Planning Act 2008
Infrastructure Planning (Changes to, and Revocation of, Development Consent Orders) Regulations 2011
Document reference: TR030006/D1/4

Able Marine Energy Park

Material Change 2

Updated version of UES

Appendix 11-2

(referenced in response to question 1.0.13)

ABLE MARINE ENERGY PARK MATERIAL CHANGE 2

UPDATED ENVIRONMENTAL STATEMENT

APPENDIX UES11-2

CHANGE IN HABITAT LOSSES WITHIN THE DESIGNATED SITE

14 December 2021
Revision: 02
Able UK Ltd

APPROVAL & REVISION REGISTER

	NAME	SIGNATURE	DATE
Originator:	R Cram	RMC	17/6/21
Checked by:	S Percival	SP	21/6/21
Approved by:	R. Cram	RMC	21/6/21

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0	Draft for Review	17/6/21
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1 INTRODUCTION

1.1.1 The Humber Estuary is a designated Special Protection Area (SPA), Special Area of Conservation (SAC), Site of Special Scientific Interest (SSSI) and Ramsar site. Development of the Able Marine Energy Park (AMEP) includes the reclamation of a significant area of intertidal mudflat and subtidal habitat within these designated sites. Compensation for the loss of habitat has already been assessed and is provided for within the AMEP DCO, following a Habitats Regulations Assessment (HRA) by the Secretary of State for Transport[1]. This document explains how the proposed material change to the quay affects the previously agreed compensation provision for habitat losses in the Humber Estuary marine site. Habitat losses for the consented scheme were initially set out in the following documents that were part of the DCO ES.

1.1.2 Explanatory Note EX 11.23, 'Immediate Habitat Losses Within the Designated Site', refer to Annex 1.

1.1.3 Explanatory Note EX 11.24, '*Medium and Long Term Quantum of Habitat Loss'*, refer to Annex 2.

2 IMMEDIATE HABITAT LOSSES

2.1.1 EX 11.23, reported the following immediate habitat losses:

Habitat Type	Description	Area
1130	Estuaries	**13.5ha** within the reclamation site
1140	Mudflat/sandflat not covered by seawater at low tide	**31.5ha** loss within the reclamation site which supports a range of waterfowl.
1140	Mudflat/sandflat not covered by seawater at low tide	**11.6ha** to the south of the reclamation site that is potentially disturbed by operational activity on the quay following completion of construction (275m disturbance zone, refer to original ES paragraph 11.6.30).
1310/1330	Salicornia and other mud and sand colonising	**1.8ha** at Cherry Cobb Sands to form the channel across the foreshore from the existing flood defence to Cherry Cobb Sans Creek. Note: This habitat would become mudflat offsetting the loss of Habitat type 1140.

[1] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/TR030001/TR030001-002225-SoS%20Decision%20letter%20with%20annexes.pdf

2.1.2 Following discussions with Natural England in 2012, the above figures were agreed with the exception of the loss of saltmarsh at Cherry Cobb Sands which was increased to 2ha (refer to the '*Statement of Common Ground on Shadow Habitats Regulations Assessment*'[2], paragraph 3.5.1, 'the SoCG').

2.1.3 The Humber Estuary is a dynamic environment, and at the time of the DCO application, it was plain that the Killingholme Marshes foreshore was accreting and that this would result in some mudflat habitat 'naturally' converting to saltmarsh over time. This was specifically mentioned by the Examining Authority in the '*Panel's Findings and Recommendations to the Secretary of State*'[3], (21 February 2013, 'the Panel's Report'). In brief, the Panel stated that:

'The Panel's assessment of the implications of the proposed NSIP on the Humber Estuary SPA is taken against the following factual background –
..

7. That conditions favourable to the formation of extensive areas of very gently sloping inter-tidal mudflat at the North Killingholme Marshes have been reinforced by the creation of the Immingham Outer Harbour [this should read Humber International Terminal] *but that the general pattern is that accreting shorelines will develop into salt marsh as has happened observably at Cherry Cobb Sands and in some locations on the Killingholme shore adjacent to the floodwall',* (paragraph 10.79,

2.1.4 To update the 2012 assessment of habitat losses, a saltmarsh survey of the AMEP reclamation area was undertaken in June 2020 by Thomson Ecology. A supplemental survey of saltmarsh extent to the south of the reclamation, covering the 275m disturbance buffer) was completed in March 2021. Both reports are included in the Technical Appendices of the PEIR. In addition, updated bathymetric information from September 2020 has been obtained for the marine site. Taking this new data into account, a revised assessment of the immediate habitat losses consequential to the construction of the quay and associated development, including the changes proposed to the quay, is tabulated below.

2.1.5 .

[2] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/TR030001/TR030001-001606-SOCG009%20TR030001%20Able%20Humber%20Ports%20Ltd%20Statement%20of%20Common%20Ground%20with%20Natural%20England%20and%20the%20Marine%20Management%20Organisation.pdf

[3] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/TR030001/TR030001-002249-The%20Able%20Marine%20Energy%20Park%20Order%20201X%20Panel's%20Findings%20and%20Recommendations%20with%20Appendices.zip

DESCRIPTION OF WORKS	HABITAT TYPE	AREA (ha)	DESCRIPTION OF HABITAT	ASSOCIATED DOCUMENTS
Reclamation Area (Intertidal)  **Intertidal Area August 2020**	1140/ 1310 1330	**31.3** **1.9**	Mudflats and sandflats not covered by seawater at low tide. Mudflat with Pioneer Saltmarsh Atlantic Salt Meadow (Saltmarsh)	Drawing AME-06077E, *Habitat Impacts*, Annex 3. '*Saltmarsh Survey – North Killingholme Marshes*', Thomson Ecology, October 2020, refer to Appendix 10.1 of the PEIR
Reclamation Area (Subtidal)	1130	**10.4**	Estuaries	Drawing AME-06077E, *Habitat Impacts*, Annex 3.
Functional Loss due to Operational Disturbance	1140/ 1310 1330	**7.7** **4.7**	Mudflats and sandflats not covered by seawater at low tide Mudflat with Pioneer Saltmarsh Saltmarsh	Drawing AME-06077E, *Habitat Impacts,* Annex 3. 'Saltmarsh Extent Survey North Killinholme
Flood Defence Breach Area	1330	**2.0**	Saltmarsh	Drawing AME-06077E, *Habitat Impacts*, Annex 3.

3 INDIRECT MEDIUM AND LONG-TERM CHANGES

3.1 GENERAL

3.1.1 Whilst the Applicant reported their assessment of indirect medium and long-term effects of the development on habitat losses in EX 11.24, '*Medium and Long Term Losses Within the Designated Site*', the Panel's Report observed:

'*10.198 The problem that emerged very clearly for the Panel was not just the complexity of the proposals but the complexity of the environment itself. The River Humber is manifestly a very complex and highly dynamic ecosystem.*

10.199 At an early stage in the examination the applicant noted –

'The prediction of geomorphological impacts (which occur over decadal timescales) is not a precise science. When the Environment Agency commissioned an assessment of geomorphological change due to sea level rise in order to inform the Coastal Habitat Management Plan for the Humber Estuary, they obtained results from three separate numerical models; all provided different results with a significant range of impacts predicted.' *[REP008, para 22.142]*.

10.200 We can be sure that the River Humber eco-system will change, with or without human intervention. Predicting the nature and extent of that change with any degree of precision, however, seems to the Panel, to be a more-than-human skill' (paragraphs 10.198 -10.200, underline added).

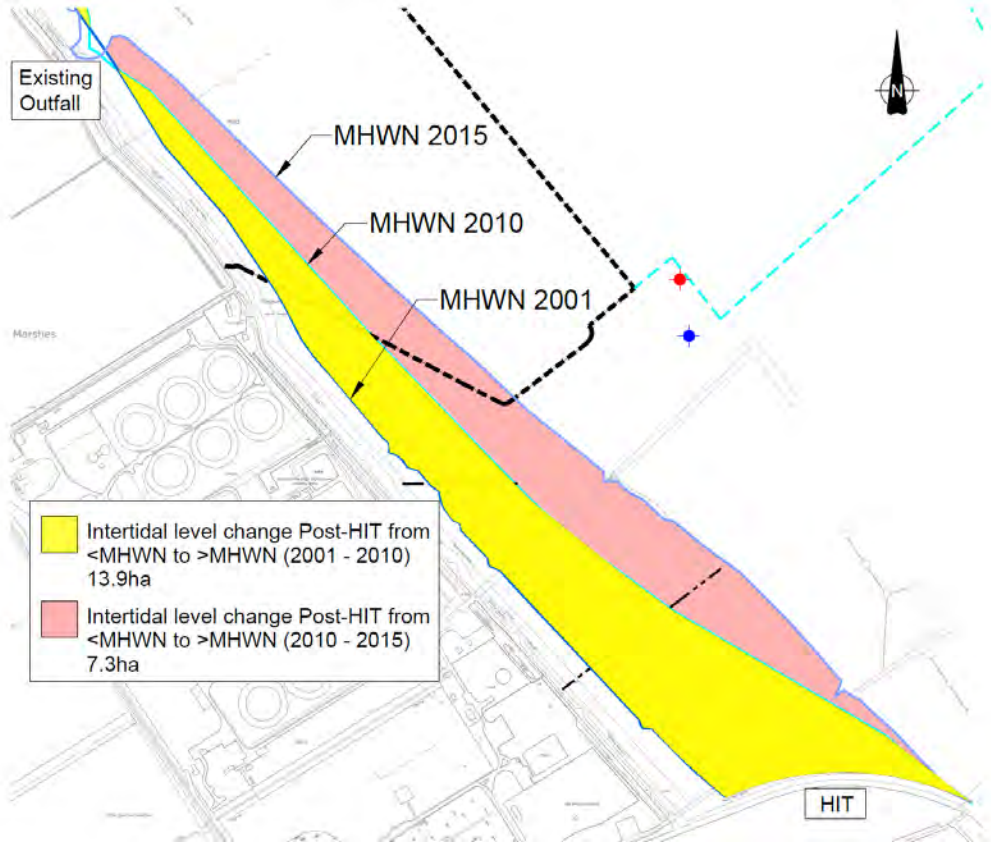
Nevertheless the 2012 assessment of medium and long-term habitat change is reviewed below.

3.2 MEDIUM TERM

3.2.1 EX11.24 reported that:

'*Indirect physical habitat impacts do not result in any new loss of habitat, only a **change** of habitat type within the estuary. Therefore, over 0-30 years the impacts of AMEP on habitat will **change**; the net loss of intertidal mud is likely to reduce whilst the net loss of sub-tidal habitat is likely to increase (but only to the same extent of the intertidal* [loss]*)'*, (EX11.24 Table 1, underline added).

3.2.2 The indirect medium-term changes consequential to the development of AMEP were assessed against the medium-term changes anticipated in the absence of AMEP (in other words, a projected medium term 'do-nothing' baseline). Specifically, to the south of the AMEP development the Killingholme Marshes foreshore is already accreting in the lee of the Humber International Terminal (HIT) which was opened in 2000 and extended in 2005. The extent of the accretion between 2001-2010 and from 2010-2015 is shown in Figure 3.1 below and illustrated in Figure 3.2. The latter also shows the emerging saltmarsh where, in 2010, there was originally mudflat. In other words, in the medium term 'do-nothing' scenario, the Killingholme Marshes foreshore will comprise significantly more saltmarsh and less mudflat than exists at present.



3.2.3

Figure 3.1: Recorded Changes to Intertidal Habitat between 2001 and 2015

Figure 3.2: Conversion of former Mudflat to Saltmarsh between HIT and AMEP.

3.2.4 In the event that AMEP proceeds then an embayment will be created delineated by the existing flood defences, HIT, and the southern revetment of AMEP. Numerical modelling was undertaken to assess medium term change and was reported in EX8.10, '*Morphological Assessment of Changes South-East of Development*'. In simple terms, it was predicted that further accretion would occur causing slightly more mudflat to convert into saltmarsh than in the do-nothing scenario. However, the loss of functional mudflat due to AMEP would not exceed the 11.6ha taken into account in the assessment of immediate losses as much of that would in any event convert into saltmarsh.

3.2.5 The assessment of changes within the embayment will not be affected by the changes proposed to the quay, as the embayment will not physically change and the previous assessment is still valid.

3.2.6 The area to the north of the development provides no functional habitat at the present time. Numerical modelling was undertaken and reported in EX8.8, '*Update to Longer Term Morphology Predictions in the region of Centrica and E.ON Intakes and Outfalls'*. Indirect medium-term impacts to the north of the development was assessed to result in the conversion of existing subtidal habitat into intertidal habitat. Specifically, EX10.8 concluded that:

'Northwest of AMEP, a broadly triangular region of deposition is predicted joining the northwest flank of AMEP and a point on the high-water mark located some 700m upriver'.

3.2.7 The potential benefit of creating functional mudflat to the north of AMEP was ignored, as there was no evidence of significant functional use of that area by SPA birds.

3.3 LONG TERM

3.3.1 Long term indirect habitat change within the Humber Estuary, consequential to AMEP was assessed by the Environment Agency who obtained expert opinion from Deltares. In short, Deltares concluded that up to 5ha of intertidal mudflat may convert to sub-tidal habitat over the next 100 years as consequence of AMEP. The. However, the applicant assessed that if AMEP was not constructed at all, then sea level rise would in any event lead to the conversion of the same amount of mudflat to sub-tidal habitat along the Killingholme Marshes foreshore over the same time period. The net effect was therefore assessed to be 1ha of additional mudflat loss.

3.3.2 The assessment of long-term change is not an exact exercise and relies on expert opinion. The precise line of the quay was irrelevant to the estimate and it can be observed that the assessment would not change. The Environment Agency confirmed on 11 June 2021 that the Deltares report remained valid (refer to Annex 4).

3.4 SUMMARY

3.4.1 The immediate effects of habitat loss are summarised below for the consented scheme, based on the 2011 baseline, and for the proposed amendment based on the 2020 baseline. Overall there is a marginally smaller loss of habitat.

Habitat Type	Habitat Loss Agreed with NE in 2012[1] (ha)	Habitat Loss 2021 (ha) (Annex 3)
1130	13.5	10.4
1140/1310[2]	43.1	39 (=31.3+5.5+2.2)
1330	2	8.6 (=1.9+4.7+2)

[1]Refer to SoCG, Table 3.2 and paragraphs 3.5.1 -3.5.2
[2] All Treated as mudflat for the purposes of compensation provision.

3.4.2 A summary of long-term effects was set out on Annex B of the SoCG and is reproduced in the Table below.

	HABITAT TYPE			
	Saltmarsh	Intertidal Mudflat	Sub-tidal (Estuary)	
LONG TERM IMPACTS				
Direct Loss		-31.5	-13.5	
Direct Change	-2	2		
Functional Loss Due to AMEP		-8.9		
TOTAL	-2	-38.4	-13.5	
Compensation	2	76.8	13.5	
Local Functional Mudflat creation - North		0	0	
Local Functional Mudflat creation - South		0.5	-0.5	
TOTAL	-2	-37.9	-14	
Direct Compensation + reduction by Indirect mudflat creation	2	75.8	14	
Local Functional Mudflat Conversion to Saltmarsh - North	0	0		
Local Functional Mudflat Conversion to Saltmarsh - South	1.1	-1.1		
Creation of saltmarsh in the disturbance zone	4.7			
TOTAL	3.8	-39	-14	
Direct Compensation + reduction by Indirect mudflat creation + Indirect mudflat conversion to saltmarsh	0	78	13.5	
LONG TERM (0-100 YEARS)				
Indirect - WL Change (Deltares)		-5	5	
TOTAL	3.8	-44	-9	
Direct + Indirect + EA Compensation	0	88	13.5	101.5

3.4.3 On exactly the same basis as the previous assessment, i.e. that the medium term changes to the south of AMEP remain the same for the material change (as explained above), and the beneficial effects of mudflat creation to the north are ignored, and the long term prediction of habitat loss by Deltares remains valid, then the only change in the previous assessment is to the immediate habitat changes. Such a revised assessment of long-term effects is tabulated below and plainly results in a lower requirement for compensatory habitat. Relevantly the calculation retains the previously estimated long term functional loss of 8.9ha of mudflat to the south of AMEP, whereas it is now evident from survey that this area is already converting to saltmarsh . If the current areas of mudflat and saltmarsh had been used in the re-assessment, the compensation requirement would be even less.

	HABITAT TYPE			
	Saltmarsh	Intertidal Mudflat	Sub-tidal (Estuary)	
LONG TERM IMPACTS				
Direct	-1.9	-31.3	-10.4	
	-2	2		
Functional Loss Due to AMEP		-8.9		
TOTAL	-3.9	-38.2	-10.4	
Compensation	3.9	76.4	10.4	
Local Functional Mudflat creation - North		0	0	
Local Functional Mudflat creation - South		0.5	-0.5	
TOTAL	-3.9	-37.7	-10.9	
Direct Compensation + reduction by Indirect mudflat creation	3.9	75.4	10.9	
Local Functional Mudflat Conversion to Saltmarsh - North	0	0		
Local Functional Mudflat Conversion to Saltmarsh - South	1.1	-1.1		
Creation of saltmarsh in the disturbance zone	4.7			
TOTAL	1.9	-38.8	-10.9	
Direct Compensation + reduction by Indirect mudflat creation + Indirect mudflat conversion to saltmarsh	0	77.6	9	
LONG TERM (0-100 YEARS)				
Indirect - WL Change		-5	5	
TOTAL	1.9	-43.8	-5.9	
Direct + Indirect + EA Compensation	0	87.6	10.4	98

4 COMPENSATION

4.1.1 At the time of the application the applicant proposed to create a 101.5ha managed realignment site at Cherry Cobb Sands, and the details were described in the SoCG as:

'Provision of new estuarine habitat at a ratio of 1:1 through a managed realignment / Regulated Tidal Exchange (RTE) scheme at CCS. Sub-tidal loss (part of the estuary feature) will be replaced with estuarine habitat', and

'Provision of new intertidal mudflat based on an overcompensation target ratio of 2:1 (based on permanent direct loss and permanent functional loss for birds). The current design proposals demonstrate that the site could provide an initial area of c86 ha of which c66 ha remains after 5 years and c57 ha after 10 years (which >1:1) … Options for increasing the area of mudflat and for maintaining more of it in the longer term are the subject of ongoing discussions', (SoCG, Table 5.1).

4.1.2 At the time, the outline design of the compensation site was being actively developed and Natural England did not agree these particular proposals within the SoCG, but did confirm the following:

It will be necessary to provide a compensatory ratio of at least 2:1 for the loss of intertidal mudflat, and a ratio of 1:1 for the loss of estuary (subtidal) habitat. (SoCG, paragraph 5.1.2).

4.1.3 Following extensive design development of the compensation scheme during the DCO Hearings, the Applicant proposed to create a more engineered proposal comprising four 18ha fields with water levels managed by significant

hydraulic structures together with a smaller managed realignment site of around 30ha that would develop as estuarine habitat.

4.1.4 Following the Secretary of State's '*minded to approve'* letter to the Applicant dated 28 August 2013, Natural England advised the Applicant in correspondence dated 11 October 2013[4] that:

'Able UK has confirmed that the RTE will create c60ha of long-term sustainable mudflat, which will be reduced to c45ha as part of the operational management of the RTE when during neap tide cycles one of the 15ha cells will be impounded. This amounts to a compensation ratio of 1.5:1 (on occasions 1:1) as compared to the 2:1 ratio that was initially proposed by Able UK and agreed by Natural England. Natural England subsequently advised that a ratio of 1:1 is acceptable provided the RTE/MR meets its quality objectives and targets', (underline added).

4.1.5 In the subsequent HRA completed by the Secretary of State prior to issuing his consent for the development to proceed, it is recorded (at paragraph 6) that there would be a direct loss of 31.5ha of inter-tidal mudflat, an additional loss of 11.6ha of functional mudflat habitat, a direct loss of 13.5ha of estuarine habitat (all from Killingholme Marshes foreshore) and a permanent loss of 2ha of saltmarsh from Cherry Cobb Sands due to the breach of the sea wall for the compensation site. The appropriate assessment then recorded Natural England's confirmation that a '*ratio of 1:1* (habitat loss: compensatory habitat) *is acceptable provided that the RTE and Managed Realignment site meets its quality objectives and targets',* (paragraph 38(b)).

4.1.6 A detailed General Arrangement drawing of the compensation scheme is included in Annex 5, and this confirms the provision of 72 ha of RTE fields (providing a maximum of 66.7ha of functional habitat, but 50.4ha when one field is impounded), and 30.4ha of estuarine/saltmarsh habitat . Relevantly therefore, and pursuant to the above, the existing compensation proposals remain adequate with the ratio of habitat compensation for mudflat being generally 50.4:39 (or 1.29:1), and the compensation ratio for estuarine and saltmarsh habitat being 30.4:19 (1.6:1). Plainly both ratios exceed the minimum threshold of 1:1.

5 COMPENSATION ENVIRONMENTAL MANAGEMENT AND MONITORING PLAN (CEMMP)

5.1.1 Since the AMEP DCO came into force the applicant has agreed the CEMMP for the site with Natural England, refer to Annex 6.

[4] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/TR030001/TR030001-002128-Natural%20England%20%20-%20Submitted%20for%20the%20DfT%20deadline%20of%2015%20November%202013%20.pdf

6 APPROVAL OF THE DETAILED DESIGN

6.1.1 In accordance with Schedule 11 paragraph 5 of the DCO, the detailed design drawings of the compensation habitat were approved by East Riding of Yorkshire Council on 2 December 2020, refer to Annex 7.

ANNEX 1

EX 11.23 *Immediate Habitat Losses Within the Designated Site*

Planning Act 2008
Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009
Regulation 5(2) [a]
Document reference: TR030001/APP/14b

Supplementary Environmental Information

Immediate Habitat Losses within the Designated Site

Supplementary Report EX 11.23

23rd May 2012
Revision: 0
Able UK Ltd

APPROVAL & REVISION REGISTER

	NAME	SIGNATURE	DATE
Originator:	J. Dawes		25/05/2012
Checked by:	R. Cram		29/05/2012
Approved by:	R. Cram		29/05/2012

REVISION	COMMENTS	DATE
A		29/05/2012

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APPENDICES

APPENDIX 1 – Drawing: AME – 06077B Habitat Impact

APPENDIX 2 – Drawing: AME – 06065A Rock Armour North Section *(Drawing A9 Flood Risk Assessment Environmental Statement Annex 13.1)*

APPENDIX 3 – Hochtief Design Drawings

APPENDIX 4 – Pumping Station Drawings (AME – 02013 A and AME – 02014 A)

1 INTRODUCTION

1.1.1 Able Marine Energy Park (AMEP) requires the reclamation of a section of intertidal and subtidal mudflat. The Humber Estuary is a designated Special Protection Area (SPA), Special Area of Conservation (SAC), Site of Special Scientific Interest (SSSI) and Ramsar site.

1.1.2 Construction of AMEP will result in the immediate loss of habitats within the designated site. The table below details the locations, size and type of habitat affected plus the activities associated with the immediate habitat loss.

1.1.3 This report should be read together with Drawing AME – 06077 B, Habitat Impact drawing and the associated documents listed in the table below and reproduced in the appendices of this report.

REF.	DESCRIPTION OF WORKS	HABITAT TYPE	AREA (ha)	DESCRIPTION OF HABITAT	ASSOCIATED DOCUMENTS
A	**Reclamation Area (Intertidal)** ***Piling:*** Approximately 550 No. tubular and 1,100 No. sheet steel perimeter piles will be driven into the bed of the estuary to form the external face of the quay. Two return walls comprising 2,300 No. steel piles and earthwork revetments (75,000 tonnes of rock armour protection) will be constructed between the ends of the quay and the existing flood defence wall. Perimeter piles will be fixed to 450 No. flap anchor piles which will be seated in a trench on the bed of the estuary. Up to 70 No. steel anchor piles will be driven into the bed of the estuary and fixed to perimeter piles. The piles will be driven via vessels moored in the Estuary. Earthwork revetments and the rock armour shall be constructed using land based plant. Drainage outfalls and cooling water outfalls will be incorporated into the piled quay. ***Reclamation:*** The area of estuary enclosed by the quay perimeter piles and the two return walls will be reclaimed using marine dredged sands and gravels. Two granular dams are to be constructed that extend from the existing flood defence wall to around the level of MLWS. These dams will divide the reclaim area into three approximately equal cells. Vessels shall pump fluidized granular material into each cell in sequence until the reclaim area is raised to its design level. Estuarine water that is retained within each cell will overflow the dams as the fluidized material is deposited and settles within the cell. The activity will continue until all cells attain their design level.	1140	31.5	Mudflats and sandflats not covered by seawater at low tide.	AME - 06077 B – Appendix 1 AME – 06065 B (Drawing A9 from ES Annex 13.1 FRA) – Appendix 2 Hochtief Design Drawings (Appendix 3): • AMEP_P1D_D_002_G: Piling layout • AMEP_P1D_D_003_G: Quay Sections 1 of 2 • AMEP_P1D_D_004_E Quay Sections 2 of 2 • AMEP_P1D_D_006_G: Northern Return Wall Elevation • AMEP_P1D_D_007_D:Southern Return Wall Elevation • AMEP_P1D_D_101_G: Indicative Sequence Plan View 1/3 • AMEP_P1D_D_102_G: Indicative Sequence Plan View 2/3 • AMEP_P1D_D_103_G: Indicative Sequence Plan View 3/3 • AMEP_P1D_D_104_C: Indicative Sequence Cross Section 1/2 • AMEP_P1D_D_105_E: Indicative Sequence Cross Section 2/2

REF.	DESCRIPTION OF WORKS	HABITAT TYPE	AREA (ha)	DESCRIPTION OF HABITAT	ASSOCIATED DOCUMENTS
B	**<u>Reclamation Area (Subtidal)</u>** Works as described above plus: ***Temporary dolphins:*** Seven temporary dolphins to be installed within the berthing pocket. Each temporary dolphin to comprise three tubular steel braced with interconnecting steelwork. The dolphins to be used to moor vessels involved in the construction of the quay, the reclamation of the estuary or the backfilling of the berthing pocket for any such works permitted by this licence.	1130	13.5	Estuaries	AME - 06077 B – Appendix 1 Hochtief Design Drawings (Appendix 3): • AMEP_P1D_D_002_G: Piling layout • AMEP_P1D_D_003_G: Quay Sections 1 of 2 • AMEP_P1D_D_004_E Quay Sections 2 of 2 • AMEP_P1D_D_005_E: Front Wall Elevation • AMEP_P1D_D_006_G: Northern Return Wall Elevation • AMEP_P1D_D_007_D:Southern Return Wall Elevation • AMEP_P1D_D_009_G:Concrete Deck General Arrangement • AMEP_P1D_D_101_G: Indicative Sequence Plan View 1/3 • AMEP_P1D_D_102_G: Indicative Sequence Plan View 2/3 • AMEP_P1D_D_103_G: Indicative Sequence Plan View 3/3 • AMEP_P1D_D_104_C: Indicative Sequence Cross Section 1/2 • AMEP_P1D_D_105_E: Indicative Sequence Cross Section 2/2

REF.	DESCRIPTION OF WORKS	HABITAT TYPE	AREA (ha)	DESCRIPTION OF HABITAT	ASSOCIATED DOCUMENTS
C	**Functional Loss due to Operational Disturbance** Once the development is operational, activity within the site may cause intermittent disturbance to the functional intertidal mudflats to the south of the quay for a distance of 275m from the quay. Area to the south of the quay will also be cut through by a new drainage channel that will be formed by the discharge of surface water.	1140	11.6	Mudflats and sandflats not covered by seawater at low tide	AME - 06077 B – Appendix 1
D	**Pumping Station & Drainage Channel** Surface water runoff will be collected in a network of ditches behind the shoreline embankment and discharged into the estuary; during extreme events and during high tide the discharge will be pumped onto the foreshore. The pumping station will discharge through concrete pipes onto the intertidal mudflat. Rock armour (0.01ha) will be placed at the pumping station outfall to prevent undermining of the outfall. This rock armour lies within the area of function loss.	1140	Included within C	Mudflats and sandflats not covered by seawater at low tide	Section 4 ES Annex 8.3 Location of pumping station and drainage channel is shown on AME - 06077 B (Appendix 4) AME - 02013 A Surface Water Pumping Station Indicative Layout AME - 02014 A Surface Water Pumping Station Indicative Elevation
E	**Flood Defence Breach Area** The works will comprise a 250 m long breach with an approximate invert level of 1.8mAOD. Removal of some of the saltmarsh fronting the breach site down to 1.8mAOD. All the saltmarsh fronting the breach site will be eroded away fairly rapidly, leading to a direct loss of about 2 ha of saltmarsh.	1310 / 1330	1.8	Salicornia and other mud and sand colonising annuals / Atlantic Salt Meadow	ES Annex 32.3 Breach Design Report

APPENDIX 1

AME – 06077 B: Habitat Impact

KEY

- Berthing Pocket
- A Intertidal Habitat Loss - 31.50ha
- B Subtidal Habitat Loss - 13.50ha
- C Limit of Operational Disturbance - 11.6ha
- D Drainage Channel & Pumping Station
- E Flood Defence Breach Area - 1.8ha
- Mean Low Water Spring
- Limit of Operational Boundary

Notes:

1. Limit of disturbance is defined by 150m offset from a point source (+).

Rev	Date	Comments	Drw	Chk	App
B	17/05/12	North Bank Added	RK	JD	RC
A	13/04/12	Preliminary Issue	JH	RC	RC

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Project: ABLE Marine Energy Park

Client: ABLE UK Ltd

Title: Habitat Impacts

PRELIMINARY

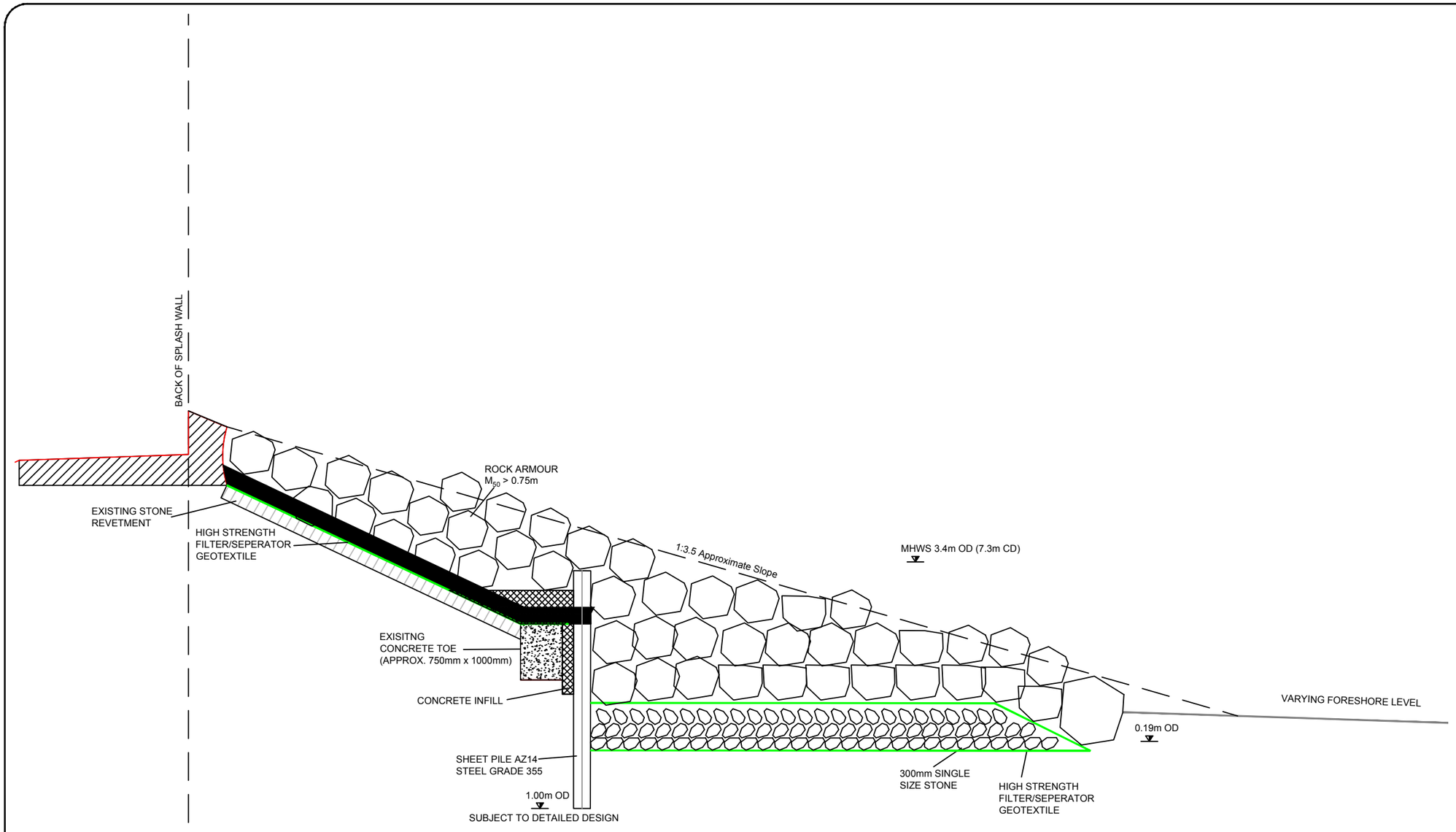
Scale:	Drawn	Checked	Approved
As Shown@A3	J Harris	R Cram	R Cram
Date	13/04/2012	13/04/2012	13/04/2012

Drawing No. AME - 06077 Revision: B

APPENDIX 2

AME – 06065A: Rock Armour North Section

(Drawing A9 Flood Risk Assessment Environmental Statement Annex 13.1)



KEY

Rev	Date	Comments	Drw	Chk	App
B	07/12/11	Splash Wall Removed	JH	RC	RC
A	03/11/11	Preliminary Issue	JH	RC	RC

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Project: ABLE Marine Energy Park

Client: ABLE UK Ltd

Title: Indicative Rock Armour Protection to Existing Northern Defences

PRELIMINARY

Scale:	Drawn	Checked	Approved
1:80@A3	J Harris	R Cram	R Cram
Date	03/11/2011	03/11/2011	03/11/2011

Drawing No. AME - 06065

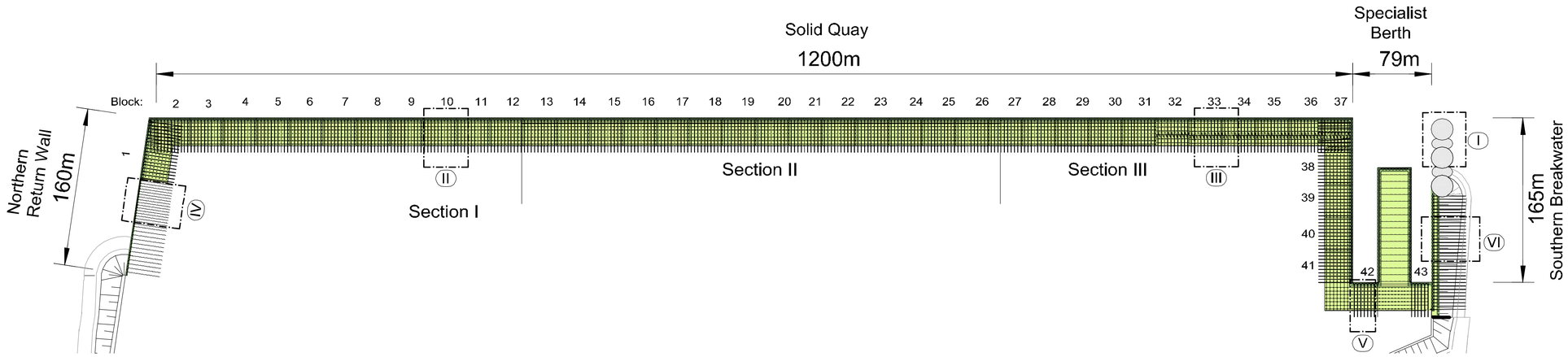
Revision: B

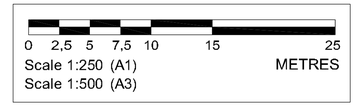
APPENDIX 3

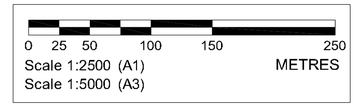
HOCHTIEF DESIGN DRAWINGS

AMEP_P1D_D_002_G: Piling layout
AMEP_P1D_D_003_G: Quay Sections 1 of 2
AMEP_P1D_D_004_E Quay Sections 2 of 2
AMEP_P1D_D_005_E: Front Wall Elevation
AMEP_P1D_D_006_G: Northern Return Wall Elevation
AMEP_P1D_D_007_D: Southern Return Wall Elevation
AMEP_P1D_D_009_G: Concrete Deck General Arrangement
AMEP_P1D_D_101_G: Indicative Sequence Plan View 1/3
AMEP_P1D_D_102_G: Indicative Sequence Plan View 2/3
AMEP_P1D_D_103_G: Indicative Sequence Plan View 3/3
AMEP_P1D_D_104_C: Indicative Sequence Cross Section 1/2
AMEP_P1D_D_105_E: Indicative Sequence Cross Section 2/2

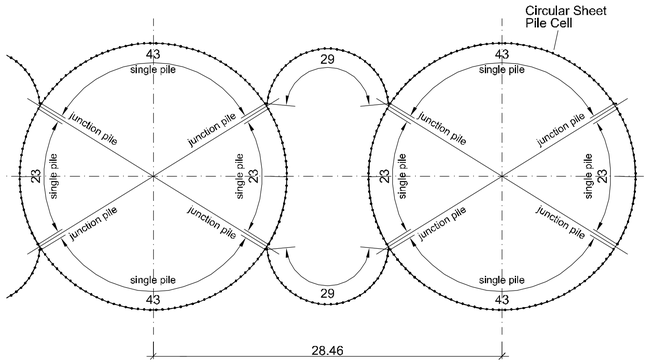
Overview 1:2500



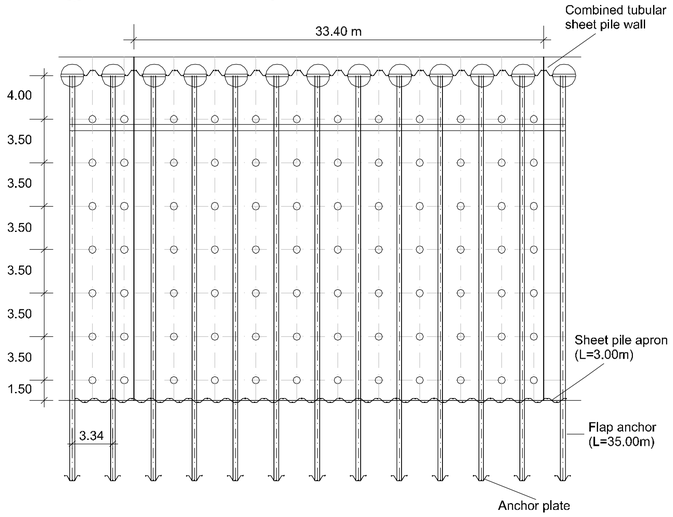




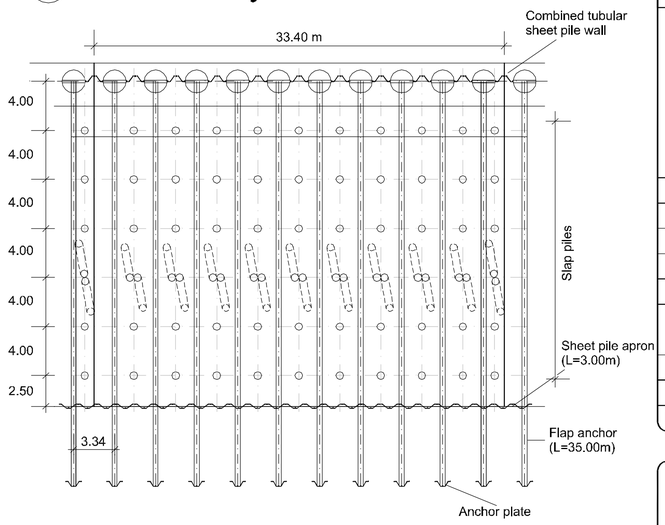
I Southern Breakwater 1:250



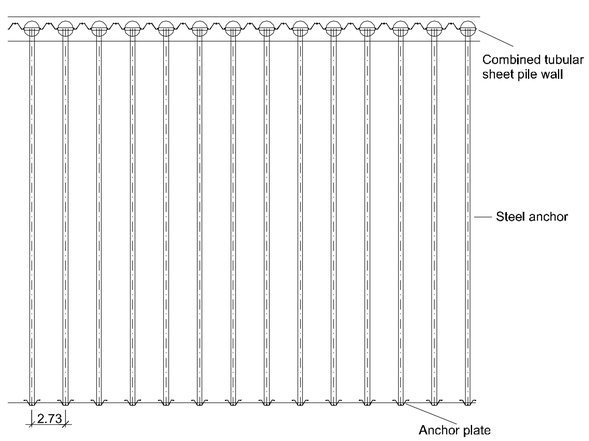
II Solid Quay Block 10 1:250



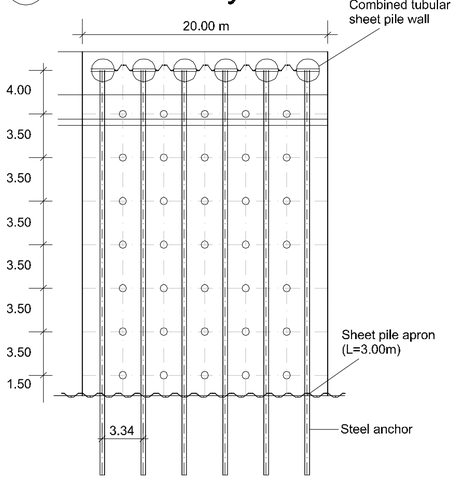
III Solid Quay Block 33 1:250



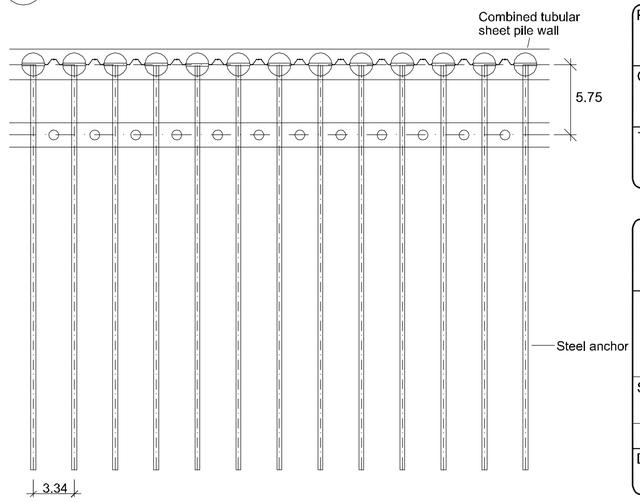
IV Northern Return Wall 1:250



V Solid Quay Block 42 1:250



VI Southern Breakwater 1:250



KEY

-Levels to Chart Datum
-Details based on preliminary design
-Levels given for the Approach Channel and the Harbour Bed are the maximum maintained levels

Rev	Date	Description	By	Chk	App
G	02.11.11	Revision IPC Application	BKY	SVF	HTA
F	21.10.11	Revision IPC Application	ASS	SVF	HTA
E	16.09.11	Revision IPC Application	ASS	SVF	HTA
D	31.08.11	Revision IPC Application	ASS	SVF	HTA
C	30.08.11	Revision IPC Application	ASS	SVF	HTA
B	21.01.11	Revision of Northern Revetment/Breakwater	ASS	SVF	HTA
A	07.01.11	EIA Masterplan Revision	ASS	SVF	HTA
0	17.09.10	Preliminary Issue	CBR	SVF	HTA

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Title: Indicative Piling Layout

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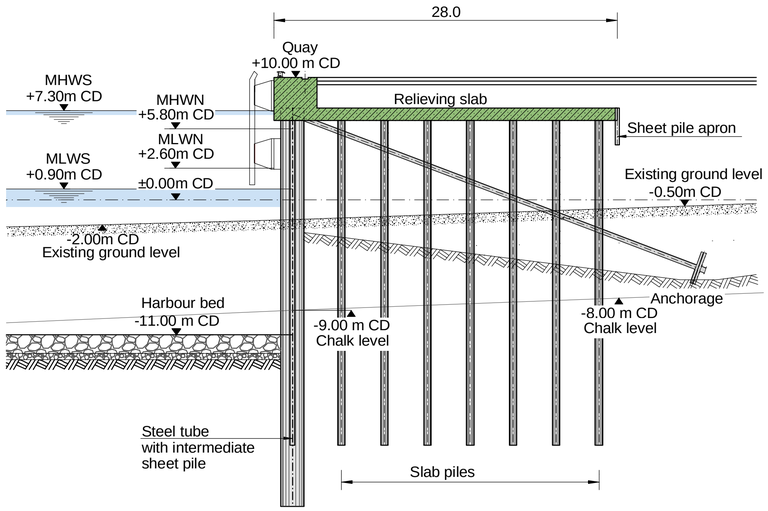
Scale:	Drawn By	Checked By	Approved By
1:250 1:2500 @A1	CBR	SVF	HTA
Date:	17.09.2010	17.09.2010	17.09.2010

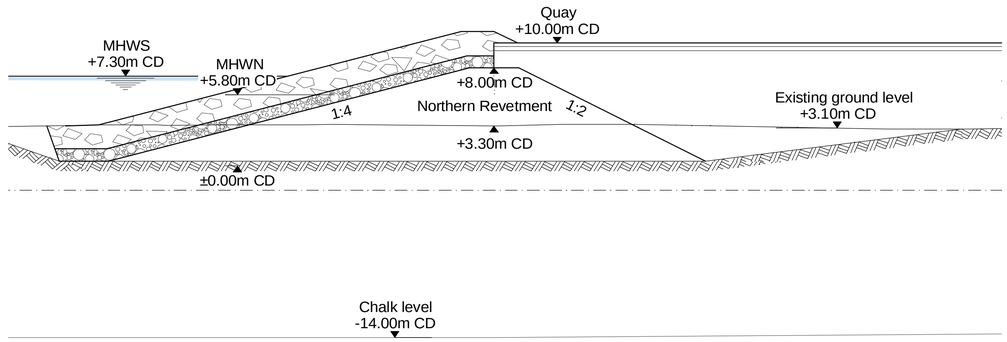
Drawing No. AMEP_P1D_D_002

Revision: G

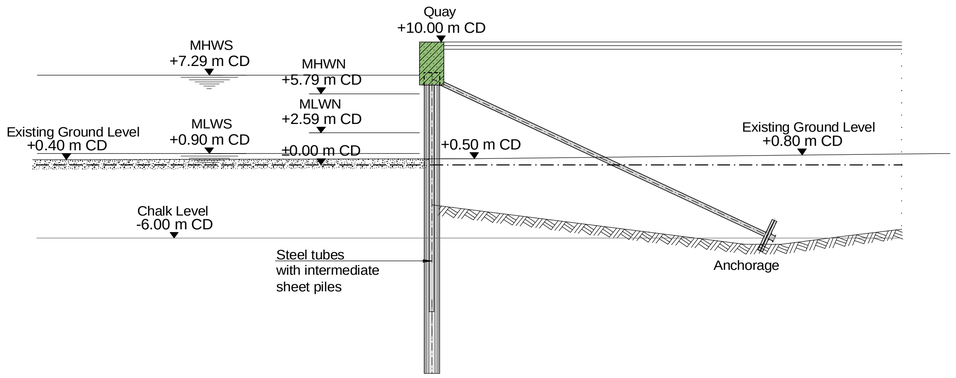
Cross Section B-B



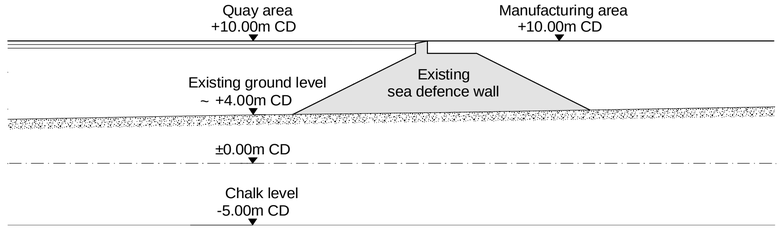
Cross Section E-E



Cross Section D-D



Cross Section H-H



KEY

-Levels to Chart Datum
-Details based on preliminary design
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Rev	Date	Description	By	Chk	App
G	05.12.11	Changed batter Northern Revetment	ASS	SVF	HTA
F	21.10.11	Revision IPC Application	ASS	SVF	HTA
E	16.09.11	Revision IPC Application	ASS	SVF	HTA
D	31.08.11	Revision IPC Application	ASS	SVF	HTA
C	30.08.11	Revision IPC Application	ASS	SVF	HTA
B	19.01.11	Revision of Northern Revetment/ Breakwater	ASS	SVF	HTA
A	07.01.11	EIA Masterplan Revision	ASS	SVF	HTA
0	17.09.10	Preliminary Issue	BKY	SVF	HTA

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Project: ABLE Marine Energy Park

Client: ABLE UK Ltd

Title: Quay Sections 1 of 2

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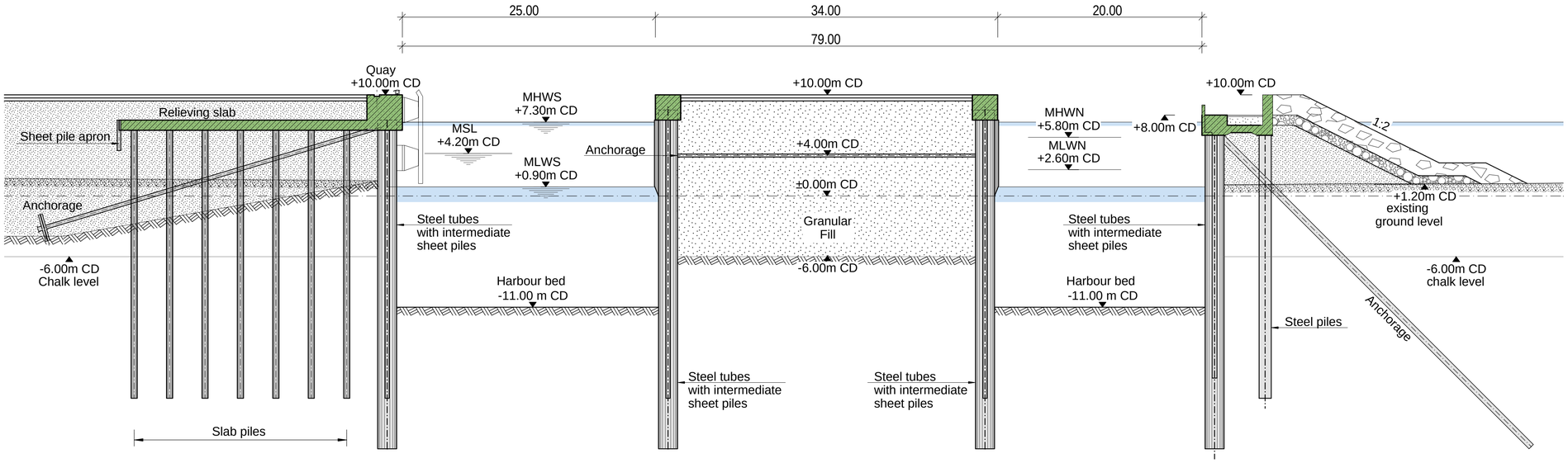
Scale:	Drawn By	Checked By	Approved By
1 : 250 @A1	BKY	SVF	HTA
Date:	17.09.2010	17.09.2010	17.09.2010

Drawing No. AMEP_P1D_D_003

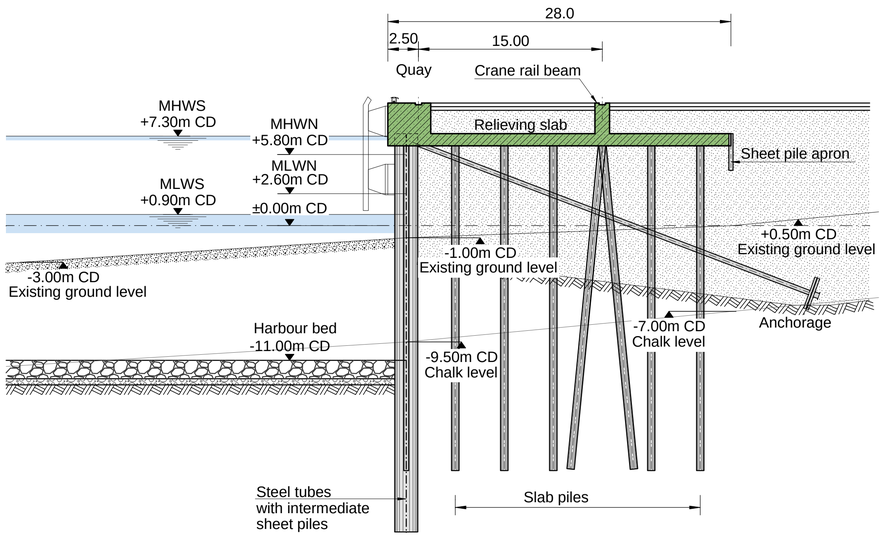
Revision: G

0 2,5 5 10 15 25
METRES
Scale 1:250 (A1)
Scale 1:500 (A3)

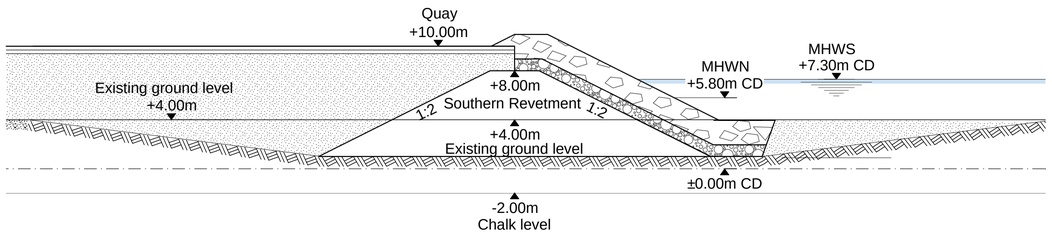
Cross Section F-F

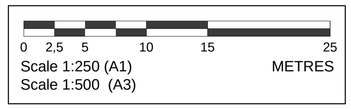


Cross Section C-C



Cross Section G-G





KEY

-Levels to Chart Datum
-Details based on preliminary design
-Levels given for the Approach Channel and the Harbour Bed are the maximum maintained levels

Rev	Date	Description	By	Chk	App
E	21.10.11	Revision IPC Application	ASS	SVF	HTA
D	16.09.11	Revision IPC Application	ASS	SVF	HTA
C	31.08.11	Revision IPC Application	ASS	SVF	HTA
B	30.08.11	Revision IPC Application	ASS	SVF	HTA
A	07.01.11	EIA Masterplan Revision	ASS	SVF	HTA
0	17.09.10	Preliminary Issue	BKY	SVF	HTA

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Project: ABLE Marine Energy Park

Client: ABLE UK Ltd

Title: Quay Sections 2 of 2

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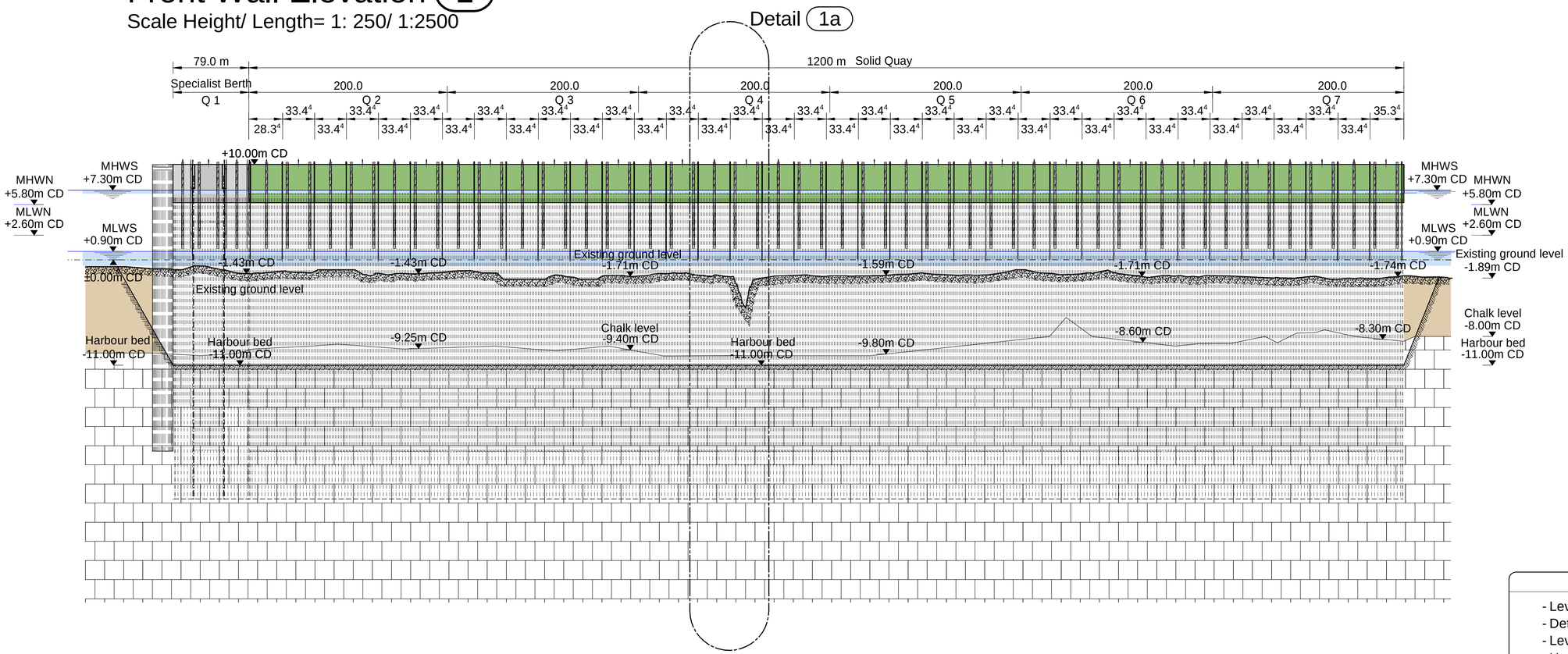
Scale:	Drawn By	Checked By	Approved By
1 : 250 @A1	BKY	SVF	HTA
Date:	17.09.2010	17.09.2010	17.09.2010

Drawing No. AMEP_P1D_D_004

Revision: E

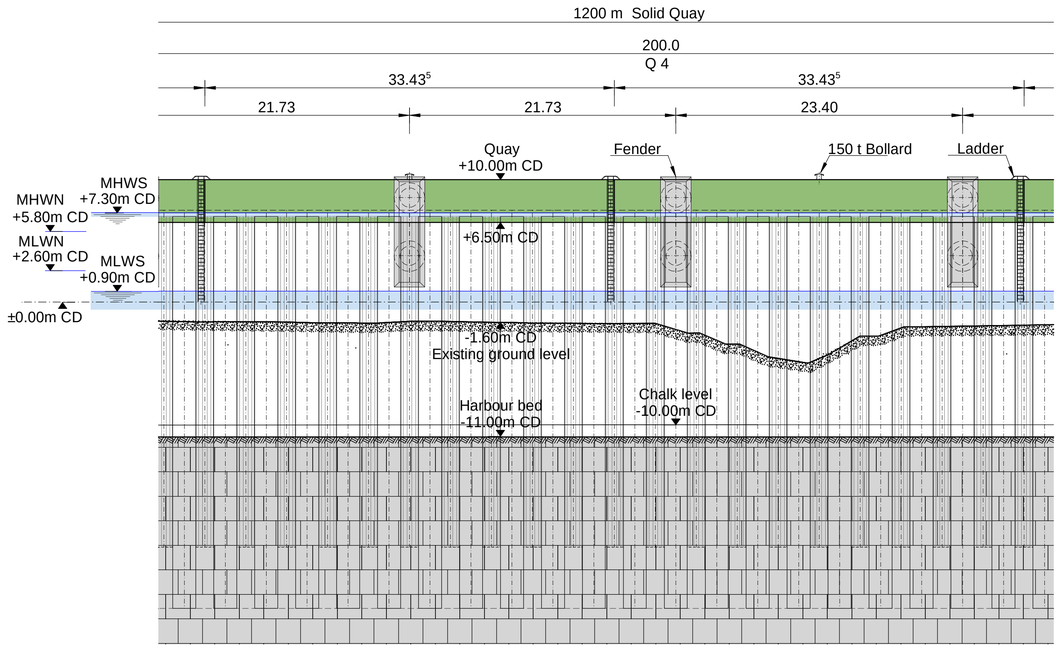
Front Wall Elevation 1

Scale Height/ Length= 1: 250/ 1:2500



Detail 1a

Scale 1:250



KEY

- Levels to Chart Datum
- Details based on preliminary design
- Levels given for the Approach Channel and the Harbour Bed are the maximum maintained levels.

Rev	Date	Description	By	Chk	App
E	02.11.11	Revision IPC Application	BKY	SVF	HTA
D	21.10.11	Revision IPC Application	BKY	SVF	HTA
C	19.09.11	Revision IPC Application	BKY	SVF	HTA
B	30.08.11	Revision IPC Application	BKY	SVF	HTA
A	07.01.11	EIA Masterplan Revision	BKY	SVF	HTA
0	17.09.10	Preliminary Issue	BKY	SVF	HTA

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Project: ABLE Marine Energy Park

Client: ABLE UK Ltd

Title: Front Wall Elevation

0 2,5 5 10 15 25
Scale 1:250 (A1)
Scale 1:500 (A3)
METRES

0 25 50 100 150 250
Scale 1:2500 (A1)
Scale 1:5000 (A3)
METRES

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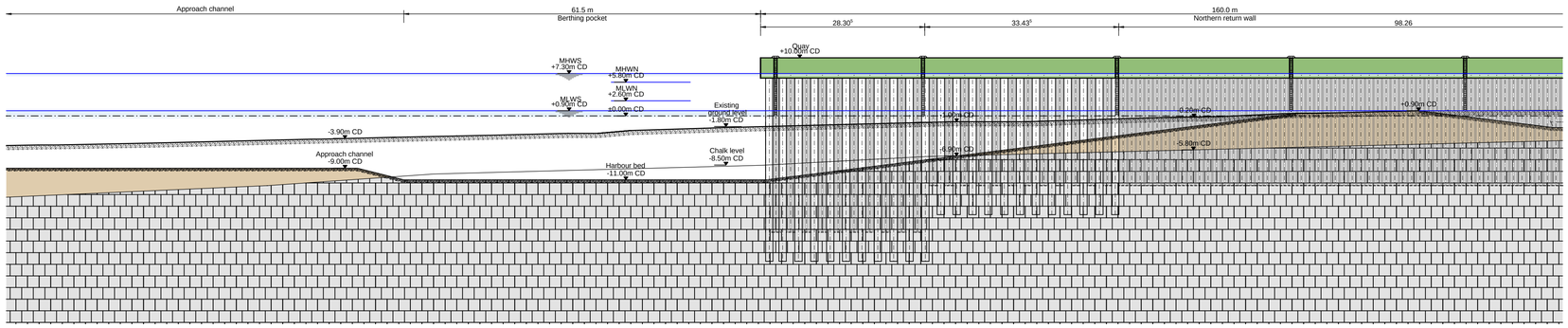
Scale:	Drawn By	Checked By	Approved By
1:250/2500 @A1	BKY	SVF	HTA
Date:	17.09.2010	17.09.2010	17.09.2010

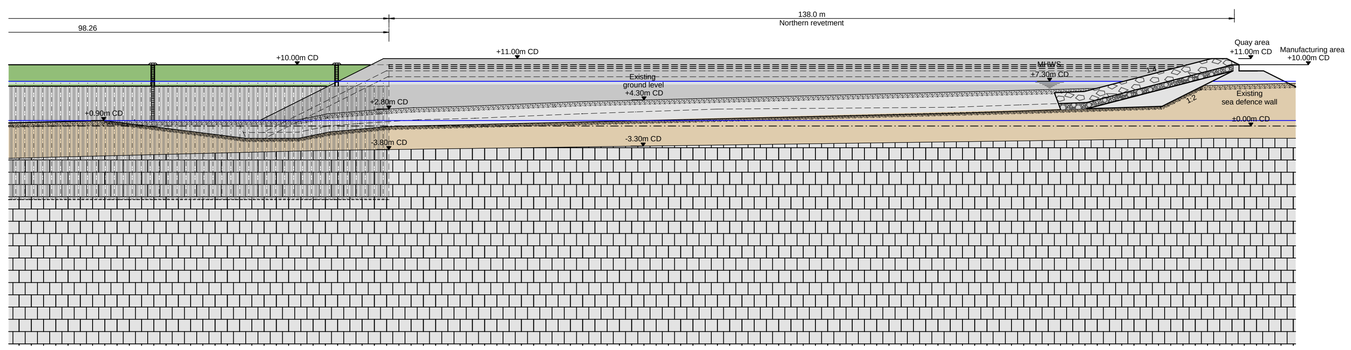
Drawing No. AMEP_P1D_D_005

Revision: E

02.11.2011

Northern Return Wall Elevation (2)





0 5 10 15 20 30 50
Scale 1:500 (A1)
Scale 1:1000 (A3)
METRES

KEY

- Levels to Chart Datum
- Details based on preliminary design
- Levels given for the Approach Channel and the Harbour Bed are the maximum maintained levels.

Rev	Date	Description	By	Chk	App
G	05.12.11	Changed batter Northern Revetment	ASS	SVF	HTA
F	21.10.11	Revision IPC Application	BKY	SVF	HTA
E	19.09.11	Revision IPC Application	BKY	SVF	HTA
D	31.08.11	Revision IPC Application	BKY	SVF	HTA
C	30.08.11	Revision IPC Application	BKY	SVF	HTA
B	19.01.2011	Revision of Northern Revetment/ Breakwater	ASS	SVF	HTA
A	07.01.11	EIA Masterplan Revision	ASS	SVF	HTA
0	17.09.10	Preliminary Issue	BKY	SVF	HTA

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Project:
ABLE Marine Energy Park

Client:
ABLE UK Ltd

Title:
Northern Return Wall Elevation

PRELIMINARY

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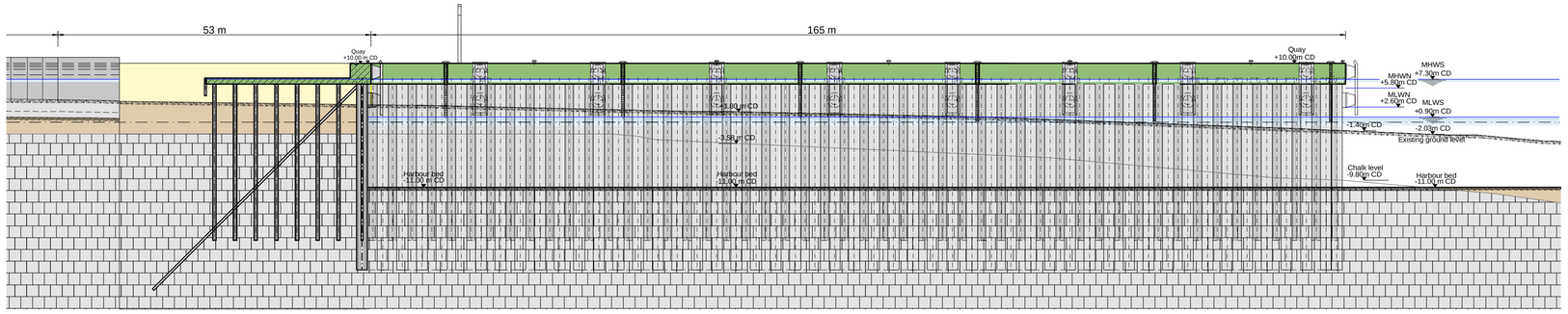
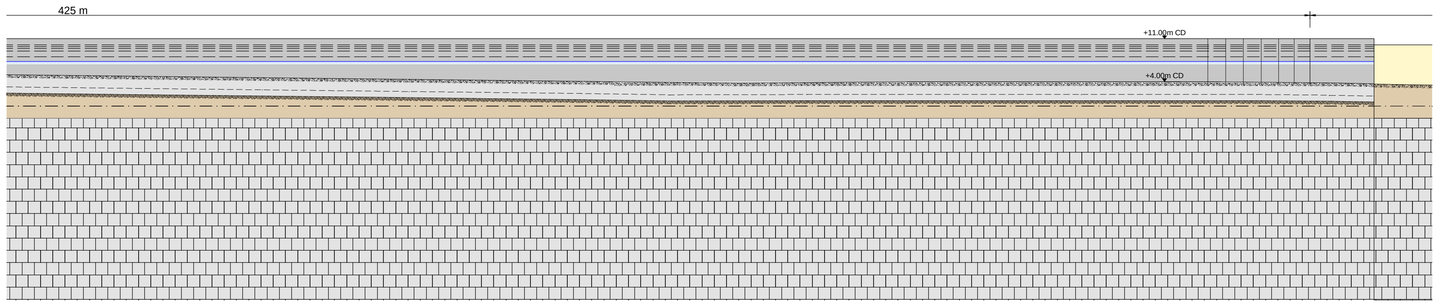
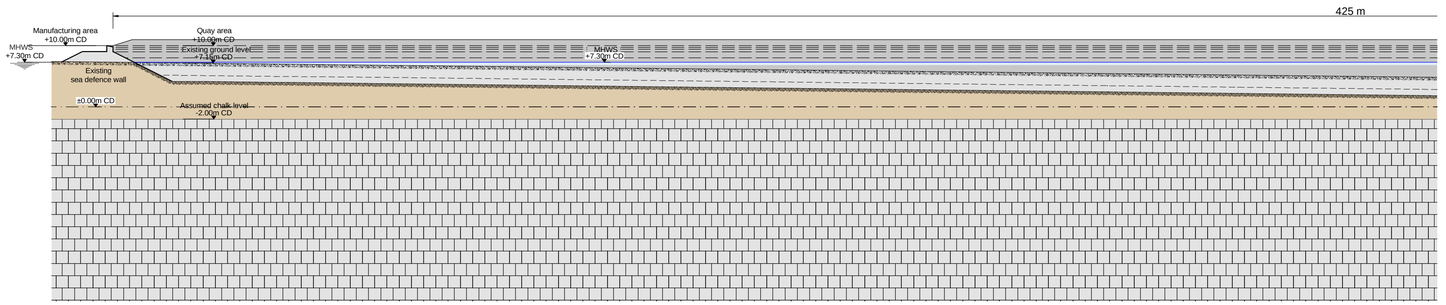
Scale:	Drawn By	Checked By	Approved By
1:500 @A1	BKY	SVF	HTA
Date:	17.09.2010	17.09.2010	17.09.2010

Drawing No. AMEP_P1D_D_006
Revision: G

Southern Return Wall Elevation 3







KEY

- Levels to Chart Datum
- Details based on preliminary design
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Rev	Date	Description	By	Chk	App
D	21.10.11	Revision IPC Application	BKY	SVF	HTA
C	19.09.11	Revision IPC Application	BKY	SVF	HTA
B	30.08.11	Revision IPC Application	BKY	SVF	HTA
A	07.01.11	EIA Masterplan Revision	ASS	SVF	HTA
0	17.09.10	Preliminary Issue	BKY	SVF	HTA

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Title: Southern Return Wall Elevation

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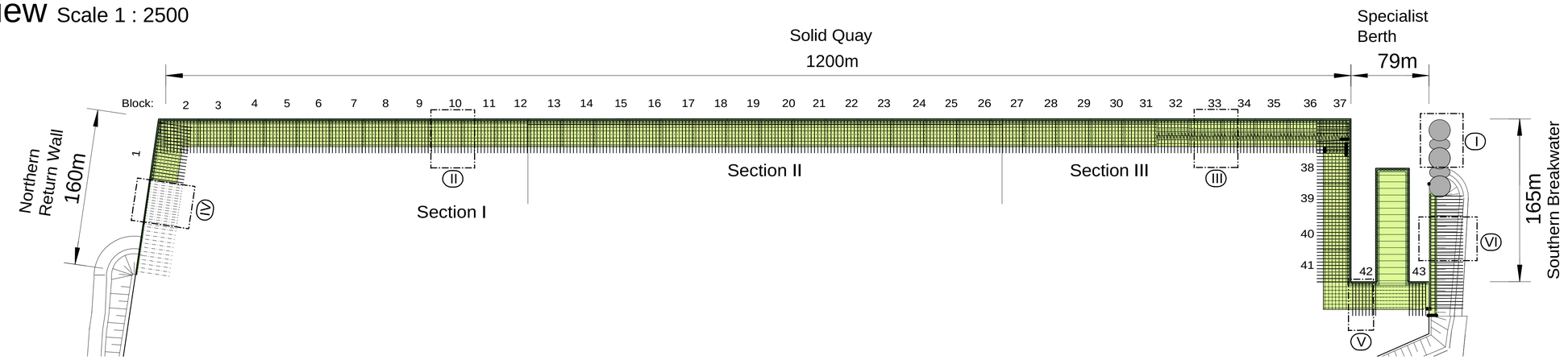
Scale:	Drawn By	Checked By	Approved By
1:500 @A1	BKY	SVF	HTA
Date:	17.09.2010	17.09.2010	17.09.2010

Drawing No. AMEP_P1D_D_007

Revision: D

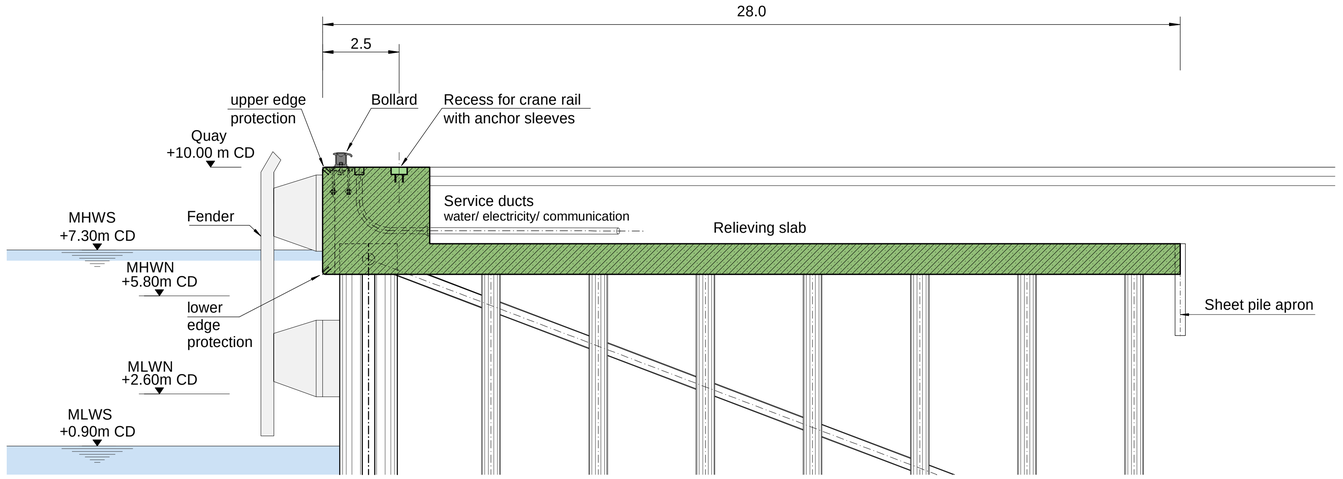
0 5 10 15 20 30 50
Scale 1:500 (A1)
Scale 1:1000 (A3)
METRES

Overview Scale 1 : 2500



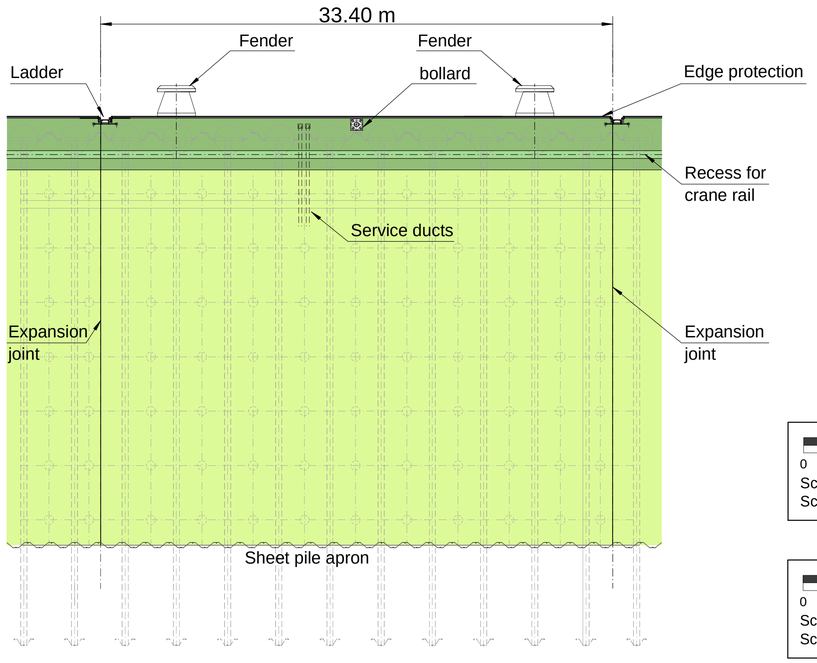
Cross Section

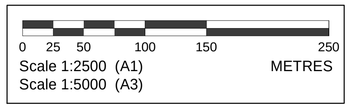
Solid Quay Block 10
Scale 1:100

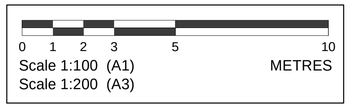


Detail (I) Top View

Solid Quay Block 10
Scale 1:200







KEY

-Levels to Chart Datum
-Details based on preliminary design
-Levels given for the Approach Channel and the Harbour Bed are the maximum maintained levels

Rev	Date	Description	By	Chk	App
G	02.11.11	Revision IPC Application	BKY	SVF	HTA
F	21.10.11	Revision IPC Application	ASS	SVF	HTA
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D	31.08.11	Revision IPC Application	ASS	SVF	HTA
C	30.08.11	Revision IPC Application	ASS	SVF	HTA
B	19.01.11	Revision of Northern Revetment/ Breakwater	BKY	SVF	HTA
A	07.01.11	EIA Masterplan Revision	BKY	SVF	HTA
0	17.09.10	Preliminary Issue	BKY	SVF	HTA

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Project: ABLE Marine Energy Park

Client: ABLE UK Ltd

Title: Concrete Deck General Arrangement

PRELIMINARY

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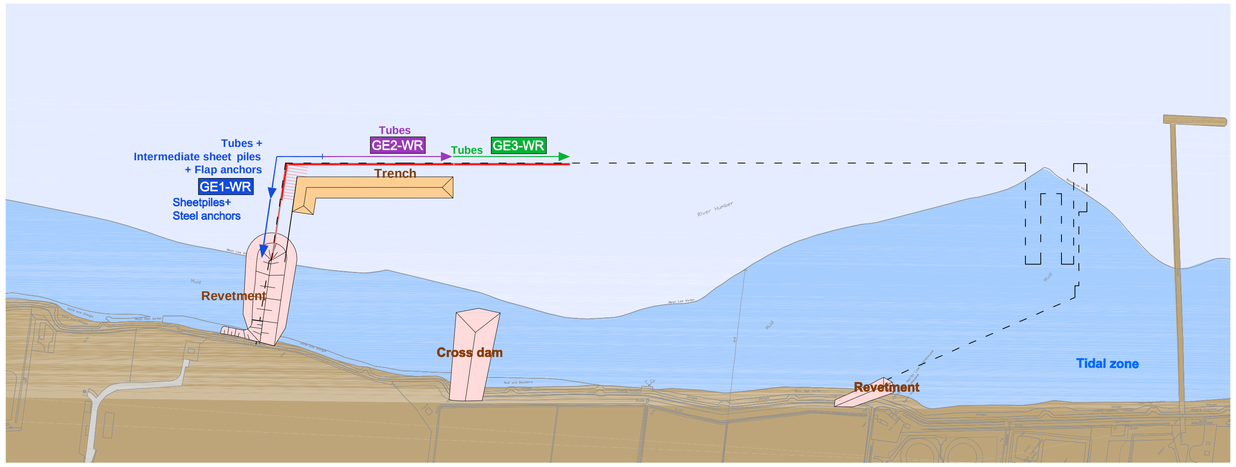
Fax. 0049-40/ 21986-200

Scale:	Drawn By	Checked By	Approved By
as shown @A1	BKY	SVF	HTA
Date:	17.09.2010	17.09.2010	17.09.2010

Drawing No. AMEP_P1D_D_009

Revision: G



STAGE 1

Dredging + Reclamation works

Dredging
- Potential removal of silt from quay footprint

Trench for flap anchors
- Section I

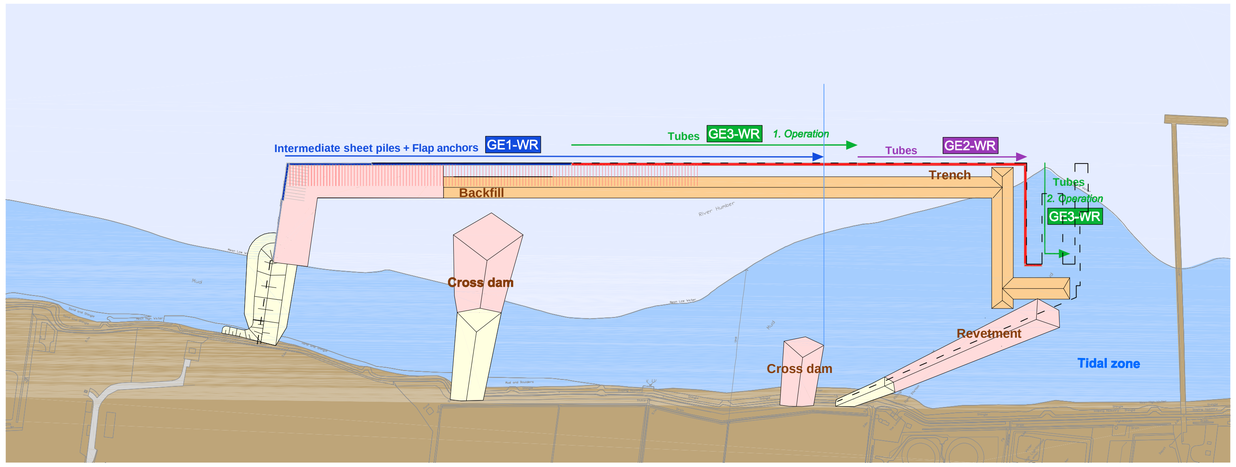
Revetments
- North
- South

Cross dams
- Section I/II

Piling works

Solid Quay
- Section I + II: Tubes

Northern Return wal l
- Section I: Intermediate sheet piles and flap anchors
-Section I: Sheet piles and steel anchors



STAGE 2

Dredging + Reclamation works

Trench for flap anchors
- Section II + III

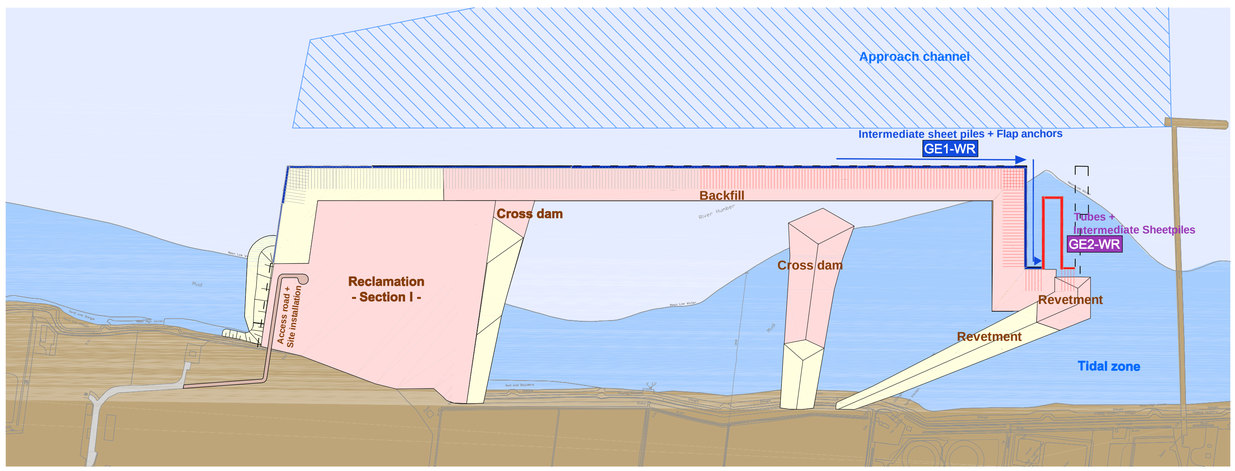
Backfill
- Section I

Revetments
- South

Cross dams
- Section I/II
- Section II/III

Piling works

Solid Quay
- Section I + II: Intermediate sheet piles and flap anchors
- Section II + III: Tubes



STAGE 3

Dredging + Reclamation works

Dredging
- Approach channel

Backfill
- Section II + III
- Return wall south

Revetments
- South

Cross dams
- Section I/II
- Section II/III

Reclamation
- Section I

Piling works

Solid Quay
- Section III: Intermediate sheet piles and flap anchors / steel anchors

Specialist Berth
-Tubes & Intermediate sheet piles

0 25 50 100 150 200 300 400 500
Scale 1:5000 (A1)
Scale 1:10000 (A3)
METRES

KEY

-Levels to Chart Datum
-Levels given for the Approach Channel and the Harbour Bed are the maximum maintained levels

LEGEND

IN PROGRESS	COMPLETED
Reclamation + Dams	Reclamation + Dams
Piling Works	Piling Works
Concrete Works	Concrete Works
Flap Anchor Trench	Pavement
Dredging Area	

EQUIPMENT UNITS

Seaside units	Landside units
GE1-WR GE3-WR GE2-WR	GE4+5-LR GE8-L GE6+7-LR

Rev	Date	Description	By	Chk	App
G	28.11.11	Adjustment of scales	AGR	SVF	HTA
F	21.10.11	Revision IPC Application	AGR	SVF	HTA
E	19.09.11	Revision IPC Application	AGR	SVF	HTA
D	31.08.11	Revision IPC Application	AGR	SVF	HTA
C	30.08.11	Revision IPC Application	AGR	SVF	HTA
B	19.01.11	Revision of Northern Revetment / Breakwater	JSE	SVF	HTA
A	07.01.11	EIA Masterplan Revision	JSE	SVF	HTA
0	17.09.10	Preliminary Issue	JSE	SVF	HTA

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Client: ABLE UK Ltd

Title: Indicative Sequence Plan View 1/3

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Scale:	Drawn By	Checked By	Approved By
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Date:	17.09.2010	17.09.2010	17.09.2010

Drawing No. AMEP_P1D_D_101

Revision: G

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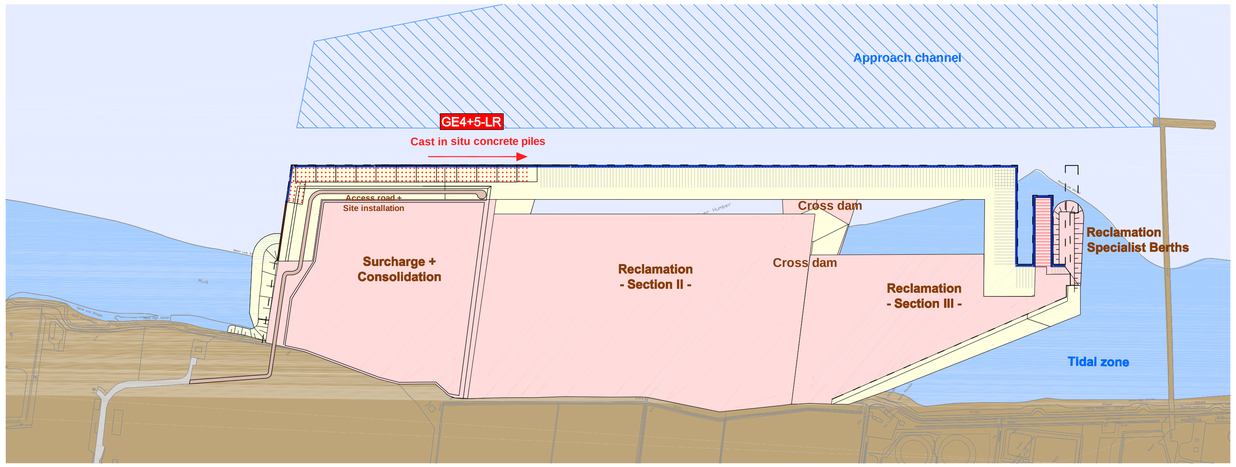


STAGE 4

Dredging + Reclamation works
Dredging
- Approach channel & Turning Area

Revetments
- Southern Breakwater

Reclamation
- Section II + III
- Specialist Berth

Surcharge + Consolidation
- Section I

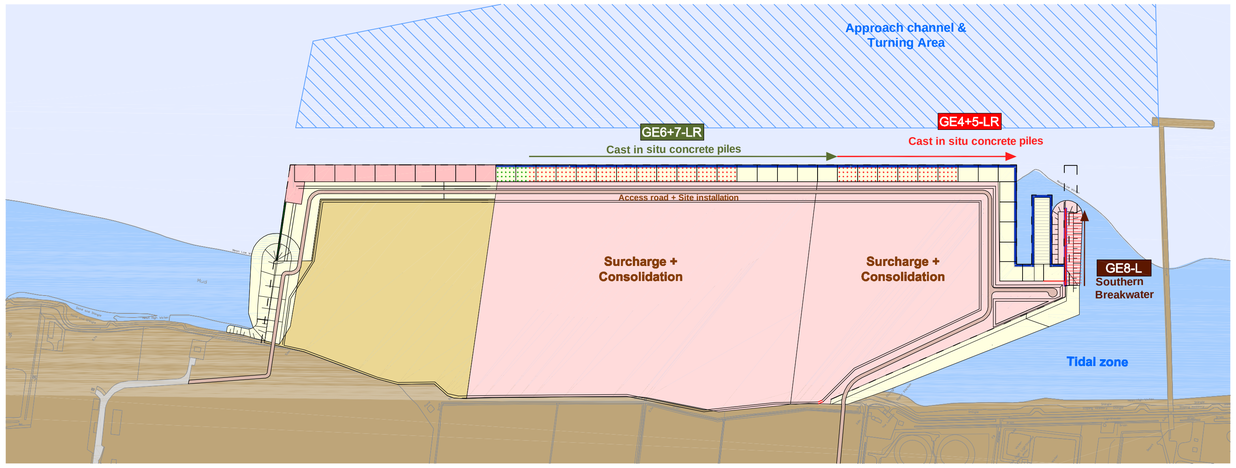
Crossdams
- Section II+III

Piling works
Cast in situ concrete piles
- Section I

Specialist Berth
-Horizontal ties

Reinforced concrete works
Return wall north
- Capping beam

Solid Quay
- Section I: Slabs



STAGE 5

Dredging + Reclamation works
Dredging
-Approach Channel & Turning Area

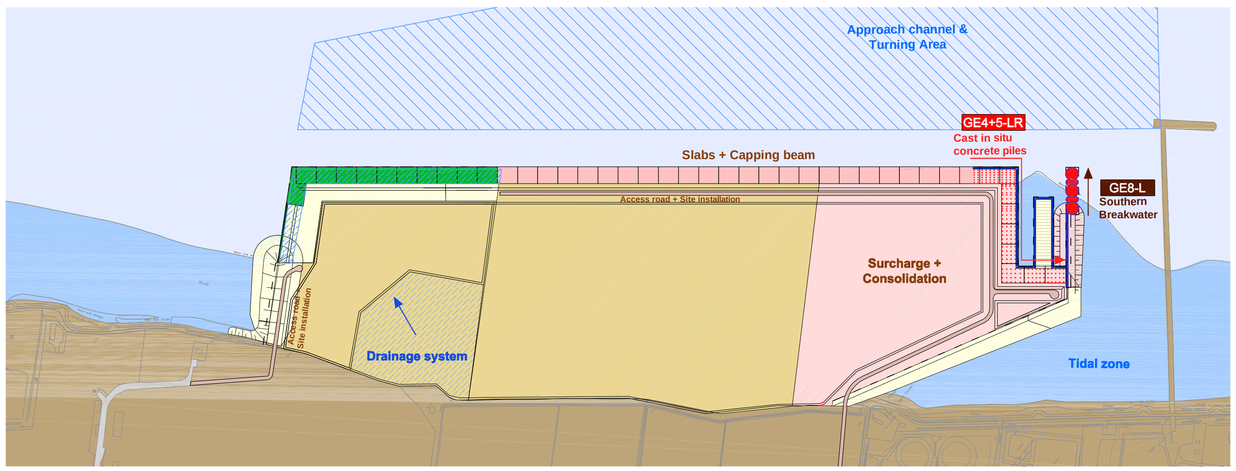
Reclamation
- Section II + III

Surcharge + Consolidation
- Section II + III

Piling works
Cast in situ concrete piles
- Section II + III

Breakwater
- South

Reinforced concrete works
Solid Quay
- Section I: Slabs + Capping beam



STAGE 6

Dredging + Reclamation works
Dredging
-Approach Channel & Turning Area

Surcharge + Consolidation
- Section III

Backfill above relieving slabs
- Section I

Landside reuse of surcharge material
- Section I

Piling works
Cast in situ concrete piles
- Section III

Breakwater
- South

Reinforced concrete works
Solid Quay
- Section II + III: Slabs + Capping beam

Drainage system
- Section I

Equipment
- Section I

Pavement
- Section I: Drainage system

KEY

-Levels to Chart Datum
-Levels given for the Approach Channel and the Harbour Bed are the maximum maintained levels

LEGEND

IN PROGRESS	COMPLETED
Reclamation + Dams	Reclamation + Dams
Piling Works	Piling Works
Concrete Works	Concrete Works
Flap Anchor Trench	Pavement
Dredging Area	

EQUIPMENT UNITS

Seaside units	Landside units
GE1-WR, GE3-WR, GE2-WR	GE4+5-LR, GE8-L, GE6+7-LR

Rev	Date	Description	By	Chk	App
G	28.11.11	Adjustment of scales	AGR	SVF	HTA
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C	30.08.11	Revision IPC Application	AGR	SVF	HTA
B	19.01.11	Revision of Northern Revetment / Breakwater	JSE	SVF	HTA
A	07.01.11	EIA Masterplan Revision	JSE	SVF	HTA
0	17.09.10	Preliminary Issue	JSE	SVF	HTA

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ABLE Marine Energy Park

Client:
ABLE UK Ltd

Title:
Indicative Sequence Plan View 2/3

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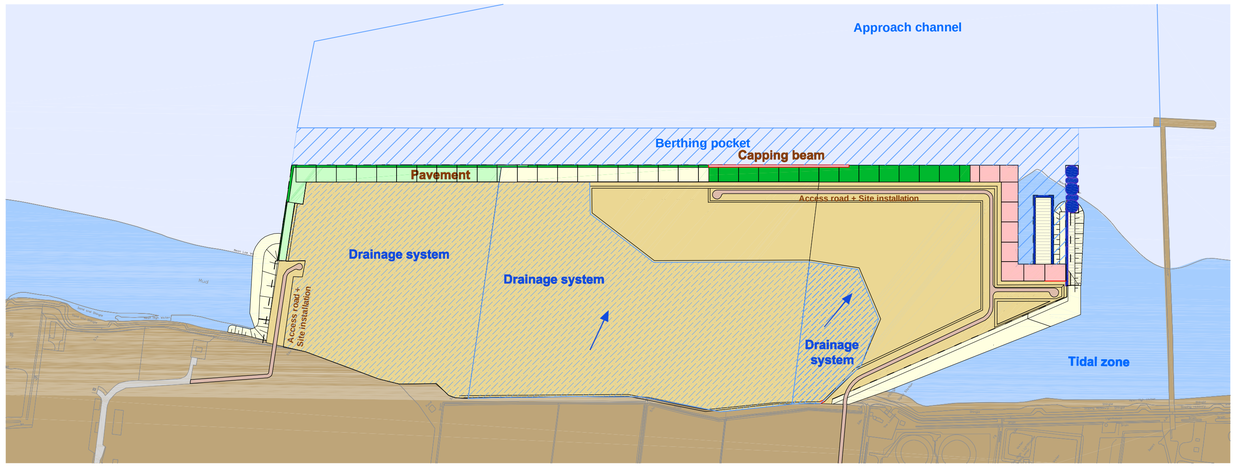
Date:	17.09.2010	17.09.2010	17.09.2010

Drawing No.: AMEP_P1D_D_102
Revision: G



STAGE 7

Dredging works
Dredging
- Berthing pocket

Backfill above relieving slabs
- Section II

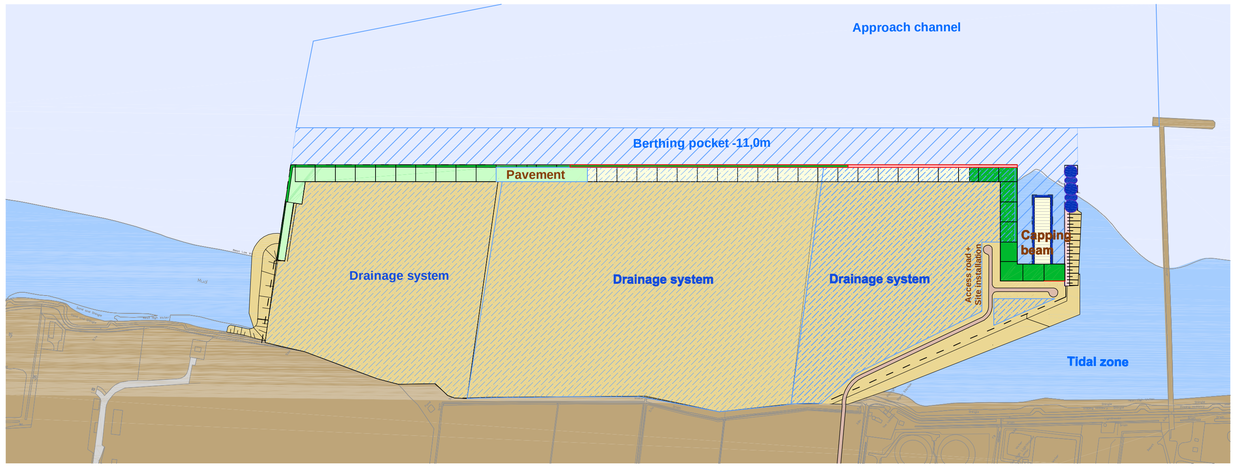
Landside reuse of surcharge material
- Section II + III

Reinforced concrete works
Solid Quay
- Section II: Capping beam
- Section III: Slabs + Capping beam

Drainage system
- Section I + II + III

Equipment
- Section I + II

Pavement
- Section I: Concrete
- Section II: Drainage system



STAGE 8

Dredging works
Dredging
- Berthing pocket

Backfill above relieving slabs
- Section II + III

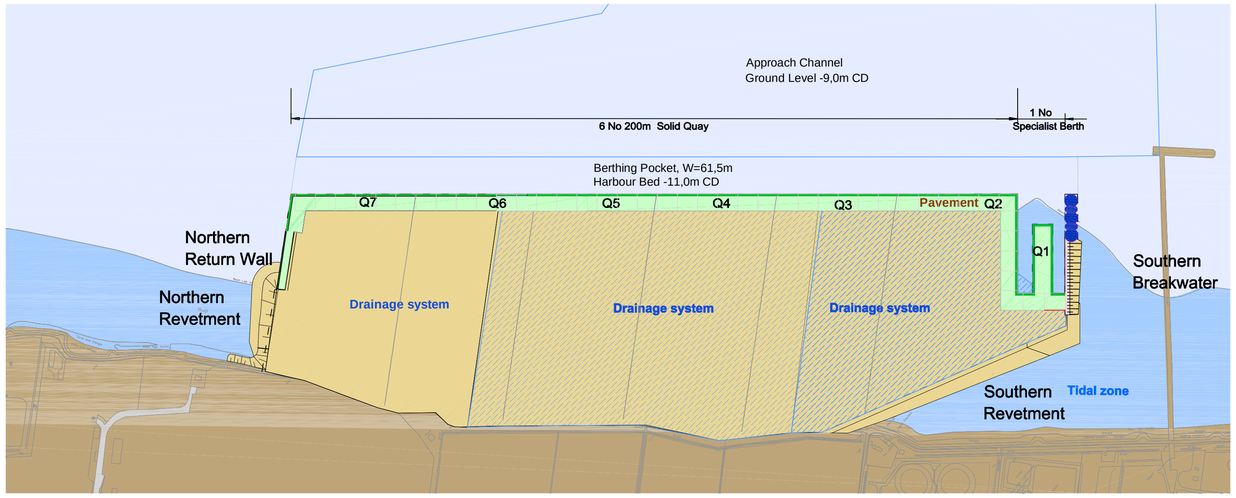
Landside reuse of surcharge material
- Section III

Reinforced concrete works
Solid Quay
- Section III: Capping beam
- Specialist Berth - Capping Beam

Drainage system
- Section I + II + III

Equipment
- Section I + II + III

Pavement
- Section II: Drainage system + Concrete
- Section III: Drainage system



STAGE 9

Drainage system
- Section II + III

Equipment
- Section II+ III
- Specialist Berth

Pavement
- Section II + III: Concrete
- Specialist Berth

Section I
- Completion: 31.01.2014

Section II
- Completion: 03.03.2014

Section III
- Completion: 01.04.2014

0 25 50 100 150 200 300 400 500
Scale 1:5000 (A1)
Scale 1:10000 (A3)
METRES

KEY

-Levels to Chart Datum
-Levels given for the Approach Channel and the Harbour Bed are the maximum maintained levels

LEGEND

IN PROGRESS	COMPLETED
Reclamation + Dams	Reclamation + Dams
Piling Works	Piling Works
Concrete Works	Concrete Works
Flap Anchor Trench	Pavement
Dredging Area	

EQUIPMENT UNITS

Seaside units	Landside units
GE1-WR, GE3-WR, GE2-WR	GE4+5-LR, GE8-L, GE6+7-LR

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Title: Indicative Sequence Plan View 3/3

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Scale:	Drawn By	Checked By	Approved By
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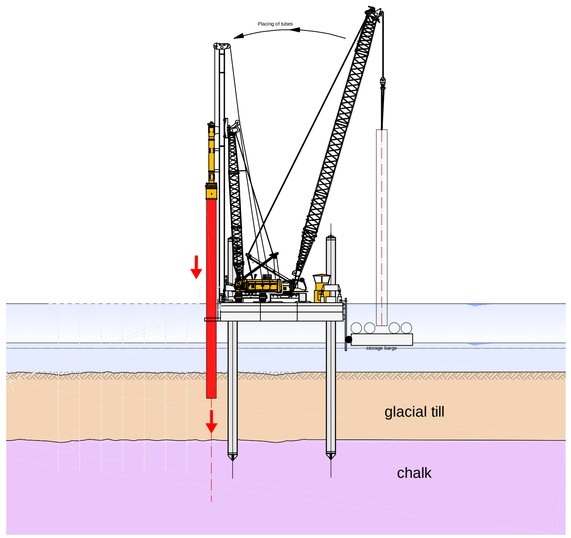
Date:	17.09.2010	17.09.2010	17.09.2010

Drawing No. AMEP_P1D_D_103
Revision: G

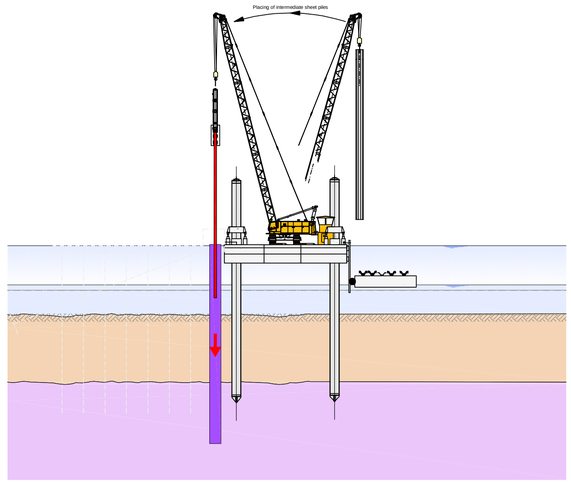
STAGE 1

- Driving of tubes



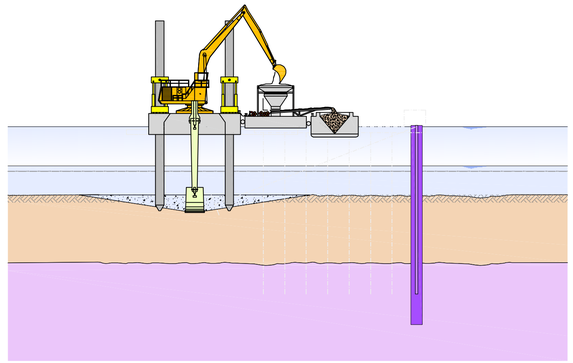
STAGE 2

- Driving of intermediate sheet piles



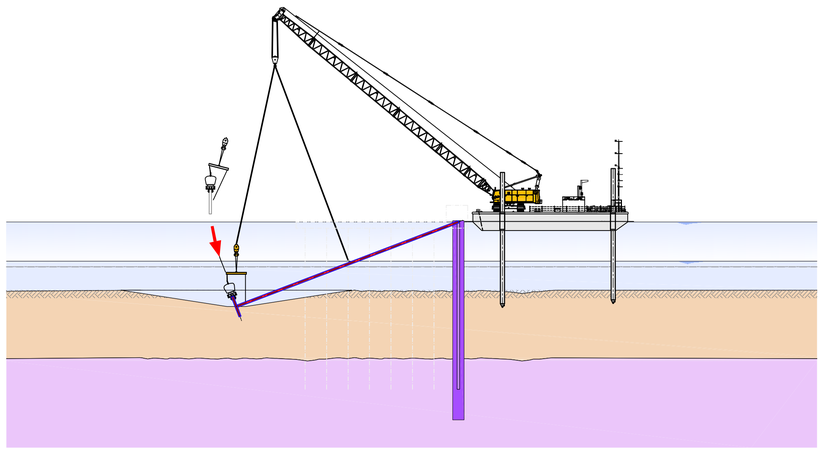
STAGE 3

- Dredging of flap anchor trench



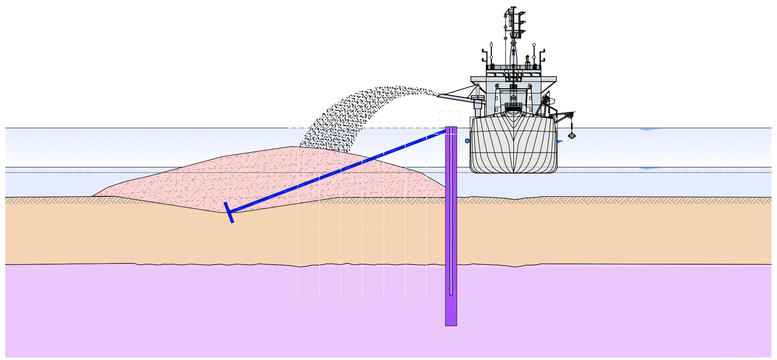
STAGE 4

- Installation of flap anchors



STAGE 5

- Backfilling



0 5 10 20 30 50 METRES

Scale 1:500 (A1)
Scale 1:1000 (A3)

KEY

-Levels to Chart Datum
-Details based on preliminary design
-Levels given for the Approach Channel and the Harbour Bed are the maximum maintained levels

Rev	Date	Description	By	Chk	App
C	28.11.11	Adjustment of scales	AGR	SVF	HTA
B	19.09.11	Revision IPC Application	AGR	SVF	HTA
A	30.08.11	Revision IPC Application	AGR	SVF	HTA
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Client: ABLE UK Ltd

Title: Indicative Sequence Cross Section 1/2

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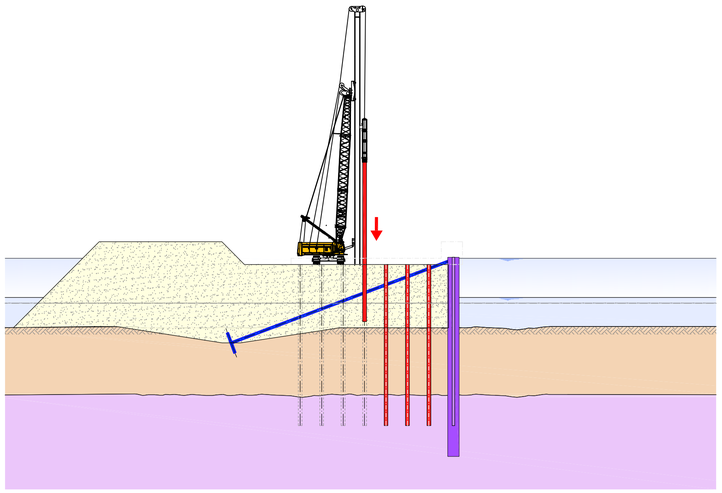
Date:	17.09.2010	17.09.2010	17.09.2010

Drawing No. AMEP_P1D_D_104

Revision: C

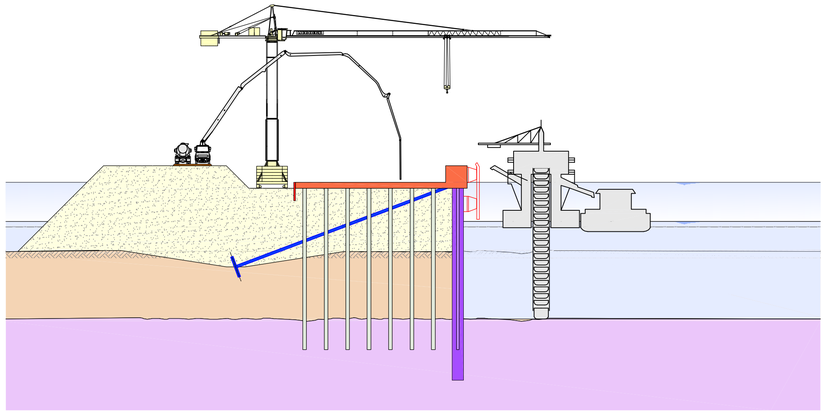
STAGE 6

- Driving of cast in situ concrete piles



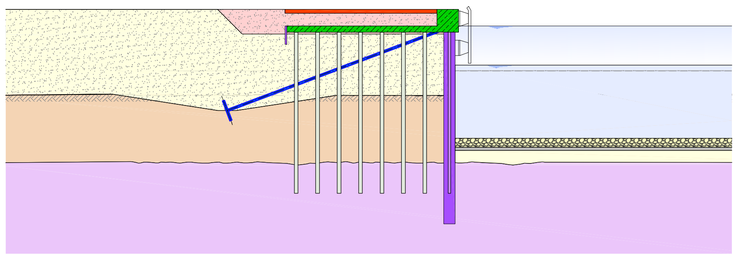
STAGE 7

- Casting of capping beam + concrete slab
- Installation of equipment
- Dredging of berthing pocket to top of chalk



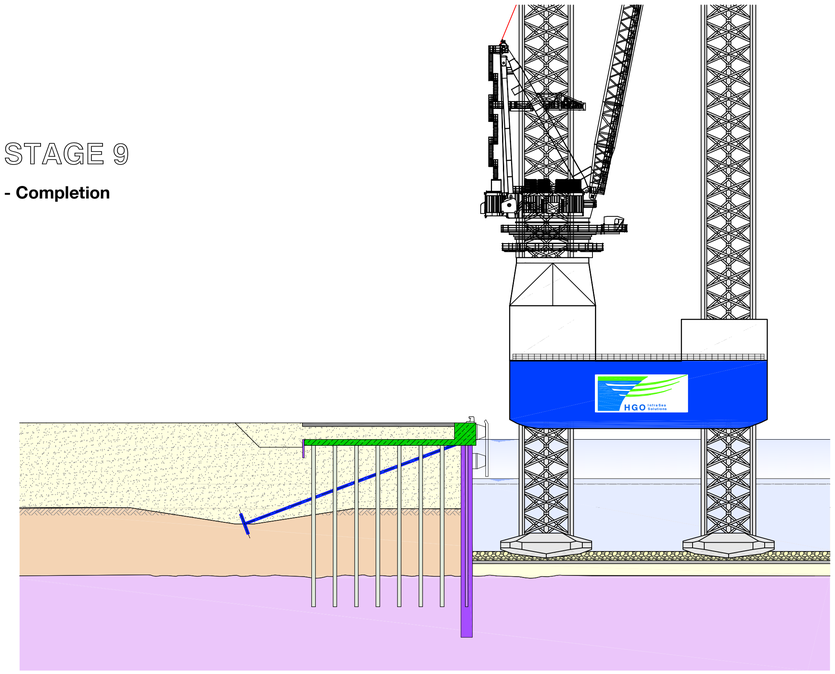
STAGE 8

- Refilling of berthing pocket with granular / rock fill
- Pavement works



STAGE 9

- Completion



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KEY

-Levels to Chart Datum
-Details based on preliminary design
-Levels given for the Approach Channel and the Harbour Bed are the maximum maintained levels

Rev	Date	Description	By	Chk	App
E	28.11.11	Adjustment of scales	AGR	SVF	HTA
D	19.09.11	Revision IPC Application	AGR	SVF	HTA
C	31.08.11	Revision IPC Application	AGR	SVF	HTA
B	30.08.11	Revision IPC Application	AGR	SVF	HTA
A	07.01.11	EIA Masterplan Revision	RBS	SVF	HTA
0	17.09.10	Preliminary Issue	JSE	SVF	HTA

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1 : 500 @A1	JSE	SVF	HTA
Date:	17.09.2010	17.09.2010	17.09.2010

Drawing No. AMEP_P1D_D_105

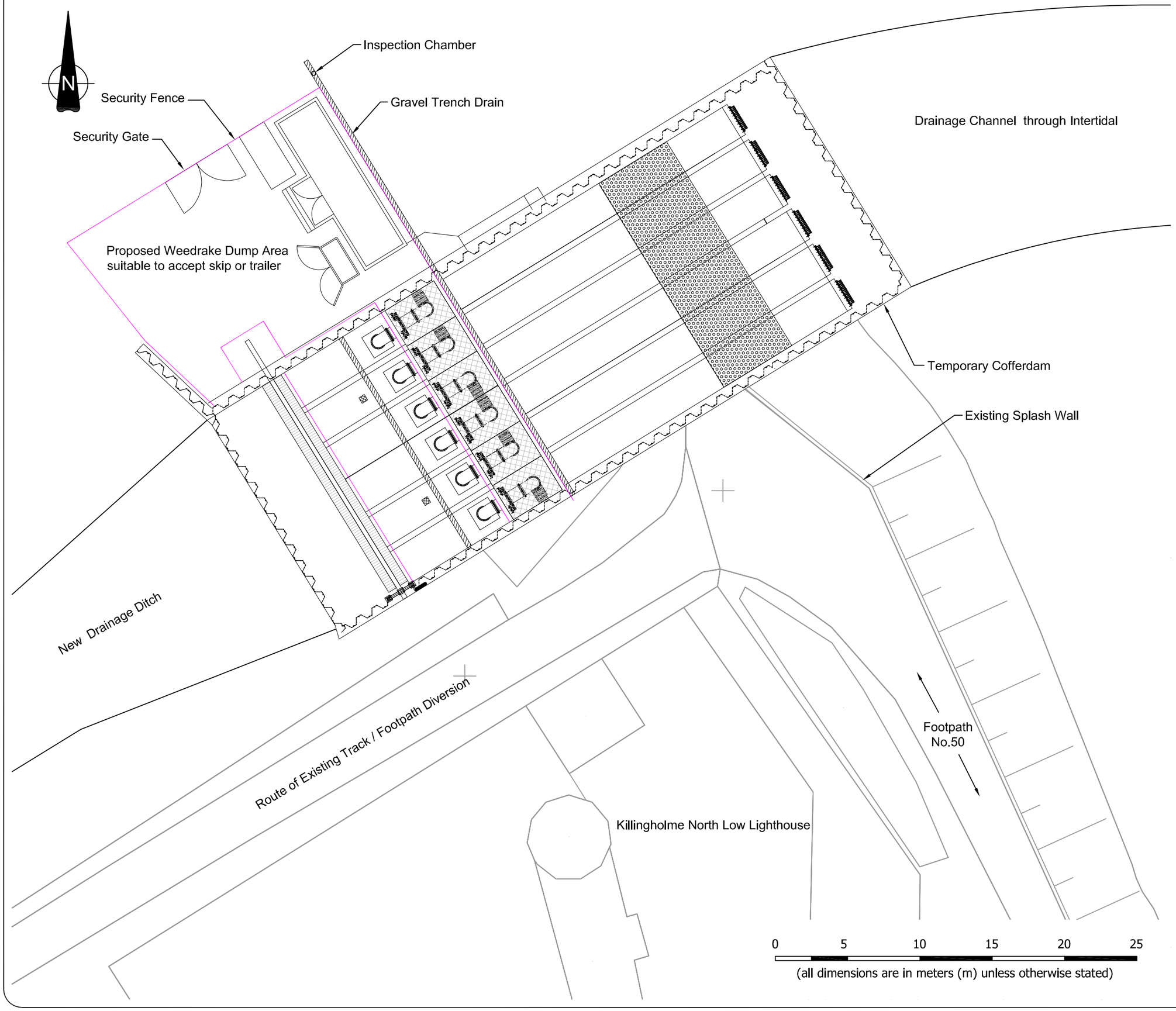
Revision: E

APPENDIX 4

PUMPING STATION DRAWINGS

AME - 02013 A: Surface Water Pumping Station Indicative Layout

AME - 02014 A: Surface Water Pumping Station Indicative Elevation



KEY

Rev	Date	Comments	Drw	Chk	App
A	12/12/11	Preliminary Issue	RK	RC	RC

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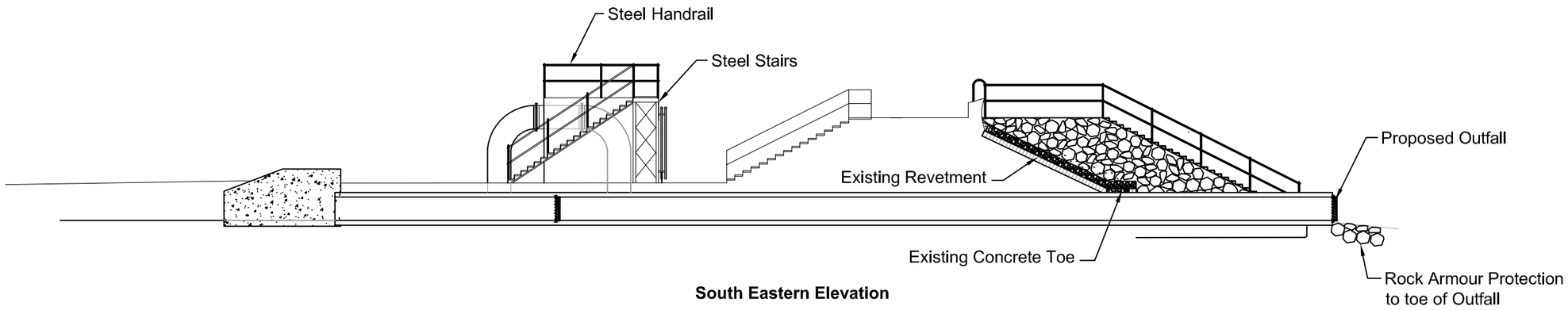
Title: Surface Water Pumping Station
Indicative Layout

PRELIMINARY

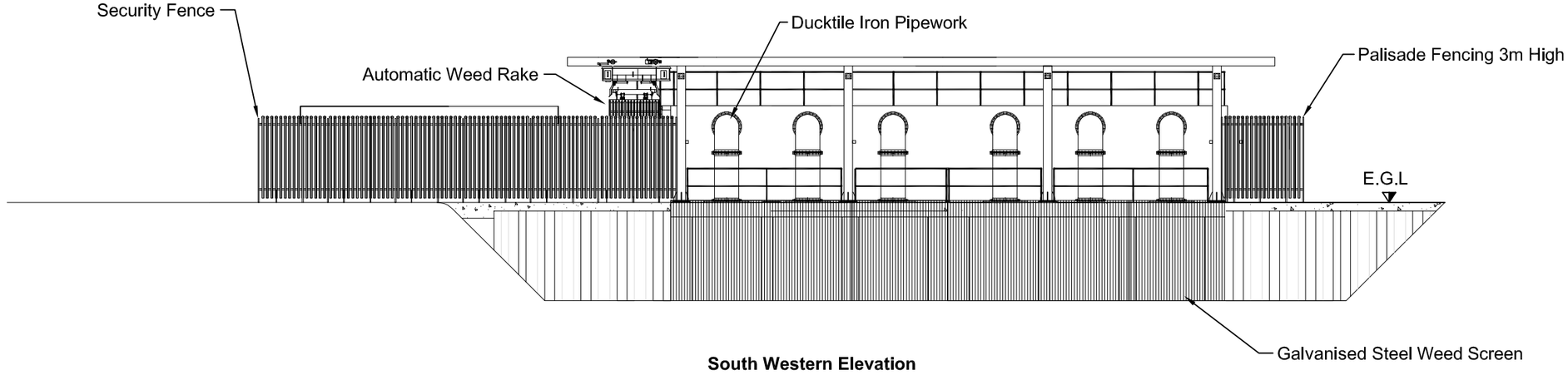
Scale:	Drawn	Checked	Approved
1:250@A3	R Keirl	R Cram	R Cram
Date	12/12/2011	12/12/2011	12/12/2011

Drawing No. AME - 02013

Revision: A



South Eastern Elevation



South Western Elevation

0 25 50 75 100 125

(all dimensions are in meters (m) unless otherwise stated)

KEY

Notes

1. Surface water to be discharged by gravity unless the outfall is tide locked or under extreme weather conditions, then the pumps will operate at total discharge rate.

2. A sheet pile coffer dam will be erected around the site during the construction phase of the pumping station.

Rev	Date	Comments	Drw	Chk	App
A	12/12/11	Preliminary Issue	RK	RC	RC

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Client: ABLE UK Ltd

Title: Surface Water Pumping Station
Indicative Elevation

PRELIMINARY

Scale:	Drawn	Checked	Approved
1:1,250@A3	R Keirl	R Cram	R Cram
Date	12/12/2011	12/12/2011	12/12/2011

Drawing No. AME - 02014

Revision: A

ANNEX 2

EX 11.24 *Medium and Long Term Quantum of Habitat Loss*

Planning Act 2008
Infrastructure Planning (Applications: Prescribed Forms and Procedure) Regulations 2009
Regulation 5(2) [a]
Document reference: TR030001/APP/14b

Supplementary Environmental Information

Medium and Long Term Quantum of Habitat Loss

Supplementary Report EX 11.24

June 2012
Revision: 0
Able UK

ABLE MARINE ENERGY PARK

MEDIUM AND LONG TERM QUANTUM OF HABITAT LOSS

JUNE 2012

Able UK Ltd
Able House,
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Tel: 01642 806080 Fax: 01642 655655

APPROVAL & REVISION REGISTER

	NAME	SIGNATURE	DATE
Originator:	R Cram		25-6-12
Checked by:	J Monk		25-6-12
Approved by:	R Cram		25-6-12

REVISION	COMMENTS	DATE
O	FIRST ISSUE	25-6-12

EXPLANATORY NOTE

INTRODUCTION

1. The development of Able Marine Energy Park (AMEP) includes for the reclamation of 45 ha of the Humber Estuary SPA/SAC; the area lost by the reclamation is habitat of community interest. Whilst, temporary construction impacts are being mitigated to avoid any additional impact on the protected habitat, once the development is operational, activity within the site may cause intermittent disturbance to the intertidal mudflats to the north and south of the quay. The intertidal area to the south of AMEP is currently used as a feeding resource by birds that are part of the SPA assemblage. Operations on the quay have the potential to reduce the functional value of the mudflat resource to the south of the quay and this potential functional loss is also a direct effect of the development.

2. The area of mudflat that may be disturbed by operations has been assessed, on a precautionary basis, to extend 275 m from the operational limit of the quay to the south.

3. The area of mudflat to the south of the quay will also be cut through by a new drainage channel that will be formed by the discharge of surface water from the industrial site associated with the development. The drainage water will discharge via a pumping station that will be located on land immediately to the south of the quay. This will be a functional change to the habitat within the disturbance zone. The new channel is illustrated on drawing AME-06077-A, refer to Appendix A.

MEDIUM TERM IMPACTS

4. Over the medium term (0-30 years) the reclamation is likely to cause a significant change in estuary processes in the upstream and downstream lee of the development, resulting in local change to the existing sub-tidal and intertidal habitats.

5. Upstream of the quay, the prediction of local effects can be informed by the changes that have been observed upstream of the Humber International Terminal (HIT), following its construction at the Port of Immingham in 2000. The changes to the Killingholme Marshes foreshore over the 10 year period between 2001 and 2010, are reported in Supplementary Report EX8.9, *'AMEP Assessment of changes to Morphology (Particularly Intertidal) Between the Humber International Terminal (HIT) and Humber Sea terminal (HST)'*, (HR Wallingford, 2012).

6. Briefly, the HIT reclamation has resulted in a change to the sedimentary regime upstream of that reclamation, with accretion occurring over a significant area and bed levels being raised by up to 3.5m over a period of 10 years, refer to Figure 1.

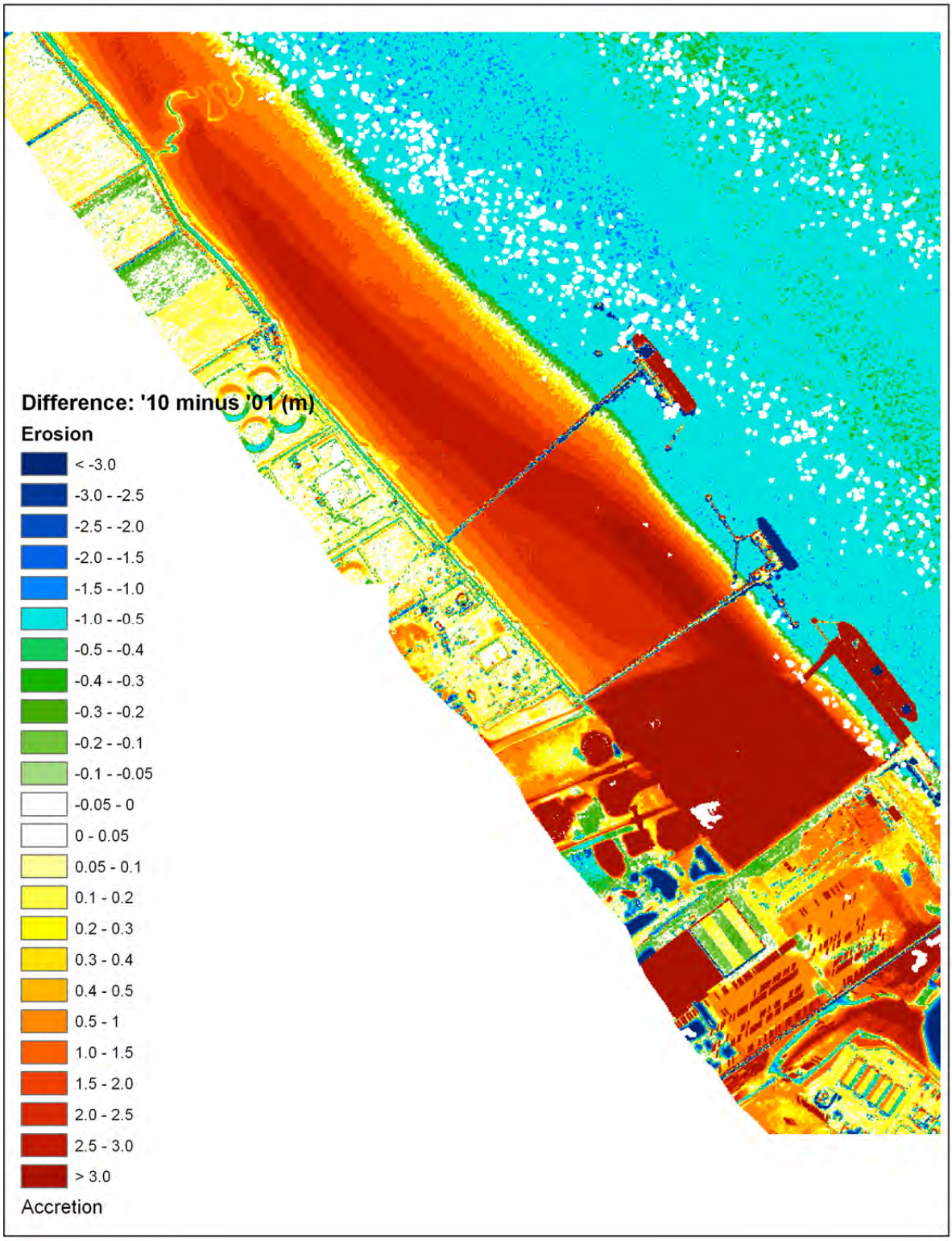


Figure 1: Accretion on Killingholme Marshes Foreshore Post-HIT (2001-10)

7. The rate of accretion in recent years appears unabated compared to earlier periods, indicating that this is a decadal scale process that is not yet complete. The MHWS contour lies along the face of the flood defence wall and is therefore constrained. Of potential significance however, is the increasing area of intertidal habitat that is lying between MHWN (+1.9 mAOD) and MHWS (+3.4 mAOD); between these levels, saltmarsh can become established (though elevation within the tidal range is only one relevant factor in saltmarsh development). Drawing AME-06090, also included in Appendix A, shows the creep into the estuary of the MHWN contour between 2001 and 2010. As a consequence of this process, over the last 10 years the intertidal area that lies between the MHWN and MHWS elevations has increased from 3.27 ha to 18.95 ha, an increase of 15.68 ha. Many confounding variables influence habitat development, which means that even in the absence of AMEP, the long term evolution of habitat on this dynamic foreshore is uncertain. All that is known for certain is that the Killingholme Marshes foreshore is undergoing a process of change and that saltmarsh is beginning to establish quite extensively; refer to Photographs 1 to 4.

8. With the development of AMEP, a wide embayment will be created to the south of the quay: AMEP's southern revetment; the flood defence wall and HIT will form an enclosure around approximately 27 ha of the estuary. Long term morphological change within this embayment has been modelled and is reported in Supplementary Report EX8.10, *'AMEP 3D Mud Modelling Morphological Assessment of Changes South-East of the Development'*. The computer modelling predicts deposition of sediment between the -5m ODN and -10m ODN, but not further inshore. The absence of accretion within the embayment is not however considered entirely credible over decadal timescales. It is more credible that the existing accretionary trend in this area will continue to progress and be exacerbated by AMEP, causing more of the intertidal zone to be raised (than would be caused by HIT alone) and to lie within the range MHWN and MHWS. A new MHWN contour is therefore postulated to develop between the northern edge of the HIT reclamation and the southern edge of the AMEP reclamation, refer to drawing AME-06033-G in Appendix A.

9. Whilst upstream of AMEP, the sedimentary regime will be affected in a similar way to the upstream changes observed at HIT, the presence of Humber Sea Terminal's dredged berths will influence the extent to which sediment is allowed to accrete. Long term morphological change to the north of the quay has been assessed and is reported in Supplementary Report EX8.8, *'AMEP Update to Longer term Morphology Predictions in the Region of the Centrica and E.ON Outfalls'*. Using this assessment, and knowledge of the intertidal changes north of HIT, then a new MHWN contour is postulated between the northern edge of AMEP and the HST berthing pockets, refer again to drawing AME-06033-G.

Photograph 1: Saltmarsh development at Immingham Gas Jetty (IGT)

Photograph 2: Looking north along flood defence bank north of HIT.

Photograph 3: Intertidal area looking south toward HIT.

Photograph 4: Intertidal area between SKOJ and IGT

LONG TERM IMPACTS

10. Over longer timescales (0-100 years) it is possible that the development will result in a change to the intertidal areas within the estuary as a whole, as a result of potentially millimetric changes to the high and low water levels as well as changes to sedimentation patterns within the estuary affecting natural geomorphological change. The Environment Agency has sought expert opinion on this matter from Deltares, and their advice is reproduced in Appendix B. In summary it suggests that the inter-tidal area within the estuary could reduce by 5 ha over 100 years as a result of the project.

11. The Deltares assessment infers morphological change from studies undertaken on set-back sites within the estuary, assuming that the quantum of habitat change resulting from previous modelled reclamation works will be pro-rata, and opposite to, the quantum of habitat change due to a substantial (808 ha) set back site on Sunk Island. The original work is reported in, '*Impacts of Setbacks on Estuarine Morphology*', (Jueken et al 2007), refer to Appendix C.

12. Using the information for the modelled Sunk Island set-back contained in Jeuken et al 2007: where area changes over time are shown in Figure 11, the change in seaward loss is about 13 ha, initial landward loss is perhaps 4ha after 5 years which after 50 years changes into a gain of 2 ha with a further perhaps 3 ha loss in the rivers. There is a gain of 30 ha in the setback area from 814 to 844 ha. Taken together this gives a gain of (30+2-13-3), or 16 ha which equates to about 2% of the Sunk Island intertidal area and not the 5% indicated by Deltares in Appendix C.

13. Modelling of morphological change carries high levels of uncertainty. Long term change in the estuary will be dictated by sea level rise (SLR). Over one hundred years, using UKCP09 95% medium emission scenario, SLR will amount to around 1055 mm between 2015 and 2115. On the same basis, over the first 50 years SLR is predicted to be 380 mm. The Humber CHaMP uses an assumption that sea levels will rise by 6mm/year between 2000 and 2050 and that this will give rise to a need for 600 ha of new intertidal habitat in order to maintain the habitat at its current quanta. (In other words, 1mm SLR has been assessed to give rise to a loss of 2ha of intertidal habitat throughout the estuary)

14. Deltares predictions are based on modelling of setbacks in combination with SLR of 1.8mm/year, whilst in the future SLR is now predicted to be 4mm/year until 2025 and then 7mm/year until 2050.

15. By contrast to the above effects, the changes in water levels due to AMEP are reported to be sub-millimetric, or virtually negligible, throughout most of the estuary and cannot be distinguished from model error (Report EX8.7), suggesting that any intertidal/subtidal change will be very small indeed.

16. In the long term, sea level rise will cause the loss of intertidal foreshore at Killingholme Marshes whether or not AMEP is consented. The area lost due to the reclamation amounts to approximately 1.2% of the whole of the middle estuary intertidal habitat (CHaMP, 2005). By 2050, the CHaMP predicts that 360 ha of intertidal will be lost in the middle estuary due to SLR. Adopting a simple pro-rata approach would suggest that, in the long term 4.32 ha of the existing intertidal at Killingholme Marshes will become sub-tidal due to SLR by 2050, and more thereafter. The long term baseline is therefore quite different to the existing baseline.

DEALING WITH UNCERTAINTY

17. Whilst the quantum of immediate direct change due to the reclamation works is measurable and therefore known with a degree of certainty, the medium and longer term impacts are less certain and that uncertainty needs to be addressed when assessing the quantum of compensatory habitat to be provided. The indirect effects also mean that the impacts of the development change over time. Initially the losses are limited to the direct habitat loss due to the reclamation works and the functional habitat loss caused by disturbance, but over decadal timescales, the indirect changes will modify the impact of the project on the estuary and this change is summarised in Table 1 below.

Table 1: Habitat Impacts of AMEP Over Time

Timescale	Impacts on the Humber Estuary SPA/SAC
Immediate	Mudflat loss = 29.5 ha Estuary habitat loss = 13.5 ha sub-tidal + 2 ha saltmarsh Σ (sub-tidal + intertidal) losses = 45 ha Functional loss of intertidal SPA habitat = 11.6 ha
Medium term 0-30 years	Sediment will accrete on the intertidal areas to the north and south of AMEP. Sediment that accretes below the existing MLWS contour will create a band of new sustainable mudflat both north and south of the quay. Sediment that accretes nearer the shore will lead to the development of a greater area of intertidal habitat lying between MHWN (+1.9 mAOD) and MHWS (+3.4 mAOD); between these levels saltmarsh is likely to develop. There is evidence of this transformation occurring in the upstream lee of HIT, 10 years after its construction. The foreshore within the area of functional loss due to AMEP is demonstrably accreting now, and is therefore likely to lose some of its functionality (due to saltmarsh development) even in the absence of AMEP. The medium term baseline is therefore different to the existing baseline. Indirect physical habitat impacts do not result in any new loss of habitat, only a **change** of habitat type within the estuary. Therefore, over 0-30 years the impacts of AMEP on habitat will **change**; the net loss of intertidal mud is likely to reduce whilst the net loss of sub-tidal habitat is likely to increase (but only to the same extent of the intertidal gain).

	In summary, over 0-30 years: Intertidal mud losses = <29.5 ha Estuary habitat losses = >15.5 ha, but Σ (sub-tidal + intertidal) losses remains 45 ha. Functional loss of SPA habitat <11.6 ha
Long term 0-100 years	Sea level rise will naturally result in some intertidal along Killingholme foreshore becoming sub-tidal. A reasonable estimate of this is around 4.32 ha. Geomorphological change caused by AMEP has been assessed by, Deltares, to give rise to a potential loss of 2-5 ha of intertidal habitat within the estuary; this would be accompanied by a sub-tidal gain. The prediction relies upon modelling of set-back sites in combination with 1.8mm/year of SLR. The relative impact of the set back may be less with the higher rate of SLR currently predicted A review of the project specific modelling of water level changes within the estuary due to AMEP shows them to be millimetric local to the development and negligible over the vast majority of the estuary. On this basis the estuary wide impacts can be estimated to be very small. Using, for the time being, a figure of 1 ha of intertidal loss and sub-tidal gain (as 4.32 ha would occur in any event), then In summary, Over 0-100 years: Intertidal losses < (29.5 ha + 1ha) mud Estuary habitat losses >(15.5 ha - 1 ha) But; Σ (sub-tidal + intertidal) losses remains 45 ha Functional loss of SPA habitat <11.6 ha

REQUIREMENT FOR COMPENSATORY HABITAT

18. It has been agreed with Natural England that the direct and indirect habitat losses affect four habitat types of community interest, none of which is a priority habitat:

    a. 1130 Estuaries

    b. 1140 Mudflats and sandflats not covered by seawater at low tide

    c. 1310 *Salicornia* and other annuals colonising mud and sand.

    d. 1330 Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)

19. It has further been agreed with Natural England that where losses are assessed to have an adverse effect on the integrity of the Humber Estuary SPA/SAC then compensation should be provided in the following ratios:

    a. For habitat type 1140, initially in the ratio of 2:1 (compensation:loss) due to uncertainty with regard to the effectiveness of the scheme. The compensatory habitat must be sustainable in the ratio of 1:1.

    b. For habitat types 1130, 1310 and 1330, in the ratio of 1:1 due to the certainty that this type of habitat will be created within the scheme.

20. On this basis, the quantum of habitat to be provided to compensate for the short, medium and long term effects of AMEP are summarised in Table 2 below.

Table 2: Habitat Compensation Requirements Over Time (Ignoring Saltmarsh Development)

Timescale	Habitat Type and Gain/Loss (ha)			TOTAL COMPENSATION AREA REQUIRED (ha)
	1130	1140	1310/1330	
Immediate Impact	13.5	41.1	2	97.7
Compensation	**13.5**	**82.2**	**2**	
Medium Term Impact Sub-tidal to mudflat (0-30 years)	>13.5	<41.1	2	>47 <97.7
Compensation	**<45** **>13.5**	**>0** **<82.2**	**2**	
Long Term Impact (0-100 years, 1 ha habitat change)	<(45-1) >(13.5-1)	>1 <(41.1+1)	2	>48 <98.7
Compensation	**<44** **>12.5**	**>2** **<84.2**	**2**	

CONFOUNDING VARIABLES

The Baseline

21. The impact of AMEP needs to be assessed against a baseline, but in this case the baseline itself is evolving due to the HIT development and due to SLR.

22. Assessing the true medium term impact of AMEP is therefore complicated by the fact that two predictions need to be made, *viz.*

- The medium/long term development of the Killingholme foreshore subject to HIT alone, and,
- The **extra** medium/long term development of the Killingholme foreshore post-AMEP.

The difference between these two predictions is the impact of AMEP on the foreshore.

23. As it is known that the foreshore is continuing to accrete, so it is conservative to address this particular uncertainty by assuming that the 2010 levels do actually provide a stable baseline and to accept the existing foreshore levels as the medium term levels.

24. The long term baseline will be characterised by a greater quantum of sub-tidal habitat and an equal reduction in intertidal habitat. This uncertainty can be addressed by, again, conservatively assuming that there is no change from the existing baseline.

25. Using the above assumptions ensures a precautionary approach.

Development of new Intertidal Habitat in the Medium Term

26. In Annex 8.2 (Figure 9a) of the ES, the evolution of the foreshore post-AMEP is postulated and from that, the quantum of sub-tidal habitat predicted to change to mudflat was estimated to be 7.88 ha. This assessment preceded the more recent Wallingford reports (EX8.8. EX8.9 and EX8.10) which enable a more informed assessment.

27. To the south of AMEP, there is a broad expanse of intertidal mudflat that extends from the flood defence, to the MLWS contour which lies just inshore of the two jetty berths (SKOJ and IGT). Between AMEP and HIT there cannot therefore be any significant increase in the area of intertidal habitat as that will be constrained by the location of the deep water channel along the jetty line; a small increase in area is therefore postulated on Drawing AME-06033-G, refer to Appendix A. Accretion over existing intertidal areas south of the quay will almost certainly continue however and bring more habitat above the level of MHWN. The flood defence wall has appeared to limit the upper level of mudflat in this area however, so the existing foreshore slope is expected to simply flatten over time.

28. To the north of AMEP the intertidal area is less extensive and accretion is likely to create new mudflat where it occurs below existing MLWS. However the areal extent of undisturbed accretion will be limited by the presence of nearby berthing pockets and the associated approach channels for HST. Any sediment accreting in those areas will be dredged before they become significant and the potential for sedimentation north of HST, whilst possible, seems unlikely.

29. Putting quantities to these impacts is, realistically, a matter of professional judgement, taking into consideration all of the information available. The extent of new intertidal habitat that is predicted to the north and south of the quay is indicated on drawing AME-06033-G which is reproduced in Appendix A.

Development of Saltmarsh in the Medium Term

30. The existing intertidal habitat on the Killingholme Marshes foreshore is mostly mudflat with a small area of mature saltmarsh in the downstream lee of Humber Work Boats' premises. The development of HIT has led to a significant response in the local sedimentary regime with accretion becoming dominant and around 40 ha of existing intertidal being raised in level. This process is continuing and over the long term saltmarsh will develop in some elevated intertidal areas whether or not AMEP is constructed.

31. Attempting to quantify the area of saltmarsh that that would evolve in the absence of AMEP and the additional saltmarsh that would develop if AMEP is constructed is a matter of judgement. The DEFRA publication, *'Suitability Criteria For Habitat Creation – Report 1 : Reviews of Present practices and Scientific Literature Relevant to Site Selection Criteria'*, (EA, 2004), provides an extensive review of the habitat requirements for saltmarsh development. In summary there are numerous factors that influence its development to a greater or lesser extent, including:

- Elevation
- Frequency of inundation
- Estuary size
- Tidal range
- Site gradient
- Drainage
- Sediment characteristics, both physical and chemical
- Salinity

32. The DEFRA report provides two formulae for the lower limit of *Spartina* (a pioneer species) and *Puccinellia maritime* (a low-mid marsh species) on the south and west coast of Britain, viz.

$$LL = -0.805 + 0.366SR + 0.053F + 0.135Log_eA \quad \textbf{(1)}$$

Where, LL = lower limit of *Spartina* (mODN)

SR = spring tidal range (m)

F = fetch length in the direction of the transect (km),

A = Estuary area (km^2), Humber estuary =

And, $LL = 0.23 + 1.39*MHWN$ **(2)**

Where, LL = lower limit of *Puccinellia maritima*

33. Using the formulae yields the values 2.54 mODN (SR=6.4, F=4.5, A=286) and 2.87 mODN for formulae (1) and (2) respectively. Whilst these formula are not directly relevant to the Humber they nevertheless provide a guide to the most significant factors in the suitability of a site for saltmarsh development. Essentially, in larger estuaries with a high tidal range, saltmarsh will colonise at higher levels.

34. In terms of tidal inundations, the DEFRA report states that, 'sites with elevations that will experience less than about 450 tidal inundations would be expected to develop salt marsh, whereas mudflat will develop at levels that experience greater than 500 inundations per year (Burd 1995)'. Annex 32.5 of the ES provides the percentage of tides at Immingham that are above various levels, the relevant table is reproduced below. Given that there are 704 high tides per year, then there are 418 high tides that exceed 2.5 mAOD every year. At a level of 2.25 mAOD, the number of annual tidal inundations increases to around 500.

Table 1 Frequency of occurrence of high tides at Immingham 1996, 2008-2011

Level mAOD	1996	2008	2009	2010	2011	Average (5 years)	Average (3 years) 1996, 2008, 2010
Percent >2.5	64.0	55.5	56.7	58.6	59.6	58.9	59.4
Percent ≥ 3.0	41.2	32.3		34.8			36.1
Percent ≥ 3.4	15.4	9.6	10.8	11.2	11.9	11.8	12.1
Percent ≥ 3.8	2.5	0.4	1.3	2.6	2.8	1.9	1.8
Percent ≥ 4.0	0.3	0.0		0.7			0.3

35. Also in Annex 32.5, the development of saltmarsh at Paull Holme Strays is reported in relation to site level, again the relevant table is reproduced below.

Table 6 Saltmarsh ground cover at Paull Holme Strays

Level group (in 2005)	Average ground coverage with saltmarsh (percent)					
	Sept 03	Sept 04	Sept 05	Sept 06	Sept 07	Sept 08
2.0-2.3	0.0	0.0	0.0	0.0	0.8	1.5
>2.3-2.6	0.0	0.0	0.1	1.3	9.1	34.2
>2.6-3.0	0.0	3.8	14.7	44.1	57.3	76.8
>3.0-3.5	0.0	40.9	55.0	74.4	67.5	74.8

Note: From Tables 4.2 from Brown (2009).

36. The evidence therefore indicates that saltmarsh development is relatively constrained below about 2.3 mAOD and that this is consistent with accepted habitat development criteria.

37. On the basis of the above, it is predicted that the foreshore will reach equilibrium with an upper level at the toe of the sea wall and that it will slope very gently towards the MHWN contour which will, over time, creep towards the berthing line of AMEP. Approximately half of the area of intertidal in the lee of AMEP will therefore have the potential to develop into saltmarsh. Some of the area to the north of HIT already has the potential to develop into saltmarsh and there is some evidence of that occurring now. The habitat changes that might occur over the medium term are detailed on drawing AME-06033.

38. Tables 3 to 5 below provide a quantitative assessment of medium and long term habitat gain and loss.

	HABITAT TYPE			
	Saltmarsh	Intertidal Mudflat	Sub-tidal (Estuary)	
IMMEDIATE IMPACTS				
Direct	-2	-31.5 2	-13.5	
Functional Loss		-11.6		
TOTAL	-2	-41.1	-13.5	
Direct Compensation	2	82.2	13.5	97.7

Table 3: Short Term Impacts of AMEP on SPA Habitat

	HABITAT TYPE			
	Saltmarsh	Intertidal Mudflat	Sub-tidal (Estuary)	
MEDIUM TERM (0-30 YEARS)				
Direct	-2	-31.5	-13.5	
		2		
Functional Loss Due to AMEP		-8.9		
TOTAL	-2	-38.4	-13.5	
Compensation	2	76.8	13.5	
Local Functional Mudflat creation - North		0	0	
Local Functional Mudflat creation - South		0.5	-0.5	
TOTAL	-2	-37.9	-14	
Direct Compensation + reduction by Indirect mudflat creation	2	75.8	14	
Local Functional Mudflat Conversion to Saltmarsh - North	0	0		
Local Functional Mudflat Conversion to Saltmarsh - South	1.1	-1.1		
Creation of saltmarsh in the disturbance zone	4.7			
TOTAL	3.8	-39	-14	
Direct Compensation + reduction by Indirect mudflat creation + Indirect mudflat conversion to saltmarsh	0	78	10.2	88.2

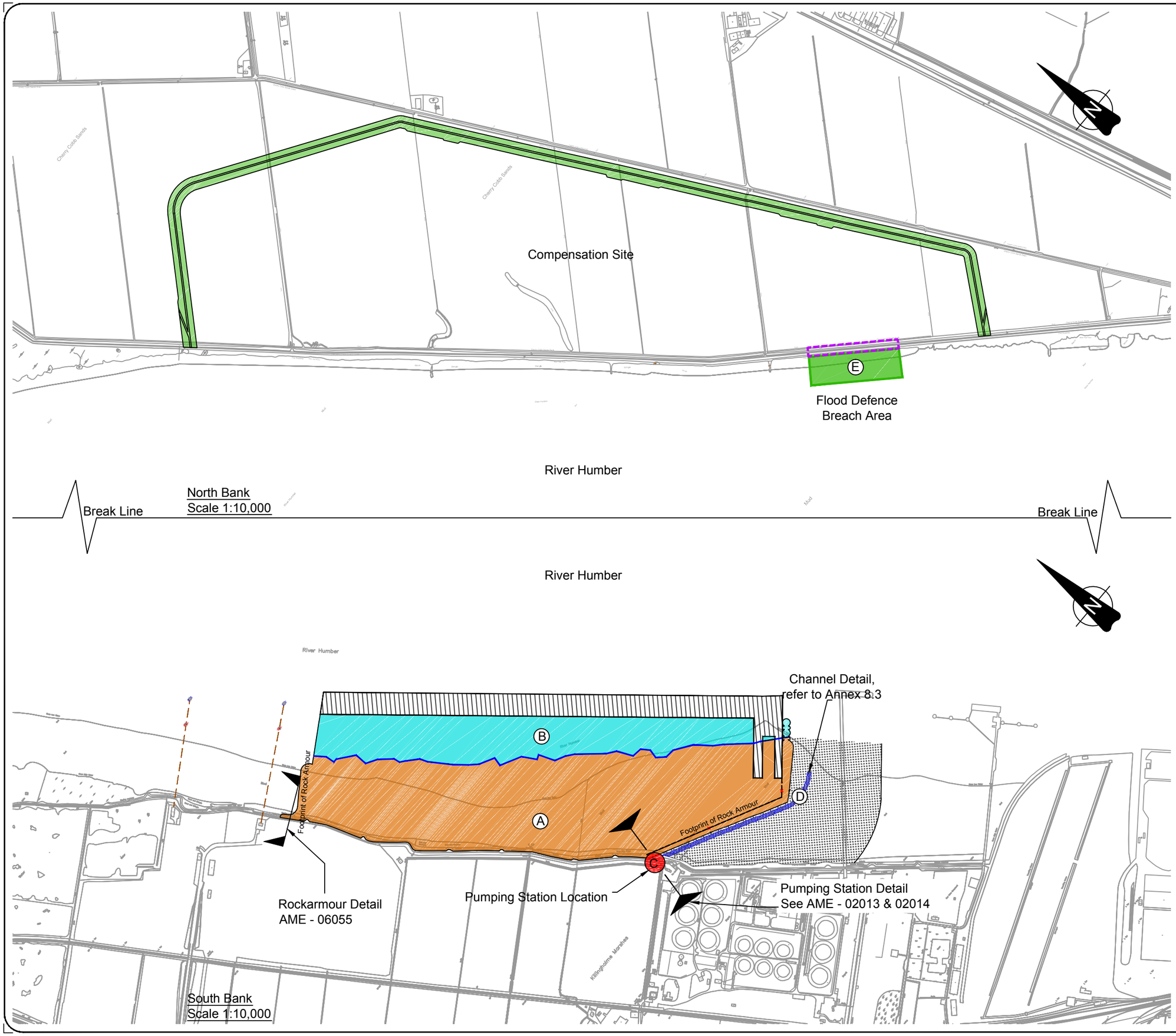
Table 4: Medium Term Impacts of AMEP on SPA Habitat

	HABITAT TYPE			
	Saltmarsh	Intertidal Mudflat	Sub-tidal (Estuary)	
LONG TERM IMPACTS				
Direct	-2	-31.5	-13.5	
		2		
Functional Loss Due to AMEP		-8.9		
TOTAL	-2	-38.4	-13.5	
Compensation	2	76.8	13.5	
Local Functional Mudflat creation - North		0	0	
Local Functional Mudflat creation - South		0.5	-0.5	
TOTAL	-2	-37.9	-14	
Direct Compensation + reduction by Indirect mudflat creation	2	75.8	14	
Local Functional Mudflat Conversion to Saltmarsh - North	0	0		
Local Functional Mudflat Conversion to Saltmarsh - South	1.1	-1.1		
Creation of saltmarsh in the disturbance zone	4.7			
TOTAL	3.8	-39	-14	
Direct Compensation + reduction by Indirect mudflat creation + Indirect mudflat conversion to saltmarsh	0	78	10.2	
LONG TERM (0-100 YEARS)				
Indirect - WL Change		-1	1	
TOTAL	3.8	-40	-13	
Direct + Indirect + EA Compensation	0	80	9.2	89.2

Table 5: Long Term Impacts of AMEP on SPA Habitat

39. The size of compensatory habitat proposed is 100 ha which is sufficient to address the changing impacts of the scheme on the habitat types within the designated site over the short, medium and long term. It also caters for the associated uncertainty of the indirect effects both local to the quay and estuary wide.

APPENDIX A – Drawings



KEY

- Berthing Pocket
- A Intertidal Habitat Loss - 31.50ha
- B Subtidal Habitat Loss - 13.50ha
- C Limit of Operational Disturbance - 11.6ha
- D Drainage Channel & Pumping Station
- E Flood Defence Breach Area - 1.8ha
- Mean Low Water Spring
- Limit of Operational Boundary

Notes:

1. Limit of disturbance is defined by 150m offset from a point source (+).

Rev	Date	Comments	Drw	Chk	App
B	17/05/12	North Bank Added	RK	JD	RC
A	13/04/12	Preliminary Issue	JH	RC	RC

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Project: ABLE Marine Energy Park

Client: ABLE UK Ltd

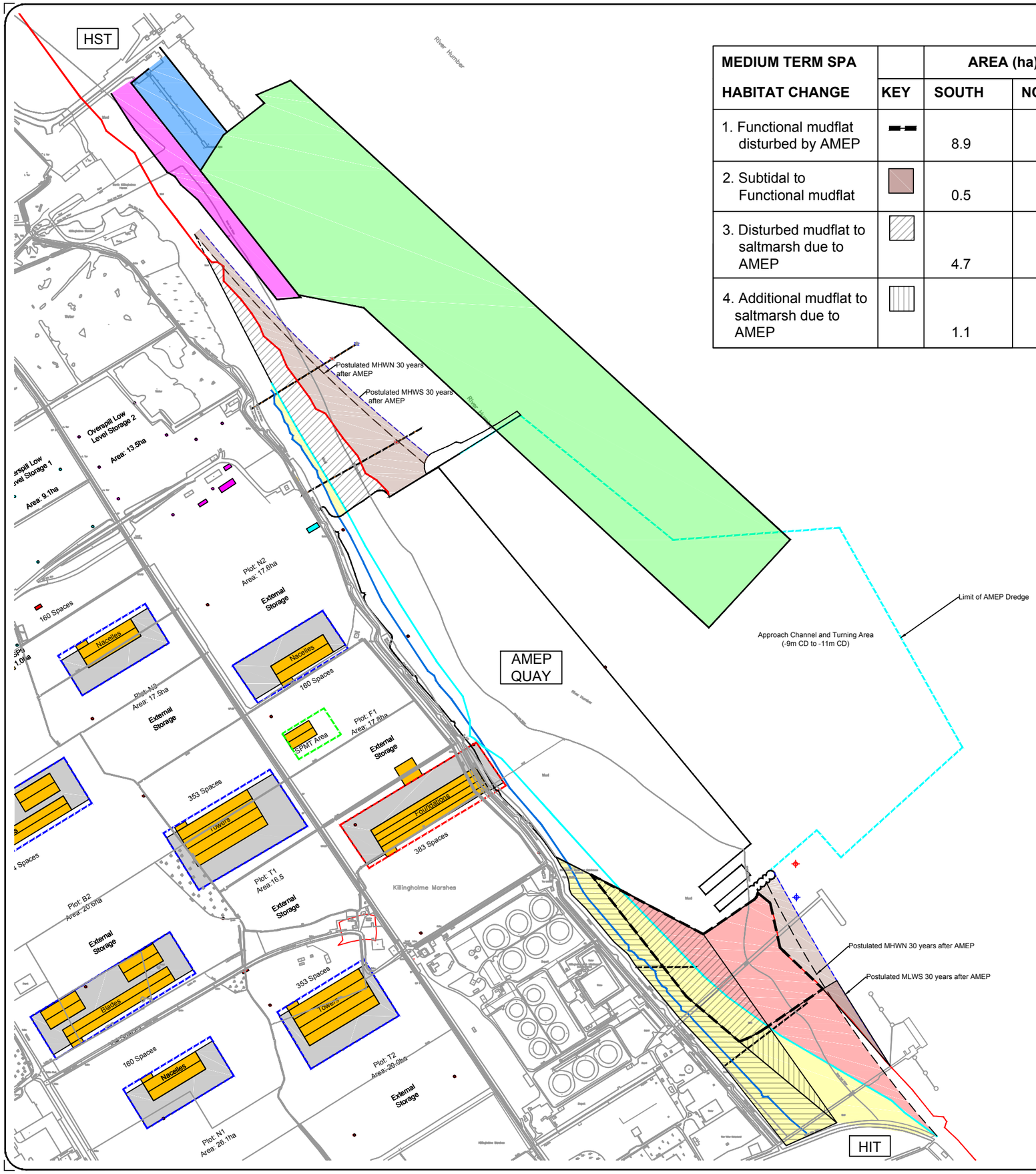
Title: Habitat Impacts

PRELIMINARY

Scale:	Drawn	Checked	Approved
As Shown@A3	J Harris	R Cram	R Cram
Date	13/04/2012	13/04/2012	13/04/2012

Drawing No. AME - 06077

Revision: B



MEDIUM TERM SPA HABITAT CHANGE	KEY	AREA (ha) SOUTH	NORTH
1. Functional mudflat disturbed by AMEP		8.9	0
2. Subtidal to Functional mudflat		0.5	0
3. Disturbed mudflat to saltmarsh due to AMEP		4.7	0
4. Additional mudflat to saltmarsh due to AMEP		1.1	0

N

KEY

- Existing MLWS
- Existing Outfall
- IUS Dolphin
- US Dolphin Constructed 2011
- HST Consented to Dredge to 9.35m CD
- HST Consented to Dredge to 7.2m CD
- HST Consented to Dredge to 6.2m CD
- 2001 MHWN 1.9m ODN
- 2010 MHWN 1.9m ODN
- Intertidal habitat above MHWN 2010
- Existing mudflat that will accrete above MHWN post AMEP
- Predicted saltmarsh development without AMEP
- Additional saltmarsh development with AMEP
- Existing sub-tidal accreting to mudflat post AMEP
- Limit of Operational Disturbance Medium Term

Rev	Date	Comments	Drw	Chk	App
H	12/06/12	Table Ammended	FM	RC	RC
G	08/06/12	2001 MHWN Added	FM	RC	RC
F	07/06/12	Image Added & Title Ammended	FM	RC	RC
E	26/04/12	Image Added	JH	RC	RC
D	09/03/12	Dolphins & Outfalls Added	JH	RC	RC
C	29/09/11	Bird Disturbance Added	JH	RC	RC
B	13/04/11	Dredge Quantities Added	JH	RC	RC
A	07/04/11	Preliminary Issue	JH	RC	RC

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Project: ABLE Marine Energy Park

Client: ABLE UK Ltd

Title: Medium Term SPA (0-30yr) Habitat Change Post-AMEP

PRELIMINARY

Scale:	Drawn	Checked	Approved
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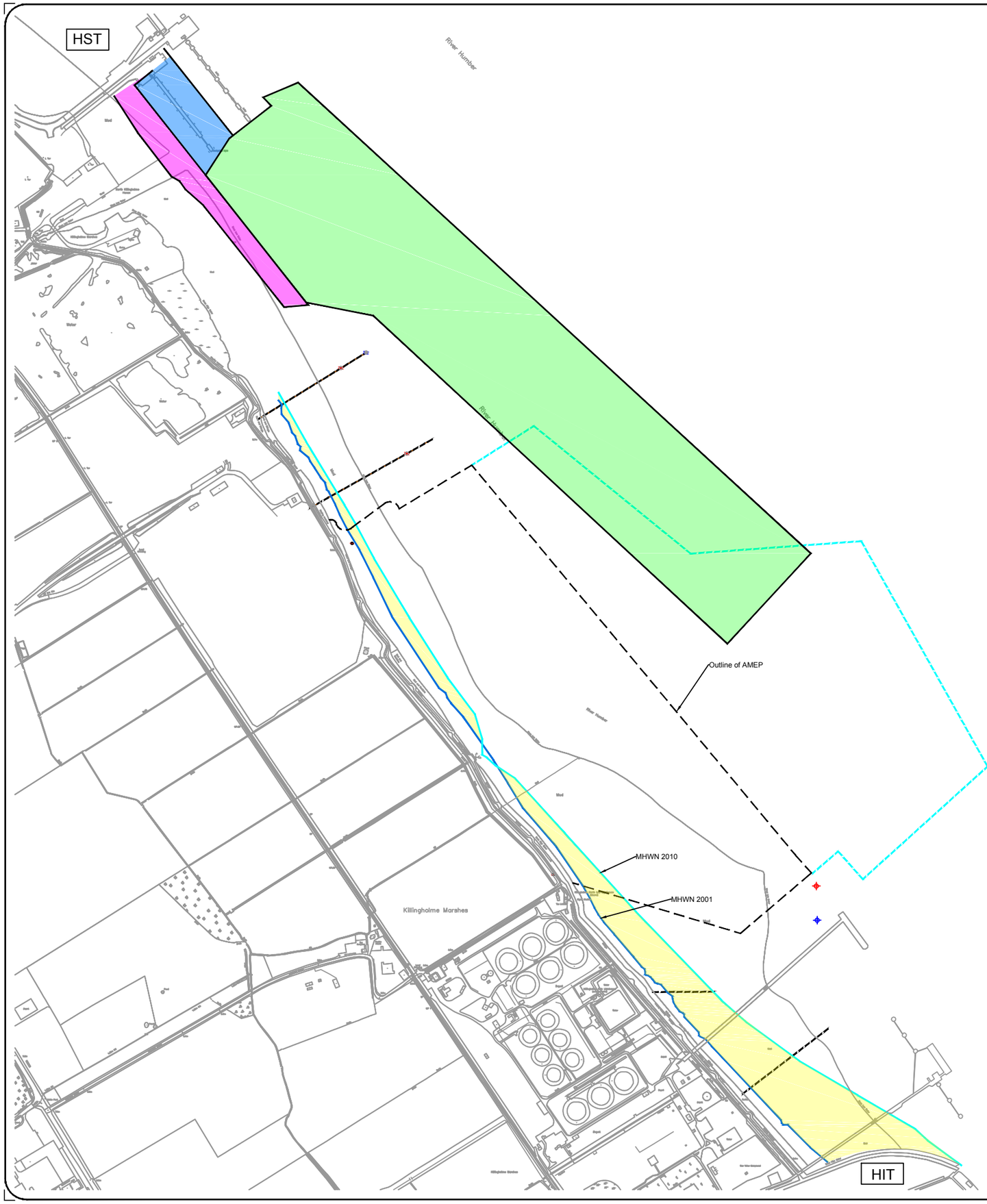
Date	07/04/2011	07/04/2011	07/04/2011

Drawing No. AME - 06033

Revision: G



KEY

- Existing Outfall
- IUS Dolphin
- US Dolphin Constructed 2011
- Turning Circle
- MHWN1.9m ODN
- 2001 MHWN 1.9m ODN
- HST Consented to Dredge to 9.35m CD
- HST Consented to Dredge to 7.2m CD
- HST Consented to Dredge to 6.2m CD
- Intertidal level change Post-HIT from <MHWN to >MHWN (2001 - 2010) 13.9ha

Rev	Date	Comments	Drw	Chk	App
A	08/06/12	Preliminary Issue	FM	RC	RC

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Project: ABLE Marine Energy Park

Client: ABLE UK Ltd

Title: 2001- 2010 Habitat Change North of HIT

PRELIMINARY

Scale:	Drawn	Checked	Approved
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Date	08/06/2012	08/06/2012	08/06/2012

Drawing No. AME - 06090

Revision: A

APPENDIX B – Deltares Report for The Environment Agency

Background

Two port developments on the north and south banks of the Humber Estuary are going through the planning process. Associated British Ports (ABP) are progressing a major north bank scheme (Green Port Hull, abbreviated as GPH). Able UK is promoting a south bank scheme (Able Marine Energy Park abbreviated as AMEP). EIA studies are available for both developments, both considering the cumulative environmental effects of the combined developments. Herein disagreement exists about whether or not the south bank scheme (AMEP) will have detrimental effects on estuarine functioning and result in further indirect losses taking place. The Environment Agency (EA) is responsible for meeting coastal squeeze losses. For this reason EA commissioned Deltares to provide an independent assessment of the claims being made.

This memo reports the results of the first part of the work, which is a desk assessment of the correspondence EA has received and of the Environmental Statements. The first section below summarizes our conclusions and gives some recommendations. The subsequent sections substantiate the conclusions by first summarising the relevant findings from the assessments of the two studies, followed by a more detailed evaluation of the impacts of the developments on the estuarine processes, i.e. the hydrodynamics, sediment transports and morphology.

Conclusions and Recommendations

For both developments, GPH and AMEP, extensive and detailed studies have been carried out for making the Environmental Statements. The relevant parts of the documents reporting the studies have been assessed in a short desk study. The conclusion from this first assessment is that both studies are sound in assessing the environmental impacts for the development they consider. Each of the studies supply detailed assessments of the impacts of its own development. We did not find indications pointing at underestimated effects in the EIA studies.

As required, both studies address the combined and cumulative effects by considering the other ongoing and planned developments. For this purpose the study on GPH has considered the impacts of AMEP, and vice versa. However, both studies lack details of the other development, apparently because of the insufficient availability of information. Therefore the evaluations of the combined and cumulative effects are precautious, as they should.

As repeatedly stated in the EIA documents for the GPH development, the assessment of the effects of AMEP is based on results of preliminary modelling because the results of detailed modelling study were not available. The statements on the effects of AMEP are meant for a precautionary evaluation of the combined and cumulative effects in the EIA of GPH. Therefore EA is advised to interpret those statements strictly in this manner.

As follow up we recommend the EA to ask the consortium who carried out the study for AMEP to present the results of the TELEMAC model concerning the impacts of the AMEP scheme to the water levels and tidal currents. This will help to answer questions that emerged from our assessment of the EIA documents for the AMEP development (see following Section). It would also be desirable to carry out the sand transport modelling using the TELEMAC model and compare the results with those from the CMS – model. It

would be ideal if both developments would be simulated with a same model with comparable resolutions of the computational grid at both sites.

AMEP documents

The following documents from the study on the AMEP development have been received from EA and assessed:

08 - Hydrodynamic and Sedimentary Regime.pdf

09 - Water and Sediment Quality.pdf

13.1 - Flood Risk Assessment and Drainage Strategy.pdf

32 - Hydrodynamic and Sedimentary Regime.pdf

32.1 Compensation site geomorphology.pdf

32.2 Hydraulic model set up report.pdf

32.3 Compensation site breach design report.pdf

32.4 Compensation site model test report.pdf

32.5 - Compensation site sedimentation and erosion.pdf

32.6 - 110ha Compensation site model test report.pdf

33 - Water and Sediment Quality.pdf

36 - Drainage and Flood Risk.pdf

44 - In-Combination.pdf

8.1 - AMEP Estuary Modelling Studies Report.pdf

8.2 - Geomorphological Review of the Humber.pdf

8.3 - Assessment of the Effects on Fine Sediments.pdf

8.4 - Dredging Plume Dispersion.pdf

9.1 - Bathymetry Hydrography Survey.pdf

9.4 - Water Framework Directive Assessment.pdf

9.5 - Anglian Water Letter.pdf

9.6 - Assessment of relocation EON outfall.pdf

92-ASS~1.PDF (draft internal document for review)

93-ASS~1.PDF (draft internal document for review)

Our assessment focused on those parts concerning the effects on estuarine processes, i.e impacts on the hydrodynamics, sediment transports and morphology. Relevant findings from the assessment of these documents are summarised as follows:

- Two different numerical models have been applied for evaluating the various effects of the AMEP scheme:
  - A 2DH hydrodynamic model based on CMS – Flow is used for the effect on water levels and currents and bed shear stresses. The results of this model are also used for the effect on short-term sediment transport processes and suspended sediment concentrations.
  - A 3D hydrodynamic model based on TELEMAC is set up and used in combination with DELWAQ for the effects on fine sediments.
- The results of the TELEMAC hydrodynamic model for the effects on water levels, currents and bed shear stresses are not presented. This is a pity as the results could be compared with those from the CMS model in relation to the next observation.
- The proposed development consists of: i) a quay, ii) an area of dredged depths comprising the berthing areas and approach channels, and iii) an area of compensation land exposed to the Estuary on the north bank. The hydrodynamic modelling results are from model runs without taking into account of the compensation area on the north bank (5.6 of document 8.1 AMEP Estuary Modelling Study Report). The quay has the effect that it decreases the tidal storage (volume between HW and LW) and the volume under LW, whereas the dredging increases the volume under LW. The combined effect on the volume under LW is an increase (5.8 of document 8.1 AMEP Estuary Modelling Study Report). In terms of hydrodynamics it means a decrease of the storage width and an increase of the cross-sectional area for flow. Based on the experience of earlier studies (Wang and Jeuken, 2004; Jeuken et al., 2007) initially a (small) increase of the tidal range through the estuary would be expected. However, the presented results show the opposite, a reduction in tidal range. A possible explanation is that the detailed model simulates circulations at the two (especially the north) ends which effectively decrease the local flow carrying cross-sectional area while the storage width remains the same. Another, additional explanation could be that the dredging in front of the quay is not fully implemented in the simulation. The following observation triggers this suspicion:
- The model results show increased peak flow velocities in the majority of the dredged area. Only in a small strip directly next to the quay, a reduction in peak velocities is simulated.
- The results of the short-term sediment transport simulations (Figure 27 in document 8.1 AMEP Estuary Modelling Study Report) point at additional sedimentation, which is remarkable given the predicted pattern of the change in flow velocity field.

GPH documents

The following documents from the study on the GPH development are received from EA and assessed:

0326_001.pdf (draft internal document for review)

10 Water Quality, Drainage and Flood Risk FINAL.pdf

1203-0099-m-Review EIA documents GPH & AMEP.doc (draft internal document for review)

1203-0100-vdraft-m-Review EIA documents GPH & AMEP.doc (draft internal document for review)

2 Need and Alternatives FINAL.pdf

21 Cumulative and Combined Effects FINAL.pdf

9 Coastal and Estuarine Processes FINAL.pdf

Appendix 10C FINAL.pdf

Appendix 9A FINAL.pdf

Chapter 10 Figures FINAL.pdf

Chapter 2 Figures FINAL.pdf

Chapter 21 Figures FINAL.pdf

Chapter 9 Figures FINAL.pdf

Compensation. PDF (re-issued as ABPmer Report R1975 260412.pdf)

Environment Agency Response 23.02.12.pdf

GPH IROPI hcc draft 23 Mar 12.doc

Green Port Hull habitat regs step guide.doc

hcc aa 23 3 12.doc

In combination update -ABPmer 22-3-12 (2).pdf

Our assessment focused on those parts concerning the effects on estuarine processes. Relevant findings from the assessment of these documents are summarised as follows:

- The EIA for GPH concerning coastal and estuarine processes is based on the 1D and 2DH numerical modelling of the consented Quay 2005 development. This is why no model simulation including AMEP is carried out in the study for evaluating the combined and cumulative effects. Evaluation for AMEP is based on preliminary modelling results from the AMEP-study.
- In their report "21 Cumulative and Combined Effects FINAL.pdf" they refer to the study "JBA (2011) South Humber Channel Marine Studies: Hydrodynamic, Wave and Sediment Study. Report to Yorkshire Forward". This latter study does not seem to be the same study as the one assessed in this desk study, i.e. "8.1 - AMEP Estuary Modelling Studies Report.pdf". This may explain why the effects of AMEP on the currents reported in paragraphs 21.152 and 21.153 of the GHP study "21 Cumulative and Combined Effects FINAL.pdf" are larger than those reported in the AMEP study. All the other statements saying that the effects of the AMEP development would be substantial are related to these larger effects on the currents.
- Obviously, a different set of models is used than the models used in the AMEP-study.
- Infilling of the dock and reclamation will require sediment dredged elsewhere. The dredging of the infilling material is not considered in the GPH study, probably because the dredging will take place outside the estuary, except that the dredged material from the IOTA development may be used for this purpose.
- It is proper to use the worst scenario for combined and cumulative impact as long as it is meant for evaluating the impact of the development under consideration. Presumably, this is not meant for judging the other developments, especially when no detailed information of another development is used.

Impact on estuarine processes

The results from the Geo Studies in the Humber Estuary Shoreline Realignment Project may be used as reference for evaluating the developments under consideration (See Wang and Jeuken, 2004; Jeuken et al., 2007). In that study various set backs along the shorelines of the Humber Estuary have been considered. The set backs have the effect that the size of the estuary, especially the intertidal zone, is increased. This is opposite than the effect of the developments of GPH and AMEP. Nevertheless, the experience obtained in that study is still relevant. Both the GPH and the AMEP developments are relatively small compared with the set backs considered in that study. Therefore, the impacts of both developments, especially concerning the large-scale and long-term effects, will be limited (see the appendix for a more quantitative consideration of effects).

It is obvious that the effects of a development depend on the size of the development, the larger the size, the more serious the effects. The size of a development should be measured with the volumes of the development in the intertidal zone and in the sub-tidal zone. The AMEP development is much larger than the GPH development. However, the difference in size between the two developments seems not sufficient to explain the reported differences in the impacts on current field by the GPH-document "21 Cumulative and Combined Effects FINAL.pdf".

As a matter of fact the reclamation for a development will simply block the local current field. This means that the maximum reduction of the current by a development is simply the maximum magnitude of the current along the edges of the development. However, this is a local effect and it should be clearly distinguished from the larger scale effects in the discussion. Whether local or large scale effect is considered depends on the model used. That different models are used in the two studies is the most logical explanation of the exaggerated differences between the effects of the two developments reported by the GPH-study.

It is noted that the local effects on the current field of a development determined by a numerical model can be dependent on the resolution of the model grid. Sufficient resolution of the model grid is needed for correctly modelling the local effects on the current field. Furthermore, one of the local effects is the generation of a circulation zone behind the development, as shown in the numerical modelling study for the AMEP development. For a correct representation of this circulation zone the horizontal eddy viscosity is an important model parameter. However, the setting of this parameter is usually considered not important in 2DH flow models as usually only the large–scale effects are considered. It is noted that validation of the models concerning the local effects is not given for any of the models used in the two studies for GPH and AMEP developments respectively. It is important to use the same or at least comparable models concerning model grid resolution and parameter setting when the local effects of the developments are compared with each other.

Another issue is the disposal of the material from capital dredging. In the GPH documents it is mentioned that the large amount of the material dredged during the AMEP development will cause problems at the disposal sites, which will not have sufficient space to accommodate all the dredging material from the various developments. This issue is not considered in detail here as detailed information about the disposal sites is not available and needs to be checked by the AMEP consortium.

References

Wang Z.B. and M.C.J.L. Jeuken, 2004, Long-term morphologic modelling of the Humber Estuary with ESTMORPH, The future morphologic evolution and the impact of set backs, Report Z3451/Z3521, WL | Delft Hydraulics.

M.C.J.L. Jeuken, Z.B. Wang and D. Keiller, 2007, Impact of setbacks on the estuarine morphology, In Dohmen-Jansen, C.M. and S.J.M.H. Hulscher (eds.), River, Coastal and Estuarine Morphodynamics, RCEM2007, Taylor & Francis, 2008, London, pp1125-1134.

Appendix - Effects on intertidal area

Basically, a realignment development (reclamation or setback) in an estuary may affect the intertidal area in three ways (Jeuken et al., 2007): (1) its direct effect, (2) change due to change of tidal range, (3) morphological change due to sedimentation and erosion. Effect (1) is local at the realignment site and it is a sudden change in time, i.e. takes place immediately after the realignment and can be considered to remain constant in time. Effect (2) is in principle through the whole estuary and it takes place immediately after the realignment and will change in time due to effect (3). Effect (3) is a gradual change in time and can in principle occur through the whole estuary. A realignment development causes thus an initial change (effects 1 & 2) as well as a change in time (effects 2 & 3) for the intertidal area. The change in time causes a long-term effect, which can be a gain or a loss of intertidal area depending on the type as well as the location of the development.

The AMEP development consists of a reclamation on the south bank of the estuary and a setback as compensation on the north bank, both in the mid – estuary zone. The reclamation has a size of 45 Ha of which 31.5 Ha in the intertidal zone and 13.5 Ha in the subtidal zone. The setback has a size of about 100 Ha, at an elevation of about ODN + 2.5 m which is around the MHW. Effect (1) for the intertidal area is thus -31.5 + 100 = + 68.5 Ha. Additionally, there is a direct functional loss [1]of 6 ha (in sector E), resulting in a total direct loss of inter-tidal area of 37.5 ha. The initial compensation ratio for the intertidal area is 100:37.5 = 2.7. The compensation ratio for the entire reclamation is 100:45 = 2.2

The combined effect of the reclamation and the compensation site on the tidal prism is a decrease, even for spring tide. MHWS = 3.4 m and MLWS = - 3 m, so the increase of tidal prism due to the compensation site is about (100 Ha * 0.9 m) 0.9 million m^3. The sub-tidal part of the reclamation causes a decrease of the tidal prism of 6.4 m * 13.5 Ha = 0.9 million m^3. The intertidal part of the reclamation will also cause about 1 million m^3 (31.5 Ha * 0.5 * 6.4 m) decrease of the tidal prism during spring tide. During neap tide the compensation site will not be flooded. Therefore the combined effect on the tidal prism is always a decrease. The dredging causes an increase of the sub-tidal water volume of the estuary which is larger than the decrease resulting from the reclamation, causing an increase of the tidal range. Therefore, the initial part of effect (2) is an extra (small) gain in intertidal area because of the expected increase of the tidal range.

For the long-term morphological development it is expected that sedimentation will take place seaward of the development and erosion landward of the development. For the evaluation of this part of the effect reference is made to the development of Sunk Island setback (because of comparable location along the estuary) reported by Jeuken et al. (2007). The trend of the development will be opposite, i.e. a long-term loss due to the AMEP development instead of the long-term gain reported in Jeuken et al. (2007) for the Sunk Island setback case. The long-term gain for the Sunk Island setback case is about 5% of the size of the development after 50 years. If this relative number is applied to the AMEP case it will mean a loss of intertidal area of about 3 Ha (68.5 * 0.05) after 50 years and an equally large gain of sub-tidal area (i.e. intertidal area changed into subtidal area). For the change after 100 years the loss is estimated to be about 5 Ha (the rate of change decreases in time, although no more reference to the

[1] It is assumed, that functional loss implies a loss in e.g. ecological value without affecting the intertidal character of Sector E.

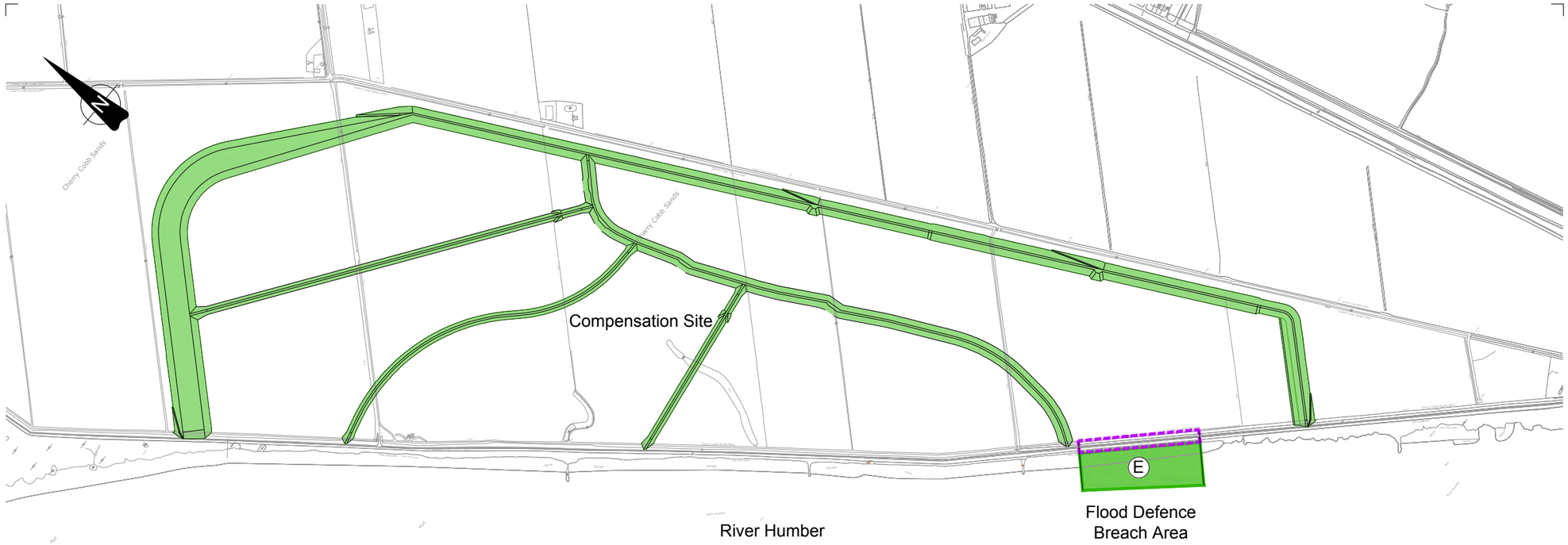
earlier study can be made). To deal with uncertainties we may take a factor 2 for the lower and the upper limits of the changes, resulting in 2 to 7 Ha loss after 50 years and 3 to 10 Ha after 100 years.

For the worst scenario after 100 years we take the upper limit of the long-term loss and ignore the initial part of effect (2), the remaining total gain of intertidal area will be about 58 Ha, i.e. 10 Ha has changed into sub-tidal area. The compensation ratio for the intertidal area is then about 1.8 (58:31.5). Taking the functional loss of 6 Ha into account as well, the compensation ratio for the intertidal area is 1.6 (58:37.5). The compensation-ratio for the entire reclamation will stay the same (i.e. 2.2) as intertidal losses will result in sub-tidal gains.

The GPH development will influence the estuary by reclamation of 7.5 Ha, 4.5 Ha in the intertidal zone and 3 Ha in the sub-tidal zone. This concerns a very small development, and it is a consented development. The long-term development will cause a similar relative loss as discussed above. For the worst case scenario this will be about 0.6 Ha (≈10*4.5/68.5) after 100 years. This is calculated with the same rule as in the AMEP case. Note that the 4.5 Ha initial change is a loss instead of gain in the AMEP case. Motivation that the long-term effect will be a loss is that the reclamation will cause a small increase of the tidal range in the estuary. The long-term increase in tidal range will be associated with increasing current velocities and erosion. During this erosion process intertidal area will be transformed into subtidal area. Thus the estimated loss of about 0.6 ha of intertidal area implies an equal gain for the sub-tidal zone.

ANNEX 3

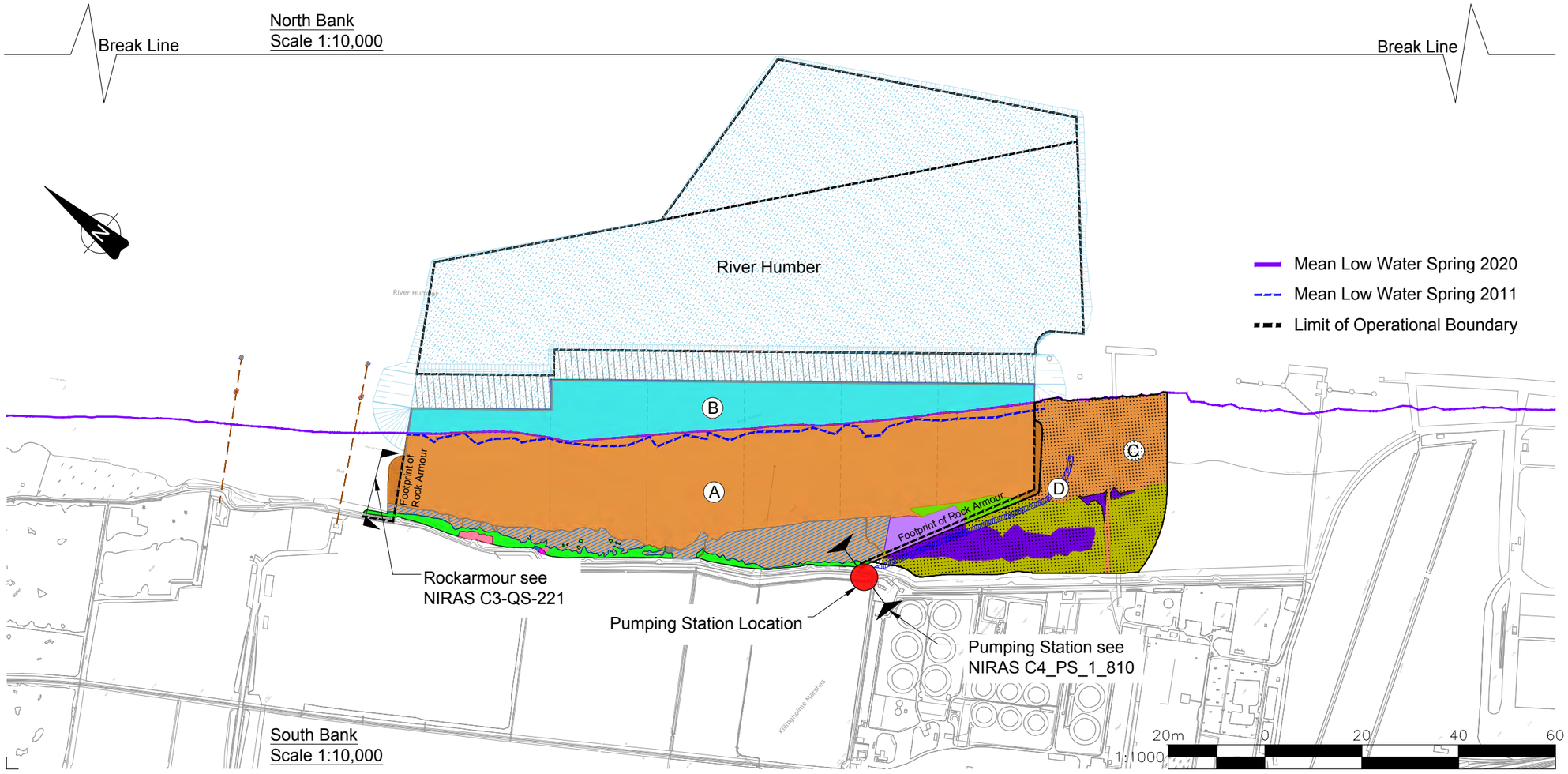
Drawing: AME – 06077E Habitat Impacts (2021)



North Bank
Scale 1:10,000

Break Line

Break Line



South Bank
Scale 1:10,000

Key & Notes

Direct Impacts

A
Mudflat Loss (H1140) - 31.3ha
Saltmarsh (H1330) - 1.9ha

Mudflat / Scattered Saltmarsh

Mudflat -	261,217m²
SM6 (small stands) -	43,308m²
Scattered Saltmarsh -	8,701m²
Total	**313,226m²**

Saltmarsh

Dense Saltmarsh -	5,010m²
SM6 -	12,158m²
SM12 -	1,098m²
SM8 -	289m²
SM21 -	88m²
SM4 -	73m²
Total	**18,716m²**

B Subtidal Habitat Loss (H1130) - 10.4ha

C **Limit of Operational Disturbance**

Mudflat (H1140)	- 5.5ha
Dense Saltmarsh (H1330)	- 4.7ha
Scattered Saltmarsh (H1310)	- 2.2ha
Total	**12.4ha**

D Drainage Channel & Pumping Station

E Flood Defense Breach Area (H1330) - 2ha

Rev.	Date	Comments	Drn	Chk	App
E	14/12/2021	Key Notes Amended	DJA	RC	RC
D	12/04/2021	Direct Mudflat Loss Amended	DJA	RC	RC
C	01/04/2021	North Bank Compensation Site Amended South Bank Quay Amended	DJA	RC	RC
B	17/05/2012	North Bank Added	RK	JD	RC
A	13/04/2012	Preliminary Issue	JH	RC	RC

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Project: ABLE Marine Energy Park

Client: ABLE UK Ltd

Drawing Title: Habitat Impacts

PRELIMINARY

Scale:	Drawn By	Checked By	Approved By
As Shown@A3	J Harris	R Cram	R Cram
Date:	13/04/2012	13/04/2012	13/04/2012

Drawing No: AME - 06077 Revision: E

14/12/2021 11:43:16

ANNEX 4

Correspondence with The Environment Agency

Richard Cram

From: Hewitson, Annette [redacted]@environment-agency.gov.uk>
Sent: 11 June 2021 14:53
To: Richard Cram
Cc: Steve Percival
Subject: RE: AMEP MC2 EA response required to NE Query

Dear Richard,

Yes I can confirm that report remains valid and the assessment is appropriate for your Material Change 2 proposal.

Kind regards,
Annette

Annette Hewitson | Principal Planning Adviser
Lincolnshire & Northamptonshire Area
Environment Agency | Ceres House, Searby Road, Lincoln LN2 4DW

[redacted]@environment-agency.gov.uk
☎ [redacted]

From: Richard Cram [mailto[redacted]@ableuk.com]
Sent: 09 June 2021 12:22
To: Hewitson, Annette [redacted]@environment-agency.gov.uk>
Cc: Steve Percival [redacted]@ecologyconsult.co.uk>
Subject: AMEP MC2 EA response required to NE Query

Annette,

NE's response to the PEIR contains the follwing extract:

> **b) Effect of AMEP on the hydrodynamics of the estuary and on estuarine habitats**
>
> In the SOCG, a report to the Environment Agency (EA) by Deltares in 2012 reviewing the longer term impacts of Green Port Hull and AMEP on the Humber Estuary was used to assume a 5ha change of intertidal mudflat habitat to sub-tidal over a 100 year timescale. This resulted in the provision of 10ha intertidal mudflat compensation, taking account of the 2:1 ratio for compensatory habitat. Natural England advises that the EA should confirm whether this assessment remains relevant.

For ease of reference the relevant Deltares report is attached at Appendix B of EX11.25 attached and the refence to 10 ha is on the final page.

Can you please confirm that the report remains valid.

Kind regards

RICHARD CRAM
Engineering Director

Able UK Ltd
Able House
Billingham Reach Industrial Estate
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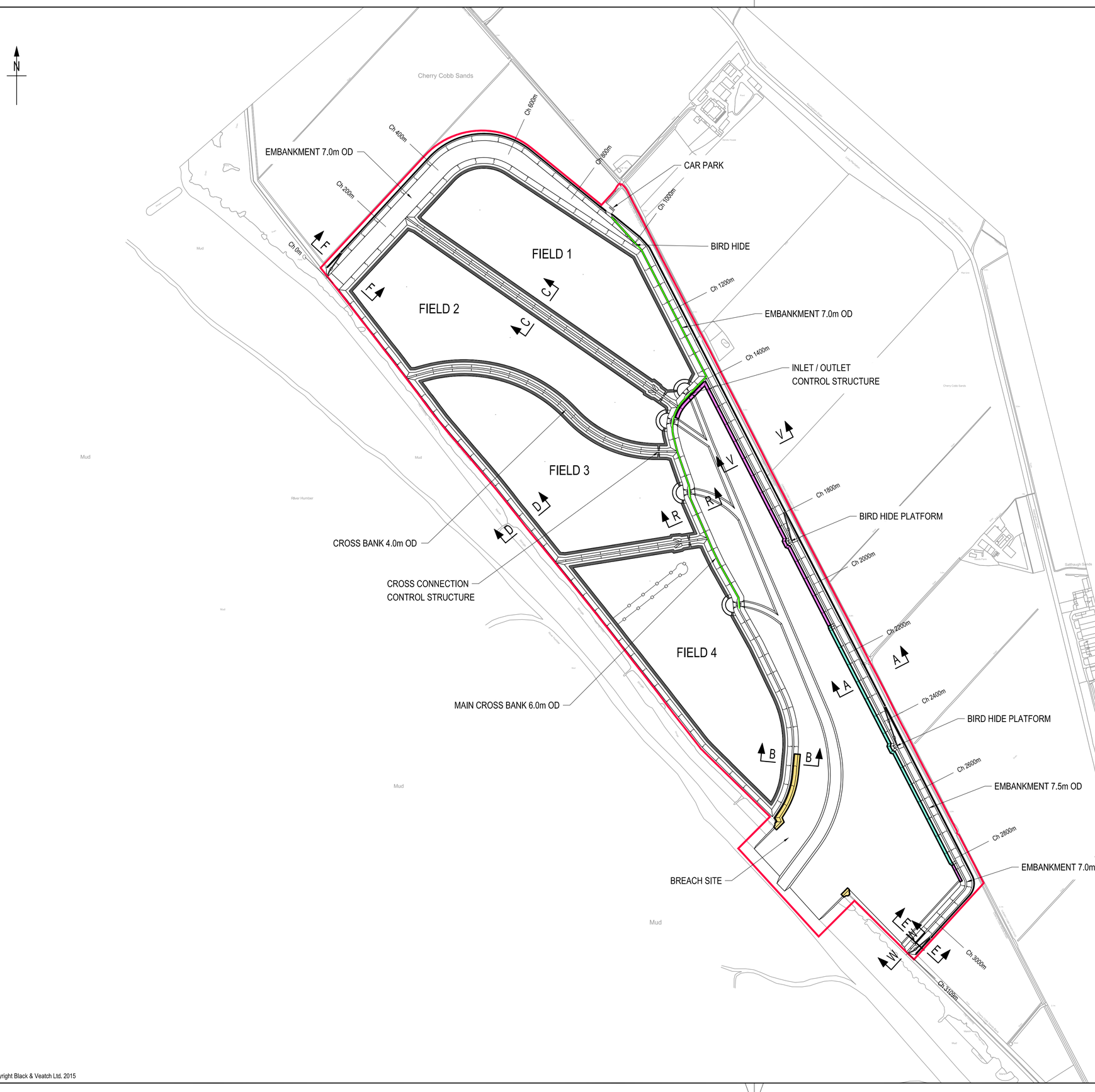
Teesside TS23 1PX

[redacted]
Email: [redacted]@ableuk.com
Web: www.ableuk.com

ANNEX 5

Drawing 122437-BVL-Z0-SW-DR-C-00002-CC01: Cherry Cobb Sands RTE, Proposed Site Plan



FIELD AREAS (ha)		
FIELD	TOTAL	EXCLUDING DITCHES
1	18.0	16.8
2	18.2	16.9
3	17.9	16.8
4	17.9	16.8
RTE	30.4	26.3

Note: The limits, including the height and depths of the Works, shown in this drawing are not to be taken as limiting the obligations of the contractor under Contract.

Notes

1. All dimensions in millimetres unless stated otherwise.
2. All levels in metres above Ordnance Datum (m OD) unless stated otherwise.
3. Sections show final required level; settlement allowances not included. Allowances are:
   Embankments to 7.0mOD and 7.5mOD - 175mm
   Embankments to 6.0mOD - 115mm
   Embankments to 4.0mOD - 45mm

References

- For 'Embankment Cross Sections - 1 of 4' see Drg. no. 122437-BVL-Z0-SW-DR-C-00031, for 'Embankment Cross Sections - 2 of 4' see Drg. no. 122437-BVL-Z0-SW-DR-C-00032 and for 'Embankment Cross Sections - 4 of 4' see Drg. no. 122437-BVL-Z0-SW-DR-C-00031.
- For 'Footpath Diversion Plan' see Drg. no. 122437-BVL-Z0-SW-DR-C-00003.

Legend

- Access track to control structures
- 'ARMORFLEX 180' or similar approved
- 'ARMORFLEX 140' or similar approved
- Rock armour
- Site boundary

Safety, Health and Environmental information
In addition to the hazards or risks normally associated with the types of work detailed on this drawing, the following significant residual risks should be noted. Further details are included in the CDM Design Risk Management Register.
Construction:
1. Possible presence of UXO within site boundary. See UXO survey. 2. Contaminants and asbestos present in grass. See ground investigation report.
Maintenance, cleaning and operation:
1. Maintenance only during daylight hours and no lone working recommended.
Decommissioning or demolition:
1. As construction.

100m 0m 100m 200m 300m

Scale 1:5000

Rev	Drawn	Chkd	Rvwd	Aprvd	Date	Description
P01	SPJ	SPC	SB	RAF	12/10/15	Suitable for client review, comment and/or approval
P02	SPJ	SPC	ET	RAF	12/11/15	Suitable for client review, comment and/or approval
P03	SPJ	SPC	SB	RAF	11/12/15	Suitable for client review, comment and/or approval
P04	SPJ	SPC	ET	SB	21/01/16	Suitable for Construction Approval
P05	SPJ	SPC	SB	RAF	05/02/16	Suitable for Construction Approval
CC01	SPJ	SPC	SB	RAF	12/04/16	Issued For Construction

Designed by: SPC Date: 30.SEP.15

Client

able www.ableuk.com

Client Drawing No. | Revision

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Black & Veatch Limited
Grosvenor House, 69 London Road, Redhill, Surrey, RH1 1LQ, United Kingdom
Tel: +44(0)1737 774155

Project

CHERRY COBB SANDS RTE

Drawing title

PROPOSED SITE PLAN

Drawing scale: 1:5000 Sheet size: A1

Drawing no. 122437-BVL-Z0-SW-DR-C-00002 | Revision CC01

ANNEX 6

Compensation Environmental Management and Monitoring Plan

COMPENSATION ENVIRONMENTAL MANAGEMENT & MONITORING PLAN

DECEMBER 2015

Able UK Ltd
Able House,
Billingham Reach Industrial Estate,
Teesside
TS23 1PX
Tel: 01642 806080 Fax: 01642 655655

APPROVAL & REVISION REGISTER

	NAME	SIGNATURE	DATE
Originator:	C. Brewis	CBrewis	16-10-2015
Checked by:	N. Jarvis	NJarvis	16-10-2015
Approved by:	R. Cram	[redacted]	16-10-2015

REVISION	COMMENTS	DATE
A	Revised Layout	14-09-2015
B	Amended following NE consultation comments	17-12-2015
C	NE Approval following revisions – Final Document Issue	16-01-2016

CONTENTS

1 INTRODUCTION

1.1 GENERAL

1.1.1 The development of the Able Marine Energy Park (AMEP) east of North Killingholme on the Lincolnshire Coast will partly affect the Humber Estuary Special Area of Conservation (SAC) and the Special Protection Area (SPA) / Ramsar site. Measures to both compensate and mitigate for the effects of AMEP on these European sites have been identified, and will be implemented as part of any future development.

1.1.2 This document is a Compensation Environmental Management and Monitoring Plan (CEMMP) for the compensation sites and it has been drawn up taking account of guidance on management planning produced by the Conservation Management System (CMS) Consortium (www.cmsconsortium.org). It describes the compensation measures that are required and lists specific objectives which are fundamental to their delivery. Further it includes targets and management actions which support the objectives and the monitoring which will be undertaken to confirm progress towards the objectives, and ultimately confirming that they have been achieved. Limits of acceptable change are defined and any necessary remedial actions which will be undertaken should the monitoring show that these limits have not been met.

1.2 PROCESS OF FINALISING OUTSTANDING TARGETS

1.2.1 The compensation proposals for AMEP are complex, and the objectives and targets / management options included in this version of the CEMMP have been subject to extensive discussions with stakeholders.

1.2.2 The CEMMP is a live working document which will be in place for as long as it is deemed necessary to achieve the agreed objectives set out in it. Updates to it will be overseen by the Steering Group (see Paragraph 1.6), whose role is explained below and includes undertaking a complete review of the EMMP every five years.

1.3 PRINCIPLE FOR REVIEW OF BENTHIC SPA BIRD PREY TARGETS

1.3.1 The benthic target protocol set out in this CEMMP is based on the current understanding of the benthic communities at North Killingholme Marshes (NKM) foreshore. It is understood that the targets can only be finalised once the baseline benthic surveys at NKM and Cherry Cobb Sands (CCS) have been completed. This will occur prior to the start of any work on AMEP that involve the loss of mudflats at the NKM foreshore, or disturbance to SPA birds that use it. The following considerations will need to be taken into account when reviewing the targets:

- The compensation site needs to function like the mudflats on NKM foreshore for black-tailed godwits and other waterfowl, and must support the benthic prey that the birds require. The review of the evidence will assess the presence of patches of high prey density and appropriate size classes associated with the numbers of foraging black-tailed godwits it has to support. The findings of the annual benthic

monitoring will be set in context within the agreed target range, taking account of natural changes at the control site(s).

- The ability of univariate and multivariate analysis techniques along with biotope mapping to adequately characterise the necessary functional aspects of Killingholme so they can be replicated within the compensation area will need to be considered; not just peak areas of prey density but also biomass of specific key prey species, only a proportion of which will represent those individuals within a suitable size range to be consumed by specific birds.

- The benthic targets will be set taking account of the energetic requirements of the black-tailed godwits. These will be defined through a combined assessment of the baseline benthic surveys of the mudflats on the NKM foreshore and the identified feeding locations of the birds.

- One of the key concerns is to avoid a situation where benthic targets are met in a single year, but with additional years' survey effort are shown to be consistently at the bottom end of the target range. This could provide sub-optimal habitat for supporting the peak numbers of black-tailed godwits, which are currently using the NKM foreshore in internationally important numbers. The regular review process will focus on benthic distribution, density, size classes and feeding requirements of black-tailed godwits, along with the numbers of birds using the site (see Annex 3 – Target Setting Protocol). This will identify sub-optimal performance early, and allow remedial management actions to be undertaken. Targets will be reviewed and the effectiveness of management actions monitored.

1.3.2 As the CEMMP is a live document it allows the current targets to be re-evaluated and adjusted as and when necessary, including once the baseline benthic surveys have been completed. The Steering Group will oversee the review of the baseline benthic survey findings, and the revision of the benthic targets based on the review findings. The Group may also agree to draw on additional external expertise if required. The cost implications to Able Humber Ports Limited (AHPL) of any changes, or additional support, will be subject to reasonable agreement between AHPL and the Steering Group.

The Benthic SPA Bird Prey Targets will be set-out in a separate document once the baseline benthic surveys at NKM and Cherry Cobb Sands (CCS) have been completed and the results analysed. This document will be made available in early 2016.

1.4 THE STEERING GROUP

1.4.1 AHPL will have overall responsibility for the implementation and delivery of the CEMMP. However, the involvement of other stakeholders is essential for the effective working of the CEMMP, and hence AHPL will establish a Steering Group whose members and terms of reference are set out in a 'Deed in Relation to the Able Marine Energy Park', between Able Humber Ports Limited and Natural England.

1.4.2 An agenda will be drawn up in advance of each Steering Group meeting by AHPL and minutes will be produced after the meeting by AHPL for agreement.

1.4.3 Unless otherwise stated, the default duration for the ecological survey work (e.g. saltmarsh intertidal and subtidal benthos and fish communities described within this document is 10 years. Continuance of any of these components beyond that period will be determined through discussion on findings etc. by the Steering Group. It is expected that some components of the compensation and the mitigation will require on-going management to ensure that the objectives continue to be met.

2 ENVIRONMENTAL BASELINE AND IDENTIFIED IMPACTS

2.1 INTERTIDAL HABITATS

Baseline North Killingholme Marsh (NKM)

2.1.1 The baseline is described in EX28.3 Part 2 in terms of historical trends, mud type, benthic community and bird populations. This identified that the shore was eroding but has entered a phase of accretion since 2000 after the construction of the Humber International Terminal. As a result, over the last 10 years the intertidal area that lies between the Mean High Water Neaps (MHWN) and Mean High Water Springs (MHWS) elevations has increased from 3.27 ha to 18.95 ha, an increase of 15.68 ha. The sediments are composed of a high proportion of fine silts giving soft and sloppy mud. The upper shore is subject to colonisation by Spartina anglica (Common Cord-grass) dominated saltmarsh. Table 1 summarises the benthic population (details of the methodology are given in Annex 10.1 of the Environmental Statement (ES). Biomass is wet (blotted) weight in grams. Further data is provided in the Marine Environmental Management and Monitoring Plan (MEMMP).

2.1.2 Further invertebrate sampling work will be undertaken in Autumn 2015 and Spring 2016 to provide a new preconstruction baseline and identify targets for the compensation site.

Table 1: Intertidal Abundance and Biomass of Principal Species

Abundance								
species	(12 x 0.01m^2 samples)	per m^2	species	(12 x 0.01m^2 samples)	per m^2	species	(12 x 0.01m^2 samples)	per m^2
Tubificoides benedii	268	2233	*Tubificoides benedii*	271	2258	*Streblospio shubsolii*	91	758
Hediste diversicolor	114	950	*Corophium volutator*	202	1683	*Corophium volutator*	88	733
Corophium volutator	109	908	Nematoda	93	775	Nematoda	21	175
Streblospio shubsolii	50	417	*Streblospio shubsolii*	50	417	*Tubificoides swirencoides*	16	133
Nematoda	49	408	*Macoma balthica*	47	392	*Tubificoides benedii*	15	125
Biomass								
Upper Shore			Mid Shore			Lower Shore		
species	(12 x 0.01m^2 samples)	per m^2	species	(12 x 0.01m^2 samples)	per m^2	species	(12 x 0.01m^2 samples)	per m^2
Hediste diversicolor	2.86	23.83	*Macoma balthica*	1.55	12.92	*Macoma balthica*	0.21	1.75
Corophium volutator	0.42	3.50	*Corophium volutator*	0.45	3.75	*Corophium volutator*	0.13	1.08
Macoma balthica	0.27	2.25	*Tubificoides benedii*	0.2	1.67	*Hediste diversicolor*	0.07	0.58
Tubificioides benedii	0.17	1.42	*Hydrobia ulvae*	0.02	0.17	*Mysella bidentata*	0.06	0.50
Streblospio shubsolii	0.01	0.08	*Streblospio shubsolii*	0.01	0.08	*Streblospio shubsolii*	0.03	0.25
Total biomass per m2		**31.08**			**18.58**			**4.17**

Note: once target abundance has been agreed from benthic survey work, abundance and biomass will be combined to provide suitable prey sizes/quality targets for the compensation site.

Impacts

2.1.3 Details of agreed impacts are provided in the Statement of Common Ground (SoCG) on the Shadow Habitat Regulations Assessment (sHRA). Habitat losses are detailed in Annex B and the amount of compensatory habitat that will be delivered is summarised in Table 2.

Table 2: Compensatory Habitat to be delivered (ha)

	Habitat Type			
	Saltmarsh	**Intertidal Mudflat**	**Sub-tidal (Estuary)**	**Total**
SPA	0	88	13.5	101.5
SAC	0	73.4	21.2	94.6

2.1.4 A combination of direct and indirect losses associated with the site together with long term losses in the Humber identified by the Environment Agency provide a requirement to replace a long term loss of 101.5 ha of habitat of which 88 ha is intertidal and 13.5 ha is sub-tidal. This total reflects the SPA habitat losses which are higher than those of the SAC (21.2 ha of estuarine and 73.4ha of intertidal) as they include functional loss of use to

birds through disturbance. They also reflect the requirement to replace intertidal habitat on 2:1 basis (due to uncertainty) and other habitats on a 1:1 basis. Sub-tidal habitat can be replaced by other estuarine habitats such as saltmarsh.

2.1.5 Nine species of bird were identified as likely to be displaced by direct habitat loss and functional disturbance to the extent that an impact on site integrity was anticipated. This assessment was based on peak counts. These peaks were all recorded from the Through the Tide Counts (TTTC) reported in Annex 11.9 Marine Energy Park Bird Survey Results April 2010 to April 2011 of the ES. These peaks were all higher than the five year mean peaks reported from WeBs counts for the period 2004/05-2008/09.

Table 3: Bird Species

Species	Humber Qualifying Population	Humber Min & Max Peaks (WeBS 2004/5-2008/09)	NKM Peak & % of Humber population represented by Peak	% Foraging during peak count
Avocet (breeding)	493	374-652	4 (0.8%) TTTC	100
Bar-tailed Godwit	5926	1490-5926	123 (3.2%) TTTC	98
Black-tailed Godwit	3887	2435-5323	2566 (66%) TTTC	49
Curlew	4440	3071-5180	158 (3.6%) TTTC	49
Dunlin	21518	14733-26305	1029 (4.8%) TTTC	99
Lapwing	18756	11700-27421	325 (1.7%) TTTC	0
Redshank	5445	3886-8494	540 (9.9%) TTTC	98
Ringed Plover	2168	781-2168	210 (9.7%) TTTC	88
Shelduck	5314	2892-5804	109 (2.0%) TTTC	95

2.1.6 Effects arising from piling on marine mammals and sea lamprey are dealt with in the MEMMP.

Baseline Cherry Cobb Sands Saltmarsh

2.1.7 The baseline is recorded in Annex 35.1 of the AMEP Environmental Statement (ES). A description of the saltmarsh that will be affected by the works is included in Annex 34.1 of the ES, and briefly summarised below.

2.1.8 The upper saltmarsh in the vicinity of Cherry Cobb Sands varies in width from five metres seaward from the base of the existing sea defences at Stone Creek in the south of the site, up to 330m at the Outstray in the north of the site (2010 data). In a similar manner, the width of the mid saltmarsh zone also varies from 60 m in the south to around 300m in the north of the site.

2.1.9 There is dense saltmarsh vegetation cover in the upper and mid saltmarsh zones, with little or no signs of erosion, which indicates that the habitat quality is good. These zones are dominated by sea couch grass Elytrigia atherica (Elymus pycnanthus) with other species of note including sea plantain Plantago maritima, red fescue Festuca rubra and Orache atriplex sp. A network of saltmarsh creeks runs through these zones, allowing

water to drain off following high tide as well as allowing freshwater from the land to discharge into the estuary.

2.1.10 The lower saltmarsh zone is extensive, stretching up to 800m from the edge of the mid saltmarsh zone. It is thought that this zone is gradually accreting. The lower saltmarsh is dominated by 'pioneer' species including annual glasswort Salicornia europea agg. and common cord grass Spartina anglica.

Impacts

2.1.11 Creation of the compensation site will require the removal of 2ha of saltmarsh for the channel in the immediate term.

2.1.12 Compensation for saltmarsh losses will be provided in the managed re-alignment (MR) component of the compensation site.

Baseline for Cherry Cobb Sands Intertidal

2.1.13 Bird surveys (EX35.14) that were undertaken between August 2010 and April 2011, in an area which covered both the intertidal habitats at CCS and the farmland which will form the compensation site, showed that the foreshore was used by important numbers of one or more of the qualifying interest species of the SPA/Ramsar site throughout the period August to April. Species such as shelduck, grey plover, curlew, redshank, knot and dunlin were present in numbers usually well in excess of 1% of the Humber Estuary SPA/Ramsar population at both high and low tides in almost all the months surveyed. Curlew was also present on the compensation site fields in important numbers over the autumn passage period (September – October). Other species such as teal, lapwing and golden plover were present in numbers exceeding 1% in October and December to March, with black tailed godwit present in December and January, and bar-tailed godwit in most months between November and April. Passage interest included ringed plover and greenshank both of which were present on the foreshore in important numbers in August, ruff in September, and little egret on the foreshore in October. WeBS counts (see Section 35.7.9 of the ES) show that important numbers of some species can occur even over the summer months (e.g. ringed plover in May and dunlin in July).

2.1.14 EX34.2 provides some information on the temporal and spatial distribution of benthic communities within the Humber estuary, including abundance data for the Cherry Cobb sands area. This is summarised in the Table 4 below;

Table 4: Prey Abundance at Cherry Cobb Sands

Mean per m2	2000	2001	2002
Abra tenuis	1367	937	0
Corophium volutator	51	51	0
Crangon crangon	0	25	0
Cyathura carinata	51	0	0
Enchytraeidae	10937	83443	8759
Eteone longa	228	76	152
Hediste diversicolor	582	1367	1190
Hydrobia ulvae	152	0	329
Macoma balthica	3165	4557	6203
Manayunkia aestuarina	3823	25	0
Nematoda	0	39595	0
Nephtys	0	25	0
Nephtys hombergii	0	0	51
Paranais litoralis	101	0	0
Pygospio elegans	0	51	1975
Scrobicularia plana	0	0	456
Streblospio shrubsolii	0	51	0
Tubificoides benedii	14532	6582	1215
TOTAL	34987	136785	20329

2.1.15 Key prey species for black-tailed godwit are highlighted in yellow and occur in higher abundance than south shore sites during the same period.

Impacts

2.1.16 Works to create the compensation site are not predicted to have significant effects on the SPA bird species. This is largely due to the visual and acoustic screening of the works which is expected from the existing sea defence wall, the diversion inland of the coastal footpath which will remove a source of disturbance to birds on intertidal habitats (which may be having effects at present) without increasing the effects on birds on inland fields, and the timing of the works to cover predominantly the summer months. This is a period when the intertidal habitats are typically less well used by waterbirds, the birds have more choice of location in which to forage and roost, and there is more daylight and good benthic invertebrate food availability across the intertidal mudflats. In addition the creation of the new embankment is several hundred metres away from the edge of the intertidal habitat which is very extensive.

2.1.17 Mitigation to reduce impacts includes timing of the work so that potentially disturbing activities closest to intertidal bird populations occur April to October.

3 TERRESTRIAL HABITATS

3.1 BASELINE FOR THE COMPENSATION SITE

3.1.1 The compensation site comprises the Regulated Tidal Exchange (RTE) and Managed Re-alignment (MR), together with the Cherry Cobb Sands Wet Grassland (CCSWG) and is described in EX28.3 Parts 3 & 4. The existing baseline is provided in Chapter 35 of the ES but updated in EX28.3 Part 6 EIA Review, to reflect the movement of the wet grassland and roost site from Old Little Humber Farm to CCSWG. The current use of the area is arable farmland. The landscape was assessed as having low ecological value. No water voles were present, but colonisation by transient animals cannot be ruled out.

3.1.2 A badger survey is reported in Annex 35.8 of the ES and updated by EX35.13. It found two main social groups associated with two mains setts and a number of outlying and subsidiary setts, with some evidence of a decline in use between surveys.

Impacts

3.1.3 These are described in EX28.3 Part 6 EIA Review and it is concluded that ecological impacts will be largely the same as those predicted in the original ES and be negligible or of minor adverse significance only.

3.1.4 Badger surveys indicated the proposals would result in the loss of 4 outlying setts associated with the group of badgers based at Sett 28, and 5 outlying setts associated with the group of badgers based at Sett 11. None of the affected setts received high levels of use from badgers in either 2011 or 2012, and none were located close to a key seasonal food source or other resource likely to be crucial to the badgers' survival. Given the availability of alternative setts elsewhere within their range, this loss would be unlikely to have a detrimental impact on badgers. A licence to close outlier setts will be required but overall the increase in foraging habitat will be beneficial.

3.1.5 Minor construction impacts could occur for reptiles without mitigation.

3.1.6 The greatest change in impacts related to the Compensation Scheme is apparent during the operation of the scheme, where there will be minor changes to views from a nearby property (Fair View) because of the widened embankment around the RTE scheme, and a minor change to the landscape as a result of the wind pumps at the wet grassland site.

Baseline for North Killingholme Haven Pits (NKHP)

3.1.7 Operational impacts are dealt with in the Terrestrial Environmental Monitoring and Management Plan (TEMMP).

3.1.8 Baseline information on NKHP is in Chapter 11 of the ES and in the sHRA. The site holds significant numbers of the Humber bird population, and those species which are present in numbers of 1% or more of the Humber Estuary SPA populations are summarised in Table 5.

Table 5: NKHP TTTC & WeBs Peaks

Species	Humber Population	Peak/mean of Peak Count	Proportion of Humber Population (%)	Month	Data Source
Assemblage	140197	4112	2.9	Aug	TTTC
		3787	2.7	Sep	WeBS
Avocet	493	16	3	Mar	TTTC
		27	5.5	Mar	WeBS
Black-tailed godwit*	3887	3 800	97.8	Aug	TTTC
		3 338	85.9	Sep	WeBS
Common sandpiper	(46)	1	2.2	Jul,Aug	TTTC
		-	-	-	WeBS
Dunlin	21518	270	1.3	Oct	TTTC
		380	1.8	Nov	WeBS
Grey heron	74	3	4.1	Oct	TTTC
		3	4.1	Sep,Oct	WeBS
Lapwing*	18756	5	<0.1	Oct	TTTC
		276	1.5	Nov	WeBS
Little egret	38	1	2.6	Jun,Jul	TTTC
		-	-	-	WeBS
Little ringed plover	6	2	34	Apr	TTTC
		-	-	-	WeBS
Mallard	2096	34	1.6	Oct	TTTC
		71	3.4	Sep	WeBS
Moorhen	146	4	2.7	Jul	TTTC
		2	1.6	Sep	WeBS
Redshank	5445	249	4.6	Aug	TTTC
		215	3.9	Aug	WeBS
Shoveler	145	61	42.1	Oct	TTTC
		29	20	Dec	WeBS
Smew	2	1	50	Jan	TTTC
		-	-	-	WeBS
Snipe	118	6	5.1	Oct	TTTC
		4	3.4	Oct	WeBS
Teal	2865	46	1.6	Oct	TTTC
		30	1.0	Nov	WeBS
Water rail	7	2	28	Jun	TTTC
		-	-	-	WeBS

Table Legend

Humber Population – Population taken from Mean of Peak data from 5 Year WeBS Core Count Data between 2004/05 – 08/09 for Sector 38950 the Humber Estuary. () indicates mean calculated from an incomplete 5 year data set.

Peak count – The highest species count recorded within North Killingholme Haven Pits from TTTC data or Mean of Peak Count taken from WeBS data (datasets expanded below).

WeBS – Mean of Peak Count derived from WeBS 5 Year Core Count Data from 2004/05 - 08/09 for Sector 38201 North Killingholme Haven Pits (TA166196).

TTTC – Through the Tide Count, Waterbird Surveys undertaken at Killingholme Marshes by Institute of Estuarine Coastal Studies (IECS) between April 2010 – April 2011

Month – For TTTC data the month(s) refers to when the peak count per species was recorded from the Peak Count column. For WeBS data the month still refers to when the peak count was recorded although the corresponding Peak Count figure for WeBS is a mean of peak rather than a peak of peaks.

Species written in red are those which are individual qualifying interests of the Humber Estuary SPA.

Species with a * by their name are listed as UKBAP species.

Impacts

3.1.9 No direct impacts are predicted but the loss of intertidal feeding arising from the development may reduce the attractiveness of NKHP as a roost site and lead to displacement resulting in an effect on site integrity.

4 OBJECTIVES

4.1 CONSTRUCTION

Rationale & Objectives

4.1.1 Construction impacts at NKM are dealt with in the MEMMP, and those at NKHP in the TEMMP.

4.1.2 Impacts have been identified during the construction of the compensation site (RTE/MR and CCSWG) and objectives to ensure appropriate mitigation and legal compliance during construction are required.

4.1.3 Impacts requiring mitigation have been identified for intertidal birds, breeding birds, reptiles, badgers (licensing of sett closures will be required), and water voles (probably not present but pre-survey required given records of transient populations in locality).

4.1.4 The agricultural fields that form the proposed compensation site are only used by curlew in any significant numbers on a regular basis. It has been agreed with Natural England that the birds currently supported on the agricultural fields that comprise the compensation site can be supported in adjacent fields. Much of the work on the inland embankment will have been completed prior to the main period of use during the autumn passage, and construction work will not be ongoing across the whole 3 km of the new embankment all at once. Hence there will be adjacent fields that will not be subject to disturbance from the works that will be available for the birds to use throughout the period they are likely to be present.

4.1.5 The intertidal area was surveyed as described in EX35.14. However this data represents peak counts only over a single non-breeding season. Targets based on WeBs data are difficult to use as the WeBs count area extends from Paull to Cherry Cobb Sands. One option may be to take the peak counts recorded in EX35.14 and apply a natural variability test derived from the standard deviation of the WeBs count data for Autumn (22% of the 5 year mean peak) and winter (42% of the 5 year mean peak). Further discussions with NE will take place to establish a suitable reference point against which disturbance can be measured– see Objective C4: Minimise construction disturbance to SPA populations, page 16

4.1.6 The construction of RTE sluices may require piling. As AHPL develop detailed planning for the construction of the sluices, if required construction is to be undertaken between April and July, then auger piling will be used in conjunction with a method statement agreed with Natural England.

4.1.7 Good construction practice and adherence to Pollution Prevention Guidance will be embedded into any works undertaken on site.

Objective C1: Construction will comply with legal requirements and best practice with regard to reptiles and water voles.

Target	No killing or injuring of protected species
Management	• Strim habitat fortnightly to ensure habitat remains unsuitable for colonisation • Ecological briefing for workforce (including recognition, contact procedures, action to be taken)
Monitoring	• Undertake pre-construction survey of suitable habitat for reptiles and water voles
Who	• Survey by suitably experienced surveyor • Briefing by Environmental manager/ Ecological Clerk of Works
When	• Pre-construction
Limits of Acceptable Change	• N/A
Remedial Action	• Cease work if animals found in work area and consult with Environmental Manager
Notes	Likelihood of either reptiles or water voles being present is low given habitat. If habitat has been colonised since the original CCS ES suitable alternative habitat would need to be created.

Objective C2: Prevent Harm to breeding birds

Target	No damage to nests or eggs, or killing or injuring of chicks of wild birds.
Management	• Remove suitable nesting habitat to north of existing sea wall (i.e. protected from disturbance to birds on intertidal area) during September-March. • Strim areas fortnightly to reduce suitability. • Ecological briefing for workforce (including recognition, contact procedures, action to be taken) • Where potential nesting habitat remains (e.g. close to intertidal) and works take place during April-August site to be checked for nesting birds.
Monitoring	• Undertake pre-construction survey of suitable habitat for nesting birds
Who	• Survey by suitably experienced surveyor • Briefing by Environmental manager/ Ecological Clerk of Works
When	• Pre-construction
Limits of Acceptable Change	• N/A
Remedial Action	• Cease work if nesting birds found in work area and consult with Environmental Manager. • Any active nests not to be disturbed until young have fledged and capable of sustained flight.
Notes	

Objective C3: Ensure construction is legally compliant in relation to badgers

Targets	• Safe and licensed exclusion of badgers from setts. • Provision of suitable foraging habitat • Provision of 10 earth mounds for sett building at base of RTE northern bund and/or around CCSWG site
Management	• Undertake repeat survey to inform licence application. • Licence application (licences are usually only issued for period 1st July-30th November). • Closure of setts under licence. • Adherence to mitigation in licence and EX35.13
Monitoring	• Pre-construction to validate 2012 survey • Post construction walkover survey to check colonisation of earth mounds and sett and latrine usage.
Who	• Monitoring by suitably experienced consultant • Environmental Manager responsible for licensing issues and adherence to conditions.
When	• Repeat survey for licence application June-July 2015 • Licence application September 2015. • Creation and planting of mounds, planting of fruit and berry bearing shrubs at wet grassland from winter May-August 2016. At RTE this process to take place in winter 2016. • Sett closure November - December 2015. • Post construction surveys annually for five years to cease after 3 years if population stable.
Limits of Acceptable Change	• 10% reduction in total number of subsidiary or outlying setts used within three years. • 5% reduction in annex setts used within two years • Cessation of use of any main sett within one year
Remedial Action	• Bait survey to inform analysis • If declines associated with foraging resource introduce supplementary feeding during periods of drought or other hardship • Increase foraging resource (further planting)
Notes	Vegetation on mounds, particularly that at CCSWG should be unsuitable for raptors and corvids (i.e. should comprise weak stemmed and low growing cover such as raspberry and bramble). No planting should be undertaken on top of any bunds to avoid providing hunting perches for raptors and corvids. Habitat enhancement for badgers would be on Northern slopes (but below top of bund) of RTE site and North East part of wet grassland.

Objective C4: Minimise construction disturbance to SPA populations

Targets	No disturbance to feeding or roosting birds on the intertidal area
Management	• Construction work will begin with sea wall area and bunds nearest to proposed CCSWG roost site to provide visual and acoustic screen. This will be carried out during April-October. • Piling will be undertaken between April-July (or if this cannot be achieved augur piling will be used). • During November-March all work will take place within screen provided by sea wall. • All piling will be conducted in accordance with the Code of Construction Practice (CoCP), which is required under DCO Schedule 11, Requirement 22 and will include controls to minimise waterbird disturbance.
Monitoring	• Numbers of birds within the compensation site and intertidal area will be counted on a monthly basis. The reference target will be agreed with NE.
Who	• Suitably experienced surveyor for monitoring. • Ecological manager/ Ecological Clerk of Works to manage construction.
When	• Monitoring during construction
Limits of Acceptable Change	• To be agreed with NE (see discussion under rationale)
Remedial Action	• Review construction methods
Notes	See Rationale regarding reference data issues

4.2 REGULATED TIDAL EXCHANGE & MANAGED REALIGNMENT

Rationale & Objectives

4.2.1 It has been agreed with the Regulators that compensation must be put in place to recreate 94.6 ha of habitat (73.4 ha of intertidal mudflat, and 21.2 ha of sub-tidal (estuary)) for the SAC, and 101.5 ha for the SPA.

4.2.2 The RTE & MR will be constructed to provide initially 88 ha of mudflat and a long term mudflat resource of at least 44 ha. The MR component of the scheme will comprise 30.6 ha of which up to 27 ha is anticipated to revert to saltmarsh. SAC targets for the saltmarsh component are that it recreates typical saltmarsh and mudflat characteristics in terms of topography, zonation and species to that of the middle Humber.

4.2.3 Targets for the mudflat relate to its sediment quality and benthic communities. In turn these underpin its ability to provide functional feeding habitat for displaced bird species (see objective B1)

4.2.4 Long term sustainable mudflat will require managing to maintain principal parameters, and the construction of the four cell RTE structure reflects the need to maintain sufficient mudflat habitat even when being managed.

4.2.5 Benthic targets will be derived from pre-construction surveys and set in agreement with Natural England (NE) as detailed in Annex 3: Target Setting Protocol.

4.2.6 The managed realignment offers potential for biodiversity gains particularly for estuarine fish. A fish survey that is as far as possible WFD compliant (EA Operational Instruction 328_07) will be implemented and agreed with the EA. Targets are based on delivering monitoring and therefore numerical targets and limits of acceptable change are not required. There are some practical difficulties in complying with WFD guidance in that whilst fyke nets could be used within the MR, seine nets could not. It may be possible to substitute a small hand hauled epibenthic sledge as a second form of sampling particularly suitable for juvenile fish. This would be dependent on it being safe to do so, and this method is not WFD compliant although it is used on other MR sites. Similarly Fyke nets may be used to sample the RTE components of the site by setting them outside the RTE sluice(s) on the outgoing tide subject to health and safety considerations.

4.2.7 Management will be targeted to produce suitable sediment types and maintain wetness both to assist feeding birds and reduce saltmarsh encroachment within the RTE. Natural processes will be allowed to develop within the MR part of the site.

4.2.8 The warping up phase will be used to inform future management and allow the operations manual to be augmented based on experience of the live system.

4.2.9 A basic manual of operations will be provided prior to the system going live. As part of the ongoing learning process all significant management interventions (e.g. dredging, bed levelling) will be logged (date & time) and photographed from fixed reference points so that they can be referenced against ecological survey data.

Objective COMP1: Construction of site and sluices

Targets	• Delivery of site to include four RTE fields each of 18ha size, with ponds and channel areas of about 1.5ha per field, operational sluices to enable impoundment of a field at near peak spring tide level and operational sluices to enable drainage of impounded water from one field to another. • Leakage into underlying soils to be less than 200mm over a 10 day period from an initial impounded depth of water of 1,000mm.
Management	• Construction to be undertaken by appointed contractor, managed by APHL
Monitoring	• Topographic survey to define extent of site • Engineering analysis to confirm sluice performance and leakage into underlying soils and through bund
Who	• Survey by suitably qualified surveyor • Analysis by suitably qualified engineer
When	• Prior to and during the construction period
Limits of Acceptable Change	• The RTE part of the site must provide a minimum of 66ha of mudflat area. This could be provided in three or more fields. Sluices to be sized accordingly. • Initial level of the RTE fields to be between +1.9m OD and +2.0m OD.
Remedial Action	• Over consolidation of field surface to reduce leakage.

Objective COMP2: Warping up of RTE fields

Targets	• Warping up of RTE fields by an average of 100mm depth of marine muds
Management	• By site managers: o After construction inlet sluices for the RTE fields are in general to be operated fully open to facilitate rapid accretion of muds across the RTE fields. o After the first winter period following breaching of the realignment site the sluices are to be operated in normal operational mode to avoid extended drying of the mudflat resource over the neap tide period.
Monitoring	• Levels over the RTE fields are to be monitored using a combination of water level monitoring, marked stakes and LiDAR or other monitoring techniques. Method statement to be prepared for the surveying.
Who	• Survey by suitably qualified surveyor
When	• Basic survey of field levels at monthly intervals during warping-up, LiDAR surveys on opportune basis of 1 to 3 year interval
Limits of Acceptable Change	• If average mud levels in the field achieve 100mm before the end of the first winter period after breaching sluices are to begin to be operated in normal operational mode.
Remedial Action	• If warping up is seen to be occurring very slowly the three additional outlet sluices could be opened up to increase exchange.
Notes	• On initial breaching the fields will be operated with the inlet sluices fully open (as per EIA assessment) and the rates of warping up in the fields and scour potential in the breach and Cherry Cobb Sands Creek assessed. If the rate of warping up in one or more of the fields would appear to benefit from increased exchange a trial period of operating the field with the outlet sluices fully open will be instigated. The erosion potential will continue to be examined. A decision will then be made regarding whether to continue exchange with the outlet sluices open. • Changes to the sluice openings from those agreed, would need to be notified to all parties prior to this trial being undertaken. Any longer-term changes to the exchange within the Regulated Tidal Exchange scheme to that currently assessed would need to be discussed with the Environment Agency, due to the potential issues with additional erosion that would occur during this period of time

Objective COMP3: Operating Manual for water level management

Targets	Operating Manual for water level management by site managers
Management	• By site manager and suitably qualified engineer: o During the initial warping up phase sluice operation, impoundment and flushing are to be trialled o Operating Manual to be developed and used as the basis for operational management of site during remainder of warping up period. o Operational Manual to be reviewed after first year of operations.
Monitoring	• Water level monitoring • Recording of sluice settings
Who	• By site managers assisted by suitably qualified surveyor
When	• Basic Operating Manual to be prepared prior to site being breached. • Revised operating manual to be prepared within 6 months of site being breached taking into account experience of managing live system • Operating Manual to be reviewed within 18-24 months of site being breached. • Operating Manual to be reviewed every 24 months thereafter.
Limits of Acceptable Change	• Operating Manual provides the basis for adaptive management of water levels within the RTE fields. In combination with the sediment management plan for the RTE fields this provides the means of maintaining the sustainable compensatory mudflat resource.
Remedial Action	• Review of Operating Manual and modification of operating procedures

Objective COMP4: Sediment Management for RTE fields

Targets	• Development and implementation of sediment management plan for RTE fields
Management	• By site manager and suitably qualified engineer: o To be developed following observation of rates and patterns of mud accretion in the RTE fields. o To be optimised over time to optimise mudflat functionality in the RTE fields based on the results of other monitoring. • Dredging and bed levelling to be undertaken by suitably experienced organisation
Monitoring	• Bed level monitoring • Photographic records • Particle size and density of accumulating material • Accumulation in channels and pond areas
Who	• By site managers assisted by suitably qualified surveyor
When	• Sediment management plan to be developed within 24-36 months of site being breached. • Implementation of plan, possibly involving initial trials, to be undertaken 5-10 years after breaching of site. • Sediment management plan to be reviewed every 24 months thereafter.
Limits of Acceptable Change	• Sediment management provides the basis for adaptive management of mudflat levels within the RTE fields. In combination with the water level management this provides the means of maintaining the sustainable compensatory mudflat resource.
Remedial Action	• Trialling and implementation of sediment management measures earlier than expected. • Methods and techniques expected to evolve over time. Could involve floating and/or land based techniques.

Objective COMP5: Monitoring of bathymetry outside the RTE fields

Targets	• Topographic monitoring of realignment site, Cherry Cobb Sands Creek, entrance to Stone Creek and wider Foul Holme Sands environment
Management	• By site manager
Monitoring	• Survey by LiDAR of local and wider area at 1-3 year intervals • Regular (3 monthly) photographic surveys of realignment site, Cherry Cobb Sands Creek and Stone Creek form fixed points. • Topographic surveys at. four sections across Cherry Cobb Sands and one section in the entrance of Stone Creek
Who	• Site manager and suitably qualified surveyor
When	• At regular intervals as outlined above. • Photographic record and topographic surveys to commence at time of consent to establish baseline conditions
Limits of Acceptable Change	• Changes in Cherry Cobb Sands channel cross section to be within limits assessed in EX28.3 on compensation site or recorded natural variability whichever is the greater. • Siltation in the entrance to Stone Creek that can be attributed to development or operation of the compensation site to be assessed for removal by AHPL.
Remedial Action	• Modifications to monitoring locations as required and in agreement with Steering Group • Bed levelling or dredging in the entrance to Stone Creek.

Objective COMP6: The RTE & MR site will contain similar infaunal communities to those found at NKM as defined by characteristic species in abundance and biomass.

Targets	• Similar faunal biotope(s) to that found at North Killingholme Marshes based on preconstruction surveys undertaken in and Autumn 2015 and Spring 2016 any additional surveys or information provided by EA • This biotope to be provided within 88ha of mudflat of which a minimum of 44ha will always be available. • Quantitative targets are to be defined and agreed following completion of full baseline (pre-construction) surveys. The Survey design for this is set out in Annex 2 and the target setting protocol in Annex 3.
Management	• Breach of sea defence to be made if possible within the peak benthic larval recruitment phase (March – May) • Bed levelling to be conducted post spawning/recruitment phase of key species;
Monitoring	• Sampling of the RTE & MR areas is detailed in Annex 2 and replicates the methods used at NKM & CCS • Samples to be taken with hand held corer (0.01 m2), sediment sampled to a depth of c.15 cm. 3 replicate benthic samples should be collected at each station (with one additional core sample collected per station to characterise the sediment). • A topographic survey will be used to inform the stratified systematic design. • Analysis will be as stipulated in Annex 2. • Particle size analysis, organic content and water salinity will also be measured.
Who	• Environmental Manager and suitably qualified surveyor
When	• Monitoring to be undertaken annually in August-September (with the optimal time being the last week of August to first week of September) for the first ten years. • Any subsequent change in monitoring to be reviewed and agreed by the Steering Group.
Limits of Acceptable Change	• Community must be characterised by the biotope and AFDW biomass/ individuals per square metre within the tolerance limits identified from the baseline survey to be undertaken in Autumn 2015 & Spring 2016 and other relevant data. See target setting protocol in Annex 3 • Intertidal mudflats across 60 ha
Remedial Action	• Alter sluice management to ensure adequate larval transport and suspended sediment transportation into the cells.

<u>Objective COMP7</u>: The RTE site post warping up will contain similar sediment distribution patterns to those found at NKM as defined by Particle Size Distribution (PSD)

Targets	• Sediment distribution to provide Sandy mud and mud as found at Transect 3 of the characterisation survey. • (79%-95% mud, 4.5%-20% sand) to provide the envelope of Particle Size Distribution
Management	• Management of warping up and sluice gates to maintain desired sediment and fluidity of sediment • However, the mud levels within the fields will continue to rise and some maintenance to clear excess sediment will be required
Monitoring	• Samples taken to support the sediment monitoring programme will be collected by means of hand coring, • When the full distribution has been constructed and the warping up phase is complete the sample should be assigned a description based on the Folk classification system (Folk, 1974) and/or the Wentworth classification system (Wentworth, 1922). • Guidelines to be used in the design and subsequent reporting of benthic monitoring are the Guidelines for the Conduct of Benthic Studies at Marine Aggregate Extraction Sites (Ware and Kenny, 2011) and the Marine Monitoring Handbook (Davies et al, 2001) unless statutory agency advice indicates an alternative approach. • **The sediment will not build up uniformly across the site. High points will be identified by visual inspection, using the water level to identify 'islands', or observing the beginnings of saltmarsh formation.**
Who	• Environmental Manager and suitably qualified surveyor
When	• Annually in autumn for the first five years • Monitoring can cease if the target is achieved for three consecutive years after the first five years of monitoring provided that the management regime remains materially unchanged. • Any changes in monitoring to be reviewed and agreed by the Steering Group
Limits of Acceptable Change	• A shift of 2 classifications within the folk system i.e. from mud to sand; OR a shift outside of the desired sediment envelope as defined by the NKM PSD data.
Remedial Action	• Sluice gate management • The high points will be removed using terrestrial based excavation plant with low ground bearing tracks, which will access the fields via ramps from the cross banks. High points will be pushed into perimeter ditches around the site or towards the control structure. • The ditches will be first cleared by holding back water within the fields on a spring tide, then releasing quickly to 'flush' the ditches. If additional assistance is required to clear the ditches, this would be done using a crane mounted suction dredging pump, which would operate from the top of the embankments.

Objective COMP8 (SAC): Provide 21.2 ha of saltmarsh habitat of similar zonation and species composition to that of the middle Humber.

Targets	• Deliver a minimum of 21.2 ha of saltmarsh of a composition typical of the middle Humber estuary to replace estuary and sub-tidal habitat loss. • Within 10 years pioneer and lower saltmarsh community to have established over 10 ha with a minimum of 70% of plant species found within similar communities on Humber • Within 15 years zonation to include middle saltmarsh community. Minimum of 70% of the plant species present over similar zonation patterns in Humber. • Within 20 years Saltmarsh extent to be equal to or greater than 21.2 ha
Management	• Natural processes to occur in MR section of compensation site to allow accretion and establishment of saltmarsh.
Monitoring	Saltmarsh extent, community, zonation and diversity will be ascertained following EA WFD guidance e.g OI 200_07 or any subsequent relevant revisions. In advance of each annual survey the most recent available aerial images will be requested from the EA (although it is noted that not every year will be updated by the EA), this information providing additional data and informing the survey process. Where the data are current (e.g. the year of image is current to the year of survey, then depending on coverage, it may be unnecessary to undertake an additional survey flight. When such images are unavailable, then a survey flight will be undertaken, with aerial colour images captured. These images will be: • of resolution of at least 25cm • 3 band red green blue (RGB) imagery • taken in daylight at low water around a spring tide • taken under stable lighting conditions (little or no cloud shadow) • taken between June and September each year, with timing to be standardised to a single month per year where possible • taken on an annual basis for a minimum of 10 years, the requirements for subsequent surveys to be determined by the Steering Group In addition to the annual aerial image survey, field survey of the saltmarsh habitat will be undertaken on an annual basis, again following guidelines in the EA's OI 200_07 This will include a series of transects of sufficient frequency to adequately describe the communities, their zonation and extent (see OI 200_07 for details). Each transect will cover both the seaward and landward extent of the saltmarsh. Transition points will be mapped and two quadrat samples taken to characterise the major community changes, recording species, cover, sward height etc. following OI 200_07 procedures.

	The saltmarsh will then be therefore assessed for the following metrics in accordance with the WFD Saltmarsh Index Tool: • saltmarsh extent as proportion of "historic saltmarsh" • saltmarsh extent as proportion of the intertidal • change in saltmarsh extent over two or more time periods • proportion of saltmarsh zones present (out of five) • proportion of saltmarsh area covered by the dominant saltmarsh zone • proportion of observed taxa to historical reference value or proportion of observed taxa to 15 taxa
Who	Environmental Manager and suitably qualified surveyor in consultation with the Environment Agency
When	• Aerial survey data obtained annually • Annual fixed point photographic surveys of MR site (at same time as vegetation monitoring) for first 10 years • Vegetation monitoring June to September (to aid species identification) for first 10 years. • After 10 years date frequency to reviewed by steering group
Limits of Acceptable Change	• Less than 10ha of saltmarsh and mudflat formed within first 10 years • Absence of lower saltmarsh within 10 years or middle saltmarsh within 15 years • Species composition of zones is less than 70% that of Humber reference sites (e.g. Cherry Cobb sands saltmarsh)
Remedial Action	• Beneficial use of sediment from within RTE to aid saltmarsh formation in MR • Planting up of saltmarsh/removal of undesirable species • Creation of artificial creek system within MR to improve dewatering
Notes	Natural England have indicated that other estuarine habitat (e.g. mudflat) would be acceptable if the full extent of saltmarsh was not achieved. If the mix of estuarine habitats equalled 21.2 ha no remedial action would be required.

<u>Objective COMP9 (SAC)</u>: Ensure Compensation site delivers 73.4 ha of SAC intertidal habitat of acceptable depth to ensure no decrease in SAC extent

Targets	• Deliver a minimum of 73.4 ha of intertidal mudflat in the immediate term and a minimum of 44 ha of sustainable mudflat in the long term • Deliver a minimum average depth of 100 mm marine mud including a minimum of 50 mm within the first year • Ensure that shore profile is developing in line with the established baseline elsewhere in the SAC, ie a shallow profile that allows regular tidal inundation providing 3 -5 hours of tidal movement over the mudflat

Management	• Inlet sluices for the RTE fields are in general to be operated fully open to facilitate rapid accretion of muds. • After the first winter period following breaching of the realignment site the sluices are to be operated in normal operational mode to avoid extended drying of the mudflat resource over the neap tide period. • Sediment Management Plan to optimise mudflat functionality to be developed within 24-36 months of site being breached
Monitoring	• Accretion monitoring in RTE fields to identify change in mudflat extent and elevation • LiDAR, bed level monitoring, marked stakes and photographic records to determine extent, elevation and change over time
Who	Site managers assisted by suitably qualified surveyor
When	bi-annually during first 2-3 years and thereafter at 1-3 year intervals
Limits of Acceptable Change	If average mud levels in the field achieve 100 mm before the end of the first winter period after breaching sluices are to begin to be operated in normal operational mode.
Remedial Action	• Variation in number of sluices operated to control exchange • Implementation of sediment management measures • Sediment management provides the basis for adaptive management of the mudflat levels
Notes	It is anticipated that bed levels will normally exceed 100mm due to accretion. Where bed levelling or dredging is required this will retain a minimum average of 100mm over the managed area.

Objective COMP10 (SAC): Ensure non-faunal attributes of compensation mudflat habitat are consistent with those of the area of SAC mudflat habitat to be lost

Targets	• PSA of accreted substrate should not differ significantly from that of the SAC area to be lost, i.e. sediment distribution to provide sandy mud and mud, with grain size varying between 0.01-0.3mm • (79%-95% mud, 4.5%-20% sand) to provide the envelope of Particle Size Distribution • High average organic carbon content of accreted sediment- this should not deviate significantly from the established SAC baseline in the area to be lost • Ensure that excessive nutrient enrichment is not taking place, as indicated by development of macroalgal mat cover in excess of the established baseline found in the SAC area to be lost
Management	• Management of sluice gates to maintain desired sediment characteristics • Expected that the sediments which settle will have similar organic content to those which have settled elsewhere in the SAC
Monitoring	• Hand-coring within RTE fields followed by PSA and analysis of organic content • Photographic record and recording of surface conditions- character and composition of surface sediments, evidence of drying, macroalgal cover
Who	Environmental Manager and suitably qualified surveyor
When	• Annually in autumn for the first five years • Monitoring can cease if the target is achieved for three consecutive years after the first five years of monitoring provided that the management regime remains materially unchanged. • Any changes in monitoring to be reviewed and agreed by the Steering Group
Limits of Acceptable Change	• A shift of 2 classifications within the Folk classification system i.e. from mud to sand • A shift outside of the desired sediment envelope for all parameters listed
Remedial Action	Sluice gate management and dredging of material

Objective COMP 11: Monitor Fish within Compensation Site

Targets	To monitor fish using WFD compliant methods as far as possible with reference to Operational Instruction 328_07 Data requirements for WFD transitional fish surveillance monitoring
Management	N/A
Monitoring	• Use of Fyke nets in main MR channel in May-June (Spring WFD) and September-October (Autumn WFD)

	• Use of epibenthic sledge (0.9m opening width, dragged for 50m) subject to safe method of work being possible to sample juvenile fish • Fyke nets to be deployed at RTE sluice twices per annum in May-June (Spring WFD) and September-October (Autumn WFD) on outgoing tide. • Results to include following data in line with 328_07 o fish species present; o abundance of each species; o length measurements (freshwater and migratory species – fork length, marine species – total length). For large catches only the first 50 lengths for each species during each netting occasion are required, the rest can be counted; o for exceptionally large catches sub-sampling techniques will be used ; o supporting water quality information: dissolved oxygen (% sat), salinity, temperature o GPS position at approximate mid-site location (12 figure NGR); • date, time, trawl duration and tide state.
Who	Suitably qualified surveyors in liaison with Environmental Manager and EA
When	• Every two years in spring & autumn for the first ten years • Any changes in monitoring to be reviewed and agreed by the Steering Group
Limits of Acceptable Change	N/A
Remedial Action	N/A
Notes	The epibenthic sledge is not WFD compliant but experience at other MR's has shown it to be a useful tool in providing additional sampling of juvenile fish not monitored by Fyke nets.

Objective COMP 12: Monitor Fish Fatalities within RTE Fields

Targets	To monitor for fish fatalities on a regular basis in accordance with Standard Operating Procedures.
Management	N/A
Monitoring	• Visual check of RTE fields for dead fish • Recording of observations on check list • Reporting of any significant fish kills to Environmental Manager • Taking of photographic evidence
Who	RTE Sluice operators
When	• Every day that RTE sluices are being operated

	• Any changes in monitoring to be reviewed and agreed by the Steering Group
Limits of Acceptable Change	• More than five dead fish in RTE fields at any one time; and/or • More than two dead fish on consecutive days
Remedial Action	Investigation of reasons for fish mortality
Notes	Fish fatalities will be monitored routinely as part of daily operational activities. Records will be reviewed regularly by Environmental Manager.

4.3 WET GRASSLAND & OPEN WATER AREA

Rationale & Objectives

4.3.1 There are no similar sized RTE schemes which have been created, and especially ones designed to support birds.

4.3.2 Creation of wet grassland is a well-established process, and hence there is greater certainty about the ability to develop it, and also about the biomass that will be available as a result for shorebirds and especially black-tailed godwits.

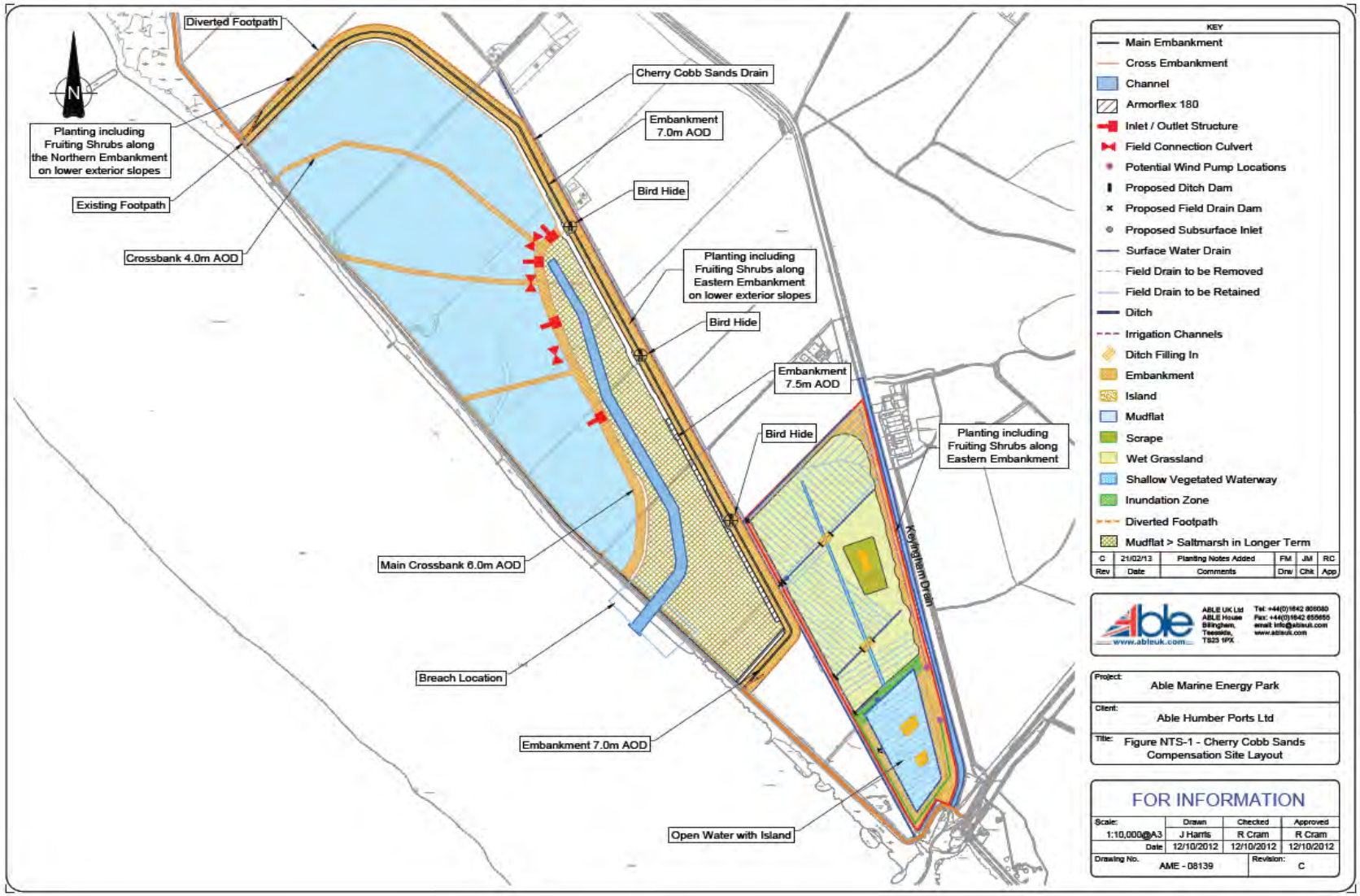
4.3.3 Wet grassland is a habitat type which is known to be used by foraging black-tailed godwits, especially as the winter progresses and intertidal food resources can become depleted. There is little grassland around the Humber Estuary at present and its provision will provide a valuable additional food resource, which will also be available to the birds at high tide.

4.3.4 The provision of the roost site (formed by islands in the open water area at the southern end of the wet grassland site) close to existing mudflats at CCS will mirror the close proximity of NKHP to the mudflats at NKM. The close proximity between a secure roost site and feeding resources is thought to be important in the use of the NKM foreshore by black-tailed godwits, especially during the autumn moulting period. The roost site at CCS is expected to facilitate more extensive use of CCS by black-tailed godwits.

4.3.5 The wet grassland and open water areas at CCS are therefore included as part of the compensation package to provide additional foraging and roosting habitat in case of any under performance of the RTE.

4.3.6 Objectives are therefore based around the construction, management and maintenance of both the roost site and wet grassland to deliver suitable functionality for black-tailed godwits in particular.

Figure 1 Indicative Layout of Wet Grassland



Objective WG1: The site will contain wide, open expanses of wet grassland habitat with unobscured views of the surrounding area – TARGET 1

Target 1	Wet or damp grassland vegetation community across 26ha of the CCSWGS
Management	• Sowing with an appropriate seed mix (for example EG8 Wet Grassland Mix from Emorsgate Seeds) and leaving uncut and ungrazed for 3 to 6 months, as appropriate • 0.2 livestock units per hectare per year in April to June inclusive in Year 1; AND • 0.3 livestock units per hectare per year in April to June inclusive in all subsequent years; OR • Equivalent management by cutting the grassland • No fertilisers to be used except if needed to boost earthworm biomass • No herbicides to be used except if needed to control problem plant species. These to be applied with a weed wipe or via spot control.
Monitoring	• 60 permanent quadrats to be established measuring 1m x 1m within the wet grassland area • Plant species and abundance to be recorded for each quadrat
Who	Contractors under supervision of Environmental Manager
When	• Monitoring to undertaken annually in June for the first five years • Monitoring can cease if the target is achieved for three consecutive years after the first five years of monitoring provided that the management regime remains unchanged subject to the agreement of the Steering Group.
Limits of Acceptable Change	• At least one species characteristic of wet or damp grasslands must be present in 50 permanent quadrats • Wet grassland vegetation community across 20ha of the CCSWGS
Remedial Action	Raise sluice heights to increase soil moisture content, providing incidence or extent of flooding does not exceed limits of acceptable change

<u>Objective WG1</u>: The site will contain wide, open expanses of wet grassland habitat with unobscured views of the surrounding area – TARGET 2

Target 2	No scrub (including bramble) or trees across the entirety of the CCSWGS
Management	• 0.2 livestock units per hectare per year in April to June inclusive in Year 1; AND • 0.3 livestock units per hectare per year in April to June inclusive in all subsequent years; OR • Equivalent management by cutting the grassland
Monitoring	Visual assessment of scrub
Who	Environmental Manager
When	• Monitoring to undertaken annually in June for the first five years • Monitoring to occur in June once every three years thereafter if limits of acceptable change have not been exceeded in the first five years subject to the agreement of the Steering Group
Limits of Acceptable Change	No more than 5% scrub or trees across the entirety of the CCSWGS
Remedial Action	Cutting down vegetation and treatment of stumps with herbicide

Objective WG2: The site should contain open water with at least one island suitable for roosting black-tailed godwits at high tide

Target 1	An open water area of 4 to 5ha in size and an average depth of 0.35m to 0.7m in depth, according to season
Management	• Topping up with water from external drains to maintain water level and extent to target levels, as and when required • Adjustment of sluice height to retain water at the appropriate depth, during the winter period • Adjustment or cessation of irrigation rate to keep extent and depth of open water within target levels, during the late summer/autumn period
Monitoring	Visual assessment of the extent of the open water area Recording the depth of the water within the open water area
Who	Environmental Manager
When	• Monitoring of water extent and depth to occur a minimum of twice weekly during the first year; and • Monitoring of water extent and depth to occur a minimum of twice monthly, and more frequently during periods of irrigation, in the next four years; • Monitoring can cease if the target is achieved for three consecutive years after the first five years of monitoring provided that the management regime remains unchanged
Limits of Acceptable Change	• No less than 3ha of open water extent • No less than 0.25m average depth
Remedial Action	• Topping up with water from external drains and cessation of irrigation subject to protocols being agreed with the Environment Agency • Re-instating the integrity of the slowly or impermeable lining of the open water area, if necessary
Notes	The Environment Agency carries out periodic maintenance of the Keyingham Drain that requires the maintenance of a head of water for flushing purposes. An abstraction licence will be required and a protocol agreed with the EA

Target 2	No more than 10% dense stands of rushes (Juncus spp), tall sedges (Carex spp), reeds (Phragmites australis, Phalaris arundinacea, Glyceria maxima, Typha spp) within the open water area
Management	Cutting dense stands of rushes, sedges and reeds in late summer/Autumn, if present
Monitoring	Visual assessment of rushes, tall sedges and reeds within the open water area
Who	Environmental Manager
When	• Monitoring to undertaken annually in June for the first five years • Monitoring to occur in June once every three years thereafter if limits of acceptable change have not been exceeded in the first five years subject to the agreement of the Steering Group
Limits of Acceptable Change	No more than 20% dense stands of rushes, tall sedges and reeds within the open water area.
Remedial Action	Cutting or excavating and removal of stands of rushes, tall sedges and reeds to give a maximum of 5% cover within the open water area
Notes	Cutting and removal of swamp vegetation to be undertaken outside the bird breeding season

Target 3	The open water area is to contain freshwater for the purpose of irrigation
Management	Only extracting freshwater from the external drains to top up the open water area, which may require adjustments in the extraction point and timing
Monitoring	• Measuring salinity within the external drains (subject to agreement with EA and Drainage Boards) • Measuring salinity within the open water area
Who	Environmental Manager
When	• Monitoring of salinity to occur continuously using data loggers during the first year within the Keyingham drain. • Monitoring of salinity to occur continuously during the late summer/autumn period for the next four years • Monitoring can cease if the limits of acceptable change have not been exceeded in the first five years, subject to the agreement of the Steering Group
Limits of Acceptable Change	Salinity of the open water area less than 1‰
Remedial Action	Adjust extraction regime to return salinity of the open water area to within acceptable limits

Target 4	Two vegetation free islands within the open water area
Management	• Islands to be capped with butyl rubber and shells/cobbles/gravel to limit vegetation growth • Removal of vegetation annually in June, if limits of acceptable change are exceeded
Monitoring	Mapping of the extent of the vegetation on each island
Who	Environmental manager
When	• Monitoring to be undertaken annually in June for the first five years • Monitoring to occur in June once every three years thereafter if limits of acceptable change have not been exceeded in the first five years, subject to the agreement of the Steering Group
Limits of Acceptable Change	Up to 25% short perennial or ephemeral vegetation but no shrubs, trees or tall ruderal vegetation in the period July to March
Remedial Action	• Cut and treat shrubs, trees or tall ruderal vegetation as appropriate; OR • Remove and replace shells/cobbles/gravel cap if islands are repeatedly colonised and management becomes difficult

Objective WG3: The soil will be moist throughout the months of August to April to concentrate invertebrates at the surface and to ensure that the soil remains soft enough to be probed by waders

Target 1	Soil penetration resistance less than 6kg on average in each month from July to March using a soil penetrometer
Management	Maintenance of damp but unflooded grassland through appropriate sluice management and irrigation
Monitoring	Monitoring to be undertaken at 100 standard sample locations spread across CCSWGS
Who	Environmental manager
When	• Monitoring to occur once per month from July to November annually for 5 years; and • Monitoring can cease if the target is achieved for three consecutive years after the first five years of monitoring provided that the management regime remains unchanged, subject to the agreement of the Steering Group.
Limits of Acceptable Change	Soil penetration resistance less than 8kg on average in each month from July to March
Remedial Action	• Increase irrigation rate in order to increase soil moisture content and reduce soil penetration resistance • Raise sluice heights to increase soil moisture content and reduce soil penetration resistance
Notes	• Soil resistance is based on data from Ausden et al 2001 • Soil resistance to be sampled using a soil penetrometer details of

	which can be found at [redacted] (see Annex 4).

Target 2	Soil moisture content greater than 100% of dry weight on average in each month from July to March
Management	Maintenance of damp but unflooded grassland through appropriate sluice management and irrigation
Monitoring	Monitoring to be undertaken at 100 standard sample locations spread across CCSWGS
Who	Environmental manager
When	• Monitoring to occur once annually in the month of September for 5 years; and • Monitoring can cease if the target is achieved for three consecutive years after the first five years of monitoring provided that the management regime remains unchanged, subject to the agreement of the Steering Group.
Limits of Acceptable Change	Soil moisture content greater than 80% of dry weight on average in each month from July to March
Remedial Action	• Increase irrigation rate in order to increase soil moisture content • Raise sluice heights to increase soil moisture content

Objective WG4: The site should be largely free of winter flooding to prevent floodwaters from killing soil invertebrates.

Target	Less than 10% flooding across the wet grassland area at any time (excluding the scrape and open water area)
Management	Appropriate sluice height and irrigation flow rate adjustment
Monitoring	Visual assessment of extent of flooding
Who	Environmental manager
When	• Minimum of twice weekly during the first year; and • Minimum of twice monthly, and more frequently during periods of irrigation, in the next four years; • Monitoring can cease if the target is achieved for three consecutive years after the first five years of monitoring provided that the management regime remains unchanged, subject to the agreement of the Steering Group.
Limits of Acceptable Change	Less than 20% flooding across the wet grassland area at any time (excluding the scrape and open water area)
Remedial Action	Appropriate sluice height and irrigation flow rate adjustment to enable flood waters to drain away

Objective WG5: The site will have a high density of macro-invertebrate fauna to provide food for wading birds.

Target	Average earthworm biomass levels of 65gm-2 (wet weight) in less than 5 years and maintained thereafter
Management	Maintenance of damp but unflooded grassland through appropriate sluice management and irrigation
Monitoring	Annual collection of 100 soil samples measuring 25 x 25 x 10cm at standard sample locations, with subsequent soil biomass calculations
Who	Environmental manager
When	• Annually in September until target is achieved and then for three years thereafter • Monitoring may cease if earthworm biomass levels greater than target levels for more than three consecutive years. Any changes in monitoring to be subject to the agreement of the Steering Group
Limits of Acceptable Change	Minimum average earthworm biomass levels of 50gm-2 (wet weight) after 3 years
Remedial Action	• Addition of organic matter as a top dressing to promote biomass increase • Adjustments to soil moisture content or extent of flooding as appropriate
Notes	Biomass target is derived from approximate average of natural, unflooded wet grasslands (Ausden et al, 2001)

Objective WG6: The wet grassland will be managed to give a suitable sward for wading birds throughout the months of August to March

Target 1	Average sward height of 10cm across the CCSWGS each month from July to March
Management	• 0.2 livestock units per hectare per year in April to June inclusive in Year 1; AND • 0.3 livestock units per hectare per year in April to June inclusive in all subsequent years; OR • Equivalent management by cutting the grassland
Monitoring	Measurement of sward height at 100 sampling points
Who	Environmental manager
When	• Monitoring to occur once per month from July to November annually for 5 years; and • Monitoring can cease if the target is achieved for three consecutive years after the first five years of monitoring provided that the management regime remains unchanged, subject to the agreement of the Steering Group.
Limits of Acceptable Change	Average sward height of 15cm across the CCSWGS each month from July to March

Remedial Action	Increase livestock density to achieve shorter swards at the end of June; OR Increase length of time livestock are present on CCSWGS to end July; OR Introduce rotational grazing/cutting from July to September across the CCSWGS; OR Cut grass once in August/early September.

Target 2	No more than 10% dense stands of rushes (Juncus spp), tall sedges (Carex spp), reeds (Phragmites australis, Phalaris arundinacea, Glyceria maxima) or tall ruderal vegetation (thistles, docks etc) in the North and Middle Fields (including the scrape)
Management	• 0.2 livestock units per hectare per year in April to June inclusive in Year 1; AND • 0.3 livestock units per hectare per year in April to June inclusive in all subsequent years; OR • Equivalent management by cutting the grassland
Monitoring	Visual assessment of the extent of the species listed above
Who	Environmental manager
When	• Monitoring to undertaken annually in June for the first five years • Monitoring to occur in June once every three years thereafter if limits of acceptable change have not been exceeded in the first five years • Return to annual monitoring for three years following exceeding the limits of acceptable change • Any changes in monitoring to be reviewed and agreed by the Steering Group.
Limits of Acceptable Change	No more than 15% cover of dense stands of rushes, tall sedges, reeds or tall ruderal vegetation in the North and Middle Fields (including the scrape)
Remedial Action	• Flailing the areas dominated by unwanted vegetation twice in the year that the limit of acceptable change is exceeded; OR • Herbicide application for severe infestations of rushes

4.4 BIRDS

Rationale & Objectives

4.4.1 The objective is to maintain populations of displaced birds. Previous sections describe objectives, management actions, and monitoring of the compensation package required to achieve this.

4.4.2 The compensation package is centred on a secure wet roost that will allow birds to exploit existing mudflat resources on the north shore immediately

as well as the new wet grassland and RTE/MR as these develop functionality.

4.4.3 The development of the full package will be incremental and how birds respond to it will require monitoring of all potential resources available to them.

4.4.4 These resources include the mudflat remaining at NKM. The total mudflat area is 77ha of which 31.5ha will be directly lost to AMEP and 11.6ha predicted to be functionally lost to disturbance. Use of the remaining area will need to be part of the monitoring programme.

4.4.5 Early provision of the roost at CCS will require monitoring of the existing mudflat between Paull and Cherry Cobb for evidence of increased use and potential competition effects.

4.4.6 The area monitored for bird numbers will therefore include not only the developing RTE/MR and wet grassland but also the remaining mudflat at NKM, the existing intertidal area between Paull and Cherry Cobb Sands, and NKHP.

4.4.7 As the compensation site develops functionality it will be required to support the peak count (see Table 3) of the birds displaced from NKM within the range of national trends. Functionality from construction for the CCSWG will be reached within 2-4 years and up to 6 years for the RTE.

4.4.8 As there is a danger that rapid declines could be masked by natural variability as expressed by the national population trend then a review would be required after any one year where declines exceeded any negative change in the national trend, or after two years of consecutive decline even where this was within the range of changes in the national trend.

Objective B1: The Compensation site supports peak counts of displaced species (see Table 3) with the same levels of foraging activity.

Targets	• When RTE/MR & CCSWG reach full functionality (i.e. when biomass and physical targets are met) they support peak counts of each species as identified in Table 3. It is anticipated the RTE will reach full functionality within 4-6 years and the CCSWG within 2-4 years. • Foraging use reflects that recorded in Table 3 (an exception is allowed for avocet as numbers are small).
Management	• Provide secure roost in first instance at CCS • Develop RTE/MR and CCSWG
Monitoring	Through the Tide Counts at NKM, CCS, CCSWG and RTE/MR and NKHP
Who	Suitably experienced surveyors
When	Twice monthly on a spring and a neap tide
Limits of Acceptable Change	• Any one year where declines exceeded negative changes in the national trend • Two years of consecutive decline even where this was within the range of negative changes in the national trend
Remedial Action	• Review data to ascertain if population is being maintained within Humber • Review data on national population to ascertain if population maintained within UK • If evidence of range decline provide additional compensation where this is achievable
Notes	If the area of functional disturbance is less than predicted and birds continue to use areas of NKM these may be counted toward the peak bird target identified for the compensation site

ANNEX 1: DECISION MATRIX FOR ASSESSMENT OF SUCCESS OR FAILURE OF COMPENSATION SITE FOR BLACK-TAILED GODWIT

Bird Targets	Invertebrate Targets (Benthic and Wet Grassland)	Outcome	Management Required
Met	Both met Roost Provided	Fully Met	Maintain
Met	Not met Roost Provided	Partially Met	Improve RTE/MR & WG management to meet invertebrate targets.
Met	Benthic met WG not met Roost Provided	Partially Met	Improve WG management to meet invertebrate targets.
Met	Benthos met WG met Roost Provided	Partially Met	Improve RTE/MR management to meet invertebrate targets.
Not met	Benthos met WG met Roost Provided	Partially Met	Determine if other reasons for birds not being present, and if numbers in SPA maintained. Identify management requirements.
Not met	Benthos met WG met Roost Provided	Partially Met	Determine if other reasons for birds not being present, and if numbers in SPA maintained. Identify management requirements. Improve WG management.
Not met	Benthos not met WG met Roost Provided	Partially Met if overall biomass acceptable	Determine if other reasons for birds not being present, and if numbers in SPA maintained. Identify any additional management requirements.
Not met		Not Met if overall biomass not acceptable.	Determine if other reasons for birds not being present, and if numbers in SPA maintained and Improve RTE/MR management to meet benthic invertebrate targets. Identify any additional management requirements. If the compensation continues to fail then this will be reported through the Steering Group to the Secretary of State.

Bird Targets	Invertebrate Targets (Benthic and Wet Grassland)	Outcome	Management Required
Not met		Partially Met if combined sub-optimal biomass is acceptable.	Determine if other reasons for birds not being present, and if numbers in SPA maintained. Identify any additional management requirements. and Improve RTE/MR and WG management to meet invertebrate targets.
Not Met		Not Met	Determine if other reasons for birds not being present, and if numbers in SPA maintained. Identify any additional management requirements. and Management of RTE/MR and wet grassland to improve invertebrate biomass. If the compensation continues to fail then this will be reported through the Steering Group to the Secretary of State.

Notes:

The outcome column describes targets as fully met if they meet both bird and invertebrate targets; partially met if they achieve some but not all of the target but do so in such a way that either bird targets are met or sufficient mix of the invertebrate targets are met. Where targets have failed they are recorded as not met.

The management column is colour coded. Green indicates management is correct and should be maintained. Amber indicates a partial failure of one or more targets and indicates that action is required to address this and should be implemented for all the failing components. Red indicates a failure of the compensation site and that if remedial action is unable to reverse this failure this will be reported through the Steering Group to the Secretary of State.

Bird targets would be based on the peak numbers presented during the Appropriate Assessment and Panel process. Higher counts of birds using NKM could occur subsequent to that process and it is acknowledged that the compensation design is based on the Appropriate Assessment figures only.

The only circumstances in which bird targets can be lowered is where there has been a significant (>1%) decline in the relevant biogeographical populations.

Where the benthic target is a mixture of RTE (including the MR component) and WG it is acknowledged that WG is a buffer against failure rather than the principle feeding resource. Therefore in assessing success or failure based on any mix of sites greater weight will be given to RTE/MR populations. Therefore any combined invertebrate target must represent a combined minimum of 150% of the theoretical 200% (based on 100% of RTE/MR & WG invertebrate targets) subject to the RTE/MR component of that mix never falling below 75%. If the RTE/MR invertebrate population falls below 75% of the target value then the whole invertebrate target fails even where this exceeds a combined value of 150% (e.g. 75% RTE/MR & 75% WG= 150% would be compliant whereas 65% RTE/MR & 100% WG= 165% would not).

ANNEX 2: SURVEY DESIGN FOR BENTHIC INVERTEBRATES

Survey rationale: the survey is designed to monitor the status of the intertidal benthic component at the compensation site (RTE and managed realignment) to be assessed against established targets as the site develops overtime. In particular, two aims have been identified for the survey:

1) to provide a good estimate of the community and target species densities in order to be assessed against the target defined at NKM;

2) to assess the development of the compensation site over time and its ability to provide intertidal habitat that is comparable to the natural mudflats in the area.

Effort has been put into devising a survey design that fulfil both aims, although it should be noted that there is not a single survey design that can be optimal for both aims. In addition, it is noted that the target assessment (aim 1) is a priority over the site development assessment (aim 2), in agreement with the importance placed by Natural England on the ability of the compensation site to meet the feeding requirements for Black-tailed Godwit. Therefore any modification of the survey design (e.g., following the revision of methods as described in Appendix 3) will be towards an improvement of the design to fulfil the target assessment, even if these modifications might involve a decrease in the power of the analysis for the site development assessment.

The survey design and methods have been devised based on existing guidelines (Guidelines for the Conduct of Benthic Studies at Marine Aggregate Extraction Sites - Ware and Kenny 2011; the Marine Monitoring Handbook, Davies et al 2001).

Sampling method: hand held corer (0.01 m2), sediment sampled to a depth of c.15 cm.

Sampling period: monitoring to be carried out annually, in late summer-early autumn (preferably between the last week of August and first week of September, to allow direct assessment against the target defined for this season).

Sampling design: the distribution of the intertidal stations in the compensation site is dependant on the extent and distribution of the inundated habitat within the site, a factor that is expected to change over the years during the sites development. It is not possible to identify a priori the number of stations and their location without knowledge of the habitat distribution within the site. In order to allow a detailed survey design a topographic survey will be undertaken soon after breaching and the resulting map will be used to guide the location of the stations within the RTE and MR site.

Although the details of the survey design cannot be defined yet, some general criteria can be identified to guide the choice of the survey stations.

As at NKM, a stratified systematic design is devised as the best way to estimate population size of clustered (patchy) populations (Mier & Picquelle 2008 and references therein). Strata would be defined in order to cover the different sections of the compensation site (four RTE fields and MR site) as well as the different intertidal habitats (e.g., with different degree of inundation). In addition, the even coverage of the available intertidal habitat within the site will provide data for spatial analysis, which will allow biotope mapping as well an assessment of performance against benthic targets (see appendix 3).

Sampling stations will be positioned at regular intervals on the available intertidal habitat, their location being chosen on a pre-defined criterion that will be followed whenever new stations need to be added.

It is of note that the ability of the sampling design to provide good estimates of the benthic species populations (considering the variability in their spatial distribution) will depend on the spatial resolution of the sampling grid (i.e. on the number of stations) rather than on the replication of sampling at each station, as indicated by Ware and Kenny (2011 - Guidelines for the Conduct of Benthic Studies at Marine Aggregate Extraction Sites). It is suggested that a similar spatial resolution to that one used in the target setting survey at NKM is used in the compensation site (1 station every 0.7 ha ca.).

As a control for the benthic community development within the site, natural mudflats outside the site should also be sampled. It is suggested that 9 stations are located in correspondence of each of the 6 transects identified within the two control sites for the impact monitoring at CCS (north and south of the breach; see Marine EMMP for details), with a total of 54 faunal samples collected. This will allow monitoring of temporal (seasonal and inter-annual) variability in natural mudflats adjacent to the compensation site, thus allowing temporal revision of the targets if required (see Annex 3 on setting and assessing targets).

One sediment sample will be taken at each station for faunal analysis and an additional sample will be collected for PSA and organic matter analysis. Sample locations will be recorded using DGPS.

Sample processing: Samples from different replicates should be kept separate. Benthic samples are to be sieved through a 0.5mm sieve. Laboratory analyses will include species (identified to highest taxonomic detail), abundance, size class and biomass (WWTB), with standard AFDW conversion factors applied (using, for example, Rumohr et al., 1987; Ricciardi and Bourget, 1998; and Eleftheriou and Basford, 1989) for comparison with targets.

Supporting parameters: Sediment particle size analysis (PSA) and organic content will also be measured in the additional sediment sample. Also sediment water content is a relevant parameter that should be measured in the sediment samples. Additional supporting parameters recorded on site will include the recording of the character and composition of surface sediments (type, colour, smell), depth of RPD layer, texture and presence of surface features. A photographic record of the sampling station and of the sediment will be also collected. It is recommended also that, during the benthic sampling, a visual estimate of the vegetation coverage and its height is derived within a 10x10 m square area around each benthic station, in order to allow a better characterisation of the wider habitat the benthic station falls within.

Supporting parameters derived from other surveys: As highlighted before, the initial topographic (LIDAR) survey, as well as regular surveys over the years will be important, not only to inform the setting and modification of the stations' location, but also to allow the characterisation of the different benthic stations based on their elevation and derived parameters (e.g., accretion, inundation frequency).

Water salinity measured within the compensation site will be relevant, particularly within RTE fields, as the water retention combined with particular conditions may lead to changes in salinity (e.g. the potential for hypersaline conditions during dry periods with high temperatures) that may affect the benthic community.

Data analysis: With the purpose of characterising the benthic community at the compensation site towards the assessment of the targets derived for NKM (see Appendix 3 for details on these targets setting and assessment), multivariate analysis will be carried out using cluster analysis (combined with similarity profile routine, SIMPROF) and ordination techniques (e.g., MDS, PCO) in order to identify different community types and gradients in the assemblage distribution/variation, as well as

applying the SIMPER routine to identify the species which contribute most to the differentiations between groups. Multivariate statistical analysis (e.g., ANOSIM, PERMANOVA) will be applied to detect changes in community structure and composition. Bio-Env routine and linkage trees (BEST) in Primer will be used to explore the relationship between biotic (community) patterns and substrate characteristics.

Benthic fauna in the compensation site will be characterised also based on the main community descriptors (e.g., abundance, richness, biomass, evenness, diversity and biomass-to-abundance ratio) as well as abundance and biomass distribution of target species. Based on these analyses, the main biotope(s) present in the site will be identified and their distribution over the compensation site will be presented in a biotope map to highlight the broad scale homogeneity in terms of MNCR biotopes. Also GIS methods will be used to present maps of the distribution of biomass/abundance/species diversity (e.g., using kernel density interpolation) in order to provide information on the spatial extent of what may be the hotspots of each parameter (biomass etc). Analysis will also be integrated with the findings of the intertidal LiDAR surveys as elevation change can influence benthic community structure hence food availability to bird species.

With the purpose of addressing the compensation site development over time towards conditions reflecting adjacent natural mudflats (aim 2), an analysis of variance will be carried out similarly to that described for the MEMMP (on a BACI-type approach, but there will be no "before" in this case). It is of note that stations within the strata defined by the different intertidal habitats present in the site (e.g. based on shore level) as well as by the distinction between the compensation site and the control areas outside will be will be considered as replicates of the strata for the purpose of the analysis.

The null hypotheses that will be tested during site development is that the mudflat community in the compensation site is developing over time, becoming more and more similar to the community in the control areas outside the site. Therefore an interaction between time (years) and treatment (compensation site/controls) will be expected, with the difference between the compensation site and the controls reducing year after year. The trajectory of change can be visualised also for the community structure through multivariate ordination techniques (e.g., MDS, PCO, in Primer), showing a decreasing dissimilarity between the compensation site and the control areas over the time during development. In turn, when the mudflat community will become established inside the compensation site, then the null hypothesis would be that its changes over the years are in line with the variability observed in the natural mudflat (control sites), hence in this case, the interaction term between time and treatment is expected to be non-significant.

ANNEX 3: TARGET SETTING PROTOCOL

Target

Targets will be set for metrics measured for the whole benthic community (community target) as well as for specific elements of the community that characterise the observed prey resource for Black-tailed Godwit (BW) at NKM (species targets, e.g., Macoma balthica, Hediste diversicolor).

The community target will be set as the average benthic community recorded at NKM.

Species targets will be set as the average abundance and biomass density (ind/m2, g/m2 the latter then being converted to AFDW g/m2 using standard conversion factors) recorded at NKM.

Target assessment criteria

The values recorded at the compensation site will be compared with the target under the management objective set for the compensation site (i.e., they should be equal or higher than the target range). However, in order to take into account the inherent natural variability of estuarine mudflat benthic fauna, an acceptable level of change (ALC) will be identified.

The ALC will be defined taking into consideration the natural levels of temporal variability associated to the specific metric. These can be quantified in different ways (or a combination of them), depending of on the data availability:

- Based on pre-construction monitoring in Autumn 2015;
- Based on Autumn 2015 survey with additional context provided by the 2010 characterisation survey.
- Based on the inter-annual variability observed in control areas in mudflats at NKM and CCS; it is of note that, as this information will be only available over the years of monitoring of the sites, it will be useful for periodical revisions of the ALC;
- Based on existing data (e.g., EA data) on mudflat benthic communities in the middle estuary in the last decade;

Data from autumn observations will be the primary source of data for the purpose of target setting, and will be under-pinned by the long term data for NKM provided by EA.. Intra-annual/seasonal variations will enable the identification of prey depletion during the winter period and provide valuable analysis of the intra-annual increase in biomass at NKM when compared to other sites, and the compensation site.

The data will be reviewed after each annual monitoring survey and as outlined within the Target assessment review section below.

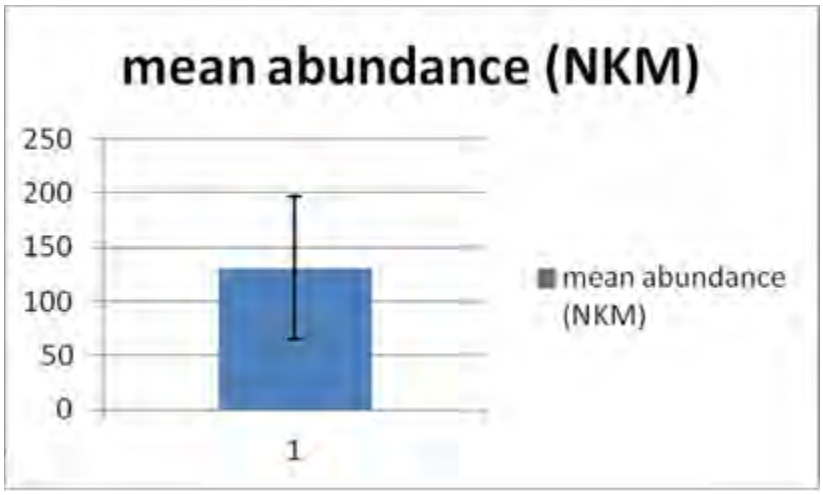
Hotspot analysis:

A suggested method for the presentation of the baseline results is to interpolate the biomass/abundance utilising a GIS method such as kernel density thus allowing the illustration of the spatial extent of what may be the hotspots of each parameter (biomass etc.) using an objective approach. As described below the target standard deviation would then be adjusted based on all data points which fall within these areas of high density infauna (hotspots).

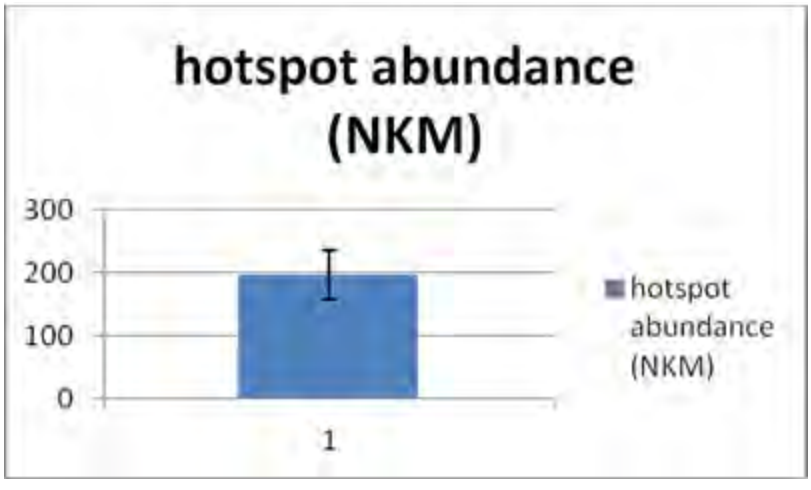
Species targets on NKM:

The target will be set using the mean value (e.g., abundance, biomass) obtained during the NKM baseline survey(s), within a range defined by the standard deviation from the mean abundance of the preferred BW foraging area.

The following numbers are randomly generated for the purpose of illustration, and should not be taken as indicative of proposed targets, or target ranges. In an example dataset of 144 samples of random numbers (within a range of 20-250 individuals per metre square) the mean is 131.0, with a standard deviation of 65.7 giving a potential target of 131 individuals within a range of 65.3-196.7; displayed graphically below.

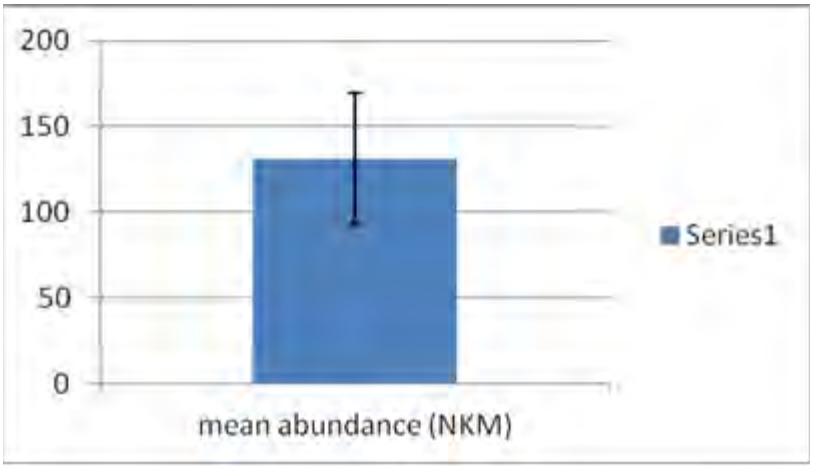


Within the preferred foraging area for BW (hotspots), assuming a number of samples (44) with a generally less variable, higher mean abundance (randomly generated numbers within a range of 120-250) the mean is 197 individuals with a standard deviation of 38.7; displayed graphically below.

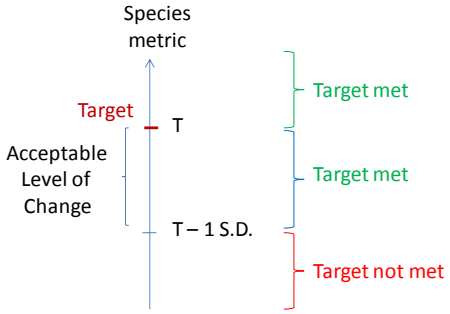


In compensating for the loss of intertidal habitat by providing comparable intertidal habitat the appropriate target is the mean abundance (or alternative metric such as biomass) across the site. However in order to provide for a level of precaution, and to reduce the risk associated with the use of the wider variability at NKM which may mask the higher density prey requirements of BWs, the range of variability is to be reduced to reflect the standard deviation from the mean biomass found within the preferred foraging area "hotspots".

Using the random generated numbers above this then provides for a mean of 131 with a standard deviation of 38.7, resulting in a target range of 92.3-169.7, again presented graphically below.



The target will be considered as met if the value measured at the compensation site is equal or higher than the target, or, if lower, it is within the ALC, i.e. higher or equal to the target minus 1 SD (calculated as described above). The initial target in the above scenario for abundance would therefore be 131 individuals per metre square at the RTE/MR with an ALC of 92.3 individuals per metre square.



Schematic representation of assessment for species targets.

Inter-annual Development targets:

It is recognised that over the longer term there may be a risk of the target being met in terms of comparable habitat but in the lower end of the range, thereby risking failure of providing bird prey. To monitor this risk it is considered that after the community has reached the point of proposed stabilisation (i.e. 5 years post breach) the long term mean biomass/abundance should be equal or greater than the target mean within a range that is linked to the inter-annual variation (measured by Standard Deviation) at the NKM control site.

A simplified representation of this would be that over 5 years from stabilisation (i.e. years 5 onwards) the annual Parameter X (e.g. abundance) may fluctuate within the target range, the target mean being 5 individuals. The data for these years are:

Year 5 =4 individuals, year 6 =5, year 7 =3, year 8 =5, year 9 =7, with a mean of 4.8. During the same period of time the Parameter X at the control site is 5, 5, 6, 4, 4.8, with a standard deviation/variation between years of 0.71.

The long term target mean is therefore 5 individuals +/- 0.7 which means the long term mean of 4.8 indicates a success of the compensation site.

Community target on NKM:

The MNCR biotopes present at NKM will be identified based on the community analysis at the study sites; allowing for ready comparison in terms of the target of providing comparable intertidal habitat (currently considered to be LS.LMu.MEst.HedMac (Hediste diversicolor and Macoma balthica in littoral sandy mud) in the upper and mid shore at NKM, and LS.LMu.MEst.NhomMacStr (Nephtys hombergii, Macoma balthica and Streblospio shrubsolii in littoral sandy mud) in the lower shore at NKM. Similarly, community data at the compensation site will inform a biotope analysis, and the results will be compared to those at NKM in order to ensure that the dominant biotopes occur in both sites. The biotopes will be mapped both at the NKM and compensation site.

The target would be that the main biotopes in NKM are to be present at the compensation site and the dominant biotope at NKM has to be also dominant at the compensation site.

Target assessment review

The targets will be set according to the methodology defined previously and agreed with the relevant authorities with recognition that the target must be validated against not only the primary objective of providing compensatory estuarine habitat, but also the provision of prey resource for the BW.

With this in mind the initial target will undergo a sensitivity analysis after the pre-construction survey data has been collated for year 1 pre-construction (PC-1) and if available year 2 pre-construction (PC-2). The PC-1 and PC-2 data will be analysed for inter-annual variation with the longer term data provided by the EA to ensure that both the target (i.e. mean biomass) and the range within which the mean target will sit (i.e. standard deviation around the mean set according to standard deviation found within preferred foraging habitat for BW) is representative of NKM as observed within the long term dataset and appropriate. This will provide the first tier of confidence in the target itself, and will be subject to review by the steering group and where appropriate the SNCBs in a special meeting held as soon as possible after the survey and data analysis has been conducted.

A second tier of confidence will also be applied whereby the understanding of the foraging behaviour in terms of preferred sediment type and giving up density of key prey species of the BWs will be used as a benchmark against which the target and range is assessed for suitability. Again this will be subject to review by the steering group and where appropriate the SNCBs in a special meeting held as soon as possible after the survey and data analysis has been conducted.

Additional methods of analysis may also be employed which may include an analysis of taxonomic distinctness within a funnel plot as has been suggested by Natural England. The use of this method is that it has the potential to identify areas which are in greater fluctuation than others – habitats under greater levels of perturbation are considered to have lower taxonomic distinctness than stable, established habitats. Whilst an advantage of using taxonomic distinctness is that it is independent of sampling effort, which can strongly influence the values of other commonly used diversity indices owing to the influence of sampling effort on species richness, given the objective to provide comparable habitat and key prey species it is not considered appropriate to use the TD analysis as a specific target setting measure. Rather these forms of analysis may be applied as an ongoing form of validation within the review periods to enable discussion

of progression of the community present within the compensation site from settlement to a stable community.

The assessment of targets will be carried out initially during the 10-years post-construction monitoring, at years 0 as highlighted above, year 5 and year 10. The end of the first 5 years is considered to be a key review period as it is at this point that the initial settlement should be reaching the proposed target and the collected data allows for the monitoring design to be adjusted, in order to ensure that sufficient data are collected at the compensation site to capture the site variability and patchiness. Within the 5 year review relevant information will be incorporated to ensure that not only the objective is on target to be met in terms of providing comparable habitat to that observed at NKM, but also that it is suitable to supporting BWs. Again the relevant information that could be included might be inter alia the giving up density of key prey items such as Macoma balthica and Hediste diversicolor

ANNEX 4: GUIDE TO USING PENETROMETER

Guide to Sampling Soil Compaction Using Hand-Held Soil Penetrometers

CEMML TPS 04-1

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January 2004

Guide to Sampling Soil Compaction Using Hand-Held Soil Penetrometers[1]

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Introduction

Vehicle traffic and foot trampling in military training areas can result in varying levels of soil compaction, depending on uses, climate, soil properties, and soil moisture at time of impact. Increased soil compaction results in higher soil bulk density (mass/unit volume), which can reduce water infiltration, reduce soil surface strength, increase runoff and erosion potential, and reduce site productivity (Braunack 1986, Thurow et al. 1995). The loss of macro-pore space via compaction has the greatest impact on water and air movement. Shrink-swell and freeze-thaw action typical of soils high in certain clays can significantly reduce surface soil compaction, but the most common remedy applied to highly compacted soils in relatively small areas is soil ripping using a chisel plow pulled by a tractor or bulldozer. Renewed root growth can also reduce soil compaction. Minimization of compaction is best achieved by confining traffic to specific areas, avoiding sensitive soils, and avoiding driving off-road when soils are excessively wet.

Soil compaction is most often characterized by changes in soil bulk density, typically expressed in Mg/m^3 or g/cc. Soil density is also related to soil resistance, which can be measured using a penetrometer much more rapidly that bulk density samples can be obtained (Miller et al. 2001). Some soils such as stony, light-textured, or highly friable soils are difficult to sample consistently

[1] Funding for this report was provided under the Land Condition-Trend Analysis (LCTA) Technical Support Contract administered by the Army Environmental Centre, Aberdeen, MD.

using hammer type bulk density samplers using corers or rings. Cone penetrometers are thus commonly used to measure soil compaction because of their easy, rapid, and economical operation (Perumpral, 1987). The purpose of this guide is to briefly discuss the advantages/disadvantages of hand operated static, dynamic, and drop cone penetrometers. Specifications and vendor information for selected penetrometers are also presented.

Compaction Issues

The level of compaction and the thickness of compacted layers can vary with soil depth and across the area of interest. Military training areas affected by compaction include assembly/administrative areas, bivouac areas, heavy equipment training areas, and off-road manoeuvre areas. Understanding the effects of compaction within the soil profile is essential for developing land repair and mitigation efforts. The follow key issues influence both the measurement and treatment of compaction (adapted from Rooney et al. (undated)):

- Intensity – How compacted is the soil relative to unimpacted soils? Slight compaction may not cause management problems and may heal over time.
- Extent – Is the compaction across the entire training/disturbed area or concentrated in specific areas?
- Depth – At what depth does the highest compaction occur?
- Thickness – How thick is the compacted layer, and does the thickness vary considerably across the site?
- Seasonality – How, if at all, does compaction change over the course of a year?

In general, an increase in compaction, as indicated in increased resistance to penetration, indicates reduced air and water movement within the soil, less favourable conditions for plant growth, and increased erosion potential.

Types of Cone Penetrometers

There are two general types of hand-held cone penetrometers: static penetrometers and dynamic penetrometers. Both measure soil resistance to vertical penetration of a probe or cone. The distinction between the two penetrometers lies in how force is applied to the cone. Static penetrometers subject to a constant hydraulic, mechanical, or electric power (via truck, tractor, or other motorized source) record data deep into the soil profile using digital data acquisition. These mechanical penetrometers work well to document compaction profiles due to the constant penetration rate, but are expensive and often limited to road-accessible sites. The drop cone penetrometer is considered a type of dynamic penetrometer, and will also be briefly discussed.

Static Cone Penetrometers

Static cone penetrometers measure the force required to push a metal cone through the soil at a constant velocity (Figure 1). The force is usually measured by a load cell or strain gauge (e.g., proving ring) coupled with an analogue dial or pressure transducer for readout (Herrick and Jones,
2002). The force is commonly expressed in kilopascals (kPa), an index of soil strength referred to as the cone index (ASAEa, 1999), or as Kg/cm^2 or PSI. As the operator pushes down on the penetrometer, the note keeper records cone index values for each depth increment to evaluate the degree, depth, and thickness of compacted layers. Cone indices depend on cone properties (angle and size) and soil properties (e.g., bulk density, texture, and soil moisture) (ASAEb,

1999; Herrick and Jones, 2002). A static cone penetrometer with a 30° cone has been recommended by the American Society of Agricultural Engineers (ASAE) as the standard measuring device for characterizing the penetration resistance of soils (ASAEa, 1999). While this configuration may work in a wide variety of soils, it is not critical that all instruments adhere to these standards, since results are generally relative to one another at a particular time and place.

Figure 1. Example of hand held static cone penetrometer. Photo courtesy Durham Geo Corp.

Although the methods for static cone penetrometer operation have been standardized, there are several limitations which may limit their use for monitoring (Herrick and Jones, 2002). Static penetrometers can be relatively expensive (≥$600), particularly for models with digital recording capability (Table 1). More importantly, since static penetrometers must be moved through the soil at a constant velocity (i.e., pressure), different rates of insertion by different observers can yield variable results and affect repeatability (Herrick and Jones, 2002). Even the pressure exerted by a single operator can be difficult to apply at a constant and repeatable rate. Operator strength may also limit the use of static penetrometers in dry soils. Recalibration to the operator is recommended to optimize repeatability. Repeatability and difficulties sampling hard or dry soils are the primary drawbacks of this type of penetrometer. Advantages of static cone penetrometers over dynamic cone penetrometers include well-documented and standardized methods and ease of use.

Dynamic Cone Penetrometers

Dynamic cone penetrometers (DCPs) apply a known amount of kinetic energy to the cone, which causes the penetrometer to move a distance through the soil (Herrick and Jones, 2002). Dynamic penetrometers do not rely on constant penetration velocity, as most dynamic penetrometers use a slide hammer of fixed mass and drop height to apply consistent energy with each blow (Figure 2). Either the number of blows required to penetrate a specified depth, or the depth of penetration per blow are measured, and results can be calculated as a cone index described above. The weight of the hammer, slide distance, and cone angle influence the energy delivered and can be adjusted to local conditions (e.g., soft vs. hard soils).

Figure 2. Example of dynamic cone penetrometer showing slide hammer (left), extension rods (centre) and cone attachment (upper right). Photo courtesy Durham Geo Corp.

Measurements are taken by placing the cone on the soil surface with the shaft upright. To minimize variability in starting depth, the cone is pressed into the soil until the soil is level with the base of the cone. The slide hammer is raised until it touches the collar and is released. The depth of penetration is recorded for each blow until a maximum or desired depth is reached. Penetrometers driven to depths greater than approximately 30 cm may be difficult to remove from the soil (Herrick and Jones 2002). Soil resistance for each soil depth interval is

calculated using standard equations that account for differences in hammer drop distance, weight, and cone size.

DCPs tend to yield much more consistent results and have a greater range of repeatability because they are not subject to operator variability (Herrick and Jones, 2002). Dynamic penetrometers have fewer limitations in dry soils and tend to be less expensive than static penetrometers (Table 1). Because of these reasons, the DCP is well suited for soil compaction monitoring on military lands. The design and application of a low-cost ($150-$200) DCP is described by Herrick and Jones (2002).

Drop Cone Penetrometers

A drop-cone penetrometer is used to estimate surface soil strength (Figure 3). It has been used to estimate compaction effects associated with cattle grazing (Paul Ayers, unpublished data) and military vehicles (Jones 2000). The drop cone used in the aforementioned studies was constructed based on design information provided by Godwin et al. (1991) and advice from Dr. Paul Ayers[2]. The drop-cone technique is rapid and precise, allowing many samples to be obtained in a short period of time. The device consists of a 30 degree metal cone and lifting rod with a combined weight of 2.0 kg, a 1 m long PVC or acrylic guide tube, and an aluminium millimetre ruler inlaid in the holding rod. The cone is machined with a collar to ensure that it falls perpendicularly through the guide tube. To take a measurement, the base of the guide tube is placed on the ground surface and the cone is lifted until its top is flush with the top of the tube. The cone is released and penetrates the ground surface. Penetration depth is recorded at the top of the guide tube by reading the ruler inlaid in the holding rod.

This apparatus is inexpensive, easy to use, rapid, and highly repeatable. The disadvantage of this penetrometer is that only surface soil resistance is measured and nothing can be inferred about the underlying soil profile.

Figure 3. Drop cone penetrometer held in release position.

[2] Former professor of Chemical and Bioresources Engineering, Colorado State University, Fort Collins, Colorado; currently at the University of Tennessee at Knoxville.

Table 1. Specifications and vendor information for hand-held cone penetrometers for measuring soil compaction. Listing of a vendor does not constitute promotion of their products.

Penetrometer Type	Manufacturer/ Vendor	Model#	Digital	Specifications	Cost[1]	Vendor Contact	Notes
dynamic	"local machine shop"	"Jornada Impact Penetrometer"	No	choice of cone angle (generally 30°, 45°, or 60°), rod length, slide hammer weight, and material (iron vs. stainless)	$150-$250	machined and constructed locally	Described in detail in Herrick and Jones (2002)
dynamic	Durham Geo	S-205	No	45° cone w/ diameter of 3.8cm; (4) 30" drill rods; 15 lb (6.8 kg) steel hammer	$425	[redacted] solutions@durhamgeo.com 800-837-0864	Model S-200 is similar but includes auger head and (4) 36" auger extensions; cost is $550
dynamic	Triggs Technologies, Inc.	Wildcat	No	Uses polymer/water slurry injection to prevent soil from caving onto rods; 35lb hammer; uses lost points (cones-90° apex, 10cm^2)	$2,145	[redacted] info@www.triggstechnologies.com.com 800-383-2624	Several optional accessories also available, including the Stork hammer-lifter ($1975). Designed to be used in augered holes at specified depths. Cones detach in holes so a new cone tip must be used each time.
dynamic	Vertek/Applied Research Associates, Inc.	Hand-Held DCP Kit	No* (see Notes)	Includes 10 disposable cones and receiver for disposable cones, Pelican case, vertical scale, 8 kg sliding weight	$1,475	[redacted] verteck@ara.com 800-639-6315.	Electronic data acquisition system also available ($4995)
dynamic (drop)	"local machine shop"		No	choice of cone angle (generally 30°, 45°, or 60°), rod length, slide hammer weight, and material (iron vs. stainless)	$150-$250	machined and constructed locally	Drop cone penetrometer data provides an index of surface soil strength and typically is only dropped once per sample. Apparatus described in Godwin et al. and has been used by D. Jones (CEMML).
static	Durham Geo	S-212	No	60° cone w/ area of 1.5cm^2; 2.5' rod; pressure gauge (kg/cm^2)	$642	[redacted] solutions@durhamgeo.com 800-837-0864	
static	Eijkelkamp	Hand Penetrometer	No	Probes to a depth of 1m; Includes (4) sizes of 60° cones; probing and extension rods; carrying case; tool set; cone check; pressure gauge (kPa)	$1,232	Soil Moisture Equipment Corp. [redacted] 805-964-3525	Similar model can probe to 3m depth ($2062); The 1m model is also available from Ben Meadows (benmeadows.com); cost is $1373
static	Eijkelkamp	Penetrologger	Yes, with datalogger & PC software	Probes to a depth of 0.8m; Records soil depth in 1cm increments; Penetration resolution of 0.1 kPa; Includes various sizes of cones; carrying case; tool set; cone check; battery charger	$5,207	Soil Moisture Equipment Corp. [redacted] 805-964-3525	

Penetrometer Type	Manufacturer/ Vendor	Model#	Digital	Specifications	Cost[1]	Vendor Contact	Notes
static	Geneq, Inc.	H-4210	No	60° cone w/ area of 1.5cm^2; 2.5' rod; pressure gauge (kg/cm^2)	$823	info@geneq.com 800-463-4363	
static	Spectrum Technologies, Inc.	Field Scout (SC-900)	Yes, with datalogger & PC software	Weighs 2.75 lbs; Records soil depth in 1" increments; Penetration resistance in PSI or kPa; GPS port	$1,495	[redacted] info@specmeters.com 800-248-8873	Identical to Investigator below
static	Forestry Suppliers, Inc.	The Investigator Soil Compaction Meter	Yes, with datalogger & PC software	Weighs 2.75 lbs; Records soil depth in 1" increments; Penetration resistance in PSI or kPa; GPS port	$1,395	[redacted] sales@forestry-suppliers.com 800-647-5368	Identical to Spectrum's Field Scout

1 - Prices as of January 2004

Compaction Sampling Guidelines

The following guidelines are provided to assist in the development of compaction sampling protocols and optimize data analysis opportunities:

- Develop written sampling objectives to direct data collection and evaluate success of the monitoring and management efforts. Include specific attributes such as intensity, depth, extent, etc. For example, “Estimate the mean penetrometer resistance of 0-10cm, 10-20cm, and 20-30cm soil depths with 90% confidence that the estimate is within 10% of the mean. These assessments will be performed every two years in high-use areas where soil compaction is a management concern”.
- Develop a standardized sampling design and methodology for use in areas of interest.
- Because soil strength is highly influenced by soil moisture, sampling of a site should take place over a short period of time to minimize potential effects of changing soil moisture. If comparison of different sites or analysis over time is desired, it is recommended to sample when soils are at or near field capacity (Miller et al. 2001).
- Sample adjacent “control” or reference areas to provide a benchmark for comparison with impacted sites. Reference areas should be relatively close to damaged areas and have a similar soil type.
- Due to the effects of soil moisture on penetration resistance, measurements should be analyzed as relative values at a particular time and place. Differences in soil texture, rainfall patterns, and sunlight exposure can affect soil moisture across the landscape.
- Sample size necessary to meet desired precision should be determined using pilot sampling. Approximately 15-25 samples are often adequate but results will depend on site heterogeneity.
- Sampling designs should be stratified if appropriate. Bias in selection of sampling locations must be minimized through the a priori selection of locations or the use of additional sampling rules of thumb. Navigation to random or systematic grid points (with a random start point) or navigation using pacing and compass are both acceptable approaches to minimize subjectivity.
- Soil moisture content and soil texture classification could be collected and recorded as corollaries to compaction.
- Repeated attempts may be necessary where stones are encountered, indicated by a distinct sound and or penetrometer vibration. In stony soils, penetrometer resistance may be poorly correlated with bulk density (Miller et al. 2001).
- Additional vegetation, disturbance, groundcover/biological crust, erosion, or other data can be collected at compaction sample points and the data can be analyzed to infer the causes of compaction, its effect on natural resources, and the effectiveness of compaction mitigation efforts.

Conclusions

A variety of types and models of hand held penetrometers are available, and present a relatively low cost and expedient alternative to collecting bulk density samples for measuring soil compaction. Following the lead of Herrick and Jones (2002), the slide hammer type DCP is recommended for sampling compacted soil areas on military installations. While DCP results are not necessarily comparable across sites and over time due to differences in soil moisture

and other factors, the procedure is highly repeatable and rapid, and addresses the key issues of compaction intensity, extent, depth, and thickness. The penetrometer can be purchased commercially from several vendors or constructed to ASAE standards using a local machine shop.

References

ASAE (American Society of Agricultural Engineers). 1999a. Soil Cone Penetrometer. ASAE Standard S313.3. American Society of Agricultural Engineers: St. Joseph, MI.

ASAE (American Society of Agricultural Engineers). 1999b. Procedures for Using and Reporting Data with the Soil Cone Penetrometer. ASAE Standard EP542. American Society of Agricultural Engineers: St. Joseph, MI.

Braunack, M.V. 1986. The residual effects of tracked vehicles on soil surface properties. Journal of Terramechanics 23(1): 37-50.

Godwin, R.J., N.L. Warner, and D.L. Smith. 1991. The development of a dynamic drop-cone device for the assessment of soil strength and the effects of machinery traffic. J. Agric. Engineering Res. 48:123-131.

Herrick, J.E. and T.L. Jones. 2002. A dynamic cone penetrometer for measuring soil penetration resistance. Soil Science Society of America Journal 66: 1320-1324.

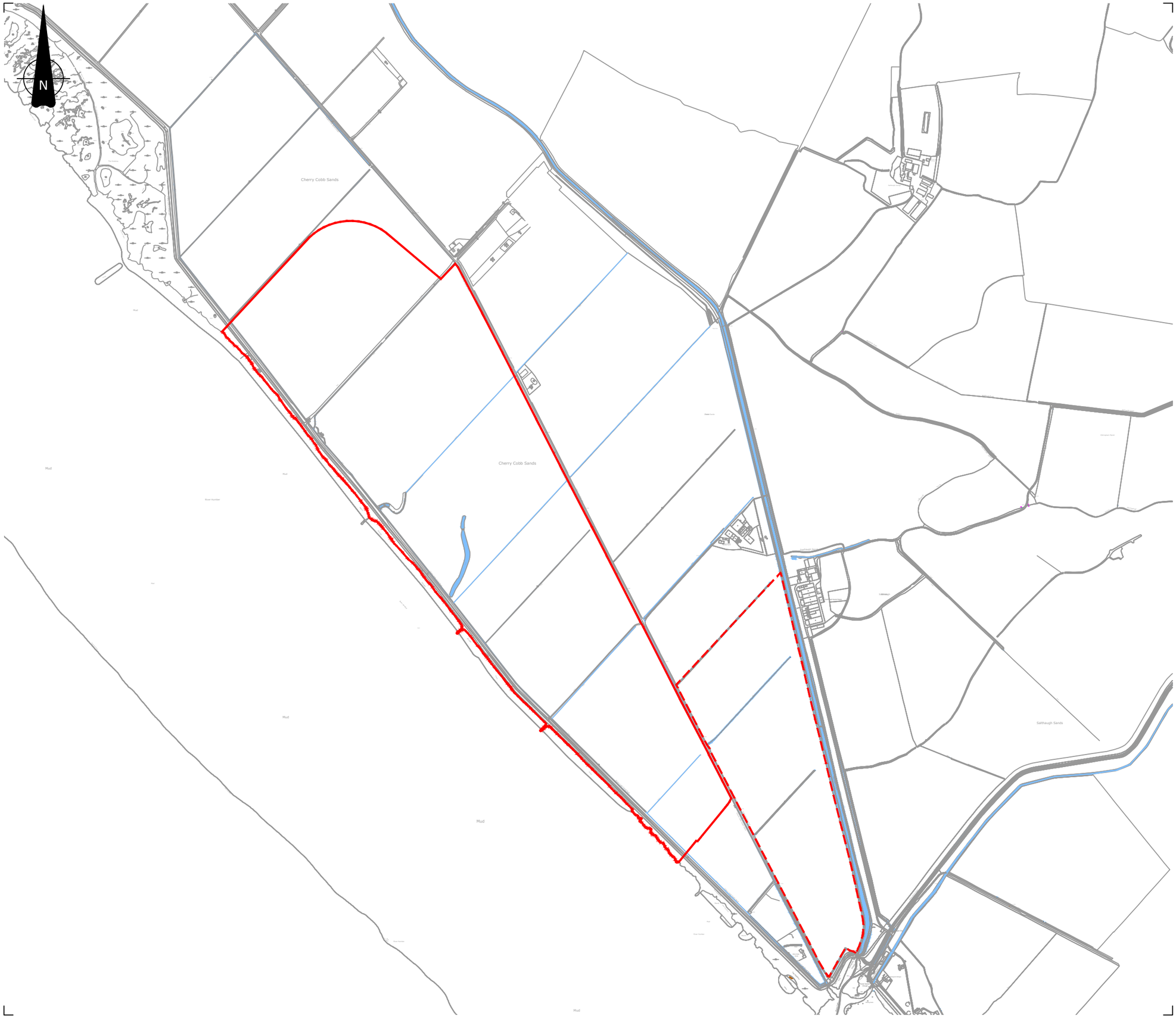
Jones, D.S. 2000. Impacts of the M1A1 Abrams Tank on Vegetation and Soil Characteristics of a Grassland Ecosystem at Fort Lewis, Washington. CEMML TPS 00-1. Centre for Environmental Management of Military Lands, Colorado State University, Fort Collins CO.

Miller, R.E., J. Hazard, and J. Howes. 2001. Precision, Accuracy, and Efficiency of Four Tools for Measuring Soil Bulk Density or Strength. USDA Forest Service Pacific Northwest Research Station Gen. Tech Report PNW-RP-532, April 2001.

Perumpral, J.V. 1987. Cone penetrometer applications: A review. Transactions of the American
Society of Agricultural Engineers 30:
939-944.

Rooney, D., M. Stelford, and D. Landolt. Undated. Site-Specific Soil Compaction Mapping Using a Digital Soil Penetrometer. Site-Specific Management Guidelines (SSMG) – 34. Potash and Phosphate Institute [redacted]

Thurow, T.L., S.D. Warren, and D.H. Varlson. 1995. Tracked vehicle effects on the hydrological characteristics of Central Texas rangeland. Transactions of the ASAE 36(6):1645-1650.



Key & Notes

Objective C1

- Cherry Cobb Sands RTE Boundary
- Cherry Cobb Sands Wet Grassland Consent Boundary
- Existing watercourse/drain

Scope of works

1) Pre-construction baseline survey within the site boundaries to be carried out before works commence for reptiles & water voles.

2) Fortnightly strimming of drain banks found to be suitable for water voles and suitable reptile habitat within the site boundaries before & during construction to prevent colonisation by water voles/reptiles and subsequent disturbance.

Rev.	Date	Comments	Drn	Chk	App
A	03.06.2015	Preliminary Issue	SDW	JM	RC

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Project: ABLE Marine Energy Park

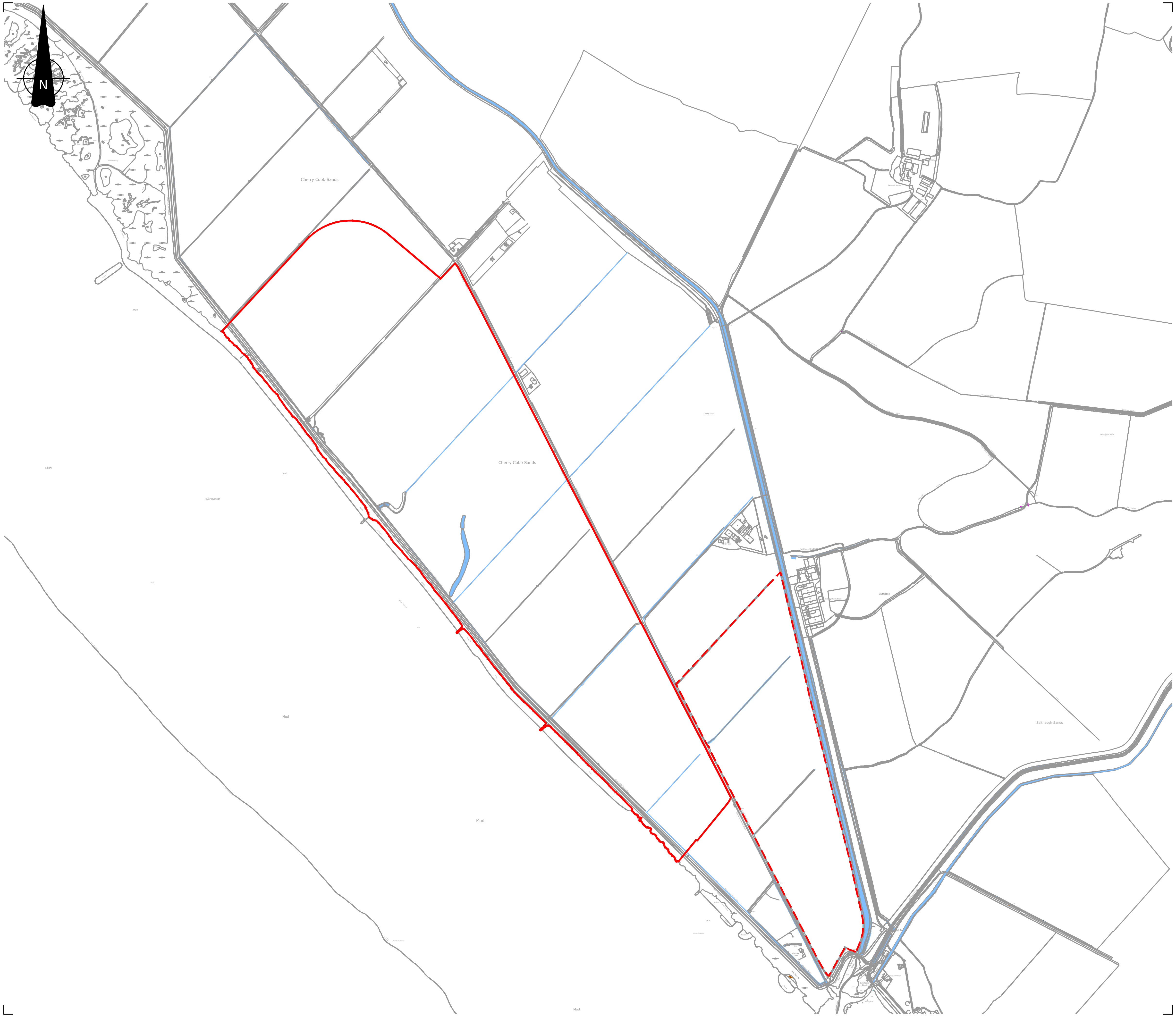
Client: ABLE Humber Ports Limited

Drawing Title: CEMMP Reptile & Water Vole Survey

PRELIMINARY

Scale:	Drawn By	Checked By	Approved By
1:12,500 @A3	S. Walton	J. Monk	R. Cram
Date:	30/04/2015	02/06/2015	02/06/2015

Drawing No: AME-009-00064 Revision: A



Key & Notes

Objective C2

Cherry Cobb Sands RTE Boundary

Cherry Cobb Sands Wet Grassland Consent Boundary

Existing watercourse/drain

Scope of works

1) Pre-construction nesting habitat survey in Feb 2016 (CCSWG only).

2) Removal of potential nesting habitat (once confirmed no birds present) on landward side of flood defence wall in March 2016 (CCSWG only). Remaining potential habitat to be surveyed fortnightly, pre-construction & during construction from this date.

3) Fortnightly surveys of RTE site during all construction activities between 1st April & 30th September.

Rev.	Date	Comments	Drn	Chk	App
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Project: ABLE Marine Energy Park

Client: ABLE Humber Ports Limited

Drawing Title: CEMMP Breeding Bird Nesting Survey

PRELIMINARY

Scale:	Drawn By	Checked By	Approved By
1:12,500 @A3	S. Walton	J. Monk	R. Cram
Date:	30/04/2015	02/06/2015	02/06/2015

Drawing No: AME-009-00065 | Revision: A

Mound Detail

Scale 1:500

Key & Notes

Objective C3

- Cherry Cobb Sands RTE Boundary
- Cherry Cobb Sands Wet Grassland Consent Boundary
- Extent of badger survey

Scope of works

Pre-construction survey, post construction colonisation survey for 5 years, to cease after 3 years if population stable.

Rev.	Date	Comments	Drn	Chk	App
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Project: ABLE Marine Energy Park

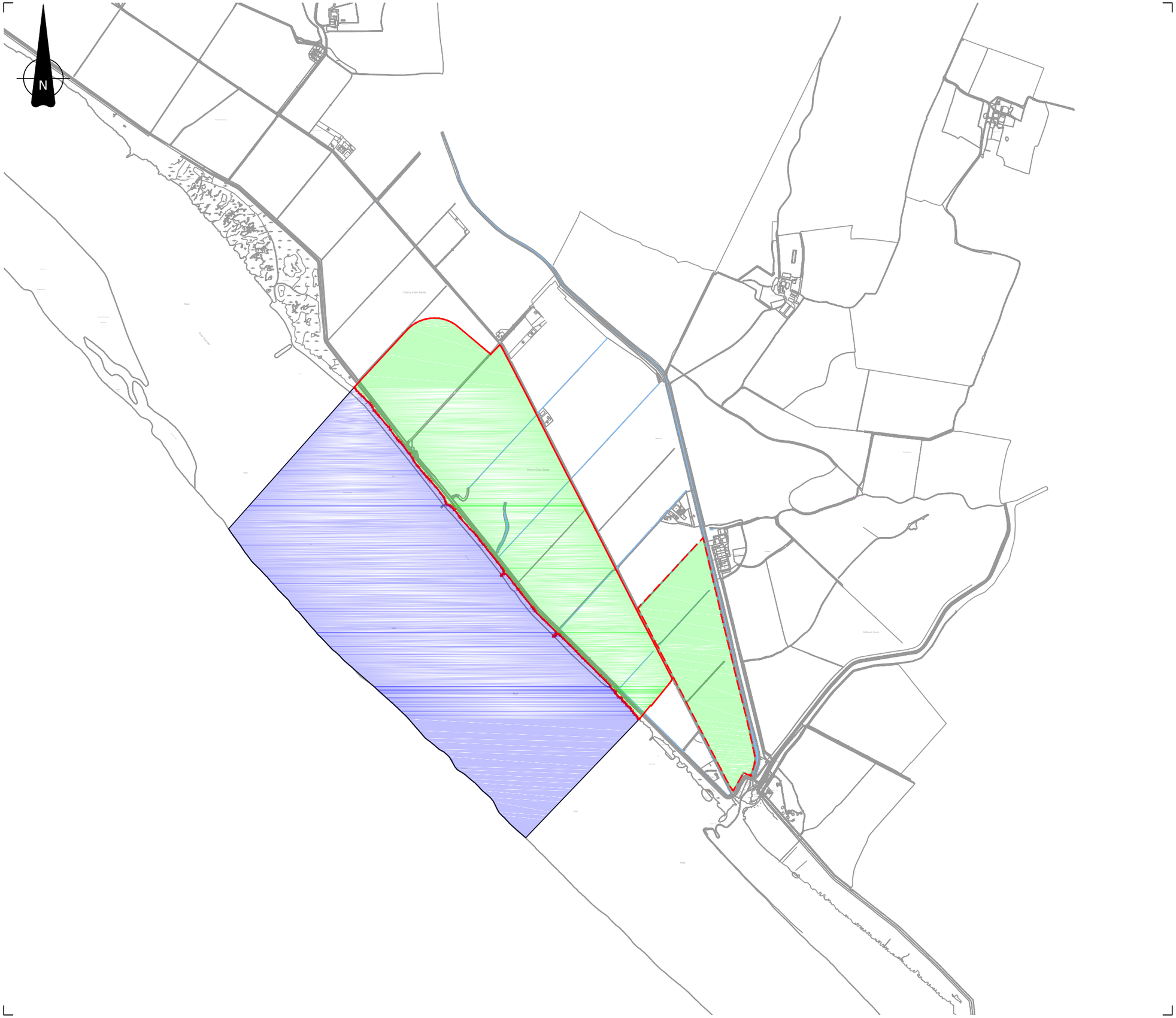
Client: ABLE Humber Ports Limited

Drawing Title: CEMMP Badger Habitat Enhancement

PRELIMINARY

Scale:	Drawn By	Checked By	Approved By
1:20,000 UNO @A3	S. Walton	J. Monk	R. Cram
Date:	30/04/2015	03/06/2015	03/06/2015

Drawing No: AME-009-00066 Revision: A



Key & Notes

Objective C4

- Cherry Cobb Sands RTE Boundary
- Cherry Cobb Sands Wet Grassland Consent Boundary
- Compensation site bird count survey
- Intertidal site bird count survey

Scope of Works:
Surveys to be undertaken monthly during the construction period.

Rev.	Date	Comments	Drn	Chk	App
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Project: ABLE Marine Energy Park

Client: ABLE Humber Ports Limited

Drawing Title: CEMMP SPA Bird Counts During Construction

PRELIMINARY

Scale:	Drawn By	Checked By	Approved By
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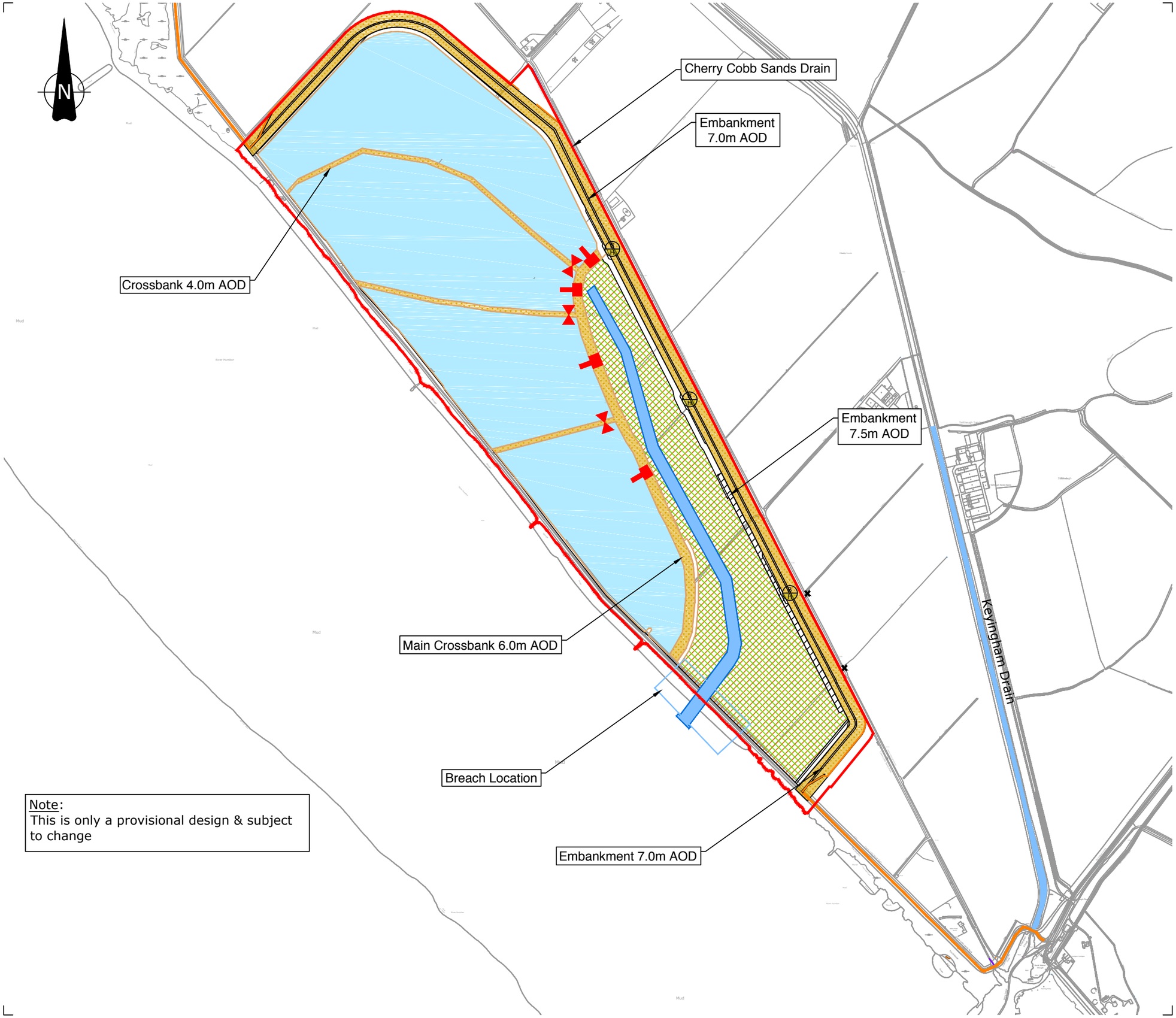
Date:	30/04/2015	02/06/2015	02/06/2015

Drawing No: AME-009-00067 Revision: A



Note:
This is only a provisional design & subject to change

Key & Notes

Objective COMP 1

- Cherry Cobb Sands RTE boundary
- Channel
- Bird hide
- Inlet / outlet structure (sluice)
- Field connection culvert

Proposed Layout Features

- New flood defence embankment
- Embankment
- Channel
- Regulated Tidal Exchange site (RTE)
- Managed Realignment site (MR)

Scope of works

Topographical survey of site area.

Survey & engineering analysis to confirm performance of sluice & bunds. Leakage to be surveyed & recorded for analysis.

Note

1. Initial level of RTE fields to be +1.9m to 2.0m AOD.
2. Leakage from RTE site to be ≤200mm depth of water over 10days following initial impoundment of 1000mm.

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Project: ABLE Marine Energy Park

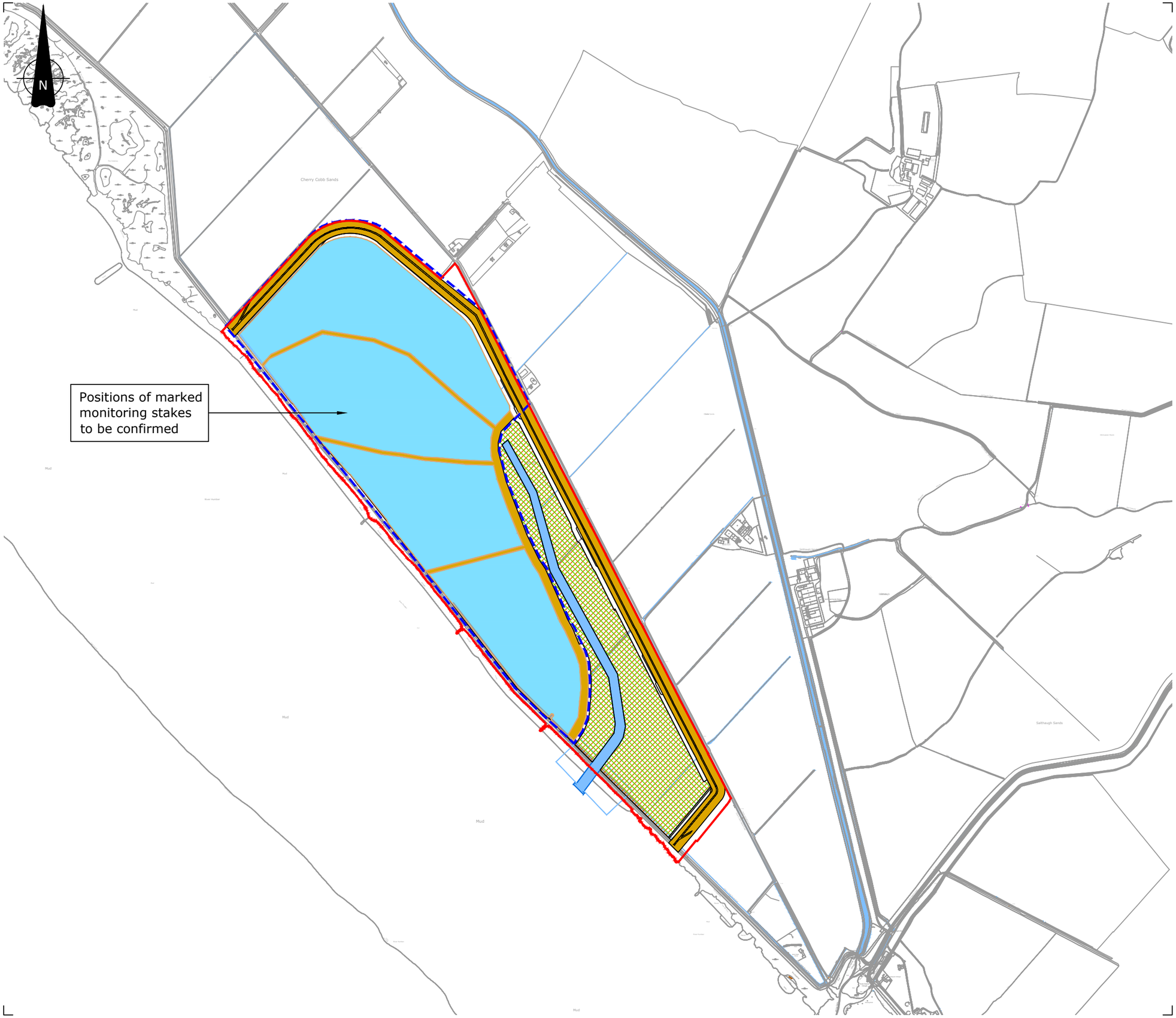
Client: ABLE Humber Ports Limited

Drawing Title: CEMMP Monitoring of Bund & Sluices

PRELIMINARY

Scale:	Drawn By	Checked By	Approved By
1:10,000 @A3	S. Walton	J. Monk	R. Cram
Date:	30/04/2015	02/06/2015	02/06/2015

Drawing No: AME-009-00068 Revision: A



Key & Notes

Objective COMP 2

- Cherry Cobb Sands RTE Boundary
- Area of LiDAR survey

Proposed Layout Features

- New flood defence embankment
- Embankment
- Channel
- Regulated Tidal Exchange site (RTE)
- Managed Realignment site (MR)

Scope of works

1) Monthly monitoring of mud & water levels in RTE fields during the warping up phase using marked stakes.

2) LiDAR surveys on no more than 3 year intervals.

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Project: ABLE Marine Energy Park

Client: ABLE Humber Ports Limited

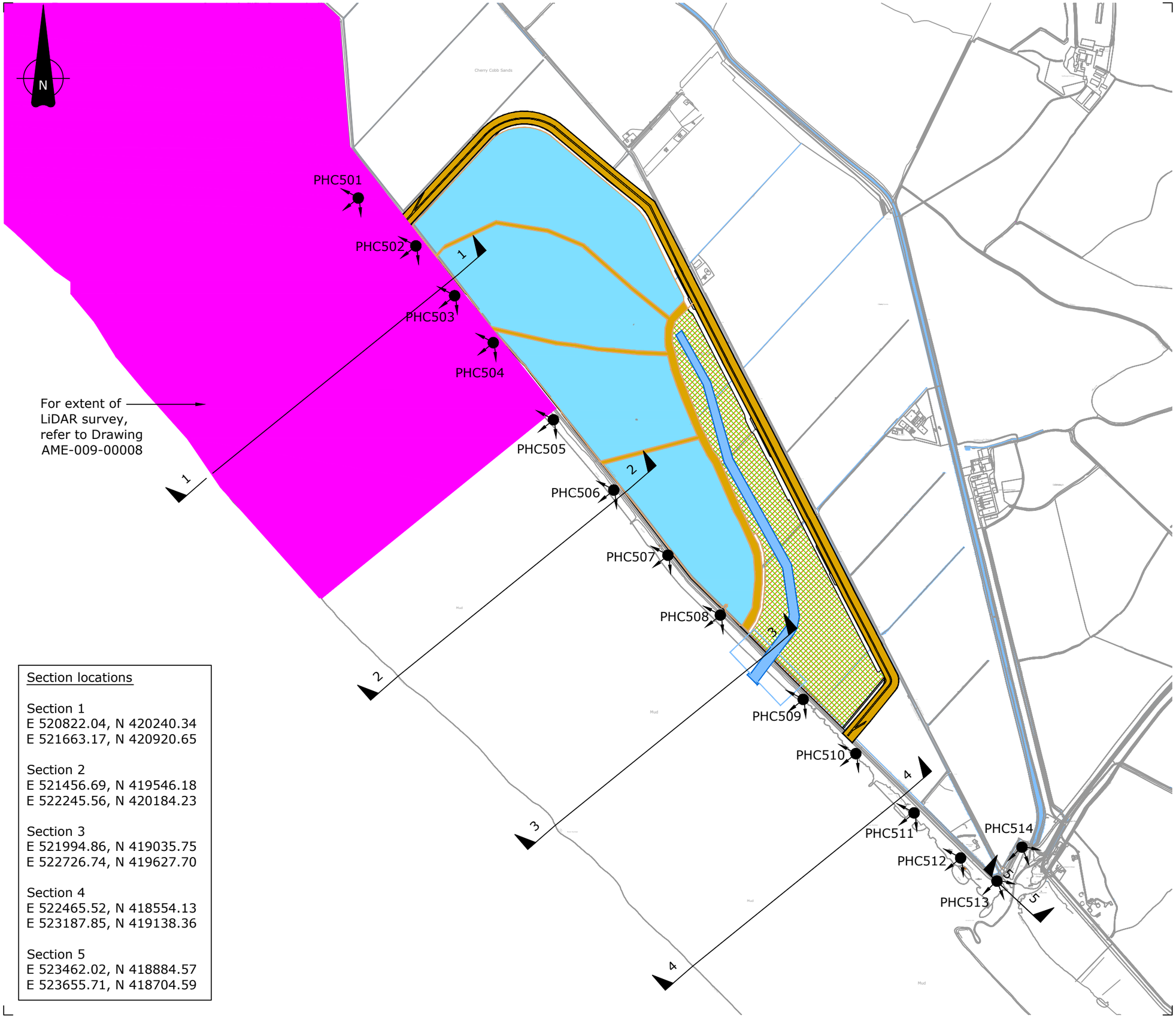
Drawing Title: CEMMP Monitoring of Warping up in RTE Fields

PRELIMINARY

Scale:	Drawn By	Checked By	Approved By
1:12,500 @A3	S. Walton	J. Monk	R. Cram
Date:	30/04/2015	02/06/2015	02/06/2015

Drawing No: AME-009-00069

Revision: A



Key & Notes

Objective COMP 5

Topographic survey section locations

Photographic survey point (marked with timber stake)

LiDAR Survey 762.1ha

Proposed Layout Features

- New flood defence embankment
- Embankment
- Channel
- Regulated Tidal Exchange site (RTE)
- Managed Realignment site (MR)

Notes:

1) Photographic survey at 3 monthly intervals from start of construction.

2) Annual topographic survey to be undertaken pre-construction, during construction & post construction.

Rev.	Date	Comments	Drn	Chk	App
A	03.06.2015	Preliminary Issue	SDW	JM	RC

Section locations

Section 1
E 520822.04, N 420240.34
E 521663.17, N 420920.65

Section 2
E 521456.69, N 419546.18
E 522245.56, N 420184.23

Section 3
E 521994.86, N 419035.75
E 522726.74, N 419627.70

Section 4
E 522465.52, N 418554.13
E 523187.85, N 419138.36

Section 5
E 523462.02, N 418884.57
E 523655.71, N 418704.59

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Project: ABLE Marine Energy Park

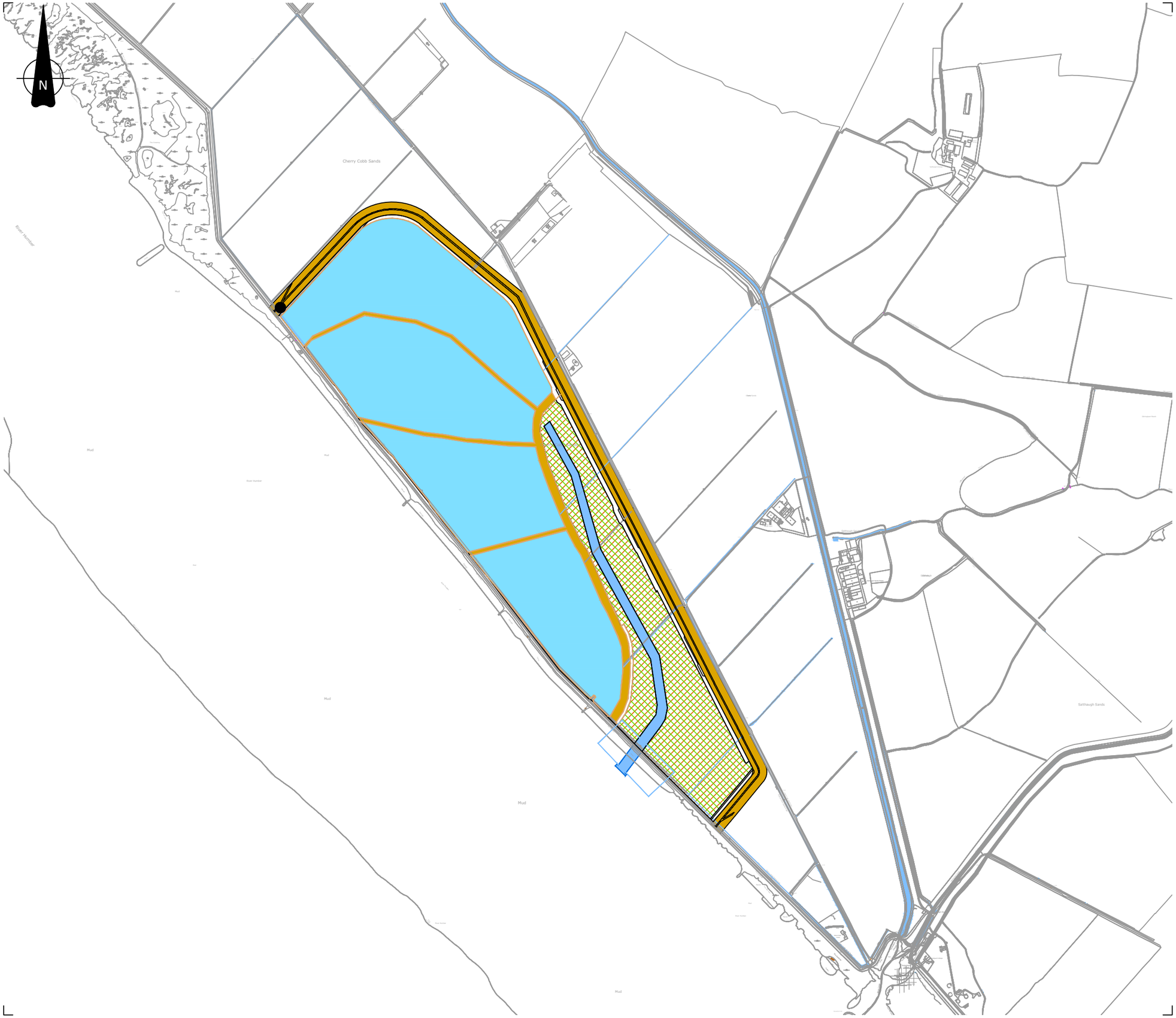
Client: ABLE Humber Ports Limited

Drawing Title: CEMMP Bathymetric Monitoring of Areas Outside of RTE Fields

PRELIMINARY

Scale:	Drawn By	Checked By	Approved By
1:12,500 @A3	S. Walton	J. Monk	R. Cram
Date:	30/04/2015	02/06/2015	02/06/2015

Drawing No: AME-009-00070 Revision: A



Key & Notes

Objective COMP 6, COMP 7 & COMP 10 (SAC)

Proposed Layout Features

- New flood defence embankment
- Embankment
- Channel
- Regulated Tidal Exchange site (RTE)
- Managed Realignment site (MR)

Scope of works

1) Sediment samples to be taken with hand held corer to a depth c15cm. Hand core samples shall be tested for:
   - Invertebrate communities
   - Particle size analysis
   - Organic content
   - Water salinity
   - Organic carbon content

   Sampling to be undertaken annually (late August/early September) for 10 years post construction (Comp 6).

2) Comp 7 & Comp 10 Sampling locations to be determined 12months after breaching.

3) Hand coring within RTE fields followed by PSA and analysis of organic content (may cease after 5 years).

4) Take photographic record of sample point.

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Project: ABLE Marine Energy Park

Client: ABLE Humber Ports Limited

Drawing Title: CEMMP Monitoring of Infaunal Communities & Non Faunal Attributes of RTE & MR Sites

PRELIMINARY

Scale:	Drawn By	Checked By	Approved By
1:10,000 @A3	S. Walton	J. Monk	R. Cram
Date:	30/04/15	02/06/2015	02/06/2015

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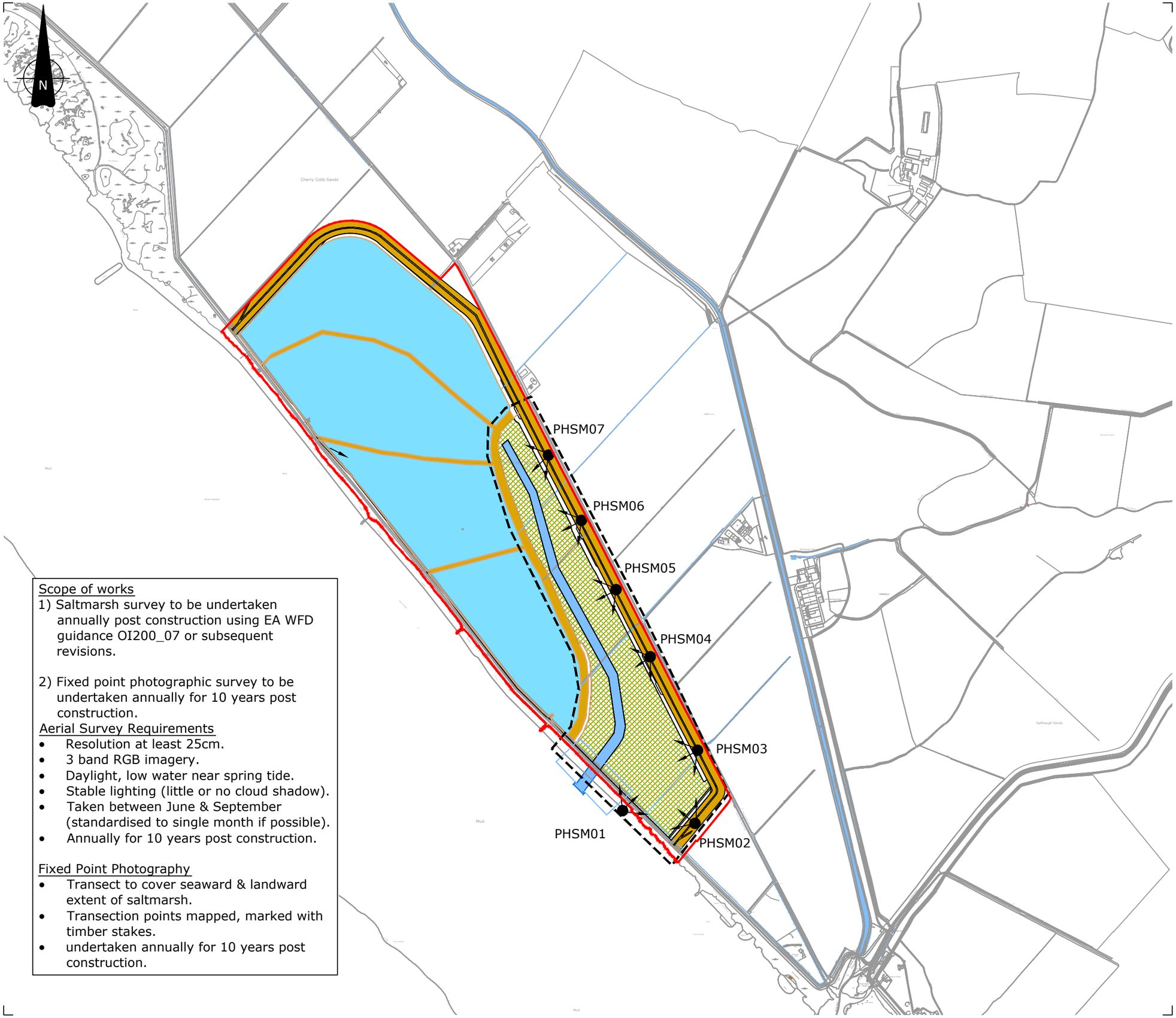

Key & Notes

Objective COMP 8(SAC)

- Cherry Cobb Sands RTE Boundary
- Saltmarsh survey area
- Fixed point photographic survey location

Proposed Layout Features

- New flood defence embankment
- Embankment
- Channel
- Regulated Tidal Exchange site (RTE)
- Managed Realignment site (MR)

Scope of works

1) Saltmarsh survey to be undertaken annually post construction using EA WFD guidance OI200_07 or subsequent revisions.

2) Fixed point photographic survey to be undertaken annually for 10 years post construction.

Aerial Survey Requirements

- Resolution at least 25cm.
- 3 band RGB imagery.
- Daylight, low water near spring tide.
- Stable lighting (little or no cloud shadow).
- Taken between June & September (standardised to single month if possible).
- Annually for 10 years post construction.

Fixed Point Photography

- Transect to cover seaward & landward extent of saltmarsh.
- Transection points mapped, marked with timber stakes.
- undertaken annually for 10 years post construction.

Rev.	Date	Comments	Drn	Chk	App
A	03.06.2015	Preliminary Issue	SDW	JM	RC

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Fax: +44(0)1642 655655

Project: ABLE Marine Energy Park

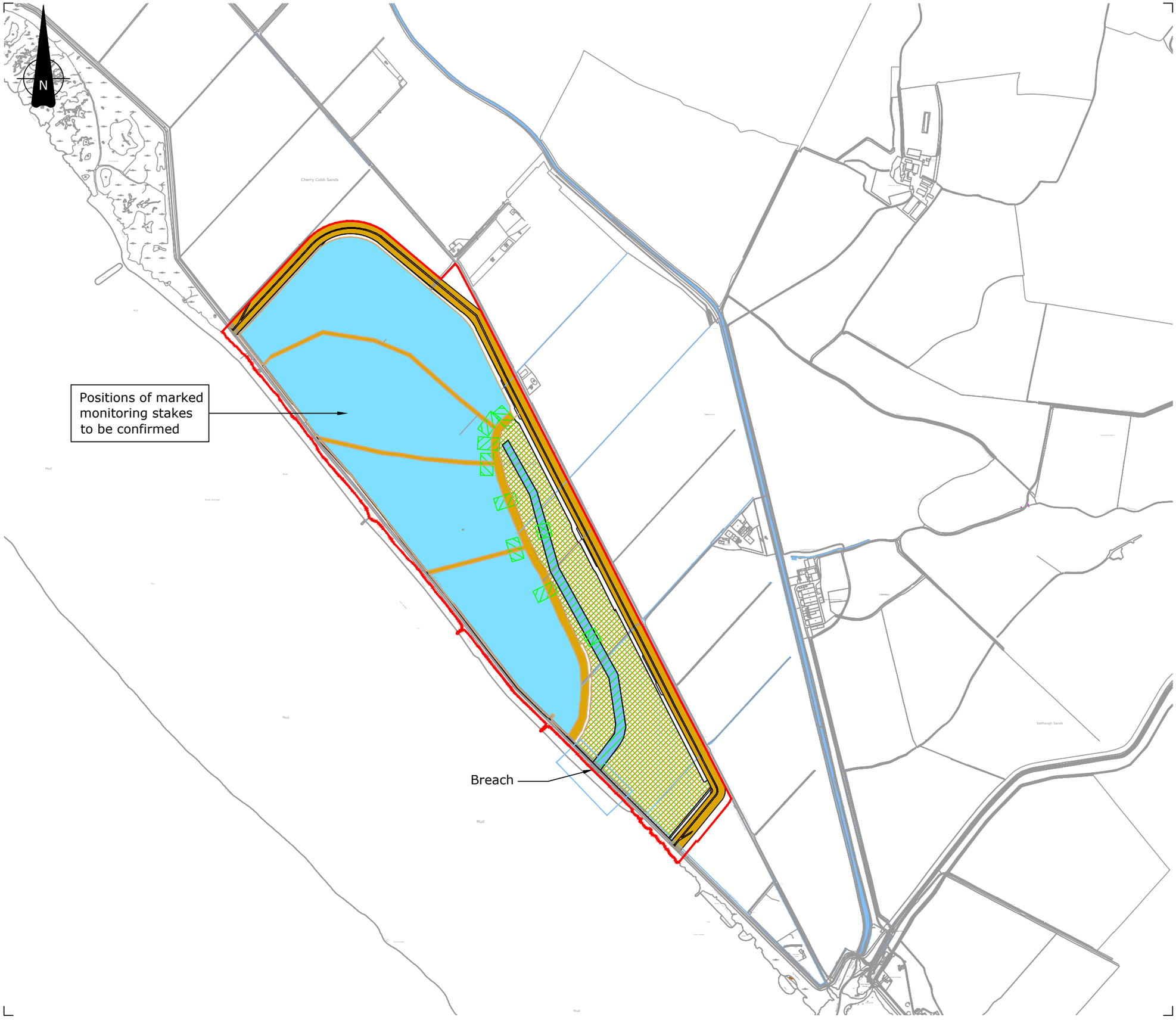
Client: ABLE Humber Ports Limited

Drawing Title: CEMMP Monitoring of New Saltmarsh Survey Areas

PRELIMINARY

Scale:	Drawn By	Checked By	Approved By
1:12,500 @A3	S. Walton	J. Monk	R. Cram
Date:	30/04/2015	02/06/2015	02/06/2015

Drawing No: AME-009-00072 Revision: A



Key & Notes

Objective COMP 9 & COMP 11

- Cherry Cobb Sands RTE Boundary
- Fyke net/epibenthic sledge survey area

Proposed Layout Features

- New flood defence embankment
- Embankment
- Channel
- Regulated Tidal Exchange site (RTE)
- Managed Realignment site (MR)

Scope of works

1) Comp 9 : LiDAR bed level monitoring, marked stakes & photographic records. Twice yearly during the first 2-3 years then at 1-3 year intervals.

2) Comp 11: Fyke net survey Of main channel & at RTE sluices to be undertaken in Spring (May-June) and Autumn (September-October)on outgoing tide every two years for 10 years post construction.

Epibenthic sledge locations to be agreed.

Rev.	Date	Comments	Drn	Chk	App
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Project: ABLE Marine Energy Park

Client: ABLE Humber Ports Limited

Drawing Title: CEMMP Fish Monitoring Within Compensation Site

PRELIMINARY

Scale:	Drawn By	Checked By	Approved By
1:12,500 @A3	S. Walton	J. Monk	R. Cram
Date:	30/04/2015	02/06/2015	02/06/2015

Drawing No: AME-009-00073 Revision: A

Key & Notes

Objective WG1

Cherry Cobb Sands Wet Grassland Consent Boundary

1m x 1m Quadrat (60 no.)

Scope of Works:

Plant species and abundance to be recorded for each quadrat. Surveys to be undertaken in June for the first five years following completion.

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Project: ABLE Marine Energy Park

Client: ABLE Humber Ports Limited

Drawing Title: CEMMP Grassland Vegetation Survey

PRELIMINARY

Scale:	Drawn By	Checked By	Approved By
1:12,500 @A3	S. Walton	J. Monk	R. Cram
Date:	30/04/2015	02/06/2015	02/06/2015

Drawing No: AME-009-00074 Revision: A

Key & Notes

Objective WG2

- Cherry Cobb Sands Wet Grassland Consent Boundary
- Island
- Visual assessment area
- Salinity monitor location
- Water depth monitoring points. Permanent static depth gauges to be installed

Scope of Works:

1) Target 1:
Water depth to be assessed from depth gauges, and water extent to be assessed visually, and a photographic record kept:
2x weekly during Year 1
2x monthly during Years 2-5

2) Target 2:
Visual assessment of rushes, tall sedges & reeds within open water post construction:
Annually in June for 5 years then every 3 years thereafter.

3) Target 3:
Salinity monitoring to be continuous during Year 1. Continuous monitoring during Summer-Autumn Years 2-5 thereafter (only if source of top-up water is Keyingham drain)

4) Target 4:
Mapping of vegetation on islands undertaken annually in June for Years 1-5 & every 3 years thereafter.

5) Photgraphic records should be kept.

Rev.	Date	Comments	Drn	Chk	App
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Project: ABLE Marine Energy Park

Client: ABLE Humber Ports Limited

Drawing Title: CEMMP Visual Assessment of Open Water Area

PRELIMINARY

Scale:	Drawn By	Checked By	Approved By
1:12,500 @A3	S. Walton	J. Monk	R. Cram
Date:	30/04/2015	02/06/2015	02/06/2015

Drawing No: AME-009-00075 | Revision: A

Key & Notes

Objective WG3, WG5 & WG6

- Cherry Cobb Sands Wet Grassland Consent Boundary
- Existing watercourse/drain
- Area of soil testing (100 locations)

Scope of Works:

1) WG3 target 1:
Soil penetration
Monthly at each location for 5 years post construction (July-November)

WG3 Target 2:
Soil moisture content
Annually at each location for 5 years (September)

2) WG5:
Soil biomass
Annually until target achieved samples collected in September (25x25x10cm) x100

3) WG6:
Monthly
Measurement of sward height at 100 sample points for 5 years (July-November)

Annual (June)

- Visual assessment for dense stands of:
- Rushes
- Tall Sedges
- Reeds
- Tall Ruderal vegetation

Rev.	Date	Comments	Drn	Chk	App
A	03.06.2015	Preliminary Issue	SDW	JM	RC

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Project: ABLE Marine Energy Park

Client: ABLE Humber Ports Limited

Drawing Title: CEMMP Soil Penetration, Biomass & Moisture Content Monitoring

PRELIMINARY

Scale:	Drawn By	Checked By	Approved By
1:12,500 @A3	S. Walton	J .Monk	R. Cram
Date:	30/04/2015	02/06/2015	02/06/2015

Drawing No: AME-009-00076 Revision: A

Key & Notes

Objective WG4

Cherry Cobb Sands Wet Grassland Consent Boundary

Existing watercourse/drain

Visual assessment of area of flooding extent

Scope of Works

Visual assessment of flooding extent :

Twice weekly Year 1

Twice monthly Year 2-5

A photographic record is to be kept on which which monthly reports are to be based.

Rev.	Date	Comments	Drn	Chk	App
A	03.06.2015	Preliminary Issue	SDW	JM	RC

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Project: ABLE Marine Energy Park

Client: ABLE Humber Ports Limited

Drawing Title: CEMMP Visual Assessment of Flooding

PRELIMINARY

	Drawn By	Checked By	Approved By
Scale: 1:12,500 @A3	S. Walton	J. Monk	R. Cram
Date:	30/04/2015	02/06/2015	02/06/2015

Drawing No: AME-009-00077 | Revision: A

North Killingholme Haven Pits (NKHP)

North Killingholme Marshes Foreshore (NKM)

Regulated Tidal Exchange Site (RTE)

Cherry Cobb Sands (CCS)

Cherry Cobb Sands Wet Grassland (CCSWG)

Key & Notes

Objective B1

Site Boundary

Scope of works

1) Through the Tide Counts to be conducted in the 5 survey areas shown below, twice monthly, on a spring and a neap tide.

2) Counts to commence in Jan 2016.

3) Annual Report to be provided with species accounts within the survey areas, population trends for the Humber Estuary SPA, and also national population trends for each species. Reporting of the Humber Estuary SPA and national trends to be based upon WeBS counts.

- CCSWG 38.2ha
- RTE 133.2ha
- CCS 390.0ha
- NKM 57.3ha
- NKHP 22.6ha

Rev.	Date	Comments	Drn	Chk	App
A	03.06.2015	Preliminary Issue	SOW	JM	RC

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Project: ABLE Marine Energy Park

Client: ABLE Humber Ports Ltd.

Drawing Title: CEMMP Bird Surveys

PRELIMINARY

Scale:	Drawn By	Checked By	Approved By
1:20,000@A1	S. Walton	J. Monk	R. Cram
Date:	30/04/2015	02/06/2015	02/06/2015

Drawing No: AME-009-00078 Revision: A

ANNEX 7

Approval of Detailed Design Drawings for the Compensation Site

EAST RIDING OF YORKSHIRE COUNCIL

County Hall, Beverley, East Riding Of Yorkshire, HU17 9BA Telephone 01482 393939
www.eastriding.gov.uk
Stephen Hunt Head of Planning and Development Management

Able UK Ltd
FAO Jamie Hoy
Able House
Billingham Reach Industrial Estate
Haverton Hill Road
Billingham
Teesside
TS23 1PX

Case Officer: Mrs Kathryn Barnes

Your Ref:
Contact: Mrs Kathryn Barnes
Email: [redacted]@eastriding.gov.uk
Tel: [redacted]
Date: 2 December 2020

Application No: **20/30203/CONDET**

NOTICE OF DECISION

TOWN AND COUNTRY PLANNING ACT 1990

Proposal:	Discharge of requirement 5 (detailed design approval) (Schedule 11) of the Able Marine Energy Park Development Consent Order 2014
Location:	Land South West Of Sands House Farm, Cherry Cobb Sands Road, Paull, East Riding Of Yorkshire, HU12 9JX,
Applicant:	Able UK Ltd
Application type:	Approval of Details req'd by Condition

The above application has been considered by the Council in pursuance of their powers under the above mentioned Act and has been **APPROVED**, in accordance with the terms and details as submitted, subject to the following conditions:

1. The details hereby approved are those contained within the following documents received 9th June 2020 and works shall be carried out in accordance with the submitted details.

   'Proposed Site Plan' drawing no. 122437_BVL-Z0-SW-DR-C-00002 Rev.CC01'
   'Detail Plan 1 of 8' Ref. 122437_BVL-Z0-SW-DR-C-00021 Rev.P03
   'Detail Plan 2 of 8' Ref. 122437_BVL-Z0-SW-DR-C-00022 Rev.P004
   'Detail Plan 3 of 8' Ref. 122437_BVL-Z0-SW-DR-C-00023 Rev.P03
   'Detail Plan 4 of 8' Ref. 122437_BVL-Z0-SW-DR-C-00024 Rev.P03
   'Detail Plan 5 of 8' Ref. 122437_BVL-Z0-SW-DR-C-00025 Rev.P03
   'Detail Plan 6 of 8' Ref. 122437_BVL-Z0-SW-DR-C-00026 Rev.P03
   'Detail Plan 7 of 8' Ref. 122437_BVL-Z0-SW-DR-C-00027 Rev.P03
   'Detail Plan 8 of 8' Ref. 122437_BVL-Z0-SW-DR-C-00028 Rev.P03
   'Hide Plan and Section' Ref. 122437_BVL-Z0-SW-DR-C-00051 Rev.CC01
   'Car Park Plan' Ref. 122437_BVL-Z0-SW-DR-C-00061 Rev.P003
   'Car Park Details' Ref. 122437_BVL-Z0-SW-DR-C-00062 Rev.CC01

Alan Menzies
Director of Planning and Economic Regeneration

Signed

[redacted]

2 December 2020

Stephen Hunt MRTPI
Head of Planning and Development Management

NOTES TO ACCOMPANY THIS DECISION

Appeals to the Secretary of State
If you are aggrieved by this decision you can appeal to the Planning Inspectorate. Appeals can be made online at: https//www.gov.uk/planning-inspectorate. If you are unable to access the online appeal form, please contact the Planning Inspectorate to obtain a paper copy of the appeal form on telephone number: 0303 444 5000.

Appeals must be made on the correct forms relating to the type of application you submitted. Information provided as part of the appeal process will be published online.

If you wish to appeal against a decision relating to:

- Householder applications - appeals must be made within 12 weeks of the date of this notice;
- Minor commercial applications - appeals must be made within 12 weeks of the date of this notice;
- Advertisement consents - appeals must be made within 8 weeks of the date of this notice;
- Any other type of application – appeals must be made within 6 months of the date of this notice.

Appellants requesting an inquiry into their appeal must notify the Local Planning Authority and Planning Inspectorate at least 10 days prior to appeal submission.

Please note - If this is a decision on a planning application relating to the same or substantially the same land and development as is already the subject of an enforcement notice, you must appeal within 28 days of the date of this notice.

If an enforcement notice is served relating to the same land and development as in your application, you must appeal within 28 days of the date of service of the enforcement notice or within 6 months
(12 weeks in the case of a householder appeal) of the date of this notice, whichever period expires earlier.

The Secretary of State can allow a longer period for giving notice of an appeal but will not normally be prepared to use this power unless there are special circumstances which excuse the delay in giving notice of appeal.

The Secretary of State need not consider an appeal if it seems that the local planning authority could not have granted planning permission for the proposed development or could not have granted it without the conditions they imposed, having regard to the statutory requirements, to the provisions of any development order and to any directions given under a development order.

Purchase Notice
If either the Local Planning Authority or the Secretary of State for the Environment refuses permission to develop land or grants it subject to conditions, the owner may claim that he can neither put the land to a reasonably beneficial use in its existing state nor can he render the land capable of a reasonably beneficial use by carrying out any development which has been or would be permitted.

In these circumstances, the owner may serve a purchase notice on the Council in whose area the land is situated. This notice will require the Council to purchase his interest in the land in accordance with Part VI of the Town and Country Planning Act 1990.

Approval of Details Required by Conditions
A fee is payable for the submission of any matters required to be submitted for approval by any conditions attached to this permission. The fee is payable for each submission, not for each condition. Please refer to the council's website at www.eastriding.gov.uk for more information.

Advisory Note

Building Control

As your project moves onto the next stage, you may need permission under the Building Regulations. The Councils Building Control service is a wholly independent, non-profit making service that operates only to protect and look after your interests. The service is certified for Quality Assurance by ISO 9001:2015.

We operate a local service from regional offices in Beverley, Bridlington and Goole, ensuring help and advice is available and inspections on the same day if requested before 10:00am. Householder applications can be undertaken on a Building Notice, which allows commencement of works within 48 hours of receiving the application.

Should you wish to discuss your project, request a fee quotation or make an application, please do not hesitate to contact us on 01482 393800 or at building.control@eastriding.gov.uk

Further details of the services we offer can also be found on [redacted]