Pagham Beach and Harbour Entrance
Potential Intervention Measures

Consultation on Concept Options – Monday 6th October 2014

Pagham Parish Council

29th October 2014 Draft for Approval of Attendees at Workshop Meeting

PB1354

Royal HaskoningDHV
Enhancing Society Together

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1 INTRODUCTION

1.1 Introduction

A workshop meeting was held on the 6th October 2014 at the Haywards Heath office of Royal HaskoningDHV to discuss and develop an earlier version of this report. In attendance were Pagham Parish Council (PPC), Arun District Council (ADC), the Environment Agency (EA), Natural England (NE), the Royal Society for the Protection of Birds (RSPB), Pagham Beach Holdings (PBH), the Arun Cabinet Member for the Environment, the local MP for Bognor Regis and Littlehampton, and Royal HaskoningDHV (RHDHV).

The workshop meeting formed part of the second of three phases in seeking to identify an approved long term sustainable scheme for protecting Pagham Beach against the present problems of coastal erosion and excessive wave overtopping. The aim was to identify one or more options to take forward to formal application and approvals. The first phase looked at issues and criteria that would be used by the regulators in assessing intervention measures. The next phase will be the formal application based on the short listed option identified in this report. PPC are looking for a conclusion to the formal application process by the 31st March 2015.

There was an expectation that the consultation would be undertaken in a spirit of openness and cooperation, and in the common belief that it should be possible to find a solution that is acceptable to all parties involved. It was noted that there is a strong 'political' will to resolve the present problems facing Pagham Beach.

The present problems are mainly caused by the encroachment of Pagham Harbour entrance channel onto Pagham Beach and an associated reduction of natural beach feed onto the frontage. As a result Pagham Beach has suffered significant erosion and the residential properties along the beach are becoming increasingly vulnerable to coastal flooding.

The solution strongly favoured by the local community is to cut a new channel entrance in line with the existing steel sheet piled training wall and thereby restore the harbour entrance channel to its pre-2001 position. This would eliminate the present encroachment of the channel onto Pagham Beach. It would also potentially allow shingle from the redundant spit to the north of the new channel to feed onto Pagham Beach.

However, Pagham Harbour is a very important conservation area where the ideal would be no intervention works at all.

Historically works have been undertaken to control the harbour entrance channel including an artificial closure in the late 1800s and the construction of the existing steel sheet piled training wall in the 1950s supplemented by timber groynes along Church Norton spit (see Appendix A for further details).

At present there is a Management Plan in place being implemented by Arun District Council and the Environment Agency (Decision Framework for Adaptive Management at Pagham Harbour) which extends to the northern extent of Pagham Beach. Adaptive Management is currently recommended for Pagham as the natural geomorphological

developments cannot be accurately predicted. The Management Plan states that a flexible approach, which builds on knowledge gathered over time, is an appropriate way of managing flood and erosion risk with the requirements of the nationally and internationally designated natural conservation sites. Natural England fully supports this approach and is a member of the established advisory group.

1.2 Attendees

Attendee Name	Organisation	Contact Details
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Table 1.1: List of Meeting Attendees.

1.3 Purpose of this Report

The main purpose of this report is to build on the Phase 1 report (July 2014) and identify one or more options to go to forward to the Phase 3 formal application.

This report is based on the workshop meeting held on the 6th October 2014 which in turn was based on an initial version of this report.

The main focus of the workshop meeting was on regulatory issues rather than engineering and funding.

1.4 Background to Concept Options

This report presents a range of solutions in terms of location, type and materials in order to build a framework of understanding.

The concept options are based on the notional options identified at Phase 1 and some further development based on best judgement using initially available information. No detailed investigations or modelling have been undertaken.

In terms of the engineering there are two key aspects, structural stability and the ability of the structure to achieve its required purpose. With regards to structural stability there is reasonable certainty that the structures can be designed to withstand their working conditions. However, there is less certainty in respect of their ability to produce the desired outcome.

For example, a structure designed to re-direct the entrance channel may be bypassed due to the dominance of the natural processes. Alternatively, a structure that successfully re-directs the channel as intended may then cause its subsequent closure. These issues would be addressed in more detail in the next phase. Also there is uncertainty concerning the prevailing conditions which may change and leave the structure less suited to the new situation.

The concept options fall into one of two main categories. The first seeks to 'steer' but not 'stop' natural processes and the second in effect 'stops' some aspect of the natural processes.

Also the concept options utilise three main types of material; shingle, rock and steel sheet piles.

Shingle structures rely on their bulk volume for their stability. They would blend in well with the surroundings and after initial construction their size can be readily increased or decreased to suit the situation.

Rock structures mainly rely on their weight for their stability. They would have some compatibility with the surroundings and their size can be readily increased or decreased after initial construction. Relative to steel sheet piled structures, they have a large footprint.

Steel sheet piled structures rely on their embedment into the ground for their stability. They would have less compatibility with the surroundings than rock structures and they are less flexible in respect of decreases in size after initial construction, although increases in size are more feasible. However, compared to rock structures they have a much smaller footprint.

Other construction materials are available such as concrete and timber, but shingle, rock and steel sheet piles represent a full range of potential construction materials.

1.5 Summary of Concept Options

This report presents six concept options that represent two variations on each of the three notional options identified in Phase 1.

The six options are as follows:

1A: Upgrade existing rock revetment and training arm involving a 100 metre nominal length training arm and some modest beach management.

1B: Upgrade existing rock revetment and training arm involving a 150 metre nominal length training arm and some minor beach management.

2A: Cut new channel at existing steel sheet piled training wall involving a new 250 metre nominal length training arm.

2B: Cut new channel at southern end of Pagham Beach involving a new 200 metre nominal length training arm.

3A: Close channel at the end of Pagham Spit.

3B: Close channel at the end of Church Norton Spit.

Layout plans of the six options can be found in Appendix B with typical cross sections found in Appendix C. Photographs of similar works can be found in Appendix D.

Option 2A is the option most favoured by the local community. Option 1A will probably be most favoured by the regulators. Option 3A is the most 'straightforward' of the six options.

1.6 Background to Assessment of Options

Each of the options has been assessed against fourteen criteria that have in general been derived from Phase 1, and each criteria has been given a score of between 1 and 5, where:-

1. Very favourable.
2. Favourable.
3. Neutral.
4. Unfavourable.
5. Very unfavourable.

Each option is then given a summary assessment based on the individual scores.

There are no weightings assigned to the various criteria and therefore the assessment is only intended to give an overall picture of each option.

1.7 Definitions of Assessment Criteria

The fourteen criteria are listed below with brief definitions.

Acceptable Principle
The general acceptance to close, divert or form a new channel without reference to the particular method or location.

Historic Precedent
The prior existence or on-going existence of a similar arrangement within the area of Pagham Harbour.

Extension of Existing Structure
New works that are connected to, and physically extend an existing operational structure with a similar purpose.

Allows for Incremental Construction
Form of construction that allows the structure to be built in discrete stages without compromising the work completed to date or the ability to undertake further stages.

Allows for Incremental Dismantling
Form of construction that allows the structure to be partially removed without major disruptive works or compromising the remaining structure.

Allows for Removal of Existing Structure
New works that render existing structures in the vicinity redundant and therefore allows for their removal.

Small Footprint
New works that have a relatively small base area in the context of their surroundings.

Sympathetic Appearance
New works that blend in with their surroundings.

Low Operational Maintenance
New works that require minimal on-going attention for their normal operation.

'Steers' not 'Stops' Natural Processes
New works that direct rather than obstruct natural processes.

Low Adverse Impact on Environmental Sensitivities
New works that result in minimal loss of existing flora and fauna.

Low Adverse Impact on Harbour Water Quality
New works that result in minimal deterioration of the water quality within the harbour.

Low Adverse Impact on Church Norton Spit
New works that result in minimal disruption to the existing formation and future natural development of Church Norton Spit.

Low Adverse Impact on Pagham Spit
New works that result in minimal disruption to the existing formation and future natural development of Pagham Spit.

2 MULTI CRITERIA ASSESSMENT OF CONCEPT OPTIONS

2.1 Introduction

For each of the six options there follows a brief description, an assessment against the fourteen criteria, and a summary assessment.

Layout plans, typical cross sections and typical photographs can be found in the appendices.

The scoring system for the detailed assessment can be found in Section 1.5.

In the reference section of the detailed assessment, Questions ("Q") relate to the report on the workshop meeting held on the 7th May 2014.

2.2 Option 1A - Description and Assessment

Upgrade existing rock revetment and training arm involving a 100 metre nominal length training arm and some modest beach management.

2.2.1 Purpose

To control the harbour entrance channel in order to limit its encroachment onto Pagham Beach.

2.2.2 Method

By strengthening and enlarging the existing structure so that it is competent to cope with the natural coastal processes and provides more control over the alignment of the channel.

The works would be undertaken using more rock or using steel sheet piling (either in part or in total). It is likely that some modest beach management will be necessary to maintain a minimum beach width.

It will also be necessary in the near future to renew the existing steel sheet piled training wall.

Construction of the training arm in rock would lend itself to an incremental approach and therefore allow for a re-assessment of the situation at each stage before any further works are undertaken.

2.2.3 Background

The option builds upon an existing structure that already has approval from the regulatory authorities. The structure also acts as a full scale prototype that provides an informed platform for further development.

2.2.4 Performance Risks

There are risks of indirect closure of the channel, or the channel bypassing the structure and encroaching onto Pagham Beach further to the north.

Also the option as it stands relies on the channel remaining reasonably stable along the length of Pagham Spit, without any significant landward migration. Should landward

migration occur it would be necessary to extend the new rock revetment or steel sheet piled training wall.

2.2.5 Detailed Assessment

No.	Criteria Description	Commentary	Reference	Score (1-5)
1	Acceptable Principle	Existing structure already approved.	Q. 2.8 Q. 2.15 Q. 2.17	1
2	Historic precedent	Structure has been in place for approx 1 year.	Appendix A	2
3	Extension of existing structure	Yes.	Q. 2.16	2
4a	Allows for incremental construction (shingle)	N/A.	Q. 2.19	-
4b	Allows for incremental construction (rock)	Yes (see section 1.3).	Q. 2.19	1
4c	Allows for incremental construction (steel sheet pile)	Yes (see section 1.3).	Q. 2.19	2
5a	Allows for incremental dismantling (shingle)	N/A.	Q. 2.19	-
5b	Allows for incremental dismantling (rock)	Yes (see section 1.3).	Q. 2.19	1
5c	Allows for incremental dismantling (steel sheet pile)	No (see section 1.3).	Q. 2.19	4
6	Allows for removal of existing structure	No (see layout plan).	Q. 2.21	4
7a	Small footprint (shingle)	N/A.	Appendix B, C, D	-
7b	Small footprint (rock)	No (see section 1.3).	Appendix B, C, D	4
7c	Small footprint (steel sheet pile)	Yes (see section 1.3).	Appendix B, C, D	2
8a	Sympathetic appearance (shingle)	N/A.	Appendix B, C, D	-
8b	Sympathetic appearance (rock)	Some compatibility (see section 1.3).	Appendix B, C, D	3
8c	Sympathetic appearance (steel sheet pile)	No (see section 1.3).	Appendix B, C, D	4
9	Low operational maintenance	Modest beach management required.	Q. 2.20	4
10	‘Steers’ not ‘stops’ natural processes	Yes (100m long training arm).	Q. 2.16	1
11	Low adverse impact on environmental sensitivity	Yes, little change from existing situation.	Q. 2.6	1
12	Low adverse impact on harbour water quality	Yes, little change from existing situation.	Q. 2.13	1
13	Low adverse impact on Church Norton Spit	Yes, little change from existing situation.	Q. 2.12 Q.2.18	1
14	Low adverse impact on Pagham Spit	Yes, little change from existing situation.	Q. 2.12 Q.2.18	1

2.2.6 Summary of Assessment

Overall this is a favourable option especially if rock is used as the construction material. The main disadvantage is the likely requirement for modest beach management although this need not to be a major obstacle if it is well managed.

2.3 Option 1B - Description and Assessment

Upgrade existing Rock Revetment and Training Arm involving a 150 metre nominal length training arm and some minor beach management.

2.3.1 Purpose

As Option 1A.

2.3.2 Method

Identical to Option 1A except for a longer training arm and the likely need for less beach management.

2.3.3 Background

As Option 1A.

2.3.4 Performance Risks

Identical to Option 1A except that the longer training arm would increase the risk of indirect closure of the channel and decrease the risk of channel encroachment further to the north.

2.3.5 *Detailed Assessment*

No.	Criteria Description	Commentary	Reference	Score (1-5)
1	Acceptable Principle	Existing structure already approved.	Q. 2.8 Q. 2.15 Q. 2.17	1
2	Historic precedent	Structure has been in place for approx 1 year.	Appendix A	2
3	Extension of existing structure	Yes.	Q. 2.16	2
4a	Allows for incremental construction (shingle)	N/A.	Q. 2.19	-
4b	Allows for incremental construction (rock)	Yes (see section 1.3).	Q. 2.19	1
4c	Allows for incremental construction (steel sheet pile)	Yes (see section 1.3).	Q. 2.19	2
5a	Allows for incremental dismantling (shingle)	N/A.	Q. 2.19	-
5b	Allows for incremental dismantling (rock)	Yes (see section 1.3).	Q. 2.19	1
5c	Allows for incremental dismantling (steel sheet pile)	No (see section 1.3).	Q. 2.19	4
6	Allows for removal of existing structure	No (see layout plan).	Q. 2.21	4
7a	Small footprint (shingle)	N/A.	Appendix B, C, D	-
7b	Small footprint (rock)	No (see section 1.3).	Appendix B, C, D	4
7c	Small footprint (steel sheet pile)	Yes (see section 1.3).	Appendix B, C, D	2
8a	Sympathetic appearance (shingle)	N/A	Appendix B, C, D	-
8b	Sympathetic appearance (rock)	Some compatibility (see section 1.3).	Appendix B, C, D	3
8c	Sympathetic appearance (steel sheet pile)	No (see section 1.3).	Appendix B, C, D	4
9	Low operational maintenance	Minor beach management required.	Q. 2.20	3
10	'Steers' not 'stops' natural processes	Yes (150m long training arm).	Q. 2.16	2
11	Low adverse impact on environmental sensitivity	Yes, only modest change to existing situation.	Q. 2.6	2
12	Low adverse impact on harbour water quality	Yes, only modest change to existing situation.	Q. 2.13	2
13	Low adverse impact on Church Norton Spit	Yes, only modest change to existing situation.	Q. 2.12 Q.2.18	2
14	Low adverse impact on Pagham Spit	Yes, only modest change to existing situation.	Q. 2.12 Q.2.18	2

2.3.6 *Summary of Assessment*

This is generally less favourable than Option 1A although it should require less beach management which may be seen as a significant benefit.

2.4 Option 2A - Description and Assessment

Cut new channel at existing steel sheet piled training wall involving a new 250 metre nominal length training arm.

2.4.1 Purpose

To control the harbour entrance channel so as to limit its encroachment onto Pagham Beach. Also to allow beach material from the disconnected Church Norton Spit to naturally feed onto Pagham Beach.

2.4.2 Method

By extending seawards the existing steel sheet piled training wall and excavating a new channel on the south side.

The extension would be constructed in either steel sheet piling or in rock.

It will also be necessary in the near future to renew the existing steel sheet piled training wall.

Construction of the training arm in rock would lend itself to an incremental approach and therefore allow for a re-assessment of the situation at each stage before any further works are undertaken. This approach also provides an opportunity to test the performance of the new channel with a minimal extension of the existing steel sheet piled training wall.

There may be a case for constructing parallel training arms either side of the new channel in order to increase its stability.

2.4.3 Background

The option is a logical development of the existing training wall which had performed satisfactorily (in terms of Pagham Beach) for at least 40 years.

It also limits all of the intervention works to one location and in effect restores the harbour entrance channel close to its pre-2001 position.

2.4.4 Performance Risks

There are risks of indirect closure of the harbour channel or the channel bypassing the structure and encroaching onto Pagham Beach further to the north.

2.4.5 *Detailed Assessment*

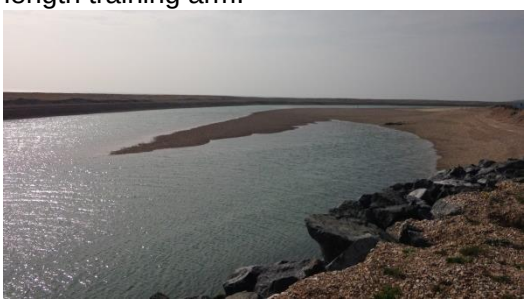
No.	Criteria Description	Commentary	Reference	Score (1-5)
1	Acceptable Principle	Principle of new channel acceptable (but not the method).	Q. 2.8 Q. 2.15 Q. 2.17	2
2	Historic precedent	New channel cut in 1937 / Existing SSP training wall in place since the 1950s.	Appendix A	1
3	Extension of existing structure	Yes.	Q. 2.16	2
4a	Allows for incremental construction (shingle)	N/A.	Q. 2.19	-
4b	Allows for incremental construction (rock)	Yes (see section 1.3).	Q. 2.19	1
4c	Allows for incremental construction (steel sheet pile)	Yes (see section 1.3).	Q. 2.19	2
5a	Allows for incremental dismantling (shingle)	N/A.	Q. 2.19	-
5b	Allows for incremental dismantling (rock)	Yes (see section 1.3).	Q. 2.19	1
5c	Allows for incremental dismantling (steel sheet pile)	No (see section 1.3).	Q. 2.19	4
6	Allows for removal of existing structure	Yes (see layout plan).	Q. 2.21	2
7a	Small footprint (shingle)	N/A.	Appendix B, C, D	-
7b	Small footprint (rock)	No (see section 1.3).	Appendix B, C, D	4
7c	Small footprint (steel sheet pile)	Yes (see section 1.3).	Appendix B, C, D	2
8a	Sympathetic appearance (shingle)	N/A.	Appendix B, C, D	-
8b	Sympathetic appearance (rock)	Some compatibility (see section 1.3).	Appendix B, C, D	3
8c	Sympathetic appearance (steel sheet pile)	No (see section 1.3).	Appendix B, C, D	4
9	Low operational maintenance	Yes, channel should remain self-flushing.	Q. 2.20	2
10	‘Steers’ not ‘stops’ natural processes	Yes (250m long training arm).	Q. 2.16	2
11	Low adverse impact on environmental sensitivity	No.	Q. 2.6	5
12	Low adverse impact on harbour water quality	Yes, possible improvement on existing situation.	Q. 2.13	1
13	Low adverse impact on Church Norton Spit	No.	Q. 2.12 Q.2.18	5
14	Low adverse impact on Pagham Spit	Yes.	Q. 2.12 Q.2.18	2

2.4.6 *Summary of Assessment*

In many ways this is a favourable option and an incremental approach to the construction of the training arm may help to ‘soften’ the impacts. However, the disruption of Church Norton Spit is still a major disadvantage that may override the other criteria.

2.5 Option 2B – Description and Assessment

Cut new channel at south end of Pagham Beach involving a new 200 metre nominal length training arm.



2.5.1 Purpose

As Option 2A.

2.5.2 Method

By constructing an entirely new training wall and training arm at the boundary between Pagham Spit and Pagham Beach, and excavating a new channel on the south side of the training arm.

The works would be undertaken using steel sheet piling or rock, or a combination of the two.

It will also be necessary in the near future to renew the existing steel sheet piled training wall.

Construction of the training arm in rock would lend itself to an incremental approach and therefore allow for a re-assessment of the situation at each stage before any further works are undertaken. This approach also provides an opportunity to test the performance of the new channel with a minimal length training arm.

2.5.3 Background

This option adopts the same principle that applies to the existing steel sheet piled training wall and the existing rock revetment and training wall.

It is located at a position that provides a good balance between protecting Pagham Beach from encroachment of the channel and allowing the natural development of Church Norton Spit.

2.5.4 Performance Risks

As Option 2A.

Also as it stands the option relies on the channel remaining reasonably stable along the length of Pagham Spit, without any significant landward migration. Should landward

migration occur it would be necessary to extend the new rock revetment or steel sheet piled training wall.

2.5.5 *Detailed Assessment*

No.	Criteria Description	Commentary	Reference	Score (1-5)
1	Acceptable Principle	Principle of new channel acceptable (but not the method).	Q. 2.8 Q. 2.15 Q. 2.17	2
2	Historic precedent	New channel cut in 1937.	Appendix A	2
3	Extension of existing structure	No.	Q. 2.16	4
4a	Allows for incremental construction (shingle)	N/A.	Q. 2.19	-
4b	Allows for incremental construction (rock)	Yes (see section 1.3).	Q. 2.19	1
4c	Allows for incremental construction (steel sheet pile)	Yes (see section 1.3).	Q. 2.19	2
5a	Allows for incremental dismantling (shingle)	N/A.	Q. 2.19	-
5b	Allows for incremental dismantling (rock)	Yes (see section 1.3).	Q. 2.19	1
5c	Allows for incremental dismantling (steel sheet pile)	No (see section 1.3).	Q. 2.19	4
6	Allows for removal of existing structure	Yes (see layout plan).	Q. 2.21	2
7a	Small footprint (shingle)	N/A.	Appendix B, C, D	-
7b	Small footprint (rock)	No (see section 1.3).	Appendix B, C, D	4
7c	Small footprint (steel sheet pile)	Yes (see section 1.3).	Appendix B, C, D	2
8a	Sympathetic appearance (shingle)	N/A.	Appendix B, C, D	-
8b	Sympathetic appearance (rock)	Some compatibility (see section 1.3).	Appendix B, C, D	3
8c	Sympathetic appearance (steel sheet pile)	No (see section 1.3).	Appendix B, C, D	4
9	Low operational maintenance	Yes, channel should remain self-flushing.	Q. 2.20	2
10	‘Steers’ not ‘stops’ natural processes	Yes (200m long training arm).	Q. 2.16	1
11	Low adverse impact on environmental sensitivity	Marginally.	Q. 2.6	3
12	Low adverse impact on harbour water quality	Yes.	Q. 2.13	2
13	Low adverse impact on Church Norton Spit	Marginally.	Q. 2.12 Q.2.18	3
14	Low adverse impact on Pagham Spit	Yes.	Q. 2.12 Q.2.18	2

2.5.6 *Summary of Assessment*

This is a more ‘neutral’ option than Option 2A with fewer significant disadvantages and fewer significant advantages.

2.6 Option 3A – Description and Assessment

Close channel at the end of Pagham Spit.

2.6.1 Purpose

To remove the potential for the harbour entrance to encroach onto Pagham Beach and to allow the coastline to act as an un-interrupted foreshore thereby improving the natural beach feed onto Pagham Beach.

2.6.2 Method

By constructing a shingle embankment across the channel at the existing steel sheet piled training wall.

It may be necessary to commence construction with shingle bags or rock in order to provide a stable core.

This type of construction lends itself to being a temporary structure which could provide sufficient time for Church Norton Spit to naturally feed onto Pagham Beach before the structure is removed and the harbour entrance re-establishes itself. The process could be repeated in the medium and long term as the need arises.

2.6.3 Background

The option returns the coastline to its condition during the late 1800s and early 1900s.

2.6.4 Performance Risks

The option relies on Church Norton spit remaining sufficiently robust to prevent a breach and the opening of a new channel.

2.6.5 *Detailed Assessment*

No.	Criteria Description	Commentary	Reference	Score (1-5)
1	Acceptable Principle	Principle of closure acceptable (but not the method).	Q. 2.8 Q. 2.15 Q. 2.17	2
2	Historic precedent	Channel closed in 1876.	Appendix A	2
3	Extension of existing structure	New shingle bank acts as 'extension' to existing shingle spits.	Q. 2.16	2
4a	Allows for incremental construction (shingle)	Yes (see section 1.3).	Q. 2.19	1
4b	Allows for incremental construction (rock)	N/A.	Q. 2.19	-
4c	Allows for incremental construction (steel sheet pile)	N/A.	Q. 2.19	-
5a	Allows for incremental dismantling (shingle)	Yes (see section 1.3).	Q. 2.19	1
5b	Allows for incremental dismantling (rock)	N/A.	Q. 2.19	-
5c	Allows for incremental dismantling (steel sheet pile)	N/A.	Q. 2.19	-
6	Allows for removal of existing structure	Yes (see layout plan).	Q. 2.21	2
7a	Small footprint (shingle)	No, but compatible with spits.	Appendix B, C, D	3
7b	Small footprint (rock)	N/A.	Appendix B, C, D	-
7c	Small footprint (steel sheet pile)	N/A.	Appendix B, C, D	-
8a	Sympathetic appearance (shingle)	Yes.	Appendix B, C, D	1
8b	Sympathetic appearance (rock)	N/A.	Appendix B, C, D	-
8c	Sympathetic appearance (steel sheet pile)	N/A.	Appendix B, C, D	-
9	Low operational maintenance	Yes.	Q. 2.20	2
10	'Steers' not 'stops' natural processes	No.	Q. 2.16	5
11	Low adverse impact on environmental sensitivity	Marginal.	Q. 2.6	3
12	Low adverse impact on harbour water quality	No.	Q. 2.13	5
13	Low adverse impact on Church Norton Spit	Marginal.	Q. 2.12 Q.2.18	3
14	Low adverse impact on Pagham Spit	Marginal.	Q. 2.12 Q.2.18	3

2.6.6 *Summary of Assessment*

From an engineering perspective this option is favourable and it has a largely indirect rather than direct impact on the local spits. However, by preventing tidal flows into the harbour it has a major impact on the nature of the harbour and on the water quality within the harbour.

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2.7 Option 3B – Description and Assessment

Close channel at end of Church Norton Spit.

2.7.1 Purpose

As Option 3A.

2.7.2 Method

By constructing a shingle embankment across the channel at the north end of the shingle spit.

It may be necessary to commence construction with shingle bags to provide a stable core.

This type of construction lends itself to being a temporary structure which could provide sufficient time for Church Norton Spit to naturally feed onto Pagham Beach before the structure is removed and the harbour entrance re-establishes itself. The process could be repeated in the medium and long term as the need arises.

2.7.3 Background

The option mimics a natural closure of the channel.

2.7.4 Performance Risks

The option relies on Church Norton Spit remaining sufficiently robust to prevent a breach and the opening of a new channel.

2.7.5 *Detailed Assessment*

No.	Criteria Description	Commentary	Reference	Score (1-5)
1	Acceptable Principle	Principle of closure acceptable (but not the method).	Q. 2.8 Q. 2.15 Q. 2.17	2
2	Historic precedent	Channel closed in 1876.	Appendix A	2
3	Extension of existing structure	New shingle bank acts as 'extension' to existing shingle spits.	Q. 2.16	2
4a	Allows for incremental construction (shingle)	Yes (see section 1.3).	Q. 2.19	1
4b	Allows for incremental construction (rock)	N/A.	Q. 2.19	-
4c	Allows for incremental construction (steel sheet pile)	N/A.	Q. 2.19	-
5a	Allows for incremental dismantling (shingle)	Yes (see section 1.3).	Q. 2.19	1
5b	Allows for incremental dismantling (rock)	N/A.	Q. 2.19	-
5c	Allows for incremental dismantling (steel sheet pile)	N/A.	Q. 2.19	-
6	Allows for removal of existing structure	Yes (see layout plan).	Q. 2.21	2
7a	Small footprint (shingle)	No, but compatible with spits.	Appendix B, C, D	3
7b	Small footprint (rock)	N/A.	Appendix B, C, D	-
7c	Small footprint (steel sheet pile)	N/A.	Appendix B, C, D	-
8a	Sympathetic appearance (shingle)	Yes.	Appendix B, C, D	1
8b	Sympathetic appearance (rock)	N/A.	Appendix B, C, D	-
8c	Sympathetic appearance (steel sheet pile)	N/A.	Appendix B, C, D	-
9	Low operational maintenance	Yes.	Q. 2.20	2
10	'Steers' not 'stops' natural processes	No.	Q. 2.16	5
11	Low adverse impact on environmental sensitivity	Marginal.	Q. 2.6	3
12	Low adverse impact on harbour water quality	No.	Q. 2.13	5
13	Low adverse impact on Church Norton Spit	Marginal.	Q. 2.12 Q.2.18	3
14	Low adverse impact on Pagham Spit	Marginal.	Q. 2.12 Q.2.18	3

2.7.6 *Summary of Assessment*

This option is very similar to Option 3A. The main difference relates to the performance risk of having to rely on a greater length of spit.

3 DISCUSSION ON ASSESSMENT OF CONCEPT OPTIONS

3.1 Key Aspects of Formal Process

The Habitats Directive protects habitats and species of European nature conservation importance together with Council Directive (2009/147/EC) on The Conservation of Wild Birds (the 'Birds Directive'). The Habitats Directive establishes a network of internationally important sites designated for their ecological status. Special Areas of Conservation (SACs) and Sites of Community Importance (SCIs) are designated under the Habitats Directive and promote the protection of flora, fauna and habitats. Special Protection Areas (SPAs) are designated under the Birds Directive in order to protect rare, vulnerable and migratory birds. These sites combine to create a Europe-wide 'Natura 2000' network of designated sites

The Conservation of Habitats and Species Regulations 2010 incorporates all SPAs into the definition of 'European sites' and, consequently, the protections afforded to European sites under the Habitats Directive apply to SPAs designated under the Birds Directive. In addition to sites designated under European nature conservation legislation, UK Government policy states that internationally important wetlands designated under the Ramsar Convention 1971 (Ramsar sites) are afforded the same protection as SACs and SPAs for the purpose of considering development proposals that may affect them.

Regulation 61 of the Habitats Regulations defines the procedure for the assessment of the implications of plans or projects on European sites. Under this Regulation, if a proposed development is unconnected with site management (i.e. of the SPA) and is likely to significantly affect a designated site, the statutory regulator of the proposed development must undertake an 'appropriate assessment' (Regulation 61(1)).

Therefore due to the environmental designations along Pagham Beach and Harbour, a scheme would need to comply with the measures set out in Council Directive (92/43/EC) on The Conservation of Natural Habitats and Wild Flora and Fauna (Habitats Directive).

Competent authorities are required to assess the impact of plans or projects that may have a significant effect on these sites, either along, or in combination with other plans or projects. Competent authorities cannot consent to plans or projects they determine will have an adverse effect on the integrity of the sites following such an assessment.

Plans or projects that have an adverse effect can only be approved provided three tests are met:

- There are no feasible alternative solutions to the plan or project which are less damaging; (therefore potential alternatives have to be carefully considered);
- There are 'imperative reasons of overriding public interest' (IROPI) for the plan or project to proceed; and
- Compensatory measures are secured to ensure that the overall coherence of the network of European sites is maintained.

The process of an Environmental Impact Assessment (EIA) first seeks opportunities to avoid environmental impacts and to enhance positive effects, then to identify ways to reduce and mitigate impacts, and finally to compensate for negative environmental impacts if avoidance and mitigation cannot be met.

- Avoidance: involves preventing any negative impacts within the site boundary. This should be given priority.

- Mitigation: normally involves measures that reduce and/or minimise impacts within the site boundary such as: changes to timings and engineering design. However, there will be circumstances where there are impacts that affect mobile species and functionally linked habitats, which may involve measures to address these impacts beyond the boundaries of designated sites.

- Compensation: involves measures, such as a new comparable habitat creation, taken beyond the site boundary that offset the residual impacts that may have a detrimental impact upon the conservation objectives for a protected site. Compensation is a last resort and should only be considered where there are residual adverse effects on site integrity that the competent authority agrees cannot be mitigated. However, strict tests have to be met before compensation is considered.

Agreement to compensation measures can be complex and requires consideration of factors such as distance from the affected site, time to establish the compensatory measures to the required quality, whether the methodology is technically proven or reasonable and if there is uncertainty or a time lag between harm to the site and the establishment of compensatory measures. Also both short term (temporary) and long term (permanent) impacts must be addressed.

3.2 Options 1A and 1B

Options 1A and 1B as compared to the other options would have significantly less impacts within the site boundary and therefore mitigation measures would be more readily achieved with greater potential to avoid the need for compensation measures. Also these options would carry less risk in terms of gaining approvals and meeting PPC's March 2015 deadline.

The option is not favoured by the community, primarily due to the recent failures of the existing rock revetment and the need for beach management. However, it should provide the solution to the objective of preventing erosion along Pagham Beach and maintaining a sufficient width of beach.

3.3 Options 2A and 2B

Option 2A in particular would have many more significant impacts within the site boundary and as a result mitigation measures would be significantly more challenging to achieve with the greater potential to require compensation measures. However, consent could not be ruled out but would be far more complicated to achieve. In addition, due to the environmental complexities and regulatory processes required, the option is likely to

prolong the consenting and approval process until after the March 2015 deadline. Consequently, costs associated with developing the necessary consents and approvals of this option are likely to be significantly higher than other options presented in this report.

To cut the channel to the pre-2001 position (Option 2A) would be challenging to gain consent in terms of it being a major change to the current situation with a significant footprint within Church Norton spit. The cut would create a disconnected length of spit with its future behaviour uncertain, and the breach could run the risk of sealing up once more. It would require significant monitoring (both during and after construction) in terms of impact on birds, coastal geomorphology and other sensitivities. However, the disconnected spit would continue to act as a natural feature albeit in a different setting.

Also for Option 2A in particular:

- The scheme would cause significant implications for breeding Terns (and other bird species) during and after construction. The implications on the disconnected length of Church Norton Spit would be difficult to compensate for, however one possibility could be to create shingle Turn Islands within Pagham Harbour.

- Construction timescales would be challenging due to the construction time required and likely disturbance of breeding birds and overwintering birds.

- Mitigation measures for bird disturbance would only lengthen the construction time.

- Mitigation for the direct loss of Church Norton Spit will be challenging and bird breeding on a disconnected migrating spit rather than the present relatively stable spit will not be favoured by the regulators.

- The breeding of Little Terns at Pagham in 2014 has been the most successful in 30 years.

Overall Option 2B is less impacting than Option 2A.

There are two main areas of risk with this option: the time associated with gaining approvals; and the risk of the option not gaining consent at all, which prevents a solution being constructed in time for winter 2015 and meeting the objective of preventing erosion along Pagham Beach and maintaining a sufficient beach width.

Therefore to mitigate this risk, it is recommended that one of the other options presented within this report with an increased chance of gaining consent, could be progressed simultaneously in order to meet the objectives of PPC before winter 2015, providing an implementable solution should Option 2A fail at gaining consent.

3.4 Options 3A and 3B

Options 3A and 3B would have the largest impact within the site boundary even if they were temporary only. They pose many challenges and have the greatest risk on

reducing the water quality within Pagham Harbour and therefore are considered to be the least favoured.

3.5 General Comments

As a general principle the use of rock would be favoured over the use of steel sheet piling. It causes less wave reflection, there is a reduced likelihood of beach lowering alongside the structure, and it can be removed more easily.

There is a lot of useful data already available to inform the EIA process which helps to reduce the need for additional surveys. However, the difficulty will be in interpreting the large amounts of data in the time available.

Numerical modelling will be required to help in assessing options and their long term impacts on Pagham Harbour Entrance and Beach. However, the natural processes are complex and there are many uncertainties which could lead to an extended programme of modelling in order to reach an acceptable level of confidence.

It is important to address both the short term temporary impacts and the long term permanent impacts when considering mitigation measures and also how these impacts will change over time.

It is important to take into consideration the nature of the area after construction, what is lost, what would remain, and future recovery times.

Also it is important to understand what funds are going to be in place for future maintenance and contingency measures.

Current options should take into account possible changes in the prevailing conditions such as a significant reduction in the natural beach feed to the Church Norton Spit.

The formal assessment process does not prevent more than one option being taken forward to the next stage.

4 SHORT LISTED OPTION

As promoters of the long term scheme for protecting Pagham Beach, the final decision on the short list was the responsibility of PPC.

Having taken into account the current assessment of the concept options and the views of their local community, PPC decided to proceed with Option 2A only.

This would involve developing the concept into a more detailed outline design ready for closer scrutiny in the formal application process.

APPENDICES

Appendix A
Brief History of Pagham Harbour

Pagham Harbour is a tidal inlet rather than an estuary due to the absence of a major river flowing into the harbour. The earliest most reliable map of Pagham coastline, drawn in 1587, shows the presence of two separate shingle spits projecting part way across the mouth of the harbour, one north-eastward from the southern shore and the other south-westwards from the northern shore. By the mid-1700s the southern spit had extended north-eastward and little remained of the northern spit. Between 1672 and 1785 the spit grew 80–90 metres and between 1774 and 1885 the spit grew a further 900 metres causing the rapid retreat of the low clay cliffs of the northern shore.

To prevent further erosion of the cliffs and to reclaim land the harbour was artificially closed in 1876. The old outlet channel was transformed into a lagoon and controlled by sluices, and the mudflats within the harbour reclaimed for pasture land.

In 1910, the shingle ridge was breached which allowed the sea to flow through the low-lying land into Pagham Harbour. By 1934, two separate ridges extended from each side of the estuary recalling the situation in the late 1500s and the intertidal gravels diverted the outflow towards the north-east. Several attempts to stabilise the breach were unsuccessful and the southern spit again grew north-eastward, necessitating the cutting of a new entrance in the south, near Church Norton in 1937.

By 1951 the spit was breached once more following a storm and a detached proportion of the spit was moved 800 metres back inside the harbour, leaving a wide southern entrance. Consequently the first steel sheet piled training wall (whose footprint remains today) was constructed in the 1950s supplemented with timber groynes at Church Norton to control the harbour entrance. By 1983 the harbour entrance had gradually reduced to a narrow gap in the centre of the two shingle spits, kept open by the steel sheet retaining wall.

At present, the shingle spit is showings signs of the pre-1910 situation with the harbour entrance to the north-east and the shingle spit protruding across the original entrance, with the Church Norton spit growing over 700 metres north-eastwards between 2001 and 2014.

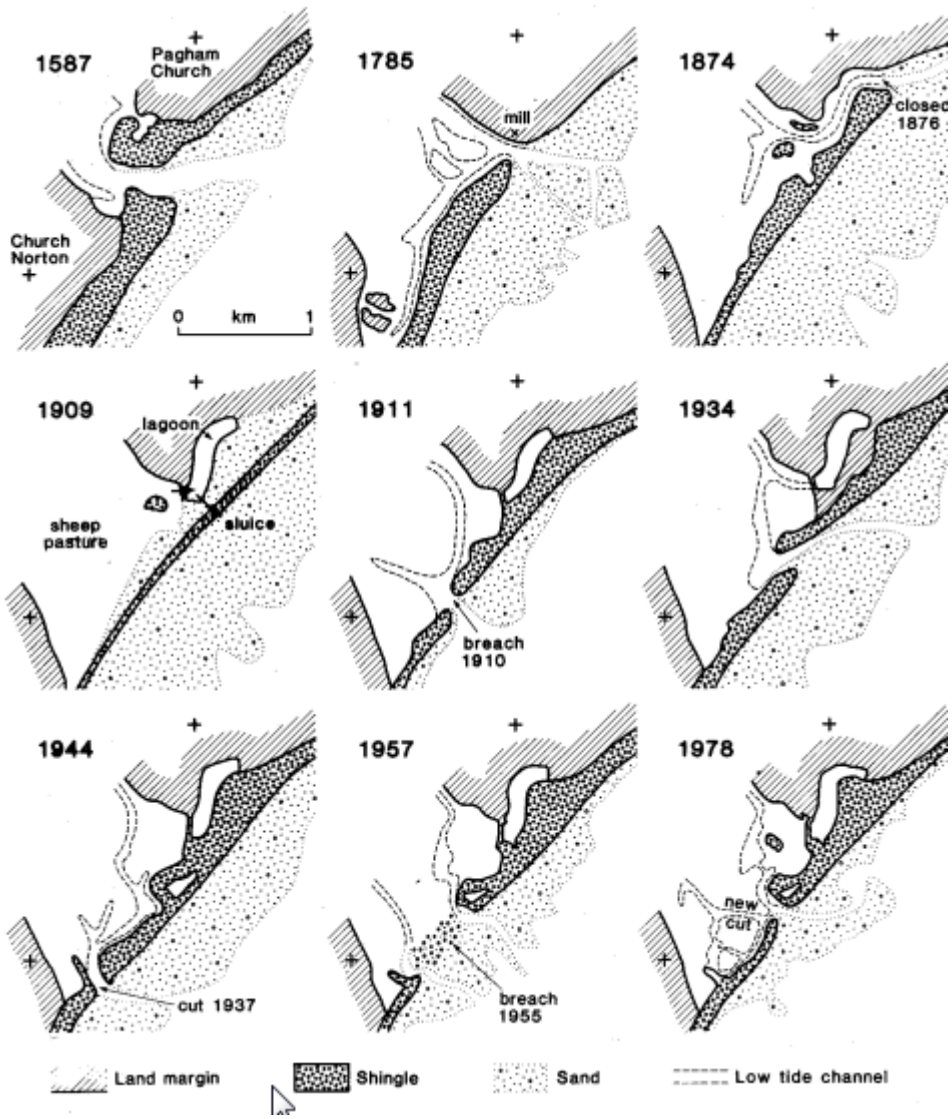
The steel sheet piled training wall was first constructed in the 1950s to stabilise the channel inlet. The wall was reconstructed in the mid to late 1980s following a major collapse. Recent asset inspections from the Environment Agency following the winter storms of December 2013 and January 2014 identified that the structure is in poor condition with many perforations. This is indicative of the lifetime of such a structure and highlights the need for its potential renewal in the near future.

Pagham Harbour, Low Water Spring 1950.

Source: http://mpp.selseycoastaltrust.org.uk/where-is-the-manhood/history-culture/sea-defences-1950s/

Pagham Harbour Shingle Spit and New Channel Entrance, 1950s.

Source: http://mpp.selseycoastaltrust.org.uk/where-is-the-manhood/history-culture/sea-defences-1950s/



Changes in the shingle spits at the entrance to Pagham Harbour.

Source: Robinson, D. A. & Williams, R. B. G. (1983). The Sussex Coast Past and Present. *Sussex: Environment, Landscape and Society.*

Appendix B
Concept Options - Layout Plans

Appendix C
Concept Options - Typical Cross Sections

Appendix D
Photographs of Similar Works

Beach Management

Shingle Re-nourishment

Shingle Re-nourishment

Beach Re-profiling

Beach Re-profiling

Shingle Bypassing

Shingle Recycling

Rock Revetment




Rock Training Arms


Steel Sheet Piled Wall