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River Hull Integrated Catchment Strategy

Habitats Regulations Assessment

Submitted to:

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APPENDICES

1.0 INTRODUCTION

1.1 Background

1.1.1 Haycock and Jay Associates Ltd was commissioned by Barton Howe Associates in March 2015 to undertake research and reporting to inform Habitats Regulations Assessment (HRA) for the River Hull Integrated Catchment Strategy (RHICS). The purpose of this report is to assist the Competent Authority (East Riding of Yorkshire Council (ERYC)) in fulfilling its obligations under the Conservation of Habitats and Species (Amendment) Regulations 2010.

1.1.2 This assessment is considered to meet the requirements of;

- Assessments of plans and projects significantly affecting Natura 2000 sites – Methodological guidance on the provisions of Article 6 (3) and (4) of the Habitats Directive 92/43/EEC 2001; and
- ODPM Circular 06/2005 on Biodiversity and Geological Conservation.

1.1.3 Assessment examines the potential effects of the proposed strategy on internationally recognised ecological receptors – two Natura 2000 sites. These are Hornsea Mere SPA and Humber Estuary SAC / SPA / Ramsar site.

1.2 Context

1.2.1 Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Flora and Fauna 1992 (known as the Habitats Directive) is part implementation of the Bern Convention 1979 to which UK is a signatory. The need for Habitats Regulations Assessment is set out in Article 6 of the Habitats Directive.

1.2.2 The Habitats Directive requires European Union (EU) Member States to implement legislation to designate a network of protected sites and maintain their ecological integrity. These sites make up the Natura 2000 network of protected sites throughout Europe. In England and Wales these sites are designated Special Area of Conservation (SAC), Special Protection Area (SPA) or Ramsar sites. A number of species are also strictly protected through this Directive.

1.2.3 In England and Wales the Habitats Directive has been transposed into law through the Conservation of Habitats and Species (Amendment) Regulations 2010. These Regulations allow for the designation of SAC, SPA and Ramsar sites and set out the methodology for HRA and Appropriate Assessment.

1.2.4 Under Article 6(3) of the Habitats Directive, an appropriate assessment is required where a plan or project is likely to have a significant effect upon a European site either individually or in combination with other projects.

1.2.5 Local planning authorities (or other competent authority) must determine whether any proposed development is likely to have a significant effect on the integrity of Ramsar or Natura 2000 sites. It should be noted that developments outside protected sites which may have a significant effect also need to be considered. The process of HRA delivers this duty.

1.2.6 This report, commissioned ultimately by East Riding of Yorkshire Council, is intended to ensure that this duty is carried out.

2.0 ASSESSMENT METHODOLOGY

2.1 Screening

2.1.1 In determining whether Appropriate Assessment should be undertaken, it is first necessary to consider whether the plan is directly connected or necessary for the management of the site.

2.1.2 Secondly it is necessary to consider whether RHICS is likely to have a significant effect on the integrity of Natura 2000 site(s).

2.1.3 In order to complete the screening process sites likely to be impacted upon by the proposed strategy are carefully considered along with their qualifying features which may be at risk. Once sites with the potential to be impacted upon are identified, then the proposals within RHICS are examined to define which elements have the potential to impact on designated features in Natura 2000 sites either by themselves, or in combination with other developments likely to impact on the designated site(s).

2.1.4 Having taken all the evidence into account, if it is considered likely that implementation of RHICS has the ability to have a significant effect on the integrity of a Natura 2000 site, then Appropriate Assessment must be undertaken. If there are elements of doubt, then the precautionary principle is applied and Appropriate Assessment is undertaken.

2.2 Appropriate Assessment

2.2.1 Having defined any elements of RHICS which are considered likely to have a significant effect on Natura 2000 site(s) the first part of the assessment involves scoping likely receptors and mechanisms for impacts due to the proposals associated with RHICS.

2.2.2 Likely adverse effects are then defined, and measures to alleviate each adverse effect are considered including avoidance and mitigation measures.

2.2.3 In the light of avoidance and mitigation measures the proposal is then re-assessed through an iterative process until adverse effects are either avoided completely, sufficient mitigation is considered to be in place, or adverse effects continue to be apparent.

2.2.4 If it is not possible to avoid or mitigate for all predicted adverse effects, then it must be considered whether alternative solutions are possible.

2.2.5 If no alternative solutions are considered feasible, then the scheme may be carried out by making a case to the Secretary of State who may be minded to agree that RHICS go ahead due to ‘imperative reasons of over-riding public interest, including those of

a social or economic nature' (Article 6 (3)). The process is detailed in Regulation 62 of the Habitat Regulations and compensatory measures must be taken to ensure the overall coherence of the Natura 2000 network.

2.3 Confidence in predictions

2.3.1 In order to ensure transparency the objectively defined scale for expressing confidence in predictions set out in Chartered Institute of Ecology and Environmental Management (CIEEM) publication 'Guidelines for Ecological Impact Assessment in the United Kingdom' (2006) has been used. Thus the following definitions apply;

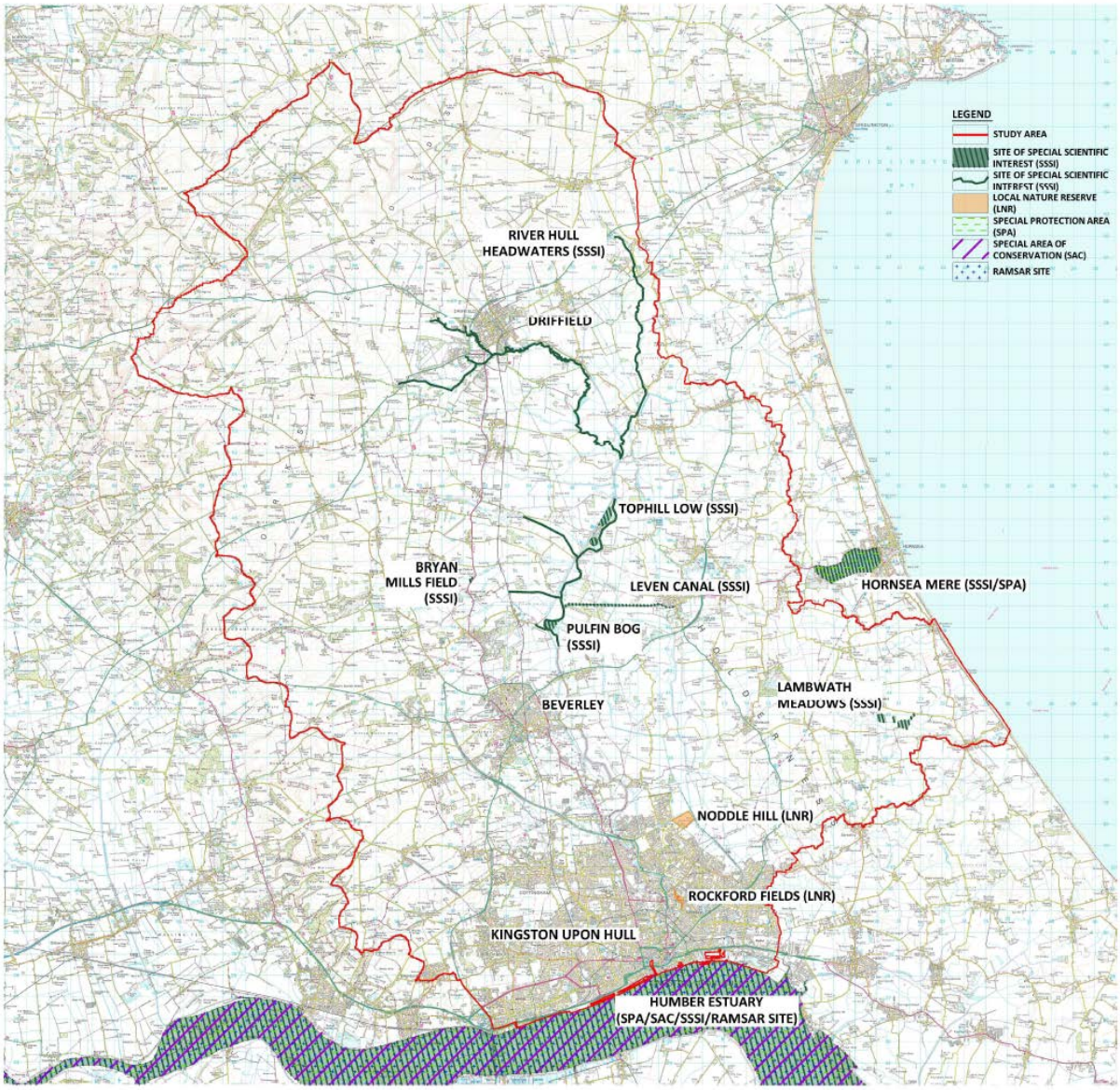
- Certain: probability estimated at 95% chance or higher;
- Likely / probable: probability estimated above 50% but below 95%;
- Unlikely; Probability estimated above 5% but below 50%; and
- Extremely unlikely: probability estimated at less than 5%.

2.3.2 These terms will be used when considering the likelihood of potential effects. Clearly for this assessment the decision as to confidence level will be largely based on expert judgement rather than empirical data.

3.0 POTENTIAL RECEPTORS

3.1 Introduction

3.1.1 The Figure below indicates the area covered by RHICS and locations of sites, including European designations, in the vicinity.



Humber Estuary Special Area of Conservation

3.1.2 The following text is closely based on the Humber Estuary SAC citation compiled in November 2009 prior to being entered in the Register of European Sites for Great Britain in December 2009.

3.1.3 The Humber is the second largest coastal plain Estuary in the UK, and the largest coastal plain estuary on the east coast of Britain. The estuary supports a full range of saline conditions from the open coast to the limit of saline intrusion on the tidal rivers of the Ouse and Trent (but not the River Hull). The range of salinity, substrate and exposure to wave action influences the estuarine habitats and the range of species that utilise them; these include a breeding bird assemblage, winter and passage waterfowl, river and sea lamprey, grey seals, vascular plants and invertebrates.

3.1.4 The Humber is a muddy, macro-tidal estuary, fed by a number of rivers including the Rivers Ouse, Trent and Hull. Suspended sediment concentrations are high, and are derived from a variety of sources, including marine sediments and eroding boulder clay along the Holderness coast. This is the northernmost of the English east coast estuaries whose structure and function is intimately linked with soft eroding shorelines. The extensive mud and sand flats support a range of benthic communities, which in turn are an important feeding resource for birds and fish. Wave exposed sandy shores are found in the outer/open coast areas of the estuary. These change to the more moderately exposed sandy shores and then to sheltered muddy shores within the main body of the estuary and up into the tidal rivers.

3.1.5 Habitats within the Humber Estuary include Atlantic salt meadows and a range of sand dune types in the outer estuary, together with sandbanks which are slightly covered by sea water all the time, extensive intertidal mudflats, *Salicornia* and other annuals colonising mud and sand, and coastal lagoons. As salinity declines upstream, reedbeds and brackish saltmarsh communities fringe the estuary. These are best-represented at the confluence of the Rivers Ouse and Trent at Blacktoft Sands.

3.1.6 Upstream from the Humber Bridge, the navigation channel undergoes major shifts from north to south banks. This section of the estuary is noteworthy for extensive mud and sand bars, which in places form semi-permanent islands. The sand dunes are features of the outer estuary on both the north and south banks particularly on Spurn peninsula and along the Lincolnshire coast south of Cleethorpes. Examples of both fixed dunes with herbaceous vegetation (`grey dunes`) and shifting dunes along the shoreline with *Ammophila arenaria* (`white dunes) occur on both banks of the estuary and along the coast. Native sea buckthorn dunes with *Hippophae rhamnoides* also occurs on both sides of the estuary.

3.1.7 Significant fish species include river lamprey *Lampetra fluviatilis* and sea lamprey *Petromyzon marinus* which breed in the River Derwent, a tributary of the River Ouse.

Life cycle

3.1.7.1 Adult river lamprey spend up to two years living in estuaries, feeding from a variety of estuarine fish species including herring, sprat and flounder. From October to December the mature lamprey begin to migrate upstream into medium to large rivers, travelling by night during the winter and early spring to their spawning grounds (Maitland 2003). Adults continue to migrate upstream throughout the winter until early April (Masters et al 2006).

3.1.7.2 It should be noted that adults require obstacle-free rivers for this migration; both natural barriers (e.g. waterfalls) and man-made obstacles (e.g. weirs, dams and pollution barriers) will adversely affect their migration (Maitland 2003).

3.1.7.3 Adults begin spawning when water temperatures reach 10-11ºC, generally from March to April in areas of flowing water containing small stones and gravel. Larvae hatch after an incubation period of about 15 to 30 days, after which they drift downstream and burrow into silt beds and other soft substrates.

3.1.7.4 The larvae then remain in silt beds as ammocoete larvae for up to eight years (Potter 1980) filter feeding on particulate matter in the river before emerging as juveniles (macrophthalmia) and migrating downriver to the estuary under cover of darkness.

3.1.7.5 Lamprey macrophthalmia are weak swimmers and are vulnerable to impacts from dams, irrigation channels and river bed modifications which can cause injury and death (Moser et al 2014). Ammocoetes and macrophthalmia of European river lamprey have been recorded in passive traps during the period November to May inclusive (Bracken and Lucas 2013) indicating that this is the period during which macrophthalmia make their way to the estuary.

3.1.7.6 This life cycle is similar to sea lamprey, however adult river lamprey feed only within the estuary whilst sea lamprey spend up to four years feeding in the open sea before returning to spawn.

Recorded presence of sea and river lamprey

3.1.7.7 Sea lamprey have not been recorded in River Hull or Holderness Drain. Whilst there are anecdotal records of sea lamprey in River Hull, no breeding sites are known with no records on NBN, no records held at North and East Yorkshire Ecological Data Centre (NEYEDC) and no records reported by Yorkshire Wildlife Trust (YWT). With no confirmed records of this species, it is considered reasonable to exclude this species from further assessment.

3.1.7.8 In contrast, river lamprey are well recorded with breeding sites known to exist in River Hull Headwaters SSSI. Environment Agency hold records of river lamprey

ammocoetes in Kelk Beck, Watton Beck, West Beck, Main Drain and Wanlass Drain and are considered likely to exist in Driffield Canal (Jon Traill YWT 2014 and Stacey Riley, Environment Agency Oct 2013). Additionally YWT have records of breeding river lamprey for Snakeholme Pastures YWT reserve. NBN has records for river lamprey at three locations on River Hull, however NEYEDC have no records.

3.1.7.9 Lamprey ammocoetes have not been recorded in tidal reaches of River Hull, and are only known to occur in fresh water usually at water depths of less than 1m (Maitland 2003).

3.1.8 Grey seals *Halichoerus grypus* come ashore in autumn to form breeding colonies on the sandy shores of the south bank at Donna Nook.

3.1.9 The following Annex I habitats are a primary reason for selection of the site;

- 1130 Estuaries; and
- 1140 Mudflats and sandflats not covered by seawater at low tide.

3.1.10 The following Annex 1 habitats are present as a qualifying feature, but not a primary reason for selection of the site;

- 1110 Sandbanks which are slightly covered by seawater all the time;
- 1150 Coastal lagoons (a Priority feature);
- 1310 *Salicornia* and other annuals colonising mud and sand;
- 1330 Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*);
- 2110 Embryonic shifting dunes;
- 2120 Shifting dunes along the shoreline with *Ammophila arenaria* (‘white dunes’);
- 2130 Fixed coastal dunes with herbaceous vegetation (‘grey dunes’)(Priority feature); and
- 2160 Dunes with *Hippopha rhamnoides*.

3.1.11 No Annex II species are cited as a primary reason for selection of this site, however, the following Annex II species are present as a qualifying feature;

- 1095 Sea lamprey *Petromyzon marinus*;
- 1099 River lamprey *Lampetra fluviatalis*; and
- 1364 Grey seal *Halichoerus grypus*.

3.1.12 Additionally a series of Conservation Objectives are relevant to the site referred to in the Conservation of Habitats and Species Regulations 2010 (the “Habitats Regulations”) and Article 6(3) of the Habitats Directive. These Objectives must be taken into account when carrying out Habitats Regulations Assessment. Conservation Objectives for Humber Estuary SAC are reproduced below;

'Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring;

- *The extent and distribution of qualifying natural habitats and habitats of qualifying species;*
- *The structure and function (including typical species) of qualifying natural habitats;*
- *The structure and function of the habitats of qualifying species;*
- *The supporting processes on which qualifying natural habitats and habitats of qualifying species rely;*
- *The populations of qualifying species; and,*
- *The distribution of qualifying species within the site*.'

3.1.13 The full citation is attached at Appendix 1.

3.2 Humber Estuary Special Protection Area

3.2.1 Humber Estuary SPA encompasses all or parts of the following Sites of Special Scientific Interest (SSSIs): Humber Estuary SSSI, North Killingholme Haven Pits SSSI, Saltfleetby-Theddlethorpe Dunes SSSI, and The Lagoons SSSI.

3.2.2 The estuary supports important numbers of water birds (especially geese, ducks and waders) during the migration periods and in winter. In summer, it supports important breeding populations of bittern *Botaurus stellaris*, marsh harrier *Circus aeruginosus*, avocet *Recurvirostra avosetta* and little tern *Sterna albifrons.*

3.2.3 As for SAC, the SPA has a series of Conservation Objectives potentially pertinent to this Habitat Regulations Assessment;

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

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

3.2.4 The full citation is attached at Appendix 2.

3.3 Humber Estuary Ramsar site

3.3.1 Essentially a precursor to designation as SPA, Ramsar sites are designated due to their international importance for birds requiring wetlands during all or part of their life cycle.

3.3.2 Humber Estuary Ramsar site supports a breeding colony of grey seals *Halichoerus grypus* at Donna Nook which is the second largest grey seal colony in England and the furthest south, regular breeding site on the east coast. Additionally the dune slacks at Saltfleetby-Theddlethorpe on the southern extremity of the Ramsar site are the most north-easterly breeding site in Great Britain for natterjack toad *Bufo calamita*.

3.3.3 The full information sheet on the Ramsar Wetland is attached at Appendix 3.

3.4 Hornsea Mere Special Protection Area

3.4.1 Hornsea Mere is a site of national ornithological importance. It consists of a large shallow eutrophic lake of about 120ha, together with its associated habitats of reedbed, fen and carr woodland, representing a relic of the once-extensive marshes and lakes of Holderness.

3.4.2 The shallowness of the lake (in general only 1-2 m) has encouraged the formation of a large area of fringing reedswamp in which common reed *Phragmites australis*, reedmace *Typha latifolia* or common club-rush *Schoenoplectus lacustris* are the dominant species.

3.4.3 As a result of eutrophication, and of high phosphate concentrations in particular dense algal blooms occur. However macrophytes too are well represented including Canadian waterweed *Elodea canadensis*, fennel pondweed *Potamogeton pectinatus*, spiked water-milfoil *Myriophyllum spicatum*, yellow water-lily *Nuphar lutea* and rigid hornwort *Ceratophyllum demersum.*

3.4.4 The mere is however principally valued for its importance as a refuge and feeding area for duck. These include wintering mallard 3,000, pochard 1,450, teal 1,000, tufted duck 500, goldeneye 200+, wigeon 1,000 and smaller numbers of goosander, scaup and long-tailed duck. Breeding species include coot (200 pairs), mallard, gadwall, pochard, teal, shoveler and tufted duck. About 800 pairs of reed warbler breed here, near the north-eastern limits of their British range. Reedbed roosts of starlings and hirundines are large.

3.5 Other Natura 2000 sites

3.5.1 No other Natura2000 sites are considered likely to be impacted upon by proposals in RHICS.

4.0 RHICS AIMS AND OBJECTIVES

4.1 Introduction

4.1.1 RHICS aims to provide a clearly defined and sustainable multi-agency strategy for the management of flood risk in the natural River Hull valley and support a modified draft River Hull Flood Risk Management Strategy.

4.1.2 The preferred approach outlined below was drafted using economic and technical criteria only. Environmental assessment information for the options rejected was not undertaken, consequently no options could be rejected on environmental grounds. The preferred approach has been reached through an iterative process taking into account ongoing environmental assessment. Further modifications to the preferred approach (in particular with regard to methods of implementation) may be necessary based on the results of project level environmental assessment.

4.1.3 RHICS is intended as a single solution for managing flood risk in the River Hull catchment. It has identified eight preferred components (packages of engineering works) within the River Hull catchment. The options have been derived through a sifting and analysis process from a long list of possible solutions. Options have been rejected because they are less hydraulically efficient or less cost effective than alternative solutions, meaning they would be unlikely to receive public flood defence funding. The sifting and analysis process to arrive at the eight preferred components did not include environmental assessment of the long list of options, consequently none were rejected on environmental grounds.

4.1.4 A draft programme has been drawn up to implement the works – most are likely to be delivered over a six year period commencing in 2015. Each has had a preliminary cost estimate prepared as part of the Strategy's submission to the Environment Agency's Large Project Review Group. Detailed designs, costings and project delivery mechanisms have yet to be drawn up.

4.2 RHICS Objectives and Timetable

4.2.1 The aim of RHICS is to provide a sustainable flood risk management strategy for the River Hull catchment over the next 100 years.

4.2.2 The following Objectives have been identified;

Economic Factors	**Objective**
Flood protection	Protect people and property by providing the necessary flood management solutions to reduce surface water and river flooding risk within the River Hull catchment
System effectiveness	Ensure adequate maintenance of or improvement of water management and flood risk assets so that the catchment network is efficient, effective and safe
Economic development	Help to realise the potential and create new opportunities for industrial or commercial activities where it was previously constrained by potential flood risk
	Continue to inform and assure stakeholders about the actual risk of flooding alongside works that are completed, ongoing and proposed
Housing development	Help ensure that proposals for and development of new housing takes account of and builds in resilience to flood risk
Agricultural production	Reduce the vulnerability of agricultural land to flooding to assist in achieving its full productive potential
	Promote farm crop and habitat diversification and on-farm microgeneration opportunities to help achieve natural attenuation and reduce run-off
Information provision	Provide accurate information to enable insurers and developers to be better informed about the degree of flood risk
Tourism and recreation	Help improve tourism, amenity and recreational opportunities by reducing flood risk to existing facilities, assist in the creation of new facilities, with improved flood resilience and maximise use of the River Hull as a tourism/recreation destination
Water resources	Protect water quantity and quality for abstraction and supply
Social factors	**Objective**
Health and wellbeing	Help reduce the psychological impact and perception of flooding on people by reducing flood risk
Transport and infrastructure	Prevent adverse impacts of flooding on communication links and energy supply infrastructure
Water Framework Directive	Help bring water bodies to a good state of health, and assist in maintaining this status so that they can be used for social, economic and environmental purposes
Cultural heritage	Prevent damage to designated and non-designated cultural heritage assets within the catchment
	Enhance heritage features and assets by careful management of works. Where new features are discovered, assist with their evaluation and records

Environmental factors	Objective
Landscape	Support and promote sustainable land use change that reduces flood risk and promotes improved, more diverse landscape character
Habitats and species	Reduce adverse impacts upon designated sites and key habitats and species; contribute towards their enhancement
	Promote the favourable condition of SSSIs and other hydrologically sensitive sites though careful water management
	Contribute to relevant UK and local BAP habitats and species targets through implementation of the RHICS
Fisheries	Help promote a natural and self-sustaining riverine coarse fishery
Climate change	Ensure that flood risk management solutions are resilient to the predicted effects of climate change

5.0 PROPOSALS AS PART OF RHICS

The following text outlines the eight components of RHICS.

5.1 Option A – Dredging of the River Hull

5.1.1 The River Hull would be subject to dredging using a technique termed 'hydrodynamic dredging' or 'Water Injection Dredging' (WID) over an approximate 18.5km length; between the Hull Tidal Barrier to Hull Road Bridge (just north-east of Beverley).

5.1.2 WID is considered to be a more cost-effective and environmentally acceptable technique than traditional dredging. The process consists of injecting large volumes of water at a low pressure into the sediment through a series of nozzles on a horizontal jet bar.

5.1.3 The injection process loosens and fluidises the cohesive sediment to create a layer of mudflow which is denser than the rest of the water column. This layer remains close to the bed and does not mix with, or cause disturbance to, the upper layers of the flow. This property of WID is considered more environmentally sound, as the aquatic ecosystem is not disturbed by silt and any contaminants present, unlike more traditional methods of dredging i.e. agitation. Tidal action and gravity then moves the sediment downstream.

5.1.4 The 18.5km stretch of the River Hull where WID is proposed will be dredged by 1m depth across a width of up to 5m. Five metres is the maximum width of boom and so this is intended to be the maximum width of dredging. The process will be carried out by a small vessel entering the River Hull from the Humber Estuary and travelling upstream to Hull Bridge. Due to the width of the vessel, riparian reedbeds will need to be removed before WID is carried out. Reedbeds will be removed by traditional dredging methods prior to commencement.

5.1.5 This option would also include the removal of numerous sunken barges, boats and other vessels to improve the overall cross sectional area of the river, and increase the effectiveness of the WID process.

5.2 Option B – Tidal Exclusion

5.2.1 The existing Hull Tidal Barrier is designed to remain open unless water levels at the outfall into the Humber are forecast to exceed 4.25 m AOD. Since a substantial length of the River Hull is tidally-impacted, the barrier offers significant protection against tidally-induced flood risk. However, tidal peaks below 4.25 m AOD are also capable of markedly increasing flood risk associated with a given fluvial event if peak fluvial and tidal timings coincide and modelling indicates that operation of the barrier at lower tides offers the potential to reduce flood risk. However a degree of

optimisation is required to prevent unnecessary closure thereby restricting river outflow and actually increasing flood risk.

5.2.2 The RHICS hydrological engineering team modelled a range of barrier closure thresholds to test this effect and demonstrated that a 2 m AOD threshold offers the optimal benefit of reduced tidal propagation without detrimentally restricting river outflow.

5.2.3 This option would entail operation of the Hull Tidal Barrier under the same basic operational regime as at present, but with a new 'mitre' tidal barrier installed close to the existing barrier to provide the activation level of 2 m AOD. The location of such a tidal barrier would be immediately up river of the existing barrier. The proposed new structure would only be operational during flood events and therefore would not affect the normal flow regime of the river.

5.2.4 Subsequent engagement with EA engineers has suggested the current Hull Tidal Surge Barrier would be able to perform the new operational rules that have been proposed and therefore investigations into this will form the first part of this option at project level.

5.3 Option C – Holderness Drain

5.3.1 Where flood inundation may be the result of 'overtopping' along a length of existing river embankment or flood defences then a simple raising of this section of bank may provide flood risk mitigation. However, this approach has two basic limitations:

- If a given section of bank is raised to prevent flooding, the resulting new, higher in-channel peak water levels may induce or worsen flooding elsewhere (upstream or downstream); it is therefore important to assess the overall impact of even a limited section of bank raising; and
- If the volume of existing flooding at a given location is substantially larger than the capacity of the local reach when the banks are full then the required amount of bank raising to prevent flooding may be large; indeed, it may extend much beyond the original extent of bank overtopping. In such situations, offline storage is more likely to be effective than simple bank raising.

5.3.2 The feasibility of embankment raising for individual sections of the Holderness Drain was assessed. Holderness Drain currently overtops its banks in several locations where a lower than average crest height occurs. This option, therefore, aims to directly alleviate flood risk by preventing this overtopping; however this would result in higher peak water levels in the impacted sections of the drain. Embankment raising of Holderness Drain is proposed downstream of Great Culvert pumping station to reduce flooding, particularly in the area of Bransholme, for a distance of approximately 2 kilometres and to an average height of 0.3m but up to 0.6m in places. In addition a section of the Ganstead Drain, totalling some 1731 metres in length, would be subject to embankment raising; with an average increase in height of 0.3m.

5.3.3 The large volume of flood inundation from the Holderness Drain upstream of the Great Culvert pumping station would require very extensive embankment raising to prevent inundation. The higher peak water levels would however, increase peak water levels detrimentally elsewhere in the Holderness Drain; resulting in substantial inundation (volume and extent). This option therefore includes a change in pumping regime to address such issues. Presently the Holderness Drain is divided into three reaches:

- An upstream reach, terminating with and drained by the Tickton Pumping Station (PS);
- A middle reach, below the Tickton PS, terminating with and drained by the Great Culvert PS; and
- A lower reach, below Great Culvert PS, drained by a combination of gravitational flow during low tides and pumping by the East Hull PS.

5.3.4 Increased pump capacity offers a simple and logical option to reduce fluvial flood risk in the Holderness Drain system. Consequently this option entails the following alterations:

- Removal of the existing Tickton PS and replacement with a flap valve and overflow weir;
- Increase in Great Culvert PS peak capacity; and
- Increase in East Hull PS peak capacity.

5.3.5 The existing bypass weir at Tickton PS is very high, relative to upstream bank levels, such that removing Tickton PS in isolation would substantially increase flood risk at upstream locations, and induce significant flooding even during fluvial baseflow conditions. It is therefore necessary to accommodate low level flows along Holderness Drain via a large flap valve to achieve comparable flood risk protection to existing conditions.

5.3.6 Embankment raising to the Holderness Drain below Great Culvert PS removes fluvial inundation risk in the Bransholme area and Ganstead Drain catchment; with some minor predicted detriment in the Foredyke Stream (drain) and its tributaries. Although in terms of volumetric reduction, embankment raising only reduces the peak 100 year inundation volume by 3%, the bulk of this reduction would occur in high-value urban areas. Furthermore the inclusion of increased pumping is predicted to decrease the peak 100 year inundation from the Holderness Drain system by 21%. A small portion of this reduction is predicted to occur upstream of the Tickton PS location, indicating that the proposed replacement of Tickton PS with a flap valve/high-flow weir does not cause a detriment when combined with increased pumping further downstream.

5.4 Option D – Bransholme Pumping Station

5.4.1 The Bransholme area of Hull is situated between the embanked River Hull to the west and Holderness Drain to the east. The area is currently drained by a Yorkshire Water

surface water network; with flows pumped into a large raised storage lagoon, adjacent to the River Hull. This lagoon has the potential to spill into the River Hull under very high storage conditions.

5.4.2 The Bransholme surface water area is split by a ridge of high land, orientated in a north-south direction, and by the Wawne drain which connects to the surface water network at its eastern end. A larger catchment to the north of the Bransholme area is drained by the Engine Drain, which under normal flow conditions will drain eastward via the Croft Drain to the Holderness Drain. Under high flow conditions, however it can also drain to the Kingswood/Bransholme area; where it is conveyed by pipe to the Wawne Drain.

5.5 Option E – Beverley and Barmston Drain/Western Drain

5.5.1 The feasibility of raising sections of existing embankment has also been assessed for the Beverley & Barmston Drain; to the south of Beverley Beck. The situation in the Beverley & Barmston Drain is similar to that for the Holderness Drain described in Option C. The Beverley and Barmston Drain, along with its Western Drain tributary, overtops its banks in several locations where a lower than average crest elevation is present. As described in Option C, raising of embankments in one section of the Drain would tend to detrimentally impact flood risk elsewhere. A proposed embankment raise of the section south of Dunswell, over a distance of some 721 metres, on average 0.25m high, up to a minimum height of 1.45 metres AOD, being the only option that reduces local flood inundation without detriment elsewhere.

5.5.2 In tandem it is proposed to raise a section of the Western Drain bank to a minimum height of 2.0 metres AOD. Bank raising would be almost contiguous along the length of Western Drain to its confluence point with the Beverley and Barmston Drain; a length of 3213 metres. The average height of required embankment would be approximately 1 m. The existing flap valve discharge from the Western Drain into the Beverley and Barmston Drain is considered inadequate for the predicted higher flows during extreme events; without causing flooding. Changes to the Western Drain therefore include a 2m wide, high flow weir constructed at the confluence point.

5.5.3 The raising of the embankments proposed by this option removes fluvial inundation risk in the area south of Beverley; however with some very minor detriment predicted further upstream.

5.5.4 Volumetrically, this option reduces the peak 100 year inundation volume for the River Hull system by only 2% but would protect relatively high value land/buildings from inundation.

5.6 Option F – Wilfholme and Hempholme Pumping Stations

5.6.1 Option F comprises an evaluation of the two existing Environment Agency pumping stations located at Wilfholme and Hempholme. The existing surface water management regime in the upper River Hull catchment includes the following transfer pumping arrangements.

5.6.2 Hempholme Pumping Station consists of three pumps that transfer water from the Roam Drain near Hempholme Bridge into the Mickley Dike immediately upstream of the Bunker Hill flap valves.

5.6.3 Wilfholme Pumping Station consists of four pumps that transfer water from the Beverley and Barmston Drain into the River Hull in the vicinity of Wilfholme Bridge.

5.6.4 It is proposed that the existing pumps are replaced with smaller, but more efficient pumps. Both the current, and proposed, pumping regime would protect local agricultural land with the additional benefit that replacement pumps would lead to a reduction in maintenance costs.

5.7 Option G – Natural Flood Management

5.7.1 The Options A to F take an approach to flood alleviation that focuses upon the conveyance of water through the catchment by increasing channel capacity and efficiency. Natural Flood Management (NFM) however aims to delay the flow of water through the catchment by means of attenuation and infiltration of surface water. NFM is generally employed upstream of towns and villages to both reduce and slow down peak flow, and involves a reversion from modern farming practices. The specific aim of this option is therefore to attenuate the predicted 100 year peak flow upstream through a range of ‘soft’ engineering measures across a greater area of upper catchment; rather than ‘hard’ engineered measures further downstream.

5.7.2 For example, if a typical farm, or small catchment, were to sacrifice between 2 and 10 per cent of the land to water attenuation and flood mitigation, this would dramatically change the characteristics of the runoff regime. Runoff Attenuation Features (RAFs) can typically be implemented within a farm or landscape to contribute to this type of flood mitigation. RAFs are favoured, and are often more desirable than traditional engineering solutions, due to their low cost and the cumulative benefits to all downstream flood sites.

5.7.3 RAFs include overland flow disconnection ponds which act as storage areas, intercepting overland flow; such features are ideal for disrupting fast surface runoff pathways during peak flow events. Other measures could include increased channel roughness, through introduction of debris, to reduce flow velocity with increased sedimentation and spillage onto the connected floodplain. These structures can also create a complex microhabitat for both aquatic and terrestrial organisms; as well as

contributing to the nutrient cycling. Further measures such as swales and infiltration trenches can be introduced to alter the conveyance of water through the catchment by encouraging infiltration.

5.7.4 Within the River Hull catchment, farming is largely arable and hence considered a suitable candidate to accommodate RAFs. Potential sites for NFM would be identified through a combination of distance from main watercourses, floodplain connectivity, terrain type, land ownership and feasibility of implementation. This strategy option will however, require the co-operation of land owners and tenant farmers to adopt the necessary approach and be involved in catchment-scale flood management.

5.7.5 The total upper catchment area covers and extensive area to the north and north-west of the study area. In order to model the potential effects, this option assumes an area of NFM equivalent to approximately 10% of the upper catchment area (292 hectares); which would be subject to agreements/initiatives with local landowners/farmers prior to implementation. The assumed 10% has been modelled to take place within the catchment areas of Upper Foston, Upper Forflorns, Driffield Beck, Driffield Trout and Watton Beck.

6.0 SCREENING

6.1 Hornsea Mere Special Protection Area

6.1.1 RHICS is not considered to be directly connected or necessary for the management of this site, consequently further consideration of the potential for significant effects is given below.

6.1.2 Hornsea Mere SPA is located outside the River Hull catchment and consequently no impacts due to changes in overland flow are predicted. However, the site is in the same groundwater body as defined by Environment Agency in River Hull River Basin Management Plan.

6.1.3 Reference to Hornsea Mere SPA citation and Site Improvement Plan (produced as a part of Improvement Programme for England's Natura 2000 Sites (IPENS)) indicates that the Mere has a catchment of some 1755ha and water levels are controlled by a sluice gate. No mention of the influence of groundwater levels is made.

6.1.4 No off-line flood storage elements are proposed as part of RHICS and so no change in infiltration rates to groundwater are predicted. Similarly changes in flow rates in River Hull and Holderness Drain catchments as a result of works associated with RHICS are not predicted to impact significantly on groundwater levels.

6.1.5 As no change in overland flow in Hornsea Mere catchment is predicted, and no significant changes in levels of groundwater body are predicted, then no significant effects are considered likely for Hornsea Mere as a result of RHICS and the site is not considered further.

6.2 Humber Estuary SAC / SPA / Ramsar site

6.2.1 RHICS is not considered to be directly connected or necessary for the management of this site, consequently further consideration of the potential for significant effects is given below.

6.2.2 The following table considers each element of RHICS and considers the likelihood that significant effects on integrity of Humber Estuary SAC / SPA / Ramsar site will occur as a result in the absence of avoidance and mitigation measures.

6.2.3 Where effects are assessed as being 'unlikely' or 'highly unlikely' the item is not considered further in this assessment. Similarly where significant effects are considered likely to be positive, no further assessment has been undertaken. Only where significant effects which are adverse are considered 'likely' or the result is uncertain is further assessment undertaken.

6.2.4 In each case the potential receptor is Humber Estuary SAC / SPA and Ramsar site.

Option	Brief description	Likelihood of significant effect	Rationale
A	Dredging R Hull from tidal barrier to Hull Bridge. Includes removal of sunken vessels and riparian reedbed.	Likely	Mobilising large volumes of sediment and contaminants poses a potential risk of impacts on Natura 2000 sites downstream. Potential effect on migrating river lamprey.
B	Tidal exclusion.	Uncertain	Whilst the additional Hull Tidal Barrier will be activated more often (16 times per year compared with 8 times per year under the existing regime), and the increase in activation will not affect the normal flow regime and of the river, there is uncertainty regarding the impact on migrating river lamprey.
C	Holderness Drain embankment raising.	Highly unlikely	Whilst an increase in pumping volumes is necessary to achieve this, water flow and sediment loads entering Humber Estuary will not be significantly increased.
D	Increasing capacity of Bransholme Pumping Station	Highly unlikely	Water flow and sediment loads entering Humber Estuary will not be significantly increased.
E	Beverley and Barmston Drain / Western Drain – embankment raising.	Highly unlikely	Water flow and sediment loads entering Humber Estuary will not be significantly increased.
F	Wilfholme and Hempholme Pumping Stations – replacement.	Highly unlikely	Water flow and sediment loads entering Humber Estuary will not be significantly increased.
G	Natural flood management – a variety of flood management measures in the upper catchment.	Likely	Significant positive effect considered likely. Flows and sediment load of River Hull likely to be reduced due to increased infiltration and evapo-transpiration.

7.0 APPROPRIATE ASSESSMENT

7.1 Scoping

7.1.1 Sea and River Lamprey

Protected status

7.1.1.1 Both sea and river lamprey are Annex II species and are present as a qualifying feature of Humber Estuary SAC. Due to their life cycle, rivers flowing into the estuary are vital for the continued survival of these species as this is where lamprey spawn and spend most of their lives.

7.1.2 Option A

7.1.2.1 Option A involves the following elements which may adversely effect qualifying features of Humber Estuary SAC and thus the integrity of this Natura 2000 site;

- Removal of sunken vessels in the River Hull;
- Removal of riparian reedbed; and
- Water Injection Dredging (WID).

Removal of sunken vessels in the River Hull

7.1.2.2 Removal of sunken vessels has the ability to mobilise sediment and any contaminants present which, in the absence of mitigation, would ultimately discharge into Humber Estuary. The relatively small volumes of sediment that are likely to be disturbed will be contained and dealt with following standard industry procedures as directed through Environmental Impact Assessment for the project and any residual impact is considered highly unlikely to have an adverse effect on integrity of Natura 2000 sites.

7.1.2.3 Silt beds and soft substrate adjacent to sunken vessels are highly unlikely to support river lamprey ammocoetes as all vessels are located in the tidal reaches of River Hull, however, river lamprey are known to migrate through this stretch of river and consequently this aspect of Option A is scoped in for further assessment with regard to potential effects on river lamprey.

Removal of riparian reedbed

7.1.2.4 Removal of riparian reedbeds using traditional dredging techniques may also mobilise accumulated sediment and associated contaminants into the water column and thus to Humber Estuary. The relatively small volumes of sediment that are likely to be disturbed will be contained and dealt with following standard industry procedures as directed through Environmental Impact Assessment for the project

and any residual impact is considered highly unlikely to have an adverse effect on integrity of Natura 2000 sites due to the small volumes of sediment involved (compared with background sediment load of Humber Estuary).

7.1.2.5 Silt beds and soft substrate associated with reedbeds are highly unlikely to support river lamprey ammocoetes as reedbeds are located in the tidal reaches of River Hull, however, river lamprey are known to migrate through this stretch of river and consequently this aspect of Option A is scoped in for further assessment with regard to potential effects on river lamprey.

Water Injection Dredging (WID)

7.1.2.6 Silt beds and soft substrate impacted by dredging are highly unlikely to support river lamprey ammocoetes as all works take place at depth in tidal reaches. However, Water Injection Dredging (WID) mobilises up to 1m of sediment on the river bed which then makes its way out of the river through natural flow processes through gravity or on the falling tide.

7.1.2.7 WID is considered likely to have the potential to have an adverse effect on Natura 2000 sites and qualifying features and is scoped in to the assessment. Identified likely adverse effects on qualifying features are disruption to river lamprey migration. Additionally there is the potential for impacts on the sediment balance of Humber Estuary and mobilisation of contaminants in sediment. There is uncertainty around predicted effects, however, sediment mobilisation due to WID is considered to have the potential to generate an adverse effect on the following Annex 1 habitats;

- Estuaries;
- Mudflats and sandflats not covered by seawater at low tide;
- Sandbanks which are slightly covered by seawater all the time;
- Coastal lagoons; and
- *Salicornia* and other annuals colonising mud and sand.

In addition , the potential adverse effects on SPA bird species also needs also to be considered as if contaminated sediment is stored in the lower reaches of the River Hull, birds could feed on these areas and could be affected by contamination.

7.1.3 Option B

7.1.3.1 Mudflats associated with the tidal reaches of the River Hull are likely to be utilised by birds which are qualifying features of Humber Estuary SPA. Increased use of the tidal barrier during high tides during high rainfall events will decrease the availability of this habitat to wading birds along the River Hull. There is no predicted impact on the availability of mudflats in Humber Estuary.

7.1.3.2 Tidal mudflats along the River Hull form a very small fraction of the tidal mudflats available in Humber Estuary SPA, consequently any loss of mudflat for period along the River Hull is considered highly unlikely to have an adverse effect on the integrity Natura 2000 sites and this item is scoped out of the assessment.

7.1.3.3 In order to complete their lifecycle river lamprey are required to pass the mouth of the River Hull on two occasions to enter or return to Humber Estuary. It is uncertain whether activation of the Hull Tidal Barrier on 16 occasions rather than 8 annually will inhibit migration of river lamprey and cause an adverse effect on this feature of a Natura 2000 site. Consequently this Option has been scoped in for further assessment.

7.1.4 Result of Scoping Assessment

7.1.4.1 The following table indicates the results of scoping assessment;

Receptor	Option A			Option B
	Removal of sunken vessels in the River Hull	Removal of riparian reedbed	Water Injection Dredging	Activation of tidal barrier
Sea lamprey	Scoped out	Scoped out	Scoped out	Scoped out
River lamprey	Scoped in	Scoped in	Scoped in	Scoped in
Birds utilising mudflats	Scoped out	Scoped out	Scoped in	Scoped out
Impacts on Humber Estuary sediment balance	Scoped out	Scoped out	Scoped in	Scoped out
Contaminated sediment entering Humber Estuary	Scoped out	Scoped out	Scoped in	Scoped out

8.0 IDENTIFICATION OF ADVERSE EFFECTS

8.1 Option A – Removal of sunken boats

8.1.1 Removal of sunken boats and other vessels from the watercourse is considered to have the potential to cause an adverse effect on a qualifying feature of Humber Estuary SAC / SPA / Ramsar site. This feature is river lamprey. Young adults migrate from spawning grounds in the Hull Headwaters to the Humber Estuary where they live for around two years prior to returning up the River Hull to spawn. Migrating at night, river lamprey rest during the day on the river bed under stones and vegetation. Migration of macrophthalmia and mature adults can take place throughout the period October to May.

8.1.2 With regard to potential impacts on river lamprey it is necessary to consider the two migration phases of the species, i.e. when lamprey macrophthalmia swim down river to the estuary, and when the adults return upstream to breed.

8.1.3 Lamprey macrophthalmia are weak swimmers and appear to move downstream as much by drifting with the current as through their own motive efforts. Once they reach the tidal reaches of the river this poses a potential problem as macrophthalmia may be washed inland on a rising tide as easily as they are impelled downstream on an ebbing tide. Consequently lamprey macrophthalmia are likely to aggregate in areas of low flow on a rising tide and then swim into the water column on the ebbing tide to make their way downstream to the mouth of the river. Any impedance to their progress downstream represents an adverse effect on this species. Macrophthalmia migrate downstream in the period November to May.

8.1.4 Similarly adult lamprey migrate upstream through the tidal reaches of River Hull on their way from the estuary to spawning grounds in River Hull headwaters. These fish are also rather poor swimmers and are known to be almost excluded from rivers with man-made impedance structures even where traditional fish passes are in place (Foulds and Lucas 2013). Adults migrate upstream in the period October to April.

8.1.5 Disturbance of the river bed due to removal of sunken vessels has the potential to disrupt and kill resting macrophthalmia and mature adult river lamprey in the vicinity, especially as sunken vessels will create areas of low flow where resting takes place. Loss of a number of individuals from the population is considered likely to have the potential to affect the nature conservation status of river lamprey in the short term.

8.2 Option A – Removal of riparian reedbed

8.2.1 Removal of riparian reedbeds is considered to have the potential to cause an adverse effect on a qualifying feature of Humber Estuary SAC / SPA / Ramsar site. This feature is river lamprey. Young adults migrate from spawning grounds in the Hull Headwaters to the Humber Estuary where they live for around two years prior to

returning up the River Hull to spawn. Migrating at night, river lamprey rest during the day on the river bed under stones and vegetation. Migration of macrophthalmia and mature adults can take place throughout the period October to May.

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8.2.4 Similarly adult lamprey migrate upstream through the tidal reaches of River Hull on their way from the estuary to spawning grounds in River Hull headwaters. These fish are also rather poor swimmers and are known to be almost excluded from rivers with man-made impedance structures even where traditional fish passes are in place (Foulds and Lucas 2013). Adults migrate upstream in the period October to April.

8.2.5 Disturbance of the river bed due to removal riparian reedbeds has the potential to disrupt and kill resting macrophthalmia and mature adult river lamprey in the vicinity, especially as reedbeds will create areas of low flow where resting takes place. Loss of a number of individuals from the population is considered likely to have the potential to affect the nature conservation status of river lamprey in the short term.

8.3 Option A – Water Injection Dredging

8.3.1 The input of large volumes of sediment relatively rapidly into the Humber Estuary SAC / SPA / Ramsar site is considered likely to have the potential to have an adverse effect on the integrity of the site and thus the Natura2000 network. There is also the possibility that pollutants in the sediment will be mobilised and would flush out into the Estuary in the absence of avoidance / mitigation measures. In addition, mobilising sediment at the base of the water column may impact upon migrating river lamprey.

Scale of Impact

8.3.2 Characterising the likely ecological impact due to Option A takes into account a number of factors including the magnitude, extent and duration of the impact. The impact is likely to be limited in time and space and must be considered in the context of background sediment load in the Humber Estuary.

8.3.3 Much of the sediment in the tidal reaches of River Hull comes from the Humber Estuary and then deposits at slack tide. It is understood that until the 1990s disturbance of sediments in the water column caused by commercial craft were sufficient to ensure that shipping lanes in the river remained silt free to a depth necessary for navigation. Since the decline of commercial traffic in the River Hull, silt has deposited. WID will aim to remove up to one metre of sediment which has accumulated in the central portion of the channel which will include deposits from before 1990s.

8.3.4 WID is carried out from a floating platform and once in the water dredging is targeted at the central portion of the river bed. In this way riparian vegetation is not disturbed unduly by the process, however, a width of 5m is necessary and some riparian reedbed will need to be removed to facilitate the process.

8.3.5 Magnitude of impact considers the volume of sediment mobilised and the nature of the substrate to be disturbed. It is estimated that approximately 10,000m³ silt will be moved downstream. Environment Agency have been asked to advise which pollutants are present and silt is currently being tested prior to undertaking the process. Study of industrial heritage and likely pathways indicates that insoluble lead, chrome, tin and zinc may be present originating from paint and chemical factories. It is not known whether soluble contaminants are present, however, if these prove to be present then it is understood that suction dredging will take place instead of WID and contaminated material will be disposed of at an off-site contaminated waste facility.

8.3.6 Extent of impact is a function of where sediment mobilised by WID will impact and the likely pathway. WID will aim to pass a column of silt down the river with minimal mixing with river water above and without breaking the surface of the river.

8.3.7 With regard to potential impacts on river lamprey it is necessary to consider the two migration phases of the species, i.e. when lamprey macrophthalmia swim down river to the estuary, and when the adults return upstream to breed.

8.3.8 Lamprey macrophthalmia are weak swimmers and appear to move downstream as much by drifting with the current as through their own motive efforts. Once they reach the tidal reaches of the river this poses a potential problem as macrophthalmia may be washed inland on a rising tide as easily as they are impelled downstream on an ebbing tide. Consequently lamprey macrophthalmia are likely to aggregate in areas of low flow on a rising tide and then swim into the water column on the ebbing tide to make their way downstream to the mouth of the river. Any impedance to their progress downstream represents an adverse effect on this species. Macrophthalmia migrate downstream in the period November to May.

8.3.9 Similarly adult lamprey migrate upstream through the tidal reaches of River Hull on their way from the estuary to spawning grounds in River Hull headwaters. These fish are also rather poor swimmers and are known to be almost excluded from rivers with

man-made impedance structures even where traditional fish passes are in place (Foulds and Lucas 2013). Adults migrate upstream in the period October to April.

8.4 Option B – Activation of Tidal Barrier

8.4.1 It is considered uncertain whether increased operation of the tidal barrier is likely to have an adverse effect on river lamprey migration, and consequently the potential issues are explored more fully here.

8.4.2 The currently predicted worst case scenario involves activation of the tidal barrier 16 times per year generally in the period October to February. Activation is triggered by the coincidence of spring tides and high rainfall events in the River Hull catchment.

8.4.3 It is considered highly unlikely that the barrier will impede progress of macrophthalmia moving downstream into Humber Estuary as the normal flow regime of River Hull will continue to operate i.e. the volume of river water discharges into Humber Estuary will continue in the usual way, however, this will be timed differently through use of the tidal barrier during a flood event. Consequently the flow into the Humber will continue to facilitate the progress of macrophthalmia into the river and adverse effects are not predicted.

8.4.4 Predicted extra closures are more likely to occur during the adult lamprey migration period which takes place over a seven month period. It has been shown that when faced with physical barriers to migration, individual adult lamprey will make multiple attempts to access their spawning grounds over the period November to April (Foulds and Lucas 2013). These attempts are positively correlated with high river flow events.

8.4.5 As lamprey appear to be stimulated to ascend spawning rivers during high flow events, it is likely that in the tidal reaches adult river lamprey will be stimulated to move upstream on the ebbing tide (i.e. when there is river flow to work against). As the barrier will be shut during high tide events only, this does not coincide with times when adult lamprey are likely to be actively migrating upstream.

8.4.6 Additionally migration takes place over the course of seven months, so even if the barrier is closed on 16 occasions (the worst case scenario) then this will leave approximately 408 other high tide events during the adult migration period when the barrier will be open. During these periods of sluicing, the barrier will remain open for more than half of the daily tide cycle to allow the stored water to flow naturally out into the Humber Estuary. As adult river lamprey make multiple attempts to access spawning rivers it appears unlikely that the frequency of closure predicted will have an adverse effect on river lamprey movements.

9.0 AVOIDANCE AND MITIGATION

9.1 Option A – Removal of sunken boats

9.1.1 In order to ensure potential effects on river lamprey are minimised, sunken vessel removal should be programmed to avoid the migration periods for both adults and macrophthalmia, i.e. works should take place in the period June to September inclusive.

9.1.2 Fish shelter habitat will be installed as soon as practically possible following wreck removal at the site of each wreck removal to compensate for loss of daytime resting habitat for adults. Pilot structures may be tested before commencing with removal works. In the medium to long term, it is considered likely that sufficient resting habitat will be available to support river lamprey population of River Hull. It is considered unlikely that access to daytime refugia currently limits the population of river lamprey on this watercourse.

Residual impact

9.1.3 If removal of sunken vessels is undertaken in the period June to September inclusive this will avoid the main migration periods for river lamprey both up and down stream. Short term replacement of resting habitat (fish shelters) is intended to mitigate for loss of resting habitat in the short term.

9.1.4 Consequently the residual impact on this qualifying feature of Humber Estuary SAC is considered to be neutral.

9.2 Option A – Removal of riparian reedbed

9.2.1 In order to ensure potential effects on river lamprey are minimised, riparian reedbed removal should be programmed to avoid the migration periods for both adults and macrophthalmia, i.e. works should take place in the period June to September inclusive.

9.2.2 Fish shelter habitat will be installed as soon as practically possible at the site of reedbed removal to compensate for loss of daytime resting habitat for adults. In the medium to long term, it is considered likely that sufficient resting habitat will be available to support river lamprey population of River Hull. It is considered unlikely that access to daytime refugia currently limits the population of river lamprey on this watercourse.

Residual impact

9.2.3 If removal of riparian reedbed is undertaken in the period June to September inclusive this will avoid the main migration periods for river lamprey both up and down stream.

Consequently the residual impact on this qualifying feature of Humber Estuary SAC is considered to be neutral.

9.3 Option A – Water Injection Dredging

9.3.1 Prior to commencement a project level Environmental Impact Assessment and Habitat Regulations Assessment (HRA) will be undertaken. This will take place once all detail about the proposed engineering works is available. These assessment will inform decisions about the project moving forward that include changes in extent, scope and alternative working methods. The assessment offered below is based on the best available knowledge which has informed RHICS to date.

9.3.2 The first stage in developing the option involves testing sediment for contaminants. If harmful contaminants are present, a silt curtain will be used as described below. However, if contaminant levels do not exceed allowed limits, dredged silt will be discharged via the water column into the Humber Estuary. In either case, an assessment of the likely impact on SAC and SPA qualifying features and associated mitigation will be made during the project level HRA. This will include WID along with construction activities, mitigation and associated maintenance.

9.3.3 Mobilised silt will travel along the bottom of the river to a storage area near the mouth of the river where it will be deposited permanently behind an underwater silt curtain which acts like an underwater weir on the river bed. If contaminants are to be mobilised using a silt curtain consent will need to be sought from regulatory authorities such as Marine Management Organisation and Environment Agency.

9.3.4 Calculations indicate that there is ample capacity to keep the silt within the river regime in this way whilst delivering the upstream increase in cross-sectional area required. By reducing the extent of impact in this way it is predicted that very little mobilised sediment and associated contaminants will enter Humber Estuary.

9.3.5 It is possible that contaminated sediment could be restricted to particular sites along the watercourse and silt curtains may not be a relevant solution. In this case the project will assess other options for these sites including conventional treatment, alternative dredging methods or even potentially not implementing proposals in these areas if mitigation isn't feasible.

9.3.6 Looking ahead, it is predicted that dredging will need to be repeated every ten years. The sediment generated in ten years time will be of a much more predictable quality and will likely be derived mainly from sediment present in Humber Estuary. Whilst future dredged sediment may be stored in a similar way within the river regime, if capacity of the storage area is reached a decision regarding the way forward will need to be made at the time based on available data and technology and prevailing ecological and social imperatives.

9.3.7 In order to ensure impacts on river lamprey are reduced, WID should be programmed to avoid the migration periods for both adults and macrophthalmia, i.e. works should take place in the period June to September inclusive.

9.3.8 If use of a silt curtain to contain sediment was implemented within the river regime will reduce depth towards the mouth of the river, however, there will always be a depth of water above the curtain allowing fish including river lamprey access in both directions. It is possible that the silt curtain will create sheltered areas for macrophthalmia to rest out of the current during their migration and has the potential to be beneficial for this life stage of the species.

Residual impact

9.3.9 Whilst it is predicted that 10,000m³ silt will be mobilised on the bed of the River Hull and travel downstream, if contaminants are present then measures will be put in place to ensure that nearly all of this stays within the river regime being stored in a downstream receptor behind a silt curtain. Through appropriate design development it is expected that the silt curtain will not impede fish movements up and down stream. With the silt curtain in place it is anticipated that very little sediment or associated contaminants will enter the Humber Estuary. As such, it is considered unlikely that there will be an adverse residual effect on the Natura 2000 sites, i.e. Humber Estuary SAC, SPA and Ramsar site. However, these assumptions will be confirmed along with any specific mitigation required during the project level HRA.

9.3.10 If contaminant levels are such that the silt curtain is not deployed, then the silt will be discharged into Humber Estuary SAC, SPA and Ramsar site. The potential impact of this discharge on qualifying features will be considered once detailed engineering proposals are in place during the project level HRA.

9.3.11 If WID and associated works are undertaken in the period June to September inclusive this will avoid the main migration periods for river lamprey both upstream and downstream. Consequently the residual impact on this qualifying feature of Humber Estuary SAC is considered to be neutral.

9.4 Option B – Activation of Tidal Barrier

9.4.1 Having explored the evidence regarding potential adverse effects on river lamprey due to increased usage of a tidal barrier at the mouth of the River Hull the following conclusion has been reached.

9.4.2 Given that adult lamprey are likely to be migrating on the ebbing tide (swimming against the flow), have been recorded making multiple attempts over several months to pass when faced with barriers and that the barrier will be shut during high tide events a maximum of 4% of high tide events during the migration period, it is

considered highly unlikely that the predicted increased usage of tidal barrier will have an adverse effect on the river lamprey population.

9.4.3 Despite this it is proposed this scheme will provide an appropriate amount of monitoring of all fish species including lamprey in the RHICS SEA. Negative impacts however, are deemed unlikely.

10.0 IN COMBINATION EFFECTS

10.1 RHICS Options A – G

10.1.1 Each Option associated with RHICS has been assessed for the likelihood that it has the potential to have a significant effect on the integrity of Natura 2000 sites. However, the intention is that all seven options will be brought forward and delivered over the next six years, so it is necessary to examine the combined effect. This assessment is based on the best available knowledge which has informed RHICS to date.

10.1.2 Significant effects on the integrity of Natura 2000 sites were considered highly unlikely for Options C to G. Options C and E involve raising embankments to reduce flooding levels at critical times, and there are implications for pumping regimes, however, in terms of significant effects on Natura 2000 sites, none could be identified. Similarly Options D and F involve the replacement of pumping stations with more efficient models, however, pumping regimes remain essentially the same and no significant effects on Natura 2000 sites could be identified. Option G is the Natural Flood Management option which is likely to generate significant effects of a positive nature for the river regime overall. Consequently no significant effects on Natura 2000 sites are identified due to implementation of Options C to G.

10.1.3 Options A and B are considered further and avoidance and mitigation measures are described above.

10.1.4 It is understood that Option A will only be carried out once the risks associated with contaminated sediment are known and suitable mitigation is in place to ensure potential impacts are avoided or mitigated for. Prior to commencement a project level Environmental Impact Assessment and Habitat Regulations Assessment will be undertaken. This will take place once engineering proposals are finalised and all detail about contaminants and associated risks are available. The current assessment is based on best available information informing development of RHICS.

10.1.5 Due to the lack of identifiable significant effects for Options C to G and the project level assessment, mitigation and avoidance measures employed for Options A and B, it is considered highly unlikely based on current understanding that RHICS in combination effects will generate an adverse effect on the integrity of Natura 2000 sites. They will however undergo further assessments at the individual project scheme level which will inform further work.

10.1.6 Based on current information on RHICS Options A to G are considered highly unlikely to generate adverse effects with implementation of avoidance measures either singly or in combination.

10.2 Humber Estuary

10.2.1 Research into relevant projects likely to impact on Humber Estuary SAC / SPA / Ramsar site with planning permission or in the pipeline in the next five years was made through contact with East Riding of Yorkshire Council (ERYC) and Associated British Ports (ABP) Sustainable Development Manager (Humber) Tom Jeynes.

10.2.2 ERYC have given an overview of potential proposals, however, none are concrete at present or known to be at an advanced stage of planning. Tom Jeynes has been approached but is yet to respond, however, he is reported to be of the opinion that ABP have no concerns about the impact of silt being moved from the River Hull into the estuary. He is reported to have commented that "The amount of silt entering the estuary will not make any difference whatsoever because it will disperse naturally with the tidal flows".

10.2.3 Potential projects identified are tabulated below;

Operator	Site	Projects
Able UK Ltd	North Killingholme, N Lincolnshire	Able Marine Energy Park – planning permission granted December 2014. Deep water port and infrastructure to support offshore renewable energy development. HRA completed in 2011 with adverse effects predicted. IROPI supported by compensatory habitat creation.
ABP	Goole	None reported.
ABP	Immingham	No projects have been reported.
ABP	Immingham	ABP proposal in the pipeline. No further detail at this stage.
ABP	Grimsby	None reported.
ABP	Hull Alexandra Dock	Siemens proposal. No further detail at this stage.
'Private operator'	the Ouse at Kilpin Pike just south of Howden (next to Howdendyke),	None reported.
Cement works	S Ferriby	None reported.
BP/Entergy complex	Saltend east of Hull	None reported.
ABP		Dredging plans in Humber – no detail at the time of writing.

10.2.4 Whilst clearly there is a lack of information on proposed projects with the potential to impact on Humber Estuary SAC / SPA / Ramsar site at this stage, based on the likely scale, magnitude, extent and duration of residual impacts generated by RHICS as described above, it is considered highly unlikely that impacts due to implementation of RHICS will be key in creating in combination effects generating an overall adverse effect on the integrity of Natura 2000 sites. However, these in combination effects will be considered further during the project level HRA, when more information on the above projects or details of additional projects on the estuary may be available.

11.0 DISCUSSION AND CONCLUSION

11.1.1 The assessment carried out in this document aims to assess the likely effect of implementation of options associated with RHICS on Natura 2000 receptors and is based on best available information informing RHICS to date.

11.1.2 One potential receptor has been identified, namely Humber Estuary SAC, SPA and Ramsar site.

11.1.3 After consideration of likely significant effects Options C to G have been screened out of the assessment as significant effects on the integrity of Natura 2000 sites was considered unlikely or highly unlikely. Option G is considered likely to generate a significant effect, however, this is likely to be a positive effect and so was not considered further in the assessment.

11.1.4 Appropriate Assessment has been undertaken for the elements of RHICS screened in with Option A considered in more detail with three elements of the option scoped in for detailed assessment; recovery and disposal of sunken vessels, removal of riparian reedbed and water injection dredging. Similarly, the potential adverse effect of increased closure of a tidal barrier (Option B) on river lamprey was also considered further.

11.1.5 Taking into account mitigation which will be developed as part of the need for project level Environmental Impact Assessment and HRA, avoidance and mitigation measures and in combination assessment, and examination of residual impact, it is considered unlikely that an adverse effect on the integrity of a Natura 2000 site will take place due to implementation of RHICS. However, for any option, once the project level HRA has been carried out, if adverse effects cannot be effectively managed through avoidance and/or mitigation measures, then implementation of the preferred measure will be reconsidered.

11.1.6 This document will be used as a guide for focused project level environmental assessments to evaluate more detailed impacts from the RHICS components. These assessments of individual elements will inform project scope, design detail, construction methods and operation moving forward. The RHICS SEA Ecological Mitigation Overview appendix will also provide a valuable resource for advising on mitigation on all projects that will help towards delivering the strategy without causing any adverse impacts.

12.0 BIBLIOGRAPHY

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APPENDIX 1

HUMBER ESTUARY SAC CITATION

APPENDIX 2

HUMBER ESTUARY SPA CITATION

APPENDIX 3

HUMBER ESTUARY RAMSAR SITE CITATION