



Aberdeen Greyhope Road Coastal Embankment

Phase 2 Recommendations Report

01 June 2017

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1 Introduction

1.1 Background and Scope

This recommendations report follows on from the MML Risk Assessment Report for the Greyhope Road coastal embankment site in Aberdeen, which is experiencing ongoing slope instability.

The risk assessment report identified areas of high and very high risk to Greyhope Road along the slopes in the north of the site, with evidence of extensive slope instability, both historic and recent. Additionally, further high and very high risk areas were identified in the east and south of the site. Aberdeen City Council (ACC) have commissioned MML to consider appropriate survey and site investigation activities to inform remedial option selection, and outline possible remediation options for the site.

The coastal embankment is located between the mouth of the River Dee and Nigg Bay, herein referred to as the site. The site location is shown in Figure 1.1.

Figure 1.1: Indicative Site Boundary



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The objectives of this Phase 2 Recommendations report are to:

- Outline any further investigation activities required, intrusive and non-intrusive.
- Propose possible remediation options for the site.
- 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 Greyhope Road Desk Study (Ref. 1)
- MML Greyhope Road Risk Assessment Report (Ref. 2)
- ACC Tender Information (Ref. 3)
- A guide to managing coastal erosion in beach/dune systems, SNH (Ref. 4)

2 Site Investigation and Design Process Recommendations

2.1 Possible Remediation Options

The slope stability risk assessment report identified significant risk to Greyhope Road from slope instability. The following sections outline potential remediation measures that could be considered for instability areas. Areas are described in terms of chainage as shown on the Site Walkover Results plan included in Appendix A.

2.1.1 Concrete Blocks (Ch100 to 150)

It is assumed that the concrete blocks installed at the north west end of the site are a temporary measure to stabilise the road and slope. The blocks are showing signs of instability and it is considered they could be replaced by a permanent retaining structure, i.e. concrete revetment.

2.1.2 Northern Slope Instability (Ch200 to 1200)

A number of possible remediation measures for the northern slopes may be appropriate, including:

- Regrading of the slope, reducing the road to one carriageway to create extra space. Potentially including soil nailing.
- Construction of a concrete retaining wall along the length of the slope.
- Closure of the northern part of Greyhope Road, in the long term.
- Upgrade and use of the existing road through the Torry Golf Course to maintain access, to allow the northern part of Greyhope Road to either be closed or remediated.
- The addition of scour protection below drainage pipes within the slope.

It is understood that Greyhope Road from the Girdleness Lighthouse to the southern junction with St Fittick's Road is to be closed and widened as part of works associated with the development of Nigg Bay, and will remain closed until 2020. This requires all traffic to use the road to the north to maintain access.

It is required to better understand the development plans for the area to select the most appropriate remediation approach. As well as the Nigg Bay development, it is understood that there are proposals to construct a mixed use recreational building on the east slopes.

A further consideration is that the slopes in the north of the site do not end at the shoreline, and that there are underwater slopes associated with the dredged channel to Aberdeen Harbour. This should be accounted for in the design of any remedial measures to avoid any impact on harbour use / access, through sub-aqueous slope instability, and ensure any remedial measures are appropriately designed.

2.1.3 Southern Slope Instability (Ch200 to 2100)

This area of instability is below the section of road closed for the development of Nigg Bay. It is not understood if the Contractor for these works has considered slope instability in their design of the road widening, and this should be better understood before remedial measures are considered.

2.1.4 Immediate Monitoring and Works

Immediate actions that may be undertaken at the site include setting up fixed monitoring points on the slope and road along the northern slopes to monitor movement. This is considered to be a significant risk and it is recommended that visual inspection is undertaken regularly i.e. every two weeks and after periods of extended rainfall, particularly as it is now the only access to Torry Battery and the lighthouses. This intensive monitoring will allow the slopes and Greyhope Road to be properly assessed and managed while an informed decision is made as to the nature and extent of remedial works.

ACC may wish to install signage along the road to warn people of the risk of road subsidence and slope instability, and prohibit parking along the crest of the slope.

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 in the interim of a decision being made about the most appropriate solution.
- Act as a baseline to determine movement of the slopes.
- Inform the design of remedial measures.

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, a bathymetric survey would be required to profile the underwater dredged channel slopes for inclusion in design. Alternatively, the relevant Aberdeen port authority may have this information.

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

2.2.2 Intrusive

To better understand the failure mechanism of the slopes and to inform the design of remedial measures a site investigation and associated testing should be undertaken. This could take the form of boreholes along the crest of the slope, and boreholes / trial pits at the base of the slope, dependant on access.

2.3 Proposed Design Processes

Before developing the design for remedial works, 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 for each of the three areas (concrete blocks, northern and southern slope instability).

A preliminary slope stability exercise would indicate the feasibility of discussed possible remediation measures for each area. This, in combination with an understanding of the plans for Greyhope Bay in the long term would allow an informed decision to be made as to the most suitable remediation approach.

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

- Slope stability analysis using intrusive investigation results and topographic survey.
- Design of remediation engineering solutions, i.e. retaining wall, regraded slope.
- Production of design drawings, plan and section, using the topographic survey as a background.

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	£20,000	<ul style="list-style-type: none"> • Point cloud survey across an area of 10 hectares. • Bathymetric survey.
Intrusive Investigation	£50,000	<ul style="list-style-type: none"> • Borehole site investigation, assuming 5 no. along crest and 5 no. along base of northern embankment slopes. 2 no. days trial pitting. • Site supervision. • Scheduling of laboratory testing.
Optioneering / Preliminary Design	£15,000	<ul style="list-style-type: none"> • Review of freely available data and preliminary slope stability assessment for three areas.
Detailed Design (option dependant)	£30,000	<ul style="list-style-type: none"> • Regrading of slope, soil nailing and road narrowing.
	£35,000	<ul style="list-style-type: none"> • Concrete retaining wall (concrete block area and northern slopes).
	£10,000	<ul style="list-style-type: none"> • Upgrade of Torry Gold Course Road. • Costs are indicative and include estimate of detailed design, construction drawings..

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

3 References

1. MML Desk Study, 378926 Greyhope Road Phase I Desk Study, Rev B, March 2017
2. MML Risk Assessment Report, 378926 Greyhope Road Risk Assessment Report, Rev B, April 2017
3. ACC, Tender Information 'Volume 2.1, Work Package 1 – Scoping Document, Aberdeen Greyhope Road Coastal Defence' ref. 3097260/CS-ACE/2.1 Rev.T00, dated 7th October 2016
4. SNH, 'A guide to managing coastal erosion in beach/dune systems', dated October 2000. [online- <http://www.snh.org.uk/publications/on-line/heritagemanagement/erosion/index.shtml>]

A. Site Walkover Results Plan



Location Map

Key to Symbols

- Current Instability
- Historic Instability
- Observation
- Structure
- + Chainage (m)
- ▭ Site Boundary

Reference Drawings

Rev	Date	Drawn	Description	SEY	AM
A	17/02/2017	KY	Draft for Comment	SEY	AM

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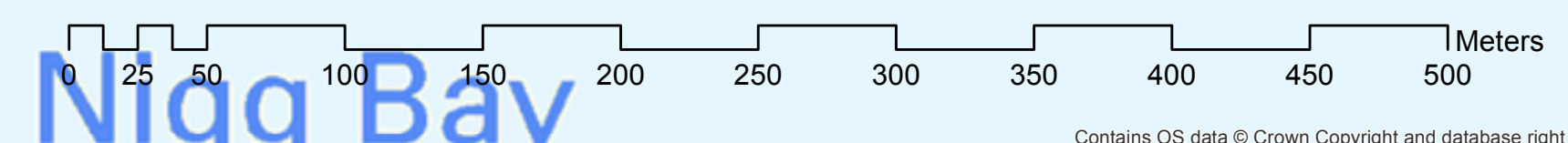
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Title
Aberdeen Coastal Embankments
Grehope Road
Site Walkover Results

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Drawn	K Young	Coordination	K Young
GIS Check	J Irons	Approved	A Martin
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