Preferred Option Report

Langstone Flood & Coastal Erosion Risk Management Scheme

Eastern Solent Coastal Partnership

60578525

April 2019

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Quality information

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1. Introduction

1.1 Background

AECOM was commissioned by the Eastern Solent Coastal Partnership (ESCP) to undertake an option appraisal study and develop an outline design and business case for a tidal flood risk management scheme at Langstone, Hampshire.

This document is the preferred option report for the study. It provides details of the final stage of the option appraisal process, the appraisal of the short list of options and selection of the preferred option. Following the confirmation of the preferred option, the outline design stage will commence and a funding case will be assembled.

For additional information on the preceding stages of the option appraisal process; selection of the long list of options and the selection of the short list of options, refer to the long list options report and the short list options report.

The 1km Langstone frontage is within the jurisdiction of Havant Borough Council (HBC) and located on the mainland, immediately to the north of Hayling Island. At the site a number of residential properties as well as two public houses and the Sailing Club which are located close to the water's edge. The study location forms part of a wider flood cell which also covers the adjacent Southmoor frontage to the west. The study area and spatial boundaries of the project are shown in Figure 1-1.

Figure 1-1: Study site

1.2 Management context

The 2010 North Solent Shoreline Management Plan (SMP) policy for the frontage is to 'Hold the Line' for the next 100 years with potential for 'Managed Realignment' at Southmoor. The subsequent Portchester to Emsworth Flood and Coastal Erosion Risk Management Strategy (2013, herein referred to as PEMS) which was adopted by HBC recommends improving the defences at Langstone to a minimum 1:75yr (1.3% AEP) Standard of Protection (SoP) through a phased approach.

For the present day there are 73 residential properties at risk of flooding from a 1 in 200 year (0.5% AEP) tidal flood event. There are also four non-residential properties at risk of flooding from the same return period event. Due to sea level rise, in 100 years' time 123 residential properties and nine non-residential properties are expected to be at risk from a 1 in 200 year (0.5% AEP) event.

In addition to the Flood and Coastal Erosion Risk Management (FCERM) context of the Langstone frontage, the A3023 road, providing the only road access to and from Hayling Island, passes through the site. The Langstone Scheme is therefore viewed as an essential element when considering the need to protect access on to and off the Island during extreme flood events, with particular reference to the requirement to maintain access for emergency services. The Local Plan review for HBC has also identified the potential for significant housing development on Hayling Island (>1000 properties by 2036) but this is likely dependent on a number of factors including the likelihood of any scheme at Langstone and its ability to help ensure safe access and egress onto the Island.

1.3 Appraisal baseline

As part of the option appraisal process it is necessary to establish a baseline from which alternative options can be compared and appraised against. The Do Nothing (walk away) and Do Minimum (patch and repair reactive maintenance) scenarios have been considered and are included in the short list of options for each Option Development Unit (ODU).

An increase in flood risk (which will occur with the Do Nothing, Do Minimum and Maintain approaches) will cause direct damages to assets in the area but will also have indirect impacts on tourism and recreation in the area and cause a loss of rental income for properties. This is likely to lead to an increase in business claims as a result of closures. The Do Nothing approach also increases the risk of public liability injury claims due to unsafe defences, degrading footpaths and associated structures. The increase in flood risk and associated impacts underlines the importance of properly planned and robust flood and erosion risk management for the frontage.

2. Short List Options

2.1 Option Development Units

To facilitate the option development and appraisal process the frontage has been broken down into four ODUs. These are presented in Figure 2-1 and are as follows:

- ODU 1: Langstone West, between the east bank of the Langbrook Stream to the edge of the formal defences at the northern end of Langstone Spit
- ODU 2: Sailing club and Langstone Spit, including the spit, sailing club and A3023 revetment
- ODU 3; Langstone east, between the Ship Inn car park and the Old Mill slipway
- ODU 4: Old Mill and Mill pond, between the Old Mill slipway and the slipway to the north east of the Mill pond.

The four ODUs have been divided further to assess options on a local level.

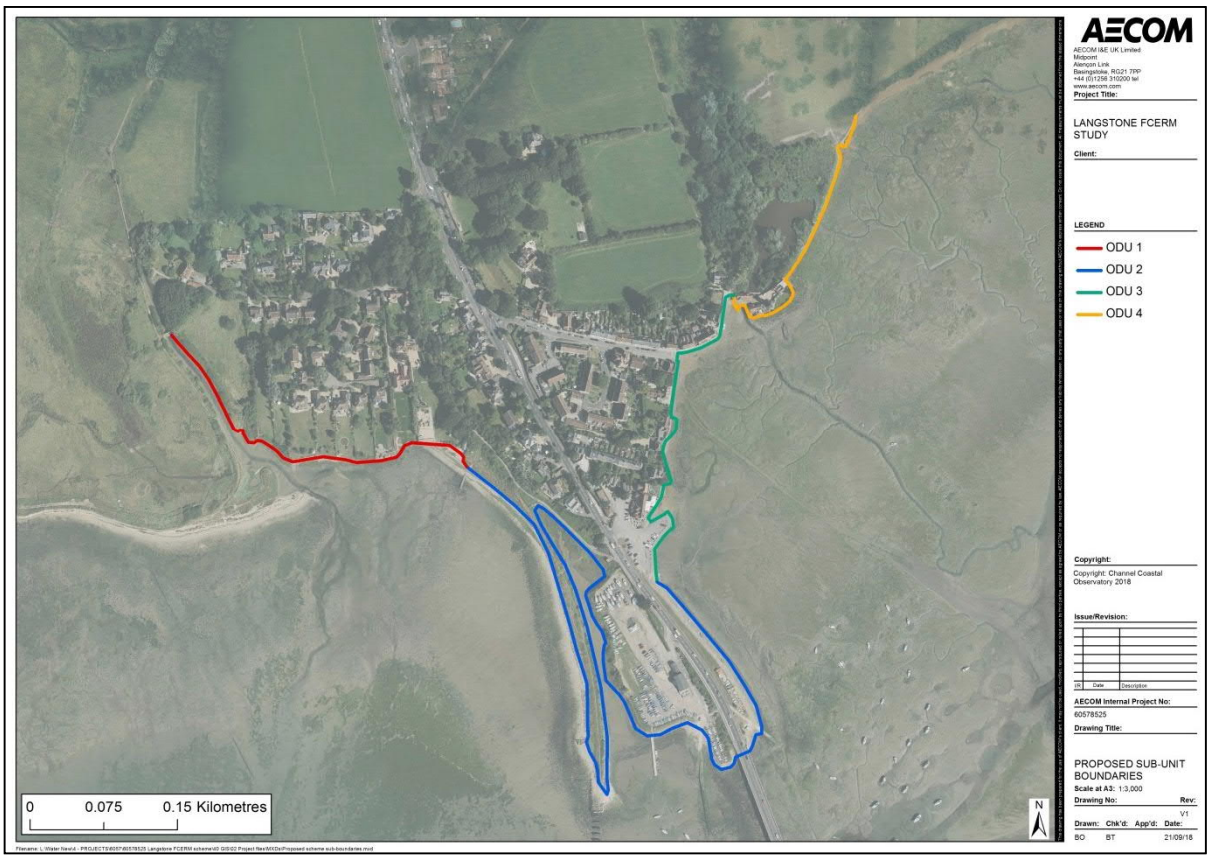

Figure 2-1: Study unit boundaries

2.2 Short list defence measures

The Short List Option report (AECOM, 2018) outlines the short list defence measures in each ODU and ODU sub-unit and how these were analysed. Typically, several different defence measures have been identified on the short list for each sub-unit. A number of the defence measures rely on the existing structures for their structural integrity (for example, crest raising relies on the existing quay walls) and therefore maintenance and refurbishment of the existing defences and shoreline structures has been included in the costing of options (see Economics Report, AECOM 2019). A breakdown of the ODU sub-units and short least options in each unit is presented below.

2.2.1 ODU 1

ODU 1 spans the east bank of the Langbrook Stream to the edge of the formal hard defences at the northern end of Langstone Spit. The ODU has been broken down into two sub-units based on existing defence types; ODU 1a and ODU 1b. The short list defence measures in each sub-unit are presented in Figure 2-2.

2.2.2 ODU 2

ODU 2 includes Langstone Spit, the Sailing Club and the National Cycle Route 2 Path. The ODU has been broken down into three sub-units; ODU 2a, ODU 2b and ODU 2c. The short list defence measures in each sub-unit are presented in Figure 2-3.

2.2.3 ODU 3

ODU 3 covers the east side of Langstone between the Ship Inn car park and the Old Mill. The defences along this frontage are varied and there are number of unique constraints at the local level so therefore this ODU has been broken down into 12 sub-units; ODU 3a to ODU 3L, to facilitate option development. The short list defence measures in each sub-unit are presented in Figure 2-4 and Figure 2-5.

2.2.4 ODU 4

ODU 4 extends from the Mill to the eastern end of the study frontage. The defences in this ODU primarily consist of a vertical brickwork retaining wall. This ODU is broken down into 2 sub-units; ODU 4a and ODU 4b, to facilitate option development. The short list defence measures in each sub-unit are presented in Figure 2-6.

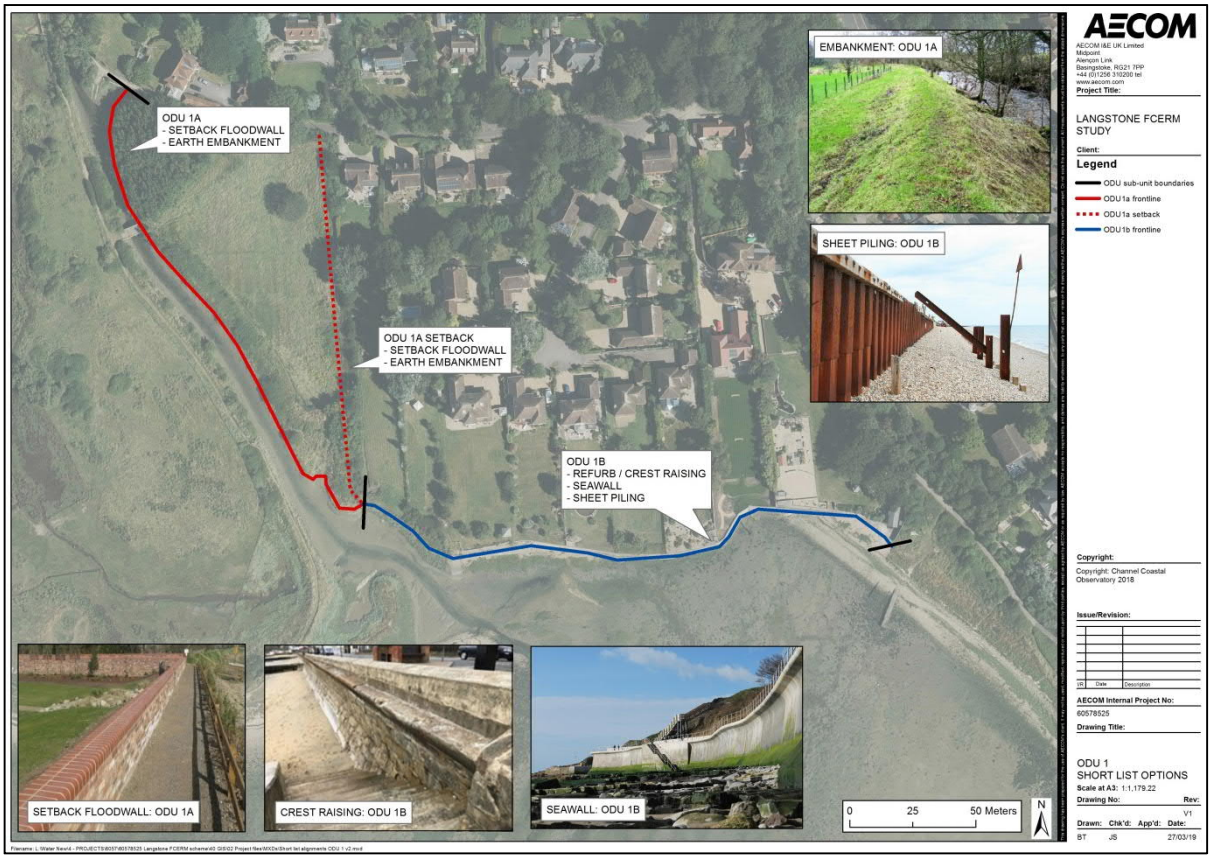

Figure 2-2: ODU 1 short list defence measures and alignments

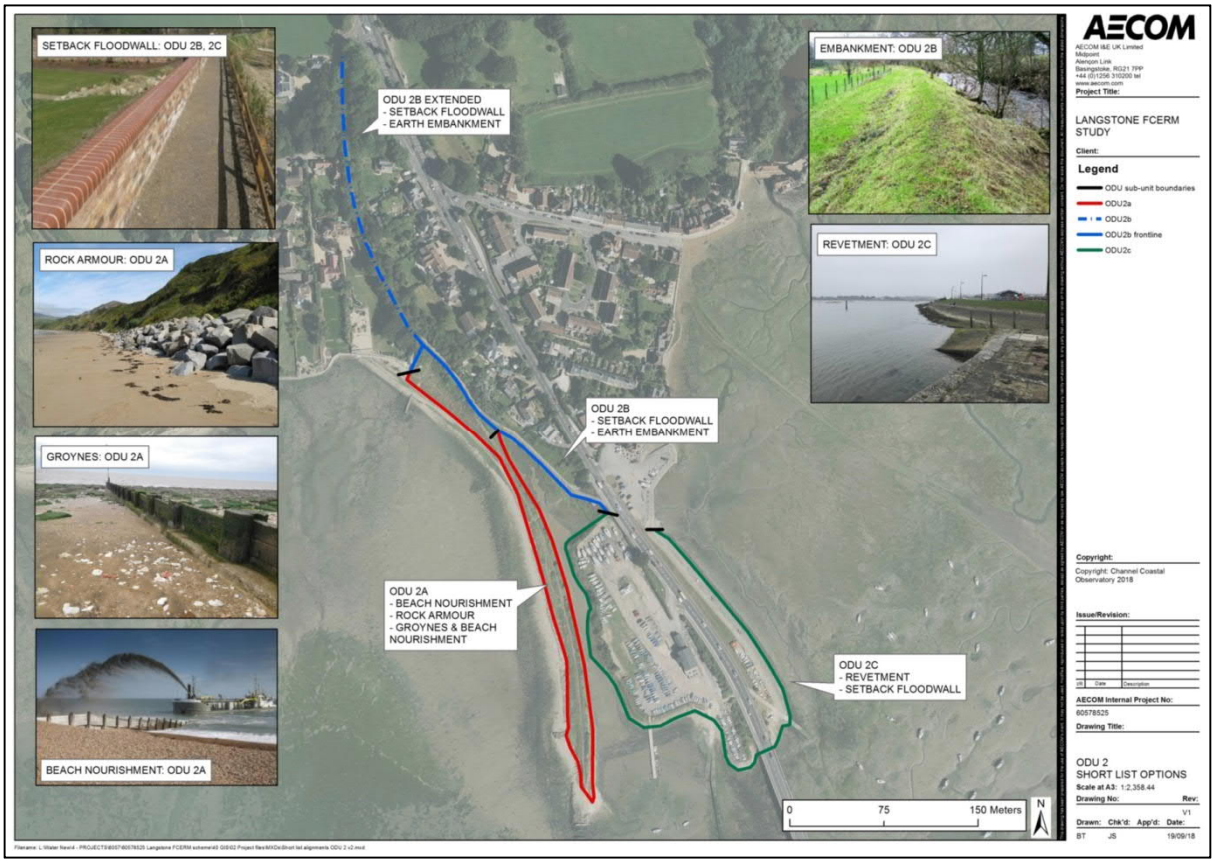

Figure 2-3: ODU 2 short list defence measures and alignments

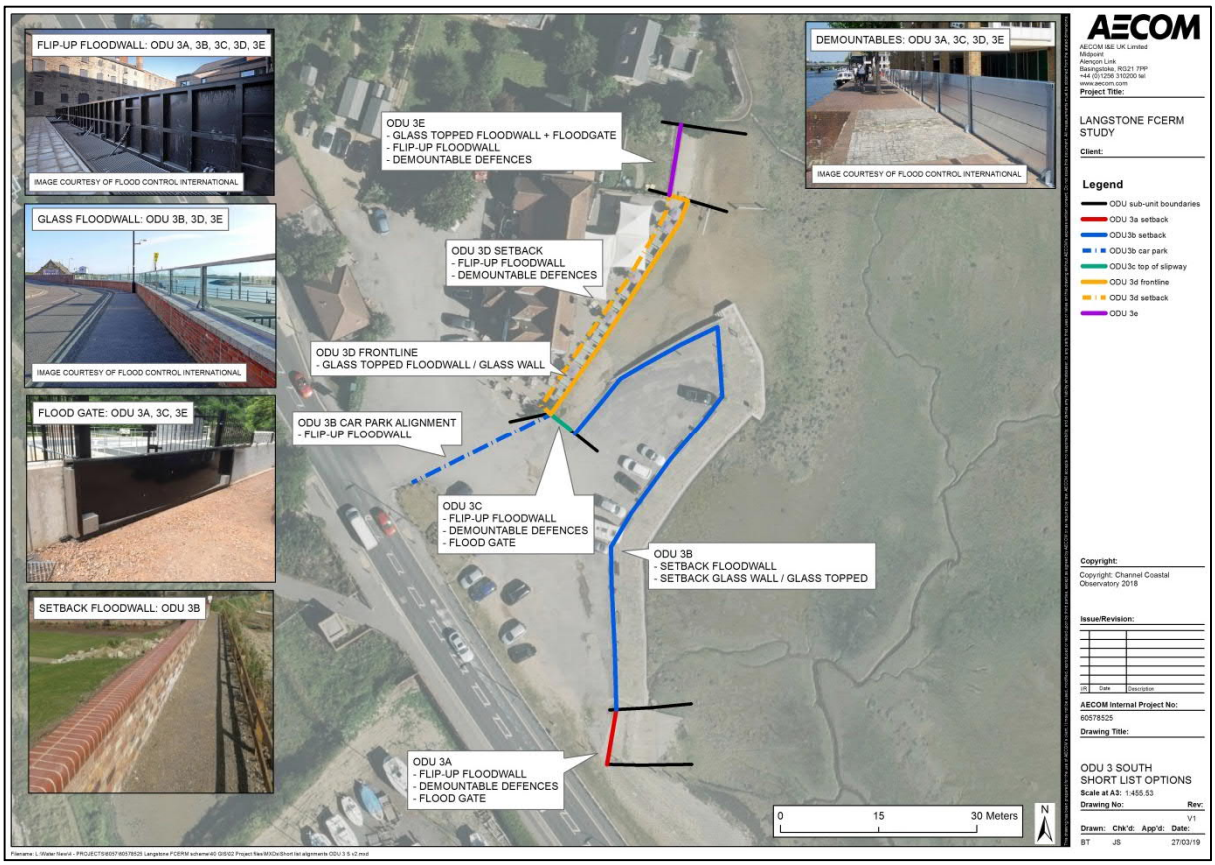

Figure 2-4: Short list defence options and alignments in ODU 3 (south section)

Figure 2-5: Short list defence options and alignments in ODU 3 (north section)

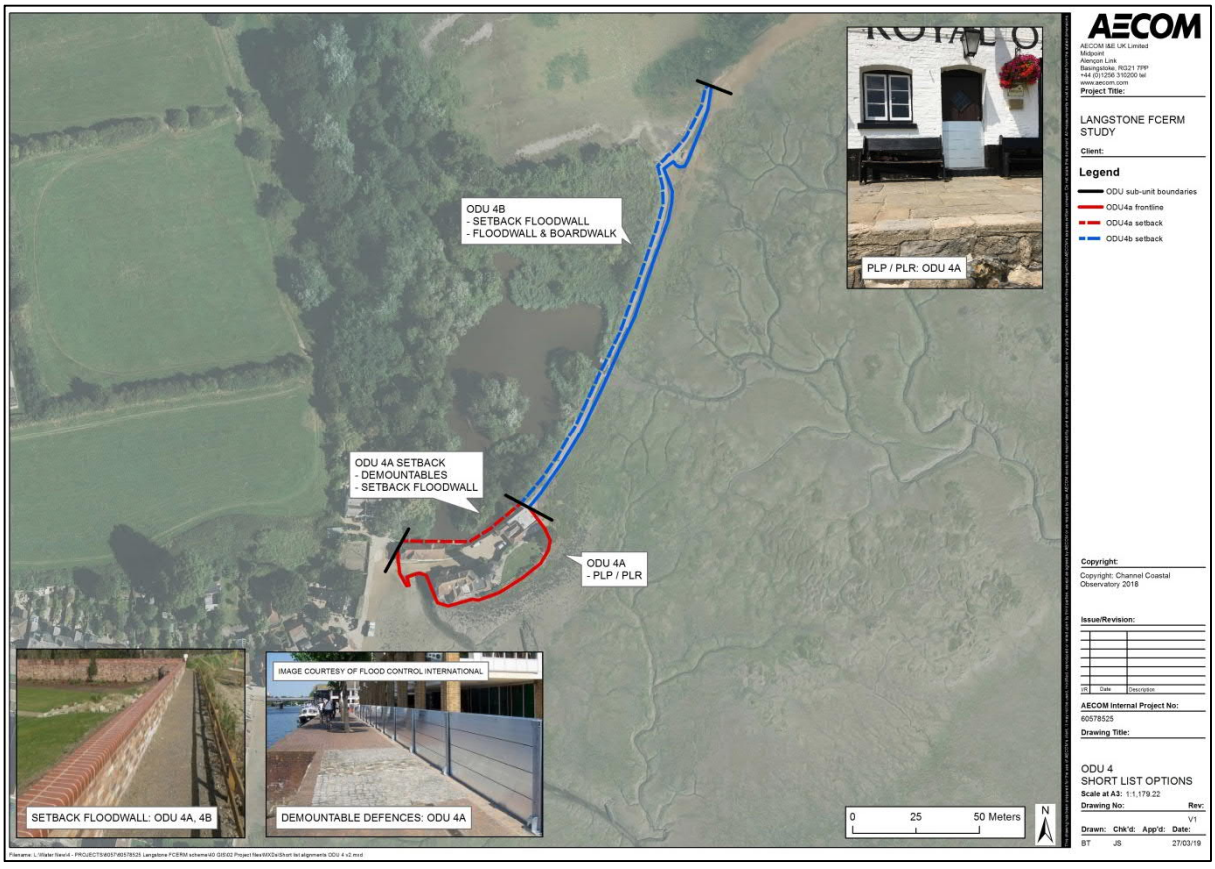

Figure 2-6: Short list defence options and alignments in ODU 4

2.3 Option apprasisal period

From a strategic perspective PEMS recommends that the standard of protection is improved at the site and then sustained for the next 100 years. This could be achieved in one of two ways:

- Precautionary approach; improving the defences now to a design standard in 100 years' time. For example, designing the defence to provide a 1 in 200 year SoP for 2119. This would essentially over-engineer the defence for the present day and lead to the defence being significantly higher than it needs to be for the majority of the next 100 years. As sea levels rise over the next 100 years, the standard of protection would gradually decrease in line with the design standard in 100 years' time. The benefit of this approach is that the defence would not need to be raised over the next 100 years (depending on observed rates of sea level rise) and the only future costs would be associated with maintenance.
- Adaptive approach; improving the defences to a design standard for the present day or an interim point in time, for example, a 1 in 200 year SoP for 2019 or a 1 in 200 year SoP for 2069. Unlike the precautionary approach, due to future sea level rise, the defence would need to be replaced or raised at a point in time, or at multiple points in time over the next 100 years. Whilst the successive raising is likely to increase future costs, the initial cost of a defence with a lower standard of protection would be less than the precautionary approach. An additional benefit of the adaptive approach is that the rates of sea level rise can monitored over time and the defence can be raised as and when required. Sea level rise is an inherently uncertain process and monitoring the observed rates provides greater flexibility and reduces the likelihood of over or under designing the defence (as with a precautionary approach).

Based on the economic analysis undertaken as part of this study a managed adaptive approach is considered a more realistic and deliverable solution at the site compared to a precautionary approach.

Due to the projected flood extent and depths at the site a precautionary approach, whereby a defence is constructed initially to a high standard mitigating climate change in 100 years' time, would require very high and long defences. This would be both technically difficult to achieve and very challenging to fund and deliver. In addition, a key issue for the local community and stakeholders relates to the impact that new high defences would have on the local landscape and environment, with both parties favouring lower defences to reduce visual impacts and help preserve the character of the area. Based on the points mentioned, the precautionary approach is not considered to be an acceptable approach at this site.

Instead, it is more appropriate for the scheme to be adaptive and deliver the desired standard of protection for either the present day or an interim period. Sea level rise over the short to medium term is expected to be significantly less than in 100 years' time so with this managed adaptive approach the defences require lower height and length, which is less technically challenging, more deliverable and is more likely to be acceptable and supported by the community and stakeholders.

Following the managed adaptive approach, it is best practice for the initial scheme to be appraised over a shorter time period (rather than the precautionary 100 year time window). As such, two scheme appraisal periods have been considered; 30 and 50 years. A number of the defence measures on the short list have typical service lives of up to 50 years (e.g. hinge flood gates, demountable defences, flip-up barriers) and therefore the likely scheme design life of up to 50 years will match the appraisal periods that are being considered. The costs and benefits of the defence measures over these shorter scheme durations have been established and are presented in the Economics Report (AECOM, 2019).

3. Appraisal Methodology

3.1 Basis for selecting the preferred option

Appraisal of the short list defence measures and selection of the preferred option has been undertaken within the framework of the FCERM appraisal guidance (FCERM-AG). The process for selecting the preferred option is outlined in the list below. There are five stages outlined in the guidance; stages 1-4 have been undertaken as part of selecting the leading economic standard of protection and are outlined in the Economics Report (AECOM, 2019).

Stage 5 is the final stage of the appraisal process. It involves considering other factors, such as the wider objectives of the study, the environment and stakeholders. This stage is important to ensure that the recommended preferred option is supported by the stakeholders involved in the project. The following chapters provide a detailed account of the Stage 5 appraisal on an ODU by ODU basis.

Stage 1 – Establish the whole life costs and benefits of the short list options. Ensure each option being taken forward and considered further has an Average Benefit Cost Ratio >1.

Stage 2a – Organise the options. Following the FCERM decision making process the short list options are organised by reducing level of probability of flooding (i.e. by their standard of protection). In instances where this cannot be done (e.g. where two or more options provide protection to a similar level of flood risk, reduce or remove coastal erosion risk, provide different strategic methods or approaches and/or provide different ways of providing the same outcome), then the options should be organised by the Average Benefit Cost Ratio (ABCR).

Stage 2b – Identify leading economic option. Once the options have been organised, the decision process is started by selecting the option with the highest ABCR as the leading economic option. Next, the Incremental Benefit Cost Ratio (IBCR) between the options is used to help decide 'how far' the probability of flooding can be reduced.

Stage 3 – Accounting for contributions. Consider any financial contributions which may have been secured and the impact this has on the average and incremental benefit cost ratios of options and the choice of the leading economic option.

Stage 4 – Testing uncertainty. Undertake sensitivity tests to determine whether uncertainty would influence the choice of the leading economic option. For example, would significant cost increases / decreases largely alter the average and incremental benefit cost ratios and how would this change the choice of the leading option?

Stage 5 – Consider other factors to determine if an alternative option would be preferred. Consider the costs and benefits of delivering more of the objectives, providing enhancements, or approaches that are adaptable to future changes in risk.

Other factors may include both monetised and non-monetised benefits and the sustainability of an option should be considered (for example, one that is more in keeping with environmental objectives or one that offers a greater degree of environmental or social enhancement). A decision should be made as to whether any additional cost is worthwhile, taking into account all factors and responses from consultation and project objectives.

The sections below discuss the wider factors considered during Stage 5 of the option appraisal process.

3.2 Environmental impacts

A detailed multi-variate appraisal of the short list defence measures in each ODU sub-unit against the key environmental objectives which were agreed by the project team. The multi-variate appraisal has been carried out by the environmental specialists from AECOM with support from the ESCP environment team. A detailed breakdown of the environmental objectives can be found in the Short List Options Report Appendices. A summary of the objectives is outlined below:

Ecology
- Ensure the Conservation Objectives of the European designated sites are not compromised and integrity of the site is not adversely affected
- To maintain and where possible enhance and restore biodiversity resulting in an overall biodiversity net gain

Landscape
- Ensure the scheme preserves, and where possible, seeks to enhance the landscape character of the waterfront
- Ensure existing trees and vegetation are retained and where this is not possible ensure they are suitably replaced
- Seek to enhance the existing public open space, wherever possible
- Maintain existing levels of access to the foreshore
- Conserve and where possible enhance the natural beauty and special qualities of the Chichester Harbour AONB

Heritage
- Preserve and enhance the character and appearance of the Langstone, Wade Court and Mill Lane Conservation Areas
- Preserve and where possible enhance the listed and locally listed buildings and their setting
- Take necessary measures to protect the heritage assets in the area from flooding while preserving their character and appearance, including their setting
- Preserve key views from the conservation areas towards the coast, wetland and harbour but also key views towards the conservation areas
- Trees and hedges contribute to the rural character of the area and make a positive contribution and they should be retained, avoiding and minimising impacts on below ground archaeological remains

The results of the multi-variate appraisal have been used to identify which of the defence measures are most beneficial to the environment with respect to the environmental objectives. This has informed the choice of the preferred defence measures in each sub-unit.

3.3 Social impacts

The short list defence measures in each ODU sub-unit were presented to the public and stakeholders in a series of workshops and public exhibition events in November 2018. Feedback on the potential defences was obtained during the events in the form of written responses, a questionnaire and verbal feedback. The feedback responses have been collated and analysed.

The public exhibition events were widely advertised to local residents and businesses with a comprehensive leaflet drop carried out two weeks before the events. The leaflet provided the public with key information about the scheme and the details of how to attend the events. In addition, the events were widely advertised on the ESCP website and social media platforms. In total 114 people attended the two events and 52 questionnaire responses were completed.

In the questionnaire, the following questions were asked:

- What is your interest in the Langstone Coastal Defence Study?
- How would you like to be kept informed about the progress of the Langstone Coastal Defence Study?
- Which options would you find acceptable in each of the areas along the Langstone frontage?

The results of the questionnaire are summarised in the Shortlisted Coastal Defence Options Event report in Appendix A. A summary of the results is provided in the following chapters.

The feedback obtained has been used to inform the choice of the preferred defence measure in each sub-unit. A further stage of public and stakeholder consultation will be undertaken on the preferred option which will provide another opportunity to obtain feedback on the proposals.

3.4 Technical feasibility

The technical feasibility of each defence measure has been assessed by the AECOM project team. The team's understanding has been informed by numerous visits to the site, a visual condition assessment of the existing defences, ground investigation surveys undertaken in September 2018 and information obtained on the utilities / services at the site (see Appendix B). The construction and buildability is likely to be more challenging for some of the defence measures which could lead to additional risks and costs during the design and construction phases

A number of the defence measures on the short list are bespoke defences and products (e.g. demountable defences, flip-up flood barriers, flood gates) which would need to be sourced from specialist suppliers, such as Flood Control International. To support the appraisal a site visit was undertaken with the project team and a

representative from Flood Control International who provided technical input and provided an initial high level confirmation that each of the bespoke defence measures being considered was suitable for the site. Specific and specialist elements of these measures will be considered during the outline and detailed design stages of the scheme should the measures be taken forward.

3.5 Cost comparison

In establishing the leading economic standard of protection, the least cost defence measure in each ODU sub-unit was adopted. Whilst each of the defence measures on the short list for each ODU sub-unit is capable of providing the same standard of protection, some of the defence measures will support the environmental and social aspects of the appraisal more so than others. In addition, some defences will be more technically challenging to implement.

A comparison of the additional costs required to deliver more expensive defence measures in each sub-unit has been undertaken. This will enable the potential additional environmental, social and technical benefits of different defence measures in each sub-unit to be compared to the relative difference in cost that would be required for delivery. The estimated costs for the present day 1:200 year SoP have been used as a basis for the cost comparison.

All costs in subsequent sections of the report are presented in present value terms across the whole life of the scheme and include 60% optimism bias (unless otherwise stated in the economics report). Note that the existing costs are an approximation based on indicative SPONS build-ups and values provided by Flood Control International. There are uncertainties with this approach but it is the most suitable approach for developing costs for option comparison and appraisal. During the next steps of the project the costs of the preferred option will be refined following outline design and after obtaining ECI. The refined costs will provide more certainty as there will be more information available on the likely defence cross sections. In addition, a Monte Carlo assessment will also be undertaken to refine the risk allowance and optimism bias which has been applied.

3.6 Option scoring / ranking

FCERM-AG states that it is useful to rank the options based on which option is most preferred in terms of the additional environmental, social and technical benefits that can be delivered. For each of the categories, the different defence measures on the short list in each ODU sub-unit have been assigned a score between -2 and +2.

The scoring for the environmental category was based on the results of the multivariate assessment undertaken by AECOM's environmental specialists. In each ODU sub-unit, the multivariate environmental scoring for the short list options has been compared to the Do Nothing scoring. This has enabled the environmental impact of the short list options, relative to the Do Nothing scenario to be assessed. Depending on the impact of the short list option relative to the Do Nothing scenario, a score of between -2 and +2 has been assigned. A description of the criteria for each scoring is found in Table 3-1.

In addition to the environmental, social and technical categories, the economic category has also been scored. In this category, the least cost defence measure has been assigned a score of 0, with more costly measures scoring either -1 or -2. This scoring has been undertaken on a relative basis on an ODU sub-unit by sub-unit basis.

An initial scoring of the options was undertaken by the AECOM project team. The total score for each defence measure was summed and based on this a preliminary draft preferred defence measure in each sub-unit was identified. Immediately following this an internal project team workshop between ESCP and AECOM staff was held. During the workshop the preliminary draft preferred options were presented. A detailed discussion was held on the preliminary draft preferred options in each ODU sub-unit and updates to the scoring were made where necessary. The workshop enabled different viewpoints within the project team to be considered and a unanimous agreement was made on the preferred option in each of the ODU sub-units. The option appraisal and agreed preferred options are outlined in the following chapters. Table 3-1 below shows the scoring criteria for each of the categories.

Table 3-1: Scoring criteria for each of the categories

Category	Score				
	-2	-1	0	+1	+2
Environment	Option does not align with the environmental objectives. Option expected to have greater detrimental impacts relative to Do Nothing	Option does not align with environmental objectives. However, relative to Do Nothing, option aligns equally with objectives	Option partially aligns with environmental objectives. Similar impacts as the Do Nothing scenario	Where impacts exist, it is likely that these can be mitigated. Generally option equally or better aligns with objectives relative to Do Nothing	Option fully supports environmental objectives
Social	Option is widely rejected by the public and stakeholders with no support relative to the other options being considered	Option is rejected by a proportion of the public and stakeholders with little support relative to the other options being considered	Option has similar levels of support from the public and stakeholders relative to the other options being considered	Option is supported by significant proportion of the public and stakeholders and has more support relative to other options being considered	Option is supported by all of the public and stakeholders
Technical	Option is technically unfeasible due to major constraints, such as lack of space availability, unavoidable significant disruption to key services and poor ground conditions. Lack of design alternatives	Option is technically challenging due to major constraints but likely to be feasible with an appropriate design, for example, service diversions. Requires large resource to deploy.	NA	Option has minor constraints which can be designed around with an appropriate design. Requires small resource to deploy.	Technically feasible option with no obvious constraints
Cost	Significantly more costly than the least cost option in the sub-unit	More costly than the least cost option in the sub-unit	Least cost option being considered in the sub-unit	NA	NA

3.7 Potential scheme alignments

There are a variety of different defence alignments which could be chosen for the scheme at the study site. Whilst it is the aspiration to maximise the number of residents and properties protected from flooding, it may not be affordable or in line with the community's aspiration to do this. As an example, some sections of the frontage (e.g. ODU 4) have very few properties at risk of flooding but would require a relatively long length of defence (at a high cost) to provide the desired standard of protection. As a result, it may be more economical and in line with stakeholder objectives to proceed with a shorter defence alignment which excludes areas with few properties at risk (e.g. ODU 4) from the scheme benefit area. This could also lead to a higher chance of attracting funding for a scheme which increases deliverability.

Four different scheme alignments were discussed in the preferred options workshop. Figures showing each alignment are presented in Appendix C. The alignments included:

- Alignment A; a defence around the full length of the frontage, including protection to ODUs 1-4. This includes protection to the spit and Sailing Club, and a defence to the area to the east of the Mill.
- Alignment B; a defence between ODUs 1-3 but excluding ODU 4 from the benefit area. This alignment would provide protection for the spit but would not protect the Sailing club for the higher standards of protection (e.g. year 2069; 75yr SoP). At the east side the alignment would tie-in to high ground in the field to the west of the Mill Pond.
- Alignment C; a defence between ODUs 2-3, excluding ODUs 1 and 4 from the benefit area. This alignment includes an extension of the ODU 2b defence to tie-in to high ground in the north and prevent outflanking of the western side of the defences into the benefit area. This alignment would not include any protection to the spit or Sailing Club.
- Alignment D; same alignment as Alignment C, except for at the Ship Inn car park in ODU 3b, where the alignment goes across the car park rather than around the front edge. This provides a shorter alignment at a lower cost as the existing frontline quay wall would not need to be maintained to support a new defence structure.

4. Option Appraisal

This chapter presents the option appraisal for the ODU sub-units across the frontage.

4.1 ODU 1a

ODU 1a comprises the east bank of the Langbrook stream and the field to the east of this. The ground elevations gradually rise towards the north which provides an ideal location to tie-in defences to high ground. To provide a present day 1:200 year SoP the defences it will not be necessary to extend the defence alignment to the north of the field as the land levels along the northern edge of the field exceed the design water level. Two defence measures are included on the shortlist for ODU 1a, these include:

- Setback floodwall
- Setback earth embankment

There are two potential alignments for a new defence in this location; immediately setback on the east river bank of the Langbrook stream, or alternatively setback along the eastern edge of the field.

A photograph of the Langbrook Stream which forms the boundary to ODU 1a is shown below in Figure 4-1.

Figure 4-1: Photograph of the Langbrook stream, looking south.

4.1.1 Environmental appraisal

Refer to Appendix D for the full environmental appraisal of the short list defence measures in ODU 1a. In summary, both the setback floodwall and earth embankment equally or better align with the landscape and heritage objectives compared to the Do Nothing scenario. Each of the measures is likely to lead to temporary impacts on ecology during construction, although these impacts can potentially be mitigated.

4.1.2 Social appraisal

Feedback from the public consultation events on the short list defence measures in ODU 1a indicates that an earth embankment is the favoured defence type in this location. Of the short list defence measures presented to the public, over 80% of respondents supported the earth embankment. There was marginally more support for the earth embankment alignment close to the river bank compared to the alignment along the eastern edge of the field. Preliminary discussions with the landowner in this location indicates that either defence measure could be achieved although further consultation will be required during the next stages.

Further comments on the short list defences in this area included there being potential to use an earth embankment as both a sea defence and also a cycle way or footpath. In order for the defence to 'double-up' in this way, it would be necessary for the public to be granted access to the field and new defence structure which is not currently available. A further comment is that there is already a partial bund along the river bank that was installed over a decade ago and has since been populated by grass and other vegetation.

4.1.3 Technical appraisal

Based on the information available the construction and maintenance of an earth embankment or a setback floodwall in this location is considered to be technically feasible. There are no known space constraints in this location. Access to the site could be achieved through Mill Lane and the adjacent field. Should this not be possible, access could be made over the foreshore from the east.

There are no known utilities / services to the east of the Langbrook Stream or along the eastern edge of the field. A number of services are located beneath Mill Lane however, but the defence alignment is not expected to extend this far north at this stage.

A detailed account of the ground investigations in this area can be found in the ground investigations report and ground models technical note. In the Langbrook stream, data from two historical boreholes (1962) is available which indicates that the top of the Portsmouth Chalk Formation was encountered at 2.3m below ground level (bgl). The boreholes indicate that the superficial deposits are composed primarily of Alluvium and Brickearth. No GI was undertaken for the field where defences are proposed in ODU 1a.

With respect to the construction phase, the setback alignment along the east side of the field is likely to be preferable. This would avoid working in close proximity to tidal water (along the east bank of the Langbrook Stream).

4.1.4 Cost comparison

In the economic analysis undertaken to identify the leading standard of protection for the entire scheme, costs for the earth embankment along the setback alignment in ODU 1a were adopted. The costs for a setback floodwall along this alignment have also been developed and are compared in Table 4-1. The additional whole life cost required to construct and maintain a setback wall over a 50 year appraisal period is approximately £100k. No cost estimates have been made for a frontline alignment along the east bank of the Langbrook Stream as this defence alignment is significantly longer and would be less economical.

Note that approximate costs have been included for land compensation. Compensation is likely to be required given that the alignment runs through a privately owned field and due to the larger defence footprint the compensation may be greater for the embankment relative to the floodwall. It is recommended that ESCP liaise with the landowner to discuss potential land compensation which will enable the estimated compensation costs to be refined.

Table 4-1: Estimated whole life PV costs to provide a present day 1:200 year SoP

Appraisal period	Least cost	Alternative 1
50 years	£320k	£400k
	Earth embankment	Setback floodwall

4.1.5 Summary

Based on the information discussed in sections 4.1.1 to 4.1.4, the short list defence measures have been scored and ranked based on their potential impact in each category. Table 4-2 below presents the scoring and based on the total scores the earth embankment has been identified as the preferred defence measure in this sub-unit.

Table 4-2: Scoring of short list defence measures in ODU 1a

Category	Earth embankment		Setback floodwall	
	Score	Notes	Score	Notes
Environment	+1	Relative to Do Nothing, generally equal or better alignment with the objectives. Temporary ecological impacts which likely can be mitigated	+1	Relative to Do Nothing, generally equal or better alignment with the objectives. Temporary ecological impacts which likely can be mitigated
Social	+1	Favored approach in feedback received from public consultation	-1	Less support for this approach in feedback received from public consultation
Technical	+2	Technically feasible	+2	Technically feasible
Economic	0	Least cost approach	-1	Higher cost approach than earth embankment
Total	+4		+1	

Two potential alignments have been identified for the earth embankment. Both alignments are considered to be technically feasible and both alignments have similar levels of public support. However, the alignment setback along the eastern edge of the field requires a shorter defence length and is therefore expected to be considerably lower cost. For this reason, the setback alignment along the eastern edge of the field has been identified as the preferred alignment. A sketch showing a potential earth embankment cross section across the field is shown in Figure 4-2. Note that ground levels change moving across the field and the height of the embankment will vary. Sketches for indicative cross sections for each of the preferred option defences are found in Appendix E.

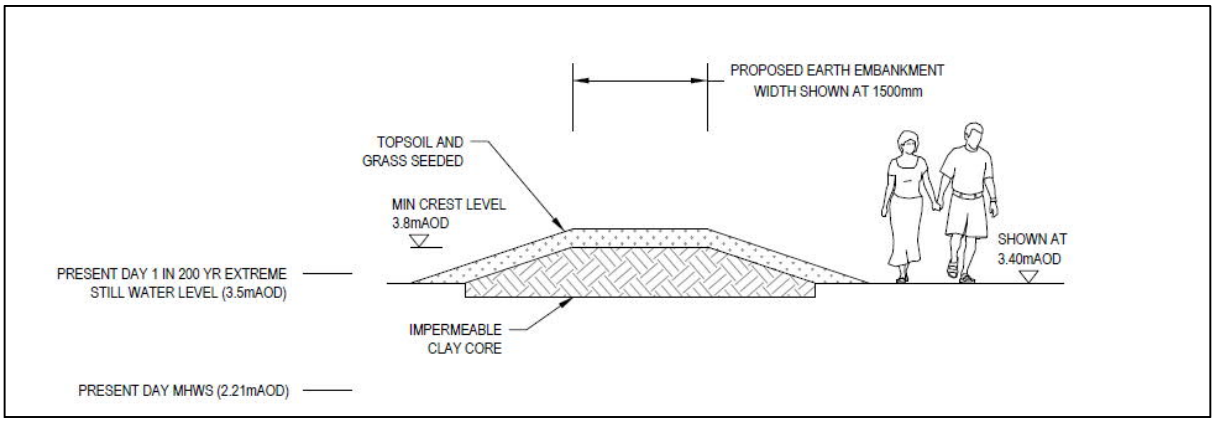

Figure 4-2: Sketch showing indicative earth embankment cross section (not to scale)

4.2 ODU 1b

ODU 1b spans the private defences that protect the properties (and gardens) of Mill Lane. The defences comprise a vertical concrete seawall with a concrete apron and sheet pile toe. There is a small section of earth embankment at the western end of the defences. The numerical modelling confirms that the height of the existing seawall provides a present day 1 in 200 year SoP. Therefore, to provide this standard of protection (or lower), the existing seawall (which is not in a good state of repair) can be utilised/refurbished and will not require raising.

If a higher standard of protection is required, then a range of defence measures have been included in the short list including;

- New seawall
- Refurbish the existing seawall (and crest raising if required)
- Sheet piling

A photograph of the existing seawall defence in ODU 1b is shown in Figure 4-3.

Figure 4-3: Existing seawall in ODU 1b

4.2.1 Environmental appraisal

Refer to Appendix D for the full environmental appraisal of the short list defence measures in ODU 1b. In summary, each of the short list defence measures better align with the landscape and heritage objectives compared to the Do Nothing scenario. Each of the measures are likely to have impacts in these categories but it is likely that the impacts can be mitigated through appropriate design, for example, cladding the structures in sympathetic materials to blend in to the existing landscape.

From an ecological perspective, the sheet piling behind the defences somewhat aligns with the objectives, although there are likely to be temporary impacts during construction which can be mitigated. However, for both the new seawall and refurbishment options there is potential to encroach into the designated intertidal area and an IROPI may be required with these options. Any encroachment would be reduced as much as possible during the design process.

4.2.2 Social appraisal

Feedback from the public consultation events on the short list defence measures in ODU 1b suggests that a seawall is the favoured defence type in this location. Of the short list defence measures presented to the public, the seawall was the measure with the greatest level of support. Sheet piling behind the existing defence had the least level of support. With the existing defence being a seawall, the feedback suggests that the public has more support for a continuation of this type of defence structure; be it replacing or refurbishing the existing seawall, or raising it if necessary.

The general theme of comments for this area is that collaboration with the local residents should be undertaken should any works on the frontline near the existing seawall be proposed. This is recognised by the project team with the gardens of the properties being located immediately behind the existing defence. Raising the height of the defences in this location was also raised as a concern by the public as this may restrict access to the foreshore.

4.2.3 Technical appraisal

Based on the available information the construction of a new seawall, refurbishment of the existing, crest raising or sheet piling are considered to be technically feasible. However, for any capital works, construction access to the site is likely to be challenging and would require further consideration at the outline design phase. Despite the challenges, a number of alternatives for plant access and construction at the site have been identified, these include:

- Plant access and construction from the landward side of the existing defences. Construction from this side would require access to the southern end of the private gardens immediately behind the existing defence. In terms of getting plant into this position, an access route could be made from the National Cycle Route 2 path to the east.
- Plant access and construction from the crest of the existing and the new defences. Should an embankment be constructed in ODU 1a, plant could be moved along the crest of this embankment into position on, or immediately behind where the defences in ODU 1b are to be constructed
- Plant access and construction from the foreshore. Due to the constraints associated with tidal working, construction with this approach is likely to be the most challenging. To limit to movement of plant on and off the site with this approach, it may be possible to construct a temporary ‘island’ 2-5m seaward of the new defence alignment to provide a platform to construct from. This island could be moved alongshore with the plant during the construction phase. Access to the site could be obtained from the foreshore to the east.

For options which include the refurbishment of the existing seawall, it is recommended that three design solutions are adopted, depending on the condition of each defence section. These include:

- Wall encasement only (where the toe of the structure is not in a poor condition)
- New concrete apron and steel sheet pile (toe repairs)
- Wall encasement, concrete apron and steel sheet piles

As shown in Figure 4-3, where exposed, the existing sheet piles at the toe of the structure have rusted significantly. However, the sheet piles could be in a better condition in areas where they are still buried beneath the foreshore and should be investigated as part of the design process. If they are in a good condition it may be possible to rely upon them in future designs which could reduce construction costs.

The replacement of the concrete apron is likely to require at least a six hour tidal window to construct a cast in-situ replacement. With the mean sea level being very close to the toe of the existing seawall, a six hour tidal window may realistically only provide a four hour ‘dry’ window where construction is possible. This constraint will need to be considered during the design process and forward programme.

There are no known utilities / services along the frontline of the existing defences.

For the option which involves sheet piling behind the existing wall, this approach is likely to be challenging given that the area immediately behind the defence alignment is privately owned by a number of different property owners. It is likely that extensive engagement with the land owners would be required to facilitate this option, and there is potential that land may need to be compulsory purchased in order to deliver this approach.

A detailed account of the ground investigations in this area can be found in the ground investigations report and ground models technical note. The ground investigations undertaken as part of this study included four hand dug trial pits in front of the existing seawall defence and one window sample borehole located at the east end of the defence. Data from a historical borehole (1962) located behind the defence in a private garden is available. The three most west located trial pits were terminated at depths of 0.3-0.7m bgl upon reaching the existing seawall foundations, whilst the most eastern trial pit was terminated at 0.3m bgl with no foundation encountered. River terrace deposits were encountered in three of the four trial pits with Alluvium encountered in one. The borehole comprised beach deposits overlying Made Ground with Portsmouth Chalk Formation found at 2.3m bgl.

4.2.4 Cost comparison

The existing seawall in this sub-unit provides a present day 1 in 200 year SoP. The cost comparison shown in Table 4-3 compares the cost for refurbishing the existing defence with the cost of replacing the defence with a new structure to the same standard of protection. The least cost of these approaches is the capital refurbishment. Over a 50 year appraisal period the additional whole life cost for sheet piling is estimated to be £271k and for a new seawall is estimated to be £550k.

Table 4-3: Estimated whole life PV costs to maintain the existing seawall

Appraisal period	Least cost	Alternative 1	Alternative 2
50 years	£1,630k	£1,640k	£1,980k
	Refurbishment (present day 1:200yr SoP)	Sheet piling behind defence	New seawall

4.2.5 Summary

Based on the information discussed in sections 4.2.1 to 4.2.4, the short list defence measures have been scored and ranked based on their potential impact in each category. Table 4-4 below presents the scoring and based on the total scores the capital refurbishment (encasement) of the existing defence is the preliminary preferred defence measure in this unit. Should a higher standard of protection be desired, then this defence measure can be adjusted to include crest raising in the refurbishment. This approach has been recommended as it makes best use of the existing defence asset in this location and is considered to be technically feasible. A sketch showing an indicative cross section of the capital refurbishment solution is shown in Figure 4-4. However, the overall score is similar to the sheet piling approach (behind the existing defences) and therefore further consultation with the private landowners in this location is required to determine whether there could be any private contributions for a defence in this area and to determine what type of defence would be preferable from their perspective.

Table 4-4: Scoring of short list defence measures in ODU 1b

Category	Capital refurbishment		Sheet piling		New seawall	
	Score	Notes	Score	Notes	Score	Notes
Environment	-2	Does not support ecology objective. Likely to require IROPI due to encroachment into designated intertidal area	+1	Relative to Do Nothing, generally equal or better alignment with the objectives. Temporary ecological impacts which likely can be mitigated	-2	Does not support ecology objective. Likely to require IROPI due to encroachment into designated intertidal area
Social	+1	Favored approach in feedback received from public consultation	-1	Less support for this approach in feedback received from public consultation	+1	Favored approach in feedback received from public consultation
Technical	+1	Technically feasible, plant access to the site could be a challenge	-1	Constraints associated with land ownership behind the defence and plan access. Otherwise technically feasible	+1	Technically feasible, plant access to the site could be a challenge
Cost	0	Least cost	0	Similar cost to capital refurbishment	-2	Significantly more costly than least cost approach
Total	0		-1		-2	

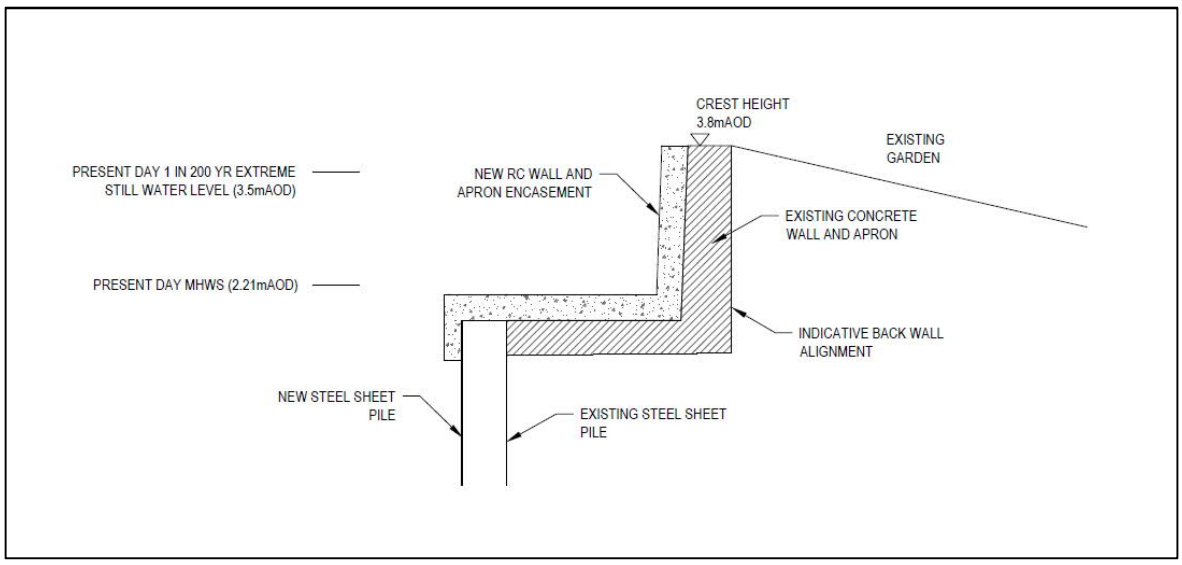

Figure 4-4: Sketch of indicative cross section of encasement (capital refurbishment) of seawall in ODU 1b (not to scale).

4.3 ODU 2a

ODU 2a encompasses Langstone Spit which is a sand / shingle spit that has remained a feature of the coastline since the Hayling Island railway came out of service. Parts of the spit are showing signs of erosion, which is particularly noticeable at the southern tip. The main risk to this ODU is from erosion rather than flooding.

The defence measures on the short list in ODU 2a include:

- Beach nourishment
- Beach nourishment with the installation of groynes
- Rock armour localised protection

For costing purposes it has been assumed that beach nourishment would be required across the full length of the spit. However, detailed sediment modelling would be required to determine the most optimal approach and this is recommended if beach nourishment (with or without groynes) is identified as the preferred option. The rock armour option has been identified on the shortlist to protect the end of the spit which has been identified as the most problematic area and is important in dissipating and attenuating wave energy to the Sailing Club frontage.

A photograph of the spit in ODU 2a is shown in Figure 4-5 below.

Figure 4-5: Photograph of the Spit in ODU 2a

4.3.1 Environmental appraisal

Refer to Appendix D for the full environmental appraisal of the short list defence measures in ODU 2a. Each of the defence options on the short list is expected to have a negative impact on the ecology and does not align with the ecology objective. ODU 2a is surrounded by the European designated sites and SSSI. The beach nourishment option could lead to smothering of the existing habitats surrounding the existing sites. Rock armour and groynes could involve permanent land-take from the SSSI and European sites depending on the size of armour required and the length of groynes.

With respect to landscape and heritage, both the beach nourishment and rock armour options equally or better align with these objectives relative to the Do Nothing scenario. However, the construction of groynes is expected to have landscape impacts and therefore does not align as well as the Do Nothing scenario in this category.

4.3.2 Social appraisal

Feedback from the public consultation events on the short list defence measures in ODU 2a suggests that localised rock armour protection is the favoured approach from the public at this location. The least supported defence measure was found to be groynes and beach nourishment.

The general theme of comments for this area concerned the condition of Langstone Spit, and the reliance of the Sailing club on this as a defence from erosion. Protecting the Spit for the purposes of maintaining the Billy Line is also considered a key priority to the local community. In terms of comments relating to the type of armour protection that would be favourable at the spit, one comment suggested that concrete blocks would be preferable as they would be similar and more in keeping with the wartime tank traps that remain in the area (rather than large granite rocks which would look incongruous and out of place). Another comment suggested the groynes would negatively change the character of the area and are also a high cost option.

4.3.3 Technical appraisal

Based on the information available the placement of rock armour, beach nourishment or the construction of groynes are all considered to be technically feasible. There are no obvious space constraints at the site and access to the site could be achieved at the northern end of the spit at the intersection between the footpath and Langstone Road (A3023).

At the southern end of the spit, high voltage electricity cables (Scottish and Southern Electricity) intersect the spit and pass through the Sailing Club before diverting to the south towards Hayling Island. Further investigation into the depth of this cable will need to be undertaken at the outline design phase should a defence be taken forward as part of the preferred option in this location. The cables are in the vicinity of where rock armour would be placed at the end of the spit to provide localised protection, and also could potentially be in the area where groynes are required (which would involve piling down beneath the spit surface).

A detailed account of the ground investigations in this area can be found in the ground investigations report and ground models technical note. One window sampler borehole was dug at the end of the spit which encountered made ground. Generally, within the wider vicinity of ODU 2 the ground investigations revealed that the superficial soils in this location are unevenly distributed and generally of low strength down to a depth of 2.2m bgl, although locally the superficial deposits were observed to extend to a much greater depth of 5.00m bgl. Below this depth soft to firm Portsmouth Chalk Formation is encountered.

4.3.4 Cost comparison

The risk in ODU 2a is from erosion, rather than from flooding. As a result, the defence measures on the short list for this unit are intended to provide erosion protection only. In the economic analysis undertaken to date, the least cost approach to providing erosion protection was identified as the placement of rock armour at the southern end of the spit. This defence measure was therefore adopted and is compared to the alternatives in Table 4-5 below. Note that the whole life cost of undertaking beach nourishment on its own is estimated to be greater than with groynes in place as it has been assumed that the nourishment without groynes would need to be undertaken more frequently (as groynes would help to hold more material in place for longer).

Table 4-5: Estimated whole life PV costs to provide a present day 1:200 year SoP

Appraisal period	Least cost	Alternative 1	Alternative 2
50 years	£330k	£2,560k	£2,910k
	Rock armour, southern end of spit	Beach nourishment with groynes	Beach nourishment

4.3.5 Summary

Based on the information discussed in sections 4.3.1 to 4.3.4, the short list defence measures have been scored and ranked based on their potential impact in each category. Table 4-6 below presents the scoring and based on the total scores the rock armour protection at the southern end of the spit has been preferred defence measure in this sub-unit.

Table 4-6: Scoring of short list defence measures in ODU 2a

Category	Rock armour, southern end of spit		Beach nourishment with groynes		Beach nourishment	
	Score	Notes	Score	Notes	Score	Notes
Environment	-2	Does not support ecology objective. Likely to require IROPI due to encroachment into designated intertidal area	-2	Does not support ecology objective. Likely to require IROPI due to encroachment into designated intertidal area	-2	Does not support ecology objective. Likely to require IROPI due to encroachment into designated intertidal area
Social	+1	Measure with greatest public support	-1	Least supported measure	0	Less support than rock armour
Technical	+1	Minor constraints - technically feasible	-1	Piling in vicinity of high voltage cables	+1	Minor constraints - technically feasible
Cost	0	Least cost approach	-2	Significantly more costly	-2	Significantly more costly
Total	0		-6		-3	

4.4 ODU 2b

ODU 2b is located along the National Cycle Route 2 public footpath and is approximately 350m long. The footpath runs adjacent to Langstone Spit at the south, and extends between residential buildings and trees to the north.

For scheme alignments C and D, the length of defence required in ODU 2b extends upto 350m along the Cycle Route 2 footpath. This defence starts at the Sailing Club and runs to the intersection with Mill Lane to the north (depending on the SoP required). Should additional sections of defence in ODU 1 be added to the overall scheme alignment (as in alignments A and B) the length of defence in ODU 2b can be reduced, and would need to tie-in to the defences in ODU 1b.

Two defence measures are included on the short list of options for this ODU sub-unit. These include:

- Setback floodwall
- Setback earth embankment

Depending on the required defence length and potential space constraints in the northern half of the footpath, a hybrid of the two defences may be the preferred approach (earth embankment in the southern half where there is more space, transistioning to a setback floodwall in the northern half where space is more limited).

A photograph of the National Cycle Route 2 footpath is shown in Figure 4-6 below.

Figure 4-6: Photograph of National Cycle Route 2 in ODU 2b

4.4.1 Environmental appraisal

Refer to Appendix D for the full environmental appraisal of the short list defence measures in ODU 2b. In summary, each of the short list defence measures equally or better aligns with the landscape and heritage objectives compared to the Do Nothing scenario. Each of the measures is likely to lead to temporary impacts on ecology during construction, although it is considered possible to mitigate these impacts.

4.4.2 Social appraisal

Feedback from the public consultation events on the short list defence measures in ODU 2b indicates that an earth embankment is the favoured defence type in this location. Of the short list defence measures presented to the public, approximately two thirds of respondents supported the earth embankment.

The majority of additional comments for ODU 2 were focussed on sub-units 2a and 2c. However, when asked what the respondants additional aspiration was for the Langstone frontage as a whole, 19% of respondants favoured footpath improvements and 11% favoured cycleway improvements. These were the second and third highest support rates, behind 22% of respondants who favoured improved pedestrian crossing/traffic calming measures on the A3023. Given the existing cycle route / footpath in this sub-unit and public support for footpath and cycleway improvements, this area has potential to deliver broader outcomes should funding be made available.

4.4.3 Technical appraisal

In the southern half of ODU 2b, between the Sailing Club and approximately where the ODU 1b defences start, both an earth embankment and setback floodwall are considered to be technically feasible solutions. In this half of the alignment, there is already an informal earth bund / natural verge which could be constructed upon or formalised into an earth embankment.

However, in the northern half of ODU 2b, from approximately the start of the defences in ODU 1b to the intersection of the cycle route with Mill Lane, the space available for a new defence measure is more constrained. Private gardens back onto either side of the cycle route / footpath alignment in this section, and there is dense tree vegetation overhanging the footpath in numerous locations. As a result, it may not be possible to construct an earth embankment in the northern half of the sub-unit.

The National Cycle Route 2 is a key corridor in terms of utilities and services in the area. There is a Portsmouth Water pipe directly beneath the cycle route path, spanning north-south along the full length of the proposed defence in the area. A Southern Water sewer pipe runs alongside this between the start of ODU1b defences and the intersection with Mill Lane. The Cycle Route 2 path intersects the Solent Way footpath (spanning east-west) approximately 50m from its northern end (intersection with Mill Lane). Here there are a number of services located beneath the Solent Way footpath, these include Openreach cables (British Telecommunications), further Portsmouth Water pipes, a further Southern Water sewer pipe, Scottish and Southern Electricity cables and a Southern Gas Network pipe.

The key services and utilities along the potential defence alignment, alongside those intersecting it at the Solent Way footpath, could lead to significant buildability challenges when constructing a defence in this area. The exact location of the services will need to be investigated at the outline design phase to determine whether a defence can be constructed without the need to divert the services, or whether a diversion will need to take place.

The most problematic area where the number of buried services is most condensed is at the intersection with the Solent Way footpath. Depending on the standard of protection that is required it may not be necessary to extend the defence this far to the north. Based on the topographic data collected by the ESCP, the ground level of the path immedietely to the south of the Solent Way intersection is approximately 3.48m AOD. When freeboard is not included, this ground level marginally exceeds the estimated extreme water level for the present day 1:75yr and 1:200yr return period events at the site which indicates that the flood extent would not likely extend this far to the north along the cycle route path. This is supported by the numerical modelling which suggests that the present day 1:75yr event and 1:200yr event flood extents stop just to the south of the Solent Way intersection. Based on this information, to deliver a present day 1:75yr or 1:200yr SoP it may not be necessary to constuct a defence across the Solent Way intersection. However, to deliver a standard of protection any higher than this (e.g. a 2069 75yr SoP or above), the defence alignment will need to extend all the way along the cycle route path to the intersection with Mill Lane. This would require passing over the most condensed area of services at the intersection with Solent Way.

A detailed account of the ground investigations in this area can be found in the ground investigations report and ground models technical note. The exploratory borehole and trial pit in this ODU sub-unit are all located in the southern half of the potential defence alignment, between the Sailing Club and the start of ODU1b defences. One window sample borehole was dug along the cycle route footpath to the south of the start of ODU1b defences whilst a trial pit was dug immediately to the north of the Sailing Club. A historical borehole log from 1962 from the intertidal area to the north of the Sailing Club is also available. The window sample borehole showed the top of the Portsmouth Chalk Formation is shown to be 2.74m to 3.35m below ground level (bgl). The trial pit showed river terrace deposits.

4.4.4 Cost comparison

Table 4-7 below compares the estimated whole life costs for the shortlist defence measures along alignments C and D, following the footpath between the Sailing Club and Mill Lane. For illustrative purposes the costs to deliver a present day 1:200 year SoP are presented. The defence options include a setback floodwall along the full length, or alternatively an earth embankment for the southern half of the alignment transitioning into a setback floodwall in the north section of the alignment.

The earth embankment (southern section) combined with a setback floodwall (north section) has been identified as the least cost approach in the economic analysis. In order to construct a setback floodwall along the full length of the defence alignment the additional cost is estimated to be £80k for a 50 year appraisal period.

Should alignments A or B be adopted instead, then the overall costs will be reduced (as the defence length is shorter). The difference in cost between the two options will also vary, but the earth embankment would be expected to the lower cost approach.

Table 4-7: Estimated whole life PV costs to provide a present day 1:200 year SoP

Appraisal period	Least cost	Alternative 1
50 years	£710k	£790k
	Earth embankment (south section) with setback floodwall (north section)	Setback floodwall (full length)

4.4.5 Summary

Based on the information presented in sections 4.4.1 to 4.4.4, the short list defence measures have been appraised based on their potential impact in each category. As outlined above, the cost comparison has been made for the long scheme alignments (C and D) along the National Route 2 Cycle path between the Sailing Club and the intersection with Mill Lane. Table 4-8 provides a comparison of the options and based on the scoring the option whereby an earth embankment is constructed in the southern half of the alignment and a setback floodwall in the north half has been identified as the preferred option.

Should a shorter alignment be adopted (e.g. alignment A or B), then only the south section of the defence will be required, and based on the appraisal the earth embankment would be the recommended approach.

Table 4-8: Scoring of short list defence measures in ODU 2b

Category	Earth embankment (south section) with setback floodwall (north section)		Setback floodwall (full length)	
	Score	Notes	Score	Notes
Environment	0	Option partially aligns with environmental objectives. Similar impacts as the Do Nothing scenario. Temporary impacts during construction	0	Option partially aligns with environmental objectives. Similar impacts as the Do Nothing scenario. Temporary impacts during construction
Social	+1	Earth embankment section has more public support	-1	Setback floodwall has less support than embankment
Technical	-1	Considered technically feasible, although services may need diversion depending on SoP	-1	Considered technically feasible, although services may need diversion depending on SoP
Cost	0	Least cost approach for this standard of protection	-1	More costly approach
Total	0		-3	

A sketch of an indicative cross section of the earth embankment (south section) of the preferred option is shown in Figure 4-7 below.

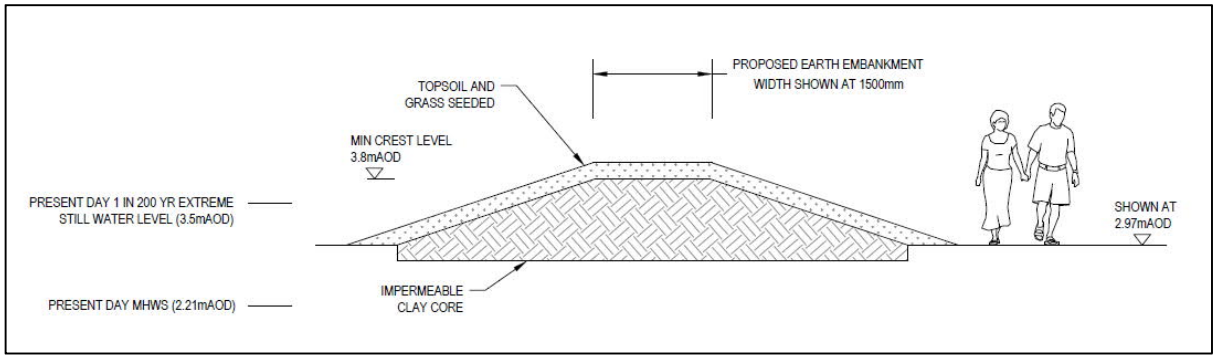

Figure 4-7: Sketch of indicative cross section of earth embankment in south section of ODU 2b (not to scale).

4.5 ODU 2c

ODU 2c includes the formal and informal defences around Langstone Sailing Club and the adjacent A3023 main road. This area is situated immediately to the east of Langstone Spit. On the east and south banks of this sub-unit both the road and the Sailing Club are currently protected from erosion and flooding by a Hampshire Highways Authority (HHA) revetment. The west bank of the Sailing club is generally undefended (natural vegetated bank) with the exception of approximately 50m of armourlock revetment.

The type of defence structure suitable to protect the Sailing Club in ODU 2c varies depending on the standard of protection that is required. The defence measures comprising the short list include:

- Flood gate
- Setback floodwall around the Sailing Club
- Revetment (frontline defence; new higher revetment in place of the HHA revetment along the east side of the bridge, extending beneath the bridge and around the west side of the sailing club).

To defend to a present day 1:75yr SoP or a 1:200yr SoP, a flood gate across the slipway is all that is required due to the higher land elevations at the Sailing Club. However, in order to protect to a higher standard of protection, for example, a 2069 75yr SoP, then linear defences around the full length (or most of) the Sailing Club would be required.

The options to increase the SoP to at least a 2069 75yr SoP are to construct a setback floodwall around the Sailing Club, or to replace the existing frontline HHA revetment structure with a higher crest level. The new revetment would protect the entire sub-unit and would be in place of the existing HHA structure along the east side of the A3023 and the south side of the Sailing Club. In the event that the revetment option is taken forward then liaison with HHA is recommended to discuss beneficiaries and potential financial contributions.

A photograph of the Sailing Club (viewpoint from the end of the Spit in ODU 2b) is shown in Figure 4-8 below.

Figure 4-8: Photograph of the Sailing Club in ODU 2c

4.5.1 Environmental appraisal

Refer to Appendix D for the full environmental appraisal of the short list defence measures in ODU 2c. In summary, each of the short list defence measures better align with the landscape and heritage objectives compared to the Do Nothing scenario. Each of the measures are likely to have impacts in these categories but it is likely that the impacts can be mitigated through appropriate design.

Depending on the design of the revetment, it has potential to impact and encroach onto the European sites and SSSI and therefore it does not align with the ecology objective. The setback floodwall is likely to have temporary impacts on ecology during construction which can likely be mitigated; however, it does not align with the ecology objective as well as the Do Nothing scenario in this location.

4.5.2 Social appraisal

Feedback from the public consultation events on the short list defence measures in ODU 2c suggests that a continuation of the revetment structure is the favoured defence type in this location. Of the short list defence

measures presented to the public, approximately 75% of respondents supported this approach. The existing revetment extends around the east and south side of the Sailing club and this would need to be lengthened and raised to protect the entire sailing club to a consistent standard of protection.

The general theme of feedback comments for this area related to the importance of the spit in protecting the Sailing club. Whilst the Spit is likely to help dissipate wave energy and prevent erosion, the spit is not believed to reduce the flood risk at the Sailing Club significantly as flooding in this area is primarily driven by still water levels.

4.5.3 Technical appraisal

The construction of both a sloping revetment (similar to the existing defence) or a setback floodwall is considered to be technically feasible at the site. There are no obvious space constraints and access to the site can be found through the Sailing Club car park and boat storage area.

The high voltage electricity cables present in ODU 2a pass beneath the south west corner of the Sailing Club in ODU 2c. These cables are in the vicinity of where defences would be required on the west bank of the Sailing Club. Further investigation as to the depth of this cable would need to be undertaken during the design phase should a defence be taken forward as part of the preferred option at this location. Depending on the depth of the cables, it is likely that a concrete revetment will pose more significant challenges with respect to the underground cables than a setback floodwall, due to the deeper foundations that would be required for the revetment structure.

A detailed account of the ground investigations in this area can be found in the ground investigations report and ground models technical note. One window sample borehole was dug in the Sailing Club boat storage area and a historical borehole log from 1962 is located on the main slipway. The top of the Portsmouth Chalk Formation is shown to be 2.74m to 3.35m bgl and groundwater was observed in the historical borehole at 2.43m bgl and is noted as tidal.

4.5.4 Cost comparison

Table 4-9 below presents the costs for a floodgate across the main slipway (present day 200yr SoP) and for information purposes it compares these with the costs for linear defences around the Sailing Club (higher SoP). This is not a like-for-like comparison in terms of SoP, because for the present day 200yr SoP linear defences around the Sailing club are not required. However, the comparison gives an indication of the potential scale of cost difference at the Sailing club in order to deliver a higher SoP.

The costs for a floodgate across the slipway to deliver a present day 1:200 year SoP are estimated to be £70k for a 50 year appraisal period. To increase the standard of protection to a 2069 75yr standard using a setback floodwall around the Sailing Club the additional cost is estimated to be approximately £1,035k for a 50 year appraisal period. The additional cost to construct and maintain a concrete revetment is estimated to be £1,400k for a 50 year appraisal period.

Table 4-9: Estimated whole life PV costs for the different defence measures required to improve the standard of protection at the Sailing Club

Appraisal period	Least cost (present day 200yr SoP)	Least cost (2069 75yr SoP)	Alternative 1 (2069 75yr SoP)
50 years	£70k	£1,100k	£1,470k
	Flood gate across slipway	Setback floodwall	Concrete revetment

4.5.5 Summary

Based on the information presented in sections 4.5.1 to 4.5.4, the short list defence measures have been appraised based on their potential impact in each category. To protect to a present day 1:75yr SoP or 1:200yr SoP a flood gate across the slipway is the only practical option as it protects to the desired standard of protection and does not affect slipway accessibility when not deployed.

Table 4-10 provides a comparison of the options to protect to a higher standard of protection. Based on the scoring, should a higher standard of protection be required then the setback floodwall is considered to be the preferred approach.

Table 4-10: Scoring of short list defence measures in ODU 2c to provide a 2069 1:75yr SoP or greater

Category	Setback floodwall		Concrete revetment	
	Score	Notes	Score	Notes
Environment	0	Similar overall impact relative to Do Nothing. Temporary ecological impacts which likely can be mitigated but does not align as well as Do Nothing in this category	-2	Does not support ecology objective. Likely to require IROPI due to encroachment into designated intertidal area
Social	-1	Less public support than a concrete revetment	+1	Measure with greatest public support
Technical	+1	Minor constraints. Technically feasible	-1	Technically feasible, but more likely that a diversion will be required for the underground electricity cables
Cost	0	Least cost approach for this standard of protection	-1	More costly
Total	0		-3	

4.6 ODUs 3a to 3c

ODU 3a to ODU 3c encompasses the car park next to the Ship Inn and the two slipways either side of this. The majority of the defence length (100m) is in ODU 3b (the car park), with the slipways either side of this being approximately 4-5m across (ODU 3a and 3c).

The car park (ODU 3b) is fronted by a public footpath with benches looking towards Hayling Island. On the front edge of the footpath there is a vertical masonry retaining wall which acts as a formal defence from flooding and erosion. Generally the car park is of poor landscape quality and the area has potential for enhancements.

There are two potential alignment options for defences in this location. One alignment includes defences across both slipways (3a and 3c) and a defence at the back of the footpath around the front edge of the car park. This defence alignment would protect the car park from flooding and also the land behind. This alignment has been adopted in alignments A, B and C, with the choice of defence measure around the front edge of the car park being either a setback floodwall or a setback floodwall with a glass crest.

An alternative alignment is a defence across the car park itself which has been adopted in Alignment D. This alignment is considerably shorter and with this approach there wouldn't be a requirement to place defences on the slipways (ODU 3a and 3c). This alignment would tie-in to higher ground along the A3023 (although the A2023 in this location may also require raising should a high defence standard be desired). The alignment is approximately 25m long, and whilst it would not protect the car park from flooding, it would form an important component of the wider scheme alignment in the area. Given that this alignment goes across the car park, during normal conditions vehicle access over the flood defence is a key consideration. Therefore, the flip-up floodwall is the only viable measure for this alignment, as when not deployed the flip-up barriers fold down into the ground and allow vehicles to drive over unobstructed. A photograph showing the frontage in ODU 3b is shown in Figure 4-9 below.

Figure 4-9: Photograph of car park and slipway (ODU 3b and 3a)

The defence measures on the short list for the slipways (ODU 3a and 3c) include:

- Flip-up floodwall
- Demountable defences
- Flood gate

The flip-up floodwalls, demountable defences and floodgate defences are bespoke engineering products and when deployed would provide the required standard of flood protection to the area behind. The main advantage of each of these products is that when they are not deployed, they will not impact access to the slipways or foreshore, or dramatically alter the landscape.

And in summary, as outlined above, the defence measures on the shortlist for the car park (ODU 3b) include:

- Setback floodwall, with/without a glass crest (around edge of car park)
- Flip-up floodwall (across car park)

4.6.1 Environmental appraisal

Refer to Appendix D for the full environmental appraisal of the short list defence measures in ODUs 3a to 3c. In summary, for ODUs 3a and 3c (the slipways), each of the short list defence measures in these units equally or better aligns with the landscape and heritage objectives compared to the Do Nothing scenario. Each of the measures is likely to lead to temporary impacts on ecology during construction, although these impacts can potentially be mitigated.

For ODU 3b (the car park), the setback glass crested floodwall has potential to impact the landscape and heritage. It therefore only partially aligns with the environmental objectives for these categories. However, it is also clear that the Do Nothing scenario also partially aligns with these objectives and therefore the impact of the glass wall relative to this scenario is expected to be limited. The flip-up floodwall partially aligns with all of the environmental objectives and for this defence it is likely that any issues could be mitigated.

Both the setback floodwall and flip-up floodwall provide opportunities for enhancement in this location. For example, improved seating could be installed along the footpath which could improve the public realm and landscape character. In addition, new information boards could be placed in the area to provide education material on the environmental importance and history of the environmental designations. Further ideas around the enhancement opportunities at this location will be considered during outline design.

4.6.2 Social appraisal

Should the longer defence around the car park with alignments A-C be taken forward, the feedback from the public consultation events on the shortlist indicates that a flood gate is the favoured defence type. Of the short list defence measures for the slipways presented to the public, approximately half of respondents supported flood gates.

With respect to the short list defence measures in-front or across the car park, the public consultation feedback demonstrates that there is a relatively even level of support for each of the defence measures in this sub-unit. The flip-up floodwall had marginally more support than the others, but this is not considered to be significant given the small sample size of respondents.

The general theme of public comments received for ODU 3b were concerned about the condition of the existing quay wall; but that a focus on defending the car park should be a lower priority that the residential and listed buildings in the study site.

A stakeholder engagement meeting was held with representatives from the Ship Inn where the short list options were presented and discussed. From the Ship Inn's perspective, defending the car park from flooding would be preferable with a defence alignment around the quay. However, a flip-up flood defence across the car park would not be opposed providing the car park can stay open for the majority of the time and the spaces for parking and seating are maintained.

4.6.3 Technical appraisal

Each of the defence measures on the shortlist in sub-units 3a to 3c are considered to be technically feasible. The flip-up floodwalls, demountable defences and flood gates are bespoke products and the options have been discussed with a representative of Flood Control International (product suppliers) during a site visit. During the visit it was initially confirmed that each of these types of defence could be used in this location.

A number of the short list defence measures being considered require deployment. The resources required to deploy the defences varies greatly however, with the deployment of demountable defences typically the most labour intensive requiring a team of trained personnel to erect the demountable barrier. A flood gate can be closed by one trained operative whilst flip-up flood barriers can be deployed electronically from an off-site or near site location. Demountable defences will also require an on-site or near site storage location to ensure that they can be deployed in an efficient manner.

In terms of key services and utilities buried at this location, at ODU 3a a Southern Gas network pipe intersects the top of the slipway parallel to the A3023. Given that there is ample space on the remainder of the slipway to place and construct a new defence the gas pipe is not expected to significantly constrain the choice of defence measure in this location. In ODU 3b a Southern Water sewer passes beneath the southern section of the car park. This sewer passes beneath the potential defence alignment that follows the edge of the car park and more investigations will be required at the outline design phase should this defence alignment be taken forward. A Southern Gas Network pipe is located along the western edge of the car park, thought to be beneath the grassed area separating the car park from the A3023. The alternative alignment across the car park will need to pass over

this pipe so further investigation will be required at the Outline Design phase. There are no known services in ODU 3c.

A detailed account of the ground investigations in this area can be found in the ground investigations report and ground models technical note. A number of trial pits were dug adjacent to the existing vertical masonry wall defence in ODU 3b and a cable percussion borehole was dug in the north east corner of the car park. The trial pits were dug to investigate the foundations of the existing sea wall defences and were terminated upon finding the base of the defence (approx. 1.0 to 1.3m deep). The general ground model proposed for the wider ODU 3 area suggests that superficial soils are unevenly distributed and of low strength down to a depth of 3.00m below ground level (bgl) where Portsmouth Chalk Foundation is encountered. The borehole in the car park encountered groundwater at 2.70m bgl.

The flip-up barrier option provides a compromise between temporary defences and a permanent defence which is not suitable across the car park. However, with all deployable defences there is a residual risk that the defences may not be deployed correctly. To account for this in the economics assessment, the flood risk benefits have been reduced. Refer to the economics report for more information on how the risk has been accounted for. To minimise the risk of deployment failure there is a capacity to connect the flip-up barriers to electrical controls which enable them to be deployed electronically from an off-site or near site location.

Should the flip-up barrier option be taken forward, because the defence will go across the car park it will be necessary to enforce parking controls to ensure that vehicles are not parked on-top of the flip up barriers (which could prevent their deployment). This could be achieved through the placement of bollards, or restrictive parking signs which will help to minimise the risk of vehicles being parked in the wrong place. With the changes to the car park there is potential to re-configure the car parking and make the spaces more efficient. For example, currently there are no designated spaces but as part of the scheme works a set number of spaces could be created to allow the car park to operate to its full capacity.

With the flip-up barrier approach may also be necessary to construct a secondary egress route from the car park onto the A2023. This route could be constructed across the earth verge that is currently located between the car park and road and could be used temporarily when the need arises. For example the egress route could be used in times when the flip-up barrier is deployed, yet cars still need to exit the car park. This would prevent cars from being stranded in the car park during periods of deployment.

4.6.4 Cost comparison

For the slipways at ODU 3a and 3c, the costs for demountbale defences or a flood gate were identified to be very similar and the least cost options. Table 4-11 below compares the whole life costs of the short list defence measures in ODU 3a and 3c. For illustrative purposes the costs to deliver a present day 1:200 year SoP are presented.

Table 4-11: Estimated whole life PV costs to provide a present day 1:200 year SoP across the slipways

Appraisal period	Least cost	Alternative 1	Alternative 2
ODU 3a 50 years	£70k	£70k	£180k
	Demountable defences	Flood gate	Flip-up floodwall
ODU 3c 50 years	£40k	£50k	£100k
	Flood gate	Demountable defences	Flip-up floodwall

Table 4-12 provides a comparison of the total whole life costs of the short list defence measures and alignments in ODU 3a to 3c. With the flip-up barrier and shorter alignment (Alignment D) in ODU 3b there will be no need for defences at the slipways (ODU 3a and 3c). However, with the longer alignment around the car park (alignments A-C) when the slipway defences are required, for the purpose of the cost comparison it has been assumed that flood gates will be used across the slipways because as shown in Table 4-11, the flood gates are expected to be either the least or joint least cost approach.

The costs for the maintenance of the existing quay wall in ODU 3b have been included in each of the alignment costs. Maintenance of this wall will be particularly important for the longer alignment around the car park given a new setback wall in this location will rely on the existing quay wall for its structural integrity. The estimated whole life costs for scheduled maintenance for the frontline quay wall are approximately £130k for a 50 year appraisal period.

Table 4-12: Estimated whole life PV costs for the different scheme alignments and defence measures in ODU 3b

Appraisal period	Least cost	Alternative 1	Alternative 2
50 years	£550k	£570k	£590k
	Flip-up floodwall across car park (short alignment), including maintenance of quay wall. No defences on slipway required	Setback floodwall around car park (long alignment), with flood gates across slipways. Including maintenance of quay wall	Glass crested setback floodwall around car park (long alignment), with flood gates across slipways. Including maintenance of quay wall

4.6.5 Summary

Based on the information discussed in sections 4.6.1 to 4.6.5, the short list defence measures have been scored and ranked based on their potential impact in each category. In order to compare the different defence alignments in this area, it has been necessary to first establish which of the shortlist defence measures across the slipway would be the preferred should the longer alignment be taken forward.

Table 4-13 scores the short list defence measures for ODUs 3a and 3c, across the slipways. These defences will only be required should the longer alignment be taken forward. Based on the scoring, flood gates across the slipway have been identified as the preferred defence measure.

Table 4-13: Scoring of shortlist defence measures for the slipways (ODU 3a and ODU 3c)

Category	Demountable defences		Flood gate		Flip-up floodwall	
	Score	Notes	Score	Notes	Score	Notes
Environment	+1	Relative to Do Nothing, generally equal or better alignment with the objectives. Temporary ecological impacts which likely can be mitigated	+1	Relative to Do Nothing, generally equal or better alignment with the objectives. Temporary ecological impacts which likely can be mitigated	+1	Relative to Do Nothing, generally equal or better alignment with the objectives. Temporary ecological impacts which likely can be mitigated
Social	-1	Least supported defence measure from public consultation feedback	+1	Most supported defence measure from public consultation feedback	0	Second most supported defence measure from public consultation feedback
Technical	-1	Straightforward construction but deployment is labour intensive	+1	Less labour intensive to deploy than demountables	+1	Least labour intensive to deploy but would require electricity supply installation
Cost	0	Comparatively similar cost to flood gate. Low cost relative to flip-up floodwall	0	Comparatively similar cost to demountable defences. Low cost relative to flip-up floodwall	-1	More expensive than both demountables and flood gate
Total	-1		+3		+1	

Table 4-14 scores the different alignments (ODUs 3a-3c) and defence measures in ODU 3b. The scoring for the flip-up floodwall is based on the shorter alignment across the car park, whilst the scoring for the setback floodwall is based on the longer alignment. For the longer alignment, the defences across the slipways would be flood gates as per the appraisal in Table 4-13.

Table 4-14: Scoring of short list defence measures and alignment (ODU 3b)

Category	Flip-up floodwall (across car park)		Setback floodwall (around car park)		Glass crested setback floodwall (around car park)	
	Score	Notes	Score	Notes	Score	Notes
Environment	0	Impacts likely can be mitigated. Generally better supports objectives compared to Do Nothing.	-1	Partially supports objectives but unlikely that landscape and heritage impacts can be mitigated. Generally similar impacts as the Do Nothing scenario	-1	Partially supports objectives but unlikely that landscape and heritage impacts can be mitigated. Generally similar impacts as the Do Nothing scenario
Social	0	Each defence measure has similar level of public support	0	Each defence measure has similar level of public support	0	Each defence measure has similar level of public support
Technical	+1	Technically feasible, although car park amendments will be required	+2	Technically feasible	+2	Technically feasible
Cost	0	Least cost approach	-1	More costly alignment due to additional length and inclusion of slipways	-1	More costly alignment due to additional length and inclusion of slipways
Total	+1		0		0	

Based on the scoring in Table 4-14 a flip-up floodwall across the car park has been identified as the preferred option and alignment in ODUs 3a to 3c. Should further work be undertaken and it is found that this approach is not deliverable then a setback floodwall around the car park provides a technically feasible alternative for this area.

A sketch of an indicative cross section for the flip-up floodwall across the car park is provided in Figure 4-10.

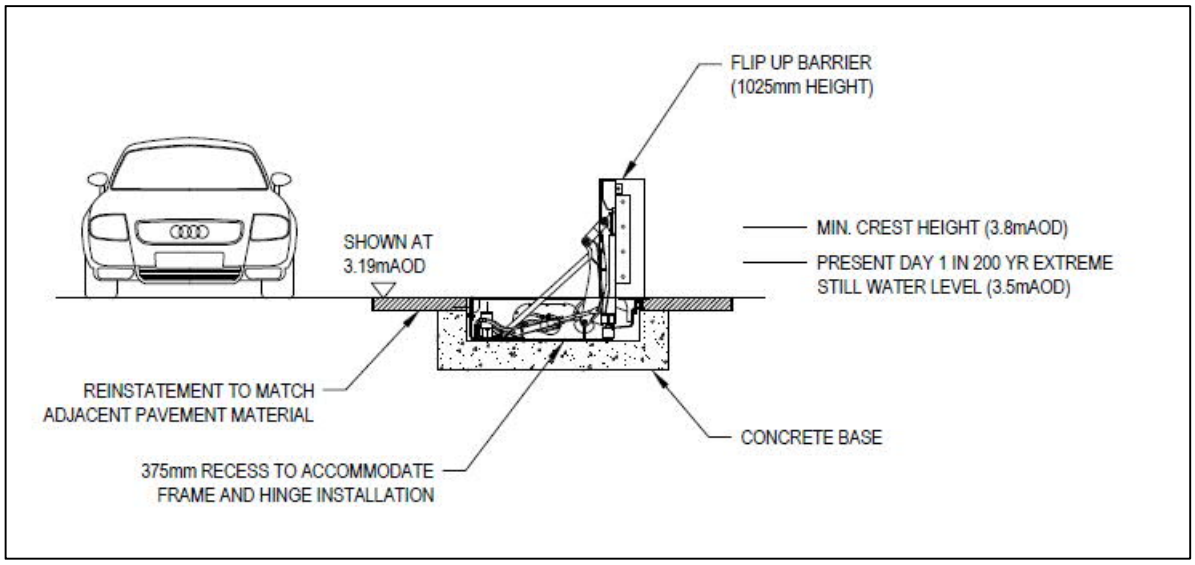

Figure 4-10: Sketch of indicative flip-up floodwall across car park in ODU 3b (not to scale)

4.6.6 Potential requirement for road raising

Depending on the standard of protection being provided by the scheme, it may be necessary to raise the A3023 road level in the area between ODU 2b and ODU 3b. This requirement has been identified by an inspection of the LiDAR in the area and the numerical modelling simulations.

Based on the information available, in order to protect to a present day 1:200 year standard of protection no road raising is understood to be required. However, to protect to a standard greater than this, for example, the 2069 1:75yr SoP or greater, it may be necessary to raise a section of the A2032 main road between the Sailing Club and Ship Inn car park. This may be necessary because based on the existing elevation the roadway could act as pathway for flood water for future higher return period events. Road raising has been identified as the preferred

approach for the management of flood risk across the road as the alternative is a flood gate; which would cease traffic flow to and from Hayling Island which is not a practical solution.

Costs for road raising of the A3023 between the Sailing Club and the Ship Inn are estimated to be £390k.

The potential requirement for road raising has been identified based on analysis of LiDAR data and the numerical model simulations and therefore there is uncertainty in the analysis. It is recommended that more detailed topographic surveys of the roadway and pavement are undertaken to establish a more accurate indication of the roadway elevation. This will enable a more robust assessment of the requirement for road raising to be undertaken.

4.7 ODU 3d and ODU 3e

ODU 3d and 3e is the Ship Inn frontage. ODU 3d forms the majority of this frontage and the functional defence consists mainly of a vertical concrete blockwork wall which is approximately 0.6m high. The wall is located on the edge of the Ship Inn courtyard / outside seating area and is approximately 40m long. The Ship Inn courtyard has views across Chichester Harbour towards Hayling Island and there is access to the foreshore at the north eastern end of the vertical wall. ODU 3e is a shorter length (12m) of frontage immediately to the north of ODU 3d. It is comprised of a concrete apron that lies in front of landscape timber garden fencing. The property in this sub-unit is also owned by the Ship Inn, has clear views across Chichester Harbour and has gated access to the foreshore through the existing fencing. The concrete apron in front of the fencing is used as part of the walkway between the Royal Oak and Ship Inn public houses.

Three defence measures are on the short list for this sub-unit:

- Demountable defences
- Flip-up floodwall
- Vertical floodwall with glass crest

For a defence outside the Ship Inn in ODU 3d, two different alignments have been identified; setback through the Ship Inn courtyard, or a frontline alignment to replace the existing parapet wall (which cannot be relied upon from an engineering perspective). The setback alignment is most suitable for the demountable defences and flip-up barrier whilst the glass topped vertical wall is suitable along the edge of the courtyard where the existing parapet wall is located.

For the defence in ODU 3e, continued access to the foreshore is required so for the glass topped floodwall approach a floodgate has been included in the costs for this defence measure. The demountable defences and flip-up barrier will not restrict access to the foreshore when they are not deployed. The alignment in this location follows that back of the concrete apron where the existing garden fencing is located. It will be necessary to maintain the concrete apron to support new defences built on top of this.

There is currently a set of concrete steps located between the courtyard in ODU 3d and the concrete apron in ODU 3e. Depending on the scheme alignment taken forward, it will be important for the stepped access to be included as part of the scheme design.

A photograph of existing blockwork wall in front of the Ship Inn courtyard is shown in Figure 4-11.

Figure 4-11: Photograph of blockwork wall and the Ship Inn Courtyard, ODU 3d

4.7.1 Environmental appraisal

Refer to Appendix D for the full environmental appraisal of the short list defence measures in ODUs 3d and 3e. In summary, each of the short list defence measures equally or better aligns with the landscape and heritage objectives compared to the Do Nothing scenario. Each of the measures is likely to lead to temporary impacts on ecology during constriction, although these impacts can be mitigated. Each of the defence measures will be setback, or within the footprint of the existing defences and therefore permanent ecology impacts are not expected.

4.7.2 Social appraisal

Feedback from the public consultation events on the short list defence measures in ODU 3d and 3e indicates that a glass topped floodwall in-front of the Ship Inn courtyard and along the concrete apron to the north is the favoured defence type in this location. This defence measure had marginally more support than a flip-up floodwall across the courtyard. The least supported defence measure in the feedback was demountable defences.

The Ship Inn owners and landlord provided their feedback on the shortlist options for this frontage during a separate stakeholder meeting. The Ship Inn feedback aligned with the views from the community that a frontline glass wall would be acceptable. It was noted that raised seating may be required and would need to be facilitated through scheme design.

From a broader outcome perspective, there is an aspiration from the owners / landlord to provide a covered space in the courtyard at some point in the future, along with landscaping. There is an opportunity to do this alongside construction of new defences but this will require continued liaison with the ESCP. Maximising the outside space is a priority for the Ship Inn and if this can be facilitated then it would be regarded as very positive. The owner / landlord would be open to discussing the potential for a financial contribution when further details on final scheme costs are available.

4.7.3 Technical appraisal

Each of the defence measures on the shortlist for ODU 3d and 3e are considered to be technically feasible. A number of the defence measures being considered require deployment. The resources required to deploy the different types of defences varies; deployment of the demountable defences is typically the most labour intensive, generally requiring a team of trained personnel to erect the demountable barrier. Demountable defences will also require an on-site or near site storage location to ensure that they can be deployed in an efficient manner. A flood gate positioned within the glass topped floodwall in ODU 3e would also require deployment but it is likely that this can be undertaken by a single trained operative. The flip-up barrier defences can be operated electronically from off-site or near-site locations.

Prior to the deployment of any of the defence measures it would be necessary to prepare the courtyard area outside the Ship Inn. For example, moving tables and chairs and ensuring members of the public are not in the immediate vicinity.

With the information currently available it is considered feasible for a vertical floodwall with a glass crest to be constructed in this location. This could either be constructed behind the existing blockwork wall, could replace the blockwork wall or could potentially incorporate the blockwork wall into the design. A potential way of incorporating the blockwork wall into the structure would be to place an in-situ concrete wall immediately behind the blockwork wall and to dowel this into the blockwork. To prevent rotation it would likely be necessary for the new concrete foundation to extend back towards the ship inn beneath the courtyard. With the information available at this stage it is unclear if the existing blockwork wall could support the additional loading of this approach but the feasibility could be investigated during outline design.

There are no known key services or utilities at this location.

A detailed account of the ground investigations in this area can be found in the ground investigations report and ground models technical note. No boreholes or trial pits were dug in the Ship Inn courtyard but a trial pit was dug adjacent to the existing parapet wall to investigate the defence's foundations (approx. 0.4-0.7m deep). The general ground model proposed for the wider ODU 3 area suggests that superficial soils are unevenly distributed and of low strength down to a depth of 3.00m below ground level (bgl) where Portsmouth Chalk Foundation is encountered.

4.7.4 Cost comparison

From a cost perspective, demountable defences have been calculated to be the least expensive defence approach in these sub-units and a flip-up floodwall is expected to be the most expensive. Table 4-15 provides the whole life costs for the short list defence measures. For illustrative purposes the costs to deliver a present day 1:200 year SoP are presented. The costs presented are the total costs for ODU 3d and 3e.

Table 4-15: Estimated whole life PV costs to provide a present day 1:200 year SoP in ODU 3d and 3e

Appraisal period	Least cost	Alternative 1	Alternative 2
50 years	£260k	£320k	£850k
	Demountable defences across courtyard and concrete apron	Floodwall (glass top) along front of courtyard. Including floodgate in section across concrete apron	Flip-up barrier across courtyard and concrete apron

4.7.5 Summary

Based on the information discussed in sections 4.7.1 to 4.7.4, the short list defence measures for ODU 3d and 3e have been scored and ranked based on their potential impact in each category. Table 4-16 below presents the scoring and based on the total scores the glass topped floodwall along the front edge of the courtyard and across the concrete apron has been identified as the preferred defence measure and alignment in these sub-units. A sketch showing an indicative cross section of the glass topped floodwall is shown in Figure 4-12.

Table 4-16: Scoring of short list defence measures in ODU 3d and 3e

Category	Demountable defences across Ship Inn courtyard and concrete apron		Glass topped floodwall along front of Ship Inn courtyard and across concrete apron		Flip-up barrier across Ship Inn courtyard and concrete apron	
	Score	Notes	Score	Notes	Score	Notes
Environment	+1	Relative to Do Nothing, generally equal or better alignment with the objectives. Temporary ecological impacts which likely can be mitigated	+1	Relative to Do Nothing, generally equal or better alignment with the objectives. Temporary ecological impacts which likely can be mitigated	+1	Relative to Do Nothing, generally equal or better alignment with the objectives. Temporary ecological impacts which likely can be mitigated
Social	-1	Least supported defence measure from public consultation feedback	+1	Most supported defence measure from public consultation feedback and from engagement with Ship Inn	0	Second most supported defence measure from public consultation feedback
Technical	-1	Straightforward construction but deployment is labour intensive	+1	Technically feasible. Single flood gate across apron section would require deployment, but can be undertaken by single operative	+1	Technically feasible, can be operated electronically but would require electricity supply
Cost	0	Least cost	-1	More costly than demountable defences	-2	Significantly more expensive than both demountables and glass topped floodwall
Total	+1		+2		0	

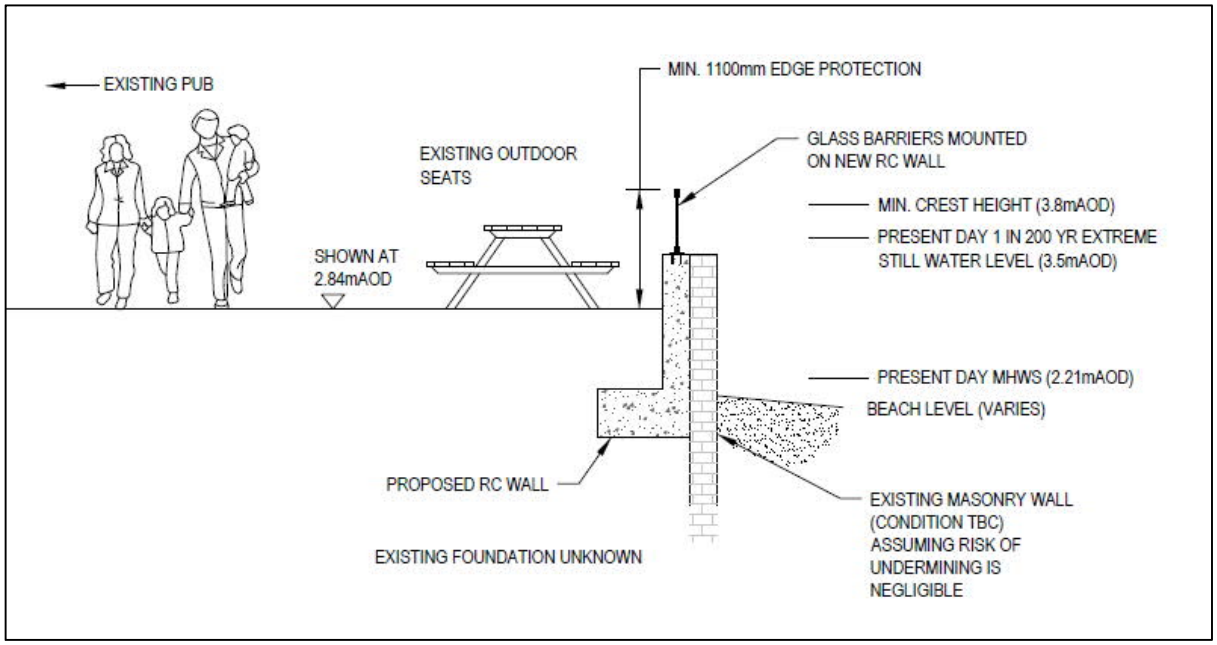

Figure 4-12: Sketch of indicative glass topped floodwall cross section for ODUs 3d-3e (not to scale).

4.8 ODU 3f to ODU 3h

ODU 3f to ODU 3h is a linear frontage approximately 125m long situated along the footpath between the Ship Inn and the Royal Oak. The footpath, which is a public right of way, is narrow (1-2m wide) and sits on top of a vertical brick wall. At the back of the footpath there are garden walls which act as informal defacto secondary defences. However, there are numerous gaps in the garden walls and in their current condition they cannot be relied upon from a structural point of view to provide a consistent level of flood protection.

The frontage in this location is particularly constrained from an option development perspective. There is limited space to construct a setback defence or a defence along the footpath in this location. In addition, any encroachment onto the foreshore to accommodate a new defence is not preferable given the environmental designations of the intertidal area.

One area along the frontage where the space availability increases is in ODU 3g which is located centrally along this frontage (approx. 30m long). Here, the width of the path increases and there is a small grassed area which could potentially be used for a new defence alignment.

For the sections of the frontage where space is most constrained (ODU 3f and 3h), two defence measures are on the short list:

- Setback floodwall adjacent to the garden wall, with a timber boardwalk in-front of the footpath
- Replace / reinforce the existing garden walls at the back of the footpath

With the boardwalk approach the walkway will enable the setback floodwall to be located along the footpath and will provide continued footpath access along this frontage. Without the boardwalk, a setback floodwall would take up the majority of the existing footpath width which would restrict access along the footpath. Replacing / reinforcing the existing garden walls will have less of an impact on the footpath width and will not require a boardwalk to maintain access.

At ODU 3g where more space is available, a wider selection of defence measures are on the shortlist. These include:

- Flip-up floodwall adjacent to the footpath (back of grassed area)
- Demountable defences adjacent to the footpath (back of grassed area)
- Frontline vertical floodwall with glass crest (front of grassed area)
- Floodwall with a boardwalk (front of grassed area)
- Self-raising flood barrier (front of grassed area)

A photograph of the footpath in ODU 3f is shown below in Figure 4-13.

Figure 4-13: Photograph of footpath in ODU 3f

4.8.1 Environmental appraisal

Refer to Appendix D for the full environmental appraisal of the short list defence measures in ODUs 3f to 3h. Of the two shortlist defence measures in ODUs 3f and 3h, the option to reinforce / replace the existing garden wall better aligns with the environmental objectives. This approach partially supports the objectives, but it is likely that any potential impacts could be mitigated (for example, if the wall was replaced, the cladding of the new wall could be like-for-like, to mitigate potential landscape impacts). This option better aligns with the environmental objectives relative to the Do Nothing scenario.

The setback floodwall and boardwalk option in this location could lead to ecology impacts on the European sites / SSSI. Whilst the boardwalk is not expected to lead to significant encroachment into the intertidal area, it could result in shading of the designated habits and it is likely that an IROPI would be required to obtain the relevant permissions for this option. The feedback from Natural England on the boardwalk was that there would be potential impacts on the designated sites due to shading and this will need to be examined in detail in the Habitats Regulations Assessment. There is potential to limit the impact of the shading through the design, for example, by increasing the spacing between the timber boardwalk planks, but it is unlikely that the impacts can be mitigated entirely.

The setback floodwall and boardwalk option is also likely to lead to impacts on the landscape character but less so on the AONB. The floodwall set-up against the side of the existing garden wall would likely detract from the character of the existing wall. However, the introduction of the boardwalk would ensure good pedestrian access and retain connections with the wider landscape for visitors.

In ODU 3g, the additional defence measures on the short list generally equally or better align with the landscape and heritage objectives compared to the Do Nothing scenario. The exception to this is the glass topped floodwall which in this particular location, directly in-front of the Green Cottage heritage assets, is likely to have a detrimental impact on the character and appearance of the conservation area. Each of the measures is likely to lead to temporary impacts on ecology during construction, although these impacts can be mitigated.

4.8.2 Social appraisal

The feedback from the public consultation events on the short list defence measures in ODU 3f and 3h showed that there was relatively even support for both for the two approaches on the shortlist. Both the setback floodwall and boardwalk, and the replacement / reinforcement of the garden walls received approximately equal levels of support (approximately 50% each). If designed appropriately, a boardwalk along this frontage could be considered as a placemaking opportunity.

For ODU 3g, where more measures are on the shortlist, there is no specific feedback from the public consultation. However, ESCP has met with the owners of the Green Cottage (immediately behind the ODU 3g frontage) on two separate occasions. In summary the owners support a setback floodwall with a boardwalk but do not support reinforcing or altering their boundary wall.

The general comments received for the ODU 3f-h frontage were concerned with the importance of keeping the footpath as it is, in order to preserve the character of the village. One comment specifically mentioned that the garden walls at the back of the footpath are part of the character of the village and need to stay the same, whilst another comment mentioned that widening of the footpath could lead to a loss of character which is not desirable.

Whilst there are public concerns about the character of the area and it needing to be maintained, if the design of a boardwalk and formal defences (either a setback wall or new garden walls) can be sympathetic to the existing character of the area, this frontage provides opportunities to deliver broader outcomes, such as footpath improvements (through widening using a boardwalk) which may be supported by the local community.

4.8.3 Technical appraisal

Based on the information available at this stage, for each of the sub-units along this frontage the floodwall and boardwalk option is considered to be technically feasible although further assessment on the technical feasibility and buildability is required at the outline design stage.

One approach to constructing this defence would be to place a gravity setback wall along the footpath alignment. However, the gravity wall will increase the loading on the existing frontline vertical brickwork wall in-front of the footpath and therefore it is recommended that this wall is rebuilt to ensure that it can support the additional loading requirements. For the purposes of costing, a rebuildof the existing frontline wall has been included in the scheme costs. The existing infill beneath the footpath will need to be assessed during the design stages because currently there is no information on the infill material. The impact of placing a gravity wall adjacent to the garden wall at the back of the footpath will also need to be considered during the design process.

There are different potential approaches for replacing or reinforcing the existing garden wall at the back of the footpath. At this stage the structural condition of the garden wall is unknown and therefore it is not possible to say with certainty which of the approaches are technically feasible. For the purposes of costing, it has been assumed that the wall will need to be replaced as this is likely to be the most costly approach. To replace the wall with a formal flood defence, due to the space constraints and height of the wall required (to match the existing), it is likely that a piled structure will be needed. This will require the existing wall to be demolished and there are a number of technical constraints associated with construction. Like-for-like cladding materials could be used to ensure the new wall looks similar to the existing.

Should reinforcing (rather than replacing) the garden walls be preferred, then a potential approach could be to make use of trench sheeting and concrete to provide the necessary reinforcement. This is likely to be a lower cost than replacing the wall entirely, but at this stage of the appriasal it is not known whether it is feasible due to unknown structural condition of the wall and would need to be investigated during design. The approach would involve excavating and placing trench sheets behind the lower portion of the existing garden wall, then infilling the space between with concrete. This design could provide structural support to the existing wall to withstand a higher depth of water on its seaward side.

There are a number of significant technical constraints associated with replacing or reinforcing the garden walls in ODU 3f and 3h with a piled structure. It may be possible, through appropriate design, to mitigated these contraints but this will need to be confirmed during the design stage. A major constraint is the lack of space for construction activities with a number of buildings located in close proximinty behind the garden walls. There is therefore potential for structural damage to these properties when piling (during the construcion phase) which would pose a risk to the inhabitants and could require compensation should damage occur. In addition, should the local residents not support this option then it is likely that the land required for the new defence would need to be obtained through compulsory purchase. Furthermore, there are a number of trees in the vicinity which overhang the existing garden walls which will require cut back for piling to commence; three of these trees in ODU 3h have Tree Preservation Orders (TPOs) in place.

In ODU 3f there are no known key services or utilities within this sub-unit. However, to the north, in ODU 3g and 3h there is a Scottish and Southern Electricity low voltage power cable and British Telecommunications Open reach cable located beneath the existing footpath in these sub-units. The cables pass beneath the potential defence alignments beneath the footpath and therefore further investigation will be required at the outline design phase to determine the feasibility of constructing within the vicinity of the cables or to discuss potential diversion costs with the service provider.

In ODU 3g the additional defence options on the short list are all considered to be technically feasible. However, similar to the setback floodwall, each measure will increase the loading on the existing frontline brick wall in front of the footpath. Due to the additional loading it will be necessary to undertake scheduled maintenance or refurbishment of the existing wall to ensure it can accommodate the load. The vertical floodwall variations are likely to lead to the greatest load increase, and therefore for costing purposes it has been assumed that the frontline wall will be refurbished to ensure that it can support the additional loading requirements.

In ODU 3g a number of the defence measures on the short list require deployment, for example the demountable defences and the flip-up flood barrier. The resources required to deploy these defences varies; ddeployment of the demountable defences is typically the most labour intensive, generally requiring a team of trained personnel to erect the demountable barrier. Demountable defences will also require an on-site or near site storage location to ensure that they can be deployed in an efficient manner. The flip-up barrier defences can be operated electronically from off-site or near-site locations.

A detailed account of the ground investigations in this area can be found in the ground investigations report and ground models technical note. A number of trial pits were dug adjacent to the defences along this frontage. The majority of trial pits in the vicinity were terminated upon discovery of a foundation slab (typically between 0.3-0.85m deep) and none of the pits extended more than 1m into the ground and groundwater was not encountered. Made ground was encountered in each of the trial pits. The general ground model proposed for the wider ODU 3 area suggests that superficial soils are unevenly distributed and of low strength down to a depth of 3.00m below ground level (bgl) where Portsmouth Chalk Foundation is encountered.

4.8.4 Cost comparison

For the central section of the frontage at ODU 3g, demountable defences are expected to be the least cost option along this 30m frontage. Table 4-17 below compares the whole life costs of the short list defence measures in ODU 3g. For illustrative purposes the costs to deliver a present day 1:200 year SoP are presented.

Table 4-17: Estimated whole life PV costs for ODU 3g to provide a present day 1:200 year SoP

Appraisal period	Least cost	Alternative 1	Alternative 2	Alternative 3
ODU 3g 50 years	£150k	£210k	£230k	£570k
	Demountable defences	Setback floodwall with a glass top	Floodwall and boardwalk	Flip-up barrier / self-raising floodwall

Table 4-18 below compares the whole life costs for the full ODU 3f to 3h frontage. To provide a consistent approach across the full frontage, the combined floodwall and boardwalk costs have been estimated for ODU 3f to ODU 3h. The alternative option in ODU 3f and 3h is to replace or reinforce the garden walls at the back of the footpath. This option is not a viable approach in the central section of the frontage at ODU 3g, and therefore for comparison purposes the costs for replacing / reinforcing the garden walls in ODUs 3f and 3h have been combined with the costs for demountbale defences in ODU 3g which is the least cost defence measure in this unit. A setback floodwall with a boardwalk is expected to be considerably lower cost than replacing the existing garden walls.

Table 4-18: Estimated whole life costs to provide a present day 1:200 year SoP for ODUs 3f to 3h

Appraisal period	Least cost	Alternative 1
50 years	£1,190k	£1,480k
	Setback floodwall with boardwalk – full length ODU 3f, 3g and 3h	Replacement of garden walls with piled floodwall in ODU 3f and 3h. Demountable defences in ODU 3g.

4.8.5 Summary

Based on the information discussed in sections 4.8.1 to 4.8.4, the short list defence measures for ODU 3f to ODU 3g have been scored and ranked based on their potential impact in each category. In order to compare the options for the frontage as a whole, it has been necessary to first establish which of the short list defence measures in ODU 3g would be the preferred approach where there are a wider variety of measures on the short list. Table 4-19 below presents the scoring for ODU 3g.

Table 4-19: Scoring of short list defence measures in ODU 3g

Category	Demountable defences		Setback floodwall with glass top		Floodwall with boardwalk		Flip-up floodwall / self-raising floodwall	
	Score	Notes	Score	Notes	Score	Notes	Score	Notes
Environment	+1	Relative to Do Nothing, generally equal or better alignment with the objectives. Temporary ecological impacts which likely can be mitigated	-2	Does not support objectives as well as Do Nothing. Likely to have negative impact on Heritage and Landscape	-2	Does not support objectives as well as Do Nothing. Likely to require IROPI due to shading on designated intertidal area	+1	Relative to Do Nothing, generally equal or better alignment with the objectives. Temporary ecological impacts which likely can be mitigated
Social	-1	Based on feedback for other areas where demountable are generally not supported by the public.	0	No direct feedback from public	+1	No direct feedback from public. But approach supported by Green Cottage owners	0	No direct feedback from public.
Technical	-1	Straightforward construction but deployment is labour intensive	-1	Buried services located beneath footpath at the back of the grassed area where this defence would be aligned. Diversion likely required	+1	Alignment along front edge or across grassed area. Services located further back and therefore not likely to require diversion.	-1	Buried services located beneath footpath at the back of the grassed area where this defence would be aligned. Diversion likely required
Cost	0	Least cost	-1	More costly than demountables	-1	More costly than demountables	-2	Considerably more costly than alternatives
Total	-1		-4		-1		-2	

Based on the total scores either the demountable defences or a floodwall and boardwalk along the front edge of the grassed area has been identified as the preferred defence measure in this sub-unit. The choice of which of these defence measures to use in this sub-unit should consider the wider preferred option along the frontage.

Table 4-20 presents the scoring for ODUs 3f and 3h. Based on this scoring the setback floodwall with a boardwalk has been identified as the preferred option in these sub-units. In the interest of constructing a linear defence across the full length of this frontage, it is considered to be most practical to also construct a setback floodwall and boardwalk in ODU 3g.

Table 4-20: Scoring of short list defence measures in ODU 3f and 3h

Category	Setback floodwall with boardwalk		Replacement of garden walls with piled floodwall	
	Score	Notes	Score	Notes
Environment	-2	Does not support objectives as well as Do Nothing. Likely to require IROPI due to shading on designated intertidal area	+1	Relative to Do Nothing, generally equal or better alignment with the objectives. Temporary ecological impacts which likely can be mitigated
Social	0	Both defence measures have similar levels of support	0	Both defence measures have similar levels of support
Technical	+1	Minor constraints but considered technically feasible with appropriate design. Depending on depth of buried services, diversion may be required in 3h but not along the whole frontage.	-2	Major constraints for piling approach such as space constraints, land ownership, trees and potential for structural damage.
Cost	0	Least cost approach	-2	Significant increase in cost relative to setback floodwall & boardwalk
Total	-1		-3	

Sketches of potential cross sections of the preferred boardwalk and floodwall defence approach are shown in Figure 4-14 and Figure 4-15 below. For illustration purposes, a sketch showing a floodwall with no boardwalk is also provided, demonstrating that this approach is unfeasible due to space constraints on the footpath (Figure 4-16).

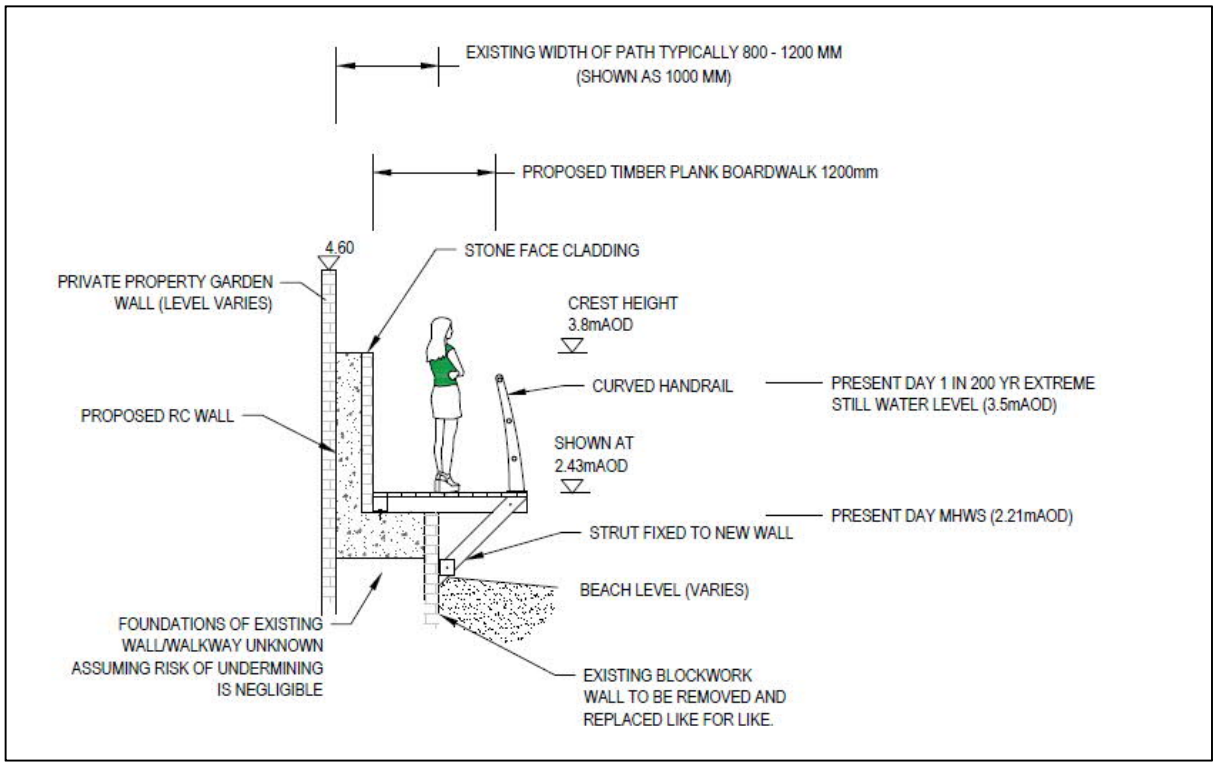

Figure 4-14: Sketch of indicative boardwalk and floodwall cross section in ODUs 3f-h, using strut to fix boardwalk to new wall (not to scale).

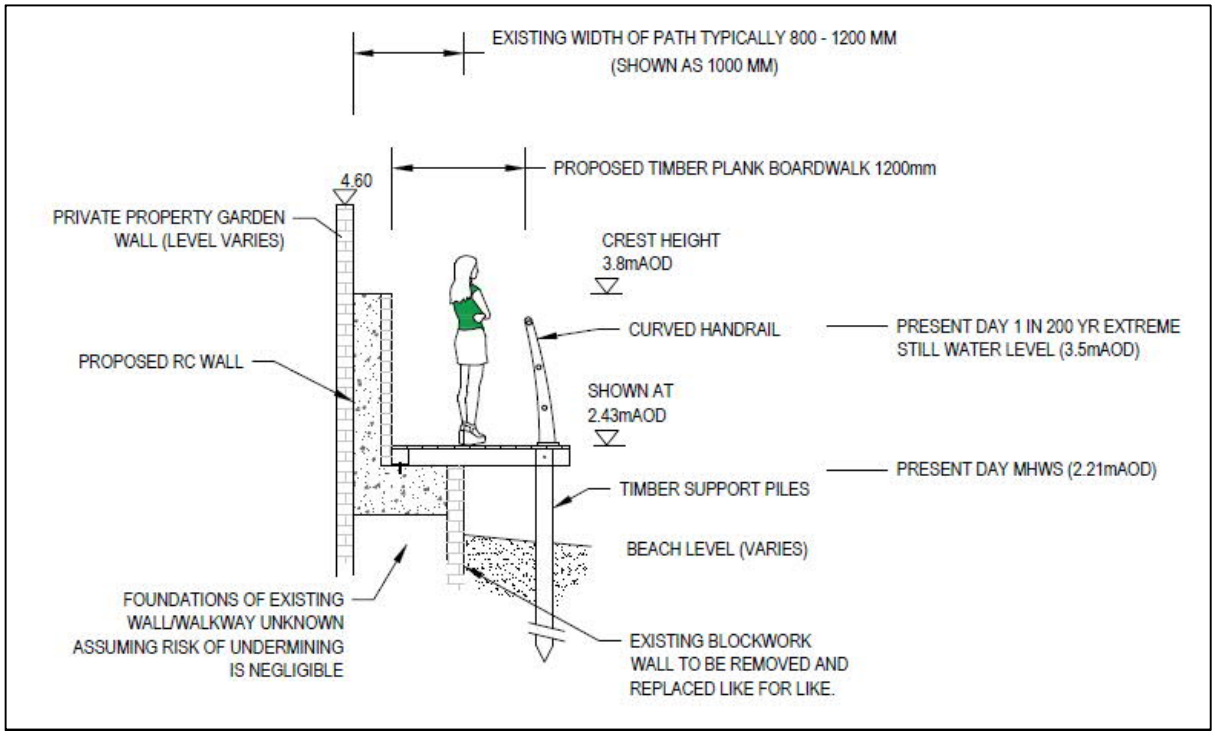

Figure 4-15: Sketch of indicative boardwalk and floodwall cross section in ODUs 3f-h, using piles to support boardwalk (not to scale).

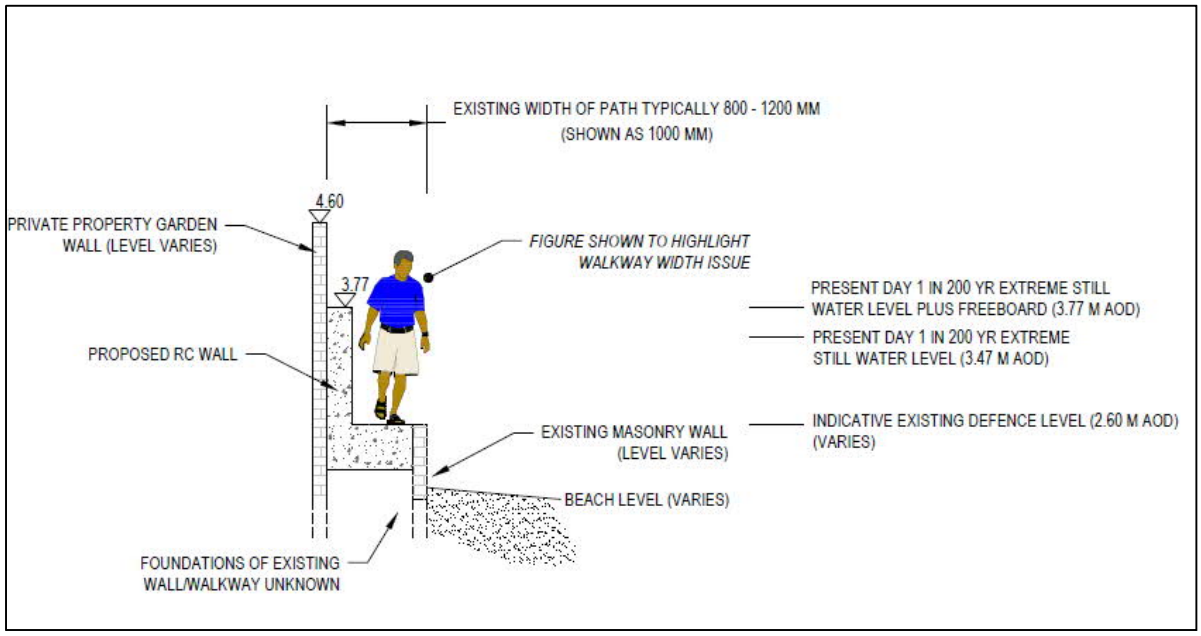

Figure 4-16: Sketch illustrating unfeasible footpath width should boardwalk not be installed (not to scale).

4.9 ODU 3i

ODU 3i is a short sub-unit approximately 10m long. The existing defence is a continuation of the vertical masonry wall with a footpath along the top that is found in ODU 3h. At the back of the footpath in this sub-unit a residential building wall forms a secondary informal flood defence (transitioning from the garden wall in ODU 3h). The footpath ends at the north end of this sub-unit where it intersects with Langstone High Street.

Three defence measures have been included on the short list for this sub-unit:

- Setback floodwall and boardwalk
- Demountable defences
- Flood proofing of the existing residential building

To tie-in to the preferred option in ODU 3h, it will be necessary for each of the defence measures in this unit to be in close proximity to the outer building wall. The setback floodwall would be located along the existing footpath alignment with the setback wall positioned against the outer building wall (with the boardwalk in front to ensure the footpath is wide enough). Likewise, the demountable defences would be positioned against the outer building wall and flood proofing would make use of the building wall itself.

Figure 4-17 shows a photograph of the residential building and footpath in ODU 3i.

Figure 4-17: Photograph of residential building and footpath in ODU 3i

4.9.1 Environmental appraisal

Refer to Appendix D for the full environmental appraisal of the short list defence measures in ODU 3i. In summary, the demountable defence and flood proofing options equally or better align with the landscape and heritage objectives compared to the Do Nothing scenario. Each of the measures is likely to lead to temporary impacts on ecology during construction, although these impacts can potentially be mitigated. Each of the defence measures will be setback, or within the footprint of the existing defences and therefore permanent ecology impacts are not expected.

The setback floodwall and boardwalk option in this location could lead to ecology impacts on the European sites / SSSI. Whilst the boardwalk is not expected to lead to significant encroachment into the intertidal area, it could result in shading of the designated habitats and it is likely that an IROPI would be required to obtain the relevant permissions for this option. There is potential to limit the impact of the shading through the design, for example, by increasing the spacing between the timber boardwalk planks, but it is unlikely that the impacts can be mitigated entirely.

4.9.2 Social appraisal

Feedback from the public consultation events on this sub-unit was grouped together with the larger ODU sub-units between ODU 3f and ODU 3g. As a result there is no specific public feedback on the level of support for flood proofing the residential building wall or the use of demountable defences for this sub-unit. Across ODUs 3f to 3i as a whole, the setback floodwall and boardwalk and the replacement / reinforcement of the garden walls received even levels of support.

Given that the defence alignment in this location is close to, or potentially makes use of, the residential building wall it is recommended that consultation with the owner of the residential property is undertaken to determine their preferred approach in this sub-unit.

On the whole across the study frontage, the feedback suggests that the public does not suport demountable defences. The wider feedback could be used to infer the feedback for this particular sub-unit.

4.9.3 Technical appraisal

At this stage of the appraisal, demountable defences are considered to be a technically feasible defence measure at this location.

Flood proofing of the residential building is considered a feasible approach. From discussions with the residential property owner it is understood that the building wall has already been flood-proofed internally and has raised foundations above the elevation of the footpath. However, it will be necessary to undertake a survey of the existing building to confirm that this is the case. Additional flood proofing could be added to the wall to increase the robustness of the defence, for example, a water proof membrane could be added to the outer wall (similar to the Royal Oak).

With the information available there is considerable uncertainty on the structural make-up of the walls and it is not known at this time whether the walls could withstand the required 0.75-1.0m of water or whether they would collapse. Therefore, it will be necessary to undertake structural investigations and undertake loading calculations on the outer building wall to help determine its integrity during flood conditions. Discussions with the building owner will also be necessary to ensure that they are in support of any scheme involving their building acting as a flood defence and that they are aware of the potential implications that this brings. For example, it could alter the value of the property.. Should the structural assessment indicate that the building cannot form a formal part of the flood defence scheme then alternative measures on the short list can be pursued.

Due to the proximity to the residential building, a setback floodwall constructed against the building wall is not considered to be technically feasible in this location. From a construction perspective, placing a reinforced concrete floodwall against the verticle brick wall could comprimise its structural integrity.

In terms of key services and utilities, there is a Scottish and Southern Electricity low voltage power cable and British Telecommunications Open reach cable located beneath the existing footpath in this ODU sub-unit. The cables pass under the footpath and are within the vicinity of the potential defence alignments so therefore further investigation will be required at the outline design phase to determine the feasibility of construction within the vicinity of the cables or to discuss potential diversion costs with the service provider.

A detailed account of the ground investigations in this area can be found in the ground investigations report and ground models technical note. Two trial pits were dug adjacent to the defences in this sub-unit. The majority of trial pits in the vicinity were terminated upon discovery of a foundation slab and none of the pits extended more than 1m into the ground and groundwater was not encountered. Made ground was encountered in each of the trial pits.

4.9.4 Cost comparison

Table 4-21 below compares the estimated whole life costs of the short list defence measures. For illustrative purposes the costs to deliver a present day 1:200 year SoP are presented.

From a cost perspective, both the setback floodwall and demountable defences are expected to have similar whole life costs. The setback floodwall would have a larger upfront cost but the cost of deploying the demountables over the full appraisal period is substantial. For both appraisal periods the flood proofing of the residential building wall is expected to be the highest cost approach, although the cost of this measure is highly uncertain. This is largely due to the unknown risks associated with this approach. For example, it is currently unknown if structural improvements will be required. This uncertainty is denoted with an asterisk in Table 4-21.

Table 4-21: Estimated whole life PV costs to provide a present day 1:200 year SoP

Appraisal period	Least cost	Alternative 1	Alternative 2
50 years	£80k	£90k	£100k* (uncertain)
	Demountable defences	Setback floodwall with boardwalk	Flood proof residential building wall

4.9.5 Summary

Based on the information discussed in sections 4.9.1 to 4.9.4, the short list defence measures have been scored and ranked based on their potential impact in each category. Table 4-22 below presents the scoring and based on the total scores flood proofing of the residential building has been identified as the preferred defence measure in this sub-unit.

As shown in Table 4-22 the demountable defences and flood proofing to the existing building have the highest overall scores and the preferred option could reasonably be selected from either of these two approaches. Given that there is not a clear favoured option in this location, the selection of the preferred defence measure in this unit was discussed in detail by the ESCP and AECOM project team during the internal preferred option selection workshop. Based on the information available it was decided that flood proofing the existing building should be selected as the preliminary preferred option subject to further discussion with the property owner and more detailed surveys. This option was selected rather than demountable defences because the building currently withstands a degree of flooding and it was considered most suitable by the project team to make use of this feature should it be possible to improve it to provide a robust defence. Demountable defences would require deployment and are unlikely to be supported by the local community based on feedback from elsewhere along the frontage. The use of a floodwall and boardwalk has been ruled out on technical grounds due to the close proximity of the residential building.

The project team acknowledges that there are risks associated with taking forward the use of the building wall as the preliminary preferred option, such as the unknown structural condition of the building wall, but at this stage it was considered appropriate to take this option forward. It was agreed that structural investigations will be carried out as part of the design process and discussions will be held with the property owner to determine the feasibility of this approach and to seek the required confidence that the building wall can provide a robust flood defence and form part of the wider scheme alignment. Should the structural assessment indicate that the building cannot form a formal part of the flood defence scheme then alternative measures on the short list can be pursued.

Table 4-22: Scoring of short list defence measures in ODU 3i

Category	Demountable defences		Setback floodwall with boardwalk		Flood proof residential building wall	
	Score	Notes	Score	Notes	Score	Notes
Environment	+1	Relative to Do Nothing, generally equal or better alignment with the objectives. Temporary ecological impacts which likely can be mitigated	-2	Does not support objectives as well as Do Nothing. Likely to require IROPI due to shading on designated intertidal area	+1	Relative to Do Nothing, generally equal or better alignment with the objectives. Temporary ecological impacts which likely can be mitigated
Social	-1	Based on feedback for other areas where demountable are generally not supported by the public	0	No direct feedback from public	0	No direct feedback from public
Technical	-1	Straightforward construction but deployment is labour intensive	-2	Not considered technically feasible at this stage due to risks associated with construction and proximity to building	-1	Structural investigations and discussions with property owner required to determine feasibility.
Cost	0	Least cost approach	0	Least cost approach	-1	Likely to be more costly than alternatives should structural improvement be required to the residential building
Total	-1		-4		-1	

4.10 ODU 3j

ODU 3j is a short ODU sub-unit in length (approx. 10m) spanning the slipway at the end of Langstone High Street. Three different defence measures are included on the short list for this ODU sub-unit:

- Flip-up floodwall
- Demountable defences
- Flood gate

Each of these defences are bespoke engineering products and when deployed would provide the required standard of flood protection to the area behind. The main advantage of each of these products is that when they are not deployed they will not impede on slipway and foreshore access at the end of the High Street.

Figure 4-18 presents a photograph of the slipway at the end of Langstone High Street (photograph taken during the GI works).

Figure 4-18: Photograph of Langstone High Street slipway

4.10.1 Environmental appraisal

Refer to Appendix D for the full environmental appraisal of the short list defence measures in ODU 3j. In summary, each of the short list defence measures equally or better aligns with the landscape and heritage objectives compared to the Do Nothing scenario. Each of the measures is likely to lead to temporary impacts on ecology during construction, although these impacts can potentially be mitigated.

4.10.2 Social appraisal

The feedback from the public consultation events on the short list defence measures in ODU 3j indicates that a flood gate is the favoured defence type in this location. Of the short list defence measures presented to the public, approximately half of respondents supported a flood gate. The other defence measures; the flip-up floodwall and demountable defences had less support.

4.10.3 Technical appraisal

Each of the short list defence measures at this location will require deployment. The resources required to deploy the defences varies greatly and is discussed in section 4.6 where similar defences are being considered.

There are numerous key services and utilities buried beneath Langstone High Street. These include a Scottish and Southern Electricity low voltage cable, British Telecommunications Openreach cables, a Southern Gas Network pipe, a Southern Water sewer pipe, and a Portsmouth Water pipe. The large number of buried services

in this location is likely to constrain the choice of the preferred option, where a defence with deep foundations is unlikely to be feasible.

The depth and extent of the structural foundations required for each of the defence measures varies. The foundation requirements for demountable defences would be limited to the slots in which the demountable posts are placed. The foundation requirements for a lift-hinged flood gate are also limited. The gates utilise a 'raise-swing-lower' mechanism and only require a flat surface to seal against. The gates do not require recessed ground channels, raised ground beams or ramps. Owing to the minimal foundation requirements for these two types of defence, both are considered to be technically feasible within the constraints of the buried services. This will need to be confirmed with the buried service providers and also with a supplier of these bespoke defence products (e.g. Flood Control International) at the outline design phase.

Whilst demountable defences and a flood gate require minimal foundations, and are considered feasible, a flip-up flood barrier defence requires mounting within a reinforced concrete pit, approximately 0.2m to 0.5m deep. Foundations of this depth are likely to conflict with the buried services and therefore it is likely that the services will need to be diverted in order to enable the flip-up defences to be utilised. Therefore, should this defence measure be taken forward, during the outline design phase discussions with the utility providers will be required and cost estimates for diversion should be obtained.

A detailed account of the ground investigations in this area can be found in the ground investigations report and ground models technical note. No Trial pits were dug in this ODU sub-unit but a borehole was located approximately 5m to the east of the slipway at the end of Langstone High Street. Ground water was observed in the borehole record at 1.2m bgl in the base of the inspection pit. The general ground model proposed for the wider ODU 3 area suggests that superficial soils are unevenly distributed and of low strength down to a depth of 3.00m bgl where Portsmouth Chalk Foundation is encountered.

Each of the defence measures will need to extend across the pavement that runs parallel to the residential building in ODU 3i. This will be necessary to tie-in with the adjacent defences in ODU 3i. The details of how the defences will tie-in will be established during the design phase. If a flood gate is taken forward as the preferred option, due to the step change in elevation between the slipway and pavement it may be necessary to install a separate smaller floodgate across the pavement or steps or a ramp.

4.10.4 Cost comparison

In the economic analysis undertaken in the Economics Report (AECOM 2019), demountable defences were identified as the least cost defence measure at this location. The costs of a flood gate are estimated to be very similar to demountable defences but a flip-up flood defence is expected to be significantly more expensive. Table 4-23 below compares the estimated whole life costs of the short list defence measures. For illustrative purposes the costs to deliver a present day 1:200 year SoP are presented.

The comparison shown in Table 4-23 shows that the estimated additional whole life cost to install, maintain and deploy a flood gate relative to a demountable defence is minimal (in relative terms), requiring an additional £20k over a 50 year appraisal period. The additional whole life investment required to install, maintain and operate a flip-up flood barrier across the slipway, relative to the demountable defences, is estimated to be £130k over a 50 year appraisal period.

Table 4-23: Estimated whole life PV costs to provide a present day 1:200 year SoP

Appraisal period	Least cost	Alternative 1	Alternative 2
50 years	£60k	£90k	£190k
	Demountable defences	Flood gate	Flip-up flood barrier

4.10.5 Summary

Based on the information discussed in sections 4.10.1 to 4.10.4, the short list defence measures have been scored and ranked based on their potential impact in each category. Table 4-24 below presents the scoring and based on the total scores the flood gate across the slipway has been identified as the preferred defence measure in this sub-unit. Figure 4-19 shows an elevation sketch of the flood gate layout (looking west up the slipway)

Table 4-24: Scoring of short list defence measures in ODU 3j

Category	Demountable defences		Flood gate		Flip-up barrier	
	Score	Notes	Score	Notes	Score	Notes
Environment	+1	Relative to Do Nothing, generally equal or better alignment with the objectives. Temporary ecological impacts which likely can be mitigated	0	Permanent feature, more difficult to mitigate landscape and heritage impacts	+1	Relative to Do Nothing, generally equal or better alignment with the objectives. Temporary ecological impacts which likely can be mitigated
Social	-1	Least supported defence measure from public consultation feedback	+1	Most supported defence measure from public consultation feedback	0	Second most supported defence measure from public consultation feedback
Technical	-1	Straightforward construction but deployment is labour intensive	+1	Technically feasible and less labour intensive to deploy than demountables	-1	Least labour intensive to deploy but potential service diversion required
Cost	0	Least cost	0	Comparatively similar cost to demountable defences	-2	Significantly more expensive than both demountables and flood gate
Total	0		+1		-2	

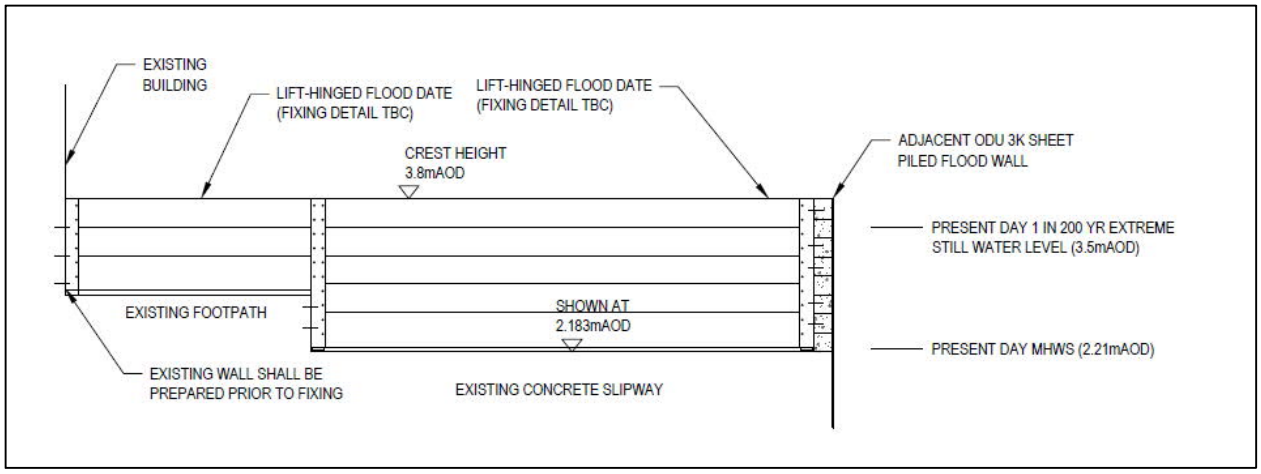

Figure 4-19: Sketch showing indicative elevation drawing of the flood gates at ODU 3j (not to scale).

4.11 ODU 3k

ODU 3k is approximately 100m long and encompasses the frontage of the Royal Oak public house and adjacent buildings and garden walls. There is a 2-3m wide footpath in front of the Royal Oak which is fronted by a vertical stone faced masonry quay wall. The footpath is wider than the footpath between ODU 3f and 3i and has sufficient space to accommodate a new flood defence.

The building and garden walls currently act as defacto defences (i.e. they provide a flood defence function without being designed as formal flood defences). In addition to this the residents make use of flood boards across their doorways to prevent floodwater entering the properties. Whilst the existing approach provides a flood defence function, the existing walls and the use of flood boards cannot be relied upon to provide a robust defence to the required standard of protection. The boards in particular haven't been included in the economic assessment. However should a new defence be constructed and the boards continue to be used, they will form an informal secondary flood defence should an above design event occur.

The short list of options for this sub-unit consists of three defence measures. These include:

- Flip-up flood barrier defence
- Frontline floodwall of the existing defences
- Flood proofing the walls of the Royal Oak and adjacent buildings, and reinforce or replace the garden / boundary walls.

For the frontline floodwall option, a variety of different materials can be used for the defence crest. Three options have been considered; a solid crest extending all the way up to the design crest level, a 0.5m glass panel replacing the top 0.5m of wall, or 0.6m of demountable panels replacing the top 0.6m of the wall. Initially only the glass crest was included on the short list, but feedback during the public and stakeholder consultation indicated that it was unlikely that this approach would be supported. Depending on the feedback during the next round of consultation, a combination of different crest types could be used along the length of the defence. For example, to preserve views in key areas such as immediately in front of the Royal Oak, it could be desirable to have glass or demountable panels, whereas in areas where views across the harbour are less important, a solid structure may be desired.

A photograph of the frontage in ODU 3k is shown in Figure 4-20 below.

Figure 4-20: Photograph of ODU 3k frontage

4.11.1 Environmental appraisal

Refer to Appendix D for the full environmental appraisal of the short list defence measures in ODU 3k. In summary, both the flip-up floodwall and option to flood proof the walls of the Royal Oak and adjacent buildings, equally or better align with the landscape and heritage objectives compared to the Do Nothing scenario. Each of

the measures is likely to lead to temporary impacts on ecology during construction, although these impacts can potentially be mitigated.

The frontline floodwall options are likely to have both landscape and heritage impacts. For example, a frontline floodwall would reduce the openness of the area. However, relative to the Do Nothing scenario, the floodwall option equally or better aligns with the landscape and heritage objectives. With respect to the ecology objectives, the frontline floodwall could result in a loss of designated habitat, although the design will look to limit the magnitude of this loss. An IROPI case is expected to be required to receive the relevant permissions for this defence option.

4.11.2 Social appraisal

Feedback from the public consultation events on the short list defence measures in ODU 3k indicates that the use of the quay wall and the building / garden walls is the favoured defence type in this location. Construction of a frontline glass crested floodwall received the least support. Alternative options exist for the crest type/material of a frontline wall (such as demountable defences or a traditional upstand wall with cladding) and have been included in the short list. These alternatives (rather than glass) may be better supported by the public.

The general comments received for this area are concerned with reinforcing the existing quay walls. Concerns were raised over the future maintenance of any defences in this location, with a comment suggesting that the council should take over responsibility for the upkeep and maintenance of any scheme that goes ahead to protect the area from flooding. A comment received suggested that neither flip-up floodwalls or glass flood walls are in keeping with the buildings in this location.

Representatives from the Royal Oak provided their feedback on the shortlist options for this frontage during a separate stakeholder meeting. The Royal Oak feedback aligned with the views from the community that favoured making use of the quay wall and the building / garden walls. The Royal Oak's second preference would be a frontline floodwall along the edge of the footpath in front of the Royal Oak although this could result in changes to the current unloading routine of deliveries (which currently unload directly onto the footpath from a lorry). Should a frontline wall be taken forward then discussions with the Royal Oak and the relevant key stakeholders (e.g. Natural England who could have an interest in lorries driving over the designated foreshore) will need to be held to determine an agreeable solution.

Discussions were also held with the Royal Oak representatives regarding potential broader outcomes and their aspirations for the site. It was communicated that there are no plans for any refurbishment of the property in the near future and the garden was refurbished three years ago. It is recommended that ESCP continue to liaise with the Royal Oak to determine if financial contributions will be likely.

4.11.3 Technical appraisal

There are numerous key services and utilities buried beneath the footpath in this location. The services follow the alignment of the footpath along the full length of the sub-unit and comprise a Scottish and Southern Electricity low voltage cable, a British Telecommunications Openreach cable, a Portsmouth Water pipe and a Southern Gas Network pipe. The large number of buried services in this location is likely to constrain the choice of the preferred option in this location, with a defence with deep foundations across the footpath unlikely to be feasible unless the services can be diverted. It is recommended that discussions are held with the service providers during the design process to facilitate potential financial contributions for protecting the key services or to discuss costs if there is a requirement to divert.

From purely a services and utilities perspective, flood proofing and making use of the existing walls of the buildings and the garden walls is likely to be the least challenging approach. This approach is unlikely to require service diversions and excavation / construction within the footpath area where the services are located or a rebuild of the frontline quay wall. However, from a structural point of view, there is currently not sufficient information available to conclude that the existing building walls can be relied upon to provide a robust flood defence over such as long length of defence. The secondary and building walls along this frontage are historic, with many gaps and there is no structural information available at this stage. It is not known whether the walls could withstand the required 0.75-1.0m of water or whether they would collapse. In addition, there are a number of windows 0.5-1.0m above the footpath level in this location which provide a weak link in the building fabric. As a result, it is not technically feasible to flood proof and make use of the existing walls of the Royal Oak and adjacent buildings. Structural surveys could be undertaken in the future to investigate this further but for the current appraisal with the information available this approach has been ruled out on technical grounds.

From a services and utilities perspective a flip-up floodwall along the existing footpath will likely require excavation and construction within the footpath area and the buried services are therefore likely to provide a significant challenge to the implementation of this measure. Depending on the loading of the flip-up barriers on the existing quay wall it may be necessary to rebuild the quay wall. Should the flip-up floodwall be taken forward as the preferred defence measure in this location then liaison with the service providers is recommended from an early stage and cost estimates for diverting the services should be obtained where possible.

There are a number of approaches which could be used to construct a frontline floodwall and raise the height of the existing defence in front of the footpath in this location. One approach would be a gravity floodwall structure along the footpath, however, this is likely to require a rebuild of the frontline quay wall and deep excavation of the footpath and the buried services make this an unviable approach unless the services can be diverted.

A technically feasible alternative approach to constructing a frontline wall would be to construct a piled structure immediately in front of the existing masonry wall. Interlocking sheet piles or tubular mini-piles could be used in this location. Use of sheet piling in-front of the existing quay wall would mean that it would not need to be rebuilt. The floodwall and front face of the piles could be clad to be similar to the existing wall material to reduce the visual impact and landscape of the area. The drawback of the frontline approach is that it will lead to encroachment onto the foreshore but the use of suitable materials and an appropriate design can limit the extent of this. The piled approach will not require excavation of the footpath and is therefore expected to have less of an impact on the buried services and utilities. However, the new structure will be in close vicinity to the buried services and therefore discussions with the service providers are still recommended.

For the frontline floodwall defence option in ODU 3k it will be necessary to construct stepped access over the defence at the northern end of the sub-unit, adjacent to ODU 3l. This will be required to provide access to and from the Old Mill and along the coastal path during periods of high tide / flooding. The details of this access will be incorporated into the option during the design process.

Some of the defence measures considered on the short list in this sub-unit would require deployment, for example the flip-up barrier defence and the demountable crest on the frontline floodwall. The deployment of demountable defences onto the frontline floodwall would be expected to be the most labour intensive requiring a team of trained personnel to erect the demountable barrier crests. The flip up flood barriers can be deployed electronically from an off-site or near site location. Demountable defences will also require an on-site or near site storage location to ensure that they can be deployed in an efficient manner.

A detailed account of the ground investigations in this area can be found in the ground investigations report and ground models technical note. A total of seven Trial pits were dug adjacent to the existing quay wall in this sub-unit and were stopped upon finding the defence foundations (typically 0.4-0.9m deep). Made ground was encountered in each trial pit and the pits in the vicinity were terminated upon discovery of a foundation slab. Groundwater was not encountered in any of the pits in this location.

The borehole discussed in section 4.10.3 is located on the foreshore in-front of the quay wall. In this borehole groundwater was observed at 1.2m bgl in the base of the inspection pit. A window sample borehole was dug immediately to the east of the Royal Oak. This encountered river terrace deposits and alluvium and the Portsmouth Chalk Formation at 3.30m blg. The general ground model proposed for the wider ODU 3 area suggests that superficial soils are unevenly distributed and of low strength down to a depth of 3.00m bgl where Portsmouth Chalk Foundation is encountered.

4.11.4 Cost comparison

The cost comparison shown in Table 4-25 provides the estimated costs for a frontline floodwall (piled solution) and a flip-up barrier. For illustrative purposes the costs to deliver a present day 1:200 year SoP are presented. No costs have been estimated for flood proofing the Royal Oak and adjacent buildings because this option has been ruled out on technical grounds and the requirements for this option are unclear. The comparison indicates that the frontline floodwall is expected to be the least cost approach.

Table 4-25: Estimated whole life PV costs to provide a present day 1:200 year SoP

Appraisal period	Least cost	Alternative 1
50 years	£1,050k	£1,850k
	Frontline floodwall	Flip-up flood barrier

4.11.5 Summary

Based on the information discussed in sections 4.11.1 to 4.11.4, the short list defence measures have been scored and ranked based on their potential impact in each category. Table 4-26 below presents the scoring and based on the total scores the frontline floodwall has been identified as the preferred defence measure in this sub-unit. A sketch showing an indicative cross section of a frontline floodwall at ODU 3k is shown in Figure 4-21.

Table 4-26: Scoring of short list defence measures in ODU 3k

Category	Frontline floodwall (piled structure)		Flip-up flood barrier		Flood proof existing buildings and garden walls	
	Score	Notes	Score	Notes	Score	Notes
Environment	-2	Does not support ecology objective. Likely to require IROPI due to encroachment into designated intertidal area	+1	Relative to Do Nothing, generally equal or better alignment with the objectives. Temporary ecological impacts which likely can be mitigated	+1	Relative to Do Nothing, generally equal or better alignment with the objectives. Temporary ecological impacts which likely can be mitigated
Social	0	Less support than use of existing buildings	0	Less support than use of existing buildings	+1	Most supported measure in public feedback
Technical	+1	Feasible with appropriate design	-1	Major impact on buried services. Service diversion likely to be required although no clear location for diversion identified	-2	Considered to be technically unfeasible due to age of structures, gaps in walls and low windows
Cost	0	Least cost approach	-2	Significantly more costly than frontline floodwall	-2	Costs largely unknown due to lack of structural information available. Potential to be high.
Total	-1		-2		-2	

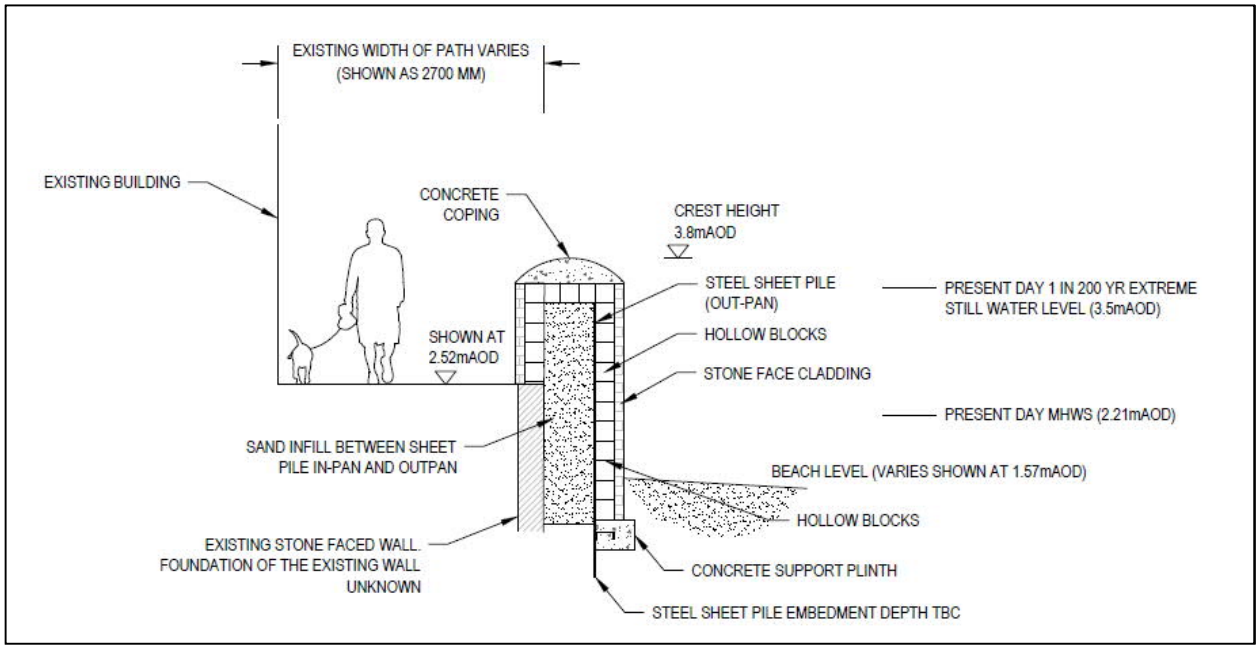

Figure 4-21: Sketch showing indicative cross section of frontline floodwall at ODU 3k (not to scale).

4.12 ODU 3l

ODU 3l extends from ODU 3k into fields to the north. A defence in ODU 3l forms part of the scheme alignments B, C and D and is necessary to tie-in to high ground and prevent outflanking of the scheme alignment given that with these alignments a formal defence in ODU 4 is not included. There are currently no existing defences in the ODU 3l sub-unit.

The short list of options for this sub-unit consists of two defence measures:

- Setback floodwall
- Setback floodwall and earth embankment (earth embankment where space allows)

The defence measures on the short list could follow one of two potential defence alignments. One alignment follows the narrow footpath (north-south direction) adjacent to the west side of the Mill Pond before directing west across the field to tie-in to higher ground. The alternative alignment turns immediately west at the end of ODU 3k and then ties-in to high ground in the field. The main difference between the two alignments is whether protection is provided to the residential building to the west of the Old Mill. The owner of this building has constructed informal flood defences around his building at their own expense, but it is unknown whether these defences can be relied upon to provide a robust level of protection. The property would benefit should a formal flood defence be constructed along the footpath to the east of the property along the west side of the Mill Pond.

A photograph showing the footpath adjacent to the west side of the Mill Pond is shown in Figure 4-22 below.

Figure 4-22: Photograph of narrow footpath adjacent to the Mill Pond (looking south)

4.12.1 Environmental appraisal

Refer to Appendix D for the full environmental appraisal of the short list defence measures in ODU 3l. In summary, both the setback floodwall and earth embankment equally or better align with the landscape and heritage objectives compared to the Do Nothing scenario. Each of the measures is likely to lead to temporary impacts on ecology during construction, although these impacts can potentially be mitigated.

4.12.2 Social appraisal

Feedback from the public consultation events on the short list defence measures in ODU 3l indicates that an earth embankment is the favoured defence meaure in this location. Approximately two-thirds of respondents favoured this approach, although due to space constraints it may not be possible to construct this defence type along the full length of the defence alignment.

4.12.3 Technical appraisal

In terms of key services and utilities at this location, there is a Scottish and Southern Electricity cable and Southern Gas Network pipe which pass adjacent to the southern end of the sub-unit, following beneath the footpath between the Royal Oak and the Old Mill. The other buried services and utilities which are located in ODU 3k stop at the southern boundary of this sub-unit, including the Portsmouth Water pipe and British Telecommunications Openreach cable. The key services and utilities will need to be considered during the outline design phase. Based on the information available at this stage it is considered likely that the defences can be designed to accommodate the buried services and utilities, but contact with the providers should be made to confirm this.

For the majority of this sub-unit through the open field there is sufficient space to construct either a setback floodwall or an earth embankment. However, at the southern end of the alignment where the defence links with the alignment in ODU 3k space is more constrained. For example, the footpath shown in Figure 4-22 adjacent to the residential building to the west of the Old Mill is approximately 1m wide which limits the possibility of constructing an earth embankment in this location. As a result, should an earth embankment be the desired defence measure to take forward, it will be necessary to combine it with a setback floodwall by adopting the floodwall defence in areas where space is more limited.

A detailed account of the ground investigations can be found in the ground investigations report and ground models technical note. There were no Trial pits or boreholes dug in this ODU sub-unit. The general ground model proposed for the wider ODU 3 area suggests that superficial soils are unevenly distributed and of low strength down to a depth of 3.00m bgl where Portsmouth Chalk Foundation is encountered.

4.12.4 Cost comparison

Table 4-27 below compares the estimated whole life costs of the short list defence measures. For illustrative purposes the costs to deliver a present day 1:200 year SoP are presented. For a given meter length of defence, an earth embankment is typically cheaper than a reinforced concrete floodwall. Therefore, the combined earth embankment and setback floodwall defence is estimated to be lower cost than the approach with the full length of defence as a setback floodwall.

Table 4-27: Estimated whole life PV costs to provide a present day 1:200 year SoP

Appraisal period	Least cost	Alternative 1
50 years	£260k	£290k
	Setback floodwall (along footpath) and earth embankment (across field)	Setback floodwall (full length)

4.12.5 Summary

Based on the information discussed in sections 4.12.1 to 4.12.4, the short list defence measures have been scored and ranked based on their potential impact in each category. Table 4-28 below presents the scoring and based on the total scores the combined earth embankment and setback floodwall approach has been identified as the preferred defence measure in this sub-unit. This will involve constructing a setback floodwall through the narrow footpath adjacent to the Mill pond and an earth embankment across the field to the west.

Table 4-28: Scoring of short list defence measures in ODU 3l

Category	Setback floodwall and earth embankment		Setback floodwall	
	Score	Notes	Score	Notes
Environment	+1	Relative to Do Nothing, generally equal or better alignment with the objectives. Temporary ecological impacts which likely can be mitigated	+1	Relative to Do Nothing, generally equal or better alignment with the objectives. Temporary ecological impacts which likely can be mitigated
Social	+1	Earth embankment had more support during public consultation. Despite not being the full length, approach likely to have more support	-1	Less support than an earth embankment during public consultation
Technical	+1	Use of setback floodwall in space constrained areas makes approach technically feasible with appropriate design	+1	Space constraints but appropriate design of setback wall should ensure approach is technically feasible
Cost	0	Least cost	-1	More costly than earth embankment
Total	+3		+1	

Sketches of indicative cross sections of the floodwall and earth embankment sections of the preferred option along the footpath and through the field in ODU 3l are shown in Figure 4-23 and Figure 4-24. Note that ground levels change moving along the footpath and across the field and the height of the defences will vary.

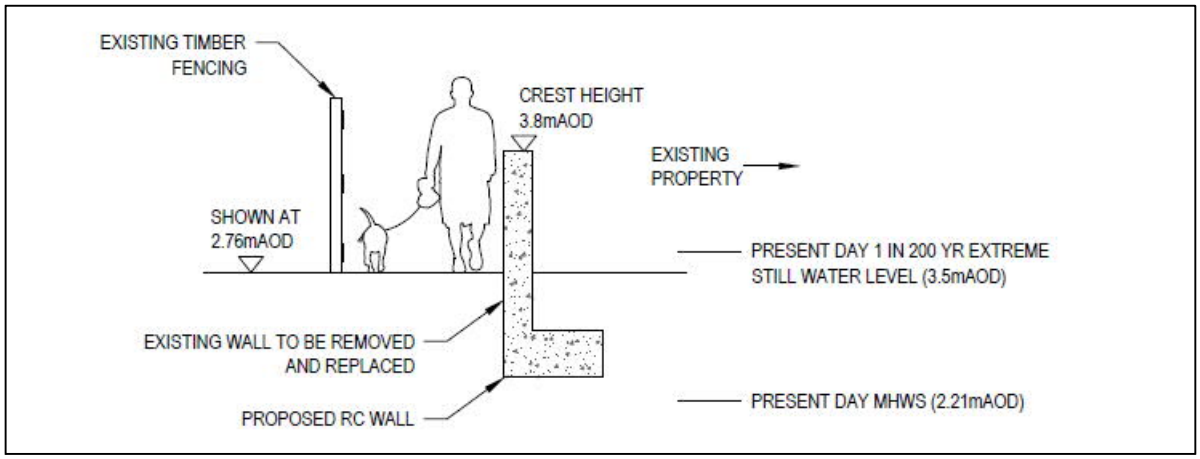

Figure 4-23: Sketch of indicative floodwall cross section along the footpath, looking south (not to scale)

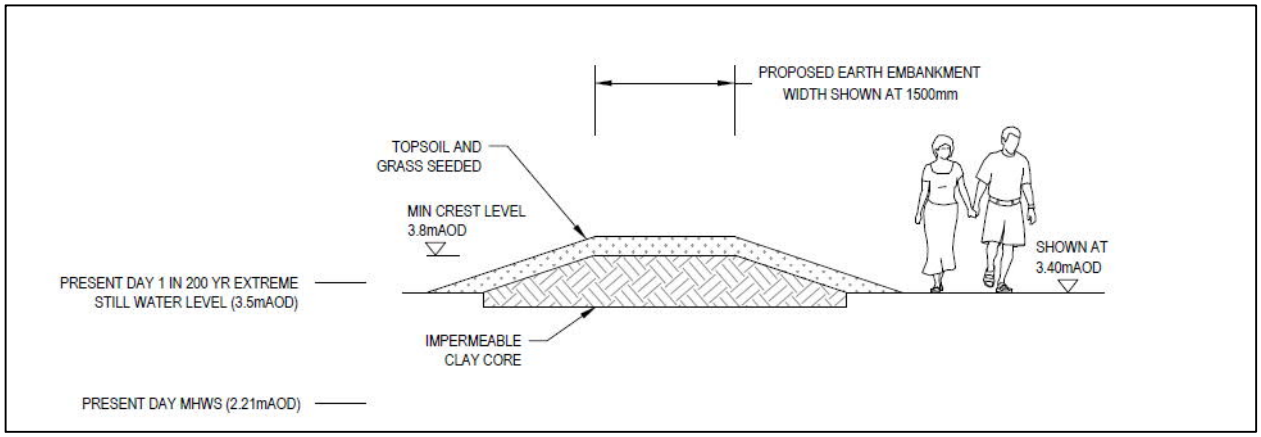

Figure 4-24: Sketch of indicative earth embankment section (through field) not to scale.

4.13 ODU 4a and 4b

ODU 4a includes the area surrounding the Old Mill. The Old Mill is a privately owned listed building and is a valued asset to the local community due to its character and visual appeal that it adds to the area. Currently there is a brickwork wall protecting the Old Mill from erosion and wave damage along the seaward face of the property. However, there is not a defence structure at the western side of the property due to the requirements for vehicle access. The property is vulnerable to flooding and the lack of formal flood defence in this sub-unit also exposed the land behind and to the west to flood risk.

ODU 4b extends approximately 200m to the east of the Old Mill, along the footpath between the Old Mill and Mill Pond. At its eastern end, the sub-unit stops on the edge of the study area where a concrete slipway forms the end of the public footpath. The footpath is supported by a vertical brickwork retaining wall along its full length. This includes a sluice gate to the Mill pond approximately half way along the footpath. The wall is in a poor state of repair and has not been maintained for a number of years. There are areas of saltmarsh vegetation in the intertidal area in front of the existing wall.

Figure 4-25: Photograph of the Mill within ODU 4a

With the exception of the Old Mill, there are no properties at risk in ODUs 4a and 4b. Therefore, the main purpose of constructing linear flood defences in 4a and 4b would be to prevent outflanking of the main scheme area, stopping floodwater passing around the back of defences in ODU 3k at the Royal Oak. To serve this purpose, new defences in ODUs 4a and 4b would be costly (due to the length of defences required) and a more economical approach to preventing outflanking of the main scheme area would be to construct a defence along the footpath and across the field in ODU 3l. Should a defence be constructed here, there would be no need to construct linear defences in ODUs 4a or 4b. As such, it is unlikely that linear flood defences will be taken forward in ODU 4a and 4b but the options for constructing linear defences have still been appraised below to provide the necessary information in the unlikely event that they are taken forward.

The defence measures on the short list for this ODU 4a include:

- Setback floodwall –located along the footpath between the Mill and the Mill pond to prevent flood water entering the land to the north and outflanking defences to the west
- Demountable defences – located along the footpath between the Mill and the Mill pond to prevent water entering the land to the north and outflanking defences to the west

The defence measures on the short list for ODU 4b include:

- Setback floodwall
- Setback floodwall and boardwalk

4.13.1 Environmental appraisal

Refer to Appendix D for the full environmental appraisal of the short list defence measures in ODU 4a and 4b. In summary, each of the short list defence measures equally or better align with the landscape and heritage objectives compared to the Do Nothing scenario. Each of the measures is likely to lead to temporary impacts on ecology during construction, although these impacts can potentially be mitigated.

4.13.2 Social appraisal

The short list defence measures in this ODU sub-unit were not presented to the public during the public consultation events. There is therefore no feedback on the defence measures to consider at this stage.

4.13.3 Technical appraisal

There is considered to be sufficient space to construct a setback floodwall along the footpath in ODU 4a and also to install demountable defences in this location. Demountable defences will require resources to deploy the defences. This will typically require a team of trained personnel to erect the demountable barrier. Demountable defences will also require an on-site or near site storage location to ensure that they can be deployed in an efficient manner.

In ODU 4b, based on the existing information available a gravity setback wall along the footpath alignment in this location is considered to be technically feasible at this stage of the appraisal. However, the gravity wall will increase the loading on the existing frontline vertical brickwork wall so this cannot be confirmed until structural calculations are undertaken (to be undertaken during the design process). To support a gravity wall it will be important for the existing vertical wall in-front of the footpath to be be maintained or refurbished to a suitable condition. The existing infill beneath the footpath will need to be assessed during the design stages because currently there is no information on the infill material.

The footpath in ODU 4b is typically wider than the footpath in ODUs 3f-h, and therefore there could be sufficient space to construct a setback floodwall without the requirement of a boardwalk to improve footpath access. This will need to be confirmed during the design stage should defences be taken forward in this location.

In ODU 4a a Scottish and Southern Electricity cable follows the alignment of the footpath between the Mill and the Mill pond before aligning to the south at the Mill. This cable is believed to be the only supply of electricity to the Mill. The alignment of the cable will conflict with a defence alignment along the footpath and therefore discussions with Scottish and Southern Electricity will be required during the outline design phase. A Southern Gas Network pipe extends to the Mill buildings but this is located to the south of the footpath and will not interfere with a defence alignment along the footpath. In ODU 4b there are no buried services or utilities along the footpath and potential defence alignment to the east of the Mill.

A detailed account of the ground investigations can be found in the ground investigations report and ground models technical note. Due to access issues it was not possible to undertake any ground investigations in this area. There are no historical boreholes shown in this area on the BGS website. The BGS geology viewer shows the Portsmouth Chalk formation in ODU 4 to be overlain by Alluvium – clay, sand, silt and gravel. Given that alluvial materials were also encountered inconsistently across the other ODU's it is considered likely that they will be present in ODU 4 also, along with varying thickness of beach deposits, made ground and river terrace deposits.

4.13.4 Cost comparison

Table 4-29 compares the whole life costs for the short list options in ODU 4a and Table 4-30 compares the whole life costs for the short list options in ODU 4b.

Table 4-29: Estimated whole life costs to provide a present day 1:200 year SoP in ODU 4a

Appraisal period	Least cost	Alternative 1
50 years	£190k	£230k
	Demountable defences	Setback floodwall

Table 4-30: Estimated whole life costs to provide a present day 1:200 year SoP in ODU 4b

Appraisal period	Least cost	Alternative 1
50 years	£1,180k	£1,230k
	Setback floodwall	Setback floodwall with boardwalk

4.13.5 Summary

Based on the information discussed in sections 4.13.1 to 4.13.4, the short list defence measures have been scored and ranked based on their potential impact in each category. Table 4-31 provides the scores for the short list options in ODU 4a. Based on the scoring the use of demountable defences in this location is considered preferable. Table 4-32 provides the scores for the short list options in ODU 4b. In this area the setback floodwall is the recommended approach should a defence be taken forward in this location.

Table 4-31: Scoring of short list defence measures in ODU 4a

Category	Demountable defences		Setback floodwall	
	Score	Notes	Score	Notes
Environment	+1	Relative to Do Nothing, generally equal or better alignment with the objectives. Temporary ecological impacts which likely can be mitigated	+1	Relative to Do Nothing, generally equal or better alignment with the objectives. Temporary ecological impacts which likely can be mitigated
Social	0	No feedback received during public consultation	0	No feedback received during public consultation
Technical	-1	Straightforward construction but deployment is labour intensive	-1	Constraints associated with services but considered feasible with appropriate design
Cost	0	Least cost	-1	More costly than demountable defences
Total	+1		-2	

Table 4-32: Scoring of short list defence measures in ODU 4b

Category	Setback floodwall		Setback floodwall with boardwalk	
	Score	Notes	Score	Notes
Environment	+1	Relative to Do Nothing, generally equal or better alignment with the objectives. Temporary ecological impacts which likely can be mitigated	+1	Relative to Do Nothing, generally equal or better alignment with the objectives. Temporary ecological impacts which likely can be mitigated
Social	0	No feedback received during public consultation	0	No feedback received during public consultation
Technical	+1	Minor constraints which can be designed around with appropriate design	+1	Minor constraints which can be designed around with appropriate design
Cost	0	Least cost	-1	More costly than setback floodwall
Total	+1		0	

4.13.6 Old Mill PLP

Separate from linear defences in ODUs 4a and 4b, small scale property level protection to the Old Mill building could be pursued. A range of property level protection measures which could be undertaken on the Old Mill buildings is provided below

A summary of potential property level protection measures which could potentially be used at the Old Mill is provided below.

- Air brick protection – covers can be installed on all air bricks to reduce the risk of water entering a property. These can work automatically and seal when flood water rises or need to be manually fitted when a flood is expected. The automatic air brick covers are activated by the flood water itself which pushes an in-built mechanism in to place to block the ventilation holes and prevent the water entering.The manual air brick covers come with a permanent fixture that sits around the air brick.
- Automatic flood doors - to replace existing doors and prevent water from entering through doorways. They work by creating a seal around the inside of the door frame.
- Manual flood doors - boards that are fitted manually to doorways and other openings to limit water entering through the gap. They are not permanent but are put in place when there is a risk of flooding.
- Resilience measures – rather than preventing water entering a property, resilience measures reduce the impact of flooding should the water get in. Typical measures include raising plug sockets or using lime plaster. These measures can reduce the internal damage caused by flooding to a property.
- Monitoring systems and flood alarms – include sensors that provide information about the water environment, such as tide gauges and river level gauges together with associated telemetry, software and alarm mechanisms. The systems monitor the rise and fall of a water course and feed this information back to your computer or mobile. Simple flood alarms can also be fitted inside properties and work much like a smoke alarm. They are placed low down on an interior wall of a property and are triggered by contact with flood water. Alarms for both local monitoring systems and national warning mechanisms can be found in this category.
- Personal Protective Equipment - equipment to be used during a flooding incident to help keep people safe, such as storage boxes, clothing, lighting, shovels, buckets and signs.
- Pumps - for removing water from a property or area.There are many different types of pump, from those that are set to automatically remove water from a cellar or basement (sump pumps); portable puddle sucker pumps for use within a property; to large pumps that can help to reduce the risk of flooding for a particular community.
- Sandbags and alternatives – a number of alternatives to traditional sandbags exist that help to prevent water from entering a property and which may also help to soak up water. They usually come vacuum packed, ready for use and are light and easy to handle. There are many examples of these products, which can be stored until needed and then disposed of.
- Sewage / Drain prevention and alarms - products such as one way valves fitted to sewage pipes to reduce the risk of flooding to a particular property or group of properties.

5. Summary of Preferred FCERM Interventions

Table 5-1 below shows the preferred defence measures in each of the ODU sub-units across the frontage. The estimated PV whole life costs to deliver a present day 1:200yr SoP for a 50 year appraisal period are also shown. Refer to Figure 2-2 to Figure 2-6 for the locations of each ODU sub-unit. The whole life costs provided in Table 5-1 include the construction and maintenance costs and an optimism bias allowance. A preliminary cost uplift has been applied to all capital costs, which is expected to cover consultant design fees. The costs presented below do not include an allowance for further appraisal costs or project costs for ESCP.

Table 5-1: Preferred defence measures in each ODU sub-unit

ODU sub-unit	Preferred defence measure	Estimated PV whole life cost
ODU 1a	Earth embankment	£320k
ODU 1b	Capital refurbishment or Refurbishment and crest raising (depending on SoP required)	£1,630k
ODU 2a	Rock armour	£330k
ODU 2b	Setback floodwall (north section) and earth embankment (south section)	£710k
ODU 2c	Flood gate or a setback floodwall (depending on SoP required)	£70k
ODU 3a	Flood gate	£70k
ODU 3b	Flip-up floodwall across car park	£550k
ODU 3c	Flood gate	£40k
ODU 3d	Floodwall with glass top	£320k
ODU 3e		
ODU 3f	Floodwall with boardwalk	£1,190k
ODU 3g		
ODU 3h		
ODU 3i	Flood proof residential building	£100k*
ODU 3j	Flood gate	£90k
ODU 3k	Frontline floodwall	£1,050k
ODU 3l	Setback floodwall (footpath section) and earth embankment (field area)	£260k
ODU 4a	Demountable defences Property level protection	£190k PLP approx. £5k**
ODU 4b	Setback floodwall	£1,180k

**note cost of flood proofing existing building in ODU 3i is uncertain due to lack of structural information and requirements of flood proofing*

*** PLP cost typically around £5k to flood proof building, however, the Old Mill is a complex structure and therefore survey and liaison with PLP supplier recommended to obtain more information on this cost*

6. Selection of the Preferred Scheme

6.1 Scheme alignment

The appraisal process outlined in Chapters 4 and 5 provides a preferred defence measure for each ODU sub-unit. Going forward with the scheme, these preferred defence measures can be combined into one of four potential alignments; alignments A to D as described in section 3.7.

Further consultation with stakeholders and the community is to be held before the preferred scheme alignment is identified. The economic analysis undertaken for each alignment has indicated that there is a significant funding shortfall for all of the alignments. The GiA for the different alignments remains fairly unchanged and therefore affordability is a key constraint and driver for selecting the preferred alignment. The selection of the preferred alignment is likely to be made at the detailed design stage when all the information is available on the funding sources for the scheme and the details of how much funding is available are known.

Whilst the choice of the preferred alignment is uncertain at this stage, during the internal preferred options workshop, and on review of all the compiled evidence and likely funding shortfalls, the project team identified Alignment D as the most likely alignment to be delivered. At this stage this is the least cost alignment and therefore has a higher chance of being delivered as the funding gap is the smallest (although still significant).

Whilst Alignment D is considered by the project team to be the most likely to go ahead, engagement with potential contributors and stakeholders could result in additional sections of defence being added to the scheme and therefore one of the alternative alignments being delivered (for example, defences in ODU 1a and 1b).

For more information on the economic comparison between the alignments, refer to the Economics Report (AECOM, 2019). The following sections outline the outcomes delivered by Alignment D and the funding case. A map showing Alignment D is shown in Figure 6-1.

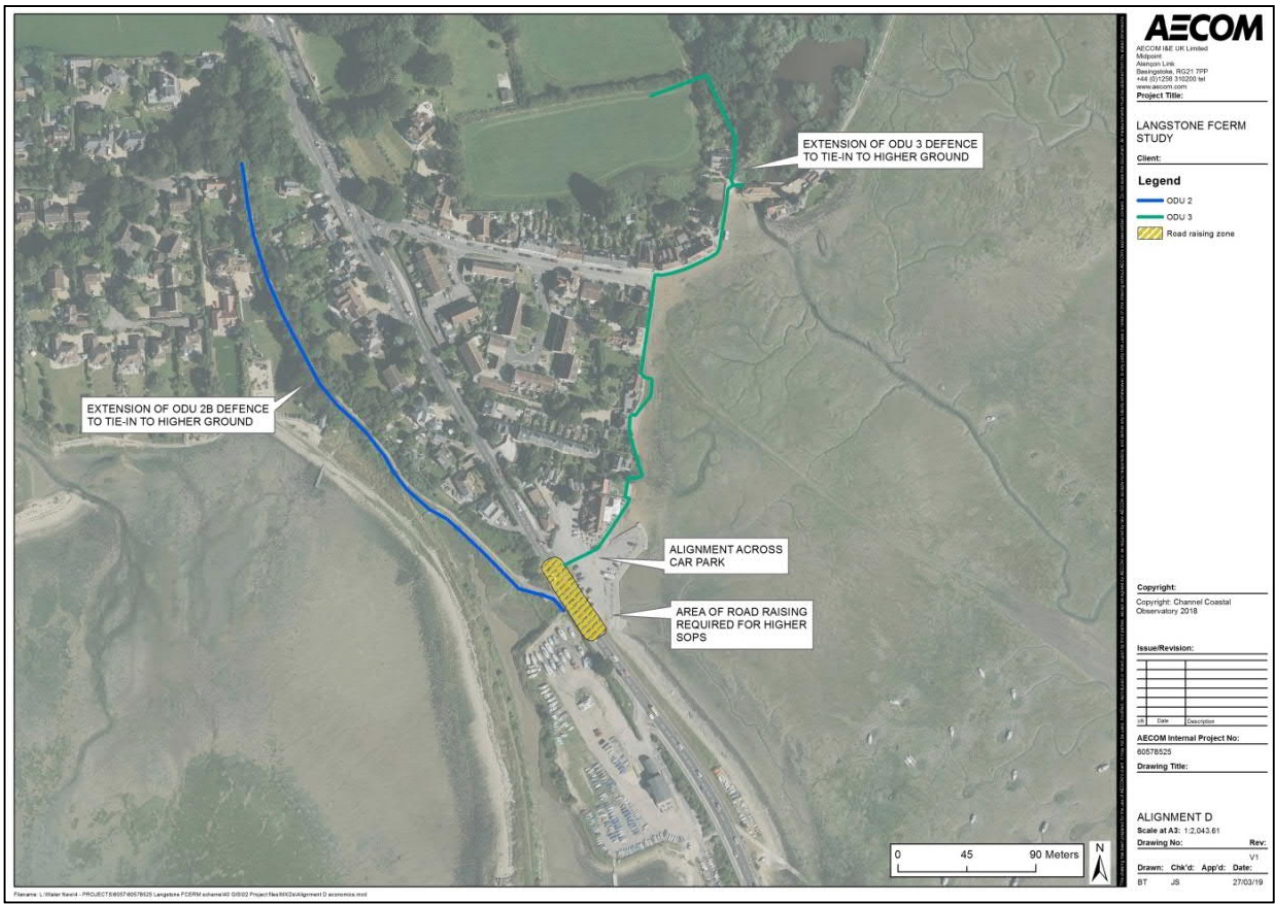

Figure 6-1: Alignment D

6.2 Standard of protection

Given the coherent flood cell at the study site it is necessary for the scheme to deliver a consistent standard of protection across the scheme area. If one section of the scheme defences had a lower standard it would compromise the effectiveness of the remainder of the scheme and the overall standard would be reduced.

As part of the economic analysis that has been undertaken (Economics Report, AECOM 2019), the option benefits and costs have been established for a range of defence standards. This allowed the economic comparison of the different standards and for the optimal standard to be identified from an economic perspective.

The analysis has identified that the leading economic option for a scheme at the study site is to provide a present day 1 in 200 year standard of protection (0.5% AEP). This conclusion differs from those in PEMS (2013), which recommended a 1:75yr SoP for the frontage. In practical terms the defence height difference between the two standards of protection is minimal; equating to approximately 0.1m.

Each of the preferred defence measures in the ODU sub units can be constructed to a range of heights and therefore can be constructed to deliver the present day 1 in 200 year standard of protection.

6.3 Outcome measures

Alignment D is expected to deliver approximately £7,552k benefits (PV terms) over a 50 year appraisal period (Outcome Measure 1). Table 6-1 below shows the number of households moving between the partnership funding risk bands before and after the scheme is implemented should a present day 1:200 year SoP be delivered. The movement of properties between the levels of risk represents the Outcome Measure 2 (OM2) benefits. For the purposes of the funding calculation and counting of OM2 benefits, 'before' refers to the level of flood risk to a property for the present day before the scheme has been constructed, and 'after' refers to the level of flood risk to a property after the scheme has been constructed, but at the end of the appraisal period (e.g. in 50 years' time). The 'after' risk therefore considered the effects of climate change on the level of risk to the properties after the scheme has been constructed.

Table 6-1: Summary of OM2s delivered by Alignment D

Risk 'before' → Risk 'after'	Level of property deprivation		
	20% most deprived	20-40% most deprived	60% least deprived
Low → Moderate	0	0	0
Low → Significant	0	0	0
Low → Very Significant	0	0	0
Moderate → Moderate	0	0	0
Moderate → Significant	0	0	5
Moderate → Very Significant	0	0	0
Significant → Moderate	0	0	0
Significant → Significant	0	0	25
Significant → Very Significant	0	0	0
Very Significant → Moderate	0	0	0
Very Significant → Significant	1	0	11
Very Significant → Very Significant	0	0	15

A total of 5 properties will be protected from erosion by the core scheme alignment in the medium term.

Should the scheme deliver a present day 1:200 year SoP, then due to climate change, a number of properties that initially move out of the significant and very significant risk bands will fall back into these risk categories by the end of the appraisal period. In order to deliver more OM2s, there is potential to include an additional cost in the whole life costs of the scheme to account for raising the defences where required or undertake PLP measures in the future. By undertaking these improvements in the future, more OM2s could be claimed by the scheme over its duration. This allowance has not currently been included in the scheme costs, but it should be discussed by the project team moving forward.

6.4 Beneficiary mapping

Figure 6-2 below shows the properties benefiting from Alignment D and those that will remain at risk of flooding. The flood risk to the properties outside of alignment D will not be increased by construction of the scheme but will increase over time as a result of climate change.

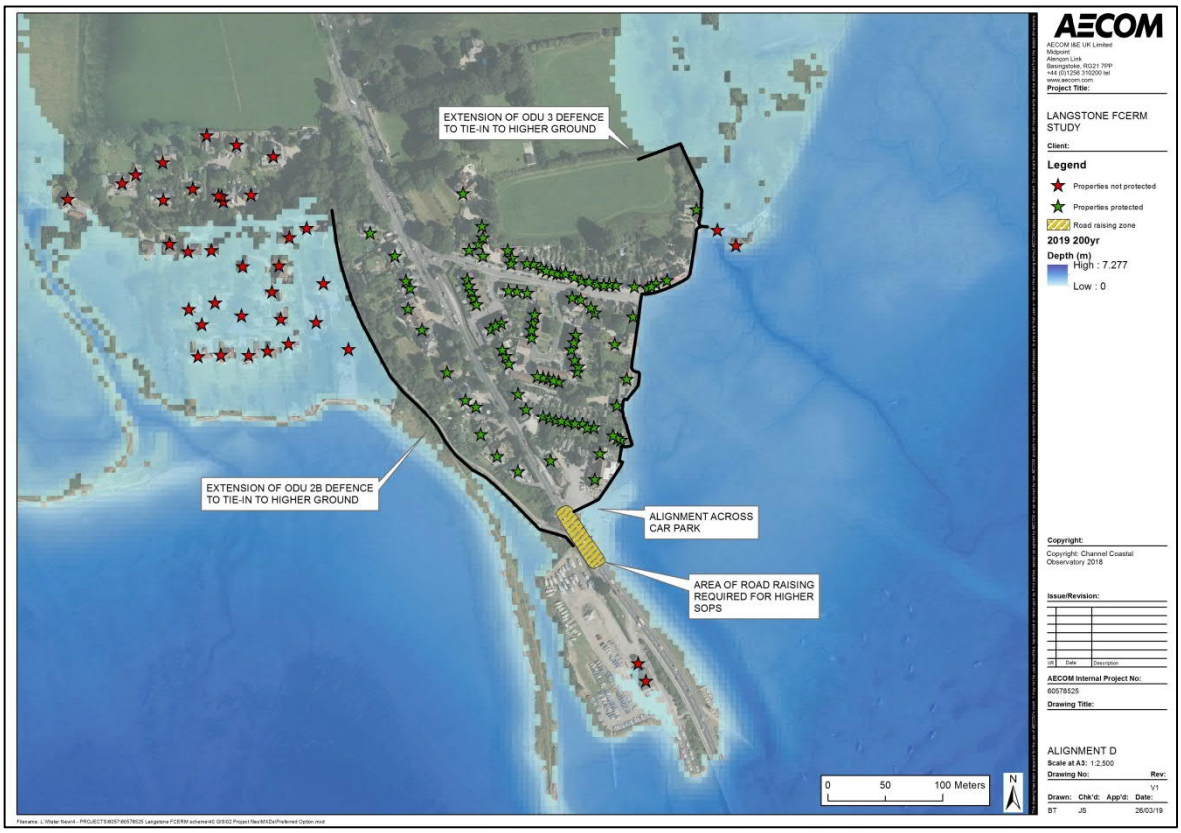

Figure 6-2: Properties benefiting from Alignment D

6.5 Wider benefits

Delivery of Alignmetn D will provide a number of wider benefits which have not been counted in the economic analysis. For a full description of these benefits refer to the Wider Benefits Assessment Report. In summary, benefits of Alignment D include reduced disruption to tourism and recreation, avoidance of between approximately £115k - £232k business disruption impacts and potential avoidance of disruption to Hayling Island (travel and business, future development, safe access/egress).

7. Cost Summary and Funding

The estimated costs of the preferred defence measures in each ODU sub-unit are provided in Table 5-1. In total, the whole life costs for the preferred defence measures for Alignment D are estimated to be £4,140k.

7.1 Alignment D partnership funding

As part of the economic analysis Partnership Funding (PF) calculations were undertaken to establish the potential Partnership Funding score for Alignment D and the amount of FCERM Grant in Aid (GiA) that the scheme would be eligible for.

As discussed in the Economics Report, the PF scores and outstanding contributions required have been based on the lowest cost defence measure in each ODU sub-unit. However, the preferred defence measures in some of the ODU sub-units are not the lowest cost approaches available. Therefore, as per the FCERM funding guidelines, the difference in cost between the lowest cost technically feasible measures and the preferred measures will require funding from non-GiA sources.

Table 7-1 below presents the partnership funding scores for the least cost approach to deliver Alignment D. The scores presented are for providing a present day 1 in 200 year standard of protection across a 50 year appraisal period, which has been identified as the leading economic option for this scheme (see Economics Report for this analysis). The raw score and adjusted score are provided; the adjusted score includes a £301k local levy contribution and £75k contribution from the Community Infrastructure Levy (CIL) which have already been secured. The adjusted score and costs also include for £376k appraisal costs and a £300k estimated design fee for the ESCP. In summary, in addition to the contributions already secured, it is estimated that an additional £3,092k is required to achieve an adjusted 100% PF score to access the potential GiA funding and deliver the least cost approach.

At the time of writing this report it is understood an additional £2.5m of funding from the CIL has been secured. Should this be confirmed then the shortfall will be reduced to approximately £592k and the adjusted partnership funding score will increase to 85%.

Table 7-1: Partnership funding score to deliver a present day 1 in 200 year SoP for Alignment D

Scheme alignment	Scheme duration	Raw PF score	Adjusted PF score	Estimated additional contributions required to achieve 100%	Estimated amount of GiA available should adjusted score reach 100%
Alignment D	50 years	11%	20%	£3,092k	£413k
Alignment D (with £2.5m CIL funding)	50 years	11%	85%	£592k	£413k

Table 7-2 below presents the whole life cost difference in capital and maintenance costs between the least cost approach and the preferred option. The costs presented in the table do not include the appraisal costs or ESCP design fee included in the PF calculation as they are being used only for a cost comparison. The main differences between the least cost approach and preferred option for Alignment D are; a glass topped floodwall (rather than demountables) in ODUs 3d-3e at the Ship Inn, a floodwall and boardwalk (rather than demountables) in ODU 3g, flood proofing in ODU 3i, and a flood gate (rather than demountables) in ODU 3j (across the High Street slipway).

Table 7-2: Cost difference between least cost and preferred option for Alignment D

Approach	
Least cost approach	£4,043k
Preferred option	£4,271k
Cost difference	+ £228k

Table 7-2 indicates that the additional cost for the preferred option compared to the least cost option for Alignment D is approximately £228k. It will be necessary to fund this cost difference from non-GiA sources and therefore the total additional contributions required (included provision for ESCP design cost and appraisal costs)

is estimated to be approximately £3,320k (£3,092k + £228k). Should the additional £2.5m of CIL funding be secured the shortfall for the preferred option is estimated to be approximately £820k.

7.2 Additional scheme preferred option partnership funding

Should additional funding be secured to implement defences in ODUs 1 and 2 (the spit and sailing club in ODU 2), Table 7-3 presents the partnership funding score for the least cost approach for Alignment B which includes defences in ODUs 1 and 2. The adjusted PF score calculations include £301k local levy contribution and £75k contribution from the Community Infrastructure Levy (CIL) which have already been secured. The adjusted score and costs also include for £376k appraisal costs and a £300k estimated design fee for the ESCP.

The additional whole life cost to deliver these defences is estimated to be approximately £1,986k and the additional funding required is estimated to be £1,738k. Note that the additional funding required is less than the additional whole life cost because the defences deliver more eligible benefits which marginally increase the amount of GiA available. The £1,738k funding required is in addition to the £3,092 - £3,320k funding required to deliver Alignment D.

Table 7-3: Partnership funding score to deliver a present day 1 in 200 year SoP for Alignment B

Scheme alignment	Scheme duration	Raw PF score	Adjusted PF score	Estimated additional contributions required to achieve 100%	Estimated amount of GiA available should adjusted score reach 100%
Additional scheme alignment – alignment B	50 years	9%	16%	£4,830k	£525k
Additional scheme alignment – alignment B (with £2.5m CIL funding)	50 years	9%	59%	£2,330k	£525k

Similar calculations have been undertaken for the other alignments considered in this report. Refer to Appendix F for a summary matrix of the PF scores and shortfalls for each of the alignments.

8. Summary and Next Steps

8.1 Summary

In summary:

- The preferred defence measures in each of the ODU sub-units have been identified.
- The most likely scheme to be delivered based on affordability and funding shortfalls is considered to be Alignment D. This spans ODU 2 and 3, protecting the main Langstone area and Langstone High Street.
- The preferred defence measures for Alignment D are a setback floodwall / earth embankment along the National Cycle Route 2, a flip-up floodwall across the car park adjacent to the Ship Inn, a glass topped floodwall in-front of the Ship Inn, a floodwall and boardwalk between the Ship Inn and Royal Oak, a floodwall variation in front of the Royal Oak, and finally a setback floodwall / earth embankment in the area to the north of the Royal Oak.
- The delivery of Alignment D remains subject to obtaining the required outstanding funding (approximately £3,320k – or 820k should the £2.5m CIL contribution be secured) to achieve an adjusted PF score of 100% and enable implementation.
- There is a funding shortfall for the scheme, irrespective of which alignment or defences are used in the preferred option. The additional funding required to deliver the least cost options for the wider scheme (Alignment B; defences also in ODU 1) is estimated to be approximately £4,830k (or £2,330k should the £2.5m CIL contribution be secured) or £5,058k for the preferred options (or £2,559k should the £2.5m CIL contribution be secured).

8.2 Next steps

The next steps of the project include:

- Project board agreement and sign-off of the preferred defence measures for all units and preferred alignments.
- As part of the outline design stage AECOM to obtain ECI to achieve more cost certainty and buildability advice on the preferred defence measures for all units and alignments. This will include consideration of placemaking opportunities and environmental enhancements.
- The existing costs are an approximation based on indicative SPONS build-ups and values provided by Flood Control International. These costs are to be refined following outline design and obtaining ECI when more information will be available on the likely defence cross sections. A Monte Carlo assessment will also be undertaken to refine the risk allowance.
- Further consultation with key stakeholders to confirm preferred scheme.
- Recommendation that a more detailed topographic survey is undertaken of the road area adjacent to the Ship Inn to better determine road raising requirements in this location.

9. Appendices

9.1 Appendix A – Public consultation feedback

Langstone Coastal Defence Study

Shortlisted Coastal Defence Options Event Report

20th & 22nd November 2018

working together - protecting our coastline

AECOM

EASTERN SOLENT | COASTAL PARTNERSHIP

Document title: Langstone Coastal Defence Study – Shortlisted Coastal Defence Options Event Report

ESCP QC & Approvals

Status:	FINALRev2
Date:	11/02/2019
Project name:	Langstone Coastal Defence Study
Author(s):	Rachel Cook / Emma Stainer
Client:	Havant Borough Council
Prepared by:	Rachel Cook
Checked by:	Emma Harris / Adam Sennitt
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Approved by:	Sam Box
Date/initials	SB 11/02/2019

Contents

1. Introduction

This report summarises the two public information events, held to present the shortlisted coastal defence options for the Langstone frontage to the local community. Prior to the events, working together with our professional Engineering Consultant AECOM, the project team appraised a wide-ranging longlist of potential defence options to reduce these down to a shortlist of options. The shortlisted options, as presented at the events, will be appraised in more detail by the project team, to identify the preferred options for the frontage. The project is being delivered by the Eastern Solent Coastal Partnership (ESCP) on behalf of Havant Borough Council (HBC).

This report provides an overview of the events held and a summary of the feedback received on the day from the attendees and via returned questionnaires.

1.1. Reason for project

The Study aims to develop preferred coastal defence options for the Langstone frontage, near Havant, as recommended in the Portchester to Emsworth Flood and Coastal Erosion Risk Management (FCERM) Strategy (the Strategy - Environment Agency 2011). The ~1km long Langstone frontage is located on the mainland immediately north of Hayling Island. Both Langstone and Chichester Harbours, abutting the frontage, are sensitive sites, designated environmentally at a local, national and international level.

The coastal defence scheme will aim to reduce ood and coastal erosion risk over the next 100 years for over 100 properties, heritage assets and critical infrastructure including the A3023; the only road crossing to Hayling Island. The existing defences consist of a mixture of concrete walls, concrete block revetments and masonry quay walls which are in a poor condition. Currently maintained by HBC and other private owners, the majority of present defences have residual lives of less than 5 years (without any maintenance) and therefore, without a scheme at Langstone the existing community will continue to be at significant flood risk.

1.2. Project Delivery

The ESCP, on behalf of HBC, are using funds secured from Defra Grant in Aid and HBC Community Infrastructure Levy to carry out a study that will identify the most appropriate way forward to reduce flood and coastal erosion risk at Langstone.

AECOM has been appointed to support the development of defence options and provide engineering support to the project team. Following an initial appraisal process, a shortlist of coastal defence options was identified and shared with the public at two drop-in events, for the community to view and provide feedback.

Following the events, the shortlisted options will be appraised to identify the most environmentally sustainable, technically feasible, economically affordable and socially acceptable options to manage Langstone's flood and erosion risks into the future.

2. Exhibition Events

2.1. Overview

Two public events were held on the 20th and 22nd of November 2018 at two venues in the Langstone area. The first was held from 4pm – 8pm at the Langstone Sailing Club and the second was held from 6pm – 9pm at the Ship Inn. The aim of the events was to present the shortlisted options to the public to allow better understanding of the study, provide an opportunity for the community to speak to the project team and to share their views on the shortlisted options being put forward.

The two venues were selected as they are within close proximity to Langstone residents and easy landmarks for non-locals. Questionnaires were handed out at each event and were also made available online on the ESCP Langstone Study web page, to gather feedback on the shortlisted options. The following questions were asked:

- What is your interest in the Langstone Coastal Defence Study?
- How would you like to be kept informed about the progress of the Langstone Coastal Defence Study?
- Which options would you find acceptable in each of the three areas along the Langstone frontage?

In total 114 people attended the two public events and 52 questionnaires were completed. The full results of the questionnaires are available in *Appendix A* along with a selection of representative comments made. In summary:

- 70% of the responders were interested in the project due to their residency in Langstone
- 25% wanted continued drop-ins with the project team in order to be kept informed about the project progress
- The following figures illustrate the percentage of acceptability of each option, per area:

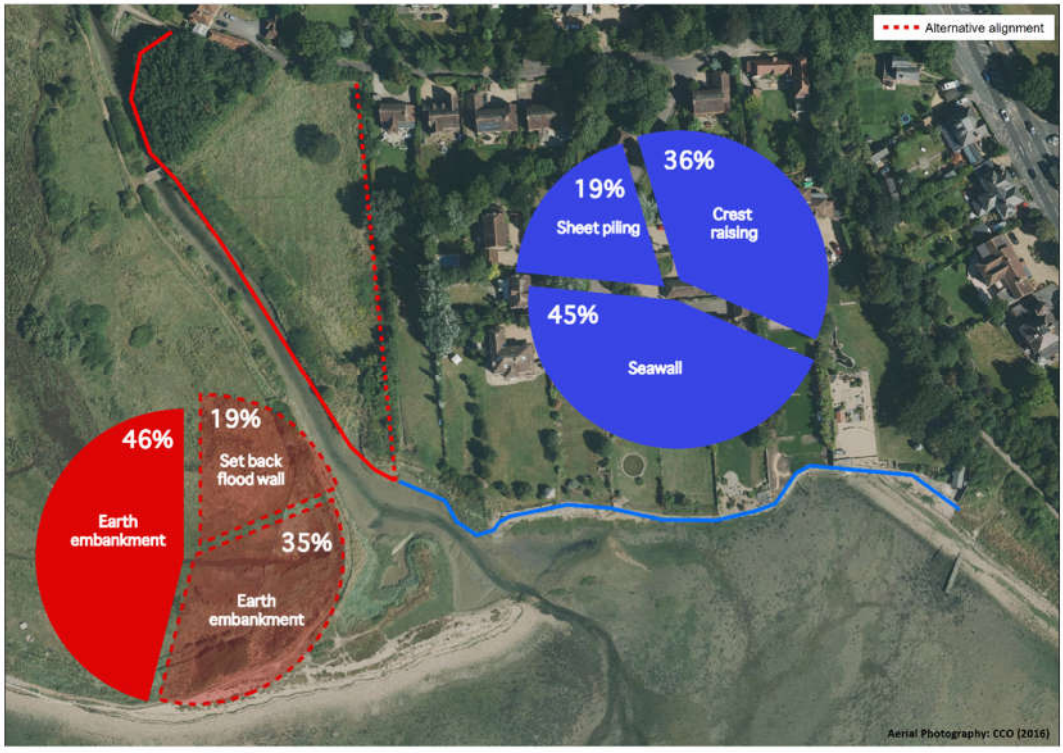


Figure 1: Area 1 – Mill Lane and Harbourside

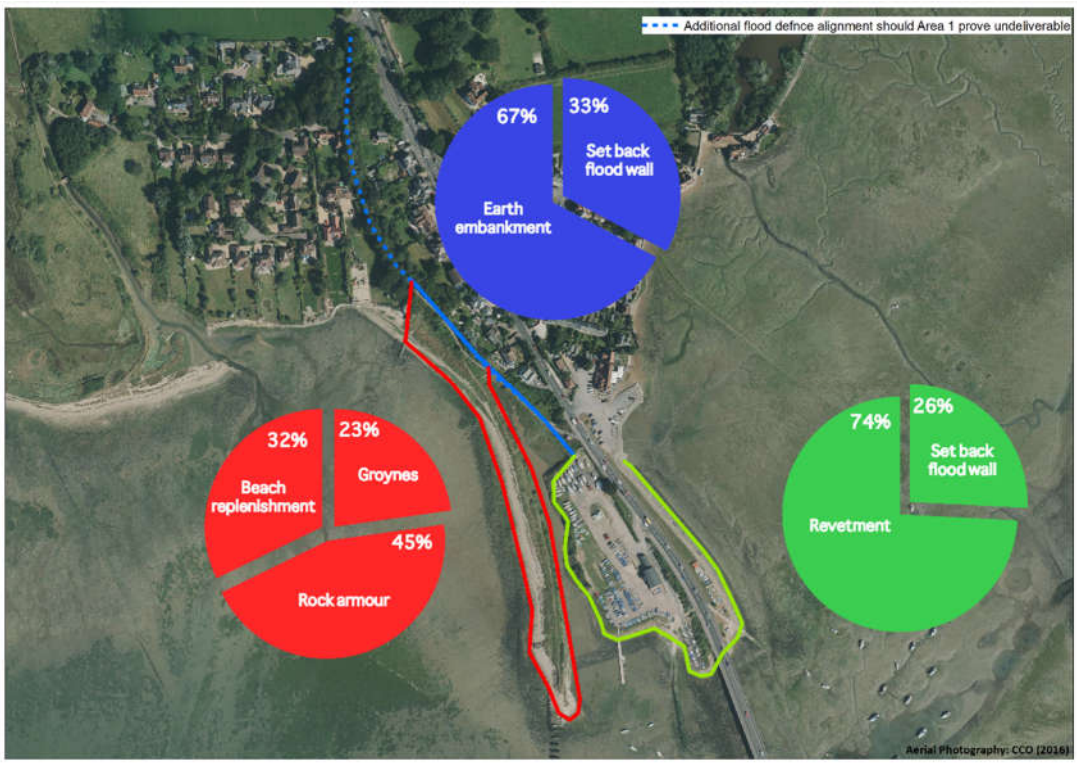


Figure 2: Area 2 – Langstone Sailing Club and Spit

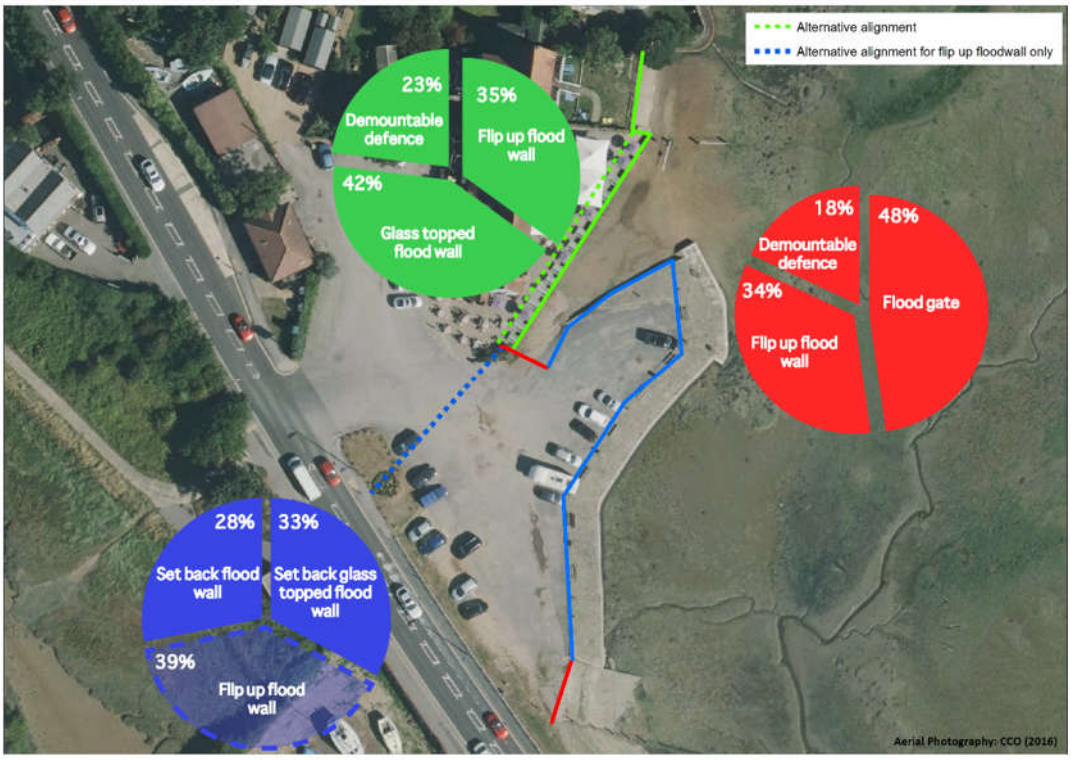


Figure 3: Area 3 – Langstone Village, the Ship Inn

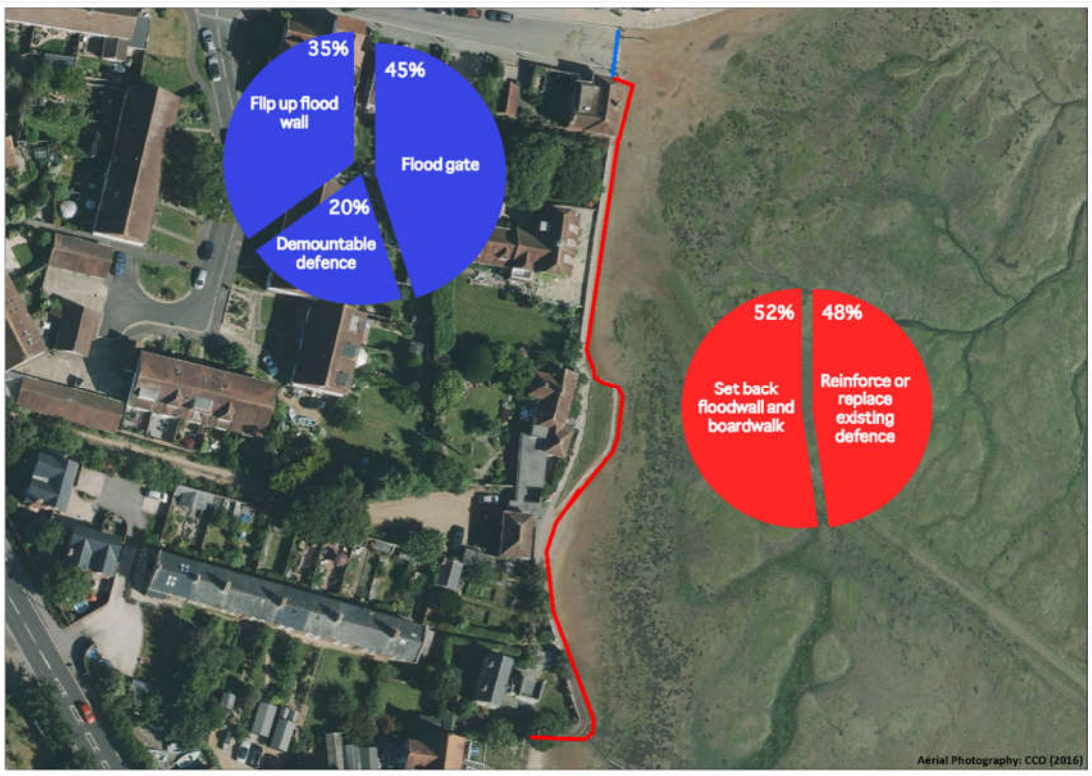


Figure 4: Area 3 – Langstone Village, Coastal Path

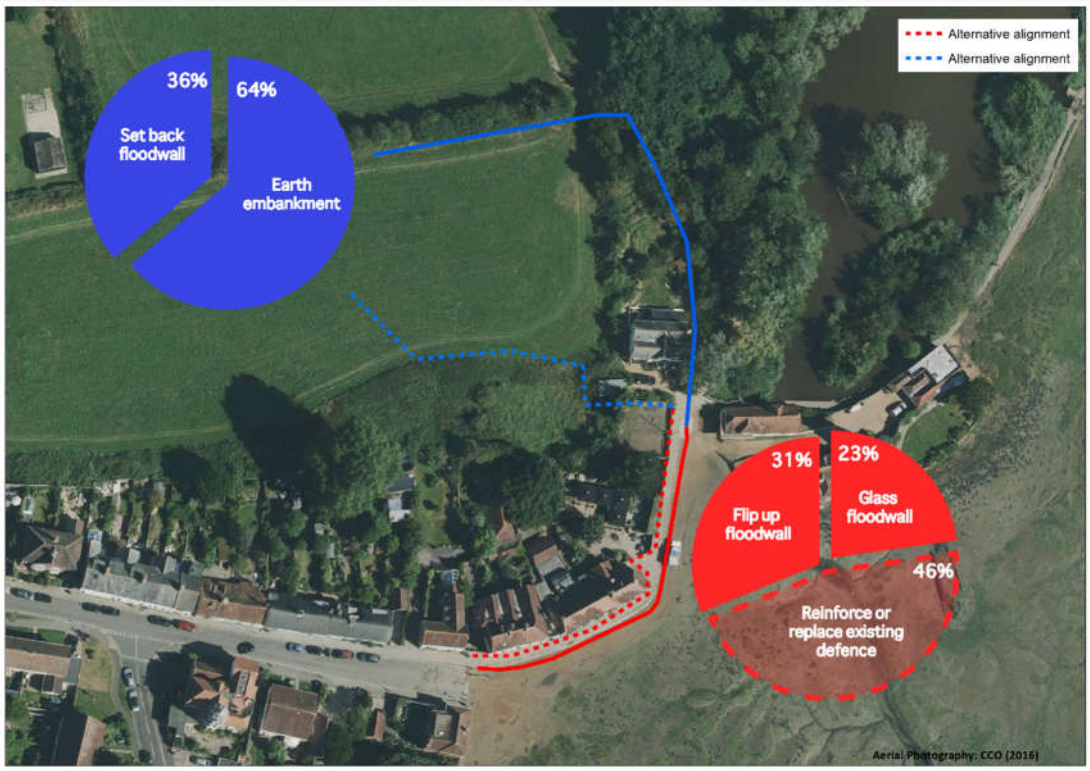


Figure 5: Area 3 – Langstone Village, the Royal Oak

2.2. Advertising and Publicity

The events were widely advertised to local residents and businesses with a comprehensive leaflet drop carried out two weeks before the events. The leaflet provided the public with key information about the scheme and the details of the events *(Appendix B)*.

In addition, the events were advertised on the ESCP website, facebook page, and shared across HBC social media. A press release was also sent out by HBC which reached local newspapers and websites. Figure 6 shows a variety of different media advertising the event.

Figure 6: Leaflet and social media advertising the events.

2.3. Event Content

In total, 114 people attended the information events, of which 77% came from Langstone and 23% came from the surrounding area.

The information on display at the events explained why the study is needed, the considerations and constraints of the study, work undertaken so far, and the shortlisted options for each area, through a series of poster boards detailing:

- **Roles and responsibilities** who are the ESCP, coastal roles and responsibilities, and funding constraints.
- **Project overview** introducing the study area, explaining why the study is necessary and how it came to be, looking at the shoreline management plan and the strategy as well as what is at risk if we did nothing,
- **Story so far** showing how the options have been developed, highlighting the environmental and heritage considerations and current defences
- **Shortlisted options** showcasing the shortlisted options for each area along the study frontage,
- **Project timeline**, detailing key stages and timescales of the project going forward.

Each of the posters used at the event are included in *Appendix C*.

2.4. Broader outcomes and opportunities exercise

During the Langstone events, the team also asked the community to identify aspirations on potential opportunities to improve the public spaces along the Langstone waterfront. The visitors to the events were asked to indicate their additional aspirations for Langstone by voting for different options on a poster with sticky dots (Figure 7).

The aspirations included in this exercise are separate from the short-listed coastal defence options presented at the events. These aspirations are ideas which could enhance a coastal defence scheme at Langstone by providing additional broader outcomes to the community than a coastal defence scheme could do alone. These aspirations are not guaranteed, and they would be subject to securing separate funding and approvals before being incorporated into a scheme.

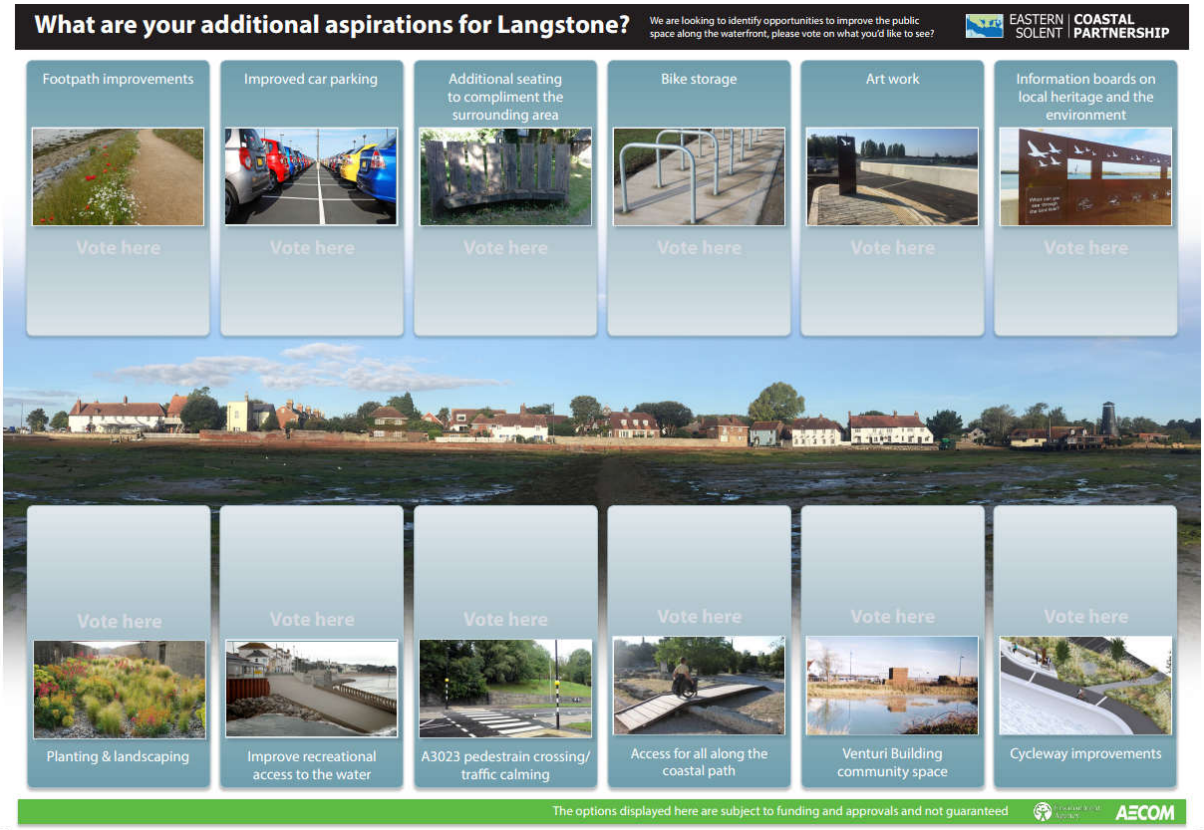


Figure 7: What are your additional aspirations for Langstone? Poster.

The percentage of visitors who voted for each aspirational option are as follows:

- A3023 pedestrian crossing/traffic calming: 22%
- Footpath improvements: 19%
- Cycleway improvement: 11%
- Access for all along the coastal path: 9%
- Information boards on local heritage and the environment: 8%
- Planting and landscaping: 8%
- Improve recreational access to the water: 8%
- Additional seating to compliment the surrounding area: 5%
- Improved car parking: 4%
- Art Work: 4%
- Bike storage: 2%

- Venturi Building community space: 1%

The project team were on hand to answer any questions. Photos from the exhibitions can be viewed in *Appendix D.*

2.5. Next steps

This exhibition report will be circulated to the project board, the steering group, key stakeholder working group and HBC communications officers. The report will also be made available to the public via the ESCP and HBC website.

Feedback from the public events and results of the questionnaires will feed into the appraisal of the shortlist options to identify a preferred way forward for Langstone. In Spring of 2019 the appraisal of the shortlisted options will be evaluated, and the preferred options selected. Once finalised and approved by the project board, the preferred options will be shared with the key stakeholder working group prior to further public engagement in early summer 2019.

Public engagement will involve an exhibition event and a 30-day public awareness event. Other engagement methods such as letters, leaflets, email updates, website and social media will also be utilised.

In the meantime, residents and stakeholders can find updates on the project via the ESCP website, Langstone Study project page and social medial updates.

Appendix A – Questionnaire results

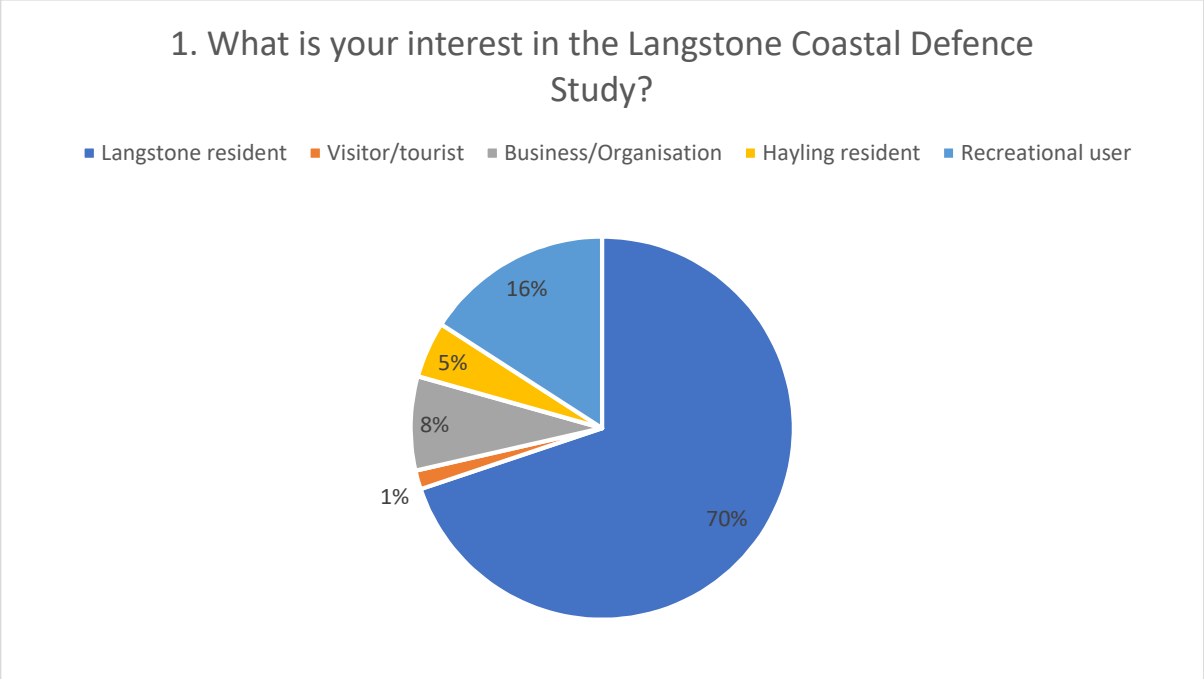


Chart 1 | Spread of responses to question 1.

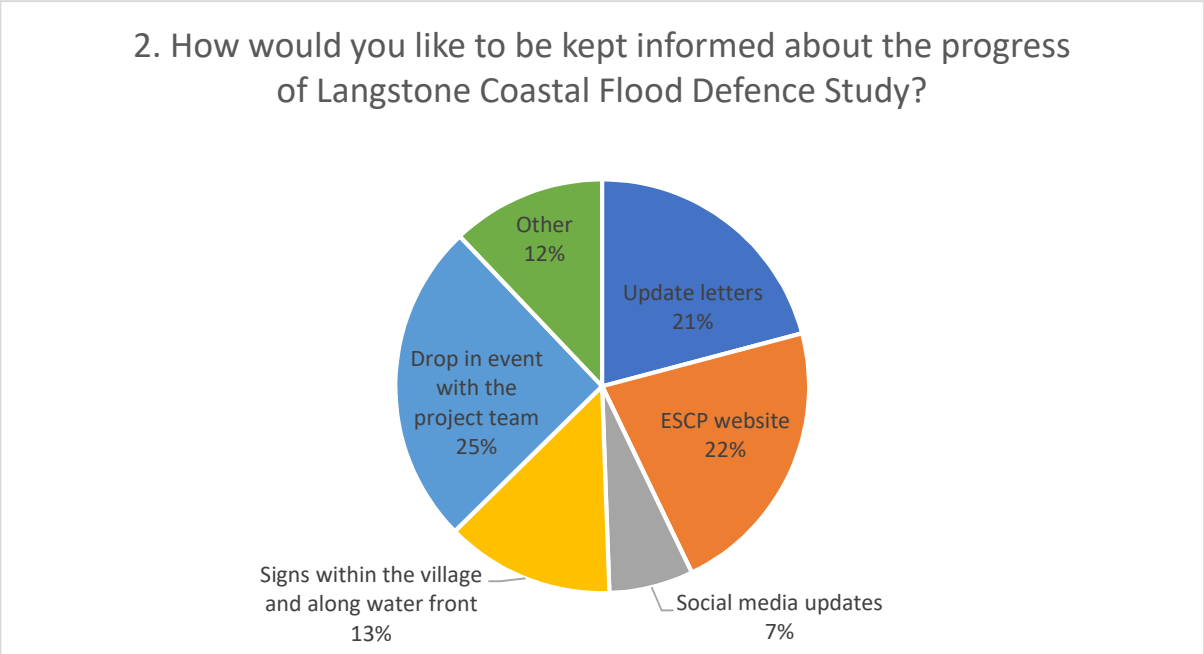
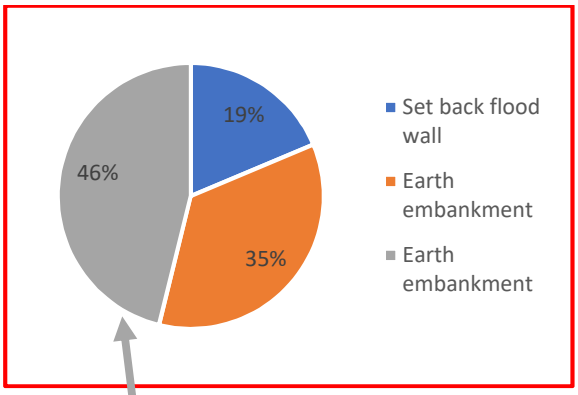


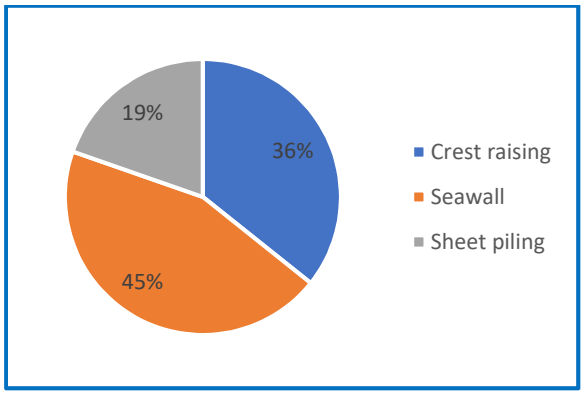
Chart 2 | Spread of responses to question 2.

For each area with shortlisted options, the respondents were instructed to tick all the options which they found acceptable on the map. The results of which are illustrated below.

Area 1 – Accepted shortlisted options

The below charts illustrate the percentage of respondents which found each of the shortlisted options for the area acceptable.





The general theme of comments made for Area 1 are concerning the existing sea wall being of sufficient height and if any works are to be carried out here, collaboration with the local residents will need to be sought.

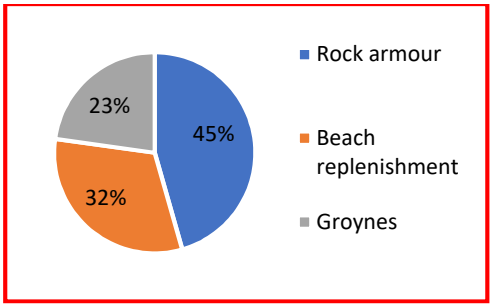
Examples of further comments:

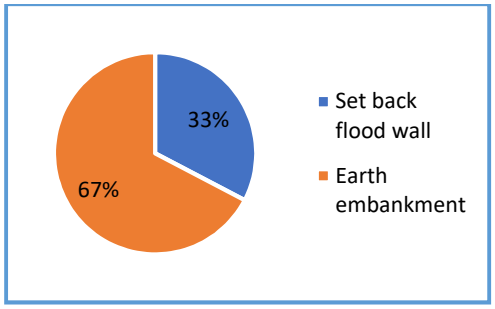
Don't favour raising the height of the defences as this may restrict access to the foreshore
The earth embankment would double as a sea defence and a cycle way or footpath.
There is already a partial bund installed over a decade ago that has been populated by grass/shrubs. Probably more cost effective to use the level of this than to do the dotted line from scratch.
The blue section is already quite high and just needs adding to.

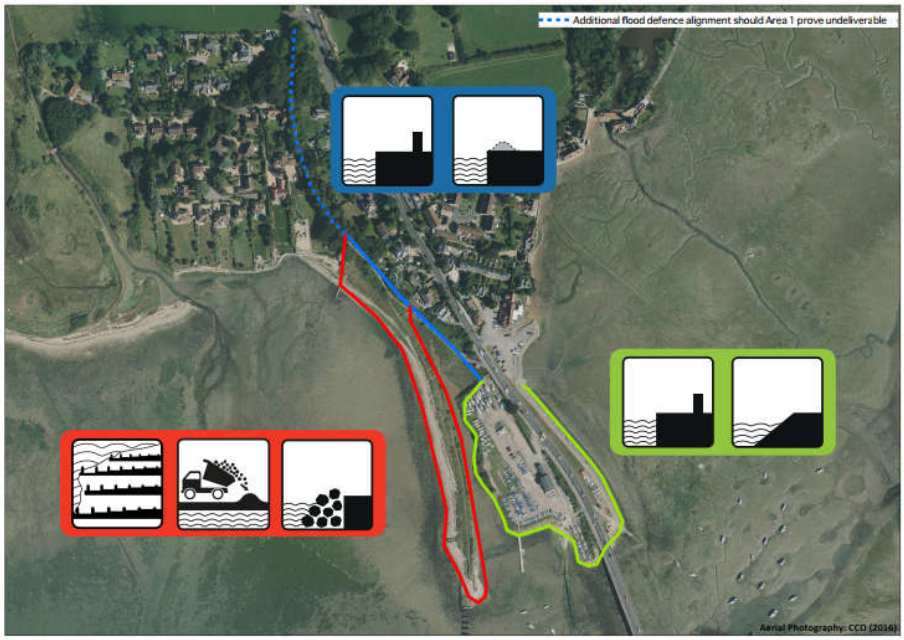
Thank you for all the hard work and work to come. Would ask as much as possible the Mill pond and history of the area should be kept in tack and the choice as sustainable for as long as possible.

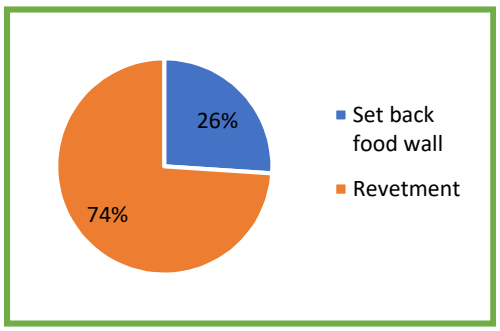
Area 2 – Accepted shortlisted options

The below charts illustrate the percentage of respondents which found each of the shortlisted options for the area acceptable.









The general theme of comments made for Area 2 are concerning the condition of the spit and the protection this affords to the sailing club behind.

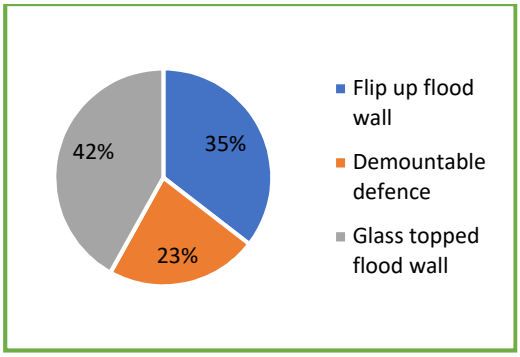
Examples of further comments:

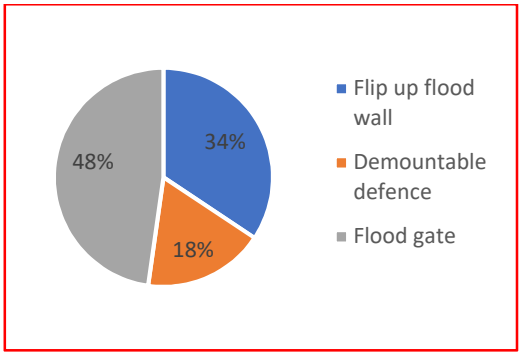
This should be priority to protect the recreational sailing in the local area. Protection of the Billy Line is a key priority to the local community.
The eastern side of the bridge approach already has a sloping hard defence and what is need is for Highways to keep this in repair. The sailing club should be allowed to put up a wall if it chooses.

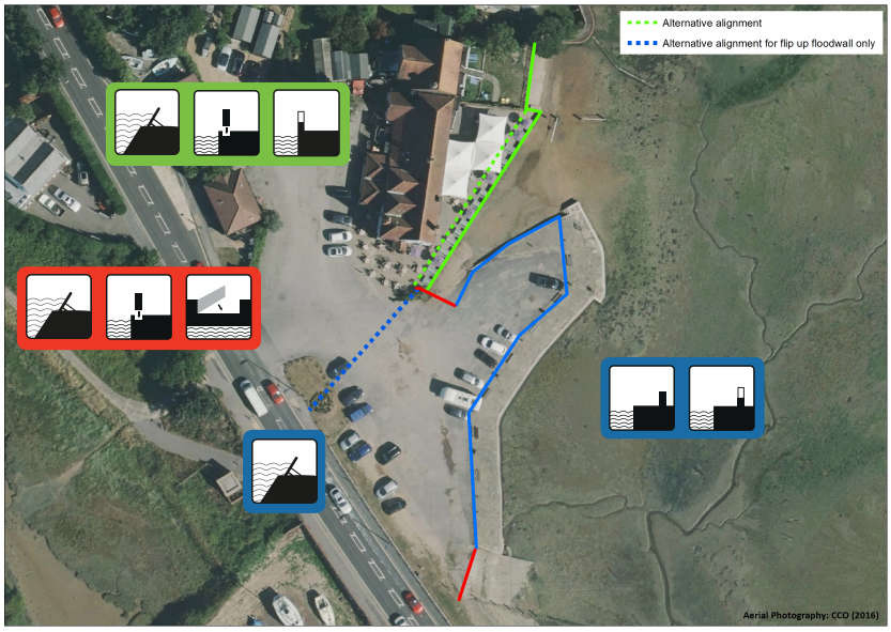
The only other need is to place large blocks along the exposed side of the spit seaward of the sailing club, preferably using concrete block like the existing wartime tank traps as large lumps of granite would look incongruous and out of place.
The sea groynes would change the area and would appear to be the most expensive option.

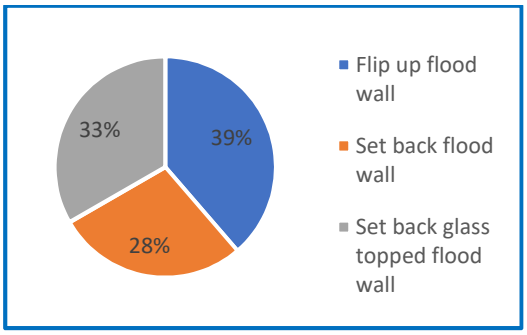
Area 3, The Ship Inn – Accepted shortlisted options

The below charts illustrate the percentage of respondents which found each of the shortlisted options for the area acceptable.









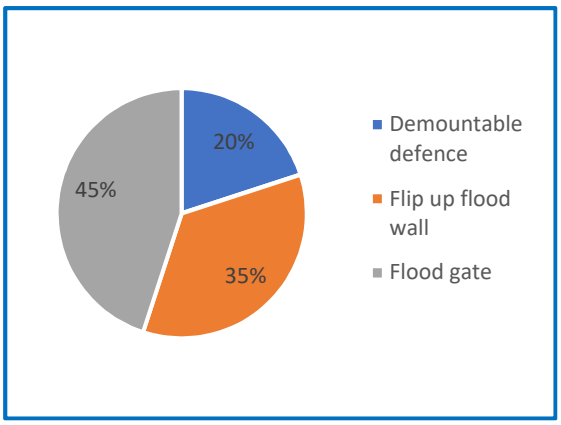
The general theme of comments made for Area 3 (Ship Inn) are concerning the condition of the existing quay wall and the carpark not requiring as much protection as listed buildings/peoples homes.

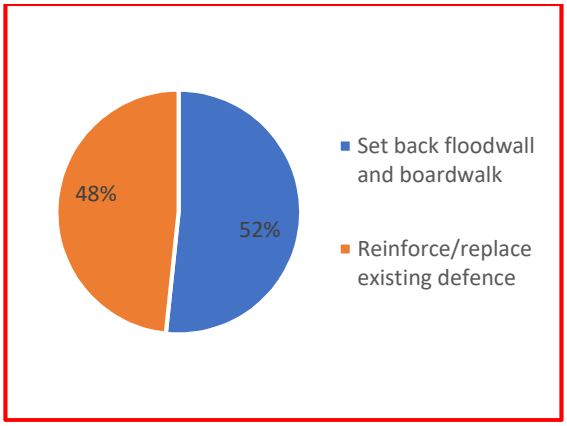
Further comments:

The areas sea defences are failing and any option would be good.
Protection please without too much gentrification. Flood gates would work. Glass topped good for disabled people in cars to see the view.
The existing brick wall is in urgent need of repair. If it was increased in height by 60cm this would solve the problems here.
The car park doesn't need the same level of protection as the pub/houses.

Area 3, Coastal Path – Accepted shortlisted options

The below charts illustrate the percentage of respondents which found each of the shortlisted options for the area acceptable.





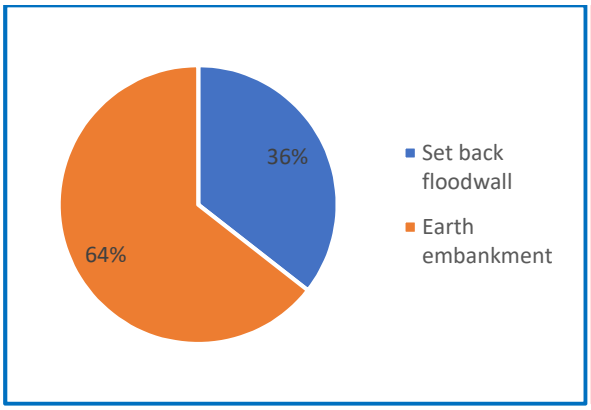
The general theme of comments made for Area 3 (Coastal path) are concerning how the existing defences could be reinforced and the importance of keeping the footpath as it is in order to preserve the character of the village.

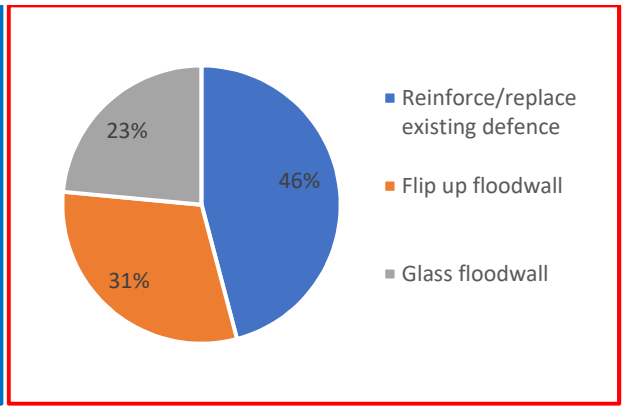
Examples of further comments:

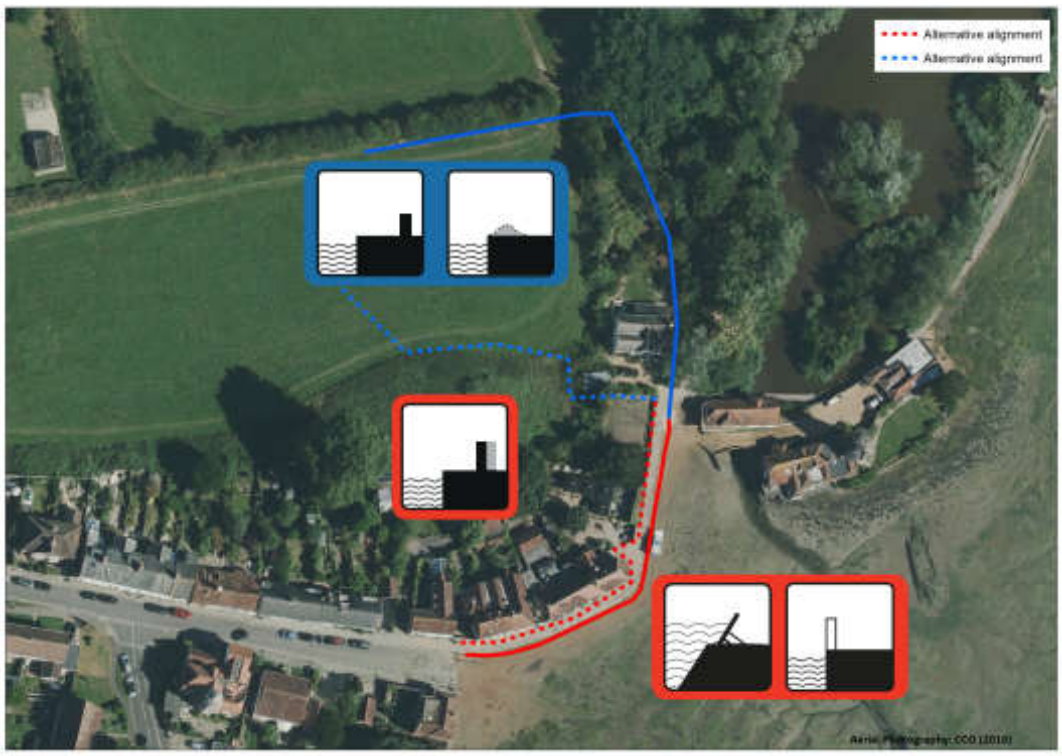
The walls along the path are part of the character of the village and need to stay the same so reinforcement from behind would be the only option I could approve.
This just needs good repair not overdoing or widening- lost character of the footpath is not desirable.
Too much gravel to allow safe operation of flip up floodwall
This needs repairing in the short term as it is degenerating quickly
The local council must accept responsibility to maintain any of the coastal protection schemes with financial backing. The idea of a boardwalk is short sited without a maintenance programme.

Area 3, Royal Oak – Accepted shortlisted options

The below charts illustrate the percentage of respondents which found each of the shortlisted options for the area acceptable.





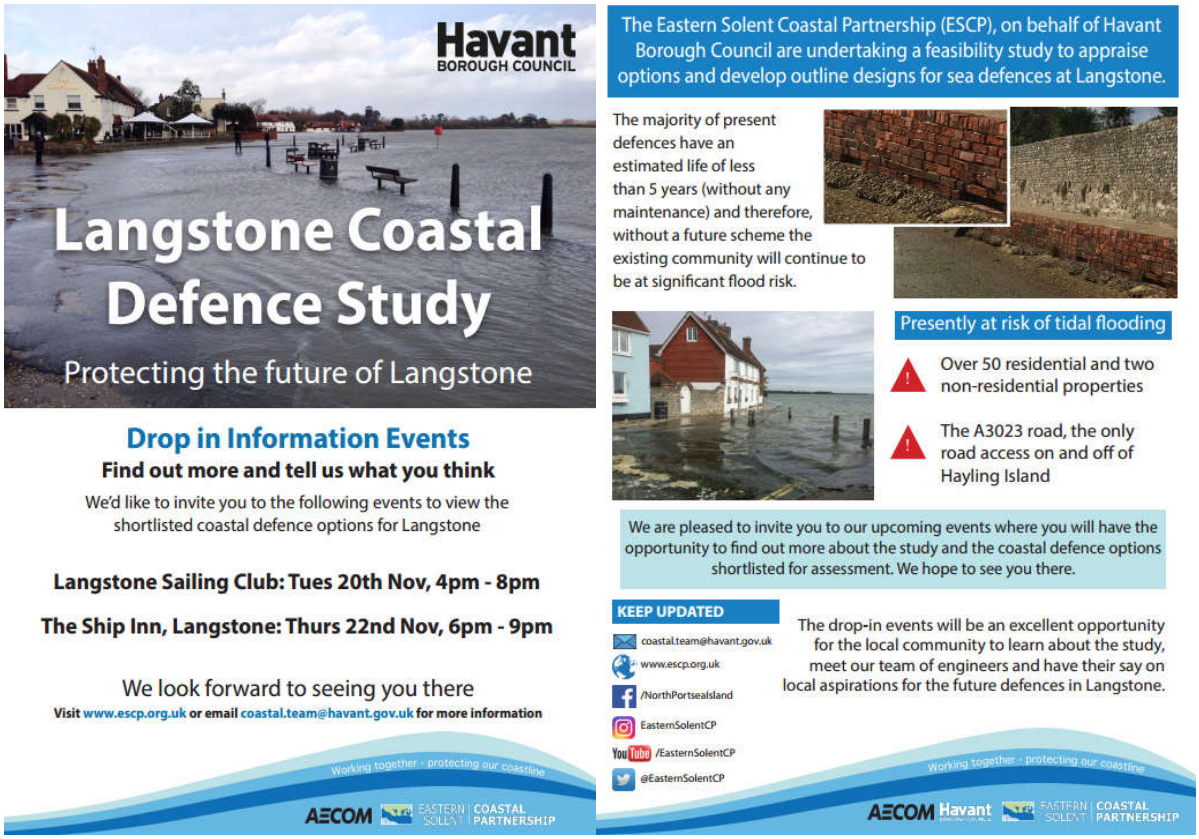


The general theme of comments made for Area 3 (Royal Oak) are concerning reinforcing the existing quay walls and not using permanent flood defence options.

Examples of further comments:

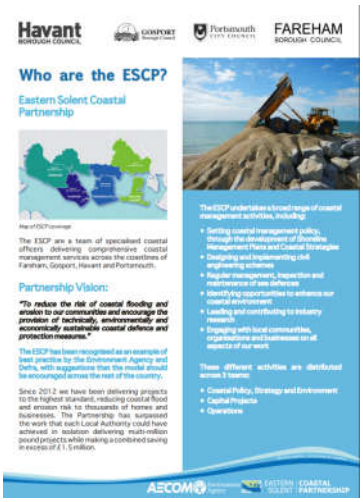
Sea wall needs repair and some occasional use barriers.
Neither flip up floodwalls or glass flood walls are in keeping with buildings.
Parking needs to be provided for this. Green King should contribute to improvements.
The listed buildings need to be left as unchanged as possible and the quay retained as it is but in good repair and condition.
If there is no obligation on anyone to maintain the sea wall as currently built (the council we are told only carries out essential maintenance) then this position needs to be changed and the council take over responsibility for the upkeep and maintenance of any scheme that goes ahead to protect the area from flooding.

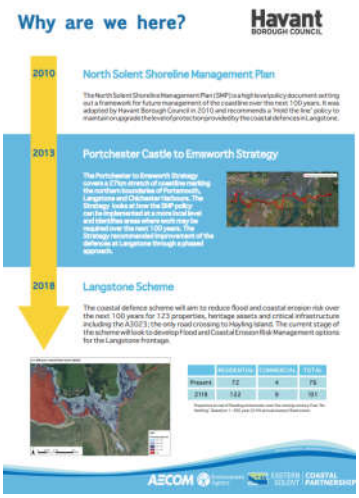
Appendix B – Advertising flyer distributed to residents

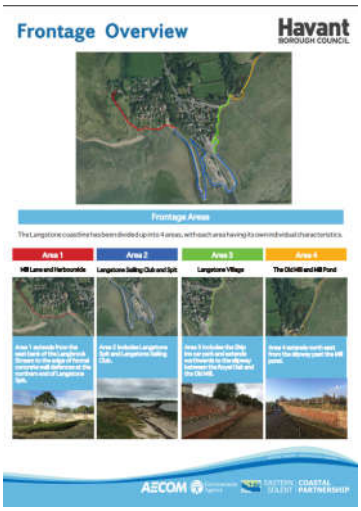


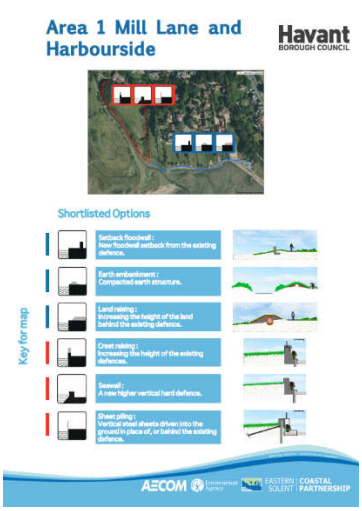
The above shows the front and back of the advertising flyer that was distributed to residents 2 weeks prior to the events.

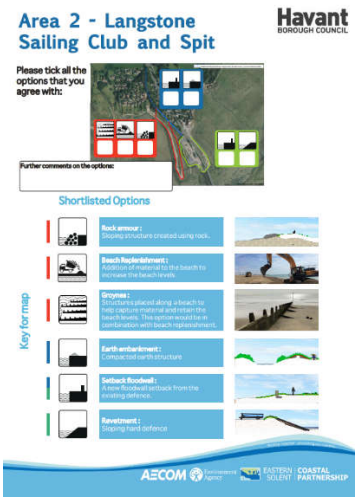
Appendix C –Exhibition poster boards displayed at the events

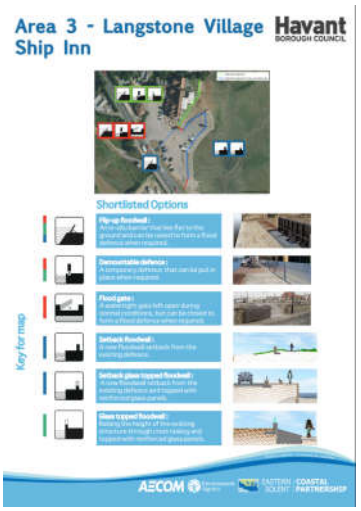


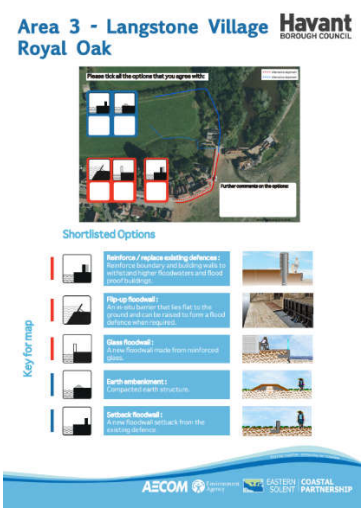




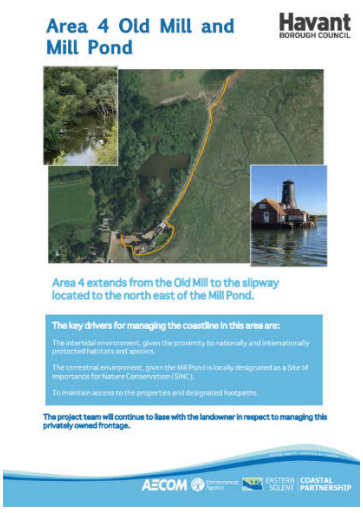


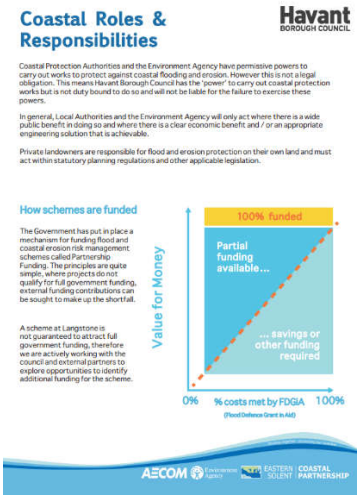


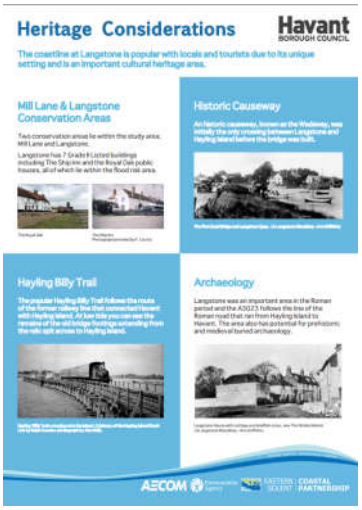


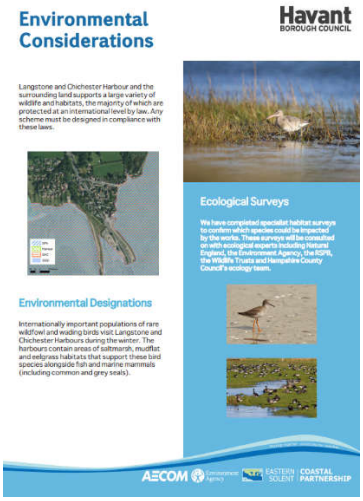

Area 3 - Langstone Village Royal Oak
Havant Borough Council
Please tick all the options that you agree with:
Further comments on the options
Shortlisted Options
Key for map
Reinforce / replace existing defences :
Reinforce boundary and building walls to withstand higher floodwaters and flood proof buildings.
Flip-up floodwall :
An in-situ barrier that lies flat to the ground and can be raised to form a flood defence when required.
Glass floodwall :
A new floodwall made from reinforced glass.
Earth embankment :
Compacted earth structure.
Setback floodwall :
A new floodwall setback from the existing defence.
AECOM
Eastern Solent Coastal Partnership


Area 3 - Langstone Village Coastal Footpath
Havant Borough Council
Shortlisted Options
Key for map
Demountable defence :
A temporary defence that can be installed when required.
Flip-up floodwall :
An in-situ barrier that lies flat to the ground and can be raised to form a flood defence when required.
Flood gate :
A watertight gate with open during normal conditions, but can be closed to form a flood defence when required.
Setback floodwall and boardwalk :
A new floodwall and wider walkway.
Reinforce / replace existing defences :
Reinforce boundary and building walls to withstand higher floodwaters and flood proof buildings.
AECOM
Eastern Solent Coastal Partnership


Area 4 Old Mill and Mill Pond
Havant Borough Council
Area 4 extends from the Old Mill to the slipway located to the north east of the Mill Pond.
The key drivers for managing the coastline in this area are:
The intertidal environment, given the proximity to nationally and internationally protected habitats and species.
The terrestrial environment, given the Mill Pond is locally designated as a Site of Importance for Nature Conservation (SINC).
To maintain access to the properties and designated footpaths.
The project team will continue to liase with the landowner in respect to managing this privately owned frontage.
AECOM
Eastern Solent Coastal Partnership

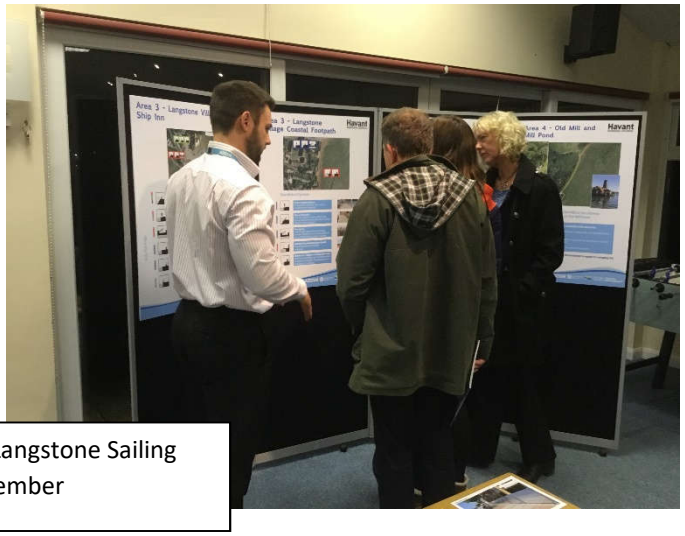

Coastal Roles & Responsibilities
Havant Borough Council
Coastal Protection Authorities and the Environment Agency have permissive powers to carry out works to protect against coastal flooding and erosion. However this is not a legal obligation. This means Havant Borough Council has the 'power' to carry out coastal protection works but is not duty bound to do so and will not be liable for the failure to exercise these powers.
In general, Local Authorities and the Environment Agency will only act where there is a wide public benefit in doing so and where there is a clear economic benefit and / or an appropriate engineering solution that is achievable.
Private landowners are responsible for flood and erosion protection on their own land and must act within statutory planning regulations and other applicable legislation.
How schemes are funded
The Government has put in place a mechanism for funding flood and coastal erosion risk management schemes called Partnership Funding. The principles are quite simple, where projects do not qualify for full government funding, external funding contributions can be sought to make up the shortfall.
A scheme at Langstone is not guaranteed to attract full government funding, therefore we are actively working with the council and external partners to explore opportunities to identify additional funding for the scheme.
Value for Money
100% funded
Partial funding available...
... savings or other funding required
0%
% costs met by FDGiA
100%
(Flood Defence Grant in Aid)
AECOM
Eastern Solent Coastal Partnership


Heritage Considerations
Havant Borough Council
The coastline at Langstone is popular with locals and tourists due to its unique setting and is an important cultural heritage area.
Mill Lane & Langstone Conservation Areas
Historic Causeway
Hayling Billy Trail
Archaeology
AECOM
Eastern Solent Coastal Partnership


Environmental Considerations
Havant Borough Council
Langstone and Chichester Harbour and the surrounding land supports a large variety of wildlife and habitats, the majority of which are protected at an international level by law. Any scheme must be designed in compliance with these laws.
Environmental Designations
Internationally important populations of rare wildfowl and wading birds visit Langstone and Chichester Harbours during the winter. The harbours contain areas of saltmarsh, mudflat and eelgrass habitats that support these bird species alongside fish and marine mammals (including common and grey seals).
Ecological Surveys
We have completed specialist habitat surveys to confirm which species could be impacted by the works. These surveys will be consulted on with ecological experts including Natural England, the Environment Agency, the RSPB, the Wildlife Trusts and Hampshire County Council's ecology team.
AECOM
Eastern Solent Coastal Partnership


What happens next?
Havant Borough Council
Now:
Public events - Shortlist options
Spring 2019:
Shortlist appraisal
Summer 2019:
Public events - Preferred options
Winter 2019:
Funding application for the next stage (detailed design and construction)
Find out more
To monitor the progress of this study and to receive regular updates of other projects and events, please follow us online via one of the links below.
Visit our Website:
www.escp.org.uk
www.havant.gov.uk
Follow us on Instagram:
@EasternSolentCP
Like us on Facebook:
EasternSolentCoastalPartnership
Havant Borough Council
Follow us on LinkedIn:
Eastern Solent Coastal Partnership
Havant Borough Council
Follow us on Twitter:
@EasternSolentCP
@HavantBorough
AECOM
Eastern Solent Coastal Partnership

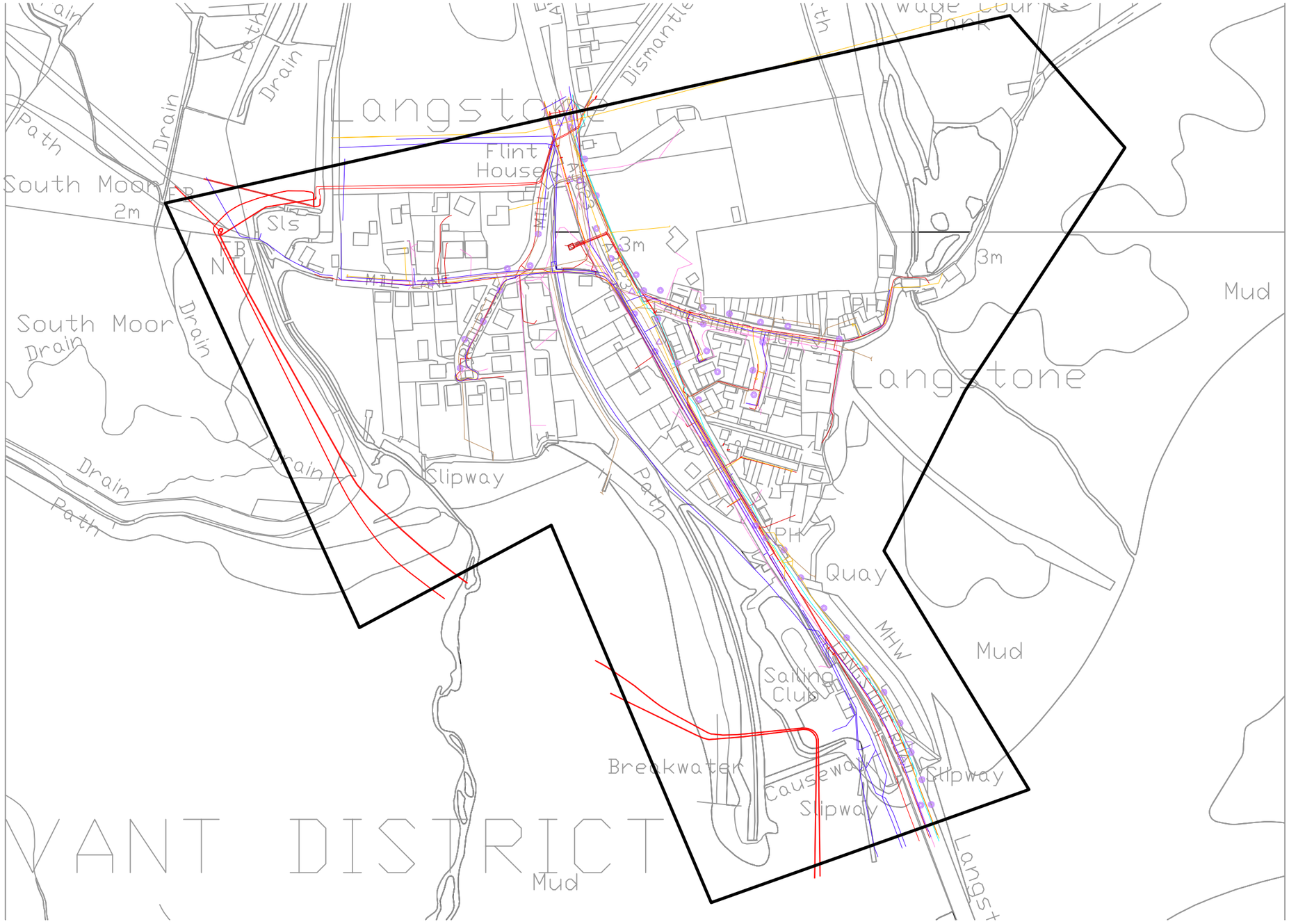
Appendix D – Photographs taken at the events



Photos taken at the Langstone Sailing Club on the 20th November

Photos taken at the Ship Inn on the 22nd November

9.2 Appendix B – Services and utilities plan



NOTE:

No liability of any kind whatsoever is accepted by Landmark Information Group Ltd, its servant or agents, for any error or omission in respect of information contained on the plans provided. This plan is a compilation of a number of plans provided at different scales and is intended to provide a graphical representation of services within the area and it is impossible to guarantee accuracy. In addition it is a compilation of information supplied by utility companies who do not guarantee the accuracy of the information. The underground services must be verified and established on site before any excavation is carried out. This data is supplied subject to the Terms and Conditions available at www.landmark.co.uk.

ISSUE:	DESCRIPTION:	BY:	DATE:
A	Site surrounding Langstone Road, Havant	TW	26/01/18

SCALE:	DRAWN:	CHECKED:	APPROVED:
Not to Scale	MUM	CaN	TW
	DATE: 18/01/2018	DATE: 19/01/2018	DATE: 26/01/2018

- Hampshire County Council
- Openreach – [British Telecommunications]
- Portsmouth Water – Water
- Scottish and Southern Electricity – High Voltage
- Scottish and Southern Electricity – Low Voltage
- SGN – (Southern Gas Networks)
- Southern Water – Sewer
- Virgin Media

TITLE:

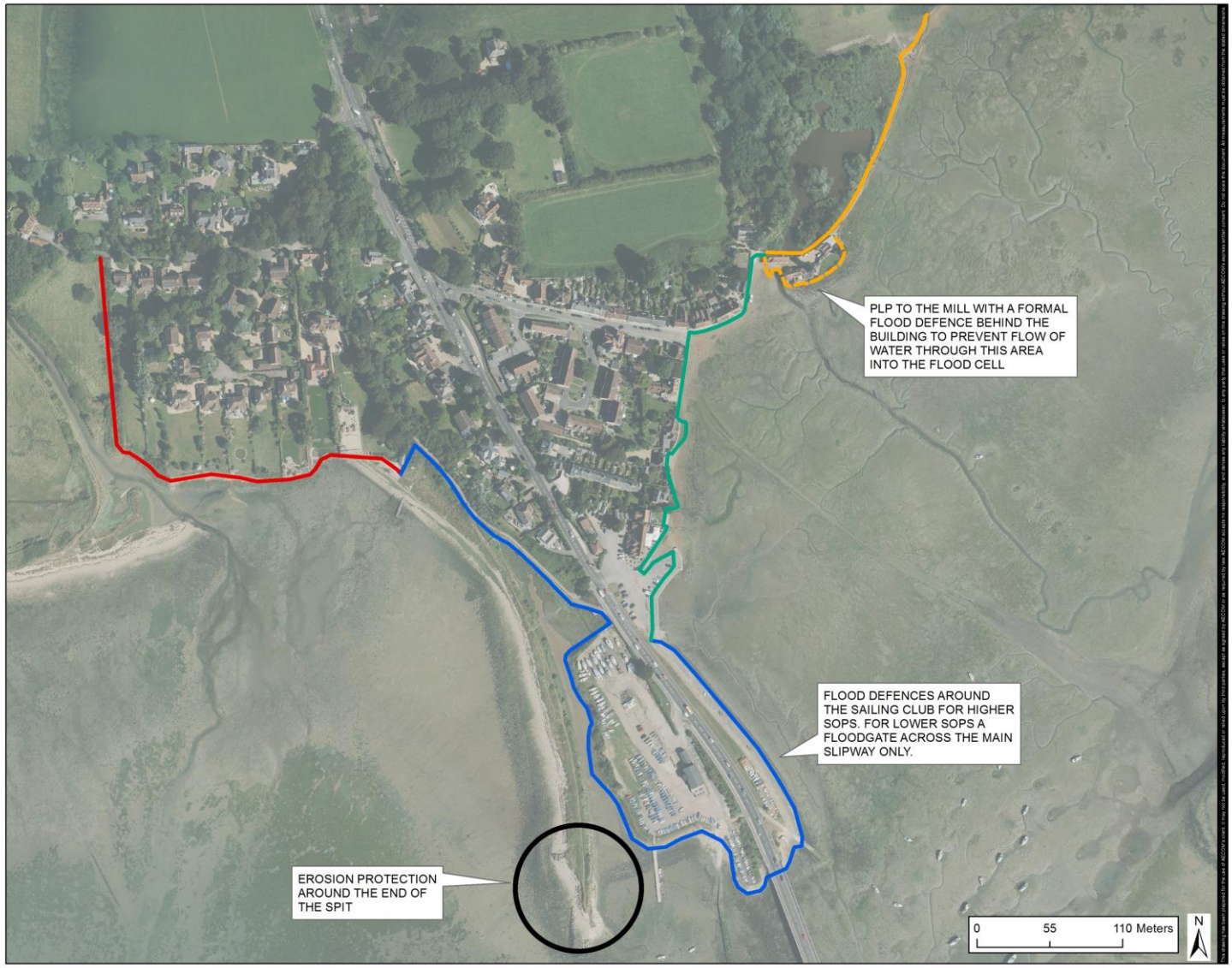
Digital Utility Overview Plan

Reference No:

151407455_1

Landmark INFORMATION GROUP
Imperium,
Imperial Way, Reading,
Berkshire,
RG2 0TD

9.3 Appendix C – Scheme alignments



AECOM
AECOM I&E UK Limited
Midpoint
Alençon Link
Basingstoke, RG21 7PP
+44 (0)1256 310200 tel
www.aecom.com

Project Title:

LANGSTONE FCERM STUDY

Client:

Legend

- ODU 1
- ODU 2
- ODU2 erosion protection
- ODU 3
- ODU 4
- ODU 4 PLP

Issue/Revision:

I/R	Date	Description

AECOM Internal Project No:

60578525

Drawing Title:

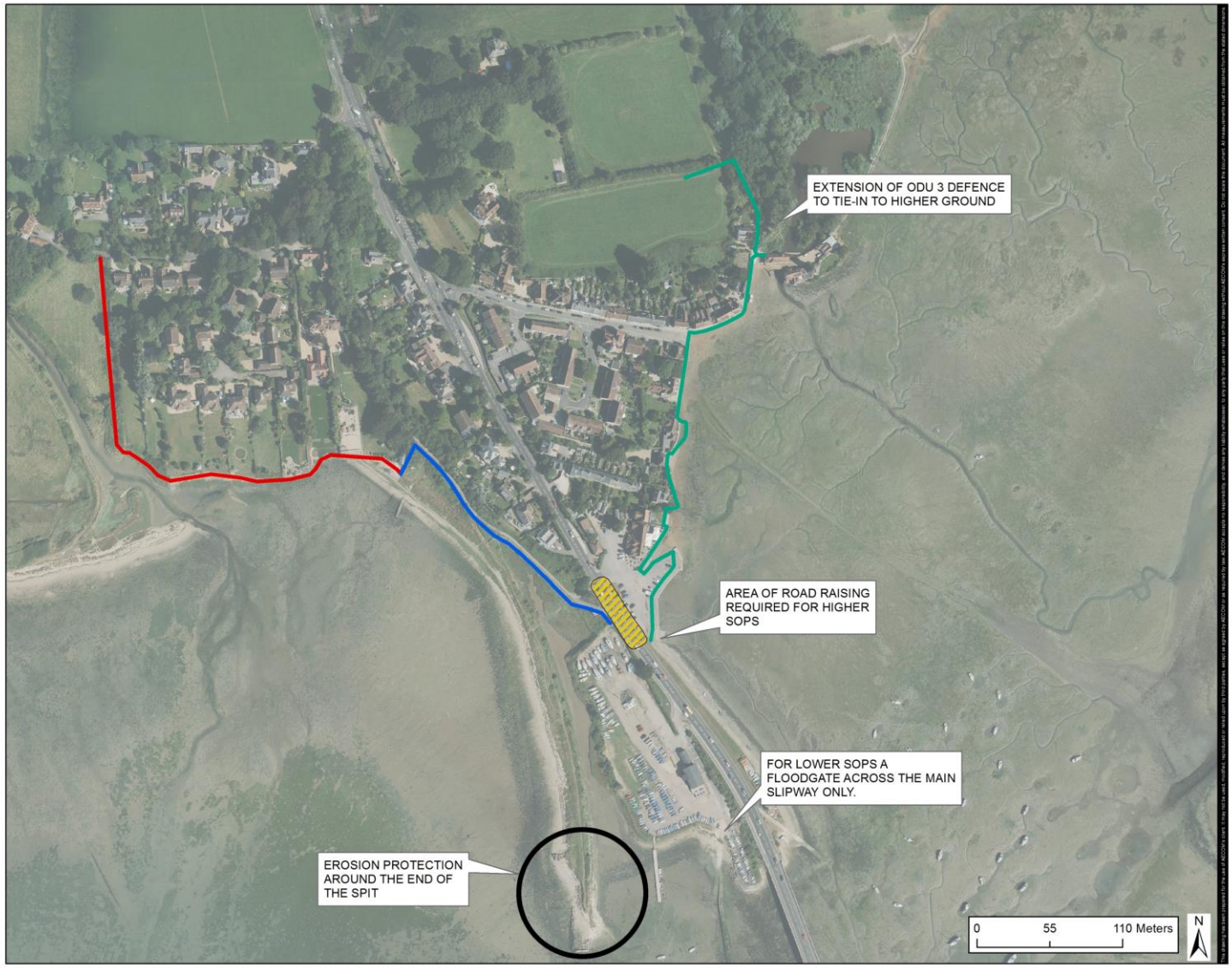
ALIGNMENT A

Scale at A3: 1:2,600

Drawing No: **Rev:** V1

Drawn:	Chk'd:	App'd:	Date:
BT	JS		12/04/19

Filename: L:\Water New\4 - PROJECTS\60578525 Langstone FCERM scheme\40 GIS\02 Project files\MXDs\Alignment A economics.mxd



AECOM
AECOM I&E UK Limited
Midpoint
Alençon Link
Basingstoke, RG21 7PP
+44 (0)1256 310200 tel
www.aecom.com

Project Title:

LANGSTONE FCERM STUDY

Client:

Legend

- ODU 1
- ODU 2
- ODU 3
- Road raising zone

Issue/Revision:

I/R	Date	Description

AECOM Internal Project No:

60578525

Drawing Title:

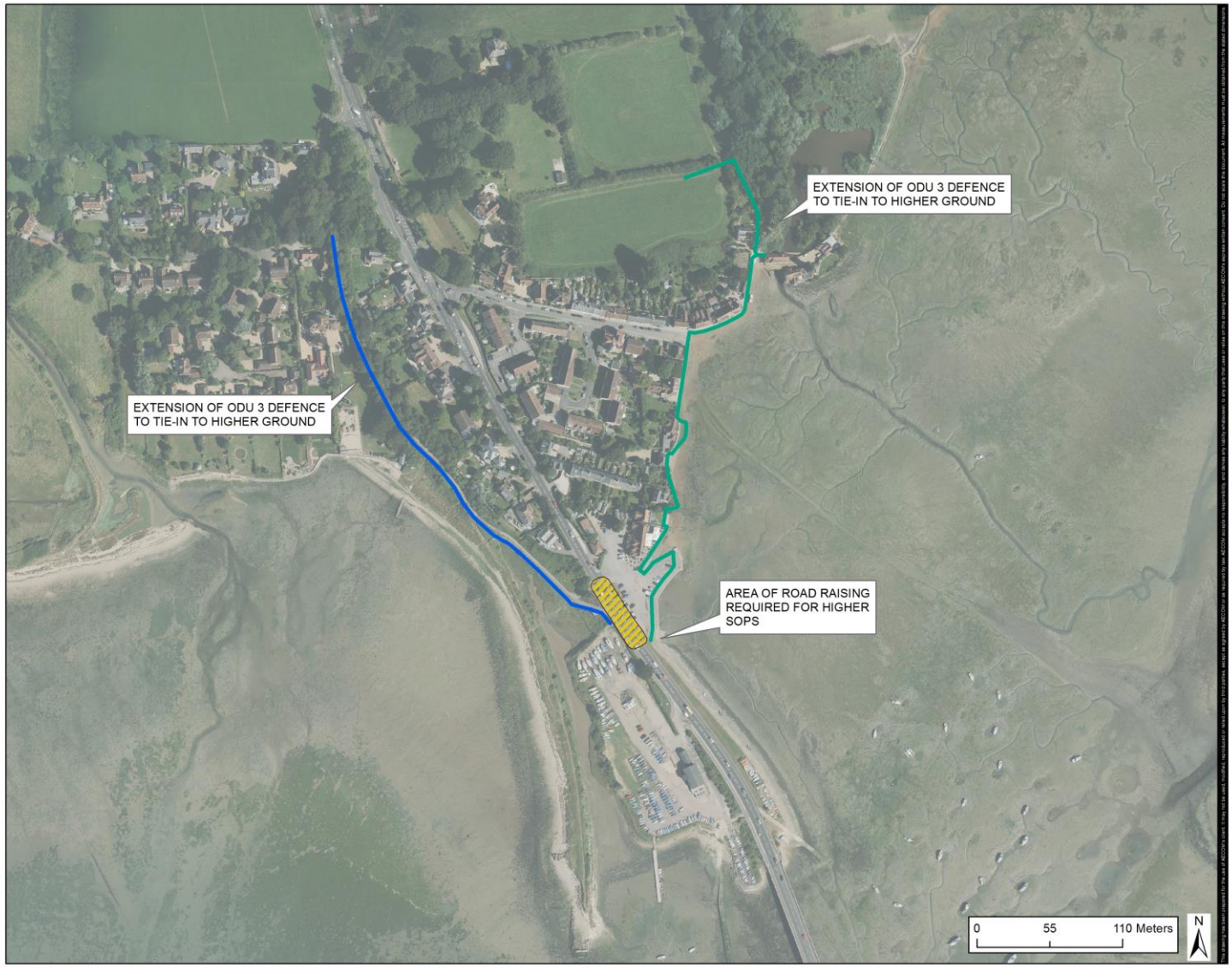
ALIGNMENT B

Scale at A3: 1:2,600

Drawing No: **Rev:** V1

Drawn:	Chk'd:	App'd:	Date:
BT	JS		12/04/19

Filename: L:\Water New\4 - PROJECTS\60578525 Langstone FCERM scheme\40 GIS\02 Project files\MXDs\Alignment B economics.mxd



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AECOM I&E UK Limited
Midpoint
Alençon Link
Basingstoke, RG21 7PP
+44 (0)1256 310200 tel
www.aecom.com

Project Title:

LANGSTONE FCERM STUDY

Client:

Legend

- ODU 2
- ODU 3
- Road raising zone

Issue/Revision:

I/R	Date	Description

AECOM Internal Project No:

60578525

Drawing Title:

ALIGNMENT C

Scale at A3: 1:2,600

Drawing No: **Rev:** V1

Drawn:	Chk'd:	App'd:	Date:
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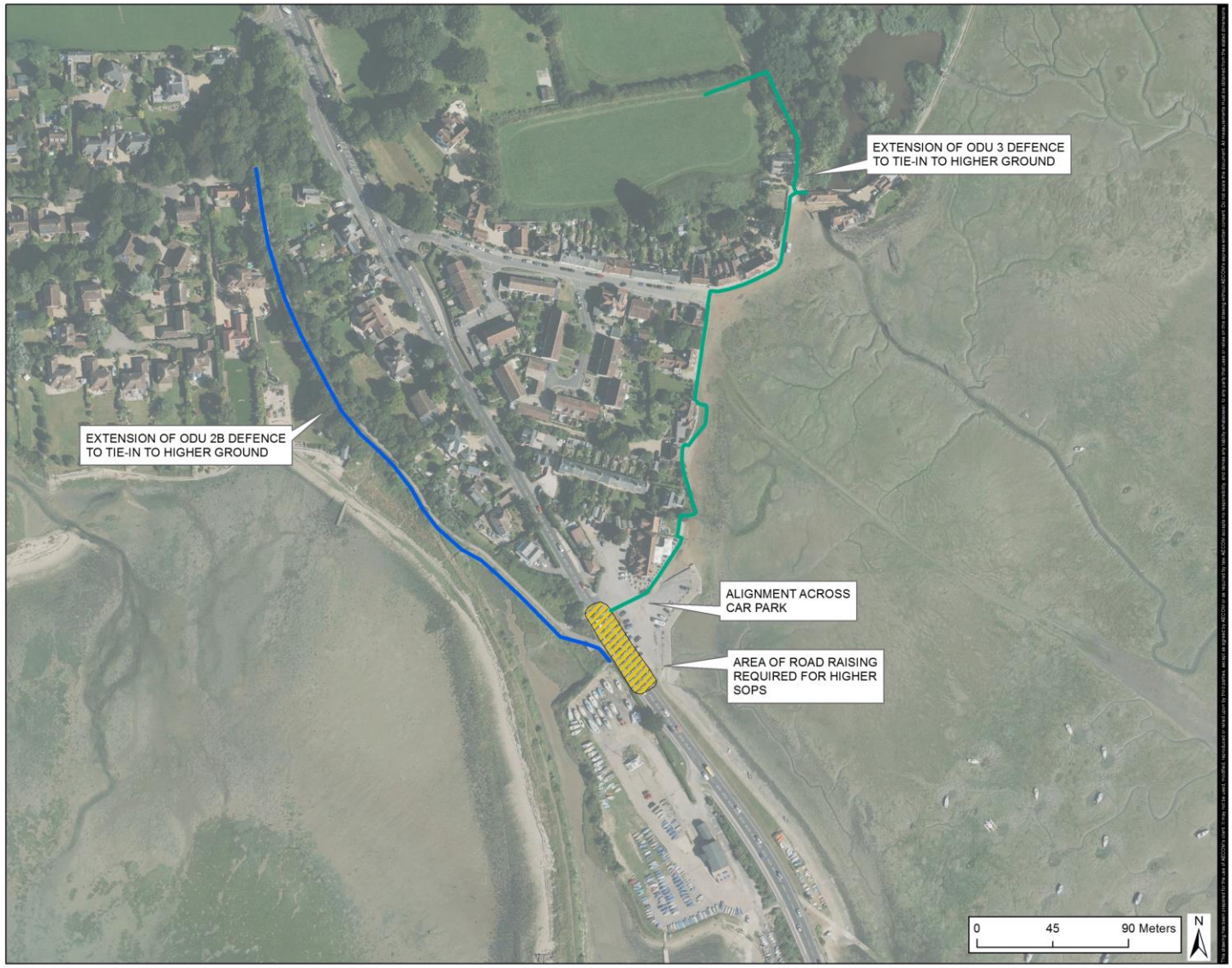

AECOM
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Midpoint
Alençon Link
Basingstoke, RG21 7PP
+44 (0)1256 310200 tel
www.aecom.com

Project Title:

LANGSTONE FCERM STUDY

Client:

Legend

- ODU 2
- ODU 3
- Road raising zone

Issue/Revision:

I/R	Date	Description

AECOM Internal Project No:

60578525

Drawing Title:

ALIGNMENT D

Scale at A3: 1:2,043.61

Drawing No: **Rev:** V1

Drawn:	Chk'd:	App'd:	Date:
BT	JS		27/03/19

Filename: L:\Water New\4 - PROJECTS\60578525 Langstone FCERM scheme\40 GIS\02 Project files\MXDs\Alignment D economics.mxd

9.4 Appendix D – Environmental appraisal

Environmental Appraisal

An appraisal of Short List options has been undertaken against the environmental objectives of the scheme using a Red, Amber and Green system for four environmental categories; Landscape, Heritage, Ecology and Other Environmental Considerations. The following scoring system was used to assign a score to each of the options under the four environmental categories.

- **Red:** Does not align with environmental objectives

- **Dark Amber:** Partially aligned with environmental objectives with no mitigation likely to be available

- **Light Amber:** Partially aligned with environmental objectives with some issues requiring further investigation (i.e. potentially mitigatable)

- **Green:** Fully aligned with environmental objectives

ODU 1

ODU 1a	Other Environmental Considerations	Landscape	Heritage	Ecology
Do Nothing	Adaptation to sea level rise or other climate change responses would not be addressed. There are a number of residential properties that are at risk of flooding from a 1 in 200 year (0.5% AEP) tidal flood event should this approach be taken forward.	Risk to existing landscape character from bank erosion and increased flooding of floodplain grazing marsh (which is a priority habitat). Increased flooding could result in loss/change in habitat and risk residential properties. No opportunity to enhance landscape character or access.	This option will preserve the setting of the heritage assets and the character and appearance of the area. However, this option might affect the assets in the long term as the risk of flooding remains.	Does not affect the integrity of the European designated site or SSSI. Maintains existing biodiversity.
Setback Floodwall	Temporary noise and vibration from plant and machinery (to install the foundations for the seawall) are likely to be experienced by nearby residential receptors during construction. Works in this unit could also be within 8m of an ordinary watercourse. Consideration should be given to setting these features back from the watercourse and/or using standard best practice measures to avoid potential contamination events during construction.	This option would have some impact on landscape character to introduce an engineered feature along riverbank; existing trees and vegetation likely to be impacted by construction and difficult to replicate with new planting; would have some impact upon natural qualities of area. Possible opportunity to improve access. This option would have some impact on landscape character to introduce an engineered feature into the floodplain grazing marsh; existing trees and vegetation likely to be impacted by construction although less so than if constructed along riverbank; would have some impact upon natural qualities of area. No opportunity to enhance access.	A setback floodwall could potentially affect views from Mill Lane Conservation Area. In addition, this option has the potential to impact upon archaeological deposits or maritime artefacts/structures. However, this option might be acceptable depending on design and screening of options.	Temporary effects on European sites/SSSI during construction but set back from boundary; effects (such as noise and visual disturbance) could be mitigated using a Construction Environmental Management Plan (CEMP) that (for example) imposed restrictions on working seasons at the intersection with the existing defence in ODU1b/ for the noisiest activities. Unknown if hedgerow removal needed. Would need to restore some grassland. Potential for disturbance to the over-wintering birds and the breeding terns at the Oysterbeds in the summer. This could be mitigated by timing of works appropriately.
Earth Embankment	Temporary noise and vibration from plant and machinery (to distribute materials to create embankment) are likely to be experienced by nearby residential receptors during construction. Consideration would need to be given to measures to reduce risk of creating pathways to the watercourse to the east of the frontage.	This option would have some impact on landscape character to introduce an engineered bank along natural riverbank, but could be mitigated through design, given existing levels in this area; existing trees and vegetation likely to be impacted by construction and difficult to replicate with new planting; would have limited impact upon natural qualities of area. No opportunity to enhance access. This option would have some impact on landscape character but could be mitigated through design and planting; existing trees and vegetation likely to be impacted by construction although less so than if constructed along riverbank. No opportunity to enhance access.	This option could be acceptable here depending on design.	Potential temporary effects on European sites/SSSI during construction but set back from boundary; effects could be mitigated using a CEMP that (for example) imposed restrictions on working seasons at the intersection with the existing defence in ODU1b / for the noisiest activities. Would maintain/enhance biodiversity and give a feature potentially suitable for reptiles. Potential for disturbance to the over-wintering birds and the breeding terns at the Oysterbeds in the summer. This could be mitigated by timing of works appropriately. Potential to affect intertidal zone adjacent to the works area. This is a Priority habitat and affects could likely be avoided via the CEMP.
ODU 1b				
Do Nothing	Adaptation to sea level rise or other climate change responses would not be addressed. There are a number of properties that are at risk of flooding from a 1 in 200 year (0.5% AEP) tidal flood event should this approach be taken forward.	Would have some impact on landscape character due to gradual erosion of existing sea defences; trees and vegetation would be increasingly impacted as sea defences fail. No opportunity to enhance landscape character or access.	This option will preserve the setting of the heritage assets and the character and appearance of the area. However, this option might affect the assets in the long term as the risk of flooding remains.	Does not affect the integrity of the European designated site or SSSI. Maintains existing biodiversity.
Encasement (+ crest raising if required)	Temporary noise and vibration from plant and machinery (to encase the existing seawall) are likely to be experienced by nearby residential receptors during construction.	The effect upon landscape character will depend upon design of encasement and scale of crest raising; some existing trees and vegetation could be impacted. No opportunity to enhance landscape character or access.	This option has the potential to affect views from and towards the Mill Lane Conservation Area. The open nature of the foreshore area could be affected. However, depending on height, design	Adjacent to or potentially within the European site and SSSI. Could potentially result in loss of designated habitat depending on the extent of the works and whether an increase in defence footprint into the European site is required, IROPI may be required. Does not allow for

	Other Environmental Considerations	Landscape	Heritage	Ecology
			and materials could be acceptable here.	biodiversity enhancements unless created elsewhere. Potential for disturbance to the over-wintering birds and the breeding terns at the Oysterbeds in the summer. This could be mitigated by timing of works appropriately.
Sea Wall	Temporary noise and vibration from plant and machinery (to install the foundations for the seawall) are likely to be experienced by nearby residential receptors during construction.	Effect upon landscape character will depend upon design and scale of replacement seawall; existing trees and vegetation likely to be impacted by construction.	This option has the potential to affect views from and towards the Mill Lane Conservation Area. Views from Langstone Harbour and Langstone Conservation Area could be affected as well. This option has also the potential to impact upon archaeological deposits or maritime artefacts/structures. However, this option might be acceptable here depending on design, height and materials.	Adjacent to, or potentially within, the European site and SSSI. Could be mitigated by confining construction to the existing footprint; however there would still be temporary effects (e.g. disturbance) during construction, although these could be mitigated with a CEMP for example) imposed restrictions on working seasons for the noisiest activities. The creation of the new sea wall could result in loss of designated habitat if it requires increase in overall footprint. Biodiversity enhancements could be incorporated into the wall, however this would likely to increase the overall footprint and result in habitat loss. IROPI would be required. Potential for disturbance to the over-wintering birds and the breeding terns at the Oysterbeds in the summer. This could be mitigated by timing of works appropriately.
Sheet Piling (behind existing defences)	Temporary noise and vibration from plant and machinery (to install the sheet piles) are likely to be experienced by nearby residential receptors during construction.	The effect upon landscape character will depend upon positioning and scale of sheet piling (this will be limited if located within existing embankment behind defences and planting introduced); existing trees and vegetation likely to be impacted by construction.	Vertical sheet piling may be visually acceptable here if the piling is faced with timber and the visibility of the sheeting reduced by raising the level of the land behind. Buried archaeological remains may be also affected.	Adjacent to the European site and SSSI but would avoid any land take issues. Even behind existing defences may have an impact due to vibration etc. and temporary construction related effects which could be mitigated with a CEMP for example) imposed restrictions on working seasons for the noisiest activities. Does not allow for biodiversity enhancements unless created elsewhere. Potential for disturbance to the over-wintering birds and the breeding terns at the Oysterbeds in the summer. This could be mitigated by timing of works appropriately.

ODU 2

ODU 2a	Other Environmental Considerations	Landscape	Heritage	Ecology
Do Nothing	Adaptation to sea level rise or other climate change responses would not be addressed. Loss of spit could negatively impact surrounding areas (sailing club)	Would have an impact on landscape character due to gradual erosion of banks, some of which have historic value and are valued by local people. No existing trees would be impacted but some colonised vegetation could be affected. No opportunity to enhance landscape character or access.	This option will preserve the setting of the heritage assets and the character and appearance of the area. However, this option might affect the assets in the long term as the risk of flooding remains.	Does not affect the integrity of the European designated site or SSSI. Maintains existing biodiversity.
Beach nourishment	Potential for noise and vibration to occur during works due to mechanical plant redistributing the nourishment material.	Whilst there would be some effect on landscape character in the short-term, as landform would change, in the long-term this option is likely to have the least impact upon landscape character, as it will result in the most natural solution. The downside is the need for replenishment, and the risk to the landscape if this wasn't undertaken regularly. Existing vegetation is likely to be impacted and it would be difficult to replicate existing vegetation with new planting.	This option will preserve key views however, the low and high tides in the area are an integral part of the local character and distinctiveness and might be affected.	ODU 2a is surrounded by the European designated sites and SSSI. Beach nourishment may impact on these sites as material is eroded into the water. Any material would need to reflect the material already present and smothering of existing designated/ supporting habitats avoided. Would possibly be undertaken from within the European designated site/SSSI Potential for disturbance to the over-wintering birds and the breeding terns at the Oysterbeds in the summer. This could be mitigated by timing of works appropriately. Beach nourishment could smother designated vegetated shingle habitat and surrounding designated features.
Rock armour	Likely to be temporary closures or partial closures of footpaths during construction to ensure the safety of members of the public.	There would be an effect on landscape character as rock armour would be an engineered solution in a natural and sensitive landscape. It would have an impact upon the natural qualities of the area. However, as the rock armour weathers the effect would not be as profound. Depending upon the construction method, damage to vegetation could be avoided.	This area is of some heritage value due to the remains of the old railway to Hayling Island however it is not designated. This option has the potential to impact upon undesignated archaeological deposits or maritime artefacts/structures.	ODU 2a is surrounded by the European designated sites and SSSI. Rock armour may impact on coastal processes and ecologically affect a wider area beyond ODU2a. Rock armour may also involve permanent landtake from the SSSI and European sites depending on location. Potential for disturbance to the over-wintering birds and the breeding terns at the Oysterbeds in the summer. This could be mitigated by timing of works appropriately.
Groynes and beach nourishment	Likely to be temporary noise and vibration effects on nearby residential receptors associated with the installation of groynes along this frontage.	Would have an impact on landscape character to introduce an engineered feature; existing vegetation may be impacted by construction and difficult to replicate with new planting; would have an impact upon the natural qualities of the area.	Construction of groynes might affect archaeological remains in the area including the remains of the old railway line.	ODU 2a is surrounded by the European designated sites and SSSI. Beach nourishment may impact on these sites as material is eroded in to the water. Would possibly be undertaken from within the European designated site/SSSI. Potential for disturbance to the over-wintering birds and the breeding terns at the Oysterbeds in the summer. This could be mitigated by timing of works appropriately.
ODU 2b				
Do Nothing	Adaptation to sea level rise or other climate change responses would not be addressed. Potential for loss of footpath / National Cycle route.	Would have an impact on landscape character due to gradual erosion of banks, access to which is valued by local people. Greater likelihood for impacting existing trees and vegetation and destruction of properties. No opportunity to enhance landscape character or access.	This option will preserve the setting of the heritage assets and the character and appearance of the area. However, this option might affect the assets in the long term as the risk of flooding remains.	Does not affect the integrity of the European designated site or SSSI. Maintains existing biodiversity.
Setback floodwall	Likely to be temporary noise and vibration effects on nearby residential receptors associated with installing the foundations of the flood wall. Construction works are also likely to result in the temporary closure or partial closure of the footpath they are located adjacent to, to ensure the safety of members of the public. If extended option is taken forward it would extend across a Public Right of Way (PRoW).	There would be an effect on landscape character as a floodwall would be an engineered solution in a predominantly natural landscape. Due to its proposed location it would have a limited impact upon the natural qualities of the area. Existing trees and vegetation would be impacted by construction and some of this would be difficult to replicate with new planting. The extended section is likely to be affected more due to loss of vegetation during construction and loss of width along footpath/cycle path.	This option could affect the setting of a number of heritage assets including the setting of the Mill Lane Conservation Area. A setback floodwall has the potential to affect views from and towards Conservation Area and affect the open character of the foreshore area. This option might affect archaeological remains in the area.	May require some removal of trees. Potential temporary effects (such as noise and visual disturbance) on European sites/SSSI during construction which can be mitigated using a CEMP (for example imposed restrictions on working seasons for the noisiest activities) but set back from boundary. Potential for disturbance to the over-wintering birds and the breeding terns at the Oysterbeds in the summer. This could be mitigated by timing of works appropriately.
Earth embankment (raising / formalising existing structure or new)	Likely to be temporary noise and vibration effects on local residents associated with creating the earth embankment. Construction works are also likely to result in the temporary closure or partial closure of the footpath they are located adjacent to, to ensure the safety of members of the public. If extended option is taken forward it would extend across a PRoW.	There would be some effect on landscape character and the area as a raised or new earth embankment would alter the landform. Existing trees and vegetation would be impacted by construction and some of this would be difficult to replicate with new planting. The anticipated land take of the embankment would have a negative effect upon users of the existing Shipwrights Way footpath, due to reduced width of the path and increased height creating a more enclosed route. If an earth embankment could be used along the southern (exposed) section and a low floodwall used alongside the (enclosed) footpath to the north, this would be the preferable option	This option might affect the setting of a number of heritage assets including the setting of the Conservation Area. This option might affect archaeological remains in the area. However, it might be acceptable here depending on design details. The construction of a new embankment has the potential to impact on buried archaeological	Potential temporary effects (such as noise and visual disturbance) on European sites/SSSI during construction. Effects can be mitigated using a CEMP (for example) imposed restrictions on working seasons for the noisiest activities. Would maintain/enhance biodiversity and give a feature potentially suitable for reptiles. Potential for disturbance to the over-wintering birds and the breeding terns at the Oysterbeds in the summer. This could be mitigated by timing of works appropriately.

		Other Environmental Considerations		Landscape		Heritage		Ecology
				as it would (subject to method) protect trees and vegetation, and fit better in both cases with landscape character.		remains.		
ODU 2c								
Do Nothing		Adaptation to sea level rise or other climate change responses would not be addressed. Risk of flooding to the sailing club, which would diminish the areas social value.		Would have an impact on landscape character due to gradual erosion, in an area valued by local people. No existing trees would be impacted but colonised vegetation could be affected and eventually the sailing club would be flooded and the building undermined. The boundary of the AONB lies along the eastern portion of 2c and there would be limited impacts on it from no active intervention. No opportunity to enhance landscape character, access or AONB.		This option will preserve the setting of the heritage assets and the character and appearance of the area. However, this option might affect the assets in the long term as the risk of flooding remains.		Does not affect the integrity of the European designated site or SSSI. Maintains existing biodiversity.
Flood gate		No additional comments		A floodgate is unlikely to result in changes to the existing landscape character and have any lasting effect on the AONB other than in the short term and during construction.		This option might have an impact on archaeological remains in the area. Consideration should be given in views towards Langstone.		Set-back from European sites/SSSI, but potential for temporary effects during construction (such as noise, vibration, and pollution) which can be mitigated using a CEMP (for example) imposed restrictions on working seasons for the noisiest activities.
Setback floodwall		Potential for disruption, noise and vibration during construction of setback floodwall.		A setback floodwall is unlikely to result in changes to the existing landscape character and have any lasting effect on the AONB other than in the short term and during construction, due to the presence of the existing revetment, which is a hard engineering solution. No opportunities to enhance character or access.		The construction of a setback wall might affect archaeological remains in the area. However, a setback floodwall here could be acceptable but consideration should be given to the impact on views across the water from Hayling Island to Langstone.		Set-back from European sites/SSSI, but potential for temporary effects during construction (such as noise, vibration, and pollution) which can be mitigated using a CEMP (for example) imposed restrictions on working seasons for the noisiest activities. Potential for disturbance to the over-wintering birds and the breeding terns at the Oysterbeds in the summer. This could be mitigated by timing of the most disturbing works appropriately.
Revetment		Potential for short term noise and vibration during construction of revetment.		Refurbishing the existing revetment is unlikely to have an effect on landscape character and the AONB, other than in the short term and during construction. Heightening the revetment could affect landscape character and the AONB but the effect is likely to be limited. Some impact upon colonised vegetation is likely, although could be limited through method/alignment. No opportunities to enhance character or access.		This option might have an impact on archaeological remains in the area. Consideration should be given in views towards Langstone.		Would be within the European designated sites and SSSI. Loss of designated habitats if it requires increase in overall footprint would require IROPI. Potential for disturbance to the over-wintering birds and the breeding terns at the Oysterbeds in the summer. This could be mitigated by timing of the most disturbing works appropriately.

ODU 3

Measures	Other Environmental Consideration	Landscape	Heritage	Ecology
ODU 3a				
Do Nothing	Adaptation to sea level rise or other climate change responses would not be addressed. Impacts would result in loss of access to the slipway and foreshore.	Gradual erosion of the concrete ramp would degrade the landscape further and put the car park, road and pub building at risk, which would impact access in an area valued by local people and visitors. No impact upon trees or vegetation. No opportunity to enhance landscape character, access or AONB.	This option will preserve the setting of the heritage assets and the character and appearance of the area. However, this option might affect the assets in the long term as the risk of flooding remains.	Does not affect the integrity of the European designated site or SSSI. Maintains existing biodiversity.
Flip-up floodwall	Likely to result in limited disruption at the existing car park during construction.	A flip up flood wall is unlikely to have an (when lying down). No impact upon trees or vegetation. No opportunity to enhance landscape character, access or AONB.	This option has the potential to impact upon undesignated archaeological deposits	Set-back from European sites/SSSI, but potential for temporary effects during construction (such as noise, vibration, and pollution) which can be mitigated using a CEMP (for example) imposed restrictions on working seasons for the noisiest activities.
Demountable defences		Demountable defences are unlikely to have an impact (subject to design). No impact upon trees or vegetation. No opportunity to enhance landscape character, access or AONB.	The use of demountable or temporary defence minimises the impact on the listed buildings and the conservation area. Demountable and temporary defences are likely to have less impact on buried archaeological/maritime deposits	
Flood Gate		Given the presence of vehicles in this location, a permanent barrier, such as a carefully designed flood gate could act as an edge restraint for cars and would negate the need to move vehicles if the flood gate needed to be closed. However, it would impact upon the open character of the promontory and could hinder visibility for people. No trees or vegetation would be affected.	This option will be visible at all times and will adversely affect the setting of the heritage assets and the character and appearance of the area. This option has the potential to impact upon undesignated archaeological deposits	
ODU 3b				
Do Nothing	Adaptation to sea level rise or other climate change responses would not be addressed. Impacts would result in the loss of the carpark used by customers of the Ship Inn, which would diminish the areas social value.	Existing landscape character and AONB compromised by the stark vertical masonry retaining wall. Erosion of the wall would degrade the landscape further and put the car park, road and pub building at risk, which would impact access in an area valued by local people and visitors. No impact upon trees or vegetation. No opportunity to enhance landscape character, access or AONB.	This option will preserve the setting of the heritage assets and the character and appearance of the area. However, this option might affect the assets in the long term as the risk of flooding remains.	Does not affect the integrity of the European designated site or SSSI. Maintains existing biodiversity.
Setback floodwall	Likely to result in limited disruption at the existing car park during construction. Construction works could also result in temporary noise and vibration effects relating to the Ship Inn and other members of the public	Given the presence of vehicles in this location, a permanent barrier, such as a carefully designed floodwall could act as an edge restraint for cars and would negate the need to move vehicles if the barrier needed to be raised. However, it would remove the open character of the promontory and could hinder visibility for people. There would be opportunities to enhance public access/landscape character here. No trees or vegetation would be affected.	This option has the potential to impact upon undesignated archaeological deposits or maritime artefacts/structures. This option could also impact on views in this very sensitive area and impact on the character and appearance of the conservation area.	Set-back from European sites/SSSI, but potential for temporary effects during construction (such as noise, vibration, and pollution) which can be mitigated using a CEMP (for example) imposed restrictions on working seasons for the noisiest activities.
Glass topped setback floodwall / glasswall		As with a setback floodwall, a glass topped floodwall would have the potential to alter the open character of the promontory and could hinder visibility for people (it would depend upon the height of the glass). There would be opportunities to enhance public access/landscape character here. No trees or vegetation would be affected.	This option could have a detrimental impact on the character and appearance of the conservation area. The openness of the area and views from the conservation area and listed buildings will be interrupted.	Set-back from European sites/SSSI, but potential for temporary effects during construction (such as noise, vibration, and pollution) which can be mitigated using a CEMP.
Flip-up floodwall (setback or across the Car Park)		A flip-up floodwall would have no impact upon trees or vegetation. The benefit of a flip-up floodwall over a permanent flood wall is that it would retain the open character of the promontory. A flip-up floodwall set back into the car park would have less of an impact than one on the frontline. There would be opportunities to enhance public access/landscape character here.	This option has the potential to impact upon undesignated archaeological deposits or maritime artefacts/structures.	Set-back from European sites/SSSI, but potential for temporary effects during construction (such as noise, vibration, and pollution) which can be mitigated using a CEMP (for example) imposed restrictions on working seasons for the noisiest activities.
ODU 3c				
Do Nothing	Adaptation to sea level rise or other climate change responses would not be addressed. Impacts would result in loss of access to the foreshore.	Gradual erosion of the concrete ramp would degrade the landscape further and put the car park and pub building at risk, which would impact access in an area valued by local people and visitors. No impact upon trees or vegetation. No opportunity to enhance landscape character, access or AONB.	This option will preserve the setting of the heritage assets and the character and appearance of the area. However, this option might affect the assets in the long term as the risk of flooding remains.	Does not affect the integrity of the European designated site or SSSI. Maintains existing biodiversity.
Flip-up floodwall	Likely to result in limited disruption at the existing car park during construction.	A flip up flood wall is unlikely to have an impact (when lying down). No impact upon trees or vegetation. No opportunity to enhance	This option has the potential to impact upon undesignated	Set-back from European sites/SSSI, but potential for temporary effects during construction (such as noise,

Measures		Other Environmental Consideration		Landscape		Heritage		Ecology
				landscape character, access or AONB.		archaeological deposits		vibration, and pollution) which can be mitigated using a CEMP (for example) imposed restrictions on working seasons for the noisiest activities.
Demountable defences				Demountable defences are unlikely to have an impact (subject to design). No impact upon trees or vegetation. No opportunity to enhance landscape character, access or AONB.		The use of demountable or temporary defence minimises the impact on the listed buildings and the conservation area. Demountable and temporary defences are likely to have less impact on buried archaeological/maritime deposits		
Flood gate				Given the presence of vehicles in this location, a permanent barrier, such as a carefully designed flood gate could act as an edge restraint for cars and would negate the need to move vehicles if the flood gate needed to be closed. However, it would impact upon the open character of the promontory and could hinder visibility for people. No trees or vegetation would be affected. No opportunity to enhance landscape character, access or AONB.		This option will be visible at all times and will affect views from and towards the Langstone Conservation Area and listed buildings, specifically here the Ship Inn This option has the potential to impact upon undesignated archaeological deposits		
ODU 3d and 3e								
Do Nothing		Adaptation to sea level rise or other climate change responses would not be addressed. Impacts would result in flooding of the Ship Inn, associated outside seating area, and loss of access to steps leading to the foreshore. This would diminish the areas social value and displace jobs.		Would have an impact on landscape character and AONB due to floodwater eroding wall and undermining pub building, which would affect the historic character of this part of Langstone Harbour, one that is much valued by local people and visitors. No existing trees or vegetation would be affected. No opportunity to enhance landscape character, access or AONB.		This option will preserve the setting of the heritage assets and the character and appearance of the area. However, this option might affect the assets in the long term as the risk of flooding remains.		Does not affect the integrity of the European designated site or SSSI. Maintains existing biodiversity.
Glass topped floodwall / glasswall		Construction works could result in temporary noise and vibration effects relating to the Ship Inn and members of the public. Construction works are also likely to result in the temporary closure or partial closure of the footpath they are located adjacent to, to ensure the safety of members of the public.		A glass topped floodwall would be a modern engineered solution adjacent to an historic building. Whilst it could work for the pub practically, it would have an effect on landscape character and the AONB. No trees or vegetation would be impacted. No opportunity to enhance landscape character, access or AONB.		The Ship Inn already has glass panels in the Courtyard seating area to provide wind protection. The design of this approach will be in keeping with the existing. However, this option could still have a detrimental impact on the character and appearance of the conservation area if not designed appropriately. The openness of the area and views from the conservation area and listed buildings will be interrupted.		Set-back from European sites/SSSI, but potential for temporary effects during construction (such as noise, vibration, and pollution) which can be mitigated using a CEMP (for example) imposed restrictions on working seasons for the noisiest activities. Glass topped floodwall will be constructed within footprint of existing defences as there is opportunity to bury foundations beneath courtyard area.
Flip-up floodwall (setback)				A setback flip-up floodwall would not have a great impact upon landscape character or visual amenity, in the context of the historic building it may not be appropriate (defer to Heritage team). No trees or vegetation would be affected. No opportunity to enhance landscape character, access or AONB.		The construction of a floodwall could impact on buried archaeological remains.		
Demountable defences		Construction works could result in temporary noise on vibration effects as the Ship Inn and other members of the public.		Demountable defences could be a positive solution, as completely removable elements would have no effect on landscape character, the AONB or visual amenity. It would depend upon their design. No trees or vegetation would be affected. No opportunity to enhance landscape character, access or AONB.		The use of demountable or temporary defence minimises the impact on the listed buildings and the conservation area. Demountable and temporary defences are likely to have less impact on buried archaeological/maritime deposis.		
ODU 3f and 3h								
Do Nothing		Adaptation to sea level rise or other climate change responses would not be addressed. There are a number of residential properties that are at risk of flooding from a 1 in 200 year (0.5% AEP) tidal flood event should this approach be taken forward. Impacts would also result in loss of the walkway between the two public houses (Royal Oak and Ship Inn).		Would have impact on landscape character and AONB due to erosion of floodwall, historic boundary wall and damage to historic properties. Access would be compromised by erosion of existing floodwall and footpath. No existing trees or vegetation would be affected.		This option will preserve the setting of the heritage assets and the character and appearance of the area. However, this option might affect the assets in the long term as the risk of flooding remains.		Does not affect the integrity of the European designated site or SSSI. Maintains existing biodiversity.
Setback floodwall + boardwalk		Construction works could result in temporary noise on vibration effects at nearby residential receptors. Construction works are also likely to result in the		This design would have an impact upon landscape character but less so on the AONB. The floodwall set up against the side of the existing wall would detract from the character of the existing wall		The construction of a floodwall could impact on buried archaeological remains. The views		Setback from the European sites/SSSI, potential for temporary effects during construction (such as noise, vibration, and pollution) which can be mitigated using a

Measures		Other Environmental Consideration		Landscape		Heritage		Ecology
		temporary closure or partial closure of the footpath (PRoW) they are located adjacent to, to ensure the safety of members of the public.		and floodgates would be needed at entrance points. However, the introduction of the boardwalk would ensure good pedestrian access and retain connections with the wider landscape for visitors. Detailing of the flood gates and guardrail/handrail will be very important to ensure it is in keeping.		in this area should remain uninterrupted, the openness of the area and the close relationship to the water should be retained. The timber fence/railings at the end of the boardwalk will affect the character and appearance of the area.		CEMP (for example) imposed restrictions on working seasons for the noisiest activities. Location of boardwalk could be within the designated sites, and could result in shading of designated habitats. IROPI likely to be required.
Reinforce / replace de-facto defences (garden wall)				There would be an impact on landscape character and visual amenity during construction, and whilst the replacement defences 'weather in', but once replaced there would be no impact upon landscape character or the AONB (depending upon design and finish of the replacement defences). No existing trees or vegetation would be affected.		This option will require the fronting path and wall to be replaced. This option has the potential to impact upon undesignated archaeological deposits. Depending on design, the replacement wall and path will need to retain the setting of the Langstone Conservation Area and listed building sin the proximity. The openness of the area and proximity to the water should be retained.		Set-back from European sites/SSSI, but potential for temporary effects during construction (such as noise, vibration, and pollution) which can be mitigated using a CEMP (for example) imposed restrictions on working seasons for the noisiest activities.
ODU 3g								
Do Nothing		Adaptation to sea level rise or other climate change responses would not be addressed. Impacts would result in loss of the footpath between the two public houses (Royal Oak and Ship Inn). Listed buildings are located behind the current defence which would be at risk of flooding with no intervention. This would diminish the areas social value and displace jobs.		Would have huge impact on landscape character and AONB due to erosion of floodwall, historic boundary wall and damage to historic properties. Access would be compromised by erosion of existing floodwall and footpath. No existing trees or vegetation would be affected.		This option will preserve the setting of the heritage assets and the character and appearance of the area. However, this option might affect the assets in the long term as the risk of flooding remains.		Does not affect the integrity of the European designated site or SSSI. Maintains existing biodiversity.
Glass crest raising + refurb wall		Construction works could result in temporary noise on vibration effects at nearby residential receptors. Construction works are also likely to result in the temporary closure or partial closure of the footpath (PRoW) they are located adjacent to, to ensure the safety of members of the public.		Glass crest raising would have a detrimental impact upon landscape character and the AONB in this location. The sense of openness forms an important element of landscape character and introducing a highly engineered feature would result in large changes to the existing landscape character and to visual amenity. No existing trees and limited vegetation would be affected. Access would remain unaffected.		A glass topped setback floodwall will have a detrimental impact on the character and appearance of the conservation area. The openness of the area and views will be interrupted.		Adjacent to European sites/SSSI, potential for temporary effects during construction (such as noise, vibration, and pollution) which can be mitigated using a CEMP (for example) imposed restrictions on working seasons for the noisiest activities. Set within footprint of the existing defence so would not lead to encroachment.
Setback floodwall + boardwalk				This design would have an impact upon landscape character but less so on the AONB. The floodwall set up against the side of the existing wall would detract from the character of the existing wall and floodgates would be needed at entrance points. However, the introduction of the boardwalk would ensure good pedestrian access and retain connections with the wider landscape for visitors. Detailing of the flood gates and guardrail/handrail will be very important to ensure it is in keeping.		The construction of a floodwall could impact on buried archaeological remains. The views in this area should remain uninterrupted, the openness of the area and the close relationship to the water should be retained. The timber fence/railings at the end of the boardwalk will affect the character and appearance of the area.		Setback from the European sites/SSSI, potential for temporary effects during construction (such as noise, vibration, and pollution) which can be mitigated using a CEMP (for example) imposed restrictions on working seasons for the noisiest activities. Location of boardwalk could be within the designated sites, and could result in shading of designated habitats. IROPI likely to be required.
Self-raising floodwall + refurb wall				This would have less of an effect than a permanent floodwall (in either location) but the engineered nature of the self-raising floodwall when laying down would have an effect upon landscape character. No existing tress and limited vegetation would be affected. Access would be retained.		The construction of a floodwall could impact on buried archaeological remains. The fact that the floodwall will only be visible temporarily is acceptable.		Set back from European sites/SSSI, potential for temporary effects during construction (such as noise, vibration, and pollution) which can be mitigated using a CEMP (for example) imposed restrictions on working seasons for the noisiest activities.
Flip-up floodwall				This would have less of an effect than a permanent floodwall (in either location) but the engineered nature of the flip-up floodwall when laying down would have an effect upon landscape character. No existing tress and limited vegetation would be affected. Access would be retained.		The construction of a floodwall could impact on buried archaeological remains. The fact that the floodwall will only be visible temporarily is welcome.		Set back from European sites/SSSI, potential for temporary effects during construction (such as noise, vibration, and pollution) which can be mitigated using a CEMP (for example) imposed restrictions on working seasons for the noisiest activities.
ODU 3i								
Do Nothing		Adaptation to sea level rise or other climate change responses would not be addressed. There are a number of residential properties that are at risk of flooding from a 1 in 200 year (0.5% AEP) tidal flood event should this approach be taken forward. Impacts would also result in loss of the		Would have huge impact on landscape character and AONB due to erosion of floodwall, historic boundary wall and damage to historic properties. Access would be compromised by erosion of existing floodwall and footpath. No existing trees or vegetation would be affected.		This option will preserve the setting of the heritage assets and the character and appearance of the area. However, this option might affect the assets in the long term as the risk of flooding remains.		Does not affect the integrity of the European designated site or SSSI. Maintains existing biodiversity.

Measures		Other Environmental Consideration		Landscape		Heritage		Ecology
		walkway between the two public houses (Royal Oak and Ship Inn).						
Setback floodwall + boardwalk		Construction works could result in temporary noise and vibration effects at nearby residential receptors.		This design would have an impact upon landscape character but less so on the AONB. The floodwall set up against the side of the existing wall would detract from the character of the existing wall and floodgates would be needed at entrance points. However, the introduction of the boardwalk would ensure good pedestrian access and retain connections with the wider landscape for visitors. Detailing of the flood gates and guardrail/handrail will be very important to ensure it is in keeping.		The construction of a floodwall could impact on buried archaeological remains. The views in this area should remain uninterrupted, the openness of the area and the close relationship to the water should be retained. The timber fence/railings at the end of the boardwalk will affect the character and appearance of the area.		Setback from the European sites/SSSI, potential for temporary effects during construction (such as noise, vibration, and pollution) which can be mitigated using a CEMP (for example) imposed restrictions on working seasons for the noisiest activities. Location of boardwalk could be within the designated sites, and could result in shading of designated habitats. IROPI likely to be required.
Demountable defences		Construction works could result in temporary noise on vibration effects as the Ship Inn and other members of the public.		Demountable defences could be a positive solution, as completely removable elements would have no effect on landscape character, the AONB or visual amenity. It would depend upon their design. No trees or vegetation would be affected. No opportunity to enhance landscape character, access or AONB.		The use of demountable or temporary defence minimises the impact on the listed buildings and the conservation area. Demountable and temporary defences are likely to have less impact on buried archaeological/maritime deposits.		Set-back from European sites/SSSI, but potential for temporary effects during construction (such as noise, vibration, and pollution) which can be mitigated using a CEMP (for example) imposed restrictions on working seasons for the noisiest activities.
Flood proof building		No additional comments.		This would have the best outcome for landscape character, provided the appearance of the flood proof building did not change/was similar/in keeping with landscape character. The impact on AONB would be minimal. No effect on trees and vegetation. No effect on access.		This option could be acceptable. The building is not listed however it falls within the Langstone Conservation Area. The character and appearance of the conservation area should be preserved.		Adjacent to European sites/SSSI, potential for temporary effects during construction (such as noise, vibration, and pollution) which can be mitigated using a CEMP (for example) imposed restrictions on working seasons for the noisiest activities.
ODU 3j								
Do Nothing		Adaptation to sea level rise or other climate change responses would not be addressed. Impacts would result in flooding of Langstone high Street and loss of access to the foreshore.		No active intervention would impact upon landscape character and AONB, due to gradual erosion threatening buildings along the street which would affect character. No trees and vegetation would be affected. Access to the beach could be affected.		This option will preserve the setting of the heritage assets and the character and appearance of the area. However, this option might affect the assets in the long term as the risk of flooding remains.		Does not affect the integrity of the European designated site or SSSI. Maintains existing biodiversity.
Flip-up floodwall		Likely to result in limited disruption at the end of the slipway during construction		This would add a hard engineering element to the location, although when laying down it would have a limited impact upon landscape character, especially as it sits at the end of a tarmac road. Its effect on the AONB would be limited. No trees or vegetation would be affected. No effect on access.		The construction of a floodwall could impact on buried archaeological remains.		Adjacent to European sites/SSSI, potential for temporary effects during construction which can be mitigated using a CEMP (for example) imposed restrictions on working seasons for the noisiest activities.
Demountable defences				Depending upon the design and position of the defences the impact upon landscape character and the AONB could be minimised. No effect on trees or vegetation. No effect on access.		The use of demountable or temporary defence minimises the impact on the listed buildings and the conservation area. Demountable and temporary defences are likely to have less impact on buried archaeological/maritime deposits.		
Flood gate				A flood gate is a highly engineered solution that would compromise existing landscape character and AONB. No impact on trees or vegetation. No opportunity to enhance landscape character, access or AONB.		This option proposes a floodgate at the eastern end of Langstone High Street. Some views are going to be affected. If the proposed gate is permanent this will affect the setting of the Langstone Conservation Area and listed buildings in the proximity.		
ODU 3k								
Do Nothing		Adaptation to sea level rise or other climate change responses would not be addressed. There are a number of residential properties and a Public House (Royal Oak) that are at risk of flooding from a 1 in 200 year (0.5% AEP) tidal flood event should this approach be taken forward. The footpath would also be at risk of damage and loss. This would diminish the areas social value and displace jobs.		Would have huge impact on landscape character and AONB due to erosion of floodwall, historic boundary wall and damage to historic properties. Access would be compromised by erosion of existing floodwall and footpath. No existing trees or vegetation would be affected.		This option will preserve the setting of the heritage assets and the character and appearance of the area. However, this option might affect the assets in the long term as the risk of flooding remains.		Does not affect the integrity of the European designated site, SSSI or SINC. Maintains existing biodiversity.
Floodwall (crest raising)		Construction works could result in temporary noise and vibration effects at nearby residential receptors. Construction works are also likely to		A floodwall would have a detrimental impact upon landscape character and the AONB in this location. The sense of openness forms an important element of landscape character and introducing		A floodwall will have a detrimental impact on the character and appearance of the conservation		Adjacent to European sites/SSSI / SINC/ little egrets, potential for temporary effects during construction (such as noise, vibration, and pollution) which can be mitigated

Measures		Other Environmental Consideration		Landscape		Heritage		Ecology
		result in the temporary closure or partial closure of the footpath (PRoW) they are located adjacent to, to ensure the safety of members of the public.		a highly engineered feature would result in large changes to the existing landscape character and to visual amenity. No existing trees and limited vegetation would be affected. Access would be limited by the crest raising.		area. The openness of the area and views will be interrupted.		using a CEMP(for example) imposed restrictions on working seasons for the noisiest activities. Option could result in loss of designated habitats if it requires increase in overall footprint. IROPI may to be required.
Flip-up floodwall (on footpath)				This would add a hard engineering element to the location and when laying down it would have some limited impact upon landscape character, It's effect on the AONB would be limited. No trees or vegetation would be affected. If pedestrians had to walk on top of the flip-up floodwall when it is down, this could affect access, although could be overcome by design.		Depending on the intrusive works that are necessary for this, the construction of a floodwall could impact on buried archaeological remains. The fact that the floodwall will only be visible temporarily is acceptable.		Adjacent to European sites/SSSI / SINC/ little egrets, potential for temporary effects during construction (such as noise, vibration, and pollution) which can be mitigated using a CEMP (for example) imposed restrictions on working seasons for the noisiest activities.
Reinforce / replace de-facto defences and flood proof building walls (e.g. the Royal Oak)				This would have the best outcome for landscape character, provided the appearance of the flood proof building did not change/was similar/in keeping with landscape character. The impact on AONB would be minimal. No effect on trees and vegetation. No effect on access.		This option will require the fronting path and wall to be replaced. This option has the potential to impact upon undesignated archaeological deposits or maritime artefacts/structures. Depending on design, the replacement wall and path will need to retain the setting of the Langstone Conservation Area and listed buildings in the proximity. The openness of the area and proximity to the water should be retained.		Adjacent to European sites/SSSI/ SINC/ little egrets, potential for temporary effects during construction (such as noise, vibration, and pollution) which can be mitigated using a CEMP (for example) imposed restrictions on working seasons for the noisiest activities.
ODU 3I								
Do Nothing		Adaptation to sea level rise or other climate change responses would not be addressed. There are a number of residential properties and a Public House (Royal Oak) that are at risk of flooding from a 1 in 200 year (0.5% AEP) tidal flood event should this approach be taken forward. This would diminish the areas social value and displace jobs.		Risk to existing landscape character from erosion and increased flooding of woodland (which is a priority habitat). Initially would retain existing trees and vegetation, but increased flooding could result in loss/change in habitat and damage to existing property. No opportunity to enhance landscape character, access or AONB.		This option will preserve the setting of the heritage assets and the character and appearance of the area. However, this option might affect the assets in the long term as the risk of flooding remains.		Does not affect the integrity of the European designated site, SSSI, SINC or little egrets. Maintains existing biodiversity.
Setback floodwall		Construction works are also likely to result in the temporary closure or partial closure of the footpath (PRoW) they are located adjacent to, to ensure the safety of members of the public.		A floodwall along the setback would harm trees and vegetation, but less so along the west alignment across the gardens. However, this location is more rural and any floodwall would have an effect upon landscape character. There would be a limited impact upon the AONB. Access to one property would appear to require a floodgate (not for setback line 2).		This option here could be acceptable depending on design as it could be screened by existing vegetation. However, this option might impact on archaeological remains.		Set back from European sites/SSSI / SINC/ little egrets, potential for temporary effects during construction (such as noise, vibration, and pollution) which can be mitigated using a CEMP (for example) imposed restrictions on working seasons for the noisiest activities. Potential for tree removal.
Earth embankment (tie-in section only)		Temporary noise and vibration from plant and machinery (to distribute materials to create embankment) are likely to be experienced by nearby residential receptors during construction. These works could also result in the temporary closure or partial closure of the footpath (PRoW). Consideration should also be given to the proximity of the waterbody to the east of the alignment.		Would have some impact on landscape character but could be mitigated through design and planting; existing trees and vegetation could be impacted by construction. No opportunity to enhance access.		This option proposes an earth embankment (tie-in section only) to the west of the pond. This area is surrounded by trees and the proposed earth embankment could be screened adequately. The construction of a new embankment might have an impact on buried archaeological remains.		Set back from European sites/SSSI / SINC/ little egrets, potential for temporary effects during construction (such as noise, vibration, and pollution) which can be mitigated using a CEMP (for example) imposed restrictions on working seasons for the noisiest activities. Potential for tree removal. Earth embankment would provide replacement habitat.

ODU 4

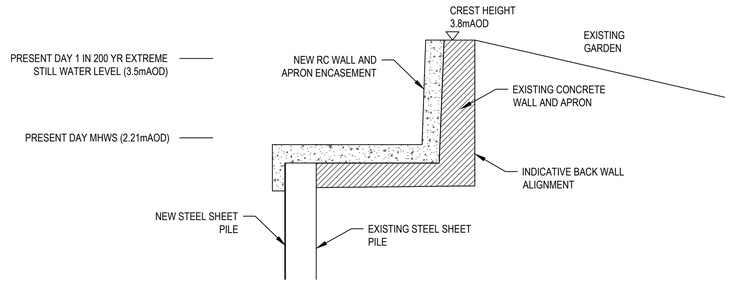
ODU 4a	Other Environmental Considerations	Landscape	Heritage	Ecology
Do Nothing	Adaptation to sea level rise or other climate change responses would not be addressed. There is a listed building (The Mill) and residential properties at risk of flooding from a 1 in 200 year (0.5% AEP) tidal flood event should this approach be taken forward.	Would have impact on landscape character and AONB due to erosion of floodwall and damage to historic properties. Access could be compromised by due to flooding. No existing trees or vegetation would be affected.	This option will preserve the setting of the heritage assets and the character and appearance of the area. However, this option might affect the assets in the long term as the risk of flooding remains.	Does not affect the integrity of the European designated site or SSSI. Maintains existing biodiversity.
Demountable defences	No further comments	Given the proposed location (setback) these are unlikely to have an effect upon landscape character or the AONB. No effect upon trees or vegetation. No effect upon access.	The use of demountable or temporary defence minimises the impact on the listed buildings and the conservation area. Demountable and temporary defences are likely to have less impact on buried archaeological/maritime deposits.	Set back from European sites/SSSI/ SINC and little egrets, potential for temporary effects during construction which can be mitigated using a CEMP (for example) imposed restrictions on working seasons for the noisiest activities. Potential for tree removal.
Setback floodwall	Likely to be temporary noise and vibration effects on local residents associated with installing the foundations of the flood wall. The works would also need to consider working close to the surface waterbody located behind the proposed alignment.	Given the proposed location (setback) these are unlikely to have an effect upon landscape character or the AONB. No effect upon trees or vegetation. Access route would be made narrower.	This option could be acceptable if designed in order to protect the setting of the Mill and any key views. The materials used should be appropriate. However, this option might impact on archaeological remains.	
PLP / PLR	No further comments	PLP/PLR would be unlikely to have an effect upon landscape character or the AONB. No effect upon trees or vegetation. No effect upon access.	This option could be acceptable depending on design. The Old Mill is a Grade I listed building therefore the design should respect the building and its setting.	Adjacent to European sites/SSSI/ SINC and little egrets, potential for temporary effects during construction which can be mitigated using a CEMP (for example) imposed restrictions on working seasons for the noisiest activities.
ODU 4b				
No Active Intervention	Adaptation to sea level rise or other climate change responses would not be addressed. There is ecologically important habitat at risk of flooding from a 1 in 200 year (0.5% AEP) tidal flood event should this approach be taken forward. The footpath would also be at risk of damage and loss.	Would have impact on landscape character and AONB due to erosion of floodwall. Access would be compromised by erosion of existing floodwall and footpath. No existing trees or vegetation would be affected.	This option will preserve the setting of the heritage assets and the character and appearance of the area. However, this option might affect the assets in the long term as the risk of flooding remains.	Does not affect the integrity of the European designated site or SSSI. Maintains existing biodiversity.
Setback floodwall	Likely to be temporary noise and vibration effects on local residents associated with installing the foundations of the flood wall. Construction works are also likely to result in the temporary closure or partial closure of the footpath they are located adjacent to, to ensure the safety of members of the public. The works would also need to consider working close to the surface waterbody located behind the proposed alignment.	Introducing an engineered feature would impact landscape character and AONB due to the unique character of this section of footpath. Some vegetation would be lost. Access would be unaffected.	This option could impact on views from and towards the shoreline. In addition, this option might impact on archaeological remains.	Set back from European sites /SSSI, but closer to the SINC, little egrets and supporting habitat, potential for temporary effects during construction which can be mitigated using a CEMP (for example) imposed restrictions on working seasons for the noisiest activities.
Crest raising (frontline) + scheduled maintenance	Construction works are also likely to result in the temporary closure or partial closure of the footpath they are located adjacent to, to ensure the safety of members of the public.	Crest raising along the frontline would have a detrimental impact upon landscape character and the AONB in this location (depending upon height). The sense of openness forms an important element of landscape character and introducing an engineered feature would result in large changes to the existing landscape character and to visual amenity. Access may be made narrower.	This option is possible to affect views from and towards the shoreline. It could be acceptable if any key views remain uninterrupted.	Maintenance to be within footprint of existing defence. Set back from European sites /SSSI, but closer to the SINC, little egrets and supporting habitat, potential for temporary effects during construction which can be mitigated using a CEMP (for example) imposed restrictions on working seasons for the noisiest activities.
Setback floodwall + boardwalk	Likely to be temporary noise and vibration effects on local residents associated with installing the foundations of the flood wall. Construction works are also likely to result in the temporary closure or partial closure of the footpath they are located adjacent to, to ensure the safety of members of the public. The works would also need to consider working close to the surface waterbody located behind the proposed alignment.	Introducing an engineered feature would impact landscape character and AONB due to the unique wild character of this section of footpath. Some vegetation would be lost. Access would be unaffected.	This option could impact on views from and towards the shoreline. In addition, this option might impact on archaeological remains.	Set back from European sites (including supporting habitat) /SSSI/ SINC and little egrets, potential for temporary effects during construction which can be mitigated using a CEMP (for example) imposed restrictions on working seasons for the noisiest activities. Location of boardwalk could be within the designated sites and could result in shading of designated habitats. IROPI likely to be required.

9.5 Appendix E – Indicative cross section sketches

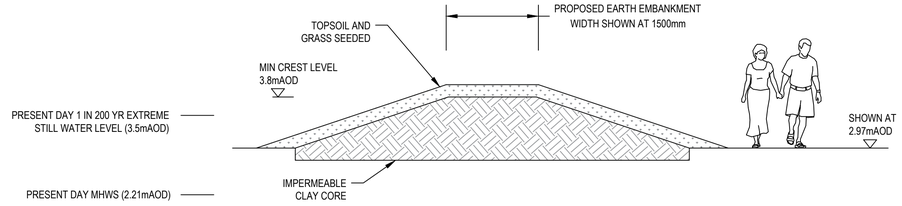
AERIAL PHOTOGRAPH OF SITE (NOT TO SCALE)

LEGEND

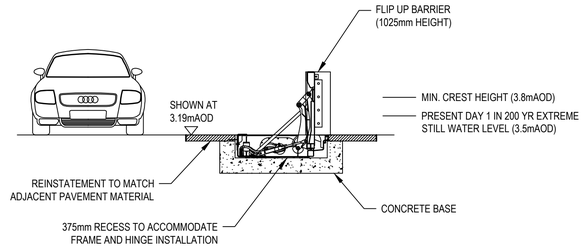
- ODU1B: CAPITAL REFURBISHMENT
- ODU 2B: EMBANKMENT/FLOODWALL
- ODU 3B: FLIP-UP FLOODWALL
- ODU 3D & 3E: GLASS CRESTED FLOODWALL
- ODU 3F TO 3H: FLOODWALL AND BOARDWALK
- ODU 3I: USE BUILDING
- ODU 3J: FLOOD GATE
- ODU 3K: FRONTLINE SHEET PILED WALL
- ODU 3L: FLOODWALL/EARTH EMBANKMENT



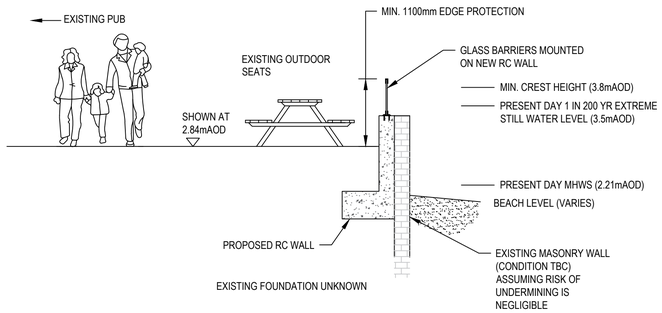
CROSS SECTION A - PROPOSED DEFENCE OPTION FOR
ODU 1B CAPITAL REFURBISHMENT (1:50)



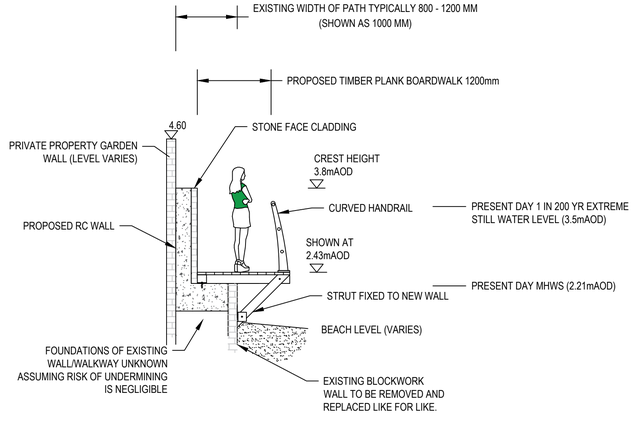
CROSS SECTION B - PROPOSED DEFENCE OPTION FOR
ODU 2B EMBANKMENT/FLOODWALL (1:50)



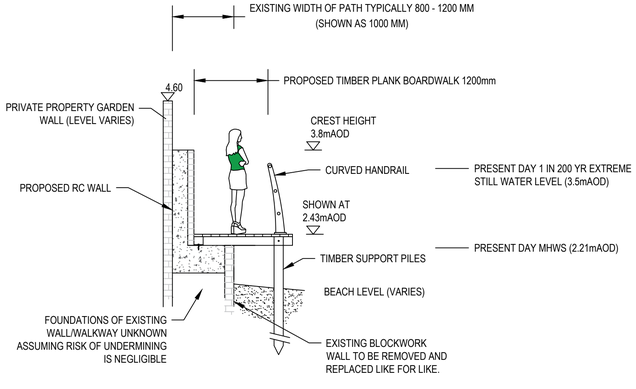
CROSS SECTION C - PROPOSED DEFENCE OPTION FOR
ODU 3B FLIP-UP FLOODWALL (1:50)



CROSS SECTION D - PROPOSED DEFENCE FOR ODU 3D
TO 3E GLASS CRESTED FLOODWALL (1:50)



CROSS SECTION E- PROPOSED DEFENCE FOR ODU 3F
TO 3H FLOODWALL AND BOARDWALK
OPTION 1 - STRUT SUPPORT (1:50)



CROSS SECTION E - PROPOSED DEFENCE FOR ODU 3F
TO 3H FLOODWALL AND BOARDWALK
OPTION 2 - PILE SUPPORT (1:50)

0 1 2 3 4 5m
SCALE 1:50

IT IS ASSUMED THAT ALL WORKS ON THIS DRAWING WILL BE CARRIED OUT BY A COMPETENT CONTRACTOR WORKING, WHERE APPROPRIATE, TO AN APPROPRIATE METHOD STATEMENT.

THIS DRAWING IS TO BE USED ONLY FOR THE PURPOSE OF ISSUE THAT IT WAS ISSUED FOR AND IS SUBJECT TO AMENDMENT.

NOTES

1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DOCUMENTATION.
2. DO NOT SCALE FROM THIS DRAWING. USE ONLY PRINTED DIMENSIONS.
3. ALL DIMENSIONS IN MILLIMETRES. ALL LEVELS ARE IN METRES TO ORDNANCE DATUM NEWLYN. ALL CHAINAGES AND COORDINATES ARE IN METRES UNLESS DEFINED OTHERWISE.
4. OPTION APPRAISAL DESIGN BASED ON LIMITED GROUND INVESTIGATIONS AND CONDITION INSPECTIONS. FURTHER ASSESSMENTS TO BE UNDERTAKEN AT DETAILED DESIGN STAGE AS REQUIRED.
5. LEVEL OF EXISTING WALKWAY (CROSS SECTION A) TAKEN FROM TOPOGRAPHIC SURVEY. LEVEL OF EXISTING FOOTPATH (CROSS SECTION B) TAKEN FROM LIDAR SURVEY.
6. OPTION APPRAISAL DESIGN INTENDED FOR SPATIAL COMPARISON OF OPTIONS RATHER THAN ASSESSING TECHNICAL FEASIBILITY.

Revision Details	By / Check	Date	Suffix

Purpose of issue
FOR INFORMATION

Client
ESCP

Project Title
LANGSTONE FCERM SCHEME

Drawing Title
INDICATIVE OPTION DRAWINGS

Designed	Drawn	Checked	Approved	Date
CP	CP	-	-	

AECOM Internal Project No.	Suitability
60578525	S2
Scale @ A1	Zone
1:50	-

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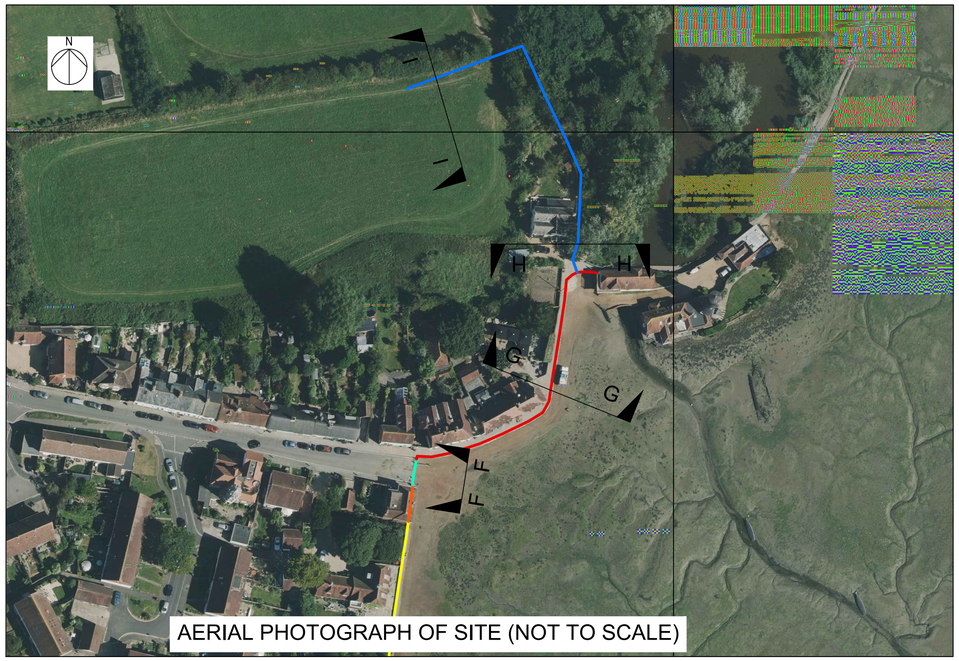
Drawing Number
LNST-ACM-XX-XX-DR-CE-0001

Rev
P1

Plot Date: 4/15/2019 2:58 PM
File Name: LNST-ACM-XX-XX-DR-CE-00001_C3*



AERIAL PHOTOGRAPH OF SITE (NOT TO SCALE)

LEGEND

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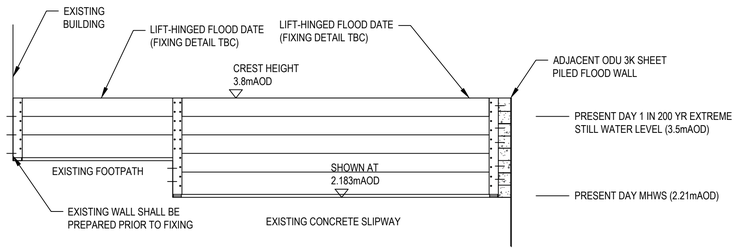
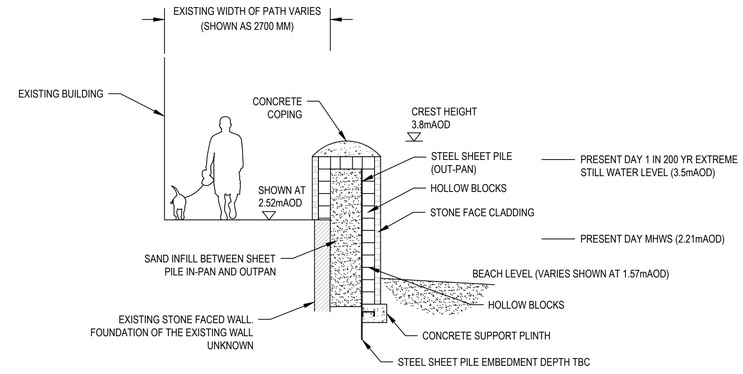
- ODU 3L: FLOODWALL/EARTH EMBANKMENT

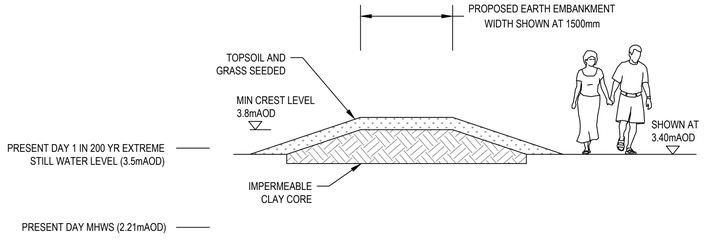


ELEVATION F - PROPOSED DEFENCE OPTION FOR ODU 3J FLOOD GATE (1:50)



CROSS SECTION G - PROPOSED DEFENCE OPTION FOR ODU 3K FRONTLINE SHEET PILED WALL (1:50)

CROSS SECTION H - PROPOSED DEFENCE OPTION FOR ODU 3L FLOOD WALL (1:50)



CROSS SECTION I- PROPOSED DEFENCE FOR ODU 3L EARTH EMBANKMENT (1:50)

0 1 2 3 4 5m

SCALE 1:50

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1. THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ALL OTHER RELEVANT DOCUMENTATION.
2. DO NOT SCALE FROM THIS DRAWING, USE ONLY PRINTED DIMENSIONS.
3. ALL DIMENSIONS IN MILLIMETRES, ALL LEVELS ARE IN METRES TO ORDNANCE DATUM NEWLYN, ALL CHAINAGES AND COORDINATES ARE IN METRES UNLESS DEFINED OTHERWISE.
4. OPTION APPRAISAL DESIGN BASED ON LIMITED GROUND INVESTIGATIONS AND CONDITION INSPECTIONS, FURTHER ASSESSMENTS TO BE UNDERTAKEN AT DETAILED DESIGN STAGE AS REQUIRED.
5. LEVEL OF EXISTING WALKWAY (CROSS SECTION A) TAKEN FROM TOPOGRAPHIC SURVEY. LEVEL OF EXISTING FOOTPATH (CROSS SECTION B) TAKEN FROM LIDAR SURVEY.
6. OPTION APPRAISAL DESIGN INTENDED FOR SPATIAL COMPARISON OF OPTIONS RATHER THAN ASSESSING TECHNICAL FEASIBILITY.

Revision Details	By / Check	Date	Suffix

Purpose of issue

FOR INFORMATION

Client

ESCP

Project Title

LANGSTONE FCERM SCHEME

Drawing Title

INDICATIVE OPTION DRAWINGS

Designed	Drawn	Checked	Approved	Date
CP	CP	-	-	

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9.6 Appendix F – Partnership Funding score matrix

Raw scores based on following assumptions:
- no contributions included

Adjusted scores based on following assumptions:
- £2,876,000 total contribution included (£2.5m CIL, £301k Local Levy, £75k CIL)

			30yr appraisal period										50yr appraisal period									
Least cost	Alignment	Description	Construction & Maint Costs inc 60 OB%	Costs including appriasal (£376k) and ESCP design cost (£300k)	Benefits	BCR	Raw PF score	Raw Contribution required	Adj. PF score	Outstanding contribution required (assuming £2,876k funding acquired)	Estimated Adj PF score (30% OB)	Estimated Outstanding Contribution required (30% OB)	Notes	Construction & Maint Costs inc OB%	Costs including appriasal (£376k) and ESCP design cost (£300k)	Benefits	BCR	Raw PF score	Raw Contribution required	Adj. PF score	Outstanding contribution required (assuming £2,876k funding acquired)	Estimated Adj PF score (30% OB)	Estimated Outstanding Contribution required (30% OB)	Notes
	A	Full scheme area, ODU 1 to ODU 4. Including Sailing club	£6,730,000	£7,406,000	£7,898,000	1.07	8%	£5,876,000	53%	£3,000,000	64%	£1,923,000	1A: Embankment. 1B: Delayed refurb. 2A: Rock armour. 2B: Embankment. 2C: Floodgate 3A: Floodgate. 3B: Setback floodwall. 3C: Floodgate. 3DE: Demountables. 3F: Boardwalk. 3G: Demountables. 3HI:Boardwalk. 3J: Floodgate. 3K: Floodwall. 4A: Demountables and PLP. 4B: Floodwall	£7,130,000	£7,806,000	£10,340,000	1.32	8%	£5,890,000	53%	£3,014,000	64%	£1,933,000	1A: Embankment. 1B: Delayed refurb. 2A: Rock armour. 2B: Embankment. 2C: Slipway 3A: Floodgate. 3B: Setback floodwall. 3C: Floodgate. 3DE: Demountables. 3F: Boardwalk. 3G: Demountables. 3HI:Boardwalk. 3J: Floodgate. 3K: Floodwall. 4A: Demountables and PLP. 4B: Floodwall
	B	Excluding ODU 4 and Sailing Club. Including ODU 1 to ODU 3	£5,741,000	£6,417,000	£6,960,000	1.08	9%	£5,216,000	59%	£2,340,000	71%	£1,395,000	1A: Embankment. 1B: Delayed refurb. 2A: Rock armour. 2B: Embankment. 3A: Floodgate. 3B: Setback floodwall. 3C: Floodgate. 3DE: Demountables. 3F: Boardwalk. 3G: Demountables. 3HI:Boardwalk. 3J: Floodgate. 3K: Floodwall. 3L: Embankment	£6,028,000	£6,704,000	£9,615,000	1.43	9%	£5,207,000	59%	£2,331,000	71%	£1,381,000	1A: Embankment. 1B: Delayed refurb. 2A: Rock armour. 2B: Embankment. 3A: Floodgate. 3B: Setback floodwall. 3C: Floodgate. 3DE: Demountables. 3F: Boardwalk. 3G: Demountables. 3HI:Boardwalk. 3J: Floodgate. 3K: Floodwall. 3L: Embankment
	C	Excluding ODU 1 and 4 and Sailing Club. Including ODU 2 and ODU 3	£3,838,000	£4,514,000	£5,315,000	1.18	10%	£3,546,000	83%	£670,000	98%	£57,000	2B: Embankment/Floodwall. 3A: Floodgate. 3B: Setback floodwall. 3C: Floodgate. 3DE: Demountables. 3F: Boardwalk. 3G: Demountables. 3HI:Boardwalk. 3J: Floodgate. 3K: Floodwall. 3L: Embankment	£4,062,000	£4,738,000	£7,552,000	1.59	11%	£3,519,000	84%	£643,000	99%	£29,000	2B: Embankment/Floodwall. 3A: Floodgate. 3B: Setback floodwall. 3C: Floodgate. 3DE: Demountables. 3F: Boardwalk. 3G: Demountables. 3HI:Boardwalk. 3J: Floodgate. 3K: Floodwall. 3L: Embankment
	D	As above (Alignment C) but across Ship Inn car park	£3,810,000	£4,486,000	£5,315,000	1.18	10%	£3,495,000	84%	£619,000	100%	£0	2B: Embankment/Floodwall. 3B: Flipup barrier. 3C: Floodgate. 3DE: Demountables. 3F: Boardwalk. 3G: Demountables. 3HI:Boardwalk.3J: Floodgate. 3K: Floodwall. 3L: Embankment	£4,043,000	£4,719,000	£7,552,000	1.6	11%	£3,468,000	85%	£592,000	100%	£0	2B: Embankment/Floodwall. 3B: Flipup barrier. 3C: Floodgate. 3DE: Demountables. 3F: Boardwalk. 3G: Demountables. 3HI:Boardwalk.3J: Floodgate. 3K: Floodwall. 3L: Embankment

Additional cost - preferred option	Alignment	Description	Construction & Maint Costs inc OB%	Costs including appriasal (£376k) and ESCP design cost (£300k)	Benefits	BCR		Raw Contribution required		Outstanding contribution required (assuming £2,876k funding acquired)			Notes	Construction & Maint Costs inc OB%	Costs including appriasal (£376k) and ESCP design cost (£300k)	Benefits	BCR		Raw Contribution required		Outstanding contribution required (assuming £2,876k funding acquired)			Notes
	A	Full scheme area, ODU 1 to ODU 4. Including Sailing club	£7,005,000	£7,681,000	£7,898,000	1.03		£6,151,000		£3,275,000			As least cost, except: 3DE: Glass topped floodwall (rather than demountables) 3G: Floodwall and boardwalk (rather than demountables) 3I: Flood proof building (rather than demountables) 3J: Flood gate (rather than demountbales)	£7,358,000	£8,034,000	£10,340,000	1.29		£6,118,000		£3,242,000			As least cost, except: 3DE: Glass topped floodwall (rather than demountables) 3G: Floodwall and boardwalk (rather than demountables) 3I: Flood proof building (rather than demountables) 3J: Flood gate (rather than demountbales)
	B	Excluding ODU 4 and Sailing Club. Including ODU 1 to ODU 3	£6,016,000	£6,692,000	£6,960,000	1.04		£5,491,000		£2,615,000			As least cost, except: 3DE: Glass topped floodwall (rather than demountables) 3G: Floodwall and boardwalk (rather than demountables) 3I: Flood proof building (rather than demountables) 3J: Flood gate (rather than demountbales)	£6,256,000	£6,932,000	£9,615,000	1.39		£5,435,000		£2,559,000			As least cost, except: 3DE: Glass topped floodwall (rather than demountables) 3G: Floodwall and boardwalk (rather than demountables) 3I: Flood proof building (rather than demountables) 3J: Flood gate (rather than demountbales)
	C	Excluding ODU 1 and 4 and Sailing Club. Including ODU 2 and ODU 3	£4,113,000	£4,789,000	£5,315,000	1.11		£3,821,000		£945,000			As least cost, except: 3DE: Glass topped floodwall (rather than demountables) 3G: Floodwall and boardwalk (rather than demountables) 3I: Flood proof building (rather than demountables) 3J: Flood gate (rather than demountbales)	£4,290,000	£4,966,000	£7,552,000	1.52		£3,747,000		£871,000			As least cost, except: 3DE: Glass topped floodwall (rather than demountables) 3G: Floodwall and boardwalk (rather than demountables) 3I: Flood proof building (rather than demountables) 3J: Flood gate (rather than demountbales)
	D	As above (Alignment C) but across Ship Inn car park	£4,085,000	£4,761,000	£5,315,000	1.12		£3,770,000		£894,000			As least cost, except: 3DE: Glass topped floodwall (rather than demountables) 3G: Floodwall and boardwalk (rather than demountables) 3I: Flood proof building (rather than demountables) 3J: Flood gate (rather than demountbales)	£4,271,000	£4,947,000	£7,552,000	1.53		£3,696,000		£820,000			As least cost, except: 3DE: Glass topped floodwall (rather than demountables) 3G: Floodwall and boardwalk (rather than demountables) 3I: Flood proof building (rather than demountables) 3J: Flood gate (rather than demountbales)