Able Marine Energy Park Environmental Management and Monitoring Plan1: Marine Works

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1. INTRODUCTION

1.1 Background and Aims of the Marine EMMP (MEMMP)

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 mitigate for the effects of AMEP on these habitats and species have been identified, and will be implemented in areas affected by AMEP.
2. This marine works Environmental Management and Monitoring Plan (MEMPP) 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 mitigation 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

3. The mitigation proposals for AMEP are complex, and the objectives and targets / management options included in this version of the MEMMP have been subject to extensive discussions with stakeholders. Prior to the DML being granted, the MEMMP will be further refined through continued regular meetings with key stakeholders about targets / management actions and subsequent monitoring requirements which are yet to be agreed.
4. The MEMMP 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, whose role is explained below and includes undertaking a complete review of the MEMMP every five years.

1.3 Steering Group

5. AHPL will have overall responsibility for the implementation of the MEMMP. However, the involvement of other stakeholders is essential for the effective working of the MEMMP, and hence AHPL will establish a Steering Group whose role will include the following:

- to monitor the progress of implementation of the MEMMP to ensure that it is meeting the objectives;
- to consider and recommend remedial measures where those objectives are not being met;

- to provide expert views, opinions and feedback to AHPL about key issues through regular meetings;
- to help direct and focus the MEMMP and its development in an interactive way including through revisions to targets, monitoring requirements and if necessary the adoption of any remedial actions;
- to undertake a comprehensive review of the MEMMP at least every five years;
- to co-opt members and working groups if necessary;
- to ensure a transparent and open process to the implementation of the MEMMP with an evident audit trail, and regular updates are produced for dissemination to a wider audience (e.g. via AHPL / HINCA websites).

6. AHPL is seeking an inclusive approach and the Steering Group will comprise the following stakeholders in addition to AHPL:

- Natural England;
- Environment Agency (EA);
- The Royal Society for the Protection of Birds (RSPB);
- Marine Management Organisation(MMO);
- representatives from the local wildlife trusts;
- representatives from the local authorities;
- Humber Industry Nature Conservation Association (HINCA); and
- Two representatives, one from the local residents and one from local interest groups (which can be rotated as required).

7. In addition to the above the Steering Group can co-opt members and form working groups where appropriate to consider specific issues. The chair of the Steering Group will be HINCA, an organisation of some standing in the Humber area (http://humberinca.co.uk/introduction.php) for over a decade, and one which the vast majority of other members of the Steering Group are already members.
8. An agenda will be drawn up in advance of each Steering Group meeting by AHPL and minutes will be produced after the meeting by them for agreement. The compensation proposals are complex and the Steering Group will meet frequently. Until 2018 the Steering Group meetings will be held at least every quarter, and then the frequency will be subject to review by the Steering Group.
9. The Steering Group will have power to lay down procedure for calling emergency meetings.

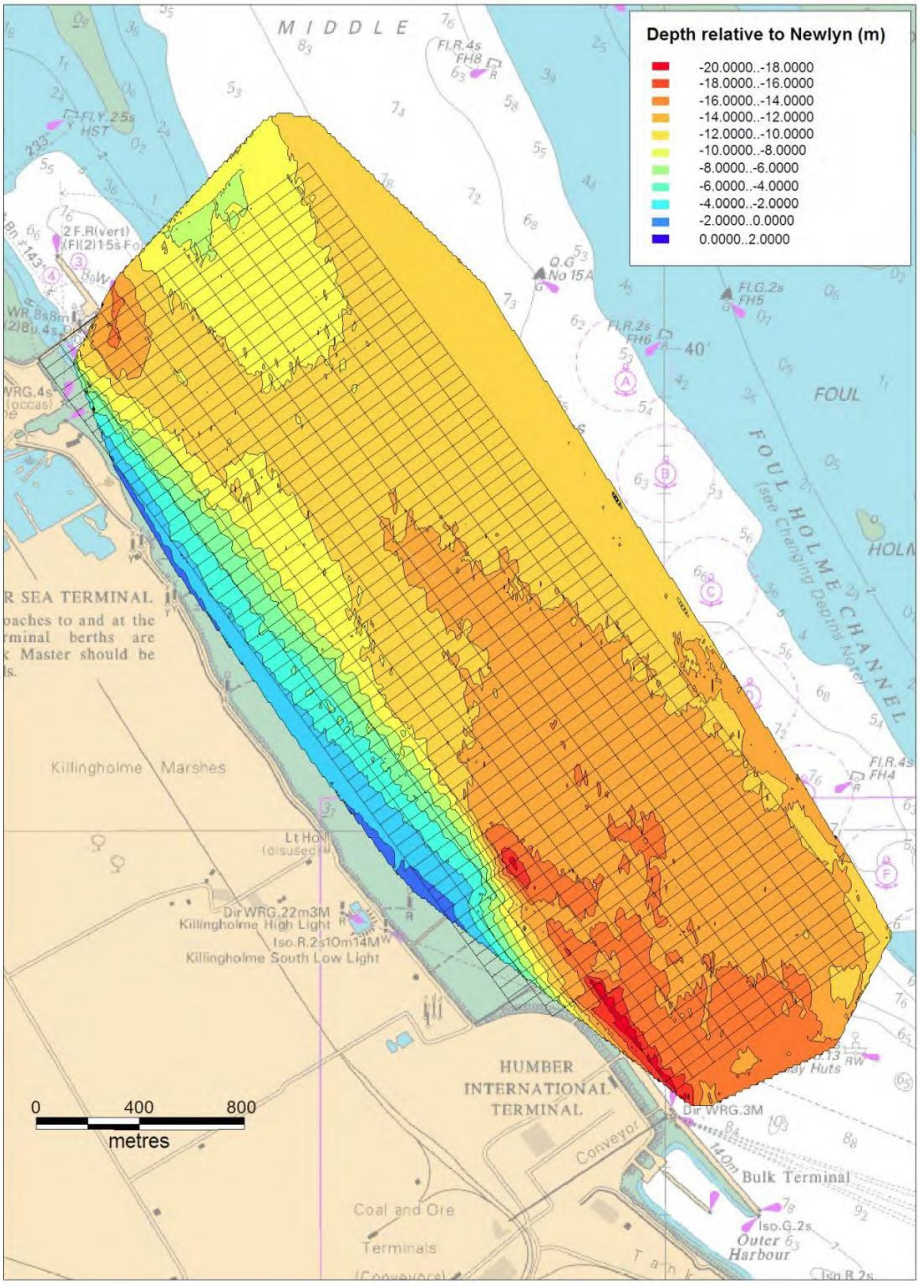
2. ENVIRONMENTAL BASELINE AND IDENTFIED IMPACTS

10. The following main environmental topic sections provide an overview of relevant headline environmental baseline data gathered from the Environmental Statement and associated documents.
11. Where these data form specific monitoring and management target(s) then these are identified. Document references are provided for additional context and information where necessary.
12. Impacts raised by the relevant Defra agencies are summarised in relation to the environmental topic sections.

2.1 Sediment Parameters

2.1.1 BASELINE

13. A survey of subtidal bathymetry was undertaken in March 2010; this is graphically summarised in Figure 1. Further information (including figures changes to intertidal profiles since 2000) is available in EX 28.3 Prt 2 (Baseline of North Killingholme Foreshore) and in Annex 9.1 of the ES.



Note: The lower extent of the intertidal zone is denoted by the seaward extent of the 2m to -4mAOD contour range (-4mAOD = -0.1mCD)

Figure 1: Subtidal Bathymetry (2010)

14. Sediment particle size analysis was undertaken at the same locations as the benthic intertidal and subtidal sites from the 2010 study (see Annex 7.2 to the ES). The baseline findings are given here for the intertidal zone (Table 1) and subtidal zone (Table 2). Sample locations were as per the benthic station locations (see Section 2.3 and 2.4 below).

Table 1: Intertidal Sediment Particle Size Data (2010)

Transect	Shore position	Mean φ	Mean µm	% Gravel	% Sand	% Mud	Sediment name	Textural group
1	Upper	5.880	16.98	0.0%	14.5%	85.5%	Very Fine Sandy Very Coarse Silt	Sandy Mud
1	Middle	6.255	13.10	0.0%	10.5%	89.5%	Very Fine Sandy Fine Silt	Sandy Mud
1	Lower	5.772	18.31	0.0%	19.0%	81.0%	Very Fine Sandy Very Coarse Silt	Sandy Mud
2	Upper	6.379	12.02	0.0%	7.5%	92.5%	Medium Silt	Mud
2	Middle	6.326	12.47	0.0%	6.9%	93.1%	Medium Silt	Mud
2	Lower	4.617	40.74	0.0%	48.5%	51.5%	Very Fine Sandy Very Coarse Silt	Sandy Mud
3	Upper	6.774	9.139	0.0%	4.5%	95.5%	Fine Silt	Mud
3	Middle	5.461	22.70	0.0%	20.6%	79.4%	Very Fine Sandy Very Coarse Silt	Sandy Mud
3	Lower	5.893	16.83	0.0%	14.5%	85.5%	Very Fine Sandy Coarse Silt	Sandy Mud
4	Upper	6.616	10.20	0.0%	5.5%	94.5%	Medium Silt	Mud
4	Middle	5.864	17.17	0.0%	15.5%	84.5%	Very Fine Sandy Very Coarse Silt	Sandy Mud
4	Lower	5.908	16.65	0.0%	12.4%	87.6%	Very Fine Sandy Coarse Silt	Sandy Mud
5	Upper	6.416	11.71	0.0%	7.5%	92.5%	Medium Silt	Mud
5	Middle	5.847	17.38	0.0%	16.0%	84.0%	Very Fine Sandy Very Coarse Silt	Sandy Mud
5	Lower	5.839	17.47	0.0%	17.3%	82.7%	Very Fine Sandy Very Coarse Silt	Sandy Mud
6	Upper	6.654	9.930	0.0%	5.2%	94.8%	Medium Silt	Mud
6	Middle	5.608	20.51	0.0%	20.3%	79.7%	Very Fine Sandy Very Coarse Silt	Sandy Mud
6	Lower	5.618	20.36	0.0%	23.8%	76.2%	Very Fine Sandy Very Coarse Silt	Sandy Mud
7	Upper	6.122	14.36	0.0%	8.4%	91.6%	Coarse Silt	Mud
7	Middle	4.828	35.22	0.0%	42.4%	57.6%	Very Fine Sandy Very Coarse Silt	Sandy Mud
7	Lower	5.878	17.01	0.0%	16.8%	83.2%	Very Fine Sandy Medium Silt	Sandy Mud
8	Upper	6.459	11.37	0.0%	6.9%	93.1%	Medium Silt	Mud
8	Middle	5.605	20.54	0.0%	19.9%	80.1%	Very Fine Sandy Very Coarse Silt	Sandy Mud
8	Lower	6.050	15.09	0.0%	11.5%	88.5%	Very Fine Sandy Coarse Silt	Sandy Mud
9	Upper	6.249	13.15	0.0%	8.7%	91.3%	Medium Silt	Mud
9	Middle	5.764	18.41	0.0%	17.3%	82.7%	Very Fine Sandy Very Coarse Silt	Sandy Mud
9	Lower	6.148	14.10	0.0%	10.4%	89.6%	Very Fine Sandy Coarse Silt	Sandy Mud
10	Upper	6.120	14.37	0.0%	13.3%	86.7%	Very Fine Sandy Fine Silt	Sandy Mud
10	Middle	6.087	14.71	0.0%	13.3%	86.7%	Very Fine Sandy Medium Silt	Sandy Mud
10	Lower	5.133	28.49	0.0%	29.3%	70.7%	Very Fine Sandy Very Coarse Silt	Sandy Mud
11	Upper	5.541	21.48	0.0%	19.3%	80.7%	Very Fine Sandy Very Coarse Silt	Sandy Mud
11	Middle	5.158	28.00	0.0%	29.8%	70.2%	Very Fine Sandy Very Coarse Silt	Sandy Mud
11	Lower	6.041	15.19	0.0%	12.6%	87.4%	Very Fine Sandy Coarse Silt	Sandy Mud
12	Upper	6.687	9.708	0.0%	6.7%	93.3%	Fine Silt	Mud
12	Middle	5.397	23.73	0.0%	23.2%	76.8%	Very Fine Sandy Very Coarse Silt	Sandy Mud
12	Lower	5.879	16.99	0.0%	14.1%	85.9%	Very Fine Sandy Very Coarse Silt	Sandy Mud

15. The baseline bathymetry and hydrography study (Annex 9.1 to the ES) indicates that typical suspended sediment concentrations near to AMEP measured in September 2010 range from 100 mg/l at slack water on a neap tide to 400-500 mg/l during the neap tide ebb flow. Concentrations during the spring tides reached 1,600 mg/l during peak flood flow and were in excess of 800 mg/l on the ebb flow. Again, these values will vary on an intra-annual basis due to natural processes.

Table 2: Subtidal Sediment Particle Size Data (2010)

Station No.	Mean φ	Mean µm	% Gravel	% Sand	% Mud	Sediment name	Textural group
1	2.492	177.8	0.0%	95.9%	4.1%	Moderately Sorted Fine Sand	Sand
2	5.849	17.35	0.0%	21.2%	78.8%	Very Fine Sandy Medium Silt	Sandy Mud
3	4.907	33.34	0.0%	43.5%	56.5%	Very Fine Sandy Medium Silt	Sandy Mud
4	3.797	71.95	0.0%	70.9%	29.1%	Very Coarse Silty Fine Sand	Muddy Sand
5	6.236	13.26	0.0%	14.4%	85.6%	Very Fine Sandy Fine Silt	Sandy Mud
6	2.944	130.0	0.0%	77.5%	22.5%	Fine Silty Medium Sand	Muddy Sand
7	4.274	51.68	0.0%	60.4%	39.6%	Very Coarse Silty Very Fine Sand	Muddy Sand
8	5.910	16.64	0.0%	18.8%	81.2%	Very Fine Sandy Fine Silt	Sandy Mud
9	5.770	18.33	0.0%	20.3%	79.7%	Very Fine Sandy Fine Silt	Sandy Mud
10	5.014	30.96	0.0%	41.0%	59.0%	Very Fine Sandy Fine Silt	Sandy Mud
11	6.056	15.03	0.0%	15.0%	85.0%	Very Fine Sandy Fine Silt	Sandy Mud
12	1.879	271.8	1.6%	83.8%	14.6%	Slightly Very Fine Gravelly Fine Silty Medium Sand	Slightly Gravelly Muddy Sand
13	3.305	101.2	0.0%	70.5%	29.5%	Fine Silty Medium Sand	Muddy Sand
14	6.071	14.88	0.0%	14.2%	85.8%	Very Fine Sandy Fine Silt	Sandy Mud
15	3.181	110.3	0.2%	71.1%	28.7%	Slightly Very Fine Gravelly Fine Silty Medium Sand	Slightly Gravelly Muddy Sand
16	3.366	97.02	2.2%	60.5%	37.3%	Slightly Very Fine Gravelly Fine Silty Medium Sand	Slightly Gravelly Muddy Sand
17	4.474	44.99	0.7%	44.5%	54.9%	Slightly Very Fine Gravelly Medium Sandy Medium Silt	Slightly Gravelly Sandy Mud
18	3.405	94.39	0.0%	69.9%	30.1%	Fine Silty Medium Sand	Muddy Sand
19	2.909	133.2	3.0%	69.6%	27.3%	Slightly Very Fine Gravelly Fine Silty Medium Sand	Slightly Gravelly Muddy Sand
20	3.296	101.8	0.9%	68.2%	30.9%	Slightly Very Fine Gravelly Fine Silty Medium Sand	Slightly Gravelly Muddy Sand
21	3.734	75.15	0.0%	59.8%	40.2%	Fine Silty Medium Sand	Muddy Sand
22	2.681	155.9	0.5%	78.7%	20.8%	Slightly Very Fine Gravelly Fine Silty Medium Sand	Slightly Gravelly Muddy Sand
23	3.122	114.9	2.9%	65.0%	32.0%	Slightly Very Fine Gravelly Very Coarse Silty Medium Sand	Slightly Gravelly Muddy Sand
24	2.315	201.0	0.0%	83.6%	16.4%	Fine Silty Medium Sand	Muddy Sand
25	4.969	31.92	0.0%	43.2%	56.8%	Very Fine Sandy Very Coarse Silt	Sandy Mud
26	2.490	177.9	6.7%	72.2%	21.1%	Very Fine Gravelly Fine Silty Medium Sand	Gravelly Muddy Sand
27	3.671	78.50	7.6%	52.3%	40.1%	Medium Gravelly Fine Silty Medium Sand	Gravelly Muddy Sand
28	4.338	49.45	0.0%	47.5%	52.5%	Medium Sandy Very Coarse Silt	Sandy Mud
29	0.220	858.5	46.7%	31.0%	22.3%	Fine Silty Sandy Coarse Gravel	Muddy Sandy Gravel
30	0.162	893.7	22.7%	70.6%	6.7%	Fine Gravelly Coarse Sand	Gravelly Sand

2.1.2 IMPACTS

NE (SHRA)

- Capital and maintenance dredging indirectly impacting on intertidal and subtidal habitats and associated benthic communities.

MMO

- Capital and maintenance dredging leading to changes in sediment conditions.

EA

- Capital and maintenance dredging leading to a reduction of Ecological Potential under WFD.
- Capital and maintenance dredging resulting in a reduction in flood protection standards. Understood to be addressed within a separate Flood Risk Management Plan.

Other

- Capital and maintenance dredging deleteriously affecting the operation of the E.ON and C.RO intake and outfall operation.

2.2 Intertidal Estuarine Habitat (Saltmarsh)

2.2.1 BASELINE

Small areas of saltmarsh were identified adjacent to the proposed AMEP site (Figure 2). Further information on these can be found in EX 28.3 Prt 2 and in Annex 10.1 to the ES.

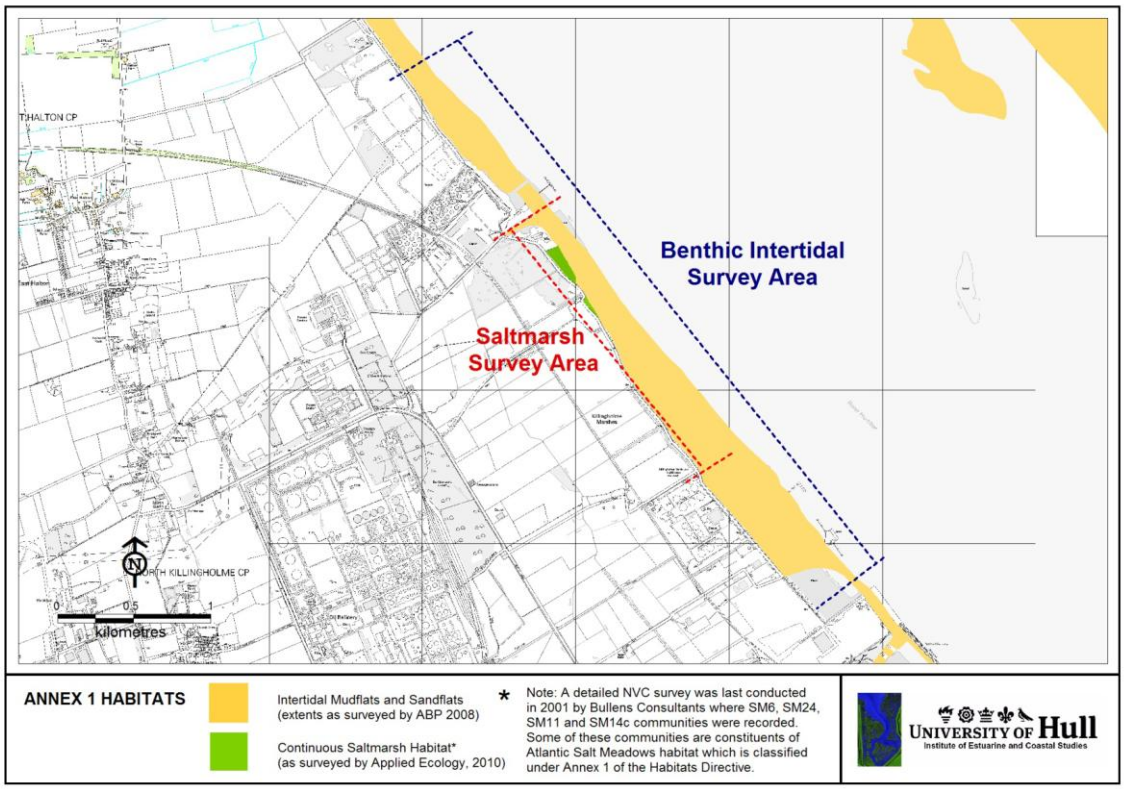


Figure 2: Saltmarsh Area

16. In the vicinity of the AMEP site a very small patch of saltmarsh was recorded on the seaward side of the seawall, close to the mouth of the main drain onto the foreshore and also adjacent to the North Killingholme Haven Pits. During the Phase 2 Survey undertaken in 2006, a number of different saltmarsh communities were identified within this area including sea couch (*Elymus pycnanthus*), saltmarsh rush (*Juncus gerardii*) and couch (*Elymus repens*).
17. Killingholme Marshes foreshore is undergoing a process of change and saltmarsh is beginning to establish quite extensively due to the foreshore rising within the tidal range (EX28.3 Prt 2).

2.2.2 IMPACTS

NE (SHRA)

- No direct impacts identified.

MMO

- No direct impacts identified.

EA

- Capital and maintenance dredging leading to a reduction of Ecological Potential under WFD.

2.3 Intertidal Estuarine Habitat (Benthos)

2.3.1 BASELINE

18. Baseline data are available from a site characterisation study undertaken at the AMEP site in May 2010. A total of 36 intertidal samples were taken along 12 intertidal transects with one sample taken using a 0.01m^2 corer at each of three stations along each transect. The location of sampling stations is shown in Figure 3; and the raw data are presented as Tables 3 and 4.
19. The most commonly occurring species in the intertidal samples were the oligochaete *T. benedii*, Nematoda, the polychaete *Streblospio shrubsolii* and the amphipod crustacean *Corophium volutator*. These species were present in most of the samples and were present at higher abundances than all other species throughout the survey area. The bivalve *M. balthica* was widespread and the polychaete *H. diversicolor* was present at most of the upper shore stations.
20. *T. benedii* was the dominant species at the upper and mid shore intertidal stations. *S. shrubsolii* was dominant at the lower shore intertidal stations where the sediments were presumably sandier.
21. Species richness (number of species recorded) ranged from 2-9 species/sample (mean = 5.8). Abundance (number of individuals/sample) ranged from 5-197 (mean = 46.4) and biomass ranged from <0.001 to 1.37 g/sample (mean = 0.18 g/sample) and was generally higher at stations where *H. diversicolor* was found.
22. All species found were typical for the intertidal area of the middle region of the Humber Estuary, with moderate abundance and diversity of mostly common species. There were no species of particular conservation importance although those present were key prey species for birds.
23. AHPL will undertake a pre-construction baseline survey of the area. This baseline survey will be designed using the characterisation survey to inform suitable sample locations to provide a random stratified survey design.
24. This survey will use a three replicate methodology and follow standard methods following the JNCC Marine Monitoring Handbook, 2001 (Davies *et al.*). However The EA's Marine Team (Peterborough) will be consulted to ensure that the methods used are WFD compliant.

Table 3: Raw biomass data (g.sample^{-1}) from North Killingholme intertidal monitoring (2010)

	Site 1			Site 2			Site 3			Site 4			Site 5			Site 6		
Taxon	**Upper**	**Mid**	**Lower**	**Upper**	**Mid**	**Lower**	**Upper**	**Mid**	**Lower**	**Upper**	**Mid**	**Lower**	**Upper**	**Mid**	**Lower**	**Upper**	**Mid**	**Lower**
TURBELLARIA													0.00					
NEMATODA	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00
Eteone flava/longa																		
Hediste diversicolor	0.28						1.36						0.26					
Nephtys hombergii																		
Scoloplos armiger						0.00												
Pygospio elegans						0.00		0.00					0.00				0.00	
Streblospio shubsolii	0.00	0.00		0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tharyx sp.														0.00			0.00	
Tharyx killariensis																		0.00
Capitella capitata (sp. complex)		0.00																
Arenicola (juvenile)												0.00			0.00			
Manayunkia aestuarina	0.00	0.00					0.00						0.00					
Paranais litoralis					0.00	0.00	0.00			0.00			0.00					
Heterochaeta costata				0.00									0.00					
Tubificoides benedii	0.03	0.12	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.04	0.01	0.00	0.02	0.00	0.00	0.03	0.00	0.00
Tubificoides swirencoides								0.00	0.00		0.00	0.00						
Enchytraeidae																		
Corophium (juvenile)								0.00										
Corophium volutator				0.02			0.00	0.09		0.08	0.03			0.09		0.00	0.01	
Diastylis rathkei																		
Hydrobia ulvae	0.00	0.02		0.00														
Mytilus edulis																	0.00	
Mysella bidentata																		0.06
TELLINACEA (juvenile)	0.00	0.00		0.00		0.00									0.00	0.00		
Macoma balthica	0.09	0.12	0.03		0.10	0.08		0.39	0.03	0.04	0.01						0.01	0.00
Abra tenuis	0.00	0.00	0.00															

Table 3 (continued): Raw biomass data (g.sample^{-1}) from North Killingholme intertidal monitoring (2010)

	Site 7			Site 8			Site 9			Site 10			Site 11			Site 12		
Taxon	**Upper**	**Mid**	**Lower**	**Upper**	**Mid**	**Lower**	**Upper**	**Mid**	**Lower**	**Upper**	**Mid**	**Lower**	**Upper**	**Mid**	**Lower**	**Upper**	**Mid**	**Lower**
TURBELLARIA																		
NEMATODA	0.00	0.00		0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00		0.00	0.00	0.00	0.00
Eteone flava/longa		0.00																
Hediste diversicolor				0.34			0.03					0.07	0.15			0.43		
Nephtys hombergii															0.00			
Scoloplos armiger																		
Pygospio elegans								0.00										0.00
Streblospio shubsolii	0.00	0.00	0.00		0.00	0.01		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
Tharyx sp.		0.00			0.00													
Tharyx killariensis																		
Capitella capitata (sp. complex)																		
Arenicola (juvenile)																		
Manayunkia aestuarina	0.00												0.00			0.00		
Paranais litoralis	0.00																	
Heterochaeta costata				0.00									0.00					
Tubificoides benedii	0.03	0.01	0.00	0.01	0.04	0.00	0.00	0.00			0.00	0.00	0.00	0.00			0.01	0.00
Tubificoides swirencoides								0.00										
Enchytraeidae													0.00			0.00		
Corophium (juvenile)																		
Corophium volutator	0.05	0.00		0.03	0.03		0.19	0.00	0.00		0.01	0.02	0.01	0.15		0.04	0.03	0.11
Diastylis rathkei															0.00			
Hydrobia ulvae																		
Mytilus edulis																		
Mysella bidentata																		
TELLINACEA (juvenile)												0.00					0.00	
Macoma balthica	0.11	0.16		0.01	0.03	0.00	0.00	0.00	0.00	0.01	0.01		0.01	0.51	0.07		0.22	
Abra tenuis																		

Table 4: Raw abundance data (individuals.sample^{-1}) from North Killingholme intertidal monitoring (2010)

	Site 1			Site 2			Site 3			Site 4			Site 5			Site 6		
Taxon	**Upper**	**Mid**	**Lower**	**Upper**	**Mid**	**Lower**	**Upper**	**Mid**	**Lower**	**Upper**	**Mid**	**Lower**	**Upper**	**Mid**	**Lower**	**Upper**	**Mid**	**Lower**
TURBELLARIA													1					
NEMATODA	5	35	1		10	5	6	8	1	3	3	1	2	7			11	3
Eteone flava/longa																		
Hediste diversicolor	12						26						5					
Nephtys hombergii																		
Scoloplos armiger						1												
Pygospio elegans						1		3					1				1	
Streblospio shubsolii	6	9		1	4		6	4	6	2	4	2	3	2	2	4	6	15
Tharyx sp.														4			2	
Tharyx killariensis																		1
Capitella capitata (sp. complex)		1																
Arenicola (juvenile)												1			1			
Manayunkia aestuarina	1	1					32						2					
Paranais litoralis					6	1	5			9			6					
Heterochaeta costata				2									1					
Tubificoides benedii	38	136	1	2	12	1	43	4	2	55	5	1	38	4	1	50	10	1
Tubificoides swirencoides								1	15		1	1						
Enchytraeidae																		
Corophium (juvenile)								1										
Corophium volutator				3			2	34		12	10			32		1	10	
Diastylis rathkei																		
Hydrobia ulvae	4	6		1														
Mytilus edulis																	1	
Mysella bidentata																		1
TELLINACEA (juvenile)	13	1		1		1									1	2		
Macoma balthica	2	5	2		4	4		9	2	1	2						4	1
Abra tenuis	3	3	1															

Table 4 (continued): Raw abundance data (individuals.sample^{-1}) from North Killingholme intertidal monitoring (2010)

	Site 7			Site 8			Site 9			Site 10			Site 11			Site 12		
Taxon	**Upper**	**Mid**	**Lower**	**Upper**	**Mid**	**Lower**	**Upper**	**Mid**	**Lower**	**Upper**	**Mid**	**Lower**	**Upper**	**Mid**	**Lower**	**Upper**	**Mid**	**Lower**
TURBELLARIA																		
NEMATODA	2	2		2	5	1	6	3	1		4	4	20		1	3	5	3
Eteone flava/longa		1																
Hediste diversicolor				24			4					3	13			30		
Nephtys hombergii															1			
Scoloplos armiger																		
Pygospio elegans								1										2
Streblospio shubsolii	12	6	9		1	15		5	4	6	2	6	9	6	5	1	1	27
Tharyx sp.		2			2													
Tharyx killariensis																		
Capitella capitata (sp. complex)																		
Arenicola (juvenile)																		
Manayunkia aestuarina	1												5			1		
Paranais litoralis	5																	
Heterochaeta costata				1									3					
Tubificoides benedii	30	16	1	6	56	1	1	3			4	3	5	2			19	3
Tubificoides swirencoides								1										
Enchytraeidae													2			1		
Corophium (juvenile)																		
Corophium volutator	10	1		13	12		52	4	2		2	15	3	70		13	27	71
Diastylis rathkei															1			
Hydrobia ulvae																		
Mytilus edulis																		
Mysella bidentata																		
TELLINACEA (juvenile)												1					1	
Macoma balthica	3	3		1	3	1	2	2	1	3	1		1	6	3		8	
Abra tenuis																		

25. Data from this pre-construction survey will be used to provide appropriate targets, taking into account seasonal variation as defined within the spring 2010 survey.

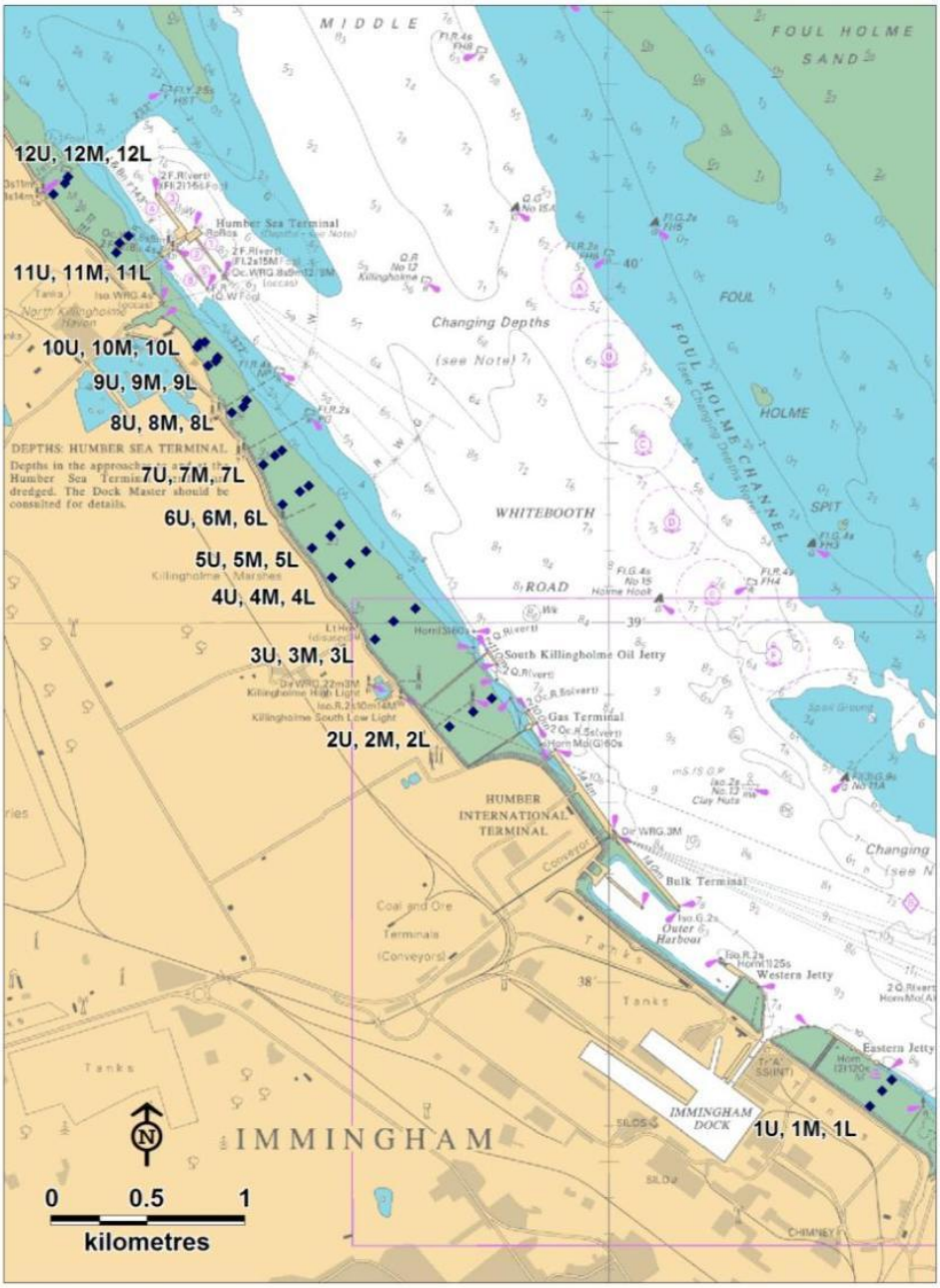


Figure 3: Intertidal benthic invertebrate sampling stations (Characterisation Study 2010)

26. Figure 4 (below) provides suggested biotopes and the spatial extent of the biotopes based on the sediment, benthic community and bathymetric data for the area. Further details are provided in document EX11.14.

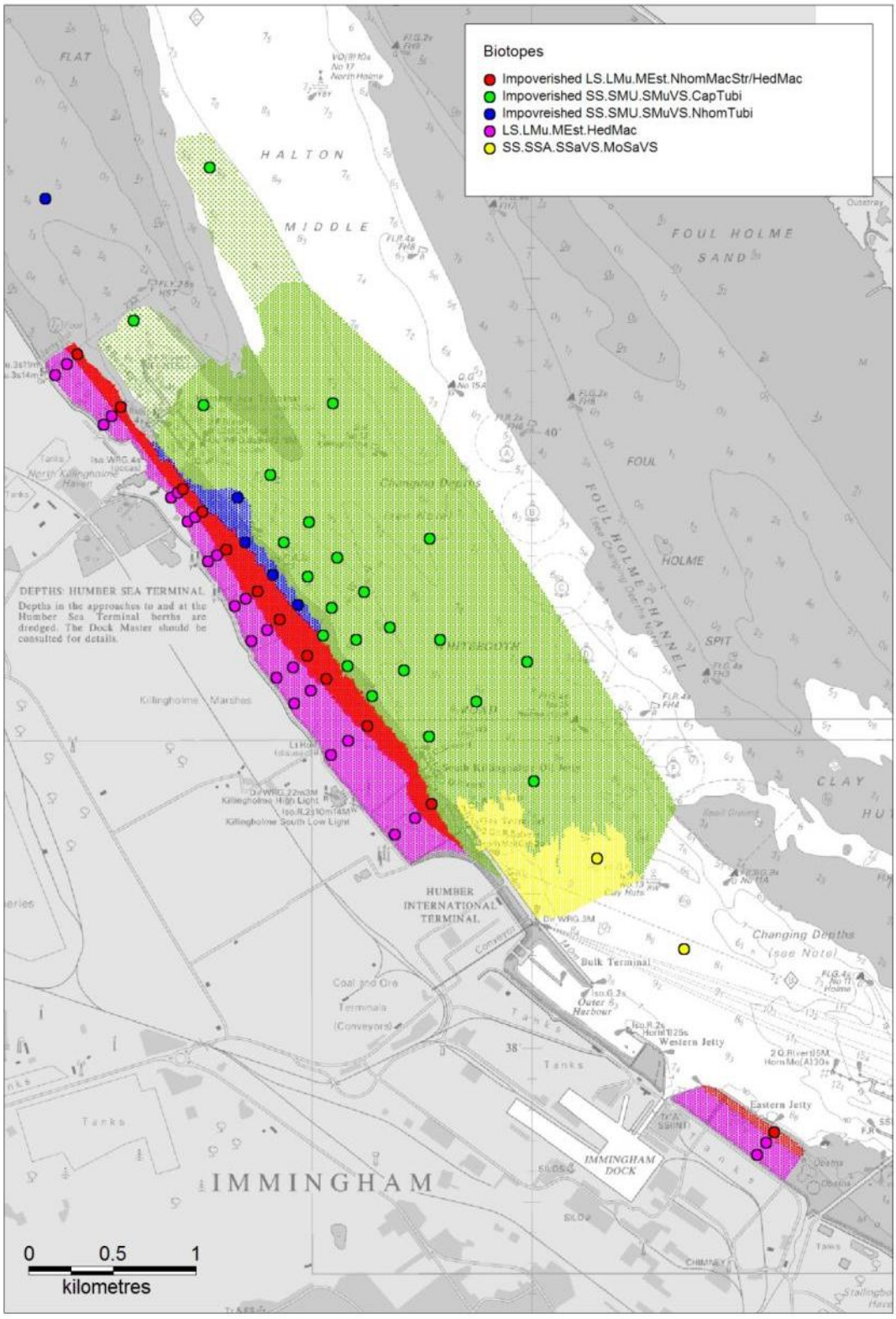


Figure 4: Biotope Location and Possible Extent based on Bathymetry

2.3.2 IMPACTS

NE (SHRA)

- Medium to longer term changes to habitat arising from the quay presence (transformation of intertidal mudflat to saltmarsh).
- Permanent loss of intertidal habitat (31.5 ha). Addressed within the CEMMP.
- All requirements in relation to SPA birds are addressed within the CEMMP and TEMMP.

MMO

- Capital and maintenance dredging leading to smothering of intertidal benthos.

EA

- Capital and maintenance dredging leading to a reduction of Ecological Potential under WFD.

2.4 Subtidal Estuarine Habitat (Benthos)

2.4.1 BASELINE

27. A total of thirty subtidal benthic samples were taken across the area that will be developed as the berthing pocket, approach channel and turning circle during May 2010 using a 0.1 m^2 Hamon grab (details of methods and results are provided in Annex 10.1 to the ES).

28. The sampling positions are shown in Figure 5 and co-ordinates are provided in Table 5.

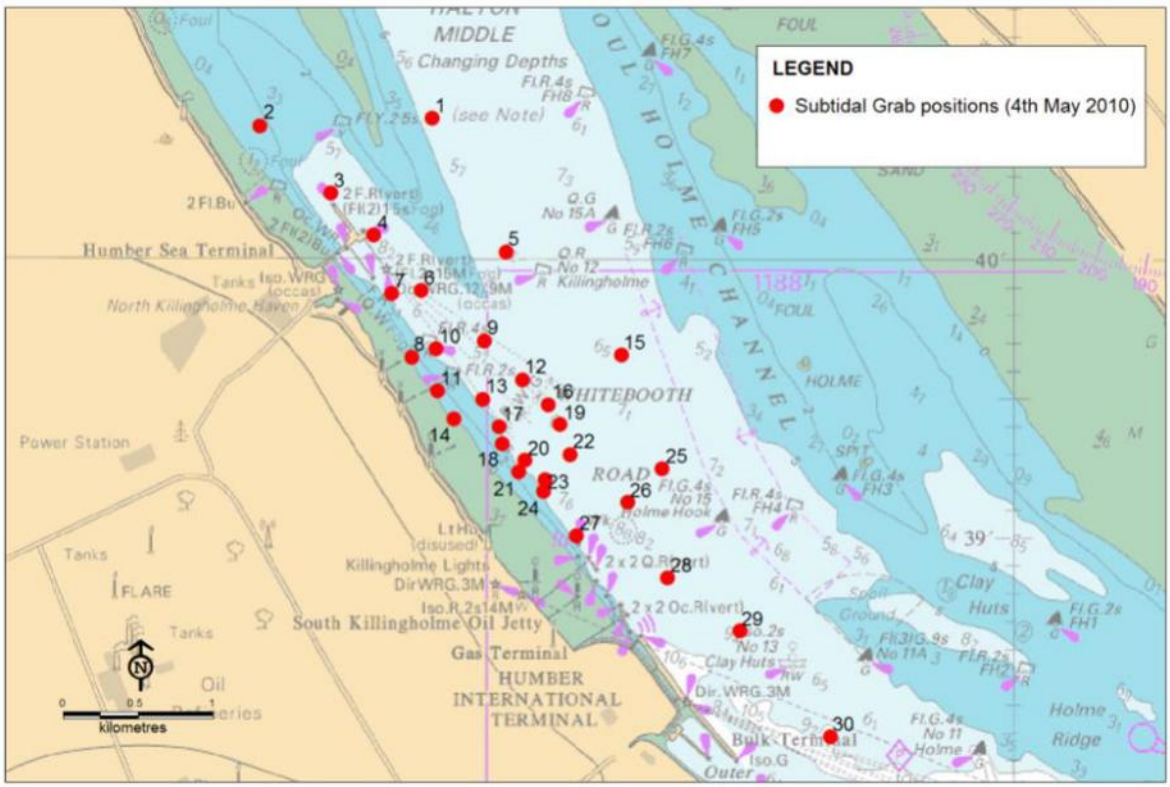


Figure 5: Subtidal Benthic Invertebrate Sampling Stations (2010)

Table 5: Subtidal Benthic Sampling Position Co-ordinates (2010)

Station No.	Date	Time	Sea State	Attempt	Depth (m)	Position (WGS 84)		Description
						Lat	Long	
1	04/05/2010	11:36	Calm	1st	10.4	53.67483	0.22367	Muddy sand
2	04/05/2010	11:44	Calm	1st	7.9	53.67433	0.24100	Mud
3	04/05/2010	11:58	Calm	2nd	14.1	53.67033	0.23383	Mud
4	04/05/2010	12:05	Calm	1st	12.6	53.66783	0.22950	Muddy sand
5	04/05/2010	12:13	Calm	1st	12.6	53.66683	0.21617	Mud & clay
6	04/05/2010	12:18	Calm	1st	11.3	53.66450	0.22467	Muddy sand
7	04/05/2010	12:25	Calm	1st	11.5	53.66433	0.22767	Mud
8	04/05/2010	12:28	Calm	1st	7.7	53.66050	0.22567	Mud
9	04/05/2010	12:43	Calm	1st	12.2	53.66100	0.22317	Clay with surface layer of sand
10*	04/05/2010	12:40	Calm	1st	12.3	53.66150	0.21833	Sandy mud
11*	04/05/2010	13:40	Calm	1st	13.6	53.65917	0.21450	Sandy mud
12*	04/05/2010	12:50	Calm	1st	10.9	53.65800	0.21850	Medium sand
13	04/05/2010	13:07	Calm	1st	8.5	53.65850	0.22300	Muddy sand
14	04/05/2010	13:22	Calm	1st	7	53.65683	0.22133	Mud
15	04/05/2010	13:44	Calm	1st	11	53.65633	0.21683	Medium sand
16	04/05/2010	13:37	Calm	1st	12.8	53.65767	0.21183	Sand with compacted clay
17*	04/05/2010	13:28	Calm	1st	11.6	53.66067	0.20450	Muddy sand
18*	04/05/2010	14:20	Calm	3rd	10.6	53.65650	0.21067	Medium sand
19*	04/05/2010	13:56	Calm	1st	10.5	53.65433	0.21417	Muddy sand
20	04/05/2010	14:09	Calm	1st	10	53.65533	0.21650	Medium sand
21	04/05/2010	14:29	Calm	3rd	9.4	53.65367	0.21483	Muddy sand
22	04/05/2010	15:02	Calm	1st	10.2	53.65250	0.21233	Sand with compacted clay
23	04/05/2010	14:58	Calm	1st	10.9	53.65317	0.21217	Muddy sand with coal fragments
24	04/05/2010	14:53	Calm	3rd	11.3	53.65467	0.20967	Muddy sand with coal fragments
25	04/05/2010	15:14	Calm	2nd	11.2	53.65383	0.20033	Sandy mud
26	04/05/2010	15:18	Calm	1st	12.5	53.65183	0.20383	Sand with coal fragments
27	04/05/2010	15:29	Calm	1st	12.9	53.64983	0.20900	Sand with coal fragments
28	04/05/2010	15:36	Calm	2nd	12.1	53.64733	0.19983	Clay with a surface layer of sand
29	04/05/2010	15:44	Calm	1st	12.9	53.64417	0.19250	Clay with a surface layer of sand
30	04/05/2010	16:03	Calm	4th	11.6	53.63783	0.18333	Sand with shell & coal fragments

* Sample collected from contaminant analysis

29. Details of the findings are given in Annex 10.1 to the ES. However Tables 6 to 8 provide abundance and biomass data for quick reference.

30. In summary, the survey results indicate a species richness that ranged from 0-17 (including colonial taxa) (mean = 4) with values of five or less being recorded from all but two stations. The most widespread species (occurring in the greatest number of samples) was the polychaete *Capitella capitata* with the barnacles *Balanus improvisus* and *Elminius modestus* being the most abundant species.

31. Abundance ranged from 0-184 individuals/sample (mean = 15) with abundance in most samples being less than 20 individuals. Biomass ranged from <0.001 to 15.5 g/sample (mean = 0.56) with values at most stations being <0.05 g.

Table 6: Raw abundance data from North Killingholme subtidal monitoring (2010)

MCS Code		TAXON	TAXON Qualifier	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
D	158	Tubulariidae		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	p	-	-	-	-	-	-	-
D	433	*Sertularia*		p	p	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	p	p	-	P	-	-	-	-
D	510	*Hartlaubella gelatinosa*		p	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	P	-	-	P	-	-	-	-	-	-
D	662	ACTINIARIA		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	1
F	1	PLATYHELMINTHES		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-		-	-	-	-	2	-	-	6	2
HD	1	NEMATODA		-	6	-	-	-	-	-	3	-	1	5	-	-	1	-	-	-	3	-	-	4	-	-	2	-	-	-	-	-	-
K	45	*Pedicellina*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	p	-	-	-	-	-
P	117/118	*Eteone flava/longa*	aggregate	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
P	499	*Nephtys hombergii*		-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
P	672	*Scoloplos armiger*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-		-	-	-	-	-	-	-	-	-
P	753	*Polydora cornuta*																						13									
P	799	*Streblospio shrubsolii*		-	3	-	-	-	-	3	11	-	-	22	-	-	5	-	-	-	1	-	-		-	-	-	-	-	-	-	-	-
P	845	*Tharyx*	species A	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
P	907	*Capitella capitata*	species complex	2	-	3	1	-	-	-	-	1	-	-	2	1	-	1	-	2	6	-	2	7	-	2	9	14	8	4	-	-	-
P	919	*Mediomastus fragilis*		-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
P	931	*Arenicola marina*		9	-	4	42	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	7	1	1	-	-	-
P	1083	*Protodriloides chaetifer*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	1
P	1490	*Tubificoides benedii*		-	-	-	1	-	-	1	1	-	-	9	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
P	1498	*Tubificoides pseudogaster*																						1									
P	1500	*Tubificoides swirencoides*		-	-	-	-	-	-	-	-	-	-	3	-	-	1	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
Q	53	ACARI		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	1	-	-	-	-	-	-	-
R	14	CIRRIPEDIA	indeterminate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	1
R	68	*Elminius modestus*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	-	-	-	-	-	-	-	-	-
R	78	*Balanus improvisus*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	124	-	-	-	-	-	-	-	-	-
R	142	COPEPODA	indeterminate	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	1	3	-	2	10	1	1	2	-	-
S	76	*Neomysis integer*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	1	-
S	86	*Schistomysis kervillei*		-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
S	471	*Gammarus*	juvenile																					1									
S	481	*Gammarus salinus*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	2	-	-	-	-
S	616	*Corophium volutator*		-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
S	1197	*Bodotria scorpioides*																						1	1								
S	1253	*Diastylis rathkei typica*																						1									
W	1696	*Mytilus edulis*	juvenile	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	11	-	-	-	1	-	-	-	-	-
W	2007	TELLINACEA	juvenile	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
W	2029	*Macoma balthica*		-	-	1	1	-	-	-	1	-	-	-	-	-	1	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
Y	112	*Walkeria uva*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	p	-	-	-	-	-	-
Y	137	*Bowerbankia*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	p	-	p	P	-	-	-	-
Y	176	*Electra crustulenta*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	P	-	-	-	-
Y	177	*Electra monostachys*		p	-	-	-	-	-	-	-	-	P	P	P	-	-	p	-	-	-	-	-	P	-	p	p	p	-	-	-	-	-
Y	187	*Flustra foliacea*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-	-	-	p	-	-	-
Y	222	*Amphiblestrum auritum*		p	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
Y	255	*Bicellariella ciliata*		-	-	-	-	-	-	p	-	-	p	-	-	-	-	-	-	-	-	-	-		-	-	-	-	P	-	-	-	-
			Quantitative	3	3	3	4	0	1	5	6	1	1	4	3	1	5	1	1	1	4	0	2	13	2	2	3	4	5	3	1	2	4
			Colonial	4	1	0	0	0	0	1	0	0	2	1	1	0	0	1	0	0	0	1	0	4	0	4	4	3	4	1	0	0	0
			Total Taxa	7	4	3	4	0	1	6	6	1	3	5	4	1	5	2	1	1	4	1	2	17	2	6	7	7	9	4	1	2	4
			Total Abundance	12	10	8	45	0	1	9	18	1	1	39	4	1	9	1	1	2	15	0	3	184	4	3	13	32	14	6	2	7	5

Table 7: Raw biomass data from North Killingholme subtidal monitoring (2010)

MCS Code		TAXON	TAXON Qualifier	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
D	158	Tubulariidae		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
D	433	*Sertularia*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
D	510	*Hartlaubella gelatinosa*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
D	662	ACTINIARIA		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.750	-	-	-	-	-	-	-	-	0.000
F	1	PLATYHELMINTHES		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.000	-	-	-	-		-	-	-	-	0.000	-	-	0.000	0.000
HD	1	NEMATODA		-	0.000	-	-	-	-	-	0.000	-	0.000	0.000	-	-	0.000	-	-	-	0.000	-	-	0.000	-	-	0.000	-	-	-	-	-	-
K	45	*Pedicellina*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
P	117/118	*Eteone flava/longa*	aggregate	0.001	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
P	499	*Nephtys hombergii*		-	-	-	-	-	-	0.015	0.003	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
P	672	*Scoloplos armiger*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.030	-	-		-	-	-	-	-	-	-	-	-
P	753	*Polydora cornuta*																						0.003									
P	799	*Streblospio shrubsolii*		-	0.000	-	-	-	-	0.001	0.003	-	-	0.007	-	-	0.001	-	-	-	0.000	-	-		-	-	-	-	-	-	-	-	-
P	845	*Tharyx*	species A	-	-	-	-	-	-	-	0.000	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
P	907	*Capitella capitata*	species complex	0.001	-	0.000	0.000	-	-	-	-	0.000	-	-	0.003	0.000	-	0.000	-	0.002	0.001	-	0.002	0.008	-	0.001	0.007	0.027	0.001	0.003	-	-	-
P	919	*Mediomastus fragilis*		-	0.000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
P	931	*Arenicola marina*		0.004	-	0.002	0.012	-	-	0.000	-	-	-	-	-	-	-	-	-	-	-	-	-	0.000	-	-	-	1.100	0.000	0.000	-	-	-
P	1083	*Protodriloides chaetifer*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	0.000
P	1490	*Tubificoides benedii*		-	-	-	0.000	-	-	0.000	0.000	-	-	0.007	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
P	1498	*Tubificoides pseudogaster*																						0.000									
P	1500	*Tubificoides swirencoides*		-	-	-	-	-	-	-	-	-	-	0.000	-	-	0.000	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
Q	53	ACARI		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	0.000	-	-	-	-	-	-	-
R	14	CIRRIPEDIA	indeterminate	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	0.000
R	68	*Elminius modestus*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.368	-	-	-	-	-	-	-	-	-
R	78	*Balanus improvisus*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10.135	-	-	-	-	-	-	-	-	-
R	142	COPEPODA	indeterminate	-	-	-	-	-	-	-	-	-	-	-	0.000	-	-	-	-	-	-	-	0.000	0.000	0.000	-	0.000	0.000	0.000	0.000	0.000	-	-
S	76	*Neomysis integer*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	0.009	-
S	86	*Schistomysis kervillei*		-	-	-	-	-	0.018	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
S	471	*Gammarus*	juvenile																					0.000									
S	481	*Gammarus salinus*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	0.067	-	-	-	-
S	616	*Corophium volutator*		-	-	-	-	-	-	-	-	-	-	-	-	-	0.001	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
S	1197	*Bodotria scorpioides*																						0.000	0.000								
S	1253	*Diastylis rathkei typica*																						0.003									
W	1696	*Mytilus edulis*	juvenile	-	-	-	-	-	-	0.000	-	-	-	-	-	-	-	-	-	-	-	-	-	0.019	-	-	-	0.000	-	-	-	-	-
W	2007	TELLINACEA	juvenile	-	-	-	-	-	-	-	-	-	-	-	0.000	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
W	2029	*Macoma balthica*		-	-	0.004	0.006	-	-	-	0.044	-	-	-	-	-	0.000	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
Y	112	*Walkeria uva*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
Y	137	*Bowerbankia*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
Y	176	*Electra crustulenta*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
Y	177	*Electra monostachys*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
Y	187	*Flustra foliacea*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
Y	222	*Amphiblestrum auritum*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
Y	255	*Bicellariella ciliata*		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	-	-	-	-	-	-
			Quantitative	3	3	3	4	0	1	5	6	1	1	4	3	1	5	1	1	1	4	0	2	13	2	2	3	4	5	3	1	2	4
			Colonial	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
			Total Taxa	3	3	3	4	0	1	5	6	1	1	4	3	1	5	1	1	1	4	0	2	13	2	2	3	4	5	3	1	2	4
			Total Biomass	0.005	0.000	0.007	0.018	0.000	0.018	0.017	0.050	0.000	0.000	0.014	0.003	0.000	0.002	0.000	0.000	0.002	0.032	0.000	0.002	15.285	0.000	0.001	0.007	1.128	0.068	0.003	0.000	0.009	0.000

Table 8: % Dominance, abundance and biomass (subtidal survey, 2010)

MCS Code		TAXON	TAXON Qualifier	Total Abundance	%
R	78	*Balanus improvisus*		124	28
P	931	*Arenicola marina*		69	15
P	907	*Capitella capitata*	species complex	65	14
P	799	*Streblospio shrubsolii*		45	10
HD	1	NEMATODA		25	6
R	142	COPEPODA	indeterminate	22	5
R	68	*Elminius modestus*		14	3
W	1696	*Mytilus edulis*	juvenile	14	3
P	753	*Polydora cornuta*		13	3
P	1490	*Tubificoides benedii*		12	3
F	1	PLATYHELMINTHES		11	2
P	672	*Scoloplos armiger*		5	1
D	662	ACTINIARIA		4	1
P	1500	*Tubificoides swirencoides*		4	1
W	2029	*Macoma balthica*		4	1
P	499	*Nephtys hombergii*		2	0
S	481	*Gammarus salinus*		2	0
S	1197	*Bodotria scorpioides*		2	0
P	117/118	*Eteone flava/longa*	aggregate	1	0
P	845	*Tharyx*	species A	1	0
P	919	*Mediomastus fragilis*		1	0
P	1083	*Protodriloides chaetifer*		1	0
P	1498	*Tubificoides pseudogaster*		1	0
Q	53	ACARI		1	0
R	14	CIRRIPEDIA	indeterminate	1	0
S	76	*Neomysis integer*		1	0
S	86	*Schistomysis kervillei*		1	0
S	471	*Gammarus*	juvenile	1	0
S	616	*Corophium volutator*		1	0
S	1253	*Diastylis rathkei typica*		1	0
W	2007	TELLINACEA	juvenile	1	0
D	158	Tubulariidae		0	0
D	433	*Sertularia*		0	0
D	510	*Hartlaubella gelatinosa*		0	0
K	45	*Pedicellina*		0	0
Y	112	*Walkeria uva*		0	0
Y	137	*Bowerbankia*		0	0
Y	176	*Electra crustulenta*		0	0
Y	177	*Electra monostachys*		0	0
Y	187	*Flustra foliacea*		0	0
Y	222	*Amphiblestrum auritum*		0	0
Y	255	*Bicellariella ciliata*		0	0
			Total Abundance	**450**	**100**
			Total Quantitative Species	**31**	

% dominance, total abundance from the subtidal surveys (quantitative species only)

MCS Code		TAXON	TAXON Qualifier	Total Biomass	%
R	78	*Balanus improvisus*		10.135	60.79
D	662	ACTINIARIA		3.750	22.49
R	68	*Elminius modestus*		1.368	8.20
P	931	*Arenicola marina*		1.119	6.71
S	481	*Gammarus salinus*		0.067	0.40
P	907	*Capitella capitata*	species complex	0.056	0.34
W	2029	*Macoma balthica*		0.054	0.32
P	672	*Scoloplos armiger*		0.030	0.18
W	1696	*Mytilus edulis*	juvenile	0.019	0.11
P	499	*Nephtys hombergii*		0.018	0.11
S	86	*Schistomysis kervillei*		0.018	0.11
P	799	*Streblospio shrubsolii*		0.012	0.07
S	76	*Neomysis integer*		0.009	0.05
P	1490	*Tubificoides benedii*		0.007	0.04
S	1253	*Diastylis rathkei typica*		0.003	0.02
P	753	*Polydora cornuta*		0.003	0.02
R	142	COPEPODA	indeterminate	0.001	0.01
HD	1	NEMATODA		0.001	0.00
P	117/118	*Eteone flava/longa*	aggregate	0.001	0.00
S	616	*Corophium volutator*		0.001	0.00
F	1	PLATYHELMINTHES		0.000	0.00
P	1500	*Tubificoides swirencoides*		0.000	0.00
S	1197	*Bodotria scorpioides*		0.000	0.00
P	845	*Tharyx*	species A	0.000	0.00
P	919	*Mediomastus fragilis*		0.000	0.00
P	1083	*Protodriloides chaetifer*		0.000	0.00
P	1498	*Tubificoides pseudogaster*		0.000	0.00
Q	53	ACARI		0.000	0.00
R	14	CIRRIPEDIA	indeterminate	0.000	0.00
S	471	*Gammarus*	juvenile	0.000	0.00
W	2007	TELLINACEA	juvenile	0.000	0.00
D	158	Tubulariidae		0.000	0.00
D	433	*Sertularia*		0.000	0.00
D	510	*Hartlaubella gelatinosa*		0.000	0.00
K	45	*Pedicellina*		0.000	0.00
Y	112	*Walkeria uva*		0.000	0.00
Y	137	*Bowerbankia*		0.000	0.00
Y	176	*Electra crustulenta*		0.000	0.00
Y	177	*Electra monostachys*		0.000	0.00
Y	187	*Flustra foliacea*		0.000	0.00
Y	222	*Amphiblestrum auritum*		0.000	0.00
Y	255	*Bicellariella ciliata*		0.000	0.00
			Total Biomass	**16.672**	**100**
			Total Quantitative Species	**31**	

% dominance, total biomass from the subtidal surveys (quantitative species only)

2.4.2 IMPACTS

NE (SHRA)

- The effects of capital and maintenance dredging and disposal on subtidal habitat and benthic communities.
- Loss of 13.5ha of subtidal habitat. Addressed within the Compensation EMMP (CEMMP).

MMO

- Capital and maintenance dredging leading to smothering of subtidal benthos.

EA

- Capital and maintenance dredging leading to a reduction of Ecological Potential under WFD.

2.5 Fish Communities

2.5.1 BASELINE

2.5.1.1 Intertidal

32. Two intertidal fish and shellfish surveys were conducted in the immediate area around the project site in May/June and October/November 2010 each comprising four fixed fyke net positions in the intertidal and eight 2m beam trawls over subtidal habitat (details of methods and results are provided in Annex 10.1 to the ES).

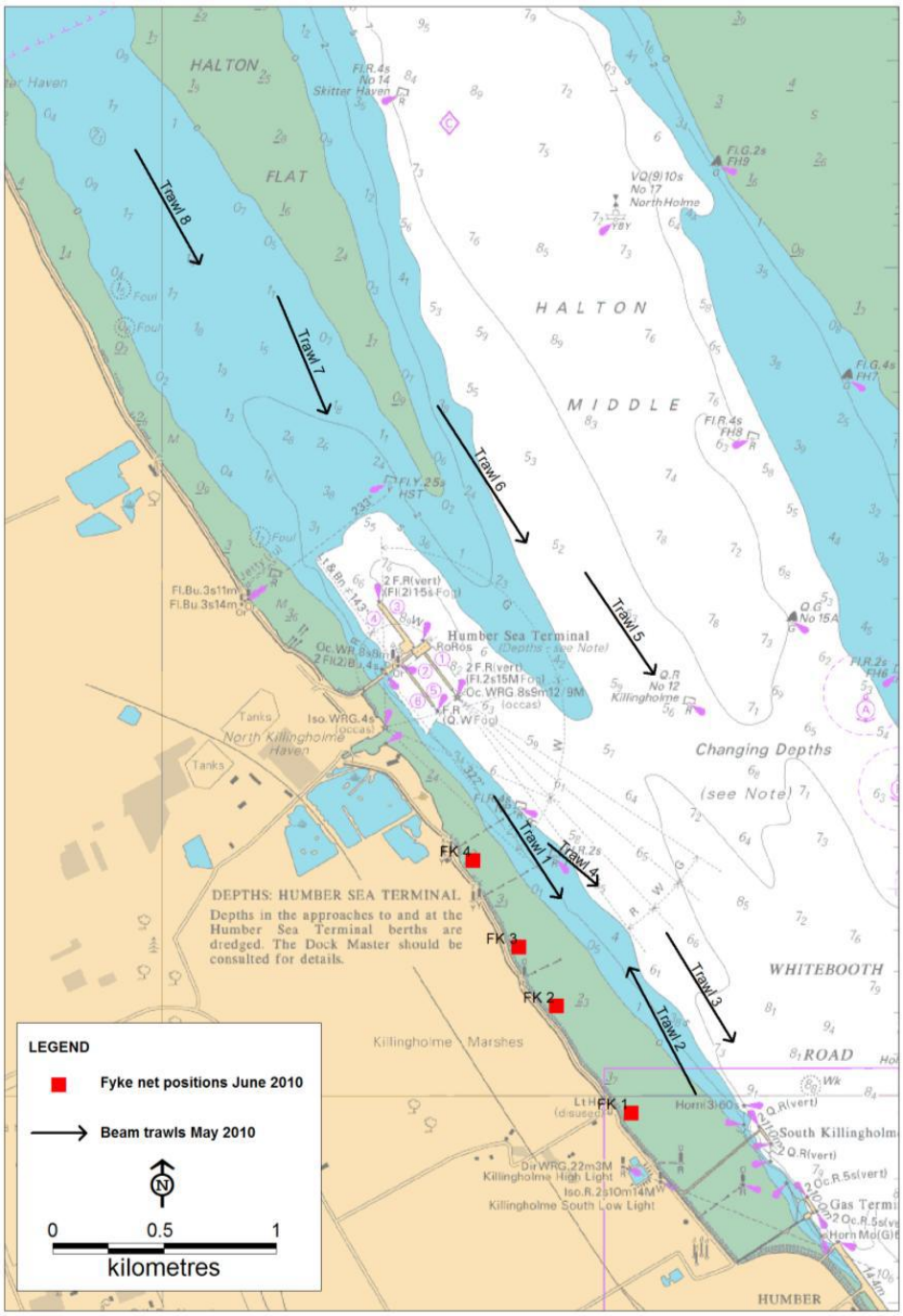


Figure 6: Location of the Intertidal and Subtidal Fish Sampling Positions

Table 9: Intertidal and Subtidal Sampling Locations (2010)

Site No.	Position (WGS 84)		Deployment		Retrieval		
	Lat (N)	Long (W)	Date	Time	Date	Time	Intertidal sampling locations
FK 1	53.64932	0.2182	08/06/2010	17:00	09/06/2010	17:30	
FK 2	53.65362	0.22324	08/06/2010	17:41	09/06/2010	18:15	
FK 3	53.65599	0.22579	08/06/2010	18:30	09/06/2010	19:00	
FK 4	53.65948	0.22891	08/06/2010	19:16	09/06/2010	19:48	
Weather conditions: Overcast and breezy with showers							

Trawl No.	Start Position		End Position		Date	Time in	Time Out	Water depth (m)	Sea state	Subtidal sampling locations
	Lat	Long	Lat	Long						
T 1	53.66217	0.22750	53.65800	0.22300	05/05/2010	09:00	09:10	12	Calm	
T 2	53.65017	0.21383	53.65517	0.21833	05/05/2010	09:17	09:30	11.3	Calm	
T 3	53.65667	0.21583	53.65217	0.21133	05/05/2010	09:42	09:53	10.2	Calm	
T 4	53.66017	0.22383	53.65850	0.22050	05/05/2010	10:01	10:13	12.1	Calm	
T 5	53.67117	0.22133	53.66700	0.21667	05/05/2010	10:26	10:36	12.2	Calm	
T 6	53.67233	0.22533	53.67783	0.23133	05/05/2010	10:45	10:55	10	Calm	
T 7	53.68217	0.24217	53.67750	0.23883	05/05/2010	11:01	11:10	8.9	Calm	
T 8	53.68817	0.25183	53.68350	0.24750	05/05/2010	11:20	11:29	8.3	Calm	
Weather conditions: Dry with sunny spells and light breeze										

33. Figure 6 and Table 9 provide details of the fish community sampling locations with further details provided in Annex 10.1 to the ES.
34. The summer catch was dominated by benthic flatfishes (flounder and sole) most probably year class 1+ flounder (born the year before) and mostly year class 0+ sole (born in present year), which highlights the role of the area (typical mudflat) as a flatfish nursery. Sand goby was recorded but due to the small size of this fish it is normally misrepresented in fyke net catches.
35. Whiting, common sole, five-bearded rockling and flounder dominated the fyke net catches (intertidal) during the autumn survey. Common sole juveniles and whiting were also present.
36. Given the background information available for the Humber Estuary and adjacent coastal area, and the gear selectivity profile of fyke nets, the fish and shellfish assemblage found during the surveys was considered normal. However, the summer abundance was low compared to previous survey programs.

2.5.1.2 Subtidal

37. Two subtidal beam trawl surveys were conducted in the subtidal area in the vicinity of the project site in May/June 2010 and October/November 2010.
38. Sole caught in the summer subtidal assessment were substantially larger that those found in the fyke nets, showing a segregation of sole year classes and indicating a distinct habitat dependency between 0+ sole and older juveniles. This segregation was not observed in autumn, although sole juveniles were present.
39. Similar to the intertidal assessment, the subtidal assemblage is consistent with previous results for the area with a real dominance of sand goby in both the summer and autumn surveys. Interestingly flounder (the more abundant species in the intertidal catch) was

recorded only once in the summer survey and six times in the autumn survey. This observation suggests the greater importance of the intertidal zone for flounder. Whiting were also common in the autumn survey, although not so in the summer survey. Common sole juveniles and whiting were also present.

2.5.2 IMPACTS

NE (SHRA)

- Lamprey movements concluded to not be impacted so not included specifically in this document.

MMO

- Capital and maintenance dredging leading to smothering of subtidal benthos.

EA

- Capital and maintenance dredging leading to a reduction of Ecological Potential under WFD.

2.6 Temperature and Suspended Sediments

2.6.1 BASELINE

40. Temperature data will be monitored in relation to DML requirements concerning piling activity mitigation for marine mammals (no adverse effect on marine mammals with agreed mitigation measures, as specified in the DML, applied). Suspended sediments will be monitored in relation to potential impacts on local water intakes/outfalls.
41. No baseline data were collected, but there is provision for specific impact monitoring (see Section 3). Some relevant baseline information is available relating to a series of water quality parameters.
42. A survey of water quality to inform the EIA process was conducted in May/June 2010 within the Humber Estuary with sampling locations across the intertidal and subtidal zone in the vicinity of the AMEP development (presented as Annex 7.2 to the Environmental Statement).
43. Data were collected throughout the day covering the full range of tidal conditions, ebb, flood and slack water.
44. The data showed little variability in temperature data, with variation of less than 1 C (17.8–18.7°C). However temperature will vary over the year outwith these parameters.
45. The baseline bathymetry and hydrography study (Annex 9.1 to the Environmental Statement) indicates that typical suspended sediment concentrations near to AMEP measured in September 2010 range from 100 mg/l at slack water on a neap tide to 400-500 mg/l during the neap tide ebb flow. Concentrations during the spring tides reached 1,600

mg/l during peak flood flow and were in excess of 800 mg/l on the ebb flow. Again, these values will vary on an intra-annual basis due to natural processes.

3. OBJECTIVES

3.1 Introduction

46. Objectives and targets have been derived with reference to a number of information sources, including the SoCG, the DCO/DML and dialogue with the Regulatory Authorities and tables to action these are presented in the following text. See Section 4 for further detail.

3.2 Sediment Parameters

3.2.1 RATIONALE & OBJECTIVES

47. Rationale: Monitoring is necessary to ensure that elevated levels of suspended solids arising from the capital and maintenance dredging activities are identified within the EX8.10, as these have the potential to affect subtidal and intertidal conditions and communities (e.g. mudflat elevation), as well as fish utilisation (e.g. barrier effects, behavioural responses).
48. They also have the potential to impact on the operation and maintenance of the adjacent E.ON and C.RO cooling water intake and outfall. Accretion rates along the pipeline relating to elevated suspended solids will also require monitoring.
49. Legal Requirement: E.ON and C.RO have cooling water intake and discharge points immediately north of the proposed quay and have expressed concerns regarding the level of suspended sediment caused by the development which may have an impact upon the operation of their cooling water pipelines and systems. The requirement to monitor suspended solids is included within Schedule 11 to the DCO, necessitating that a monitoring scheme be established for monitoring sedimentation along the lines of and in front of the E.ON and C.RO cooling water intake and outfall facilities.
50. There will also be requirements under WFD compliance monitoring as well as the Humber Estuary EMS Conservation Objectives.
51. Objective(s): During dredging ensure sediment levels remain within limits agreed under the DML in relation to C.RO and E.ON intake/outfall operation. To corroborate predictions on intertidal accretion/erosion from EX8.10 and ES.

3.2.2 MONITORING

3.2.2.1 Suspended Solids and Accretion Monitoring

52. Suspended solids monitoring will be undertaken using automatic monitoring equipment installed on the same specialised 1250mm diameter buoy as used for the water quality monitoring.
53. Turbidity (suspended solids) monitoring will be carried out using a YSI 6600 multi sonde which will also be used to monitor temperature & dissolved oxygen (as above).

54. The sensor within the sonde can monitor turbidity within a range from -0 to 1000 NTU with an accuracy of. ± 2% of reading or 0.3 NTU whichever is greater.
55. Suspended solids monitoring will be carried out for a prolonged period prior to the start of dredging and piling works to give sufficient time to ascertain suspended solids levels and from which to agree trigger levels with both E.ON and C.RO. The monitoring will continue up to and including first maintenance dredging.
56. Accretion monitoring will also be undertaken to identify change in the intertidal mudflat elevation, with a monitoring scheme to be established for the monitoring of the foreshore and sediment levels around the quay.
57. A specific monitoring scheme will be drafted for this purpose and will be submitted to the Marine Management Organisation and subject to approval in writing by the MMO, in consultation with the Environment Agency, C.RO and E.ON UK plc.

3.2.2.2 Elevation Change Monitoring

58. Elevation changes in the intertidal zone are covered under Section 3.3 Intertidal Habitat (Saltmarsh).

3.2.2.3 Bathymetric Change Monitoring

59. EA requirements associated with changes to the bathymetry and associated sediment characteristics are covered in Section 3.5 Subtidal Benthos.

3.3 Intertidal Habitat (Saltmarsh)

3.3.1 RATIONALE & OBJECTIVES

60. Rationale: Monitoring is necessary to identify any changes to saltmarsh community and extent in the wider AMEP area of impact. Impacts may arise from modification to erosion and deposition patterns on the intertidal zone relating to the influence of the quay and from capital and maintenance dredging.
61. Legal Requirement: WFD compliance and the Humber Estuary EMS Conservation Objectives.
62. Objective(s): To record changes in extent and composition of saltmarsh.

3.3.2 MONITORING

63. A LiDAR survey will be undertaken by Able in the month prior to the commencement of works seaward of the EA flood defences, including an area 500 m up and down the estuary at not greater than 50 m line spacing. These surveys shall be repeated at six month intervals for a minimum of 10 years and will provide an indication of the extent of saltmarsh vegetation (gain and loss).

64. Approach and reporting of the LiDAR survey will be as laid out in the Environment Agency's proposals (reproduced as Appendix 1 to this document).
65. An NVC survey will be carried out annually across the identified areas of saltmarsh using standard methods (Rodwell, 2006).

3.4 Intertidal Habitat (Benthos)

3.4.1 RATIONALE & OBJECTIVES

66. Rationale: Monitoring is necessary to identify any changes to the intertidal area and extent in the wider AMEP area of impact, and in particular, the associated benthic community as defined during the characterisation and baseline surveys. Direct loss from the AMEP footprint is addressed in the CEMMP, however indirect impacts may arise from modification to erosion and deposition patterns on the intertidal zone relating to the influence of the quay and from capital and maintenance dredging. These impacts may take the form of actual habitat loss through erosion (or accretion to a level that the zone becomes saltmarsh), but may also occur in the form of a substantial shift in community attributes (both physical and biological), above natural variation.
67. Legal Requirement: WFD compliance and the Humber Estuary EMS Conservation Objectives.
68. Objective(s): To identify deleterious change to intertidal benthic invertebrate fauna.
69. It should however be noted that a comprehensive baseline intertidal benthic survey will be undertaken pre-construction, and the metrics associated with this study used to update the characterisation data and to populate specific monitoring metrics. Standard univariate and multivariate analysis shall be used to define the diversity, abundance and biomass of the intertidal faunal community alongside multivariate analysis to characterise the communities present.

3.4.2 MONITORING

3.4.2.1 General

70. Samples taken to support the intertidal benthic invertebrate monitoring programme will be collected by means of hand coring.
71. 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.

72. Should WFD-specific guidance become available then this will be incorporated, and during the derivation of the detailed survey methods and MMO licensing, approval of techniques for WFD compliance will be sought from the EA's Marine team.

3.4.2.2 Survey

73. The intertidal areas that remain to the north and to the south of the quay development (i.e. at Killingholme Marshes foreshore adjacent to North Killingholme Haven Pits and the foreshore near to South Killingholme Haven) will comprise the survey area; effectively Sectors A and E (as monitored for the baseline assessments); and a non-impacted south bank control area will also be surveyed (e.g. within 1 km of the quay development).
74. Ongoing monitoring surveys will be carried out at the same time of year as the baseline survey. If the same month cannot be accommodated then sampling in the same season will at least be ensured. This will allow temporal compatibility between the data sets and reduce the effects of inter-seasonal variation in any comparisons made. This is considered particularly important in relation to the timing of peak abundance and biomass relating to the worm *Hediste diversicolor* and the bivalve *Macoma balthica*.
75. As part of the overall quality assurance strategy the continued validity of stations selected as representative of impacted and reference conditions will be ensured through regular evaluations. Therefore, some allowance will be made for the possible modification in locations in response to unanticipated anthropogenic or natural influences.
76. All surveys will be logged in a pre-designed field log or electronic datasheet. Each log-sheet will be clearly laid out, providing prompts for all the information required.
77. For each area, sampling will be undertaken at three stations along each of three transects across the foreshore, effectively covering the upper, mid- and lower-intertidal (i.e. a total of nine sampling stations within each of three areas).
78. Although approximately evenly spaced, one or more transects (and station) locations will be positioned within an area known to be preferred by Black-tailed Godwit as a foraging resource.
79. Four replicate samples will be taken at each station, three of which will be subsequently analysed for species composition, abundance, size class and biomass etc with the fourth being used for an assessment of sediment particle size and organic content.
80. Sampling will be carried out using hand-held corers (e.g. 0.01 m^2 sampling area) to a depth of c.15 cm. Sample locations along transects will be recorded using DGPS to allow for greater station fidelity between years.
81. In addition to core sampling, observational monitoring will be conducted at each sampling station:

- Recording obvious sediment surface conditions (e.g. algae coverage, evidence of drying, casts, etc.);
- Recording the character and composition of surface sediments; and
- Providing a photographic record of the sampling station.

82. All sites will be monitored on a biannual basis; monitoring in the spring will be used to compare against the original site characterisation data, whilst monitoring in the autumn, when productivity and biomass is highest, will show the amount of food that is available to overwintering/passage birds and in particular, Black-tailed Godwit.
83. A full (spring and autumn) pre-construction baseline survey of the Cherry Cobb Sands intertidal and the proposed north bank control site will be carried out using a similar methodology to augment existing baseline characterisation data.
84. Monitoring will continue for a period of at least ten years following completion of the works.

3.4.2.3 Analysis

85. In order to provide analytical quality assurance, invertebrate identification, biomass and particle size analysis will be performed by laboratories that are members of the NMBAQC scheme.
86. 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).
87. Sediment particle size analysis and organic content will also be measured.
88. Standard univariate statistical analyses, either parametric (e.g., ANOVA, t-test) or non-parametric (e.g., Kruskal-Wallis test, Mann-Whitney test, PERMANOVA) will then be applied to the data of abundance, richness, biomass, eveness, diversity and biomass-to-abundance ratio.
89. In line with WFD requirements, the IQI (infaunal quality index) will be calculated for benthic samples, the three parameters which feed into this are:
    - number of taxa;
    - AZTI* Marine Biotic Index (AMBI); and
    - Simpson's Evenness.
90. Multivariate analysis will be also 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. Bio-Env routine and linkage trees (BEST) in Primer will be

used to explore the relationship between biotic (community) patterns and substrate characteristics.

91. Analysis will also be integrated with the findings of the intertidal LiDAR surveys described in Section 3.3, as elevation change can influence benthic community structure.

3.5 Subtidal Habitat (Benthos)

3.5.1 RATIONALE & OBJECTIVES

92. Rationale: Monitoring is necessary to identify any changes to the subtidal area and extent in the wider AMEP area of impact, and in particular, the associated benthic community as defined during the characterisation and baseline surveys. Direct loss from the AMEP footprint is addressed in the CEMMP, however indirect impacts may arise from modification to erosion and deposition patterns on the subtidal zone relating to the influence of the quay and from capital and maintenance dredging. These impacts may take the form of actual habitat loss through erosion but may also occur in the form of a substantial shift in community attributes (both physical and biological), above natural variation.
93. Legal Requirement: WFD compliance monitoring and Humber Estuary EMS Conservation Objectives.
94. Objective(s): To identify deleterious change to subtidal benthic invertebrate fauna due to dredging and dredge disposal e.g. including WFD compliance. To derive baselines for dredging and disposal impacts and to validate boundaries of disposal grounds.

3.5.2 MONITORING

3.5.2.1 General

95. The subtidal benthic monitoring will be carried out using the same framework as defined for benthic intertidal samples in Section 3.3.
96. Samples for the subtidal invertebrate monitoring will be taken using a 0.1 m^2 Hamon grab. 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.
97. Should WFD-specific guidance become available then this will be incorporated, and during the derivation of the detailed survey methods and MMO licensing, approval of techniques for WFD compliance will b sought from the EA's Marine team.

3.5.2.2 Survey

98. The initial impact of operational dredging on the subtidal benthic invertebrate assemblages within the berthing pocket, approach channel and turning circle will be monitored.

99. A total of 15 stations (nine stations within the combined area of the proposed berthing pocket, approach channel and turning circle plus a further three stations outside of the dredged area in the subtidal region between the berthing pocket and the Humber Sea Terminal and three more in the subtidal region to the south-east of the proposed dredging area) will be monitored.
100. Additional sampling stations will be located at the site of WFD sampling stations identified as being potentially affected by the dredge spoil removal and dumping plumes in the Lower Humber Estuary WFD zone.
101. Samples will be collected using a 0.1 m^2 Hamon grab or similar.
102. Three replicate benthic samples will be collected from each station for subsequent invertebrate analysis, with a further replicate for particle size analysis and organic content. Each sample will be analysed for species composition, abundance and biomass together with an assessment of sediment particle size and organic content. Dedicated sediment particle size and organic content will be carried out on the fourth replicate.
103. Monitoring of subtidal benthos will only cover the first round of maintenance dredging. Any longer-term monitoring requirements will be determined by the EAG.
104. In addition, and prior to the commencement of any marine disposal activities, in order to be meet WFD compliance, a scheme for the protection and enhancement of benthic invertebrates through the monitoring and management of disposal activities within, and immediately surrounding, the disposal sites of the Lower Humber water body, will be submitted to and agreed in writing with the EA. The scheme will include the following:
    - A timetable for when monitoring shall be undertaken;
    - A detailed monitoring methodology;
    - An evaluation of the contribution the disposal activities make to the overall ecological potential of the Lower Humber water bodies.
105. The monitoring will ensure that all WFD monitoring locations within the identified potential area of impact from the operations will be assessed for WFD compliance.

3.5.2.3 Analysis

106. In order to provide analytical quality assurance, invertebrate identification, biomass and particle size analysis will be performed by laboratories that are members of the NMBAQC scheme.
107. Laboratory analyses will include species (identified to highest taxonomic detail), abundance, size class and biomass (WWTB), with standard AFDW conversion factors applied. Sediment particle size analysis and organic content will also be measured.
108. Standard univariate statistical analyses, either parametric (e.g., ANOVA, t-test) or non-parametric (e.g., Kruskal-Wallis test, Mann-Whitney test, PERMANOVA) will then be applied

to the data of abundance, richness, biomass, eveness, diversity and biomass-to-abundance ratio.

109. In line with WFD requirements, the IQI (infaunal quality index) will be calculated for benthic samples, the three parameters which feed into this are:
    - number of taxa;
    - AZTI* Marine Biotic Index (AMBI); and
    - Simpson's Evenness.
110. Multivariate analysis will be also 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. Bio-Env routine and linkage trees (BEST) in Primer will be used to explore the relationship between biotic (community) patterns and substrate characteristics.

3.5.2.4 Bathymetric Survey

111. Additional bathymetric surveys will be taken to assess potential impacts at dredge disposal sites and across the wider estuary. These will be as laid out in the Environment Agency's proposals (reproduced as Appendix 1 to this document) with the surveys to ensure WFD compliance.

3.6 Fish Communities

3.6.1 RATIONALE & OBJECTIVES

112. Rationale: Monitoring is necessary to identify any changes to the fish communities in the vicinity of the AMEP. Impacts may arise from capital and maintenance dredging, changes to habitat type and elevation relating to the presence of the quay. These impacts may take the form of a change in community attributes (e.g. species composition and size class abundance), above natural variation.
113. Legal Requirement: WFD compliance monitoring and Humber Estuary EMS Conservation Objectives.
114. Objective(s): That there is no significant change to baseline community attributes resulting from the AMEP development within a degree of natural variability.

3.6.2 MONITORING

3.6.2.1 General

115. Fish sampling on the intertidal will be undertaken by fyke netting whilst subtidal fish sampling will be by means of beam trawling. In both instances WFD compliant methods will be employed as detailed in the 'UK TAG transitional water assessment methods: fish fauna' as available on the UK WFD TAG (technical Advisory Group) website at: http://www.wfduk.org/sites/default/files/Media/Characterisation%20of%20the%20water%20environment/Biological%20Method%20Statements/Transitional%20fish.pdf.

3.6.2.2 Intertidal

116. Bi-annual (six-monthly) fyke net surveys of the intertidal mudflat will be undertaken. This monitoring will continue for an initial period of ten years.
117. For each survey one double-ended fyke net will be deployed at each of two sites, with each deployment covering two full tidal cycles.
118. As far as is practicable survey locations will be based on those used for the baseline study (i.e. sites FK1 and FK4 of the 2010 baseline survey).
119. Each double fyke net assembly will be deployed parallel to the shore, the nets being secured with canes and/or anchors. It will be important to ensure that the possibility of entrapment of waterbirds and mammals is minimised (e.g. by fitting otter guards and by following associated Environment Agency regulations).
120. Deployment will be at the low tide point and the nets left in place for 24 h (two tidal cycles). Catch will be collected after 12 h and 24 h to prevent the catch from drying out. Following retrieval of the nets, the catch will be collected and returned (frozen in insulated containers) to the laboratory for identification, enumeration and measurement.
121. Monitoring will be undertaken during the spring and autumn, but with consideration to key periods of waterbird sensitivity (i.e. avoiding the main winter period and the autumn passage as a minimum).

3.6.2.3 Subtidal

122. Subtidal fish monitoring will be undertaken by means of a 2m-wide research beam trawl fitted with a 5mm cod end sleeve.
123. Sampling locations will utilise hose used in the baseline study, but will be extended to also cover WFD sampling locations in the Middle and Lower Humber water body identified as being potentially effected by the dredging operation.
124. Each trawl will be deemed to commence from the point at which the gear reaches the seabed after the warp length is paid out and the winch is locked. Trawling will be conducted

with a warp length of three times the depth at constant speed (2 knots) following a straight path (towards or away from the station fix) to a predetermined finish point.

125. All relevant details (including, for each tow: station and tow number; start & end times and positions; shooting & hauling times and positions; any significant changes in tow direction; depth; length of warp; speed over ground; tidal state; weather and sea conditions; and shipping activity, together with date and gear type) will be recorded. Positions to be recorded using DGPS.
126. After the completion of the sampling run, the trawl will be quickly hauled to the vessel's deck and the sample will be recovered into a container. The net will then be checked for any remaining epifauna and fish, before the cod end is refastened, prior to redeployment at the next station.
127. After completion of the sampling run and hauling up to survey vessel's deck, samples will be cleared of large debris and the total catch shall be photographed. Fish species will be sorted from epifaunal invertebrates, divided into species groups, counted and measured (total length) to the closest millimetre.
128. Any species not identified on board will be coded and preserved in 10% buffered formaldehyde solution in seawater or frozen and identified on return to the laboratory.

3.7 Marine Mammals

3.7.1 RATIONALE & OBJECTIVES

129. Although no baseline data were collected, potential impacts to marine mammals from piling activity on the AMEP were identified, although with no adverse effect with mitigation measures applied.
130. Legal Requirement: Piling conditions are identified within the DML, with a requirement to undertake noise monitoring to ensure agreed piling restrictions are met. There are also requirements for water and air temperature as well as dissolved oxygen to be monitored and piling restrictions prescribed around a series of thresholds. Furthermore, there is a requirement for a qualified Marine Mammal Observer to be present.
131. Objectives(s): Ensure compliance with piling restrictions to restrict or remove potential impacts on sensitive marine mammal receptors.

3.7.2 MONITORING

132. As per the piling conditions detailed within the DML, a Marine Mammal Observer (MMO) will be present (within 100 metres of the pile being driven) during marine piling works.
133. The MMO will operate standard protocols to ensure that piling work is not undertaken when a marine mammal is in the vicinity of the works.

134. Additional monitoring of parameters relating to the conditions of the DML will be undertaken with automatic monitoring equipment installed on a specialised 1250mm diameter buoy. The buoy will be anchored to the river bed and connected via a chain of approximately 15m in length (to allow for tidal movement and wave height).
135. The location of the monitoring buoy in relation to the intake and outfall locations and the AMEP development is provided in Figure 7.

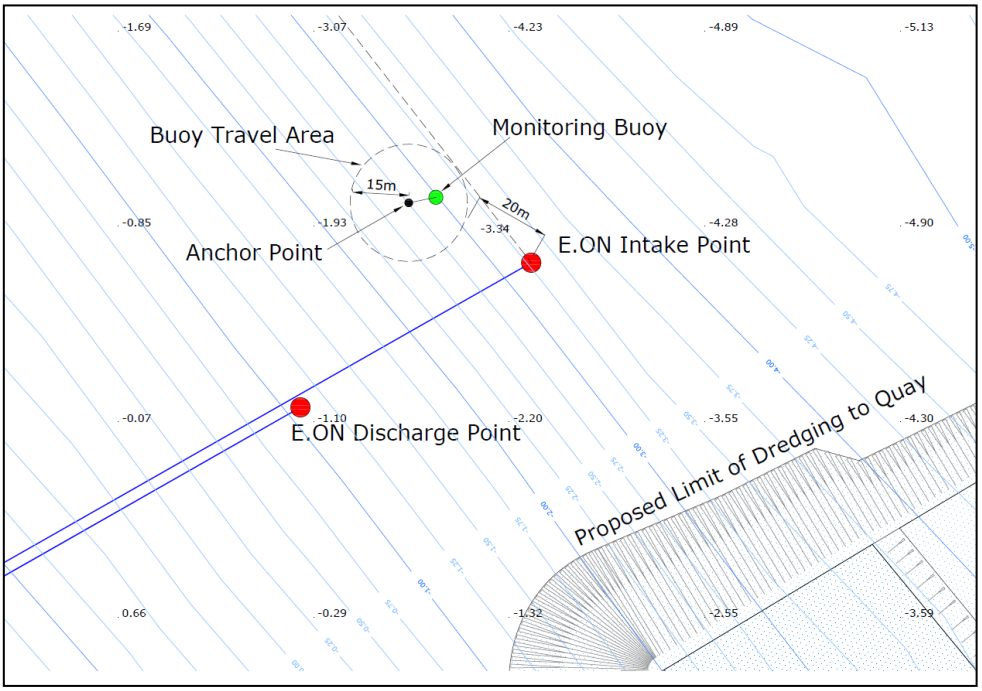


Figure 7: Proposed Monitoring Buoy Location

3.7.2.1 Temperature Monitoring

136. Temperature monitoring will be carried out using a YSI 6600 multi sonde installed onto the buoy.
137. The sensor within the sonde can monitor temperatures within a range from -5 ^{o}C to +50 ^{o}C with an accuracy of $\pm$0.15 ^{o}C.
138. Temperature monitoring will be carried out by default when the suspended solids are monitored.

3.7.2.2 Dissolved Oxygen Monitoring

139. Dissolved oxygen monitoring will be carried out by installation of an additional sensor onto the YSI 6600 multi sonde which is used to monitor temperature and suspended solids.
140. The sensor within the sonde can monitor dissolved oxygen within a range from -0 to 50mg/L with an accuracy of. ± 0.2mg/L or 2% of reading whichever is greater for 0 to 20mg/L range and ±6% of reading for 20 to 50 mg/L range.

141. Able propose to carry out dissolved oxygen monitoring approximately two weeks prior to commencement of the piling and dredging works and throughout the duration of the works.

3.7.2.3 Underwater Noise

142. Underwater noise levels will be monitored by an automatic monitoring buoy to demonstrate that restrictions on piling laid out with the DML are complied with.
143. Noise monitoring will carried out using a separate sensor fitted to the same buoy described in Section 3.1. The sensor is an Ic-Listen-LF smart hydrophone with a bandwidth of 0.1 to 1600 Hz.
144. Able will carry out noise monitoring approximately two weeks prior to commencement of the piling and dredging works and throughout the duration of the works.
145. As per the piling conditions detailed within the DML, a Marine Mammal Observer (MMO) will be present (within 100 metres of the pile being driven) during marine piling works.
146. The MMO will operate standard protocols to ensure that piling work is not undertaken when a marine mammal is in the vicinity of the works.

3.7.2.4 Air Temperature

147. In addition to the monitoring of water-related parameters, air temperature will be monitored. Piling will not be permitted during extended periods of cold weather.
148. However, the details of the thresholds and agreement have yet to be finalised.

4. TARGET SETTING AND TRIGGERS

149. As noted above, objectives and targets have been derived with reference to a number of information sources, including the SoCG, the DCO/DML and dialogue with the Regulatory Authorities and tables to action these are presented in the following text.

150. However, where objectives, targets and/or remedial actions have yet to be agreed in full, then these are identified in the following tables with an asterisk (*) and will be developed through subsequent dialogue with the appropriate Regulatory Authorities.

151. Whilst the agreement on many of these can be formed through bilateral discussion, the cross cutting nature of some of these may require multi-lateral discussion, perhaps at a meeting. A suggested timetable for the completion of this process is 21st December 2012, however this timetable can be revised depending on the requirements of the appropriate Regulatory Authorities.

5. TABULATED ACTION PLANS

152. For the broad Objectives identified in the preceding text, the following Action Plans summarise Targets, Actions (or Monitoring) to achieve those Targets and the Responsible Body to undertake the Actions (or Monitoring). Timing for the Action (or Monitoring) is provided, as well as Limits of Acceptable Change (LACs) against which any change from baseline conditions can be identified. Finally, potential types of Intervention are identified where LACs have been exceeded.

153. Importantly given the status of this plan, items within the plan that have yet to be agreed and thus require further consultation with regulators are marked with an asterisk (*) at the initial Objective headline.

154. As described within Section 1.3, the findings from the monitoring programmes will be submitted to the Steering Group, and required actions will be identified where necessary, based on baseline data and compliance with agreed targets and triggers.

TOPIC: SEDIMENT PARAMETERS

Objective: During dredging ensure sediment levels remain within limits agreed under the DML in relation to C.RO and E.ON intake/outfall operation *

Target	Ensure sediment levels remain within ranges identified and agreed through pre-construction monitoring at automatic monitoring buoy. NB existing baseline data suggest typical range of 100-1600 mg/l within the Humber Estuary
Management	n/a
Monitoring	Automatic monitoring buoy equipped with YSI 6600 multi Sonde
Who	AHPL
When	Continuous monitoring: initial pre-construction monitoring will be used to develop new baseline; monitoring will continue up to, and including, the first maintenance dredging
Limits of Acceptable Change	As set out in the DML, to be agreed following collection of baseline data and included within the monitoring scheme submitted to, and approved by, the MMO, in consultation with the EA, C.RO and E.ON
Remedial Action	As set out in the DML, to be agreed and included within the monitoring scheme submitted to, and approved by, the MMO, in consultation with the EA, C.RO and E.ON
Notes	Details of scheme to be developed and agreed prior to development

Objective: To corroborate predictions on intertidal accretion/erosion from EX8.10 and ES

Target	No target – impact verification Any changes in intertidal mudflat elevation to be within ranges modelled and described in EX8.10.
Management	n/a
Monitoring	LiDAR
Who	AHPL appointed consultant/contractor
When	Detail of monitoring dates laid out in Appendix 1; to include pre- and post-construction for a period of at least ten years
Limits of Acceptable Change	As outlined in EX8.10
Remedial Action	Dredging if required
Notes	

TOPIC: INTERTIDAL ESTUARINE HABITAT (SALTMARSH) - WFD / HUMBER ESTUARY EMS MONITORING

Objective: To record changes in extent and composition of saltmarsh

Target	No target; ongoing monitoring to address WFD and Humber Estuary EMS Conservation Objectives issues
Management	n/a
Monitoring	• LiDAR survey of intertidal between the flood defence wall and MLWN or -2m ODN (whichever is the greater) and between HST and HIT to determine saltmarsh extent and elevation, and change over time; • NVC surveys of identified areas of saltmarsh to determine species composition, and change over time
Who	AHPL appointed consultant/contractor
When	• LiDAR as per EA monitoring requirements presented as Appendix 1 (biannual, for a minimum of ten years post-construction); • NVC annually during summer; pre-construction and post-construction for at least ten years
Limits of Acceptable Change	n/a
Remedial Action	n/a
Notes	

TOPIC - INTERTIDAL ESTUARINE HABITAT (BENTHOS)

Objective: To identify deleterious change to intertidal benthic invertebrate fauna *

<table>
<tr><td>Target</td><td>No impact on WFD status (status currently assessed as Moderate for Lower Humber, and predicted as being Moderate in 2015 for Lower Humber; no assessments for Middle Humber) – WFD assessments include number of taxa; AZTI* Marine Biotic Index (AMBI); and Simpson's Evenness
Quantitative targets to be defined and agreed following completion of full baseline (pre-construction) surveys.
Possible metrics to include:
Abundance and biomass dominance (key species such as Hediste diversicolor, Macoma balthica and Corophium volutator); Provisional biomass target (wet weights as g/m^2) based on spring (May) characterisation (in line with NE suggestions, a nominal increase of 20% is included within the figures below as this is considered to provide for the autumn peak);
<table>
<tr><th>Species</th><th>Upper shore</th><th>Mid shore</th><th>Lower shore</th></tr>
<tr><td>Hediste diversicolor</td><td>28.60</td><td>n/a</td><td>0.7</td></tr>
<tr><td>Macoma balthica</td><td>2.70</td><td>15.50</td><td>2.10</td></tr>
<tr><td>Corophium volutator</td><td>4.20</td><td>4.50</td><td>1.3</td></tr>
</table>

Overall benthic invertebrate biomass (wet weight / m^2) to exceed agreed thresholds;
Abundance of specific size classes of key species (e.g. Macoma > 2 mm, Hediste) to exceed agreed thresholds;
Biotope composition and extent to remain unaffected.
</td></tr>
<tr><td>Management</td><td>n/a</td></tr>
<tr><td>Monitoring</td><td>Intertidal survey using hand-held corers (standard methods – including species and community analysis, particle size analysis, organic content)</td></tr>
<tr><td>Who</td><td>AHPL appointed consultant/contractor</td></tr>
<tr><td>When</td><td>Biannual (spring & autumn) surveys beginning with establishing new baseline pre-construction and continuing for ten years post-construction</td></tr>
<tr><td>Limits of Acceptable Change</td><td>To be based on uni- and multi-variate statistical analysis of temporal and spatial community variability and change</td></tr>
<tr><td>Remedial Action</td><td>n/a</td></tr>
<tr><td>Notes</td><td>Full targets to be defined and agreed following completion of full baseline (pre-construction) surveys</td></tr>
</table>

Objective: To record and identify potential changes in intertidal topography

Target	To meet EA monitoring requirements and to validate model predictions of changes in bathymetry to the south-east of the AMEP quay as described in EX 8.10
Management	n/a
Monitoring	LiDAR survey of intertidal between the flood defence wall and MLWN or -2m ODN (whichever is the greater) and between HST and HIT (area shown in Appendix 2)
Who	AHPL appointed consultant/contractor
When	• Once during month prior to commencement of construction works; • biannual surveys for ten years post-construction
Limits of Acceptable Change	
Remedial Action	n/a
Notes	Further details as per Environment Agency monitoring requirements attached as Appendix 1

TOPIC - SUBTIDAL ESTUARINE HABITAT (BENTHOS)

Objective: To identify deleterious change to subtidal benthic invertebrate fauna due to dredging and dredge disposal e.g. including WFD Compliance*

Target	To identify potential impact on WFD status (status currently assessed as Moderate for Lower Humber, and predicted as being Moderate in 2015 for Lower Humber; no assessments for Middle Humber) – WFD assessments includes number of taxa; AZTI* Marine Biotic Index (AMBI); and Simpson's Evenness Quantitative targets to be defined and agreed following completion of full baseline (pre-construction) surveys. Possible metrics to include: • Abundance and biomass dominance; • Overall benthic invertebrate biomass (wet weight / m^2) to exceed agreed thresholds; • Biotope composition and extent to remain unaffected.
Management	n/a
Monitoring	Subtidal benthic invertebrate survey of (maintenance) dredge areas using Hamon grab (standard methods – including species and community analysis, particle size analysis, organic content); Subtidal benthic invertebrate survey of areas within, and immediately surrounding, dredge disposal sites; Additional monitoring at agreed WFD locations.
Who	AHPL appointed consultant/contractor
When	Dredge sites: annual (spring) surveys beginning with establishing new baseline pre-construction and continuing for ten years post-construction Disposal sites: scheme for monitoring and management of disposal activities to be submitted to, and agreed with, the EA; the scheme shall include: • timetable for when monitoring shall be undertaken; • detailed monitoring methodology; • evaluation of the contribution the disposal activities make to the overall ecological potential of the Humber Lower water body
Limits of Acceptable Change	To be based on uni- and multi-variate statistical analysis of temporal and spatial community variability and change
Remedial Action	n/a
Notes	Full targets to be defined and agreed following completion of full baseline (pre-construction) surveys. Further details regarding disposal site monitoring as per Environment Agency monitoring requirements attached as Appendix 1

Objective – to derive baselines for dredging and disposal impacts and to validate boundaries of disposal grounds

Target	Derive baselines for dredging/disposal impacts and to validate assumptions on boundaries of disposal grounds
Management	n/a
Monitoring	Bathymetric survey of dredge areas and disposal sites and of intertidal between HST and HIT
Who	AHPL appointed consultant/contractor
When	Once during month prior to commencement of construction works; Fortnightly during capital dredging and the month following; Annual surveys for ten years post-construction
Limits of Acceptable Change	Sedimentation patterns indicating greater levels of erosion in comparison to those defined in Chapter 8 of ES or subsequent revision
Remedial Action	As noted below, the annual surveys will provide the information needed to either validate the boundaries of the deposit grounds, or trigger the need for them to be amended, and will also allow ongoing management of the dredge and disposal.
Notes	• The first surveys shall provide the baseline for determining the impacts of dredge and disposal works, and should allow natural variability to be accounted for in any assessment. • The subsequent surveys shall provide the information needed to either validate the boundaries of the deposit grounds, or trigger the need for them to be amended. It shall also allow ongoing management of the dredge and disposal. • Surveys will be undertaken on similar tidal ranges and state of tide wherever possible. This will allow volumetric differences to be roughly compared, meaning the approximate portion of sediment retained and dispersed may be deducted. Further details as per Environment Agency monitoring requirements attached as Appendix 1

TOPIC - FISH COMMUNITIES

Objective: To identify deleterious change to intertidal fish populations *

Target	To identify potential impact on WFD status (status currently assessed as Good for Middle and Lower Humber, and predicted as being Good in 2015 for Middle and Lower Humber) and Humber Estuary EMS Conservation Objectives
Management	n/a
Monitoring	Intertidal fyke net surveys
Who	AHPL appointed consultant/contractor
When	Annual beginning with establishing new baseline pre-construction and continuing for ten years post-construction
Limits of Acceptable Change	No change to WFD status
Remedial Action	n/a
Notes	

Objective: To identify deleterious change to subtidal fish populations *

Target	To identify potential impact on WFD status (status currently assessed as Good for Middle and Lower Humber, and predicted as being Good in 2015 for Middle and Lower Humber) and Humber Estuary EMS Conservation Objectives
Management	n/a
Monitoring	Subtidal beam trawl surveys
Who	AHPL appointed consultant/contractor
When	Annual beginning with establishing new baseline pre-construction and continuing for ten years post-construction
Limits of Acceptable Change	No change to WFD status
Remedial Action	n/a
Notes	

TOPIC: MARINE MAMMALS

Objective: Ensure compliance with piling restrictions to restrict or remove potential impacts on sensitive marine mammal receptors

Target	Piling only to take place when dissolved oxygen levels are above defined threshold value as specified within the DCO
Management	n/a
Monitoring	Automatic monitoring buoy equipped with YSI 6600 multi Sonde
Who	AHPL
When	Continuous monitoring: to include pre-construction monitoring and subsequent monitoring throughout construction phase
Limits of Acceptable Change	Dissolved oxygen to be at, or in excess of, 5 mg/l
Remedial Action	No percussive piling to take place whilst dissolved oxygen is below 5 mg/l
Notes	All details as per DML

Objective: Ensure compliance with piling restrictions to restrict or remove potential impacts on sensitive marine mammal receptors

Target	Piling only to take place when water temperature is above defined threshold value as specified within the DCO
Management	n/a
Monitoring	Automatic monitoring buoy equipped with YSI 6600 multi Sonde
Who	AHPL
When	Continuous monitoring: to include pre-construction monitoring and subsequent monitoring throughout construction phase
Limits of Acceptable Change	Water temperature to be at, or below, 21.5 °C
Remedial Action	No percussive piling to take place whilst water temperature exceeds 21.5 °C
Notes	All details as per DML

Objective: Ensure compliance with piling restrictions to restrict or remove potential impacts on sensitive marine mammal receptors

Target	Piling only to take place at times specified within the DCO
Management	n/a
Monitoring	Automatic monitoring buoy equipped with Ic-Listen-LF smart hydrophone
Who	AHPL
When	Continuous monitoring: to include pre-construction monitoring and subsequent monitoring throughout construction phase
Limits of Acceptable Change	No percussive piling shall take place between 7 April and 1 June inclusive in any calendar year. No percussive piling shall take place before 0600 hours or after 2200 hours on any day. Percussive piling shall be restricted at other times as follows: • from 2 June to 22 July inclusive in any year, the maximum amount of percussive piling permitted within any four-week period shall not exceed: o 101 hours where a single piling rig is in operation, or o a total of 168 hours where two or more rigs are in operation; • from 23 July to 10 September inclusive in any year, the maximum amount of percussive piling permitted within any week-long period shall not exceed: o 25 hours where a single piling rig is in operation, or o a total of 42 hours where two or more rigs are in operation; • from 11 September to 31 October inclusive in any year, the maximum amount of percussive piling permitted within any four-week period shall not exceed: o 134 hours where a single piling rig is in operation, or • a total of 224 hours where two or more rigs are in operation. • from 1 November in any year to 6 April in the following year inclusive, the maximum amount of percussive piling permitted within any eight-week period shall not exceed: o 336 hours where a single piling rig is in operation, or o a total of 560 hours where two or more rigs are in operation. o The measurement of time during each work-block shall begin at the start of each timeframe, roll throughout it, then cease at the end, where measurement will begin again at the start of the next timeframe, such process to be repeated until the end of piling works.
Remedial Action	Piling to cease outside of permitted times.
Notes	All details as per DML

Objective: Ensure compliance with piling restrictions to restrict or remove potential impacts on sensitive marine mammal receptors

Target	To ensure no marine mammal presence in vicinity of piling activity
Management	n/a
Monitoring	Direct observation by Marine Mammal Observer using standard protocols (e.g. JNCC guidance, 2009)
Who	AHPL appointed consultant/contractor
When	Whenever piling is being undertaken
Limits of Acceptable Change	No marine mammal within 100 metres of the pile being driven
Remedial Action	Cessation of piling while any marine mammals are within 100 metres of the pile being driven
Notes	All details as per DML

Objective: Ensure compliance with piling restrictions to restrict or remove potential impacts on sensitive marine mammal receptors

Target	To ensure no piling activity during extended periods of cold weather
Management	n/a
Monitoring	Temperature monitoring at sites to be agreed
Who	AHPL appointed consultant/contractor
When	Whenever piling is being undertaken
Limits of Acceptable Change	Range of temperature-based restrictions set out in DCO (still to be fully defined – see notes)
Remedial Action	Cessation of piling when cold-weather thresholds are breached
Notes	No operations consisting of piling shall commence until a cold weather piling restriction strategy is submitted and agreed with the MMO, following consultation with Natural England. A finalised strategy has yet to be produced.

SUBTIDAL – FLOOD RISK ASSESSMENT

Objective - To assess longer-term impacts of AMEP within the wider estuary on standard of protection of EA defences

Target	Validation of predicted changes in sedimentation patterns, as defined in Chapter 8 of ES or subsequent revision
Management	n/a
Monitoring	Bathymetric and LiDAR surveys within the area shown in Appendix 2.
Who	AHPL appointed consultant/contractor
When	Once during month prior to commencement of construction works; Annual surveys post-construction to 2033 (Humber Strategy Period)
Limits of Acceptable Change	Sedimentation patterns indicating greater levels of erosion in comparison to those defined in Chapter 8 of ES or subsequent revision
Remedial Action	Monitoring frequency increased to biannual until either: • there are two confirmed surveys indicating erosion - which will trigger a Standard of Protection (SoP) Review to be undertaken for affected locations; or • there is no further evidence of erosion and a pattern of stabilisation can be detected; at which point the monitoring may return to annual frequency
Notes	Understood to be addressed within a separate Flood Risk Management Plan; Further details as per Environment Agency monitoring requirements attached as Appendix 1

6. REFERENCES

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APPENDIX 1

Agreed monitoring for Able Marine Energy Park (AMEP) Capital Dredging and Disposal Activities

APPENDIX ONE

Monitoring for Able Marine Energy Park (AMEP) Capital Dredging and Disposal Activities

A. Bathymetric Monitoring

Able shall undertake bathymetric surveys (as defined in Section E) at the following locations and for at least 500 metres up and down the estuary, at not greater than 50 metre line spacing:-

1) AMEP berth pocket dredge (bounded by co-ordinates (53°39.506N, 00°13.416W), (53°39.496N, 00°13.448W), (53°39.515N, 00°13.463W), (53°39.537N, 00°13.376W), (53°38.972N, 00°12.631W) and (53°38.946N, 00°12.678W));
2) AMEP approach channel dredge (bounded by co-ordinates (53°39.537N, 00°13.376W), (53°39.579N, 00°13.230W), (53°39.094N, 00°12.296W), (53°38.956N, 00°12.570W) and (53°38.972N, 00°12.631W));
3) AMEP turning area dredge (bounded by co-ordinates (53°39.406'N, 00°12.893'W), (53°39.414'N, 00°12.524'W), (53°39.112'N, 00°12.261'W) and (53°39.094'N, 00°12.296'W));
4) HU080 Disposal site down estuary (bounded by co-ordinates (53°36.95'N, 00°03.47'W), (53°36.55'N, 00°00.42'E), (53°36.30'N, 00°00.62'W) and (53°36.47'N, 00°02.32'W)) ;
5) HU082 Disposal down estuary (bounded by co-ordinates (53°37.47'N, 00°02.27'W), (53°37.25'N, 00°00.80'W), (53°36.97'N, 00°00.81'W) and (53°37.12'N, 00°02.29'W));

The first surveys shall be undertaken and completed within the month prior to the commencement of any marine construction, dredge or disposal works. Surveys shall thereafter be repeated no less than once a fortnight, or suitable timescale to be agreed, during the capital dredge programme (as defined in the dredge and disposal strategy, clause 32 (1) Schedule 8 of the Development Consent Order). Upon completion of the capital dredge programme, surveying shall continue at the agreed frequency for one month.

Within 2 weeks of the completion of each survey, Able shall:-

- Supply the results of each report to the EA via email to humber.strategy@environment-agency.gov.uk, unless otherwise advised in writing by the EA.

Able shall produce a report collating and analysing the monitoring undertaken to date:-

- Every 6 months from the commencement of monitoring; and
- Supply a copy of each report to the EA via email to humber.strategy@environment-agency.gov.uk, unless otherwise advised in writing by the EA.

Note:

- The first surveys shall provide the baseline for determining the impacts of dredge and disposal works, and should allow natural variability to be accounted for in any assessment.
- The subsequent surveys shall provide the information needed to either validate the boundaries of the deposit grounds, or trigger the need for them to be amended. It shall also allow ongoing management of the dredge and disposal.
- Surveys shall be undertaken on similar tidal ranges and state of tide wherever possible. This shall allow volumetric differences to be roughly compared, meaning the approximate portion of sediment retained and dispersed may be deducted.

B. LiDAR Monitoring Upstream and Downstream of AMEP

Able shall undertake LiDAR surveys (as defined in Section E) at the following locations, at not greater than 50 metre line spacing:-

6) Between the top of the flood defence wall and MLWN or -2m ODN (whichever is the greater) upstream of AMEP, from quay wall to HST (as defined in drawing AME-06114 revB);
7) Between the top of the flood defence wall and MLWN or -2m ODN (whichever is the greater) downstream of AMEP, from quay wall to HIT (as defined in drawing AME-06114 revB);

Able shall survey locations 6 and 7 in the month prior to the commencement of any marine construction, dredge or disposal works and thereafter one month following completion of the quay construction. These surveys shall be repeated at six month intervals, or suitable timescale to be agreed, for 10 years in order to record the level of sedimentation taking place upstream and downstream of the quay.

Within 2 weeks of the completion of each survey, Able shall:-

- Supply the results of each report to the EA via email to humber.strategy@environment-agency.gov.uk, unless otherwise advised in writing by the EA.

Able shall produce a report collating and analysing the monitoring undertaken to date:-

- Every 12 months from the commencement of monitoring; and
- Within 6 weeks of the each annual survey; and
- Compare the results to the modelling results presented in Chapter 8 of the ES and all technical appendices and subsequent supplementary information submitted with the application; and
- Supply a copy of each report to the EA via email to humber.strategy@environment-agency.gov.uk, unless otherwise advised in writing by the EA.

If the rate of sedimentation is significantly different to that predicted in the ES, or there is any indication of significant erosion of sediment in either location (6 or 7) and there is a risk of flood defences being undermined, Able shall:

Increase the frequency of monitoring to every 12 weeks until such time that either:

- there is no further evidence of erosion and a pattern of stabilisation can be detected; at which point the monitoring may return to the 6 monthly frequency identified above; OR
- there are two confirmed surveys indicating erosion. This shall trigger a Standard of Protection (SoP) Review, at Able's cost, for all defences identified in the monitoring results showing a change in sedimentation patterns. The standard of protection that is provided by the current defence line against flooding from the sea shall be reviewed at Able's expense using those parameters in use by the EA and which have been notified to Able in writing by the EA. If the results show a reduction in SoP Able shall, at its own expense, undertake improvement works to restore the affected lengths of defence to the original SoP. The original SoP, shall be agreed by both parties prior to the Commencement. This SoP review shall extend from Humber Sea Terminal (HST) to Humber International Terminal (HIT). Prior to any improvement works being undertaken by Able, the methodology shall be agreed in writing with the EA.

C. Longer term Monitoring of Impacts of AMEP within the Wider Estuary on Standard of Protection of EA Defences

Able shall undertake the following surveys;-

Bathymetric surveys (as defined in Section E) at not greater than 500 metre line spacing:-

- In the area upstream and adjacent to AMEP as defined in drawing AME-06114 revB, across the width of the estuary up to MLWN; and
- In the area upstream and downstream of the disposal grounds as defined in drawing AME-06115 revB, across the estuary from MLWN at the north bank to the northern edge of the Sunken Dredged Channel

LiDAR surveys (as defined in Section E) at not greater than 50 metre line spacing:-

- In the areas upstream and opposite to AMEP as defined in drawing AME-06114 revB, between the top of the flood defence wall and MLWN or -2m ODN (whichever is the greater) at both the north and south river banks; and
- In the area upstream and downstream of the disposal grounds as defined in drawing AME-06115 revB, , between the top of the flood defence wall and MLWN or -2m ODN (whichever is the greater) at the north river bank

These surveys shall be undertaken on a 12 monthly basis for 10 years, commencing one month after completion of the marine and capital dredging works. At the end of the 10 year period the EA shall review the results; which may include a SoP review (as defined Section B) at Able's expense if there is a significant change in the surveyed levels which demonstrate that erosion is occurring, which will impact upon the flood defences. The EA may require monitoring to be undertaken for a further 10 years if it considers this to be reasonably necessary and justifiable following the SoP review.

Within 2 weeks of the completion of each survey, Able shall:-

- Supply the results of each report to the EA via email to humber.strategy@environment-agency.gov.uk, unless otherwise advised in writing by the EA.

Able shall produce a report collating and analysing the monitoring undertaken so far:-

- Every 12 months from the commencement of monitoring; and
- Within 6 weeks of the each annual survey; and
- Compare the results to the modelling results presented in Chapter 8 of the ES and all technical appendices and supplementary information submitted with the application; and
- Supply a copy of each report to the EA via email to humber.strategy@environment-agency.gov.uk, unless otherwise advised in writing by the EA.

If at any point during the monitoring period there is a significant change in the sedimentation patterns defined in the baseline assessment (based on Chapter 8 or the ES subject to suitable revisions of this chapter by Able) Able shall:

Increase the frequency of monitoring to every 6 months until such time that either:

- there is no further evidence of erosion and a pattern of stabilisation can be detected; at which point the monitoring may return to the 12 monthly frequency identified above ; OR

- there are two confirmed surveys indicating erosion. This shall trigger a Standard of Protection (SoP) Review to be undertaken by Able for those locations identified which appear to be affected (following methodology defined in Section B). If the results show a reduction in SoP Able shall, at its own expense, undertake improvement works to restore the affected lengths of defence to the original SoP. The original SoP, shall be agreed by both parties prior to the Commencement. The methodology for improvement works shall be agreed, in advance of work being undertaken, in writing with the EA.

D. Benthic Invertebrates

Prior to the commencement of any marine disposal activities, a Scheme for the protection and enhancement of benthic invertebrates through the monitoring and management of disposal activities within, and immediately surrounding, the disposal sites of the Lower Humber water body, shall be submitted to and agreed in writing with the EA. The Scheme shall include the following:-

i. A timetable for when monitoring shall be undertaken, including monitoring before, during and after disposal activities are undertaken;
ii. A detailed methodology for the monitoring;
iii. An evaluation of the contribution the disposal activities make to the overall ecological potential of the Humber Lower water body as assessed by the biological elements, supporting elements, supporting conditions and ecological potential assessment as set out in Annex B of the Humber River Basin Management Plan;

If the evaluation of i)-iii) shows that marine disposal works contribute to, or are likely to contribute to, a failure of the water body in achieving its WFD objectives, a Remedial Action Plan shall be submitted to the EA that detail measures to ensure disposal activities are amended such that, as far as is reasonably practicable, they do not contribute towards a deterioration of the Humber Lower water body status (including deterioration within existing status class), should such arise. The Remedial Action Plan may include variations to disposal activities to reduce their impact and/or specific measures to protect and enhance benthic invertebrates.

Within 2 weeks of the completion of each piece of monitoring, Able shall:-

- Supply the results of each report to the EA via email to humber.strategy@environment-agency.gov.uk, unless otherwise advised in writing by the EA.

Able shall produce a report collating and analysing the monitoring undertaken so far:-

- Every 6 months from the commencement of monitoring; and
- Within 6 weeks of the each annual survey; and
- Supply a copy of each report to the EA via email to humber.strategy@environment-agency.gov.uk, unless otherwise advised in writing by the EA.

Should a Remedial Action Plan be deemed necessary as a result of the Scheme, Able shall:-

- As soon as reasonably practicable, submit a Remedial Action Plan to the EA for their approval,
- As soon as reasonably practicable following the approval of the Remedial Action Plan, implement any actions agreed in the plan

Definitions

MHWS- Mean High Water Springs

MHWN- Mean High Water Neaps

MLWS- Mean Low Water Springs

MLWN – Mean Low Water Neaps

Bathymetric Survey

All survey work shall be undertaken in accordance with the EA survey specification v3.1, relating directly to Section VII (Hydrographic Surveys of River channels and other Water Areas using Swathe Bathymetry), or shall be provided in accordance with an agreed alternative method.

A multibeam echo sounder should be used. The system measures water depths across a wide swathe perpendicular to the vessel track, thus giving greater coverage of bed features along the line than traditional single beam. The additional horizontal coverage shall vary depending upon the water depths, but should approximate between 3 to 8 times the water depth, and produce wide channels of data capture, and ultimately complete coverage of the river channel.

The results need to include the methodology used to collect the data; the equipment deployed, including but not limited to Echo Sounder, Motion Sensor, Sound Velocimeter; position fixing equipment and processing. The software used to collect and process the data and the software used to produce charts and digital x,y,z outputs.

All surveys are to be referenced to UK National Grid, and any vertical datum shall be referenced to Ordnance Datum Newlyn.

The following data shall be supplied.

i) ASCII raster format *.asc 1m gridded data set supplied per OS Grid Square

ii) XYZ data *.txt 1m gridded data set per study reach

iii) Survey report.

Following the initial baseline survey, all subsequent data shall be compared to the baseline for the identification of river bed and bank movement.

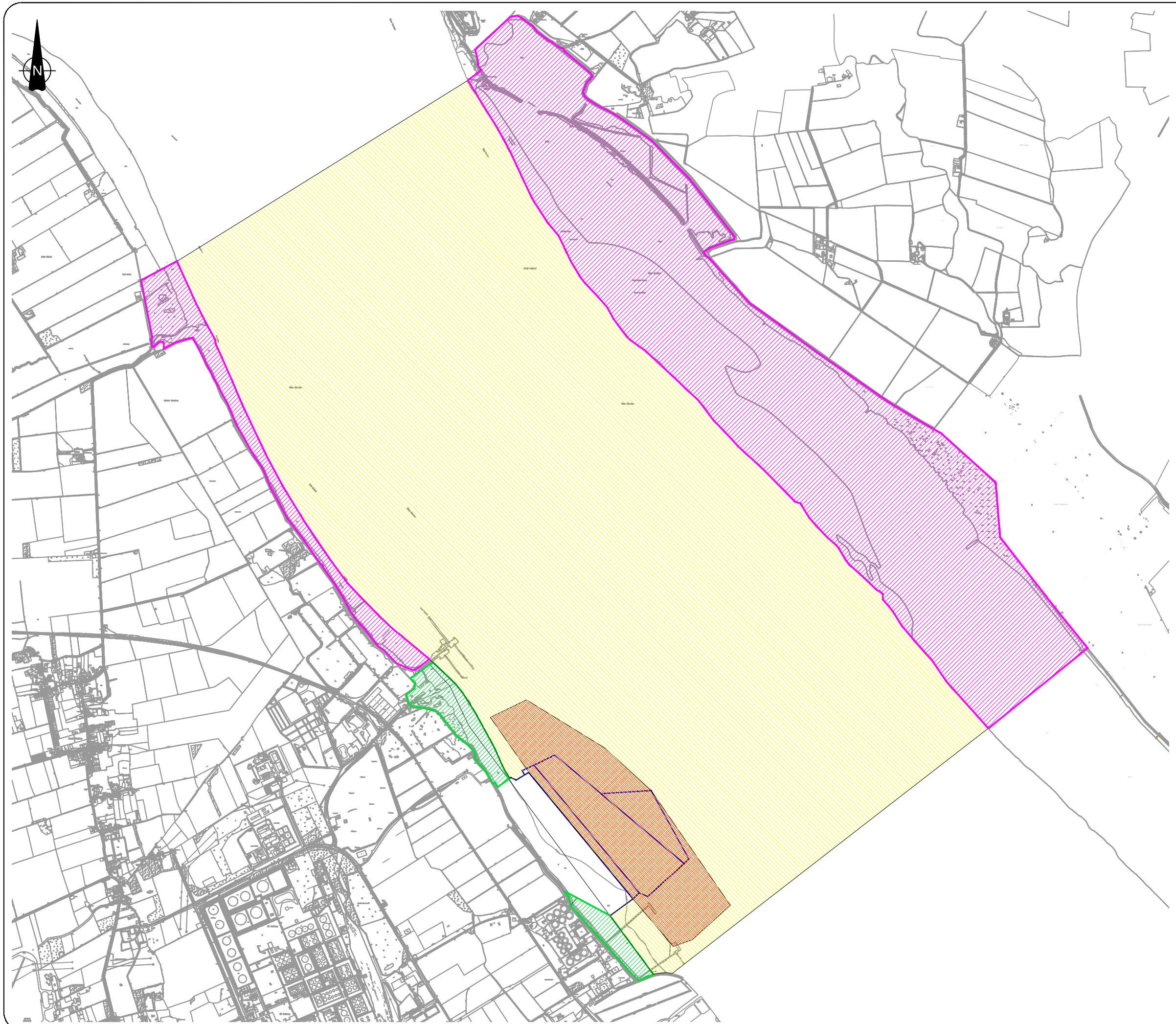
LiDAR Survey

A LIDAR Digital Surface Model (DSM) and Digital Terrain Model (DTM) in ArcView ASCII Grid file in 0.25m x 0.25m and 0.5m x 0.5m file sizes for each polygon defined. Also supplied shall be last return XYZI point cloud data in LAS format and DSM XYZ ASCII TXT.
Data shall be collected during tidal windows in the order of 1 hour either side of Low Water, or suitable agreed time period.
The error specification for LIDAR surveys shall be an RMSE of +/- 15cm.
Ground truth surveys for the checking of LIDAR height accuracy shall be carried out within each polygon.
A full quality control report shall be supplied to the EA on completion of each survey. This shall include at least the following:

- A plot of all data indicating polygon coverage and aircraft navigation lines.
- A copy of the flight log for all polygons.
- Data processing procedures.
- A report on the comparison of these data with available ground truth data.

APPENDIX 2

LiDAR and bathymetric survey locations



KEY

AMEP Quay & Capital Dredging Extent

Bathymetric Survey
Start - One month prior to marine works
Interval - Fortnightly during capital dredging until one month after works

LiDAR Survey
Start - One month prior to marine works
Interval - One month after completion of marine works and every 6 months (or rate to be agreed) for 10 years

Bathymetric Survey
Start - One month after completion of marine works
Interval - Every 12 months for 10 years after completion of marine works

LiDAR Survey
Start - One month after completion of marine works
Interval - Every 12 months for 10 years after completion of marine works

Rev	Date	Comments	Drw	Chk	App
B	20/11/12	Surveys areas updated	IW	RC	PMS
A	09/11/12	Preliminary Issue	IW	RC	RC

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Project: Able Marine Energy Park

Client: Able UK Ltd

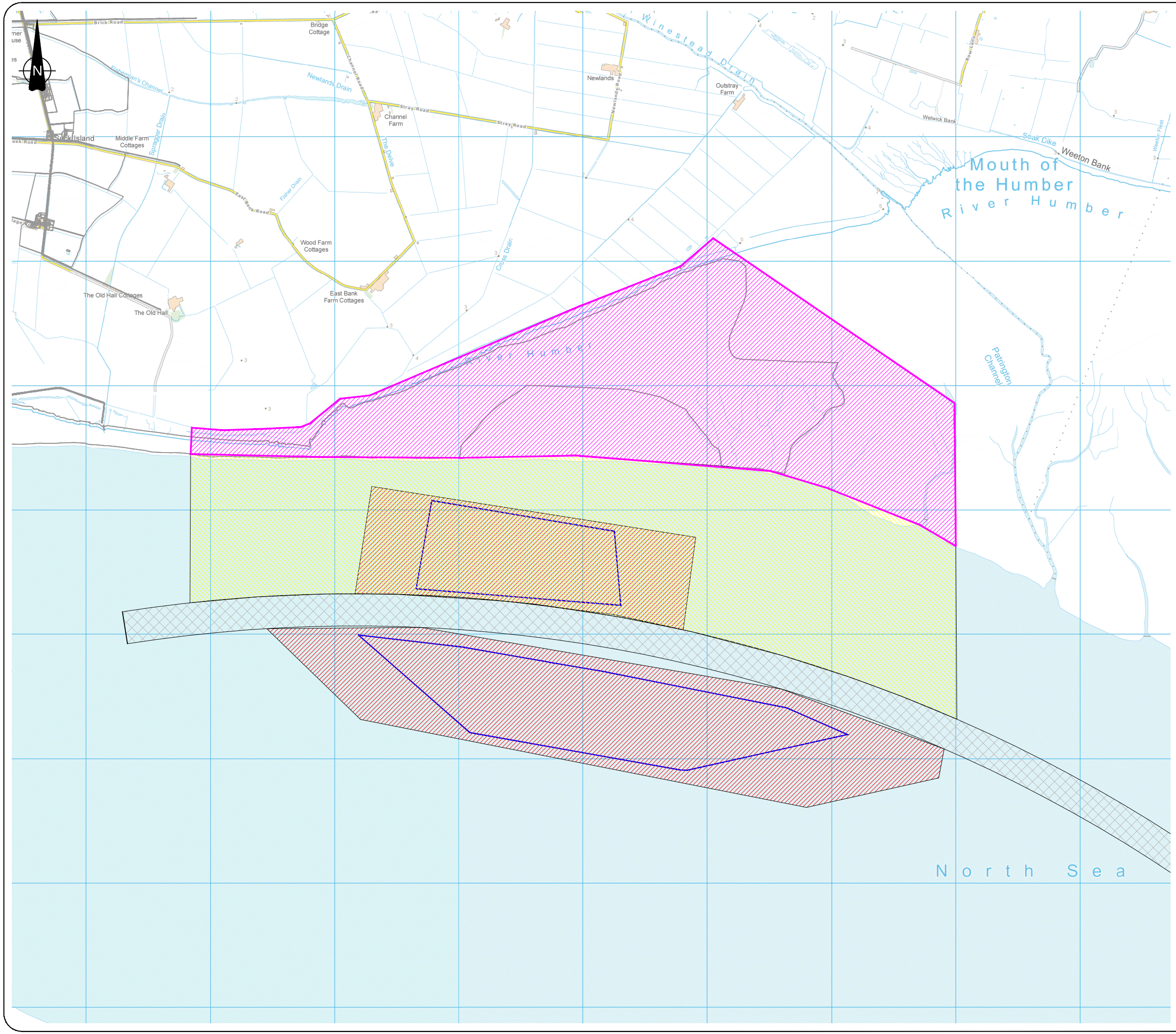
Title: AMEP Marine & Capital Dredging Monitoring - Sheet 1

PRELIMINARY

Scale:	Drawn	Checked	Approved
NTS	IW	R Cram	R Cram
Date	09/11/2012	09/11/2012	09/11/2012

Drawing No. AME - 06114

Revision: B



KEY

- Disposal Grounds
- Sunken Dredged Channel
- Bathymetric Survey
  Start - One month prior to marine works
  Interval - Fortnightly during capital dredging until one month after works
- Bathymetric Survey
  Start - One month after completion of marine works
  Interval - Every 12 months for 10 years after completion of marine works
- LiDAR Survey
  Start - One month after completion of marine works
  Interval - Every 12 months for 10 years after completion of marine works

Rev	Date	Comments	Drw	Chk	App
B	20/11/12	Monitoring Area updated	IW	RC	PMS
A	09/11/12	Preliminary Issue	IW	RC	RC

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Project: Able Marine Energy Park

Client: Able UK Ltd

Title: AMEP Marine & Capital Dredging Monitoring - Sheet 2

PRELIMINARY

Scale:	Drawn	Checked	Approved
NTS	IW	R Cram	R Cram
Date	09/11/2012	09/11/2012	09/11/2012

Drawing No. AME - 06115

Revision: B