



Aberdeen North Beach Coastal Defence

Phase 2 Recommendations Report

26 May 2017

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1 Introduction

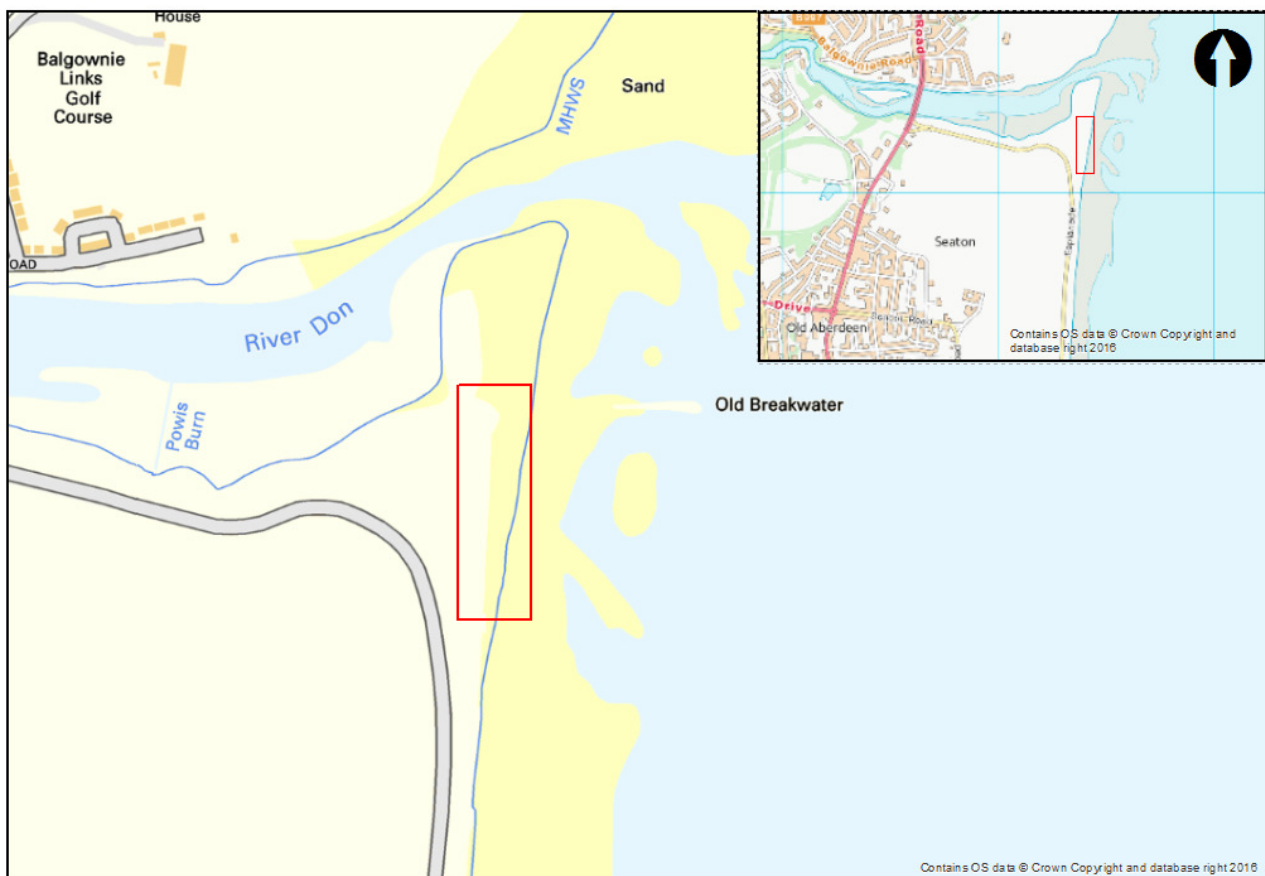
1.1 Background and Scope

This recommendations report follows on from the Mott MacDonald (MML) Feasibility Report for the North Beach coastal embankment site in Aberdeen (Ref. 2), which is experiencing ongoing erosion and slope instability.

The feasibility report proposed potential remediation strategies to the slope instability issues. Aberdeen City Council (ACC) have commissioned MML to consider which of the proposed strategies may be the most appropriate for the site, and outline the associated required survey and design processes for those options.

The coastal embankment is located between the mouth of the River Don and Aberdeen Beach Esplanade, herein referred to as the site. The site location is shown in Figure 1.1.

Figure 1.1: Indicative Site Boundary



Source: Contains OS Data @ Crown Copyright 2016 Licence No. 100026791 Ref. 1

Note : Coastal outline shown by OS map does not adequately represent the current coastal profile.

The objectives of this Phase 2 Recommendations report are to:

- Propose up to three remediation strategies / options for the site, chosen from those presented in the feasibility report.
- Outline any further investigation activities required, intrusive and non-intrusive.
- Provide approximate costs for investigation and design activities.

1.2 Sources of Information

The following sources of information summarised below have been used to compile this report.

- MML North Beach Desk Study (Ref. 1)
- MML North Beach Feasibility Report (Ref. 2)
- ACC Tender Information (Ref. 3)
- A guide to managing coastal erosion in beach/dune systems, SNH (Ref. 4)
- Use of Joint Probability Methods in Flood Management, Hawkes (Ref. 5)
- Manual on wave overtopping of sea defences and related structures. EurOtop (Ref. 6)

2 Site Investigation and Design Process Recommendations

2.1 Proposed Remediation Options

Several options / strategies were proposed in the feasibility report (Ref. 2), including Do Nothing, beach recharge, gabions, rock armour revetment and concrete revetment. Of those options, it is considered that the most appropriate for the site are:

- Do Nothing
- Hold the Line - Beach Recharge
- Hold the Line - Rock Armour Revetment

These options are discussed in further detail below.

2.1.1 Do Nothing

The appropriateness of this option depends on the future plans for the land surrounding the site. Should there be plans to develop beyond the current use of informal recreational scrubland then this option may not be the most suitable. However, should the land be developed more suitable options could be installed at that time. The potential consequences of do nothing include:

- Further erosion and regression taking place, resulting in further collapse of the embankment and remaining gabions, with associated continued deposition of debris on the beach/foreshore.
- Potential for flooding of the surrounding area and road during storm surge events.

Surveys and monitoring would be required to understand the risk of this strategy, to gain a better understanding of the processes and rate of regression of the site. It may be that the rate of erosion does not warrant remediation of the slopes, as the cost outweighs the benefit.

2.1.2 Beach Recharge

This option is likely to require multiple recharge top-ups during its lifetime due to characteristic transport of material alongshore, as already visible along the Aberdeen Esplanade, and due to storm events. Timber or rock groynes could be constructed to interrupt beach drift northwards, as employed south of the site, however, this would not prevent storm event transport (Ref. 4).

An understanding of previous movement of the beach could aid in predicting the frequency of recharge required.

2.1.3 Rock Armour Revetment

This option is already employed at the southern end of the site and would be a relatively easy to maintain solution and more economical for a longer design life.

A rock armour revetment would limit access to the beach, particularly as it would be required to wrap around the coast into the River Don estuary. Should ACC wish to maintain access to the beach for recreational use then boardwalks and more formal reinforced concrete (RC) stair arrangements could be constructed to allow this.

2.1.4 Supplementary Works

Supplementary works to those mentioned above could include:

- Planting at the crest of the slope to increase resilience to erosion, with chestnut pails and marram grass with a green / grey scour prevention system to allow it to establish.
- Boardwalks at the crest of the slope, set further back than the current informal path, to help manage people movement and allow planting to establish and prevent edge erosion.

2.1.5 Immediate Works

It is considered that no immediate actions or temporary works should be undertaken at the site with respect to prevention of further erosion while the remediation options are considered, as there is currently no immediate significant risk to infrastructure.

ACC may wish to install the following to inform and protect members of the public, as recommend in the feasibility report:

- Warning signs to inform public of the unstable coastal slopes.
- Some form of deterrent such as temporary wooden fencing be installed to prevent the public walking along the informal path running along the crest of the slope.
- Warning signs to inform public that the piled concrete beam at the northern end of the site is a hazard and should not be climbed on or walked under for their own safety.

2.2 Proposed Site Investigation and Surveys

To determine the most appropriate response to the ongoing issues, undertaking the following site investigation / surveys should be considered.

2.2.1 Non-intrusive

A detailed topographic survey of the site is required, potentially with fixed survey points to allow measurement, i.e. at the crest of the embankment. This would:

- Allow monitoring of the beach in the interim of a decision being made about the most appropriate solution.
- Act as a baseline to determine the rate of regression, and allow long term monitoring if the do nothing approach is considered the most appropriate response.
- Inform the design of a solution, should a remedial works option be chosen as the most appropriate.

This survey could take the form of either a traditional topographic survey, i.e. using total station and staff, or a point cloud survey and photogrammetry using an Unmanned Aerial Vehicle (UAV). MML has moved to the use of UAV surveys recently due to speed of data acquisition, associated potential cost savings and health and safety aspects, as well as ease of comparison of subsequent surveys.

Additionally, if not already available, the commissioning of a wave return survey / study would allow design of any remediation options for significant wave heights associated with specific return periods and therefore a specific design life and allow a better understanding of processes on site.

ACC may also wish to commission an environmental survey to inform the decision.

2.2.2 Intrusive

Should a remedial works option be chosen, a trial pit investigation with associated testing would inform the design, giving information on the nature of the embankment material and beach deposits.

2.3 Proposed Design Processes

Before developing the design for a remedial works option, there is an optioneering or preliminary design exercise to be undertaken, looking at available data including the proposed topographical survey, historical lidar, charts, aerial photography, environmental and any climate change and storm event data. This, in combination with an understanding of the plans for the area and surrounding coastal protection would determine if the do nothing or hold the line approach is the most appropriate.

Developing the detailed design for a remedial works option would involve the following:

- Undertaking wave modelling either using a site specific wave survey or available wave data. A joint probability analysis on sea level and wave height may be undertaken, further details are provided below.
- Sizing of rock armour / design of beach recharge based on the wave modelling / joint probability analysis and best practise design documentation, i.e. The Rock Manual, CIRIA.
- Slope stability analysis using intrusive investigation results and topographic survey.
- Production of design drawings, plan and section, using the topographic survey as a background.

2.3.1 Joint Probability Analysis Methodology

As part of the analysis required to design the coastal sea defences, extreme wave and water level conditions between the mouth of the River Don and the Aberdeen Beach Esplanade frontage would be calculated and used to assess wave overtopping along the frontage.

Water level data required for the study would be obtained from the closest UK Class-A tide gauge at Aberdeen through the British Oceanographic Data Centre (BODC). A 32-year long offshore wave data time-series may be purchased from Met Office, to undertake a Joint Probability Analysis (JPA) for extreme water levels and wave height following well-established statistical Environment Agency (EA) method (Ref. 5).

The resulting extreme water level/wave conditions would be transformed from offshore to the toe of the structure, using spectral wave (SW) model built using purchased bathymetric data. These data would be merged with cross-shore profile data from the proposed topography survey and lidar data.

The overtopping assessment of the defence would follow the procedures in the best practise manual on wave overtopping (Ref. 6). Overtopping rates for 3 return periods would be determined for up to 3 climate change scenarios, i.e. 1 in 10 (10% AEP), 1 in 50 (2%AEP) and 1 in 100 years (1%AEP).

2.4 Estimated Costs

Included in Table 1 below is an estimate of costs associated with the site investigation / surveys and design processes outlined.

Table 1: Approximate Costs

Aspect	Estimated Costs	Assumptions
Non-intrusive Investigation	£8,000	<ul style="list-style-type: none"> • Point cloud survey across an area of 2 hectares. • Undertaking of Environmental Survey
Intrusive Investigation	£5,000	<ul style="list-style-type: none"> • Day rate for excavator and engineer, 2 days due to coastal environment time restrictions. • Classification testing.
Optioneering / Preliminary Design	£6,000	<ul style="list-style-type: none"> • Review of freely available data.
Detailed Design	£37,000	<p><u>Rock Armour Revetment</u></p> <ul style="list-style-type: none"> • Purchase of wave data. • Joint probability analysis of sea level and waves (requires topographic survey and lidar data). • Sizing of rock armour (primary and secondary). • Check of wave run up. • Slope stability analysis and geotechnical design memo. • Preparation of drawings. • Specifications and Contract Documents.
	£40,000	<p><u>Beach Recharge</u></p> <ul style="list-style-type: none"> • Purchase of wave data. • Joint probability analysis of sea level and waves (requires topographic survey and lidar data). • Design of beach recharge and associated fencing / groynes. • Check of wave run up. • Slope stability analysis and geotechnical design memo. • Preparation of drawings. • Specifications and Contract Documents.

Additionally, ACC should be aware of other potential associated costs including licensing (marine, environmental).

3 References

1. MML Desk Study, 378926 North Beach Phase I Desk Study, Rev B, Jan 2017
2. MML Feasibility Report, 378926 North Beach Feasibility Report, Rev B, March 2017
3. ACC, Tender Information 'Volume 2.3, Work Package 3 – Scoping Document, Aberdeen North Beach Coastal Defence' ref. 3097260/CS-ACE/2.3 Rev.T00, dated 7th October 2016
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5. Hawkes, P. (2005). Use of Joint Probability Methods in Flood Management: A guide to best practice. R & D Technical Report FD2308/TR2, 80pp.
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