

Shoebury Common Flood Defence Review

December 2014

Southend-on-Sea Borough Council

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Mott MacDonald

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Southend-on-Sea Borough Council

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Issue and revision record

Revision	Date	Originator	Checker	Approver	Description
A	October 2014	RHCT CM MW	NC	PJP	For Issue
B	December 2014	NC			Added Options F and G

Information Class: Standard

Contents

Executive Summary

This report has reviewed the available information with regards to the preferred PAR option for the Shoebury Common Scheme and the alternative proposed by various stakeholder groups. The review aimed to ensure that the options tabled to date have been assessed on a comparable level. It is noted that the assessment is hindered by the differing level of design development of each of the options.

In terms of a need for the flood protection scheme at Shoebury Common there is general consensus within the stakeholder groups that a scheme is required in order to provide long-term flooding protection.

While the proposed preferred scheme within the PAR would have provided a functional and robust flood defence with a reasonable economic return it is clearly unacceptable to local resident groups in its current form.

While the range of alternative options proposed differ in their level of development it is clear that each scheme has its own merits and failings. In particular it has become clear that there is no single solution which is unanimously acceptable to all the differing stakeholder groups. The table below provides a summary of the scheme options and their compliance with a range of criteria, colours give an indication of the acceptance of the option (i.e. Green does not indicate universal acceptance or approval); further explanation is provided within this report.

OPTION	ASSESSMENT CRITERIA			
	Technical	Economic	Environment	Stakeholder
A (PAR)				
B (FoSC)				
C (MARMUS)				
D (BERA)				
E (Glass Walls)				
F (PAR Option 2)				
G (PAR Option 3)				

This report concludes by outlining a range of activities and steps that could be adopted in order to progress towards gaining general support for a scheme.

1 Introduction

1.1 Purpose of this review

Mott MacDonald has been asked to undertake an objective and independent review based on available information and knowledge of the proposed options for the Shoebury Common Flood Defences at the eastern extent of Southend-on-Sea.

The review is to assess the feasibility of the options proposed against criteria similar to that of the original project appraisal report. Owing to the time constraints on producing this report the assessment is at a higher level of detail than would be carried out for a formal appraisal and cannot replace a full Project Appraisal Process.

As part of the review Mott MacDonald have conducted a revised whole-life cost estimate for each of the schemes. This has been carried out for the purpose of option comparison and lack the detail that would be expected at formal appraisal level and so should not be seen as robust or accurate estimates of construction costs.

Given the time constraints and the significant stakeholder interest the aim of the review has not been to provide a definitive answer to the scheme option. The outcome of the review will be presented as a summary of the findings with outline recommendations on how the scheme may be progressed.

1.2 Background

The approved Shoreline Management Plan (SMP) policy is to hold the current alignment and to sustain the existing standard of protection against coastal flood risk in line with sea level rise.

The proposed Strategy policy is to 'Hold the Line' and raise defences where economically justified to mitigate against sea level rise.

Between 2011 and 2012 Southend-on-Sea Borough Council and their Consultants undertook a Project Appraisal Report considering the future management of the sea defences which examined 14 different management options for the frontage, assessing each in terms of technical and environmental suitability, whole life cost etc. and recommended a Preferred Option of a setback, brick clad defence to the east. In the main this new, setback defence was located behind the beach huts. In the scheme the set back wall was to be sheet piled in order to provide some hydraulic cut off for seepage through the

underlying gravel strata. Access ramps and flood gates are also included. In the west the proposal is for the existing seawall to be raised.

The PAR also assessed two options, the first provided a wall along the road at the rear of Shoebury Common, whilst the second option provided a combination of embankment (including road raising) and walls to achieve an optimised scheme. Following a meeting with Stakeholders on the 26th November 2014 assessment of these two options has been added to this report.

Since the publication of the preferred option in 2012 residents and interested parties locally have proposed alternative options including:

- Friends of Shoebury Common (FoSC)
  - FoSC proposed two options
    - 1. Raise the level of the existing sea wall and the promenade with associated earth works behind. This would involve moving (and subsequently raising) the beach huts.
    - 2. Raise the level of the beach using material recently made available by the West Cliff scheme (also known as the Marmus scheme).
- Burges Estates Residents Association
    - This option proposes management of the beach for flood defence recommending that the beach is stabilised using groynes with a terminal groyne/breakwater at the eastern end of the frontage.
- Flood Control International
    - This option involves the raising of the seawall using glass walls using glass flood barriers.

From here in the Report the five options to be considered will be referred to as follows:

Table 1.1: Future management proposals for Shoebury Common

Option	Source	Brief Description
A - PAR	Black & Veatch Project Appraisal Report	Setback, sheet piled wall
B - FoSC	FoSC	Raise the level of the promenade
C - Marmus	FoSC	Use of buried material to bolster beach levels
D - BERA	A letter from BERA to SBC dated 23rd May 2013	Beach management and groyne construction
E - FCI	Flood Control International	Use of glass flood barriers to raise the level of the defence
F – PAR Option 2	Black & Veatch Project Appraisal Report	Setback wall behind B1016 at the rear of Shoebury Common
G – PAR Option 3	Black & Veatch Project Appraisal Report	Combination of setback wall and embankments (inc. road raising)

Source: Collated from Black and Veatch Reports and drawings, from letters submitted to Southend-on-Sea Borough Council etc.

The purpose of this report is to review all of the available data around these options and to undertake a fair, high level review of each of the options.

2 The Need for the Scheme

2.1 Background

This section summarises the impartial desk study review undertaken by Mott MacDonald on the flood risk at Shoebury Common in order to confirm the need for the scheme.

2.2 Existing sea defences

Figure 2.1 shows the variation in elevations along the seawall at the Shoebury Common site. The present day seawall elevation is varies between 5.02 and 5.97m ODN across the frontage.

A conceptual sketch of a typical section of the Shoebury Common frontage is shown in Figure 2.2 consists of a concrete seawall (5.05m ODN), fronted by a concrete revetment (1 in 3.25 slope) and a beach (1 in 10 slope). Leeward of the defence line there is a promenade (7m width) and lower lying land.

Design drawings for the Shoebury Common sea wall improvement scheme (1962) confirm a design level of 16.5ft ODN (approx. 5.03m ODN). No as-built drawings were available for this desk study review. Pre-1962 the sea defences consisted of a revetment at approximately 14.4ft ODN (4.39m ODN).

Mott MacDonald has reviewed the latest topographic survey data (2011) to confirm the levels of the existing sea defence. A summary of levels is presented in Table 2.1.

The minimum seawall elevation is 5.02m ODN. Along the frontage there are 6 no. access steps and 2 no. access ramps to the beach. The elevation of one of the access steps is shown to be at 4.47m ODN (more than 500mm below the typical seawall elevation).Site photographs show the steps rising above the seawall crest. This has been confirmed as a known error by Southend-on-Sea Borough Council and should be corrected before any flood modelling is undertaken. The crest level of the ramps is shown to be 5.00m ODN.

An estimate of the residual life was not undertaken by Mott MacDonald. It is understood that the sea defences have a residual life of between 15 and 30 years (Black and Veatch, 2011).

Figure 2.1: Variation in seawall elevation along the Shoebury Common frontage. Levels at the west section (red) vary between 5.04 and 5.88m ODN. Levels at the east section (blue) vary between 5.02 – 5.06m ODN.

Figure 2.2: Conceptual cross section of the Shoebury Common frontage. Levels interpreted from the 2011 topographic survey (not to scale).

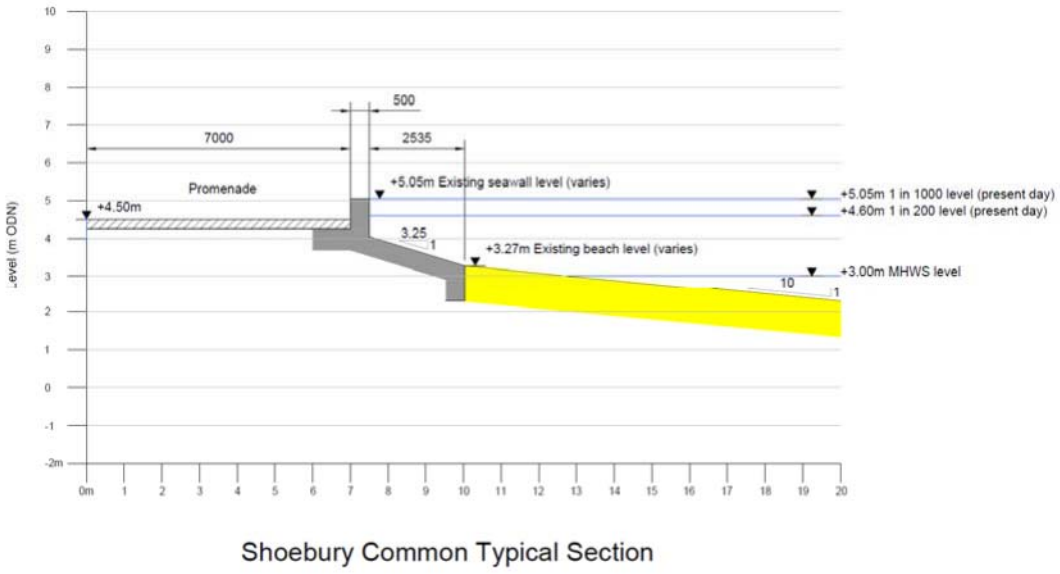


Table 2.1: Summary of ground levels for the Shoebury Common frontage. Levels exclude step and ramp structures.

	Maximum level (m ODN)	Average level (m ODN)	Minimum level (m ODN)
Seawall	5.88	5.16	5.02
Seawall toe/Revetment crest	5.02	4.04	3.19
Revetment toe/beach level	4.06	3.68	3.20

2.1 Extreme water levels

As part of the Southend-on-Sea Shoreline Strategy Plan Black and Veatch undertook a coastal processes review (CPR) (November 2011). Water levels adopted in the Strategy were based on the Southend SMP (Haskoning, 2007) but corrected to a base year of 2010. Defra (October 2006) guidance on sea level rise was used to provide present day (2010), 50 years time (2059) and 100 years time (2109) extreme water levels at Southend.

Mott MacDonald has reviewed the water levels presented in the CPR against the EA design sea levels published in 2011 (2008 base year). Levels at Southend were used for comparison and correct to a base

year of 2010. A summary of extreme water levels is presented in Table 2.2. The 50 year and 100 year water levels were calculated using the same sea level rise allowances as presented in the CPR. Table 2.2 shows extreme water levels used in the CPR are typically between 50 and 110mm lower than the most recent guidance for design sea levels.

Table 2.2: Extreme water level return periods: present day (2010), and 50 years' time (2059) and 100 years' time (2109). Top: estimate using the design sea levels published by the Environment Agency. Bottom: estimate using the water level return periods used in the Shoebury Common PAR.

Year	Return Period Levels (m ODN)										
Environment Agency, 2011											
2010	3.61	3.87	4.00	4.13	4.18	4.32	4.47	4.64	4.69	4.87	5.05
2059	3.98	4.24	4.37	4.50	4.55	4.69	4.84	5.01	5.06	5.24	5.42
2109	4.65	4.91	5.04	5.17	5.22	5.36	5.51	5.68	5.73	5.91	6.09
Southend Strategy (Black and Veatch, 2011)											
2010	3.50	3.80	4.00	4.20	4.22	4.30	4.50	4.60	4.66	4.83	5.00
2059	3.86	4.16	4.36	4.56	4.58	4.66	4.86	4.96	5.02	5.19	5.36
2109	4.54	4.84	5.04	5.24	5.26	5.34	5.54	5.64	5.70	5.87	6.04

Source: Black and Veatch, 2011. EA, 2011a

2.2 Flood Risk

2.2.1 Historic

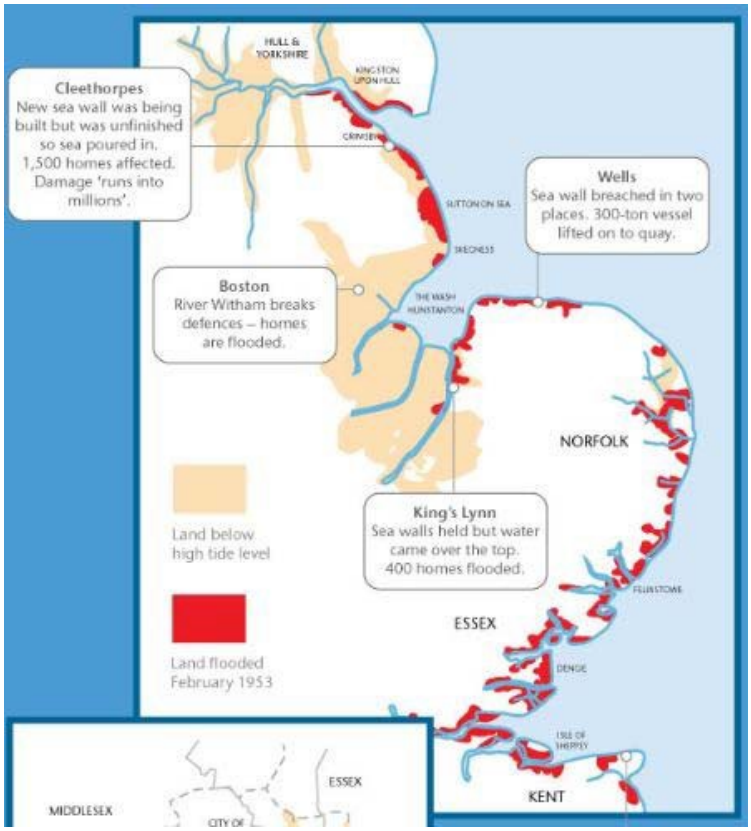
The UK coast has experienced a number of extreme coastal flooding events, most notably the 1953 east coast surge event when the observed water level at Southend was 4.60m ODN (Robinson, 1953).

At the time the event was considered to have a Return Period of 1 in 250 Years. 50 Years later due to climate change and an increase in storm events this had reduced to 1 in 120 years and it is projected that by 2080 this magnitude of event will occur every 5 years (BBC, 2003).

No flood records were found during this desk study review, however anecdotal evidence suggests that the beach huts were pushed to the back of the common by the surge. Information published in papers on the storm event provides further evidence of flooding in the area (see Figure 2.3). An estimated 219 flood causalities received hospital treatment at Southend (Baxter, 2005). The extent of flooding for the 1953 event is unknown. Analysis of nearby observed water levels

shows a level exceeding the pre-1962 sea defence elevation (by 0.21m). Some form of localised flooding may have occurred but cannot be confirmed. This excludes other flooding sources and pathways (e.g. surface water flooding and wave overtopping).

Figure 2.3: Map showing some of the worst affected regions in England during the 1953 storm surge event



Source: Met Office, 2013

2.2.2 Present day

The present day seawall elevation varies between 5.02m and 5.97m ODN across the Shoebury Common frontage (see Figure 2.1). Figure 2.4 shows the Shoebury Common flood map for the 1 in 200 and 1 in 1000 year flood event. The water levels for the respective events are 4.64m (380mm below the lowest seawall crest elevation) and 5.05m ODN (at or just above the seawall crest elevation).

Observed water level records at Sheerness (Table 2.3) support evidence that there has been no recent history of flooding or erosion. Freely available records are only available up to December 2012. The

highest water level recorded is 4.02m ODN. This is one metre below the lowest level of the sea defences at Shoebury Common and equates to an extreme water level return period of 1 in 14 (mean sea level offset to 2008). The events listed in Table 2.3 may have caused localised overtopping at the promenade but without wave data and/or flooding records this cannot be confirmed.

Table 2.3: Top 10 observed water levels at Sheerness, Kent (assumed to be applicable to Shoebury Common for this desk study review).

Rank	Date	Observed water level (m ODN)		
		No MSL offset	MSL offset (2008)	Return period (years)
1	10 December 1965	4.02	4.08	14
2	14 December 1973	3.90	3.92	7
3	14 December 1993	3.87	3.89	6
4	29 October 1996	3.87	3.89	6
5	15 November 1993	3.83	3.85	5
6	24 December 1988	3.82	3.85	5
7	16 December 2005	3.82	3.82	4
8	25 November 1973	3.80	3.85	5
9	22 February 2004	3.79	3.80	4
10	20 February 1996	3.78	3.80	4

The recent PAR states that the existing Standard of Protection along the frontage is within the range of 1 in 5 to 1 in 50 although the overtopping limit defined as 'failure' is not confirmed in the PAR.

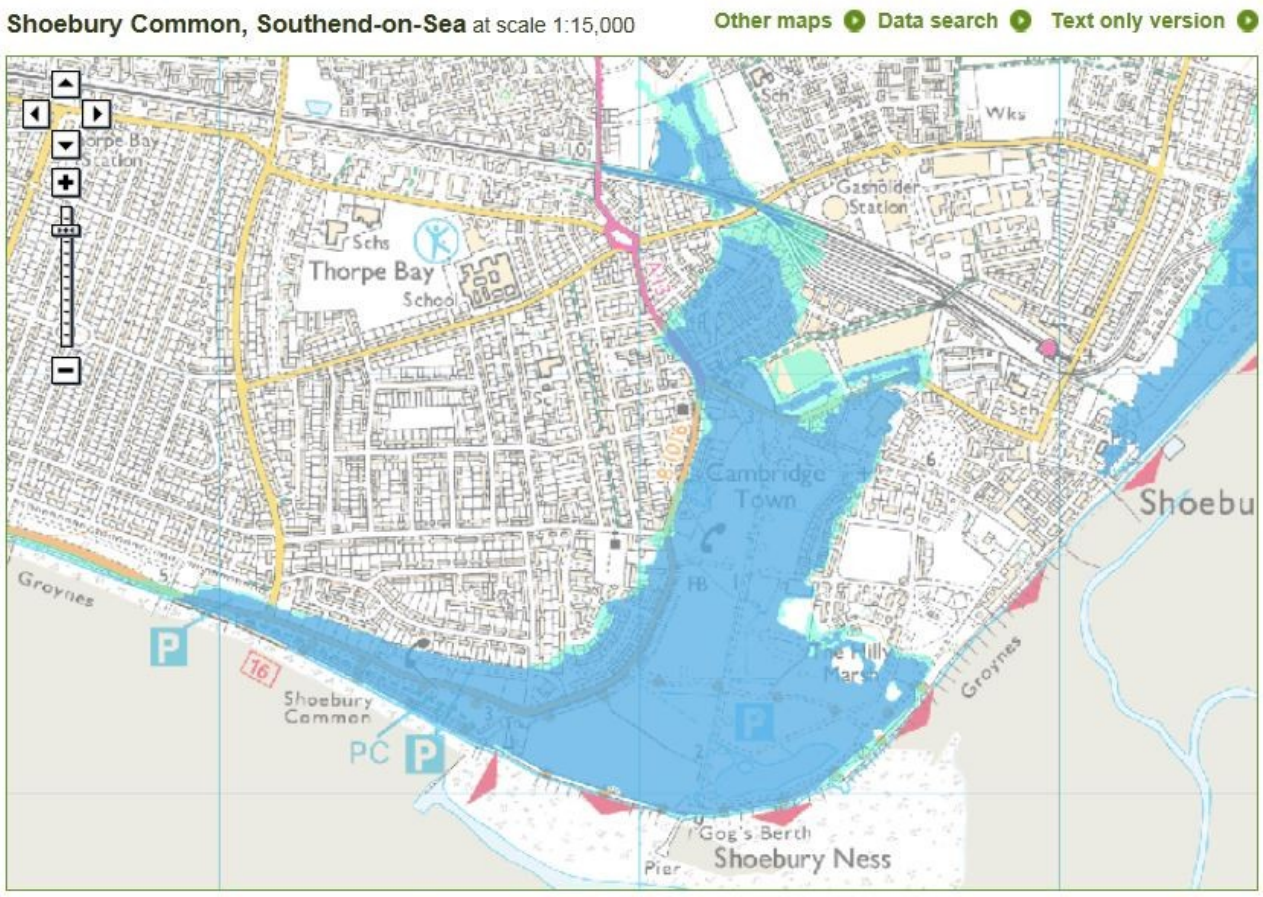
In this review, a check was conducted on the overtopping rates for the 1 in 5 year joint probability event. The estimated overtopping rate is 64 l/s/m. The calculation is based on the combination of conditions defined in the PAR; lowest crest level, lowest beach elevation and least beach crest. Wave and water levels used in the Southend Strategy Study (2011) were adopted in this review (again mirroring the method in the PAR). However, it is not clear what exact nearshore wave conditions were used in the PAR analysis.

It should be noted that this figure is based on a preliminary analysis and is likely to be a conservative estimate. However, it highlights that there is a flood risk to the Shoebury Common as higher return period events would increase the rate of overtopping further. Based on the

combination of the conditions outlined above, this review estimates the current day Standard of Protection against wave overtopping is likely to be within the order of magnitudes defined within the PAR, but could be as high as 1 in 50 and 1 in 100.

Whilst, we note that the overtopping analysis shows a potential for inundation, the PAR does not present a report on the modelling study so no modelling results for the present day are available to help assess the present day flood risk. Additionally, to fully understand the risk from wave overtopping clarification is required regarding the definition of overtopping 'failure' criteria used in the PAR.

Figure 2.4: Shoebury Common Flood Map showing 1 in 200 year (dark blue) and 1 in 1000 year (light blue) return period coastal flood event.



Source: Environment Agency, 2014

2.2.3 Future

Table 2.2 presents the increase in extreme sea levels including allowances of sea level rise. Within the PAR the Standard of Protection offered by the defences at Shoebury Common is estimated to fall from between 1 in 50 and 1 in 100 (present day) to less than 1 in 5 by 2109.

2.3 Summary

This section has reviewed the historic, present day and future flood risk at Shoebury Common, using information and findings from the original PAR (B&V, 2013). It is confirmed that the analysis shows that the frontage is at risk of flooding in large storm events and that this risk increase as sea level rise is realised in the future.

Key findings and comparisons to the PAR are presented below:

- The sea defences have a residual life of between 15 and 30 years (Black and Veatch, 2011).
- The PAR estimates the present day Standard of Protection as greater than 1 in 5. This review estimates the Standard of Protection could be higher, between 1 in 50 and 1 in 100 depending on the criteria used to define failure under overtopping.
- Over the 100 year appraisal period, the Standard of Protection is estimated to fall to less than 1 in 5 Year Return Period.

3 Stakeholder Consultations

3.1 Initial Consultations

Stakeholder consultation was initially undertaken as part of the PAR development during the 15th April to 12 May 2013. During the consultation period an exhibition and two public meetings were held in April 2013 while other comments and responses were gathered via written or electronic communications.

The initial stakeholder consultation gained opinions on three proposed options. All options were strongly opposed with more than 65% of respondents opposing all options. The final preferred option was the most opposed with approximately 80% of respondents opposing the scheme.

Support for the schemes was limited with a maximum of 20% supporting the Option 3 within the PAR (Floodwall along Lodwick) and approximately 18% supporting the proposed preferred option of the defence wall across Shoebury Common.

A review of the consultation responses has highlighted the following issues raised by the Stakeholders:

- Drivers for the scheme are not well understood. The preferred option is supporting further development in the area and the re-use of material from other construction schemes. This has led people to believe that these are the primary drivers.
- Local stakeholders are keen for the grassed area of the common to remain untouched.
- The best supported scheme was Option 3 (of those proposed in the PAR consultation) which has a flood wall running along Lodwick Road. Of the alternatives proposed the major support was for a new seawall to be built or for a raising of the Promenade.
- There was a general feeling that the Council were not listening to Stakeholders and the decision had already been made.

Stakeholders were also provided with the opportunity to put forward comments during the Planning Application process.

3.2 Stakeholder Group Meeting (10th Sept 2014)

A stakeholder meeting was held on the 10th of September 2014. The objective of the meeting was to allow representatives of the most active stakeholder groups to provide commentary on their current position relating to the proposed preferred scheme and the alternative schemes which had been put forward by various stakeholder groups (Refer to Section 4 for details).

The meeting was attended by the following groups:

- Councillor Martin Terry (Chair)
- Southend Borough Council (R. Atkins, P. Geraghty, and M. Sarsgood)
- Southend Beach Hut Owners Association
- Friends of Shoebury Common
- Garrison Residents Association
- Shoeburyness Residents Association

Burgess Estate Resident Association were also invited but were unavailable to attend. They provided a statement which was read to the meeting by Councillor Terry.

The format of the meeting was to invite representatives of each stakeholder group to voice their objections regarding the proposed preferred scheme, concerns in general relating to the frontage and the flood risk, and discussion of proposed alternative schemes. In order to keep the meeting as a positive discussion forum it was requested that no history was discussed surrounding the scheme development.

3.2.1 Southend Beach Hut Owners Association (SBHOA)

Representatives of the SBHOA outlined the following items:

- Out of the options previously presented they had a preference for an option within the PAR that made use of a flood wall along the B1016 Shoebury Common Road. For the SBHOA, this option was acceptable as it left the beach huts as they currently exist, in terms of location, elevation and views, and also had least impact on Shoebury Common. It had been rejected on the basis of intrusiveness and technical resilience due to the use of a large gate to cross the road;
- The main objective for the SBHOA would be to have a scheme that did not affect the beach huts as they currently exist. It is their opinion that moving the beach huts could cause a

significant number to collapse due to their fragile nature. They also wish to retain the current unimpeded view of the frontage from the beach huts;
- In relation to the preferred option within the PAR they stated they had no strong objection, as this option leaves the beach huts in their existing location and does not impact the sea views;
- The SBHOA queried whether the preferred scheme had been developed using a Landscape Architect (it was confirmed this was not the case at the meeting) and suggested that this may have helped its acceptability to stakeholders.

3.2.2 Friends of Shoebury Common (FoSC)

The FoSC raised the following issues:

- The FoSC strongly object to the proposed preferred option. The main objection is due to the height of the proposed wall and its alignment which runs through the middle of Shoebury Common. They also feel that the proposed preferred option is inconvenient to disabled users;
- They presented a written statement (edited during the meeting to remain in the spirit of not returning to historic events);
- The FoSC have submitted an alternative option (referred to in this report as Option B– FoSC) which looks at raising the existing promenade with slopes behind to tie-in with existing levels. This scheme would be their preferred option for implementation;
- The SBHOA commented that this required the moving of *ca.* 150 beach huts. FoSC stated they have contacted a specialist contractor who has advised that 90% of the beach huts can be moved at a cost of approximately £1Million (FoSC agreed to provide the quotation to Mott MacDonald; this has yet to be received);
- There is a general comment that it is felt the initial alternative option proposed was not considered in a fair manner during previous consultations;
- A second alternative scheme (referred to in this report as Option C - MARMUS) has also been submitted which utilises fill material placed in geotextile to raise the existing beach profile.

3.2.3 Garrison Residents Association (GRA)

The representatives of the GRA raised the following points:

- They raised the issue of surface water flooding from sources other than the coastal flooding. These issues related to the sluice maintenance and planning within the area – Whilst these points were raised they were not the subject of the meeting;

- In general the GRA prefer any option that minimises the visual impact. They raised a concern over the visual impact of the proposed preferred option with the seawall/floodwall running along Shoebury Common. In relation to the visual aspect they stated a preference for the FoSC "Raised Promenade";
- They recognise that the scheme is important to provide continued protection to lives and property of people within the area;
- The GRA highlighted that they felt that the seawalls along the Garrison are a "good" example of seawalls that could be adopted – they believe these seawalls to be effective;
- They feel that the dredging for the Thames Gateway Port has actually been positive. Providing some additional deposition of material which is reducing wave action along the East Beach/Garrison Area;
- One member didn't believe the flood risk from coastal sources existed and that the money should focus on drainage in the area (the area is historically a marsh);
- They would like to reduce the reliance on concrete and to protect the existing views. Their opinion was that the preferred option was "not very attractive"

3.2.4 Shoeburyness Residents Association (SRA)

The representatives of the SRA outlined the following points:

- They would like a confirmation of the number of properties at risk from flooding as previously several numbers have been quoted and they feel the message is no longer clear;
- The key objectives of the scheme must be the safety of people in the area and protection to infrastructure;
- They don't want a scheme that is not affordable, therefore it is important to ensure that the whole life costs are accurate and include maintenance costs for each of the options;
- They highlighted that Relative Sea Level Rise is occurring and is a serious issue in the Southeast of the UK due to the process of isostatic adjustment in the SE England causing land tilt. This is occurring with or without contributions to sea level rise due to Global Warming;
- The SRA want to preserve or improve the amenity value of the Shoebury Common area as this is important for local business, particularly Tom's Cabin which provides the only commercial outlet in the area, and encouraging tourists to come to "the end of the line";
- The SRA stated that the existing seawall requires maintenance as there are areas where you can "see through the wall". It was advised that this maintenance was planned to be included with the proposed preferred option, due to the scheme on hold SBC will subsequently review when the work is to be carried out;

- It is important that the proposed scheme does not lose or reduce the current level of car parking facilities;
- The SRA stated that local resident Les Dowry was around in 1953, and has anecdotally remarked that Shoebury Common didn't flood during the extreme event. This raised questions over the need for the scheme at its current proposed level;
- The SRA concluded that "It makes sense that something is done" – their preference is currently for the FoSC "Raising the Promenade" as this has least impact on the Shoebury Common area.

3.2.5 Closing Comments from Cllr Martin Terry

Councillor Martin Terry gave the following closing comments:

- Sea level rise is going to occur, we need to be prepared and this is a priority of the Government;
- The proposed preferred scheme from the PAR will not go ahead in its current form as it is unacceptable to the Public Stakeholders;
- Martin proceeded to read out letter on behalf of BERA;
- Beach recharge is an option that has not been rejected;
- MM will review the previous Stakeholder Engagement and Planning Objections.

3.2.6 Key Issues Identified by Mott MacDonald

The following issues have been identified by Mott MacDonald through the discussion at the meeting:

- In a change from the original consultation there was a general understanding of the flood risk and there is support for a scheme to go ahead. A few people query the need for the scheme based on the fact that flooding has not occurred in recent years. Whilst this may be true currently relative sea level rise will modify the sea levels and will increase the potential for flooding each year. The approach to providing continued defence should be seen as being pro-active.
- The visual impact of the scheme is a high priority and maybe hasn't been previously given such a priority – involvement of a Landscape Architect may have benefitted the proposed scheme development.
- Beach Hut Owners are strongly against moving the huts. They do not want a change from their existing view and there is a concern as to how successful it would be to move the huts. It is also noted that the quotes for the cost of moving the huts is approximately £1 Million, at this stage it is unclear who would fund this.
- The whole-life costing of schemes must be considered on an even playing field. The community do not want to commit to a

scheme which is not affordable in the immediate or long-term future.

3.3 Stakeholder Group Meeting (26th Nov 2014)

A further Stakeholder Meeting was held on the 26th November 2014 where a summary of this report (Revision A) were presented.

In general the findings were well received by Stakeholders in terms of the assessment process and the outcomes.

Following the presentation the following items were discussed:

- Options 2 and 3 regarding the provision of a wall at the rear of Shoebury Common had not been considered by the review (Revision A). While these options had been initially rejected on the grounds of aesthetics in the previous consultation it was considered important that the options be brought back to the table and reassessed against all the options.
- The Garrison development was not a driver for the scheme. The flood protection scheme would have been provided to meet the statutory duties of Southend-on-Sea Borough Council as the Lead Flood Authority. However, the inclusion of a contribution from the Garrison site developers enabled the Standard of Protection of the scheme to be raised from the economically justified 1 in 75 years to the 1 in 200 years thus providing a longer term, more robust solution.
- It was noted that the colouring of the chart within the Executive Summary depicting the traffic lights seemed to give the Friends of Shoebury Common scheme a Green for acceptance under the Stakeholder criteria. It was clarified that full details were contained within the report which clarified that this seemed to be the most supported scheme subject to further consultation and the consideration of the views of the Beach Hut Owners Association as detailed in the full table in Section 5.

This report (Revision B) has subsequently been commissioned to incorporate the assessment of Options 2 and 3 from the PAR.

4 Review of the Scheme Options

Each of the scheme options is discussed, in turn, below in terms of technical robustness, acceptability to stakeholders and environmental considerations with a rapid review of costs in a concluding section.

Given that the western extent is to provide a raised section of existing seawall, which has not received significant Stakeholder objection the review will focus on the eastern extent at Shoebury Common (Refer to Figure 4.1 below). It should be noted that this raising of the western section is not required if flood protection is provided along the rear of the B1016 road (Options F and G).

Figure 4.1: Definition of East and West Sections of the Shoebury Scheme

4.1 Option A - PAR Preferred Scheme

The preferred option outlined in the Project Appraisal process involves the construction of a new second line defence. The scheme was designed to protect against flooding with a Return Period of 1:200 Years (Annual Exceedence Probability (AEP) of 0.05%) and allowed for 50 years of sea level rise.

The set back wall involves a sheet piled structure, intended to cut off seepage through the gravel strata, set back behind the beach huts and promenade, with a concrete capping beam. In areas where sufficient space is available on the Common the scheme proposed to utilise

material made available by nearby cliff stabilisation works in order to 'landscape' up to the wall with the intention of softening the visual impact of the set back wall.

In addition to the set back wall this option requires flood gates and ramps in some locations.

This option requires the existing 1960s seawall, the groynes and the beach to be maintained as part of the defence against overtopping and requires that a system of improvement of awareness of risk and flood warning will continue to be important.

The Council prepared outline design drawings which can be found in Appendix A.

4.1.1 Technical Assessment

This is the most fully developed of all the options reviewed in this report as it was selected for outline design through the project appraisal process. The outline design is technically sound and would provide a functional flood defence against the proposed inundation levels. The design of the wall does not rely on any existing assets or beach levels in order to function; it is also of a robust construction with a sheet pile wall backed by an embankment and therefore the potential for breach of the defence under flood loading was minimised.

However, there are aspects of the design that could be altered or amended in order to minimise the impact of the scheme on the area. These items include:

- Review and optimisation of the height of the proposed wall which we believe would vary along the length depending on the structures fronting the wall. The current design proposes a single height along the entire defence length. Where the wall is set back from the seaward edge it is likely that the height of the wall could be reduced.
- Review and optimisation of the alignment of the proposed wall behind the beach huts. In combination with a review of the level of the wall the alignment should also be reviewed. The further landward the position the higher the wall will appear due to the lie of the land running away from the shoreline.
- Review and reduce the footprint of the area to be filled. The initial proposal was to raise the car parking area to reduce the

visual impact of the embankment. If there is objection to the coverage of the Shoebury Common then this could be excluded from the scheme. Opportunities to reduce the impact of the option on the green space and car park should be explored, particularly with input from a landscape architect. These opportunities should be discussed with the stakeholders to ascertain whether the option can be altered from its present form in order to make it suitable for the area and its residents.

4.1.2 Environmental considerations

It is considered that some of the amenity value of the area will be lost if the Shoebury Common area is raised.

During consultation it was identified that the landscaping and visual impact had not been considered adequately and therefore the designs did not portray a positive visual image of the proposed scheme.

This option would not impact the designated mudflat area.

Use of the West Cliff material was a positive environmental aspect provided that it could be integrated within the scheme without deteriorating the existing ground conditions.

4.1.3 Stakeholder considerations

This scheme has been discussed at length locally. Some of the key concerns include:

- Safety and security in the area once a set back wall obscures the promenade from view.
- Flooding from surface water, underground streams & springs being 'held' within the common rather than being able to freely drain into the sea.
- It is considered locally that some of the amenity value of the area will be lost if the embankment is constructed on the Shoebury Common area.

This scheme has now been rejected on the basis of the significant public objection to the scheme. Should a similar scheme be proposed it would require to address all the concerns raised during the existing consultation exercises.

4.1.4 Cost Assessment

The detailed cost breakdown of the Preferred PAR option was not considered in detail during this review because to do so would reflect the more detailed outline design of this option which is already available. Instead Mott MacDonald conducted a strategic cost assessment at a similar level of detail for all options in order undertake an independent review, assessing the headline cost and benchmarking the overall figures presented in the PAR.

It should be noted that all costs are for comparative purposes only and due to the time available for this study are based on costs for the headline items with allowances made for detailed items such as access points. Further uncertainty in the costings is related to the level of design development for each item. Uncertainties are highlighted within the description below.

Recharge costs have included an allowance for the difficulties associated with getting material into this very shallow water site.

The baseline costs are built-up from both the relevant works associated in this option and included an allowance for an initial beach recharge in the initial construction works. Therefore, units are:

- Sheet piled along 660m. approx.
- Placing material: in situ concrete, landscape and filling with borrowed material from West Cliff scheme.
- 10 Flood gates.
- Beach recharge (70,000 m3).

The whole life cost has been calculated by including the future capital and maintenance works laid out in the PAR, which are required to guarantee protection against sea level rise for the next 100 years. The resulting costs according to the gross analysis carried by Mott MacDonald are shown in the table below:

Figure 4.2: Reviewed baseline and design life costs of Option A

Option A	Costs (£m)
Baseline costs	5.0
Whole life costs	34.4

Works have been distributed as recommended in the PAR along the 100 years, and they involve further beach recharges and recycling,

surveys and maintenance of structures as well as new brand seawall and groynes.

Cost rates have been obtained from the Black & Veatch PAR, or where relevant previous Mott MacDonald projects or from SPONS's (a database of construction costs). Design life of groynes and their maintenance works have been extracted from Turner *et al.* (2011).

4.2 Option B - Friends of Shoebury Common Scheme

This option proposed by the Friends of Shoebury Common (FoSC) and detailed by APS Design Associates Limited.

This option involves a concrete / secondary set back set back wall on the site of the existing promenade, to compensate for the height of the wall the promenade is also proposed to be raised. There are currently 169 beach huts on the promenade some of which are connected to gas services which will need to be removed and replaced slightly further back onto a landscaped section of the Common.

4.2.1 Technical Assessment

This option is technically viable and could provide adequate flood protection. The current option would require further development in order to address some of the key technical issues and confirm any cost differences.

The two key issues with this scheme are firstly to confirm the required increase to the level of the promenade and secondly to understand foundation requirements for the raised promenade. The current proposal shows a new mass concrete promenade constructed above the existing seawall. Investigations and analysis would be required to confirm that the existing seawall could act as a foundation for the raised promenade element without additional supports required. Should the existing wall not be sufficient then the solution would be to introduce piles to support the additional load. While this provides a technical solution it also would add a significant additional cost to the scheme.

The available West Cliff fill material could be utilised in this scheme as fill material for earthworks at the rear of the raised promenade to provide slopes back into the existing levels on the Shoebury Common.

Providing increased flood protection along the existing seawall would require a slightly higher crest level of the defence when compared with a setback wall due to the mechanics of wave overtopping.

The reliance of this option on the continued maintenance and support of the existing seawall provides a greater residual risk of failure. In order to reduce the residual risk the existing seawall would in all likelihood require to be replaced with a solution designed to support the raised promenade, particularly over the 100 year life of any proposed scheme. Whilst this is technically achievable it could add additional cost to the scheme.

4.2.2 Environmental considerations

This option still requires some landscaping of Shoebury Common which is not considered acceptable to the public in Option A, the PAR option. The team will need to consult with the public on this and on the potential need for piling if this scheme is to be developed and carried forward.

This option would not have a long-term impact on the designated foreshore areas. Any lighting on the raised promenade would require approval from Natural England who would want to ensure light does not spill onto the foreshore and disturb the feeding birds.

4.2.3 Stakeholder Considerations

This option has wide support from a range of stakeholder groups. The main objection to the scheme is likely to come from the Southend Beach Hut Owners Association, some promenade users, and residents with properties that overlook Shoebury Common. These objections are likely to be based on the visual change that a raised promenade and beach huts would bring to sight lines, as well as the construction requirement to remove and replace the beach huts.

4.2.4 Cost Assessment

As part of this review we have undertaken a separate costing exercise to assess the cost impact. Our costing of this option generally supports the costing previously undertaken by Black & Veatch, and puts the initial construction cost of the scheme at circa £6.4m. This cost is based on the supplied drawings and doesn't take account of any amendments required to the design to ensure it is technically feasible.

A key uncertainty with initial construction cost of this option is associated with the moving and replacement of the Beach Huts. The Black & Veatch costing allowed for a cost of £200k to move and replace the beach huts on to the raised promenade. A cost of circa £900k was advised as the cost to replace all 169 beach huts with new should the moving of the beach huts mean that they are irreparably damaged. At this stage the costs for removal of the beach huts has not been included in our costings because funds for moving the beach huts would not come from Defra/EA flood defence budgets.

The cost of any foundation works required, such as the provision of piles, has not been considered and would increase the current cost estimate.

The baseline costs are made up from both, the relevant works associated to this option plus the costs of an initial beach recharge in the initial construction, similar to Option A.

- Setback in situ concrete wall.
- Raising huts.
- 3 Flood gates.
- Beach recharge (70,000 m3).

Within the costing of this option an initial beach recharge was included in the initial capital construction costs because we consider that continued 'maintenance' of the existing seawall would require a beach fronting the wall. This has been included as it is recommended to help support the load increase and to provide additional resistance and protection to the foundations of the existing seawall.

The raised promenade option will still leave the existing 1960's seawall as part of the main coastal defence structure which, as previously stated has a residual structural life of 15-30 years. Therefore, continued maintenance is required to be carried out. Future maintenance works as allowed for in Option A have been considered in the calculation of the whole life costs. It should be noted that there would be a residual risk that further degradation of the wall may require the existing wall to be entirely replaced if maintenance becomes unsustainable. This cost has not been included in the whole-life cost at this stage but if this option is developed further it should be assessed whether replacement of the existing seawall element as part of the raised promenade is a more cost effective long-term solution.

The table below shows the incurred costs resulted from the analysis of this Option B.

Figure 4.3: Reviewed baseline and design life costs of Option B

Option B	Costs (£ Million)
Baseline costs	6.4
Whole life costs	35.5

4.3 Option C - Marmus Scheme

This alternative option, also proposed by the Friends of Shoebury Common, involves raising the level of the beach by placing fill material (recently made available by the West Cliff stabilisation scheme) within geotextile along the toe of the seawall and also increasing the seawall crest level by some 600mm to reduce potential overtopping.

4.3.1 Technical robustness

The main technical issue relating to this option is the untested provision of clay material within a geotextile under the beach. There is a high uncertainty of the impact on the coastal processes and the ability for the beach material to remain in-situ. There is a potential that as the clay material is of significantly lower permeability this will alter the groundwater profile within the beach and cause an increase in the rate of erosion of beach material.

Further investigation into the seawall to consider what improvements would need to be made to the wall in order to support the raising of the wall would also need to take place. There are also concerns regarding the stability of the wall with the height of the seawall upstand increasing the potential for rotational failures when under wave load.

4.3.2 Environmental considerations

If the beach footprint within this scheme encroached on the designated mudflats then acceptability and mitigation measures would have to be discussed with Natural England.

4.3.3 Stakeholder considerations

This option does not require the beach huts to be removed for construction (or only a minimum number in order to provide construction access). However, the increased crest wall height would partially obscure the existing view from the beach huts.

Access from the promenade to the beach for pedestrians and disabled users would also need to be reconfigured in order to get up and over the raised defence.

4.3.4 Cost Assessment

The initial construction capital costs that have been considered for this option are:

- Beach management: excavation, screening of material, geotextile disposition, imported material from West Cliff scheme and filling to make up beach levels (approx. 59,000 m3)
- Raise the seawall by 600mm along the East seawall (600 m approx.) with in situ concrete previous conditioning of surfaces.
- 6 timber groynes to replace the existing groynes, providing greater height and length.

Like the previous two options (A and B), the proposal still leaves the existent seawall as the main coastal defence, so the construction of a brand new seawall together with the other maintenance works named before have also been included in the overall future works. This would provide protection against sea level rise over the next 100 years. The table below summarises the resulted capital costs for the initial capital costs and for the whole life of this scheme.

Figure 4.4: Reviewed baseline and design life costs of Option C

Option C	Costs (£m)
Baseline costs	3.6
Whole life costs	29.3

4.4 Option D – Burgess Estate Residents Association Scheme

The Burges Estate Resident's Association (BERA) put forward an alternative scheme in a letter dated 23rd May 2013 from Councillor Ron

Woodley, Chairman of the Burges Estate Residents' Association to Mr Andrew Lewis, Corporate Director for Place, Southend-on-Sea Borough Council.

This option involves raising the seawall and managing the beaches. The seawall is to be raised by 300mm, with the raised seawall intended to rely on increased beach levels to support the wall as well as dissipate some of the wave energy prior to waves impacting the wall. The management of the beach would be achieved through the installation of a field of wooden groynes 50m in length at 50m spacing (the crest height of the groynes is not given). A crescent shaped concrete/rock groyne (crest level not given) is included to act as a terminal groyne this would act to break incoming waves and prevent the loss of beach material beyond the Shoebury Common frontage. In addition, monitoring of beach levels and beach recharge is also to be included.

4.4.1 Technical robustness

Providing additional unsupported upstand height to the existing seawall would require analysis to determine if the seawall foundation could withstand the additional lever-arm without resulting in a rotational failure even though in this option the anticipated wave attack would be reduced due to the breakwater and additional groynes maintaining increased beach levels.

This option is reliant on beach levels to reduce overtopping and to protect a raised sea wall. There are concerns that raising the seawall without additional improvements/replacement of the foundations, may result in foundation failure.

For any option which relies on beach levels to form part of the defence against flooding there will always be a residual risk that the beach level could be low when a storm commences, or reduced during prolonged storm activity resulting in a reduction in protection. Beach levels could be low due to encountering previous storms, or due to the cyclical nature of beach nourishment (i.e. nourishment planned every 5 years and the storm occurs in 4 Years and 11 months into the programme). Low beach levels would compromise the ability of the beach to dissipate wave energy, allowing larger waves to attack and potentially destabilise the seawall. This issue could be overcome with the construction of a new seawall and foundation along the shoreline but would significantly increase the cost of the scheme.

Rock groynes are generally robust structures but as such they have a relatively large footprint on the foreshore. In order to design the groyne a detailed assessment of the wave climate, substrate and rock sizing would need to be undertaken. The geometry of a rock groyne requires a suitable crest width and between 1:2 to 1:4 side slopes, from the crest level down to a suitable founding level.

4.4.2 Environmental considerations

The biggest environmental issue relating to this option is the construction of the rock terminal groyne. Natural England, who are one of the key statutory consultees for coastal schemes, are likely to object to the construction of the rock groyne on the mudflat area. The mudflats form part of the designated foreshore area which supports the large over-wintering bird population. This would need to be discussed with Natural England at the earliest stages of consideration.

A key environmental consideration would be the footprint of this terminal groyne on the foreshore and this is likely to be Natural England's key concern with this option.

4.4.3 Stakeholder considerations

This option would seem to be generally acceptable to most local stakeholders although this option has not been presented for Public Consultation.

Objection to this option could come from the Southend Beach Hut Owners Association and its members, as well as some promenade users owing to the small increase in wall height which would impact the sight lines available from the promenade.

This option would not require the beach huts to be moved.

4.4.4 Cost Assessment

The initial capital costs included in this option involve:

- Beach recharge: a small beach recharge has been allowed for to top up the newly created groyne bays after construction.
- Raise the existing seawall by 300mm along the whole section (projected from the BERA's letter) with in situ concrete,.
- 50m long groynes provided at 50m intervals.

- Terminal rock groyne.

The initial construction cost of this scheme is estimated to be approximately £3.4m.

Future maintenance works would consist of maintenance to the timber groynes and beach levels (in the form of recharge and recycling). As timber groynes would be utilised an allowance for major overhaul and reconstruction of the groynes every 25 years has been provided.

The costs of this option for the initial construction and 100 year whole-life costs are summarised below:

Figure 4.5: Reviewed baseline and design life costs of Option D

Option D	Costs (£m)
Baseline costs	3.4
Whole life costs	18.1

4.5 Option E - Glass Wall Scheme (Flood Protection International Ltd)

Following news of the Shoebury Common scheme Flood Protection International Ltd. proposed the use of their glass flood wall product to provide increased protection.

The concept of the option is to affix stainless steel upstand posts at fixed intervals, between which glass panels would be installed. The glass panels would provide a continuous increase to the existing seawall level.

The technical assessment of this option within this report is limited as it is not as developed as other options and no drawings are available. Further detailed technical assessment of this option would be required to confirm its viability.

4.5.1 Technical robustness

Glass panel walls have been successfully implemented along rivers and in sheltered areas not exposed to significant wave action. We are currently unaware of any installation where glass panels have been used as a primary defence against potential wave action.

The solution of raising the existing seawall with glass panels is constructible and could form a functional flood defence. However, there are a number of technical issues that would need to be addressed and confirmed before the option could be considered as a feasible alternative:

- Breaking waves can induce loads significantly greater than still water and can also carry debris or beach material at high velocities. These loads and debris could combine and cause the brittle glass panels to shatter leading to flooding.
- The brittle nature of glass means that they are prone to fatigue failure. It would need to be established that the panels could withstand repeated storm loadings.
- Providing further unsupported upstand height to the existing seawall would require analysis to determine if the seawall foundation could withstand the additional lever-arm without resulting in a rotational failure.
- Access points from the promenade on to the beach would require significant reconfiguration in order to maintain a continuous defence line and viable access to the beach.
- Other minor technical issues relate to the aesthetic durability of the glass (e.g. would it gradually become frosted due to sand abrasion during future storms).
- The option relies on the existing seawall being structurally sound. This includes a reliance on beach levels in front of the structure being maintained and critically in place during a storm event to prevent undermining of the existing seawall. This issue could be overcome with the construction of a new seawall foundation along the shoreline but would significantly increase the cost of the scheme.

4.5.2 Environmental considerations

This option would have a minimal impact in terms of environmental impact on ecology and the designated foreshore areas. The primary consideration in terms of environment would be the visual impact and its impact on the views of the shoreline.

Secondary issues that would require resolving include the retention of access points for all users including the disabled, these would need to be constructed up and over the raised defence.

Lastly it should also be considered from an amenity point of view that although the majority of the structure would be glass and therefore should give a relatively open and transparent outlook, the support system would involve substantial steel framing which could prove obtrusive to the view.

4.5.3 Rapid review of baseline & whole life cost

During the costing exercise, undertaken as part of this review, indicative costs for the proposed wall were obtained from Flood Protection International Ltd. As a baseline construction cost for comparison purposes only indicate a scheme would cost in the region of £5.9m.

At this stage the maintenance costs are uncertain. In theory maintenance of this option would be limited to replacement of any glass panels showing signs of damage or defects.

Future raising of the defence level, if sea level rise exceeded current predictions or to provide continued protection in beyond the 50 year horizon, would be difficult. The entire glass panel system would need to be removed and replaced with larger panels.

4.5.4 Stakeholder considerations

The primary stakeholder considerations relate to the acceptability of the scheme to the Beach Hut Owners and Promenade Users with regards to the visual and access impacts.

This option would not require the beach huts to be removed as its construction would be along top of the existing seawall.

In general this option meets the other stakeholder aspirations as it would not have any impact on the Shoebury Common area.

4.6 Option F - PAR Option 2: Setback Wall

The PAR considered an option to provide a setback wall behind the B1016 Shoebury Common Road. The wall ran from Maplin Way and terminated at the large grassed area landward of the B1016 Shoebury Common Road. Owing to the ground levels being significantly lower behind the B1016 the wall to be provided is approximately 2.1m in

height, this section of wall also requires 17 flood gates in order to retain the access points to each of the residential houses. Further east an additional section of wall would tie-in to the higher ground and run along the western edge of Waterford Road. This would then be broken by the provision of a large 15m wide flood gate across the B1016 Shoebury Common Road before the a wall continued along the boundary of the MoD site and interfaced with the MoD seawall.

The set back wall involves a sheet piled structure, intended to cut off seepage through any gravel strata, this would be clad with a brick fascia, with a concrete capping beam. The large 15m wide flood gate at the eastern extent across the B1016 would require to be mechanised due to the size and weight of the gate.

The Council prepared outline design drawings, which can be found in Appendix A.

4.6.1 Technical Assessment

This option can be developed further to provide the required 1 in 200 year Standard of Protection. The residual risk of the structures is low as they would be constructed around a new sheet pile core and would therefore not be reliant upon any existing structures.

The main residual risk would relate to the provision of flood gates as these would require to be closed during a flood event. In particular the 17 gates along the section of wall along the B1016 residential properties is a significant number of potential weak points in the flood defence system. A clear understanding and agreement by the property owners and SBC would be required to ensure who is responsible for the operation and maintenance of the flood gates.

There would be no requirement to move, temporarily or permanently the beach huts on the promenade.

The option would need to carefully consider if the beach and the seawall along the promenade were to be considered as a part of the overall flood defence system as this could affect the height required for the setback wall.

The works to the Western Section of the seawall (as defined in Figure 4.1) would not be required with this scheme as the defence line would be setback.

There are aspects of the option design that could be altered or amended in order to optimise the solution. These items include:

- Review the requirement to provide floodgates at each property along the B1016 to try to reduce the number of flood gates within the scheme.
- Review the requirement for the 15m wide flood gate. Determine if carriageway realignment or position of the gate could reduce the width required.
- Review and optimisation the level of the wall ensuring that the minimum level to achieve the Standard of Protection is provided.
- Within the PAR the B1016 Shoebury Common Road was considered to be “Critical Infrastructure” which would require access by the Emergency Services. This requirement should be reviewed to understand if there are any suitable alternative access roads.

4.6.2 Environmental considerations

One of the key reasons this option was not progressed from the PAR was the objection to a wall approximately 2.1m high, which would look quite imposing on the area.

The option should be reviewed in detail to understand the potential options for mitigating and minimising the visual impact of the setback wall. However, it would be difficult to get away from the large structures required in order to provide adequate flood protection, particularly at the flood gate across the B1016.

This option would not impact the designated mudflat area.

4.6.3 Stakeholder considerations

This scheme was presented at the consultation events for the PAR. Some of the key concerns include:

- Visual impact on the area with such a large setback wall, particularly where the wall comes to cross the B1016 this could create the feeling of a gated community.
- The B1016 would become flooded during a large flood event and access / egress to residential properties would be restricted.

In the latest stakeholder meetings this option was requested to be assessed. Primarily this option provides a solution that has minimal impact on the beach, promenade and grassed areas of Shoebury Common on the seaward side of the B1016. Whilst this is clearly acceptable to the Stakeholder Groups currently engaged during this review it would require further consultation with wider groups who utilise the B1016 and the residents whose would subsequently have the flood wall provided at their property boundary.

4.6.4 Cost Assessment

A cost breakdown was prepared utilising the same methodology as the other options within this report. Mott MacDonald conducted a strategic cost assessment at a similar level of detail for all options in order undertake an independent review, assessing the headline cost and benchmarking the overall figures presented in the PAR.

It should be noted that all costs are for comparative purposes only and due to the time available for this study are based on costs for the headline items with allowances made for detailed items such as access points. Further uncertainty in the costings relates to the level of design development for each item. Uncertainties are highlighted within the description below.

Unfortunately within the timeframe given for this study it has not been possible to obtain quotes for some of the largest motorised gates as detailed in the Black and Veatch option. The dimensions for flood gates were taken from drawings in Appendix A:

- 6.75mW x 1.00mH (Western Section)
- 4.9mW x 1.7mH
- 11.7mW x 2.0-2.65mH
- 4.26mW x 1.65mH
- 3.1mW x 2.5mH
- 5.3mW x 1.8mH

In order to provide costs for the option within the timeframe given for undertaking this study we have altered the option to exclude motorised gates and to instead provide costs for a series of smaller gates covering the same length, coupled with varying boundary levels/wall lengths etc. which would achieve the same flood protection. Should SBC wish to pursue this option further these costs would be revised.

As a result of this change the dimensions provided for the new flood gates are:

- 1.00mW x 2.00mH (x17 no.)
- 5.00mW x 1.00mH (x1 no.)
- 5.00mW x 1.7mH (x2 no.)
- 5.00mW x 2.00mH (x2 no.)
- 3.00mH x 2.00mH (x2 no.)
- 5.00mW x 1.8mH (x1 no.)

Our baseline costs are built-up from both the relevant works associated in this option and included an allowance for an initial beach recharge in the initial construction works. Therefore, units are:

- Demolition 450 linear meters of wall up to 2m height.
- Sheet piling along 580m. approx. and 6.65m depth.
- Placing material: in situ concrete, landscaping and filling with borrowed material from West Cliff scheme.
- Flood gates described above
- Beach recharge (70,000 m3).

The whole life cost has been calculated by including the future capital and maintenance works laid out in the PAR, which are required to guarantee protection against sea level rise for the next 100 years. Confirmation of the items to be included within the whole-life in terms of maintenance of the seawall would need to be reviewed and confirmed during a detailed revision of the option. The resulting costs according to the gross analysis carried by Mott MacDonald are shown in the table below:

Option F	Costs (£m)
Baseline costs	4,600
Whole life costs	33,700

Works have been distributed as recommended in the PAR along the 100 years, and they involve further beach recharges and recycling, surveys and maintenance of structures as well as new brand seawall and groynes as these come to the end of their structural lives.

Cost rates have been obtained from the Black & Veatch PAR, or where relevant previous Mott MacDonald projects or from SPONS's (a database of construction costs). Design life of groynes and their

maintenance works have been extracted from Turner *et al.* (2011). Recharge costs have included an allowance for the difficulties associated with getting material into this very shallow water site.

4.7 Option G - PAR Option 3: Setback Wall with Embankments and Road Raising

Option G (PAR Option 3) was a modification of previous option. It considered the provision of a similar setback wall behind the B1016 Shoebury Common Road. The wall ran from Maplin Way and terminated at the large grassed area landward of the B1016 Shoebury Common Road. Owing to the ground levels being significantly lower behind the B1016 the wall to be provided is approximately 2.1m in height, this section of wall also requires 17 flood gates in order to retain the access points to each of the residential houses. Further east at Waterford Road the option differed to the previous option with the provision of an embankment and a re-alignment of the road to minimise the wall height and the gate heights and widths.

The set back wall involves a sheet piled structure, intended to cut off seepage through any gravel strata, this would be clad with a brick fascia, with a concrete capping beam. The width of the B1016 Shoebury Common Road would be realigned to minimise the flood gate width.

The Council prepared outline design drawings, which can be found in Appendix A.

4.7.1 Technical Assessment

This option can be developed further to provide the required 1 in 200 year Standard of Protection. The residual risk of the structures is low as they would be constructed around a new sheet pile core and would therefore not be reliant upon any existing structures. The smaller sized flood gates in the eastern section of wall would be easier to maintain and operate.

The main residual risk would relate to the provision of flood gates as these would require to be closed during a flood event. In particular the 17 gates along the section of wall along the B1016 residential properties is a significant number of potential weak points in the flood defence system. A clear understanding and agreement by the property

owners and SBC would be required to ensure who is responsible for the operation and maintenance of the flood gates.

There would be no requirement to move, temporarily or permanently the beach huts on the promenade.

The option would need to carefully consider if the beach and the seawall along the promenade were to be considered as a part of the overall flood defence system as this could affect the height required for the setback wall.

The works to the Western Section of the seawall (as defined in Figure 4.1) would not be required with this scheme as the defence line would be setback.

There are aspects of the option design that could be altered or amended in order to optimise the solution. These items include:

- Review the requirement to provide floodgates at each property along the B1016 to try to reduce the number of flood gates within the scheme.
- The current option with embankments still requires some wall to obtain the 1 in 200 Year flood defence level. Additional review of the option could assess if a more extensive re-alignement of the roads at the B1016 and Waterford Junction could achieve the flood defence level without the need for a wall as this would then remove the requirement for a gate. This would greatly reduce the residual risk within the scheme. It may also be considered that embankments are more visually acceptable than walls.
- Review and optimisation the level of the wall ensuring that the minimum level to achieve the Standard of Protection is provided.
- Within the PAR the B1016 Shoebury Common Road was considered to be “Critical Infrastructure” which would require access by the Emergency Services. This requirement should be reviewed to understand if there are any suitable alternative access roads.

4.7.2 Environmental considerations

This option attempts to mitigate and minimise the visual impact of the eastern section of the setback wall and flood gates using embankments to minimise wall heights and road realignment to minimise the gate width. However, owing to the restricted space the western section of setback wall along the B1016 from Maplin Way would still be visually intrusive at nearly 2.1m in height.

This option would not impact the designated mudflat area.

Use of the West Cliff material for the construction of the embankments would be a positive environmental aspect provided that it could be integrated within the scheme without deteriorating the existing ground conditions.

4.7.3 Stakeholder considerations

This scheme was presented at the consultation events for the PAR. Some of the key concerns include:

- Visual impact on the area with such a large setback wall,
- The B1016 would become flooded during a large flood event and access / egress to residential properties would be restricted.

In the latest stakeholder meetings this option was requested to be assessed. Primarily this option provides a solution that has minimal impact on the beach, promenade and grassed areas of Shoebury Common on the seaward side of the B1016. Whilst this is clearly acceptable to the Stakeholder Groups currently engaged during this review it would require further consultation with wider groups who utilise the B1016 and the residents whose would subsequently have the flood wall provided at their property boundary.

4.7.4 Cost Assessment

A cost breakdown was prepared utilising the same methodology as the other options within this report. Mott MacDonald conducted a strategic cost assessment at a similar level of detail for all options in order undertake an independent review, assessing the headline cost and benchmarking the overall figures presented in the PAR.

It should be noted that all costs are for comparative purposes only and due to the time available for this study are based on costs for the headline items with allowances made for detailed items such as access points. Further uncertainty in the costings relates to the level of design development for each item. Uncertainties are highlighted within the description below.

The main difference between this option and Option F relates to filling volumes and the dimensions of the flood gates. The volume of material required to raise the road was estimated based on available drawings. Flood gate dimensions where either noted on drawings or measured/scaled, to give the following list:

- 6.75mW x 1.00mH (Western Section)
- 5.13mW x 1.47mH
- 14.8mW x 0.66-1.2mH
- 5.05mW x 2.35mH
- 3.1mW x 2.5mH
- 4.26mW x 1.65mH

The same approach as for Option F has been taken where we propose to either reduce and/or divide the designed gates, resulting:

- 1.00mW x 2.00mH	(x17 no)
5.00mW x 1.00mH	(x4 no)
- 5.00mW x 1.70mH	(x2 no)
- 5.00mW x 2.00mH	((x1 no)
- 3.00mW x 2.00mH	(x2 no)

As per the previous option, the baseline costs were built-up from both the allocated relevant works, plus an allowance for an initial beach recharge. Year 0 costs then include:

- Demolition 450 linear meters of wall up to 2m height.
- Sheet piling along 580m. approx. and 6.65m depth.
- Placing material: in situ concrete, landscape and filling with borrowed material from West Cliff scheme.
- Flood gates as described above
- Beach recharge (70,000 m3).

The whole life cost has been calculated by including the future capital and maintenance works laid out in the PAR, which are required to guarantee protection against sea level rise for the next 100 years. The resulting costs according to the gross analysis carried by Mott MacDonald are shown in the table below:

Option G	Costs (£m)
Baseline costs	4,400
Whole life costs	33,500

Works have been distributed as recommended in the PAR along the 100 years, and they involve further beach recharges and recycling, surveys and maintenance of structures as well as new brand seawall and groynes. Recharge costs have included an allowance for the difficulties associated with getting material into this very shallow water site.

Cost rates have been obtained from the Black & Veatch PAR, or where relevant previous Mott MacDonald projects or from SPONS's (a database of construction costs). Design life of groynes and their maintenance works have been extracted from Turner *et al.* (2011).

5 Summary and Recommendations

5.1 Summary

This review has revisited the available information in order to ensure that the options tabled to date have been assessed on a comparable level.

In terms of the need for the scheme there is general consensus within the stakeholder groups that there is a need for the scheme in order to provide long-term flooding protection. However, information on the project drivers could have been conveyed more clearly as even during this review we have been unable to close some of the key knowledge gaps from the available documentation.

Our review has found that although the proposed preferred scheme within the PAR would have provided a functional and robust flood defence with a reasonable economic return, it is clearly unacceptable to the local stakeholders in its current form.

Costs were generated in order to benchmark and allow for an indicative comparison between options. Due to the time available for this study costs are based on headline items with allowances made for detailed items such as access points. The greatest uncertainty in the costs are related to the level of design development for each option and the limited design information that is available for the less developed alternative options. Uncertainties in the costs are highlighted within the discussion of each option.

Although not the subject of the review it is noted that earlier involvement and consultation of stakeholders in the PAR process may have assisted in the option development and selection.

While the range of alternative options proposed differ in their level of development it is clear that each scheme has its own merits and failings. In particular it has become clear that there is no single solution which is unanimously acceptable to all the differing stakeholder groups.

The following sections of the review look to provide recommendations in order to develop a scheme which is acceptable to the majority of stakeholders whilst also being technically robust.

The following table provides a summary of the options against the criteria in this review. A short commentary is provided to give an indication as to the classification. The association of the colours follows the general rules:

- Red - indicates that there is a significant issue with the criterion for that option,
- Orange – indicates that there is at least one issue raised that requires further information or development in order to determine the impact or if the option remains feasible.
- Green – indicates the option is generally acceptable for the criterion.

Many of the uncertainties relating to the alternative options are as a result of the level of design development that has been provided in the options to date. In general further design development would allow these unknowns to be reviewed and addressed. Where a significant issue is already identified this should be confirmed first before any further design progression is undertaken.

OPTION	ASSESSMENT CRITERIA			
	Technical	Economic	Environment	Stakeholder
A (PAR)	Robust solution with minimal residual risk in providing flood risk protection	Was determined to be the most cost effective in the PAR	Doesn't impact designated foreshore areas. Ramps provided for access over flood wall.	Not Acceptable to local public organisations
B (FoSC)	Robust solution but requires further design of foundation. Some residual risk due to reliance on existing seawall.	Initial capital cost is marginally higher than PAR scheme. Whole-life cost needs to determine anticipated beach recharge allowances.	Doesn't impact designated foreshore areas. Ramps provided for access on to beach.	Has strong support but would need to address issues relating to the beach huts.
C (MARMUS)	The provision of fill material beneath a beach to raise beach levels is untested.	Low initial construction costs. Whole-life cost needs to determine anticipated beach recharge allowances.	Is potentially unacceptable to Natural England due to imported material being placed below the existing beach.	Level of stakeholder acceptance unknown as option has not been previously presented in public forum.
D (BERA)	Relies on the performance of beach levels as part of the primary defence. Therefore has significant residual risks	Low initial construction costs and whole life maintenance. However, scheme in current form does not provide 100 year benefits.	Is unlikely to be acceptable to Natural England due to construction of rock groyne on the designated mudflats	Some support from stakeholders. Further consultation would be required to determine if this could be a preferred option.
E (Glass Walls)	Glass wall panels and existing seawall would require assessment to confirm ability to withstand direct wave loading. High residual risk of glass panel failure.	Initial capital cost is likely to be high. Potentially low whole-life cost as limited maintenance.	Low environmental impact	Level of stakeholder acceptance unknown as option has not been previously presented in public forum. Unlikely to be supported by Beach Hut Owners

OPTION	ASSESSMENT CRITERIA			
	Technical	Economic	Environment	Stakeholder
F (PAR Option 2: Setback Wall)	Robust solution as no reliance on existing structures. Residual Risk relates to the significant number of flood gates required.	Capital and Whole-life costs are likely to return adequate cost benefit.	Has no impact on the designated foreshore or the promenade. Visual impact of wall may be unacceptable	Acceptable solution to the majority of the stakeholder groups engaged to date as no impact on the main frontage. Would require consultation with residential properties backing on to the B1016.
G (PAR Option 3: Setback Wall with Embankments)	Robust solution as no reliance on existing structures. Residual Risk relates to the significant number of flood gates required.	Capital and Whole-life costs are likely to return adequate cost benefit. This option is likely to be marginally less expensive than Option F (depending on final alignments)	Has no impact on the designated foreshore or the promenade. Visual impact of wall may be unacceptable but likely to be more acceptable than Option F.	Acceptable solution to the majority of the stakeholder groups engaged to date as no impact on the main frontage. Would require consultation with residential properties backing on to the B1016.

5.2 Clarification of the Flooding Drivers for Scheme

At present it appears that a thorough appraisal of the flooding issues at the site would benefit the scheme. There are some key residual unknowns, in terms of the mechanism and propagation of flooding. A review of this would help to communicate the risk to Stakeholders and may also help to develop alternate solutions.

It is also understood that the flood outlines are principally based on wave overtopping calculations situated at the location of the existing sea wall. If the flooding mechanisms are fully understood there may be opportunity to optimise the levels of the options and still to provide similar flood protection performance.

5.3 Stakeholder Engagement

Owing to the popularity of the area this is a highly emotive scheme. It is clear from our review of previous consultation responses that moving forward there should be a review of the underlying drivers for the scheme in order that they can be clearly communicated. Secondary issues should also be clearly communicated i.e. the contribution from other developers and the beneficial reuse of local material from other schemes.

It would be our recommendation that further development of any scheme be carried out with a high level of stakeholder engagement. Further reviews and development of the options would most likely be very beneficial to work through the next stages of development of any future schemes with the local stakeholders, a team of SBC representatives and Mott MacDonald staff from a range of disciplines.

It is proposed that a workshop could be held with the groups that attended the recent Stakeholder Meeting (September 2014) where ideas can be discussed and stakeholder's priorities can be better understood which will be absorbed in order to derive a technically robust, economically sustainable solution.

The team will then develop the ideas from the Workshop before a wider consultation campaign can take place prior to agreeing a Preferred Option.

5.4 Involvement of Specialist Disciplines

In recognition that no single option will suit all parties it will be key to seek ways to minimise the impact of any proposed schemes and identify opportunities for maximise the acceptance. We recommend that a landscape architect is involved at an early stage in the development of further options in order to assist with this.

5.5 Dividing the Scheme into Sections

While the scheme has to be completed as a single construction project it may be helpful to split the scheme in to two sections. The west section where the beach huts are seaward of the seawall generally has been the least controversial with stakeholders and the option to raise the existing seawall where required has received little comment.

This would allow the development of options to focus on the controversial area where the beach huts are located behind the promenade where potential alignments

5.6 Development of the Stakeholder Proposed Schemes

At present this report has been conducted in a short period to facilitate the review timeframe. Moving forward it may be helpful to progress two or more alternate schemes to the same level of detail as that of the Preferred PAR option so that they are directly comparable. This will allow a more accurate understanding and comparisons of the options and will remove some of the uncertainty due to the varying information available for each option

6 References

Baxter, 2005 - The east coast Big Flood, 31 January–1 February 1953: a summary of the human disaster. Phil. Trans. R. Soc. A, 15 June 2005 vol. 363 no. 1831 1293-1312

BBC, 2003 – The Great Flood of 1953. http://www.bbc.co.uk/dna/ptop/plain/A65192231

Environment Agency, 2011a – Coastal flood boundary conditions for UK mainland and islands. Project: SC060064/TR2: Design sea levels. Flood and Coastal Erosion Risk Management Research and Development Programme.

Robinson, 1953 – The Storm Surge of 31st January - 1st February, 1953: and the associated metrological tidal conditions. *Geography* Vol. 38, No. 3 (JULY, 1953), pp. 134-141.

Turner R., Kemp. J., Brampton, A. Tonks, V. Phipps, P. and Oakes, T. (2011) Evaluating the Performance, Cost and Amenity Value of Timber & Rock Groyne Beach Management Structures: Deriving a Coastal Management Scheme for Central Felixstowe.

Appendices

Appendix A. Drawings and Visualisations of Option A