



Environmental Statement
Appendix H2
Outline Design Briefing Note for
Natural England. March 2022
Langstone FCERM SCHEME

Langstone FCERM Scheme - Review and refinement of outline design options

Introduction

This briefing note sets out refined concept design options that have been developed for Frontages 3, 4 and 5 of the Langstone FCERM Scheme. These refined concept design options are based on the outline design (as submitted with the EIA Screening and Scoping request in January 2021) but have been modified and developed following additional information received from further Ground Investigation, Structural Investigation, community input and Early Contractor Involvement (ECI) during 2021 and January 2022.

This briefing note summarises the refined concept design options for Frontages 3, 4 and 5 in order to seek feedback from Natural England under the Discretionary Advice Service (DAS) pre-application agreement for the Langstone FCERM Scheme to feed into the detail design and EIA work. Additional cross sections and larger versions of drawings included in this note are available in the accompanying 'Langstone design freeze sketches' PDF drawing pack.

The locations of Frontages 3, 4 and 5 are shown on the map below (**Figure 1**) and are summarised as:

- Frontage 3: A3023 to The Look Out
- Frontage 4: The Look Out to Winklemarket
- Frontage 5: High Street to Royal Oak

There have been no changes to the options proposed at outline design for Frontages 1A and 2 (Billy Line Footpath and Embankment), Frontage 1B (Mill Lane and Harbourside) or Frontage 6 (Langstone Spit).

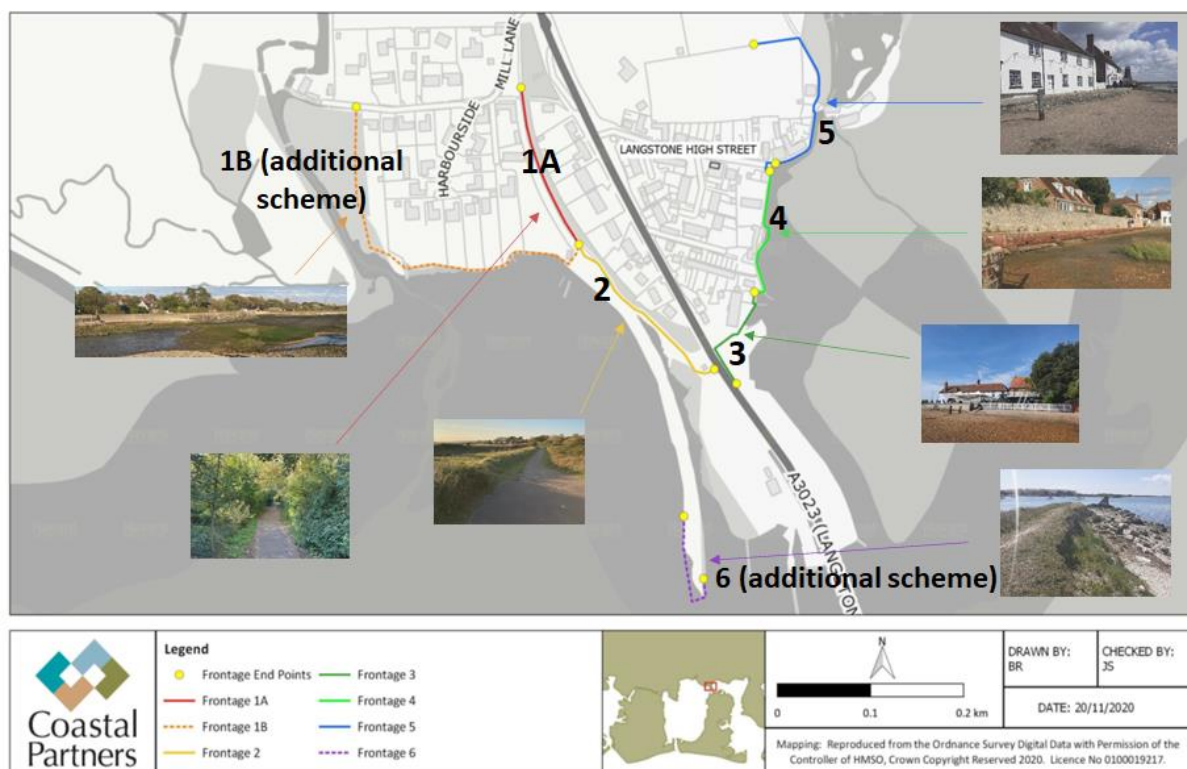


Figure 1: The frontages of the Langstone FCERM scheme

The sections below set out the previous outline design option and the refined concept design option for each of Frontages 3, 4 and 5, together with the reasoning for the refined concept option. Any changes to impacts on the European designated sites are also set out, in particular any changes to the extent of intertidal encroachment from the refined concept option compared to the previous outline design option.

Frontage 3: A3023 to The Look Out

Frontage 3 is part of the Core scheme and runs between the east side of the A3023 and The Look Out (9 Coastguard Cottages) residential property and includes the Ship Inn Car Park. The changes between the outline design and updated refined concept option design for this frontage are shown in **Table 1**. The layout and cross-sections of the refined concept design option are shown in **Figure 2** and **Figure 3** below.

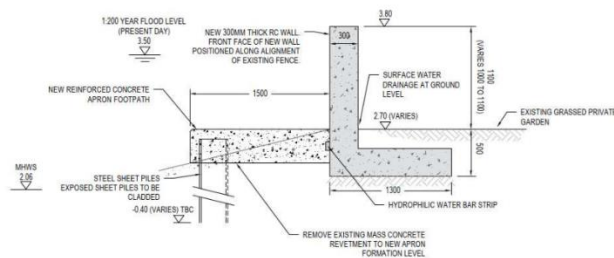
Table 1: Outline design option and updated concept design option for Frontage 3 (A3023 to The Look Out)

Outline Design	Updated Design Option
A3023: Reinforced concrete dwarf floodwall running along the west edge of the car park Ship Inn Car Park: Flip-up flood barrier with reinforced concrete floodwall across car park verge Ship Inn Concrete Apron: Reinforced L-shaped concrete floodwall	A3023: Reinforced concrete dwarf floodwall running along the west edge of the car park Ship Inn Car Park: Raised car park: - approximate volume of raising 300m³ - slope profiles to allow vehicles to manoeuvre and slipway access - Drainage / attenuation storage for excess water due to wave run-up Ship Inn: new sheet pile retaining wall with rendered blockwork along Ship Inn beer garden boundary Ship Inn Concrete Apron: Reinforced concrete floodwall with sheetpile cut-off. Replacement of existing concrete apron to provide suitable access path between Ship Inn and the Lookout.
Pros - Not clearly visible when undeployed Cons: - Residual risks – flood barrier operation and deployment - Takes car parking space - Maintenance / debris clearance	Pros: - Low maintenance - Passive defence – no operation required and therefore no operational residual risks - Less disruption to car park during periods when barriers would otherwise be deployed (i.e. during the window either side of flood events or periods of high risk) - Seepage cut-off provided by sheetpile foundation - Provides a suitable access path Cons: - Wave run-up potential - Change to car park layout required

No intertidal encroachment into the European Marine Sites	No intertidal encroachment into the European Marine Sites. The new sheet pile wall along the Ship Inn beer garden boundary will be built on the existing alignment so there will be no permanent intertidal habitat loss. The sheetpile alignment along the apron will remain within the existing footprint so there will be no permanent intertidal habitat loss. Temporary loss/disturbance of intertidal habitat during construction
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Frontage 3:A3023 to Look Out Chainage 373 to 482m

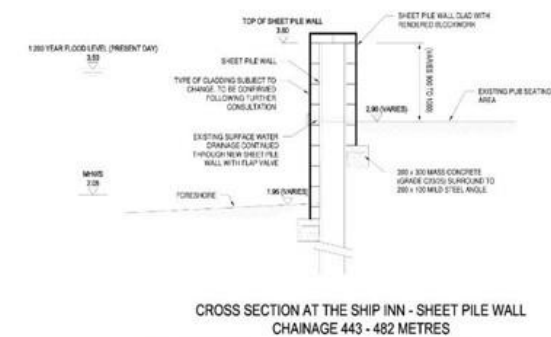
Ship Inn Car Park: Raised Car Park Flood Defence Level 3.6mAOD



Flood Gate No.1



Ship Inn: Sheet Pile Wall with Rendered Blockwork Flood Defence Level 3.8 mAOD Length 40m



A3023: Reinforced Concrete Flood Wall Flood Defence Level 3.6mAOD Length 55m

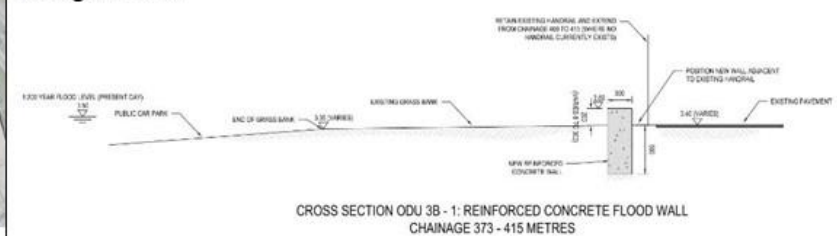


Figure 2: Frontage 3 (A3023 to The Look Out) refined concept options layout

Ship Inn Car Park :

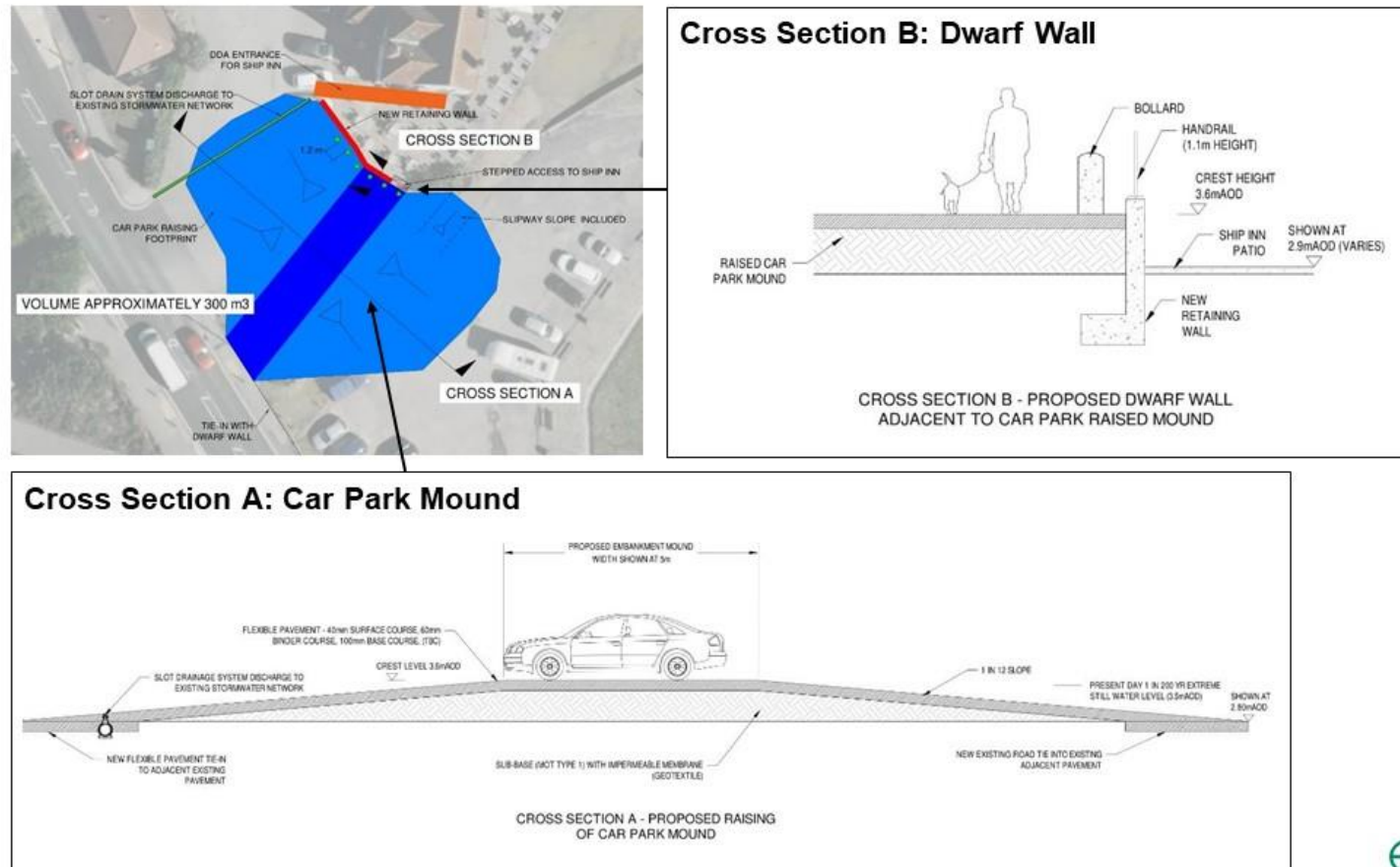


Figure 3: Typical cross-sections of the proposed refined concept design option for Frontage 3 (Ship Inn Car Park).

Frontage 4: Look Out to Winklemarket

Frontage 4 is part of the Core scheme and runs between The Look Out residential property and the Winklemarket (24 Langstone High Street) residential property. The frontage is characterised by a narrow walkway and foreshore access. This frontage has been split into four sub-frontages and the changes between the outline design and the updated refined concept option design for each sub-unit along this frontage are described below.

The design for a boardwalk along the extent of the frontage has not been taken forwards from Outline design for several reasons, including operation and maintenance implications and strong community opposition. It is very unlikely that with the levels of opposition from the community towards the boardwalk that the design would have been approved by Havant Borough Council Cabinet and/or the Local Planning Authority.

Coastal Partners and AECOM therefore considered an alternative to the boardwalk in the form of a concrete cantilevered overhang. However, following structural analysis this option was ruled out because there would be issues associated with 'uplift' caused by wave action beneath the overhang section. There are also complexities with its construction and Early Contractor Involvement (ECI) advice is that a soffit shutter would be required and there would remain overshadowing of the foreshore.

Look Out to Green Cottage

The outline design for this section of Frontage 4 was to construct a reinforced concrete floodwall and boardwalk seaward of the existing brick wall, with trench sheeting and a new brick quay wall constructed directly seaward of the existing quay wall, as shown in **Figure 4** below.

However, as described above for the whole of Frontage 4, the boardwalk option was ruled out due to operation and maintenance concerns and significant community opposition. Alternative options considered were:

- i) Reinforced concrete L-shaped floodwall adjacent (landward) of the existing brick wall; and
- ii) Use of existing brick and masonry structures with no structural reinforcement (i.e. no change).

However, following the results of the Structural Investigation, seepage analysis and receipt of ECI advice, both of these options have since been ruled out because they do not provide a continuous impermeable barrier, and therefore seepage would be expected to occur, and hence they do not meet the design requirements of the scheme to prevent future erosion risk as well as flood risk. Furthermore, the Structural Investigation found that the brickwork wall at The Look Out would require structural support to withstand the expected hydrostatic and hydrodynamic loadings with a sufficient factor of safety and the existing quay wall is in poor condition with multiple voids and a residual life of less than 10 years. Therefore, the existing brickwork wall and quay wall are unsuitable for reuse and incorporation into the scheme and new structures are necessary to provide the required design life and standard of protection to meet the scheme objectives.

In addition, the reinforced concrete L-shaped floodwall landward of the existing brick wall option doesn't enable Havant Borough Council (HBC) to meet their requirements to maintain an accessible footpath along the frontage. This option wouldn't see any work undertaken to the quay or footpath and the residual life of the quay footpath is less than 50 years.

Therefore, the updated leading option for The Look Out to Green Cottage is now the same as that proposed between Green Cottage and the Winklemarket - a reinforced concrete floodwall immediately seaward of the existing brickwork wall and masonry wall, clad in appropriate material. A new brick quay wall will be constructed seawards of the existing sea wall to provide the required footpath width of minimum 1.5m. The new quay wall will have sheet pile foundations with a buried concrete apron/slab to minimise permanent intertidal habitat loss as far as technically possible. It should be noted that along this section of the frontage, the footpath in many parts is already at 1.5m and in some areas wider so it may be that during detailed design it is possible to create some habitat gains in some section to offset the losses in other areas where the footpath is currently narrower. The foreshore encroachment will be kept to the absolute minimum necessary and intertidal habitat losses and gains will be fully described and quantified in the detailed design for inclusion in the Habitats Regulations Assessment to be submitted in support of the planning and marine licence applications.

The outline design, updated concept design option and alternatives considered for The Look Out to Green Cottage are summarised in **Table 2** below. A typical cross-section of the updated concept design option is shown in **Figure 4**.

Coastal Partners and AECOM also investigated the possibility of developing a design for The Look Out to Green Cottage section to construct along the existing garden wall alignment. However, initial discussions with the ECI Contractor raised concerns surrounding buildability and affordability of replacing the existing walls and indicated that construction as per the updated leading design is more viable. Concerns included security issues and more disruption for the landowners, reinstatement of the garden would be required as excavation of the garden down to footpath level is needed, increased muck-away, visual appearance of the walls on the landward side is less appealing, provision of a back shutter would be required, and the existing wall may currently offer some level of support which could refine the thickness of the reinforced concrete wall through detailed design. There are also concerns relating to the Listed Status of Green Cottage and the extent of the curtilage boundary; the Green Cottage owners have informed Coastal Partners that the curtilage extends 2m from the property.

Table 2: Outline design option, updated concept design option and alternatives considered for Frontage 4: Look Out to Green Cottage

Outline Design	Updated Design Option	Alternative(s) considered		
Reinforced concrete floodwall and boardwalk. - Floodwall constructed adjacent (seaward) of existing brick wall - Trench sheeting and new brick quay wall constructed directly seaward of the existing quay wall	Reinforced concrete floodwall immediately seaward of existing brickwork wall and masonry wall, clad in appropriate material. - New brick quay wall seaward of existing quay wall, to provide adequate footpath width (where required to maintain min. 1.5m wide footpath), with sheet pile foundations and buried concrete apron/slab - No boardwalk	Use of existing brick and masonry structures with no structural reinforcement (i.e. no change)	Reinforced concrete L-shaped floodwall adjacent (landward) of existing brick wall - Provides support to garden wall during flooding but does not rely on existing garden wall for structural stability - No boardwalk - Requirement for sheet pile cut-off TBC	Construct along the existing garden wall alignment
Pros: - Boardwalk minimises permanent encroachment onto foreshore Cons: - Boardwalk not accepted by community - Loss of historic brick wall facing on seaward side (heritage) - Shading of intertidal foreshore from boardwalk and minor permanent loss	Pros: - Seepage cut-off provided by sheet pile foundation - Apron/slab buried beneath foreshore, reducing permanent encroachment - Apron/slab move sheet piles away from buildings / existing structures to reduce risk of obstructions and vibration risks Cons: - Increase in permanent encroachment relative to	Pros: - No change to intertidal habitat Cons: - Structural support required, risk of failure - Eurocode 6 guidance not applicable to masonry wall section – non-compliant to the current standard - Design life	Pros: - Makes use of existing brick wall - No footpath width reduction (all works on landward side so width unchanged) - No boardwalk therefore shading / permanent intertidal habitat loss is avoided. Cons:	Pros: - No footpath width reduction - No / reduced intertidal encroachment Cons: - Concerns surrounding buildability and affordability of replacing the existing walls - Security issues

Outline Design	Updated Design Option	Alternative(s) considered		
of intertidal habitat under trench sheets and piles/supports for the boardwalk - Come temporary loss/disturbance of foreshore habitat during construction of boardwalk supports and installation of trench sheeting / new quay wall	outline design but minimised as far as possible by buried toe - Increase in temporary foreshore habitat loss/disturbance from buried toe	- Seepage risk	- Complex cut-off (if required) and providing continuity with adjacent cut-off - Groundwater considerations - Doesn't meet HBC requirements for minimum 1.5m footpath width - No work to quay or footpath and residual life of the quay footpath is less than 50 years	- Significant excavation and reinstatement of private garden - Impacts on Listed Building

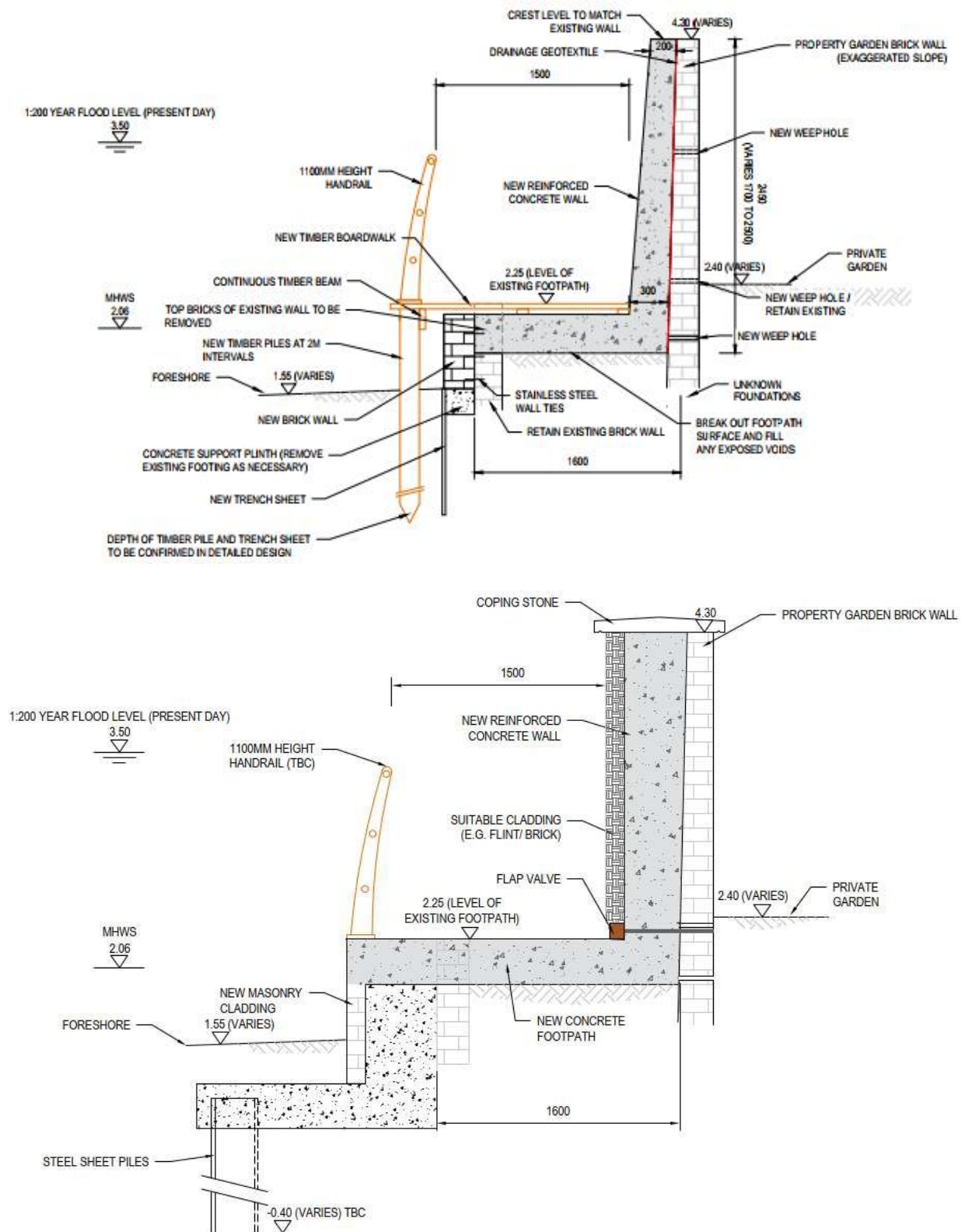


Figure 4: Original Outline Design (top) and typical cross-section of the updated concept design option (bottom) for Frontage 4: Look Out to Green Cottage. (N.B. The cross section for the updated concept design is not a true representation of the expected intertidal habitat encroachment - along much of this section the footpath is already wide enough so there may be potential for habitat gain but in some locations there may be small areas of encroachment. Encroachment will be minimised as far as technically possible and habitat losses and gains will be confirmed and quantified during detailed design.)

Green Cottage

This section of Frontage 4 has significant competing constraints from ecological considerations (avoiding / minimising foreshore encroachment), HBC's duty and commitment to improving accessibility and equality (minimum 1.5m footpath width requirement), heritage (Grade II listed building), flood protection (ability of the flood scheme to perform as a whole, closing off the whole flood cell) and private ownership of the green (landowner agreement required to provide an alternative footpath route).

The outline design for this section of Frontage 4 was to construct a reinforced concrete T-shaped floodwall around the edge of the green area with a boardwalk to preserve the footpath width, as shown in **Figure 5** below. A new brick wall with mass concrete fill was also proposed to be constructed seaward of the existing quay wall and apron.

In addition to this outline design, an alternative design solution was also considered, assessing whether the new quay wall could be constructed with an 'overhang' to reduce the amount of foreshore encroachment by the new quay wall, following strong community feedback regarding the boardwalk. This solution was however ruled out as there would be issues associated with uplift forces caused by the wave action beneath the overhang section. Furthermore, due to the complexities associated with this solution, the cost of this approach was anticipated to be higher than the updated leading option, and there would also be issues with 'shading/shadowing' of the foreshore, even if direct encroachment would be minimised. Subsequent community feedback also opposed the cantilevered path approach.

The results of the structural investigations indicate that the existing brickwork wall around the green is in poor condition and is unsuitable for reuse and incorporation into the scheme. In addition, the tall masonry wall and the dwarf masonry wall are not compliant with current design standards. Seepage calculations also indicate that under existing conditions there is a risk of uplift and seepage through the frontage during periods of high-water levels, as the quay wall and footpath fill are permeable, and therefore an impermeable cut-off is required to prevent this. These results combined, therefore mean that it is not possible to make use of the existing walls as the flood defence without any modifications as the design requirements of the scheme would not be met.

In addition, the owners of Green Cottage have stated that the scheme cannot take any land on the northern extent of the green due to the fragility of the Grade II listed building (the end gable wall is only of single skin construction) and they do not want flood waters being brought closer to the property. Therefore, the northern extent of the green cannot be taken landward of its existing alignment and all the width of the footpath must be provided seawards of the existing alignment at this location. Along the eastern edge of the green, the landowners have agreed to a 1:1 land exchange with the area of existing footpath. This approach is to ensure the owners of Green Cottage comply with their legal obligations to preserve the listed status of the building and its curtilage.

Considering the structural investigation results, information above and receipt of ECI advice, the updated leading option for the green is to construct a reinforced concrete T-shaped floodwall around the edge of the green area, with no boardwalk or overhang path, as shown in **Figure 5** below. The footpath is to be constructed seaward of the T-shaped floodwall, with a new brick quay wall constructed seaward of the existing quay wall to provide adequate footpath width. Foundations of the new brick quay wall will be a concrete apron with sheet piles, buried beneath the foreshore to minimise permanent intertidal habitat loss as far as technically possible. There will be a limited amount of permanent encroachment into the intertidal habitat as the new quay wall will be seaward

of the existing quay wall, but the majority of the new footprint will be within the footprint of the existing concrete apron.

The outline design, updated concept design option and alternatives considered for Green Cottage are summarised in **Table 3** below. A typical cross-section of the updated concept design option is shown in **Figure 5** below.

Table 3: Outline design option, proposed refined concept design option and alternative considered for Frontage 4: Green Cottage

Outline Design	Updated Design Option	Alternative(s) considered			
Reinforced concrete T-shaped floodwall with boardwalk. - Floodwall constructed around the edge of the green area with boardwalk to preserve footpath width - New brick quay wall and mass concrete fill constructed seaward of the existing quay wall and apron	Reinforced concrete T-shaped floodwall around the edge of the green area. - Footpath constructed seaward of the T-shaped floodwall with the landward extent of the design limited to the 1:1 ratio land-take of the existing footpath to be diverted agreed with private landowner. - New brick quay wall constructed seawards of the existing quay wall, primarily utilising the extent of the existing concrete apron to provide adequate footpath width, minimising foreshore encroachment as far as technically possible. - New brick quay wall sheet pile foundations and concrete apron/slab buried beneath the foreshore to reduce permanent intertidal habitat loss - No boardwalk	Reinforced concrete T-shaped floodwall with overhang quay wall	Use of existing brick and masonry structures with no structural reinforcement (i.e. no change). Footpath remaining as existing.	New floodwall along existing Green Cottage property boundary. Footpath along existing alignment immediately seawards of Green Cottage	Wall along the line of the existing quay wall with no footpath around it. Footpath remains along existing alignment immediately seawards of Green Cottage
Pros: - Minimum permanent encroachment area	Pros: - Seepage cut-off provided by sheet pile foundation	Pros: - Reduced permanent encroachment area	Pros:	Pros:	Pros:

Outline Design	Updated Design Option	Alternative(s) considered			
Cons: - Boardwalk - Shading of intertidal foreshore from boardwalk and minor permanent loss of intertidal habitat under piles/supports for the boardwalk	- Apron/slab buried beneath foreshore, reducing permanent intertidal encroachment - Apron/slab moves sheet piles away from buildings / existing structures to reduce risk of obstructions and vibration risks - Wall set back from quay wall minimises number of flood gates required, minimising maintenance and operation requirements and residual risk of failure during an extreme event. - Meets footpath accessibility requirements for minimum 1.5m width Cons: - Increase in temporary foreshore habitat loss / disturbance impact from buried toe - Some permanent intertidal encroachment, but reduced as far as technically possible by buried toe	(relative to updated leading option) - Seepage cut-off through sheet piles Cons: - Risk of piling obstructions - Uplift pressures from wave action beneath overhang - Community opposition - Shadowing of intertidal foreshore	- No intertidal encroachment Cons: - Eurocode 6 guidance not applicable to masonry wall section – non-compliant to the current standard - Seepage risk - Doesn't meet HBC requirement to provide an accessible footpath width to 1.5m	- Would reduce need for footpath width to encroach seawards Cons: - Existing quay wall not suitable for reuse in design - a new quay wall would still be required to address erosion risk - Potential to narrow existing footpath surface reducing accessibility - Risks associated with working close to Green Cottage (Listed Building)	- No intertidal encroachment Cons: - Increased risk of failure as flood gates (x2) would be open and requires greater operational measures - Doesn't meet HBC requirement to provide an accessible footpath width to 1.5m

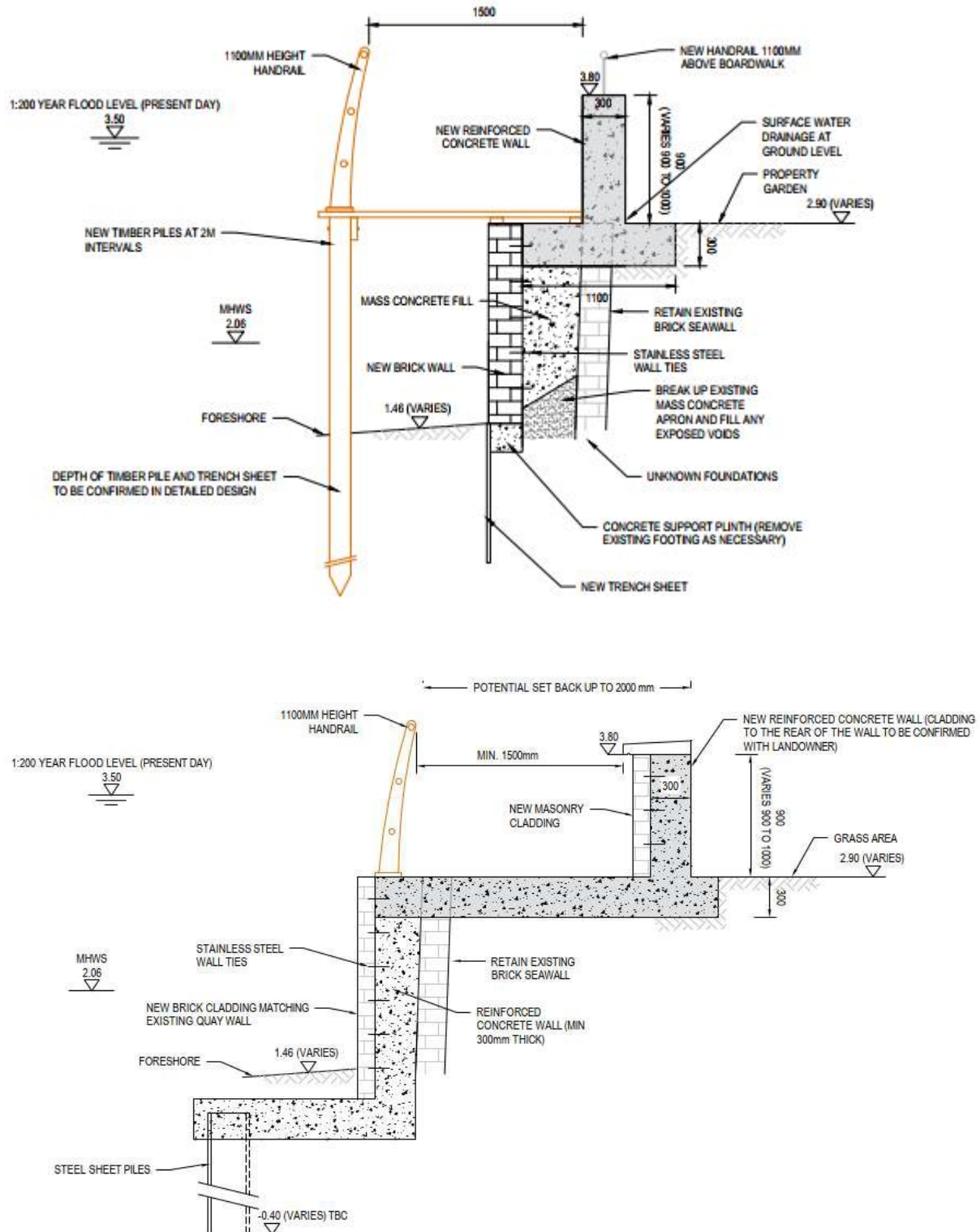


Figure 5: Original Outline Design (top) and typical cross-section of the updated concept design option (bottom) for Frontage 4: Green Cottage. N.B. the existing concrete apron is not shown in these sketches so the permanent encroachment onto the intertidal habitat will be less than shown. Additional cross sections showing the updated design options for the existing dwarf wall and flint wall to the north of Green Cottage are available in the accompanying design freeze sketches drawing pack.

Green Cottage to Winklemarket

The outline design for this section of Frontage 4 was to construct a reinforced concrete floodwall and boardwalk, with the floodwall constructed immediately seaward of the existing brick wall, and trench sheeting and a new brick quay wall constructed directly seaward of the existing quay wall, as shown in **Figure 6** below.

However, as described above for the whole of Frontage 4, the boardwalk option was ruled out due to operation and maintenance concerns and significant community opposition. Alternative options considered were:

- i) An overhang quay wall;
- ii) Use of the existing flint wall as a flood defence with landside structural support; and
- iii) Use of the existing flint wall as a flood defence, with no additional support provided.

However, following the results of the Structural Investigation, seepage analysis and receipt of ECI advice, all three of these alternatives were ruled out.

The overhang solution was ruled out as there would be issues associated with uplift forces caused by the wave action beneath the overhang section. Furthermore, due to the complexities associated with this solution, the cost of this approach was anticipated to be higher than the updated leading option, and there would also be issues with 'shading/shadowing' of the foreshore, even if direct encroachment would be minimised. Subsequent community feedback also opposed the cantilevered path approach.

The results of the structural investigation indicated that the existing walls are not suitable for reuse or incorporation into the design without any modifications. Furthermore, seepage analysis identified a risk of seepage along the frontage indicating requirement for an impermeable cut-off. The existing quay wall is in poor condition and in need of replacement with a new quay wall in order to provide sufficient structural support to the new floodwall on top of the footpath, adjacent to the existing flint wall.

Therefore, the updated concept design between Green Cottage and the Winklemarket is now the same as that proposed for The Look Out to Green Cottage - a reinforced concrete floodwall immediately seaward of the existing flint wall, clad in appropriate material. A new brick quay wall will be constructed seaward of the existing quay wall, to provide the required footpath width of minimum 1.5m, as shown in **Figure 6** below. The new quay wall will have sheet pile foundations with a buried concrete apron/slab to minimise permanent intertidal habitat loss as far as technically possible. The foreshore encroachment will be kept to the absolute minimum necessary and the majority of the new quay wall footprint is expected to be within the footprint of the existing concrete apron. The intertidal habitat losses and gains will be fully described and quantified in the detailed design for inclusion in the Habitats Regulations Assessment to be submitted in support of the planning and marine licence applications.

The updated concept design option for the Green Cottage to Winklemarket section of Frontage 4 is shown in **Table 4** below. A typical cross-section of the updated concept design option is shown in **Figure 6**.

Table 4: Outline design option, updated concept design option and alternatives considered for Frontage 4: Green Cottage to Winklemarket

Outline Design	Updated Design Option	Alternative – quay wall	Alternatives – flood wall	
Reinforced concrete floodwall and boardwalk. - Floodwall constructed immediately seaward of existing brick wall - Trench sheeting and new brick quay wall.	Reinforced concrete floodwall immediately seaward of existing flint wall, clad in appropriate material. - New brick quay wall seaward of existing quay wall, to provide adequate footpath width, with sheet pile foundations and buried concrete apron/slab - No boardwalk	Overhang quay wall	Use of the existing flint wall as flood defence with landside structural support	Use of the existing flint wall as flood defence, no additional structural support provided
Pros - Minimum permanent encroachment area Cons: - Boardwalk - Shading of intertidal foreshore from boardwalk and minor permanent loss of intertidal habitat under piles/supports for the boardwalk	Pros: - Seepage cut-off provided by sheet pile foundation - Apron/slab buried beneath foreshore, reducing permanent encroachment - Apron/slab move sheet piles away from buildings / existing structures to reduce risk of obstructions and vibration risks Cons: - Increase in permanent encroachment relative to outline design but minimised as far as possible by buried toe - Increase in temporary foreshore habitat disturbance from buried toe	Pros - Reduced permanent encroachment area (relative to leading option) - Seepage cut-off through sheet piles Cons: - Risk of piling obstructions - Uplift pressures from waves beneath overhang - Community opposition	Pros - Reduced permanent encroachment (relative to leading option) - Retain seaward flint wall facing (heritage) - No change to footpath width Cons: - Access / buildability - Risk of piling obstructions - Complexities in providing seepage cut-off on landward side of flint wall - Landowner opposition	Pros - Reduced permanent encroachment (relative to leading option) - Retain seaward flint wall facing (heritage) - No change to footpath width - Community support Cons: - Technically unviable, structural support required to meet design requirements

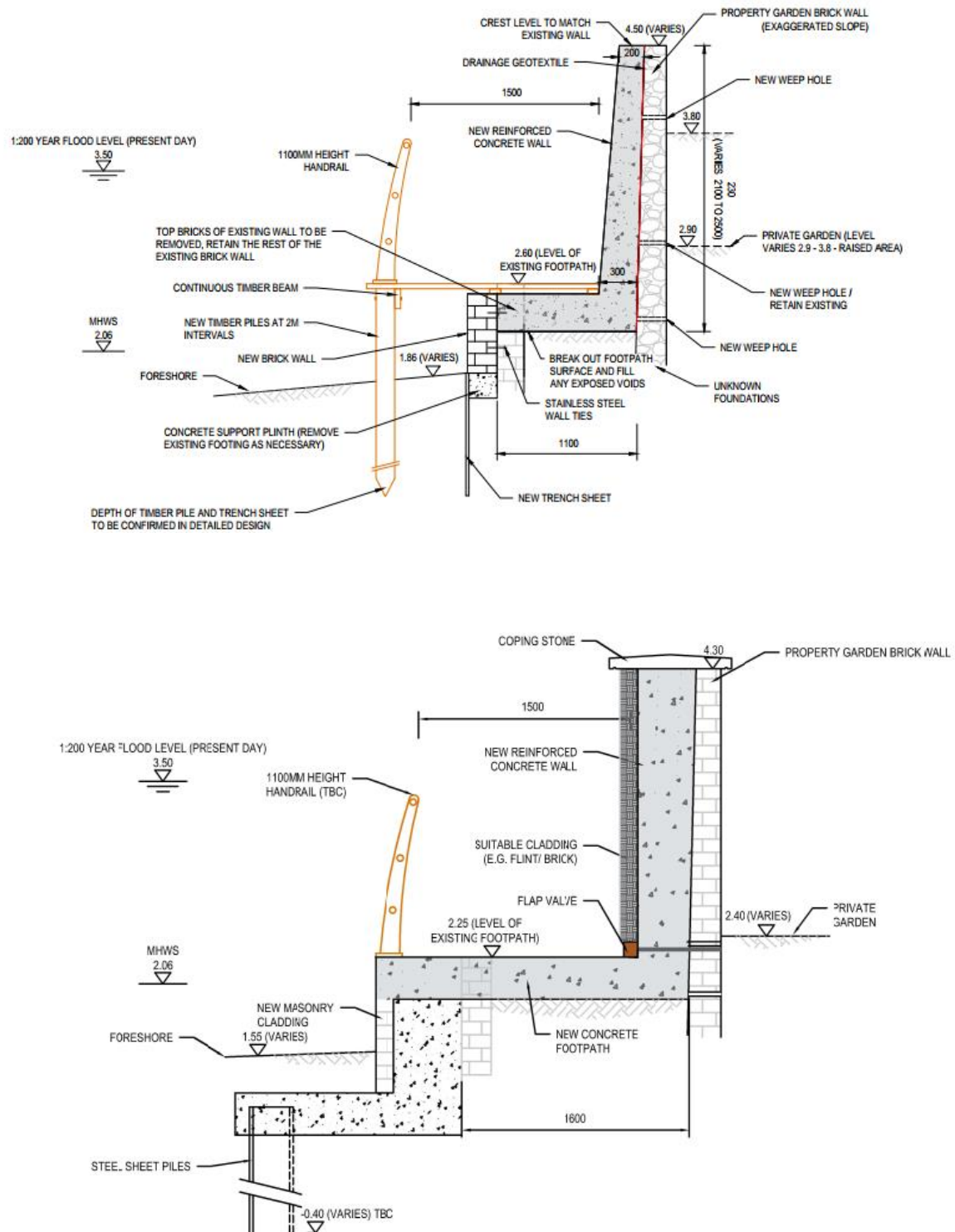


Figure 6: Typical cross-section of the outline design option (top) and the updated concept design option (bottom) for Frontage 4: Green Cottage to Winklemarket. N.B. the existing concrete apron is not shown in these sketches so the permanent encroachment onto the intertidal habitat will be less than shown.

Winklemarket

The outline design for this section of Frontage 4 was to use the building as part of the flood defence, with flood proofing measures, subject to structural investigations and identification of a suitable flood proofing measure which would meet the requirements of the scheme of a 50-year design life. However, through further investigations this approach has been ruled out.

The results of the structural investigations on the brickwork wall (side wall located on Langstone High Street) indicate the structure is in a good condition and could be deemed suitable for reuse and incorporation into the scheme, provided an effective waterproofing system is applied to prevent water ingress into the building during a flood event. There is currently no waterproofing system along this wall section.

The results of the structural investigations on the masonry brickwork wall (seaward facing wall) also indicate the structure is in a good condition and could be deemed suitable for reuse and incorporation into the scheme, provided an effective waterproofing system is applied to prevent water ingress into the building during a flood event. The existing waterproofing to the building was installed approximately 15 years ago. Documentation provided by the owner indicates this solution has been implemented from the inside face to the seaward facing wall only. The waterproofing works do not provide adequate confidence that the existing system will prevent water ingress during flood events for another 50 years. The guarantee for the sea defence performance without seepage through the building is also limited as Coastal Partners and AECOM cannot check with the installation company as it has been dissolved since 2015. A market survey was undertaken by AECOM, which failed to find a suitable product that can be applied externally without impacting on the visual appearance of the existing wall and which provides a service life of 50 years.

Seepage calculations also indicate that under existing conditions there is a risk of uplift and seepage through the frontage during periods of high-water levels, as the quay wall and footpath fill are permeable, and therefore an impermeable cut-off is required to prevent this. These results combined, therefore mean that it is not possible to make use of the existing walls as the flood defence without implementation of an effective waterproofing system, as the design requirements of the scheme would not be met.

Instead, the updated concept design is to continue the adjacent reinforced concrete floodwall, constructing it immediately seaward of the Winklemarket and around the building wall where it will terminate at the floodgate. The height of the floodwall will be reduced to match the flood level (3.8mAOD) and run below the bay windowsill of the building (where special provision will be made to provide flood protection while maintaining the view) and will be clad in a suitable material to match the existing brickwork as close as possible.

A new brick quay wall will be constructed seaward of the existing quay wall to provide the required minimum footpath width of 1.5m. Foundations for the new brick quay wall will be a concrete apron with sheet piles, buried beneath the foreshore to minimise permanent intertidal habitat loss as far as technically possible, as shown in **Figure 7**. The foreshore encroachment will be kept to the absolute minimum necessary and the majority of the new quay wall footprint is expected to be within the footprint of the existing concrete apron. The intertidal habitat losses and gains will be fully described and quantified in the detailed design for inclusion in the Habitats Regulations Assessment to be submitted in support of the planning and marine licence applications.

The updated concept design option for the Winklemarket is shown in **Table 5**. A typical cross-section of the updated concept design option is shown in **Figure 7** below.

Table 5: Outline design option and proposed refined concept design option for Frontage 4: Winklemarket

Outline Design	Updated Design Option
Building used as the defence - Internal flood proofing / treatment - Boardwalk	Reinforced concrete floodwall adjacent to building wall (seaward), clad in appropriate material. - New brick quay wall constructed seaward of existing to provide adequate footpath width, with sheet pile foundations and buried concrete apron/slab - No boardwalk
Pros - No visual change to existing situation - No foreshore encroachment (only shading) Cons: - Low design life - Lack of appropriate water proofing solutions (UV) - Building owner permissions and maintenance - Future liability / potential impact on house value - Boardwalk - Risk of seepage - Shading of intertidal foreshore from boardwalk and minor permanent loss of intertidal habitat under piles/supports for the boardwalk	Pros: - Continuation of defence from adjacent area, although tapering/width could potentially be adjusted - Cut-off and seepage protection - Robust solution, long design life - Quay wall foundation benefits (see previous sections) associated with slab/apron design Cons: - New quay wall will lead to permanent encroachment onto foreshore but minimised as far as possible by buried toe - Increase in temporary foreshore habitat loss/disturbance from buried toe



Frontage 5: High Street to Royal Oak

Frontage 5 is part of the Core scheme and runs between Langstone High Street, continuing in front of the Royal Oak public house and adjacent properties, following the footpath to the west of the Mill Pond and into the northern field boundary.

The outline design for Frontage 5 was to install a flood gate across Langstone High Street and construct either a parapet wall on the alignment of the existing wall or to construct a king post wall with precast reinforced concrete panels and cladding in front of the Royal Oak, as shown in **Figure 8**. Following the results of the Structural Investigation, seepage analysis and receipt of Early Contractor Involvement (ECI) advice, both of these options have since been ruled out because they do not provide a continuous impermeable barrier, and therefore seepage would be expected to occur, and hence they do not meet the design requirements of the scheme to prevent future erosion risk as well as flood risk. Furthermore, the Structural Investigation found that the existing quay wall is in poor condition with multiple voids and a residual life of less than 10 years. Therefore, the existing quay wall is unsuitable for reuse and incorporation into the scheme and a new structure is necessary to provide the required design life and standard of protection to meet the scheme objectives.

In addition to the outline design, an alternative design solution was considered to utilise the existing Royal Oak building as part of the flood defence, however this solution was also ruled out, for similar reasons as described above. Cyclic seawater exposure on the structure will increase the risk of excessive moisture and increase the risk of rotting to timber elements, and ultimately lead to structural issues. Therefore, minimal intervention to the existing timber frame structure is recommended and use of the existing structures was ruled out. Seepage analysis indicates that a cut-off curtain is required in this location with a nominal 1m embedment into less a permeable stratum (i.e., Alluvium/Chalk Dm). A pile toe level of -0.4mOD minimum is required to prevent seepage through to the landward side of the defence. These results combined, therefore mean that it is not possible to make use of the existing building as the flood defence without any modifications as the design requirements of the scheme would not be met.

The updated design is to construct a glass topped clad sheet pile wall with base apron buried beneath the foreshore. The reinforced concrete apron will enable the sheet pile toe to be moved further from the existing wall foundations, reducing the chance of hitting obstructions during piling and also vibration damage. It will also enable a thinner wall to be constructed above the foreshore, minimising the amount of permanent encroachment into the intertidal foreshore. This updated design option will also provide a long-term benefit to and protection of the Grade II listed buildings along this frontage with respect to climate change and sea level rise. For the High Street, the design remains the same as at outline design, i.e. installation of a flood gate across Langstone High Street.

The outline design, updated concept design and alternative options for the High Street to Royal Oak frontage are summarised in **Table 6**. Typical cross-sections of the updated concept design option in front of the Royal Oak are shown in **Figure 9** below. Cross sections for the footpath and earth embankment are included in the attached 'Langstone design freeze sketches' drawing pack.

Table 6: Outline design option, updated concept design option and alternatives considered for Frontage 5 (Royal Oak)

Outline Design	Updated Design Option	Alternative(s)
Either: A new parapet wall on the alignment of existing wall Or: King post wall with precast reinforced concrete panels and cladding (dependent on further Structural Investigation)	Sheet pile wall (clad in appropriate material) with base slab/apron buried beneath the foreshore. - Slab/apron will enable the sheet pile foundations to be moved further away from the existing structure - Glass top (subject to funding), will be designed to accommodate full height clad wall should funding not be sought	Using Royal Oak and residential buildings as flood defence Refurbishment of quay wall to prevent undermining.
Pros: - Parapet wall avoids any intertidal encroachment Cons: - King post wall will result in intertidal encroachment - Does not provide seepage protection as not a continuous impermeable structure - Risk of striking obstacles during king post piling. Vibration risk - Permanent loss of intertidal habitat from new king post wall - Temporary loss/disturbance of intertidal habitat during construction	Pros: - Continuous impermeable defence, providing seepage protection - Slab/apron will enable a thinner wall to be constructed above, reducing permanent intertidal encroachment relative to solution without slab/apron - Piling moved further away from potentially vulnerable buildings (vibration risk) and also away from foundation obstacles Cons: - New quay wall will lead to some permanent encroachment onto foreshore. However, this has been reduced considerably with the new buried foundation design - Temporary loss/disturbance of intertidal habitat during construction of buried base slab/apron	Pros: - Minimal impact on landscape / visual / heritage Cons: - High residual risk of flooding – through windows, deployable defences not being deployed etc. Doesn't meet design requirements. - Seepage risk - Future liability / potential impact on property values

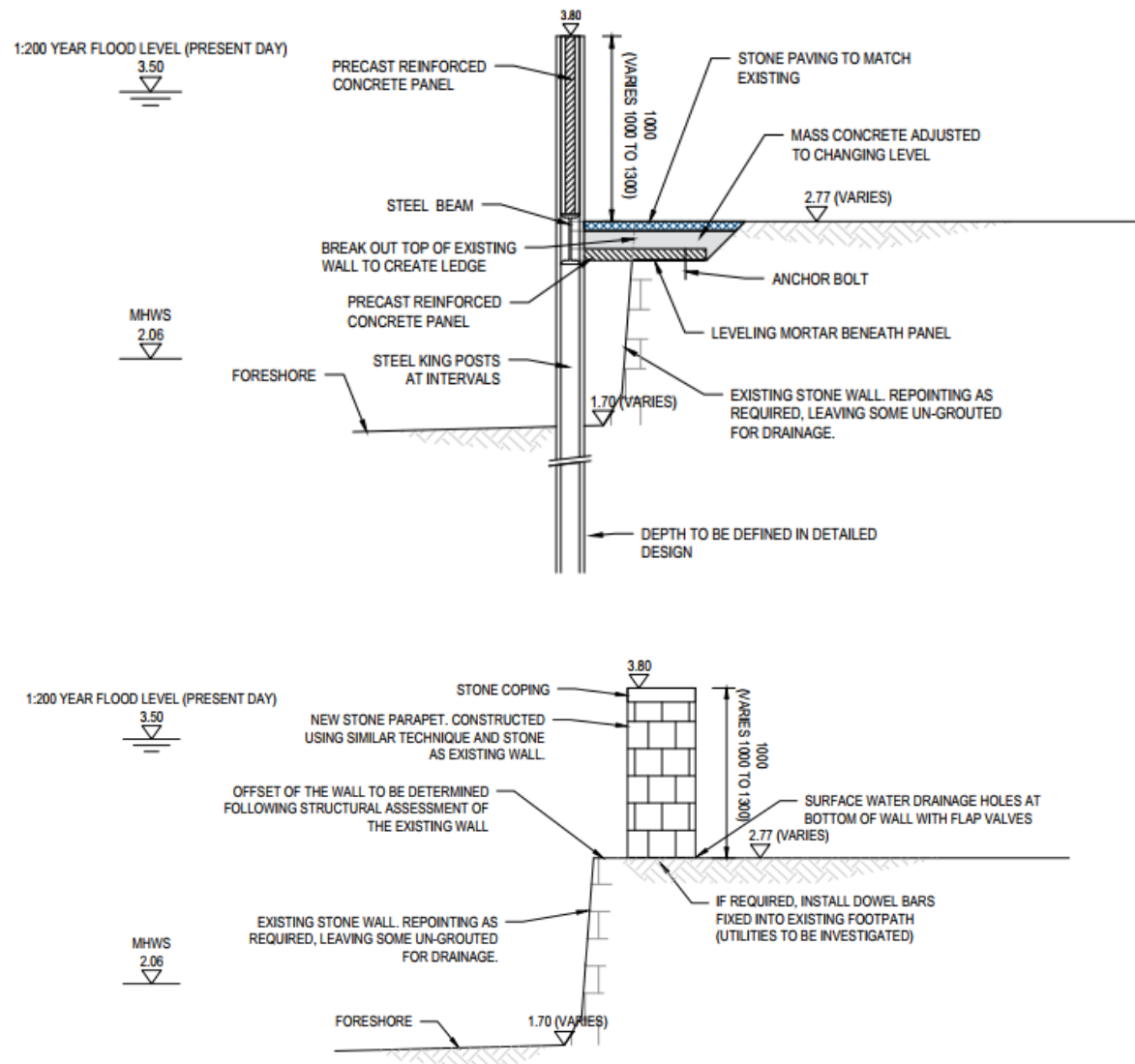


Figure 8: Outline Design options for Frontage 5 (High Street to Royal Oak) - king post wall (top) or parapet wall (bottom)

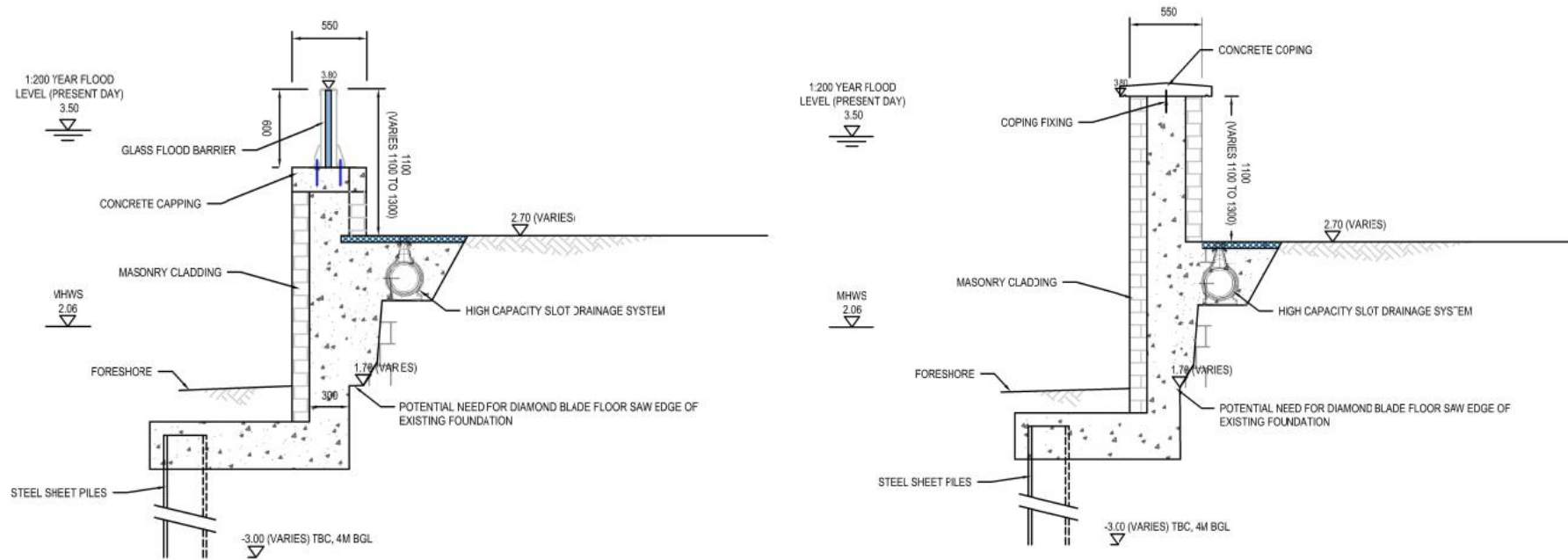


Figure 9: Typical cross-section of the updated concept design option for Frontage 5 (High Street to Royal Oak) with glass topped flood wall (left) and with full height solid flood wall (right).

Frontages 1, 2 & 6

There have been no changes to the options proposed at outline design for Frontages 1A and 2 (Billy Line Footpath and Embankment), Frontage 1B (Mill Lane and Harbourside) or Frontage 6 (Langstone Spit), but the options for these frontages are summarised below for completeness.

Frontage 1A – Billy Line Footpath Raising

- No change from outline design - Raising of the existing footpath and National Cycle Route (170m long) along a section of the old Hayling Billy line (see **Figure 10**).
- Width of path to be 3m to comply with highway standards.

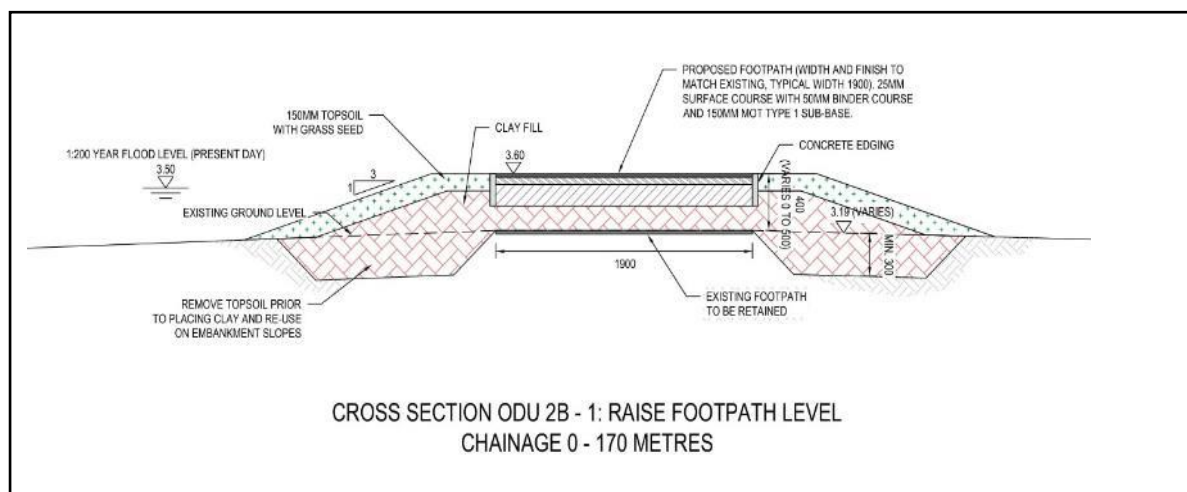
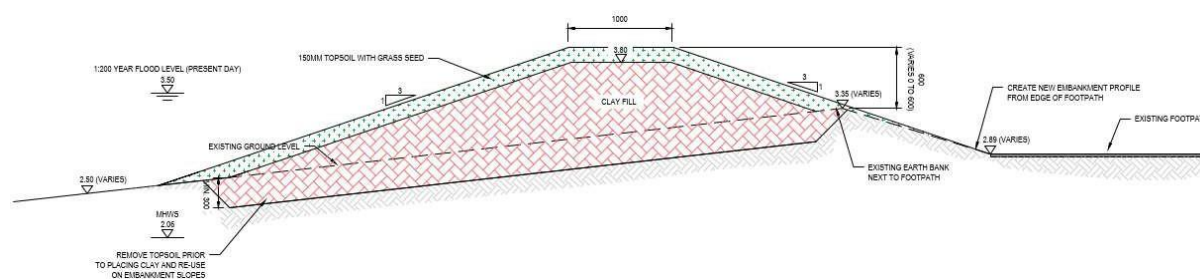


Figure 10: Typical cross section of the updated concept design option for Frontage 1A (Billy Line Footpath Raising)

Frontage 2 – Billy Line Earth Embankment

- No change to outline design - earth embankment (see **Figure 11**)
- Width of path to be 3m to comply with highway standards.
- Localised Raising of Low Spots to 3.8m AOD



Additional Scheme: Frontage 1B – Mill Lane and Harborside

- No change to outline design - earth embankment and capital refurbishment

The proposed design layout and typical cross sections for Frontage 1B (Mill Lane and Harbourside) are shown in **Figure 12** below.

Additional Scheme: Frontage 6 – Langstone Spit

- No change to outline design - rock armour

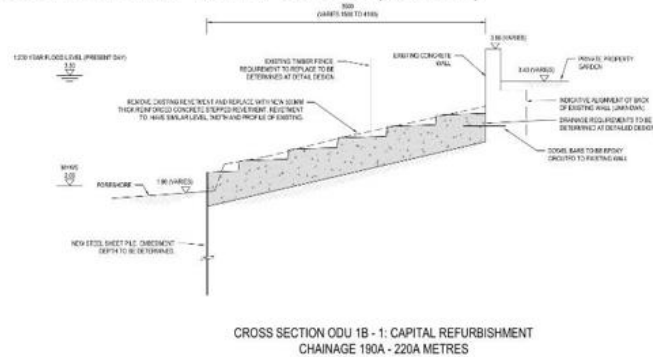
The proposed design layout and typical cross sections for Frontage 6 (Langstone Spit) are shown in **Figure 13** below.

Frontage F1B: Mill Lane and Harbourside Chainage 0A to 325Am

Earth Embankment
Flood Defence Level 3.6mAOD
Length 105m



Capital Refurbishment of Revetment
Flood Defence Level 3.85m (Varies)



Capital Refurbishment of Sea Wall
Flood Defence Level 3.95m (Varies)

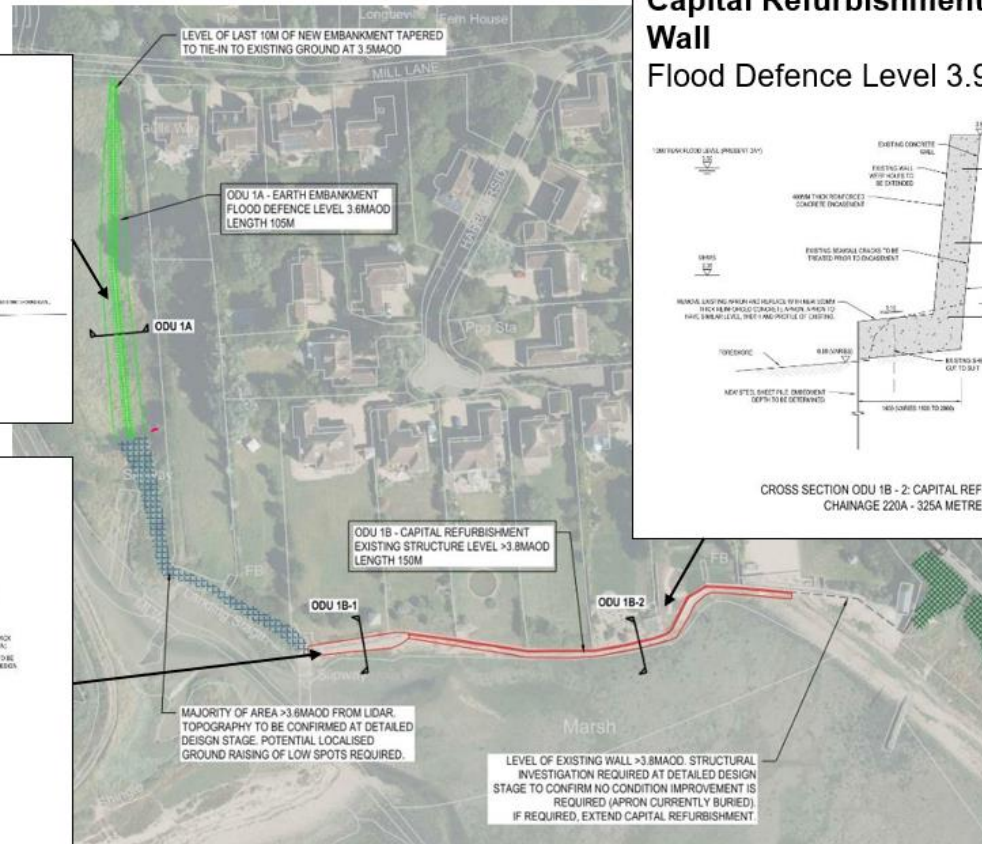
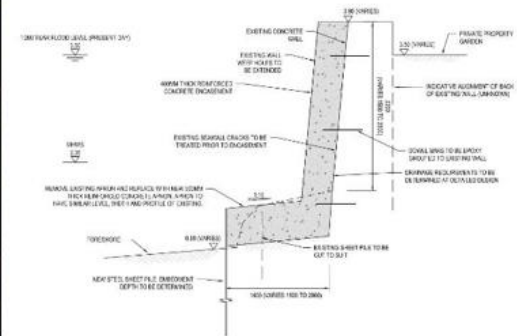


Figure 12: Layout and typical cross sections for Frontage 1B (Mill Lane and Harbourside)

Frontage 6: Spit

Rock Armour

Flood Defence Level 4.61m (Varies)
Length 50m

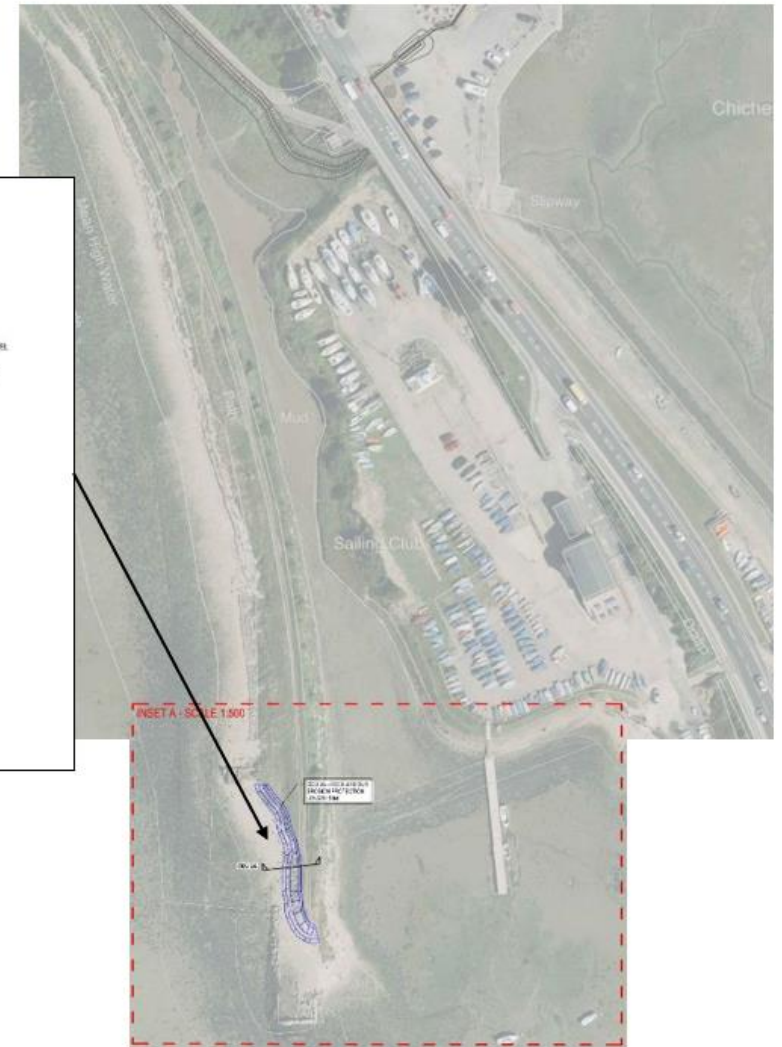
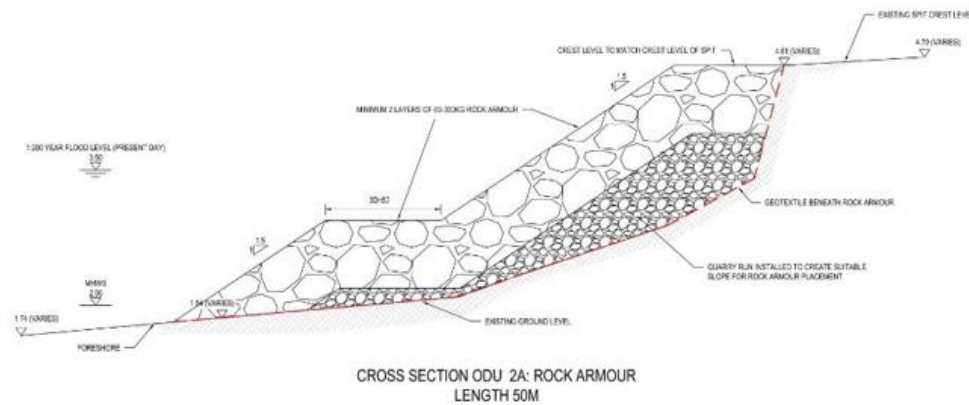


Figure 13: Layout and typical cross sections for Frontage 6 (Langstone Spit)