



11d1 Hodbarrow Point to Selker

(Technical report by Jacobs)

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Policy area: 11d1 Hodbarrow Point to Selker

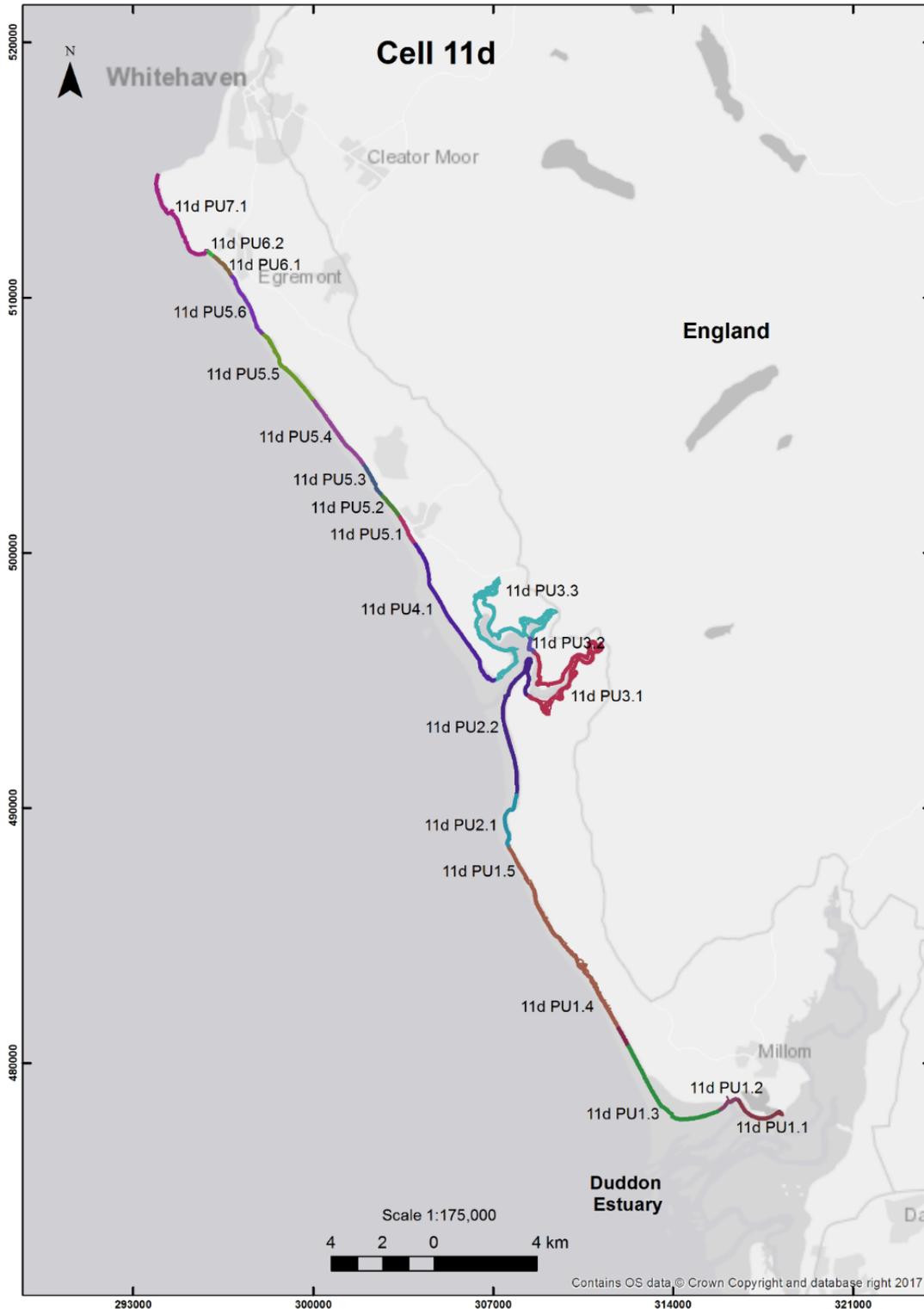


Figure 1 Sub Cell 11d Hodbarrow Point to St Bees Head Location Plan of policy units. Baseline mapping © Crown copyright and database rights, 2019. Ordnance Survey licence number: 1000019596.

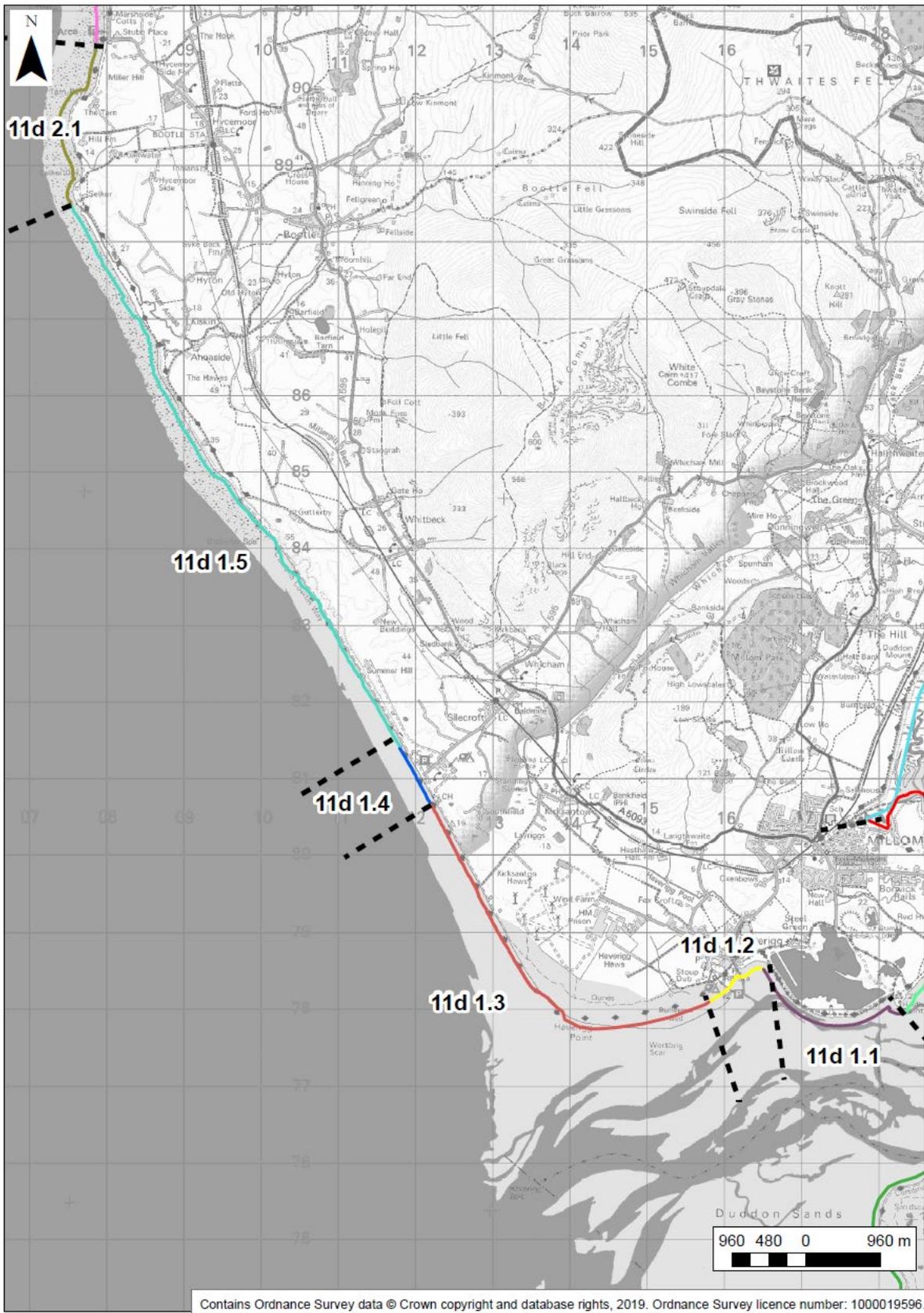


Figure 2 Location of Policy Area 11d1: Hodbarrow Point to Selker. Baseline mapping © Crown copyright and database rights, 2019. Ordnance Survey licence number: 1000019596.

1 Introduction

1.1 Location and site description

Policy units:	<p>11d1.1 Hodbarrow Point to Haverigg (priority unit)</p> <p>11d1.2 Haverigg</p> <p>11d1.3 Haverigg to Hartrees Hill</p> <p>11d1.4 Silecroft (Hartrees Hill)</p> <p>11d1.5 Hartrees Hill to Selker</p>
Responsibility:	<p>Copeland Borough Council</p> <p>Private</p>
Location:	<p>The policy area extends between Haverigg in the south and Selker Point, near Bootle. The shoreline encompasses Hodbarrow lagoon, the sand dune system of Haverigg Haws and the cliffed open coast to the north.</p>
Site Overview:	<p>The frontage commences on the northern bank of the Duddon Estuary, extending along the coast line to the north. The coastline between Hodbarrow Point and Haverigg is artificial (policy unit 11d1.1) and is characterized by the Outer Barrier, which encloses Hodbarrow Lagoon and fixes the backshore position. Hodbarrow Point itself is a rocky limestone outcrop. There is no beach at high water in front of the Outer Barrier, but the area is fronted by an intertidal sandflat. At Haverigg, there is a wide sand beach, crossed by the low water channels of Haverigg Pool, which constrains the lateral extent of the beach.</p> <p>To the west of Haverigg village is Haverigg Haws; a dune belt which widens to the west. At Haverigg Village the dunes are relatively narrow and there are signs of damage, possibly due to recreational use. The dune systems of Kirksanton Haws and Haverigg Haws are complex in form, consisting of linear dunes backed by hummocky and parabolic dunes.</p> <p>Glacial till cliffs are exposed along the backshore at Silecroft and continue north to Selker Point, they are relatively low in height and capped by sand. A shingle spit runs along the length of the River Annas, parallel to the shore for 1.6 km, finally meeting the sea at close to Selker Point.</p> <p>The main villages and communities within the potential risk areas of these policy units are Haverigg, Steel Green and Port Haverigg Holiday village and the outskirts of Millom in the south and Hartrees Hill on the coast further north. Silecroft and Kirksanton are set back from the coast. The hinterland is largely comprised of large tracts of agricultural land and farmsteads. There are a number of isolated properties and access roads between these smaller communities. The Cumbrian Coast Line is located around 900 m or more inland along this frontage so is not at significant risk from coastal erosion here.</p> <p>The frontage has high environmental value with international and national designations covering Hodbarrow Lagoon as well as the sand dunes, intertidal and offshore areas. Haverigg Lagoon is a flooded mine working and the largest coastal lagoon in north west England. The Outer Barrier encloses a large lake with boats of the Port Haverigg Holiday Village in the northwest and the Hodbarrow lake nature reserve within the remains of the inner barrier in the northeast. The Outer Barrier has a central lighthouse.</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), but non priority units have been greyed out.

Table 1 Current SMP Policy for policy area 11d1

<p>Overview: <i>The long term plan is to enable a naturally functioning shoreline and avoid interruption of natural coastal processes. Ongoing accretion of dunes will provide natural defence to much of Haverigg; and where local defence is needed here it can be provided without compromising coastal processes.</i></p> <p><i>This plan will promote a naturally functioning coastline helping to maintain a number of habitats and SSSIs, and preventing habitat loss in the long term and there are strong coastal process links to the Duddon Estuary.</i></p> <p><i>A limited number of properties, parts of a golf course and a strip of agricultural land will be at increasing risk of erosion, so the implementation of this plan will need to manage residual risks to isolated properties and infrastructure.</i></p>				
Location		Policy and Approach (from 2010)		
		0-20 years	20-50 years	50-100 years
11d1.1	Hodbarrow Point to Haverigg	Hold the line – Manage flood risk by maintaining existing defences. During this period future policy should be evaluated to provide justification to repair and upgrade or realign at the end of the structures residual life.	Managed realignment – If deemed not feasible or affordable to maintain the structure into the future. Managed realignment may be required to make allowance for the lagoon becoming tidal upon failure of the structure. However, suitable compensatory habitat would be required.	Hold the line – Manage risk to assets and property in Haverigg either at the Outer Barrier or at set back defences.
11d1.2	Haverigg	Hold the line – By maintaining the rock revetments and Haverigg Pool training wall if required.	Hold the line – By maintaining and improving defences to reduce risk of overtopping and flooding if required.	Hold the line – By maintaining and improving defences to reduce risk of overtopping and flooding if required.
11d1.3	Haverigg to Hartrees Hill	No active intervention – Continued natural erosion of cliffs and evolution of internationally designated dune system.	No active intervention – Continued natural erosion of cliffs and evolution of internationally designated dune system.	No active intervention – Continued natural erosion of cliffs and evolution of internationally designated dune system.
11d1.4	Silecroft (Hartrees Hill)	Hold the line (private funding agreement) – Manage erosion risk by maintaining existing defences to an adequate standard as long as no adverse effects on sediment movement or coastal processes and sustainable to do	Hold the line (private funding agreement) – Manage erosion risk by maintaining existing defences to an adequate standard as long as no adverse effects on sediment movement or coastal processes and sustainable to do so.	Hold the Line (private funding agreement) – Manage erosion risk by maintaining existing defences to an adequate standard as long as no adverse effects on sediment movement or coastal processes and sustainable to do so.
11d1.5	Hartrees Hill to Selker	No active intervention – Continued natural erosion of cliffs.	No active intervention – Continued natural erosion of cliffs.	No active intervention – Continued natural erosion of cliffs.

2 Appraisal of priority units

One unit within this area has been defined as a priority unit:

- 11d1.1 Hodbarrow Point to Haverigg

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 the priority unit. The primary justifications for the policies at the SMP level were:

- Social: Amenity value of the lagoon will be maintained if deemed justified and affordable following investigation. In the event of the lagoon breaching the failed structure would remain into the long term providing calm sheltered waters during the high tide period.
- Environmental: Either nature reserve habitat in lagoon will be maintained if justified, or the coast will return to a more natural state by the lagoon becoming tidal (as in the past). Managed realignment of the lagoon (part of the Duddon Estuary SPA and Ramsar site) is only feasible if freshwater compensatory habitat created.
- Economic: Policy is economically viable but investigations are required to determine best way of managing the defences and the related environmental risks and opportunities.

2.1.2 Current defences

Haverigg Outer Barrier was constructed between 1900 and 1905, the nature reserve and lake is a result of mining work. The structure itself was designed as a dam to prevent the inflow of the sea onto the land that is prone to subsidence from historical mining.



Figure 3 View along Haverigg Outer Barrier looking west towards Haverigg. 2015 aerial © North West Regional Monitoring Programme.



Figure 4 Haverigg Outer Barrier rock and concrete block protection. Taken from CH2M (2017b).

The Outer Barrier is made up of a curved wall over 2 km long, 12 m high, with a maximum crest width of 25 m, and a maximum width at its base of 64 m. The seaward 1 in 1.5 slope consists of 25 tonnes concrete armour blocks on some 475,000 cubic metres of limestone rubble. Reportedly, the landward 1 in 1 slope comprised 26,000 cubic metres of slag, substituted by 415,000 cubic metres of clay fill and 61,000 cubic metres of concrete during construction. The practical completion certificate of this stage is dated 1 October 1904, and the last stone was laid on 13 April 1905 (<http://www.engineering-timelines.com/scripts/engineeringitem.asp?id=876>).

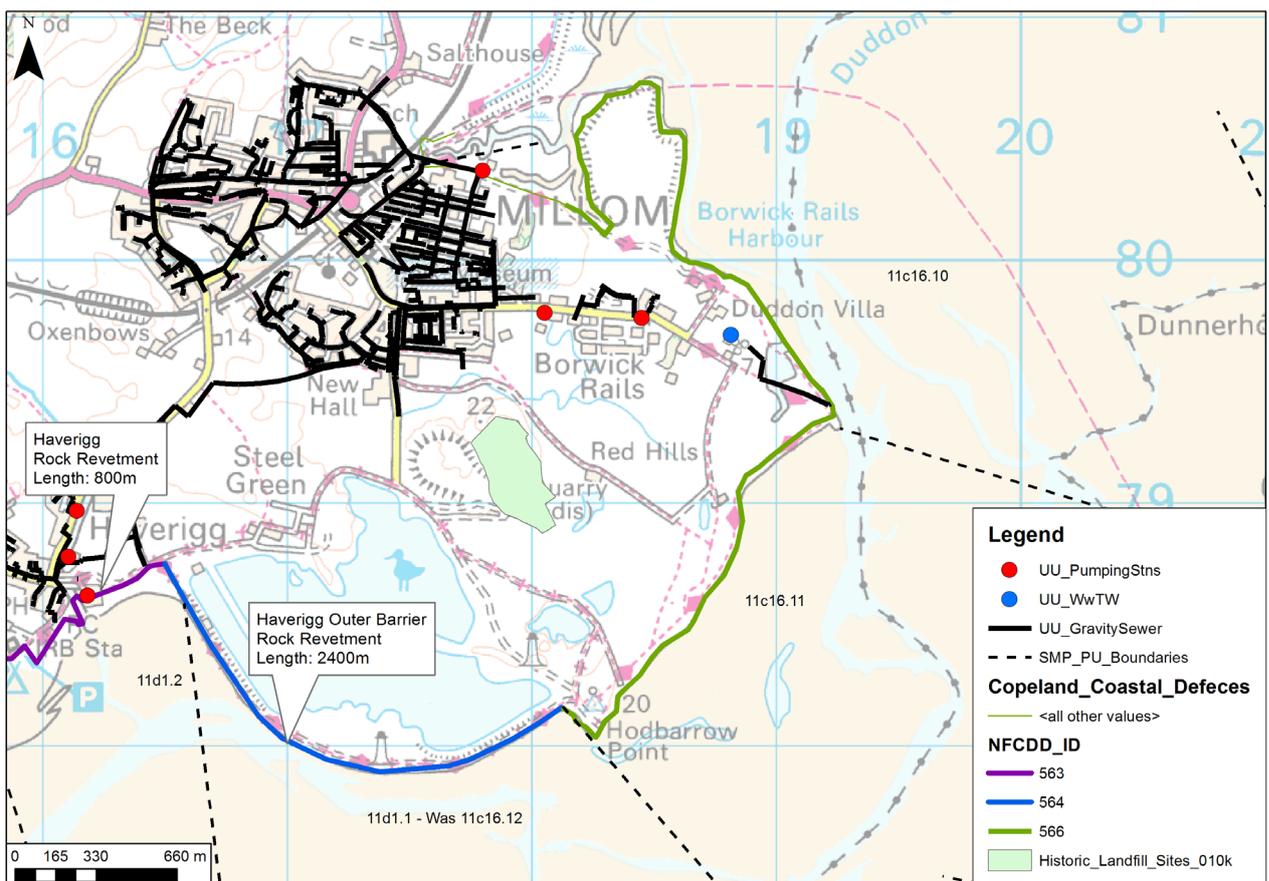


Figure 5 Policy units and summary of defence lengths Around Haverigg Outer Barrier. Baseline mapping © Crown copyright and database rights, 2019. Ordnance Survey licence number: 1000019596.

It is understood that the barrier is a privately managed defence with multiple owners (2001 CECS – reported in CH2M, 2017b). Based upon the most recent asset inspections (CH2M, 2017b), undertaken as part of the North West Regional Monitoring Programme, the condition of the

Haverigg Outer Barrier (EA asset ref. 011KD90280301C02) is good, with a residual life of 20 to 50 years.

Rock armour extends at either end of the Outer Barrier main concrete block structure. The rock is estimated as being 3 to 6 tonnes and the crest height of the revetment is approximately +7.5 mOD.

The asset inspection carried out by CH2M (2017b) identified that the foreshore and channel position appear to be generally stable at the present time, but the defences may be vulnerable to major changes in the estuary regime. There is anecdotal evidence of outfalls from the lagoon, but these no longer function (D Bechelli, pers. comm.) It is understood that waters from the impounded lagoon have been pumped out to sea over the crest of the defences since the previous inspection in 2016 (CH2M, 2017b).

The most recent asset inspection (CH2M, 2017b) further identified that there was no obvious change in the condition of the structure but disturbance of the crest was observed on the west side of the lighthouse and further to the west at new inspection locations.

2.1.3 Shoreline change

The Duddon Estuary is wide relative to its tidal length and is bounded by reclaimed marshland and raised shore platforms. The present surface and near surface sediments of the estuary are predominantly sandy, with extensive mobile sand flats and channels in the lower estuary. There is a major sand dune system at Haverigg Haws. This system has largely developed as a result of littoral sediment drift into the mouth of the estuary from the open coast to the north (Halcrow, 2010).

The shoreline modifications have been primarily as a result of the 19th century mining and quarrying in the area. Various piers and jetties and the Haverigg barrier were built to accommodate this industry. Mining ceased in the 1960s and the area behind the barrier was flooded to provide a lagoon which is a local nature reserve and is used for water sports (Copeland Borough Council, 2015).

Tidal flows into and out of the estuary are strong, and wave action is also significant at high water due to the wide mouth and south westerly exposure (Halcrow, 2010). Predominant waves entering the estuary are generally from the south west. As they move up the estuary, they are significantly modified in direction and reduced in energy by a combination of the shape of the estuary, the shoreline location and the bank and channel arrangements (Copeland Borough Council, 2015). At Haverigg beach, sediment generally moves landward towards the shoreline (Copeland Borough Council, 2015). The pocket beach in front of Hodbarrow Point provides a 'sink' for sediment pushed into the estuary from offshore.

Analysis reports are produced to report on analysis of beach level data collected as part of the North West Monitoring Programme: the Copeland Analysis report covers this frontage. The most recent report includes analysis of data up to 2016 (CH2M, 2017a).

The summary interpretation for the Haverigg Beach and Dunes (11d1.1) section of the Duddon estuary from CH2M (2017a) is:

- **Short term:** Seasonal changes result in elevation changes (both increases and decreases) of up to 1.5 m, resulting from the onshore movement of ridges, as described below. There has been little change in the dune face. Change over the annual cycle has been of slightly greater magnitude, but represents a similar process. It is difficult to distinguish any net trend in terms of beach elevation.
- **Long term:** Generally, behaviour here relates to the development and movement of a series of intertidal ridges (bars) and nearshore banks eastwards towards the Duddon Estuary. The beach ridges (bars) tend to migrate landwards over time, accompanied by steepening of the lower foreshore. In the absence of a major storm event or realignment of channels in the estuary, wave action is likely to eventually drive these bars further onshore and weld them to the existing dune front, leading to advance of the dunes. The key exception to this trend is at the western end of the frontage, where conditions are more exposed. Here there has been erosion of frontal

dune since 2009, most of the observed change resulted from the 2013 and 2014 storms but there is evidence of further erosion since.

2.2 Outline of the problem

2.2.1 Background

Flooding is the key risk within the Duddon Estuary as there are expansive areas of reclaimed marshland around margins of current estuary and river floodplains. There is also a potential flood route through to Millom. There is risk to properties in parts of Millom and in Haverigg and large tracts of agricultural land and farmsteads lie within the flood risk zone. There is also flood risk to the road network, including a short section of the A5093 as well as the access roads which link the small communities. In addition there is a risk of flooding to a short section of the Cumbrian Coast Railway Line which feeds Millom station.

The key feature of the frontage is Hodbarrow Lagoon, a flooded mine, which is the largest coastal lagoon in north west England. To the east of this feature along policy unit 11c16.11 (which is discussed in the report for policy area 11c16) erosion is not currently an issue although in the future erosion may be predicted slightly.

The existing defences are stable and there are currently no areas of concern regarding performance. The revetment crest height is +7.5 mOD so it is inferred that this asset provides flood protection to the land behind.

2.2.2 Issues, constraints and opportunities

The current SMP2 policy is Hold the line in the short term, by maintaining the existing defences, moving to managed realignment in the medium term, once front line defences are no longer technical feasible or affordable. Haverigg is vulnerable to any increase in tide heights as both the village and agricultural land would be inundated if the sea defences were to be breached or overtopped.

The strategy approach for this frontage needs to be considered alongside the approach for 11c16.10 and 11c16.11 due to the combined flood risk to Millom.

The whole of Duddon Estuary is of international conservation importance consisting of intertidal sand and mudflats, important for large numbers of wintering and passage waterfowl. It is covered by a number of national and international designations, namely: Duddon Estuary Ramsar and SSSI, Morecambe Bay SAC, Morecambe Bay and Duddon Estuary SPA. The coastal lagoon behind the outer barrier is also included in the Morecombe Bay SAC and Morecambe Bay and Duddon Estuary SPA.

Statutory heritage designations include the listed building of Hodbarrow mine office, in Haverigg Holiday Village, and Hodbarrow Beacon Scheduled Monument.

Along the crest of the Outer Barrier embankment is a byway which is used as a cycleway and a popular walking route. Natural England is working on proposals to improve public access to the coast between Silecroft and Silverdale, which includes this section (see <https://www.gov.uk/government/publications/england-coast-path-in-the-north-west-of-england>).

United Utilities (UU) assets in Haverigg (11d1.2) include a Wastewater Pumping Station (WwPS) which pumps a 100 mm foul only sewage and is located above some sloping masonry.

2.2.3 Strategy considerations and general approach

Key considerations

Since the SMP was produced further monitoring data has been collated. The strategy has considered this more recent data to appraise:

- recent shoreline change.

- current conditions and level of risk.
- effectiveness of the existing approach to managing coastal flood and erosion risk and their potential impact on shoreline change.
- 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 economic assessments to justify 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.

For the single priority unit of 11d1.1, the following long listed options have been considered:

- Do nothing
- Do minimum
- Hold the line: maintain through proactive maintenance
- Hold the line: maintain through reinforcing existing defences
- Managed realignment – Construct defences once set back.

The second stage has been to appraise the short listed options, section 2.4 outlines 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 is 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. These have been costed and the benefits of the strategic options identified and evaluated. The Do nothing option provides the baseline for the economic appraisal. This is reported in the **Economic assessment** report.

2.4 11d1.1 Hodbarrow Point to Haverigg

2.4.1 11d1.1 – Initial screening of options

Table 2 below summarises the rationale for taking long options forward to the short list stage.

Table 2 Screening of long list options for 11d1.1

Long list options	Description	Short listed?	Rationale
Do nothing	No further works undertaken, defences left to deteriorate and fail.	Baseline only	This option 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 flood risks to property assets. However, this may become the default option if funding is no longer available.
Hold the line: maintain through proactive maintenance	Measures to maintain the defences	Yes	Current defences are in a good condition; therefore, this may be an appropriate solution. Due to the age of the structure, this may involve refurbishment of elements of the structure and then ongoing maintenance to maintain the existing defences.
Hold the line: reinforce existing defences	Low cost measures such as ad hoc rock toe works, gabions to improve longevity of existing defences.	No	Defences currently consist of rock and large concrete block revetment, it is likely that works would either be to maintain the defence (considered in option above) or to improve the defence, potentially by increasing its height or width to reduce overtopping risk (considered in option below). Therefore, this has not be taken forward as a separate option.
Managed realignment: construct new defences once set back	Construction of a new earth embankment or seawall to create a setback line of defence.	Yes	The sustainability of the outer barrier encasing the coastal lagoon may become less viable over time. Consideration of the benefit of the continued provision of the defence and the opportunity to downgrade long term maintenance obligations by constructing a new setback flood line may be appropriate. Therefore, this option has been taken forward for further consideration.

2.4.2 11d1.1 - Development and appraisal of 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 (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	<p>The revetment at the Haverigg Outer Barrier is currently in good condition but without maintenance it is expected that this could start to fail within 20 to 50 years. The Outer Barrier structure is a substantial structure, so failure is likely to be progressive, with the bulk of the structure remaining in place throughout the strategy period. This residual structure would probably continue to provide calm sheltered waters.</p> <p>During the strategy period the hinterland may become exposed to increasing risk of tidal flooding due to sea level rise and reduced protection by the barrier so, this requires further investigation.</p>
Environmental	<p>This option could result in increased risk of flooding to agricultural land, and several properties within Haverigg as well as the Port Haverigg Holiday Park. There is a Listed Building within this holiday park which would also be at risk. United Utilities pumping stations would also be at risk of damage.</p> <p>Though Do nothing would eventually result in a more natural coastline potentially enhancing the designations as outlined within the Do nothing option of other priority units, there is a saline lagoon</p>

	<p>(BAP habitat) which may be damaged or lost should the outer barrier breach. This saline lagoon forms a key part of the Hodbarrow RSPB Reserve and is one of only two examples of this habitat in Cumbria, with the shingle island adjacent to the barrier supporting one of the largest tern breeding colonies in the UK. Do nothing would result in the lagoon becoming tidal with a likely change in habitats and species as a result, the RSPB would also be impacted. Consideration to this site must be given and full assessment of impacts to the SAC, SPA, and Ramsar must be undertaken under the Habitats and Species Conservation Regulations (2017) and impacts to the SSSI must be assessed under the Countryside and Rights of Way Act (2000).</p> <p>As the Haverigg Outer Barrier deteriorates, the well used walking route along the crest would become unsafe for use and could eventually be lost. Any breach could also affect the current amenity value provided by the impounded water level.</p>
Cost	There are no costs associated with the Do nothing option.
Damages	The key damages are associated with potential flood damages to Port Haverigg holiday village, New Hall Farm and potentially south Millom. With possible impacts from flooding of the disused Red Hills quarry. The cost of damages is estimated to be £167,700 k, which is a combination of damages for units 11c16.10, 11c16.11 and 11d1.1. This does not include valuation of ecosystems damages related to changes in coastal habitats in the lagoon.

Do minimum (Option 2)

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.	
Technical	Given the large size of the concrete blocks these are unlikely to require any works; if there were damage large plant would be required to reposition or replace the blocks which would not be feasible under this low cost option. Therefore, the patch and repair works would be restricted to minor repairs on the crest and the rock armour at either end of the Outer Barrier. These would be unlikely to be sufficient to prevent the progressive failure of the defences, in the longer term. The outcome would therefore be similar to Do nothing.
Environmental	Once defences fail, the impacts would be as for the Do nothing option.
Costs	There is no Present Value Capital Cost, since costs are restricted to patch and repair works only. The Present Value Total Cost with Optimism Bias (PV(OB)c) is estimated to be £800 k.
Benefits	<p>The key damages avoided are associated with potential flood damages to Port Haverigg holiday village, New Hall Farm and potentially south Millom. With possible impacts from flooding of the disused Red Hills quarry.</p> <p>It is unlikely, under this option, that works would significantly delay failure at this frontage beyond that estimated for Do nothing (Option 1).</p> <p>The benefits are estimated to be £26,930 k (combined benefits for units 11c16.10, 11c16.11 and 11d1.1 over 30 years).</p>

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

Measures to maintain the existing defences. This would be a continuation of current activities maintaining defences involving annual inspections and periodic maintenance. There would be no works to raise the crest to adapt to rising sea levels.	
Technical	Proactive repairs, if carried out well and are timely, could be effective in maintaining the integrity of the structure. However, options to patch and repair the revetment is not going to provide a long term solution. This would not include for works to reprofile or replace the main armour due to the scale and cost of the plant required. The residual life may be extended by around 10 to 20 years by this option, which allows for reprofiling of the rock in year 20, potentially extending the residual life beyond 50 years.
Environmental	It is unlikely that such works would be sufficient to delay failure of defence in the long term, therefore impacts are considered to be the same as the Do nothing option in the longer term (beyond 50 years): see Option 1 for details.
Costs	<p>As with Option 2 Do minimum, this option would be limited to patch and repair of the crest and rock armour with the inclusion of annual inspections, as per current practice.</p> <p>The Present Value Capital Cost is estimated to be £1,510 k and the Present Value Total Cost with Optimism Bias (PV(OB)c) is estimated to be £3,310 k. Assumes capital works are undertaken in year 20.</p>

Benefits	<p>The key damages avoided are associated with potential flood damages in the long term to Port Haverigg holiday village, New Hall Farm and potentially south Millom. With possible impacts from flooding of the disused Red Hills quarry.</p> <p>The benefits will depend upon works undertaken in 11c16.10 and 11c16.11. If only do minimum is undertaken here, then combined benefits would be as shown for Option 2 in the summary table below (26,930k). However, if Hold the line or Managed realignment options are undertaken in 11c16.10 and 11c16.11, then overall the defence could provide up to a 50 year design, with combined benefits estimated to be £34,690 k.</p>
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Managed realignment: construct sea defences once set back (Option 4)

This approach will only be required if flood risk to assets is considered significant enough to warrant intervention. Two potential options that may be considered are: (a) seawall and (b) embankment	
Technical	<p>This option would leave the Outer Barrier in place and manage the flood risk to assets along the setback frontage. As the defences will be set back their degree of exposure will be less than the Outer Barrier due to its protection.</p> <p>The new structure would be designed to withstand the waves and water levels that might be expected and provide a long term solution to future flood risk issues. The set back defences would only be required if a breach were to form in the Outer Barrier, increasing flood risk to the hinterland.</p>
Environmental	<p>Option (a) would involve a new structure along the coastline but the embankment (b) could be set further back, to manage the flood risk route to Millom and Haverigg. There would be little impact on longshore drift as most of the Outer Barrier is expected to remain in place.</p> <p>The location of the new defences would need to be determined in a more detailed study. Under option (a) the structure would probably be constructed within the areas of environmental designation, which extend landward of the lagoon. Additionally, holding the line at a set back location may still constrain the natural evolution of the frontage, which may affect these designations. Full impacts on these would need to be assessed under the Habitats and Species Conservation Regulations (2017) and the Countryside and Rights of Wat Act (2000). Any impacts on the WFD objectives of the relevant waterbodies including Duddon Sands coastal waterbody as a result of this option should be assessed. This option would only be implemented if there was a high risk of breach of the Outer Hodbarrow Barrier, and so needs to also consider the potential loss of the saline lagoon (BAP Habitat) and potential impacts to the RSPB Reserve.</p> <p>As this would involve a new structure there would be implications for the landscape character and the visual amenity of the frontage. As much of the frontage currently has views of the lagoon from the properties of Port Haverigg Holiday Park that are unobstructed, construction of a new hard engineered defence may result in significant changes.</p>
Costs	<p>Significant cost of building a new defence at a set back location (embankment or seawall).</p> <p>In case of building a seawall, the Present Value Capital Cost is estimated to be £4,580 k and the Present Value Total Cost with Optimism Bias (PV(OB)c) is estimated to be £7,400 k.</p> <p>In case of building an embankment, the Present Value Capital Cost is estimated to be £9,670 k and the Present Value Total Cost with Optimism Bias (PV(OB)c) is estimated to be £15,540 k.</p> <p>The present value cost estimates above assume that the capital works would be implemented in year 50.</p>
Benefits	<p>Both options would provide flood risk protection to south Millom and potentially Port Haverigg holiday village (although this could be relocated) and New Hall Farm. Assuming Hold the line or Managed realignment options are undertaken in 11c16.10 and 11c16.11, the monetised benefits for the whole flood cell would be £159,410 k, (including benefits for 11c16.10 and 11c16.11) over 100 years. However, the environmental and amenity damages and benefits associated with the change to the lagoon have not been monetised.</p>

2.4.3 11d1.1 - Discussion

Table 3 provides an economic summary of costs and benefits for the various options considered above combined with policy units 11c16.10, 11c16.11 and 11d1.1 due to the shared damages or benefits within the combined flood cell. Options considered here should be read in conjunction with options proposed for policy units 11c16.10 and 11c16.11.

The Haverigg Outer Barrier is a substantial structure and given its age it is in a good condition. It is considered that the private owners may continue to provide minor maintenance for the foreseeable future but that more substantial repairs if required in future may not be affordable due to the scale

of works that may be required. It is therefore considered that in the longer term maintenance will become unsustainable. A review of potential flood risk to properties is required once the defence fails to determine the location or extent of any new managed realigned defence.

The SMP recommended that a flood risk options study for Millom and Haverigg be undertaken to allow options to renew or retreat at the end of the existing structures residual life. This should include evaluating the environmental risks and habitat losses and gains and needs for compensatory habitat under realignment options. At the present time the failure mechanism that could lead to potential breaching and breach locations are not well understood, but it is expected that the majority of the structure is likely to remain in place over the duration of the strategy even if breached by storm damage.

The SMP policy suggests realignment may be required during the medium term, 20 to 50 year epoch. However, given the current good condition and the substantial nature of the armouring the defences may be sustainable beyond 50 years with only minor maintenance and therefore the need for realignment to a set back defence could potentially be deferred into the 50 to 100 year epoch. This could, for 11d1.1, defer the short term need for a more detailed study of the approach to the set back defences, long term implications of future conditions on the barrier and the need for mitigation or replacement of currently protected habitats.

If a change in medium term SMP policy were to be considered, an SMP Change Process would need to be initiated. Any proposed changes to SMP policy should include community and stakeholder consultation prior to being submitted for approval by local authority cabinet, submission to the Regional Flood and Coastal Committee (RFCC) and final approval by the Environment Agency.

Table 3 Policy units 11c16.10, 11c16.11 and 11d1.1 summary of economics for a range of option combinations

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 (11c16.10, 11c16.11 & 11d1.1)	0	0	0	-
Option 2 Do minimum (11c16.10, 11c16.11 & 11d1.1)	0	0.81	26.93	33.13
Option 3a Hold the line: improve through constructing new seawalls (11c16.10, 11c16.11)/ Option 4 Managed realignment - set back defences (11d1.1)	15.98	25.95	159.41	6.14
Option 3b Hold the line: improve through constructing new embankments (11c16.10, 11c16.11)/ Option 4 Managed realignment - set back defences (11d1.1)	18.03	29.84	159.41	5.34
Option 4 Set back embankments in 11c16.11 and 11d1.1, new revetment in 11c16.10.1)	17.64	28.77	159.41	5.54
<i>*Present Value cost (PVC) inclusive of 60% optimism bias</i>				

2.4.4 11d1.1 - Strategic way forward

The existing SMP proposes a change from hold the line to managed realignment in the medium term, with a recommendation for a specific study to consider future options. This study has not yet been undertaken.

Given the current good condition and the substantial nature of the armouring, the defences may be sustainable beyond 30 years with only minor maintenance (Option 2 Do Minimum) and therefore the need for realignment to a set back defence could potentially be deferred. However during this period the recommended study should be undertaken, involving consultation with local authorities, landowners, Natural England and RSPB to consider feasible future options. This approach also needs to be developed in combination with flood defence measures in policy units 11c16.10 and 11c16.11.

The recommended strategic approach from the short term is therefore to continue maintenance of defences (Do minimum) and to monitor ongoing condition of the defences.

Future recommended activities include:

- Inclusion of frontage in a South Millom coastal flood risk study to review all sources of flood and erosion risk to Millom and Haverigg, including frontages 11c16.10 to 11d1.2.
- Continued monitoring of intertidal and beach change, as part of the North West Regional Monitoring Programme to appraise changes in risk level.
- Continued inspection and private maintenance of the existing structures, with repairs and remedial works undertaken as necessary.

Further details on actions and responsibilities are provided in the **Action Plan**.

3 Appraisal of non priority units

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

- 11d1.2 Haverigg
- 11d1.3 Haverigg to Hartrees Hill
- 11d1.4 Silecroft (Hartrees Hill)
- 11d1.5 Hartrees Hill to Selker

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

3.1 11d1.2 Haverigg

3.1.1 11d1.2 - Existing approach to flood and coastal erosion risk management

The existing SMP2 policy along policy unit 11d1.2 Haverigg is Hold the line for the next 100 years. The primary justification of this policy is to manage flood risk to the village of Haverigg, associated infrastructure and wider flood risk area by maintaining existing defences.



Figure 6 Eastern extent of 11d1.2 showing the jetty and rock revetment adjacent to Hodbarrow Lagoon. Aerial photograph © North West Regional Monitoring Programme, 2013.

Only minimal erosion is predicted for the area fronted by a rock revetment, adjacent to Hodbarrow lagoon, in the future (NCERM) and at the short section of harbour jetty or revetment no significant change is expected over the next 100 years. There are however larger changes anticipated for the undefended area to the west of this, where between 15 and 40 m of change may occur in the next 100 years.

Areas of Haverigg do fall within the boundaries of Environment Agency Flood Zones 2 and 3. The tidal flood pathway is via Haverigg Pool. Haverigg is also at risk of surface water and fluvial flooding

from Haverigg Pool and there was a significant flood event following heavy rainfall in September 2017 (CCC, 2018). There are tidal flood defences around Haverigg Pool that are maintained by the Environment Agency and although they may have been close to overtopping in previous storms there are no reports of flooding. In the medium to long term there will be a need to adapt these defences to sea level rise.

Table 4 Existing Defence Details, taken from the latest coastal asset inspection (CH2M, 2017b)

Location	Structure Type	Length (m)	Crest Level (mOD)	Foreshore Toe Level (mOD)	Residual Life (years)	Responsibility
Haverigg (11d1.2)	Rock Revetment	800	+7.5	-0.88 to -3.67	20-50	Copeland Borough Council
Haverigg Pool tidal defences	Raised flood walls and tidal flap valve	180	unknown	unknown	unknown	Environment Agency

The policy to the east of the unit (11d1.1 Hodbarrow Point to Haverigg) is Hold the line for the first and long term epochs, with Managed realignment to a set back position in the medium term if required. More recent asset information suggests that the defences may be sustainable beyond 50 years with only minor maintenance (Option 2 Do Minimum) and therefore the need for realignment to a set back defence could potentially be deferred into the 50 to 100 year epoch (see section 2.4).

The policy unit to the west (11d1.3 Haverigg to Hartrees Hill) is No active intervention for the next three epochs, however as the defences do not cover the entire length of policy unit 11d1.2, there is opportunity in the future to extend the defences should outflanking be a problem, without extending into policy unit 11d1.3. This would, however, be subject to necessary consents.

3.1.2 11d1.2 - Strategy considerations

There are national and international designated sites within this area. The Duddon estuary is a SSSI and SPA as well as SAC and Ramsar site. The status of the SSSI sites are favourable (with one exception, linked to scrub management) and although the SMP policy is Hold the line, the area was considered to be naturally accreting, so not presently undergoing habitat loss.

Haverigg village has a small population and community, set back from the coastline and fronted by established vegetation. There is also beachside parking and easy access to the beach across the revetments. The policy unit also contains an important road and coastal connection routes for the offshore windfarm.

The tidal flood risk at Haverigg was reduced by the construction of two rock groynes either side of the jetty, approximately 20 years ago, however recently water levels are reported to be beginning to reach the top of the sea wall. Future raising of the defences should be considered to manage the increasing flood risk to the village due to climate change.

3.1.3 11d1.2 - Discussion

There is no justification for any change in policy, which supports the small coastal village of Haverigg.

In the medium long term, should the dune system to the west of the rock revetment erode, it may be necessary to consider realigning the defence to prevent outflanking and maintain the current level of protection against flooding. Therefore, an intermediate area, whereby defences can be built around the area of outflanking should be considered. This activity can be undertaken within the policy unit and does not need to extend into the adjacent unit which is an area of No active intervention.

In the long term, management of this frontage is likely to be affected by any change in management of Hodbarrow Lagoon (unit 11d1.1), which in turn is related to management of the wider flood risk to Millom and Haverigg.

3.1.4 11d1.2 - Strategic way forward

The proposed strategic approach is to continue to Hold the line through maintaining existing defences. These may require improvements in the future, through raising the crest level and possibly extending defences. However, timing and justification for possible future works should be considered in conjunction with reviewing the standard of protection required as part of the Haverigg and Millom flood risk modelling study.

Future recommended activities include:

- Inclusion of frontage in a South Millom coastal flood risk study to review all sources of flood and erosion risk to Millom and Haverigg, including frontages 11c16.10.1 - 11d1.2.
- Continued monitoring of intertidal and beach change, as part of the North West Regional Monitoring Programme to appraise changes in risk level. The present monitoring data type, frequency and accuracy is considered generally appropriate for informing coastal flood and erosion risk management at this location, although it was recommended that monitoring of the dune toe position at Haverigg would be beneficial to confirm the suspected advance of the dune toe position, and the degree and extent of any recession during adverse conditions (CH2M, 2018).
- Continued inspection and maintenance of the existing structures, with repairs and remedial works undertaken as necessary. Consider development of a management plan to indicate the need for advance planning of works, including identification of possible funding sources and suitable options. This should include consideration of the need for future raising of defences at Haverigg to adapt to rising sea levels and maintain protection to the hinterland from coastal flooding.
- Safe siting of the England Coast Path; Natural England is working on proposals to improve public access to the coast between Silecroft and Silverdale. (see <https://www.gov.uk/government/publications/england-coast-path-in-the-north-west-of-england>).

Further details on actions and responsibilities are provided in the **Action Plan**.

3.2 11d1.3 Haverigg to Hartrees Hill

3.2.1 11d1.3 - Existing approach to flood and coastal erosion risk management

The existing SMP2 Policy for policy unit 11d1.3 Haverigg to Hartrees Hill is No active intervention for the next three epochs. The primary justification for the policy was that it allows a continuation of natural processes conducive to the international and national conservation designations, namely the Duddon Estuary SSSI, Morecambe Bay SAC, Morecambe Bay and Duddon Estuary SPA and Ramsar site.



Figure 7 Views North over Kirksanton relict dune system, showing shingle upper beach and extensive sandy foreshore. Aerial photograph © North West Regional Monitoring Programme, 2015.

There are no formal defences within 11d1.3 Haverigg to Hartrees Hill. This policy unit abuts two policy unit areas which SMP2 policy is to Hold the line for the next three epochs.

NCERM estimated between 15 and 40 m of erosion within this frontage in the next 100 years (NCERM, 2010), whilst in both the short and medium term it was expected that a maximum of 15 m recession could occur.

3.2.2 11d1.3 - Strategy considerations

The Duddon Estuary has a high environmental value, covered by SSSI and SAC, SPA and Ramsar designation. The status of the SSSI sites are favourable (with one exception, linked to scrub management) and the SMP policy is in accordance with the management principles for this designation, by allowing coastal processes to proceed freely. No active intervention allows this section of coast to respond naturally to sea level rise, notably by “maintaining (or restoring where necessary) the natural processes and dynamics of dune development and succession.” (Natural England Views About Management (VAM) statement, 2005¹).

The dunes along the south facing stretch are linear in form, backed by hummocky and parabolic dunes. These linear dunes may indicate the system is currently prograding (advancing seaward) and this seems to be the case in the lee of the shingle ridges (CH2M, 2018). Along the east facing stretch of open coast, parabolic dunes are present along the coastal edge and erosion of these has resulted in blowouts (areas of bare sand, usually of lower elevation than the surrounding dunes). Parabolic dunes are more indicative of mature systems and exposure of these may suggest a net trend of erosion along this stretch of frontage (CH2M, 2018). Sediment released from this section is likely to be feeding the adjacent stretch of prograding dunes (CH2M, 2018). Much of the dune system has been modified for its previous use as an airfield, and it is currently a site for a windfarm. The dune belt has also been used for a golf course and agricultural use.

The dunes provide natural coastal defence to low lying hinterland including Haverigg Prison, Haverigg and Kirksanton.

¹ The VAM is available online: <https://designatedsites.naturalengland.org.uk>

3.2.3 11d1.3 - Discussion

There is no justification for any change in policy, which supports the international and national conservation designations by allowing natural coastal processes to continue. Therefore, the recommendation would be for the policy to remain.

3.2.4 11d1.3 - Strategic way forward

The preferred strategic approach is to implement the SMP policy of No Active Intervention through Do nothing, allowing natural coastal processes to continue, with the dune systems providing natural defence to the low lying area.

Future activities include:

- Continued monitoring of the beach and dunes, as part of the North West Regional Monitoring Programme. The present monitoring data type, frequency and accuracy is considered generally appropriate for informing coastal flood and erosion risk management at this location (CH2M, 2018). The data collated should continue to monitor impact of holding the line at Silecroft.
- Safe siting of the England Coast Path, the route of which is still to be decided.

Further details on actions and responsibilities are provided in the **Action Plan**.

3.3 11d1.4 Silecroft (Hartrees Hill)

3.3.1 11d1.4 - Existing approach to flood and coastal erosion risk management

The current SMP2 policy for policy unit 11d1.4 Silecroft (Hartrees Hill) is Hold the line for the next three epochs. The justification for this policy is that it allows management of erosion risk to the car park, beach access and properties. It was considered in the SMP that these private defences were not significantly reducing the sediment supply in relation to the large section of undefended cliffs.

Private defences, mostly in the form of gabion baskets are present. These have a crest level of between +6.0 to +8.5 mOD and estimated residual life of 10 to 20 years (CH2M, 2017b). The policy for adjacent units (11d1.3 Haverigg to Hartrees Hill and 11d1.5 Hartrees Hill to Selker) is No active intervention; therefore, outflanking of these defences may be an issue in the future.

Across the frontage, erosion is expected to increase between the present and the next 100 years, ranging from 2 to 5 m in the short term, 5 to 15 m in the medium term and 15 to 40 in the long term (NCERM, 2010).



Figure 8 Hartrees Hill and caravan site, showing shingle beach and large sandy foreshore, with private defences fronting properties. Aerial photograph © North West Regional Monitoring Programme, 2015.

3.3.2 11d1.4 - Strategy considerations

The SMP allows for long term maintenance of the private defences, however any change or extension to the existing defences would require appropriate consents. Further development of the car park at Raywick Hole has been proposed, which is currently permissible under the Hold the line Policy; however, there could be implications for holding this in the longer term. Increased visitor numbers are anticipated due to the newly designated Lake District World Heritage Site: development of a car park at this location is in response to this.

There are no statutory environmental designations covering the foreshore along this frontage, although it does fall within the buffer zone of the Duddon Estuary SSSI, but adjacent to the coast is the Shaw Meadow and Sea Pasture SSSI. Part of the site is in unfavourable recovering status (last assessed in 2009), but this is due to gorse and willow encroachment rather than a coastal management issue.

This frontage lies within the Lake District National Park, which has recently become a World Heritage Site.

3.3.3 11d1.4 - Discussion

There is currently no justification for changing the policy within this unit as there is insufficient evidence that current defences are significantly impacting adjacent sites. The conceptual coastal processes assessment from the regional monitoring studies, (CH2M, 2018, CH2M, 2017a) indicates that annual longshore drift direction is variable due to the alignment near perpendicular to the predominant wave direction and is understood to be typically northwards but southwards under certain conditions. It was also noted that the beach monitoring data (2012 to 2016) indicates accretion on upper beach at Silecroft and although the cause was uncertain it could be influenced by the defences and should be monitored further in future as the SMP policy is contingent on the defences not adversely impacting natural processes.

Under the current policy, the private defences will therefore continue to provide protection to properties in Hartrees Hill, Silecroft. However, should erosion rates accelerate in the future, these may become increasingly exposed and difficult to retain and may begin to have impacts on wider coastal processes. At this time, the potential for setting back the defences should be considered. This would also apply to any new defences required for the car park at Raywick Hole.

3.3.4 11d1.4 - Strategic way forward

The preferred strategic approach is to implement the SMP policy of Hold the line, through repair and maintenance to the existing private defences, while sustainable, and subject to defences causing no adverse effects on sediment movement or coastal processes.

Future activities include:

- Continued monitoring of the beach and dunes, as part of the North West Regional Monitoring Programme. The present monitoring data type, frequency and accuracy is considered generally appropriate for informing coastal flood and erosion risk management at this location (CH2M, 2018). The data collated should continue to monitor impact of holding the line here.
- Safe siting of the England Coast Path, the route of which is still to be decided.
- Determining future defence requirements for the car park and identification of who will pay for these.

Further details on actions and responsibilities are provided in the **Action Plan**.

3.4 11d1.5 Hartrees Hill to Selker

3.4.1 11d1.5 - Existing approach to flood and coastal erosion risk management

The present SMP2 policy for policy unit 11d1.5 Hartrees Hill to Selker is No active intervention for the next 100 years. The primary justification for the policy was that it allows a continuation of natural processes conducive to the international and national conservation designations located both to the north and south.

There are no formal defences along the frontage.



Figure 9 The northern extent of 11d1.5 where the stable shingle spit fronting the River Annas protects the coastline behind. Aerial photograph © North West Regional Monitoring Programme, 2009.

For the majority of the frontage, NCERM estimated between 15 and 40 m of erosion within this frontage in the next 100 years (NCERM, 2010). Furthermore, in both the short and medium term it is expected that a maximum of 15 m will occur. A section of coast approximately 1 km long is not expected to change significantly as it is protected by a large spit of shingle, which constrains the Annas River. However, natural changes to this spit can cause local flooding issues due to impinging on river flows.

Flood Zones 2 & 3 extend along the (rural) flood plain of the River Annas, although the area at risk of flooding is relatively small in relation to the wider policy unit.

The SMP2 policy to the south of the unit, 11d1.4 Silecroft (Hartrees Hill), is Hold the line. In the long term future this may cause some impact on alongshore drift erosion to this unit as the coastline erodes. To the north of this unit the policy is No active intervention.

3.4.2 11d1.5 - Strategy considerations

The hinterland is largely agricultural and does not support a high population.

The cliffs between Gutterby and Annaside are covered by Annaside and Gutterby Banks SSSI. This is a geological site comprising soft sea cliffs that are constantly being eroded by the actions of the sea. Natural processes are continuing creating fresh exposures and removing debris and this is a key element of the designation. Currently the site is in favourable condition (last assessed: 2014).

Further north, there is a small SSSI site, Annaside SSSI, which covers the area fronted by the shingle spit, that is designated for its important breeding population of natterjack toads. Currently the site is in favourable condition (last assessed: 2014), however during this survey it has been noted that severe storms moved the beach shingle ridge back significantly over winter 2013 and 2014, impinging on river flow.

The River Annas used to cut through the spit into the sea, however there are current issues of water becoming landlocked during storms. Previous potential solutions have considered creating a culvert through the shingle spit to allow water to escape.

3.4.3 11d1.5 - Discussion

Due to the low risk of flooding or erosion to the population within policy unit 11d1.5, alongside the need to allow natural processes continue within the nature designations, there is no justification to change the policy within this unit. There are no defences on the frontage and no justification for significant intervention. However, low cost management options should be considered to manage the tidal locking of the river during storm events if this continues to be an ongoing problem.

Should the shingle bank along the River Annas roll back and push the river onto the SSSI, this may cause the SSSI to become less favourable to natterjack toads. However, this would be part of a natural process.

3.4.4 11d1.5 - Strategic way forward

The preferred strategic approach is to implement the SMP policy of No active intervention, through Do nothing whilst allowing local management measures to manage tide locking at Annaside spit.

Future recommended activities include:

- Continued monitoring of the beach and dunes, as part of the North West Regional Monitoring Programme. Specifically, focus should be on appraising changes to the Annaside spit.
- Monitoring of flood risk relating to natural changes to Annaside spit and possible consideration of management measures to manage the risk. As this would impact on the SSSI site, consent will be required from Natural England. Therefore, early consultation with Natural England is recommended.
- Safe siting of the England Coast Path, the route of which is still to be decided.

Further details on actions and responsibilities are provided in the **Action Plan**.

4 Summary of proposed strategy: 11d1

Preferred strategic approach: Environmental enhancement – allow the area to function as naturally as possible and look for environmental opportunities, whilst maintaining existing defences at Haverigg and Hodbarrow Lagoon to manage wider scale flood risks.

		Next 10 years	Beyond 10 years
11d 1.1	Hodbarrow Point to Haverigg	Do minimum, with private maintenance of defences. Include frontage in review of all sources of flood risk to Millom and Haverigg.	Continue to reduce risk to assets and property in Haverigg and Millom - maintain and monitor condition of the Outer Barrier, reviewing approach if necessary.
11d 1.2	Haverigg	Maintain existing defences and review standard of protection provided as part of Haverigg and Millom flood risk modelling study to determine timing of possible future defence raising.	Continue to manage risk of coastal erosion and flooding to assets and property in Haverigg. Review risk of outflanking if dunes erode and justification for raising defences.
11d 1.3	Haverigg to Hartrees Hill	Allow area to function as naturally as possible with the dune systems providing natural defence to the low lying area.	
11d 1.4	Silecroft (Hartrees Hill)	Repair and maintenance to the existing private defences subject to defences causing no adverse effects on coastal processes.	Continue to manage risk of coastal erosion to assets and property in Hartrees Hill, Silecroft, considering potential for setting back the defences.
11d 1.5	Hartrees Hill to Selker	Allow area to function as naturally as possible, through a Do nothing approach, whilst allowing localised measures to manage fluvial risk related to blockage of the Annas by the spit.	Allow area to function as naturally as possible but recognising the flood risk caused to hinterland by the migration of Annaside spit.

Key actions and activities (next 10 years):



- Monitor condition of defences
- Monitor foreshore levels, cliff, dune and shoreline change
- Monitor flood risk relating to natural changes to Annaside spit
- Monitor of impacts of defences at Silecroft on coastal processes



- Maintain existing defences where required and subject to funding
- Implement measures to address tide-locking by Annaside spit



- Millom and Haverigg flood risk study (with 11c16.10 and 11c16.11) to review all sources of flood and erosion risk to Millom and Haverigg. Including considering standard of protection provided by existing embankments and establish monitoring of saltmarsh change to determine if/when works will be needed to increase standard of protection.



- Liaison between stakeholders as part of South Millom coastal flood risk study
- Determine future defence requirements for the car park and identification of funding

Further details on actions and responsibilities are provided in the **Action Plan**.

5 References

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