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Memorandum

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Subject	**Technical options appraisal for Southwold frontage**	**Project Name**	Southwold FCRM Initial Assessment
Attention	Appendix B Initial Assessment	**Project Number**	704171CH.19
From	Andy Schofield/ Duncan Hunt (Jacobs)		
Date	15th October 2018		
Copies to			

The following memorandum documents the high-level technical appraisal of identified options for the Southwold Town and adjacent Easton Marsh frontage and provides details of the adopted shortlisted options. This document forms an appendix to the Southwold FCRM Initial Assessment report.

The frontage has been split into three sections due to the different constraints and drivers affecting coastal protection and/or the lead authority responsible for the frontage. The identified frontages are:

- Waveney District Council (WDC) town frontage; located south of the pier, a frontage comprising amenity beach and timber beach control structures and a promenade atop a seawall.
- WDC Easton Marshes frontage; located north of the pier, a frontage consisting of amenity beach and rock groyne structures and seawall promenade which extends to an access ramp at the end of the paved car park behind the seawall.
- Environment Agency (EA) Easton Marshes frontage; located north of the pier from the access ramp to the start of the cliffs at Easton Bavents - enclosed embayments contained between rock groynes with a stepped concrete seawall behind.

The study area can be seen in Figure 1.

Table 1 to Table 3 below detail the short-listed options and reason for adoption. These options require further appraisal but would provide an appropriate technical solution to issues along the frontage in combination with a suitable regime of beach nourishment. Table 4 to Table 6 describe the remaining long-list options not short-listed, along with the main reason for rejection. The full high-level technical appraisal of all considered options is contained in Table 7 to Table 9.

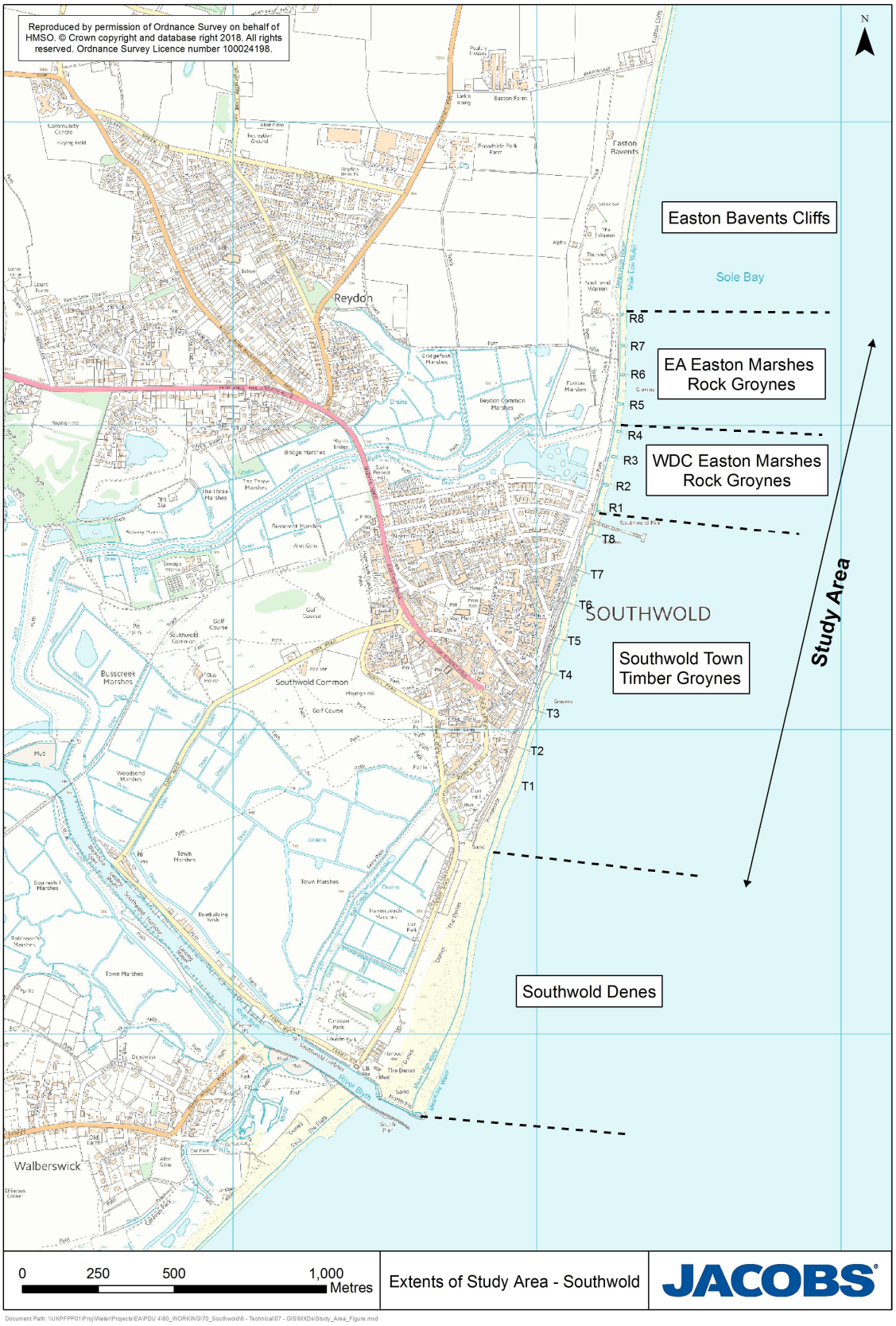

Figure 1 Study area

Table 1 - Options shortlisted for WDC town frontage

Ref ID	Option	Reason for adoption	Short-list ID
TF DN	Do Nothing (No repair)	Used in appraisal to act as a baseline against which all other options are tested.	TF BL 1
TF DM	Do Minimum (Patch and repair)	Used in appraisal to act as a baseline against which all other options are tested.	TF BL 2
TF PAR	Implement PAR	Continue on current programme. Options should be appraised against implementing existing PAR.	TF PAR
TF LL 2	Beach Nourishment (existing grading)	Possible to protect wall through management of beach levels through ongoing programme of nourishment with increasing frequency over the life of scheme.	TF SL 1
TF LL 4	Lengthen timber groyne(s)	Increasing length of groyne should retain more sand within embayments.	TF SL 2
TF LL 5	Reduce timber groyne spacing	Reducing spacing of groynes should allow for a more compact and stable beach plan to develop.	TF SL 3
TF LL 6	Modify timber groynes (T-Head)	Reducing the effective spacing of groynes will allow for a more compact beach plan shape. This option would provide the greatest protection from cross shore conditions.	TF SL 4

Table 2 - Options shortlisted for WDC Easton Marshes frontage

Ref ID	Option	Reason for adoption	Short-list ID
WEM DN	Do Nothing (No repair)	Used in appraisal to act as a baseline against which all other options are tested.	WEM BL 1
WEM DM	Do Minimum (Patch and repair)	Used in appraisal to act as a baseline against which all other options are tested.	WEM BL 2
WEM PAR	Implement PAR	Continue on current programme. Options should be appraised against implementing existing PAR.	WEM PAR
WEM LL 4	Modification of existing groyne length	Increasing length of groyne should retain more sand within embayments.	WEM SL 1
WEM LL 5	Modification of existing groyne spacing	Reducing spacing of groynes should allow for a more compact and stable beach plan to develop.	WEM SL 2
WEM LL 6	Modification of existing groyne shape/type	T- Head likely preferred arrangement. Reducing the effective spacing of groynes will allow for a more compact beach plan shape. This option would provide the greatest protection from cross shore conditions.	WEM SL 3

Table 3 - Options shortlisted for EA Easton Marshes frontage

Ref ID	Option	Reason for adoption	Short-list ID
EAEM DN	Do Nothing (No repair)	Used in appraisal to act as a baseline against which all other options are tested.	EAEM BL 1
EAEM DM	Do Minimum (Patch and repair)	Used in appraisal to act as a baseline against which all other options are tested.	EAEM BL 2
EAEM PAR	Implement PAR	Continue on current programme. Options should be appraised against implementing existing PAR.	EA PAR
EAEM LL 8	Retain existing groynes, create new rock revetment and construct new northern control structure (J Groyne)	Rock revetment would provide increased stability to seawall to combat lowering beach levels. Revetment should reduce overtopping and reduce scour in front of the wall. Retaining existing groynes should act to keep beach levels more stable compared to if they are removed and reduce pressure on WDC Easton Marshes frontage. J Groyne structure would create a fixed point and reduce risk of erosion and outflanking at northern extent of Easton Marshes wall by encouraging accumulation of material in its lee also providing an area suitable for beach access.	EAEM SL 1
EAEM LL 9	Dismantle existing groynes, create new rock revetment ad construct new northern control structure (J Groyne)	Rock revetment would provide increased stability to seawall to combat lowering beach levels. Revetment should reduce overtopping and reduce scour in front of the wall. J Groyne structure would create a fixed point and reduce risk of erosion and outflanking at northern extent of Easton Marshes wall by encouraging accumulation of material in its lee also providing an area suitable for beach access.	EAEM SL 2

Table 4 - Long-list options not taken forward for WDC town frontage

Ref ID	Option	Reason for rejection
TF.LL 1	Beach Recycling	Insufficient material available from the Denes to renourish entire frontage. Should be considered as part of a more comprehensive option.
TF LL 3	Beach Nourishment (coarser grading)	Diminished amenity of the bays. Larger material more likely to damage timber groynes.
TF LL 7	Offshore Reefs	Change to seaward vista and general feel of Southwold frontage. Technically challenging requiring modelling to get position of reefs correct and also marine construction. Cost in comparison to timber options likely prohibitive. May negatively impact longshore movement.
TF LL 8	Rock revetment between existing groyne bay(s)	Current beach levels are sufficiently high to protect the seawall, so the expense of rock revetment at this location is difficult to justify. Would have amenity impacts.
TF LL 9	Proactive management of timber groyne board height	Would require frequent monitoring, close management and flexible manpower resourcing. Technically would be difficult to predict and therefore unlikely to meet project objectives.
TF LL 10	Steel Plating	Current beach levels are sufficiently high to protect the seawall. If Seawall is exposed and plating required then stability would be an issue.

Table 5 - Long-list options not taken forward for WDC Easton Marshes frontage

Ref ID	Option	Reason for rejection
WEM LL 1	Beach recycling	Insufficient material available from the Denes to renourish entire frontage. Transport to area north of the pier likely problematic.
WEM LL 2	Beach Nourishment (existing grading)	Increasing pressure along this frontage means holding a beach will become more difficult with the period of recharge increasing with time and therefore recharge is likely to be prohibitively expensive.
WEM LL 3	Beach nourishment (coarser grading)	Diminished amenity of the bays. To ensure material remains within extents of groyne then a significantly large material is likely required.
WEM LL 7	Create offshore reefs between existing groynes	Change to seaward vista and general feel of Southwold frontage. Technically challenging requiring modelling to get position of reefs correct and also marine construction would be required. May negatively impact longshore movement.
WEM LL 8	Retain existing groynes and construct additional rock revetment	Current beach levels are sufficiently high in bays R1-R3 to protect the seawall and issues can be likely managed with groyne modification so the expense of rock revetment at this location is difficult to justify. Would have amenity impacts. May be considered in combination with other options as pressure on WDC frontage increases.
WEM LL 9	Dismantle groyne(s) to create rock revetment	Current beach levels are sufficiently high in bays R1-R3 to protect the seawall and issues can be likely managed with groyne modification so the expense of rock revetment at this location is difficult to justify. Would have amenity impacts. May be considered in combination with other options as pressure on WDC frontage increases. Greater exposure of the pier supports could require discrete protection.
WEM LL 10	Steel Plating	As beach levels lower there would be increasing risk of geotechnical instability that would not be counteracted with plating alone.
WEM LL 11	Managed Realignment	Not necessary or appropriate at this stage. Issues can be addressed by more cost-effective options. Could be more appropriate in the future as erosion pressure increases along the EM frontage as the cliffs continue to erode.

Table 6 - Long-list options not taken forward for EA Easton Marshes frontage

Ref ID	Option	Reason for rejection
EAEM LL 1	Beach Recycling	Insufficient material available from the Denes to renourish entire frontage. Transport to area north of the pier likely problematic.
EAEM LL 2	Beach nourishment (existing grading)	Increasing pressure along this frontage means holding a beach will become more difficult. Does not have the same amenity implications as WDC frontage as beach is closed to public.
EAEM LL 3	Beach nourishment (coarser grading)	Increasing pressure along this frontage means holding a beach will become more difficult. Does not have the same amenity implications as WDC frontage as beach is closed to public.
EAEM LL 4	Modification of existing groyne length	Historically groynes along this frontage shorter than WDC groynes. Longer groynes could starve beaches to the south and accelerate erosion of the cliffs and increase the outflanking risk to the north. Increasing pressure along this frontage means holding a beach will become increasingly difficult and threaten beach levels at toe of seawall. Does not have the same amenity implications as WDC frontage as beach is closed to public.
EAEM LL 5	Modification of existing groyne spacing	Increasing pressure along this frontage means holding a beach will become increasingly difficult and threaten beach levels at toe of seawall. Does not have the same amenity implications as WDC frontage as beach is closed to public.

EAEM LL 6	Modification of existing groyne shape/type	Increasing pressure along this frontage means holding a beach will become increasingly difficult and threaten beach levels at toe of seawall. Does not have the same amenity implications as WDC frontage as beach is closed to public.
EAEM LL 7	Create offshore reefs between existing groyne(s)	Technically challenging requiring modelling to get position of reefs correct and also marine construction would be required. May negatively impact longshore movement.
EAEM LL 10	Retain existing groynes. New detached reef control structure and additional rock revetment	Likely costly and technically challenging and would require significant analysis and modelling during design with the risk of it still not providing suitable solution at extent of frontage to reduce outflanking risk. Would require marine plant to construct.
EAEM LL 11	Dismantle existing groynes. New rock revetment with new detached reef control structure.	Likely costly and technically challenging and would require significant analysis and modelling during design with the risk of it still not providing suitable solution at extent of frontage to reduce outflanking risk. Would require marine plant to construct.
EAEM LL 12	Steel Plating	As beach levels lower there would be increasing risk of geotechnical instability that would not be counteracted with plating alone.
EAEM LL 13	Managed realignment	Not necessary or appropriate at this stage. Issues can be addressed by more cost-effective options. Could be more appropriate in the future as erosion pressure increases along the EM frontage as the cliffs continue to erode.

Key to long-list options
Baseline
Consider in combination
Shortlist

Table 7 - Long List Options for Waveney District Council (WDC) Town Frontage

Option	Name	Description of works	Commentary	Shortlist	Commentary
TF LL DN	Do Nothing	No repair, maintenance or other works would be carried out other than necessary actions to deal with immediate health and safety risks.	Volatility would continue putting seawall at risk of toe exposure and potentially impact amenity value. Beach levels would drop and beach crest would narrow (as pre 2005 PAR scheme where previous groynes failed) increasing overtopping.	Yes	Do Nothing is used in appraisal to act as a baseline against which all other options are tested.
TF LL DM	Do Minimum	Removal of material from area of beach that is accreting (e.g. The Denes) to feed the groyne bays that have depleted to maintain the trigger levels detailed in the Beach Management Plan.	Under Do Minimum groynes should be left to fail. Works should only be undertaken to ensure stability of seawall to avoid structural failure and eventual breach.	Yes	Do Minimum is used in appraisal to act as a baseline against which all other options are tested. Ensuring beach level does not fall below trigger level should protect against structural stability.
TF LL PAR	Implement existing PAR	Continue with works to WDC Town frontage from current scheme detailed in the existing PAR.	Continuing works from existing PAR should continue to provide limited protection to the frontage but would not address issues that have been highlighted with this Initial Assessment. Volatility would continue putting seawall at risk of toe exposure and potentially impact amenity value.	Appraisal	Would not achieve project objectives and situation would likely worsen with time.
TF LL 1	Beach recycling	Removal of material from area of beach that is accreting (e.g. The Denes) to feed the groyne bays that have depleted.	2016 ENBE reports estimates there is 5,000m^3 of material that could be removed from the Denes without significant impact. However, this would not be sufficient to restore the beaches to their design profile, although it may delay erosion in the worst hit bays or provide enough material for a small number of bays. Uncertainty as to whether the renourished beach would remain for a sufficient length of time especially in the most volatile bays and availability of future material would need to be explored through ongoing monitoring. Sheet pile toe thickness has mostly been protected by beach post-scheme, so sheet pile repairs may not be necessary.	No (but considered in conjunction with other options)	Obtaining recharge material from the Denes would be subject to ongoing monitoring supporting the availability of material. Current available quantity is calculated to be less than requirement to fully restore beaches (ENBE, 2016). Could be employed to provide nourishment for those options that require it although additional nourishment sources may also be required. Aligns with PAR recommendations for future beach management. Without sufficient ongoing nourishment, if beach level in front of seawall lowers significantly geotechnical stability may become an issue.

Option	Name	Description of works	Commentary	Shortlist	Commentary
TF LL 2	Beach nourishment (existing grading)	Beach nourishment along frontage and periodic replenishment through nourishment or recycling. Requirement likely for Pier-T8 and T8-T7 and T7-T6	Estimated that 10,000m^3 of beach has been lost in affected bays south of the pier since the 2005 scheme (ENBE, 2016) and, therefore, a similar amount would be required to restore the bays to their design profile. Based on the rate of loss since 2006, required beach recharge frequency would be approximately every 15 years although the required frequency would likely increase as exposure and erosion pressure increases. In between recharge, beach levels would lower, crest would narrow and overtopping and pressure on seawall would increase as existing groynes would not be sufficient to maintain stable beach. Sheet pile toe thickness has mostly been protected by beach post-scheme, so sheet pile repairs may not be necessary.	Yes	Resilience of recharge could be improved with coarser material but still uncertainty as to whether the renourished beach would remain for a sufficient length of time increasing pressure on seawall. Periodic nourishment and maintenance repairs align with the PAR assumptions on future management activities for this frontage. To increase viability and improve cost effectiveness (due to high mobilisation costs of dredgers) recharge over the Town frontage would likely be combined with recharge to other frontages. Without sufficient ongoing nourishment, if beach level in front of seawall lowers significantly, geotechnical stability may become an issue.
TF LL 3	Beach nourishment (coarser grading)	Beach Nourishment with a coarser shingle material along frontage to provide greater stability due to larger particle size and encourage a steeper beach slope to form between the existing groynes. Would require initial nourishment and periodic replenishment through nourishment or recycling. Requirement likely for bays Pier-T8, T8-T7 and T7-T6.	Would have amenity implications. Material would be less mobile than current beach material, reducing movement and loss through the system, although still uncertainty as to whether the renourished beach would remain for a sufficient length of time. Would likely require a heavy shingle to be effective. Sheet pile toe thickness has mostly been protected by beach post-scheme, so sheet pile repairs may not be necessary. Would require future nourishment but less frequent than sandier option as more material would be contained in the bays.	No	Would not provide guarantee against losses unless very heavy grading used. Coarser material would diminish amenity value of those bays. To increase viability and improve cost effectiveness (due to high mobilisation costs of dredgers) recharge over the Town frontage would likely be combined with recharge to other frontages. Without sufficient ongoing nourishment, if beach level in front of seawall lowers significantly geotechnical stability may become an issue.
TF LL 4	Lengthen timber groyne(s) with nourishment	Lengthening the timber groynes at the WDC frontage south of the pier to reduce the amount of material lost from long-shore processes and reduce material escaping the bay under cross-shore conditions. Would require initial nourishment and periodic replenishment through nourishment or recycling. Requirement likely for bays Pier-T8, T8-T7 and T7-T6.	Would reduce the amount of sediment moving through the system and trap sediment before it transports long-shore. Lengthen to achieve say 1 in 1.5 to 1 in 2 length to spacing ratio. Beach management manual (CIRIA C685, 2010) suggests 1:4 is the maximum. Sheet pile toe thickness has mostly been protected by beach post-scheme, so sheet pile repairs may not be necessary. May require some initial nourishment, although design should reduce losses and hence reduce requirement for future nourishment.	Yes	Lengthening may be technically challenging/expensive due to water depth requiring marine plant. Option would not protect against cross-shore movement, although drawn down material may still be contained within the groyne bay with the longer groynes and then be pushed back up the beach under more favourable wave conditions.

Option	Name	Description of works	Commentary	Shortlist	Commentary
TF LL 5	Reduce timber groyne spacing with nourishment	The introduction of shorter timber groynes at the centre of affected groyne bays to increase the beach width allowing more stable bays to form. Would require initial nourishment and periodic replenishment through nourishment or recycling. Requirement likely for Pier-T8, T8-T7 and T7-T6.	By introducing additional groynes in the most volatile bays, the ratio of length to spacing will be reduced allowing a more stable and compressed beach to form with wider crest widths. Sheet pile toe thickness has mostly been protected by the beach post-scheme, so sheet pile repairs may not be necessary. May require some initial nourishment, although design should reduce losses and hence reduce requirement for future nourishment.	Yes	Would be simpler to construct and therefore less expensive than groyne lengthening or modification options since working mostly in the dry would be possible. Option would not protect against cross-shore movement but would encourage more material to be held in the bays, thus making the bays more resilient to cross-shore loss.
TF LL 6	Modify timber groynes (T-Head) with nourishment	Introduction of T-Head feature to end of existing timber groynes (most likely with rock for resilience/low maintenance reasons) to reduce effective groyne spacing and provide a sheltering effect landward of the head reducing cross-shore losses. Would require initial nourishment and periodic replenishment through nourishment or recycling. Requirement likely for bays Pier-T8, T8-T7 and T7-T6 which are most volatile.	Consideration would need to be given to how rock interfaces with existing timber structure. Sheet pile toe thickness has mostly been protected by the beach post-scheme, so sheet pile repairs may not be necessary. May require some initial nourishment, although design should reduce losses and hence reduce requirement for future nourishment.	Yes	Modification to T-Head may be technically challenging/expensive due to combining rock and timber structures in significant water depth. Public perception may be impacted by change in seaward vista and radical change to current groyne appearance (especially if rock is used).
TF LL 7	Offshore Reefs with nourishment	Construct small offshore reefs (possibly submerged) within existing bay(s) to reduce cross-shore losses and promote creation of crenulate-shape embayments. Would require initial nourishment and periodic replenishment through nourishment or recycling.	Would be relatively expensive to construct, probably requiring marine plant. Would act as a barrier to easterly storms and reduce cross-shore losses. Salient would likely form in the lee increasing bay stability. Would require initial nourishment although design should reduce losses compared to the existing situation regarding future nourishment. Sheet pile toe thickness has mostly been protected by the beach post-scheme, so sheet pile repairs may not be necessary.	No	Cost may be prohibitive. Would be a challenge aesthetically – interrupted view of horizon if reefs are not fully submerged and public perception may be impacted by radical change in seaward vista. Reefs would improve performance under cross-shore conditions but could prevent bays filling through long-shore processes – encouraging more material to pass long-shore across the bay. Would be a challenging design to ensure success.
TF LL 8	Rock revetment between existing groyne bay(s)	Construction of a rock revetment across the WDC Town frontage between the existing groyne bays. Pile plating or repiling may also be required to safeguard seawall integrity against future low beach levels and pile exposure and corrosion and abrasion.	Rock revetment would provide stability to the seawall and reduce reflection and scour at the toe if seawall is exposed. Interface detail with existing defences would be required. Would impact amenity beach use and access may need to be altered.	No	Current beach levels are sufficiently high to protect the seawall, so the expense of rock revetment at this location would be difficult to justify. However, it could be a future option in bays Pier-T8 and T8-T7 and later extended as pressure increases further south along the Southwold Town frontage.

Option	Name	Description of works	Commentary	Shortlist	Commentary
TF LL 9	Proactive management of timber groyne board height	Reduce/increase height of groynes to better manage and control the quantity of material moving to the north and the south, as required.	Relying on this solution to solely provide enough feed to the worst hit bays would introduce an element of risk and require ongoing monitoring and reactive actions that could be difficult to resource at short notice. May be possible to use over a longer timescale, in conjunction with other methods, to improve the long-shore flow of material from overperforming bays. Planks could be reinstated at a later point if not found to be beneficial. Strategy would be more effective in southern section of frontage than northern which is more volatile. Sheet pile toe thickness has mostly been protected by the beach post-scheme, so sheet pile repairs may not be necessary.	No	Would require frequent monitoring, close management, and flexible manpower resourcing Possible modification to plank fixings to facilitate easy adjustment may be required and would require significant manpower resources. Option would allow freer movement of material feed from the south (desirable) but would also allow freer loss of material from within the bays under northerly conditions unless managed effectively. Risk of loss of material from the system if not adequately managed. ENBE (2016) confirmed that dominant movement is north to south along the frontage which may not be conducive to moving material northward to volatile bays but excess material may move south and captured at the Denes where it would be available for recycling.
TF LL 10	Steel plating	Where sheet pile at seawall toe has been exposed use steel plating to patch and repair existing sheet piles as they near end of life. Following plating drill down and inject concrete into voids.	Beach levels currently above critical level and sheet pile is protected by beach material. Condition of sheet pile below beach level is unknown. Would not maintain amenity value of town frontage.	No	Should be possible to hold beach at town frontage and therefore plating alone would not meet project objectives. Could be used in combination with other options to repair sheet pile wall if defects are found, dependent on thickness of sheet pile.

Table 8 - Long List Options for Waveney District Council (WDC) Easton Marshes (EM) Frontage

Option	Name	Description of works	Commentary	Shortlist	Commentary
WEM BL DN	Do Nothing	No repair, maintenance or other works would be carried out other than necessary actions to deal with immediate health and safety risks.	Volatility would continue putting seawall at risk of toe exposure and potentially impact amenity value. Beach levels would drop and beach crest would narrow (as pre 2005 PAR scheme where previous groynes failed) increasing overtopping.	Yes	Do Nothing is used in appraisal to act as a baseline against which all other options are tested.
WEM BL DM	Do Minimum	Patch and repair existing seawall. Use rock from existing structures to provide stability to wall when critical beach levels are exceeded.	Works only undertaken to mitigate the risk of breach. Eventually, beach levels would drop and beach crest would narrow (as pre 2005 PAR scheme where previous groynes failed) increasing overtopping and risk of seawall failure. Using material from existing structures would be cheapest means of obtaining material required to provide short term stability to seawall. Removing rock from structures would likely accelerate the lowering of beach levels.	Yes	Do Minimum is used in appraisal to act as a baseline against which all other options are tested.
WEM LL PAR	Implement existing PAR	Continue with works to Easton Marshes frontage from current scheme detailed in the existing PAR.	Continuing works from existing PAR should continue to provide limited protection to the frontage but would not address issues that have been highlighted with this Initial Assessment. Volatility would continue putting seawall at risk of toe exposure and potentially impact amenity value.	Appraisal	Would not achieve project objectives and situation would likely worsen with time.
WEM LL 1	Beach recycling	Removal of material from area of beach that is accreting (e.g. The Denes) to feed the groyne bays that have depleted. Pile plating or repiling and repairs to the concrete wall may also be required to safeguard seawall integrity against low beach levels, pile exposure and continued corrosion and abrasion.	2016 ENBE reports estimates there is 5,000m^3 of material that could be removed from the Denes without significant impact. However, this would not be sufficient to restore all bays to design profile although may delay erosion in worst hit bays or provide enough material for a small number of bays. Availability of future material would need to be explored through ongoing monitoring. Unlikely that the renourished beach would remain for a sufficient length of time unless combined with other options designed to better retain the beach.	No	Obtaining recharge material from the Denes would be subject to ongoing monitoring supporting the availability of material. Potential transport logistic issues moving material from the Denes north to the affected areas. Transport under the pier would not be possible and transport through town is unlikely to be acceptable. May become more feasible as a maintenance option of any future scheme.

Option	Name	Description of works	Commentary	Shortlist	Commentary
WEM LL 2	Beach nourishment (existing grading)	Beach nourishment along frontage. Retain existing groynes unmodified. Pile plating or repiling and repairs to the concrete wall may also be required to safeguard seawall integrity against low beach levels, pile exposure and continued corrosion and abrasion.	Estimated that approx. 22,000m^3 of beach has been lost from the WDC EM frontage since the 2006 scheme (ENBE, 2016) and, therefore, a similar amount would be required to restore the bays to their design profile. Based on the rate of loss since 2006, required beach recharge frequency would initially be approximately 15 years although the required frequency would likely increase as exposure and erosion pressure increases. Eventually, beach levels would drop and beach crest would narrow (as pre 2005 PAR scheme where previous groynes failed) increasing overtopping.	Yes	Resilience of recharge could be improved with coarser material but still uncertainty as to whether the renourished beach would remain for a sufficient length of time. To increase viability and improve cost effectiveness (due to high mobilisation costs of dredgers) recharge would likely be combined with recharge to other frontages. Option may require future modifications to be sustainable across the entire appraisal period.
WEM LL 3	Beach nourishment (coarser grading)	Nourishing the WDC EM groyne bays with a coarser shingle material would provide greater stability due to larger particle size and encourage a steeper beach slope to form between the existing groynes. Pile plating or repiling and repairs to the concrete wall may also be required to safeguard seawall integrity against low beach levels, pile exposure and continued corrosion and abrasion.	Would have amenity implications. Material would be less mobile than current beach material, reducing movement and loss through the system, although still uncertainty as to whether the renourished beach would remain for a sufficient length of time. Would likely require a heavy shingle to be effective. Too little material could result in pebbles/cobbles being thrown landwards during storms. Heavier pile plating or piling may be required due to the coarser material.	No	Would not provide guarantee against losses unless very heavy grading used. Coarser material would diminish amenity value of those bays (and potentially those south of the pier over time). To increase viability and improve cost effectiveness (due to high mobilisation costs of dredgers) recharge would likely be combined with recharge to other frontages. Option may require future modifications to be sustainable across the entire appraisal period.
WEM LL 4	Modification of existing groyne length with nourishment	Groynes at WDC EM could be lengthened to better hold material under long-shore conditions, and reduce material escaping the bay under cross-shore conditions. Would require nourishment. Pile plating or repiling and repairs to the concrete wall may also be required to safeguard seawall integrity against low beach levels, pile exposure and continued corrosion and abrasion. Two approaches are possible depending on the approach at EA EM; remove R4 and undertake works to bays R1-R2 and R2-R3 or leave R4 in place and undertake works to R1-R2, R2-R3 and R3-R4.	Would reduce supply of sediment to town frontage under southerly drift conditions. Would also reduce supply of material to the north under northerly drift conditions. Would also require nourishment. Lengthening the most northerly groyne could encourage formation and stability of higher beach levels in front of the existing access ramp, thereby improving beach access. Option would not protect against cross-shore movement although drawn down material may still be contained within the groyne bay with the longer groynes and then be pushed back up the beach under more favourable wave conditions.	Yes	For options that remove the existing groynes from the EA frontage to the north, the transition between the EA frontage and the WDC EM frontage will be key to overall scheme success. The ideal would be to encourage retention of material at the existing access ramp and within the bays, whilst allowing material to move from north to south to feed the Town frontage, and also having a non-detrimental impact on the EA defence under southerly conditions. If defences along EA frontage are removed this would increase pressure on this frontage and therefore works are more likely to be required with the greatest pressure experienced in bay adjacent to where defences are removed. Option may require future modifications to be sustainable across the entire appraisal period.

Option	Name	Description of works	Commentary	Shortlist	Commentary
WEM LL 5	Modification of existing groyne spacing with nourishment	Construction of new groynes (rock or timber) between existing rock groynes at WDC EM to create a more compressed beach plan shape. Would require nourishment. Pile plating or repiling and repairs to the concrete wall may also be required to safeguard seawall integrity against low beach levels, pile exposure and continued corrosion and abrasion. Two approaches are possible depending on the approach at EA EM; remove R4 and undertake works to bays R1-R2 and R2-R3 or leave R4 in place and undertake works to R1-R2, R2-R3 and R3-R4.	Compressed beach shape would allow a wider bay to exist in the mid-point of the bay, hold more material and help to mitigate the effects of cross-shore loss although bays would still be susceptible to that cross-shore (easterly storm) loss. Would also require nourishment. If rock groynes adopted, then groynes would likely require more rock than some of the options to modify the existing groynes. Option would not protect against cross-shore movement but would encourage more material to be held in the bays, thus making the bays more resilient to cross-shore loss Option alone would not benefit beach levels in front of existing access ramp.	Yes	Loss of material and volatility within WDC rock groyne bays north of pier is currently less than along the EA frontage. The impacts of options considered on the EA frontage to the north need to be considered with reference to their potential impact on the WDC frontage. Increased volatility may be an impact, in which case this option becomes more relevant. If defences along the EA frontage are removed this would increase pressure on this frontage and therefore works are more likely to be required with the greatest pressure in the most northerly bay. Option may require future modifications to be sustainable across the entire appraisal period.
WEM LL 6	Modification of existing groyne shape/type with nourishment	Modify the seaward extent of WDC EM groynes to create ‘T’ head or ‘Y’ shape groynes. Would require nourishment. Pile plating or repiling and repairs to the concrete wall may also be required to safeguard seawall integrity against low beach levels, pile exposure and continued corrosion and abrasion. Two approaches are possible depending on the approach at EA EM; remove R4 and undertake works to bays R1-R2 and R2-R3 or leave R4 in place and undertake works to R1-R2, R2-R3 and R3-R4.	Modifying the existing groyne shape could improve sand retention within the bays by reducing potential for cross-shore losses and assist in managing the transition between the EA and Town frontage. Would need to be considered in conjunction with the preferred option at EA EM to ensure the options are compatible. Would also require nourishment. Modifying the most northerly groyne could encourage formation and stability of higher beach levels in front of the existing access ramp, thereby improving beach access.	Yes	Modification of most northerly WDC groyne, R4 almost certainly required to manage the transition (which would be more abrupt) if groynes to the north are dismantled as this would increase pressure on this frontage. In such a case, then modification could also encourage beach retention to help beach access at the existing ramp. Modifications to R1-3 may be more likely if increased volatility is expected in these bays if groynes to the north are dismantled. Option may require future modifications to be sustainable across the entire appraisal period.
WEM LL 7	Create offshore reefs between existing groyne(s) with nourishment	Construct small offshore reefs (possibly submerged) within existing bays to reduce cross-shore losses and promote creation of crenulate-shape, embayments. Would require nourishment. Pile plating or repiling and repairs to the concrete wall may also be required to safeguard seawall integrity against low beach levels, pile exposure and continued corrosion and abrasion. Two approaches are possible depending on the approach at EA EM; remove R4 and undertake works to bays R1-R2 and R2-R3 or leave R4 in place and undertake works to R1-R2, R2-R3 and R3-R4.	Would be relatively expensive to construct, probably requiring marine plant. Would act as a barrier to easterly storms and reduce cross-shore losses. Salient would likely form in the lee increasing bay stability. Would require initial nourishment although design should reduce losses based on the existing situation regarding future nourishment. Could benefit beach levels at the existing access ramp, provided reef option is extended to the adjacent bay between R4 & R5.	No	Cost may be prohibitive but could be a viable option if predictions indicate that the bays along the WDC EM frontage will be significantly more volatile if groynes along the EA EM frontage are removed. May be less than ideal aesthetically – interrupted view of horizon if reefs are not submerged. Reefs would improve performance under cross-shore conditions but could prevent bays filling through long-shore processes – encouraging more material to pass long-shore across the bay. Would be technically challenging and likely expensive option. Option may require future modifications to be sustainable across the entire appraisal period.

Option	Name	Description of works	Commentary	Shortlist	Commentary
WEM LL 8	Retain existing groynes and construct additional rock revetment	Install rock revetment between groyne bay(s) to provide support to the seawall and scour protection to the toe of the structure. The toe of the revetment should be designed to be installed at a level below future predicted beach levels. Pile plating or repiling and repairs to the concrete wall may also be required to safeguard seawall integrity against low beach levels, pile exposure and continued corrosion and abrasion.	Rock revetment would provide stability to the seawall and reduce reflection and scour at the toe. The presence of the groynes would mean that the bays would still retain some sand for additional protection and may provide periodic amenity benefits, however over the medium to long term there would likely be a loss of WDC amenity north of pier without increasing the frequency of recharge. Interface detail with existing defences would be required. Impacts on existing pedestrian beach access would need considering. Option alone would not benefit beach levels in front of existing access ramp, although if a similar option is selected for the EA frontage, the revetment rock could be selectively placed to create a relatively smooth slope down onto the beach.	No	Volatility within bays R1-R3 is less of a problem or can be better managed by groyne modification with a regime of recharge. Some revetment within R3-R4-R5 may be required to safeguard against foreshore erosion adjacent to piles over transition and at the existing access ramp. May reduce overtopping and resulting impact on beach hut users but could increase spray. Option would have negative impact on amenity and may not be necessary at this time and may be more appropriate in the future (i.e. 20+ years) as erosion pressure increases along the frontage.
WEM LL 9	Dismantle groyne(s) to create rock revetment	Dismantle existing rock groyne(s) and use the rock as part of the construction of a rock revetment across the WDC EM frontage. Pile plating or repiling and repairs to the concrete wall may also be required to safeguard seawall integrity against low beach levels, pile exposure and continued corrosion and abrasion.	Rock revetment would provide stability to the seawall and reduce reflection and scour at the toe. Interface detail with existing defences would be required. Impacts on existing pedestrian beach access would need considering. Would involve loss of WDC amenity beach frontage north of pier. Removal of existing groynes would put more pressure on the defences south of the pier. Removing the groynes would mean that a significant amount of sediment disperses southwards. Option would not benefit beach levels in front of existing access ramp, although if a similar option is selected for the EA frontage, the revetment rock could be selectively placed to create a relatively smooth slope down onto the beach.	No	Volatility in the bays immediately north of the pier (pier to R3) is currently less than elsewhere and the piles are not currently threatened. It is likely that a protective beach can be maintained here by the existing (or modified) groynes and a regime of recharge, hence there is currently no pressing requirement for such an option. Removing the groynes would push the transition point further south and potentially adversely impact the Town frontage, reducing amenity south of the pier. North of the pier, option would have negative impact on amenity and may not be necessary at this time and may be more appropriate in the future (i.e. 20+ years) as erosion pressure increases along the frontage. Greater exposure of the pier supports may require discrete protection.
WEM LL 10	Steel plating	Where sheet pile at seawall toe has been exposed use steel plating to patch and repair existing sheet piles as they near end of life. Following plating drill down and inject concrete into voids.	Steel plating at the toe is the current practice for repairing degradation through corrosion and abrasion at the sheet pile toe. A short distance (circa 20 m) of pile plating repair of the most eroded areas is scheduled to occur outside current IA/OBC process. These areas would not require rework. As beach levels drop failure of seawall would likely be from geotechnical stability of the seawall rather than degradation of the sheet pile.	No	Without intervention to maintain beach or provide stability through rock revetment, beach levels are likely to fall below critical levels within the appraisal period and therefore plating alone would not be sufficient. Could be used in combination with other options to repair sheet pile wall if defects are found, dependent on thickness of sheet pile.

Option	Name	Description of works	Commentary	Shortlist	Commentary
WEM LL 11	Managed Realignment	Creation of setback embankment behind existing WDC EM defence. Remove existing seawall and groynes. Provide erosion protection to promontory created north of Pier. Remove areas of seawall that have been abandoned due to realignment. Improve existing/ create suitable beach access ramp to ensure access to foreshore following the realignment.	SMP discussed realignment at this location in the period 2026-2055. Would better align the EM defence with the eroding cliff frontage to the north but would move the current pressure point at the north end of the EM defence, to the Pier. Would need to be considered in conjunction with similar and concurrent option for EA EM seawall. Allowing to fail would create severe H&S risks so must be dismantled. Dismantling to leave safe would be technically challenging and very costly. Cost of re-build of clay embankment within marshland behind would also be substantial.	No	Aligns with SMP as potential future management policy for the EM frontage but would be hugely challenging and expensive (both to safely dismantle existing and build new set-back defence in marshland). Not necessary or appropriate at this stage. Issues can be addressed by more cost-effective options. May be more appropriate in the future as erosion pressure increases along the EM frontage as the cliffs continue to erode.

Table 9 - Long List Options for Environment Agency (EA) Easton Marshes (EM) Frontage

Option	Name	Description of works	Commentary	Shortlist	Commentary
EAEM BL DN	Do Nothing	No repair, maintenance or other works would be carried out other than necessary actions to deal with immediate health and safety risks.	Volatility would continue putting seawall at risk of toe exposure. Beach levels would drop and beach crest would narrow (as pre 2005 PAR scheme where previous groynes failed) increasing overtopping.	Yes	Do Nothing is used in appraisal to act as a baseline against which all other options are tested.
EAEM BL DM	Do Minimum	Patch and repair existing seawall. Use rock from existing structures to provide stability to wall when critical beach levels are exceeded.	Works only undertaken to mitigate the risk of breach. Eventually, beach levels would drop and beach crest would narrow (as pre 2005 PAR scheme where previous groynes failed) increasing overtopping and risk of seawall failure. Using material from existing structures would be cheapest means of obtaining material required to provide short term stability to seawall. Removing rock from structures would likely accelerate the lowering of beach levels.	Yes	Do Minimum is used in appraisal to act as a baseline against which all other options are tested..
EAEM PAR	Implement existing PAR	Continue with works to Easton Marshes frontage from current scheme detailed in the existing PAR.	Continuing works from existing PAR should continue to provide limited protection to the frontage but would not address issues that have been highlighted with this Initial Assessment. Volatility would continue putting seawall at risk of toe exposure and potentially impact amenity value.	Appraisal	Would not achieve project objectives and situation would likely worsen with time.
EAEM LL 1	Beach recycling	Removal of material from area of beach that is accreting (e.g. The Denes) to feed the groyne bays that have depleted. Pile plating or repiling and repairs to the concrete wall may also be required to safeguard seawall integrity against low beach levels, pile exposure and continued corrosion and abrasion.	2016 ENBE reports estimates there is 5,000m^3 of material that could be removed from the Denes without significant impact. However, this would not be sufficient to restore all bays to design profile although may delay erosion in worst hit bays or provide enough material for a small number of bays. Availability of future material would need to be explored through ongoing monitoring. Unlikely that the renourished beach would remain for a sufficient length of time unless combined with other options designed to better retain the beach.	No	Given available limited recycling quantity calculated by ENBE, this is not a feasible option for the EA EM frontage. Recycling from the Denes cannot be transported along the beach to the EM frontage, so would have to come through the town, which would be problematic. Supply would not meet demand given increased erosion pressure over this frontage in the future. If material was obtained from the Denes it would be subject to ongoing monitoring supporting the availability of material. May become more feasible option as a future maintenance option of any future scheme.

Option	Name	Description of works	Commentary	Shortlist	Commentary
EAEM LL 2	Beach nourishment (existing grading)	Beach Nourishment along EA EM frontage. Retain existing groynes unmodified. Pile plating or repiling and repairs to the concrete wall may also be required to safeguard seawall integrity against low beach levels, pile exposure and continued corrosion and abrasion. Create access through modification of existing cliff face allowing beach access at the northern extent of scheme.	Estimated that 25,000m^3 of beach has been lost from 2006 scheme (EA EM frontage) (ENBE, 2016) and, therefore, a similar amount would be required to restore beaches to design profile. Based on the losses since 2006, required beach recharge frequency would initially be approximately 15 years although the frequency would likely increase as exposure and erosion pressure increases. Eventually, beach levels would drop and beach crest would narrow (as pre 2005 PAR scheme where previous groynes failed) increasing overtopping. The construction of a new beach access ramp at the transition with Easton Bavents will provide alternative, more reliable maintenance access to the beach.	No	Increasing erosion pressure will make it ever more difficult to hold a beach along the EA EM frontage. Required nourishment campaigns will become more frequent. Resilience of recharge could be improved with coarser material but still uncertainty as to whether the renourished beach would remain for a sufficient length of time. To increase viability and improve cost effectiveness (due to high mobilisation costs of dredgers) recharge would likely be combined with recharge to other frontages Without plating, there would be a risk of further prolonged exposure of sheet piles potentially leading to failure.
EAEM LL 3	Beach nourishment (coarser grading)	Nourishing the EA EM groyne bays with a coarser shingle material to provide greater stability due to larger particle size and encourage a steeper beach slope to form between the existing groynes. Pile plating or repiling and repairs to the concrete wall may also be required to safeguard seawall integrity against low beach levels, pile exposure and continued corrosion and abrasion. Create access through modification of existing cliff face allowing beach access at the northern extent of scheme.	Less of an amenity concern since the EA EM frontage not considered an amenity beach. Material has added effect of being less mobile than sand, further reducing movement and loss through the system although uncertainty as to whether the renourished beach would remain for a sufficient length of time. Would likely require a heavy shingle to be effective. Heavier pile plating or piling may be required due to the coarser material. The construction of a new beach access ramp at the transition with Easton Bavents will provide alternative, more reliable maintenance access to the beach.	No	Although a coarser grade nourishment material would be expected to be more resilient, increasing erosion pressure will still make it difficult to hold a beach along the EA EM frontage. Required nourishment campaigns will become more frequent. To increase viability and improve cost effectiveness (due to high mobilisation costs of dredgers) recharge would likely be combined with recharge to other frontages. Without plating, there would be a risk of further prolonged exposure of sheet piles potentially leading to failure.

Option	Name	Description of works	Commentary	Shortlist	Commentary
EAEM LL 4	Modification of existing groyne length with nourishment	Lengthen existing rock groyne(s) over EA EM frontage to better hold material under long-shore conditions, and reduce material escaping the bay under cross-shore conditions. Would require nourishment. Pile plating or repiling and repairs to the concrete wall may also be required to safeguard seawall integrity against low beach levels, pile exposure and continued corrosion and abrasion. Would also require a robust solution to deal with the outflanking risk at the northern end of the wall. Create access through modification of existing cliff face allowing beach access at the northern extent of scheme.	Would reduce supply of sediment to the Town frontage and WDC EM frontages under southerly drift conditions as more material is trapped in the EA EM bays. Would require initial nourishment although design should reduce future losses. Lengthening groyne R8 at the northern end could accelerate cliff erosion and enhance outflanking risk under southerly conditions. It may not be feasible to lengthen groynes sufficiently to reliably maintain a protective beach. Bays would still be susceptible to cross-shore (easterly storm) loss although drawn down material may still be contained within the groyne bay with the longer groynes and then be pushed back up the beach under more favourable wave conditions. Should encourage formation and stability of higher beach levels in front of the existing access ramp, thereby improving beach access. The construction of a new beach access point at the transition with Easton Bavents will provide alternative access to the beach.	No	The transition between the EA frontage and the WDC EM frontage is key to overall scheme success. Expensive to modify groynes in this way. Groyne ends would have to be extended into deeper water, possibly requiring marine plant. Beach material would still be susceptible to cross-shore movement/loss. Longer groynes could starve beaches to the south and accelerate erosion of the cliffs and increase the outflanking risk to the north. Option may require future modifications to be sustainable across the entire appraisal period.
EAEM LL 5	Modification of existing groyne spacing with nourishment	Construction of new rock groyne(s) between existing rock groynes at EA EM frontage to create a more compressed beach plan shape. Would require nourishment. Pile plating or repiling and repairs to the concrete wall may also be required to safeguard seawall integrity against low beach levels, pile exposure and continued corrosion and abrasion. Would also require a robust solution to deal with the outflanking risk at the northern end of the wall. Create access through modification of existing cliff face allowing beach access at the northern extent of scheme.	Compressed beach shape would allow a wider beach to exist in the mid-point of the bay, hold more material and help to mitigate the effects of cross-shore loss although bays would still be susceptible to cross-shore (easterly storm) loss. Would also require nourishment. If rock groyne adopted then groynes likely require more rock than some of the options to modify existing groynes. Option would not protect against cross-shore movement but would encourage more material to be held in the bays, thus making the bays more resilient to cross-shore loss. With initial nourishment, should encourage formation and stability of higher beach levels in front of the existing access ramp. The construction of a new beach access point at the transition with Easton Bavents will provide alternative access to the beach.	No	Should increase the stability of the material in the bays under typical long-shore conditions, but the bays would still be vulnerable to cross-shore losses. That pressure will increase as the cliffs to the north continue to erode making the EM frontage more exposed. Unlikely that a beach could be held without frequent recharge campaigns. Option may require future modifications to be sustainable across the entire appraisal period.

Option	Name	Description of works	Commentary	Shortlist	Commentary
EAEM LL 6	Modification of existing groyne shape/type with nourishment	Modify the seaward extent of EA EM groyne(s) to create 'T' head or 'Y' shape groynes. Would require nourishment. Pile plating or repiling and repairs to the concrete wall may also be required to safeguard seawall integrity against low beach levels, pile exposure and continued corrosion and abrasion. Would also require a robust solution to deal with the outflanking risk at the northern end of the wall. Create access through modification of existing cliff face allowing beach access at the northern extent of scheme.	Modifying the existing groyne shape would improve sand retention within the bays by reducing potential for cross-shore losses. Would require initial nourishment although design should reduce losses compared to the existing situation regarding future nourishment. With initial nourishment, should encourage formation and stability of higher beach levels in front of the existing access ramp, thereby improving beach access. The construction of a new beach access point at the transition with Easton Bavents will provide alternative access to the beach.	No	Should improve resilience against cross-shore losses but would not eliminate risk entirely. Modification of R8 is almost certainly required to manage the transition between the EA EM frontage and the eroding cliffs to the north and facilitate maintenance access to the beach – as discussed in other options. Option may require future modifications to be sustainable across the entire appraisal period.
EAEM LL 7	Create offshore reefs between existing groyne(s) with nourishment	Construct small offshore reefs (possibly submerged) within existing bay(s) to reduce cross-shore losses and promote creation of crenulate-shape, embayments. Would require nourishment. Pile plating or repiling and repairs to the concrete wall may also be required to safeguard seawall integrity against low beach levels, pile exposure and continued corrosion and abrasion. Would also require a robust solution to deal with the outflanking risk at the northern end of the wall.	Would be relatively expensive to construct, probably requiring marine plant. Would act as a barrier to easterly storms and reduce cross-shore losses. Salient would likely form in the lee increasing bay stability. Would require initial nourishment although design should reduce losses based on the existing situation regarding future nourishment. Should encourage formation and stability of higher beach level in front of the existing access ramp, thereby improving beach access. The construction of a new beach access point at the transition with Easton Bavents will provide alternative access to the beach.	No	Costs likely to be relatively high. Although the reefs should reduce losses and volatility, losses would still be expected, and relatively frequent nourishment campaigns may be required due to increasing erosion pressure over this frontage in the future. Reefs would improve performance under cross-shore conditions but could prevent bays filling through long-shore processes – encouraging more material to pass long-shore across the bay. Would be technically more challenging and likely expensive. Option may require future modifications to be sustainable across the entire appraisal period.
EAEM LL 8	Retain existing groynes, create new rock revetment and construct new northern control structure	Install modified/J-shape groyne at northern extent of EA EM wall to promote formation of a stable embayment within the cliff frontage to the north and facilitate maintenance access. Extend across toe of cliff to reduce EA EM wall outflanking risk. Install rock revetment between groyne bay(s) affected by beach drawdown to provide support to the seawall and scour protection to the toe of the structure. The toe of the revetment should be designed to be installed at a level below future predicted beach levels. Pile plating or repiling and repairs to the concrete wall may also be required to safeguard seawall integrity against low beach levels, pile exposure and continued corrosion and abrasion.	Cliff erosion may accelerate immediately north of the control structure until the embayment stabilises, but the current erosion hotspot would be pushed north (thereby reducing the outflanking risk) and away from nearby cliff-top residences. As the coastline realigns before reaching equilibrium, it may trap sediment from the north reducing the sediment available for the frontages to the south for a time, but the impact of this will be lessened by the presence of the rock revetment which would provide stability to the seawall and reduce reflection and scour at the toe. Bays would still retain some sand for additional protection. Interface detail with existing defences would be required. The construction of a new beach access point at the transition with Easton Bavents will provide alternative access to the beach.	Yes	Retaining the existing groynes should ensure that some beach material is retained within the bays and reduce the risk of the revetment becoming undermined. Retaining the groynes would also lessen the impact on the WDC EM frontage compared to options where they are removed. Option to add new rock to form revetment may be more cost-effective than dismantling the existing groynes (which would not provide a sufficient quantity so would also incur rock barge mobilisation costs) and could prove more expensive overall due to the cost in dismantling. At the access at the transition between WDC and EM frontage the revetment rock could be selectively placed to create a relatively smooth slope down onto the beach.

Option	Name	Description of works	Commentary	Shortlist	Commentary
EAEM LL 9	Dismantle existing groynes, create new rock revetment and construct new northern control structure	Install modified/J-shape groyne at northern extent of EA EM wall to promote formation of a stable embayment within the cliff frontage to the north and facilitate maintenance access through modification of existing cliff face. Extend across toe of cliff to reduce EA EM wall outflanking risk. Dismantle existing rock groynes and use the rock to construct a rock revetment across the EA EM frontage to provide support to the seawall and scour protection to the toe of the structure. The toe of the revetment should be designed to be installed at a level below future predicted beach levels. Pile plating or repiling and repairs to the concrete wall may also be required to safeguard seawall integrity against low beach levels, pile exposure and continued corrosion and abrasion.	Cliff erosion may accelerate immediately north of the control structure until the embayment stabilises, but the erosion hotspot would be pushed north (thereby reducing the outflanking risk) and away from nearby cliff-top residences. As the coastline realigns before reaching equilibrium, it may trap sediment from the north reducing the sediment available for the frontages to the south for a time. The impact of this will be lessened by the presence of the rock revetment which would provide stability to the seawall and reduce reflection and scour at the toe. Removing the groynes would mean that a significant amount of sediment disperses southwards. The construction of a new beach access point at the transition with Easton Bavents will provide alternative access to the beach.	Yes	With the removal of the groynes, beach levels in front of the seawall will drop further. This could impact (increase) wave loading on the seawall and increase overtopping (although this may be less of a concern along the EA EM frontage which has low amenity value). Removal of the groynes will increase pressure on the neighbouring WDC EM frontage, which may in turn require a more robust solution, but should allow freer sediment feed from the north. Re-using the rock from the groynes is an advantage but that may be off-set by high dismantling costs. Also, the existing groynes provide insufficient material with which to build the revetment, so additional imported rock will still be required incurring rock barge mobilisation costs. At the access at the transition between WDC and EM frontage the revetment rock could be selectively placed to create a relatively smooth slope down onto the beach.
EAEM LL 10	Retain existing groynes. New detached reef control structure and additional rock revetment	Create offshore structure at northern extent of EA EM frontage to allow long-shore moving material to bypass structure whilst reducing net erosion at the southern end of the cliffs. Structure would be positioned to allow salient to form in the lee protecting cliffs and encouraging stable bay formation, whilst still allowing material to move long-shore. Would require rock revetment at northern end to provide additional erosion protection. Install rock revetment between groyne bays affected by beach drawdown to provide support to the seawall and scour protection to the toe of the structure. The toe of the revetment should be designed to be installed at a level below future beach levels. Create access through modification of existing cliff face allowing beach access at the northern extent of scheme. Pile plating or repiling and repairs to the concrete wall may also be required to safeguard seawall integrity against low beach levels, pile exposure and continued corrosion and abrasion.	Cliff erosion may accelerate immediately north of the offshore control structure until the embayment stabilises, but the erosion hotspot would be pushed north (thereby reducing the outflanking risk) and away from nearby cliff-top residences. As the coastline realigns before reaching equilibrium, it may trap sediment from the north reducing the sediment available for the frontages to the south for a time, but the impact of this will be lessened by the passage of material landward of the structure and the presence of the rock revetment which would provide stability to the seawall and reduce reflection and scour at the toe. Bays would still retain some sand for additional protection. Interface detail with existing defences would be required. The construction of a new beach access point at the transition with Easton Bavents will provide alternative access to the beach.	No	Retaining the existing groynes should ensure that some beach material is retained within the bays and reduce the risk of the revetment becoming undermined. Retaining the groynes would also lessen the impact on the WDC EM frontage compared to options where they are removed. The ability of the offshore structure to allow long-shore material to pass landward, will reduce its effectiveness in creating a stable equilibrium bay. The design would need to balance these two objectives which could be challenging/risky - particularly in the light of known long-shore drift reversal and the requirement to accommodate future changes in cliff alignment. Likely to require more extensive modelling than other options, and relatively expensive marine plant to install. At the access at the transition between WDC and EM frontage the revetment rock could be selectively placed to create a relatively smooth slope down onto the beach.

Option	Name	Description of works	Commentary	Shortlist	Commentary
EAEM LL 11	Dismantle existing groynes. New rock revetment with new detached reef control structure	Create offshore structure at northern extent of EA EM frontage to allow long-shore moving material to bypass structure whilst reducing net erosion at the southern end of the cliffs. Structure would be positioned to allow salient to form in the lee protecting cliffs and encouraging stable bay formation, whilst still allowing material to move long-shore. Would require rock revetment at north end to provide additional erosion protection. Dismantle existing rock groynes and use the rock to construct a rock revetment across the EA EM frontage to provide support to the seawall and scour protection to the toe of the structure. The toe of the revetment should be designed to be installed at a level below future predicted beach levels. Pile plating or repiling and repairs to the concrete wall may also be required to safeguard seawall integrity against low beach levels, pile exposure and continued corrosion and abrasion. Create access through modification of existing cliff face allowing beach access at the northern extent of scheme.	Cliff erosion may accelerate immediately north of the offshore control structure until the embayment stabilises, but the erosion hotspot would be pushed north (thereby reducing the outflanking risk) and away from nearby cliff-top residences. As the coastline realigns before reaching equilibrium, it may trap sediment from the north reducing the sediment available for the frontages to the south for a time, but the impact of this will be lessened by the passage of material landward of the structure and the presence of the rock revetment which would provide stability to the seawall and reduce reflection and scour at the toe. The construction of a new beach access point at the transition with Easton Bavents will provide alternative access to the beach.	No	The ability of the offshore structure to allow long-shore material to pass landward, will reduce its effectiveness in creating a stable equilibrium bay. The design would need to balance these two objectives which could be challenging/risky - particularly in the light of known long-shore drift reversal and the requirement to accommodate future changes in cliff alignment. Likely to require more extensive modelling than other options, and relatively expensive marine plant to install. With the removal of the groynes, beach levels in front of the seawall will drop further. This could impact (increase) wave loading on the seawall and increase overtopping (although this may be less of a concern along the EA EM frontage which has low amenity value). Removal of the groynes will increase pressure on the WDC EM frontage but should allow freer sediment feed from the north. Re-using the rock from the groynes is an advantage but that may be off-set by high dismantling costs. Also, the existing groynes provide insufficient material with which to build the revetment, so additional imported rock will still be required incurring high barge mobilisation costs. At the access at the transition between WDC and EM frontage the revetment rock could be selectively placed to create a relatively smooth slope down onto the beach.
EAEM LL 12	Steel plating	Where sheet pile at seawall toe has been exposed use steel plating to patch and repair existing sheet piles as they near end of life. Following plating, drill down and inject concrete into voids.	Steel plating at the toe is the current practice for repairing degradation through corrosion and abrasion at the sheet pile toe. A short distance (circa 20 m) of pile plating repair of the most eroded areas is scheduled to occur outside current IA/OBC process. These areas would not require rework. As beach levels drop failure of seawall would likely be from geotechnical stability of the seawall rather than degradation of the sheet pile.	No	Without intervention to maintain beach or provide stability through revetment, beach levels are likely to fall below critical levels within the appraisal period and therefore plating alone would not be sufficient. Could be used in combination with other options to repair sheet pile wall if defects are found, dependent on thickness of sheet pile.
EAEM LL 13	Managed realignment	Creation of setback embankment behind EA EM defence including the removal of some of the existing groynes affronting the EA defences and removal of the EA EM Sea Wall. Existing beach access would be at transition with WDC extent and would require improvement.	SMP discussed realignment at this location in the period 2026-2055. Would better align the EM defence with the eroding cliff frontage to the north but would move the current pressure point at the north end of the EM defence, to the Pier. Allowing to fail would create severe H&S risks so must be dismantled. Dismantling to leave safe would be technically challenging and very costly. Cost of re-build of clay embankment within marshland behind would also be substantial. Would need to be considered in conjunction with similar and concurrent option for WDC EM seawall.	No	Aligns with SMP as potential future management policy for the EM frontage but would be hugely challenging and expensive (both to safely dismantle existing and build new set-back defence in marshland). Not necessary or appropriate at this stage. Issues can be addressed by more cost-effective options. May be more appropriate in the future as erosion pressure increases along the EM frontage as the cliffs continue to erode.

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