REPORT (FINAL)

# Minehead Beach Management Plan

*Prepared for*

Environment Agency, West Somerset Council and Somerset County Council (Highways)

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# Executive Summary

This Beach Management Plan (BMP) covers the section of west Somerset coastline from the Culver Cliffs, located to the west of Minehead, to Blue Anchor in the east. Coastal flood and erosion risk management along the area covered by this BMP is the responsibility of the Environment Agency, West Somerset Council, Somerset County Council and private landowners. In addition, Plymouth Coastal Observatory (PCO) undertakes coastal monitoring of the area as part of the South West Strategic Regional Coastal Monitoring Programme (SWRCMP), whilst Wessex Water maintain a number of outfalls that discharge to the sea at various points along the BMP frontage.

The aim of this BMP, which has been developed utilising best practice contained in the *CIRIA Beach Management Manual* (CIRIA, 2010), is to inform, guide and assist the responsible authorities and organisations in managing the beach and associated hard coastal defences, and to ensure that the risk of coastal flooding and erosion to properties and other assets along the BMP frontage continues to be managed sustainably, whilst recognising and managing the environmental and amenity implications of doing so.

The key objective of this BMP is to manage the risk of coastal flooding and erosion to property and other assets along the Minehead to Blue Anchor frontage for the next 20-30 years within the context of the long-term (100 year) policy intent which has been defined alongside developing this BMP.

The BMP sets out the plan for monitoring and intervention to maintain the beach and associated hard coastal defences to ensure they continue to provide adequate coastal flood and erosion risk management to the BMP area in the immediate future, whilst also identifying measures to develop and implement more sustainable longer-term solutions to the management of these issues and the risk posed by potential breaching of the shoreline along The Warren and Dunster Beach section to the wider low-lying area of Minehead. This monitoring and intervention plan has been developed in the context of providing a technically, economically, environmentally and socially sustainable management approach for the next 20-30 years, in line with the long-term preferred option to coastal flood and erosion risk management developed alongside this BMP.

In summary, this preferred option for the long-term strategic coastal flood and erosion risk management approach along the BMP frontage is to take an adaptive approach to coastal flood and erosion risk management. For each sub-section of the BMP frontage (refer to Figure EX-1), this will involve the following:

- **West of Minehead and Minehead Harbour**

  The defences for the West of Minehead are operated by West Somerset Council. These defences will be improved in the near future by the construction of a new toe along the length of the wall to reduce the risk of undermining. This will be supported by recycling of sediment from east to west along this frontage before it goes around the breakwater towards the harbour. A trigger level based on sediment build-up against the harbour will be used to guide when this beach recycling activity occurs. This should reduce the need for moving sediment build-up across the harbour mouth (though this may still be needed occasionally depending on conditions). In implementing this beach recycling regime, discussions will need to be held between West Somerset Council and the RNLI to agree how the operations to recycle beach material will interact with / be complimented by RNLI activity to re-profile the beach for lifeboat launch/recovery access.

  The new toe structure and beach recycling should increase the SoP against wave overtopping, however this would reduce over time with sea level rise. Wave overtopping could still occur though, and installation / short-term deployment of demountable defences during storm events will divert water flowing down the road back into the sea via the Minehead Harbour slipway (NB: properties seawards of the demountable defence line may need property level resilience measures installed as well). Further work is needed on the

organisation and man power commitments relating to deployment of demountable defences, including further flood modelling in the immediate future.

It may be that in future there is a need to consider raising the level of the seawall in this area, and the approach set-out in this preferred option would not preclude this. Flood modelling to guide demountable defence requirements in the immediate future could usefully be utilised to assess potential future wall raising needs.

- **Minehead Town**

  The preferred option for Minehead town will see ongoing beach recycling and maintenance works to the seawall and groynes (guided by regular inspection and monitoring) to maintain the 1997 sea defence scheme operated by the Environment Agency. This will also involve beach recharge at a point in the future otherwise the sediment between the groynes will continue to reduce over time. Beach recharge will be triggered when monitoring shows beach sediment volumes to be insufficient to achieve the minimum design level in order for the beach to fulfil its role as part of the overall defence system.

  This approach will help maintain the condition of the defences, however, with sea level rise the defences may become less effective over time. At a later date it may therefore be necessary to re-consider the need to transition the management approach to that set out in Option S2, i.e. to modify/upgrade the groynes and/or seawall in order to maintain the coastal defence function of the structures along the frontage, reduce windblown sand and aid retention of the recharged beach in the future.

- **The Warren and Dunster Beach**

  At The Warren and Dunster Beach, subject to further coastal flood risk/surface water drainage modelling and ground investigation studies in the near future, the preferred option will see the construction of a set-back defence within the next 10 years which would then be maintained by the Environment Agency. This set-back defence, anticipated to be an unarmoured earth bank at this time (though armouring could be added if required), will reduce the risk of widespread flooding as a result of a breach occurring along this frontage due to storm events in the future.

  As part of this preferred option, it is expected that periodic ad hoc intervention will occur along the existing shoreline of The Warren, initially by the Environment Agency (until a set-back defence is in place) and then by Minehead Golf Club (if they wish to). This will involve placing rock armour in erosion hot spots along The Warren shoreline to reduce the risk of erosion and so breaching. In doing so, no recycling and re-profiling of shingle from the inter-tidal area is expected to occur unless in an emergency situation when it will take too long to import rock and only until such time as the set-back defence line is constructed. In addition, any placement of rock-armour will need to ensure doing so has minimal effect on dune vegetation. It is also expected that there will be a continuation of the existing management approach at Dunster Beach, led by Dunster Beach Holidays Ltd. However, in relation to both these activities, it is important to note the following:

    - Funding for these activities will likely need to come largely from third-party (non-FCERM-GiA) sources, especially once the set-back defence line is in place.
    - These activities will likely become less sustainable in the future as sea levels rise, and more frequent overtopping of the shoreline features would be expected to occur (the impacts of which will be minimised by the presence of the set-back defence).

- **Ker Moor**

  Works in the immediate future will involve placing rock armour immediately to the east of the River Avill Flood Relief Channel by the Environment Agency, in order to manage the existing outflanking risk posed in this area. Future adjustment of this rock armour may be needed as erosion of the undefended coast to the east will continue as sea levels rise.

Along the rest of Ker Moor, no works are expected to occur for FCERM purpose. The implication of this will be the increasing risk of erosion and flooding posed to the West Somerset Railway line, which will need to undergo realignment to move it out of the erosion risk area. This would be wholly funded by non-FCERM-GiA sources.

- **Blue Anchor**

  At Blue Anchor, the highways authority (Somerset County Council) has confirmed that they are committed to maintaining the road along this frontage and so the coastal defences that protect it. As part of this preferred option, it is expected that the existing seawall and rock armour along the highway will therefore be maintained by Somerset County Council. This will be supported by construction of additional rock armour revetment to extend the existing rock armour further west. A new seawall at the eastern end of Blue Anchor will secure the defence line in this area, and plans to implement this by the landowner are already in progress; although Somerset County Council are also looking at possible future management options in this area and some form of joint-approach between the highways authority and private landowner may be appropriate.

  There will remain a risk of outflanking to east and west of Blue Anchor in the longer-term, which can be managed by the flexibility that use of rock armour in these areas provides, thus ensuring the transition from defended to undefended coastline in both directions is addressed sustainably.

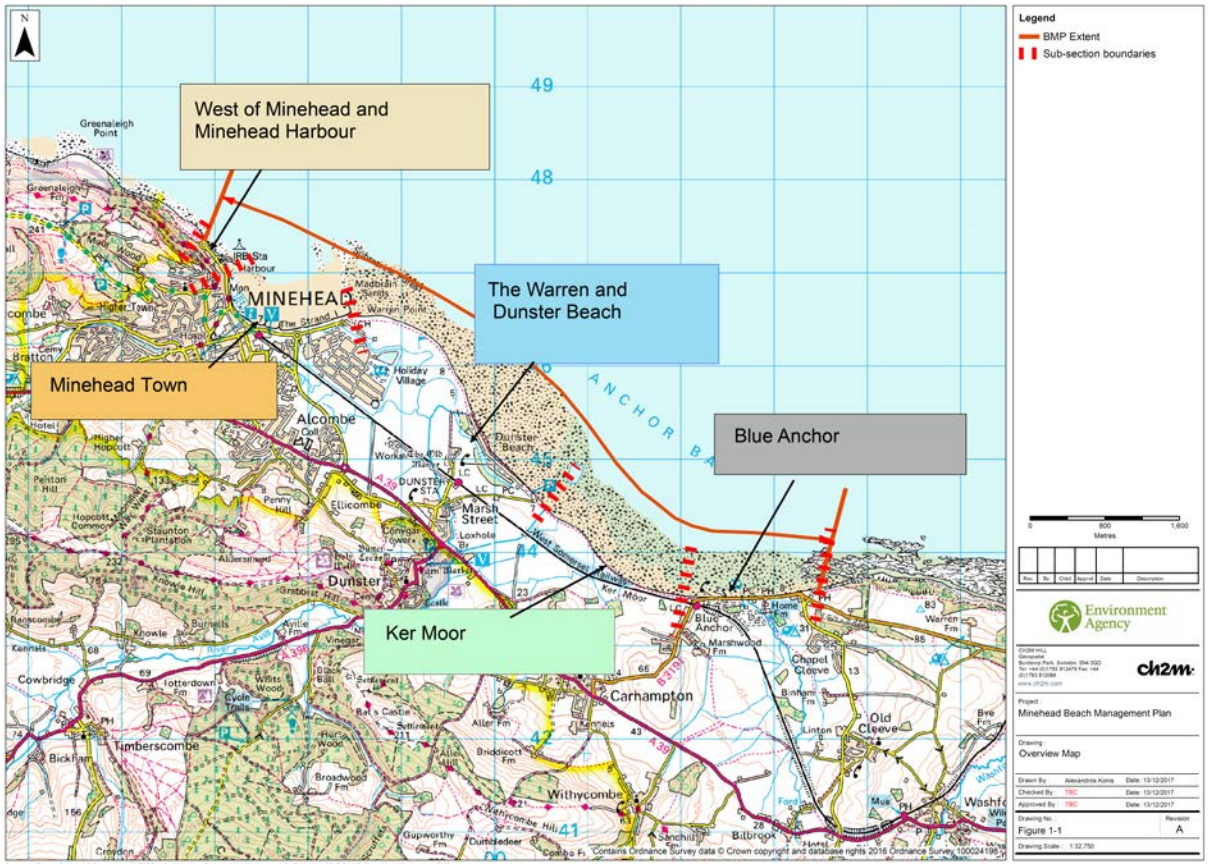



*Figure EX.1 BMP extent and sub-sections.*

This preferred option was selected as it provides the best balance between technical viability, environmental acceptability and economic case in the immediate future, but does not preclude additional, adaptive, works at a later date if required (guided by ongoing monitoring of the BMP frontage).

In order to progress towards implementation of the preferred option, there are a number of activities to be undertaken in the near future (next 5 years), as follows:

1. Within the next 0-1 years, West Somerset Council are to develop the seawall toe-protection and demountable defences scheme for West of Minehead Harbour. This should include working with the Environment Agency to undertake flood modelling to assess wave loading and overtopping to guide the design. This in turn will allow refinement of the economic assessment and could also usefully be used to assess potential future need for raising the wall level in this area and application of demountable defences (see point (2) below). Development of the scheme at this time will also need to identify and secure partnership funding contributions, and produce a business case.
2. In years 1-2, subject to approval of a viable business case (see point (1) above), implement the seawall toe-protection and demountable defences scheme for West of Minehead Harbour.
3. Within the next 0-1 years, the Environment Agency are to undertake a flood modelling study of the area from Minehead Harbour to the River Avill Flood Relief Channel to improve understanding of the present and future flood risks under different defined extreme return period events and allowing for climate change. *NB: this flood modelling study could be combined for efficiency with modelling required for West of Minehead Harbour (see point (1) above).*

   As part of this flood modelling study, the following outputs should be derived:

   a) Re-appraisal of the BMP assessment of the present and future standard of protection provided by existing defences against wave overtopping (refer also to **Section 3.2** of the BMP and/or **Appendix D**);

   b) An updated assessment of potential economic damages as a result of coastal flooding (refer also to **Appendix A**); and

   c) An initial assessment of the feasibility of a set-back defence line along The Warren/Dunster Beach frontage, including technical, environmental and economic assessment (the economic case will use the results from (b) above, and should include: (i) an updated benefit:cost assessment that includes amenity and Gross-Value Added benefits; and (ii) an updated partnership funding contribution requirements assessment).
4. Subject to a favourable outcome from 3(c) above, in years 2-4, detailed investigation and design will be required to develop the set-back defence line scheme. This will include ground investigations, assessment of surface water implications, refinement of the economic case, identifying and securing partnership funding contributions, and production of a business case.
5. In years 5-6, subject to approval of a viable business case (see point (4) above), implement the set-back defence line scheme along The Warren and Dunster Beach section.

Whilst the above studies are being investigated and implemented, there will be ongoing beach recycling and maintenance of all assets along the BMP area, guided by ongoing visual inspection and monitoring as part of the South West Regional Coastal Monitoring programme (refer to **Sections 4 and 5** of this BMP).

The BMP should be reviewed every 10 years or as and when future significant changes occur to the coastal flood and erosion risk management approach along the frontage.

# Introduction

## 1.1 Project Background

This Beach Management Plan (BMP) has been prepared for the Environment Agency, West Somerset Council and Somerset County Council (Highways), and covers the coastline from the Culver Cliffs, located to the west of Minehead, to Blue Anchor in the east (**Figure 1-1**). *Note, the BMP frontage is divided into a number of sub-sections as shown on Figure 1-1 and this BMP makes regular reference to these sub-sections.*

The BMP frontage is at risk of both coastal flooding and erosion. To reduce these risks, various coastal defences have been constructed along the frontage over the years; with the current coastal defences being comprised of seawalls, rock revetment, rock groynes, concrete harbour jetties/piers, recharged beach, and natural features including cliffs and shingle and dune ridges.

These coastal defences protect a large number of assets along the BMP extent, including around 200 residential properties and more than double that number of commercial properties at risk of flooding in the extensive low-lying area between the River Avill flood relief channel in the east, and west of Minehead Harbour; the discounted Present Value (PV) of these property flood risks is estimated to be in excess of £105,242k. In addition, towards Blue Anchor there are a further 18 to 37 non-residential properties at potential risk of coastal erosion over the next century; the discounted Present Value (PV) of these property erosion risks is estimated to be in excess of £1,492k. Further details on the economic benefits of continued coastal flood and erosion risk management activity along the BMP frontage is provided in **Appendix A**.

The long-term approach to coastal flood and erosion risk management along the BMP frontage is guided by the North Devon & Somerset Shoreline Management Plan (SMP2) policies defined in 2010, which range from Hold the Line to Managed Realignment and No Active Intervention along the frontage. Currently, there are a number of coastal flood and erosion risk management issues along the frontage that need to be addressed in order to deliver the SMP2 policies of the long-term, as follows:

- At the western end of the frontage is Minehead Harbour which has a breakwater and groyne that projects seaward from the main harbour arm. The harbour is operated by West Somerset Council, the harbour provides shelter but also prohibits the supply and distribution of sediment from the occasional cliff erosion to the west as well as a reworking of surficial sediments. The harbour is frequently infilled by sand and shingle and annual dredging is necessary to remove the material and allow harbour operations to continue. The dredged material is placed on the shoreline to the east of the Red Lion slipway. In addition, to the west of the harbour arm the existing seawall is subject to exposure and increased risk of undermining at times when beach levels are low. There is a need to consider the dredging and recycling regimes in a more holistic way, to make best use of sediment dredged from the harbour in the future.
- Within Minehead Bay (east of the harbour arm), existing coastal defences include concrete seawalls and groynes that have been constructed and maintained over many decades. The most recent construction took place in 1998 when the Environment Agency implemented a scheme comprising construction of a wave return wall in combination with the placing of 183,000m$^3$ of sand via a beach recharge. New groynes were also constructed to hold the recharged beach in place and thereby help stabilise the shoreline. This scheme followed a flood event caused by wave overtopping of the previous defences during a storm in October 1996, which caused the old seawall to collapse and resulted in flooding of a significant number of assets located on the low-lying hinterland. There is a need to define how beach levels and control structures are to be managed, and whether or not any modifications/additions to the control structures are required in the future.
- Beyond the eastern-most groyne of the 1998 Minehead scheme, the shoreline of Warren Point that fronts the golf course is subject to severe erosion. Here it has been necessary to build up

beach levels since 1998, and in 2016 works were also undertaken to repair storm damage to the dunes. There is a need to consider how to manage the risk of flooding to Minehead via this frontage in the future, and how the proposed transition to the long-term SMP2 policy of managed realignment can be implemented.

- Along the Dunster Beach Chalets site to the east of Warren Point and Minehead Golf Course, timber groynes have been constructed along the upper foreshore over a length of approximately 800m, to hold beach material. There is a need to consider how to manage the risk of flooding to Minehead via this frontage in the future, and how the proposed transition to the long-term SMP2 policy of managed realignment can be implemented.
- Within Blue Anchor Bay, a masonry and concrete seawall, rock armour and stone groynes are present at the eastern end of the bay fronting Blue Anchor; these are operated by Somerset County Council and were upgraded between 2002 and 2005; erosion at the very easternmost end of the wall poses a possible future outflanking risk to a number of local properties, including the Blue Anchor Hotel. The remainder of the bay is protected by the gravel storm ridge, which is subject to management to maintain its function as a sea defence. There is a need to consider how to manage the risk of flooding and erosion along this frontage in the future, and how the proposed transition to the long-term SMP2 policy of managed realignment or no active intervention can be implemented.

To address these issues, a preferred option for long-term (100-year) coastal flood and erosion risk management for the BMP frontage from Minehead to Blue Anchor has been developed alongside this BMP. This is documented in full in the Options Appraisal Report (see **Appendix B**) and summarised in **Section 1.1.1** for ease of reference. This BMP sets out the coastal flood and erosion risk management activities required along the frontage in the next 20-30 years, within the context of the preferred option for the longer-term, sustainable and integrated plan for managing these risks over the next 100 years.

*Note, recommendations are contained throughout the BMP, and are identified with **bold underlined text**. These are also summarised in an Action Plan presented in **Section 6**.*

### 1.1.1 Preferred option

The preferred option for long-term coastal flood and erosion risk management for the BMP frontage is to take an adaptive approach to coastal flood and erosion risk management. For each sub-section of the BMP frontage (refer to Figure 1-1), this will involve the following:

- **West of Minehead and Minehead Harbour**

  The defences for the West of Minehead will be improved in the near future by the construction of a new toe along the length of the wall to reduce the risk of undermining. This will be supported by recycling of sediment from east to west along this frontage before it goes around the breakwater towards the harbour. A trigger level based on sediment build-up against the harbour will be used to guide when this beach recycling activity occurs. This should reduce the need for moving sediment build-up across the harbour mouth (though this may still be needed occasionally depending on conditions). In implementing this beach recycling regime, discussions will need to be held between West Somerset Council and the RNLI to agree how the operations to recycle beach material will interact with / be complimented by RNLI activity to re-profile the beach for lifeboat launch/recovery access.

  The new toe structure and beach recycling should increase the SoP against wave overtopping, however this would reduce over time with sea level rise. Wave overtopping could still occur though, and installation / short-term deployment of demountable defences during storm events will divert water flowing down the road back into the sea via the Minehead Harbour slipway (NB: properties seawards of the demountable defence line may need property level resilience measures installed as well). Further work is needed on the organisation and man power commitments relating to deployment of demountable defences, including further flood modelling in the immediate future.

It may be that in future there is a need to consider raising the level of the seawall in this area, and the approach set-out in this preferred option would not preclude this. Flood modelling to guide demountable defence requirements in the immediate future could usefully be utilised to assess potential future wall raising needs.

- **Minehead Town**

  The preferred option for Minehead town will see ongoing beach recycling and maintenance works to the seawall and groynes (guided by regular inspection and monitoring) to maintain the 1997 sea defence scheme. This will also involve beach recharge at a point in the future otherwise the sediment between the groynes will continue to reduce over time. Beach recharge will be triggered when monitoring shows beach sediment volumes to be insufficient to achieve the minimum design level in order for the beach to fulfil its role as part of the overall defence system.

  This approach will help maintain the condition of the defences, however, with sea level rise the defences may become less effective over time. At a later date it may therefore be necessary to re-consider the need to transition the management approach to that set out in Option S2, i.e. to modify/upgrade the groynes and/or seawall in order to maintain the coastal defence function of the structures along the frontage, reduce windblown sand and aid retention of the recharged beach in the future.

- **The Warren and Dunster Beach**

  At The Warren and Dunster Beach, subject to further coastal flood risk/surface water drainage modelling and ground investigation studies in the near future, the preferred option will see the construction of a set-back defence within the next 10 years which would then be maintained. This set-back defence, anticipated to be an unarmoured earth bank at this time (though armouring could be added if required), will reduce the risk of widespread flooding as a result of a breach occurring along this frontage due to storm events in the future.

  As part of this preferred option, it is expected that periodic ad hoc intervention will occur along the existing shoreline of The Warren. This will involve placing rock armour in erosion hot spots along The Warren shoreline to reduce the risk of erosion and so breaching. In doing so, no recycling and re-profiling of shingle from the inter-tidal area is expected to occur unless in an emergency situation when it will take too long to import rock and only until such time as the set-back defence line is constructed. In addition, any placement of rock-armour will need to ensure doing so has minimal effect on dune vegetation. It is also expected that there will be a continuation of the existing management approach at Dunster Beach, led by Dunster Beach Holidays Ltd. However, in relation to both these activities, it is important to note the following:

  - Funding for these activities will likely need to come largely from third-party (non-FCERM-GiA) sources, especially once the set-back defence line is in place.
  - These activities will likely become less sustainable in the future as sea levels rise, and more frequent overtopping of the shoreline features would be expected to occur (the impacts of which will be minimised by the presence of the set-back defence).

- **Ker Moor**

  Works in the immediate future will involve placing rock armour immediately to the east of the River Avill Flood Relief Channel in order to manage the existing outflanking risk posed in this area. Future adjustment of this rock armour may be needed as erosion of the undefended coast to the east will continue as sea levels rise.

  Along the rest of Ker Moor, no works are expected to occur for FCERM purpose. The implication of this will be the increasing risk of erosion and flooding posed to the West Somerset Railway line, which will need to undergo realignment to move it out of the erosion risk area. This would be wholly funded by non-FCERM-GiA sources.

- **Blue Anchor**

At Blue Anchor, the highways authority has confirmed that they are committed to maintaining the road along this frontage and so the coastal defences that protect it. As part of this preferred option, it is expected that the existing seawall and rock armour along the highway will therefore be maintained. This will be supported by construction of additional rock armour revetment to extend the existing rock armour further west. A new seawall at the eastern end of Blue Anchor will secure the defence line in this area, and plans to implement this by the landowner are already in progress; although Somerset County Council are also looking at possible future management options in this area and some form of joint-approach between the highways authority and private landowner may be appropriate.

There will remain a risk of outflanking to east and west of Blue Anchor in the longer-term, which can be managed by the flexibility that use of rock armour in these areas provides, thus ensuring the transition from defended to undefended coastline in both directions is addressed sustainably.

This option was selected as it provides the best balance between technical viability, environmental acceptability and economic case in the immediate future, but does not preclude additional, adaptive, works at a later date if required (guided by ongoing monitoring of the BMP frontage).

In order to progress towards implementation of the preferred option, there are a number of activities to be undertaken in the near future (next 5 years), as follows:

1. Within the next 0-1 years, develop the seawall toe-protection and demountable defences scheme for West of Minehead Harbour. This should include flood modelling to assess wave loading and overtopping to guide the design. This in turn will allow refinement of the economic assessment and could also usefully be used to assess potential future need for raising the wall level in this area. Development of the scheme at this time will also need to identify and secure partnership funding contributions, and produce a business case.
2. In years 1-2, subject to approval of a viable business case (see point (1) above), implement the seawall toe-protection and demountable defences scheme for West of Minehead Harbour.
3. Within the next 0-1 years, undertake a flood modelling study of the area from Minehead Harbour to the River Avill Flood Relief Channel to improve understanding of the present and future flood risks under different defined extreme return period events and allowing for climate change. *NB: this flood modelling study could be combined for efficiency with modelling required for West of Minehead Harbour (see point (1) above).*

   As part of this flood modelling study, the following outputs should be derived:

   d) Re-appraisal of the BMP assessment of the present and future standard of protection provided by existing defences against wave overtopping (refer also to **Section 3.2** and/or **Appendix D**);

   e) An updated assessment of potential economic damages as a result of coastal flooding (refer also to **Appendix A**); and

   f) An initial assessment of the feasibility of a set-back defence line along The Warren/Dunster Beach frontage, including technical, environmental and economic assessment (the economic case will use the results from (b) above, and should include: (i) an updated benefit:cost assessment that includes amenity and Gross-Value Added benefits; and (ii) an updated partnership funding contribution requirements assessment).
4. Subject to a favourable outcome from 3(c) above, in years 2-4, detailed investigation and design will be required to develop the set-back defence line scheme. This will include ground investigations, assessment of surface water implications, refinement of the economic case, identifying and securing partnership funding contributions, and production of a business case.
5. In years 5-6, subject to approval of a viable business case (see point (4) above), implement the set-back defence line scheme along The Warren and Dunster Beach section.

Whilst the above studies are being investigated and implemented, there will be ongoing beach recycling and maintenance of all assets along the BMP area, guided by ongoing visual inspection and monitoring as part of the South West Regional Coastal Monitoring programme (refer to **Sections 4 and 5** of this BMP).

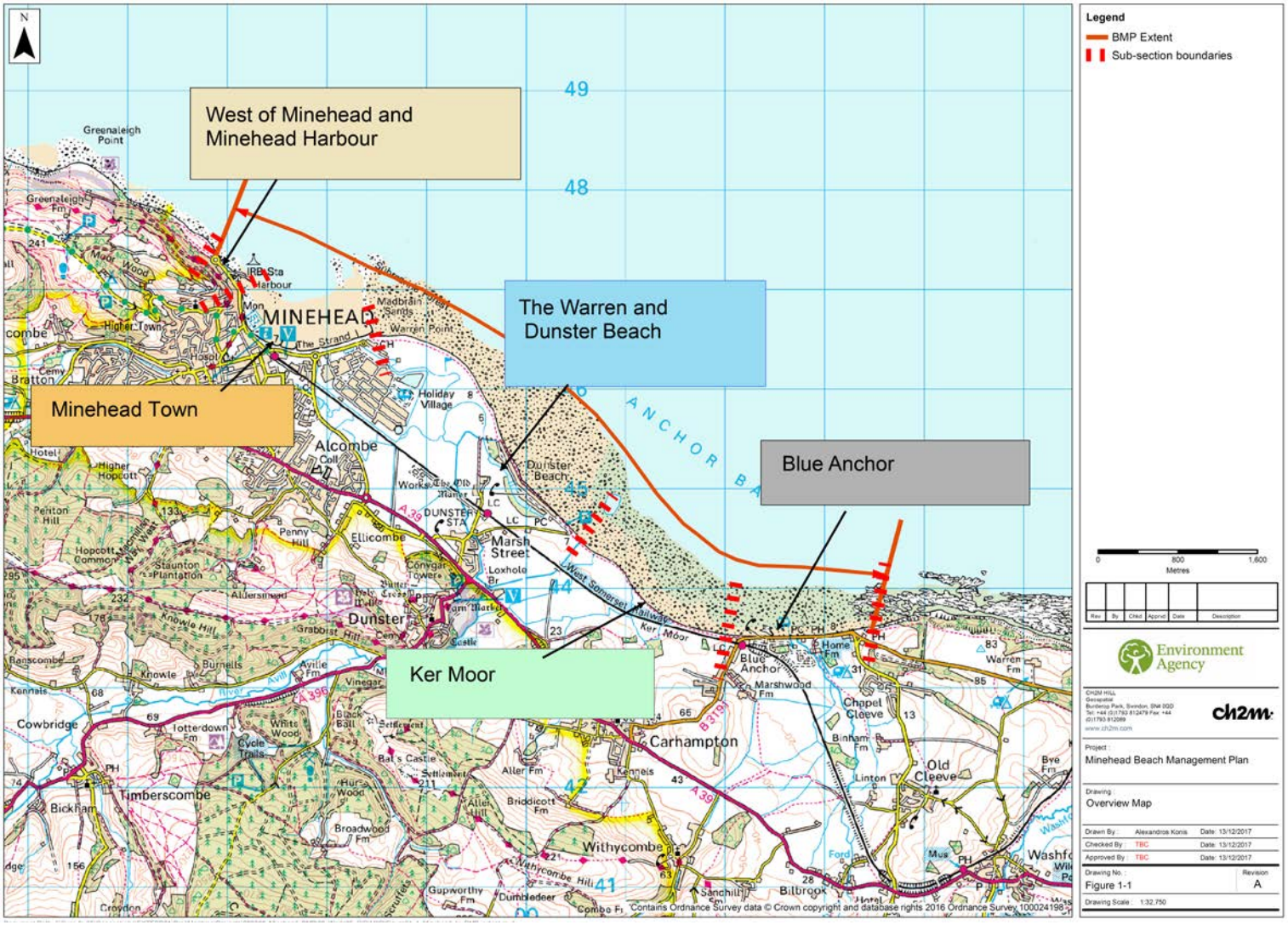



FIGURE 1-1
**Minehead to Blue Anchor BMP extent (and sub-sections)**

## 1.2 Objectives

The coastline covered by this BMP is the responsibility of a range of landowners and/or asset operators, including the Environment Agency, West Somerset Council, Somerset County Council (Highways), and private companies and individuals. In addition, Plymouth Coastal Observatory (PCO) undertakes coastal monitoring of the area as part of the South West Regional Coastal Monitoring Programme (SWRCMP), whilst Wessex Water maintain infrastructure that discharges to the sea through parts of the coastal defences along the frontage, particularly along the Minehead town section.

The purpose of this BMP, which has been developed utilising best practice contained in the *CIRIA Beach Management Manual, 2nd Edition* (CIRIA, 2010), is to inform, guide and assist the responsible authorities and organisations in managing the beach and hard coastal defences along the BMP area, and to ensure that the risk of coastal flooding and erosion to properties and other assets along the Minehead to Blue Anchor frontage continues to be managed sustainably, whilst recognising and managing the environmental and amenity implications of doing so.

The key objective of this BMP is to manage the risk of coastal flooding and erosion to property and other assets along the Minehead to Blue Anchor frontage for the next 20-30 years within the context of the long-term (100 year) policy intent which has been defined alongside developing this BMP (refer to **Section 1.1.1**).

The BMP sets out the plan for monitoring and intervention to maintain the beach and associated hard coastal defences to ensure they continue to provide adequate coastal flood and erosion risk management to the BMP area in the immediate future, whilst also identifying measures to develop and implement more sustainable longer-term solutions to the management of these issues and the risk posed by potential breaching of the shoreline along The Warren and Dunster Beach section to the wider low-lying area of Minehead (refer to **Section 1.1**).

This monitoring and intervention plan has been developed in the context of providing a technically, economically, environmentally and socially sustainable management approach for the next 20-30 years in line with the long-term preferred option to coastal flood and erosion risk management developed alongside this BMP, as described in **Section 1.1.1**, which in turn aligns to the Shoreline Management Plan policies for this frontage that are set for a 100 year planning horizon (refer to **Section 1.7.1**).

The BMP includes recommendations for further studies and investigations to refine the preferred long-term option and lead to its implementation within the next 5 years (see **Section 1.1.1**). **The BMP itself should be reviewed every 10 years** – the BMP review period – or as and when future significant changes occur to the coastal flood and erosion risk management approach along the frontage.

## 1.3 Location

### 1.3.1 Environmental setting

The BMP area contains the following environmental and conservation designations:

- Blue Anchor to Lilstock Coast SSSI.
- Two Geological Conservation Review (GCR) blocks and one site.
- Historical and Cultural Heritage including:
    - Scheduled Monument - Four medieval fish weirs 500m east of the Harbour
    - Designated Wreck - Wreck at Minehead, possibly the Bristol Packet
    - Listed buildings.
- Quay street, Minehead Conservation Area.
- Vale of Taunton and Quantock Fringes National Character.

- Designated Bathing Waters.

These are important in the consideration of options for beach management, with many having legislative requirements to ensure they are not adversely impacted by human actions.

**Section 2.7** and **Appendix C** provides much more detail on these and other environmental features within and around the BMP area.

### 1.3.2 History of flooding and erosion

The Minehead to Blue Anchor BMP frontage has a long history of coastal flooding and erosion, as illustrated by the following summary of past flood events is taken from a report by Black & Veatch (2009):

*Minehead has flooded several times in the past from the sea including in 1910, 1936, 1981, 1989, 1990, 1992 and twice in 1996, the latter resulting in the most destructive event of recent years, flooding large parts of Minehead. The October 1996 event destroyed the original sea wall in front of the town, flooding the Butlins holiday complex (then Somerset World); the golf club; the arcades along the front and a number of cottages around the harbour area. It has been estimated this event to have had an annual exceedance probability of between 20% and 5% (or 1 in 5 year and 1 in 20 year flood event).*

*During the October 1996 event, Minehead Golf Course flooded from overtopping at a number of location. Overtopping occurred at the access point to the ridge from Warren Road approximately 50m to the west of the golf club house. The wall adjacent to the Golf Club car park was overtopped. Overtopping also occurred along the ridge adjacent to greens 15, 16 and 18 (adjacent to the Golf Club House). Flooding was exacerbated in the Golf Course Car Park by the inability of floodwater to drain back out to sea through a blockage in the outfall structure.*

It was following the 1996 event that the current defences at Minehead were implemented.

Erosion events also occur, as evidenced in the recent past by (a) erosion along The Warren in 2010 that led to placement of rock revetment immediately east of the Minehead terminal groyne as emergency works, and (b) winter 2014 storms caused erosion along Ker Moor that posed a risk to the West Somerset Railway, necessitating emergency repairs undertaken by the railway.

There is also ongoing erosion of the cliffs to the east of Blue Anchor that poses an outflanking risk to assets in this area. In addition, the seawall at Blue Anchor is also regularly overtopped when storm waves coincide with high tide, leading to closure of the highway along this section for periods.

### 1.3.3 Defence history

Coastal defences along the BMP frontage has had numerous phases of construction over several centuries. Full details are summarised in Section 2 of **Appendix D**, and key points for each part of the BMP frontage can be summarised as follows:

- **Minehead:**
  - In the 1330s Minehead's first harbour was constructed.
  - In 1616 a new quay was constructed which forms the stub of the quay which exists today.
  - In the 1800s a major extension to the harbour was built along with improvement works.
  - In 1900 the first concrete sea wall was constructed to stabilise the Minehead frontage at the back of the pleasure beach.
  - In the 1920s properties on Quay Street were demolished. The road was widened and defences strengthened. The street level was raised by approximately 1m.
  - In 1954 a terminal breakwater/groyne was constructed at the western end of outer face of the Minehead Harbour arm.
  - Post-1956 a series of groynes were constructed West of Minehead Harbour along Quay west to prevent waves from eroding the coastline and subsequently exposing the landfill behind

(believed to be Victorian). A masonry wall also extends from Quay West around the seaward side of Minehead Harbour.

- In 1961 Butlins was constructed and the following year a new recurve seawall was built along the 290m stretch of coastline in front of the resort replacing the original seawall which was built in 1900.
- Between 1997 and 2000, the Minehead Coastal Defence Scheme was implemented. These are the current defences seen along the Minehead frontage, and are supported by ongoing beach recycling and re-profiling activities.

- **The Warren:**
  - In 1750 the first groynes at Warren Point were constructed.
  - In 1966 a paling fence was used to trap windblown sand and build up dunes on top of the shingle ridge.
  - Between 1967 and 1982 extended gabion groynes were installed along the coastline adjacent to the Minehead golf club house as part of the Dunster Warren Sea Defence Scheme (NB: these are no longer present).
  - Between 1982 and 1996 the Water Authority began replenishing the shingle ridge with material from the foreshore. This recharge process was continued by the Environment Agency up until 1996.
  - In 1997/1998 the terminal groyne at Warren Point was constructed as part of the Minehead Coastal Defence Scheme.
  - Emergency works in 2010 included the construction of a new beach profile with nearshore material to protect the western most end of the embankment which protects Minehead Golf Course. This embankment extends east from the terminal rock groyne at Minehead, and includes a public access footpath at the top of the bank.
- **Dunster Beach:**
  - In the 1920s and 1930s, the Dunster Beach Holiday Camp was first established and developed, such that there is now approximately 250 privately owned chalets occupying the area of a former dune system.
  - The eastern limit of the Dunster Beach frontage is the River Avill Flood Relief Channel, a shallow sloping concrete structure that discharges high flow events from the Avill to the sea. This was constructed following severe flooding of the area in the 1960's.
  - Between 1990 and 2003 the private owners of the chalet incorporated 40 timber post groynes and sand fences, which are actively maintained along the beach in front of the chalets. These defences trap windblown sand, promoting accretion in front of the chalets.
- **Ker Moor and Blue Anchor (Blue Anchor Bay):**
  - In 1859 an embankment and road were constructed at Blue Anchor by driving two rows of timber post piles and filling the area landward with clay and shingle.
  - In 1868 storm damage extended approximately 100m both west and east of Pill Bridge, which led to an extension of the embankment and road.
  - In March 1899, an approximately 9m wide and 700m long wall was built approximately 15m inland of the coast, abandoning the original road and Pill Bridge. The west section adopted concrete stone pitched slopes rather than the recommended piling and dwarf wall.
  - In 1908 the beach level had continued to drop and threatened to undermine the newly constructed sea wall. A protecting apron was constructed at the toe, with an extension added in 1909.

- In 1919 beach levels were reported to have dropped by approximately 4m since 1899 and so the sea wall was extended again with a further apron built to protect the toe of the older lengths. This work was completed in 1923.
- Between 1921 and 1928 gorse defences were installed on the beach, held together with wire netting and strengthened by mats of brushwood. These was only temporary and were destroyed relatively quickly.
- After 1928, expanded steel trap structures were built at the toe of the seawall at the eastern end of the frontage. These were open at the landward end but closed at the seaward face. This allowed shingle to roll over the top of a mesh, falling in to the structure and become trapped as material would be transported offshore.
- In 1968 the beach was re-profiled, with sand moved to the top of the beach, before being covered with coarse stone pitching. This was then grouted with hot mastic asphalt to prevent ingress of water which would lift the pitching or washing out the sand.
- Along the easternmost part of the BMP frontage, a series of defences were constructed along the coast fronting the Blue Anchor Hotel by the owners of the hotel between the 1940s and 1950s. The defences step back from the adjacent defences to the west, and comprise an approximately 50m long vertical concrete seawall with an upper concrete revetment and wave return wall. These structures were built to stop cliff erosion, however they are currently in very poor condition, and in some sections have been outflanked or destroyed.
- In the 1980s, Somerset County Council proposed the construction of a rubble mound protection for the toe of the existing sea wall. The work would involve breaking the existing apron, forming a core of small size rocks and shingle against the toe of the wall, supported by fabric filter material, and armoured with large rocks laid individually in a double layer. At the design stage, different crest levels were considered and estimates of suitable rock armour sizes were made (HR Wallingford, 1985). It is understood from discussions with the Environment Agency during a site visit on 31st October 2016, that this work by HR Wallingford led to the selection of a preferred final design that was then constructed in the late 1980's, although no details confirming the exact final design have been identified.
- In January 2004 maintenance works was undertaken comprising of the replacement of the seawall parapet, 360m from the east end of the main seawall protecting the Blue Anchor settlement. The replacement structure included the same style as the previous structure, and included additional accessibility points.
- In 2013/14 storms eroded the natural crest defence at the western end of frontage along Ker Moor. Beach sediment was pushed into a trench which separates the beach from the adjacent railway line, and allowed waves to run-up and over the railway line, damaging the embankment. In response, in January 2015 West Somerset Railway, with advice from the Environment Agency and Natural England, undertook work to manage beach erosion along the Ker Moor frontage. Material was excavated from the trench and distributed over the crest into areas which had been eroded.

**Figures 1-2 to 1-5** highlight the current coastal defences, whilst **Section 3.1** and **Appendix D** provide further technical details about these.

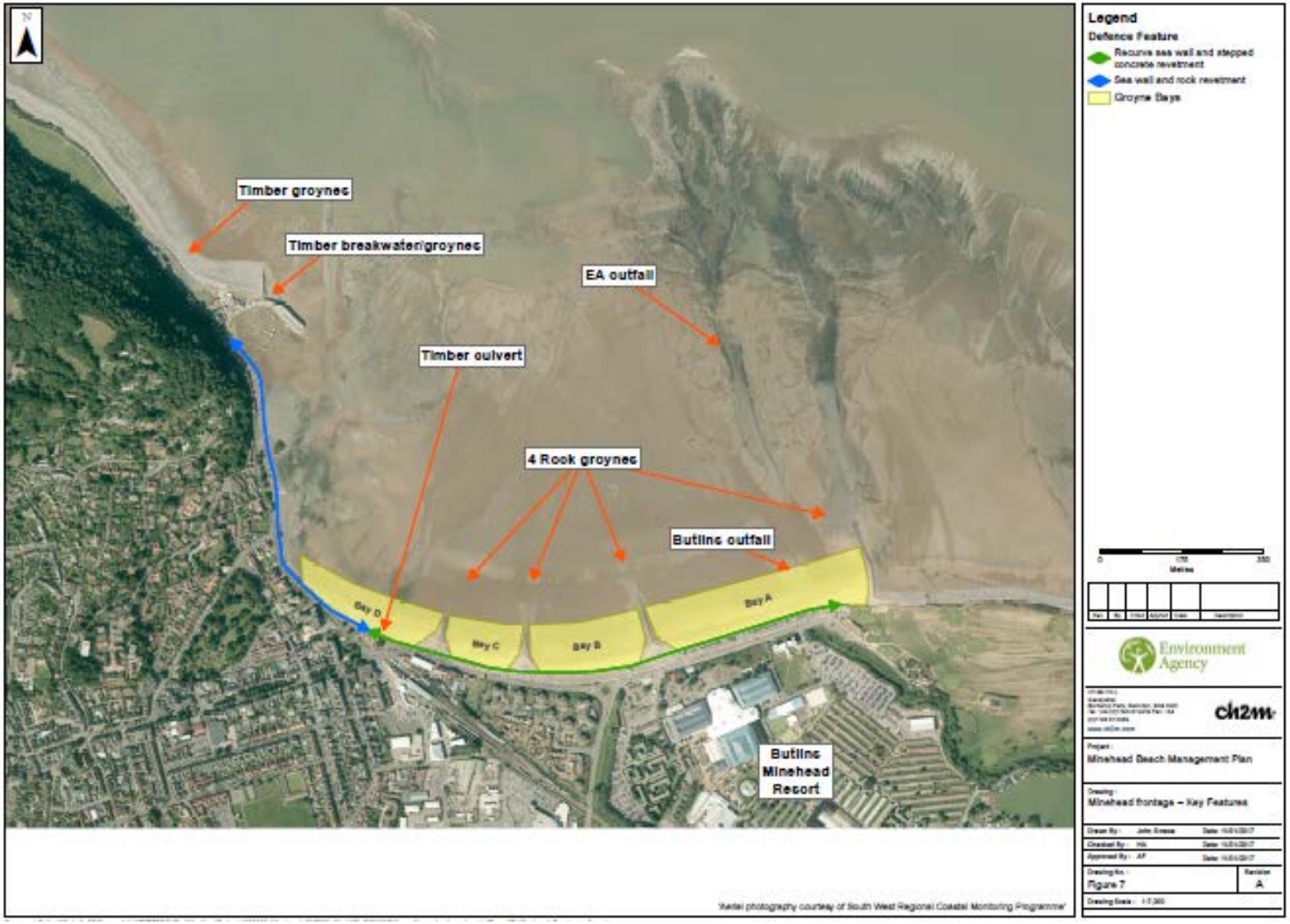



FIGURE 1-2
**Key features along the Minehead section of the BMP frontage.**

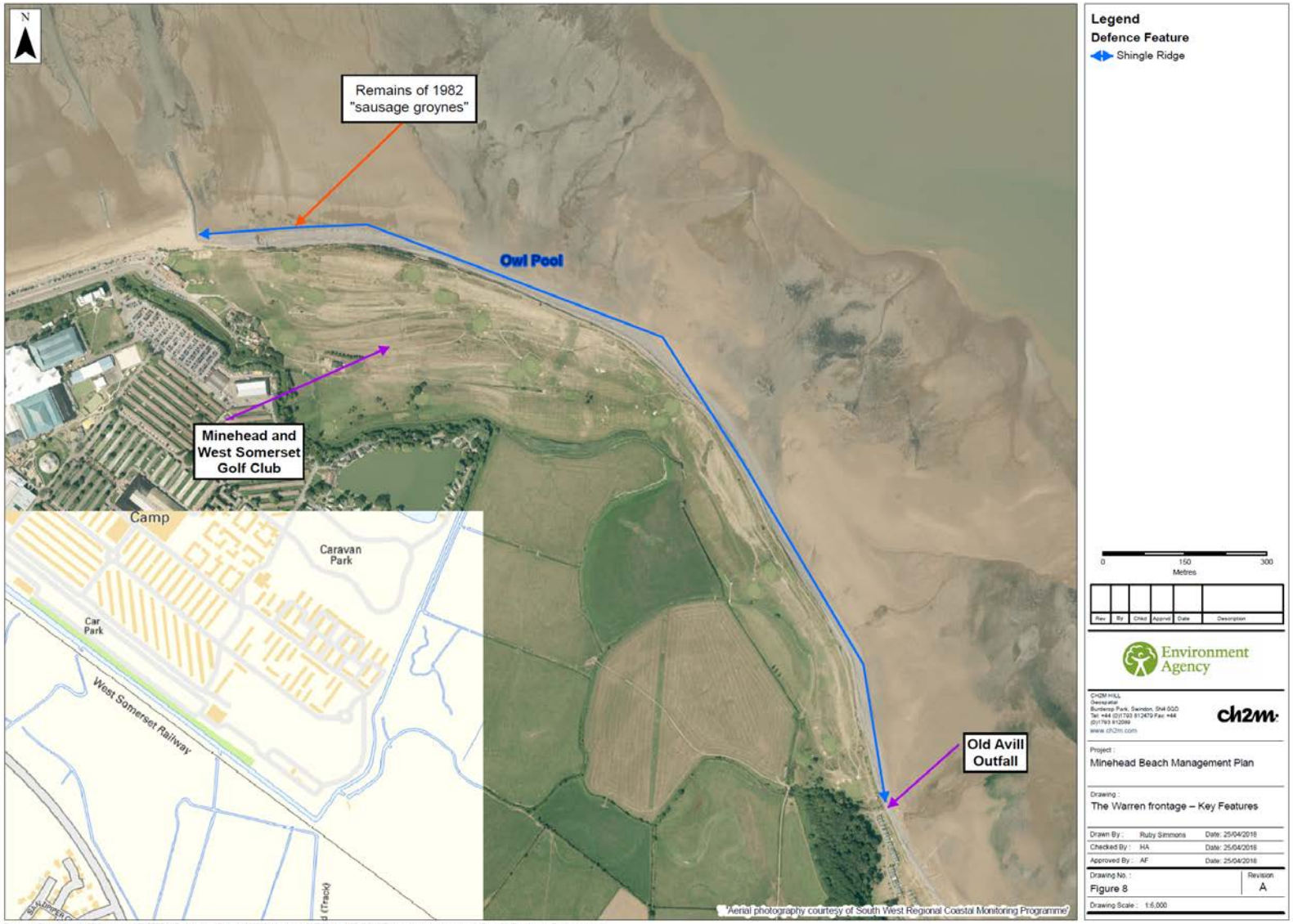



FIGURE 1-3
**Key features along The Warren section of the BMP frontage.**

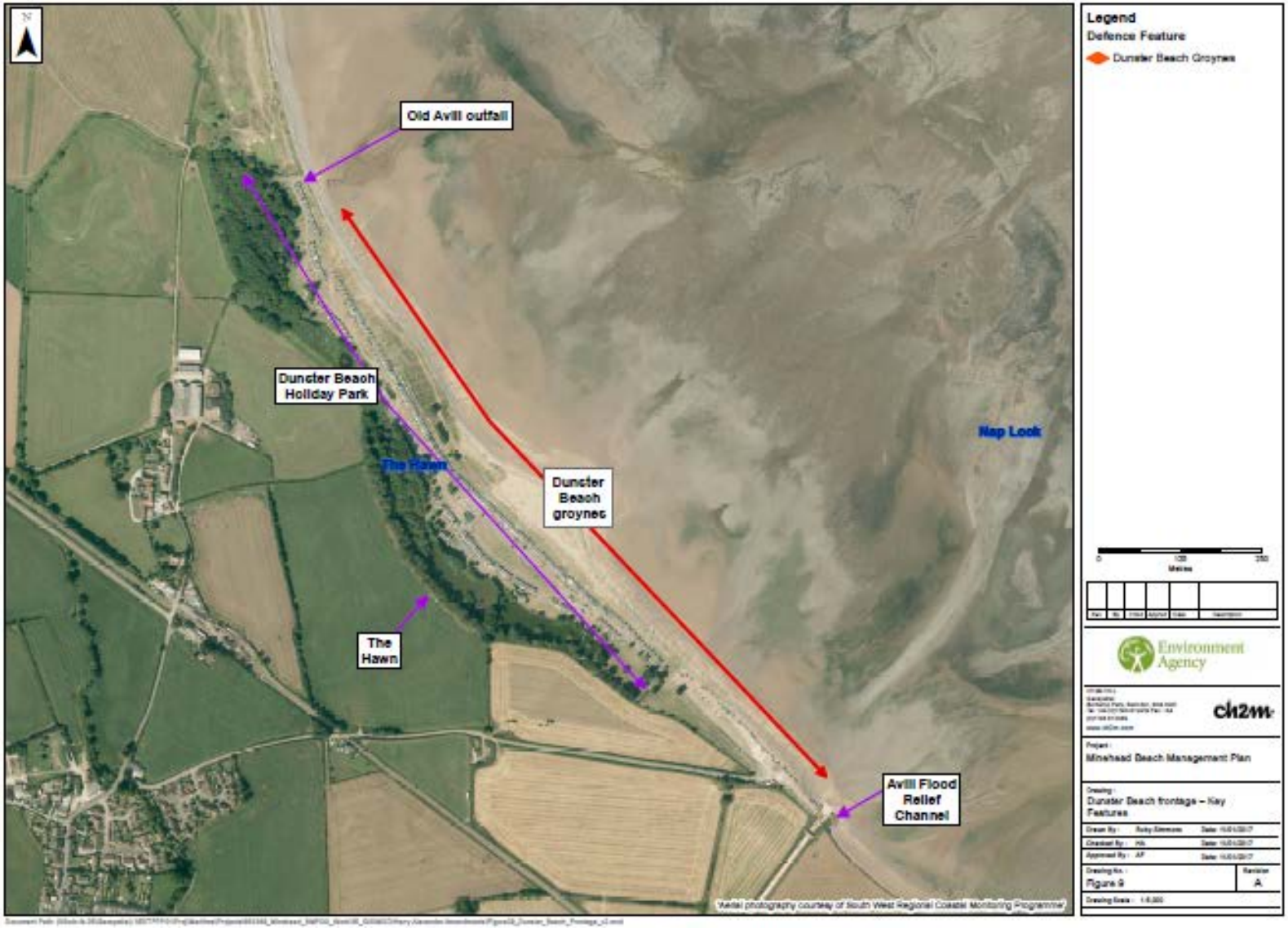



FIGURE 1-4
**Key features along the Dunster Beach section of the BMP frontage**


FIGURE 1-5
**Key features along the Blue Anchor Bay section of the BMP frontage.**

### 1.3.4 Current defence condition

As part of developing this BMP, a coastal defence visual condition assessment was undertaken in accordance with the Environment Agency's *Condition Assessment Manual* (Environment Agency, 2012a). This is described in detail in Section 3 of **Appendix D** and summarized in **Table 1.1**. The key conclusion of this assessment is that most defence elements along the BMP frontage are in a "Fair" or better condition with a typical residual life (with ongoing maintenance) of at least 20 years or more. The main area of more immediate concern is sections of seawall defence at Blue Anchor, which are assessed as being in a poor condition with a residual life of 0-15 years at best.

TABLE 1-1
**Summary of condition grade and residual life assessment for each coastal defence element**

| Frontage | Defence element | Condition Grade | Residual Life Estimate |
|---|---|---|---|
| 1 | Concrete seawall | 3 (Fair) | 15-30 years; |
| | Timber groynes | 3 (Fair) | 5-9 years |
| | Beach | 2 (Good) | 34-59 years |
| 2 | Terminal Groyne | 3 (Fair) | 15-30 years |
| | Outer wall | 2 (Good) | 40-55 years |
| | Inner wall | 2 (Good) | 40-55 years |
| | Slipway walls | 2 (Good) | 40-55 years |
| 3 | Concrete seawall | 1 (Very Good) | 55-70 years |
| | Rock revetment | 1 (Very Good) | 50 to 60 years |
| | Flood gate 1 | 1 (Very Good) | 27 to 30 years |
| | Groyne 1 | 2 (Good) | 171 to 181 years |
| | Groyne 2 | 2 (Good) | 171 to 181 years |
| | Groyne 3 | 2 (Good) | 171 to 181 years |
| | Groyne 4 | 2 (Good) | 171 to 181 years |
| | Flood gate 2 | 1 (Very Good) | 27 to 30 years |
| 4 | Bank repairs | 3 (Fair) | 30 to 50 years |
| | Beach | 3 (Fair) | 20 to 45 years |
| 5 | Groyne field 1 | 2 (Good) | 11 to 14 years |
| | Beach | 1 (Very Good) | 50 to 75 years |
| | Groyne field 2 | 2 (Good) | 11 to 14 years |
| 6 | Beach | 4 (Poor) | 0 to 25 years |
| | Composite wall | 3 (Fair) | 20 to 30 years |
| | Curved concrete wall | 3 (Fair) | 15 to 30 years |
| | Concrete revetment | 3 (Fair)/4 (Poor)- | 20 to 30 years- |
| | Blockwork wall | 3 (Fair) | 15 to 30 years |
| | Blockwork wall and revetment | 3 (Fair) | 15 to 30 Years |
| | Rock T groyne 1 | 4 (Poor) | 76 to 86 years |
| | Rock T groyne 2 | 2 (Good) | 171 to 181 years |
| | Rock T groyne 3 | 2 (Good) | 171 to 181 years |

| Frontage | Defence element | Condition Grade | Residual Life Estimate |
|---|---|---|---|
| | Concrete wall 1 | 4 (Poor) | 0 to 15 years |
| | Concrete wall 2 | 4 (Poor) | 15 years |
| | Concrete wall 3 | 4 (Poor) | 15 years |

### 1.3.5 Amenity value

Minehead is a Victorian seaside resort town and as such tourism is a major source of employment within the area, in particular the Butlins' holiday centre in Minehead, which in the peak holiday season is home to up to c.6,000 visitors at a time. As an important tourism designation Minehead also has hotels / guest houses, seafront, holiday camp, steam railway and easy access to Exmoor.

Minehead and West Somerset Golf Course is situated on the headland of Warren Point and adjacent to the beach from Butlin's holiday centre to the start of Dunster Beach holiday park and its extensive array of chalets set on the beach.

There has been a Harbour at Minehead since the late 1300's and it is now home to a busy charter boat fleet and has an active leisure boat community. Events on the Harbour include the Minehead Harbour festival in July and the RNLI raft race in August which is the largest of its kind in the country; both events attracting visitors to the area. The harbour and local area also offers varied and diverse recreational fishing opportunities (Minehead Harbour, 2015).

The West Somerset Steam Railway is the longest Heritage line in the United Kingdom and a further major tourist attraction that runs along the BMP frontage. The line runs over 20 miles starting at Bishops Lydeard near the county town of Taunton and finishing at Minehead. The line links the three largest settlements in the District by rail for much of the year, but due to the tourist nature of the railway, it does not provide a commuter service. On a number of occasions the line has also been used to carry substantial loads of rock for coastal protection purposes. In Minehead, the historically important Railway Terminal and Goods Shed (both listed buildings) are located behind the road adjacent to Minehead Beach (less than 0.1 km) at the junction of Warren Road, the Esplanade and The Avenue. Further along the line there are stations at Dunster and Blue Anchor which are in close proximity to the coastlline, approximately 0.4 km and less than 0.1 km respectively. A section of the train line that runs from Dunster to Blue Anchor runs very close to the beach in this location affording passengers spectacular coastal views.

The new Somerset Coast Path, a 58-mile route, linking to the South West Path, opened in March 2016 and is the latest addition to the England Coast Path. The Somerset Coast Path takes walkers from Minehead to Brean Down at the end of one of the longest stretches of sandy beach in Europe (Visit Somerset, 2016).

At the northern end of the extensive rows of chalets at Dunster Beach Holiday Park is a public car park also next to the beach. More beach front chalets are present at Hoburne Blue Anchor Holiday Park situated east along the undefended section of Blue Anchor beach. Blue Anchor has a number of tourist amenities including a café, pub and guest houses.

The path along eastern section of the BMP area at Blue Anchor marks the start of Somerset's Jurassic Coast attracting visitors to discover and admire the nationally important geological features and fossils of the cliffs and beach.

### 1.3.6 Land ownership

The land ownership along the BMP frontage varies from that owned by the Local Authority to private land ownership. It is understood the key land ownership

- Minehead Harbour and the coastal defences to the west of it are owned and operated by West Somerset Council.

- The sea defences along Minehead Town beach, constructed in the 1990's, are the responsibility of the Environment Agency. Wessex Water also own and operate a number of outfalls that discharge to the sea through this frontage.
- Minehead Golf Course own land between the easternmost groyne at Minehead and Dunster Beach Holiday Park, the boundary being about the outfall of the Old Avill channel.
- Dunster Beach Holiday Park own the land between the Old Avill channel and the Avill Flood Relief Channel. They operate their own coastal defence measures, primarily timber-post groynes and occasional beach recycling.
- Hoburne Blue Anchor Holiday Park own land at Blue Anchor.
- The sea defences within Blue Anchor Bay are operated by Somerset County Council (highways);
- The defences and slipway that surrounds the Blue Anchor Inn are privately owned (understood to be by the Inn).

### 1.3.7 Contaminated Land

There is a historic landfill site situated along the coastal frontage beyond the far end of Quay Road, north east of Minehead harbour. From environment agency records the Minehead Quarry landfill site took waste from 1912 to 1971. The type of waste present at the site is described as inert, industrial, commercial and household (Environment Agency, 2016a).

### 1.3.8 Highways, services and utilities

Highways, services and utilities within the Minehead to Blue Anchor BMP area are:

**West of Minehead Harbour**

- Quay West (road) and public car parking.
- A sewage outfall is buried within the beach.
- The lifeboat station is placed behind the harbour, access has no formal slipway and runs over the beach to the north.

**Minehead Harbour**

- Quay West Road merges into Quay Street.
- Parking/access is available within the harbour.

**Minehead Beach**

- Quay Street merges into Esplanade, then Warren Road
- Outfalls are present within the beach at the junction of Esplanade, The Avenue and Warren Road.
- A public car parking is present at the eastern end of Warren Road.

**Minehead Golf Course**

- No roads, services or utilities are present.

**Dunster Beach**

- At western end (where meets eastern end of golf course) is the Old Avill Outfall operated by the environment agency.
- Access roads are present within the Chalet Park leading from Sea Road.
- A public carpark is present at the eastern end of Dunster beach at the end of Sea Road adjacent to the River Avill Flood Relief Channel.

**Blue Anchor**

- The B3191 runs along the seawall defences at Blue Anchor and is the only route into Blue Anchor from the village of Carhampton in the west and the harbour town of Watchet in the east.
- Pill River Outfall (Environment Agency asset) discharges to sea through Blue Anchor Seawall further to the east.
- A little to east of the Pill River Outfall is another outfall (privately owned).

## 1.4 Issues

### 1.4.1 Coastal flood and erosion risk management

The beach and hard defences along the BMP frontage protect against the risk of coastal flooding and erosion, as illustrated in **Figure 1-6** and **Figure 1-7** respectively (refer also to **Appendix E**).

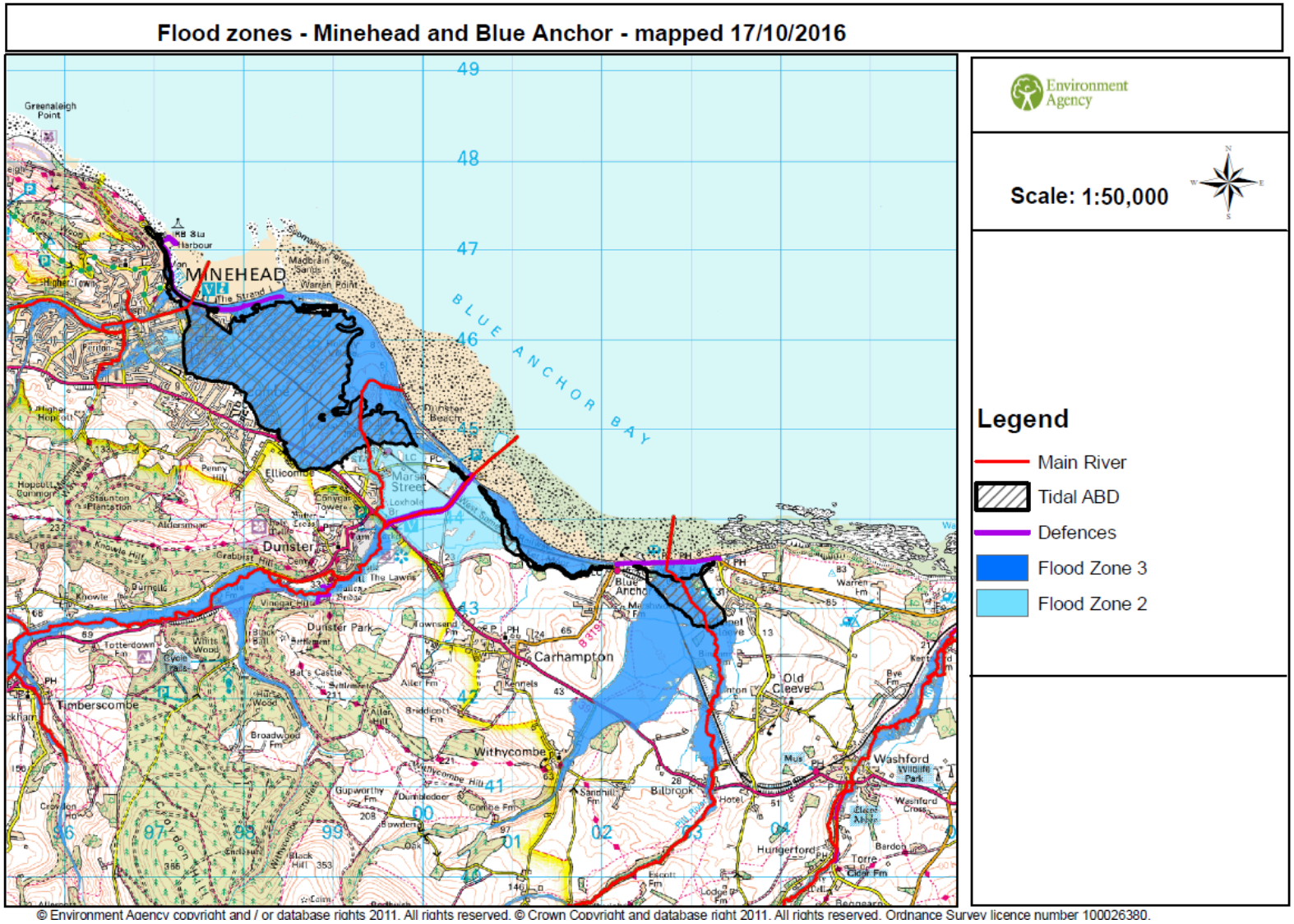
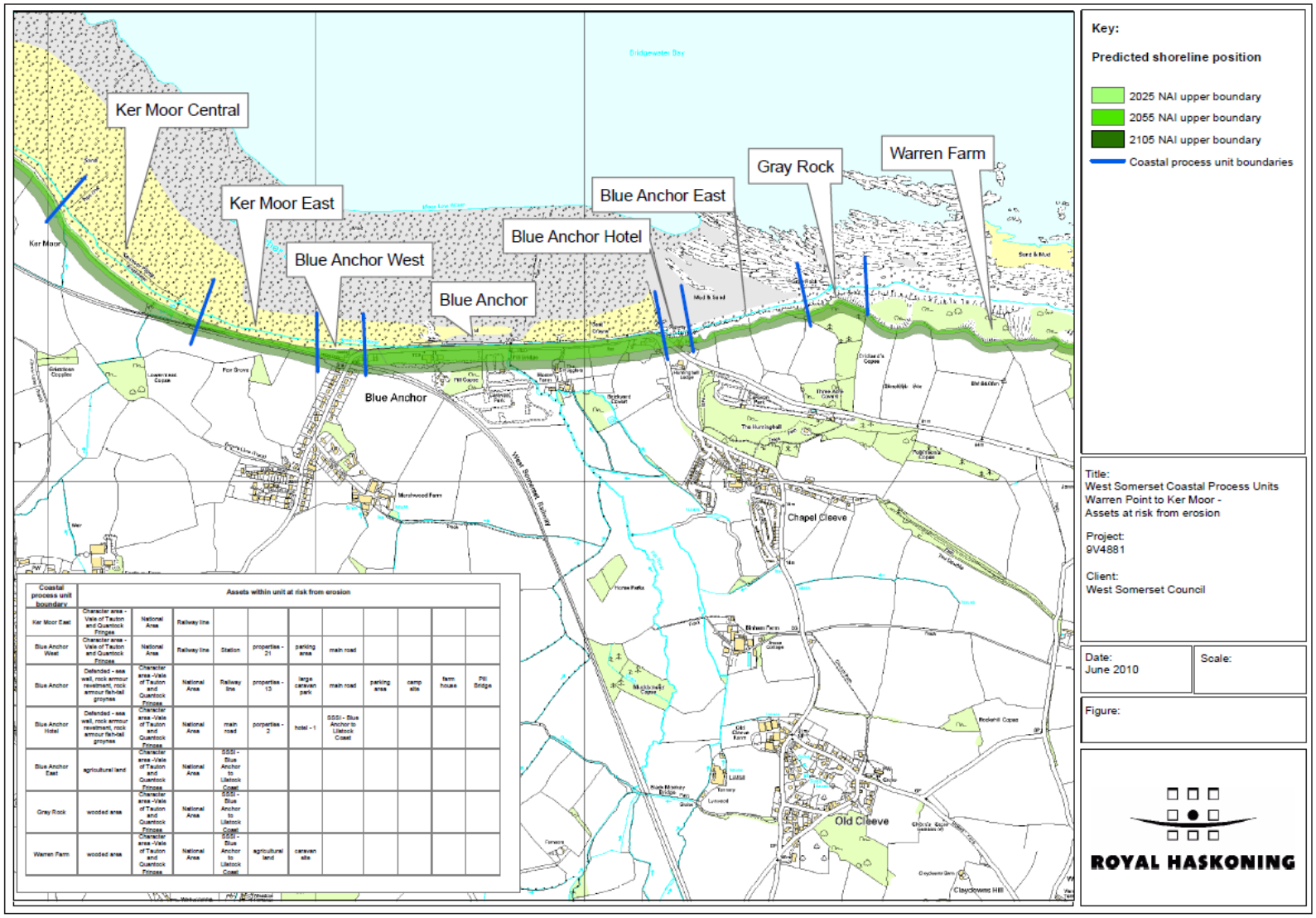



FIGURE 1-6
**Coastal flood risk along the BMP frontage (from Environment Agency).**




| Coastal process unit boundary | Assets within unit at risk from erosion | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Ker Moor East | Character area - Vale of Taunton and Quantock Fringes | National Area | Railway line | | | | | | | | |
| Blue Anchor West | Character area - Vale of Taunton and Quantock Fringes | National Area | Railway line | Station | properties - 21 | parking area | main road | | | | |
| Blue Anchor | Defended - sea wall, rock armour revetment, rock armour fish-tail groynes | Character area -Vale of Taunton and Quantock Fringes | National Area | Railway line | properties - 15 | large caravan park | main road | parking area | camp site | farm house | Pill Bridge |
| Blue Anchor Hotel | Defended - sea wall, rock armour revetment, rock armour fish-tail groynes | Character area -Vale of Taunton and Quantock Fringes | National Area | main road | properties - 2 | hotel - 1 | SSSI - Blue Anchor to Lilstock Coast | | | | |
| Blue Anchor East | agricultural land | Character area -Vale of Taunton and Quantock Fringes | National Area | SSSI - Blue Anchor to Lilstock Coast | | | | | | | |
| Gray Rock | wooded area | Character area -Vale of Taunton and Quantock Fringes | National Area | SSSI - Blue Anchor to Lilstock Coast | | | | | | | |
| Warren Farm | wooded area | Character area -Vale of Taunton and Quantock Fringes | National Area | SSSI - Blue Anchor to Lilstock Coast | agricultural land | caravan site | | | | | |

FIGURE 1-7
**Coastal erosion risk along the BMP frontage (from Royal Haskoning, 2011).**

The current coastal defence system along the BMP frontage (i.e. beach, groynes, revetments and seawalls in combination) have been constructed over a period of years (refer to **Section 1.3.3**). Analysis completed as part of this BMP indicates that, with the exception of parts of the defences at Blue Anchor, the defences are generally in good to fair condition with many years of service left in them provided they are appropriately maintained (refer to **Section 1.3.4**); which is to be guided by ongoing monitoring as defined in **Section 4** of this BMP. However, there are two key challenges to be addressed to minimise the risk of coastal flooding and erosion:

1. Ensuring beach levels along the Minehead frontage are maintained to a sufficient level so as to minimise the amount of wave overtopping experienced during storm events; and
2. Managing the risk of breaching of the defence line and thus flooding of Minehead that is posed by a combination of storm-event driven erosion and longer-term rollback in response to sea level rise of The Warren and Dunster Beach.

The preferred option for addressing these challenges has been developed alongside this BMP, and is described in **Section 1.1.1**.

### 1.4.2 Environmental considerations

The following environmental considerations for beach management activities between Minehead and Blue Anchor have been identified:

- Access and noise/visual disturbance to recreational users in the vicinity of BMP activities, as the beach is used extensively for amenity purposes – all works will need to be programmed to minimise the impact on amenity users by avoiding the peak holiday season, where possible. Also, there is a need to ensure safe public access of any possible recycling/re-profiling works.
- Access and noise/visual disturbance to residents/local businesses.
- Access/egress route over the beach for the Minehead Lifeboat west of Minehead Harbour.
- Impact of beach management activities on internationally and nationally designated sites – need to avoid disturbance to notable and protected habitats and species. Potential requirement for Habitats Regulations Assessment to assess impacts of beach management activities on the integrity of the international conservation sites. Early consultation with Natural England during the development of any scheme will be required (refer also to **Section 1.6**).
- Access for vehicles and personnel during any construction on to the beach may limit works.

### 1.4.3 Public safety and amenity considerations

No public health and safety concerns were encountered during the visual condition assessment of the frontage (refer to **Appendix D**).

However, **public safety issues such as condition of handrails and paving along promenades, and obstructions along the beaches etc. should be considered as part of future regular visual inspections of the area, in accordance with the Environment Agency's Public Safety Risk Assessment procedures for consistency of approach along the BMP frontage**. This requirement is thus included in the recommended monitoring and maintenance regime presented in **Sections 4 and 5** of this BMP.

### 1.4.4 Uncertainties about coastal processes

A detailed review of coastal processes was undertaken as part developing this BMP. This is presented in full in **Appendix E**, with key information for beach management decisions summarised in **Sections 2.1 to 2.6**. This generally provides a reasonable understanding of the coastal dynamics along the BMP frontage. However, there remain a number of key uncertainties and limitations to our understanding of the behaviour of the coastline between Minehead and Blue Anchor, and which will ultimately determine the future behaviour and therefore management of the frontage. These uncertainties include:

- The sediment pathway between the nearshore and offshore remains uncertain, particularly how much and where sediment may be being stored in the nearshore/offshore zone. More detailed and regular bathymetry surveys supported by sediment sampling would help to clarify this matter.
- Breach modelling is limited to the work completed by JBA (2014), for which flood risk modelling been completed for eight locations in the BMP area. Two of these locations allowed for a breach scenario, including one at Dunster Marsh and Dunster Beach. The Dunster Marsh location aligns with an area identified in this report to be at risk of breaching. The Dunster Beach location does not, although it is close by and therefore gives a reasonable indication of the risk area. The modelling makes the assumption that land-levels will be lowered to 6m with an extreme water level of 1 in 200 (0.5% AEP) and provides a flood map of the area at risk from flooding should a breach occur. For all other locations identified to be at risk from breaching in this report, such modelling is not available. The alternative source of information on flooding resulting from breach is Black and Veatch (2009). The benefits of undertaking further breach modelling would need to be considered carefully, since the likelihood is dependent on many variables including incident hydrodynamic conditions, wave overtopping and status of the dune/shingle/gravel barrier and backshore.
- Although beach profile data is available from 2007 to 2015 through the SWRCMP, there are inherent uncertainties relating to long-term trends which extend beyond 2007. In some locations, the profile does not include the gravel/shingle ridge and it has therefore not been possible to assess the changes occurring along the backshore.
- Identification of erosion hotspots at The Warren – Dunster Beach is limited to two locations, however, further study of the area would help to understand the changes occurring in more detail and therefore help to differentiate between short and long-term trends.

Monitoring of data to help improve understanding and overcome some of the uncertainties in present understanding is included in **Section 4** of this BMP.

## 1.5 Responsibilities for management

Responsibility for the management and operation of activities along the BMP frontage varies depending upon the activity and ownership. **Table 1-2** summarises the roles and responsibilities.

TABLE 1-2
**Assigned responsibilities for coastal flood and erosion risk management activities between Minehead and Blue Anchor.**

| Management Activity | Assigned Responsibility *(note, responsibility varies along the frontage for some management activities)* |
|---|---|
| Monitoring of beach and other coastal processes | South West Coastal Monitoring Group |
| Initiation of post-storm surveys | Environment Agency / West Somerset Council |
| Operations to maintain beach profile for FCERM purposes | Environment Agency / West Somerset Council / Dunster Beach Chalets Ltd |
| Operations to alter beach profile west of Minehead Harbour for lifeboat access purposes | RNLI (in consultation with West Somerset Council) |
| Cleaning/clearance of promenades/backing roads, etc of beach debris for amenity. | West Somerset Council / Somerset County Council (Highways) |
| Cleaning/clearance of beach in response to pollution incidents. | West Somerset Council or Somerset County Council *(depending on nature of hazard)* |

| Management Activity | Assigned Responsibility *(note, responsibility varies along the frontage for some management activities)* |
|---|---|
| All structural inspection and maintenance of coastal defence assets including promenades, seawalls, rock groynes etc. (Minehead and The Warren) | Environment Agency / West Somerset Council |
| All structural inspection and maintenance of groynes at Dunster Beach | Dunster Beach Chalets Ltd |
| All structural inspection and maintenance the River Avill Flood Relief Channel and protecting rock armour | Environment Agency |
| All structural inspection and maintenance of coastal defence assets at Blue Anchor. | Somerset County Council (Highways) / Private landowner |
| All inspection and maintenance of access steps and ramps to beach from seawalls/promenades that form part of the formal coastal defences | Environment Agency / West Somerset Council / Dunster Beach Chalets Ltd / Somerset County Council (Highways) / Private landowner |
| All maintenance of footpath and cycleways including signs for designated public footpaths and rights of way. | Somerset County Council / Private Landowners |
| Litter clearance | West Somerset Council / Private Landowners |
| Maintenance of seats, litter bins, etc. | West Somerset Council / Private Landowners |
| Provision of signage | West Somerset Council / Somerset County Council / Private Landowners |
| Flood warning | Environment Agency |
| Flood incident response actions | Environment Agency and Somerset County Council |
| Emergency planning | West Somerset Council, Environment Agency and Somerset County Council |

Actual ownership of the assigned responsibility for each management operation identified in **Table 1-2** is in some cases held by different departments within the identified organisation. Therefore, in order to support **Table 1-2** and to provide clarity on who should be contacted for each item, **Appendix F** provides more specific contact details for those responsible for each management operation.

## 1.6 Licences, approval and consents

In order to undertake any future beach recycling, beach recharge or other capital scheme along the BMP frontage as described in **Section 5**, a range of licences, approvals and consents will be required, including:

- Marine Licence under the Marine and Coastal Access Act 2011 (see **Section 1.6.1**).
- SSSI consent from Natural England (see **Section 1.6.1**).
- Planning Application under the Town and Country Planning Act 1990 (see **Section 1.6.2**).

The following sections summarise the required consents and the processes to obtaining them.

Discussions should be held with the relevant consenting organisations in a timely manner to ensure that all requirements of licence/consent applications are confirmed and addressed in order to minimise the risk of delays in being able to implement works. These discussions should also assess the applicability of

progressing a licence application through the streamlined process defined in the Coastal Concordant for England published in November 2013 (Defra, 2013).

### 1.6.1 Marine Licence

At present along the frontage no Marine Licence is held to facilitate the beach management works envisaged to be implemented within the next few years to fulfil the preferred option identified as part of developing this BMP (refer to **Section 1.1.1**). As such, as part of any future scheme development to implement beach recycling or any other works along the BMP frontage, the Marine Management Organisation (MMO) will need to be engaged to seek a Marine Licence or Licences to facilitate both the capital works and/or any ongoing maintenance activities.

As part of the process of obtaining a Marine Licence for any works, consideration of The Marine Works (Environmental Impact Assessment) (Amendment) Regulations 2015 will also be needed to determine whether an environmental impact assessment is required. The MMO would most likely act as the Competent Authority in this regards.

A Water Framework Directive Assessment may also be required to support the Marine Licence application. The scope of any such assessment would require consultation with the Environment Agency.

Although there are no areas in the immediate vicinity of the study area that are designated under The Conservation of Habitats and Species Regulations 2010, there is potential connectivity for migratory birds to the Severn Estuary SPA. As such, a Habitats Regulations Assessment screening will likely be required (as a minimum) as part of a Marine Licence application. The Competent Authority for this would be Natural England.

With regards to undertaking beach recycling works, it should be noted that the MMO guidance has previously advised that beach recycling activities within the same sediment cell are exempt from the need for a Marine Licence. However, there is still a need to notify the MMO of a licence exempt activity notified via the MMO website (see https://www.gov.uk/guidance/make-a-marine-licence-application). Should the MMO not agree with the exemption they will notify the applicant (usually within a week). **It is strongly recommended that a Scoping Opinion be sought from the MMO in the immediate future to clarify this and determine whether or not a Marine Licence is required for ongoing beach recycling covering a period of 10-20 years (in advance of any new scheme being implemented) and, if needed and given the time-scale involved in obtaining a Marine Licence (typically 14 weeks), obtain a Marine Licence from the MMO in good time to enable beach management works to be implemented when it becomes required**, rather than having this 14 week delay at a time when such a delay may increase risk of failure of the seawall, etc. Any Marine Licence should be kept up-to-date so there is no lapse. It may be pertinent to seek a Marine Licence in the immediate future that would facilitate undertaking emergency works prior to the any planned works that are to be developed in further detail in the near future.

For works at Blue Anchor, particularly the eastern end of the seawall adjacent the Blue Anchor to Lilstock SSSI, **consent will be needed from Natural England each time works are carried out in the SSSI area**.

### 1.6.2 Planning Application

Any capital scheme will also require some form of planning consent from West Somerset Council. It is recommended that the local planning officer be consulted at the time when a capital scheme is being developed to determine the most appropriate route for planning consent.

Above the MHWS the planning authority would act as the Competent Authority and planning permission would be sought. An application under these circumstances would also require consideration under the Town and County Planning (Environmental Impact Assessment) regulations 2011. In this regard, West Somerset Council would likely act as the Competent Authority.

# 1.7 Linkages to other relevant documents

## 1.7.1 Shoreline Management Plan policy

The current Shoreline Management Plan (SMP) covering the BMP frontage was adopted in December 2010 (Halcrow, 2010). The SMP policy recommended for this section of coast is defined by the following policy units:

- 7d19 - Minehead
- 7d20 - The Warren (Minehead Golf Course)
- 7d21 - Dunster Beach
- 7d22 - Dunster Beach (east) to Ker Moor
- 7d23 - Blue Anchor

Recommendations for Minehead to Blue Anchor (policy units 7d19 to 7d23) are stated in the SMP2 as being:

*'The long term plan for this area is to continue to minimise flood risk to Minehead, including that from The Warren to Ker Moor frontage, whilst achieving a more sustainable defence line along the adjacent frontages to the east. This will involve continuing to maintain an adequate level of protection to Minehead with provision of a set-back defence along the adjacent frontages. It is expected that any realigned position would have to be seaward of, or incorporate in some way, the West Somerset Railway in order that this resource of value to the economy of the area is retained; to relocate or realign the railway is unlikely to be feasible.*

*At Blue Anchor it will increasingly become technically difficult to maintain the present defences. As these reach the end of their effective life replacement is unlikely to attract public funds from the flood and coastal defence budget. Therefore, in the long term there will be a move towards a no intervention policy.*

*The plan will both provide long term protection to the majority of shoreline assets, whilst affording potential habitat gains through implementation of managed realignment. There would be potential for impacts on the golf course and also some shoreline assets, depending upon the location of the set back defences. The timing of providing a set back defence will vary along the shoreline and will require investigation to determine the most appropriate realignments.'*

**Table 1-3** summarises the SMP policies that apply to the BMP area.

Table 1-3

**SMP Policies adopted December 2010 (from Halcrow, 2010) along the BMP area**

| Policy Unit | Short Term (to 2025) | Medium Term (to 2055) | Long-term (to 2105) |
|---|---|---|---|
| **7d19 - Minehead** | Maintain and improve the existing defences to continue to provide protection to Minehead, through a **hold the line** policy. | Maintain and further improve the existing defences to continue protection for Minehead, through a **hold the line** policy. | Maintain and further improve the existing defences to continue protection for Minehead, through a **hold the line** policy. |
| **7d20 - The Warren (Minehead Golf Course)** | Continue to provide protection by replacing and maintaining embankment defences along existing alignment, possibly supported by beach recycling and replenishment, under a policy of **hold the line**. Investigate and | Continue to provide protection by maintaining embankment defences along existing alignment, possibly supported by beach recycling and replenishment, under a policy of **hold the line**. Maintain the secondary defence embankment inland | As it becomes unsustainable to maintain defence along the existing alignment, move to a policy of **managed realignment**, whereby the secondary defence line becomes the primary defence line. |

| Policy Unit | Short Term (to 2025) | Medium Term (to 2055) | Long-term (to 2105) |
|---|---|---|---|
| | construct a secondary defence embankment inland to protect Minehead against flood risk. | to protect Minehead against flood risk. | |
| **7d21 - Dunster Beach** | Continue to provide protection through beach management under a policy of **hold the line**. Investigate and construct a secondary defence embankment inland to protect Minehead against flood risk. | Continue to provide protection through beach management under a policy of **hold the line**. Maintain the secondary defence embankment inland to protect Minehead against flood risk. | As it becomes unsustainable to maintain defence along the existing alignment, move to a policy of **managed realignment**, whereby the secondary defence line becomes the primary defence line. |
| **7d22 - Dunster Beach (east) to Ker Moor** | Investigate and implement construction of set-back defence embankment under a policy of **managed realignment**. | **Hold the line** of the realigned defence through continued maintenance. | **Hold the line** of the realigned defence through continued maintenance and improvement. |
| **7d23 - Blue Anchor** | Maintain the existing seawall and rock revetment defences, and replace defences at the eastern end near the Blue Anchor Hotel. Extend them a little to the east, to continue protecting people, property and the B3191 from erosion risk, through **hold the line**. | Maintain the defences to continue protection against flood and erosion risk, through **hold the line**. | Allow natural coastal evolution to occur by moving towards a policy of **no active intervention**, with implementation of local **managed realignment** if necessary to protect the railway. |

### 1.7.2 West Somerset Council Local Plan 2015 to 2032

The current West Somerset Local Plan was adopted on in January 2015. The Plan sets out the aim of the plan to guide where development in East Devon will occur and how the great natural asset will be conserved and enhanced. Pertinent policies are identified below:

- Policy MD1: Minehead Development
- MD2: Key Strategic Development Allocation At Minehead/Alcombe
- LT1: Post 2026 Key Strategic Development Sites
- CC2: Flood Risk Management
- CC3: Coastal Change Management Area
- CC4: Coastal Zone Protection
- CC6: Water Management
- NH1: Historic Environment
- NH2: Landscape Character Protection
- NH3: Nature Conservation And The Protection And Enhancement Of Biodiversity.

### 1.7.3 Exmoor National Park Partnership Plan 2012-2017

The Partnership Plan is a management plan aimed at prioritising actions to protect and enhance the National park landscape, wildlife and cultural heritage. Relevant priority actions of the plan are identified as:

- Prioirty A1: Protect and manage the special character of Exmoor's unique landscapes
- Priority A3: Maintain in good condition, extend and connect Exmoor's important wildlife habitats and the species they support
- Prority C3: Helping farmers, foresters and land managers to produce food, timber and other produce while protecting and enhancing Exmoor's special qualities and delivering ecosystem services (protect inundation of coastal soils due to sea-level rise).
- Priority A4: Engage people in understanding, protecting and managing Exmoor's cultural heritage and historic environment.

### 1.7.4 West Somerset Catchment Flood Management Plan (CFMP)

The CFMP (Environment Agency, 2012b) acknowledges sources of flooding from rivers in the West Somerset Catchment. It describes significant tidal flooding in Minehead with risks to people, property and infrastructure. The plan highlights preferred risk management policies for West Somerset with a recommended 'we can generally take further action to reduce flood risk' (Policy Option 5) for Minehead.

### 1.7.5 South West Inshore Marine Plan

The BMP area lies within the South West Inshore Marine Plan area. This Marine Plan is currently being developed by the Marine Management Organisation (MMO) in parallel to the South West Offshore Marine Area. Once published and adopted, the Marine Plan will be a statutory planning document used to guide licence and consent decisions within the marine environment up to the MHW mark including beach management activities (refer also to **Section 1.6.1**). Marine planning for the south west began spring 2016; finalisation, adoption and publication of the plans are expected winter 2019.

### 1.7.6 River Basin Management Plan, 2015

The South West River Basin Management Plan (Environment Agency, 2016b) was prepared under the Water Framework Directive (WFD) as an update to the original programme produced in 2009 as part of a series of six-year planning cycles. It contains actions to improve the ecological status of water bodies in river basin catchments, including coastal waters out to 1 nautical mile. The BMP area lies within one such WFD Coastal Water Body and so activities need to comply with the requirements of this plan.

### 1.7.7 West Somerset Coastal & Marine Habitat Action Plan (2008)

The West Somerset Biodiversity Action Plan was published in 2008 by West Somerset Council. It laid out a series of actions that was needed to be taken at a regional level to halt the decline in biodiversity in the region. The plans cover, what are now termed priority habitats and species within the terrestrial coastal, intertidal and sub-tidal zones. The plans also identify specific threats and impacts which may be pertinent to the Minehead to Blue Anchor BMP options appraisal process going forward.

# Supporting Information

This section of the BMP provides a summary of the physical setting of the BMP area. The aim of this summary is to provide an overview of the coastal processes affecting the Minehead to Blue Anchor frontage and the impacts of human intervention upon them, as well as details of the environmental features of the site that must be considered when undertaking beach management in this area. This includes the following information:

- Wave climate (typical waves, extreme waves).
- Water level climate (tidal information, extreme water levels).
- Joint probability extreme wave and water levels.
- Climate change.
- Sediment transport (sediments, shoreline movement, beach stability).
- Environmental characteristics.

This summary is largely based upon detailed assessment undertaken as part of developing the BMP, which is provided in **Appendix E**.

## 2.1 Wave climate

### 2.1.1 Typical waves

Wave data in the vicinity of the BMP area is limited to the South West Regional Coastal Monitoring Programme's Directional WaveRider Buoy, which is located offshore of the coast of Minehead (**Figure 2-1**). The dataset indicates that a predominant north-westerly wave regime operates along this coastline, with smaller and less frequent waves approaching from the north-east and east (**Figure 2-2**).

The coastline between Minehead and Blue Anchor is typically orientated north-west-to south-east, varying at Minehead where the bay is orientated west-east. This affords a degree of shelter from the incoming north-westerly waves as they approach the shoreline here obliquely and refract around the headlands at Greenaleigh Point and Warren Point (Royal Haskoning, 2011). However, the orientation of the coastline does also mean that it is exposed to the less dominant north/north-easterly wave regime.

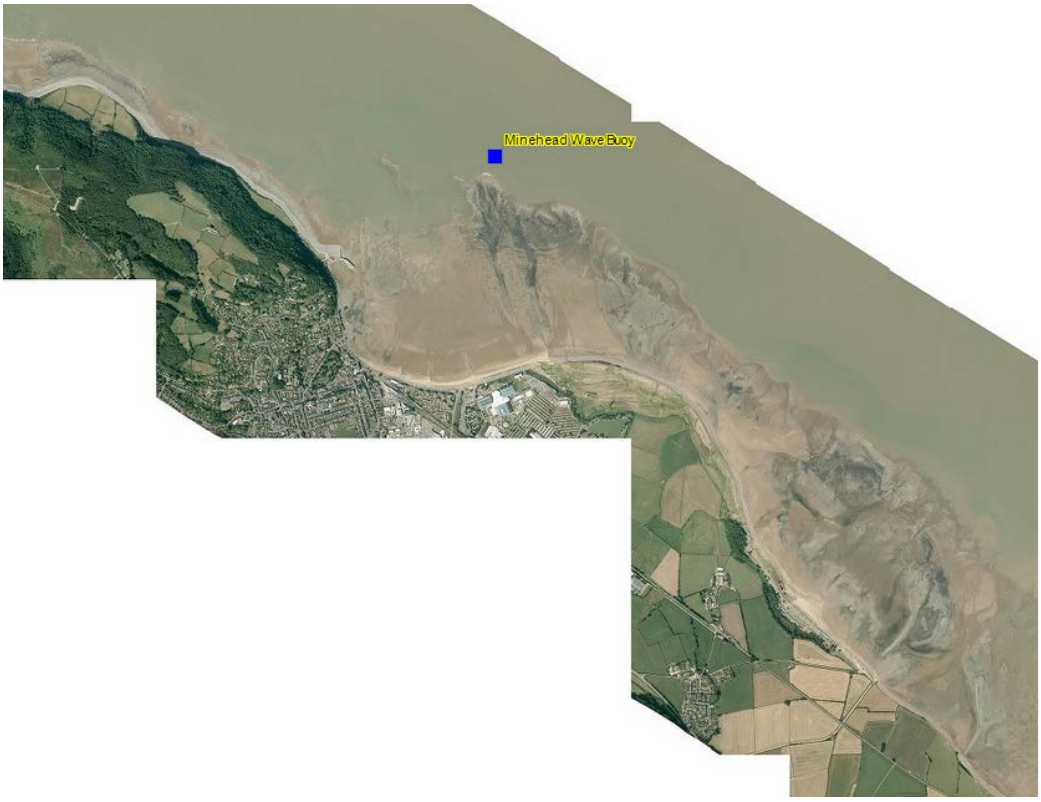



FIGURE 2-1
**Minehead Directional WaveRider Buoy Map showing the location of the Minehead Directional WaveRider Buoy (Aerial photography courtesy of PCO)**

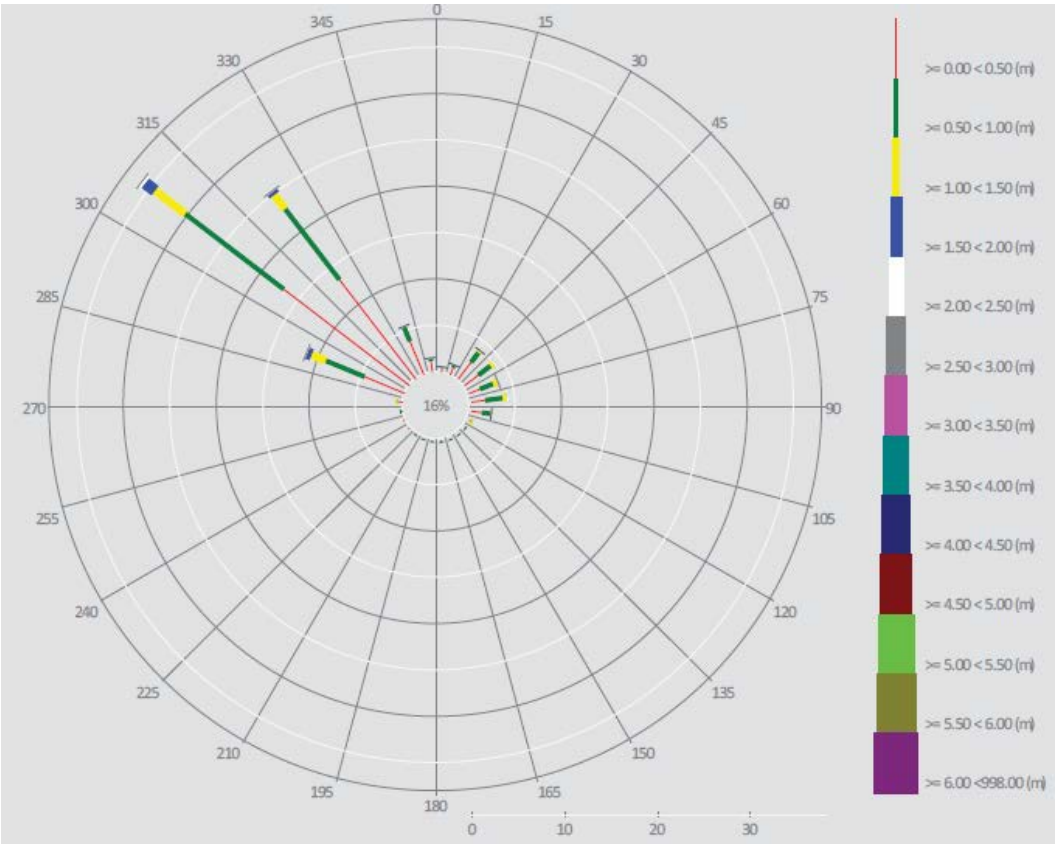



FIGURE 2-2
**Wave data recorded by the Minehead Directional WaveRider Buoy Wind rose showing the offshore wave height measured between 19/12/2006 and 31/08/2015 (source: PCO, 2015)**

### 2.1.2 Extreme waves

As part of their annual reporting procedures, wave data from the Minehead Directional WaveRider buoy is analysed by PCO; data from the most recent report for the period April 2014 to March 2015 (PCO, 2015) is discussed here. PCO determined how many storms occurred between April 2014 and March 2015 by deploying their 'Peaks-over-Threshold method' and defining a threshold storm wave height of 2.3m. PCO report that there was a high frequency of storms (five in total) spread mainly across autumn and winter, generally from the north-west and with wave heights of typical magnitude for the site. The largest significant wave height of 2.72m was measured on 30 January 2015; a full storm analysis for the year is presented in **Table 2-1**.

TABLE 2-1
**Storm wave analysis for April 2014 to March 2015 (Storm wave analysis Minehead WaveRider Buoy (source: PCO, 2015))**

| Date | Hs (m) | Tp (s) | Tz (s) | Dir. (o) | Water Level Elevation (mOD) | Tidal Stage (Hours re. HW) | Tidal Range (m) | Tidal Surge (m) | Max Surge (m) |
|---|---|---|---|---|---|---|---|---|---|
| 21 Oct 14 | 2.55 | 7.7 | 6.7 | 297 | -0.12 | HW +3 | 6.5 | 0.27 | 0.53 |
| 26 Dec 14 | 2.35 | 7.1 | 6.2 | 311 | 1.48 | HW +2 | 7.7 | -0.14 | 0.31 |
| 28 Jan 15 | 2.43 | 8.3 | 5.1 | 309 | 2.89 | HW | 5.1 | 0.04 | 0.28 |
| 30 Jan 15 | 2.72 | 6.7 | 6.3 | 304 | 0.62 | HW +3 | 5.1 | 0.45 | 0.51 |
| 31 Mar 15 | 2.49 | 9.1 | 5.3 | 305 | 2.72 | HW +1 | 5.5 | 0.22 | 0.47 |

The Environment Agency's *Coastal Flood Boundary Conditions for UK Mainland and Islands* (Environment Agency, 2011) and/or *Parameters for Tidal Flood Risk Assessment – Wave Parameters* (Royal Haskoning, 2012) typically provide extreme wave (climate data for locations around the south-west coast of England. However, neither datasets extend sufficiently far eastwards up the Bristol Channel to provide assessment of extreme waves applicable to the Minehead to Blue Anchor coast.

The most recent available extreme wave data for the BMP frontage was therefore that produced for the *Somerset North Coast Flood Warning Water Levels project* (JBA, 2012). This data provided an estimate of the wave height at points of varying distances offshore along the study area, examining a range of extreme water levels and storm events (force 6, 8, 10) from 240 degrees, 270 degrees and 300 degrees. While the data provides sufficient information to complete wave overtopping analysis, the number of nearshore wave data points was limited due to the relative location of some nearshore data points to parts of the BMP frontage. **Figure 2-3** shows the location of data points from the previous JBA (2012) work for which extreme wave and water level data has been extracted for the BMP frontage which is tabulated in **Table 2-2a** to **Table 2-2f** (Section 4.2 of **Appendix D** provides further details).


FIGURE 2-3

**Nearshore extreme wave (and water level) data points from JBA (2012) in relation to beach profile locations. Background imagery from Google Earth).**

TABLE 2-2A

**Nearshore wave data for Minehead 2 wave data point (bed level at 1.59mOD).**

| | 10 year WL and Force 10 storm | 25 year WL and Force 10 storm | 50 year WL and Force 10 storm | 75 year WL and Force 10 storm | 100 year WL and Force 10 storm |
|---|---|---|---|---|---|
| **$H_{m0}$ (m)** | 2.33 | 2.36 | 2.38 | 2.39 | 2.38 |
| **$T_p$ (s)** | 9.9 | 9.9 | 9.9 | 9.9 | 9.7 |
| **SWL (mOD)** | 6.96 | 7.08 | 7.16 | 7.21 | 7.24 |

TABLE 2-2B

**Nearshore wave data for Minehead 5 wave data point (bed level at 2.50mOD).**

| | 10 year WL and Force 10 storm | 25 year WL and Force 10 storm | 50 year WL and Force 10 storm | 75 year WL and Force 10 storm | 100 year WL and Force 10 storm |
|---|---|---|---|---|---|
| **$H_{m0}$ (m)** | 2.3 | 2.35 | 2.38 | 2.4 | 2.4 |
| **$T_p$ (s)** | 9.8 | 9.8 | 9.8 | 9.8 | 9.5 |
| **SWL (mOD)** | 7.01 | 7.13 | 7.21 | 7.26 | 7.29 |

TABLE 2-2C

**Nearshore wave data for Dunster Beaches 6 wave data point (bed level at 3.08mOD).**

| | 10 year WL and Force 10 storm | 25 year WL and Force 10 storm | 50 year WL and Force 10 storm | 75 year WL and Force 10 storm | 100 year WL and Force 10 storm |
|---|---|---|---|---|---|
| **$H_{m0}$ (m)** | 1.87 | 1.89 | 1.91 | 1.92 | 1.92 |
| **$T_p$ (s)** | 9.1 | 9.1 | 9.1 | 9.1 | 9 |
| **SWL (mOD)** | 7.1 | 7.22 | 7.3 | 7.35 | 7.38 |

TABLE 2-2D
**Nearshore wave data for Blue Anchor 3 wave data point (bed level at 2.95mOD).**

| | 10 year WL and Force 10 storm | 25 year WL and Force 10 storm | 50 year WL and Force 10 storm | 75 year WL and Force 10 storm | 100 year WL and Force 10 storm |
|---|---|---|---|---|---|
| **$H_{m0}$ (m)** | 2.26 | 2.3 | 2.32 | 2.34 | 2.34 |
| **$T_p$ (s)** | 9.1 | 9.1 | 9.1 | 9.1 | 9 |
| **SWL (mOD)** | 7.23 | 7.23 | 7.32 | 7.37 | 7.4 |

TABLE 2-2E
**Nearshore wave data for Blue Anchor 4 wave data point (bed level at 0.91mOD).**

| | 10 year WL and Force 10 storm | 25 year WL and Force 10 storm | 50 year WL and Force 10 storm | 75 year WL and Force 10 storm | 100 year WL and Force 10 storm |
|---|---|---|---|---|---|
| **$H_{m0}$ (m)** | 2.64 | 2.67 | 2.72 | 2.74 | 2.74 |
| **$T_p$ (s)** | 9 | 9 | 9 | 9 | 8.9 |
| **SWL (mOD)** | 7.12 | 7.24 | 7.32 | 7.37 | 7.4 |

TABLE 2-2F
**Nearshore wave data for Blue Anchor 5 wave data point (bed level at 1.54mOD).**

| | 10 year WL and Force 10 storm | 25 year WL and Force 10 storm | 50 year WL and Force 10 storm | 75 year WL and Force 10 storm | 100 year WL and Force 10 storm |
|---|---|---|---|---|---|
| **$H_{m0}$ (m)** | 2.44 | 2.47 | 2.48 | 2.49 | 2.49 |
| **$T_p$ (s)** | 9 | 9 | 9 | 9 | 8.9 |
| **SWL (mOD)** | 7.12 | 7.24 | 7.33 | 7.38 | 7.41 |

## 2.2 Water levels

### 2.2.1 Tidal information

This is a macro-tidal coastline with a spring tidal range of 9.6m at Minehead and 10.2m to the east at Watchet. This tidal range occurs as a result of the funneling effect of tidal waters through the Bristol Channel and Severn Estuary and produces strong local tidal currents up to 2m/s over the mean spring tide (Royal Haskoning, 2011).

Due to the geographical spread of the BMP study area and the variance in tidal levels within the Bristol Channel, tide levels for both Minehead and Watchet (the next nearest site to Blue Anchor) are provided in this BMP, see **Table 2-3**.

TABLE 2-3
**Tide levels (in mOD) for Minehead and Watchet (Tidal data converted from the nearest tide data point at Port of Bristol (Avonmouth) from mACD to mOD using conversion factor of -5.40m for Minehead and -5.80m for Watchet (UKHO, 2013))**

| Tidal Condition | Tide Level Minehead (mOD) | Tide Level Watchet (mOD) |
|---|---|---|
| Highest Astronomical Tide (HAT) | 6.40 | 6.80 |
| Mean High Water Spring (MHWS) | 5.20 | 5.50 |
| Mean High Water Neap (MHWN) | 2.50 | 2.50 |
| Mean Sea Level (MSL) | 0.31 | 0.07 |
| Mean Low Water Neap (MLWN) | -1.80 | -1.90 |
| Mean Low Water Spring (MLWS) | -4.40 | -4.70 |

### 2.2.2 Extreme water levels

Still water level is defined as the water surface elevation at a point in time, including the mean sea level and storm surge (an increase in level caused by the effects of wind and atmospheric pressure changes associated with a storm), but excluding the effect of waves.

Extreme still water levels can lead to a risk of flooding and the level of risk will depend on the tide level and surge height at that time. For the purpose of coastal planning and design, a method has been adopted which enables predictions to be made about when and how frequently these extreme water levels could occur. The method involves the statistical analysis of existing water level data to determine the likelihood of a particular water level occurring and expressing this in terms of levels attributed to their respective average return period and equivalent annual exceedance probability (AEP).

In 2011, the Environment Agency undertook a national R&D project (Environment Agency, 2011) to estimate extreme water levels for a number of locations around the coast of England, Scotland and Wales, for a range of return periods. The relevant extreme water levels for Minehead are presented in **Table 2-4** showing that for a 1:200 year event, extreme water levels could be in the order of 7.45mOD, increasing up to 8.12mOD in 100 years' time.

TABLE 2-4
**Extreme water levels for Minehead (Sourced from: Environment Agency 2011b; levels based on 'Med 95%ile' sea level rise scenario; refer to Section 2.4)**

| Year | *Increase in Sea Level (m)* | MHWS Level (mOD) | Extreme Water Levels (mOD) by return period (1 in X years) and AEP (%) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 (100%) | 5 (20%) | 10 (10%) | 20 (5%) | 50 (2%) | 100 (1%) | 200 (0.5%) | 500 (0.2%) | 1000 (0.1%) |
| **2016** | 0 | 1.95 | 6.81 | 7.01 | 7.09 | 7.18 | 7.29 | 7.37 | 7.45 | 7.56 | 7.66 |
| **2025** | 0.051 | 2 | 6.86 | 7.06 | 7.14 | 7.23 | 7.34 | 7.42 | 7.50 | 7.61 | 7.71 |
| **2050** | 0.209 | 2.1 | 7.02 | 7.22 | 7.30 | 7.39 | 7.50 | 7.58 | 7.66 | 7.77 | 7.87 |
| **2065** | 0.317 | 2.1 | 7.13 | 7.33 | 7.41 | 7.50 | 7.61 | 7.69 | 7.77 | 7.88 | 7.98 |
| **2085** | 0.477 | 2.22 | 7.29 | 7.49 | 7.57 | 7.66 | 7.77 | 7.85 | 7.93 | 8.04 | 8.14 |
| **2100** | 0.608 | 2.36 | 7.42 | 7.62 | 7.70 | 7.79 | 7.90 | 7.98 | 8.06 | 8.17 | 8.27 |
| **2116** | 0.671 | 2.36 | 7.48 | 7.68 | 7.76 | 7.85 | 7.96 | 8.04 | 8.12 | 8.23 | 8.33 |

## 2.3 Joint probability extreme waves and water levels

A joint probability analysis assessing the combinations of extreme water levels and extreme wave heights was produced for the *Somerset North Coast Flood Warning Water Levels project* (JBA, 2012) and is described above in **Section 2.1.2** (refer to **Table 2-2a** to **Table 2-2f**). This is the most recent assessment available of joint extreme wave and water level conditions for the BMP frontage.

## 2.4 Climate change and risk

Climate model projections suggest that the global average rate of sea level rise will increase in the 21st Century. A general assumption is that any increase in mean sea level is likely to cause an equal increase in all other water levels, including extreme water levels.

Information on the impacts of climate change is available from *Advice for Flood and Coastal Erosion Risk Management Authorities* (Environment Agency, 2016c). This is the latest guidance and highlights that the main risk of climate change in relation to beach management is from sea level rise. The latest advice from the Environment Agency based on this guidance is that beach management should take account of a 'change' factor covering the whole of the decision lifetime. The change factor is defined as follows:

*"The change factors quantify the potential change (as either mm or percentage increase depending on the variable) to the baseline. It is recommended that option are developed planning for the change factor covering the whole of the decision lifetime. However, rather than base options solely on the change factor the upper and lower end estimates can be used to refine the options to prepare for a rider range of future change."*

The guidance (Environment Agency, 2016c) states that predictions of the future rate of sea level rise for the UK coastline should be taken from UKCP09. Data downloaded from UKCP09 provides sea level rise from 1990. Anticipated rates of relative sea level rise and surge estimates over three time periods are presented in **Table 2-5** for ease of reference. The following estimates are presented in the table:

- Lower End Estimate: this is the low emissions scenario, 50% frequency, taken from the UKCP09 User Interface.
- Change Factor: this is the medium emissions scenario, 95% frequency, taken from the UKCP09 User Interface.
- Upper End Estimate: these are generic values of sea level rise provided in the climate change guidance; they are 4mm (up to 2025), 7mm (2026 to 2050), 11mm (2051 to 2080), and 15mm (2081 to 2115).
- H++ Scenario: these are generic values of sea level rise provided in the climate change guidance; they are 6mm (up to 2025), 12.5mm (2026 to 2050), 24mm (2051 to 2080), and 33mm (2081 to 2115).
- Upper End Estimate + Surge Estimate: This is the upper end estimate plus the upper end surge estimate. The surge estimate are generic values provided in the climate change guidance; they are 20cm (up to the year 2020's), 35cm (up to the year 2050's), and 70cm (up to the year 2080's). With regard to the surge increase, the uncertainty with surge increase is even greater than for sea level rise.

The climate change guidance (Environment Agency, 2016c) recommends that in planning future coastal management options, the Change Factor (medium 95% frequency scenario) be used as the preferred scenario. All other scenarios are included to demonstrate the sensitivity of decision making through time, and can be used to refine the options to prepare for a wider range of future change.

TABLE 2-5
**Relative sea level rise estimates for Minehead. See text above for an explanation of the terms used in this table.**

| Scenario | Low 50%ile | Med 95%ile | Upper End* | Surge for Upper End | Upper End + Surge | H++ |
|---|---|---|---|---|---|---|
| **2016 to 2025** | 0.03m | 0.05m | 0.04m | 0.20m | 0.24m | 0.05m |
| **2016 to 2055** | 0.14m | 0.24m | 0.27m | 0.35m | 0.62m | 0.49m |
| **2016 to 2116** | 0.37m | 0.67m | 0.93m | 0.70m | 1.63m | 1.94m |

**Although the upper end value is actually less than the medium 95%ile derived from the UKCP09 data, it is based on data within the current EA guidance note (2016).*

# 2.5 Sediment transport

## 2.5.1 Sediments

Sediment is sourced from a number of locations within the study area; these are discussed below.

- Release of material from the cliffs west as far as Hurlstone Point by weathering processes and wave attack (Royal Haskoning, 2011) and subsequent transport east (see **Section 2.5.2**). The supply of sediment from further west, around Hurlstone Point, is thought to be minimal (Halcrow, 2002), with the main source of beach-building material reported to be from the glacial deposits exposed at Greenaleigh Point (Halcrow, 2010). Generally, the volume of transport today is much reduced from its historical rate and is dependent on the frequency of cliff falls and the ability for sediment to

bypass coastal structures. Black and Veatch (2009) report that the presence of the Minehead Harbour breakwater and the construction of defences as part of the Minehead Coastal Defence Scheme have interrupted this supply.

- Sea cliffs to the east of Blue Anchor, comprised of Jurassic mudstone and some Quaternary deposits (Royal Haskoning, 2011).
- Erosion of shore platforms, including those at the toe of the cliffs to the east of Blue Anchor, comprised of small gravelly beach deposits (Royal Haskoning, 2011).
- Erosion and winnowing of the shoreline at The Warren (Royal Haskoning, 2011).
- Artificial gravel recharge at The Warren from 1982 to 1996 (Royal Haskoning, 2011).
- Artificial introduction of material from beach recharge, sourced from Holm Sands licensed dredge area in the Bristol Channel.
- Limited inputs of material from fluvial sources, for example The River Avill, which has a mobile gravel bed that results in a need for annual gravel management in the flood channel leading to the beach.

### 2.5.2 Sediment transport mechanisms

Strong tidal currents in the Bristol Channel and Severn Estuary are reported to have a significant influence on the patterns of sediment transport and subsequent erosion and deposition (Royal Haskoning, 2011). Halcrow (1998) report that there is a strong ebb current residual, which has a tendency to move sediment offshore and Royal Haskoning (2011) conclude that this is particularly relevant to fine material, which once eroded from cliffs and the shore platform can be transported eastwards to the Bridgwater Bay mud belt. The mud belt is an extensive depositional feature that has developed in Bridgwater Bay as a result of its relative sheltering from wave action and low tidal currents, combined with high suspended sediment concentrations derived from the Severn Estuary and Bristol Channel (Halcrow, 2010).

The predominant wave influence along the coastline between Minehead and Blue Anchor is from the north-west, and less dominant wave influence from the north-east and east (see **Section 2.5.1**). Studies indicate a net easterly movement of gravel and sand material along the coastline in response to this predominant wave direction (Halcrow, 2002; Royal Haskoning, 2011), which is also supported by local observations. However, the movement of material along the coast is hindered by the presence of coastal defences, constructed at various locations between Minehead and Blue Anchor. Black and Veatch (2009) report that the presence of the harbour arm and groynes at Minehead reduce the volume of material that would have otherwise moved east along the coast.

Key sediment transport pathways include:

- transport of sand sediment in the nearshore zone (Black and Veatch, 2009)
- the movement of gravel and cobble material, which has become detached from the apex of Warren Point, eastwards towards Blue Anchor. Within Blue Anchor Bay, it is reported in the SMP (Halcrow, 2010) that the width of the nearshore zone is increasing suggesting that this is an area of net sediment accumulation. This is likely to result in reduced wave action at the shoreline.

Further details are provided in **Appendix E**.

## 2.6 Shoreline movement

### 2.6.1 Overview of the evolution of this shoreline

#### 2.6.1.1 Long-term historic evolution

To the west of the BMP study area there are high cliffs, which extend as far west as Hurlstone Point. The cliffs are extensively vegetated and comprise heavily faulted and folded Devonian Sandstone (Black and Veatch, 2009). At Greenaleigh Point, there is a small exposure of Quaternary deposits (Halcrow, 2002)

and from here towards Minehead, the cliff toe slopes gently towards the beach. The overall shoreline position and form from Hurlstone Point to Minehead is thought to have remained largely unchanged since sea levels reached more or less their present levels about 4,000 years ago (Halcrow, 2010).

To the east of Minehead, the coastal hinterland is low-lying with an extensive area of former salt marsh and river terrace deposits (Halcrow, 2010). A historic dune system extends from Warren Point to Dunster Beach, understood to have been sourced from the onshore movement of sand from the Bristol Channel, and later, the eastward transport of material eroded from cliffs further west (see below).

As sea levels rose during the Holocene (the last 10,000 years) sand and gravel material was eroded from the cliffs between Hurlstone Point and Minehead and moved east by littoral transport, where:

- some of the material was subsequently deposited and organised by the local wave regime into a series of shingle and dune ridges, which underlies the Minehead and West Golf Course;
- sand-sized material fed the dune system between Warren Point and Dunster Beach;
- gravel-sized material was organised into a ridge and moved onshore. Today, this gravel extends along the length of this coastline from Hurlstone Point in the west to Blue Anchor in the east. Some of this material contributed to the infilling of the valleys of the Avill and Pill Rivers and the formation of barriers across their mouths (Royal Haskoning, 2011).

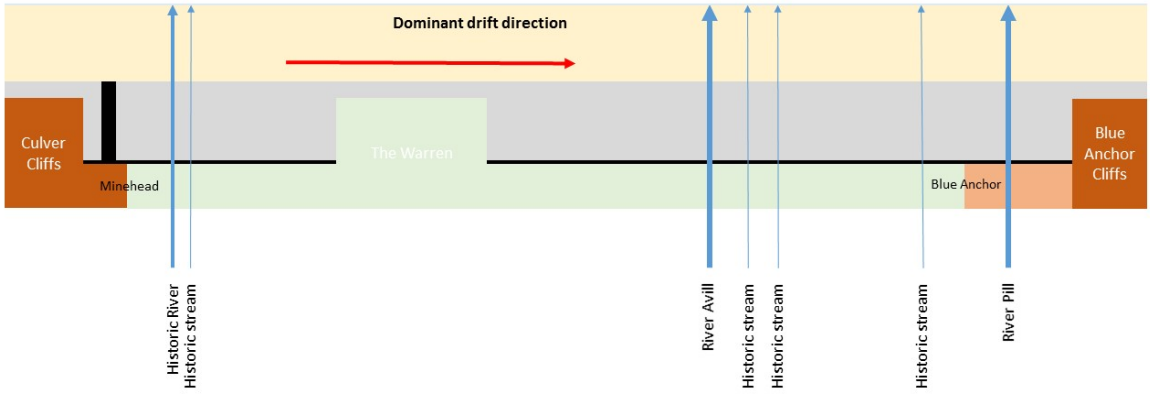
At the eastern end of the study area at Blue Anchor, the cliffs are steep and simple and comprised of Mercia mudstone overlain by head deposits (Royal Haskoning, 2011).

#### 2.6.1.2 Contemporary evolution

In order to understand the more recent, contemporary evolution of the BMP coastline, a conceptual understanding of shoreline behaviour and response has been developed based on a synopsis of the various data sources reviewed and the new analysis presented in **Appendix E**. The conceptual understanding is summarised below and in **Figure 2-4**.

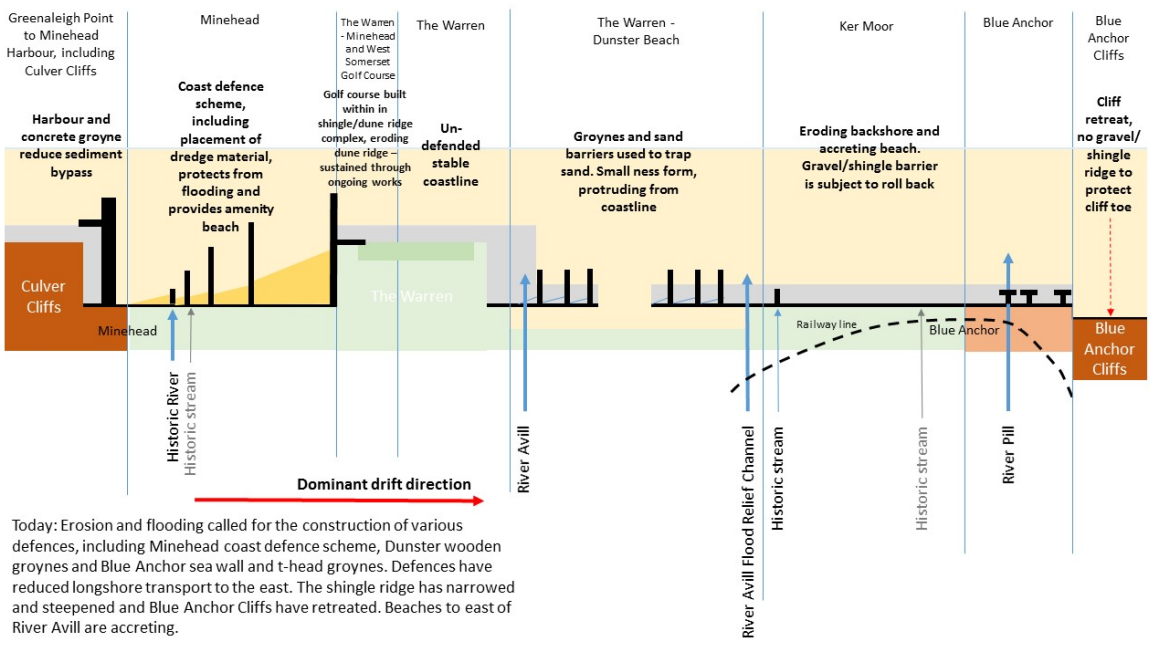
- At a large scale, this coastline is controlled by the geology and geomorphology features. To the west, this is by the more resistant sandstone and quaternary deposits that make up the Culver Cliffs, to the centre, the dune and shingle ridge barrier that is The Warren and to the east, the Mercia mudstone cliffs. Between the land is comprised of reclaimed low-lying Holocene saltmarsh deposits and river gravels, which has led to the formation of a series of embayment's, including Minehead and the wider Blue Anchor Bay (which includes Dunster, Ker Moor and Blue Anchor).
- The beach is defined by a gravel/shingle barrier and sandy foreshore that extends virtually along the entire length of the BMP study area. The barrier is thought to be derived from Holocene deposits transported onshore as sea levels rose. A large number of gravel deposits are present across the foreshore, sourced from the cannibalisation of the gravel/shingle barrier itself and longshore transport from the west.
- Wave data for Minehead indicate that the predominant wave direction is from the north-west, less frequent but sometimes large waves approach from the north/north-east, resulting from easterly storm conditions. The wave climate directly influences sediment transport along the coast, so that sediment transport is predominantly from west to east. During storms the gravel/shingle ridge appears to be pushed up the beach and becomes narrower. The change in orientation of the coastline along the east face of The Warren and Dunster Beach affords some protection from the predominant wave regime, and here the beaches and dunes appear to experience less erosion.
- Defences constructed along the coastline have fixed the backshore position at Minehead Harbour, Minehead and Blue Anchor. Groynes have also been used to stabilise the beach at Minehead, Dunster and Blue Anchor. These defences act to reduce longshore transport along the coastline. The north and east facing coasts of The Warren remain undefended as does Ker Moor.
- Erosion hot spots exists at the following locations, and all but Quay West Car Park and Blue Anchor Cliffs are at risk from breaching during severe events leading to flooding;

- Quay West Car Park;
- The Warren – north facing coastline, 300m east of the Minehead coastal scheme terminal groyne;
- At Dunster - the beach to the north and south of the ness feature;
- Ker Moor - River Avill flood relief channel to the Ker Moor outfall / pipe line;
- Ker Moor – Where the railway embankment runs parallel to the coastline; and
- Blue Anchor Cliffs.




Early 1800's: Minehead to Blue Anchor coastline based on Ordnance Survey map from 1809. few defences in place. Minehead Harbour present. Marsh extended from Minehead to Ker Moor. High land at Blue Anchor. All rivers and streams flowed directly to the sea.

**Mainly undefended shoreline in 1809**




Today: Erosion and flooding called for the construction of various defences, including Minehead coast defence scheme, Dunster wooden groynes and Blue Anchor sea wall and t-head groynes. Defences have reduced longshore transport to the east. The shingle ridge has narrowed and steepened and Blue Anchor Cliffs have retreated. Beaches to east of River Avill are accreting.

**Defended shoreline today**

FIGURE 2-4

**Conceptual model for the coastline between Minehead and Blue Anchor (Undefended shoreline based on Ordnance Survey map from 1809, source: http://www.visionofbritain.org.uk/maps/)**

## 2.6.2 Beach profile analysis

Changes in beach profile been assessed in detail in Section 4 of **Appendix E**. This analysis has been based upon a range of beach profile and LiDAR survey data captured since 2007 as part of the South West Regional Coastal Monitoring Programme (SWRCMP).

Changes observed since 2007 are best summarised in the overview plots produced by Plymouth Coastal Observatory (PCO) for the SWRCMP (see **Figures 2-5a to 2-5f**); this shows changes in cross-sectional area along a number of beach profiles along the BMP frontage between Spring 2007 and Spring 2015.

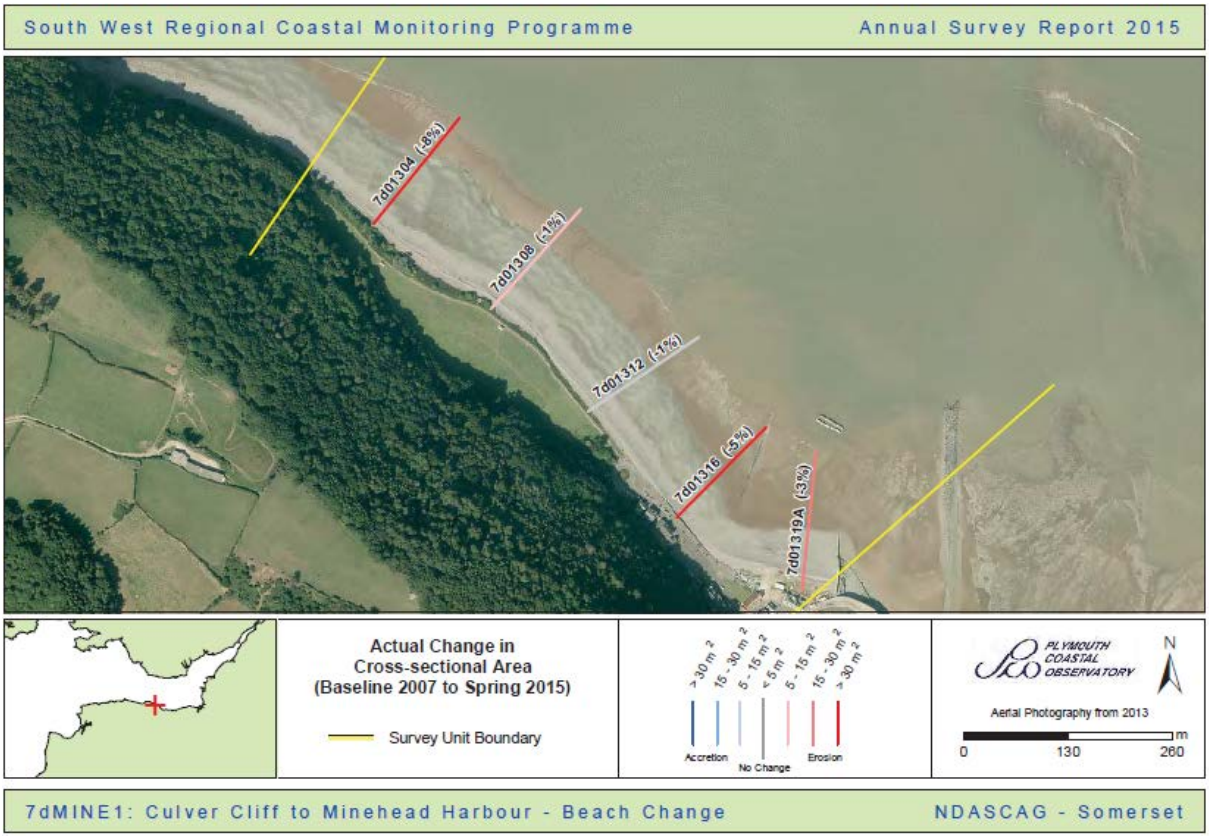



FIGURE 2-5A

**Change in cross-sectional area for the Culver Cliffs to Minehead Harbour section of the BMP frontage (from PCO, 2015).**

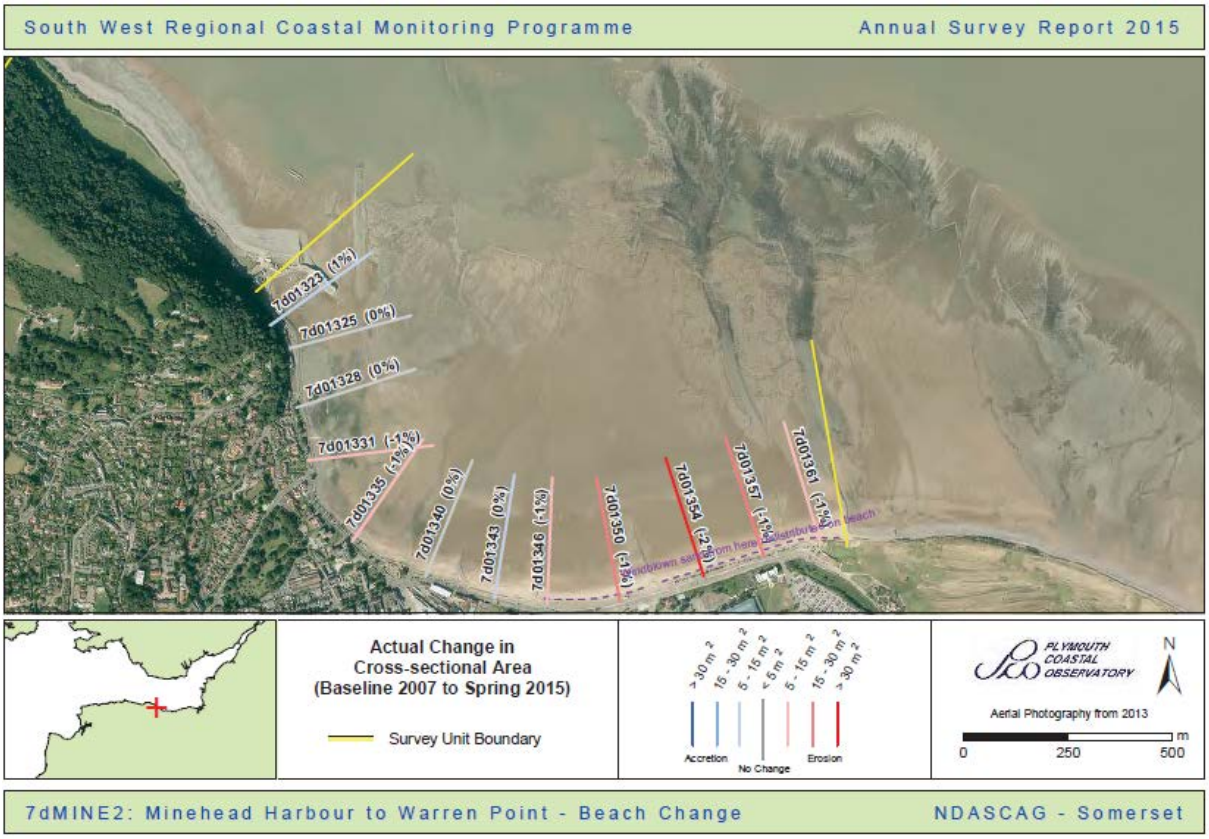
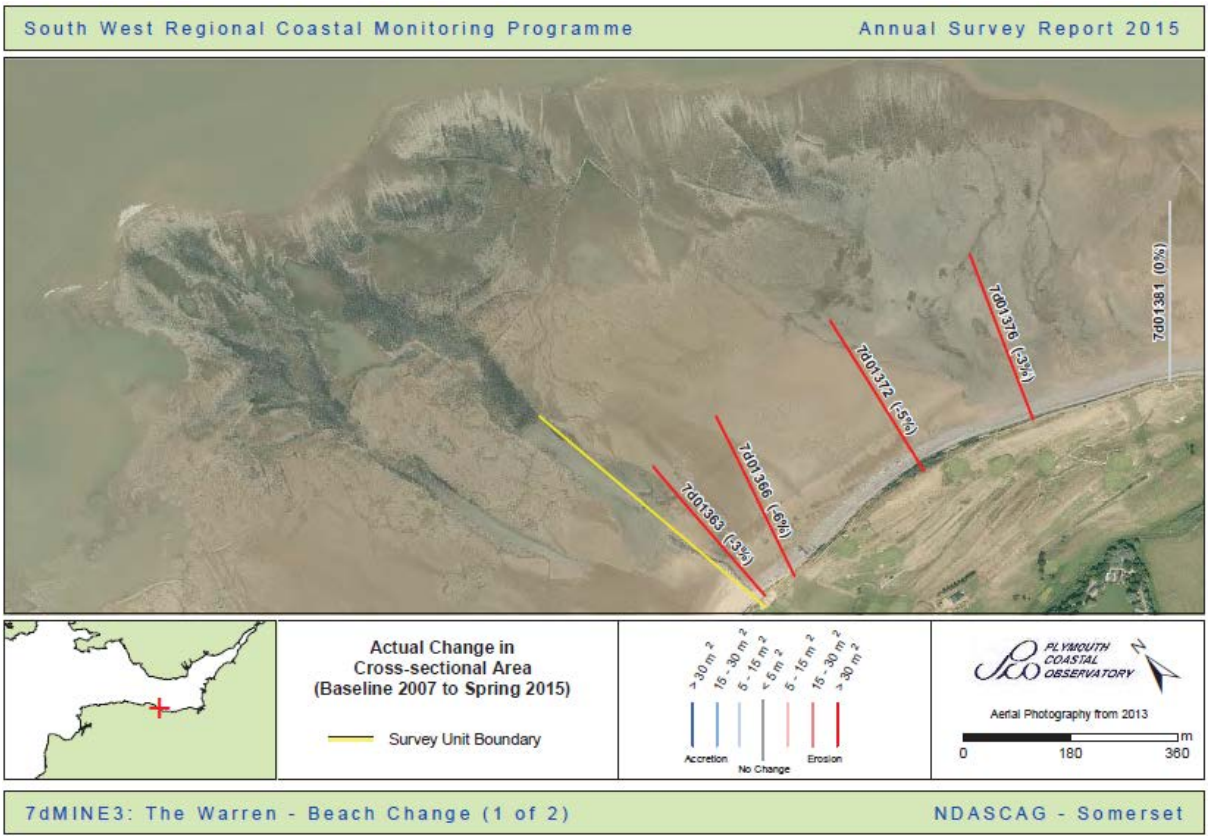



FIGURE 2-5B

**Change in cross-sectional area for the Minehead Harbour to Warren Point section of the BMP frontage (from PCO, 2015).**



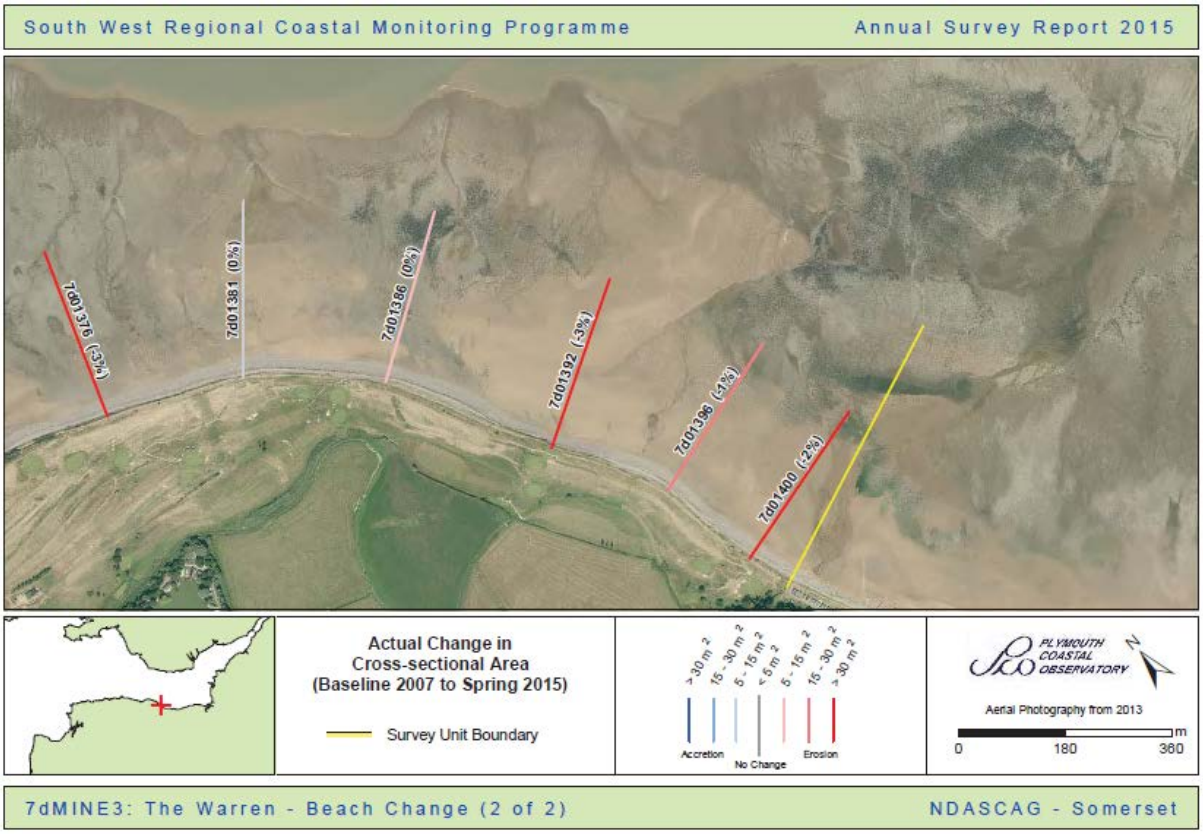



FIGURE 2-5C

**Change in cross-sectional area for the Warren section of the BMP frontage (from PCO, 2015).**

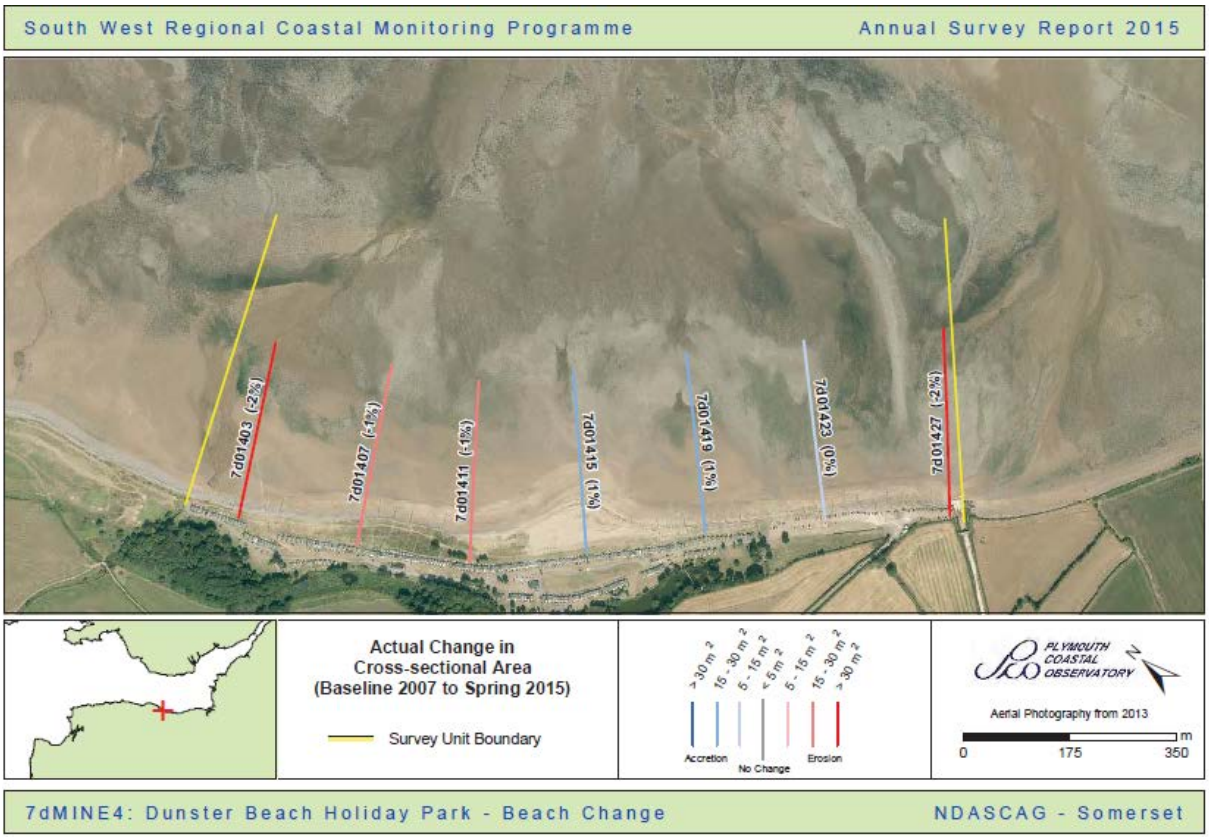
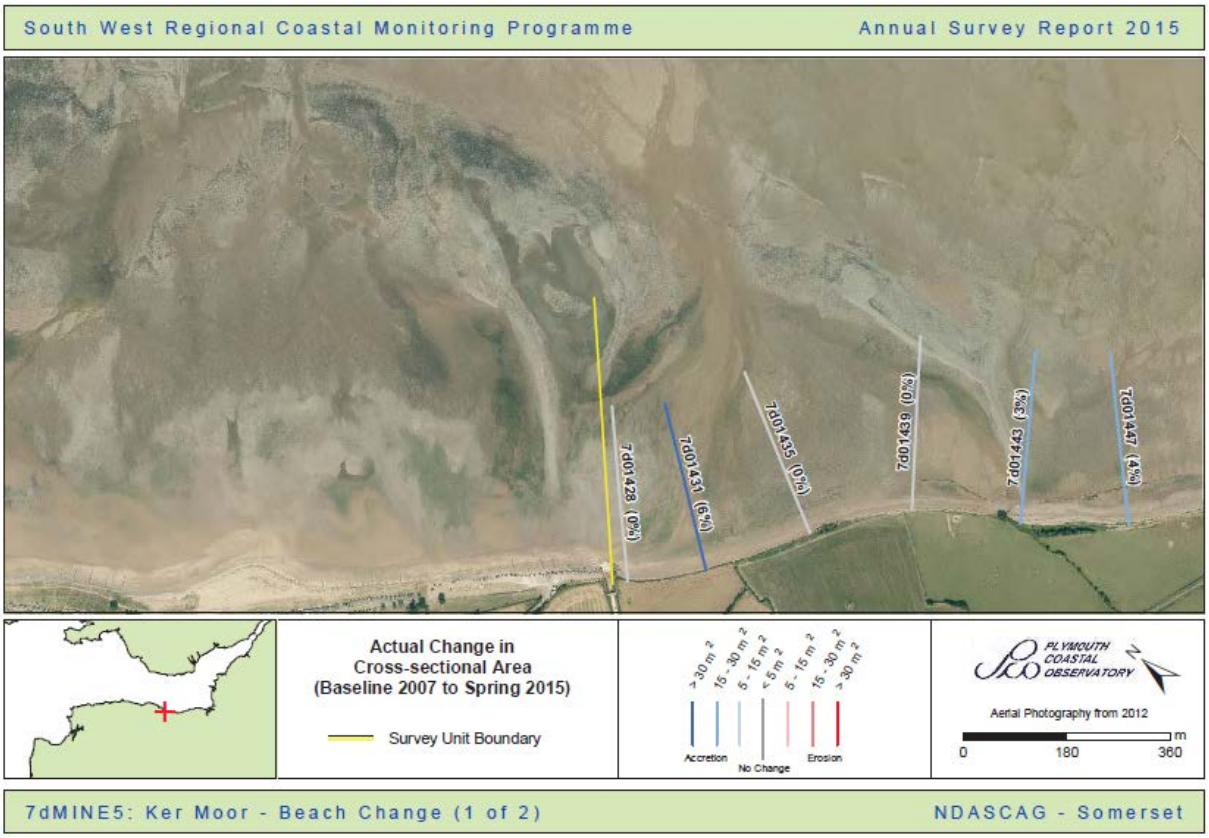



FIGURE 2-5D

**Change in cross-sectional area for the Dunster Beach section of the BMP frontage (from PCO, 2015).**


South West Regional Coastal Monitoring Programme
Annual Survey Report 2015
7d01428 (0%)
7d01431 (6%)
7d01435 (0%)
7d01439 (0%)
7d01443 (3%)
7d01447 (4%)
Actual Change in
Cross-sectional Area
(Baseline 2007 to Spring 2015)
Survey Unit Boundary
> 30 m²
15 - 30 m²
5 - 15 m²
< 5 m²
5 - 15 m²
15 - 30 m²
> 30 m²
Accretion
No Change
Erosion
PLYMOUTH COASTAL OBSERVATORY
Aerial Photography from 2012
0
180
360
m
7dMINE5: Ker Moor - Beach Change (1 of 2)
NDASCAG - Somerset

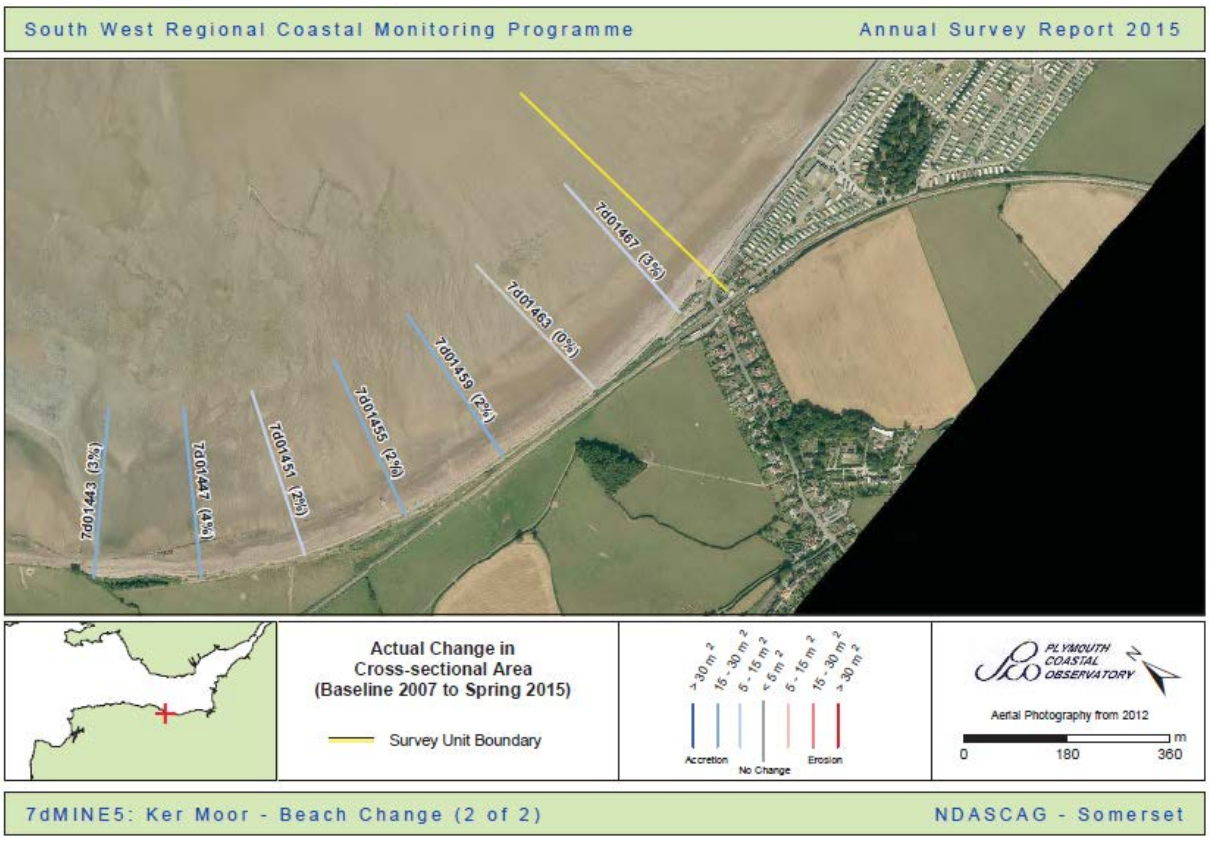

South West Regional Coastal Monitoring Programme
Annual Survey Report 2015
7d01443 (3%)
7d01447 (4%)
7d01451 (2%)
7d01455 (2%)
7d01459 (2%)
7d01463 (0%)
7d01467 (3%)
Actual Change in
Cross-sectional Area
(Baseline 2007 to Spring 2015)
Survey Unit Boundary
> 30 m²
15 - 30 m²
5 - 15 m²
< 5 m²
5 - 15 m²
15 - 30 m²
> 30 m²
Accretion
No Change
Erosion
PLYMOUTH COASTAL OBSERVATORY
Aerial Photography from 2012
0
180
360
m
7dMINE5: Ker Moor - Beach Change (2 of 2)
NDASCAG - Somerset

FIGURE 2-5E

**Change in cross-sectional area for the Ker Moor section of the BMP frontage (from PCO, 2015).**

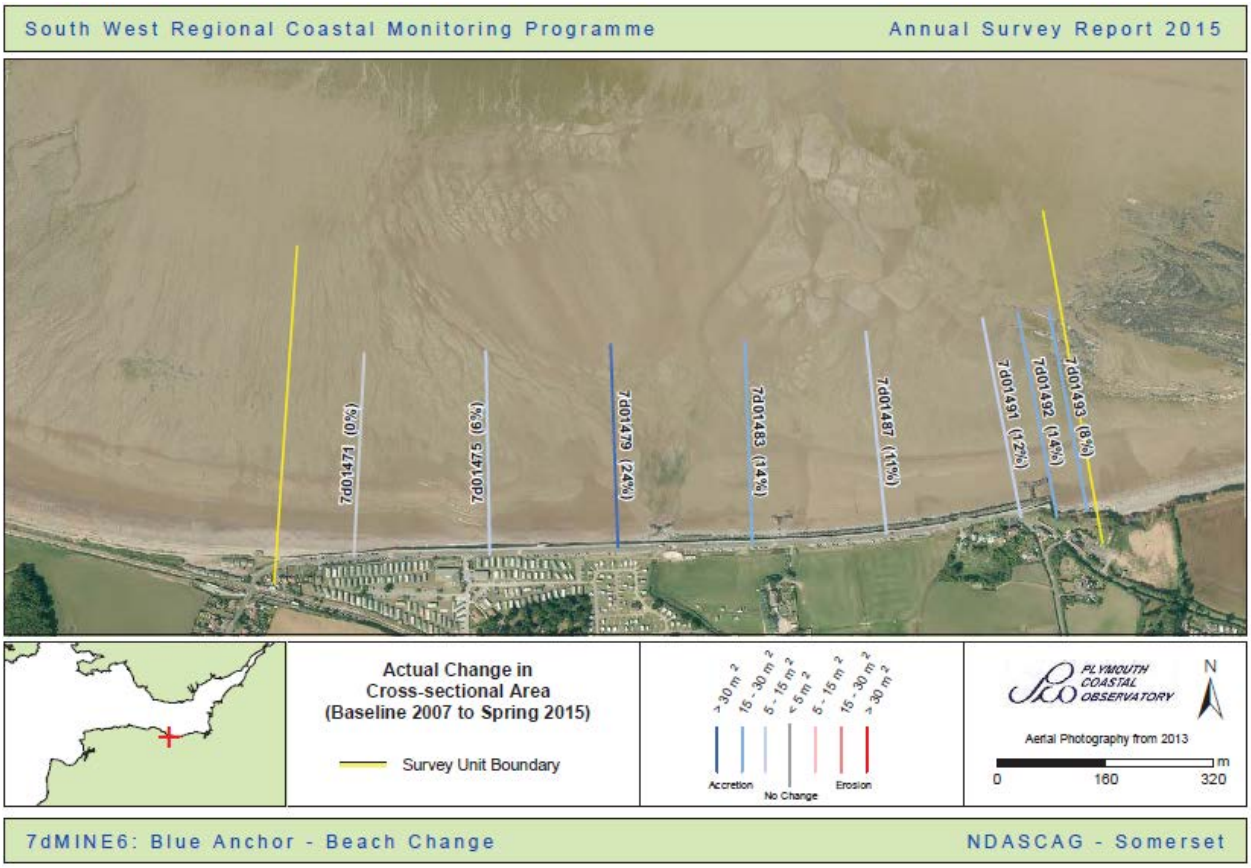



FIGURE 2-5F
**Change in cross-sectional area for the Blue Anchor section of the BMP frontage (from PCO, 2015).**

Key points to note from the analysis presented in **Appendix E** are as follows:

- **Greenaleigh Point to Minehead Harbour, including Culver Cliffs**
  - The gravel beach is rolling back but, due to restrictions caused by the presence of the seawall and higher ground, has become narrow and steep and is vulnerable to cliffing. LiDAR data further supports these observations, showing a trend of beach elevation decrease opposite the Quay West car park. This section of coastline is therefore considered to be a potential **erosion hotspot.**
  - Considering the section of the beach either side of the RNLI lifeboat station, LiDAR shows that when beach levels to the immediate east (profile 7d0138) are low, they are high to the west (7d0139A), and when beach levels at 7d0138 are high, they are low at 7d0139A. This suggests that material may move back and forth between the outfall and concrete groyne.
- **Minehead**
  - The beach at Minehead is subject to cyclical change, with periods of erosion occurring between Spring 2011 and Spring 2012; Spring 2013 and Spring 2014 and periods of accretion between alternate surveys. The erosion observed between Spring 2013 and Spring 2014 could be related to a storm event that occurred on the 25th October 2014.
  - Considering the whole frontage, the LiDAR data indicates that much of the change relates to erosion of the upper beach (between HAT and MHWS), but there has been an increase in elevation of the middle beach (between MHWN and MSL) and in some places accretion of the lower beach (MSL to MLWN). Beach profile volume analysis also shows this, with an increase in beach volume between 2007 and 2014 in the region of 11,000m$^3$. This suggests that beach material is being drawn-down from the upper to lower beach resulting in overall beach

shallowing. This may indicate that the design beach and its function is diminishing over time, assuming that beach crest width and height are the critical design parameters.

- In their beach profile analysis, PCO (2015), whose profiles extend further offshore and therefore capture a greater distance of the beach, found there to be an overall reduction in beach profile cross-sectional area for this section of the coastline. This suggests that over time there has been permanent losses of material from the system, rather than simply the redistribution of material from upper to lower beach. Some of this is occurring via wind-blown processes (as described above), but potentially there is also removal further offshore and alongshore by waves and currents.
- Beach profile analysis completed as part of developing this BMP indicates that the design beach is diminishing, however, in the main, the beach is continuing to meet the minimum design criteria to provide the necessary protection to the seawall and revetment. Key exceptions to this are the locations of profiles 7d01353 and 7d01354 (eastern side groyne 6) and 7d01357 to 7d01359 (opposite Butlins Holiday Park) where, for most of the time, the beach height is less than 6.5m and the beach berm is considerably less than the design berm width.

- **The Warren - Minehead and West Somerset Golf Course**
  - Beach profile analysis by PCO (2015) show a reduction in beach cross-sectional area between 2007 and 2015 in the order of 3% and 6%. The greatest losses occurred between profile 7d01366 and 7d01372, covering a 500m length of coastline starting 50m east of Minehead terminal rock groyne. Comparison of LiDAR data from 2007 to 2016 (in house and via PCO) also shows the gravel ridge, starting from a point some 50m east of the Minehead terminal rock groyne and extending 300m east, also shows a trend for a reduction in elevation. Areas of elevation increase may reflect the placement of rock along this section of coast rather than accretion. This section of coastline is therefore considered to be an **erosion hotspot**.
  - Further to the east, the remainder of this section of coastline along The Warren has generally remained stable or increased in elevation between 2007 and 2016, as the beach and gravel barrier appears to switch between periods of beach growth to beach lowering.
  - The eroding nature of the beach and gravel barrier along Warren Point between a point approximately 50m east of the Minehead terminal groyne and 300-500m to the east and the low-lying nature of the hinterland could mean that this section of coastline is at risk of breach. The likelihood of a breach occurring will depend on the water levels and wave conditions that induce sufficient overtopping/overwashing and erosion of the dune ridge; and in turn the likelihood of where along this section of coastline a breach could occur would depend on the width and the height of the dune/gravel ridge. The level and extent of likely flooding depends on the level of the hinterland behind; along the central section of this coastline flood risk is reduced due to the higher ridges.

- **The Warren**
  - LiDAR data from 2007 to 2016 shows that the gravel ridge and beach along this section of coastline experience alternating periods of elevation increase or decrease, with no clear trend. However, beach profile data PCO (2015) shows that the beach eroded between 2007 and 2015, with cross-sectional area losses in the region of 1% and 3%.
  - The gravel ridge appeared to be particularly dynamic, with the presence of a number of storm berms, and towards the northern end shore-oblique ridges, likely to have formed in response to long-shore waves. This suggests that the coastline is particularly vulnerable when exposed to wave activity when water levels are high, such as during storms or at times of very high tides.
  - The eroding nature of the backshore and beach and the low-lying land behind does mean this coastline is at risk from breach, since the only protection from flooding is the dune ridge/gravel barrier. As shown by LiDAR data, the height of the dune ridge/gravel barrier is lower that the coastline to the north, with a typical elevation of between 7.5mOD and 8.5mOD reducing in a southerly direction. It is difficult to specific exactly where a breach could occur as this will

depend upon a range of factors including water levels, wind direction, overtopping, height of the dune/gravel barrier overtopping and erosion at that point in time.

- **The Warren - Dunster Beach**
  - PCO's annual monitoring reports for the period 2007 to 2015 and LiDAR data show the beach to alternate between periods of accretion and erosion. However, PCO (2015) suggest that the net trend along this coastline is for erosion to the north of the ness feature and stability/accretion to the south of the ness. The exception to this net trend, is immediately updrift of the River Avill Flood Relief Channel, where there has been some localised erosion of the beach. The ness feature appears to have accreted over this period and possibly extended eastwards.
  - This dynamic coastline is subject to fluctuations, occurring over the short-term in response to seasonal conditions and over the longer-term determined by a combination of the geomorphology and local wave and tidal currents. The relatively wide backshore and foreshore means that the risk here is more likely to be overwashing rather than a breach and it is difficult to pinpoint particular areas of erosion. To understand the risk better, more work will need to be undertaken with a site-specific study that considers the changes to the backshore, movement of the ness and related redistribution of sediment and more in-depth analysis of beach profile data. **Erosion hot spots** along this section therefore include the coastline immediately to the south of the ness feature.
  - The backshore is showing signs of erosion with water levels and wave activity clearly reaching the limits of the upper beach. The risk of flooding here is thought to be high, since land levels are low. LiDAR data indicate that the elevation of the backshore is generally between 7.5mOD and 8.5m, and considering height of the extreme water levels presented in **Table 2-4** above, the risk of overtopping/overwashing and breach is high.
- **Ker Moor**
  - The coastline at Ker Moor falls into two discrete sections, defined by different geomorphology and erosion processes operating along the coastline:
    - Section (i) extends from the River Avill Flood Relief Channel to the Ker Moor outfall / pipe line. Here the backshore is eroding but the intertidal beach is stable/accreting.
    - Section (ii) extends from the Ker Moor outfall / pipe line to Blue Anchor and is defined by a more gently sloping backshore derived of gravel and shingle, which grades into the hinterland behind. The gravel/shingle barrier is subject to roll back and break down. Storms over the winter 2013/14 broke through the ridge and also pushed beach sediment into a ditch that normally separates the railway and the ridge. This allowed waves to run-up and over the railway line, damaging the embankment. Works were undertaken in February 2015 to clear the trench of beach material by excavating out the ditch and placing the material over the ridge and into low spots where recent erosion from wave action was observed.
- **Blue Anchor**
  - The backshore position has been fixed following construction of the seawall. Beach profile analysis for the period 2007 to 2015 (PCO, 2015) shows the beach has been stable and/or accreting over this period. At profile 7d01479, located on the updrift side of the western rock groyne the cross-sectional area increased by 24%.
- **Blue Anchor Cliffs**
  - The entire length of cliffs are considered to be an **erosion hot spot**. Beach profile analysis for the period 2007 to 2015 (PCO, 2015) shows the beach to be accreting, with cross-sectional change between 8% and 14%. This accretion is probably a result of increased sediment supply, source directly from erosion of the cliffs and a wider trend of accretion occurring within the nearshore zone in Blue Anchor Bay, which has been taking place since 1982.

### 2.6.3 Beach profile storm response

Historical and anecdotal information indicates that this coastline is susceptible to storms, with a resultant risk of increased wave overtopping and even breaching along parts of the shoreline potentially resulting. Should a breach occur, then it has the potential to flood a wide-area of low-lying land behind the shoreline resulting in significant economic damages (refer to **Appendix A**).

Since 2007, in addition to undertaking routine beach profile surveys, PCO has also undertake post-storm surveys as part of the SWRCMP (refer to **Section 4.1.2**). These have, however, only been undertaken along various parts of the BMP frontage in an inconsistent way, and only for a few storm events that occurred on or around the following dates:

- 7th April 2010
- 11th June 2012
- 19th October 2012
- 25th October 2014
- 12th February 2016
- 15th March 2016.

Analysis of the available beach profile data shows that the beach is drawn down during storm events, with MHWN acting as a tipping point with removal of material above MHWN and deposition below MHWN. Observations of cyclical change, noted above, suggest that the beach does generally recover after storms at most locations. Further detail and analysis of these storm impacts are provided in Section 4.2 of **Appendix E**.

### 2.6.4 Predictions of future shoreline change

Section 6 of **Appendix E** provides predictions for future shoreline change under two scenarios: “No Active Intervention” and “With Present Management”. As the intent of future management along the frontage is to broadly continue with current management approaches (refer to **Section 1.1.1**), the following briefly summarises the expected future shoreline change under that scenario only:

- **Greenaleigh Point to Minehead Harbour, including Culver Cliffs**

  Where undefended, the coastline would behave as at present, with erosion of the cliffs and general erosion of the beach and rollback of the gravel ridge. At the eastern end of the beach, in the lee of the harbour arm, the beach is likely to be squeezed against the higher ground and seawall, becoming steeper and narrower over time.

- **Minehead**

  The backshore will be held in place by the seawall and revetment. The harbour arm and concrete groyne will continue to afford some protection to the west facing coast at Minehead, and sediment is likely to continue to bypass both structures albeit at a reduced rate. To the west of the Minehead town culvert, as long as there is sufficient sand supply, the beach will continue to accrete in its upper reaches. Between the Minehead town culvert and the terminal groyne, the beach will continue to adjust to the predominant wave regime, with an overall flattening and narrowing of the recharge portion and a permanent loss of material via draw-down and transport offshore, wind-blown processes and transport eastwards to The Warren. As predicted by the SMP (Halcrow, 2010), the beach would therefore become increasingly dependent upon beach management activities and beach recharging to maintain the integrity of the defence function of the shoreline to reduce the risk of flooding of the extensive low-lying hinterland.

- **The Warren - Minehead and West Somerset Golf Course**

  This section of coastline is very vulnerable to erosion and breaching of the narrow dune/gravel ridge, and present management practices of bolstering the revetment along the toe of the dunes

will reduce the amount of erosion of the dune/gravel ridge temporarily. Emergency works would need to be ongoing to prevent further erosion and wave overtopping.

- **The Warren - Dunster Beach**

  The gravel/shingle ridge would continue to narrow and steepen within the groyne bays, and the backshore is likely to experience ongoing erosion where already at risk. The potential for longshore sediment transport will be reduced by the groyne bays. The ness feature is likely to continue to accrete assisted with the use of sand fencing. The flanks of the River Avill Flood Relief Channel would experience ongoing erosion and cutback requiring further measures to maintain functionality of the channel and outfall.

- **Ker Moor**

  There are currently no defences protecting this length of shoreline. The backshore will continue to erode and the gravel and shingle barrier will roll back. Along the beach, there is no reason to expect current trends to change unless sedimentation cannot keep pace with sea level rise, resulting in a change from beach stability/accretion to beach erosion. This will ultimately be affected by the management practices undertaken along the adjacent coastline.

- **Blue Anchor**

  The backshore will be held in position by the seawall. The beach and foreshore is reported to be accreting and there is no reason to suggest that this ongoing trend would change unless sediment deposition cannot keep pace with the rate of sea level rise.

- **Blue Anchor Cliffs**

  The present defences are failing, so would require maintenance if present management is to continue. However, current defences are being outflanked so would eventually become redundant. The cliffs would continue to recede via cliff falls and toe erosion. The beach is reported to be accreting and there is no reason to suggest that this ongoing trend would change unless sediment deposition cannot keep pace with the rate of sea level rise.

## 2.7 Environmental characteristics

This section provides an overview of the environmental setting and identifies key environmental features within the BMP area (refer to **Figure 1-1**) used to inform environmental assessment of options for future beach management activities for the Minehead to Blue Anchor frontage, as described in the Options Appraisal Report provided in **Appendix B** (refer also to **Section 1.1.1**).

The section is structured around a number of environmental topics as highlighted in the first column of **Table 2-6**. These follow the recommended structure contained in the Beach Management Manual (CIRIA, 2010). The second column in **Table 2-6** makes reference to the environmental aspects documented in Annex 4 of the European Union Directive 2011/92/EU '*on the assessment of the effect of certain public and private project on the environment*' (the EIA Directive).

This is provided by way of cross-reference to the EIA requirements such that the information in this report is able to be developed further should the need arise at a future date, e.g. if the preferred option is determined to present a significant scale or impact as to need a statutory Environmental Statement (ES) to accompany the consent applications. As well as helping to identify the important environmental issues locally, this will provide a robust level of documentation to support the project at this stage and subsequent stages. Additional supporting information can be found in **Appendix C**.

TABLE 2-6
**A summary of the environmental topic and cross-reference to EIA Directive topics**

| Environmental topics (with reference to the Beach Management Manual 2nd edition) | Sub-topics | BMP section reference | Reference to the environmental aspects outlined in Annex 4 of the EIA Directive |
|---|---|---|---|
| Geology and Geomorphology | Geology | 2.7.1.1 | Soil |
| | Designated Geological Sites | 2.7.1.2 | |
| | Geomorphology | 2.7.1.3 | |
| Ecology | Designated Nature Conservation Sites | 2.7.4.1 | Flora and Fauna |
| | Biodiversity Action Plan Habitats and Species | 2.7.4.2 | |
| | Fish Ecology | 2.7.4.3 | |
| Fisheries | Commercial fisheries | 2.7.5.1 | Material Assets including the architectural and archaeological heritage |
| | Recreational fisheries | 2.7.5.2 | |
| Navigation | | 2.7.6 | Material Assets including the architectural and archaeological heritage |
| Landscape setting | Designations | 2.7.7.1 | Landscape |
| | Landscape character | 2.7.7.2 | |
| Archaeology and Cultural Heritage | | 2.7.8 | Material Assets |
| Sediment quality | | 2.7.2 | Soil |
| Water quality | | 2.7.3 | Water |
| Air quality | | 2.7.9 | Air |
| Noise | | 2.7.10 | Population |
| Amenity value | | 1.3.5 | Population |

## 2.7.1 Geology and geomorphology

### 2.7.1.1 Designated Geological Sites

The eroding cliffs at the eastern end of the BMP frontage form part of the Blue Anchor to Lilstock Coast SSSI (see **Figure 2-6**). Designated for geological features, the west edge of the SSSI designation, which includes the foreshore, can be identified by the rock groyne placed adjacent to the slip way at the base of the Blue Anchor pub. The designated beach features are visible by exposed rock shelves.

The site description and reasons for designation are noted in **Table 2-7a**. The SSSI designation is further described in Units, the condition assessment of the units within the BMP area are presented in **Table 2.7b**.

TABLE 2-7A

**Blue Anchor to Lilstock coast SSSI: Description and Reasons for Designation (Natural England, 1986)**

| | |
|---|---|
| 1. Blue Anchor - Lilstock Coast (Hettangian - Pliensbachian) | An outstanding series of sections through the Lover Lias, spanning the Hettangian and Lover Pliensbachian Stages. This sequence and the good Rhaetian succession beneath are repeatedly affected by faulting, making many sections available in comparison to the same interval on the Glamorgan and Dorset casts. In a British context the Watchet coast is the thickest succession for this interval. This makes it of international significance, for Britain's Lias sequences are arguably the best in N.W. Europe. In addition, it has been proposed that this coast be accepted as the standard for the base of the Hettangian Stage, and thus by definition the Jurassic as a whole. An internationally important stratigraphic locality. |
| 2. Blue Anchor Point - (Rhaetian) | A site shoving the complete Rhaetian succession developed locally, from the Grey Marls to the Blue Lias. The Sully Beds are noteworthy for their fish, reptiles and coprolites, and the early mammal *Hypsoprymnopsis*. Abundant *ostracode* occur in the Cotham Beds. Sully, Westbury. Cotham, Langport, Watches and Pre-planorbis Beds are all represented in these classic late Triassic sections. |
| 3. Doniford - (Pleistocene of Somerset) | This classic site shows Pleistocene sediments, including a fine example of alluvial sediments formed in a cold-stage river valley, superbly exposed in the low sea cliffs. Mid-Acheulian and Late Upper Paleolithic implements as well as bones and tusks of *Elephas primigenius* have been found in the deposits, together with a wide range of fluvial and cryoturbation structures. The stratigraphy of the deposits has, however, only been described in very general terms, and is long overdue for re-description. This site is of great importance as one of the best localities in the country for periglacial phenomena and cold-stage river valley sediments and it has considerable regional stratigraphic significance. |
| 4. St Audries Bay - (Rhaetian) | A site showing a complete Rhaetian section from the Grey Marls to the Pre-planorbis Beds. The Grey Marl sequence (including the Sully Beds) is very thick, approaching twenty-six metres. First recorded in the mid-1800's the section here still has great potential for future research, and with the Blue Anchor section affords the best available Rhaetian exposures on the classic Watchet coast. |
| 5. Blue Anchor - Watchet - Lilstock (Coastal Geomorphology) | Blue Anchor - Watchet - Lilstock is important for coastal geomorphology. It demonstrates a particularly well-developed series of intertidal shore platforms varying in width from about 200-600 m. The platforms are veneered in part by shingle, sand and mud and in details of form reflect the variable resistance to erosion of the Rhaetic and Lower Lias bedrock. A key feature of the platforms is their development in a macro-tidal environment, and they are among the best examples of such coastal features in Britain. |

TABLE 2-7B

**Blue Anchor to Lilstock Coast SSSI site condition within the BMP study area (Natural England, 2011)**

| SSSI Unit | Main habitat | Condition status | Reason for adverse condition | Condition assessment comment |
|---|---|---|---|---|
| 001<br>Blue Anchor to Watchet Cliffs | Earth Heritage | Favourable | No identified Condition Threat | Excellent coastal section exposing elements of the Mercia Mudstone, Rhaetic and Lias deposits |
| 002<br>Blue Anchor to Watchet Foreshore | Earth Heritage | Favourable | No identified Condition Threat | Good exposures on the foreshore in the form of rock shelves |

### 2.7.1.2 Geological Conservation Review (GCR)

The GCR was designed to identify those sites of national and international importance needed to show all the key scientific elements of the Earth heritage of Britain. These sites display sediments, rocks, fossils, and features of the landscape that make a special contribution to our understanding and appreciation of Earth science and the geological history of Britain, which stretches back over 2,800 million years. After over two decades of site evaluation and documentation, over 3,000 GCR sites were

selected for around 100 categories (GCR 'Blocks'), encompassing the range of geological and geomorphological features of Britain (JNCC, 2015).

There is one GCR site and two GCR blocks that underpin the Blue Anchor to Lilstock Coast SSSI located in the eastern section of the BMP area, as mentioned above (**Section 2.7.1.1**):

- **GCR 2101: Blue Anchor - Watchet – Lilstock**

  *'This site, which comprises two areas east and west of Watchet, is characterized by cliffs rising to a maximum of 84 m and fronted by a particularly well-developed series of intertidal platforms varying in width from 120 m to over 500 m'.*

  *'The platforms are veneered in part by shingle, sand and mud, and reflect in detail the variable resistance to erosion of the Turassiched Marls, Penarth Beds and Lower Lias bedrock. A key feature of the platforms is their development in a macrotidal environment and their different exposure from narrower platforms in similar rocks on the northern side of the Bristol Channel at Nash Point'*.

  *'The western part of the site extends from the eastern end of the sea-wall at Blue Anchor (ST 034 436) to just west of Watchet (ST 070 438). Near-vertical cliffs rise eastwards to Blue Anchor Point (ST 040 437) where they give way to higher cliffs that are much affected by many small landslips. From their highest elevation of 84 m, they fall steadily towards sea level at Watchet.'*

  *'The alignment of the coastline of the western part of the site has little relationship to the direction of wave attack from the Atlantic Ocean. The coastal plan is primarily a function of the varying strengths and structures truncated by the cliffs and platforms. Differential erosion is a dominant force both in the general form and the detail of the coastal features. The platform varies between 300 m and 500 m in width. The general slope of the platform reflects the process of marine planation in cutting across the outcrop, but the varying strength, dip and strike of the beds give rise to a varied micro-relief. Parts of the platform warrant the description 'washboard-like relief', a form that has been described elsewhere but rarely reported in Britain'*.

  (JNCC, 2008)

- **GCR 1259: Blue Anchor Point**

  **The GCR block – Rhaetian**

  *'The GCR sites selected for this GCR Block represent the British geological record of Earth history from about 210 to 205 million years ago (Ma). This interval is the last part of the Late Triassic Epoch, which spans from 227 to 205 Ma. Rocks that formed during the Late Triassic Epoch (part of the Triassic Period, 250–205 Ma) constitute the Upper Triassic Series (part of the Triassic System). British rocks of Rhaetian age include the Penarth Group, the formal lithostratigraphical name for rocks formerly called the 'Rhaetic' in Britain. However, owing to the formal definition of the Rhaetian Age, British Rhaetian strata include the uppermost part of the Triassic Mercia Mudstone Group, and the lowermost part of the otherwise Jurassic Lias Group. The main focus of this GCR Block is the Penarth Group sediments'.*

  *'The fossils of the Penarth Group include a range of predominantly marine forms including foraminifera, corals, annelids, gastropods, bivalves, crustaceans, echinoderms, brachiopods, conodonts, and fishes (sharks, chimaeras, bony fishes, coelacanth), and organic-walled microplankton (dinoflagellate cysts and acritarchs), but also including continental organisms (plants, insects, lungfish, dinosaurs)'.*

  (JNCC, 2008)

- **GCR 145: Blue Anchor - Lilstock Coast**

  GCR block - Hettangian, Sinemurian and Pliensbachian (HET-PBN):

  *'The GCR sites selected for this GCR Block represent the British geological record of Earth history from about 200 to 184 million years ago (Ma). This interval is the first part of the Jurassic Period;*

*together with the succeeding Toarcian Age this age range constitutes the Early Jurassic Epoch. Rocks that formed during the Early Jurassic Epoch (part of the Jurassic Period) constitute the Lower Jurassic Series (part of the Jurassic System).*

*The Hettangian (200–197 Ma), Sinemurian (197–192 Ma) and Pliensbachian (192–184 Ma) strata are included in one GCR Block together because they are geologically commonly closely associated –over much of southern England they approximately equate with the lithostratigraphically defined terms, 'Lower Lias' and 'Middle Lias', (the Toarcian Stage being equated to the 'Upper Lias').*

*With few exceptions these deposits are fully marine and mark a striking contrast with the predominantly terrestrial deposits of the preceding Triassic System. They encompass a broad range of facies representing a correspondingly diverse range of environments. Most of these facies are fossiliferous, sometimes richly so, occasionally yielding exceptionally preserved material.'*

*'The many different depositional environments that developed in Britain during Early Jurassic times mean that the fossil record is rich and varied'*

(JNCC, 2008).

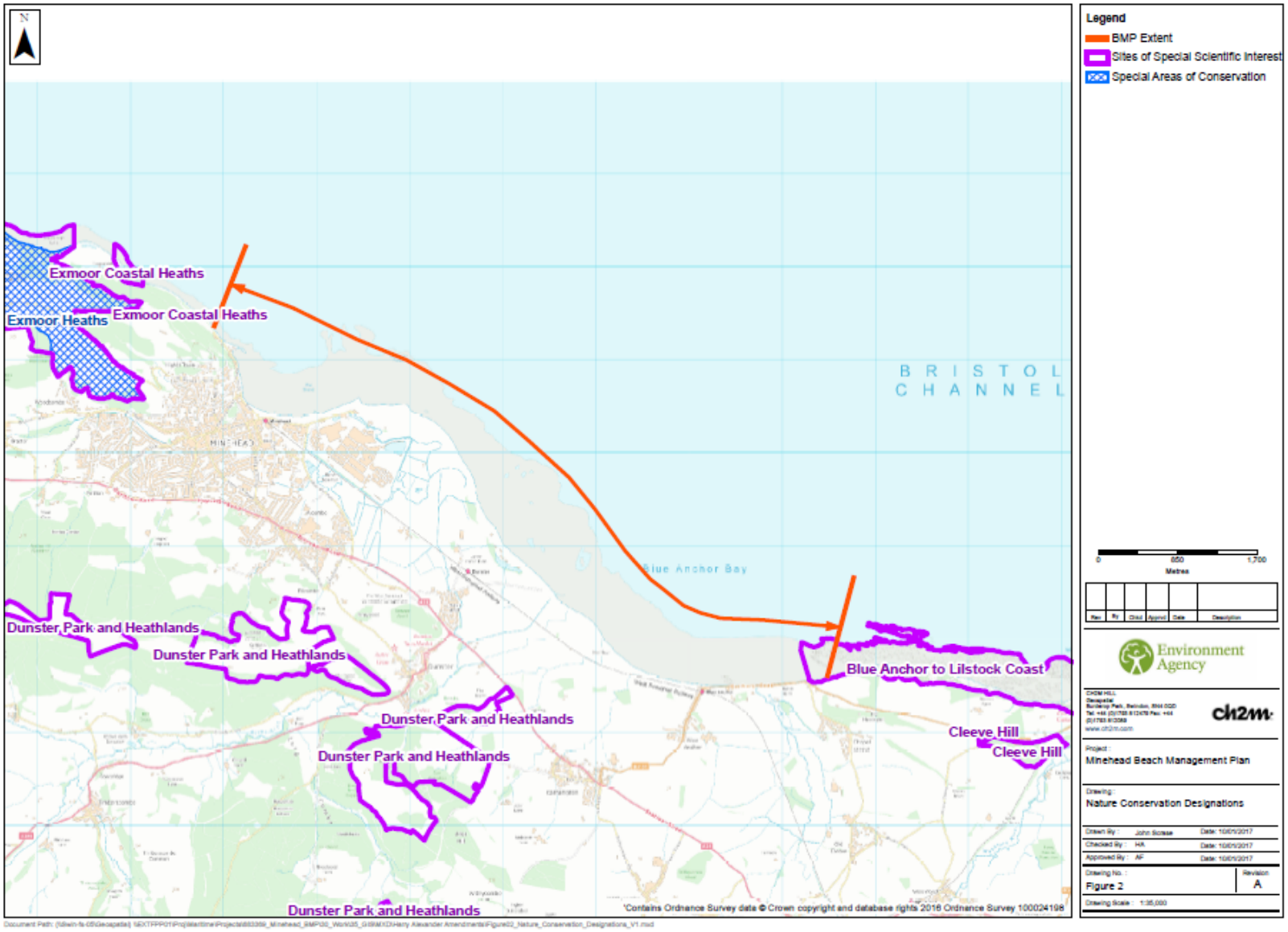



FIGURE 2-6
**Natural environmental designations.**

#### 2.7.1.3 Geomorphology

To the west of the BMP area there are high cliffs, which extend as far west as Hurlstone Point. The cliffs are extensively vegetated and comprise heavily faulted and folded Devonian Sandstone (Black and Veatch, 2009). At Greenaleigh Point, there is a small exposure of Quaternary deposits (Halcrow, 2002) and from here towards Minehead, the cliff toe slopes gently towards the beach. The overall shoreline position and form from Hurlstone Point to Minehead is thought to have remained largely unchanged since sea levels reached more or less their present levels about 4,000 years ago (Halcrow, 2010).

To the east of Minehead, the coastal hinterland is low-lying with an extensive area of former salt marsh and river terrace deposits (Halcrow, 2010). A historic dune system extends from Warren Point to Dunster Beach, understood to have been sourced from the onshore movement of sand from the Bristol Channel, and later, the eastward transport of material eroded from cliffs further west (see below).

As sea levels rose during the Holocene (the last 10,000 years) sand and gravel material was eroded from the cliffs between Hurlstone Point and Minehead and moved east by littoral transport, where:

- some of the material was subsequently deposited and organised by the local wave regime into a series of shingle and dune ridges, which underlies the Minehead and West Golf Course;
- sand-sized material fed the dune system between Warren Point and Dunster Beach;
- gravel-sized material was organised into a ridge and moved onshore. Today, this gravel extends along the length of this coastline from Hurlstone Point in the west to Blue Anchor in the east. Some of this material contributed to the infilling of the valleys of the Avill and Pill Rivers and the formation of barriers across their mouths (Royal Haskoning, 2011).

At the eastern end of the study area at Blue Anchor, the cliffs are steep and simple and comprised of Mercia mudstone overlain by head deposits (Royal Haskoning, 2011).

Further details on the wave and tidal forces that drive coastal geomorphology, and the key sediment transport processes along the BMP frontage, are described further in **Sections 2.1 to 2.6** above.

### 2.7.2 Ecology

#### 2.7.2.1 Designated nature conservation sites

There are no designated nature conservation sites within the BMP study area. However, there is a geological designation, see **Section 2.7.1**.

There are, however, international and national nature conservation designations in close proximity to the BMP area. These are important in the consideration of options for the beach management plan and are as follows:

<u>Internationally Designated Sites</u>

- **Exmoor Heaths SAC** is located within Exmoor National Park and is located within 1km (west) from the study area at its nearest point. There is unlikely to be any impact from the BMP but it will need to be considered during development of BMP options. The SAC is a protected designated site under the EC Habitats Directive for the following reasons:

  a) Annex I habitats (listed under Annex 1 of the EC Habitats Directive) that are a primary reason for selection of this site:
     - 4010 Northern Atlantic wet heaths with *Erica tetralix*
     - 4030 European dry heaths.

  b) Annex I habitats (listed under Annex 1 of the EC Habitats Directive) present as a qualifying feature, but not a primary reason for selection of this site:
     - 1230 Vegetated sea cliffs of the Atlantic and Baltic Coasts
     - 7130 Blanket bogs (* if active bog) * Priority feature

- 7230 Alkaline fens
- 91A0 Old sessile oak woods with Ilex and Blechnum in the British Isles.

The following sites are strictly protected sites classified in accordance with Article 4 of the EC Birds Directive, which came into force in April 1979. They are classified for rare and vulnerable birds (as listed on Annex I of the Directive), and for regularly occurring migratory species.

The following sites are being considered as they have the potential to be ecologically linked to habitat present within or in close proximity to the Minehead to Blue Anchor BMP area. Bird species that are notified as mobile qualifying features of the designated sites may have potential to use the area as suitable alternative habitat to the designated site. As an example, birds may use the site as an alternative winter feeding grounds according to weather conditions. Internationally designated sites for birds within approximately 20 km of the BMP area that may potentially hold some connectivity have been considered.

- **Severn Estuary SPA/SAC/Ramsar site** is approximately 14.5 km east from the BMP area at its nearest point. The Severn Estuary is a large estuary with extensive intertidal mud-flats and sand-flats, rocky platforms and islands. Saltmarsh fringes the coast backed by grazing marsh with freshwater ditches and occasional brackish ditches. The seabed is rock and gravel with sub-tidal sandbanks. The species-poor invertebrate community includes high densities of ragworms, lugworms and other invertebrates forming an important food source for passage and wintering waders.
    - **The Severn Estuary SPA** qualifies under Article 4.1 of the Directive (79/409/EEC) by supporting populations of Over winter: Bewick's Swan Cygnus *Columbianus bewickii*, Curlew *Numenius arquata*, Redshank *Tringa totanus,* Shelduck *Tadorna*; and on passage: Ringed Plover *Charadrius hiaticula*. Connectivity is possible due to the availability of mudflat habitat within the BMP study area. Grazing marsh also backs the study area at Blue Anchor Bay with potential to support some associated features**.**
    - **The Severn Estuary Ramsar** qualifies primarily for meeting the following criteria**:** Habitat features as presented within the SAC designation (as noted below). Large tidal range, unusual estuarine communities, reduced species diversity and high productivity. It is particularly important for migratory fish (between sea and river) and migratory birds on passage in spring and autumn. The site regularly supports over 20,000 waterfowl in winter
    - **The Severn Estuary SAC** is designated for the following Annex 1 habitats as a primary reason for site selection: estuaries; Mudflats and sandflats not covered by seawater at low tide; Atlantic salt meadows. Annex II species that are a primary reason for selection: 1095 Sea lamprey, River lamprey and Twaite shad. Annex I habitats present as a qualifying feature, but not a primary reason for site selection: Sandbanks which are slightly covered by sea water all the time and Reefs.

  *The Severn Estuary SPA/SAC/Ramsar site may require consideration in the process of defining the options for the BMP as there may be some connectivity for some featured bird species and wetland habitat in close proximity to the site i.e. Dunster Marshes where there are wetland habitat improvement plans being considered (see **"local wildlife sites"** section below). This may also raise the opportunity to create wetland habitat in compensation for future losses that are predicted within the SAC/SPA/Ramsar site due to coastal squeeze. This should also be considered during FCERM options for the frontage*

## Nationally Designated Sites

Sites within 1 km of the BMP area are:

- **Exmoor Coastal Heaths SSSI** underpins the Exmoor Heaths SAC and forms part of Exmoor national Park. At its nearest point, a section of the SSSI is located within 1 km east from the study area situated along the coastal edge at Culver cliff. The SSSI is designated for extensive areas of heathland communities which are rare in Britain and confined largely to South West England and South Wales. The site is also important for the presence, range and transitions

between habitats including upland heath, mires and grassland. At lower altitudes and in the coastal zone further important habitats occur including woodland and scrub, acidic and maritime grassland. There are a wide range of nationally rare and scarce plants associated particularly with the coastal communities and woods. A breeding colony of a nationally rare butterfly also occurs. The Exmoor Coastal Heaths SSSI habitats supports a number of bird species. **Table 2.8** provides further details.

TABLE 2.8
**Exmoor Coastal Heaths SSSI site condition adjacent to the BMP study area (Natural England, 2011)**

| SSSI Unit | Main habitat | Condition status | Reason for adverse condition | Condition assessment comment (Natural England, 2011) |
|---|---|---|---|---|
| 022 Culver Cliff (Exmoor National Park Authority) | Dwarf Shrub Heath - Upland | Unfavourable – Recovering | Medium condition threat | *'Feature of interest is the Sorbus subcuneata present in open woodland conditions, forming part of the Higher Plant Assemblage. The woodland itself has a high % of exotics which contribute to higher levels of shade than desirable. Rhodendron is present, although some has been controlled. Open areas are present but do not meet thresholds of a max of 10% tree cover in gaps. ENPA have done some work to create openings and this will continue under the new EWGS. Vascular plant assemblage Sorbus vexans and Sedum fosteranum assessed. Sorbus present subcuneata present in 2005 in current monitoring cycle and meets site specific target. Sedum present in 2003 outside the CSM cycle, but as there has been no targeted survey, suitable habitat is still present, specialist assessment is that there is no reason to fail the unit. Assessed as Favourable for both species combined this unit.'* |
| 021 North Hill (Exmoor National Park Authority) | Dwarf Shrub Heath - Upland | Unfavourable - Recovering | No identified Condition Threat | *'Bracken cover high at 2/10 stops. Rhodendron present as scattered /seedlings following previous control. Lack of moss layer and indicator species in 2/10 stops and scrub in 1 stop. Continued rhododendron follow up needed and new Moorland Management Plan needs to examine need for bracken, scrub control in places.'* |

- **Dunster Park and Heathlands SSSI** is approximately 1.2 km south from the BMP study are at its nearest point buffered by the West Somerset Railway line and the A39. The SSSI is designated for UK priority habitats lowland dry heath, dry lowland acid grassland, wood-pasture with veteran trees and ancient semi-natural oak woodland habitats. The fauna of the lowland heath includes a nationally rare butterfly, "the heath fritillary" *Mellicta athalia*. The assemblage of beetles associated with the veteran trees is of national significance along with other scarce invertebrates including hoverfly. The woodland supports a very diverse community of breeding bird species.

## Local Wildlife Sites

The following wildlife sites are within or in close proximity to the study area and will require consideration during the options appraisal:

- Dunster Marshes: are within the BMP area: According to the West Somerset Local Plan to 2032 (West Somerset, 2009a and 2009b), there is a plan to restore Dunster Marshes, to become a wetland wildlife haven. Lying within the floodplain, the area north and east of Seaward Way contains notable UK Priority Habitat, Coastal and Flood Plain Grazing Marsh as well as a local wildlife site. Development proposals have been refused in the past for this reason. There are three local wildlife sites at Dunster Marsh:

  - The river Avill: The river is known to have key species that indicates high biological quality
  - Dunster Marsh: Coastal grazing marshes, rhynes and watercourse, an important ornithological site
  - Dunster Beach: Narrow coastal strip with a variety of habitats, including woodland, scrub, grassland, shingle, sand, open water and reedbeds.
- Culver Cliff Wood: is an area of ancient woodland with mixed and conifer plantation. It is situated in the north-west section of the BMP area, overlooking Culver Beach and accessed from the coastal path.
- Blue Anchor Railway Line and Upper.

#### 2.7.2.2 Biodiversity Action Plan (BAP) priority habitats and species

The following UK Priority habitats are present within the study area and require consideration during development of the BMP options. These habitats are considered a UK priority and also mentioned within the West Somerset Coastal & Marine Habitat Action Plan (2008) for nature conservation:

- Mudflats: present across the foreshore of the entire BMP
- Maritime cliff and slope: present at the in the far western edge of the BMP
- Coastal dune: a small section is present at Warren Point where in fronts the Minehead and West Somerset golf course (observed during a site visit 31st October 2016). The dunes are thought to naturally built up here in the last 10 years as a result of sand recharge from a previous coastal defence scheme.
- Coastal shingle: The habitat is present along the ridge fronting the train line running adjacent to the beach at Blue Anchor beach and includes pioneer species such as sea kale *Crambe maritima.*

The West Somerset Coastal & Marine Habitat Action Plan (2008) noted as part of its actions within the BMP study area, that a habitat management plan was in use by Dunster Chalet Park Ltd. Any detail of the actions within the Dunster Chalet Park Habitat Management Plan were not described and no information on this has been provided for this BMP.

In addition to the above habitats, there are also records of protected species within 2km of the area which will need consideration of future FCERM options for the frontage. Records were viewed online using the government web based data search https://www.magic.gov.uk and the National Biodiversity Network Gateway https://data.nbn.org.uk/, and are as follows (including identification of original source of information stated on the two aforementioned online portals):

- Marine mammals: JNCC, Sea Watch Foundation, Sea Mammal Research Unit, 2015:
  - Atlantic White Sided Dolphin
  - Harbour Porpoise
  - Minke Whales
  - Common Bottlenose Dolphin
  - White Beaked Dolphin
- Otter: there are numerous recent records (Somerset Environmental records Centre, 2000 to 2015, JNCC, 2000) within the BMP area within a 1km grid of Dunster Beach and the River Avill.
- Eel: There are six recent records of presence recorded within or in close proximity to the study area. Two record are present within a 1km grid of Blue Anchor Caravan Park (Environment Agency, 2008, Somerset Environmental Records Centre, 2004). The remaining records are present within a 1km grid of Dunster Castle (National Trust, 2010, Somerset Environmental Records, 2001 to 2007).

- Sea trout: There are six recent recorded sightings. Three recorded sightings are with a 1km grid of Blue Anchor Caravan Park (Somerset Environmental Records Council, 2010 to 2013, Environmental Agency, 2008). Three are located with a 1km grid of Dunster Castle (Somerset Environmental Records Council, 2010 to 2013, National Trust, 2010)
- Slow worm: There are recent recorded sightings within a 1km grid south of Blue Anchor (Amphibian and Reptile Conservation, Somerset Environmental Records Centre 2001 to 2013)
- Bats: There is one recent record of a protected species license for the period of 2011 – 2013, granted within 2km of the study area (Natural England, 2015 viewed on magic.gov.uk)
- Badgers: There are 55 1km grid recorded sightings around Minehead Town and Carhampton (landward south of Blue Anchor) (The Mammal Society, Somerset Environmental Records Council, People's Trust for Endangered Species 2007 to 2015).
- Dormouse: There are 14 recent records within a 1km grid east of study area boundary at Blue Anchor, around Cridland's Copse (Somerset Environmental Records Council, People's Trust for Endangered Species 2001 to 2011).

#### 2.7.2.3 Fish ecology

Fish nursey and spawning areas with require consideration of future FCERM options for the frontage.

The Centre for Environment Fisheries and Aquaculture Science (CEFAS – UK) report 'Spawning and nursery grounds of selected fish species in UK waters' (Ellis *et al*, 2012) reported the following species in the surrounding waters of the Minehead to Blue Anchor BMP area:

| | |
|---|---|
| Tope shark *Galeorhinus galeus* | Low intensity nursery area |
| Thornback ray *Raja clavata* | Low intensity nursery area |
| Spotted ray *Raja montagui* | Low intensity nursery area |
| Whiting *Merlangius merlangus* | Low intensity nursery area |
| Anglerfish *Lophius piscatorius* | Low intensity nursery area |
| Sandeels *Ammodytidae* | Low intensity spawning area |
| | Low intensity nursery area |
| Plaice *Pleuronectes platessa* | Low intensity nursery area |
| Sole *Solea* | Low intensity nursery area |

The possibility of the existence of an unmapped herring *(Clupea harengus)* spawning area around Minehead is being investigated by Devon & Severn Inshore Fisheries Conservation Authority (IFCA) (See the **Section 2.7.3.1**).

There are no designated Shellfish Waters or harvesting areas within or in close proximity to the BMP area.

## 2.7.3 Fisheries

### 2.7.3.1 Commercial fishing

The BMP study area is within the Devon and Severn (IFCA) district. It is unclear how many vessels are based at Minehead, but in their quarterly report for the period ending November 2015 (viewed online at http://www.devonandsevernifca.gov.uk/4a-role-function-and-management-of-the-authority), Devon & Severn IFCA reported the following:

*'IFCA officers were invited to join a commercial fishing boat from Minehead (Thistle, P7) to observe traditional herring drift netting activity. It provided an opportunity for an excellent dialogue about the history of fishing in Minehead, current fishing activities and fish distribution. In particular, the possibility of the existence of an unmapped herring spawning area around Minehead was discussed. IFCA officers*

*have been invited back to observe the fishing of traditional fish weirs in Minehead that have been in place for many centuries.'*

The local commercial fishing community have raised concerns about potential damage to traditional fishing grounds (herring and cod) from any future potential Minehead to Blue Anchor BMP works. These fisheries should be considered as part of any future beach management and broader flood and coastal erosion risk management activities.

#### 2.7.3.2 Recreational fishing

Known sea angling hotspots reported by Devon & Severn IFCA include Minehead and Blue Anchor.

Minehead Harbour promote the area for varied and diverse seasonal opportunities for sea anglers. Species noted are Cod, Codling, Thornback, Small eyed, Spotted and Blonde rays, Dogfish, Bass, Smoothound, mullet, sole, conger, turbot, Pollock and whiting. Several angling boats available for charter.

The harbour promotes light rock fishing for smaller species and boasts autumn and winter for some of the best cod and codling fishing in the country along with good catches of whiting. Crab line fishing is also promoted from inside the harbour and crab races down the harbour slipway. A fishing tackle shop is situated on the quayside.

### 2.7.4 Navigation

Navigational information from the website www.visitmyharbour.com notes the approach to Minehead Harbour to be only possible about two hours either side of High Water. Hazards are noted as the high shingle banks that shift around making the already complicated approach around the sewage outfall pipe even more difficult to navigate. The outfall pipe is laid on the bottom and protected by boulders; starting approximately 180 m east of the harbour pierhead and reaches out to the lit perch 2 cables north of the pierhead. There is an anchorage off Minehead which is visible by its location opposite a rock painted white above the High Water mark.

A slipway within the harbour also provides access.

### 2.7.5 Landscape setting

The importance of landscape to the Minehead area is recognised by the following nationally and regionally important designations (see also **Figure 2-7**):

- **Exmoor National Park**

  The National Parks and Access to the Countryside Act 1949 established the National Park designation in England and Wales. In addition, the Environment Act 1995 requires relevant authorities to have regard for nature conservation. In the case of Exmoor National Park, the relevant authority is the free standing Exmoor National Park Authority (ENPA).

  The Exmoor National Park boundary is approximately 200 m from the BMP study area west of Minehead Harbour. The national Park as its nearest and most eastern point is situated on the Beacon overlooking west of Minehead Harbour. The designation is also present along the coastal frontage, adjacent to the BMP study from Culver Cliff.

  Exmoor National Park is a unique landscape of moorland, woodland, valleys and farmland, shaped by people and nature over thousands of years (ENPA, 2016).

- **Exmoor Heritage Coast**

  Heritage coasts are 'defined' rather than designated, established to conserve the best stretches of undeveloped coast in England. A heritage coast is defined by agreement between the relevant maritime local authorities and Natural England (Natural England, 2015).

  Exmoor Heritage Coast is incorporated within Exmoor National Park as described above with its coastal boundary stretching out approximately 1km at sea from Culver cliff.

- **National Character Area**

  National Character Areas are 159 distinct natural areas defined by a unique combination of landscape, biodiversity, geodiversity and cultural and economic activity (Natural England, 2014).

  The BMP is encompassed within the Vale of Taunton and Quantock Fringes National Character Area (NCA Profile: 146 (NE550), Natural England, 2014). The NCA area in relation to the BMP is described as follows:

  'The Vale of Taunton and Quantock Fringes National Character Area (NCA) lies between Exmoor NCA in the west, the Somerset Levels and Moors NCA in the east and the Blackdowns NCA to the south. It wholly encircles the Quantock Hills NCA. It provides an ecological link between the upland habitats of both Exmoor and the Quantock Hills, and links these uplands with the Bristol Channel which bounds the NCA to the north.'

  'Strong visual links across the coastal landscapes of Bridgwater Bay to Exmoor in the west and the Somerset Levels and Moors to the east. Views from these upland NCAs across the area to the coast are also significant. The NCA overlooks the Bristol Channel to the north and the wooded Blackdown Hills Area of Outstanding Natural Beauty (AONB) to the south'

  'The coastline falls within the Hartland Point to Anchor Head sediment cell and the Minehead and Brean Down sediment sub-cell, which links this NCA with the Somerset Levels and Moors NCA and Exmoor NCA by physical coastal geomorphological processes. The dominant sediment transport direction is from east to west, with wave action causing seasonal offshore and onshore movement. The coastline of the NCA is generally exposed and it is particularly affected by westerly and northwesterly gales.'

  'Sweeping views from the coast across the bay…to Minehead in the west. Exmoor, the Blackdown Hills and the Quantock Hills provide a backdrop to the area and expansive views from these uplands emphasise the lush pastoral nature of this area.

- **Conservation Areas**

  Conservation Areas (CA) are areas of special architectural or historic interest which the Local Planning Authority designates under the Listed Buildings and Conservation Areas Act 1990 with aim to preserve or enhance. There are two conservation areas within Minehead BMP to Blue Anchor BMP study area and one in close proximity.

  Quay street CA is located within the BMP study area. This coastal CA incorporates the harbour area (and properties including the lifeboat station) and the area and properties that run along Quay Street up to the junction of Esplanade Road at Minehead Beach. Higher town CA incorporates a large area within the centre of the town bordering Quay Street CA. Both CA's are shown in the Figure below (**Figure 2-8a**)

  Wellington Square CA is within the BMP study area. The CA includes the coastal frontage of Esplanade Road from Quay West up to Warren Road and includes the area that surrounds the West Somerset Railway Terminal and much of the central part of town further west (**Figure 2-8b**).

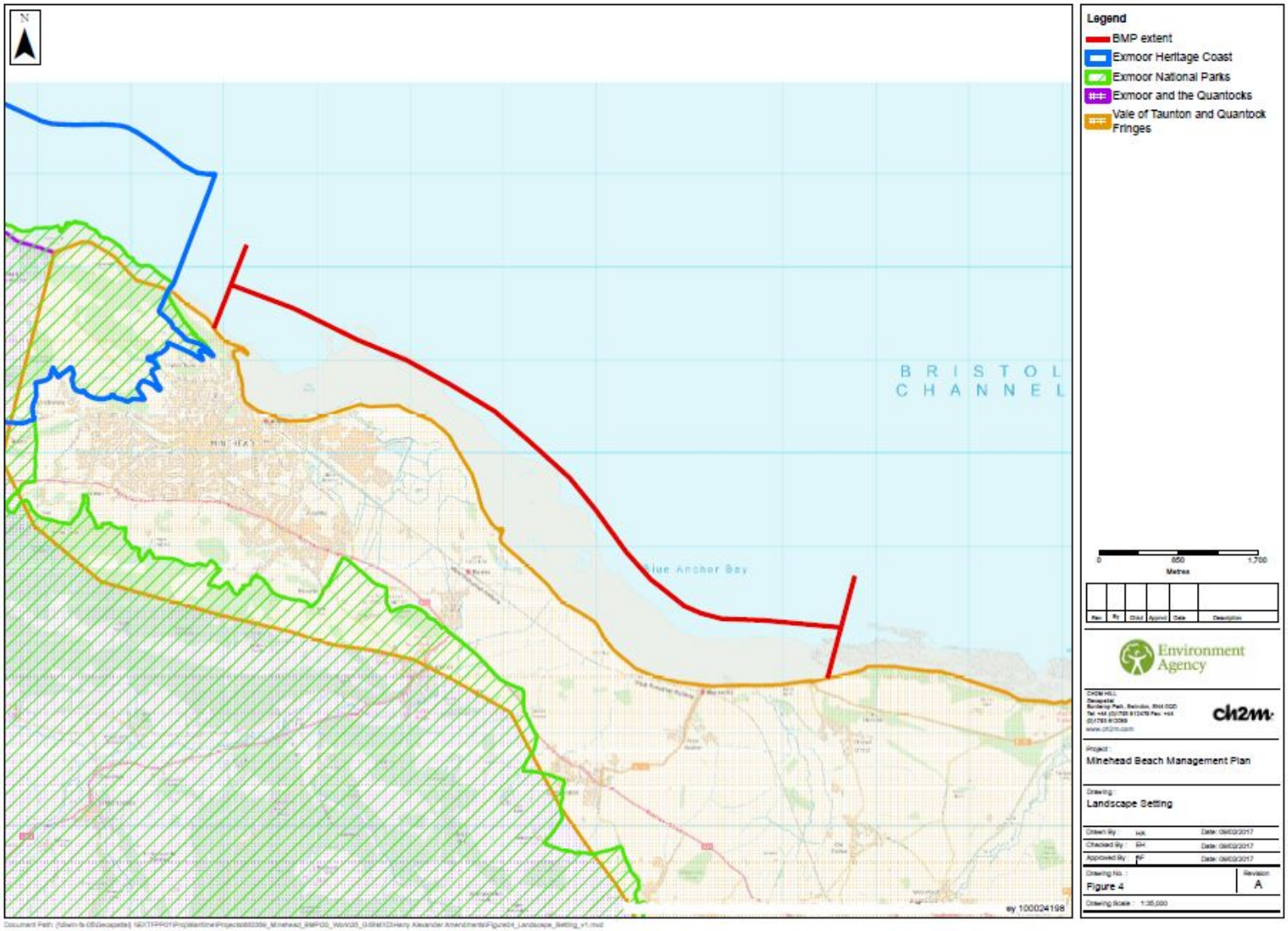



FIGURE 2-7
**Minehead BMP to Blue Anchor BMP: Landscape Designations**


FIGURE 2-8A

**Minehead: Quay Street and Higher Town Conservation Areas. (West Somerset Council, 2003)**

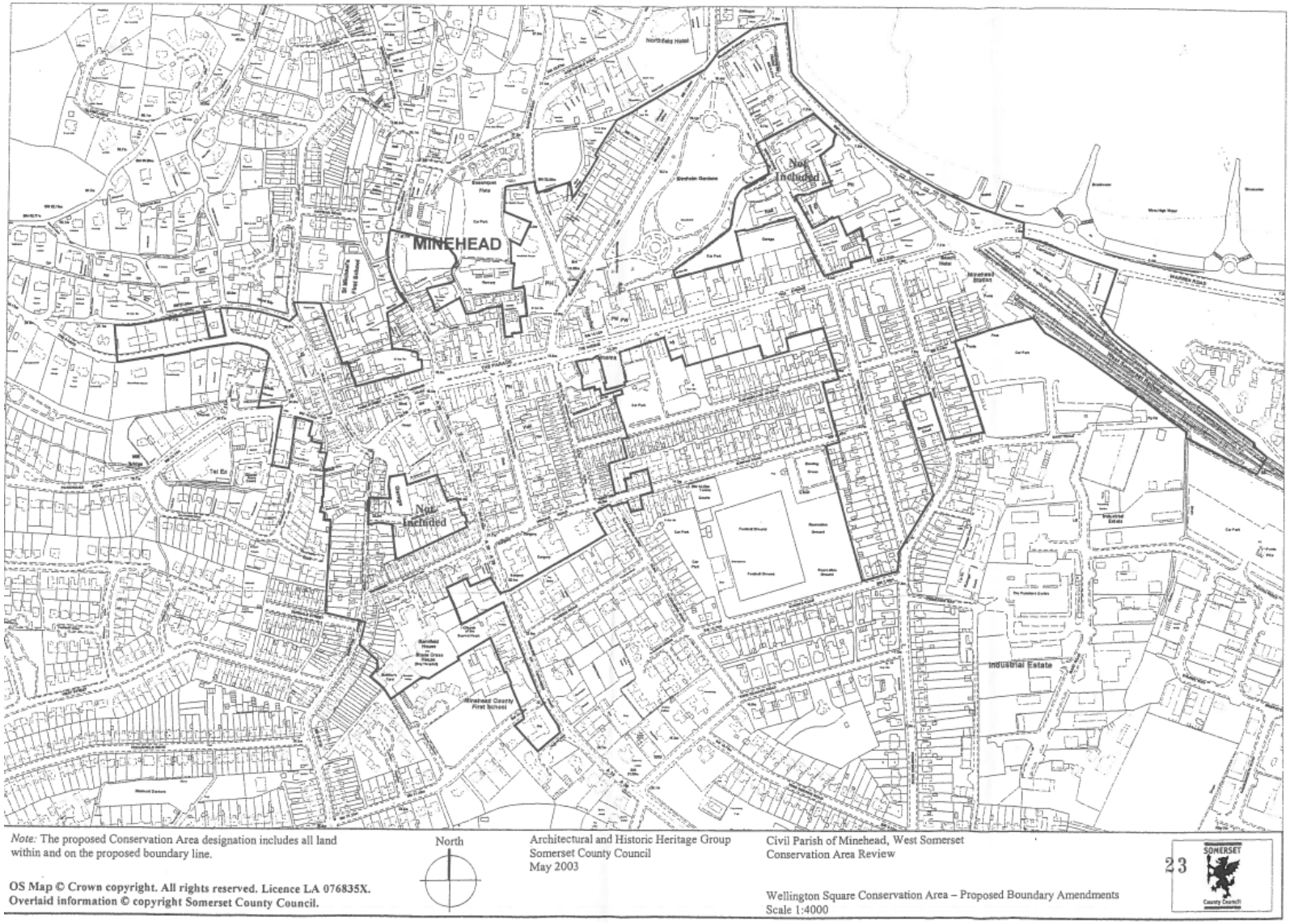



FIGURE 2-8B
**Minehead: Wellington Square Conservation Area (West Somerset Council, 2003)**

### 2.7.6 Archaeology and cultural heritage

The importance of historic and cultural heritage to the Minehead to Blue Anchor area is recognised by the following national and regional designations:

- **Scheduled Monument**

  A medieval fish weir and designated scheduled monument is present within the BMP area. The fish weir is situated within the bay, adjacent to and east of the quay wall of Minehead Harbour.

- **Designated Wreck**

  The remains of a wooden sailing vessel of late 18th to early 19th century date, located in the inter-tidal zone at Madbrain Sands off Warren Point at Minehead and present within the study area. Recently designated as a scheduled monument (November 2016), the vessel is believed to be the remains of the Bristol Packet, lost in 1808. The scheduled area has been defined from the centre point of the wreck at National Grid Reference SS 9851346734 (centre point) with a radius of 35m to ensure that the site, including any buried remains, is adequately protected (Historic England, 2016).

- **Registered Parks and Gardens**

  Dunster castle and its registered Parks and Gardens are located within approximately 1 km of the BMP study area buffer by the West Somerset Railway line and the A39.

- **Listed Buildings**

  A number of other scheduled monuments and listed buildings are present within, and in close proximity of the BMP study area

  The Minehead harbour quay itself is a listed building. A further number of listed buildings are present around the harbour and behind the seawall along Quay road. The properties behind the seawall include listed buildings which are known to be susceptible to flooding from the result of spray inundation from waves hitting the sea wall.

  The WWII concrete infantry box present on the beach in front of the chalets at Blue Anchor beach is a designated listed building.

- **Non-Designated Archaeology and Cultural Heritage**

  At Minehead Harbour a line of wooden posts marking the remains of the old wooden pier that runs from the seawall to opposite the head of the harbour wall at the harbour mouth.

  A further number of wooden posts, possibly non-designated archaeological features were noted to be present at low tide during the site visit.

  The features at Minehead, Dunster Beach and Blue Anchor Bay are considered likely to be the remnants of a further number of stone fish weir structures, with some net hang lines, ground line gullies and other miscellaneous features (Chadwick and Catchpole, 2010).

  The West Somerset Steam Railway (the longest UK Heritage line) runs direct adjacent to the beach in part of the BMP study area (Blue Anchor Bay).

  There are a number of non-designated WWII concrete infantry boxes present within the BMP area within Blue Anchor Bay.

  Infantry boxes are present on the edge of Dunster beach, two boxes are present at the southern section of the golf course and the border of Dunster chalet park, a further box is present within the Dunster Beach public carpark.

**Figure 2-9** shows these various historic environment features within the vicinity of the BMP area.

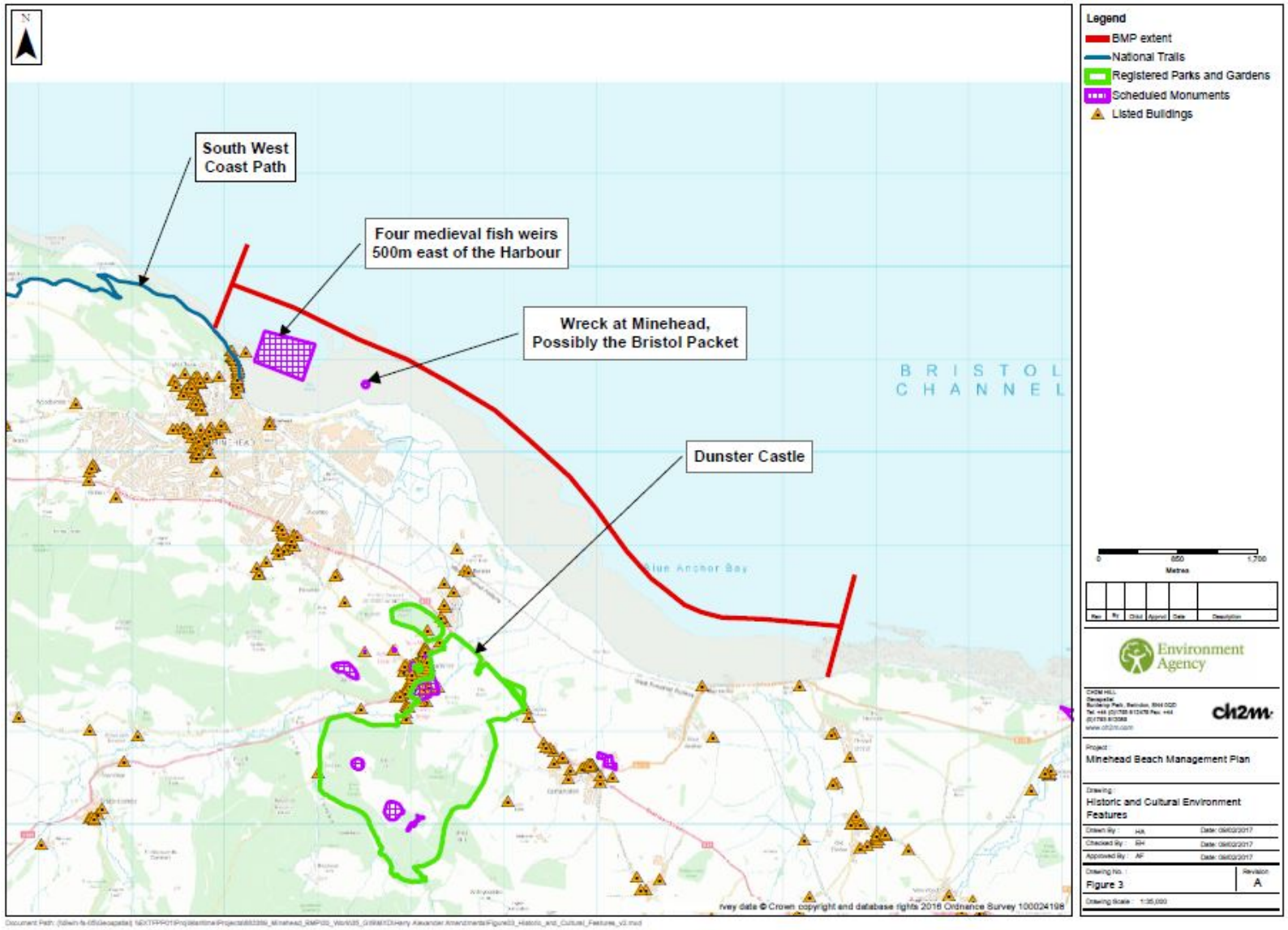



Figure 2-9
**Historic environment designations**

## 2.7.7 Sediment quality

Section 2.5.1 and Section 2.7.1.3 provide description of beach material present within the BMP area. Sediment quality data including chemical composition is not readily available.

## 2.7.8 Water quality

The Minehead to Blue Anchor BMP area is situated within West Somerset designated Bathing Waters area.

The Bathing Water quality profile is tested from three different Environment Agency sampling stations within the BMP area (see **Figure 2-10**). The results of water quality testing at these three points from 2013 to 2016 are presented within **Table 2-9**.

TABLE 2-9

**Environment Agency Bathing Water Profile and Water Quality Classification description within the Minehead to Blue Anchor BMP area. (Environment Agency 2016d, 2016e and 2016f).**

| Environment Agency Water sampling point<br>Environment Agency Bathing Beach Profile (2016) | Water Quality Classification | | | |
|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 |
| **Minehead Terminus**<br>Sand and shingle beach resort, approximately 2.6 km wide, close to the town. Current water quality classification is Good, based on samples taken from 2013 through to 2016:<br>*'There are three streams which flow out to sea in the area. The Park Stream discharges 200 m west of the Environment Agency monitoring point, and the Summerwest and Duckpond streams discharge 700 m to the east the Environment Agency monitoring point.'*<br>*'The outfall from Minehead STW, discharges to the sea 2 km from the beach. This discharge is disinfected and designed to protect bathing water quality.'*<br>*'There is an emergency/storm overflow from the Quay West pumping station, that discharges to the sea north of the harbour wall. There are storm overflows from the Blenheim Road and the Green Spot CSOs, that discharge through the same outfall to the sea north of the harbour wall.'*<br>*'There is an emergency/storm overflow from the Minehead STW pumping station, that discharges to the sea 2 km from the beach. The operation of the overflows can lead to a drop in bathing water quality'.*<br>*'The Environment Agency worked with Wessex Water to carry out a review of sewerage performance within the Blue Anchor area. Subsequent repairs and improvements to the sewerage infrastructure in 2010 have helped to further improve the bathing water quality.'*<br>*'Seven warnings advising against swimming due to an increase risk of short term pollution were issued in 2016 due to the effects of heavy rain on the water quality.'* | Excellent | Good | Good | Good |
| **Dunster North West**<br>Sand and pebble beach resort, approximately 2.6 km wide, backed by beach chalets. Current water quality classification is Good, based on samples taken from 2013 through to 2016:<br>*'The River Avill enters the sea 200 m southeast of the Environment Agency monitoring point. The Avill Spillway flood relief channel enters the sea 1.4km southeast of the Environment Agency monitoring point.'*<br>*'The outfall from Minehead STW, discharges to the sea 1.3km from the Environment Agency monitoring point. This discharge is disinfected and designed to protect bathing water quality.'*<br>*'There is an emergency overflow from the Dunster Beach pumping station, that discharges to the sea 200m from the Environment Agency* | Good | Good | Good | Good |

| Environment Agency Water sampling point<br>Environment Agency Bathing Beach Profile (2016) | Water Quality Classification | | | |
|---|---|---|---|---|
| | 2013 | 2014 | 2015 | 2016 |
| *monitoring point. The operation of the overflow can lead to a drop in bathing water quality.'*<br>*'Seventeen warnings advising against swimming due to an increase risk of short term pollution were issued in 2016 due to the effects of heavy rain on the water quality'* | | | | |
| **Blue Anchor West**<br>The beach is shingle and sand, and the water has a naturally cloudy colour. The beach has a shallow slope and a very large tidal range so that it can be up to half a km to the sea at low tide. Current water quality classification is Sufficient, based on samples taken from 2013 through to 2016:<br>*'The Pill River and Carhampton Stream flow across the beach at this bathing water and can affect water quality after heavy rainfall.'*<br>*'The Environment Agency are working with Wessex Water to carry out a review of sewerage performance within the Blue Anchor area. The Environment Agency will make recommendations for further improvements to protect and improve the bathing water quality.'*<br>*'The outfalls from Minehead and Watchet STWs discharge 4.5 km west and east of the Environment Agency monitoring point respectively. These discharges are treated and designed to protect bathing water quality.'*<br>*'There is an emergency/storm overflow from the Blue Anchor pumping station that discharges into the Pill River at the bathing water. The operation of the overflow can lead to a drop in bathing water quality'*<br>*'Four warnings advising against swimming due to an increase risk of short term pollution were issued in 2016 due to the effects of heavy rain on the water quality'* | Good | Good | Good | Sufficient |

The Minehead BMP to Blue Anchor BMP study is also within the following Water Framework Directive (WFD) Estuarine and Coastal Water Bodies Cycle 2 (see **Figure 2-10**), which is described as follows:

- **Unique Waterbody ID:** GB640807670000
- **Waterbody Name:** Bristol Channel Inner South
- **River Basin District Name:** South West
- **Waterbody Category:** Coastal
- **Waterbody Type:** Moderately exposed, Macrotidal.

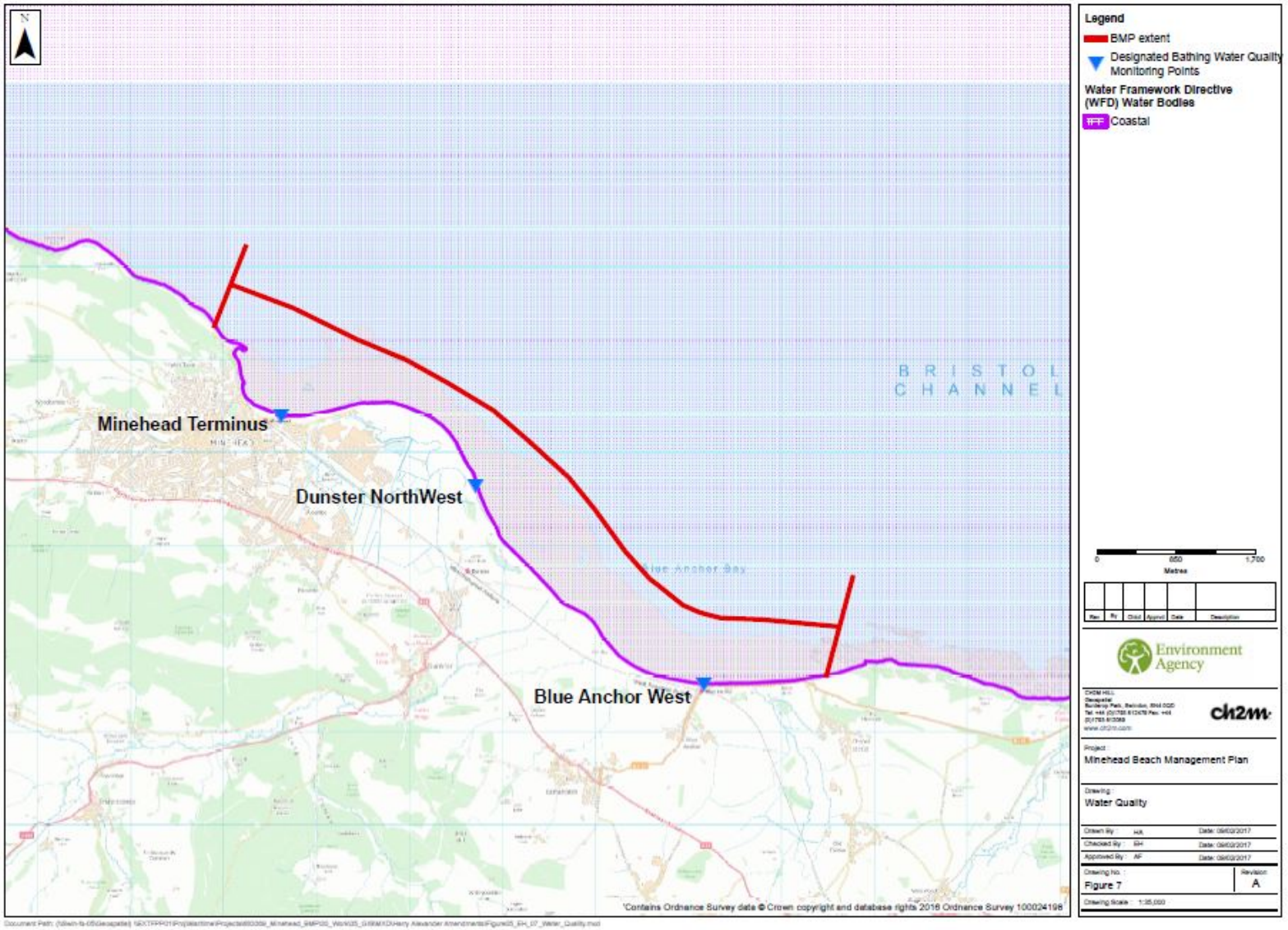



FIGURE 2-10
**Bathing water quality monitoring points and WFD designations within the vicinity of Minehead to Blue Anchor BMP frontage**

### 2.7.9 Air quality

There are no Air Quality Management Areas in the BMP area.

### 2.7.10 Noise

No baseline data on existing background noise level has been sourced for this baseline report. This may be required prior to any management activities depending on their scale and scope to produce elevated levels of noise.

# Scheme Design

## 3.1 Scheme description

As described in **Section 1.3.3**, coastal defences along the Minehead to Blue Anchor BMP frontage have developed over many years. This section presents details of the key phases of recent construction that have resulted in the coastal defences presently located along the various part of the BMP frontage. Further details are provided in **Appendix D**.

### 3.1.1 Minehead

The following section provides details on these current FCERM defence assets at Minehead, extending from Quay West (west of Minehead Harbour) to the terminal groyne at Warren Point *(NB: **Section 1.3.3** and **Appendix D** provide further details of the full history of coastal defence construction at Minehead).*

#### 3.1.1.1 West of Minehead Harbour and Minehead Harbour

At Quay West to the west of Minehead Harbour, there is a mixed sand and gravel beach backed by a seawall constructed in the 1950s protecting the promenade. Within the beach there are a small number of timber groynes and a buried outfall.

The Minehead Harbour structures have developed over the past two centuries and include a breakwater/groyne extending northwards.

No details or drawings relating to the construction any of the above identified structures have been located in the course of developing this BMP. As such, it is not possible to provide design details of these assets.

#### 3.1.1.2 Minehead Coastal Defence Scheme (1997-2000)

Along the Minehead Town part of the BMP frontage, a recurve wall extends from the slipway at the harbour, along Quay Street to Warren Point. This is fronted with 0.9km of rock revetment at the western end and 0.9km of stepped concrete revetment at its eastern end, along with a recharged sand beach along much of its length. There are also a series of groynes and outfalls present along the beach. These defences were constructed by the National Rivers Authority as the Minehead Coastal Defence Scheme between 1997 and 2000 in response to severe flooding in the 1990s. The purpose of the scheme was to improve the standard of protection offered by the sea defences to provide an acceptable degree of protection against storms of up to 1 in 200 year return period for a 50-year design life. The scheme was designed to limit overtopping to 40 l/s/m to avoid structural damage to buildings behind the sea wall (Environment Agency, 2004). Future maintenance of these defences was defined to be organised and undertaken by the County Council, District Council and private owners. The scheme was designed by Mouchel Consulting Limited, and constructed in three phases as described in detail in Sections (a) to (d) below. Further details on the design rationale along with scheme drawings are provided in **Appendix G**.

##### (a) Phase 1 (1997-1998)

The first phase was constructed by Tarmac Civil Engineering between January 1997 and July 1998 and covered the structural works including the following elements:

- 1.8 km of replacement seawall, including reinforced precast concrete, steel sheet piling and hollow tube steel bearing piles. 0.9km of this seawall includes a fronting rock revetment while the remaining 0.9km includes a fronting concrete block revetment;
- Construction of three “Access and Viewing Points” along the Warren Road promenade;
- Construction of three sets of beach access steps and one access ramp (at Warren Road) onto the beach;
- Upgrading of beach access ramp at Quay Street;

- Re-routing of an existing culverted stream (Town Culvert) and construction of a new culvert;
- Service diversions and modifications to existing seawall outfalls;
- Upgrading and raising the promenade, including remedial paving and surfacing works;
- Demolition of a ticket office;
- Repositioning and raising four existing seafront shelters in Jubilee Gardens and Quay Street Green; and
- Landscaping works with provision of new bench seating.

**Appendix G** provides further details of the construction works completed between 1997 and 1998. The construction elements are described along the three frontages Quay Street, Esplanade and Warren Road which are shown on the general arrangement in **Figure 3-1**. Typical cross sections for each frontage are included with details of the seawall, revetment and beach, along with a description of the four groynes.

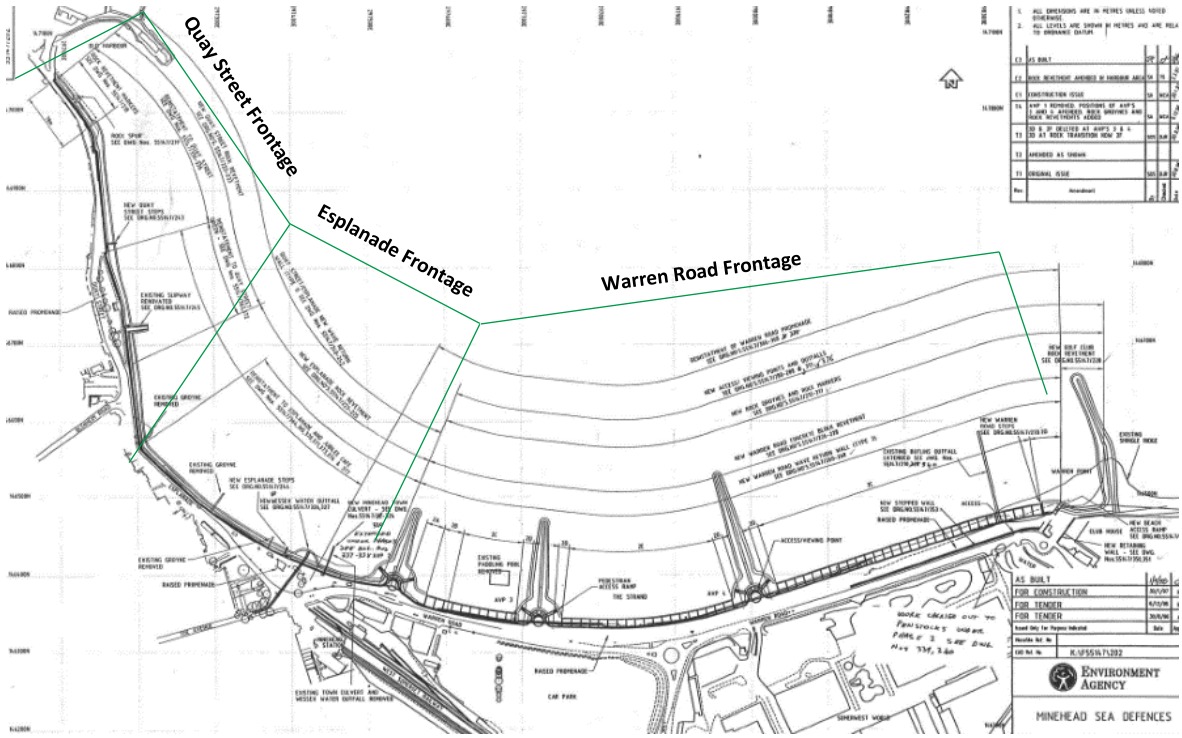



FIGURE 3-1
**As-built drawing showing the general arrangement of phase 1 (from Mouchel, 2000; see also Appendix G).**

### Quay Street

**Figure 3-2** shows the typical cross section proposed for the Quay Street frontage. The seawall comprises a new raised wave return wall which increases the crest elevation of the defences to +8.9m ODN. The revetment component comprises a double layer of rock ($W_{50}$=1 t) placed on a geotextile laid over general fill.

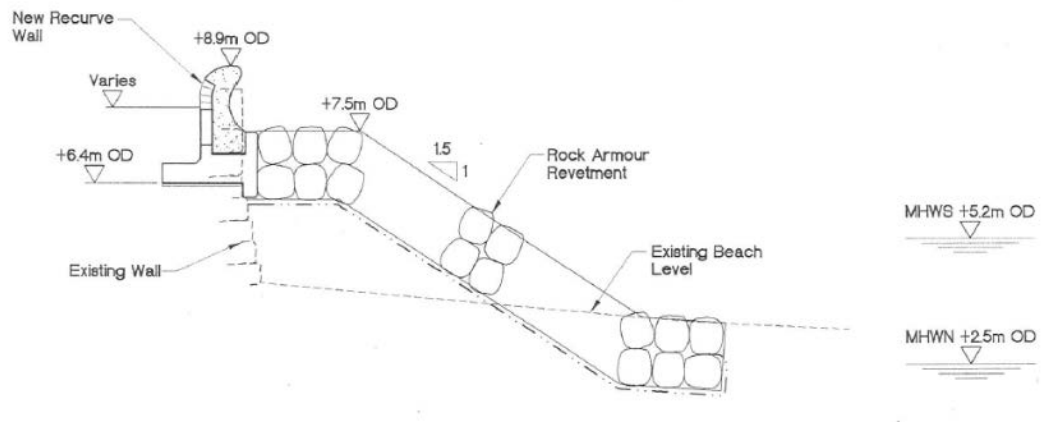



FIGURE 3-2
**Typical Quay Street seawall cross-section (from Mouchel, 2000; see also Appendix H).**

### The Esplanade

**Figure 3-3** shows the typical cross section of the Esplanade frontage. The seawall is the same as for the Quay Street frontage with a recurve wall with crest level of +8.9m ODN. The difference from Quay Street is the size of armour rock used in the revetment and the addition of beach nourishment material. The revetment comprises of a double layer of rock ($W_{50}$=1.5 t) placed upon a geotextile laid over general fill.

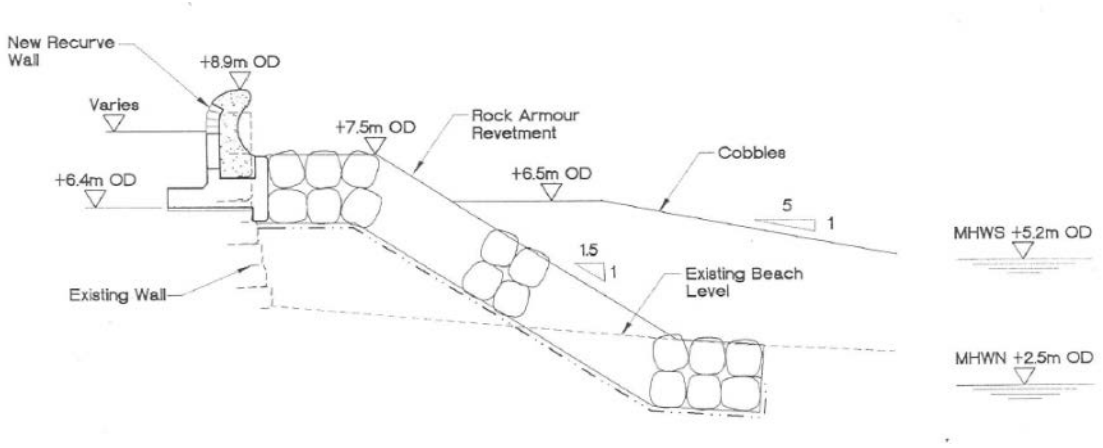



FIGURE 3-3
**Typical Esplanade seawall cross-section (from Mouchel, 2000; see also Appendix H).**

### Warren Road

**Figure 3-4** shows the typical cross section of the Warren Road frontage which comprised the demolition of the original wall and the construction of a new recurve wall to the crest level of +8.9m ODN. The seawall was set back and is fronted by a stepped block revetment with access viewing points constructed at the root of each groyne. The concrete block revetment comprises precast interlocking concrete blocks laid on a 200mm thick filter layer supported by a 1m thickness of special fill material and three geotextile layers.

Part of the new seawall is constructed on piles, and the toe beam of the revetment is also supported on sheet piles. This allows differential movement of the blockwork structure within acceptable limits, however the information reviewed does not specify what the limits are.

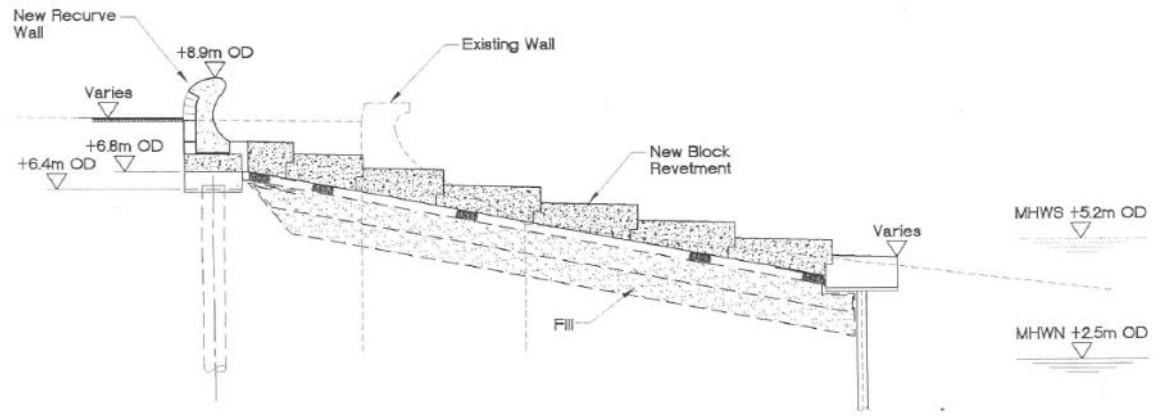



FIGURE 3-4
**Typical Warren Road seawall cross-section (from Mouchel, 2000; see also Appendix H).**

### Rock Groynes

Four rock groynes along with access/viewing points (AVP) at their roots were constructed during Phase I of the scheme and, are numbered on **Figure 3-1** above from "4" to "7". The rock groynes and rock revetment are constructed from Mendip Limestone, for which abrasion has been allowed for within the design life of the structure.

All four groynes comprise rock armour laid upon a geotextile and general fill, with an asymmetrical double layer of armour on the western side and a single layer on the eastern side. The double layer on the western side is faces the predominant north-westerly wave direction. **Figure 3-5** shows the typical cross section of the groynes.

The groynes increase in length from west to east along Warren Road and have varying rock armour size along the length of the structure, transitioning from two-tonne rock armour at the seaward ends and between 3.5 and 4 tonnes at the landward end. The lengths and rock armour sizes used on each groyne can be seen in **Table 3-1** and the plan drawings **Figure 3-6** to **Figure 3-9**.

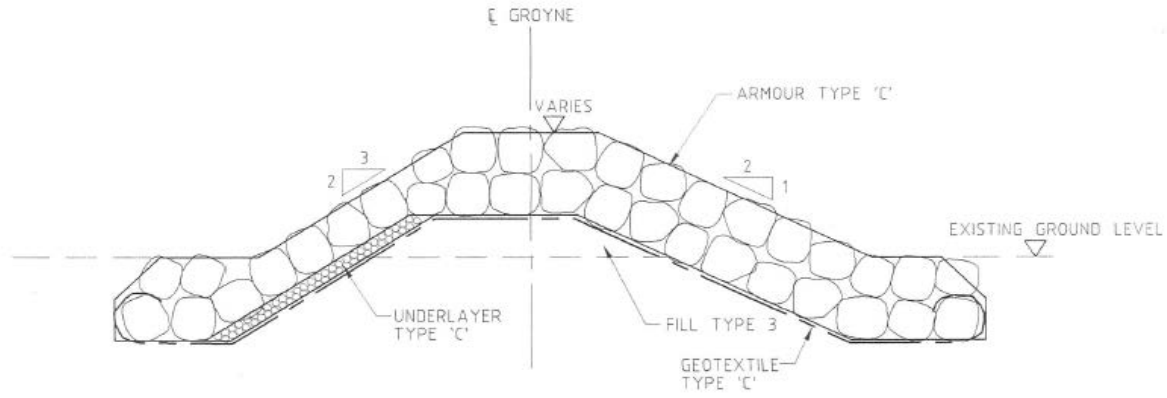



FIGURE 3-5
**Typical groyne cross section**

TABLE 3-1
**Groyne Lengths and rock armour sizes**

| Groyne Number | Total Length (m) | Landward section | | Seaward section | |
|---|---|---|---|---|---|
| | | Length (m) | Rock weight, $W_{50}$ (t) | Length (m) | Rock weight, $W_{50}$ (t) |
| **No 4** | 105 | 52.5 | 4.0 | 52.5 | 2.0 |
| **No 5** | 135 | 80.0 | 4.0 | 50.0 | 2.0 |
| **No6** | 175 | 100.0 | 3.5 | 73.0 | 2.0 |
| **No 7** | 196 | 100.0 | 3.5 | 96.0 | 2.0 |

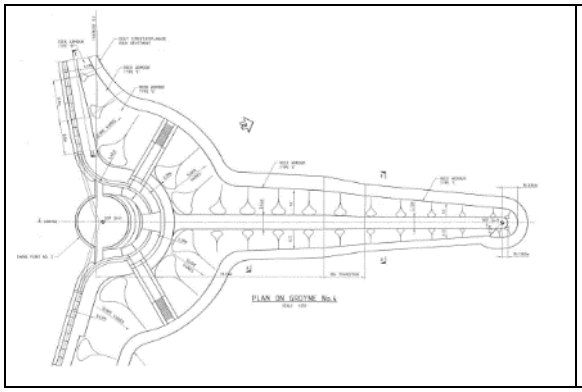


FIGURE 3-6
**Plan of groyne no.4**

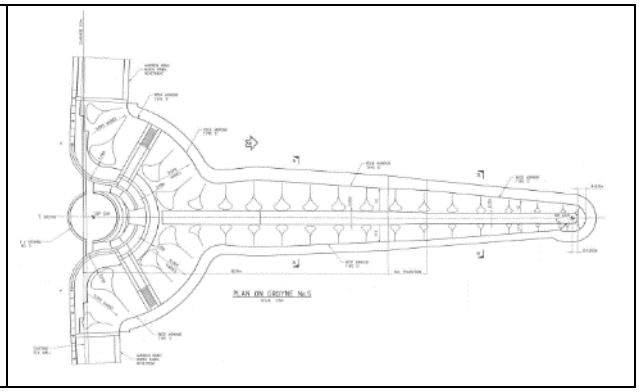


FIGURE 3-7
**Plan of groyne no.5**

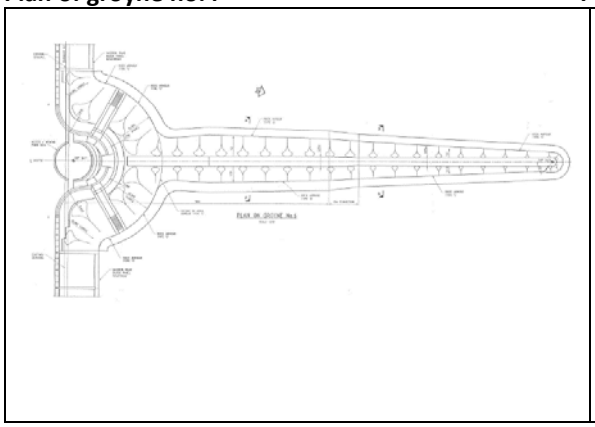


FIGURE 3-8
**Plan of groyne no.6**

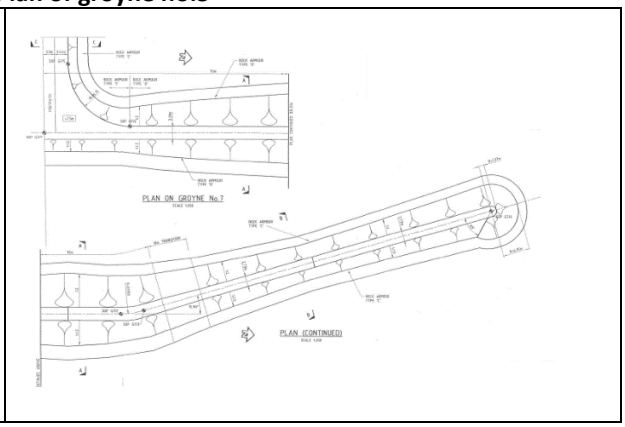


FIGURE 3-9
**Plan of groyne no.7**

Groyne 7 shown in **Figure 3-9** is the longest of the groynes and is positioned at the east of Warren Road. The groyne differs from the others as it does not include a viewing point instead joining the West Somerset Coast Path adjacent to the Minehead Golf Club.

Further drawings including seawall, beach, and groyne section details can be found in **Appendix G**.

## (b) Minehead's Outfalls (1998)

Within Groyne No 1 a 375ø pipe was broken out and replaced with a 525ø class H concrete pipe at 1 in 100 with a 500mm (min) concrete surround on a mass concrete footing 2m into the existing beach. The pipe extends beyond the end of the existing outfall shown in **Figure 3-10** below and has an invert level of +3.05. A manhole was constructed in line with the 375ø pipe with two new sewers of 450ø with invert level 4.7m and 300ø with invert level 6.5m. The flapped manhole was constructed with a 900mm opening and bolt down cover.

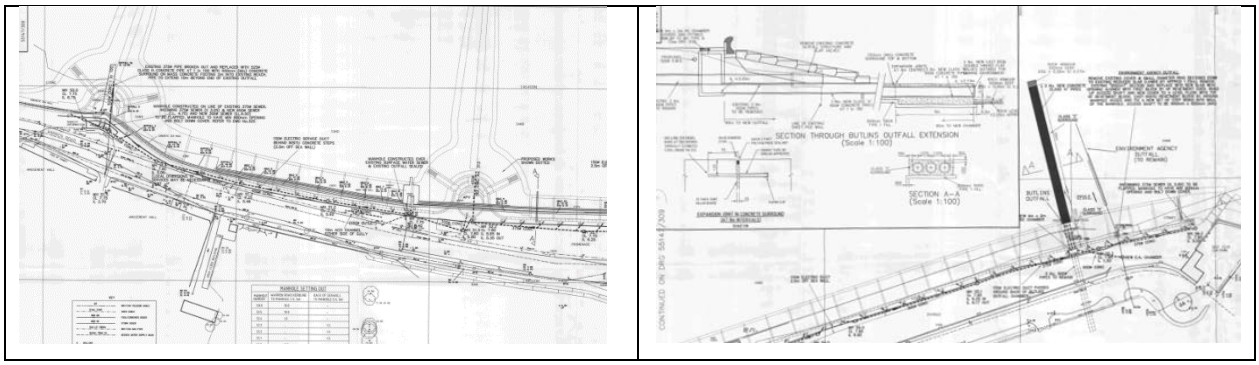


FIGURE 3-10
**Minehead Culvert and Outfalls (Left - Groyne 1, Right - Butlin and EA Outfall)**

The Butlin's outfall is located West of the Minehead Golf Club carpark. The outfall is between $D_{50}$ 0.26m and 0.27m and was extended with 3 new concrete class H pipes and class Z surround. The pipes connect to a 4m x 2m RC chamber with class z surround located beneath the concrete block revetment. The 3 pipes are 900ø and were installed with new cast iron double hinged flap valves which were suitable for the marine environment and had an invert level of +2.73m.

To the east of the Butlin's outfall is the Environment Agency's outfall. In late 1990s the existing cover and small diameter rings sections were removed along with the biscuit section. The biscuit section was replaced with a new slab and access shaft with a new cover flush with the top revetment block. The access shaft was 900mm x 600mm.

### (c) Minehead Coastal Defence Scheme Phase II (1999)

The second phase of the scheme was constructed by Ham Dredging Ltd. between June and August 1999 and involved the replenishment of the Minehead foreshore in front of the new seawall. The recharge involved the importation of 340,000 tons (approximately 182,683m$^3$) of sand from the Holm Sands licensed dredge area in the Bristol Channel to Minehead via barges. The sand was placed between the town culvert and groynes 4, 5, 6, and 7 with plant used to move the material and form the new beach.

The volumes of sand placed in 1999 are shown in **Table 3-2**, with the frontage separated into four bays (see **Figure 3-11**):

TABLE 3-2
**Volumes of sand placed at Minehead (from Mouchel, 2000)**

| Bay | Location | Volume placed in 1999 (m$^3$) |
|---|---|---|
| **A** | Between groyne 7 and 6 | 97,389 |
| **B** | Between groyne 6 and 5 | 48,747 |
| **C** | Between groyne 5 and 4 | 28,453 |
| **D** | Between groyne 4 and Town Culvert | 8,094 |
| **Total** | | 182,683 |

Along the Esplanade frontage the nourishment consisted of sand and cobbles with the cobbles placed adjacent to the rock revetment in the form of a 3m wide berm with a crest level of 5.0-6.5m OD and a 1 in 5 foreshore slope. The cobble nourishment is overlain with sand recharge laid at a slope of 1 in 15 to the east of the town culvert but to the west the 1in 15 slope is solely made up of cobbles. The Warren Road frontage consisted of sand with an average diameter ($D_{50}$) of 0.87mm which was placed to form a berm of between 10m and 70m in width and a crest level of 6.5m OD. The nourishment then tapers into the existing foreshore at a slope of 1 in 20 (Mouchel, 2000).

After the beach nourishment material was placed on the foreshore, it was analysed to ensure compliance with the specification and used as an aid for monitoring changes in the grading over time.

Four samples were taken from each of the 54 loads of 3,600m$^3$ placed on the beach between Bays A to D. The sand was then tested by an onsite contractor in accordance with BS 1377 using sieve sizes between 6.3mm and 0.063mm. The results from the tests indicated that the beach nourishment was either within specification or larger than specified ($D_{50}$, $D_{85}$ and $D_{15}$ were all larger than the specified range). These results indicate a beach which should be more stable (steeper slope) than that specified.

As part of Phase II it was recommended that beach sections be monitored every two months and thereafter at six monthly intervals. When the beach nourishment was completed in August 1999 an out-survey was carried to record the beach cross sections. Beach monitoring was conducted by the Environment Agency, with the first surveys completed in Feb/March 2000. Groyne section markers were also put in place to measure any movement or settlement of the rock armour groynes.

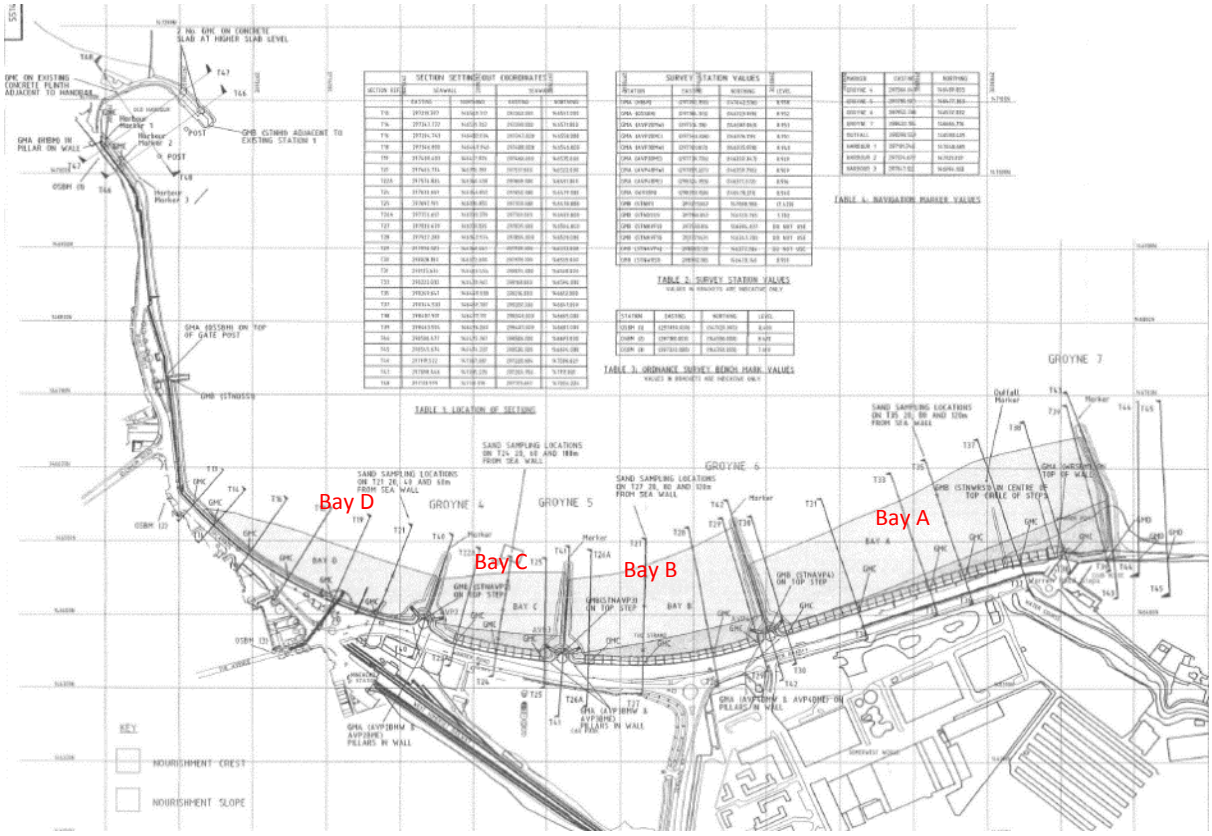



FIGURE 3-11
**Beach monitoring topographical survey lines (Environment Agency, 2004)**

## (d) Minehead Coastal Defence Scheme Phase III (Jan-Apr 2000)

The third phase was constructed by the Environment Agency Emergency Work Force between January and April 2000 and included a further 16m extension of the Minehead Town Culvert and the upgrading of the penstocks controlling water levels around Butlins holiday camp. There was also a telemetry station installed at Minehead Harbour to measure tide levels, wind speed and direction as recommended in the BMP. The specific elements of work for this phase are listed below:

- Diversion and extension of the Minehead Town Culvert by 16m;
- Extension of an existing storm water sewer overflow;
- Extension of a surface water drainage outfall from the Butlin's site;
- Interception of an Agency drainage outfall and redirection to the Butlin's outfall;
- Upgrading of three penstocks on the line of the Butlin's outfall to Environment Agency standards;
- Surface water drainage and outfall works;
- Extending, raising and reinstatement of the existing promenade;

- Associated landscaping and enhancement works, including raised walkways, raised shelters, raised planting beds and new traffic calming measures; and
- Installation of telemetry station at Minehead Harbour.

Most outfalls modified in this phase have been protected by flap valves, either at the end of the outfall or in a junction chamber on the landward side of the sea wall to prevent flooding during storm events. In the case where flap valves have not been provided at the ends of outfalls and where junction chambers are used, reinforced manholes with bolt down covers have been used to prevent covers from being lifted off due to high pressures beneath.

#### 3.1.1.3 Sea Front Enhancement (2000-2001)

Following the completion of the scheme, West Somerset District Council embarked on a 12-month sea front enhancement scheme which involved the complete replacement of the existing street furniture, tree planting, creation of a linear sculpture park and turning 250m of Warren Road into a sea view car park. Some of the landscaping and enhancement work carried out under Phases 1,2 and 3 described in **Section 3.1.1.2** was augmented by the West Somerset Council scheme.

#### 3.1.1.4 Beach maintenance activities (ongoing)

Defences within the Minehead Bay frontage experience ongoing maintenance activities to ensure the design beach profile is retained, and to avoid loss of material from the system. The Environment Agency conduct regular 6-monthly recycling of beach material, predominantly focusing on the redistribution of sand from the back of the beach and behind the seawall to the intertidal area between the groyne structures. *NB: sand from behind the seawall (on the Esplanade) is actually picked up and returned over the seawall to the upper part of the beach on the stepped revetment by West Somerset Council, though the timing at which West Somerset Council do this is not aligned to when the Environment Agency do the beach recycling works.*

**Figure 3-12** shows the locations from where beach sediment was recycled from and to in the most recent maintenance activities at the end of 2016. **Appendix D** provides further details.

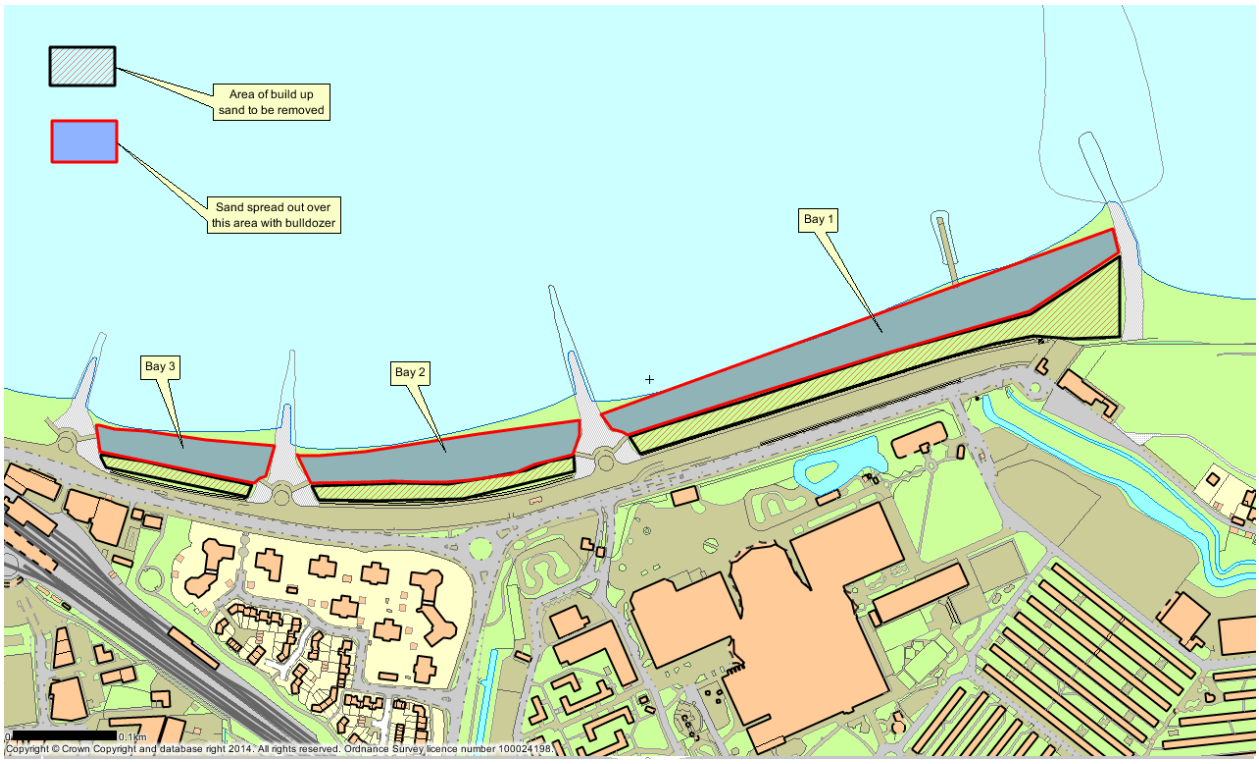



FIGURE 3-12
**Locations of extraction and deposition during maintenance recycling (Environment Agency, 2016g)**

### 3.1.2 The Warren

The Warren section of the BMP frontage extends from Warren Point in the west to the end of Minehead Golf Course in the east (see also **Figure 1-3** above). A shingle/dune ridge and earth embankment protects low lying areas from tidal inundation along the full length of this section. Behind the shingle ridge is an ancient shingle ridge and dune system underlying the Minehead Golf Course. The area is vulnerable to erosion from direct wave action, and relic dunes and ridges indicate that the coastline has fluctuated many times in the past (Black and Veatch, 2009). The dunes and ridges along this section of coast provide the majority of the coastal defence along this frontage.

The West Somerset Coastal Processes Study (Royal Haskoning, 2011) identified that the ridge is vulnerable to extreme storm events with evidence of erosion and general landward movement. In particular, it highlights the 300m section facing due north directly in the lee of the Minehead terminal groynes as being the area most affected by cliffing. The cliffing in this area has resulted in exposure of the coastal footpath at the seaward edge of the ridge.

In response to this risk, this western end of The Warren was subject to emergency works in 2010 that placed rock armour against the existing eroded ridge. These emergency works also included the construction of a new beach profile with nearshore material to protect the western most end of the newly armoured ridge which protects Minehead Golf Course. This armoured length of ridge extends a short distance east from the terminal rock groyne at Minehead, and includes a public access footpath at the top of the bank that extend all the way round to Dunster Beach. There are signs of erosion immediately east of the rock protection as it becomes outflanked and in other parts of the undefended ridge, with notable cliffing where the embankment has eroded for quite a length of the frontage; resulting in partial loss of the footpath in places.

**Appendix E** provides further details.

### 3.1.3 Dunster Beach

Dunster Beach extends from the eastern end of the golf course at the old Avill outfall to the River Avill flood relief channel. A shingle/sand beach, supported by 40no. timber-post groynes maintained by the owners of the Dunster Beach Holiday Park and backed by an earth embankment, provides coastal flood protection along this part of the BMP frontage (refer to **Figure 1-4** above) Recycling and re-profiling of sediment by Dunster Beach Holiday Park has occurred in the past to further support the timber groynes and overall protection of this section of coast.

The defences along Dunster Beach are less vulnerable to direct wave action as they are east facing and therefore protected from the dominant erosive westerly waves. They are, however, low lying and vulnerable to elevated water levels and sea level rise (Black and Veatch, 2009).

The eastern limit of the Dunster Beach frontage is the River Avill Flood Relief Channel, a shallow sloping concrete structure that discharges high flow events from the Avill to the sea. This was constructed following severe flooding of the area in the 1960's. To the east of this channel there is marked recent erosion as the coastline cuts back with cliffing evident and has eroded West Somerset Coast Path.

No drawings of the assets along this frontage have been identified and as such, specific details cannot be provided in this BMP.

**Appendix D** provides further details.

### 3.1.4 Blue Anchor Bay

Blue Anchor Bay extends south-eastwards from the River Avill Flood Relief Channel to the Blue Anchor Hotel. The western end of the frontage is comprised of a natural shingle beach ridge which provides protection against the risk of coastal flooding to the West Somerset Railway and low-lying areas inland of the coast. The eastern end of the frontage at Blue Anchor is defended by a 1.2km long concrete seawall, partially fronted by a rock revetment and three rock fish-tail groynes (refer to **Figure 1-5** above).

There have been many efforts to provide coastal defence to the Blue Anchor part of Blue Anchor Bay since the 1850's (refer to **Section 1.3.3** and/or **Appendix D**). The following provides key details of these efforts that form the defences currently located along this Blue Anchor part of the BMP frontage:

- The seawall along Blue Anchor now operated by Somerset County Council (Highways) was constructed in the early 20th century and provided an approximately 9m wide and 700m long wall built approximately 15m inland of the coast, abandoning the original road and Pill Bridge at Blue Anchor. The construction adopted concrete stone pitched slopes.

  Ongoing maintenance and addition to extend the wall and/or address undermining issues due to falling beach levels in front of the seawall have then occurred. The most recent works in this regard occurred in the 1980s, when Somerset County Council proposed the construction of a rubble mound protection for the toe of the existing sea wall. The work would involve breaking the existing apron, forming a core of small size rocks and shingle against the toe of the wall, supported by fabric filter material, and armoured with large rocks laid individually in a double layer. At the design stage, different crest levels were considered and estimates of suitable rock armour sizes were made (HR Wallingford, 1985). It is understood from discussions with the Environment Agency duri[illegible]it on 31st October 2016, that this work by HR Wallingford led to the selection of a pr[illegible]al design (illustrated in **Figure 3-13**) that was then constructed in the late 1980's, although no details confirming the exact final design have been identified.

Ker Moor

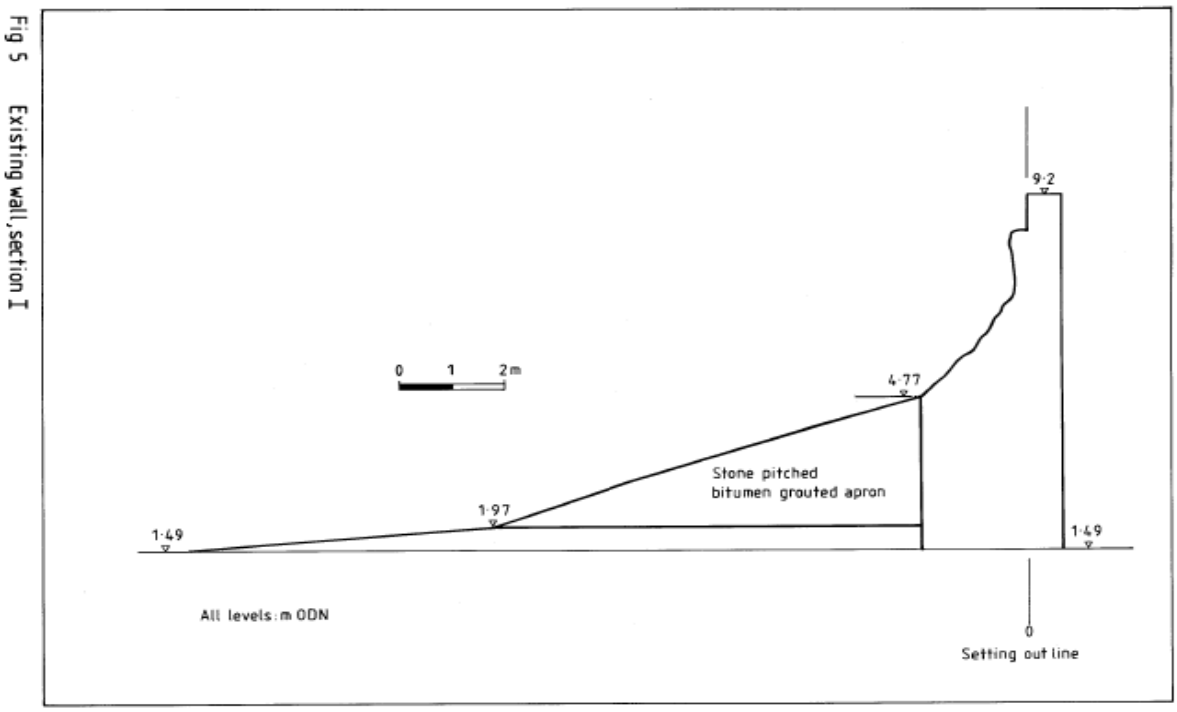



FIGURE 3-13
**Section of Blue Anchor Sea Wall in 1985 showing area of stone pitching (HR Wallingford, 1985)**

In January 2004 maintenance works was undertaken comprising of the replacement of the seawall parapet, 360m from the east end of the main seawall protecting the Blue Anchor settlement. The replacement structure included the same style as the previous structure, and included additional accessibility points.

- Abutted to the eastern end of the Somerset County Council (Highways) seawall, a series of defences along the coast fronting the Blue Anchor Hotel were constructed by the owners of the hotel between the 1940s and 1950s. The defences step back from the adjacent defences to the west, and comprise an approximately 50m long vertical concrete seawall with an upper concrete revetment and wave return wall. These structures were built to stop cliff erosion, however they are currently in

very poor condition, and in some sections have been outflanked or destroyed (Royal Haskoning, 2011).

The western end of Blue Anchor Bay at Ker Moor is not protected by any formal defences. Protection here is in the form of a natural narrow shingle beach ridge that primarily protects the West Somerset Railway from coastal flooding and erosion. As such, the West Somerset Railway has previously undertaken works to maintain the defence function of the natural shoreline. The most recent example of this occurred following storms in 2013/14 storms that eroded the natural crest defence with beach sediment being pushed into a trench which separates the beach from the adjacent railway line, and which allowed waves to run-up and over the railway line, damaging the embankment. In January 2015, West Somerset Railway, with advice from the Environment Agency and Natural England, undertook work to manage beach erosion along the Blue Anchor frontage. Material was excavated from the trench and distributed over the crest into areas which had been eroded. Further details are provided in **Appendix D**.

## 3.2 Standard of protection

### 3.2.1 Overtopping analysis

One of the key performance criteria of sea defences is the wave overtopping discharge permitted by the structure. One of the aims of the BMP is therefore to ensure that the coastal defences along the BMP frontage continue to provide the required standard of protection against wave overtopping.

It is unclear from previous documentation what standard of protection the older defences along parts of the BMP frontage were designed to provide. The exception to this are the defences at Minehead constructed in the later 1990s, which are stated to have been designed to provide an acceptable degree of protection against storms of up to 1 in 200 year return period for a 50-year design life (to 2049), based on the scheme being designed to limit overtopping to 40 l/s/m (refer to **Section 3.1.1.2** / **Appendix D**).

The wave and water level data available for wave overtopping analysis (refer to **Section 2.1.2**) is insufficient to establish the existing standard of protection for flood defences at Minehead and assess if the design standard is being provided at this time, as the joint probability of extreme wave and water level events was not defined.

However, using the small number of suitable nearshore wave and water level data points identified in **Section 2.1.2**, some limited overtopping was undertaken in developing this BMP to provide an indication of the overtopping risk associated with defined input data using the latest guidance. The wave and water level data used is consistent with the data used for the derivation of tidal procedures for the area, and can therefore be considered relevant for the local operations team. Full details of this overtopping analysis are provided in Section 4 of **Appendix D**.

The results of this overtopping analysis indicate the areas at most significant risk of flooding by overtopping of coastal defences in the present day are the undeveloped area between the Dunster Beaches chalets and the Ker Moor at Blue Anchor, the western section of Minehead Bay, and the eastern section of the Blue Anchor frontage. The limit for public and vehicle safety is exceeded in most location throughout the study area for all present day conditions examined, and the very large overtopping rates for some areas are likely to exceed the design stability limits.

The change in overtopping risk as a consequence of sea level rise has also been examined, with a pragmatic approach of increasing the still water level with UKCP09 guidance and an increase in wave height to reflect elevated storminess. It is recognised that the changes in wave transformation expected by additional water depth in the nearshore are not represented by this approach, and future overtopping discharges may therefore be underestimated.

Overtopping analysis for future events show significant increases in risk to all areas except the embankment protecting the Minehead Golf Course. This embankment comprises a very steep gravel and cobble beach area that shows signs of significant wave action in the present day due to storm ridges high

on the embankment. It is likely that the bank will suffer erosion and failure under extreme design conditions, lowering the crest level and increasing the overtopping discharge experienced in this area.

To enable a more robust appraisal of overtopping risk to be completed, **it is highly recommended that extreme wave and water level data is collected or derived for a range of joint probability return periods at nearshore locations.** Further **numerical modelling for future years (accounting for sea level rise) is recommended to account for the changes in energy dissipation and wave transformation as design waves propagate to the coast** and this should form part of the studies recommended to occur within the next five years to progress the preferred option for long-term coastal flood and erosion risk management along the BMP frontage, as set out in **Section 1.1.1**.

### 3.2.2 Undermining/scour risk

Draw down in the level of the beach in front of the seawalls can result in undermining leading to slumping, collapse and failure of the defence. Assessment of this risk was undertaken as part of developing this BMP, and is described in full **Appendix D**. In summary, this assessment concluded that there was no evidence of undermining of the majority of the defences along the BMP frontage at the present time (though this has been a documented issue historically, particularly at Blue Anchor). The one area of the frontage that does present a potential undermining risk at the present time is the seawall to west of Minehead Harbour, where the toe of the seawall is regularly exposed by fluctuating beach levels and shows evidence of previous wash-out. If left unaddressed, further deterioration could lead to slumping of the crest or failure of the roadway behind, increasing the risk of flooding and coastal erosion to properties. Measures to address this issue are set out in the preferred option defined in **Section 1.1.1** and in **Section 5.1.4**.

Regular assessment of the undermining risk will continue to be monitored as part of future asset inspections (refer to **Section 4.1.8** and **Section 4.2**).

## 3.3 Trigger levels

When beach levels reach a specific elevation or 'trigger level', an action may be taken. The guidance within *Toe Structures Management Manual* (Environment Agency, 2012c) recommends estimation of the trigger level consistent with times when the probability of structural failure reaches thresholds that are deemed important. The trigger levels of a beach will often coincide with the point at which beach levels threaten an unacceptable rate of overtopping or probability of stability failure. Multiple trigger levels can be adopted for a beach which will reflect different risk levels or points at which action is required.

This section defines trigger levels in terms of "Alarm Level" and "Crisis Level" for a range of actions along different sub-sections of the BMP frontage (refer to **Figure 1-1**). Responses to be taken should either of these levels be reached are set out in **Sections 5.2 and 5.3**.

### 3.3.1 West of Minehead Harbour

West of Minehead Harbour beach recycling will be triggered depending on beach levels relative to:

(a) the seawall in order to manage the risk of the seawall toe being exposed which could lead to undermining (refer to **Section 3.2.2**), and

(b) to reduce the rate of sediment moving towards the mouth of Minehead Harbour.

**Trigger Level A:** In respect of beach levels along the seawall, trigger levels are defined to ensure the toe of the seawall is not exposed for any significant length of time, as follows:

- **Alarm Level:** If the drop from the crest of the seawall to the beach is greater than 2m or the steel mesh/concrete toe of the wall is exposed, this will be the trigger for increased frequency of monitoring of the beach levels through visual inspection (refer to **Section 4.1.8**) to determine if it is persistent or if it is merely a temporary occurrence as a result of naturally dynamic beach level fluctuations. This more frequent monitoring will ensure that if the beach level lowers

further to the Crisis Level, then this will be observed in a timely manner and not be missed by less frequent planned beach profile surveys. This trigger level is illustrated in **Figure 3-14**.

- **Crisis Level:** If the drop from the crest of the seawall to the beach is greater than 2m or the steel mesh/concrete toe of the wall is exposed for a period of more than three-weeks, this will be the trigger to undertake beach recycling works (refer to **Section 5.3**).

NB: **these Alarm and Crisis Levels will need to be revisited following implementation of the toe protection works planned to occur within the next five years** as defined in **Section 1.1.1**.


FIGURE 3-14
**Illustration of Action Levels along the seawall West of Minehead Harbour.**

**Trigger Level B:** In order to reduce the rate of sediment transport towards the mouth of Minehead Harbour it will be necessary to intervene when beach levels build-up at the eastern end of the beach to the West of Minehead Harbour. Trigger levels are therefore defined as follows:

- **Alarm Level:** When beach sediment builds up against the harbour arm at the eastern end of the beach to a point where it can be pushed over and/or around the harbour arm by wave action (illustrated in **Figure 3-15**), this will be the trigger to implement beach recycling (refer to **Section 5.2**).
- **Crisis Level:** Same as Alarm Level.


FIGURE 3-15
**Illustration of Action Levels along the harbour arm at the eastern end of the beach West of Minehead Harbour.**

### 3.3.2 Minehead Harbour

No Alarm or Crisis Levels are defined for Minehead Harbour to trigger beach recycling works.

Any 'trigger level' type works, if required, will be reactionary and in response to build-up of sediment across the harbour mouth to the level at which it impedes navigation and requires sediment to be moved within the system, as has occurred historically.

### 3.3.3 Minehead Town

#### 3.3.3.1 Triggers for beach recycling and re-profiling

Along the Minehead Town section of the BMP frontage, beach recycling and re-profiling will be triggered depending on beach levels relative to:

(a) the crest of the seawall to ensure the seawall is able to function as intended and is not prevented to do so by sediment build-up in front of it, and

(b) the toe of the seawall to ensure sufficient sediment coverage of the seawall foundations to prevent damage that could lead to undermining.

**Trigger Level A:** In respect of beach levels in relation to the crest of the seawall, trigger levels are defined as follows:

- **Alarm Level:** If sediment has built up to cover the second step from the top of the wall (step 2 – refer to **Figure 3-16**) along a length of 50m or more, then this will be a trigger to implement beach recycling (refer to **Sections 5.1.2 and 5.2**).
- **Crisis Level:** Same as Action Level.

**Trigger Level B:** In respect of beach levels in relation to the crest of the seawall, trigger levels are defined as follows:

- **Alarm Level:** If step 6 (refer to Figure 3-16) is exposed, this will be the trigger to implement increased frequency of monitoring of the beach levels through visual inspection (refer to **Section 4.1.8**) to determine if it is persistent or if it is merely a temporary occurrence as a result of naturally dynamic beach level fluctuations. This more frequent monitoring will ensure that if the beach level lowers further to the Crisis Level, then this will be observed in a timely manner and not be missed by less frequent planned beach profile surveys.

- **Crisis Level:** If the top of the steel sheet piles are exposed (see **Figure 3-16**), this will be the trigger to implement beach recycling (refer to **Section 5.3**).

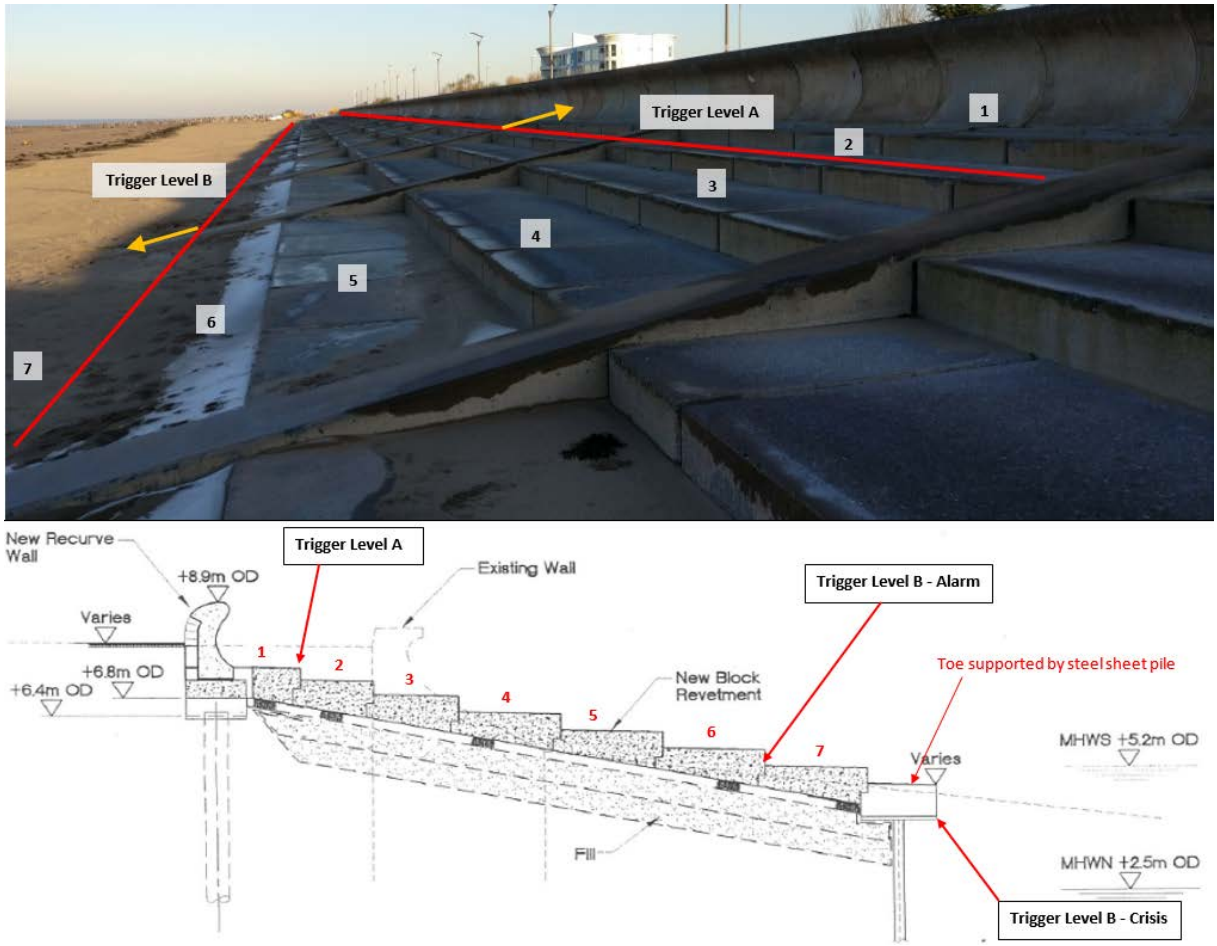



FIGURE 3-16
**Illustration of the Alarm and Crisis Levels along the Minehead Town frontage.**

### 3.3.3.2 Triggers for beach recharge

In addition to the above, trigger levels are also defined for the Minehead Town frontage for when beach recharge should be considered in the future. These trigger levels, which were first defined as part of the original scheme (refer to Section 3.1.1) and remain valid, are as follows:

- A reduction in crest width below 3m;
- A reduction in crest level below 6.5mOD; or
- Beach volume losses across the frontage are greater than 50m$^3$/m (or 35% of the total original recharge volume, so 64,000m$^3$).

## 3.3.4 The Warren

Along The Warren the main concern is erosion of the current shoreline during a storm event(s) that could breach the defence line and lead to widespread flooding. In order to manage this risk, areas of erosion along The Warren frontage are to be repaired as they are identified. As there is not a consistent profile along this section of coast, the trigger point for intervention is defined in relation to the distance between the seaward edge of the footpath and the “edge” of natural ridge, as follows:

- **Alarm Level:** If the distance between the seaward edge of the path and the “edge” of the natural ridge is less than 0.5m (refer to **Figure 3-17**), then intervention to prevent further erosion is required (refer to **Section 5.2**).
- **Crisis Level:** Same as Action Level.

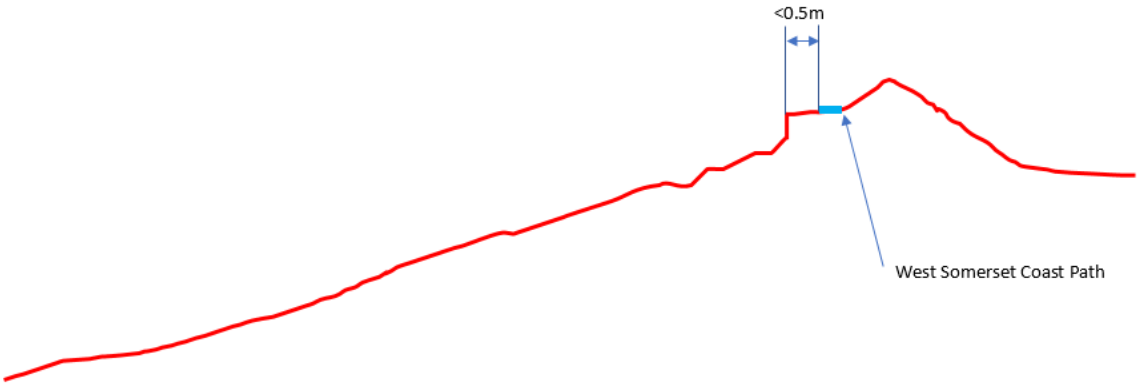



FIGURE 3-17
**Illustration of Alarm Level along The Warren based on distance between seaward edge of the coast path and the "edge" of the natural ridge.**

### 3.3.5 Dunster Beach

No Alarm or Crisis Levels are defined for Dunster Beach to trigger beach recycling works.

Any 'trigger level' type works, if required, will be reactionary and based on inspection following an event.

### 3.3.6 Ker Moor

No Alarm or Crisis Levels are defined for Ker Moor to trigger beach recycling works.

Any 'trigger level' type works, if required, will be reactionary and based on inspection following an event.

### 3.3.7 Blue Anchor

No Alarm or Crisis Levels are defined for Blue Anchor to trigger beach recycling works.

Any 'trigger level' type works to the hard defences along the Blue Anchor frontage, if required, will be reactionary and based on inspection following an event.

# Monitoring Regime

Over the next 5 years, a comprehensive monitoring programme is recommended to be undertaken in order to provide a greater level of quantitative field data. This will aid improved understanding of the coastal processes operating along the Minehead to Blue Anchor BMP frontage and wider coastal area, as discussed in **Section 1.4.4**, and inform future management decisions in this area.

The following sections discuss the recommended monitoring requirements over the next 5 years with this objective in mind. In doing so, it incorporates the ongoing monitoring undertaken by the Plymouth Coastal Observatory (PCO) as part of the South-West Regional Coastal Monitoring Programme (SWRCMP), who already carry out two annual beach profile surveys (and post-storm surveys when needed), a 5-yearly bathymetry survey, and undertake aerial LiDAR and aerial photography on a frequent basis. **The continuation of this monitoring programme is vital to improving the understanding of the coastal processes that lead to coastal flood and erosion risks along the BMP area**.

## 4.1 Beach monitoring

### 4.1.1 Routine beach profile survey

Topographic beach profile surveys are carried out by the PCO every spring and autumn at pre-defined locations along the BMP frontages (as illustrated in **Figures 2-5a to 2-5f** above). **Monitoring of beach profiles every spring and autumn by PCO is to continue as part of the SWRCMP**. Data is available through the PCO website (www.coastalmonitoring.org) from 2007 onwards (when PCO was established). For locations at Minehead, the Environment Agency also holds data from 1999.

There are over 180 beach profile survey locations along the BMP frontage. All of these locations are surveyed every few years as part of the baseline surveys undertaken as part of the SWRCMP. A sub-set are also currently surveyed twice per year as part of the SWRCMP (see **Table 4-1**), and of which a further sub-set are also currently used to capture additional post-storm survey profiles (refer to **Section 2.5.3**). **It is recommended that the last 3 digits of at least some, if not all, of the Profile IDs listed in Table 4-1 be marked upon the seawalls at Minehead and Blue Anchor** to allow ease of identification during future walkover inspections of the area.

In order to improve understanding of sediment movements along the BMP frontage (refer to **Section 1.4.4**), **it is recommended that the Environment Agency and West Somerset Council work with PCO to make the following changes to the current survey regime, to either be part of the SWRCMP or in addition to:**

**(a) As a minimum, to help better understand changes along the backshore, the profiles surveyed bi-annually by PCO should extend further inland to cover the back of the dune/shingle/gravel barrier around The Warren and at Dunster Beach.**

**(b) A greater number of profiles should ideally be surveyed on a regular (bi-annual) basis (i.e. additional profiles to be surveyed should be drawn from those only surveyed every few years as part of baseline surveys by the SWRCMP).**

**(c) To improve data density and so volume change analysis, consideration should be given to using a grid-base GPS survey or terrestrial laser scan approach for each survey.**

Table 4-1

**PCO beach profile survey locations within the BMP area between Minehead and Blue Anchor that are surveyed at least twice-per year (NB: those highlighted in yellow have previously been/are currently surveyed as post-storm profiles – refer also to Section 2.5.3).**

| Profile ID | Origin Easting | Origin Northing | Date of first survey | Date of most recent survey |
|---|---|---|---|---|
| 7d01304 | 296499 | 147500 | 28/10/2011 | 30/09/2016 |
| 7d01308 | 296639 | 147396 | 28/10/2011 | 30/09/2016 |
| 7d01312 | 296738 | 147290 | 28/10/2011 | 30/09/2016 |
| 7d01316 | 296860 | 147133 | 28/10/2011 | 30/09/2016 |
| 7d01319A | 297116 | 147140 | 28/10/2011 | 30/09/2016 |
| 7d01323 | 297092 | 146988 | 01/08/1999 | 30/09/2016 |
| 7d01325 | 297139 | 146934 | 01/08/1999 | 30/09/2016 |
| 7d01328 | 297154 | 146792 | 01/08/1999 | 30/09/2016 |
| 7d01331 | 297184 | 146666 | 01/08/1999 | 30/09/2016 |
| 7d01335 | 297287 | 146471 | 01/08/1999 | 30/09/2016 |
| 7d01340 | 297463 | 146388 | 01/08/1999 | 30/09/2016 |
| 7d01343 | 297629 | 146336 | 01/08/1999 | 30/09/2016 |
| 7d01346 | 297756 | 146325 | 01/08/1999 | 30/09/2016 |
| 7d01350 | 297930 | 146330 | 01/08/1999 | 30/09/2016 |
| 7d01354 | 298131 | 146388 | 01/08/1999 | 30/09/2016 |
| 7d01357 | 298274 | 146436 | 01/08/1999 | 30/09/2016 |
| 7d01361 | 298409 | 146472 | 01/08/1999 | 30/09/2016 |
| 7d01366 | 298523 | 146382 | 03/06/2007 | 01/10/2016 |
| 7d01372 | 298806 | 146317 | 02/06/2007 | 01/10/2016 |
| 7d01376 | 298982 | 146294 | 02/06/2007 | 01/10/2016 |
| 7d01381 | 299163 | 146221 | 01/06/2007 | 01/10/2016 |
| 7d01386 | 299309 | 146079 | 31/05/2007 | 01/10/2016 |
| 7d01387 | 299315 | 146062 | 31/05/2007 | 02/10/2012 |
| 7d01392 | 299448 | 145818 | 30/05/2007 | 01/10/2016 |
| 7d01396 | 299532 | 145665 | 30/05/2007 | 01/10/2016 |
| 7d01400 | 299571 | 145491 | 29/05/2007 | 01/10/2016 |
| 7d01403 | 299616 | 145293 | 22/05/2007 | 01/10/2016 |
| 7d01407 | 299760 | 145142 | 22/05/2007 | 01/10/2016 |
| 7d01411 | 299844 | 144953 | 22/05/2007 | 01/10/2016 |
| 7d01415 | 299966 | 144780 | 22/05/2007 | 01/10/2016 |
| 7d01419 | 300130 | 144656 | 22/05/2007 | 01/10/2016 |
| 7d01423 | 300279 | 144520 | 22/05/2007 | 01/10/2016 |
| 7d01427 | 300415 | 144383 | 22/05/2007 | 01/10/2016 |
| 7d01428 | 300454 | 144344 | 17/05/2007 | 02/10/2016 |
| 7d01431 | 300582 | 144251 | 17/05/2007 | 02/10/2016 |
| 7d01435 | 300754 | 144134 | 17/05/2007 | 02/10/2016 |
| 7d01439 | 300869 | 144068 | 17/05/2007 | 02/10/2016 |

| Profile ID | Origin Easting | Origin Northing | Date of first survey | Date of most recent survey |
|---|---|---|---|---|
| 7d01443 | 300977 | 143916 | 17/05/2007 | 02/10/2016 |
| 7d01447 | 301108 | 143754 | 17/05/2007 | 02/10/2016 |
| 7d01451 | 301289 | 143654 | 15/05/2007 | 02/10/2016 |
| 7d01455 | 301483 | 143599 | 15/05/2007 | 02/10/2016 |
| 7d01459 | 301680 | 143549 | 15/05/2007 | 02/10/2016 |
| 7d01463 | 301876 | 143502 | 15/05/2007 | 02/10/2016 |
| 7d01467 | 302072 | 143467 | 15/05/2007 | 02/10/2016 |
| 7d01471 | 302274 | 143488 | 13/05/2007 | 02/10/2016 |
| 7d01475 | 302475 | 143491 | 13/05/2007 | 02/10/2016 |
| 7d01479 | 302665 | 143501 | 13/05/2007 | 02/10/2016 |
| 7d01483 | 302864 | 143507 | 13/05/2007 | 02/10/2016 |
| 7d01487 | 303064 | 143521 | 13/05/2007 | 02/10/2016 |
| 7d01491 | 303263 | 143546 | 13/05/2007 | 02/10/2016 |
| 7d01492 | 303327 | 143492 | 13/05/2007 | 02/10/2016 |
| 7d01493 | 303372 | 143501 | 13/05/2007 | 02/10/2016 |

### 4.1.2 Post-storm beach profile survey

In addition to undertaking routine beach profile surveys, PCO also undertake post-storm surveys although not always along the same profiles each time. To date, very few post-storm surveys have been carried out (refer to **Section 2.5.3** and/or **Appendix E**).

In order to capture post-storm surveys in the future, **a number of Environment Agency or local authority staff who are regularly on-site should be encouraged to report to a key contact in the Environment Agency as to when a storm event has occurred and resulted in notable change in the beach levels** (refer also to **Section 3.3**). The key contact in the Environment Agency can then call-out post-storm surveys via PCO. **To support this, some basic training should be provided to the staff who are regularly on-site so they know what to look for**. This could be based upon the Environment Agency's *Condition Assessment Manual* (Environment Agency, 2012a) or key beach crest levels marked upon the seawalls at Minehead (refer also to **Section 4.1.8**). **The arrangements for this, once confirmed, should be captured in a formal communication document so that the role can be communicated to others in the future**.

Once a greater amount of post-storm survey data is gathered, it will be possible to review data and determine if the post-storm profiles surveyed by PCO are the correct ones to be surveying in these circumstances (i.e. are the post-storm profiles representative of storm driven changes in the beaches?). In addition, a greater amount of post-storm survey data may enable **pre-storm profiles to occur if (a) sufficient understanding of the conditions of most concern can be developed through continued capture and review of post-storm surveys in the coming years (refer also to Section 4.4.2), and (b) opportunity arises and/or funding is available.** This is not a key requirement of the monitoring regime but would provide useful additional understanding of the beach behaviour in storm events to inform future management decisions.

### 4.1.3 Master profile survey

There is uncertainty about the precise volume of sediment along the beaches of the BMP frontage. This uncertainty is a result of a lack of understanding of where the sub-strata on which the beach sits, is located beneath the beach.

To address this uncertainty **a survey of underlying bed level could be undertaken if the opportunity arises and/or funding is available**. This data, in turn, will provide a definitive 'Master Profile' for use in beach profile analysis and will allow more accurate estimates of beach volumes to be made. Definition of the definitive master profile is not essential at this time for assessing trends in beach volume change as changes are referenced to a defined assumed master profile. Therefore this task could be the subject for more academic research in the coming years but not form a requirement of the monitoring programme in the next 5 years.

### 4.1.4 Beach recycling logs

Whenever beach recycling works occur in the future, then **beach recycling logs are to be maintained** by those undertaking the works, with the records then being passed to the Environment Agency and PCO. This information will allow future analysis of beach volume changes to more accurately account for the effects of beach recycling work and will enable the underlying natural beach movements to be identified.

To support this, a template beach recycling log to be used is provided in **Appendix H**. It is to be completed in a simple manner, by tallying the number of truck or dumper loads (of known capacity) transported along the beach during a recycling event. **This could be supported by completing a pre- and post-beach recycling survey for the first one or two beach recycling campaigns to provide actual data against which the recycling logs can be validated.**

### 4.1.5 Bathymetric survey

Bathymetric surveys are to continue as part of the SWRCMP, in line with the schedule determined by PCO. The next bathymetric survey for the Minehead to Blue Anchor area is not currently programmed.

### 4.1.6 Sediment sampling

No sediment sampling is proposed to occur over the next five years.

### 4.1.7 Current monitoring

No current monitoring is proposed to occur over the next five years.

### 4.1.8 Walkover survey

**Visual walkover inspections should be undertaken by the relevant asset operators along the BMP frontage to monitor beach crest level against the defences.**

One walkover survey should be undertaken every month during the winter (October to March) and one survey every two months during the summer (April to September). Throughout the year, additional walkover surveys will need to be carried out prior to and immediately after storm events, as required. Visual inspection of the beach level against the seawall and groynes is required to allow use of the trigger levels identified in **Section 3.3**. **To aid the visual inspection, markers defining the beach level in relation to the beach crest level trigger levels could be marked on the seawalls at Minehead and Blue Anchor.**

**Along the seawall West of Minehead Harbour, these visual walkover inspections should also measure 'dip levels' along the frontage (i.e. distance drop from the seaward edge of the seawall to the beach)** to capture useful information about the variation in beach level against the seawall in the periods between regular beach profile surveys (refer also to **Section 4.2.1**). These dip levels will also provide for assessment against trigger levels defined in **Section 3.3**.

### 4.1.9 Aerial photography and LiDAR

Aerial photography and LiDAR surveys are to continue to be flown every one to three years as part of the SWRCMP. This data is available through the PCO website (www.coastalmonitoring.org). With regards to the aerial photography, **it is recommended that these continue to be delivered as high quality aerial photo surveys – similar to those collected in recent years – and that when undertaken, the survey**

**specification should state the need to achieve a RMSE of better than +/-10cm. These should be undertaken every two years as a minimum, but ideally annually.**

Continuation of the SWRCMP aerial photography and LiDAR surveys, combined with the regular monitoring of beach profiles (refer to **Section 4.1.1**), will inform future derivation of long-term trends of beach volume changes and beach and cliff recession rates.

## 4.2 Structure monitoring

### 4.2.1 Visual inspection

There are a number of defence assets located along the BMP frontage under the responsibility of different operators, including the Environment Agency, West Somerset Council, Somerset County Council (Highways) and private landowners. **Section 1.3.4** and **Appendix D** notes the condition of most of the defence elements along the BMP frontage are in a "Fair" or better condition with a typical residual life (with ongoing maintenance) of at least 20 years or more. The main areas of more immediate concern are:

- The toe of the seawall to west of Minehead Harbour is regularly exposed by fluctuating beach levels and shows evidence of previous wash-out. If left unaddressed, further deterioration could lead to slumping of the crest or failure of the roadway behind, increasing the risk of flooding and coastal erosion to properties.
- The shoreline around The Warren is eroding in places and could be breached by storm events, leading to wide-spread flooding.
- Sections of seawall defence at Blue Anchor, which are assessed as being in a poor condition with a residual life of 0-15 years at best.

Section 5.1.4 contains actions to address these immediate areas of concern.

**In order to ensure all assets along the BMP frontage remain in good to fair condition, ongoing maintenance is required and this will be informed by regular re-inspection of the defences in a similar way to that reported in Appendix D at least once every two years, although annually would be preferable if budgets allow**. These inspections should occur during the spring of each year to allow identification of any issues so that subsequent completion of any maintenance works required can be completed prior to the busy summer period, thus avoiding impacting on the amenity use of the beach.

Visual inspections to monitor structures after storms should also occur, since damage to the structures is most likely to occur during storms.

Monitoring of the various structures should be, where possible, undertaken in combination with the visual walkover inspection of the beach as described in **Section 4.1.8**, particularly following storm events. Each visual inspection should be recorded in a consistent way. To aid this, a template is provided in **Appendix I**.

The following items should be checked as part of these inspections:

- Visual checking of the beach level in front of the seawalls at Minehead and Blue Anchor to ensure that the trigger levels defined in **Section 3.3** are not reached (refer also to **Section 4.1.8**).
- Visual checking of access ramps, steps, hand rails, etc. to ensure that these are in a safe condition of public use. This should be carried out in accordance with the Environment Agency's public safety risk assessment operational instruction. Refer also to **Section 1.4.3** and **Section 5.1.1.**
- Visual identification and checking of any defects (e.g. cracks in the seawall; rock groyne voids, etc.) and overall defence condition in accordance with the *Condition Assessment Manual* (Environment Agency, 2012a). Refer also to Section 3 of **Appendix I** as a baseline.

### 4.2.2 Detailed inspection

In addition to the annual and post-storm visual inspections described in **Section 4.2.1**, **full structural inspections of the coastal defences at Minehead and Blue Anchor should be carried out every five years.**

As with the visual inspections, in order to ensure a complete and consistent set of data is recorded as part of these detailed inspections, the template provided in **Appendix I** should be used.

These inspections should also include a photographic record of the structures at the time of the inspection and these should be kept with the inspection records for future reference.

## 4.3 Environmental monitoring

The area covered by this BMP is within the vicinity of a number of environmental designations, including international and European nature conservation features, designated bathing waters, and local landscape designations (refer to **Section 2.7**). Future beach recycling, beach recharge and/or construction (or modification) of coastal defence structures along the BMP frontage (refer to **Sections 5.1.2 to 5.1.4**) has the potential to impact upon the some of these designations and so detailed investigation of the physical and chemical characteristics of the any proposed beach recharge source and/or new coastal defence scheme will be needed before any sediment is placed (most likely at Minehead), or any construction occurs.

**When / if beach recycling or beach recharge occurs in the future, or if new coastal defence structures are constructed (or existing ones modified), there will be a need to undertake regular water quality monitoring to assess the impacts (if any) of moving/placing material along the shoreline and/or altering the coastal defence arrangement.** Bathing water quality monitoring is undertaken by the Environment Agency at several locations along the BMP area (refer to **Section 2.7.8**). This data is considered sufficient to provide a robust baseline for future Water Framework Directive (WFD) assessment that would be needed as part of any potential future beach recycling or beach recharge that may occur. Post-implementation monitoring could be delivered to ensure the WFD objectives are not compromised by any future works along the frontage.

There are many historic environment features in the area around BMP area (see **Section 2.7.6**) and **visual inspections should seek to identify any impacts on these features as a result of beach works (or indeed if 'new' features are uncovered by storm events)**. In the event of impacts or new features being identified, then the Somerset Historic Environment Service should be contacted.

## 4.4 Physical conditions

### 4.4.1 Sea conditions

Wave climate is monitored by a wave buoy located approximately at the -10mCD contour offshore of Minehead (refer to **Section 2.1.1**). This wave buoy is maintained by PCO as part of the SWRCMP and recorded data is available through the PCO website (www.coastalmonitoring.org).

Tide level data is recorded at Minehead and Watchet (refer to **Section 2.2.2**).

The continuation of data capture by the wave buoy and tide gauges is vital to improving the amount of information available for future assessment of typical and extreme wave and water level climate in the area, and validating numerical models.

### 4.4.2 Storm events

The movement of material along the BMP frontage, and the risk of beach lowering leading to increased wave overtopping, undermining and/or breaching of parts of the defence line, is significantly increased during storms as a result of increased wave action, particularly when storms waves combine with high tide levels. In order to understand the effect of storm events upon the beach response, **details of the**

**storm conditions (waves, winds and water levels) will need to be recorded** in support of the post-storm profile surveys (refer to **Section 4.1.2**).

Data from the wave buoy at Minehead and the tide gauges at Minehead and Watchet (refer to **Section 4.4.1**) should be used for obtaining details of the wave and water level conditions at the time of the storm event.

Additional information on the offshore wave climate should also be recorded from other data sources such as near real time data from the National Data Buoy Centre (www.ndbc.noaa.gov/) and the CEFAS Wavenet (www.cefas.co.uk/cefas-data-hub/wavenet/) websites. These websites provide data for a number of locations between the Atlantic and the Bristol Channel that are relevant to the BMP frontage, and recording of this information will allow assessment of any linkages between offshore and nearshore wave climate to be made once a sufficient data set is collected.

**To aid future understanding, a local wind gauge located along the promenade at Minehead should also be installed to record wind speed and direction as both can have a significant impact on the effect of storm events on the beach response.**

This wind, wave and tide data should be recorded as part of the storm event record. This storm record should contain details of all storm events including the prevailing conditions (as discussed in this section), any pre/post-storm surveys, and effects/impacts of the event.

# 4.5 Warning and emergency procedures

## 4.5.1 Flood warning and response procedures

Flood warnings and responses are coordinated by the Environment Agency's Flood Incident Management Duty Officer based in Exeter. The Duty Officer procedures are available through the Environment Agency's South West Incident Management (SWIM) website (www.imflooding.co.uk) – note this is a secure site for approved Environment Agency users only and all duty officers have access to the SWIM website. Up-to-date hard copies of the procedures are held in the Environment Agency Area Incident Room in Exeter.

## 4.5.2 Pollution incidents

Pollution incidents can occur at varying scales. Minor pollution such as litter and small debris are typically dealt with by West Somerset Council.

Larger pollution incidents are dealt with by a range of organisations including West Somerset Council, Somerset County Council and the Environment Agency.

# 4.6 Data

Having collected the beach monitoring data, it is important that all of the information is stored and analysed to allow decisions to be made with respect to ongoing maintenance and future management of the beaches and coastal defence assets along the BMP frontage for coastal flood and erosion risk management purposes.

Following each scheduled twice-yearly beach profile survey, the information collected is uploaded for storage and analysis to a database system that operated by the South West Regional Coastal Monitoring Programme at PCO. Additional survey data that is to be collected as per the requirements set out in this BMP, should be collected, stored and analysed in accordance with PCO quality standards and be compatible with PCO's database system (if PCO are not used to undertake the additional survey work).

Additional monitoring data, obtained from sources such as the post-storm visual walkover inspections (with associated storm event data – see **Section 4.4.2**), beach recycling logs (see **Section 4.1.4**), or defence inspection reports (see **Section 4.2**) should also be stored in the same database. The database should include any photographs taken during each survey.

This information should be used in assessing the need/potential for future beach recycling/recharge, as well as compiling future annual beach monitoring reports produced by PCO and for use in future studies along the BMP frontage.

In addition, **each year a review of all survey data should be carried out with particular focus on trigger levels defined in Section 3.3 and associated coastal flood and erosion risks**.

# Maintenance Regime

The following describes the maintenance regime that is necessary to ensure that the beach and defences along the Minehead to Blue Anchor BMP frontage continue to provide adequate coastal flood and erosion risk management of the area in the immediate future.

## 5.1 Ongoing works

### 5.1.1 Structure maintenance

Routine maintenance works to the various coastal defence structures along the BMP frontage will be guided by ongoing inspection by the relevant asset owner/operator (refer to **Section 4.2**). **When either routine inspection or rapid assessment following a storm event identifies a defect in the defence, be it a crack in the defence or damage to public safety aspects of the defence (e.g. buckled hand railings or trip hazards, etc.) then the following steps are to be followed**:

1. **Increased defect monitoring** – should any defects be identified then it may be appropriate to implement an increased level monitoring rather than immediately undertaking remedial works. This could also involve the use of additional monitoring devices such as crack gauges. This step would only occur if the identified defect is not considered an immediate safety risk (i.e. this step is optional and may or may not occur prior to Step 2).
2. **Remedial works** – once an identified defect is considered to be in need of remedial work, then the design of remedial works should be undertaken and an appropriate repair specification generated. To ensure consistent information on repairs undertaken is recorded, a defence repair record template is provided in **Appendix J**.

In respect of public safety issues along the BMP frontage, visual checking of access ramps, steps, hand rails, etc. to ensure that these are in a safe condition of public use should be carried out in accordance with the Environment Agency's public safety risk assessment operational instruction by all asset operators for consistency of approach across the frontage. Refer also to **Section 1.4.3** and **Section 4.2.1**.

### 5.1.2 Beach recycling

Beach recycling is to primarily occur periodically along the West of Minehead Harbour and Minehead Town sections of the BMP frontage, guided by ongoing monitoring and with regards to trigger levels defined in **Section 3.3.** Beach recycling operations will move sediment along the frontage from areas of accretion to areas of erosion as illustrated in Figure 5-1. This will continue to be the case after implementation of the scheme to deliver the preferred option described in **Section 1.1.1**.

Note, when undertaking beach recycling West of Minehead Harbour, engagement is required to take place with the RNLI to manage implications for lifeboat access over the beach (refer also to **Section 1.1.1**).

Periodic beach recycling will also continue, as required, along the Dunster Beach section of the BMP frontage. This will be undertaken by Dunster Beach Chalets Ltd.


FIGURE 5-1
**Map showing areas of accretion (source areas) and deposition areas for beach recycling operations along the West of Minehead Harbour and Minehead Town sections of the BMP frontage.**

### 5.1.3 Beach recharge

In order to ensure there is sufficient volume of sediment in the system and along the shoreline to provide the required beach levels, beach recharge is expected to be required at some point in the future along the Minehead Town part of the BMP frontage, though not within the next five years. The timing of when beach recharge is likely to be required should be reviewed regularly using new information derived from ongoing monitoring. Beach recharge will be triggered when monitoring shows beach sediment volumes to be insufficient to achieve the minimum design level in order for the beach to fulfil its role as part of the overall defence system (refer to **Section 3.3**).

**In order to be in a position to readily implement beach recharge when it becomes required in the future, it is recommended that a study be undertaken in the near future to assess potential sources of recharge sediment.**

### 5.1.4 Modifications to existing defences

As noted in **Section 4.2.1**, there are three main areas of more immediate concern in terms of existing defences along the BMP frontage. Actions to address these concerns in the next five years is to be as follows:

- **New toe protection is to be constructed along the base of the seawall to the West of Minehead Harbour in order to reduce the risk of the seawall being undermined** which would lead to slumping of the crest or failure of the roadway behind, increasing the risk of flooding and coastal erosion to properties. As set out in **Section 1.1.1**, work to progress these works is to occur in the next 0-2 years.
- The shoreline around The Warren is eroding in places and could be breached by storm events, leading to wide-spread flooding. **To manage the risk, erosion hot-spots (refer to trigger levels**

**defined in Section 3.3) are to be filled with 3-6 tonne rock placed within the eroded area with crest height limited to the height of the current land level**.

- Sections of seawall defence at Blue Anchor, which are assessed as being in a poor condition with a residual life of 0-15 years at best. The landowner is currently progressing a scheme to improve the seawall in this area; as such no other immediate action at Blue Anchor is defined in this BMP.

## 5.2 Alarm trigger level works

If Alarm Levels defined in **Section 3.3** for different parts of the BMP frontage are reached, then this will trigger alarm level works as follows:

- **West of Minehead Harbour:**
  - **Trigger Level A:** Alarm level response is increased monitoring (refer to **Section 3.3**). No works are triggered.
  - **Trigger Level B:** Undertake beach recycling to move sediment back westwards from where it has built up against the harbour arm (refer to **Section 5.1.2**).
- **Minehead Town:**
  - **Trigger Level A:** Undertake beach recycling to move sediment away from the top of the beach (refer to **Section 5.1.2**).
  - **Trigger Level B:** Alarm level response is increased monitoring (refer to **Section 3.3**). No works are triggered.
- **The Warren:**
  - Place 3-6 tonne rocks in the area of erosion in order to protect against the risk of breaching during storm events (refer to **Section 5.1.4**).

## 5.3 Crisis trigger level works

If Crisis Levels defined in **Section 3.3** for different parts of the BMP frontage are reached, then this will trigger crisis level works as follows:

- **West of Minehead Harbour:**
  - **Trigger Level A:** Undertake beach recycling to build-up beach levels against the seawall, likely moving sediment from against the harbour arm (refer to **Section 5.1.2**).
  - **Trigger Level B:** Undertake beach recycling to move sediment back westwards from where it has built up against the harbour arm (refer to **Section 5.1.2**).
- **Minehead Town:**
  - **Trigger Level A:** Undertake beach recycling to move sediment away from the top of the beach (refer to **Section 5.1.2**).
  - **Trigger Level B:** Undertake beach recycling (refer to **Section 5.1.2**) to move sediment from areas of accretion to cover the lower part of the seawall to at least step 6 (refer to **Figure 3-16**).
  - If beach recharge trigger levels are reached, implement beach recharge.
- **The Warren:**
  - Place 3-6 tonne rocks in the area of erosion in order to protect against the risk of breaching during storm events (refer to **Section 5.1.4**).

# 5.4 Implementation of works

Should any works described in **Sections 5.1 to 5.3** be required along any part of the BMP frontage, which will be guided by ongoing monitoring (refer to **Section 4**), then it is important to **ensure that maintenance works utilise appropriate methods and materials in order to maximise effectiveness and extend structure life as long as possible into the future**.

In addition, when works are undertaken then the items detailed below will also form important considerations for actual implementation of any works.

## 5.4.1 Plant requirements

No specific plant requirements are defined in this BMP.

The plant required to undertake capital works will depend upon the nature of the works and should be considered by the designer and contractor at the time any such works are to occur along the frontage covered by this BMP. A key factor in this regards will be the capacity of the access points (refer to **Section 5.4.2**).

## 5.4.2 Access

When any works are to be carried out along the BMP frontage, consideration will need to be given as to the access requirements given the size of any plant being considered, and with regards to the limited tidal window for working along the respective part of the BMP frontage. However, Table 5-1 identifies the locations along the BMP frontage that are likely to be suitable for plant access to the beach.

TABLE 5-1
**Locations of suitable access points for plant to access the beach along the BMP frontage.**

| Location | OS Coordinates |
|---|---|
| Access to the beach west of Minehead Harbour via the lifeboat beach ramp. | 297068.567, 147149.920 |
| Access to Minehead Harbour via the Minehead Harbour Slipway. | 297091.388, 147055.001 |
| Access to Minehead beach via the slipway with flood gate opposite 'The Quay Inn' (Quay Street). | 297184.654, 146721.294 |
| Access to Minehead Beach/The Warren via the slipway to the east of Warren Road Carpark. | 298401.078, 146473.578 |
| Access to the Old Avill outfall and beach through Dunster Beach Chalets. | 299717.052, 145441.700 |
| Access to the Avill Flood Relief Channel and beach from Dunster Beach parking area. | 300451.272, 144566.589 |
| Access to Blue Anchor Beach near Blue Anchor Chalets. | 302092.684, 143471.212 |
| Access to East Blue Anchor Beach via the slipway near The Blue Anchor Hotel. | 303289.595, 143561.832 |

## 5.4.3 Public access, amenity and safety

**Beach and coastal defence works, when they are required, should avoid the peak holiday season, weekends and public holidays where possible.** This will minimise the impact of works on beach users and will reduce the minor risk to public safety that such work would pose. In order to ensure the safety of the public whilst works are being carried out, **restrictions on public access to the areas of the beach being worked on should be implemented, with alternative routes provided if possible.**

Experience elsewhere has shown that closing the beach entirely is likely to be impractical, **and it is suggested that a banks-man is present with each machine, and that spare personnel along with signage are employed to direct public access to safe sections of the shoreline during works.**

**Information boards should be displayed whilst the works are being carried out to explain what is being done and why.** This will also serve to improve public education. **Appendix K** contains a best practice guide on how to communicate with the public and local businesses when undertaking beach maintenance works.

### 5.4.4 Notifying others

In addition to communicating effectively with the public (refer to **Section 5.4.3**), **it is recommended that explicit notification of any works, and contact details should there be any queries, be provided to the following organisations/groups as appropriate depending upon the location where works are occurring and who is undertaking the works:**

- Environment Agency;
- West Somerset Council;
- Somerset County Council (Highways);
- The local Town and Parish Councils;
- Minehead Coastal Community Team;
- Minehead Harbour Master;
- RNLI Lifeboat Station;
- Rights of Way Office at Somerset County Council;
- Private landowners;
- Minehead Golf Club;
- Dunster Beach Chalets Ltd;
- West Somerset Railway;
- The Crown Estate;
- The Marine Management Organisation;
- Exmoor National Park;
- Wessex Water;
- Somerset Drainage Boards Consortium;
- Devon & Severn IFCA and local fishermen;
- Those people who have a day to day interest in what is happening along the frontage where works are to occur, i.e. any businesses that may be affected;
- Local residents directly affected by any road or access closures along the frontage when works occur;
- Natural England (in relation to nature conservation and coastal access interests);
- Somerset Historic Environment Service and South West Heritage Trust (in relation to historic environment interests).

# Action Plan

## 6.1 Overview

This section provides a summary of the recommendations made above in the form of an Action Plan (**Table 6-1**). The Action Plan is presented below and identifies actions grouped by type as being either for 'Management', 'Monitoring', 'Maintenance' or 'For Future Studies', although there is some inter-relationship between these broad action types.

It is intended that this Action Plan be used to guide future management of this area.

TABLE 6-1
**Minehead BMP Action Plan**

| Action No. | Action Description | Who by? | Date action First Defined? | When by? | Related BMP Section | Current Status |
|---|---|---|---|---|---|---|
| **MANAGEMENT ACTIONS** | | | | | | |
| **MAN_001** | The BMP should be reviewed every 10 years or as and when future significant changes occur to the coastal flood and erosion risk management approach along the frontage. | Environment Agency and partner organisations | May 2018 | May 2028 | 1.2 | Not started |
| **MAN_002** | It is strongly recommended that a Scoping Opinion be sought from the MMO in the immediate future to clarify this and determine whether or not a Marine Licence is required for ongoing beach recycling covering a period of 10-20 years (in advance of any new scheme being implemented) and, if needed and given the time-scale involved in obtaining a Marine Licence (typically 14 weeks), obtain a Marine Licence from the MMO in good time to enable beach management works to be implemented when it becomes required | Environment Agency and partner organisations | May 2018 | May 2019 | 1.6.1 | Not started |
| **MAN_003** | Review trigger levels West of Minehead Harbour once new toe protection is implemented refer also to Action No. FUT_001 and FUT_002). | West Somerset Council | May 2018 | May 2020 | 3.3.1 | Not started |
| **MAN_004** | Each year a review of all survey data should be carried out with particular focus on trigger levels defined in Section 3.3 and associated coastal flood and erosion risks. | Environment Agency and partner organisations | May 2018 | Annually, ongoing | 4.6 | Not started |
| **MONITORING ACTIONS** | | | | | | |
| **MON_001** | Public safety issues such as condition of handrails and paving along promenades, and obstructions along the beaches etc. should be considered as part of future regular visual inspections of the area, in accordance with the Environment Agency's Public Safety Risk Assessment procedures for consistency of approach along the BMP frontage | All Asset Operators | May 2018 | Ongoing | 1.4.3 + 4.2.1 | Not started |
| **MON_002** | Monitoring of beach profiles every spring and autumn by PCO is to continue as part of the SWRCMP. | PCO / SWRCMP | May 2018 | Ongoing | 4.1.1 | Ongoing (currently funded to 2021) |
| **MON_003** | It is recommended that the last 3 digits of at least some, if not all, of the Profile IDs listed in Table 4-1 be marked upon the seawalls at Minehead and Blue Anchor to allow ease of identification during future walkover inspections of the area. | Environment Agency / West Somerset Council / Somerset County Council | May 2018 | May 2019 | 4.1.1 + 4.1.8 + 4.2.1 | Not started |
| **MON_004** | In order to improve understanding of sediment movements along the BMP frontage, it is recommended that the Environment Agency and West Somerset Council work with PCO to make the following changes to the current survey regime, to either be part of the SWRCMP or in addition to:<br>(d) As a minimum, to help better understand changes along the backshore, the profiles surveyed bi-annually by PCO should extend further inland to cover the back of the dune/shingle/gravel barrier around The Warren and at Dunster Beach.<br>(e) A greater number of profiles should ideally be surveyed on a regular (bi-annual) basis (i.e. additional profiles to be surveyed should be drawn from those only surveyed every few years as part of baseline surveys by the SWRCMP).<br>(f) To improve data density and so volume change analysis, consideration should be given to using a grid-base GPS survey or terrestrial laser scan approach for each survey. | Environment Agency / West Somerset Council / Somerset County Council | May 2018 | 2021/22 (as part of planning for next phase of the SWRCMP) | 4.1.1 | Not started |
| **MON_005** | In order to capture post-storm surveys in the future, a number of Environment Agency or local authority staff who are regularly on-site should be encouraged to report to a key contact in the Environment Agency as to when a storm event has occurred and resulted in notable change in the beach levels (refer to trigger levels defined in Section 3.3). The key contact in the Environment Agency can then call-out post-storm surveys via PCO. To support this, some basic training should be provided to the staff who are regularly on-site so they know what to look for. This could be based upon the Environment Agency's *Condition Assessment Manual* (Environment Agency, 2012a) or key beach crest levels marked upon the seawalls at Minehead (refer to Action No. MON_003). The arrangements for this, once confirmed, should be captured in a formal communication document so that the role can be communicated to others in the future. | Environment Agency / West Somerset Council | May 2018 | May 2019 | 4.1.2 | Not started |

| Action No. | Action Description | Who by? | Date action First Defined? | When by? | Related BMP Section | Current Status |
|---|---|---|---|---|---|---|
| **MON_006** | Whenever beach recycling works occur in the future, then beach recycling logs are to be maintained by those undertaking the works, with the records then being passed to the Environment Agency and PCO. | Environment Agency / West Somerset Council | May 2018 | Ongoing | 4.1.3 + Appendix H | Not started |
| **MON_007** | In order to verify beach recycling logs (see Action No. MON_006), undertake a pre- and post-beach recycling survey for the first one or two beach recycling campaigns to provide actual data against which the recycling logs can be validated. Data to be passed tp the Environment Agency and PCO. | Environment Agency / West Somerset Council | May 2018 | May 2020 | 4.1.4 | Not started |
| **MON_008** | Visual walkover inspections should be undertaken by the relevant asset operators along the BMP frontage to monitor beach crest level against the defences. | All Asset Operators | May 2018 | Ongoing | 4.1.8 | Not started |
| **MON_009** | Along the seawall West of Minehead Harbour, visual walkover inspections (see Action No. MON_008) should also measure 'dip levels' along the frontage (i.e. distance drop from the seaward edge of the seawall to the beach) to capture useful information about the variation in beach level against the seawall in the periods between regular beach profile surveys | West Somerset Council | May 2018 | Ongoing | 4.1.8 | Not started |
| **MON_010** | For future aerial photography campaigns, it is recommended that these continue to be delivered as high quality aerial photo surveys – similar to those collected in recent years – and that when undertaken, the survey specification should state the need to achieve a RMSE of better than +/-10cm. These should be undertaken every two years as a minimum, but ideally annually. | Environment Agency / SWRCMP | May 2018 | Ongoing | 4.1.9 | Not started |
| **MON_011** | In order to ensure all assets along the BMP frontage remain in good to fair condition, ongoing maintenance is required and this will be informed by regular re-inspection of the defences in a similar way to that reported in Appendix D at least once every two years, although annually would be preferable if budgets allow. | All Asset Operators | May 2018 | Ongoing | 4.2.1 | Not started |
| **MON_012** | Full structural inspections of the coastal defences at Minehead and Blue Anchor should be carried out every five years. See also Action No. MON_008 and MON_011. | All Asset Operators | May 2018 | Ongoing | 4.2.2 | Not started |
| **MON_013** | When / if beach recycling or beach recharge occurs in the future, or if new coastal defence structures are constructed (or existing ones modified), undertake regular water quality monitoring to assess the impacts (if any) of moving/placing material along the shoreline and/or altering the coastal defence arrangement. | All Asset Operators | May 2018 | As required | 4.3 | Not started |
| **MON_014** | There are many historic environment features in the area around BMP area (see Section 2.7.6) and visual inspections should seek to identify any impacts on these features as a result of beach works (or indeed if 'new' features are uncovered by storm events). In the event of impacts or new features being identified, then the Somerset Historic Environment Service should be contacted. See also Action No. MON_008. | All Asset Operators | May 2018 | Ongoing | 4.3 | Not started |
| **MON_015** | In order to understand the effect of storm events upon the beach response, details of the storm conditions (waves, winds and water levels) need to be recorded in support of the post-storm profile surveys. | Environment Agency / SWRCMP | May 2018 | Ongoing | 4.4.2 | Not started |
| **MON_016** | To aid future understanding, a local wind gauge located along the promenade at Minehead should also be installed to record wind speed and direction as both can have a significant impact on the effect of storm events on the beach response. | Environment Agency / SWRCMP | May 2018 | Ongoing | 4.4.2 | Not started |
| **MAINTENANCE ACTIONS** | | | | | | |
| **MAI_001** | For works at Blue Anchor, particularly the eastern end of the seawall adjacent the Blue Anchor to Lilstock SSSI, consent will be needed from Natural England each time works are carried out in the SSSI area. | Somerset County Council (Highways) / Private Landowner | May 2018 | As required, subject to funding and consents | 1.6.1 | Not started |
| **MAI_002** | Implement Alarm or Trigger Level actions set out in Sections 5.2 and 5.3 when Trigger Levels defined in Section 3.3. are reached. | All Asset Operators | May 2018 | As required, subject to funding and consents | 3.3 (and 5.2 and 5.3) | Not started |
| **MAI_003** | When either routine inspection or rapid assessment (see Action No. MON_008) following a storm event identifies a defect in the defence, be it a crack in the defence or damage to public safety aspects of the defence (e.g. buckled hand railings or trip hazards, etc.) then the following steps are to be followed:<br>1. Increased defect monitoring – should any defects be identified then it may be appropriate to implement an increased level monitoring rather than immediately undertaking remedial works. This could also involve the use of additional monitoring devices such as crack gauges. This step would only occur if the identified defect | All Asset Operators | May 2018 | As required, subject to funding and consents | 5.1.1 + Appendix I + Appendix J | Not started |

| Action No. | Action Description | Who by? | Date action First Defined? | When by? | Related BMP Section | Current Status |
|---|---|---|---|---|---|---|
| | is not considered an immediate safety risk (i.e. this step is optional and may or may not occur prior to Step 2).<br>2. Remedial works – once an identified defect is considered to be in need of remedial work, then the design of remedial works should be undertaken and an appropriate repair specification generated. To ensure consistent information on repairs undertaken is recorded, a defence repair record template is provided in Appendix J. | | | | | |
| **MAI_004** | New toe protection is to be constructed along the base of the seawall to the West of Minehead Harbour in order to reduce the risk of the seawall being undermined which would lead to slumping of the crest or failure of the roadway behind, increasing the risk of flooding and coastal erosion to properties. See also Action No. FUT_001 and FUT_002. | West Somerset Council | May 2018 | May 2020, subject to funding and consents | 5.1.4 | Not started |
| **MAI_005** | To manage the risk posed by erosion along The Warren section of the BMP frontage, erosion hot-spots (refer to trigger levels defined in Section 3.3) are to be filled with 3-6 tonne rock placed within the eroded area with crest height limited to the height of the current land level, subject to funding being available and consents being granted. See also Action No. MAI_002. This will also need to be informed by further study in Action No. FUT_003. | Environment Agency / Minehead Golf Club | May 2018 | As required, subject to funding and consents | 5.1.4 | Not started |
| **MAI_006** | Should any works described in Sections 5.1 to 5.3 be required along any part of the BMP frontage, which will be guided by ongoing monitoring (refer to Section 4), then it is important to ensure that maintenance works utilise appropriate methods and materials in order to maximise effectiveness and extend structure life as long as possible into the future. | All Asset Operators | May 2018 | As required | 5.4 | Not started |
| **MAI_007** | Beach and coastal defence works, when they are required, should avoid the peak holiday season, weekends and public holidays where possible. | All Asset Operators | May 2018 | Ongoing | 5.4.3 | Not started |
| **MAI_008** | In order to ensure the safety of the public whilst works are being carried out, restrictions on public access to the areas of the beach being worked on should be implemented, with alternative routes provided if possible. Experience elsewhere has shown that closing the beach entirely is likely to be impractical, and it is suggested that a banks-man is present with each machine, and that spare personnel along with signage are employed to direct public access to safe sections of the shoreline during works. | All Asset Operators | May 2018 | Ongoing | 5.4.3 | Not started |
| **MAI_009** | Information boards should be displayed whilst the works are being carried out to explain what is being done and why. This will also serve to improve public education. | All Asset Operators | May 2018 | Ongoing | 5.4.3 + Appendix K | Not started |
| **MAI_010** | In addition to communicating effectively with the public (refer to Section 5.4.3), it is recommended that explicit notification of any works, and contact details should there be any queries, be provided to the following organisations/groups as appropriate depending upon the location where works are occurring and who is undertaking the works:<br>• Environment Agency;<br>• West Somerset Council;<br>• Somerset County Council (Highways);<br>• The local Town and Parish Councils;<br>• Minehead Coastal Community Team;<br>• Minehead Harbour Master;<br>• RNLI Lifeboat Station;<br>• Rights of Way Office at Somerset County Council;<br>• Private landowners;<br>• Minehead Golf Club;<br>• Dunster Beach Chalets Ltd;<br>• West Somerset Railway;<br>• The Crown Estate;<br>• The Marine Management Organisation;<br>• Exmoor National Park;<br>• Wessex Water; | All Asset Operators | May 2018 | Ongoing | 5.4.4 | Not started |

| Action No. | Action Description | Who by? | Date action First Defined? | When by? | Related BMP Section | Current Status |
|---|---|---|---|---|---|---|
| | • Somerset Drainage Boards Consortium;<br>• Devon & Severn IFCA and local fishermen;<br>• Those people who have a day to day interest in what is happening along the frontage where works are to occur, i.e. any businesses that may be affected;<br>• Local residents directly affected by any road or access closures along the frontage when works occur;<br>• Natural England (in relation to nature conservation and coastal access interests);<br>• Somerset Historic Environment Service and South West Heritage Trust (in relation to historic environment interests). | | | | | |
| **FOR FUTURE STUDIES/RESEARCH** | | | | | | |
| **FUT_001** | Within the next 0-1 years, develop the seawall toe-protection and demountable defences scheme for West of Minehead Harbour. This should include flood modelling to assess wave loading and overtopping to guide the design. This in turn will allow refinement of the economic assessment and could also usefully be used to assess potential future need for raising the wall level in this area. Development of the scheme at this time will also need to identify and secure partnership funding contributions, and produce a business case. | West Somerset Council / Environment Agency | May 2018 | May 2019, subject to funding | 1.1.1 | Not started |
| **FUT_002** | In years 1-2, subject to approval of a viable business case (see Action No. FUT_001), implement the seawall toe-protection and demountable defences scheme for West of Minehead Harbour. | West Somerset Council / Environment Agency | May 2018 | May 2020, subject to funding | 1.1.1 | Not started |
| **FUT_003** | Within the next 0-1 years, undertake a flood modelling study of the area from Minehead Harbour to the River Avill Flood Relief Channel to improve understanding of the present and future flood risks under different defined extreme return period events and allowing for climate change. NB: this flood modelling study could be combined for efficiency with modelling required for West of Minehead Harbour (see Action No. FUT_001).<br>As part of this flood modelling study, the following outputs should be derived:<br>a) Re-appraisal of the BMP assessment of the present and future standard of protection provided by existing defences against wave overtopping (refer also to Section 3.2 and/or Appendix D);<br>b) An updated assessment of potential economic damages as a result of coastal flooding, including from breach (refer also to Appendix A); and<br>c) An initial assessment of the feasibility of a set-back defence line along The Warren/Dunster Beach frontage, including technical, environmental and economic assessment (the economic case will use the results from (b) above, and should include: (i) an updated benefit:cost assessment that includes amenity and Gross-Value Added benefits; and (ii) an updated partnership funding contribution requirements assessment). | Environment Agency | May 2018 | May 2019, subject to funding | 1.1.1 | Not started |
| **FUT_004** | Subject to a favourable outcome from preceding studies (see Action No. FUT_003), in years 2-4, detailed investigation and design will be required to develop the set-back defence line scheme. This will include ground investigations, assessment of surface water implications, refinement of the economic case, identifying and securing partnership funding contributions, and production of a business case. | Environment Agency | May 2018 | May 2022, subject to funding | 1.1.1 | Not started |
| **FUT_005** | In years 5-6, subject to approval of a viable business case (see Action No. FUT_004), implement the set-back defence line scheme along The Warren and Dunster Beach section. | Environment Agency | May 2018 | May 2024, subject to funding and consents | 1.1.1 | Not started |
| **FUT_006** | To enable a more robust appraisal of overtopping risk to be completed, it is highly recommended that extreme wave and water level data is collected or derived for a range of joint probability return periods at nearshore locations. This could usefully be combined with studies proposed under Action No. FUT_002. | Environment Agency | May 2018 | May 2020, subject to funding | 3.2.1 | Not started |
| **FUT_007** | Further numerical modelling for future years (accounting for sea level rise) is recommended to account for the changes in energy dissipation and wave transformation as design waves propagate to the coast and this should form part of the studies recommended to occur within the next five years to progress the preferred option for long-term coastal flood and erosion risk management along the BMP frontage. This could usefully be combined with studies proposed under Action No. FUT_002. | Environment Agency | May 2018 | May 2020, subject to funding | 3.2.1 | Not started |
| **FUT_008** | If a greater amount of post-storm survey data can be collected (see Action No. MON_005), undertake a study to determine trigger conditions for pre-storm surveys. This will be dependent on (a) being able to develop sufficient | Environment Agency | May 2018 | If opportunity arises | 4.1.2 | Not started |

| Action No. | Action Description | Who by? | Date action First Defined? | When by? | Related BMP Section | Current Status |
|---|---|---|---|---|---|---|
| | understanding of the conditions of most concern through continued capture and review of post-storm surveys in the coming years, and (b) opportunity arises and/or funding is available. | | | | | |
| **FUT_009** | There is uncertainty about the precise volume of sediment along the beaches of the BMP frontage. This uncertainty is a result of a lack of understanding of where the sub-strata on which the beach sits, is located beneath the beach. To address this uncertainty a survey of underlying bed level could be undertaken if the opportunity arises and/or funding is available. | Environment Agency | May 2018 | If opportunity arises | 4.1.3 | Not started |
| **FUT_010** | In order to be in a position to readily implement beach recharge when it becomes required in the future, it is recommended that a study be undertaken in the near future to assess potential sources of recharge sediment. | Environment Agency | May 2018 | May 2019, subject to funding | 5.1.3 | Not started |

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# Glossary of Terms

| Term | Definition |
|---|---|
| Accretion | Accumulation of sediment due to the natural action of waves, currents and wind. |
| AIMS | Asset Information Management System. |
| Alarm Level | A Trigger Level. The level before Crisis Level. This is usually a predetermined value where the monitored beach parameter falls to within range of the Crisis Level, but has not resulted in systematic failure of the function being monitored, e.g. recession of a beach crest eroding to within 10m of an asset, where it has been predetermined that an extreme storm event could result in recession of 5m. The Alarm Level in this example is therefore a 5m buffer. Increased monitoring would be required when an Alarm Level is compromised and intervention undertaken if deemed necessary. Managing Alarm Levels can be planned in advance. |
| Amenity | The tangible or intangible elements of a location that contribute to a perceived positive character of the area for the enjoyment of those that use it. |
| Anthropogenic | General term used to describe the influence of man, e.g. the influence of sea defences or management actions on coastal processes. |
| APO | Annual probability of occurrence. |
| ATT | Admiralty Tide Table. |
| Backwash | The seaward return of the water following the up-rush (swash) of the waves. For any given tide stage the point of farthest return seaward of the backwash is known as the Limit of backwash. |
| BAP | Biodiversity Action Plan. A strategy for conserving and enhancing wild species and wildlife habitats in the UK. |
| Bathymetry / Bathymetric (survey) | The measurement of depths of water in oceans, seas and lakes. Also the information derived from such measurements. |
| Beach | A deposit of non-cohesive material (e.g. sand, gravel) situated on the interface between dry land and the sea (or other large expanse of water) and actively 'worked' by present day hydrodynamic processes (i.e. waves, tides and currents) and sometimes by winds. |
| Beach Profile | Cross-section perpendicular to the shoreline. The profile can extend seawards from any selected point on the landward side or top of the beach into the nearshore. |
| Beach recharge (nourishment) | Artificial process of replenishing a beach with material from another source. |
| Beach recycling/re-profiling | The movement of sediment along a beach area, typically from areas of accretion to areas of erosion, and shaping the beach profile to have a desired crest height, width and slope. |
| BMP | Beach Management Plan. It provides a basis for the management of the beach and defence asset system for flood and coastal erosion risk management purposes, taking into account coastal processes and the other uses of the coastal environment. |
| Breaching | Failure of the beach head allowing flooding by tidal action. |
| CIRIA | Construction Industry Research and Information Association. |
| Climate Change | Long-term changes in climate. The term is generally used for changes resulting from human intervention in atmospheric processes through, for example, the release of greenhouse gases to the atmosphere from burning fossil fuels, the results of which may lead to increased rainfall and sea level rise. |
| Coastal Change | Physical change to the shoreline, i.e. erosion, coastal landslip, permanent inundation and coastal accretion. |
| Coastal squeeze | The reduction in habitat area which can arise if the natural landward migration of a habitat under sea level rise is prevented by a fixation of the high water mark. |
| Crest | Highest point on a beach face, breakwater or seawall. |

| Term | Definition |
|---|---|
| Crest level/height | The vertical level of the beach relative to mOD. |
| Crest width | The horizontal distance of the beach measured from the seaward edge of the promenade to the point where the beach slope angle drops down towards the sea. |
| Crisis Level | A Trigger Level. The level at which the function being monitored, such as the stability of the beach and/or any structures (seawall/promenade/groyne), could be compromised and emergency remedial action becomes necessary, e.g. as in the case described under Alarm Level above, the beach crest recedes to within 4m of an asset that requires protection, where it has been predetermined that an extreme event could result in 5m of recession. |
| Defra | Department for Environment, Food and Rural Affairs (formerly known as MAFF) |
| EA | Environment Agency. UK non-departmental government body responsible for delivering integrated environmental management including flood defence, water resources, water quality and pollution control. |
| Erosion | Wearing away of the land, usually by the action of natural forces. |
| Flood and Coastal Erosion Risk Management (FCERM) | FCERM addresses the scientific and engineering issues of rainfall, runoff, rivers and flood inundation, and coastal erosion, as well as the human and socio-economic issues of planning, development and management. |
| FCERM GiA | FCERM Grant in Aid. The mechanism by which central Government funding for coastal flood defence and erosion protection works is accessed by operating authorities to deliver schemes. |
| Flood Zone | A geographical area officially designated subject to potential flood damage. The Environment Agency uses Flood Zone 2 and Flood Zone 3. |
| Geomorphology/ morphology | The branch of physical geography/geology which deals with the form of the Earth, the general configuration of its surface, the distribution of the land, water, etc. |
| GIS | Geographical Information System |
| Groyne | Narrow, roughly shore-normal structure built to reduce longshore currents, and/or to trap and retain beach material. Most groynes are of timber or rock, and extend from a seawall, or the backshore, well onto the foreshore and rarely even further offshore. |
| Hard defence | General term applied to impermeable coastal defence structures of concrete, timber, steel, masonry, etc, which reflect a high proportion of incident wave energy. |
| Hold the Line | An SMP policy to maintain or change the level of protection provided by defences in their present location. |
| $H_s$ | Significant wave height |
| IFCA | Inshore Fisheries and Conservation Authority. |
| Joint probability | The probability of two (or more) things occurring together. |
| Joint Probability Analysis (JPA) | Function specifying the joint distribution of two (or more) variables. |
| Joint return period | Average period of time between occurrences of a given joint probability event. |
| LiDAR | Light Detection and Ranging. This is an airborne mapping technique which uses a laser to measure the distance between the aircraft and the ground. |
| Listed Building | A building or other structure officially designated as being of special architectural, historical or cultural significance. |
| Locally generated (wind) waves | Locally generated short period and irregular waves created by the flow of air over water. |
| Longshore transport | Movement of material parallel to the shore, also referred to as longshore drift. |
| mCD | metres Chart Datum. Approximately the lowest astronomical tidal level, excluding the influence of the weather. |
| mOD | metres Ordnance Datum. A universal zero point used in the UK, equal to the mean sea level at Newlyn in Cornwall. |

| Term | Definition |
|---|---|
| Managed Realignment | An SMP policy, allowing the shoreline to move backwards or forwards, with management to control or limit movement. This includes reducing erosion or building new defences on the landward side of the original defences. |
| Mean Sea Level (MSL) | Average height of the sea surface over a 19-year period. |
| Mean High Water (MHW) | The average of all high waters observed over a sufficiently long period. |
| Mean High Water Springs (MHWS) | The average height of the high waters of spring tides. |
| Mean Low Water (MLW) | The average of all low waters observed over a sufficiently long period. |
| Mean Low Water Springs (MLWS) | The average height of the low waters of spring tides. |
| Met Office | UK Meteorological Office. |
| Monitoring | Systematic recording over time |
| MMO | Marine Management Organisation. An executive non-departmental public body established and given powers under the Marine and Coastal Access Act 2009. Responsible for managing activities in the marine environment including marine licensing and marine planning. |
| Natural England | A non-departmental public body of the UK government responsible for ensuring that England's natural environment, including its land, flora and fauna, freshwater and marine environments, geology and soils, are protected and improved. It also has a responsibility to help people enjoy, understand and access the natural environment. |
| Nearshore | The zone that extends from the swash zone to the position marking the start of the offshore zone, typically to water depths of about 20m. |
| NFCDD | National Flood and Coastal Defence Database. |
| No Active Intervention | An SMP policy that assumes that existing defences are no longer maintained and will fail over time or undefended frontages will be allowed to evolve naturally. |
| Offshore | The zone beyond the nearshore zone where sediment motion induced by waves alone effectively ceases and where the influence of the seabed on wave action has become small in comparison with the effect of wind. |
| Overtopping | Water carried over the top of a coastal defence due to wave run-up exceeding the crest height. |
| Partnership Funding | A mechanism that provides funding in full or in part (alongside a proportion of total funding need from FCERM GiA) for coastal flood defence and erosion protection from multiple sources (including those that benefit directly from such measures). |
| PCO | Plymouth Coastal Observatory. Based at the University of Plymouth, responsible for the South-West Strategic Regional Coastal Monitoring Programme (SWRCMP). |
| Policy Unit | A Policy Unit relates to the policy area defined by the Shoreline Management Plan (SMP). |
| Ramsar | Designated under the, “Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat.” 1971. The objective of this designation it to stem the progressive encroachment onto, and loss of wetlands. |
| Return Period | A statistical measurement denoting the average probability of occurrence of a given event over time. |
| Rock Armour | Wide-graded quarry stone normally bulk-placed as a protective layer to prevent erosion of the seabed and or other slopes by current and/or wave action. |
| Rock Revetment | A sloping surface of rock or stone used to protect a shoreline against erosion. |

| Term | Definition |
|---|---|
| SAC | Special Area of Conservation: this designation aims to protect habitats or species of European importance and can include Marine Areas. SACs are designated under the EC Habitats Directive (92/43/EEC) and will form part of the Natura 2000 site network. All SACs sites are also protected as Site of Special Scientific Interest, except those in the marine environment below the Mean Low Water (MLW). |
| Scheduled Monument | Scheduled Monument: formerly referred to as Scheduled Ancient Monuments. Scheduled Monuments are nationally important archaeological sites which have been awarded scheduled status in order to protect and preserve the site for the educational and cultural benefit of future generations. The main legislation concerning archaeology in the UK is the Ancient Monuments and Archaeological Areas Act 1979. This Act, building on legislation dating back to 1882, provides for nationally important archaeological sites to be statutorily protected as Scheduled Monuments. |
| Scour | Removal of underwater material by waves or currents, especially at the toe of a shore protection structure. |
| Sea level change | The rise and fall of sea levels throughout time in response to global climate and local tectonic changes. |
| Seawall | Massive structure built along the shore to prevent erosion and damage by wave action. |
| Sediment transport | The movement of a mass of sedimentary material by the forces of currents and waves. |
| Significant wave height | The average height of the highest of one third of the waves in a given sea state. |
| SMP | Shoreline Management Plan. It provides a large-scale assessment of the risks associated with coastal processes and presents a policy framework to manage these risks to people and the developed, historic and natural environment in a sustainable manner. |
| Somerset County Council | Lead Local Flood Authority under the Flood and Water Management Act, 2010. |
| SPA | Special Protection Area. These are internationally important sites, being set up to establish a network of protected areas for birds. |
| Spit | A long, narrow accumulation of sand or shingle, generally lying in-line with the coast, with one end attached to the land the other projecting into the sea or across the mouth of an estuary. |
| SSSI | Sites of Special Scientific Interest. These sites, notified by Natural England, represent some of the best examples of Britain's natural features including flora, fauna, and geology. This is a statutory designation. |
| Standard of Protection (SoP) | The level of return period event which the defence is expected to withstand without experiencing significant failure. |
| Storm surge | A rise in the sea surface on an open coast, resulting from a storm. |
| Sustainability (in coastal flood and erosion risk management) | The degree to which coastal flood and erosion risk management options avoid tying future generations into inflexible or expensive options for flood defence. This usually includes consideration of other defences and likely developments as well as processes within catchments. It will take account of long-term demand for non-renewable materials. |
| Swash | The area onshore of the surf zone where the breaking waves are projected up the foreshore. |
| Swell waves | Remotely wind-generated waves (i.e. Waves that are generated away from the site). Swell characteristically exhibits a more regular and longer period and has longer crests than locally generated waves. |
| SWL | Still water level. The level that the sea surface would assume in the absence of wind and waves. |
| SWRCMP | South-West Strategic Regional Coastal Monitoring Programme. Based at the University of Plymouth with Teignbridge District Council as lead authority (see also PCO). |
| Tide | Periodic rising and falling of large bodies of water resulting from the gravitational attraction of the moon and sun acting on the rotating earth. |

| Term | Definition |
|---|---|
| Toe level | The level of the lowest part of a structure, generally forming the transition to the underlying ground. |
| Trigger level | This is usually a predetermined value where the monitored beach parameter falls to within range that results in management action being required (see also Action Level and Crisis Level). |
| UKCP09 | UK Climate Projections 2009. Research giving predictions of how future climate change may affect the UK. |
| UKHO | United Kingdom Hydrographic Office. |
| Wave climate | Average condition of the waves at a given place over a period of years, as shown by height, period, direction, etc. |
| Wave direction | Direction from which a wave approaches. |
| Wave height | The vertical distance between the crest and the trough. |
| Wave hindcast | In wave prediction, the retrospective forecasting of waves using measured wind information. |
| Wave period | The time it takes for two successive crests (or troughs) to pass a given point. |
| Wave refraction | Process by which the direction of approach of a wave changes as it moves into shallow water. |
| Wave reflection | The part of an incident wave that is returned (reflected) seaward when a wave impinges on a beach, seawall or other reflecting surface. |
| WSC | West Somerset Council. Coastal Operating Authority as defined under the Coast Protection Act 1949 with permissive powers to provide defence against coastal erosion. |
| WFD | Water Framework Directive. A European Directive that aims to establish a framework for the protection of inland surface waters (rivers and lakes), transitional waters (estuaries), coastal waters and groundwater. |

# Appendix A
# Economics Baseline Assessment

# Appendix B
# Options Appraisal Report

# Appendix C
# Environmental Designation Information

# Appendix D
# Defence Assessment Baseline

# Appendix E
# Coastal Processes Baseline Understanding

# Appendix F
# List of Contacts

# Appendix G
# Scheme Drawings

# Appendix H
# Beach Recycling Log Template

# Appendix I
# Defence Inspection Proforma

# Appendix J
# Defence Repair Proforma

# Appendix K
# EA Best Practice Guide for Public Engagement when undertaking beach maintenance works