of the Environment Agency and ABP, namely:

- The ability to meet the scheme objectives;
- Lessons learnt from previous modelling and schemes on the estuary; and
- Options design appraisal criterion:

- Modelling results;
  - Inundation of site;
  - Habitat created;
  - Connection with estuary; and
  - Cut/fill balance.
- Geotechnical;
  - Material required to construct embankment;
  - Source of material;
  - Contaminated land;
  - Bank removal; and
  - Settlement issues.
- Technical;
  - Drainage;
  - Economics;
  - Infrastructure; and
  - Services.
- Environmental;
  - Carbon Tool;
  - Archaeology;
  - Terrestrial ecology;
  - Impact on designations;
  - marine ecology;
  - Landscape and visual;
  - Freshwater ecology; and
  - Access and Amenity.

As a result, many options were discounted for not meeting the project objectives, funding requirements and the selection criteria above, leaving five options on the short list.

2.3.4.2 Short list of options and preferred option selection

The long list of options was reduced to a short list of five options using value for money, sustainability, technical, environmental and geotechnical and the project objectives as criteria.

Table 2.1 presents the short list of options considered for preferred option selection, and a summary of the reasons for selecting the preferred option and discounting the alternatives.

Table 2.1: Short list of options

Option	Components	Initial assessment
Option 1	Create intertidal habitat in all areas i.e. West 1, West 2, East 1, East 2 & East 3 – this requires the relocation of Winestead Outstrays pumping station.	**Decision:** Ruled out on cost, potential impact on the relic sand dune habitat (SSSI/SAC feature), technical concerns about the quality of the intertidal habitat created in West 2 (i.e. would it drain?), potential issues with electricity and gas mains.
Option 1a	As Option 1 and include a linking channel between West 2 and East 1.	**Decision:** Ruled out for same reasons as Option 1, technical uncertainty and also it would have an unacceptable impact on the relic sand dunes (SSSI/SAC feature) at Haverfield Quarry.
Option 2	Create intertidal habitat in West 1, East 1, East 2 & East 3 and wet grassland on West 2.	**Decision:** Option acceptable as it meets the objectives of ABP and the Environment Agency by: • Creating intertidal habitat; • Minimal on the relic sand dune habitat; and • Creating SPA functional habitat.
Option 2a	As for Option 2 and also: i) connect West 1 to the existing ABP Welwick MR by bank removal and ii) remove fronting banks to existing foreshore level where possible and appropriate.	**Decision:** Option preferred for same reasons as Option 2 and that by linking sites and removing front banks, a more natural and open site with better sight lines for birds and less risk of human disturbance is achieved. **This option was selected as the preferred option.**
Option 3	Create a regulated tidal exchange on all or part of East 2 to create mudflat. Create intertidal habitat via managed realignment on West 1, East 1, & East 3 and wet grassland in West 2.	**Decision:** Ruled out due to cost and technical uncertainty of regulated tidal exchange.

In addition to looking at the above criteria and the project objectives, two specific assessments formed part of the short list evaluation. These were:

- Assessing whether re-locating Winestead Outstrays Pumping Station provided good for value for money; and
- Assessing whether it was appropriate to further remove the existing flood defences to create a higher quality habitat.

Winestead Outstrays Pumping Station Assessment

The Eels (England and Wales) Regulations 2009 apply at Winestead Outstrays pumping station and it is a considered a high priority site due to its prominent location in the Humber Estuary. Currently the pumping station is not compliant with the regulations, having an exemption until 2020. It is likely that, for a complex high priority station like Outstrays, an extension will be granted in 2020 when the current exemption expires. The current proposed works associated with the Outstrays Managed Realignment, to raise the flood defences around Winestead Outstrays Pumping Station, do not trigger the need to improve eel passage due to them being external and not affecting or changing the pumping regime.

The Flood Defence Grant in Aid (FDGiA) benefits from the pumping station do not provide enough funding to address the required Eel Regulation compliance issues as part of this project. A parallel demainment project for Winestead Drain has been initiated to look at addressing these issues around the pumping station.

Existing flood defence assessment

The investigation into whether the existing fronting embankments should be removed or remain concluded that removing the fronting embankments delivers good value for money and fits with the nationally agreed principles between the Environment Agency and Natural England.

In conclusion, option 2a was selected as the preferred option because it meets the Environment Agency and ABP objectives (section 1.4.7) and complies with funding requirements as stated in the business case prepared for the project.

The final preferred option is for Option 2a to:

- Create intertidal habitat in West 1, East 1, East 2 & East 3;
- Create supporting habitat (including wet grassland) in West 2 and adjacent to East 1;
- Connect West 1 to the existing ABP Welwick managed realignment by bank removal; and
- Remove fronting banks to existing foreshore level where possible and appropriate.

2.4 Development of preferred option design

The Scheme has been developed through dialogue with local residents, organisational and statutory stakeholder (notably, Natural England, ERYC, MMO and the local parish councils) (see Section 2.5). The contractor has been involved in the outline design stage to review and provide information to facilitate the design and construction. A number of design refinements and the inclusion of stakeholder recommendations have been included in the preferred option since option selection, namely:

- Gravity drainage design, allowing removal of the requirement to build a pumping station on Weeton Fleet, reducing carbon generated by the Scheme;
- Works to Winestead Outstrays Pumping Station to make it more resilient and raise the flood defence level in line with our proposals;
- Further coastal modelling to refine the design of the breaches and creeks;
- Refinement of the flood risk modelling, which has resulted in an additional length of flood defence works being required for the Outstrays Managed Realignment;
- Public access will be designed in line with the 2010 Equality Act and Environment Agency Guidance *Access for All;* to ensure less mobile members of the public can enjoy the site;
- The new access path for the Welwick to Skeffling Managed Realignment will be upgraded to Bridleway status, allowing access for horses from Skeffling, connecting with an existing Bridleway at Patrington Haven;
- The new car park for the Welwick to Skeffling Managed Realignment will allow parking for horse boxes;
- To enhance the success of the Scheme and to avoid importing embankment construction material the design of the embankments is tailored to enable site-won material to be used. This has been further refined to create the creek design for the site to ensure it functions with the estuary tidal cycle;
- Facilities to enable future management of the intertidal area if required;
- Badger proof netting will be used on sections of the embankment to prevent damage to the embankments;
- Bird hides have been designed in line with guidance from stakeholders; and
- Access to the site compound on the Welwick to Skeffling site will be via a new access track, east of Weeton to reduce construction traffic turning down Humber Lane.

2.5 Stakeholder consultation

The option appraisal work and development of the preferred option design has been informed by a range of stakeholder engagement activities at each stage, including workshops, newsletters, surgeries and drop-in sessions to engage the local communities along with the formal EIA scoping request. A summary is provided below, along with how this influenced the option development, and the outcome of the EIA scoping stage.

2.5.1 Stakeholder engagement activities

- **Initial scoping consultation letter** (May 2015) - a letter was sent to the local community and stakeholders describing the principles of the Scheme and the initial study area being considered and requesting information from consultees. The responses highlighted issues surrounding the landfill site, protected habitats and species, flood risk concerns and public access. We reviewed and took all considerations into account when preparing the original Scheme proposals. Appendix 2.2 contains the letter that was sent to stakeholders.
- **Public drop-in event** (June 2015) - held in the local community on the 18th June 2015 to discuss the Scheme and responses to the initial consultation. We

presented the study area and responded to questions on the need for the Scheme and how we will manage flood risk in the area.

- **Surgery sessions** (2016 onwards) - held before local parish council meetings, or as stand-alone sessions or coffee mornings in Patrington, Easington, Welwick and Skeffling to ensure continued engagement with the local community. Sessions have been advertised through letters and/or the newsletters. Dates of the surgery sessions are included in Appendix 2.2.
- **Scoping letter – scheme update** (July 2016) - a second letter was sent to the local community and stakeholders. This letter described the updated scheme boundary to include the western land within the scheme boundary (West 1 and West 2 in addition to East 2 and East 3) and asked the same questions as the original letter. Appendix 2.2 contains the letter that was sent to stakeholders. Further information provided by the public included information on access through Haverfield Quarry, existing habitat created by a local resident, as well as further information on protected habitats and species.
- **Public drop-in** (July 2016) - held on the 14th July 2016 to discuss the Scheme and responses to the second scoping letter.
- **Local community workshop** (July 2016) - held on the 27th July 2016, attended by 11 members of the community. The objectives of the workshop were to address the questions raised at the previous drop-in event; identify areas for discussion and agreement; and review public consultation needs. The participants provided information on existing infrastructure within the site, protected species, routes used by cyclists, horse riders and walkers, potential car park locations and aspirations for access and to create a nature reserve at Haverfield Quarry. This information was documented and used to further develop the design of the Scheme.
- **Organisational workshop** (July 2016) - also held on the 27th July 2016, attended by representatives of 14 statutory and non-statutory organisations with an interest or stake in the implementation of the Scheme (see Appendix 2.2 for a list of these organisations). The issues discussed included flood risk, habitat creation requirements, access and amenity. The information and suggestions provided by the organisations has been taken into consideration through the scheme design.
- **Regular newsletters** (July 2016 onwards) – from July 2016, a monthly/bimonthly edition has been prepared to update the local community and organisations on the Scheme's progress and to inform them of upcoming public events. Newsletters have covered the following topics: site investigation works, options development, responding to questions by the public, modelling, archaeology, drainage, need for habitat creation, flood risk and a site visit to Alkborough Flats Managed Realignment. The newsletters have been distributed by post to all households with the communities and rural areas of Sunk Island, Patrington, Welwick, Weeton, Skeffling, Easington and Kilnsea (over 1400 properties). Copies of the newsletters are included in Appendix 2.2.
- **Alkborough site visit and workshop** (October 2016) – to help the local community's and organisations' understanding of managed realignment, a site visit to Alkborough Flats Managed Realignment[3] (publicised in a newsletter) and was attended by several members of the local community and organisations on the 19th October 2016. A workshop was held afterwards for those who attended the site visit to discuss how elements of the Alkborough site could be applied to the Outstrays to Skeffling Managed Realignment Scheme.

[3] This scheme, which created 440ha of intertidal habitat, was the result of a joint project between the Environment Agency, Natural England, Associated British Ports and North Lincolnshire Council.

- **Public drop-in** (June 2017) - held on the 28th June 2017 to update the community and stakeholders on the scheme design. This included the new embankment alignment, new access provisions, how the site will function and how the landfill will be dealt with as part of the Scheme.
- **Local community workshop** (July 2017) - held on 3rd July 2017. Key points were raised by the community about the need for additional local knowledge on drainage, need for further investigation into the PRoW alignment, and the need to consider additional amenities as part of the Scheme. It was agreed that the combination of newsletters and workshops worked well for the community and allowed them to keep up-to-date and discuss the Scheme.
- **Organisational workshop** (July 2017) - also held on 3rd July 2017 for key statutory and non-statutory organisations. See Appendix 2.2 for a list of attending organisations. Topics discussed were habitat creation requirements/improvements, access and amenity. The information gained from the organisational stakeholders has been taken into consideration through the scheme design.
- **Public drop-in on archaeology** (September 2017) - held on the 4th September 2017 to display and discuss the archaeological findings of the site investigations that took place in autumn 2016. Over 40 people attended the event, which was led by York Archaeological Trust, who undertook the site investigations.
- **Public drop-in on access** (May 2018) - held on the 3rd May 2018 to present the public access alignment and proposed amenities across the site, and to explain how community and stakeholder suggestions were taken into consideration. The updated scheme design was also presented, including the new embankment alignment and the removal of the need for a pumping station on Weeton Fleet.
- **Ongoing consultation** - Regular newsletters will continue to be sent to the local community and organisational stakeholders for the duration of the design and construction phases of the Scheme. Surgery sessions will continue to be held to maintain ongoing dialogue with the local community. The need for any further community or stakeholder workshops will be considered as the Scheme continues to develop.

2.5.2 Request for Scoping Opinion

On the 15th June 2017, a formal scoping opinion request for the Scheme was made to ERYC and the MMO. This request was supported by a PEIR, setting out our understanding of the key environmental issues and the proposed scope of the EIA, to allow the subsequent assessment and evaluation stages to focus on possible significant effects. The scoping method used is summarised in section 4, and a copy of the Scoping Letter and PEIR is provided in Appendix 1.3.

The PEIR was issued to a number of ERYC departments and external consultees as part of this process. These consultees were:

- **ERYC departments:** Public Protection, Nature Conservation and Ecology, Landscape, Highways Development Management, Lead Local Flood Authority, Public Rights of Way, Conservation, Biodiversity, Civil Engineering and Coastal and Sustainable Development;
- **Other statutory consultees:** Natural England, Environment Agency, Historic England and MMO; and
- **Non-statutory consultees:** South Holderness Internal Drainage Board, Yorkshire Wildlife Trust, Yorkshire Water Services and the Royal Society for the Protection of Birds (RSPB).

The full scoping responses and further detail on how the comments raised have been addressed can be found in Appendix 1.3 (Scoping Response Table), and the following sections including Table 2.2.

2.5.3 Scoping update

In August 2018, we wrote to ERYC and the MMO to provide an update on the development of the Scheme's design. We explained that the scope of the EIA had not changed as a result of these developments and both organisations confirmed that they did not have any further comments on the scope (see Appendix 1.3).

2.5.4 Key issues raised during consultation

The stakeholder and community engagement activities outlined above helped inform the consideration of alternatives, the selection of the preferred option, design development of the Scheme and the EIA. The key issues identified during consultation were:

- Impacts on the Natura 2000 network;
- Impacts on terrestrial and marine ecology;
- Impacts on contaminated land;
- Impacts on flood risk and drainage;
- Impacts on access and recreation;
- Impacts on landscape and seascape character;
- Construction-related noise and air quality impacts; and
- Impacts on archaeology and cultural heritage.

The scoping opinion responses confirmed a suitable scope for the EIA, and our environmental assessment (reported in this ES) was expanded to include the following aspects in addition to those set out in the PEIR:

- **Marine biodiversity:** effects on marine mammals and migratory fish have been considered, including effects due to underwater noise and vibration during construction;
- **Landscape and visual amenity:** potential effects on seascape character and on the Spurn Heritage Coast;
- **Noise and vibration:** scoped in for the construction period;
- **Air quality**: scoped in for the construction stage; and
- **Artificial lighting, litter and vermin control**: scoped in for a high-level assessment for both construction and operation stages.

2.5.5 Scoping outcome – summary

The outcome of the EIA scoping is summarised in Table 2.2, setting out which topics have been included or not in the assessments reported in chapters 5 to 18. The focus of the EIA has been on the potential effects of the construction and operation phases, as it is anticipated that the Scheme is unlikely to be decommissioned. It could be

modified in the future, where potential effects from modifications would be similar to construction impacts, so have not been considered as requiring further assessment.

Table 2.2: Summary of the scope of the EIA and changes due to the scoping responses

Topic	During construction	During operation	Change in scope due to scoping responses
Socio-economics and land use	**Scoped in**	**Scoped in**	Potential impacts on agricultural land, port and flood risk management activities. Inclusion of potential impacts on economy, education and tourism following the scoping responses. Potential impacts on commercial fisheries have been scoped out.
Population and recreation	**Scoped in**	**Scoped in**	Diversion of PRoW and Highways anticipated. Potential impacts on the population relating to access and recreation, health and wellbeing, and changes in flood risk. No change in scope required due to the scoping responses.
Physical processes and the hydrodynamic environment	**Scoped in**	**Scoped in**	Potential impacts on marine physical/hydrodynamic processes, due to the introduction of an additional area subject to tidal processes. No change in scope required due to the scoping responses.
Water environment	**Scoped in**	**Scoped in**	Potential impacts from construction on water quality. No change in scope required due to the scoping responses.
Geology and soils and hydrogeology	**Scoped in**	**Scoped in**	Potential impacts from the proposed breach and sourcing material to build the new defences. No change in scope required due to the scoping responses.
Terrestrial biodiversity	**Scoped in**	**Scoped in**	A number of designated sites and protected species have been identified within and adjacent to the Scheme boundary, with potential for direct and indirect effects from the Scheme. No change in scope required due to the scoping responses.
Marine biodiversity	**Scoped in**	**Scoped in**	Following the scoping responses, effects on marine mammals and migratory fish will be considered, including effects due to underwater noise and vibration during construction.
Landscape and visual amenity	**Scoped in**	**Scoped in**	Potential for changes to the landscape and for visual impacts during both construction and operation. Potential effects on seascape character and on the Spurn Heritage Coast have been assessed, following the scoping responses.
Historic environment	**Scoped in**	**Scoped in**	Potential for archaeology of all periods from the Mesolithic to the present. Extant heritage assets include WW2 defensive structures and post-medieval and modern flood banks and sluice structures. There are also a number of Listed Buildings and Scheduled Monuments that may have setting impacts as a result of the scheme. No change in scope required due to the scoping responses.
Traffic and transport	**Scoped in**	**Scoped in**	Potential effects relating to highways traffic, commercial and recreational navigation are assessed. No change in scope required due to the scoping responses.
Noise and vibration	**Scoped in**	**Scoped out**	This topic was scoped in for construction following the scoping responses. Potential noise and vibration effects on human receptors are considered in Chapter 16 Noise and vibration, along with a summary of residual effects on ecological receptors. The full assessment of noise and vibration effects on ecological receptors are included in the biodiversity chapters, Chapters 10 and 11.
Air quality	**Scoped in**	**Scoped out**	This topic was scoped in for construction following the scoping responses. Potential dust impacts on human receptors are considered Chapter 15, and potential impacts on ecological receptors are considered in the biodiversity chapters, Chapters 10 and 11.
Artificial lighting, litter and vermin control	**Scoped in**	**Scoped in**	These topics were scoped in for a high-level assessment of potential significant effects, following the scoping responses.
Climate change	**Scoped out**	**Scoped out**	An assessment of climate change-related effects is scoped out of the EIA as sea level rise has been taken into account when designing the Scheme to minimise its vulnerability to climate change, and the Scheme itself is not expected to contribute to climate change through greenhouse gas emissions as traffic movements during construction will be local in scale and minimal emissions will occur during the operation phase. The creation of intertidal, wet grassland and terrestrial grassland habitat will sequester carbon in the long-term, reducing the carbon footprint of the Scheme. The contribution to climate change of each option, calculated using a carbon tool, was used in the option selection criteria during the design development, and climate change is considered when describing the future baseline environment in the EIA. The contractor also has a target to reduce carbon during the detailed design and construction phases of the Scheme.
Major accidents and disasters	**Scoped out**	**Scoped out**	Major accidents and disasters are scoped out as the Scheme is not vulnerable to such events and is not likely to cause any events. The effect of any changes in flood risk on the population is assessed in Chapter 6: Population and Recreation.
Human health	**Scoped in**	**Scoped in**	Human health is scoped in to the EIA and is covered in various chapters. Potential effects relate to changes in flood risk (assessed in Chapter 6), wellbeing and amenity (Chapter 6), noise and air quality and traffic during construction (Chapters 14, 15 and 16) and potential contamination (Chapters 8 and 9).
Material assets	**Scoped out**	**Scoped out**	Material assets include community facilities, utilities and infrastructure. Effects were scoped out as there are very few assets within or near to the Scheme boundary. There is a buried gas pipeline within West 2; this will not be affected by the Scheme. The only other assets nearby are existing car parks and roads. Potential effects on these assets are assessed in Chapter 14, Traffic and Transport.

3 The preferred option

Options have been considered with the aim of creating compensatory habitat as well as improving protection from tidal flooding in the locale. The Scheme has been developed through dialogue with the local community, and statutory and non-statutory organisations (including Natural England, ERYC, MMO and the local parish councils).

An overview of the preferred option is presented on Figure 3.1 below. The two sites have been divided into specific areas (see Plate 2.4):

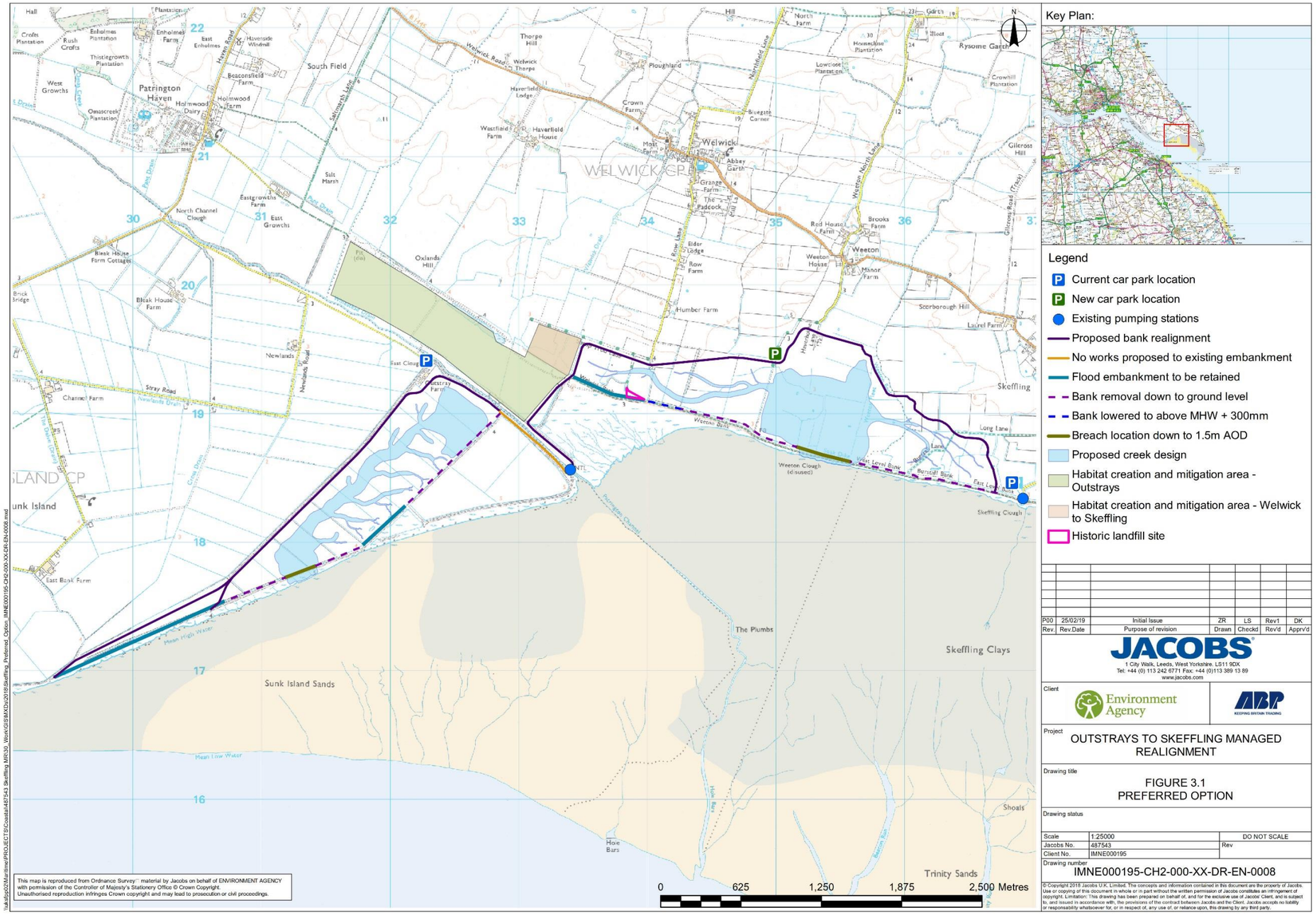
Outstrays Managed Realignment:

- West 1 (land south of Outstrays Farm); and
- West 2 (land north of Outstrays Farm)

Welwick to Skeffling Managed Realignment:

- East 1 (Land south of Welwick);
- East 2 (Land south out of Weeton); and
- East 3 (Land south of Skeffling).

Plate 3.1: The preferred option



3.1 Outstrays Managed Realignment (western site)

The Outstrays Managed Realignment involves the construction of a new retreated coastal flood defence embankment and the creation of compensatory intertidal habitat. This will be achieved by building a new setback embankment and then breaching the existing coastal defences. It also includes the creation of wet grassland and expansion and restoration of sand dune habitat. The key works associated with the preferred option shown on Plate 3.1 are:

- Excavation of approximately 100 ha to dig creeks and provide material for new embankment;
- New embankment approximately 4.5 km in length and 2 to 2.5 m high above ground level;
- A 250 m wide breach of the existing embankment;
- Removal down to ground level of most of the rest of the existing embankment;
- Piling works at Winestead-Outstrays Pumping Station and Welwick Bushes;
- Creation of approximately 116 ha of intertidal habitat; and
- Creation of approximately 65 ha of wet grassland and other terrestrial habitat.

The individual works are described below in more detail.

3.1.1 The new set-back defence alignment

A new earth embankment will be constructed, running along the back of West 1. It will form a continuous line of defence by tying into two locations towards Hawkins Point at the western end and an improved existing embankment that leads along the western side of Winestead Drain to Winestead-Outstrays Pumping Station at the eastern end. A section of new embankment will also be constructed to join the new defence alignment to the section of existing embankment to be retained at the western end of West 1, to separate the area which will become intertidal habitat from the area which will be kept as terrestrial habitat.

The embankments will be constructed from cohesive material that will be excavated from within West 1. Site investigations and laboratory testing have been carried out to assess the suitability of in-situ materials for use as fill for the embankments, which confirmed that suitable material is available within the site for the construction of the embankment. The borrow pits will form a creek system once the site is breached to form an array of intertidal habitats.

The new West 1 embankment will have a design level of 5.4 m Above Ordnance Datum (AOD) Flood Defence Level with additional allowances for settlement. This equates to an average construction height of 5.8 m AOD.

The new flood embankment will have a wider profile than that of the current embankment to make it more robust. As it is a new embankment, it will have a longer life than the current embankment which was constructed a number of years ago.

Improvements will be undertaken to raise the defences at Winestead-Outstrays Pumping Station to a 5.6 m AOD Flood Defence Level. This will include sheet piling and is necessary to protect the infrastructure and maintain a minimum Flood Defence Level across the site.

From Winestead-Outstrays Pumping Station along the eastern side of Winestead Drain, the existing embankment will be modified and improved and will have a Flood Defence Level of 5.6 m AOD with additional allowances for settlement.

A new earth embankment will be constructed along the edge of West 2. This embankment will have a design level of 5.6 m AOD Flood Defence Level with additional allowances for settlement. This equates to an average construction height of 5.8 m AOD. The new West 2 embankment will tie into the modified embankment at the western end and sheet piling at Welwick Bushes at the eastern end. The constructed level of the sheet piling will be 5.6 m AOD. This piling is required to continue the flood defence level and to protect the SSSI.

For all embankments within the western site, the side slopes will be 1 in 5 on the estuary side and 1 in 4 on the landward side (typically) with a minimum crest width of 4m.

3.1.2 Breaching and removal of the existing embankment in West 1

Once the new flood defences have been constructed, a breach will be created within West 1 by removing a 250 m section of the existing embankment down to approximately 1.5 m AOD and reprofiling the fronting saltmarsh. The existing embankment either side of this breach location will be removed down to ground level. A section of the embankment will be retained for ecological mitigation at Outstray Scrapes, and the western end will be retained as this area will not become intertidal habitat as part of this Scheme.

3.1.3 Intertidal habitat in West 1

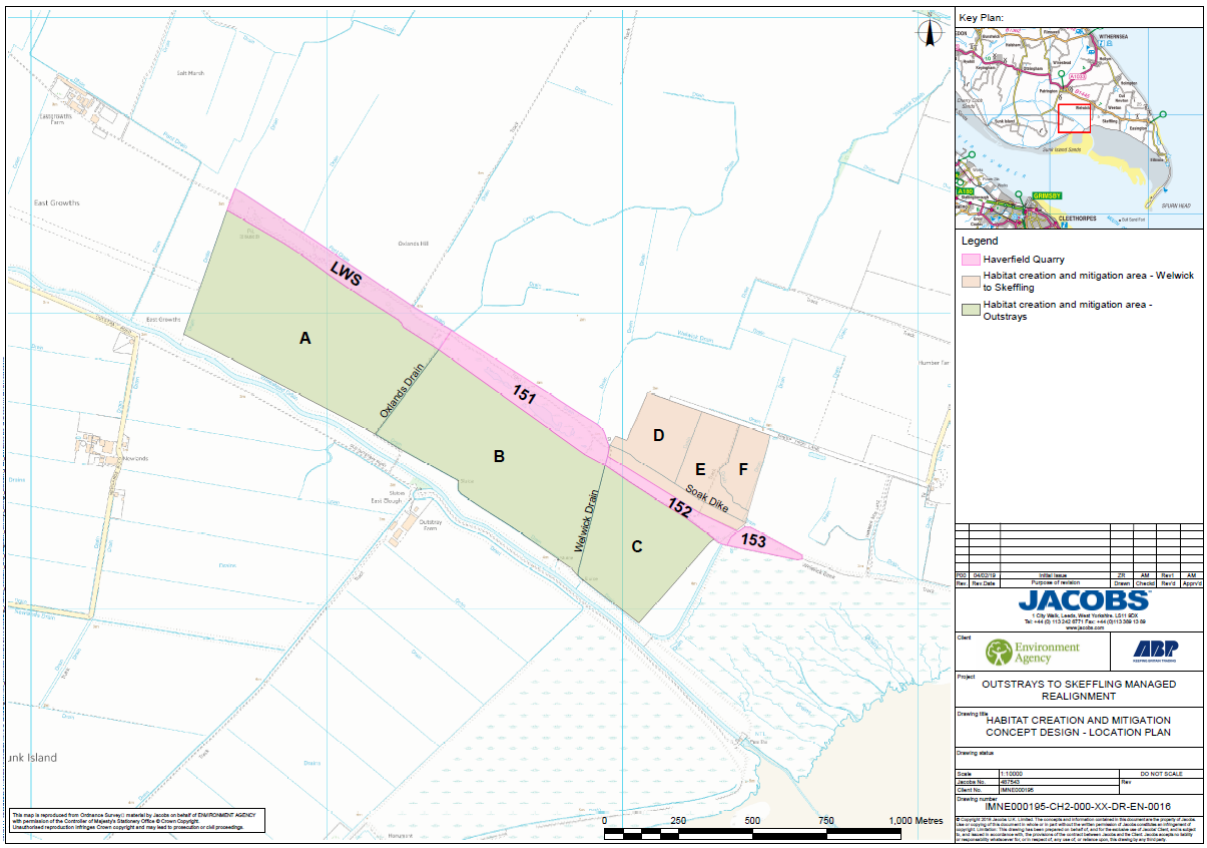
The detailed design of the West 1 intertidal habitat will investigate the potential for including informal water storage areas, low level bunds and small scale regulated tidal exchanges. This design will be developed in consultation with stakeholders.

3.1.4 Habitat creation in West 2

The West 2 site is adjacent to Welwick Saltmarsh and Haverfield Quarry LWS (both part of Humber Estuary SPA, SAC and SSSI), and in close proximity to Winestead Drain cLWS. Habitat creation will reflect the habitats of these sites and enhance them by increasing connectivity between them, creating buffers between the sites and agricultural operations, and facilitating the expansion of habitats and species associated with these conservation areas. This area will also be used for ecological mitigation for protected species and habitats.

The West 2 site will comprise an area of freshwater wet grassland, expansion and restoration of fixed dune grassland and an area of terrestrial grassland communities. The design for this area is indicative and is based on a review of the site's requirements at a fixed point in time. The exact area (ha) and location of proposed habitats may change during the development of the detailed and final design, which will be informed by further field surveys and consultation with stakeholders. Detailed ecological targets will be set as part of this design development. Appendix 10.3 includes further detail on the drivers for the habitat requirements for West 2 and the flexibility of the areas and locations proposed. The proposals are summarised below and the site layout with the sub-areas labelled is below on Plate 3.2.

Plate 3.2: Sub-areas within the habitat creation and mitigation area



3.1.4.1 Wet grassland

Wet grassland is proposed in Fields A and B on Plate 3.2 to provide ecological mitigation, high tide roosts and feeding areas for waders and waterfowl and benefit the estuary ecosystem as a whole. In order to manage the water levels of the site, a “cut-off” trench will be dug around Fields A, B and C, to block sub-soil drainage systems and thus ‘wet-up’ the soils within hydrologically isolated units. Two wind pumps are proposed to be installed to draw water into the site from Winestead drain, when required.

A variety of habitats, water depths and sward heights will be created. The area will be periodically flooded and grazing or mowing will help to maintain the diversity of grassland species. Watercourse channels, scrapes, ponds and reedbeds are also proposed.

3.1.4.2 Fixed dune grassland

The concept design includes restoration and expansion of fixed dune grassland at Haverfield Quarry and Welwick Bushes. Sandy substrate in Field C (Plate 3.2) will be exposed by redistributing the overlying arable top soil as bunds and islands across West 2. Excess sand from the Scheme will be moved to this field and also mixed with substrate along the boundary of Haverfield Quarry. This will provide a buffer between the fixed dune grassland habitat, the wet grassland area and adjacent agricultural land. Over time it is expected that natural succession will enable further expansion of the fixed dune grassland.

Other grassland communities

Areas of scrub planting are proposed at this site and along the western boundary of Field A, with scrub being translocated from local sources including Welwick Bushes and Hodgson's Fields Nature Reserve.

Dry grassland habitat is also proposed in the northern corner of Field A, as this area cannot be developed into wet grassland due to the presence of a main gas pipeline. This will be achieved through natural regeneration.

New nesting boxes will be installed across West 2 and old ones will be repaired or replaced.

3.1.5 Associated works

The following associated works will take place as part of the scheme:

- Piling works at Winestead-Outstrays Pumping Station to stabilise the structure;
- Piling works at Welwick Bushes to maintain the proposed flood defence level and minimise the flood defence footprint to protect the SSSI relic sand dune feature;
- Construction of two new viewing platforms or bird hides within West 1. Indicative locations are approximately 500m along top of new West 1 embankment from Outstrays Farm and at the western end of West 1;
- Reinstatement of the existing bird hide within Haverfield Quarry;
- Creation of new permissive access route from Outstrays Farm to the western end of West 1. This will be partly on the crest of the embankment and partly along the dry side toe of the embankment to provide amenity while minimising bird disturbance;
- Creation of a public access route around the edge of West 2, with the route along the north-eastern boundary being a designated bridleway;
- Improvement of other footpaths and footbridges;
- Access ramps at each end of the site to ensure access for all to the top of the bank;
- Provision of fencing along the new access alignment and in West 2;
- A French drain along the dry side toe of the new West 1 embankment; and
- Vegetation clearance, including the removal of woodland at the western end of West 1.

3.1.6 Embedded mitigation

Mitigation has been embedded into the design of the Scheme to address issues identified by surveys, stakeholder engagement, lessons learnt from other managed realignment projects and professional expertise. For the Outstrays Managed Realignment this includes:

- Footpath alignment: this has been designed to increase amenity value for visitors while minimising disturbance to birds in sensitive areas;
- Fencing: this has been included in the design to reduce disturbance to birds. Fencing will run along the new access path alignment to prevent public access to the intertidal zone;
- Creek design: this design has been developed to enable excavated material from the creeks to be used for the new embankments, which has reduced construction traffic movements and removed the need for new material to be imported; and
- Embankment design: the new embankment alignment will be sinuous and will have gentle slopes to help reduce landscape and visual impacts.

3.2 Welwick to Skeffling Managed Realignment (eastern site)

The Welwick to Skeffling Managed Realignment involves the construction of a new retreated coastal flood defence embankment, and the creation of compensatory intertidal habitat. This will be achieved by building a new setback embankment and then breaching the existing coastal defences. An area of freshwater habitat including terrestrial grassland will also be created. The key works associated with the preferred option shown on Plate 3.1 are:

- Excavation of approximately 80 ha to dig creeks and provide material for new embankment;
- New embankment approximately 4.5 km in length and 2 to 2.5 m high from ground level;
- A 400 m wide breach of the existing embankment;
- Removal down to ground level of the majority of the rest of the existing embankment;
- Creation of approximately 175 ha of intertidal habitat; and
- Creation of approximately 10 ha of freshwater habitat including terrestrial grassland.

The individual works are described below in more detail.

3.2.1 The main works

A new earth embankment will be constructed along the back of East 1, 2 and 3. The new bank will have a design level of 5.6 m AOD Flood Defence Level with allowances for settlement. This equates to an average construction height of 5.8 m AOD. The side slopes will be 1 in 5 on the estuary side and 1 in 4 on the landward side (typically) with a minimum crest width of 4 m. Cut material from within East 1, 2 and 3 will be used for the new flood defence embankment and to aid the creation of intertidal habitat.

The new flood embankment will have a wider profile than that of the current embankment to make it more robust. As it is a new embankment, it will have a longer life than the current embankment which was constructed a number of years ago.

A breach will be created within East 2 by removing a 400 m section of the existing embankment down to approximately 1.6 m AOD and reprofiling the fronting saltmarsh. The existing embankment either side of the breach location will be removed down to ground level as it will no longer serve as a flood defence. A section of existing embankment will be retained at the western end, and a section will be lowered to above 300m above MHWS, to retain it as terrestrial land to ensure continued riparian landownership for the Yorkshire Wildlife Trust and associated marshes.

The detailed design of the East 1, 2 and 3 intertidal habitat will investigate the potential for including informal water storage areas, low level bunds and small scale regulated tidal exchanges. This design will be developed in consultation with stakeholders.

A new drainage ditch will be constructed immediately behind the new embankment. This will be a gravity flow system and capture drainage from watercourses and ditches to avoid adverse impacts on drainage and will include sufficient working width for maintenance access.

Welwick Bank landfill and any contaminated material from the track that leads to it will be remediated and landscaped. Remediated material will be reused on site to raise the landfill above flood risk.

A new bridleway will be created along the back of East 3, East 2 and East 1. This will form the diverted PRoW and link into the Bridleway and PRoWs at either end of the sites. Access

will be partially on top of the new flood bank and partially behind to provide users with views across the estuary but also limit disturbance to birds in adjacent sensitive areas.

The habitat creation and mitigation area in fields D, E and F on Plate 3.2 will be delivered as part of the Welwick to Skeffling Managed Realignment. These fields are proposed to be converted from arable farmland to grassland habitat. A “cut off” trench will be dug and along the western and eastern boundaries of the site to reduce drainage function across the site, and a mosaic of different grassland communities will develop through natural regeneration. Ponds will also be created. The design for this area is indicative and is based on a review of the site’s requirements at a fixed point in time. The exact area (ha) and location of proposed habitats may change during the development of the detailed and final design, which will be informed by further field surveys and consultation with stakeholders. Detailed ecological targets will be set as part of this design development. Appendix 10.3 includes further detail on the drivers for the habitat requirements for West 2 and the flexibility of the areas and locations proposed.

3.2.2 Associated works

The following associated works will take place as part of the Welwick to Skeffling Managed Realignment:

- New car park south of Weeton;
- Three new viewing platforms or bird hides on top of the new embankment, indicative locations at the end of Row Lane, end of Humber Side Road and on Humber Lane;
- Provision of fencing along the new access alignment;
- Improvements to footpaths and footbridges;
- Gravity fall drainage;
- Provision of access ramps where the footpath changes from being at the dry side toe to the crest of the embankment; and
- A ramp over the new flood embankment so that excavation machinery can access the intertidal area for post-construction intervention work, if required.

3.2.3 Works to Skeffling Pumping Station

The Flood Risk Assessment for the Scheme (see Appendix 8.3) has identified that works will be required to increase the capacity of Skeffling Pumping Station in order to manage the increase in discharge volumes that will result from the Scheme. These works will be carried out as a separate element that does not need to be included in the Welwick to Skeffling Managed Realignment planning application, as they will be carried out under the Environment Agency’s Permitted Development Rights.

It is anticipated that the works will involve replacing the existing pumps and associated infrastructure within the confines of the pumping station structure. There would be no changes to the visual appearance of the pumping station, minimal construction traffic (using Humber Lane, which will not be used for the construction of the Welwick to Skeffling Managed Realignment) and no in-channel works except any required to remove the pumps and put the new ones in place. It is assumed that the current maintenance regime would continue.

The works are small-scale and would not require an EIA. They are not likely to result in significant adverse effects either on their own or combined with the rest of the works for the Welwick to Skeffling Managed Realignment, so have therefore been screened out of this assessment. This approach has been discussed and agreed with East Riding of Yorkshire Council.

3.2.4 Embedded mitigation

Mitigation has been embedded into the design of the Scheme to address issues identified by surveys, stakeholder engagement, lessons learnt from other managed realignment projects and professional expertise. For the Welwick to Skeffling Managed Realignment this includes:

- Construction access: to remove the need for construction vehicles to travel via Humber Lane, a construction access track will be built east of Weeton;
- Contaminated land: as part of the design, the historic landfill site will be remediated to remove any contamination risks;
- Landowner access: To minimise impacts on recreation and local organisations, Yorkshire Wildlife Trust and the Wildfowlers Association will have maintained access to their land, including a ramp over the new embankment at Welwick Bushes and an access track;
- Weeton Fleet pumping station: a new pumping station was initially included in the design; this has now been removed from the design by using a passive drainage solution, which has reduced visual and ecological impacts and carbon and material usage/transportation;
- Footpath alignment: this has been designed to increase amenity value for visitors while minimising disturbance to birds in sensitive areas;
- Fencing: this has been included in the design to reduce disturbance to birds. Fencing will run along the new access alignment to prevent access to the intertidal zone;
- Creek design: this design has been developed to enable excavated material from the creeks to be used for the new embankments, which has reduced construction traffic movements and removed the need for new material;
- The creek design has been aligned to avoid areas of high archaeological interest; and
- Embankment design: the new embankment alignment will be sinuous and will have gentle slopes to help reduce landscape and visual impacts.

3.3 Construction details

3.3.1 Construction programme

The indicative construction programme for the Scheme (including both western and eastern sites) is show below in Table 3.1. Both sites will be constructed at the same time.

Table 3.1: Indicative construction programme

	2019			2020						2021					
Activity	**July**	**A**	**S**	**Apr**	**M**	**J**	**J**	**A**	**S**	**Apr**	**M**	**J**	**J**	**A**	**S**
Archaeology investigations															
Set up sites															
Dig creeks															
Build new embankments															
Build habitat creation and mitigation area															
Remediate landfill															
Breach existing embankments and remove fronting saltmarsh															
Remove existing embankment sections															
Notes: No earthworks will take place during wintering bird season.															

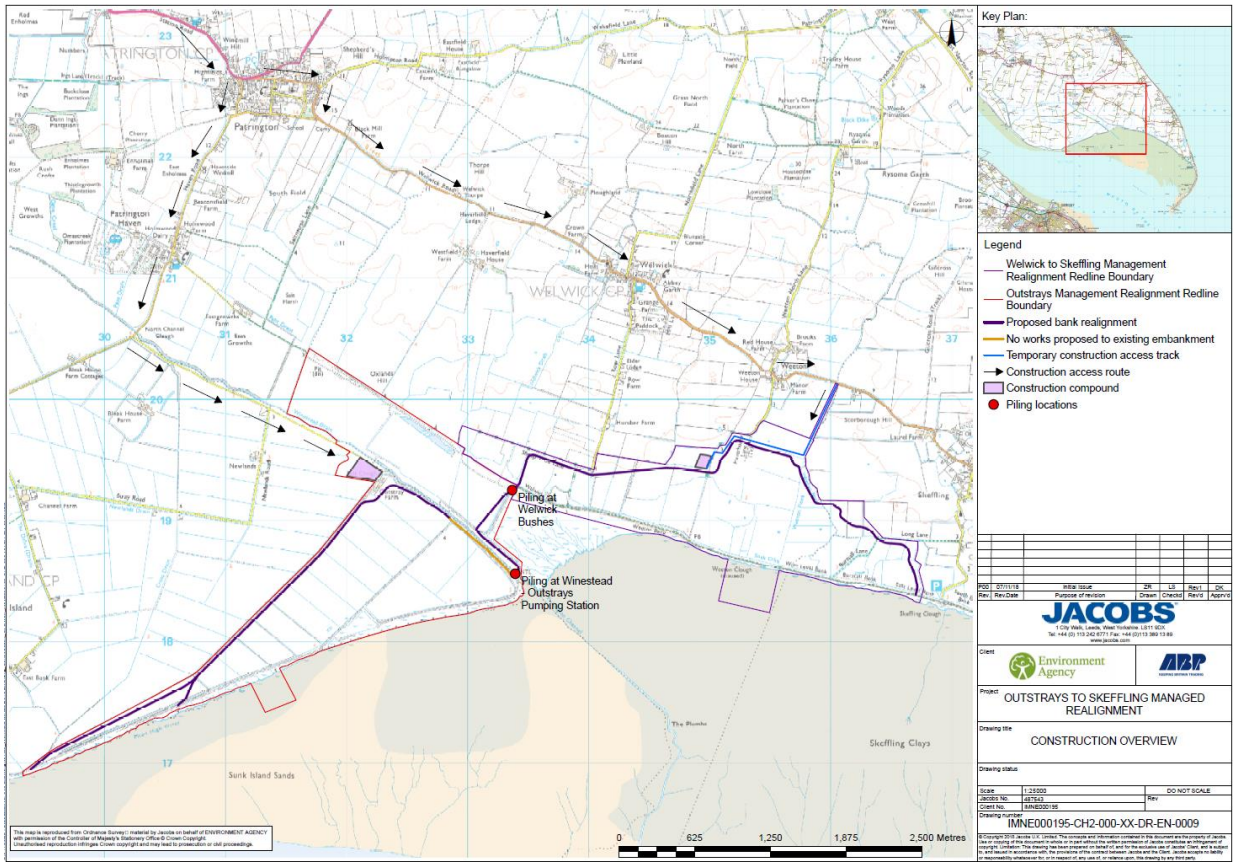
Works will be done during the spring and summer seasons, between April and the end of September each year, and between April and June for breaching and bank removal, to minimise impacts on over-wintering birds in the Humber Estuary. From October to March each year a small number of staff are likely to be on site for security and to carry out vegetation clearance that cannot be done in spring or summer.

3.3.2 Construction compounds and access routes

Plate 3.3 shows the proposed locations of the two construction compounds and access routes. The main construction compound will be located adjacent to Outstrays Farm, next to West 1 and West 2. This compound will be accessed from the A1033 at Patrington via Humber Lane, Haven Road, Main Street, Patrington Road, to Outstrays Road. Another compound will be located adjacent to East 1 and 2. This compound and the eastern site will be accessed from the A1033 at Patrington, along the B1445, then along a construction access track which will be installed for the Scheme and will join the B1445 just east of Weeton. Both compounds will be in place for the duration of the works.

Haul roads will be laid across the site, two existing bridges over Winestead Drain will be reinforced with steel structures and an additional two bridges will be installed, closer to Winestead-Outstrays Pumping Station. Additional temporary bridges may be required to cross the drains within West 2.

Plate 3.3: Locations of the two construction compounds and access routes



3.3.3 Construction methods, plant required and vehicle movements

Work is likely to be undertaken during day time working hours. Normal working hours will be from 0700 to 1900 Monday to Friday. It is assumed that any work on a Saturday would be undertaken from 0700 to 13.00. Site staff will use the access routes set out above to get to the site and will park in the site compounds. The majority of staff will park at the main compound. Car-sharing will be encouraged.

Most of the larger construction vehicles are likely to arrive on site at the start of the construction season in April and remain until the end of the construction season at the end of September each year. Occasional movements on and off the site will be required in the event of breakdowns or changing plant requirements and for deliveries.

Water abstraction for dust suppression is likely to be required. This would be abstracted from Winestead Drain.

3.3.3.1 Earthworks

The earthworks will comprise the excavation of the creeks and the construction of embankments. Haul roads will be laid out to provide access to the areas to be excavated. A dewatering system will be installed if required. Two excavation setups will be in operation at the same time in order to complete the works within schedule. The creeks will be excavated using excavators and material will be transported in dump trucks to the new embankment locations. The material will then be tipped and levelled using the dozers and compacted using rollers. Once each excavation is finished, the haul roads will be lifted and moved to the next location. An indication of plant requirements is provided below:

- 4 no. 35t excavators;
- 2 no. 21t excavators;
- 16-20 30t Articulated Dump Trucks;
- 5 no D6 dozers;
- 4 no 10t rollers; and
- 2 no. tractors and bowsers (for dewatering or dust suppression).

It is anticipated that the embankments will be constructed on a minimum of two fronts in both western and eastern sites. Additional fronts may be required, depending on the programming of the works.

Shifting of excavated/excess material will be contained within the site.

The construction of the Scheme includes an element of reprofiling works both within the area that will become intertidal and the existing fronting intertidal. This will ensure that elevations within the Scheme are best suited to the creation of intertidal habitats. In addition, this ensures that sediments are of local origin thereby negating the need to import material to achieve the same purpose.

3.3.3.2 Piling for the Outstrays Managed Realignment

At Winstead-Outstrays Pumping Station, piling will be carried out using vibratory methods from either a leader rig or a crane. Percussive piling will be used only as a last resort, if obstructions are encountered. These works are expected to take 4 weeks.

At Welwick Bushes, it is anticipated that a piling rig would install anchor piles using vibratory methods and a Giken piler would then be used to push the rest of the piles into place. If the ground conditions are not suitable for press piling, vibratory methods will be used. Percussive piling will be used only as a last resort, if obstructions are encountered. The piling equipment would be transported from the main compound at Outstrays Farm across West 2. These works are expected to take eight weeks.

3.3.3.3 Breach works

The breaching works will be carried out using bulk excavation equipment.

3.3.3.4 West 2 habitat creation

The creation of habitat in West 2 will be carried out by excavators, dump trucks and dozers.

3.3.4 Land reinstatement

Prior to the commencement of works, all accesses and land to be used for the project, including access routes, compound and storage areas will be surveyed and their condition photographically recorded. On completion of the works or part of the works, where appropriate, these areas will be re-surveyed and a schedule of remedial works prepared.

3.3.5 Materials requirements

Materials required for the construction of the Scheme include:

- Site compound units and hoarding for both sites;
- Surfacing materials for the compounds and haul roads across both sites;

- Surfacing materials for the new footpaths and access ramps across both sites;
- Fencing for both sites;
- Surfacing materials for the car park and construction access track for the eastern site;
- Badger meshing for the western site;
- Materials to build new bird hides or viewing platforms for both sites and reinstate the bird hide in West 2;
- Steel for reinforcing and building bridges across the drains for the western site; and
- Piles for the western site.

Excavated material from the creek areas will be used to build the new embankments. It is anticipated that no surplus material for the embankments will be required to be brought to site, and that there will be no surplus excavated material from the creeks that will need to be transported offsite.

3.4 Post-construction details

Once construction is complete, the site will be reinstated; this will involve removing site compounds (including welfare units), removing the temporary access track and clearing the site of any other construction related material and equipment. Roads used for construction access will be surveyed and restored to their previous condition where necessary.

3.5 Operation

3.5.1 Flood defence maintenance

Maintenance and inspection requirements for the new flood embankments will be determined in line with Environment Agency standards.

3.5.2 General site management

The overall responsibility for site management will remain with the Environment Agency and ABP; however, the management of some elements, such as land drainage assets, habitat creation areas and access facilities, by other organisations is being considered.

The Scheme will be monitored after the completion of construction, to ensure that it is delivering on its objectives. This will be in accordance with the Environmental Maintenance and Monitoring plan for the Scheme, and specific targets for bird species that will be agreed with Natural England.

3.5.3 Intervention works in East 2

To ensure the continued functioning of the Welwick to Skeffling Managed Realignment, intervention may be required. The method and frequency of any such intervention has not yet been defined and the requirement will be determined by the future compensation objectives that are set for ABP (as East 2 is compensating for losses from ABP activities), and how the site evolves. The objectives are likely to depend on the regulatory framework and policy applicable at the time.

It is assumed, however, that the intervention would require the East 2 area to be re-profiled to return it to elevations suited to sustaining mudflat. The most appropriate plant for the scale and type of work required will be defined as and when required. Supporting assessments will also be undertaken at this time to support the necessary consents and licensing requirements, as it is adjacent to the SPA, SAC, SSSI. These would reflect the temporary and localised nature of any such works as well as their underlying objective to promote sustainable mudflat. Access to East 2 would be from the new car park south of Weeton via an access ramp over the new embankment.

4 Methodology

4.1 Environmental Impact Assessment methodology

The EIA process provides information to describe and assess the likely significant environmental effects which may arise directly or indirectly as a consequence of a proposed development. The assessment considers the effects of the project on standard environmental receptors, based on best practice guidelines and the sensitivity of the receptors. The EIA will follow the requirements of our own, internal procedures and take into account the scoping responses received following the submission of the PEIR.

4.1.1 Assessment process

This ES provides an account of the existing baseline environmental conditions and identifies key issues which have been obtained through consultation and review of relevant baseline data. The assessment and evaluation stage of the EIA will be as follows:

- Overlay the proposed scheme onto the baseline information taking into account information provided during the scoping consultation;
- Consider the interaction of the scheme with environmental receptors, during the construction phase and operation (i.e. presence and maintenance activities), to identify potential effects. The focus of the EIA has been on the potential effects of the construction and operation phases, as it is anticipated that the scheme is unlikely to be decommissioned. It could be modified in the future, where potential effects from modifications would be similar to construction impacts, so have not been considered as requiring further assessment;
- Establish what mitigation measures are appropriate to remove or reduce potential effects to an acceptable level and what environmental outcomes may be delivered; and
- Determine the significance of the residual effects.

4.1.2 Assessment of significance

The approach to assigning significance of effect relies on reasoned argument, professional judgement and taking on board the advice and views of appropriate organisations. Significance is a factor of the value / sensitivity of the receptor and the magnitude of the predicted effect. The assessment of significance will be determined by the application of accepted industry standards. The general impact assessment criteria for determining significance are presented below, although certain topics (including biodiversity, landscape and visual, noise and air quality) follow industry standard criteria and guidance that is specific to that topic.

4.1.3 Environmental Impact Assessment criteria

4.1.3.1 Background to Environmental Impact Assessment

The Environmental Impact Assessment will demonstrate best practice and will refer to the following EIA guidance:

- IEMA Guidelines for Environmental Impact Assessment (2004);

- Highways Agency Design Manual for Roads and Bridges (2008); and
- Internal Environment Agency Management Systems Guidance.

Table 4.1 below provides an overview of the key stages and activities in the EIA process to be followed for the Scheme.

Table 4.1: Key stages and activities in the EIA process for the scheme

Stage	Activity	Reporting
Screening	Determine whether the proposed scheme requires an EIA under Schedule 2, Part 10 (Infrastructure Projects) of the Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulation 2017), and parts of the works also fall under the requirements of the Marine Works (Environmental Impact Assessment) Regulations 2017.	Scoping report (PEIR)
Scoping	Determine the aspects of the environment likely to be significantly affected by the proposed development. Collect and appraise baseline data and identify relevant resources and receptors. Carry out consultation to assist with baseline data gathering and identification of the views and concerns of local people and relevant organisations regarding the scheme. Request a formal scoping opinion from ERYC and MMO and incorporate their recommendations into the assessment.	Scoping report (PEIR)
Prediction of effects	Identify changes to the environment likely to be generated by the proposal. Identify resources and receptors likely to be affected by these changes and establish the pathways linking cause and effect. Identify likely effects to the environment as a result of the predicted changes, taking into consideration the direct effects and any indirect, secondary, cumulative, short, medium and long-term, permanent and temporary, positive and negative effects of the proposal. Predict the nature, extent and magnitude of anticipated impacts.	Environmental Statement
Evaluation of significance of effects	Assign levels of significance to the likely effects.	Environmental Statement
Mitigation measures and monitoring	Identify mitigation measures to avoid, reduce or offset any significant adverse effects. Identify methods of monitoring that can be implemented to assess the actual environmental effects of the development.	Environmental Statement Environmental Action Plan

4.1.3.2 Prediction and evaluation of effects

The prediction and evaluation stages consider the direct and indirect, cumulative, short, medium and long term, permanent and temporary, reversible and irreversible, adverse and beneficial effects of the proposed scheme during the construction and operation phases. The

prediction stage identifies how the Scheme will change the baseline environmental conditions and predicts the effects that those changes could have on different environmental receptors. The evaluation stage assesses the significance of those effects before the implementation of mitigation measures.

A number of criteria will be used to determine whether the potential effects of the scheme are 'significant'. These will be outlined with reference to specific environmental topics in the appropriate subsections the ES. Wherever possible, a quantitative assessment of the effects has been undertaken and where this was not possible, a qualitative assessment was undertaken, based on the available information.

In carrying out the EIA, a general method for grading the significance of environmental effects will be adopted to ensure consistency in the terminology of significance, whether for a beneficial or an adverse effect. The two principal criteria are the sensitivity of the receptor (Table 4.2) and the magnitude (Table 4.3) of the change arising from the Scheme. The sensitivity of a receptor is related to the importance of the receptor, for example its rarity or the level of protection afforded it. It also relates to the vulnerability of the receptor, for example, the range of environmental conditions that the receptor can tolerate.

Table 4.2: General criteria for classifying the value of sensitivity of environmental resources or receptors

Value	Criteria
Very High	International importance
High	National importance
Medium	Regional importance
Low	District/Parish importance
Negligible	No listed importance

Table 4.3: General criteria for classifying the magnitude and nature of impacts

Magnitude	Definition
Major negative	Impact with serious consequences and/or on a large area
Moderate negative	Impact with undesirable consequences
Minor negative	Discernible negative impact and/or on a small area
Negligible	No impact or no discernible impact
Minor positive	Discernible positive impact and/or on a small area
Moderate positive	Impact with favourable consequences
Major positive	Impact provides substantial gains and/or on a large area

As shown in Table 4.4, the assessment of significance is classed as major, moderate, minor or none; either beneficial (positive) or adverse (negative). This is standard for an EIA categorisation, which is derived from the Guidelines for Environmental Impact Assessment (IEMA, 2004) and the Design Manual for Roads and Bridges (Highways Agency, 2008).

Table 4.4: Assessment of significance of environmental effects and residual effects

Magnitude	Value/sensitivity			
	Very High	**High**	**Medium**	**Low**
Major negative	Major adverse	Moderate adverse – Major adverse	Moderate adverse	Minor adverse – Moderate adverse
Moderate negative	Moderate adverse- Major adverse	Moderate adverse	Minor adverse – moderate adverse	Minor adverse
Minor negative	Minor adverse – Moderate adverse	Minor adverse – Moderate adverse	Minor adverse	Minor adverse
Negligible	No effect			
Minor positive	Minor beneficial – Moderate beneficial	Minor beneficial – Moderate beneficial	Minor beneficial	Minor beneficial
Moderate positive	Moderate beneficial – Major beneficial	Moderate beneficial	Minor beneficial – Moderate beneficial	Minor beneficial
Major positive	Major beneficial	Moderate beneficial – Major beneficial	Moderate beneficial	Minor beneficial – Moderate beneficial
Note: effects that are moderate or above are considered significant in terms of the EIA regulations (shaded grey).				

Another consideration is the duration of the effect, for example, whether it is likely to be temporary or permanent, and if temporary, whether it is of short, medium or long term duration. Defining the duration of the effect can be subjective, depending on the receptor. For example, following temporary clearance of land, it may take many years for an area of woodland to re-establish. Although in ecological terms this period may not be long, for the people who use the woodland it is significant in relation to their lifetime and could therefore be considered permanent. A general method for grading the duration of environmental effects has been adopted to ensure consistency in the terminology of significance (Table 4.5).

Table 4.5: Duration of effects

Nature of change	Duration	Definition/description
Temporary	Short term	Effect continues during construction (1 to 3 years) and up to 1 year following construction
	Medium term	Effect continues 1 to 5 years following construction
	Long term	Effect continues 5 to 10 years following construction
Permanent		Due to the subjectivity of human perception of timeframes, those effects that continue for greater than 10 years following construction can be defined as permanent

4.1.3.3 Mitigation measures and monitoring

The EIA Regulations prescribe that an ES should include "…a description of the measures envisaged to prevent, reduce and where possible remedy any significant adverse effects on the environment". For this Scheme, a variety of mitigation measures have been considered. Those that have been adopted fall into one of three groups:

- Measures incorporated into the design of the works during the design development process to control the effects at the source;
- Construction control procedures consistent with regulatory requirements or industry good practice; for example, following Environment Agency Pollution Prevention Guidelines to prevent contamination of soils or groundwater; and
- Measures to provide mitigation where unavoidable significant adverse effects occur; for example, returning the existing car park to grassland habitat to mitigate the loss of grassland habitat elsewhere within the Scheme.

A detailed description of the proposed mitigation measures and the identification of individuals or organisations responsible for their implementation will be provided within an Environmental Action Plan (EAP) which has been developed for the Scheme. The EAP will be used to manage and monitor the implementation of the identified mitigation measures and will be regularly checked and updated. The monitoring that is proposed to be undertaken as part of the Scheme will also be described in the ES.

4.1.3.4 Residual effects

Residual effects are the remaining effects of the Scheme assuming successful implementation of the identified mitigation measures. The significance ratings of residual effects are, if appropriate, assessed within the relevant subsections of the ES.

4.1.3.5 Uncertainties

The certainty with which effects on the environment can be predicted and evaluated is dependent on the data that is available and the knowledge about how different receptors respond to changes in the environment. Uncertainties and limitations encountered and assumptions made in the EIA are documented within the relevant topic assessments in the ES.

5 Socio-economics and land use

5.1 Introduction

The analysis in this chapter will outline the prevailing socio-economic environment of the study area to establish the baseline conditions and identify socio-economic receptors that may be affected by the Scheme. This baselining analysis establishes the overall context within which the impact of the Scheme on various socio-economic receptors can be assessed.

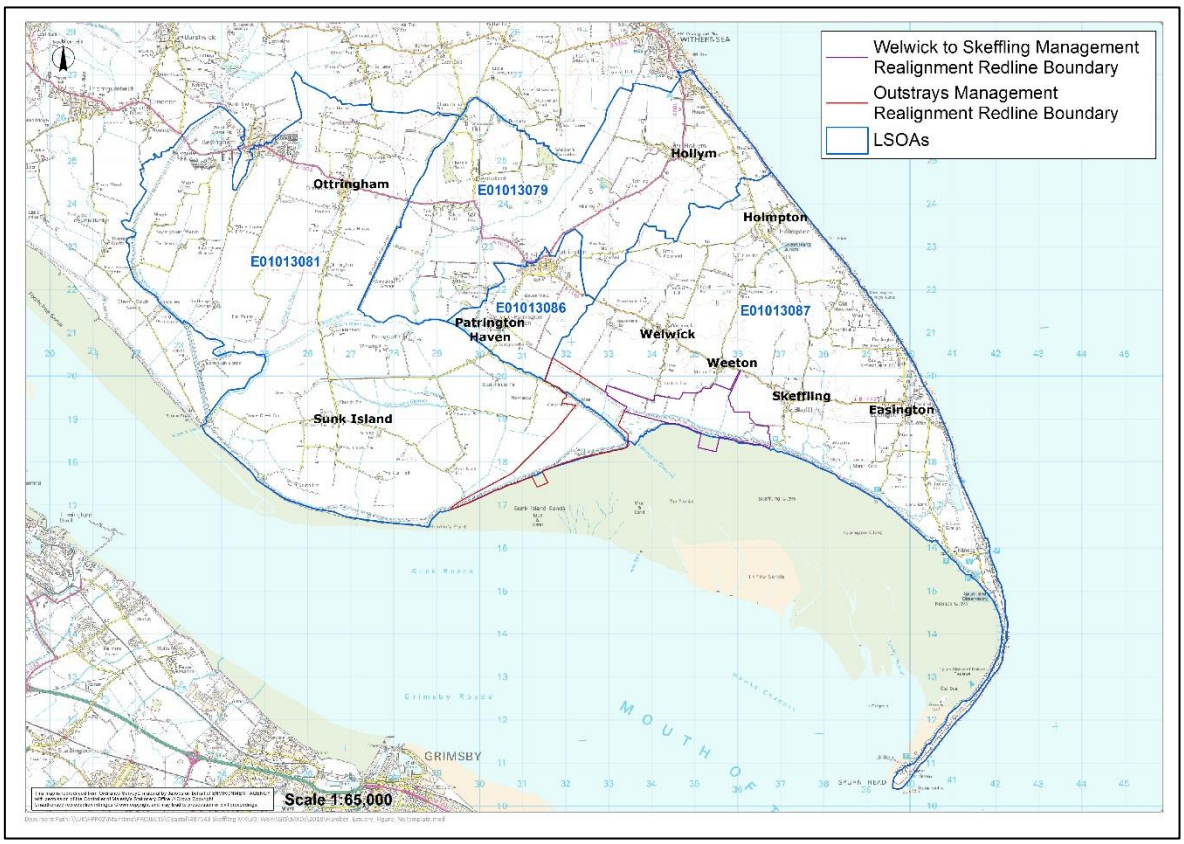
5.2 Methodology

5.2.1 Study area

The potential socio-economic impacts of the Scheme can only be established by understanding the existing socio-economic conditions within the Scheme's context areas. The context areas are defined as follows:

- Immediate study area – comprising the settlements of Patrington, Patrington Haven, Weeton, Welwick, Skeffling and surrounding agricultural land, covered by Lower Super Output Areas (LSOA) E01013081, E01013079, E01013086 and E01013087 (unless stated otherwise), as illustrated in Plate 5.1 below.

Plate 5.1: Immediate study area



- Relevant local authorities – East Riding of Yorkshire (in which the project is located) and City of Kingston upon Hull (nearby major urban area that will benefit from the project);
- Relevant UK Regional Benchmark – Yorkshire and the Humber; and
- Relevant UK National Benchmark – England.

A range of socio-economic indicators are considered within the study area and relevant benchmarks, incorporating the following themes:

- Demography;
- Economic Activity and Unemployment;
- Skills, Occupation and Social Grade;
- Employment and Business Profile;
- Deprivation Analysis; and
- Land Use

5.2.2 Baseline data collection

For the purpose of this analysis, all of the data used has been obtained from Nomis. Nomis is an online data service that is provided by the Office for National Statistics that provides data on local labour market statistics. Appropriate data was downloaded for various context areas.

5.2.3 Impact assessment

This assessment is based on the methodology set out in Chapter 4 of this ES.

5.3 Uncertainties, assumptions and limitations

Baseline data downloaded from Nomis from the Census was from 2011, this was the latest year that data was available for the socio-economic indicators. It should be noted that the numbers presented in terms of population and other socio-economic indicators would have changed since then. Therefore, the data in some instances does not reflect the current position for some demographic metrics.

Furthermore, as no detailed information was available relating to the quantum and type of crops that were currently grown on the land it has not been possible to undertake this analysis. This analysis would have been included under the direct loss of agricultural land section.

Future baseline predictions for socio-economics and land use are difficult to predict, as there are limited estimations and data available.

5.4 Existing environment

5.4.1 Baseline socio-economic conditions

The detailed baseline socio-economic analysis that has been undertaken is presented in Appendix 5.1. This section presents a summary of the analysis undertaken for each of the socio-economic indicators presented in Appendix 5.1.

5.4.1.1 Demography

- The 2011 Census survey reveals that the immediate study area was home to approximately 6,000 residents. Growth in the population since 2001 within the study area and local authority grew slower than the national average.
- There is an ageing population in the immediate study area, it contains the highest proportion of individuals aged 65+ in comparison to national, regional and local authority benchmarks.

5.4.1.2 Economic activity and unemployment

- Both the immediate study area and Hull have a lower economic activity rate when compared to regional and national benchmarks.
- The unemployment rate within the immediate study area is in line with the local authority and national average, whilst Hull has an unemployment rate that is twice the national average.
- This trend is reflected in the number of individuals that claim Job Seekers Allowance (JSA). Within the immediate study area this is lower than national and regional benchmarks, whereas Hull has a higher proportion of claimant count compare to the benchmarks. This alongside aforementioned economic indicators shows that the area needs investment that would help to catalyse economic development and regeneration.
- The Indices of Multiple Deprivation (2015) highlights that the Lower Super Output Areas that the immediate study area resides within have low levels of employment deprivation.

5.4.1.3 Skills, occupation and social grade

- Census 2011 data reveals that within the immediate study area the proportion of individuals that have no qualifications is higher than both regional and national benchmarks.
- Within the immediate study area, 34% of individuals are employed within high-level occupations categories. This is lower in comparison to East Riding of Yorkshire (40%) Kingston Upon Hull, City of (26%), Yorkshire and The Humber (37%) and England (41%).
- The Annual Survey of Hours and Earnings (2016) indicates that residents of Hull typically earn a gross weekly pay that is less than both national and regional averages across all years presented.

- The Indices of Multiple Deprivation's Income Domain demonstrates that the study area does not suffer from significant deprivation from an income perspective.
- A person's approximated social grade is based primarily on their occupation but also includes information about their employment status, qualifications gained, tenure, income and whether they work full-time, part-time or are not working. The immediate study area has 56% of individuals within the lower social grade, in comparison to the national and regional averages of 52% and 46% respectively.

5.4.1.4 Employment and business profile

- The sectoral profile of workplace employment reveals the importance of tourism and recreation within the vicinity of the Scheme.
- Hull has a higher than average number of individuals in the manufacturing and construction sector when compared to national and regional averages.
- The region holds an important position in terms of presence of oil and natural gas as it benefits from the proximity to the Southern North Sea gas fields.
- The immediate study area and relevant local authorities do suffer from below average levels of employment in finance and insurance activities and professional, scientific and technical activities that are typically high-paid, high-value jobs.

5.4.1.5 Tourism and recreation

- The visitor economy employs about 14,000 people in the Yorkshire and Humber region, which represents a contribution of 2.4% of the region's employment.
- The Humber Estuary area consists of many tourism attractions and destinations both along the coast and inland, ranging from beaches to natural amenities to urban centres.

5.4.1.6 Summary of socio-economic indicators

In light of the above findings, a study by Hull Business School commissioned by the Humber Local Enterprise Partnership (GVA growth in the Humber Economy, 2016) shows that the Humber is below the national average across key socioeconomic metrics, including economic prosperity, productivity, manufacturing output, value-added jobs, skills, employment and social mobility. The study stresses the need for action to reverse the trend in the region. Some of the recommendations are: to consolidate the Humber as the Energy Estuary (renewable energy generation and related manufacturing); to develop the port-based economy and to develop an integrated multi-modal freight and passenger Gateway; and to support or develop other sectors such as chemicals and processing and information and communication. Investment in major infrastructure related to flood risk management could help the Humber achieve this aspiration, by improving investor interest and confidence and unlocking economic development and regeneration.

5.4.1.7 Deprivation analysis

- Household deprivation data from Census (2011) measures if a household is deprived across one or more of the following; employment, education, health and disability or housing.

- Trends within the data indicate that the immediate study area is performing in line with national benchmarks, whilst Hull performs worse than regional and national benchmarks.
- Aggregate deprivation from the IMD (2015) depicts that Hull suffers from the most deprivation relative to the comparator geographical contexts. The immediate study area suffers from low levels of deprivation.

5.4.2 Land use and the rural economy

5.4.2.1 Land use classification

- The immediate study area is classified as 'rural villages in a sparse setting' as part of the 2011 Census Rural-Urban Classification.

5.4.2.2 Farming

- A Land Research Associates report (2016) on the 'Agricultural Quality of Land Between Welwick to Skeffling, East Riding of Yorkshire' shows that most of the 418 ha of land in the immediate study area is in agricultural use.
- At least 52% of that land is of best and most versatile quality which is reflected in the grading of 2 and sub-grade 3a.
- The primary agricultural activities revolve around tenant farming, with a focus on primary crops. There is limited livestock farming.
- Nix's (2017) 'Farm Management Pocketbook' states that the estimated value of agricultural land is around £21,000 per hectare (2016 estimate). As such, the total value of agricultural land in the immediate study area amounts to around £8.8 million.

5.4.2.3 Rural economy

- Yorkshire and the Humber produces 12% of England's agricultural output and employs 10% of the country's agricultural workforce.
- Bioeconomy is an evolving concept and the Yorkshire and the Humber region already contributes to 10% of the country's bioeconomy (BioVale, n.d.).

5.5 Future baseline

The England Coast Path, delivered by Natural England to fulfil the Right of Coastal Access legislation, is likely to increase interest in nature tourism. If not managed carefully, ongoing tourism activities combined with potential nature tourism related activities could cause damage to important estuarine habitats and species.

Furthermore, without the Scheme, ABP would be unable to fulfil their ambition and vision of expanding their port activity as they are required to compensate for habitat losses, which this project would help achieve. Moreover, without the project, both the operational stage and construction stage jobs and subsequent Gross Value Added (GVA) generated would not be realised.

Without the Scheme, flood risk in this area is likely to increase due to likely deterioration of the existing defences and sea-level rise due to climate change.

5.6 Likely significant effects

5.6.1 Outstrays Managed Realignment

5.6.1.1 Construction

Direct jobs and GVA impacts

Construction stage impacts such as job creation are estimated as a function of scheme costs. Following established benchmarks for translating construction expenditure into jobs, the analysis demonstrates that an estimated 74 gross construction stage jobs will be created as a result of the Outstrays Managed Realignment. This estimate is based on a construction cost per job benchmark which is applied to the total construction costs.

The analysis previously undertaken in Section 5.4 illustrates that there are positive trends within the immediate study area, relating to both unemployment and other key socio-economic indicators. The sectoral profiles of employment for the immediate study area reveals that the construction industry is strong, with over 8% of individuals employed within that sector. This is higher than both regional and national benchmarks.

Where possible, locally sourced workers will be used. That said, the specialised nature of the construction industry means that it is not always possible to guarantee jobs will be sourced from the local labor market. The jobs created as a result of the Outstrays Managed Realignment that are appointed to local workers will help to sustain the growing construction industry within the immediate study area and help the immediate study area develop an expertise in construction.

As well as impacts related to jobs during the construction stage, there will be an uplift in GVA which is estimated to be £2.8 million, arising through investment in the preparatory and construction stages. Given its size and strength, the sensitivity of the local construction industry as a socio-economic receptor can be described as **medium.**

Given the scale of impacts on the local construction industry, the magnitude of the impacts is considered to be **moderate positive** in light of the temporary nature of impacts and the potential for non-local impacts.

Combining the medium sensitivity of the local labour market and the medium positive magnitude of the impact of construction, the significance of the availability of new construction-related employment opportunities and subsequent effects on the local construction industry can be described as **moderate beneficial** short-term effect**.**

Indirect jobs and GVA impacts

Indirect construction stage impacts arise as a result of increased expenditure by contractors within their supply chain (leading to increased employment demand and output within the supply chain) and increased expenditure by employees on consumer

goods and services (leading to increased employment demand and output within the consumer industry).

The supply chain and consumer services business receptors that will benefit from the boost could be local. Similarly, expenditure impacts are also likely to be local, given that construction stage employees are likely to either be local people or stay within the immediate study area for a period of the construction stage.

During the construction stage, non-local employees will consume goods and services from nearby businesses which will be either micro or small businesses Therefore, any fluctuations in expenditure will have a disproportionate impact on the revenue of the business. Thus, the sensitivity of local business receptors can be described as **medium**. Established benchmarks also allow for the quantification of indirect jobs created within the construction stage. The analysis demonstrates that an estimated 63 indirect jobs could be created, giving rise to an indirect GVA impact of £2.38 million.

As per the magnitude of the direct impacts, in light of the temporary nature of indirect impacts and the potential for some impacts to be felt outside of the immediate study area, the magnitude of indirect impacts is likely to be **moderate positive**.

Combining the medium sensitivity of local business and services and the moderate positive magnitude of the impact, the indirect employment opportunities and GVA uplift for the local economy can be described as a **moderate beneficial** short-term effect.

Impact on education

The contractor will be required to sign up to the Considerate Constructors Scheme through which there may arise opportunities to involve school children through site visits as well as presentations given to them. Moreover, there may also be opportunities for apprenticeships. Compared to national and regional benchmarks, the immediate study area ranks highly in terms of employment within construction. Furthermore, the immediate study area has the highest proportion of individuals that have an apprenticeship. Given the specialist nature of the immediate study area in construction, it is estimated that the sensitivity of the educational receptor can be described as **low.**

As per the magnitude of the impacts, the IMD (2015) Employment Deprivation demonstrates that the immediate study area suffers from some levels of employment deprivation. It is envisaged that a few apprenticeships may be offered, given this information the estimated magnitude of impact on the level of apprentices within the immediate study is considered to be **minor positive**.

Combining the low sensitivity of the education receptor and the minor positive magnitude, the impact of providing apprenticeships and some educational visits or presentations can be described as a **minor beneficial** short-term effect**.**

Direct impact as a result of loss of agricultural land

Current land use in the site area is agricultural land, with site visits revealing the growing of oil seed rape, wheat/barley and peas. The Agricultural Land Classification shows at least 52% of the land to be of best and most versatile quality. Following site delivery, existing agricultural crop land will no longer be available for the same activities. There is potential for some of the intertidal land replacing the existing agricultural crop land to be used for sheep grazing. However, no specific plans have

been formalised to date. As such, it is prudent to assume that agricultural land will be lost due to the Outstrays Managed Realignment. This loss of land is likely to be incurred from the start of the construction stage and is therefore considered a construction stage impact. It should be noted that it is a long-term and permanent impact which will continue into the operational stage.

Compared to national and regional benchmarks, the immediate study area ranks low in terms of employment within agriculture. Furthermore, the Environment Agency has already negotiated land purchase for agricultural land assets where ownership is required to deliver the managed realignment site. Thus, employment within the agricultural sector is considered as a **low** sensitivity receptor.

The land within the site area West 1 and 2 is already owned by the Environment Agency and leased for agricultural use on a short-term basis. The Environment Agency has purchased the remaining land at market value, by agreement with the land owners.

While it is not possible to quantify the impact of the loss of crops due to a lack of information on the crop rotation and output levels, given the high quality of land it is estimated that there will be a sizeable monetary impact as a result of the loss of agricultural land. However, due to the compensation mechanism that has already been put in place that addresses the land owners that have been impacted, loss of agricultural land is considered to be a **minor negative** magnitude of impact. Combining the low sensitivity receptor and the minor negative magnitude impact, the loss of agricultural land can be described as a **minor adverse** long-term effect.

5.6.1.2 Operation

Direct (operational) employment impacts

Once implemented, the site has the potential to generate operational phase employment related to the management and maintenance of the site. This will provide a small number of additional jobs for the local economy. Job creation remains a key objective underpinning local as well as national planning policy. Therefore, the labour market is considered as a **medium** sensitivity receptor. However, minimal job creation (one site manager plus maintenance support) is anticipated in the operation phase of the site. Taking this into account, the impact of operational stage employment opportunities is of **minor positive** magnitude.

Combining the medium sensitivity of the local labour market and the low magnitude employment impact as a result of the operational stage, the effect on the local labour market can be described as a **minor beneficial** long-term effect.

Indirect (operational) impact as a result of loss of agricultural land

Some of the current agricultural land will be used for reactional activities such as bird watching. The permissive access route that is being proposed along the embankment will provide access to this through designated areas that will be used for bird watching. Thus, there will be improved public amenities. The eastern side of the West 2 access route will also be a designated bridleway, creating recreational opportunities.

The Outdoor Recreation Valuation Tool (ORVal) has been used to estimate the value of recreational activities within the Middle Super Output Areas (MSOA) that the site will be built in. This tool estimates the existing value to be nearly £2.2 million per year. This

is relatively higher than the surrounding MSOAs, therefore, the tourism sector, measured in the form of recreational activity is a **medium** sensitivity receptor due to the given popularity of recreational activities within the area.

Currently there is a permissive access route through Haverfield Quarry, approximately 2.1 km long. This will be upgraded to a designated bridleway (Public Right of Way, PRoW). As part of the proposals approximately 5.3 km of new permissive access route (along West 1 and around the western and northern edge of West 2) will be provided in the western site. The footpath will provide an extension of 5.3 km of new public access route to the existing 2.1 km route.

The average public footpath within that area according to the ORVal tool is estimated at nearly £8k per year from a recreational perspective. Thus, the site could enhance the value of recreation by £8k. Based on the scale of the uplift in recreational value of enhancing tourism opportunities, the magnitude can be described as **minor positive.**

Given the medium sensitivity of the tourism industry as a receptor, combined with the low magnitude of the impacts, the effect on recreational values can be described as a **minor beneficial** long-term effect.

Wider economic benefits

By providing enhanced flood protection, the managed realignment site could lead to wider regeneration throughout the immediate study area, as well as Kingston Upon Hull through the development of flood risk management activities in Hull.

Investment in major infrastructure related to flood risk management could improve investor interest and confidence, thereby unlocking economic development and regeneration opportunities within Hull and the wider Humber region. This could help address the socio-economic challenges faced by Hull, as the occupational structure analysis indicates Hull has a higher rate of individuals occupied within low-level occupations when compared to regional and national benchmarks.

Components of the wider economy benefiting from such impacts could include key emerging and growth sectors such as the bioeconomy, which is already established in the sub-region.

Once the site is operational the site manager may be able to facilitate school visits as well as other educational visits to provide a better understanding to locals about the construction industry. Moreover, through the provision of newsletters and drop-in sessions the community's knowledge of construction can be further deepened, further enhancing the immediate study areas expertise in the construction industry. Given the deprived nature of Hull compared to the region, the sensitivity of the sub-regional economy can be described as **high**. The site has the potential to have a transformational impact of the sub-regional economy by driving economic development and regeneration. As a result, the magnitude of the impact can also be described as **major positive**. Thus, the effect of the site on wider socio-economic conditions in the sub-region can be described as a **major beneficial** long-term effect.

5.6.2 Welwick to Skeffling Managed Realignment

5.6.2.1 Construction

Direct jobs and GVA impacts

Construction stage impacts such as job creation are estimated as a function of site costs. Following established benchmarks for translating construction expenditure into jobs, the analysis demonstrates that an estimated 74 gross construction stage jobs will be created as a result of the Welwick to Skeffling Managed Realignment. This estimate is based on a construction cost per job benchmark which is applied to the total construction costs.

The analysis previously undertaken in section 5.4 illustrates that there are positive trends within the immediate study area, relating to both unemployment and other key socio-economic indicators. The sectoral profiles of employment for the immediate study area reveals that the construction industry is strong, with over 8% of individuals employed within that sector. This is higher than both regional and national benchmarks.

Where possible, workers will be sourced locally. That said, the specialised nature of the construction industry means that it is not always possible to guarantee that jobs will be sourced from the local labour market. The jobs created as a result of the Welwick to Skeffling Managed Realignment that are appointed to local workers will help to sustain the growing construction industry within the immediate study area and help the immediate study area develop an expertise in construction.

As well as impacts related to jobs during the construction stage, there will be an estimated £2.8m uplift in GVA. This is expected to arise through investment in the site preparation and construction stages. Given its size and strength, the sensitivity of the local construction industry as a socio-economic receptor can be described as **medium**.

Given that an estimated 74 construction stage jobs will be created, the magnitude of impacts are considered to be **medium positive**, considering the temporary nature of impacts and the potential for non-local impacts.

Combining the medium sensitivity of the local labour market and the medium magnitude of the impact of construction, the significance of the availability of new construction-related employment opportunities and subsequent effects on the local construction industry can be described as a **moderate beneficial** short-term effect.

Indirect jobs and GVA impacts

Indirect construction stage impacts arise as a result of increased expenditure by contractors within their supply chain (leading to increased employment demand and output within the supply chain) and increased expenditure by employees on consumer goods and services (leading to increased employment demand and output within the consumer industry).

The supply chain and consumer services business receptors that will benefit from the boost could be local. Similarly, expenditure impacts are also likely to be local, given that construction stage employees are likely to either be local people or stay within the immediate study area for the period of the construction stage.

During the construction stage, non-local employees will consume goods and services from nearby businesses which will be either micro or small businesses. Therefore, any fluctuations in expenditure will have a disproportionate impact on the revenue of the business. Thus, the sensitivity of local business receptors can be described as **medium**.

Existing benchmarks also allow for the quantification of indirect jobs created within the construction stage. The analysis demonstrates that an estimated of 63 jobs could be created. The analysis demonstrates that an estimated 63 indirect jobs could be created, giving rise to an indirect GVA impact of £2.38 million.

As per the magnitude of the direct impacts, in light of the temporary nature of indirect impacts and the potential for some impacts to be felt outside of the immediate study area, the magnitude of indirect impacts is likely to be **moderate positive**.

Combining the medium sensitivity of local business and services and the moderate positive magnitude of the impact, the indirect employment opportunities and GVA uplift for the local economy can be described as a **moderate beneficial** short-term effect.

Impact on education

The contractor will be required to sign up to the Considerate Constructors Scheme through which there may arise opportunities to involve school children through site visits as well as presentations given to them. Moreover, there may also be opportunities for apprenticeships. Compared to national and regional benchmarks, the immediate study area ranks highly in terms of employment within construction. Furthermore, the immediate study area has the highest proportion of individuals that have an apprenticeship. Given the specialist nature of the immediate study in construction, it is estimated that the sensitivity of the educational receptor can be described as **low.**

As per the magnitude of the impacts, the IMD (2015) Employment Deprivation demonstrates that the immediate study area suffers from some levels of employment deprivation. It is envisaged that a few apprenticeships may be offered, given this information the estimated impact on the level of apprentices within the immediate study is considered to be a minor positive short-term effect.

Combining the low sensitivity of the education receptor and the minor positive magnitude, the impact of providing apprenticeships and some educational visits or presentations can be described as a **minor beneficial** short-term effect**.**

Direct impact as a result of loss of agricultural land

Current land use in the site area is agricultural land, with site visits revealing the growing of oil seed rape, wheat/barley and peas. The Agricultural Land Classification shows at least 52% of the land to be of best and most versatile quality. Following site delivery, existing arable land will no longer be available for the same activities. There is potential for some of the intertidal land replacing the existing arable land to be used for sheep grazing. However, no specific plans have been formalised to date. As such, it is prudent to assume that agricultural land will be lost as a result of the Welwick to Skeffling Managed Realignment. This loss of land is likely to be incurred from the start of the construction stage and is therefore considered a construction stage impact. It should be noted that it is a long-term and permanent impact which will continue into the operational stage.

Compared to national and regional benchmarks, the study area ranks low in terms of employment within agriculture. Furthermore, the Environment Agency is in the process of negotiating land purchase for agricultural land assets where ownership is required to deliver the scheme. Thus, employment within the agricultural sector is considered as a **low** sensitivity receptor.

Land within the site area is partially owned by the Environment Agency or Associated British Ports and leased for agricultural use on a short-term basis. The Environment Agency has started a process for purchasing the remaining land and agreements will be put in place. Compared to national and regional benchmarks, the study area ranks low in terms of employment within agriculture.

While it is not possible to quantify the impact of the loss of crops due to a lack of information on the crop rotation and output levels, given the high quality of land and it is estimated that there will be a sizeable monetary impact as a result of the loss of agricultural land. However, due to the compensation mechanism that has already been put in place that will address the land owners that have been impacted, loss of agricultural land is considered a **minor negative** magnitude of impact. Combining the low sensitivity receptor and the minor negative magnitude impact, the loss of agricultural land can be described as a **minor adverse** long-term effect.

5.6.2.2 Operation

Direct (operational) employment impacts

Once implemented, the site has the potential to generate operational phase employment related to site management and maintenance. This will provide a small number of additional jobs for the local economy. Job creation remains a key objective underpinning local as well as national planning policy. Therefore, the labour market is considered as a **medium** sensitivity receptor.

However, minimal job creation (one site manager plus maintenance support) is anticipated in the operation phase of the site. Taking this into account, the impact of operational stage employment opportunities is of **minor positive** magnitude.

Combining the medium sensitivity of the local labour market and the low magnitude employment impact as a result of the operational stage, the effect on the local labour market can be described as a **minor beneficial** long-term effect.

Indirect (operational) impacts as a result of loss of agricultural land

Some of the agricultural land will be used for recreational purposes, potentially benefitting the tourism industry. As part of the proposal, a new car park south of Weeton will be provided. The existing footpath (PRoW) within the site will be diverted, and the proposed path realignment will be longer than the current alignment. The extended access route will have designated areas for bird hides/viewing platforms. Therefore, there will be an increase in both access and amenity facilities.

The Outdoor Recreation Valuation Tool (ORVal) has been used to estimate the value of recreational activities within the Middle Super Output Areas (MSOA), E02002722, that the scheme will be built in. This tool estimates the existing value to be nearly £2.1 million per year. This is relatively higher than the surrounding MSOA's, therefore, the tourism sector, measured in the form of recreational activity and value as a result of the scheme, is a **medium** sensitivity receptor due to the given popularity of recreational activities within the area.

The footpath (PRoW) along the existing embankment is approximately 3.5 km long and will be diverted along the new embankment and around the edge of the Welwick to Skeffling habitat creation and mitigation area adjacent to East 1. It will be upgraded to a designated bridleway (PRoW). This increases the overall length of the PRoW by

approximately 1.5 km. The average public footpath within that area according to the ORVal tool is estimated at nearly £5k per year from a recreational perspective. Thus, the site could hence increase the value of recreation by £5k. Based on the scale of the uplift in recreational value of enhancing tourism opportunities, the magnitude can be described as **minor positive**.

Given the medium sensitivity of the tourism industry as a receptor combined with the minor positive magnitude of impacts, the effect on recreational values can be described as a **minor beneficial** long-term effect**.**

Wider economic benefits

By producing enhanced flood protection, the scheme could lead to wider regeneration through the immediate study area as well as Kingston Upon Hull. With reference to the baseline socioeconomic conditions highlighted in Section 5.4, the managed realignment site could have implications on a range of socio economic receptors.

Investment in major infrastructure related to flood risk management could improve investor interest and confidence, thereby unlocking economic development and regeneration opportunities within Hull and the wider Humber region. This could help improve the socio-economic challenges faced by Hull, as the occupational structure analysis indicates, Hull has a higher rate of individuals occupied within low-level occupations when compared to regional and national benchmarks. It will also support the wider economy, including key emerging and growth sectors such as the bioeconomy which is already established in the sub-region.

Once the site is operational the site manager may be able to facilitate school visits as well as other educational visits to provide a better understanding to locals about the construction industry. Moreover, through the provision of newsletters and drop-in sessions the community's knowledge of construction can be further deepened, further enhancing the immediate study area's expertise in the construction industry.

The site will also will support the long-term expansion aspirations of ABP and help capture the business opportunities within the port areas, as ABP is required to compensate for habitat loss through their expansion. The site would also help create ecological opportunities and give rise to the formation of a new habitat as ABP are legally required to provide estuarine habitats. The expansion of the ABP could lead to economic regeneration of the area through the creation of new jobs.

Given the deprived nature of Hull compared to the region, the sensitivity of the sub-regional economy can be described as **high**. The site has the potential to transform the sub-regional economy by driving economic development and regeneration. As a result, the magnitude of the impact can also be described as **major positive**. Thus, the effect of the site on wider socio-economic conditions in the sub-region can be described as a **major beneficial** long-term effect.

5.7 Mitigation

5.7.1 Outstrays Managed Realignment

No significant adverse effects have been identified, therefore no mitigation measures are deemed necessary. One minor adverse effect is noted relating to loss of agricultural land. However, the Environment Agency have already put in place a

mechanism to purchase land at market value, by agreement with the land owners. This process is built into the Scheme and no further mitigation is required.

5.7.2 Welwick to Skeffling Managed Realignment

No significant adverse effects have been identified, therefore no mitigation measures are deemed necessary. One minor adverse effect is noted, relating to loss of agricultural land. However, the Environment Agency and ABP have started the process for purchasing the land and agreements will be put in place with the land owners. This process is built into the Scheme and no further mitigation is required.

5.8 Residual effects

5.8.1 Outstrays Managed Realignment

As no mitigation measures are deemed necessary, the residual effects are consistent with the likely significant effects outlined in Section 5.6.

5.8.2 Welwick to Skeffling Managed Realignment

As no mitigation measures are deemed necessary, the residual effects are consistent with the likely significant effects outlined in Section 5.6.

6 Population and recreation

6.1 Introduction

This chapter considers the effects of the Scheme on the local population, access, and on recreational users within the study area.

The following effects will be assessed:

- Effects on public access and recreation within the study area;
- Effects of any change in flood risk on the local population and properties; and
- Effects on health and wellbeing of the local population related to the topics above.

Other effects of the Scheme on the local population are considered within other chapters of this Environmental Statement. The health and safety of the local community and construction workers with regards to potential contamination is assessed in relation to the water environment in Chapter 8 and in relation to geology, soils and hydrogeology in Chapter 9. Chapter 12 assesses the effects on visual amenity. The potential effects relating to disturbance or nuisance effects from changes in traffic and transport, air quality, and noise and vibration during construction are assessed within Chapter 14, 15, and 16, respectively.

6.2 Regulatory and policy framework

In addition to the regulatory and policy documentation listed within Chapter 1 and Appendix 1.4, other relevant legislation and key policies have been considered:

- East Riding Local Plan, Open Space Supplementary Planning Document, November 2016

This document is to aid the implementation of the East Riding Local Plan to encourage access to open spaces that offer numerous benefits to members of the community.

- East Riding of Yorkshire Council Rights of Way Improvement Plan 2008 – 2018 (Refresh 2011).

This document assesses the current extent and accessibility of rights of way and identifies opportunities for improvement.

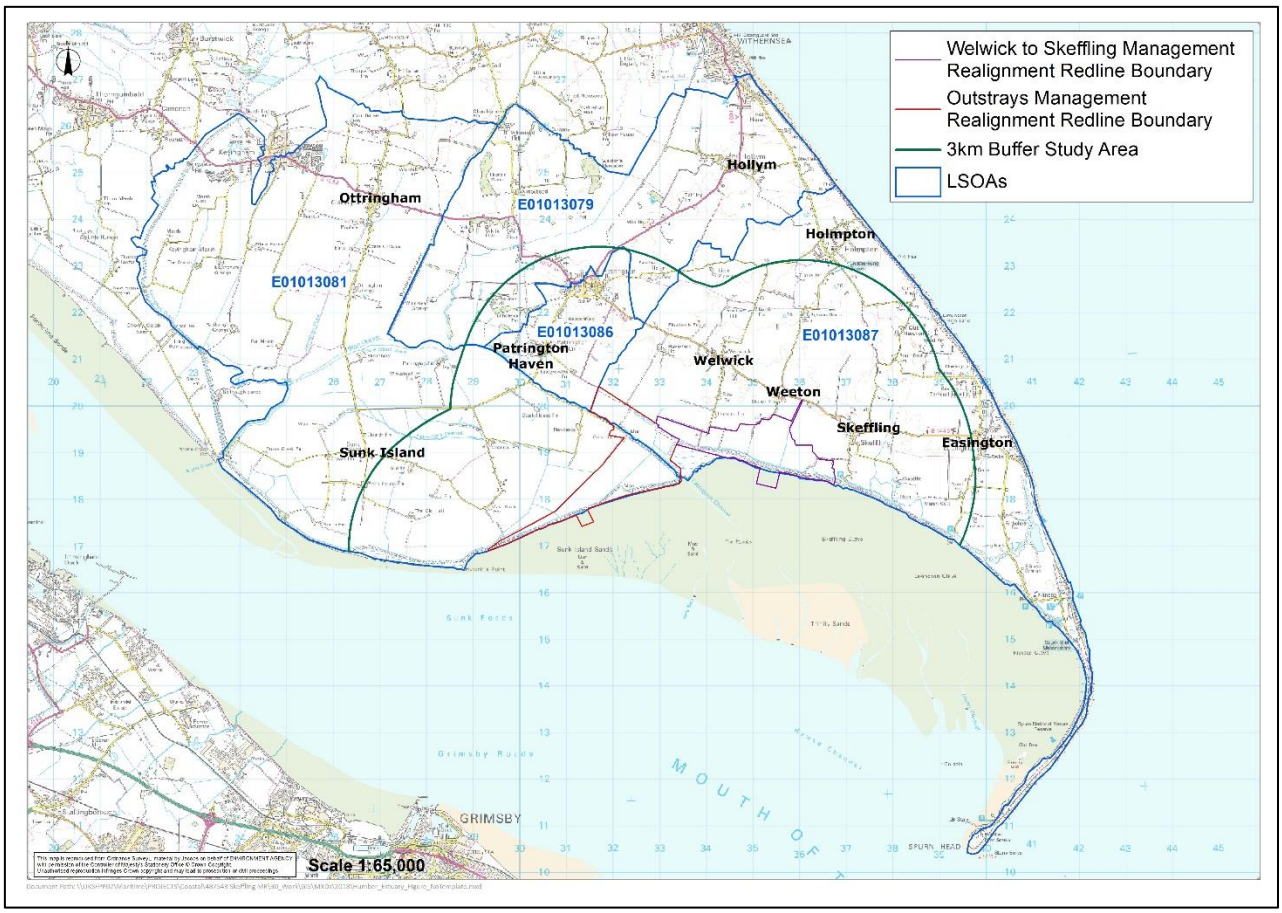
6.3 Methodology

6.3.1 Study area

The study area is taken to be the Scheme boundary and the surrounding 3 km. The area comprises the parishes of Easington, Patrington, Welwick, Weeton, Skeffling and Sunk Island. The study area aligns to that of Chapter 5 (defined by Lower Super Output Areas (LSOA) E01013081, E01013079, E01013086 and E01013087). It should be noted that the chosen LSOAs cover a wider area which includes the settlements of

Hollym, Ottringham and Holmpton. Plate 6.1 shows the boundaries of the LSOAs, along with the 3km buffer area which is under consideration.

Plate 6.1: Study area



6.3.2 Baseline data collection

A desk-based assessment collected data to inform the baseline information for population and recreation. Site visits were also undertaken to take note of baseline conditions. The following data sources are listed in Table 6.1.

Table 6.1: Key data sources

Data Source	Area of Research
Nomis – Census Data 2011	Population: number of residents
East Riding of Yorkshire Council (ERYC) Definitive Map and Statement of Public Rights of Way, dated June 2015.	Recreation: Public Rights of Way (PRoW)
Site visit undertaken by Access and Countryside Management Ltd, August 2017 (specific research for the Scheme)	Recreation: existing facilities and access
ERYC's http://walkingtheriding.eastriding.gov.uk/	Recreation: walking routes

6.3.3 Consultation

The importance of balancing the recreational demands of the local area with nature conservation of the internationally important Humber Estuary Natura 2000 site has been considered throughout the Scheme design and has been subject to extensive consultation with stakeholder groups, the general public and expert organisations and individuals. Table 6.2 below lists the organisations and individuals consulted as part of the development of the access and amenity proposals.

Table 6.2: Organisations and individuals consulted on access and amenity

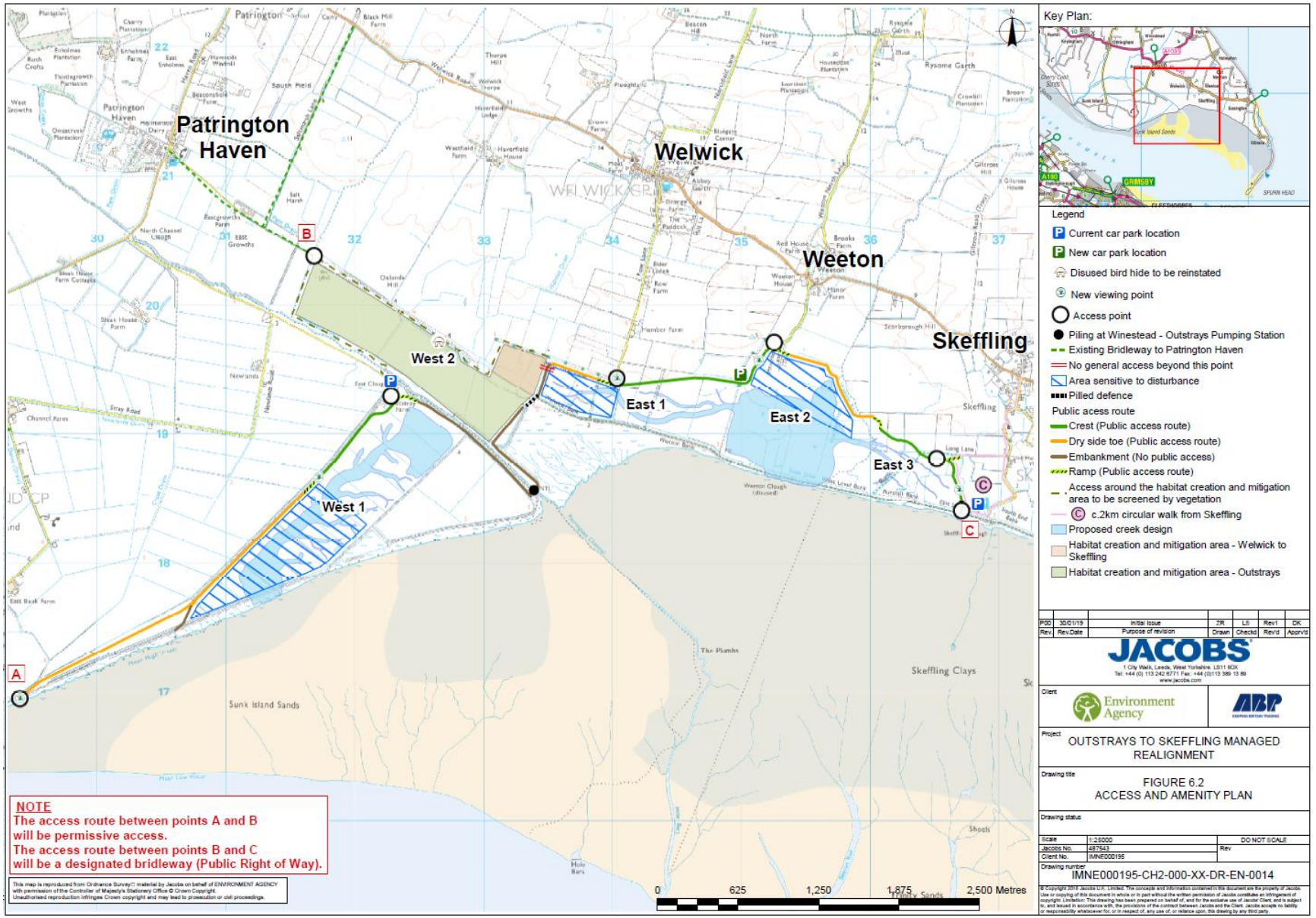
Stakeholders	
Local community	Hull County Council
Humber Nature Partnership	Environment Agency
ERYC Countryside Access	Independent ornithological consultant
ERYC Biodiversity	Spurn Bird Observatory
Chair, Local Access Forum	Yorkshire Wildlife Trust
University of Hull - Institute of Estuarine and Coastal Studies	RSPB
Access and Countryside Management Ltd (independent consultant on access)	RSPB Frampton Marshes Senior Site Manager
Riding Club, British Horse Society	Hull and East Riding Wildfowlers Association
Botanical Society British Isles	Holderness and Humber Wildfowlers
South Holderness Countryside Society	Carter Jonas – agents for Crown Estate
Historic England	EYRC, Definitive Maps Team
Natural England	Riding Centre, Easington
Lincolnshire Wildlife Trust	Regional and Local Ramblers Society

Surgery sessions and public drop-in sessions have been held, as described in Chapter 2 of this ES, where feedback has been received from the local community on the proposed access alignments, and comments have been taken into account during design. For example, the final access route will partly be a designated bridleway following a concern raised by a member of the public regarding horses using the main road. This consultation has also informed other amenity features of the Scheme, such as the introduction of bird hides and a new car park.

The conservation objectives for the Humber Estuary SPA, as described by Natural England, are to avoid the significant disturbance of the qualifying features, ensuring the integrity of the site is maintained. As part of the consultation and research undertaken for the Scheme, areas sensitive to disturbance for the birds were identified across the sites, which influenced and the location of the access route. The preferred access

alignment for the Scheme was agreed with Natural England in December 2017. Therefore, mitigation for the access and recreation effects has been embedded within the design. Plate 6.2 below shows the access and amenity proposals for the Scheme.

Plate 6.2: Access and amenity plan



6.3.4 Impact assessment

The assessment of likely significant effects uses the methodology described in Chapter 4 of this ES.

The sensitivity value assigned to recreational receptors and those requiring access follows the scale set out in Chapter 4, whereby the sensitivity value of the receptor directly relates to its operational extent e.g. the Ramblers society is a regional group and therefore considered to be of regional importance (medium sensitivity).

Regarding health, the World Health Organisation (WHO) recommends definitions thereof to include "a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (WHO 2009[1]). In the context of the current study, the synergistic nature of health impacts with impacts on safety and well-being can result from exposure to flood risk (safety, mental health, well-being), access to greenspaces and recreational opportunities (well-being) and the quality of the local environment (amenity). The population and human health aspect of this assessment has assumed that 'people and their health' have a 'very high' value or sensitivity, based on professional judgement.

6.4 Uncertainties, assumptions and limitations

The certainty with which effects on the environment can be predicted and evaluated is dependent on the data that is available and the knowledge about how different receptors respond to changes in the environment, introducing an element of subjectivity to the assessment.

6.5 Existing environment

6.5.1 Demography

At the time of the 2011 Census, the study area was home to 5,942 residents. Table 6.3 provides a breakdown of population by LSOA and their location in relation to the scheme.

Table 6.3: Demographic profile of the study area

LSOA	Settlements included	2011 Population
E01013081	Sunk Island, Ottringham	1,485
E01013079	Hollym	1,516
E01013086	Patrington, Patrington Haven	1,576
E01013087	Easington, Skeffling, Welwick, Weeton	1,365
	Total:	**5,942**

[1] http://www.who.int/ accessed 09/11/2018

LSOA	Settlements included	2011 Population
	EYRC:	334,179
		1.8% of ERYC

E01013087 contains within its boundary the majority of the Scheme extents, but tabulates the lowest population count owing to the rural setting of the Scheme. The closest population centres to the Scheme are the hamlets of Patrington Haven, Welwick, Weeton, and the village of Skeffling, as shown on Plate 6.2. Properties within 500 m of the Scheme boundary include residential properties consisting of Outstray Farm, Eastgrowths Farm, Row Farm, Humber Farm, Manor Farm, Scorborough House and the southern parts of Welwick and Weeton.

6.5.2 Access and Public Rights of Way

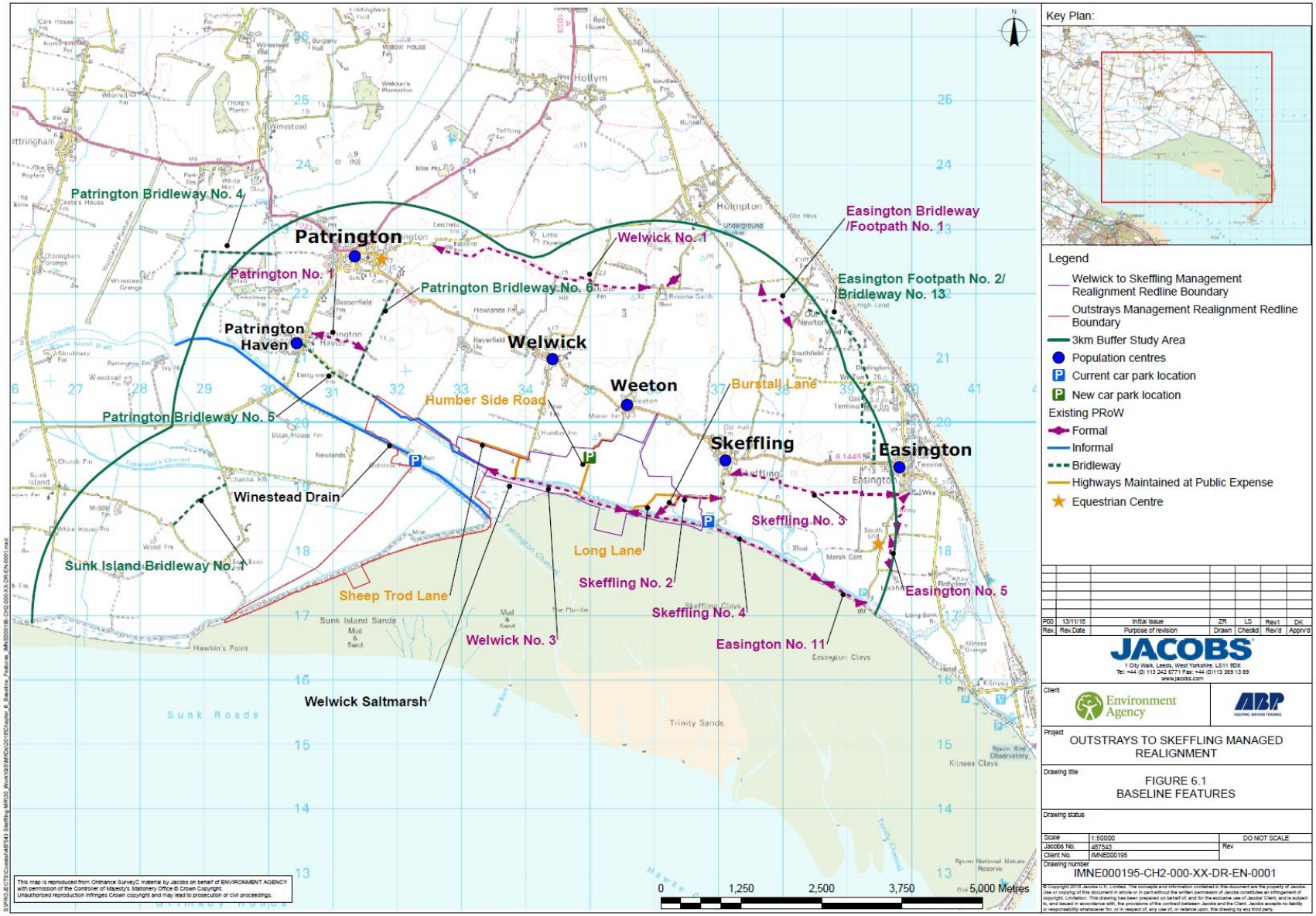
There are a number of statutorily and non-statutorily recognised access routes into the Scheme area. These are listed in Table 6.4 and shown on Plate 6.3 below.

Table 6.4: Formal access routes

Access Route	Approximate length within scheme extents (km)	Location in relation to Scheme
Skeffling Footpath No.2 (PRoW)	0.8	Burstall Lane and Long Lane, partially within East 3
Welwick Footpath No.3 (PRoW)	2.3	Along top of embankment of East 1 and 2
Skeffling Footpath No.4 (PRoW)	1.2	Continuing from the end of Welwick Footpath No.3 along the top of the embankment of East 3 and heading east
Easington Footpath No.11 (PRoW)	Not within Scheme extents	Continuing from the end of Skeffling Footpath No.4 along the top of the embankment, ending at Humber Side Lane and car park
Patrington Bridleway No.5 (PRoW)	Adjacent	Near West 2 and Eastgrowths Farm
Patrington Bridleway No.6 (PRoW)	Not within Scheme extents	From Eastgrowths Farm to Black Mill Farm near Patrington, northwest of scheme
Patrington Footpath No.1 (PRoW)	Not within Scheme extents	From Patrington Bridleway No.6 to Back Lane in Patrington Haven
Winestead Drain (Informal)	2.5	Between West 1 and West 2
Haverfield Quarry (Informal)	2.2	Along the boundary to West 2 - Informal footpath connecting Welwick No. 3 and Patrington Bridleway No. 5
Sheep Trod Lane (Highway maintainable at public expense);	1.4	Edge of East 1
Humber Side Road (Highway maintainable at public expense).	1.1	Edge of East 2

Access Route	Approximate length within scheme extents (km)	Location in relation to Scheme
Long Lane & Burstall Lane (Highway maintainable at public expense)	2	East 3

Plate 6.3: Baseline features plan



Currently, the total length of uninterrupted PRoW on the top of the bank and adjacent to the coastline is approximately 6.3km, of which approximately 3.5km is within the Scheme boundary, as shown in Plate 6.3. This includes Welwick No.3 and Skeffling No.4; the convergence of these footpaths is shown in Plate 6.4.

Plate 6.4: PRoW - Skeffling Footpath No.4 leading to Welwick Footpath No.3

Within West 2 and passing through Haverfield Quarry is an undesignated track that links Patrington Bridleway No.5 to Welwick Footpath No.3 (PRoW). This track is currently being used as a bridleway but is not a formal PRoW (Plate 6.3).

Access to the estuary at this location is relatively difficult, PRoWs are disjointed, and access points do not demonstrate access for all. The formal recreational value of the study area is low; however, it is appreciated that it is of importance to the local community. A key action stated in the ERYC Rights of Way Improvement Plan is to improve connectivity of the network for horse-riders and cyclists.

6.5.3 Recreational use and facilities

The study area is used for a range of recreational activities by the public and various clubs/organisations. A visitor survey conducted for the Humber Nature Partnership in 2012 interviewed 614 visitor groups (112 in summer and 502 in winter) across 20 sites around the Humber Estuary, including Patrington and Easington. It found that the majority of visitors surveyed generally stayed at the estuary sites for between 1 and 2 hours in summer, and less than 1 hour in winter. The survey also highlighted that 30% of the interviewed groups visited the Patrington site on a daily basis, and a further total of 60% suggested they visited most days to three times a week. Across the Humber Estuary, the mean length of routes for dog-walking, walking and wildlife-watching were between 2 km and 3.5 km in both summer and winter.

Across the Humber, a large proportion of visitors chose their destination because it is close to home, suggesting the importance of the estuary to the local population for their recreational activities. The 2012 visitor survey identified the main recreational activities being undertaken in the Patrington area as dog walking, walking, wildfowling and bait digging, although noted relatively low levels of access (Fearnley et al., 2012). Fishing in Winestead Drain is also known to take place by local anglers with wildlife-watching being popular throughout the Estuary. There are currently no bird hides in the study area, although there is a disused hide on the edge of West 2, within Haverfield Quarry. Other formal recreational groups within the area include a local branch of The Ramblers association.

As shown on Plate 6.3, The British Horse Society is active in the area, with several stables located within the study area, including Patrington Show Yard (Patrington) and North Humberside Riding Centre (south of Easington) and horse-riders currently use bridleways and highways in the area and the existing flood embankments informally within the Scheme extents.

A local wildfowling association owns a site adjacent to East 1 (section of Welwick Saltmarsh), shown on Plate 6.3, for which they have private access. Wildfowling season is between 1st September and 20th February. Wildfowling takes place at dusk or dawn and usually involves a visit of 2.5 hours (Fearnley et al., 2012).

The Yorkshire Wildlife Trust (YWT) also own a section of Welwick Saltmarsh and have a grazier stocking sheep on the banks and saltmarsh.

In 2013/14, a Humber Winter Bird Disturbance Study (Ross, K., Liley, D., 2014) was carried out at 10 locations around the Humber Estuary (including Welwick), to record levels of human activity, counts of birds and responses of birds to disturbance. The study noted that the Welwick site generally had low levels of human activity compared to other sites, and access and infrastructure (car parking, walking options etc.) is currently limited.

The villages from Patrington Haven to Easington are served by buses from Hull and Withernsea, making it possible for visitors to arrive by public transport. Access by car is limited but there is roadside parking within the villages, in addition to two small car parks close to the Humber banks.

These two car parks are located:

- At Outstrays Farm, adjacent to West 1. Informal; capacity 4 vehicles.

Plate 6.5: Informal parking at Outstrays Farm

- At Skeffling pumping station, adjacent to East 3. Formal; capacity >10 vehicles.

Plate 6.6: Formal parking at Skeffling Pumping Station

Although facilities such as tourist information centres and public toilets are located further away in Withernsea, Hedon and Kilnsea, the villages of Patrington, Welwick and Easington have pubs and cafes that can provide for visitors to the area, and several easy circular walks starting in Patrington, Easington and Skeffling are advertised by EYRC.[2]

6.5.4 Flood defences and flood risk

As described in Chapter 1 and shown in Plate 6.7 below, the population of the study area is currently protected from flooding by earth embankments. As noted in the Humber FRMS (2008), the current standard of protection in the Sunk Island area (which includes West 1) is generally about 10% Annual Exceedance Probability (AEP) or better, but is 50% AEP in places. The Welwick to Skeffling area generally has a standard of protection of about 5% AEP but is 50% AEP in places.

The effects on health, safety and wellbeing of the local community and visiting recreational users during and after a flood event can have an effect on physical health in the form of injury, and mental health such as stress.

[2] Website http://walkingtheriding.eastriding.gov.uk/, accessed 10/09/18.

Plate 6.7: Current flood risk at Outstrays to Skeffling (source: Environment Agency, 2018[3])

6.6 Future Baseline Scenario

Without the introduction of the Scheme, access to the estuary at this location will remain relatively difficult, PRoW will remain disjointed, and access points will not demonstrate access for all. The area will remain of a low level of formal recreational value.

In the absence of the Scheme, flood risk to properties in the study area will continue to increase due to sea level rise resulting from climate change. The Humber FRMS (2008) stated that flood defences in this area were generally in good condition but were expected to need minor repairs every few years and major improvement in about 20 years. If no repairs or improvements are carried out, the standard of protection would reduce. More frequent or extensive flooding of the area will persistently disconnect recreational users from the area, which could drive the recreational value of the area down and deter recreational users and visitors from the area in the long term.

[3] https://flood-map-for-planning.service.gov.uk/, accessed 02/11/2018.

6.7 Likely significant effects

6.7.1 Outstrays Managed Realignment

6.7.1.1 Access and Recreation

Construction

Access and PRoW

There are no formal Public Rights of Way (PRoW) within the Outstrays Managed Realignment site, therefore no applications for diversions or closures of footpaths are required for this element. The informal footpath route along the northeastern boundary of West 2 connecting Welwick Footpath No. 3 and Patrington Bridleway No. 5 will be impacted by the works. To maintain safety to the general public this route will be closed during the works. The current informal carpark at Outstrays Farm, as shown in Plate 6.5, will be adjacent to the main construction compound and will be closed for the duration of the works, with no access to the estuary from here during construction. The magnitude of this impact is considered to be minor negative. The fragmented, informal routes are considered to be of low sensitivity due to the overall low recreational value and therefore a **short-term, minor adverse** effect on access is likely.

Recreation

The area along Winestead Drain to the pumping station is believed to be used informally by recreational users, such as horse-riders, walkers and anglers. The use of this area by recreational users is of district level importance and therefore of a low sensitivity. There will be no access to Winestead Drain within the site boundary during the construction phase, which will reduce the area available for informal fishing within the drain, resulting in a minor negative magnitude of impact. This will likely cause a **short term, minor adverse** effect.

Operation

Access and PRoW

The Outstrays Managed Realignment will introduce approximately 4 km of new access routes following the alignment of the new embankment. It will consist of a combination of crest access and, in areas of high bird sensitivity, dry side toe access, as shown on Plate 6.2. The new embankment is approximately 500 m further landward than the existing embankment.

Following construction, the Outstrays carpark will be reopened. The access has been designed to allow ‘Access for All’ whereby a 1:20 gradient ramp will be installed from the carpark to a new crest access. This will enable access for pushchairs, wheelchair users and others less able to walk to experience views over the estuary.

Considering the fragmented PRoW routes between Welwick No. 3 and Patrington Bridleway No. 5, and taking into account the recommendations raised by the British Horse Society, a new, linked, designated bridleway will be introduced along the north-eastern boundary of West 2 (following the route of the existing informal access route). It is considered that the improvement in connectivity of the PRoW will have a moderate positive magnitude of impact.

The East Riding of Yorkshire Council Local Plan identifies the important benefits of green infrastructure include creating access to nature and recreation and identifies the study area as a green infrastructure corridor of regional importance. In addition to this, a key action within the ERYC Rights of Way Improvement Plan is to improve connectivity of the network for horse-riders and cyclists.

The creation of the designated bridleway and permissive access route across the Outstrays Managed Realignment is considered to be of regional importance (medium sensitivity) and creates a moderate positive magnitude of impact for the area. Therefore, a **moderate beneficial** effect is likely as a result of the Outstrays Managed Realignment.

Recreation

The baseline information recorded that wildlife-watching was a popular activity for the area. Two new wildlife-watching viewing points/bird hides will be installed in West 1, with indicative locations shown on Plate 6.2. In addition, the disused bird hide in Haverfield Quarry (West 2) will be reinstated. The West 2 habitat is sensitive to disturbance and therefore low-lying bunds and vegetation will be used as screens which will result in reduced visibility for users along this section.

As previously mentioned, part of the route will be upgraded to a connected bridleway along the northerneastern boundary of West 2, which is of benefit to local horse-riders and walkers. This increases the length and connectivity of bridleway easily accessible from North Humberside Riding Centre in the east and Patrington Show Yard outside of Patrington.

New noticeboards will be installed for visitor interest along the routes.

As Winestead Drain will be unaffected by the operational Scheme, no impact to recreational angling is anticipated and has been scoped out. The provision of formal fishing platforms along the drain will be considered further at the detailed design stage.

The use of this area by recreational users is of district level importance and therefore of a low sensitivity. Overall, the magnitude of impact is considered to be minor positive, with the introduction of a formal area for recreational activities and improved access. Therefore, a **minor, beneficial** effect on the population is likely.

6.7.1.2 Flood Risk

Construction

Sunk Island is protected by 11.8 km of earth embankments of which approximately 4 km are within the site boundary; which prevents 6733 ha of land behind from flooding. The existing embankment will only be breached and lowered after the new embankment has been built, so there will be a flood defence in place throughout the construction period. Therefore, the magnitude of the impact of flood risk on the population and properties during construction is negligible, resulting in **no effect.**

Operation

A Flood Risk Assessment has been produced to support and inform the design of the Scheme, assessing the impact of the Scheme on flood risk (see Appendix 8.3).

The new bank will be constructed to an average height of 5.4 m AOD Flood Defence Level with additional allowances for settlement. The site is designed to ensure there is no increase in tidal flood risk through delivery. Indeed, the new flood embankment has

been designed to provide a consistent flood defence throughout the study area that provides increased flood protection and accounts for sea level rise. The new embankment will also have a wider profile than that of the current embankment to make it more robust. As it is a new embankment, it will have a longer design life than the current embankment.

The Outstrays Managed Realignment will see some flood risk receptors removed entirely from the flood extent baseline, while others will experience a reduction in flood risk. A reduction in flood risk would have a positive benefit to the health, safety and wellbeing of the local community and visiting recreational users. In terms of tangible health issues (physical health), the magnitude of the positive impact gained from the Outstrays Managed Realignment reducing flood risk is anticipated to be of a large scale. In terms of intangible health issues, i.e. reduced stress associated with flood risk, dealing with insurers, finding alternative accommodation etc., the magnitude of the positive impact gained from the reduction in flood risk is anticipated to be of a large scale. As such, there is anticipated to be a **moderate to major beneficial long-term effect** on those with reduced flood risk because of the managed realignment, based on very high value receptors and a moderate positive magnitude.

The sensitivity allocation for properties and their inhabitants is of high value, as described in methodology section 6.3.4. The improvement in flood risk to the population is considered a moderate positive magnitude of impact, and therefore the effect of the Scheme is **moderate beneficial** and long term.

There is one receptor showing an increase in flood risk as a result of the Outstrays Managed Realignment. This receptor is an ancillary building associated with Outstrays Farm and has an increase in depth and velocity resulting in an increased hazard rating for the design scenario. This receptor is in close proximity to the new embankment. The residential receptor associated with Outstrays Farm remains in the same hazard rating and therefore, the magnitude of impact on the local population is negligible, resulting in **no effect**.

6.7.2 Welwick to Skeffling Managed Realignment

6.7.2.1 Access and Recreation

Construction

Access and PRoW

There are four highways maintained at public expense within the Welwick to Skeffling Managed Realignment site boundary as shown on Plate 6.3. These roads will be within the intertidal area and therefore will be permanently closed. To maintain public safety during construction (before they become intertidal), these routes will be closed through a highway stopping up order.

There are three Public Rights of Way which are within the site boundary. During the construction of the new embankment the PRoWs will be closed to ensure safety of the public, with little opportunity for a reasonable diversion, until the site is complete and new footpaths become operational. Closures will be formalised through PRoW closure orders.

The PRoWs and highways are utilised by local residents and recreational groups within the area, such as Yorkshire Wildlife Trust (YWT), British Horse Society and the

Ramblers, which is considered to be of regional importance and therefore of medium sensitivity. As a result of the closures during construction there will be a minor negative magnitude of impact. This will likely result in a **short term, minor adverse** effect.

Recreation

During construction, YWT, the Wildfowling Association, and recreational users will not have access to this area for reasons of public safety. This places the area of medium value and the ceasing of access for recreation in the area will create a temporary minor negative magnitude of impact. The temporary disconnect between the other PRoWs along the coast line will impact upon recreational users and will likely cause a **short-term, minor adverse** effect.

Operation

Access and PRoW

The final design has taken into account the scoping opinion responses of East Riding of Yorkshire Council which suggest that the new PRoW should maintain the recreational value of estuary views by rerouting the footpath similarly at the crest of the new bank. This was reflected in concerns raised during consultation with key stakeholders.

The new alignment through the Welwick to Skeffling Managed Realignment will provide approximately 10 km of uninterrupted formal PRoW from Easington Bank to Patrington. A circular route from Skeffling approximately 2.2 km in length will also be created, fulfilling an aim of the ERYC Rights of Way Improvement Plan, where circular routes are a strategy to improve the network. Additionally, this aligns with the average route distance for a dogwalker in the area, as identified in the Humber Visitor Survey. On the other hand, the new PRoW is fundamentally greater in length, which may adversely affect those who desire a shorter route, but the installation of circular routes can mitigate this impact.

The PRoW is a combination of crest and dry side toe partly designated bridleway to take into account areas sensitive for wildlife, as shown on Plate 6.2. The access has been redesigned to allow ‘Access for All’ whereby a 1:20 gradient ramp will be installed from dry side toe to the new crest footpath, to enable access for pushchairs, wheelchair users and others less able to walk to experience views over the estuary.

A new formal carpark is proposed adjacent to East 2 which will provide formal parking for recreational users and activity groups.

The East Riding of Yorkshire Council Local Plan identifies the important benefits of green infrastructure include creating access to nature and recreation and identifies the study area as a green infrastructure corridor of regional importance. In addition to this, a key action within the ERYC Rights of Way Improvement Plan is to improve connectivity of the network for horse-riders and cyclists. The creation of the uninterrupted Bridleway as part of the Welwick to Skeffling Managed Realignment is considered to be of regional importance (medium sensitivity) and creates a moderate positive magnitude of impact for the area. Therefore, a **moderate beneficial** effect is likely as a result of the Welwick to Skeffling Managed Realignment.

Recreation

The baseline information recorded that wildlife watching was a popular activity for the area. Three new wildlife watching viewing points/bird hides will be installed at locations

along the top of the new embankment, indicative locations shown on Plate 6.2. The footpath is further set back from the existing coastline, potentially changing views of the coast as was previously experienced, but the use of the crest and viewing platforms will provide coastal views.

As previously mentioned, the routes will be upgraded to a connected partly designated bridleway which is of benefit to local horse riders and walkers. This gives access to 10 km of bridleway easily accessible from North Humberside Riding Centre in the east and Patrington Show Yard outside of Patrington.

The highways maintained at public expense are likely to be tracks used by farmers and also provide access for recreational users as they lead to the current embankment. Row Lane, Sheep Trod Lane and Humber Side Lane are used by the YWT and the Wildfowlers Association to access their sites. On completion, the highways will end at the site boundary, but these groups will have private access to their sites. Signage and physical barriers to restrict members of the public to access this area will be used, and any visitors to the area will use the new formal carpark and access points, which will be located at the ends of the existing highways. The Humber Visitor survey identified that the majority of visitors were from the local area and visited frequently, showing the site's high local importance.

New noticeboards and signage will be installed for visitor interest along the routes.

As mentioned previously, access to recreation is considered to be of regional importance (medium sensitivity) to the area and as a result, the creation of the uninterrupted partly designated bridleway as part of the Welwick to Skeffling Managed Realignment is considered to create a moderate positive magnitude of impact for the area. Therefore, a **moderate beneficial** effect is likely to occur.

6.7.2.2 Flood Risk

Construction

The Welwick to Skeffling area is protected by 4.8 km of earth embankments, which prevents 411 ha of land behind from flooding. The existing embankment will only be breached and lowered after the new embankment has been built, so there will be a flood defence in place throughout the construction period. Therefore, the magnitude of the impact of flood risk on the population and properties during construction is **negligible**, resulting in **no effect.**

Operation

A new earth embankment approximately 4.5 km long will be constructed along the back of East 1, 2 and 3. The new bank will be constructed to an average height of 5.6 m AOD Flood Defence Level with additional allowances for settlement, and taking sea level rise into account.

A Flood Risk Assessment has been produced to support and inform the design of the site, assessing the impact of the site on flood risk (see Appendix 8.3).

The site is designed to ensure there is no increase in tidal flood risk through delivery. The new flood embankment has been designed to provide a consistent flood defence that increases flood protection. The new embankment will also have a wider profile than that of the current embankment to make it more robust. As it is a new embankment, it will have a longer life than the current embankment.

The Welwick to Skeffling Managed Realignment will see some flood risk receptors removed entirely from the flood extent baseline, while others will experience a reduction in flood risk. A reduction in flood risk would have a positive benefit to the health, safety and wellbeing of the local community and visiting recreational users. In terms of tangible health issues (physical health), the magnitude of the positive impact gained from the site reducing flood risk is anticipated to be of a large scale. In terms of intangible health issues, i.e. reduced stress associated with flood risk, dealing with insurers, finding alternative accommodation etc., the magnitude of the positive impact gained from the site reducing flood risk is anticipated to be of a large scale. As such, there is anticipated to be a **moderate to major beneficial long-term effect** on those with reduced flood risk because of the managed realignment, based on very high value receptors and a moderate positive magnitude.

The sensitivity allocation for properties and their inhabitants is of high value, as described in methodology section 6.3.4. The improvement in flood risk to the population is considered a moderate positive magnitude of impact, and therefore the effect of the site on flood risk is **moderate beneficial** and long term.

6.8 Mitigation

6.8.1 Outstrays Managed Realignment

6.8.1.1 Access and Recreation

Construction

The design incorporates aspects of embedded mitigation for the impacts on access and recreation during construction. For example, footpath closures will be implemented in advance of the works.

Additionally, the contractor will be required to erect notices around the site prior to works commencing to inform users that the permissive access to the area of the car park and estuary at Outstrays will be restricted, along with the proposed timing of the works. These notices will remain in place throughout the construction phase.

The monthly/bimonthly newsletters to the local community will continue into the construction phase, distributed by post to all households within the communities and rural areas of Sunk Island, Patrington, Welwick, Weeton, Skeffling, Easington and Kilnsea (over 1400 properties). The newsletters will keep the public up to date with the works. There may also be opportunities to leave newsletters in key village locations, and to publicise information about the works via local radio announcements.

Operation

Section 6.7 outlines the embedded mitigation for access and recreation as part of the design, for example the improved access points, connected footpaths and reinstatement of the existing bird hide. It is anticipated that there will be a moderate positive effect on access and recreation as a result of the Outstrays Managed Realignment and therefore no additional mitigation is proposed.

6.8.1.2 Flood Risk

Construction

No effect is anticipated on receptors from flood risk during the construction phase and therefore no additional mitigation is proposed.

Operation

The Outstrays Managed Realignment provides greater flood protection to the population within the study area and therefore no additional mitigation is proposed.

6.8.2 Welwick to Skeffling Managed Realignment

6.8.2.1 Access and Recreation

Construction

The design incorporates aspects of embedded mitigation for the impacts on access and recreation during construction. For example, footpath closures will be implemented in advance of the works.

Additionally, the contractor will be required to erect notices around the site prior to works commencing to inform users that access to the area of the car park and estuary from Welwick to Skeffling will be restricted, along with the proposed timing of the works. These notices will remain in place throughout the construction phase.

The monthly/bimonthly newsletters to the local community will continue into the construction phase, distributed by post to all households with the communities and rural areas of Sunk Island, Patrington, Welwick, Weeton, Skeffling, Easington and Kilnsea (over 1400 properties). The newsletters will keep the public up to date with the works. There may also be opportunities to leave newsletters in key village locations, and to publicise information about the works via local radio announcements.

Operation

Section 6.7 outlines the embedded mitigation for access and recreation as part of the design, for example, the improved interconnected bridleway. It is anticipated that there will be a moderate positive effect as a result of the Welwick to Skeffling Managed Realignment and therefore no additional mitigation is proposed.

6.8.2.2 Flood Risk

Construction

No effect is anticipated on receptors from flood risk during the construction phase and therefore no additional mitigation is proposed.

Operation

The Welwick to Skeffling Managed Realignment provides greater flood protection to the population within the study area and therefore no additional mitigation is proposed.

6.9 Residual effects

6.9.1 Outstrays Managed Realignment

6.9.1.1 Access and Recreation

Construction

The short-term adverse effects on the local population and recreational users associated with health and safety and disruption during the construction period will require close monitoring of compliance with contractual obligations imposed upon contractors to minimise potential impacts and ensure sensitive working. With effective mitigation in place, the nuisance impact is anticipated to be reduced in magnitude to minor, resulting in an impact of minor adverse significance.

As access will be restricted in the works area, to maintain safety for locals and visitors accessing the site for recreation, there will be a short term **minor adverse residual effect** remaining during the construction phase.

Operation

Due to the embedded mitigation for access and recreation as part of the design, for example the improved access points, connected footpaths, along with improvements to the existing bird hide, it is anticipated that there will be a long term **moderate positive residual effect** as a result of the Outstrays Managed Realignment.

6.9.1.2 Flood Risk

Construction

Due to the embedded mitigation in the construction methodology, there will be **no residual effects** during the operation of the site.

Operation

A long-term reduction in flood risk as a result of the Outstrays Managed Realignment will create a long-term **moderate beneficial residual effect** to human health, safety, and wellbeing, of local residents and recreational users.

6.9.2 Welwick to Skeffling Managed Realignment

6.9.2.1 Access and Recreation

Construction

The short-term adverse effects on the local population and recreational users associated with health and safety and disruption during the construction period will require close monitoring of compliance with contractual obligations imposed upon contractors to minimise potential impacts and ensure sensitive working. With effective mitigation in place, the nuisance impact is anticipated to be reduced in magnitude to minor, resulting in an impact of minor adverse significance.

Additionally, access will be restricted in the works area, to maintain safety for locals and visitors accessing the site for recreation. This will result in a short-term **minor adverse residual effect** remaining during the construction phase.

Operation

Due to the embedded mitigation for access and recreation as part of the design, for example the improved access points and connected bridleways, it is anticipated that there will be a residual long-term **moderate positive effect** as a result of the Welwick to Skeffling Managed Realignment.

6.9.2.2 Flood Risk

Construction

Due to the embedded mitigation in the construction methodology, there will be **no residual effects** during the operation of the site.

Operation

A long-term reduction in flood risk as a result of the Welwick to Skeffling Managed Realignment will create a long-term **moderate beneficial residual effect** to human health, safety, and wellbeing, of local residents and recreational users.

7 Physical Processes and the Hydrodynamic Environment

7.1 Introduction

The Scheme has the potential to affect physical/hydrodynamic processes, due to the creation of an additional area subject to tidal processes. Following the Environmental Impact Assessment (EIA) scoping exercise, the physical processes and the dynamic environment have been scoped into the EIA for the construction and operation phases of the proposed scheme.

The following sections describe:

- The physical environmental baseline of the estuary with which the Scheme will interact;
- An overview of the scheme design methodology and the modelling undertaken to determine the impact of the proposed managed realignment on the estuary and the physical functioning of the scheme;
- Assessment of the likely significant effects on the physical marine environment for the impact pathways for the construction and operation phases of the development.

Changes to the physical processes and hydrodynamic environment have the potential to affect the Water Environment (Chapter 8), Geology, Soils and Hydrogeology (Chapter 9) and Marine Biodiversity (Chapter 11).

7.2 Methodology

7.2.1 Study area

The study area is defined as the area over which the potential direct and indirect impacts of the Scheme are predicted to occur. These are limited to the area immediately fronting the proposed Scheme with potential minor changes in hydrodynamic parameters limited to within approximately 1.5 km of each breach.

7.2.2 Baseline data collection

The physical marine environment has been characterised based on available data, literature and calibrated hydrodynamic model results. This includes:

- Geomorphological studies;
- Ecology survey reports; and
- Environmental assessments for other schemes and projects in the estuary.

No site-specific baseline data has been collected to inform the assessment process.

7.2.3 Impact assessment

The EIA methodology that has been used to understand the potential significance of environmental effects is presented in Chapter 4. Where additional expert knowledge or information has been used to further inform the assessment this has been clearly stated within the respective pathway.

7.2.3.1 Modelling

The effects of the Scheme have been assessed using a two-dimensional (2D) hydrodynamic model. This model was based upon ABPmer's existing calibrated Delft 3D model of the Humber, details on the modelling for the Outstrays and Welwick to Skeffling Managed Realignments in Appendix 7.1. Details of the model calibration are provided in ABPmer, 2017.

This model, operating in 2D, has a variable spatial resolution that enabled more detailed investigations of the hydrodynamic effects to be made in the areas of particular interest. The model grid was refined across the proposed Scheme and the fronting estuary to resolve features of interest, including natural drainage channels linking to the main estuary channel. The model resolution across the proposed managed realignment site is approximately 15 m x 17 m.

Hydrodynamic modelling runs were undertaken throughout a full spring neap cycle (15 days) with data extracted for approximate mean spring and mean tidal conditions under two bathymetric conditions:

- Design bathymetry and layout at point of initial inundation; and
- Evolved bathymetry: A predicted bathymetry taking account of an assessment of the likely sedimentation that would occur over approximately the first five years. This was based on lessons learnt from the monitoring of the ABP Welwick managed realignment as well as other managed realignments within the estuary and elsewhere, along with the modelling results from the scheme at the point of inundation (including flow speeds and bed shear stress (BSS) distribution relative to erosion and deposition thresholds).

Parameters extracted and interpreted from the modelling results were tidal elevations, flow speed and directions and bed shear stresses, both actual and as differences from the baseline to determine magnitude and extent of impact on the Humber Estuary (see Appendix 7.1).

It should be noted that for the purposes of the modelling a fronting channel was excavated to meet the natural 1.5 m contour approximately 100 m and 300 m from the Western and Eastern breaches respectively. This channel, however will not be constructed, instead a natural in/out flow channel will be allowed to form over the intertidal. This difference has been accounted for when undertaking the respective assessments.

7.2.4 Uncertainties, assumptions and limitations

There is always a degree of uncertainty associated with making predictions in a highly dynamic environment. This is particularly true for making forward projections with respect to scheme evolution over the medium to long term. Within the Humber Estuary, for example, there is considerable variability in the bathymetry over a range of spatial and temporal scales. A fully calibrated model has, however, been used to inform the

assessment process along with a well-developed conceptual understanding for the estuary. Lessons learnt from existing managed realignment schemes have also been factored into the respective predictions of environmental effects. Nevertheless, there is considerable uncertainty when predicting the future baseline based on the existing trends and natural variability along with uncertainty surrounding future climate change.

7.3 Existing environment

The Humber Estuary SAC is protected for having multiple Annex I features of the European Commission (EC) Habitats Directive (92/43/EEC). The primary reason for designation is the presence of two broad scale habitats, “Estuaries” and “Mudflats and sandflats not covered by seawater at low tide”. These broad scale habitats support other more specific habitats which are qualifying features but not a primary reason for designation. In this context the physical processes and the hydrodynamic environment are considered to be of international importance and as such a Very High Sensitivity. This is applicable to each of the characteristics of the physical environment as described throughout this Section.

7.3.1 Geology

The Humber lies in a complex of solid and superficial geology that can be simplified into three groups; the pre-Quaternary, the glacial (or Pleistocene) and post glacial (or Holocene) (Environment Agency, 1998). These geologies have affected the historic development of the Estuary and provides control on the geomorphological evolution.

Today the Humber Estuary area is significantly smaller than its original extent following the deceleration of Holocene sea level rise (circa 6,000 years before present), due to the formation of saltmarshes and intertidal flats (followed by their reclamation by man over historical times). See Chapter 9 for more detail of the geology of the site.

7.3.2 Geomorphology

The Humber is one of the largest estuaries in the United Kingdom (UK), measuring some 24,240 ha. It is approximately 6.5 km wide at its entrance (opening to 9.5 km wide immediately past its entrance at Spurn Point in the area of the Scheme, and its upper reaches (some 48 km upriver) are 2.5 km wide. It is the largest macro-tidal coastal-plain estuary on the British North Sea Coast and drains more than one fifth of the area of England. Major tributaries include the Trent, Ouse, Don and Aire (National Rivers Authority, 1991). Additional freshwater inputs to the Humber include the Hull, Ancholme, Foulness and Holderness Drains.

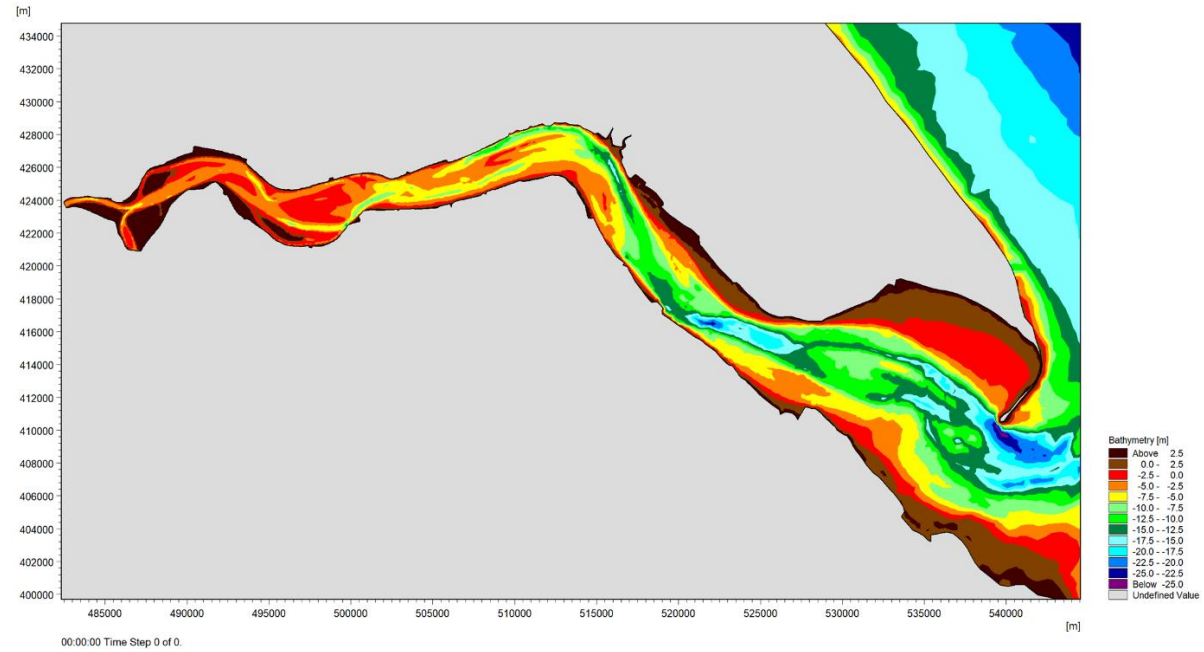
The estuary upstream of the Humber Bridge represents an older estuary system formed in the last interglacial (120,000 to 80,000 years before present (BP)) with the estuary mouth at this time being located near the current Bridge. Downstream of this point the estuary is more recent in geological terms, the channel having formed in immediate post glacial times as melt water cut down through glacial till deposits. During the post glacial period of sea level rise the former river channel underwent marine transgression and became subject to estuarine sedimentation.

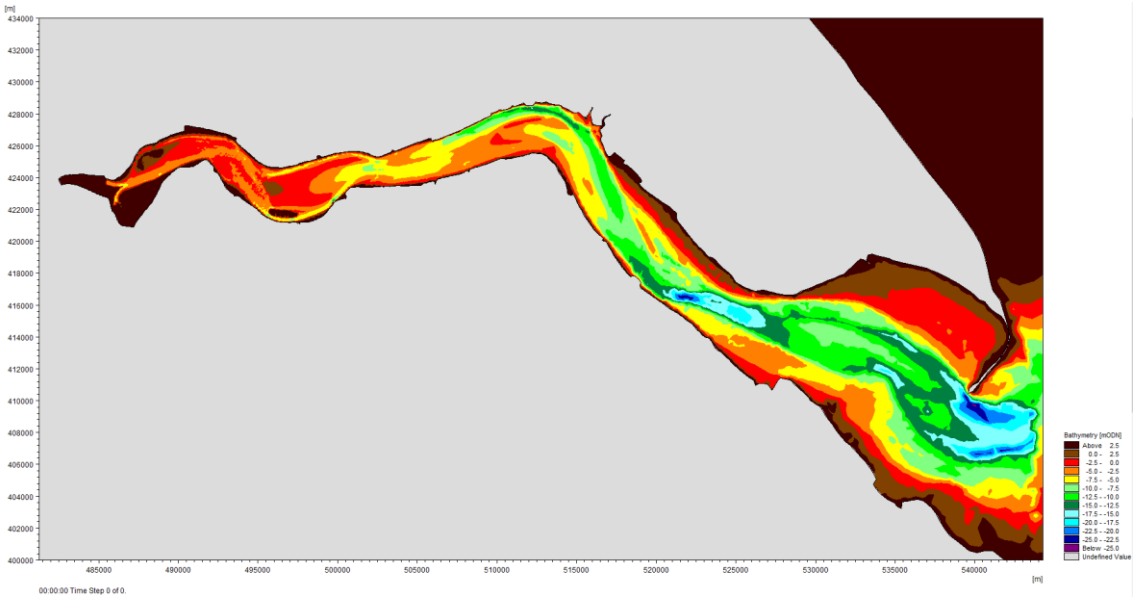
In the Inner Humber the presence of the underlying chalk has been a key factor controlling the extent of the earlier proto-Humber mouth, the extent of the most recent

(Devensian) ice incursion from the North Sea and the formation and release of waters from the Inner Humber Lake, which led to the cutting of the Middle and Outer Humber channel. In the Outer Humber, the presence of boulder clay deposits, both beneath the surface and as outcrops provides a geological constraint which influence the form of the channel and position of some of the sand banks (e.g. Clee Ness Sand) and intertidal areas (such as Spurn Bight) and Spurn Point peninsular spit at the mouth.

The coastal and estuarine processes around the Estuary are particularly dynamic in nature. This large area of open water has fast-flowing currents, shifting sands and shallow waters, and the bathymetric charts of the Estuary demonstrate that the channels and banks are constantly changing. By way of an example Plate 7.1 compares the bathymetry for a 2013 (latest composite) at the top and that for 1993 at the bottom.

Plate 7.1: Comparison of Humber bathymetry 2013 (top) and 1993 (bottom)





Data describing the key characteristics of the Humber Estuary, as defined in Environment Agency (2000), are provided in Table 7.1.

Table 7.1: Summary of the key morphological characteristics of the Humber Estuary

Property	Values for the Humber	
Lengths	To Trent Falls, 62km; to tidal limit on River Trent, 147km	
Areas	Cross-sectional area (CSA) @ mouth = 85,538m^2 to mtl Plan area @ High Water (HW) = 2.8x10^8 m^2; @ Low Water (LW) = 1.8x10^8 m^2 Intertidal area = 1x10^8 m^2 Saltmarsh area = 6.3x10^6 m^2 (all between Spurn and Trent Falls)	
Volumes	Total volume @ HW = 2.5x10^9 m^3 Total volume @ LW = 1.1x10^9 m^3	
Widths and Depths	Width @ mouth = 6,620 m; hydraulic depth @ mouth = 13.2 m Width @ tidal limit = 52 m; hydraulic depth @ tidal limit = 2.9 m Average width = 4,265 m; average hydraulic depth = 6.5 m	
Form descriptions	Area=84·exp(6.7·x/l); r^2 = 0.99 Width=198·exp(3.7·x/l); r^2 = 0.89 Depth=0.55·exp(3·x/l); r^2 = 0.91 (Length, l=145km)	
Tidal levels and range	MHWS = 3.0; MHWN = 1.6; MLWN = -1.2; MLWS = -2.8 (all levels metres Ordnance Datum Newlyn at Bull Sand Fort)	
Tidal wavelength (λ)	Using linear theory (i) with depth at mouth, λ = 500 km; (ii) with average depth, λ = 350 km	
Tidal constituent ratio's	F=0.06 i.e. tide is semi-diurnal (o [0.1] semi-diurnal, o [10] diurnal) M_4/M_2 amplitude = 0.003; $2M_2$-M_4 phase = 223 at mouth M_4/M_2 amplitude = 0.25; $2M_2$-M_4 phase = 52 at Burton Stather on R. Trent. (i.e. significant sea surface distortion and ebb dominance at the mouth changing to flood dominance upstream)	
Tidal asymmetry	Dronkers gamma -1 = -0.05; 0.13; 1.51 Net excursion* = -1.35; -10.35; -0.9 km Net slack duration+ = 0.18; 0.22; 0 hrs Values are for Spurn, Hull and Trent Falls. Positive values indicate flood dominance.	Indicates dominance for: - tidal equilibrium - coarse sediment - fine sediment Thresholds used: * >0.9m/s; + <0.2m/s
Hydraulic geometry relationships	CSA/tidal prism = 5.7x10^{-5} m^{-1} (springs) and 1x10^{-4} m^{-1} (neaps) LW volume/HW plan $area^2$ = 1.32x10^{-8} m^{-1} LW plan area/HW plan $area^{1.5}$ = 3.8x10^{-5} m^{-1} Discharge exponents: mean velocity, m = 0.1 (r^2=0.39) width, b = 0.48 (r^2=0.85), mean depth, f = 0.41 (r^2=0.91), energy slope, z = -0.2 (r^2=0.89)	
Acronyms used in the table	F = tide form ratio M_4/M_2 = tidal components mtl = mean tide level r^2 = coefficient of determination λ = wavelength	MHWN = mean high water neaps MHWS = mean high water springs MLWN = mean low water neaps MLWS = mean low water springs

(Source: Environment Agency, 2000)

The Estuary can be divided into three regions (Townend *et al.,* 2000), see Plate 7.2

- The Inner Humber (Trent Falls to Humber Bridge);
- The Mid Humber (Humber Bridge to Grimsby); and

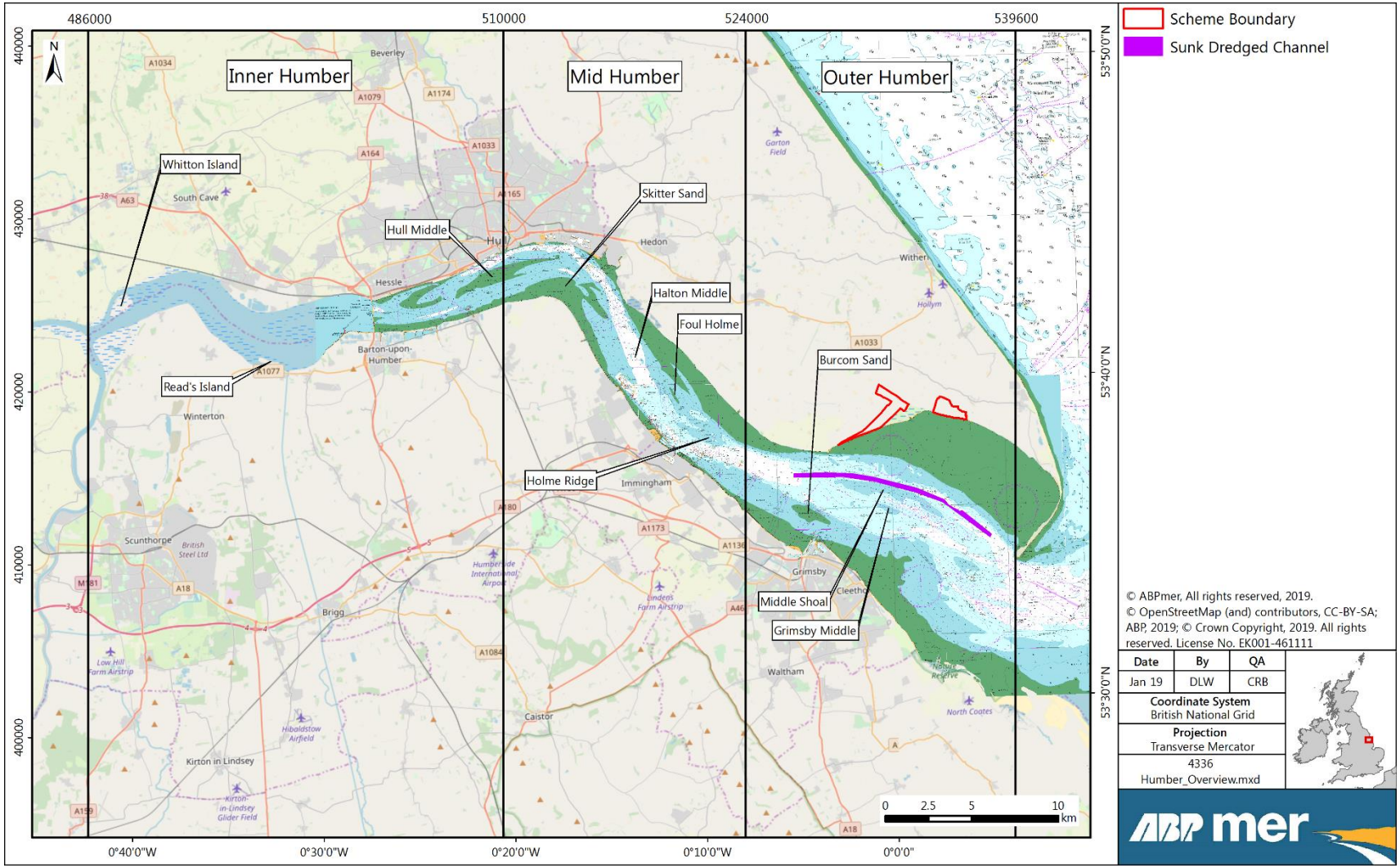
- The Outer Humber (Grimsby to Spurn Point).

In the Inner Humber downstream of Trent Falls, where the Rivers Trent and Ouse merge, the Estuary is characterised by a number of extensive intertidal banks composed of sand/ silt. These banks include Winteringham Middle Sand, Redcliff Middle Sand, Hessle Sand and Barton Ness Sand. Gameson (1982) reports that the area has two main geomorphological characteristics:

- The stabilisation of the channel since the construction of training walls in the River Trent in the mid 1930's, before which the channel had oscillated from side to side depending on the magnitude of freshwater discharge from the Ouse and Trent; and
- The marked variation in the position of channels and shoals in the vicinity of Read's Island. There is a pattern of movement of the channels which has repeated a number of times in the last circa 150 years. This dynamism appears to be associated with a perturbation to the system caused by the reclamation of Read's Island between 1850 and 1891. This perturbation has been 'damping out' over time, causing smaller changes and longer periods between channel switching (ABPmer, 2015). The channel movement is believed to be controlled by the freshwater discharge, particularly sustained high flows, tidal regime and antecedent conditions (Townend *et al.,* 2000).

The Middle Humber is similar in its characteristics to the Inner Humber, particularly the upper half, having a number of main banks and channels that have a preferred configuration. Secondary channels, however, through the banks erode and then in-fill over time, changing the magnitude of the local physical processes at work in this section of the estuary. In the northernmost section, the main channel consistently runs close to the Hull Waterfront, but depths vary by the order of 1 – 2 m over time. In the western section of the region where the main channel meets Hessle Sand, a secondary channel develops along the southern shore, which at times cuts through Skitter Sand and Halton Flats which dominate the middle section of this region. The downstream section (from Immingham to Grimsby) of the Middle Humber is the deepest and least dynamic part i.e. the most stable part of the Estuary.

Plate 7.2: Humber Estuary locations



The Outer Humber (where the Scheme is located on the north bank) is dominated by a three-channel system at the mouth, a large submerged sandbank (the Middle Shoal) and a single deep channel leading to the Middle Humber. The three channels are Haile Channel, Bull Channel and Hawke Road (Channel). Upstream, Hawke Channel has been capital dredged and has required maintenance at highly varying rates of dredging. This part of the channel is known as the Sunk Dredged Channel (SDC) and provides deep draught shipping access to the ports of Immingham and Hull. The presence of boulder clay deposits in the Outer Humber provides a geological constraint that influences the movement of some of the sand banks, intertidal areas and Spurn Point itself.

7.3.2.1 Long term historical change

The Environment Agency has funded a number of studies into the geomorphology of the Humber Estuary at different timescales. A detailed historic analysis of the morphology was produced in late 1999 and a synthesis of the complete studies in March 2000 (Environment Agency, 2000). The analysis carried out in these studies was then re-worked in 2004 by ABPmer (2004) to provide a greater understanding of the morphological changes demonstrated by the Estuary.

Whilst initial studies reveal that estuary volumes have remained roughly constant since the 1850's, the more recent analysis has identified a long-term trend of an increase in estuary volume (ABP Research & Consultancy, 1999). All the studies found the form of the Estuary to be changing, with the high-water plan area reducing and the low water plan area increasing slightly. Together these changes mean that up until 1985 there had been a gradual loss of total intertidal area in the estuary, particularly in the Outer Estuary. Since this time (up to 2000, the extent of the analysis), however, it appears that intertidal areas (the combined mud/sand flat and saltmarsh habitats) throughout the whole Estuary have begun to increase in extent. Further detailed analysis would be required to determine whether this has continued although the comparison in Plate 7.1 does suggest this may be the case, particularly in the Outer Estuary.

The Environment Agency's Humber Estuary Flood Risk Management Strategy (2008), and associated Habitat Regulations Assessment (HRA), predicted possible intertidal habitat losses from its programme of flood risk management works and from potential coastal squeeze using sea level rise predictions (see section 1.4.6 in Chapter 1). A Comprehensive Review of the Humber Flood Risk Management Strategy for the Environment Agency and partners is ongoing, which will review the coastal squeeze predictions for the Humber Estuary. This will consider the contribution that the existing flood defences, along with other contributory and inter-linking factors, have made to changes in habitat extent through coastal squeeze.

An analysis of the energy flux indicates that, the Estuary is developing slowly towards its ideal "steady state ", although on a smaller scale some sections appear to be moving away from the theoretical ideal (ABP R & C, 1999). Morphological measures of the tidal asymmetry suggest the Estuary as a whole has become more flood dominant (in the most simplistic form peak flood flows are stronger than those on the ebb) over the last 150 years, however this is more attributable to the area up-estuary of the Humber Bridge, since in the reaches down-estuary of Hull there has been increased ebb dominance. Spatial and temporal patterns of change of intertidal and subtidal volume are similar to the respective patterns of slack duration at high water and the ebb dominant net tidal excursions. In summary, this suggests fine sediments are being

imported along the intertidal zone, whilst coarser sandy material is gradually being lost from the subtidal sections of the Estuary.

A general trend of accretion within the Estuary was observed during 1851-1936. During this period the main areas of accretion were located at Grimsby Middle, Middle Shoal, Foul Holme Sand and around Read's Island. Since 1936 however, discrete areas have been seen to erode whilst for the Estuary, generally there has been greater erosion of the intertidal area near Grimsby and greater accretion in the Inner Estuary. This indicates that trends are variable in time and location within the Estuary.

7.3.2.2 Natural variability

The Humber Estuary is highly dynamic in its morphology, particularly in areas where there are no constraints (either geological or man-made). This dynamism manifests itself in cyclical variations in the positions of channels and banks throughout different regions of the Estuary. The processes experienced by many of these regions appear to be interconnected. The dominant influences on morphological change are tides, waves, freshwater flows, tidal surges, sediment supply and biological activity which affects the density of the substrate and its resistance to erosion and is highly variable. These influences produce changes in Suspended Sediment Concentrations (SSC), deposition rates, bed composition and ultimately channel/ bank configurations. This variability in the banks and channels has been particularly noticeable around the Hull Bend during the last circa 15 - 20 years, with large changes to the intertidal banks and secondary channels in the areas of Hull Middle, Skitter Sand and Halton Flats. At the same time significant erosion of the northern end of Halton Middle has been prevalent, see Plate 7.1.

In the Outer Estuary rapid changes in the configuration of Middle Shoal occurred in the mid-1990s, with similar changes occurring at present, whilst there was relative stability between about 2005 – 2012.

7.3.3 Tides

The Humber Estuary is macro-tidal (meaning it has a tidal range in excess of 4 m), with a mean spring tidal range of 5.7 m at Spurn Head increasing to 7.4 m at Saltend then decreasing to 6.9 m at Hessle, which is 45 km inland. During the neap spring tide sequence at Saltend the tidal range varies from 5.8 m to 7.4 m. Tides are semi-diurnal with a slight diurnal inequality, amounting to a 0.2 m difference in high water spring tides at Immingham (British Transport Docks Board, 1971).

The Humber tides are driven by the amphidromic system centred off the west coast of Denmark in the central North Sea. As the tide passes south of North Shields, it enters shallow water conditions, which amplify the range from 4.3 m to 4.6 m at the River Tees entrance and 5.7 m at Spurn. This amplified tidal range drives the Humber tidal system so that the macro tidal range within the Estuary is a product of the general morphology of the east coast as well as the Estuary itself. As noted above tidal amplification occurs within the estuary up until approximately Hull.

There are two admiralty tide gauges in relatively close proximity to the potential managed realignment site; one at Spurn 8.7 km downstream of the site, and one at Immingham 15.5 km upstream of the site. The spring tidal ranges at these gauges are

5.7 m and 6.4 m, respectively (see Table 7.2; shown in metres relative to Ordnance Datum Newlyn (ODN).

Table 7.2: Summary tidal data for Spurn and Immingham and extrapolated to Outstrays and Welwick to Skeffling Managed Realignments (OtSMR)

Tidal Data			Spurn	Extrapolated to OtSMR	Immingham
			mODN	mODN	mODN
Tidal Level	Highest Astronomical Tide	HAT	3.8	3.9	4.1
	Mean High Water Springs	MHWS	3.0	3.15	3.4
	Mean High Water Neaps	MHWN	1.6	1.75	1.9
	Mean Low Water Neaps	MLWN	-1.2	ND	-1.3
	Mean Low Water Springs	MLWS	-2.7	ND	-3.0
Tidal Range	Spring Range	(MHWS - MLWS)	5.7	ND	6.4
	Neap Range	(MHWN - MLWN)	2.8	ND	3.2
ND – Not Determined					

(Source: UKHO, 2017 and extrapolation)

Currents fronting the proposed Scheme vary throughout the tide. Along the fronting intertidal the flows exhibit a roughly northward flow during the flood tide, followed by a period when flows are more aligned (in an easterly direction) with the shoreline and a subsequent period of approximately southward flows as the tide drops. Peak flows along the fronting intertidal are typically less than 0.5 m/s. Within the subtidal areas (3.5 km from the potential managed realignment site), flows are aligned with the channel (which runs approximately parallel to the shoreline), peaking at around 2 m/s on ebbing spring tides. This general flow regime over the intertidal fronting the proposed managed realignment site is controlled by the interaction of the propagation of the tide in a north/south direction along the Holderness Coast interacting with the 'sheltering' afforded by the Spurn Peninsula to drive the tides up and down the estuary.

7.3.3.1 Extreme water levels

At any instant in time, the water level in the Humber Estuary is the summation of an astronomical tidal level, and a residual (surge) component. Surges are formed by rapid changes in atmospheric pressure with an inverse relationship, with low atmospheric pressure raising the water surface (positive surge) and high atmospheric pressure depressing the water surface (negative surge). The surge component is generally much smaller in the summer than the winter, where deep atmospheric depressions and strong winds can have a significant effect on tidal levels and propagation at high tide. The co-timing of tidal and non-tidal contribution to water level is important as a positive surge in conjunction with a high tidal level will result in an unusually high-water level. Wave-induced sediment transport is likely to be lowered during these events, as a reduction in near-bed orbital current velocities would result in weaker bed shear stresses and therefore a decrease in seabed mobility (assuming local wind/wave

conditions are not enhanced at the same time). At the same time, however, the surge is likely to increase the tidal flows. Conversely, a negative surge in conjunction with a low tidal level will result in an unusually low water level, thus providing a suitable condition for increased wave-induced sediment transport.

The Coastal Flood Boundary Dataset (CFBD) (Environment Agency (2011)) indicates that the peak water level outside of the proposed managed realignment for a 1 in 200 year tidal surge is 4.8 ± 0.3 mODN. This event has a 22% likelihood occurrence during the 50 year design life when coupled with a 50 year sea level rise allowance, Jacobs/ABPmer (2019). These data, however, were derived before the extreme surge event of December 2013. As a result, extreme surge levels have been the subject of a recent study. This analysis has indicated higher levels than the CFBD with equivalent levels of 5.26 mODN west of the proposed Scheme and 5.14 mODN between the locations of the proposed breaches. Waves

In deep, offshore water the wind dominates the character of the waves. As waves travel into shallower, nearshore waters, they are affected by refraction, shoaling and diffraction due to variations in depth, currents and energy dissipation through friction and breaking.

Waves propagating towards an estuary can influence sediment transport by suspending sediment directly and/ or by generating wave induced currents. These currents can act independently or in conjunction with tidal and wind induced currents.

Wave action generally reduces landward within the Estuary due to the tendency of waves to refract towards the shoreline and due to energy losses resulting from shallow water effects. Locally generated waves can therefore be important for sediment movement within estuaries.

In the Humber, the effect of waves propagating from offshore is limited to the Outer Humber. In terms of locally generated waves, significant wave energy can be generated from the fetches within the Estuary, particularly in the area of Spurn Bight and the rear of Spurn, due to the prevailing south-westerly winds.

An analysis of waves recorded at Bull Sand Fort (circa 10 km SSE of the site) at the entrance to the Humber Estuary between 1984 and 1986 identified that significant wave height only exceeds 1 m for 11 % of the time, although there was seasonal variability (ABP Research and Consultancy, 1986). The maximum significant wave height recorded was 2.8 m. Waves approaching from the south-east cause localised increases in wave energy that extend to approximately 5 km east and west of Hawkins Point and refract over Spurn Bight; i.e. areas of increased wave energy under these conditions will extend very close to the potential managed realignment sites at higher states of the tide. Significant wave energy is also generated in the area of Spurn Bight and to the rear of Spurn due to the prevailing south westerly winds (ABPmer, 2009b), which will also have an important role in erosion/accretion and sediment transport along the shoreline fronting the Scheme (particularly along the upper intertidal).

7.3.4 Salinity

There is a strong longitudinal salinity gradient up the Estuary with average values of around 30 psu at Spurn, reducing to around 5 psu at Trent Falls (where ‘psu’ refers to practical salinity units). Note that seawater is typically 3.5% salt (i.e. 35 psu) and

freshwater contains only traces of salt and therefore concentrations of 0 psu can be expected.

The Humber is generally a well-mixed estuary except under conditions of high freshwater flow when demarcation between freshwater at the surface and dense saline water at the bottom becomes more exaggerated (ABP Research & Consultancy, 2000). The well mixed status is largely a reflection of high tidal current velocities. As saline water moves into the Estuary it meets the seaward flow of freshwater from the Rivers Ouse and Trent, and the more dense saline water tends to flow beneath the less dense fresh water. The high velocities of the tidal currents cause almost total mixing of the two water bodies, except under conditions of very high freshwater flows (ABP Research & Consultancy, 2000).

7.3.4.1 Freshwater flow

The major flows of freshwater into the Humber Estuary are from the River Trent and River Ouse catchments. The National River Flow Archive maintains gauge records of river flows for the Trent, Ouse, Don and Aire, which all discharge into the Humber Estuary. Annual mean flows derived from data spanning 40-50 years are 88.4 m^3/s, 50.5 m^3/s, 16.0 m^3/s and 34.8 m^3/s for the Rivers Trent, Ouse, Don and Aire, respectively. Flows downstream of Hull (and in the area around the development site) are not sensitive to fluvial inputs (ABPmer, 2009a). Smaller freshwater inputs include the catchments of the River Hull, River Foulness, Mires Beck and the Ancholme as well as local land drainage along the Estuary, including Old Fleet Drain which drains across the Saltend mudflat. The Ouse catchment flows are derived mainly from the Rivers Don, Aire, River Wharfe, Derwent and Upper Ouse.

There are a number of large abstractions on most principal rivers flowing to the Estuary. Water is abstracted, under licence from the Environment Agency, for agriculture and industrial purposes as well as public water supply. The majority of abstracted water is eventually returned to the catchment that it was extracted from, although up to 40 % abstracted for cooling purposes may be lost by evaporation at power stations such as Ferrybridge and Drax.

The potential managed realignment sites are dissected by a number of drains which are part of the Winestead and Fosse/Skeffling waterbodies. Based on aerial imagery interpretation only the Winestead Drain forms any noticeable channel of significance through the saltmarsh and mudflat.

7.3.5 Sediment transport

Sediment transport processes are an important physical characteristic of the Humber Estuary. The Humber has historically been considered an accretionary estuary or sediment sink, and long-term records (within last 200 years) indicate continuous deposition has occurred both in the intertidal and the subtidal regions (ABP Research & Consultancy, 1999; ABPmer, 2004), although erosion and accretion areas are both temporally and spatially variable.

In terms of sediment budget, the three main sediment sources for the Humber are its tributaries, the North Sea (in the form of background suspended sediment) and the eroding Holderness coast. Previous work shows that the exchange between the rivers and the estuary is an order of magnitude smaller than the flux of sediment through the mouth on each tide and that the inputs and outputs on each tide are very much smaller

than the volume of sediment held in suspension within the Estuary (Townend and Whitehead, 2003).

The amount of sediment supplied by these sources varies over time. Furthermore, the intertidal and subtidal areas of the estuary also act as both sources and sinks as well as short term stores for sediment, with the morphological evolution of these areas varying over time (ABPmer, 2009b).

Within the estuary sediment transport pathways are complex and probably continually changing as indicated by changes in the historical bathymetry that have been identified throughout the estuary (ABPmer, 2009a). GeoSea Consulting (1990) undertook a sediment transport study in the estuary based on sediment trend data and identified a general counter clockwise circulation pattern incorporating Foul Holme Spit (in the Middle Humber) and a clockwise circulation of sediments based around the Middle Shoal (within the Outer Humber) with little indication of a direct link between the two areas. Across the muddy intertidal in the Outer Humber, i.e. along the frontage of the proposed Scheme, net sediment transport was identified in a down-estuary direction (i.e. towards the mouth).

Extensive surveys of the distribution of suspended solids in the Estuary have been undertaken, such as that described by Gameson (1982), and naturally high background SSCs have been attributed to the macro-tidal nature of the Estuary combined with the dominance of muddy bed sediments (particle size below 63 microns). These concentrations are subject to natural variability, due to the influence of tide, wave and seasonal changes, with the highest concentrations (turbidity maxima) in the Estuary occurring in winter, usually in the rivers up estuary of Trent Falls. SSC levels also vary along the Estuary, with concentrations up estuary of Hull being twice as high as those found down-estuary.

Mean values of these SSCs in the Inner and Middle Estuary are generally greater than 200 mg/l at all depths, with peak values regularly exceeding 1,000 mg/l on spring tides. It is estimated that on a given tide up to 1.26 million tonnes of sediment may be in the water column. An initial net sediment budget was presented for the Estuary (Environment Agency, 1998) and refined further (Townend and Whitehead, 2003). Riverine inputs provide an average of 335 tonnes suspended sediment per tide, compared to a net import of around 100 tonnes per tide from marine sources.

Around 440 tonnes of sediment are deposited within the Estuary per tide. This, however, compares to an exchange of sediment through the mouth of the Estuary in the order of 120,000 tonnes per tide.

Borehole data (Environment Agency, 2000) indicate that most of the mobile material within the Estuary is of marine origin. The coarser elements of this mobile material tend to migrate toward the mouth of the Estuary, with the fines moving up-estuary, albeit to a less significant degree.

Extreme tidal range and differences between spring and neap tides give rise to characteristic spring/ neap deposition cycles. Changes in bed levels of 0.1 m or more during a spring/ neap cycle and/ or extreme events are not uncommon, and variations of bed levels of over 1 m have been recorded on an annual basis in the Outer Estuary. Over longer periods, cyclical variation of more than 10 m has been noted (ABPmer, 2004).

7.4 Future baseline

The physical processes in the Humber are continually changing in both the short term (i.e. spring/ neap variations and seasonal effects) and longer term based on variations in freshwater flows and the 18.6 year lunar nodal cycle. These variations are also influenced by climate change affecting the propensity for high flows, changes in temperature patterns as well as the effect of Sea Level Rise (SLR). The driving forces that influence the physical processes are continually changing in largely unpredictable ways, all of which affect the sedimentary processes throughout the Estuary. In turn, these affect the morphology which has a feedback to the coastal processes. This high degree of variability in both the form and physical processes operating in the subtidal and intertidal would be expected to continue in the absence of the potential Scheme.

In front of the managed realignment, as sea level rises mudflat and saltmarsh levels are expected to rise, but in the longer time may not keep pace with sea level rise. In addition, the existing sea defences will be increasingly overtopped, causing flooding of the areas of the proposed managed realignments. Without maintenance, the defences are likely to fail/breach with time.

7.4.1 Climate change and sea level rise

It is now widely accepted that climatic change will cause a continuing increase in mean sea level, although changes in relative sea level are a combination of climatic effects and changes in altitude of the land due to isostatic rebound, subsidence and tectonic effects. Information on the rate and magnitude of anticipated relative sea-level change nearby to the site during the 21st Century is available from the UK Climate Impacts Programme (UKCIP) (http://www.ukcip.org.uk/). A summary of the predictions given by UK Climate Projections (UKCP09) for changes in relative sea-level at the potential managed realignment site are presented in Table 7.3. These findings suggest that by 2100 relative sea-level will have risen between 0.43m and 0.65m above 2008 levels (based on medium emissions, 50 %ile and 95 %ile scenarios), with rates of change projected to increase during the second half of the 21st Century. This increase in sea level may (for example) allow larger waves to reach the existing seawall with less of their energy lost to friction over the fronting intertidal, thus potentially leading to an increase in upper intertidal erosion.

Table 7.3: Summary Statistics of 21st Century Relative Sea-Level Rise (rSLR) at the Managed Realignment Site (Relative to 2008 Levels)

Year	rSLR Based On Medium Emissions 50%ile Scenario (m)	rSLR Based On Medium Emissions 95%ile Scenario (m)
2008	0.00	0.00
2018	0.04	0.05
2050	0.17	0.25
2100	0.43	0.65
2118	0.53	0.82

(Source: Lowe et al., 2009)

Modelling as part of UKCP09 (Lowe et al., 2009) also gives the most up-to-date projection of the likely future wave climate. Changes in climate over the 21st Century may involve changes in mean wind speed and direction, which will ultimately determine the wave regime. In the Southern North Sea, mean winter and summer significant wave heights are projected to increase by between 0 and ~0.1 m by 2100, however, this increase is relatively insignificant when compared with the present day (baseline) wave conditions.

7.5 Likely significant effects

The following sections set out the likely significant effects on the marine physical environment arising from the Outstrays and Welwick to Skeffling Managed Realignments, presented for the two sites separately below.

7.5.1 Outstrays Managed Realignment

The development of the Scheme at the western site has the potential to affect the physical environment of the Humber Estuary. Each impact pathway that has been scoped into the assessment for both the construction and operational phases of the Scheme are presented below.

7.5.1.1 Construction

The construction of the Outstrays Managed Realignment will mostly be undertaken behind the existing embankments before the site is breached. Therefore, the only construction works that could affect the marine physical processes and hydrodynamics are:

- Reprofiling of the saltmarsh in front of the breach and lowering of the sections of existing flood embankment and construction of the breach.

Reprofiling of saltmarsh and lowering of flood embankment and breach construction

The construction activities to reprofile the saltmarsh and lower existing embankments (including the breach section) will be undertaken at lower states of the tide and as such will not directly interact with marine physical processes. Sediments will, however, be disturbed and could be placed in a less consolidated form on top of the existing mudflat/saltmarsh. In such cases there would be potential for the higher tidal states to disperse some of this material, creating a shallow water plume, which would be enhanced under wave activity.

The flow speeds near to HW are, however, low/near slack and therefore any dispersion is likely to remain local to the breach and would re-settle over the higher mudflats or become trapped within the remaining saltmarsh. Given the size of the works any such impact would be small (millimetric), and unlikely to noticeable with respect to the natural variability which occurs over a spring neap cycle, which has been measured on a centimetric/decimetric level.

The estuary feature (along with the intertidal habitats) is recognised through international designations and as such the sensitivity is classified as **Very high**. The magnitude of change is considered to be **Negligible** with respect to background suspended sediment concentrations and depth changes on the intertidal compared to

the natural variability. Any impact would also be short lived (for one or two tide cycles). On this basis, the significance of environmental effect is classified as **No effect**.

7.5.1.2 Operation

The operational phase of the Outstrays Managed Realignment has the potential to affect physical processes through the following impact pathways:

- Changes to the hydrodynamic regime (i.e. flows, water levels, exchange volumes) within the estuary;
- Changes to the morphological parameters of the estuary; and
- Hydrodynamic and morphological functioning of the Outstrays Managed Realignment

Changes to the hydrodynamic regime (i.e. flows, water levels, exchange volumes) within the estuary

The results of the numerical modelling of the operational phase of the Outstrays Managed Realignment are presented in Appendix 7.1.

Water levels within the estuary are unaffected by the operation of the Outstrays Managed Realignment, except at the immediate entrance of the breached embankment. This result is a function of the small tidal exchange (tidal prism) of 1.14 million m³, on mean spring tides. This flow into the site represents 0.08 % of the mean range tidal prism of the estuary as a whole. This is considerably lower than the 5 to 10 % lowest limit of tidal prism difference considered by Legget et al. (2004) to likely cause change to the estuary.

As noted above, the tidal prism exchanged with the estuary is small and confined to the highest part of the tide when the main estuary flows are slowing, but the flows over the intertidal mudflats are greatest. These baseline flows are still, however, slow (rarely exceeding 0.2 m/s). With the Outstrays Managed Realignment in operation, flows are attracted towards the breach on the flood and disperse, in an approximate 'radial' pattern centred on the breach on the ebb. Maximum flow speeds modelled just outside the breach reach about 0.65 m/s and are confined partially by the entrance channel in the modelled design. Maximum extents of effect are confined to within about a 650 m radius of the centre of the breach.

The modelling included an approach channel in the fronting mudflat. The approach channel, as modelled, will not however be constructed as part of the Scheme. This channel was larger than that which might be expected to form “naturally”. The increases in flow speeds approaching and leaving the breach, shown by the modelling, are therefore likely to be lower than is initially likely following breaching of the Outstrays Managed Realignment. These increased flow speeds would be quickly reduced by the 'initial shallow lagoon' effect outside of the breach (due to the breach level being initially lower than the fronting intertidal mudflat). From this ‘lagoon’ a channel is likely to erode across the mudflat and the flow speeds will reduce as the channel develops. Initially, it is likely that the minor changes in flow speeds could extend up to 1 km radius from the breach, potentially causing small mudflat erosion, however, as any channel develops, the effect would become more focussed around the developing channel itself.

On a worst-case assumption, changes in flow speed caused by the initial operation of the Outstrays Managed Realignment are therefore likely to extend up to 1 km radius of

the breach. The area of potential impact is likely to represent up to about 1.6 % of the total intertidal of the estuary or 0.6 % of the total estuary area. This would be expected to reduce through time as the site evolves. Small changes could continue for the order of a decade, but these will not be evident against the natural variability.

The physical hydrodynamic processes operating within the estuary have an important influence on internationally designated features. On this basis, the hydrodynamic regime is assigned a **Very high** sensitivity. From the above discussion the magnitude and nature of environmental effect on the estuary is assessed as **Minor negative** due to a worst case of discernible impact over a small area of the estuary. Most of the impact is expected to occur within the first year. The significance of the environmental effects is therefore identified as **Minor adverse - Moderate adverse**. The above assessment has been based on the worst case for spring tides. However, this can physically only occur on average for less than 20 % of the time. On this basis the assessment of significance on the hydrodynamic regime should be considered near to the minor adverse end of this range.

Changes to the morphological parameters of the estuary

Hydrodynamic modelling of various parameters (water levels, flows and bed shear stresses) has shown that for the worst case the effects of the Outstrays Managed Realignment are confined to within 1 km radius of the centre of the breach. This represents a maximum impact of 0.6 % of the area of estuary morphology. Most changes are likely to be erosional due to the evolution of a meandering channel across the mudflat from the breach.

Outside the site, as noted in the previous section, the flows attracted to and radiating from the breach are increased above the circa 0.2 m/s maximum speed that presently occurs over the mudflat. These flows will initially be 'damped' by the ‘shallow lagoon’ conditions that will initially form in front of the breach. A narrow channel will form over time, confining more flow towards the breach. The plan form and depth of the channel is not predictable as it will depend in the bed density and sediment distribution in plan and depth over the mudflat. It will, however, tend to meander down the gradient of the mudflat across the intertidal, similar to channels to the existing saltmarsh and particularly the channel from Winestead Drain. Additional sedimentation across the mudflat is not predicted from interpretation of the results of the hydrodynamic modelling.

Similarly, there is negligible potential for the creation of accretional areas elsewhere within the estuary. The Outstrays Managed Realignment increases the tidal prism of the estuary by a maximum of about 0.08 % and removes of the order of 0.015 % of the sediment from the water column per tide. These changes are small and are of the same order of magnitude (or less) than the possible accuracy in determining the estuary wide parameters, particularly considering the high natural variability in the existing estuary morphology as a whole.

The variability in the estuary morphology is predominantly controlled by the flow patterns and significant changes in the subtidal banks and channels throughout the estuary. By comparison the intertidal areas are considerably more stable. The Outstrays Managed Realignment only affects the estuary dynamics within the fronting intertidal area and only has potential to affect the morphology for less than 20 % of time, due to the high elevation with respect to the tidal range.

This assessment of processes potentially affecting morphological change and suspended sediment concentrations suggests that there will be no discernible change to the sediment accretion and erosion patterns in the area of the neighbouring saltmarsh, and the estuary as a whole as a result of the introduction of the Outstrays Managed Realignment.

Estuary is a specific feature which is internationally designated, therefore the sensitivity to change in the morphology is assessed as **Very high**. The magnitude of any effects on the estuary, however, are very small and within the accuracy that is likely to be obtained for the assessment parameters. The overall impact on the estuary is therefore considered as no discernible impact, therefore of **Negligible magnitude**. As a result, there will be **No effect** when considering the estuary morphology as a whole.

Hydrodynamic and morphological functioning of the Outstrays Managed Realignment

Hydrodynamics

Numerical modelling has shown that the Outstrays Managed Realignment will flood completely on spring tides from the time that the breach is opened, creating approximately 107 ha of intertidal habitat on mean spring tides. The site, however, is located high in the tidal frame. This means the site, except for the creeks, will be inundated for less than approximately 5 hours on a spring tide and hardly at all on neap tides. The area of inundation on neap tides is reduced to about 27 ha, almost entirely within the initially designed creek system. On this basis the majority of the site will only be 'wet 'for less than 20 % of the year, and then predominantly only at the lower elevations.

The modelling has also shown that when tidal levels are high enough in the estuary, the designed breach and 'channel' through the existing saltmarsh are sufficient not to restrict the tidal propagation through the site. Assuming a non-vegetated site, maximum water levels within the site are raised up to 0.04 m above the tidal level just outside the breach. Such differences would be expected to decrease over time as saltmarsh vegetation develops. Modelling (Appendix 7.1) suggests the decrease would be circa 0.01m over about five years, but the rate of water level reduction is likely to increase as the volume in the site reduces due to siltation.

The results of modelling the flow speeds and bed shear stresses show that the designed creek system, whilst allowing the site to flood with little obstruction, does not allow unobstructed conveyance of the ebb flow as a result of the bed friction. This means the managed realignment does not completely drain before the next tide with a mean spring range.

The existing estuary flood defence is being lowered to the surrounding ground level, as is the dividing embankment between the Outstrays Managed Realignment and the existing Welwick site. These elevations are, however, still high in the tidal frame and are only overtopped on the highest tides. This results in Negligible change on the hydrodynamic functioning of both sites.

Following evolution of the site, accounting for potential accretion (see below), the site is shown by the modelling to still function as it still allows almost unaffected tidal exchange with the estuary. The modelling results show that the Outstrays Managed Realignment continues to function as an intertidal area in the future despite the

accretion, however, depths and times of inundation will change, hence the proportions and types of habitat created will evolve, see Chapter 11 (Marine Biodiversity).

Morphology

As soon as the Outstrays Managed Realignment is breached, the flow into the site will import sediment (mainly silt and clay particles), which has the potential to move over the complete area of the site on spring tides, but will be restricted to the channels on neap tides. The distribution of flows and site drainage characteristics suggest that, with the exception of the creek footprint and channel through the existing saltmarsh, the site will be accretional for most of the time. The modelled flow regime suggests that most of the incoming sediment will be trapped within the site causing continuous accretion. As this accretion occurs the tidal prism of the site will decrease (and hence imported sediment load will also reduce with time).

The modelling presented in Appendix 7.1 includes an assessment of the hydrodynamic characteristics for an evolved site bathymetry after circa five years, i.e. accounting for the potential effects of the accretion. The evolved bathymetry was determined from lessons learnt from monitoring existing Humber Managed Realignments and more specifically the rates of sediment build up that occurred at the adjacent Welwick Managed Realignment. The potential accretion rates used in the model accounted for circa 36 % reduction in the mean spring tidal prism equating to an in situ volume of accretion of about 405,000 m^3, the majority of which is likely to occur nearest to the breach and the 'bowl' at the rear of the site within the first circa two years. As a result, the effect on the hydrodynamics of the estuary assessed in the previous section will reduce with time.

Based on the difference in tidal prism exchanged on spring and neap tides, it is likely that nearly all accretion will be associated with the spring tides. The evolved bathymetry represents an average accretion of about 230 m^3 in situ per spring tide over the five year period, albeit it is recognised more will occur in the first two years compared to the last two. Using the average spring tidal prism over the five year period, the average spring tide accretion rate equates to about 0.00024 m^3 in situ for every m^3 of water exchanged with the estuary. Assuming an in situ ‘wet’ bed density of circa 1500 kg/m^3, which would be representative of mudflat after about five years, this equates to an average sediment concentration of the incoming water of about 186 mg/l (on the assumption that all sediment deposits). This is in line with the average concentrations that occur in this part of estuary (see baseline Section 7.3.6).

The Humber Estuary has in the order of 1.2 million tonnes of sediment in motion in the water column on each tide. The potential accretion in the Outstrays Managed Realignment equates to about 178 tonnes per tide, i.e. 0.015 % of the total sediment in suspension and a similar order to the estimated import of sediment from the North Sea each tide.

Overall, the flow speeds and bed shear stresses are likely to be just sufficient to maintain the creek system and breach from accretion, but insufficient to cause any significant erosion from the initial design. Accretion across the remainder of the site will play a part in influencing habitat development with saltmarsh predicted to increase in extent through time.

The establishment of the functioning intertidal hydrodynamic and sedimentary regime within the site is assessed as a **Moderate positive** effect with respect to the estuary as it restores tidal volume that was removed when the defences were originally built. This

is set in the context of the international importance of such physical parameters that comprise the estuary feature. The significance of this effect is therefore **Moderate beneficial – Major beneficial** from an estuary perspective.

7.5.2 Welwick to Skeffling Managed Realignment

The development of the Scheme at the eastern site has the potential to affect the physical environment of the Humber Estuary. Each impact pathway that has been scoped in to the assessment for both the construction and operational phases of the Scheme are presented below.

7.5.2.1 Construction

The construction of the Welwick to Skeffling Managed Realignment will mostly be undertaken behind the existing embankments before the entrances are breached.

Therefore, the only construction works that could affect the marine physical processes and hydrodynamics are:

- Reprofiling of the saltmarsh in front of the breach and lowering of the sections of existing flood embankment and construction of the breach.

Reprofiling of saltmarsh and lowering of flood embankment

The construction activities to reprofile the saltmarsh and lower existing embankments will be undertaken at lower states of the tide and as such will not directly interact with marine physical processes. Sediments will, however, be disturbed and could be placed in a less consolidated form on top of the existing mudflat/saltmarsh. In such cases there would be potential for the higher tidal states to disperse some of this material, creating a shallow water plume, which would be enhanced under wave activity.

The flow speeds near to HW are, however, low/near slack and therefore any dispersion is likely to remain local to the breach and would re-settle over the higher mudflats or become trapped within the remaining saltmarsh. Given the size of the works any such impact would be small (millimetric), and unlikely to noticeable with respect to the natural variability which occurs over a spring neap cycle, which has been measured on a centimetric/decimetric level.

The estuary feature (along with the intertidal habitats) is recognised through international designations and as such the sensitivity is classified as **Very high**. The magnitude of change is considered to be **Negligible** with respect to background suspended sediment concentrations and depth changes on the intertidal compared to the natural variability. Any impact would also be short lived (one or two tide cycles). On this basis, the significance of environmental effect is classified as **No effect**.

7.5.2.2 Operation

The operational phase of the Welwick to Skeffling Managed Realignment has the potential to affect physical processes through the following impact pathways:

- Changes to the hydrodynamic regime (i.e. flows, water levels, exchange volumes) within the estuary;
- Changes to the morphological parameters of the estuary; and

- Hydrodynamic and morphological functioning of the Welwick to Skeffling Managed Realignment including the potential for ongoing intervention.

Changes to the hydrodynamic regime (i.e. flows, water levels, exchange volumes) within the estuary

The results of the numerical modelling of the operational phase of the Welwick to Skeffling Managed Realignment are presented in Appendix 7.1.

Water levels within the estuary are unaffected by the operation of the Welwick to Skeffling Managed Realignment, except at the immediate entrance of the breached embankment. This result is a function of the small tidal exchange (tidal prism) of 1.14 million m^3, on mean spring tides. This flow into the site represents 0.11 % of the mean range tidal prism of the estuary as a whole. This is considerably lower than the 5 to 10 % lowest limit of tidal prism difference considered by Legget et al. (2004) to likely cause change to the estuary.

As noted above, the tidal prism exchanged with the estuary is small and confined to the highest part of the tide when the main estuary flows are slowing, but the flows over the intertidal mudflats are greatest. These baseline flows are still, however, slow (rarely exceeding 0.2 m/s). With the Welwick to Skeffling Managed Realignment in operation, flows are attracted towards the breach on the flood and disperse, in an approximate 'radial' pattern centred on the breach on the ebb. Maximum flow speeds modelled just outside the breach reach about 0.9 m/s during flood tides and are confined partially by the entrance channel in the modelled design. Maximum extents of effect are confined to within about 1.3 km of the breach.

The modelling included an approach channel in the fronting mudflat. The approach channel, as modelled, will not however be constructed as part of the Scheme. This channel was larger than that which might be expected to form “naturally”. The increases in flow speeds approaching and leaving the breach, shown by the modelling, are therefore likely to be lower than is initially likely following breaching of the Welwick to Skeffling Managed Realignment. These increased flow speeds would be quickly reduced by the 'initial shallow lagoon' effect outside of the breach (due to the breach level being initially lower than the fronting intertidal mudflat). From this ‘lagoon’ a channel is likely to erode across the mudflat and the flow speeds will reduce as the channel develops. Initially, it is likely that the minor changes in flow speeds could extend up to 1.5 km from the breach, however, as any channel develops, the effect would become more focussed around the developing channel itself.

On a worst-case assumption, changes in flow speed caused by the initial operation of the Welwick to Skeffling Managed Realignment are therefore likely to extend up to 2 km radius of the breach. The area of potential impact is likely to represent up to about 2 % of the total intertidal of the estuary or 0.7 % of the total estuary area. This would be expected to reduce through time as the site evolves. Small changes could continue for the order of a decade, but these will not be evident against the natural variability.

The physical hydrodynamic processes operating within the estuary have an important influence on internationally designated features. On this basis, the hydrodynamic regime is assigned a **Very high** sensitivity. From the above discussion the magnitude and nature of environmental effect on the estuary is assessed as **Minor negative** due to a worst case of discernible impact over a small area of the estuary. Most of the impact is expected to occur within the first year. The significance of the environmental effects is therefore identified as **Minor adverse - Moderate adverse**. The above

assessment has been based on the worst case for spring tides. However, this can physically only occur on average for less than 20 % of the time. On this basis the assessment of significance on the hydrodynamic regime should be considered near to the minor adverse end of this range.

Changes to the morphological parameters of the estuary

Hydrodynamic modelling of various parameters (water levels, flows and bed shear stresses) has shown that for the worst case the effects of the Welwick to Skeffling Managed Realignment are confined to within 2 km radius of the centre of the breach. This represents a maximum impact of 0.7 % of the area of estuary morphology. Most changes are likely to be erosional due to the evolution of a meandering channel across the mudflat from the breach.

Outside the site, as noted in the previous section, the flows attracted to and radiating from the breach are increased above the circa 0.2 m/s maximum speed that presently occurs over the mudflat. These flows will initially be 'damped' by the ‘shallow lagoon’ conditions that will initially form in front of the breach. A narrow channel will form over time, confining more flow towards the breach. The plan form and depth of the channel is not predictable as it will depend in the bed density and sediment distribution in plan and depth over the mudflat. It will, however, tend to meander down the gradient of the mudflat across the intertidal, similar to channels to the existing saltmarsh and particularly the channel from Winestead Drain. Additional sedimentation across the mudflat is not predicted from interpretation of the results of the hydrodynamic modelling.

Similarly, there is negligible potential for the creation of accretional areas elsewhere within the estuary. The Welwick to Skeffling Managed Realignment increases the tidal prism of the estuary by a maximum of about 0.11 % and removes of the order of 0.024 % of the sediment from the water column per tide. These changes are small and are of the same order of magnitude (or less) than the possible accuracy in determining the estuary wide parameters, particularly considering the high natural variability in the existing estuary morphology as a whole.

The variability in the estuary morphology is predominantly controlled by the flow patterns and significant changes in the subtidal banks and channels throughout the estuary. By comparison the intertidal areas are considerably more stable. The Welwick to Skeffling Managed Realignment only affects the estuary dynamics within the fronting intertidal area and only has potential to affect the morphology for less than 20 % of time, due to the high elevation with respect to the tidal range.

This assessment of processes potentially affecting morphological change and suspended sediment concentrations suggests that there will be no discernible change to the sediment accretion and erosion patterns in the area of the neighbouring saltmarsh, and the estuary as a whole as a result of the introduction of the Welwick to Skeffling Managed Realignment.

Estuary is a specific feature which is internationally designated, therefore the sensitivity to change in the morphology is assessed as **Very high**. The magnitude of any effects on the estuary, however, are very small and within the accuracy that is likely to be obtained for the assessment parameters. The overall impact on the estuary is therefore considered as no discernible impact, therefore of **Negligible magnitude**. As a result, there will be **No effect** when considering the estuary morphology as a whole.

Hydrodynamic and morphological functioning of the Welwick to Skeffling Managed Realignment

Hydrodynamics

Numerical modelling has shown that the Welwick to Skeffling Managed Realignment will flood completely on spring tides from the time that the breach is opened, thus creating 127 ha of intertidal habitat on mean spring tides. The site, however, is located high in the tidal frame. This means the site, except for the creeks, will be inundated for less than approximately 5 hours on a spring tide and hardly at all on neap tides. The area of inundation on neap tides is reduced to about 42 ha, almost entirely confined to the ‘bowl’ inside the breach. On this basis the majority of the site will only be 'wet 'for less than 20 % of the year, and then predominantly only at the lower elevations.

The modelling has also shown that when tidal levels are high enough in the estuary, the designed breach and 'channel' through the existing saltmarsh are sufficient not to cause a restriction to tidal propagation through the site. Assuming a non-vegetated site, maximum water levels within the site are raised up to 0.04 m above the tidal level just outside the breach. Such differences would be expected to decrease overtime as saltmarsh vegetation develops. Modelling (Appendix 7.1) suggests the decrease would be circa 0.01m over about five years, but the rate of water level reduction is likely increase as the volume in the site reduces due to siltation.

The results of modelling the flow speeds and bed shear stresses show that the designed creek system, whilst allowing the site to flood with little obstruction, does reduce the conveyance of the ebb flow as a result of the bed friction. This means the creek system does not completely drain before the next tide with a mean spring range.

The existing estuary flood defence is being lowered to the surrounding ground level. These elevations are, however, still high in the tidal frame and are only overtopped on the highest tides. This has Negligible change on the hydrodynamic functioning of the site.

Following evolution of the site, accounting for potential accretion (see below), the site is shown by the modelling to still function as it still allows almost unaffected tidal exchange with the estuary. The modelling results show that the Welwick to Skeffling Managed Realignment continues to function as an intertidal area in the future despite the accretion, however, depths and times of inundation will change, hence the proportions and types of habitat created will evolve, see Chapter 11 (Marine Biodiversity).

Morphology

As soon as the Welwick to Skeffling Managed Realignment is breached the flow into the site will import sediment (mainly silt and clay particles), which has the potential to move over the complete area of the site on spring tides, but will be restricted to the channels on neap tides. The distribution of flows and site drainage characteristics suggest that, with the exception of the creek footprint and channel through the existing saltmarsh the site will be accretional for most of the time. The modelled flow regime suggests that most of the incoming sediment will be trapped within the site causing continuous accretion. As this accretion occurs the tidal prism of the site will decrease (and hence imported sediment load will also reduce with time).

The modelling presented in Appendix 7.1 includes an assessment of the hydrodynamic characteristics for an evolved site bathymetry after circa five years, i.e. accounting for the potential effects of the accretion. The evolved bathymetry was determined from lessons learnt from monitoring existing Humber Managed Realignments and more specifically the rates of sediment build up that occurred at the adjacent Welwick Managed Realignment. The potential accretion rates used in the model accounted for circa 43 % reduction in the mean spring tidal prism equating to an in situ volume of accretion of about 667,000 m^3, the majority of which is likely to occur nearest to the breach and the 'bowl' at the rear of the site within the first circa two years. As a result, the effect on the hydrodynamics of the estuary assessed in the previous section will reduce with time.

Based on the difference in tidal prism exchanged on spring and reap tides, it is likely that nearly all accretion will be associated with the spring tides. The evolved bathymetry represents an average accretion of about 380 m^3 in situ per spring tide over the five-year period, albeit it is recognised more will occur in the first two years compared to the last two. Using the average spring tidal prism over the five-year period, the average spring tide accretion rate equates to about 0.0003 m^3 in situ for every m^3 of water exchanged with the estuary. Assuming an in situ ‘wet’ bed density of circa 1500 kg/m^3, which would be representative of mudflat after about five years, this equates to an average sediment concentration of the incoming water of about 232 mg/l (on the assumption that all sediment deposits). This is in line with the average concentrations that occur in this part of estuary (see baseline Section 7.3.6).

The Humber Estuary has in the order of 1.2 million tonnes of sediment in motion in the water column on each tide. The potential accretion in the Welwick to Skeffling Managed Realignment equates to about 289 tonnes per tide, i.e. 0.024 % of the total sediment in suspension and a similar order to the estimated import of sediment from the North Sea each tide.

Overall, the flow speeds and bed shear stresses are likely to be just sufficient to maintain the creek system and breach from accretion, but insufficient to cause any significant erosion from the initial design. Accretion across the remainder of the site will play a part in influencing habitat development with saltmarsh predicted to increase in extent through time.

The establishment of the functioning intertidal hydrodynamic and sedimentary regime within the site is assessed as a **Moderate positive** effect with respect to the estuary as it restores tidal volume that was removed when the defences were originally built. This is set in the context of the international importance of such physical parameters that comprise the estuary feature. The significance of this effect is therefore **Moderate beneficial – Major beneficial** from an estuary perspective.

Future Intervention Works

As noted in Chapter 3, one of the objectives of the Welwick to Skeffling Managed Realignment is to provide compensatory habitat for future port development on the estuary (should this prove necessary). At the present time, the magnitude, timescale and characteristics of any such compensation requirements are unknown. It is anticipated, however, that this is likely to include an element of mudflat habitat. In order to maintain mudflat within the site into the future, it is recognised that some form of intervention works may be necessary. The method and frequency of any such

intervention has not yet been defined as it will be dependent not only on the specifics of the compensation objectives but also how the site has evolved.

The potential effects from such works are not assessed here given the uncertainties. It is assumed, however, that potential intervention works will require the evolved bathymetry to be re-profiled to return it to elevations suited to sustaining mudflat. The most appropriate plant for the scale and type of work required will be defined as and when required. Supporting environmental assessments for the intervention works as to the effect on the physical processes and hydrodynamics will also be undertaken at this time to support the necessary consents and licensing requirements. These would reflect the temporary and localised nature of any such works, as well as their underlying objective to promote mudflat in the long-term.

By their nature, these works will change the bathymetric form and the habitat distribution within the site. The functioning and overall intertidal area of the site will be maintained and potentially enhanced following completion of the works. It should be noted, however, that following any such re-profiling of the site, it would be expected to continue to accrete and as such a cyclical programme of intervention could be required.

7.6 Mitigation

The managed realignment design and proposed construction methods have been developed in a way to embed mitigation to minimise potential effects on physical processes for both sites. Therefore, the assessment above is made assuming such mitigation is implemented. Such embeded mitigation measures include:

- During construction, all works to form the new coastal defence embankments and the topography within the site will be undertaken before opening the sites to the estuary. This practice will therefore eliminate any effects on the estuary physical processes and hydrodynamics from these works;
- The breaches require lowering/removal of the fronting embankment as well as reprofiling of the immediate fronting saltmarsh. Where possible this will be undertaken at lower states of the tide, thereby minimising direct disturbance effects to the estuary processes and hydrodynamics.

7.7 Residual effects

The implementation of the mitigation measures set out in Section 7.6 were already included in the assessment of potential effects above. Therefore, the conclusions of the predicted residual effects remain the same as those described above in section 7.5.

8 Water Environment

8.1 Introduction

This chapter describes the impacts and associated effects of the Scheme on the water environment. This topic covers water quality, water quantity and geomorphology relating to non-tidal and marine (estuarine) surface water features such as rivers, streams, ponds and lakes. Water quantity considers water as a resource (e.g. availability for consumption and dilution of discharges). All of these aspects are referred to in this assessment as the “water environment”.

The assessment of effect upon groundwater is considered in the Geology, Soils and Hydrogeology assessment (Chapter 9). Where relevant, the assessment of effect upon the water environment has been informed by the conclusions from Chapter 7 (Physical Process and the Hydrodynamic Environment). This chapter also makes reference to the ecological impact assessment which can be found in the Biodiversity Chapters (Chapters 10 and 11).

A Water Framework Directive (WFD) assessment has been produced and is presented as Appendix 8.1. WFD data has been used to inform the baseline environment and is presented below in section 8.4. A Flood Risk Assessment is presented in Appendix 8.3 and has been used to inform this assessment.

8.2 Regulatory and policy framework

Water resources are managed and protected under UK legislation and regulations consistent with European Community Directives. In addition to the Directives, Regulations and Policies described in Chapter 1 and Appendix 1.4, the main legal and policy framework, environmental consents and permits relevant to the water environment, is described further in in Appendix 8.2. The key ones include the following:

- Water Act 2003, as amended;
- Water Act 2014;
- EC Directive 2000/60/EC establishing a framework for Community action in the field of water policy (known as the ‘Water Framework Directive or WFD’) and the Water Environment (Water Framework Directive) (England and Wales) Regulations (SI 3242/2003) which transpose the WFD into regulations in England;
- Land Drainage Act 1991, as amended;
- Water Resources Act 1991 (as amended);
- Marine and Coastal Access Act 2009;
- Environmental Permitting (England and Wales) Regulations 2016;
- The Floods Directive (2007/60/EC) and the Flood Risk Regulations 2009; and
- Flood and Water Management Act 2010.

A key directive is the Water Framework Directive (WFD) 2000/60/EC, which requires all-natural water bodies to achieve both good chemical status and good ecological status. Water bodies that are designated in the River Basin Management Plan (RBMP) as Heavily Modified Water Bodies (HMWB) or Artificial water bodies (AWB) may be prevented from reaching good ecological status by the physical modifications for which they are designated (e.g. navigation, flood defence, urbanisation). Instead they are required to achieve good ecological potential (rather than status), through implementation of a series of mitigation measures outlined in the RBMP. Further information on the WFD is also found in Appendix 8.1.

8.3 Methodology

8.3.1 Study area

The study area for the non-tidal water environment assessment includes a 500m buffer from the proposed Red Line Boundary. This incorporates Winestead Drain, Welwick Drain, Weeton Fleet, Fosse Drain and several named and un-named drains as well as numerous ponds. The study area boundary and features of the water environment are presented on Plate 8.1 and in more detail in Figure 8.1 in Appendix 1.1.

The study area for the marine (estuarine) water environment is defined as the area over which the potential direct and indirect impacts of the Scheme are predicted to occur. This is limited to the Humber Lower transitional water body.

8.3.2 Baseline data collection

The following data sources have been used in undertaking the assessment:

- Ordnance survey mapping;
- Mapping provided by Google;
- Data from the British Geological Survey (BGS) website (https://www.bgs.ac.uk/, accessed 30/10/2018);
- Mapping and data from Magic (http://www.magic.gov.uk/, accessed 30/10/2018);
- Environment Agency catchment data explorer from (https://environment.data.gov.uk/catchment-planning/WaterBody/GB104027069593, accessed 30/10/2018);
- Environment Agency data from “What’s on your Backyard” (WIYBY) website (http://apps.environment-agency.gov.uk/wiyby/default.aspx accessed 30/10/2018); and
- Hull and East Riding Catchment Abstraction Licensing Strategy, Environment Agency, 2013 (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/305452/lit_7867_a7b9fe.pdf, accessed 30/10/2018); and
- Sediment contamination sampling undertaken in May 2017 and October 2018.

8.3.3 Impact assessment

In addition to the value criteria presented in Table 4.2 in Chapter 4, this can be expanded upon for the water environment as detailed in Table 8.1.

Table 8.1: Indicative Criteria for Estimating the Value of Water Environment Receptors

Value	Criteria
Very High	• A surface water resource of pristine or near pristine water quality (WFD class "*High*"), where water quality is not significantly affected by anthropogenic factors, and where water quality does not affect the diversity of species of flora and fauna. Includes sites with international and European nature conservation designations with water-dependent ecosystems. • Natural (unmodified) watercourse with natural flow conditions.
High	• A surface water resource with a measurable degradation in its water quality as a result of anthropogenic factors, where the resulting water quality has only limited effect on the species diversity of flora and fauna in the water resource (WFD class "Good"). Includes non-statutory sites of regional or local importance designated for water dependent ecosystems. • Natural watercourse with few modifications and flow conditions (i.e. may be classed as Heavily modified under the WFD).
Medium	• A surface water resource with moderate water quality (WFD class "Moderate") resulting from anthropogenic factors, where the species diversity of flora and fauna is more affected by significant water quality degradation. • A modified watercourse (i.e. may be classed as Heavily modified under the WFD).
Low	• A surface water body not included in the above categories includes WFD class "Poor and Bad". • A modified watercourse (i.e. may be classed as Heavily modified under the WFD). • Includes man-made surface water features that serve purely a drainage function.

Potential impacts resulting from the Scheme are then identified along with the magnitude of the impact. The criteria in Table 4.2 has been used to identify the magnitude of impact for the water environment.

By considering the value of the receptor and the magnitude and nature of the impact the significance of the effect on the receptors and receptor's attributes (such as water quality) during both construction and operation can be established using the matrix in Table 4.4. Those effects described as 'moderate significant' or 'major significant' are usually considered to be significant in terms of the EIA Regulations. Other conclusions acknowledge that there may be some change from the baseline conditions but that these are not significant.

8.3.4 Uncertainties, assumptions and limitations

In undertaking this assessment, the following uncertainties are recognised:

- Detailed drainage information is not available; and
- Some aspects of the Scheme which may impact upon the Water Environment will not be known until the detailed design stage, this is not limited to but includes the following:
    - number of outfalls to the new soak dyke from the proposed filter drain;
    - the operation of the habitat creation and mitigation area in West 2 and its water demands;
    - how existing drain inflowing to the new soak dyke will be dealt with; and

In undertaking this assessment, the following assumptions have been made:

- The pumping regime of Outstrays and Skeffling Pumping Stations will not be altered and will continue to operate during the construction period.
- Winestead Drain has been identified as the only source of water abstraction for dust suppression at this time.
- Mitigation is based upon the concept design for the proposed wet grassland creation and other habitat creation and does not significantly change from that currently proposed.
- Mitigation will be implemented as described, in accordance with best practice and managed appropriately. There is greatest uncertainty around the success of measures to manage the risk of silt pollution due to the significant quantities of earthworks. The success of the mitigation is dependent upon various factors, i.e. timing, weather, working methods, sequence etc which cannot be determined at this time. Monitoring proposed as part of the mitigation will be important to determine the effectiveness of the mitigation and identify any additional measures if required.
- Assumes outfalls and culvert extensions will be pre-cast concrete units and no cast in-situ works required within watercourse.

There is always a degree of uncertainty associated with making predictions as to how a managed realignment scheme will function in a highly dynamic environment. The marine assessments have been founded in the results of numerical modelling and a conceptual understanding of the estuary. Lessons learnt from existing managed realignment schemes within the area and extensive use of the literature have been factored in to the respective predictions of environmental effects and habitat.

8.4 Existing environment

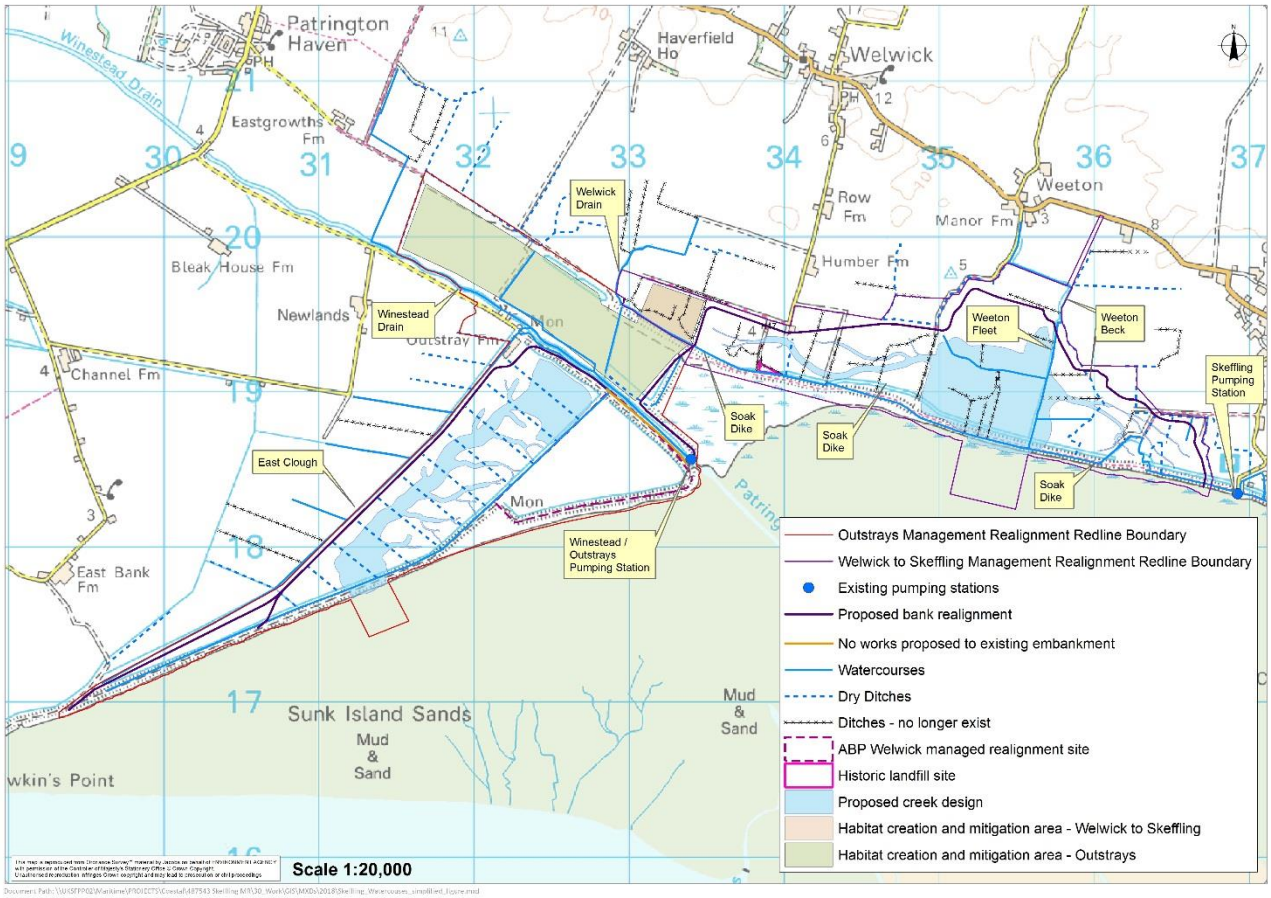
This section initially discusses the existing environment of the two managed realignment sites, followed by the marine (estuarine) environment fronting these sites.

8.4.1 Outstrays Managed Realignment

8.4.1.1 Surface waters features and drainage

Surface water features for the Outstrays MR site (the “western site”) are presented on Plate 8.1 below and in more detail in Appendix 1.1. The main surface water feature within the site is Winestead Drain (Plate 8.2a and 8.2b), which downstream of the Mean High Water Level is known as the Patrington Channel. Winestead Drain originates near Withernsea, from where it flows southwards between Winestead and Patrington. It is then joined by a drain (North Channel) from the west, and turns to flow south eastwards, past Patrington Haven, into the Humber Estuary. The drain is located in West 2 (downstream of Outstrays Farm), close to the boundary with West 1. Within the site Winestead Drain is approximately 5 - 15m wide and is an artificial trapezoidal channel which is subject to routine maintenance by the Environment Agency to ensure the conveyance of flows. The watercourse is designated as Main River from Winestead Bridge in Patrington, through the study area to the Estuary.

Plate 8.1: Surface water features



Winestead/Outstrays Pumping Station (WOPS) is located at the confluence of Winestead Drain and the Humber Estuary. This pumping station is owned, operated and maintained by the Environment Agency. The outfall to the Humber is entirely pumped. The Pumping station was originally designed to allow gravity outfall but this has not been maintained due to the high silt load in the Humber. The pumps currently operate to attempt to maintain a water level in Winestead Drain of about 0.5m OD. There is also a booster pumping station on Winestead Drain just north west of Patrington (i.e. upstream of the study area) called Winestead Booster Pumping Station.

Plate 8.2a: Winestead Drain, looking upstream from WOPS.

Plate 8.2b: Winestead Drain, looking downstream towards WOPS.

Welwick Drain (Plate 8.3) and a network of unnamed drains are located within the land to the south of Weeton. Welwick Drain flows southwards within the study area and enters the Red Line Boundary of the Western Scheme within West 1 at the southern end of Haverfield Quarry (Figure 8.1 and Figure 10.2 in Appendix 1.1). Welwick Drain continues southwards through the proposed wet grassland habitat creation area to discharge into Winestead Drain.

Plate 8.3: Welwick Drain within the proposed wet grassland compensatory area.

Within West 2 there are also several un-named drains and ditches, some of which can be dry at times. These ditches are man-made features for the purposes of land drainage to facilitate agriculture. These are depicted on Figure 8.1. Some of these drains originate from outside of the site and also flow into Winestead Drain or Welwick Drain. The drains all have deep channels with steep banks and typically shallow water with sluggish flows.

South Holderness IDB manage the watercourses within West 2 as part of the Skeffling area, which includes Welwick Drain (Figure 8.1). The IDB also manages Winestead Drain on behalf of the Environment Agency and the drains to the north (left bank) of Winestead Drain upstream of the site to the North Channel confluence and then drains on both sides of Winestead Drain upstream of this location.

A watercourse called East Clough runs along the north/west boundary of West 1 (Plate 8.1). This flows north eastwards, from near Hawkins Point, and discharges into Winestead Drain at Outstray Farm.

There are also numerous un-named drains, including a series of parallel drains within West 1 as shown on Plate 8.1, some of which are dry at times (Plate 8.4). A network of parallel ditches, to the north of West 1, also flow into East Clough along its north (left) bank, including a watercourse called Newlands Drain. The water levels in these un-named drains are dictated by the pumping rules and inlet levels at WOPS, as well as the variable invert levels along those drains, which result in many of the drains having standing water at their base throughout the year.

Pant Drain, Welwick Drain, Newlands Drain and East Clough are all within proximity of the development site and will have a hydrological effect on the site.

Plate 8.4: View of typical drain within proposed MR site.

West 1 also contains three man made freshwater ponds located immediately behind the existing embankment at its western end. Two of these support flora indicating saline conditions. In West 2 two ponds are located formed from old gravel pits are located within the Haverfield Quarry SSSI unit of the Humber Estuary SSSI as shown on Plate 8.1 and Figure 10.2 in Appendix 1.1. These ponds can vary in size and have swamp and extensive reedbeds along the margins. They are described further in Chapter 10.

8.4.1.2 Surface Water Quality

Winestead Drain is classified under the WFD (Section 8.4.1 as the "Winestead Drain from Source to Humber" river water body (Water body ID: GB104026066570). The waterbody is described further in the WFD assessment (Appendix 8.1). The waterbody has a catchment area of nearly 60km^{2,} a length of approximately 15.5km and is considered to be heavily modified for land drainage purposes. The waterbody is currently (cycle 2, 2016) classified as having Moderate overall status with a target to achieve Good potential by 2027. The waterbody is currently not at good ecological potential due to Fish (poor); Invertebrates (moderate); Biological Oxygen Demand (BOD) (moderate); dissolved oxygen (moderate) and phosphate (poor). Chemical status is classified as good.

Water quality data is collected by the Environment Agency on Winestead Drain at Humberside Road Bridge (North Channel Clough), approximately 3.7km upstream of WOPS. Results from the sampling location indicate that in recent years, particularly during summer months the dissolved oxygen levels have been very low (15- 60 % saturation dissolved oxygen), which is likely to cause stress to aquatic life. Orthophosphate levels (reactive phosphorus) is also recorded as high leading to eutrophication. The section upstream of WOPS can be particularly affected due to stagnant flows and is subject to significant algal blooms.

Water quality data is not available for the other water features within the study area, however their water quality is likely to reflect the adjacent agricultural land uses and associated management practices.

The north-eastern half of West 1 and all of West 2 is located within a surface water Nitrate Vulnerable Zone (NVZ). NVZs are areas of land that drain into a freshwater water body which has or could have if action is not taken, a nitrate concentration greater than 50mg/l.

8.4.1.3 Abstractions and discharges to the water environment

There are no records of abstraction licences from Winestead Drain or any other watercourses within the scheme extents.

There is a Yorkshire Water (YW) discharge consent associated with Patrington Haven Pumping station, located near the village for a discharge into a tributary of Winestead Drain (near Pant Drain).

There are two YW discharge consents, related to Welwick sewage treatment works (STW) located on Welwick Drain between Welwick village and the northern boundary of West 2/East 1.

8.4.1.4 Flood mechanisms and flood risk

The primary source of flood risk is from tidal flooding from the North Sea via the Humber Estuary. Other local sources of flood risk include, but aren't limited to, blockages of watercourses, culverts and the land drainage network. More detail on the existing flood risk is available in Appendix 8.3 Flood Risk Assessment.

Tidal flood risk

The Environment Agency's River and Tidal flood map shows that the majority of the development site lies within Flood Zone 3 (greater than a 0.5% AEP tidal incident without defences), the remainder of the development site lies within Flood Zone 2 (between a 0.5% and 0.1% AEP tidal incident without defences). The area currently benefits from tidal flood defences, which is predominantly earth embankments. The flood risk in the area is dictated by the relationship between extreme water levels in River Humber, existing flood defences and areas of high ground. Baseline modelling has shown that the extent of flooding is greater in the Western area (than the east), with flood depths in the region of 2.5 mAOD and below.

In the Western development site, there are significant lengths of embankment that have been reinforced with gabion baskets to the front of the embankment crest, and rock armouring at the toe. The existing defences show evidence of erosion with significant sections of over steepened banks, in some locations this erosion has damaged gabions and has potential to erode the structural core of the defences.

Fluvial flood risk

The fluvial flood risk is dictated by the relationship between the discharge capacity of the pumping stations, inflows from the land drainage network and storage capacity in channels. Overall, considering the levels in the surrounding watercourses are already maintained by the pumping stations and the fact that the risk is primarily dominated by the tidal influence, the risk of flooding from rivers is considered to be low.

Surface water flood risk

Groundwater flood risk

The majority of historical boreholes in the site did not record any groundwater strikes. However, new boreholes drilled as part of the scheme have recorded groundwater levels between 1.5m below ground level (bgl) and 13.7m bgl. The range in the water level means that there are some areas that may be at risk of groundwater flooding. However, there is unlikely to be any above ground flooding based on the underlying geological conditions. therefore, the risk of flooding from groundwater is considered to be low.

8.4.2 Welwick to Skeffling Managed Realignment

8.4.2.1 Surface waters features and drainage

Surface water features for the Welwick to Skeffling MR site ("the eastern site") are presented on Plate 8.1 above and in more detail in Appendix 1.1. All the drains and watercourses within the eastern site are managed by South Holderness IDB.

Soak Dyke is located on the landward side of the existing flood embankment located along the southern boundary of East 1, 2 and 3 and runs parallel to the dry side toe of the embankment. The section of Soak Dike behind Welwick Bank (East 1) is also known as Welwick Bank Drain and this section normally flows westwards to enter Welwick Drain (Section 8.4.1.1) which flows through West 2 and discharges to Winestead Drain. Flows within the Soak Dike can also go eastwards towards Skeffling Pumping Station.

The Soak Dike also intercepts Weeton Beck and Weeton Fleet Drain, which drain southwards through East 2 and 3, from Manor Farm, near Weeton and north of the study area. Weeton Fleet forms a short and straight drain taking flows from Weeton Beck and discharging them into the Soak Dike. Weeton Fleet Drain outfalls into Weeton Drain which discharges into the Soak Dike.

Also, within the 500m study area but outside of the red line boundary is Fosse Drain which flows southwards to enter the Humber, on the east side of Skeffling village. Where it enters the Humber, at Skeffling Clough, the watercourse is approximately 250m from the proposed bank alignment. Soak Dike and Fosse Drain / Skeffling Drain are therefore hydraulically connected. Both outfall into the estuary via Skeffling Pumping Station.

Within the eastern Site there are also numerous un-named drains and ditches (Figure 8.1), some of which can be dry at times. These ditches are man-made features for the purposes of land drainage to facilitate agriculture. These ultimately discharge into the primary drains/watercourses named above. The water levels in drains are dictated by the pumping rules and inlet levels at Skeffling, as well as the variable invert levels along those drains, which result in many of the drains having standing water at their base throughout the year.

Within the Eastern Site there are also numerous Ponds as shown on Figure 8.1. Most ponds in East are either ephemeral or have high nutrient levels due to agricultural run-off.

8.4.2.2 Surface Water Quality

Fosse Drain is within the 500m study area but outside of the red line boundary. It forms the Fosse Drain/Skeffling Drain (Water body ID: GB104026066530) which is classified

under the WFD as being an artificial water body (AWB). It is approximately 3.8km long with a catchment area of approximately 20km^2. The waterbody is currently (cycle 2, 2016) classified as having Moderate overall status. The waterbody is currently not at good ecological potential due to Invertebrates (moderate); pH (moderate) and phosphate (poor). Chemical potential is classified as good. The WFD catchment for Fosse Drain includes all the watercourses within the Eastern Site, although these are not classified themselves and are not necessarily hydrologically linked to Fosse Drain.

Water quality within these watercourses is likely to reflect the surrounding land uses which is predominantly agriculture and it is highly likely that there are sections of drains which are eutrophic.

The area within East 1 to the west of Row Lane is located within a surface water Nitrate Vulnerable Zone (NVZ). NVZs are areas of land that drain into a freshwater water body which has or could have if action is not taken, a nitrate concentration greater than 50mg/l.

A historical landfill (Welwick Riverbank) is located within East 1, behind the existing sea defences. As part of the Ground Investigation the surface water in the ditch adjacent to the landfill was sampled. Results for samples recovered indicate significant levels of heavy metals, with exceedances of Environmental Quality Standards (EQS) of Copper, Lead and Zinc recorded. Further details are provided in Chapter 9.

8.4.2.3 Abstractions and discharges to the water environment

There are no records of abstraction licences from any watercourses within the scheme extents.

8.4.2.4 Flood mechanisms and flood risk

The primary source of flood risk is from tidal flooding from the North Sea via the Humber Estuary. Other local sources of flood risk include, but aren't limited to, blockages of watercourses, culverts and the land drainage network. More detail on the existing flood risk is available in Appendix 8.3 Flood Risk Assessment.

Tidal flood risk

The Environment Agency's River and Tidal flood map shows that the majority of the development site lies within Flood Zone 3 (greater than a 0.5% AEP tidal incident without defences), the remainder of the development site lies within Flood Zone 2 (between a 0.5% and 0.1% AEP tidal incident without defences). The area currently benefits from tidal flood defences, which is predominantly earth embankments. The flood risk in the area is dictated by the relationship between extreme water levels in River Humber, existing flood defences and areas of high ground. Modelling undertaken for the scheme has shown that flood waters are deeper on the Eastern side, reaching up to 3.5 mAOD.

In the Eastern development site, the existing defences were breached by a storm surge in 2013. The breach was infilled as part of emergency works. The breach in 2013 demonstrated that the existing defences are not sufficient to provide suitable protection to the local population from tidal flooding. Projected climate change will result in an increase of flood frequency and severity, which will only increase the susceptibility of this area to tidal flooding.

Fluvial flood risk

The fluvial flood risk is dictated by the relationship between of the discharge capacity of the pumping stations, inflows from the land drainage network and storage capacity in channels. Overall, considering the levels in the surrounding watercourses are already maintained by the pumping stations and the fact that the risk is primarily dominated by the tidal influence, the risk of flooding from rivers is considered to be low.

Surface water flood risk

The flood risk present on site from surface water is variable across the site and is detailed in the Flood Risk Assessment in Appendix 8.3. The risk of surface water flooding is considered to be low.

Groundwater flood risk

Water level data from boreholes across the site indicate that there are some areas that may be at risk of groundwater flooding. However, any above ground flooding is likely to be low based on the underlying geological conditions and therefore, the risk of flooding from groundwater is considered to be low.

8.4.2.5 Value of receptors

Table 8.2 below identifies the water environment (non-tidal) receptors of relevance to the Scheme. The value of the receptors has been identified based upon the criteria in Table 8.1.

Table 8.2: Water environment receptors and their value.

Receptor	Reasoning for receptor value	Receptor Value
Outstrays Managed Realignment		
Winestead Drain	• WFD overall status of Moderate. • Classified as a HMWB • Artificial trapezoidal channel subject to regular maintenance regime and geomorphological features of low importance. • Pumped discharge into the Humber via WOPS. • Main River within the study area. • Tributary (upstream of study area) receives YW discharge from sewage network. • Not located within a European Nature Conservation Site but discharges into the Humber Estuary SAC, SPA, Ramsar and SSSI (as described in Chapter 10).	Medium
Welwick Drain (West 2)	• Water quality likely to be affected by inputs from agriculture. • Located in Surface water NVZ.	Low

Receptor	Reasoning for receptor value	Receptor Value
	• Receive discharges from STWs in Welwick village. • Ordinary watercourse managed by the IDB. • Trapezoidal channel with few "natural" sections. • A short length of approximately 180m within Haverfield Quarry passes through the Humber Estuary SAC, SPA, Ramsar and SSSI (as described in Chapter 10). However, as these sites are not dependent upon Welwick Drain the designation has not been considered when determining value as this would be disproportionate.	
East Clough (West 1)	• Water quality likely to be affected by inputs from agriculture. • Ordinary watercourse managed by the IDB. • Ephemeral. • Trapezoidal channel and few geomorphological features of low importance.	Low
Un-named drains within West 1	• Water quality likely to be affected by inputs from agriculture • Located in Surface water NVZ. • Ordinary watercourse managed by the IDB. • Trapezoidal channels, some can be ephemeral. Few geomorphological features of low importance.	Low
Un-named drains within West 2	• Water quality likely to be affected by inputs from agriculture • Located in Surface water NVZ. • Ordinary watercourse managed by the IDB. • Trapezoidal channels, some can be ephemeral. Few geomorphological features of low importance.	Low
Ponds within West 1 (x 3)	• Water quality likely to be affected by inputs from agriculture. • Man-made ponds.	Low

Receptor	Reasoning for receptor value	Receptor Value
Ponds within West 2 (x 2)	• Water quality likely to be affected by inputs from agriculture • Located within Humber Estuary SSSI and associated with Haverfield Quarry.	High
Welwick to Skeffling Managed Realignment		
Weeton Beck	• Water quality likely to be affected by inputs from agriculture • Ordinary watercourse managed by the IDB. Few geomorphological features of low importance.	Low
Weeton Fleet (Drain)	• Water quality likely to be affected by inputs from agriculture • Ordinary watercourse managed by the IDB. Linear watercourse with few geomorphological features of low importance.	Low
Soak Dike	• Man-made channel. • Few geomorphological features of low importance.	Low
Fosse Drain (Skeffling Drain)	• Main River • WFD overall status of Moderate. • Classified as an AWB	Medium
Un-named drains	• Water quality likely to be affected by inputs from agriculture • Those within East 1 located in Surface water NVZ. • Ordinary watercourse managed by the IDB. • Trapezoidal channels, some can be ephemeral. Few geomorphological features of low importance.	Low
Ponds	• Water quality likely to be affected by inputs from agriculture. • Some Man-made ponds.	Low

8.4.3 Marine (Estuarine) Waters

This section regarding marine (estuarine) waters provides a single baseline for the Scheme and does not attempt to describe the two distinct sites separately. This reflects

the inter-connectivity of the marine environment and as such the applicability of the baseline description to both the eastern and western site. The baseline description is therefore directly applicable to both sites.

8.4.3.1 Water quality

The Scheme is located adjacent to the Humber Lower transitional water body (ID: GB530402609201); a heavily modified water body (hydromorphological designation for Coastal protection; Flood protection; and Navigation, ports and harbours) with a surface area of nearly 250 km^2 covering estuarine waters from Hull to the mouth of the Humber Estuary. It is currently (2016) classified as being at overall moderate status based on moderate ecological potential and failing to achieve good chemical status. Moderate ecological potential is reported due to the less than good status of Angiosperms (moderate); Invertebrates (moderate); and Dissolved inorganic nitrogen (moderate), as well as the Mitigation measures assessment highlighting measures currently not in place. In addition, the priority hazardous substance Tributyltin (TBT) compounds is currently classified as 'fail' (i.e. failing to achieve good).

The Humber Lower transitional water body is designated under the Nitrates Directive, while large sections of the Humber coastline are designated as surface water NVZs. As noted in Section 8.3.1.2, surface water 246 (Winestead Drain from Source to Humber) is a surface water NVZ located within the Scheme boundary and drains into the Humber Lower transitional water body. There are no coastal "Sensitive Areas (Eutrophic)" in the vicinity of the Scheme, with River Trent and River Torne (Rivers) "Sensitive Areas (Eutrophic)" located approximately 50 km upstream of the Scheme (Department for Environment, Food and Rural Affairs (Defra), 2012).

Cleethorpes and Humberston Fitties are the two closest bathing waters to the Scheme, located approximately 10 km to the south. Water quality at Cleethorpes was classified as 'good' between 2015 and 2017 and 'excellent' in 2018, while Humberston Fitties has been consistently classified as 'excellent' during this period. Withernsea is also located approximately 10 km from the Scheme (classified as 'good' in 2018); however, this bathing water is located to the north on the North Sea coast and, therefore, the potential for a hydrological connection is further reduced given the detachment from the Scheme around Spurn Head.

There are no designated shellfish water protected areas situated within the Humber Estuary; the nearest are located within The Wash at greater than 50 km distance to the south of the Scheme.

A request for water quality data collected by the Environment Agency in the vicinity of the Scheme was submitted in October 2018 (RFI/2018/101462). Water temperature, salinity, oxygen saturation and dissolved oxygen concentration were reported at a number of sites, with the most comprehensive data set (October 2008 to September 2018) available from 'River Humber at Salt End Jetty' (Grid Reference: TA3960010800) approximately 19 km to the northwest of the Scheme. Other small, ad-hoc data sets have been collected in closer proximity to the Scheme.

A seasonal trend in water temperature and salinity are apparent from the 'River Humber at Salt End Jetty' monitoring site, with minimum values of 1.3°C in January 2010 and 0.6 part per thousand (ppt) in March 2010, and maximum values of 21.7°C in July 2018 and 24.88 ppt in June 2011 (Plate 8.5). The range in water temperatures between summer and winter months is similar to data obtained from other monitoring sites in the vicinity of the Scheme; however, salinity values are typically lower at the

‘River Humber at Salt End Jetty’ monitoring site, likely as a result of its location further upstream the estuary and locality to other riverine inputs (Table 8.3).

Monthly mean oxygen saturation levels at the ‘River Humber at Salt End Jetty’ monitoring site have been consistently above 80% over the last 10 years, with the mean dissolved oxygen concentration during this period being 9.5 mg/l. There is a notable seasonal trend in dissolved oxygen concentration, with the highest concentrations recorded in winter months (16.7 mg/l in April 2015) and lowest concentrations recorded in summer months (6.58 mg/l in July 2018) (Plate 8.6). Oxygen saturation and dissolved oxygen concentrations reported from other Environment Agency monitoring sites in the vicinity of the Scheme have suggested a similar range of values (Table 8.4).

Data collected between 2008 and 2012 from the ‘River Humber at Spurn Point’ monitoring site, located approximately 10 km to the southeast of the Scheme, also includes a variety of contaminant concentrations from water samples. The concentrations of metals in these samples were consistently below the respective environmental quality standards (EQS) as shown in Table 8.4. it should be noted that one sample concentration for copper (9.78 µg/l in December 2010) was reported above the EQS (3.76 µg/l); however, this EQS relates to an annual average (AA) and it is unlikely this concentration was exceeded in the long-term given all other copper concentrations were reported as less than 2.7 µg/l between 2008 and 2012... Furthermore, specifically in 2010, the average copper concentration from water samples collected at this site was 2.85 µg/l (n = 6), thus below the EQS.

Plate 8.5: Monthly average water temperature (top) and salinity (bottom) (both with standard deviation bars) at Salt End Jetty' monitoring site

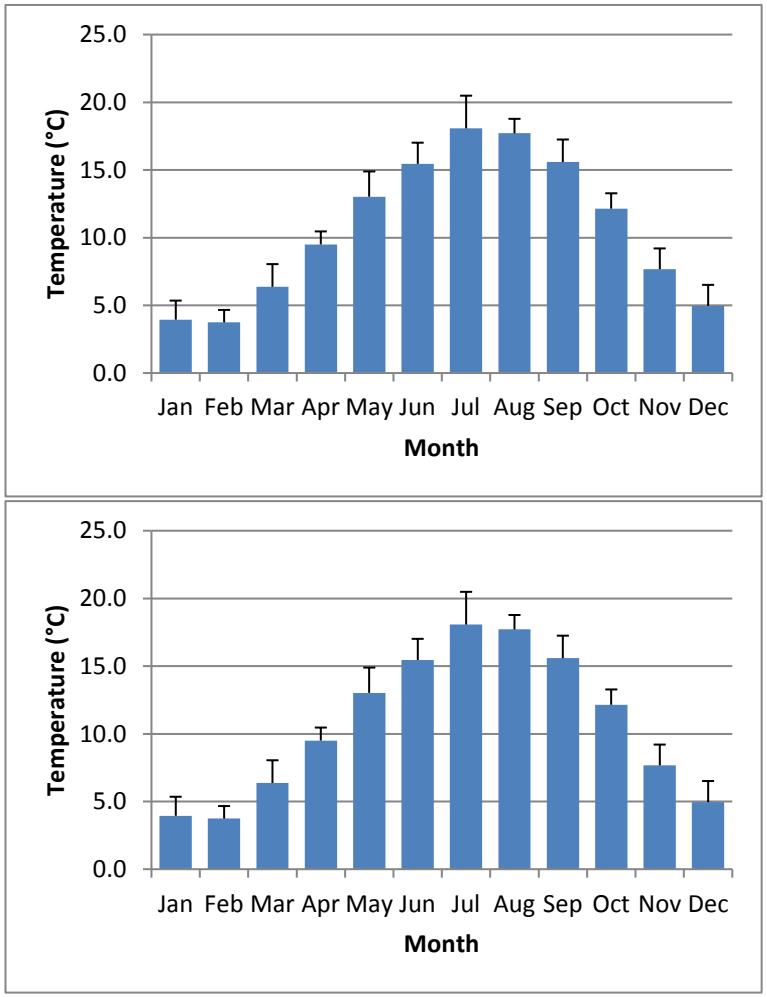
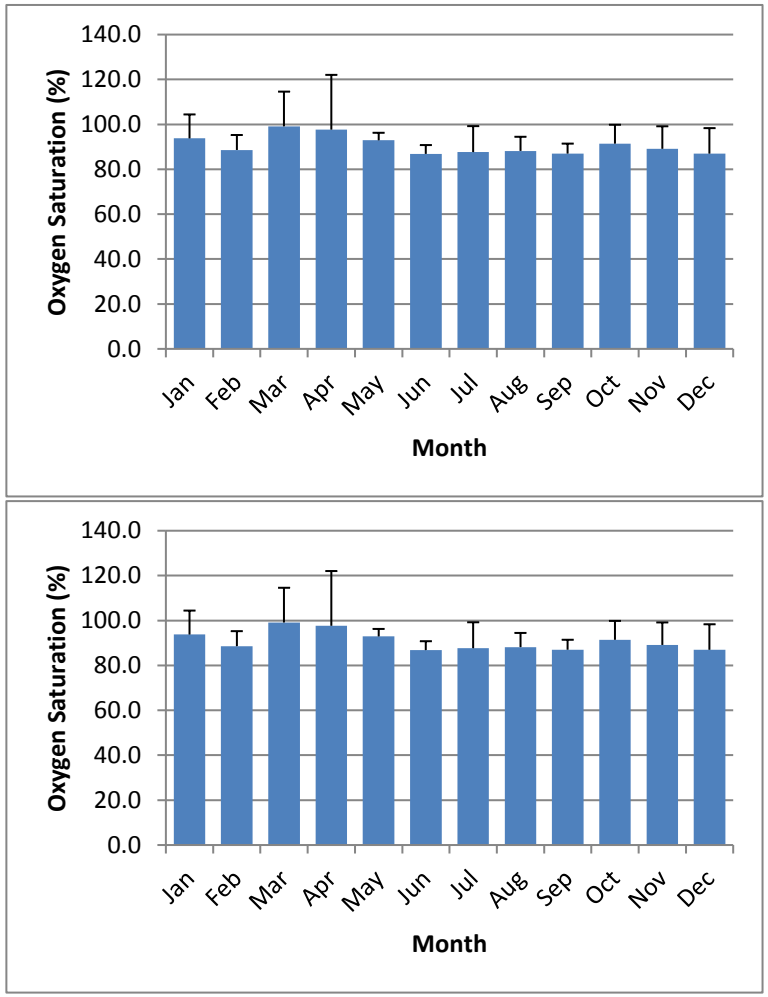
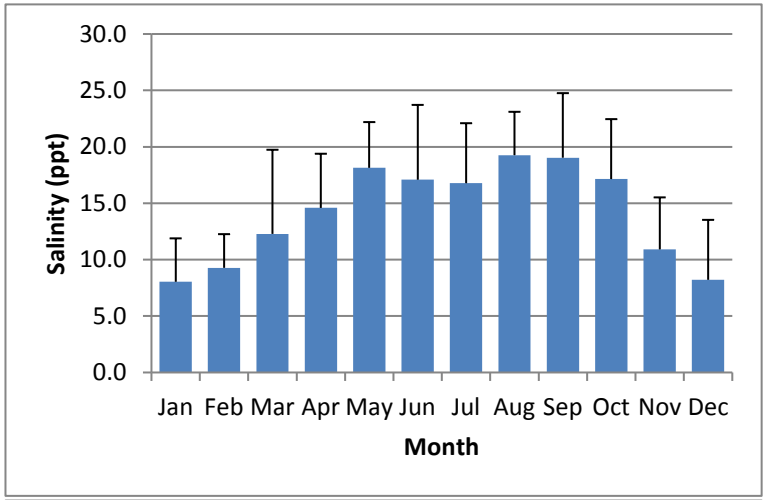
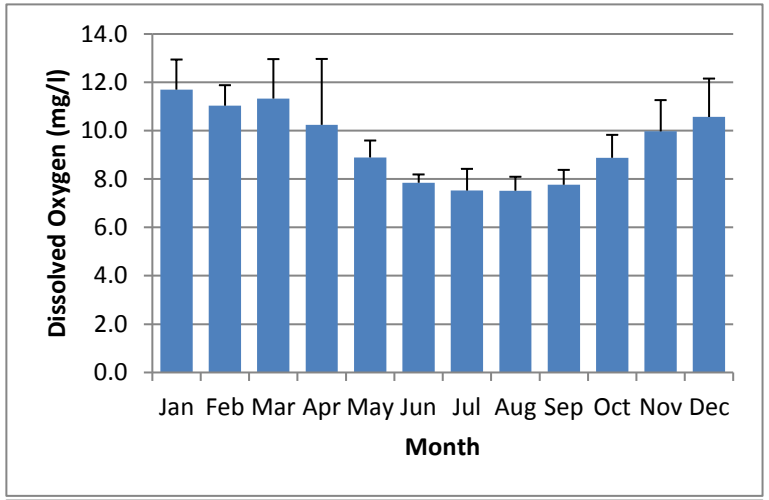
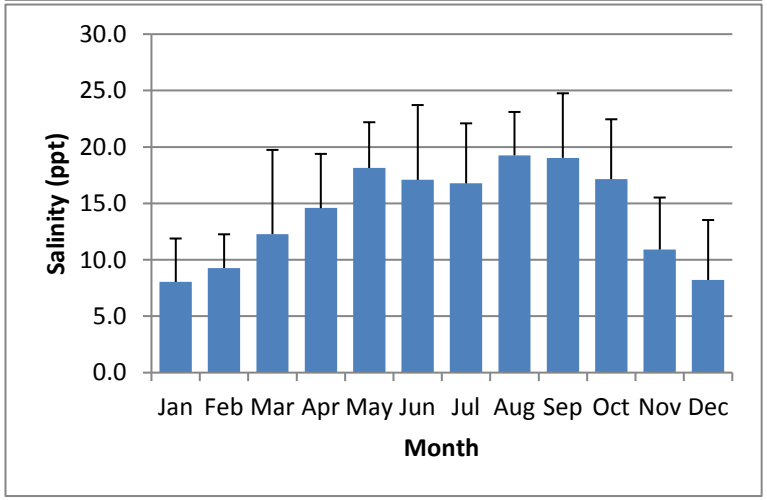


Plate 8.6: Monthly average oxygen saturation (top) and dissolved oxygen concentration (bottom) (both with standard deviation bars) at Salt End Jetty' monitoring site




30.0
25.0
20.0
15.0
10.0
5.0
0.0
Salinity (ppt)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month


14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Dissolved Oxygen (mg/l)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month


30.0
25.0
20.0
15.0
10.0
5.0
0.0
Salinity (ppt)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month

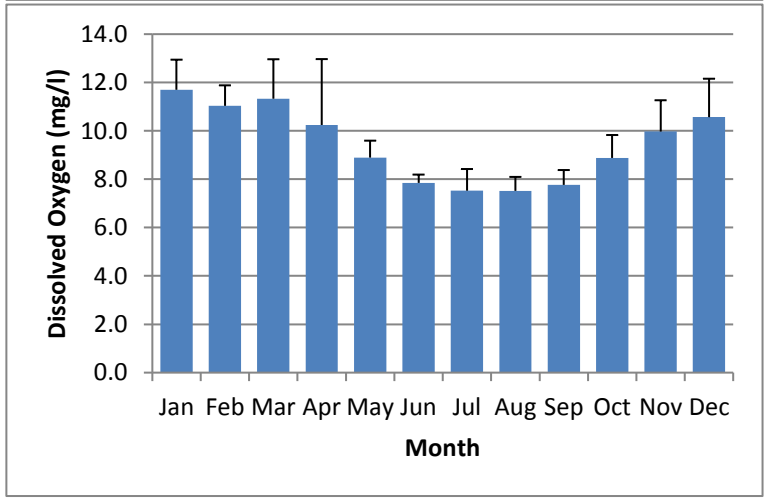

14.0
12.0
10.0
8.0
6.0
4.0
2.0
0.0
Dissolved Oxygen (mg/l)
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month

Table 8.3: Several water parameters at Environment Agency Monitoring Site

Parameter		Environment Agency Monitoring Site						
		River Humber at Salt End Jetty	Humber at Foulholme Sands (Seine Net Site)	Sunk Island Sands, Patringham, Nr Hull	Humber at Hawkins Point (Seine Net Site)	Humber at Spurn (Seine Net Site)	Kilnsea – Humber Estuary at Kilnsea Inn	River Humber at Spurn Point
Temperature (°C)	Min	1.3	1.5	5.4	12.1	1.1	4.2	3.67
	Max	21.7	19.7	18.31	16.9	16.4	17.58	17.5
Salinity (ppt)	Min	0.6	19.12	20.79	21.7	25.9	25.08	25.4
	Max	24.88	25.89	31.2	29.48	32.59	33.22	33.21
Oxygen Saturation (%)	Min	57.9	85.7	90.0	64.3	83.0	91.2	91.2
	Max	153.6	97.7	99.1	102	100	99.3	104
Dissolved Oxygen (mg/l)	Min	6.5	7.18	7.47	5.73	7.0	7.57	7.66
	Max	16.7	8.58	11.1	9.42	8.97	10.5	11.3

Table 8.4: Contaminant concentrations in water samples collected at the Environment Agency's 'River Humber at Spurn Point' monitoring site

Contaminant	Sample Concentration (µg/l)		Saltwater EQS (µg/l) *
	Min	Max	
Arsenic	1.3	2.3	25 (AA)
Cadmium	<0.04	<0.04	0.2 (AA)
Chromium	<0.5	<0.5	0.6 (AA); 32 (MAC)
Copper	0.83	9.78	3.76 (AA)
Lead	<0.04	0.121	1.3 (AA); 14 (MAC)
Mercury	<0.01	<0.01	0.07 (MAC)
Nickel	0.62	1.58	8.6 (AA); 34 (MAC)
Zinc	1.56	4.19	9.7 (AA)

* Environmental Quality Standards (EQS) based on The Water Framework Directive (Standards and Classification) Directions (England and Wales) 2015. AA – Annual Average (long-term); MAC – Maximum Allowable Concentration (short-term).

8.4.3.2 Sediment quality

Six surface sediment samples were collected in May 2017 from the intertidal mudflat fronting the Scheme (samples 1, 2 and 3 were collected from the mudflat fronting the West 1 breach and samples 4, 5 and 6 were collected from the mudflat fronting the East 2 breach; see Table 8.6). The samples were collected in accordance with a

sediment contamination sampling plan as provided by the Marine Management Organisation. In addition, sediment samples were collected in October 2018 from the saltmarsh fronting the West 1 (WS01, WS02, WS03 and WS04) and East 2 (WS05, WS06, WS07, WS08, WS09, WS10, WS11 and WS12) breaches. Surface sediment samples were collected from each location, plus one further sample at depth from WS02, WS06, WS09, WS10 and WS12 (i.e. 17 samples were collected in total). All samples were tested for sediment composition to determine particle size distribution and analysed for contaminant concentrations, including metals, organotins, polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs). Samples collected in May 2017 were also analysed for total hydrocarbon content (THC).

Table 8.5 provides the results of particle size analysis (PSA) of the sediment samples collected from the intertidal mudflat and saltmarsh fronting the Scheme breaches. Sediments were predominantly comprised of sand (up to 52%) and silt/clay (up to 99%). Gravel content was minimal in all samples (<3%). There were no notable differences in sediment composition between samples collected from the West 1 and East 2 breach locations.

Table 8.5: Particle size distribution from samples collected at the two breach locations

Location	Sample (depth, m)	Particle Size Distribution (%)			Sample Description
		Gravel (>2 mm)	Sand (<2 mm - >63 µm)	Silt/Clay (<63 µm)	
Intertidal mudflat (May 2017)					
West 1 breach	1 (0.0)	0.09	21.40	78.52	Slightly sandy mud
	2 (0.0)	0.74	34.33	64.92	Sandy mud
	3 (0.0)	0.36	41.74	57.90	Sandy mud
East 2 breach	4 (0.0)	0.08	52.33	47.59	Muddy sand
	5 (0.0)	0.78	14.00	85.23	Slightly sandy mud
	6 (0.0)	0.00	44.24	55.76	Sandy mud
Saltmarsh (October 2018)					
West 1 breach	WS01 (0.0-0.3)	0.57	0.43	99.00	-
	WS02 (0.0-0.35)	1.93	13.23	84.43	-
	WS02 (0.35-0.7)	0.33	11.11	88.42	-
	WS03 (0.0-0.1)	2.62	32.32	64.76	-
	WS04 (0.0-0.15)	0.09	13.97	85.94	-
East 2 breach	WS05 (0.1-0.6)	2.40	31.42	66.18	-
	WS06 (0.1-0.5)	0.65	24.49	74.85	-
	WS06 (1.0-1.4)	0.70	17.93	81.37	-
	WS07 (0.0-0.5)	1.14	12.68	86.18	-
	WS08 (0.1-0.5)	2.16	21.15	76.68	-

Location	Sample (depth, m)	Particle Size Distribution (%)			Sample Description
		Gravel (>2 mm)	Sand (<2 mm - >63 µm)	Silt/Clay (<63 µm)	
	WS09 (0.1-0.6)	0.43	7.30	92.27	-
	WS09 (1.0-1.5)	0.29	8.37	89.18	-
	WS10 (0.22-0.6)	0.68	7.99	91.33	-
	WS10 (1.2-1.8)	0.40	6.74	92.86	-
	WS11 (0.1-0.3)	0.61	8.18	91.21	-
	WS12 (0.1-0.5)	2.22	4.99	92.79	-
	WS12 (0.5-1.2)	0.67	12.54	86.79	-

Unlike water quality, there are no formal quantitative EQS in the UK for the concentration of contaminants in sediments, although the WFD has introduced optional standards for a small number of priority and priority hazardous substances. The Centre for Environment, Fisheries and Aquaculture Science (Cefas) has prepared a series of Guideline Action Levels to determine the contaminant loading of material and its suitability for disposal at sea. In general, contaminant levels in dredged material below Cefas Guideline Action Level 1 (AL1) are likely to be acceptable for disposal at sea. In contrast, dredged material with contaminant levels above Cefas Guideline Action Level 2 (AL2) is generally considered unsuitable for disposal at sea. Material with contaminant levels between AL1 and AL2 requires further consideration before a decision can be made. The Cefas Guideline Action Levels should not be viewed as pass/fail thresholds; however, these guidelines provide context for consideration of contaminant levels in sediments in the UK.

Table 8.6 provides contaminant concentrations from the six sediment samples collected from the mudflat fronting the proposed breach locations. Table 8.7 and Table 8.7 provide contaminant concentrations from the sediment samples collected from the saltmarsh fronting the proposed West 1 and East 2 breach locations, respectively. Metal concentrations were below AL1 or slightly above AL1 (no exceedances of AL2), while the concentration of organotins and PCBs were consistently below AL1. The concentration of PAHs varied between samples and contaminant; values ranged from below AL1 up to an order of magnitude above AL1 (there is no AL2 for PAHs). There were no notable differences in contaminant concentrations between samples collected fronting the Scheme.

Table 8.6: Contaminant concentrations from sediment samples collected from the intertidal mudflat fronting the proposed breach locations

Contaminant	Units	Cefas Guideline Action Level		Sample Concentration					
				West 1			East 2		
		AL1	AL2	1	2	3	4	5	6
Metals									
Arsenic	mg/kg	20	100	19.2	17.2	16.1	14.5	21.4	14.9
Cadmium	mg/kg	0.4	5	0.24	0.23	0.64	0.20	0.22	0.18
Chromium	mg/kg	40	400	54.1	48.9	41.1	33.4	72.4	35.7
Copper	mg/kg	40	400	27.7	23.7	21.0	17.1	28.4	17.6
Lead	mg/kg	50	500	57.3	53.5	40.3	34.5	68.5	34.4
Mercury	mg/kg	0.3	3	0.20	0.15	0.11	0.08	0.18	0.08
Nickel	mg/kg	20	200	35.1	29.1	25.9	20.8	39.8	22.2
Zinc	mg/kg	130	800	147	132	116	98.2	160	101
Organotins									
Dibutyltin	mg/kg	0.1	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Tributyltin	mg/kg	0.1	1	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Polychlorinated Biphenyls (PCBs)									
PCB#28	µg/kg	-	-	0.558	0.456	0.442	0.27	0.647	0.336

Contaminant	Units	Cefas Guideline Action Level		Sample Concentration					
				West 1			East 2		
		AL1	AL2	1	2	3	4	5	6
PCB#52	µg/kg	-	-	0.431	0.35	0.318	0.202	0.498	0.236
PCB#101	µg/kg	-	-	0.454	0.394	0.258	<0.2	0.419	0.209
PCB#118	µg/kg	-	-	0.337	0.233	<0.2	<0.2	0.311	<0.2
PCB#138	µg/kg	-	-	0.435	0.411	0.315	0.278	0.472	0.218
PCB#153	µg/kg	-	-	0.454	0.573	0.281	0.283	0.474	<0.2
PCB#180	µg/kg	-	-	0.354	0.902	0.207	<0.2	0.344	<0.2
Sum of ICES 7	µg/kg	10	-	3.02	3.32	1.82	1.03	3.17	1.00
Sum of 25 Congeners	µg/kg	20	200	5.55	6.71	2.68	1.52	5.60	1.44
Polycyclic Aromatic Hydrocarbons (PAHs) and Total Hydrocarbon Content (THC)									
Acenaphthene	µg/kg	100	-	51.7	43.6	36.4	23.6	56.1	48.3
Acenaphthylene	µg/kg	100	-	14.1	10.5	9.74	5.79	13.2	8.96
Anthracene	µg/kg	100	-	94.2	80.4	86.3	39.4	97.4	78.5
Benzo(a)anthracene	µg/kg	100	-	230	202	190	104	248	179
Benzo(a)pyrene	µg/kg	100	-	300	240	209	116	306	206
Benzo(b)fluoranthene	µg/kg	100	-	297	225	192	108	306	204

Contaminant	Units	Cefas Guideline Action Level		Sample Concentration					
				West 1			East 2		
		AL1	AL2	1	2	3	4	5	6
Benzo(ghi)perylene	µg/kg	100	-	279	214	187	103	275	189
Benzo(k)fluoranthene	µg/kg	100	-	136	109	97.9	47.3	143	90.2
Chrysene	µg/kg	100	-	199	169	196	89.3	234	149
Dibenzo(ah)anthracene	µg/kg	100	-	51.4	39.4	34.3	18.9	52	35.7
Fluoranthene	µg/kg	100	-	491	413	369	203	524	397
Fluorene	µg/kg	100	-	105	85.4	72.4	49.2	102	87
Indeno(123-cd)pyrene	µg/kg	100	-	234	189	159	87.4	249	158
Naphthalene	µg/kg	100	-	313	246	200	155	244	215
Phenanthrene	µg/kg	100	-	478	392	344	214	440	373
Pyrene	µg/kg	100	-	441	374	324	192	454	351
Total Hydrocarbon Content (THC)	mg/kg	-	-	885	637	608	343	776	550
Key	Below AL1								
	Above AL1, Below AL2								
	Above AL2								

Table 8.7: Contaminant concentrations from sediment samples collected from the saltmarsh fronting the proposed West 1 breach location

Contaminant	Units	Cefas Guideline Action Level		Sample Concentration (West 1)				
		AL1	AL2	WS01 (0.0-0.3 m)	WS02 (0.0-0.35 m)	WS02 (0.35-0.7 m)	WS03 (0.0-0.1 m)	WS04 (0.0-0.15 m)
Metals								
Arsenic	mg/kg	20	100	12.9	19.4	17.6	10.4	10.5
Cadmium	mg/kg	0.4	5	0.27	0.36	0.39	0.22	0.20
Chromium	mg/kg	40	400	31.3	43.8	66.1	22.7	23.8
Copper	mg/kg	40	400	22.2	34.2	35.9	18.0	16.7
Lead	mg/kg	50	500	67.0	61.6	103.8	42.1	46.7
Mercury	mg/kg	0.3	3	0.14	0.21	0.30	0.09	0.08
Nickel	mg/kg	20	200	27.0	29.8	32.3	18.9	20.2
Zinc	mg/kg	130	800	112.1	153.4	159.6	88.6	94.4
Organotins								
Dibutyltin	mg/kg	0.1	1	<0.005	<0.005	<0.005	<0.005	<0.005
Tributyltin	mg/kg	0.1	1	<0.005	<0.005	<0.005	<0.005	<0.005
Polychlorinated Biphenyls (PCBs)								
PCB#28	µg/kg	-	-	0.43	1.02	0.25	0.55	0.40

Contaminant	Units	Cefas Guideline Action Level		Sample Concentration (West 1)				
		AL1	AL2	WS01 (0.0-0.3 m)	WS02 (0.0-0.35 m)	WS02 (0.35-0.7 m)	WS03 (0.0-0.1 m)	WS04 (0.0-0.15 m)
PCB#52	µg/kg	-	-	0.39	0.85	0.23	0.45	0.33
PCB#101	µg/kg	-	-	0.00017	0.63	0.08	0.26	0.14
PCB#118	µg/kg	-	-	0.12	0.50	<0.08	0.17	0.08
PCB#138	µg/kg	-	-	0.10	0.79	<0.08	0.25	0.13
PCB#153	µg/kg	-	-	0.09	0.89	<0.08	0.27	0.11
PCB#180	µg/kg	-	-	<0.08	0.58	<0.08	0.16	<0.08
Sum of ICES 7	µg/kg	10	-	1.30	5.26	0.56	2.11	1.19
Sum of 25 Congeners	µg/kg	20	200	3.31	12.28	1.61	4.69	2.93
Polycyclic Aromatic Hydrocarbons (PAHs)								
Acenaphthene	µg/kg	100	-	33.0	57.6	89.9	14.9	20.4
Acenaphthylene	µg/kg	100	-	15.0	31.7	33.1	5.28	6.22
Anthracene	µg/kg	100	-	43.7	93.2	138	25.4	23.3
Benzo(a)anthracene	µg/kg	100	-	123	246	505	62.6	64.3
Benzo(a)pyrene	µg/kg	100	-	152	300	524	74.5	71.8

Contaminant	Units	Cefas Guideline Action Level		Sample Concentration (West 1)				
		AL1	AL2	WS01 (0.0-0.3 m)	WS02 (0.0-0.35 m)	WS02 (0.35-0.7 m)	WS03 (0.0-0.1 m)	WS04 (0.0-0.15 m)
Benzo(b)fluoranthene	µg/kg	100	-	158	296	505	84.3	87.1
Benzo(ghi)perylene	µg/kg	100	-	156	267	407	83.2	76.5
Benzo(k)fluoranthene	µg/kg	100	-	70.1	129	280	33.4	32.2
Chrysene	µg/kg	100	-	129	250	378	65.4	67.2
Dibenzo(ah)anthracene	µg/kg	100	-	27.4	52.6	81.2	14.7	11.9
Fluoranthene	µg/kg	100	-	239	463	1010	114	117
Fluorene	µg/kg	100	-	38.3	73.3	104	23.4	19.3
Indeno(123-cd)pyrene	µg/kg	100	-	122	229	372	51.4	47.7
Naphthalene	µg/kg	100	-	104	231	152	58.5	47.3
Phenanthrene	µg/kg	100	-	207	411	550	129	117
Pyrene	µg/kg	100	-	231	440	969	129	127
Key	Below AL1							
	Above AL1, Below AL2							
	Above AL2							

Table 8.8: Contaminant concentrations from sediment samples collected from the saltmarsh fronting the proposed East 2 breach location

Contaminant	Units	Cefas Guideline Action Level		Sample Concentration (East 2)											
		AL1	AL2	WS05 (0.1-0.6)	WS06 (0.1-0.5)	WS06 (1.0-1.4)	WS07 (0.0-0.5)	WS08 (0.1-0.5)	WS09 (0.1-0.6)	WS09 (1.0-1.5)	WS10 (0.22-0.6)	WS10 (1.2-1.8)	WS11 (0.1-0.3)	WS12 (0.1-0.5)	WS12 (0.5-1.2)
Metals															
Arsenic	mg/kg	20	100	40.2	48.1	30.0	25.7	23.8	24.8	21.6	26.9	21.3	14.6	18.0	15.0
Cadmium	mg/kg	0.4	5	0.60	0.51	0.57	0.38	0.30	0.55	0.43	0.37	0.58	0.67	0.69	0.44
Chromium	mg/kg	40	400	87.3	88.9	65.6	64.0	64.1	75.5	59.2	73.6	72.9	57.5	49.5	48.1
Copper	mg/kg	40	400	47.1	48.1	50.6	42.6	49.8	71.0	44.0	43.2	65.7	57.7	52.6	38.4
Lead	mg/kg	50	500	106	106	98.6	84.7	64.7	115	90.0	82.2	109	62.4	83.7	92.8
Mercury	mg/kg	0.3	3	0.32	0.37	0.37	0.27	0.32	0.46	0.28	0.28	0.37	0.18	0.27	0.30
Nickel	mg/kg	20	200	36.4	37.1	32.1	36.7	32.6	39.2	36.7	40.4	38.8	42.2	36.3	27.1
Zinc	mg/kg	130	800	230	256	217	177	161	249	208	194	219	166	159	143
Organotins															
Dibutyltin	mg/kg	0.1	1	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0069	0.0067	<0.005	<0.005	<0.005	<0.005

Contaminant	Units	Cefas Guideline Action Level		Sample Concentration (East 2)											
		AL1	AL2	WS05 (0.1-0.6)	WS06 (0.1-0.5)	WS06 (1.0-1.4)	WS07 (0.0-0.5)	WS08 (0.1-0.5)	WS09 (0.1-0.6)	WS09 (1.0-1.5)	WS10 (0.22-0.6)	WS10 (1.2-1.8)	WS11 (0.1-0.3)	WS12 (0.1-0.5)	WS12 (0.5-1.2)
Tributyltin	mg/kg	0.1	1	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0060	0.0081	<0.005	<0.005	<0.005	0.0116
Polychlorinated Biphenyls (PCBs)															
PCB#28	µg/kg	-	-	2.36	2.13	2.30	1.90	1.38	2.11	1.40	1.42	1.27	1.19	1.26	0.90
PCB#52	µg/kg	-	-	1.80	1.71	1.94	1.53	1.07	1.80	1.18	1.23	1.16	1.09	1.13	0.76
PCB#101	µg/kg	-	-	1.60	1.42	1.65	1.17	0.94	1.48	0.89	0.94	0.97	0.90	0.68	0.43
PCB#118	µg/kg	-	-	1.33	1.17	1.41	1.00	0.86	1.30	0.71	0.74	0.73	0.74	0.46	0.29
PCB#138	µg/kg	-	-	2.56	2.25	2.24	1.64	1.26	1.41	1.12	1.18	1.12	0.82	0.65	0.32
PCB#153	µg/kg	-	-	2.48	2.37	2.40	1.65	1.37	1.62	1.26	1.45	1.22	0.95	0.67	0.38
PCB#180	µg/kg	-	-	1.74	1.52	1.49	1.12	0.84	1.34	1.17	1.13	1.20	1.05	1.48	0.97
Sum of ICES 7	µg/kg	10	-	13.9	12.6	13.4	10.0	7.70	11.1	7.70	8.10	7.70	6.70	6.30	4.10
Sum of 25 Congeners	µg/kg	20	200	30.5	27.2	29.6	22.4	16.8	24.2	16.5	17.9	15.8	13.9	12.6	7.90
Polycyclic Aromatic Hydrocarbons (PAHs)															
Acenaphthene	µg/kg	100	-	66.8	91.5	236	44.6	68.0	179	69.6	75.7	138	131	77.1	98.1

Contaminant	Units	Cefas Guideline Action Level		Sample Concentration (East 2)											
		AL1	AL2	WS05 (0.1-0.6)	WS06 (0.1-0.5)	WS06 (1.0-1.4)	WS07 (0.0-0.5)	WS08 (0.1-0.5)	WS09 (0.1-0.6)	WS09 (1.0-1.5)	WS10 (0.22-0.6)	WS10 (1.2-1.8)	WS11 (0.1-0.3)	WS12 (0.1-0.5)	WS12 (0.5-1.2)
Acenaphthylene	µg/kg	100	-	50.4	61.2	95.9	35.7	38.7	91.6	38.0	35.2	53.8	56.6	45.6	43.5
Anthracene	µg/kg	100	-	108	133	385	75.2	109	367	117	130	245	221	147	164
Benzo(a)anthracene	µg/kg	100	-	322	423	830	233	338	764	313	319	606	462	386	435
Benzo(a)pyrene	µg/kg	100	-	396	487	1110	276	393	1030	393	387	763	644	458	530
Benzo(b)fluoranthene	µg/kg	100	-	410	555	1030	309	421	921	361	356	664	565	398	472
Benzo(ghi)perylene	µg/kg	100	-	392	476	860	265	374	770	350	329	541	475	403	388
Benzo(k)fluoranthene	µg/kg	100	-	181	282	405	126	169	488	150	162	346	258	225	251
Chrysene	µg/kg	100	-	307	465	844	248	357	653	316	325	519	417	355	418
Dibenzo(ah)anthracene	µg/kg	100	-	70.0	84.1	152	50.1	70.5	138	59.8	58.1	116	86.7	82.6	72.2
Fluoranthene	µg/kg	100	-	594	796	1750	423	611	1630	567	607	1090	855	697	843
Fluorene	µg/kg	100	-	86.9	101	245	60.7	83.6	223	102	107	140	133	104	106
Indeno(123-cd)pyrene	µg/kg	100	-	346	430	844	246	339	771	304	281	514	459	326	363
Naphthalene	µg/kg	100	-	398	479	609	288	376	477	341	323	289	307	397	245

Contaminant	Units	Cefas Guideline Action Level		Sample Concentration (East 2)											
		AL1	AL2	WS05 (0.1-0.6)	WS06 (0.1-0.5)	WS06 (1.0-1.4)	WS07 (0.0-0.5)	WS08 (0.1-0.5)	WS09 (0.1-0.6)	WS09 (1.0-1.5)	WS10 (0.22-0.6)	WS10 (1.2-1.8)	WS11 (0.1-0.3)	WS12 (0.1-0.5)	WS12 (0.5-1.2)
Phenanthrene	µg/kg	100	-	574	726	1140	407	568	887	520	527	769	595	667	546
Pyrene	µg/kg	100	-	536	716	1570	387	547	1410	538	559	1250	954	645	872
Key	Below AL1														
	Above AL1, Below AL2														
	Above AL2														

In addition, sediment contamination samples (bore holes, window samples) have also been collected from the location of a former landfill site that falls within the Scheme boundary. These have been analysed for a wide range of metals, petroleum hydrocarbons and PAHs. The landfill site covers an area of approximately 0.8 ha and is predominantly flat, surrounded by ditches on all sides. The landfill is accessed off Sheep Trod Lane via an unsurfaced track (which is actually a public highway). Whilst the site was indicated to have taken waste over many years, there is actually very little made ground present, with a typical thickness of 1.2 m, although one bore hole recorded potentially reworked clay to 3.0 m below ground level. This is considered to be unlikely as it would be below groundwater level.

The made ground consisted mainly of ash and demolition arisings in a cohesive matrix which is consistent with the anecdotal evidence that the site was actually used for disposal by burning, combined with some fly tipping. The track to the landfill was reputed to have been formed by waste deposition early in the life of the site, and the ground investigation also confirmed this to be the case. Chemical laboratory testing indicated that the landfill site is affected by localized hydrocarbon contamination with occasional heavy metals, and the access track is affected predominantly by heavy metals, namely zinc and lead. Asbestos fibres have been identified within the material forming the landfill, but not the access track and the asbestos is more likely to be associated with the intermittent tipping of demolition materials.

Leachate testing has indicated that zinc is potentially leachable from within the made ground at the former landfill site, at concentrations above the adopted screening criteria (selected to be protective of coastal/brackish surface waters), along with cadmium, copper and lead, but to a lesser extent. The surface water immediately surrounding the landfill within the ditches has been tested and has indicated that copper, lead and zinc are present in the ditches, indicating that they may be affected by surface run-off from the access track or the landfill. Groundwater testing also indicated that a similar range of heavy metals are present within the shallow groundwater local to the landfill, indicating that leachate is being mobilised by infiltration of rainwater.

8.5 Future baseline

In terms of the future baseline for hydrology, the long-term effects of climate change are anticipated to lead to increased temperatures and a change in rainfall patterns across the region. Precipitation will become more seasonal, with an increase expected in winter and a decrease in summer. Dry spells will increase in frequency and rainfall events will get heavier and/or longer. Both summer and winter temperatures are expected to change as heatwaves will become more frequent. There is some uncertainty as to whether sub-zero temperatures will decrease in frequency to increase due to melting arctic ice. In turn, this will modify patterns of river flow, for example lower flows in summer and larger flows (and flood events) may become more frequent, more severe and more prolonged. Groundwater recharge will be affected due to changes in rainfall. These changes will affect the availability of water for the aquatic environment. In addition, changes in geomorphology may result from a change in flows and more frequent flooding with corresponding changes in sediment dynamics.

In terms of water quality, WFD aims to improve and protect water quality. Assuming legislation remains in place to protect water quality through requirements such as environmental permits (discharge consents) and abstraction licenses it can be anticipated that the current water quality is maintained and/or improved in the long term.

The current objective for the Humber Lower transitional water body is moderate overall status by 2015. Clearly this does not suggest achievement of the primary objective for the WFD whereby all water bodies achieve at least good overall status; however, it is recognised that the reasons for not achieving good overall status for this water body relate to 'unfavourable balance of costs and benefits', 'cause of adverse impact unknown' and 'disproportionate burdens'. Hence, the current objective for the Humber Lower transitional water body does not provide a future date (e.g. 2027; end of Cycle 3 of the WFD) for improvement as this is not currently foreseen as achievable. Nevertheless, it is likely that water quality of the Humber Lower transitional water body will generally improve in the future.

8.6 Likely significant effects

8.6.1 Outstrays Managed Realignment

8.6.1.1 Construction

All construction impacts are anticipated to be temporary and of short-term duration (up to 1 year after construction).

Effects on the non-tidal water environment

Water Quality

With any construction work undertaken close to a watercourse there is an inherent risk of surface water contamination which can impact upon water quality. In several locations, the construction works will take place adjacent to, directly over or within watercourses. The main sources of pollutants which may affect water quality during construction: sediments in runoff and other substances usually brought to site for use in construction works are considered below.

Silt pollution

There would be an increased pollution risk from elevated suspended solids which could potentially impact on the physical, chemical and microbiological water quality characteristics of watercourses. Consequent impacts and heavy silt deposition could include: damage to fish gills by sediment particles; impacts on aquatic vegetation by sediment coating of leaves; visual changes to the watercourse; and silting. In terms of geomorphology, the overlying fine sediment layer caused by excessive siltation can 'hide' in-channel geomorphological features.

The mobilisation of silts and sediments could occur during earthworks and from the movement of heavy plant. During the construction phase large areas of earth will be exposed as new embankments and breaches are constructed and existing embankments reduced. Stockpiles of earth will also be required within the Eastern site which will provide a significant source of sediment. Earth may also be exposed during the general construction activities associated with constructing the drainage, construction compounds and access tracks.

There is a high likelihood of silt being generated from these activities which will be greater after rainfall events when sediment can be mobilised and washed directly in runoff from exposed areas, particularly slopes associated with stockpiles and the

embankments into receiving waters. Runoff may also emanate from poor site drainage provision and from washing and cleaning activities.

Any areas where works are required within watercourses, such as for constructing/extending culverts, outfalls structures and piling (i.e. associated with WOPS), there will be a greater risk of mobilising existing sediment and any associated pollutants within the watercourses and causing pollution. If water needs to be pumped out of the working areas this water could be silt-laden and if discharged to water or to ground could pose a risk to the water environment. Cofferdams to create dry working areas may be formed by installing sheet piles, and pile placement and removal has the potential to mobilise existing sediment and silt on the bed and banks of any affected watercourses.

The magnitude of the impact upon water quality will depend upon the location, quantities of sediment released and the flows within the receiving watercourse at the time. Impacts may be temporary or of long duration should the sediment settle out over bed of watercourses.

Without mitigation, the impact could be moderate negative. The effect upon Winestead Drain (medium value) is considered to be **minor adverse** as the works are located in the most downstream reach of the watercourse. The greatest risk is from piling at WOPS and any silt pollution caused will be short-lived as the Pumping Station will discharge the polluted waters to the Estuary.

The two ponds of high value within the Humber Estuary SSSI are adjacent to the low-level bund to be created as part of the new grassland habitat area. The risk of silt pollution to the ponds is anticipated to be minimal but as a worse case, without mitigation, a moderate negative impact results in a **moderate adverse** effect.

For the other low value receptors (i.e. Welwick Drain, East Clough, un-named drains and ponds) the significance of effect is **minor adverse** without mitigation.

Use of polluting substances

Construction works will necessitate the use of heavy plant and machinery, as well as the temporary storage of oils and diesel at the site compounds. Everyday operation and maintenance of this plant has the potential to result in chemical contamination of the environment through oil / fuel leaks from vehicles, chemical storage leaks and accidental spillages etc. which may become mobilised during storm events. Construction plant may also generate a diffuse source of hydrocarbons and to a lesser extent heavy metals that could enter the drainage network or leach into the subsoil and find their way into surface waters.

There is also the potential for the release of pollutants such as concrete, cement grout and bitumen paint into watercourses resulting in a temporary reduction in water quality. Under certain circumstances, spillage of materials used during the construction process could directly enter surface waters or seep into underlying groundwater which would ultimately have an adverse effect on both the groundwater and surface waters.

Where works occur adjacent to or within a watercourse the risk is greatest. The construction of new outfalls and the culverts will require the use of potentially polluting substances within the channel of watercourses. The risk will be greater if these structures are cast in-situ (however it has been assumed that all units will be pre-cast). The infilling between the existing and new sheet piles proposed at WOPS with concrete will pose a greater risk to the water environment.

The magnitude of impact is dependent upon the scale and nature of any spillages or chemical pollution into the water environment. The likelihood of a major spill is very low; however, the risk of more frequent minor spills is higher. The impact is likely to be of a temporary duration and localised.

Without mitigation, the impact could be moderate negative upon surface waters. The effect upon Winestead Drain (medium value) is considered to be **minor adverse** as the works are located in the most downstream reach of the watercourse. Any pollution caused will be short-lived as the WOPS will discharge the polluted waters to the Estuary causing no impact due to its significant dilution capacity.

The two ponds of high value within the Humber Estuary SSSI are adjacent to the low-level bund to be created as part of the new grassland habitat area and area to be piled, resulting in minimal construction activities and traffic nearby. The risk of pollution to the ponds is anticipated to be minimal but as a worse case, without mitigation, a moderate negative impact results in a **moderate adverse** effect.

For the other low value receptors (i.e. Welwick Drain, East Clough, un-named drains and ponds) the significance of effect is **minor adverse** without mitigation.

Dust Suppression

As described in the Chapter 3, water abstraction may be required from Winestead Drain for dust suppression. Given the significant amount of earthworks required for the Scheme, dust suppression techniques may be required on site for prolonged periods of time. This could require significant water supplies which may not, especially in a dry year, be possible from Winestead Drain without an impact upon flows. Water quality in Winestead Drain is known to be poor with low oxygen levels and high levels of phosphate. Abstracting water for dust suppression may further worsen water quality within Winestead Drain. Abstractions of 20 cubic metres or less a day do not require an abstraction licence. If a dry summer was to occur during the works, during which dust suppression would be more likely to be required, even the amount possible for extraction without a licence may worsen the already poor water quality in Winestead Drain. Its most likely that due to the size of the scheme the requirements will be significantly more than this. This is anticipated to have a moderate negative impact upon Winestead Drain (medium value) resulting in a **moderate adverse** effect upon flows and water quality.

Hydrology and Groundwater

Dewatering Activities

De-watering activities associated with construction are likely to be exempt from requiring an abstraction licence if they prevent interference with engineering works where the abstraction lasts less than six consecutive months, subject to restrictions. The location and duration of any de-watering activities has not been established in any detail at present. It is assumed that any requirements for dewatering will be discussed with our Contractors prior to the works occurring to ensure any necessary licences are in place. Therefore, this impact is not assessed further.

Geomorphology

By their nature, flood defence works pose a risk to the geomorphology of the channels and floodplains as significant proportions of the required works, such as excavation, construction and landscaping are located within or in close proximity to watercourses.

Works within the watercourses pose the greatest risk of causing impacts to the hydromorphology.

The working methods (vegetation clearance, piling and excavation) may result in damage to and increased instability of the channel bed and banks for all watercourses where works occur within the channel. As both bed and banks become destabilised by the works (i.e. tracking on the bed, vibration due to piling, loading of the bank top and damage of the bank face), material from them becomes more likely to be delivered to the channel and is therefore available to be entrained and transported downstream. Potential impacts include damage to channel bank form, increased sediment supply to channel, change to flow conditions and sediment dynamics. This will extend past construction until there has been sufficient flows to redistribute sediment and adjust to the change in conditions. Potential impacts upon hydromorphology during construction are anticipated to be temporary and localised due to the watercourses affected by the Scheme being predominantly small drains and ditches and therefore negligible, resulting in **no effect**.

Effects on the marine (estuarine) environment

The construction of the western site has the potential to affect water environment receptors through the following impact pathways:

- Accidental release of pollutants during construction (e.g. oil from plant and equipment) and disturbance of sediment; and
- Mobilisation/re-suspension of sediment-bound contaminants (e.g. metals, nutrients, organic material) during reprofiling of saltmarsh.

Accidental release of pollutants during construction and disturbance of sediment

Any construction accident has the potential to lead to a spillage of cargo or fuel oil from the plant(s) involved. These types of accident are the ones most likely to lead to large scale oil spills; however, they are also relatively rare events.

Without the adoption of appropriate working practices and pollution prevention guidance, there could be a potential impact on water quality from wheel wash, spills and leaks of fuel from construction plant. The sensitivity of the site is considered to be very high given its locality to international nature conservation designated sites. Given the scale of construction works, the magnitude of any wash off and potential spillage is predicted to be minor negative. Therefore, the effect of spillages is considered to be direct, temporary, **minor adverse to moderate adverse**.

Mobilisation/re-suspension of sediment-bound contaminants during reprofiling of saltmarsh

Reprofiling of the saltmarsh and removal of the existing embankment will be undertaken at lower states of the tide. There is potential for unconsolidated material (disturbed/moved during construction works) to be dispersed during the subsequent higher tidal states, creating a shallow water plume. However, any dispersion is likely to remain local to the construction works and would re-settle over the higher mudflats or become trapped within the remaining saltmarsh due to relatively low flow speeds.

The estuary mudflat and saltmarsh are designated at an international level therefore the sensitivity of the environmental receptor is classified as very high. The magnitude of change is considered to be negligible with respect to background suspended

sediment concentrations. Any impact would also be short lived (1 or 2 tides) and, on this basis, the significance of environmental effect is assessed as **no effect**.

8.6.1.2 Operation

Effects on the non-tidal environment

Water Quality

Habitat Creation and Mitigation in West 2

The concept design for the West 2 habitat creation and mitigation area has included a series of ponds and/or wetland areas immediately after the abstraction locations from Winestead Drain to enable water treatment of the abstracted water to reduce nutrient levels within the wet grassland areas. Some of the water required to support the site will be discharged back into Winestead Drain and this will be of a better quality than the runoff currently entering Winestead Drain from the arable fields. The discharge quantities from the site are unknown so the magnitude of the impact cannot be determined but will be a **beneficial effect** (no more than slight beneficial).

The Outstrays Managed Realignment will also remove agricultural land which is intensively managed and a source of diffuse pollution. This will reduce the levels of nutrients entering the watercourses which would have drained the site and ultimately Winestead Drain which suffers from poor water quality due to high levels of phosphates. This is a positive impact but due to the small size of the agricultural land lost compared to the size of Winestead Drain catchment is likely to be a negligible resulting in **no effect**.

Access tracks and associated with the proposed scheme (i.e. alongside the new Soak Dyke) will be constructed of aggregate with some areas of flexipave. Where aggregate is to be used runoff from these areas may contribute silts and any associated contaminates from vehicles using the tracks to receiving watercourses. The impact is anticipated to be minor negative. As the receiving waters (i.e. the new Soak Dyke) are of low value the effect is considered to be **minor adverse**.

Hydrology

Loss of Water features

The Scheme will lead to the permanent loss of watercourses that are currently located on the west side of the proposed embankment and under its footprint. This mostly impacts the un-named drains, the three ponds and East Clough within West 1. Watercourses within West 2 will not be lost. The permanent loss of these features (all of low value) is Major negative. Given most of the features are man-made the significance of the effect is anticipated to be **minor adverse** without mitigation.

In West 1 the new proposed embankment will be constructed to the front of the existing relict embankment. This new embankment will reduce overall contributing area from this area into WOPS. This will however result in a small increase in water discharging directly into East Clough Drain to the rear of the relict embankment. Previously, East Clough Drain and the area south of the relict embankment operated independently and converged immediately before the outfall (East Clough) into Winestead Drain. This change in flows is anticipated to be a negligible impact and therefore **no effect** upon the receptors.

The permanent loss of the drains and change from arable land to part of the MR site will also reduce the catchment area contributing to flows within Winestead Drain. Most of the drains are considered to be ephemeral (i.e. in dry weather would not contribute flow to Winestead Drain) and thus the affect upon flows in Winestead Drain is likely to be unnoticeable and this has not been considered further.

Habitat Creation and Mitigation area – West 2 – Water Abstraction

The site for West 2 for the creation and mitigation area currently comprises of arable fields that are artificially drained by sub surface field drainage. The concept design for the site includes removing this drainage reprofiling the land levels. Appropriate water level management will be required for habitat creation; without intervention, the groundwater levels will be too low to create wet grassland areas and permanent pools of water. Engineering works are required to reduce the permeability of the soils and increase groundwater levels. This will be achieved by installing “cut-off” trenches around and within the site to block sub-soil drainage systems and thus ‘wet-up’ the soils within hydrologically isolated units.

The grassland within West 2 will require periodic flooding or water logging by freshwater during the winter months. It is proposed that, once created, water to support the habitat is sourced from rainfall and supplemented by water abstracted from Winestead Drain (using a wind or solar pump system) if necessary. The effect upon the flows within Winestead Drain is likely to be minimal and temporary (short-term) as water will be abstracted over the winter months when levels are anticipated to be higher within the Drain. According to the concept design, water will be abstracted in two locations and will flow along new channels, one through Field A and one through Field B and discharge back into Winestead Drain further downstream. Abstraction quantities, duration and frequency of abstraction has not yet been determined but as a worst case the impact is anticipated to be no greater than Minor negative which results in a **Minor adverse** effect without mitigation. In reality the majority of water abstracted will form new water features within the site and/or mostly be discharged back into Winestead Drain resulting in **no effect**.

Flood Risk

Table 8.7 below presents the flood risk to the development and the impact of flood risk upon the development from the various sources of flooding. These are discussed in further detail in the paragraphs below. See also Appendix 8.3 Flood Risk Assessment.

Table 8.7: Summary of flood risk impacts

Source of flooding		Flood Risk		Mitigation Required
		To the development	Development impact on risk	
Sea		High	Low	No
Fluvial	Main river	Low	Low	No
	Ordinary water course	Low	Low	No
Surface water		Low	Low	No
Groundwater		Low	Low	No
Reservoir		Low	Low	No

Sewers	Low	Low	No
Canal	Low	Low	No

Tidal flood risk

The proposed development with a setback embankment brings the Tidal flood defence in closer proximity to properties. Therefore, it is necessary to consider the impact of this change and provide mitigation to ensure that there is no increase in flood risk as a result of the proposed scheme.

The Eastern development defences are proposed to be a height of 5.6 mAOD (not including settlement allowances and topsoil). In the Eastern scheme only modelling there is a notable reduction in the flood extent, particularly around Patrington Haven and the area immediately to the south of the settlement. There is also a reduction in extent to the north of the proposed embankment, although receptors in the settlement of Weeton are still affected and Skeffling Road is still flooded.

Combining the two developments gives the most significant reduction in flood risk from the 0.5% AEP event. In the western area, towards Patrington Haven and adjacent to Winestead Drain, the risk has been reduced significantly in comparison with each scheme individually. The results show that for the 5.75mAOD water level, 551 fewer receptors (using the National Receptor Database) fall within the tidal 0.5% AEP event flood extent with the new embankments when compared to the existing embankments.

Flood depths and/or velocities are reduced for the majority of properties following implementation of the scheme, suggesting an overall reduction in danger to people. Some properties experience an increase in flood depth or velocity as a result of the scheme, however, for all bar one this doesn't result in an increase in hazard rating. Only a single property, a non-residential outbuilding of Outstrays Farm, has an increase in Depth and Velocity that results in a change in hazard rating. This change was to be expected due to the proximity of the receptor to the new embankment alignment. The residential receptor associated with Outstrays Farm remains in the same hazard rating. Outstrays farm is owned by the Environment Agency, therefore it is the responsibility of the EA to ensure that they manage this risk accordingly.

Considering the above information and the role of the development, there is an improvement on the current level of flood risk. Whilst a risk still remains, and the land taken as part of the development will flood due to the nature of managed realignment, the amount of properties at risk from flooding has reduced and the level of risk to the majority of those remaining at risk has also reduced. The defence height has considered extreme water levels and therefore the risk of breach is less than the existing situation. Taking all this into consideration, the impact of the development on flood risk is considered to be low and no further mitigation is required.

Fluvial flood risk

The proposed development interacts with several drains. The drainage strategy for the proposed scheme has been designed to ensure that through the diversion of these networks there is no increase in flood risk and where reasonably practicable a reduction in flood risk. Furthermore, the combined proposed schemes will reduce the contributing areas to both the Winestead Outstrays and Skeffling Pumping Stations, reducing the overall demand on these assets. As a result of the scheme therefore is anticipated to be no change in fluvial flood risk.

Surface water flood risk

There are a number of points along the proposed defence alignment where the existing flood risk may interact with the proposed scheme. The areas of interest are mainly those against the proposed defence alignment which are currently at risk of surface water flooding and so could result in blockage of current surface water drainage routes. However, the design of the drainage along the defences proposes to mimic the current surface water drainage situation (i.e. a new soak dyke will be installed behind the defences) so there should be no increase in the current areas of ponding. Furthermore, the proposed development will not result in any increase in hardstanding or impermeable areas, meaning there is unlikely to be any increase in the volume of surface run off. This also means that there will be the flows to the two pumping stations should not increase. Consequently, the development impact to flood risk is considered to be low and mitigation is not required.

Groundwater

The proposed development will primarily require above ground construction excluding works regarding drainage networks and foundations. Once construction is complete; it is possible that new foundations may increase the chance of groundwater emergence. Toe drainage for the new embankment will be considered in detailed design. Therefore, the impact on groundwater flood risk from the proposed scheme is considered to be low.

Groundwater

Impacts relating to saline intrusion may occur due to the relocation of the embankment inland exposing new areas to saline waters. The impact of this upon groundwaters is unknown but any impacts are likely to be localised. Some degree of saline intrusion will already be experienced and the nature of this is not anticipated to change only the location at which is occurs (i.e. further inland).

Any changes in the salinity of groundwaters may also impact the salinity in the downstream reaches of watercourses affected by the Scheme. Those which have a large Baseflow index (i.e. the proportion of flow provided by groundwater) will be affected the most. The duration, locations and magnitude of such impacts cannot be quantified. However, as the watercourses are likely to be already be affected by the saline waters the change in salinity is likely to be **negligible** with only the location being most likely to be affected.

Geomorphology

In locations where, new culverts and outfalls are proposed in retained watercourses the geomorphology will be permanently affected. Culverts can result in channel restrictions and increase flow velocity and turbulence which can lead to scour and change sediment dynamics (i.e. increase sediment inputs). They also constrain the channel preventing lateral and vertical adjustment, which results in a reduction in morphological diversity. Outfalls can lead to the permanent removal of lengths of the watercourse bank and bed in the location of the new outfalls. This can cause localised changes to flow processes with potential for alterations in sediment movement through interrupting longshore processes. The locations of culverts and outfalls has not yet been determined however, the drains and watercourses within the Western Site are generally trapezoidal (man-made) and contain few geomorphological features of low importance. As any impacts will be localised the impact upon geomorphology is anticipated to be no greater than minor negative resulting in a **minor adverse** effect.

The piling proposed at WOPS on Winestead Drain will be located in front (on the wet side) of the existing piles. This will lead to a permanent narrowing of the channel and therefore a loss of channel bed in Winestead Drain in the location of the piling. The new piles will be 1-2m in front of the existing and be located on both sides of the bank upstream of WOPS. In this location the water regime is artificially managed and therefore flows are unlikely to be affected by the additional constriction resulting in a negligible impact and **no effect**. The loss of the channel bed is also of negligible impact (permanent) as the channel is man-made and trapezoidal with little natural features resulting in a negligible impact and **no effect**.

Due to the tying in of the new piles with the existing banks on Winestead Drain (medium value) an additional section of bank will be permanently lost behind the new piles which is currently part of the un-piled channel. The banks are also currently trapezoidal and with no geomorphological diversity. The length affected is negligible compared to the overall length of the waterbody. The impact is considered to be negligible resulting in **no effect**.

The impact of the piling on the downstream banks has been assessed in Chapter 7.

It may be possible to provide enhancements to Winestead Drain as part of the proposed scheme which would benefit its ecology, water quality and geomorphology. This could include the creation of a sinuous two-stage channel within the current bank alignment or low-level shelf/ledges within the bank.

The proposed piling at WOPS could incorporate a green shelf/terrace between the existing and new piles or contain a low-level ledge. Alternatives to piling should also be considered such as concrete crib walls that can be planted. Any enhancements will be limited by its drainage function, but opportunities will be investigated during detailed design.

Effects on the marine (estuarine) environment

The operation of the western site has the potential to affect water environment receptors through the following impact pathways:

- Mobilisation/re-suspension of sediment-bound contaminants (e.g. metals, nutrients, organic material) after the site has been breached; and
- Potential long-term improvements in water quality of adjacent estuarine waters due to nutrient cycling/burial service of intertidal habitats, reduced agricultural activity and potential oxygen enrichment.

<u>Mobilisation/re-suspension of sediment-bound contaminants after the site has been breached</u>

There will be short-term increases in suspended sediment concentrations (SSCs) at the breach site due to the change in density of sediments on the bed (i.e. uncompact material through construction of the breach). Similarly, there will be minor increases in SSC as the channel on the fronting mudflat develops. However, any elevation in SSC will be localised and negligible compared to natural variation within the wider estuary given the high levels of suspended solids observed in the Humber Estuary. Furthermore, increases in SSC will be periodic as the breach and western site will only become inundated at high water.

Sediment-bound contaminants could be mobilised during the construction works and initial operation of the western site.

Relatively low levels of contamination were observed in sediment samples collected from the intertidal mudflat and saltmarsh fronting the proposed West 1 breach site (see Table 8.6 and Table 8.7; minor exceedances of Cefas Guideline AL1 for metals; PAHs frequently above Cefas Guideline AL1). There could be short-term, small increases in dissolved contaminant concentrations through mobilisation of these sediments, although it is unlikely to result in significant impacts to water quality. No substances are expected to be directly discharged during the operational life of the project.

The sensitivity of the western site is considered to be very high given its locality to international nature conservation designated sites. Given the short term, localised and small-scale changes in SSC as a result of the Scheme and the relatively low levels of contamination reported at the breach site, the magnitude of change regarding the mobilisation/re-suspension of contaminated sediments is considered to be negligible. Therefore, the potential significance of environmental effects has been assessed as **no effect.**

Potential long-term improvements in water quality of adjacent estuarine waters

One of the key environmental services associated with intertidal habitats (particularly saltmarsh) is that of nutrient (nitrogen and phosphorus) cycling/burial and trapping of carbon. This trapping arises through a combination of primary production, sedimentation and denitrification predominantly in intertidal areas. It should be noted that the processes leading to nutrient and sediment storage in estuaries are highly non-linear, and are dependent on the concentrations in the water column (Nedwell et al. 1999). Nevertheless, the loss or gain of intertidal areas directly impacts storage capacity.

Coastal saltmarsh vegetation is involved in the regulation of water purity through the take up of excess inorganic nutrients such as nitrates and phosphates, therefore reducing the potential for eutrophication (Peterson et al. 2008). Saltmarsh sediments tend to be anoxic and carbon-rich, providing ideal conditions for denitrifying bacteria (Drake et al. 2009). Denitrification rates tend to be high, and can be accountable for a majority of nitrogen flux in saltmarshes (Davis et al. 2004). The vegetation found on saltmarshes is also an important nutrient sink through the generation of plant biomass (Verhoeven et al. 2006). Furthermore, on warm, sunny summer days, oxygen enrichment occurs over saltmarshes during high water, as light penetrates the thin layer of water covering the saltmarsh and the plants release oxygen into the water column (Maris et al. 2008).

The Humber Lower transitional water body is currently failing to achieve good status due to angiosperms (moderate), invertebrates (moderate), dissolved inorganic nitrogen (moderate) and TBT compounds (fail), while it is also designated under the Nitrates Directive. The Scheme will not introduce a new source of nutrients to the marine environment, and thus would not result in a deterioration of the dissolved inorganic nitrogen parameter. It is anticipated that the Scheme will result in the provision of up to 110 ha of new saltmarsh (angiosperms) habitat within the western site after approximately 5 years of operation, with associated enhancements in fauna (invertebrates).

The sensitivity of the western site is considered to be very high given its locality to international nature conservation designated sites. Given the relatively small scale nature of the Scheme (minimal reduction in agricultural land), the magnitude of nutrient cycling/burial and oxygen enrichment effects on an estuary scale is considered to be negligible to minor positive. Therefore, the potential significance of environmental effects has been assessed as **minor beneficial to moderate beneficial**.

8.6.2 Welwick to Skeffling Managed Realignment

8.6.2.1 Construction

All construction impacts are anticipated to be temporary and of short-term duration (up to 1 year after construction).

Effects on the non-tidal water environment

Water Quality

With any construction work undertaken close to a watercourse there is an inherent risk of surface water contamination which can impact upon water quality. In several locations, the construction works will take place adjacent to, directly over or within watercourses. The main sources of pollutants which may affect water quality during construction: sediments in runoff and other substances usually brought to site for use in construction works are considered below.

Silt pollution

There would be an increased pollution risk from elevated suspended solids which could potentially impact on the physical, chemical and microbiological water quality characteristics of watercourses. Consequent impacts and heavy silt deposition could include: damage to fish gills by sediment particles; impacts on aquatic vegetation by sediment coating of leaves; visual changes to the watercourse; and silting. In terms of geomorphology, the overlying fine sediment layer caused by excessive siltation can 'hide' in-channel geomorphological features.

The mobilisation of silts and sediments could occur during earthworks and from the movement of heavy plant. During the construction phase large areas of earth will be exposed as new embankments and breaches are constructed and existing embankments reduced. Stockpiles of earth will also be required within the Site which will provide a significant source of sediment. Earth may also be exposed during the general construction activities associated with constructing the drainage, construction compounds and access tracks.

There is a high likelihood of silt being generated from these activities which will be greater after rainfall events when sediment can be mobilised and washed directly in runoff from exposed areas, particularly slopes associated with stockpiles and the embankments into receiving waters. Runoff may also emanate from poor site drainage provision and from washing and cleaning activities.

Any areas where works are required within a watercourse, such as for constructing/extending culverts and outfalls structures pose a risk of mobilising existing sediment and any associated pollutants, causing pollution. If water needs to be pumped out of the working areas this water could be silt-laden and if discharged to water or to ground could pose a risk to the water environment. Cofferdams to create dry working areas may be formed by installing sheet piles, and pile placement and removal has the potential to mobilise existing sediment and silt on the bed and banks of any affected watercourses.

The magnitude of the impact upon water quality will depend upon the location, quantities of sediment released and the flows within the receiving watercourse at the time. Impacts may be temporary or of long duration should the sediment settle out over the bed of watercourses.

Without mitigation, the impact could be moderate negative. For Weeton Beck, Weeton Fleet (Drain), Soak Dike, the Un-named drains and ponds within the Eastern Site (all low value) this is anticipated to result in a **minor adverse** effect without mitigation. Impacts upon Fosse Drain are not anticipated as the watercourse is only connected to the watercourses within the site during high return period flood events.

Use of polluting substances

Construction works will necessitate the use of heavy plant and machinery, as well as the temporary storage of oils and diesel at the site compounds. Everyday operation and maintenance of this plant has the potential to result in chemical contamination of the environment through oil / fuel leaks from vehicles, chemical storage leaks and accidental spillages etc. which may become mobilised during storm events. Construction plant may also generate a diffuse source of hydrocarbons and to a lesser extent heavy metals that could enter the drainage network or leach into the subsoil and find their way into surface waters.

There is also the potential for the release of pollutants such as concrete, cement grout and bitumen paint into watercourses resulting in a temporary reduction in water quality. Under certain circumstances, spillage of materials used during the construction process could directly enter surface waters or seep into underlying groundwater which would ultimately have an adverse effect on both the groundwater and surface waters.

Where works occur adjacent to or within a watercourse the risk is greatest. The construction of new outfalls and the culverts will require the use of potentially polluting substances within the channel of watercourses. The risk will be greater if these structures are cast in-situ. The magnitude of impact is dependent upon the scale and nature of any spillages or chemical pollution into the water environment. The likelihood of a major spill is very low; however, the risk of more frequent minor spills is higher. The impact is likely to be of a temporary duration and localised.

Without mitigation, the impact could be moderate negative upon surface waters within the Eastern Site (i.e. Welwick Drain, East Clough, un-named drains and ponds) resulting in a **minor adverse** effect without mitigation. Impacts upon Fosse Drain are not anticipated as the watercourse is only connected to the watercourses within the site during high return period flood events.

Hydrology and Groundwater

Dewatering Activities

De-watering activities associated with construction are likely to be exempt from requiring an abstraction licence if they prevent interference with engineering works where the abstraction lasts less than 6 consecutive months, subject to restrictions. The location and duration of any de-watering activities has not been established in any detail at present. It is assumed that any requirements for dewatering will be discussed with our Contractors prior to the works occurring to ensure any necessary licences are in place. Therefore, this impact is not assessed further.

Geomorphology

By their nature, flood defence works pose a risk to the geomorphology of the channels and floodplains as significant proportions of the required works, such as excavation, construction and landscaping are located within or in close proximity to watercourses.

Works within the watercourses pose the greatest risk of causing impacts to the hydromorphology.

The working methods (vegetation clearance, piling and excavation) may result in damage to and increased instability of the channel bed and banks for those watercourses where in-channel works will occur. As both bed and banks become destabilised by the works (i.e. tracking on the bed, vibration due to piling, loading of the bank top and damage of the bank face), material from them becomes more likely to be delivered to the channel and is therefore available to be entrained and transported downstream. Potential impacts include damage to channel bank form, increased sediment supply to channel, change to flow conditions and sediment dynamics. This will extend past construction until there has been sufficient flows to redistribute sediment and adjust to the change in conditions. Potential impacts upon hydromorphology during construction are anticipated to be temporary and localised due to the watercourses affected by the Scheme being predominantly small drains and ditches and therefore negligible, resulting in **no effect**.

Effects on the marine (estuarine) environment

The construction of the eastern site has the potential to affect water environment receptors through the following impact pathways:

- Accidental release of pollutants during construction (e.g. oil from plant and equipment) and disturbance of sediment; and
- Mobilisation/re-suspension of sediment-bound contaminants (e.g. metals, nutrients, organic material) during reprofiling of saltmarsh.

Accidental release of pollutants during construction and disturbance of sediment

Any construction accident has the potential to lead to a spillage of cargo or fuel oil from the plant(s) involved. These types of accident are the ones most likely to lead to large scale oil spills; however, they are also relatively rare events.

Without the adoption of appropriate working practices and pollution prevention guidance, there could be a potential impact on water quality from wheel wash, spills and leaks of fuel from construction plant. The sensitivity of the site is considered to be very high given its locality to international nature conservation designated sites. Given the scale of construction works, the magnitude of any wash off and potential spillage is predicted to be minor negative. Therefore, the effect of spillages is considered to be direct, temporary, **minor adverse to moderate adverse**.

Mobilisation/re-suspension of sediment-bound contaminants during reprofiling of saltmarsh

Reprofiling of the saltmarsh and removal of the existing embankment will be undertaken at lower states of the tide. There is potential for unconsolidated material (disturbed/moved during construction works) to be dispersed during the subsequent higher tidal states, creating a shallow water plume. However, any dispersion is likely to remain local to the construction works and would re-settle over the higher mudflats or become trapped within the remaining saltmarsh due to relatively low flow speeds.

The estuary mudflat and saltmarsh are designated at an international level therefore the sensitivity of the environmental receptor is classified as very high. The magnitude of change is considered to be negligible with respect to background suspended

sediment concentrations. Any impact would also be short lived (1 or 2 tides) and, on this basis, the significance of environmental effect is assessed as **no effect**.

8.6.2.2 Operation

Effects on the non-tidal environment

Water Quality

Diffuse Pollution

The Welwick to Skeffling Managed Realignment will also remove agricultural land which is intensively managed and a source of diffuse pollution. This will reduce the levels of nutrients entering the watercourses which would have drained the site and discharges via Skeffling Pumping Station. This is a positive impact but due to the small size of the agricultural land lost compared to the size of catchment draining through Skeffling Pumping Station and the location of the land in the very downstream reaches of the catchment the impact is likely to be negligible resulting in **no effect**.

Access tracks associated with the proposed scheme (i.e. alongside the new Soak Dyke) will be constructed of aggregate with some areas of flexipave. Where aggregate is to be used runoff from these areas may contribute silts and any associated contaminates from vehicles using the tracks to receiving watercourses. The impact is anticipated to be minor negative. As the receiving waters (i.e. the new Soak Dyke) are of low value the effect is considered to be **minor adverse**.

The proposed compound and car park in East 1 will be constructed of a permeable surface allowing rainfall to infiltrate into the soil naturally. Flows from the carpark will be conveyed at a restricted rate in a southernly direction to connect into the proposed new soak dike, from here flows will then be routed in a south-westerly direction via the proposed soak dike towards the freshwater grassland in West 2. There is a risk of pollutants from the car parking areas entering the freshwater grassland habitat via the new Soak Dyke. The impact is anticipated to be minor negative and the effect **minor adverse** upon water quality in the new Soak Dyke.

Contaminated Land

The historic landfill site located within East 1 is currently having a detrimental impact upon water quality in the adjacent ditches with high levels of zinc recorded. The scheme involves remediating the landfill site and the impacts of this upon the surface and groundwaters has been assessed in Chapter 9.

Hydrology

Loss of Water features

The proposed scheme will lead to the permanent loss of some of the water features that are currently located on the wet side of the proposed embankment and under its footprint. This includes the following:

- Un-named drains;
- At least five ponds in East 3;
- Over 800m of Weeton Beck;

- The total length of Weeton Fleet; and
- The majority of the Soak Dyke (Plate 8.7) between Haverfield Quarry and Skeffling Pumping Station (over 3km).

The permanent loss of these features (all of low value) is considered to be a Major negative impact. Given most of the features are man-made the significance of the effect is anticipated to be **Minor adverse** without mitigation.

Plate 8.7: Existing embankment, looking west across East 2, with Soak Dike on the right-hand side.

Change in flow direction and catchments

The proposed drainage diversion for East 1, will see flows being conveyed in a south-westerly direction to the West 2 freshwater grassland, as opposed to the existing easterly flows that discharge into Welwick Bank. Along the length of the proposed soak dike are a number of existing drains, these drains will be connected into the soak dike to assist with diverting flows into West 2.

The drainage proposal for East 2 and 3 primarily consists of diverting the flow route of Weeton Fleet Drain to discharge at Skeffling Pumping Station (SPS). This drainage route diversion will require upgrades to SPS to ensure SPS is pumping efficiently.

Along the newly diverted route to SPS, the proposed soak dike will collect other land drainage routes along the way, further diverting the existing flows within East 2 and 3. The existing drain running parallel to the proposed soak dike in East 2 will be landscaped out, as this will no longer be required with the proposed soak dike and diversions of the current field drains.

The impact from the change in flow direction is anticipated to be minor negative. The drains are low value receptors; therefore, the effect is **minor adverse**.

Change in contributing areas

The change from arable land to intertidal areas as part of the MR site will also reduce the catchment area contributing to flows entering the section of the Soak Dyke to be retained (which outfalls via Skeffling Pumping Station). Most of the un-named drains are considered to be ephemeral (i.e. in dry weather would not contribute flow) and thus the affect upon flows in the Soak Dyke is likely to be unnoticeable and this has not been considered further.

Habitat Creation and Mitigation Area – Welwick to Skeffling

The Welwick to Skeffling habitat creation and mitigation area (Figure 3.1 in Appendix 1.1) is located adjacent to East 1 and split into three fields separated by species-poor hedgerows which run north to south across the site. The Soak Dyke runs along the southern boundary. The site is currently dominated by open arable fields. These fields are low lying and relatively flat with a shallow slope from north to south up to Soak Dyke. Two relic drains run along two hedgerows, one on the western boundary and the second within the site. Although these no longer function as drains, there are two notable sections that retain a short section of shallow water for much of the year and effectively act as ponds. The concept design for this area includes widening and deepened to create new ponds. This permanent change from drainage ditch to pond will be a positive impact, albeit minor resulting in a **minor beneficial effect** as the ponds are likely to be of better quality than the ditches that will be lost.

Flood Risk

Table 8.8 below presents the flood risk to the development and the impact of flood risk upon the development from the various sources of flooding. These are discussed in further detail in the paragraphs below. See also Appendix 8.3 Flood Risk Assessment.

Table 8.8: Summary of flood risk impacts

Source of flooding		Flood Risk		Mitigation Required
		To the development	Development impact on risk	
Sea		High	Low	No
Fluvial	Main river	Low	Low	No
	Ordinary water course	Low	Low	No
Surface water		Low	Low	No
Groundwater		Low	Low	No
Reservoir		Low	Low	No
Sewers		Low	Low	No
Canal		Low	Low	No

Tidal flood risk

The proposed development with a setback embankment brings the Tidal flood defence in closer proximity to properties. Therefore, it is necessary to consider the impact of this change and provide mitigation to ensure that there is no increase in flood risk as a result of the proposed scheme.

As discussed in section 8.6.1.2 combining the two developments gives the most significant reduction in flood risk from the 0.5% AEP event with, 551 fewer receptors falling within the tidal 0.5% AEP event flood extent with the new embankments when compared to the existing embankments.

Flood depths and/or velocities are reduced for the majority of properties following implementation of the scheme, suggesting an overall reduction in danger to people. Some properties experience an increase in flood depth or velocity as a result of the scheme, however, for all bar one (as described in section 8.6.1.2) this doesn't result in an increase in hazard rating.

Considering the above information and the role of the development, there is an improvement on the current level of flood risk. The impact of the development on flood risk is considered to be low and no further mitigation is required.

Fluvial flood risk

The proposed development interacts with several drains. The drainage strategy for the proposed scheme has been designed to ensure that through the diversion of these networks there is no increase in flood risk and where reasonably practicable a reduction in flood risk. Furthermore, the proposed combined managed realignment sites will reduce the contributing areas to both the Winestead Outstrays and Skeffling Pumping Stations, reducing the overall demand on these assets. As a result of the scheme therefore is anticipated to be no change in fluvial flood risk.

Surface water flood risk

There are a number of points along the proposed defence alignment where the existing flood risk may interact with the proposed scheme. The areas of interest are mainly those against the proposed defence alignment which are currently at risk of surface water flooding and so could result in blockage of current surface water drainage routes. However, the design of the drainage along the defences proposes to mimic the current surface water drainage situation (i.e. a new soak dyke will be installed behind the defences) so there should be no increase in the current areas of ponding. Furthermore, the proposed development will not result in any increase in hardstanding or impermeable areas, meaning there is unlikely to be any increase in the volume of surface run off. This also means that there will be the flows to the two pumping stations should not increase. Consequently, the development impact to flood risk is considered to be low and mitigation is not required.

Groundwater

The proposed development will primarily require above ground construction excluding works regarding drainage networks and foundations. Once construction is complete; it is possible that new foundations may increase the chance of groundwater emergence. Toe drainage for the new embankment will be considered in detailed design. Therefore, the impact on groundwater flood risk from the proposed scheme is considered to be low.

Groundwater

Impacts relating to saline intrusion may occur due to the relocation of the embankment inland exposing new areas to saline waters. The impact of this upon groundwaters is unknown but any impacts are likely to be localised. Some degree of saline intrusion will already be experienced and the nature of this is not anticipated to change only the location at which is occurs (i.e. further inland).

Any changes in the salinity of groundwaters may also impact the salinity in the downstream reaches of watercourses affected by the Scheme. Those whom have a large Baseflow index (i.e. the proportion of flow provided by groundwater) will be affected the most. The duration, locations and magnitude of such impacts cannot be quantified. However, as the watercourses are likely to be already be affected by the saline waters the change in salinity is likely to be negligible with only the location being most likely to be affected.

Geomorphology

Culverts and Outfalls

In locations where, new culverts and outfalls are proposed on retained watercourses the geomorphology will be permanently affected. Culverts can result in channel restrictions and increase flow velocity and turbulence which can lead to scour and change sediment dynamics (i.e. increase sediment inputs). They also constrain the channel preventing lateral and vertical adjustment, which results in a reduction in morphological diversity. Outfalls can lead to the permanent removal of lengths of the watercourse bank and bed in the location of the new outfalls. This can cause localised changes to flow processes with potential for alterations in sediment movement through interrupting longshore processes. The locations of culverts and outfalls has not yet been determined however, the drains and watercourses within the Eastern Site are generally trapezoidal (man-made) and contain few geomorphological features. Impacts will be permanent but localised. The effect upon geomorphology is anticipated to be no greater than minor negative resulting in a **minor adverse** effect.

Effects on the marine (estuarine) environment

The operation of the eastern site has the potential to affect water environment receptors through the following impact pathways:

- Mobilisation/re-suspension of sediment-bound contaminants (e.g. metals, nutrients, organic material) after the site has been breached;
- Potential impact of the historical landfill site upon surface waters and ground water; and
- Potential long-term improvements in water quality of adjacent estuarine waters due to nutrient cycling/burial service of intertidal habitats, reduced agricultural activity and potential oxygen enrichment.

Mobilisation/re-suspension of sediment-bound contaminants after the site has been breached

There will be short-term increases in SSCs at the breach site due to the change in density of sediments on the bed (i.e. uncompact material through construction of the breach). Similarly, there will be minor increases in SSC as the channel on the fronting mudflat develops. However, any elevation in SSC will be localised and negligible compared to natural variation within the wider estuary given the high levels of suspended solids observed in the Humber Estuary. Furthermore, increases in SSC will be periodic as the breach and eastern site will only become inundated at high water.

Sediment-bound contaminants could be mobilised during the construction works and initial operation of the eastern site.

Relatively low levels of contamination were observed in sediment samples collected from the intertidal mudflat and saltmarsh fronting the proposed East 2 breach site (see Table 8.6 and Table 8.8; minor exceedances of Cefas Guideline AL1 for metals; PAHs frequently above Cefas Guideline AL1). There could be short-term, small increases in dissolved contaminant concentrations through mobilisation of these sediments, although it is unlikely to result in significant impacts to water quality. No substances are expected to be directly discharged during the operational life of the project.

The sensitivity of the eastern site is considered to be very high given its locality to international nature conservation designated sites. Given the short term, localised and small scale changes in SSC as a result of the Scheme and the relatively low levels of contamination reported at the breach site, the magnitude of change regarding the mobilisation/re-suspension of contaminated sediments is considered to be negligible. Therefore, the potential significance of environmental effects has been assessed as **no effect.**

Potential impact of the historical landfill site upon surface waters and ground water

As part of the Scheme, the location of the access track would be breached to allow waters to enter the new intertidal habitat to the north of the landfill, and the actual landfill area would be inundated. A remedial solution is therefore required to prevent this occurring. The proposed solution is to raise the ground over the entire landfill area to achieve a level above the maximum wave height to prevent any risk of the site being inundated using low permeability clay. This approach would remove the risk of leachate mobilisation by infiltration and run-off pathways, and also remove the associated human health risks due to the asbestos fibres within the soils.

An additional precaution proposed at this site includes erosion protection around the periphery of the landfill, and this is likely to include infilling of the ditches and slope protection with materials designed to resist erosion, which is likely to incorporate geosynthetics (see Chapter 9).

Potential long-term improvements in water quality of adjacent estuarine waters

One of the key environmental services associated with intertidal habitats (particularly saltmarsh) is that of nutrient (nitrogen and phosphorus) cycling/burial and trapping of carbon. This trapping arises through a combination of primary production, sedimentation and denitrification predominantly in intertidal areas. It should be noted that the processes leading to nutrient and sediment storage in estuaries are highly non-linear, and are dependent on the concentrations in the water column (Nedwell et al. 1999). Nevertheless, the loss or gain of intertidal areas directly impacts storage capacity.

Coastal saltmarsh vegetation is involved in the regulation of water purity through the take up of excess inorganic nutrients such as nitrates and phosphates, therefore reducing the potential for eutrophication (Peterson et al. 2008). Saltmarsh sediments tend to be anoxic and carbon-rich, providing ideal conditions for denitrifying bacteria (Drake et al. 2009). Denitrification rates tend to be high, and can be accountable for a majority of nitrogen flux in saltmarshes (Davis et al. 2004). The vegetation found on saltmarshes is also an important nutrient sink through the generation of plant biomass (Verhoeven et al. 2006). Furthermore, on warm, sunny summer days, oxygen enrichment occurs over saltmarshes during high water, as light penetrates the thin layer of water covering the saltmarsh and the plants release oxygen into the water column (Maris et al. 2008).

The Humber Lower transitional water body is currently failing to achieve good status due to angiosperms (moderate), invertebrates (moderate), dissolved inorganic nitrogen (moderate) and TBT compounds (fail), while it is also designated under the Nitrates Directive. The Scheme will not introduce a new source of nutrients to the marine environment, and thus would not result in a deterioration of the dissolved inorganic nitrogen parameter. It is anticipated that the Scheme will result in the provision of 144 ha of new saltmarsh (angiosperms) habitat b within the eastern site after approximately 5 years of operation, with associated enhancements in fauna (invertebrates).

The sensitivity of the western site is considered to be very high given its locality to international nature conservation designated sites. Given the relatively small-scale nature of the Scheme (minimal reduction in agricultural land), the magnitude of nutrient cycling/burial and oxygen enrichment effects on an estuary scale is considered to be negligible to minor positive. Therefore, the potential significance of environmental effects has been considered to be **minor beneficial to moderate beneficial**.

8.7 Mitigation

8.7.1 Outstrays Managed Realignment

8.7.1.1 Construction

Non-tidal and marine (estuarine) water quality

Moderate adverse effects have been identified prior to mitigation upon water quality as a result of potential sediment pollution and pollution from the use of polluting substances required as part of the works. To reduce the effect the following mitigation is proposed.

The appointed Contractor would be responsible for ensuring compliance with relevant environmental legislation, Local Authority, NE and Environment Agency requirements for construction works (including temporary works) through the implementation of the Construction Environmental Management Plan (CEMP) and their Method Statements. The CEMP will be informed by the Environmental Action Plan (EAP). An Environmental Clerk of Works (ECW) will be appointed and attend site to ensure that the Contractors are adhering to the CEMP.

The CEMP will include specific mitigation for works over, within or adjacent to any watercourse. Method statements for works in these sensitive locations will be produced which will include details of the site specific environmental protection measures to be implemented. These measures will be determined by the Contractor including obtaining the necessary land drainage and environmental permits for temporary works. The Contractor will also be responsible for agreeing Method Statements with NE for activities that have the potential to impact upon the Humber Estuary SSSI (Haverfield Quarry).

The Contractor will be required to demonstrate that all site staff will be provided with the relevant training and awareness of site procedures and best construction practice.

A Surface Water Management Plan (SWMP) will be produced as part of the CEMP. This will describe the management processes and procedures that will be employed to control, mitigate and monitor contamination of surface water during the construction

phase. The SWMP will also identify measures to reduce the risk of pollution or flooding occurring when working within the floodplain. The SWMP will also contain a Pollution Incident Response Plan (PIRP) detailing actions to be taken in the event of an incident and reporting procedures. The contractor will be expected to use effective sustainable drainage systems to minimise pollution, contamination and sedimentation impacts on receiving waters.

In addition, a Silt Management Plan (SMP) will be produced for the Scheme as part of the CEMP. This will describe the management processes and procedures that will be employed to control, mitigate and monitor silt generation and the risks to surface water during the construction phase and will include the main works and the creation of the new habitat areas (wet grassland and terrestrial grassland).

The mitigation of construction impacts will be defined in the CEMP and surface water management plan for the Scheme, and will include:

- Implementation of standard spill/leak control measures (e.g. bunded fuel storage area, spill kits, interceptors). Site signage will be erected showing who to contact in the event of a spillage or emergency. The Environment Agency will be informed of all pollution incidents and action taken.
- Development of a strategy or Method Statement for in-channel works and temporary de-watering activities, to minimise both the disruption to ecological elements and the risk of siltation/scour during the construction phase.
- Appropriate design of temporary or permanent in-channel structures to mitigate the potential for scour/channel migration.
- Installation of temporary drains and silt traps where required in temporary works areas; this will be included in the scope of a silt management plan for the Scheme.
- Consideration and mitigation of the risk of silt generation from temporary stockpile areas from rainfall/flood events, and of leachate generation from excavated materials, e.g. by the use of impermeable bases, flood bunds, and temporary covering of exposed material: this will be included in the scope of a Silt Management Plan for the Scheme.

To reduce the risk of erosion and silt generation mitigation also includes adherence to best practice construction methods to minimise the potential to erode /disturb soils and sediments. Soil erosion prevention measures will include restricting plant on unvegetated ground, avoidance of repeated tracking, provision of erosion protection matting where possible and the design of site drainage to minimise erosion risk. If required retained watercourses will be dredged upon completion of the works to remove excess siltation and maintain the drainage regime. If required any mitigation associated with reducing the impacts from dredging will form part of the silt management plan.

The proposal to abstract water from Winestead Drain for dust suppression may cause negative impacts on the water environment that require mitigation. If abstraction above 20 cubic metres a day is proposed an abstraction licences will be required which will include conditions to prevent environmental damage. It is assumed that in this instance the effect upon the water environment would be reduced to an acceptable level (i.e. minor adverse effect or less). If abstractions are proposed under this value that do not require a licence or if a licence is not granted then the following measures should be undertaken:

- Visual monitoring of Winestead Drain if abstractions below 20 cubic metres a day are proposed. If poor water quality and quantity is observed, evidenced through algal blooms and slow flow then alternative forms of abstraction should be considered. It may be necessary to take dissolved oxygen level readings prior to abstraction and this should be agreed with the Environment Agency.
- Alternative sources should be used where possible including the following:
    - Use of existing drains for rainwater storage;
    - Use of water from the Humber Estuary (for areas which will be exposed to tidal waters following the completion of the works); and
    - Creation of a storage area for rainwater which could be used after construction to provide additional water to the wet grassland in West 2.

8.7.1.2 Operation

Non-tidal environment

No significant effects during operation have been identified that require mitigation. Minor adverse effects have been identified upon three ponds in West 1 and un-named drains which will be lost as a result of the scheme. The new creek system within the intertidal areas and the creation of the wet grassland (West 2) and terrestrial grassland (East 1) will compensate for what is lost and provide a betterment. More ponds are proposed to be created than are to be lost.

Minor adverse effects have been identified from pollutants in runoff from access tracks. A suitable aggregate should be chosen for surfacing to reduce silt generation and aggregates which may affect the pH of the watercourses should be avoided.

Changes in geomorphology as a result of new culverts and outfalls results in a minor adverse effect. To reduce impacts, the structures should be designed to minimise bed and bank loss. Erosion protection measures included if required should consider soft engineering techniques.

Marine (estuarine) environment

All impact pathways identified during the operation of the Scheme have been assessed as minor adverse or no impact (and likely to provide some long-term improvements in water quality). Therefore, mitigation is not required.

8.7.2 Welwick to Skeffling Managed Realignment

8.7.2.1 Construction

Non-tidal and marine (estuarine) water quality

Minor adverse and moderate adverse effects have been identified prior to mitigation upon water quality as a result of potential sediment pollution and pollution from the use of polluting substances required as part of the works. To reduce the effect the following mitigation is proposed.

The appointed Contractor would be responsible for ensuring compliance with relevant environmental legislation, Local Authority, NE and Environment Agency requirements for construction works (including temporary works) through the implementation of the

Construction Environmental Management Plan (CEMP) and their Method Statements. The CEMP will be informed by the EAP. An Environmental Clerk of Works (ECW) will be appointed and attend site to ensure that the Contractors are adhering to the CEMP.

The CEMP will include specific mitigation for works over, within or adjacent to any watercourse. Method statements for works in these sensitive locations will be produced which will include details of the site specific environmental protection measures to be implemented. These measures will be determined by the Contractor including obtaining the necessary land drainage and environmental permits for temporary works.

The Contractor will be required to demonstrate that all site staff will be provided with the relevant training and awareness of site procedures and best construction practice.

A Surface Water Management Plan (SWMP) will be produced as part of the CEMP. This will describe the management processes and procedures that will be employed to control, mitigate and monitor contamination of surface water during the construction phase. The SWMP will also identify measures to reduce the risk of pollution or flooding occurring when working within the floodplain. The SWMP will also contain a Pollution Incident Response Plan (PIRP) detailing actions to be taken in the event of an incident and reporting procedures. The contractor will be expected to use effective sustainable drainage systems to minimise pollution, contamination and sedimentation impacts on receiving waters.

In addition, a Silt Management Plan (SMP) will be produced for the Scheme as part of the CEMP. This will describe the management processes and procedures that will be employed to control, mitigate and monitor silt generation and the risks to surface water during the construction phase and will include the main works and the creation of the new habitat areas (wet grassland and terrestrial grassland).

The mitigation of construction impacts will be defined in the CEMP and surface water management plan for the Scheme, and will include:

- Implementation of standard spill/leak control measures (e.g. bunded fuel storage area, spill kits, interceptors). Site signage will be erected showing who to contact in the event of a spillage or emergency. The Environment Agency will be informed of all pollution incidents and action taken.
- Development of a strategy or Method Statement for in-channel works and temporary de-watering activities, to minimise both the disruption to ecological elements and the risk of siltation/scour during the construction phase.
- Appropriate design of temporary or permanent in-channel structures to mitigate the potential for scour/channel migration.
- Installation of temporary drains and silt traps where required in temporary works areas; this will be included in the scope of a silt management plan for the Scheme.
- Consideration and mitigation of the risk of silt generation from temporary stockpile areas from rainfall/flood events, and of leachate generation from excavated materials, e.g. by the use of impermeable bases, flood bunds, and temporary covering of exposed material: this will be included in the scope of a Silt Management Plan for the Scheme.

To reduce the risk of erosion and silt generation mitigation also includes adherence to best practice construction methods to minimise the potential to erode /disturb soils and sediments. Soil erosion prevention measures will include restricting plant on unvegetated ground, avoidance of repeated tracking, provision of erosion protection

matting where possible and the design of site drainage to minimise erosion risk. If required retained watercourses will be dredged upon completion of the works to remove excess siltation and maintain the drainage regime. If required any mitigation associated with reducing the impacts from dredging will form part of the silt management plan.

The proposal to abstract water from Winestead Drain for dust suppression may cause negative impacts that require mitigation. If abstraction above 20 cubic metres a day is proposed an abstraction licences will be required which will include conditions to prevent environmental damage. It is assumed that in this instance the effect upon the environment would be reduced to an acceptable level (i.e. minor adverse effect or less). If abstractions are proposed under this value that do not require a licence or if a licence is not granted then the following measures should be undertaken:

- Visual monitoring of Winestead Drain if abstractions below 20 cubic metres a day are proposed. If poor water quality and quantity is observed, evidenced through algal blooms and slow flow then alternative forms of abstraction should be considered. It may be necessary to take dissolved oxygen level readings prior to abstraction and this should be agreed with the Environment Agency.
- Alternative sources should be used where possible including the following:
    - Use of existing drains for rainwater storage;
    - Use of water from the Humber Estuary (for areas which will be exposed to tidal waters following the completion of the works); and
    - Creation of a storage area for rainwater which could be used after construction to provide additional water to the habitat creation and mitigation area.

Mitigation associated with reducing the risks of pollution during construction from the landfill site are described in Chapter 9.

8.7.2.2 Operation

Non-tidal environment

No significant effects during operation have been identified that require mitigation. Minor adverse effects have been identified for the ponds and un-named drains (all low value) which will be lost as a result of the scheme. The new creek system within the intertidal areas and the habitat creation and mitigation area (West 2 and adjacent to East 1) will compensate for what is lost and provide a betterment. More ponds are proposed to be created than are to be lost.

A new soak dyke is also proposed at the dry side toe of the embankment to replace the soak dyke that will be lost. The section of drain along the back of East 2 and 3 are expected to be wet all year with 40cm of standing water and the drain along the back of East 1 will dry out in the summer. This will mitigate for the loss of the existing Soak Dyke.

Minor adverse effects have been identified from pollutants in runoff from access tracks and car parking area. A suitable aggregate should be chosen for surfacing to reduce silt generation and aggregates which may affect the pH of the watercourses should be avoided. The new car park should also include measures to prevent pollution (i.e. petrol interceptors/an isolated drainage system) and these should be investigated at the detailed design stage.

Changes in geomorphology as a result of new culverts and outfalls results in a minor adverse effect. To reduce impacts, the structures should be designed to minimise bed and bank loss. Erosion protection measures if required should consider soft engineering techniques.

Marine (estuarine) environment

All impact pathways identified during the operation of the Scheme have been assessed as minor adverse or no effect (and likely to provide some long-term improvements in water quality). Therefore, mitigation is not required.

8.8 Residual effects

8.8.1 Outstrays Managed Realignment

8.8.1.1 Construction

Non-tidal environment

Moderate adverse effects have been identified prior to mitigation upon water quality due to the potential to cause pollution whilst working near watercourses and the abstraction of water for dust suppression. To reduce the effect, mitigation has been proposed which includes implementing best practice measures which will reduce the impact to negligible resulting in **no effect** upon the water environment.

Marine (estuarine) environment

The effects on water quality as a result of accidental releases of pollutants and disturbance of sediment was assessed as being minor to moderate adverse without mitigation. However, with the mitigation measures highlighted in Section 8.7, residual effects are considered to be **minor adverse**.

No other effects were assessed as moderate adverse (or worse) during construction and, therefore, no mitigation measures are required. Residual effects for all other pathways are therefore considered the same as in Section 8.6.

8.8.1.2 Operation

Non-tidal environment

Minor adverse effects have been identified upon ponds and watercourses due to loss of some of these features and changes in hydromorphology as a result of the Scheme as described in Section 8.6. With the mitigation described in Section 8.7 which includes the creation of new habitats as part of the Scheme the impact will be reduced resulting in **no effect**.

Marine (estuarine) environment

No effects were assessed as moderate adverse (or worse) during operation and, therefore, no mitigation measures are required. Residual effects for all other pathways are therefore considered the same as in Section 8.6.

8.8.2 Welwick to Skeffling Managed Realignment

8.8.2.1 Construction

Non-tidal environment

Minor adverse effects have been identified prior to mitigation upon water quality due to the potential to cause pollution whilst working near watercourses and the abstraction of water for dust suppression. To reduce the effect mitigation has been proposed which includes implementing best practice measures which will reduce the impact to negligible resulting in **no effect** upon the water environment.

Marine (estuarine) environment

The effect on water quality as a result of accidental releases of pollutants and disturbance of sediment was assessed as being minor to moderate adverse without mitigation. However, with the mitigation measures highlighted in Section 8.7, residual effects are considered to be **minor adverse**.

No other effects were assessed as moderate adverse (or worse) during construction and, therefore, no mitigation measures are required. Residual effects for all other pathways are therefore considered the same as in Section 8.6.

8.8.2.2 Operation

Non-tidal environment

Minor adverse effects have been identified upon ponds and watercourses due to loss of some of these features and changes in hydromorphology as a result of the Scheme as described in Section 8.6. With the mitigation described in Section 8.7 the impact will be reduced resulting in **no effect**.

Marine (estuarine) environment

No effects were assessed as moderate adverse (or worse) during operation and, therefore, no mitigation measures are required. Residual effects for all other pathways are therefore considered the same as in Section 8.6.

9 Geology, soils and hydrogeology

9.1 Introduction

This chapter considers the potential impacts and subsequent effects on the geology, superficial geology and hydrogeology within the study area by the Scheme, comprising both Outstrays (western) and the Welwick to Skeffling (eastern) Managed Realignment sites. It also considers any foreseeable impacts and effects to human health, controlled waters and the proposed scheme from the presence of contamination and aggressive ground conditions.

9.2 Regulatory and policy framework

9.2.1 Environmental Protection Act 1990

Legislation covering the assessment of contaminated sites is provided under Part 2A of the Environmental Protection Act 1990 (EPA 1990), as introduced by Section 57 of the Environment Act 1995. This came into effect in England on 1st April 2000 as The Contaminated Land (England) Regulations 2000. These regulations were subsequently revoked with the provision of the Contaminated Land (England) Regulations 2006, which consolidated the previous regulations and amendments. The Regulations were further amended in 2012.

Contaminated land is defined in Part 2A of the EPA 1990 as *'any land which appears to the local authority in whose area it is situated to be in such a conditions, by reason of substances in, on or under the land that:*

- *significant harm is being caused or there is a significant possibility of such harm being caused; or*
- *pollution of controlled waters is being, or is likely to be, caused'*

The principal objectives of the legislation are described in the Defra document 'Environmental Protection Act 1990: Part 2A – Contaminated Land Statutory Guidance', 2012 as:

- *To identify and remove unacceptable risks to human health and the environment.*
- *To seek to ensure that contaminated land is made suitable for its current use.*
- *To ensure that the burdens faced by individuals, companies and society as a whole are proportionate, manageable and compatible with the principles of sustainable development.*

These three objectives underlie the 'suitable for use' approach to the assessment and remediation of 'land contamination'. This approach recognizes that the risks presented by any given level of land contamination will vary greatly according to the use of the

land and a wide range of other factors, such as the sensitivity of the underlying geology and the receptors which may be affected.

9.2.2 Water Framework Directive 2015

The Water Framework Directive 2015 states guideline values for a variety of determinants within surface, groundwater and saline water environments that should be complied with where local guideline values do not apply, with the aim to achieve good qualitative and quantitative status for all water bodies.

9.2.3 Health and Safety Legislation

The risks to human receptors are managed through health and safety legislation, such as the Control of Substances Hazardous to Human Health (COSHH) Regulations. These regulations require the employer to carry out an assessment of the risks associated with the exposure to hazardous substances and then to prevent them, or if this is not reasonably practical, adequately control such exposures.

9.2.4 Model Procedures for the Management of Land Contamination (CLR11)

Guidance for assessing and managing land contamination is presented in the Contaminated Land Report (CLR) 11 (Environment Agency 2004). This provides a technical framework for identifying and remediating land affected by contamination through the application of a risk management process.

9.2.5 CL:AIRE Definitions of Waste

Guidance for excavated soils to be re-used on site where geotechnically and chemically suitable for use (subject to waste regulatory controls) e.g. CL:AIRE Definitions of Waste: Development Industry Code of Practice (CL:AIRE, 2011) Material Management Plan (MMP), Environmental Permit or Exemption from Permitting.

It is recommended that a Soil Resource Plan also be prepared for the proposed development following the guidance provided in Defra (2009) Code of Practice for the Sustainable Use of Soils on Construction Sites. The Soil Resource Plan should include:

- Areas of soil to be protected from earthworks and construction activities;
- The areas and types of topsoil and subsoil to be stripped, haul routes, stockpile locations;
- The methods for stripping, stockpiling, re-spreading and ameliorating landscape soils.

The following mitigation measures should be employed during the construction phase:

- Stripping, stockpiling or placing soil, should be undertaken during dry conditions;
- Tracked equipment should be used for reducing soil compaction;
- Traffic movement should be confined to designated routes;
- Soil should be stored for as short a time as possible; and

- Stockpiles of different soil materials should be clearly defined.

9.2.6 British Standards

Guidelines on the stripping and stockpiling of subsoils and topsoil's is given in BS 8601:2013 and BS 3882:2015 respectively.

They state that where direct re-use onsite is not possible, or appropriate, these materials should ideally be sent off-site for reuse in the improvement of agricultural land (e.g. for land levelling, contouring or improving land quality), again subject to the appropriate waste legislative controls. Disposal at landfill should only be considered if there are no other options available.

9.3 Methodology

In order to determine if there are any significant constraints presented by the existing ground conditions and geology, a review of the desk study and available ground investigation information has been undertaken. In relation to contamination at the site which may pose a risk of harm to human health, controlled waters, the environment or site structures, a risk-based approach to the assessment of environmental impacts and effects was adopted.

This follows the guidance in the Environment Agency Publication CLR11 "Model Procedures for the Management of Land Contamination" (Environment Agency, 2004), which advocates the source-pathway-receptor concept which, when all three are present, constitutes a potential contaminant linkage. Should any element of the potential contaminant linkage not be present, then, although a contaminant source may be present, the contaminant is not considered to pose a risk. Such contaminant linkages are identified through the development and iterative review of a Conceptual Site Model (CSM).

The tables in Chapter 4 Methodology were used to assess sensitivity of resources, and assess the impacts and subsequent effects of the scheme, in line with the general methodology in Chapter 4 in addition to that stated above.

The receptors identified within this chapter were identified using professional judgement, assessing the potential future users of the site and any potential environmental receptors. The assessment of sensitivity, magnitude and significance was undertaken using professional judgment.

9.3.1 Study area

The study area primarily consists of reclaimed mudflats, which are long established agricultural fields and pasture to the north of an existing sea bank approximately 9.5 km long. Land within the western part of the site, adjacent to Patrington Channel and Winestead Drain was drained circa 1909, with the remainder of the area drained earlier following the construction of the sea defences. The study area is predominantly low lying and is relatively level, with an approximate elevation between 2.5 – 5.0m Above Ordinance Datum (AOD), with the Welwick to Skeffling area of the site at 6 – 7mAOD, and the elevation increases westward to 10mAOD near Row Lane. The Scheme boundary, which contains the study area, is shown on Figure 2.1 in Appendix 1.1.

With respect to potential sources of contamination and receptors, an area of up to 500m surrounding the site has been considered within this chapter.

9.3.2 Baseline data collection

A combination of desk-study and field data were collated to establish the existing baseline environment.

A large ground investigation was undertaken in 2016 (CH2M, 2018) involving 57 cable percussion (CP) boreholes, 126 Cone Penetration Tests (CPTs), 41 windowless sampler locations, 40 machine dug trial pits, 11 hand dug trial pits and the installation of 29 standpipes in boreholes and 9 in the windowless sampler (WS) locations. An archeological investigation was also undertaken as part of this investigation, and is discussed in Chapter 13, Historic Environment. The table below summarises the investigation for the Scheme.

Table 9.1: Summary of Ground Investigation for the scheme

Outstrays Managed Realignment		Welwick to Skeffling Managed Realignment	
West 1	**West 2**	**East 1**	**East 2 and 3**
14 x CP boreholes 26 x CPTs 15 x WS 3 x trial pits 3 x hand dug pits	10 x CP boreholes 27 x CPT 2 x hand dug pits	11 x CP boreholes 33 x CPT 11 x trial pits 2 x hand dug pits Historical breach: 2 x CP boreholes 3 x CPT 8 X WS Historical landfill: 1 x CP borehole 7 x CPT 6 x WS	19 x CP boreholes 37 x CPT 12 x WS

9.3.3 Sources of Information

- Highways England, 2016, Design Manual for Roads and Bridges Volume 11 Environmental Assessment, Part 11 Geology and Soils;
- Environment Agency, 2004, Contaminated Land Report 11, Model Procedures for the Management of Land Contamination;
- British Geological Survey online database GeoIndex and Lexicon (accessed July 2018);
- British Geological Survey Sheet 81 1:50,000 scale (1991), Patrington, Solid and Drift Edition;

- Multi-Agency Geographic Information for the Countryside (MAGIC) website (accessed July 2018);
- Environment Agency online database – What's in your Backyard (www.data.gov.uk). The WIYBY portal is no longer active, however data is still available through data.gov.uk (Accessed July 2018);
- Natural England (2010), Agricultural Land Classification Map West Midlands Region (ALC004);
- CH2M, 2018, Welwick to Skeffling Managed Realignment Ground Investigation and Preliminary Design Report, Document number IMNE000195-CH2-000-ZZ-SI-GT-0002, included in Appendix 9.1
- GroundSure EnviroInsight and GeoInsight reports, references HMD-252-2055007, HMD-252-2055008, HMD-252-2055009 dated May 2015 and HMD-252-2667765, HMD-252-2667766, HMD-252-2667767 dated January 2016.
- Environmental Protection Act 1990;
- The Coal Authority Interactive Map Viewer (http://coal.decc.gov.uk, accessed July 2018)
- Control of Substances Hazardous to Human Health (COSHH), 2002;
- Water Resources Act 1991;
- BS8601:2013, Specification for subsoil and requirements for use;
- BS3882:2015 Specification for Topsoil;
- CIRIA, 2001, C552, Contaminated Land Risk Assessment;
- Environment Agency, 2010, GPLC1 – Guiding Principles for Land Contamination.

9.4 Uncertainties, assumptions and limitations

The ground conditions implied from the 2016 ground investigation cover a small percentage of the site, and therefore the ground conditions between the intrusive locations may vary.

The shallow superficial deposits are assumed to be suitable for re-use in earthworks, and as such the design is based on this assumption. There is the potential that this may not be the case, and therefore the material has the potential to be unsuitable for use.

9.5 Existing environment

9.5.1 Superficial geology

The superficial geology of the Scheme is largely consistent between the two sites, however each of the deposits encountered varied between the two. Therefore, the geology in the following section relates to both sites, with site-specific differences mentioned where appropriate. In this chapter the term 'superficial geology' is used

rather than soils. The below information is based on the Ground Investigation Report (CH2M, 2018), included in Appendix 9.1.

9.5.1.1 Made Ground

Outstrays Managed Realignment

The Made Ground that made up the relict flood bank within West 1 was proven to a thickness of 2.8m, which varied across the flood bank in its composition, between "*firm, sandy clay with occasional firm laminations of sand and fine sand"*, "*very soft, silty slightly sandy clay with fine laminations of sand"*, to "*gravelly, sandy clay, rare rootlets"*.

No Made Ground was encountered within West 2, however there is anecdotal evidence that dredged material from Winestead Drain is placed on the northern bank. The locations within 5m of Winestead Drain encountered "*soft, brown, silty, slightly sandy clay with frequent roots and rootlets*".

The Made Ground present in the existing flood banks across the schemes varied in its composition, however the logs recorded typically "*slightly sandy, slightly gravelly clay with rootlets", "firm to stiff, slightly sandy, slightly gravelly clay" over "stiff, slightly sandy silt with occasional decomposed rootlets"* or *"firm brown, mottled orange-brown and grey clay"* up to 3.0m below ground level (bgl). Windowless sample locations also were drilled through the flood bank, recording "*firm, brown and light brown, clayey silt"* to depths of up to 3.2m bgl. The bank adjacent to Winestead Drain was also investigated, and the Made Ground was very similar to that of the existing flood bank.

Welwick to Skeffling Managed Realignment

Within the scheme extents, the ground investigation typically encountered deposits of Made Ground confined to the existing and relict flood banks, in addition to the area of historical landfill adjacent to Welwick Bushes within East 1. However, localized areas of Made Ground were encountered outside of these areas, for example containing glass, brick and ceramic pottery in the north-western corner of East 2 and within historical ponds located across the scheme. This was recorded at a location of a house shown on the historical mapping which is no longer present.

The Made Ground present within the existing flood bank within the Welwick to Skeffling Managed Realignment was reported to have the same varying descriptions as that present within the Outstrays Managed Realignment, described above.

The existing flood bank known to have historically breached within East 1, was also investigated, finding that the Made Ground was between 2.0m and 2.6m thick, and was generally described as "*gravelly, silty clay, with gravel of sandstone, flint, chalk and limestone".* Two locations noted wood fragments, and a further two locations noted some *"organic fragments*".

Within the subsection East 1 Made Ground was also encountered in the hand pits undertaken on the access track located south of Row Lane. It was a thin layer of approximately 0.02m, which was described to contain a sandy gravel, with gravel of glass, brick, flint, concrete and igneous road chippings.

9.5.1.2 Storm Beach Deposits

Outstrays Managed Realignment

Storm Beach Deposits were encountered within West 2, bordering the north-western corner of Welwick Saltmarsh. The deposits were generally described as “grey, slightly silty, sand with frequent shell fragments”, with a maximum thickness of 1.2m, overlying the Tidal Flat Deposits.

Welwick to Skeffling Managed Realignment

Storm Beach Deposits were encountered within East 1, bordering the north-western corner of Welwick Saltmarsh. The deposits were generally described as “*grey, slightly silty, sand with frequent shell fragments”*, with a maximum thickness of 1.2m, overlying the Tidal Flat Deposits.

9.5.1.3 Tidal Flat Deposits

Outstrays Managed Realignment

The Tidal Flat Deposits were recorded to be present across the majority of the sub-sites. The deposits were reported in two types; an upper layer and a lower layer.

The upper layer was typically described as “soft, orange-brown mottled grey, slightly sandy, silty clay”, “soft to firm, grey-brown clay”, “very soft, brown silty, slightly sandy clay” with “soft to firm, grey mottled yellow, silty clay”, “fine laminations of sandy silt”, and rare shell fragments also recorded.

The lower layer was typically described as “very soft to soft, brown to dark grey, clayey, sandy silt” and “very soft, dark grey and brown, silty, slightly sandy clay”, commonly recording shell fragments. The deposit was typically encountered with a thickness of 0.45 – 3.8m.

Welwick to Skeffling Managed Realignment

The Tidal Flat Deposits were recorded to be present across the majority of sub-sites, with the northern half of the western site recording it not to be present. The deposits were reported in two types; an upper layer and a lower layer.

The upper layer was typically described as “*soft, orange-brown mottled grey, slightly sandy, silty clay”, “soft to firm, grey-brown clay”, “very soft, brown silty, slightly sandy clay” with “soft to firm, grey mottled yellow, silty clay”, “fine laminations of sandy silt”,* and rare shell fragments also recorded. A maximum thickness of 3.0m was recorded in East 2 and 3, with a typical thickness of between 1.1m to 2.0m.

The lower layer was typically described as “*very soft to soft, brown to dark grey, clayey, sandy silt”* and “*very soft, dark grey and brown, silty, slightly sandy clay”*, commonly recording shell fragments. The deposit was typically encountered with a thickness of 0.45 – 3.8m.

9.5.1.4 Estuarine Deposits

Outstrays Managed Realignment

Granular Estuarine Deposits were encountered within West 1 and West 2 within the scheme, recorded beneath the Tidal Flat Deposits. The Estuarine Deposits were typically described as grey-brown to brown silty sand to fine to medium sand and a grey to black organic silty sand. A maximum thickness of 7.0m was recorded within the subsection West 1, however the typical thickness across West 2 was between 0.5m and 1.0m

Welwick to Skeffling Managed Realignment

Granular Estuarine Deposits were encountered within East 1, recorded beneath the Tidal Flat Deposits. The Estuarine Deposits were typically described as grey-brown to brown silty sand to fine to medium sand and a grey to black organic silty sand. The typical thickness across East 1 was between 0.5m and 1.0m.

9.5.1.5 Blown Sand Deposits

Welwick to Skeffling Managed Realignment

The BGS mapping shows an area of blown sand occupying the location of Welwick Bushes. One location, undertaken at the base of the existing flood bank on the north-western face, encountered *"brown, slightly gravelly, silty, fine to medium sand"* underlying the flood bank from 0.1m bgl. This deposit was encountered overlying *"brown, gravelly, fine to coarse sand"* from 0.4m bgl, with a recorded thickness of 0.2m. The blown sand deposits were recorded overlying tidal flat deposits and were not encountered within any other exploratory holes drilled during the 2016 Ground Investigation.

9.5.1.6 Glaciofluvial Deposits

Outstrays Managed Realignment

Glaciofluvial Deposits were only encountered boreholes within West 2, located within the north-western field, described as "*dark grey, silty slightly, gravelly sand. Gravel is rounded fine of chalk (possible shell fragments)".* This layer was encountered underlying 9.2m of Glacial Till, and was proven to the base of the borehole at 16.5m bgl.

9.5.1.7 Glacial Till

Outstrays Managed Realignment

Glacial Till Deposits were encountered across the two schemes, with some areas where the overlying Tidal Flat Deposits were of a considerable thickness that the Glacial Till was not proven.

The glacial till was typically encountered as firm to stiff, becoming very stiff, red-brown, orange-brown and dark brown, slightly sandy, slightly gravelly, clay. The gravel comprised of *"sub-rounded to rounded, fine to coarse of predominantly chalk and occasional sandstone, siltstone, mudstone, chert and flint".* The Glacial Till within subsection West 2 also recorded bands of glaciofluvial deposits.

Welwick to Skeffling Managed Realignment

Glacial Till Deposits were encountered across the two schemes, with some areas where the overlying Tidal Flat Deposits were of a considerable thickness that the Glacial Till was not proven.

The glacial till was typically encountered as firm to stiff, becoming very stiff, red-brown, orange-brown and dark brown, slightly sandy, slightly gravelly, clay. The gravel comprised of *"sub-rounded to rounded, fine to coarse of predominantly chalk and occasional sandstone, siltstone, mudstone, chert and flint".* The base of the Glacial Till was not proven in the 2016 ground investigation however, it was proven to a maximum

depth of 25.5m bgl (East 2 and 3). Within the Glacial Till within subsection West 2 bands of glaciofluvial deposits were also encountered, and are described below.

9.5.1.8 Solid Geology

The anticipated solid geology beneath the study area is the Upper Cretaceous Flamborough Chalk Formation and was not encountered as part of the 2016 ground investigation.

Given the depth to which the superficial deposits have been proven, it is considered unlikely that the bedrock is likely to be encountered as part of this scheme.

The BGS mapping indicates that there are no known faults within the study area or within the surrounding area.

9.5.2 Mineral extraction

A review of The Coal Authority Interactive Map Viewer has confirmed that the study area is not at risk from underground coal mine workings.

The GroundSure GeoInsight reports (2015 and 2016) indicate that non-coal mining (chalk) may have been undertaken within the study area, however this is not the case as the chalk is at considerable depth. The historical mapping identifies the area northwest of Welwick Marsh adjacent to Soak Dike as being likely to have been affected by sand and gravel extraction. This area is shown on present day mapping as Haverfield Quarry.

9.5.3 Hydrogeology

A review of the Environment Agency website indicates that bedrock of the Flamborough Chalk Formation which underlies the study area, is designated a “Principal” aquifer. A Principal aquifer refers to “layers of rock that have high inter-granular and/or fracture permeability – meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale”.

The Tidal Flat and Glacial Deposits beneath the site are designated as unproductive strata. The Beach and Tidal Flat Deposits that underlie the Humber Estuary and Welwick Saltmarsh are classified as Undifferentiated Secondary Aquifer, indicating “variable characteristics in permeability within the strata; however, the movement and storage within the strata is typically restricted to the local scale”.

The Storm Beach Deposits, located in West 2 and East 1, are designated as a Secondary A Aquifer, indicating “permeable layers capable of supporting water supplies at local rather than strategic scale, and in some cases forming an important source of base flow to rivers”.

The study area is not shown to be located within a source protection zone.

With reference to the Groundsure EnviroInsight reports, the soils within the study area have been assigned a soil vulnerability category of H1. This classification refers to “soils which readily transmit liquid discharges because they are shallow of susceptible to rapid flow directly to rock, gravel or groundwater”. The report does not specify to which superficial deposits this classification applies.

Groundwater strikes were recorded during the 2016 ground investigation within the intrusive locations, and levels were monitored after the fieldwork was completed. The groundwater was encountered within the granular layers in the Tidal Flat Deposits, Estuarine Sand Deposits, Storm Beach Deposits and Glacial Till, and levels generally ranged between 0.1m and 2.29m bgl.

A number of installations were placed within areas of proposed ground lowering and potential borrow pit locations, recorded groundwater levels typically between 0.9m and 2.0m bgl. Some of the installations recorded significant variability in levels, for example 0.51m bgl to 1.58m bgl, which is considered likely to be due to tidal influence at the locations, however no direct correlation was established.

9.5.4 Ground Hazards

Generally, the materials were classified as very aggressive across the Scheme, and is predominantly due to the plasticity and organic matter content, particularly close to the existing flood banks. This was identified during the 2016 ground investigation when samples of each of the deposits encountered underwent laboratory testing for sulphate aggressivity as per BRE Special Digest 2007.

The GroundSure Geoinsight reports identify that areas within both schemes are at moderate risk from compressible ground and running sand, associated with the beach & tidal flat deposits. These deposits have been identified by BGS mapping to underlie West 1 and West 2, and a large proportion of East 1, 2 and 3. They may therefore pose a constraint to works undertaken with these sites.

9.5.5 Environmental Designations and Records

The Humber Estuary is designated a Site of Special Scientific Interest (SSSI) and includes SSSI units covering Haverfield Quarry and Welwick Bushes, which are within the study area. The Humber Estuary also has the higher-level designations of a Special Area of Conservation (SAC), a Special Protection Area (SPA) and a Ramsar site. A Nitrate Vulnerable Zone (NVZ) also applies to the northern part of West 1 and all of West 2.

These designations are for biodiversity primarily, with the exception of the NVZ, and are discussed further in Chapter 10, Terrestrial Biodiversity.

The Humber estuary SSSI also protects the geomorphology of Spurn Point, located approximately 6.5km downstream of the Scheme.

9.5.5.1 Environment Agency Records

One of the discharge consents identified within the Groundsure Envirosight report is located 1.2km west of West 2, east of Patrington Haven, and relates to storm water overflow into what appears to be Pant Drain. This flows west-east through the study area, flowing past the Haverfield Quarry. Although the Pant Drain flows through the study area, given the distance of the source, it is likely that should any contamination exist, that it will have been dispersed before reaching the study area.

One Part A (1) IPPC authorised activities or List 1 or List 2 Dangerous Substance Inventory entry is located some 900m northwest of West 1. This relates to Newlands Farm for the process of intensive farming; >2,000 pigs and was effective from September 2009. There are no records of Part A(2) and Part B activities and

enforcements within 500m of the study area. There are no records of Control of Major Accident Hazards (COMAH) or Notification of Installations Handling Hazardous Substances (NIHHS) sites within 500m of the study area.

There are six recorded industrial land uses within the boundary of the study area. Two relate to livestock farming and tanks (generic) at Humber Farm, located on Row Lane to the north of West 2. Two are located along the southern boundary at Patrington Channel and correspond to the pumping station and associated substation. A second pumping station is located within the south-eastern corner of the study area at Skeffling Clough, at the southern end of Humber Lane. The final industrial land use is located at Elder Lodge on Row Lane, north of East 1 and relates to agricultural contractors.

9.5.6 Contaminative Sources

9.5.6.1 Landfill

A review of the Environment Agency website, supplemented by the Groundsure EnviroInsight reports indicates that a historical landfill (Welwick Riverbank) is located within the study area, and is located some 300m south of Row Lane and adjacent to the northern side of the existing flood embankment. The landfill site is located within East 1, behind the existing sea defences and is recorded as receiving waste between 1st January 1959 and 31st December 1978. The Environment Agency records show that the site accepted inert and industrial waste, excluding waste from mines, quarries and agricultural wastes. The licence for this waste site was issued on 22nd June 1977 and surrendered on 27th July 1978, despite the site first being recorded in January 1959.

The 2016 ground investigation included a number of locations within this landfill, and five exploratory locations were drilled through the landfill. The Made Ground encountered typically between 0.7m bgl and 0.9m bgl, with one location recording Made Ground to 2.0m bgl. The Made Ground was recorded as *"gravelly, sandy silt, with gravel of flint, ash, concrete, clinker, limestone, glass, chalk and limestone*", with one location recording "*occasional decomposed organic fragments, ash and aluminium fragments".* Three of the locations also recorded a strong hydrocarbon odour during drilling, and cloth and paper were also noted within the borehole logs. Chemical testing was completed on samples collected from these locations, the results of which are discussed in section 9.4.7.

9.5.6.2 Historical Development

Table 9.2 below summarises the historical development of the study area, sourced from the GroundSure Envirosight report obtained for the Preliminary Sources Study Report (CH2M, 2016)

Table 9.2: Summary of Historical Development of the Study Area

Date	Key developments
1854 - 1891	Welwick to Skeffling Managed Realignment East 1, 2 and 3 – typically open agricultural land Outstrays Managed Realignment West 1 – indicated as 'Saltings' (an area of coastal land that is regularly covered by the tide). The saltings extend SE from 'East Clough' sluice to

	the River Humber. The Patrington Channel borders the saltings to the north, which is bound by levees itself. A N-S orientated flood embankment is shown some 900m SE of New Clough sluice, and separates the open land from the saltings to the east. The flood defence follows the N-W boundary of West 1. Winestead Drain is shown in its current alignment. Several ponds are identified across the study area, and correspond with areas of potential historical workings identified in the GroundSure report. Three ponds are recorded along the southern boundary of East 2 and 3, and pre-date the mapping, and therefore may be associated with the construction of the flood defences in the area. West 2 – typically open agricultural land.
1888, 1890 and 1891	Welwick to Skeffling Managed Realignment Embankment extending eastwards from Welwick Bank, along Weeton Bank and Burstall Bank, to Skeffling Clough. This represents the existing flood bank along the southern boundaries of East 1, 2 and 3. The embankment continues to the east beyond the study area. A sluice is shown at Skeffling Clough (currently Skeffling pumping station).
1907 – 1908 and 1909	Outstrays Managed Realignment The south-eastern boundary of West 2 shows an embankment extending northwards from Patrington Channel to Welwick Bank, west of Welwick Saltmarsh.
1907 – 1908	Welwick to Skeffling Managed Realignment Shows Row Lane, Sheep Trod Lane, Humber Side Lane, Long Lane and Humber Lane to be present in their current-day alignments within the study area. Outstrays Managed Realignment Elder Lodge, Row Farm and Humber Farm, located along Row Lane north of West 2, are shown on the 1909 edition map. The map also shows the construction of an embankment on the site of the current ABP West bank. On the landward side of the embankments, the former saltings are now shown as open land, having been reclaimed from the marshland of the Humber Estuary. At the south-eastern end of the new embankment a new breakwater (and later groynes) is shown extending south-eastwards and into the estuary. The mudflats on the estuary side of the embankments are now recorded as saltings, and are shown to cover a greater area than previously recorded, extending southeast and into an area previously only mapped as mudflats in the Humber Estuary.
1910	Outstrays Managed Realignment Outstray Road, Newland Road (including Newlands Farm) and Stray Road are shown in their present-day alignments. The mapping also defines the channel of Pant Drain.
1948	Welwick to Skeffling Managed Realignment

	Two ponds are shown to the west of Welwick Drain on the 1948 edition map, on the north-eastern boundary of West 2, within what in the present-day is referred to as Haverfield Quarry. An unspecified pit is also shown within the northwest part of this site. Buildings, later collectively referred to as Outstray Farm are recorded within the northwest corner of West 1.
1952	Welwick to Skeffling Managed Realignment 1:10,560 scale map identifies a tramway within the area of Oxland Hill, immediately north of West 2. This is not identified on subsequent mapping suggesting that it was removed.
1970, 1971-1975	Outstrays Managed Realignment The flood defences along the southern to south-eastern boundaries of the study area appear to have been modified based on the mapping. Welwick Saltmarsh, located adjacent to West 2 appears to have increased in area, extending towards the southeast and resulted in the mean high-water mark regressing further into the Humber Estuary. The 1970 edition mapping also shows the Soak Dyke running along the landward side of the flood embankment located along the southern boundary of the study area, southwest of Skeffling. Further drains have also been constructed within the fields to the north, draining towards the south into the Soak Dyke. West of the study area a floodgate is defined on Winestead Drain within the area of North Channel Clough. This area is generally defined as Saltmarsh on the 1972 edition maps. A small area of spoil is recorded on the 1971-75 edition map, at the southern extent of Humber Side Lane, adjacent to the flood embankment and within the western area of East 1. This is the location of Welwick Riverbank landfill site as shown on the EA records. The area of spoil is not shown on the subsequent mapping. Welwick to Skeffling Managed Realignment The pit located along the northern boundary of West 2, is recorded to be partially disused, with the eastern half labelled as a *"gravel pit"*. From the 1975 the pit as a whole is shown as disused, and remains on subsequent historical mapping up to and including the 2002 edition.
1986, 1988	Welwick to Skeffling Managed Realignment The sluice at New Clough (adjacent to the north-western corner West 1) is no longer shown, the embankments and drainage ditches within this area having undergone minor changes. East Clough sluice still remains. Patrington pumping station, and its adjacent electricity substation are recorded within their present-day located east of the north-east corner of West 1 from 1988 onwards.
2002	Outstrays Managed Realignment A second pumping station is shown at the location of the sluice at Skeffling Clough, located at the eastern extent of the study area and within the southwest corner of East 3 on the 2002 edition map.

9.5.7 Geoenvironmental Assessment

As part of the 2016 ground investigation (see section 9.6.2), numerous samples of the deposits encountered underwent chemical analysis to assess potential contamination. The results were assessed against values for Public Open Space (not near residential) Suitable for Use Levels (S4ULs).

The results indicate that the majority of potential contaminants were below screening criteria for Public Open Space Suitable For Use Levels. The results indicate statistical outliers with respect to metals in a number of locations, located south of Humber Side Road at the northern boundary of East 2 and 3. Two samples obtained from this trial pit recorded an exceedance with respect to lead. Additional exceedances, with respect to metals, have been identified in samples obtained from the track at the southern limit of Row Lane in East 1 and in a borehole located on the farm track to the south of Outstray Farm in West 1.

The leachate results for the site have been reviewed and compared to screening criteria from the Water Framework Directive (2015) for a saline environment. Exceedances were noted in Chromium, copper, lead and zinc, spread throughout the site, predominantly within the former tidal flat deposits. This includes the existing banks which are formed from desiccated alluvium and the desiccated alluvium across the sites. The unusually high levels of chromium, copper, lead and zinc are found right across the site, throughout the full depth of the sampling and also within the existing defences, in areas which have not been accessible for disturbance or deposition since before the industrial revolution. Due to the consistent concentrations and wide spread of these metals and lack of contaminative land uses on the site, it is considered likely, that the metals within the sediments are naturally occurring and not of significance in the context of the wider area.

9.5.7.1 Landfill Results

During the 2016 ground investigation ten samples of Made Ground recovered from the landfill, and four from the underlying natural superficial deposits were tested for a general suite of contaminants. Asbestos was identified within three samples between 0.7 and 0.7m bgl, recording both amosite and chrysotile loose fibre bundles.

The chemical results recorded significant levels of heavy petroleum hydrocarbons, as well as the presence of lead, chromium, copper and nickel, and PAHs (polycyclic aromatic hydrocarbons). The heavy metals were recorded to exceed the screening levels in one location drilled, and the hydrocarbon exceedances were recorded in three locations. No exceedances were reported within the natural superficial deposits underlying the landfill location.

Leachate results were also assessed and indicated significant levels of heavy metals, reporting exceedances of cadmium, lead, copper and zinc.

Groundwater and surface water samples were also collected for chemical analysis. The surface water results for samples recovered from the ditch adjacent to the landfill indicate significant levels of heavy metals, with exceedances of Copper, Lead and Zinc recorded. Groundwater samples that underwent analysis reported exceedances of boron, zinc, copper, nickel and selenium. Elevated levels of TPH (Total Petroleum Hydrocarbons) and PAHs were also reported, with an exceedance of fluoranthene.

9.5.7.2 Potential Sources of Contamination

The potential sources of contamination identified through the historical mapping from the Groundsure report and ground investigation undertaken in 2016 are:

- Made Ground
- Existing Flood Banks
- Historical Landfill (Welwick to Skeffling scheme only)

9.5.7.3 Potential Receptors

The potential receptors and their classification of sensitivity are listed below:

- The Humber Estuary (SAC, SPA, Ramsar, SSSI etc.) Sensitivity of **Very High**
- Surface water – drainage ditches which drain to the existing pumping station, then to the Humber Estuary. Sensitivity of **Medium**
- Groundwater – within the Tidal Flats and Estuarine Deposits which may be connected with the Humber Estuary. Groundwater within Glacial Till and Glaciofluvial deposits, however it is considered that there is a limited pathways to this potential receptor. Sensitivity of **Medium**
- Future site users – footpath users. Sensitivity of **High**
- Construction workers. Sensitivity of **High**

9.5.7.4 Potential Pathways

The following four pathways are identified as routes of contamination to reach site users:

- Ingestion, inhalation and dermal contact – construction workers, unlikely as they will be using personal protective equipment
- Ingestion, inhalation and dermal contact by recreational site users – likely, sitting on the grass, picnics, and children playing
- Inhalation of vapours – outdoor air only
- Inhalation of fibres from any asbestos containing materials – site users and construction workers

The following four pathways are identified as routes of contamination to reach the environmental receptors:

- Site run-off
- Mobilisation of leachate – infiltration of rainwater
- Vertical and lateral migration of groundwater
- Shall lateral migration of groundwater

9.6 Future Baseline

Without the Scheme, the existing contamination present within the area would continue to pose risk to the receptors identified, including general public, groundwater and surface water and the Humber Estuary. Any future flooding of the area may increase the mobilisation of these contaminants, in particular the historical landfill, resulting in the risk increasing over time, which could pose a risk to future users of the site, and

potentially impact on the Humber Estuary SSSI through the contamination spreading into the SSSI.

In the future, climate change may cause more frequent flooding of the landfill, and in the case of rising sea levels, the groundwater level will raise, potentially further mobilising contaminants present and affecting the water quality of the existing ditch.

9.7 Likely significant effects

9.7.1 Outstrays Managed Realignment

9.7.1.1 Construction

During the construction process, or prior to that within any further investigation undertaken, contamination within the ground may be identified where it previously had not. Any unknown contamination identified may pose a risk of harm to human health, groundwater, surface water or the Humber Estuary. Any effects caused by identifying any unknown contamination will likely have a short duration, as this would be dealt with within the construction phase.

The Outstrays Managed Realignment also includes improvements to the flood banks surrounding the Winestead-Outstrays pumping station, linking them to the proposed new embankment through West 2, and tying into sheet piling and associated works at Welwick Bushes. The magnitude of impact of these works on geology, superficial geology and hydrogeology is anticipated to be negligible, leading to **no effect**.

9.7.1.2 Operation

The scheme is not anticipated to have any significant effects on the geology, superficial geology and hydrogeology during the operation phase.

Inundation of the scheme from the breach in the existing embankments by tidal waters will result in a change to saline conditions and probable accretion of sediment. This conversion of the land to intertidal habitats will have a permanent impact on the shallow superficial geology of the site and will result in the loss of high quality agricultural land. The impacts on land use associated with the changes at the site are evaluated in Chapter 5 Socio-economics and land use.

9.7.2 Welwick to Skeffling Managed Realignment

9.7.2.1 Construction

During the construction process, or prior to that within any further investigation undertaken, contamination within the ground may be identified where it previously had not. Any unknown contamination identified may pose a risk of harm to human health, groundwater, surface water or the Humber Estuary. Any effects caused by identifying any unknown contamination will likely have a short duration, as this would be dealt with within the construction phase.

The Welwick to Skeffling Managed Realignment will cause a loss in access to the Glacial Till, a resource often used for construction. There is currently an accessible

area of the till within the eastern site, within a hill. After the breach of the existing bank, this hill will become an island and no longer accessible for acquiring the material. This is considered to have a moderate negative magnitude of impact on the Glacial Till as a resource, resulting in a **Minor Adverse – Moderate Adverse permanent effect**.

9.7.2.2 Operation

The existing landfill area within the eastern site is currently having a negative effect on the local surface water and groundwater. The primary way to reduce or remove the risk of mobilisation of contaminants is to reduce the risk of infiltration and surface run-off. It is therefore proposed to remediate the former landfill by installing a significant clean cover system, raising the ground sufficiently that it cannot be overtopped, even during flood events. It is proposed to raise the ground above the former landfill. Land raising should be done using geotechnically suitable, clean, site won fill. The sides of this former landfill should be protected from erosion. This work is included within the design for the site, so has been taken into account when assessing likely significant effects.

The remediation of the landfill area will result in a moderate positive magnitude of impact, which will result in a **Minor Beneficial – Moderate Beneficial permanent effect** on the study area throughout the operation phase due to the remediation of the landfill. By the use of the clean cover preventing infiltration of water into the landfill and preventing the interaction with surface water, both the surface water and groundwater quality will improve over time. The risk to human health will also be reduced due to the clean cover layer severing the pathway between humans and the contaminants.

9.8 Mitigation

An Emergency Pollution Response Plan will be produced as part of the CEMP which will provide a full list of management activities and communication channels with the Environment Agency in the event of an accidental pollution incident. Appropriate equipment spill kits and absorption mats will also be made available, by the Principal Contractor, and easily accessible around site for use is the event of an accidental spillage or pollution incident. Plant nappies and/or drip trays will be used when refuelling plant and equipment in order to provide spill containment whilst also catching drips. Furthermore, biodegradable oils and grease should be used to further reduce risks on site.

9.8.1 Outstrays Managed Realignment

The new flood banks will be constructed from site-won Tidal Flat Deposits, rather than imported material, which must be kept covered during storage and construction to avoid drying of the material as a consequence of long periods of exposure. Following placement, the new embankments should be covered with a thick topsoil (a minimum of 0.3m) and well vegetated with managed grass as per the existing flood defences.

The site-won Tidal Flat Deposits will be sourced from the construction of creeks and borrow pits within the site, the areas from which these will be located will become new habitat areas.

9.8.2 Welwick to Skeffling Managed Realignment

No mitigation is proposed for the Welwick to Skeffling Managed Realignment. Landfill remediation is included in the design.

The site-won Tidal Flat Deposits will be sourced from the construction of creeks and borrow pits within the site, the areas from which these will be located will become new habitat areas.

9.9 Residual effects

9.9.1 Outstrays Managed Realignment

Through the breach of the existing banks, loss of agricultural land will occur, and loss of high quality agricultural land. This is discussed Chapter 5 – Socio-economics and land use.

9.9.2 Welwick to Skeffling Managed Realignment

As discussed above, with the construction of the capping layer, and associated mitigation works involving the landfill, the Welwick to Skeffling Managed Realignment will have a **permanent Minor beneficial - moderate beneficial effect** on the study area.

As discussed above, the site will cause a loss in access to the Glacial Till, a resource often used for construction. There will be **a Minor Adverse - Moderate Adverse permanent** residual effect on the Glacial Till as a resource.

10 Terrestrial Biodiversity

10.1 Introduction

This chapter describes the Ecological Impact Assessment (EcIA) on terrestrial and freshwater habitats and species of the proposed Outstrays Managed Realignment (the western site) and Welwick to Skeffling Managed Realignment (the eastern site), as described in Chapter 3.

A separate EcIA chapter has been produced for marine habitats and species (including the estuary's nature conservation interests), from the toe of the embankment on the estuarine side of the existing flood defences in Chapter 11 (Marine Biodiversity).

The flora and fauna in areas landward of the existing flood defences are described below and valued in the context of nature conservation legislation and relevant planning policy. The important ecological features have been identified and are subject to detailed impact assessment to describe all potentially significant ecological effects associated with the proposed development. Much of the ecological mitigation is inherent in the design of the managed realignment(s) and therefore the potential impacts of the development are assessed for this mitigated design. Further mitigation is then described to ensure compliance of the Proposed Scheme with nature conservation legislation and biodiversity policy and any enhancements are proposed. The Scheme is also assessed for cumulative impacts with other plans and projects in Chapter 17. Finally, the residual impacts and their significance are assessed, and a monitoring programme proposed to assess the success of the mitigation.

The assessment of effect upon terrestrial/freshwater biodiversity has also been informed by the conclusions from Chapter 8 (Water Environment) and Chapter 16 (Noise and Vibration).

The EcIA considers all stages of the development, namely enabling works, construction and operation. This chapter is accompanied by technical reports detailing the baseline surveys in Appendix 10.1.

10.1.1 Planning policy and legislation

In the UK, certain habitats and species are afforded legal protection to varying degrees through national and European legislation. In addition to legislation, advice pertaining to wildlife is given in various planning policy documents and guidance. Relevant legislation, national and local planning policies are presented in the relevant technical reports in Appendix 10.1.

Legislation and biodiversity plans and policies of relevance to this chapter are listed below:

- Wildlife and Countryside Act (WCA) 1981 (as amended);
- Protection of Badgers Act 1992;
- Countryside and Rights of Way Act 2000;
- Natural Environment and Rural Communities Act 2006;
- Conservation of Habitats and Species Regulations 2010 (as amended);

- The Hedgerow Regulations 1997;
- Local BAP: East Riding of Yorkshire Biodiversity Action Plan;
- UK Post-2010 Biodiversity Framework (JNCC and DEFRA, 2012) which has succeeded the UK BAP by the creation of country level strategies. In England, this is termed Biodiversity 2020: a strategy for England's wildlife and ecosystem services (Defra, 2011);
- Revised National Planning Policy Framework (2018).

10.2 Methodology

The EcIA follows guidelines for ecological impact assessment in the UK and Ireland (terrestrial, freshwater and coastal) published by the Chartered Institute of Ecology and Environmental Management (CIEEM, 2018). The following section identifies methods employed as part of the ecological scoping and assessment process to identify and assess all potential ecological receptors with respect to the Scheme.

10.2.1 Study Area

The shape of the proposed site is complicated and has been evolving, as it changes to avoid constraints identified by surveys, takes advantage of opportunities through design and incorporates areas for mitigation and compensation. As such, the site assessed comprises the 'red line boundaries' displayed in Appendix 1.1, which will henceforth be referred to as the 'Western Site' or 'Eastern Site' herein.

The Scheme 'Footprint' is defined as the embankments, managed realignment areas, drainage, access tracks, working areas and all associated infrastructure (temporary and permanent) necessary for construction.

Areas surveyed to inform the EcIA depend on the zone (s) of influence (ZoI) of the different ecological features, as described below, and are not constrained by the Site boundary or the Scheme Footprint. Therefore, the 'Study Area' is defined as the land within the Scheme Footprint and the maximum extents of the ecological surveys and/or data search in and around it.

10.2.2 Establishing zone(s) of influence

Desk study and ecological surveys have been targeted to the specific ZoI for each ecological feature scoped into the assessment. The ZoI for a Scheme is the area over which ecological features may be subject to significant effects as a result of the proposed Scheme and associated activities (CIEEM, 2018).

Ecological features occurring within the Scheme footprint will be affected by changes in land cover, caused by the construction of new flood embankments and their associated features (e.g. new access track, drains and parking) and inundation of land with tidal water following the removal of the existing embankment. All land within the managed realignment will effectively be lost and then convert to either saltmarsh or mudflat habitats.

The ZoI varies for different ecological features depending on their sensitivity to an environmental change. Often there are seasonal variations in distribution, abundance

and activity of species. For example, some species may stay dormant over winter then make regular movements within and across the site between spring and autumn.

For many ecological features, the ZoI extends beyond the Proposed Scheme, for example where there are ecological or hydrological links beyond the site boundaries. The removal of drains within the managed realignment and construction of new drains along the dry side of the embankment will have impacts on the hydrology and connectivity of wider drain network. In this instance, there could be effects on ecological features associated with the drainage network.

The wider landscape has relatively poor ecological links, being dominated by open arable farmland with narrow field boundaries, intensively managed drains and general absence of hedgerows. Ecological connectivity to the wider terrestrial landscape is constrained to the embankments, Haverfield Quarry and the main agricultural drains.

Survey effort was therefore focused along the band of semi-natural habitat at Haverfield Quarry and along the embankments, as these represent an important “core habitat” for many ecological receptors across the Sites. This approach meets the requirements for proportionate impact assessment (CIEEM, 2018) and takes account of reasonable uncertainty for areas where it is concluded that professional judgement indicates no significance to the overall assessment findings. Professional judgement requires a trained and appropriately experienced individual to apply their skills and knowledge to reach an informed decision, as per British Standard 42020:2013, Biodiversity - Code of practice for planning and development. The desk study and field survey methodologies, below, detail the Study Areas applied, based on the ZoI approach.

10.2.3 Preliminary Ecological Appraisal - desk study

Species information and details of statutory and non-statutory designated sites were gathered from North and East Yorkshire Ecological Data Centre (NEYEDC) with supplementary species information obtained from East Yorkshire Bat Group (EYBG) and East Yorkshire Badger Protection Group (EYBPG). An initial request to NEYEDC was made in 2015 to inform the Preliminary Ecological Appraisal for the Welwick to Skeffling Managed Realignment scheme. An updated request to NEYEDC was carried out in 2016 to include the Outstrays Managed Realignment scheme.

Further sources of information included East Riding of Yorkshire Biodiversity Action Plan (October 2010), Multi Agency Geographic Information for the Countryside (MAGIC) and Botanical Society of Britain & Ireland – South East Yorkshire, Vice County 61.

The Desk Study search areas included: -

- European designated sites located within 10km and up to 30km (Special Areas of Conservation (SACs) with bats as qualifying features and sites with possible hydrological connectivity to the Proposed Scheme) from the Proposed Scheme, Sites of Special Scientific Interest (SSSIs) and other UK statutory sites within 2km of the Proposed Scheme and non-statutory designated sites within 1km of the Proposed Scheme (refer to Appendix 1.1);
- Records of protected and notable species within 2km of the Proposed Scheme were sought from NEYEDC and EYBPG and were extended to 5km from the centre of East 2 for records from EYBG.

10.2.3.1 Consultations

As described in Chapter 2, a thorough stakeholder and public engagement process has been on-going since 2015. This process included a number of internal consultation exercises within the Environment Agency, discussions with relative statutory authorities and public stakeholder consultations.

A stakeholder site visit was undertaken in August 2017 to help develop the management proposals for Haverfield Quarry and the outline design for the habitat creation areas in West 2 and the wider site. Key consultees in terms of the habitat creation and mitigation areas, who have attended site or responded via email, have included representatives Yorkshire Wildlife Trust, Spurn Bird Observatory, Natural England (NE), South Holderness Countryside Society and the BSBI vice-county recorder.

Badger sett locations were largely informed by members of the public, who were a key source of information and informed field ecologists throughout the timescale of the Scheme.

Freshwater fish data has been provided by the Environment Agencies Fisheries Team, who monitor Winestead Drain annually.

10.2.4 Field survey

A series of ecological assessments have been carried out to establish a thorough and comprehensive baseline. These are summarised in Table 10.1 below and are provided in detail in Appendix 10.1.

Table 10.1: Ecological reports to support the assessment

Survey Type	Survey Guidance	Date	Study Area	Objectives
Preliminary ecological appraisal (PEA)	Guidelines for Preliminary Ecological Appraisal (CIEEM, 2013)	CH2M, March 2015	Welwick to Skeffling Managed Realignment scheme	Gain an overview of the habitats present on the site, identify any potential ecological constraints and ascertain the need and extent of further surveys
Preliminary ecological appraisal (PEA)	Guidelines for Preliminary Ecological Appraisal (CIEEM, 2013)	CH2M, April 2016	Outstrays Managed Realignment scheme	Same objectives were applied.
National Vegetation Classification (NVC) Survey	National Vegetation Classification: User's Handbook	CH2M, July 2015	Welwick to Skeffling embankment and Haverfield Quarry SAC and SSSI.	Classify potentially important/priority terrestrial habitats.

Survey Type	Survey Guidance	Date	Study Area	Objectives
	(Rodwell, 2006)			
National Vegetation Classification (NVC) Survey	National Vegetation Classification: User's Handbook (Rodwell, 2006)	CH2M, July 2016	Outstrays embankment and Haverfield Quarry LWS	Same objectives were applied
Reptile Survey	Reptile Mitigation Guidelines (Natural England, 2011)	CH2M, 2015	Welwick to Skeffling Managed Realignment scheme, including Haverfield Quarry SAC/SSSI	Presence / absence survey to establish the extent of reptile populations.
Reptile Survey	Reptile Mitigation Guidelines (Natural England, 2011)	CH2M, 2016	Welwick to Skeffling embankment and Outstrays embankment	Population size class assessment
Reptile Survey	Reptile Mitigation Guidelines (Natural England, 2011)	CH2M, 2017	Haverfield Quarry LWS and Outstray Scraps	Population size class assessment. These combined surveys informed the reptile mitigation strategy.
Water Vole and Otter Survey	Water Vole Conservation Handbook (Strachan & Moorhouse, 2011)	CH2M, April 2015	All drains within 1km of the Welwick to Skeffling Managed Realignment scheme.	Presence / absence survey to establish the extent of water vole and otter populations.
Water Vole and Otter Survey	Water Vole Mitigation Handbook (Dean *et al*, 2016)	CH2M, June and September 2016	All drains within 1km of the Proposed Scheme.	Same objectives were applied
Water Vole and Otter Survey	Water Vole Mitigation Handbook	CH2M, June and August 2017	All drains within 1km of the Outstrays Managed	Same objectives were applied. These combined surveys informed

Survey Type	Survey Guidance	Date	Study Area	Objectives
	(Dean *et al*, 2016)		Realignment scheme.	the water vole mitigation strategy
Great Crested Newt (GCN) Survey	Great Crested Newt Mitigation Guidelines (English Nature, 2001)	CH2M, April to June 2015	All ponds (where access was permitted) and suitable ditches within 500m of the Welwick to Skeffling Managed Realignment scheme.	Presence / absence survey to establish the extent of GCN populations. Population size class assessment where the presence of GCN was confirmed.
Great Crested Newt (GCN) Survey	Great Crested Newt Mitigation Guidelines (English Nature, 2001)	CH2M, April to June 2016	All ponds and suitable ditches within 500m of the Outstrays Managed Realignment scheme and ponds not captured by the 2015 surveys.	Presence / absence survey to establish the extent of GCN populations. Population size class assessment where the presence of GCN was confirmed.
Bat Activity Survey	Bat Surveys for Professional Ecologists: Good Practice Guidelines (Bat Conservation Trust, 2012)	CH2M, Spring, Summer and Autumn 2015	East 1 and East 3	To assess bat activity levels and patterns and identify any areas of value.
Bat Activity Survey	Bat Surveys for Professional Ecologists: Good Practice Guidelines (Bat Conservation Trust, 2016)	CH2M, Spring, Summer and Autumn 2016	West 1	Same objectives were applied
Badger Survey	Surveying badgers (Harris *et al*, 1989)	CH2M, April 2015	Welwick to Skeffling Managed Realignment scheme, including the	Presence / absence survey to establish the extent of badger populations.

Survey Type	Survey Guidance	Date	Study Area	Objectives
			southern half of Haverfield Quarry.	
Badger Survey	Surveying badgers (Harris *et al*, 1989)	CH2M, April to June 2016	All potential badger habitat within the Proposed Scheme, including the northern half of Haverfield Quarry.	Same objectives were applied
Entomology Survey	Various survey guidelines applied for survey methods and specialist groups.	Grayson, 2015	All semi natural habitats within the Welwick to Skeffling Managed Realignment scheme, including the southern half of Haverfield Quarry and Welwick Saltmarsh.	Identify scarce and threatened species in Natural England's Humber Estuary SSSI citation, plus identify features or habitats which are essential, or potentially essential, to their ecological requirements.
Entomology Survey	Various survey guidelines applied for survey methods and specialist groups.	Grayson, 2016	All semi natural habitats within the Proposed Scheme. Ponds with suitable habitat within 500m of the Proposed Scheme were also surveyed.	Same objectives were applied. Included additional survey methods such as moth trapping and detailed inspections for the crucifix ground beetle *Panagaeus cruxmajor.*

Additional surveys were carried out by the Institute of Estuarine and Coastal Studies (IECS) from 2012-2017 to provide data to inform the Habitats Regulations Assessment

and to update the protected species surveys (see chapter 11). Assessment for the intertidal habitats, and breeding and overwintering coastal birds (qualifying features of Humber Estuary SAC, SPA and Ramsar) and benthic invertebrate surveys are provided in the Marine Ecology Chapter 11 and are not repeated here. This chapter includes an assessment of breeding birds which are not qualifying features of the Humber Estuary SPA and Ramsar.

10.2.4.1 Survey Limitations

The limitations and constraints associated with the survey methods used are all detailed in the relevant survey reports and highlighted where relevant in this chapter. In summary, the main limitations were access in and around the ponds at Haverfield Quarry.

Due to the dense, deep layer of scrub which surrounds the banks and a reedbed around the edges of the ponds, access to open water was very limited and only short sections of bankside could be accessed. Subsequently only a spot check assessment could be carried out for any survey method. Scrub and reed clearance was not carried out (Unit 151 of the Humber Estuary SSSI), due to the presence of sensitive ecological receptors including breeding marsh harrier and otter.

A deviation from the standard survey protocol was required for amphibian and riparian mammal surveys. In both instances, a presence/absence survey was completed but it was not feasible due to access restrictions to carry out detailed inspections and/or population size class assessments. Great crested newt and otter population size predictions, have been made based on habitat suitability and availability.

10.2.4.2 Uncertainties and Assumptions

Where there are uncertainties in terms of the effects of the scheme and/or success of the mitigation a degree of confidence (see 10.2.5.3 – Assessment of Effect) has been set.

In some instances, the effects of the scheme are difficult to quantify as individuals of each species, will have different levels of tolerance and react differently to noise and visual disturbances. Detailed soil tests in the habitat creation areas will be carried out as part of the detailed design. It is assumed these areas can support the target habitat or remediation works are possible. Literature, local knowledge and lessons learnt from similar schemes have been used to inform the predictions.

Where design assumptions have been made these are stated in the assessment. The main assumptions are based on the eastern scheme drainage design. As a result, it is not possible at this stage to confirm the water levels in the drain (and its suitability for water vole) and whether a hedgerow can be planted along the full length of the embankment adjacent to the drainage channel.

A management plan for the habitat creation and mitigation areas has yet to be produced. It is assumed that the site manager in accordance with the EA and Natural England, will avoid or mitigate any operational impacts from habitat management activities.

10.2.5 Impact assessment

This assessment has been undertaken according to published Guidelines (CIEEM, 2018). The significance of likely effects was determined through a four-stage process:

- Identification of the ecological features likely to be affected, and determination of their importance, including their role in functioning of ecosystem services and natural capital;
- Identification of impacts potentially affecting important ecological features and characterising magnitude and nature of ecological impacts and cumulative impacts;
- Formulation of appropriate mitigation to avoid, reduce or compensate for predicted effects; and;
- Assessment of the significance of residual effects following mitigation.

10.2.5.1 Terminology

The term 'ecological feature' is used throughout the EcIA process to cover habitats, species and ecosystems that may be affected by the Scheme. The term 'impact' is defined as '*actions resulting in changes to an ecological feature, which can be positive, neutral or negative*'. The term 'effect' is defined as '*the outcome to an ecological feature from an impact*'.

10.2.5.2 Determination of Importance of Ecological Features

Determining 'importance' of ecological features relies on professional judgement and includes consideration of factors such as size, conservation status and quality, as well as the policy and legal significance. 'Importance' is measured against published selection criteria (where available) and with reference to published lists (e.g. the UK Post-2010 Biodiversity Framework). 'Importance' should take into account potential for future restoration of habitats, species populations or ecosystems, which are currently in unfavourable or sub-optimal condition. It should also take into account the importance of the feature to other important features (e.g. a low quality habitat that will allow migration of an adjacent high quality habitat as a consequence of climate change, stepping stone habitats for migratory species or species dispersal).

It should be noted that some species are subject to legal protection with temporal variation (e.g. birds have special protection during the breeding season), or legal protection that does not relate to conservation status (e.g. badgers which are subject to protection primarily on animal welfare grounds). Where protected species are present and there is potential for an offence to be caused, those features should be considered as 'important' features. Legally controlled species such as those listed on Schedule 9 of the Wildlife and Countryside Act 1981 (as amended), are also considered 'important', to ensure activates associated with the Scheme do no cause an offence.

To achieve no net loss of biodiversity and maintenance of healthy ecosystems it is essential to consider impacts at all scales. CIEEM guidelines (2018) recommend the importance of each ecological feature be described in terms of its 'geographic frame of reference'. The following definitions have been used to categorise the value of an ecological feature, in the context of its geographical frame of reference, that may be affected by the Scheme (Table 10.2):

Table 10.2: Definitions of values that can be given to ecological receptors, in terms of their geographical frame of reference

Value/ Importance	Criteria
International (European)	Habitats: Internationally designated or proposed sites, (Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Ramsar) or an area which would meet the published selection criteria for designation. A viable area of habitat listed in Annex 1 of the Habitats Directive. Species: Any regularly occurring population of international important species, threatened or rare in the UK.
National (England)	Habitats: Nationally designated sites or proposed sites, (Sites of Special Scientific Interest (SSSIs), National Nature Reserve (NNR), Marine Nature Reserve) or an area which would meet published selection criteria for national designation. A viable area of priority habitat identified in the UK BAP. Species: A regularly occurring, regionally or county significant population/number of an internationally/nationally important species. Any regularly occurring population of a nationally important species which is threatened or rare in the region or county (see local BAP). A feature identified as of critical importance in the UK BAP.
Regional (NCA 41 - Humber Estuary)	Habitats: Sites containing viable areas of threatened habitats that are significant at a regional scale or areas that are comfortably exceeding Local Wildlife Site (LWS) criteria, but are not meeting SSSI selection criteria. Species: Any regularly occurring, locally significant population of a species listed as being nationally scarce. A regularly occurring, locally significant population/number of a regionally important species. Sites maintaining populations of internationally/ nationally important species that are not threatened or rare in the region or county.
District (South Holderness)	Habitats: Sites containing viable areas of threatened habitats that are significant at a district scale or areas that meet Local Wildlife Site (LWS) criteria. Species: Any regularly occurring, locally significant population of a species listed as being regionally scarce. A regularly occurring, locally significant population/number of a district important species. Sites maintaining populations of regionally important species that are not threatened or rare in the district.
Local (immediate area)	Habitats: Areas of habitat that appreciably enrich the local habitat resource (e.g. species-rich hedgerows, ponds etc). Sites that retain other elements of semi-natural vegetation that due to their size, quality or the wide distribution within the local area are not considered for the above classifications. Species: Population/assemblages of species that appreciable enrich the biodiversity resource within the local context. Sites

Value/ Importance	Criteria
	supporting population of district important species that are not threatened or rare in the region or district, and are not integral to maintaining those populations.
Less than Local (Limited ecological importance)	Sites that retain habitats and/or species of limited ecological importance due to their size, species composition or other factors.

10.2.5.3 Assessment of Effects

For important features, a detailed assessment was undertaken to:

- identify and characterise impacts;
- incorporate measures to avoid, mitigate and compensate for impacts (in a hierarchical process).

Likely significant effects without mitigation are reported for good practice reasons as recommended by CIEEM (2018), to demonstrate the importance of implementing mitigation hierarchy (see 10.2.9 Mitigation Hierarchy).

Impacts likely to cause significant effects, are described with reference to the following, where relevant, to determine the significance of the impact:

- Direct, indirect, secondary and cumulative nature of impacts;
- Extent (spatial or geographical area over which the impact/effect may occur);
- Magnitude (size, amount, intensity and volume);
- Duration (short-term, medium-term, long-term, temporary or permanent);
- Timing (whether the activity coincide with critical life-stages or seasons);
- Frequency (the number of times an activity occurs);
- Reversibility (whether a recovery is possible or not within a reasonable timescale); and
- Positive or negative (a change that improves or reduces the quality of the environment).

The definition of 'Magnitude of Change' and 'temporary and permanent effects' used to characterise impacts are presented within tables 10.3 and 10.4.

Table 10.3: Definition of the scale of magnitude of change

Category for magnitude of change.	High	Medium	Low	Very Low
Extent	75% of area or receptor affected	25-75% of area or receptor affected	5-25% of area or receptor affected	>0 but <5% of area or receptor affected

Category for magnitude of change.	High	Medium	Low	Very Low
Integrity	Adverse affect on the integrity of site, in terms of coherence of ecological structure or function.	Significant impacts on the sites ecological objectives	Neither integrity affected nor significant impacts, but minor adverse effects	No observable impact

Table 10.4: Definition of 'temporary' and 'permanent' effects used for the impact assessment predictions

Nature of change	Duration	Definition/description
Temporary	Short term	Impact continues during construction (1 to 3 yrs) and up to 1 year following construction
	Medium term	Impact continues 1 to 5 years following construction
	Long term	Impact continues 5 to 10 years following construction
Permanent		Due to the subjectivity of human perception of timeframes, those impacts that continue for greater than 10 years following construction can be defined as permanent

The degree of confidence in impact assessment is based on the following scale:

- Certain: probability estimated at 95% chance or higher.
- Probable: probability estimated above 50% but below 95%.
- Possible: probability estimated above 5% but less than 50%.
- Unlikely: probability estimated at less than 5%.

A direct impact could be the loss of habitat due to land-take whereas an indirect impact could be loss and/or degradation of habitat due to hydrological changes. Both could result in the same overall effect i.e. a reduction in the total resource which may have a significant effect on the conservation status of the habitat at a defined geographic scale. Predicting impacts and effects also considered ecological structure and function of the important feature e.g. impacts on available resources, environmental and ecological processes and relationships, and human influences (e.g. management, disturbance).

All aspects of construction and operation of the proposal have been subject to an assessment of effects. The assessment is made in relation to the predicted baseline within the Zol at the time of the impact, with reference to other assessments (e.g. noise, air quality, hydrology, water quality etc.).

All ecological features at 'less than local importance' have been scoped out of the assessment. Full justification is provided for those impacts that are considered either

unlikely to occur or if they did occur, are not significant. Those features are scoped out and not assessed further in the EcIA.

The Site contains multiple designations and potential impacts on features within designations are considered with respect to legislation and policy for each designation.

10.2.5.4 Significance of Effects

A 'significant effect' is an effect that is sufficiently important to require assessment and reporting so that the decision-maker is adequately informed of the environmental consequences of permitting a Scheme.

A 'significant effect' can support or undermine biodiversity conservation objectives for 'important ecological features' or for biodiversity in general (CIEEM, 2018). Conservation objectives may be specific (e.g. for a designated site) or broad (e.g. national/local nature conservation policy) or more wide-ranging (enhancement of biodiversity). Effects can be considered significant at a wide range of scales from international to local.

The geographic scale of significance of an effect may not be the same as the geographic context in which the feature is considered important. For example, an effect on a species which is on a national list of species of principal importance for biodiversity may not have a significant effect on its national population. Mitigation or compensation should be consistent with the geographic scale at which the effect is significant.

The significance of the effects of the proposal were assessed before and after mitigation and enhancement. Any significant residual effects remaining after mitigation, compensation and enhancement are the factors to be considered against legislation and planning policy in determining the application.

10.2.5.5 Mitigation Hierarchy and Delivery

Avoidance, mitigation, compensation (including biodiversity offsets) and enhancement measures are applied in a sequential process (mitigation hierarchy). The evolution of the measures and associated monitoring proposed to minimise residual significant effects is provided for transparency. In order to account for any uncertainty associated with mitigation, design factors considered include among others: technical feasibility, size, quality, commitment and time-scale of the mitigation proposal. These measures will be carried forward within an Environmental Monitoring and Management Plan for the Scheme, incorporating requirements for monitoring.

10.3 Existing Environment

The following sections describe those features of ecological value that have been identified through the data collection processes outlined above.

For each feature of interest, the following factors have been considered:

- Current condition / status of the habitat or species on site, including the usage of the site;
- Factors upon which the conservation status or integrity of the feature depends; and

- Value of the feature, including the consideration of its significance on different geographical scales.

10.3.1 Nature conservation designations

The Humber Estuary is the only internationally designated site within 10km of the Proposed Scheme. The Estuary has various designations (international and national) including Special Area of Conservation (SAC), Special Protection Area (SPA), Ramsar site and Site of Special Scientific Interest (SSSI). Two non-statutory designated Local Wildlide Sites (LWS) are located within 1 km of the Proposed Scheme, Table 10.5 and Appendix 1.1.

Table 10.5: European designated sites located within 10km, UK statutory sites within 2km and non-statutory designated sites within 1km of the Proposed Scheme

Site	Protection	Proximity to Proposed Scheme	Importance
Humber Estuary	SAC, SPA and Ramsar	Within West 2 and East 1.	International
Humber Estuary	SSSI	Within West 2 and East 1.	National
Haverfield Quarries	LWS	Within West 2	Regional
Winestead Drain	Candidate LWS	Between West 1 and West 2	District

The statutory and non-statutory designated sites listed above are all located within the Proposed Scheme. Where the potentially impacts relate to the estuary side of the existing flood embankment, these are discussed in the Marine Biodiversity *Chapter 11*. Where the flood embankments and/or Haverfield Quarry and/or Welwick Bushes support qualifying features, these are discussed in this chapter.

10.3.1.1 Humber Estuary SAC

The Humber Estuary SAC incorporates the flood embankments within the Proposed Scheme extent and also incorporates Welwick Bushes, up to the western boundary of East 1 and eastern boundary of West 2 (Appendix 1.1). It is primarily designated for its estuarine/coastal habitats, lamprey and grey seals.

Although the site supports fixed dune grassland (SD8/SD9), these are not deemed a SAC qualifying feature (Annex 1 2130 Fixed dune with herbaceous vegetation). Natural England have confirmed that the sand dune feature would have to be part of an active sand dune system in order to qualify, and, in the case of the Humber these are on the open coast, mainly at Spurn and south of Cleethorpes. The flood embankments and Welwick Bushes do not support any of the SAC qualifying features.

10.3.1.2 Humber Estuary SPA

The Humber Estuary SPA incorporates the same area as the Humber Estuary SAC, as described above and in addition incorporates a band of dune grassland to the immediate west of Welwick Bank, together with two standing waterbodies within Haverfield Quarry (West 2) (Appendix 1.1). The SPA supports internationally significant wintering, passage and breeding bird populations.

The SPA is noted for its breeding populations of marsh harrier *Circus aeruginosus* - 10 females, breeding, representing an average of 6.3% of the GB population (5 year mean 1998-2002). Haverfield Quarry (West 2) supports up to three breeding pairs of marsh harrier in the summer, which is at levels of national importance. Marsh harrier is discussed in further detail in the species section, below.

10.3.1.3 Humber Estuary Ramsar Site

The Humber Estuary Ramsar site incorporates the same area as the Humber Estuary SPA, as described above (Appendix 1.1). It is designated due to the estuary habitats, bird and lamprey assemblages it supports, breeding colony of grey seals *Halichoerus grypus* at Donna Nook and natterjack toad *Bufo calamita* population at Saltfleetby-Theddlethorpe.

Marsh Harrier is included as noteworthy fauna for the same reason specified in the SPA qualifying features.

10.3.1.4 Humber Estuary SSSI

The Humber Estuary SSSI incorporates the same area as the Humber Estuary SPA and Ramsar, as described above (see Figures 11.1a and 11.b in Appendix 1.1). The SSSI is noted for its intertidal and subtidal habitats, breeding bird assemblage, winter and passage waterfowl, river and sea lamprey, grey seals, vascular plants and invertebrates. These are reportable features in the SSSI designation.

In addition to the site's characteristic intertidal and subtidal habitats, the SSSI citation describes three other characteristic habitats, which are recorded on the landward side of the embankments:

- Saline lagoons;
- Sand dunes, including examples fixed dune grassland; and
- Standing waters.

The proposed works fall within SSSI units 150 to 156.

SSSI unit 151 supports standing water, with two large gravel pit ponds. In the SSSI citation Haverfield Quarry (in particular unit 151) is noted for its breeding birds and value for roosting and feeding area for waterfowl.

The unit supports pockets of fixed dune grassland, but these are declining in condition and cover. Lack of management has also led to encroaching scrub and coarse grasses being dominant in the swards. There are records of regionally scarce early-forget-me-not *Myosotis ramosissima,* knotted clover *Trifolium striatum* and rue-leaved saxifrage *Saxifraga tridactylites* in this unit, which are notable plants in sandy well drained soils, often associated by coastal sites. These species may also be in decline or absence due to the decline in condition of the grassland.

The ponds are a characteristic habitat of the SSSI, they present extensive reedbeds along the margins and dense scrub surrounds the ponds. The reedbeds are known to

support breeding marsh harrier and surveys have confirmed the presence of otter, which are both discussed in further detail in the species section, below.

Haverfield Quarry SSSI unit 152 supports an extensive band of fixed dune grassland, namely *Festuca rubra – Galium verum* (SD8) and *Ammophila arenaria – Arrhenatherum elatius* (SD9), which again is a characteristic habitat of the SSSI. Regionally rare rough clover *Trifolium scabrum* has been recorded adjacent to the footpath in unit 152. There are also records of regionally scarce little mouse-ear *Cerastium semidecandrum*. Dune bedstraw *Gallium verum* subspecies *maritimum* is a notable component of the SD8 grassland. This unit is manged under High Level Stewardship (HLS), a grazing regime and weed control is in place to maintain the SSSI grassland features.

The nationally scarce spiral tasselweed *Ruppia cirrhosa* was recorded in 1999 (south-east Yorkshire – rare plant register) the drainage channel to the north west of Welwick Saltmarsh, also within unit 152. The vice-county recorder, surveyed this ditch in 2017 but no evidence of spiral tasselweed was recorded. This species is included within the Humber Estuary SSSI citation.

Welwick Bushes (SSSI unit 153) also supports fixed dune grassland, as described in unit 152 above. This unit is managed by the Yorkshire Wildlife Trust (YWT) and is subject to a grazing regime. There are records of regionally scarce grey field-speedwell *Veronica polita* and local rarities lesser chickweed *Stellaria pallida*, and the moss *Plagiomnium rostrate* have also been noted in this location. During the stakeholder site visit in August 2017, regionally rare round fruited rush *Juncus compressus* was noted in the northern section of the unit.

Welwick Bushes provides nesting habitat for the sea aster mining bee *Colletes halophilus.* Sea aster mining bee is discussed in further detail in the species section, below.

SSSI unit 150 Hawkins Point to Welwick includes the Outstrays embankment up to the eastern corner of Outstrays Scrapes. SSSI unit 154 Welwick Saltmarsh and unit 156 Weeton Bank to East Level Bank includes the Welwick to Skeffling embankment. These units are included for their saltmarsh habitat, which is a characteristic feature of the SSSI and is discussed in Chapter 11 Marine Biodiversity. The neutral grassland communities on these embankments are not characteristic features of the SSSI and are discussed in the habitats section of this chapter. An assessment of the Scheme's impacts on SSSI reportable features is included in Appendix 10.5.

Characteristic features of the Humber Estuary SSSI, including fixed dune grassland, standing water, notable vascular plant assemblages plus breeding marsh harrier and sea aster mining bee are noted within the Scheme Boundary. As a result of the habitats and faunal assemblages they support, Humber Estuary SSSI within the zone of influence is of **national importance**.

10.3.1.5 Non-Statutory Designations

Two non-statutory wildlife sites lie within 1km of the proposed scheme extent (Appendix 1.1):

- Haverfield Quarries Local Wildlife Site (LWS); and
- Winestead Drain candidate Local Wildlife Site (cLWS).

Haverfield Quarries LWS is located in West 2, adjacent to Humber Estuary SSSI unit 151. Haverfield Quarries LWS was managed as a nature reserve by the South

Holderness Countryside Society (SHCS) between 1990 and approximately 2001. They carried out scrub clearance, reedbed and grassland management. Since this period scrub encroachment has lost or degraded much of the fixed dune grassland. The site is dominated by dense scrub with small pockets of fixed dune grassland. Ground flora is often sparse or absent in the dense scrub and the grassland components are in decline due to scrub encroachment. Where fixed dune grassland areas are still present, notable plants have been recorded. Regionally rare corn parsley *Petroselinum segetum* and regionally scare knotted hedge-parsley *Torilis nodosa* were recorded in LWS. A local botanist has propagated these plants and as a result there locally abundant along the southern boundary of the LWS. There are also records of regionally rare small-flowered buttercup *Ranunculus parviflorus* in the same location.

Haverfield Quarries LWS provides a valuable wildlife refuge for birds, amphibians, reptiles, mammals and notable fixed sand dune flora. This area complements the value of other site systems associated with the Humber Estuary by facilitating species movements, colonisation and expansion. The site represents opportunities for ecological enhancement/restoration. The ecological functions the site provide means the site is of **regional importance**.

Winestead Drain cLWS is located between West 1 and West 2. It runs parallel with Haverfield Quarry, approximately 0.5km to the south. Winestead Drain cLWS is subject to intensive drainage management. The embankments are very steep, especially on the northern bank and numerous slips have been noted along the embankment. As a result, the banks are regularly re-profiled, with vegetation cleared from the banks and margins. The banks go through cycles of vegetation cover and are often sparsely vegetated or bare, the margins are dominated by a narrow but dense band of reeds. The high levels of disturbance limit the ecological value of the watercourse for many faunal species.

Agricultural run-off also occurs and a thick layer of algae on the top of the water is often present in late summer. This is discussed in further detail in the freshwater fish section of this chapter. Winestead Drain cLWS complements the value of other site systems associated with the Humber Estuary by facilitating species movements, colonisation and expansion. The site represents opportunities for ecological enhancement/restoration and the ecological functions the site provide mean the site is of **district importance**.

10.3.2 Habitats

The results of the Phase 1 habitat survey including desk study records are described fully in Appendix 10.1. The Phase 1 habitat maps are shown in Appendix 1.1.

The semi-natural habitat corridors are generally confined to the designated sites, described above. Habitats which are characteristic features of the designated sites, i.e. saline lagoon, fixed dune grassland and standing water with associated reedbeds, are not described further in this section. Habitats within designated sites, which are not characteristic habitat features, are described in the sections below for the two sites.

10.3.2.1 Outstrays Managed Realignment

The following describes the specific vegetation within Outstrays Managed Realignment and Table 10.6 summarises the value of each habitat type.

Table 10.6: Assigning Value to Habitats at Outstrays Managed Realignment

Habitat (Phase 1 category)	Occurrence (frequency / extent)	Quantity within Proposed Scheme (ha) or (m) for linear habitats	Policy importance / biodiversity status	Biodiversity importance
Broad-leaved plantation	Western corner of West 1	0.3 ha	N/A	Local
Scrub	Access track by Outstray Farm and throughout Outstray Scrapes and Haverfield Quarry; non-native species present.	12.6 ha	N/A	Local
Neutral Grassland – Semi improved	Outstrays Embankment	9.3 ha	Neutral grassland HAP	Regional
Marshy Grassland	Outstray Scrapes	2.5 ha	Neutral grassland HAP	District
Poor semi-improved Grassland	Some fields in West 2.	N/A	N/A	Less than local
Standing water	Three ponds in Outstray Scrapes	0.8 ha	Ponds HAP	Local

Habitat (Phase 1 category)	Occurrence (frequency / extent)	Quantity within Proposed Scheme (ha) or (m) for linear habitats	Policy importance / biodiversity status	Biodiversity importance
	Two ponds Haverfield Quarry			
Running water	Extensive ditch network throughout including Winestead Drain	11270 m	River HAP (Winestead Drain only).	Local
Arable fields	Dominant and widespread	N/A	Arable farmland HAP	Less than local
Hedgerows	Along northern and southern boundary of West 1	3590 m	Hedgerows HAP	Local
Dry Ditch	Widespread throughout West 1	N/A	N/A	Less than local
Sea wall – artificial material	Western part of West 1 embankment	N/A	N/A	Less than local

Broad-Leaved Plantation

There is a small broad-leaved plantation in the far western corner of West 1. Many of the planted species are hybrids, non-natives and outside of their normal range. Small plantations are common and widespread in the district, many associated with farm buildings.

The size and age of the woodland is such that it is of limited ecological value, but it does make an important contribution to the local habitat diversity and is a source of shelter and foraging opportunities for wildlife. The broad-leaved plantation is considered to be of local importance.

Scrub

There is a large area of planted scrub at Outstray Scrapes, many species being hybrids, non-natives and outside of their normal range. Dense scrub is also the dominant habitat at Haverfield Quarry LWS, which is described in detail in the designated sites section. Otherwise there are small patches of bramble scrub along the access track by Outstray Farm. Scrub is a common and widespread habitat elsewhere in the district, but is relatively scarce locally. Scrub makes an important contribution to

the habitat diversity, locally and a source of shelter and foraging opportunities for wildlife. Collectively, these areas of scrub are considered to be of **local importance**.

Neutral Grassland – Semi Improved

The Outstrays embankments are characterised by species-poor swards of tall grasses, but in places they support a more distinctive flora and fauna. The embankments are mown bi-annually. The habitat to the rear of the embankment is unmanaged and characterised by more frequent rank grassland indicators, including false oat-grass *Arrhenatherum elatius*. Orchids appear to be a feature of both areas, with southern-marsh orchid *Dactylorhiza praetermissa*, common spotted orchid *D. fuchsii* and pyramidal orchid *Anacamptis pyramidalis* all noted. The toe of the embankment on the estuary side is also unmown and supports upper saltmarsh communities.

This habitat falls within the Humber Estuary SSSI and SAC, but is not a reason for site selection. The habitat is moderately species-rich and forms a very extensive band of terrestrial, semi-natural habitat: a corridor which extends around Sunk Island and across the northern banks of the Humber Estuary. The habitat therefore makes a valuable contribution to the biodiversity of the area and is considered to be of **regional importance.**

Marshy Grassland

An area referred as Outstray Scrapes is located near the centre of the southern boundary of West 1. Around the 1980s the area was left fallow and naturally reverted to marshy grassland with a brackish water influence. The area is dominated by common couch *Elymus repens* with frequent false oat grass and locally abundant tall fescue *Festuca arundinacea*. The grassland is rank and species poor but makes an important contribution to the habitat diversity of the area. This area of marshy grassland is considered to be of **district importance**.

Poor - Semi Improved Grassland

Poor semi-improved grassland is located in some fields to the north of Winestead Drain and some sections of flood embankment in West 1 and West 2. This grassland is sown with ryegrass seed mix which is species-poor and dominated by ubiquitous plant species. This grassland is considered to be of **less than local importance**.

Standing Water

Three ponds are located in Outstray Scrapes, two are dominated by sea club rush *Bolboschoenus maritimus* and the third has a large bund around the edge with an island in the middle, but does not appear to have the same brackish water influence. Collectively, these ponds are considered to be of **local importance**.

Running Water

A network of drains surround most of the large open arable fields. Some contain shallow running water and the majority show no conceivable flow. Some drains, especially in West 1, are dry with no water present, these are described separately as dry ditches, below. Running water is the key component of Winestead Drain cLWS, which is described in detail in the designated sites section.

Drains in West 1 and West 2 are generally steep sided and subject to an intensive management regime, with vegetation clearance and dredging, generally on an annual or biennial basis. The drains are also subject to agricultural runoff, which impacts on

the water quality in most drains. Despite this, at certain times of year, generally prior to ditch maintenance activities, the ditch system supports extensive stands of swamp and associated fen habitats. This habitat is common and widespread around the boundaries of arable fields in the area. Collectively, the communities are considered to be of **local importance.**

Arable

West 1 and West 2 are dominated by large open arable fields with narrow field boundaries and field drains affected by agricultural runoff. Most fields are artificially drained through a network of sub-surface drains and field drains. Field boundaries are narrow or non-existent and support species poor grassland or ruderal vegetation. The fields present homogenous areas with little shelter, high disturbance and poor foraging.

The location of these fields is important in terms of its proximity to the Humber Estuary, as these fields represent high tide roost locations for estuarine birds. However, this habitat dominates the wider landscape and is readily available elsewhere, and for this reason is of **less than local importance**.

Hedgerows

The hedges between the fields are generally absent and/or sparse. Where present these are defunct and species-rich. There is a notable length of defunct species-rich hedgerow on the northern boundary of West 1. The hedgerow is located on top of an embankment and has a drainage ditch running parallel. This hedgerow supports a small number of mature hawthorn *Crataegus monogyna* and due to their growth form, it suggests they were managed as a hedgerow in the past. A row of trees (various species) has been interplanted between these features in the past 5-10 years. Due to a lack of management, along most of its length it functions as a line of planted trees with regular small gaps and occasional larger gaps over 20m wide.

A recently planted treeline/hedgerow is located along the southern boundary of West 1. The size and age of the hedgerow is such that they are of limited nature conservation value it also appears to support many hybrid varieties of trees. Collectively the hedgerows are of **local importance**

Dry Ditch

A series of narrow dry ditches run from north to south across West 1. The ditches are species poor and dominated by coarse grasses. This is a common feature around neglected field boundaries and is considered to be of **less than local importance**.

Sea Wall

An engineered sea wall has recently been constructed as part of remedial work along the western section of the West 1 embankment. Large boulders and gabion baskets have replaced what was previously a grassy embankment. The sea wall is sparsely vegetated and is considered to be of **less than local importance**.

Non-Native Invasive Species

The desk study revealed no records for invasive species within the search area. However, two invasive plant species were recorded during the NVC surveys (Table 10.7). Japanese rose, listed on Schedule 9 of the Wildlife and Countryside Act 1981 (as amended), was found to be widespread at Outstray Scrapes, with one patch also recorded in Haverfield Quarry LWS. A second, unidentified species of cotoneaster

(*Cotoneaster* sp.) was recorded during other ecological surveys at Outstray Scrapes. A number of non-native cotoneasters are listed on Schedule 9.

Table 10.7: Invasive plant species recorded within the Outstrays Managed Realignment Scheme

Species	Location	Date and source
Japanese rose (Rosa rugosa))	Haverfield Quarry LWS	2016, NVC
	Outstrays Scrapes	2016, NVC
Cotoneaster (Cotoneaster sp.)	Outstrays Scrapes	2016, CH2M

10.3.2.2 Welwick to Skeffling Managed Realignment

The following describes the specific vegetation within Welwick to Skeffling Managed Realignment and Table 10.8 summarises the value of each habitat type.

Table 10.8: Assigning Value to Habitats at Welwick to Skeffling Managed Realignment

Habitat (Phase 1 / NVC category)	Occurrence (frequency / extent)	Quantity within Proposed Scheme (ha) or (m) for linear habitats	Policy importance / biodiversity status	Biodiversity importance
Scrub	Welwick Bushes and occasionally in East 1	0.2 ha	N/A	Local
Neutral Grassland – Semi improved	Eastwards along the embankment from Weeton Bank	5.3 ha	Neutral grassland HAP	Regional
Poor semi improved grassland	Some fields in East 3	N/A	N/A	Less than local
Standing water	Throughout but prominent in East 3.	0.4 ha	Ponds HAP	Local
Running water	Extensive drainage network throughout	5655 m	N/A	Local
Arable fields	Dominant and widespread	N/A	Arable farmland HAP	Less than local
Ephemeral/short perennial	Widespread, present along tracks, edge of	N/A	N/A	Less than local

Habitat (Phase 1 / NVC category)	Occurrence (frequency / extent)	Quantity within Proposed Scheme (ha) or (m) for linear habitats	Policy importance / biodiversity status	Biodiversity importance
	ditches and the Burning Ground.			
Species-poor hedge - defunct	Sparse but widespread.	3975 m	Hedgerows HAP	Local

Scrub

Scrub is largely confined to East 1, where it forms small extensions to some hedgerows. Welwick Bushes is the main notable area of scrub; a rare lichen *Ramalina sp.* has also been noted by a local botanist, on some hawthorns in this location. Individual hawthorns are also sparsely scattered across field boundaries in the area. Collectively, these areas of scrub are considered to be of **local importance**.

Neutral Grassland – Semi improved

The Welwick to Skeffling embankments are characterised by species-poor swards of tall grasses, but in places they support a more distinctive flora and fauna. The embankments are mown bi-annually in mid-summer and autumn. Over three hectares of relatively species-rich grassland is noted on the landward side of the embankment, east of Weeton Bank. The toe of the embankment on the estuary side is unmown and is dominated by sea couch. Neglected couch *Elytigia campestris* syn. *E. repens arenosa* (recorded as a notable species under the SSSI criteria), has been recorded on Welwick Bank and the regionally scarce sea wormwood *Artemisia maritima* has been recorded at toe of embankment.

This habitat falls within the Humber Estuary SSSI and SAC, but is not a reason for site selection. The habitat is not generally considered part of the Neutral Grassland Section 41 Priority habitat, being semi-improved, but it does bear affinities with it. The habitat is moderately species-rich and forms a very extensive band of terrestrial, semi-natural habitat: a corridor which extends almost as far as Spurn Head. The habitat therefore makes a valuable contribution to the biodiversity of the area and is considered to be of **regional importance**.

Poor Semi Improved Grassland

Some fields in East 3 have been sown with a pasture grass seed mixture and been reverted to sheep grazing. These fields are species poor and represent little structural diversity. They are considered to be of **less than local importance**.

Standing Water

A total of seven ponds are located in East 1, 2 and 3. The ponds in East 1 are mainly former slurry lagoons along Sheep Trod Lane, now dominated by dense reeds.

A single slurry lagoon pond is located on the northern boundary of East 2. This is in current use and for this reason has negligible ecological value.

The majority of the ponds are located south of Long Lane in East 3. All ponds show signs of eutrophic conditions and some are particularly badly affected. All ponds are located in agricultural land, which is either heavily grazed and in the middle of an arable field. Either way the margins are short and narrow, with common reed noted in the centre of some ponds. Many of the ponds recorded in the centre of arable fields are ephemeral pools and do not support any vegetation.

Despite being species-poor and having general lack of aquatic vegetation, other than filamentous algae, the ponds represent an important feature in a landscape with is otherwise devoid of features. Collectively, these ponds are considered to be of **local importance.**

Running Water

A network of drains surround most of the large open arable fields. Some contain shallow running water and the majority show no conceivable flow. Many of the drains only support shallow pools of water and are dry for much of the year.

The drains are generally steep sided and subject to an intensive management regime, with vegetation clearance and dredging, generally on an annual or biennial basis. The drains are also subject to agricultural runoff, which impacts on the water quality in most drains. Despite this, at certain time of year, generally prior to ditch maintenance activities, the ditch system supports extensive stands of swamp and associated fen habitats. Often the banks are dominated by tall ruderal vegetation shortly after bank re-profiling. Collectively, the communities are considered to be of **local importance**.

Arable Fields

West 1 and West 2 are dominated by large open arable fields with narrow field boundaries and field drains affected by agricultural runoff. Most fields are artificially drained through a network of sub-surface drains and field drains. Field boundaries are narrow or non-existent and support species poor grassland or ruderal vegetation. The fields present homogenous areas with little shelter, high disturbance and poor foraging.

The location of these fields is important in terms of its proximity to the Humber Estuary, as these fields represent high tide roost locations for estuarine birds. However, this habitat dominates the wider landscape and is readily available elsewhere, and for this reason is of **less than local importance.**

Ephemeral/Short Perennial

An area referred as the Burning Ground is located north of the embankment in East 1. This is an area of contaminated land and was previously used as a refuge site. Subsequently the ground is a mix of aggregates and is sparsely vegetated in certain areas, especially to the west of the area which is used as a car park. The open vegetation communities recorded at the Burning Ground are widespread across the country and support a limited number of species. They are considered to be of **less than local importance**.

Species Poor Hedge – Defunct

Short defunct sections of hedgerow are scattered across the site. These are all hawthorn hedgerows and few other species have been noted. The hedgerows have minimal ground flora and generally the arable fields extend directly up to the hedgerow. Despite this, the hedgerows represent an important feature in a landscape that is

otherwise devoid of features. Collectively, these hedgerows are considered to be of **local importance**.

Non-Native Invasive Species

The desk study revealed no records for invasive non-native species within the search area. However, one invasive non-native plant was recorded during the NVC surveys (Table 10.9). Variegated yellow archangel (Lamiastrum galeobdolon subsp. argentatum), listed on Schedule 9 of the Wildlife and Countryside Act 1981 (as amended), was recorded under hawthorn scrub on Welwick Bank, close to the end of Humber Side Lane.

Table 10.9: Invasive plant species recorded within the Welwick to Skeffling Managed Realignment Scheme

Species	Location	Date and source
Variegated yellow archangel (*Lamiastrum galeobdolon* subsp*. argentatum*)	Welwick Bank	2015, NVC

10.3.3 Species

The results of the protected species survey including desk study records are described fully in in separate reports in Appendix 10.1.

Protected and notable species primarily associated with terrestrial habitats are described in the sections below for the two sites. Species primarily associated with estuarine habitats are described in Chapter 11 (Marine Biodiversity).

10.3.3.1 Outstrays Managed Realignment

The following describes the faunal receptors within Outstrays Managed Realignment and Table 10.10 summarises the value of each species/group.

Table 10.10: Summary of importance of faunal species and species groups

Species / species group	Receptor	Legal status/ policy importance / biodiversity status	Biodiversity importance
Marsh Harrier - Haverfield Quarry	Breeding at Haverfield Quarry ponds.	Wildlife and Countryside Act (1981) Classified as an Amber List species under the Birds of Conservation Concern review.	National
Barn Owl	Widespread foraging	Wildlife and Countryside Act (1981) Schedule 1, Part 1.	District
Farmland birds	Breeding skylark, yellow wagtail, yellowhammer in field boundaries.	Wildlife and Countryside Act (1981) Red list species	District

Species / species group	Receptor	Legal status/ policy importance / biodiversity status	Biodiversity importance
	Breeding linnet at Haverfield Quarry Breeding house sparrow, tree sparrow and starling, associated with Outstrays Farm and Winestead Pumping Station.		
Reptiles – Outstrays population (common lizard and grass snake)	Present along Outstrays embankment and at Outstray Scrapes.	Bern-A3 UK Biodiversity Action Plan priority species S41 List NERC Act (2006) Local priority species ERBAP Wildlife and Countryside Act (1981) Schedule 5	Regional
Water vole	Present in East Clough and Pant Drain. Winestead Drain is an important commuting corridor.	UK Biodiversity Action Plan priority species S41 List NERC Act (2006) Local priority species ERBAP Wildlife and Countryside Act (1981) Schedule 5	District
Otter	Present in Haverfield Quarry suspected holt/couch in this location. Winestead drain, Soak Dyke and Welwick Drain noted as commuting routes.	Bern-A2 ECCITES-A Red List - Near Threaten UK Biodiversity Action Plan priority species S41 List NERC Act (2006) Local priority species ERBAP Wildlife and Countryside Act (1981) Schedule 5 The Conservation (Natural Habitats, &c.) Regulations 2010 (Schedule 2)	Regional
Great crested newt – Haverfield Quarry	Not confirmed meta-population at Haverfield Quarry.	S41 List NERC Act (2006) UK Biodiversity Action Plan priority species Local priority species ERBAP	Local

Species / species group	Receptor	Legal status/ policy importance / biodiversity status	Biodiversity importance
		Wildlife and Countryside Act (1981) Schedule 5 The Conservation (Natural Habitats, &c.) Regulations 2010 (Schedule 2)	
Other amphibians (smooth newt and common toad)	Large smooth newt population at Outstray Scrapes. Small population of common toad at Outstray Scrapes and Haverfield Quarry.	Toad - S41 List NERC Act (2006) Toad – Local priority species ERBAP	Local
Bats	Low-level activity by common/widespread species recorded across Outstrays Scheme.	Wildlife and Countryside Act (1981) Schedule 5 The Conservation (Natural Habitats, &c.) Regulations 2010 (Schedule 2)	Less than local - Scoped out
Badger	Main sett and Outlier setts identified.	Protection of Badgers Act 1992	Local
Sea aster mining bee -Haverfield Quarry	Single nest in West 2	S41 List NERC Act (2006) UK Biodiversity Action Plan priority species Local priority species ERBAP Nationally Notable A IUCN - Near Threatened	National
Invertebrate assemblage at outstray scrapes	Outstray scrapes	Regionally Scare	District
Freshwater Fish	Winestead Drain desk study records.		District
Brown hare - Haverfield Quarry	Regular sightings in West 2	S41 List NERC Act (2006) UK Biodiversity Action Plan priority species Local priority species ERBAP	Local
Roe deer	Regular sightings in West 1		Less than local - Scoped out

Birds – Marsh Harrier

Haverfield Quarry generally supports up to two breeding pairs of marsh harrier *Circus aeruginosus*. In exceptional years a third pair have tried unsuccessfully to breed on the site. This breeding population is considered to be of **national importance**.

Birds – Barn Owl

There were irregular sightings of barn owl *Tyto alba* throughout the survey period in 2015 and 2016 with little conclusive evidence of breeding. However, given that the species favours farmland, with scattered trees, and the limited human contact, it was estimated up to three pairs could be breeding in the Proposed Scheme (IECS, 2012). There were two barn owl boxes in West 1, but between 2016 and 2017, both boxes deteriorated and collapsed. Subsequently nesting opportunities have declined in West 1 and this area may no longer be able to support breeding barn owls. The only nesting opportunities are within farm buildings at Outstray Farm, as such there is potential up to 1 breeding pair across West 1 and West 2. It is also noted that the WeBS surveyor for the Welwick section had regular sightings of an individual barn owl during the winter of 2015/16, but a dead individual was found in early 2016 and with a probable absence thereafter. Due to the current lack of nesting opportunities the barn owl population is considered to be of up to **district importance.**

Birds – Farmland Birds

Of the UK Red List species identified breeding in the area, Skylark *Alauda arvensis* is the most abundant, and is widely distributed over arable fields, grassy embankments and saltmarsh vegetation. Yellow Wagtail *Motacilla flava* and Yellowhammer *Emberiza citronella*, both Red List species, are present in lower numbers. Whilst Yellow Wagtail are associated with open fields and grassy margins, Yellowhammer are found breeding along hedgerows and in the scrub fringing the Haverfield Quarry. Haverfield Quarry is a stronghold for breeding Linnet *Carduelis cannabina* in the area. Other species on the Red List include House Sparrow *Passer domesticus*, Tree Sparrow *Passer montanus* and Starling *Sturnus vulgaris*. Both species of sparrows are scarce breeders and are associated with the Outstray farm. Starling are breeding at the Winestead Pumping Station. The farmland bird population is considered to be of **district importance**.

Reptiles

Surveys in 2015 confirmed the presence of common lizard in the southern half of Haverfield Quarry (Appendix 10.1). This area is dominated by fixed dune grassland, which is subject to various grazing regimes.

- Welwick Bushes (Humber Estuary SSSI - Unit 153) is heavily grazed and the short turf presents limited opportunities for shelter and refuge for reptiles. No reptiles were recorded in this location during 2015;
- The grassland directly north of this location (Humber Estuary SSSI - Unit 152) is subject to light grazing and common lizard were regularly recorded. In this location the grassland has a dense thatch, which provide shelter and refuge for common lizard; and
- The grassland directly south of the ponds (Humber Estuary SSSI - Unit 151) has no grazing and a single common lizard was recorded in this location during 2015. Coarse grasses are gradually dominating this location and reducing the value of this resource for common lizard.

The surveys were extended in 2017 to include the northern half of Haverfield Quarry (Appendix 10.1). This area is dominated by extensive areas of scrub with no/minimal ground flora and occasional small open areas of grassland. The surveys recorded 'low' populations of common lizard, localised in the few open grassland areas. The dense scrub is a limitation to the expansion of this population. The grassland component has rapidly reduced in this location over the past decade, which is a likely cause of the gradual decline in reptile numbers.

Given the potential of Haverfield Quarry (under appropriate management) to support larger reptile population and the fact it is directly connected to the embankments in East 1, the population can be considered part of the Welwick to Skeffling Managed Realignment scheme and of **regional importance**.

Surveys in 2016 confirmed the embankment to the south east of the West 1 is a valuable habitat resource for reptiles and supports a 'good' common lizard population and 'low' grass snake population (Appendix 10.1). Surveys were extended in 2017 to include Outstray Scrapes, which adjoins the embankment and located within the proposed managed realignment. This area also supports a 'good' common lizard population which is comparable to the population recorded on the embankment (Appendix 10.1). No grass snake were recorded during the 2017 surveys but the presence of a 'low' population can be assumed.

The embankment presents an area of shelter, refuge and basking for reptiles with limited foraging opportunities for much of the year, due to the bi-annual grass cutting regime. It is likely that the primary foraging habitat is along the upper reaches of the saltmarsh. Saltmarshes can provide valuable foraging habitat for reptiles, as the tides change and the water level rises, this forces many invertebrates to the upper areas of the saltmarsh.

The embankment provides connectivity along the banks of the estuary and the surveys assume that reptiles are present along the Humber Estuary embankment in this region (Sunk Island). The continuity in management of the embankment by the Environment Agency and the undisturbed saltmarsh is likely to result in stable reptile populations. It is reasonable to conclude that the populations on the embankment are at or near carrying capacity and are unlikely to significantly alter unless natural events cause an increase in mortality rates.

Outstray Scrapes is a mosaic of open grassland and scrub, with three ponds. The area is subject to no/minimal management and is rarely accessed by humans. Encroaching scrub is gradually dominating much of the site. The dominance of scrub in some locations is gradually degrading the area's value for reptiles, but these are unlikely to significantly alter during the timescales of the Scheme. The Outstrays Managed Realignment scheme's reptile populations can be considered to be of **regional importance**.

Water Vole

Surveys in June and September 2016 confirmed two small water vole populations, one in East Clough and the second in Pant Drain (Appendix 10.1). Across the two surveys, evidence of water vole was only recorded on the first visit in both ditches. East Clough was dry by the second visit and dense vegetation restricted access but also degraded the value of the ditch for water voles in Pant Drain.

No evidence of water vole was recorded during updated surveys of Outstrays Managed Realignment Scheme in 2017 (Appendix 10.1). East Clough supported shallow water during the first visit in June and was dry by the second visit in August. Drainage

management over winter 2016/17 had cleared Pant Drain of all vegetation on both banks and in the channel.

Fisherman's Channel is located 2km west of West 1 and is known to support a viable water vole population. Winestead Drain is also likely to be an important dispersal route for local water vole populations, due to its size and length, although no evidence of water vole has recorded in the location during the 2016 and 2017 surveys.

Water voles are considered to be 'likely present' in East Clough, Newlands Drain and Pant Drain. All these watercourses are located outside of the proposed managed realignment and habitat creation areas.

No watercourses within West 1 and 2 represent stable long-term optimal habitat and the suitability can fluctuate regularly and unexpectedly due to ditch maintenance, flooding and drought. In addition, mink, which prey on water vole, were recorded in 2016 and 2017 at or near Haverfield Quarry (Appendix 10.1). The Outstrays Managed Realignment Scheme is unlikely to support a long term viable water vole population; any populations recorded in this area are due to the expansion/dispersal of more stable populations from the wider area. For this reason, the water vole population at Outstrays Managed Realignment Scheme is of **district importance.**

Otter

No evidence of otter was recorded in West 1 during the drainage ditch inspections carried out alongside the water vole surveys in 2016 and 2017 (Appendix 10.1).

Otter is not listed as a reason for designation for any statutory designated site on the Humber Estuary, although it is noted in Natural England's Natural Character Area profile (NE 344: NCA Profile: 41 Humber Estuary, 2012) that reedbeds provide valuable shelter for otter on the estuary. The Humber environment in focus 2011 (Environment Agency. 2011), describes otter populations in Hull and east riding catchment as recovering with a patchy distribution east of Hull and significant expansion west of Hull.

Surveys in 2017 confirmed the presence of otter in the southern pond at Haverfield Quarry (Appendix 10.1). Otter footprints were also recorded next to the bridge across Winestead Drain, opposite Outstray Farm. It can be assumed that the drains which run perpendicular to Haverfield Quarry and Winestead Drain are used by otters for commuting between each area.

It is not possible to determine the size of otter population at Haverfield Quarry due to access constraints and survey limitations (see limitations). The ponds are unlikely to provide an important foraging habitat for otters due to their size and the small fish populations they are likely to support. The ponds and their associated reed beds provide refuge and shelter for otter on the Humber Estuary. The otter population at Outstrays Managed Realignment Scheme is deemed to be of at least **regional importance**.

Great Created Newt

The absence of great crested newt (GCN) could be confirmed in all the surveyed ponds in 2016 (Appendix 10.1). Outstray Scrapes is surrounded by large open arable field with narrow field boundaries and dry ditches. This habitat dominates the wider landscape and presents poor dispersal routes for amphibians. The nearest ponds (beyond which were included in the survey) are almost 2km from Outstray Scrapes,

subsequently it is unlikely any outlying populations will colonise this site. It is reasonable to assume the absence of GCN in these ponds in the near future.

In 2015, eDNA samples and a series of traditional survey methods confirmed the likely absence of GCN at Haverfield Quarry (Appendix 10.1). Attempts were made to collect eDNA samples, set out bottle traps, carry out torch inspection and search for eggs but a full representative survey could not be carried out (see limitations section). Due to survey limitations in 2015 (and records of GCN at Haverfield Quarry), an eDNA survey was repeated in 2016. In 2016, the presence of GCN was confirmed at Haverfield Quarry, through eDNA (Appendix 10.1). This confirmed the eDNA sample collected in 2015 was likely to be a false negative.

Haverfield Quarry and its associated habitats (dune grassland, scrub and reedbeds) represent high value habitats for amphibians. Haverfield Quarry is surrounded by open arable fields with narrow field boundaries, which represent poor quality habitat for amphibians. The ditches either experience some rate of flow or are dry, all are likely to be of poor water quality given the surrounding intensive agricultural land use. Given the absence of great crested newt in the ponds and poor suitability of the ditches, no ditches warranted further survey.

Haverfield Quarry represents the core habitat for this meta-population and they are unlikely to disperse beyond this area, often. The ponds at Haverfield Quarry are limited in their suitability for GCN, due to the size of the ponds and the presence of a large waterfowl and fish population in the ponds. These factors are also likely to be constraints to the expansion amphibian populations in these ponds. GCN are only likely to survive in small pockets along the shallow margins of the ponds. For these reasons, the GCN population at Outstrays Managed Realignment Scheme is of at least **local importance**.

Bats

No buildings, structures or trees within the Outstrays Managed Realignment Scheme were considered to have bat roost potential. There were no records of bats within the Outstrays Managed Realignment Scheme but there are a small number of records from the outlying villages. Based on the limited quality of the surrounding habitat, lack of potential roost sites and limited records, the Outstrays Managed Realignment Scheme is considered to support limited habitat suitability for bats (Appendix 10.1). On the basis of this preliminary assessment, bat activity and automated surveys were designed in line with guidelines published by the Bat Conservation Trust (2016).

West 1 supported localised, low level irregular foraging by small numbers of common pipstrelle bats. Incidental recordings of noctule (single bat pass during summer survey only) and soprano pipstrelle (negligible number of bat passes in summer automated survey only) were also recorded. Most activity was recorded over 1 hour after sunset; this suggests any roosts are located well outside of West 1.

In terms of the level of bat activity (number of bat passes) recorded at the automated survey location, very low levels were recorded on most nights. Even where the highest levels of activity were recorded, these could only be attributed to regular activity by solitary or small number of common pipistrelle bats.

The single or occasional small numbers of common pipistrelle bats recorded at the transect are considered to indicate a very small population and are likely to account for a negligible percentage of Local populations. Common pipistrelle is a common and widespread species of bat and the populations using West 1 are considered to be of **less than local importance** and any impacts on bats would not be significant. As a

result, bats are scoped out of the EcIA. However, best working practices take into consideration the possibility of bats being found during construction.

Badger

Details for badger can be provided on request, these are held in a confidential appendix.

The badger populations at Outstrays Managed Realignment Scheme are deemed to be of **local importance**.

Amphibians (except great created newt)

There are three ponds within the West 1, located at Outstray Scrapes and a single pond within 500m of the West 1 boundary. Two further ponds were also surveyed on the estuary side of the embankment and were confirmed to be saline, with the presence of green shore crab *Carcinus maenas* recorded on the first survey.

Smooth newt were confirmed in two ponds at Outstray Scrapes. The surveys suggest that in West 1, frogs are absent and there is a small toad population. During the reptile surveys in 2017, a small population of common toad in Haverfield Quarry LWS was also recorded incidentally. Amphibian populations (other than great created newt) at the Outstrays Managed Realignment scheme are considered to be of **local importance**.

Invertebrates

Surveys in 2015 and 2016 confirmed the presence of sea aster mining bee *Colletes halophilus*, in the West 2. As the majority of the population is located in East 1, the distribution of sea aster mining bee is discussed in the Welwick to Skeffling Managed Realignment scheme description. A single nesting site was recorded in the southern end of Haverfield Quarry, just within the West 2 boundary.

Given that sea aster mining bee is a notified feature of the Humber Estuary SSSI, the population within the site is of **national importance**.

The 2016 survey also included an assessment which valued habitats based their suitability and confirmed records of invertebrates, including JNCC listed invertebrates, Species of Principal Importance (SPIE) and regionally scare invertebrates.

Outstray Scrapes was noted for supporting a small assemblage of regionally scarce invertebrates and for its refuge value in what is otherwise an intensively farmed area. Many of the species noted at Outstray Scrapes are unavoidably of regional scarcity, as they are mainly restricted to coastal areas with saltmarshes, brackish ditches, coastal grasslands and similar habitats, all of which are scarce habitats in South Holderness. Although regionally scarce, these flies tend to be locally common, and occur in abundance in suitable locations around much of the British coast. For this reason the invertebrate assemblage at Outstray Scrapes is of **district importance.**

The embankment mainly consists of regularly mown grassland, with relatively few forbs, on clay-based soils. Arable fields surrounded by defunct hedgerows and ditches dominate the Outstrays Managed Realignment Scheme. Some ditches were shallow and dry, whilst others were deeply cut, regularly dredged and polluted by agricultural run-off, some sections being thickly polluted by an oily sludge. The majority of the site is of **less than local importance** for invertebrates.

Freshwater Fish

Winestead Drain is a main river and currently classified as poor status under the WFD. The watercourse is a eutrophic lowland drain with excessive nutrient levels, resulting in extensive macrophyte growth during the summer. Large fluctuations in the fish populations have been noted in this watercourse between 2004 and 2016 (Appendix 10.1). This has been attributed to intermittent water quality problems and unsympathetic drainage management, which leads to excessive in-channel vegetation removal. The drainage management tends to leave minimal aquatic and marginal vegetation for the winter, which is likely to impact on the over winter survival of fish populations in the watercourse.

Winestead Drain can support notable roach and bream populations and in some years, represent valuable fishing grounds. The channel supports low species diversity and no species of conservation importance have been recorded in this watercourse.

Although no specific survey has been carried out, it is assumed that the ponds at Haverfield Quarry support fish populations. Local accounts have also confirmed the presence of fish in these ponds.

No fish were noted in any other drainage channels or ponds within the Outstrays Scheme. Many of the drains are regularly dry and are susceptible to water quality problems from agricultural run-off.

Collectively, the freshwater fish populations are considered to be of **district value**.

Other Mammals

Brown hare were regularly recorded within West 2 during the numerous site surveys undertaken. The wide expanse of flat arable fields with the diverse boundary features along Haverfield Quarry provide good fields of view, foraging habitats and suitable lay-down sites for this species. The brown hare populations at Outstrays Realignment scheme are deemed to be of **local importance**.

Roe deer were regularly seen in West 1 during the numerous site surveys undertaken. The scrub within Outstray Scrapes and deep, dry drainage channels provide cover and foraging opportunities for this species. These are common and widespread locally and are considered to be of **less than local importance.**

10.3.3.2 Welwick to Skeffling Managed Realignment

The following describes the faunal receptors within Welwick to Skeffling Managed Realignment and Table 10.11 summarises the value of each species/group.

Table 10.11: Summary of importance of faunal species and species groups

Species / species group	Receptor	Legal status/ policy importance / biodiversity status	Biodiversity importance
Barn owl	Up to two breeding pairs of barn owl	Wildlife and Countryside Act (1981) Schedule 1, Part 1.	Regional
Short eared owl	Up to four overwintering short eared owl	Wildlife and Countryside Act (1981) Schedule 1, Part 1.	Regional

Species / species group	Receptor	Legal status/ policy importance / biodiversity status	Biodiversity importance
Farmland birds	Breeding Linnet and Yellowhammer Skylark associated with arable fields.	Wildlife and Countryside Act (1981) Red List species.	Local
Reptiles – Welwick to Skeffling population (common lizard and grass snake)	Present along Welwick to Skeffling embankment and within Haverfield Quarry.	Bern-A3 UK Biodiversity Action Plan priority species S41 List NERC Act (2006) Local priority species ERBAP Wildlife and Countryside Act (1981) Schedule 5	Regional
Water vole	Present in low numbers in Welwick Drain, Weeton Beck and Soak Dike.	UK Biodiversity Action Plan priority species S41 List NERC Act (2006) Local priority species ERBAP Wildlife and Countryside Act (1981) Schedule 5	District
Otter	Soak Dyke noted as a probable commuting route.	Bern-A2 ECCITES-A Red List - Near Threaten UK Biodiversity Action Plan priority species S41 List NERC Act (2006) Local priority species ERBAP Wildlife and Countryside Act (1981) Schedule 5 The Conservation (Natural Habitats, &c.) Regulations 2010 (Schedule 2)	Regional
Great crested newt - Skeffling	Large meta-population in Skeffling village (Scoped out of assessment)	S41 List NERC Act (2006) UK Biodiversity Action Plan priority species Local priority species ERBAP Wildlife and Countryside Act (1981) Schedule 5 The Conservation (Natural Habitats, &c.) Regulations 2010 (Schedule 2)	Regional - Scoped out

Species / species group	Receptor	Legal status/ policy importance / biodiversity status	Biodiversity importance
Great crested newt - Humber Farm	Small meta-population at Humber Farm, just north of East 1.	S41 List NERC Act (2006) UK Biodiversity Action Plan priority species Wildlife and Countryside Act (1981) Schedule 5 Local priority species ERBAP The Conservation (Natural Habitats, &c.) Regulations 2010 (Schedule 2)	Local
Other amphibians (smooth newt, palmate newt and common toad)	Skeffling village (Scoped out of assessment)	Toad - S41 List NERC Act (2006) Toad – Local priority species ERBAP	Local - Scoped out
Bats	Low-level activity by common/widespread species recorded across Welwick to Skeffling Scheme.	Wildlife and Countryside Act (1981) Schedule 5 The Conservation (Natural Habitats, &c.) Regulations 2010 (Schedule 2)	Less than local - Scoped out
Badger	Main sett and associated outlier setts.	Protection of Badgers Act 1992	Local
Sea aster mining bee - Haverfield Quarry	Welwick Bushes (East 1) and Welwick Bank	S41 List NERC Act (2006) UK Biodiversity Action Plan priority species Local priority species ERBAP Nationally Notable A IUCN - Near Threatened	National
Freshwater fish	Stickleback recorded in some ponds.		Less than local - Scoped out
Brown hare	Rarely sighted.	S41 List NERC Act (2006) UK Biodiversity Action Plan priority species Local priority species ERBAP	Less than local - Scoped out
Roe deer	Rarely sighted.		Less than local - Scoped out

Birds – Barn Owl

There were irregular sightings of barn owl *Tyto alba* throughout the survey period in 2015 and 2016 with little conclusive evidence of breeding. However, given that the species favours farmland, with scattered trees, and the limited human contact, it was estimated up to three pairs could be breeding in the Proposed Scheme (IECS, 2012). There is one barn owl nest box in East 1, adjacent to Sheep Trod Lane and one barn owl box in East 3, on Burstall Bank. A breeding pair were recorded in the nest box on Burstall Bank in 2015.

Up to two nesting pairs of barn owl could occupy the nest boxes, as such the barn owl population is considered to be of up to **regional importance**.

Birds – Short Eared Owl

The Welwick area including the flood banks and the fronting marsh is a wintering site for short-eared owl *Asio flammeus* (Annex 1, Amber List BoCC4).

Up to 4 short eared owl use the area over most winters, as such the short-eared owl population is considered to be of up to **regional importance**.

Birds – Farmland Birds

The complex of mature hedgerows and copses found around Sheep Trod Lane, to the north of Welwick Saltmarsh, supports a good breeding population of Linnet *Carduelis cannabina* and a few pairs of Yellowhammers *Emberiza citronella*. Outside this pocket of good habitats, Red-Listed farmland birds are scarce, with the exception of Skylark *Alauda arvensis* which is present in the majority of arable fields during the breeding season. With the exception of the hedgerows associated with Sheep Trod Lane, there are limited nesting opportunities across East 1, 2 and 3. As such, the farmland bird population is considered to be of **local importance.**

Reptiles

Surveys in 2015 confirmed in areas identified as supporting suitable habitat for reptiles, there was a widespread distribution of common lizard and localised distribution of grass snake (Appendix 10.1). Small numbers of common lizards were recorded in Haverfield Quarry and on the embankment adjacent to Welwick Saltmarsh and a single grass snake and common lizard were recorded on the farm access track along Long Lane in East 3.

The narrow grassland and hedgerow buffers along some farm access namely Long Lane, Sheep Trod Lane and Haverholme Lane also support suitable habitat for reptiles. Common lizard and possibly grass snake are considered to be likely present in low numbers in these additional locations.

Surveys in 2016 confirmed the embankment to the south of the East 1, 2 and 3 is a valuable habitat resource for reptiles, which supports a ‘good’ common lizard population and ‘low’ grass snake population (Appendix 10.1. The embankment represents similar habitat under a similar management regime to the Outstrays embankment. The baseline is likely to remain constant, due to the continuity in management of the embankment and the presence of the saltmarsh habitat. The embankment provides connectivity along the Humber Estuary towards Spurn Point and the surveys assume that reptiles are present along the embankments in this region (Holderness). The Welwick to Skeffling Managed Realignment schemes reptile populations can be considered to be of **regional importance**.

Water Vole

Surveys in April 2015 recorded small populations of water vole in Weeton Beck and in an unnamed drain between Humber Farm and Haverholme Lane (Appendix 10.1). No burrows were identified but a small number of droppings were noted in both drains. Possible field signs (feeding remains only) were also noted in Welwick Drain. The survey suggested that water vole were largely absent or had been displaced northwards, due to storm events in winter 2014/15 and the subsequent intensive ditch management.

The site supports a large network of drains but due to the intensive ditch maintenance, these are continuously in a variety of conditions. In 2015, all drains had been fully excavated within the last 1-2 years, with many being cleared during the previous autumn/winter period. The drains are steep sided and many had little or no vegetation cover and some were dry or had no conceivable flow. The survey noted that the Soak Dike appeared to support higher value habitat with deeper water and more established vegetation. However due to recent storm events, Soak Dike supported brackish water, which reduces suitability for water voles. The report predicted as the vegetation establishes the overall suitability of the site for water vole should increase.

Surveys in June and September 2016 confirmed three small water vole populations, in Welwick Drain/Soak Dike, Weeton Beck and Soak Dike at East Level Bank (Appendix 10.1). As with surveys in West 1 and West 2, evidence of water vole was only recorded on a single survey period, in any one section of ditch. All bankside and in-channel vegetation was cleared by the second survey in Welwick Drain, destroying any suitable habitat for water vole.

The ditch maintenance creates a cycle of habitat loss and degradation. Water voles are considered 'likely present' in the main drainage channels within East 1, 2 and 3, these include Welwick Drain, Soak Dike and Weeton Beck/Fleet. During some events, the water vole populations may temporarily disperse in to minor drains. The water vole populations at Welwick to Skeffling Managed Realignment scheme are deemed to be of **district importance**.

Otter

No evidence of otter was recorded during the drainage ditch inspections in 2015 and 2016. The network of drains in East 1, 2 and 3 present negligible foraging opportunities for otter, as they are unlikely to support any significant fish populations. With the exception of Soak Dike, these do not provide connectivity to suitable foraging areas.

It is strongly anticipated that otter commute along Soak Dike from Welwick Saltmarsh towards Haverfield Quarry, although no field signs have been confirmed in this watercourse. This along with Welwick Drain is the most direct watercourse connecting the Humber Estuary with Haverfield Quarry. As this is the same otter population associated with the Outstrays Managed Realignment Scheme, this is considered to have **regional importance**.

Great Crested Newt

There are three confirmed great crested newt meta-populations within 500m of the Welwick to Skeffling Scheme. These are Skeffling Village, Humber Farm and Haverfield Quarry (described above).

Skeffling Village supports a high density of ponds, many of which are surrounded by or close to good foraging habitat and potential hibernation features for great crested newt. The village offers a mosaic of habitats including woodland, hedgerows, rough

grassland and private gardens, which support four meta-populations of great crested newt of medium to potentially large sizes. The village acts as the principal foraging territory, used by these great crested newt metapopulations. The Skeffling great crested newt meta-population can be considered to be of **regional importance**.

Arable farmland dominates the landscape between Skeffling village and the Welwick to Skeffling Scheme. Large expanses of intensively farmed land are less favoured by great crested newt and they are less likely to disperse across these areas (Froglife, 2001), especially when higher value habitat is found within Skeffling village. The farmland across the Welwick to Skeffling Scheme is particularly poor with narrow field boundaries and defunct hedgerows. The scheme boundary is over 450m from the nearest pond in Skeffling Village. Given the habitat quality and availability within Skeffling Village and the absence of high quality habitat between the Scheme Boundary and Skeffling Village, no impacts are anticipated on amphibian populations within Skeffling Village. As a result, the Skeffling Village great crested newt meta-populations are scoped out of the EcIA. However, best working practices take into consideration the possibility of great crested newt being found during construction.

A small great crested newt meta population was recorded in 2015 at Humber Farm (Appendix 10.1). This includes two ponds, one within a private garden and the second within the centre of an arable field. The principle foraging territory is likely to be the private garden at Humber Farm, with small number of great crested newt travelling between the two ponds. The arable field boundary along Row Lane is likely to be a commuting corridor between the two ponds. There is also a farm storage area to the south of these ponds, there are a series of rubble piles and occasional brash piles, which could potentially support amphibians.

The habitat suitability assessment of the Humber Farm pond suggests it should support larger numbers of great crested newt, but the presence of stickleback in this pond is likely to limit the expansion of this great crested newt population. The Humber Farm great crested newt meta-population can be considered to be of **local importance**.

Other amphibians

All the ponds that support great crested newt populations in Skeffling Village also support smooth or palmate newts (Appendix 10.1). Large numbers of smooth newt were recorded in some ponds. No frogs were recorded during the surveys, with occasional solitary toads recorded in Pond 2. Amphibian populations (other than great created newt) at Skeffling Village are considered to be of **local importance**. As per the assessment made for the Skeffling Village great crested newt meta-populations, no impacts are anticipated on amphibian populations within Skeffling Village. As a result, amphibian populations within Skeffling Village are scoped out of the EcIA. However, best working practices take into consideration the possibility of great crested newt being found during construction.

Bats

No buildings, structures or trees within the Welwick to Skeffling Managed Realignment scheme were considered to have bat roost potential. There are no bat records within the Welwick to Skeffling Managed Realignment scheme. Two common pipistrelle maternity roosts have been recorded, one in Easington and the second in Skeffling, in 2006 and 1998 respectively. Based on the limited quality of the surrounding habitat, lack of potential roost sites and limited records, the Welwick to Skeffling Managed Realignment scheme is considered to support limited habitat suitability for bats. On the basis of this preliminary assessment, bat activity and automated surveys were

designed in line with guidelines published by the Bat Conservation Trust (2012). Surveys were undertaken in spring, summer and autumn 2015 (Appendix 10.1).

The levels of activity are comparable to the walked transect and automated surveys at Outstrays Managed Realignment Scheme, as described above. Again, most activity was recorded over 1 hour after sunset, which suggests any roosts are located well outside of the Welwick to Skeffling Managed Realignment scheme. The two or three common pipistrelle bats recorded at each transect in Spring, Summer and Autumn are considered to be a small population and are likely to account for a small percentage of Local populations. Registrations by other species were very infrequent, with a two *Myotis sp*. bat passes and a single possible brown long eared bat call across all surveys. These numbers of bat passes would be expected at any rural location and the Welwick to Skeffling Managed Realignment scheme of less than local value for any rarer or less widespread species.

Common pipistelle is a common and widespread species of bat and the populations using the Welwick to Skeffling Managed Realignment scheme are considered to be of **less than local importance** and any impacts on bats would not be significant. As a result, bats are scoped out of the EcIA. However, best working practices take into consideration the possibility of bats being found during construction.

Badger

Details for badger can be provided on request, these are held in a confidential appendix.

The badger populations at Welwick to Skeffling Managed Realignment scheme are deemed to be of **local importance.**

Invertebrates

Surveys in 2015 and 2016 aimed to assess the presence or likely absence of five invertebrate species detailed as scarce or threatened in Natural England's SSSI citation for the Humber Estuary (Appendix 10.1). Out of these five key species, sea aster mining bee *Colletes halophilus*, was recorded in the Welwick to Skeffling Scheme. Sea aster mining bee is a scarce species both nationally and internationally, is designated as near threatened by IUCN and is a Species of Principal Importance (SPIE). The species has been the subject of targeted conservation action in Great Britain, and is listed in section 41 of The Natural Environment and Rural Communities (NERC) Act (2006). Buglife have produced a Species Management Sheet for this species, which includes mitigation options in respect to managed realignment projects. The Humber Estuary marks the northern limit of its British range. Its global distribution is restricted to coastal regions of England, France, Belgium, The Netherlands and Germany.

In 2015 and 2016, large nesting aggregations of sea aster mining bee were recorded at Welwick Bushes, with other nesting sites immediately west and east of this area at Haverfield Quarry and on Welwick Bank. All nests were recorded on vertical, bare sandy soil surfaces. This habitat is restricted to these locations, with the majority of Welwick to Skeffling Scheme supporting clay-based soils.

Given that sea aster mining bee is a notified feature of the Humber Estuary SSSI, the population within the site is of **national importance**.

With the exception of Welwick Bushes and the sandy exposure on Weeton Bank, which are described above, the Welwick to Skeffling Scheme does not support any other

habitats of notable importance for invertebrates. The majority of the site is of negligible importance for invertebrates. The embankment mainly consists of regularly grazed or mown grassland, with relativity few forbs, on clay-based soils. Arable fields surrounded by defunct hedgerows and ditches dominate the Welwick to Skeffling Scheme. Some ditches were shallow and dry, whilst others were deeply cut, regularly dredged and polluted by agricultural run-off. The invertebrate assemblage at Welwick to Skeffling Managed Realignment Scheme is of **less than local importance**.

Freshwater Fish

Stickleback were recorded in a pond at Humber Farm (which also supports great crested newt).

No fish were noted in any other drainage channels or ponds within the Welwick to Skeffling Scheme. Many of the drains and ponds are susceptible to water quality problems from agricultural run-off. The fish populations are considered to be of **less than local importance** and any impacts would not be significant.

Other Mammals

Brown hare and roe deer were rarely recorded in Welwick to Skeffling Scheme. Although they are present in the wider area, the Welwick to Skeffling Scheme does not provide any notable value for these species. The brown hare and roe deer populations are considered to be of **less than local importance** and any impacts would not be significant.

10.3.4 Future baseline

A prediction of the future baseline without the Scheme has been made as part of this assessment, and the most significant changes anticipated to terrestrial ecology of the Study Area are summarised here.

It is reasonable to assume that under the current drainage management and the confirmed presence of mink, water vole populations will continue to decline at risk of local extinction in the near future.

The long-term effects of climate change are anticipated to lead to increased temperatures and a change in rainfall patterns across the region. In turn, this will modify patterns of river flow, for example lower flows in summer and larger flows (and flood events) may become more frequent, more severe and more prolonged. These changes will affect the local ecology (habitats and species). Generalist species will typically be more tolerant of these changes, compared with specialist species, which often adapted to narrow niche and have very specific environmental conditions to survive. A notable example is the sea aster mining bee which has a limited distribution due to the combined effects of its oligolectic nature and its preferences for salt marsh habitats, both limited resources which can increase its vulnerability.

Flows in drainage ditches are likely to become more responsive to changes with higher, more flashier flows in winter and lower flows in summer. Again, this could adversely impact water vole populations.

Without any further intervention, scrub encroachment at Haverfield Quarry LWS, Humber Estuary SSSI Units 151 and 152, will gradually degrade the ecological value of these areas, as the scrub expands in range. The scrub will gradually reduce structural diversity of the habitats and only benefit a narrow range of species.

10.4 Likely Significant Effects

10.4.1 Outstrays Managed Realignment

10.4.1.1 Construction

Humber Estuary SSSI (National Importance)

Figure 11.1b in Appendix 1.1 shows the Humber Estuary SSSI units in the vicinity of the Scheme. As mentioned in section 10.3.1, this chapter considers impacts on the features within SSSI units 151, 152 and 153, while Chapter 11 Marine Biodiversity considers impacts on the features within SSSI units 150, 154 and 156. Features that are also part of the Natura 2000 designations, including coastal waterbird species, are also assessed in the HRA (Appendix 10.2).

Damage/Habitat Loss at Humber Estuary SSSI

Construction of the piling wall through the north west boundary of Welwick Bushes (SSSI unit 153) will directly impact the fixed dune grassland (notable feature of SSSI). A piling wall has been selected for this location to avoid/minimise the extent of permanent habitat loss within the Humber Estuary SSSI.The proposed alignment has been designed to avoid plant communities SD8 and SD9 (fixed dune grassland) and sea aster mining bee nests, where possible. The alignment will run through a band of predominantly MG1 and MG11 grassland communities to the west and north of Welwick Bushes, respectively. These grassland types are common and widespread and relatively species poor compared with fixed dune grassland.

Access through the Humber Estuary SSSI (Haverfield Quarry), is required to facilitate construction and habitat creation in West 2. Machinery crossing the site will directly impact the fixed dune grassland (notable feature of SSSI). The access track is located through SSSI unit 152. The total area of the SSSI unit is 5.86 ha, so the direct impacts are likely to occur on less than 1% (0.54%) of the total area of the SSSI unit.

Effect without mitigation

Permanent loss of up to 0.02 ha of SSSI along the footprint of the piling wall.

Temporary loss of up to 0.1 ha of SSSI during construction of the structure of which fixed dune grassland makes up a negligible area.

Sand dunes are naturally dynamic habitats and the species present on site will readily colonise newly exposed areas of sand.

Significant Negative impact (Certain) at a Local Level in the Short to Medium Term (1-3 years) due to the direct loss of grassland along the new piling wall and temporary loss of habitat along the works footprint.

The track runs through approximately 0.03 ha of fixed dune grassland and hawthorn scrub. There will be temporary loss of 0.03 ha of SSSI habitat during construction. However, sand dunes are naturally dynamic habitats and species present on site will readily colonise exposed areas of sand.

Significant Negative impact (Certain) at a Local Level in the Short to Medium Term (1-3 years) due to the direct loss of grassland along the temporary access track and temporary loss of habitat along the works footprint.

Haverfield Quarries LWS (Regional Importance)

Change in habitat type at Haverfield Quarries LWS

The restoration of Haverfield Quarries LWS is a requirement of the Reptile Mitigation Strategy (creating a suitable receptor site). This includes the removal of scrub and the promotion of varied structure scrub, grassland, and bare ground to create habitat mosaic. Scrub encroachment at Haverfield Quarries LWS is resulting in the degradation of the key LWS feature (fixed dune grassland) by restricting growth of more desirable wild flowers and grasses by shading them out and adding nutrients to the soil (leaf litter). Although some scrub with a varied structure is good for small mammals, reptiles, and birds, the extent of the scrub cover is currently too high. Ground flora is often sparse and absent in the areas where there is a dense band of scrub. The scrub lacks structure, being dominated by an even-aged mature stand. The lack of structure limits the site's potential ecological value.

Up to 50% of the scrub cover within the LWS is due to be removed, coupled with chemical spot treatment to kill stumps to prevent regrowth. Fixed dune grassland vegetation can be established through natural regeneration. As the majority of the scrub encroachment has occurred in the last 10-15 years, there is still likely to be viable seeds of the desired plant community in the seed bank. Seed can also naturally disperse from the pockets of remnant grassland within the site. With appropriate management, the extent of the fixed dune grassland could be increased, and the quality of resource improved.

An Environmental Monitoring and Maintenance Plan will be produced by the Main Works Contractor, in consultation with the Site Manager, the EA, and Natural England. This plan will include specific targets to promote growth, development, and distribution of LWS features, which will be finalised as the Scheme progresses. A site manager will be appointed to manage and monitor the site. The first 10 years of site management is included in the Scheme costs, and it is anticipated that management and monitoring will continue in the long term.

Effect without mitigation

Without mitigation, the result will be direct loss of up to 2.4 ha of scrub and the restoration of up to 2.4 ha of grassland/bare ground mosaic. The reduction in the extent of scrub provides a suitable balance between the scrub and other priority habitats. Scrub clearance and the promotion of fixed dune grassland represents a habitat improvement.

Significant positive impact (Certain) at a Regional Level in the Short Term (within 1st year).

Winestead Drain cLWS (District Importance)

Degradation of water quality at Winestead Drain LWS

There is anticipated to be an increase in sediment and nutrient run-off from arable land into Winestead Drain as a result of the creation of two new outlet channels as part of the wet grassland habitat creation in West 2.

Effect without mitigation

Given the length and size of Winestead Drain and its existing poor water quality, any changes in water quality are likely to be immeasurable. Impacts will be temporary until the wet grassland establishes and the water quality of the run-off improves.

Significant negative impact (Possible) at a Local Level in the Short Term (up to 1 year following construction)

Scrub (Local Importance)

Loss of scrub

The managed realignment in West 1 will result in the direct loss of Outstay Scrapes, including the irreversible and permanent loss of up to 1.2 ha of scrub. Although some scrub has an intrinsic value for small mammals, birds, and reptiles, the scrub within Outstay Scrapes is non-native/hybrid species and species outside their normal range. Scrub should be grown from locally sourced seed to ensure local adaptions and wildlife relationships are preserved.

The restoration of Haverfield Quarries LWS will result in the direct loss of 2.4 ha of scrub (as described in Haverfield Quarries LWS) which represents up to 50% of the scrub habitat within Haverfield Quarries LWS.

Effect without mitigation

Direct and permanent loss of up to 1.2 ha of scrub in Outstay Scrapes and up to 2.4 ha of scrub in Haverfield Quarries LWS, which represents up to 29% of scrub within the Scheme Extents.

Significant Negative impact (certain) at a Local Level.

Neutral semi-improved grassland (Regional Importance)

Loss of neutral semi-improved grassland

The removal of embankments along the southern boundary of West 1 and West 2 will result in the direct loss of up 5.9 ha of neutral semi-improved grassland. This embankment forms an extensive band of semi-neutral habitat along the northern bank of the Humber Estuary and therefore makes a valuable contribution to the biodiversity of the area. With the exception of the grassland that will be retained on the current embankment (3.4 ha), this represents approximately 64% of neutral semi-improved grassland within the scheme extent. The removal of the embankment in West 1 will fragment the habitat.

Effect without mitigation

Direct, temporary loss of up to 5.9 ha of neutral semi-improved grassland along the West 1 and West 2 embankments.

Significant Negative impact (Certain) at a Regional Level in the Short-Term.

Without intervention it is likely that grassland would naturally develop, although this would take longer and there is greater uncertainty as to what type of grassland would develop.

No significant impact at a Regional Level in the long term (up to 10 years) when the grass develops naturally along the new West 1 flood embankment. The new

embankment will probably replace the ecological functionality of the existing embankment in the long term (up to 10 years).

Marshy grassland (District Importance)

Loss of marshy grassland

The managed realignment in West 1 will result in direct loss of Outstay Scrapes including irreversible loss of up to 2 ha of marshy grassland, which represents all of the marshy grassland within the Scheme Extent.

Effect without mitigation

Direct permanent loss of up to 2 ha of marshy grassland.

Significant Negative impact (Certain) at a District Level.

Standing Water (Local Importance)

Loss of standing water

The managed realignment in West 1 will result in the direct loss of Outstay Scrapes including the irreversible loss off three small to medium size ponds.

Effect without mitigation

Direct and permanent loss of three small to medium ponds with a total area of 0.2 ha. With the exception of the ponds associated with Haverfield Quarry, this represents all ponds within the Scheme Extents.

Significant Negative impact (certain) at a Local Level.

Running Water (Local Importance)

Loss of running water

The managed realignment in West 1 will result in the direct loss of drainage channel along the southern and eastern boundary, which represents just over half the drainage channels within West 1. These drains are of low ecological quality, being trapezoidal, intensively managed through vegetation

clearance and dredging and subject to agricultural runoff which impacts on the water quality in most of the drains. The drainage channels within West 2 are being retained.

Effect without mitigation

Direct permanent loss of approximately 4.8 km of running water (agricultural drainage channels) which represents up to 43% of running water within the Scheme Extents.

Significant Negative impact (certain) at a Local Level.

Hedgerows (Local Importance)

Loss of Hedgerows

The managed realignment in West 1 will result in the direct loss of a recently planted treeline/hedgerow along the southern boundary as well as short sections of defunct species-poor hedgerow between some field boundaries. The hedgerow on the

southern boundary of West 1 is of limited ecological value, due to its size and age, and the many hybrid trees present.

The hedgerow of along the northern boundary of West 1 will be retained. This represents a notable length of defunct species-rich hedgerow, but its ecological potential is limited due to the lack of management. There are also some large gaps between some sections of this hedgerow.

Effect without mitigation

Direct and permanent loss of approximately 1.8 km of hedgerow (approximately 380 m of the total length of lost hedgerow is along relic embankment. This has been calculated based on the loss of 123 trees, 17% of the total length of hedgerow along the relic embankment), which represents just over 50% of hedgerows within the Scheme Extents.

Significant Negative impact (certain) at a Local Level.

Spread of Non-Native Invasive Species (NNIS)

NNIS have been recorded in the Outstay Scrapes and Haverfield Quarries LWS. Any works in these locations present a risk of causing the spread of NNIS in the wild with seeds being spread by boots, equipment, and machinery, contravening legislation. Japanese Rose and cotoneaster are spread by seed and can propagate through vegetative means. Therefore, there is potential risk of spread at any time of year through self-propagation, but there is a greater risk in the late summer when both plants are seed bearing. Ultimately the tidal inundation from the managed realignment will eradicate the NNIS at Outstay Scrapes.

Effect without mitigation

The spread of NNIS across the site and into the wild would contravene legislation. Both species can invade valued natural and semi-natural habitats. Japanese Rose is capable of forming dense thickets where few outher high plant species can grow. Cotoneaster can spread rapidly and have more local impacts on vegetation.

Significant Negative effect (Probable) at a Local Level in the Medium Term (up to 5 years) if the NNIS were to spread, develop and out-compete more desirable wild flowers and grasses and/or both plants were to invade valued natural and semi-natural habitats.

Marsh Harrier (National Importance)

Disturbance to marsh harrier

Site preparation and habitat creation activities in West 2 would result in increased noise and vibration during construction. This will vary depending the type of activity and proximity to Haverfield Quarry. In addition, the presence of site machinery and personnel along the south west boundary of Haverfield Quarry could potentially disturb breeding marsh harrier which are generally quite sensitive to disturbance, affecting their to successfully breed, rear young, and forage during breeding season. In general, nests are more likely to be deserted from early in the nesting attempt to the young chick stage and increasingly less likely when well-grown young are present. Even if nests are not deserted entirely, eggs may chill or be exposed to predation if adults are kept off their nests for long periods, especially in bad weather.

The tall bund to the south west of Haverfield Quarry ponds will be retained and will effectively act as a visual barrier between the works and the ponds during construction. The scrub around the ponds and reedbed within the ponds will also provide dense cover and act as a further visual barrier.

Effect without mitigation

Disturbance from construction activities, particularly early in the breeding season and prior to laying, would result in the likely abandonment of the site, for all breeding females given their proximity to the works. If works are delayed until the young are hatched (c. early June), then adults will be more tolerant and likely to continue to feed the young until fledged, although if disturbance was sufficiently high then this would have the effect of reducing feeding rates (and potentially foraging) and possible mortality of unfledged young.

Timing of nesting can be variable e.g. a late nesting bird was recorded at the EA Goole Hall site. In this instance, it appeared the birds were tolerant of site activity c. 100 m away, although the nest was in any case close to a busy road c. 50m away (although separated by a flood bank) (per comms IECS). In this instance it was agreed to increase the works buffer to 200 m once the nest was identified. The nesting pair were tolerant of disturbance at this distance.

Legislation will be contravened if breeding marsh harriers are disturbed during construction. There is no alternative suitable habitat available on site and suitable sites elsewhere on Humber Estuary are likely to be occupied. The effect is likely to be reversible as construction impacts are temporary.

There is an anticipated negative impact for up to two breeding seasons, extending up to 200m from the nest location/s. Depending on the type of works up to 100% of the local population could abandon the site and/or reduce feeding rates leading to unfledged bird mortality, during construction. Based on this, magnitude of change is high.

Significant Negative effect (Probable) at the National Level in the Short Term (during construction).

Marsh Harrier (National Importance)

Disturbance to Marsh Harrier

Creation of piling wall through Welwick Bushes has the potential to disturb breeding Marsh Harrier at Haverfield Quarry ponds. The ponds (typical nesting locations) are located over 500 m north-west of the piling wall. Humber Estuary SSSI - unit 152 is located between the two locations. The undulating ground and scrub, and the dense scrub and reedbed surrounding/within the ponds, will act as a natural visual barrier between the works and the breeding site.

The piling at Welwick Bushes will result in noise levels at Haverfield Quarry Ponds of 40 dB, which is the same as the background noise levels.

Any noise from the piling works will be almost imperceptible. Piling works are proposed in mid-summer (ideally July), to minimise disturbance to estuarine birds. The works are expected to take two weeks to complete.

Effect without mitigation

The works are at a sufficient distance that any disturbance impacts are highly unlikely.

No Significant impact (Certain) at a National Level in Short Term.

Marsh Harrier (National Importance)

Loss of marsh harrier foraging habitat

Marsh Harriers hunt over many types of open areas, including reedbeds, saltmarshes, heathlands and arable farmland. The loss of arable farmland in West 1 and West 2 and the associated habitats along the embankment and drainage channels is likely to impact on food availability (small mammal, farmland bird and reptile populations) and the subsequent foraging success of marsh harrier within the scheme extents. Males may hunt up to 7 km from their nesting territory. Females have smaller home ranges, but these increase in size when they start to feed young (from 100–1,300 ha) (Hardey *et al*, 2013).

Effect without mitigation

Male marsh harriers have a large home range and are likely to successfully forage in alternative habitat during construction. Female marsh harriers have a smaller home range and could be more susceptible to the temporary loss of habitats and subsequent decline of prey. Possible negative effect on female marsh harrier foraging success for up to five years. There are alternative foraging habitats to the north of Haverfield Quarry (arable farmland) and at Welwick Saltmarsh, which will be unaffected by construction activities. Based on this, the magnitude of change is low. The effect is likely to be reversible as construction impacts are temporary.

Significant Negative effect (Possible) at the District Level in the Medium Term (up to 5 years).

Barn Owl (District Importance)

Loss of barn owl foraging habitat

Removal of West 1 embankment during construction will removal higher value foraging habitat for barn owls. Other lower value habitats or seasonal habitats (winter cereal crops, hedgerow and scrub) will also be lost during the construction of the managed realignment area. Visual disturbance from construction activities and human presence across West 1 and West 2, affecting the ability of barn owls to hunt during construction. There will be a negative impact across West 1 and West 2, affecting the local barn owl population to varying extents over two years.

Effect without mitigation

Temporary displacement from site (due to loss of foraging habitat and/or disturbance). Negative effect on hunting success for up to 2 years. Alternative foraging habitat is available outside of the scheme boundary. Based on this, the magnitude of change is low.

Given the lack of nesting opportunities within the scheme boundary, no disturbance of breeding birds is anticipated. The effect is likely to be reversible as construction impacts are temporary.

Significant Negative effect (Probable) at a Local Level in the Medium Term (up to 5 years).

Farmland birds (District Importance)

Loss of farmland bird (nesting and foraging) habitat

The restoration of Haverfield Quarries LWS will result in the direct loss of scrub and nesting opportunities for farmland birds. As described previously, the scrub is of even size and age, with little structural diversity. This benefits a small diversity of farmland birds, compared to its potential value if it was managed to promote structural diversity. As well as being an important breeding habitat, scrub is an important source of food for autumn passage migrants and winter visitors. Hedgerows and broad-leaved plantation woodland within the managed realignment will be lost, removing nesting opportunities for farmland birds. Arable fields will be lost in West 1. The arable field boundaries are narrow and species poor, and present poor-quality habitat for farmland birds, compared to its potential value if it was managed to promote wider field boundaries. Breeding habitat will largely be maintained across Haverfield Quarry and along the northern boundary of West 1.

Effects without mitigation

There will be a negative effect on breeding success through the reduction in nesting and foraging opportunities. This would potentially contravene legislation if vegetation clearance is carried out during the breeding bird period (March – August inclusive). Alternative foraging habitat is available outside of the scheme boundary and much of the habitat within Haverfield Quarry will be retained and improved. Based on this, the magnitude of change is medium.

Direct loss of up to 3.6 ha of scrub (approximately 29% of scrub on site). Direct loss of 1.8 m of hedgerow (just over 50% of hedgerows on site). Direct loss of 0.3 ha of broadleaved plantation (100% of broadleaved plantation). Permanent loss of approximately 30-40% of the nesting and foraging habitat.

Significant Negative effect (Certain) at the Local Level.

Reptiles (Regional Importance)

Killing and injury to reptiles

The removal of West 1 embankment during construction will remove basking, foraging and hibernation habitat for reptiles. The managed realignment in West 1 will result in the loss of Outstray Scrapes and the associated reptile population. Any reptiles retained on the Outstrays Triangle will be isolated by over 500 m of saltmarsh/mudflat habitats (at its closest point).

Effect without mitigation

There will be a permanent loss of reptile population along the West 1 embankment and Outstray Scrapes and the population unlikely to recover in the long term. Based on this, the magnitude of change is high. Isolation, which could lead to potential local extinction of retained population at Outstrays Triangle. Contravenes legislation by killing and injuring reptiles.

Significant Negative impact (Certain) at the Regional level.

Water Vole (District Importance)

Disturbance to water vole

There is likely to be frequent works activity along this northern boundary of West 1 (area adjacent to East Clough) during construction of the new embankment, including regular movement of heavy machinery and removal of some of the hedgerow along the relic embankment. There is a risk any water vole populations in East Clough could be disturbed during construction and abandon the burrows. The relic embankment (tall bund) along the northern boundary of West 1 will be retained and will effectively act as a visual barrier between the works East Clough, during construction. Approximately 83% of the hedgerow along the top of the relic embankment will be retained and will also provide cover and act as a further visual barrier. East Clough/Newlands Drain occasionally dry up and water voles are naturally displaced, typically on an annual basis.

Effect without mitigation

Potential for temporary displacement from East Clough/Newlands Drain during construction, due to regular visual and noise disturbance to the south of East Clough.

Significant negative effect (Possible) at the Local Level in the Short Term (during construction)

Otter (Regional Importance)

Disturbance to otter

The preparation of the site and the habitat creation activities in West 2, would result in increased noise and visual disturbance during construction, affecting the ability of otter at Haverfield Quarry to seek refuge/shelter and foraging opportunities. This will vary depending on the type of activity and proximity to Haverfield Quarry.

The creation of a piling walls within Winestead Drain at Winestead Pumping Station and the presence of site workers and machinery along Oxlands Drain, Welwick Drain and Soak Dike could disturb otters whilst they try to access Haverfield Quarry and Welwick Saltmarsh.

This would affect the ability of otter to access or leave Haverfield Quarry. The tall bund to the south of the Haverfield Quarry ponds will be retained and will effectively act as a visual barrier between the works and the ponds, during construction. The scrub around the ponds and reedbed within the ponds will also provide dense cover and act as a further visual barrier.

Effect without mitigation

Possible temporary displacement of otter population from Haverfield Quarry and abandonment of site, during constriction. Based on this, the magnitude of change is high. This potentially contravenes legislation if otter are disturbed during construction. Reversible as construction is for two years and otter are likely to return during operation.

Significant Negative effect (Possible) at a Regional scale in the short term (During Construction).

Great Crested Newt (Local Importance)

Incidental mortality during site clearance/construction

This is risk of disturbance of habitats within 500 m of great crested newt population at Haverfield Quarry, caused by habitat creation activities in West 2. The habitat creation activities in West 2 will be carried out entirely on arable farmland, which represents poor quality habitat for amphibians. The narrow field boundaries (which represent some potential refuge value for amphibians), along the southern boundary of Haverfield Quarry and along the banks of Oxlands and Welwick Drain, will be unaffected by the works in West 2. The core habitat within Haverfield Quarry will be unaffected, with the exception of possible minor disturbance during habitat restoration activities in Haverfield Quarry.

Effect without mitigation

There is possible risk of GCN being present in West 2 during construction and possible risk of killing and injuring or disturbing GCN, if present. Any impacts are likely to affect a small number of individuals, which is likely to account for a negligible proportion of the total population. Works will not affect the conservation status of the local population. Given the size and extent of the habitat creation works in West 2 and proximity to the GCN meta-population, there is a small risk of GCN being present in West 2, which could result in a possible significant negative effect at a less than Local scale. Based on this, the magnitude of change is very low.

Significant Negative impact (Possible) at a less than Local Level in the Short Term (during construction).

Badger (Local Importance)

Details for badger can be provided on request, these are held in a confidential appendix.

The badger populations at Welwick to Skeffling Managed Realignment scheme are deemed to be of **local importance.**

Loss and disturbance of badger setts

The managed realignment in West 1 will result in the loss of a single outlier which was partially active in 2015 with no evidence of use in 2016 or 2017. A cluster of five lower status setts are likely to be disturbed and potentially damaged. The main sett associated with these lower status setts will be unaffected by the works. There are likely to be alternative outlier setts associated with this clan outside of the zone of influence of the scheme.

Works in West 2 will result in the loss of a single possible annex which was recently excavated in 2017 and has showed regular evidence of use throughout 2018. The size of the spoil heaps outside the sett entrances suggest this is currently used as an annex sett. A main sett with associated lower status setts will also possibly be disturbed through works in West 2. An existing tall bund which will be retained, and dense hawthorn scrub will effectively act as visual barriers between the works and main badger sett. There are alternative setts associated with this clan, which will be unaffected by the works.

Effect without mitigation

The certain loss of a single outlier sett is unlikely to affect the population or its conservation status due to their being little evidence of its use. There is probable disturbance of up to six outlier setts within West 1 and possible disturbance of the main

sett. The certain loss of a single possible annex sett is unlikely to effect on the population or its conservation status given that a large number of setts including the main sett will be retained. Based on this, the magnitude of change is low.

Significant Negative effect (Certain) at a less than Local Level in the short term (during construction).

Badger (Local Importance)

Loss of badger habitat within West 1

The managed realignment in West 1 will permanently displace badgers and reduce the available foraging habitat for the local badger population. No evidence of badger has been recorded east of Outstray Scrapes, this suggests areas to the east of Outstray Scrapes are outside of the normal home range of the local badger clan. It also suggests there is no or little competition from other badger clans within the site boundary. A small number of badger latrines have been recorded within West 1, which suggests that individuals from the local badger clan occasionally forage in this area. The effect is to cause permanent displacement of badgers from the West 1 area. As the adjacent landscape is dominated by arable fields like those in West 1, there is ample alternative habitat for this species.

Effect without mitigation

There will be permanent loss of badger foraging habitat in West 1, including arable farmland and scrub habitat. As the adjacent landscape is dominated by arable fields like those in West 2, there is ample alternative habitat for this species. Based on this, the magnitude of change is low.

Significant Negative effect (Unlikely) at a less than Local Level.

Amphibians (Except Great Crested Newt) (Local Importance)

Loss of amphibian habitat

The managed realignment in West 1 will result in the permanent loss of the ponds and associated habitats at Outstray Scrapes and subsequently, the associated amphibian population. There are no other ponds within 2.5 km of Outstray Scrapes, so the amphibian population is effectively an isolated population. As the adjacent landscape is dominated by arable fields like those in West 1, there is no alternative habitat for this species.

Effect without mitigation

The loss of Outstray Scrapes will result in the permanent loss of amphibian habitat and therefore populations at this location. Based on this, the magnitude of change is high.

Significant Negative impact (Certain) at the Local Level.

Sea Aster Mining Bee (National Importance)

Damage/disturbance to sea aster mining bee

The presence of site workers during the construction of the piling wall in Welwick Bushes has the potential to inadvertently trample and subsequently damage sea aster mining bee nests. Occasional tramping is unlikely to have any impact on the

conservation status of the population, but regular trampling could damage the entrance to the nests and expose the colony, which could lead to incidental mortality. The main colony is located to the south east end of Welwick Bushes but smaller nests are also located at the western end close to the piling works. Loss or damage to the sea aster mining bee colony in Welwick Bushes could affect the population or its conservation status.

Effect without mitigation

Construction activities, in particular the presence of site workers, could possibly cause damage the sea aster mining bee colony in West 2. The colony at Welwick Bushes represent almost the entire local population. Any impacts are likely to be restricted to the western end which is likely to represent less than 5% of the local population. Based on this, the magnitude of change is low.

Significant Negative effect (possible) at a District Level in the short term (during construction).

Assemblage of Invertebrates at Outstray Scrapes (District Value)

Loss of invertebrate habitat

The managed realignment in West 1 will result in the permanent loss of Outstray Scrapes and the associated invertebrate population. Outstray Scrapes supports a small assemblage of regionally scarce invertebrates. Many of these species are unavoidably scarce, as they are restricted to coastal areas with saltmarshes, brackish ditches, costal grasslands and other similar habitats, all of which are scare in South Holderness. Where these habitats exist, the species recorded at Outstray Scrapes are locally common and occur in abundance in suitable habitat around the British coast.

Effect without mitigation

The loss of Outstray Scrapes will result in the permanent loss of the assemblage of invertebrates at Outstray Scrapes. Based on this, the magnitude of change is high. Species will readily re-colonise new saltmarsh and other wetland habitats, from areas elsewhere on the estuary.

No Significant effect (Probable) at a District Level in the Medium Term (up to 5 years), when the saltmarsh habitats develop in West 1 and the species naturally recolonise the site.

Freshwater fish (District Value)

Disturbance to fisheries

The creation of the piling wall in Winestead Drain for Winestead Pumping Station has the potential to disturb fish population. Piling (vibro-piling) will be undertake in the freshwater side of the pumping station where the water depths are between 0.5-1.5 m across the channel with the edges (where piling will take place) being in depths of 1.2 m.

Vibro-piling is recognised as a quieter method for piling and often used as a mitigation measure to protect fish. The frequency range of vibro-piling equipment is generally between 20 and 40 Hz (based on a 2.6 m pile diameter) and has a Peak Sound Level of around 143 dB re 1 µPa. Whilst Cyprinidae are the most sensitive family to sound and have a threshold of 106 dB re 1 µPa at 40 Hz, it is unlikely that vibro-piling

combined with the soft-start/ramp up would have an adverse effect on the fish population. Any noise from the vibro-piling will dissipate (absorbed into the river bed and earth banks but refracted off the river surface) quickly bringing any adverse noise level to below their hearing threshold within a relatively short distance.

Effect without mitigation

The use of the vibro-piling method is inherent mitigation. No significant effect (Probable) at a District Level in the Short Term (During Construction).

Brown Hare (Local Value)

Disturbance to brown hare

The construction activities in West 2 will include the use of machinery and the presence of teams of site workers. Brown hare, which forage in West 2 and seek shelter in Haverfield Quarry, are likely to be temporarily displaced from West 2 during construction. There will be a negative impact across West 2, affecting 100% of the local population to varying extents over two years. Although the level of disturbance is likely to reduce the suitability of the site for brown hare, suitable alternative habitat is found adjacent to the site. The impacts of construction disturbance and temporary land take are short term.

Effects without mitigation

Construction activities could possibly cause the temporary displacement of brown hare from West 2. As the adjacent landscape is dominated by arable fields like those in West 2, there is ample alternative habitat for this species.

Significant Negative impact (Possible) at the less than Local Level in the Short Term (During construction).

10.4.1.2 Operation

Marsh Harrier (National Importance)

Disturbance to marsh harrier

The creation of the bridleway through Haverfield Quarry and improved access routes across the site will facilitate increased numbers of visitors to Haverfield Quarry.

Currently Haverfield Quarry is a quiet and remote location which has very low visitor numbers, these typically being a small number of locals, local birdwatchers and rarely people walking from the holiday park at Patrington Haven. The ponds at Haverfield Quarry are subject to minimal disturbance and most areas are inaccessible due to dense scrub.

The improved access across the site may increase visitor numbers. Currently Welwick Saltmarsh is one of the least known wildlife sites, which is owned and managed by the Wildlife Trust (ICRT, 2010). Depending on the success of the Scheme on attracting estuarine birds and other wildlife, there could be a notable increase in visitor numbers.

Spurn Point is located to the east of the site and attracts an estimated 48,000 visitors a year (Natural England, 2006). Improved awareness of the site could attract a notable number of visitors, especially given the proximity to Spurn Point which is a well-known wildlife site. Visitors could increase disturbance through general noise and people

accessing areas outside of the designated bridleway. People accessing the edge of the pond, particularly those with dogs, could displace breeding marsh harrier from the site and potentially cause site abandonment.

Marsh Harrier generally require nest sites in areas that are largely free from human activity. Marsh Harriers require open freshwater wetlands with dense, tall vegetation (particularly reedbeds) for nesting.

Effect without mitigation

There is no alternative habitat available on site and suitable sites elsewhere on the Humber Estuary are already likely to be occupied by Marsh Harrier. There is a possible permanent negative effect on breeding success for up to 2 breeding pairs. Based on this, the magnitude of change is high.

Significant Negative effect (Possible) at the National Level.

Otter (Regional Importance)

Disturbance to otter

The creation of the bridleway through Haverfield Quarry and improved access routes across the site will facilitate increased numbers of visitors to Haverfield Quarry (as described in marsh harrier operational impacts).

Although otters can tolerate occasional disturbance, the less disturbed a site, the higher the possibility that otters may use sites.

Effect without mitigation

There is possible permanent displacement of otter population from Haverfield Quarry and abandonment of site. Based on this, the magnitude of change is high.

Significant Negative effect (Possible) at a Regional scale.

10.4.2 Welwick to Skeffling Managed Realignment

10.4.2.1 Construction

Scrub (Local Importance)

Creation and translocation of scrub

Scrub planting as part of the habitat creation and mitigation area will result in an increase in the total area of scrub across the Scheme Extents.

Up to 2 ha of scrub creation/planting is proposed across the habitat creation and mitigation area. The locations have been selected to expand sections of retained hedgerow and provide new pockets of scrub within the fields. Stakeholders have requested that scrub should be translocated from local sources i.e. Welwick Bushes and Hodgson's Fields Nature Reserve (Both YWT sites) rather than using nursery plants. This approach could provide cross party benefits, as scrub removal in the sites mentioned above will help promote desirable grassland habitats. Translocating more established scrub plants onto the habitat creation and mitigation area will ensure the

plants are of local provenance and provide benefits in terms of cover and refuge in a shortened time frame compared to planting young nursery plants.

The scrub planting should be designed to benefit target faunal receptors. Scrub planting will:

- be locally sourced (as per guidance in Forestry Commission Practice note FCPN008);
- promote a mixed aged stand of scrub; and
- promote a patchy distribution with habitat mosaics.

An Environmental Monitoring and Maintenance Plan will be produced by the Main Works Contractor, in consultation with the Site Manager, the EA, and Natural England. This plan will include specific targets to promote growth, development, and distribution of scrub, which will be finalised as the Scheme progresses. A site manager will be appointed to manage and monitor the site. The first 10 years of site management is included in the Scheme costs, and it is anticipated that management and monitoring will continue in the long term.

Effect without mitigation

There will be permanent gain of up to 2 ha of scrub in the habitat creation and mitigation area.

Significant Positive impact (Certain) at a Local Level in the Long Term (up to 10 years), when the scrub develops and matures in the habitat creation and mitigation area.

Neutral semi-improved grassland (Regional Importance)

Loss of semi-improved neutral grassland

The removal of the existing embankment along the southern boundary of East 1, 2 and 3 will result in the direct loss of 5.3 ha of neutral semi-improved grassland.

The embankment forms an extensive band of semi natural habitat along the northern bank of the Humber Estuary and therefore makes a valuable contribution to the biodiversity of the area.

Removal of the East 1, 2 and 3 embankment will fragment the habitat.

With the exception of the sections of embankment which are being retained (<1 ha), this represents the majority of neutral semi-improved grassland within the Scheme Extents.

Effect without mitigation

Direct temporary loss of up to 5.3 ha of neutral semi-improved grassland along the East 1, 2 and 3 embankments.

Significant Negative impact (Certain) at a Regional Level in the Short Term (1-2 years) due to the direct loss of grassland along the West 1 embankment.

Without any intervention, it is likely that grassland would naturally develop on the embankments, although this would take longer and there is greater uncertainty as to what type of grassland would develop.

No Significant impact (Probable) at a Regional Level in Long Term (up to 10 years), when the grass develops along the new West 1 flood embankment. The new

embankment will probably replace the ecological functionality of the old embankment in the long term (up to 10 years).

Standing water (Local Importance)

Loss of standing water

The managed realignment will result in the direct loss of two ponds (former slurry lagoons along Sheep Trod Lane) in East 1, a single pond (large slurry lagoon) in East 2 and five small to medium sized ponds in East 3.

All ponds in East 3 are located in the centre of agricultural land, which is either heavily grazed or in the centre of an arable field. They all show signs of eutrophic conditions and half of them are badly affected, dominated by dense filamentous algae. The ponds in the centre of arable fields are ephemeral and do not support any vegetation.

Two defunct drains (in the habitat creation and mitigation area), which are effectively acting as ponds, will be retained.

Effect without mitigation

There will be direct permanent loss of eight small to medium sized ponds. Total area is 0.4 ha. Up to 95 % of the ponds (based on total area) within the scheme boundary will be lost. All ponds in East 2 and 3 will be lost.

Significant Negative impact (Certain) at a Local Level.

Running water (Local Importance)

Loss of running water

The managed realignment in East 1, 2 and 3 will result in the direct loss of 4 km of drainage channels.

The drains are of low ecological quality, being trapezoidal, intensively managed through vegetation clearance and dredging and subject to agricultural runoff which impacts on the water quality in most drains.

Effect without mitigation

Direct permanent Loss of 4 km of running water (agricultural drainage channels), which represents up to 71% of running water within the Scheme Extents.

Significant Negative impact (Certain) at a Local Level.

Hedgerows (Local Importance)

Loss of hedgerows

The managed realignment in East 1, 2 and 3 will result in the direct loss of predominantly short sections of defunct species-poor hedgerow between some field boundaries. Hedgerows within the habitat creation and mitigation area and along Humber Side Lane will be retained.

All the hedgerows are species poor, dominated by hawthorn. The arable field typically extends directly up to the hedgerows, subsequently the hedgerows have minimal ground flora.

Effect without mitigation

Direct permanent Loss of 2.6 km of hedgerow, which represents 66% of hedgerows within the Scheme Extents.

Significant Negative impact (Certain) at a Less than Local Level.

Potential spread of non-native invasive species (NNIS)

NNIS have been recorded on the embankment next to Burning Ground. Any works in this location presents a risk of causing the spread of NNIS in the wild, contravening legislation.

Variegated yellow archangel can propagate through vegetative means. Stolon fragments can grow into a new colony. Stolons break readily if the plant is pulled up.

Effect without mitigation

Probable spread of NNIS across the site and into the wild, which would contravene legislation.

Variegated yellow archangel can invade valued natural and semi-natural habitats. It can form a dense carpet which excludes other plants.

Significant Negative effect (Possible) at a Local Level in the Medium Term (up to 5 years), when the NNIS spread, develop and invade valued natural and semi-natural habitats.

Marsh Harrier (National Importance)

Disturbance to marsh harrier

Site preparation and habitat creation activities in the habitat creation and mitigation area adjacent to East 1 would result in increased noise and vibration during construction. This will vary depending the type of activity and proximity to Haverfield Quarry. In addition, the presence of site machinery and personnel along the south east boundary of Haverfield Quarry could potentially disturb breeding marsh harrier which are generally quite sensitive to disturbance, affecting their to successfully breed, rear young, and forage during breeding season. In general, nests are more likely to be deserted from early in the nesting attempt to the young chick stage and increasingly less likely when well-grown young are present. Even if nests are not deserted entirely, eggs may chill or be exposed to predation if adults are kept off their nests for long periods, especially in bad weather.

The scrub around the ponds and reedbed within the ponds will provide dense cover and act as a visual barrier between the works and the ponds during construction.

Effect without mitigation

Disturbance from construction activities, particularly early in the breeding season and prior to laying, would result in the likely abandonment of the site, for all breeding females given their proximity to the works. If works are delayed until the young are hatched (c. early June), then adults will be more tolerant and likely to continue to feed the young until fledged, although if disturbance was sufficiently high then this would have the effect of reducing feeding rates (and potentially foraging) and possible mortality of unfledged young.

Timing of nesting can be variable e.g. a late nesting bird was recorded at the EA Goole Hall site. In this instance, it appeared the birds were tolerant of site activity c. 100 m away, although the nest was in any case close to a busy road c. 50m away (although separated by a flood bank) (*pers. comms.* IECS). In this instance it was agreed to increase the works buffer to 200 m once the nest was identified. The nesting pair were tolerant of disturbance at this distance.

Legislation will be contravened if breeding marsh harriers are disturbed during construction. There is no alternative suitable habitat available on site and suitable sites elsewhere on Humber Estuary are likely to be occupied. The effect is likely to be reversible as construction impacts are temporary.

There is an anticipated negative impact for up to two breeding seasons, extending up to 200 m from the nest location/s. Depending on the type of works up to 100% of the local population could abandon the site and/or reduce feeding rates leading to unfledged bird mortality, during construction. Based on this, magnitude of change is high.

Significant Negative effect (Probable) at the National Level in the Short Term (during construction).

Marsh Harrier (National Importance)

Loss of marsh harrier foraging habitat

Marsh Harriers hunt over many types of open areas, including reedbeds, saltmarshes, heathlands and arable farmland. The loss of arable farmland in East 1, 2 and 3 and the associated habitats along the embankment and drainage channels is likely to impact on food availability (small mammal, farmland bird and reptile populations) and the subsequent foraging success of marsh harrier within the scheme extents. Males may hunt up to 7 km from their nesting territory. Females have smaller home ranges, but these increase in size when they start to feed young (from 100–1,300 ha) (Hardey *et al*, 2013).

Effect without mitigation

Male marsh harriers have a large home range and are likely to successfully forage in alternative habitat during construction. Female marsh harriers have a smaller home range and could be more susceptible to the temporary loss of habitats and subsequent decline of prey. Possible negative effect on female marsh harrier foraging success for up to five years. There are alternative foraging habitats to the north of Haverfield Quarry (arable farmland) and at Welwick Saltmarsh, which will be unaffected by construction activities. Based on this, the magnitude of change is low. The effect is likely to be reversible as construction impacts are temporary.

Significant Negative effect (Possible) at the District Level in the Medium Term (up to 5 years).

Barn owl (Regional Importance)

Loss of foraging habitat

Removal of East 1, East 2 and East 3 embankment during construction will remove high value foraging habitat for barn owls. Other lower value habitats or seasonal habitats (winter cereal crops and hedgerow) will also be lost during the construction of the managed realignment area.

Visual disturbance from construction activities and human presence across the Scheme, affecting the ability of barn owls to hunt during construction.

There will be a negative impact across the Scheme, affecting the local barn owl population to varying extents over two years.

Effect without mitigation

Temporary displacement from site, due to loss of foraging habitat and/or disturbance. Negative effect on hunting success for up to 2 years. Alternative foraging habitat is available outside of the scheme boundary. The effects are reversible as construction is for two years.

Based on this, the magnitude of change is low.

Significant Negative effect (Probable) at a District Level in the Medium Term (up to 5 years).

Barn owl (Regional Importance)

Loss of barn owl nesting habitat

To facilitate the construction of the new embankment and the removal of the current embankment, a barn owl box at Sheep Trod Lane and one on Burstall Bank will be lost, removing all the available barn owl nesting habitat on site.

Effect without mitigation

Permanent loss of nesting features. There is likely to be alternative nesting habitat in farm buildings outside of the scheme boundary. Based on this, the magnitude of change is medium.

Significant Negative effect (Certain) at a District Level.

Short eared owl (Regional Importance)

Loss of foraging (over wintering) habitat

Works are programmed during the spring and summer seasons, from April to the end of September each year, to minimise impacts on over-wintering birds in the Humber Estuary.

From October to March each year a small number of staff are likely to be on site for security and to carry out vegetation clearance that cannot be done in spring or summer. All these activities are located a considerable distance from Welwick Saltmarsh and the East 1, East 2 and East 3 embankment.

Effect without mitigation

The works will avoid the short eared owl over-wintering period. Any activities during the winter will be commensurable with typical levels of activity along the embankment, such as farming activities and members of the public using the embankment.

No significant effect (Probable) at a Regional Level in the Short Term (During Construction).

Farmland birds (Local Importance)

Loss of farmland bird (nesting and foraging) habitat

Hedgerows within the managed realignment will be lost, removing nesting opportunities for farmland birds.

Arable fields will be lost in East 1, East 2 and East 3. The arable field boundaries are narrow and species poor, and present poor-quality habitat for farmland birds, compared to its potential value if it was managed to promote wider field boundaries.

Breeding habitat (hedgerows) will be maintained across the habitat creation and mitigation area.

Effect without mitigation

Negative effect on breeding success through the reduction in nesting and foraging opportunities.

Potentially contravenes legislation if vegetation clearance is carried out during the breeding bird period (March – August inclusive).

Direct loss of 2.6 km of hedgerow (approximately 66% of hedgerows on site). Alternative foraging habitat is available outside of the scheme boundary (Haverfield Quarry). Based on this, the magnitude of change is medium.

Permanent loss of nesting and foraging habitat. Significant Negative effect (Certain) at the Local Level.

Reptiles (Regional Importance)

Killing and injury to reptiles

Removal of East 1, East 2 and East 3 embankment during construction will remove basking, foraging and hibernation habitat for reptiles.

Other populations at Sheep Trod Lane and Long Lane are likely to be displaced, either through the construction of the new embankment and/or the tidal inundation of the site resulting from the breach.

Effect without mitigation

Permanent loss of reptile population along the East 1, East 2 and East 3 embankment. Population unlikely to recover in the long term. Based on this, the magnitude of change is high.

Contravenes legislation by killing and injuring reptiles.

Significant negative impact (Certain) at the Regional level.

Water Vole (District Importance)

Loss of water vole habitat

In order to construct the flood embankment, all the drains within the managed realignment will be destroyed and a new drain will be created along the dry-side toe of the flood embankment to re-divert any flow.

A new creek channel will be created within the managed realignment area. The tidal inundation of the site resulting from the breach will result in the creeks becoming intertidal over time. This inundation will result in increased levels of salinity within the creeks, making the habitat unsuitable for water vole.

At present, the drains provide variable habitat quality for water vole. Some drains provide suitable habitat (typically in the Spring), but the value is regularly lost or degraded through intensive management (dredge and strip the entire ditch of vegetation) and lack of water in the drain, causing them to dry out. In addition, mink, which prey on water vole are confirmed to be present at the site.

Water vole populations fluctuate and expand, and the effect of habitat loss will be to reduce the carrying capacity of the site for any future water vole population.

Any population in Welwick Drain will be unaffected by the works.

Effect without mitigation

Permanent displacement from the drainage channels in East 1, 2 and 3 during construction, due to the tidal inundation. Based on this, the magnitude of change is high.

Significant negative impact (Certain) at the District Level in the Short Term (during construction).

Otter (Regional Importance)

Disturbance to otter

The presence of site workers and machinery along Welwick Drain and Soak Dike could disturb otters whilst they try to access Haverfield Quarry and Welwick Saltmarsh. This would affect the ability of otter to access or leave Haverfield Quarry.

Effect without mitigation

Possible temporary displacement of otter population from Haverfield Quarry and abandonment of site, during constriction.

Potentially contravenes legislation if otters are disturbed during construction.

Reversible as construction is for two years and otter are likely to return during operation.

Significant Negative effect (Possible) at a Regional scale in the short term (During Construction)

Great Crested Newt (Local Importance)

Disturbance and risk of killing/injury to great crested newt – Humber Farm meta population

Disturbance of habitats within 500 m of great crested newt population at Humber Farm, caused by the construction of the new flood embankment in East 1 and East 2.

The flood embankment will be constructed along arable farmland, which represents poor quality habitat for amphibians.

The core habitat at Humber Farm will be unaffected.

Effect without mitigation

Possible risk of GCN being present in East 1 and East 2 during construction and possible risk of killing and injuring or disturbing GCN, if present.

Any impacts are likely to affect a small number of individuals, which is likely to account for a negligible proportion of the total population. Works will not affect the conservation status of the local population.

Given the size and extent of the works and proximity to the GCN meta-population, there is a small risk of GCN being present in East 1 and East 2, which could result in a possible significant negative effect at a less than local scale.

Significant Negative effect (Possible) at a less than Local Level in the Short Term (during construction).

Badger (Local Importance)

Loss of badger habitat in East 1, East 2, and East 3

The managed realignment in East 1, East 2 and East 3 will permanently displace badgers and reduce the available foraging habitat for the local badger population.

With the exception of two areas, no evidence of badger has been recorded within the Scheme extents. All main setts and primary foraging habitats are located outside of the site boundary or in areas which will be unaffected by the works.

The badger clan within these two areas is likely to occasionally forage in the arable field in East 1 (seasonally) - the primary habitat in these areas will be retained. Given that arable fields dominate the wider landscape, there is a large area of alternative habitat available for this clan.

Similarly, the badger clan to the south-east of Skeffling is likely to occasionally forage in the arable fields in East 3. The fields where the badger setts are located will be retained and higher value habitat around Skeffling village will remain unaffected by the works.

The fields in East 2 are typically over 1 km from the nearest badger clan and are unlikely to be within the normal home range of the local badger clans.

Effect without mitigation

Permanent loss of secondary value badger foraging habitat in East 1, East 2 and East 3, predominantly arable farmland. The primary foraging habitat and main setts are unaffected. As the adjacent landscape is dominated by arable fields like those in East 1, East 2 and East 3, there is ample alternative habitat for this species.

Significant Negative effect (Unlikely) at a less than Local Level.

Sea Aster Mining Bee (National Importance)

Cessation of sheep grazing at Welwick Bushes during construction

Sheep grazing maintains a short sward at Welwick Bushes and occasional trampling on the banks maintain the vertical sand banks. These actions maintain the entrances to the sea aster mining bee nests.

Welwick Bushes is required as a temporary displacement site for reptiles during construction (see reptile mitigation strategy). To create a suitable displacement site for reptile populations a tall sward needs to be maintained, so the current management (sheep grazing) will cease during construction.

The cessation of sheep grazing over a two-year period during construction could cause the entrances of the sea aster mining bee nests to vegetate over. This could degrade the value of the nesting habitat by restricting or blocking access to the exposed sandy banks.

Effect without grazing

Degrading the nesting habitat could cause a decline in the sea aster mining bee colony. The magnitude of impact is unclear, but sea aster mining bee are unlikely to use vegetated banks. So, the impact largely depends on the rate of vegetation colonisation.

Significant Negative effect (possible) at a National Level in the short term (during construction).

10.4.2.2 Operation

Marsh Harrier (National Importance)

Disturbance to marsh harrier

The creation of the designated bridleway along the line of the new embankment and the provision of a new car park south of Weeton will facilitate increased numbers of visitors to Haverfield Quarry.

Currently Haverfield Quarry is a quiet and remote location which has very low visitor numbers, these typically being a small number of locals, local birdwatchers and rarely people walking from the holiday park at Patrington Haven. The ponds at Haverfield Quarry are subject to minimal disturbance and most areas are inaccessible due to dense scrub.

The improved parking and access across the site may increase visitor numbers. Currently Welwick Saltmarsh is one of the least known wildlife sites, which is owned and managed by the Wildlife Trust (ICRT, 2010). Depending on the success of the scheme on attracting estuarine birds and other wildlife, there could be a notable increase in visitor numbers.

Spurn Point is located to the east of the site and attracts an estimated 48,000 visitors a year (Natural England, 2006). Improved awareness of the site could attract a notable number of visitors, especially given the proximity to Spurn Point which is a well-known wildlife site. Visitors could increase disturbance through general noise and people accessing areas outside of the designated footpath. People accessing the edge of the pond, particularly those with dogs, could displace breeding marsh harrier from the site and potentially cause site abandonment.

Marsh Harrier generally require nest sites in areas that are largely free from human activity. Marsh Harriers require open freshwater wetlands with dense, tall vegetation (particularly reedbeds) for nesting.

Effect without mitigation

There is no alternative habitat available on site and suitable sites elsewhere on the Humber Estuary are already likely to be occupied by Marsh Harrier. There is a possible permanent negative effect on breeding success for up to 2 breeding pairs. Based on this, the magnitude of change is high.

Significant Negative effect (Possible) at the National Level.

Sea Aster Mining Bee (National Importance)

Damage/disturbance to sea aster mining bee

Improvements to the eastern scheme public access route and the provision of new car park at Haverholme Lane, will facilitate increased numbers of visitors to Welwick Bushes.

Currently Haverfield Quarry is a quiet and remote location which has very low visitor numbers, these typically being small number of locals, local birdwatchers and rarely people walking from the holiday park at Patrington Haven.

The footpath and improved parking across the site is likely to increase visitor numbers. Currently Welwick Saltmarsh is one of the least known wildlife sites, which is owned and managed by the Wildlife Trust. Depending on the success of the scheme on attracting estuarine birds and other wildlife, there could be a notable increase in visitor numbers.

Spurn Point is located to the east of the site and attracts an estimated 48,000 visitors a year. Improved awareness of the site could attract a notable number of visitors, especially given the proximity to Spurn Point which is a well-known wildlife site.

Visitors inadvertently trample and subsequently damage sea aster mining bee nests through accessing areas outside of the designated footpath.

Occasional tramping is unlikely to have any impact on the conservation status of the population, but regular trampling could damage the entrance to the nests and expose the colony, which could lead to incidental mortality.

The main colony is located in Welwick Bushes. Loss or damage to the sea aster mining bee colony in Welwick Bushes could affect the population or its conservation status.

Effect without mitigation

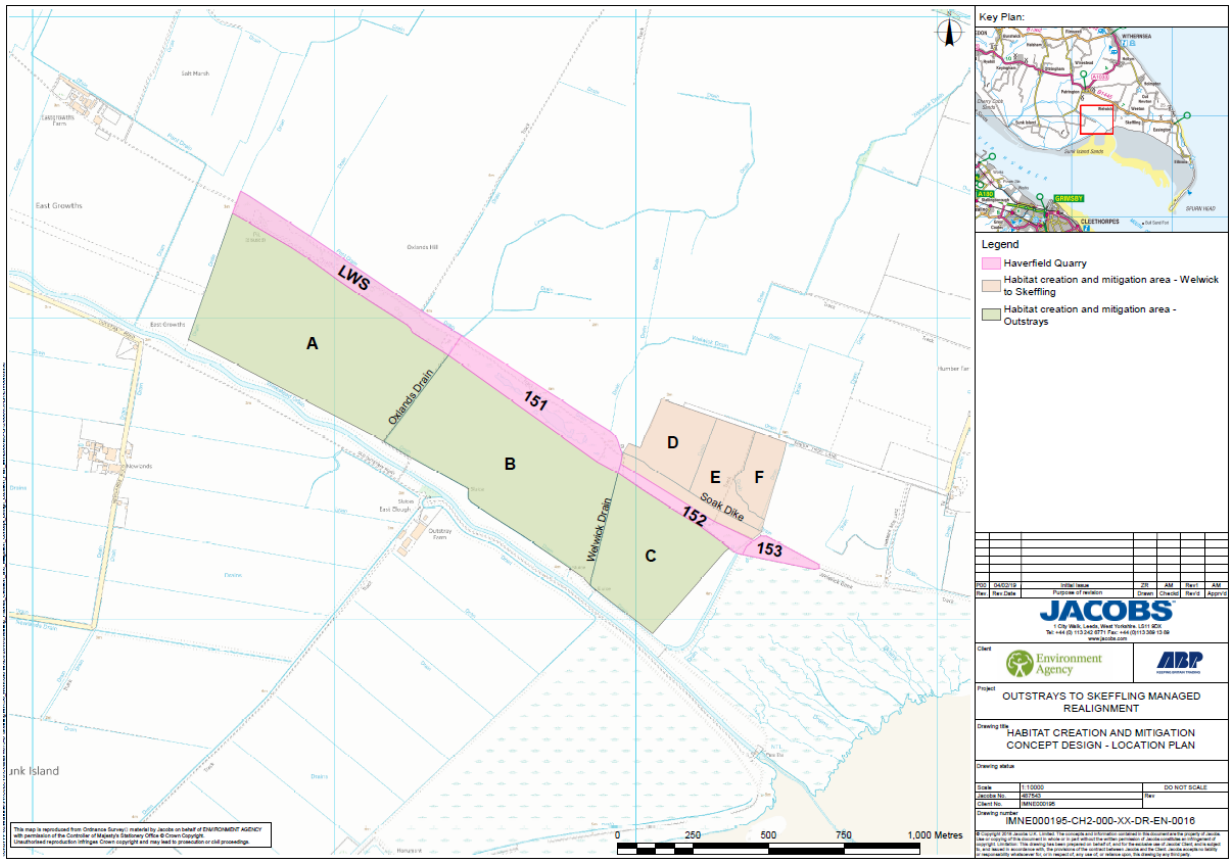
Operational activities, in particular the presence of additional visitors, could possibly cause Permanent damage the sea aster mining bee nests at Welwick Bushes. This represent almost the entire local population.

Significant Negative effect (Possible) at a National Level.

10.5 Mitigation

Much of the ecological mitigation for the Scheme has been incorporated into the concept design for the habitat creation and mitigation area (West 2 and adjacent to East 1). The design for this area is indicative and is based on a review of the site's requirements at a fixed point in time. The exact area (ha) and location of proposed habitats may change during the development of the detailed and final design, which will be informed by further field surveys and consultation with stakeholders. Detailed ecological targets will be set as part of this design development. Appendix 10.3 includes further detail on the drivers for the habitat requirements for West 2 and the flexibility of the areas and locations proposed. Plate 10.1 shows the location of the fields referred to in this section.

Plate 10.1: Habitat creation and mitigation area location plan



10.5.1 Outstrays Managed Realignment

10.5.1.1 Construction

Humber Estuary SSSI (National Importance)

Damage/habitat loss at Humber Estuary SSSI

The works footprint will be minimised where possible. Work will be confined to the footprint of the current embankment, within the fence boundary either side of the embankment.

Grassland (within works footprint) will be reinstated after construction, through natural regeneration and monitoring/maintenance in the medium term (up to 3 years), to remove undesirable species.

Field C (Appendix 1.1) in West 2 site has an underlying sand substrate with a shallow layer of arable top soil above. The scheme proposes to expose the sandy substrate by re-distributing the topsoil as bunds and islands across Field C. Excess sand from the scheme will be moved to this field and also mixed with substrate along the boundary of Haverfield Quarry (southern boundary of the eastern site habitat creation and mitigation area). Sand is expected to be gained from West 1, during the excavation of the creeks. It is estimated that approximately 29,400 to 10,100m^3 of material will potentially be available. Sand will be transferred in to Field C from September 2019, to avoid disturbance impacts on breeding marsh harrier.

Although dune grasslands are dynamic habitat systems which are not normally replicated, it is envisaged that natural succession will enable the expansion of grassland associated with the relic sand dune systems at Haverfield Quarry. By exposing underlying sandy substrates and importing sand onto the site from elsewhere on site, a buffer will be created between Haverfield Quarry, the wet grassland area and adjacent agricultural land. This in turn could benefit species such reptiles and potentially ground nesting bird species, both of which require undisturbed grasslands, offering nature conservation gain for the relic sand dune system.

An Environmental Monitoring and Maintenance Plan (EMMP) will be produced by the Main Works Contractor, in consultation with the Site Manager, the Environment Agency, and Natural England. This plan will include specific targets to promote growth, development, and distribution of fixed dune grassland and dune ponds, which will be finalised as the Scheme progresses. A site manager will be appointed to manage and monitor the site. The Plan will ensure any disturbance effects are avoid or mitigated, as part of the habitat management. The first 10 years of site management is included in the Scheme costs, and it is anticipated that management and monitoring will continue in the long term.

A temporary aluminium access track will be constructed through the site to minimise the footprint of the works through the SSSI.

Temporary access will predominantly follow route of existing farm access track (not suitable for construction due to radius of bends).

The proposed alignment will run through a large stand of hawthorn scrub to the south east of the track. Scrub is a negative component of the SSSI grassland. The removal of scrub will increase the extend of fixed dune grassland.

The track crosses the SSSI unit at its narrowest point.

Grassland will be reinstated after construction. Through natural regeneration and monitoring/maintenance in the medium term (up to 3 years), to remove undesirable species.

Haverfield Quarries LWS (Regional Importance)

Change in habitat at Haverfield Quarries LWS

Restoration works do not impact on the key LWS feature (fixed dune grassland).

No mitigation required.

Winestead Drain cLWS (District Importance)

Degradation of water quality at Winestead Drain cLWS

Standard site procedures, including adherence to guidelines like the Guidelines for Pollution Prevention (*withdrawn)*, will be adopted for any works near or in water to ensure pollutants do not enter aquatic environments.

Sediment traps will be installed at the outlets in the short term.

Scrub (Local Importance)

Loss of scrub

Up to 2 ha of scrub planting is proposed in the habitat creation and mitigation area in West 2. A band of scrub planting is proposed along the western boundary of Field A to provide a visual buffer between the new footpath and the habitat creation and mitigation area. The extent and density of scrub planting will need to provide a balance between providing a visual barrier (to minimise potential disturbance impacts on birds) and ensuring an open landscape is maintained. Please refer to landscape assessment (Chapter 12), for further comments on scrub planting.

The scrub planting will be designed to benefit target faunal receptors. Scrub planting will: -

- be locally sourced (as per guidance in Forestry Commission Practice note FCPN008);
- promote a mixed aged stand of scrub; and
- promote a patchy distribution with habitat mosaics.

An EMMP will be produced and include targets for scrub (as per above).

Neutral semi-improved grassland (Regional Importance)

Loss of neutral semi-improved grassland

Up to 6 ha of turf will be stripped from the existing embankment and translocated to the new embankment (as per reptile mitigation strategy). The translocated turf on the new embankment will establish within the short term (few months after translocation). This represents a like-for-like replacement of the grassland lost on the old embankment.

The new embankment is longer and wider than the existing embankment, so the stripped turf will need to be supplemented through additional seeding. Up to 10 ha of additional embankment will also be created, which will be seeded with a seed sourced from a locally based supplier.

Up to 15 ha of arable field is proposed to be reverted to species rich grassland in the West 2 habitat creation and mitigation area. The arable reversion to species-rich grassland in Field A presents a large increase in the total amount of neutral semi-improved grassland.

The grassland should be designed to benefit target faunal receptors (see barn owl mitigation) and promote a species-rich sward not a sown agricultural grassland.

Stakeholders have stated a preference for natural regeneration rather than using seed mixtures. Natural regeneration is preferred as this guarantees the local provenance of the seed. Seeds will disperse naturally from the adjacent grasslands in Haverfield Quarry. Allowing the field to germinate offers the opportunity to assess the soil's seed bank. If the establishing vegetation is unsuitable and there is little opportunity for suitable species to colonise, the field can be re-worked and seed sown.

An EMMP will be produced and include targets for neutral semi-improved grassland (as per above).

Marshy grassland (District Importance)

Loss of marshy grassland

Approximately 28 ha of wet grassland is proposed to be created in West 2 (arable reversion to wet grassland). The proposed creation of wet grassland in West 2 presents a major increase in the total amount of marshy grassland.

The creation of an open landscape (at least 19 ha) to act as a high tide roost to support populations of redshank, knot and dunlin is an Environment Agency scheme objective. Targets will also be set to promote SPA birds. This will include: -

- maintaining a mosaic of sward heights and water depths, through water level management and a combination of targeted grazing and if necessary mowing; and
- maintaining an open landscape with wide vistas for adult birds to detect approaching predators.

An EMMP will be produced and include targets for marshy grassland (as per above).

Standing water (Local Importance)

Loss of standing water

Up to 14 ponds in Fields A and B (approximately 1 ha), 10 dune slack pools in Field C (approximately 1 ha) and 2 lagoons with islands in Field C (approximately 3 ha), are proposed to be created in the West 2 habitat creation and mitigation area. These will be variety of designs (size and shape) to benefit the target ecological receptors.

Each pond will be designed and managed to provide new habitat for either marsh harrier, great created newt, other amphibians, reptiles and/or water vole (as per specific mitigation for each receptor). Detailed specification for the design of each pond will be produced to benefit the target receptors.

The design and construction will be based on the guidance set out in Section 8.3.1 of the Great Crested Newt Mitigation Guidelines (English Nature, 2001), Section 4.4 of the Water Vole Mitigation Handbook (Dean et al, 2016) and will follow the range of guidance documents provided from the Freshwater Habitats Trust website.

An EMMP will be produced and include targets for standing water (as per above).

Running water (Local Importance)

Loss of running water

Up to 2 km of new channel and a further 2 km of linear scrapes are proposed to be created in the West 2 habitat creation and mitigation area.

Each drain will be designed and managed to provide new habitat for marsh harrier, reptiles and/or water vole. Detailed specification for the design of each drain will be produced to benefit the target receptors.

An EMMP will be produced and include targets for running water (as per above).

Hedgerows (Local Importance)

Loss of hedgerows

Hedgerow across the northern boundary of West 1 will be improved through additional planting and ongoing management where possible. This will result in the creation of new hedgerow to connect the large gaps that currently exist along this hedgerow.

An EMMP will be produced and include targets for hedgerows (as per above).

Spread of non-native invasive species (NNIS)

Ongoing monitoring will be undertaken by the Ecological Clerk of Works (ECoW) to ensure any new stands of invasive species are identified and dealt with in line with best practice and that they are not spread by the works.

The scheme represents an opportunity to eradicate all non-native invasive species from the Scheme extents.

An EMMP will be produced and include targets to ensure works do not cause the spread of NNIS (as per above).

Marsh Harrier (National Importance)

Disturbance to marsh harrier

The significance of disturbance to the ecology of individual birds is variable, but legally it is clear that a precautionary approach should be taken.

Pre-construction marsh harrier surveys to confirm the presence or absence of breeding marsh harrier. Up to five vantage point surveys carried out between mid-April to early July. A works exclusion zone will be established and could be amended depending on the location of any marsh harrier nests, for example if the nest is located in the southern pond only, the 200 m exclusion zone could extend from this location.

In the event that the absence of breeding can be confirmed, agreement will need to be obtained from Natural England for works to be carried out within the proposed exclusion zone during the marsh harrier breeding season. In the event that breeding subsequently commences cessation of all works during that period will take place.

Marsh Harrier (National Importance)

Loss of marsh harrier foraging habitat

As per the marsh harrier mitigation, detailed above, no works are proposed in the exclusion zone in West 2 during the marsh harrier breeding period (March to August inclusive). This coincides with the period where marsh harrier forage in and around West 2.

The creation of varied and structurally diverse habitats in West 2, as part of the habitat creation and mitigation area, is likely to increase the prey availability and available nesting habitat, which will subsequently improve marsh harrier foraging and breeding success in the medium term.

An EMMP will be produced and include targets for marsh harrier (as per above).

Barn owl (District Importance)

Loss of barn owl foraging habitat

No night time working is proposed during construction. This will limit the extent and duration of disturbance impacts during construction.

Turf will be stripped from old embankment and re-located to new embankment (as per reptile mitigation strategy). This will reinstate habitat but is unlikely to establish a mammal population except in the medium term (up to five years).

Up to 15 ha of arable field is proposed to be reverted to grassland in West 2. This will be managed to create patches or strips of rough grassland with a high field vole population.

An EMMP will be produced and include targets for barn owl (as per above).

In addition, all barn owl boxes (which are currently damaged/defunct) will be reinstated after construction. An additional barn owl box will be created in the habitat creation and mitigation area.

Farmland Birds (District Importance)

Loss of farmland bird (nesting and foraging) habitat

Vegetation clearance outside of the breeding bird period (March – August inclusive) to avoid contravening legislation.

Pre-construction checks for active nests if vegetation clearance is done during breeding bird season. Establishment of no-go areas (if breeding birds are recorded).

Replacement scrub planting. See scrub mitigation.

Replacement hedgerow planting. See hedgerow mitigation.

An EMMP will be produced and include targets for farmland birds (as per above).

As scrub can take a few years to develop and mature, in the short-term up to 20 schwegler nest boxes will be installed in Haverfield Quarries LWS to provide additional temporary nesting bird habitat.

Reptiles (Regional Importance)

Killing and Injury to reptiles

Reptile mitigation strategy will be implemented (see. Appendix 10.1). This includes:

Restoration of Haverfield Quarries LWS to promote mosaic of bare ground, rough grassland and patches of scrub (start autumn 2019). Additional refuges/hibernacula will be created such as log/brash piles and earth banks by scraping back areas of top soil.

Trapping/translocation of reptile population at Outstray Scrapes (completed before tidal inundation in 2021) and West 1 embankment (completed before bank removal in 2021). Population relocated to Haverfield Quarries LWS receptor site.

Gradual displacement of remaining reptile population onto Outstray Triangle and towards Outstray Pumping Station (completed before bank removal in 2021).

Turf will be stripped from old embankment and re-located to new embankment. This will effectively replace the lost habitat like-for-like.

Grassy mounds will be created along the line of the existing ABP embankment to create high tide refuges for reptiles foraging on the saltmarsh. These will provide

stepping stones between Outstray Triangle and Outstray Pumping Station embankment.

Up to 15 ha of species rich grassland and approximately 28 ha of wet grassland is proposed to be created in West 2 to provide additional habitat for the expansion of the Haverfield Quarries LWS population.

Water Vole (District Importance)

Disturbance to water vole

A pre-works inspection of East Clough and Newlands Drain to determine the presence or likely absence. No mitigation required if absence confirmed.

If presence is confirmed, exclusion zones will be created to restrict access along the top of the banks to the south of East Clough during construction.

Otter (Regional Importance)

Disturbance to Otter

Site workers will be informed as to the presence of otter and the safeguards in place to avoid disturbance during construction. No works will be carried out in and around (within 30 m) the ponds at Haverfield Quarry.

Where works are required within 30 m of the ponds, works will be carried out under licence, to ensure compliance with legislation. The licence will include safeguards to avoid disturbance impacts, this could include avoiding works during the summer, as this coincides with the period where otter have been activity recorded in Haverfield Quarry.

Construction equipment, materials and site cabins will be kept over 100 m away from pathways that are likely to be used by otter (Oxlands Drain, Welwick Drain and Soak Dyke) and the ponds at Haverfield Quarry. Where works are required within 100 m of these pathways, no works will be carried out within 100 m of at least one other pathway into Haverfield Quarry, maintaining at least one commuting route into and out of Haverfield Quarry Ponds, at any one time.

No night working will be carried out in West 2.

As per the marsh harrier mitigation, no works are proposed in West 2 in an exclusion zone during the marsh harrier breeding period (March to August inclusive). This coincides with the period and the location where otter have been recorded in Haverfield Quarry. If the absence of breeding marsh harrier is confirmed, this mitigation will not be applicable.

Great Crested Newt (Local Importance)

Incidental mortality during site clearance/construction

Where required, works will be carried out under licence, to ensure compliance with legislation.

Agricultural practice will continue in West 2 until works commence. Once the final crop is harvested, the works contractor will ensure vegetation does not develop, as this could improve the areas suitability for GCN during construction.

The EPS mitigation licence will apply the new licencing policies. This includes: -

Policy 1, which avoids the need for exclusion or relocation measures where the work will not affect the conservation status of the local population – given that the core habitat (Haverfield Quarry) will be unaffected, a trapping and translocation is not proportionate to the potential impacts, mitigation will focus of habitat creation and management/monitoring; and

Policy 4, which accepts a lower than standard survey effort where the impacts of development can be predicted with sufficient certainty. Plus mitigation or compensation will ensure that the licensed activity does not detrimentally affect the conservation status of the local population of any EPS – due to survey limitations a standard survey effort was not possible. The scheme can demonstrate that the conservation status of local great crested newt population will remain unaffected.

Up to 14 ponds are proposed to be created in the West 2 habitat creation and mitigation area. These will be designed and managed to provide new habitat for great crested newt and other species. Detailed specification for the design of each pond will be produced to benefit the target receptor. See Pond mitigation.

An EMMP will be produced and include targets for GCN (as per above).

Badger (Local Importance)

Loss and disturbance of badger setts

Pre-construction surveys will be undertaken to identify any new setts, and if found, they may require closure under licence. The site will be continually monitored during construction.

Works will be carried out under licence, to ensure compliance with legislation.

A badger mitigation strategy will be developed from the results of further survey and monitoring work. The strategy will include the closure of one outlier sett and the annex sett under licence, to ensure compliance with legislation.

Any deep excavations or trenches will be covered up or fenced to prevent access by badgers or left with an escape route in the event of a badger falling into them.

Fencing will also be in place to enforce a 30 m exclusion zone around any known setts that are not going to be closed under licence or where disturbance impacts are anticipated.

Badger (Local Importance)

Loss of badger habitat in West 1

The hedgerow along the northern boundary of West 1 provides important cover and foraging for the local badger population and will be largely retained and enhanced through additional planting where possible (see hedgerow mitigation).

Amphibians (except great crested newt) (Local Importance)

Loss of amphibian habitat

New ponds will be created in the West 2 habitat creation and mitigation area (see pond mitigation).

Amphibians will be captured alongside reptiles at Outstray Scrapes (as per Reptile Mitigation Strategy). These will be translocated to the newly created ponds.

An EMMP will be produced and include targets for amphibians (as per above).

Sea Aster Mining Bee (National Importance)

Damage/disturbance to sea aster mining bee

Exclusion zones created around sea aster mining bee nests during construction. These will demarcate the location of the nests and ensure the entrances are not blocked or damaged.

A dune grassland with associated ponds and islands are proposed to be created in Field C (see Appendix 1.1) in the habitat creation and mitigation area (See Humber Estuary SSSI mitigation).

This area will create:

- South-facing raised banks using material scraped from sites with a high sand content;
- Undulating surfaces with pits and mounds to provide a range of microhabitats and microclimates that mimic their natural habitat;
- Areas of bare ground, which will be maintained cutting the vegetation and scraping back to bare earth – this will help suppress dominant vegetation such as coarse grasses.

Brown hare (Local Importance)

Disturbance to brown hare

No night working will be carried out in West 2.

As per the marsh harrier mitigation, no works are proposed in West 2 in an exclusion zone during the marsh harrier breeding period (March to August inclusive). If the absence of breeding marsh harrier is confirmed, this mitigation will not be applicable.

10.5.1.2 Operation

Disturbance to marsh harrier

Access will be restricted to the designated bridleway through Haverfield Quarry and to the permissive access route around the edge of the West 2 habitat creation and mitigation area.

Scrub will be maintained along the access route along the edge of the Haverfield Quarry ponds, to deter people accessing the edge of the pond. If required, fencing could be installed along the bridleway as a further barrier between the ponds and the footpath. The fencing should deter human access but allow the movement of other mammals (badger and otter).

The bird hide between the two main ponds at Haverfield Quarry will be reinstated. This will provide a facility for people to view the ponds without accessing the edge of the ponds.

Creation of additional nesting habitat (reedbed) away from access route. Field B has been identified as a potential expansion site for the breeding Marsh Harrier (see Plate 10.1). A new reedbed is proposed adjacent to the Haverfield Quarry Ponds (Unit 151) to increase the carrying capacity of the site for breeding Marsh Harrier.

Other reedbeds (treatment wetlands) are proposed near the Winestead Drain abstraction areas. The primary focus is to improve water quality on the wet grasslands, but again these could facilitate the expansion of breeding Marsh Harriers and support other reedbed species.

An EMMP will be produced and include targets for Marsh Harrier (as per above).

Disturbance to otter

See mitigation for operational impact on marsh harrier. The same mitigation applies to otters.

Restricting access to the Haverfield Quarry ponds, will avoid any potential disturbance impacts during operation.

The proposed new reed bed habitat in the West 2 habitat creation and mitigation area will support additional prey for otter, such as amphibians, small waterfowl and reptiles. The reed bed will also provide a tall, dense undisturbed shelter, which could support additional couch/holt sites for otter.

The West 2 habitat creation and mitigation area will improve connectivity between Haverfield Quarry, Winestead Drain and Welwick Saltmarsh, facilitating the otter movement across these areas.

An EMMP will be produced and include targets for otter (as per above).

10.5.2 Welwick to Skeffling Managed Realignment

10.5.2.1 Construction

Neutral semi-improved grassland (Regional Importance)

Loss of neutral semi-improved grassland

A survey of the ABP Welwick embankment (behind the existing managed realignment site) will be undertaken prior to the works commencing outlined below to determine the presence or absence of stone parsley (*Sison amomum*). If stone parsley is present this will be translocated under ecological supervision to the new embankment.

Turf will be stripped from old embankment and trans-located to new embankment (as per reptile mitigation strategy). The translocated turf on the new embankment will establish within the short term (few months after translocation). This represents a like-for-like replacement of the grassland lost on the old embankment.

The new embankment is longer and wider than the existing embankment, so the stripped turf will need to be supplemented through additional seeding. Approximately 9 ha of additional embankment will also be created, which will be seeded with a seed sourced from a locally based supplier. Up to 7 ha of arable field is proposed to be reverted to species rich grassland in the habitat creation and mitigation area adjacent to East 1. The arable reversion to grassland in the habitat creation and mitigation area presents a large increase in the total amount of neutral semi-improved grassland.

New cut-off trenches to the east and west of the site aim to reduce drainage function across the site and provide a mosaic of different grassland communities, especially given that this site has a noticeable slope from north to south.

The grassland will be designed to benefit target faunal receptors and promote a species-rich sward not a sown agricultural grassland.

Stakeholders have stated a preference for natural regeneration rather than using seed mixtures. Natural regeneration is preferred as this guarantees the local provenance of the seed. Seeds will disperse naturally from the adjacent grasslands in Haverfield Quarry.

Allowing natural regeneration offers the opportunity to assess the soil's seed bank. If the establishing vegetation is unsuitable and there is little opportunity for suitable species to colonise, the field can be re-worked and seed sown.

An EMMP will be produced and include targets for neutral semi-improved grassland (as per above).

Standing water (Local Importance)

Loss of standing water

Up to seven ponds (total area approximately 0.3 ha) are proposed to be created in the habitat creation and mitigation area adjacent to East 1.

These will be variety of designs (size and shape) to benefit the target ecological receptors. Each pond will be designed and managed to provide new habitat for wildlife including high tide roost features for birds, breeding ponds for amphibians and foraging resources for reptiles and water vole (as per specific mitigation for each receptor).

The two ephemeral ponds along the two defunct drainage ditches in the habitat creation and mitigation area are proposed to be widened and deepened to create two larger ponds. Total area is approximately 0.2 ha. With appropriate management, the extent of permanent open water features will be increased, and the quality of the resource improved.

The design and construction will be based on the guidance set out in Section 8.3.1 of the Great Crested Newt Mitigation Guidelines (English Nature, 2001), Section 4.4 of the Water Vole Mitigation Handbook (Dean et al, 2016) and will follow the range of guidance documents provided from the Freshwater Habitats Trust website.

An EMMP will be produced and include targets for standing water (as per above).

Running water (Local Importance)

Loss of running water

A new channel will be created along the dry-side toe of the new embankment.

The drain will be designed and managed to provide new habitat for water vole, where possible. Detailed specifications for the design of the drains will be produced to benefit the target receptors.

An EMMP will be produced and include targets for running water (as per above).

Hedgerows (Local Importance)

Loss of hedgerows

Hedgerows within the habitat creation and mitigation area will be improved through additional planting and ongoing management. This will result in the creation of new hedgerow to connect the large gaps that currently exist along this hedgerow.

New hedgerow will be planted along the boundary of the site where possible, in East 2 and East 3. The length and exact location of hedgerow planting will depend on the detailed drainage design and maintenance access requirements. The creation of new hedgerows will provide improved wildlife connectivity if continuous sections are able to be planted.

An EMMP will be produced and include targets for hedgerows (as per above).

Marsh Harrier (National Importance)

Disturbance to marsh harrier

The significance of disturbance to the ecology of individual birds is variable, but legally it is clear that a precautionary approach should be taken.

Pre-construction marsh harrier surveys to confirm the presence or absence of breeding marsh harrier. Up to five vantage point surveys carried out between mid-April to early July. A works exclusion zone will be established and could be amended depending on the location of any marsh harrier nests, for example if the nest is located in the southern pond only, the 200 m exclusion zone could extend from this location.

In the event that the absence of breeding can be confirmed, agreement will need to be obtained from Natural England for works to be carried out within the proposed exclusion zone during the marsh harrier breeding season. In the event that breeding subsequently commences cessation of all works during that period will take place.

Marsh Harrier (National Importance)

Loss of marsh harrier foraging habitat

As per the marsh harrier mitigation, detailed above, no works are proposed in the 200 m exclusion zone during the marsh harrier breeding period (March to August inclusive). This coincides with the period where marsh harrier forage in and around the Welwick to Skeffling habitat creation and mitigation area.

The creation of varied and structurally diverse habitats in the habitat creation and mitigation area is likely to increase the prey availability and available nesting habitat, which will subsequently improve marsh harrier foraging and breeding success in the medium term.

An EMMP will be produced and include targets for marsh harrier (as per above).

Potential spread of non-native invasive species (NNIS)

An invasive species management plan will be produced by the main works contractor to ensure works do no cause the spread of non-native invasive species. This will include cleaning boots, equipment and machinery when moving from contaminated site to elsewhere on the site.

Ongoing monitoring will be undertaken by the ECoW to ensure any new stands of invasive species are identified and dealt with in line with best practice and that they are not spread by the works.

Barn owl (Regional Importance)

Loss of barn owl foraging habitat

No night time working is proposed during construction. This will limit the extent and duration of disturbance impacts during construction.

Turf will be stripped from old embankment and re-located to new embankment (as per reptile mitigation strategy). This will reinstate habitat but is unlikely to establish a mammal population except in the medium term (up to five years).

Up to 7 ha of arable field is proposed be reverted to grassland in the habitat creation and mitigation area adjacent to East 1. This will be managed to create patches or strips of rough grassland with a high field vole population.

An EMMP will be produced and include targets for barn owl (as per above).

Barn owl (Regional Importance)

Loss of nesting habitat

Two barn owl boxes will be fitted after construction.

One will be fitted in the habitat creation and mitigation area.

One will be fitted on a retained section of Burstall Bank.

Farmland birds (Local Importance)

Loss of farmland bird (nesting and foraging habitat)

Vegetation clearance outside of the breeding bird period (March – August inclusive) to avoid contravening legislation.

Pre-construction checks for active nests if vegetation clearance is carried out during the breeding bird season. Establishment of no-go areas (if breeding birds are recorded).

Replacement scrub planting.

Replacement hedgerow planting where possible.

An EMMP will be produced and include targets for farmland birds (as per above).

Reptiles (Regional Importance)

Killing and injury to reptiles

Reptile mitigation strategy will be implemented (see. Appendix 10.1). This includes:

Restoration of Humber Estuary SSSI (Unit 151) to promote mosaic of bare ground, rough grassland and patches of scrub (start autumn 2019). Additional refuges/hibernacula will be created such as log/brash piles and earth banks by scraping back areas of top soil.

Trapping/translocation of reptile population at East 1, East 2 and East 3 embankment (completed before bank removal in 2021). Population relocated to Humber Estuary SSSI (Unit 151) receptor site.

Gradual displacement of remaining reptile population onto Welwick Bushes and retained embankment to the east of East 3 (completed before bank removal in 2021).

Turf will be stripped from old embankment and re-located to new embankment. This will effectively replace the lost habitat like for like.

Grassy mounds will be created along the line of the old flood embankment to create high tide refuges for reptiles foraging on the saltmarsh. These will provide stepping stones between Welwick Bushes and the far eastern side of the embankment.

Up to 7 ha of rough grassland is proposed to be created in the habitat creation and mitigation area to provide additional habitat for the expansion of the Haverfield Quarry populations.

An EMMP will be produced and include targets for reptiles (as per above).

Water vole (District Importance)

Loss of water vole habitat

Repeat surveys of all watercourses should be undertaken 8-12 weeks before construction begins. The survey to be undertaken 8-12 weeks in advance of construction will inform the need for a licence application. Surveys would need to take into consideration time to obtain a licence if required.

During construction works an ecologist should be present on site, to check for burrows immediately prior to any destruction of ditches.

An appropriate water vole mitigation strategy will be developed from the results of further survey and monitoring work. Details will be developed in consultation with water vole experts and in-line with best practice. The strategy will include capture, translocation, release (with or without *captive* breeding) and post release site creation, maintenance and monitoring (see Water vole - Concept mitigation strategy in Appendix 10.1).

The drainage ditches will not support a long-term healthy water vole population without a change in ditch design and management that is sympathetic to wildlife conservation alongside flood risk management. The Scheme represents an opportunity to introduce a new ditch design, which can facilitate a change in management and more suitable profiles. Details for the management and maintenance of the new drain along the dry-side toe of the flood embankment are still outstanding. Drain improvements as specified in the drainage strategy will need to permit a sensitive maintenance regime, in line with Environment Agency maintenance requirements. If possible, at least one side of the drain should remain vegetated at any one time to provide suitable habitat for water voles.

The drain will support varying depths of water. The East 2 and East 3 sections are expected at have a minimum water depth of 40 cm. The East 1 section is expected to dry out during summer. Dry drains are generally unsuitable for water vole. At this stage of the design it is not possible to confirm an exact length of drain that will support suitable habitat for water vole, but it is assumed that the East 2 and 3 section will be suitable for foraging and refuge. The dry section of the drain is likely to be suitable for water vole movement/migration across the site.

New ponds will be created in habitat creation and mitigation area (see standing water mitigation).

An EMMP will be produced and include targets for water vole (as per above).

Water voles should not be displaced and/or translocated onto a new site where mink are present. As mink have been recorded at Haverfield Quarry (southern pond) and in some of the adjacent drains a mink control programme is required.

Mink trapping is proposed in and around Haverfield Quarry. Trapping should initially be seasonal trapping (in and around Haverfield Quarry) in 2018 and then an assessment should be made as to whether a re-active trapping approach may be appropriate.

If mink keep re-occupying Haverfield Quarry an assessment should be made as to whether an increased trapping effort is required and possible whether habitat creation and mitigation area is a suitable receptor site.

Otter (Regional Importance)

Disturbance to otter

Construction equipment, materials and site cabins will be kept over 100 m away from pathways that are likely to be used by otter (Welwick Drain and Soak Dyke) and the ponds at Haverfield Quarry. Where works are required within 100m of these pathways, no works will be carried out within 100m of at least one other pathway into Haverfield Quarry, maintaining at least one commuting route into and out of Haverfield Quarry Ponds, at any one time.

No night working will be carried out in West 2.

As per the marsh harrier mitigation, no works are proposed in West 2 during the marsh harrier breeding period (March to August inclusive). This coincides with the period where otter have been activity recorded in Haverfield Quarry. If the absence of breeding marsh harrier is confirmed, this mitigation will not be applicable.

Great crested newt (Local Importance)

Disturbance and risk of killing/injury to great crested newt – Humber Farm meta population

Works will be carried out under licence, to ensure compliance with legislation.

Agricultural practice will continue in East 1 and East 2 until works commence. Once the final crop is harvested, the works contractor will ensure vegetation does not develop, as this could improve the areas suitability for GCN during construction.

The EPS mitigation licence will apply the new licencing policies. This includes:

Policy 1, which avoids the need for exclusion or relocation measures where the work will not affect the conservation status of the local population – given that the core habitat (Humber Farm) will be unaffected, a trapping and translocation is not proportionate to the potential impacts, mitigation will focus of habitat creation and management/monitoring.

Up to seven ponds will be created in the habitat creation and mitigation area. These will be designed and managed to provide new habitat for great crested newt and other species. Detailed specification for the design of each pond will be produced to benefit the target receptor.

An EMMP will be produced and include targets for GCN (as per above).

Badger (Local Importance)

Loss of badger habitat in East 1, East 2, and East 3.

Any new hedgerow along the boundary of the site would provide important cover and foraging and maximise landscape connectivity for local badger populations (see hedgerow mitigation: hedgerow will be planted where possible in East 2 and East 3).

The habitat creation works across the habitat creation and mitigation area are likely to improve connectivity and foraging resources for the badger clan within the scheme extents.

Sea Aster Mining Bee (National Importance)

Cessation of sheep grazing at Welwick Bushes during construction

Vegetation around the entrance and base of the nests will be carefully cleared by hand at the end of July or early August, prior to the bee emerging. This will help maintain the exposed vertical sandy banks across Welwick Bushes.

Works will be carried out by the main contractor and overseen by the ECoW.

10.5.2.2 Operation

Disturbance to marsh harrier

Access will be restricted to the designated bridleway around the edge of the Welwick to Skeffling habitat creation and mitigation area, which will link to the access route through Haverfield Quarry.

An EMMP will be produced and include targets for Marsh Harrier (as per above).

Sea Aster Mining Bee (National Importance)

Damage/disturbance to sea aster mining bee.

Notice boards will be fitted at the entrances to Welwick Bushes to inform people about the bee colony and the importance of keeping to the designated footpath.

The Welwick to Skeffling Managed Realignment will create up to 125 ha of saltmarsh habitats. This will benefit sea aster mining bee by creating a large area of additional foraging habitat.

An EMMP will be produced and include targets for sea aster mining bee (as per above).

10.6 Residual Effects

10.6.1 Outstrays Managed Realignment

10.6.1.1 Construction

Humber Estuary SSSI (National Importance)

Damage/habitat loss at Humber Estuary SSSI

Fixed dune grassland will be reinstated after the piling works are completed. The Environmental Monitoring and Maintenance plan will ensure the success of the natural colonisation.

Humber Estuary SSSI units 152 and 153 (the main areas of fixed dune grassland) represent 3.6 ha in total. Field C represents approximately 4 ha of new sand dune habitat. The sand dune buffer strip along the southern boundary of Haverfield Quarries LWS represents approximately an additional 7 ha.

This represents a major expansion area for the fixed dune grassland habitat and help protect the semi-natural vegetation within the SSSI, including the species it supports.

Significant Positive impact (Probable) at a National Level in the Medium to Long Term (up to 5 years), when thin, impoverished soils have developed on the raw sand and the grassland develops in Field C.

Fixed dune grassland will be reinstated after construction. The monitoring and maintenance plan will ensure the success of the natural colonisation.

No Significant impact (Certain) at a Local Level in the Short to Medium term (1-3 years), when the fixed dune grassland recolonises the access track.

Haverfield Quarries LWS (Regional importance)

Change in habitat type at Haverfield Quarries LWS

No Significant impact (Certain) at a Local Level in the Medium to Long Term (up to 10 years), when mitigation applied for scrub, reptiles and farmland birds.

Winestead Drain cLWS (District Importance)

Degradation of water quality at Winestead Drain cLWS

Industry standard methods are applied and no negative impacts on water quality are anticipated during construction.

No significant impact (Probable) at a Local Level in the Medium Term (3-5 years), when the grassland develops in the West 2 habitat creation and mitigation area.

Scrub (Local Importance)

Loss of scrub

The proposals represent a loss in the total area of scrub (approximately 2 ha). The new scrub planting in West 2 presents an improvement in terms of improving the structure, diversity and distribution of scrub across the site.

No Significant impact (Certain) at a Local Level in the Long Term (up to 10 years), when the scrub develops and matures in West 2.

Neutral semi-improved grassland (Regional Importance)

Loss of neutral semi-improved grassland

The proposals represent a major increase in the total area of neutral semi-improved grassland (from 5.9 ha to up to 31 ha).

An Environmental Monitoring and Maintenance Plan will ensure that the habitat creation in the West 2 habitat creation and mitigation area is successfully carried and manged in the long-term.

Significant Positive impact (Certain) at a Regional Level in the Medium Term (3-5 years), when the grassland develops in the West 2 habitat creation and mitigation area.

Marshy grassland (District Importance)

Loss of marshy grassland

The proposals represent an increase in the total area of marshy grassland.

Management and monitoring of West 2 habitat creation and mitigation area, will ensure the marshy grassland benefits the target ecological receptors.

Significant Positive impact (Certain) at a Regional Level in the Medium Term (3-5 years) when the grassland in West 2 develops.

Standing water (Local Importance)

Loss of standing water

Mitigation presents a major increase in the number of ponds within the scheme with three ponds lost (approximately 0.2 ha) and 26 ponds created (up to 5 ha). The diversity and abundance of ponds represents an improvement at a regional level in the size, extent and ecological quality of the habitat.

The proposed management and monitoring of West 2 habitat creation and mitigation area, will ensure the ponds benefits the target ecological receptors.

Significant Positive impact (Certain) at a Regional Level in the Medium Term (3-5 years) when the ponds establish.

Running water (Local Importance)

Loss of running water

The proposals represent a slight decrease in the total length of running water (Approximately 1 km).

The new drainage channels in West 2 present an improvement in terms of improving the overall ecological value of the habitat.

No Significant impact (Certain) at a Local Level in the Short Term (up to 1 year after construction), when the watercourse develops and matures.

Hedgerows (Local Importance)

Loss of hedgerows

The proposals represent a loss in the total length of hedgerows.

Although there is a loss in the total length of hedgerow, the additional interplanting and future management of the hedgerow across the northern boundary of West 1 presents a local improvement in terms of the overall ecological value of the habitat.

No Significant impact (Certain) at a Local Level in the Long Term (up to 10 years), when the new hedgerow in West 1 develops and matures.

Spread of non-native invasive species (NNIS)

Negative effect from the spread of NNIS is avoided.

No Significant effect (Probable) at a Local Level in the Short Term (during construction).

Marsh harrier (National Importance)

Disturbances to marsh harrier

Negative effect on breeding success is avoided. There is no negative effect on the population or its conservation status.

No Significant effect (Certain) at the National Level in the Short Term (during construction).

Marsh harrier (National Importance)

Loss of marsh harrier foraging habitat

The creation of the West 2 habitat creation and mitigation area is likely to improve the foraging value of the habitat directly adjacent to Haverfield Quarry, which could lead to an increase in the number of successful breeding pairs at the site and/or the number of chicks which are successfully reared at the site. Any increase in the number of breeding pairs is significant at a national level.

Significant Positive effect (Possible) at the National Level in the Medium Term (up to 5 years).

Barn owl (District Importance)

Loss of barn owl foraging habitat

Unavoidable loss of foraging habitat during construction. The associated small mammal population is unlikely to recover in the short term. Probable negative effect on barn owl foraging success during construction.

Significant Positive effect (Probable) at a District Level in the Medium Term (3-5 years) when the new habitats develop, and small mammal population establishes and expands. The reinstated/new barn owl boxes will allow the future expansion of the barn owl population.

Farmland birds (District Importance)

Loss of farmland bird (nesting and foraging) habitat

Direct impacts on nesting farmland birds are avoided during construction.

Unavoidable loss of nesting and foraging habitat. Probable negative effect on farmland bird nesting and foraging success during construction.

No Significant effect (Certain) at a District Level in the Medium to Long Term (up to 10 years), when the scrub, hedgerow and other habitats associated with the West 2 habitat creation and mitigation area develop and mature in West 2.

Reptiles (Regional Importance)

Killing and injury

There is likely to be some minor unavoidable losses in the short term, which could impact the conservation status of local reptile populations.

Significant Negative impact (Probable) at a Local Level in the Short Term (during construction).

The creation of the West 2 habitat creation and mitigation area is likely to improve the foraging value of the habitat directly adjacent to Haverfield Quarry and which could lead to an increase in the reptile population levels at the site.

Significant Positive effect (Possible) at a District Level in the Medium Term (up to 5 years) when the new habitats develop in West 2, and the reptile population expands into these new habitats.

Water Vole (District Importance)

Disturbance to water vole

Negative effect from disturbance is avoided. There is no negative effect on the population or its conservation status.

No significant (Certain) effect at a **Local Level** in the **Short Term** (during construction).

Otter (Regional Importance)

Disturbance to otter

Negative effect from disturbance is avoided. There is no negative effect on the population or its conservation status.

The West 2 habitat creation and mitigation area in West 2 will provide an extensive area of new high-quality terrestrial and aquatic habitats for otters, and could facilitate an expansion in the otter population.

Significant positive effect (Possible) at a Regional Level in the Medium Term (up to 5 years), when the reedbed habitat develops and matures.

Great crested newt (Local Importance)

Incidental mortality during site clearance/construction

The West 2 habitat creation and mitigation area will provide an extensive area of new high-quality terrestrial and aquatic habitats for local amphibian populations, which will facilitate a significant expansion in the local GCN population.

Significant Positive effect (Probable) at a District Level in the Medium Term (up to 5 years) when the new habitats develop, and the great crested newt population expands.

Badger (Local Importance)

Loss and disturbance of badger setts

Negative effect from disturbance is avoided where possible. There is no negative effect on the population or its conservation status.

No Significant (Probable) effect at a Local Level in the Short Term (during construction).

Badger (Local Importance)

Loss of badger habitat in West 1

Negative effect on badger is avoided. There is unlikely to be a negative effect on the population or its conservation status.

No Significant effect (Probable) at a Local Level in the Medium Term (up to 5 years) when the new hedgerow develops in West 1.

Amphibians (except great crested newt) (Local Importance)

Loss of amphibian habitat

Negative effect on amphibians is largely avoided. There is no significant negative effect on the population or its conservation status.

Significant Positive effect (Probable) at a Local Level in the Medium Term (3-5 years) when the new ponds develop, and the amphibian population expands.

Sea Aster Mining Bee (National Importance)

Damage/disturbance to sea aster mining bee

Negative effect on sea aster mining bee is avoided. There is no negative effect on the population or its conservation status.

Field C in the West 2 habitat creation and mitigation area in will provide an extensive area of new high-quality terrestrial and aquatic habitats for sea aster mining bee population, which could facilitate an expansion in the sea aster mining bee population.

Significant positive effect (Possible) at a National Level in the Medium Term (up to 5 years), when the fixed sand dune habitat develops and matures.

Assemblage of invertebrate habitat

Loss of invertebrate habitat

No Significant effect (Probable) at a District Level in the Medium Term (up to 5 years), when the saltmarsh habitats develop in West 1.

Brown hare (Local Importance)

Disturbance to brown hare

Negative effects on brown hare are avoided, where possible. There is no significant negative effect on the population or its conservation status.

No Significant effect (Probable) at a Local Level in the Short Term (during construction).

10.6.1.2 Operation

Disturbance to marsh harrier

Negative effect from disturbance is avoided. There is no negative effect on the population or its conservation status.

No significant (Probable) effect at a National Level during operation.

Disturbance to otter

Negative effect from disturbance is avoided. There is no negative effect on the population or its conservation status.

No significant (Probable) effect at a District Level during operation.

10.6.2 Welwick to Skeffling Managed Realignment

10.6.2.1 Construction

Scrub (Local Importance)

Creation and translocation of scrub

The proposals represent an increase in the total area of scrub. Scrub removal from Welwick Bushes will restore the desirable SSSI grassland habitats. A structurally diverse habitat, managed on a rotational basis will benefit a greater diversity of species.

Significant Positive impact (Certain) at a District Level in the Long Term (up to 10 years), when the scrub develops and matures in the habitat creation and mitigation area.

Neutral semi-improved grassland (Regional Importance)

Loss of neutral grassland

The proposals represent a major increase in the total area of neutral semi-improved grassland. The habitat management plan will ensure that the habitat creation in the habitat creation and mitigation area is successfully carried and manged in the long-term.

Significant Positive impact (Certain) at a Regional Level in the Medium Term (3-5 years), when the grassland develops in the habitat creation and mitigation area.

Standing water (Local Importance)

Loss of standing water

The number of ponds within the scheme will remain the same (seven ponds lost, two ponds retained and extended, up to seven ponds created). The diversity and abundance of the mitigation ponds represents an improvement at a local level in the size, extent and ecological quality of the habitat.

The proposed management and monitoring of habitat creation and mitigation area, will ensure the ponds benefit the target ecological receptors.

Significant Positive impact (Certain) at a Local Level in the Medium Term (3-5 years) when the ponds establish.

Running water (Local Importance)

Loss of running water

The proposals represent a slight gain of approximately 0.4 km (10%) in the total length of running water.

The new drainage channel along the dry-side toe of the new embankment presents an improvement in terms of improving the overall ecological value of the habitat.

No Significant impact (Certain) at a Local Level in the Short Term (up to 1 year after construction), when the watercourse develops and matures.

Hedgerows (Local Importance)

Loss of hedgerows

New hedgerow planting will be of greater ecological value than existing hedgerow. Defunct hedgerow in the habitat creation and mitigation area will be improved. Any continuous sections of hedgerow will provide improved wildlife connectivity.

No Significant impact (Certain) at a Local Level in the Long Term (up to 10 years), when the new hedgerow develops and matures.

Potential spread of non-native invasive species (NNIS)

Negative effect from the spread of NNIS is avoided.

No Significant effect (Probable) at a Local Level in the Short Term (during construction).

Marsh harrier (National Importance)

Disturbances to marsh harrier

Negative effect on breeding success is avoided. There is no negative effect on the population or its conservation status.

No Significant effect (Certain) at the National Level in the Short Term (during construction).

Marsh harrier (National Importance)

Loss of marsh harrier foraging habitat

The creation of the habitat creation and mitigation area is likely to improve the foraging value of the habitat directly adjacent to Haverfield Quarry, which could lead to an increase in the number of successful breeding pairs at the site and/or the number of chicks which are successfully reared at the site. Any increase in the number of breeding pairs is significant at a national level.

Significant Positive effect (Possible) at the National Level in the Medium Term (up to 5 years).

Barn owl (Regional Importance)

Loss of barn owl foraging habitat

Unavoidable loss of foraging habitat during construction. The associated small mammal population is unlikely to recover in the short term.

Probable negative effect on barn owl foraging success during construction.

Significant Positive effect (Probable) at a District Level in the Medium Term (3-5 years) when the new habitats develop, and small mammal population establishes and expands. The reinstated/new barn owl boxes will allow the future expansion of the barn owl population.

Barn owl (Regional Importance)

Loss of barn owl nesting habitat

All nesting features lost during construction will be replaced.

No Significant effect (Certain) at a District Level in the Short Term (after construction).

Farmland Birds (Local Importance)

Loss of farmland bird (nesting and foraging) habitat

Direct impacts on nesting farmland birds are avoided during construction.

Unavoidable loss of nesting and foraging habitat. Probable negative effect on farmland bird nesting and foraging success during construction.

No Significant effect (Certain) at a District Level in the Medium to Long Term (up to 10 years), when the scrub, hedgerow and other habitats associated with the habitat creation and mitigation area and new embankment develop and mature.

Reptiles (Regional Importance)

Killing and injury to reptiles

There is likely to be some minor unavoidable losses in the short term, which could impact the conservation status of local reptile populations.

Significant Negative impact (Probable) at a Local Level in the Short Term (during construction).

The creation of the habitat creation and mitigation area is likely to improve the foraging value of the habitat directly adjacent to Haverfield Quarry and which could lead to an increase in the reptile population levels at the site.

Significant Positive effect (Possible) at a District Level in the Medium Term (up to 5 years) when the new habitats develop, and the reptile population expands into these new habitats.

Water vole (District Importance)

Loss of water vole habitat

Providing a network of new drains and ponds, which can be managed sympathetically for drainage and wildlife, will improve habitat quality and connectivity for local water vole populations (and other wildlife), enabling an expansion in size and range of the populations.

Significant Positive effect (Probable) at the Local Level in the Medium Term (up to 5 years), when the drainage ditch and ponds develop and mature.

Otter (Regional Importance)

Disturbance to otter

Negative effect from disturbance is avoided. There is no negative effect on the population or its conservation status.

No Significant (Probable) effect at a District Level in the short term (during construction)

Great crested newt (Local Importance)

Disturbance and risk of killing/injury to great crested newt – Humber Farm meta population

The habitat creation and mitigation area will provide an extensive area of new high-quality terrestrial and aquatic habitats for local amphibian populations, which will facilitate a significant expansion in the local GCN population.

Significant Positive effect (Probable) at a District Level in the Medium Term (up to 5 years) when the new habitats develop and the great crested newt population expands.

Badger (Local Importance)

Loss of badger habitat in East 1, East 2, and East 3

Negative effect on badger is avoided. There is unlikely to be a negative effect on the population or its conservation status.

No Significant effect (Probable) at a Local Level in the Medium Term (up to 5 years) when the new areas of hedgerows develop.

Sea aster mining bee (National Importance)

Damage/disturbance to sea aster mining bee

Negative effect on sea aster mining bee is avoided. There is no negative effect on the population or its conservation status.

No Significant effect (Certain) at a District Level in the Short Term (during construction).

Sea aster mining bee (National Importance)

Cessation of sheep grazing at Welwick Bushes during construction

Negative effect on sea aster mining bee is avoided. There is no negative effect on the population or its conservation status.

No Significant effect (Certain) at a National Level in the Short Term (during construction).

10.6.2.2 Operation

Disturbance to marsh harrier

Negative effect from disturbance is avoided. There is no negative effect on the population or its conservation status.

No significant (Probable) effect at a National Level during operation.

Sea Aster Mining Bee (National Importance)

Damage/disturbance to sea aster mining bee

The managed realignment will provide an extensive area of additional saltmarsh habitats and foraging opportunities for sea aster mining bee population, which could facilitate an expansion in the sea aster mining bee population.

Significant positive effect (Possible) at a Regional Level in the Short to Medium Term (up to 5 years), when the saltmarsh habitat develops and matures.

10.7 Monitoring

During site preparation and constriction an Ecological Clerk of Works (ECoW), will be appointed. They oversee works and ensure all legislative and planning requirements are being adhered to. A watching brief will be required for all works in Haverfield Quarry and any works requiring displacement, trapping and translocation. This will include reptiles, amphibians (including GCN), water vole and mink.

The Scheme includes a number of habitat creation elements, which deliver key mitigation measures that reduce the significance of numerous potential impacts. The delivery of these habitat creation measures are therefore central in ensuring that the predicted residual impacts in this EcIA are correct.

A suite of post-construction monitoring measures will be put in place to ensure the delivery of these habitats. The proposed monitoring requirements will be included in the Environmental Monitoring and Maintenance Plan.

10.8 Enhancements

This habitat creation scheme (terrestrial habitats) delivers ecological benefits up to a National level, by increasing the size, extend and quality of habitats associated with the Humber Estuary. These benefits outweigh the short term adverse effects during construction. Much of the habitat creation in habitat creation and mitigation areas provide additional benefits above and beyond what would normally be expected to mitigation the impacts of the scheme. The scheme objectives are met and exceeded in terms of the terrestrial habitats, which are created.

Haverfield Quarry and Welwick Bushes represent a high value grassland. There are opportunities for habitat enhancements, particularly in SSSI Unit 151. Scrub removal in and around the ponds and reed bed management within the ponds is required. Given the constraints imposed by breeding marsh harrier and otter, and the levels of disturbance during construction, it has been deemed beyond the scope of the Scheme to carry out enhancement measure at this stage. But this should be seen as a long-term objective and carried out as part of future management.

Haverfield Quarry LWS is subject to a large amount of restoration works and at this stage it would not be appropriate to identify enhancement opportunities until the grassland habitats have fully established.

10.9 Summary

Ecological assessment including receptors, impacts, significant effects, mitigation and residual effects in construction and operation phases are summarised in Table 10.12 for Outstrays Managed Realignment and Table 10.13 for Welwick to Skeffling Managed Realignment.

Table 10.12: Ecological assessment summary for Outstrays Managed Realignment

Value of Receptor	Description of Impact	Magnitude of Change	Significance of effect (without mitigation)	Mitigation Measures	Significance of effects of residual impacts (after mitigation)
Construction					
Humber Estuary SSSI (National Importance)	Damage/Habitat Loss at Humber Estuary SSSI - construction of the piling wall at Welwick Bushes Negligible impacts in fixed dune grassland (notable feature of SSSI). The alignment would run through a band of predominantly MG1 and MG11 grassland communities.	Very Low	**Significant Negative** impact (Certain) at a **Local Level** in the **Short to Medium Term** (1-3 years)	The works footprint will be minimised where possible. Grassland will be reinstated after construction. Up to 11 ha of new sand dune habitat is proposed to be created in West 2 habitat creation and mitigation area.	**Significant Positive** impact (Probable) at a **National Level** in the **Medium to Long Term** (up to 5 years), when thin, impoverished soils have developed on the raw sand and the grassland develops in Field C.
Humber Estuary SSSI (National Importance)	Damage/Habitat Loss at Humber Estuary SSSI – New access route through Haverfield Quarry. Direct impacts on fixed dune grassland (notable feature of SSSI).	Very Low	**No Significant** impact (Probable) at a **Local Level** in the **Short to Medium Term** (1-3 years), when the fixed dune grassland naturally recolonises the access track.	A temporary aluminium access track will be constructed through the site to minimise the footprint of the works through the SSSI. Grassland will be reinstated after construction.	**No Significant** impact (Certain) at a **Local Level** in the **Short to Medium Term** (1-3 years), when the fixed dune grassland recolonises the access track.
Haverfield Quarries LWS (Regional importance)	Habitat Restoration - Haverfield Quarries LWS. Removal of scrub to create a habitat mosaic (scrub, grassland and bare ground). Direct loss of up to 2.4 ha of scrub. Restoration of up to 2.4 ha of a grassland/bare ground mosaic.	Medium	**Significant Positive** impact (Certain) at a **Regional Level** in the **Short Term** (within 1st year).	Restoration works do not impact on the key LWS feature (fixed dune grassland). No mitigation required.	Residual impacts addressed through the impacts on scrub, reptiles and farmland birds.
Winestead Drain cLWS (District Importance)	Degradation of water quality at Winestead Drain cLWS. Increased run off from arable farmland in to Winestead Drain is anticipated, due to the creation of new outlet channels as part of the wet grassland habitat creation.	Very Low	**Significant Negative** impact (Possible) at a **Local Level** in the **Short Term** (up to 1 year following construction).	Standard site procedures, including adherence to Guidelines for Pollution Prevention, will be adopted for any works near or in water to ensure pollutants do not enter aquatic environments. Sediment traps will be installed at the outlets in the short term.	**No Significant** impact (Probable) at a **Local Level** in the **Medium Term** (3-5 years), when the grassland develops in West 2 habitat creation and mitigation area.
Scrub (Local Importance)	Loss of Outstray Scrapes (1.2 ha of scrub) and removal of scrub in Haverfield Quarries LWS as part of habitat restoration (up to 2.4 ha).	Medium	**Significant Negative** impact (Certain) at a **Local Level**.	Up to 2 ha of scrub planting in West 2 habitat creation and mitigation area.	**No Significant** impact (Certain) at a **Local Level** in the **Long Term** (up to 10 years), when the scrub develops and matures in West 2 habitat creation and mitigation area.
Neutral semi-improved grassland (Regional Importance)	Loss of West 1 and West 2 embankments. Direct, temporary loss of up to 5.9 ha of neutral semi-improved grassland.	Medium	**Significant Negative** impact (Certain) at a **Regional Level** in the **Short Term** (1-2 years) due to the direct loss of grassland along the embankments. **No Significant** impact (Probable) at a **Regional Level** in **Long Term** (up to 10 years), when the grass naturally	Turf is proposed to be translocated to the new embankment. Up to 10 ha of additional embankment is also proposed to be created. Up to 15 ha of arable field is proposed to be reverted to species rich grassland in the West 2 habitat creation and mitigation area.	**Significant Positive** impact (Certain) at a **Regional Level** in the **Medium Term** (3-5 years), when the grassland develops in the West 2 habitat creation and mitigation area.

Value of Receptor	Description of Impact	Magnitude of Change	Significance of effect (without mitigation)	Mitigation Measures	Significance of effects of residual impacts (after mitigation)
			develops along the new West 1 flood embankment.		
Marshy grassland (District Importance)	Loss of Outstray Scrapes. Permanent loss of up to 2 ha of marshy grassland. This represents all the marshy grassland habitat within the Scheme Extents.	High	**Significant Negative** impact (Certain) at a **District Level**.	Approximately 28 ha of wet grassland is proposed to be created in West 2 (arable field reversion to wet grassland).	**Significant Positive** impact (Certain) at a **Regional Level** in the **Medium Term** (3-5 years) when the grassland in West 2 develops.
Standing water (Local Importance)	Loss of Outstray Scrapes. Permanent loss of three small to medium sized ponds. Total area is 0.2 ha. Apart from the ponds associated with Haverfield Quarry, this represents all ponds within the Scheme Extents.	Medium	**Significant Negative** impact (Certain) at a **Local Level**.	Up to 14 ponds (approximately 1 ha), 10 dune slack pools (approximately 1 ha) and 2 lagoons with islands (approximately 3 ha) are proposed to be created in the West 2 habitat creation and mitigation area. These would be variety of designs (size and shape) to benefit the target ecological receptors.	**Significant Positive** impact (Certain) at a **Regional Level** in the **Medium Term** (3-5 years) when the ponds establish.
Running water (Local Importance)	Managed realignment - direct loss of 4.8 km of running water (agricultural drainage channels).	Medium	**Significant Negative** impact (Certain) at a **Local Level**.	Up to 2 km of new channel and up to a further 2 km of linear scrapes are proposed to be created in the West 2 habitat creation and mitigation area.	**No Significant** impact (Certain) at a **Local Level** in the **Short Term** (up to 1 year after construction), when the watercourse develops and matures.
Hedgerows (Local Importance)	Managed realignment - direct loss of approximately 1.8 km of hedgerow.	Medium	**Significant Negative** impact (Certain) at a **Local Level**.	Hedgerow across the northern boundary of West 1 is proposed to be improved through additional planting and ongoing management	**No Significant** impact (Certain) at a **Local Level** in the **Long Term** (up to 10 years), when the new hedgerow in West 1 develops and matures.
Spread of non-native invasive species (NNIS)	Potential spread of NNIS across the site and into the wild, which would contravene legislation.	Very Low	**Significant Negative** effect (Probable) at a **Local Level** in the **Medium Term** (up to 5 years), when the NNIS spread, develop and out-compete native species/habitats.	NNIS management and clearance. Ongoing monitoring would be undertaken by the ECoW to ensure NNIS are not spread by the works.	**No Significant** effect (Probable) at a **Local Level** in the **Short Term** (during construction).
Marsh harrier (National Importance)	Disturbance from construction activities, would result in the likely abandonment of the site, for all breeding females given their proximity to the works.	High	**Significant Negative** effect (Probable) at the **National Level** in the **Short Term** (during construction).	Works timed to avoid marsh harrier breeding season. No works within a 200 m buffer of any marsh harrier nests.	**No Significant** effect (Certain) at the **National Level** in the **Short Term** (during construction).
Marsh Harrier (National Importance)	Creation of piling wall through Welwick Bushes has the potential to disturb breeding Marsh Harrier. The works are at a sufficient distance that no disturbance impacts are anticipated.	Very Low	**No Significant** impact (Certain) at a **National Level** in **Short Term** (During Construction).	No mitigation required.	**No Significant** impact (Certain) at a **National Level** in **Short Term** (During Construction).
Marsh harrier (National Importance)	Loss of marsh harrier foraging habitat. Possible negative effect on female marsh harrier foraging success for up to five years. There are alternative unaffected foraging habitats to the north of Haverfield Quarry and at Welwick Saltmarsh.	Low	**Significant Negative** effect (Possible) at the **District Level** in the **Medium Term** (up to 5 years).	The West 2 habitat creation and mitigation area will provide an extensive area of new high-quality terrestrial and aquatic habitats for marsh harrier population, which could facilitate an expansion in the marsh harrier population (approximately 2 ha of reedbed	**Significant Positive** effect (Possible) at the **National Level** in the **Medium Term** (up to 5 years).

Value of Receptor	Description of Impact	Magnitude of Change	Significance of effect (without mitigation)	Mitigation Measures	Significance of effects of residual impacts (after mitigation)
				over three locations).	
Barn owl (District Importance)	Temporary displacement from site (due to loss of foraging habitat and/or disturbance). Negative effect on hunting success for up to 2 years. Alternative foraging habitat is available outside of the scheme boundary.	Low	**Significant Negative** effect (Probable) at a **Local Level** in the **Medium Term** (up to 5 years).	No night time working is proposed during construction. Grassland habitat creation in West 2. Habitats managed to promote high field vole population. All barn owl boxes (which are currently damaged/defunct) will be reinstated after construction.	**Significant Positive** effect (Probable) at a **District Level** in the **Medium Term** (3-5 years) when the new habitats develop, and small mammal population establishes and expands. The reinstated/new barn owl boxes will allow the future expansion of the barn owl population.
Farmland birds (District Importance)	Negative effect on breeding success through the reduction in nesting and foraging opportunities. Permanent loss of approximately 30-40% of the nesting and foraging habitat. Loss of arable fields.	Medium	**Significant Negative** effect (Certain) at the **Local Level**.	Vegetation clearance outside of the breeding bird period (March – August inclusive) to avoid contravening legislation. Replacement scrub and hedgerow planting. Up to 20 schwegler nest boxes will be installed in Haverfield Quarries LWS.	Direct impacts on nesting farmland birds are avoided during construction. Unavoidable loss of nesting and foraging habitat. Probable negative effect on farmland bird nesting and foraging success during construction. **No Significant** effect (Certain) at a **District Level** in the **Medium to Long Term** (up to 10 years), when the scrub, hedgerow and other habitats associated with the West 2 habitat creation and mitigation area develop and mature.
Reptiles (Regional Importance)	Removal of West 1 embankment. Permanent loss of reptile population along the West 1 embankment and Outstray Scrapes. Population unlikely to recover in the long term.	High	**Significant Negative** impact (Certain) at the **Regional Level**.	Reptile mitigation strategy: translocation and habitat creation in West 2 habitat creation and mitigation area.	There is likely to be some minor unavoidable losses during construction, which could impact the conservation status of local reptile populations. **Significant Positive** effect (Possible) at a **District Level** in the **Medium Term** (up to 5 years) when the new habitats develop in West 2, and the reptile population expands into these new habitats.
Water Vole (District Importance)	Potential for temporary displacement from East Clough/Newlands Drain, due to regular visual and noise disturbance to the south of East Clough.	Low	**Significant Negative** effect (Unlikely) at the **Local Level** in the **Short Term** (during construction).	A pre-works inspection to determine the presence or likely absence. No mitigation required if absence confirmed. If presence is confirmed, exclusion zones would be created.	**No significant** (Certain) effect at a **Local Level** in the **Short Term** (during construction).
Otter (Regional Importance)	Possible temporary displacement of otter population from Haverfield Quarry and abandonment of site, during constriction.	High	**Significant Negative** effect (Possible) at a **Regional Level** in the **Short Term** (During Construction).	No works are proposed in West 2 during the marsh harrier breeding period (March to August inclusive). No night working will be carried out in West 2.	**No significant** (Probable) effect at a **District Level** in the **Short Term** (during construction).

Value of Receptor	Description of Impact	Magnitude of Change	Significance of effect (without mitigation)	Mitigation Measures	Significance of effects of residual impacts (after mitigation)
				Pathways to and from Haverfield Quarry will be maintained during constriction. Standard mitigation will be applied.	
Great crested newt (Local Importance)	Incidental mortality during site clearance/construction. Possible risk of GCN being present in West 2 during construction and possible risk of killing and injuring or disturbing GCN, if present.	Very Low	**Significant Negative** effect (Possible) at a less than **Local Level** in the **Short Term** (during construction).	Works will be carried out under licence, to ensure compliance with legislation. Up to 14 ponds are proposed to be created in the West 2 habitat creation and mitigation area. These will be designed and managed to provide new habitat for great crested newt and other species.	**Significant Positive** effect (Probable) at a **District Level** in the **Medium Term** (up to 5 years) when the new habitats develop, and the great crested newt population expands.
Badger (Local Importance)	Loss of a single outlier sett and suspected annex sett. Probable temporary disturbance of up to six outlier setts and possible temporary disturbance of main sett.	Low	**Significant Negative** effect (Certain) at a **less than Local** Level in the **Short Term** (during construction).	A badger mitigation strategy will be developed from the results of further survey and monitoring work. The strategy will include the closure of one outlier sett and the annex sett. Exclusion zones will be created to protect remaining setts.	**No Significant** (Probable) effect at a **Local Level** in the **Short Term** (during construction).
Badger (Local Importance)	Permanent loss of badger foraging habitat in the West 1, including arable farmland and scrub habitat. As the adjacent landscape is dominated by arable fields like those in West 2, there is ample alternative habitat for this species.	Low	**Significant Negative** effect (Unlikely) at a **less than Local Level**.	The hedgerow along the northern boundary of West 1 provides important cover and foraging for the local badger population and will be retained and enhanced through additional planting.	**No Significant** effect (Probable) at a **Local Level** in the **Medium Term** (up to 5 years) when the new hedgerow develops in West 1.
Amphibians (except great crested newt) (Local Importance)	The loss of Outstray Scrapes would result in the permanent loss of amphibian habitat and therefore populations at this location.	High	**Significant Negative** impact (Certain) at the **Local Level**.	Amphibians will be captured alongside reptiles at Outstray Scrapes (as per Reptile Mitigation Strategy). These will be translocated to the newly created ponds in the West 2 habitat creation and mitigation area.	**Significant Positive** effect (Probable) at a **Local Level** in the **Medium Term** (3-5 years) when the new ponds develop, and the amphibian population expands.
Sea aster mining bee (National Importance)	Construction activities, in particular the presence of site workers, could possibly cause damage the sea aster mining bee colony in West 2.	Low	**Significant Negative** effect (possible) at a **District Level** in the **Short Term** (during construction).	Exclusion zones created around sea aster mining bee nests during construction. These will demarcate the location of the nests and ensure the entrances are not blocked or damaged. A dune grassland with associated ponds and islands are proposed to be created in Field C.	**Significant Positive** effect (Possible) at a **National Level** in the **Medium Term** (up to 5 years), when the fixed sand dune habitat develops and matures.
Assemblage of invertebrates at Outstray Scrapes (District Value)	The loss of Outstray Scrapes would result in the loss of the assemblage of invertebrates at Outstray Scrapes.	High	Species would readily re-colonise new saltmarsh and other wetland habitats, from areas elsewhere on the estuary. **No Significant** effect (Probable) at a **District Level** in the **Medium Term** (up	No mitigation required	**No Significant** effect (Probable) at a **District Level** in the **Medium Term** (up to 5 years), when the saltmarsh habitats develop in West 1.

Value of Receptor	Description of Impact	Magnitude of Change	Significance of effect (without mitigation)	Mitigation Measures	Significance of effects of residual impacts (after mitigation)
			to 5 years), when the saltmarsh habitats develop in West 1.		
Freshwater fish (District Value)	The creation of the piling wall at Winestead Pumping Station has the potential to disturb fish populations in Winestead Drain.	None	it is unlikely that vibro-piling combined with the soft-start/ramp up would have an adverse effect on the fish population. **No significant** effect (Probable) at a **District Level** in the **Short Term** (During Construction).	No mitigation required	**No Significant** effect (Certain) at a **District Level** in the **Short Term** (Post Construction).
Brown hare (Local Value)	Construction activities could possibly cause the temporary displacement of brown hare from West 2. However the adjacent landscape is dominated by arable fields like those in West 2, there is ample alternative habitat for this species.	Low	**Significant Negative** impact (Possible) at the **less than Local Level** in the **Short Term** (During construction).	No works are proposed in West 2 during the marsh harrier breeding period (March to August inclusive). No night working will be carried out in West 2.	**No Significant** effect (Probable) at a **Local Level** in the **Short Term** (during construction).
Operation					
Marsh Harrier (National Importance)	Increased numbers of visitors to Haverfield Quarry could increase disturbance to nesting marsh harrier. If marsh harrier are not tolerant of the disturbance, this could lead to permanent displacement of otter population from Haverfield Quarry and abandonment of site.	High	**Significant Negative** effect (Possible) at the **National Level.**	Access will be restricted to designated bridleway only and screening/fencing will be put in place. The bird hide between the two main ponds at Haverfield Quarry will be reinstated.	**No Significant** (Probable) effect at a **National Level**.
Otter (Regional Importance)	Increased numbers of visitors to Haverfield Quarry could increase disturbance to otter. If otters may not be tolerant of the disturbance, this could lead to permanent displacement of otter population from Haverfield Quarry and abandonment of site.	High	**Significant Negative** effect (Possible) at a **Regional scale.**	Access would be restricted to designated bridleway only and screening/fencing will be put in place.	**No Significant** (Probable) effect at a **Regional Level**.

Table 10.13: Ecological assessment summary for Welwick to Skeffling Managed Realignment

Value of Receptor	Description of Impact	Magnitude of Change	Significance of effect (without mitigation)	Mitigation Measures	Significance of effects of residual impacts (after mitigation)
Construction					
Scrub (Local Importance)	Welwick to Skeffling habitat creation and mitigation area would result creation of up to 1.7 ha of scrub.	High	**Significant Positive** impact (Certain) at a **Local Level** in the **Long Term** (up to 10 years), when the scrub develops and matures in the habitat creation and mitigation area.	No mitigation required.	**Significant Positive** impact (Certain) at a **District Level** in the **Long Term** (up to 10 years), when the scrub develops and matures in the habitat creation and mitigation area.
Neutral semi-improved grassland (Regional Importance)	Loss of East 1, East 2 and East 3 embankment. Direct, temporary loss of up to 5.3 ha of neutral semi-improved grassland.	High	**Significant Negative** impact (Certain) at a **Regional Level** in the **Short Term** (1-2 years) due to the direct loss of grassland along the embankments. **No Significant** impact (Probable) at a **Regional Level** in **Long Term** (up to 10 years), when the grass naturally develops along the new West 1 flood embankment.	Turf will be translocated to the new embankment. Up to 9 ha of additional embankment will also be created. Up to 7 ha of arable field is proposed to be reverted to species rich grassland in the Welwick to Skeffling habitat creation and mitigation area.	**Significant Positive** impact (Certain) at a **Regional Level** in the **Medium Term** (3-5 years), when the grassland develops in the Welwick to Skeffling habitat creation and mitigation area.
Standing water (Local Importance)	Managed realignment - loss of two ponds in East 1, a single pond in East 2 and five small to medium sized ponds in East 3. Two defunct drains, which are effectively acting as ponds, would be retained.	High	**Significant Negative** impact (Certain) at a **Local Level**.	Up to seven ponds (0.3 ha) are proposed to be created in the Welwick to Skeffling habitat creation and mitigation area. Two existing ponds will be improved.	**Significant Positive** impact (Certain) at a **Local Level** in the **Medium Term** (3-5 years) when the ponds establish.
Running water (Local Importance)	Managed realignment - direct loss of 4 km of running water (agricultural drainage channels).	Medium	**Significant Negative** impact (Certain) at a **Local Level**.	Drainage channel approximately 4.4 km in length to be created along the dry-side toe of the new embankment. Detailed specifications for the design of the drains will be produced to benefit the target receptors.	**No Significant** impact (Certain) at a **Local Level** in the **Short Term** (up to 1 year after construction), when the watercourse develops and matures.
Hedgerows (Local Importance)	Managed realignment - direct loss of 2.6 km of hedgerow - up to 66% of hedgerows within the Scheme Extents.	Medium	**Significant Negative** impact (Certain) at a **Local Level**.	Hedgerows within the Welwick to Skeffling habitat creation and mitigation area proposed to be improved through additional planting and ongoing management. New hedgerow will be planted along the boundary of the site where possible in East 2 and 3.	**No Significant** impact (Certain) at a **Local Level** in the **Long Term** (up to 10 years), when the new hedgerow develops and matures.
Potential spread of non-native invasive species (NNIS)	Potential spread of NNIS across the site and into the wild, which would contravene legislation.	Very Low	**Significant Negative** effect (Possible) at a **Local Level** in the **Medium Term** (up to 5 years), when the NNIS spread, develop and invade valued natural and semi-natural habitats.	NNIS management and clearance. Ongoing monitoring will be undertaken by the ECoW to ensure NNIS are not spread by the works.	**No Significant** effect (Probable) at a **Local Level** in the **Short Term** (during construction).

Value of Receptor	Description of Impact	Magnitude of Change	Significance of effect (without mitigation)	Mitigation Measures	Significance of effects of residual impacts (after mitigation)
				The scheme represents an opportunity to eradicate all non-native invasive species from the Scheme extents.	
Marsh harrier (National Importance)	Disturbance from construction activities would result in the likely abandonment of the site, for all breeding females given their proximity to the works.	High	**Significant Negative** effect (Probable) at the **National Level** in the **Short Term** (during construction).	Works timed to avoid marsh harrier breeding season. No works within a 200 m buffer of any marsh harrier nests.	**No Significant** effect (Certain) at the **National Level** in the **Short Term** (during construction).
Marsh harrier (National Importance)	Loss of marsh harrier foraging habitat. Possible negative effect on female marsh harrier foraging success for up to five years. There are alternative unaffected foraging habitats to the north of Haverfield Quarry and at Welwick Saltmarsh.	Low	**Significant Negative** effect (Possible) at the **District Level** in the **Medium Term** (up to 5 years).	Habitat creation adjacent to East 1.	**Significant Positive** effect (Possible) at the **National Level** in the **Medium Term** (up to 5 years).
Barn owl (Regional Importance)	Temporary displacement from site (due to loss of foraging habitat and/or disturbance). Negative effect on hunting success for up to 2 years. Alternative foraging habitat is available outside of the scheme boundary.	Low	**Significant Negative** effect (Probable) at a **District Level** in the **Medium Term** (up to 5 years).	No night time working is proposed during construction. Grassland habitat creation in Welwick to Skeffling habitat creation and mitigation area. Habitats managed to promote high field vole population.	**Significant Positive** effect (Probable) at a **District Level** in the **Medium Term** (3-5 years) when the new habitats develop, and small mammal population establishes and expands. The reinstated/new barn owl boxes would allow the future expansion of the barn owl population.
Barn owl (Regional Importance)	Removal of two barn owl boxes.	Medium	**Significant Negative** effect (Certain) at a **District Level.**	Two barn owl boxes will be fitted after construction. One will be fitted in the habitat creation and mitigation area. One will be fitted on a retained section of Burstall Bank.	**No Significant** effect (Certain) at a **District Level** in the **Short Term** (after construction).
Short Eared Owl (Regional Importance)	The works would avoid the short eared owl over-wintering period. Any activities during the winter would be commensurable with typical levels of activity along the embankment.	None	**No Significant** effect (Probable) at a **Regional Level** in the **Short Term** (During Construction).	No Mitigation Required	**No Significant** effect (Probable) at a **Regional Level** in the **Short Term** (During Construction).
Farmland birds (Local Importance)	Negative effect on breeding success through the reduction in nesting and foraging opportunities. Direct loss of 2.6 km of hedgerow (approximately 66% of hedgerows on site). Loss of arable fields.	Medium	**Significant Negative** effect (Certain) at the **Local Level**.	Vegetation clearance outside of the breeding bird period (March – August inclusive) to avoid contravening legislation. Replacement scrub and hedgerow planting where possible.	Unavoidable negative effect on farmland bird nesting and foraging success during construction. **No Significant** effect (Certain) at a **District Level** in the **Medium to Long Term** (up to 10 years), when habitats develop and mature.
Reptiles (Regional Importance)	Permanent loss of reptile population along the East 1, East 2 and East 3	High	**Significant Negative** impact (Certain) at the **Regional level**.	Reptile mitigation strategy: translocation and habitat creation.	There is likely to be some minor unavoidable losses during construction,

Value of Receptor	Description of Impact	Magnitude of Change	Significance of effect (without mitigation)	Mitigation Measures	Significance of effects of residual impacts (after mitigation)
	embankment. Population unlikely to recover in the long term.				which could impact the conservation status of local reptile populations. **Significant Positive** effect (Possible) at a **District Level** in the **Medium Term** (up to 5 years) when the new habitats develop in the habitat creation and mitigation area, and the reptile population expands into these new habitats.
Water Vole (District Importance)	Permanent displacement from the drainage channels in East 1, 2 and 3 during construction, due to the tidal inundation.	High	**Significant Negative** impact (Certain) at the **District Level** in the **Short Term** (during construction).	Water Vole Mitigation Strategy: translocation and habitat creation.	**Significant Positive** effect (Probable) at the **District Level** in the **Medium Term** (up to 5 years), when the drainage ditch and ponds develop and mature.
Otter (Regional Importance)	The presence of site workers and machinery along Welwick Drain and Soak Dike could disturb otters whilst they try to access Haverfield Quarry and Welwick Saltmarsh. This would affect the ability of otter to access or leave Haverfield Quarry.	Low	**Significant Negative** effect (Possible) at a **Regional Level** in the **Short Term** (During Construction).	No night working will be carried out in West 2. Pathways to and from Haverfield Quarry will be maintained during constriction. Standard mitigation will be applied.	**No Significant** (Probable) effect at a **District Level** in the **Short Term** (during construction).
Great crested newt (Local Importance)	Possible risk of GCN being present in East 1 and East 2 during construction and possible risk of killing and injuring or disturbing GCN, if present. Humber Farm meta population.	Very Low	**Significant Negative** effect (Possible) at a **less than Local Level** in the **Short Term** (during construction).	Works will be carried out under licence, to ensure compliance with legislation. Mitigation will be applied through licence application.	**Significant Positive** effect (Probable) at a **District Level** in the **Medium Term** (up to 5 years) when the new habitats develop and the great crested newt population expands.
Badger (Local Importance)	The managed realignment in East 1, East 2 and East 3 would permanently displace badgers and reduce the available foraging habitat for the local badger population.	Low	**Significant Negative** effect (Unlikely) at a **less than Local Level**.	New hedgerow along the boundary of the site where possible in East 2 and East 3. Improvements to hedgerow in habitat creation and mitigation area and creation of foraging habitat.	**No Significant** effect (Probable) at a **Local Level** in the **Medium Term** (up to 5 years) when the new hedgerow develops.
Sea aster mining bee (National Importance)	The cessation of sheep grazing over a two-year period during construction could cause the entrances of the sea aster mining bee nests to vegetate over. This could degrade the value of the nesting habitat by restricting or blocking access to the exposed sandy banks.	Medium	**Significant Negative** effect (possible) at a **National Level** in the **Short Term** (during construction).	Vegetation around the entrance and base of the nests will be carefully cleared by hand at the end of July or early August, prior to the bee emerging. This will help maintain the exposed vertical sandy banks across Welwick Bushes. Works will be carried out by the main contractor and overseen by the ECoW.	**No Significant** effect (Certain) at a **National Level** in the **Short Term** (during construction).
Operation					
Marsh Harrier (National Importance)	Increased numbers of visitors to Haverfield Quarry could increase disturbance to nesting marsh harrier. If marsh harrier are not tolerant of the disturbance, this could lead to permanent	High	**Significant Negative** effect (Possible) at the **National Level.**	Access will be restricted to designated bridleway only.	**No Significant** (Probable) effect at a **National Level**.

Value of Receptor	Description of Impact	Magnitude of Change	Significance of effect (without mitigation)	Mitigation Measures	Significance of effects of residual impacts (after mitigation)
	displacement of otter population from Haverfield Quarry and abandonment of site.				
Sea aster mining bee (National Importance)	Operational activities, in particular the presence of additional visitors, could possibly cause damage the sea aster mining bee nests at Welwick Bushes. This represent almost the entire local population.	High	**Significant Negative** effect (Possible) at a **National Level.**	The managed realignment will provide an extensive area of additional saltmarsh habitats and foraging opportunities for sea aster mining bee population, which could facilitate an expansion in the sea aster mining bee population.	**Significant Positive** effect (Possible) at a **Regional Level** in the **Short to Medium Term** (up to 5 years), when the saltmarsh habitat develops and matures.

11 Marine Biodiversity

11.1 Introduction

This section considers the potential impacts and associated effects on the marine biodiversity within and in the vicinity of the Scheme (referred hereafter as the Scheme) during the construction stage (which includes enabling works) and operational stage of the proposed development as described in Chapter 3. A separate assessment has been produced for terrestrial and freshwater habitats and species landward of the toe of the embankment in Chapter 10 (Terrestrial Biodiversity).

The Scheme consists of two distinct sites; the western site (Outstrays Managed Realignment, consisting of West 1 and 2, Figure 2.1 in Appendix 1.1) and the eastern site (Welwick to Skeffling Managed Realignment, East 1, 2 and 3). Within the existing environment section (Section 11.4) each receptor has been described for the Scheme as a whole (and not specifically for each site). This reflects the inter-connectivity of the marine environment and as such the applicability of the baseline description to both the eastern and western site. The assessment of likely significant effects (Section 11.6) and mitigation (Section 11.7) has been described separately for the two sites to allow for the evaluation of each site individually.

The assessment of effect upon marine biodiversity has been informed by the conclusions from Chapter 7 (Physical Process and the Hydrodynamic Environment), Chapter 8 (Water Environment), Chapter 15 (Air Quality) and Chapter 16 (Noise and Vibration).

11.2 Regulatory and policy framework

This assessment takes into account the relevant regulations, policies and guidance, including those listed below and within Appendix 1.4:

- Summarised within Appendix 1.4;
  - Marine and Coastal Access Act 2009;
  - UK Marine Policy Statement (Her Majesty's (HM) Government, 2011); and
  - East Inshore Marine Plan (HM Government, 2014)
- Summarised below;
  - Marine Strategy Framework Directive;
  - Marine Conservation Zones;
  - Protected marine species; and
  - Invasive species

11.2.1 Marine Strategy Framework Directive (2008/56/EC)

The aim of the European Union (EU) Marine Strategy Framework Directive (MSFD) (adopted in June 2008) is to protect more effectively the marine environment across Europe. It aims to achieve good environmental status (GES) of marine waters by 2020

and to protect the resource base upon which marine-related economic and social activities depend. It enshrines in a legislative framework the ecosystem approach to the management of human activities having an impact on the marine environment, integrating the concepts of environmental protection and sustainable use.

The MSFD constitutes the vital environmental component of future maritime policy, designed to achieve the full economic potential of oceans and seas in harmony with the marine environment. It establishes European Marine Regions on the basis of geographical and environmental criteria. Each Member State is required to develop strategies for their marine waters. A Statutory Instrument transposing the MSFD into UK law came into force on 15 July 2010 and puts in place a clear legal framework to enable the MSFD to be implemented in the UK. The Scheme is located within the Humber Estuary. As this is considered a transitional water body, the MSFD does not apply and the Scheme will not have an impact upon the environmental status of the Great North Sea Marine Region.

11.2.2 Marine Conservation Zones

The Marine and Coastal Access Act 2009 aims to ensure clean, healthy, safe, productive and biologically diverse oceans and seas, by putting in place better systems for delivering sustainable development of marine and coastal environments. The Act has created a type of Marine Protected Area (MPA) called a Marine Conservation Zone (MCZ) which can be designated anywhere in English and Welsh inshore and UK offshore waters to protect nationally important marine wildlife, habitats, geology and geomorphology.

The nearest MCZ to the Scheme is over 8 km away (Holderness Inshore MCZ, see Section 11.4.1). Given that there are no MCZs in proximity to the Scheme, a formal MCZ assessment is not considered necessary.

11.2.3 Protected marine species

Various species of marine animals are protected from being killed, injured or disturbed under provisions in the Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora (Habitats Directive) and Section 9(4) and Schedule 5 of the Wildlife and Countryside Act 1981 (WACA) (as amended). Of particular relevance to the Scheme are coastal waterbirds (see Section 11.4.5).

The Habitats Directive, Article 12, obliges Member States to prohibit deliberate disturbance of Annex IV species in their natural range, particularly during the period of breeding, rearing, hibernation and migration. Guidance on the interpretation of Article 12 requirements has recently been issued by the European Commission. With respect to disturbance, this emphasises the need for a case-by-case approach and points out that:

‘it would also seem logical that for disturbance of a protected species to occur a certain level of negative impact which is likely to be detrimental must be involved’. The guidance also states that ‘the intensity, duration and frequency of repetition of disturbances are important parameters when assessing the possible impact of disturbance on a species’.

For a significant effect on the local distribution or abundance of a species to occur, disturbance would need to produce more than a transient effect. For this to occur, it seems likely that the disturbance would have to be repeated over a period of time. For

example, frequent or prolonged underwater noise from seismic surveys in an area of sea could cause the abandonment of the area by cetaceans. If there are no alternative sites nearby for the cetaceans to move to, the disturbance could be considered to have affected the local distribution or abundance of the population.

The Habitats Directive is transposed into UK Law by the Conservation of Habitats and Species Regulations 2017 (Habitats Regulations). Section 43 of the Habitats Regulations make it an offence (subject to exceptions) to deliberately capture, kill, disturb, or trade in the animals listed in Schedule 2 of the Habitats Regulations (i.e. European Protected Species). Paragraph 2 of Section 43 specifies that disturbance of animals includes in particular any disturbance which is likely:

- to impair their ability:
    - to survive, to breed or reproduce, or to rear or nurture their young; or
    - in the case of animals of a hibernating or migratory species, to hibernate or migrate; or
- to affect significantly the local distribution or abundance of the species to which they belong.

Section 9(4) of the WACA makes it an offence to intentionally or recklessly disturb dolphins, whales or basking sharks subject to a defence that the act was the incidental result of a lawful operation and could not reasonably have been avoided. Natural England and Countryside Council for Wales (CCW) (now Natural Resources Wales (NRW)) have produced detailed guidance on the application of these provisions (Natural England and CCW, 2007).

If protected species are likely to be deliberately disturbed by development operations, the activity can be licenced by, Natural England (terrestrial species) or the Marine Management Organisation (MMO) (for marine species) under the overriding public interest purpose of the Habitats Regulations if the necessary criteria are met (Natural England and CCW, 2007). If the degree of deliberate disturbance is considered to fall below the threshold for the Habitats Regulations, no licence under this legislation is necessary, but the disturbance may still be an offence under the WACA. In this case, no licence can be issued, as there is no appropriate purpose, and the developer must consider whether the ‘incidental result’ defence is applicable.

Given the level of protection of these species, potential disturbance impacts to protected species under the Habitats Regulations and WACA have been assessed in this EIA in accordance with Natural England and CCW/NRW guidance (Natural England and CCW, 2007). The assessment is presented in Section 11.6, which includes necessary measures that will be undertaken to avoid or mitigate any significant impacts.

11.2.4 Invasive species

The European Union Regulation (No 1143/2014) on the prevention and management of the introduction and spread of invasive alien species (IAS) entered into force in 2015. A key instrument of the Regulation is the List of IAS of Union concern, known as 'the Union list'. Species that are included in this list are subject to a number of measures including prevention, early detection and rapid eradication of new invasions, and management of invasions that are already widespread.

The principal UK legislation dealing with non-native species is Section 14 of the WACA. Section 14 makes it illegal to release or allow to escape into the wild any animal which

is not ordinarily resident in Great Britain and is not a regular visitor to Great Britain in a wild state, or is listed in Schedule 9 to the WACA. Schedule 9 contains both animals and plants of which Section 14 applies.

Section 23 of the Infrastructure Act 2015, amended Section 14 and Schedule 9 of the WACA, by introducing Schedule 9A. Schedule 9A allows both the English and Welsh governments to introduce Species Control Agreements and Orders, which enable rapid responses to eradicate any Schedule 9 species. Guidance on how to implement agreements and orders has been produced by the Department for Environment, Food and Rural Affairs (Defra) (Defra, 2017).

11.3 Methodology

11.3.1 Study Area

The 'study area' is defined as the area over which the potential direct and indirect impacts of the Scheme are predicted to occur. These are limited to the intertidal area fronting the Scheme (as informed by the numerical modelling undertaken to inform the assessment of the Scheme (see Chapter 7)).

11.3.2 Baseline data collection

A series of Scheme-specific surveys have been undertaken to understand and characterise the baseline marine environment. The data from these surveys has been supplemented with data collected within the vicinity of the Scheme, specifically the adjacent Associated British Ports (ABP) Welwick Managed Realignment. These surveys are summarised in Table 11.1, and the results are presented fully in the relevant sections below.

Table 11.1: Ecological surveys to support the baseline characterisation

Survey Type	Date	Study Area	Objectives
Phase 1 Habitat survey ABPmer, 2016	September 2015	The eastern site Section 11.4.2	Map the spatial extents of each biotope present in the survey area.
Intertidal benthic invertebrates ABPmer, 2016	September 2015	Mudflat seaward of the eastern site Section 11.4.2 (Plate 11.2)	Understand the distribution of biotopes and invertebrate composition of the intertidal mudflats.
ABP Welwick Managed Realignment annual ecological monitoring ABPmer, 2018a and 2018b	2003 – ongoing	ABP Welwick Managed Realignment and fronting mudflat Section 11.4.2	Continual ecological monitoring of ABP's managed realignment site at Welwick. Receptors covered include coastal waterbirds and benthic habitats and species.

Survey Type	Date	Study Area	Objectives
Fish studies of the Humber Estuary Pérez-Dominguez, 2008	2007 – 2008	ABP Welwick Managed Realignment and other locations in the Humber Section 11.4.3	Sampling of several managed realignment sites along the Humber to better understand the usage of these realigned areas.
Environment Agency's National Fish Populations Database Environment Agency, 2018	Ongoing	Off Hawkins Point (approximately 1 km from the Scheme) Section 11.4.3	Regular sampling of the fish in the Humber to monitor species abundance and understand fish stocks of each water body.
Sea Watch Foundation (SWF) Regional Sightings Network SWF, 2018	Ongoing	The entire Humber region Section 11.4.4	A national sightings network to record and analyse the patterns of cetacean distributions.
Donna Nook Annual Seal Monitoring Lincolnshire Wildlife Trust, 2018	2006 - ongoing	Seal haul out site at Donna Nook, 20 km southeast of the Scheme Section 11.4.4	Monitoring of the seal population at Donna Nook to better understand breeding success and site fidelity.
Coastal waterbird surveys Institute of Estuarine and Coastal Studies (IECS), 2014a; 2014b; 2015; 2016a; 2016b; 2016c	2011 – 2016	The Scheme and surrounding areas Section 11.4.5 (Plate 11.3)	Gain an overview of the coastal waterbirds present on the site and identify any potential seasonal, tidal or spatial patterns of use.
Satellite tracking of Curlew and Redshank Cook *et al*, 2016	2015-2016	Both Welwick saltmarshes Section 11.4.5	Understand the fine-scale utilisation of saltmarsh areas by Curlew and Redshank.

11.3.3 Impact assessment

To facilitate the marine biodiversity impact assessment process a standard analysis methodology has been applied. This methodology has been developed from a range of sources, including the Town and Country Planning (EIA) Regulations 2017 (as amended), Marine Works (EIA) Regulations 2007 (as amended), the new EIA Directive (2014/52/EU), consultations and experience from previous projects.

The chapter has furthermore been undertaken following the principles of the Charted Institute of Ecology and Environmental Management's (CIEEM) latest guidelines for ecological impact assessment (EcIA) in the UK and Ireland (which consolidate advice for terrestrial, freshwater and coastal environments) (CIEEM, 2018). The CIEEM Guidelines state that 'EcIA is a process of identifying, quantifying and evaluating the potential effects of development-related or other proposed actions on habitats, species and ecosystems'. It requires an assessment of likely significant effects on important ecological features, and as such, does not require consideration of effects on every species or habitat that may be present within the site (CIEEM, 2018).

The Transboundary Regulation 17 of the Marine Works (EIA) (amendment) Regulations 2017 has not been considered in the impact assessment due to the predicted localised effects of the Scheme and the large distance between the study area and the nearest Member State.

The chapter considers the impacts from the entire proposed activity, covering the whole scope of the Scheme (described in Chapter 3). Under each topic, the environmental issues are divided into distinct 'receiving environments' or 'receptors'. The effect of the proposed activity on each of these is assessed by describing in turn: the baseline environmental conditions of each receiving environment; the 'impact pathways' by which the receptors could be affected; the significance of the impacts occurring; and the measures to mitigate for significant adverse impacts where these are predicted.

This Impact Assessment Framework, which is presented in the following sections, is designed to incorporate the key criteria and considerations without being overly prescriptive.

11.3.3.1 Stage 1 – Identify Receptors and Changes

The first stage identifies the potential environmental changes resulting from the Scheme and the features of interest (receptors) that are likely to be affected (which are together referred to as the impact pathway).

11.3.3.2 Stage 2 – Understanding Change and Sensitivity

The second stage involves understanding the nature of the environmental changes to provide a benchmark against which the changes and levels of exposure can be compared. The scale of the impacts via the impact pathways depends upon a range of factors, including the following:

- Magnitude (local/strategic):
  - Spatial extent (small/large scale);
  - Duration (temporary/short/intermediate/long-term);
  - Frequency (routine/intermittent/occasional/rare);
- Reversibility;
- Probability of occurrence;
- Confidence, or certainty, in the impact prediction;
- The margins by which set values are exceeded (e.g. water quality standards);
- The sensitivity of the receptor (resistance/adaptability/recoverability);
- The baseline conditions of the system; and

- Existing long-term trends and natural variability.

11.3.3.3 Stage 3 – Impact assessment

The likelihood of a feature being vulnerable to an impact pathway is then evaluated as a basis for assessing the level of the impact and its significance. The matrices in Tables 11.2 to 11.4 have been used to help assess significance (see below).

Determination of the significance of the predicted ecological effects is based on professional judgement having regard to the positive (beneficial) or negative (adverse) nature; extent; magnitude; duration; timing; frequency; and reversibility of the impacts assessed as well as the importance of the feature.

The key significance levels for either **beneficial** or **adverse** impacts are described as follows:

1. **Insignificant:** Insignificant change not having a discernible effect;
2. **Minor:** Effects tending to be discernible but tolerable;
3. **Moderate:** Where these changes are adverse they may require mitigation; and
4. **Major:** Effects are highest in magnitude and reflect the high vulnerability and importance of a receptor (e.g. to nature conservation). Where these changes are adverse they will require mitigation.

Impact assessment guidance tables

Table 11.2 was used as a means of generating an estimate of exposure. Magnitude of change needs to be considered in spatial and temporal terms (including duration, frequency and seasonality), and against the background environmental conditions in a study area. Once a magnitude has been assessed, this should be combined with the probability of occurrence to arrive at an exposure score which can then be used for the next step of the assessment, which is detailed in Table 11.3. For example, an impact pathway with a medium magnitude of change and a high probability of occurrence would result in a medium exposure to change.

Table 11.2: Exposure to change, combining magnitude and probability of change

Probability of Occurrence	Magnitude of Change			
	Large	Medium	Small	Negligible
High	High	Medium	Low	Negligible
Medium	Medium	Medium/Low	Low /Negligible	Negligible
Low	Low	Low /Negligible	Negligible	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible

Table 11.3 was then used to score the vulnerability of the features of interest based on the sensitivity of those features and their exposure to a given change. Where the exposure and sensitivity characteristics overlap then vulnerability exists and an adverse effect may occur.

For example, if the impact pathway previously assessed with a medium exposure to change acted on a receptor which had a high sensitivity, this would result in an assessment of high vulnerability. Sensitivity can be described as the intolerance of a

habitat, community or individual of a species to an environmental change and essentially considers the response characteristic of the feature. Thus, if a single or combination of environmental changes is likely to elicit a response then the feature under assessment can be considered to be sensitive. Where an exposure or change occurs for which the receptor is not sensitive, then no vulnerability can occur. Similarly, vulnerability will always be 'none' no matter how sensitive the feature is, if the exposure to change had been assessed as 'negligible'.

Table 11.3: Estimation of vulnerability based on sensitivity and exposure to change

Sensitivity of Feature	Exposure to Change			
	High	Medium	Low	Negligible
High	High	High	Moderate	None
Moderate	High	Moderate	Low	None
Low	Moderate	Low	Low	None
None	None	None	None	None

In order to determine whether there are likely to be significant effects, it is necessary to identify whether an ecological feature is 'important'. To achieve this, where possible, species and their populations have been valued on the basis of a combination of their rarity, status and distribution, using contextual information where it exists.

The CIEEM Guidelines recognise that determining ecological importance is a complex process, which is a matter of professional judgement guided by the importance and relevance of a number of factors. These include designation and legislative protection as well as biodiversity value and secondary/ supporting value (e.g. where habitats may function as a buffer or resource associated with an adjacent designated area). Consideration of each ecological feature with respect to these factors allows their importance to be determined having regard to the geographic frame of reference and protected status.

To determine overall significance the vulnerability was then combined with the importance of the feature of interest using Table 11.4. For example, if a high vulnerability was previously given to a feature of low importance, an initial level of significance of minor would be given.

Table 11.4: Estimation of significance based on vulnerability and importance

Importance of Feature	Vulnerability of Feature to Impact			
	High	Moderate	Low	None
High	Major	Moderate	Minor	Insignificant
Moderate	Moderate	Moderate/Minor	Minor/Insignificant	Insignificant
Low	Minor	Minor/Insignificant	Insignificant	Insignificant
None	Insignificant	Insignificant	Insignificant	Insignificant

11.3.3.4 Stage 4 – Impact Management

The final stage is to identify any impacts that are found to be moderate (including moderate/minor) and/or major adverse significant (and so are considered to be 'significant' in EIA terms) and require mitigation measures to reduce residual impacts, as far as possible, to environmentally acceptable levels. Within the assessment procedure the use of mitigation measures will alter the risk of exposure and, hence, will require significance to be re-assessed and thus the residual impact (i.e. with mitigation) identified.

11.3.4 Uncertainties, assumptions and limitations

There is always a degree of uncertainty associated with making predictions as to how a managed realignment scheme will function in a highly dynamic environment, with additional uncertainty over future management and environmental conditions (e.g. climate change). The assessments have been founded in the results of numerical modelling and a conceptual understanding of the estuary. Lessons learnt from existing managed realignment schemes within the area and extensive use of the literature have been factored in to the respective predictions of environmental effects and habitat development within the site. The predictions have also been underpinned by the collection of site-specific ecological data.

11.4 Existing environment

This section provides baseline information on marine biodiversity receptors of the Humber Estuary focussing on the footprint of the Scheme. The descriptions are based on the latest available information derived from multiple sources (summarised in Section 11.3.2). The existing environment section provides a single baseline for the Scheme and does not attempt to describe the two distinct sites separately.

The individual receptors that have been considered within this section include:

- Nature conservation;
- Benthic habitats and species;
  - Saltmarsh habitats;
  - Intertidal mudflat and associated species;
- Fish;
- Marine mammals; and
- Coastal waterbirds.

11.4.1 Nature conservation

11.4.1.1 International designations

The Scheme falls within the boundary of the Humber Estuary Special Protection Area (SPA), Special Area of Conservation (SAC) and Ramsar Site (Plate 11.1a). The SPA is designated for the protection of birds, with the Humber Estuary maintaining the seventh largest population of non-breeding waterbirds alongside international important breeding species (Frost *et al*., 2018). The Ramsar site is designated for multiple reasons, specifically nationally important wetland habitats and presence of protected

species (including mammals, birds and fish). The SPA and Ramsar qualifying species are shown in Table 11.5 and Table 11.6, for full discussion on coastal waterbirds see Section 11.4.5.

Table 11.5: Qualifying features of the Humber Estuary SPA

Internationally Important Populations of Regularly Occurring Annex 1 Species	
Breeding Species Population	
Bittern† Botaurus stellaris	2 calling males (10.5% of the GB population)
Marsh Harrier Circus aeruginosus	10 breeding females (6.3% of the GB population)
Avocet Recurvirostra avosetta	64 pairs (8.6% of the GB population)
Little Tern Sternula albifrons	51 pairs (2.1% of the GB population)
Wintering Species Population	
Bittern†	4 (4.0% of the GB population)
Hen harrier Circus cyaneus	8 (1.1% of the GB population)
Bar-tailed Godwit Limosa lapponica	2,752 (4.4% of the GB population)
Golden Plover Pluvialis apricaria	30,709 (12.3% of the GB population)
Avocet	54 (1.7% of the GB population)
On passage Species population	
Ruff Calidris pugnax	128 (1.4% of the GB population)
Internationally Important Populations of Regularly Occurring Migratory Species	
Wintering Species Population	
Teal† Anas crecca	2,322 (<1% of the population)
Wigeon† Mareca penelope	5,044 (<1% of the population)
Mallard† Anas platyrhynchos	2,456 (<1% of the population)

Turnstone† Arenaria interpres	629 (<1% of the population)
Common Pochard† Aythya ferina	719 (<1% of the population)
Greater Scaup† Aythya marila	127 (<1% of the population)
Brent Goose† Branta bernicla	2,098 (<1% of the population)
Goldeneye† Bucephala clangula	467 (<1% of the population)
Sanderling† Calidris alba	486 (<1% of the population)
Dunlin Calidris alpina	22,222 (1.7% of the Northern Siberia/Europe/Western Africa population)
Red Knot Calidris canutus	28,165 (6.3% of the North-eastern Canada/Greenland/Iceland/North-western Europe population)
Ringed Plover† Charadrius hiaticula	403 (<1% of the population)
Oystercatcher† Haematopus ostralegus	3503 (<1% of the population)
Black-tailed Godwit Limosa limosa	1,113(3.2% of the Icelandic Breeding population)
Curlew† Numenius arquata	3,253 (<1% of the population)
Grey Plover† Pluvialis squatarola	1,704 (<1% of the population)
Shelduck Tadorna tadorna	4,464 (1.5% of the North-western Europe population)
Redshank Tringa totanus	4,632(3.6% of the Eastern Atlantic Wintering population)
Northern Lapwing† Vanellus vanellus	22,765 (<1% of population)
On passage Species Population	
Sanderling†	818 (<1% of the population)

Dunlin	20,269 (1.5% of the Northern Siberia/Europe/Western Africa population)
Red Knot	18,500 (4.1% of the North-eastern Canada/Greenland/Iceland/North-western Europe population)
Ringed Plover†	1,766 (<1% of the population)
Black-tailed Godwit	915 (2.6% of the Icelandic Breeding population)
Whimbrel† Numenius phaeopus	113 (<1% of the population
Grey Plover†	1,590 (<1% of the population)
Greenshank† Tringa nebularia	77 (<1% of the population)
Redshank	7,462 (5.7% of the Eastern Atlantic Wintering population)
Internationally Important Assemblage of Waterfowl	
Waterfowl assemblage	153,934 waterfowl
†Species with this symbol do not represent a population that is > 1% of the international threshold but are included in the wildfowl assemblage.	

Table 11.6: Qualifying marine features of the Humber Estuary Ramsar Site

Ramsar Criterion	
Criterion 1 – natural wetland habitats that are of international importance	
The site is a representative example of a near-natural estuary with the following component habitats: dune systems and humid dune slacks, estuarine waters, intertidal mud and sand flats, saltmarshes, and coastal brackish/saline lagoons.	
Criterion 3 – supports populations of plants and/or animal species of international importance	
The Humber Estuary Ramsar site supports a breeding colony of grey seals *Halichoerus grypus* at Donna Nook. It is the second largest grey seal colony in England and the furthest south regular breeding site on the east coast.	
Criterion 5 – Bird Assemblages of International Importance	
Wintering waterfowl	153,934 waterfowl (5 year peak mean 1998/99-2002/3)
Criterion 6 – Bird Species/Populations Occurring at Levels of International Importance	
Species	**Spring/Autumn Population (5 year peak mean 1996-2000)**
Golden Plover	17,996 (2.2% of the Iceland & Faroes/East Atlantic population)
Red Knot	18,500 (4.1% of the West & Southern African wintering population)
Dunlin	20,269 (1.5% of the West Siberia/West Europe population)

Black-tailed Godwit	915 (2.6% of the Iceland/West Europe population)
Redshank	7,462 (5.7% of the population)
Species	**Wintering Population (5 year peak mean 1996/7-2000/1)**
Shelduck	4,464 (1.5% of the North-western Europe Population)
Golden Plover	30,709 (3.8% of the Iceland & Faroes/East Atlantic population)
Red Knot	28,165 (4.1% of the West & Southern African wintering population)
Dunlin	22,222 (1.7% of the West Siberia/West Europe population)
Black-tailed Godwit	1,113 (3.2% of the Iceland/West Europe population)
Bar-tailed Godwit	2,752 (2.3% of the West Paleartic population)
Criterion 8 – Internationally important source of food for fishes, spawning grounds, nursery and/or migration path	
The Humber Estuary acts as an important migration route for both river lamprey *Lampetra fluviatilis* and sea lamprey *Petromyzon marinus* between coastal waters and their spawning areas.	

The Humber Estuary SAC is a 36,657 ha area protected for having multiple Annex I features of the European Commission (EC) Habitats Directive (92/43/EEC). The primary reason for designation is the presence of two broad scale habitats, “Estuaries” and “Mudflats and sandflats not covered by seawater at low tide”. These broad scale habitats support other more specific habitats which are qualifying features but not a primary reason for designation. These are:

- Sandbanks which are slightly covered by sea water all the time;
- Coastal lagoons (identified as a priority feature);
- Salicornia and other annuals colonizing mud and sand;
- Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*);
- Embryonic shifting dunes;
- Shifting dunes along the shoreline with *Ammophila arenaria* (‘white dunes’);
- Fixed coastal dunes with herbaceous vegetation (‘grey dunes’) (identified as a priority feature); and
- Dunes with *Hippopha rhamnoides*.

Alongside the habitats that the SAC is designated for, there are also three mobile species listed on Annex II of the EC Habitats Directive (92/43/EEC). The three species are:

- Sea lamprey *P. marinus*;
- River lamprey *L. fluviatilis*; and
- Grey seal *Halichoerus grypus*.

Collectively the internationally designated sites of the Humber Estuary are all component sites of the Humber Estuary European Marine Site (EMS). EMS (as defined by the Habitats Regulations) refers to those marine areas of both SACs and SPAs

which are protected under the Habitats Directive and Directive 2009/147/EC of the European Parliament on the conservation of wild birds (Birds Directive).

Management of the designated sites is governed by the conservation objectives and Supplementary Advice on Conservation Objectives (SACOs). Natural England published SACOs for the Humber Estuary SAC and SPA in 2017 and 2018, respectively (Natural England, 2017 & 2018). Alongside Natural England's management advice, the Humber Nature Partnership (HNP) has produced the Humber Management Scheme (HNP, 2016), which provides an action plan on how to achieve the conservation objectives set by Natural England.

11.4.1.2 National Designations

There is one Sites of Special Scientific Interest (SSSIs), designated under WACA, that directly overlaps with the Scheme and one within 5 km of the Scheme. The Humber Estuary SSSI directly overlaps the Scheme (Plate 11.1a and 11.1b) and The Lagoons SSSI is located approximately 4 km to the east. The Humber Estuary SSSI is designated for its nationally important habitat assemblage (intertidal mudflats and sandflats, and coastal saltmarsh) geological interest, importance to breeding, wintering and passage birds, breeding grey seal and the presence of river and sea lamprey. The Lagoons SSSI is designated for supporting saline lagoons and a nationally important population of breeding Little Terns.

The Scheme overlaps the several units of the Humber Estuary SSSI. Each SSSI is split into multiple units to allow for better management. There are 187 units that make up the Humber Estuary SSSI, eight of these overlap with the Scheme (see table below). Some of these have no marine component and are not assessed within this chapter (see Chapter 10, Terrestrial Biodiversity).

Table 11.7: SSSI Units

Unit Number (ID)	Unit Name	Unit Condition	Marine Features
149 (ID 1028410)	Sunk Island Sands	Unfavourable - Recovering	Yes (benthic habitats and species and coastal waterbirds)
150 (ID 1028455)	Hawkins Point to Welwick	Unfavourable - Recovering	Yes (benthic habitats and species)
151 (ID 1028450)	Haverfield Quarries	Unfavourable - No Change	No, assessed in Chapter 10
152 (ID 1028412)	Sheep Trod Lane	Unfavourable - Recovering	No, assessed in Chapter 10
153 (ID 1028451)	Corner of Welwick Bank	Unfavourable - Recovering	No, assessed in Chapter 10
154 (ID 1028414)	Welwick Saltmarsh	Unfavourable - Recovering	Yes

Unit Number (ID)	Unit Name	Unit Condition	Marine Features
			(benthic habitats and species and coastal waterbirds)
155 (ID 1028415)	Spurn Bight	Unfavourable - Recovering	Yes (benthic habitats and species and coastal waterbirds)
156 (ID 1028416)	Weeton Bank to Skeffling Clough	Unfavourable - Recovering	Yes (benthic habitats and species)

The “Unfavourable – Recovering” status for SSSI unit 150 is on account of experiencing coastal squeeze impacts (which are dealt with in the approved Humber FRM Strategy), with units 149, 154, 155 and 156 assessed this way due to the birds species and/or numbers recorded being in a recovering state. Units 152 and 153 were assessed as “Unfavourable – Recovering” due to appropriate land management put in place. Unit 151 was given “Unfavourable – No Change” status as currently no agreed management has been put in place. The proposed breach locations and bank lowering/removal would be within the Weeton Bank to Skeffling Clough (unit 156) and Hawkins Point to Welwick (unit 150), both assessed as “Unfavourable – Recovering”.

Plate 11.1a: Location of the internationally and nationally designated sites in the vicinity of the Scheme

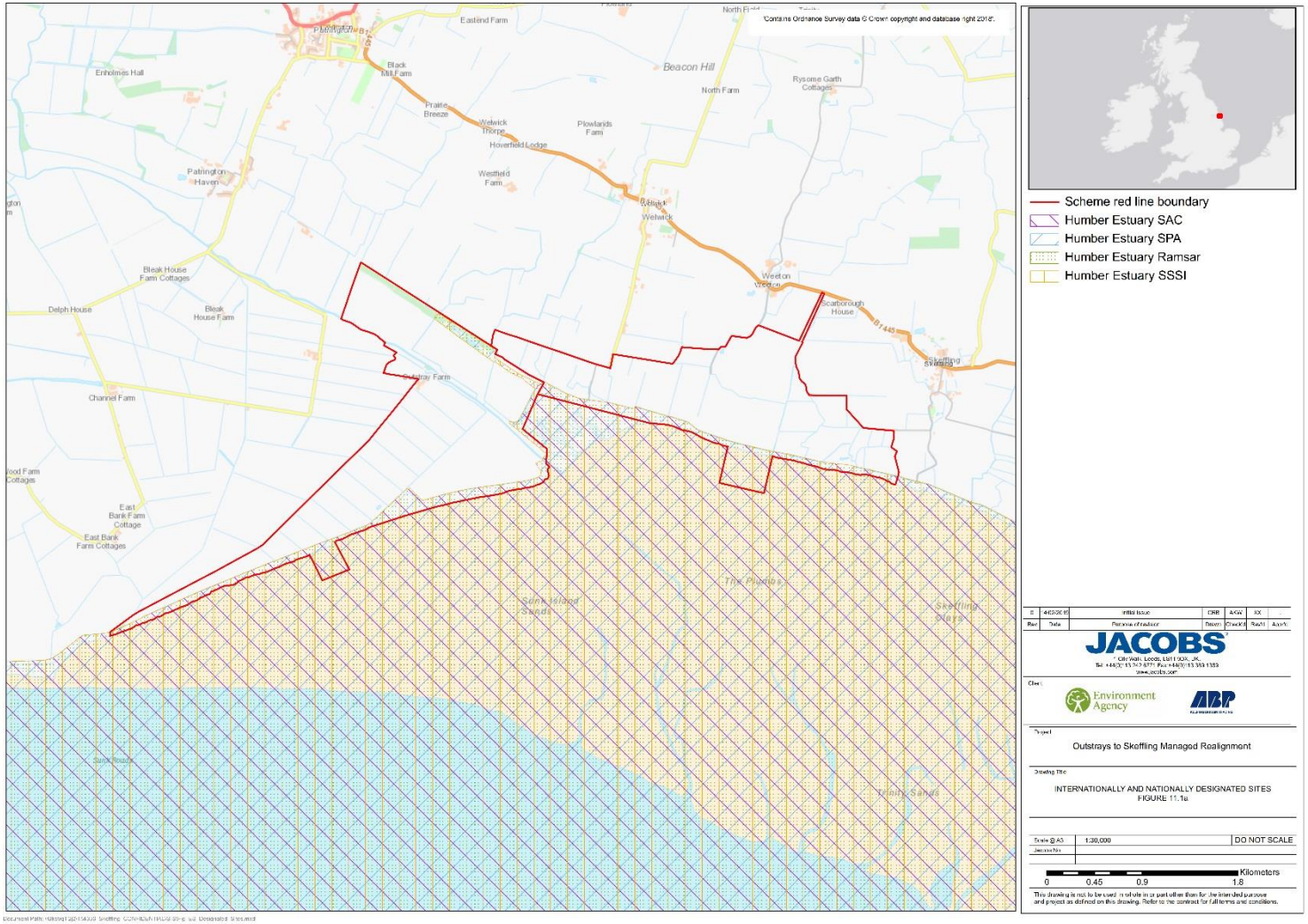
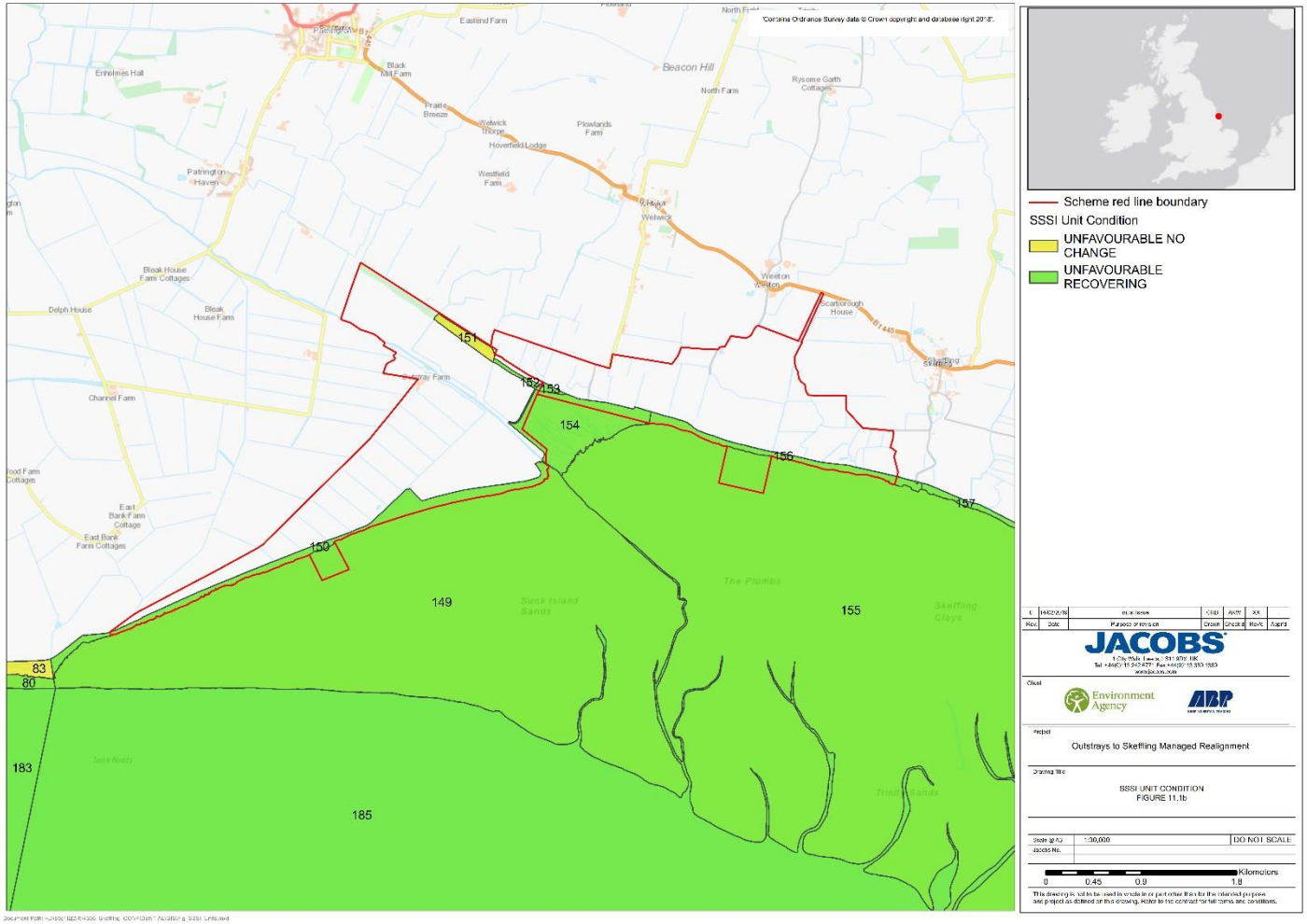


Plate 11.1b: Condition of the Humber Estuary SSSI units that overlap with the Scheme



11.4.2 Benthic habitats and species

11.4.2.1 Humber Estuary overview

The Humber is the second-largest coastal plain estuary in the United Kingdom (UK), and the largest coastal plain estuary on the east coast of Britain. It is a muddy, macro-tidal estuary that supports a range of benthic habitats including, saltmarshes, sand dunes, subtidal sandbanks, extensive intertidal mudflats, glasswort beds and coastal lagoons. Many of these habitats are qualifying features of the international and/or national designations (see Section 11.4.1).

The total extent of the entire Humber Estuary is just over 35,000ha and intertidal habitats cover approximately a third (10,000 ha) with 90% of this intertidal habitat being extensive mudflats (Natural England, 2003b). The largest areas of mudflat occur in the outer estuary at Spurn Bight and Pyewipe, at Foul Holme and Skitter Sand in the middle estuary and across most of the estuary width above the Humber Bridge. The extensive mud and sandflats support a range of benthic communities, which in turn are an important feeding resource for birds and fish.

Alongside the extensive mudflats, there are approximately 630 ha of saltmarsh along the banks of the Humber. The composition of Humber saltmarsh is unusual compared to other UK estuaries with four distinct zones, pioneer marsh, low to mid marsh communities, mid to upper marsh communities and transitional communities. The unusual nature of the Humber saltmarsh communities derives from the markedly truncated structure with mid-marsh communities containing significant amounts of low-marsh and pioneer species (Hammond, 2011).

11.4.2.2 Scheme-specific baseline

All benthic habitats described in this section are positioned seaward of the toe of the existing embankment/sea defences. This section has been structured in a seaward progression so that the saltmarsh habitats fronting the scheme are described first and then the adjacent intertidal mudflat. The baseline description is based on Scheme-specific surveys which mapped the intertidal habitats from Winestead Drain to South End Bank and the annual monitoring of ABP Welwick Managed Realignment and adjacent area.

Saltmarsh habitats

Fronting the entire proposed Scheme there is a band of saltmarsh. This is comprised predominantly of low (pioneer) to mid saltmarsh communities. Immediately in front of the existing embankment/sea defences swards of common cordgrass *Spartina anglica* dominate the assemblage interspersed with pools of standing water and small clumps of sea purslane *Halimione portulacoides*, *Salicornia* spp, annual seablite *Suaeda maritima*, common saltmarsh grass *Puccinellia maritima* and sea aster *Aster tripolium* also present. The extent of this habitat ranges in width from approximately 30 metres (m) at the eastern end of the Scheme to almost a kilometre at the Welwick Saltmarsh before it tapers back off to approximately 50 m at the most western part of the Scheme.

In general, pioneer species such as common cordgrass *S. anglica* and marsh samphire *Salicornia* spp. are more abundant in the lower elevations of this zone, creating a mosaic of these two biotopes. An increasing abundance of sea purslane *H. portulacoides* and other mid-marsh species is observed towards the toe of the embankment. At the eastern end of the Scheme, near Humber Lane there are extensive stands of the common reed *Phragmites australis*.

This is typical of the zonation of saltmarsh communities throughout most of the Humber Estuary, where they have been described as markedly truncated with mid-marsh communities containing significant amounts of low-marsh and pioneer species (Hammond, 2011).

There are also two main areas of established saltmarsh within the vicinity of the Scheme, the ABP Welwick Managed Realignment (fronting West 1) and the Welwick Saltmarsh (southwest of East 1). These areas of saltmarsh are dominated by mid to upper saltmarsh species predominately swards of common cordgrass *S. anglica* with small clumps of sea purslane *Halimione portulacoides*, *Salicornia* spp, annual seablite *Suaeda maritima*, common saltmarsh grass *Puccinellia maritima* and sea aster *Aster tripolium* also present (ABPmer, 2016b; Hammond, 2017).

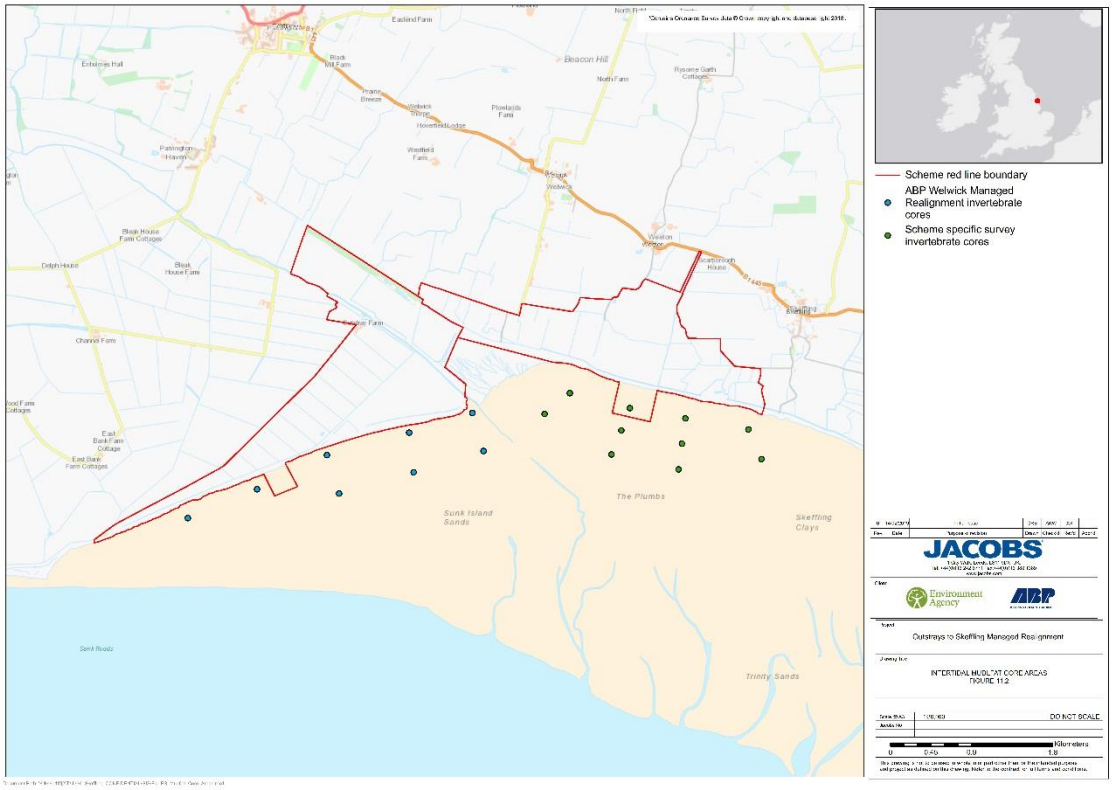
Intertidal mudflat and associated species

Seaward of the Scheme there is an extensive area of intertidal mudflat which is characterised by common invertebrate communities (ABPmer, 2016b; ABPmer, 2018b). During the Scheme-specific surveys in September 2015 the mudflats adjacent to the Scheme were sampled to better understand and quantify the infaunal assemblages found in the area (ABPmer, 2016b). Alongside the Scheme-specific survey in September 2015 annual monitoring has been undertaken on the mudflat fronting the Scheme since 2003 (ABPmer, 2018a). The invertebrate assemblage within the ABP Welwick Managed Realignment has also been monitored annually since 2007.

<u>Fronting mudflat</u>

Invertebrate samples have been collected at 18 locations in the intertidal mudflats fronting the Scheme (eight from the 2003 to 2017 monitoring of ABP Welwick Managed Realignment and 10 from the 2015 Scheme-specific survey, see Plate 11.2). The survey locations are representative of tidal elevations across the study area.

Plate 11.2: Intertidal invertebrate core samples



Overall, the number of taxa found throughout the survey ranged from 6 to 23, and the number of individuals from 2,857 organisms per m² to 59,732 organisms per m². The intertidal infaunal community was found to be relatively uniform across the intertidal frontage and was characterised by a range of taxa including nematodes, oligochaetes, polychaete worms (such as the predatory worm *Eteone longa* and tube-living deposit feeding worm *Pygospio elegans*) and bivalve molluscs. The range in total species biomass in a single sample was between 24 and 1,211 grams per m² with the Baltic tellin *Limecola balthica* contributing most to the total biomass.

The most abundant polychaetes recorded within the area were the predatory worm *Eteone longa*, tube-living deposit feeding worm *Pygospio elegans*. These species occurred in densities of 143 to over 1,500 organisms per m² in a single sample. The abundance of the oligochaete *Tubificoides benedii*, ranged from 1,142 to 20,000 organisms per m². This species is a deposit feeding oligochaete which is commonly recorded in mud habitat and can tolerate a high degree of anoxic (and sulfidic) conditions (Giere *et al*., 1999).

The bivalve species recorded in highest abundances were tellinoidea clams including the *L. balthica and Abra tenuis.* These species can occur in very high densities. For example, Ratcliffe *et al.* (1981) reported adult densities of *L. balthica* in the Humber Estuary, UK, between 5,000 organisms per m² and 40,000 organisms per m² depending on time since a successful spatfall. Densities of between approximately 430 organisms per m² and 9000 organisms per m² were recorded during the fronting mudflat surveys.

Gastropods recorded included the mud snail *Peringia ulvae* and *Retusa obtusa*. *P. ulvae* is widespread throughout the UK coast and can occur in very high densities, of up to 300,000 organisms per m² but was recorded in lower densities during the fronting mudflat surveys (between 143 and 18,285 organisms per m²). This species is highly mobile and usually very quick to colonise areas of mudflats due to the considerable dispersive ability of the abundant pelagic larval form and the ability of adults to immigrate into areas with the tide by floating on a mucous raft (Jackson, 2000). *R. obtusa* is a burrower in mud or muddy sand, living below the surface in the first few centimetres, and feeds on *P. ulvae* (de Kluijver *et al.,* 2015).

The assemblage recorded in the mudflat fronting the Scheme has been relatively consistent throughout the monitoring period (2003 to 2017), as expected for a well-established, stable mudflat. The species present are characteristic of this part of the Humber Estuary (JNCC, 2008; ABPmer, 2018a).

ABP Welwick Managed Realignment site

Alongside the 18 samples collected on the fronting mudflat, six samples have been collected from the mudflat within the completed ABP Welwick Managed Realignment site annually since 2007 (ABPmer, 2018b). Overall, a similar invertebrate community has been recorded within the site as observed within the fronting mudflats. Since the breach in 2006, and first survey in 2007, there has been considerable fluctuation in the species richness, abundance and biomass recorded within the site, this replicates the variation that is observed in the adjacent mudflat.

Initially the site was dominated by highly mobile species that can easily colonise a newly created area (e.g. gastropods *P. ulvae* and *R. obtusa*). In more recent years there has been colonisation of the mudflat area by more terrestrial species as the saltmarsh extent has increased, with *Dolichopodidae* larva, Collembola spp. and *Enchytraeidae* recorded in larger numbers than their marine counterparts. The most common marine species recorded across the realignment site has stayed similar since

inundation, typically including the oligochaete *T. benedii*, polychaete *H. diversicolor* and the gastropod *P. ulvae* recorded in the largest numbers. *L. balthica* and the polychaete *H. diversicolor* typically contribute most to the overall biomass.

11.4.3 Fish

11.4.3.1 Humber Estuary overview

The Humber Estuary contains a varied fish population with a range of common estuarine, freshwater and marine species present. Species that are regularly occurring include flounder *Platichthys flesus*, gobies *Pomatoschistus sp.*, Dover sole *Solea solea*, plaice *Pleuronectes platessa*, smelt species *Osmerus eperlanus* and *Atherina presbyter* and herring *Clupea harengus*. In general, the abundance and diversity of fish increases towards the mouth of the Estuary with up to 50 species recorded compared to approximately 30 species within the middle and upper transitional water catchments of the Humber. The middle and upper estuary are dominated by common freshwater or brackish species including bream *Abramis brama*, flounder, perch *Perca fluviatilis* and roach *Rutilus rutilus* (Pérez-Dominguez, 2008; Environment Agency, 2018).

Migratory fish in the Humber Estuary

Alongside supporting a large variety of common estuarine fish there are several migratory species that utilise the Humber Estuary as a gateway to their spawning rivers. Species such as Atlantic salmon *Salmo salar*, brown trout *Salmo trutta*, European eel *Anguilla anguilla*, river *Lampetra fluviatilis* and sea lamprey *Petromyzon marinus* travel upstream from the sea, to spawn in rivers such as the Don, Aire, Ouse, Wharfe and Derwent; the last of which has SSSI and SAC status.

European eel is included as a threatened and or declining species under the OSPAR Convention (OSPAR, 2010), listed as Critically Endangered on the International Union for Conservation of Nature (IUCN) Red List, and is a species of conservation concern in the Humber. The Humber River Basin District (RBD) has an eel recovery plan which forms part of the national eel recovery plan which the UK is required to implement in compliance with European Council Regulation No. 1100/2007. The most vulnerable stage of the *A. anguilla* lifecycle is the silver eel migration downstream and back out to the spawning grounds in the Atlantic in autumn, typically on dark, stormy nights (Environment Agency, 2010). This downstream migration coincides with the closed season between 1st October and 31st March for yellow and silver eel under The Eels (England & Wales) Regulation 2009.

Atlantic salmon is classified as an Annex II species (whose conservation requires the designation of SAC species) in freshwater and Annex V species (whose taking in the wild and exploitation may be the subject of management measures) under the EC Habitats Directive (92/43/EEC) and are also protected under Salmon & Freshwater Fisheries Act (1975). Atlantic salmon are anadromous, with the adults migrating from the sea to spawn in the river of their birth. Atlantic salmon spawning ‘runs’ occur between April and August. Spawning usually takes place from October to December, at five to six years of age. The spent adults, referred to as ‘kelts’, return to the sea to spawn the following year, although for many, this will be the final spawning run. The juveniles remain in freshwater as ‘parr’ for between one and three years before descending as smolts (Whitehead *et al.* 1989, cited in English Nature, 2003). Whilst historical trends have shown declines in salmonid populations in other English estuaries, the Humber system has shown an increase, with the Environment Agency,

reporting increasing numbers of both salmon and trout following improvements in water quality (Environment Agency, 2009 & 2015).

Sea trout is protected under the Salmon and Freshwater Fisheries Act 1975 and is another anadromous species which migrates through the Humber Estuary from the sea to reach its spawning grounds in freshwater rivers and streams. The sea trout spawning 'runs' can take place during spring, summer or autumn, but in general, occur from September/October to January, with adults between three and four years of age migrating upstream to spawn between October and January (English Nature, 2003). Spent adults return to the sea to spawn the following year. The juveniles remain in freshwater for up to five years before descending to the sea (Whitehead *et al.* 1989, cited in English Nature, 2003). As noted above, the Environment Agency reported increasing numbers of both salmon and trout in recent years following improvements in water quality (Environment Agency, 2009 & 2015).

River lamprey and sea lamprey are classified as Annex II species under the EC Habitats Directive (92/43/EEC). Both species are a primary qualifying feature of the River Derwent SAC and the Humber Estuary Ramsar site and a non-primary qualifying feature of the Humber Estuary SAC. The river lamprey is also classified as an Annex V species whose taking in the wild and exploitation may be the subject of management measures. The sea lamprey is included as a threatened and/ or declining species under the OSPAR Convention (OSPAR, 2009).

Both species are anadromous, spawning in freshwater but completing part of their lifecycle in the sea. The larvae (ammocoetes) of both species metamorphose into the adult form upon reaching a critical size (at about three to five years of age for river lamprey and about five years of age for sea lamprey; Maitland, 2003) and migrate downstream out of their freshwater environment, going into or through the estuary to reach coastal areas where they feed and grow until they reach sexual maturity. Sea lamprey are thought to migrate further into the marine environment compared to the river lamprey. During the life cycle phase in the estuary/marine environment, the adult form of both species are parasitic, attaching to various fish species (e.g. herring, flounder, cod, salmon). Upon reaching sexual maturity, both species of lamprey migrate upstream to spawn (not necessarily in the river from which they originated, although for the Humber it is likely they return to this catchment, particularly for river lamprey; Martyn Lucas, Durham University, pers. comm.). Both species are semelparous, only reproducing a single time within their lifecycle, with all individuals dying immediately after spawning. Any sexually mature individuals unable to reach the spawning grounds also die as their digestive systems degenerate at this point in the lifecycle.

River lamprey and sea lamprey are present in the Estuary and adjacent coastal areas all year round; however, there are temporal variations in local abundance related to their migratory movements.

Juvenile river lamprey migrate downstream into the Humber Estuary between late winter/ early-mid spring and are likely to reach the middle and outer Humber in May - July (i.e. local abundance of juveniles peaks at this time; Franco, 2015). An impingement study at the South Humber Bank Power Station at Stallingborough, approximately 8 km southwest of the Scheme, showed that impingement of juvenile river lamprey occurred between May and August with the peak period of capture around June and July (IECS, 2008). River lamprey spend about 1.5 years feeding in the estuary/ sea before reaching sexual maturity and migrating upstream to spawn. The spawning migration starts in August/ September, with the major migration in the Estuary occurring between September to November (i.e. local abundance of mature

adults peaks at this time; Franco, 2015). In the Humber catchment, spawning occurs between March and May when the water temperature reaches 10°C (Maitland, 2003; Franco, 2015).

The sea lamprey is much rarer than the river lamprey but abundance will vary locally in relation to migratory movements. Peak movements through the Estuary, associated with downstream juvenile migration are likely to occur in winter/ early spring, with the major migration through the estuary probably occurring in January to March. Sea lamprey spend about two to three years feeding in the estuary/ sea before reaching sexual maturity and migrating upstream to spawn. Peak movements through the estuary related to spawning migration of adults is likely to occur in late winter through to spring (into March to April; Franco, 2015). In the Humber catchment, the sea lamprey usually spawns in late May to July, when the water temperature reaches at least 15°C (Maitland, 2003; Franco, 2015). Migratory activity of lamprey may be reduced at high water flows and is not stimulated at low flows (Masters *et al.*2006).

11.4.3.2 Scheme-specific baseline

Surveys in the vicinity of the Scheme were undertaken by IECS within the ABP Welwick Managed Realignment site and the adjacent mudflat (Pérez-Dominguez, 2008). Fyke nets and bottle traps were used during the sampling, this method targets a wide range of shallow water species. The bottle traps used were limited to small individuals, but gave a different capture method and at a different water column height to increase potential diversity during the sampling. Flounder and sand gobies *Pomatoschistus minutus* dominated the species composition during the fyke net sampling in both the mudflat (55 % of the organisms caught where of these two species) and the saltmarsh (98 % of the organisms caught where of these two species). Other species present included five-bearded rockling *Ciliata mustela*, sea bass *Dicentrarchus labrax* and whiting *Merlangius merlangus* (Table 11.8).

Table 11.8: Number of fish caught within sampling at Welwick mudflat and saltmarsh

Common Name	Scientific Name	Summer / Autumn		Winter / Spring	
		Marsh	Mudflat	Marsh	Mudflat
Five-bearded rockling	Ciliata mustela	1	5	0	0
Sea bass	Dicentrarchus labrax	0	6	0	0
Whiting	Merlangius merlangus	0	1	0	0
Smelt	Osmerus eperlanus	0	1	0	0
Flounder	Platichthys flesus	21	15	0	4
Plaice	Pleuronectes platessa	0	1	0	0
Dab	Pollachius virens	1	0	0	0
Sand goby	Pomatoschistus minutus	94	4	0	0
Sprat	Sprattus sprattus	0	1	0	0

The closest Environment Agency fish monitoring is undertaken just off Hawkins Point, approximately 2.5 km to the south west of the proposed Scheme. Beam trawl sampling was undertaken twice a year in 2014, 2015 and 2017 once in summer (June) and once in autumn (September) (Environment Agency, 2018). Two beam trawls, of an unknown duration, were undertaken in each season. Beam trawls unselectively capture bottom dwelling fish and therefore can capture a large variety, with mesh size the limiting factor. The mesh size of these trawls is unknown. The species caught were similar to those found elsewhere along the estuary, with Dover sole, plaice and sand goby the most frequently caught species.

11.4.4 Marine mammals

The most commonly occurring marine mammals within the Humber Estuary are grey and common seals (SCOS, 2016). Both species are listed in Annex II of the EU Habitats Directive (1992) and the grey seal is a non-primary qualifying feature of the Humber Estuary SAC. The grey seal is also listed as an Appendix III species under the Bern Convention (1979) which prohibits the deliberate disturbance/ capture/ killing of species and disturbance of their breeding grounds. Grey seals are also recognised within the Humber Estuary Ramsar site due to the breeding colony at Donna Nook (approximately 20 km southeast of the Scheme). Both species are also protected under the Conservation of Seals (England) Order 1999 No. 3052.

The outer Humber Estuary is utilised as a foraging area for grey seals and common seals (particularly those hauling out on the sandflats at Donna Nook on the Lincolnshire coast). The breeding population of grey seal at Donna Nook has been increasing year-on-year since 1981, when less than 50 pups were born to just over 2,000 pups in the latest census in 2017 (Lincolnshire Wildlife Trust, 2018). There is no evidence to suggest that the area seaward of the Scheme is used by a significant number of seals for foraging or resting (haul-out).

In addition to seal species, several cetacean species have been recorded in the Humber region with harbour porpoise *Phocoena phocoena* the most frequently observed. Sightings provided to SWF are shown in Table 11.9 (SWF, 2018). None of the sightings have occurred close to the Scheme.

Table 11.9: Recent cetacean sightings in the Humber and approaches reported to SWF

Species	Number	Location	Date
Harbour porpoise	1	Grimsby Dock, River Humber	4 September 2018
Harbour porpoise	5	Haille Fort, River Humber	29 August 2018
Harbour porpoise	3	Grimsby Dock, River Humber	23 August 2018
Harbour porpoise	3	Haille Fort, River Humber	09 February 2018
Harbour porpoise	2	Haille Fort, River Humber	23 January 2018

Species	Number	Location	Date
Harbour porpoise	6	Haille Fort, River Humber	19 January 2018
Harbour porpoise	4	Haille Fort, River Humber	21 December 2017
Harbour porpoise	5	Haille Fort, River Humber	14 December 2017
Harbour porpoise	2	Haille Fort, River Humber	12 December 2017
Harbour porpoise	5	Haille Fort, River Humber	12 December 2017
Harbour porpoise	4	Haille Fort, River Humber	25 October 2017
Harbour porpoise	2	Haille Fort, River Humber	22 October 2017
Harbour porpoise	4	Haille Fort, River Humber	08 October 2017

11.4.5 Coastal waterbirds

This section focuses on coastal waterbirds that regularly occur within the Scheme and the wider Humber Estuary. Within this section coastal waterbirds is used to refer to any bird that is ecologically dependant on coastal aquatic habitats for a proportion of their life history. The bird families covered under this are: *Gaviidae* (divers), *Podicipedidae* (grebes), *Phalacrocoracidae* (cormorants), *Ardeidae* (herons and egrets), *Threskiornithidae* (ibises and spoonbills), *Ciconiidae* (storks), *Anatidae* (swans, geese and ducks), *Rallidae* (rails), *Haematopodidae*, *Recurvirostridae*, *Charadriidae* and *Scolopacidae* (waders), *Laridae* (gulls and terns) and *Alcedinidae* (kingfishers).

11.4.5.1 Humber Estuary overview

The Humber Estuary holds the seventh most populous aggregation of waterbirds in Britain (Frost *et al.*, 2018). The average number of overwintering waterbirds that use the expansive intertidal mudflats and nearby coastal areas is close to 150,000 individuals. These internationally important populations of multiple species have led to the Humber being designated as a SPA. Several of the designated features are facing a decline in the number of birds using the Humber Estuary. Species such as Wigeon, Goldeneye, Lapwing, Golden Plover and Black-tailed Godwit are showing short-term (5 years) population declines and have been listed as amber on the BTO WeBS Alerts (Cook *et al*., 2013). Alongside some stark reduction of certain features, several others have been recorded in increasing numbers in the short-term, e.g. a 143 % increase in Cormorant and a 12 % increase in Teal. Detailed analysis undertaken suggested varying reasons for the population changes, with anthropogenic activities likely to be responsible, at least in part, for present day number and distribution of waterbirds. However, on-going changes in flyway scale distribution are likely to be responsible for differing background population trajectories between species (Woodward *et al.*, 2015).

The most recent estuary-wide data from 2012 until 2017 WeBS Core Counts (Appendix 11.1) indicate that several species surpass the international or national threshold of

importance. Pink-footed Goose, Shelduck, Avocet, Knot, Golden Plover, Grey Plover, Black-tailed Godwit, Bar-tailed Godwit and Redshank all have average populations that are greater than the international importance threshold. Species that regularly occur in numbers greater than the national or international threshold but are not included in the SPA citation are considered part of the SPA assemblage in this assessment. Some of the qualifying features of the Humber Estuary SPA (namely Dunlin, Knot and Golden Plover) have a WeBS 5-year mean that surpasses the SPA citation value. The difference in values is addressed in summary tables where both the latest 5-year WeBS mean and the SPA citation value are presented to give a better representation of the current situation.

Low tide WeBS counts of the Humber Estuary (last undertaken overwinter 2011/12), recorded large numbers of Pink-footed Goose, Dark-bellied Brent Goose, Teal, Golden Plover and Lapwing. Many of these species use the expansive mudflats and tidal islands in the inner Humber (such as Whitton and Read's Island). Other species, like Dark-bellied Brent Goose, prefer the outer estuary on more marine influenced environments (such as Haille Sands or Sunk Islands Sands). Golden Plover and Shelduck show a much wider distribution with large counts in the inner and outer Humber.

11.4.5.2 Scheme-specific baseline

This section describes three studies that have been undertaken within and adjacent to the proposed Scheme:

- A series of Scheme-specific surveys have been undertaken over a large area of both terrestrial and intertidal habitats between 2011 and 2016 (IECS, 2014a; 2014b; 2015; 2016a; 2016b; 2016c). All these studies are summarised and additional interpretation provided in Cutts, 2019;
- Annual surveys at the ABP Welwick Managed Realignment and the adjacent foreshore since 2006 (ABPmer, 2018a); and
- Humber Wader Ringing Group (HWRG) and BTO's satellite tracking at ABP Welwick Managed Realignment (Cook *et al.*, 2016).

Scheme-specific Studies

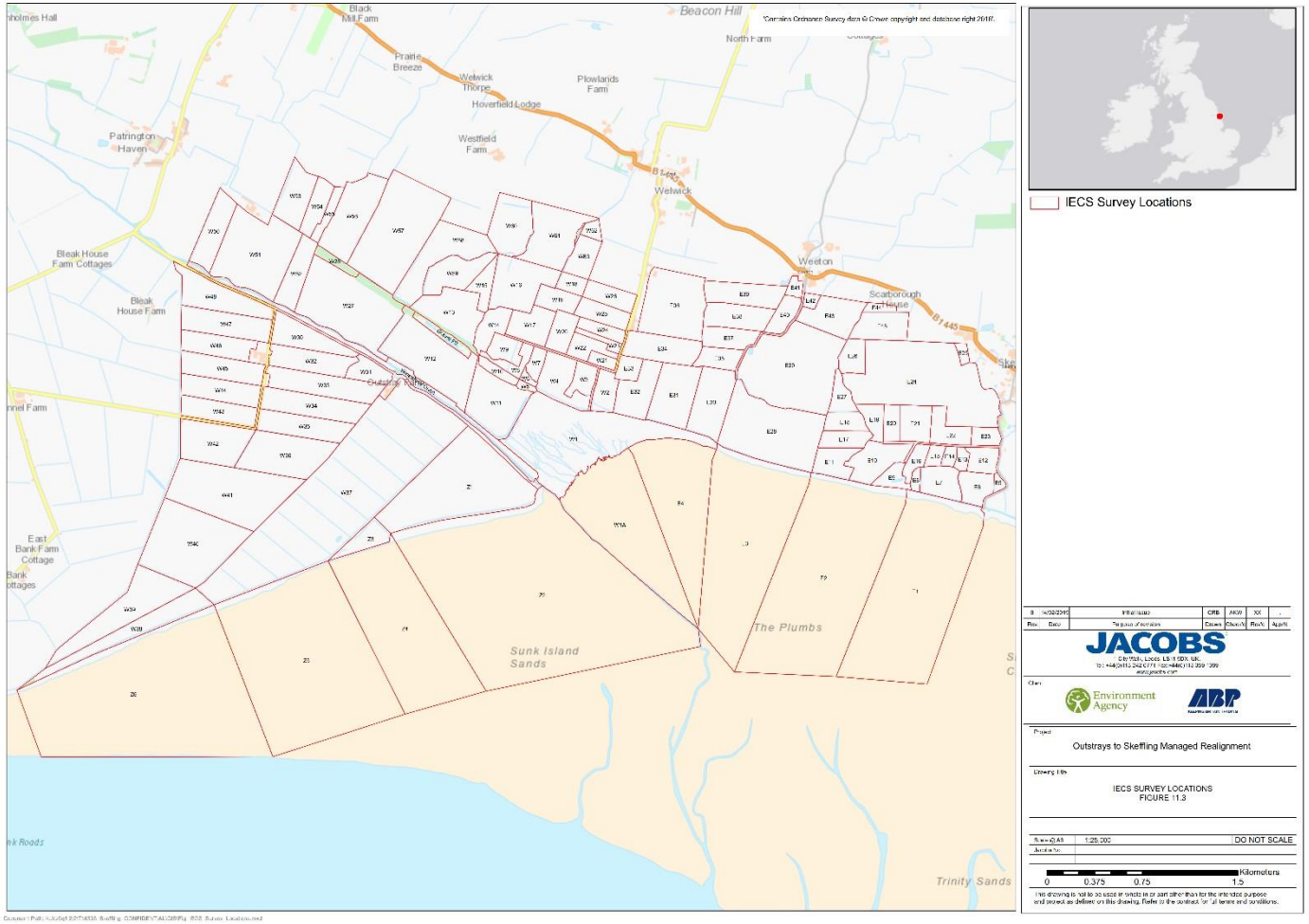
Ornithology monitoring in the area of the proposed Scheme was undertaken by IECS between 2011 and 2016 (Cutts, 2019). These year-round, bi-monthly monitoring surveys have primarily focused on understanding the functional value of the area for overwintering birds. Summer and autumn surveys were also undertaken to better understand usage during breeding and passage periods (Table 11.10). The results of these surveys have been presented in a range of reports (IECS, 2014a; 2014b; 2015; 2016a; 2016b; 2016c; Cutts, 2019) and are summarised below.

Table 11.10: Summary of waterbird counts undertaken by IECS

Year	Month											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2011												
2012												
2014												
2015												
2016												
Key		Smaller study area: Winestead Drain to Skeffling Pumping Station										
Key		Larger study area: East Bank Farm to Skeffling Pumping Station										

The total area covered by the surveys varied between years (see Table 11.10), but the majority of the survey periods were of the larger East Bank Farm to Skeffling Pumping Station (Plate 11.3). Each individual sector was counted separately with the results summarised as a cumulative value for either the intertidal or the terrestrial habitat.

Plate 11.3: Count sections during IECS Surveys



Intertidal usage (low water)

The intertidal zone fronting the Scheme is an important section within the estuary for waterbirds during both low and high water (Tables 11.11 and Table 11.12 respectively). The extensive mud and sandflats are used to a greater extent during low water periods when the foraging resources are accessible. In addition, the Welwick saltmarsh and the ABP Welwick Managed Realignment site provide important roosting grounds for coastal waterbirds at high water.

Around low water the intertidal zone fronting the scheme supports an important assemblage of a number of wader species including foraging Knot, Dunlin, Grey Plover and Bar-tailed Godwit, with large flocks of Golden Plover, and to a lesser extent, Lapwing, loafing/roosting. For the most part these species can be widely distributed across the mid to low sections of the intertidal area, but with Redshank tending to prefer the upper shore even at low water when other areas are available. It should be noted that during the survey programme undertaken by IECS, the extreme low shore was not visible from the flood banks, although a number of species for instance Bar-tailed Godwit tended to preferentially locate along the tideline to forage at this time. Brent Goose can also be present in foraging flocks, with foraging Shelduck also widely distributed across the intertidal mudflats and with the rising tide also revealing foraging Mallard and loafing Teal and Wigeon utilising the creek system.

With the incoming tide, most wildfowl and waders move up-shore, with some moving with the tideline to forage e.g. Bar-tailed Godwit. Other species, including large flocks of Knot and the often associated Dunlin are more mobile, moving both up and along shore to take advantage of foraging opportunities with these mixed Calidris groups often present in congregations in excess of 25,000 individuals.

Whilst some species will continue to feed into the upper shore on a rising tide, others establish pre-roosts. The duration and size of these roosts (and foraging potential) depends on the time of year and height of tide, with a large intertidal wader roost habitually used to the east of the Welwick embayment on Neap tides. On most tides an upper shore roost is also utilised on the intertidal edge of the Welwick saltmarsh, with some birds continuing to feed e.g. Redshank, but with large spring tides forcing birds from these areas to either a series of preferred fields to the north and east of the Welwick embayment, and onto the ABP Welwick Managed Realignment. In addition, there are some movements further to the west e.g. to the fields of Sunk Island.

Of specific interest for the Scheme, the habitual utilisation of the ABP Welwick Managed Realignment as a high tide has been observed, albeit with changes in the species composition and distribution of use within the site altering as the site has developed. The presence of large flocks of Bar-tailed Godwit, Knot and Dunlin have been recorded roosting on the site on most high tides, and the area is also being increasingly used by Redshank and Curlew.

On large tides around the Spring period, the majority of waders from the area can move onto the realignment site, as well as some wildfowl e.g. Shelduck and Teal. In such conditions, a substantial waterbird assemblage can utilise the realignment site, including some species in nationally important numbers and/or representing utilisation in excess of a regionally important concentration. The old flood defences fronting the realignment site can also be used by waders at high tide e.g. Oystercatcher, Bar-tailed Godwit, Redshank, Curlew and Turnstone.

On the falling tide there is broadly similar pattern of reversed movement. Waders rapidly move out from the realignment site (or fringing intertidal areas on neap tides), with most following the tide. Redshank tend to remain on the upper shore but other

species disperse down and along shore into the mid and then lower elevation intertidal areas, with other flocks e.g. Knot, Dunlin and Grey Plover moving in from the east e.g. Spurn Bight and adjacent fields south of Skeffling.

It is emphasised that the above is a broad indication of patterns of use, and will alter between seasons and tide height, with the gradual evolution of the Scheme also modifying roost function for species over time. A summary of high tide roost utilisation in the Welwick/Skeffling area is included below.

Intertidal usage (high water)

During high water counts, waterbirds were primarily aggregated on the upper mudflat and nearby saltmarsh. The majority of the wader population were distributed on the highest elevation areas of intertidal zone, near Patrington Channel, with small roosts establishing on the fringe of Welwick saltmarsh.

A broadly similar assemblage of waterbird species to that observed at low water was also recorded at high water. Knot, Dunlin and Lapwing were the most common wader species (peak counts of 28,000, 4,500 and 2,606 respectively). Black-tailed Godwits and Bar-tailed Godwits were recorded in higher numbers than present during low water (with the Welwick Managed Realignment site an established roosting location for this species). Waterfowl counts during high water continued to represent a large proportion of the WeBS 5-year mean, with Shelduck, Wigeon and Teal all present in important numbers (50 %, 32 % and 19 % of the WeBS 5-year mean respectively).

Table 11.11: Intertidal low tide peak count

Species	Peak Count per reporting period					Max Count	Humber Estuary WeBS 5-year mean	Max count as % of Humber Estuary WeBS 5-year mean	Max count as % of Humber Estuary SPA citation value
	Sep 11 – Mar 12 (w)	Apr – Sep 14 (b & p)	Oct 14 – Mar 15 (w)	Oct 15 – Apr 16 (w)	Jul – Sep 16 (b & p)				
Mute Swan	-	0	0	3	0	3*	155	1.9	-
Whooper Swan	-	0	0	4	0	4*	80	5.0	-
Pink-footed Goose	-	0	0	350	0	350*	10,357	3.4	-
Greylag Goose	-	0	197	80	115	197**	1,552	12.7	-
Canada Goose	-	0	0	0	9	9*	422	2.1	-
Dark-bellied Brent Goose	270	13	308	122	2	308*	3,513	8.8	14.6
Shelduck	796	1,050	230	418	2,600	2,600***	4,606	56.4	58.2
Wigeon	393	0	500	550	8	550**	2,562	21.5	10.9
Gadwall	-	0	0	0	24	24**	177	13.6	-
Teal	230	110	500	130	65	500**	3,130	16.0	21.5
Mallard	434	1	127	400	300	434**	1,176	36.9	17.7
Pintail	-	0	19	3	0	19**	29	65.5	-
Cormorant	-	0	10	4	2	10*	222	4.5	-

Species	Peak Count per reporting period					Max Count	Humber Estuary WeBS 5-year mean	Max count as % of Humber Estuary WeBS 5-year mean	Max count as % of Humber Estuary SPA citation value
	Sep 11 – Mar 12 (w)	Apr – Sep 14 (b & p)	Oct 14 – Mar 15 (w)	Oct 15 – Apr 16 (w)	Jul – Sep 16 (b & p)				
Little Egret	-	4	9	7	6	9*	163	5.5	-
Grey Heron	-	1	2	1	3	3*	28	10.7	-
Moorhen	-	0	0	1	0	1*	57	1.8	-
Oystercatcher	220	0	12	5	3	220	5,089	4.3	6.3
Ringed Plover	-	0	1	1	29	29*	1,089	2.7	7.2
Golden Plover	18,186	2,000	5,600	4,555	4,340	18,186***	30,427	59.8	59.2
Grey Plover	459	1,170	517	240	173	1,170***	3,091	37.9	68.7
Lapwing	5,679	0	1,690	950	0	5,679**	11,702	48.5	24.9
Knot	21,620	2,800	20,130	6,000	850	21,620***	24,580	88.0	76.8
Dunlin	4,456	1,745	9,065	2,700	1,750	9,065***	12,898	70.3	40.8
Ruff	-	15	0	0	3	15**	58	25.9	11.7
Snipe	-	0	1	4	14	14**	117	12.0	-
Black-tailed Godwit	67	0	5	1,200	18	1,200***	2,951	40.7	107.8
Bar-tailed Godwit	1,737	62	1,750	542	16	1,750***	1,457	120.1	63.6
Whimbrel	-	15	0	2	10	15***	118	12.7	13.3

Species	Peak Count per reporting period					Max Count	Humber Estuary WeBS 5-year mean	Max count as % of Humber Estuary WeBS 5-year mean	Max count as % of Humber Estuary SPA citation value
	Sep 11 – Mar 12 (w)	Apr – Sep 14 (b & p)	Oct 14 – Mar 15 (w)	Oct 15 – Apr 16 (w)	Jul – Sep 16 (b & p)				
Curlew	1,098	572	718	159	248	1,098**	2,806	39.1	33.8
Common Sandpiper	-	0	0	0	1	1*	20	5.0	-
Spotted Redshank	-	0	0	0	1	1*	25	4.0	-
Greenshank	-	1	0	0	1	1*	42	2.4	1.3
Redshank	1,153	375	787	130	262	1,153***	3,368	34.2	15.5
Turnstone	-	0	0	1	0	1	249	0.4	<1
Black-headed Gull	-	551	4	25	830	830	8,162	10.2	-
Mediterranean Gull	-	0	0	0	1	1	6	16.7	-
Common Gull	-	0	51	7	15	51	1,335	3.8	-
Lesser Black-backed Gull	-	19	13	35	60	60	79	75.9	-
Herring Gull	-	14	15	245	55	245	1,256	19.5	-
Great Black-backed Gull	-	8	4	6	26	26	330	7.9	-
Results reported from September 2011 until March 2012 (IECS, 2014a) focused on “Key SPA waterbirds” and did not report other species. b = breeding season surveyed, p = passage period surveyed, w = winter period surveyed.									

Species	Peak Count per reporting period					Max Count	Humber Estuary WeBS 5-year mean	Max count as % of Humber Estuary WeBS 5-year mean	Max count as % of Humber Estuary SPA citation value
	Sep 11 – Mar 12 (w)	Apr – Sep 14 (b & p)	Oct 14 – Mar 15 (w)	Oct 15 – Apr 16 (w)	Jul – Sep 16 (b & p)				
* above the local importance level (>1 % Humber five year mean from the WeBS 2012/13-2016/17)									
** above the regional importance level (>10 % Humber five year mean from the WeBS 2012/13-2016/17)									
*** above the national importance level (>1 % of the national population)									

Table 11.12: Intertidal high tide peak count

Species	Peak Count per reporting period					Max Count	Humber Estuary WeBS 5-year mean	Max count as % of Humber Estuary WeBS 5-year mean	Max count as % of Humber Estuary SPA citation value
	Sep 11 – Mar 12 (w)	Apr – Sep 14 (b & p)	Oct 14 – Mar 15 (w)	Oct 15 – Apr 16 (w)	Jul – Sep 16 (b & p)				
Mute Swan	-	2	0	3	2	3*	155	1.9	-
Whooper Swan	-	0	0	9	0	9**	80	11.3	-
Pink-footed Goose	-	0	0	44	0	44	10,357	0.4	-
European White-fronted Goose		0	2	0	0	2**	12	16.7	-
Greylag Goose	-	1	100	185	370	370**	1,552	23.8	-
Canada Goose	-	0	0	24	0	24*	422	5.7	-
Dark-bellied Brent Goose	260	143	910	430	2	910***	3,513	25.9	43.4
Shelduck	456	8	590	642	2,600	2,600***	4,606	56.4	58.2
Wigeon	298	0	676	835	210	835**	2,562	32.6	16.6
Teal	185	25	311	613	440	613**	3,130	19.6	26.4
Mallard	549	4	177	122	155	549**	1,176	46.7	22.4
Pintail	-	0	37	87	0	87**	29	300.0	-

Species	Peak Count per reporting period					Max Count	Humber Estuary WeBS 5-year mean	Max count as % of Humber Estuary WeBS 5-year mean	Max count as % of Humber Estuary SPA citation value
	Sep 11 – Mar 12 (w)	Apr – Sep 14 (b & p)	Oct 14 – Mar 15 (w)	Oct 15 – Apr 16 (w)	Jul – Sep 16 (b & p)				
Shoveler		0	0	8	0	8*	107	7.5	-
Pochard		0	0	2	0	2*	129	1.6	<1
Cormorant	-	0	8	9	17	17*	222	7.7	-
Little Egret	-	26	13	36	44	44**	163	27.0	-
Grey Heron	-	0	2	1	1	2*	28	7.1	-
Moorhen	-	0	0	1	1	1*	57	1.8	-
Oystercatcher	300	2	349	402	18	402*	5,089	7.9	11.5
Avocet		0	0	0	2	2	1,457	0.1	1.6
Ringed Plover	-	1	2	0	180	180**	1,089	16.5	44.7
Golden Plover	1,000	0	884	1,400	2,000	2,000*	30,427	6.6	6.5
Grey Plover	423	645	1,249	450	30	1,249***	3,091	40.4	73.3
Lapwing	900	0	2,606	2,600	2	2,606**	11,702	22.3	11.4
Knot	7,246	60	15,575	28,000	1,500	28,000***	24,580	113.9	99.4
Dunlin	3,764	300	4,500	3,000	850	4,500***	12,898	34.9	20.3
Ruff	-	9	0	0	2	9**	58	15.5	7.0
Snipe	-	0	0	1	4	4*	117	3.4	-

Species	Peak Count per reporting period					Max Count	Humber Estuary WeBS 5-year mean	Max count as % of Humber Estuary WeBS 5-year mean	Max count as % of Humber Estuary SPA citation value
	Sep 11 – Mar 12 (w)	Apr – Sep 14 (b & p)	Oct 14 – Mar 15 (w)	Oct 15 – Apr 16 (w)	Jul – Sep 16 (b & p)				
Black-tailed Godwit	1,200	20	120	1,800	0	1,800***	2,951	61.0	161.7
Bar-tailed Godwit	1,235	0	1,368	1,200	500	1,368***	1,457	93.9	49.7
Whimbrel	-	7	0	6	14	14***	118	11.9	12.4
Curlew	644	67	689	1,400	1,700	1,700***	2,806	60.6	52.3
Common Sandpiper	-	9	0	0	0	9***	20	45.0	-
Green Sandpiper		0	0	0	2	2***	14	14.3	-
Spotted Redshank	-	0	0	0	1	1***	25	4.0	-
Greenshank	-	6	1	0	9	9**	42	21.4	11.7
Redshank	451	240	373	380	840	840**	3,368	24.9	11.3
Turnstone	-	0	2	4	4	4*	249	1.6	<1
Black-headed Gull	-	743	1	68	640	743	8,162	9.1	-

Species	Peak Count per reporting period					Max Count	Humber Estuary WeBS 5-year mean	Max count as % of Humber Estuary WeBS 5-year mean	Max count as % of Humber Estuary SPA citation value
	Sep 11 – Mar 12 (w)	Apr – Sep 14 (b & p)	Oct 14 – Mar 15 (w)	Oct 15 – Apr 16 (w)	Jul – Sep 16 (b & p)				
Mediterranean Gull	-	0	0	0	1	1	6	16.7	-
Common Gull	-	0	6	35	17	35	1,335	2.6	-
Lesser Black-backed Gull	-	2	3	59	6	59	79	74.7	-
Herring Gull	-	0	6	44	45	45	1,256	3.6	-
Great Black-backed Gull	-	0	1	30	13	30	330	9.1	-
Sandwich Tern		0	0	0	2	2	596	0.3	-
Kingfisher		0	0	1	0	1	3	33.3	-

Results reported from September 2011 until March 2012 (IECS, 2014a) focused on “Key SPA waterbirds” and did not report other species.

b = breeding season surveyed, p = passage period surveyed, w = winter period surveyed.

* above the local importance level (>1 % Humber five year mean from the WeBS 2012/13-2016/17).

** above the regional importance level (>10 % Humber five year mean from the WeBS 2012/13-2016/17).

*** above the national importance level (>1 % of the national population).

Terrestrial Usage (high water)

Alongside the important intertidal areas, the small to medium sized arable fields and wet grasslands beyond the flood protection banks are known to be utilised by several species associated with the Humber Estuary SPA. Overall, the use of the fields for either foraging or roosting is relatively limited and confined almost to three or four areas immediately adjacent to the flood bank and intertidal area. The most frequented fields are those stretching along the eastern section of the survey area from Weeton Bank to the Skeffling Pumping Station. Ornithological survey work undertaken for the Scheme has identified a series of terrestrial fields being utilised by waterbirds associated with the Humber Estuary.

There is a large amount of variability in usage by waterbirds, but with large flocks e.g. of regional importance, recorded on occasion. This is influenced by a number of external variables e.g. agricultural activity, water logging, crop type and crop height. To aid comparison between survey years, only data from 2014, 2015 and 2016 have been analysed within this section as these years represented similar crop usage within the fields.

Both wader and waterfowl species have been recorded within the fields that make up the Scheme, in particular Golden Plover, Lapwing, Curlew, Greylag Geese and Dark-bellied Brent Geese (Table 11.13). Wader species are seen more often roosting rather than foraging and waterfowl species typically use the fields for foraging with cereal and oil seed rape fields preferred during the winter months. Individual field utilisation is again affected by external variables such as agricultural utilisation.

Several species surpass the level of regional importance for both their maximum counts and the three year mean of the maximum, whereby they occur at levels greater than 1 % of the 5-year mean of the latest WeBS counts (2012-2016) (Table 11.13). Two species surpass the national importance level (1 % of the national population), Ringed Plover which is often found during autumn passage in large flocks, and Whimbrel. Whimbrel's national importance level is set at 1, and therefore any presence of more than one bird surpasses this threshold. Overall the fields are utilised to a small extent in comparison to the adjacent intertidal habitat, with relatively small numbers using the site consistently, but with peak counts occurring at levels of regional and national importance.

Table 11.13: Usage of the terrestrial fields of the Scheme (maximum count and three-year mean (2014-16) of the maximum counts)

Species	West 1		West 2		East 1		East 2		East 3		All fields	
	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean
Mute Swan	0	0	10*	6*	2*	1	9*	4*	0	0	16**	11*
Pink-footed Goose	0	0	19	6	7	3	8	3	2	1	36	12
Greylag Goose	280**	113*	205**	108*	0	0	8	4	4	1	489**	227**
Canada Goose	3	1	3	1	0	0	0	0	0	0	3	2
Dark-bellied Brent Goose	2	1	0	0	0	0	0	0	0	0	2	1
Shelduck	17	6	2	1	4	2	7	3	4	3	30	14
Teal	0	0	5	2	0	0	0	0	0	0	5	2
Mallard	4	2	6	4	2	1	26*	10	14*	6	37*	23*
Little Egret	3*	2*	1	1	7*	3*	2*	1	7*	4*	11*	10*
Grey Heron	2*	1	2*	1	0	0	0	0	0	0	4**	2*
Ringed Plover	0	0	22*	7	475***	158**	0	0	0	0	497***	166**
Golden Plover	350*	125	400*	133	750*	409*	1,800*	663*	1,314*	446*	4,289***	1,777*
Grey Plover	0	0	0	0	10	6	150*	50*	0	0	152*	56*
Lapwing	2	1	550*	199*	300*	103	500*	220*	396*	140*	1,446**	663*
Knot	0	0	160	53	800*	281	200	67	0	0	800*	401*
Dunlin	0	0	0	0	250*	185*	2,000**	680*	0	0	2,250**	865*

Species	West 1		West 2		East 1		East 2		East 3		All fields	
	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean	Max	Mean
Snipe	0	0	0	0	2*	1	0	0	0	0	2*	1
Bar-tailed Godwit	0	0	0	0	1	0	0	0	0	0	1	0
Whimbrel	30***	10***	0	0	21***	7***	0	0	8***	3***	39***	20***
Curlew	440**	165*	3	1	61*	31*	340**	168*	71*	41*	887**	406**
Common Sandpiper	0	0	0	0	0	0	1*	0	0	0	1*	0
Redshank	1	1	1	0	66*	22	25	8	10	3	93*	35*

* above the local importance level (>1 % Humber five year mean from the WeBS 2012/13-2016/17)

** above the regional importance level (>10 % Humber five year mean from the WeBS 2012/13-2016/17)

*** above the national importance level (>1 % of the national population)

ABP Welwick Managed Realignment Surveys

Concurrently to the Scheme-specific surveys (described above), IECS have also undertaken monthly surveys at ABP Welwick Managed Realignment site and the adjacent foreshore since 2006.

Results from the latest (2017/2018) monitoring season indicated that the site continued to support large numbers of roosting waders around the high water period. Utilisation was less during low water with the majority of birds using the adjacent mudflat (Table 11.14 and 11.15). In total, 31 species of waterbird were observed in the 2017/2018 monitoring period using the area. Wader species recorded in the highest numbers were Knot, Lapwing, Dunlin and Curlew with Shelduck being the most numerous duck species.

Table 11.14: Peak count recorded at high water in the ABP Welwick site

Species	Overwinter					5 year (13/18) peak mean
	13/14	14/15	15/16	16/17	17/18	
Shelduck	530	1,146	210	630	1,220	747
Brent Goose	125	359	148	546	26	241
Greylag Goose	180	87	123	180	84	131
Mallard	45	175	286	150	56	142
Teal	95	350	220	900	640	441
Wigeon	65	197	1,084	840	174	472
Oystercatcher	27	10	36	280	2	71
Golden Plover	2,000	26	24	3,000	0	1,010
Grey Plover	265	700	27	198	180	274
Lapwing	450	1,130	1,500	5,000	400	1,696
Knot	1,500	3,900	670	5,000	385	2,291
Dunlin	422	1,500	770	3,680	580	1,390
Black-tailed Godwit	0	60	850	0	26	187
Bar-tailed Godwit	4	860	1,100	600	255	564
Curlew	440	400	615	700	460	523
Redshank	381	245	207	156	300	258

Table 11.15: Peak count recorded at low water in the ABP Welwick site

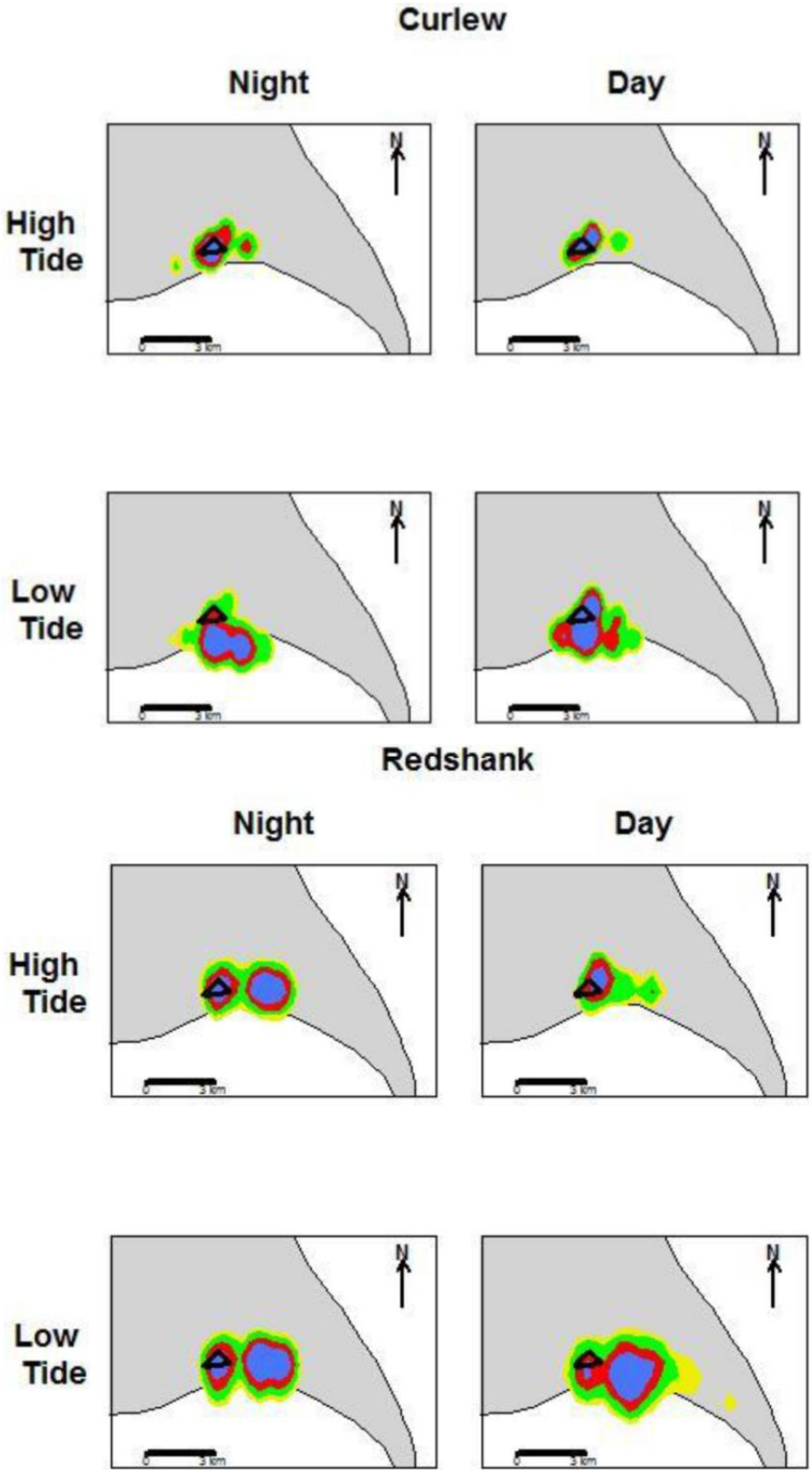
Species	Overwinter					5 year (13/18) peak mean
	13/14	14/15	15/16	16/17	17/18	
Shelduck	53	63	73	26	18	47
Brent Goose	85	28	118	7	0	48
Greylag Goose	75	120	72	199	2	94
Mallard	12	35	20	91	48	41

Species	Overwinter					5 year (13/18) peak mean
	13/14	14/15	15/16	16/17	17/18	
Teal	4	0	0	0	1	1
Wigeon	0	0	0	0	0	0
Oystercatcher	0	0	0	0	0	0
Golden Plover	0	460	1	7	10	96
Grey Plover	35	9	0	9	0	11
Lapwing	100	1,031	2,000	420	5	711
Knot	3	0	1	0	0	1
Dunlin	15	1	36	2	0	11
Black-tailed Godwit	0	0	0	1	2	1
Bar-tailed Godwit	3	0	0	0	0	1
Curlew	5	16	21	4	6	10
Redshank	15	19	47	23	10	23

Redshank and Curlew usage of the Scheme area

To help understand the connectivity between managed realignment sites and the wider area and to improve the understanding of the home ranges of different species, the HWRG and the BTO undertook a limited study on the fine-scale movement patterns in the Humber Estuary (Cook *et al.*, 2016). The study captured three Curlew and five Redshank on the mudflat and saltmarsh within ABP Welwick Managed Realignment and fitted with small global positioning system (GPS) tags that recorded the location of each bird every 90 minutes. There were noticeably different individual strategies employed but the overall site fidelity was high with the core home range small for the majority of individuals (Plate 11.4). Initial results showed Redshank used larger individual areas then Curlew and were affected by the tides less, this was an expected result as Curlew are better adapted to forage on open mudflat.

The results of this study are relevant to the Scheme as it demonstrates the species are able to rapidly colonise and use areas that have been realigned. Each bird showed a strong site fidelity during this study, with the majority of them centred around the ABP managed realignment site at Welwick. The rapid colonisation and utilisation of the realignment site by waders as a home site should be seen as a positive example of the role managed realignments can play for coastal waterbirds.



Source: Cook et al., 2016

Plate 11.4. Kernel density analysis of Curlew and Redshank during the day and night and in relation to high and low tide. *Blue = 50% kernel, Red = 75% kernel, Green = 90% kernel and Yellow = 95% kernel.*

11.5 Future Environment

The Coastal Habitat Management Plan for the Humber Estuary (Environment Agency, 2005) based upon estimates of 6 mm sea level rise per annum predicted a loss of coastal habitat of 450 ha (+ 150ha) by 2055. An estimated 60 % of the habitat loss is predicted to occur within the Middle Estuary. Since the latest Defra guidance predicts 4 mm sea level rise per year to 2025 and subsequently 8.5 mm per year for the remaining 30 years (see Chapter 7 Physical processes and the hydrodynamic environment), the habitat losses are likely to be greater during the period 2025 – 2050 although the broad predictions still remain valid. The original 6 mm prediction still falls within the latest range of modelled projections compiled by the UK Climate Impacts Programme and therefore these predictions still remain valid (Lowe *et al.*, 2009).

The future baseline of fish, mammal and ornithological features is hard to predict but some ecological consequences of global climate change have already been observed., for example range distribution shifts, change in breeding season time and duration and physiological changes (Walther *et al.*, 2002; Rijnsdorp *et al.*, 2009; Evans *et al.*, 2010). These changes are expected to be observed in more species as climate change continues and has potential to change the communities of species observed within the Humber Estuary.

11.6 Likely significant effects

11.6.1 Outstrays Managed Realignment

The implementation of the Outstrays Managed Realignment has the potential to affect marine biodiversity receptors. Each impact pathway and the associated effect that has been scoped in to the assessment has been addressed in the appropriate receptor specific section below.

11.6.1.1 Nature Conservation

This section considers the potential changes to baseline conditions which may be brought about by the Outstrays Managed Realignment. The potential effects on benthic habitats, fish, marine mammals and coastal waterbird features of the environmentally designated sites are discussed within the individual sections below, see summary table to identify where appropriate assessment is. An assessment of the Scheme's impacts on SSSI reportable features is also included in Appendix 10.5. Additionally, a Habitats Regulation Assessment (HRA) is provided in Appendix 10.2. The terrestrial features of these designated sites are assessed in Chapter 10 Terrestrial Biodiversity.

Table 11.16: Assessment section matrix

Designation	Feature	Section covering assessment
Humber Estuary SPA	Multiple bird species designated under Annex I, Article 4.1 and Article 4.2 of the EU Birds Directive	Coastal waterbirds
Humber Estuary Ramsar Site	Near-natural estuary, with dune systems and humid dune slacks, estuarine waters, intertidal mud and sand flats, saltmarshes, and coastal brackish/saline lagoons.	Benthic habitats and species; and

Designation	Feature	Section covering assessment
		Chapter 7 Physical Processes
	Breeding colony of grey seals at Donna Nook	Marine mammals
	Multiple bird species	Coastal waterbirds
	River and sea lamprey	Fish
Humber Estuary SAC	Annex I features of the Habitats Directive (broad scale and specific habitats)	Benthic habitats and species; and Chapter 7 Physical Processes
	Annex II species (grey seal, sea lamprey and river lamprey)	Marine mammals and fish
Humber Estuary SSSI	Sublittoral sediment, mudflats and saltmarsh	Benthic habitats and species
	Multiple species of birds	Coastal waterbirds
	Grey seal, sea lamprey and river lamprey	Marine mammals and fish

11.6.1.2 Benthic habitats and species

The implementation of the Outstrays Managed Realignment has the potential to affect benthic habitat and species receptors. Each impact pathway that has been scoped in to the assessment for both the construction and operational phases of the Scheme are presented below.

There is considered to be no pathway for the introduction and/or spread of marine non-native species as a result of the Scheme. This is because the movement of vessels (which are a key pathway for the introduction of non-native species) will not occur during either construction or operation. The habitats that will be created by the Scheme are already present in this part of the estuary and as such do not offer a new substrate type to colonise. On this basis, the risk of transfer and spread of marine non-natives has been scoped out of requiring further assessment.

Construction

The construction of the western site has the potential to affect benthic habitats and species receptors through the following impact pathways:

- Saltmarsh extent change during construction; and
- Potential impacts to benthic habitats and species due to changes in water quality as a result of the excavation of the breach and reprofiling of fronting saltmarsh.

Saltmarsh extent change during construction

During construction of the Outstrays Managed Realignment, the total extent of saltmarsh will be altered through direct loss of this habitat type. An area of saltmarsh will be reprofiled in the area directly seaward of the breach location in West 1 as well as in the footprint of the piling at Winestead Outstrays pumping station (WOPS). The

saltmarsh fronting the breach will be reprofiled to a level of 1.5 mAOD to facilitate tidal inundation of the site. A mix of commonly occurring pioneer and lower to mid saltmarsh species will be lost, including *Saliconia* sp., *Spartina* sp. and *P. maritima*. The approximate extent of direct saltmarsh loss is 1 ha.

In contrast, the removal of the existing embankments to ground level will result in the creation of approximately 1.7 ha of intertidal habitat (at typical saltmarsh elevations, noting saltmarsh colonisation has been observed within a year within the adjacent ABP Welwick Managed Realignment site).

Furthermore, any works undertaken within the vicinity of the saltmarsh will be undertaken in accordance with clearly defined working practices to avoid the potential for wider damage to this habitat type. This will include contractor engagement/training and de-marked access routes.

This footprint of habitat loss and the creation of additional space for saltmarsh to colonise is considered to be very small in the context of the extent of existing saltmarsh found locally in the area and more widely in the Humber Estuary. The saltmarsh assemblages found seaward of the breach and near WOPS are also characterised by locally common species that are abundant in the wider region.

Based on these factors, the magnitude of effect is considered to be **small** and although the probability of occurrence is **high** the overall exposure is assessed as **low**. The sensitivity of the saltmarsh to removal is considered to be **high**, leading to vulnerability to change as being assessed as **moderate**. The value of these saltmarsh habitats and associated species is considered to be **high** (given the protection they are afforded as part of international designations). On this basis, the overall effect is **moderate adverse**.

Potential impacts to benthic habitats and species due to changes in water quality as a result of the excavation of the breach and reprofiling of fronting saltmarsh

Bed disturbance as a result of the excavation of the breach and reprofiling of fronting saltmarsh during construction of the Outstrays Managed Realignment has the potential to cause elevated suspended sediment concentrations and the release of sediment bound contaminants into the water column. Changes in suspended sediment concentrations are expected to be highly localised and indistinguishable against the already high existing background levels. Species occurring in the intertidal habitats in the area (i.e. within mudflats and saltmarsh) are considered well adapted to living in highly turbid conditions.

Sediment sampling suggests that seabed contamination levels in the vicinity of the breach are relatively low (below Cefas Action Level 2) and water quality impacts have been described as minor adverse (Chapter 8). Contaminants released into the water column will also be rapidly dissipated by the strong hydrodynamic conditions in the area and are therefore considered unlikely to produce adverse effects in any species.

Based on these factors, the expected localised and temporary changes in suspended sediment concentrations and water column contaminant concentrations is expected to be of a **small magnitude**. The exposure to this change is considered to be **low** as the probability of the occurrence is **high**. The sensitivity to change is **low** and therefore vulnerability is also assessed as **low**. The value of these saltmarsh habitats and associated species is considered to be **high** (given the protection they are afforded as part of international designations). On this basis, the overall effect is therefore considered to be **minor adverse.**

Operation

The Outstrays Managed Realignment has the potential to affect benthic habitats and species receptors through the following impact pathways during operation:

- Potential changes in the extent and quality of intertidal habitat within the inundation area;
- Potential changes in the extent and quality of intertidal habitat fronting the Scheme; and
- Potential impacts to benthic species and habitat receptors due to changes in water quality as a result of the breach.

Potential changes in the extent and quality of intertidal habitat within the inundation area

The breach will allow a large proportion of the Outstrays Managed Realignment to be tidally inundated which will result in the existing agricultural land changing to intertidal habitat. The predicted extents of different intertidal habitats in the western site following initial tidal inundation and after five years are shown in Table 11.17**.** This is based on an understanding of scheme elevations in the tidal frame, inundation frequencies as predicted by the numerical modelling, lessons learnt from the ABP Welwick Managed Realignment (and others) and the distribution of habitats in this part of the estuary (see Appendix 7.1 Modelling Report). The potential extent of different habitat types has been presented as indicative ranges to reflect the high degree of uncertainty of scheme evolution and the timescales over which this may occur. Typically, however, the rate of change in habitat extent within the inundation area would be expected to reduce after the initial five years.

It should also be noted that given the nature of the new embankments placement has the potential to contribute to coastal squeeze in the longer term. The magnitude of any such losses will be minimised through the removal of existing embankments and avoiding the introduction of hard structures where possible.

The potential development and changes to saltmarsh and mudflat extent are discussed further below.

Table 11.17: Indicative predicted extents of different intertidal habitats in the western site

Habitat	Initial extent (ha)	Extent after 5 years inundation (ha)
Grassland and transitional grassland	10	10
Mudflat	30 to 50	10 to 20
Pioneer to mid Saltmarsh	60 to 80	90 to 100
Upper saltmarsh	<5	<5

Saltmarsh

Saltmarsh species show strong zonation with succession occurring temporally (Gray, 1992). This succession is often linked to tidal elevation and is increased by high accretion rates (like those occurring in the Humber Estuary). Intertidal mudflat transition

to saltmarsh occurs where the frequency of inundation is sufficiently reduced to permit saltmarsh development. In areas with sufficient shelter and sediment availability, mudflats will slowly increase in height (i.e. accrete) and turn into saltmarsh. Higher subtidal areas would conversely be expected to convert to mudflat under such conditions. It is generally understood that intertidal mudflats require at least 450 inundations per annum in order for vegetation establishment to be suppressed (Toft *et al.*, 1995; Leggett *et al.*, 2004). The amount of saltmarsh is therefore expected to increase as the site develops morphologically through time, as demonstrated in several other managed realignment sites on the Humber Estuary (Halcrow, 2013, ABPmer, 2015).

Based on scheme elevations at the time of the breaching approximately 65 to 80 ha of the site would be suited to saltmarsh development. In practice saltmarsh colonisation would be expected to occur within the first year of inundation. This reflects the ready supply of saltmarsh propagules within the immediate vicinity of the scheme and lessons learnt from other managed realignment schemes, particularly Welwick (see below). Within five years the extent of saltmarsh within the western site could be as much as 105 ha based on predicted accretion rates (see Chapter 7). As highlighted above these estimates of extent are subject to a large degree of uncertainty.

The development of saltmarsh communities within the Outstrays Managed Realignment is expected to be similar to that which has been observed at the adjacent ABP Welwick Managed Realignment site. This site was initially colonised by species characteristic of pioneer to middle saltmarsh zones particularly *Salicornia* (annual glassworts) marsh community. Species such as *Suaeda maritima* (annual sea-blite), *Puccinellia maritima* and clumps of *Spartina anglica* (common cordgrass) became increasingly widespread within the first three years following breaching. Approximately five years following the breach there was clear evidence of ongoing succession with lower elevation sections of the site characterised by pioneer vegetation (such as *Salicornia* and *Spartina*) and upper sections dominated by lower middle saltmarsh (such as *Puccinellia maritima* dominated communities). There was also an expansion of pioneer *Salicornia* vegetation onto open mud as accretion of the site continued. Between five and 10 years post-breach the majority of the site consisted of *Puccinellia maritima* dominated communities with *Salicornia* and *Spartina* dominated communities at lower elevations. There was also an increase in the extent of *Puccinellia maritima* dominated communities as well as *Aster tripolium* (sea aster) (ABPmer, 2018b). Similar changes in saltmarsh communities have also been observed at other sites in the Humber Estuary such as Paull Holme Strays (Halcrow, 2013).

The magnitude of change is considered to be **large**, the probability of this change occurring is **high** and therefore the exposure is considered **high**. The sensitivity of saltmarsh to habitat change is considered to be **high** and therefore the vulnerability to change is **high.** The value of saltmarsh habitats and associated species is considered to be **high** (given the protection they are afforded as part of international designations). On this basis, the overall effect on the saltmarsh and associated species is therefore considered to be **major beneficial**.

Mudflat

At the point of inundation, the elevations within the Western site are predicted to be suited to the development of approximately 30 ha to 50 ha of intertidal mudflat. This is predicted to reduce through time where after five years the predicted extent is reduced to approximately 10 ha to 20 ha (due to colonisation by saltmarsh resulting from

accretion). The continued expansion of saltmarsh at this site through time should be expected.

The mudflat is expected to be colonised by a range of commonly occurring marine estuarine invertebrate species as seen at the ABP Welwick managed realignment site (ABPmer, 2008). Colonisation by marine invertebrates following tidal inundation of the site is expected to be relatively rapid with a range of species such as *H. diversicolor*, *P. elegans*, *L. balthica* and *P. ulvae* (which are commonly occurring on the mudflats outside of the site at similar elevations) expected to be present within the first year (Section 11.4.2). The subsequent years are expected to maintain a similar assemblage although abundances levels are likely to fluctuate annually. As the site develops over time the composition of the benthic assemblage is expected to change with an overall shift to a community with increasing numbers of fly larvae and other species associated with saltmarsh and other upper littoral fringe habitats dominating. However, based on monitoring data from the nearby ABP Welwick Realignment Site, marine estuarine invertebrate species will still be present in the sediments (ABPmer, 2018a).

The magnitude of the impact is considered to be **medium**, the probability of this change occurring is **high** and therefore the exposure is considered **medium.** The sensitivity of mudflat to habitat change is considered to be **high** and therefore the vulnerability to change is **high.** The value of mudflat habitats and associated species is considered to be **high** (given the protection they are afforded as part of international designations). On this basis, the overall effect on the mudflat and associated species is therefore considered to be **major beneficial**.

Potential changes in the extent and quality of intertidal habitat fronting the Scheme

Saltmarsh

There is the potential for erosion of saltmarsh adjacent to the breach channel following tidal inundation. However, the channel that will be cut through the saltmarsh at the breach location in West 1 will be wide (approximately 250 m). This will ensure that flow rates through the channel are low and therefore erosion is expected to be limited (Chapter 7). This is supported by monitoring of the saltmarsh adjacent to the two breach locations at the ABP Welwick Managed Realignment. Monitoring of the saltmarsh adjacent to the breach continued for five years post inundation. During this time, there was little evidence of changes in the extent, zonation or distribution of saltmarsh plant communities adjacent to the breaches. This suggested that the flow of tidal water through the breaches was not causing changes to the adjacent saltmarsh (ABPmer, 2012).

In addition, the lowering of the bank along the northern boundary of ABP Welwick Managed Realignment is not expected to cause a measurable change in the extent or quality of saltmarsh present. Tidal inundation at this part of the western site will only occur on the highest of spring tides due to the positioning within the tidal frame, and is therefore not expected to have an erosive effect on the saltmarsh present.

Based on these factors, the magnitude of the impact is considered to be **small**, the probability of this change occurring is **low** and therefore the exposure is considered **negligible**. The sensitivity to this change is considered to be **moderate**, resulting in no vulnerability**.** The value of saltmarsh habitats and associated species is considered to be **high** (given the protection they are afforded as part of international designations. On this basis, the overall effect on the saltmarsh and associated species is therefore considered to be **insignificant**.

Mudflat

Following breaching, physical disturbance of intertidal habitats fronting the breach will occur as a result of scouring caused by the flow of water through the breach and across the mudflat. This will include the formation of a narrow channel over time as well as the creation of smaller spur channels off the main channel. The plan form and depth of the channel that will gradually form is not predictable as it will depend in the bed density and sediment distribution in plan and depth over the mudflat. However, over time equilibrium is expected to be reached with the morphology of the channels expected to be broadly similar to those found locally in the area.

Further information on these morphological changes is provided in the physical processes and the hydrodynamic environment chapter (Chapter 7). However, the existing sediment type is not expected to broadly change and a broadly similar community to that already found in this area is expected to continue to occur in the inlet channel (Chapter 7).

These relatively localised changes are therefore considered be of a small magnitude, with a high probability of occurrence and an overall exposure assessed as low. The sensitivity of mudflat to this change is considered to be low and therefore the vulnerability to change is low. The value of these mudflat habitats and associated species is considered to be high (given the protection they are afforded as part of international designations). On this basis, the overall effect is therefore considered to be minor adverse.

Potential impacts to benthic species and habitat receptors due to changes in water quality as a result of the breach

The mobilisation and re-suspension of sediments and any sediment-bound contaminants into the water column once the site is tidally inundated and during the formation of a narrow channel within the mudflat has the potential to affect marine habitats and species.

Elevated levels of suspended sediment (increased turbidity) can cause a reduction in light penetration through the water column, restricting the light availability for photosynthesis in primary producers such as phytoplankton, periphyton and macrophytes. Such primary producers are important sources of food and oxygen (Chapman and Fletcher, 2002). Increased suspended sediment levels may lead to the clogging of the gills of suspension feeders (grazing on suspended organic matter) and favour the development of deposit feeders (that graze on settling organic matter) such as polychaete species over bivalves and other suspension feeders (Boyd *et al*., 2004). However, any potential increases in suspended sediment concentrations following inundation would be expected to be temporary and very localised and as such not discernible from background concentrations. The formation of the channel is not expected to increase sedimentation at a scale that cannot be tolerated by benthic species that occur in the Humber Estuary. Benthic habitats and species within the Humber Estuary are also considered well adapted to living in an area with high and variable suspended sediment loads and as such would not be sensitive to this level of change.

With respect to sediment-bound contaminants released into the water column, as outlined in Chapter 8, contamination levels in the intertidal mudflat and fields landward of the breach were found to be low and are unlikely to result in significant impacts to water quality. In addition, any contaminants released into the water column will be rapidly dissipated by the strong hydrodynamic conditions in the area and are therefore considered unlikely to produce adverse effects in any benthic species.

Based on these factors, the expected localised and temporary changes in suspended sediment concentrations and concentrations of contaminants in the water column during operation is expected to be of a **small** magnitude, with a **high** probability of occurrence, and therefore a **low** exposure. The sensitivity to the change is considered to be **low** and therefore the vulnerability to change is **low.** The value of the intertidal habitats associated species in the area is **high** (given the protection they are afforded as part of international designations). On this basis, the overall effect is therefore considered to be **minor adverse**.

11.6.1.3 Fish

Construction

The construction of the Outstrays Managed Realignment has the potential to affect fish within the estuary through the following impact pathway:

- Potential impacts to fish due to noise and vibration effects.

Potential impacts to fish within the estuary due to noise and vibration effects

Elevated underwater noise and vibration levels caused by construction activities has the potential to disturb fish by causing physiological damage and/or inducing adverse behavioural reactions and masking (Hawkins *et al*., 2015). The ability to detect sound is of considerable biological importance to many fish species, and is often used to assess the suitability of a potential mate or during territorial displays and during predator prey interactions.

Noise and vibration will potentially be generated by construction activities associated with the Outstrays Managed Realignment, (particularly from vibro piling at Welwick Bushes and WOPS). However, the proposed piling works will occur on the upper shore (at the embankment) and pile driving is not expected to occur during periods when the piles might be covered with seawater. Propagation of airborne piling noise into the marine environment is therefore anticipated to be limited. Other construction noise sources (such as the movement of machinery or vehicles) are not expected to propagate into the marine environment.

Based on these factors, the magnitude of change is **negligible**, the probability of occurrence is **high** and exposure is considered to be **negligible**. The sensitivity of fish to underwater noise is considered to be **high** but the vulnerability to change is **none**. The value of fish is considered to range from **moderate** (for commonly occurring estuarine species) too **high** for protected migratory species. On this basis, the overall effect on fish is **insignificant**.

Operation

The operational phase of the Outstrays Managed Realignment has the potential to affect fish receptors through the following impact pathway:

- Potential impacts on fish due to changes in available habitat; and
- Potential impacts on fish due to changes in water quality.

Potential impacts on fish due to changes in available habitat

Beneficial impacts are anticipated for estuarine fish from the introduction of the managed realignment scheme. In general, intertidal habitats are known to be valuable feeding and nursery grounds for many fish species, including whiting, flounder, herring and bass (Dixon et al., 2008; Brown et al., 2007; Hemingway et al., 2008). The benefits

of managed realignment sites to fish has also been proven by research and monitoring undertaken at a number of other realignment sites around the Humber including Paull Holme Strays, and Chowder Ness (Tide Facts, 2017).

The creation of a mosaic of intertidal habitats within the Outstrays Managed Realignment will provide additional foraging and nursery areas for fish. The magnitude of the change in habitats is assessed as **medium**, with a **high** probability of occurrence and therefore a **medium** exposure. The sensitivity of estuarine fish to this change is **moderate** and vulnerability is therefore considered to be **moderate**. The value of fish is considered to range from **moderate** (for commonly occurring estuarine species) to **high** for protected migratory species. On this basis, the overall effect of the creation of intertidal habitat for estuarine fish species is considered to be **minor to moderate beneficial**.

Potential impacts on fish due to changes in water quality

The mobilisation and re-suspension of sediments and any sediment-bound contaminants into the water column once the site is tidally inundated and during the formation of a narrow channel in the mudflat has the potential to affect marine fish. This can cause changes in a range of water quality parameters including turbidity and dissolved oxygen level. These changes in turn have the potential to affect the distribution and health of fish species Britwell (2000).

Estuarine fish in the Humber Estuary are considered to be well adapted to living in an environment subject to high ambient suspended sediment concentrations which occur naturally in the Humber Estuary. In addition, their high mobility enables them to move freely to avoid areas of adverse conditions and to use other food sources in the estuary. Estuarine fish are therefore not considered sensitive to the temporary and localised changes in suspended sediments expected. Certain species of migratory fish such as Atlantic salmon are considered more sensitive to sediment plumes which have the potential to create a barrier to migratory movements. However, the suspended sediment plumes will be confined to a localised area which only represents a small proportion of the width of the Estuary. Furthermore, the predicted suspended sediment levels are not expected to present a detectable barrier to migration (particularly given the high existing background concentrations that occur throughout the Estuary). Therefore, no barrier effects are anticipated.

With respect to sediment-bound contaminants released into the water column, as outlined in Chapter 8, contamination sampling in the intertidal mudflat and fields landward of the breach were found to low and are unlikely to result in significant impacts to water quality. In addition, contaminants released into the water column will also be rapidly dissipated by the strong hydrodynamic conditions in the area and are therefore considered unlikely to produce adverse effects in any fish species.

Based on these factors, the expected localised and temporary changes in suspended sediment concentrations and water column contaminant levels during operation is expected to be of a **small** magnitude, with a **high** probability of occurrence and therefore of **low** exposure. The sensitivity of estuarine fish to this change is **low** and therefore the vulnerability to this change is **low.** The value of fish is considered to range from **moderate** (for commonly occurring estuarine species) to **high** for protected migratory species. On this basis, the overall effect is therefore considered to be **insignificant** for some species but **minor adverse** for others.

11.6.1.4 Marine mammals

Construction

The construction of the Outstrays Managed Realignment has the potential to affect marine mammal receptors through the following impact pathway:

- Potential impacts to marine mammals due to noise and vibration.

Potential impacts to marine mammals due to noise and vibration effects

Elevated underwater noise and vibration levels caused by construction activities have the potential to disturb marine mammals. The impacts of noise on marine mammals can broadly be split into lethal and physical injury, auditory injury and behavioural responses. The possibility exists for lethality and physical damage to occur at very high exposure levels, such as those typically close to underwater explosive operations or offshore impact piling operations. A permanent threshold shift (PTS) is permanent hearing damage caused by very intensive noise or by prolonged exposure to noise. A temporary threshold shift (TTS) involves a temporary reduction of hearing capability caused by exposure to noise. At lower sound pressure levels, it is more likely that behavioural responses to underwater sound will be observed. These reactions may include the animals leaving the area for a period of time, or a brief startle reaction. Masking effects may also occur at lower levels of noise. Masking is the interference with the detection of biologically relevant communication signals such as echolocation clicks or social signals (Clark *et al*., 2009).

During construction of the Outstrays Managed Realignment, noise will potentially occur as a result construction activity (particularly from vibro piling at Welwick Bushes and WOPS). However, the proposed piling works will occur on the upper shore (at the embankment) and pile driving is not expected to occur during periods when the piles might be covered with seawater. Propagation of airborne piling noise into the marine environment is therefore anticipated to be limited. Other construction noise sources (such as the movement of machinery or vehicles) are not expected to propagate into the marine environment.

Based on these factors, the magnitude of change is **negligible**, the probability of occurrence is **high** and exposure is considered to be **negligible**. The sensitivity of marine mammals to underwater noise is considered to be **high** but the vulnerability to change is **none**. The value of marine mammals is considered to **high**. On this basis, the overall effect on marine mammals is **insignificant**.

11.6.1.5 Coastal waterbirds

Construction

The construction of the Outstrays Managed Realignment has the potential to affect coastal bird receptors through the following impact pathways:

- Potential impacts to coastal waterbirds due to disturbance; and
- Potential impacts on coastal waterbirds due to loss and changes in intertidal habitat.

Potential impacts to coastal waterbirds due to disturbance

There is the potential for waterbirds to be temporarily disturbed as result of construction related activity including the movements of people, machinery and vehicles, piling operations and the removal and/or lowering of current sea defences. These activities

are sources of noise and visual stimuli which could elicit a disturbance response in waterbirds. The construction activities that are considered to be most impactful on coastal waterbirds using the area are expected to be vibration piling at the WOPS and Welwick Bushes and the lowering of the sea defences along the northern boundary of ABP Welwick Managed Realignment. This would be particularly apparent if the works are undertaken during the over wintering period.

Evidence suggests that waterbirds generally show a flight response to human activities on or near the foreshore at approach distances of between 20 m and 100 m although distances of more than 250 m has been observed in some sensitive species (Cutts *et al.*, 2013; Ross & Liley, 2014; IECS, 2009). Other research has indicated that in general, birds appear to habituate to continual noises (such as machinery noise or piling) as long as there is no large amplitude 'startling' component (IECS, 2009; Dwyer, 2010; McLeod, *et al*., 2013; Glover *et al*., 2015).

The modelled noise levels of the piling activities in the western site are not expected to produce a flight response or dispersal from the area given the scale of disturbance The 12 hour average of noise 50 m from the piling location is estimated to be 60 dB(A). This does not surpass the suggested disturbance threshold (Cutts *et al.*, 2013). As well as not surpassing the suggested threshold birds show a moderate and not adverse disturbance response when the noise is regular and repetitive. The piling method suggested to be used at the western site is vibration piling, this is likely to cause regular noise and is therefore expected to disturb the birds to an even lesser extent.

Based on the results of these studies, regular construction activities are expected to generally cause infrequent, mild behavioural responses in a localised area in the vicinity of the works. The responses observed are likely to range from increased vigilance, avoidance walking and short flights with birds rapidly resettling and resuming feeding or roosting near their original location. Occasional larger disturbance events (causing birds to flush and leave the immediate vicinity) could occur. Rather than evacuating the area completely, birds would be expected to redistribute to other nearby parts of the Humber Estuary. The main areas into which the birds disturbed are likely to move into are the two present saltmarshes (ABP Welwick Managed Realignment and Welwick Saltmarsh) which are outwith the disturbance radius for the majority of the works. Both of these areas support a large range of species, including those likely to be displaced (Cutts, 2019). Should this occur, the effect would only likely be short term with birds expected to rapidly return following completion of the construction works.

Based on these factors, magnitude is considered to be **medium**, with a **high** probability of occurrence, and therefore a **medium** exposure to change. The sensitivity of birds to the construction related disturbance highlighted is considered to be **moderate to low** (depending on the disturbance tolerance of the species) and therefore have a **moderate to low** vulnerability. Value is considered to be **high** for all waterbird species (given the protection they are afforded). On this basis the impacts are considered to be **minor to moderate adverse**.

<u>Potential impacts on coastal waterbirds due to loss and changes in intertidal habitat</u>

There is the potential for intertidal habitat loss and change to impact on waterbirds as a result of the construction works. A small area of saltmarsh will be reprofiled in the area directly seaward of the breach location in West 1 as well as in the footprint of the piling at WOPS. The breach will involve the lowering of the existing bank to approximately 1.5 mAOD and either side of the breach will be lowered to ground level. Approximately 1 ha will be lost directly through the breach. In contrast, the removal of the existing embankments to ground level will result in the creation of approximately

1.7 ha of intertidal habitat (initially intertidal mudflat but due to the area being at typical saltmarsh elevations succession is expected to occur.).

This footprint of habitat loss is considered to be very small in the context of the extent of existing saltmarsh found locally in the area and more widely in the Humber Estuary (1 ha lost out of 630 ha around the Humber Estuary). Any waterbirds using this very small area of saltmarsh for roosting would be expected to be able to easily redistribute locally to similar nearby habitat (e.g. ABP Welwick Managed Realignment and Welwick Saltmarsh which maintain similar assemblages and have a combined extent of approximately 100 ha). There is however, no evidence of habitual use of the saltmarsh fronting the breach (Cutts, 2019).

Based on these factors, magnitude is considered to be **small**, with a **high** probability of occurrence and therefore a **low** exposure to change. The sensitivity of birds to habitat change is considered to be **low** due to the scale of change and the easy access to other appropriate habitats and therefore the vulnerability is assessed as **low**. The value of waterbird species is considered to be **high** (given the protection they are afforded). On this basis, the overall effect is therefore considered to be **minor adverse**.

Operation

The western site which has the potential to affect coastal waterbird receptors through the following impact pathways during operation:

- Potential impacts on coastal waterbirds due to changes in available habitat; and
- Potential impacts on coastal waterbirds due to disturbance.

Potential impacts on coastal waterbirds due to changes in available habitat

The creation of additional existing intertidal habitat as part of the Scheme will increase the amount of functional supporting habitat available for coastal waterbirds and potentially improve the number of coastal waterbirds in the area (Halcrow, 2011; ABPmer, 2015). In general, feeding densities of most wader species typically increase at managed realignment sites during the first two to four winters following the introduction of tidal inundation. This largely reflects the rate of increase in biomass of their main invertebrate prey. Waders which feed primarily on larger bivalves (which can take several years to attain maximum size) would be expected to take longer to attain maximum densities than waders that feed on more rapidly maturing, smaller benthic invertebrate species (ABPmer, 2015).

The fields that are proposed to be inundated are currently not habitually used by large numbers of coastal waterbirds and are therefore considered to currently be of relatively low functional value, in the context of the Humber Estuary (Section 11.4.5). There is likely to be a change in the community that utilise these areas as the current fields are replaced by a mosaic of new habitats.

The Scheme is predicted to create a range of intertidal habitats (mudflats, saltmarsh and coastal grassland) that will be utilised by a variety of birds including species that are likely to be affected by coastal squeeze and loss of mudflat (Halcrow, 2011). Consideration has been given to the habitat preferences of all bird species targeted by the scheme, in order to ensure, as far as possible, that the scheme matches their requirements.

The species specifically targeted for the scheme include Teal and Black-tailed Godwit, Shelduck, Mallard, Golden Plover, and Lapwing. The habitat preference, niche and food preference of these six species has been reviewed by IECS and Jacobs (formerly Halcrow) (Halcrow, 2011). The review concluded that initially the Scheme can provide

appropriate habitat, ecological niches and prey resources for the target species. The extent of these beneficial features is likely to change as the intertidal habitats created change. Over time, the extent of saltmarsh habitat is expected to generally expand, replacing the initial mudflat, with mudflat habitat remaining in creeks, channels and lower elevation pools (Section 11.6.1.2). This changing evolution of habitats at the site will mean that the usage and functionality of the site for different bird species (and the proportion of birds engaged in different behaviours such as feeding, roosting and loafing) is also expected to change.

It is predicted that after five years there will be up to approximately 20 ha mudflat, 100 ha saltmarsh and 6 ha coastal grassland. While a reduction in available mudflat habitat for feeding and loafing waterbirds is predicted to occur in the long term, the overall usage of the site by waterbirds is expected to remain high based on the results of monitoring at other realignment sites in the Humber Estuary. For example, the adjacent ABP Welwick Managed Realignment site continues to support a wide range of foraging waterbirds despite an overall reduction in mudflat extent (particularly Grey Plover, Curlew and Redshank). The site is also utilised by a diverse range of roosting and loafing birds in large numbers including Golden Plover, Lapwing, Knot, Curlew and Dunlin. The average peak count of the years surveyed since the site was breached (2005/2006 to 2016/2017) was 9,189 with broadly similar numbers occurring ten years after breaching compared with first winter post inundation (ABPmer, 2018). Mander *et al.* (2007) also found that the Paull Holme Strays Managed Realignment Site supported a waterbird assemblage of similar composition to that of adjacent existing intertidal areas within three years of creation.

Based on these factors, the magnitude of change is considered to be **large**, with a **high** probability of occurrence and therefore a **high** exposure. The sensitivity of birds to this change is considered **moderate** and therefore the vulnerability is high. The value of waterbird species is considered to be **high** (given the protection they are afforded). On this basis, the overall effect is therefore considered to be **major beneficial**.

Potential impacts on coastal waterbirds due to disturbance

Disturbance to waterbirds could potentially occur once the site is breached as a result of recreational visitors (such as walkers (including dog walkers), bird watchers, cyclists etc.) with the overall number of recreational visitors using the area anticipated to increase as a direct result of the proposed Scheme (Chapter 6). A previous study suggested that birds in this area are considered susceptible to disturbance stimuli due to a limited amount of existing human activity (Ross & Liley, 2014).

As discussed in Chapter 6, human activities in the vicinity of the foreshore (including recreational pressure) can cause bird disturbance. Birds initially show increased vigilance to threats perceived as low risk such as low level background noise. As perceived threat levels increase, birds begin to exhibit avoidance behaviour which can result in a flight response and dispersal from a site. Repeated recreational disturbance may eventually lead to displacement from an area which may be permanent or temporary (Ferns et al., 2000; Stillman and Goss-Custard, 2002, Dwyer, 2010; Navedo and Herrera, 2012.).

Birds will vary their response to recreational activities depending on the type of the activity, the speed and randomness of approach, the distance to which the disturbance factor approaches and the frequency of disturbance (Burton et al., 2002., Rees *et al*., 2005). It generally appears that birds are most disturbed by irregular human movements. Large groups of noisy people; the chaotic and high speed approach of

dogs off leads and aerial objects such as kites are all considered activities particularly likely to heighten the response of individuals (Smit and Visser, 1993; IECS, 2009).

On this basis, ongoing recreational disturbance pressure as a result of the Scheme has the potential to cause repeated disturbance events over a long duration of time. However, birds would be expected to become habituated to some extent. In addition, the bank at the back of the ABP Welwick Managed Realignment site will be removed which will prevent public access along the wall and reduce the potential for disturbance in this area. Nevertheless, regular disturbance at the Western site could cause birds to disperse from the area on a temporary or even permanent basis.

Based on these factors, the magnitude is considered to be **medium**, with a **high** probability of occurrence and therefore a **medium** exposure. The sensitivity of birds to the regular disturbance is considered to be **moderate to low** (depending on the disturbance tolerance of the species), with the vulnerability assessed as **moderate to low**. The value of waterbird species is considered to be **high** (given the protection they are afforded). On this basis, the overall effect is therefore considered to be **minor to moderate adverse**.

11.6.2 Welwick to Skeffling Managed Realignment

The development of Welwick to Skeffling Managed Realignment has the potential to affect marine biodiversity receptors. Each impact pathway and the associated effect that has been scoped in to the assessment has been addressed in the appropriate receptor specific section below.

11.6.2.1 Nature Conservation

This section considers the potential changes to baseline conditions which may be brought about by the Welwick to Skeffling Managed Realignment. The potential effects on benthic habitats, fish, marine mammals and coastal waterbird features of the environmentally designated sites are discussed within the individual sections below, see summary table to identify where appropriate assessment is. Additionally, a Habitats Regulation Appraisal (HRA) is provided in Appendix 10.2.

Table 11.18: Humber Estuary designated sites

Designation	Feature	Section covering assessment
Humber Estuary SPA	Multiple bird species designated under Annex I, Article 4.1 and Article 4.2 of the EU Birds Directive	Coastal waterbirds
Humber Estuary Ramsar Site	Near-natural estuary, with dune systems and humid dune slacks, estuarine waters, intertidal mud and sand flats, saltmarshes, and coastal brackish/saline lagoons.	Benthic habitats and species; Chapter 7 Physical Processes
	Breeding colony of grey seals at Donna Nook	Marine mammals
	Multiple bird species	Coastal waterbirds
	River and sea lamprey	Fish
	Annex I features of the Habitats Directive (broad scale and specific habitats)	Benthic habitats and species;

Designation	Feature	Section covering assessment
Humber Estuary SAC		Chapter 7 Physical Processes
	Annex II species (grey seal, sea lamprey and river lamprey)	Marine mammals and fish
Humber Estuary SSSI	Sublittoral sediment, mudflats and saltmarsh	Benthic habitats and species
	Multiple species of birds	Coastal waterbirds
	Grey seal, river and sea lamprey	Marine mammals and fish

11.6.2.2 Benthic habitats and species

The development of the Welwick to Skeffling Managed Realignment has the potential to affect benthic habitat and species receptors. Each impact pathway that has been scoped in to the assessment for both the construction and operational phases of the Scheme are presented below.

There is considered to be no pathway for the introduction and/or spread of marine non-native species as a result of the Scheme. This is because the movement of vessels (which are a key pathway for the introduction of non-native species) will not occur during either construction or operation. The habitats that will be created by the Scheme are already present in this part of the estuary and as such do not offer a new substrate type to colonise. On this basis, the risk of transfer and spread of marine non-natives has been scoped out of requiring further assessment.

Construction

The construction of the Welwick to Skeffling Managed Realignment has the potential to affect benthic habitats and species receptors through the following impact pathways:

- Saltmarsh extent change during construction;
- Potential impacts to benthic habitats and species due to changes in water quality as a result of the excavation of the breach and reprofiling of fronting channel.

Saltmarsh extent change during construction

During construction of the eastern site, the total extent of saltmarsh will be altered through direct loss and gains of this habitat type. A part saltmarsh reprofiled in the area directly seaward of the breach location in East 2. A mix of commonly occurring mid to upper and pioneer saltmarsh species will be lost, including *Saliconia* sp., *Spartina* sp. and *P. maritima*. The saltmarsh fronting the breach will be reprofiled to a level of 1.6 mAOD to facilitate tidal inundation of the site. The approximate extent of direct saltmarsh loss is 2.5 ha.

In contrast, the removal of the existing embankments to ground level will result in the creation of approximately 2 ha of intertidal habitat (at typical saltmarsh elevations, noting saltmarsh colonisation has been observed within a year within the adjacent ABP Welwick Managed Realignment site).

Furthermore, any works undertaken within the vicinity of the saltmarsh will be undertaken in accordance with clearly defined working practices to avoid the potential for wider damage to this habitat type. This will include contractor engagement/training and de-marked access routes.

This footprint of habitat loss and the creation of additional space for saltmarsh to colonise is considered to be very small in the context of the extent of existing saltmarsh found locally in the area and more widely in the Humber Estuary. The saltmarsh assemblages found seaward of the breach are also characterised by locally common species that are abundant in the wider region.

Based on these factors, the magnitude of effect is considered to be **small** and although the probability of occurrence is **high** the overall exposure is assessed as **low**. The sensitivity of the saltmarsh to removal is considered to be **high**, leading to vulnerability to change as being assessed as **moderate**. The value of these saltmarsh habitats and associated species is considered to be **high** (given the protection they are afforded as part of international designations). On this basis, the overall effect is **moderate adverse**

Potential impacts to benthic habitats and species due to changes in water quality as a result of the excavation of the breach and reprofiling of fronting saltmarsh

Bed disturbance as a result of the excavation of the channel during construction of the eastern site has the potential to cause elevated suspended sediment concentrations and the release of sediment bound contaminants into the water column. Changes in suspended sediment concentrations are expected to be highly localised and indistinguishable against the already high existing background levels. Species occurring in the intertidal habitats in the area (i.e. within mudflats and saltmarsh) are considered well adapted to living in highly turbid conditions.

Sediment sampling suggests that seabed contamination levels in the vicinity of the breach are relatively low (below Cefas Action Level 2) and water quality impacts have been described as minor adverse (Chapter 8). Contaminants released into the water column will also be rapidly dissipated by the strong hydrodynamic conditions in the area and are therefore considered unlikely to produce adverse effects in any species.

Based on these factors, the expected localised and temporary changes in suspended sediment concentrations and water column contaminant concentrations is expected to be of a **small magnitude**. The exposure to this change is considered to be **low** as the probability of the occurrence is **high**. The sensitivity to change is **low** and therefore vulnerability is also assessed as **low**. The value of these saltmarsh habitats and associated species is considered to be **high** (given the protection they are afforded as part of international designations). On this basis, the overall effect is therefore considered to be **minor adverse.**

Operation

The eastern site has the potential to affect benthic habitats and species receptors through the following impact pathways during operation:

- Potential changes in the extent and quality of intertidal habitat within the inundation area;
- Potential changes in the extent and quality of intertidal habitat fronting the Scheme; and
- Potential impacts to benthic species and habitat receptors due to changes in water quality as a result of the breach.

Potential changes in the extent and quality of intertidal habitat within the inundation area

The breach will allow a large proportion of the eastern site to be tidally inundated which will result in the existing agricultural land changing to intertidal habitat. The predicted extents of different intertidal habitats in the eastern site following initial tidal inundation and after five years are shown in Table 11.19. This is based on an understanding of scheme elevations in the tidal frame, inundation frequencies as predicted by the numerical modelling, lessons learnt from the ABP Welwick Managed Realignment (and others) and the distribution of habitats in this part of the estuary (see Appendix 7.1 Modelling Report). The potential extent of different habitat types has been presented as indicative ranges to reflect the high degree of uncertainty of scheme evolution and the timescales over which this may occur. Typically, however, the rate of change in habitat extent within the inundation area would be expected to reduce after the initial five years.

It should also be noted that given the nature of the new embankments and in locations where piling is put in place this has the potential to contribute to coastal squeeze in the longer term. The magnitude of any such losses will be minimised through the removal of existing embankments and avoiding the introduction of hard structures where possible.

The potential changes to saltmarsh and mudflat habitat are discussed further below.

Table 11.19: Indicative predicted extents of different intertidal habitats in the eastern site

Habitat	Initial extent (ha)	Extent after 5 years inundation (ha)
Grassland and transitional grassland	30	30
Mudflat	50 to 90	10 to 30
Pioneer to mid Saltmarsh	50 to 90	110 to 125
Upper saltmarsh	20	25

Saltmarsh

Saltmarsh species show strong zonation with succession occurring temporally (Gray, 1992). This succession is often linked to tidal elevation and is increased by high accretion rates (like those occurring in the Humber Estuary). Intertidal mudflat transition to saltmarsh occurs where the frequency of inundation is sufficiently reduced to permit saltmarsh development. In areas with sufficient shelter and sediment availability, mudflats will slowly increase in height (i.e. accrete) and turn into saltmarsh. Higher subtidal areas would conversely be expected to convert to mudflat under such conditions. It is generally understood that intertidal mudflats require at least 450 inundations per annum in order for vegetation establishment to be suppressed (Toft *et al.*, 1995; Leggett *et al.*, 2004). The amount of saltmarsh is therefore expected to increase as the site develops morphologically through time, as demonstrated in several other managed realignment sites on the Humber Estuary (Halcrow, 2013, ABPmer, 2015).

Based on scheme elevations at the time of the breaching approximately 50 to 90 ha of the entire 189 ha would be suited to saltmarsh development. In practice saltmarsh colonisation would be expected to occur within the first year of inundation. This reflects

the ready supply of saltmarsh propagules within the immediate vicinity of the scheme and lessons learnt from other managed realignment schemes, particularly Welwick (see below). Within five years the extent of saltmarsh within the eastern site could be as much as 150 ha based on predicted accretion rates (see Chapter 7).

The development of saltmarsh communities at the eastern site is expected to be similar to that which has been observed within the adjacent ABP Welwick Managed Realignment. This site was initially colonised by species characteristic of pioneer to middle saltmarsh zones particularly *Salicornia* (annual glassworts) marsh community. Species such as *Suaeda maritima* (annual sea-blite), *Puccinellia maritima* and clumps of *Spartina anglica* (common cordgrass) became increasingly widespread within the first three years following breaching. Approximately five years following the breach there was clear evidence of ongoing succession with lower elevation sections of the site characterised by pioneer vegetation (such as *Salicornia* and *Spartina*) and upper sections dominated by lower middle saltmarsh (such as *Puccinellia maritima* dominated communities). There was also an expansion of pioneer *Salicornia* vegetation onto open mud as accretion of the site continued. Between five and ten years post-breach the majority of the site consisted of *Puccinellia maritima* dominated communities with *Salicornia* and *Spartina* dominated communities at lower elevations. There was also an increase in the extent of *Puccinellia maritima* dominated communities as well as *Aster tripolium* (sea aster) (ABPmer, 2018b). Similar changes in saltmarsh communities have also been observed at other sites in the Humber Estuary such as Paull Holme Strays (Halcrow, 2013).

The magnitude of change is considered to be **large**, the probability of this change occurring is **high** and therefore the exposure is considered **high**. The sensitivity of saltmarsh to habitat change is considered to be **high** and therefore the vulnerability to change is **high.** The value of saltmarsh habitats and associated species is considered to be **high** (given the protection they are afforded as part of international designations). On this basis, the overall effect on the saltmarsh and associated species is therefore considered to be **major beneficial**.

Mudflat

At the point of inundation, the elevations within the Eastern site are predicted to be suited to the development of approximately 50 ha to 90 ha of intertidal mudflat. This is predicted to reduce through time where after five years the predicted extent is reduced to approximately 10 ha to 30 ha (due to colonisation by saltmarsh resulting from accretion). The continued expansion of saltmarsh at this site through time should be expected.

The mudflat is expected to be colonised by a range of commonly occurring marine estuarine invertebrate species as seen at the ABP Welwick managed realignment site (ABPmer, 2008). Colonisation by marine invertebrates following tidal inundation of the site is expected to be relatively rapid with a range of species such as *H. diversicolor*, *P. elegans*, *L. balthica* and *P. ulvae* (which are commonly occurring on the mudflats outside of the site at similar elevations) expected to be present within the first year (Section 11.4.2). The subsequent years are expected to maintain a similar assemblage although abundances levels are likely to fluctuate annually. As the site develops over time the composition of the benthic assemblage is expected to change with an overall shift to a community with increasing numbers of fly larvae and other species associated with saltmarsh and other upper littoral fringe habitats dominating. However, based on monitoring data from the nearby ABP Welwick Managed Realignment, marine estuarine invertebrate species will still be present in the sediments (ABPmer, 2018a).

The magnitude of the impact is considered to be **medium**, the probability of this change occurring is **high** and therefore the exposure is considered **medium.** The sensitivity of mudflat to habitat change is considered to be **high** and therefore the vulnerability to change is **high.** The value of mudflat habitats and associated species is considered to be **high** (given the protection they are afforded as part of international designations). On this basis, the overall effect on the mudflat and associated species is therefore considered to be **major beneficial**.

Potential changes in the extent and quality of intertidal habitat fronting the Scheme

Saltmarsh

There is the potential for erosion of saltmarsh adjacent to the breach channel following tidal inundation. However, the channel that will be cut through the saltmarsh at the breach location in East 2 will be wide (approximately 400 m). This will ensure that flow rates through the channel are low and therefore erosion is expected to be limited (Chapter 7). This is supported by monitoring of the saltmarsh adjacent to the two breach locations at ABP Welwick Managed Realignment. Monitoring of the saltmarsh adjacent to the breach continued for five-years post inundation, in this time, there was little evidence of changes in the zonation or distribution of saltmarsh plant communities adjacent to the breaches between 2009 and 2011. This suggested that the inflow and outflow of tidal water through the breaches is not having much impact on mature saltmarsh to either side (ABPmer, 2012).

Based on these factors, the magnitude of the impact is considered to be **small**, the probability of this change occurring is **low** and therefore the exposure is considered **negligible**. The sensitivity to this change is considered to be **moderate**, resulting in no vulnerability. The value of saltmarsh habitats and associated species is considered to be **high** (given the protection they are afforded as part of international designations. On this basis, the overall effect on the saltmarsh and associated species is therefore considered to be **insignificant**.

Mudflat

Following breaching, physical disturbance of intertidal habitats fronting the breach will occur as a result of scouring caused by the flow of water through the breach and across the mudflat. This will include the formation of a narrow channel over time as well as the creation of smaller spur channels off the main channel. The plan form and depth of the channel that will gradually form is not predictable as it will depend in the bed density and sediment distribution in plan and depth over the mudflat. However, over time equilibrium is expected to be reached with the morphology of the channels expected to be broadly similar to those found locally in the area.

Further information on these morphological changes is provided in the physical processes and the hydrodynamic environment chapter (Chapter 7). However, the existing sediment type is not expected to broadly change and a broadly similar community to that already found in this area is expected to continue to occur in the inlet channel (Chapter 7).

These relatively localised changes are therefore considered be of a **small** magnitude, with a **high** probability of occurrence and an overall exposure assessed as **low**. The sensitivity of mudflat to this change is considered to be **low** and therefore the vulnerability to change is **low.** The value of these mudflat habitats and associated species is considered to be **high** (given the protection they are afforded as part of international designations). On this basis, the overall effect is therefore considered to be **minor adverse**.

Potential impacts to benthic species and habitat receptors due to changes in water quality as a result of the breach

The mobilisation and re-suspension of sediments and any sediment-bound contaminants into the water column once the site is tidally inundated and during the formation of a narrow channel within the mudflat has the potential to affect marine habitats and species.

Elevated levels of suspended sediment (increased turbidity) during construction works can cause a reduction in light penetration through the water column, restricting the light availability for photosynthesis in primary producers such as phytoplankton, periphyton and macrophytes. Such primary producers are important sources of food and oxygen (Chapman and Fletcher, 2002). Increased suspended sediment levels may lead to the clogging of the gills of suspension feeders (grazing on suspended organic matter) and favour the development of deposit feeders (that graze on settling organic matter) such as polychaete species over bivalves and other suspension feeders (Boyd *et al*., 2004). However, any potential increases in suspended sediment concentrations following inundation would be expected to be temporary and very localised and as such not discernible from background concentrations. The formation of the channel is not expected to increase sedimentation at a scale that cannot be tolerated by benthic species that occur in the Humber Estuary. Benthic habitats and species within the Humber Estuary are also considered well adapted to living in an area with high and variable suspended sediment loads and as such would not be sensitive to this level of change.

With respect to sediment-bound contaminants released into the water column, as outlined in Chapter 8, contamination sampling in the intertidal mudflat and fields landward of the breach were found to low and are unlikely to result in significant impacts to water quality. In addition, any contaminants released into the water column will be rapidly dissipated by the strong hydrodynamic conditions in the area and are therefore considered unlikely to produce adverse effects in any benthic species.

Based on these factors, the expected localised and temporary changes in suspended sediment concentrations and concentrations of contaminants in the water column during operation is expected to be of a **small** magnitude, with a **high** probability of occurrence, and therefore a **low** exposure. The sensitivity to the change is considered to be **low** and therefore the vulnerability to change is **low.** The value of the intertidal habitats associated species in the area is **high** (given the protection they are afforded as part of international designations). On this basis, the overall effect is therefore considered to be **minor adverse**.

11.6.2.3 Fish

Construction

The construction of the eastern site has the potential to affect fish receptors through the following impact pathway:

- Potential impacts to fish due to increased noise.

Potential impacts to fish due to increased noise

Elevated underwater noise caused by construction activities has the potential to disturb fish by causing physiological damage and/or inducing adverse behavioural reactions and masking (Hawkins et al., 2015). The ability to detect sound is of considerable

biological importance to many fish species, and is often used to assess the suitability of a potential mate or during territorial displays and during predator prey interactions.

During construction of the eastern site, noise will potentially occur as a result construction activity. However, the proposed construction works will occur on the upper shore and are not expected to occur during high tide periods when underwater noise propagation can occur. Propagation of airborne noise into the marine environment is therefore anticipated to be limited. Other construction noise sources (such as the movement of machinery or vehicles) are not expected to propagate into the marine environment.

Based on these factors, the magnitude of change is negligible, the probability of occurrence is high and exposure is considered to be negligible. The sensitivity of fish to underwater noise is considered to be high but the vulnerability to change is none. The value of fish is considered to range from moderate (for commonly occurring estuarine species) to high for protected migratory species. On this basis, the overall effect on fish is insignificant.

Operation

The operational phase of the eastern site has the potential to affect fish receptors through the following impact pathway:

- Potential impacts on fish due to changes in available habitat; and
- Potential impacts on fish due to changes in water quality

Potential impacts on fish due to changes in available habitat

Beneficial impacts are anticipated for estuarine fish from the introduction of the managed realignment scheme. In general, intertidal habitats are known to be valuable feeding and nursery grounds for many fish species, including whiting, flounder, herring and bass (Dixon et al., 2008; Brown et al., 2007; Hemingway et al., 2008). The benefits of managed realignment sites to fish has also been proven by research and monitoring undertaken at a number of other realignment sites around the Humber including Paull Holme Strays, and Chowder Ness (ABPmer, 2015).

The creation of a mosaic of intertidal habitats within the eastern site will provide additional foraging and nursery areas for fish. The magnitude of the change in habitats is assessed as **medium**, with a **high** probability of occurrence and therefore a **medium** exposure. The sensitivity of estuarine fish to this change is **moderate** and vulnerability is therefore considered to be **moderate**. The value of fish is considered to range from **moderate** (for commonly occurring estuarine species) to **high** for protected migratory species. On this basis, the overall effect of the creation of intertidal habitat for estuarine fish species is considered to be **minor to moderate beneficial**.

Potential impacts on fish due to changes in water quality

The mobilisation and re-suspension of sediments and any sediment-bound contaminants into the water column once the site is tidally inundated and during the formation of a narrow channel in the mudflat has the potential to affect marine fish. This can cause changes in a range of water quality parameters including turbidity and dissolved oxygen level. These changes in turn have the potential to affect the distribution and health of fish species Britwell (2000).

Estuarine fish in the Humber Estuary are considered to be well adapted to living in an environment subject to high ambient suspended sediment concentrations which occur naturally in the Humber Estuary. In addition, their high mobility enables them to move

freely to avoid areas of adverse conditions and to use other food sources in the estuary. Estuarine fish are therefore not considered sensitive to the temporary and localised changes in suspended sediments expected. Certain species of migratory fish such as Atlantic salmon are considered more sensitive to sediment plumes which have the potential to create a barrier to migratory movements. However, the suspended sediment plumes will be confined to a localised area which only represents a small proportion of the width of the Estuary. Furthermore, the predicted suspended sediment levels are not expected to present a detectable barrier to migration (particularly given the high existing background concentrations that occur throughout the Estuary). Therefore, no barrier effects are anticipated.

With respect to sediment-bound contaminants released into the water column, as outlined in Chapter 8, contamination sampling in the intertidal mudflat and fields landward of the breach were found to low and are unlikely to result in significant impacts to water quality. In addition, contaminants released into the water column will also be rapidly dissipated by the strong hydrodynamic conditions in the area and are therefore considered unlikely to produce adverse effects in any fish species.

Based on these factors, the expected localised and temporary changes in suspended sediment concentrations and water column contaminant levels during operation is expected to be of a **small** magnitude, with a **high** probability of occurrence and therefore of **low** exposure. The sensitivity of estuarine fish to this change is **low** and therefore the vulnerability to this change is **low.** The value of fish is considered to range from **moderate** (for commonly occurring estuarine species) to **high** for protected migratory species. On this basis, the overall effect is therefore considered to be **insignificant** for some species but **minor adverse** for others.

11.6.2.4 Marine mammals

Construction

The construction of the eastern site has the potential to affect marine mammal receptors through the following impact pathway:

- Potential impacts to marine mammals due to increased noise.

Potential impacts to marine mammals due to increased noise

Elevated underwater noise levels caused by construction activities have the potential to disturb marine mammals. The impacts of noise on marine mammals can broadly be split into lethal and physical injury, auditory injury and behavioural responses. The possibility exists for lethality and physical damage to occur at very high exposure levels, such as those typically close to underwater explosive operations or offshore impact piling operations. A permanent threshold shift (PTS) is permanent hearing damage caused by very intensive noise or by prolonged exposure to noise. A temporary threshold shift (TTS) involves a temporary reduction of hearing capability caused by exposure to noise. At lower sound pressure levels, it is more likely that behavioural responses to underwater sound will be observed. These reactions may include the animals leaving the area for a period of time, or a brief startle reaction. Masking effects may also occur at lower levels of noise. Masking is the interference with the detection of biologically relevant communication signals such as echolocation clicks or social signals (Clark *et al*., 2009).

During construction of the eastern site, noise will potentially occur as a result construction activity. However, the proposed construction works will occur on the upper shore and are not expected to occur during high tide periods when underwater noise

propagation can occur. Propagation of airborne noise into the marine environment is therefore anticipated to be limited. Other construction noise sources (such as the movement of machinery or vehicles) are not expected to propagate into the marine environment.

Based on these factors, the magnitude of change is **negligible**, the probability of occurrence is **high** and exposure is considered to be **negligible**. The sensitivity of marine mammals to underwater noise is considered to be **high** but the vulnerability to change is **none**. The value of marine mammals is considered to **high**. On this basis, the overall effect on marine mammals is **insignificant**.

11.6.2.5 Coastal waterbirds

Construction

The construction of the eastern site has the potential to affect coastal bird receptors through the following impact pathways:

- Potential impacts to coastal waterbirds due to disturbance; and
- Potential impacts on coastal waterbirds due to loss and changes in intertidal habitat.

Potential impacts to coastal waterbirds due to disturbance

There is the potential for waterbirds to be temporarily disturbed as result of construction related activity including the movements of people, machinery and vehicles and the removal and/or lowering of current sea defences. These activities are sources of noise and visual stimuli which could elicit a disturbance response in waterbirds. The construction activities that are considered to be most impactful on coastal waterbirds using the area are expected to be the breaching and lowering of the adjacent banks. This would be particularly apparent if the works are undertaken during the over wintering period.

Evidence suggests that waterbirds generally show a flight response to human activities on or near the foreshore at approach distances of between 20 m and 100 m although distances of more than 250 m has been observed in some sensitive species (Cutts *et al.*, 2013; Ross & Liley, 2014; IECS, 2009). Other research has indicated that in general, birds appear to habituate to continual noises (such as machinery noise) as long as there is no large amplitude 'startling' component (IECS, 2009; Dwyer, 2010; McLeod, *et al*., 2013; Glover *et al*., 2015).

Based on the results of these studies, regular construction activities are expected to generally cause infrequent, mild behavioural responses in a localised area in the vicinity of the works. The responses observed are likely to range from increased vigilance, avoidance walking and short flights with birds rapidly resettling and resuming feeding or roosting near their original location. Occasional larger disturbance events (causing birds to flush and leave the immediate vicinity) could occur. Rather than evacuating the area completely, birds would be expected to redistribute to other nearby parts of the Humber Estuary. The main areas into which the birds disturbed are likely to move into are the two present saltmarshes (ABP Welwick Managed Realignment and Welwick Saltmarsh) which are outwith any disturbance radius for the majority of the works. Both of these areas support a large range of species, including those likely to be displaced (Cutts, 2019). Should any temporary displacement occur the effect would only likely be short term with birds expected to rapidly return following completion of the construction works.

Based on these factors, magnitude is considered to be **medium**, with a **high** probability of occurrence, and therefore a **medium** exposure to change. The sensitivity of birds to the construction related disturbance highlighted is considered to be **moderate to low** (depending on the disturbance tolerance of the species) and therefore have a **moderate to low** vulnerability. Value is considered to be **high** for all waterbird species (given the protection they are afforded). On this basis the impacts are considered to be **minor to moderate adverse**.

Potential impacts on coastal waterbirds due to loss and changes in intertidal habitat

There is the potential for intertidal habitat loss and change to impact on waterbirds as a result of the construction works. A small area of saltmarsh will be reprofiled in the area directly seaward of the breach location in East 2. The breach will involve the lowering of the existing bank to approximately 1.6 mAOD. Approximately 2.5 ha will be lost directly through the breach. In contrast, the removal of the existing embankments to ground level will result in the creation of approximately 2 ha of intertidal habitat (initially intertidal mudflat but due to the area being at typical saltmarsh elevations succession is expected to occur).

This footprint of habitat loss is considered to be very small in the context of the extent of existing saltmarsh found locally in the area and more widely in the Humber Estuary region (2.5 ha out of 630 ha around the Humber Estuary. Any waterbirds using this small area of saltmarsh for roosting would be expected to be able to easily redistribute locally to similar nearby habitat (e.g. ABP Welwick Managed Realignment and Welwick Saltmarsh which maintain similar assemblages and have a combined extent of approximately 100 ha). There is however, no evidence of habitual use of the saltmarsh fronting the breach (Cutts, 2019).

Based on these factors, magnitude is considered to be **small**, with a **high** probability of occurrence and therefore a **low** exposure to change. The sensitivity of birds to habitat change is considered to be **low** due to the scale of change and the easy access to other appropriate habitats and therefore the vulnerability is assessed as **low**. The value of waterbird species is considered to be **high** (given the protection they are afforded). On this basis, the overall effect is therefore considered to be **minor adverse**.

Operation

The eastern site which has the potential to affect coastal waterbird receptors through the following impact pathways during operation:

- Potential impacts on coastal waterbirds due to changes in available habitat; and
- Potential impacts on coastal waterbirds due to disturbance.

Potential impacts on coastal waterbirds due to changes in available habitat

The creation of additional existing intertidal habitat as part of the Scheme will increase the amount of functional supporting habitat available for coastal waterbirds and potentially improve the number of coastal waterbirds in the area (Halcrow, 2011; ABPmer, 2015). In general, feeding densities of most wader species typically increase during the first two to four winters following the introduction of tidal inundation; this largely reflects the rate of increase in biomass of their main invertebrate prey. Waders which feed primarily on larger bivalves (which can take several years to attain maximum size) would be expected to take longer to attain maximum densities than waders that feed on more rapidly maturing, smaller benthic invertebrate species. Target species are expected to colonise this area relatively quickly after inundation (ABPmer, 2015).

The fields that are proposed to be inundated are currently not habitually used by large numbers of coastal waterbirds and are therefore considered to currently be of relatively low functional value, in the context of the Humber Estuary (Section 11.4.5). There is likely to be a change in the community that utilise these areas as the current fields are replaced by a mosaic of new habitats.

The Scheme is predicted to create a range of intertidal habitats (mudflats, saltmarsh and coastal grassland) that will be utilised by a variety of birds including species that are likely to be affected by coastal squeeze and loss of mudflat (Halcrow, 2011). Consideration has been given to the habitat preferences of all bird species targeted by the scheme, in order to ensure, as far as possible, that the scheme matches their requirements.

The species specifically targeted for the scheme include Teal and Black-tailed Godwit, Shelduck, Mallard, Golden Plover and Lapwing. The habitat preference, niche and food preference of these six species has been reviewed by IECS and Jacobs (formerly Halcrow) (Halcrow, 2011). The review concluded that initially the Scheme can provide appropriate habitat, ecological niches and prey resources for the target species. The extent of these beneficial features is likely to change as the intertidal habitats created change. Over time, the extent of saltmarsh habitat is expected to generally expand, replacing the initial mudflat, with mudflat habitat remaining in creeks, channels and lower elevation pools (Section 11.6.1). This changing evolution of habitats at the site will mean that the usage and functionality of the site for different bird species (and the proportion of birds engaged in different behaviours such as feeding, roosting and loafing) is also expected to change.

It is predicted that after five years will be up to approximately 12 to 27 ha mudflat, 129 to 144 ha saltmarsh and 21 ha coastal grassland. While a reduction in available mudflat habitat for feeding and loafing waterbirds is predicted to occur in the long term, the overall usage of the site by waterbirds is expected to remain high based on the results of monitoring at other realignment sites in the Humber Estuary. For example, the adjacent ABP Welwick Managed Realignment site continues to support a wide range of foraging waterbirds despite an overall reduction in mudflat extent (particularly Grey Plover, Curlew and Redshank). The site is also utilised by a diverse range of roosting and loafing birds in large numbers including Golden Plover, Lapwing, Knot, Curlew and Dunlin. The average peak count of the years surveyed since the site was breached (2005/2006 to 2016/2017) was 9,189 with broadly similar numbers occurring ten years after breaching compared with first winter post inundation (ABPmer, 2018). Mander *et al.* (2007) also found that the Paull Holme Strays Managed Realignment Site supported a waterbird assemblage of similar composition to that of adjacent existing intertidal areas within three years of creation.

Based on these factors, the magnitude of change is considered to be **large**, with a **high** probability of occurrence and therefore a **high** exposure. The sensitivity of birds to this change is considered **moderate** and therefore the vulnerability is high. The value of waterbird species is considered to be **high** (given the protection they are afforded). On this basis, the overall effect is therefore considered to be **major beneficial**.

Potential impacts on coastal waterbirds due to disturbance

Disturbance to waterbirds could potentially occur once the site is breached as a result of recreational visitors (such as walkers (including dog walkers), bird watchers, cyclists etc.) with the overall number of recreational visitors using the area anticipated to increase as a direct result of the Scheme (Chapter 6). A previous study suggested that

birds in this area are considered susceptible to disturbance stimuli due to a limited amount of existing human activity (Ross & Liley, 2014).

As discussed in Chapter 6, human activities in the vicinity of the foreshore (including recreational pressure) can cause bird disturbance. Birds initially show increased vigilance to threats perceived as low risk such as low level background noise. As perceived threat levels increase, birds begin to exhibit avoidance behaviour which can result in a flight response and dispersal from a site. Repeated recreational disturbance may eventually lead to displacement from an area which may be permanent or temporary (Ferns et al., 2000; Stillman and Goss-Custard, 2002, Dwyer, 2010; Navedo and Herrera, 2012.).

Birds will vary their response to recreational activities depending on the type of the activity, the speed and randomness of approach, the distance to which the disturbance factor approaches and the frequency of disturbance (Burton et al., 2002., Rees *et al*., 2005). It generally appears that birds are most disturbed by irregular human movements. Large groups of noisy people; the chaotic and high speed approach of dogs off leads and aerial objects such as kites are all considered activities particularly likely to heighten the response of individuals (Smit and Visser, 1993; IECS, 2009).

On this basis, ongoing recreational disturbance pressure as a result of the Scheme has the potential to cause repeated disturbance events over a long duration of time. However, birds would be expected to become habituated to some extent. Nevertheless, regular disturbance at the eastern site could cause birds to disperse from the area on a temporary or even permanent basis.

Based on these factors, the magnitude is considered to be **medium**, with a **high** probability of occurrence and therefore a **medium** exposure. The sensitivity of birds to the regular disturbance is considered to be **moderate to low** (depending on the disturbance tolerance of the species), with the vulnerability assessed as **moderate to low**. The value of waterbird species is considered to be **high** (given the protection they are afforded). On this basis, the overall effect is therefore considered to be **minor to moderate adverse**.

11.6.2.6 Future Intervention Works

As noted in Chapter 7, one of the objectives of the Welwick to Skeffling Managed Realignment (eastern site) is to provide compensatory habitat for future port development on the estuary (should this prove necessary). At the present time the magnitude, time scale and characteristics of any such compensation requirements are unknown. It is anticipated, however, that this is likely to include an element of mudflat habitat. In order to maintain mudflat within the site in to the future it is recognised at this stage that some form of intervention works may be necessary. The method and frequency of any such intervention has not yet been defined as it will be dependent not only on the specifics of the compensation objectives but also how the site has evolved.

It is assumed, however, that this will require the evolved bathymetry to be re-profiled to return it to elevations suited to sustaining mudflat. The most appropriate plant for the scale and type of work required will be defined as and when required. Supporting assessments will also be undertaken at this time to support the necessary consents and licensing requirements. These would reflect the temporary and localised nature of any such works as well as their underlying objective to promote sustainable mudflat. More specifically it would consider the re-colonisation of any such area by invertebrates and the implications for birds using the Scheme in terms of both habitat and prey resource as well as disturbance.

By their nature, the intervention works will change the bathymetric form and the habitat distribution within the site. The functioning and overall intertidal area of the site will be maintained and potentially enhanced following completion of the works. It should be noted, however, that following any such re-profiling of the site would be expected to accrete and as such a cyclical programme of intervention could be required.

11.6.3 Summary

Table 11.20: Summary of likely significant effects

Receptor	Impact pathway	Outstrays Managed Realignment (western site)	Welwick to Skeffling Managed Realignment (eastern site)
Benthic habitats and species (including designated features)	Construction – Saltmarsh extent change	Moderate adverse	Moderate adverse
	Construction – Potential impacts to benthic habitats and species due to changes in water quality as a result of the excavation of the breach and reprofiling of fronting saltmarsh	Minor adverse	Minor adverse
	Operation – Potential changes in the extent and quality of intertidal habitat within the inundation area	Saltmarsh – Major beneficial	Saltmarsh – Major beneficial
		Mudflat – Major beneficial	Mudflat – Major beneficial
	Operation – Potential changes in the extent and quality of intertidal habitat fronting the Scheme	Saltmarsh – Insignificant	Saltmarsh – Insignificant
		Mudflat – Minor adverse	Mudflat – Minor adverse
	Operation – Potential impacts to benthic species and habitat receptors due to changes in water quality	Minor adverse	Minor adverse

Receptor	Impact pathway	Outstrays Managed Realignment (western site)	Welwick to Skeffling Managed Realignment (eastern site)
Fish (including designated features)	Construction – Potential impacts to fish within the estuary due to noise and vibration effects (eastern site) Construction – Potential impacts to fish within the estuary due to increased noise (western site)	Insignificant	Insignificant
	Operation – Potential impacts on fish due to changes in available habitat	Minor to Moderate beneficial	Minor to Moderate beneficial
	Operation – Potential impacts on fish due to changes in water quality	Insignificant for some species, Minor adverse for others depending on sensitivity	Insignificant for some species, Minor adverse for others depending on sensitivity
Marine mammals (including designated features)	Construction – Potential impacts to marine mammals due to noise and vibration effects (eastern site) Construction – Potential impacts to marine mammals due to increased noise and vibration effects (western site)	Insignificant	Insignificant

Receptor	Impact pathway	Outstrays Managed Realignment (western site)	Welwick to Skeffling Managed Realignment (eastern site)
Coastal waterbirds (including designated features)	Construction – Potential impacts to coastal waterbirds due to disturbance	Minor to Moderate adverse	Minor to Moderate adverse
	Construction – Potential impacts on coastal waterbirds due to loss and changes in intertidal habitat	Minor adverse	Minor adverse
	Operation – Potential impacts on coastal waterbirds due to changes in available habitat	Major beneficial	Major beneficial
	Operation – Potential impacts on coastal waterbirds due to disturbance	Minor to Moderate adverse	Minor to Moderate adverse

11.7 Mitigation

Mitigation has been embedded into the design of the Scheme to address issues identified by surveys, stakeholder engagement, lessons learnt from other managed realignment projects and professional expertise. Those impact pathways for which a Moderate adverse (including Moderate/Minor) or higher, was identified and as such where mitigation is required, are outlined below.

11.7.1 Outstrays Managed Realignment

11.7.1.1 Saltmarsh extent change during construction

The direct result of reprofiling a section of saltmarsh fronting the breach location was assessed as being minor to moderate adverse without mitigation. However, this 1 ha loss is offset by the creation of between 65 and 80 ha initially and between 90 to 105 ha after five years of breaching. Saltmarsh species encroach onto mudflat habitats as mudflat accretes and becomes higher up within the tidal frame (ABPmer, 2015). The net gain of saltmarsh across the western site is vast and is expected to be far larger than the amount lost.

11.7.1.2 Potential impacts to coastal waterbirds due to disturbance during construction

During construction there is potential for waterbirds to be disturbed. There is a gradual increase in birds using the habitats within the vicinity of the Scheme from September until peaking in mid-winter. To avoid the peak periods for overwintering birds the construction works will be undertaken during the spring and summer (April to the end September) which avoids the peak overwintering period although construction will still overlap with passage periods for birds. To reduce disturbance in the autumn passage period (when numbers of birds start to increase) the most disturbing activities during construction (lowering existing banks, piling and breach creation) will be restricted further to the period of lowest bird numbers (April to June for bank lowering and breaching, and ideally mid-July for piling due to the need to avoid the most important months for Marsh Harrier breeding).

A detailed Construction Environmental Management Plan (CEMP) will be prepared (as part of discharging any respective licence conditions), detailing all relevant mitigation measures to avoid bird disturbance.

11.7.1.3 Potential impacts on coastal waterbirds due to disturbance during operation

In addition to the constructional disturbance, there is potential for coastal waterbirds to be disturbed by an increased number of visitors visiting the western site during the operation. In anticipation of this, there have been embedded mitigation within the Scheme design in order to address these issues. Design considerations at the western site to reduce the operational impacts on coastal waterbirds include:

- Fencing has been included in the design to reduce disturbance to birds. Fencing will run along the new access alignment to prevent public access to the intertidal zone from humans and dogs;
- Public access along the bank crest has been restricted to areas which are likely to cause the least disturbance to birds;

- Screening vegetation is used throughout the site to reduce the visual disturbance of humans, and allow areas of mudflat to be void of human disturbance; and
- Bird hide design has taken into consideration the placement direction to avoid overlooking the most important areas, and placed strategically so that people going to access such hides walk to them is as less disruptive as possible.

Monitoring of coastal waterbirds will take place once the Scheme is constructed, as part of the measures included in the Environmental Monitoring and Maintenance Plan, and to ensure that site objectives are met.

11.7.2 Welwick to Skeffling Managed Realignment

11.7.2.1 Saltmarsh extent change during construction

The impact to saltmarsh as a direct result of reprofiling a section at the front of the breach location was assessed as being minor to moderate adverse without mitigation. However, this 2.5 ha loss is offset by the creation of between 68 and 108 ha initially and between 127 to 147 ha after five years of breaching. Saltmarsh species encroach onto mudflat habitats as mudflat accretes and becomes higher up within the tidal frame (ABPmer, 2015). The net gain of saltmarsh across the eastern site is vast and is expected to be far larger than the amount lost.

11.7.2.2 Potential impacts to coastal waterbirds due to disturbance during construction

During construction there is potential for waterbirds to be disturbed. There is a gradual increase in birds using the habitats within the vicinity of the Scheme from September until peaking in mid-winter. To avoid the peak periods for overwintering birds the construction works will be undertaken during the spring and summer (April to the end September) which avoids the peak overwintering season although construction will still overlap with passage periods for birds. To reduce disturbance in the autumn passage period (when numbers of birds start to increase) the most disturbing activities during construction (lowering existing banks and breach creation) will be restricted further to the period of lowest bird numbers (April to June). A detailed CEMP will be prepared (as part of discharging any respective licence conditions), detailing all relevant mitigation measures to avoid bird disturbance.

11.7.2.3 Potential impacts on coastal waterbirds due to disturbance during operation

In addition to the constructional disturbance, there is potential for coastal waterbirds to be disturbed by an increased number of visitors visiting the eastern site during the operation. In anticipation of this, there has been embedded mitigation within the Scheme design in order to address these issues. Design considerations at the eastern site to reduce the operational impacts on coastal waterbirds include:

- Fencing has been included in the design to reduce disturbance to birds. Fencing will run along the new access alignment to prevent public access to the intertidal zone from humans and dogs;
- Public access along the bank crest has been restricted to areas which are likely to cause the least disturbance to birds;
- Screening vegetation is used throughout the site to reduce the visual disturbance of humans, and allow areas of mudflat to be void of human disturbance; and

- Bird hide design has taken into consideration the placement direction to avoid overlooking the most important areas, and placed strategically so that people going to access such hides walk to them is as less disruptive as possible.

Monitoring of coastal waterbirds will take place once the Scheme is constructed, as part of the measures included in the Environmental Monitoring and Maintenance Plan, and to ensure that site objectives are met.

11.8 Residual effects

11.8.1 Outstrays Managed Realignment

The impact to saltmarsh as a direct result of reprofiling a section at the front of the breach location was assessed as being minor to moderate adverse without mitigation. However, with the mitigation measures highlighted in Section 11.7.1**,** residual effects are considered to be **moderate beneficial**.

The impact to waterbirds as a result of temporary disturbance during construction was assessed as being of minor to moderate adverse. However, with mitigation measures highlighted in Section 11.7.1 and the CEMP**,** residual effects are considered to be **minor adverse.**

The impact to waterbirds as a result of disturbance during operation was assessed as being of minor to moderate adverse without mitigation. However, with the mitigation measures highlighted in Section 11.7.1**,** residual effects are considered to be **minor adverse.**

No other impacts were assessed as moderate (or higher) and therefore no mitigation measures are required. Residual effects for all other pathways are therefore considered the same as in Section 11.6.1.

11.8.2 Welwick to Skeffling Managed Realignment

The impact to saltmarsh as a direct result of reprofiling a section at the front of the breach location was assessed as being minor to moderate adverse without mitigation. However, with the mitigation measures highlighted in Section 11.7.2**,** residual effects are considered to be **moderate beneficial**.

The impact to waterbirds as a result of disturbance during construction was assessed as being of minor to moderate adverse. However, with mitigation measures highlighted in Section 11.7.2 and the CEMP**,** residual effects are considered to be **minor adverse.**

The impact to waterbirds as a result of disturbance during operation was assessed as being of minor to moderate adverse without mitigation. However, with the mitigation measures highlighted in Section 11.7.2**,** residual effects are considered to be **minor adverse.**

No other impacts were assessed as moderate (or higher) and therefore no mitigation measures are required. Residual effects for all other pathways are therefore considered the same as in Section 11.6.2.

12 Landscape and visual

12.1 Introduction

This chapter provides a summary of the full Landscape and Visual Impact Assessment (LVIA) which can be found in Appendix 12.1. The summary and full LVIA should be read in conjunction with landscape Figures 12.1 to 12.4 in Appendix 1.1, Chapter 10 Terrestrial biodiversity, Chapter 11 Marine biodiversity and Chapter 13 Historic Environment.

12.2 Regulatory and policy framework

The main policy documents relating to this assessment are the NPPF and the East Riding Local Plan, which are summarised in Chapter 1 and Appendix 1.4.

12.3 Methodology

12.3.1 Study area

The LVIA considers an area covering a 3km radius from the Scheme, in order to establish the spatial parameters of the assessment and identify potential landscape and visual effects arising from the proposals. The extent of the study area, illustrated on Figure 12.1 in Appendix 1.1, is shown as a combined 3 km radius for the whole Scheme i.e. Outstrays Managed Realignment (western site) and Welwick to Skeffling Managed Realignment (eastern site) together.

This defined study area is considered appropriate for this type of development within this locale, and has been agreed with East Riding of Yorkshire Council.

12.3.2 Baseline data collection

Baseline data collection for the study area has been informed by a combination of desk based and site-based appraisal techniques to build up a thorough baseline for use in the assessment of landscape and visual effects. These techniques include site walkovers, undertaking viewpoint photography, appraisal of aerial photography and base mapping, interrogation of web based environmental data sets and landscape specific data and character assessments pertinent to the study area.

For details of the baseline data, refer to the full LVIA.

12.3.3 Impact assessment

The LVIA for the proposed works has been undertaken in accordance with the methods recommended in the following best practice guidance:

- Guidelines for Landscape and Visual Impact Assessment (Third Edition) published by the Landscape Institute and the IEMA (2013).

For details of the assessment approach and methodology, refer to the full LVIA.

12.4 Uncertainties, assumptions and limitations

The key assumption of the LVIA has been to assess the proposed embankment construction height, which includes an allowance for settlement, in order to assess landscape and visual effects against the worst case height of new embankments. There is an assumption that settlement will occur to some degree within the geotechnical parameters of the embankment design. While a settlement range is indicated, to make the LVIA approach consistent the assessment has been based on construction height (pre-settlement).

12.5 Existing environment

12.5.1 Outstrays Managed Realignment

The Outstrays Managed Realignment is located in an intensively farmed arable agricultural area on the north bank of the Humber Estuary south of Patrington. The site is divided into two sections:

- West 1 (land south of Outstray Farm) located on Sunk Island, south west of Winestead Drain; and
- West 2 (land north of Outstray Farm) located in arable fields north east of Winestead Drain.

12.5.1.1 Landscape baseline

Representative viewpoints

A number of viewpoints were considered through a process of desk-based review and field studies. The final list of five representative viewpoints (eleven in total within the western and eastern site) were agreed with Stephen Robinson of East Riding of Yorkshire Council Trees and Landscape Unit (22 November 2017) as being appropriate to this assessment. A further viewpoint was added in the western site post consultation when the site proposals were extended further west at Sunk Island.

For a full list and overview of the viewpoints in terms of their type, spatial relationship to the site and designations/Landscape Character Areas (LCA), refer to the full LVIA. Viewpoint locations are shown on Figure 12.3 and baseline views for each of the viewpoints are included in Figure 12.4 in Appendix 1.1.

Current landscape character of the site

The 3km study area covered the following National and Local Landscape and Seascape Character Areas. For their characteristics and relevance to the site as well as relevant landscape designations, refer to the full LVIA.

National Character Areas (NCA) as defined by Natural England:

- NCA Area Number 41: Humber Estuary
- NCA Number 40: Holderness

Local Landscape Character Types / Areas (LCA) as defined by East Riding of Yorkshire Council:

- Landscape Character Type 21 / LCA 21B: Sunk Island
- Landscape Character Type 21 / LCA 21C: South Patrington, Ottringham and Keyingham Farmland
- Landscape Character Type 19 / LCA 19E: Burstwick to Withernsea Farmland

Seascape Character Areas (SCA) as defined by Natural England:
- SCA Area 6: Humber Waters

The current landscape character is defined by a largely reclaimed, bleak and empty landscape of large open arable fields bounded by ditches and drains. Trees and small blocks of woodland provide vertical features and historical assets, including the spire of St Patrick's Church in Patrington, provide vertical landmarks in the landscape.

Existing embankments which protect the land from flooding typically screen the estuary itself and the embankment and scattered trees form the southern horizon of the view from lower ground. There are long open views from the crest of embankments across saltmarsh, mudflats and the open water of the Humber where large ships can be seen moving in and out.

Haverfield Quarry in West 2, characterised by plantation woodland, ponds and relic sand dunes provides a contrast to surrounding arable farmland. West 1 and West 2 are separated by the deep channel of Winstead Drain.

12.5.2 Welwick to Skeffling Managed Realignment

The Welwick to Skeffling Managed Realignment is in an intensively farmed, predominantly arable agricultural area between Welwick and Skeffling. For ease the site has been divided into three sections:

- East 1 (land south of Welwick) located south of Sheep Trod Lane and west of Humber Side Road track;
- East 2 (land south of Weeton) located between Humber Side Road track and Weeton Beck (drain); and
- East 3 (land south west of Skeffling) located east of Weeton Beck (drain).

12.5.2.1 Landscape baseline

Representative viewpoints

A number of viewpoints were considered through a process of desk-based review and field studies. The final list of six representative viewpoints (eleven in total within the western and eastern site) were agreed with Stephen Robinson of East Riding of Yorkshire Council Trees and Landscape Unit (22 November 2017) as being appropriate to this assessment. A further viewpoint was added in the western site post consultation when the site proposals were extended further west at Sunk Island.

For a full list and overview of the viewpoints in terms of their type, spatial relationship to the site and designations/LCA, refer to the full LVIA. Viewpoint locations are shown on Figure 12.3 and baseline views for each of the viewpoints are included in Figure 12.4 in Appendix 1.1.

Current landscape character of the site

The 3km study area covered the following National and Local Landscape and Seascape Character Areas. For their characteristics and relevance to the site as well as relevant landscape designations, refer to the full LVIA.

National Character Areas (NCA) as defined by Natural England:

- NCA Area Number 41: Humber Estuary
- NCA Number 40: Holderness

Local Landscape Character Types / Areas (LCA) as defined by East Riding of Yorkshire Council:

- Landscape Character Type 21 / LCA 21B: Sunk Island
- Landscape Character Type 21 / LCA 21C: South Patrington, Ottringham and Keyingham Farmland
- Landscape Character Type 19 / LCA 19E: Burstwick to Withernsea Farmland

Seascape Character Areas (SCA) as defined by Natural England:

- SCA Area 6: Humber Waters

The current landscape character is defined by a low-lying drained arable farmland landscape which is slightly more elevated than the flat landscape of Sunk Island to the south west. In general, it has a remote and isolated character. The area is intensively farmed with large fields on the fringes of the Humber bounded by ditches and drains and partially delineated by fragmented hedgerows. Trees growing along the banks of drains provide vertical features and historical assets, including the spire of St Patrick's Church in Patrington and the tower of St Helen's Church in Skeffling, provide vertical landmarks in the landscape.

Existing embankments which protect the land from flooding typically screen the estuary itself and the embankment and scattered trees form the southern horizon of the view from lower ground. There are long open views from the crest of embankments across saltmarsh, mudflats and the open water of the Humber where large ships can be seen moving in and out.

12.6 Likely significant effects

12.6.1 Outstrays Managed Realignment

12.6.1.1 Visual effects

The detailed assessment for the five viewpoints agreed with East Riding of Yorkshire Council and for the additional viewpoint is located within Section 12.5.1 – Site Assessment of the Outstrays Managed Realignment LVIA in Appendix 12.1. The most notable effects have been summarised below.

Viewpoint 1 – East Bank Road, Sunk Island

Construction effects

Existing trees will filter views towards the proposed site, but construction vehicles and construction activity will be discernible for the closest receptors. This will cause a **moderate, adverse** visual effect for residential receptors in five properties; for more

distant residential receptors, and public footpath users / equestrians it will be **minor**, **adverse** but temporary due to the short-term nature of the work during the construction phase only.

Operational effects

Views to the site will be filtered through existing scattered vegetation which will be predominantly retained. Due to the distance and the perceived scale of the works the change will be barely discernible. The most notable change will be the loss of a small woodland block prominent in the landscape; loss of the feature will slightly increase the monotony and bleakness of the view. The changes will result in a **minor, adverse** effect for residential receptors in the five closest properties that will be permanent. For more distant residential receptors, and footpath users / equestrians it will be **negligible, adverse** as the change will be barely perceptible.

Viewpoint 2 – East Bank Road, Sunk Island

Construction effects

Existing trees will filter views towards the site but construction vehicles and construction activity will be discernible for the closest receptors. This will cause a **moderate, adverse** visual effect for residential receptors in six properties; for more distant residential receptors, and public footpath users / equestrians it will be **minor**, **adverse** but temporary due to the short-term nature of the work during the construction phase only.

Operational effects

Views to the site will be filtered through existing scattered or dense vegetation which will be predominantly retained. Due to the distance and the perceived scale of the works the change will be barely discernible. The most notable change will be the loss of a small woodland block prominent in the landscape; loss of the feature will slightly increase the monotony and bleakness of the view. The changes will result in a **minor, adverse** effect for residential receptors in the six closest properties that will be permanent. For more distant residential receptors, and footpath users / equestrians it will be **negligible, adverse** as the change will be barely perceptible.

Viewpoint 3 – Newlands Road

Construction effects

Existing trees will filter views through to the site but construction vehicles and the site compound will be partially visible. This will cause a **moderate, adverse** visual effect for residential receptors in the two closest properties and **minor**, **adverse** for more distant residential receptors and road users, but will be temporary due to the short-term nature of the work during the construction phase only.

Operational effects

The proposed new embankment would not be discernible, filtered through a dense shelter belt of trees. For residential receptors in two properties and road users with views of the habitat creation area, the Outstrays Managed Realignment would result in a noticeable improvement in the quality and character of the view resulting in a **minor, beneficial** effect that will be permanent. **Neutral** effect for other receptors.

Viewpoint 4 – Eastgrowths Farm / Patrington Bridleway No. 6 and No. 5, east of Patrington Haven

Construction effects

During the construction phase existing trees will filter views through to the site but construction vehicles and the site compound will be partially visible. This will cause a **moderate, adverse** visual effect for residents and bridleway users but will be temporary due to the short-term nature of the work during the construction phase only.

Operational effects

The proposed new embankment would be barely discernible, filtered by vegetation and receptors would have closer views of the habitat creation area. The Outstrays Managed Realignment would result in an obvious improvement in the quality and character of the view resulting in a **minor, beneficial** effect for pedestrians and equestrians that will be permanent. For residential receptors it will be **negligible**, **beneficial** and permanent.

Viewpoint 5 – Southside, Patrington

Construction effects

Construction vehicles will be barely discernible in distant views from this location. Visual effects for residents, staff and pupils at the primary school, and road users will be no more than **negligible, adverse** and temporary due to the short-term nature of the work during the construction phase only.

Operational effects

The proposed new embankment will be no more noticeable than the existing embankment in distant views. The only perceivable change to the view will be that once the existing embankment is taken down to ground level a wider and closer view of open water in the estuary will cause a positive feature to become more visible. This will result in a **negligible, beneficial** permanent effect for residents, staff and pupils at the primary school and road users.

Viewpoint 6 – Outstrays Pumping Station, track heading east from Outstray Road

Construction effects

Neutral, as the access track will be closed for the duration of the works.

Operational effects

For recreational receptors **moderate, adverse** effects as a result of the new higher embankment and loss of existing features and views will be balanced by **moderate, beneficial** effects due to creation of habitat with increased visual and wildlife interest. Overall, **neutral** permanent effect. Workers accessing the pumping station will have a slightly increased awareness of the raised embankments, the effect will be **negligible**, **adverse** and permanent.

12.6.1.2 Landscape effects

The detailed landscape assessment is located within Section 12.5.1 of the Outstrays Managed Realignment LVIA found within Appendix 12.1. The most notable effects have been summarised below.

The Outstrays Managed Realignment would result in a major alteration to the key valued elements, features and characteristics of the landscape baseline. The site at West 1 would change from arable fields with ditches and drains to a mosaic of intertidal

habitats. Existing features including trees, would be lost. The site would be located adjacent to but outside of the protected area of Sunk Island Conservation Area.

At West 2 habitat creation site the landscape would change from arable fields to a mosaic of wetland habitats, including channels, ponds, reedbed and scrub; and there would be enhancement and restoration of fixed dune grassland at Haverfield Quarry. Given the surrounding context the site would not appear out of place with the surroundings. Overall this is considered as a positive landscape impact introducing diversity in the area and improving its wildlife value.

It has been assessed that the effect on the landscape and seascape character would be overall **moderate/minor, beneficial** and permanent.

12.6.2 Welwick to Skeffling Managed Realignment

12.6.2.1 Visual effects

The detailed assessment for the six viewpoints agreed with East Riding of Yorkshire Council is located within Section 12.5.2 – Site Assessment of the Welwick to Skeffling Managed Realignment LVIA found within Appendix 12.1. The most notable effects have been summarised below.

Viewpoint 7 – Welwick Bank near Welwick Bushes

Construction effects

Lack of intermediate elements will allow views through to the site with construction vehicles and construction activity being visible and the public footpath will need to be closed. This will cause a **major, adverse** visual effect for recreational receptors walking on roads to the north; passengers and crew will be **moderate** and **minor, adverse** respectively but will be temporary due to the short-term nature of the work during the construction phase only.

Operational effects

For recreational receptors **moderate, adverse** effects as a result of the new higher embankment and loss of existing features and views will be balanced by **moderate, beneficial** effects due to creation of habitat with increased visual and wildlife interest. Overall, **neutral** permanent effect. Passengers and crew on ships in the channel will experience **neutral** permanent effects on transient distant views.

Viewpoint 8 – Row Lane, south of Welwick

Construction effects

Existing trees and hedges will only partially filter views towards the site and construction vehicles and construction activity will be noticeable for the closest receptors. This will cause a **moderate, adverse** visual effect for the closest residential receptors, and **minor**, **adverse** effect for road users but will be temporary due to the short-term nature of the work during the construction phase only.

Operational effects

Views to the site are partially open on the east side and here the closer embankment will be a detracting element, more apparent in the view than the existing embankment due to the lack of any significant vegetation screening. It will also be within the setting

of a historic asset (World War II battery) resulting in a **minor, adverse** effect on views for residents and a **negligible adverse** effect for road users that will be permanent.

Viewpoint 9 – Humber Side Road, south of Weeton

Construction effects

Lack of intermediate elements will allow views through to the site with construction vehicles and the site compound being visible, although partially screened by undulating topography. This will cause a **moderate, adverse** visual effect for residents but will be temporary due to the short-term nature of the work during the construction phase only.

Operational effects

Views to the site are open as intermediate hedges are low and fragmented although they will be partially screened by undulating topography at ground level and there are no receptors with direct views. Nevertheless, the closer embankment will be a detracting element, more apparent in the view than the existing embankment resulting in a **minor, adverse** effect that will be permanent.

Viewpoint 10 – B1445 Skeffling Road, east of Weeton

Construction effects

Lack of intermediate elements will allow views through to the site with construction vehicles and the site compound being visible, although partially screened by undulating topography. This will cause a **moderate, adverse** visual effect for residential receptors and **minor**, **adverse** for road users but will be temporary due to the short-term nature of the work during the construction phase only.

Operational effects

Views to the site are open as intermediate hedges are low and fragmented. They will be partially screened by undulating topography and the visible water channel will be narrower so that only a glimmer is visible at ground level. However, there will be a benefit as residents will see the new saltmarsh habitat nearer to them in first floor views. The closer embankment will be a detracting element, more apparent in the view than the existing embankment resulting in a **minor, adverse** permanent effect for road users. For residential receptors the minor, adverse effect will be balanced by a negligible, beneficial effect due to closer views of inundation sites with increased visual and wildlife interest, overall **negligible, adverse** permanent effects for residents.

Viewpoint 11 – Church Road, south of Skeffling

Construction effects

Views towards the site will be partially filtered by trees along the drains and partially screened by undulating topography. Nevertheless, construction vehicles and construction activity will be noticeable for the closest receptors and an existing public footpath will need to be diverted. This will cause a **major**, **adverse** visual effect for footpath users, for residents it will be **moderate, adverse** and for church users and visitors the effect will be **minor**, **adverse** but will be temporary due to the short-term nature of the work during the construction phase only.

Operational effects

Views to the site are filtered by scattered trees along the drains and partially screened by undulating topography at ground level. Nevertheless, the closer embankment will be

a detracting element, more apparent in the view than the existing embankment resulting in a **minor, adverse** effect for residential receptors and church users and visitors that will be permanent.

For recreational receptors the diverted footpath will provide closers estuarine views. Assessed as **minor**, **adverse** due to the closer, higher embankment which will be more apparent in the view, and **moderate**, **beneficial** due to the creation of habitat with increased visual and wildlife interest, and closer views of the estuary. Overall visual effect for footpath users is considered to be **minor, beneficial** and permanent.

Viewpoint 12 – Skeffling Footpath No. 4 (Coastal Path), South End Bank, Humber Lane

Construction effects

Lack of intermediate elements will allow views through to the site with construction vehicles and construction activity being visible and the public footpath will need to be diverted. This will cause a **major, adverse** visual effect for recreational receptors; passengers and crew will be **moderate** and **minor, adverse** respectively but will be temporary due to the short-term nature of the work during the construction phase only.

Operational effects

Views to the site are open due to lack of intermediate elements. The public right of way will need to be permanently diverted which will mean a longer walk for receptors and views of the estuary will be lost for half of its length due to wildlife sensitivity. For recreational receptors **moderate, adverse** effects as a result of the new higher embankment and loss of existing features and views will be balanced by **moderate, beneficial** effects due to creation of habitat with increased visual and wildlife interest. Overall, **neutral** permanent effect. Passengers and crew on ships in the channel will experience **neutral** permanent effects on transient distant views.

12.6.2.2 Landscape effects

The detailed landscape assessment is located within Section 12.5.2 of the Welwick to Skeffling Managed Realignment LVIA found in Appendix 12.1. The most notable effects have been summarised below.

The Welwick to Skeffling Managed Realignment would result in a major alteration to the key valued elements, features and characteristics of the landscape baseline. The site would change from arable fields with ditches and drains to a mosaic of intertidal habitats. Existing features including trees would be lost. The west side of East 1 would be a terrestrial habitat creation site, changing from arable fields to a mosaic of habitats, including scrub and ponds with a sand dune buffer adjacent to Haverfield Quarry. Given the surrounding context the site would not appear out of place with the surroundings. Overall this is considered as a positive landscape impact introducing diversity in the area and improving its wildlife value.

It has been assessed that the effect on the landscape and seascape character would be overall **minor, beneficial** and permanent.

The new embankment closer to St Helen's Church would be more apparent in the setting, however the church itself is surrounded by trees and hedges which will be retained so while the change would be perceivable it would remain broadly consistent with the baseline.

It has been assessed that the effect on the landscape character would be **negligible, adverse** on a localised area of LCA 19E due to the effect on the setting of St Helen's Church, and overall **minor, beneficial** and permanent on other character areas.

12.7 Mitigation

The following measures have been incorporated into the proposals:

12.7.1 Outstrays Managed Realignment

Landscape Treatment

In accordance with the GLVIA – 3rd Edition Section 4.21, mitigation measures can be considered in three categories;

1. **Primary measures**, developed through the iterative design process, which have become integrated or embedded into the project design;
2. **Standard construction** and operational management practices for avoiding and reducing environmental effects; and
3. **Secondary measures**, such as new planting, access and interpretation features implemented using standard construction practices have been incorporated into the Outstrays Managed Realignment.

The first category, primary measures, have been addressed and integrated within the design through the initial flood and buildability assessments and proposed alignments have been chosen to reduce environmental impacts. The embankments are designed with sinuous banks and shallow slopes to help integrate them into the landscape.

The secondary category of mitigation, standard construction and operational management practices, will depend on good construction practices to ensure that all environmental risks have been identified and that all protection measures are implemented so that no deliberate or inadvertent damage occurs during the construction period.

The third category, secondary mitigation measures, leads to improvements or enhancements:

- Improved public access and east-west connectivity with new viewing points;
- Habitat creation measures as described in Chapter 10;
- Native shrub planting around new viewing areas;
- Hedgerow planting and scattered native tree planting along the existing drain;
- Interpretation features setting out historic heritage assets and ecological assets, explaining the rationale behind the site.

12.7.2 Welwick to Skeffling Managed Realignment

The first category, primary measures, have been addressed and integrated within the design through the initial flood and buildability assessments and proposed alignments have been chosen to reduce environmental impacts. The embankments are designed with sinuous banks and shallow slopes to help integrate them into the landscape.

The secondary category of mitigation, standard construction and operational management practices, will depend on good construction practices to ensure that all environmental risks have been identified and that all protection measures are implemented so that no deliberate or inadvertent damage occurs during the construction period.

The third category, secondary mitigation measures, leads to improvements or enhancements:

- Upgraded public footpath / bridleway with new viewing points;
- Habitat creation measures as described in Chapter 10.
- Native shrub planting around new viewing areas;
- Hedgerow planting where possible along the boundary of the site and around the car park;
- Interpretation features setting out historic heritage assets and ecological assets, explaining the rationale behind the site.

12.8 Residual effects

12.8.1 Outstrays Managed Realignment

Mitigation has been integrated into the design with specific secondary measures to be included in the environmental masterplan which will form the outline design for the design and build phase of the Scheme. The operational (year 15) effects summarised below include consideration of all mitigation categories outlined in the assessment and assumed implementation.

Visual effects

Of the six viewpoints, the assessment finds that the Outstrays Managed Realignment would result in a **minor, adverse** visual effect for viewpoints 1 and 2 through its operation phase and a negligible, adverse effect for one group of receptors at viewpoint 6.

At two of the viewpoints (3 and 4), the assessment finds that the Outstrays Managed Realignment would result in a **minor, beneficial** effect through its operation phase and at Viewpoint 5 it would be **negligible, beneficial**.

Landscape Effects

The landscape assessment finds that the effect on landscape character would be **moderate, beneficial** in LCA 21C; **negligible**, **beneficial** in LCA 19E; and overall **minor, beneficial** and permanent in the other host character areas.

There would not be any significant effects on the landscape character of the wider National or Local Character Areas.

12.8.2 Welwick to Skeffling Managed Realignment

Mitigation has been integrated into the design with specific secondary measures to be included in the environmental masterplan which will form the outline design for the design and build phase of the Scheme. The operational (year 15) effects summarised

below include consideration of all mitigation categories outlined in the assessment and assumed implementation.

Visual effects

Of the six viewpoints, the assessment finds that the Welwick to Skeffling Managed Realignment would result in a **minor, adverse** visual effect for viewpoints 8, 9, 10 and 11 through its operation phase.

At two viewpoints, 7 and 12, the assessment finds that the Welwick to Skeffling Managed Realignment would result in an overall **neutral** effect through its operation phase.

Landscape Effects

The landscape assessment finds that the effect on landscape character would be **negligible, adverse** and permanent on a localised area of LCA 19E.

The effect on landscape character would be **negligible**, **beneficial** in LCA 21B; and **minor, beneficial** and permanent in the other host character areas.

There would not be any significant effects on the landscape character of the wider National or Local Character Areas.

13 Historic environment

13.1 Introduction

This chapter examines the potential effects of the Scheme on cultural heritage assets. A heritage asset is defined by the NPPF as “a building, monument, site, place or landscape identified as having a degree of significance meriting consideration in planning decisions, because of its heritage interest”.

Heritage assets include designated assets (World Heritage Sites, Scheduled Monuments, Listed Buildings, Conservation Areas, Registered Parks and Gardens, Registered Battlefields and Registered Historic Wrecks) and non-designated assets identified by the Local Planning Authority (for example: locally listed buildings, archaeological sites and monuments and historic landscapes).

Both designated and non-designated cultural heritage assets have been examined as part of this assessment. Collectively, these assets are also identified as the historic environment.

13.2 Legislation and policy

13.2.1 Ancient Monuments and Archaeological Areas Act 1979

This Act (amended by the National Heritage Acts of 1983 and 2002) provides for the protection of Scheduled Monuments and Archaeological Areas but does not afford any protection to their settings.

13.2.2 Planning (Listed Buildings and Conservation Areas) Act 1990

The Town and Country Planning Act (1971) as amended by the Planning (Listed Buildings and Conservation Areas) Act 1990 details the statutory protection afforded Listed Buildings. The relevant legislation in this case extends from Section 66 (1) of the 1990 Act, which states that, in considering planning applications, the Local Planning Authority (LPA) shall have special regard to the desirability of preserving the Listed Building or its setting, or any features of special architectural or historic interest that it possesses.

In addition, Section 72 of the 1990 Act states that in exercising all planning functions, LPAs must have special regard to the desirability of preserving or enhancing Conservation Areas.

13.2.3 National Planning Policy Framework

Section 16 of the NPPF contains paragraphs which relate to development proposals that have an effect upon cultural heritage assets. Such policies provide the framework

that LPAs need to refer to when setting out a strategy for the conservation and enjoyment of the historic environment in their Local Plans.

When determining planning applications, the NPPF directs LPAs to apply the presumption in favour of sustainable development. Where a development plan is absent, silent or out-of-date, permission should be granted except where adverse impacts would significantly and demonstrably outweigh those benefits, when assessed against NPPF policies as a whole; or where specific policies contained within the NPPF (including those with regard to designated heritage assets) indicate that development should be restricted to some degree.

13.2.4 Local Policy

Current local policy is provided by the East Riding Local Plan 2012-2029 and is contained within Appendix 1.1.

13.3 Methodology

13.3.1 General

Cultural heritage has been considered under the following three sub-topics:

- Archaeological Remains;
- Historic Buildings; and
- Historic Landscape.

The assessment methodology follows the guidelines set out in Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, Part 2, HA 208/07 including Annexes 5 (Archaeological Remains), 6 (Historic Buildings) and 7 (Historic Landscape) professional judgement and criteria set out in Chapter 4: Methodology.

This chapter is informed by a Cultural Heritage Desk-Based Assessment (DBA) undertaken for an earlier version of the Scheme (Appendix 13.2) and a project design for the Scheme (Appendix 13.3). The Scheme footprint, and therefore the study area, has changed from the scheme used within Appendices 13.2 and 13.3. The report was compiled in accordance with the standard set out by the Chartered Institute for Archaeologists (CIfA) for Historic Environment Desk-Based Assessments (2017) and the Environment Agency's minimum technical requirements (2015). Geophysical surveys were undertaken for the Scheme (Appendices 13.4-13.6) and a geoarchaeological assessment and archaeological trial trenching was undertaken for the Scheme (Appendix 13.7). An archaeological strategy was designed for the Scheme in order to outline further evaluation required, mitigation requirements and the research objectives behind the archaeological works on the Scheme (Appendix 13.8).

13.3.2 Study area

The study area has been defined as the redline boundary of the Scheme plus a 200m radius surrounding area. The study area for this assessment is considered appropriate in regard to Archaeological Remains, Historic Buildings and the Historic Landscape

due to the nature of the proposed works and anticipated sensitivity of the receiving environment. Prior to the Environment Statement being produced, a gap analysis was undertaken of the previous studies in order to ensure a comprehensive baseline source collection was contained within an appropriate study area.

Cultural heritage assets contained within the visual envelope outlined in Chapter 12: Landscape and Visual Amenity were assessed for impacts on their setting.

13.3.3 Consultation

Extensive consultation has been undertaken with the Principal Archaeologist for the Humber Archaeology Partnership and Historic England by the Environment Agency, Jacobs and York Archaeological Trust (YAT). This has included a series of workshops in which completed and proposed archaeological investigations were discussed and agreed. Research priorities were also agreed, which form part of the Archaeological Strategy (Appendix 7.8) in addition to public outreach options. The strategy for further archaeological investigation and survey was agreed to by the Principal Archaeologist for the Humber Archaeology Partnership and Historic England prior to the Environmental Statement being produced. Some of the work outlined in the strategy has started and will be ongoing.

13.3.4 Baseline data collection

The data used to determine the baseline conditions for this assessment were accessed from the following sources:

- National Heritage List for England (NHLE) for information on designated cultural heritage assets;
- Humber Historic Environment Record (HER) for information on non-designated assets including archaeological sites and monuments, previous archaeological events, and historic landscape characterisation data;
- East Riding of Yorkshire Council for information on locally listed buildings and Conservation Areas;
- Ground Investigation (GI) reports for the Scheme and geological information held by the British Geological Survey (BGS);
- Historic maps (contained within Appendices 13.2 and 13.3) and pertinent historical material available online;
- The results of previous archaeological investigations within, and in close proximity to, the Scheme; and
- A site inspection was undertaken in August 2018;

Plots of designated and non-designated assets are shown on Figures 13.1-13.3, Appendix 1.1.

Each asset discussed below is identified by a unique asset number that can be cross-referenced to the gazetteer provided at Appendix 13.1.

13.3.5 Assessment of value (sensitivity)

DMRB HA208/07 provides a methodology for the assessment of the value of cultural heritage assets and use of this methodology in this assessment aligns with the guidance provided by the NPPF. Conservation Principles (English Heritage, 2008) were taken into consideration within the assessment of the value of cultural heritage assets.

The assessment was undertaken on a five-point scale of Very High, High, Medium, Low and Negligible. DMRB provides a robust methodology for the assessment of value of heritage assets and is widely accepted by the main heritage bodies. Table 13.1 is consulted throughout to provide the appropriate value for each heritage asset identified below.

Table 13.1: Assessing the value of cultural heritage assets

Value	Criteria
Very High	World Heritage Sites (including buildings and those inscribed for their historic landscape qualities) Assets of acknowledged international importance Assets that can contribute significantly to acknowledged international research objectives Extremely well-preserved historic landscapes with exceptional coherence, time-depth or other critical factors
High	Scheduled Monuments (including standing remains) Designated historic landscapes of outstanding interest Undesignated assets of schedulable quality and importance Assets that can contribute significantly to national research objectives Grade I and II* Listed Buildings Other Listed Buildings that can be shown to have exceptional qualities in their fabric or historical associations Conservation Areas containing very important buildings Undesignated structures of clear national importance Undesignated landscapes of outstanding interest, high quality or importance and of demonstrable national value Well-preserved historic landscapes, exhibiting considerable coherence, time-depth or other critical factors
Medium	Designated or undesignated assets that contribute to regional research objectives Undesignated historic landscapes that would justify special historic landscape designations, or landscapes of regional value Averagely well-preserved historic landscapes with reasonable coherence, time-depth or other critical factor Grade II Listed Buildings

Value	Criteria
	Conservation Areas containing buildings that contribute significantly to its historic character Historic Townscape or built-up areas with important historic integrity in their buildings, settings or built settings
Low	Designated and undesignated assets of local importance Robust undesignated historic landscapes and historic landscapes with importance to local interest groups Historic landscapes whose value is limited by poor preservation and / or poor survival of contextual associations Assets compromised by poor preservation and/or poor survival of contextual associations Assets of limited value, but with potential to contribute to local research objectives 'Locally Listed' buildings Historic (unlisted) buildings of modest quality in their fabric or historical association Historic Townscape or built-up areas of limited historic integrity in their buildings, or built settings
Negligible	Assets with very little or no surviving archaeological interest Buildings of no archaeological or historical note, or buildings of an intrusive character Landscapes with little or no significant historical interest
Unknown	The importance of the resource has not been ascertained, or buildings with some (hidden) potential for historical significance

13.3.6 Magnitude of Impact

Magnitude of impact is the degree of change that would be experienced by an asset as a result of the Scheme, as compared with a 'do nothing' situation. Magnitude of impact is assessed without reference to the value of the receptor, and may include physical impacts upon the asset, or impacts upon its setting or amenity value. Assessment of magnitude with and without mitigation is based on professional judgement informed by DMRB methodology and criteria for Archaeological Remains, Historic Buildings and the Historic Landscape, as set out in Table 13.2.

Table 13.2: Assessing the Magnitude of Impact

Magnitude	Factors in the Assessment of Magnitude of Impact
Major	Change to most or all key archaeological materials, such that the resource is totally altered. Change to key historic building elements, such that the resource is totally altered. Change to most or all key historic landscape elements, parcels or components; extreme visual effects; gross change of noise or

Magnitude	Factors in the Assessment of Magnitude of Impact
	change to sound quality; fundamental changes to use or access; resulting in total change to historic landscape character unit. Comprehensive changes to setting
Moderate	Changes to many key archaeological materials, such that the resource is clearly modified. Change to many key historic building elements, such that the resource is significantly modified. Changes to the setting of a cultural heritage asset, such that it is significantly modified. Changes to many key historic landscape elements, parcels or components, visual change to many key aspects of the historic landscape, noticeable differences in noise or sound quality, considerable changes to use or access; resulting in moderate changes to historic landscape character.
Minor	Changes to key archaeological materials, such that the asset is slightly altered. Change to key historic building elements, such that the asset is slightly different. Change to setting of a cultural heritage asset, such that it is noticeably changed. Changes to few key historic landscape elements, parcels or components, slight visual changes to few key aspects of historic landscape, limited changes to noise levels or sound quality; slight changes to use or access: resulting in limited changes to historic landscape character.
Negligible	Very minor changes to archaeological materials, or setting. Slight changes to historic buildings elements or setting that hardly affect it. Very minor changes to key historic landscape elements, parcels or components, virtually unchanged visual effects, very slight changes in noise levels or sound quality; very slight changes to use or access; resulting in a very small change to historic landscape character.
No Change	No change to fabric, setting. No change to elements, parcels or components; no visual or audible changes; no changes arising from in amenity or community factors.

13.3.7 Significance of Effect

The significance of effect is determined through the combination of the value (sensitivity) of the asset and the magnitude of impact as set out in Table 4.4 in Chapter

4: Methodology. In Table 13.3 below, five levels of significance of effect are defined which apply equally to adverse and beneficial impacts.

Table 13.3: Significance of effect

Value/Sensitivity					
Magnitude	Very High	High	Medium	Low	Negligible
Major	Major	Moderate-Major	Moderate	Minor - Moderate	No effect
Moderate	Moderate - Major	Moderate	Minor - Moderate	Minor	No effect
Minor	Minor - Moderate	Minor - Moderate	Minor	Minor	No effect
Negligible	No effect	No effect	No effect	No effect	No effect

13.3.8 Guidance

The assessment of setting impacts was undertaken in general accordance with the following guidance:

- Conservation Principles (English Heritage 2008); and
- Good Practice Advice Note 3: The Setting of Heritage Assets (Historic England 2017).

13.4 Uncertainties, assumptions and limitations

Some areas requiring geophysical survey were inaccessible during the surveys and therefore the potential for archaeological remains within the areas not surveyed is uncertain.

Archaeological evaluation by trial trenching was undertaken in a limited scope, generally only targeting potential archaeological sites identified by the geophysical survey.

13.5 Existing environment

13.5.1 Outstrays Managed Realignment

13.5.1.1 Archaeological Remains

There are 20 archaeological remains within the 200m study area surrounding the footprint of the Scheme recorded in the HER. There are no designated archaeological remains within the study area. These are shown on Figure 13.1 and detailed within Appendix 13.1: Gazetteer.

Prehistoric period (circa 750,000 BP – 43AD)

Palaeoenvironmental studies suggested a Mesolithic wooded landscape across higher, dryer parts of the site, whilst in the lowlands, the landscape was open grasslands and freshwater wetlands, with the gravel beach along the Partington Chanel all of which would have been attractive to Mesolithic communities.

During the Neolithic and Bronze Age the lower ground in the study are is marked by flooding depositing both estuarine and freshwater alluvium.

There are no features of prehistoric date known within the study area. Archaeological trial trenching recovered residual fragments of worked flint which were predominantly recovered from the plough soils or other modern features with no features of prehistoric date identified (Asset 11) (Appendix 13.7). This asset has been assessed to be of negligible value as they are mainly residual finds.

Romano-British period (43 AD – 410 AD)

The Humber Wetlands Project did not identify Roman activity within 15 miles of Skeffling, but as more developer-led archaeology has taken place in Eastern Holderness, linked with pipelines and other linear developments, the area's potential for significant Roman settlement has been realised.

The rise in sea-levels after c.1000 BC noted above continued into the Roman period, where greater deposition of mineral-rich alluvium permitted more intensive agricultural use of the former wetland carrs (Van de Noort, 2004). There is a marked increase in small farmstead sites in the Lower Hull valley and development of 'ladder-type' settlements at Sutton upon Derwent (Van de Noort, 2004) and Hessle (York Archaeological Trust, 2014). Metal working, pottery production and salt making are all noted in greater concentration, along with continued livestock farming; all of these activities seem to serve the larger Roman settlements to the north-west, such as York, and to the south-west, including Doncaster and Lincoln. To the east, into the Skeffling area, relatively little activity is known.

There is evidence of Roman activity near to the Skeffling site; a large Roman brooch was found in the 19th century in the area of Burstall Garth. Further afield numerous other Roman sites have been identified with Humber estuary acting as a major Roman port and the wetlands around it were extensively settled (RCZA p125). Since the 18th century, a Roman road linking Brough with Spurn Point and running to the north of the site, has been suggested. In the wider region, Roman period settlements such as Brough and Winteringham, 42km west of Skeffling, occupied similarly low-lying positions by the Humber and were clearly associated with the control of trade, river transport and crossing.

There is one asset from the Romano-British period recorded in the HER within the study area in the HER - a brooch found on Burstall Garth (asset 20). This asset has been assessed to be of negligible value as it has been removed from its location.

Archaeological trial trenching identified three enclosures dating from the Romano-British period (Assets 33-35; Appendix 13.7) within the eastern site but none were identified within the western site. Asset 34 measured c.40m by c.50m and asset 35 measured c.65 in diameter. A fourth enclosure of likely Romano-British date was identified by geophysical survey (Asset 32; Appendix 13.6).

Early Medieval and Medieval period (410 AD – circa 1540 AD)

A further rise in sea-levels in the later Roman period may have resulted in widespread flooding and the 'abandonment' of large areas of the Humber wetlands into the early

medieval period (Van de Noort, 2004). The impact of this on the Skeffling area is unknown and of key importance to the study of this area. The nearest archaeological evidence is known from Halsham, 7 miles north-west of Skeffling, where settlement may have been located on higher ground. Otherwise, the major early medieval settlements are mostly to the west, and include Barton-on-Humber, South Ferriby and Flixborough, which seem to reflect a 'recolonisation' starting on 'islands' or ridges of higher ground (Van de Noort, 2004).

North of the study area are the surviving medieval villages of Skeffling and Welwick and the Hamlet of Weeton. All these villages may have Anglo-Saxon origins but are not referred to in Domesday (HAP, 2011).

South of the site, beyond the bank beneath the saltmarsh and mudflats are possibly up to 6 lost medieval settlements: Orwithfleet, Pensthorpe, Burstall Priory, Tharlesthorpe, Friskmersk and East Somerte. These settlements suffered increasing encroachment from the estuary and most were lost by the mid 14th century; the remains of Burstall were largely lost to the Humber in the 18th century although some ruins remained up until the well-documented floods of 1900 (HAP, 2011). There are traces of ridge and furrow cultivation across the site which have been picked up in geophysical survey and are also evident from aerial photography.

There are six assets from the medieval period recorded in the HER within the study area.

Of these, five are the sites of towns or villages recorded via aerial photography and documentary sources. These settlements consist of East Somerle (asset 1), Frismersh Village (asset 6), Penisthorpe (asset 7), Winestead Fleet (asset 9) and Wheeton (asset 17). Winestead Fleet (asset 9) and Wheeton (asset 17) continued into the post-medieval period) but would not have had modern development within them. These assets have been assessed to be of medium value due to their potential contribution to the knowledge of medieval settlement in the area if remains survive.

An area of medieval and post-medieval ridge and furrow (asset 11) was identified as cropmarks but is no longer visible and likely to have been ploughed out. This asset has been assessed to be of low value as much of the remains have likely been denuded but some evidence for the ridge was furrow was identified within geophysical survey and archaeological trial trenching.

Archaeological trial trenching undertaken for the Scheme (Appendix 13.7) identified medieval ridge and furrow within the Scheme (asset 11).

The geoarchaeological assessment (Appendix 13.7) included a borehole within the existing flood bank (asset 3). A single radiocarbon date of the 6th century was recovered from borehole sediments beneath the flood bank but there is no currently no further evidence for a 6th century anthropogenic landscape. A 12th century date was retrieved from the sediments of the current earthwork, suggesting that the existing flood bank may contain elements of an earlier flood defence or could have been constructed with redeposited material of medieval date.

Post-medieval period (circa 1540 AD – 1900 AD)

The medieval ridge and furrow cultivation is likely to have continued into this period, until the area was enclosed. The current dykes, lanes and field boundaries are visible on the historic mapping of the study area as early as the 18th century; the most accurate early representation is that of the mid-19th century.

The drainage and reclamation of the former wetlands for agricultural use is well attested (Van de Noort, 2004). The 2016 site investigations identified extensive warp deposits along the eastern margin of Sunk Island that relate to documented campaigns of land reclamation from the mid-19th century onwards. The extant flood defence bank and sluices contain post-medieval - early modern elements and may seal earlier flood defences and land surfaces beneath them. Any significant historic breaches would have compromised the integrity of previous land surfaces.

There are eight assets dating from the post-medieval period recorded in the HER within the study area. Three of these have been identified on historic maps, consisting of the site of South End House (asset 12), the site of Weeton Manor House (asset 16) Weeton Beck Bridge (asset 18). Archaeological trial trenching (Appendix 13.7) identified a cobble spread or surface and pits which may have been remains of South End House and its outbuildings. These assets have been assessed to be of negligible value.

The existing flood bank at Skeffling (asset 3) was constructed in the 17th century. However, it may have replaced or built upon an earlier medieval flood defence as a flood defence is recorded in the area in AD1350. It includes the Weeton Clough Drainage Sluice (asset 4). These assets have been assessed to be of low value due to their limited contribution to our knowledge of medieval flood defences and the evolution of the flood defence bank.

Weeton beck or fleet (asset 5); and Welwick drain (asset 13) were constructed in the 17th century and may represent some of the initial earthworks erected to reclaim land on the Humber in this period. These assets have been consistently maintained and repaired since the 17th century. These assets have been assessed to be of low value due to their limited contribution to our knowledge of post-medieval land reclamation within the area.

The remaining asset dating from the post-medieval period is Sheep Trod Lane (asset 14) which led to a location known as the Sheep Trod. This asset has been assessed to be of negligible value.

Modern (1900AD- present)

Modern additions and changes to the landscape can be seen in mapping, particularly in the form of Second World War defences and associated structures. Changes to field boundaries, dykes and flood defences can all be followed with the Ordnance Survey map sequence along with the current configuration of farm buildings and access lanes.

There are two modern assets known within the study area.

The possible site of a 20th century shipwreck (asset 19) was identified. Due to the lack of certainty as to the assets survival, this asset has been assessed to be of negligible value.

An Anti-Aircraft Battery, south of Humber Farm (asset 10) is recorded within the HER. The 3.7" anti-aircraft battery consisted of four emplacements and an associated structure, with other buildings grouped around the battery. The site was visited in 1992 by the Fortress Studies Group; they found some remains of the emplacement itself, evidence of the magazine and the base of a Nissen hut to the north of the site. The Nissen hut and the remains of several concrete block buildings in poor and overgrown condition, along with brick and concrete rubble representing recent demolition, were present on the site in 2009. This asset has been assessed to be of low value due to its ability to contribute to our knowledge of WWII military defence within the area.

Undated

There are three undated assets recorded in the HER within the study area. These include a circular cropmark identified from aerial photographs, possibly representing bomb craters (asset 2); and cropmarks of an enclosure and linear ditch of uncertain date (asset 15). These assets have been assessed to be of negligible value due to their uncertain archaeological potential. The third undated asset consists of a circular enclosure which was identified from a cropmark (asset 8). It is not visible on current mapping. This asset has been assessed to be of low value due to its uncertain date and function.

Archaeological Investigations

Prior to the laying out of the connecting pipeline to the Humber Gateway Offshore Windfarm, excavations were undertaken within 200m of the proposed scheme footprint (asset 31). The excavations uncovered evidence of Iron Age settlement in the form of six postholes, two ditches, four ring gullies and a pit. Medieval settlement was also uncovered, including four enclosures, and multiple ditches, gullies and features.

During 2016-2017, a programme of archaeological and geotechnical assessment and evaluation was conducted on the Scheme. The methods of evaluation included geophysical survey (Appendices 13.4 – 13.6), geoarchaeological window sampling and archaeological trial trenching (Appendix 13.7).

The first phase of geophysical survey was undertaken during November 2015 to January 2016 on available land throughout the eastern site (Appendix 13.4). This survey identified four possible enclosures and a group of ditch-like anomalies. Anomalies of agricultural origin and old watercourses were identified. A number of anomalies of uncertain origin were identified by the survey. The second phase of geophysical survey was undertaken in August 2016 and surveyed areas of land in West 1, East 1 and East 3 (Appendix 13.5). Although anomalies of likely agricultural origin, such as ploughing and drainage were identified, no anomalies of potential archaeological origin were identified. A geophysical survey was undertaken in October 2016 (Appendix 13.6) on an area of land in East 1. The survey identified a settlement site, comprised of enclosures, roadways and pit-like features (asset 32).

Archaeological trial trenching was undertaken across the Scheme in 2016 (Appendix 13.7). Only one trench was excavated within the western site as test pitting had indicated extensive modern warp deposits were present across the area to a greater depth than could be reached by trenching.

A geoarchaeological assessment across the Scheme was undertaken in 2016 (Appendix 13.7). The results are summarized below.

Geoarchaeological Assessment

Environmental evidence collected from organic sediments dated to the Mesolithic suggest a wooded landscape across higher, dryer parts of the site, whilst in the lowlands, the landscape was open grasslands and freshwater wetlands which would have been attractive to Mesolithic communities. Boreholes within the Patrington Channel in West 2 revealed gravel deposits that were interpreted as a remnant beach with radiocarbon dating also suggesting a Mesolithic date.

Both estuarine and freshwater alluvium overlying the Mesolithic sediments were dated to the Neolithic and Bronze Age through radiocarbon dating and it is known that such environments were intensely used by humans during later prehistory, and therefore the

potential for buried archaeology survival from later prehistory was considered high. In particular, the model highlighted possible palaeochannels within the central Scheme area possibly part of a network which operated from late Pleistocene/early Holocene. During times of freshwater dominance, peats would have formed and therefore relict later prehistoric landscapes may be preserved.

Alluvium intentionally deposited to reclaim low-lying areas and create productive farmland (Warp) in the post-medieval period is also a feature of this landscape.

From west to east, the geoarchaeological investigation identified c.10m of superficial sequences with a mixture of warp, estuarine and freshwater alluvium, peats, sands and gravels and glacial tills in which early land surfaces were found.

In the western site, on the Sunk Island shoreline, interbedded Mesolithic and Neolithic estuarine and freshwater alluvium, coarse sands and freshwater peat horizons were observed. These deposits were spatially extensive and of low archaeological significance and quality, reflecting the significant mixing and reworking of these sediments as suggested by both paleoenvironmental analysis and radiocarbon dating. This reworking of sediments may be associated with a number of storm events as well as tidal processes recognised in this area from the sedimentary record.

North of Sunk Island, in the former Patrington Channel, borehole survey identified a mix of warp deposits and alluvium. Beneath that, coarse gravel deposits and cobbles suggest a beach environment with a single radiocarbon sample dated to the Mesolithic.

East of the Patrington Channel and south of the village of Welwick, the survey identified warp overlain by estuarine alluvium. Palaeoenvironmental preservation was poor with a mixing of sequences. Buried land surfaces were found beneath the modern embankment.

In the eastern site, south of the village of Weeton, the geoarchaeological investigation encountered predominantly freshwater and estuarine alluvium. Peat deposits were found at c.6-7m BGL which were overlain by Neolithic / Bronze Age alluvium indicative of rising sea levels. A Mesolithic radiocarbon date was recorded from below these deposits. At the eastern end, sediments within a surface depression, which corresponds to the modern Weeton Beck provided Bronze Age dates and may indicate a buried palaeochannel with the potential for well-preserved organic remains.

Potential for Previously Unknown Archaeological Remains

There is low potential for previously unknown archaeological remains within the depth of impact on the western site due to the thick warp deposits on the reclaimed land. Any buried archaeological remains would be at a greater depth than the Scheme will impact on.

13.5.1.2 Historic Buildings

There are seven designated assets located within the ZVI, and an additional Grade I Listed Building located on its periphery with extensive views of the surrounding landscape, which has also been included due to its prominence in the landscape (the Church of Saint. Peter in Patrington). These are shown on Figure 13.2 and detailed within Appendix 13.1: Gazetteer.

Grade I Listed Buildings

There are two Grade I Listed Buildings; the Church of St Helen in the ZVI, and the Church of St Peter on its periphery. Both of these buildings are of high value.

The Church of St Helen (asset 23) is a Parish Church located within Welwick and was initially constructed in the 1460's in the Perpendicular Gothic style, with later additions including a 19th century porch and roof. The Church was restored several times in the 20th century, with the latest made in 1984-5. The chancel of the Church contains several monuments dating to the late 15th century onward, including a 15th century grave slab, and a pair of 18th century floor slabs to Holme family. The font is also of 15th century date.

The Church of St Pater (asset 30) is a Parish church located in the heart of Patrington. It was built in the first half of the 14th century and reused 12th-13th century masonry in its construction. The spire and east window are later 14th century or 15th century additions. It was restored in 1866 and 1885. The Church is located outside the ZVI; it discussed here due to its prominence in the local landscape (it is located 9m above sea-level; the rest of Patrington is 6m above sea-level), with its spire being a landmark and an important part of the skyline in Holderness.

Grade II Listed Buildings

There are six Grade II Listed Buildings within the ZVI, all of which are of medium value.

One of these assets is associated with the Church of St Helen, the standing cross in its churchyard (asset 22). The cross is thought to date to the 14th-15th century, and a sundial was added to it in the 18th century. It may be the original churchyard cross, but could also have been a wayside cross moved to its current location in the 18th century.

There are three farmhouses located within the Sunk Island Conservation Area within the ZVI. These assets represent the reclamation of this area from wetland in the 17th century and its development into a structured agricultural landscape, by the Crown Estate. All three of the farmhouses East Bank Farmhouse (asset 21), 4-5 Bleak House Farm Cottages (asset 25), and Channel Farmhouse (asset 24) were built in 1855-7 as part of a major building programme undertaken by the Crown; and were designed by S.S. Teulon for the Crown Commissioner, in his typical Gothic Style constructed using pattern brickwork.

There is an earlier farmhouse in the ZVI north of Welwick, Haverfield House (asset 26). This asset was built in 1779 and has undergone later minor alterations.

There is one windmill building, Patrington Mill (asset 27), which was built in the late 18th-early 19th centuries. The windmill ceased production in the 1940's, but is still in use for small scale flour grinding.

Conservation Areas

There are two Conservation Areas in the ZVI, both of which are of medium value.

The Sunk Island Conservation Area (asset 28) covers the area of structured agricultural landscape created by the reclamation of land between the 17th century and 19th century under the Crown Estate, which expanded the area linked the original island to the bank of the Humber. The layout of the farmland is more typical of that seen in the Netherlands, and is unique in the East Riding of Yorkshire. The historic buildings in the area are relatively isolated with farmsteads and associated farmhouses and cottages spread throughout the landscape. The earlier properties are at the west end of the island and date from the 17th century onward, with a marked increase in buildings in the mid-19th century due to a building programme undertaken by the Crown.

Patrington Conservation Area (asset 29) covers the town of the same name, which lies three miles from both the sea to the north east and the Humber, to the south. The character of the area lies in its historic role as a small market town, and in its historic core. The town lies in a prominent position at the junction of the road which runs south east to Easington and the Spurn peninsula, facilitating trade and the resulting wealth allowed the townspeople to construct buildings of somewhat greater scale than those encountered in other villages in Holderness. The Church of St Peter is preeminent in the Conservation Areas, with views from and to the Church informing much of the towns aesthetic and historic character. The Westgate and Market Place are also key to the character of the town.

13.5.1.3 Historic Landscape Character

There are four historic landscapes identified within the Scheme. These consist of Coastal (HLT1), Fields and Enclosures (HLT2), Settlement (HLT3) and Unenclosed Land (HLT4). These assets have been assessed to be of low value. These are shown on Figure 13.3 and detailed within Appendix 13.1: Gazetteer.

The general landscape of the Scheme is flat, low-lying, reclaimed arable fields, heavily farmed with drains separating the fields with some scrub along the banks of the drains. There is a pronounced lack of vertical elements. The landscape does contain occasional trees, but the trees are sparse. The spire of the St. Patricks Church in Patrington is a distinctive marker within the landscape, likely to have been used as a navigation marker by ships in the Humber.

Beyond the existing embankment lies the salt marsh, mudflats and open water of the Humber Estuary. Although the existing embankment screens some views of the Estuary, the visual relationship between the land and the Estuary is an important inter-relationship. The wider landscape is mainly arable farmland with occasional farmsteads and farm tracks, such as Sheep Trod Lane with a feeling of an isolated, bleak, rural farming landscape with a low population. There are villages dotted throughout the wider landscape, including Welwick, Skeffling, Easington, Patrington and Patrington Haven. The landscape of Sunk Island is particularly flat, resulting from its formation as reclaimed land, having been reclaimed since the 17th century onwards, between the sand bar and the Estuary and was developed by the Crown as a series of large farms. Haverfield Quarry is a distinct area within the landscape, its plantation woodland, scrub and relict sand dunes contrast with the surrounding bleak arable landscape. Detailed landscape information is contained within Chapter 12: Landscape and Visual.

13.5.2 Welwick to Skeffling Managed Realignment

13.5.2.1 Archaeological Remains

There are 20 archaeological remains within the 200m study area surrounding the footprint of the Scheme recorded in the HER. There are no designated archaeological remains within the study area. These are shown on Figure 13.1 and detailed within Appendix 13.1: Gazetteer.

Prehistoric period (circa 750,000 BP – 43AD)

There are no features of prehistoric date known within the study area. Archaeological trial trenching recovered residual fragments of worked flint which were predominantly recovered from the plough soils or other modern features with no features of prehistoric

date identified (Asset 11) (Appendix 13.7). This asset has been assessed to be of negligible value as they are mainly residual finds.

Romano-British period (43 AD – 410 AD)

The Humber Wetlands Project did not identify Roman activity within 15 miles of Skeffling, but as more developer-led archaeology has taken place in Eastern Holderness, linked with pipelines and other linear developments, the area's potential for significant Roman settlement has been realised.

The rise in sea-levels after c.1000 BC noted above continued into the Roman period, where greater deposition of mineral-rich alluvium permitted more intensive agricultural use of the former wetland carrs (Van de Noort, 2004). There is a marked increase in small farmstead sites in the Lower Hull valley and development of 'ladder-type' settlements at Sutton upon Derwent (Van de Noort, 2004) and Hessle (York Archaeological Trust, 2014). Metal working, pottery production and salt making are all noted in greater concentration, along with continued livestock farming; all of these activities seem to serve the larger Roman settlements to the north-west, such as York, and to the south-west, including Doncaster and Lincoln. To the east, into the Skeffling area, relatively little activity is known.

There is evidence of Roman activity near to the Skeffling site; a large Roman brooch was found in the 19th century in the area of Burstall Garth. Further afield numerous other Roman sites have been identified with Humber estuary acting as a major Roman port and the wetlands around it were extensively settled (RCZA p125). Since the 18th century, a Roman road linking Brough with Spurn Point and running to the north of the site, has been suggested. In the wider region, Roman period settlements such as Brough and Winteringham, 42km west of Skeffling, occupied similarly low-lying positions by the Humber and were clearly associated with the control of trade, river transport and crossing.

There is one asset from the Romano-British period recorded in the HER within the study area in the HER - a brooch found on Burstall Garth (asset 20). This asset has been assessed to be of negligible value as it has been removed from its location.

Archaeological trial trenching identified three enclosures dating from the Romano-British period (Assets 33-35; Appendix 13.7) within the eastern site but none were identified within the western site. Asset 34 measured c.40m by c.50m and asset 35 measured c.65 in diameter. A fourth enclosure of likely Romano-British date was identified by geophysical survey (Asset 32; Appendix 13.6).

A group of ditches, pits and a dump which may be an enclosure (asset 33) was identified in East 2 which corresponded to anomalies on the geophysical survey. Pottery was recovered from some of the features which is likely to be 2nd century AD in date.

A rectangular enclosure was identified by the trial trenching in East 2 (asset 34) of approximately 40m x 50m in size which corresponded to anomalies on the geophysical survey. An assemblage of pottery was recovered which is likely of early 2nd century AD in date. Early bread wheat appears to have been processed on site although snail shells found suggest that the immediate environs weren't suitable for arable farming, so the wheat is likely to have been imported from elsewhere.

A third enclosure from the Romano-British period was identified by the trial trenching at East 1 (asset 35) which corresponded to anomalies on the geophysical survey. A circular enclosure with a dimeter of c.65m was identified with early 2nd century AD

pottery recovered from it. A sub-rectangular enclosure, c.55m by c.40m, was also identified, which overlay the northern part of the circular enclosure from which pottery of mid-2nd century AD date was recovered. A single, disarticulated, human femur was present in the backfill of this rectangular enclosure.

An enclosure of potential Romano-British date (asset 32) was identified by geophysical survey (Appendix 13.4) in East 1 but was not investigated by archaeological trial trenching. It is an enclosure complex of enclosures, roadways and pit-like features.

A medieval ditch was identified within the site of a Romano-British enclosure (asset 34) in East 2 and may be part of a field system.

Early Medieval and Medieval period (410 AD – circa 1540 AD)

A further rise in sea-levels in the later Roman period may have resulted in widespread flooding and the 'abandonment' of large areas of the Humber wetlands into the early medieval period (Van de Noort, 2004). The impact of this on the Skeffling area is unknown and of key importance to the study of this area. The nearest archaeological evidence is known from Halsham, 7 miles north-west of Skeffling, where settlement may have been located on higher ground. Otherwise, the major early medieval settlements are mostly to the west, and include Barton-on-Humber, South Ferriby and Flixborough, which seem to reflect a 'recolonisation' starting on 'islands' or ridges of higher ground (Van de Noort, 2004).

North of the study area are the surviving medieval villages of Skeffling and Welwick and the Hamlet of Weeton. All these villages may have Anglo-Saxon origins but are not referred to in Domesday (HAP, 2011).

South of the site, beyond the bank beneath the saltmarsh and mudflats are possibly up to 6 lost medieval settlements: Orwithfleet, Pensthorpe, Burstall Priory, Tharlesthorpe, Friskmersk and East Somerte. These settlements suffered increasing encroachment from the estuary and most were lost by the mid 14th century; the remains of Burstall were largely lost to the Humber in the 18th century although some ruins remained up until the well-documented floods of 1900 (HAP, 2011). There are traces of ridge and furrow cultivation across the site which have been picked up in geophysical survey and are also evident from aerial photography.

There are six assets from the medieval period recorded in the HER within the study area.

Of these, five are the sites of towns or villages recorded via aerial photography and documentary sources. These settlements consist of East Somerle (asset 1), Frismersh Village (asset 6), Penisthorpe (asset 7), Winestead Fleet (asset 9) and Wheeton (asset 17). Winestead Fleet (asset 9) and Wheeton (asset 17) continued into the post-medieval period) but would not have had modern development within them. These assets have been assessed to be of medium value due to their potential contribution to the knowledge of medieval settlement in the area if remains survive.

An area of medieval and post-medieval ridge and furrow (asset 11) was identified as cropmarks but is no longer visible and likely to have been ploughed out. This asset has been assessed to be of low value as much of the remains have likely been denuded but some evidence for the ridge was furrow was identified within geophysical survey and archaeological trial trenching.

Archaeological trial trenching undertaken for the Scheme (Appendix 13.7) identified medieval ridge and furrow within the Scheme (asset 11).

The geoarchaeological assessment (Appendix 13.7) included a borehole within the existing flood bank (asset 3). A single radiocarbon date of the 6th century was recovered from borehole sediments beneath the flood bank but there is no currently no further evidence for a 6th century anthropogenic landscape. A 12th century date was retrieved from the sediments of the current earthwork, suggesting that the existing flood bank may contain elements of an earlier flood defence or could have been constructed with redeposited material of medieval date.

Post-medieval period (circa 1540 AD – 1900 AD)

The medieval ridge and furrow cultivation is likely to have continued into this period, until the area was enclosed. The current dykes, lanes and field boundaries are visible on the historic mapping of the study area as early as the 18th century; the most accurate early representation is that of the mid-19th century.

The drainage and reclamation of the former wetlands for agricultural use is well attested (Van de Noort, 2004). The 2016 site investigations identified extensive warp deposits along the eastern margin of Sunk Island that relate to documented campaigns of land reclamation from the mid-19th century onwards. The extant flood defence bank and sluices contain post-medieval - early modern elements and may seal earlier flood defences and land surfaces beneath them. Any significant historic breaches would have compromised the integrity of previous land surfaces.

There are eight assets dating from the post-medieval period recorded in the HER within the study area. Three of these have been identified on historic maps, consisting of Weeton Clough Drainage Sluice (asset 4), the site of South End House (asset 12), the site of Weeton Manor House (asset 16) and Weeton Beck Bridge (asset 18). Archaeological trial trenching (Appendix 13.7) identified a cobble spread or surface and pits which may have been remains of South End House and its outbuildings. These assets have been assessed to be of negligible value.

The existing flood bank at Skeffling (asset 3) was constructed in the 17th century. However, it may have replaced or built upon an earlier medieval flood defence as a flood defence is recorded in historical recorded in AD1350. It includes the Weeton Clough drainage sluice (asset 4). These assets has been assessed to be of low value due to its ability to contribute to our knowledge of medieval flood defences and the evolution of the flood defence bank.

Weeton beck or fleet (asset 5); and Welwick drain (asset 13) were constructed in the 17th century and may represent some of the initial earthworks erected to reclaim land on the Humber in this period. These assets have been consistently maintained and repaired since the 17th century. These assets have been assessed to be of low value due to their ability to contribute to our knowledge of post-medieval land reclamation within the area.

The remaining asset dating from the post-medieval period is Sheep Trod Lane (asset 14) which led to a location known as the Sheep Trod. This asset has been assessed to be of negligible value.

Modern (1900AD- present)

Modern additions and changes to the landscape can be seen in mapping, particularly in the form of Second World War defences and associated structures. Changes to field boundaries, dykes and flood defences can all be followed with the Ordnance Survey map sequence along with the current configuration of farm buildings and access lanes.

There are two modern assets known within the study area.

The possible site of a 20th century shipwreck (asset 19) was identified. Due to the lack of certainty as to the assets survival, this asset has been assessed to be of negligible value.

An Anti-Aircraft Battery, south of Humber Farm (asset 10) is recorded within the HER. The 3.7" anti-aircraft battery consisted of four emplacements and an associated structure, with other buildings grouped around the battery. The site was visited in 1992 by the Fortress Studies Group; they found some remains of the emplacement itself, evidence of the magazine and the base of a Nissen hut to the north of the site. The Nissen hut and the remains of several concrete block buildings in poor and overgrown condition, along with brick and concrete rubble representing recent demolition, were present on the site in 2009. This asset has been assessed to be of low value due to its ability to contribute to our knowledge of WWII military defence within the area.

Undated

There are three undated assets recorded in the HER within the study area. These include a circular cropmark identified from aerial photographs, possibly representing bomb craters (asset 2); and cropmarks of an enclosure and linear ditch of uncertain date (asset 15). These assets have been assessed to be of negligible value due to their uncertain archaeological potential. The third undated asset consists of a circular enclosure which was identified from a cropmark (asset 8). It is not visible on current mapping. This asset has been assessed to be of low value due to its uncertain date and function.

Archaeological Investigations

Prior to the laying out the connecting pipeline to the Humber Gateway Offshore Windfarm excavations were undertaken within 200m of the proposed scheme footprint (asset 31). The excavations uncovered evidence of Iron Age settlement in the form of six postholes, two ditches, four ring gullies and a pit. Medieval settlement was also uncovered, including four enclosures, and multiple ditches, gullies and features.

During 2016-2017, a programme of archaeological and geotechnical assessment and evaluation was conducted on the Scheme. The methods of evaluation included geophysical survey (Appendices 13.4 – 13.6), geoarchaeological window sampling and archaeological trial trenching (Appendix 13.7).

The first phase of geophysical survey was undertaken during November 2015 to January 2016 on available land throughout the eastern site (Appendix 13.4). This survey identified four possible enclosures and a group of ditch-like anomalies. Anomalies of agricultural origin and old watercourses were identified. A number of anomalies of uncertain origin were identified by the survey. The second phase of geophysical survey was undertaken in August 2016 and surveyed areas of land in West 1, East 1 and East 3 (Appendix 13.5). Although anomalies of likely agricultural origin, such as ploughing and drainage were identified, no anomalies of potential archaeological origin were identified. A second geophysical survey was undertaken in October 2016 (Appendix 13.6) on an area of land in East 1. The survey identified a settlement site, comprised of enclosures, roadways and pit-like features (asset 32).

Archaeological trial trenching was undertaken across the Scheme in 2016 (Appendix 13.7) which focused on the eastern site as test pitting indicated that the western site contained warp deposits at greater depth than the trial trenching would be undertaken.

A geoarchaeological assessment across the Scheme was undertaken in 2016 (Appendix 13.7). The results are summarised below.

Geoarchaeological Assessment

Environmental evidence collected from organic sediments dated to the Mesolithic suggest a wooded landscape across higher, dryer parts of the site, whilst in the lowlands, the landscape was open grasslands and freshwater wetlands which would have been attractive to Mesolithic communities. Boreholes within the Patrington Channel in West 2 revealed gravel deposits that were interpreted as a remnant beach with radiocarbon dating also suggesting a Mesolithic date.

Both estuarine and freshwater alluvium overlying the Mesolithic sediments were dated to the Neolithic and Bronze Age through radiocarbon dating and it is known that such environments were intensely used by humans during later prehistory, and therefore the potential for buried archaeology survival was considered high from later prehistory. In particular, the model highlighted possible palaeochannels within the central Scheme area - possibly part of a network which operated from late Pleistocene/early Holocene. During times of freshwater dominance, peats would have formed and therefore relict later prehistoric landscapes may be preserved.

Alluvium intentionally deposited to reclaim low-lying areas and create productive farmland (Warp) in the post-medieval period is also a feature of this landscape.

From west to east, the geoarchaeological investigation identified c.10m of superficial sequences with a mixture of warp, estuarine and freshwater alluvium, peats, sands and gravels and glacial tills in which early land surfaces were found.

In the western site, on the Sunk Island shoreline, interbedded Mesolithic and Neolithic estuarine and freshwater alluvium, coarse sands and freshwater peat horizons were observed. These deposits were spatially extensive and of low archaeological significance and quality, reflecting the significant mixing and reworking of these sediments as suggested by both palaeoenvironmental analysis and radiocarbon dating. This reworking of sediments may be associated with a number of storm events as well as tidal processes recognised in this area from the sedimentary record.

North of Sunk Island, in the former Patrington Channel, borehole survey identified a mix of warp deposits and alluvium. Beneath that, coarse gravel deposits and cobbles suggest a beach environment with a single radiocarbon sample dated to the Mesolithic.

East of the Patrington Channel and south of the village of Welwick, the survey identified warp overlain by estuarine alluvium. Palaeoenvironmental preservation was poor with a mixing of sequences. Buried land surfaces were found beneath the modern embankment.

In the eastern site, south of the village of Weeton, the geoarchaeological investigation encountered predominantly freshwater and estuarine alluvium. Peat deposits were found at c.6-7m BGL which were overlain by Neolithic / Bronze Age alluvium indicative of rising sea levels. A Mesolithic radiocarbon date was recorded from below these deposits. At the eastern end, sediments within a surface depression, which corresponds to the modern Weeton Beck, provided Bronze Age dates and may indicate a buried palaeochannel with the potential for well-preserved organic remains.

Potential for Previously Unknown Archaeological Remains

There is a low potential for remains dating from the prehistoric period. There is a moderate potential for archaeological remains from the Romano-British period and the medieval and post-medieval periods.

13.5.2.2 Designated Assets

There are seven designated assets located within the ZVI, and an additional Grade I Listed Building located on its periphery with extensive views of the surrounding landscape, which has also been included due to its prominence in the landscape. These are shown on Figure 13.2 and detailed within Appendix 13.1: Gazetteer.

Grade I Listed Buildings

There are two Grade I Listed Buildings; the Church of St Helen in the ZVI, and the Church of St Peter on its periphery.

The Church of St Helen (asset 23) is a Parish Church located within Welwick and was initially constructed in the 1460s in the Perpendicular Gothic style, with later additions including a 19th century porch and roof. The Church was restored several times in the 20th century, with the latest made in 1984-5. The chancel of the Church contains several monuments dating to the late 15th century onward, including a 15th century grave slab, and a pair of 18th century floor slabs dedicated to the Holme family. The font is also of 15th century date.

The Church of St Pater (asset 30) is a Parish church located in the heart of Patrington. It was built in the first half of the 14th century and reused 12th-13th century masonry in its construction. The spire and east window are later 14th century or 15th century additions. It was restored in 1866 and 1885. The Church is located outside the ZVI; it is discussed here due to its prominence in the local landscape (it is located 9m above sea-level; the rest of Patrington is 6m above sea-level), with its spire being a landmark and an important part of the skyline in Holderness.

Grade II Listed Buildings

There are six Grade II Listed Buildings within the ZVI.

One of these assets is associated with the Church of St Helen, the standing cross in its churchyard (asset 22). The cross is thought to date to the 14th-15th century, and a sundial was added to it in the 18th century. It may be the original churchyard cross, but could also have been a wayside cross moved to its current location in the 18th century.

There are three farmhouses located within the Sunk Island Conservation Area within the ZVI. These assets represent the reclamation of this area from wetland in the 17th century and its development into a structured agricultural landscape, by the Crown Estate. All three of the farmhouses, East Bank Farmhouse (asset 21), 4-5 Bleak House Farm Cottages (asset 25), and Channel Farmhouse (asset 24) were built in 1855-7 as part of a major building programme undertaken by the Crown; and were designed by S.S. Teulon for the Crown Commissioner, in his typical Gothic Style, constructed using pattern brickwork.

There is an earlier farmhouse in the ZVI north of Welwick, Haverfield House (asset 26). This asset was built in 1779 and has undergone later minor alterations.

There is one windmill building, Patrington Mill (asset 27), which was built in the late 18th-early 19th centuries. The windmill ceased production in the 1940's, but is still in use for small scale flour grinding.

Conservation Areas

There are two Conservation Areas in the ZVI.

The Sunk Island Conservation Area (asset 28) covers the area of structured agricultural landscape created by the reclamation of land between the 17th century and 19th century under the Crown Estate, which expanded the area that linked the original island to the bank of the Humber. The layout of the farmland is more typical of that seen in the Netherlands, and is unique in the East Riding of Yorkshire. The historic buildings in the area are relatively isolated with farmsteads and associated farmhouses and cottages spread throughout the landscape. The earlier properties are at the west end of the island and date from the 17th century onward, with a marked increase in buildings in the mid-19th century due to a building programme undertaken by the Crown.

Patrington Conservation Area (asset 29) covers the town of the same name, which lies three miles from both the sea to the north east and the Humber, to the south. The character of the area lies in its historic role as a small market town, and in its historic core. The town lies in a prominent position at the junction of the road which runs south east to Easington and the Spurn peninsula, facilitating trade and the resulting wealth allowed the townspeople to construct buildings of somewhat greater scale than those encountered in other villages in Holderness. The Church of St Peter is preeminent in the Conservation Areas, with views from and to the Church informing much of the towns aesthetic and historic character. The Westgate and Market Place are also key to the character of the town.

13.5.2.3 Historic Landscape Character

There are four historic landscapes identified within the Scheme. These consist of Coastal (HLT1), Fields and Enclosures (HLT2), Settlement (HLT3) and Unenclosed Land (HLT4). These assets have been assessed to be of low value. These are shown on Figure 13.3 and detailed within Appendix 13.1: Gazetteer.

The general landscape of the Scheme is flat, low-lying, reclaimed arable fields, heavily farmed with drains separating the fields with some scrub along the banks of the drains. There is a pronounced lack of vertical elements. The landscape does contain occasional trees, but the trees are sparse. The spire of the St. Patricks Church in Patrington is a distinctive marker within the landscape, likely to have been used as a navigation marker by ships in the Humber.

Beyond the existing embankment lies the salt marsh, mudflats and open water of the Humber Estuary. Although the existing embankment screens some views of the Estuary, the visual relationship between the land and the Estuary is an important inter-relationship. The wider landscape is mainly arable farmland with occasional farmsteads and farm tracks, such as Sheep Trod Lane with a feeling of an isolated, bleak, rural farming landscape with a low population. There are villages dotted throughout the wider landscape, including Welwick, Skeffling, Easington, Patrington and Patrington Haven. The landscape of Sunk Island is particularly flat, resulting from its formation as reclaimed land, having been reclaimed since the 17th century onwards, between the sand bar and the Estuary and was developed by the Crown as a series of large farms. Haverfield Quarry is a distinct area within the landscape, its plantation woodland, scrub and relict sand dunes contrast with the surrounding bleak arable landscape. Detailed landscape information is contained within Chapter 12: Landscape and Visual.

13.6 Future baseline

In the absence of the Scheme, ploughing of the cultivated fields would continue, which would negatively impact on the buried archaeological remains, some of which have already been truncated by ploughing. The physical processes in the umber are continually changing and these are influenced by climate change. The effect of Sea Level Rise (SLR), due to climate change, may cause flooding of the Site or expansion of the Humber which may lead to silt accretion over archaeological remains, or may cause erosion of the archaeological remains. The existing tidal defences will be increasingly overtopped, which would cause flooding of the Site. These defences are likely to fail/breach over time without maintenance, which could lead to erosion of the Site and of the historic environment assets.

13.7 Likely significant effects

13.7.1 Outstrays Managed Realignment

13.7.1.1 Construction

Archaeological Remains

Groundworks associated with the construction of the creek and new embankment may impact on remains of the site of Frismersh Village (asset 6; medium value) if remains survive here but the potential is low as the location of the medieval village is not confirmed and may be located elsewhere and no direct evidence for the village was found during the geophysical surveys or archaeological trial trenching. The deposits within West 1 are deep deposits of warp material and any medieval remains would be at a greater depth than the development impact. In consideration of this, the magnitude of the permanent impact would be negligible and the significance of effect would be **no effect**.

Groundworks associated with habitat creation and the construction of the new embankment would physically impact on Welwick Drain (asset 13; low value). However, the impact would be minimal and on a small area of the drain. In consideration of this, the magnitude of the permanent impact would be negligible and the significance of effect would be **no effect**.

There are no impacts predicted on the other known archaeological remains assets as a result of the construction of the western site.

Historic Buildings

The distance views from Sunk Island Conservation Area (asset 28; medium value) towards the western site would be impacted on by the construction machinery and activities. However, the western site is at approximately 450m to the east of the Conservation Area and the character of it would not be impacted on. In consideration of this, the magnitude of the short term temporary impact would be negligible and the significance of effect would be **no effect**.

The construction machinery and activities would be visible within distance of views from Channel Farmhouse (asset 24; medium value), 4-5 Bleak House Farm Cottages

(asset 25; medium value) and Haverfield House (asset 26; medium value) and would impact on the rural character of the assets' setting. However, the western site is at a distance from the assets and would not alter the immediate landscape setting of the assets. In consideration of this, the magnitude of the short term temporary impact would be minor and the significance of effect would be **minor adverse**.

There are no impacts are predicted on the other historic building assets as a result of the construction of the western site.

The noise and vibration assessment (see Chapter 16) identified that there would be a negligible magnitude of impact during construction leading to no significant effect on nearby dwellings, which would include the Listed Buildings.

The vibration from piling will be too distant from the Listed Buildings to impact on them.

Historic Landscapes Character

Groundworks associated with the construction of the creek and new embankment on the western site will impact on Coastal (HLT1; low value), Fields and Enclosures (HLT2; low value), and Unenclosed Land (HLT4; low value). However, only a small portion of the landscapes will be removed, the landscapes won't be severed and will still be understood. In consideration of this, the magnitude of the permanent impact would be negligible and the significance of effect would be **no effect**.

13.7.1.2 Operation

Archaeological Remains

Although the hydrology of the Scheme is likely to change due to removal of drains and the habitat creation, which may lead to desiccation of archaeological and organic remains, the location and duration of any de-watering activities is not currently known. The created habitat will require periodic flooding or water logging by freshwater during the winter months. There may be changes in soil chemistry due to saline intrusion, due toto the relocation of the embankment inland exposing new areas to saline waters. The impact of this upon groundwaters is unknown but any impacts are likely to be localised and some degree of saline intrusion will already be experienced (see Chapter 8 Water Environment).

In addition to a change in saline intrusion, inundation of the scheme from the breach in the existing embankments by tidal waters will result in a probable accretion of sediment (Chapter 9 Geology, soils and hydrogeology). However, the level of accretion, and therefore the impact to archaeological remains from the accretion of sediment, is not currently known.

There are no impacts predicted on archaeological remains as a result of the operation of the western site.

Historic Buildings

The new embankment would be closer to Sunk Island Conservation Area (asset 28; medium value) than the existing embankment. However, it would not introduce a new element into the views or the setting of the Conservation Area as the existing embankment is currently visible. It will also not impinge views of the Humber. In consideration of this, the magnitude of the permanent impact would be negligible and the significance of effect would be **no effect**.

There are no impacts predicted on the other historic building assets as a result of the operation of the western site.

Historic Landscape Character

The landscape will go through large changes as a result of the Scheme. The current arable fields will become a mosaic of intertidal and wetland habitats and the embankment will be closer to houses and more prominent, which future settling of materials may soften. However, this Humber landscape is a dynamic landscape which has seen substantial changes throughout time, including periods of accretion and erosion, changes from intertidal and wetland habitat in prehistory to the current arable landscape. The changes to the landscape as a result of the Scheme would contribute another layer to the changing story of this landscape and therefore would not alter the dynamic foundation of the landscape. In consideration of this, the magnitude of the permanent impact would be negligible and the significance of effect would be **no effect**.

13.7.2 Welwick to Skeffling Managed Realignment

13.7.2.1 Construction

Archaeological Remains

The preferred approach for heritage assets is preservation in situ. The Scheme design was informed and guided by the requirement to preserve archaeological remains in situ. Where this is not possible due to Scheme design constraints, mitigation through excavation and recording will be undertaken.

Groundworks associated with the construction of the creek and reduction of the embankment to ground level would impact on the Skeffling embankment (asset 3; low value). In consideration of the permanent partial removal of the asset, the magnitude of impact would be moderate and the significance of effect would be **minor adverse**.

Groundworks associated with the construction of the creek and reduction of the embankment to ground level would impact on the Weeton Clough drainage sluice (asset 4; low value). In consideration of the permanent partial removal of the asset, the magnitude of impact would be moderate and the significance of effect would be **minor adverse**.

Groundworks associated with the construction of the creek would impact on part of the Weeton Beck (asset 5; low value). In consideration of the permanent partial removal of the asset, the magnitude of impact would be minor and the significance of effect would be **minor adverse**.

Groundworks associated with habitat creation would impact on Sheep Trod Lane (asset 14; low value). However, the impacts would be minimal and would only impact on a small area of the lane and only resurfacing would be undertaken which would not impact on lower layers. In consideration of this, the magnitude of the permanent impact would be negligible and the significance of effect would be **no effect**.

The construction activities associated with the new embankment would impact on the setting of a WWII AA Battery (asset 10; low value). The battery is currently situated in a rural, tranquil location with views towards the Humber. The construction activities and machinery would alter the assets setting to a mechanical one and would impact on the

setting due to noise and visual intrusion. In consideration of this short term temporary impact, the magnitude of impact would be moderate and the significance of effect would be **minor adverse**.

If topsoil stripping occurred for the construction of the compound and car park, this would impact on the eastern remains of a likely Romano-British settlement, identified as geophysical survey anomalies (asset 32; medium value). In consideration of the permanent partial removal of the asset, the magnitude of impact would be moderate and the significance of effect would be **moderate adverse**.

Groundworks associated with the new embankment cut-off trench could impact on any outlying features of two Romano-British settlements (assets 32 and 24; medium value) if remains extend into the trench. In consideration of the small portion of the assets that would be permanently removed, the magnitude of impact would be minor and the significance of effect would be **minor adverse**.

The excavation of the creek will impact on a Romano-British settlement identified by geophysical survey (Asset 33; medium value). In consideration of the permanent partial removal of the asset, the magnitude of impact would be major and the significance of effect would be **moderate adverse**.

The excavation of the creek will impact on medieval remains identified during trial trenching (Asset 36; low value). In consideration of the permanent partial removal of the asset, the magnitude of impact would be major and the significance of effect would be **moderate adverse**.

There are no impacts predicted on the other archaeological remains assets as a result of the construction of the eastern site.

Historic Buildings

The construction machinery and activities would be visible within glimpsed views from the Church of St. Helen (asset 23; high value) and the construction noise would impact on its tranquil setting. However, views from the church is screened by trees and vegetation and any views out would be glimpsed. The church is enclosed by screening and has an isolated feeling from the landscape, which would not be impacted on by the eastern site. In consideration of this, the magnitude of the short term temporary impact would be minor and the significance of effect would be **minor adverse**.

The construction machinery and activities would be visible within distance of views from Haverfield House (asset 26; medium value) and would impact on the rural character of the assets setting. However, the eastern site is at a distance from the assets and would not alter the immediate landscape setting of the asset. In consideration of this, the magnitude of the short term temporary impact would be minor and the significance of effect would be **minor adverse**.

There are no impacts predicted on the other historic building assets as a result of the construction of the western site.

The noise and vibration assessment (see Chapter 16) identified that there would be a negligible magnitude of impact during construction leading to **no effect** significance of effect on nearby dwellings, which would include the Listed Buildings.

The vibration from piling will be too distant from the Listed Buildings to impact on them.

Historic Landscape Character

Groundworks associated with the construction of the creek and new embankment on the western site will impact on Coastal (HLT1; low value), Fields and Enclosures (HLT2; low value), and Unenclosed Land (HLT4; low value). However, only a small portion of the landscapes will be removed and the landscapes won't be severed and will still be understood. In consideration of this, the magnitude of the permanent impact would be negligible and the significance of effect would be **no effect**.

13.7.2.2 Operation

Archaeological Remains

Although the hydrology of the Scheme is likely to change due to removal of drains and the habitat creation, which may lead to desiccation of archaeological and organic remains, the location and duration of any de-watering activities is not currently known. The created habitat will require periodic flooding or water logging by freshwater during the winter months. There may be changes in soil chemistry due to saline intrusion, due toto the relocation of the embankment inland exposing new areas to saline waters. The impact of this upon groundwaters is unknown but any impacts are likely to be localised and some degree of saline intrusion will already be experienced (see Chapter 8 Water Environment).

In addition to a change in saline intrusion, inundation of the scheme from the breach in the existing embankments by tidal waters will result in a probable accretion of sediment (Chapter 9 Geology, soils and hydrogeology). However, the level of accretion, and therefore the impact to archaeological remains from the accretion of sediment, is not currently known.

There are no impacts predicted on archaeological remains as a result of the operation of the eastern site.

Historic Buildings

The new embankment would be closer to the Church of St. Helen (asset 23; high value) than the existing embankment. However, a closer embankment would not impact on the rural setting of the church and any views would be glimpsed due to existing screening. In consideration of this, the magnitude of the short term permanent impact would be negligible and the significance of effect would be **no effect**.

There are no impacts predicted on the other historic building assets as a result of the operation of the western site.

Historic Landscape Character

The landscape will go through large changes as a result of the Scheme. The current arable fields will become a mosaic of intertidal and wetland habitats and the embankment will be closer to houses and more prominent, which future settling of materials may soften. However, this Humber landscape is a dynamic landscape which has seen substantial changes throughout time, including periods of accretion and erosion, changes from intertidal and wetland habitat in prehistory to the current arable landscape. The changes to the landscape as a result of the Scheme would contribute another layer to the changing story of this landscape and therefore would not alter the dynamic foundation of the landscape. In consideration of this, the magnitude of the permanent impact would be negligible and the significance of effect would be **no effect**.

13.8 Mitigation

13.8.1 Outstrays Managed Realignment

13.8.1.1 Construction

Archaeological Remains

The preferred approach for heritage assets has been preservation in situ. The Scheme design was informed and guided by the requirement to preserve archaeological remains in situ. Where this is not possible due to Scheme design constraints, mitigation through excavation and recording will be undertaken.

There is no mitigation required for archaeological remains during the construction phase of the western site.

Historic Buildings

There is no mitigation required for historic buildings during the construction phase of the western site.

Historic Landscape Character

There is no mitigation required for historic landscapes during the construction phase of the western site.

13.8.1.2 Operation

Archaeological Remains

There is no mitigation required for archaeological remains during the operation phase of the western site.

Historic Buildings

There is no mitigation required for historic buildings during the operation phase of the western site.

Historic Landscape Character

There is no mitigation required for historic landscapes during the operation phase of the western site. Please see Chapter 12 Landscape and Visual for specific landscaping and planting.

13.8.2 Welwick to Skeffling Managed Realignment

13.8.2.1 Construction

Archaeological Remains

Research agendas and mitigation requirements are outlined in Appendix 13.7: Archaeological Strategy.

Recording of the existing Skeffling flood defence is required (asset 3), including additional sediment sequencing and dating will be undertaken of the embankment, on the dryland side of the embankment and in the breach location, to ascertain if there is a surviving Anglo-Saxon land surface.

Historic building recording Level 1 should be undertaken on the Weeton Clough drainage sluice (asset 4) due to its permanent removal.

The Weeton Beck (asset 5) requires further characterisation of its deposits. This will be undertaken using boreholes and ElectroMagnetic geophysical survey.

A photographic survey will be undertaken of the WWII AA Battery (asset 10) in order to record the assets current setting.

A monitored strip of the compound will be undertaken to identify and record any assets of the Romano-British settlement (asset 32). Any identified remains may require excavation.

An archaeological watching brief shall be undertaken of the drainage cut-off trench works and during stripping of the creek areas to identify and record any archaeological remains.

Further geophysical survey is required of areas that were inaccessible in previous surveys. Further evaluation and mitigation may be required based on the results of the geophysical survey.

Strip, map and record will be undertaken in order to record archaeological remains at Asset 33, Group 1 enclosure and at Asset 36, Group 4 medieval remains.

A formal Written Scheme of Investigation (WSI) for the archaeological mitigation will be undertaken and agreed with the Humber Archaeology Partnership Principal Archaeologist.

Historic Buildings

There is no mitigation required for historic buildings during the construction phase of the eastern site.

Historic Landscape Character

There is no mitigation required for historic landscapes during the operation phase of the eastern site.

13.8.2.2 Operation

Archaeological Remains

There is no mitigation required for archaeological remains during the operation phase of the eastern site.

Historic Buildings

There is no mitigation required for historic buildings during the operation phase of the eastern site.

Historic Landscape Character

There is no mitigation required for historic landscapes during the operation phase of the eastern site. Please see Chapter 12 Landscape and Visual for specific landscaping and planting.

13.9 Residual effects

13.9.1 Outstrays Managed Realignment

The assessment above identifies that all effects after mitigation will be no more than minor adverse and therefore not significant in terms of the EIA regulations 2017 as described in Chapter 4. The residual effects remain minor adverse to no effect, as summarised in Tables 13.4 and 13.5.

The contractor should be aware of the potential for chance finds. Toolbox talks should be given to the contractors.

The professional archaeological contractor will demonstrate a recognised suite of Public Engagement skills and deliver a coherent Public Engagement programme during 2018 – 2021. This will be designed in consultation with the client, the Principal Archaeologist for the Humber Archaeology Partnership and the Historic England Inspector of Ancient Monuments.

Interpretation information on the cultural heritage of the area within the Scheme lies in should be provided for the public such as information boards.

13.9.1.1 Construction

Table 13.4: Summary Table of Impacts during the construction phase of Outstrays Managed Realignment

Receptor	Value of receptor	Description of Potential Impact	Magnitude of Predicted Impact	Significance of effect (without mitigation)	Mitigation Measures (where Significance moderate or greater)	Significance of Residual Effect (with mitigation)
Asset 6 Frismersh Village	Low	Partial removal by construction works if remains survive	Negligible	No effect	None proposed	No effect
Asset 13 Welwick Drain	Low	Partial removal by construction works	Negligible	No effect	None proposed	No effect
Asset 28 Sunk Island Conservation Area	Medium	Impacts on its setting	Negligible	No effect	None proposed	No effect
Asset 24 Channel Farmhouse	Medium	Impacts on its setting during construction works	Minor	Minor adverse	None proposed	Minor adverse
Asset 25 4-5 Bleak House Farm Cottages	Medium	Impacts on its setting during construction works	Minor	Minor adverse	None proposed	Minor adverse
Asset 26 Haverfield House	Medium	Impacts on its setting during construction works	Minor	Minor adverse	None proposed	Minor adverse

Receptor	Value of receptor	Description of Potential Impact	Magnitude of Predicted Impact	Significance of effect (without mitigation)	Mitigation Measures (where Significance moderate or greater)	Significance of Residual Effect (with mitigation)
HLT1 Coastal	Low	Partial removal by construction works	Negligible	No effect	None proposed	No effect
HLT2 Fields and Enclosures	Low	Partial removal by construction works	Negligible	No effect	None proposed	No effect
HLT4 Unenclosed Land	Low	Partial removal by construction works	Negligible	No effect	None proposed	No effect

13.9.1.2 Operation

Table 13.5: Summary Table of Impacts during the operation phase of Outstrays Managed Realignment

Receptor	Value of receptor	Description of Potential Impact	Magnitude of Predicted Impact	Significance of effect (without mitigation)	Mitigation Measures (where Significance moderate or greater)	Significance of Residual Effect (with mitigation)
Asset 28 Sunk Island Conservation Area	Medium	Impacts on its setting	Negligible	No effect	None proposed	No effect

13.9.2 Welwick to Skeffling Managed Realignment

The assessment above identifies that all effects after mitigation will be no more than minor adverse and therefore not significant in terms of the EIA regulations 2017 as described in Chapter 4. Mitigation has been identified as best practice and to reduce the effects further. With mitigation the effects remain minor adverse to no effect, as summarised in Tables 13.6 and 13.7.

The contractor should be aware of the potential for chance finds. Toolbox talks should be given to the contractors.

The professional archaeological contractor will demonstrate a recognised suite of Public Engagement skills and deliver a coherent Public Engagement programme during 2018 – 2021. This will be designed in consultation with the client, the Principal Archaeologist for the Humber Archaeology Partnership and the Historic England Inspector of Ancient Monuments.

Interpretation information on the cultural heritage of the area within the Scheme lies in should be provided for the public such as information boards.

13.9.2.1 Construction

Table 13.6: Summary Table of Impacts during the construction phase of Welwick to Skeffling Managed Realignment

Receptor	Value of receptor	Description of Potential Impact	Magnitude of Predicted Impact	Significance of effect (without mitigation)	Mitigation Measures (where Significance moderate or greater)	Significance of Residual Effect (with mitigation)
Asset 3 Skeffling embankment	Low	Partial removal by construction works if remains survive	Moderate	Minor adverse	Archaeological recording, topographic survey,sediment sequencing and dating	No effect
Asset 4 Weeton Clough drainage sluice	Low	Partial removal by construction works	Moderate	Minor adverse	Historic building recording Level 1	Minor adverse
Asset 5 Weeton Beck	Low	Partial removal by construction works	Minor	Minor adverse	Geoarchaeological study	No effect
Asset 14 Sheep Trod lane	Negligible	Resurfacing	Negligible	No effect	None proposed	No effect
Asset 10 WWII AA Battery	Low	Impacts on its setting works	Moderate	Minor adverse	Photographic survey	Minor adverse
Asset 32 Enclosure complex	Medium	Partial removal during topsoil stripping for compound / car park	Moderate	Moderate adverse	Archaeological watching brief and recording	Minor adverse

Receptor	Value of receptor	Description of Potential Impact	Magnitude of Predicted Impact	Significance of effect (without mitigation)	Mitigation Measures (where Significance moderate or greater)	Significance of Residual Effect (with mitigation)
Asset 33 Group 1 enclosure	Medium	Partial removal by construction activities	Major	Moderate adverse	Strip, map and record	Minor adverse
Asset 34 Group 2 enclosure	Medium	Partial removal during topsoil stripping for compound / car park	Moderate	Minor adverse	Archaeological watching brief and recording	Minor adverse
Asset 36 Group 4 medieval remains	Low	Potential partial removal by construction activities	Major	Moderate adverse	Strip, map and record	Minor adverse
Asset 23 Church of St. Helen	Medium	Impacts on its setting by construction works	Minor	Minor adverse	None proposed	Minor adverse
Asset 26 Haverfield House	Medium	Impacts on its setting by construction works	Minor	Minor adverse	None proposed	Minor adverse
HLT1 Coastal	Low	Partial removal by construction works	Negligible	No effect	None proposed	No effect

Receptor	Value of receptor	Description of Potential Impact	Magnitude of Predicted Impact	Significance of effect (without mitigation)	Mitigation Measures (where Significance moderate or greater)	Significance of Residual Effect (with mitigation)
HLT2 Fields and Enclosures	Low	Partial removal by construction works	Negligible	No effect	None proposed	No effect
HLT4 Unenclosed Land	Low	Partial removal by construction works	Negligible	No effect	None proposed	No effect

13.9.2.2 Operation

Table 13.7: Summary Table of Impacts during the operation phase of Welwick to Skeffling Managed Realignment

Receptor	Value of receptor	Description of Potential Impact	Magnitude of Predicted Impact	Significance of effect (without mitigation)	Mitigation Measures (where Significance moderate or greater)	Significance of Residual Effect (with mitigation)
Asset 23 Church of St. Helen	High	Impacts on its setting	Negligible	No effect	None proposed	No effect

14 Traffic and Transport

14.1 Introduction

The purpose of this chapter is to assess the likely traffic and transport effects of the Outstrays Managed Realignment (western site) and Welwick to Skeffling Managed Realignment (eastern site). This includes an assessment of effects on navigation of commercial and recreational vessels.

This chapter considers the following items that are related to the two sites:

- Legislative context of the navigational environment;
- The methodology used for this chapter; including information on the study area, the baseline data, and the impact assessment;
- Traffic figures generated as a result of the two sites;
- Information on the current environment for the two sites; including the characteristics of the local highway network and navigational environment;
- The likely significant effects of the construction and operation from a traffic and transport perspective, including effects on the local highway network, public transport and on marine navigation;
- The mitigation measures proposed for the potential effects; and
- The residual effects of the Scheme's two sites following implementation of the mitigation.

Likely significant effects on Public Rights of Way (PRoW) have been assessed in Chapter 6 Population and Recreation. Effects relating to traffic generated during the operational phase of the Scheme by maintenance and inspection activities has been scoped out as these activities will create only a small number of infrequent vehicle movements.

Regardless of the findings of this assessment, the construction traffic impacts of this Scheme will be managed during the construction of the development through a Construction Traffic Management Plan (CTMP).

14.2 Legislative context of the highway network

14.2.1 Primary Legislation

The primary legislation that the UK Government has to control its planning system, in England, is the National Planning Policy Framework (NPPF). From a highways perspective, the NPPF states "any significant impacts from the development on the transport network…or on highway safety, can be cost effectively mitigated to an

acceptable degree"[1]. Therefore, any highway impacts brought about due to the two realignment schemes will require sufficient measures brought in to mitigate against these.

The NPPF states that development can be refused on a highways basis due to an "unacceptable impact on highway safety, or the residual cumulative impacts on the road network that would be severe."**Error! Bookmark not defined.**

Where a development has the likelihood to have an impact on the transport network, a transport assessment (TA) should be prepared. The Department for Transport state in their guidance document that a TA be used to "determine whether the impact of the development on transport is acceptable."[2]

14.2.2 Guidance

The following guidance documents have been used in preparation of this chapter. These documents provide information regarding the issues that should be taken into consideration when assessing the highways impact:

- Department for Transport (DfT), Manual for Streets (DfT, 2007);
- Department for Transport (DfT), Guidance on Transport Assessment (DfT, 2007);
- Institute of Environmental Assessment (IEMA), Guidelines for the Environmental Assessment of Road Traffic (IEMA, 1993); and
- Ministry of Housing, Communities & Local Government (MoHCLG) National Planning Policy Framework (MoHCLG, 2018).

14.3 Legislative context of the navigational environment

14.3.1 Primary Legislation

International protocols and conventions relating to safety, laws of the sea and pollution apply to shipping and ports. The UK Government has a responsibility to ensure that measures are implemented in order to honour its commitments to these protocols, not least of these is the UK's responsibility under Article 60(7) of the United Nations Convention on the Law of the Sea (UNCLOS) relating to provisions for 'Artificial islands, installations and structures in the exclusive economic zone'.

Within UK territorial waters, the UK Government uphold the right of innocent passage as defined in Article 17 of UNCLOS, beyond the 12 nm-(nautical-mile) limit of UK territorial waters shipping has the freedom of navigation. The regulation of shipping should be carried out by the 'flag state control' operated by the country in which the

[1] Ministry of Housing, Communities & Local Government '*National Planning Policy Framework*' – Accessed 18/01/2019 - https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/740441/National_Planning_Policy_Framework_web_accessible_version.pdf

[2] Department for Transport '*Guidance on Transport Assessment'* – Accessed 21/01/2019 - https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/263054/guidance-transport-assessment.pdf

ship is registered. As this has proved unsatisfactory 'port state control' has become common in national jurisdictions. Under this regime the UK Government represented by the inspection division of the Maritime and Coastguard Agency (MCA), exercises the rights of the port state to inspect and, if appropriate, detain sub-standard ships.

The majority of port operations are administered by a Statutory Harbour Authority (SHA). Every SHA is self-governed with specific legislation (Acts of Parliament) creating the SHA as an entity, with further powers, duties and amendments made over time in response to the changing scope and remit of the SHA. Underpinning the powers of an SHA is a range of national legislation, which places statutory responsibility on the Harbour Authority to ensure navigation and safety within the harbour limits. This includes the 'Harbours, Docks and Piers Clauses Act 1847' and the 'Harbour Act 1964'. The Humber Estuary is managed by ABP, who is the SHA (see 14.6.3).

14.3.2 Guidance

The following guidance documents have been used in preparation of this chapter. These documents provide information regarding the issues that should be taken into consideration when assessing the effect on navigational safety:

- International Maritime Organization (IMO) Revised Guidelines for Formal Safety Assessment (FSA) for use in the IMO rule making process (IMO, 2015);
- Maritime and Coastguard Agency (MCA), Marine Guidance Note 543 (MGN 543 Merchant + Fishing) Safety of Navigation: Offshore Renewable Energy Installations (OREIs) – Guidance on UK Navigational Practice, Safety and Emergency Response (MCA, 2016); and
- Port Marine Safety Code (DfT/MCA, 2016).

14.4 Methodology

14.4.1 Study area: highway traffic

From a traffic and transport perspective, the study area for the two sites is the local highway network. This network includes Skeffling Road (B1445), Haven Road and Outstray Road, which have the potential to be affected by the construction and operational elements of the two sites.

Residential areas, which also have the potential to be affected, within the study area include Patrington, Patrington Haven, Welwick and Weeton. The network will be further investigated in the following sections.

14.4.2 Baseline data collection: highway

The baseline data used in this assessment has been gathered from desk-based research to understand the local highway network of the study area.

A description of the baseline highway environment has been based on the following data sources:

- East Riding of Yorkshire Council: Local Transport Plan – Strategy 2015 – 2029;

- Google Street View – no site visit was undertaken; and
- OS mapping – highlighting the sites and highway network.

No traffic modelling has been undertaken due to the small-scale nature of proposed traffic movements for the Scheme. Discussions were held with East Riding of Yorkshire Council regarding traffic generation rather than current usage.

14.4.3 Study area: marine navigation

The study area for commercial and recreational navigation comprises the area enclosed by a line from Spurn Head to Grimsby Royal Dock Lock and from Grimsby Royal Dock Lock to Hawkin's Point.

14.4.4 Baseline data collection: marine

A description of the baseline navigational environment has been based on the following data sources:

- British Admiralty Chart Number 1188 'East Coast, River Humber, Spurn Head to Immingham'
- Automatic Information System (AIS) Data, 2015. The AIS vessel transit data for 2015 was processed by ABPmer on behalf of the MMO, using data supplied by the Maritime and Coastguard Agency (MCA), following a methodology previously developed by ABPmer under MMO project number 1066, 'Mapping UK Shipping Density and Routes from AIS'. http://vision.abpmer.net/maritime/AIS2015/
- MarNIS 'Port Assessment Toolkit' Accident/Incident Database
- Visual inspection of aerial imagery (Google Earth mapping)

14.4.5 Impact assessment

The general criteria for assessing the magnitude and nature of the traffic and transport effects are based on the factors in Tables 4.2, 4.3 and 4.4 in Chapter 4. The general criteria for classifying the value of the sensitivity, as seen in Table 4.2 have been deemed suitable with regards to highway traffic as the traffic generated assumptions are low, and would therefore not have an impact on a national scale, but potentially just on a local level.

In terms of assessing the traffic impact, two pieces of guidance have been used, by the Department for Transport (DfT) and the Institute of Environmental Assessment (IEMA).

In its 'Guidance on Transport Assessments' the DfT states assessments should be undertaken on developments where they produce a minimum of at least 30 two-way peak hour vehicle trips. This is a good basis to see what effect a development would have on the local highway network.

The Institute of Environmental Assessment's (IEMA) (1993) 'Guidelines for the Environmental Assessment of Road Traffic' has been used to inform the assessment.

Chapter 3, within this document, focuses on the 'Traffic Issues' that could arise and states "different types of development will attract different levels and types of traffic…"[3]

The guidance sets out two assumptions that should be followed to assess if the development will have an impact on the highway network:

- Where private or heavy goods vehicles increase by 30%; or
- In "specifically sensitive areas where traffic flows have increase by 10% or more"[3]

However, it should be noted that at the time of writing, existing traffic flows for any of the local highway network were not available. Therefore, although it will not be possible to undertake these calculations, it is still a reliable guidance document that should be kept in mind.

These two pieces of guidance will assist in assessing the traffic generation of the two developments.

14.5 Uncertainties, assumptions and limitations

This assessment is based on information available at the time of writing, namely traffic generation figures from the Contractor, and the current understanding of the construction programme and vehicle requirements. Assumptions have been made relating to numbers and types of vehicles, and that no vessel activities will be associated with the Scheme; these may change as the Schemes' designs develop. The majority of the estimates of highway traffic vehicle movements were only available for the two sites (Outstrays and Welwick to Skeffling) combined, due to the maturity of the construction programming at the time of assessment. These combined movements were considered , then implications for the individual sites have been considered.

As described in Chapter 7, it is assumed that the potential effects to physical estuarine processes are likely to be very localised and not of scale that would impact on commercial or recreational navigation.

It should be noted that there can be limitations on predicting future based data due to the availability and quality of assumptions available at the time this assessment was undertaken.

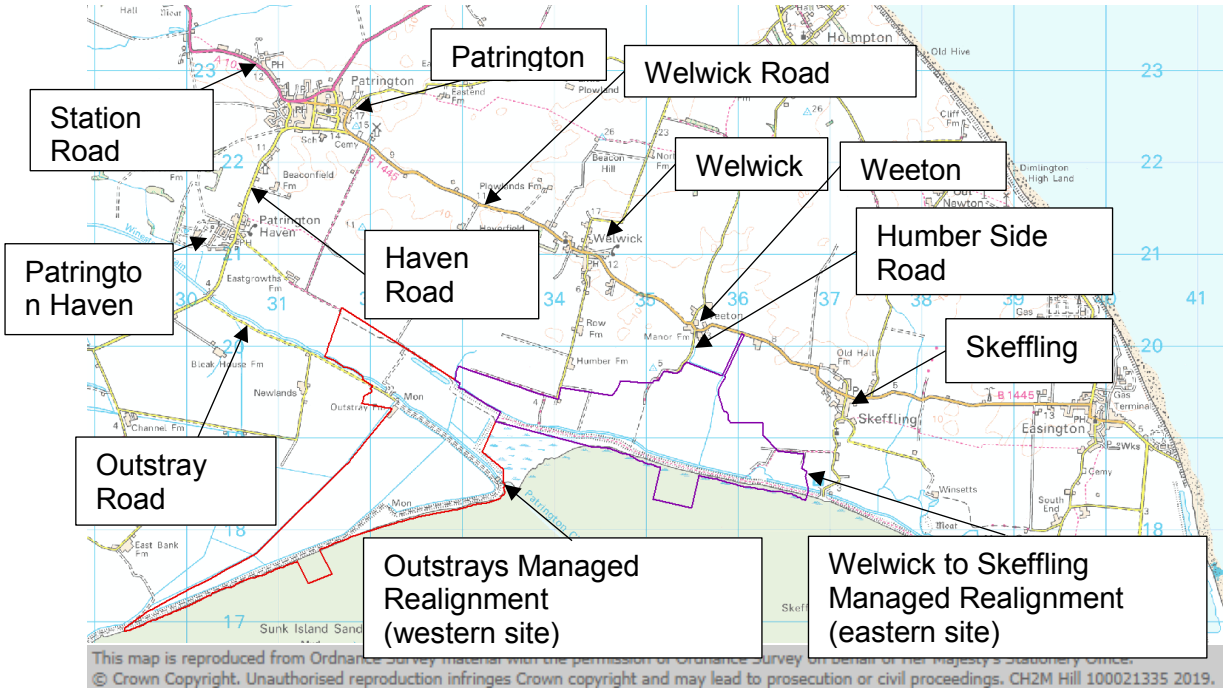
14.6 Existing environment: highway traffic

This section reviews some of the key routes that could be affected by the Scheme. The eastern and western sites will be looked at individually.

Plate 14.1 displays an overview of the highway network and highlights the main roads and areas of the Scheme.

[3] Institute of Environmental Assessment 'Guidelines for the Environmental Assessment of Road Traffic'.

Plate 14.1: Highway network overview



14.6.1 Outstrays Managed Realignment

To access the western site, vehicles will be travelling from Patrington via Haven Road and Outstray Road.

Characteristics of Haven Road include:

- Provides a 2km (1.3 miles) north to south movement from the southern western side of Patrington, through the settlement of Patrington Haven, to its junction with Outstray Road.
- After its priority junction with Outstray Road, Haven Road continues for another 1.5km (1mile) where it reaches a junction with Brick Road (heading west) and Channel Road (heading south).
- The northern part of Haven Road connects to Humber Lane, which in turn connects to the Station Road/Westgate (A1033).
- Haven Road is of an S2 nature, meaning there is a single lane in each direction, and has a varying width between 6.5m and 7.3m. With a maximum width of a road haulage vehicle being 2.55m wide[4] (as stated by the Department for Transport), this means that two vehicles of this nature would be able to pass each other on Haven Road. In Figure 7.1[5] in Manual for Streets (MfS) states that a 5.5m carriageway would cope with two-way movements of HGVs on a straight alignment, but around corners this would need to be wider.

[4] Department for Transport *'Towing a trailer with a car or van: the basics'* – Accessed 12/11/2018 - https://www.gov.uk/government/publications/towing-a-trailer-with-a-car-or-van/towing-a-trailer-with-a-car-or-van-the-basics

[5] Department for Transport 'Manual for Streets' – Accessed 07/02/2019 - https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/341513/pdfmanforstreets.pdf

- The speed limit varies along its length from 40mph between Patrington and Patrington Haven, 30mph through Patrington Haven and then 60mph south of Patrington Haven to Outstrays Road.
- A footpath exists on the southbound side of Haven Road from Patrington to Patrington Haven.

Characteristics of Outstray Road include:

- Provides an approximate 1.5km (1 mile) north-west to south-east movement from its junction with Haven Road to the site boundary.
- The road is a single track with widths varying between 3 and 3.5m, which makes it difficult for two-way vehicle flow, especially if both vehicles were plant vehicles.
- Approximately three passing places exist along Outstray Road that are unevenly spaced out. This does not provide adequate provisions for two-way flows. Vehicles meeting each other would require one to manoeuvre onto the verge to pass the other.
- Outstray Road has a junction with Newlands Road, which connects to Stray Road and Channel Road.
- Is subject to a 60mph speed limit.
- There are no footways on either side of the carriageway.

From the characteristics of these two roads, certain parts may not be suitable for construction traffic due to existing road widths, pinch points and road surfacing.

Public Transport

For public transport users, the closest bus stops to the site access route are located on Station Road (A1033), which runs east to west across the northern section of Patrington. The closest railway station to the site is Hull Paragon Interchange, which is approximately 23 kilometres away from Patrington.

As both the locations of the closest bus stops and railway station are some distance away from the main construction route into the western site, the works due to take place are not likely to have an impact on either the bus or railway networks.

Accidents

Personal Injury Accident data was not available at the time of writing and has not been included in this assessment.

14.6.2 Welwick to Skeffling Managed Realignment

To access the eastern site, the existing key roads are Skeffling Road (B1445) and Humber Side Road.

Characteristics of Skeffling Road (B1445) include:

- Provides a 5km west to east link between Patrington and Humber Side Road.
- Connects to Station Road (A1033) at Patrington.
- Is subject to a 60mph speed limit apart from through Patrington where it is 30mph.

- A footway is available on the eastbound side of the carriageway near Patrington.
- Skeffling Road is of an S2 nature, meaning there is a single lane in each direction, and has a varying width between 6.5m and 7.5m. With a maximum width of a road haulage vehicle being 2.55m wide[4] (as stated by the Department for Transport), this means that two vehicles of this nature would be able to pass each other on Skeffling Road. In Figure 7.1[5] in Manual for Streets (MfS) states that a 5.5m carriageway would cope with two-way movements of HGVs on a straight alignment, but around corners this would need to be wider.

Characteristics of Humber Side Road include:

- Provides an approximate 720m north to south movement from its junction with the newly constructed access route to the site compound.
- The road is a single track, which in some places is unsurfaced and is affected by vegetation overgrowth and has an approximate width of 3m. This makes it difficult for two-way vehicle flow especially if both vehicles were plant vehicles.
- Approximately two passing places exist along Humber Side Road that are unevenly spaced out. This does not provide adequate provisions for two-way flows. Vehicles meeting each other would require one to maneuver onto the verge to pass the other.
- Is subject to a 60mph speed limit.
- There are no footways on either side of the carriageway.

From the characteristics of these two roads, certain parts may not be suitable for construction traffic due to existing road widths, pinch points and road surfacing.

Public Transport

With regards to public transport users, the closest bus stops are located on Skeffling Road (B1445) at its junction with Humber Side Road. These stops offer approximate hourly services to Withernsea and Easington. The closest railway station to the site is Hull Paragon Interchange, which is approximately 28km (crow fly distance) away from Weeton.

As both of these locations are some distance away from the main construction route into the eastern site, or the services are not regular, the works due to take place are not likely to have an impact on either the bus or railway networks.

Accidents

Personal Injury Accident data was not available at the time of writing and has not been included in this assessment.

14.7 Existing environment: marine navigation

14.7.1 Introduction

The Humber Estuary is one of the busiest waterways in the United Kingdom, with around 30,000 commercial shipping movements in 2017, bound for 27 principal dock, jetty and river locations (including anchorages). The vast majority of the Humber Estuary is open water, buoys and light floats mark the main navigational channels. The

channel chosen and track followed will be dictated by tide to tide, depending on the tidal height and draught of the transiting vessel.

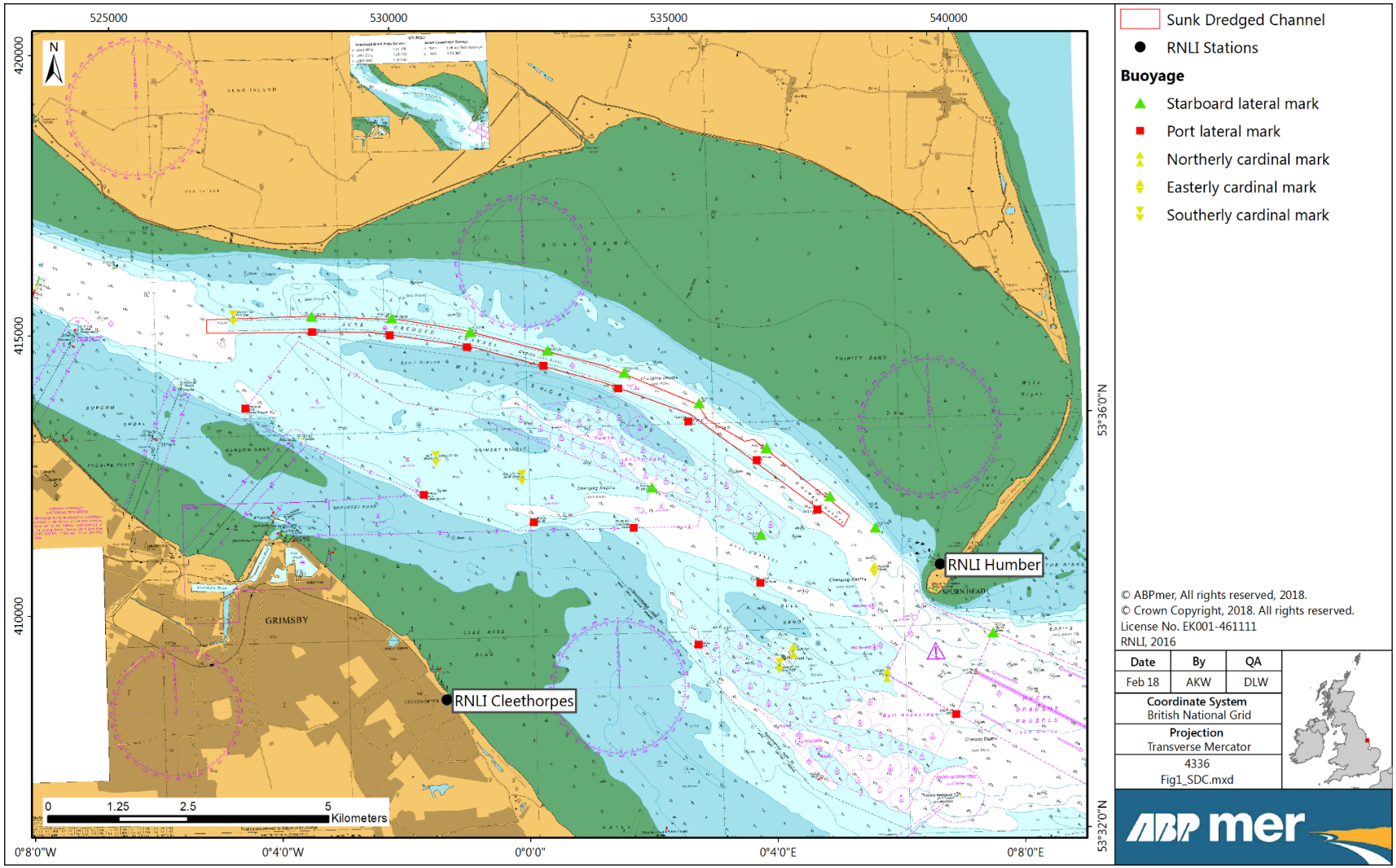
The major Humber ports of Hull, Goole, Grimsby and Immingham handled 10.2 million tonnes, 1.4 million tonnes and 54.4 million tonnes of cargo respectively in 2016 (DfT, 2017). The principal commercial dock operations of Hull, Goole, Grimsby and Immingham are owned, managed and operated by ABP. In addition to these dock and jetty facilities, a number of other facilities are offered at terminals such as Salt End Jetties (owned by ABP) Immingham Oil Terminal (owned by ABP) North and South Killingholme, New Holland, Humber Sea Terminal and various smaller wharf operators above the Humber Bridge.

In addition to commercial activity, the Estuary is also used by recreational clubs and individuals for leisure activities. A large proportion of recreational vessel movements are composed of vessels transiting between the network of rivers and canals connecting the Humber with inland waterways and therefore, are not relevant to the project as they occur up-estuary of the Humber Bridge. However, Marina facilities also exist at Grimsby, Hull and Goole with smaller moorings available in creeks around the Estuary.

14.7.2 Navigational environment

The Scheme is located on the northern shore of the Humber. The area is covered by Admiralty Chart 1811 (UKHO, 2017) which is a primary source of navigational information for mariners. The chart shows that there are marked anchorages, a buoyed channel and cardinal marks in the main channel approximately two nautical miles to the south of the Scheme. The area surrounding the project seaward is marked as intertidal area with a drying height of 2 m indicated by a green area on an Admiralty chart meaning that it is unlikely commercial and large recreational vessels will be able to navigate close to the shoreline. See Plate 14.2 for principal navigational features.

Plate 14.2: Principal Navigational Features



14.7.3 Harbour Authority

ABP is the SHA for the Humber Estuary. ABP's, duties and responsibilities as a SHA are drawn from the history of Acts and legislation. ABP, by virtue of the Humber Conservancy Acts 1852-1907 and the Humber Harbour Reorganisation Scheme 1966, and plus the Confirmation Order 1967, is empowered as the Conservancy and Navigation Authority for the River Humber. ABP exercises its powers and duties as harbour authority for the Humber through Humber Estuary Services (HES), an independent body under the authority of the Harbour Master 'Humber' who assume responsibility for the safe operation of the harbour.

The principal responsibility for navigational safety lies with the Harbour Master 'Humber' who is empowered to regulate shipping by virtue of Section 52 and 53 of the 'Harbours, Docks and Piers Clauses Act' 1847, amplified as necessary by special Acts and Bye-laws. For the purposes of these clauses, the most important aspect is the power to give direction. This level of control enables the Harbour Master to regulate the movements of traffic within the harbour area to minimise the risk of collision and ensure the safe and timely movement of vessels. This control is exercised through Vessel Traffic Services (VTS) and the Pilotage Service. ABP is also the Local Lighthouse Authority within the meaning of the Merchant Shipping Act 1995, and by virtue of the Pilotage Act 1987 is the Competent Harbour Authority responsible for the provision of pilotage services.

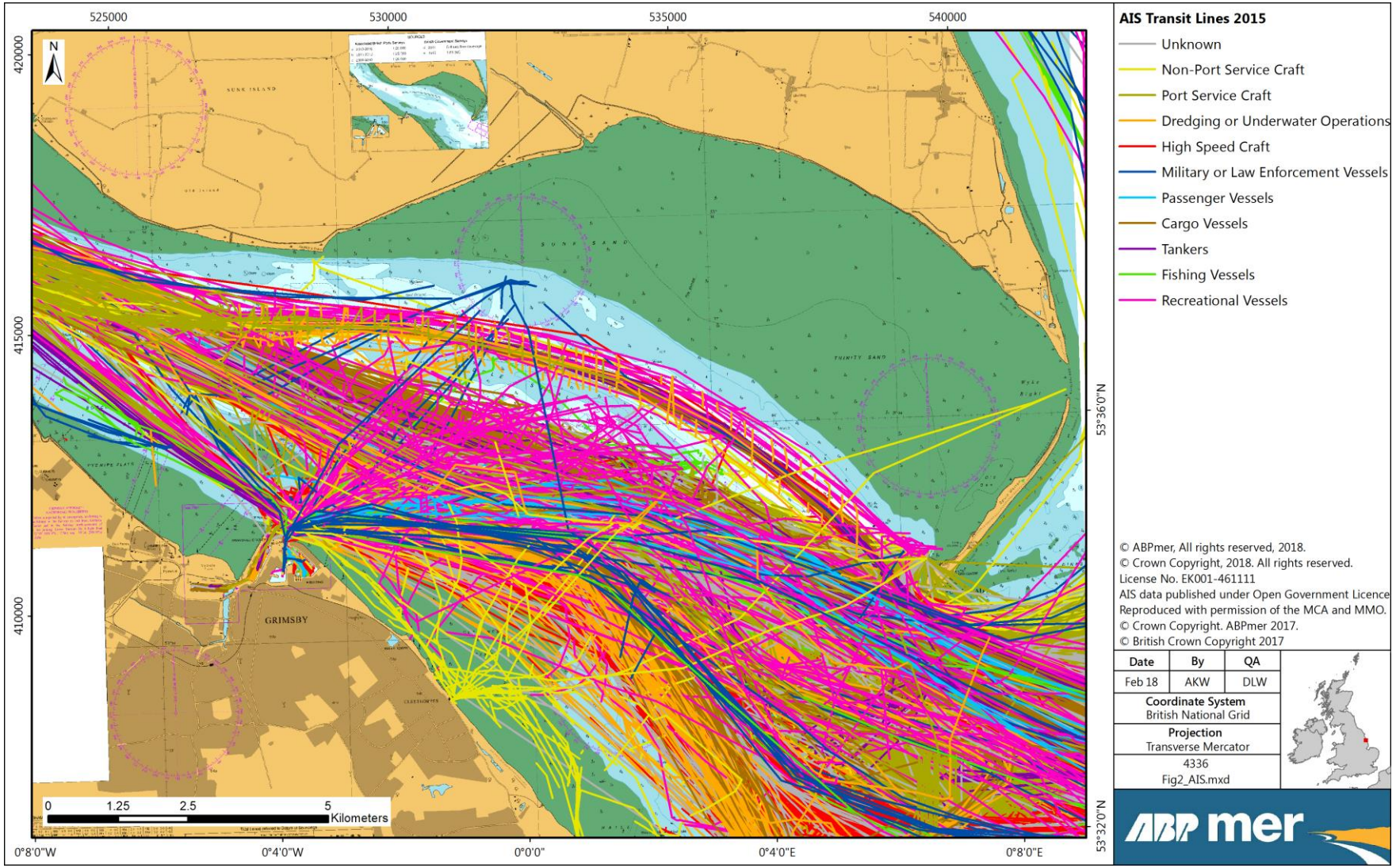
Vessels inbound requiring the service of an authorised pilot must give twelve hours advance notice to VTS. Vessels leaving estuary berths (other than the Trent or Ouse) must give at least two hours warning of departure. Under the Pilotage Act 1987 Masters of vessels who are regular users of the Estuary may apply for a Pilotage Exemption Certificate (PEC). Subject to successful completion of the qualifying trips and other necessary pre-requisites and examination, a PEC is issued, which allows the certificate holder to pilot their own vessel between defined locations.

ABP's VTS for the Humber Estuary is operated from a control centre at Grimsby with vessel planning and pilotage administration operated from Grimsby. 'VTS Humber' provides information and Traffic Organisational Service (TOS) for arrival, berthing, anchorage and departures of vessels from the sea approaches to the Humber Bridge and an Information Only (IO) service above the Humber Bridge. VTS Humber acts as the focal point for navigational safety information, tidal information and vessel movement within the Estuary.

14.7.4 Vessel Transits

AIS data, representative of 84 days of AIS collected in 2015 has been used to create transit lines. This data has been obtained from Maritime and Coastguard Agency (MCA) information, released by the Marine Management Organisation (MMO) for the purposes of marine planning, and is the latest Government data available for this purpose. Transits within the study area are shown in Plate 14.3 which are broken down into classes of vessel identified by type. The vessel types have been taken from AIS classifications inherent within the AIS signal.

Plate 14.3: Vessel transits



It can be seen from Plate 14.3 that there are no vessel transits in the vicinity of the Scheme. Commercial vessels draught is too large to transit the area adjacent to the Scheme as it is located in the intertidal area. Recreational vessels would only be able to navigate at high water, however the lack of moorings and accessibility to the shore mean that it is unlikely that they would navigate in the area. At the closest point, vessels transit approximately 1.2 nm from the project boundary.

14.7.5 Recreational Navigation

The Humber Estuary has approximately 1,000 permanent berths for recreational craft, which are used mainly by recreational sailors, predominantly at the weekend. There are also around 120 visitors' berths, which increase activity in the Estuary. A further category of recreational navigation comprises trailer sailors (vessels launched and recovered via a road trailer) owners of personal power craft (jet bikes and skies) and small unpowered watercraft (kayaks etc) who launch from public slipways around the Estuary. Established recreational vessel destinations in the Humber Estuary include:

- Hull Marina, which has accommodation for 312 boats and 20 visitor berths;
- Goole Boathouse which offers 140 moorings;
- South Ferriby Marina, which provides accommodation for 100 boats plus 20 visitor berths;
- Meridian Quay Marina (Grimsby Fish Dock), run by the Cruising Association which provides 200 berths plus 20 visitor berths; and
- Grimsby and Cleethorpes Yacht Club which use Royal Dock and Alexandra Dock have 51 berths for permanent boats.

In addition, there are various creeks around the Estuary providing further capacity, namely Tetney Haven (Humber Mouth Yacht Club) where small numbers of moorings are available, Stone Creek (located on the north side of the river opposite Immingham), Hessle Haven and Barrow Haven, which both provide anchorages. The yacht havens of Brough and Winteringham (Humber Yawl Club) also provide limited mooring for small vessels and visiting yachts and motor cruisers (HES, 2008). However, as mentioned in the previous section, the lack of moorings and accessibility to the shore mean that it is unlikely that recreational vessels would navigate in the area of the Scheme.

14.7.6 Emergency Response

14.7.6.1 Harbour authority

HES operate a number of emergency, contingency and risk prevention plans which specify means of raising the alarm, summoning assistance, and establishing the role of those organisations involved in order to co-ordinate the activities necessary to safeguard life, property and the environment in the event of a marine emergency or incident.

14.7.6.2 Royal National Lifeboat Institution

There are two lifeboat stations covering the Humber, located at Spurn Head and Cleethorpes (see Plate 14.4). The following provides a brief overview of each lifeboat station:

- Spurn Head is manned by a voluntary crew and the station operates an all-weather Severn class lifeboat; and
- Cleethorpes is manned by a voluntary crew and the station operates and an inshore D class lifeboat.

14.7.7 Marine Incidents

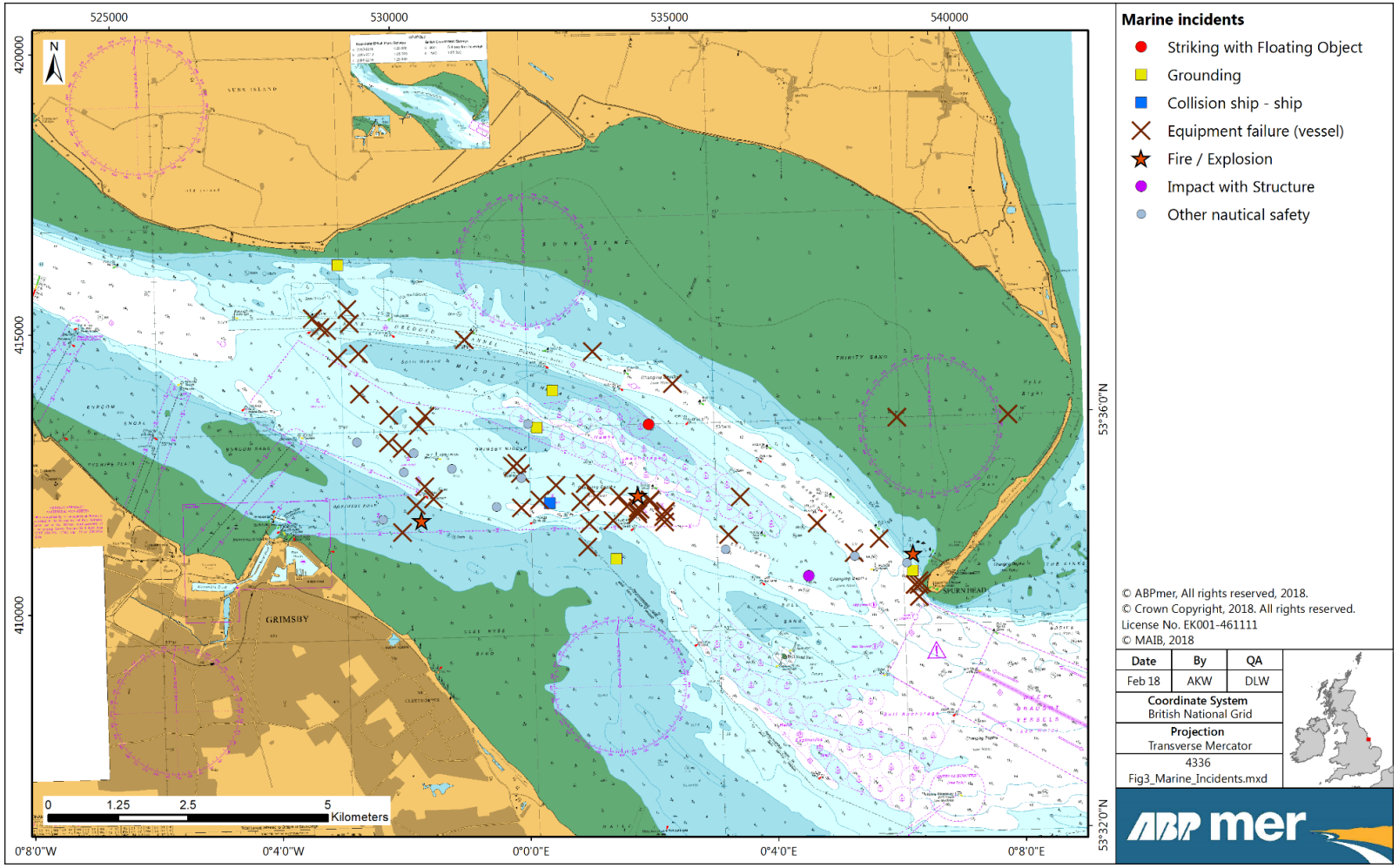
This section reviews marine incidents that have occurred within the study area. The analysis is intended to provide a general indication as to whether the study area is in an area of low or high risk in terms of marine incidents. The ABP MarNIS 'Port Assessment Toolkit' database has been queried to identify any accidents or incidents which have occurred in the area. Table 14.1 details the incidents from the MarNIS database separated by incident type.

Table 14.1: Marine Incidents in the area (2010 - 2017)

Incident type	Year								Total	Incidents per year
	2010	2011	2012	2013	2014	2015	2016	2017		
Collision ship - ship						1			1	0.13
Equipment failure (vessel)	8	6	18	10	8		3	9	62	7.8
Fire/Explosion			1	1	1				3	0.38
Grounding		1	1		2			1	5	0.63
Impact with Structure								1	1	0.13
Other nautical safety					2		6	3	11	1.38
Striking with Floating Object		1							1	0.13
Total	8	8	20	11	13	1	9	14	84	10.5

The majority of incidents in the area are 'Equipment failure (vessel)', specifically reports of vessel defects when entering the SHA area. The closest incident to the project is approximately 1.2 nm to the south-west of the scheme with most incidents occurring in the established shipping routes approximately 2.5 nm to the south. The incidents have been shown spatially in Plate 14.4.4.

Plate 14.4: Marine Incidents



14.8 Future baseline - highway

Without the introduction of the Scheme, it is assumed that no new roads would be built in the study area and existing roads would continue to be repaired in line with the relevant authorities' current road maintenance programme. Due to the nature of the area being rural and a low number of trip generators, it is assumed that traffic volumes in the study area would remain similar to existing volumes.

14.9 Future baseline – marine navigation

The future growth and development of ports and shipping on a macro level is intrinsically linked to world trade patterns and the economic climate, and is reactive to changing economic circumstances. Shipping volumes bear a direct relationship to the global economic market. As markets react to the changing financial situation, shipping lines respond with services to move goods and people. Economic growth and increasing world trade results in higher levels of shipping and growth of port operations; economic slowdown and recession results in lower levels of global trade and of shipping as a result. The shipping channel is not in the vicinity of the Scheme.

14.10 Likely significant effects: highway traffic

This section assesses the likely significant effects for the two sites. Information on the predicted type and volume of traffic, construction compound locations and construction access routes was provided by the Contractor for this assessment.

The construction work is anticipated to be undertaken over three years between the following periods:

- 2019 – 1st July to 30th September;
- 2020 – 1st April to 30th September; and
- 2021 – 1st April to 30th September.

Both construction compounds and their respective access routes are shown on Figure 3.2 in Appendix 1.1.

Work is likely to be undertaken during day time working hours. Normal working hours will be from 0700 to 1900 Monday to Friday. It is assumed that any work on a Saturday would be undertaken from 0700 to 13.00. Site staff will use the access routes set out to get to the site and will park in the site compounds. The majority of staff will park at the main compound, and car-sharing will be encouraged. Staff would be likely to arrive between 0630 and 0730 and leave between 1830 and 1930 on a weekday and 1300 and 1330 on a Saturday. It is assumed deliveries would not be occurring on a weekend.

During the rest of the year, it is expected that there will only be a small number staff on site for security and to carry out vegetation clearance.

It has been assumed that two-thirds of the vehicles associated with construction workers will be travelling to the western site with the remaining one-third travelling to the eastern site.

The Contractor has provided estimated traffic generated figures regarding the works that need to be undertaken for the Scheme. At the time of writing, information relating to these vehicle movements split between the two sites was not available, so these movements have been considered, followed by a summary of the implications for the individual sites (section 14.10.1). Further assessment of each site individually is undertaken in sections 14.10.2 and 14.10.3.

14.10.1 Both Sites

14.10.1.1 Earthworks

Table 14.2 shows the traffic generated for the 'Earthworks' requirements for the two sites. The assumptions for each task are below the table. The figures shown are 'monthly' totals, and where these appear initially high, a daily total (excluding weekends) has been calculated in the 'Notes' column.

One task that appeared, from its monthly total, to generate a significant amount of traffic is:

- 'Lime for stabilisation of roads and fill' - 350 estimated vehicles in 2020 equated to:
    - May & June 2020: 4 vehicles per day.

From Table 14.2, the estimated traffic generated trips associated for the 'Earthworks' requirements would appear not to have an effect upon the local highway network. These are deemed to be negligible and therefore the significance has been considered to be of **no effect**. These figures fall beneath the minimum values set out in the DfT (30 two-way trip peak hour) guidance document. Activities will be coordinated to take place at different times of the day. Therefore, vehicles arriving for each task would be at separate times to each other.

Table 14.2: Earthworks Traffic Generation

Earthworks - ITEMS IN CURRENTLY PLANNED WORKS	Unit	Contractor Vehicle Estimates			Vehicles Per Month 2019 - July 2020 & 21 - April			Vehicles Per Month 2019 - Aug - Sept 2020 & 2021 - May - Sept			Notes
		2019	2020	2021	2019	2020	2021	2019	2020	2021	
Mobilise Earthworks Plant Items to Site (1)	-	10	48	48	8	38	38	1	2	2	
Demobilise Earthworks Plant Items from Site (1)	-	10	48	48	8	38	38	1	2	2	
		Contractor Vehicle Estimates			Vehicles Per Month						
Fuel Deliveries for plant (2)	-	-	-	-	8	8	8	-	-	-	
		Contractor Vehicle Estimates			Vehicles Per Month 2020 & 2021 - May & June			Vehicles Per Month 2020 & 2021 - July - Sept			
Lime for stabilisation of roads and fill (3)	3,400t	-	120	50	-	30	13	-	20	8	

Crushed Stone to Cap limed roads (3)	10,000t	-	350	150	-	88	38	-	58	25	May 2020 figures equate to 4 vehicles a day.
		Contractor Vehicle Estimates			**2020 – Vehicles Per Month**			**2021 (Over 6 months)**			
		2019	**2020**	**2021**	**July**	**Aug**	**Sept**	**Per Month**			
Geogrid to place under Embankment (4)	301,900m2	-	15	5	-	8	8	1			

Note - figures have been rounded

Assumption (1) 80% over 1st month each season, 20% spread remainder each season

Assumption (2) 2 per week

Assumption (3) 50% over 1st 2 months each season, 50% spread remainder each season

Assumption (4) Nothing first month 2020. Remainder spread over each season

14.10.1.2 Other Activities

Table 14.3 shows the traffic generated for the 'Other Activities' that need to be undertaken for the Scheme. The assumptions for each task are below the table. The figures shown are 'monthly' totals, and where these appear initially high, a daily total (excluding weekends) has been calculated in the 'Notes' column.

Tasks that appeared, from the monthly totals, to generate a significant amount of traffic are:

- Crushed stone import (access road, compounds, platforms etc) - 1000 estimated vehicles in 2019 equated to:
    - July to September 2019: 15 vehicles per day;
- Crushed stone import (footpaths, drains) – 845 estimated vehicles in 2020, and 800 in 2021 equated to:
    - August & September 2020: 20 vehicles per day;
    - August & September 2021: 18 vehicles per day.
- Disposal of Compounds, Access Roads & Vegetation - equated to:
    - April & May 2020: 4 vehicles per day;
    - June to September 2020: 2 vehicle trips per day;
    - April to July 2021: 3 vehicle trips per day;
    - August & September 2021: 19 vehicle trips per day.

From Table 14.3, the estimated traffic generated trips associated with 'Other Activities' would appear not to have an effect upon the local highway network. These are deemed to be negligible and therefore the significance has been considered to be of **no effect**. These figures fall beneath the minimum values set out in the DfT (30 two-way trip peak hour) guidance document. Activities will be coordinated to take place at different times of the day. Therefore, vehicles arriving for each task would be at separate times to each other.

Table 14.3: Other Activities Traffic Generation

Other Activities - ITEMS CURRENTLY IN PLANNED WORKS	Unit	Contractor Vehicle Estimates			Vehicles Per Month 2019 - July 2020 & 21 - April			Vehicles Per Month 2019 - Aug & Sept 2020 & 2021 - May - Sept			Notes
		2019	2020	2021	2019	2020	2021	2019	2020	2021	
Plant General - Mobilise to site (1)	-	15	10	5	12	8	4	3	2	1	-
Plant General - De-Mobilise from site (1)	-	5	10	15	4	8	12	1	2	3	-

		Contractor Vehicle Estimates			Vehicles Per Month 2019 - July - Sept	Vehicles Per Month 2020 - July - Sept	
		2019	2020	2021	2019	2020	
Crushed Stone import - Access Roads, Compounds, platforms etc. (2)	23,600t	1000	180	-	333	60	Approx. 15 vehicles per day for 2019 figures

		Contractor Vehicle Estimates			Vehicles Per Month 2020 - Aug & Sept	Vehicles Per Month 2021 - Aug & Sept	
		2019	2020	2021	2020	2021	
Crushed Stone import - Footpaths, Drains (3)	44,900t	-	845	800	423	400	Approx. 20 (2020) and 18 (2021) vehicles per day
Geotextiles for Paths, erosion protection, badgers etc. (3)	353,800m2	-	18	18	9	9	-

		Contractor Vehicle Estimates			Vehicles Per Month 2019 - July - Sept	Vehicles Per Month 2020 - July - Sept	
		2019	2020	2021	2019	2020	
Concrete (4)	360m3	60	20	-	20	7	-

		Contractor Vehicle Estimates			Vehicles Per Month			Vehicles Per Month		
					July - Sept	Apr & May	June - Sept	April - July	Aug & Sept	
		2019	2020	2021	2019	2020	2020	2021	2021	
Disposal of Compounds, Access Roads, vegetation etc. (5)	28,400 t	50	300	1070	17	100	25	54	428	Approx. vehicles per day: 2020: 4 (Apr & May) & 2 (June - Sept) 2021: 3 (Apr - July) & 19 (Aug - Sept)

		Contractor Vehicle Estimates			Vehicles Per Month 2019 - July - Sept 2020 & 2021 - Apr - Sept			
		2019	2020	2021	2019	2020	2021	
Allowance for various other plant/materials (6)	-	50	30	20	17	5	3	-

Note - figures have been rounded

As

As(

As

As

AsJ

As

14.10.1.3 Risk Items

The activities listed in Table 14.4 are 'Risk Items' which relate to activities that may not occur during the Scheme. A task relating to 'Large scale import of Embankment Fill if on site Unsuitable' was included in this list but no timescales were given to provide trip generation levels.

Table 14.4 shows the traffic generated from the 'Risk Activities'. The assumptions for each task are also shown below the table. The figures shown are 'monthly' totals, and where these appear initially high, a daily total (excluding weekends) has been calculated in the 'Notes' column.

Tasks that appeared, from their monthly totals, to be of some significance were:

- Lime Stabilised Haul Road material if not suitable to retain – 2550 estimated vehicles in 2021 equated to:
    - June to September 2021: 29 vehicle trips per day.
- Historic Landfill disposal if Capping solution not acceptable – 765 estimated vehicles in 2020 equated to:
    - June & July 2020: 17 vehicle trips per day.

From Table 14.4, the estimated traffic generated trips associated with the 'Risk Items' tasks would appear not to have an effect upon the local highway network. The effects on local highway network are deemed to be negligible and therefore the significance has been considered to be of **no effect**. These figures fall beneath the minimum values set out in the DfT (30 two-way trip peak hour) guidance document. It is assumed that activities would be coordinated to take place at different times of the day. Therefore, vehicles arriving for each task would be at separate times to each other.

14.10.1.4 Summary

Overall, considering all the vehicle movements outlined above, the movements for both sites combined would not exceed the DfT 30 two-way trip peak hour threshold, and are not anticipated to have an effect on the local highway network; therefore, the movements relating to either site on its own would not have an effect.

Table 14.4: Risk Items Trip Generation

Risk Items	Unit	Contractor Vehicle Estimates			2021 Vehicles Per Month		Notes
		2019	2020	2021	2021		
Lime Stabilised Haul Road material if not suitable to retain (1)	30,000 m^3	-	-	2550	638		Approx. 29 vehicles per day (excluding weekends)
		2019	2020	2021	Vehicles Per Month		
					June 2020	July 2020	
Historic Landfill disposal if Capping solution not acceptable (2)	9,000 m^3	-	765	-	383	383	Approx. 17 vehicles per day (excluding weekends)
Access track to Landfill disposal if place on L/fill not acceptable (2)	1,250 m^3	-	113	-	57	57	-

No

As

As

14.10.2 Outstrays Managed Realignment

14.10.2.1 Construction

To access the western site, construction traffic and abnormal loads are expected to travel along Haven Road and Outstray Road to access Outstray Farm where the main site compound will be located.

The characteristics of each road has been set out in section 14.6.1. From these characteristics, Haven Road would be suitable for two-way construction traffic.

However, Outstray Road's characteristics state that this road is a single track with widths of between 3 and 3.5m. Vehicles are only able to pass at a few passing places along its length. Although this road would be suitable for use, the CTMP needs to set out options for more passing places to allow for better two-way movement.

Following the delivery of the plant items, which are set out in section 14.8.1, construction staff vehicles will then commence to arrive and depart at the western site. It has been estimated that a total of approximately 30 staff vehicles will be undertaking 60 two-way trips to the western site each day arriving in the morning and departing in the evening. The expected arrival times on site are between 0630 and 0730, therefore with 30 vehicles arriving this averages at a vehicle every two minutes. Vehicles will leave site approximately between 1830 and 1930, averaging out at one every two minutes. However, these time periods may extend, therefore spreading the number of vehicles arriving or leaving over a longer time period.

No vehicles are expected to leave the site in the morning period, or enter during the evening period, therefore the risk of two vehicles meeting should will be low. Both of these time periods are also outside of the standard peak hour periods of 0800 to 0900, and 1700 to 1800.

For 2019, most of the construction plant vehicles will arrive on site in July and remain until the end of September, as most of the movements associated with the construction phase are expected to be site-internal earthworks, including moving material between different parts of the site. For 2020 and 2021, most of these vehicles will arrive on site in April and remain until the end of September each year.

These low generated vehicle figures are not expected to be an issue on the local highway network as they fall beneath the minimum values set out in the DfT (30 two-way trip peak hour) guidance documents. Therefore, these impacts have been deemed to have a negligible receptor sensitivity and negligible magnitude. The significance has therefore been calculated to be of **no effect**, following the methodology in Chapter 4.

For each of the years, once these vehicles are site-internal, they will not be operating and having a potential effect on the local highway network. However, at the end of September each year, the vehicles will be exiting the site.

Occasional movements to and from the site for general supplies, maintenance of the construction vehicles on site and fluctuating plant requirements will also take place. These occasional trips have been deemed to have a negligible receptor sensitivity and negligible magnitude impact. The significance has then been calculated to be of **no effect**.

Public Transport Users

With regards to public transport users, the receptor sensitivity has been deemed negligible, and the magnitude negligible due to lack of proximity of the site from the closest public transport stops. The significance has then been calculated to be of **no effect** to public transport users.

14.10.2.2 Operation

While there may be increases in visitor numbers to the site following completion of the western site, it is anticipated that the absolute numbers of visitors to the site are expected to be low in terms of private vehicles.

Both the receptor sensitivity and magnitude have both been deemed negligible. The significance has therefore been calculated to be of **no effect**.

14.10.3 Welwick to Skeffling Managed Realignment

14.10.3.1 Construction

To access the eastern site, construction traffic and abnormal loads are expected to travel along Skeffling Road (B1445) until they research the junction to the newly constructed access route. From the characteristics set out in section 14.6.2, Skeffling Road would be suitable for two-way construction traffic.

To access the site from Skeffling Road, vehicles will travel down a newly constructed access track that shall lead to Humber Side Road and then the site. The specifications and design guidance of the new access track will be set out in the CTMP for this site.

Following the delivery of the plant items, which are set out in section 14.8.1, it has been estimated that a total of 15 staff vehicles will be undertaking two-way trips to the eastern site each day during the morning (between 0630 and 0730) and evening periods (1830 and 1930). The effects on local highway network are deemed to be negligible and therefore the significance has been deemed to be of **no effect**. These figures fall beneath the minimum values set out in **the** DfT (30 two-way trip peak hour) guidance document.

Occasional movements to and from the site for general supplies, maintenance and fluctuating plant requirements will also take place. These occasional trips have been deemed to have a negligible receptor sensitivity and magnitude. The significance has therefore been calculated to be of **no effect**, on the local highway network when they occur.

Public Transport

With regards to public transport users, the receptor sensitivity has been deemed negligible, and the magnitude negligible due to lack of proximity of the site from the closest public transport stops. The significance has then been calculated to be of **no effect** to public transport users.

14.10.3.2 Operation

While there may be increases in visitor numbers to the site following completion of the eastern site, including the construction of a new car park accommodating 10 vehicles, the absolute numbers of visitors to the site is expected to be small. Therefore, both the

receptor sensitivity and magnitude have both been deemed negligible. The significance has therefore been calculated to be of **no effect**.

14.11 Likely significant effects: marine navigation

14.11.1 Outstrays Managed Realignment

14.11.1.1 Construction Phase

The baseline information presented shows that there is not currently any use of the immediate area of the Outstrays Managed Realignment for either commercial or recreational vessels. Vessel navigation in this area is restricted by the large intertidal area meaning that there would only be sufficient depth of water to navigate close to the Outstrays Managed Realignment at high tide; vessels are not currently thought to use the area around the site for this reason. This also means that the Outstrays Managed Realignment is unlikely to affect emergency response or result in accidents relating to vessels.

There are no vessel activities associated with the Scheme and the potential effects to physical estuarine processes are likely to be localised (see Chapter 7 Physical Processes), so there will be no impact on commercial or recreational navigation associated with the Outstrays Managed Realignment.

Overall navigation on the Humber Estuary is considered to be of international importance given its contribution to trading relationships and the UK and regional economy. The sensitivity of this receptor is therefore classified as **Very high**. The magnitude of change in parameters that could influence navigation is considered to be **Negligible** and as such the significance of environmental effect is classified as **No effect**.

14.11.1.2 Operational Phase

During the operational phase of the Outstrays Managed Realignment there will be no vessel activities associated with the scheme. As described for the construction phase, there is no vessel traffic which uses the area adjacent to the Outstrays Managed Realignment. Similarly, potential effects to physical estuarine processes are likely to be localised, so there will be no impact on commercial or recreational navigation associated with the Outstrays Managed Realignment.

Overall navigation on the Humber Estuary is considered to be of international importance given its contribution to trading relationships and the UK and regional economy. The sensitivity of this receptor is therefore classified as **Very high**. The magnitude of change in parameters that could influence navigation is considered to be **Negligible** and as such the significance of environmental effect is classified as **No effect**.

14.11.2 Welwick to Skeffling Managed Realignment

14.11.2.1 Construction Phase

The baseline information presented shows that there is not currently any use of the immediate area of the Welwick to Skeffling managed realignment for either commercial or recreational vessels. Vessel navigation in this area is restricted by the large intertidal area meaning that there would only be sufficient depth of water to navigate close to the Welwick to Skeffling Managed Realignment at high tide; vessels are not currently thought to use the area around the site for this reason. This also means that the Welwick to Skeffling Managed Realignment is unlikely to affect emergency response or result in accidents relating to vessels.

There are no vessel activities associated with the Scheme and the potential effects to physical estuarine processes are likely to be localised (see Chapter 7 Physical Processes), so there will be no impact on commercial or recreational navigation associated with the Welwick to Skeffling Managed Realignment.

Overall navigation on the Humber Estuary is considered to be of international importance given its contribution to trading relationships and the UK and regional economy. The sensitivity of this receptor is therefore classified as **Very high**. The magnitude of change in parameters that could influence navigation is considered to be **Negligible** and as such the significance of environmental effect is classified as **No effect**.

14.11.2.2 Operational Phase

During the operational phase of the Welwick to Skeffling Managed Realignment there will be no vessel activities associated with the scheme. As described for the construction phase, there is no vessel traffic which uses the area adjacent to the Outstrays Managed Realignment. Similarly, potential effects to physical estuarine processes are likely to be localised, so there will be no impact on commercial or recreational navigation associated with the Welwick to Skeffling Managed Realignment.

Overall navigation on the Humber Estuary is considered to be of international importance given its contribution to trading relationships and the UK and regional economy. The sensitivity of this receptor is therefore classified as **Very high**. The magnitude of change in parameters that could influence navigation is considered to be **Negligible** and as such the significance of environmental effect is classified as **No effect**.

14.12 Mitigation: highway traffic

This section sets out the mitigation measures for the two sites. A number of mitigation measures were discussed at a meeting held on 29th August 2018 between Environment Agency, the Contractor, East Riding of Yorkshire Council and Jacobs.

Even though no effects were anticipated, the measures set out below will still be implemented.

14.12.1 Outstrays Managed Realignment

14.12.1.1 Construction

As a part of the western site's development, a CTMP is to be developed to show how the construction traffic will be managed. Appropriate routes and travel time periods will be selected to minimise impacts on the highway network.

With planned routes for the construction traffic in place, this would reduce the likelihood of construction-related traffic travelling on parts of the local highway network that may be unsuitable for them.

To reduce the impact on normal traffic utilising Haven Road, passing places will be introduced in case vehicles come up against construction traffic at narrower points on the network. The locations of the passing places will be identified in the CTMP. Pre- and post-works condition surveys will be proposed, so any defects can be picked up and addressed if necessary.

Wheel wash facilities will be provided to stop the spread of mud and debris onto the local highway network which will have an impact on the effectiveness of the existing road surface. These two aspects of improving the local highway network will reduce the level of risk to a low level.

Information will be given to the residents of Patrington, so they are aware of when and where plant vehicle movements will occur.

14.12.1.2 Operation

It is considered that there will be no mitigation measures required for the western site when it is in operation.

14.12.2 Welwick to Skeffling Managed Realignment

14.12.2.1 Construction

As a part of the eastern site's development, a CTMP is to be developed to show the access arrangements and how all the construction traffic will be managed. Appropriate routes and travel time periods will be selected to minimise impacts on the highway network.

With planned routes for the construction traffic in place, this would reduce the likelihood of construction related traffic travelling on parts of the local highway network that may be unsuitable for them.

To access the site, vehicles will be travelling along a newly constructed access track, which will be accessed via Skeffling Road (B1445) approximately 530m to the east of the Skeffling Road/Humber Side Road junction. This access track will run for approximately 1km and then connect into Humber Side Road, which connects to the site compound. The CTMP will identify any requirements for a holding area on each end of the access track which could be signal controlled to avoid conflicts on the track. There may also be a requirement to widen the first 30m of the access track to accommodate two HGV vehicles so vehicles are not queuing on Skeffling Road (B1445). Once construction has been completed, this construction track will be removed and the land will be returned to how it was before construction.

The stretch of Humber Side Road that will be used to access the eastern site will be resurfaced and have adequate passing places provided. The placing of these passing places will be set out in the CTMP.

Wheel wash facilities will also be provided to stop the spread of mud and debris onto the local highway network which could have an impact on the effectiveness of the existing road surface.

14.12.2.2 Operation

It is considered that there will be no mitigation measures required for the eastern site when it is in operation.

14.13 Mitigation: marine navigation

14.13.1 Outstrays Managed Realignment

There has been no mitigation identified for commercial and recreational navigation for the Outstrays Managed Realignment.

14.13.2 Welwick to Skeffling Managed Realignment

There has been no mitigation identified for commercial and recreational navigation for the Welwick to Skeffling Managed Realignment.

14.14 Residual effects: highway traffic

This section will look at the residual effects for the two sites once the above mitigation is implemented.

14.14.1 Outstrays Managed Realignment

14.14.1.1 Construction

Following implementation of the mitigation measures during construction, a **minor beneficial** effect on the local highway network may occur. This is because passing places to be installed on Haven Road and Outstray Road would be in use once construction has finished, and a post-works survey would lead to any defects being addressed.

14.14.1.2 Operation

There are no residual effects identified for the highway network for the Outstrays Managed Realignment.

14.14.2 Welwick to Skeffling Managed Realignment

14.14.2.1 Construction

Following implementation of the mitigation measures during construction, a **minor beneficial** effect on the local highway network may occur, relating to the improved condition of the southernmost section of Humber Side Road (due to resurfacing).

14.14.2.2 Operation

There are no residual effects identified for the highway network for the Welwick to Skeffling Managed Realignment.

14.15 Residual effects: marine navigation

14.15.1 Outstrays Managed Realignment

There are no residual effects identified for commercial and recreational navigation for the Outstrays Managed Realignment.

14.15.2 Welwick to Skeffling Managed Realignment

There are no residual effects identified for commercial and recreational navigation for the Welwick to Skeffling Managed Realignment.

15 Air quality

15.1 Introduction

This chapter assesses the likely significant effects of the proposed Scheme on local air quality during construction. Effects on air quality during the operation phase of the Scheme have been scoped out given the limited emissions from maintenance/habitat management activities and passive operation of the flood defences, and are not considered further.

The pollutant of concern relevant to the construction phase of the Scheme is Particulate Matter (PM_{10} and $PM_{2.5}$). Dust is defined by the Institute of Air Quality Management (IAQM) as solid particles up to 75 µm in diameter that are suspended in air and can give rise to soiling, as well as human health and ecological impacts. PM_{10} and $PM_{2.5}$ fall within IAQM's definition of dust, as they are suspended particles with aerodynamic diameters of less than 10 µm and 2.5 µm respectively. $PM_{2.5}$ and PM_{10}, which includes primary mineral components such as aluminium, silicon, iron and calcium, are typically found in coarse dusts from construction and demolition work.

15.2 Regulatory and policy framework

The European Union (EU) Framework Directives 96/62/EC and 2008/50/EC on ambient air quality and cleaner air for Europe provides regulations pertaining to the assessment of air quality as well as sets limit values for relevant pollutants, known as Air Quality Standards (AQS). Limit Values are set for individual pollutants and are made up of a concentration value, an averaging time over which it is to be measured, the number of exceedances allowed per year, if any, and a date by which it must be achieved.

Local authorities have no legal requirement to meet air quality objectives but are expected to do so to meet statutory EU Directives. The Local Air Quality Management (LAQM) process, as set out in Part IV of the Environment Act (1995) and the AQS, places an obligation on all local authorities to regularly review and assess air quality in their areas, and to determine whether air quality objectives are being achieved or not.

Where it is anticipated that an air quality objective will not be met, it is a requirement of the Act that an Air Quality Management Area (AQMA) is declared. Where an AQMA is declared, the local authority is obliged to produce an Action Plan in pursuit of the achievement of the air quality objectives.

The AQS of most relevance to the proposed Scheme is PM due to suspended dust from construction stages, and from traffic emissions as a result of the use of Heavy Goods Vehicles (HGVs), thus NO_2 is subsequently emitted and relevant to the assessment. AQS objective guidelines for NO_2 and PM_{10} are shown in Table 15.1 below.

Table 15.1: Air Quality Standards for NO_2 and PM_{10}

Pollutant	Concentrations	Averaging Period
Nitrogen Oxides (NO_x) (for the protection of vegetation and ecosystems)	30 µg/m^3	Annual Mean
Nitrogen Dioxide (NO_2)	200 µg/m^3 not to be exceeded more than 18 times a year	1-Hour Mean
	40 µg/m^3	Annual Mean
Particulates (PM_{10}) (gravimetric)	50 µg/m^3 not to be exceeded more than 35 times a year	24-Hour Mean
	40 µg/m^3	Annual Mean
Particulate Matter ($PM_{2.5}$) (for human health)	25 µg/m^3	Annual Mean

15.3 Methodology

The assessment of the air quality impacts associated with the construction phase of the Scheme will follow the Institute of Air Quality Management (IAQM) '*Guidance on the assessment of dust from demolition and construction activities*' (2014). The full criteria for each classification is provided in Appendix 15.1.

15.3.1 Study area

The proposed Scheme is situated within the administrative boundary of the East Riding of Yorkshire Council (ERYC) – see Figure 2.1 in Appendix 1.1. To date, the ERYC has no declared AQMAs. The 2015 Air Quality Updating and Screening Assessment for ERYC, prepared in fulfilment of Part IV of the Environment Act, 1995, indicates that air quality within the East Riding is generally good and within AQS Objectives.

15.3.1.1 Key sensitive receptors

Human receptors are identified up to 350m from the construction boundary shown in Figure 15.1, Appendix 1.1, while ecological receptors are considered up to 50m from the construction boundary.

The construction of the Scheme is partially within four ecological designated sites:

- Humber Estuary SAC;
- Humber Estuary SPA;
- Humber Estuary Ramsar site; and
- Humber Estuary SSSI.

15.3.2 Baseline data collection

As the two sites are found in an area that is characterised by a very low variability in terms of sources of air pollutants, the baseline conditions pertaining to the Outstrays

Managed Realignment (western site) and the Welwick to Skeffling Managed Realignment (eastern site) have been consolidated and described below.

There are two principal methods used for measuring air quality, either using passive sampling techniques, such as diffusion tubes, or via continuous (automatic) monitoring equipment. Local authorities progressively adapt their air quality monitoring strategies in accordance with the air quality issues specific to the area and to the requirements of the LAQM system. The majority of monitoring undertaken within local authorities focus on NO_2 and PM, as the concentrations of other pollutants generally fall below levels that are considered to be harmful.

ERYC monitor NO_2 and PM_{10} concentrations by automatic monitors and NO_2 from a network of diffusion tubes positioned at various locations throughout the area.

The latest available results pertaining to the three automatic monitoring stations located in the ERYC are from 2012. According to the 2015 Air Quality Updating and Screening Assessment for ERYC, efficiency measures saw the decommissioning of these automatic monitoring stations, in favour of an enhanced roadside network of NO_2 diffusion tubes (non-automatic). In 2012, the closest automatic monitoring station to the Scheme was at Beverley Station, located approximately 9 km north-west of the Scheme area. The 2012 annual average NO_2 concentration at this location was 29 µg/m³, which is below the mean annual AQS Objective for NO_2 of 40 µg/m^3.

There were 77 NO_2 diffusion tubes located within the ERYC area in 2016, which measured an annual average NO_2 concentration ranging from 16 to 53 µg/m³. Of the 77 diffusion tubes, 4 were noted as exceeding the AQS objective. Of the monitoring positions, the closest to the Scheme is Hazeldene, Main St, Keyingham, in operation since August 2013, located approximately 14 km west-north-west of the Scheme. In 2016, the monitoring site recorded an annual average NO_2 concentration of 24 µg/m³, below the AQS Objective.

Background data from the grid squares for ERYC have been downloaded from the Defra website for the current year (2017) and the project construction commencement date (2019), as summarised in Table 15.2. These have been projected using the updated 2015 based reference year background maps. As indicated in Table 15.2, background concentrations, both average and maximum, are below the respective AQS objectives.

Table 15.2: ERYC background pollutant concentrations for current year (2017) and construction commencement year (2019)

Pollutant	2017 Maximum Concentration (µg/m³)	2017 Average Concentration (µg/m³)	2019 Maximum Concentration (µg/m³)	2019 Average Concentration (µg/m³)
NO_x	30.3	12.0	28.7	11.2
NO_2	20.4	9.0	19.5	8.4
PM_{10}	20.2	13.4	20.0	13.3
Exceedances with the AQS Objectives are shown in **bold**.				

15.3.3 Impact assessment

The IAQM guidance ('*Guidance on the assessment of dust from demolition and construction activities*', 2014) addresses the risks of dust impacts from four construction activities: demolition, earthworks, construction and trackout (transport of

dust and dirt offsite by vehicles via public road networks). The risk is determined through combination of the scale and nature of the works, with the sensitivity of the surrounding area. Sensitive receptors (i.e. locations where members of the public are likely to be exposed to pollutant concentrations over a long period of time) have been identified to advise the overall sensitivity of the local area. These receptors can be either human or ecological and are chosen based on their sensitivity to dust soiling or deposition, and exposure to PM_{10}. Once the level of risk has been ascertained, site-specific mitigation measures are selected proportionate to the outcomes of the assessment.

There will be HGV movements across the Scheme during the construction phase. Based on available data, for both sites combined throughout the construction phase, there is expected to be no greater than 50 outward movements in any one day (see Chapter 14 Traffic and Transport for more detail).

Note that the estimated figures above exclude worker movements to and from site, which is not considered to represent a concern for air quality.

Because the project's construction phase is anticipated to require less than 50 HGV movements per day, according to the IAQM guidance: 'Land-Use Planning and Development Control' (v1.1, May 2015), the need for a detailed assessment has been scoped out and the impact is considered to be not significant.

15.4 Uncertainties, assumption and limitations

The main sources of uncertainty with this assessment relate to:

- Data regarding construction activities and the related timescale;
- Limited information in terms of existing air quality conditions; and
- Data regarding meteorological conditions that can affect the generation of dust (e.g. abnormal dry conditions during summer could increase the amount of dust generated on site).

15.5 Existing environment

As displayed in Table 15.2, the baseline level of NO_2 and PM_{10} is well below the AQS level; therefore, the current baseline conditions are expected to be comfortably within the limit. This is supported by available information on the surrounding environment, including a lack of major sources of air pollution, such as industries, large urban areas and trafficked roads within the vicinity of the Scheme.

15.6 Future baseline

Should the Scheme not occur, the future baseline conditions are likely to continue to be comfortably within national air quality limits due to a lack of major sources of air pollution, such as industries, large urban areas and trafficked roads. Should there be any major developments in the area in the future, the forecasted baseline air quality conditions should be revised accordingly.

15.7 Likely significant effects

The main pollutants of concern most relevant to the construction phase of both sites include NO_2 and PM, associated with the movement of construction vehicles within each site. These pollutants are known to have detrimental cardiopulmonary (heart and lung) effects on the human body and can trigger increased hospital admissions and contribute to premature mortality. They can also have adverse impacts on sensitive ecological receptors through dry deposition, which can alter photosynthetic processes, affecting ecosystem health (IAQM, 2016).

Dust deposition onto properties can lead to complaints and may constitute a statutory nuisance (IAQM, 2016).

Ecological designated sites sensitive to nitrogen deposition and nitrogen oxides associated with road traffic emissions, could be affected by changes in emissions associated with the construction of both the eastern and western sites.

15.7.1 Outstrays Managed Realignment

Following IAQM guidance for the assessment of impacts (dust soiling, human health, and ecological) associated with the different construction phases, the overall significance of risk is considered to be Medium to Negligible during Demolition (dismantling of existing structures or features), High to Low during Earthworks (excavation and/or rearrangement of existing soils), Low to Negligible during Construction (construction of new structures or features), and Medium to Low during Trackout (outward movement of vehicles from site generating dust emissions).

See Appendix 15.1 for full findings and the outlined receptor sensitivity considered in this assessment.

15.7.2 Welwick to Skeffling Managed Realignment

Following IAQM guidance for the assessment of impacts (dust soiling, human health, and ecological) associated with the different construction phases, the overall significance of risk is considered to be Medium to Negligible during Demolition, High to Low during Earthworks, Low to Negligible during Construction, and Medium to Low during Trackout.

See Appendix 15.1 for full findings and the outlined receptor sensitivity considered in this assessment.

15.7.3 Construction traffic

The construction of both sites may also affect air quality due to tailpipe emissions from HGVs. Note that tailpipe emissions (e.g. NO_x) are separate to dust emissions ($PM_{2.5}$ and PM_{10}) generated from construction and demolition activities. According to the IAQM guidance, where a large number of vehicle movements are expected to be generated over a long period of time (i.e. one year or more) in the same location, the impact of construction phase traffic should be considered. For this Scheme, construction activities are likely to take place between July and September in 2019 and April and September in 2020 and 2021, thus HGV movements will be expected through

this period.Yhe impact on local air quality from tailpipe emissions of construction phase traffic will be insignificant. Tailpipe emissions have not been scoped in for assessment.

15.8 Mitigation

15.8.1 Outstrays Managed Realignment

During the construction phase of the western site, best practices to limit the formation of dust will be in place in order to minimise the risk for significant effects resulting from onsite activities. For example, water abstraction for dust suppression is likely to be required. This would be abstracted from Winestead Drain (see Chapter 3). Requirements for implementation of best practice pollution prevention, including measures for dust suppression, will be included within the Environmental Action Plan and further information and requirements will also be included in the Construction Traffic Management Plan.

15.8.2 Welwick to Skeffling Managed Realignment

During the construction phase of the eastern site, best practices to limit the formation of dust will be in place in order to minimise the risk for significant effects resulting from onsite activities. For example, water abstraction for dust suppression is likely to be required. This would be abstracted from Winestead Drain (see Chapter 3). Requirements for implementation of best practice and measures for dust suppression will be included within the Environmental Action Plan and further information and requirements will also be included in the Construction Traffic Management Plan.

15.9 Residual effects

15.9.1 Outstrays Managed Realignment

Although multiple receptors were identified within proximity of the western site, assuming best practice and standard dust mitigation measures are put in place prior to the commencement and during the construction phase, short-term impacts can be avoided, and **no residual effect** is anticipated from the temporary construction works. In terms of traffic during the construction phase, residual effects are considered as **not significant** as there are no exceedances directly linked to the proposed works in these sites.

15.9.2 Welwick to Skeffling area

Although multiple receptors were identified within proximity of the eastern site, assuming best practice and standard dust mitigation measures (see section 15.6) are put in place prior to the commencement and during the construction phase, short-term impacts can be avoided, and **no residual effect** is anticipated from the temporary construction works. In terms of traffic during the construction phase, residual effects are considered as **not significant** as there are no exceedances directly linked to either of the schemes.

16 Noise and Vibration

16.1 Introduction

This chapter contains the assessment of effects from construction noise expected from the works to construct the proposed Scheme. Existing baseline noise levels have been monitored, and calculations undertaken of the predicted noise and vibration levels during construction. This is to assess any potential effects from construction noise at the closest, worst case, residential receptor locations. The potential effects from construction noise and vibration on ecological receptors are examined in Chapter 10 Terrestrial Biodiversity and Chapter 11 Marine Biodiversity, and the residual effects are summarised in this chapter, Section 16.9.

Significant operational noise effects are not expected given the small scale of any maintenance/habitat management activities and passive operation of the flood defences and has therefore previously been scoped out of the assessment for residential receptors. However, operational noise effects on ecological receptors are considered as part of an assessment of noise and visual disturbance in Chapters 10 and 11.

In addition, possible impacts from vibration during construction have also been scoped out. Intervention or maintenance works have also been scoped out as these are likely to be of low scale, short in timescale, and are considered best dealt with by noise control at the time of the works. The only activities likely to have any vibration impact is piling at Winestead-Outstrays pumping station and at Welwick bushes. However, since these activities are due to be undertaken in excess of 1,000m from the closest residential receptors, any effects would be negligible and so vibration is not considered further in this assessment for residential receptors.

16.2 Regulatory and policy framework

16.2.1 Control of Pollution Act 1974 (CoPA)

The Control of Pollution Act (CoPA) 1974 grants powers to deal with noise nuisances. Much of CoPA has been replaced and extended by the Environmental Protection Act 1990. However, Sections 60 and 61 which relate to noise and vibration from construction sites remain relevant.

Section 60 (S60) of CoPA allows a local authority to serve a notice of its requirements for the control of site noise to the individual or entity carrying out or controlling the works. The notice may stipulate noise limits for work, particular plant or machinery that should be avoided, hours during which construction activities may be carried out and provide for any change in circumstances.

Section 61 (S61) of CoPA concerns the procedures adopted when a contractor or developer approaches the local authority prior to any construction activities taking place, with the intention of agreeing noise and vibration limits in advance of works.

If consent is granted under S61, then this would be considered a valid defence by the Magistrate's court if the local authority was to later reverse its position and pursue an action under S60.

16.2.2 Environmental Protection Act (EPA) 1990

Part III, Section 79, of the Environmental Protection Act 1990 (EPA 1990) defines what activities may constitute a Statutory Nuisance, and what activities are specifically exempt. The Section imposes a duty on local authorities to periodically survey environmental noise levels and to investigate noise complaints. The Act requires local authorities to serve notice when noise nuisance exists. Under these statutory nuisance provisions, the operators of a site or facility could be required to adopt best practicable means to abate noise nuisance at any time once operations have commenced. It is, therefore, essential that potential nuisance effects are properly considered, so as to ensure that the operators are seen to adopt best practice, and that any potential requirements for mitigation are considered.

16.2.3 British Standard BS 5228:2009+A1:2014 "Code of practice for noise and vibration control on construction and open sites – Part 1: Noise"

This code of practice provides guidance and recommendations on methods for the measurement of construction noise and assessing its impact on those exposed to it. It also makes reference to the legislative background to noise control on construction sites, and gives recommendations for basic methods of noise control. Also, suitable methods are provided for the calculation of noise from construction activities, including basic information regarding noise levels from a range of construction equipment.

Part 1: Noise, of BS 5228 provides suitable methods for the calculation of noise from construction activities, including basic information regarding noise levels from a range of construction equipment. For the calculation of construction noise at the receptor locations the selected A-weighted sound power levels of the plant and equipment are corrected to consider: the "Percentage On-time" (portion of time in which the equipment is operating at its maximum power); "Duration of Activity" (amount of time in relation to the "Shift Duration" in which the equipment is expected to operate); distance between sound sources and receptors; percentage of soft ground; and any screening corrections from obstacles between the sound propagation path.

16.3 Methodology

16.3.1 Study area

For the purpose of this assessment, the study area for the Scheme consists of the two sites (the western site Outstrays Managed Realignment and the eastern site Welwick to Skeffling Managed Realignment). These two sites have been assessed separately, although for noise it is possible that works in one site may impact on receptors within the other site if they are closer. Construction noise effects have been studied at the closest sensitive receptors from the location of the works.

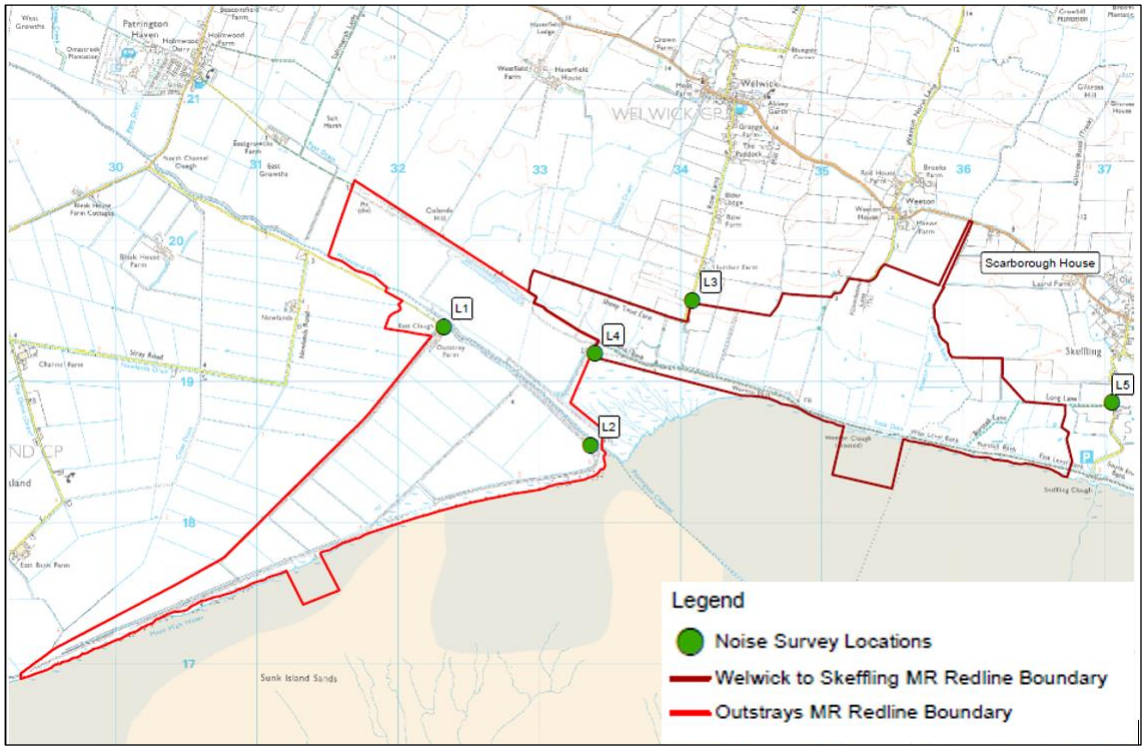
16.3.2 Baseline data collection

Noise measurements were undertaken on the 26th October 2017 to establish existing noise conditions in the area of the Scheme. Survey locations were chosen to either be representative of the closest residential noise sensitive receptors or ecological receptors, and these are shown in Plate 16.1 and also on Figure 16.1 in Appendix 1.1.

The noise measurement equipment used comprised 01dB Solo Sound Level Meters (serial numbers 61046 and 61083). The meters were calibrated using a 01dB CAL21 Sound Level Calibrator (serial number 51031300). The sound level meter was calibrated prior to and on completion of each measurement. No significant drifts in calibration level occurred. The microphone was located in free-field position (i.e. away from any large reflecting surfaces) in all the survey locations.

There was a light wind (<5m/s) from the west throughout the measurements and occasional spits of rain. These conditions are considered suitable for environmental noise measurements.

Plate 16.1: Noise survey locations for both sites



For all measurements it is considered that the time periods measured are sufficient to provide a good representation of the daily noise levels in the area. It is assumed no work will be undertaken at night, hence no noise measurements have been undertaken during this period. In addition, it is assumed that the measured weekday noise levels would be similar at those experienced in the area at the weekend.

At L3 the intention was to measure close to the nearby Humber Farm. However, during the survey there were a considerable amount of noisy activities taking place at Humber Farm which would have elevated the background to a non-representative level. A location on the corner of Row Lane and Sheep Trod Lane was therefore selected and it is considered that this would provide an indication of representative noise levels at Humber Farm.

During the baseline noise survey there were no measurements undertaken in a location which could be considered representative of Manor Farm and Scorborough House, near Weeton (see Plate 16.1 for the locations of these receptors). These were not included in the survey as with them being so close to a dominant noise source (i.e. the B1445), the noise level could be predicted and so a measurement was not required.

In order to obtain an indication of the baseline noise level in this area, reference can be made to the strategic noise maps produced by DEFRA in 2012 (http://extrium.co.uk/noiseviewer.html). Due to the low traffic flow on the B1445, this road was not included within the DEFRA noise maps. The closest road to be included in the DEFRA mapping was the A1033, which indicated a daytime noise level of around 65 dB(A) at 25m from the road. This level of 65 dB(A) can be taken and an estimate made of corrections for traffic flow and the fact that the side of the dwelling facing the works is partially screened from the B1445. Taking into account the reduced flow and lower speed limit, a correction of -5 dB(A) is considered appropriate for the traffic. For partial screening, BS 5228-1 uses -5 dB(A), so this can be applied in this situation. This would then provide a level of 55 dB(A), which is considered appropriate for a baseline level at Manor Farm and Scorborough House.

16.3.3 Impact assessment

This section describes the calculation methodology that has been used in the assessment to estimate the noise level from each of the proposed construction activities at the nearest sensitive receptors.

Calculation of noise propagation outdoors is undertaken in line with the methodology set out in ISO 9613-2:1996: “Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation” (ISO, 1996) contained in BS 5228:2009+A1:2014: “Code of practice for noise and vibration control on construction and open sites”. The sound power levels from onsite activities during these phases were based on data available in BS 5228-1:2009+A1:2014 (BSI, 2014a).

An indication of the plant and equipment complement that may be used for each phase of the construction works is presented in Appendix 16.1. The information in its table is based on experience of similar projects and information provided by scheme designers on likely construction methods. It should be considered as indicative, and subject to change upon appointment of a contractor. The proposed working hours that have been considered for the calculations were as follows:

- 07:00 to 19:00 hrs Monday to Friday, referred to as weekday.
- 07:00 to 13:00 hrs Saturday, referred to as weekend.

The assessment of noise and vibration on ecological receptors can be found in Chapter 10 Terrestrial Biodiversity and Chapter 11 Marine Biodiversity. A summary of the residual noise and vibration effects on ecological receptors is included in this chapter, Section 16.9.

In order to assess the noise effects on ecological receptors during construction, baseline and predicted noise levels were provided to the scheme ecologists for the two piling locations and at regular distances from the two piling locations. Piling is anticipated to be the noisiest activity, so this was used to assess the worst-case in terms of noise effects. For assessment of vibration effects on ecological receptors, professional judgement was used, based on an understanding of the proposed piling

methods. Operational effects of noise on ecological receptors have been considered as part of an assessment of noise and visual disturbance from recreational visitors; this assessment is based on professional judgement and experience from other sites.

16.3.4 Assessment criteria

16.3.4.1 Construction noise

Annex E of BS 5228-1 describes methods for evaluating the potential significant effect of construction noise depending on the existing noise level at the site. The Annex presents the ABC method which considers that a potential adverse effect is indicated when the site noise level exceeds the value listed in an A/B/C category which is dictated by the existing noise level.

Table 16.1 from Table E.1 in BS 5228-1 Annex E provides impact thresholds for construction activities at residential premises based on the ABC Method. In relation to construction noise, day is 07:00 to 19:00, evening is 19:00 to 23:00 and night is 23:00 to 07:00.

Table 16.1: ABC method for assessing construction noise at dwellings

Reference Period	Threshold value L_{Aeq}, [dB]		
	Category A [1]	Category B [2]	Category C [3]
Daytime weekdays (07.00−19.00) Daytime Saturdays (07.00−13.00)	65	70	75
Evenings weekdays (19:00-23:00) Saturdays (13.00–23.00) Sundays (07.00–23.00)	55	60	65
Night-time weekdays and weekends (23:00-07:00)	45	50	55
[1] Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values. [2] Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as category A values. [3] Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than category A values.			
Note 1: A potential significant effect is indicated if the L_{Aeq}, daytime noise level arising from the site exceeds the threshold level for the category appropriate to the ambient noise level.			

Source: BSI, 2014a

The effects of construction noise are temporary and defined by the intrusion that construction noise causes in the existing noise environment (or soundscape) of the area. If, when considering mitigation, the noise levels are still above the relevant threshold in Table 16.2, BS 5228-1 states that noise insulation may be offered (using the discretionary powers provided by Regulation 5 of the Noise Insulation Regulations) if those noise levels remain for a long enough period of time (i.e. for a period of 10 or more days of working in any 15 consecutive days or for a total number of days exceeding 40 in any 6 consecutive months (BSI, 2014a)).

16.3.5 Assessment of significance

16.3.5.1 Magnitude of impact

The magnitude of the impact from the results of the construction noise when applying the ABC method are assessed following the criteria in Table 16.2.

Table 16.2: Criteria for classifying the magnitude of impact from construction noise

Magnitude	Noise Criteria based on the ABC Method [1]
Major negative	>10 dB above the threshold criteria of the relevant ABC category
Moderate negative	3.0 to 9.9 dB above the threshold criteria of the relevant ABC category
Minor negative	0.1 to 2.9 dB the threshold criteria of the relevant ABC category
Negligible	Below the threshold criteria of the relevant ABC category
[1] Refer to Table 16.1 where the criteria of the ABC method contained in BS 5228-1 is presented.	

16.3.5.2 Sensitivity of Resource

The identification of the sensitivity of the receptors in proximity to the construction works is set out in Table 16.3. The receptors sensitivity category is based upon Table 4.2 in Chapter 4 Methodology, and the receptor type definition is based upon the guidance in HA205/08 (Highways Agency, 2008).

Table 16.3: Criteria for classifying the Sensitivity and Value of Receptors

Receptor Sensitivity (Value)	Receptor Type Definition
Very High	International designated area, special cases for noise or vibration sensitivity
High	Residential, educational buildings, medical facilities
Medium	Hotel, community facilities and places of worship
Low	Commercial buildings (e.g. offices)
Negligible	Farmland, Industrial premises

Residential receptors have been identified within the study area, hence the value of these receptors have been classified with a High sensitivity.

16.3.5.3 Significance of Effect

The significance of effect is determined from the combination of the receptor's sensitivity and the magnitude of impact. In order to address any potential significant adverse effect, the criteria presented in Chapter 4 Methodology have been followed. Magnitude is only presented for increases of noise (negative impact scale) as there would not be any decreases expected. A significant adverse effect is considered to be where the effect is assessed as Moderate or Major.

16.4 Uncertainties and limitations

A noise assessment requires the prediction of the noise produced by various activities which use various items of plant. Until a contractor is actually on-site there is always uncertainty surrounding exact methods of construction and items of plant that will be used. Although every effort has been made to gather this information, there will remain some uncertainty over these assumptions.

16.5 Existing environment

16.5.1 Outstrays Managed Realignment

The noise measurement survey results for the western site, together with the observations made during the survey, are summarised in Table 16.4.

Table 16.4: Noise Measurement Results Summary for the western site

Location	Time Start	Duration	Measured Noise Level, dB				Observations
			$L_{Aeq,T}$	L_{Afmax}	$L_{A90,T}$	$L_{A10,T}$	
L1	10:08	14-min	50.0	68.5	35.6	47.7	Background noise included occasional cars using the nearby car park and occasional overflying aircraft and helicopter.
	11:42	25-min	48.2	67.1	34.3	48.7	
Average			49.2	-	35.0	48.2	
L2	09:04	1-hour	39.7	59.4	34.9	40.6	Background noise included bird song and occasional overflying helicopter.
L3	11:07	30-min	36.3	60.0	29.5	38.3	Background noise included distant road traffic from B1445, birdsong and occasional overflying aircraft.
L4	11:38	15-min	34.3	45.9	30.5	36.9	Background noise included distant road traffic from B1445, birdsong and occasional overflying aircraft.

16.5.2 Welwick to Skeffling Managed Realignment

The noise measurement survey results for the eastern site, together with the observations made during the survey are summarised in Table 16.5.

Table 16.5: Measurement Results Summary for the eastern site

Location	Time Start	Duration	Measured Noise Level, dB				Observations
			$L_{Aeq,T}$	L_{Afmax}	$L_{A90,T}$	$L_{A10,T}$	
L3	11:07	30-min	36.3	60.0	29.5	38.3	Background noise included distant road traffic from B1445, birdsong and occasional overflying aircraft.
L5	09:08	30-min	39.3	64.7	29.2	41.3	Background noise included distant road traffic noise from B1445, birdsong and occasional overflying aircraft.

16.6 Future baseline

The future baseline noise levels of the area without the Scheme are considered to be the same as at the present. There may be a slight growth in traffic over time, but this is expected to generate negligible increases in noise. No major changes in land use in the area are anticipated without the Scheme

16.7 Likely significant effects

16.7.1 Construction Noise Impacts

The proposed managed realignment scheme will involve undertaking a number of construction activities, listed in Table 16.6, for which the noise impacts have been assessed. For each site in turn, the calculation methodology set out in BS 5228-1 has been employed to estimate the noise level at sensitive receptors from each of the proposed activities. The predicted noise levels have been added to the measured baseline L_{Aeq}.

Table 16.6: Construction activities for each site likely to produce noticeable levels of noise

Scheme	Construction activities
Outstrays Managed Realignment	• construction of the main compound at Outstrays Farm; • new earth embankment; • sheet pilling at Winestead-Outstrays pumping station; • sheet piling at Welwick Bushes; • cut material for new flood defence; and • removal/lowering and breaching of existing flood bank. • Use of Outstray Road to access the site
Welwick to Skeffling Managed Realignment	• construction of the satellite compound south of Weeton; • new earth embankment; • new drainage; • cut material for new flood defence; • haul route usage; • removal/lowering and breaching of existing flood bank; and • construction of access track via B1445 to site

16.7.2 Outstrays Managed Realignment

Receptors have been identified for each of the activities at the western site and are listed in Table 16.7 together with the associated calculated construction noise levels at the closest construction activities. It has been assumed Outstrays Farm will be vacant during construction, hence the next closest sensitive receptor has been identified as being Newlands Farm. It is considered that the noise measurements undertaken at Outstrays Farm are representative of Newlands Farm.

Table 16.7: Calculated Construction Noise Levels at the western site

Activity	Receptor (assumed representative measurement location)	Closest distance to construction activities (m)	Predicted noise level from construction activity	
			weekday	weekend
Construction of the compound	Newlands Farm (L1)	750	49.2	49.2
New earth embankment	East Bank Farm Cottages (L1)	750	49.3	49.3
	Humber Farm (L3)	450	40.1	39.5

Activity	Receptor (assumed representative measurement location)	Closest distance to construction activities (m)	Predicted noise level from construction activity	
			weekday	weekend
Sheet pilling at Winestead-Outstrays pumping station	Humber Farm (L3)	800	39.5	39.0
Sheet piling at Welwick Bushes	Newlands Farm (L1)	2,300	49.2	49.2
Cut material for new flood defence	Newlands Farm (L1)	1,000	49.2	49.2
Removal of existing flood bank	Newlands Farm (L1)	200	50.8	50.5
Access track at Patrington leading to Outstrays Road	House between Outstray Rd and Newlands Rd (L1)	10	55	55

The ABC method considers a potential impact when the noise level exceeds the value of the A/B/C category listed in Table 16.1. The category is dictated by the existing noise level at the site hence, category A is considered as the threshold level (i.e. 65 dBA). The exceedances predicted to be above the Category A threshold and where sensitive receptors are identified have been highlighted in Table 16.8.

The resultant magnitude of the impact and significance of effect during weekdays and weekends are presented in Table 16.8, considering the exceedances over Category A and the value of receptors.

Table 16.8: Estimated construction noise impacts at the western site (both weekdays and weekends)

Sensitive receptor	Increase over Category A [dBA][1]	Magnitude of Impact	Significance of Effect
Construction of the compound			
Newlands Farm	0	Negligible	No effect
New earth embankment			
East Bank Farm Cottages	0	Negligible	No effect
Humber Farm	0		
Sheet pilling at Winestead-Outstrays pumping station			
Humber Farm	0	Negligible	No effect

Sensitive receptor	Increase over Category A [dBA][1]	Magnitude of Impact	Significance of Effect
Sheet pilling at Welwick Bushes			
Newlands Farm	0	Negligible	No effect
Cut material for new flood defence			
Newlands Farm	0	Negligible	No effect
Removal of existing flood bank			
Newlands Farm	0	Negligible	No effect
Access track at Patrington leading to Outstrays Road			
House between Outstray Rd and Newlands Rd	0	Negligible	No effect

[1] Increase above the threshold criteria of the relevant ABC category. Category determined based on the existing noise level at the site.

No adverse effects from potential noise impacts during construction are expected on weekdays or at weekends.

16.7.3 Welwick to Skeffling Managed Realignment

Receptors have been identified for each of the activities at the eastern site and are listed in Table 16.9 together with the associated calculated construction noise levels at the closest construction activities.

Table 16.9: Calculated Construction Noise Levels at the eastern site

Activity	Receptor (assumed representative measurement location)	Closest distance to construction activities (m)	Predicted noise level from construction activity	
			weekday	weekend
Construction of the compound	Humber Farm (L3)	950	36.8	36.7
New earth embankment	House at Humber Lane (L5)	300	43.9	43.3
	Manor Farm	500	55.1	55.0
New drainage	Manor Farm	480	55.1	55.0
	Scorborough House	500	55.0	55.0
Cut material for new flood defence	House at Humber Lane (L5)	480	41.2	40.9
	Manor Farm	1,000	55.0	55.0

Activity	Receptor (assumed representative measurement location)	Closest distance to construction activities (m)	Predicted noise level from construction activity	
			weekday	weekend
Haul route usage	Scorborough House	140	45.0	45.0
Removal of existing flood bank	House at Humber Lane (L5)	480	41.2	40.9
Construction of access track	Scorborough House	140	56.2	56.0
	Manor Farm	400	55.1	55.1

The ABC method considers a potential impact when the noise level exceeds the value of the A/B/C category listed in Table 16.1. The category is dictated by the existing noise level at the site hence, category A is considered as the threshold level (i.e. 65 dBA). The exceedances predicted to be above the Category A threshold and where sensitive receptor are identified have been highlighted in Table 16.10.

The resultant magnitude of the impact and significance of effect during weekdays and weekends are presented in Table 16.10, considering the exceedances over Category A and the value of receptors.

Table 16.10: Estimated construction noise impacts at the eastern site (both weekdays and weekends)

Sensitive receptor	Increase over Category A [dBA][1]	Magnitude of Impact	Significance of Effect
Construction of the compound			
Humber Farm	0	Negligible	No effect
New earth embankment			
House at Humber Lane	0	Negligible	No effect
Manor Farm	0		
New drainage			
House at Humber Manor Farm	0	Negligible	No effect
Scorborough House	0		
Cut material for new flood defence			
House at Humber Lane	0	Negligible	No effect
Haul route usage			
Scorborough House	0	Negligible	No effect

Sensitive receptor	Increase over Category A [dBA][1]	Magnitude of Impact	Significance of Effect
Removal of existing flood bank			
House at Humber Lane	0	Negligible	No effect
Construction of access track			
Scorborough House	0	Negligible	No effect
Manor Farm	0		
[1] Increase above the threshold criteria of the relevant ABC category. Category determined based on the existing noise level at the site.			

No adverse effects from potential noise impacts during construction are expected on weekdays or at weekends.

16.8 Mitigation

16.8.1 Construction

Although during the construction of the Scheme no adverse effects are expected for the Outstrays Managed Realignment or the Welwick to Skeffling Managed Realignment works, the use of Best Practicable Means, BPM (as defined in Section 72 of the Control of Pollution Act 1974) will be adopted on site in order to reduce construction noise levels as best practice. Also, where practicable, the control measures set out in BS 5228:2009+A1:2014 Part 1 (BSI, 2014a) will be implemented. These will include:

- The quietest available plant or machinery should be used;
- All equipment should be maintained in good mechanical order and fitted with appropriate silencers, mufflers or acoustic covers;
- Stationary noise sources should be sited as far away from noise sensitive development as possible;
- Acoustic barriers consisting of site materials such as bricks, earth mounds or proprietary types should be constructed when noise cannot be sufficiently reduced by careful siting of noise sources;
- Piling should be carried out by methods causing minimum noise and vibration;
- All workers on site, including sub-contractors, self-employed staff and employees must be made aware of the need to keep noise and disruption to a minimum from building works, equipment, plant and machinery, radios, music, vehicles or any other sources;
- The movement of vehicles to and from the site must be controlled to minimise noise and disturbance to nearby residents;
- Careful selection of working methods and programme;
- Shutting down of equipment when not in use, i.e. maintain a ‘no idling policy’;

- Positioning of equipment behind physical barriers, i.e. existing features, hoarding or purpose built acoustic barriers;
- Directing noise emissions from plant, including exhausts or engines, away from sensitive positions;
- Handling of all materials in a manner which minimises noise, including minimising drop heights into hoppers and lorries;
- Switching all audible warning systems to the minimum setting required by the health and safety executive, and using banksmen as an alternative to audible alarms wherever practicable, and;
- Engaging in community liaison to explore ways of minimising noise impacts and increasing local tolerance to noise.

Implementation of BPM and measures from the British Standard will be a requirement within the Environmental Action Plan for the Scheme. The measures will also be set out in the Construction Traffic Management Plan, which will be agreed with the Local Authority.

16.9 Residual effects

16.9.1 Human receptors

No significant effects have been predicted during the construction works for either site (although mitigation will be applied as best practice) and therefore **no residual effects** are anticipated for residential receptors.

16.9.2 Summary of residual effects on ecological receptors

This section summarises the residual effects from noise and vibration on ecological receptors, as reported in Chapter 10 and Chapter 11. For the full assessment of these effects, please refer to these chapters.

16.9.2.1 Outstrays Managed Realignment

Construction

- No significant noise and vibration effects on Marsh Harrier due to distance from piling works and mitigation in place during West 2 works;
- No significant noise effect (as part of noise and visual disturbance assessment) on water voles in East Clough/Newlands Drain during West 1 works;
- No significant noise effect (as part of noise and visual disturbance assessment) on otter in Haverfield Quarry during West 2 works due to mitigation in place;
- No significant noise and vibration effects on freshwater fish in Winestead Drain due to piling works as noise would dissipate quickly;
- No significant noise and vibration effects on marine fish in the estuary due to piling works as works will be carried out a low tide and propagation of noise into the marine environment will be limited; and

- Minor adverse noise effect (as part of noise and visual disturbance assessment) on coastal waterbirds due to construction activities.

Operation

- No significant effect (as part of noise and visual disturbance assessment) on Marsh Harrier with access restrictions for visitors in place; and
- Minor adverse noise effect (as part of noise and visual disturbance) on coastal waterbirds due to recreational visitors.

16.9.2.2 Welwick to Skeffling Managed Realignment

Construction

- No significant noise and vibration effects on Marsh Harrier due to mitigation in place;
- No significant noise effect (as part of noise and visual disturbance) on otter due to mitigation in place;
- No significant noise and vibration effects on marine fish as works will take place at low tide and noise would not propagate into the marine environment; and
- Minor adverse noise effect (as part of noise and visual disturbance) on coastal waterbirds due to construction activities.

Operation

- No significant effect (as part of noise and visual disturbance assessment) on Marsh Harrier with access restrictions for visitors in place; and
- Minor adverse noise effect (as part of noise and visual disturbance) on coastal waterbirds due to recreational visitors.

17 Other issues

17.1 Introduction

This chapter provides information on potential impacts associated with the Scheme that are not considered likely to give rise to potentially significant environmental effects with the implementation of standard site working practices, but may be of interest to stakeholders and are therefore assessed at a high level. This chapter also outlines the proposals for environmental management and monitoring activities.

17.2 Artificial Lighting

A high-level assessment of potential effects from artificial light was selected due to the location and minimal amount of lighting being introduced by the Scheme (construction phase only). A desk-based study of the site and surrounding area was undertaken to identify potential light sensitive receptors, using ordnance survey maps, plans and aerial photography. Relevant legislation, policy and guidance relating to obtrusive light were also reviewed.

17.2.1 Policy

Relevant legislation and guidance reviewed:

- The National Planning Policy Framework (2012)
- Clean Neighbourhoods and Environment Act 2005
- The Environmental Protection Act 1990
- Planning Practice Guidance – Light Pollution (2014)
- Institute of Lighting Professionals' (ILP) Guidance Notes for the Reduction of Obtrusive Light (2011)

17.2.2 Existing environment

The main existing sources of artificial lighting within and surrounding the Scheme area are individual houses (mainly farmstead properties) within and on the fringes of the settlements of Patrington Haven, Patrington, Welwick, Weeton and Skeffling, along with the associated road network. A large proportion of roads within the Scheme area do not have walls or hedges bordering them, so vehicle headlights are not contained. In addition, lighting from agricultural machinery is present throughout the night during the harvest period (this is a largely agricultural area, so harvest activities dominate the landscape at this time of year). Outside of the harvest period, the area is generally quite dark at night, but it is not a designated Dark Skies area.

Long views towards the Scheme site are available from the edge of surrounding settlements and from isolated properties across the flat, open landscape. Existing visual barriers within the area include undulating topography and built form which

screens most views from Weeton and Welwick; woodland and scrub at Haverfield Quarry; a linear belt of trees at Oustrays Farm and tall hedgerows along Sheep Trod Lane. Trees following watercourses and remnant hedgerows also help to filter views towards the site.

17.2.3 Sensitive receptors

Sensitive receptors to artificial lighting from the Scheme would be individual and farmstead properties in close proximity to the Scheme, including Bleak House Farm, Newlands Farm, Eastgrowths Farm, Humber Farm, Row Farm, Humber View and East View. These receptors are within 1km of the scheme. In addition, Outstrays Farm is adjacent to West 1 but is expected to be vacant during the construction period. Motorists on the nearby roads that are not screened from the site by hedges or walls also have the potential to be sensitive receptors. In addition, artificial lighting from the Scheme has the potential, without mitigation, to affect existing habitats suitable for light sensitive species from glare or intrusion.

17.2.4 Likely significant effects

Artificial lighting required for construction is likely to be minimal, as the majority of works are expected to take place from April to the end of September during the daytime period between the hours of 0700 to 1900 hours. It is possible that artificial lighting at the proposed site compounds and site offices and task-specific lighting may be visible to sensitive receptors as identified in Section 17.1.4. The receptors already experience periods of night-time artificial light during the harvest period, and parts of the eastern site will not be within the line of sight of the construction work due to features within the landscape.

Any lighting that is used, such as tower lights and headlights on construction plant, will be managed through the Construction Environmental Management Plan (CEMP) to minimise light pollution (see 17.5.1), which will ensure that any temporary adverse effects such as glare and intrusion onto these receptors can be avoided. As the construction lighting will be minimal and will be managed through good site working practices, the Scheme is not anticipated to have a significant adverse effect on sensitive receptors from artificial lighting during construction.

There is not expected to be any artificial lighting during the operation of the Scheme (including the car park and footpaths) as any maintenance or inspections will be carried during the daytime. Therefore, no adverse effects on sensitive receptors is anticipated.

If the Scheme was not to proceed, there would be no change in artificial lighting as no major developments are currently planned within this location.

17.2.5 Mitigation

The CEMP will set out the good site working measures to reduce potential adverse effects from artificial lighting associated with the Scheme during the construction phase. The general principles of such measures include the following:

- Lighting should be located away from sensitive receptors (identified in Section 17.2.3) wherever possible;

- Lighting should be directed so it does not intrude (or light intrusion) outside of the immediate working area/site compounds, and switched off when not in use;
- Vehicle lights should be properly directed, and lenses must be intact to prevent unnecessary glare and breakout of obtrusive light;
- If appropriate, to reduce the need for fixed visible lighting outside working hours, the use of infrared floodlighting and CCTV systems should be considered for security;
- All lighting related to the works will be designed and fitted to minimise light intrusion onto any sensitive habitats such as hedgerows and drainage ditches;
- Using appropriately designed luminaires for the task at hand; and
- Use of automated devices to switch lights on and off according to activity/ambient light levels.

17.2.6 Residual effects

Any effects from temporary artificial lighting during the construction phase that may be visible to the sensitive receptors identified in Section 17.2.3 (such as glare and intrusion) can be avoided through implementation of good site working practices as set out in Section 17.1.7, resulting in no residual effects. There is not expected to be any artificial lighting during the operation of the scheme, therefore no residual effects on sensitive receptors is anticipated.

In conclusion, no adverse residual effects are expected in relation to artificial lighting.

17.3 Litter

During construction, there will be an increased presence of personnel (approximately 30) within the area who might bring food and other materials onto the site, which has the potential for introducing litter into the environment. However, it is not envisaged that levels of litter will significantly increase from baseline conditions during the construction period with the implementation of good site working practices. These include:

- Implementation and monitoring of site management procedures including regular litter sweeps within the site and the surrounding environment;
- Recycling and waste facilities to be placed at site compounds in the form of enclosures or containers to prevent material being dispersed by the wind;
- Recycling and waste facilities to be stored securely on site to prevent the escape of litter and protection against vandalism, vermin or outside interference; and
- All employees and contractors to have a Duty of Care when working on site and will dispose of litter at recycling and waste facilities at site compounds only.

During the operation of the Scheme there is anticipated to be an increase in visitor numbers. The site manager will report any fly-tipping/litter incidents to the local authority and/or the Environment Agency.

In conclusion, no adverse residual effects are expected in relation to litter.

17.4 Vermin control

During the construction phase, when the construction site becomes more established with portable site accommodation like site offices, canteens and toilet blocks there is the potential that these facilities can provide harbourages for rodents, such as rats and mice, with the potential further attraction of vermin to any food and waste present on the site. However, these can be managed with the implementation of good site working practices to keep the site clean and tidy, and to manage and dispose of waste streams (such as food products) in an appropriate manner. The site will be monitored and managed in line with the CEMP which will set out these measures, to be prepared by the contractor.

Although the number of visitors during the operation of the Scheme is anticipated to increase compared to current levels and there will be occasional visits by personnel during any maintenance works and inspections, vermin control is unlikely to be needed due to the small presence of site personnel and the nature of the Scheme. The site manager will notify East Riding of Yorkshire Council's Environmental Health Team and the Environment Agency if any vermin outbreaks are identified within the site.

17.5 Environmental management issues

The Scheme will incorporate a sensitive design, mitigation measures and sensitive working methods to minimise potential adverse effects associated with the proposed works. The effective delivery of these measures is therefore central in delivering this objective.

17.5.1 Environmental Action Plan

All mitigation measures identified in this ES necessary to protect the environment prior to and during construction, or during operation of the Scheme, will be incorporated into the contract documents by means of an Environmental Action Plan (EAP). The EAP is provided in Appendix 1.2 and is a mechanism to manage the environmental impacts set out in the ES and ensure compliance with environmental commitments. This will be maintained as a live document throughout Scheme finalisation and delivery, for example by adding any additional commitments that may be required to meet planning conditions.

The EAP includes the requirement for a number of separate method statements and sub-plans relating to specific areas of mitigation (including a Construction Traffic Management Plan, Materials Management Pan and a Site Waste Management Plan). In addition, the EAP provides a starting point for the consideration of the environmental management of the proposed construction activities, which would need to be adopted by the contractor in their CEMP. The CEMP would also need to consider the management and re-use of waste associated with the development, and include a Site Waste Management Plan.

We have defined roles and responsibilities in the EAP to ensure, firstly, the implementation of the mitigation measures, secondly, the monitoring procedures to

check their implementation and thirdly, audit and review mechanisms to ensure that mitigation measures are implemented and adhered to.

The EAP therefore collates mitigation measures identified throughout the ES, both for ease of reference and for use by those overseeing the contract documents. It provides a record of our commitments, and those of the Contractor, which will be incorporated within the contract documents and to which the Contractor will be obliged to adhere to throughout the contract period. Together with contract supervision, the EAP will be used to control any details of design over and above those included in the ES, and the implementation of environmental mitigation and improvement measures (e.g. through

the employment of an Ecological Clerk of Works (ECoW) and/or an Environmental Clerk of Works (ECW)).

17.5.2 Construction phase and post-development monitoring

A number of construction phase and post-development monitoring measures will be implemented for the Scheme. These are outlined in the topic-specific chapters in this ES and the EAP where appropriate and will also relate to conditions from the consents and licences. The Scheme will be monitored after the completion of construction, to ensure that it is delivering on its objectives. This will be in accordance with the Environmental Maintenance and Monitoring Plan for the Scheme, and specific targets for bird species that will be agreed with Natural England. In addition, on completion of the Scheme there will be a Site Manager responsible for overseeing the operation of the Site.

Monitoring of the hydromorphology both sites will be undertaken via the Environment Agency's regular LiDAR monitoring. Any further monitoring requirements will be defined as part of the licence conditions associated with the Scheme for impact verification and objective compliance purposes.

18 Cumulative effects

18.1 Introduction

Cumulative effects derive from a combination of multiple events or developments, which may result in greater or different effects than those resulting from an individual development. In-combination effects occur when a receptor experiences more than one type of environmental effect from the same proposed development. Cumulative effects occur as a result of the likely impacts of the proposed development interacting with the impacts of other developments in the vicinity.

This chapter assesses the in-combination and cumulative effects associated with the construction and operation of the Scheme. In-combination effects and cumulative effects with other developments are considered for each managed realignment site separately, so that the effects of each planning application are clear. The cumulative effects of both managed realignment sites (i.e. the whole Scheme) together are also assessed.

18.2 In-combination effects

18.2.1 Methodology

To determine whether there will be in-combination effects on any receptors, a review of all residual effects from the construction and operation phases of the two sites reported in topic chapters 5 to 17 was undertaken, to identify any receptors that will experience more than one type of effect. Consideration was also given to impacts with a 'negligible' magnitude that result in 'no effect' on their own (see Chapter 4 Methodology) but could result in an effect when combined with other effects. Professional judgement was used to assess whether the in-combination effects would be significant.

18.2.2 Outstrays Managed Realignment

During construction, residents of properties along or just off Outstray Road may experience an in-combination effect relating to construction traffic travelling to and from site, associated noise and dust impacts, and the restriction of access to the site for recreational use (which will be in place throughout construction anyway). Although the traffic, noise and dust impacts would not result in a residual effect on their own, when added together with the access restriction, they may result in an in-combination effect. However, this is not anticipated to be significant and will be controlled by best practice measures and the Construction Traffic Management Plan (CTMP).

Beneficial in-combination effects may occur relating to biodiversity and landscape, as hedgerow planting and reinforcement will benefit the landscape character of the area and provide habitat for farmland birds.

18.2.3 Welwick to Skeffling Managed Realignment

In-combination effects relating to traffic, dust and noise are less likely for the eastern site than the western site, as the construction traffic would be using a specially constructed access track to reach the site from the B1445. Any effect would not be significant and would be controlled by best practice measures and the CTMP.

Beneficial in-combination effects may occur relating to biodiversity and landscape, as hedgerow planting and reinforcement will benefit the landscape character of the area and provide habitat for farmland birds.

18.3 Cumulative effects

18.3.1 Methodology

Three main types of development were considered in this assessment. The study areas vary for each type, to enable a reasonable and proportionate assessment of cumulative effects. The types of development considered are:

- Recently approved, pending and prospective planning applications within 3km of the Scheme;
- Other larger developments or site allocations/policies in the wider Humber area; and
- Other proposed Environment Agency schemes in the Humber Estuary, including the consideration of the delivery of the western and eastern managed realignment sites together.

The 3 km buffer for planning applications was chosen as this area includes all the main villages close to the scheme and encompasses the study areas of the majority of assessments for the individual topics for the Scheme.

ERYC was contacted in October 2018 to request details of any planning applications (including recently approved, pending decision, and upcoming submissions) within 3 km of the Scheme, and any larger developments or site allocations/policies in the wider Humber area, that could result in cumulative effects with the Scheme. A search of the ERYC planning portal was also conducted to identify any other relevant planning applications. ERYC local plan documents were searched for relevant polices and site allocations.

The developments were assessed in combination with first the Outstrays Managed Realignment and then the Welwick to Skeffling Managed Realignment (section 18.3.2.1). Cumulative effects that could arise if the two managed realignment sites both went ahead have also been assessed (section 18.3.2.2).

The following points were considered when assessing likely significant cumulative effects:

- Types and significance of environmental effects of each development;
- Temporal and spatial overlaps of environmental effects; and
- Sensitivity of the existing environment.

18.3.2 Likely significant cumulative effects

18.3.2.1 Other developments in the study area

Table 18.1 contains an assessment of cumulative effects between other developments and the two managed realignment sites.

Table 18.1: Cumulative effects with other developments

Development	Likely significant cumulative effects	
	Outstrays Managed Realignment	Welwick to Skeffling Managed Realignment
(1) 17/04319/STPLFE Construction of a pipeline landward of mean low water springs mark, including the landfall works, beach installation, tunnel beneath the Dimlington Cliff SSSI, installation of the pipeline into the northern boundary of Dimlington Terminal and associated outside storage, car parking and office facilities (in association with the Tolmount Offshore Gas Development) (submitted in tandem with planning application for construction of a new gas reception, separation and metering facility reference 17/04317/STPLFE) Approved 23/05/2018. Not commenced. Land North of Dimlington Terminal, Dimlington Road, Easington, HU12 0TY	Site is approx. 5.9 km from the Outstrays Managed Realignment but construction traffic would be within 3 km. Peak construction traffic flows for the development are likely to increase traffic on the B1445, which could also lead to secondary effects relating to noise, air quality and community safety. However, the peak traffic flow will be in November 2019 when no construction will be taking place on the western site. The CTMP for the western site will be cognisant of other developments in the area. No significant adverse traffic cumulative effects (or associated secondary effects) expected. Due to the distance between the western site and Dimlington Terminal, no other cumulative effects are anticipated during construction or operation.	Site is approx. 2.7 km from the Welwick to Skeffling Managed Realignment. Peak construction traffic flows for the development are likely to increase traffic on the B1445, which could also lead to secondary effects relating to noise, air quality and community safety. However, the peak traffic flow will be in November 2019 when no construction will be taking place on the eastern site. The CTMP for the eastern site will be cognisant of other developments in the area. No significant adverse traffic cumulative effects (or associated secondary effects) expected. Due to the distance between the eastern site and Dimlington Terminal, no other cumulative effects are anticipated during construction or operation.
(2) 17/04317/STPLFE Construction of a new gas reception, separation and metering facility (consisting of an emergency shut down valve (ESDV)), pig receiver, slug catcher and slug catcher separator, condensate stabilisation and metering system, methanol storage tanks, chemical injection methanol pumps, methanol recovery system, pipe rack, condensate de-watering unit, condensate stabilisation unit, condensate pre-heater and flash drum, condensate storage facilities, local	Site is approx. 5.9 km from the Outstrays Managed Realignment but construction traffic would be within 3 km. Peak construction traffic flows for the development are likely to increase traffic on the B1445, which could also lead to secondary effects relating to noise, air quality and community safety. However, the peak traffic flow will be in November 2019 when no construction will be taking place on the western site. The CTMP for the western site will be cognisant of	Site is approx. 2.7 km from the Welwick to Skeffling Managed Realignment. Peak construction traffic flows for the development are likely to increase traffic on the B1445, which could also lead to secondary effects relating to noise, air quality and community safety. However, the peak traffic flow will be in November 2019 when no construction will be taking place on the eastern site. The CTMP for the eastern site will be cognisant of other developments in the area. No significant adverse traffic cumulative effects (or associated secondary effects) expected.

Development	Likely significant cumulative effects	
	Outstrays Managed Realignment	Welwick to Skeffling Managed Realignment
equipment room, hot oil heating system and fired heaters); tie into existing facilities and temporary construction lay down and working areas at Perenco UK Dimlington Terminal (in association with the Tolmount Offshore Gas Development) (submitted in tandem with planning application for onshore pipeline reference 17/04319/STPLFE). Approved 23/05/2018. Not commenced. Perenco, Dimlington Terminal, Dimlington Road, Easington HU12 0TY	other developments in the area. No significant adverse traffic cumulative effects (or associated secondary effects) expected. Due to the distance between the western site and Dimlington Terminal, no other cumulative effects are anticipated during construction or operation.	Due to the distance between the eastern site and Dimlington Terminal, no other cumulative effects are anticipated during construction or operation.
(3) 18/00791/PLF Alterations to existing car park and landscaping layout to serve Engine House development (re-submission of 17/03747/PLF). Provision of 42 car parking spaces, 7 gardens and associated landscaping. Application validated 05/04/2018. Pending Consideration. Engine House Development, Enholmes Lane, Patrington, HU12 0PR	Approx. 2.3 km from the Outstrays Managed Realignment. No cumulative effects anticipated as there is no intervisibility between this development and the western site (so no landscape and visual or setting effects would occur) and they would not use the same access roads from Patrington, and the development would be built on a brownfield site so no cumulative effects relating to loss of agricultural land or habitat are anticipated to occur.	Approx. 3.8km from the Welwick to Skeffling Managed Realignment. No cumulative effects anticipated due to distance.
(4) 18/00822/PLF Erection of 4 dwellings including associated access, hard and soft landscaping (Resubmission of 17/02113/PLF). Application validated 04/04/2018. Pending Consideration. High Street Allotments, High Street, Patrington HU12 0RE	Approx. 2.2 km from the Outstrays Managed Realignment. This development is proposed on a former allotment site in the centre of Patrington, in close proximity to St Patricks Church. This development could affect the setting of Patrington Conservation Area and St Patricks Church; however, the western site would not affect the setting of these assets or views of	Approx. 3.9km from the Welwick to Skeffling Managed Realignment. No cumulative effects anticipated due to distance. The eastern site would not affect views or the setting of Patrington Conservation Area or St Patricks Church.

Development	Likely significant cumulative effects	
	Outstrays Managed Realignment	Welwick to Skeffling Managed Realignment
	them. The development would result in a loss of open space, while the western site would improve access and amenity. No cumulative effects anticipated.	
(5) 17/04034/PLF Conversion of agricultural building to 3 dwellings, erection of single storey extensions to rear following demolition of existing outbuildings. Application approved 31/01/2018. Land and Buildings South of Elder Lodge, Row Lane, Welwick HU12 0SA.	Approx. 1.3 km from the Outstrays Managed Realignment. The development would result in the loss of barn owl roosts but this would be mitigated by installation of a barn owl box as specified in the planning documents. Therefore, no significant cumulative effects with the western site on barn owls are anticipated. Construction programme for the development is unknown but Row Lane would not be used to construct the western site, so no significant adverse cumulative traffic effects are anticipated.	Approx. 0.8 km from the Welwick to Skeffling Managed Realignment. The development would result in the loss of barn owl roosts but this would be mitigated by installation of a barn owl box as specified in the planning documents. Therefore, no significant cumulative effects with the eastern site on barn owls are anticipated. Construction programme for the development is unknown but Row Lane would not be used to construct the eastern site, so no significant adverse cumulative traffic effects are anticipated.
(6) England Coast Path – developed by Natural England A new National Trail around all of England's coast. Proposals are in development for the section between Humber Bridge and Easington. An Access and Sensitive Features Appraisal (including an HRA) is being completed for this project (not yet available).	The England Coast Path is anticipated to adopt the new access alignment through the western site. Likely beneficial cumulative effect on access and amenity as both projects will improve public access along the Humber Estuary shoreline. We have been working with Natural England to ensure that our Scheme and these proposals align. There is currently no PRoW along the estuary edge around Sunk Island adjacent to the western site, outside of site boundary. Any required Coast Path works in this area could occur at the same time as the construction of the	The England Coast Path is anticipated to adopt the new access alignment through the eastern site. Likely beneficial cumulative effect on access and amenity as both projects will improve public access along the Humber Estuary shoreline. We have been working with Natural England to ensure that our Scheme and these proposals align. There are unlikely to be any required Coast Path works adjacent to the eastern site outside of the site boundary as there is already a PRoW along the estuary edge to the east of the site. Therefore, no cumulative effects are anticipated during construction.

Development	Likely significant cumulative effects	
	Outstrays Managed Realignment	Welwick to Skeffling Managed Realignment
	western site. However, it is assumed that any coast path works would be small in scale, such as installing gates and fencing, and therefore no adverse cumulative effects relating to disturbance of coastal waterbirds during construction activities are anticipated. Once both developments are operational there may be an increase in visitor numbers along the new access routes, as a result of both developments. However, a significant adverse cumulative residual effect relating to disturbance of coastal waterbirds is not anticipated, as birds would be expected to become habituated to such disturbance to some extent, and mitigation embedded in the Scheme design will minimise potential disturbance. Measures include screening, fencing and access restrictions. These measures will also protect Marsh Harrier in Haverfield Quarry, and no significant adverse cumulative residual effect is anticipated for this species due to disturbance. The HRA for the Outstrays Managed Realignment concludes no adverse effect on site integrity due to operational disturbance alone or in combination (Appendix 10.2). Natural England is undertaking an Access and Sensitive Features Appraisal of the Coast Path, which will include an HRA, to ensure that it will not result in adverse effects on the integrity of the Natura 2000 site.	Once both developments are operational there may be an increase in visitor numbers along the new access routes, as a result of both developments. However, a significant adverse cumulative residual effect relating to disturbance of coastal waterbirds is not anticipated, as birds would be expected to become habituated to such disturbance to some extent, and mitigation embedded in the Scheme design will minimise potential disturbance. Measures include screening, fencing and access restrictions. The HRA for the Welwick to Skeffling Managed Realignment concludes no adverse effect on site integrity due to operational disturbance alone or in combination (Appendix 10.2). Natural England is undertaking an Access and Sensitive Features Appraisal of the Coast Path, which will include an HRA, to ensure that it will not result in adverse effects on the integrity of the Natura 2000 site.

Development	Likely significant cumulative effects	
	Outstrays Managed Realignment	Welwick to Skeffling Managed Realignment
(7) DCO - River Humber Replacement Pipeline project between Goxhill and Paull. Under construction. Tunnel Boring Machine expected to reach the north side of the estuary by April 2019. The gas pipeline will be installed in spring 2020.	Approx. 16.5 km from the Outstrays Managed Realignment. Any disturbance to coastal waterbirds would be during construction and localised to the pipeline entrances. No adverse cumulative effect expected due to distance from the western site. No other cumulative effects are anticipated due to the distance from the site.	Approx. 18.7 km from the Welwick to Skeffling Managed Realignment. Any disturbance to coastal waterbirds would be during construction and localised to the pipeline entrances. No adverse cumulative effect expected due to distance from the eastern site. No other cumulative effects are anticipated due to the distance from the site.
(8) Environment Agency - Maintenance, ad hoc and small-scale repairs to flood defences assets around the estuary. Ongoing.	Maintenance works are consistent with the management approach in the Humber FRMS HRA (2011), and are carried out under individual Area (Yorkshire, Lincolnshire etc) Agreements. Maintenance works will be small-scale in nature, so no cumulative effects anticipated during the construction or operation of the western site.	Maintenance works are consistent with the management approach in the Humber FRMS HRA (2011), and are carried out under individual Area (Yorkshire, Lincolnshire etc) Agreements. Maintenance works will be small-scale in nature, so no cumulative effects anticipated during the construction or operation of the eastern site.
(9) 18/01058/FULL ERYC in partnership with the Environment Agency Humber: Hull Frontage Flood Defence Improvement Scheme on the Humber north bank. Major upgrade to the existing tidal flood defences along the Humber edge of the city of Hull to reduce the risk of flooding to 113,000 properties. Land Adjacent to Humber Estuary, Including St Andrews Quay, St Andrews Dock, William Wright Dock, Albert Dock, Island Wharf, Humber Dock Basin, Victoria Pier, Victoria Dock Village and West	Approx. 21km from the Outstrays Managed Realignment. The construction periods of both developments are anticipated to overlap. However, no adverse cumulative effects are anticipated due to the distance between the sites.	Approx. 25km from the Welwick to Skeffling Managed Realignment. The construction periods of both developments are anticipated to overlap. However, no adverse cumulative effects are anticipated due to the distance between the sites.

Development	Likely significant cumulative effects	
	Outstrays Managed Realignment	Welwick to Skeffling Managed Realignment
Application approved 21/12/2018. Preliminary works have begun. The scheme is expected to be complete by March 2021.		
(10) Environment Agency - Paull Holme Strays on the Humber north bank Works to flood embankments. Construction ongoing. Works are due to be completed end November 2018, with possible final work in spring 2019.	Approx. 13km from the Outstrays Managed Realignment. The construction periods of both developments are unlikely to overlap as work on the western site is expected to start in July 2019. No adverse cumulative effects are anticipated due to this and due to the distance between the sites.	Approx. 15km from the Welwick to Skeffling Managed Realignment. The construction periods of both developments are unlikely to overlap as work on the eastern site is expected to start in July 2019. No adverse cumulative effects are anticipated due to this and due to the distance between the sites.
(11) Environment Agency - Donna Nook Managed Realignment on the Humber south bank. Main works completed, possible construction works to breach the flood bank from the estuary side will be carried out in Spring 2019 (but uncertain at present), which would be expected to take approximately six weeks.	Approx. 23km from the Outstrays Managed Realignment. The construction periods of both developments are unlikely to overlap as work on the western site is expected to start in July 2019. No adverse cumulative effects are anticipated due to this and due to the distance between the sites.	Approx. 20km from the Welwick to Skeffling Managed Realignment. The construction periods of both developments are unlikely to overlap as work on the eastern site is expected to start in July 2019. No adverse cumulative effects are anticipated due to this and due to the distance between the sites.
(12) Environment Agency - Humber Estuary Erosion Protection (HEEP) on both Humber banks throughout the estuary. Minor works to improve erosion protection around the estuary. The programme of works is still to be finalised and an HRA will be completed. Project in development.	It is uncertain how close these works would be to the Outstrays Managed Realignment. The key effect from HEEP may be direct habitat loss in the SAC/SPA, but as the western site will be creating habitat, no cumulative effects are anticipated.	It is uncertain how close these works would be to the Welwick to Skeffling Managed Realignment. The key effect from HEEP may be direct habitat loss in the SAC/SPA, but as the eastern site will be creating habitat, no cumulative effects are anticipated.

18.3.2.2 Outstrays Managed Realignment and Welwick to Skeffling Managed Realignment together

The Outstrays Managed Realignment and the Welwick to Skeffling Managed Realignment will have similar types of effects on sensitive receptors as the proposals are similar for each site. These effects are assessed for each site separately in detail in Chapters 5 to 17 and are considered together here. The only significant adverse residual effects (significant in terms of the EIA Regulations) anticipated as a result of the two sites individually are visual effects on some receptors during construction, and significant beneficial residual effects are anticipated relating to biodiversity, access and amenity and socio-economics (see summary in Chapter 19).

In terms of non-significant adverse residual effects, during construction, both sites alone are anticipated to result in residual adverse effects relating to loss of agricultural land, restricted public access, disturbance to coastal waterbirds, views from certain points and setting of some heritage assets. During operation, both sites alone are anticipated to result in adverse residual effects relating to disturbance of coastal waterbirds.

Non-significant beneficial residual effects include those relating to educational opportunities during construction for both sites, remediation of the landfill area within the Welwick to Skeffling Managed Realignment and provision of new intertidal habitat for estuarine fish species.

Given the potential for there to be similar potential environmental effects on the same receptors of both sites, combining the effects of both sites could be anticipated to result in 'additive' cumulative effects, rather than 'synergistic' effects that interact to produce a different nature of the final impact compared with the individual impacts. Potential additive effects could have a greater magnitude and therefore significance than for the individual effect.

As both sites will be constructed at the same time, construction-related noise, dust, visual effects and traffic from both sites would occur simultaneously. However, the effect on individual receptors is not anticipated to be greater than the effects reported in Chapters 5 to 17, as the combined effects, if any, remain local in scale. For example, residential properties in Weeton may experience adverse dust effects from construction works at the eastern site, but will not be affected by the works at the western site due to the distance between them.

The potential effects on terrestrial and marine biodiversity during construction relate to a loss of habitat and disturbance of protected species such as marsh harrier, coastal waterbirds, otter, reptiles and water vole. There is potential for a higher significance of effects on these receptors than from the sites alone, as the magnitude of impact on a particular receptor (e.g. a species) when combining both sites could be considered to be greater. However, the mitigation strategies for protected species and habitat planting proposals have been developed for the Scheme as a whole (both sites together), to ensure that the mitigation for each site does not conflict with mitigation or the site design of the other site. As no synergistic effects would occur, the mitigation measures proposed in chapters 10 and 11 are considered sufficient to mitigate any potential adverse cumulative effects.

Once construction is complete, long-term cumulative beneficial effects would occur with the two sites together. From a biodiversity perspective, the sites will complement each other, as they will both provide areas of new terrestrial and marine habitat which will support a variety of species and have been designed to help support the integrity of the

Humber Estuary SAC/SPA/Ramsar/SSSI. In addition, both sites will improve recreation and amenity facilities, and will contribute to the wider economy directly and indirectly. These effects are likely to be of greater significance than for each site individually.

During the operation of both sites, there would be no cumulative effects relating to a change in the hydrodynamic regime of the estuary, as the change in flow speeds at the breach locations will be localised and small-scale, and will not interact with each other.

In conclusion, it is considered that combining the proposed mitigation for each site (as set out in Chapters 5 to 17) would sufficiently reduce any adverse effects and also result in no residual significant adverse cumulative effects; therefore, no additional mitigation is proposed. The sites together are anticipated to result in cumulative beneficial effects during their operation stages.

18.4 Uncertainties, assumptions and limitations

There is no established methodology for undertaking in-combination effects assessments. Each receptor may vary in its ability to accommodate multiple effects from any one scheme or event, and so the assessment of significance of in-combination effects is subjective. The assessment was based on professional judgement.

The cumulative effects assessment with other projects was based on the limited information available about the other developments in the study area, and in some cases detailed information about construction programmes, methods and works involved were not known.

19 Summary

19.1 Beneficial effects

The Outstrays to Skeffling Managed Realignment Scheme will result in beneficial effects (before mitigation) that are 'significant' in EIA terms (moderate beneficial or better (see 4.1.3)). These include:

- Moderate beneficial effect relating to direct and indirect job creation and GVA uplift during construction for both sites;
- Major beneficial effect relating to wider economic benefits from both sites, linked to the opportunity to improve flood risk management infrastructure in Hull;
- Moderate beneficial effect relating to improved access across both sites and improved recreational facilities at the eastern site;
- Moderate to major beneficial effect on health, safety and wellbeing linked to reduced flood risk at both sites;
- Major beneficial effect on benthic habitats and species and coastal waterbirds due to the creation of new intertidal habitat (approximately 116 ha for Outstrays and 175 ha for Welwick to Skeffling); and
- Moderate beneficial effect on Landscape Character Area 21C (South Patrington, Ottringham and Keyingham Farmland) due to creation of the habitat creation and mitigation area in the western site.

In addition to these beneficial effects, some of the significant adverse effects listed in Table 19.1 and Table 19.2 will become significant beneficial residual effects once mitigation has been implemented. These mainly relate to the proposed habitat creation and mitigation area in West 2 and adjacent to East 1, which will include the creation of new wet grassland, other grassland types and sand dune habitat. The new habitats will cover an area of approximately 75 ha, will support a range of species and support the SPA, SAC, Ramsar and SSSI features of the Humber Estuary.

19.2 Adverse effects

The adverse effects of the Scheme that are deemed 'significant' in EIA terms (moderate adverse or worse) are summarised along with their proposed mitigation measures and residual effects in Table 19.1 (Outstrays Managed Realignment) and Table 19.2 (Welwick to Skeffling Managed Realignment) below. The only significant adverse effects anticipated to occur during the operational phase relate to terrestrial biodiversity.

Following the implementation of mitigation, the only residual significant adverse effects relate to temporary visual effects during construction for footpath users, passengers and crew on ships in the estuary, and a number of nearby properties. As mentioned above, several of the potentially significant adverse effects on biodiversity will become significant beneficial residual effects once mitigation is implemented, due to the proposed habitat creation in West 2 and adjacent to East 1.

19.2.1 Outstrays Managed Realignment summary

Table 19.1: Outstrays Managed Realignment adverse effects, mitigation and residual effects summary

Receptor and sensitivity/value	Description of impact and magnitude	Significance of effect	Mitigation	Residual effect and significance in terms EIA regulations
Water environment - construction				
Ponds (within Haverfield Quarry) **Sensitivity/value: High**	Risk of silt pollution from earthworks **Magnitude: Moderate negative**	**Moderate Adverse**	Best practice measures will be set out in the CEMP, surface water management plan and silt management plan	No effect EIA regulations: **Not Significant**
Ponds (within Haverfield Quarry) **Sensitivity/value: High**	Risk of pollution from use of polluting substances. **Magnitude: Moderate negative**	**Moderate Adverse**	Best practice measures will be set out in the CEMP, including surface water management plan	No effect EIA regulations: **Not Significant**
Winestead Drain **Sensitivity/value: Medium**	Use of water for dust suppression affecting flows and dilution capacity and water quality. **Magnitude: Moderate negative**	**Moderate adverse**	Adherence to any conditions for abstraction licences for larger abstractions. Use of water from the estuary for dust suppression in saline-exposed areas of the MR site following the works. Investigate potential storage of rainwater for dust suppression.	No effect EIA regulations: **Not Significant**
Terrestrial biodiversity - construction				
Humber Estuary SSSI **Sensitivity/value: National Importance**	Damage/Habitat Loss at Humber Estuary SSSI - construction of the piling wall at Welwick Bushes. **Magnitude: Very low**	**Significant Negative impact** (Certain) at a Local Level in the Short to Medium Term (1-3 years)	The works footprint will be minimised where possible. Grassland will be reinstated after construction.	**Significant Positive impact** (Probable) at a National Level in the Medium to Long Term (up to 5 years), when thin, impoverished soils have developed on the raw sand and the grassland develops in Field C.

Receptor and sensitivity/value	Description of impact and magnitude	Significance of effect	Mitigation	Residual effect and significance in terms EIA regulations
			Up to 10.1 ha of new sand dune habitat will be created in West 2.	
Winestead Drain cLWS **Sensitivity/Value: District Importance**	Degradation of water quality at Winestead Drain cLWS. Increased run off from arable farmland in to Winestead Drain is anticipated, due to the creation of new outlet channels as part of the wet grassland habitat creation. **Magnitude: Very Low**	**Significant Negative impact** (Possible) at a Local Level in the Short Term (up to 1 year following construction).	Standard site procedures, including adherence to Guidelines for Pollution Prevention, will be adopted for any works near or in water to ensure pollutants do not enter aquatic environments. Sediment traps will be installed at the outlets in the short term.	**No significant impact** (Probable) at a Local Level in the Medium Term (3-5 years), when the grassland develops in the West 2 habitat creation and mitigation area.
Scrub **Sensitivity/Value: Local Importance**	Loss of Outstray Scrapes (1.2 ha of scrub) and removal of scrub in Haverfield Quarries LWS as part of habitat restoration (up to 2.4 ha) **Magnitude: Medium**	**Significant Negative impact** (Certain) at a Local Level.	Up to 2 ha of scrub planting in West 2 habitat creation and mitigation area.	**No significant impact** (Certain) at a Local Level in the Long Term (up to 10 years), when the scrub develops and matures in West 2 habitat creation and mitigation area.
Neutral semi-improved **grassland** **Sensitivity/value: Regional Importance**	Loss of West 1 and West 2 embankments. Direct, temporary loss of up to 5.9 ha of neutral semi-improved grassland. **Magnitude: medium**	**Significant Negative** impact (Certain) at a Regional Level in the Short Term (1-2 years).	Turf is proposed to be translocated to the new embankment. Up to 10 ha of additional embankment is also proposed to be created. Up to 15 ha of arable field is proposed to be reverted to species	**Significant Positive** impact (Certain) at a **Regional Level** in the **Medium Term** (3-5 years), when the grassland develops in West 2 habitat creation and mitigation area.

Receptor and sensitivity/value	Description of impact and magnitude	Significance of effect	Mitigation	Residual effect and significance in terms EIA regulations
			rich grassland in the West 2 habitat creation and mitigation area.	
Marshy grassland **Sensitivity/value: District Importance**	Loss of Outstray Scrapes. Permanent loss of up to 2 ha of marshy grassland. This represents all the marshy grassland habitat within the Scheme Extents. **Magnitude: High**	**Significant Negative** impact (Certain) at a District Level.	Up to 28 ha of wet grassland will be created in West 2 (arable reversion to wet grassland).	**Significant Positive** impact (Certain) at a Regional Level in the Medium Term (3-5 years) when the grassland in the West 2 habitat creation and mitigation area develops.
Standing water **Sensitivity/value: Local Importance**	Loss of Outstray Scrapes. Permeant loss of three small to medium sized ponds. Total area is 0.16 ha. Apart from the ponds associated with Haverfield Quarry, this represents all ponds within the Scheme Extents. **Magnitude: Medium**	**Significant Negative** impact (Certain) at a Local Level.	Up to 14 ponds (approximately 1 ha), 10 dune slack pools (approximately 1 ha) and 2 lagoons with islands (approximately 3 ha), will be created in the West 2 habitat creation and mitigation area. These will be variety of designs (size and shape) to benefit the target ecological receptors.	**Significant Positive** impact (Certain) at a Regional Level in the Medium Term (3-5 years) when the ponds establish.
Running water **Sensitivity/value: Local Importance**	Managed realignment - direct loss of 4.8 km of running water (agricultural drainage channels). **Magnitude: Medium**	**Significant Negative** impact (Certain) at a Local Level.	Up to 2 km of new channel and up to a further 2 km of linear scrapes are proposed to be created in the West 2 habitat creation and mitigation area.	**No Significant** impact (Certain) at a Local Level in the Short Term (up to 1 year after construction), when the watercourse develops and matures.
Hedgerows **Sensitivity/value: Local Importance**	Managed realignment - direct loss of approximately 1.8 km of hedgerow. **Magnitude: medium**	**Significant Negative** impact (Certain) at a Local Level.	Hedgerow across the northern boundary of West 1 is proposed to be improved through additional planting and ongoing management.	**No Significant** impact (Certain) at a Local Level in the Long Term (up to 10 years), when the new hedgerow in West 1 develops and matures.

Receptor and sensitivity/value	Description of impact and magnitude	Significance of effect	Mitigation	Residual effect and significance in terms EIA regulations
Spread of non-native invasive species (NNIS)	Potential spread of NNIS across the site and into the wild, which would contravene legislation. **Magnitude: Very low**	**Significant Negative** effect (Probable) at a Local Level in the Medium Term (up to 5 years).	NNIS management and clearance. Ongoing monitoring will be undertaken by the ECoW to ensure NNIS are not spread by the works.	**No Significant** effect (Probable) at a Local Level in the Short Term (during construction).
Marsh harrier **Sensitivity/value: National Importance**	Disturbance from construction activities, would result in the likely abandonment of the site, for all breeding females given their proximity to the works. **Magnitude: High**	**Significant Negative** effect (Probable) at the National Level in the Short Term (during construction).	Works timed to avoid marsh harrier breeding season. No works within a 200 m buffer of any marsh harrier nests.	**No Significant** effect (Certain) at the National Level in the Short Term (during construction).
Marsh harrier **Sensitivity/value: National Importance**	Loss of marsh harrier foraging habitat. Possible negative effect on female marsh harrier foraging success for up to five years. There are alternative unaffected foraging habitats to the north of Haverfield Quarry and at Welwick Saltmarsh. **Magnitude: Low**	**Significant Negative** effect (Possible) at the District Level in the Medium Term (up to 5 years).	The West 2 habitat creation and mitigation area will provide an extensive area of new high-quality terrestrial and aquatic habitats for marsh harrier population, which could facilitate an expansion in the marsh harrier population (approximately 2 ha of reedbed over three locations).	**Significant Positive** effect (Possible) at the National Level in the Medium Term (up to 5 years).
Barn owl **Sensitivity/value: District Importance**	Temporary displacement from site (due to loss of foraging habitat and/or disturbance). Negative effect on hunting success for up to 2 years. Alternative foraging habitat is available outside of the scheme boundary. **Magnitude: Low**	**Significant Negative** effect (Probable) at a Local Level in the Medium Term (up to 5 years).	No night time working is proposed during construction. Grassland habitat creation in West 2. Habitats managed to promote high field vole population. All barn owl boxes (which are currently damaged/defunct) will be reinstated after construction.	**Significant Positive** effect (Probable) at a District Level in the Medium Term (3-5 years) when the new habitats develop, and small mammal population establishes and expands. The reinstated/new barn owl boxes will allow the future expansion of the barn owl population.

Receptor and sensitivity/value	Description of impact and magnitude	Significance of effect	Mitigation	Residual effect and significance in terms EIA regulations
Farmland birds **Sensitivity/value: District Importance**	Negative effect on breeding success through the reduction in nesting and foraging opportunities. Permanent loss of approximately 30-40% of the nesting and foraging habitat. Loss of arable fields. **Magnitude: Medium**	**Significant Negative** effect (Certain) at the Local Level.	Vegetation clearance outside of the breeding bird period (March – August inclusive) to avoid contravening legislation. Replacement scrub and hedgerow planting. Up to 20 schwegler nest boxes will be installed in Haverfield Quarries LWS.	Direct impacts on nesting farmland birds are avoided during construction. Unavoidable loss of nesting and foraging habitat. Probable negative effect on farmland bird nesting and foraging success during construction. **No Significant** effect (Certain) at a District Level in the Medium to Long Term (up to 10 years), when the scrub, hedgerow and other habitats associated with the West 2 habitat creation and mitigation area develop and mature.
Reptiles **Sensitivity/value: Regional Importance**	Removal of West 1 embankment. Permeant loss of reptile population along the West 1 embankment and Outstray Scrapes. Population unlikely to recover in the long term. **Magnitude: High**	**Significant Negative** impact (Certain) at the Regional level.	Reptile mitigation strategy: translocation and habitat creation in the West 2 habitat creation and mitigation area.	There is likely to be some minor unavoidable losses during construction, which could impact the conservation status of local reptile populations. **Significant Positive** effect (Possible) at a District Level in the Medium Term (up to 5 years) when the new habitats develop in West 2 habitat creation and mitigation area, and the reptile population expands into these new habitats.
Water Vole **Sensitivity/value: District Importance**	Potential for temporary displacement from East Clough/Newlands Drain, due to regular visual and noise disturbance to the south of East Clough.	**Significant Negative** effect (Unlikely) at the Local Level in the Short Term (during construction).	A pre-works inspection to determine the presence or likely absence. No mitigation required if absence confirmed. If presence is confirmed, exclusion zones will be created.	**No significant** (Certain) effect at a Local Level in the Short Term (during construction).

Receptor and sensitivity/value	Description of impact and magnitude	Significance of effect	Mitigation	Residual effect and significance in terms EIA regulations
	Magnitude: Low			
Otter **Sensitivity/value: Regional Importance**	Possible temporary displacement of otter population from Haverfield Quarry and abandonment of site, during constriction. **Magnitude: High**	**Significant Negative** effect (Possible) at a Regional Level in the Short Term (During Construction).	No works are proposed in West 2 during the marsh harrier breeding period (March to August inclusive). No night working will be carried out in West 2. Pathways to and from Haverfield Quarry will be maintained during constriction. Standard mitigation will be applied.	**No significant** (Probable) effect at a District Level in the short term (during construction).
Great crested newt **Sensitivity/value: Local Importance**	Incidental mortality during site clearance/construction. Possible risk of GCN being present in West 2 during construction and possible risk of killing and injuring or disturbing GCN, if present. **Magnitude: Very Low**	**Significant Negative** effect (Possible) at a less than Local Level in the Short Term (during construction).	Works will be carried out under licence, to ensure compliance with legislation. Up to 14 ponds will be created in the West 2 habitat creation and mitigation area. These will be designed and managed to provide new habitat for great crested newt and other species.	**Significant Positive** effect (Probable) at a District Level in the Medium Term (up to 5 years) when the new habitats develop, and the great crested newt population expands.
Badger **Sensitivity/value: Local Importance**	Loss of a single outlier sett and suspected annex sett. Probable temporary disturbance of up to six outlier setts and possible temporary disturbance of main sett. **Magnitude: Low**	**Significant Negative** effect (Certain) at a less than Local Level in the short term (during construction).	A badger mitigation strategy will be developed from the results of further survey and monitoring work. The strategy will include the closure of one outlier sett (Outstray Scrapes) and the annex sett (Welwick Bushes). Exclusion zones will be created to protect remaining setts.	**No Significant** (Probable) effect at a Local Level in the Short Term (during construction).
Badger **Sensitivity/value: Local Importance**	Permanent loss of badger foraging habitat in the West 1,	**Significant Negative** effect	The hedgerow along the northern boundary of West 1 provides important cover and foraging for the local badger population and will	**No Significant** effect (Probable) at a Local Level in the Medium Term (up

Receptor and sensitivity/value	Description of impact and magnitude	Significance of effect	Mitigation	Residual effect and significance in terms EIA regulations
	including arable farmland and the scrub habitat. As the adjacent landscape is dominated by arable fields like those in West 2, there is ample alternative habitat for this species. **Magnitude: Low**	(Unlikely) at a less than Local Level.	be retained and enhanced through additional planting.	to 5 years) when the new hedgerow develops in West 1.
Amphibians (except great crested newt) **Sensitivity/value: Local Importance**	The loss of Outstray Scrapes will result in the permanent loss of amphibian habitat and therefore populations at this location. **Magnitude: High**	**Significant Negative** impact (Certain) at the **Local Level**.	Amphibians will be captured alongside reptiles at Outstray Scrapes (as per Reptile Mitigation Strategy). These will be translocated to the newly created ponds in the West 2 habitat creation and mitigation area.	**Significant Positive** effect (Probable) at a **Local Level** in the **Medium Term** (3-5 years) when the new ponds develop, and the amphibian population expands.
Sea aster mining bee **Sensitivity/value: National Importance**	Construction activities, in particular the presence of site workers, could possibly cause damage the sea aster mining bee colony in West 2. **Magnitude: Low**	**Significant Negative** effect (possible) at a **District Level** in the **Short Term** (during construction).	Exclusion zones created around sea aster mining bee nests during construction. These will demarcate the location of the nests and ensure the entrances are not blocked or damaged. A dune grassland with associated ponds and islands are proposed to be created in Field C.	**Significant Positive** effect (Possible) at a **National Level** in the **Medium Term** (up to 5 years), when the fixed sand dune habitat develops and matures.
Brown hare **Sensitivity/value: Local Value**	Construction activities could possibly cause the temporary displacement of brown hare from West 2. **Magnitude: Low**	**Significant Negative** impact (Possible) at the **less than Local Level** in the **Short Term** (During construction).	No works are proposed in West 2 during the marsh harrier breeding period (March to August inclusive). No night working will be carried out in West 2.	**No Significant** effect (Probable) at a **Local Level** in the **Short Term** (during construction).

Receptor and sensitivity/value	Description of impact and magnitude	Significance of effect	Mitigation	Residual effect and significance in terms EIA regulations
Terrestrial biodiversity - operation				
Marsh Harrier **Sensitivity/value: National importance**	Increased number of visitors to Haverfield Quarry, causing increased disturbance to nesting Marsh Harrier. **Magnitude: High**	**Significant Negative** effect (Possible) at the **National Level.**	Access will be restricted to designated bridleway only and screening/fencing will be put in place. The bird hide between the two main ponds at Haverfield Quarry will be reinstated.	**No Significant** (Probable) effect at a **National Level.**
Otter **Sensitivity/value: Regional importance**	Increased number of visitors to Haverfield Quarry, causing increased disturbance to otter. **Magnitude: High**	**Significant Negative** effect (Possible) at the **National Level.**	Access will be restricted to designated bridleway only and screening/fencing will be put in place.	**No Significant** (Probable) effect at a **Regional Level.**

Receptor and sensitivity/value	Description of impact and magnitude	Significance of effect	Mitigation	Residual effect and significance in terms EIA regulations
Marine biodiversity - construction				
Saltmarsh habitat and associated species **Sensitivity/value: High**	Removal of approx. 1 ha saltmarsh at breach location. **Magnitude: Small**	**Moderate adverse effect**	Creation of between 65 and 80 ha initially and between 90 to 105 ha after five years of breaching.	Moderate beneficial EIA regulations: **Significant**
Landscape and visual amenity - construction				
Viewpoint 1 - East Bank Road, Sunk Island **Sensitivity/value: High for residential receptors**	Construction vehicles and construction activity will be discernible for the closest receptors. **Magnitude: Moderate negative**	**Short term moderate, adverse effect** for five residential receptors	No mitigation available.	Moderate adverse effect. However, this will be short term as it will occur during construction only. EIA regulations: **Significant**
Viewpoint 2 -East Bank Road, Sunk Island **Sensitivity/value: High for residential receptors**	Construction vehicles and construction activity will be discernible for the closest receptors. **Magnitude: Moderate negative**	**Short-term, moderate, adverse effect** for six residential receptors	No mitigation available.	Moderate adverse effect. However, this will be short term as it will occur during construction only. EIA regulations: **Significant**
Viewpoint 3 – Newland Road **Sensitivity/value: High for residential receptors**	Construction vehicles and the site compound will be partially visible. **Magnitude: Moderate negative**	**Short-term, moderate, adverse** effect for two residential receptors	No mitigation available.	Moderate adverse effect. However, this will be short term as it will occur during construction only. EIA regulations: **Significant**
Viewpoint 4 – Eastgrowths Farm/ Patrington Bridleway	Construction vehicles and the site compound will be partially visible. **Magnitude: Moderate negative**	**Short-term, moderate, adverse effect** for residents and bridleway users	No mitigation available.	Moderate adverse effect. However, this will be short term as it will occur during construction only. EIA regulations: **Significant**

Receptor and sensitivity/value	Description of impact and magnitude	Significance of effect	Mitigation	Residual effect and significance in terms EIA regulations
No. 6 and No. 5, east of Patrington Haven **Sensitivity/value: High for residential receptors and bridleway users**				
Air quality - construction				
Ecological receptors **Sensitivity/value: High**	Dust emissions from construction vehicles and construction activities. **Magnitude:** **Small during Demolition** **Large during Earthworks** **Medium during Trackout**	**Medium during Demolition** **High during Earthworks** **Medium during Trackout**	Best practice and standard dust mitigation measures are put in place prior to the commencement and during the construction phase and will be documented in the CEMP.	No effect EIA regulations: **Not Significant**

19.2.3 Welwick to Skeffling Managed Realignment summary

Table 19.2: Welwick to Skeffling Managed Realignment adverse effects, mitigation and residual effects summary

Receptor and sensitivity/value	Description of impact and magnitude	Significance of effect	Mitigation	Significance in terms of residual effect/EIA regulation
Terrestrial biodiversity – construction				
Neutral semi-improved grassland **Sensitivity/value: Regional Importance**	Loss of East 1, East 2 and East 3 embankment. Direct, temporary loss of up to 5.3 ha of neutral semi-improved grassland. **Magnitude: High**	**Significant Negative** impact (Certain) at a **Regional Level** in the **Short Term** (1-2 years) due to the direct loss of grassland along the embankments.	Turf will be translocated to the new embankment. Up to 9 ha of additional embankment will also be created. Up to 7 ha of arable field will be reverted to species rich grassland in the Welwick to Skeffling habitat creation and mitigation area.	**Significant Positive** impact (Certain) at a **Regional Level** in the **Medium Term** (3-5 years), when the grassland develops in the Welwick to Skeffling habitat creation and mitigation area.
Standing water **Sensitivity/value: Local Importance**	Managed realignment - loss of two ponds in East 1, a single pond in East 2 and five small to medium sized ponds in East 3. Two defunct drains, which are effectively acting as ponds, will be retained. **Magnitude: High**	**Significant Negative impact** (Certain) at a Local Level.	Up to seven ponds (03. ha) are proposed to be created in the Welwick to Skeffling habitat creation and mitigation area.. Two existing ponds will be improved.	**Significant Positive** impact (Certain) at a **Local Level** in the **Medium Term** (3-5 years) when the ponds establish.
Running water **Sensitivity/value: Local Importance**	Managed realignment - direct loss of 4 km of running water (agricultural drainage channels). **Magnitude: Medium**	**Significant Negative impact** (Certain) at a Local Level.	Drainage channel approximately 4.4 km in length will be created along the dry-side toe of the new embankment. Detailed specifications for the design of the drains will be produced to benefit the target receptors.	**No Significant** impact (Certain) at a **Local Level** in the **Short Term** (up to 1 year after construction), when the watercourse develops and matures.
Hedgerows **Sensitivity/value: Local Importance**	Managed realignment - direct loss of 2.6 km of hedgerow. **Magnitude: Medium**	**Significant Negative impact**	Hedgerows within the Welwick to Skeffling habitat creation and mitigation area are proposed to be	**Significant Positive** effect (Certain) at a **Local Level** in the **Long Term**

Receptor and sensitivity/value	Description of impact and magnitude	Significance of effect	Mitigation	Significance in terms of residual effect/EIA regulation
		(Certain) at a Local Level.	improved through additional planting and ongoing management. A new hedgerow will be provided along the boundary of the site where possible, in East 2 and 3.	(up to 10 years), when the new hedgerows develops and matures.
Potential spread of non-native invasive species (NNIS)	Potential spread of NNIS across the site and into the wild, which would contravene legislation. **Magnitude: Very low**	**Significant Negative** effect (Possible) at a **Local Level** in the **Medium Term** (up to 5 years), when the NNIS spread, develop and invade valued natural and semi-natural habitats.	NNIS management and clearance. Ongoing monitoring will be undertaken by the ECoW to ensure NNIS are not spread by the works. The scheme represents an opportunity to eradicate all non-native invasive species from the Scheme extents.	**No Significant** effect (Probable) at a **Local Level** in the **Short Term** (during construction).
Marsh harrier **Sensitivity/value: National Importance**	Disturbance from construction activities would result in the likely abandonment of the site, for all breeding females given their proximity to the works. **Magnitude: High**	**Significant Negative** effect (Probable) at the **National Level** in the **Short Term** (during construction).	Works timed to avoid marsh harrier breeding season. No works within a 200 m buffer of any marsh harrier nests.	**No Significant** effect (Certain) at the **National Level** in the **Short Term** (during construction).
Marsh harrier **Sensitivity/value: National Importance**	Loss of marsh harrier foraging habitat. Possible negative effect on female marsh harrier foraging success for up to five years. There are alternative unaffected foraging habitats to the north of Haverfield Quarry and at Welwick Saltmarsh. **Magnitude: Low**	**Significant Negative** effect (Possible) at the **District Level** in the **Medium Term** (up to 5 years).	Habitat creation adjacent to East 1.	**Significant Positive** effect (Possible) at the **National Level** in the **Medium Term** (up to 5 years).
Barn owl	Temporary displacement from site (due to loss of foraging habitat	**Significant Negative** effect	No night time working is proposed during construction.	**Significant Positive** effect (Probable) at a **District Level** in the

Receptor and sensitivity/value	Description of impact and magnitude	Significance of effect	Mitigation	Significance in terms of residual effect/EIA regulation
Sensitivity/value: Regional Importance	and/or disturbance). Negative effect on hunting success for up to 2 years. Alternative foraging habitat is available outside of the scheme boundary. **Magnitude: Low**	(Probable) at a **District Level** in the **Medium Term** (up to 5 years).	Grassland habitat creation in Welwick to Skeffling habitat creation and mitigation area. Habitats managed to promote high field vole population.	**Medium Term** (3-5 years) when the new habitats develop, and small mammal population establishes and expands.
Barn owl **Sensitivity/value: Regional Importance**	Removal of two barn owl boxes. **Magnitude: Medium**	**Significant Negative effect** (Certain) at a District Level	Two barn owl boxes will be fitted after construction. One will be fitted in the habitat creation and mitigation area. One will be fitted on a retained section of Burstall Bank.	**No Significant** effect (Certain) at a **District Level** in the **Short Term** (after construction).
Farmland birds **Sensitivity/value: Local Importance**	Negative effect on breeding success through the reduction in nesting and foraging opportunities. Direct loss of 2.6 km of hedgerow (approximately 66% of hedgerows on site). Loss of arable fields. **Magnitude: Medium**	**Significant Negative effect** (Certain) at the Local Level.	Vegetation clearance outside of the breeding bird period (March – August inclusive) to avoid contravening legislation. Replacement scrub and hedgerow planting where possible.	Unavoidable negative effect on farmland bird nesting and foraging success during construction. **No Significant** effect (Certain) at a **District Level** in the **Medium to Long Term** (up to 10 years), when habitats develop and mature.
Reptiles **Sensitivity/value: Regional Importance**	Permanent loss of reptile population along the East 1, East 2 and East 3 embankment. Population unlikely to recover in the long term. **Magnitude: High**	**Significant Negative impact** (Certain) at the Regional level.	Reptile mitigation strategy: translocation and habitat creation.	There is likely to be some minor unavoidable losses during construction, which could impact the conservation status of local reptile populations. **Significant Positive** effect (Possible) at a **District Level** in the **Medium Term** (up to 5 years) when the new habitats develop in the habitat creation and mitigation area, and the reptile population expands into these new habitats.
Water Vole	Permeant displacement from the drainage channels in East 1, 2	**Significant Negative** impact	Water Vole Mitigation Strategy: translocation and habitat creation	**Significant Positive** effect (Probable) at the **District Level** in

Receptor and sensitivity/value	Description of impact and magnitude	Significance of effect	Mitigation	Significance in terms of residual effect/EIA regulation
Sensitivity/value: District Importance	and 3 during construction, due to the tidal inundation. **Magnitude: High**	(Certain) at the **District Level** in the **Short Term** (during construction).		the **Medium Term** (up to 5 years), when the drainage ditch and ponds develop and mature.
Otter **Sensitivity/value: Regional Importance**	The presence of site workers and machinery along Welwick Drain and Soak Dike could disturb otters whilst they try to access Haverfield Quarry and Welwick Saltmarsh. This would affect the ability of otter to access or leave Haverfield Quarry. **Magnitude: Low**	**Significant Negative** effect (Possible) at a **Regional Level** in the **Short Term** (During Construction).	No night working will be carried out in West 2. Pathways to and from Haverfield Quarry will be maintained during constriction. Standard mitigation will be applied.	**No Significant** (Probable) effect at a **District Level** in the **Short Term** (during construction).
Great crested newt **Sensitivity/value: Local Importance**	Possible risk of GCN being present in East 1 and East 2 during construction and possible risk of killing and injuring or disturbing GCN, if present. Humber Farm meta population. **Magnitude: Very low**	**Significant Negative** effect (Possible) at a **less than Local Level** in the **Short Term** (during construction).	Works will be carried out under licence, to ensure compliance with legislation. Mitigation will be applied through licence application.	**Significant Positive** effect (Probable) at a **District Level** in the **Medium Term** (up to 5 years) when the new habitats develop and the great crested newt population expands.
Badger **Sensitivity/value: Local Importance**	The managed realignment in East 1, East 2 and East 3 will permanently displace badgers and reduce the available foraging habitat for the local badger population. **Magnitude: Low**	**Significant Negative effect** (Unlikely) at a less than Local Level.	New hedgerow along the boundary of the site where possible in East 2 and East 3. Improvements to hedgerow in habitat creation and mitigation area and creation of foraging habitat.	**No Significant** effect (Probable) at a **Local Level** in the **Medium Term** (up to 5 years) when the new hedgerow develops.

Receptor and sensitivity/value	Description of impact and magnitude	Significance of effect	Mitigation	Significance in terms of residual effect/EIA regulation
Sea aster mining bee **Sensitivity/value: National Importance**	The cessation of sheep grazing over a two-year period during construction could cause the entrances of the sea aster mining bee nests to vegetate over. This could degrade the value of the nesting habitat by restricting or blocking access to the exposed sandy banks. **Magnitude: Medium**	**Significant Negative** effect (possible) at a **National Level** in the **Short Term** (during construction).	Vegetation around the entrance and base of the nests will be carefully cleared by hand at the end of July or early August, prior to the bee emerging. This will help maintain the exposed vertical sandy banks across Welwick Bushes. Works will be carried out by the main contractor and overseen by the ECoW.	**No Significant** effect (Certain) at a **National Level** in the **Short Term** (during construction).
Terrestrial Biodiversity – operation				
Marsh Harrier **Sensitivity/value: National importance**	Increased number of visitors to Haverfield Quarry, causing increased disturbance to nesting Marsh Harrier. **Magnitude: High**	**Significant Negative** effect (Possible) at the **National Level.**	Access will be restricted to designated bridleway only and screening/fencing will be put in place. The bird hide between the two main ponds at Haverfield Quarry will be reinstated.	**No Significant** (Probable) effect at a **National Level.**
Sea aster mining bee **Sensitivity/value: National importance**	Operational activities, in particular the presence of additional visitors, could possibly cause damage the sea aster mining bee nests at Welwick Bushes.	**Significant Negative** effect (Possible) at the **National Level.**	The managed realignment will provide an extensive area of additional saltmarsh habitats and foraging opportunities for sea aster mining bee population, which could facilitate an expansion in the sea aster mining bee population.	**Significant Positive** effect (Possible) at a **Regional Level** in the **Short to Medium Term** (up to 5 years), when the saltmarsh habitat develops and matures.

Receptor and sensitivity/value	Description of impact and magnitude	Significance of effect	Mitigation	Significance in terms of residual effect/EIA regulation
Marine biodiversity – construction				
Saltmarsh habitat and associated species **Sensitivity/value: High**	Removal of approx. 2.5 ha saltmarsh at breach location. **Magnitude: small**	**Moderate adverse**	Creation of between 68 and 108 ha initially and between 127 to 147 ha after five years of breaching.	Moderate beneficial EIA regulations: **Significant**
Landscape and visual amenity – construction				
Viewpoint 7 – Welwick Bank near Welwick Bushes **Sensitivity/value: Public footpath users/recreational receptors: high. Ferry passengers: medium**	Construction vehicles and construction activity being visible and the public footpath will need to be diverted. **Magnitude: Moderate negative**	**Major, adverse** effect for recreational receptors walking on roads to the north	No mitigation available.	Major adverse effect. However, this will be short term as it will occur during construction only. EIA regulations: **Significant**
		Moderate short-term effect on ferry passengers		Moderate adverse effect. However, this will be short term as it will occur during construction only. EIA regulations: **Significant**
Viewpoint 8 – Row Lane, south of Welwick **Sensitivity/value: Residential receptors: High.**	Construction vehicles and construction activity will be noticeable for the closest receptors. **Magnitude: Moderate negative**	**Short term, moderate, adverse effect** for the closest residential receptors	No mitigation available.	Moderate adverse effect. However, this will be short term as it will occur during construction only. EIA regulations: **Significant**
Viewpoint 9 – Humber Side Road, south of Weeton **Sensitivity/value: Residential receptors: High**	Construction vehicles and the site compound being visible. **Magnitude: Moderate negative**	**Short term, moderate, adverse effect** for residents	No mitigation available.	Moderate adverse effect. However, this will be short term as it will occur during construction only. EIA regulations: **Significant**

Receptor and sensitivity/value	Description of impact and magnitude	Significance of effect	Mitigation	Significance in terms of residual effect/EIA regulation
Viewpoint 10 – B1445 Skeffling Road, east of Weeton **Residential receptors: high**	Construction vehicles and the site compound being visible. **Magnitude: Moderate negative**	**Short term moderate, adverse effect** for residential receptors	No mitigation available.	Moderate adverse effect. However, this will be short term as it will occur during construction only. EIA regulations: **Significant**
Viewpoint 11 – Church Road, south of Skeffling **Residential receptors and footpath users: high**	Construction vehicles and construction activity will be noticeable for the closest receptors and an existing public footpath will need to be diverted. **Magnitude: Moderate negative**	**Short term major, adverse visual effect** for footpath users	No mitigation available.	Major adverse effect. However, this will be short term as it will occur during construction only. EIA regulations: **Significant**
		Moderate, adverse short-term effect for residents		Moderate adverse effect. However, this will be short term as it will occur during construction only. EIA regulations: **Significant**
Viewpoint 12 – Skeffling Footpath No. 4 (Coastal Path), South End Bank, Humber Lane **Footpath users: high. Ferry passengers: medium**	Views through to the site with construction vehicles and construction activity being visible and the public footpath will need to be diverted. **Magnitude: Major negative**	**Short term major, adverse effect** for recreational receptors	No mitigation available.	Major adverse effect. However, this will be short term as it will occur during construction only. EIA regulations: **Significant**
		Short term moderate adverse effect for ferry passengers		Moderate adverse effect. However, this will be short term as it will occur during construction only. EIA regulations: **Significant**
Historic environment – construction				
Asset 32 Enclosure complex **Sensitivity/value: Medium**	Partial removal during topsoil stripping for compound / car park. **Magnitude: Moderate negative**	**Moderate adverse**	Archaeological watching brief and recording	Minor adverse EIA regulations: **Not Significant**

Receptor and sensitivity/value	Description of impact and magnitude	Significance of effect	Mitigation	Significance in terms of residual effect/EIA regulation
Asset 33 Group 1 enclosure **Sensitivity/value: Medium**	Partial removal by construction activities. **Magnitude: Major negative**	**Moderate adverse**	Strip, map and record	Minor adverse EIA regulations: **Not Significant**
Asset 36 Group 4 medieval remains **Sensitivity/value: Low**	Potential partial removal by construction activities. **Magnitude: Major negative**	**Moderate adverse**	Strip, map and record	Minor adverse EIA regulations: **Not Significant**
Air quality – construction				
Ecological receptors **Sensitivity/value: High**	Dust emissions from construction vehicles and construction activities. **Magnitude:** **Small during Demolition** **Large during Earthworks** **Medium during Trackout**	**Medium during Demolition** **High during Earthworks** **Medium during Trackout**	Best practice and standard dust mitigation measures are put in place prior to the commencement and during the construction phase and will be documented in the CEMP.	No effect EIA regulations: **Not Significant**

19.3 Cumulative effects

There are not anticipated to be any significant adverse in-combination effects (different effects on the same receptor) for either managed realignment site, or cumulative effects arising from either site with other proposed developments in the vicinity.

In considering both the Outstrays and the Welwick to Skeffling Managed Realignment sites together, no significant adverse cumulative effects are anticipated, but significant beneficial cumulative effects are likely to occur in relation to biodiversity, access and amenity, socio-economics and human health.

19.4 References

ABP Research & Consultancy, 1986. Humber Estuary Wave Measurements at Bull Sand Fort. ABP Research and Consultancy Ltd, Report No. R.327.

ABP Research & Consultancy, 1999. Historic Analysis of Humber Morphology. ABP Research and Consultancy Ltd, Report No. R.839.

ABP Research & Consultancy, 2000. Humber Geomorphological Studies - Stage 2, 3D Modelling of Flows, Salinity and Sediment Transport, Report No. R.854.

ABP Research and Consultancy, 1986. Humber Estuary Wave Measurements at Bull Sand Fort. ABP Research and Consultancy Ltd, Report No. R.327.

ABP Research, 1991. Estuaries Research Programme - Phase 1: An Investigation of the Gross Properties of UK Estuaries, Report R0900

ABP Research, 2000. Humber Geomorphological Studies - Stage 2, 3D Modelling of Flows, Salinity and Sediment Transport, Report No. R.854.

ABPmer, 2004. Environmental Management and Monitoring Plan for Immingham Outer Harbour, Quay 2005 and Accompanying Habitat Creation and Enhancement Proposals, ABP Marine Environmental Research Ltd, Report No. R.1040, May 2004.

ABPmer, 2004. Historical Analysis of Humber Estuary Morphology, Report No. R.1005.

ABPmer, 2008. Humber Estuary: Environmental Management and Monitoring Plan: Data 2008. ABP Marine Environmental Research Ltd, Report No. R.1469, November 2008

ABPmer, 2009. Immingham Oil Terminal Approach Channel Deepening: Environmental Statement, ABP Marine Environmental Research Ltd, Report No. R.1416, February 2009

ABPmer, 2009a. Grimsby RO-RO Berth: Environmental Statement. September 2009. ABP Marine Environmental Research Ltd, Report No. R.1506.

ABPmer, 2009b. Immingham Oil Terminal Approach Channel Deepening: Environmental Statement. February 2009. ABP Marine Environmental Research Ltd, Report No. R.1416.

ABPmer, 2012. Humber Estuary Environmental Management and Monitoring Plan: Data 2011/12. ABP Marine Environmental Research Ltd, Report No. R.2017, October 2012

ABPmer, 2015. Environment Agency Read's Island Bathymetric Analysis. Report No. 2447.

ABPmer, 2015. Creating and Sustaining Compensatory Mudflat. ABP Marine Environmental Research Ltd, Report No. R. 2397. A report for Natural England.

ABPmer, 2016b. Skeffling Intertidal Ecology Surveys. A report to the Environment Agency.

ABPmer, 2017. Green Port Hull, Environmental Management and Monitoring Plan, ABP Marine Environmental Research Ltd, Report No. R.2014, January 2017.

ABPmer, 2017. Welwick to Skeffling Managed Realignment, Modelling Options, ABPmer Report No. R.2768.

ABPmer, 2018a. Humber Estuary Environmental Management and Monitoring Plan – Data 2016 to 2017. ABP Marine Environmental Research Ltd, Report No. R.2955, May 2018.

ABPmer, 2018b. Humber Estuary Environmental Management and Monitoring Review, Compensation review 2006-2018, ABPmer Report No. R.3015. A report produced by ABPmer for ABP Humber, June 2018.

Bat Conservation Trust (2016). Bat Surveys for Professional Ecologists: Good Practice Guidelines, 3rd Edition. Bat Conservation Trust, London.

Bibby CJ, Burgess ND, Hill DA and Mustoe SH (2000). Bird Census Techniques, 2nd Edition. Academic Press, London.

Bolam, S.G., Schratzberger, M., Whomersley, P., 2004. Macrofaunal recolonization in intertidal mudflats: the effect of organic content and particle size. Journal of Experimental Marine Biology and Ecology 306.

British Geological Survey online database GeoIndex and Lexicon (accessed July 2018)

British Geological Survey Sheet 81 1:50,000 scale (1991), Patrington, Solid and Drift Edition

British Geological Survey, Map Viewer, available at https://www.bgs.ac.uk/data/mapViewers/home.html. Accessed 10 July 2018.
British Standards Institute (BSI), 2012. BS 5837:2012 British Standard for Trees in relation to design, demolition and construction.

British Standards Institution (BSI), 2014. BS5228-1:2009+A1:2014. Code of practice for noise and vibration control on construction and open sites – Part 1: Noise. (BSI, 2014a).

British Transport Docks Board 1971. Collection of Base Data from the Humber Tidal Model. Report to Humber Estuary Research Committee (HERC) No H4.

Britwell, I. K. (2000) Effects of Sediment on Fish and Their Habitat, DFO Pacific Region, Habitat Status Report 2000/01 E, Canada.

Brown, S.L., Pinder, A., Scott, L., Bass, J., Rispin, E., Brown, S., Garbutt, A., Thomson, A., Spencer, T., Moller, I. and Brooks, S.M., 2007. Wash Banks Flood Defence Scheme - Freiston Environmental Monitoring 2002-2006. Centre for Ecology and Hydrology, 374p.

BS3882:2015 Specification for Topsoil

BS8601:2013, Specification for subsoil and requirements for use

Burdon, D., Mazik, R., and Pérez-Dominquez, R., 2011. South Humber Channel Marine Studies: Intertidal and Subtidal Benthic & Fish Surveys 2010. A report by IECS to Yorkshire Forward.

CEC. 1979. Council Directive 79/409/EEC, of 2 April 1979, on the conservation of wild birds. Commission of the European Communities. OJ EU. L103:1–18, 25 April 1979.

CEC. 1979. Council Directive 79/409/EEC, of 2 April 1979, on the conservation of wild birds. Commission of the European Communities. OJ EU. L103:1–18, 25 April 1979.

CEC. 1992. Directive 92/43/EEC, of the 21st May, on the conservation of natural habitats and wild fauna and flora. Commission of the European Communities. OJ EU. L206:7 – 50, 22 July 1992.

CEC. 1992. Directive 92/43/EEC, of the 21st May, on the conservation of natural habitats and wild fauna and flora. Commission of the European Communities. OJ EU. L206:7 – 50, 22 July 1992.

CEC. 2000. Directive 2000/60/EC, of 23rd October, establishing a framework for community action in the field of water policy. Commission of the European Communities. OJ EU. L327:1–73, 22 December 2000.

CEC. 2000. Directive 2000/60/EC, of 23rd October, establishing a framework for community action in the field of water policy. Commission of the European Communities. OJ EU. L327:1–73, 22 December 2000.

CEC. 2014. Directive 2014/52/EU, of 16th April, amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment L 124/2.

CEC. 2014. Directive 2014/52/EU, of 16th April, amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment L 124/2.

CH2M 2015. Skefflling Managed Realignment: Habitat potential Report (Draft)

CH2M, 2018, Welwick to Skeffling Managed Realignment Ground Investigation and Preliminary Design Report

Chartered Institute for Archaeologists (2017) Standards and Guidance for Historic Environment Desk-Based Assessments available online from:

CIEEM (2017) Guidelines for Preliminary Ecological Appraisal, 2nd edition. Chartered Institute of Ecology and Environmental Management, Winchester.

CIEEM (2018) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine. Chartered Institute of Ecology and Environmental Management, Winchester.

CIEEM (2018) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine. Chartered Institute of Ecology and Environmental Management, Winchester.

CIRIA, 2001, C552, Contaminated Land Risk Assessment

conservation interest. Report No 547.

Control of Substances Hazardous to Human Health (COSHH), 2002

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

Cook, A.S.C.P., Turner, D. T., Burton, N. H. K., and Wright, L. J. (2016). Tracking Curlew and Redshank on the Humber Estuary. BTO Research Report 688. BTO, Thetford.

Cutts, N. (2019). Skeffling Waterbird Utilisation Review 2014-2016: Sector Importance Assessment

Cutts, N., Hemingwat, K., and Spencer J., (2013). Waterbird disturbance mitigation toolkit: Informing Estuarine Planning & Construction Projects.

DCLG, 2012. National Planning Policy Framework. Department of Communities and Local Government. ISBN: 988-1-4098-3413-7.

DCLG, 2012. National Planning Policy Framework. Department of Communities and Local Government. ISBN: 988-1-4098-3413-7.
Dean, M., Strachan, R., Gow, D. and Andrews, R. (2016). The Water Vole Mitigation Handbook (Mammal Society Mitigation Guidance Series). Eds Fiona Mathews and Paul Chanin. Mammal Society, London.

Defra (2007) Hedgerow Survey Handbook. A standard procedure for local surveys in the UK. Defra, London

DEFRA, 2009. Part IV of the Environment Act 1995, Local Air Quality Management (LAQM), Policy Guidance (PG09). Available from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69348/pb13566-laqm-policy-guidance-part4-090302.pdf

Defra, 2013. A Coastal Concordat for England. Available from: https://www.gov.uk/government/publications/a-coastal-concordat-for-england .

Defra, 2013. A Coastal Concordat for England. Available from: https://www.gov.uk/government/publications/a-coastal-concordat-for-england .

Defra, 2017. Species Control Provisions; Code of Practise for England.

DEFRA, 2018. UK AIR, Air Information Resource. Background Mapping for local authorities – 2015. Available from https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2015

Department for Environment, Food and Rural Affairs. (2018). Multi-Agency Geographic Information for the Countryside. http://magic.defra.gov.uk/MagicMap.aspx. Accessed August 2018.

Department for Transport, 2007. Guidance on Transport Assessment [Online]. DfT. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/263054/guidance-transport-assessment.pdf

Department for Transport, 2007. Manual for Streets [Online]. DfT. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/341513/pdfmanforstreets.pdf

Department for Transport, 2016. Towing a trailer with a car of van: the basics [Online]. DfT. Available from: https://www.gov.uk/government/publications/towing-a-trailer-with-a-car-or-van/towing-a-trailer-with-a-car-or-van-the-basics

DfT, 2017. Port Freight Statistics: 2016 final figures tables [Online]. DfT. Available from: https://www.gov.uk/government/statistics/port-freight-statistics-2016-final-figures

Dixon, M., Morris, R.K.A, Scott, C.R., Birchenough A. and Colclough, S., 2008 Managed realignment - Lessons from Wallasea, UK. Maritime Engineering 161(2). 61-71

Dwyer, R.G., 2010. Ecological and anthropogenic constraints on waterbirds of the Forth Estuary: population and behavioural responses to disturbance. Thesis submitted as candidature for the degree of Doctor of Philosophy Centre for Ecology and Conservation

East Riding of Yorkshire Council (2010) East Riding of Yorkshire BAP Strategy

East Riding of Yorkshire Council (ERY) 'Landscape Character Assessment' November 2005

East Riding of Yorkshire Council (ERYC), 2015. 2015 Air Quality Updating and Screening Assessment for East Riding of Yorkshire Council. In fulfilment of Part IV of

the Environment Act 1995 Local Air Quality Management. Available from https://www.eastriding.gov.uk/environment/pollution/air-pollution/air-quality-monitoring/

East Riding of Yorkshire Council, Conservation Areas, available at https://www.eastriding.gov.uk/environment/planning-and-building-control/planning-in-conservation-areas/conservation-areas/. Accessed 22 October 2018.
Ecosystemsknowledge.net. (2018) *ORVal (Outdoor recreation valuation tool)* | *Ecosystems Knowledge Network*. [online] Available at: https://ecosystemsknowledge.net/orval-outdoor-recreation-valuation-tool

Edwards, T., 2004. Humber Management Scheme. Annex D - Water Quality. Available from: www.humberems.co.uk/downloads/Annex%20D%20-%20Water%20Quality.pdf

Edwards, T., 2004. Humber Management Scheme. Annex D - Water Quality. Available from: www.humberems.co.uk/downloads/Annex%20D%20-%20Water%20Quality.pdf

English Heritage. (2008). Conservation Principles, Policies and Guidance for the Sustainable Management of the Historic Environment.

English Nature (2001). Great Crested Newt Mitigation Guidelines. English Nature, Peterborough.

English Nature (2002) Barn owls on site: A guide for developers and planners 2nd Edition. English Nature

English Nature (2003) The Humber Estuary: A comprehensive review of its nature

Environment Agency (2001). Humber Estuary Shoreline Management Plan.

Environment Agency (2004). Humber Estuary Coastal Habitat Management Plan. Black & Veatch Consulting Ltd, March 2004.

Environment Agency (2008). Humber Estuary Flood Risk Management Strategy.

Environment Agency (2009) Water for life and livelihoods: River Basin Management Plan Humber River Basin Management District.

Environment Agency (2010). Eel Management plans for the United Kingdom.

Environment Agency (2013). Review of fish population data in the Humber Estuary.

Environment Agency (2013). Review of fish population data in the Humber Estuary.

Environment Agency (2015) Water for life and livelihoods. Part 1: Humber river basin district River basin management plan.

Environment Agency (2018). TraC Fish Counts for all Species for all Estuaries and all years [online] Available from: https://data.gov.uk/dataset/41308817-191b-459d-aa39-788f74c76623/trac-fish-counts-for-all-species-for-all-estuaries-and-all-years (accessed 09/09/2018)

Environment Agency 1998. Strategic Studies, Shoreline Management Plan, geomorphology review, The Humber Estuary tidal defence strategy, July 1998.

Environment Agency 2000. Humber Estuary Geomorphological Studies- Phase 2, Volume 1, March 2000.

Environment Agency catchment data explorer from https://environment.data.gov.uk/catchment-planning/WaterBody/GB104027069593

Environment Agency data from “What’s on your Backyard” (WIYBY) website http://apps.environment-agency.gov.uk/wiyby/default.aspx.

Environment Agency online database – What's in your Backyard (www.data.gov.uk). The WIYBY portal is no longer active, however data is still available through data.gov.uk (Accessed July 2018)

Environment Agency, 2001. Humber Estuary Shoreline Management Plan.

Environment Agency, 2004, Contaminated Land Report 11, Model Procedures for the Management of Land Contamination

Environment Agency, 2004. Humber Estuary Coastal Habitat Management Plan. Black & Veatch Consulting Ltd, March 2004.

Environment Agency, 2008. Humber Estuary Flood Risk Management Strategy.

Environment Agency, 2010, GPLC1 – Guiding Principles for Land Contamination.

Environment Agency, 2011. Humber Flood Risk Management Strategy: Habitats Regulation Assessment. Halcrow Group Limited.

Environment Agency, 2011b. Humber Flood Risk Management Strategy: Strategic Environmental Assessment. Halcrow Group Limited.

Environment Agency, 2011c. Coastal Flood Boundary Conditions for UK Mainland and Islands. Project: SC060064/TR2: Design Sea Levels. Environment Agency, Almondsbury, 142p.

Environment Agency, 2013. Review of fish population data in the Humber Estuary.

Environment Agency. (2018). Water management: abstract or impound water.https://www.gov.uk/guidance/water-management-abstract-or-impound-water

Environmental Protection Act 1990

European Commission, 2018. Environmental, Air Quality – Existing Legislation. Available from http://ec.europa.eu/environment/air/quality/existing_leg.htm

Evans, P.G., Pierce, G.J. and Panigada, S., 2010. Climate change and marine mammals. Journal of the Marine Biological Association of the United Kingdom, 90(8), pp.1483-1487.

Fearnley et al., 2012. Visitor Survey, conducted for the Humber Nature Partnership by Footprint Ecology. http://www.humbernature.co.uk/admin/resources/footprint-ecology-humber-visitor-report-6th-july-2012.pdf accessed 01/11/2018

Ferns, P.W., Rostron, D.M. and Siman, H.Y., 2000. Effects of mechanical cockle harvesting on intertidal communities. Journal of Applied Ecology, 37, 464-474

Franco, A., 2015. Lamprey in the Humber presentation at the Humber Nature Forum meeting December 2015.

Froglife (1999). Froglife Advice Sheet 10: reptile survey. Froglife, London.

Frost, T.M., Austin, G.E., Calbrade, Mellan, H.J., Hearn, R.D., Stroud, D.A., Wotton, S.R. and Balmer, D.E. (2018). Waterbirds in the UK 2016/17: The Wetland Bird Survey. BTO/RSPB/JNCC. Thetford.

Gameson, A.L.H., 1982. Physical characteristics. In: The quality of the Humber Estuary 1961-1981, Gameson, A.L.H. Ed., Humber Estuary Committee.

Gent T and Gibson S (2003). Herpetofauna Workers Manual. JNCC, Peterborough.

GeoSea Consulting, 1990. Sediment Transport in the Humber Estuary. Report to Sir William Halcrow and Partners.

Glover, H. K., Guay, P. J., and Weston, M. A., 2015. Up the creek with a paddle; avian flight distances from canoes versus walkers. Wetlands Ecology and Management, 1-4.

Google, 2018. Google Earth Pro Software

GroundSure EnviroInsight and GeoInsight reports, references HMD-252-2055007, HMD-252-2055008, HMD-252-2055009 dated May 2015 and HMD-252-2667765, HMD-252-2667766, HMD-252-2667767 dated January 2016.

GSB Prospection Ltd, 2016, *Areas 1a-1g, 2, 3 and 5b-5h, Skeffling, East Yorkshire*, Geophysical Survey Report G15144

GVLIA, 2013. Guidelines for Landscape and Visual Impact Assessment (GLVIA3). Landscape Institute and the Institute of Environmental Management and Assessment. Routledge. ISBN: 978-0-415-68004-2.

Halcrow, 2013. Humber Estuary Managed Realignments: Lessons for the Future. Main Report: Review Document. A report for the Environment Agency.

Halcrow. 2011. Habitat Creation at Skeffling: Preliminary Design Guidance. A report for the Environment Agency.

Hammond, M. 2011. Saltmarsh vegetation monitoring at Outstray Farm, Sunk Island (2011). A report to ABP Marine Environmental Research Ltd.

Hammond, M. 2017. Vegetation development on new inter-tidal habitat at Outstray Farm (Sunk Island) in 2017. A report to ABP Marine Environmental Research Ltd.

Hemingway, K.L., Cutts, N.C. and R. Pérez-Dominguez., 2008. Managed Realignment in the Humber Estuary, UK. Institute of Estuarine & Coastal Studies (IECS), University of Hull, UK. Report produced as part of the European Interreg IIIB HARBASINS project.

Her Majesty's Stationery Office, HMSO (1974). Control of Pollution Act (as amended), CoPA 1974.

Her Majesty's Stationery Office, HMSO (1990). Environmental Protection Act (as amended), EPA 1990.

HES (2008). Humber Estuary Services Humber Pilot Handbook. May 2008. Associated British Ports Publication.

Highways Agency (HA), 2008. Design Manual for Roads and Bridges (DMRB) Volume 11, Section 2, Part 5, HA205/08 - Assessment and management of environmental effects. (Highways Agency, 2008)

Highways Agency, 2007. Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, Part 2, HA 208/07, Cultural Heritage.
Highways England, 2016, Design Manual for Roads and Bridges Volume 11 Environmental Assessment, Part 11 Geology and Soils

Historic England (2017) Historic Environment Good Practice Advice in Planning Note 3: The Setting of Heritage Assets

HM Government, 2011. UK Marine Policy Statement

HM Government, 2014. East Inshore and East Offshore Marine Plans

HMSO, 2017. The Town and Country Planning (Environmental Impact Assessment Regulations 2017.
https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/577143/SI-Town_and_Country_Planning.pdf

HSMO, 2010. Conservation of Habitats and Species Regulations 2010(a) (assessment of implications for European site and European offshore marine sites.

HSMO, 2017. The Marine Works (Environmental Impact Assessment) (Amendment) Regulations 2017. http://www.legislation.gov.uk/uksi/2017/588/made

http://www.archaeologists.net/sites/default/files/CIfAS&GDBA_2.pdf

Hull University Business School, 2016. GVA growth in the Humber Economy: Briefing note for Humber Local Enterprise Partnership Board. Available at: http://www.humberlep.org/wp-content/uploads/2016/04/Paper-C-Appendix-GVA-growth-in-the-Humber-Economy_V17.pdf

Humber Field Archaeology, 2011, *Skeffling Managed Realignment, Skeffling, East Riding of Yorkshire, Assessment of Archaeological Potential*, Humber Archaeology Report No. 372

Humber Nature Partnership (HNP), 2016. Humber Management Scheme, Action Plan.

Humber Nature Partnership (HNP), undated. Humber Management Scheme. Fact sheet: Saltmarsh.

IAQM, 2016. Guidance on the Assessment of Dust from Demolition and Construction v1.1. Available from http://www.iaqm.co.uk/text/guidance/construction-dust-2014.pdf

ICRT (2010) Economic Potential of Nature Tourism in Eastern Yorkshire

IECS, 2008. Assessment of Lamprey impingement at South Humber Bank Power Station: November 2003-February 2006. Report for Humber Power Ltd. May 2008.

IECS, 2009. Construction and Waterfowl: Defining Sensitivity, Response, Impacts and Guidance. Institute of Estuarine and Coastal Studies Report to Humber INCA

IECS, 2014a. Ornithological baseline usage in an area considered for realignment sites on the Humber Estuary. Report (YBB195-F-2014) for the Environment Agency.

IECS, 2014b. Ornithological baseline usage in an area considered for managed realignment on the Humber Estuary: update on passage survey findings (April 2014 to September 2014). Report (YBB195-V1-2014) for the Environment Agency.

IECS, 2015. Waterbird baseline usage in an area considered for managed realignment on the Humber Estuary: update on winter survey findings (October 2014 to March 2015). Report (YBB195-winter 2014/15 V1-2015) for the Environment Agency.

IECS, 2016a. Waterbird baseline usage in an area considered for managed realignment on the Humber Estuary: update on winter and passage survey findings (October 2015 to April 2016). Report (YBB312-2015/16 V1-2016) for the Environment Agency.

IECS, 2016b. Waterbird baseline usage in an area considered for managed realignment on the Humber Estuary: update on autumn passage survey findings (July 2016 to September 2016). Report (YBB312-V1.0-2016) for the Environment Agency.

IECS, 2016c. Humber Estuary High Tide Roost Review 2013-2014. Report (YBB200/219-F-2016) for RSPB & Natural England.

IEEM, 2006. Guidelines for ecological impact assessment in the United Kingdom. Institute of Ecology and Environmental Management. Access at: http://www.cieem.net/data/files/Resource_Library/Technical_Guidance_Series/EcIA_Guidelines/TGSEcIA-EcIA_Guidelines-Terestrial_Freshwater_Coastal.pdf

IEMA, 1993. Institute of Environmental Management and Assessment - Guidelines for the Environmental Assessment of Road Traffic.

International Organization for Standardization (ISO), 1996 and reviewed in 2012. ISO 9613-2 'Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation'. (ISO, 1996).

JNCC (2004). Common Standards Monitoring Guidance for Birds, Version August 2004. JNCC, Peterborough.

JNCC (2004). Common Standards Monitoring Guidance for Reptiles and Amphibians, Version February 2004. JNCC, Peterborough.

JNCC (2010) Handbook for Phase 1 habitat survey – a technique for environmental audit. Joint Nature Conservation Committee, Peterborough

JNCC (2016). Annex I habitats and Annex II species occurring in the UK. Available here: http://jncc.defra.gov.uk/page-1523

JNCC and Defra (on behalf of the Four Countries' Biodiversity Group). 2012. UK Post-2010 Biodiversity Framework. July 2012. http://jncc.defra.gov.uk/page-6189

JNCC, (2016). Annex I habitats and Annex II species occurring in the UK. Available from: http://jncc.defra.gov.uk/page-1523. Accessed September 2018.

JNCC, 2008. Information Sheet on Ramsar Wetlands (RIS): Humber Estuary

Landscape Character Assessment: Guidance for England and Scotland, published by Scottish Natural Heritage and the Countryside Agency (2002).

Landscape Institute Advice Note 01/2011: Photography and Photomontage in landscape and visual assessment.

Langton T, Beckett C and Foster J (2001). Great Crested Newt Conservation Handbook. Froglife, Suffolk

Leggett, D.J., Cooper, N., and Harvey, R., 2004. Coastal and estuarine managed realignment – design issues. Construction Industry Research and Information Association, London, 215p.
Leggett, D.J., Cooper, N., and Harvey, R., 2004. Coastal and estuarine managed realignment - design issues. Construction Industry Research and Information Association, London, 215p.

Lincolnshire Wildlife Trust, 2018. Yearly Summaries from Donna Nook [online] available at: https://www.lincstrust.org.uk/get-involved/top-reserves/donna-nook/weekly-update (accessed 08/08/2018)

Lincolnshire Wildlife Trusts, 2016. Evaluation report for Heritage Lottery Fund. Donna Nook - see the seals safely.

Lowe, J., Howard, T., Pardaens, A., Tinker, J., Holt, J., Wakelin, S., Milne, G., Leake, J., Wolf, J., Horsburgh, K., Reeder, T., Jenkins, G., Ridley, J., Dye, S., and Bradley, S. 2009. UK Climate Projections Science Report: Marine and coastal projections. Met Office Hadley Centre, Exeter, 99p

Magnitude Surveys, 2016a, *Geophysical Survey Report MSTA36 of Land at Sunk Island, East Riding of Yorkshire*

Magnitude Surveys, 2016b, *Geophysical Survey Report MSTA57 of Skeffling, East Yorkshire*

Maitland (2003). Ecology of the River, Brook and Sea Lamprey: Conserving Natura 2000 Rivers Ecology Series No. 5. English Nature, Peterborough.

Mander, L., Cutts, N.D., Allen, J., and Mazik, K., 2007. Assessing the development of newly created habitat for wintering estuarine birds. Estuarine, Coastal and Shelf Science S 75, 163-174.

Marine Ecological Surveys Limited, 2008. Marine Macrofauna Genus Trait Handbook. http://www.genustraithandbook.org.uk

Masters, J.E.G., Jang, M.H., Ha, K., Bird, P.D., Frear, P.A., Lucas, M.C (2006). The commercial exploitation of a protected anadromous species, the river lamprey (*Lampetra fluviatilis* (L.)), in the tidal River Ouse, north-east England. *Aquatic conservation: Marine and Freshwater Ecosystems*, 16: 77-92.

McLeod, E. M., Guay, P. J., Taysom, A. J., Robinson, R. W., and Weston, M. A., 2013. Buses, cars, bicycles and walkers: the influence of the type of human transport on the flight responses of waterbirds. PloS one, 8(12), e82008

Middleton, R. and Cook, P.J. (2015) South-east Yorkshire (vc61) Rare Plant Register. 3rd Edition

Ministry of Housing, Communities & Local Government [Online]. MoHCLG. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/740441/National_Planning_Policy_Framework_web_accessible_version.pdf

Mitchell-Jones AJ (2004). Bat Mitigation Guidelines. English Nature.

Mitchell-Jones AJ and McLeish AP (2004). The Bat Workers' Manual, 3rd Edition. JNCC, Peterborough

Multi-Agency Geographic Information for the Countryside (MAGIC) website (accessed July 2018)

National Rivers Authority 1991 The Water Quality of the Humber Estuary 1990: A report from the Humber Committee of the NRA.

Natural England (2003b) The Humber Estuary European Marine Site: English Nature's advice given under Regulation 33(2) of the Conservation (Natural Habitats &c.) Regulations 1994.

Natural England (2006) England Leisure Visits – Report of the 2005 Survey Cheltenham: Natural England

Natural England (2010), Agricultural Land Classification Map West Midlands Region (ALC004)

Natural England (2011) Reptile mitigation guidelines. Natural England Technical Information Note TIN102.

Natural England and Countryside Council for Wales (CCW) (2007) Disturbance and protected species: understanding and applying the law in England and Wales: A view from Natural England and the Countryside Council for Wales. Natural England, Peterborough, 30p.

Natural England, 2012. National Character Area (NCA) 28: Vale of York. Available from: http://publications.naturalengland.org.uk/publication/3488888 (Accessed September, 2018).

Natural England, 2017. Humber Estuary SAC Supplementary advice [online] Available at: https://designatedsites.naturalengland.org.uk (accessed 01/10/2018)

Natural England, 2018. Humber Estuary SPA Supplementary advice [online] Available at: https://designatedsites.naturalengland.org.uk (accessed 01/10/2018)

Natural England, 2018. Multi-Agency Geographic Information of the Countryside (MAGIC). Available from: https://magic.defra.gov.uk/MagicMap.aspx [Accessed: September 2018]

Natural England/Environment Agency (2016). Habitats Regulations considerations of designated site losses from coastal squeeze caused by a 'Hold The Line' (HTL) policy on the Humber Estuary.

Navedo, J. G., and Herrera, A. G., 2012. Effects of recreational disturbance on tidal wetlands: supporting the importance of undisturbed roosting sites for waterbird conservation. Journal of Coastal Conservation, 16(3), 373-381.

Nix, 2017. Farm Management Pocketbook. John Nix, 47th edition by Graham Redman. Published September 2016.

Nomisweb.co.uk. *Nomis - Nomis - Official Labour Market Statistics*. [online] Available at: https://www.nomisweb.co.uk/

OSPAR, 2009. Background Document for Sea lamprey Petromyzon marinus. OSPAR Biodiversity Series.

OSPAR, 2010. Background Document for the European eel Anguilla anguilla.

Patrington Conservation Area Appraisal May 2006

Pérez-Dominguez, R., 2008. Fish Pilot Studies in the Humber Estuary, UK. Institute of Estuarine & Coastal Studies (IECS), University of Hull, UK. Report produced as part of the European Interreg IIIB HARBASINS project.

Rijnsdorp, A.D., Peck, M.A., Engelhard, G.H., Möllmann, C. and Pinnegar, J.K., 2009. Resolving the effect of climate change on fish populations. ICES journal of marine science, 66(7), pp.1570-1583.

Rodwell JS (2006). National Vegetation Classification: Users' Handbook. JNCC, Peterborough.

Rodwell, John S., ed. (1998–2000). British Plant Communities.

Ross, K. and Liley, D. (2014). Humber Winter Bird Disturbance Study. Unpublished report for the Humber Management Scheme by Footprint Ecology.

Ross, K. and Liley, D., 2014. Humber Winter Bird Disturbance Study, conducted for the Humber Nature Partnership by Footprint Ecology. http://www.humbernature.co.uk/admin/resources/humber-winter-bird-disturbance-study-2014.pdf accessed 01/11/2018

SCOS, 2016. Scientific Advice on Matters Related to the Management of Seal Populations: 2015

Sea Watch Foundation (SWF), 2018. Recent Sightings database [online] Available at: www.seawatchfoundation.org.uk/recentsightings (accessed 01/10/2018)

Seascape Characterisation around the English Coast (Marine Plan Areas 3 and 4 and Part of Area 6 Pilot Study) published in 11th October 2012

Sheils Flynn: Humber Estuary integrated landscape & investment study - Sunk Island flood risk management area 3 and Skeffling flood risk management area 2

Smit, C.J. and Visser, J.M., 1993. Effects of disturbance on shorebirds: a summary of existing knowledge from the Dutch Wadden Sea and Delta area, In: Disturbance to Waterfowl on Estuaries, August 1993.

Stillman, R. A., and Goss-Custard, J. D., 2002. Seasonal changes in the response of oystercatchers Haematopus ostralegus to human disturbance. Journal of Avian Biology, 33(4), 358-365.

Strachan R and Moorhouse T (2006). Water Vole Conservation Handbook, 2nd Edition. Wildlife Conservation Research Unit (WildCRU), Oxford University.

Sunk Island Conservation Area Appraisal December 2006

The Coal Authority Interactive Map Viewer (http://coal.decc.gov.uk, accessed July 2018)

Tide Facts, 2017. Tidal River Development – The Humber Estuary. Access at: http://www.tide-project.eu/

Toft, A.R., Pethick, J.S., Burd, F., Gray, A.J., Doody, J.P., Penning-Rowsell, E., and Maddrell, R.J., 1995. A guide to understanding and management of saltmarshes. National Rivers Authority, Bristol, 213p.

Townend, I. and Whitehead, P., 2003 A preliminary net sediment budget for the Humber Estuary. The Science of the Total Environment, 314-316 2003, p755-767.

Townend,I., Pethick. J., Balson, P., Roberts, W. and Young, R., 2000. The Geomorphology of the Humber Estuary. In: Proceedings of the 35th MAFF Conference of the River and Coastal Engineers.

UKHO 2017. United Kingdom Hydrographic Office UKHO, 2017. Admiralty Tide Tables, 2018, Volume 1. Published by UKHO.

UKHO, 2017. Admiralty Chart 1188: England – East Coast, river Humber, Spurn Head to Immingham. October 2017.

Walther, G.R., Post, E., Convey, P., Menzel, A., Parmesan, C., Beebee, T.J., Fromentin, J.M., Hoegh-Guldberg, O. and Bairlein, F., 2002. Ecological responses to recent climate change. Nature, 416(6879), p.389.

Water Resources Act 1991

Whitehead, P.J.P., Bauchot, M.-L., Hureau,. J.-C., Nielsen, J. & Tortonese, E., eds., 1989. Fishes of the North-eastern Atlantic and the Mediterranean: Volume I. Second edition. Paris: United Nations Educational Scientific and Cultural Organization (Unesco), pp. 1-510.

Woodward, I. D., Calbrade, N. A. and Holt, C. A., 2015. Humber Estuary Bird Decline Investigation 2014. BTO Research Report No. 668

York Archaeological Trust (YAT), 2016, *Welwick to Skeffling Managed Realignment Scheme Revised Draft Stage 1 Risk Map*, Report Number 2016/24

York Archaeological Trust (YAT), 2017, *Archaeological Investigations at Welwick to Skeffling Managed Realignment*, Report Number 2017/12

Appendix 3 – Humber Ports Biosecurity Plan

Humber Ports Biosecurity Plan

Associated British Ports

March 2024

Contents

Figure

1 Introduction

The number of invasive non-native species (INNS) in Britain is increasing, principally due to transport via ballast waters and sediments, biofouling and imported consignments of cultured species (Cook *et al.*, 2014). A range of initiatives have been established to seek to limit or control the spread and transfer of INNS, including statutory measures such as the Ballast Water Management Convention (BWMC), the EU Regulation 1143/2014 on Invasive Alien Species and the EC Water Framework and Marine Strategy Framework Directives (2000/60/EC and 2008/56/EC respectively).

Within England and Wales, good practice guidance has been developed on how to manage marine biosecurity risks at sites and when undertaking activities through the preparation and implementation of biosecurity plans (Cook *et al*., 2014). It is also worth noting that regulators in both England and Wales have a duty to ensure that the habitats and features of European designated sites are not negatively impacted by the spread of INNS to such sites (Special Areas of Conservation (SACs) and Special Protection Areas (SPAs)).

In the marine environment, having a robust biosecurity plan is particularly important as eradication or control of INNS post-introduction is often extremely difficult. Although there is not, at present, legislation enforcing the preparation of biosecurity plans, having a robust plan is compliant with other national and international legal commitments; for example, the Marine Strategy Framework Directive, Water Framework Directive, Wildlife and Countryside Act 1981 (as amended) and the EU Invasive Alien Species Regulation (Cook *et al.*, 2014).

Associated British Ports (ABP) has developed biosecurity plans for use across the ABP group, as well as procedures for INNS management and for new INNS incidents. This Biosecurity Plan is focussed on the Humber ports (Hull, Goole, Grimsby and Immingham) and is supported by a Biosecurity Information Pack for Port Users (Appendix A). A paper copy of the Plan, along with relevant documentation, is located in Emergency Boxes held at each ABP Port. The plan is regularly reviewed to account for the latest data on invasive species and activities being undertaken at each Port. It is therefore a 'live' document and updated on an iterative basis.

This Biosecurity Plan aims to assess the risk of introduction or spread of INNS from a source environment to a receiving environment and to highlight where one-off events increase the risk of introduction. The approach being taken within this plan is primarily to identify the highest risk pathways for introduction of non-native species and introduce measures that allow us to manage those risks as far as reasonably practicable. This allows management measures to be put in place without detailed knowledge of species present. The risk assessment will take into account the likelihood of introduction or spread of INNS and the severity of the impacts that would be realised if INNS were to colonise the receiving environment. Appropriate biosecurity control measures have then been assigned and captured within the biosecurity plan to sufficiently manage and reduce this risk.

The Biosecurity Plan is based on the good practice document developed for England and Wales (Cook *et al*., 2014). This plan provides:

- Port details and site activity for the Humber Estuary;
- Roles and responsibilities;
- Details of INNS in and around the area;
- Risk assessment and mitigation measures;

- Inspection and monitoring regime;
- Contingency planning steps to be taken in event of new species sighting or high risk activity;
- Details of interested parties;
- Biosecurity log; and
- Process for reviewing and updating the Biosecurity Plan.

Links are also provided to other useful sources of information where appropriate.

2 Port Details

Details of each of the Humber Ports that is relevant to the management of biosecurity risks is presented below.

Site Location
Location: Humber Estuary The Humber is a macro tidal soft geology estuary on the east coast of England. It is highly turbid with a large tidal exchange of water across its mouth. Geomorphologically it is a product of the Holocene era with a distinctive breakwater at Spurn. Despite significant reclamation within the last 300 years, it still retains a form reminiscent of its immediate post glacial state. Turbidity varies along its length and the salinity gradient varies according to spring/neap cycle and freshwater input. The Humber River basin drains a fifth of the land mass of England. **The Ports of Hull, Goole, Grimsby and Immingham are located on the River Humber (Humber Estuary)** The Humber accounts for 17% of the UK's seaborne trade which largely transits ABP's ports of Immingham, Grimsby, Hull and Goole. Whilst these ports have historic routes and legacy infrastructure together with the incumbent challenges that this presents, more modern developments are also in evidence together with dredged and maintained channels/ berth pockets. Since the post war period when improvements in the quality of steel enabled large jetties to be constructed to accommodate increased vessel sizes, the pace of development on the estuary has been significant. The Humber contains the deepest navigable fairways between the Thames and the Tees with deep sea vessels carrying a range of products from liquid bulks to ores and break bulks. Short sea shipping is also important contributor with a number of wharfs in existence run by third parties.


Pocklington
Escrick
Market Weighton
Sancton
Holme-on-Spalding-Moor
Barlby
Selby
Brayton
Howden
Gilberdyke
South Cave
Brough
Snaith
Associated British Ports
Barton-upon-Humber
Brandesburton
Hornsea
Leven
Leconfield
Beverley
Woodmansey
Rise
Aldbrough
Cottingham
Hull
Associated British Ports
Willerby
Hessle
Roos
Hedon
Withernsea
Thorngumbald
Humber
Patrington
Holmpton
Easington
Associated British Ports
South Killingholme
Immingham
Kilnsea
Associated British Ports
Stallingborough
Grimsby
Associated British Ports
Laceby
Waltham
Thorne
Crowle
Keadby
Scunthorpe
Hatfield
Belton
Broughton
Wrawby
Brigg
Armthorpe
Epworth
Messingham
Grasby
Hibaldstow

Sensitive Receptors

The Humber Estuary – Protected Sites
The whole of the Estuary is a Special Protection Area (SPA), Special Area of Conservation (SAC), Ramsar site, working together these designations create a European Site which is administered by the Humber Estuary relevant authorities' group (now hosted by the Humber Nature Partnership) which ABP is member of in their role as a statutory harbour authority. Under the Habitats Regulations ABP is therefore defined as a relevant authority. The Humber Estuary is also designated as a Site of Special Scientific Interest (SSSI). The Holderness Inshore Marine Conversation Zone has been designated to protect the eastern elevation of sensitive but morphologically variable spit at Spurn Head at the mouth of the Humber Estuary. A number of areas are also protected or designated due to their importance for birdlife including the National Nature Reserves of Donna Nook, Spurn Head and Far Ings.

Site Activities

Humber:
- A large amount of maintenance dredging occurs within the Humber each year and this correlates to three marine licences for removal and the disposal of dredged arisings at eight licensed disposal sites within the estuary. There is a significant number of wind turbines in the Humber's near shore area of the North Sea at Humber Gateway, Westernmost Rough and Hornsea. All these types of sites have the potential to act as 'steppingstone' areas for INNS to become established. Further wind turbines are set to be installed at greater distances offshore particularly as part of the Hornsea Round Three Zone.
- Significant areas in the approaches and the mouth of the Estuary are designated anchorages for larger ships. This presents a biosecurity risk as slow moving and stationary vessels have an increased potential to host INNS.
- The Humber Estuary is popular with recreational vessels and is home to approximately 1000 recreational marina and mooring berths. The RYA classify it as a medium use area.
- Latterly the Humber is being seen as an important growth opportunity for the UK energy sector with the burgeoning offshore wind industry and biomass sector playing an important role.

Grimsby:
- This port is one of the largest UK car importers and handles more than 500,000 cars a year, the majority of ships come from mainland Europe.
- Centre for the operations and maintenance aspects of the offshore wind sector.
- A lot of Grimsby's cargo, especially timber products come, from Scandinavia and The Baltic States.
- 3rd party Marina
- 3rd party RDF – export to Scandinavia
- Land acquisition – the former Tioxide Site, to the west of the Port.

Hull:

- Hull specialises in handling forest products and out of all UK ports it is the largest importer of forest products. Hull is on the softwood timber trade routes from Northern Europe, the Baltic States, and Scandinavia. There are daily week-day sailings to Rotterdam and two sailings a week to the Baltic States.
- The port is a land-and-sale point for wet fish from local trawlers and from all over the British Isles.
- P&O Ferries operate Terminal 1 for their daily Hull-Rotterdam freight, car, and passenger crossings.
- 3rd party Dry Dock facilities for vessel servicing, repair and cleaning.
- Scrap imports and exports
- RDF exports
- Import and export of bulk cargoes
- Marine Engineering Support Unit – clean pilot launches and navigational buoys.
- Operational plant and equipment wash down facilities
- A recent reclamation at Alexandra Dock allowed Siemens Gamesa to establish a facility for the manufacture, assembly and export of off shore wind turbine components.

Goole:

- Timber is predominantly imported from the Baltic States, Finland, and Sweden.
- Scrap metal export
- RDF
- Fertiliser and bulks from Europe
- Goole's constant water level allows heavy lift working on most berths.
- Goole's enclosed dock basins are fresh water receiving input from inland waterways. There is very little connectivity to the River Ouse (brackish water) other than lock water level equalisations and general seepage.
- 3rd party Marina

Immingham:

- Immingham is the UK's largest port by tonnage, handling around 55 million tonnes.
- Offers an extensive range of roro and lo-lo freight services to Northern Europe, Scandinavia, and the Baltic. Regions covered include Holland, Belgium, the Baltic, Scandinavia, and Iceland, with significant container vessel calls per week.
- Significant volumes of deep-sea imports from the far east
- Processed fish products, which are also imported from all over the world.
- Eight roro berths, handling more than 30 sailings each week to/from Northern Europe and Scandinavia with DFDS Seaways.
- Other notable cargoes include, liquid bulks, agribulks, scrap metals, biomass, petrochemicals and other general cargoes.

- Further development projects are on-going. The Immingham Eastern Roro Terminal which is a facility for the handling of roro vessels on the Eastern frontage, and the Immingham Green Energy Terminal which contemplates the import of liquid bulks associated with the UK's transition to a low carbon economy.

Site Features - Water

The salinity gradient in the Humber Estuary varies according to freshwater input from upstream and the tidal cycle. This has a direct impact upon our Port operations as varying salinity has a direct input on density of the water column and will therefore affect vessel drafts. Water density is directly attributable to varying temperature and salinity.

Kg/m³:

- Immingham/Grimsby - Range LW – HW is about 1012 to 1022 the average from the data we have is 1016.9
- Saltend – Range LW – HW is about 1009 to 1018; Average 1013.5
- Hessle – Range LW – HW is about 1002 to 1012; Average 1006.8
- Hull Average of Saltend and Hessle is 1010.2
- Goole is the UK's most inland port. The water in the enclosed dock basins is fresh although some limited saline intrusion maybe evident from seepage through the river wall and via lock water level equalisation.

Site Features – Submerged Man-Made Structures

Whilst the Estuary in its current form mostly resembles its post glacial geomorphological appearance some significant anthropogenic change has happened, most notably in the last few hundred years. Large sections of the Estuary have had formal and informal flood defences installed and significant port infrastructure is evident around the more heavily more urbanised areas. Buoys, light floats and marker piles are also a key feature in order to regulate and manage the safe passage of merchant shipping. Our published chart catalogue can be accessed via the following link and shows the location of key marine infrastructure and navigational aids, http://humber.com/Estuary_Information/Marine_Information/Chart_Catalogue/Current_Humber_Charts/

3 General Roles and Responsibilities

The key roles and responsibilities across the Humber Ports in relation to biosecurity are summarised below.

Regional Biosecurity Manager - A Biosecurity Manager should have a sound understanding of the operation, as well as the biosecurity risks associated with that operation. They should be familiar with the identification of INNS and best practices to prevent their introduction and spread, and directly input into the preparation of the Biosecurity Plan. The Biosecurity Manager should own the plan and have responsibility for:

- Periodic review; updating when required; and
- Communication and providing training to others with a responsibility under the plan.

The Biosecurity Manager must be readily contactable to assist in the event of the discovery of INNS and is responsible for communicating this information to all licence holders as well as the relevant organisations (most notably, the GB Non-Native Species Secretariat and Marine Biological Association (MBA)[1]).

Biosecurity Officer –The primary role of the Biosecurity Officer should be to provide educational material and general biosecurity support to vessel operators who operate under a marine licence, as well as wharfs in the region.

Port Manager - The Port Manager is responsible for ensuring implementation of the elements of the Biosecurity Plan that are relevant to the wharf. In particular, the Port Manager should maintain a biosecurity logbook (see Section 6) and ensure this is filled out as and when required.

Port Staff - All staff should have an awareness of biosecurity and should photograph and report any new 'suspect' marine plant or animals to the wharf manager and biosecurity manager.

Licence Holder(s) - The responsibility of the participating licence holder(s) (of any marine licensable activity within the port) is to minimise the risk of transfer / spread of INNS when carrying out the activities defined in a marine licence. This includes compliance with the relevant regional Biosecurity Plan. Licence holder(s) should input into the review of the Biosecurity Plan, which should be updated periodically, as well as in response to changes in operation, a change in legislation or a change in understanding of biosecurity. The licence holder(s) should also have mechanisms in place to implement the plan and ensure those working in accordance with the marine licence, which might be direct employees or subcontractors, understand and are able to adhere to the plan. Changes to the plan should be communicated to all stakeholders, including staff members and interested parties. The Licence Holders might together appoint one Regional Biosecurity Manager to assist in the practical implementation of the Biosecurity Plan. Additionally, each licence holder might appoint a Biosecurity Officer, to provide support and educational material to those who operate under its marine licence(s) for that region.

[1] NRW has furthermore requested that it be notified whenever any species identified as 'high risk' on the Welsh monitoring or surveillance lists are found.

Vessel Master - The Vessel Master has ultimate command of the vessel and must ensure the relevant control measures outlined in the Biosecurity Plan in relation to the vessel are adhered to by the crew. The Vessel Master should have an understanding of supplementary shipping industry legislation that is relevant to biosecurity, for example the Ballast Water Management Convention. The Vessel Master should keep a Biosecurity Logbook (see Section 6) on board and ensure this is filled out as and when required.

Vessel Crew - All staff should have an understanding of the Biosecurity Plan and must report any new ‘suspect’ marine plant or animals to the vessel master and biosecurity manager, for recording in the Biosecurity Logbook.

4 Invasive Species Data

Details of invasive species within the vicinity of each port has been collected via:

- Site specific surveys; and
- Detailed review of published data sources.

4.1 Site specific surveys

For each of the locations identified in Section 2 (Port details), an assessment of the INNS in the direct vicinity and nearby location has been carried out. An 'at site' assessment focused on the specific port and a 'near site' assessment identified species that are recorded as being present in the vicinity, for example this might include species recorded in 'Grimsby' but not necessarily at the port itself.

Wold Ecology, Richard Baines, PGDip, MCIEEM (Ecologist/Director) completed terrestrial biodiversity surveys in the Ports of Hull, Goole, Immingham and Grimsby between June 2019 and December 2019. Reports can be viewed on ABP SharePoint link: Biodiversity Surveys 2019 (Land)

An ongoing monitoring schedule for key locations arounds the ports is provided in Section 5.2.

4.2 Data review

A number of general information sources were drawn upon to identify INNS that might be present within the vicinity of the ports, including:

- GB Non-Native Species Secretariat, with records of each species in the Species Information Portal: http://www.nonnativespecies.org/factsheet/index.cfm;
- Additional marine NNS listed on the European Commission's list of 'Invasive Alien Species of Union Concern' (European Commission, 2022);
- The UK Technical Advisory Group (UKTAG) on the Water Framework Directive (WFD) revised classification of aquatic alien species according to their level of impact (WFD UKTAG, 2015);
- Schedule 9 of the Wildlife and Countryside Act 1981 (as amended);
- Joint Research Centre (JRC) European Alien Species Information Network (EASIN): https://easin.jrc.ec.europa.eu/; and
- HELCOM and OSPAR target species list: http://jointbwmexemptions.org/.
- National Biodiversity Network: https://nbn.org.uk/;
- MarLIN Marine Biodiversity and Information: http://www.marlin.ac.uk/;
- Natural England / Natural Resources Wales marine experts;
- The MSFD baseline marine INNS layers and associated report ; and
- The MSFD UK priority monitoring and surveillance species lists (Cefas, 2015).

These data sources were also used to provide a list of species that are not yet present but there is considered to be a relatively high risk of introduction.

These data sources are reviewed periodically to ensure that the species lists remain current.

4.3 INNS to be aware of in the area

The following species are present in the area:

- Leathery Sea Squirt;
- Japanese Skeleton Shrimp;
- Wakame;
- Trumpet Tube Worm;
- Darwins barnacle;
- Japanese Knotweed;
- Himalayan Balsam; and
- Giant Hogweed.

Species not yet present but which staff should be aware of include:

- Wireweed;
- Asian Shore/Brush Clawed Crab;
- Pacific Oyster;
- Slipper Limpet;
- Carpet Sea Squirt; and
- Chinese Mitten Crab.

The Humber Biosecurity Information Pack for Port Users (Appendix A) and Invasive Non Native Species BIO-SECURITY Marine Posters in port areas provide information and pictures of the above species.

If these species are observed, then reporting and management procedures outlined in Section 5 should be implemented. The surveillance and monitoring programme (as outlined in Section 5.2) also provides a feedback loop to ensure INNS lists remain current.

5 Risk Assessment and Critical Control Points

The information identified in Section 2 (Port activity) and Section 4 (Invasive species data) was used to inform a risk assessment and mitigation plan. A risk rating was assigned to each activity based on a combination of the likelihood of introduction or spread of INNS from the source to the receiving environment and the severity of the impacts if INNS introduction/spread was to occur. Biosecurity control measures have been assigned as appropriate to mitigate the risk, and the residual risk calculated in the same way.

5.1 Risk assessment

Activity/Location	Pathway/ Vector details	Risk before mitigation	Actions to reduce risk	Risk after mitigation
Type of activity or use of a particular area	*Describe the pathways associated with the activity/area, including who controls it.*	*High, Medium or Low*	*Identify priority actions to take to reduce the biosecurity risk (if any), where, when and who will carry out the action. If none are to be taken say why.*	*Risk following mitigating actions (H/M/L)*
BIOFOULING: Ships residing in the port for a significant period of time due to lay-by etc; Ships transiting the port for cargo operations; ABP vessels – pilot boats, dredgers movements in the river whilst going about day-to-day operations; Hull Cleaning by Port	Non-native species can be brought in from other ports. Where vessels reside longer in ports, biofouling is more likely to build up – high risk. However, biofouling commences instantly. Ships from high-risk area ports (NE Atlantic, West Africa, the Mediterranean or via the Suez Canal) are more likely to transit invasive non- native species. ABP Pilot Ships and Dredgers are subject to regular inspection,	Medium	• Alert Biosecurity Team when ships are to remain in port for more than 30 days • Awareness / familiarisation for employees on identification of non-native species • All suspected sightings of non -native species to be reported to the Biosecurity Team. • Visual aids in mess rooms and offices near to quaysides to aid identification • Reporting NNS to relevant authorities • Monitor for NNS via submerged object which will be viewed periodically for NNS (Minimum 1 in each Port).	Low

Activity/Location	Pathway/ Vector details	Risk before mitigation	Actions to reduce risk	Risk after mitigation
Tenants; Movement / cleaning of buoys from the river; Permanent submerged structures such as lock gates, berths, fenders, port walls.	but still have the potential for biofouling due to transiting the Humber. NNS brought in on vessels from other ports and dislodged when hull cleaning takes place (especially high risk if not compliant with legal requirements - has the potential for the biofouling to be dispersed into the river).		• ABP Pilot boats subject to regular inspection: photographs taken to be forwarded to Biosecurity Team for inspection and further action if required. • Liaise with tenants to ensure they are aware of biosecurity requirements. Encourage tenants to carryout hull cleaning ensure legal requirements are being met. No water back into marine environment/ use interceptor. • Do not allow avoidable activity to occur within our areas of jurisdiction unless absolutely necessary. Where it is deemed necessary, ensure that any techniques and equipment used for in-water hull cleaning use a fully enclosed system that will retain all of the biological debris • Ensure that debris from hull cleaning is prevented from being discharged back into the dock and disposed of appropriately • UKD (UK Dredging, ABP's principal dredging contractor) to have their own biosecurity plan to ensure they minimise the risk of biofouling to both Humber Ports and other locations they dredge/remove buoys from. • When diving inspections are made to check physical integrity of submerged marine infrastructure consideration will be made as	

Activity/Location	Pathway/ Vector details	Risk before mitigation	Actions to reduce risk	Risk after mitigation
			to whether a biofouling survey can also take place or is feasible/practicable/safe. • Survey data received from engineers lock gate inspections.	
Ballast water discharge from vessels in the river / port	Vessels form other ports entering the Humber Estuary / Humber Ports and emptying their ballast tanks with no prior approval from the port. Ships from high-risk area ports (NE Atlantic, West Africa, the Mediterranean or via the Suez Canal) are more likely to transit invasive non- native species.	High	• Notice to master's given by Ship's Agent prior to entry to Port detailing ballast requirements. • Vessels follow IMO Guidelines and Ballast Water Management Convention (BWMC): • All ships in international traffic will be required to have a Ballast Water and Sediment Management Plan in place. • Ballast water exchange (BWE) must be: o At least 200 nautical miles from the nearest land and in water at least 200 metres in depth, or if not possible; o As far from the nearest land as possible, and in all cases at least 50 nautical miles from the nearest land and in water at least 200 metres in depth, or if not possible; o In designated BWE areas (e.g. Intra-North Sea BWE area). • Vessels crossing international waters will be required to have an approved ballast water treatment system installed to comply with the D2 standards in the BWMC. • For vessels only transiting within UK waters, ballast water should be exchanged	High

Activity/Location	Pathway/ Vector details	Risk before mitigation	Actions to reduce risk	Risk after mitigation
			as far away from the wharf or harbour as is safe and practicable for the vessel. • Any concerns about vessels discharging without permission or not following IMO Guidelines report to MCA (Marine Guidance Note No 363 http://www.dft.gov.uk/mca/ mgn363.pdf.) • Awareness and familiarisation for employees on identification of non-native species. • All suspected sightings of non -native species to be reported to the Biosecurity Team. • Visual aids to aid identification. • Reporting NNS to relevant authorities. • Encourage sustainable means of ballast water control. • Any concerns or doubts about the discharge, seek confirmation from the MCA that the discharge is acceptable.	
Import and export of cargo	Non-native species moving between countries by hitchhiking in cargo or on the vessels that are importing or exporting the cargo. Ships from high-risk area ports are more likely to transit invasive non- native species.	Low	• Cargos are visually checked prior to discharge/loading. • Any detection of living species (Flora/Fauna/Insects) discharge/ loading will cease. On authority of Operation Mgr./Cargo Surveyor. • Take appropriate action for cargo as per operational procedures. • Report findings to Biosecurity Team.	Low

Activity/Location	Pathway/ Vector details	Risk before mitigation	Actions to reduce risk	Risk after mitigation
	High risk cargoes are bulk food and feed, fresh produce, forest products, containerised cargoes. Passenger ferries may have the potential for people to smuggle pets into and out of the country. Road going vehicles discharged / loaded onto ships have the potential to trap seeds in their wheels.		• Awareness and familiarisation for employees on identification of non-native species. • Visual aids to aid identification. • Reporting NNS to relevant authorities. • Ports have good housekeeping and road sweeping activities. • Where possible do not transfer material from one site to another e.g., on tyres or if soil needs to be shifted/disposed of.	
Day to day operations of Marinas, Port Tenants or other Ports/Wharfs etc in the Humber Area	Other nearby facilities may not adhere to any guidelines regarding non-native species or may not have facilities for the inspection or cleaning of boats within their facility. Non-native species may creep from these areas into our Ports.	Medium	• Communicate with other water users to ascertain what actions they are taking to control non-native species. • Work with other water users to minimise the risk of a non-native species entering our ports. • Report NNS to relevant authorities. • Information sharing with stakeholders. • Annual and quarterly meetings with Stakeholders where Biosecurity will be discussed.	Low
Localised non-native species already residing in the area on a domestic level / commercial level.	Release or escape of non-native species from the general public/commercial establishments (e.g., mink farms) in areas local to the port	Low	• Communicate and work with any known commercial establishment on the control of non-native species. • Awareness familiarisation for employees on identification of non-native species. • Visual aids to aid identification.	Low

Activity/Location	Pathway/ Vector details	Risk before mitigation	Actions to reduce risk	Risk after mitigation
	estates resulting in them creeping onto the Port.		• Report any non-native species to the Biosecurity Team. • Reporting NNS to relevant authorities. • Annual and quarterly meetings with stakeholders where biosecurity will be discussed.	
Development of new projects on the Port Estates e.g. Storage Areas, Office Buildings, berths etc.	As areas of the port are developed soil / materials containing seeds or non-native species can be moved from the Port / or to the Port	Low	• Survey the area before the development of any land to ensure no non-native species are present. • If non-native species are identified ensure they are managed to prevent spread. • Ensure any soil or materials brought into the port for any development is from an approved contractor who is aware of biosecurity requirements. • Awareness and training for employees on identification of non-native species. • Visual aids to aid identification. • Report any non-native species to the Biosecurity Team and to relevant authorities. • Make sure any structures going into the water arrive clean and that all contractors are aware of biosecurity procedures. • Ensure approved hazardous waste contractor is used for removal of Japanese Knotweed and Giant Hogweed. • Report to the police any illegal removal of Japanese Knotweed and Giant Hogweed	Low

Activity/Location	Pathway/ Vector details	Risk before mitigation	Actions to reduce risk	Risk after mitigation
Day to day working on the Port Estate. Natural dispersion.	Plant fragments and seeds can be spread around the port estate by those working on the port or those visiting the port on shoes, plant and equipment. Natural dispersion of seeds via wind and insects can also bring non-native plant species to the port.	Low	• Awareness and familiarisation for employees on identification of non-native species. • Visual aids to aid identification. • Report any non-native species to the Biosecurity Team. • Reporting NNS to relevant authorities. • Regular cleaning of all plant and equipment. • PPE to be kept clean. • Periodic monitoring of nominated areas to look for non-native species. • Annual inspection of the Port Estate. • Maintain good links with local wildlife organisations to assist with awareness of species of concerns in the area. • Ensure that preventative measures are in place, including managing INNS known to be present. • Annual and quarterly meetings with stakeholders where biosecurity will be discussed.	Low
Movement of submersible infrastructure.	Pontoons or other submersible equipment being either taken to or away from our ports could result in the movement of INNS. Permanent submersible structures provide good	Low	• Remain vigilant to signs of INNS on submerged infrastructure and equipment (e.g. high degree of fouling on pontoons or other materials being brought into our port). • Ensure structures are free from debris before being placed in the water in accordance with the “Check, Clean, Dry”	Low

Activity/Location	Pathway/ Vector details	Risk before mitigation	Actions to reduce risk	Risk after mitigation
	locations for marine INNS to establish, as INNS are often able to survive less hospitable environments. Such locations can provide a foothold, from which they can spread further.		campaign: http://www.nonnativespecies.org/checkcleandry/biosecurity-for-everyone.cfm • Encourage external organisations (e.g. educational establishments or conservation groups) to carry out surveys for species present within the dock system and investigate suitable mitigation, control and eradication measures.	

5.2 Surveillance, monitoring and reporting procedure

It is important to make provision for the early detection and containment of INNS, through a continuous cycle of surveillance, monitoring and reporting. Outlined below are the procedures for internal reporting/escalation to the Biosecurity Manager, as well as external procedures to report new findings to the relevant organisations. Key contacts and interested parties are detailed in Section 8. The Biosecurity Manager is responsible for external reporting, to prevent duplication of reports and maintain a key point of contact.

Inspection and monitoring regime (periodic regular and in event of INNS presence)
All Port Areas – Staff identification – staff who have been given information regarding non-native species will monitor during normal operations and report any sightings to Biosecurity Team. Regular Dock User Safety Liaison Meetings will be a basis for bringing familiarisation to Port Tenants. Familiarisation will take the form of visual aids to identify species and Biosecurity Information Pack. Periodic terrestrial monitoring of nominated areas on the Ports to look for non-native species – as indicated in location descriptions below. High Risk Areas (those areas where non-native species have been known to exist). Monitor risk associated with invasive species by assessing build-up of biofouling – this will be completed via photographic information being taken and forwarded to the Biosecurity Team: • Buoys at scheduled inspection. • Biofouling on lock gates at scheduled inspection. • Pilot boats at scheduled inspection. If a vessel is due to be in Port for over 90 days a marker will be submerged in the water and removed at selected intervals to check for biofouling. There will be at least 1 marker per port on a permanent basis to check for biofouling. Port Tenants – supply Port Tenants with Biosecurity Information Pack, Invasive Non-Native Species Biosecurity Alert Poster, Check-Clean-Dry Poster, alerts, and notices. Biosecurity matters will be raised at regular intervals in customer and user liaison meetings. We will request that: • The contractor/tenant submits an updated Biosecurity Risk Assessment for written approval by the 31 January each year. • The contractor/tenant ensures that all equipment, materials, machinery and PPE used are in a clean condition prior to their arrival on site to minimise risk of introducing non-native species into the marine environment. Any non-native species found on the Port Estate will be monitored and managed – guidance taken from ABP Group Environment, Environment Agency/Natural England. Risk basis new high-risk species.

Locations for monitoring, frequency and time of year:

Grimsby

Site	Marine/Terrestrial	Time Periods
Goats track slipway – East Royal Dock frontage	Marine	April, September
Biofouling marker – location to be conf.	Marine	April, September
Terrestrial tbc	Terrestrial	April, September
Terrestrial tbc	Terrestrial	April, September

Hull

Site	Marine/Terrestrial	Time Periods
Fells Landing	Marine	April, September
Biofouling marker – location tbc	Marine	April, September
Terrestrial tbc	Terrestrial	April, September
Terrestrial tbc	Terrestrial	April, September

Goole

Site	Marine/Terrestrial	Time Periods
Middle Pier by Ouse Dock	Marine	April, September
Biofouling marker – location tbc	Marine	April, September
Ship Yard Goole	Terrestrial	April, September
River Front Ouse Dock	Terrestrial	April, September

Immingham

Site	Marine/Terrestrial	Time Periods
Queens Steps	Marine	April, September
Biofouling marker – location tbc	Marine	April, September
Terrestrial tbc	Terrestrial	April, September
Terrestrial tbc	Terrestrial	April, September

5.3 Contingency plan

A contingency plan is required to ensure there is a mechanism in place in the event of a failure of one of the biosecurity control measures. It provides a step-by-step guide of immediate actions that need to be taken in the event of a biosecurity issue. Those with a responsibility under the plan should be familiar with the steps required and have quick access to a copy of the plan (Cook *et al.*, 2014). Quick and accurate identification and notification to the appropriate body (i.e. GB NNS secretariat or MBA) is essential, as the sooner INNS are detected, the sooner a management plan can be drawn up and implemented where considered necessary, increasing the chances of successful management (Cook *et al.*, 2014).

Contingency Planning Steps to be taken in event of new species sighting or high risk activity

If any signs of INNS are noted, then a response is required in order to fulfil legal obligations. The response will depend on the nature of what is found but steps taken include:

- Report high risk situations or sighting (including photos of it *in situ* and close up with something to indicate scale) of an actual or potential INNS as necessary to:
- Biosecurity Manager and Group Environment
- Scotland – Scottish Natural Heritage
- England and Wales – GB Non-Native Species Secretariat alertnonnative@ceh.ac.uk
- Interested parties if they could be affected or could be the source
- Try to identify the species or reason for raised concerns and the extent/spread
- Seek advice and information on how best to manage the situation
- Isolate area if possible (e.g. isolating equipment or area, only remove item from the water if it can be done so keeping INNS intact and allow it to dry, restrictions on movement in the area)
- If INNS discovered on-board the vessel, refer to NNSS factsheet to check whether species can be discharged back into the seawater.

NB: the Biodiversity Log (Section 8) below should be updated with any such events.
Section 6 highlights the process flow chart that will fit most responses, although a more specific process may be required if a specific risk warrants it.

6 Biosecurity Log

The Biosecurity Log should be used for any new confirmed INNS arrival, significant survey or monitoring results, for an exceptional event or non-routine occurrences. It should be readily accessible and a version should be available on-board each vessel active in the port, as well as at the ports for the port manager to complete. The Biosecurity Manager (or person with the ultimate responsibility for completing the logbook) is responsible for ensuring all information is captured and, in particular, new biosecurity information shared between all parties (i.e., so that ports share information with vessels and vice-versa). The Biosecurity Manager reviews all new information captured within the biosecurity logbooks monthly and distributes an update amongst all parties.

Date	Event (e.g. incident, inspection, routine treatment etc.)	Details and comments	Further action required?	Responsibility and deadline	Completed? (Date)
January 2019	Darwins barnacle				
December 2020	Demex noted Japanese Knotweed whilst demolishing site	Japanese Knotweed Management Plan put in place see hyperlink in next column.	ABP SharePoint link: Japanese Knotweed Management Plan: ABP SharePoint link: Biosecurity Plan (Emergency Preparedness)	Gary Coult	
27/05/2021	Giant Hogweed On completing a survey on behalf of the Environment Agency, BAM Nuttall found Giant Hogweed in the Old Shipyard Area in Goole. Giant hogweed is present within the woodland to the north of the site,	There is a high risk that this Schedule 9 species will be spread by movement of contractors and plant between the compound and the riverbank, so a treatment and eradication plan should be enacted before works start.	Giant hogweed has been treated by the contractor working for the Environment Agency in the Shipyard. Contractor selected 15/10/2021 now going through the control of contractors.	Tina Raleigh Gary Coult	Ongoing

Date	Event (e.g. incident, inspection, routine treatment etc.)	Details and comments	Further action required?	Responsibility and deadline	Completed? (Date)
	as young plants within the compound and within the publicly accessible area near the turning circle. – For more information see Badger Survey. ABP attended site visit to look at the area – warning signs/barriers were erected in public areas	We are in the process of obtaining quotes for the treatment and management of these INNS	First treatment applied July 2022 by Japanese Knotweed UK ABP SharePoint link: Biosecurity Plan (Emergency Preparedness)		
27/05/2021	Himalayan Balsam On completing a survey on behalf of the Environment Agency, BAM Nuttall found Himalayan Balsam in Old Shipyard Area in Goole.	Grows in dense stands and it shades out and crowds out many native species. It produces much nectar and therefore is attractive to pollinating insects, possibly to the detriment of native flowering plants (which are no longer visited by these insects and thus don't get pollinated).	No action at the present time other than monitoring.	Tina Raleigh Gary Coult	

Date	Event (e.g. incident, inspection, routine treatment etc.)	Details and comments	Further action required?	Responsibility and deadline	Completed? (Date)
07/07/2021	Japanese Oyster *Magallana gigas* University of Hull found Japanese Oyster at Grimsby River Terminal			Monitoring	
31/01/2023	Japanese Knotweed On completing a survey of the area to enable it to be upgraded to a blade storage area Japanese Knotweed was found. It has been located in haul Road (see map in file)	Japanese Knotweed thrives in disturbed areas and once established can spread rapidly, creating monoculture stands that threaten native plant communities. For more detail see Japanese Knotweed Non-native Invasive Species Card. Risk to property and infrastructure	This work is being completed by a contractor who have employed a specialist Company to remove and bury	Joe Kobkiw , Mike Rimmington (ABP Project Manager's)	
Suspected - 15/06/2023 Confirmed 06/07/2023	Giant Hogweed and Japanese Knotweed Dutch Riverside Giant Hogweed - https://w3w.co/scraper.miss.stung	Japanese Knotweed UK to attend site and advise costs for treatment of Giant Hogweed. Property presently determining whether this is the responsibility of the	Contractor has been selected - JKLH59419.	Gary Coult	

Date	Event (e.g. incident, inspection, routine treatment etc.)	Details and comments	Further action required?	Responsibility and deadline	Completed? (Date)
	Giant Hogweed and Japanese Knotweed – https://w3w.co/gears.impaled.perfectly	Canal and Rivers or ABP. When Japanese Knotweed UK come on site to view giant hogweed above we will ask them to look at this area as well. ABP will treat and manage the invasive species.			
Suspected – 20/10/2023 Confirmed – 23/10/2023	Japanese Knotweed Moody Lane – RWE Site Grimsby. https://w3w.co/unfair.puddles.gave	Japanese Knotweed attended site on 09/11/2023 to complete initial treatment and survey. Has spread to Highways – Highways have been informed and ABP will treat along with their land	Determining if this will continue to sit under Operations as treatment and management plan or if the site will require burial or disposal due to being looked at for the GAT project		

7 Regular Review of Biosecurity Plan

This is intended as a live document that is updated when new information becomes available, including changes in operational practices, legislation changes and changes in biosecurity awareness. In addition to this, the Biosecurity Plan should be subject to a periodic review to ensure the information is kept up to date and that the plan is being used appropriately and effectively. A periodic review will include the following:

- A review of the list of INNS using any new evidence, for example from benthic surveys;
- Check for updates from data sources, for example new alert species identified by the GB NNS secretariat;
- A review of the performance of the plan;
- Updates to legislation; and
- A check to make sure contact details and action owners remain valid.

Any changes to the plan should be cascaded to those who use the plan and communicated to those with an interest in the plan. Figure 1 provides the process for developing and updating this Biosecurity Plan.

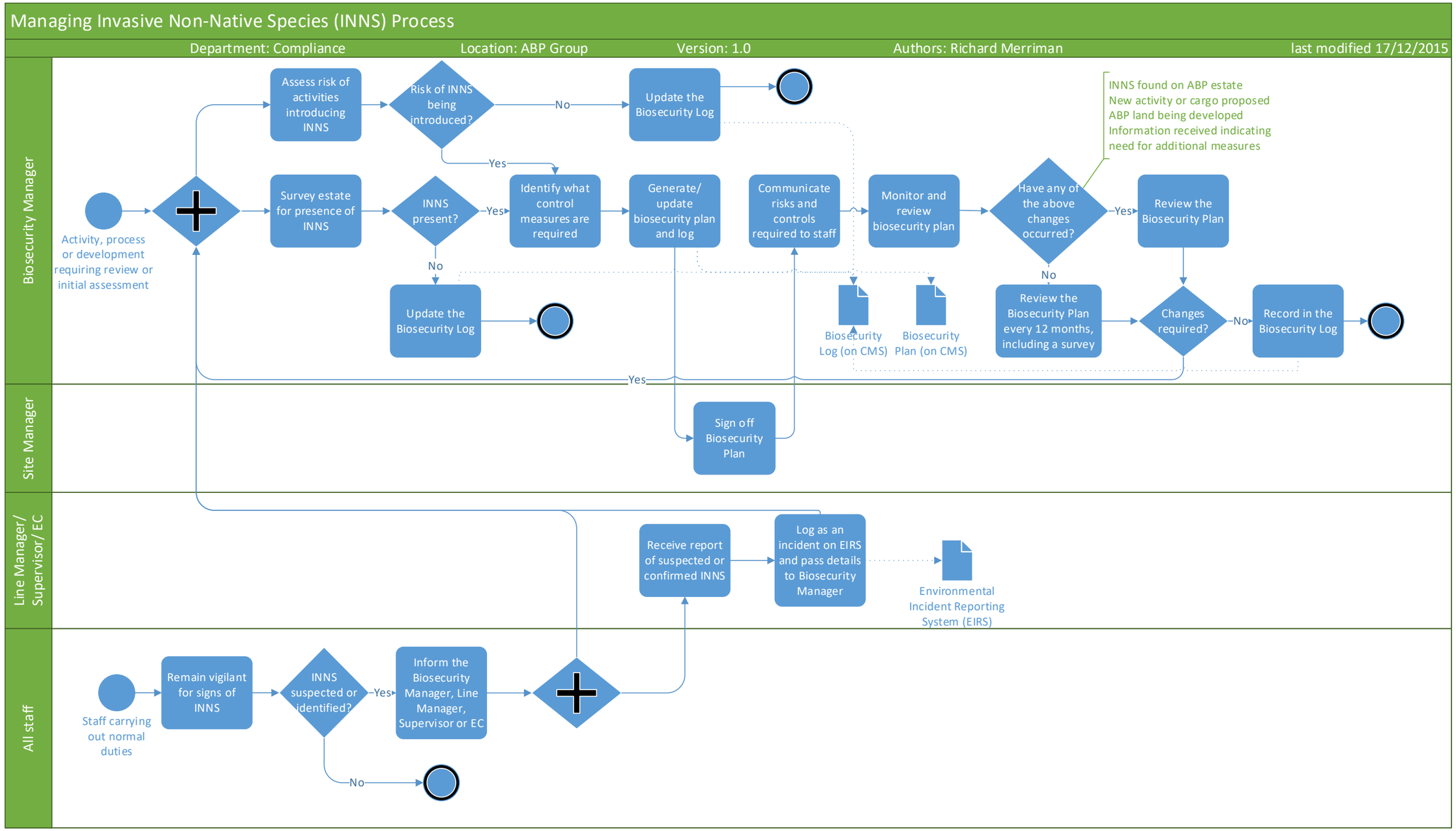


Figure 1. Process for managing INNS

8 Interested Parties

Any updates of changes to the Biosecurity Plan, or any occurrences of INNS reported should be communicated to interested parties clearly and efficiently:

Interested parties	Contact details	Specific interest / knowledge
GB Non-Native Species Secretariat (GB NNSS)	[redacted]	For notification of species http://www.nonnativespecies.org/index.cfm?sectionid=81
Specific alert recipients	Various	The GB NNSS species guides: http://www.nonnativespecies.org/index.cfm?sectionid=47 have contact details for sending in alerts for specific species
Local Wildlife Trust	[redacted]	Likely to know the types of species in the local area that may be affected by INNS. Also have resources for surveys and may already have INNS plans in place that we can tap into
Local Action groups		May already be taking action and have a plan that we can fit into.
Humber Port Director		Overall oversight of the Port activity
Head of Operations Humber		Operational management of cargo handling
MESU		Provision and management of buoys, markers, survey vessels and pilot launches

Interested parties	Contact details	Specific interest / knowledge
Humber Estuary Services – Harbour Master	[redacted]	Harbour authority, local lighthouse authority, pilotage provider, VTS management
Head of Marine Humber		Overall control of al marine activity on the Humber
Dock Master Humber		Effectively harbour Master role for discreet port areas
Head of Engineering Humber		Responsible for the provision of infrastructure and equipment whether estuarine or terrestrial in nature
Group Head of Corporate Communications		Responsible for all communications both internal and external for Humber Ports
Head of Health, Safety and Environment (Humber)		Daily management of compliance on the Humber Ports
Port Tenants	Held within the 'Send Word Now' electronic security alert system	Offer port related or value-added services which are either integral to or incidental to the passage of cargo through the Ports.
Environment Agency	[redacted]	Environmental regulator under a number of pieces of legislation such as Water Framework Directive, Water Resources Act. Humber Biodiversity Officer

Interested parties	Contact details	Specific interest / knowledge
Natural England	[redacted]	Area Manager
Humber Nature Partnership		Facilitating organisation comprised of industrial members, NGO's and regulators who have an interest in ecological management of the estuary also hosts the Humber Estuary relevant authorities' group
MCA		Regulator for matters related to shipping (Department of Transport).
North Lincolnshire Council		Local authorities – Project officer (Ecologist)
NE Lincolnshire Council		Local authorities Ecology Officer
Hull City Council		Local authorities
East Riding of Yorkshire Council		Local authorities – Biodiversity Officer
Canal and Rivers Trust		Navigation authority for inland waterways
Hull Marina		Local Marina – Marina Manager

Interested parties	Contact details	Specific interest / knowledge
University/College – Research	[redacted]	
Nearby Ports Tetney Terminal Grimsby Immingham South Killingholme C.RO New Holland Barrow-on-Humber Barton Haven King's Ferry, Burton-upon-Stather Flixborough Neap House Grove Wharf Keadby Gunness Goole Caldaire Terminal Howden Salt End		

Interested parties	Contact details	Specific interest / knowledge
Queen Elizabeth Dock Alexandra Dock King George Dock Hull Marina Albert Dock and Wm Wright Dock Hessle Haven		
Public Slipways Humber Mouth Yacht Club Brighton Street, Cleethorpes Pier Slipway, Cleethorpes Wonderland slip, Cleethorpes Humber Rescue, Kingston-Upon-Hull	Biosecurity Action: Encourage signage to be put up at these locations alerting the public to the risk from INNS and asking them to be vigilant and to clean their craft before bringing them to the area in future. [redacted]	
Local Sailing Clubs Humber Mouth Yacht Club Humber Cruising Association Grimsby & Cleethorpes Yacht Club North Lincolnshire & Humberside Sailing Club South Ferriby Marina Humber Yawl Club Welton Sailing Club Hull Sailing Club Hull Marina	Biosecurity contact list in the "Send Word Now" electronic alert system Encourage communications with these clubs, e.g., circulate updates on new NNS discovered or ones you are concerned about. Ask for their help to monitor the area. Annual meeting at which Biosecurity is a point for discussion.	

9 References

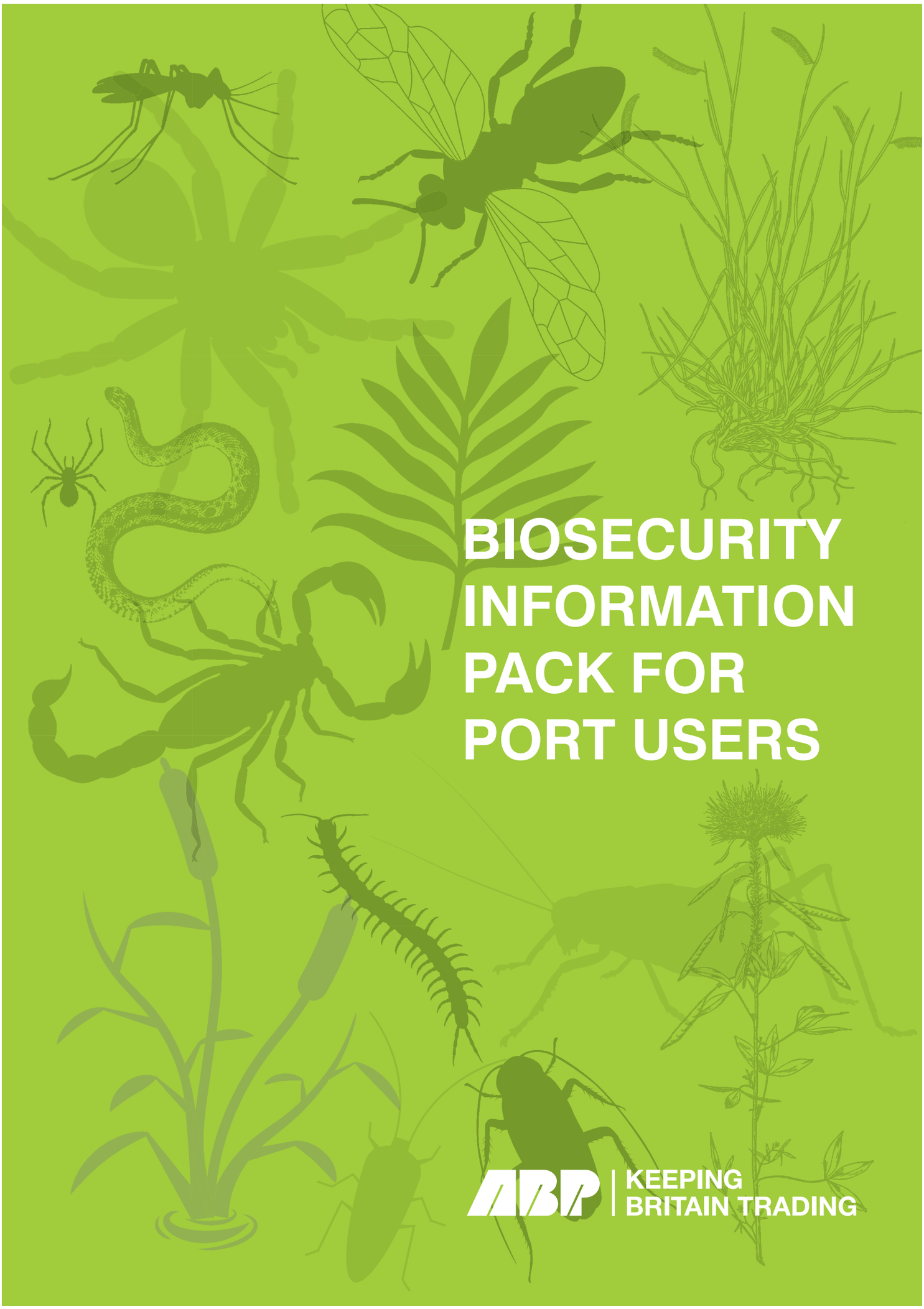
Cefas (2015). Development of priority species lists for monitoring and surveillance of marine non-natives in the UK. Cefas contract report C6484. Issue date 30/10/2015.

Cook, E.J., Macleod, A. Payne, R.D., and Brown, S. (2014) edited by Natural England and Natural Resources Wales (2015). Marine Biosecurity Planning – Guidance for producing site and operation-based plans for preventing the introduction and spread of non-native species in England and Wales.

European Commission (2022). Invasive alien species [Online] Available at: https://environment.ec.europa.eu/topics/nature-and-biodiversity/invasive-alien-species_en (accessed 7 March 2024).

UKTAG (2015). Classification of aquatic alien species according to their level of impact [Online] Available at: https://www.wfduk.org/sites/default/files/UKTAG%20classification%20of%20alien%20species%20working%20paper%20v8.pdf (accessed 7 March 2024).

Appendix A: Biosecurity Information Pack for Port Users



BIOSECURITY INFORMATION PACK FOR PORT USERS

ABP | KEEPING BRITAIN TRADING

Purpose:

The purpose of this document is to make all Port Users aware of non-native species of flora and fauna and the threat that they may cause to our native species. It will give the reader an awareness of the species we are most likely to encounter and what your actions should be on encountering such species.

Scope:

This document covers the Ports of Immingham, Grimsby, Goole and Hull.

Definitions:

Non-Native Species - is a species of flora or fauna living outside its native distributional range, which has arrived there by human activity, either deliberate or accidental. Non-native species can have various effects on the local ecosystem.

Invasive Non-Native Species - is any non-native flora or fauna that has the ability to spread causing damage to the environment, the economy, our health and the way we live.

Flora - the plants of a particular region, habitat.

Fauna - the animals of a particular region, habitat.

Biosecurity Plan - a set of preventive measures designed to reduce/control the risk of non-native species gaining entry to the United Kingdom.

Site of Special Scientific Interest - a site designated by Natural England as an area of special interest by reason of any of its flora, fauna, geological or physiographical features.

Special Protection Area - strictly protected sites classified in accordance with Article 4 of the **EC Birds Directive**, which came into force in April 1979. They are classified for rare and vulnerable birds (as listed on Annex I of the Directive), and for regularly occurring migratory species.

Special Areas of Conservation - strictly protected sites designated under the EC Habitats Directive. Article 3 of the Habitats Directive requires the establishment of a European network of important high-quality conservation sites that will make a significant contribution to conserving the 189 habitat types and 788 species identified in Annexes I and II of the Directive (as amended).

Ramsar Site - Ramsar sites are wetlands of international importance designated under the Ramsar Convention.

Marine Non-Native Species you are most likely to see in the Humber Ports:

Species which are present in the area, reasonably easy to identify and useful to monitor:

- Leathery Sea Squirt
- Japanese Skeleton Shrimp
- Wakame
- Trumpet Tube Worm

Please display Invasive Non Native Species BIO-SECURITY Marine Poster in relevant areas.

Information and pictures of the above species can also be found in Appendix 2 of this information pack.

Species not yet present but which staff should be aware of:

- Wireweed
- Asian Shore/Brush Clawed Crab
- Pacific Oyster
- Slipper Limpet
- Carpet Sea Squirt
- Chinese Mitten Crab

Information and pictures of the above species can be found in Appendix 2 of this information pack.

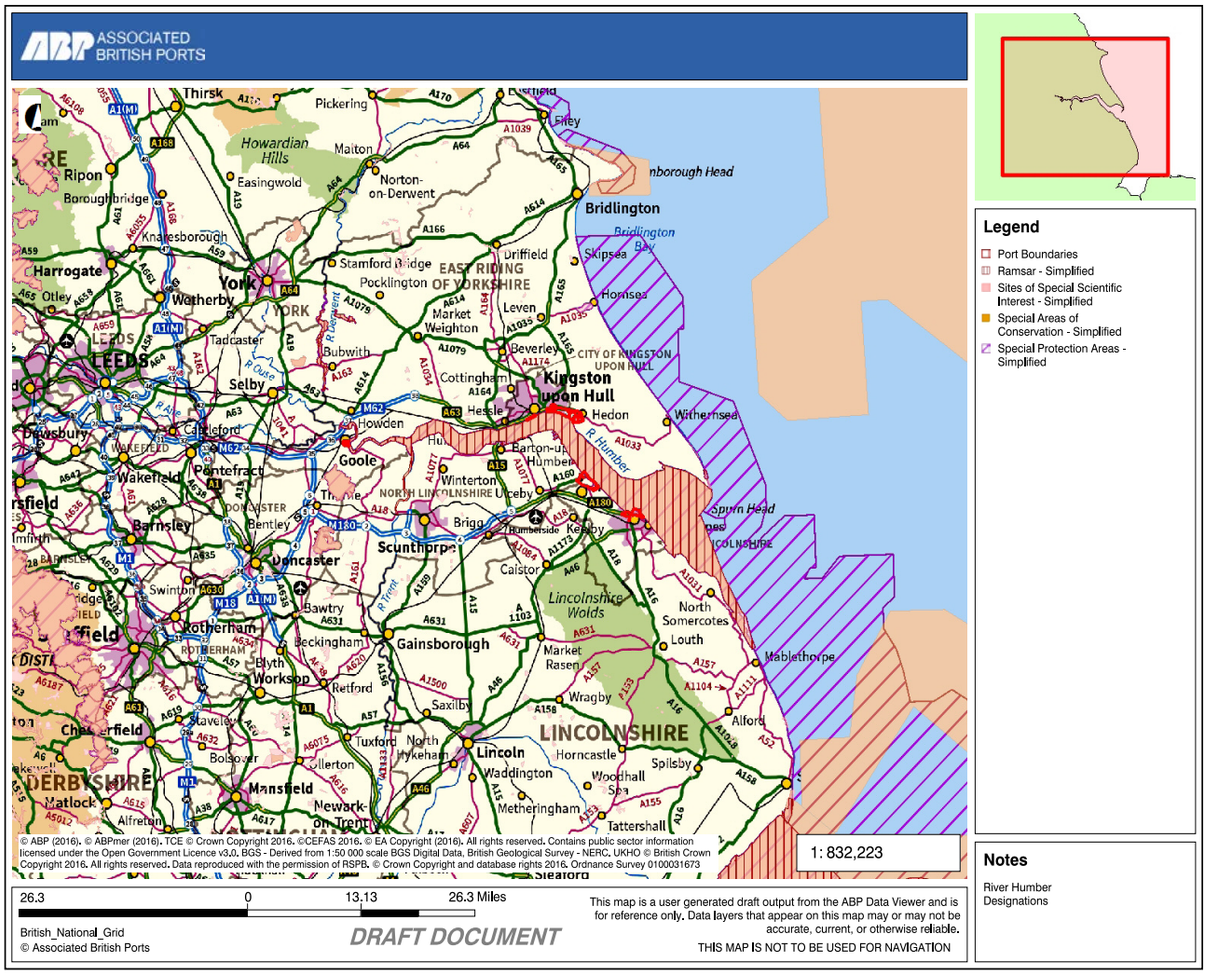
Terrestrial Non-Native Species you need to be aware of:

Terrestrial species, reasonably easy to identify:

- Japanese Knotweed
- Himalayan Balsam
- Giant Hogweed

Please display Invasive Non Native Species BIO-SECURITY Terrestrial Poster in relevant areas.

Information and pictures of the above species can also be found in Appendix 1 of this information pack.



River Humber

The River Humber is a:

- Site of special Scientific Interest
- Special Area of Conservation
- Special protection Area
- RAMSAR Site

It is recommended by Natural England that marine infrastructure sites in close proximity to SSSI's should produce their own Biosecurity Risk Assessments. If any Port Tenant or Contractor feel that their operations would benefit from this please contact ABP Environmental Coordinator who will be happy to assist.

All equipment, materials, machinery and PPE used on the Port Estate should be in a clean condition prior to their arrival on site to minimise the risk of introducing non-native species into the marine environment.

What to do in the event of identifying a suspected Non Native Species

1. Port Users - On identifying a suspected Non-Native Species in your portal area take photographs, document location of sighting and approximate size of the area affected and report to your Management Team. For marine species if possible take a specimen (do not put yourself in danger). If specimen is held ensure it is kept secure so as not to contaminate other areas.

2. The Management Team, will report all information taken to the Biosecurity Team by contacting one of the following people:

   - Tina Raleigh - [redacted]**@abports.co.uk** / [redacted]
   - Nicola Bell - [redacted]**@abports.co.uk** / [redacted]
   - Tom Jeynes - [redacted]**@abports.co.uk** / [redacted]

3. Biosecurity Team member will visit the site to collate any further information prior to informing ABP Group or any external parties.

4. On collation of information from site the Biosecurity Team will:

   - In the first instance contact ABP Group Environment for direction.
     - Alan Tinline - [redacted]**@abports.co.uk** / [redacted]
   - Follow any direction given by Group.
   - If directed by Group to do so, then contact external agencies to advise findings and any actions taken to date.

5. If the species has been confirmed as non-native any external publication / alert will be completed in conjunction with and on approval by the external agencies and the ABP Communications Department.

   - Humber Communications - **humber.communications@abports.co.uk**

   Alerts will be sent out via the ABP Send Word Now electronic alert system which is pre-programmed with all relevant contact details as per the Biosecurity Plan and the Humber Clean Plan.

6. The Biosecurity Team will record findings of any non-native species sited on the Biosecurity Plan.

7. The Biosecurity Team will ensure that any non-native species which have been identified are discussed at:
   - The Annual Estuary Liaison Meeting
   - Quarterly Dock Users Port Safety Liaison Meetings, Hull, Goole,
   - Port Partnership Meetings – Immingham and Grimsby

8. This procedure will be reviewed on an annual basis and will form part of any future biosecurity audits.

TERRESTRIAL SPECIES IDENTIFICATION PACK APPENDIX 1

ABP | KEEPING BRITAIN TRADING

Invasive Non-Native Species
BIO-SECURITY

Asian Hornet

Not easily confused with any other species. Dark brown or black velvety body. Characteristically dark abdomen and yellow tipped legs. Smaller than the native European Hornet. Introduced to France in 2004 where it has spread rapidly. In 2016 the first UK sighting was confirmed in Gloucestershire. A highly aggressive predator of native insects. Poses a significant threat to honey bees.
Could be found in timber cargoes.



Japanese Knotweed

Tall herbaceous perennial with bamboo like stems. Often grows into dense thickets. Characteristic leaves and stems, persistence of last year's dead canes and distinctive underground root-like stems enables year round identification. Spreads rapidly in the wild.

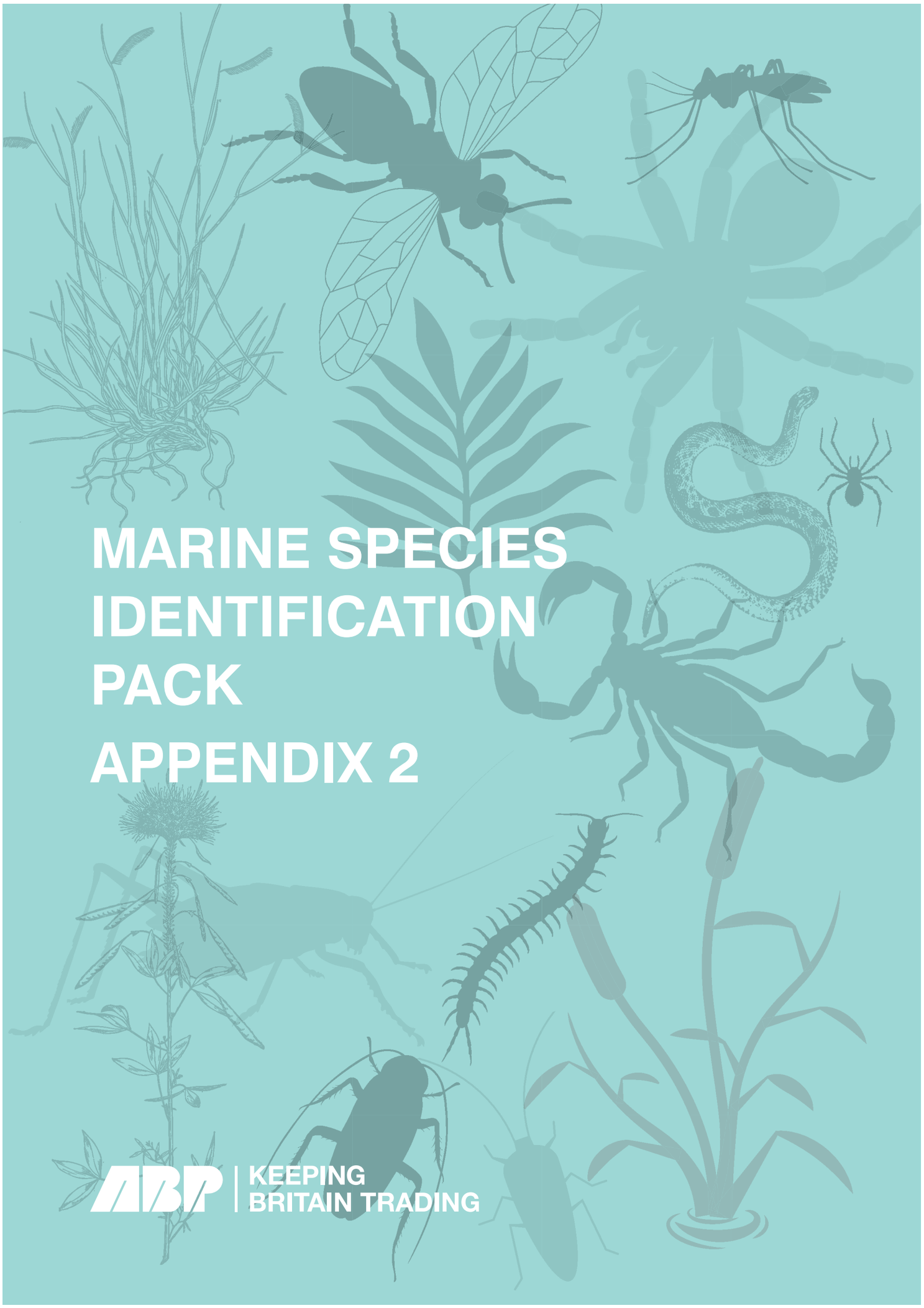

Himalayan Balsam

A tall, annual plant with explosive seed heads. Easy to identify as a mature plant with its pink-purple flowers, fleshy stem and characteristic leaves. Found mostly on river banks and in damp woodland, can grow in other damp habitat.


Giant Hogweed

Contact with any part of this plant must be avoided as even minute amounts of sap can cause blistering of the skin following exposure to sunlight.
Easy to identify when fully grown by height, size of leaves and size of flowers.


ABP
KEEPING BRITAIN TRADING



MARINE SPECIES IDENTIFICATION PACK

APPENDIX 2

ABP | KEEPING BRITAIN TRADING

Invasive Non-Native Species
BIO-SECURITY

Leathery Sea Squirt

An animal shaped like a stout bag with two openings. Different from other sea squirts in the UK by being solitary, with each individual having its own stalk. The body can be up to 12cm long and it will have a leathery appearance and a knobbly surface. Large populations dominate and displace other species through competition for food and space. It is also a fouling pest on ship hulls and aquacultural infrastructure.

Japanese skeleton shrimp

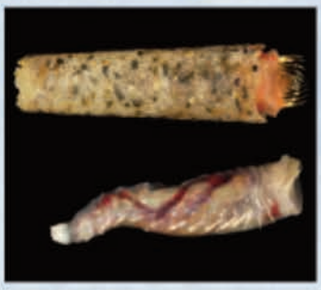
Relatively large shrimp, reaching a maximum length of 50 mm (2.0 in). They are omnivorous highly adaptable opportunistic feeders. They are usually found in dense colonies attached to submerged man-made structures, floating seaweed, and other organisms. They are characterized by slender bodies and elongated appendages.

Wakame / Japanese Kelp

This brown seaweed spreads rapidly through the production of millions of spores which are quickly able to attach to the surfaces of objects in the water. A large kelp can reach 1 - 3m in length with a branched root like structure which anchors the seaweed to the sea bed. The blade is broad, flattened with wavy edges, lance like in shape with a distinct midrib. It fouls the hulls of boats and harbour structures and forms drifting mats when detached.

Trumpet Tube Worm

This worm is about 2.5 cm (1 in) long and relatively broad. The head has two pairs of tentacles and two bunches of gleaming golden spines which are used for digging. It also bears a lid type apendage for sealing the tube in which it lives. The animal is pale pink and iridescent, with two pairs of red gills and several red blood vessels visible beneath the surface. It lives inside a long, narrow, conical tube composed of a single layer of grains of sand.



ABP
KEEPING BRITAIN TRADING

KEEPING
BRITAIN TRADING