

WIRRAL COUNCIL

Hilbre Island Defence Inspection and Report **July 2016**



Draft Report

September 2016

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Wirral Council

Hilbre Island Inspection and Report – July 2016 September 2016

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Draft

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Coastal Engineering UK Ltd has prepared this report in accordance with the instructions of their client, Wirral Council. Any other persons who use any information contained herein do so at their own risk.

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1. INTRODUCTION & BACKGROUND

Hilbre Island is the largest and northern most sandstone outcrop of the Hilbre archipelago of islands (the others being Middle Eye and Little Eye) and lies off the north-west corner of Wirral, as shown in Figure 1.1. The island is cut off from the mainland at high water but access can be gained across the inter-tidal sands during low water periods.



The island has significant archaeological and historical heritage and also sits within several environmental designations related to the Dee Estuary (SPA, SAC, RAMSAR, SSSI) and the islands themselves (LNR).

The island is formed from naturally outcropping bedrock (bunter sandstone) that is subject to erosion by the action of winds, waves and tides. In the 1830s the islands were purchased by the trustees of the Liverpool Docks which subsequently became the Mersey Docks and Harbour Board (MDHB) acquired the lease to the islands. The islands were sold to Hoylake Urban District Council in 1945 for £2,500, before becoming the responsibility of Wirral Borough Council on its formation, following local government re-organisation, in 1974.

During the ownership of the MDHB sections of the sandstone cliffs around the island were reinforced with near vertical profile infills made up of sandstone blocks, which were quarried locally from the sandstone outcrops on the foreshore. These works are believed to have been constructed during the second half of the 19th century¹.

Figure 1.1 – Location Plan

Over the years there has been deterioration in the condition of the sandstone infills that has led to further erosion. Management of the island and these defences is the responsibility of Wirral Council, which is carried out through the Regeneration & Environment Directorate's Parks and Countryside Service. Limited maintenance is carried out to the island's man-made defences however in past years community groups have coordinated and carried out reconstruction of some of the failed sections of masonry wall. The most recent

¹ Wirral Borough Council, 2003. Hilbre Islands Local Nature Reserve – Draft Management Plan – Appendices (2003).

significant Council intervention was in 2004 when stabilisation works were undertaken by a concrete repair contractor to the lifeboat slipway following significant storm damage. Photographic inspections and monitoring of the condition of the man made defences has been carried out in the past however recent natural rock falls on Hilbre and Middle Eye have highlighted health and safety concerns associated with the defences.

To address these concerns Wirral Council commissioned CEUK to review the condition of the defences and to advise on how best to manage the risks associated with them within the context of Hilbre's environmental and heritage interests and its popularity with the general public.

2. AIMS & REQUIREMENTS

The Council have commissioned the report to address, specifically:

- The stability of the existing walls and their likelihood of failure;
- The impact of this failure in inducing further cliff falls; and
- Other health and safety risk associated with maintenance of the walls.

The main elements of the commission are:

1. A full walkover and visual inspection of the masonry structures at Hilbre Island;
2. Production of an inspection report including photographs identifying the location of defects and other observations identified in the report;
3. A risk assessment of the current management practices for the cliffs and structures at Hilbre Island – identifying, where appropriate, the health and safety impacts for tourism to the island;
4. Identification of a prioritised schedule of remedial and / or maintenance / reconstruction works for the defences at the north-west of Hilbre Island based on the inspections undertaken;
5. Production of outline specifications and estimates for remedial works identified, taking account of the difficult working arrangements and environmental designations;
6. Recommendations for further survey or inspection work to improve understanding of the risk of failure of the structures.

3. **INSPECTION DETAILS**

An inspection of Hilbre Island was carried out on the 28th July 2016. The weather was overcast with rain showers and accompanying west to south westerly winds, estimated maximum force 4-5.

The inspection was carried out by Alan Williams of Coastal Engineering UK Ltd accompanied by Ms Christine Smyth of Wirral Council's Park and Countryside Service and Mr Neil Thomas and Mr Mark Wardle of Wirral Council's Highways Management – Highways section.

The inspection commenced from the bottom of the steps adjacent to the Buoy Master's House approximately half way along the east (landward) facing side of the Island and proceeded in an anti-clockwise direction along the foreshore around the whole of the island, back to the starting point. At the north west corner of the island, due to tidal access limitations, it was necessary to traverse across the island from the location of the old lifeboat station to the foreshore access steps on the western side and returning northerly across the foreshore to examine the most extensive defences on the north west corner

The inspection comprised taking photographs and recording the location and condition of the defences and other natural key features around the island.

Photographs were taken using a Sony Cybershot DSC-HX100V digital still camera at 5MP (2592x1944) image setting, identified as HI_160728_ZZZ, where 160728 is the date of the inspection (YYMMDD format) and ZZZ represents the sequential photo number of the photograph taken on the day. A number of photographs were recorded using the "Sweep Panorama" function. In addition all the majority of photos are geotagged.

Details of the location the photographs have been taken (in Latitude and Longitude) can be found in the file properties of each photograph. Alternatively the locations can be viewed using either Google Picasa software (downloaded from <http://picasa.google.com/>) or by loading the Google Earth file provided with the report ([Hilbre Inspection Photos 160728.kmz](#)). The geotagged information can also be extracted and used to import the locations into a suitable GIS system. In addition all photograph locations were recorded on a hand held GPS, with a position accuracy of ± 10 metres. Each location is denoted e.g. **HI012**. Positions are recorded in decimal lat/long co-ordinates and subsequently converted to OSGB36 National Grid with ± 2 metre accuracy.

The locations of the photographs are provided on the Google Earth file - *Hilbre Inspection Photos 160728.kmz* – provided with the report.

The geotagging allows for direct comparison, of conditions applying at present, with repeat photographs taken during future inspections.

A CD Rom containing MS Word and Pdf versions of the report together with all the digital images of the individual photographs, in jpg format, is provided to accompany the report.

4. **OVERVIEW OF PHYSICAL & EXPOSURE CONDITIONS**

Around much of Hilbre the exposure of both artificial defences and the cliffs themselves is limited by the outcropping bedrock that forms the upper part of the foreshore. The relative levels of the land and the foreshore obtained from 0.25m resolution LiDAR data² are shown in Figure 4.1 below.

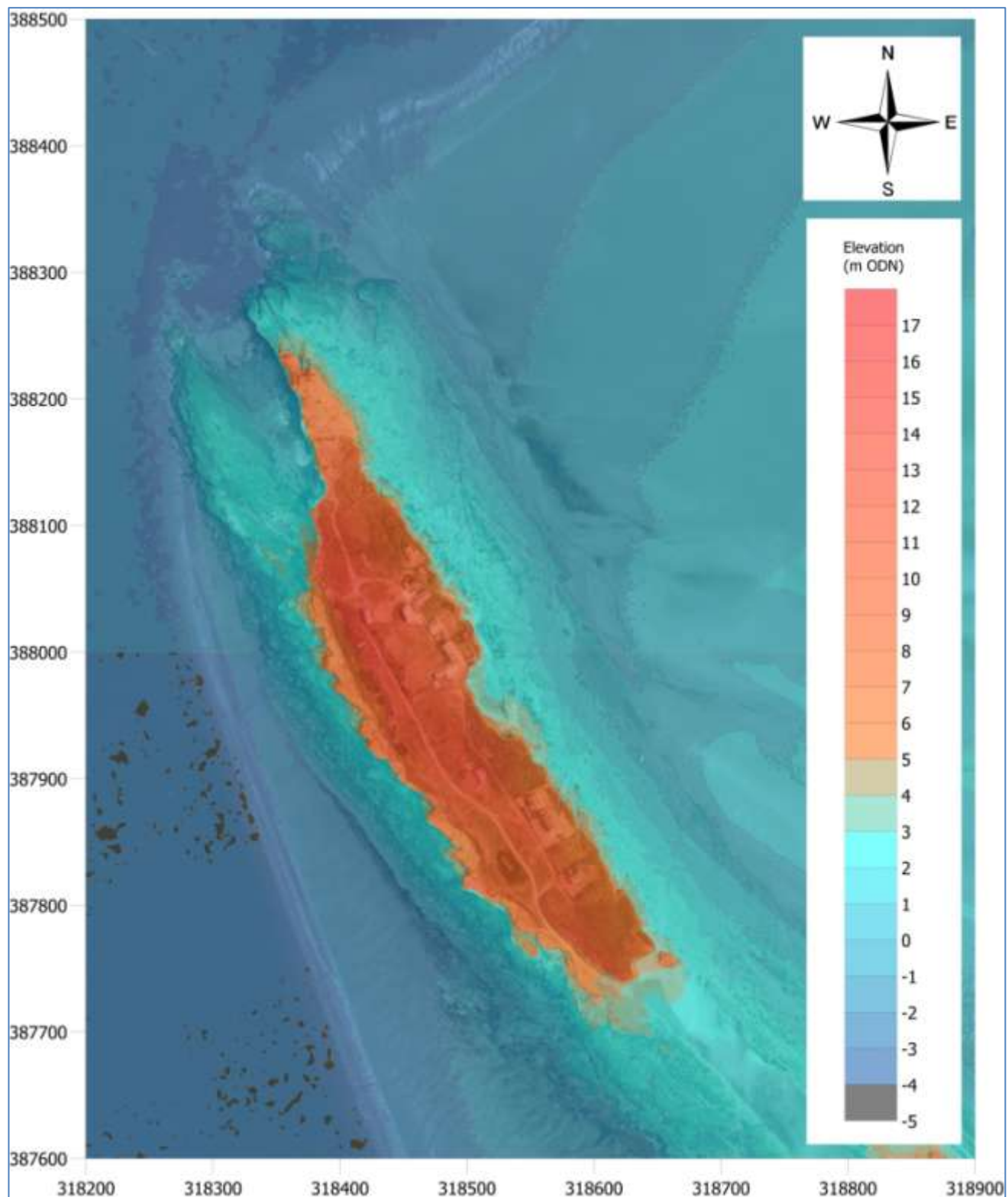


Figure 4.1 – Ground and Foreshore Levels (ex LiDAR)

² <http://environment.data.gov.uk/ds/survey/#/survey?grid=SJ18>

Exposure is primarily driven by the combination of tidal water levels and wave conditions predominantly generated by winds blowing across the Irish Sea and Liverpool Bay.

Predicted (normal) tidal levels applying at the site are reproduced in Table 1 below. These values are levels that will apply due to the normal movements of the tides without any external environmental influences and are based on predictions provided by the UK Hydrographic Office.

Table 1: Predicted Tidal Levels (Hilbre Island)	
Tidal Contour	Level (m ODN)
Highest Astronomical Tide (HAT)	5.27
Mean High Water Spring Tide (MHWST)	4.07
Mean High Water Neap Tide (MHWNT)	2.27
Mean Tide Level (MTL)	0.22
Mean Low Water Neap Tide (MLWNT)	-1.83
Mean Low Water Spring Tide (MLWST)	-3.63
Lowest Astronomical Tide (HAT)	-4.60
Chart datum to Ordnance datum factor	-4.93

The above predicted tidal levels do not however account for changes in atmospheric conditions e.g. air pressure which can lower or increase the level of the tide (surges), or persistent wind conditions that can generate wind-driven currents and set-up water levels.

Storm surges in the Irish Sea are dominated by external forcing from outside the region. The largest surges are generated by depressions travelling from the south and south west at speeds of around 75km/hour (Halcrow, 2008).

Estimates of extreme water levels that will apply less frequently can be made based on available records and numerical modelling. The EA/DEFRA funded R&D project (SC060064) entitled "Coastal Flood Boundaries" (formerly "Development & Dissemination of Information on Coastal and Estuary Extremes"), was completed in 2011 and provides the most up to date and consistent set of extreme sea levels for the coastline of England and Wales. Estimates in the vicinity of Hilbre are shown in Table 2 below.

Table 2: Estimated Extreme Tidal Levels for location off Hilbre Island (ex Coastal Flood Boundaries Study published 2011) ³									
Return Period (Annual Probability of Exceedance)	1 (>99.9%)	5 (20%)	10 (10%)	20 (5%)	50 (2%)	100 (1%)	200 (0.5%)	500 (0.2%)	1000 (0.1%)
Level	5.28	5.52	5.62	5.72	5.84	5.94	6.03	6.16	6.25
Confidence Limits (m)	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3

¹ Values provided by this study (base year 2008) can be considered accurate to one decimal place

In addition it should be noted that present climate change predictions all identify that sea levels will rise over the next century, with the rate of rise a matter of debate and uncertainty. Predictions for the increase in sea level vary and are dependent on a number of factors, specifically CO₂ emissions. The latest available climate change guidance (UKCIP, 2009) provides revised predictions for the rise in relative sea level (sea level + land changes) for the whole of the UK coastline. The figures for the part of the Dee Estuary that includes Hilbre Island are provided in Table 3 below for different dates in the future and different predicted CO₂ emission scenarios.

³ Environment Agency, February 2011b. Coastal flood boundary conditions for UK mainland and islands. Project: SC060064/TR4: Practical guidance design sea levels

Table 3: Estimated Relative Sea Level Rise during the 21st Century (mm) [ex UKCIP, 2009]			
CO2 Emission Scenario	Year		
	2036	2066	2116
5%ile			
Low	33	76	163
Medium	36	84	177
High	42	96	207
50%ile			
Low	74	172	374
Medium	90	210	337
High	110	256	560
95%ile			
Low	115	269	586
Medium	144	337	735
High	178	416	910
Note: The above UKCIP figures are relative to a base date of 2008 used in the most recent extreme level predictions (ref Table 2). The figures highlighted in green are those recommended to be used in FCERM appraisal by the latest EA guidance ⁴			

Generally, apart from the defences in the most exposed section, the NW corner, exposure of the sections of artificial defences is predominantly driven by extreme water levels in combination with extreme waves.

There are no current measurements of waves in the vicinity of Hilbre Island. The Cell 11 Joint Tide and Wave Probability Study completed by Halcrow in 2012, provides numerically modelled estimates of extreme wave heights offshore of the mouth of the River Dee, as shown in Table 4 below.

Table 4: Estimated of Marginal Extreme Wave Heights for location off the mouth of the Dee Estuary (ex Cell 11 Joint Probability Study, published 2012)⁵								
Return Period (Annual Probability of Exceedance)	0.5 (200%)	1 (>99.9%)	5 (20%)	10 (10%)	20 (5%)	50 (2%)	100 (1%)	200 (0.5%)
Significant Wave Height (m)	3.14	3.39	3.92	4.14	4.36	4.64	4.86	5.07

From 2005 to mid 2007 the Liverpool Bay Coastal Observatory operated a wave buoy in the Hilbre Channel (grid reference 317850E, 389211N) approximately 1 km NNW off the north end of Hilbre Island. Analysis of this data⁶ identified the following:

- For approximately 90% of the time recorded wave heights were less than 1 metre in height;
- Less than 0.5% of waves are in excess of 2.0 metres in height; and
- Approximately 60% of waves are from directions 270-360° WCB.

This shows the effect the sand banks at the mouth of the estuary have in limiting the height of waves entering the estuary.

⁴ Environment Agency, 2016. Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities.

⁵ Halcrow, January 2012. North West England and North Wales Shoreline Management Plan SMP2 Supporting Studies. Joint Probability Study. Extreme wave heights and JOIN-SEA results.

⁶ Coastal Engineering UK Ltd, April 2008. Flintshire County Council – Annual Local Monitoring Report 2006.

5. **REPORTING**

The inspection has recorded the conditions and defences in seven discrete areas around the island, as listed below and shown on Figure 5.1 below:

1. East Side: Buoy Keeper's House Access Steps to Lifeboat Station;
2. North End: Around Lifeboat Station;
3. North West Corner: North of Access Steps;
4. West Side: South of Access Steps;
5. West Side: South End Access Ramp;
6. South End; and:
7. East Side: South of Buoy Master's House.

The report of the inspection is provided below within a standard inspection record proforma that has been developed by and used by CEUK for use in defence inspections elsewhere in the UK. The proforma used to record the inspection provides the following:

- Summary information relating to location, structure type, exposure conditions for each defence length;
- An assessment of the condition of each element of each structure, in accordance with the Environment Agency's (EA) Condition Assessment Manual (ref Appendix I) ;
- An assessment of the residual life expectancy of the structure, assuming that the structure continues to be maintained in accordance with good practice;
- Assessment of the overall level of flood and coastal erosion risk (FCER) in relation to the section of frontage, the condition of structure(s) in each frontage and what they are protecting (ref Appendix II)
- Description of the defences and observations with regard to the exposure and their condition;
- Definition and assessment of the specific risks associated with each section (see below);
- Location details of and copies of the photographs recorded; and
- Discussion on the future management requirements.

The individual record sheets identify what the specific risks are in each section of the frontage and each risk is assessed on its magnitude of probability, consequence and overall risk rating below, which in turn informs what action is required to mitigate the risk, based on the scoring system identified below.

Rating for Likelihood (Probability) and Consequence for each risk					
L	Rated as Low		E	Rated as Extreme (Used for Consequence only)	
M	Rated as Medium		NA	Not Assessed	
H	Rated as High				
Grade: Combined effect of Likelihood/Seriousness					
	Consequence				
Likelihood		low	medium	high	EXTREME
	low	N	D	C	A
	medium	D	C	B	A
	high	C	B	A	A
Recommended actions for grades of risk					
Grade	Risk mitigation actions				
A	Mitigation actions, to reduce the likelihood and consequences, to be identified and implemented immediately.				
B	Mitigation actions, to reduce the likelihood and consequences, to be identified and appropriate actions implemented as soon as possible.				
C	Mitigation actions, to reduce the likelihood and consequences, to be identified and costed, if appropriate, for possible action if required.				
D	To be noted - no action is needed unless grading increases over time.				
N	No action at present.				



Figure 5.1 – Hilbre Inspection Sections – July 2016

HILBRE ISLAND –DEFENCE INSPECTION SHEET JULY 2016**5.1 EAST SIDE: BUOY KEEPER'S HOUSE ACCESS STEPS TO LIFEBOAT STATION****Survey Details**

Date: 28th July 2016
Time: 10:20-11:05
Inspector: AJW
Low water time: 13.00 hours BST (Hilbre)
Low water height: -2.4m (OD) Newlyn
Weather conditions: Overcast with showers later. Wind W-SW Force 3-5.

Start Coordinate:	318515E 387995N	Finish Coordinate:	318380E 388220N
Length:	260 metres	Responsibility:	Wirral Council
CPSE Defence Length Ref:	No Ref.	NFCDD/EA Asset Ref:	No Ref
SMP2 Policy Unit:	11e/PU2.3		

HAT Level:	5.3m ODN	Exposure:	Medium
Defence Crest Level:	Varies m ODN	Beach Stability:	Stable
Est. Foreshore Toe Level:	4.0-5.0m ODN	Foreshore Dependency:	Medium
Action Beach Level:	NA	Relative Foreshore Level:	No data

Beach Type: Upper rock outcrop interspersed with sand and shingle. Lower sand and mud.

Defence Type: Revetment/Vertical wall

Defence Material: Masonry sandstone blocks

Design Standard: Unknown, variable

NFCDD Element and Survey Data (ref Appendix I)

Element	Type	Sub-type	Material	Revetment	Slope	Width	Condition	Weighting
1	CS	Foreshore	Sand/mud	-	-	-	-	-
2	CS	Foreshore	Bedrock	-	-	-	3	2
3	FI	Defence	Masonry	-	0.05	-	3	6
Residual life		20-50	Urgency	Routine	Overall Defence Condition			3
					Data Quality			1

Overall Structure Condition (Con)

1 Very Good	2 Good	3 Fair	4 Poor	5 V Poor/Failed
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FCERM OVERALL RISK ASSESSMENT (REF Appendix II)

Score: 24 **Assessment Rating: Medium**

DESCRIPTION/OBSERVATIONS

Apart from a short section immediately north of the access steps to the buoy keeper's house, which is a stepped wall construction built in front of the cliff (plates 18, 19, 22, 23) the remaining sections are intermittent infills of sandstone blocks between or underneath eroded sections of natural cliff (plates 24-27, 31-32, 36-38) above which are located some of the former working properties on the island (the buoy keepers house, telegraph keeper's cottage etc).

At the northern end of the section (plates 39-45) where the sandstone rises to a plateau behind the old lifeboat station, similar infills have been constructed but at a higher elevation.

Sandstone block boundary walls have been constructed along the crest of the cliff fronting the main properties (plates 27-30) but these serve no coastal defence/erosion protection purpose).

The properties were built in the mid 19th century so it is reasonable to assume that the wall sections were presumably built after the properties to stabilise sections of cliff where there was variable resistance to erosion/weathering and in order to prevent the land above from collapsing along with the properties. The infills at the northern end do not protect any property but may have been carried out to ensure access to the lifeboat station could be maintained.

There are no details of the actual construction and it is not clear what the foundation arrangements of the stepped section but it would be assumed that it is founded on the underlying bedrock, as are the infill sections.

Each of the major sections of wall/infill have deliberately missing blocks (plates 22, 26, 31, 37, 39), presumably to relieve ground water pressure build up behind the wall sections, although this was not clear from inspection. The one in the stepped wall (plate 22) originally was covered by a grillage, presumably due to its lower elevation, to prevent beach material becoming lodged in it and sealing it up. This grill has been damaged and broken off.

This section of frontage is sheltered from the predominant offshore wind and wave conditions and accordingly exposure conditions are less severe than across the northern end and NW corner of the island. Generally the walls here are in reasonable condition for their age and apart from some rounding/weathering of edges on the blocks on the stepped section and missing pointing (e.g. plate 19) showing only minimal deterioration.

There are two areas of damaged blockwork at the northern end (plates 42 and 45).

RISK DEFINITION

The primary risks and potential consequences associated with this section of the defences are shown below

Description of Risk (including any identified 'triggers')	Impact (Identify consequences)	Assessment of Likelihood	Assessment of Consequence	Risk Grade (combined Likelihood and Seriousness)	Suggested Risk Mitigation Actions (Preventative or Contingency)
Failure of blockwork with risk of cliff falls	Death or injury to people walking on beach	L	H	B	Carry out remedial repairs to defences, as necessary and on-going watching brief
Erosion of cliff	Loss of land and eventually heritage property along the cliff top.	L	M	D	Carry out watching brief

PHOTOGRAPHS JULY 2016

Way-point	Location	Easting	Northing	Photo Nos. HI_160728_***)	
HI01	Steps adjacent to Buoy Keeper's House	318516	387995	016-021	
HI02	N End of immediate protection around Buoy Keeper's House	318509	388019	022, 023	
HI03	Below Properties 1	318511	388034	024-030	
HI04	Below Ranger's Building	318479	388061	031-033	
HI05	Below final property	318469	388093	036-037	
HI06	Between final building and rock outcrop	318471	388115	038	
HI07	North end rock outcrop 1	318424	388172	039-042	
HI08	North end rock outcrop 2	318412	388183	043-044	056
HI09	South of lifeboat station	318392	388212	045	



Frame HI_190728_016



Frame HI_190728_017



Frame HI_190728_018



Frame HI_190728_019



Frame HI_190728_020



Frame HI_190728_021



Frame HI_190728_022



Frame HI_190728_023



Frame HI_190728_024



Frame HI_190728_025



Frame HI_190728_026



Frame HI_190728_027



Frame HI_190728_028



Frame HI_190728_029



Frame HI_190728_030



Frame HI_190728_031



Frame HI_190728_032



Frame HI_190728_033



Frame HI_190728_036



Frame HI_190728_037



Frame HI_190728_038



Frame HI_190728_039



Frame HI_190728_040



Frame HI_190728_041



Frame HI_190728_042



Frame HI_190728_043



Frame HI_190728_044



Frame HI_190728_045



Frame HI_190728_056

DISCUSSION/MANAGEMENT OPTIONS

There is little need for major attention across this section with a continued watching brief required and some local replacement of missing blocks and/or re-pointing.

This work could be carried out either using a local contractor or alternatively using volunteer workforce, as has been utilised previously.

The primary constraints associated with remedial works in this section are:

- Tidal working;
- Working in an environmentally sensitive area;
- Access for plant and materials;
- Sources of suitable material;
- Costs.

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HILBRE ISLAND –DEFENCE INSPECTION SHEET JULY 2016**5.2 NORTH END: AROUND LIFEBOAT STATION****Survey Details**

Date: 28th July 2016
Time: 10:20-11:05
Inspector: AJW
Low water time: 13.00 hours BST (Hilbre)
Low water height: -2.4m (OD) Newlyn
Weather conditions: Overcast with showers later. Wind W-SW Force 3-5.

Start Coordinate:	318380E 388220N	Finish Coordinate:	318360E 388200N
Length:	30 metres	Responsibility:	Wirral Council
CPSE Defence Length Ref:	No Ref.	NFCDD/EA Asset Ref:	No Ref
SMP2 Policy Unit:	11e/PU2.3		

HAT Level:	5.3m ODN	Exposure:	High
Defence Crest Level:	Varies m ODN	Beach Stability:	Stable
Est. Foreshore Toe Level:	4.0-6.0m ODN	Foreshore Dependency:	Medium
Action Beach Level:	NA	Relative Foreshore Level:	No data

Beach Type: Upper rock outcrop with lower sand beach.
Defence Type: Vertical wall infills. Sandstone block slipway
Defence Material: Masonry sandstone blocks, spray concrete
Design Standard: Unknown, variable

NFCDD Element and Survey Data (ref Appendix I)

Element	Type	Sub-type	Material	Revetment	Slope	Width	Condition	Weighting
1	CS	Foreshore	Sand	-	-	-	-	-
2	CS	Foreshore	Bedrock	-	-	-	3	2
3	FI	Defence	Masonry	-	0.05	-	3	6
Residual life		20-50	Urgency	Routine	Overall Condition			3
					Data Quality			1

Overall Structure Condition (Con)

1 Very Good	2 Good	3 Fair	4 Poor	5 V Poor/Failed
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FCERM OVERALL RISK ASSESSMENT (REF Appendix II)

Score: 18 **Assessment Rating: Low**

DESCRIPTION/OBSERVATIONS

Although this section is directly exposed to the predominant wind and waves from offshore there are only a couple of sections of concrete infill – on either side of the lifeboat station (plates 46 and 55).

There is some local damage to the blockwork infill on the east side of the lifeboat ramp (highlighted on plate 46 below). The infill on the west side is in reasonable condition with perhaps only a little pointing required.

The lifeboat station walls are in good condition (plates 47 and 48) but upper sections of blocks of the ramp have been removed, requiring the exposed edges to be sealed with spray concrete although there are some exposed blocks to the edge which are more vulnerable to wash out from future tide and wave conditions (plate 49). The blocks that have been removed have been re-distributed over the rock outcrop on the east side of the slipway (see plate 44 in previous section 4.1).

The concrete bridge over the old tide gauge siphon cut (plate 52), installed in 1908, appears to have been

overlaid with concrete at some point in the past but is in acceptable condition and does not require action at present.

RISK DEFINITION

The primary risks and potential consequences associated with this section of the defences are shown below

Description of Risk (including any identified 'triggers')	Impact (Identify consequences)	Assessment of Likelihood	Assessment of Consequence	Risk Grade (combined Likelihood and Seriousness)	Suggested Risk Mitigation Actions (Preventative or Contingency)
Risk of cliff falls	Death or injury to people;	L	H	C	Repair as necessary and on-going watching brief
Risks associated with access over the damaged slipway and areas of algal growth.	Falls and Injury	L	H	C	Repair, maintain as necessary and on-going watching brief

PHOTOGRAPHS JULY 2016

Way-point	Location	Easting	Northing	Photo Nos. HI_160728_***)	
HI10	Lifeboat Station	318381	388245	046-052	055



Frame HI_190728_046



Frame HI_190728_047



Frame HI_190728_048



Frame HI_190728_049



Frame HI_190728_050



Frame HI_190728_051



Frame HI_190728_052



Frame HI_190728_055

DISCUSSION/MANAGEMENT OPTIONS

Generally there is little need for attention across this section, although the following would be recommended:

- Repairing the damaged section of infill wall on the east side (ref plate 46); and
- Sealing the exposed edges of the lifeboat slipway (ref plate 49). This is not essential but, if left unchecked, would lead to undermining of the walls to the lifeboat station/bird hide eventually.

Pointing of the wall infill on the west side (plate 55) is also not essential at the present time. Access to this ledge would have to be effected from above using suitable rock climbing equipment.

The primary risk to public safety is slipping on algal growth on the sandstone. The bridge over the siphon cut requires specific monitoring in this respect.

The primary constraints associated with remedial works in this section are:

- Tidal working;
- Working in an environmentally sensitive area;
- Access for plant and materials;
- Costs.

HILBRE ISLAND –DEFENCE INSPECTION SHEET JULY 2016**5.3 NORTH WEST CORNER: NORTH OF ACCESS STEPS****Survey Details**

Date: 28th July 2016
Time: 10:20-11:05
Inspector: AJW
Low water time: 13.00 hours BST (Hilbre)
Low water height: -2.4m (OD) Newlyn
Weather conditions: Overcast with showers later. Wind W-SW Force 3-5.

Start Coordinate:	318360E 388200N	Finish Coordinate:	318390E 388030N
Length:	175 metres	Responsibility:	Wirral Council
CPSE Defence Length Ref:	No Ref.	NFCDD/EA Asset Ref:	No Ref
SMP2 Policy Unit:	11e/PU2.3		

HAT Level:	5.3m ODN	Exposure:	High
Defence Crest Level:	Varies m ODN	Beach Stability:	Stable
Est. Foreshore Toe Level:	1.0-5.0m ODN	Foreshore Dependency:	High
Action Beach Level:	No data	Relative Foreshore Level:	No data

Beach Type: Sand, shingle, cobble and boulders with sandstone outcrop on upper beach at south end

Defence Type: Vertical infill wall

Defence Material: Masonry sandstone blocks

Design Standard: Unknown, variable

NFCDD Element and Survey Data (ref Appendix I)

Element	Type	Sub-type	Material	Revetment	Slope	Width	Condition	Weighting
1	CS	Foreshore	Sand/shingle	-	-	-	-	-
2	CS	Foreshore	Bedrock	-	-	-	3	2
3	FI	Defence	Masonry	-	0.05	-	3-4	6
Residual life		<10	Urgency	Routine	Overall Defence Condition			3-4
					Data Quality			1

Overall Structure Condition (Con)

1 Very Good	2 Good	3 Fair	4 Poor	5 V Poor/Failed
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FCERM OVERALL RISK ASSESSMENT (REF Appendix II)

Score: 18-36 **Assessment Rating: Medium**

DESCRIPTION/OBSERVATIONS

This section covers the exposed NW corner of the island from the north end to the access steps on the west side.

There are no structures built into the sandstone over the first 50 metres moving southerly along the frontage from the north end, with the sandstone cliffs of the order of 10 metres in height, abutting a mixed sediment beach comprising sand, shingle, cobbles and boulders (plate 60). Over the majority of the remaining section of frontage vertical sections of sandstone wall infill have been constructed between the lower and upper sections of exposed bedrock (plates 57-59 and 61-76). At the southern end of the frontage rock begins to outcrop in front of the cliff (ref plates 72, 73 and 76). The beach level rises in front of the cliffs moving southwards from approximately 1.0m ODN at the northern end of the infill (point HI12) to above 5.0m ODN where the rock starts to outcrop (adjacent to HI14). With the beach comprising mobile sediments beach levels along the toe of the cliff will fluctuate. At the southern end the rock outcrop has an elevation of 7-8 metres ODN.

The nature of the bedrock both below and above the blockwork appears to be variable with some sections founded on what appears to be more resistant rock (e.g. plate 73) and other areas where the rock appears to be potentially more prone to gradual erosion (e.g. plate 71). The rock above the blockwork looks weathered.

The whole of this section apart from the most southerly section is exposed to regular wave and tide action, with the degree of exposure decreasing moving southerly as beach levels rise. At the southern end the upper cliff will only be exposed during combinations of extreme tide levels and wave conditions.

Generally across the majority of this section the wall sections are in reasonable condition for their age with only minimal rounding/weathering of individual blocks visible. This is primarily due to the orientation of the walls being mostly obliquely orientated to the predominant waves such that wave impacts are generally not "head-on".

The exception to this is the section at the promontory at HI13 where the cliff receives direct incident wave impacts. The result of this has been damage and failure of a section of infill behind which a cavern under the cliff has opened up as material behind has been drawn out by tide and wave action (Plates 64-70). The cavern is approximately 4 metres wide at the entrance x 2-2.5 metres high and extends approximately 10 metres from the line of the original infill. The short section of infill to the right of the cavern up to the CoD in the cliff is looking distressed with some blocks having been peeled away from the cliff behind (ref plates 64-66, 72).

The failure of the wall section has taken place in the past ten years. Photos from inspections in 2000 and 2005 (ref Appendix III) indicate the section to be intact at those times. The historical and contemporary photos (particularly plates 57, 61 & 64) show that the promontory adjacent to the cavern appears to be supporting a piece of rock cliff that is separate to the main cliff with a clear fault line between the two (as shown on plate 57 below). Reference to recent (2015) oblique aerial photographs (Appendix IV) suggests that the walls were constructed to prevent undercutting continuing. The cavern that has been created following the failure of the section of wall appears to be partially undercutting the main cliff and partially the outer piece primarily under the main cliff. If the wall fails at the corner and the rock above shears away from the main rock cliff, it will likely compromise the integrity of all the masonry infill to the south, destabilising the main cliff across this section.

This section of wall also has deliberately missing blocks as observed on sections on the east side of the island (which can be seen in plates 68, 71 and 74). As identified previously they are presumably to relieve ground water pressure build up behind the wall sections, although this was not clear from inspection.

At the southern end there is evidence of tide and wave waters reaching the toe of the upper cliff, where edge protection to the steps has been constructed (plate 77).

RISK DEFINITION

The primary risks and potential consequences associated with this section of the defences are shown below

Description of Risk (including any identified 'triggers')	Impact (Identify consequences)	Assessment of Likelihood	Assessment of Consequence	Risk Grade (combined Likelihood and Seriousness)	Suggested Risk Mitigation Actions (Preventative or Contingency)
Risk of defence failure spreading	Cliff integrity potentially compromised	M	H	B	Erect warning signs and/or barriers as necessary Repair as necessary and on-going watching brief
Risks of cliff failure due to on-going undermining/defence failure	Potential injury to people or death	M	H	B	
Risk of material falling from cliffs onto beach	Potential injury to people or death	L	H	C	Erect warning signs and/or barriers as necessary
Erosion of cliff top	Loss of land	L	M	C	

PHOTOGRAPHS JULY 2016

Way-point	Location	Easting	Northing	Photo Nos. HI 160728_***)	
HI11	Above NW corner defences	318391	388142	057-059	
HI12	North end of NW corner defences	318379	388153	060-063	
HI13	Adjacent cavern behind NW corner defences	318389	388114	064-072	
HI14	South end of NW corner defences	318382	388079	073-075	
HI15	N side of Access Steps	318385	388048	076-077	
HI16	Stepped Access	318389	388033	079	

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Frame HI_190728_071



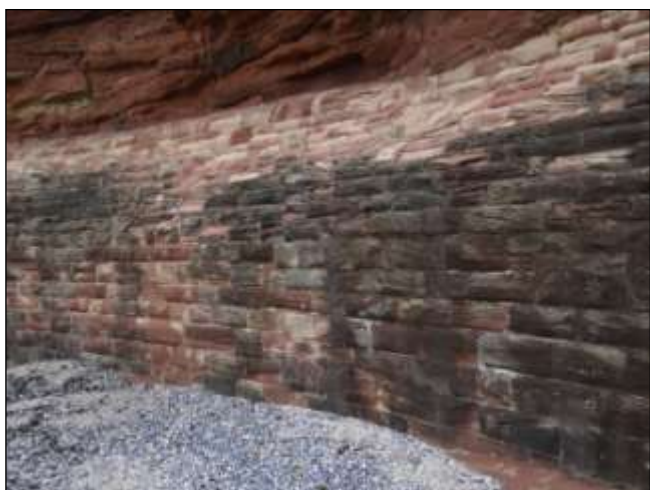
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DISCUSSION/MANAGEMENT OPTIONS

Over the majority of its length the wall infills are not in need of any attention but a watching brief is suggested to check for defects.

The failed section however needs some attention as it is likely that eventually if it is left unchecked that there could be a significant failure of the outer section of cliff which would compromise the infill section of walling to the south. It is not possible to put an exact timescale on this, as it is dependant on a number of criteria, particularly:

- Frequency of future environmental and climatic conditions. The current beach level directly in front of the cavern is between 2 and 3m ODN, which suggests that the majority of high water conditions will reach it. With coincident wave action the potential for on-going scour and weathering of the rocks increases;
- The integrity of the under and overlying rock formation. Visual evidence suggests that there are fault lines in the cliffs and the risk of falls or shear of over the outer section increases as the cavern increases in size.

There is no property or infrastructure at risk however the risk of cliff falls/collapse provides a danger to visitors to Hilbre either walking the cliff top or walking on the beach. Failure could occur suddenly and without warning at any time during a storm or when the tide is out.

The following management options could be considered:

- Do Nothing but allow the defences to continue to deteriorate and leave the cliffs to function naturally thereafter;
- Provide warning signs along the cliff top (minimum option);
- Provide barriers along the cliff top to keep the public away from the danger area;
- Filling and sealing the cavern; or
- If greater budgets are available imported rock could be used to provide a buttress/revetment directly in front of the cliff to provide long term protection.

In addition if major repair works (4th and 5th bullet points) are undertaken then the opportunity should be taken to repair any joints or replace any missing pointing to areas of infill blockwork.

As a minimum, in the short term at least, it would be suggested that visitors should be warned of the potential dangers through appropriate signing and potentially a barrier to keep them away from the cliff edge.

The primary constraints associated with remedial works in this section are:

- Tidal working;
- Working in an environmentally sensitive area;
- Access for plant and materials;
- Sources of suitable material;
- Costs.

These options are discussed further in Section 6.

HILBRE ISLAND –DEFENCE INSPECTION SHEET JULY 2016**5.4 WEST SIDE: SOUTH OF ACCESS STEPS****Survey Details**

Date: 28th July 2016
Time: 10:20-11:05
Inspector: AJW
Low water time: 13.00 hours BST (Hilbre)
Low water height: -2.4m (OD) Newlyn
Weather conditions: Overcast with showers later. Wind W-SW Force 3-5.

Start Coordinate:	318390E 388030N	Finish Coordinate:	318510E 387820N
Length:	250 metres	Responsibility:	Wirral Council
CPSE Defence Length Ref:	No Ref.	NFCDD/EA Asset Ref:	No Ref
SMP2 Policy Unit:	11e/PU2.3		

HAT Level:	5.3m ODN	Exposure:	High
Defence Crest Level:	9 m ODN	Beach Stability:	Stable
Est. Foreshore Toe Level:	1.0-2.0m ODN	Foreshore Dependency:	Medium
Action Beach Level:	No data	Relative Foreshore Level:	No data

Beach Type:	Upper rock outcrop with lower mixed bedrock and boulder bed
Defence Type:	Revetment/Vertical wall
Defence Material:	Masonry sandstone blocks
Design Standard:	Unknown, variable

NFCDD Element and Survey Data (ref Appendix I)

Element	Type	Sub-type	Material	Revetment	Slope	Width	Condition	Weighting
1	CS	Foreshore	Boulders	-	-	-	-	-
2	CS	Foreshore	Bedrock	-	-	-	3	2
3	FI	Defence	Masonry	-	0.05	-	3	6
Residual life		20-50	Urgency	Routine	Overall Condition			3
					Data Quality			1

Overall Structure Condition (Con)

1 Very Good	2 Good	3 Fair	4 Poor	5 V Poor/Failed
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FCERM OVERALL RISK ASSESSMENT (REF Appendix II)

Score: 12	Assessment Rating: Low
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DESCRIPTION/OBSERVATIONS

Rock outcrops along all this length of frontage with a visible cliff top at about 9-10m ODN and an interface to the mixed bedrock and boulder beach at about 1-2m ODN. Accordingly the cliff toe is subject to repeated tide and wave action that has been shaped by natural forces to an irregular sculptured alignment. Above the rock outcrop the bedrock is overlain with a mixture of sands and gravels and this cliff face is vegetated along the length.

The interface between the visible outcropping cliff and the vegetated upper slope is subject to erosion, probably from a combination of overtopping spray during storm conditions and surface water run off from the cliff face above. To combat this dwarf masonry walls have been intermittently constructed along sections.

These walls have been constructed by volunteers and where done so have been effective in combating the erosion of the vegetated slope (e.g. plate 82). This is an on-going requirement and there are areas that require similar attention (e.g. plate 84). These walls provide no formal defence function.

RISK DEFINITION

The primary risks and potential consequences associated with this section of the defences are shown below

Description of Risk (including any identified 'triggers')	Impact (Identify consequences)	Assessment of Likelihood	Assessment of Consequence	Risk Grade (combined Likelihood and Seriousness)	Suggested Risk Mitigation Actions (Preventative or Contingency)
Risk of upper cliff slippage	Loss of land along the cliff top	L	L	N	On-going watching brief. Extend dwarf walls as funds permit
Risk of cliff falls along the beach	Danger to public but the beach area is not conducive to access	L	L	N	On-going watching brief.

PHOTOGRAPHS JULY 2016

Way-point	Location	Easting	Northing	Photo Nos. HI_160728_***)	
HI16	Stepped Access	318389	388033	078	080, 081
HI17	West Side South Of Steps 1	318043	387989	082, 083	
HI18	West Side South Of Steps 2	318431	387938	084-087	
HI19	West Side South Of Steps 3	318454	387904	088-089	
HI20	West Side South Of Steps 4	318487	387869	090-091	
HI21	West Side South Of Steps 5	318512	387818	092-096	



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DISCUSSION/MANAGEMENT OPTIONS

Continuation of the present arrangements of providing dwarf walls to the interface between the vegetated cliff and outcropping sandstone is the only requirement for this frontage, alongside a watching brief.

It is understood that this work has been carried out by a volunteer workforce, which would appear to be best way to proceed in the future.

The primary constraints associated with remedial works in this section are:

- Access for plant and materials;
- Working in an environmentally sensitive area;
- Sources of suitable material;
- Costs.

HILBRE ISLAND –DEFENCE INSPECTION SHEET JULY 2016**5.5 WEST SIDE: SOUTH END ACCESS RAMP****Survey Details**

Date: 28th July 2016
Time: 10:20-11:05
Inspector: AJW
Low water time: 13.00 hours BST (Hilbre)
Low water height: -2.4m (OD) Newlyn
Weather conditions: Overcast with showers later. Wind W-SW Force 3-5.

Start Coordinate:	318560E 387810N	Finish Coordinate:	318620E 387740N
Length:	95 metres	Responsibility:	Wirral Council
CPSE Defence Length Ref:	No Ref.	NFCDD/EA Asset Ref:	No Ref
SMP2 Policy Unit:	11e/PU2.3		

HAT Level:	5.3m ODN	Exposure:	Low
Defence Crest Level:	Varies m ODN	Beach Stability:	Stable
Est. Foreshore Toe Level:	5.0-6.0m ODN	Foreshore Dependency:	Medium
Action Beach Level:	No data	Relative Foreshore Level:	No data

Beach Type:	Upper rock outcrop with lower mixed bedrock and boulder bed
Defence Type:	Vertical wall and infills
Defence Material:	Masonry sandstone blocks
Design Standard:	Unknown, variable

NFCDD Element and Survey Data (ref Appendix I)

Element	Type	Sub-type	Material	Revetment	Slope	Width	Condition	Weighting
1	CS	Foreshore	Sand/mud	-	-	-	-	-
2	CS	Foreshore	Bedrock	-	-	-	3	2
3	FI	Defence	Masonry	-	0.05	-	3	6
Residual life		20-50	Urgency	Routine	Overall Structure Condition			3
					Data Quality			1

Overall Structure Condition (Con)

1 Very Good	2 Good	3 Fair	4 Poor	5 V Poor/Failed
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FCERM OVERALL RISK ASSESSMENT (REF Appendix II)

Score: 12	Assessment Rating: Low
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DESCRIPTION/OBSERVATIONS

The structures have been built as retaining walls to the edge of the sloping access ramp (plates 97, 98) and to infill sections of undercut cliff on the approaches to the ramp (plates 100, 101). The level in front of the exposed sandstone on the approaches rises from approaches rises from about 5m ODN to 6m ODN at the base of the concrete surfaced ramp. At the top of the ramp the level is about 10.0m ODN.

The section is protected from direct wave action but where the sandstone has not been infilled it is prone to sudden failure (see plate 102).

The retaining wall to the ramp is of open jointed construction with different materials having been used at different times – sandstone and what appear to be, presumably imported, limestone blocks. The LNR management plan identifies the wall as being originally constructed in 1897 but it has presumably been reconstructed/added to since that time.

Overall the structures are in fair condition being sheltered from predominant wave attack and mainly subject only to extreme water levels.

RISK DEFINITION

The primary risks and potential consequences associated with this section of the defences are shown below

Description of Risk (including any identified 'triggers')	Impact (Identify consequences)	Assessment of Likelihood	Assessment of Consequence	Risk Grade (combined Likelihood and Seriousness)	Suggested Risk Mitigation Actions (Preventative or Contingency)
Risk of cliff slippage and slumping	Failure to the retaining wall - blockage of the only vehicular access to the island and potential for injury to pedestrians if sudden collapse occurred	L	M	D	On-going watching brief. Remedial works to wall as necessary.
	Potential for injury to pedestrians if sudden collapse occurred	L	H	C	

PHOTOGRAPHS JULY 2016

Way-point	Location	Easting	Northing	Photo Nos. HI_160728_***)	
HI22	Steps adjacent to Buoy Keeper's House	318558	387810	097	
HI23	N End of immediate protection around Buoy Keeper's House	318581	387770	098-100	
HI24	Below Properties 1	318604	387752	101, 102	



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Frame HI_190728_100



Frame HI_190728_101



Frame HI_190728_102

DISCUSSION/MANAGEMENT OPTIONS

A watching brief and remedial attention to the wall, as necessary, is recommended for this section.

The primary constraints associated with remedial works in this section are:

- Access for plant and materials;
- Working in an environmentally sensitive area;
- Sources of suitable material;
- Costs.

HILBRE ISLAND –DEFENCE INSPECTION SHEET JULY 2016**5.6 SOUTH END****Survey Details**

Date: 28th July 2016
Time: 10:20-11:05
Inspector: AJW
Low water time: 13.00 hours BST (Hilbre)
Low water height: -2.4m (OD) Newlyn
Weather conditions: Overcast with showers later. Wind W-SW Force 3-5.

Start Coordinate:	318620E 387740N	Finish Coordinate:	318650E 387765N
Length:	40 metres	Responsibility:	Wirral Council
CPSE Defence Length Ref:	No Ref.	NFCDD/EA Asset Ref:	No Ref
SMP2 Policy Unit:	11e/PU2.3		

HAT Level:	5.3m ODN	Exposure:	Low
Defence Crest Level:	Varies m ODN	Beach Stability:	Stable
Est. Foreshore Toe Level:	5.0m ODN	Foreshore Dependency:	Medium
Action Beach Level:	No data	Relative Foreshore Level:	No data

Beach Type: Sand and shingle upper beach with sand/mud lower down.
Defence Type: No defences
Defence Material: Not applicable
Design Standard: Not applicable

NFCDD Element and Survey Data (ref Appendix I)

Element	Type	Sub-type	Material	Revetment	Slope	Width	Condition	Weighting
1	CS	Foreshore	Sand/mud	-	-	-	-	-
2	CS	Foreshore	Bedrock	-	-	-	2	2
Residual life		NA	Urgency	Routine	Overall Condition			2
					Data Quality			1

Overall Structure Condition (Con)


1 Very Good	2 Good	3 Fair	4 Poor	5 V Poor/Failed
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FCERM OVERALL RISK ASSESSMENT (REF Appendix II)

Score: 12 **Assessment Rating: Low**

DESCRIPTION/OBSERVATIONS

The sandstone cliffs are only between 3 and 5 metres in height at this end of the island and there are no artificial defence measures.

RISK DEFINITION					
The primary risks and potential consequences associated with this section of the defences are shown below					
Description of Risk (including any identified 'triggers')	Impact (Identify consequences)	Assessment of Likelihood	Assessment of Consequence	Risk Grade (combined Likelihood and Seriousness)	Suggested Risk Mitigation Actions (Preventative or Contingency)
Cliff slippage and slumping	Potential for injury to pedestrians if sudden collapse occurred	L	M	D	On-going watching brief. Remedial works to wall if problems arise.
PHOTOGRAPHS JULY 2016					
Way-point	Location	Easting	Northing	Photo Nos. HI_160728_***)	
HI25	Off South End	318644	387721	103	
					
Frame HI_190728_103					
DISCUSSION/MANAGEMENT OPTIONS					
No specific management actions – watching brief for changes					

HILBRE ISLAND –DEFENCE INSPECTION SHEET JULY 2016**5.7 EAST SIDE: SOUTH OF BUOY MASTER'S HOUSE****Survey Details**

Date: 28th July 2016
Time: 10:20-11:05
Inspector: AJW
Low water time: 13.00 hours BST (Hilbre)
Low water height: -2.4m (OD) Newlyn
Weather conditions: Overcast with showers later. Wind W-SW Force 3-5.

Start Coordinate:	318650E 387765N	Finish Coordinate:	318515E 387995N
Length:	270 metres	Responsibility:	Wirral Council
CPSE Defence Length Ref:	No Ref.	NFCDD/EA Asset Ref:	No Ref
SMP2 Policy Unit:	11e/PU2.3		

HAT Level:	5.3m ODN	Exposure:	High
Defence Crest Level:	Varies m ODN	Beach Stability:	Stable
Est. Foreshore Toe Level:	4.0-5.0m ODN	Foreshore Dependency:	Medium
Action Beach Level:	No data	Relative Foreshore Level:	No data

Beach Type: Mostly upper rock outcrop interspersed with some sand and shingle. Lower sand and mud.

Defence Type: Vertical wall infills
Defence Material: Masonry sandstone blocks
Design Standard: Unknown, variable

NFCDD Element and Survey Data (ref Appendix I)

Element	Type	Sub-type	Material	Revetment	Slope	Width	Condition	Weighting
1	CS	Foreshore	Sand/mud	-	-	-	-	-
2	CS	Foreshore	Bedrock	-	-	-	2	2
3	FI	Defence	Masonry	-	0.05	-	3	6
Residual life		20-50	Urgency	Routine	Overall Condition			3
					Data Quality			1

Overall Structure Condition (Con)

1 Very Good	2 Good	3 Fair	4 Poor	5 V Poor/Failed
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FCERM OVERALL RISK ASSESSMENT (REF Appendix II)

Score: 18 **Assessment Rating: Low**

DESCRIPTION/OBSERVATIONS

This section is the southern half of the island on its eastern flank. Three out of the original four private properties remain. The cliffs are generally only 3-5 metres in height but locally 5-7 metres at the south end of the frontage, immediately north of the Buoy Keeper's house where there is a local indentation in the shoreline resulting, presumably, from there being in the past more readily erodable material in front of the rock cliffs here.

There are no artificial defence measures in front of the properties (plates 106-110) but there has been some local sandstone block infilling between lower and upper sandstone beds, within the indentation at the southern end (plates 09-15).

The infills, as elsewhere on the island, are mostly in reasonable condition but there are a few sections that would benefit from some remedial attention (ref plates 11-13) where some additional limestone or granite

blocks appear to have been (re)placed at a later date. There is also evidence of some slight groundwater seepage from behind the wall (plate 14).

Exposure conditions are low with only high spring and/or surge tide levels reaching the toe of the defences and little direct wave action affecting the frontage.

RISK DEFINITION

The primary risks and potential consequences associated with this section of the defences are shown below

Description of Risk (including any identified 'triggers')	Impact (Identify consequences)	Assessment of Likelihood	Assessment of Consequence	Risk Grade (combined Likelihood and Seriousness)	Suggested Risk Mitigation Actions (Preventative or Contingency)
Blockwork failure with risk of cliff slippage and slumping	Potential injury to pedestrians walking on the beach if sudden collapse occurred	L	H	C	Remedial works to defects identified. Maintain existing boundary fencing to cliff top area to prevent public access On-going watching brief

PHOTOGRAPHS JULY 2016

Way-point	Location	Easting	Northing	Photo Nos. HI_160728_***)	
HI26	East side - south end	318652	387778	105	
HI27	East side - below 1st property	318605	387860	106, 107	
HI28	East side - below 4th property	318579	387902	108-110	
HI29	Infill south of Buoy Keeper's House	318513	387974	007-014	
HI01	Steps adjacent to Buoy Keeper's House	318516	387995	015	021



Frame HI_190728_105



Frame HI_190728_106



Frame HI_190728_107



Frame HI_190728_108



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Frame HI_190728_110



Frame HI_190728_007



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Frame HI_190728_012



Frame HI_190728_013



Frame HI_190728_014

**Frame HI_190728_015****Frame HI_190728_021****DISCUSSION/MANAGEMENT OPTIONS**

There is a need for remedial attention to the section of wall infill – local re-setting of blocks, re-pointing etc. Also, it would be suggested that the cause of ground water leakage should be investigated. Otherwise an on-going watching brief is recommended.

This work could be carried out either using a local contractor or alternatively using volunteer workforce, as has been utilised previously.

The primary constraints associated with remedial works in this section are:

- Tidal working;
- Working in an environmentally sensitive area;
- Access for plant and materials;
- Sources of suitable material;
- Costs.

6. **MANAGEMENT OVERVIEW**

Current defence arrangements around Hilbre Island have not changed since the end of the 19th/beginning of the 20th century, so the present arrangements have been in service for over 100 years.

It is apparent in the majority of places that where artificial works have been carried out, they appear to have been done so to prevent undercutting of the sandstone cliffs.

The following key points have arisen from the inspection and examination of available data carried out:

- The primary areas of the island where the condition of the defences poses a potential risk, to either existing infrastructure/property or to the wellbeing of people who visit the island, are:
 - The NW Corner of the island (ref section 5.3) where the 19th century blockwork has been breached in the past ten years and if it continues it is likely to lead to progressive on-going damage of the remaining adjacent sections of blockwork and undercutting of sections of the cliff that would, as a result, become exposed behind. The primary risks here are of destabilisation of the cliffs and loss of land on the cliff top and the potential risk to people using this area.
 - The northern half of the east facing side of the island where the defences appear to have been built to provide additional protection to the cliff top properties and, in the vicinity of the Buoy Keeper's House to provide local protection around the access steps. The primary risk is preventing loss of land in front of the properties and the less likely risk of cliff falls onto the foreshore and the risk this poses to people walking along the foreshore;
- Elsewhere there is little major risk around the island from either a coastal defence or public safety position, with the following secondary areas identified as requiring minor attention and/or monitoring:
 - The old lifeboat slipway, which has been damaged and sandstone blocks have been moved over the adjacent foreshore. The edge has been sealed with sprayed concrete but there is evidence of further undermining; and
 - Rock fall adjacent to the vehicular access ramp at the southern end of the island with the potential for blockage of the access; and
 - Stability of stone retaining wall to vehicular access ramp.

6.1 **MANAGEMENT ACTIONS**

Management of Coastal Defence risk is underpinned by the policy laid down in the Shoreline Management Plan (SMP). The present SMP that includes Hilbre Island is the North West England and North Wales SMP⁷, which was adopted by Wirral Council in September 2010. The policy for Hilbre Island (ref Policy Unit 5.11) is to Hold the Line for the next 100 years, "through limited intervention to maintain the integrity of the island". The primary justifications for this policy are that it:

- Maintains the island as a tourist attraction and helps manage health and safety issues due to cliff collapse. Whilst managing the flood risk to the West Kirby frontage;
- Allows a continuation of natural processes where possible, conducive to the SSSI designation and is of strategic importance to coastal and estuary processes at the mouth of the Dee; and
- There is limited erosion risk to properties and assets on the island, but there would be damage to assets at risk along the West Kirby frontage if the island disappears, which is likely to economically justify the costs of limited intervention.

Building on the policy identified in the SMP2, the draft Wirral Coastal Strategy⁸ identified that:

- "the preferred management approach for the Hilbre Islands is one of no intervention (Do-Nothing), unless there are specific requirements to either maintain existing protection to property and/or infrastructure or carry out works that would help maintain the strategic natural defence and shelter that the islands provide";
- "The focus of the management approach in the short term is to carry out such maintenance of existing structures that may be necessary, recognising that this would have to be funded from Council revenue budgets or from other public or private contributions e.g. grants from other sources"; and

⁷ Halcrow, 2010. North West England and North Wales Shoreline Management Plan SMP2.

⁸ AECOM, May 2013. Wirral Coastal Strategy – Main Document.

- “No specific monitoring is currently carried out and there is a need to establish the specific requirements for the islands and develop a mini strategy for their on-going monitoring and management.

In reality it is considered unlikely, even if no intervention was carried out to maintain existing defences, that the island would disappear in the next 100 years.

Notwithstanding this the SMP2 and the subsequent strategy does provide the necessary basis for managed intervention to be carried out.

The inspection has identified a range of actions to be considered for management of the man-made defences around the island, specifically:

1. On-going monitoring;
2. Minor repairs to sandstone blockwork infills/walls (area 1);
3. Repairs in vicinity of the lifeboat slipway (area 2);
4. Continuation of construction of dwarf walls and stone infill at upper cliff/bedrock interface to west side of the island (area 4); and
5. Management of defences to the north west corner of the island (area 3).

6.1.1 Monitoring

Across most of the island there is no need for any action although a watching brief should be carried out to identify if there is any evidence of worsening conditions. This would sensibly take the form of an informal walk over by staff to look for any changes and review conditions against those identified in this inspection. Alternatively this could be formalised with the report provided here updated on a regular basis.

6.1.2 Minor Repair Work

Where there are minor defects in the artificial defences as identified herein these should be rectified. Generally these requirements are to replace missing or damaged sections of blockwork and or re-point areas where pointing is missing.

Blockwork to construct these defences was originally obtained by quarrying sandstone from the outcropping rock platforms around the island. Replacement blockwork could either be obtained from local sources on the mainland or could be recycled from blocks on the foreshore e.g. those dislodged from the old lifeboat slipway. The latter approach would require approval from statutory bodies including the Hilbre Islands Nature Reserve Management Committee but would be a more sustainable approach. The quantity of blocks required is not large, although the blocks required would have to be hewn from the larger blocks on the foreshore.

If sandstone blocks can be recycled then this is primarily a labour operation with the only other materials being a suitable mortar mix for pointing the blockwork.

This work could be carried out by engaging a local contractor or alternatively by using volunteer staff supervised by Wirral Parks & Countryside staff.

6.1.3 Lifeboat Slipway

The underlying blockwork to the damaged slipway that was overlaid with spray concrete in 2004 is exposed along its leading edge (ref photo 049) and the blockwork remains vulnerable to disruption which if left unchecked would lead eventually to the undermining and damage to the remains of the lifeboat station and bird hide.

Remedial attention to seal the exposed edge using the same method would be recommended.

Suitable local Contractors e.g. Gunform of Hoylake (<http://www.gunform.com/>) could carry out this work.

The estimated cost of carrying out the remedial works to the slipway is £3,000.

6.1.4 Dwarf Wall Reconstruction

Erosion of the upper cliff south of the access steps on the west facing side of the island does not present a significant risk. Nevertheless the provision of a wall at the interface of the sandstone and the overburden appears to be aesthetically acceptable and provides a suitable control measure to reduce erosion and slippage of the overlying soils.

Continuation of this practice using volunteer labour, as at present, is recommended.

6.1.5 NW Corner Defences

The condition of the blockwork facing and infills at the NW corner of the island (photos 57-76) is the major issue in respect of management of the artificial defences around the island, both in respect of the scale of works required and the constraints associated with carrying out any remedial works.

It is the constraints imposed on carrying out work, primarily associated with tidal restriction, access arrangements and environmental designations that impose the major hurdles on carrying out on actions in a cost effective manner.

As the inspection identified there is no property at risk in this section of the island and the primary consequences of no further action would be in relation to the potential risk to personal safety (staff and visitors) from cliff falls and associated loss of cliff top land. Accordingly it is worth noting at the outset that under current EA FCERM rules it is unlikely that funding would be available through the Grant in Aid (GiA) mechanism, unless significant environmental benefit could be identified, as no property is at risk.

The damage to the blockwork facing is progressive and will eventually lead to damage/breaching of adjacent sections with the section to the south being the most vulnerable.

There are three potential courses of action available to deal with the breached section

- A. The least cost option of allowing the cliff to deteriorate but managing the risk through the provision of appropriate warning signs to keep the public away from the danger area, as much as possible. If it was felt that additional measures were required then consideration to barriers could be given.

Warning signs need to be clear but not be worded such that they require placing all round the island, as there are dangers of people falling from cliffs at other locations and at present no warning signage is provided. A simple message such as "Local cliff undermining – Keep to the path" would probably be appropriate.

If a barrier were proposed in addition a simple timber post and railing fence would probably be most appropriate.

Suggested positions for signage and barriers are as shown in Figure 6.1 below.

- B. The middle cost option of repairing the defence line. The breach in the defences has caused scour behind and underneath the rock cliff, so any option would need to fill that cavern in before providing protection to the outer face. There are a number of options in this respect, such as:

- Pumping a cementitious based material into the void;
- Filling the cavern with imported or site derived fill material; or
- Filling the cavern with material harvested from the adjacent beach.

Once the cavern has been filled it may, dependant on the fill material used, be necessary to provide a facing to prevent future washout of the fill. Similarly there are a number of ways that this could be achieved i.e.

- Re-build masonry facing;
- Spray concrete facing;
- Use imported rock boulders and suitable geo membrane to provide outer facing; or
- Use boulders/rock from adjacent areas of beach.

In conjunction with the above repairs to the existing sound blockwork and re-pointing should be carried out. This work would due to the working conditions be most appropriately carried out by a specialist contractor.

- C. A highest cost longer term alternative would be to provide a rock armour buttress in directly in front of the cliff to prevent further undercutting along the whole length between points HI12 and HI14 – a distance of approximately 100 metres.

This option would involve importing approximately 3-4,000 tonnes of rock armour. Due to the location the material would have to be imported by barge and offloaded onto the foreshore in front of the works to be re-handled into position by plant due at low tide periods. Suitable material would be sourced from either North Wales – Carboniferous limestone or granite or alternatively from Southern Ireland e.g. Arklow Basalt. The igneous rock is more durable and aesthetically potentially more acceptable being generally darker in colour. Material from North Wales could be loaded onto barges at Port Penrhyn (Bangor) and transported along the North Wales coast to Hilbre. Material from southern Ireland would be transported across the Irish Sea, also on barges.



Figure 6.1 – Potential Signage and Barrier Locations

Approvals

The first constraint on any of the works being carried out is that approvals would be required to complete the works. Primarily the requirements would be to obtain planning permission and a Marine Consents Licence from the Marine Management Organisation (MMO), which is part of the Department for Environment Food and Rural Affairs (DEFRA). This licence is required to deposit materials on the foreshore below Mean High Water Spring Tide (MHWST) level.

Given the raft of environmental designations the minimum requirement would be consent under the Habitats Regulations and the EU Habitats Directive and approval under the Water Environment (Water Framework Directive) (England and Wales) Regulations 2003 (WFD) and request for an environmental screening opinion from Wirral Council Planning Department. Possibly a full Environmental Impact Assessment (EIA) would be

required to support this application, which would be scrutinised to ensure that the proposed works would not have any adverse on the environmental habitats around Hilbre, by Natural England amongst others.

In November 2013, a coastal concordat⁹ was agreed between the Department for Environment, Food and Rural Affairs, the Department for Communities and Local Government, the Department for Transport, the Marine Management Organisation, the Environment Agency, Natural England and the Local Government Association's Coastal Special Interest Group.

The concordat applies to the consenting of coastal developments in England where several bodies have a regulatory function, and is designed to form the basis of agreements between the main regulatory bodies and coastal local planning authorities. It provides a framework within which the separate processes for the consenting of coastal developments in England can be better coordinated.

The concordat is based on five high level principles, as set out below:

1. Applicants seeking regulatory approval should be provided with a single point of entry into the regulatory system for consenting coastal development, guiding them to the organisations responsible for the range of consents, permissions and licences that may be required for their development;
2. Regulators should agree a single lead authority for coordinating the requirements of Environmental Impact Assessment Directive or Habitats Regulations Assessments;
3. Where opportunities for dispensing or deferring regulatory responsibilities are legally possible and appropriate, they should be taken;
4. Where possible, at the pre-application stage, competent authorities and statutory advisors should agree the likely environmental and habitats assessment evidence requirements of all authorities at all stages of the consenting process; and
5. Where possible regulators and statutory advisors should each provide coordinated advice to applicants from across their respective organisations.

It is expected that implementation of the concordat should generate long term efficiency savings for regulators, advisors and applicants. The costs to the applicant are expected to decrease through better working and there should be less time needed for individual discussions with all the bodies concerned. Where an applicant parallel tracks applications, evidence may only need to be produced once, rather than many times, as at present.

In October 2014, an implementation document¹⁰ was provided for staff of the regulatory bodies to use and a list of local authorities who had adopted the concordat. At the present time, Wirral Council has not formally adopted the coastal concordat but may do so in the future.

The requirement for MMO approval could be waived but only if the works to be carried out were deemed to be maintenance of existing defences i.e. they were like for like reinstatement, which would limit the choice of options.

Construction Considerations

Assuming the necessary approvals could be obtained, in considering the merits of the various options identified, the primary constraints on construction are:

- Access restrictions; and
- Tidal working.

⁹ DEFRA, November 2013. A Coastal Concordat for England.

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/256234/coastal-concordat-20131111.pdf

¹⁰ DEFRA, October 2014. A Coastal Concordat for England: Implementation Document.

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/360022/cc-imp-plan-20141001.pdf

Specifically in this location getting plant onto the beach and to the site is a major issue. Access over to the island, whilst time consuming, is relatively straightforward for tracked plant, excavators but more so for wheeled machinery, which may encounter soft spots on the traverse to the island and have to cross areas of outcropping sandstone.

Once at the island access to the higher parts is limited by the width (approx 2.5 metres) of the access road (see plate 97 and 98). Access over the foreshore to the works location has to be either northwards along the west facing coast or alternatively along the eastern side and round the northern end. Both are problematic.

The majority of the foreshore on the west side is a mixture of rock outcrop and boulders and impassable for wheeled traffic, without either a purpose built access road over it, or a pathway being made by movement of boulders. Even access for tracked vehicles would potentially be difficult without these measures. The lower part of the beach is sand (see Appendix IV) which potentially would allow access for plant but this is set at a level of -2.0m ODN which means it only becomes visible during spring tides and then only for at most approximately ± 2 hours either side of low water. Even then there is still a requirement to travel across the rock to reach

Conversely, due to the combination of the topography of the outcropping bedrock at the northern end of the island and the time restrictions imposed by the level and movement of the tidal conditions applying, access around the north end would be virtually impossible (see Figure 4.1).

These restrictions could rule out options that require major plant i.e. importing or re-using rock fill and boulder protection, leaving the most viable option logistically being to fill the cavern by pumping material from above and re-facing with sandstone blocks, either retrieved from the beach nearby (see photo or blocks retrieved from those displaced from the lifeboat slipway, as referenced in 6.1.2 above).

This option would, apart from the fill pumping element, be a highly labour intensive operation at beach level with small plant e.g. compressors, mixers etc located on the cliff top. The primary constraints on the operation are:

- Approval for use of / specification for grout fill to be used in marine environment e.g. fly-ash/cement mix;
- Provision of water to mix with the grout (water would most likely need to be delivered in bowsers as there is no mains water supply on the island;
- Getting the pumping material and fill/grout to a location on the cliff top, from where it can be pumped, given the limited access width of the road to the top of the island.

Estimated Requirements

The following is schedule of the estimated principle materials quantities and budget costs:

A. Provision of warning signs and barriers

2 or 3 signs would be required. If a barrier was provided this would be approximately 100 metres in length. It should be noted that soil cover is shallow and foundations for signs and barriers could require fixing with concrete into holes excavated into the underlying bedrock.

If fixing of the signs and barriers does not require excavation into bedrock then this work could potentially be carried out by volunteer labour, at an estimated cost of the order of £1-2,000. If excavation into bedrock is required then a contractor may need to be employed for all part of the works, which could potentially double the cost.

B. Cavern Fill Option

- Fill material: 50m³ / 100 tonnes
- Sandstone blockwork: 15m² or approx 170 no. 0.3m² x 0.25m deep blocks

A ballpark estimate of costs would be £50-75,000. A local Contractor has been approached to provide a more detailed assessment of costs. We are still awaiting confirmation of this.

C. Rock Armour Buttress Option

- Rock Armour material: 3-4,000 tonnes; and
- Geotextile underlayer: 1000m².

A ballpark estimate of costs would be £450-500,000.

Discussion

The cost of the fill operation is high for the extent of work required and there is a premium on the cost due to the constraints.

If access could be gained to the site by tracked plant and material could be recycled from around the island e.g. sandstone fill from rock falls, such as occurred at the base of the access ramp at the south end, supplemented by the use of boulders retrieved from the foreshore then this would have virtually a zero material cost, which would make it economically more viable. This operation would require a number of mobilisations due to the tidal restrictions which would incur a number of hire on-off (delivery of plant to site) charges (approx £1000 a time). Maximum working time would be 2 hours per tidal window and working approximately 1 week in every two, so progress would be slow.

Provision of a full rock armour buttress provides for longer term security but this option is considered likely to be cost prohibitive in relation to Council budgets, unless external funding can be sourced, given that the works are not safeguarding people or property and therefore grant aid is unlikely to be forthcoming from Central Government

Recommendations

As a minimum, in the short term at least, it would be suggested that visitors should be warned of the potential dangers through appropriate signing and potentially a barrier to keep them away from the cliff edge.

Discussions should be opened with statutory bodies to elicit an informal position with regard to the potential position(s) on proposed works.

7. GLOSSARY OF TERMS AND ACRONYMS

- DEFRA Department for Environment, Food & Rural Affairs
- EA Environment Agency
- FCER Flood and Coastal Erosion Risk
- FCERM Flood and Coastal Erosion Risk Management
- GiA (Flood Defence) Grant In Aid
- MHWST Mean High Water Spring Tide
- MMO Marine Management Organisation
- ODN Ordnance Datum Newlyn
- SMP Shoreline Management Plan

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Appendix I: Glossary of Terms used on Inspection Record Forms

Asset Type

All structures are split into asset types as set out by EA and the acronyms used on the forms have the following meanings:

CB	Channel Bed – approximately below mean low water. No other information is recorded for channel beds
CS	Channel side – low water to highest tide level
FI	Face Inner – a roughly vertical element of the structure that is orientated to face towards the sea
Berm	A roughly horizontal element of the structure
FO	Face Outer – a roughly vertical element of the structure that is orientated to face away from the sea
FC	Flood Crest – the highest element of the structure

Sub-type

Sub-types are descriptions of the category of the structure, e.g. foreshore, wall, revetment

Material

Material refers to the construction of the element, e.g. concrete, rock etc.

Revetment

NFCDD uses the term revetment to refer to a facing material that is attached to the element

Slope

Slopes recorded for element are approximate and established by eye during visual assessment

Width

Widths are approximate and estimated by eye during the inspection

Condition

Condition grades are as described in **Appendix II**

Weightings

Weightings are as set out by EA as follows:

Title	Weighting Number	Description
Very Minor	1	Elements that relate to non-flood or non-erosion risk reduction. However such elements may be important to other aspects of asset performance.
	2	An element that is not part of the engineered structure but does have a function connected with flood or erosion risk reduction.
Important (Low)	3	An element that is integral to the asset but has limited function in reducing flood or erosion risk.
	4	An element that is part of the asset that works together with other major elements to reduce flood or erosion risk.
Important (Medium)	5	Part of the asset, which by its failure will not cause the asset to fail. However, may lead to failure over a long period of time.
Important (High)	6	An element which when it fails will cause the structure to fail over a long period of time (up to a year).
	7	An element which when it fails will cause the structure to fail, not immediately, but prior to the next inspection date.
Near-critical	8	An element which when it fails will cause the structure to fail, not immediately but within 3 months.
Critical	9	An element which when it fails will cause the structure as a whole to fail immediately.

Appendix II: FCERM - Assessment of Risk of Erosion and Flooding

A review of the overall level of risk in relation to the structure/shoreline condition and the protection it is providing has been carried out based on the following criteria:

- the condition of the structure identified from the inspection (nature);
- an assessment of it's rate of deterioration (status); and
- what is at risk if the defences fail (consequence).

This is based on a methodology developed as part of CEUK's regime for monitoring of coastal defence structures, which is provided below

The results of this assessment for Hilbre Island are reproduced in the table following.

Introduction and Methodology

Risk is defined as the combination of the likelihood of an event occurring (probability) and the consequences associated with that event, if it occurs.

The rationale behind the assessment is based upon the three criteria given by DEFRA relating to High Level Targets for Flood and Coastal Defence Risk Management (2005), amended by CEUK to take into account natural shorelines e.g. dunes that provide a coastal defence function and improved indicators relating to what is at risk. The guidelines are that the assessment of defences with regard to the risk of coastal erosion should take into account **Status, Nature and Consequence**.

Status

The status of the defence is an indication of the condition of the asset, asset being defined as a defence length and coded using DEFRA's system. This will ensure compatibility with "database identified assets" as required by the target. The assessment of condition is to be based upon those identified in the Environment Agency publication "National Sea & River Defence Surveys - Condition Assessment Manual".

Defence Lengths are scored as follows:

- 1 Very Good**
- 2 Good**
- 3 Fair**
- 4 Poor**
- 5 Very Poor/Failed**

The status of the asset should also reflect the deterioration rate of the structure as follows:

- 1 Improving**
- 2 None/Minimal**
- 3 Low**
- 4 Medium**
- 5 High**

Nature

The nature of the defence can be used to reflect the type of defence either Hard or Soft. Identification of soft defences gives credence to the improving status identified below as a deterioration rate.

Consequence

The Consequence indicator relates to the consequences if the coastal defences were breached or removed. Categories in this respect have been defined based on the generic consequences of erosion and/or flooding that would occur as detailed in the table below:

CONSEQUENCE INDICATOR	
Category	Weighting
Effects on local population, property	5
Damage to or loss of infrastructure	4
Loss/damage to species and/or habitats or sites of historic importance	4
Loss/damage to land	3
Loss of amenity	2
No significant consequences	1

Assessment of Risk of Coastal Erosion or Flooding

The overall level of risk is the product of the condition, deterioration and consequence scores. Under the above system the maximum score for a defence length will be 125 with the following rationale for determining whether a defence length should be considered as high, medium or low risk is proposed.

If a defence length scores ≤ 2 in both status scores it should be considered as low risk

For a defence length to be high risk both status scores should be > 3 and Consequence score should be ≥ 3

Overall Score vs Risk Scores

Score	Risk Level
≤ 20	Low Risk
> 20 to ≤ 45	Medium Risk
> 45	High Risk

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HILBRE ISLAND - FCERM OVERALL RISK ASSESSMENT (July 2016)

CEUK Report Ref. No. (1604/..)	Structure		Responsibility	Description	Residual Life Expectancy (yrs) ¹	Nature - Condition	Status - Deterioration	Consequence	Risk Score	Risk level
	Name	Length (m)								
1	East Side: Buoy Keeper's House Access Steps to Lifeboat Station	260	Wirral Council	Stepped sandstone block wall and sandstone block infills	20-50	3	2	4	24	Medium
2	North End: Around Lifeboat Station	30	Wirral Council	Short sections of sandstone block infill, old lifeboat station walls and sandstone block slipway	20-50	3	2	3	18	Low
3	North West Corner: North of Access Steps	175	Wirral Council	Extensive length of low level sandstone infill	<10	3-4	2-3	3	18-36	Medium
4	West Side: South of Access Steps	250	Wirral Council	Dwarf Masonry wall to toe of upper cliff slope	20-50	3	2	2	12	Low
5	West Side: South End Access Ramp	95	Wirral Council	Open jointed retaining wall and masonry block infills to cliffs	20-50	3	2	2	12	Low
6	South End	40	Wirral Council	No defences	NA	2	2	3	12	Low
7	East Side: South of Buoy Master's House	260	Wirral Council	Local sandstone block infill at south end, otherwise no other artificial measures	20-50	3	2	3	18	Low
Total Length		1110	metres							

¹ Based on routine maintenance of existing defences. Where there are different types of defence within a frontage, the minimum life is estimated

Appendix III: Historical Inspection Photographs



NW Corner Defences 2000



NW Corner Defences 2005

Appendix IV: Extracts from Oblique Aerial Photographs (2015)

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East Side Northern End 2015



West Facing Side 2012



West Facing Side 2015



East Side Properties at Northern End 2015



East Side Properties at Southern End 2015



North West Corner 2015