



11e3 Workington to Maryport

(Technical report by Jacobs)

Policy area: 11e3 Workington to Maryport

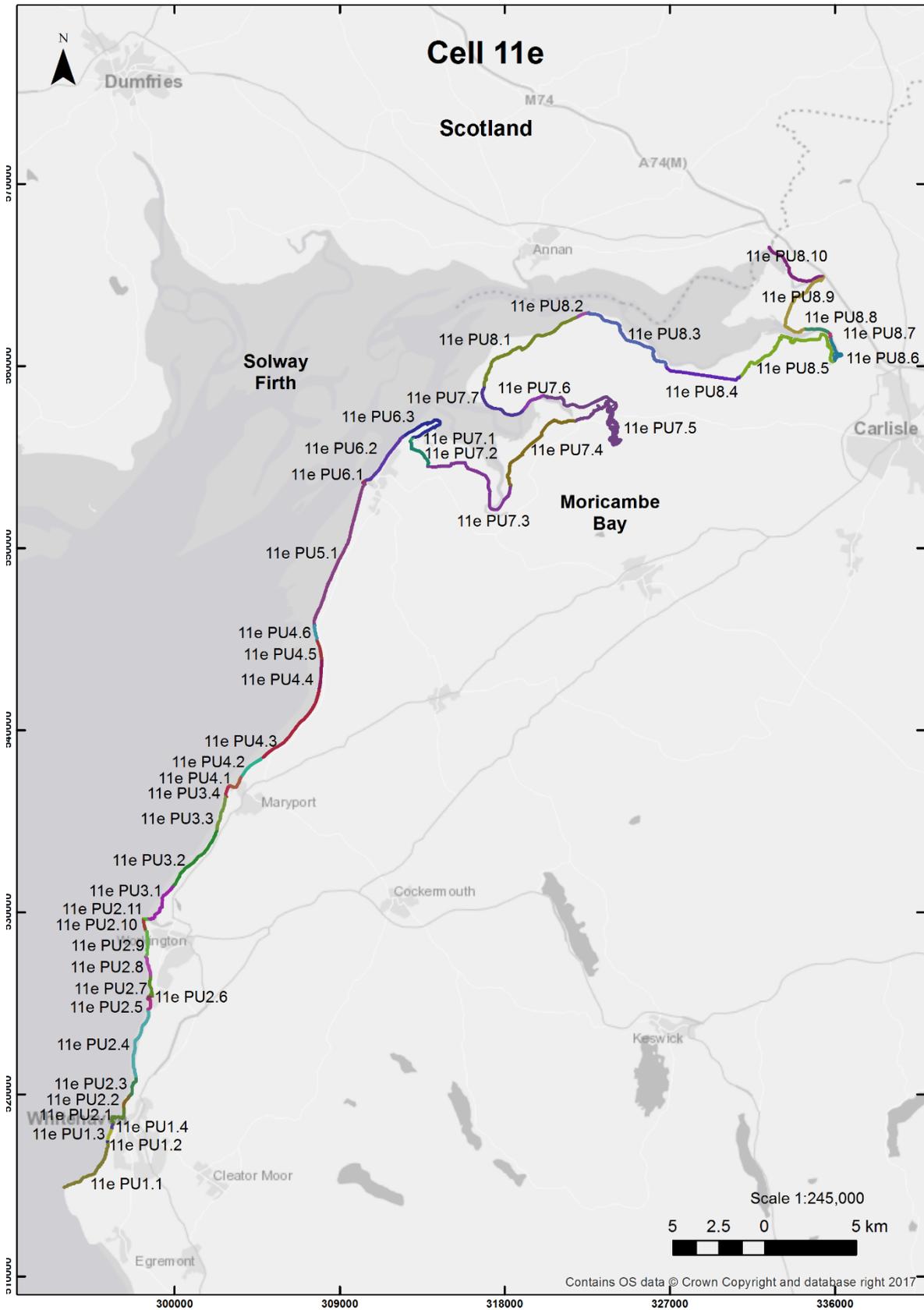


Figure 1 Sub Cell 11e St Bees Head to Scottish Border Location Plan of policy units. Baseline mapping © Ordnance Survey: licence number 100026791.

1 Introduction

1.1 Location and site description

Policy units:	<p>11e3.1 Workington Harbour to Siddick (priority unit)</p> <p>11e3.2 Siddick to Risehow (priority unit)</p> <p>11e3.3 Risehow to Maryport Marina</p> <p>11e3.4 Maryport Harbour and Marina</p>
Responsibilities:	<p>Allerdale Borough Council</p> <p>Network Rail</p> <p>United Utilities - Workington Waste water Treatment Works (WwTW)</p>
Location:	<p>This unit stretches along the open coastline between Workington Harbour and Maryport includes north Workington, Siddick, Flimby, Risehow, and the southern side of Maryport.</p>
Site overview:	<p>The hinterland gently slopes away from the coast along this frontage, meaning that some locations are at risk from both flooding and erosion. The shoreline has been heavily modified through tipping of industrial waste in the past, which resulted in the coastline advancing seawards by up to 200 m. Erosion of this has resulted in cliffs forming in places, exposing a mix of industrial waste materials. Most of the beaches comprising boulder beds and coarse sediments, interspersed with outcropping bedrock, but in some locations, there are also hardened slag deposits on the foreshore (CEUK, 2016). Longshore drift is northwards, historically resulting in accumulations developing updrift of headlands and other structures, but generally there is limited sediment availability. Changes along this shoreline have generally been small over the last few centuries, due to the area experiencing no change or a net fall in relative sea level, with any erosion being mainly the result of storms (CEUK, 2016).</p> <p>Approximately a third of this frontage is currently undefended (CEUK, 2016) and most of these sections comprise artificial tipped deposits such as slag waste and colliery spoil. Elsewhere there are intermittent concrete defences.</p> <p>There are several settlements within this policy area: Workington, Siddick, Flimby, and Risehow, with the harbours of Workington and Maryport representing important centres of commerce and recreation. Key industries supported by the area are: power generation, agriculture, fishing, recreation and tourism; with two wind turbine sites located along this frontage, a sewage works is located north of Siddick (Workington WwTW) and a former chemical plant adjacent to this. The Cumbria Coast Line runs parallel, immediately adjacent to the coastline between Siddick and Risehow and is both an important connective link between the various towns and villages, and a strategic link to Workington Port. The A596 comes within 200 m of the coastline between Siddick and Flimby. There are also a number of unclassified roads in the policy area that link the smaller settlements to Workington and Maryport. The England Coast Path runs parallel to the coastline for much of the policy unit and there are multiple PRowWs throughout the area.</p> <p>There are land based sites of designated national or international conservation importance within this policy area at Maryport Harbour SSSI and Siddick Pond SSSI. Solway Firth pSPA, covers the nearshore zone and is designated to protect rare, vulnerable and migratory birds. There are a number of listed buildings within Maryport, along with local and features of historical importance that are at potential longer term risk from erosion or flooding.</p>

1.2 Current SMP policy

The policy details for the whole policy area are shown in the table below, taken directly from the SMP2 (Halcrow, 2011); non priority units have been greyed out.

Table 1 Current SMP Policy for policy area 11e3

<p>Overview: The towns of Workington and Maryport are key regional centres and therefore, continued flood and erosion risk management to these towns is central to the long term SMP vision for this area. Between Workington and Siddick the long term plan is to allow a naturally functioning coast, assuming wind farms will be decommissioned within 20 to 50 years, but continue to manage risks to current assets meanwhile. North of Risehow, defences will be allowed to fail to allow a return to a more natural shoreline, providing sediment input, from cliff erosion, to local beaches and adjacent frontages. If the railway is going to remain operational then the long term plan would be to maintain it in its current position and continue to afford defence to it along the Siddick to Risehow frontage. If the railway were not to remain, then the long term plan would be to set back defences to a more sustainable alignment. The policies manage the risks to existing commercial, residential and community assets and a number of Scheduled Monuments thus meeting related objectives. Areas of natural coast will be allowed to behave and erode naturally which in the long term may result in the loss of some agricultural land and isolated properties. The recommended policy is adaptive and may be influenced by longer term changes to energy assets and railway infrastructure. Decisions on Managed realignment and the timing will be influenced by knowledge on contamination and erosion rates as explored through the Action Plan.</p>				
Location		Policy and Approach (from 2010)		
		0-20 years	20-50 years	50-100 years
11e3.1	Workington Harbour to Siddick	Hold the line – By maintaining existing defences – assumes wind farm remains for the short term epoch. Undertake study to assess long term policy in more detail, including pollution risks from contaminated land and risks to assets.	Managed realignment – By monitoring cliff erosion and intervening when railway, wind farm or other assets are threatened or using measures to slow erosion at the cliff toe.	Managed realignment – By monitoring cliff erosion and intervening when significant assets threatened or using measures to slow erosion at the cliff toe.
11e3.2	Siddick to Risehow	Hold the line - By maintaining rock revetment and railway embankment.	Hold the line - By maintaining or upgrading rock revetment and railway embankment if required.	Hold the line - By maintaining or upgrading rock revetment and railway embankment if required.
11e3.3	Risehow to Maryport Marina	No active intervention – By allowing failure of defences and return to natural shoreline.	No active intervention – Allow natural erosion.	No active intervention – Allow return to naturally functioning coast.
11e3.4	Maryport Harbour and Marina	Hold the line – By maintaining rock and masonry revetments and harbour defences.	Hold the line - Maintaining or upgrading defences.	Hold the line - Maintaining or upgrading defences.

2 Appraisal of priority units

Two units within this area have been defined as priority units:

- 11e3.1 Workington Harbour to Siddick (priority unit)
- 11e3.2 Siddick to Risehow (priority unit)

2.1 Existing approach to flood and coastal erosion risk management

2.1.1 Justification of current SMP policy

Section 1.2 sets out the SMP policies for these priority units. The primary justifications for the policies at the SMP level were:

- **Social:** For policy unit 3.1, the key justification for holding the line was managing risk to Workington commercial assets, the railway and wind farms; similarly, at 3.2, the key justifications were risks to: transport routes (rail and A road), industrial sites, sewage works (Workington WwTW) and the village of Flimby.
- **Environmental:** There were no adverse impacts on designated conservation sites (adjacent to this area) recognised, but Hold the line policies at 3.1 in the short term would provide time to investigate the risks of pollution from potential contamination and risks to wind farms; whilst a longer term policy of Managed realignment would potentially release more sediment to the beach system.
- **Economic:** The economic viability of long term Hold the line policies along the railway frontage of 3.1 was recognised as being dependent upon benefits from the railway and wind farm, whilst 3.2 was identified as having a stronger economic case, due to the flood risk to various assets within the flood plain.

2.1.2 Current defences

No specific design details have been obtained for this frontage. Based upon the most recent asset inspections (CH2M, 2017a), undertaken as part of the North West Regional Monitoring Programme, the condition of the existing defences ranges from Poor (4) to Good (2), with sections of undefended artificial and natural cliff.

Figure 2 shows the policy units, together with a summary of defence lengths between Workington and Maryport. Table 2 provides a summary of the condition and estimated residual life for the various defence structures, whilst the following text provides further detail regarding current condition and recent management, based upon information taken from the most recent asset inspection report (CH2M, 2017a) and previous inspection reports by Coastal Engineering UK and Capita Symonds (reported in CH2M, 2017a).

Table 2 Existing defence condition and estimated residual life (taken from CH2M, 2017a).

Unit	Location	EA Asset Ref	Defence Type	Condition	Residual Life
11e3.1	North of Workington Pier	011KE90420101C01	Vertical seawall and rock armour	Fair (3)	10-20
11e3.1	North Side 1	011KE90420101C02	Concrete sloping or stepped revetment with gabion rear wall.	Poor (4)	5-10

11e3.1	North Side 2	011KE90420101C03	Concrete sloping revetment and gabion rear wall.	Poor (4)	0-5
11e3.1	North Side 3	011KE90420101C04	Stepped revetment	Fair (3)	10-20
11e3.1	Oldside 1	011KE90420101C05	Concrete and rock revetment with concrete groynes	Fair (3)	10-20
11e3.1	Oldside 2	011KE90420101C06	Rock armour	Fair (3)	10-20
11e3.1	North Side Cliff	011KE90420101C08	Man-made cliffs	Fair (3)	NA
11e3.1	Siddick 1	011KE90420101C09	Man-made cliff	Fair (3)	10-20
11e3.1	Siddick 2	011KE90420101C10	Rock revetment	Fair (3)	20-50
11e3.2	Lowca Lane	011KE90420101C11	Rock revetment	Fair (3)	20-50
11e3.2	Seaton	011KE90430101C03	Rock revetment	Good (2)	20-50
11e3.2	Sewage works (Workington WwTW)	011KE90430101C04	Rock revetment and concrete rear wall	Fair (3)	10-20
11e3.2	Seaton to St Helen Halt	011KE90430101C05	Beach with tipped material	Good (3)	-
11e3.2	St Helen Halt	-	Rock revetment	Good (2)	10-20
11e3.2	St Helen Halt to Flimby	011KE90430101C06	Beach with tipped material	Good (3)	-
11e3.2	Flimby	011KE90430201C02	Sandstone block revetment	Fair (3)	20-50
11e3.2	Flimby Outfall	011KEPENY0101B01	Outfall and rock groyne	Fair (3)	20-50
11e3.3	Flimby to Maryport	011KE90430201C03 011KE90430301C01 011KE90440101C01	Slag cliff with intermittent rock armour protection	Fair (3)	-
11e3.3	Maryport South Pier	011KE90440101C02	Rock armour and sloping revetment groyne	Fair (3)	20-50

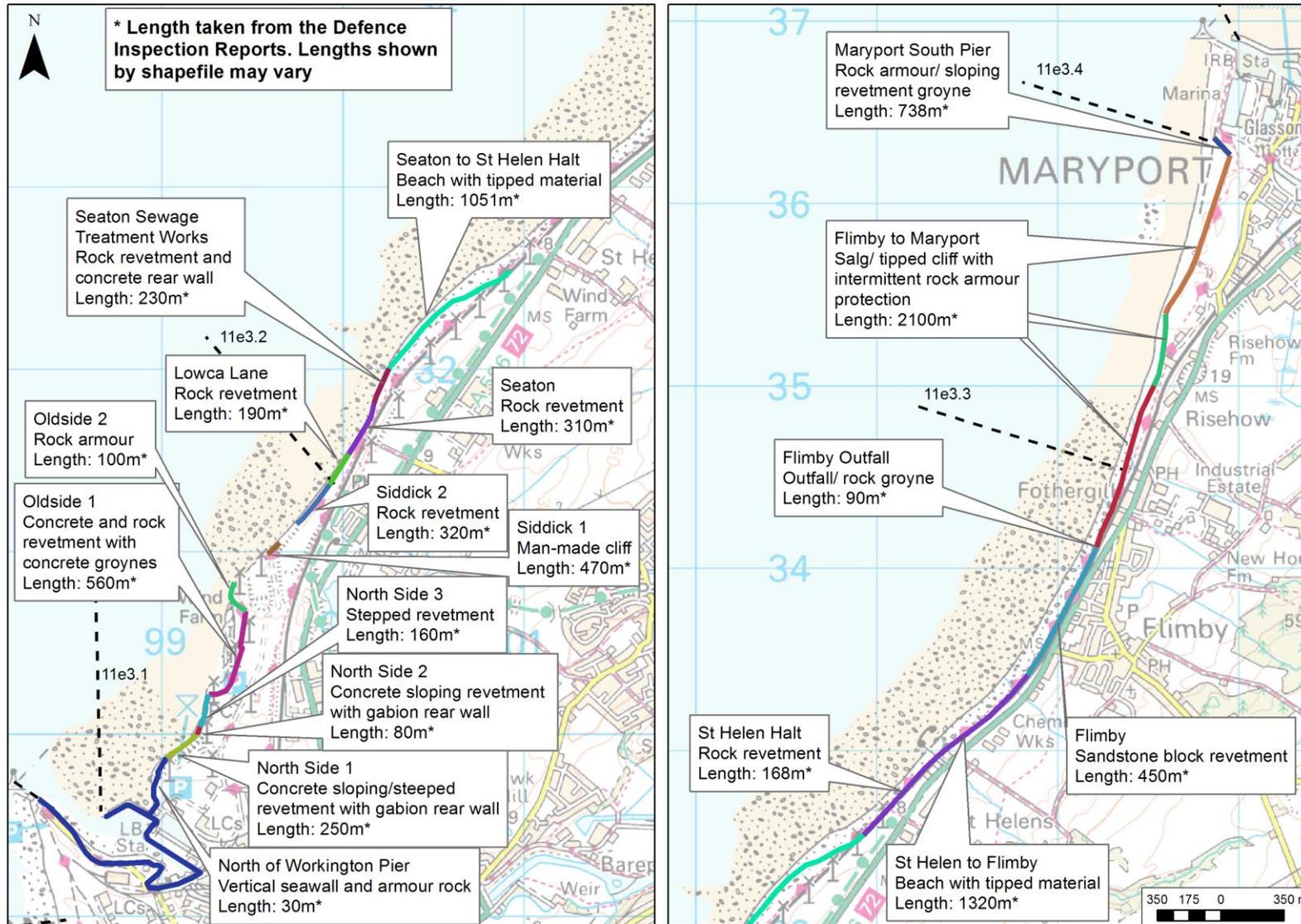


Figure 2 policy units and summary of defence lengths between Workington and Maryport. Baseline mapping © Ordnance Survey; licence number 100026791.

Policy unit 11e3.1 (Workington Harbour to Siddick)

North of Workington Pier: vertical concrete seawall, rock revetment (30 m) – Port of Workington



Figure 3 North of Working Pier. Photograph taken during CH2M (2017a) asset inspection.

In 2012 the wall was identified to be in fair condition with some surface defects but not under any apparent distress. There have been no changes in structure or conditions since. Current maintenance is understood to be carried out by Port of Workington, which is owned and operated by Cumbria County Council. The Port Manager has advised that the rock armour was placed around 10 years ago to manage toe scour and raised concern about the condition of this defence and the associated risk to land adjacent to the port.

North Side Cliff: man-made cliffs (470 m) – Allerdale BC

No specific observations have been made as part of the asset inspections carried out as part of the North West Monitoring Programme. There is no management other than monitoring.

North Side 1: concrete sloping or stepped revetment and gabion wall (250 m) – Allerdale BC



Figure 4 North Side defences. Photograph taken during CH2M (2017a) asset inspection.

Deterioration of this asset has been ongoing since the first recorded inspection in 2010. Although some concrete repairs and replacement crest gabions have been carried out over time, the latest inspection records this as generally dilapidated and overall in poor condition. In 2016, some armour stone boulders were placed along the failed section near the southern end, although these were observed to be of 'limited value'.

The current defences pose a health and safety risk in respect of access due to the damage they have sustained.

Current management is to carry out remedial works and maintenance as required. Damaged gabions require replacement but a more robust construction e.g. rock armour with appropriate geotextile filter, may be too expensive to provide the short term fix required.

North Side 2: concrete sloping revetment and gabion wall (80 m) – Allerdale BC



Figure 5 North Side defences. Photograph taken during CH2M (2017a) asset inspection.

This section has been in poor condition since the first inspection carried out as part of the North West Regional Monitoring Programme, in 2010: precast slabs having broken away on sections of the face and apron and the concrete at the foot of the grass banking had eroded in large sections.

Further damage to the structure occurred in 2014 when the paving slab facings suffered significant damage in the middle of the frontage end, where the exposure is greatest due to lower beach levels, exposing a concrete filled sandbagged wall behind.

Although no worsening of conditions has been identified since, deposits behind the defences remain vulnerable to erosion. Current management is to monitor condition but to not actively maintain. Current requirements include the need for repairs to damaged sections to address health and safety risks.

North Side 3: Stepped Concrete Revetment (160 m) – Allerdale BC

These defences comprise a partial random tipped rock along toe of slag cliff, primarily to reduce erosion risk due to close proximity of the wind turbine site. Although there has been some localised change in surficial beach deposits, no change in condition has been noted in recent asset inspections. Current management is to monitor condition but to not actively maintain.

Oldside 1: stepped concrete and rock revetment with concrete groynes (560 m) – Allerdale BC

The structure is located landward of an equilibrium location across northern part of frontage but seaward across southern part, based upon the location of the high tide line.

The defence has been considered to be in poor condition since 2015, with the groynes considered to be in poor condition since 2012. There has been no notable change in condition since.

Current management is to monitor condition and carry out remedial works as necessary. No specific outstanding actions identified as this length is in a better state than most of the other sections of wall.



Figure 6 Oldside stepped revetment. Photograph taken during CH2M (2017a) asset inspection.

Oldside 2: rock revetment (100 m) – Allerdale BC

The defence here comprises partial random tipped rock along toe of slag cliff offering some erosion protection to wind turbine site. In 2014 it was noted that the slag bank has suffered some erosion at northern end, where rock armour tapers out, but otherwise no changes have been observed.

Current management is to monitor condition but to not actively maintain.

Siddick 1: slag and tipped cliff (470 m) – Allerdale BC

These are unprotected artificial cliffs. There are some remnants of gabion protection on beach. Year on year, since 2012, it has been noted in the asset inspections that although there is no change in the slag cliff features, softer deposit cliffs have suffered ongoing slow erosion.

Current management is to monitor condition but to not actively maintain.

Siddick 2: rock revetment (320 m) – Allerdale BC

In general, this structure is considered to be in good order, although some local terminal erosion was identified at the southern end interface of the revetment in 2012. Since then no change in defence condition has been observed.

Current management is to monitor condition and carry out remedial works as necessary. No specific outstanding actions identified.

Policy unit 11e3.2 (Siddick to Risehow)

Lowca Lane: rock revetment (190 m) – Network Rail

Although in general this rock revetment is in good condition, approximately 50 m south of slipway, there has been localised disruption and overtopping of the armour, causing washout of the fill behind, noted in 2014. Asset inspection reports suggest that this was where the armour profile was deficient. Although no remedial works appear to have been carried out to this damage, there has been no observed change in condition since.



Figure 7 Rock revetment at Lowca Lane. Photograph taken during CH2M (2017a) asset inspection.

Current management is to monitor condition and carry out remedial works as necessary. Remedial work to low spot is still required.

Seaton: vertical concrete seawall and rock revetment (310 m) – Network Rail

This rock armour revetment is in good order, constructed in front and over previous damaged section of seawall. No change in condition since 2012 has been observed.

Current management is to monitor condition and carry out remedial works as necessary. No specific outstanding actions identified.

Sewage works (Workington WwTW): vertical concrete seawall and rock revetment (230 m) – Network Rail



Figure 8 Defences at sewage works (Workington WwTW). Photograph taken during CH2M (2017a) asset inspection.

In 2012 the rock revetment, constructed in front of the rear vertical wall, was identified to be in good order. Prior to this there had been little change at the terminal north end of this section, although inspections noted that beach levels are variable and storm conditions could cause draw down that potentially could undermine the wall causing it to fail.

In 2014 a short section of vertical wall at rear end had been breached during storms but this was replaced with a new section of rock armour. In 2015, the armour stone section was improved across the entire length, such that the wall section is now largely redundant.

Current management is to monitor condition and carry out remedial works as necessary. No specific outstanding actions identified.

Seaton to St Helen Halt: natural or tipped shoreline (1051 m) – Network Rail



Figure 9 Seaton to St Helen Halt: beach includes tipped material. Photograph taken during CH2M (2017a) asset inspection.

This is a largely unprotected section of frontage along which tipped material from local industries has historically been tipped. This practice has now ceased. A rear blockwork wall or fence (NR boundary) runs along the landward edge of the foreshore.

In 2014 there was significant erosion of the fill material on the shoreline; the crest of which was overtopped during the previous winter storms. By 2015 vegetation had recovered and no significant further erosion has taken place.

Current management is to monitor condition but to not actively maintain.

St Helen Halt: rock revetment (168 m) – Network Rail

Figure 10 Rock revetment along St Helen Halt. Photograph taken during CH2M (2017a) asset inspection.

These defences were constructed in 2014 to protect the railway. The flanks remain vulnerable to erosion and in 2016 Network Rail were observed stockpiling armour stone on landward side of railway adjacent to this section, presumably to extend the defences at both ends (although it is not clear if these works have since been carried out). Note that some of the pink armour indicates a conglomerate material rather than a natural rock (origin unknown and physical characteristics are potentially suspect).

Current management is to monitor condition and react to events after they occur, although the stockpiling of armour indicates a more proactive approach.

St Helen Halt to Flimby: natural or tipped shoreline (1320 m) – Network Rail

This is a largely unprotected section of frontage with natural beach deposits having historically been supplemented with tipped material from local industries which has now ceased. A rear blockwork wall or fence (NR boundary) runs along the landward edge of the foreshore.

Between 2012 and 2014 there was significant erosion of the fill material on the shoreline, the crest of which was overtopped during the storms. It concluded that ultimately extension of the rock armour at St Helen Halt will be required across this section. A section of boundary wall was also damaged. By 2015 a new section of fence was erected across damaged section of boundary wall; however, the wall was missing in other sections and upper beach deposits vulnerable in extreme conditions, particularly at southern end.

Current management is to monitor condition but to not actively maintain.

Flimby: masonry wall (sandstone block revetment) (450 m) – Network Rail and United Utilities

In 2012, the wall was buried apart from at the underpass adjacent to outfall. A new rear floodwall had been constructed on landward side of railway and underpass. By 2014, winter storms had eroded tip deposits, exposing blockwork revetment on northern side of underpass at Flimby. The revetment at this time appeared to be in good condition but was more exposed.

There has since been some recovery of deposits over the revetment either side of Flimby Outfall, mostly due to sand movement by wind, but otherwise no changes have been observed.

Current management approach is to monitor condition but to not actively maintain. Exposure of wall may require reappraisal of this by Network Rail.



Figure 11 Figure 11 Defences at Flimby Outfall. Photograph taken during CH2M (2017a) asset inspection.

2.1.3 Shoreline change

Analysis reports are produced to report on analysis of beach level data collected as part of the North West Regional Monitoring Programme. The most recent reports include analysis of data up to October 2016 (CH2M, 2017b), and incorporate findings from previous reports.

Workington to Siddick (11e3.1)

This frontage has not been surveyed since 2014. Information from the asset inspections (summarised in Section 2.1.2) indicates that the defences at the back of the beach are generally in a poor condition and storm damage has occurred in the past, indicating that these defences are vulnerable.

Siddick to Lowca Lane (part of 11e3.2)

Three beach profiles have been recorded here. The data show that the beach levels generally change very little over time, by less than 0.2 m, with some variation associated with pockets of sand accumulating and subsequently being remobilised and redistributed across the lower beach (below mean sea level). There is no notable net trend in beach level over time for the period of data available (2012 – 2016).

Lowca Lane to Flimby (part of 11e3.2)

This frontage has not been surveyed since 2014. It has been noted, however, that beach levels along this frontage do vary, which can leave structures vulnerable to overtopping and damage. There has also been previous erosion of the backshore during the 2013 and 2014 storms, although some post storm recovery has been noted during the asset inspections.

Flimby (part of 11e3.2)

At the southern end of Flimby the beach levels have fluctuated over time by up to 0.75 m, due to the movement of sand bars across the beach; but no net trend is evident from the data sets. There has also been some erosion of the backshore; two periods of erosion are evident: winter 2013 and 2014 and winter 2015 and 2016. In total around 7 m of erosion has occurred.

Just south of the railway station, where a low grassed bank fronts the railway line, beach levels have fluctuated over time by around a metre, but net change between 2012 and 2017 was small. It is likely that sand builds up on the southern side of the small beck that outflows here, before being moved northwards. The data suggests that between 2013 and 2014 there was some erosion of the crest of the grassed bank, whilst evidence from Google Earth images from 2003 and 2008 (see Figure 12 below) suggests that erosion has been an ongoing trend since 2003.



Figure 12 Google Earth images from 2008 and 2003 showing backshore changes near Flimby railway station

Predictions of future erosion from NCERM suggest the following bands of change:

	By year 20	By year 50	By year 100
11e3.1 Workington Harbour to Siddick	0 to 8 m	6 to 20 m	20 to 40 m
11e3.2 Siddick to Risehow	0 to 8 m	3 to 20 m	20 to 40 m
11e3.3 Risehow to Maryport Marina	-	-	-
11e3.4 Maryport Harbour and Marina	-	-	-

In recent years, erosion along this frontage has been mainly storm driven and along the dune frontages, the backshore position has fluctuated over time in some locations. Based on the limited data available, these rates seem reasonable, but it should be recognised that several metres of erosion may occur during a storm, with erosion likely to be episodic in nature, rather than progressive.

2.2 Outline of the problem

2.2.1 Background

The Cumbrian Coastal Railway Line runs along the back of the beach along much of this frontage, and is therefore at risk from erosion and overtopping in places. Although the beaches are not particularly dynamic compared to other parts of the country, there are locations where the beach level has dropped over time increasing the vulnerability of the railway, but even where this is not the case the low lying nature of this asset means it is vulnerable to storm events, when the combined effect of high tides and surge conditions means the beaches no longer offer sufficient protection and waves are able to reach the backshore. There is a limited volume of sediment being moved along the frontage between the partial barriers created by the harbours at either end and other structures along the frontage.

Further details are provided for each policy unit in Section 2.4.

2.2.2 Issues, constraints and opportunities

A key risk is coastal erosion of old spoil deposits which form the backshore morphology. There are some localised flood issues related to culverted outfalls and concerns regarding Port of Workington structures, namely the southern breakwater extension and the north beach retaining wall. There is also concern regarding the slag bank area to the north of Workington which has recently eroded significantly.

Between Workington and Siddick, the key assets at risk are wind turbine sites; the railway and properties are set back from the coast and at no current risk.

North of Siddick the railway embankment forms the frontline defence and is vulnerable to tidal erosion and overwashing under extreme water levels as it lies at the back of the beach. In places, there is little or no raised embankment and the railway does not appear to sit any higher than the level of the beach. With any increase in sea level, overwashing will increase in frequency and magnitude. Directly behind the railway there are various developments, including settlements, industrial sites, and several wind turbines as well as a main road. Although some of these assets are located on the gently rising ground, and so may not be susceptible to flooding, they would be at risk from erosion in the long term if the railway were breached. Elsewhere, it would appear that there is a very real risk of flooding to properties if the slightly raised bank upon which the railway is sited were to be breached. At a local level, for example at Flimby, there are issues with culverts or outfalls becoming blocked by beach material, resulting in inland drainage issues.

There is potential for redevelopment of former industrial sites, e.g. at Flimby, but this would rely on securing coastal protection from erosion.

The current SMP policy of Managed realignment at 11e3.1 may have implications due to highly contaminated nature of site – however alternative would require funding.

Apart from Siddick Pond, which is set back behind the railway and road there are no land based statutory environmental designations and there are also limited opportunities for environmental improvements within this area. However, there may be water quality issues related to erosion of the spoil cliffs, so defence of these in the future could be beneficial.

2.2.3 Strategy considerations and general approach

Key considerations

Since the SMP2 was produced further monitoring data has been collated including beach profile data and asset inspections. The strategy has considered the following:

- current defence conditions and level of risk
- future management options.

Strategy approach

The following situations arise along this frontage, and will be addressed as follows:

- Privately owned or funded defences – these are locations where the SMP policy may allow Hold the line subject to private funding or investment. The strategy will investigate the performance or impact of the defences and make recommendations on measures to ensure a strategic solution along the frontage. It is unlikely that these locations will attract significant FDGiA funding – here the focus will be on considering varying costs of approaches, environmental impacts on the wider coast and making recommendations accordingly.
- Proposed future developments – these are locations where the SMP policy may still be appropriate for current hinterland assets but where future developments are proposed. Here the strategy will consider possible measures taking account of a possible change to policy. Future or proposed developments cannot be included in FDGiA - here the focus will be on considering varying costs of approaches, environmental impacts on the wider coast and making recommendations accordingly.

2.3 Options development and appraisal

The main options report defined the long list options, each of these has been screened at a high level against technical, economic and environmental criteria to develop a list for final detailed appraisal.

The table below summarises the long list options for each priority policy unit covered in this policy area, in addition to the baseline options of:

- Do nothing
- Do minimum.

No potential for habitat creation sites has been identified for any of the above frontages.

Table 3 Long list options considered for priority units in 11e3 Workington to Maryport

Priority Unit	Hold the line								Managed realignment			
	Maintain: proactive maintenance	Maintain: reinforce existing defences	Sustain: reinforce existing defences	Improve: improve existing defences	Improve: construct new shore control structures	Improve: construct new revetments or seawalls	Improve: beach recharge	Improve: cliff or slope stabilisation measure	Construct erosion slowing defences	Construct defences once set back	Construct secondary embankments	Remove existing defences
11e3.1 Workington Harbour to Siddick	✓	✓		✓	✓	✓	✓	✓	✓	✓		
11e3.2 Siddick to Risehow ¹	✓	✓		✓	✓	✓	✓					

The second stage has been to appraise the short listed options. The sections below outline for each frontage the shortlisted options and approaches (measures) that could be adopted to achieve these.

Do nothing has been appraised as a baseline in all frontages. This option assumes that no further works would be undertaken and the existing defences would deteriorate over time, resulting in failure.

Additional information on environmental impacts will be provided in a **Strategic Environmental Assessment: Environmental Report** which systematically appraises the potential environmental consequences of the proposed strategy and recommend any actions needed to mitigate and monitor identified adverse effects.

The economic feasibility of implementing a particular option has been appraised through considering the packages of measures required for its implementation which have been costed and the benefits of the strategic options which were identified and evaluated. The Do nothing option provides the baseline for the economic appraisal. This is reported in the **Economic assessment** report.

2.4 11e3.1: Workington Harbour to Siddick

This unit essentially comprises three sections: undefended slag cliffs at either end, which are actively eroding, between which are a series of concrete walls or revetments fronting the former landfill site and wind turbine site. Further rock protection has been placed for a short length along sections at either end of these walls.

Throughout this frontage, the railway is well set back so not directly at erosion risk. Likewise, most development is also well back, with the only justification for any defences here being the potential erosion and loss of individually sited wind turbines that are present along the length of this unit, and the possible risks of pollution from erosion of the former iron works site.

At the most southern end of the unit, adjacent to Workington Harbour (11e2.11), despite the Managed realignment policy this is one area where continued defence will need to be provided to ensure erosion and flood risk to the harbour and beyond are managed appropriately. For the adjacent unit (11e2.11), the SMP policy is Hold the line through to the long term. It is assumed that the SMP justification for the Hold the line policy at the port of Workington remains.

¹ This has been considered as two parts, due to the differing nature of the coastline and defences present.

2.4.1 11e3.1 - Initial screening of options

A fundamental issue with respect to the future strategy here is the outcome of the investigations identified by the SMP to confirm the appropriate management policy for the second and third epochs (medium term and long term, respectively).

The SMP states that:

- Hold the line in short term provides time to investigate the nature of potential contamination and landfill and residual life of the wind farms.
- The economic viability of the policy may depend on benefits from the railway and wind farm, not quantified at this [the SMP] stage.

It does not appear that either of these matters have been progressed since the SMP was developed, therefore the appropriateness of the policy remains uncertain and needs to be considered in the strategy. However, undertaking contaminated land investigations would require detailed site based sampling and monitoring which is beyond the scope of the current desk based strategy study.

The approach therefore at this stage has been to suggest possible approaches based upon alternative outcomes.

For example, should it be concluded that there are no contamination issues from the former iron works site and that the wind turbines are soon to be decommissioned, then the most appropriate management approach would be to limit interventions as far as possible to remedial work options only, then reverting to a Do nothing approach in those same areas.

But, if there is a need to continue protecting these same assets for several more decades, through at least epoch 2 and perhaps epoch 3, then different approaches to provide more permanent protection will be required.

Although the future policy is presented as Managed realignment, it could be described as a combination of Hold the line and No active intervention, the latter described as 'monitoring cliff erosion and intervening when railway, wind turbines or other assets are threatened or using measures to slow erosion at the cliff toe.'

If the erosion of the former industrial would cause an unacceptable pollution risk to the coastal waterbody, public health or the designated sites, and other options such as excavation and disposal to a licenced inland site are not more viable, then that section of this frontage would need to be Hold the line through the remaining epochs of the SMP. As some wind turbines also sit above this site, those would also receive protection irrespective of plans for those.

Elsewhere, and indeed for the whole frontage, if there is no requirement to protect the former industrial site, the long term plans for the wind turbines will drive policy and thus protection requirements. The existing 7 wind turbines were installed in mid 1990s and are operated by E.On. Given the recent expansion of other offshore and onshore wind turbine sites in Cumbria it may be that when the existing turbines reach end of design life they could be replaced like for like, or upgraded to larger units. If replaced with larger units, the turbine spacing requirements and so locations may differ. As potential future turbine locations and their resilience to flood and erosion risks are unknown the SMP Policy of Managed realignment appears to remain appropriate for this frontage. When the turbines require replacement, it may be possible for these to be sited further inland, away from the erodible cliff edge and failing existing defences and to be made resilient from flood risks, in which case the policy can be one of installing new defences in a retired position once the risk presents itself, but in the meantime No active intervention. This is essentially how the current 'Managed realignment' policy is presented.

Table 4 below summarises the rationale for taking long options forward to the short list stage.

Table 4 Screening of long list options for 11e3.1

Long list options	Description	Short listed?	Rationale
Do nothing	No further works undertaken, defences left to deteriorate and fail.	Baseline only	This option results in uncontrolled erosion risks to the wind turbines nor prevent exposure of potentially contaminated land. It has been assessed for comparative purposes only.
Do minimum	Reactive patch and repair of defences only.	No	Defences are already in such a poor state this is unlikely to be viable. Low cost solutions have been considered in Hold the line: maintain through reinforcing existing defences.
Hold the line: maintain through proactive maintenance	Measures to maintain the existing defences.	No	The current seawalls, for much of this unit, are in a very poor state and the protection added to the north and south end of the seawalls is little more than partial random tipped rock. As such, options to patch and repair the seawalls are considered to be futile along most of this frontage. The only exception is along the Oldside 1 frontage: here the seawall is currently in Fair condition and also sits in an embayment so may be less vulnerable than some other sections of wall. Proactive maintenance could help to extend the serviceable life of this asset for some time to come. This has not been considered as an option elsewhere.
Hold the line: maintain through reinforcing existing defences	Low cost measures such as ad hoc rock toe works, gabions to improve longevity of existing defences.	Yes	Options to introduce low cost measures in front of defences would provide short term protection to assets and therefore may be appropriate if the wind turbine sites do not require protection in the long term. It is a viable option to be considered.
Hold the line: improve existing defences	Measures to improve defence resilience, such as rock toe works, raising crest levels.	No	Many of the existing structures are already in a poor state therefore options to modify and adapt them are likely to be futile.
Hold the line: improve through constructing new shore control structures	Measures to retain beach material, such as timber or rock groynes, breakwaters.	Yes	<i>This will only be appropriate if wind turbines will require protection beyond the short term.</i> This is only applicable along one stretch of shoreline (Oldside 1; see Figure 2) where control structures could assist in holding a beach. It is likely, however, that there would need to be some other benefits of having a beach in this area, as this will be a more expensive option than the other alternatives.
Hold the line: improve through constructing new revetments or seawalls	New shore parallel defences replacing or extending existing defences	Yes	<i>This will only be appropriate if wind turbines will require protection beyond the short term.</i> Replacing like for like (i.e. new seawalls) is not recommended. A more appropriate option would be to construct new rock revetments in place of the poor and failed walls, and to remove and replace the areas of random tipped rock with more formal revetments.
Hold the line: improve through beach recharge	Addition of new material to beaches.	Yes	<i>This will only be appropriate if wind turbines will require protection beyond the short term.</i> This is only applicable along one stretch of shoreline (Oldside 1; see Figure 2) where control structures could assist in holding a beach due to the set back position of the shoreline. It is likely, however, that there

			would need to be some other benefits of having a beach in this area, as this will be a more expensive option than the other alternatives.
Hold the line: improve through cliff or slope stabilisation measure	It is likely that the most appropriate solution would be provision of a rock toe.	No	This option has been considered as part of Hold the line: improve existing defences and has not been taken forward as a separate option.
Managed realignment: construct erosion slowing defences	Low tech measures such as gabion baskets to reduce erosion rates.	Yes	Options to introduce low cost measures would provide short term protection to assets and therefore may be appropriate if the wind turbines sites do not require protection in the long term. This may be deployed along with "Hold the line: maintain through reinforcing existing defences" along existing defences.
Managed realignment: construct defences once set back	Allow erosion to continue and then construct defences	Yes	This would not provide protection to the wind turbines in their current location, but relocation may be a possibility. Other assets here (excluding the development immediately south of the harbour) are set back more than 200 m and are unlikely to be at risk within lifetime of the strategy (100 years).

2.4.2 11e3.1 - Development and appraisal of short listed options

Do nothing (Option 1)

This is considered as a baseline against which other options can be appraised. Under this option all maintenance and management of the defences would cease and defences would be allowed to fail.	
Technical	In many places the seawall is in a very poor (even failed) state of repair and considered to pose a health and safety risk. There is a risk of cliff erosion, although the rate of erosion is uncertain: NCERM erosion rates range from 0 to 8 m in the first 20 years, 10 to 20 m by year 50 and 20 to 40 m by year 100.
Environmental	<p>This option would not reduce risk of flooding and coastal erosion to commercial properties north of the harbour, the wind turbines or its associated infrastructure.</p> <p>At the southern end of this unit there is also a risk that beach retreat could impact on harbour structures through progressively exposing the North Pier to wave and tidal action, placing it at risk of failure. This would impact on the harbour's operation. As there is a life boat stationed here, this could also have wider community impacts.</p> <p>There is a flood risk to the railway line and a short section of road at Siddick; although these assets are set back from the coastal edge, coastal erosion would increase the risk of overtopping and inundation. This could lead to more regular closures of the railway and road, with consequences both on the local community and wider afield; as these are key connective routes between settlements and strategic transport links.</p> <p>The adopted route of the England Coast Path runs along the coastline, both behind existing defences and along undefended stretches. Sections of the route would be at increasing risk of erosion and flooding, although it is already recognised in the proposals that some sections would need to roll back as a direct result of coastal processes.</p> <p>This option may allow for natural coastal processes to become reinstated, potentially enhancing the habitats within the pSPA (e.g. increased area of mudflats at Workington); full impacts on this site will require assessment under the Habitats and Species Conservation Regulations (2017). Siddick Ponds SSSI, which lies around 500 m inshore from the coastline is not expected to be directly affected.</p> <p>Although there is not expected to be any impact on the scheduled monument of Burrows Walls Roman Fort, which lies over 900 m from the coast, the presence of this monument indicates potential for further archaeology in the area, which may be undiscovered through flooding or erosion.</p> <p>There is a historic landfill present but it is located over 400m inland and not at erosion risk over the strategy. The coastal frontage includes the site of and tipped spoil from the former iron works and therefore, a cautionary approach should be used to potentially contaminated land. Impacts of</p>

	implementation of this policy would have to take into consideration the objectives of the Solway Outer South coastal waterbody under the WFD.
Cost	There are no costs associated with the Do nothing option.
Damages	The key damages are associated with loss of the wind turbines infrastructure. The Do nothing PV damages are estimated to be £520 k.

Hold the line: maintain through reinforcing existing defences (Option 2)

This would involve more low cost measures to maintain, but not improve, the existing standard of protection. It could involve rock gabions or similar sacrificial defence options. This should be considered in combination with erosion slowing, such as placement of rock, along the toe of undefended cliffs.	
Technical	<p>Rock gabions might offer a temporary solution to quickly fix problems and delay failures by a few more years, but geobags are unlikely to be a feasible option to consider along this coastline. This option could address the immediate issues, but is not suitable as a long term solution. During severe events gabions are likely to become damaged and therefore require repair or replacement, there is also a risk that prior to repair works damage could be caused to the defence behind by subsequent storms.</p> <p>There would be no additional works undertaken to address overtopping risk; therefore this would remain a vulnerability of the existing defences.</p>
Environmental	The defences would provide protection for some time, although this will depend upon severity of storms and resultant damage to defences, but this option would ultimately lead to failure of defences and impacts would be as in Option 1 from the medium term. During severe events the gabions could become damaged and may split, which could be a health and safety hazard to beach users
Costs	<p>Costs associated with initial placement of rock gabions and subsequent future replacement.</p> <p>The Present Value Capital Works are estimated to be £550 k and the Present Value Total Cost with Optimism Bias (PV(OB)c) is estimated to be £2,460 k.</p>
Benefits	The wind turbine site may remain protected from erosion for some time, allowing continued operation; although this will depend upon severity of storms and resultant damage to defences. Eventually it may become uneconomic to continue replacing or repairing gabions and the situation may revert to Do nothing from the medium term. The benefits are estimated to be £520 k.

Hold the line: improve through constructing new shore control structures (Option 3)

This is only appropriate for a short stretch of shoreline (Oldside 1) and could involve construction of headland groynes at either end of this embayment to help retain sediment. This would need to be undertaken in combination with beach nourishment (Option 5) and alternative management approaches elsewhere along the frontage.	
Technical	<p>The landward setting and embayment could be more conducive to sand or shingle retention than other locations: there is already evidence that a combination of the sheltering effect of Workington Harbour and the headland formed by the landfill site are supporting a higher foreshore. Rock structures would replace failing walls at either end, creating headlands that will enhance the sediment retention characteristics here.</p> <p>In combination with measures employed elsewhere, this will provide a long term protection to the wind turbine site.</p>
Environmental	<p>In combination with works elsewhere, this option could reduce the long term risk of erosion and flooding to infrastructure, potentially contaminated land of the former iron works, the England Coast Path and the SSSI. Additionally, the new groynes may create an extended area of beach that would be accessible to the public, thereby enhancing local tourism.</p> <p>The nearshore zone lies within the Solway Firth pSPA, therefore the impacts of constructing new control structures would need careful consideration under the Habitats and Species Conservation Regulations 2017, to assess the potential for significant effects on the integrity of the Natura 2000 sites. Similarly, the works should not compromise the achievement of WFD objectives relating to the Solway Outer South coastal waterbody. Impacts of new defences would, however, depend on their location, nature, and footprint, which will not be defined until scheme stage.</p>

	The construction of new defences also has the potential to affect landscape character and visual amenity.
Costs	<p>Large capital costs associated with construction of headland groynes, and subsequent maintenance through replacing rock as required. Additional costs associated with required recharge (Option 5).</p> <p>The Present Value Capital Works are estimated to be £360 k and the Present Value Total Cost with Optimism Bias (PV(OB)c) is estimated to be £7,050 k.</p>
Benefits	In combination with other measures along the rest of the frontage, this option would continue to protect the wind turbines taking account of potential increases in sea level rise, changes in wave climate or storminess. The benefits are estimated to be £520 k.

Hold the line: improve through constructing new revetments or seawalls (Option 4)

This may involve constructing (a) a seawall along this length OR (b) constructing a seaward berm of rock, backfilled either with locally sourced material or with other rock	
Technical	<p>(a) The new seawall would replace and extend the existing structure, and be designed to withstand the higher sea levels, wave forces, and foreshore lowering that might be expected and provide a long term solution to current issues of undermining and overtopping.</p> <p>(b) A (potentially cheaper) alternative would be to move the interface between sea and defence further seaward, and at the same time avoid having to raise the wall or add further scour protection. This could be achieved by constructing a seaward berm of rock, backfilled either with locally sourced material or with other rock (thus effectively creating a berm breakwater). It is not anticipated that this would significantly affect alongshore transport, due to the exposed nature of this shoreline and the scarcity of sediment within the system.</p>
Environmental	<p>Option (a) would look slightly different from what is there today, but would be a similar footprint, whilst option (b) would be a larger footprint. There would therefore be some impacts on landscape character. Construction of any new defence may alter the available views out to sea or alter the character of the frontage. Both of these may impact on the visual amenity of the site.</p> <p>Both options (a) and (b) would reduce the long term risk of erosion and coastal flooding to infrastructure and potentially contaminated land of the former iron works and provide adequate defence against future overtopping that might be a result of any sea level rise, which should allow for safe access along the England Coast Path.</p> <p>The nearshore zone lies within the Solway Firth pSPA, and therefore the impacts of constructing new control structures would need careful consideration under the Habitats and Species Conservation Regulations 2017, to assess the potential for significant effects on the integrity of the Natura 2000 sites. Similarly, there could be impacts on WFD objectives of the Solway Outer South coastal waterbody. Impacts of new defences would depend on their location, nature, and footprint, which will not be defined until scheme stage, however option (b) is likely to involve a larger footprint on the nearshore which is a part of the pSPA designation.</p>
Costs	<p>Both options will involve high capital costs, but should be reduced maintenance requirements.</p> <p>a) The Present Value Capital Works are estimated to be £15,530 k and the Present Value Total Cost with Optimism Bias (PV(OB)c) is estimated to be £25,060 k.</p> <p>b) The Present Value Capital Works are estimated to be £3,650 k and the Present Value Total Cost with Optimism Bias (PV(OB)c) is estimated to be £5,900 k.</p>
Benefits	Both options would continue to protect the wind turbines taking account of potential increases in sea level rise, changes in wave climate or storminess. The benefits are estimated to be £520 k.

Hold the line: improve through beach recharge (Option 5)

This is only appropriate for a short stretch of shoreline (Oldside 1) and could involve import of sand or shingle to improve beaches here, which would form a key part of the defence system. Construction of headland groynes at either end of this embayment to help retain sediment. This would require control structures (see Option 3) and would need to be undertaken in combination with alternative management approaches elsewhere along the frontage.	
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Technical	The landward setting and embayment could be more conducive to sand or shingle retention than other locations: there is already evidence that a combination of the sheltering effect of Workington Harbour and the headland formed by the landfill site are supporting a higher foreshore. Rock structures would be required to help retain sand or shingle.
Environmental	<p>Origins and nature of material considered for use in beach recharge must be undertaken, as there is a risk of possible release of fine sediment to water environment, with implications for water quality within this frontage, potentially moving into adjacent frontages. Impacts on the WFD objectives of the Solway Outer South coastal waterbody would require consideration.</p> <p>The nearshore zone lies within the Solway Firth pSPA, therefore the impacts of recharging the beach would need careful consideration under the Habitats and Species Conservation Regulations 2017, to assess the potential for effects on the integrity of the Natura 2000 site.</p> <p>Assuming this was undertaken with Option 3, this option would provide long term protection to the railway infrastructure.</p>
Costs	<p>High initial capital costs and they may be a requirement for future top ups. Additional costs associated with construction of rock groyne (Option 3).</p> <p>The Present Value Capital Works are estimated to be £660 k and the Present Value Total Cost with Optimism Bias (PV(OB)c) is estimated to be £1,540 k.</p>
Benefits	In combination with other measures along the rest of the frontage, this option would continue to protect the wind turbine site taking account of potential increases in sea level rise, changes in wave climate or storminess. The benefits are estimated to be £520 k.

Managed realignment: construct erosion slowing defences (Option 6)

The most likely solution is for toe protection, e.g. placement of rock to help stabilise the cliffs and reduce rather than halt erosion.	
Technical	<p>At present erosion of the backshore is believed to be mainly storm driven, therefore these measures could help reduce the wave energy at the toe of the cliffs and thereby reduce erosion. It may become necessary to realign the rock, as the cliff retreats to ensure continued management. There is also less certainty regarding what sort of rate of retreat may be expected. Under the worst case scenario, erosion would continue at similar rates to the Do nothing.</p> <p>This would not provide a long term protection to the wind turbine site but should prevent catastrophic loss and allow time for alternative plans to made, such as relocation or simply removal. It would also allow time for investigations into the contamination risk associated with the site.</p>
Environmental	<p>This option would slow erosion and protect the wind turbine site for a time. There is a risk that during severe events the rock would be displaced and transported into the nearshore zone. The origins and nature of the sacrificial material must therefore be considered as it is expected to enter the beach system, potentially moving into adjacent frontages.</p> <p>If there are no further works, in the medium to long term the situation would revert to Do nothing (see Option 1).</p>
Costs	<p>Moderate capital costs associated with placement of rock. Also maintenance costs associated with relocation of rock as required.</p> <p>The Present Value Capital Works are estimated to be £400 k and the Present Value Total Cost with Optimism Bias (PV(OB)c) is estimated to be £640 k.</p>
Damages	This option would not provide a long term protection to the wind turbine site, but may allow time for relocation. If not relocated, damages would be as for Do nothing. The benefits are estimated to be £320 k.

Construct defences once set back (Option 7)

This is would involve monitoring of the situation but effectively Do nothing until there is a need to install new defences in a retired position.	
Technical	The timing of this option will depend upon the future plans for the wind turbine sites. The choice of appropriate defences will therefore depend upon assets at risk and shoreline conditions, given that new defences are unlikely to be required until beyond the medium term.

Environmental	Any asset located behind the proposed defence would be protected, however impacts would be as in Option 1 for any assets seaward of the defence. Further appraisals would be required at a later date. There would be impacts on local landscape character and visual amenity dependant on the location and nature of the setback defence.
Costs	Construction costs would be deferred until later date. Assume Option 4 costs beyond this. The Present Value Capital Works are estimated to be £3,650 k and the Present Value Total Cost with Optimism Bias (PV(OB)c) is estimated to be £5,900 k.
Damages	It is assumed that defences would be constructed to defend future development assets further inland, therefore this option would not protect the wind turbines and there are no quantifiable benefits at present.

2.4.3 11e3.1 - Discussion of Options

Table 5 summaries the cost and benefit calculations for the various options presented above.

The assessments recommended in the SMP to investigate potential contamination risks from erosion of the site should be carried out as soon as possible as the medium term policy is dependent upon this and the most cost effective approach to defence management in 11e3.1 cannot be established until more information is available. Arising from that better understanding, an Asset Management Plan should be developed for this frontage, including stability assessments, overtopping potential, identification of trigger levels, monitoring and responses.

If there is a long term need to Hold the line for large parts of this policy unit, then the most suitable technical approach is to replace many of the existing defences with formal rock revetment, designed to withstand any further erosion over the remainder of the SMP and strategy period. In the central section there may be scope to maintain the existing seawall to provide that protection, although some adaptation or enhancement would be required in due course, and there is even scope to develop a beach in this area if there were other benefits of doing so.

If there is a need to maintain protection in places along the current line for the next 10 to 20 years but not beyond that, then the most suitable approach would be to carry out maintenance and remedial works on the current defences. However, apart from the central 500 m or so of seawall, the remainder has reached a state where it cannot be relied upon to provide that protection and therefore other measures will be required. Those would include the introduction of additional rock to bolster cliff protection and low tech solutions such as gabions to provide some temporary resistance. There may then be opportunity in the future to reuse some of these materials (rock armour and stone from gabion baskets) at other locations once the need to continue defending here has passed.

Where there is no requirement to continue defending on the current line, then no further investment in maintaining the defences might apply. This is effectively what is being implemented at present, but it is resulting in many of those structures becoming a health and safety hazard. As such, mitigation measures are required to manage the risk to the public from accessing those areas, or areas of cliff behind that may now be at risk from collapse.

Table 5 policy unit 11e3.1 Summary of economics

Option	Present Value Capital Works £m	Present Value Total cost (PVC)* £m	PV Benefit (Damage Avoided) £m	Average Benefit Cost Ratio
Option 1 Do nothing	0.00	0.00	0.00	-
Option 2 Hold the line: maintain through reinforcing existing defences	0.55	2.46	0.52	0.21
Option 3 Hold the line: improve through constructing new shore control structures	0.36	7.05	0.52	0.07

Option 4 Hold the line: improve through constructing new revetments or seawalls	a	16.90	27.30	0.52	0.02
	b	4.50	5.90	0.52	0.09
Option 5 Hold the line: improve through beach recharge		0.66	1.54	0.52	0.34
Option 6 Managed realignment: construct erosion slowing defences		0.40	0.64	0.32	0.5
Option 7 Managed realignment: construct defences once set back		3.65	5.90	0.0	-
Additional costed option: 3+5		1.02	15.49	0.52	0.03
<i>*Present Value cost (PVC) inclusive of 60% optimisation bias</i>					

2.5 11e3.2: Siddick to Risehow

This policy unit is much lower lying than units to the south, and can be broadly divided into two areas: the southernmost kilometre (south of Workington WwTW) along which rock revetment has been placed to provide the primary defence; then approximately three kilometres of shoreline north of Workington WwTW, which is generally lower and currently largely unprotected other than a couple of localised defences.

In contrast to other areas further south, there does seem to be a better beach along most of the presently undefended lengths. At the moment, there appears to be little erosion of the unprotected area in front of the railway line except when major storms occur. There are signs of natural recovery of the backshore area following such events; however, in future with sea level rise the presence of the railway and lack of space for this recovery will increasingly limit the potential for that to occur.

2.5.1 11e3.2 - Initial screening of options

The policy here is to continue to Hold the line through to the long term, not simply on the basis of maintaining the railway line but to also provide protection to various assets behind that may be vulnerable to flooding or, eventually, at risk from erosion.

There is reported to be potential for redevelopment of former industrial sites, for example at Flimby.

Table 6 below summarises the rationale for taking long options forward to the short list stage. There are two distinct frontages, a defended frontage south of Workington WwTW and a mainly undefended frontage to the north (including Flimby); therefore, these have been considered separately.

Table 6 Screening of long list options for 11e3.2

(A) South of Workington WwTW:

Long list options	Description	Short listed?	Rationale
Do nothing	No further works undertaken, defences left to deteriorate and fail.	Baseline only	This option would not manage erosion and overwashing risks to the railway line or to various assets behind. It has been assessed for comparative purposes only.
Do minimum	Reactive patch and repair of defences only.	Baseline only	This option would not manage long term erosion and overtopping risks to the railway line or to various assets behind. However, this may become the default option if funding is no longer available.
Hold the line: maintain through	Measures to maintain the existing defences.	Yes	Patch repairs if carried out well and are timely could be effective in maintaining the integrity of the defences for several more

proactive maintenance			years and as such is a viable option to be considered.
Hold the line: maintain through reinforcing existing defences	Low cost measures such as ad hoc rock toe works, gabions to improve longevity of existing defences.	Yes	Options to modify and adapt existing defences may offer a suitable approach to future management of assets along this coastline, although consideration needs to be given to the expected performance and design life to be attained. It is a viable option to be considered.
Hold the line: improve existing defences	Measures to improve defence resilience, such as rock toe works, raising crest levels.	Yes	Options to modify and adapt existing defences, through raising them, strengthening them or providing toe protection, may offer a suitable approach to future management of assets along this coastline, although consideration needs to be given to the expected performance and design life to be attained. It is a viable option to be considered.
Hold the line: improve through constructing new shore control structures	Measures to retain beach material, such as timber or rock groynes, breakwaters.	No	This frontage is more exposed than that at Flimby therefore substantial nourishment and structures are likely to be required, at high cost. This option has not been considered further for this location.
Hold the line: improve through constructing new revetments or seawalls	New shore parallel defences replacing or extending existing defences	No	As the condition of defences is fair to good, there is unlikely to be a need to replace these with new defences.
Hold the line: improve through beach recharge	Addition of new material to beaches.	No	This frontage is more exposed than that at Flimby therefore substantial nourishment and structures are likely to be required, at high cost. There would also be the issue during storms of beach material being swept over the back onto the railway line, so there would be an ongoing need to clear that each time for the railway to be operational. This option has not been considered further for this location.

(B) North of Workington WwTW:

Long list options	Description	Short listed?	Rationale
Do nothing	No further works undertaken, defences left to deteriorate and fail.	Baseline only	Apart from a 450 m sandstone block revetment at the underpass and a short stretch of defences at St Helens, there are no formal defences along this section. However, this option would not manage future erosion and overwashing risks to the railway line or to various assets behind. It has been assessed for comparative purposes only.
Do minimum	Reactive patch and repair of defences only.	Yes (part)	This is not relevant for much of this frontage, where there are no formal defences. This option may be appropriate for the defences at Flimby and at St Helens, which are currently in good condition.
Hold the line: maintain through proactive maintenance	Measures to maintain the existing defences.	Yes (part)	This is not relevant for much of this frontage, where there are no formal defences. This option may be appropriate for the defences at Flimby and at St Helens, which are currently in good condition. Here, patch

			repairs if carried out well and are timely could be effective in maintaining the integrity of the defences for several more years and as such is a viable option to be considered.
Hold the line: maintain through reinforcing existing defences	Low cost measures such as ad hoc rock toe works, gabions to improve longevity of existing defences.	Yes (part)	This is not relevant for much of this frontage, where there are no formal defences, but may be appropriate for the defences at Flimby and at St Helens, where options to modify and adapt existing defences may offer a suitable approach to future management of assets along this coastline, although consideration needs to be given to the expected performance and design life to be attained.
Hold the line: improve existing defences	Measures to improve defence resilience, such as rock toe works, raising crest levels.	Yes	This approach could be adopted at Flimby and at St Helens, where options to modify and adapt existing defences, through raising them, strengthening them or providing toe protection, may offer a suitable approach to future management of assets along this coastline. It is assumed that this option would be combined with constructing new defences to improve protection along the remainder of the frontage.
Hold the line: improve through constructing new shore control structures	Measures to retain beach material, such as timber or rock groynes, breakwaters.	No	Much of the backshore along this frontage is low lying; any beach development solution would need to be higher, and thus wider, to be able to prevent overwash during storm events. In addition, there is no space behind the current beach for natural beach rollback, therefore it would need to extend further seaward, requiring considerable recharge and control structures. There would also be the issue during storms of beach material being swept over the back onto the railway line, so an ongoing maintenance issue to clear that each time for the railway to be operational.
Hold the line: improve through constructing new revetments or seawalls	New shore parallel defences replacing or extending existing defences	Yes	Although there are short stretches of defences, there is not a continuous line of defences here. There are a number of possible options for defences; therefore, this option has been taken forward for further consideration.
Hold the line: improve through beach recharge	Addition of new material to beaches.	No	Much of the backshore along this frontage is low lying; any beach development solution would need to be higher, and thus wider, to be able to prevent overwash during storm events. A possible solution would be a mega scale nourishment (sand engine), such as prototyped in The Netherlands, which would not involve control structures. This would, however, be an expensive option and additional expense would also be incurred to divert culverts and outfalls to prevent further inland drainage issues.

2.5.2 11e3.2 - Development and appraisal of short listed options

(A) South of Workington WwTW

Do nothing (Option 1 (A))

<p>This is considered as a baseline against which other options can be appraised. Under this option all maintenance and management of the defences would cease and defences would be allowed to fail.</p>	
<p>Technical</p>	<p>Beach levels along this frontage and there has also been previous erosion of the backshore, where undefended, and damage to defences. In the future the risk of overwashing and toe erosion may increase. Current condition of defences varies along the shoreline from fair to good, so timing of failure is likely to vary along the frontage and is likely to depend upon the frequency and magnitude of future storms. During storms, beach drawdown can occur, which leaves the defences vulnerable to failure and breach.</p> <p>If not repaired any breaches are likely to worsen, leading to erosion and flooding (where the hinterland is low lying) of assets. Flooding will be the key risk along much of the frontage. The rate at which the spoil slope will erode is uncertain: NCERM estimates of cliff erosion range from 0 to 8 m in the first 20 years, 10 to 20 m by year 50 and 20 to 40 m by year 100, but higher rates could apply depending upon the nature of material re-exposed once the embankment is lost.</p>
<p>Environmental</p>	<p>This option would not reduce risk of flooding or damage from erosion to multiple assets along the frontage. This includes various residential and commercial properties, the Cumbria Coast Line, and the A596. The railway and road serve as important connective routes between Siddick and Flimby and other coastal communities such that damage or reduced operation of these assets would impact on the ability of these communities to connect to the wider area. They are also important strategic routes for industry, in particular Workington Port.</p> <p>The England Coast Path runs adjacent to the coast and along most of this frontage is seaward of the railway line and in places is also seaward of existing defences. This will therefore be lost through erosion, although it is already recognised in the proposals that some sections would need to roll back as a direct result of coastal processes.</p> <p>This option would also impact on the wind turbine site and Workington wastewater treatment works. The latter of these presents a potential contamination risk through repeated inundation and therefore will impact on the WFD objectives of the Solway Outer South waterbody.</p> <p>The coastline would be allowed to return to a more natural alignment; this may benefit the Solway Firth pSPA by allowing the expansion of habitats which support the qualifying bird populations of the pSPA. Assessment of the impacts on the pSPA would require consideration under the Habitats and Species Conservation Regulations (2017).</p>
<p>Cost</p>	<p>There are no costs associated with the Do nothing option.</p>
<p>Damages</p>	<p>The key damages are associated with forced closure and ultimately loss of the railway infrastructure (but operation may be affected before this), damage or loss of Workington WwTW and damage or loss of the A596. The residential and non residential damages are estimated to be £4,460 k (areas A and B combined). Damages related to delays and disruption due to flood risk to the railway have not been quantified at this stage.</p>

Do minimum (Option 2 (A))

<p>This is also considered as a baseline against which other options can be appraised. Under this option only reactive patch and repair maintenance would be undertaken, with no works to address any increase in risk due to sea level rise.</p>	
<p>Technical</p>	<p>Works would be low cost and reactive only, as for Do nothing the future lifespan of the existing defences would depend upon future conditions, for example storm frequency and magnitude. Where repairs are not carried out in a timely manner, then further problems may arise, accelerating time to failure.</p> <p>This would not provide a long term solution, particularly along this stretch where previous interventions suggest there has been undermining in the past.</p>
<p>Environmental</p>	<p>This Option would only result in a delay in the onset of defence failure. Once defences fail, the impacts would be as for the Do nothing option: see Option 1 for details.</p>
<p>Costs</p>	<p>There are no Present Value Capital Works, since works are restricted to patch and repair works only. The Present Value Total Cost with Optimism Bias (PV(OB)c) is estimated to be £380 k.</p>

Damages	The key damages are associated with forced closure and ultimately loss of the railway infrastructure, and risk to properties and business located inland of the railway line. Under this option, works may delay failure beyond that estimated for Do nothing (Option 1) by 10 years. The property related damages are estimated to be £4,290 k (Areas A & B combined). Damages related to delays and disruption due to flood risk to the railway have not been quantified at this stage.
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Hold the line: maintain through proactive maintenance (Option 3 (A))

Measures to maintain the existing standard of protection.	
This is would be a continuation of current activities involving patch repairs to the defences, based upon regular inspections and as part of a scheduled programme of works.	
Technical	In many cases, patch repairs if carried out well and timely, can be effective in maintaining the integrity of the structure for several more years. However, where these are not carried out then further problems can arise which can then necessitate far more substantial and expensive interventions later on. Works to prevent undermining and scour at the toe, together with a proactive approach to remedial works, may help to maintain the stability of this seawall for another 10 to 20 years. Beyond this, the situation may revert to Do nothing if repair works become too expensive or extensive.
Environmental	In the short term, this will continue to manage risks to the railway, road and Workington WwTW. Works will take place along the existing structure, so there is no anticipated impact on landscape quality or qualifying features of Solway Firth pSPA. It is unlikely that such works would be sufficient to delay failure of defence beyond the short term, therefore longer impacts are considered to be the same as the Do nothing option: see Option 1 for details. This option would not address any increase in overtopping risk, which may leave the aforementioned assets at risk of more frequent inundation in the future.
Costs	Cost of patch and repair on an annual basis. The Present Value Capital Works are estimated to be £410 k and the Present Value Total Cost with Optimism Bias (PV(OB)c) is estimated to be £1,000 k.
Damages	The key damages are associated with forced closure and ultimately loss of the railway infrastructure, and risk to properties and business located inland of the railway line. Under this option, works may delay failure beyond that estimated for Do nothing (Option 1) by 10 years. The property related damages are estimated to be £4,290 k (Areas A & B combined). Damages related to delays and disruption due to flood risk to the railway have not been quantified at this stage.

Hold the line: maintain through reinforcing existing defences (Option 4 (A))

This would involve more low cost measures to maintain, but not improve, the existing standard of protection. It could involve rock gabions or similar sacrificial defence options.	
Technical	Rock gabions might offer a temporary solution to quickly fix problems and delay failures by a few more years, but are not going to provide a suitable long term solution. During severe events gabions are likely to become damaged and therefore require repair or replacement, there is also a risk that prior to repair works damage could be caused to the defence behind by subsequent storms. There would be no additional works undertaken to address overtopping and overwashing risk; therefore, this would remain a vulnerability of the existing defences.
Environmental	This option would maintain the current situation in the short term and impacts will be as in Option 3. It is unlikely that such works would be sufficient to delay failure of defence beyond the short term, and therefore it is likely that the situation will revert to Do nothing: see Option 1. Works will take place along the existing structure, so there is no anticipated impact on landscape quality or qualifying features of Solway Firth pSPA. There does, however, need to be consideration as to the origins and nature of the sacrificial material used within the gabions as there is a risk that this could be released to the coastal environment if the gabions fail.
Costs	Cost associated with the continual maintenance and filling the existing voids with rock armour.

	The Present Value Capital Works are estimated to be £380 k and the Present Value Total Cost with Optimism Bias (PV(OB)c) is estimated to be £1,150 k.
Damages	The key damages are associated with forced closure and ultimately loss of the railway infrastructure, and risk to properties and business located inland of the railway line. Under this option, works may delay failure beyond that estimated for Do nothing (Option 1) by 10 years. The property related damages are estimated to be £4,290 k (Areas A & B combined). Damages related to delays and disruption due to flood risk to the railway have not been quantified at this stage.

Hold the line: improve existing defences (Option 5 (A))

	This would involve more substantial measures to maintain the existing standard of protection through improving the resilience of the existing defences. A sound toe structure is needed (i.e. rock armour rather than gabions) to ensure that the wall cannot be undermined by lowering of the foreshore. To address increasing risk due to sea level rise, it may need to be modified by raising, extending (toe) or strengthening.
Technical	This should address the issues of undermining, which is understood to be the key failure mechanism along this frontage. Such works are unlikely to affect adjacent frontages. The overtopping risk would be minimised through increasing the crest level, if and when required. However, such works will require further investigations into the defence structure to assess the ability of the current wall to take the addition load (weight of wall and additional wave loading).
Environmental	This option will allow assets to be defended while also addressing future overtopping risk. There would be an increase in footprint; as the nearshore zone lies within the Solway Firth pSPA, the impacts of constructing rock armour along the toe of the defences would need careful consideration under the Habitats and Species Conservation Regulations 2017, to assess the potential for significant effects on the integrity of the Natura 2000 sites. Impacts on the WFD objectives of the Solway Outer South waterbody would also require further assessment. The construction of new defences may impact on the landscape character and visual amenity of the frontage. The route of the England Coast Path should not be affected, but further assessment may be required at scheme stage.
Costs	Capital cost associated providing a formalised toe to resist scour and storm damage with reduced regular maintenance compared to options 3 and 4. The Present Value Capital Works are estimated to be £1,490 k and the Present Value Total Cost with Optimism Bias (PV(OB)c) is estimated to be £3,090 k.
Benefits	The railway, road and Workington WwTW would remain protected through to the long term from both erosion and overtopping, allowing continued operation. The benefits are estimated to be £4,250 k (Areas A & B combined).

(B) North of Workington WwTW

Do nothing (Option 1 (B))

	This is considered as a baseline against which other options can be appraised. Under this option all maintenance and management of the defences would cease and defences would be allowed to fail.
Technical	Much of this shoreline is undefended, with only short lengths of defences present; therefore, this option represents the current situation. Beach levels along this frontage have varied over time and there has been previous erosion of the backshore, which consists of a grassed bank. Further erosion of the grassed area which lies between the back of beach and the railway line is anticipated in the future, with a very real potential for it to be breached. During storms there will remain a risk that the bank is overwashed resulting in flooding to a strip of hinterland. Flooding will be the key risk along much of the frontage. The rate at which the hinterland will erode is uncertain: NCERM estimates of cliff erosion range from 0 to 8 m in the first 20 years, 10 to 20 m by year 50 and 20 to 40 m by year 100, but higher rates could apply depending upon the nature of material re-exposed as the coastline retreats.
Environmental	This option would not reduce risk of flooding or erosion to this frontage. Residential properties in Flimby as well as Flimby Primary School and other community services would be a risk of flooding or

	<p>damage or loss to coastal erosion. There are also recreational facilities such as playing fields and the England Coast Path which would be at risk.</p> <p>This option would also reduce or prevent operation of the Cumbrian Coast Line, Flimby Station, and the A596 within the frontage. This would impact on the ability of Flimby and other coastal communities to connect to the wider area and have wider implications due to the strategic importance of these transport routes to coastal industries.</p> <p>The nearshore area of the frontage is designated under the Solway Firth pSPA. Impacts of implementing Do nothing on this designation under the Habitats and Species Conservation (2017) and the WFD objectives of the Solway outer South coastal waterbody would require consideration.</p>
Cost	There are no costs associated with the Do nothing option.
Damages	The key damages are associated with forced closure and ultimately loss of the railway infrastructure (but operation may be affected before this) and damage to properties in Flimby. The residential and non residential damages are estimated to be £4,460 k (areas A and B combined). Damages related to delays and disruption due to flood risk to the railway have not been quantified at this stage.

Do minimum (Option 2 (B))

This is also considered as a baseline against which other options can be appraised. Under this option only reactive patch and repair maintenance would be undertaken of existing defences.	
Technical	<p>Along much of the shoreline, the situation would remain as present and Do nothing. Works to existing defences would be low cost and reactive only, and the longevity of these will depend upon any continued erosion of adjacent undefended areas, which may result in outflanking of the defences in their current position.</p> <p>This does not therefore provide a long term solution.</p>
Environmental	For much of frontage the outcome would be the same as Do nothing, but outfalls and section of railway would remain protected for a short time.
Costs	There are no Present Value Capital Works, since works are restricted to patch and repair works only. The Present Value Total Cost with Optimism Bias (PV(OB)c) is estimated to be £130 k.
Damages	There will be continued risk of erosion and flooding due to overwashing along most of frontage. Maintaining defences will continue to protect the outfall for a short time. The property related damages are estimated to be £4,290 k (Areas A & B combined). Damages related to delays and disruption due to flood risk to the railway have not been quantified at this stage.

Hold the line: maintain through proactive maintenance (Option 3 (B))

Measures to maintain the existing standard of protection. This is would be a continuation of current activities involving patch repairs to the defences, based upon regular inspections and as part of a scheduled programme of works; this would only apply to defences, with no works undertaken along the undefended stretches.	
Technical	<p>Along much of the shoreline, the situation would remain as present and Do nothing. As for Option 2 (B), the longevity of existing defences at St Helens and Flimby will depend upon any continued erosion of adjacent undefended areas, which may result in outflanking of the defences in their current position.</p> <p>This does not therefore provide a long term solution.</p>
Environmental	<p>This option would maintain the current situation in the short term, minimising risk of erosion and flooding to environmental assets for a short time, where defences currently exist.</p> <p>As this not a long term solution, the defences will eventually fail and the situation will revert to Do nothing (see Option 1).</p>
Costs	<p>Cost of patch and repair on an annual basis.</p> <p>The Present Value Capital Works are estimated to be £350 k and the Present Value Total Cost with Optimism Bias (PV(OB)c) is estimated to be £720 k.</p>
Damages	There will be continued risk of erosion and flooding due to overwashing along most of frontage. Maintaining defences will continue to protect the outfall for a short time. The property related damages are estimated to be £4,290 k (Areas A & B combined). Damages related to delays and disruption due to flood risk to the railway have not been quantified at this stage.

Hold the line: maintain through reinforcing existing defences (Option 4 (B))

<p>This would involve more low cost measures to maintain, but not improve, the existing standard of protection. It could involve adding additional rock along existing defences and to address issues of outflanking.</p>	
<p>Technical</p>	<p>This option assumes that no additional works are undertaken along the undefended sections but additional rock or rock gabions are added to address issue of outflanking around the existing defences. Gabions would not provide a long term solution, but maybe sufficient to address risks, whilst options for relocation are considered.</p> <p>There would be no additional works undertaken to address overtopping and overwashing risk; therefore this would remain a vulnerability of the existing defences.</p>
<p>Environmental</p>	<p>This option would maintain the current situation in the short term and impacts will be as in Option 3 with the inclusion that if works are stopped, will revert to impacts as in Option 1.</p> <p>The origins and nature of the sacrificial material used within the gabions needs consideration as there is a risk that this would eventually be released to the coastal environment when the gabions fail in the longer term.</p>
<p>Costs</p>	<p>Costs associated with initial placement of rock gabions and subsequent future replacement.</p> <p>The Present Value Capital Works are estimated to be £450 k and the Present Value Total Cost with Optimism Bias (PV(OB)c) is estimated to be £1,080 k.</p>
<p>Damages</p>	<p>There will be continued risk of erosion and flooding due to overwashing along most of frontage. Maintaining defences will continue to protect the outfall for a short time. The property related damages are estimated to be £4,290 k (Areas A & B combined). Damages related to delays and disruption due to flood risk to the railway have not been quantified at this stage.</p>

Hold the line: improve existing defences (Option 5 (B))

<p>This would involve more substantial measures to maintain the existing standard of protection through improving the resilience of the existing defences. A sound toe structure is needed (i.e. rock armour rather than gabions) to ensure that the defences cannot be undermined by lowering of the foreshore. To address increasing risk due to sea level rise, defences need to be modified by raising, extending (toe) or strengthening. Under this scenario it is assumed Option 6 (B) would also apply along some or all of the undefended frontage.</p>	
<p>Technical</p>	<p>This would address the issues of undermining and overwashing. Such works are unlikely to affect adjacent frontages and in combination with Option 6 (B) would avoid risks of outflanking and provide a long term solution to flood and erosion risk.</p> <p>The overtopping risk would be minimised through increasing the crest level, if and when required.</p>
<p>Environmental</p>	<p>The impacts of this option would be as in Option 3. The defence would have a greater footprint and therefore could have potential impact on the nearshore, which lies within the Solway Firth pSPA, and would need careful consideration under the Habitats and Species Conservation Regulations 2017, to assess the potential for significant effects on the integrity of the Natura 2000 site. Impacts on the WFD objectives on the Solway Outer South coastal waterbody would also require further assessment.</p> <p>Improving the existing defences is likely to result in some changes to the local landscape character and visual amenity.</p>
<p>Costs</p>	<p>Capital cost associated providing a formalised toe and reprofiling of the rock armour to resist scour and storm damage with reduced regular maintenance compared to Options 3 and 4.</p> <p>The Present Value Capital Works are estimated to be £1,420 k and the Present Value Total Cost with Optimism Bias (PV(OB)c) is estimated to be £2,530 k.</p>
<p>Benefits</p>	<p>The railway, outfalls and hinterland assets would be protected through to the long term from both erosion and overtopping. The benefits are estimated to be £4,250 k.</p>

Hold the line: improve through constructing new revetments or seawalls (Options 6 (B) a and b)

<p>Under this option, there various possible approaches, such as (a) extension of rock revetments along undefended sections (b) rock revetment plus secondary flood defence.</p>	
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Technical	<p>(a) This frontage is backed by a low bank of spoil material; as such rock revetments may need to be constructed higher, and with some form of backstop, to prevent inundation during extreme storm events.</p> <p>(b) An alternative solution is to have a lower rock revetment or rip rap along the front of the bank to prevent erosion, combined with a flood defence along the rear of the bank to protect other land and property behind. This would probably take the form of a low upstand concrete wall rather than anything more substantial such as a secondary embankment, as there is no space available between the railway and properties to consider this approach.</p>
Environmental	<p>Implementation of additional or extension of rock revetments may result in similar impacts as outlined in Option 3. Construction of defences where previously there have been none are likely to impact on the landscape character and visual amenity of the area. In particular, the construction of a seawall should consider the views from the railway line which is known for its landscape value due to uninhibited views out to sea.</p> <p>As the nearshore zone lies within the Solway Firth pSPA, the impacts of constructing rock armour along the toe of the defences would need careful consideration under the Habitats and Species Conservation Regulations 2017, to assess the potential for significant effects on the integrity of the Natura 2000 site. Impacts on the WFD objectives of the Solway Outer South coastal waterbody would also require further assessment.</p> <p>While the protection of undefended sections of coastline would likely protect the England Coastal Path, the alignment of any secondary flood defence would need to consider this long distance route, and views from this path.</p>
Costs	<p>High capital costs associated with construction of either option. Would involve reduced regular maintenance compared to Options 3 and 4.</p> <p>a) The Present Value Capital Works are estimated to be £12,650 k and the Present Value Total Cost with Optimism Bias (PV(OB)c) is estimated to be £21,490 k.</p> <p>b) The Present Value Capital Works are estimated to be £9,490 k and the Present Value Total Cost with Optimism Bias (PV(OB)c) is estimated to be £16,430 k.</p>
Benefits	<p>This option would ensure continued protection of the wind turbine site and may be required to reduce risk of outflanking of defences to north and south. The benefits are estimated to be £4,250 k.</p>

2.5.3 11e3.2 - Discussion of Options

Table 7 summaries the cost and benefit calculations for the various options presented above.

There is a need to better understand the level of risks to the railway and operations for continued safety and avoidance of unacceptable risk, as sudden erosion or overtopping during storms could result in damage and failure. An Asset Management Plan should be developed for this frontage, including stability assessments, overtopping potential, identification of trigger levels, monitoring and responses. A Flood Risk Assessment for the properties at Flimby and other locations here is also required to establish levels of risk and therefore requirements for that Plan.

There are several alternative approaches to Hold the line in the long term, although the most suitable technical approach is to provide a formal rock revetment. That may however need to be higher than the current low bank level to appropriately manage risks from wave overtopping and flooding in the future.

Table 7 policy unit 11e3.2 Summary of economics

Option	Present Value Capital Works £m	Present Value Total cost (PVC)* £m	PV Benefit (Damage Avoided) £m	Benefit Cost Ratio
Option 1 Do nothing	0.00	0.00	0.00	-
Option 2 Do minimum	0.00	0.51	0.00	-

Option 3 (A&B) Hold the line: maintain through proactive maintenance	0.76	1.72	0.00	-
Option 4 (A&B) Hold the line: maintain through reinforcing existing defences	0.86	2.23	0.00	-
Option 5 (A&B) Hold the line: improve existing defences Option 6 (B) Hold the line: improve through constructing new revetments or seawalls	12-16	22-27	4.25	<1
<i>*Present Value cost (Pvc) inclusive of 60% optimisation bias</i>				

For comment

3 Appraisal of non priority units

There are two additional units within this area, which have been defined as non priority units:

- 11e3.3 Risehow to Maryport Marina
- 11e3.4 Maryport Harbour and Marina

A light touch review has been undertaken of current SMP recommendations, taking into account conclusions from option appraisals for the adjacent frontages, where appropriate.

3.1 11e3.3 Risehow to Maryport Marina

3.1.1 Existing approach to flood and coastal erosion risk management

The SMP policy for 11e3.3 Risehow to Maryport Marina is No active intervention from the short term, through allowing failure of defences. The justification was that there was no economic justification for coastal defences based on erosion or flood risks and that there would be no adverse impacts on Maryport Harbour SSSI or the adjacent WHS.

This is generally an undefended section of frontage (Figure 13), fronting open land with major road and rail infrastructure located some distance landward. There are two localised sections of rock armour protection: around a local promontory and as cliff face protection to a long sea outfall just south of Maryport. These are currently in a Poor condition (CH2M, 2017a), although there has been no recorded change to the defences since the first asset reports from the Regional Monitoring Programme (2012). It is understood that no defence management is be carried out at present, apart from monitoring of outfall armour.

3.1.2 Strategy considerations

Since the SMP2 was adopted there has been a proposal to extend the current SPA, with a change in name from the Upper Solway Flats and Marshes Special Protection Area SPA to Solway Firth SPA. Other than this there have been no changes in environmental designations. The adopted England Coastal Path runs along the crest of the low slag cliffs, following the path of an existing track, but the route is subject to rollback in response to coastal change.

The Scheduled Monument of Rise How Tower, which forms part of the Roman frontier defences along the Cumbrian coast, lies within 100 m of the coast, but inland of the railway line. Maryport Harbour SSSI lies to the north of this unit. The designation covers a strip of grassland and scrapes between the town of Maryport and the sea wall, which supports nationally rare flora and is also an important habitat for the small blue butterfly. The site is currently defined as unfavourable recovering but this is due to human disturbance and exposed conditions, rather than coastal processes.

The hinterland is open grassland and there are limited assets at risk, apart from along the southern stretch of this unit, where the railway line lies within 80 m of the shoreline and there are a few properties. The A596 lies inland of the railway and around 100 m from the shoreline.

There has been ongoing slow erosion of the unprotected slag cliffs, which has previously severed access paths along the cliff top in places (CEUK, 2014). Beach monitoring data (as part of the North West Regional Monitoring Programme) is not collected along this frontage, but reportedly the beach and foreshore at Maryport, to the north, have been progressively lowering and reducing in volume over time (CEUK, 2016; CH2M, 2018).

The SMP2 (Halcrow, 2011) estimated that by year 100, recession of between 10 and 50 m could occur; this is based on analysis carried out as part of Futurecoast (Halcrow, 2002). However, there is no recent data available to confirm these rates.



Figure 13 Maryport frontage, showing low slag slopes fronted by a shingle and sand beach.

3.1.3 Discussion

Based on the assets at risk, there is no justification to change SMP policy at this location. However, at the southern end of this units, the railway line lies closer to the shoreline and here monitoring is required to assess any change in risk. Continued defence of the shoreline to the south may result in some accelerated erosion at the end of defence, which would need to be addressed to minimise risk to the southern end of this unit. This area should therefore be included in any Asset Management Plan developed for unit 11e3.2.

There may be a need to relocate the England Coast Path, but this is already recognised in the proposals, which state *“The proposed route ... south of Maryport is therefore an initial route ... If in the future any part of the trail becomes affected by coastal erosion or other geomorphological processes, or by visible signs of their onset, it would be able to roll back without further reference to the Secretary of State, to a more suitable location landward of the affected area.”*

The northern end of this unit abuts 11e3.4, where the policy is Hold the line. The existing defence along this frontage does extend inland, but there may be a need in the future to improve protection of this: this should be considered in the adjacent unit, rather than here.

Future actions include:

- Monitoring of this frontage, as part of the North West Regional Monitoring Programme could improve estimates of cliff recession and therefore improve assessment of risks, particularly along the southern part of this frontage.
- Inclusion of the southern end of this unit in an Asset Management Plan for Network Rail, to ensure a strategic approach to managing risks along the wider frontage.
- Liaison with Natural England regarding the England Coastal Path that will potentially need to be rolled back in the future.

3.2 11e3.4 Maryport Harbour and Marina

3.2.1 Existing approach to flood and coastal erosion risk management

The SMP policy for 11e3.4 Maryport Harbour and Marina is Hold the line through to the long term (50 to 100 years) through maintaining and upgrading rock and masonry revetments and harbour defences. Justification was that this would maintain the integrity of Maryport town and manage risk to Scheduled Monuments and heritage assets in the harbour area, including the Maryport Lighthouse (Grade II listed). It was recognised that the economic viability of the policy could depend on the commercial and amenity use of harbour and surrounding area.

Maryport Harbour is a Trust Port managed by Maryport Harbour Authority, who are responsible for maintenance and management of the harbour. Maryport Marina is operated by an independent private company.

The defences consist of a sandstone block embankment (constructed in 1860) with access road and marine basin immediately to landward (Figure 14). At the harbour entrance there is a timber framed pier structure with a central concrete core which restricts the movement of sediment northerly across the harbour mouth, causing a build-up of deposits to the south. A concrete outfall groyne crosses the foreshore approximately 300 m from the harbour, which assists in holding beach levels to a degree on its south side (CEUK, 2013). At the southern end, the defence turns inland and abuts the natural shoreline in unit 11e3.3. At this end the toe of the embankment has been protected by rock armour to address lowering beach levels, but this end remains vulnerable and there has been some movement and displacement of armour stone in the past. The condition of the defences is currently defined as Fair (CH2M, 2017a).

Maryport North Pier is of solid construction, with a few surface defects as would be expected for a structure of its age (CEUK, 2013). There is an additional buttress along the toe of the seaward face, presumably to address risk of undermining in the past. At the end of the masonry pier is a timber pier, which is understood to be a navigation rather than coastal defence structure. The overall structure is in Fair condition with no signs of distress.



(a)



(b)

Figure 14 Defences along Maryport Marina: (a) at the southern end of the defences, where they turn inland, rock has been placed to address beach lowering, there has also been concrete encasement of the original structure; (b) to the north, the beach widens in front of the defence, due to sediment build up at Maryport South Pier. Taken from CH2M (2017a).

3.2.2 Strategy considerations

Since the SMP2 was adopted there has been a proposal to extend the current SPA, with a change in name from the Upper Solway Flats and Marshes Special Protection Area SPA to Solway Firth SPA. Other than this there have been no changes in environmental designations. The adopted England Coastal Path skirts the edge of Elizabeth Dock before re-joining the coast at the northern edge of Maryport Coastal Park, Glasson.

Maryport Harbour SSSI covers a strip of grassland and scrapes between the town of Maryport and the sea wall, which supports nationally rare flora and is also an important habitat for the small blue butterfly. The site is currently defined as unfavourable recovering but this is due to human disturbance and exposed conditions, rather than coastal processes.

There are potential coastal erosion risks to Scheduled Monuments and heritage assets in the harbour area, including the Maryport Lighthouse (Grade II listed).

There are ambitions to regenerate Maryport, with a focus on developing tourism in the area. Currently, leisure and tourism activity in Maryport is concentrated around the harbour area (marina, aquarium, museum, The Wave (Maryport Area Coastal Community Team: Economic Plan, Allerdale BC, 2016). It is also understood that Maryport Harbour Authority is actively exploring development opportunities for land at the harbour.

The beach and foreshore at Maryport have reportedly been progressively lowering and reducing in volume over time (CEUK, 2016; CH2M, 2017b; 2018), which has been attributed to the coastline being held further seaward than it would form naturally (CEUK, 2016). Beach monitoring data (from the North West Regional Monitoring Programme) indicate the upper beach levels can fluctuate by up to 0.5 m over time and CEUK (2016) suggests that although the South Pier of Maryport Harbour assists in restraining northwards movement, material is susceptible to being drawn down the beach further offshore, where it can be more readily mobilised for longshore transport by waves and locally induced flows.

3.2.3 Discussion

There is no justification at the current time to change the SMP policy; economic arguments for continuing to Hold the line will be enhanced by regeneration of the marina and harbour area.

The southern corner of the embankment will, however, become increasingly exposed and it is likely that additional works will be required to address this. The policy for the unit to the south (11e3.3) is No active intervention, so there could be continued erosion of the cliffs at this location.

No details of the structure have been obtained and it is not known whether the structure has a solid or granular filled core or its toe depth; both of which will affect its susceptibility to failure. Further investigation is therefore required before the best approach can be confirmed.

It is also recommended that any regeneration plans for Maryport consider potential improvements to the coastal frontage including upgrading the current defence; this would also be an opportunity to improve access and amenity use of the frontage.

The SSSI sits behind the seawall, so maintenance of this structure should continue to protect this designated area, although any change to the defence in the future, such as raising the wall, would need to consider possible impacts that may result due to the change in linkage between the shoreline and this backshore area.

Possible options to address future risk could include:

- Rock toe works: this would be an extension of the current rock toe as required, but consideration would need to be given to the appropriate size of material use, as there has been previous displacement of the existing rock armour. This would not, however, address any future deterioration of the outer masonry layer, which has been addressed previously along sections of this frontage by encasing the lower part with concrete. It is also unknown whether beach lowering is a critical issue along this defence; this depends upon the foundation depth of the structure. There would be limited change in defence footprint therefore impacts on the foreshore and pSPA would be smaller than other options and the SSSI would be unlikely to be affected. The impact on the landscape would also be small.
- New sea wall, with sheet piled toe: this would be costly and would involve extensive and intrusive works with a larger footprint than the current structure, with impacts on marina operations and the wider environment, including the designated pSPA, which will require

various consents. It would also significantly change the landscape. Impacts on the SSSI would also need to be considered as the designation covers the area at the top of the existing wall. This option could, however, be considered as part of any regeneration plans for the marina and would provide long term protection to the frontage and could be designed to improve access along the frontage.

- Full height rock revetment: rather than replacing the structure with a new seawall, an alternative could be to encase the existing structure with a full height rock revetment. It is not known whether an additional sheet piled toe would be required. This would be fairly expensive and would change the landscape of the frontage. It would involve an increased footprint, with an impact on the foreshore and designated pSPA, which will require various consents. Impacts on the SSSI are likely as it includes the grassed area at the top of the wall. This option could, however, be considered as part of any regeneration plans for the marina and would provide long term protection to the frontage and could be designed to improve access along the frontage.
- Modifications to the existing structure: there may be potential to modify the existing structure, such as constructing an upstand wall to reduce risk of overtopping and enhancement of the masonry wall, for example using traditional blockwork stone. This will require further information on the current defence design. There would be no change in defence footprint therefore impacts on the foreshore and pSPA would be minimised. The impact on the landscape would depend upon the materials used. This would not, however, reduce exposure of the structure and further works may be required at a later date.
- Construction of a new groyne: there is evidence that the existing outfall groyne results in some disruption to drift and helps retain a small beach. Extension of this structure, and possible encasement with rock, could be an option which would help retain a wider beach at the exposed corner. Alternatively, a new groyne could be constructed, possibly a small fishtail design, to provide a similar function. A wider beach would reduce exposure of the structure to waves and also reduce overtopping. There would need to be careful consideration of longshore sediment linkages and in particular the possible impact on Maryport South Pier, as this is currently protected by the build-up of sediment (although material is also believed to be lost through draw down). There would be an impact on the foreshore and designated pSPA, which will require various consents. A new defence would also mean a change in the local landscape. There could, however be additional benefits such improving the amenity beach and access along the frontage.

Future actions include:

- Continued inspection and maintenance of harbour structures and embankment in front of the marina, with repairs and remedial works undertaken by Maryport Harbour Authority and Allerdale Borough Council as necessary.
- Liaison between potential developers, the Coastal Community Team and Allerdale Borough Council to develop future regeneration plans and ensure integrated approach to considering coastal erosion and flooding risks along adjacent frontages and to identify potential funding opportunities.
- Further investigations into the design details of the existing structure to improve understanding of its vulnerability and potential failure mechanisms.

4 References

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