Hundale Point to Scalby Ness Strategy Review – Stage II Report

August 2006

Halcrow Group Limited

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Contents Amendment Record

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1	0	Draft Issue – For Comment	Feb 2006	
2	1	Final – including SBC Comments	Aug 06	
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Contents

Executive Summary

This study was commissioned to review the Hundale Point to Scalby Ness Strategy Study. It concentrates on the area around Scalby Ness, where the majority of the properties considered to be "at risk from coastal erosion" are located. Coastal erosion, combined with slippage of the coastal slopes, is thought to be causing instability and therefore posing a threat to the properties located at Scalby Ness.

The Strategy Study identified various failure scenarios, which threatened these properties, and the road to the south which is the sole vehicular access to the Sea Life Centre. The road is needed to ensure the Sea Life Centre remains a key tourist attraction. However, the collected geotechnical information was not sufficient to confirm these failure scenarios and further monitoring was recommended in the strategy. Scarborough Borough Council (SBC) commissioned further monitoring and once sufficient further data was collected, also commissioned this review to reappraise the findings of the Strategy Study.

This study has been completed in two stages. Stage 1 re-maps the coastal slopes and reviews the geotechnical analysis, using the recently collected data. It then determines the actual risk to people and property. Stage 2 then considers suitable options to mitigate the risk to people and property and the economics of doing so.

The outcome of this most recent study is that the findings of the draft Strategy study remain valid for the northern section of the Hundale Point to Scalby Ness Coastal Unit, i.e. north of Scalby Ness. However, the increased knowledge, and updated analysis of monitoring data has indicated that the coastal slopes are more stable than previously thought. The analysis shows that slopes are marginally unstable during periods of extreme rainfall, when ground levels become temporarily raised. At these times, the factor of safety falls to between 1.1 - 1.3, which is just below that recommended by British Standards and other codes of practice. Nevertheless, it is above unity and prevails for short periods during the extreme event.

A further consequence of this recent analysis is that the road to the Sea Life Centre and therefore the Centre itself, are not now considered to be at risk from Coastal erosion at Scalby Ness.

It is recognised that the frequency of extreme storms is increasing as a result of climate change. Consequently the marginal stability conditions may be more prevalent, but on a temporary basis during the storm event.

The main threat to the public and properties therefore still arises from continued coastal erosion of the toe and crest erosion caused by surface water flowing down the slope. The crest of the slope will continue to move landward, typically at between 0.18 – 0.2 m per year, to a point where the properties at Scalby Ness will either be lot or blighted by the threat of loss from coastal erosion. If nothing was to be done at Scalby Ness, i.e. Do Nothing, properties would be progressively lost by continuous erosion at this rate and the public would be put at risk. This was investigated in this study as Option 1.

The next level of investment is investigated as Option 2 in this report and considers monitoring only. Whilst monitoring provides an improved understanding of the progression of coastal erosion and slope activity, it does not of course prevent, or reduce, the rate of erosion. An argument is made that the decision for SBC not to intervene with protection works, would adversely affect property values and there would be a small consequential loss in property values due to blight. This analysis approach is done purely to assess the extent of economic change between Doing Nothing and Monitoring.

Monitoring Costs can be summarised as follows:

- initial capital costs of £50,000 with a repair and maintenance of monitoring equipment cost of £5,000 every 10 years thereafter
- maintenance costs of £4,500 each year, with an additional £2,000 every 10 years for installation of replaced equipment
- initial design and supervision costs of £3,675 in the first 2 years for the monitoring programme.

The present value of Option 2 is estimated at £0.219 million.

The impact of climate change on coastal erosion rates would be captured by the ongoing monitoring.

Option 2 has a benefit cost ratio of 0.5. Works cannot therefore be justified on economic grounds. This attracts a Defra priority score of 20 as there would be no mitigating capital construction works associated with this ostensibly monitoring option.

Option 3 investigates Slope Protection works. The failure mechanisms are such that loss occurs from a combination of toe and crest erosion simultaneously: remedial works must address both of these. Water levels in the coastal slope must also be controlled by appropriate drainage.

The option investigated, i.e. Option 3, is detailed later in this report, but includes:

- A rock toe bund;
- Crest protection works, including soil nails at the narrowest points;
- Crest drainage works;
- Counterfort drains to control ground water.

The cost of these capital works is estimated at £1.17 million, with a 5 year spend stream as identified below.

	Capital	Design	Supervision	Monitoring	Total
Year 1	£0	£47,026	£0	£0	£47,026
Year 2	£1,029,901	£25,747	£72,093	£0	£1,127,741
Year 3	£0	£0	£0	£1,000	£1,000
Year 4	£0	£0	£0	£1,000	£1,000
Year 5	£0	£0	£0	£1,000	£1,000

Option 3 Five year spend stream

There are some 50 properties at risk from coastal erosion, 28 of which are next to the crest of the Scalby Ness slopes. The market value of these properties has been estimated at £3.908 million pounds. The loss associated with coastal erosion is a combination of delayed loss, and blight. The present value loss is estimated at £1.554 million. Once Option 3 is implemented, all this loss is avoided.

Economically, it is marginally beneficial to implement Option 3, with a Benefit Cost ratio of 1.04. However, when various elements of uncertainty are investigated, the BCR varies from between 0.71 – 1.25. This achieves a Defra priority score of 5.

Major slope protection works over and above Option 3, i.e. involving deep piles, slope re-grading, were not considered as no further benefits will arise from this approach, as erosion is curtailed with Option 3. Therefore, by inspection this approach would yield a benefit cost ratio less than that of Option 3.

A major scheme to protect the properties at Scalby Ness is therefore on the margins of economic justification. Additionally, the works are not likely to be of sufficient priority to attract Defra funding at this time.

The following recommendations as a consequence of this Strategy Review:

- A programme of monitoring be implemented as outlined in the Stage 1 Report.
- Undertake a re-evaluation of the risk to properties and viability of works to the properties at Scalby Ness at intervals not greater than 5 years. This shall incorporate the data collected by the proposed monitoring.
- Instigate and develop a forum, by which the residents of Scalby Ness can be informed of the actions taken by SBC and the changing circumstances, in terms of risk from erosion etc.

1 Introduction

1.1 Terms of reference

Halcrow Group Ltd. (Halcrow) was appointed by Scarborough Borough Council (SBC) in December 2004 to undertake a two phase coastal strategy review. This followed on from the draft Hundale Point to Scalby Ness Coastal Strategy completed in May 2003.

The draft strategy (Ref. 2, HPR 2003) identified slope instability to be a problem in the south of the study area at Scalby Ness, where residential properties on a cliff top adjacent to Scalby Beck are at risk from the effects of marine erosion, slope steepness and groundwater conditions.

The draft strategy study recommended that the policy for the coastline between Hundale Point and Scalby Ness should be "do nothing", with the bulk of the assets at risk located at Scalby Ness.

During the preparation of the draft coastal strategy, Defra revised the Flood and Coastal Defence Project Appraisal Guidelines (FCDPAG) and prioritisation of funding for coastal defence schemes. In September 2003, Defra concluded that the then strategy prioritisation score was not sufficient to enable works to proceed. They also suggested that the strategy study's recommendation for further monitoring be implemented to confirm the nature of the risk to Scalby Ness assets, properties and the public in this area.

As a consequence of this, SBC commissioned a two stage study in autumn 2004. Stage 1 consisted of:

- reviewing the geotechnical data from monitoring undertaken in 2004;
- repeating the geotechnical stability analysis in light of the collected information;
- reappraisal of the risks to assets and properties at Scalby Ness.

The Stage 1 report is presented in Appendix A.

Stage 2 of this project consisted of:

- reviewing the existing information in the light of the findings of the Stage 1 work and updating the need or otherwise for coastal protection and slope stabilisation;
- identifying feasible options and options costing;
- economic appraisal of the options according to Defra's Flood and Coastal Defence Project Appraisal Guidance 3;
- preparation of a strategy plan and project appraisal report.

This report details the work undertaken by Halcrow in completing Stage 2.

1.2 Objective

The general objective of this Coastal Strategy Review is to identify a strategy to minimise the risk to assets and properties at Scalby Ness that is economical, technically and environmentally acceptable.

Specifically, this review updates the assessment in the light of recently collected geotechnical monitoring information and changes to Defra's project appraisal approach in regard to time frames and discount rates.

1.3 Scope of study

The previous draft coastal strategy covered management Unit 19E from Hundale Point to Scalby Ness, as presented in Figure 2. The majority of the area is agricultural land, with no properties at the cliff top edge. However, Management Unit 19E/VI in the south of the area at Scalby Ness fronts a housing development in which some properties are less than 10m from the cliff edge. This review only covers Management Unit 19E/VI as there has been no significant change to the northerly coastal frontages and so the previous strategy study recommendations remain valid.

Photograph 1. Panoramic view of properties near the cliff edge above north-east facing slope in management unit 19E/VI

SBC's requirements for Stage 1 of the coastal strategy review, as described in the Employer's Requirements document (SBC, August 2004), are as follows:

- geomorphological mapping of the whole of the Scalby Ness site area;
- comparison with previous mapping;
- analysis and interpretation of existing data and mapping to prepare a ground model;
- review of previous assumptions and use of new ground model to determine the validity of the previous assumptions;
- slope stability analysis to determine most likely mechanisms of failure, current stability of the slopes and the sensitivity of the slopes to changes in groundwater level;

- development of an event history of the slope through a review of available aerial photography to confirm cliff recession rates;
- use of recession rates to calculate probability of asset loss;
- preparation of recommendations for appropriate monitoring and response actions by SBC for Scalby Ness.

The Stage 1 report addressing these requirements is presented in Appendix A.

The requirements for Stage 2 are:

- to review the original information and management strategy contained in the draft Strategy Report in light of the new analysis and interpretation in Stage 1;
- to identify all reasonable and significant options which address the strategic objectives;
- to develop and appraise the options by way of a technical assessment, economic appraisal, risk analysis and environmental appraisal;
- to develop a recommendation for a preferred strategic option.

The strategy life has been extended from 50 years in the previous report to 100 years and property values have been updated to 2005 present day values. This is in line with changes to Defra's PAG since the completion of the previous report.

2 Description of study area

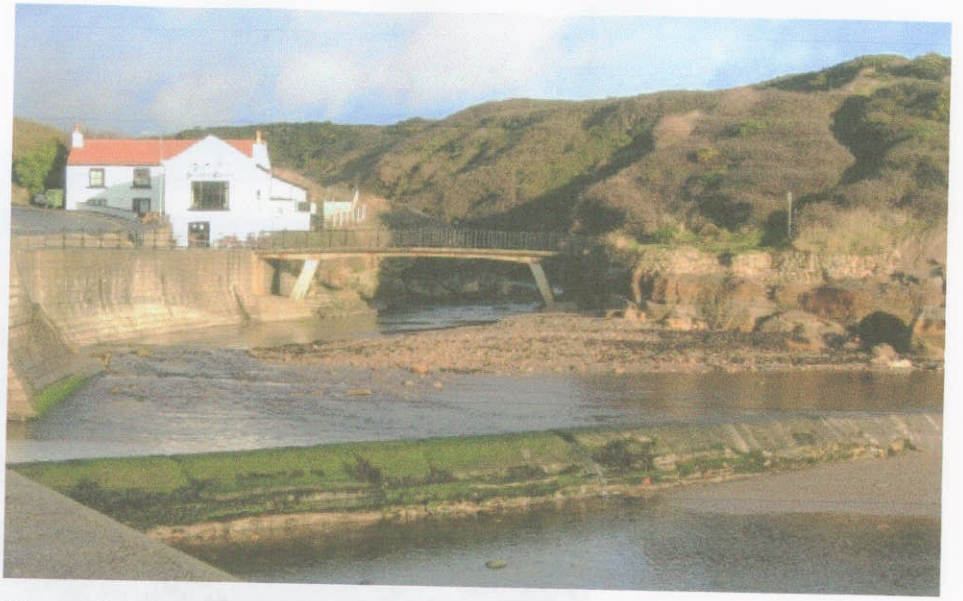
The study area is located at the southern end of Management Unit 19E, 3km north of Scarborough town centre at Scalby Mills. The site consists of a deeply incised coastal cliff, formed in glacial till with a stream channel, Scalby Beck, at the cliff toe. The site location is shown in Figure 1.

Scalby beck is described on OS mapping as a "sea cut" and acts as an overflow for the River Derwent during flooding. See photograph 2. It emerges from the river near Everley and runs a distance of approximately 8km in an easterly direction through Scalby. At Scalby Mills, it flows northeast and then turns sharply southeast at Scalby Ness and outfalls to the sea between the Sea Life Centre and Scalby Ness headland (as shown in photograph 3).

Photograph 2. View of Scalby Beck below north-east facing slope

The coastal frontage of the study area and the northern slope of Scalby Beck are part of a Site of Special Scientific Interest (SSSI). Scalby Beck to Long Nab is a Site of Nature Conservation Importance (SNCI) and the northern part of the area lies within the North York Moors National Park.

Observations on site indicate that the river outfall of Scalby Beck is affected by marine influences, with wave rush and backing up of the river during periods of high sea states. The outfall characteristics of the river are significantly restricted by tidal influence and storm surge, particularly during spring tides and strong south easterly winds. The interaction of flood river water and tidal action during storm conditions adversely affects the toes of slopes adjacent to the beck.



Photograph 3. View up Scalby Beck from the sea defences adjacent to the Sealife Centre

The north-west facing slope consists of recent shallow instability developed in the over steepened glacial till.

Photograph 4. View of north-west facing slope (to the centre left of the picture)

The north-east facing slope consists of a larger, deep embayment in glacial till with a back scar, approximately 100m in width, and a distinct reverse slope bench feature located midway up the slope. The southern part of the slope comprises an arcuate headscarp, with vegetated glacial till slopes beneath.

Photograph 5. View of north-east facing slope

A relatively recent housing development at Scalby Ness lies to the south and west of Scalby Beck, at the top of the slopes. In some cases the houses on Scholes Park Road are located within 10m of the slope crest. The slopes have degraded over time and the slope crest is receding towards the property. The assets at risk consist of fifty properties on Scholes Park Road, in the form of flats, semi-detached houses and their associated garages. An aerial view of the properties is presented in figure 3.

3 Geotechnical Assessment

3.1 *Introduction*

This section summarises the findings of the Stage 1 geotechnical report (Ref. 1, Halcrow 2005) presented in Appendix A.

3.2 *Comparison with previous HPR analysis*

The significant difference between the ground model used in the Stage 1 report (Ref. 1, Halcrow 2005) and the model previously used in the draft coastal strategy (Ref. 2, HPR 2003), is the depth of the shear surface beneath the central back-tilted block, in the north-eastern slopes. Analysis of the monitoring data obtained, since the writing of the draft strategy revealed that basal movement occurred significantly deeper than in the previous interpretation. This increased depth of movement changes the geometry of the sliding block and increases the factor of safety associated with the likely failure of this existing slip.

3.3 *Behaviour units*

Three behaviour units have been defined for the Scalby Ness study area, based on the geomorphological mapping, results of stability analysis, historical data and slope monitoring. The Behaviour Units and geomorphology are summarised in Figure 3 of the Stage 1 report and reproduced in the FIGURES section of this report.

The behaviour units are considered independent, due to: their predominant failure mechanisms; the historical rate of change; and past influences of engineering and development activities.

3.3.1 Behaviour unit 1 – north-west slopes

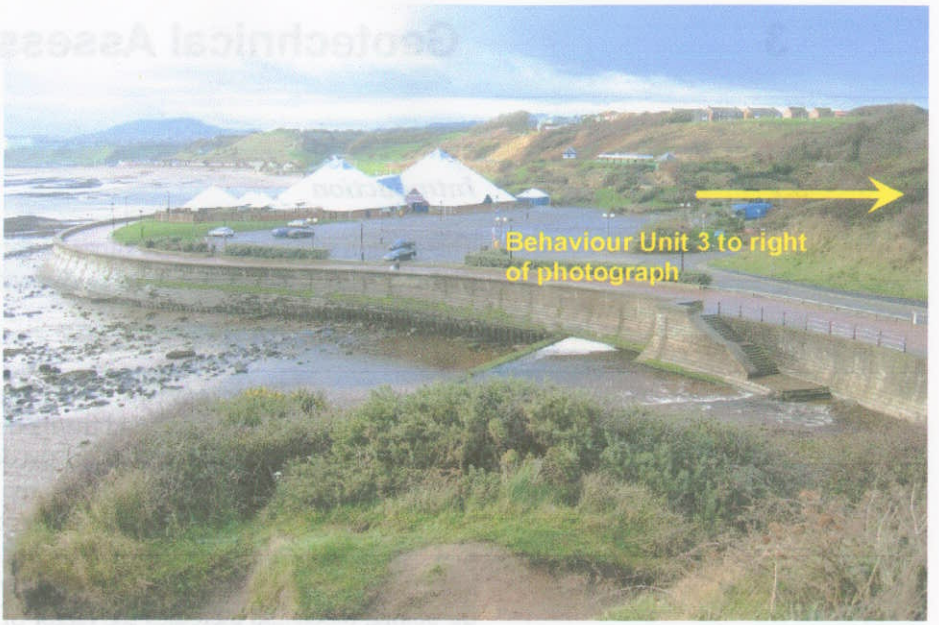
This behaviour unit is characterised by a non-circular failure involving the translational motion on a non-planar surface in glacial till deposits. There is evidence of blocky, episodic loss at the crest. This unit is likely to be subject to periodic movement, evidenced by fresh headscarp and cracking in the centre of the slope. Active toe erosion is occurring, reducing support for the material above.

3.3.2 Behaviour unit 2 – north-east slopes (northern part)

This behaviour unit is characterised by an oversteep headscarp above oversteep glacial till slopes, which show evidence of cracking and localised shallow surface movement. There is evidence of blocky episodic loss at the crest. A large back-tilted block is present across the unit, the location and morphology of which suggests a large ancient deep-seated landslide. Part of the lower slope is inactive, but the part that is currently active shows saturated ground and tension cracks. Active toe erosion is taking place.

3.3.3 Behaviour unit 3 – north-east slopes (southern part)

The slope in this unit was re-graded during the road construction and is currently well vegetated and showing no signs of instability. The toe is protected by rock outcrops at Scalby Beck and by toe protection put in place around the Sea Life Centre car park. This unit is considered stable.



Photograph 6. Behaviour unit 3 looking south towards the Sea Life Centre

3.4 Slope stability analysis results

3.4.1 General impacts

Each unit is discussed in turn below. However, there is a risk of failure for both behaviour units 1 and 2 if ground water levels were to rise significantly following a prolonged period of heavy rain. There is also potential for localised failure, due to the presence of more permeable bands of sand and gravel within the glacial till. This potential is further increased if the permeable bands are not allowed to drain freely due to a slip of soil from a higher level.

3.4.2 Behaviour unit 1

The north-west slopes are steeper and therefore less stable, with possible instability occurring on both the upper and lower parts of the slope. Lower slope instability would occur with a rise in ground water level and increased toe erosion. On the upper slopes, instability is due to over steepening, resulting in shallow instability. The slope is marginally stable, although the factor of safety becomes less than 1 when the ground water levels rise by 2m or more in response to an event such as high rainfall.

3.4.3 Behaviour unit 2

Slope stability analysis of the north-east slopes revealed that the central back tilted block is currently stable, and that movement will only occur with high ground water levels and significant toe erosion. The upper slope is found to be marginally stable, although the factor of safety becomes less than 1 if ground water levels rise by 4m or more, such as after a prolonged period of high rainfall. Large scale failure of the whole slope is considered unlikely to occur during the lifetime of the study period (100 years).

3.5 Coastal cliff retreat

Recession of the headscarp is taking place through the localised failure of blocks, typically 0.75 to 1.0m wide, falling from the headscarps onto the slopes below. The rate of retreat has been estimated based on aerial photography and observations on site. Full details are presented in section 6 of the Stage 1 report (Ref. 1, Halcrow 2005) in Appendix A.

3.6 Impact of climate change on stability and retreat

3.6.1 Increased rainfall

Climate change may lead to an increase in storminess and therefore, extreme events may become more frequent. Although this would mean that the marginal conditions would become more prevalent, they would still nevertheless remain marginally stable.

3.6.2 Coastal erosion

The rate of coastal erosion may increase as a consequence of increased rainfall eroding the crest and increased flows in the beck eroding the toe. This has been accommodated in the risk based approach used to assess erosion rates.

In both cases, action can be taken to mitigate the impact of reduced stability of the coastal slopes and this is investigated in Section 4 of this report.

4 Option Identification

4.1 Basis of option identification

Options to manage the slope have been identified based upon the updated ground model and slope stability analysis. Five options have been considered at this stage:

- do nothing;
- monitoring;
- slope protection;
- extensive slope protection works;
- property acquisition.

Only the first three options were found to merit further analysis by means of a cost/benefit analysis. The rationale behind the identification and/or rejection of each option is discussed below.

4.2 Option 1 – Do Nothing

The first option to be considered is that of the Do Nothing scenario. This represents a situation where no construction works are undertaken and all maintenance and monitoring activity is withdrawn. The Do Nothing scenario has already been found to be unacceptable by SBC (Ref. 3, SBC 2004) and is used purely as an economic baseline in the cost/benefit analysis. This conforms to Defra FCDPAG3 and facilitates the comparison of other options.

4.3 Option 2 – Monitoring

An option consisting of monitoring is considered because SBC would, as responsible landowners, be expected to implement a monitoring scheme as a Do Minimum option. A monitoring scheme would also be needed to comply with Defra's requirement that all coastal authorities must carry out an appropriate level of coastal monitoring. This option would involve the implementation of a monitoring and field observation scheme, and the installation of piezometers and inclinometers with subsequent analysis and comment. A properly designed and implemented monitoring scheme could provide an early warning of possible major failure, i.e. a catastrophic or deep seated land slip, thus allowing SBC the possibility to notify owners and facilitate evacuation of the properties at risk. However, the act of monitoring alone would not prevent further erosion and the associated property losses, nor would it reduce the risk of a deep seated slip occurring.

4.4 Option 3 – Slope protection

The next option considered is that of Do Something, in this case the implementation of slope protection works. The stage 1 report (Ref. 1, Halcrow 2005) identified that the main failure mechanism for the slopes are shallow landslips, which are governed by both crest and toe erosion and a rise in ground water levels. Protection works are therefore needed at the toe

and crest of the slopes, with interceptor drains at the crest and counterfort drains running down the slope to control ground water levels. Installing crest or toe works separately is not sufficient to stabilise the slope, and therefore work at both the toe and crest would be necessary.

4.4.1 Toe works

The toes of both slopes at Scalby Ness could be protected using 1-5T rock armour, with a backing geotextile to separate it from the slope soil.

4.4.2 Crest works

The crest of each slope could be covered with vegetated geotextile and soil nailing will be used to anchor the soil where the crest is less than 10m from the properties. An intercept drain placed 2m back from the crest would prevent the bulk of surface water from flowing down the slope. We have assumed that an interceptor drain can be connected to a suitable outfall.

4.4.3 Slope drainage

Counterfort drains could be installed on the north-west facing slope as shown in Appendices C and D. The drains could run from the up-slope edge of the back tilted block at a depth of 1m, to the bottom of the slope where they would run into the proposed rock armour toe works at Scalby Beck up to a depth of 5m.

The works identified in this option are those needed to stabilise the slopes and minimise further erosion. They do not include measures to anchor any deep seated slip surfaces within the slopes, as there is only a risk of this failure mechanism occurring if the ground water level rises to a high level. The installation of counterfort drainage in the slopes would control the ground water levels, minimising the risk of a deep seated slip.

4.5 *Option 4 – Extensive slope protection works*

Extensive slope protection works to deal with the risk of deep seated slips were also considered. This included installing bored piles into the slope, along with toe and crest protection works. This option is not considered further in the analysis, as no additional benefit is gained. It would also be considerably more expensive and therefore less economic, as well as being more disruptive on local residents and the environment.

4.6 *Option 5 – Property acquisition*

The final option considered is for SBC to acquire the properties at risk and demolish them as they become unusable. However, given the considerable disruption that this would cause to the local community and the associated legal costs, this option would be unreasonably expensive and unpopular. The 2005 cash value of the properties to be bought is £3,908,000, and the present value cost is £1,554,464. This does not include any of the other costs that would be associated with this option and is therefore significantly more expensive than the present value cost of Do Something. This option is therefore not considered further in the analysis, but has been undertaken to appreciate the viability or otherwise, of this course of action.

4.7 *Summary of options identified warranting further consideration*

The options identified for comparison via a cost/benefit analysis are therefore:

- Option1 – Do Nothing
- Option2 – Monitoring (Do Minimum)
- Option 3 – Slope protection (Do Something)

5 Scheme Benefits

5.1 General Approach

Scheme benefits are defined as the difference between the losses associated with each scheme and the baseline Do Nothing losses. Scheme losses are based on the current property values and the timing of loss, which itself is a function of anticipated erosion rates.

5.1.1 Affected Properties

Based on the assumed erosion rates determined in the Stage 1 study, fifty properties will be affected by erosion at Scalby Ness during the study period. These are categorised as either front line or secondary properties, depending on their location.

Front line properties are those immediately at risk of erosion, whereas secondary properties are those which will be blighted due to being adjacent to front line properties[1].

An aerial view of the affected properties is presented in Figure 3.

5.1.2 Property Values

Property values were taken from the previous strategy report and have been increased by 80 per cent in this analysis. The property values were originally independently determined by an estate agent and the 80 per cent increase is based on anecdotal evidence supplied by SBC, reflecting the recent increase of property values in Scarborough.

Property loss is split into blight and write-off to reflect the timing of loss and its impact on the community.

Garages have been priced at a replacement cost of £4000. This figure represents the cost of bricks and mortar, i.e. the building fabric and construction. The value of the garage forms part of the parent property value.

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[1] It is acknowledge that the use of the word "blight" has negative connotations. However, it is used to reflect the negative impact an increased risk would have on property values. We have therefore used the word "blight" to reflect this phenomenon and to allow a quantitative analysis of the impact of coastal erosion and consequential loss.

This is not strictly in accordance with Defra's Project Appraisal Guidance, which states:

"Usually 'permanent' buildings which are at risk from total loss from flooding or erosion should be valued at their current market value, excluding any adjustment in value for the erosion or flood risk."(PAG3, section 4.1.1).

However, once the concept of phased loss is introduced, i.e. write off values being reduced as erosion progresses, the change in property values can be included as a real loss, thus validating the approach.

5.1.3 Property Linking

Many of the front line properties are within blocks. It has been assumed that loss to all properties in a block occurs when the nearest part of the block to the crest is affected by erosion. Residents in the block would be evacuated as the damage on the block manifests itself.

The garages are assumed to be lost when the property to which they are attached are lost as they cannot be used.

5.1.4 Calculation of Loss and Blight

Front line property loss has been assumed to occur when the distance between the property and the crest is below the loss threshold. In this case, the loss threshold has been set at:

- 8m for properties currently further than 15m from the crest
- 5m for properties currently less than 10m from the crest

Property blight has been assumed to occur when the distance between the property and the crest is:

- 15m for properties currently further than 15m from the crest
- 6m for properties currently less than 10m from the crest

There are currently no properties greater than 10m but less than 15m from the crest.

Secondary properties are not at risk of loss within the strategy period considered. However, there is a risk that the value of these properties will be adversely affected by blight should the front line properties be lost. Blight represents both a 20 per cent reduction in value of properties fronted by derelict properties, and the perception that the community is at risk from further coastal erosion.

5.1.5 Erosion Rates

The erosion rates used in the analysis are taken from the Stage 1 report. Erosion occurs from loss of toe due to a combination of coastal and fluvial erosion and blocky or episodic erosion of the crest. A probabilistic approach has been used to determine loss, for which a high, best and low estimate has been given. The erosion rates are shown in Table 5.1 below.

	Erosion rates (m/yr)		
	Low	Best	High
Probability	0.150	0.750	0.100
Behaviour Unit 1	0.050	0.180	0.310
Behaviour Unit 2	0.035	0.200	0.360

Table 5.1 Erosion rates

The range of erosion rates reflects the uncertainties in aerial photography interpretation and the use of coastal data "inland" in deciding rate estimates.

Further details can be found in section 6.5 of the Stage 1 report in Appendix A.

5.1.6 Threat to Properties from Land Slips and Rotational Slips

The Stage 1 report describes the threat to properties from land slips and rotational slips. The main points were:

- *Shallow slips prevail as the failure mechanism.* This threat can be resolved by the installation of drainage and toe and crest works as described in Option 3.
- *The factor of safety for rotational slips is at or marginally below 1.2 (considered the acceptable minimum value by BS 8012).*
- *The factor of safety falls towards 1.0 when ground water levels rise.* However, this would be controlled by the drainage identified in Option 3 and therefore no extra benefit would be associated with works to prevent further slips, such as deep piling to increase the factor of safety for deep seated rotational slips.

Because the factor of safety for rotational slips exceeds 1, the risk to properties from this failure mechanism is not considered in the analysis. The failure mechanisms are described in the Stage 1 report (Ref. 1, Halcrow 2005) and the mitigation works described in section 4.

5.2 *Option 1 – Do Nothing*

In Option 1 no action would be taken to resolve the risk of erosion and losses arise in the form of blight and property loss. Losses are first calculated at cash value and then converted to Present Value costs using Defra discount factors. The Option 1 loss analysis is shown in Appendix E.

Table 5.2 below shows when blight and write-off will occur to the affected properties. The low, best and high time estimates refer to the erosion rates used in the analysis.

		Time estimate (years)		
		Low	Best	High
Front line properties	Time to blight	12	3	2
	Time to loss	46	12	6
Secondary properties	Time to blight	46	12	6

Table 5.2 Time estimates

The cash value and present value of losses incurred by this option are:

- Cash value of loss = £4,540,200
- Present value loss = £ 1,970,833

The Do Nothing option is used as the economic baseline in this analysis. It must be recognised that the cash value of loss includes the blight loss incurred by the secondary line of properties which would not be written off within the strategy period, but would suffer as a consequence of increased risk and disruption.

5.3 Option 2 – Monitoring

Option 2 is much the same as Option 1, except that some costs are incurred installing and maintaining monitoring equipment, undertaking visual monitoring and reporting.

As no intervention occurs to prevent losses due to erosion, the timing of those losses is the same as in Option 1 (see Table 5.2).

A possible consequence of SBC adopting this option would be to decrease property values as there would be a perception of non-intervention and therefore abandonment in the community. We acknowledge that this contravenes the PAG3 guidance, in that we are making an adjustment to current market property values due to the risk of erosion. However, this analysis has been done as a way to measure the potential intangible benefit of monitoring alone compared with Do Nothing or intervention. As a responsible landowner and coastal authority, SBC is likely to be required to carry out such monitoring in order to anticipate losses and action to save people and belongings. It should be stressed that any benefit from this option is an intangible benefit, as nothing is actually being done to resolve the erosion problem, and the blight arises from a change in property values.

The analysis assumes that once a decision has been made to monitor, the affected properties will be blighted immediately as nothing is being done to protect them. The blight factors for front line and secondary properties are 0.9 and 0.95 respectively. This small reduction reflects the uncertainty associated with this approach and is considered to be a conservative estimate.

Loss and blight due to erosion are then calculated in exactly the same way as in Option 1, except that the initial property prices are lower.

The cash value and prevent value of losses incurred by this option are:

- Cash value of loss = £4,118,190
- Present value loss = £ 1,794,852

5.4 Option 3 – Slope Protection

The extent of the slope protection works is described in section 4.4. The toe and crest works curtail erosion and the drainage works control the groundwater levels. Consequently, the threat of erosion is removed and once the works are in place no further loss will occur.

The loss value for this option is therefore £0.

5.5 Summary of Benefits and Losses

A summary of the benefits and losses is shown in Table 5.3 below.

	Option 1	Option 2	Option 3
Cash value loss	£4,540,200	£4,118,190	£0
Present value loss	£1,970,833	£1,794,852	£0
Present value benefit	£0	£175,980	£1,970,833

Table 5.3 Summary of benefits and losses

6 Scheme Costs

6.1 Introduction

The construction, supervision and design costs used in the analysis are based on rates used by Halcrow on similar projects and have been verified by a geotechnical specialist. The extent of works is described in sections 3 and 4.

6.2 Option 1 – Do Nothing

No costs are incurred by Option 1.

6.3 Option 2 – Monitoring

The present value costs incurred in Option 2 are shown in detail in Appendix E.

6.3.1 Capital costs

The capital cost of equipment and installation is £50,000 and is included in year 2, as the monitoring scheme design will take place during year 1. A capital cost of £5,000 is included for repair of equipment every 10 years thereafter.

6.3.2 Equipment maintenance costs

Maintenance costs have been assessed as being £4,500 a year. This includes a site inspection, data collection and analysis, report and fees. Every 10 years an extra £2,000 is added to pay for the production of a more detailed report.

6.3.3 Other costs

Other costs in years 1 and 2 have been assessed as being £3,675 and are associated with the design and supervision of the monitoring system. This is composed of 6% of the initial capital cost of £50,000 and 15% of maintenance costs of £4,500. For each year thereafter, the other costs are assessed as being 15% of maintenance costs for that year.

6.4 Option 3 – Slope Protection

6.4.1 Capital costs

A breakdown of the capital costs for Option 3 is given in Appendix E. The total capital cost of £1,287k includes the cost of construction, preliminaries (at 30% of construction costs) and a contingency of 20% of the construction costs.

Based on the assumption that implementation of the slope protection scheme is not delayed, the initial capital cost of £1,030k occurs in year 2. In year 50 a capital cost of £257k (representing 25% of the initial capital cost) is incurred for repair and renovation of the slope protection works.

6.4.2 Maintenance costs

A maintenance cost of £1,000 is incurred each year, starting in year 3. During year 50 there are no maintenance costs due to repair works, which are included in the capital costs.

6.4.3 Other costs

Other costs are incurred in years 1, 2 and 50. In year 1, other costs of £47k include further costs associated with the detailed design and environmental study. The remaining design costs of £98k are incurred in year 2, which also includes the cost of site supervision, project management and SBC costs. In year 50 the other cost of £26k is for the associated design and supervision costs of repair works, assumed to amount to 10% of the capital cost of repair works.

6.5 Summary of costs

A discount factor is applied to the costs for each year to calculate the overall option cost. The sum of these costs represents the present value cost for each scheme. An optimism bias of 60% is then added to give the total present value cost in line with Defra recommendations.

	Option 1 Do Nothing	Option 2 Monitoring	Option 3 Slope Protection
∑ cash cost	£0	£634,025	£1,553,991
PV costs	£0	£219,251	£1,180,779
Optimism bias (at 60%)	£0	£131,550	£708,467
Total PV cost	£0	£350,801	£1,889,247

Table 6.1 Summary of costs

7 Economics and option selection

7.1 General

The economic analysis is based upon the Flood and Coastal Defence Project Appraisal Guidance (FCDPAG) published by Defra.

7.2 Summary of results

A summary of the option results is given in Table 7.1 below. The most likely preferred option is that of Slope Protection, which has the highest benefit/cost ratio.

	Option 1 Do Nothing	Option 2 Monitoring	Option 3 Slope Protection
PV costs PVc		£219,251	£1,180,780
Optimism bias (at 60%)		£131,551	£708,468
Total PV cost		£350,802	£1,889,247
PV damage PVd	£1,970,833	£1,794,852	£0
PV damage avoided		£175,980	£1,970,833
Total PV benefits PVb		£175,980	£1,970,833
Net Present Value NPV		£43,271	£790,053
Average benefit/cost ratio		0.50	1.04
Incremental benefit/cost ratio			1.2

Table 7.1 Summary of cost/benefit analysis

7.3 Sensitivity analysis

The economic robustness of the preferred option (Slope Protection) was tested via a sensitivity analysis. A sensitivity analysis is a method of testing the uncertainties present in the economic model and the effect of changes in model parameters. The parameter variations tested were:

- Primary blight value ± 25%
- Blight and loss thresholds ± 25%
- Property values ± 15%
- Costs ± 15%
- Timing of works

Erosion rates have not been included in the sensitivity analysis, as low, best and high estimates were utilised in the main analysis. This risk based approach obviates the need for further sensitivity analysis.

7.3.1 Primary blight value

The default primary blight value used in the analysis is 0.5. This was tested in the sensitivity analysis by varying its value ± 25%. Blight refers to the reduction in property value incurred by front line properties when they become affected by erosion. The level of uncertainty in this assumption is quite high, which is reflected in the 50% sensitivity margin.

	Benefit/cost ratio
Best estimate primary blight value	1.04
Primary blight value + 25%	1.20
Primary blight value - 25%	0.88

Table 7.2 Primary blight sensitivity

7.3.2 Blight and loss thresholds

The default blight and loss thresholds used in the analysis have been tested to ± 25% in the sensitivity analysis. The blight threshold is the distance at which the proximity of the crest to a property affects the value of that property. The loss threshold is the distance at which the proximity of the crest leads to a property being lost. The level of uncertainty in setting the default blight and loss threshold values is quite high, which is reflected in testing a 50% sensitivity margin.

	Benefit/cost ratio
Best estimate blight and loss thresholds	1.04
Blight and loss thresholds + 25%	1.25
Blight and loss thresholds - 25%	0.71

Table 7.3 Blight and loss threshold sensitivity

7.3.3 Property values

The default property values (as shown in Appendix E) have been tested to ± 15% in this sensitivity analysis. The 30% sensitivity margin reflects a lower level of uncertainty in predicting property values.

	Benefit/cost ratio
Best estimate property values	1.04
Property values + 15%	1.20
Property values - 15%	0.89

Table 7.4 Property value sensitivity

7.3.4 Costs

The overall default scheme costs (as shown in Appendix E) have been tested to ± 15% in the sensitivity analysis. The sensitivity margin of 30% represents both the low level of uncertainty in the cost estimate and the fact that it already includes the 60% optimism bias.

	Benefit/cost ratio
Best estimate cost	1.04
Cost + 15%	0.91
Cost - 15%	1.23

Table 7.5 Cost sensitivity

7.3.5 Timing of works

The sensitivity analysis also included testing the impact on the benefit/cost ratio, of delaying the start of works associated with Option 3 by 0, 5 and 10 years. All other parameters are set at default conditions. As shown in the table below, there is no advantage to be gained in delaying the implementation of protection works.

	Benefit/cost ratio
Work delayed by 0 years	1.04
Work delayed by 5 years	0.99
Work delayed by 10 years	0.94

Table 7.6 Timing of works sensitivity

7.3.6 Summary of the sensitivity analysis

The results of the sensitivity analysis show that the case for the only viable technical scheme is marginal. Additionally, this remains the preferred option for each of the sensitivity analyses. However, the viability of the scheme hovers around unity. Sensitivity analysis on the timing of works shows that delaying the works would not be beneficial.

7.4 *Defra Priority Score*

The following information was used to calculate the Defra priority scores:

Category	Option 2 Monitoring	Option 3 – Slope Improvement Works
Study Related to Works	No	Yes
PV Costs –incl. Opt Bias (£k)		1,889
PV Benefits (£k)		1,971
No. of Residences	50	
Risk	High	
Vulnerability	5,034	
BAP, SSI, Other habitat protected	0	
Heritage sites	Neither	
Priority Score	**20**	**5**

Table 7.7 Defra priority scores

8 Conclusions and recommendations

8.1 Conclusions

This report reviews and updates the previous 2004 draft coastal strategy (Ref. 2, HPR 2003). It builds on the findings of the stage 1 geotechnical report (Ref. 1, Halcrow 2005) and re-examines the need for coastal protection and slope stabilisation works. Various options have been considered and an economic appraisal of potential options has been completed. The options have been appraised using a cost/benefit analysis, which included a sensitivity analysis to test its economic robustness.

The main conclusions of the work are described below.

Stage 1 Report
A new ground model of the Scalby Ness area was produced during stage 1, based on new information from the site. It was found that the shear surface below the north-eastern slope is deeper than previously thought, thus changing the geometry of the sliding block. This new analysis demonstrates that the factor of safety is higher than previously thought and is approximately 1.2. This is considered acceptable as long as ground water levels are controlled.

Erosion rates of the crest and toe of the slopes were estimated using historical aerial photographic data. A risk based approach was adopted to estimate the likely timing of property loss, using high, medium and low rates of erosion. Typically, erosion rates of approximately 0.18 - 0.2m per year were adopted for this analysis, with the impact due to be felt by the community in the next 5 -10 years, depending on the erosion scenario.

Stage 2 – This Study
Option 2 provides no actual benefit other than an increase in knowledge, which in turn will support future management decisions for the coastal slopes at Scalby Ness. The analysis used here was undertaken to quantify the viability of this option when measured against intangible benefits associated with property blight. The benefit cost ratio for this option is 0.5 and therefore the case for this option on pure economic grounds is not made. The Defra priority score associated with this action is 20 as the option is ostensibly to monitor and not to instigate capital works, to reduce the risk to properties and people to an acceptable level.

Option 2 represents a course of action that SBC could take as the land owner to allow it to monitor ongoing coastal erosion and the changing risk to assets, properties and the public.

Adopting this course, i.e. continued and more structured monitoring, will allow for further information to be collected and confirm erosion rates at Scalby Ness. This will provide SBC with a better understanding of the risk to the residents of Scalby Ness and allow a more conclusive and robust appraisal of the situation at a future date. It will also establish a protocol for identifying stability issues at the slopes, i.e. following periods of extreme rainfall and the potential for raised ground water levels and temporary lower factors of safety. This in turn can be communicated to the residents and emergency actions can be taken as required.

Option 3 represents the most beneficial course of action economically. However, the BCR is approximately 1 and has a low priority score of 5. It is unlikely therefore to attract Defra funding.

Option 3 "Slope protection" was found to be the only viable technical scheme to reduce the risk to properties to an acceptable level. Other schemes considered were shown to be more expensive but bring no extra benefit in terms of slope stabilisation.

Sensitivity analysis confirmed that Option 3 remains the most beneficial option, but the BCR remains at or about unity. The sensitivity analysis did not change the priority score calculations.

Sensitivity testing of the timing of works confirmed that there is no tangible benefit in delaying the scheme other than providing information about actual erosion rates and the likely risk to assets, residents and properties at Scalby Ness.

8.2 *Recommendations*

The main recommendations from this Strategy review are as follows:

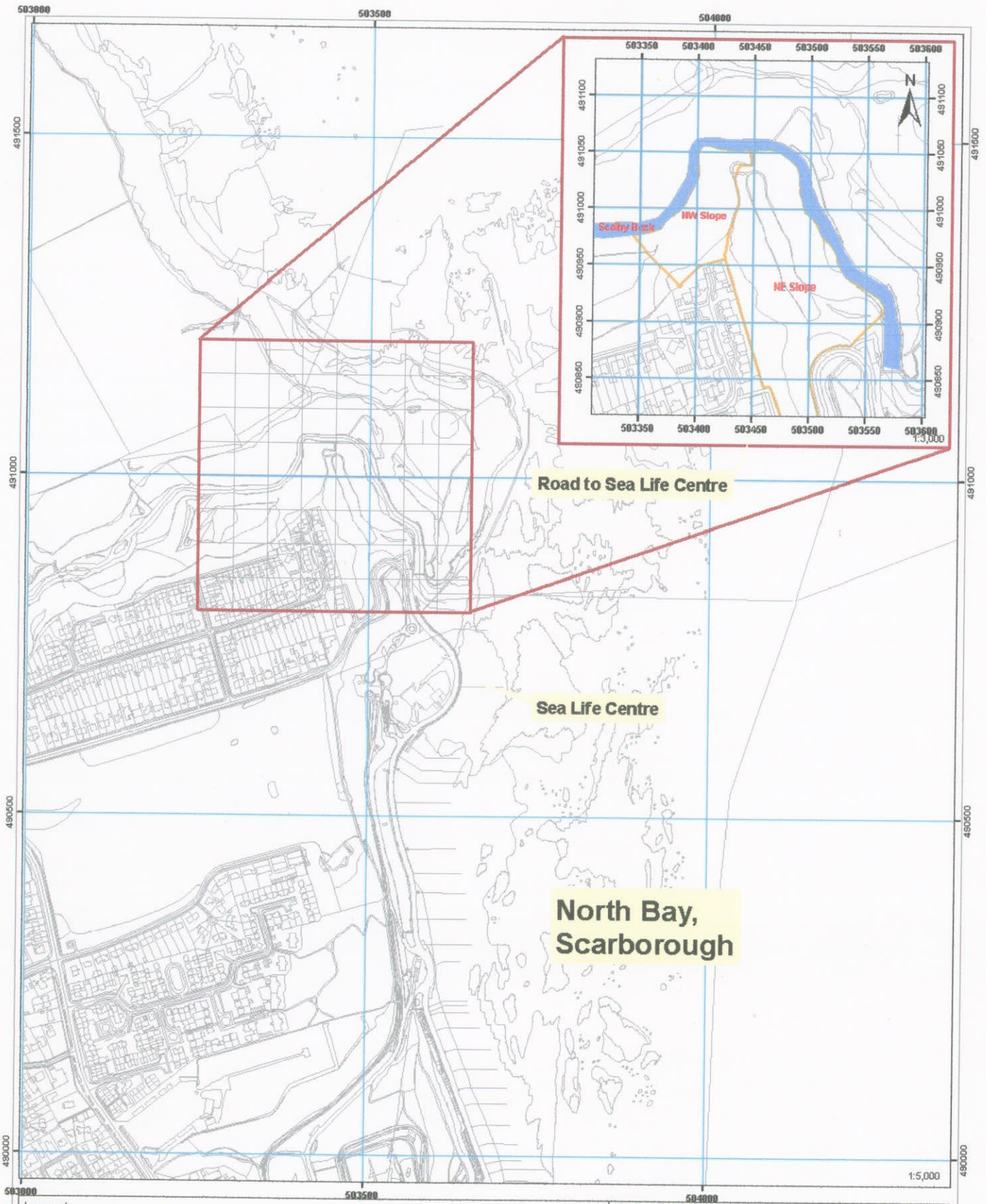
- That monitoring be implemented as outlined in the Stage 1 Report.
- Undertake a re-evaluation of the risk to properties and viability of works to the properties at Scalby Ness at intervals not greater than 5 years. This shall incorporate the data collected by the proposed monitoring.
- Instigate and develop a forum, by which the residents of Scalby Ness can be informed of the actions taken by SBC and the changing circumstances, in terms of risk from erosion etc.

References

1. Halcrow Group Ltd. *Hundale Point to Scalby Ness Instability Section One - Data Gathering and Analysis.* October 2005
2. High Point Rendal. *Hundale Point to Scalby Ness Coastal strategy Study.* May 2003
3. Scarborough Borough Council. *Employer's Requirements Hundale Point to Scalby Ness Coastal Strategy.* August 2004

Figures

Figure 1 – Site Location



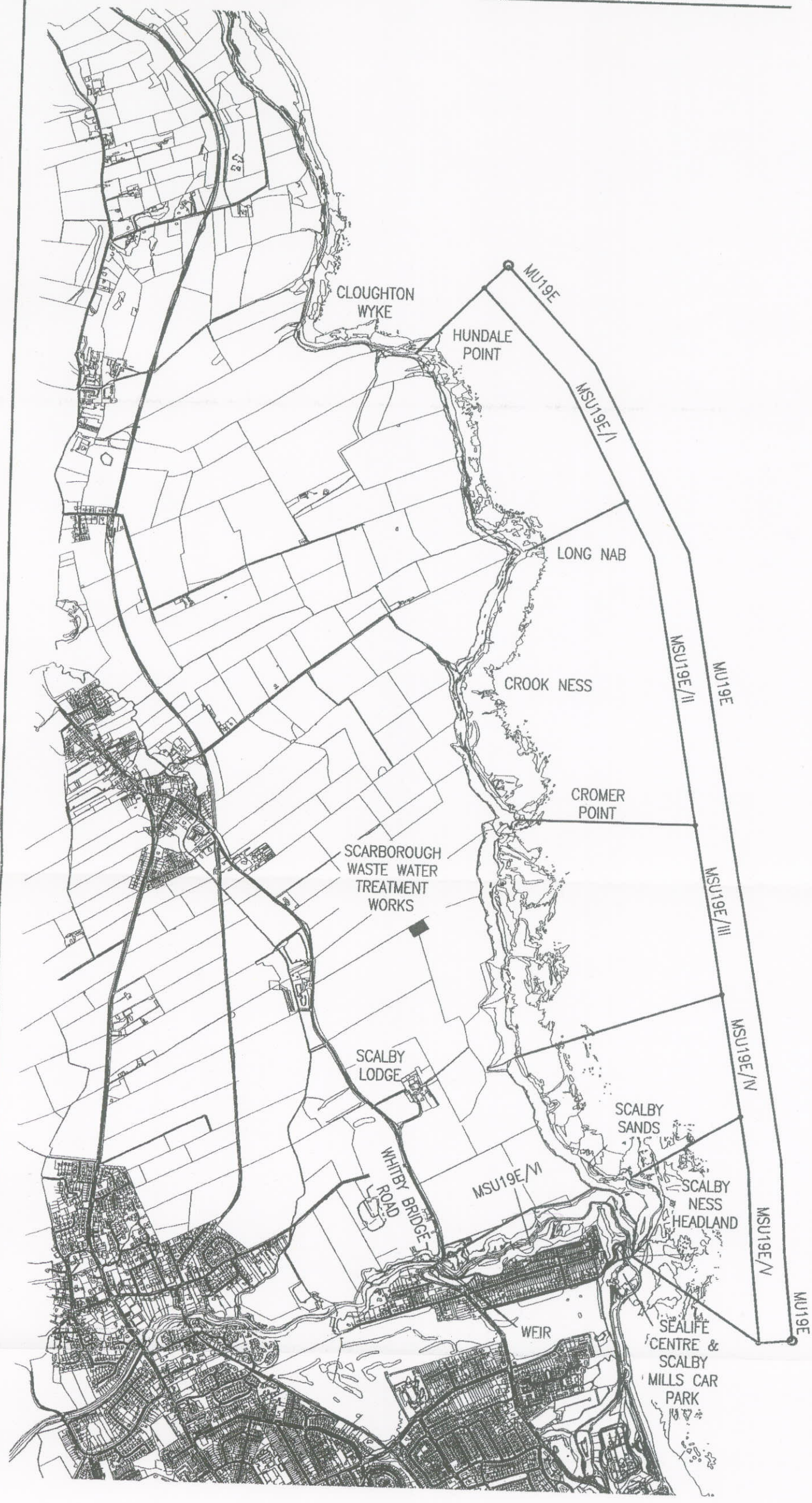
Legend:

Legend

Client: Scarborough Borough Council	Licence details: To be confirmed by SBC
Halcrow Group Limited	Data source: OS tradline
Halcrow	Survey date(s):
Drawn by: - JLM	Date: - 21/05/05
Checked by: - SKT	Date: - 21/05/05
Approved by: -	Date: -

Figure 1 Site location

Figure 2 – Coastal management units



0 20 100 200m

ORIGINAL SCALE 1:2000

CAD FILE 1404-P-Fig2.1

HUNDALE POINT TO SCALBY NESS STRATEGY STUDY

LOCATION OF MANAGEMENT SUB-UNITS

Figure No. 2.1

Scale 1:2000

High-Point Rendel

High-Point Rendel

Figure 3 – Aerial view of properties at risk

0 10 20 30 40 50

SCALE 1:500 (A1)
SCALE 1:1000 (A3)

METRES

(INDICATIVE ONLY – DO NOT SCALE)

PROPERTY NO.	ADDRESS	DISTANCE FROM CREST (m)
1	221–223 SCHOLES PARK ROAD	24.6
2	217–219 SCHOLES PARK ROAD	32.9
3	213–215 SCHOLES PARK ROAD	31.3
4	209–211 SCHOLES PARK ROAD	31.7
5	205–207 SCHOLES PARK ROAD	23.6
6	201–203 SCHOLES PARK ROAD	18.9
7	197–199 SCHOLES PARK ROAD	18.7
8	193–195 SCHOLES PARK ROAD	17.8
	GARAGE FOR 8&9?	9.44
9	189–191 SCHOLES PARK ROAD	20.7
	GARAGE FOR 10?	11.7
10	185–187 SCHOLES PARK ROAD	9
11	181–183 SCHOLES PARK ROAD	8.4
	GARAGE FOR 11&12?	7.3
12	177–179 SCHOLES PARK ROAD	15.6
13	173–175 SCHOLES PARK ROAD	17.8
14	169–171 SCHOLES PARK ROAD	18.3
	GARAGE FOR 13&14?	25.22
15	8 BAY GARAGE	
16	59 SCHOLES PARK ROAD	
17	165–167 SCHOLES PARK ROAD	
18	161–163 SCHOLES PARK ROAD	
19	157–159 SCHOLES PARK ROAD	
20	153–155 SCHOLES PARK ROAD	
21	4 BAY GARAGE	
22	149–151 SCHOLES PARK ROAD	
23	143–145–147 SCHOLES PARK ROAD	
24	148–150 SCHOLES PARK ROAD	
25	144–146 SCHOLES PARK ROAD	
26	140–142 SCHOLES PARK ROAD	
27	136–138 SCHOLES PARK ROAD	

Notes:

1. DO NOT SCALE OFF THIS DRAWING.

2. DISTANCE FROM CREST TO PROPERTY EXTREMITY APPROXIMATE ONLY. HOWEVER ACCURACY SUFFICIENT & COMMENSURATE WITH EROSION RATE ESTIMATES.

Rev	By	Chkd	Apprvd	Date	Description
-	-	-	-	-	-

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Project

HUNDALE POINT TO SCALBY NESS COASTAL STRATEGY

Drawing

PROPERTIES AT RISK FROM EROSION

Drawn by: GIC Date: 10-08-2005
Checked by: AS REPORT Date: AS REPORT
Approved by: AS REPORT Date: AS REPORT

Drawing No. FIGURE 3

Revision -

Drawing Scale: 1:500 @ A1

Figures extracted from Stage 1 Report

Figure 3 – Geomorphology and Behaviour Units

Figure 13 – Aerial Photography – Historic Crest/Toe Positions

Figure 16 – Cliff Recession Rates

Figure 3 – Geomorphology and Behaviour Units

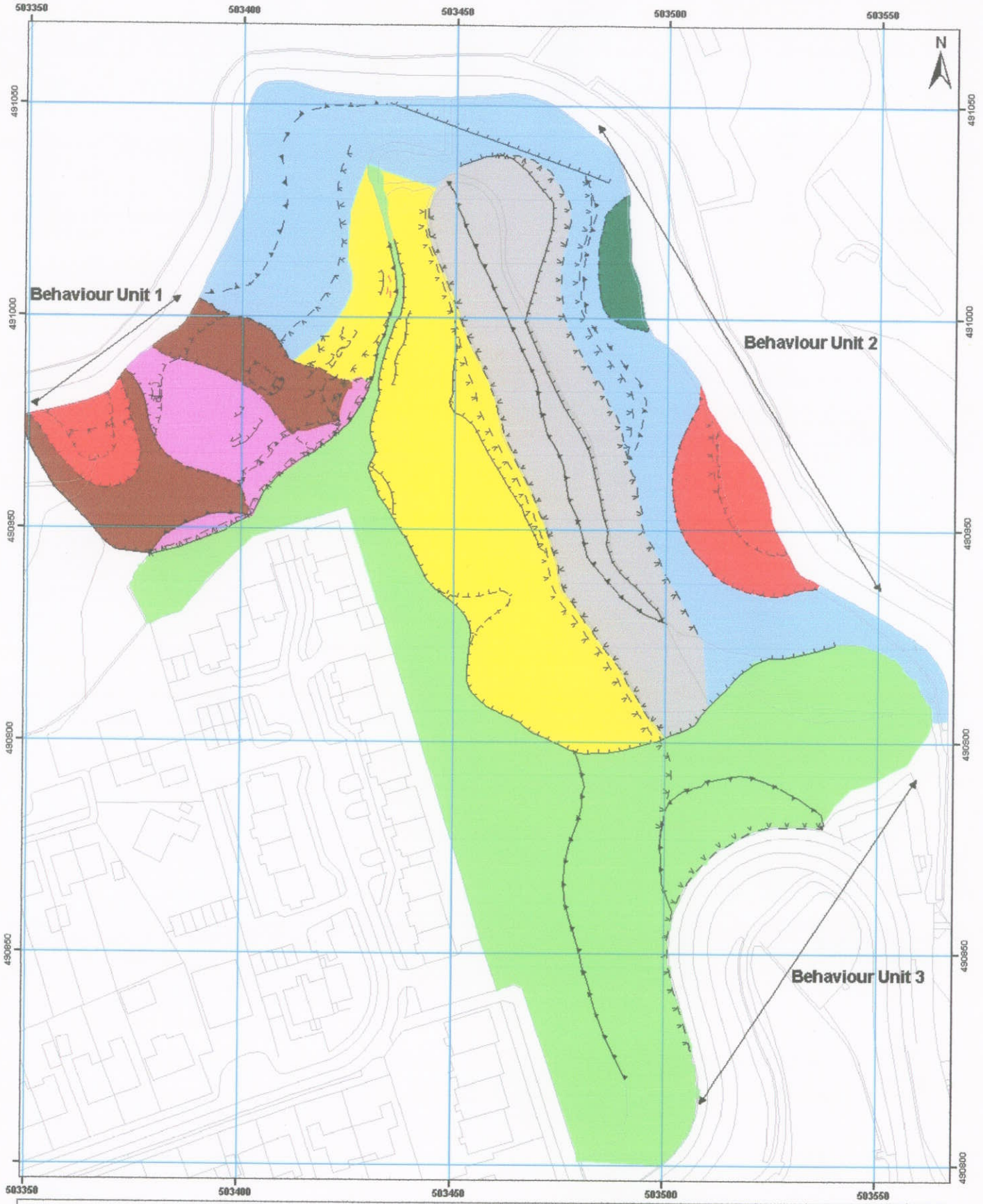


Figure: 3 Geomorphology

Figure 13 – Aerial Photography – Historic Crest/Toe positions

Legend:

Retreat lines

1946

1999-2000

2003

Note: Refer to Section 6 of the Section One- Data Gathering and Analysis Report, No. R6641, for a discussion of the errors which should be considered in the use of aerial photography data.

1:1,000

Client

Scarborough Borough Council

Licence details:

No. LA07 9251

Halcrow Group Limited

Halcrow

Data source:
OS Landline
Aerial photography

Survey date(s):

Drawn by: - JLB | Date: - 22/06/05

Checked by: - SKT | Date: - 22/06/05

Approved by: - | Date: -

Figure 13 Aerial photography 2003

Figure 16 – Cliff Recession Rates

Legend:

——— Position of headscarp in 2003
Expected upslope migration of the headscarp in years:
2005
2015
2025
2035
2045
2055
2105

Note. This figure is based on the anticipated average recession rate derived from interpretation of aerial photographs from 1946 to 2003. Reference should be made to the Section One- Data Gathering and Analysis Report, No. R6641, for a full discussion of the derivation of the rates of recession

1:900

Client:
Scarborough Borough Council

Licence details:
No. LA079251

Halcrow Group Limited

Halcrow

Data source:
2003 Aerial photography
Recession rates - see report

Survey date(s):

Drawn by: - JLM	Date: - 22/05/05
Checked by: - SKT	Date: - 22/05/05
Approved by: -	Date: -

Figure 16 Cliff recession scenarios - average retreat rate

Appendices

Appendix A – Executive summary from Stage 1 report

Appendix B – Existing slope sections

Appendix C – Proposed slope protection works

Appendix D – General arrangements for sections

Appendix E – Economic analysis

Appendix A – Executive summary from Stage 1 report

Executive Summary

The present stability and potential future stability of the cliffs at Scalby Ness have been investigated using a combination of new geomorphological mapping, new and previous ground investigation data, site monitoring and historic aerial photographs (1946, 1999-2000 and 2003) interpretation. This has been used to review the existing modelling and site interpretation and to develop the slope instability model using slope stability analysis. As a result, a number of key conclusions can be drawn from this study.

1. The previous ground model has been reviewed and revised in accordance with the results of the mapping and the stability analysis carried out for this study.

    a. The ground model has been revised for the north-east slopes. The shear surface at the base of the central back-tilted block is known to be at a greater depth than previously thought because further monitoring has revealed deeper movement in inclinometer SN1. Monitoring over the winter of 2002 to 2003 revealed the basal movement to be between 10.8 and 11.7mbgl, significantly deeper than the previous interpretation. This increased depth of movement changes the geometry of the sliding block and increases its factor of safety. Analysis of this deeper seated back-tilted block reveals it to be more stable than earlier analysis had shown. This change in interpretation is supported by the results of the geomorphological mapping. The location and morphology of the block suggests that this feature formed as a result of a much larger ancient deep-seated translation or rotational landslide, where the entire block moved as a single unit over a defined shear surface. The predominant mode of failure identified for these slopes is shallow failure of the upper oversteep glacial till slopes, with active toe erosion by the beck and subsequent localised failures of the lower slopes. The upper slopes are marginally stable. Increases in pore water pressure in the slopes reduce the factor of safety and could cause localised instability, especially where lenses of more permeable sands and gravels may be present. This can be anticipated in periods of intense rainfall.

b. The ground model for the north-west slopes has been refined, following further monitoring and the new geomorphological mapping, with two mudslide units identified within a shallow translational slide. Active toe erosion is taking place by the beck. The predominant failure mode identified from the analysis and the mapping is shallow translational failure, with localised block detachment processes at the head scarp also occurring. The north-west slopes are shown by analysis and the mapping to be marginally stable. Continued toe erosion or an increase in porewater pressure in the slopes reduces the factor of safety against instability.

c. The southern part of the north-east slopes has been partially regraded during the earthworks carried out to form the road to the Sea-Life Centre. This area is considered to be stable in current conditions, although localised shallow instability could occur in periods of heavy rainfall. The factors of safety for the slopes are less than would ideally be designed in accordance with BS6031.

2. A number of issues with the data provided by SBC have been highlighted in the report. In particular, some of the monitoring data is not correctly referenced and its source cannot be identified on site, for example, survey pin data and manual groundwater level monitoring in "SN3". Recommendations have been provided to improve the slope monitoring network and systematic recording of data and observation.

3. The data is sparse in some areas of the site, requiring interpretation of the ground conditions between widely spaced boreholes. It is noted there remain significant uncertainties with the past behaviour or development of the Scalby Ness slopes, most notably the frequency and magnitude of past slope failure events and historical rates of recession of the slope crest.

4. The interpretation of the predominant mechanisms acting on the slopes, and an assessment of the rates of retreat of the headscarps from aerial photography has allowed the identification of three landslide behaviour units:

   - Behaviour Unit I (the north-west slopes) - an episodically active behaviour unit characterised by oversteep slopes that have been subjected to shallow translation movement and localised mudslide/

debris flow movements. The headscarp area has evidence of ongoing episodic block detachment and active toe unloading is evident at the base of the slope.

- Behaviour Unit II (the northern part of the north-east slopes) - an episodically active behaviour unit characterised by an oversteep rear headscarp, a mid-slope back-rotated block from a previous historic period of deeper instability, and localised active toe unloading in the lower slope.
- Behaviour Unit III (the southern part of the north-east slopes) - a currently stable behaviour unit that has undergone previous regrading and re-shaping as a result of the engineering works to form the access road to the Sea-Life Centre.

The behaviour units may be regarded independent of one another on account of their predominant mechanisms of slope failure, the historical rates change and past influences of engineering and development activities. The units have been used to define scenarios of slope development over the next hundred years (i.e. the strategy lifetime). The scenarios are not predictions, rather they are projections of what might happen given the occurrence of a particular set of environmental conditions over time, which are in themselves largely uncertain. The three scenarios consider a lower-bound, best-case and upper-bound projection of slope development at specified time steps over the next 100 years, for the three behaviour units. The scenarios are used to determine the possible future impacts of slope behaviour on built development at Scalby Ness. Probabilities have been assigned to each of the scenarios. The anticipated rates of recession with a "do nothing" approach have been considered for the three behaviour units to allow the impact of the retreat on property assets at Scalby Ness to be determined.

5. The results of this assessment indicate that assuming a "do nothing" option, the earliest anticipated date the crest of the slope will be approximately 1m from a property boundary is 2015. The probability of this occurring is considered low (0.15). Using the average retreat rates the estimated date by which the crest of the slope will be approximately 1m from a property boundary at Scalby Ness is 2025. The probability of this occurring is more likely (0.75). The most optimistic calculation shows that no property will be directly affected by 2105, although the crest of the north-east slope is likely

to be format or close to the property boundary; the probability of this scenario is considered low (0.1).

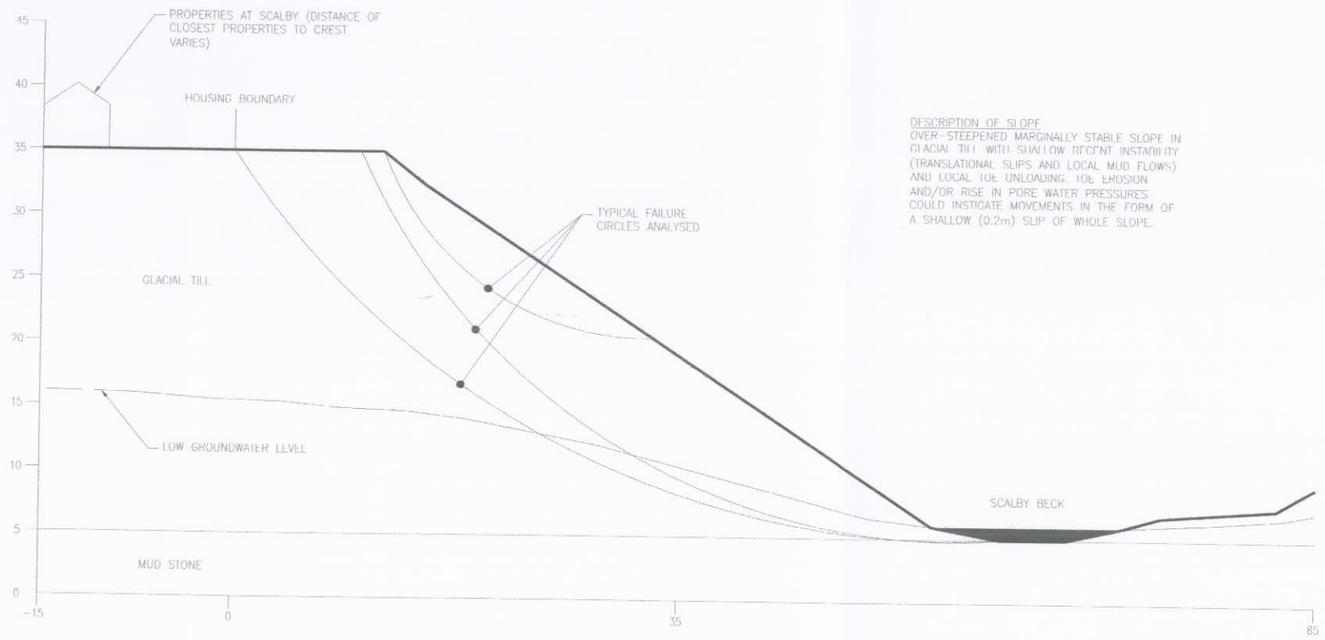
6. Scalby Ness cliff management

   a. Given current limitations with data and monitoring records at the site, it is considered that provision of trigger levels for the site would not be meaningful.

   b. On the basis of the nature of the three behaviour units, it is considered that the preparation of a detailed action plan for implementation on the event of significant instability being detected is inappropriate and unnecessary at present, provided that a robust monitoring and field observation strategy is implemented.

   c. Recommendations are made for implementation of a robust monitoring and field observation strategy for Scalby Ness and details are provided to enable a short-term management strategy to be implemented, based on hazard status colours, using the results of the this study. Recommendations are also made for consideration of remedial measures at the site and further ground investigation. A longer-term management strategy is also presented. Full details are given in Section 9 of the report.

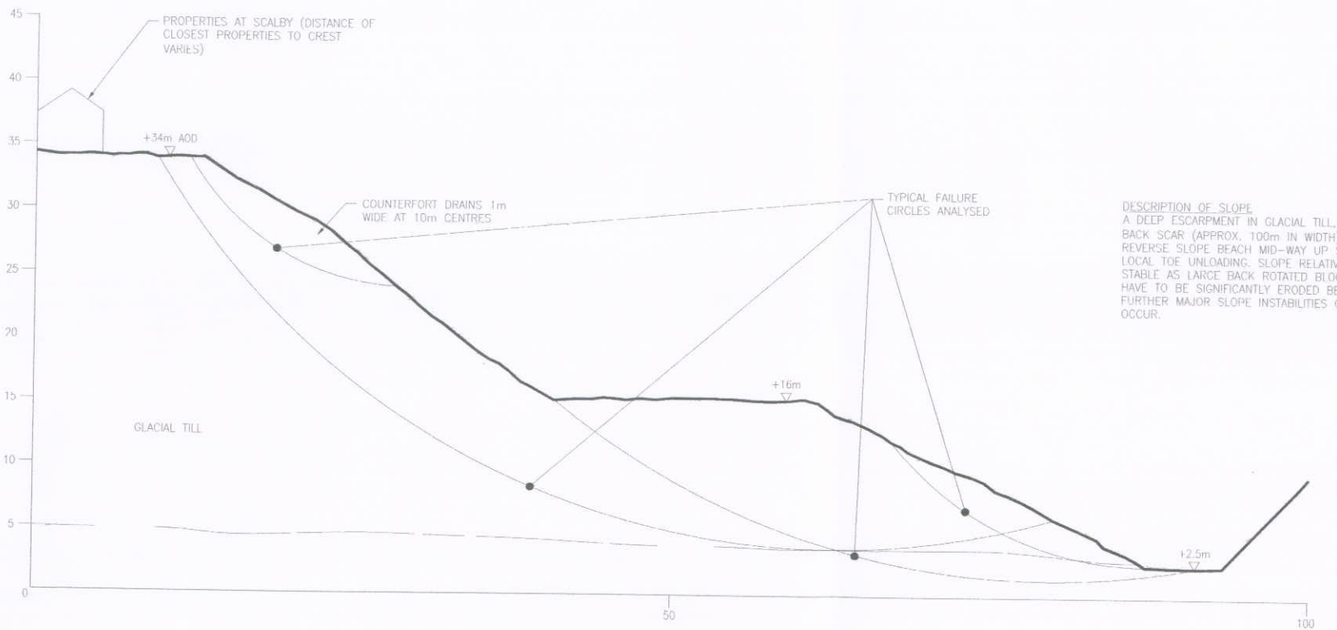
Appendix B – Existing slope sections



DESCRIPTION OF SLOPE
OVER-STEEPENED MARGINALLY STABLE SLOPE IN GLACIAL TILL WITH SHALLOW RECENT INSTABILITY (TRANSLATIONAL SLIPS AND LOCAL MUD FLOWS) AND LOCAL TOE UNLOADING. TOE EROSION AND/OR RISE IN PORE WATER PRESSURES COULD INSTIGATE MOVEMENTS IN THE FORM OF A SHALLOW (0.2m) SLIP OF WHOLE SLOPE.

SECTION A-A'
SCHEMATIC CROSS SECTION OF EXISTING NORTH-WEST FACING SLOPE, BEHAVIOUR UNIT I

0 5 10 15 20
SCALE 1:250 (A1)
SCALE 1:500 (A3)
METRES



DESCRIPTION OF SLOPE
A DEEP ESCARPMENT IN GLACIAL TILL, WITH A BACK SCAR (APPROX. 100m IN WIDTH), DISTINCT REVERSE SLOPE BEACH MID-WAY UP SLOPE AND LOCAL TOE UNLOADING. SLOPE RELATIVELY STABLE AS LARGE BACK ROTATED BLOCK WOULD HAVE TO BE SIGNIFICANTLY ERODED BEFORE ANY FURTHER MAJOR SLOPE INSTABILITIES COULD OCCUR.

SECTION B-B'
SCHEMATIC CROSS SECTION OF EXISTING NORTH-EAST FACING SLOPE, BEHAVIOUR UNIT II

0 5 10 15 20
SCALE 1:250 (A1)
SCALE 1:500 (A3)
METRES

Notes:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE
2. ALL LEVELS ARE IN mAOD
3. DO NOT SCALE OFF THIS DRAWING.

Rev	By	Chkd	Apprvd	Date	Description

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Project
HUNDALE POINT TO SCALBY NESS COASTAL STRATEGY

Drawing
SECTIONS THROUGH REVISED STRATEGY

EXISTING DETAILS

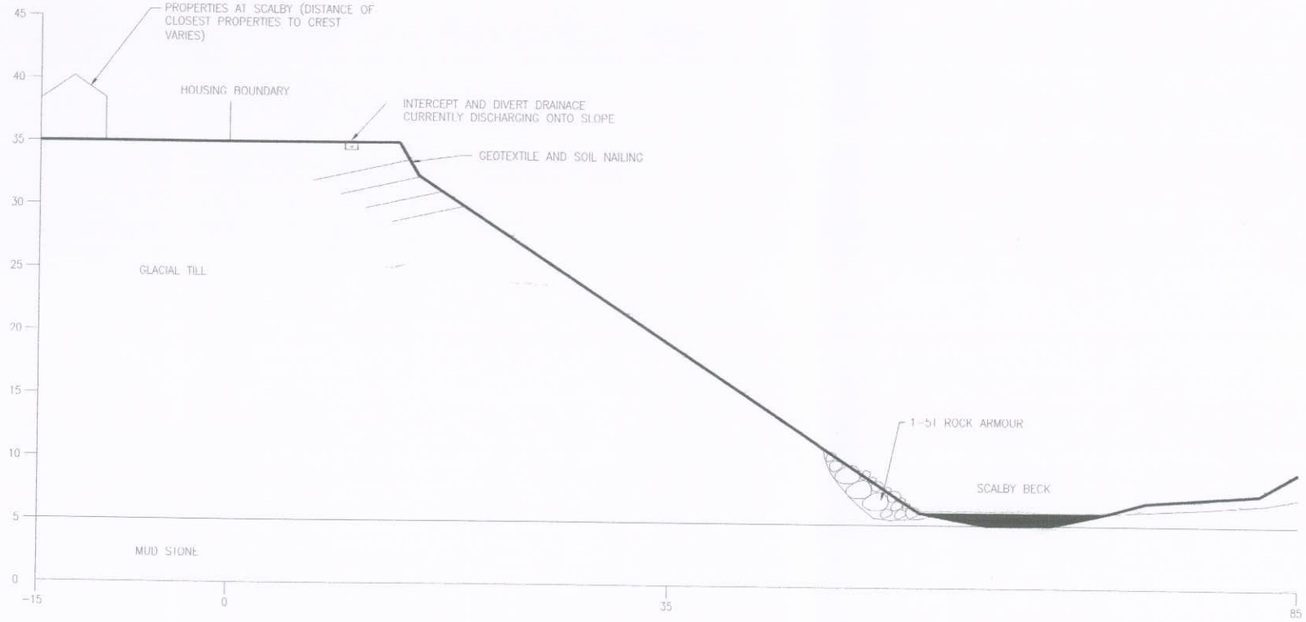
Drawn by: G.I.CHATER	Date: 18.10.02
Checked by:	Date:
Approved by:	Date:
Drawing No. Appendix B	Revision 0

Drawing Scale: 1:250 @ A1

Appendix C – Proposed slope protection works

MITIGATION MEASURES TO BE CONSIDERED

- INTERCEPT DRAINAGE AT CREST
- TOE PROTECTION WORKS (PREVENTING EROSION)
- CREST PROTECTION WORKS (PREVENTING LOCAL SLIPS IN CREST)

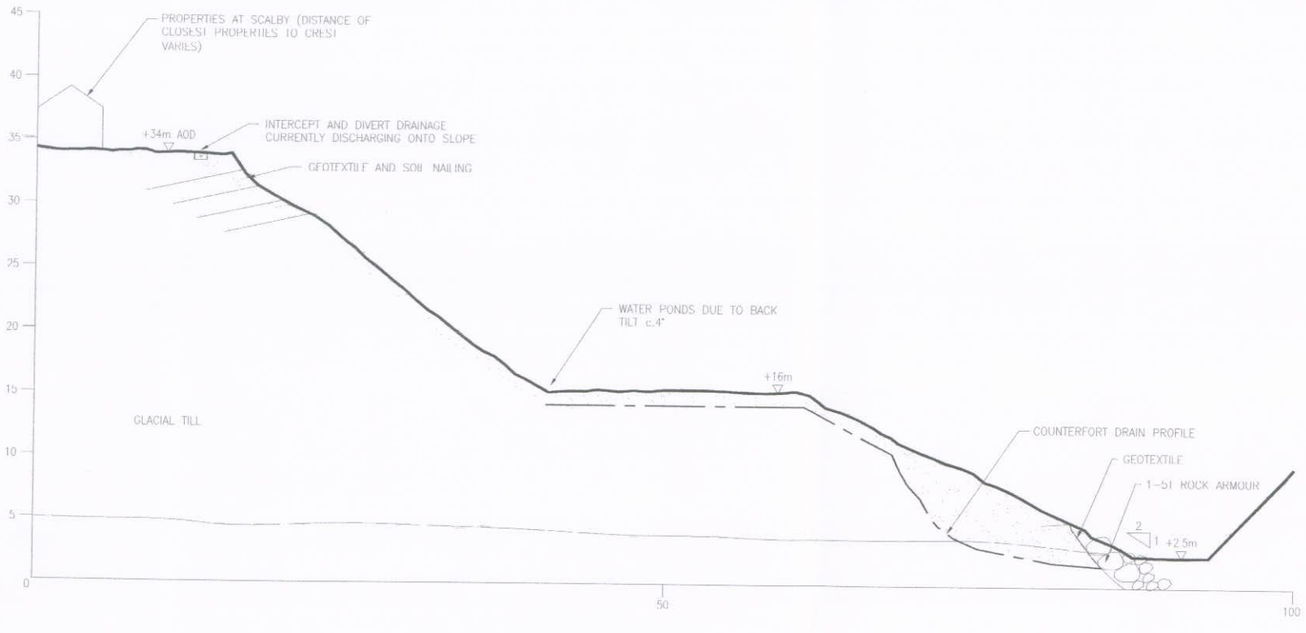


SECTION A-A'
SCHEMATIC CROSS SECTION OF NORTH-WEST FACING SLOPE,
BEHAVIOUR UNIT I

0 5 10 15 20
SCALE 1:250 (A1)
SCALE 1:500 (A3)
METRES

MITIGATION MEASURES TO BE CONSIDERED

- INTERCEPT DRAINAGE AT CREST
- TOE PROTECTION WORKS (PREVENTING EROSION)
- CREST PROTECTION WORKS (PREVENTING LOCAL SLIPS IN CREST)
- SLOPE DRAINAGE WORKS (LOWER GROUNDWATER/PORE PRESSURE IN BACK TILTED BLOCK.



SECTION B-B'
SCHEMATIC CROSS SECTION OF NORTH-EAST FACING SLOPE,
BEHAVIOUR UNIT II

0 5 10 15 20
SCALE 1:250 (A1)
SCALE 1:500 (A3)
METRES

Notes:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE
2. ALL LEVELS ARE IN mAOD
3. DO NOT SCALE OFF THIS DRAWING.

Rev	By	Chkd	Apprvd	Date	Description
-	-	-	-	-	-

Client

Halcrow Group Limited
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tyne&wear@halcrow.com
www.halcrow.com
in association with:

Halcrow

Project

HUNDALE POINT TO SCALBY NESS COASTAL STRATEGY

Drawing

SECTIONS THROUGH REVISED STRATEGY

PROPOSED OPTION 3

Drawn by: G.I.CHATER	Date: 18.10.02
Checked by:	Date:
Approved by:	Date:
Drawing No. Appendix C	Revision 0

Drawing Scale: 1:250 @ A1

Appendix D – General arrangements for sections

Notes:

1. ALL DIMENSIONS ARE IN MILLIMETRES UNLESS NOTED OTHERWISE.
2. ALL LEVELS ARE IN mAOD.
3. DO NOT SCALE OFF THIS DRAWING.

TOE PROTECTION.

CREST GEOTEXTILE

COUNTER FORT DRAINS.

CREST|SOIL NAILING, GEOTEXTILE

0 10 20 30 40 50 60 70 80 90 100

SCALE 1:1000 (A1)
SCALE 1:2000 (A3)
METRES

0	GIC	–	–	18.10.05	xxx
Rev	By	Chkd	Apprvd	Date	Description

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Project

HUNDALE POINT TO SCALBY NESS STRATEGY STUDY

Drawing

GENERAL ARRANGEMENTS
REVISED STRATEGY OPTION 3

Drawn by: G.I CHATER — Date: 18.10.05
Checked by: — Date:
Reviewed by: — Date:
Approved by: — Date:

Drawing No.: APPENDIX D — Revision: 0

Drawing Scale: 1:1000 @ A1

Appendix E – Economic analysis

Option 1 - Do Nothing
PV Losses

For properties where crest already > 15 m from crest (2005)

Distance at which Blight occurs for residential properties (m) 15 m
Garage Blight/loss occurs with property loss -
Property Loss occurs when crest < 8 m

For properties where crest already < 10 m from Crest (2005)

Blight occurs when crest < 6 m
Property Loss occurs when crest < 5 m
Cost of Flat (£) 139,000 Cost of property 59 (£) 234000
Material cost of Garage (£) 4,000
Blight Loss Factor 0.5

Property			Distance from	Erosion Rates (m/yr)			Time to Blight (Yrs)			Time to Loss (yrs)			Property Type	Nr of Properties/	Property Value (£) -	PV Blight Loss (£)			PV Property Loss			Actual Loss	PV Property
				low	Best	High	low	Best	High	low	Best	High				low	Best	High	low	Best	High		
	Garage for 13&14(169-175)	BU1	15.6	0.05	0.18	0.31	12	3	2	152	42	25	Garage	1	4,000	137	1,353	290	-	375	131	4,000	2,286
14	169-171 Scholes Park Road	BU1	15.6	0.05	0.18	0.31	12	3	2	152	42	25	flat	2	278,000	9,521	94,028	20,145	-	26,051	9,131	278,000	158,875
13	173-175 Scholes Park Road	BU1	15.6	0.05	0.18	0.31	12	3	2	152	42	25	flat	2	278,000	9,521	94,028	20,145	-	26,051	9,131	278,000	158,875
12	177-179 Scholes Park Road	BU1	15.6	0.05	0.18	0.31	12	3	2	152	42	25	flat	2	278,000	9,521	94,028	20,145	-	26,051	9,131	278,000	158,875
	Garage for 12&11(177-183)	BU1	7.3	0.05	0.18	0.31	37	7	4	66	12	6	Garage	1	4,000	58	1,220	271	25	1,027	244	4,000	2,846
11	181-183 Scholes Park Road	BU2	7.3	0.035	0.2	0.36	37	7	4	66	12	6	flat	2	278,000	4,027	84,807	18,806	1,760	71,406	16,961	278,000	197,767
10	185-187 Scholes Park Road	BU2	7.3	0.035	0.2	0.36	37	7	4	66	12	6	flat	2	278,000	4,027	84,807	18,806	1,760	71,406	16,961	278,000	197,767
	Garage for 10(185-187)	BU2	7.3	0.035	0.2	0.36	37	7	4	66	12	6	Garage	1	4,000	58	1,220	271	25	1,027	244	4,000	2,846
9	189-191 Scholes Park Road	BU2	17.8	0.035	0.2	0.36	80	14	8	280	49	27	flat	2	278,000	1,157	64,404	16,388	-	21,182	8,236	278,000	111,367
	Garage for 9&8(189-195)	BU2	9.44	0.035	0.2	0.36	80	14	8	280	49	27	Garage	1	4,000	17	927	236	-	305	119	4,000	1,602
8	193-195 Scholes Park Road	BU2	17.8	0.035	0.2	0.36	80	14	8	280	49	27	flat	2	278,000	1,157	64,404	16,388	-	21,182	8,236	278,000	111,367
7	197-199 Scholes Park Road	BU2	17.8	0.035	0.2	0.36	80	14	8	280	49	27	flat	2	278,000	1,157	64,404	16,388	-	21,182	8,236	278,000	111,367
6	201-203 Scholes Park Road	BU2	17.8	0.035	0.2	0.36	80	14	8	280	49	27	flat	2	278,000	1,157	64,404	16,388	-	21,182	8,236	278,000	111,367
5	205-207 Scholes Park Road	BU2	23.6	0.035	0.2	0.36	246	43	24	446	78	43	flat	2	278,000	-	25,292	9,451	-	9,121	5,058	278,000	48,922
4	209-211 Scholes Park Road	BU2	23.6	0.035	0.2	0.36	246	43	24	446	78	43	flat	2	278,000	-	25,292	9,451	-	9,121	5,058	278,000	48,922
3	213-215 Scholes Park Road	BU2	24.6	0.035	0.2	0.36	274	48	27	474	83	46	flat	2	278,000	-	21,817	8,524	-	8,061	4,629	278,000	43,032
2	217-219 Scholes Park Road	BU2	24.6	0.035	0.2	0.36	274	48	27	474	83	46	flat	2	278,000	-	21,817	8,524	-	8,061	4,629	278,000	43,032
1	221-223 Scholes Park Road	BU2	24.6	0.035	0.2	0.36	274	48	27	474	83	46	flat	2	278,000	-	21,817	8,524	-	8,061	4,629	278,000	43,032
Secondary properties (only blight applicable)																							
15	8 Bay Garage						12	3	2				Garage	1	4,000	137.0	1,352.91	289.86				4000	1,780
16	59 Scholes Park Road						12	3	2				semi-detached	1	234,000	8,013.9	79,145.47	16,956.52				234000	104,116
17	165 - 167 Scholes Park Road						12	3	2				flat	2	278,000	9,520.7	94,027.53	20,144.93				278000	123,693
18	161 - 163 Scholes Park Road						12	3	2				flat	2	278,000	9,520.7	94,027.53	20,144.93				278000	123,693
19	157 - 159 Scholes Park Road						12	3	2				flat	2	278,000	9,520.7	94,027.53	20,144.93				278000	123,693
20	153 - 155 Scholes Park Road						12	3	2				flat	2	278,000	9,520.7	94,027.53	20,144.93				278000	123,693
21	4 Bay Garage						12	3	2				flat	2	278,000	9,520.7	94,027.53	20,144.93				278000	123,693
22	149 - 151 Scholes Park Road						12	3	2				Garage	1	4,000	137.0	1,352.91	289.86				4000	1,780
23	143 - 145 - 147 Scholes Park Road						12	3	2				flat	2	278,000	9,520.7	94,027.53	20,144.93				278000	123,693
24	148 - 150 Scholes Park Road						12	3	2				flat	3	417,000	14,281.1	141,041.29	30,217.39				417000	185,540
25	144 - 146 Scholes Park Road						12	3	2				flat	2	278,000	9,520.7	94,027.53	20,144.93				278000	123,693
26	140 - 142 Scholes Park Road						12	3	2				flat	2	278,000	9,520.7	94,027.53	20,144.93				278000	123,693
27	136 - 138 Scholes Park Road						12	3	2				flat	2	278,000	9,520.7	94,027.53	20,144.93				278000	123,693
															7,069,000							7,069,000	2,960,598

Option 3 - Revised Strategy Option Costs

RPI May 2003	181.5
RPI Sep 2005	193.1
Increase	1.06
Maintainance before works (say)	4500.00
Maintainance after works	1000.00
10 yearly capital expenditure	125000.00

Item	Description	Dimensions L (m)	D (m)	W (m)	Nr	Unit	Quantity	Rate	Price
1	**General Items**								
	Temp works - access/ haul roads								£60,000.00
	General site clearance					Ha	5	£2,500.00	£12,500.00
2	Ground investigation					Sum			£20,000.00
3	**Slope Stabilisation**								
3.1	Slope Drainage								
	Deep counterforts					m	150	£225.00	£33,750.00
	Shallow counterforts					m	370	£45.00	£16,650.00
	Disposal of arisings					m^3	667	£15.00	£10,005.00
	Intercept drainage					m	220	£50.00	£11,000.00
	Drain to highway					m	90	£30.00	£2,700.00
	Connection to highway drain						1	£2,500.00	£2,500.00
3.2	Cliff Top Stabilisation								
	Geomat	200	20	1	1	m^2	4000	£5.00	£20,000.00
	Soil nails	50	20	1	1	m^2	1000	£100.00	£100,000.00
3.3	Toe Protection								
	Excavate & double handle earth	340	3	3	1	m^3	3060	£36.17	£110,689.39
	Rock Armour (1-5 tonne)	340	3	3	1	m^3	3060	£58.52	£179,056.36
	Ancillaries related to RA						50%	£190,500.19	£95,250.09
4	**General landscaping & replanting**					Ha	5	£2,500.00	£12,500.00
5	**Contingency @ 20%**								£137,320.17
								Preliminaries (30% Construction Costs)	£205,980.25
								Construction	£686,600.85
								Contingency	£137,320.17
								GRAND TOTAL	**£1,029,901.27**

Option 3 - Revised Strategy Option Costs

Item	Project Stage	Estimate of Works Value	Fee % of Works Value	Specialist Studies	Cost
		£1,029,901.27			
1	**Design Stage**		5%		£51,495
1.1	Environment Impact Study			£21,278	£21,278
2	**Site supervision/Project Management** (incl expenses)		5%		£51,495
3	**Head Office Supervision**		2%		£20,598
Total Consultants Fee Estimate					**£144,866**

Item	Estimate
Cost of Works	£1,029,901.27
Consultant Fees	£144,866
GRAND TOTAL	**£1,174,767.66**

Project Summary Sheet

Client/Authority				Prepared (date)	Oct-05
Scarborough Borough Council				Printed	29/11/2005
Project name				Prepared by	ETB
Hundale Point to Scalby Ness				Checked by	
Project reference	WCHPSN			Checked date	
Base date for estimates (year 0)	Mar-2005				
Scaling factor (e.g. £m, £k, £)	£	(used for all costs, losses and benefits)			
Principle land use band	A	(A to E)			
Discount rate	3.5%	3.0%	2.5%		
Costs and benefits of options					

	Costs and benefits £					
	Option 1 (do nothing)	Business Usual Option 2	Revised Strategy Study Option 3	Option 4: Major Improvement Works	Option 5:	
PV costs PVc	-	219,251	1,180,780	-	-	
Optimism bias (at 60%)		131,551	708,468			
Total PV cost		350,802	1,889,247			
PV damage PVd	2,960,598	2,735,028	0			
PV damage avoided		225,570	2,960,598			
PV assets Pva	-	-	-	-	-	
PV asset protection benefits		-	-	-	-	
Total PV benefits PVb		225,570	2,960,598	-	-	
Net Present Value NPV		6,319	1,779,818	-	-	
Average benefit/cost ratio		0.64	1.57			
Incremental benefit/cost ratio			1.8			
		-	Highest b/c			

Brief description of options:
Option 1 (do nothing)
Business Usual Option 2
Revised Strategy Study Option 3
Option 4: Major Improvement Works
Option 5:

Notes:
1) Benefits will normally be expressed either in terms of damage avoided or asset values protected. Care is needed to avoid double counting
2) PV damage avoided is calculated as PV damage (No Project) - PV damage (Option)
PV asset protection benefits are calculated as PVa (Option) - PVa (No Project)
PV benefits calculated as PV damage avoided + PV asset protection benefits
3) Incremental benefit/cost ratio is calculated as:
(PVb(current option) - PVb(previous option))/(PVc(current option) - PVc(previous option))

Present Value Costs for all options

Client/Authority: Scarborough Borough Council
Project name: Hundale Point to Scalby Ness
Project reference: WCHPSN
Base date for estimates (year 0): Mar-2005
Scaling factor (e.g. £m, £k, £): £
Discount rate: 3.5% 3.0% 2.5%

Sheet Nr.

Prepared (date): Oct-05
Printed: 29/11/2005
Prepared by: GC
Checked by: ETB
Checked date: Nov-05

Results £

PV total costs	Option 1 (do nothing)	Business Usual Option 2	Revised Strategy Study Option 3	Option 4: Major Improvement Works
	0.00	219251.06	1180779.54	0.00

		Option 1 (do nothing)			TOTALS:		Business Usual Option 2			TOTALS:		Revised Strategy Study Option 3			TOTALS:		Option 4: Major Improvement Works			TOTALS:	
		Capital	Maint.	Other	Cash	PV	Capital	Maint.	Other	Cash	PV	Capital	Maint.	Other	Cash	PV	Capital	Maint.	Other	Cash	PV
	cash sum	0	0	0	0.00	0.00	£95,000	£463,500	£75,525	£634,025	£219,251	£1,287,377	£96,000	£170,614	£1,553,991	£1,180,780	£0	£0	£0	£0	£0
year	Discount Factor																				
0	1.000				0.00	0.00				£0	£0				£0	£0				£0	£0
1	0.966				0.00	0.00		£4,500	£3,675	£8,175	£7,899			£47,026	£47,026	£45,436				£0	£0
2	0.934				0.00	0.00	£50,000	£4,500	£3,675	£58,175	£54,307	£1,029,901.27		£97,841	£1,127,742	£1,052,759				£0	£0
3	0.902				0.00	0.00		£4,500	£675	£5,175	£4,668		£1,000		£1,000	£902				£0	£0
4	0.871				0.00	0.00		£4,500	£675	£5,175	£4,510		£1,000		£1,000	£871				£0	£0
5	0.842				0.00	0.00		£4,500	£675	£5,175	£4,357		£1,000		£1,000	£842				£0	£0
6	0.814				0.00	0.00		£4,500	£675	£5,175	£4,210		£1,000		£1,000	£814				£0	£0
7	0.786				0.00	0.00		£4,500	£675	£5,175	£4,068		£1,000		£1,000	£786				£0	£0
8	0.759				0.00	0.00		£4,500	£675	£5,175	£3,930		£1,000		£1,000	£759				£0	£0
9	0.734				0.00	0.00		£4,500	£675	£5,175	£3,797		£1,000		£1,000	£734				£0	£0
10	0.709				0.00	0.00	£5,000	£6,500	£975	£12,475	£8,844		£1,000		£1,000	£709				£0	£0
11	0.685				0.00	0.00		£4,500	£675	£5,175	£3,545		£1,000		£1,000	£685				£0	£0
12	0.662				0.00	0.00		£4,500	£675	£5,175	£3,425		£1,000		£1,000	£662				£0	£0
13	0.639				0.00	0.00		£4,500	£675	£5,175	£3,309		£1,000		£1,000	£639				£0	£0
14	0.618				0.00	0.00		£4,500	£675	£5,175	£3,197		£1,000		£1,000	£618				£0	£0
15	0.597				0.00	0.00		£4,500	£675	£5,175	£3,089		£1,000		£1,000	£597				£0	£0
16	0.577				0.00	0.00		£4,500	£675	£5,175	£2,984		£1,000		£1,000	£577				£0	£0
17	0.557				0.00	0.00		£4,500	£675	£5,175	£2,884		£1,000		£1,000	£557				£0	£0
18	0.538				0.00	0.00		£4,500	£675	£5,175	£2,786		£1,000		£1,000	£538				£0	£0
19	0.520				0.00	0.00		£4,500	£675	£5,175	£2,692		£1,000		£1,000	£520				£0	£0
20	0.503				0.00	0.00	£5,000	£6,500	£975	£12,475	£6,270		£1,000		£1,000	£503				£0	£0
21	0.486				0.00	0.00		£4,500	£675	£5,175	£2,513		£1,000		£1,000	£486				£0	£0
22	0.469				0.00	0.00		£4,500	£675	£5,175	£2,428		£1,000		£1,000	£469				£0	£0
23	0.453				0.00	0.00		£4,500	£675	£5,175	£2,346		£1,000		£1,000	£453				£0	£0
24	0.438				0.00	0.00		£4,500	£675	£5,175	£2,266		£1,000		£1,000	£438				£0	£0
25	0.423				0.00	0.00		£4,500	£675	£5,175	£2,190		£1,000		£1,000	£423				£0	£0
26	0.409				0.00	0.00		£4,500	£675	£5,175	£2,116		£1,000		£1,000	£409				£0	£0
27	0.395				0.00	0.00		£4,500	£675	£5,175	£2,044		£1,000		£1,000	£395				£0	£0
28	0.382				0.00	0.00		£4,500	£675	£5,175	£1,975		£1,000		£1,000	£382				£0	£0
29	0.369				0.00	0.00		£4,500	£675	£5,175	£1,908		£1,000		£1,000	£369				£0	£0
30	0.356				0.00	0.00	£5,000	£6,500	£975	£12,475	£4,445		£1,000		£1,000	£356				£0	£0
31	0.346				0.00	0.00		£4,500	£675	£5,175	£1,790		£1,000		£1,000	£346				£0	£0
32	0.336				0.00	0.00		£4,500	£675	£5,175	£1,738		£1,000		£1,000	£336				£0	£0
33	0.326				0.00	0.00		£4,500	£675	£5,175	£1,687		£1,000		£1,000	£326				£0	£0
34	0.317				0.00	0.00		£4,500	£675	£5,175	£1,638		£1,000		£1,000	£317				£0	£0
35	0.307				0.00	0.00		£4,500	£675	£5,175	£1,590		£1,000		£1,000	£307				£0	£0
36	0.298				0.00	0.00		£4,500	£675	£5,175	£1,544		£1,000		£1,000	£298				£0	£0
37	0.290				0.00	0.00		£4,500	£675	£5,175	£1,499		£1,000		£1,000	£290				£0	£0
38	0.281				0.00	0.00		£4,500	£675	£5,175	£1,455		£1,000		£1,000	£281				£0	£0
39	0.273				0.00	0.00		£4,500	£675	£5,175	£1,413		£1,000		£1,000	£273				£0	£0
40	0.265				0.00	0.00	£5,000	£6,500	£975	£12,475	£3,307		£1,000		£1,000	£265				£0	£0
41	0.257				0.00	0.00		£4,500	£675	£5,175	£1,332		£1,000		£1,000	£257				£0	£0
42	0.250				0.00	0.00		£4,500	£675	£5,175	£1,293		£1,000		£1,000	£250				£0	£0
43	0.243				0.00	0.00		£4,500	£675	£5,175	£1,255		£1,000		£1,000	£243				£0	£0
44	0.236				0.00	0.00		£4,500	£675	£5,175	£1,219		£1,000		£1,000	£236				£0	£0
45	0.229				0.00	0.00		£4,500	£675	£5,175	£1,183		£1,000		£1,000	£229				£0	£0
46	0.222				0.00	0.00		£4,500	£675	£5,175	£1,149		£1,000		£1,000	£222				£0	£0
47	0.216				0.00	0.00		£4,500	£675	£5,175	£1,115		£1,000		£1,000	£216				£0	£0
48	0.209				0.00	0.00		£4,500	£675	£5,175	£1,083		£1,000		£1,000	£209				£0	£0
49	0.203				0.00	0.00		£4,500	£675	£5,175	£1,051		£1,000		£1,000	£203				£0	£0
50	0.197				0.00	0.00	£5,000	£6,500	£975	£12,475	£2,461	£257,475		£25,748	£283,223	£55,869				£0	£0
51	0.192				0.00	0.00		£4,500	£675	£5,175	£991		£1,000		£1,000	£192				£0	£0
52	0.186				0.00	0.00		£4,500	£675	£5,175	£962		£1,000		£1,000	£186				£0	£0
53	0.181				0.00	0.00		£4,500	£675	£5,175	£934		£1,000		£1,000	£181				£0	£0
54	0.175				0.00	0.00		£4,500	£675	£5,175	£907		£1,000		£1,000	£175				£0	£0
55	0.170				0.00	0.00		£4,500	£675	£5,175	£881		£1,000		£1,000	£170				£0	£0
56	0.165				0.00	0.00		£4,500	£675	£5,175	£855		£1,000		£1,000	£165				£0	£0
57	0.160				0.00	0.00		£4,500	£675	£5,175	£830		£1,000		£1,000	£160				£0	£0
58	0.156				0.00	0.00		£4,500	£675	£5,175	£806		£1,000		£1,000	£156				£0	£0
59	0.151				0.00	0.00		£4,500	£675	£5,175	£782		£1,000		£1,000	£151				£0	£0
60	0.147				0.00	0.00	£5,000	£6,500	£975	£12,475	£1,831		£1,000		£1,000	£147				£0	£0
61	0.143				0.00	0.00		£4,500	£675	£5,175	£737		£1,000		£1,000	£143				£0	£0
62	0.138				0.00	0.00		£4,500	£675	£5,175	£716		£1,000		£1,000	£138				£0	£0
63	0.134				0.00	0.00		£4,500	£675	£5,175	£695		£1,000		£1,000	£134				£0	£0
64	0.130				0.00	0.00		£4,500	£675	£5,175	£675		£1,000		£1,000	£130				£0	£0
65	0.127				0.00	0.00		£4,500	£675	£5,175	£655		£1,000		£1,000	£127				£0	£0
66	0.123				0.00	0.00		£4,500	£675	£5,175	£636		£1,000		£1,000	£123				£0	£0
67	0.119				0.00	0.00		£4,500	£675	£5,175	£618		£1,000		£1,000	£119				£0	£0
68	0.116				0.00	0.00		£4,500	£675	£5,175	£600		£1,000		£1,000	£116				£0	£0
69	0.112				0.00	0.00		£4,500	£675	£5,175	£582		£1,000		£1,000	£112				£0	£0
70	0.109				0.00	0.00	£5,000	£6,500	£975	£12,475	£1,363		£1,000		£1,000	£109				£0	£0
71	0.106				0.00	0.00		£4,500	£675	£5,175	£549		£1,000		£1,000	£106				£0	£0
72	0.103				0.00	0.00		£4,500	£675	£5,175	£533		£1,000		£1,000	£103				£0	£0
73	0.100				0.00	0.00		£4,500	£675	£5,175	£517		£1,000		£1,000	£100				£0	£0
74	0.097				0.00	0.00		£4,500	£675	£5,175	£502		£1,000		£1,000	£97				£0	£0
75	0.094				0.00	0.00		£4,500	£675	£5,175	£488		£1,000		£1,000	£94				£0	£0
76	0.092				0.00	0.00		£4,500	£675	£5,175	£476		£1,000		£1,000	£92				£0	£0
77	0.090				0.00	0.00		£4,500	£675	£5,175	£464		£1,000		£1,000	£90				£0	£0
78	0.087				0.00	0.00		£4,500	£675	£5,175	£453		£1,000		£1,000	£87				£0	£0
79	0.085				0.00	0.00		£4,500	£675	£5,175	£442		£1,000		£1,000	£85				£0	£0
80	0.083				0.00	0.00	£5,000	£6,500	£975	£12,475	£1,039		£1,000		£1,000	£83				£0	£0
81	0.081				0.00	0.00		£4,500	£675	£5,175	£420		£1,000		£1,000	£81				£0	£0
82	0.079				0.00	0.00		£4,500	£675	£5,175	£410		£1,000		£1,000	£79				£0	£0
83	0.077				0.00	0.00		£4,500	£675	£5,175	£400		£1,000		£1,000	£77				£0	£0
84	0.075				0.00	0.00		£4,500	£675	£5,175	£390		£1,000		£1,000	£75				£0	£0
85	0.074				0.00	0.00		£4,500	£675	£5,175	£381		£1,000		£1,000	£74				£0	£0
86	0.072				0.00	0.00		£4,500	£675	£5,175	£372		£1,000		£1,000	£72				£0	£0
87	0.070				0.00	0.00		£4,500	£675	£5,175	£363		£1,000		£1,000	£70				£0	£0
88	0.068				0.00	0.00		£4,500	£675	£5,175	£354		£1,000		£1,000	£68				£0	£0
89	0.067				0.00	0.00		£4,500	£675	£5,175	£345		£1,000		£1,000	£67				£0	£0
90	0.065				0.00	0.00	£5,000	£6,500	£975	£12,475	£812		£1,000		£1,000	£65				£0	£0
91	0.063				0.00	0.00		£4,500	£675	£5,175	£328		£1,000		£1,000	£63				£0	£0
92	0.062				0.00	0.00		£4,500	£675	£5,175	£320		£1,000		£1,000	£62				£0	£0
93	0.060				0.00	0.00		£4,500	£675	£5,175	£313		£1,000		£1,000	£60				£0	£0
94	0.059				0.00	0.00		£4,500	£675	£5,175	£305		£1,000		£1,000	£59				£0	£0
95	0.057				0.00	0.00		£4,500	£675	£5,175	£298		£1,000		£1,000	£57				£0	£0
96	0.056				0.00	0.00		£4,500	£675	£5,175	£290		£1,000		£1,000	£56				£0	£0
97	0.055				0.00	0.00		£4,500	£675	£5,175	£283		£1,000		£1,000	£55				£0	£0
98	0.053				0.00	0.00		£4,500	£675	£5,175	£276		£1,000		£1,000	£53				£0	£0
99	0.052				0.00	0.00		£4,500	£675	£5,175	£270		£1,000		£1,000	£52				£0	£0

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