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Walk-over Visual Inspections of Selected Assets following Storm Surge of 5th December 2013

Scarborough Borough Council Supplementary Report

December 2013

Scarborough Borough Council

Coast Protection Assets
Walk-over Visual Inspections of Selected Assets following Storm Surge of 5th December 2013

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Preamble

The Cell 1 Regional Coastal Monitoring Programme covers approximately 300km of the north east coastline, from the Scottish Border (just south of St. Abb's Head) to Flamborough Head in East Yorkshire. This coastline is often referred to as 'Coastal Sediment Cell 1' in England and Wales (*Figure 0-1*). Within this frontage the coastal landforms vary considerably, comprising low-lying tidal flats with fringing salt marshes, hard rock cliffs that are mantled with glacial sediment to varying thicknesses, softer rock cliffs and extensive landslide complexes.

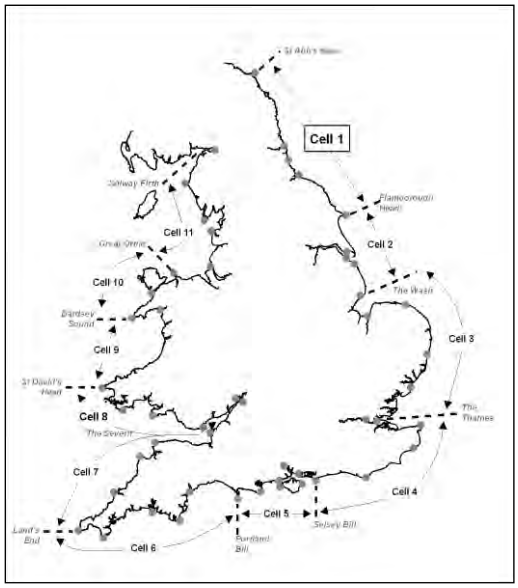


Figure 0-1: Sediment Cells in England and Wales

The work commenced with a three-year monitoring programme in September 2008 that was managed by Scarborough Borough Council on behalf of the North East Coastal Group. This initial phase has been followed by a five-year programme of work, which started in October 2011. The work is funded by the Environment Agency, working in partnership with the following organisations:

Northumberland County Council
Northumberland Coast AONB
North Tyneside Council
South Tyneside Council
Sunderland City Council
Durham County Council
Redcar & Cleveland Borough Council
Hartlepool Borough Council
Whitby Scarborough Filey Borough of Scarborough
A great place to live, work & play
East Riding of Yorkshire Council
Environment Agency
Natural England
The National Trust

The original three year programme of work was undertaken as a partnership between Royal Haskoning, Halcrow and Academy Geomatics. For the current five year programme of work the data collection associated with beach profiles, topographic surveys and cliff top surveys is being undertaken by Academy Geomatics. The analysis and reporting for the programme is being undertaken by Halcrow.

The main elements of the Cell 1 Regional Coastal Monitoring Programme involve:

- beach profile surveys
- topographic surveys
- cliff top recession surveys
- real-time wave data collection
- bathymetric and sea bed characterisation surveys
- aerial photography
- walk-over surveys

In addition, separate reports are produced for other elements of the programme as and when specific components are undertaken, such as beach profile, topographic and cliff top surveys, wave data collection, bathymetric and sea bed sediment data collection, and aerial photography.

The present report provides a summary of the main findings of the Coastal Walk-over visual Inspections of selected assets of Scarborough Borough Council's frontage and post storm beach surveys that were carried out in December 2013.

On 5th December 2013 a significant storm surge, driven by strong northerly winds, coincided with one of the highest astronomical tides of the year. The normal astronomical tide level prediction for Whitby on the afternoon of 5th December (circa 1730hrs) was expected to be 2.8mAOD but the actual real-time (unchecked data) recorded sea level was 4.3mAOD, implying a 1.75m storm surge element. The surge event was accompanied by strong winds and large waves and resulted in significant reported damage to many coastal assets on Scarborough's Borough Council's frontage. Visual inspections of several assets were carried out by Halcrow in December 2013 and the findings are presented in this report and the records have been updated to include the latest findings. Other locations were inspected by Scarborough's own staff and are not included in this report. Post storm beach surveys were undertaken by Academy at several selected locations. This data has been compared to the Autumn 2013 profile data and the findings reported in this report and also in the Autumn 2013 Analytical report.

1 Introduction

A storm surge on 5th/6th December 2013 caused significant damage to built and natural coastal defences along the north east coast of England. After the storm surge Scarborough BC requested Halcrow to visit selected locations and update inspection reports that were previously undertaken in 2012. For the coastal defences the inspections were limited to Sandsend, and Runswick Bay. Selected cliff and coastal slope inspections were also undertaken at locations throughout the borough considered to be at higher risk frontages where there are properties and other assets at risk from coastal cliff instability.

It should be noted that although only selected locations have been visited for this report, the whole coastline will be subjected to repeat inspections under the Cell 1 Monitoring Programme later in 2014.

Although many parts of the coast were not inspected for this report, for consistency and to enable easy cross-referencing to the previous reports the format of this report follows that of the 2012 coastal inspection report, and for those locations visited, photographs and results from the 2012 report have been included to illustrate the baseline, with new text and photograph captions highlighted in bold text.

1.1 Methodology

Background

Coastal Walkover Inspections have previously been undertaken every 2 years since 2002 between Scottish Border to River Tyne, and every 2 years since 2008 between River Tyne and Flamborough Head (with an inspection along the Scarborough Borough Council frontage in 2009, but no inspection in 2010). The approach to the inspections for this update is consistent with the previous work. The asset and slope inspectors have included Chartered Engineers (focusing on the built coastal protection structures) and Engineering Geomorphologists (focusing mainly on the natural cliffs and coastal slopes) ensuring suitable skills are applied to each length of frontage.

Tide, surge and wave conditions

Information on the exceptional tide, surge and wave conditions that occurred during the December 2013 storm are available from coastal monitoring instrumentation deployed under the Cell 1 Regional Monitoring at Whitby and Scarborough and also from national monitoring at the Tyne. Tees Cefas wave buoy. Further information on analyses of these data will be included in the 2013 wave data analysis update report which will be published under the regional monitoring programme later in 2014. However, for completeness of this report highlighted information from the near-real time telemetry data has been included in Section 2.3.

Coastal Slope Condition Assessment

In 2012 a full Coastal Slope Condition Assessment was undertaken by systematic walk-over inspection of the whole coastline by a team of geomorphologists familiar with the site having undertaken previous inspections for SBC. The inspection involved visual assessment of cliff activity and noting specific areas of activity (e.g. landslides and tension cracks). All observations were documented with photographs and field notes. Each unit was identified, photographed and classified according to the five point activity scale as defined in Table 1.1. This classification scheme is the same as that used in previous cliff activity assessments undertaken by Halcrow for Scarborough Borough Council in Cell 1 (Halcrow 2002, Halcrow 2005, Halcrow 2009). The 2012 Coastal Slope Condition Assessment walkover survey was conducted between 10th and 28th September 2012, working in a north to south direction. The weather during that time was generally mild and dry. The 2012 inspection, full details of which are presented in Halcrow (2013) has been used as the baseline for this selective update. For the locations visited photographs from the 2012 inspection have been included in this report to illustrate changes.

For ease of reference and consistency with previous reports the photographs presented in this report have also been bordered with the colours from the key indicated below. Maps showing current activity and change in cliff activity since the last survey are provided in Appendix A.

Rank	Activity Class	Description
1	Dormant	Protected cliffline or landslide complex with no visible evidence of landslide activity.
2	Inactive	Relict cliffs or landslides with vegetated slopes and localised erosion of the toe or failure of the headscarp.
3	Locally Active	Retreating cliffline with localised small landslides or areas of erosion.
4	Partly Active	Retreating cliffline with very common smaller-scale landslides or areas of intense erosion.
5	Totally Active	Retreating cliff line almost entirely affected by large-scale landsliding or intense erosion.

Table 1.1. Cliff activity classes used 2012 assessment

Coast Protection Asset Assessment

A visual assessment of all coast protection assets was carried out by Chartered Engineers in October and November 2012 and is reported alongside the coastal slope inspections in Halcrow (2013). In this report coastal defences were only inspected at Runswick Bay and Sandsend. Assets were visually inspected, photographed, and notes on changes since the previous inspection are included. The defences are graded based on their condition as defined in Table 1.2 following standard Environment Agency guidelines as presented in the Condition Assessment Manual (EA, 2011). This classification scheme was the same as that used during previous inspections. Inspections were made from both the seaward and landward side of defence where possible.

Grade	Rating	Description
1	Very Good	Cosmetic defects that will have no effect on performance.
2	Good	Minor defects that will not reduce the overall performance of the asset
3	Fair	Defects that could reduce performance of the asset.
4	Poor	Defects that would significantly reduce the performance of the asset. Further investigation needed.
5	Very Poor	Severe defects resulting in complete performance failure

Table 1.2 Condition assessment grading used in the 2012 inspections

For ease of reference the photos presented in this report have also been bordered with the colours from the key indicated above. Maps showing current condition and locations of changes since the 2010 inspections are provided in Appendix B.

Post Storm Beach Condition Assessment

Following the storm on the 5th and 6th December 2013 a number of additional beach profiles were taken to compare to the standard set of beach profiles which have been recorded since 2008. There were also additional topographic plots carried out at Runswick Bay and Sandsend, near Whitby. The profiles and topographic plots were recorded between 9th and 18th December 2013.

The findings from the assessment of beach condition are provided as part of the text for each of the bays where data collection was carried out.

1.2 Study Area

This report provides and update to the condition of the coastal cliffs and assets from Cowbar Nab, Staithes in the north, to Filey Bay in the south. An overview of the study area is provided in Figure 1-1 below, which also shows the SMP2 Management Areas. Detailed maps of the cliff units are in Appendix A.

The cliff behaviour units (CBUs) previously mapped along this stretch of coast in 2008 were again used in this inspection for continuity and easy reference to the previous work.

The naming convention for CBUs in this region is as follows: For CBU E59/6 the prefix relates to Future Coast unit E59 and the suffix 6 relates to the specific area as defined in this case by the headland at Redhouse Nab (between Boulby and Cowbar).

The built coastal defence assets are named using the system established within the National Flood and Coastal Defence Database (NFCDD), as used on the previous surveys of this frontage.

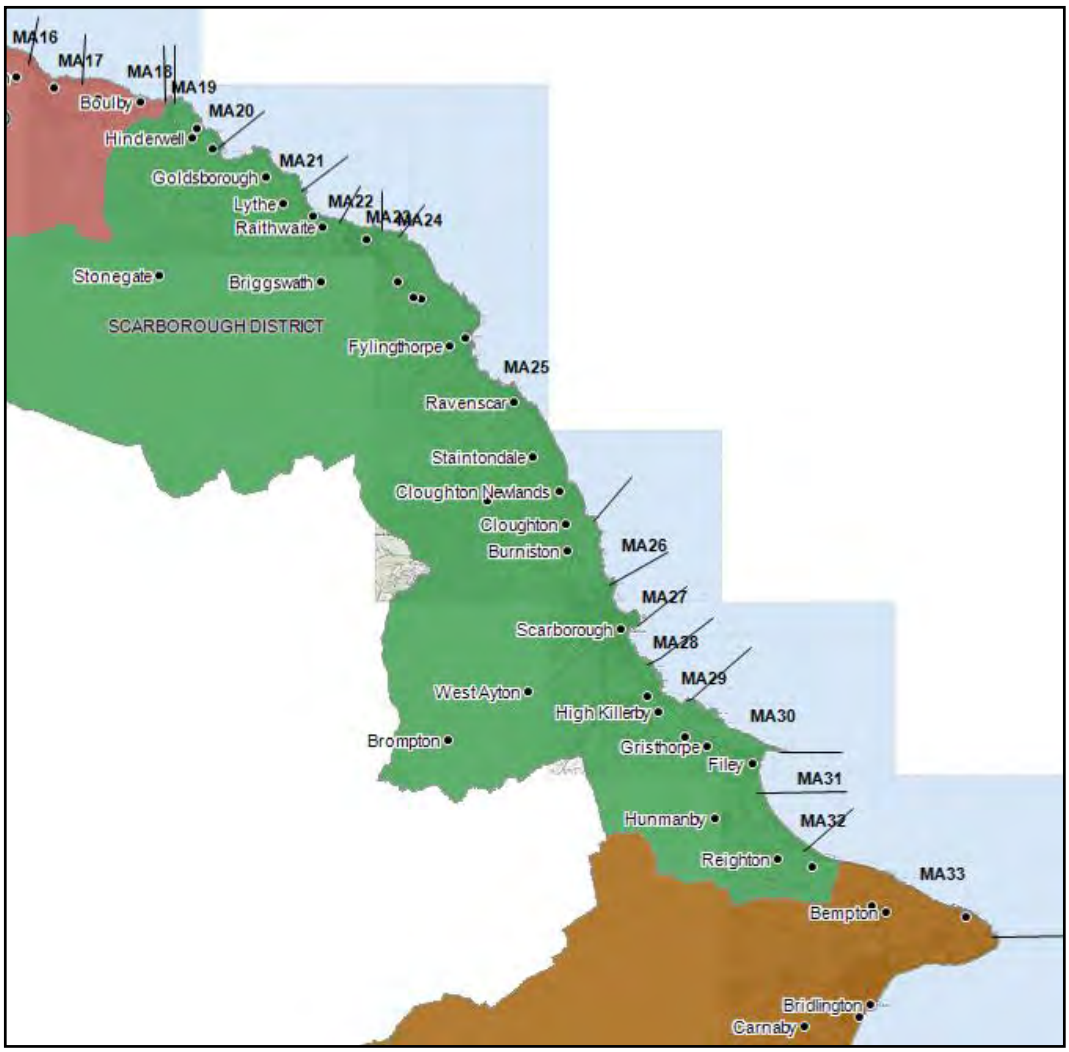


Figure 1-1: Study Area showing SMP2 Management Areas

2 Overview

2.1 Overview of Coastal Slope Condition Assessment

There is significant variation in the level of cliff activity within the SBC region, reflecting the diverse geology, history of landsliding and the range of cliff protection and stabilisation measures in place to tackle erosion and slope instability issues.

The SBC coastal frontage features numerous important assets, ranging from the busy coastal towns of Scarborough, Filey and Whitby to smaller settlements such as Staithes, Robin Hood's Bay and Runswick Bay. The Cleveland Way footpath follows the cliff top along the coastline and in other areas, such as Cayton Bay, strategic roads are routed close to the cliff top.

During the 2008 walkover survey, the following areas were highlighted as having significant cliff activity in the vicinity of key assets:

- **Cayton Bay North**: In early 2008 there was a major reactivation of large scale, deep seated landslide activity at Cayton Cliff. This resulted in the loss of land and demolition of a number of properties.The Cleveland Way footpath also required rerouting. The activity of the landslide slowed during 2009 so the unit was reclassified from Totally to Partly Active. This situation remains in 2012 as localised headscarp recession still occurs periodically, threatening the remaining properties.
- **Filey Town**: Localised cliff instability was evident in 2008 which had led to the closure of some footpaths in Filey. The instability was thought to be related to the significant rainstorm event which affected the town in 2007, which caused widespread damage. The impacts of this event have been remediated and the cliff was categorised as inactive in 2012.

In addition, the 2009 walkover survey identified the following areas of activity:

- **Filey Brigg**: There is ongoing and intensifying activity around Filey Brigg. While the on-going erosion will have little direct impact on coastal assets there is a risk to beach and cliff users. This remains an area of localised activity
- **Cornelian Bay**: This bay sits to the north of Knipe Point, Cayton Bay and has been subjected to increased activity and headscarp recession during 2009, leading to closure of the cliff path and threatening some properties at Knipe Point. . The activity appears to have reduced during 2012. However, careful observation of this area is important to minimize the risk to nearby land and property.
- **Robin Hood's Bay**: For the most part the units at Robin Hood's Bay are heavily defended at the toe and therefore classified as Dormant. There is a large overhang in the coastal cliff to the north of the defended section and signs of increasing instability to the south.

The 2012 walkover survey identified the following additional area of activity

- **Filey Bay**: The activity of the cliffs above Speeton Sands continues to be high but two of the frontages have been upgraded to Partly Active or Totally Active in the 2012 walkover survey.

The December **2013** inspection focused on only a limited number of units around the coastal towns and villages and did not cover the whole coastline. However, during that inspection, the following areas were elevated in status or were noted for sustained high activity:

- **Runswick Bay** – Two units (**MU7/2 and MU7/3**) have been elevated in activity status due to increased erosion of the toe of the till cliffs following the storm surge.
- **Upgang Beach** – The unit occupying the majority of this area (MU10/2) has retained its 'Partly Active' status. However the western end of the cliff is totally active

vegetation absent from large sections of the cliff and evidence of very recent mudsliding.

- **Whitby West** – This defended section (**MU11/1 and MU11/2**) has been elevated in activity status due to toe erosion (resulting in the removal of vegetation and exposure of sediments) and recent shallow mudsliding (likely a reactivation of an existing slide) in a section that is defended by a sea wall but not rock armour and the consequent exposure of drainage pipes. There is also evidence of smaller shallow failures further up in the cliff.
- **Robin Hoods Bay** – One unit (**MU16/2**) has been increased in activity status to reflect the undefended nature of the northern third of the unit which is significantly undermined at its toe and from which relatively recent rockfalls have occurred.
- **Scarborough North Bay (Scalby Ness)** - This unit had experienced toe erosion comprehensively throughout the unit and recent failures higher up in the cliff had occurred.
- **Filey Brigg –** Several units to the south of Filey Brigg have experienced widespread toe erosion. A recent mudslide initiating near the top of the cliff with its toe coming to rest on the beach was noted near Filey Sailing Club.
- **Filey Bay –** All units in this area now either remain, or have been elevated to 'Partly Active' Status. Whilst the upper cliff remains largely vegetated there is evidence of failure throughout the whole cliff in some units and the units immediately around Flat Cliffs (MU29/AR and MU29/AS) have experienced particularly severe toe erosion and failure of the lower cliff

2.2 Overview of Coast Protection Asset Condition Assessment

There are a large number of built coastal defence assets along this stretch of coastline, generally associated with the coastal towns and villages. At the time of the 2012 inspection many of these assets were in good or fair condition but there were also a large number requiring minor repair works. The most common works required included blockwork repointing, resealing of joints, reinforcement of undercut zones, repairing cracks, replenishment of rock armour and resurfacing. Several areas were also noted as requiring more extensive works.

The storm surge of 5th/6th December 2013 caused damage to a significant number of coastal defence assets. However, the inspections for this report were restricted to Runswick Bay and Sandsend. A brief overview for these two locations is given below.

Runswick Bay: The rock armour defence remains in good condition. However, the series of patchwork defences to the north of the RNLI building exhibit a variety of defects. There are several large cracks in the walls and erosion and abrasion of the rocky foreshore is undercutting the foundations in several locations. However, there has been a slight recovery of beach levels with a small build-up of coarse grey sand / gravel from the eroding cliff to the north. Following the storm surge of 5th December 2013 significant elements of the patchwork defences north of the RNLI building have been damaged and removed by the sea. The RNLI timber slipway has also been damaged.

Sandsend: In Autumn 2012 it was noted that the toe of the revetment at the car park at the north of the village is exposed and being undercut and there is a large void under the adjacent slipway. The beach levels are low at the failed groyne system fronting the main length of seawall and the timber breastwork retaining the ad hoc toe armour is failing. There is a large void under the toe apron at the south end of the blockwork defence with cantilevered walkway. The sloping concrete revetment at the south side of Sandsend had a failed section with a large void that needs urgent attention.

Following the storm surge of 5th December 2013 significant elements of the sloping concrete defences south of Sandsend have been broken out and scoured by the sea. North Yorkshire County Council carried out a quick inspection on 8th December 2013 which also showed complete loss of beach sand on the foreshore. By the 17th December 2013 the beach had

significantly recovered. The voids have been refilled with rock debris rescued from the beach area (ongoing operation on 17th December) but the whole wall needs urgent attention. The large void under the toe apron at the south end of the blockwork defence with the cantilevered walkway is now more apparent. The walkway itself suffered significant damage from waves and has been closed to the public. It is notable that tonnes of beach material has accumulated in the East Row Beck inlet area between the retaining walls.

2.3 *Tide and wave conditions during the 5th / 6th December 2013 surge*

Recorded sea levels during the surge

Whitby: There is a Class A tide gauge located at Whitby that forms part of the National monitoring programme, with real-time and checked historical data published regularly on the internet. Figure 2-1 below shows predicted and recoded tide levels for Whitby during the December 5th / 6th storm surge event. Note that Chart Datum is 3.0m below Ordnance Datum.

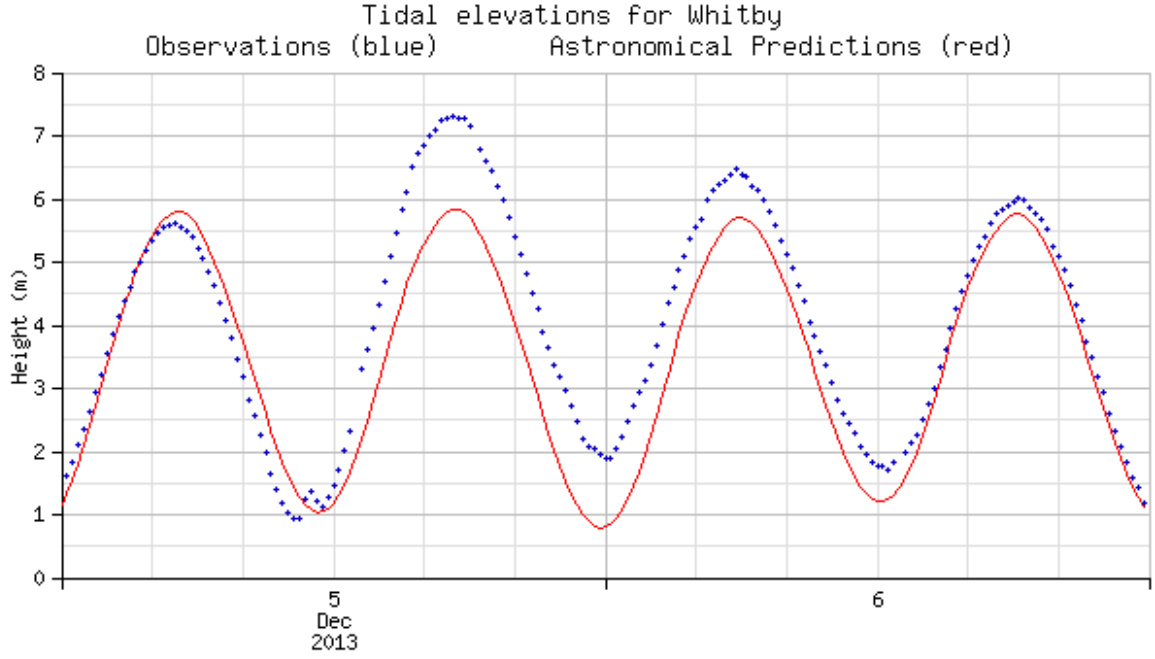


Figure 2-1 Predicted and near real time measurements of tide level (mCD) at Whitby on 5th to 6th December 2013. Image and data courtesy of National tide and Sea Level Facility at the National Oceanography Centre (http://www.ntslf.org/data/realtime?port=Whitby&from=20131205&span=4)

Scarborough: There is a tide gauge in Scarborough Harbour that has been present since about 2006, and has been managed under the Cell 1 regional monitoring programme since 2012. Data is displayed in near real-time on both the Channel Coastal Observatory and North East Coastal Observatory websites. Figure 2-2 below shows real time recorded and predicted recoded levels.

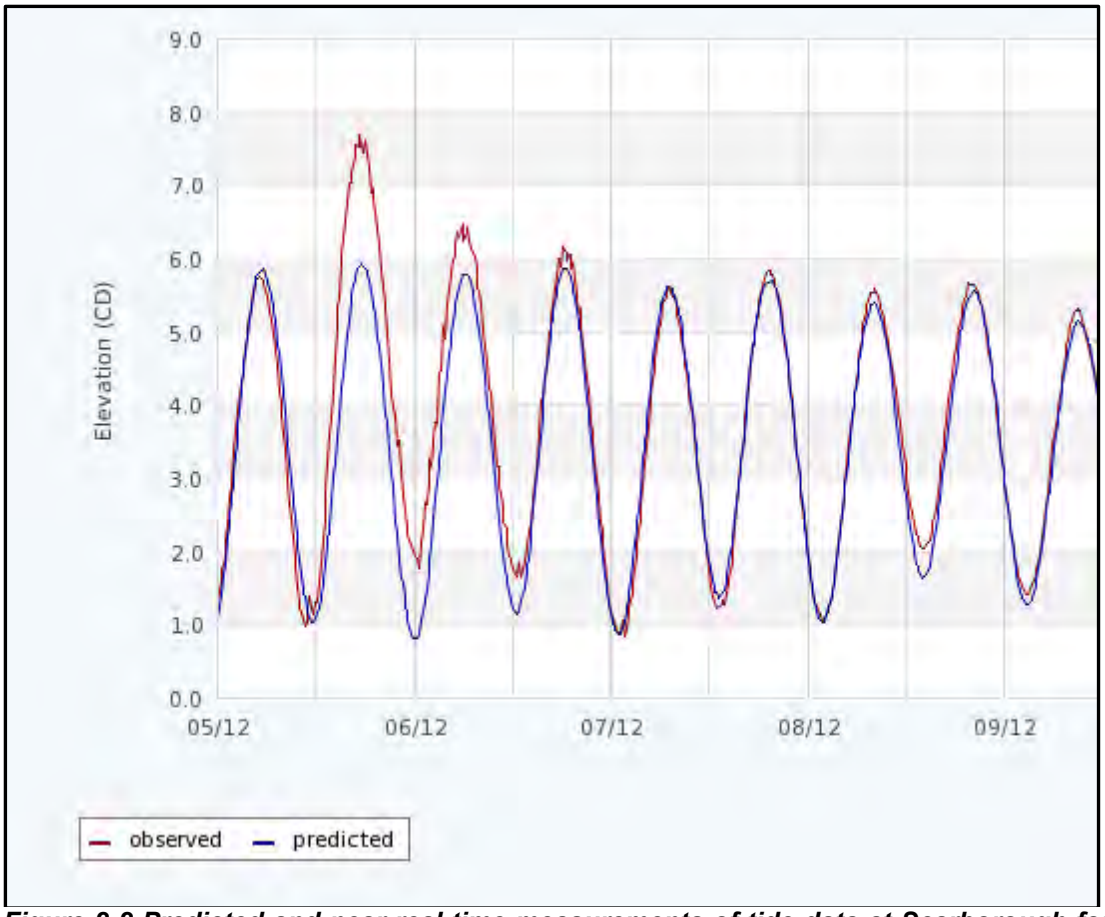


Figure 2-2 Predicted and near real-time measurements of tide data at Scarborough for the December 5th/ 6th storm surge. Image courtesy of Channel Coastal Observatory (http://www.channelcoast.org/data_management/real_time_data/charts_neco/?chart=111&tab=tides&start=1386201600&end=1386806400&disp_option=&datum=chart)

The annual tide gauge report for the Scarborough tide gauge (CCO, 2014, http://www.northeastcoastalobservatory.org.uk/Default.aspx?view=pnlTexts&text=Reports) indicates that the maximum water level recorded was 4.39m OD on 05-Dec-2013 at 17:20. The surge (difference between predicted and measured) was 1.66m at the time of the maximum water level, but the maximum surge height recorded occurred during the rising tide and was 1.75m on 05-Dec-2013 at 15:50. The highest previously recorded tide level since the gauge was deployed in 2003 occurred in 2005 and was 3.66m OD.

The EA (2011) Coastal Flood Boundary Condition extreme water level data for Scarborough (Chainage 3750) indicates that the 1 in 100 (1% AEP) level = 4.0mOD, 1 in 200 (0.5%) = 4.2mOD, 1 in 500 (0.2%) = 4.3mOD, 1 in 1000 (0.1%) = 4.5mOD. However, the confidence level at 1% AEP is +/-0.3m and at 0.1% AEP is +/- 0.5m. This therefore suggests that in terms of maximum recorded water level the event was between a 1 in 200 (1%AEP) and 1 in 1000 (0.1%AEP) event. At Whitby the results are similar as the recorded level of approx. 4.3mOD compares to the EA (2011) CFB levels for the 1 in 200 and 1 in 500 levels of 4.1mOD and 4.3mOD, which both have confidence level of +/-0.3m.

Recorded Wave data during the storm surge

There are three wave buoys in the region that record wave data, these being the offshore Tyne / Tees Cefas WaveNet buoy and the Whitby and Scarborough wave buoys deployed under the Cell 1 regional monitoring programme. Unfortunately the Scarborough buoy was off station during the storm due to an earlier incident so did not record data. Figure 2-3 below shows the recorded wave data at Whitby and Tyne Tees, plotted together with recorded tide levels from Scarborough. It is interesting to note that the peak wave heights were not

exceptionally large at the time of the maximum surge and that larger waves occurred on the following two high waters.

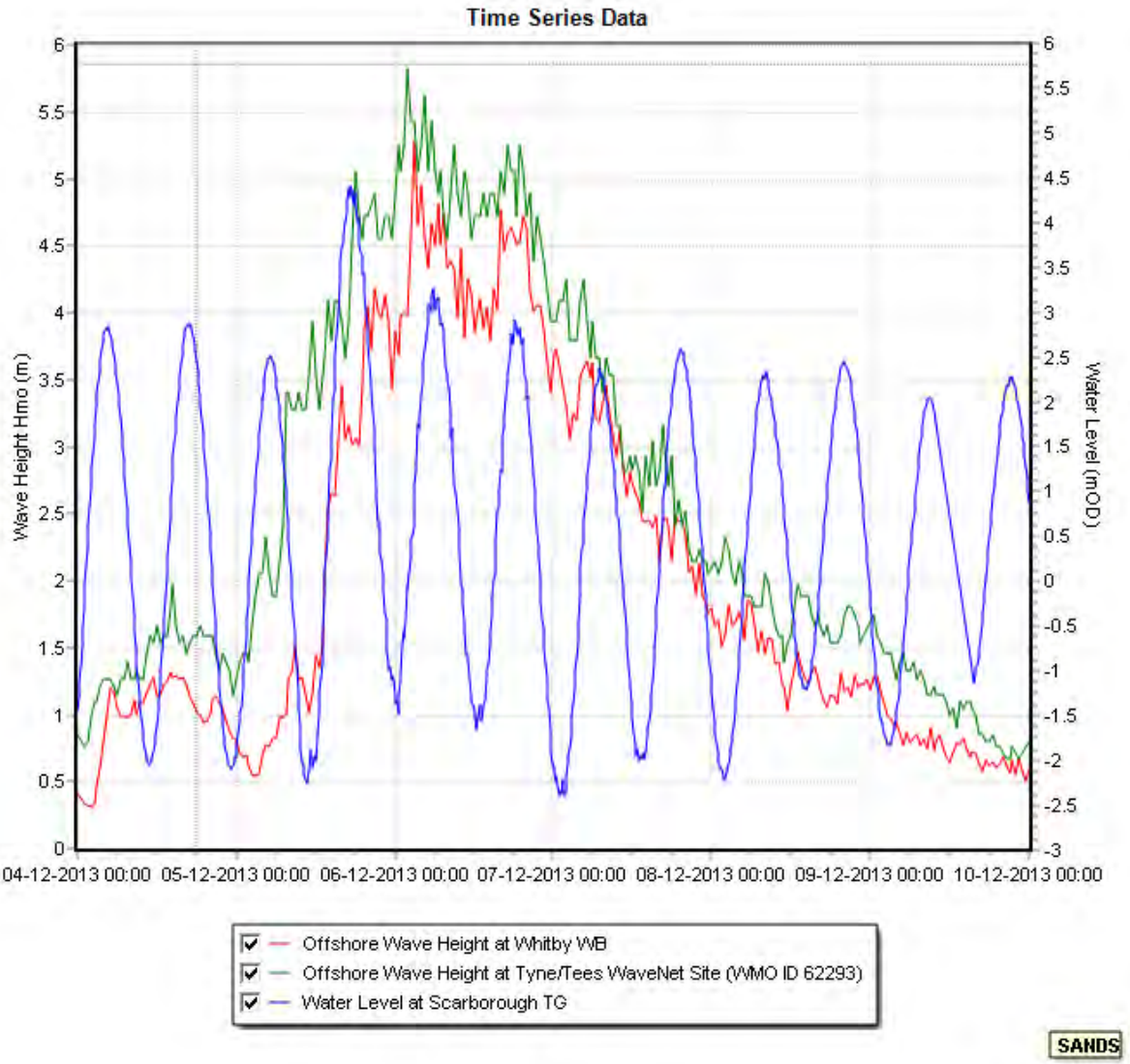


Figure 2-3 Recorded wave data at Tyne Tees and Scarborough plotted together with water level data for Scarborough

The data from the wave buoy shows that the storm surge that damaged many defences and received significant media attention on 5th and 6th December 2013 does not appear to have had an exceptional wave conditions. At the time of the maximum water level the wave heights were still building and larger waves were experienced on the two subsequent high waters. This means that the storm beach profiles created during the highest water levels of the surge event on the 5th will have been redistributed during the subsequent two days.

2.4 Post-Storm Beach Condition overview

The beach profiles and difference plots for the post storm survey show the impact of the early December storm event. The profiles and topographic survey data recorded between 9th and 18th December 2013 have been compared to the Autumn 2013 Full Measures survey data wheich were recorded in September 2013. Profiles plotted with SANDS are presented in Appendix A, alongside the mapping of the topographic surveys and difference plots showing changes from October to December. For one location at Sandsend two profiles were taken after the storm, on 9th and 18th of December and these illustrate the rapid recovery of the sand veneer beach at that location. The photograph of the beach taken on 8th December showed that there were significant areas of clay substrate exposed. There were a number of

profiles, particularly at Whitby / Sandsend that showed erosion. However, in most locations the beach profile had flattened.

3 Condition Assessment

This section provides an account of observations made on the condition of cliffs and coastal assets within Scarborough Borough Council's coastline, running from north to south. For this update report only locations where either the coastal slopes or defences were inspected by Halcrow in December 2013 have been included in this report. Information extracted from the 2012 report to give the baseline for each location and **comments from the December 2013 inspections are given in bold text.**

Coastal Slope Condition Assessment
Brief descriptions and photographs are presented for each Management Unit. Photographs have been bordered with colours in order to show their activity status, as follows:

- Totally Active
- Partly Active
- Locally Active
- Inactive
- Dormant

Coastal slope condition data, that also show areas of change, are provided in Maps 1-11 in Appendix A.

Coast Protection Asset Condition Assessment
Brief descriptions and photographs are presented for key assets and those where there are significant defects or the condition has changed significantly since the previous inspection. Photographs have been bordered with colours in order to show their condition as follows:

- 5 – Very Poor
- 4 – Poor
- 3 – Fair
- 2 – Good
- 1 – Very Good

Coast protection asset data for the Autumn 2012 inspection are also provided in the Maps 1 to 7 in Appendix B to illustrate the location of the assets visited.

3.1 Management Unit 4 - Staithes

Coastal Slope Condition Assessment
This Management Unit comprises the high cliffs of Cowbar Nab and those behind and immediately to the east of Staithes (Appendix A Map 1).

The eastward facing end of Cowbar Nab (MU4/1a and E60/1a) features exposed, bedded and jointed rock and has very limited vegetation cover. There is ongoing erosion of softer material at the headscarp and evidence of recent rockfall activity from the blocky lower face is present along the walkway beneath the cliff face. As a result this unit was classified in 2012 as Totally Active, as it was in 2008.

During the post-surge inspection in December 2013, it was noted that in these units there had been relatively recent rockfalls and that there were significant talus deposits. Displaced rock armour and a rockfall block was noted on the path beneath these units,

although it is not completely evident whether these blocks had been purposefully moved or had come to rest there. Given this high level of activity, the 'Totally Active' status for these units has been retained.

Unit MU4/1b is the south facing side of Cowbar Nab which runs adjacent to Staithes Beck. This unit is sheltered from the wave action because it is upstream of the harbour walls. The cliff does fail occasionally and has been given a classification of Partly Active. Further upstream from MU4/1b a rockfall occurred on the steep slope adjacent to Staithes Beck and was stabilised during 2012. **No change in the level of activity following the December 2013 storm surge here was noted and therefore the 'Partly Active' status has been retained.**

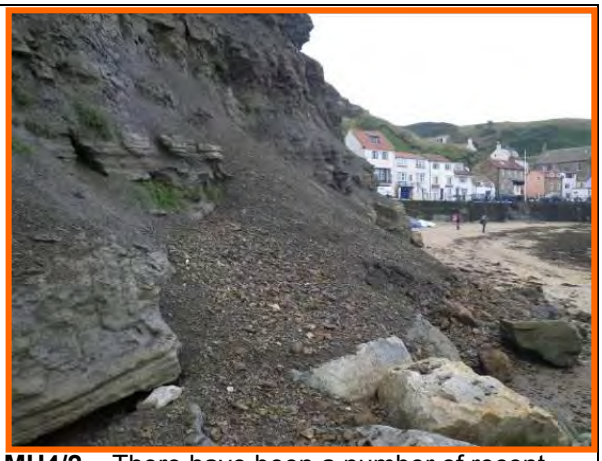
Unit MU4/2 sits behind Staithes Harbour and is classified as Partly Active. This cliff is generally well vegetated with small localised patches of erosion. The eastern end of the unit is more exposed than the rest of the unit because of its position in the bay and is more prone to erosion. Failed material was evident in at the toe of the cliff during the 2012 inspection, when activity was also by residents of the eastern part of High St. In 2012 The unit was re classified from Locally Active to Partly Active to reflect this recent phase activity, which was likely to have been triggered by the exceptionally wet weather of 2012. **Following the December 2013 storm surge, this unit appeared to conform to the same description albeit with less evidence of talus at the toe which may have been removed during the surge.**

Further east, beyond the extent of Staithes harbour is unit **MU4/3**. The face of this unit is almost entirely exposed and showing signs of active erosion. Unlike any of the other cliffs within this Management Unit, this section is not protected at the toe and is therefore subject to marine erosion. This unit was classified as Partly Active in the 2009 and 2012 walkover surveys. **During the post December 2013 storm surge survey, evidence of rockfall accumulations at the base of the cliff were noted, along with evidence of recent failure in the overlying tills, indicated by exposed material at the top of the cliff and 'streaking' on the cliff face.**

MU4/1a - Exposed and active end of Cowbar Nab, the southern half (Totally Active). Photo from Sept 2012

E60/1a - The northern half of Cowbar Nab. The cliff face is showing signs of erosion (Totally Active) Photo from Sept 2012

MU4/2 –Vegetated cliff with localised erosion, behind Staithes harbour (Partly Active). Photo from Sept 2012



MU4/2 – There have been a number of recent failures in this management unit, which is now classed as Partly Active. Photo from Sept 2012

MU4/1a The southern part of Cowbar Nab after the December 2013 surge – note fresh scarring in cliff face (Totally Active)

E60/1a- The northern part of Cowbar Nab after the December 2013 surge. Note relatively fresh scarring and talus accumulation on left of photo. (Totally Active)

MU4/1a Close up photo of talus accumulation behind rock armour after the December 2013 surge. (Totally Active)

MU4/1a Displaced rock armour and rockfall block on path after the December 2013 surge. (Totally Active)

MU4/1a Beach condition after the December 2013 storm surge. (Totally Active)

MU4/1b – No noticeable change in activity status following the surge. (Partly Active)

MU4/2 – Cliff behind Staithes harbour. No notable change post December 2013 surge except lack of talus accumulation. (Partly Active)

MU4/2 Beach condition post December 2013 storm surge. Note absence of talus at base of cliff. (Partly Active)

MU4/3 – Undefended cliff east of Staithes Harbour. Note red-brown 'streaking' on cliffs from failures in till.

Coast Protection Asset Condition Assessment

Coastal defences at Staithes were not included in the December 2103 inspections

3.2 Management Unit 5 - Jet Wyke

Coastal Slope Condition Assessment

The coastal slopes in Management Unit 5 were not included in the December 2013 inspections.

Coast Protection Asset Condition Assessment

There are no coastal defence assets within this Management Unit.

3.3 Management Unit 6 - Old Nab to Runswick Bay

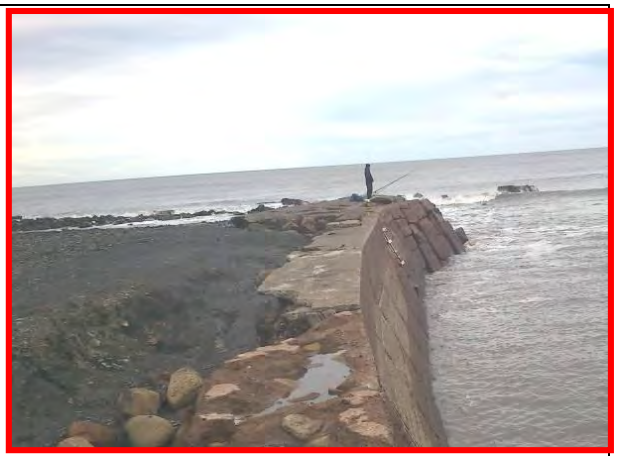
Coastal Slope Condition Assessment

The coastal slopes in Management Unit 5 were not included in the December 2013 inspections.

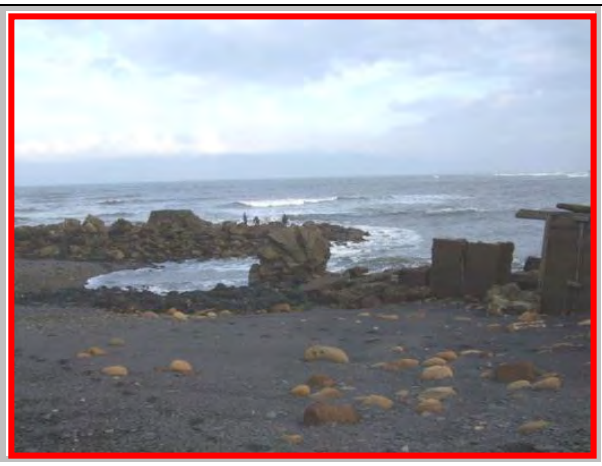
Coast Protection Asset Condition Assessment
There are no coastal assets within Sub-Management Units 6A and 6C.

Mu6B (MA20) – Port Mulgrave
As noted during the 2008 and 2009 inspections, this is a former port and ironstone mine that has been derelict for 70 years and is considered to be redundant (Appendix B, Map 1). Virtually all coastal defences have been lost to the sea. What is left of the southern breakwater is undergoing large scale cracking, deformation, undercutting and outflanking. It is estimated that half of its original length has now been eroded (Asset Ref. 1221D901D0502C01). In autumn 2012 it was reported that the northern breakwater appeared to have suffered further damage and lowering of the crest since the 2009 inspection. Two additional overview images have been added below, showing further deterioration in July and December 2013.

Looking at the end of the breakwater with evidence of erosion and failure in 2009 (Asset Ref. 1221D901D0502C01)



View of breakwater, 30/10/2012 (Asset Ref. 1221D901D0502C01)



Overview of asset in 2009
(Asset Ref. 1221D901D0502C01)

Overview of asset in Oct 2012.
(Asset Ref. 1221D901D0502C01)

Overview of asset in July 2013
(Asset Ref. 1221D901D0502C01)

Overview of asset in December 2013 following storm surge of 5th December 2013. Significant loss of fill material adjacent to the breakwaters since July 2013 (see left).
(Asset Ref. 1221D901D0502C01)

3.4 Management Unit 7- Runswick Bay

Coastal Slope Condition Assessment

Mu7A – Runswick Bay Village
This sub-management unit consists of **units MU7/1 and MU7/2** (Appendix A, Map 1).

Unit MU7/1 includes Runswick Bay village itself and the adjacent slopes. It is well vegetated and is defended at the toe by a sea wall and rock armour. The outflanking of these defences to the north (within Mu6C) indicates the nature of the erosion which may be occurring here if it were not for the protective influence of these structures. There is some minor evidence of very localised, small scale erosion on the engineered slopes to the south of the village, but this does not appear to be significant. **No change to this status was noted at unit MU7/1 during the post-December 2013 storm surge inspection. However, small rockfalls were observed in MU6/8 just beyond the northern end of the Runswick Bay Village defences with other evidence of recent erosion (see Coast Protection Asset Condition Assessment subsection below).**

Unit MU7/2 is a narrow unit located to the south of Runswick Bay village. The slopes are relatively shallow and well vegetated. The only activity evident is at the unit toe, where the cliffs are subject to marine erosion in the absence of protection measures. This unit is also classified at Inactive.

In September 2012 it was noted that these units had not changed activity class since the 2009 walkover survey.

Following the December 2013 storm surge and a preceding night of heavy rain, a significant flow of water was noted issuing through the defences in this section. Also, toe erosion seems to have increased at the southern end of the unit therefore the activity status of this unit has been increased to 'Locally Active'.

MU7/1 – The slopes of Runswick Bay village (Inactive) September 2012

MU7/2 (right of image with rock armour at toe - Inactive) **MU7/3** (left with eroding toe – Locally Active). September 2012

MU7/1 – Runswick Bay Village post December 2013 Storm Surge. Inactive

MU6/8 – Small rockfalls witnessed from this unit during post December 2013 Storm Surge Inspection. Partly Active

MU7/2 Stream issuing through defences after heavy rainfall during post-December 2013 storm surge inspection. Locally Active.

MU7/2 Increased toe erosion at southern end (where defences lower) at far right of photo. Locally Active.

Mu7B – Runswick Sands

This sub-management unit consists of units MU7/3 and MU7/4.

Units MU7/3 and MU7/4 are located behind Runswick Sands. The cliffs here are vegetated and of a shallow gradient, similar to those within unit MU7/2. The units do not have any protection at the toe and therefore are subject to continual marine activity. The toe is generally steep as a result, does not support any vegetation cover, and shows evidence of recent slumping. As a result, both units were classified as Locally Active in 2012.

MU7/4 – Toe erosion at the base of the cliff (Locally Active) (September 2012)

MU7/3 Widespread toe erosion and significant failure at the toe of the cliff post December 2013 surge. Also note exposure of coarse material on the beach. (Partly Active)

These units did not change activity class between 2009 and 2012.

Only MU7/3 was inspected during the post-December 2013 storm surge inspection and throughout this unit, significant erosion and failures were noted at the toe of the cliff. Due to the widespread nature of this recent erosion, the activity status for this unit has been increased to Partly Active although upper slopes at the time of inspection still remained vegetated.

This Management Unit is divided into 2 Sub-Management Units:
Mu7A – Runswick Bay Village (Map 1, Appendix B)

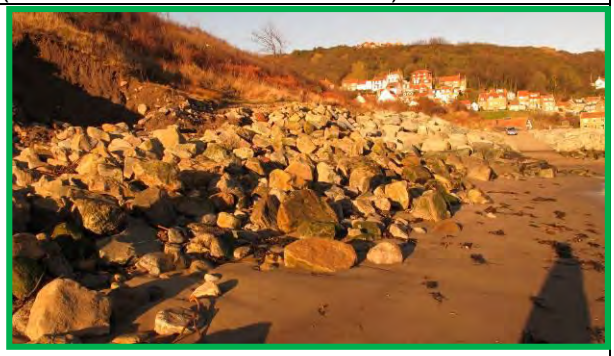
In recent years new coastal defences have been constructed in Runswick Bay, associated with the building of a new pumping station (adjacent to the lifeboat station) and associated with the remediation of the landslip that damaged the defence near the end of the road. The other defences fronting the properties at the north of the bay are of variable age and condition.

The rock armour defences (Asset ref: 1221D901D0602C01) remain in very good condition, with the rocks tightly packed with good coverage and no evidence of significant deformation. The associated slipway towards the south from the end of the road and boat park is also in good condition. Beach levels appeared relatively high at the time of the inspection, so the toe was not visible. There is ongoing erosion of the undefended cliff at the southern end of the defence and some of the locally sourced smaller rock used at the tie in has been scattered, see below right, however this is not a cause for concern at present.

Runswick Bay village rock armour defences, Oct 2012. (Asset Ref. 1221D901D0602C01)

Southern end of Runswick bay rock armour defences, Oct 2012.
(Asset Ref. 1221D901D0602C01)

Runswick Bay village rock armour defences, 17th December 2013.
(Asset Ref. 1221D901D0602C01)



Southern end of Runswick Bay rock armour defences, 17th December 2013.
(Asset Ref. 1221D901D0602C01)

The Sailing Club, located in the bay some 600m south of the village, where the beach is wider has been constructed on timber struts and features a mix of coastal defences (Asset Ref. 1221D901D0602C05), below left and right. The informally placed relic tank trap blocks at the south end show extensive cracking. The timber defences across the front of the main building are showing signs of rot and will need replacement in future. **Since the storm surge of 5th December 2013, it is notable that beach levels in front of the Sailing Club are now higher than in 2012. However one set of access steps has been demolished by wave action.**

Runswick Bay sailing club timber defences at south end, Oct 2012.
(Asset Ref. 1221D901D0602C05)

Northern end of defences at Runswick Bay sailing club, Oct 2012.
(Asset Ref. 1221D901D0602C05)

Runswick Bay sailing club timber defences at south end, 17th December 2013. Note missing steps to beach.
(Asset Ref. 1221D901D0602C05)

Northern end of defences at Runswick Bay sailing club, 17th December 2013. Note higher beach levels compared to 2012.
(Asset Ref. 1221D901D0602C05)

Runswick Bay sailing club concrete block defences at south end, 17th December 2013.
(Asset Ref. 1221D901D0602C05)

Eroding cliffs at Dunsley Dale near Runswick Bay Sailing club, 17th December 2013.

At the northern end of the rock armour, the slipway adjacent to the RNLI building was reported to be in good overall condition in October 2012, although the timber strips to support the small boats were rotting in many places and will need replacing and joints between slabs need resealing, below left. The seawall around the pumping station to the north of the RNLI building was also in very good condition, below right, although the standards for all of the handrails were showing corrosion and needed cleaning and repainting.

Northern slipway adjacent to the RNLI, Oct 2012. (Asset Ref. 1221D901D0601C04)

Seawall around the pumping station, Oct 2012. (Asset Ref. 1221D901D0601C07)

Northern slipway adjacent to the RNLI, 17th December 2013. Some timbers now missing. (Asset Ref. 1221D901D0601C04)

Seawall around the pumping station, 17th December 2013. (Asset Ref. 1221D901D0601C07)

RNLI slipway damage, 17th December 2013 (Asset Ref. 1221D901D0601C04)

RNLI slipway damage viewed from the pumping station, 17th December 2013. (Asset Ref. 1221D901D0601C04)

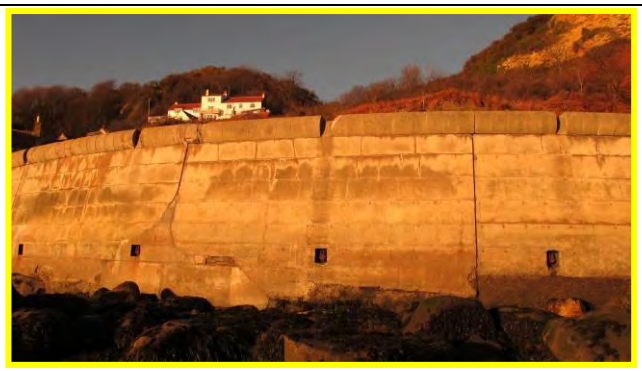
In October 2012 it was noted that the sea wall defences to the north of the new pumping station showed a variety of defects ranging from minor to more significant issues. The most northern coastal sea wall (Asset Ref. 1221D901D0601C01) is suffering from surface cracking and erosion. Erosion of the underlying rocky foreshore continues to cause undercutting of the sea wall. Further investigation is required to determine the rate of undercutting. Further defects include washed out sealant joints, flap valves on weep holes which have seized shut, wash out of the joints under the capping beam, vertical cracks through the wall, missing joints and filler in the seawall face and promenade surface with vegetation growth, and outflanking at tie in to eroding cliff at northern end, see photo lower right below. It was noted in 2012 that although changes are limited since the 2009 inspection it was recommended that the issues described were addressed.

Since the storm surge of 5th December 2013 various elements of seawall blockwork have been removed by wave action.

Undercutting of the northern coastal sea wall (Photo taken from 2009 report

Foreshore scour at toe of seawall, photo from 30/10/2012 (Asset Ref. 1221D901D0601C01) October 2012

Northern coastal seawall, 17th December 2013 (Asset Ref. 1221D901D0601C01)



Northern coastal seawall, 17th December 2013 (Asset Ref. 1221D901D0601C01)

Northern coastal seawall toe, 17th December 2013 (Asset Ref. 1221D901D0601C01)

Northern coastal seawall toe, 17th December 2013 (Asset Ref. 1221D901D0601C01)

Promenade on top of northern seawall, 30/10/2012 (Asset Ref. 1221D901D0601C01)

Erosion of cliff adjacent to north end of seawall, 30/10/2012 (Asset Ref. 1221D901D0601C01)

Promenade on top of northern seawall, 17th December 2013. Evidence of overtopping shown. (Asset Ref. 1221D901D0601C01)

Erosion of cliff adjacent to north end of seawall,17th December 2013. (Asset Ref. 1221D901D0601C01)

Cliff adjacent to north end of seawall from the top promenade, 10th July 2013. (Asset Ref. 1221D901D0601C01)

Further erosion of cliff adjacent to north end of seawall, and seawall damage since July 2013, from the top promenade, 17th December 2013. Old concrete wall/cliff abutment now missing. (Asset Ref. 1221D901D0601C01)

Moving south, the protruding section of wall (1221D901D0601C06) protecting the individual property is in fair condition. There are signs of repairs to the large vertical cracks in the wall and toe apron. However there are cracks in the top of the concrete bagwork part of the wall. **The fencing (private property) on top of the wall has been damaged during the storm surge event of 5th December 2013 indicating significant wave overtopping in this area.**

Repaired vertical cracks to toe of wall, and horizontal cracks holding, Oct 2012.
(Asset Ref. 1221D901D0601C06)

View of northern end of wall with cracked concrete bagwork, Oct 2012.
(Asset Ref. 1221D901D0601C06)

Toe of cottage wall, 17th December 2013.
(Asset Ref. 1221D901D0601C06)

View of northern end of concrete bagwork, 17th December 2013.
(Asset Ref. 1221D901D0601C06)

Toe of cottage wall, 17th December 2013. Note loss of timber fencing and undercutting of toe.
(Asset Ref. 1221D901D0601C06)

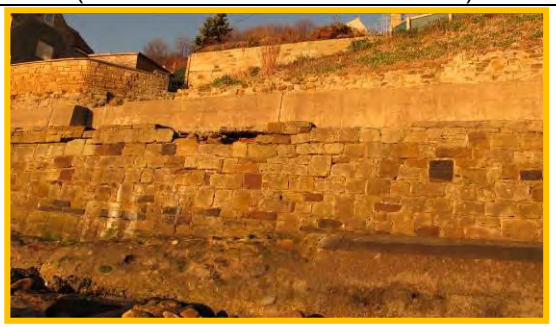
View of Runswick Beck outfall, 17th December 2013.
(Asset Ref. 1221D901D0601C06)

The main length of wall below the properties, Asset Ref. 1221D901D0601C03 is in variable condition. Although there are signs of repair work there are significant cracks in the wall and undercutting of the toe in several locations, see photos below. In October 2012 it was noted that the beach level has recovered here since the 2009 inspection with a small accumulation of coarse grey shale sand from the eroding landslip to the north of the village. **Various elements of blockwork on top of the wall have been damaged during the storm surge event of 5th December 2013.**

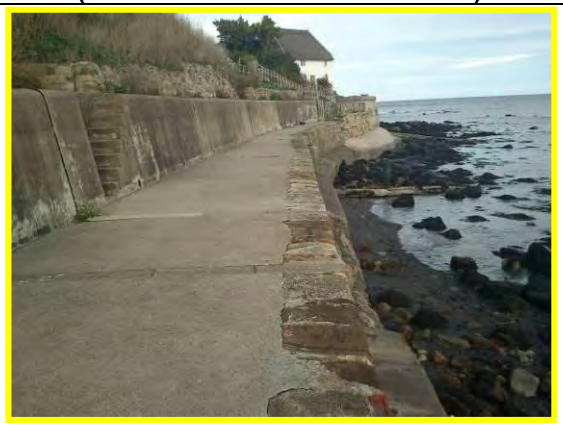
Diagonal cracks in wall. Oct 2012.
(Asset Ref. 1221D901D0601C03)

Gaps at joints and missing blocks, Oct 2012.
(Asset Ref. 1221D901D0601C03)

Same area as above with diagonal cracks and coping damage in wall, 17th December 2013.
(Asset Ref. 1221D901D0601C03)



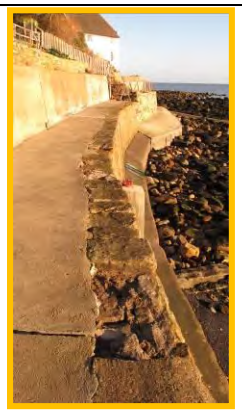
Gaps at joints and more missing blocks, 17th December 2013.
(Asset Ref. 1221D901D0601C03)



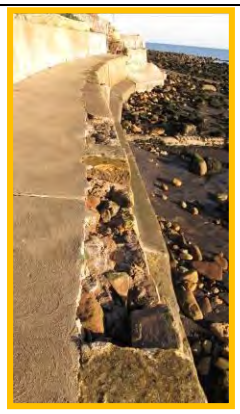
Overview of wall, Oct 2012.
(Asset Ref. 1221D901D0601C03)

Undercutting of toe adjacent to steps, Oct 2012
(Asset Ref. 1221D901D0601C03)

17th December 2013



Damage to wall blocks



(Asset Ref.

1221D901D0601C03)

The concrete breakwater or groyne (Asset Ref. 1221D901D0601C02) to the north of the pumping station and lifeboat slip was noted to be in need of repair during the 2009 survey, with large horizontal and vertical cracks on both sides propagating through the defence. **The condition at the time of the October 2012 and December 2013 inspections was similar or slightly worse.**

Large horizontal crack to breakwater, Oct 2012. (Asset Ref. 1221D901D0601C02)

Oct 2012 (Asset Ref. 1221D901D0601C02)

Large horizontal crack to breakwater, 17th December 2013. (Asset Ref. 1221D901D0601C02)

Head of breakwater, 17th December 2013. (Asset Ref. 1221D901D0601C02) and blockwork wall (Asset Ref. 1221D901D0601C03)

Runswick Bay's beach levels on 17th December 2013. (Asset Ref. 1221D901D0602C01-7)

Beach Condition Assessment following the December 2013 Storm.

Observations:

The topography recorded on the 16th December for Runswick shows shore parallel bathymetry and no obvious areas of scour. The topographic difference plot shows the changes between the September and December 2013 surveys. The difference plot shows that overall there has been reasonably small change following the early December 2013 storm. The majority of the bay has changed within a range of ±0.25m. The centre of the bay had modest accretion while the ends of the bay and the top of the centre of the bay had eroded by up to 0.5m. The largest recorded change was in the extreme south of the bay where the erosion was most consistent and the beach level had dropped by up to 1m.

The surveyor noted that the southern cliff line had deeper pockets / caves created by the sea. The cliff line had been shaped by the storm surge. South of the revetment the dunes have slipped onto beach revealing mud banks.

Interpretation:

The observed changes were modest, apart form in the southern part of the bay, where up to 1m of erosion had occurred. The changes in beach level are not consistent with a large storm with large destructive waves. Thus it is considered that Runswick Bay was sheltered from the worst of the storm. The southern extent of the survey, which showed 1m of erosion may have been the most exposed area in the monitored part of the Bay. The storm data shows that the storm had a mean vector of 70°, as a result the changes to the beach must have been due to the refraction of the waves into Runswick Bay.

3.5 Management Unit 8 - Runswick Bay to Sandsend

Coastal Slope Condition Assessment

The coastal slopes in Management Unit 8 were not included in the December 2013 inspections.

3.6 Management Unit 9 – Sandsend

Coastal Slope Condition Assessment

This Management Unit is divided into three Sub-Management Units, as follows (Appendix A, Map 2):

Mu9A and Mu9B – Sandsend Village
These management units comprise units MU9/1 and MU9/2. Both units are defended at the toe by the Sandsend sea wall, groynes and some rock armour. As a result there was no evidence of activity during the 2012 surveys and the units are both again classified as Dormant.

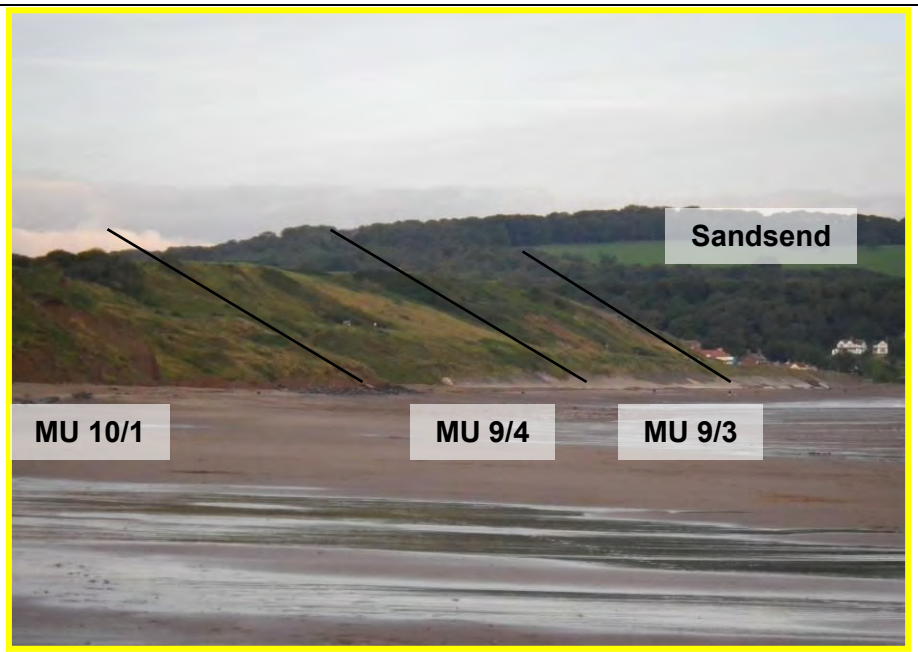
No change to the activity status of these units has been made following the post-December 2013 storm surge inspection.

MU9/1 is located close to Sandsend (Dormant) September 2012

MU9/2 is the slope above the village of Sandsend (Dormant) September 2012

Mu9C – East Sandsend
This sub-management unit consists of unit MU9/3 only. This unit is located above the concrete sea defences immediately to the east of Sandsend. There has been some effort to stabilise the slopes within this unit, which acted to reduce the level of activity. However the presence of erosive features in the exposed materials provides evidence of ongoing instability. This unit was formerly classified Partly Active in 2008, but was classified as Locally Active in 2012.

During the post-December 2013 storm surge inspection numerous erosive features in the upper slope were noted, as was erosion immediately upslope of the concrete defences and therefore the Locally Active status has been retained.



MU9/3 and MU 9/4 The slope overall is stable with erosion apparent at the shore where the defence has become degraded (Locally Active). October 2012

MU9/3 – Note erosive features in the upper slope as well as failure of toe defence. December 2013

MU9/3 Note erosive features in upper slope and failure of defence at the toe. December 2013

Coast Protection Asset Condition Assessment
Mu9A and Mu9B – Sandsend Village (Map 2, Appendix B)

Coastal defences at Sandsend vary from fair to **very** poor condition.

The most northerly defence at Sandsend car park area, is a sloping concrete revetment with recurve crest wall and rock armour toe protection (Asset Ref No.1221D901D0701C02). The concrete wall is in fair condition with minimal damage to the surface. There is some minor cracking and surface erosion which is typical of concrete defences such as this. The north end of the revetment has lost thickness of concrete at the base through abrasion, with exposure of reinforcement bars, although the worst area noted in the 2009 inspection was not visible as it was covered with cobbles and may have been repaired. Encasement of this reinforcement is advised from a structural perspective, as well as preventing any H&S accidents occurring due to sharp edges of the exposed bars. The toe of the revetment was noted in 2012 as exposed and undercut in many places, with abrasion of the soft rock on which the wall is founded ongoing, see below left. The toe armour was noted to be displaced and not fully protecting the toe; this could be ameliorated by re-profiling and topping up the rock armour protection. There was a large void under the south side of slipway adjacent to

Sandsend Beck, see below right. There was also missing filler in the slipway joints and in the crest wall joints (2012). **The 17th December inspection found the condition to be similar, with defects slightly worse.**

Displaced toe armour, undercutting to concrete revetment and abrasion damage to revetment, Oct 2012. (Asset Ref No.1221D901D0701C02)

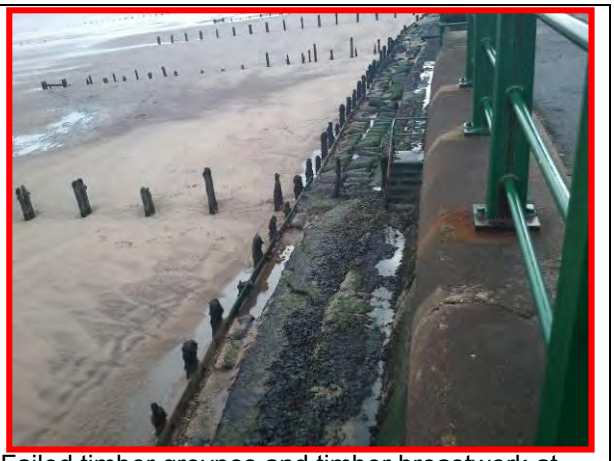
Void under slipway at the north of Sandsend, Oct 2012. (Asset Ref No.1221D901D0701C02)

Concrete revetment at the north of Sandsend, 17th December 2013. (Asset Ref No.1221D901D0701C02)

Slipway at the north of Sandsend, 17th December 2013. (Asset Ref No.1221D901D0701C02)

Similarly to the 2009 inspection, the beach was low in front of the main concrete seawall in front of Sandsend village (Asset Ref. 1221D901D0702C01) (October 2012 **and December 2013**). The groyne field is derelict and the remains have no significant impact on sand movement. The toe of the seawall was showing evidence of significant damage and movement in 2009 and the defence appears to have worsened over the last three years, with the timber breastwork deteriorating and allowing the ad hoc toe protection units to move. There are cracks in the wall and significant abrasion at the steps.

Timber toe of sea wall in a poor state - photo from 2009 (Asset Ref. 1221D901D0702C01)



Failed timber groynes and timber breastwork at toe of wall in front of Sandsend, Oct 2012. (Asset Ref. 1221D901D0702C01)

Failed timber groynes and timber breastwork at toe of wall in front of Sandsend, 17th December 2013. (Asset Ref. 1221D901D0702C01)

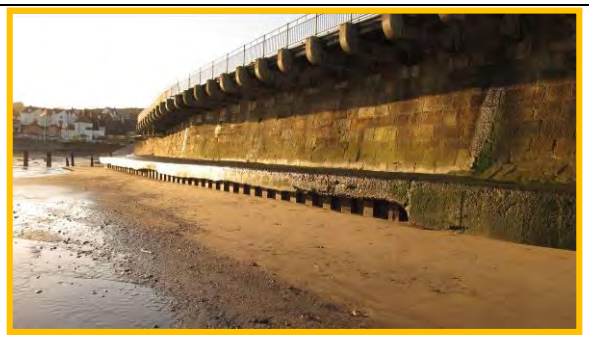
Failed timber breastwork at toe of wall in front of Sandsend, 17th December 2013. (Asset Ref. 1221D901D0702C01)

The newer short section of masonry blockwork sea wall (Asset Ref. 1221D901D0702C04) that supports a cantilevered promenade just north of East Row Beck was noted in the 2008 inspection to suffer from undercutting of the toe of the structure with steel sheet piling in need of repair. Although the main wall is in fair condition the defence has an overall rating of poor. The steel toe piling was visible in several locations during the 2012 inspection and is corroded and abraded. There are holes through the piles and voids behind under the apron. There is a particularly large void under the southern end of the apron, see below left. **The large void under the toe apron at the south end of the blockwork defence with the cantilevered walkway is now more apparent since the storm surge of 5th December 2013. The walkway itself has also suffered significant damage from wave action and has been closed to the public. Pedestrians are currently having to use the carriageway in this location.**

Masonry blockwork sea wall with cantilevered footway, showing large void under toe apron and failed groynes, Oct 2012.
(Asset Ref. 1221D901D0702C04)

Exposure of toe piling below masonry wall, Oct 2012. (Asset Ref. 1221D901D0702C04)

Masonry blockwork sea wall with cantilevered footway, 17th December 2013, showing larger void under toe apron and failed groynes.
(Asset Ref. 1221D901D0702C04)



Thin veneer of sand reducing exposure of toe piling below masonry wall, 17th December 2013.
(Asset Ref. 1221D901D0702C04)

Cantilevered footway, 17th December 2013, showing storm damage on 5th December.
(Asset Ref. 1221D901D0702C04)

Cantilevered footway, 17th December 2013, showing storm damage on 5th December.
(Asset Ref. 1221D901D0702C04)

The low masonry wall (Asset Ref. 1221D901D0702C03), below left and right, that returns into both sides of East Row Beck adjacent to the road bridge is in overall good condition, although there is minor abrasion damage to some blocks and locally missing sections of mortar. **It is notable that since the storm surge of 5th December 2013, extensive beach material has accumulated in the East Row Beck inlet area between the retaining walls.**

Low masonry wall at east Row Beck, south bank, Oct 2012. (Asset Ref. 1221D901D0702C03)

Low masonry wall at east Row Beck, north bank, Oct 2012. (Asset Ref. 1221D901D0702C03)

Low masonry wall at East Row Beck, south bank, 17th December 2013. Note accumulation of sand with the beck cutting through. (Asset Ref. 1221D901D0702C03)

Low masonry wall at East Row Beck, north bank, 17th December 2013. (Asset Ref. 1221D901D0702C03)

Mu9C – East Sandsend

Southeast of Sandsend, a large sloping concrete revetment covering light weight rock armour / rubble runs parallel to the coastal road (Asset Ref. 1221D901D0702C02). This 800m long defence features many significant defects throughout. In October 2012 there was a large void > 1.5m across where the revetment had failed and the underlying rubble was being actively eroded, see photo below top left. There is frequent surface cracking and localised spalling and undercutting and erosion of the toe. There was evidence of several significant repairs since the previous inspection at the east end of the revetment (below top right) and several other areas. The whole asset is in poor condition and it is understood that a capital improvement scheme planned to be undertaken in the near future.

Significant further damage to the asset was evident following the storm surge of 5th December 2013. North Yorkshire County Council (NYCC) carried out a visual inspection on 8th December 2013 as the defence fronts the A174 carriageway. Notable during this inspection was the loss of beach material on the foreshore exposing clay. Some sand recovery is however evident during the inspection of 17th December. Various elements of the sloping concrete defences south of Sandsend have been broken out and scoured by the sea during the storm surge. The voids have been temporarily refilled with rock debris rescued from the beach area (ongoing operation on 17th Dec 2013) but the whole wall needs urgent attention.

Large void in revetment adjacent to recent patch repair, Oct 2012. (Asset Ref. 1221D901D0702C02)

New large void in revetment adjacent to previous and more recent patch repairs, 17th December 2013. Compare to 2012 inspection (left).
(Asset Ref. 1221D901D0702C02)

Repair at east end of the concrete revetment since 2009 inspection, Oct 2012.
(Asset Ref. 1221D901D0702C02)

East end of the concrete revetment, 17th December 2013. Note lower beach levels compared to 2012 inspection (left). (Asset Ref. 1221D901D0702C02)

Sandsend seawall revetment and eroded beach following the storm surge of 5th December 2013. Photo taken on 8th December 2013, NYCC inspection.
(Asset Ref. 1221D901D0702C02)

Viewing defence east to west, void in eastern revetment, 17th December 2013.
(Asset Ref. 1221D901D0702C02)

Extensive damage to revetment temporarily filled in, 17th December 2013.
(Asset Ref. 1221D901D0702C02)

Extensive damage to revetment temporarily filled in, 17th December 2013.
(Asset Ref. 1221D901D0702C02)

Extensive damage to revetment and cliff material above revetment. Note also the scoured beach with no sand in front of the revetment, 8th December 2013, NYCC inspection.
(Asset Ref. 1221D901D0702C02)

Previous repairs to revetment scoured out, 17th December 2013. Note slight recovery of beach sand compared to 8th December photograph at the same location (left).
(Asset Ref. 1221D901D0702C02)

Extensive damage to revetment and the scoured beach with no sand in front of the revetment, 8th December 2013, NYCC inspection.
(Asset Ref. 1221D901D0702C02)

Extensive damage to revetment on 17th December 2013. Same location as previous photo (left). Again slight recovery of beach sand evident.
(Asset Ref. 1221D901D0702C02)

Extensive damage to toe of revetment, 17th December 2013. (Asset Ref. 1221D901D0702C02)

Temporary repairs to revetment being carried out on 17th December 2013.
(Asset Ref. 1221D901D0702C02)

Temporary repairs to revetment voids on 17th December 2013. (Asset Ref. 1221D901D0702C02)

Extensive damage to revetment slabs, 17th December 2013. (Asset Ref. 1221D901D0702C02)

Cracks and voids in surface of concrete revetment, Oct 2012. (Asset Ref. 1221D901D0702C02)

Gabions protecting café at NW end of revetment, Oct 2012. (Asset Ref. 1221D901D0702C02)

Cracks and voids in surface of concrete revetment, 17th December 2013. (Asset Ref. 1221D901D0702C02)

Corner of gabions protecting café at NW end of revetment being repaired, 17th December 2013. (Asset Ref. 1221D901D0702C02)

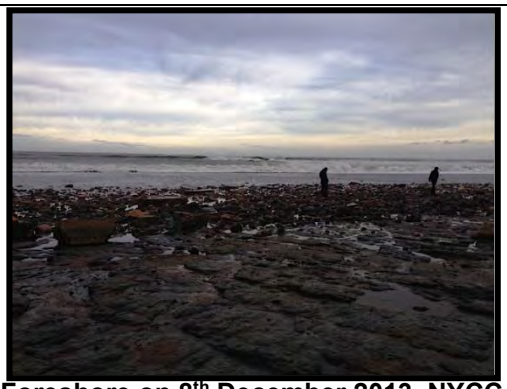
Cracks and voids in surface of concrete revetment, 17th December 2013. (Asset Ref. 1221D901D0702C02)

Gabions protecting café at NW end of revetment, 17th December 2013. Area to the left being repaired with extension to gabions. (Asset Ref. 1221D901D0702C02)

Extensive damage to revetment temporarily filled in, 17th December 2013. (Asset Ref. 1221D901D0702C02)

More voids forming in surface of concrete revetment, 17th December 2013. (Asset Ref. 1221D901D0702C02)

Cracks in surface of concrete revetment, 17th December 2013. (Asset Ref. 1221D901D0702C02)



Foreshore on 8th December 2013, NYCC inspection. (Asset Ref. 1221D901D0702C02)

General view of Sandsend beach looking North West with beach levels on 17th December 2013. (Asset Ref. 1221D901D0702C02)

General view of Sandsend beach looking South East with beach levels on 17th December 2013. (Asset Ref. 1221D901D0702C02)

Beach Condition Assessment following the December 2013 Storm.

Observations

During the topographic survey of Sandsend on 9th December the surveyor noted that "post-storm there have been big slumps in the mud cliffs, damage to sea defences and a number of fences have been destroyed." The topographic survey covers a very small area of the beach close to the toe of the cliff fronting Sandsend Road east of Sandsend. The topographic difference plot for the area covered shows that the beach at the toe of the cliff has eroded by around 1m between September and December 2013. This area corresponds to the part of the highlighted as being particularly damaged during the coastal defences inspection on the 17th December.

The difference plot shows that the toe of the cliff was eroded, which is likely to cause increased cliff recession through the winter of 2013/14. Also the material eroded from the cliff is likely to be moved around on the beach.

Two post storm profiles were taken at 1dWB1, on 9th and 18th December, see Appendx C. The beach profiles show that the storm of the 6th December affected 1dWB1 and 1dWB2 by steepening and eroding the upper beach while the lower beach gained a mound of material compared to the previous profiles. The 18th December survey showed that the upper beach had recovered quickly, as demonstrated in the photographs taken during inspections 8th and 17th December, see above. The post storm profile at 1dWB3 was the lowest recorded profile.

At WB1 between September 2013 and December 2013 the upper beach around HAT and MHWS had accreted by 0.2m. The mid and lower beach were comparable in the September and December 2013 profiles. At 1dWB2 the September profile showed a berm in the lower beach, this appeared to have been flattened by the December survey. The beach between MHWS and MLWS appeared to have accreted by around 0.2m throughout.

The profile below the seawall at 1dWB3 had eroded by 0.5m between September and December 2013. The beach level had dropped but the gradient was comparable to previous surveys.

Damage to the defence close to Profile 1dWB1. Photo taken on 9th December 2013

Interpretation

The profile which showed the most straightforward erosion and dropping of the beach level in response to the storm was WB3. Profiles WB1 and 2 had steepened upper beaches which were relatively low and lower beaches which appeared to have accreted to some degree when compared to previous surveys. However, both profiles appeared

to have accreted since September 2013. This may be due to the much lower part of the beach, below the extent of the profiles, being eroded and the material swept onshore during the storm.

Alternatively, the only profile to show consistent erosion was profile WB3, which is backed by a defence. Thus it is possible that the upper beach or cliff toe in the region of WB2 eroded, releasing material onto the upper beach which was later re-worked, potentially explaining the slightly higher profiles that were recorded in December 2013.

The topographic plot covers only a small area but it shows that the beach near the cliff toe had eroded by around 1m. Thus the destructive storm waves would have affected the beach and destabilised the cliffs and defences to some degree.

3.7 Management Unit 10 – Upgang Beach

Coastal Slope Condition Assessment
This Management Unit comprises units **MU9/4, MU10/1** and **MU10/2** (Appendix A, Map 2).

Unit MU9/4 is comprised of well vegetated slopes which are protected in part by the concrete toe defences. There is still some minor localised erosion at the unit toe so that this unit is classified as Locally Active. Further east, **unit MU10/1** is a small unit classified as Inactive. The relict cliffs are vegetated down most of their length, with some small patches of erosion evident at the unit toe.

Unit MU10/2 comprises the till cliffs behind Upgang Beach. These cliffs are prone to episodic failure in the form of mudsliding and block failure onto the beach. Vegetation cover is patchy along the cliff face and is likely to be related to the landslide cycles. This unit is classified as Partly Active.

None of these units changed activity class between the 2009 and 2012 walkover surveys.

During the post-December 2013 storm surge inspection, recent toe erosion and active erosion in the upper slopes were noted in unit MU9/4 and its status of 'Locally Active' has therefore been retained. Toe erosion in unit MU10/1, whilst relatively limited in its upslope extent, was continuous through seaward farcing part of the unit and therefore the activity status of the this unit has been elevated to 'Locally Active'. Unit MU10/2 had experience significant toe erosion along the entirety of its length, but with erosive activity increasingly extending into the upper slopes towards the eastern end of the unit. The difference in the extent of activity into the upper slopes towards the eastern end of the unit could arguably justify a 'Totally Active' status. However due to the lesser degree of activity in the upper slopes towards the western end of the unit an activity status of 'Partly Active' has been retained. There may be a case for splitting this unit into MU10/2a and MU10/2b, with the more westerly receiving a 'totally active status'. This should be reviewed during the 2014 walkover inspection.

Coast Protection Asset Condition Assessment
There are no coast protection assets within this Management Unit.

MU9/4 (Locally Active) Sept 2013

MU10/1 Well vegetated slopes (Inactive) Sept 2013

MU9/4 Recent erosion of the toe (above the defences) and erosive features in the upper slopes (December 2013). (Locally Active).

MU10/1 (Right of centre) Note toe erosion resulting in elevation of status to 'Locally Active'

MU10/2 The collapsing till cliffs at Upgang Beach (Partly Active) (Sept 2013)

MU10/2 An example of the failures seen along Upgang Beach (Partly Active) (Sept 2013)

MU10/2 Typical section of the western end of the unit in December 2013. Note , toe erosion, exposed material in upper cliff and tension crack in centre of photo but still significant vegetation (Partly Active)

MU10/2 – Near totally active section of cliff further east within the unit. Note very recent mudslide deposit at toe of the slope.

MU10/2 Active mudslide in east of unit (Partly Active)

MU10/2 Near totally active section of cliff near eastern end of unit. (Partly Active)

3.8 Management Unit 11 – Whitby West

Coastal Slope Condition Assessment
This Management Unit is divided into 2 Sub-Management Units (Appendix A, Map 2):

Mu11A – Whitby Sands West
This Sub-Management Unit consists of **units MU11/1 and MU11/2**.

These units are comprised of re-graded slopes which are largely protected by the sea wall and promenade. As a result there is very little evidence of activity. Unit MU11/1 is classified Inactive.

Within unit **MU11/2**, there has previously been evidence for slope wash and footpath erosion causing localised damage and the unit was classified as Locally Active in 2009. However, during the 2012 inspection, no evidence for erosion was seen and the unit was classified as Inactive.

Following the December 2013, the activity status of unit MU11/1 has been elevated to 'Locally Active' due to the repeated instances of erosion immediately upslope of the sea wall and small, shallow upslope failures and the apparent reactivation of a significant failure in the lower slope. The significant failure in the lower slope is coincident with a gap in the rock armour which protects the sea wall, potentially

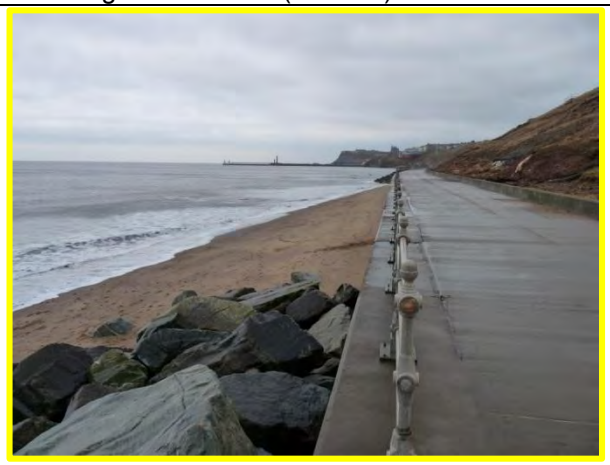
allowing more powerful waves to overtop of the sea wall at the highest tides and cause toe erosion at this point. Some recent movement and chipping of rockfall blocks was also noted and bedrock was exposed at the most eastern point in the unit.

In unit MU11/2 numerous shallow midslope failures were also noted causing the activity status of this unit to also be elevated to 'Locally Active'.

MU11/1 Regraded, stabilised slopes (Inactive) Oct 2012

MU11/1 The upper sections of the slopes are in good condition (Inactive) Oct 2012

MU11/1 – Reactivation of significant failure in lower slope. Note toe erosion exposing drainage pipe and recently exposed scar. December 2013. (Locally Active)



MU11/1 – Gap in rock armour beneath active lower slope December 2013. (Locally Active).

MU11/1 – Recently chipped and moved rockfall blocks at eastern end of unit. December 2013. (Locally Active)

MU11/2 – Failures in upper to midslope. December 2013. (Locally Active).

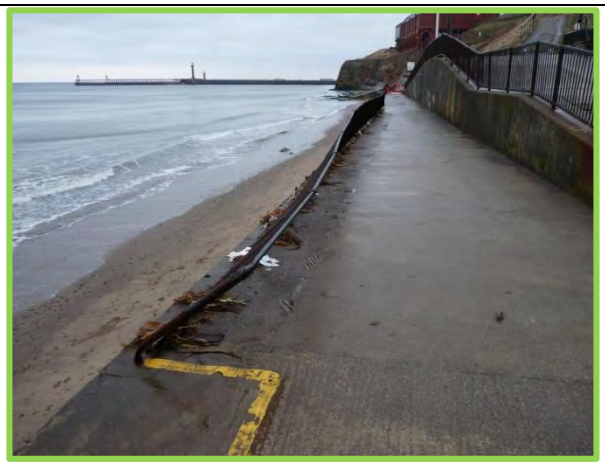
Mu11B – Whitby Sands East
This Management Sub-Unit consists of units **MU11/3** and **MU11/4**.

These units are generally protected by a variety of coastal structures. The coastal slope at **unit MU1/3** shows very few signs of activity and therefore is classified as Inactive. Exposed rock faces are showing minor erosion in the absence of defences in places within **unit MU11/14**. As a result, this unit is classified as Locally Active.

In October 2012 it was noted that these units had not changed activity status since the 2009 walkover survey. **However, in unit MU11/3 damage to the fence and a small rockfall was noted following the December 2013 storm surge.**

MU11/3 Defended slopes with little evidence of recent activity (Inactive)

MU11/4 Localised erosion above Whitby Sands (Locally Active)



MU11/13 – Damage to fence following December 2013 storm surge. (Inactive)

MU11/13 – Small rockfall (centre photo) observed during the post-December 2013 storm surge inspection. (Inactive)

Coast Protection Asset Condition Assessment

Coast protection assets in Whitby were not included in the scope of the December 2013 inspections.

3.9 Management Unit 12 – Whitby

Coastal Slope Condition Assessment

This Management Unit consists of **unit MU12/1**, which is situated beneath Whitby Abbey and St Mary's church on the town's East Cliff (Appendix A, Map 2). The slopes are well vegetated with toe protection afforded by the harbour walls meaning much of their face is covered by a debris apron. Localised activity occurs at the headscarp and in the debris apron. This unit is classified as Locally Active, which has not changed status since 2009.

Following the September 2012 inspection, a significant but localised failure of the headscarp occurred on 29 November 2012, which lead to loss of part of the graveyard of St Mary's church and deposition of debris on properties along Henrietta Street. It is thought that the failure was associated with damaged drainage pipes and the very wet conditions of 2012.

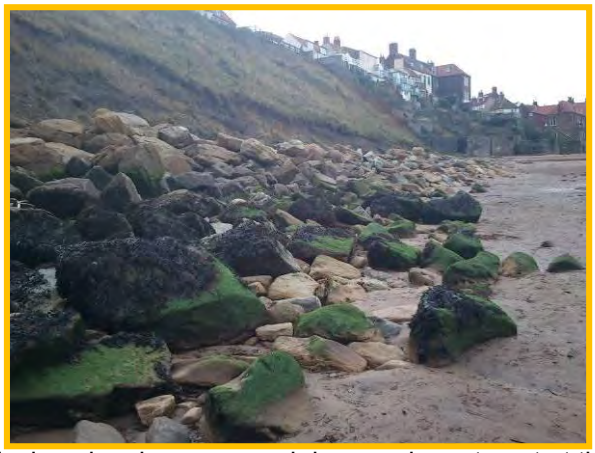
MU12/1 Below Whitby Abbey the slopes are vegetated, but with localised signs of erosion (Locally Active). Cliffs behind Henrietta St (row of white cottages extending along cliff face below St Mary's

church) are subject to periodic failure.

This status is felt to be still correct following the December 2013 storm surge. However the consistent toe erosion above the rock armour was apparent during the inspection.

MU12/1 Note toe erosion above rock armour along full length of the slope. December 2013

The 2012 inspection report noted the poor condition of the rock armour revetment here, (Asset Ref. 1221D901D0803C05), inshore of the main East Pier. The revetment was constructed in 2001, but is in poor condition, showing signs of significant damage, with displacement of the armour and exposure of the geotextile netting stabilising the slope above, see photo below. It was recommended that this armour needs re-profiling and topping up with larger armour.



Displaced rock armour and damaged revetment at the Haggerlythe inside harbour adjacent to East pier October 2012 (Asset Ref. 1221D901D0803C05)

Coast Protection Asset Condition Assessment

Coast protection assets in Whitby were not included in the scope of the December 2013 inspections.

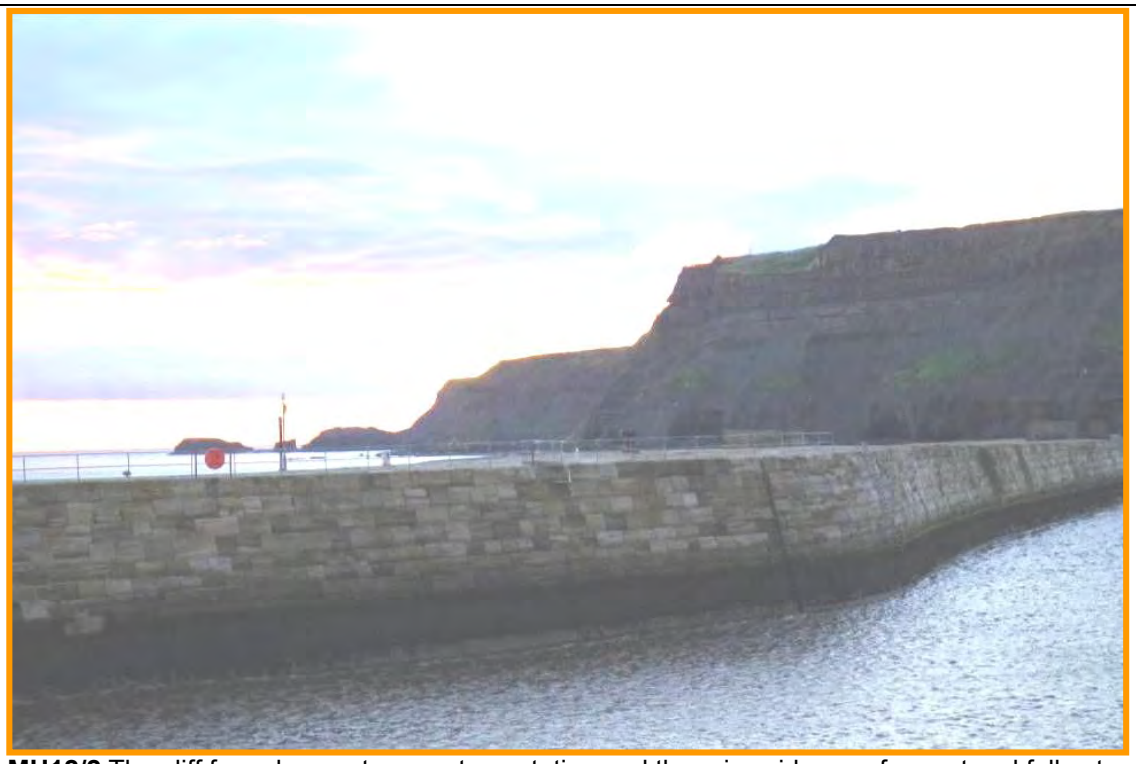
It is noted that the storm surge caused significant flooding to properties surrounding the quayside areas in Whitby.

3.10 Management Unit 13 – Whitby East

Coastal Slope Condition Assessment
This Management Unit is divided into 2 Sub-Management Units:

Mu13A – Cliffs east of Whitby Harbour
This Sub-Management Unit consists of **unit MU12/2** only (Appendix A, Map 2). The high cliffs which comprise this unit are classified as Partly Active. There is evidence of a large recent rockfall from the upper part of the cliff and ongoing erosion at the headscarp. In 2012 almost the entire cliff face is exposed with very little vegetation cover. There was no change in activity level since 2008.

Unit MU12/2 was also inspected during the post-December 2013 storm surge inspection. Major rockfalls, midslope landsliding and toe erosion were all visible in this unit despite rock armour at the toe of the cliff. However, the status of this unit is already 'Partly Active' and therefore no change to the status of this unit has been deemed necessary.



MU12/2 The cliff face does not support vegetation and there is evidence of recent rockfalls at a number of points along the unit (Partly Active). September 2012.

MU12/2 – Major recent rockfall and failure of lower slope/toe erosion indicating 'Partly Active' status is still appropriate. December 2013.

Mu13B – Whitby East to Widdy Head

MU13 B was not included within the December 2013 post-surge inspections.

3.11 Management Unit 14 – Widdy Head to Pursglove Stye Batts

Coastal Slope Condition Assessment

MU14 was not included within the December 2013 post-surge inspections.

Coast Protection Asset Condition Assessment
There are no coastal assets within this Management Unit.

3.12 Management Unit 15 – Pursglove Stye Batts to Robin Hood's Bay

Coastal Slope Condition Assessment

MU15 was not included within the December 2013 post-surge inspections.

Coast Protection Asset Condition Assessment
There are no coastal assets within this Management Unit.

3.13 Management Unit 16 – Robin Hood's Bay

Coastal Slope Condition Assessment
This Management Unit is divided into 3 Sub-Management Units:

Mu16A – Robin Hood's Bay Village
This Sub-Management Unit is composed of **units MU16/1, MU16/2 and MU16/3** (Appendix A, Map 3)

Unit MU16/1 is the cliff fronting the upper part of Robin Hood's Bay Village and is classified as Partly Active. The upper slopes are composed of soft material and support some vegetation cover with evidence of slumping and localised recession of the headscarp. The lower slopes are near vertical with no vegetation cover. The lower cliff has been undercut by marine erosion.

Units MU16/2 and MU16/3 are stabilised landslides that form the lower parts of Robin Hood's Bay Village and are both classified as Dormant. The units are protected by sea defences and show no evidence of recent activity.

None of these units changed activity status between the 2009 and 2012 inspections.

During the post-December 2013 storm surge inspection, MU16/1 was noted to still be very active with recent erosion and accumulation of coarse, angular debris at the cliff toe. The substantial notch at the cliff toe indicating undercutting of the cliff in the northern third of unit MU16/2continued to be present, and failures in the bedrock cliff, beyond the end of the rock armour toe defences were noted here. Previously, unit had been assessed as 'Dormant'. However, during this inspection because of the activity in the northern third of the unit, its activity status has been elevated to 'Locally Active'. There were also several failures of the cliff behind the rock armour.

MU16/1 Cliffs below the upper part of Robin Hood's Bay Village (Partly Active) Sept 2012

MU16/1 the base of the cliff continues to erode. The undercutting of the cliff is evident in the left side of the photograph (Partly Active) Sept 2012

MU16/2 The cliffs have been stabilised at the toe but show some signs of erosion on their face (Dormant). Sept 2012

MU16/3 The cliff at this location has been stabilised and is not visible through much of the unit (Dormant).Sept 2012

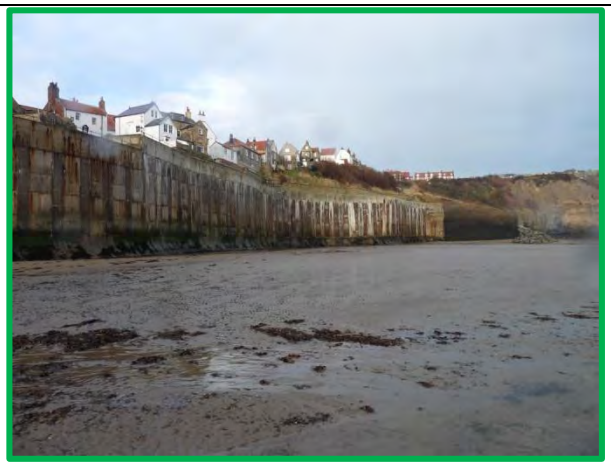
MU16/1 – Partly Active, December 2013.

MU16/1 Eroson and coarse, angular debris (centre photo) at the cliff toe, December 2013.

MU16/2 Northern half of MU 16/2, December 2013. Note increase activity beyond end of defences (Locally Active)

MU16/2 Close up of scar in cliff in northern third of the unit indicating continued erosion and therefore a status of 'Locally Active'. December 2013.

MU16/3 – Robin Hoods Bay Village, December 2013 (Dormant)



MU16/3 Robin Hoods Bay Village, December 2013 (Dormant). Note vertical, exposed south facing bedock cliff between the northern end of the sea wall and the rock armour (right of centre).

South of Robin Hood's Bay Village

This Sub-Management Unit consists of **unit MU17/1** only. This unit is defended at the toe by a sea wall and rock armour. The slopes are densely vegetated with trees and shrubs and show little evidence of recent activity. As a result in 2012 this unit was classified as Inactive, as it was in 2008**. No change was noted here during the post-December 2013 storm surge inspection.**

MU17/1 The defended toe and heavily vegetated slopes show that the unit has been stable (Inactive) Sept 2012

MU17/1 No change was noted to this unit following the December 2013 storm surge.

Cowling Scar

This Sub-Management Unit consists of **unit MU17/2** and part of **unit MU17/3**.

Unit MU17/2 is protected in part by rock armour at the toe. The slopes are generally well vegetated with some exposed areas at the head and mid-slope where evidence of sliding and gullies are present. A tension crack has opened at the back of the cliff so the instability if continuing and propagating landward. This unit classified as Locally Active 2009, but in 2012 was considered to be Partly Active, due to the evidence of instability throughout the unit. **Following the December 2013 storm surge recent erosion and failure of the toe beyond the extent of the rock armour defence was noted and therefore the activity status of 'Partly Active' has been retained.**

Further south, within **unit MU17/3**, defences are absent and the cliffs are more active. There is significant slumping and sliding activity at beach level as well as at the cliff head and mid-slopes. **This unit has previously been classified as Partly Active and continues to be so following the December 2013 storm surge.**

MU17/2 The land drains from the adjacent fields are draining on to the cliff and causing instability (Partly Active). Sept 2012

MU17/2 The slope is showing evidence of ground movement (Partly Active). Sept 2012

MU17/3 Looking south across Robin Hood's Bay (Partly Active) (approx. unit extents shown) Sept 2012

MU17/2 Recent erosion at toe and erosive features higher in cliff, December 2013 (Partly Active).

MU17/3 Recent toe erosion and failure at toe, December 2013 (Partly Active).

Coast Protection Asset Condition Assessment

Robin Hood's Bay coast protection assets were not included in the scope of the December 2013 inspections.

3.14 Management Unit 17 – Cowling Scar to Peak Steel

Coastal Slope Condition Assessment

The two sections of this Management Unit, Mu17A – Boggle Hole and Mu17B – Boggle Hole to Peak Steel, were not included within the December 2013 inspections.

Coast Protection Asset Condition Assessment

There are no coastal defences present in Mu17.

3.15 Management Unit 18 – Peak Steel to southern end of Beast Cliff

Coastal Slope Condition Assessment
Neither of the two sections of this Management Unit, Mu18A – Peak Steel to Blea Wyke Steel and Mu18B – Common Cliff and Beast Cliff were included in the December 2013 inspections.

Coast Protection Asset Condition Assessment
There are no coastal assets within this Management Unit.

3.16 Management Unit 19 – Beast Cliff to Scalby Ness

Coastal Slope Condition Assessment
This Management Unit is divided into 5 Sub-Management Units, of which only Mu19E was included in the December 2013 inspections.

Mu19E – Hundale Point to Scalby Ness
This Sub-Management Unit consists of **unit MU19/6** and **units MU19/7 to MU19/11.**

Units MU19/7 and MU19/8 extend from Long Nab in the north to Cromer Point in the south. They are both classified as Locally Active. The cliffs are generally well vegetated, with boulder lobe deposits at the base of the cliff. Minor activity is evident at the toe as a result of marine action and there is localisation recession of the headscarp.

Units MU19/9 and MU19/10 are located between Cromer Point and Scalby Ness and are classified as Locally Active. The toe of these units is subject to marine action and is slumped in places. The headscarp is steep, exposed and actively receding over much of the unit lengths. Despite the vegetation cover, mid-slope there are tension cracks, slumping, sliding and gliding blocks indicating ongoing activity. These units were classified as Partly Active in the 2009 walk over survey but in 2012 were reclassified to Locally Active.

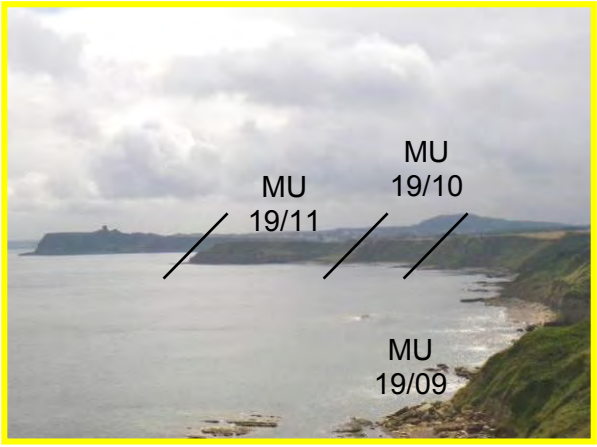
The Scalby Ness headland comprises **unit MU19/11**. This area is well vegetated with only localised activity evident at the toe and some recession at the headscarp. This unit is classified as Locally Active.

Only units MU19/9 and 19/10 changed activity status between the 2009 and 2012 walkover surveys, having reduced in activity. **However, Scalby Ness headland has increased in activity status following the post-December 2013 storm surge due to there being widespread toe erosion right around the headland with and numerous instances of failure and erosive features further up in the cliff. The degree of activity increases around the headland away from the more sheltered south-facing cliff adjacent to the mouth of Scalby Beck, although failure of the superficial deposits overlying the bedrock was noted on the upstream side of the bridge at the mouth of the beck.**

MU19/7 Looking north towards Long Nab (Locally Active)

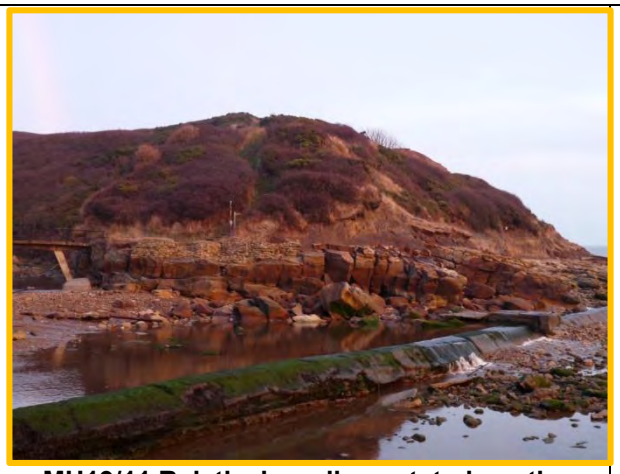
MU19/8 Looking south towards Cromer Point (Locally Active)

MU19/9 There is evidence of headscarp erosion and erosion of the toe (Locally Active) Sept 2012



MU19/10 The units on this part of the bay are Locally Active Sept 2012

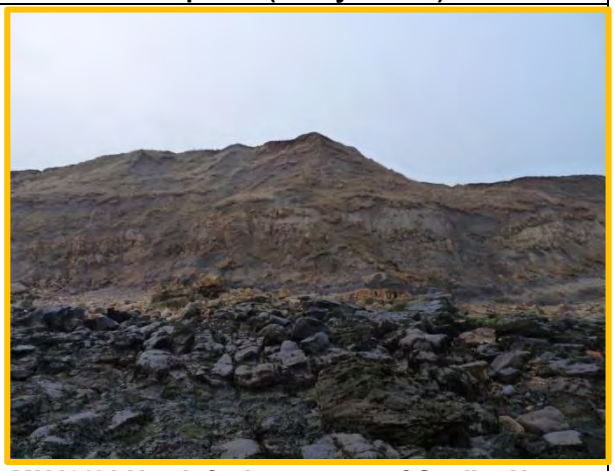
MU19/11 Long Nab is eroding at the toe but the cliff face is well-vegetated and stable (Locally Active) Sept 2012



MU19/11 Relatively well vegetated south facing section of Scalby Ness Headlance, December 2013 (Partly Active)

MU19/11 More active east-facing aspect of Scalby Ness, December 2013. Note very recent erosive feature near toe centre left of the photo (Partly Active).

MU19/11 Very active lower slope on east facing aspect of Scalby Ness, December 2013 (Partly Active)



MU19/11 North facing aspect of Scalby Ness. Less active than east-facing aspect but with still with substantial parts of the cliff unvegetated. December 2013 (Partly Active).

Coast Protection Asset Condition Assessment
Mu19 – Beast Cliff to Scalby Ness

There are no formal sea defences within MU 19.

3.17 Management Unit 20 – Scarborough North Bay

Coastal Slope Condition Assessment
This Management Unit is divided into 2 Sub-Management Units (Appendix A, Map 6):

Mu20A – Northern North Bay
This Sub-Management Unit consists of **units MU20/1 and MU20/2**.

Both of these units are defended at the toe by the sea wall which runs the entire length of North Bay. The slopes are well vegetated and in 2012 showed no obvious evidence of recent activity, thus they are both classified as Dormant, as they were in 2009. **This status has remained unchanged following the post-December 2013 storm surge inspection.**

MU20/1 (Dormant) Sept 2012

MU20/2 Behind the sea wall (Dormant) Sept 2012

MU20/1 December 2013 (Dormant)

MU 20/2 December 2013 (Dormant)

Mu20B – Southern North Bay
This Sub-Management Unit comprises **units MU20/3, MU20/4a and MU20/4b.**

Unit MU20/3 is well vegetated and shows no obvious evidence of recent instabilities. It is classified as Dormant, with no change since 2009.

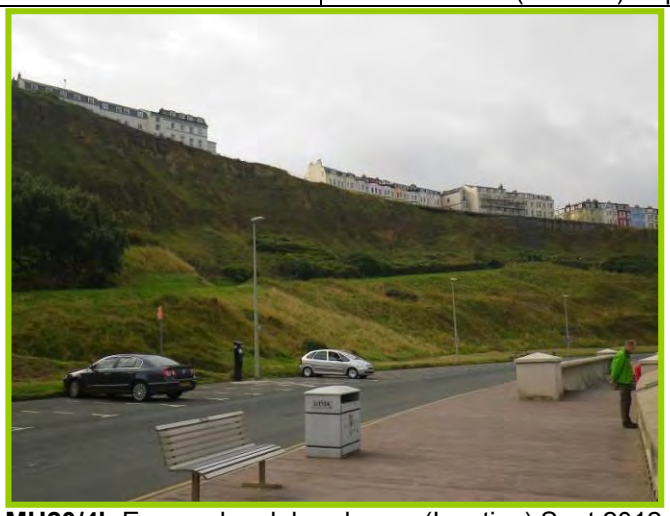
Unit MU20/4a is located to the rear of North Sands and is classified as Inactive. The relict slopes are well vegetated with only minor and localised evidence of erosion at the headscarp, it remains classified as inactive.

Unit MU20/4b covers the area of Clarence Gardens and has previously been slightly more active than the adjacent unit MU20/4a. However, recent remediation works have repaired cracks and the slopes are now well vegetated with exposed rock at the headscarp. This unit classified as Locally Active in 2009 but in 2012 was downgraded to Inactive.

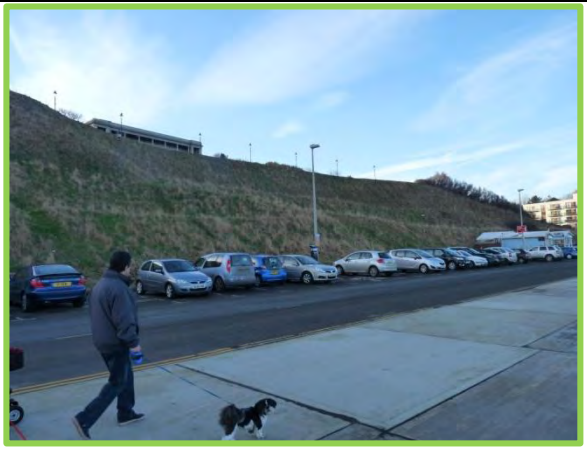
The status of all of these units remains unchanged following the post-December 2013 storm surge inspection.

MU20/3 Well vegetated slopes (Inactive) Sept 2012

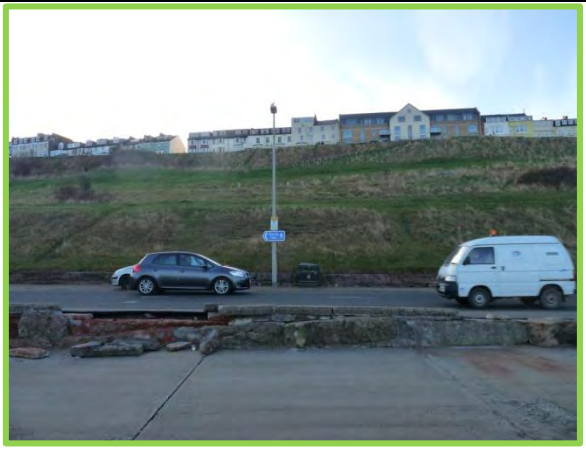
MU20/4a Relict slopes with localised activity (Inactive) Sept 2012



MU20/4b Exposed rock headscarp (Inactive) Sept 2012



MU20/3 December 2013 (Inactive)



MU20/4a December 2013 (Inactive)

MU 20/4b December 2013 (Inactive)

Coast Protection Asset Condition Assessment

The coast protection assets in Scarborough North Bay were not included in the scope of the December 2013 inspections.

3.18 Management Unit 21 – Castle Cliff, Scarborough

Coastal Slope Condition Assessment
This Management Unit is divided into 2 Sub-Management Units (Appendix A, Map 7):

Mu21A – Castle Cliff
This Sub-Management Unit consists of **units MU21/1 and MU21/2.**

Unit MU21/1 is located at The Holms and continues to be classified as Inactive. In this unit the rock is prone to rockfalls and there are patches of rock on the face where small cliffs are exposed. There was no evidence of recent rockfalls and the majority of the unit is well vegetated**. This classification has also been deemed appropriate during the post-December 2013 storm surge inspection.**

Unit MU21/2 forms the Castle Cliff promontory and continues to be classified as Locally Active. The cliffs are steep with variable vegetation cover and extensive toe protection measures. Locally, bedrock is exposed where it is subject to ongoing weathering and erosion from rainfall.

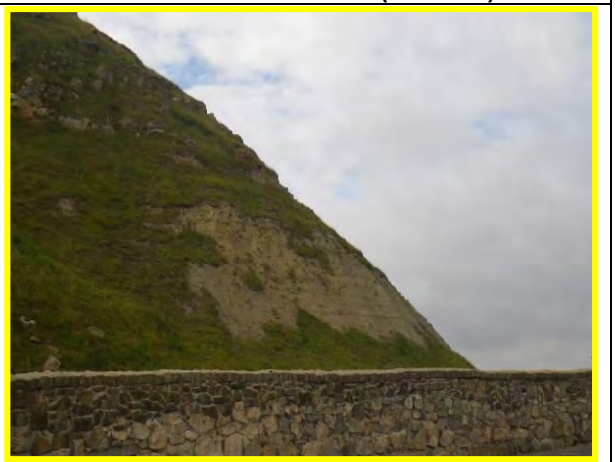
Castle Cliff promontory was observed to still be locally active during the December 2013 walkover inspection, with significant areas of the cliff vegetated, but also with large areas of exposed bedrock. Large rockfall debris was present at the toe of the slope (behind the wall separating the cliff from the road) and a near-continuous stratum of particularly eroded sandstone was noted near the top of the cliff, the erosion of which may be undermining and causing rockfalls from the more competent strata above.

MU21/1 Well jointed hard rock has a thick cover of vegetation (Inactive). Sept 2012

MU21/1 December 2013 – No change from previous status (Inactive)

MU20/1 December 2013 – No change from previous status. Note minor exposure of substrate behind van (Inactive).

MU21/2 Well jointed hard rock (Locally Active) Sept 2012



MU21/2 Steep, exposed cliff (Locally Active) Sept 2012

MU21/2 – December 2013. Large rockfall but with significant proportions of the slope still vegetated (Locally Active)

Mu21/2 – December 2013. Note near continous band of eroded sandstone towards top of cliff. (Locally Active).

Mu21B – The Harbour

There are no natural cliff units within this Sub-Management Unit.

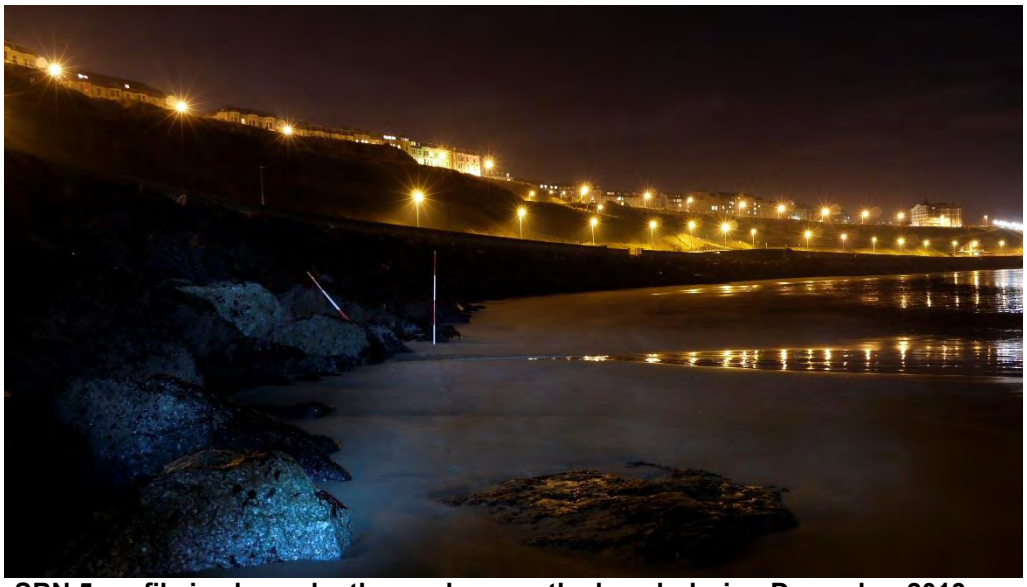
Coast Protection Asset Condition Assessment

The coast protection assets in Scarborough North Bay and the harbour were not included in the scope of the December 2013 inspections.

North Bay Beach Condition Assessment following the December 2013 Storm.

Observations:

The post storm North Bay Beach Profiles SBN1, 2 and 3 in the north and centre of the bay are all within the range of the previous results, close to the middle. Profiles SBN 4 and SBN 5 in the south of the bay are both close to the lowest recorded profiles. In all cases the December 2013 profile has eroded compared to the September 2013 profile. The erosion recorded tended to be in a range of 0.4m-0.6m and in the upper part of the profile. At profile SBN4 the rocks in the upper beach had been completely exposed.



The SBN 5 profile is shown by the markers on the beach during December 2013 survey. The post-storm survey showed one of the lowest recorded beach levels.

Interpretation:
All of the North Bay profiles have eroded, generally the upper beach close to the defence has eroded more than the lower beach. The erosion of the upper beach may be due to the reflection of wave energy from the defences. At SBN4 the rocks in the upper beach had been exposed to a much greater degree than in any previous survey.

3.19 Management Unit 22 – Scarborough South Bay

Coastal Slope Condition Assessment
This Management Unit is divided into two smaller Sub-Management Units (Appendix A, Map 4):
Mu22A – St Nicholas Cliff
There are no natural cliff units within this Sub-Management Unit.
Mu22B – South Cliff and Holbeck Gardens
This Sub-Management Unit consists of **units MU22/1 to MU22/8**, all of which are protected at the toe by the sea wall, promenade and in places, rock armour.
Unit MU22/1 is the most northerly unit located in Scarborough's South Bay and is classified as Inactive. It is well vegetated with only minor, localised activity evident as footpath cracks. **No new activity was noted in this unit following the storm surge in 2013.**

Unit MU22/2 comprises the area around and to the north of the Spa complex. This unit was classified as Locally Active in 2009 as a result of ongoing shallow instability and damage to footpaths. Following remedial work the unit was classified as Inactive in 2012**. No new activity was noted in this unit following the storm surge in 2013.**

Unit MU22/3 is located just south of the Spa Complex in the vicinity of the cliff lift. The steep slopes of this unit are well vegetated with little evidence of instability apart from cracking to footpaths. Therefore, this unit is classified as Inactive. **No new activity was noted in this unit following the storm surge in 2013.**

Units MU22/4 and MU22/5 comprise the northern part of the South Cliff Gardens and are both classified as Inactive. These units are generally well vegetated and appear to be largely stable. Locally, there are some minor cracks within footpaths and some exposed rock faces near the cliff toe. **No new activity was noted in MU22/4 following the storm surge in 2013. However, a small shallow slip was noted in the midslope of MU22/5, behind a small building**.

Unit Mu22/6 is located behind the former bathing pool and is classified as Inactive. The slopes of this unit are well vegetated although there are some signs of very localised rockfall near the unit toe. The unit was classified as Locally Active in 2009 due to more widespread activity. **Small areas of localised activity were noted in this unit but were not sufficiently significant to change the status of the unit.**

Unit MU22/7 is located at Holbeck Gardens (just north of the run-out lobe) and is classified as Inactive. A number of footpaths in this area remain closed due to cracking and ongoing instability. However this does not represent an increase in activity since 2008. Otherwise, the slopes are well vegetated. **No new activity was noted in this unit following the storm surge in 2013.**

Unit MU22/8 comprises the stabilised Holbeck Hall landslide run-out lobe and is protected at the toe by boulder armour. The slopes here are hummocky and are well-vegetated. However, localised sections near the headscarp are exposed and tension cracks are visible in the debris lobe. This unit is classified as Locally Active. **No new activity was noted in this unit following the storm surge in 2013.**

Only MU22/2 and 22/6 changed activity status between the 2009 and 2012 walkover surveys. **However, as described above, only small areas of recent localised activity were noted during the post-December 2013 storm surge inspection in units MU 22/5 and MU22/6.**

MU22/1 to MU 22/6 Well vegetated slopes with large coastal defences at the toe (Inactive) Sept 2012

MU22/6 Well-vegetated slopes behind the former bathing pool (Inactive). Sept 2012

MU22/7 The cliff face shows stability overall (Inactive). Sept 2012

MU22/8 Localised activity at the headscarp of the Holbeck Hall landslide run-out (Locally Active) Sept 2012

MU22/1 – December 2013 (Inactive)

MU22/2 – December 2013 (Inactive)

MU22/3 – December 2013. (Inactive)

MU22/4 – December 2013. (Inactive)

MU22/5 – Exposed cliff face above furthest right (south) end of huts. December 2013. (Inactive)

MU22/5 – Small midslope failure (centre photo, above building). December 2013. (Inactive)

MU22/6 – December 2013. (Inactive).

MU22/7 –Small areas of the cliff are without vegetation and therefore indiciative of limited ongoing activity. December 2013. (Inactive).

MU22/8 – Locally active (note small slips in scarp). December 2013 (Locally Active).

MU22/8 – Locally Active. On the day of survey a small amout of flow was issuing through the rock armour at this toe. 2013

MU22/8 – Close up of headscarp failures. December 2013. (Locally Active).

MU22/8 – Small outflow of groundwater through rock armour toe defences. December 2013. (Locally Active).

Coast Protection Asset Condition Assessment

The coast protection assets in Scarborough South Bay were not included in the scope of the December 2013 inspections.

Beach Condition Assessment following the December 2013 Storm.

Observations

For the Scarborough South Bay area all of the profiles for December 2013 are near the middle of the range of previous results, apart from SBS3 where the beach level is the lowest recorded. When comparing the September and December 2013 profiles the beach has flattened at each location although the levels are similar.

From SBS2 looking down the mid-section of the beach the flatness of the post storm beach profile can be seen.

Interpretation

The beach profiles show that the profiles have flattened to give a more uniform sloping profile since September 2013 but the beach level has not changed greatly. The majority of the profiles have comparable levels with the previous surveys, with the exception of SBS3, where the profile is low. It is interesting to note that the wave data shows that the large waves continued for two tides after the peak in water levels. This may explain the smoothed out beach profiles, because the original storm will have attacked the upper beach but later larger waves will have impacted the lower levels when the tide level dropped.

3.20 Management Unit 23 – Holbeck to Knipe Point

Coastal Slope Condition Assessment

This Management Unit consists of a large number of units, from MU23/A in the north to MU24/A7 at Knipe Point in the south (Appendix A, Map 4).

Unit MU23/A is located immediately south of the Holbeck Hall landslide run-out lobe and is classified as Partly Active. This unit has well-vegetated upper slopes, but the cliff experiences on-going marine action and rockfalls.

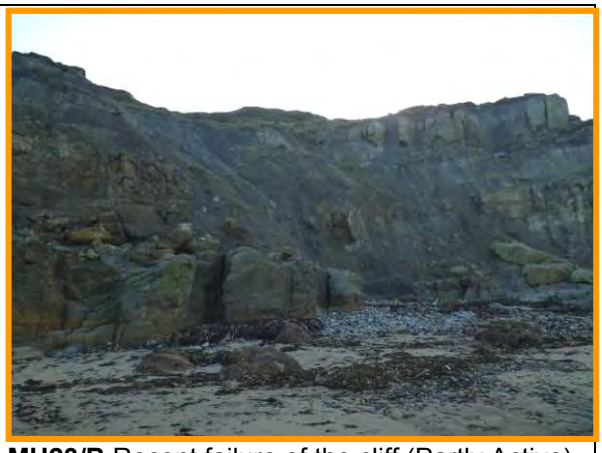
Units MU23/B is also classified as Partly Active, having been upgraded from Locally Active in 2009. In 2012 it was noted that a failure had recently occurred in this unit, with mudslide debris cascading from the top of the cliff to the beach. The cliffs tend to be steep and in some cases undercut by marine erosion.

Unit MU23/C remains classified as Locally Active. The unit is well-vegetated with only localised patches of erosion. The cliff toe is steep and eroding.

During the post-December 2013 storm surge inspection recent activity was observed in units MU23/A, MU23B and MU23/C, with the most activity being apparent in MU23/A. Therefore the previous activity statuses of these units have been retained.

Units MU23/D1, MU23/D2 and MU23/D3 are located at Wheatcroft Cliff above Black Rocks. These units are active down much of their length, with on-going recession of the headscarp, slumping in the mid-slope and erosion of the toe. All three units were classified as Partly Active in 2009. **MU23/D2 and 23/D3** have been downgraded to Locally Active in 2012 as activity is more localised than previously seen.

MU23/A Erosion of the toe (Partly Active) Sept 2012



MU23/B Recent failure of the cliff (Partly Active) Sept 2012

MU23/C Ongoing marine driven erosion is evident on this unit (Locally Active) Sept 2012

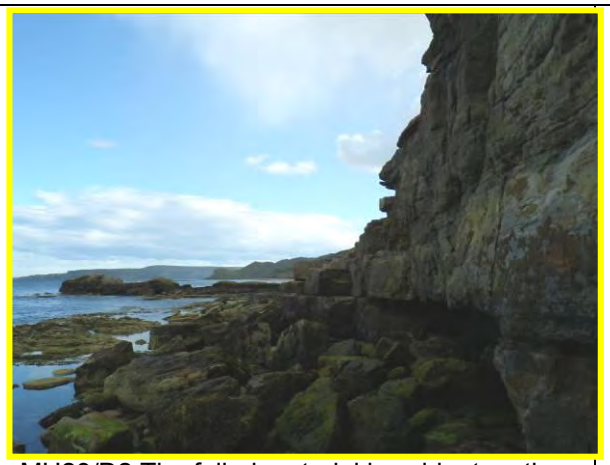
MU23/A – Continued toe erosion and failures of the sea cliff. December 2013 (Partly Active).

MU23/A – Recent rockfalls (centre right). December 2013 (Partly Active

MU23/B – December 2013 (Partly Active).

MU23/C - December 2013. Toe erosion throughout (Locally Active).

MU23/D1 failed blocks at the toe of the cliff (Partly Active) Sept 2012



MU23/D2 The failed material is evident on the shore (Partly Active) Sept 2012

MU23/D3 Joint bound blocks in the cliff face (Locally Active) Sept 2012

Units MU23/D to MU23 J were not visited during the December 2013 post storm inspections.

Coast Protection Asset Condition Assessment

There are no coastal defence assets within this Management Unit.

3.21 Management Unit 24 – Cayton Bay

Coastal Slope Condition Assessment
This Management Unit is divided into 2 Sub-Management Units (Appendix A, Map 5):

Mu24A – Cayton Bay North

This Sub-Management Unit consists of **units MU24/A and A2, MU24/B and MU24/B1 to B10.**

Unit MU24/A comprises the main body of the Cayton Cliff landslide complex that reactivated during 2008-2009. Significant recession of the headscarp was occurred in this event, resulting in the loss of land and properties at Knipe Point Drive. During 2009, headscarp recession and activity within the body of the landslide had reduced resulting in a classification of Partly Active. Activity has reduced more by 2012, with only localised activity noted at the toe and headscarp, and no evidence for movement noted in the body of the landslide. The unit is therefore considered to be Locally Active. **During the post-December 2013 storm surge inspection, no new activity was noted within the landslide complex. However toe erosion was continuous throughout the unit, exposing a range of materials in the landslide blocks including bedrock and superficial deposits. It was evident that waves during the storm surge had penetrated some way inland as in more gently sloping areas of the toe, water flattened vegetation (flattened in a landward direction) was evident well above mean high water.**

Unit MU24/B forms the main part of the Tenants' Cliff landslide and is classified as Inactive. The toe of Tenants' Cliff is comprised of a number of smaller landslide units **MU24/B1 to B10**, which are all classified as Locally Active. There is variable vegetation cover within these units and evidence of localised erosion and occasional rockfall. None of these units changed activity status between the 2009 and 2012 walkover surveys.

MU24/A The toe of Cayton Cliff is Partly Active - Sept 2012

MU24/A - General view including beach level and Knipe Point. December 2013. (Locally Active)

MU23/A – General view including beach and toe erosion in tills. December 2013 (Locally Active)

MU24/A - Toe erosion in bedrock (not in situ). December 2013. (Locally Active)

MU24/A - Wave-flattened vegetation and ponded water above MHW following December 2013 storm surge. (Locally Active).

MU24/B and B1 to 10 Tenants' Cliff upper slopes are inactive. Units at the toe are Locally Active. Sept 2012

Mu24B – Cayton Bay South

This Sub-Management Unit consists of units MU24/C to MU24/T. **These units were not visited during the December 2013 post storm inspections.**

Coast Protection Asset Condition Assessment
The coast protection assets in Cayton Bay were not included in the December 2013 inspections.

3.22 Management Unit 25 – Lebberston Cliff and Gristhorpe Cliff

Coastal Slope Condition Assessment
The coastal slopes and cliffs of MU25 were not included in the December 2013 post storm surge inspections.

Coast Protection Asset Condition Assessment
There are no coastal assets within this Management Unit.

3.23 Management Unit 26 – Newbiggin Cliff and North Cliff

Coastal Slope Condition Assessment
The coastal slopes and cliffs of MU25 were not included in the December 2013 post storm surge inspections.

Coast Protection Asset Condition Assessment
There are no coastal assets within this Management Unit.

3.24 Management Unit 27 – Filey Brigg

Coastal Slope Condition Assessment
The coastal slopes and cliffs of MU27 were not included in the December 2013 post storm surge inspections.

Coast Protection Asset Condition Assessment
There are no formal coast protection structures in this unit.

3.25 Management Unit 28 – Filey Bay North

Coastal Slope Condition Assessment
This Management Unit is divided into 2 Sub-Management Units (Appendix A, Map 6):

Mu28A – North of Filey Town
This Sub-Management Unit consists of **units MU27/O to MU27/X**, located to the north of Filey town.

Units MU27/O to MU27/S are situated below the North Cliff Country Park and are classified as Partly Active, with the exception of **MU27/R**. These cliffs are composed of glacial sediment and are undergoing erosion down much of their length. This erosion is particularly intense at the steep unit toe area where the cliffs are subject to marine action. Up slope, there is greater vegetation cover with areas of sliding, cracking and recession at the unit heads. Unit **MU 27/O** was classified as Totally Active in 2009 and this was downgraded to Partly Active in 2012. Unit MU27/R was Partly Active in 2009 and reclassified as Locally Active in 2012. The remainder of the above units retained their activity classification from 2009 to 2012. A failure occurred in the lower half of unit 27/S during 2012, resulting in a debris lobe being deposited on the beach.

Units MU27/T and MU27/U are located in the vicinity of Filey sailing club and were classified as Locally Active in 2012. These units were better vegetated than those Partly Active units to the north, yet feature localised common areas of erosion. In 2012 there was minor activity at the unit head scarps and toes, with some slumping and sliding mid-slope. Both units were Locally Active in 2009 and again in 2012. **These units were increased in status to Partly Active following the December 2013 storm surge due to widespread toe erosion and recent failures in these units.**

Unit MU27/V, is located just south of the sailing club. The unit was classified as Partly Active in 2012. This unit is lacking in vegetation cover, has an eroding headscarp and is heavily rilled and gullied. **Following the December 2013 storm surge a very recent mudslide was noted which affected almost the entire height of the cliff; the source being near the cliff top and its runout lobe on the beach. Also, encroachment of the toe of the cliff onto the sailing club slipway was noted.**

Units MU27/W and MU27/X lie immediately north of Filey town. Vegetation cover of these units is variable, with localised areas of activity throughout. There is ongoing recession at the headscarp and erosion of the toe by marine activity. These units were classified as Locally Active in 2009 and 2012. **Unit MU27/W has been upgraded to Partly Active following the December 2013 storm surge, due to widespread toe erosion and recent activity further up in the cliff. Unit MU27/X has been retained at Locally Active status following the storm surge as activity is evident, particularly at the undefended northerly end of the unit.**

MU27/O to MU27/T Intense erosion (Partly Active and Locally Active) Sept 2012

MU27/U entry to the sailing club (Locally Active) Sept 2012

MU27/V Slopes around Filey sailing club (Partly Active) Sept 2012

MU27/W entry to the sailing club (Locally Active) Sept 2012

MU27/X entry to the sailing club (Locally Active) Sept 2012

MU27/T – Nothern end of unit. Note recent toe erosion throughout unit. December 2013 (Partly Active)

MU27/T – Southern end of unit. Note recent toe erosion throughout unit. December 2013 (Partly Active)

MU27/V – Far northern end of unit. Note encroachment of the toe of the cliff onto the sailing club slipway

MU27/V – South of sailing club. Note mudslide lobe on beach in left of photo (behind people). December 2013.

MU27/V – Close up of mudslide lobe. December 2013 (Partly Active)

MU27/V – Mudlside from top of cliff. Note unvegetated mudlside track in centre photo and lobe just visible on the beach (left of centre). December 2013 (Partly Active).

MU27/W – Toe erosion and scarp failure evident throughout unit. December 2013 (Partly Active).

MU27/X – Some toe erosion occurring at undefended northern end of unit (closest in photo) and movement on slope (Note angle of red sign). December 2013 (Locally Active).

Mu28B – Filey Town Frontage

This Sub-Management Unit consists of **units MU28/Y and MU28/Z** at Filey town.

Much of the town frontage lies within **unit MU28/Y**. There were no signs of activity on the coastal slopes in 2012 and this unit was classified as Inactive**. In December 2013, it was noted that several areas of the landscaped gardens on the cliff showed some signs of minor slope movements, including cracked walls and pathways. Nonetheless a status of 'Inactive' is still deemed appropriate for this relict cliff unit.**

Unit MU28/Z is located at the southern end of Filey and is also classified as Inactive. It was noted in 2012 that, significant slope stabilisation works had been undertaken within the ravine. In 2012 this unit was downgraded from Locally Active, its classification in 2009. **This classification was maintained during the post-December 2013 storm surge inspection, as only limited signs of instability were noted including off-horizontal steps.**

MU28/Y and Z The Filey frontage does not show any signs of slope failure (Inactive). Sept 2012

MU28/Y – Cracking in pathway within landscaped gardens Dec 2013

MU27/Y - Cracking in wall in landscaped gardens. December 2013 (Inactive).

MU27/Z – Off-horizotnal steps in woodland gardens. December 2013 (Inactive).

Coast Protection Asset Condition Assessment
The coast protection assets at Filey were not included in the December 2013 post storm surge inspections.

3.26 Management Unit 29 – Filey Bay

Coastal Slope Condition Assessment
This Management Unit is divided into three smaller Sub-Management Units, as follows (appendix A, Map 6):

Mu29A – Muston Sands
This Sub-Management Unit comprises **units MU29/AA to MU29/AI** along Muston Sands. None of these units changed activity level between 2009 and 2012. **However, the activity status of all these units has been increased to Partly Active following the December 2013 storm surge due to extensive toe erosion and some failure further upslope.**

Units MU29/AA and MU29/AB are located immediately south of Filey town and were classified as Locally Active in 2012. Despite the presence of some rock armour protecting the toe of **unit MU29/AA**, there are very common areas of intense erosion and active recession of the headscarp. **Unit MU29/AB** is not defended at the toe and is steep and undergoing active erosion as a result. Both units were classified as Partly Active in the 2009 walkover survey. B**oth have been increased in status to Partly Active again following the December 2013 inspection. During the inspection work was ongoing to repair the rock armour defence at the northern end of MU19/AA.**

Units MU29/AC to MU29/AI extend southwards to Mile Haven and were all classified as Locally Active in 2012. These relatively shallow cliffs are cut into soft glacial sediments that are vulnerable to erosion. They were generally well vegetated however, with only localised areas of erosion. For example, the unit toes are steep and exposed with evidence of mudsliding onto the beach. There is recession of the headscarp in places, and some sliding and slumping mid-slope. **Following the post-December 2013 storm surge inspection, the activity status of all of these units was increased to Partly Active due to widespread toe erosion and numerous failures in the lower slopes.**

MU29/AA Very common intense erosion and headscarp recession (Locally Active) Sept 2012

MU29/AB Eroding toe and sliding mid-slope (Locally Active) Sept 2012

MU29/AA – Toe erosion and unvegetated cliff. December 2013 (Partly Active)

MU29/AB – Significant toe erosion and failure of lower cliff. December 2013 (Partly Active).

MU29/AC Well vegetated with some toe erosion (Locally Active) Sept 2012

MU29/AD Recession of the headscarp (Locally Active) Sept 2012

MU29/AC Note further failure of toe to centre left of photo relative to earlier photo (above). December 2013 (Partly Active).

MU29/AC – Further failure of toe. December 2013 (Partly Active).

MU29/AD - Extensive toe erosion. December 2013 (Partly Active).

MU29/AE The slope is well vegetated with erosion at the toe and headscarp (Locally Active) Sept 2012

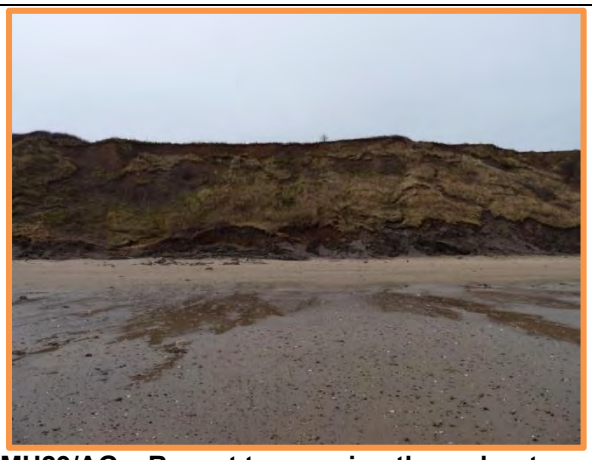
MU29/AF Well vegetated with some toe erosion (Locally Active) Sept 2012

MU29/AE – Toe erosion throughout unit to several metres above the beach level. Note detachment of vegeation indicating failure of lower slope throughout much of the unit. December 2013 (Partly Active)

MU29/AF – Extensive toe erosion throughout unit. Note particularly severe toe erosion on left of photograph. December 2013 (Partly Active).

MU29/AG The slope is showing localised signs of erosion (Locally Active) Sept 2012

MU29/AH Heavily vegetated with toe erosion, which is severe in places (Locally Active) Sept 2012



MU29/AG – Recent toe erosion throughout unit. December 2013 (Partly Active)

MU29/AH – Still substantially vegetated but with erosion to >2m above the beach at the toe of the slope. Failure affecting near whole slope in left of photo (see photo below). December 2013 (Partly Active).

MU29/AH Failure affecting near whole slope. December 2013 (Partly Active)

MU29/AI Locally steep, exposed unit toe (Locally Active) Sept 2012

MU29/AI -= Whole unit, December 2013. Continues to have locally steep exposed toe throughout unit. Erosion here possibly less severe relative to units further north.

MU29/AI – North end of unit. December 2013 (Partly Active)

MU29/AI – South end of unit. December 2013. Partly Active)

Mu29B – Hunmanby Sands

This Sub-Management Unit consists of units MU29/AJ at Mile Haven to MU29/BE2 at Hunmanby Gap.

Unit MU29/AJ is a very small unit located immediately south of the inlet at Mile Haven. It is composed of similar material to those units in Sub-Management Unit Mu29A and is classified as Partly Active. It is characterised by a receding cliff line, slumping and sliding mid-slope and erosion at the toe. This unit has not changed classification since 2009.

Units MU29/AK to MU29/BA comprise the area in and around the hamlet of Flat Cliffs, extending southwards to Butcher Haven. All units are were classified as Locally Active in 2012. The low lying cliffs are generally well vegetated with localised areas of erosion. On-going racking of roads, walls and footpaths was evident at Flat Cliffs, but there was no observed increase in activity by 2012. Only unit MU29/AO changed activity class in 2012, from Partly Active in 2009 to Locally Active in 2012 as a mudslide became stabilised. **However, in December 2013 all units within this section were elevated in activity status due to comprehensive toe erosion throughout the section. This appeared to be most severe at Flat Cliffs hamlet itself (units MU29/AR and MU29/AS) where severe toe erosion and recent failure of the lower cliff was evidenced by exposed laminated sand layers, protruding pipework, blocks of failed glacial till and failed infrastructure (steps and fences).**

Units MU29/BB to MU29/BE are located between Butcher Haven and Hunmanby Gap and are all classified as Partly Active. These cliffs are generally steeper than those units further north and are characterised by headscarp recession and very common areas of intense erosion. The toes of these units are particularly active with slumping and sliding of materials onto the beach. None of these units have changed classification.

Unit MU29/BE2 is a newly (2012) defined unit at Hunmanby Gap. The cliffs here are relatively shallow and well vegetated. There is localised erosion at the unit toe and some sliding and cracking mid-slope resulting in a classification of Locally Active.

MU29/AJ Areas of intense erosion at the toe and headscarp (Partly Active). Sept 2012

MU29/AK Well-vegetated low lying cliffs (Locally Active). Sept 2012

MU29/AJ – Continued intense upslope erosion and redcent toe erosion/failure, particualrly in the centre photo. December 2013 (Partly Active).

MU29/AK – Recent toe erosion and unvegeated areas in the mid and upper-slopes (Partly Active).

MU29/AL and M Erosion at the toe and headscarp, sliding mid-slope (Locally Active).

MU29/AN Toe erosion on an otherwise vegetated slope (Locally Active).

MU29/AL and M – Severe Erosion at the toe exposing laminated sandy strata over which clay has slumped onto beach. December 2013 (Partly Active).

MU29/AN - Severe toe erosion. December 2013 (Partly Active)

MU 29/AP – Northern end of unit. December 2013 (Partly Active).

MU29/AP – Southern end of unit. December 2013 (Partly Active).

MU29/AQ – December 2013. Substantial toe erosion. (Partly Active)

MU29/AQ (right of photo) and AR (Northern end, left of Photo) – December 2013. (Partly Active)

MU29/AR Continuing mudslide activity and toe erosion at Flat Cliffs (Locally Active). Sept 2012

MU29/AS Continuing mudslide activity and toe erosion at Flat Cliffs (Locally Active). Sept 2012

MU29/AR and AS – Substantial toe erosion throughout unit exposing drainage pipes. December 2013 (Partly Active).

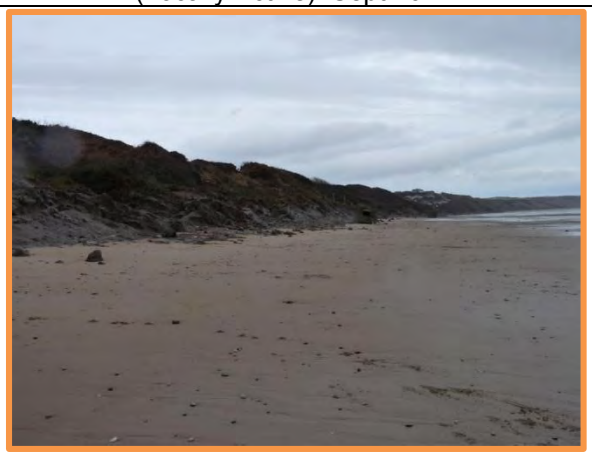
MU29/AS – Severe toe erosion including failue blocks. Note protruding pipe. December 2013 (Partly Active)

MU29/AS – Severe toe erosion adn failure of steps and fences, southern end of unit. December 2013 (Partly Active).

MU29/AS and AR – Beach condition. December 2013 (Partly Active)

MU29/AT this large unit is showing eroding at the toe with thick vegetation higher up the unit (Locally Active). Sept 2012

MU29/BA The small unit at Butcher Haven does not support vegetation on its lower slopes and is undergoing erosion. (Locally Active). Sept 2012



MU29/T – Showing toe erosion and beach condition. December 2013 (Partly Active)

MU29/T – Showing erosion in lower cliff and position of pillbox for future reference. December 2013 (Partly Active).

MU29/BB and BC Steeper cliffs with very common areas of intense erosion (Partly Active). Sept 2012

MU29/BD Slumping and sliding on the beach (Partly Active). Sept 2012

MU29/BE Headscarp and toe erosion (Partly Active). Sept 2012

MU29/BE2 The Hunmanby Gap unit is more stable than the units to the NW (Locally Active). Sept 2012

Mu29C – Reighton Sands

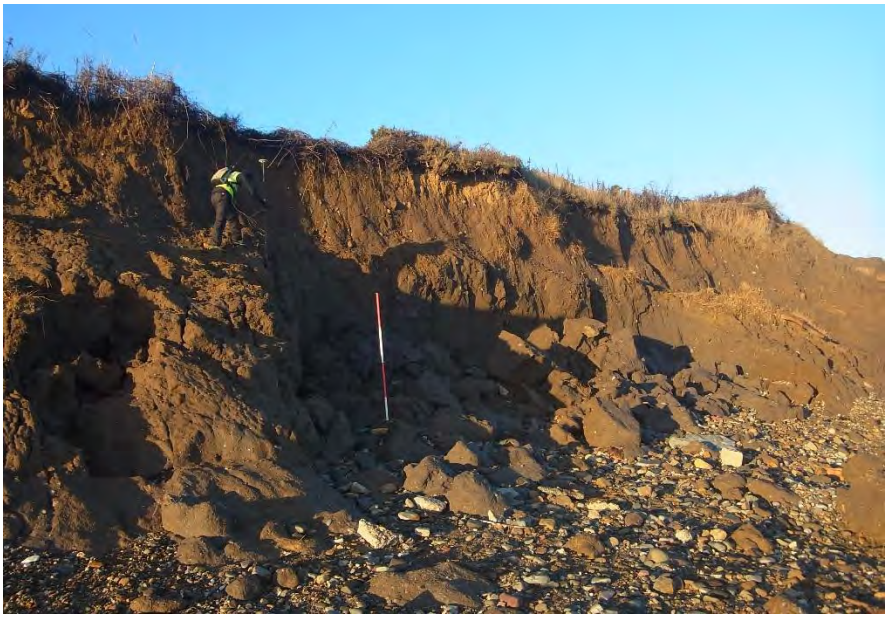
This Sub-Management Unit, consisting of units MU29/BF near Hunmanby Gap to MU29/BQ below Reighton Moor was not included in the December 2013 inspections.

Coast Protection Asset Condition Assessment
There are no formal coastal defence assets within Management Unit 29.

Beach Condition Assessment following the December 2013 Storm.

Observations

The following description of the changes to Filey Beach from the post storm surge beach profile surveys covers the north, centre and south of Filey Bay. Profiles FB1 to FB4 in the north and centre of the bay are all in the middle of the range of results. Profile FB5, near Reighton Gap, is low but not the lowest survey recorded. Between September and December 2013 the profiles have flattened although the beach level has remained similar.



At Profile FB3, close to Flat Cliffs the cliff line had eroded due to the December 2013 storm.

Interpretation
The beach in Filey Bay did not show large scale erosion following the 5th / 6th December 2013 storm surge. The beaches have flattened, which is likely to be due to the redistribution of material which had been built into berms in the September 2013 survey.
The inspection of cliff activity shows that the toe of the cliffs have been eroded throughout much of the Filey frontage. It is considered likely that the existing beach material had eroded to some extent and then been renourished by material from the cliffs.

3.27 Management Unit 30 – Filey Bay South

Coastal Slope Condition Assessment
This Management Unit, which is divided into two Sub-Management Units: MU30A Reighton Gap and MU30B at Speeton Sands was not included in the December 2013 inspections.

Coast Protection Asset Condition Assessment
There are no coastal defence assets within this Management Unit

4 Comparison with Previous Assessments

4.1 Coastal Slope Condition Assessment

The change in condition of the cliffs is shown in Maps 1 to 6 in Appendix A. Areas of increased or sustained high levels of activity are summarised below:

Increased Activity

Following the December 2013 storm surge, those units which were inspected and had increased in activity status were:

- **MU7/2 and MU7/3** -Elevated in activity status due to increased erosion of the toe of the till cliffs following the storm surge.
- **MU10/11** – A small unit has been elevated from inactive to locally active due to limited toe erosion throughout its shore-parallel section,
- **MU11/1** - Elevated in activity status due to toe erosion (resulting the removal of vegetation and exposure of sediments) and recent shallow mudsliding (likely a reactivation of an existing slide) in a section that is defended by a sea wall but not rock armour and the consequent exposure of drainage pipes.
- **MU11/2** - Evidence of smaller shallow failures in the mid and upper cliff.
- **MU16/2** - Increased in activity status to reflect the undefended nature of the northern third of the unit which is significantly undermined at its toe and from which relatively recent rockfalls have occurred.
- **MU19/11** - This unit has experienced toe erosion comprehensively throughout the unit and recent failures higher up in the cliff have occurred.
- **MU27/T, MU27/U and MU27/W** – Several units to the north of Filey town have experienced widespread toe erosion.
- **MU29/AA to MU29/AT - E**levated to 'Partly Active Status'. Whilst the upper cliff remains largely vegetated there is evidence of failure throughout the whole cliff in some units and the units immediately around Flat Cliffs (**MU29/AR and MU29/AS**) have experienced particularly severe toe erosion and failure of the lower cliff

The following units have sustained high activity:

- **MU10/2** – This unit has retained its 'Partly Active' status. However the western end of the cliff is totally active vegetation absent from large sections of the cliff and evidence of very recent mudsliding.
- **MU27/V** – A recent mudslide initiating near the top of the cliff with its toe coming to rest on the beach was noted near Filey Sailing Club and the toe of this unit is encroaching onto the sailing club slipway..

4.2 Coast Protection Asset Condition Assessment

Widespread damage to coastal defences throughout the Scarborough Borough Council area were reported following the December 2013 storm surge. However, coast protection asset inspections undertaken as part of the strategic coastal monitoring commission were restricted to Runswick Bay and Sandsend.

Mu7 - Runswick Bay
Many of the defences along the sea front at Runswick Bay were in a similar condition to that reported by the Halcrow 2008, 2009 and 2012 inspections. However, the storm surge had caused further damage to the defences to the northern part of the village.

Mu9 – Sandsend Village
The defences at the Sandsend Village had deteriorated further since the 2012 inspections. The defects noted to the revetment around the car park at the north and the adjacent slipway had worsened. The toe apron to the main vertical wall remains exposed and continues to

worsen. The void under the toe apron of the section of wall with cantilevered footway had worsened, potentially compromising the wall. Sections of the cantilevered footway had been badly damaged by wave uplift pressures and the footway was closed. The concrete revetment east of Sandsend had suffered severe damage and although temporary repairs were being undertaken a long term solution is urgently needed.

5 Problems Encountered and Uncertainty in Analysis

Coastal Slope Condition Assessment
During the December 2013 inspection the only problems encountered concerned the combined tidal pattern and limited daylight hours. The tidal pattern restricted access to the cliff toe and assessment of beach condition at those sites visited in the late afternoon, although where it was felt necessary these sites were revisited at the next low tide during daylight hours. Low light and higher tides also made photographs of the whole of some of the larger units difficult. However, several closer shots were taken where this was the case to ensure a comprehensive record. Neither of these issues had a significant impact on the assessment of the cliffs activity status.

Coast Protection Asset Assessment
No problems were encountered during the coast protection asset inspections.

Post storm Beach Condition Assessment
There were difficulties in getting to the parts of the beaches which needed to be surveyed because the beach and defences had been eroded in places. Parts of the Filey frontage could not be measured due to vegetation and lack of access. The extent of the surveys was also limited due to limited daylight hours and the tide times, but the work was scheduled to capture data as soon after the storm as possible.

6 Conclusions and Recommended Actions

Recommended Actions for Coastal Slopes

The next inspections under the current programme are scheduled to be undertaken later during 2014. It is recommended that particular attention be paid during the scheduled regular 2014 inspection to the condition of the units highlighted in section 4.1. It is likely that the steepening of the cliff profile through erosion of the toe in many of these units will be a contributory factor in future failures of the upper cliff during prolonged wet periods.

Recommended Actions for Coast Protection Assets

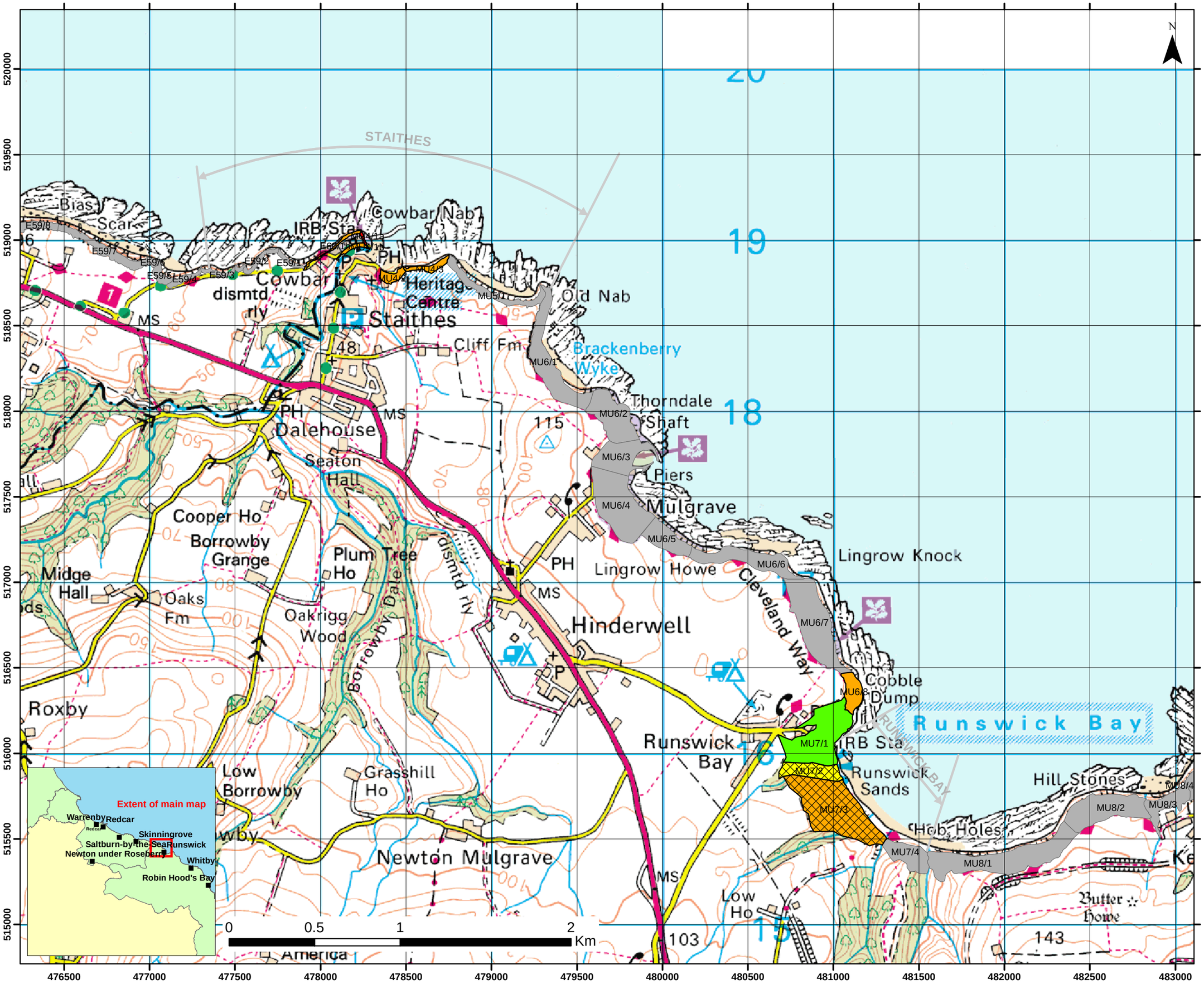
Although only a very limited number of the coast protection assets were inspected as part of the post storm strategic monitoring in December 2013, local media reports have indicated damage in many other areas and Scarborough Borough Council staff undertook inspections at the other areas. It is recommended that findings of the post storm inspections and photographs of the damage are added to the SANDS database. This could be done during the next full set of defence inspections, which is scheduled for later in 2014.

Recommended Actions for Beaches and Beach Levels

The beaches are low in some areas and subsequent storms may therefore exacerbate the issues of beach and cliff erosion. The only location where beach management by reprofiling or recycling material is occasionally undertaken is Scarborough South Bay. During the storm there was a significant amount of sand transported onto Foreshore Road and it is expected that reprofiling or recycling of material to the Spa frontage may need to be undertaken as in previous years. Elsewhere the management of the beaches through renourishment or similar is not considered necessary or appropriate. The next set of beach profile data will be collected in the Spring of 2014 and it will be interesting to see to what degree the beach levels have recovered or whether the erosion reported over the winter of 2013/14 is noteworthy compared to previous years.

Appendix A

Coastal Slope Condition and Change



KEY

Cliff activity

December 2013

- Totally active
- Partly active
- Locally active
- Inactive
- Dormant
- Not inspected

Change due to surge

Sept 2012 to Dec 2013

- Increase in activity
- Reduction in activity
- No change in activity

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Post Storm Surge Cliff Inspection December 2013 Scarborough Borough Council

Map 1 - Staithes and Runswick Bay Cliff Activity

Halcrow
A CH2M HILL COMPANY

Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

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www.halcrow.com

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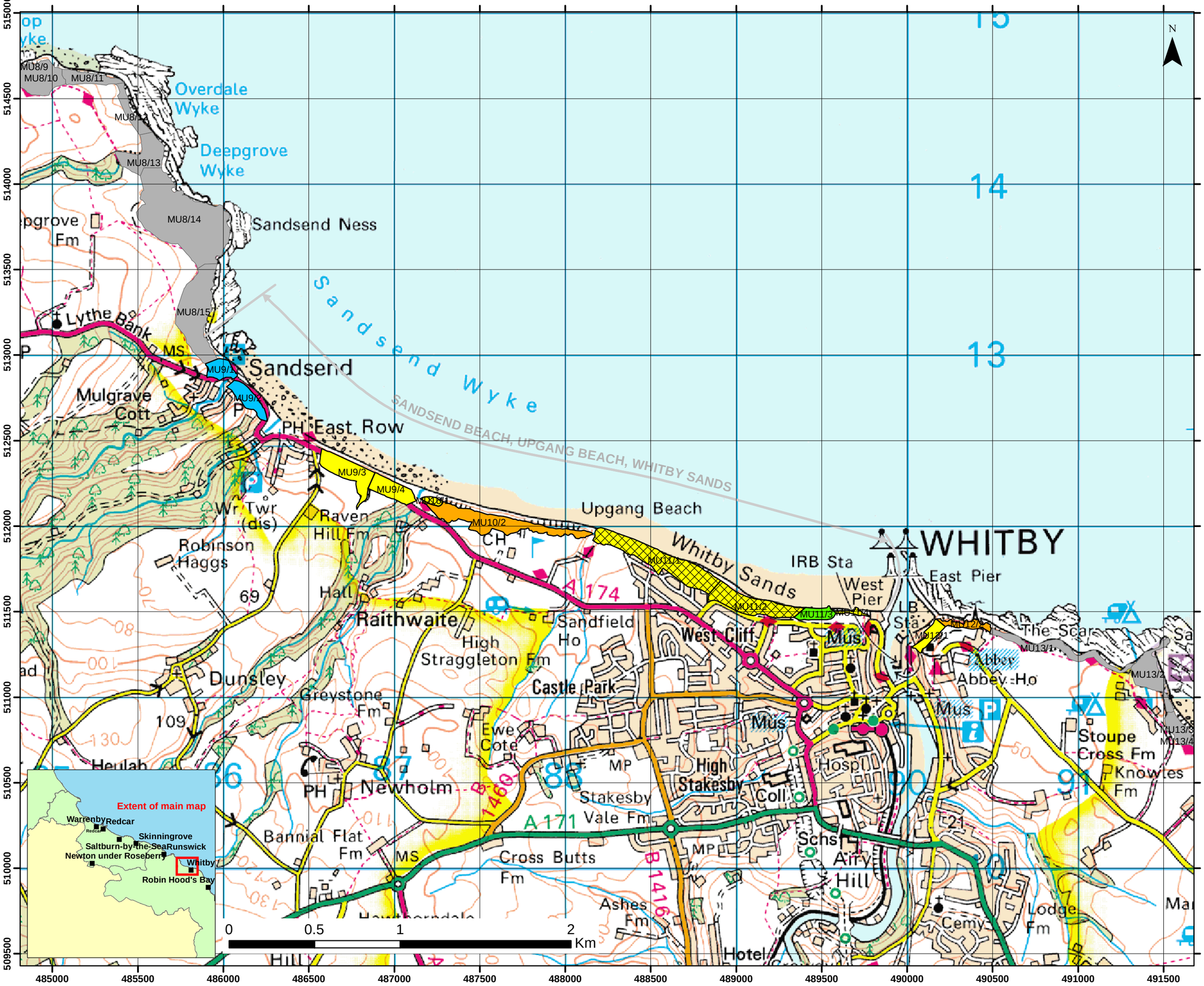

KEY

Cliff activity

December 2013

- Totally active
- Partly active
- Locally active
- Inactive
- Dormant
- Not inspected

Change due to surge

Sept 2012 to Dec 2013

- Increase in activity
- Reduction in activity
- No change in activity

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Post Storm Surge Cliff Inspection December 2013 Scarborough Borough Council

Map 2 - Whitby Bay Cliff Activity

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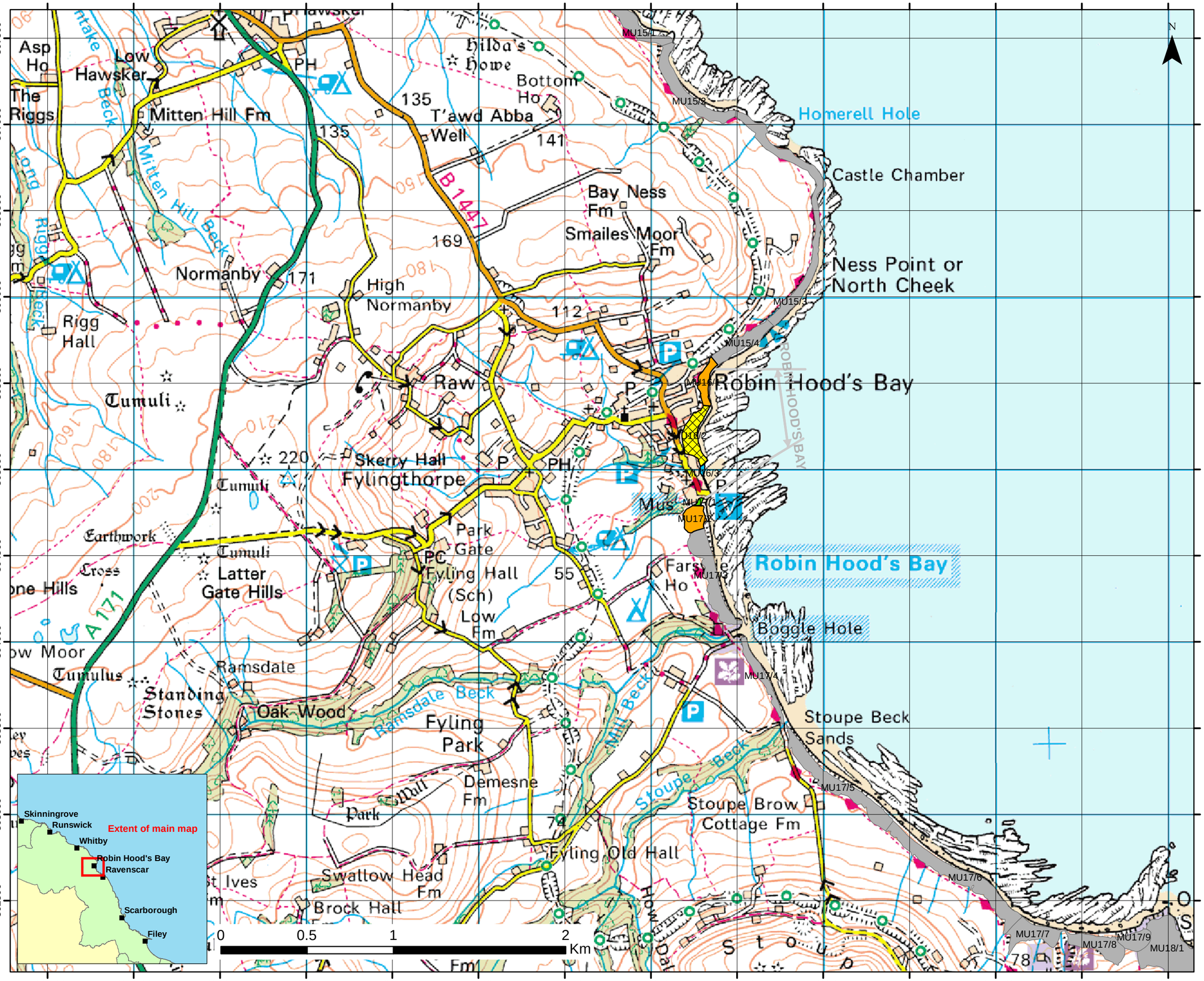

KEY

Cliff activity

December 2013

- Totally active
- Partly active
- Locally active
- Inactive
- Dormant
- Not inspected

Change due to surge

Sept 2012 to Dec 2013

- Increase in activity
- Reduction in activity
- No change in activity

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Post Storm Surge Cliff Inspection December 2013 Scarborough Borough Council

Map 3 - Robin Hood's Bay Bay Cliff Activity

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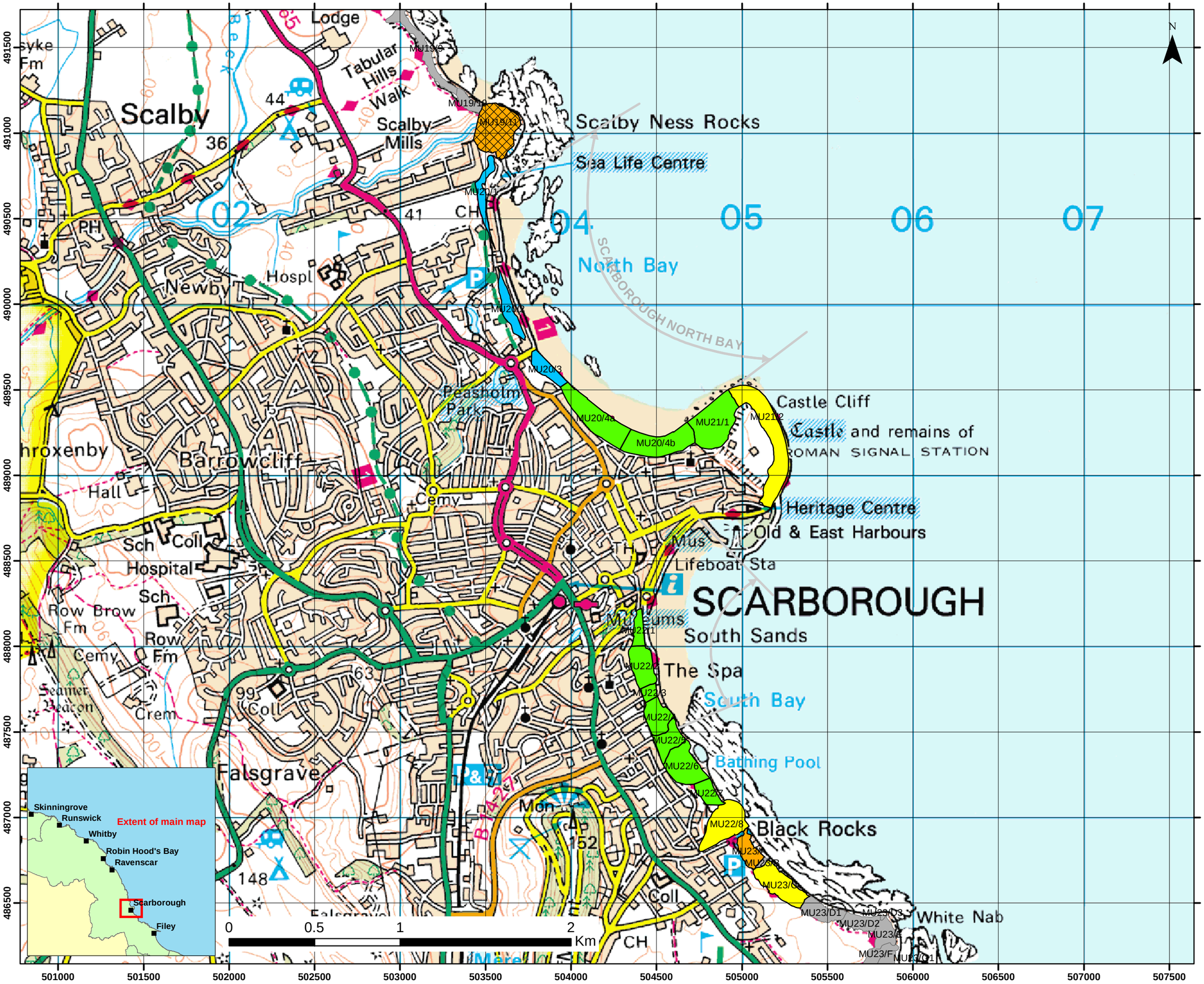

KEY

Cliff activity

December 2013

- Totally active
- Partly active
- Locally active
- Inactive
- Dormant
- Not inspected

Change due to surge

Sept 2012 to Dec 2013

- Increase in activity
- Reduction in activity
- No change in activity

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Post Storm Surge Cliff Inspection December 2013 Scarborough Borough Council

Map 4 - Scarborough Bay Cliff Activity

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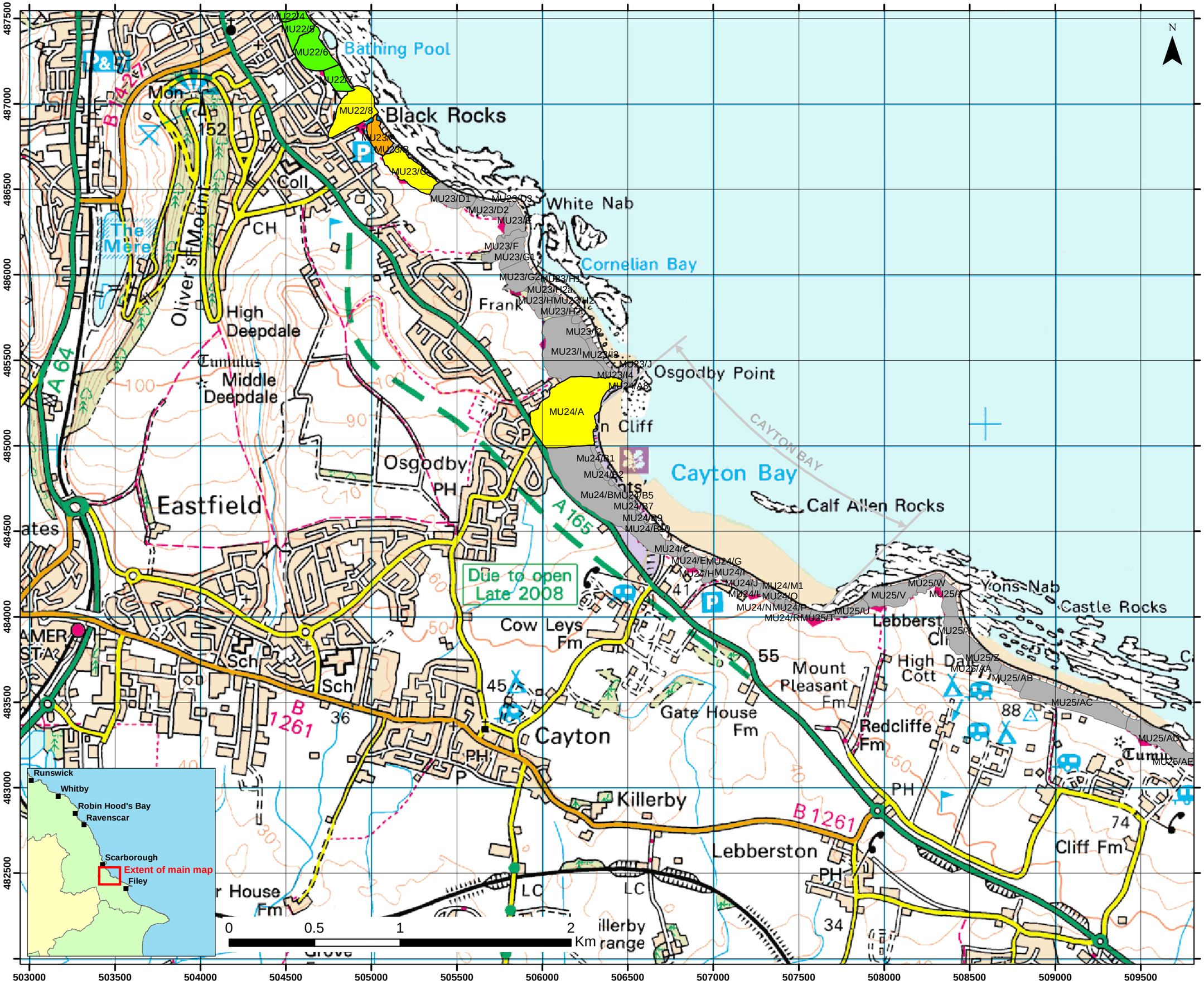

KEY

Cliff activity

December 2013

- Totally active
- Partly active
- Locally active
- Inactive
- Dormant
- Not inspected

Change due to surge

Sept 2012 to Dec 2013

- Increase in activity
- Reduction in activity
- No change in activity

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Post Storm Surge Cliff Inspection December 2013 Scarborough Borough Council

Map 5 - Cayton Bay
Bay Cliff Activity

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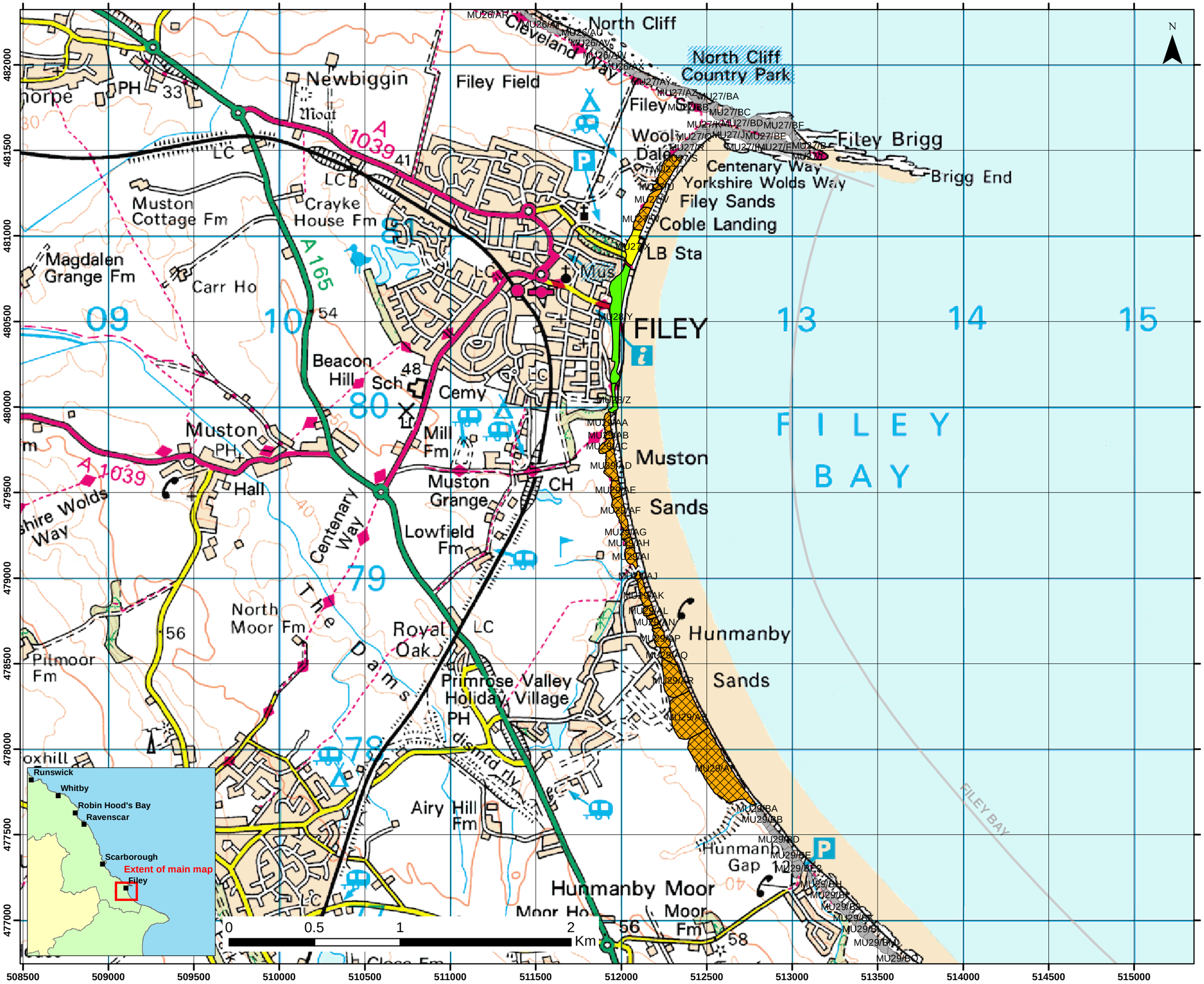

KEY

Cliff activity

December 2013

- Totally active
- Partly active
- Locally active
- Inactive
- Dormant
- Not inspected

Change due to surge

Sept 2012 to Dec 2013

- Increase in activity
- Reduction in activity
- No change in activity

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Post Storm Surge Cliff Inspection December 2013 Scarborough Borough Council

Map 6 - Filey Bay
Bay Cliff Activity

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Appendix B

Coast Protection Asset Locations

MA19

N

1221D901D0402C02
1221D901D0402C03
1221D901D0402C01
1221D901D0403C03
1221D901D0402C06
1221D901D0402C04
1221D901D0402C22
1221D901D0402C05
1221D901D0403C07
1221D901D0403C01
1221D901D0403C02
1221D901D0403C05
1221D901D0403C04

1221D901D0601C01
1221D901D0601C06
1221D901D0601C03
1221D901D0601C02
1221D901D0601C07
1221D901D0601C04
1221D901D0602C01

1221D901D0602C01

1221D901D0602C05

Extent of main map
Skinningrove
Runswick
Whitby
Robin Hood's Bay
Ravenscar
Scarborough
Filey

0 0.5 1 2 Km

477500 478000 478500 479000 479500 480000 480500 481000 481500 482000 482500 483000 483500 484000

520500 520000 519500 519000 518500 518000 517500 517000 516500 516000 515500

KEY

Management Unit

Asset condition (2012)

Very good
Good
Fair
Poor
Very poor

Asset condition change

△△△△ Worsened since 2009/10
○○○ Improved since 2009/10

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Map 1
Coast Protection Asset Condition 2012

Scarborough Borough Council

2012 Coastal Inspection

Halcrow
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N

MA22

MA23

MA24

1221D901D0701C02
1221D901D0702C01
1221D901D0702C04
1221D901D0702C03
1221D901D0702C02

1221D901D0801C01
1221D901D0802C01
1221D901D0802C02
1221D901D0802C03
1221D901D0802C13
1221D901D0802C05
1221D901D0802C06
1221D901D0802C04
1221D901D0802C12
1221D901D0802C09
1221D901D0802C15
1221D901D0802C10
1221D901D0802C07
1221D901D0802C14

1221D901D0803C01
1221D901D0803C04
1221D901D0803C03
1221D901D0803C02
1221D901D0803C12
1221D901D0803C09
1221D901D0803C05
1221D901D0803C06
1221D901D0803C09
1221D901D0803C08
1221D901D0803C07
1221D901D0803C10

WHITBY
DRACULA
West Cliff
East Pier
IRB (summer only)
Abbey House
Castle Park
Sandsend
Sandsend Ness
Deep Grove Quarries (dis)
Upgang Beach
Raithwaite
Stoupe Cross Farm
Holiday Park
Knowles Farm
Brook House
Fishburn Park
High Stakesby
Greystone Farm
Ewe Cote
Moss Brow Farm
Sandfield House
Raven Hill Farm
Robinson Haggs
Mulgrave Cottage
East Row
Home Farm
High Straggleton Farm
Duckhill
Cliff Lane
Dismal Ry
Sandsend Road
Club House
Sewage Works
Reservoir
Wt Twr (dis)
Ford
Weirs
Waterfall
Overstale
Wyke
Kelchowe Steel
Oxepasture Wyke
Wasterfall
Sandsend Wyke
Mulgrave Wyke
Whitby Abbey (Benedictine)
Abbey House
Heritage Centre
Remains of Abbey House
Rail Holes
Saltwick Bay
Saltwick Nab
North Batts
Whitby Pier
Whitby Sands
Whitby Lighthouse
Whitby Harbour
Whitby Marina
Whitby Swing Bridge
Whitby Museum
Whitby Library
Whitby Sch
Whitby Sta
Whitby Lifeboat Station
Whitby Coastguard Station
Whitby Fish Auction
Whitby Boat Yard
Whitby Boat Yard Slipway
Whitby Boat Yard Crane
Whitby Boat Yard Workshop
Whitby Boat Yard Office
Whitby Boat Yard Car Park
Whitby Boat Yard Toilets
Whitby Boat Yard Shop
Whitby Boat Yard Cafe
Whitby Boat Yard Pub
Whitby Boat Yard Hotel
Whitby Boat Yard Guesthouse
Whitby Boat Yard Bed and Breakfast
Whitby Boat Yard Self Catering
Whitby Boat Yard Holiday Cottages
Whitby Boat Yard Caravan Park
Whitby Boat Yard Campsite
Whitby Boat Yard Touring Park
Whitby Boat Yard Static Caravans
Whitby Boat Yard Chalets
Whitby Boat Yard Lodges
Whitby Boat Yard Apartments
Whitby Boat Yard Flats
Whitby Boat Yard Houses
Whitby Boat Yard Bungalows
Whitby Boat Yard Cottages
Whitby Boat Yard Farmhouses
Whitby Boat Yard Barns
Whitby Boat Yard Outbuildings
Whitby Boat Yard Stables
Whitby Boat Yard Kennels
Whitby Boat Yard Cattery
Whitby Boat Yard Aviary
Whitby Boat Yard Zoo
Whitby Boat Yard Aquarium
Whitby Boat Yard Museum
Whitby Boat Yard Art Gallery
Whitby Boat Yard Theatre
Whitby Boat Yard Cinema
Whitby Boat Yard Concert Hall
Whitby Boat Yard Opera House
Whitby Boat Yard Ballet School
Whitby Boat Yard Dance School
Whitby Boat Yard Music School
Whitby Boat Yard Art School
Whitby Boat Yard Drama School
Whitby Boat Yard Film School
Whitby Boat Yard Photography School
Whitby Boat Yard Sculpture School
Whitby Boat Yard Painting School
Whitby Boat Yard Drawing School
Whitby Boat Yard Printmaking School
Whitby Boat Yard Ceramics School
Whitby Boat Yard Glass School
Whitby Boat Yard Textiles School
Whitby Boat Yard Fashion School
Whitby Boat Yard Jewellery School
Whitby Boat Yard Metalwork School
Whitby Boat Yard Woodwork School
Whitby Boat Yard Furniture School
Whitby Boat Yard Upholstery School
Whitby Boat Yard Carpentry School
Whitby Boat Yard Joinery School
Whitby Boat Yard Cabinetmaking School
Whitby Boat Yard Boatbuilding School
Whitby Boat Yard Shipwright School
Whitby Boat Yard Sailmaking School
Whitby Boat Yard Rigging School
Whitby Boat Yard Navigation School
Whitby Boat Yard Seamanship School
Whitby Boat Yard Lifeboat School
Whitby Boat Yard Coastguard School
Whitby Boat Yard Fishing School
Whitby Boat Yard Angling School
Whitby Boat Yard Diving School
Whitby Boat Yard Swimming School
Whitby Boat Yard Sailing School
Whitby Boat Yard Rowing School
Whitby Boat Yard Canoeing School
Whitby Boat Yard Kayaking School
Whitby Boat Yard Windsurfing School
Whitby Boat Yard Kitesurfing School
Whitby Boat Yard Surfing School
Whitby Boat Yard Bodyboarding School
Whitby Boat Yard Skimboarding School
Whitby Boat Yard Waterskiing School
Whitby Boat Yard Wakeboarding School
Whitby Boat Yard Jetskiing School
Whitby Boat Yard Powerboating School
Whitby Boat Yard Motorboating School
Whitby Boat Yard Speedboating School
Whitby Boat Yard Yachting School
Whitby Boat Yard Cruising School
Whitby Boat Yard Racing School
Whitby Boat Yard Regatta
Whitby Boat Yard Festival
Whitby Boat Yard Carnival
Whitby Boat Yard Fair
Whitby Boat Yard Market
Whitby Boat Yard Car Boot Sale
Whitby Boat Yard Flea Market
Whitby Boat Yard Antiques Fair
Whitby Boat Yard Craft Fair
Whitby Boat Yard Food Festival
Whitby Boat Yard Beer Festival
Whitby Boat Yard Wine Festival
Whitby Boat Yard Cider Festival
Whitby Boat Yard Perry Festival
Whitby Boat Yard Mead Festival
Whitby Boat Yard Gin Festival
Whitby Boat Yard Whisky Festival
Whitby Boat Yard Rum Festival
Whitby Boat Yard Vodka Festival
Whitby Boat Yard Tequila Festival
Whitby Boat Yard Brandy Festival
Whitby Boat Yard Cognac Festival
Whitby Boat Yard Armagnac Festival
Whitby Boat Yard Calvados Festival
Whitby Boat Yard Pommeau Festival
Whitby Boat Yard Liqueur Festival
Whitby Boat Yard Absinthe Festival
Whitby Boat Yard Pastis Festival
Whitby Boat Yard Ouzo Festival
Whitby Boat Yard Raki Festival
Whitby Boat Yard Arak Festival
Whitby Boat Yard Sambuca Festival
Whitby Boat Yard Limoncello Festival
Whitby Boat Yard Grappa Festival
Whitby Boat Yard Marc Festival
Whitby Boat Yard Eau de Vie Festival
Whitby Boat Yard Schnapps Festival
Whitby Boat Yard Aquavit Festival
Whitby Boat Yard Akvavit Festival
Whitby Boat Yard Snaps Festival
Whitby Boat Yard Kummel Festival
Whitby Boat Yard Bitters Festival
Whitby Boat Yard Amaro Festival
Whitby Boat Yard Fernet Festival
Whitby Boat Yard Campari Festival
Whitby Boat Yard Aperol Festival
Whitby Boat Yard Cynar Festival
Whitby Boat Yard Ramazzotti Festival
Whitby Boat Yard Averna Festival
Whitby Boat Yard Montenegro Festival
Whitby Boat Yard Nonino Festival
Whitby Boat Yard Jagermeister Festival
Whitby Boat Yard Underberg Festival
Whitby Boat Yard Becherovka Festival
Whitby Boat Yard Unicum Festival
Whitby Boat Yard Zwack Festival
Whitby Boat Yard Pisang Ambon Festival
Whitby Boat Yard Tia Maria Festival
Whitby Boat Yard Kahlua Festival
Whitby Boat Yard Baileys Festival
Whitby Boat Yard Irish Cream Festival
Whitby Boat Yard Advocaat Festival
Whitby Boat Yard Egg Nog Festival
Whitby Boat Yard Christmas Festival
Whitby Boat Yard New Year Festival
Whitby Boat Yard Easter Festival
Whitby Boat Yard Halloween Festival
Whitby Boat Yard Bonfire Night Festival
Whitby Boat Yard Remembrance Sunday Festival
Whitby Boat Yard Armistice Day Festival
Whitby Boat Yard Veterans Day Festival
Whitby Boat Yard Memorial Day Festival
Whitby Boat Yard Independence Day Festival
Whitby Boat Yard Canada Day Festival
Whitby Boat Yard Australia Day Festival
Whitby Boat Yard New Zealand Day Festival
Whitby Boat Yard Waitangi Day Festival
Whitby Boat Yard Anzac Day Festival
Whitby Boat Yard Queens Birthday Festival
Whitby Boat Yard Labour Day Festival
Whitby Boat Yard Thanksgiving Festival
Whitby Boat Yard Columbus Day Festival
Whitby Boat Yard Indigenous Peoples Day Festival
Whitby Boat Yard Veterans Day Festival
Whitby Boat Yard Remembrance Day Festival
Whitby Boat Yard Armistice Day Festival
Whitby Boat Yard Memorial Day Festival
Whitby Boat Yard Independence Day Festival
Whitby Boat Yard Canada Day Festival
Whitby Boat Yard Australia Day Festival
Whitby Boat Yard New Zealand Day Festival
Whitby Boat Yard Waitangi Day Festival
Whitby Boat Yard Anzac Day Festival
Whitby Boat Yard Queens Birthday Festival
Whitby Boat Yard Labour Day Festival
Whitby Boat Yard Thanksgiving Festival
Whitby Boat Yard Columbus Day Festival
Whitby Boat Yard Indigenous Peoples Day Festival

Extent of main map
Skinningrove
Runswick
Whitby
Robin Hood's Bay
Ravenscar
Scarborough
Filey

0 0.5 1 2 Km

515500
515000
514500
514000
513500
513000
512500
512000
511500
511000
510500

485500 486000 486500 487000 487500 488000 488500 489000 489500 490000 490500 491000 491500 492000

KEY

Management Unit

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Map 2
Coast Protection Asset Condition 2012

Scarborough Borough Council

2012 Coastal Inspection

Halcrow
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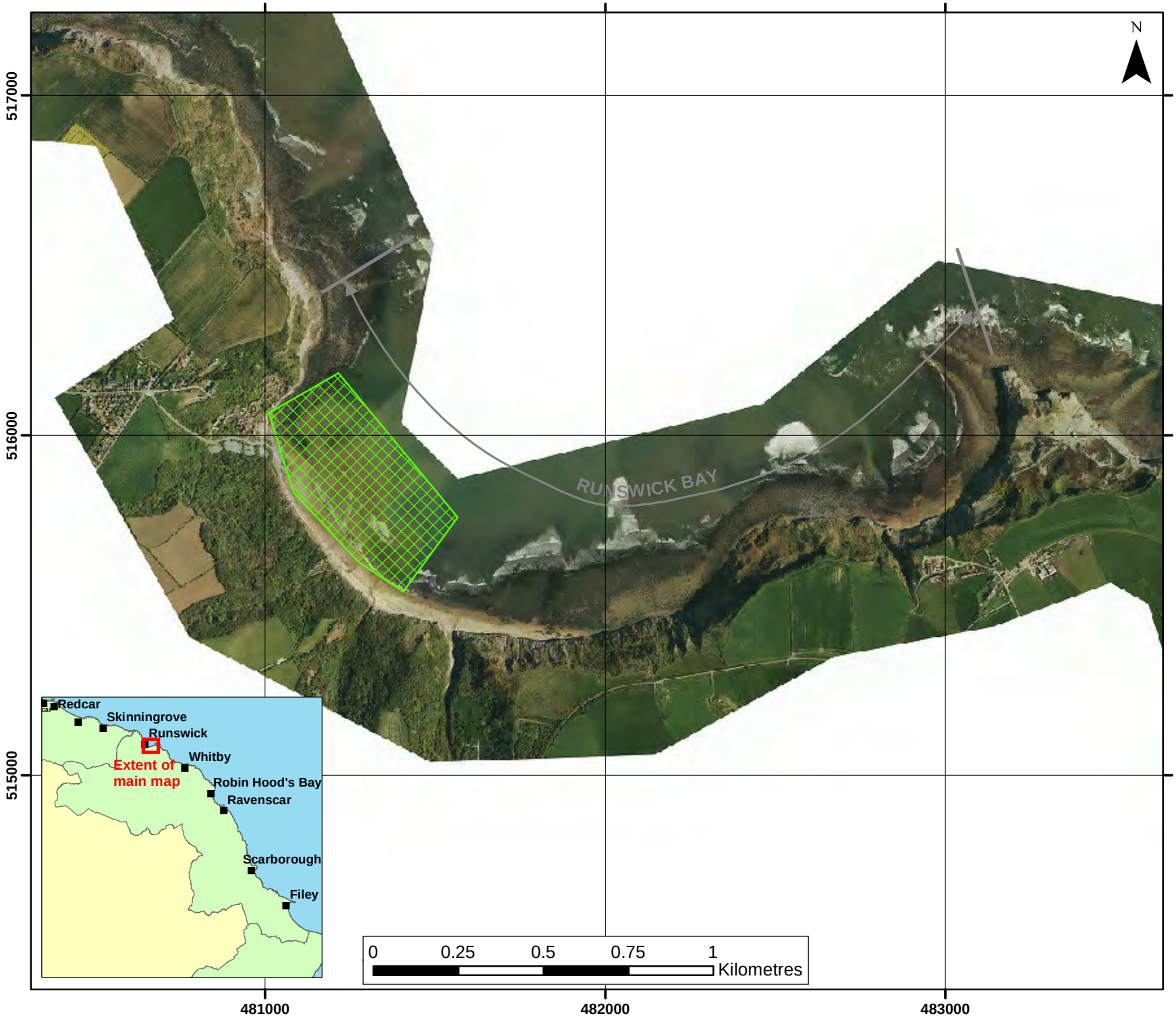
Appendix C

Post storm beach profile plots



KEY

Topographic Profiles

- Annual
- 6 monthly

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs

- 50m centres
- 100m centres
- 300m centres

(Indicative survey extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Figure 2 - Map 2
Survey Locations
Runswick Bay
Scarborough Borough Council

Analytical Report 6
Full Measures Survey
Autumn 2013

CH2MHILL
Halcrow

Halcrow Group Ltd, Lyndon House, 62 Hagley Road, Edgbaston, Birmingham, B16 8PE

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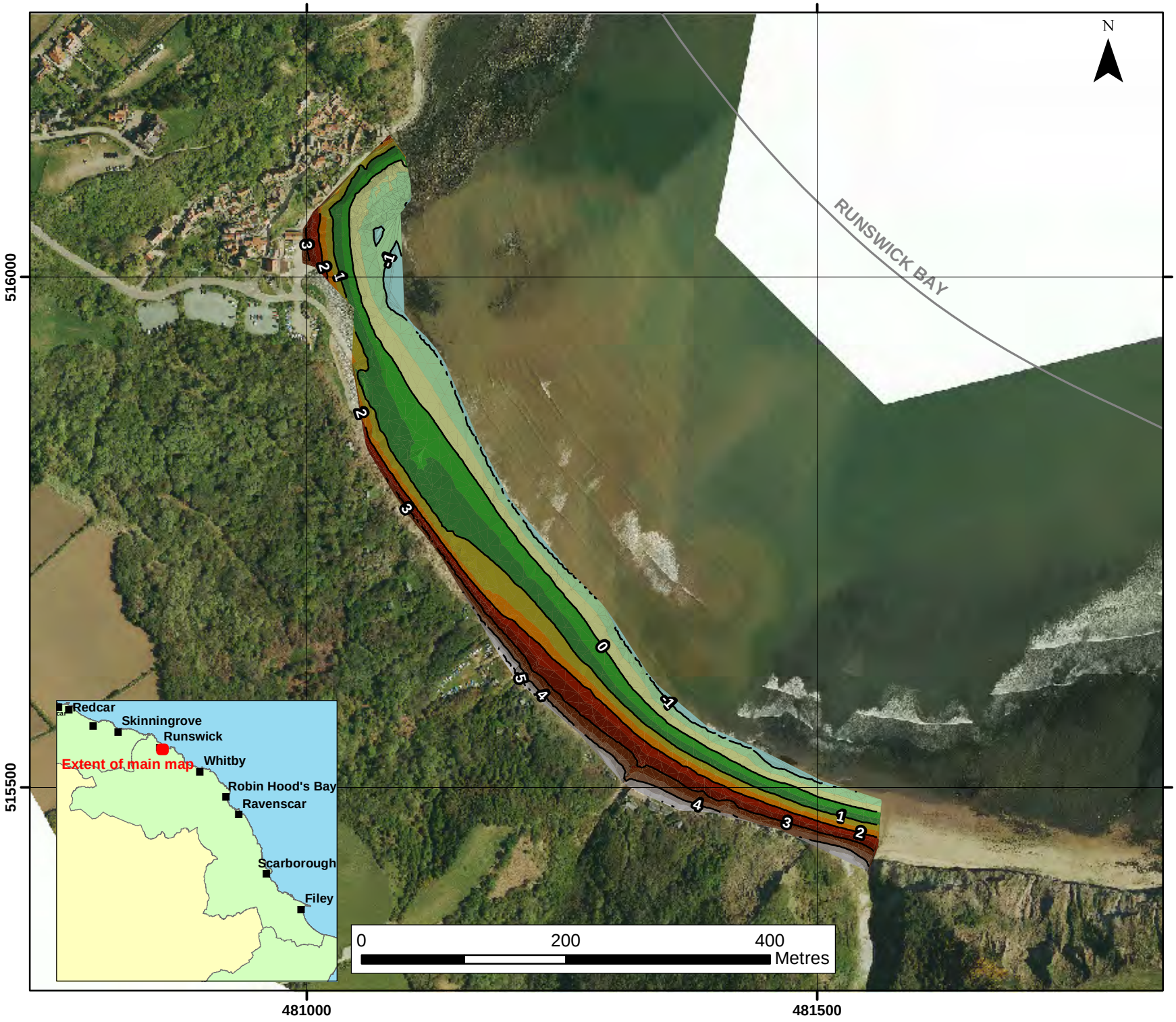
Fax: +44(0)121 456 1569
www.halcrow.com

Photography courtesy of North East Coastal Observatory
www.northeastcoastalobservatory.org.uk



KEY

Elevation (m OD)

- 5 - 5.5
- 4.5 - 5
- 4 - 4.5
- 3.5 - 4
- 3 - 3.5
- 2.5 - 3
- 2 - 2.5
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0 - 0.5
- -0.5 - 0
- -1 - -0.5
- -1.5 - -1
- Contour 1m

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix C
Topographic Survey
Runswick
Scarborough
Borough Council

Post-Surge Survey
16 December 2013

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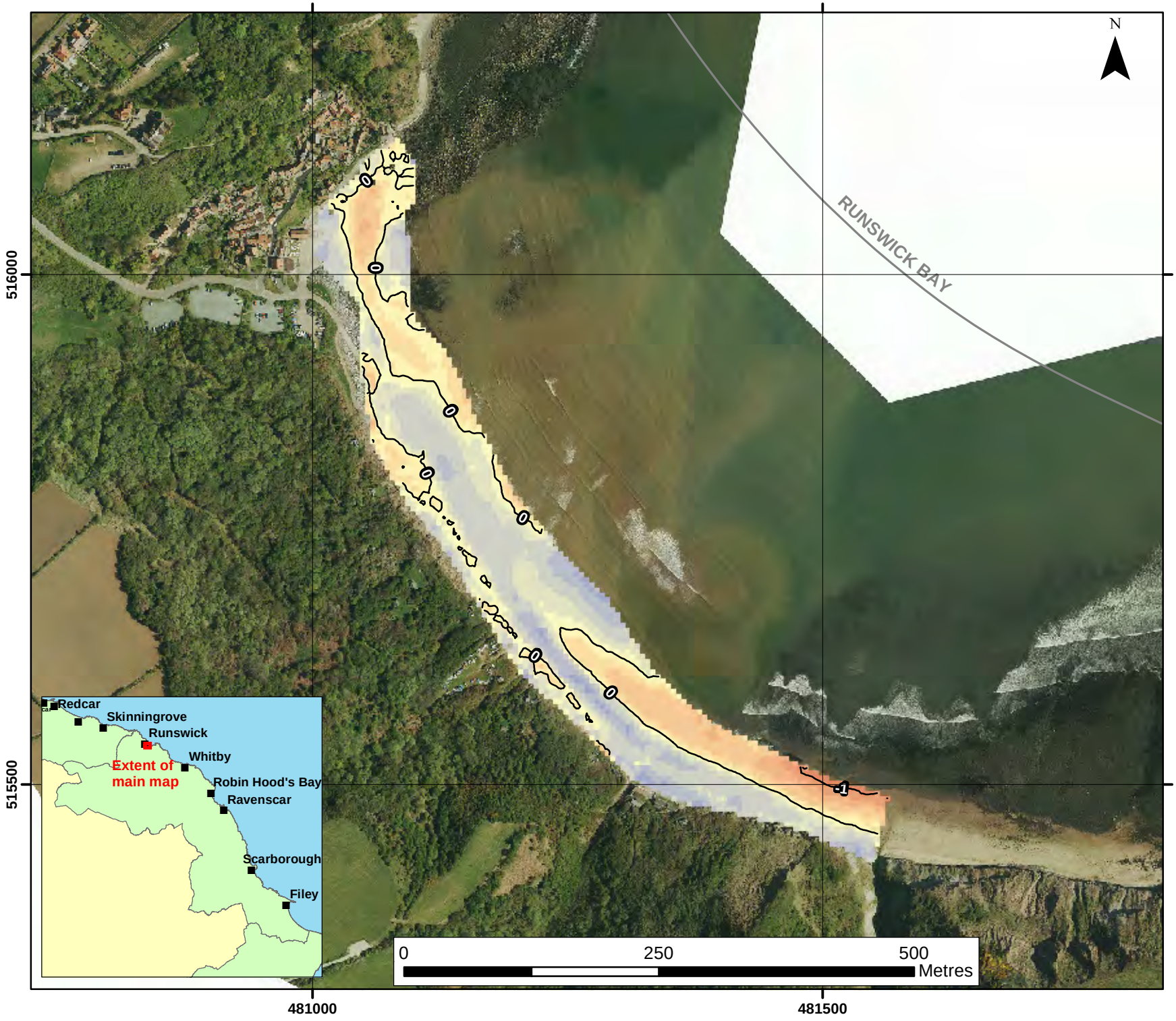
Photography courtesy of North East Coastal Observatory
www.northeastcoastalobservatory.org.uk



KEY 06 Sept 2013 and 16 Dec 2013
Change in elevation (m)

<-2	Loss
-2 - -1.75	
-1.75 - -1.5	
-1.5- -1.25	
-1.25 - -1	
-1 - -0.75	
-0.75 - -0.5	
-0.5 - -0.25	
-0.25 - -0.1	
-0.1 - 0	Change < 0.1 m
0 - 0.1	
0.1 - 0.25	
0.25 - 0.5	
0.5 - 0.75	
0.75 - 1	
1 - 1.25	Gain
1.25 - 1.5	
1.5 - 1.75	
1.75 - 2	
>2	

Contours of change

Client: North East Coastal Group
Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix C
Pre- to Post-Surge Elevation Change
Runswick
Scarborough Borough Council

Post-Surge Survey
16 December 2013

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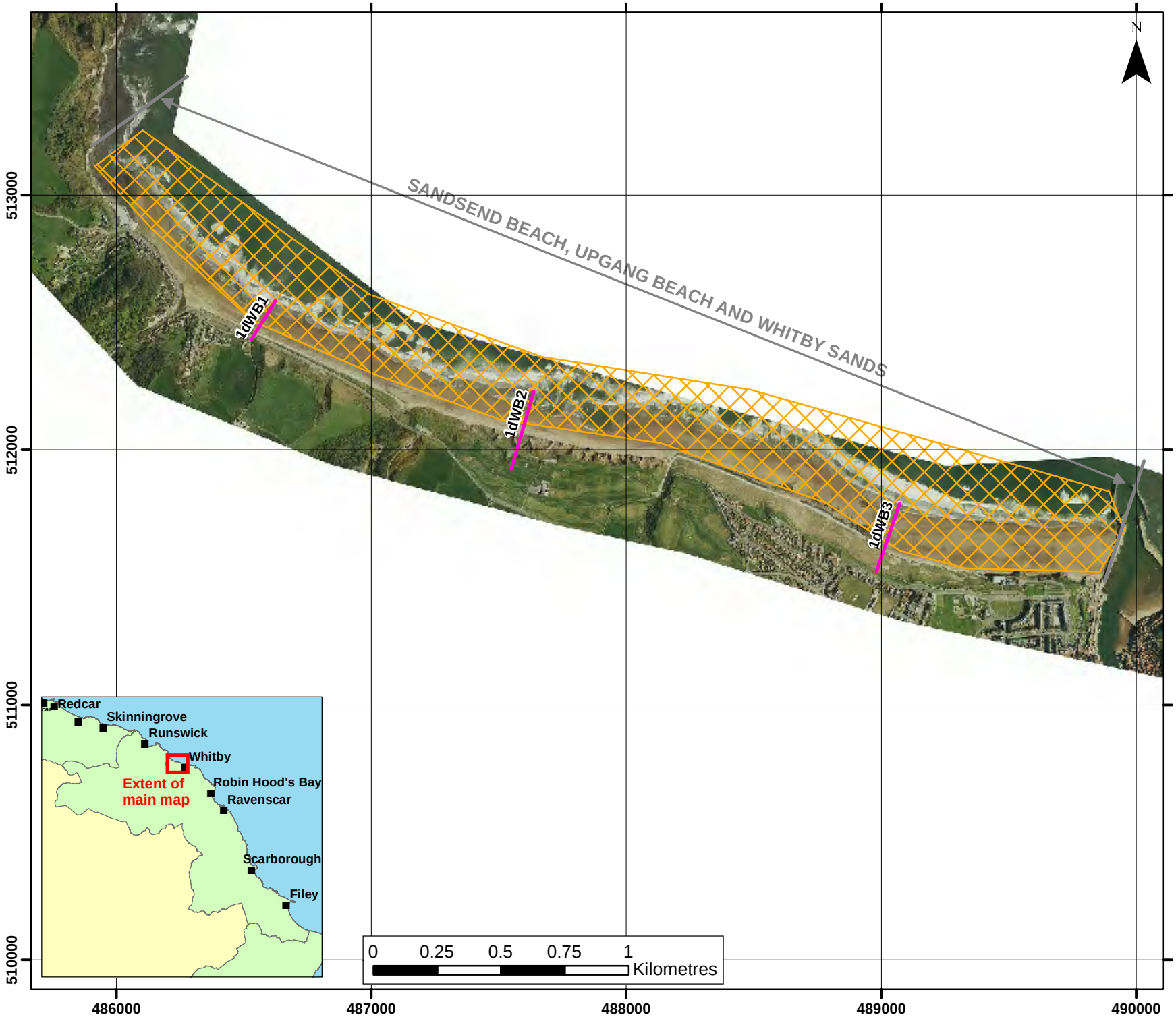

KEY

Topographic Profiles
- Annual
- 6 monthly

Topographic Surveys
- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs
- 50m centres
- 100m centres
- 300m centres

(Indicative survey extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Figure 2 - Map 3
Survey Locations
Sandsend to Whitby
Scarborough Borough Council

Analytical Report 6
Partial Measures Survey
Autumn 2013

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KEY

Elevation (m OD)

- 4.5 - 5
- 4 - 4.5
- 3.5 - 4
- 3 - 3.5
- 2.5 - 3
- 2 - 2.5
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- Contour 1m

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix C
Topographic Survey
Sandsend
Scarborough Borough Council

Post-Surge Survey
18 December 2013

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KEY

19 Sept 2013 and 18 Dec 2013
Change in elevation (m)

<-2	Loss
-2 - -1.75	
-1.75 - -1.5	
-1.5- -1.25	
-1.25 - -1	
-1 - -0.75	
-0.75 - -0.5	
-0.5 - -0.25	
-0.25 - -0.1	
-0.1 - 0	Change < 0.1 m
0 - 0.1	
0.1 - 0.25	Gain
0.25 - 0.5	
0.5 - 0.75	
0.75 - 1	
1 - 1.25	
1.25 - 1.5	
1.5 - 1.75	
1.75 - 2	
>2	

Contours of change

Client: North East Coastal Group
Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix C
Pre- to Post-Surge Elevation Change
Sandsend
Scarborough Borough Council

Post-Surge Survey
18 December 2013

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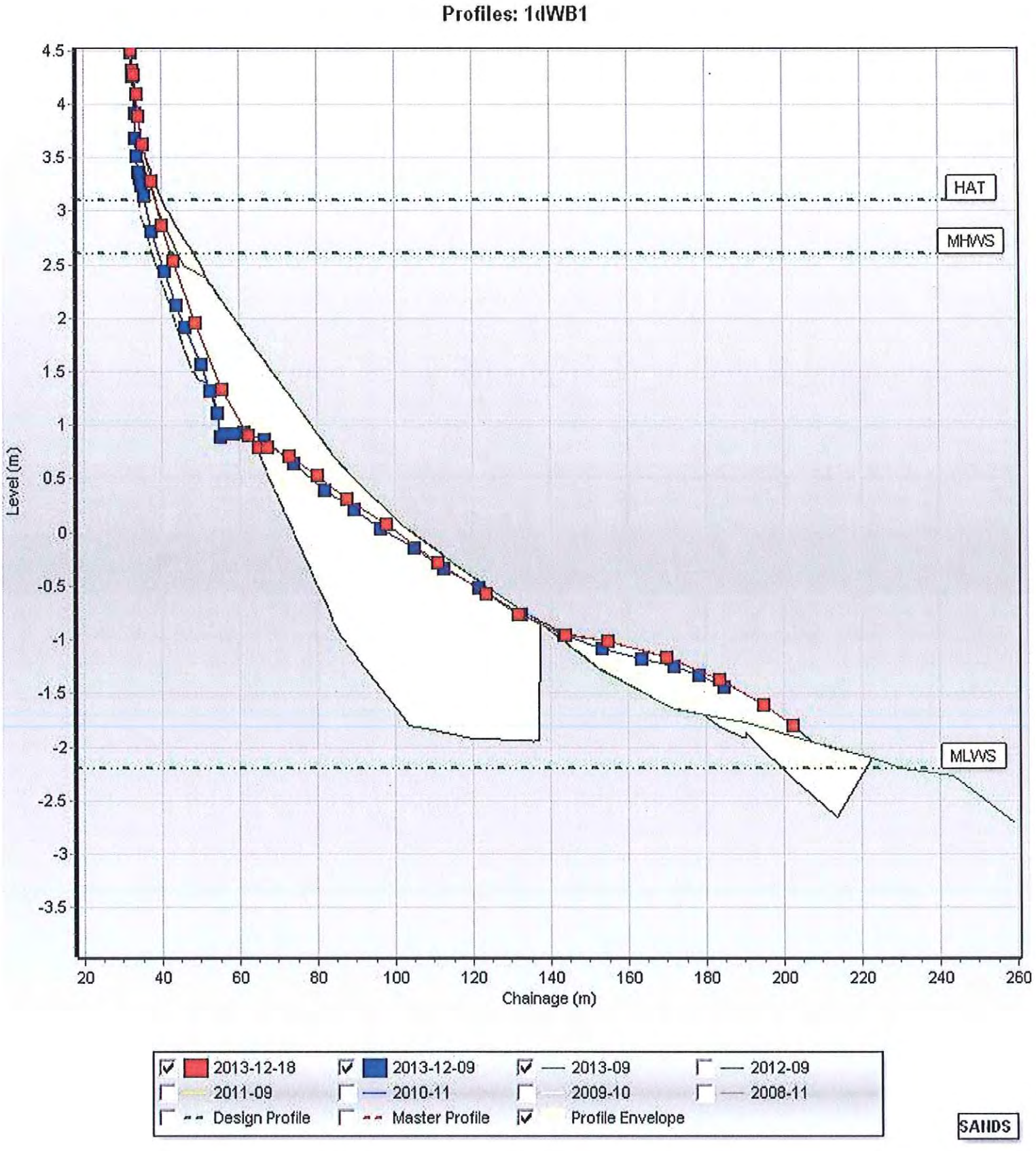
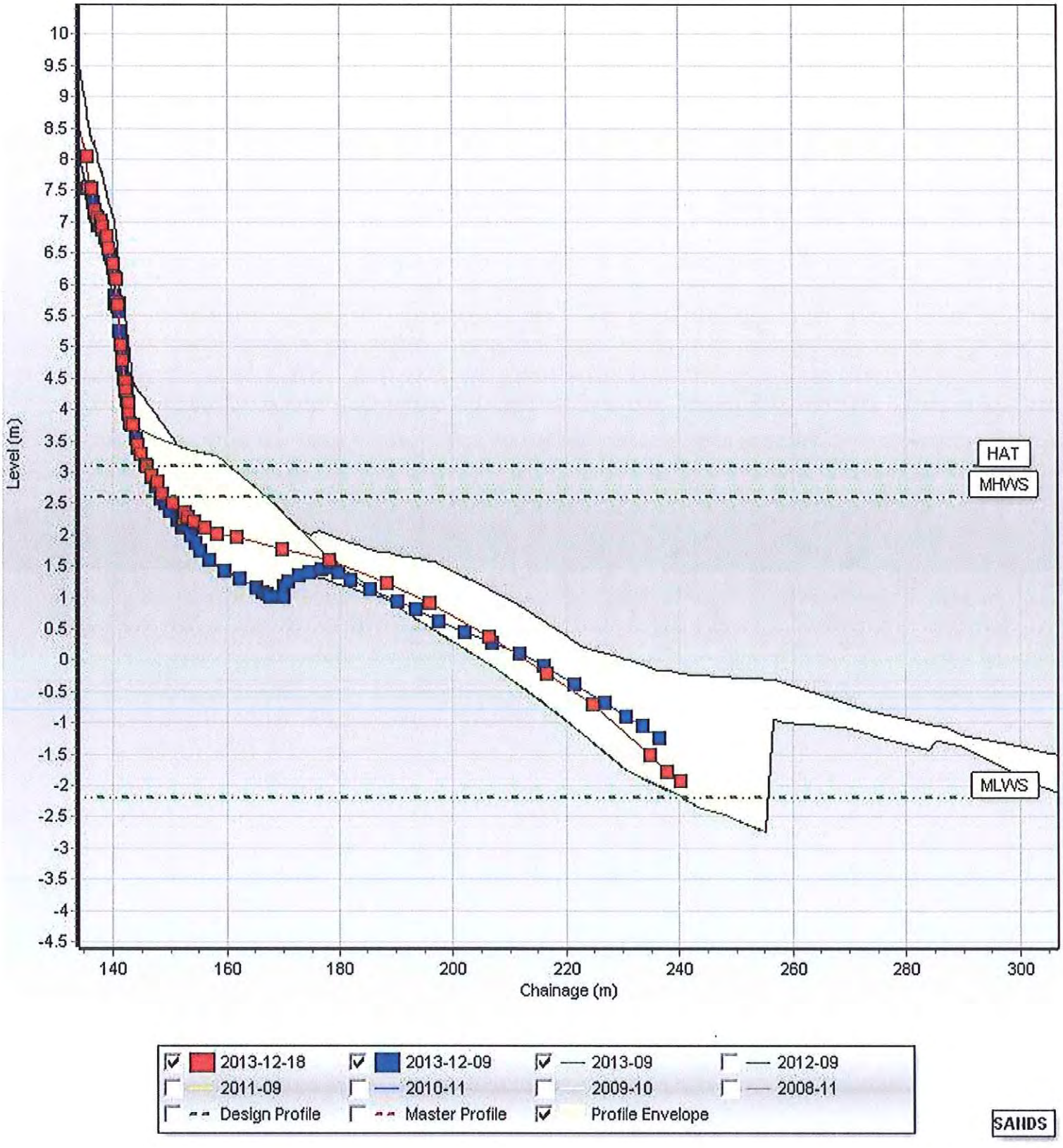
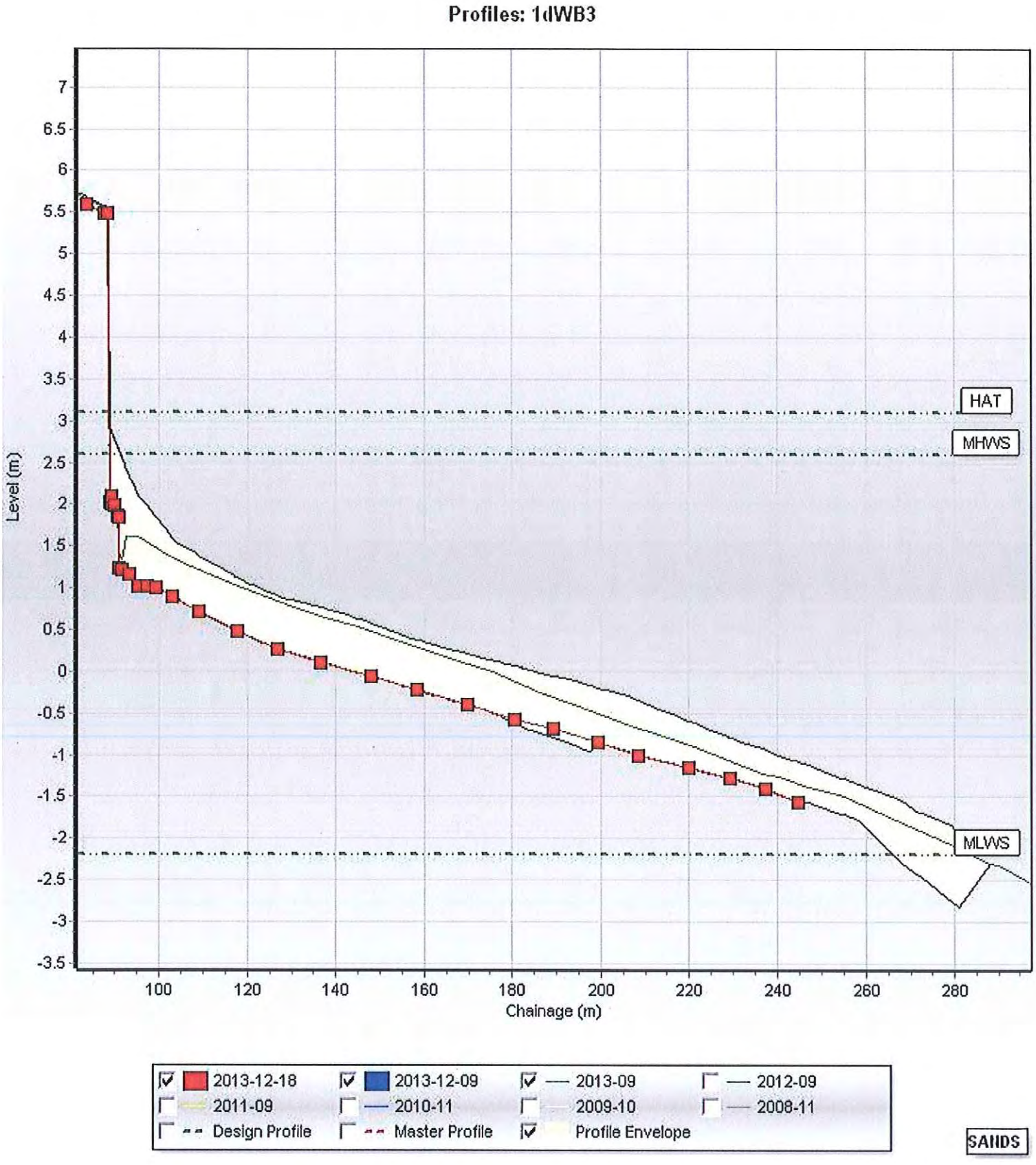
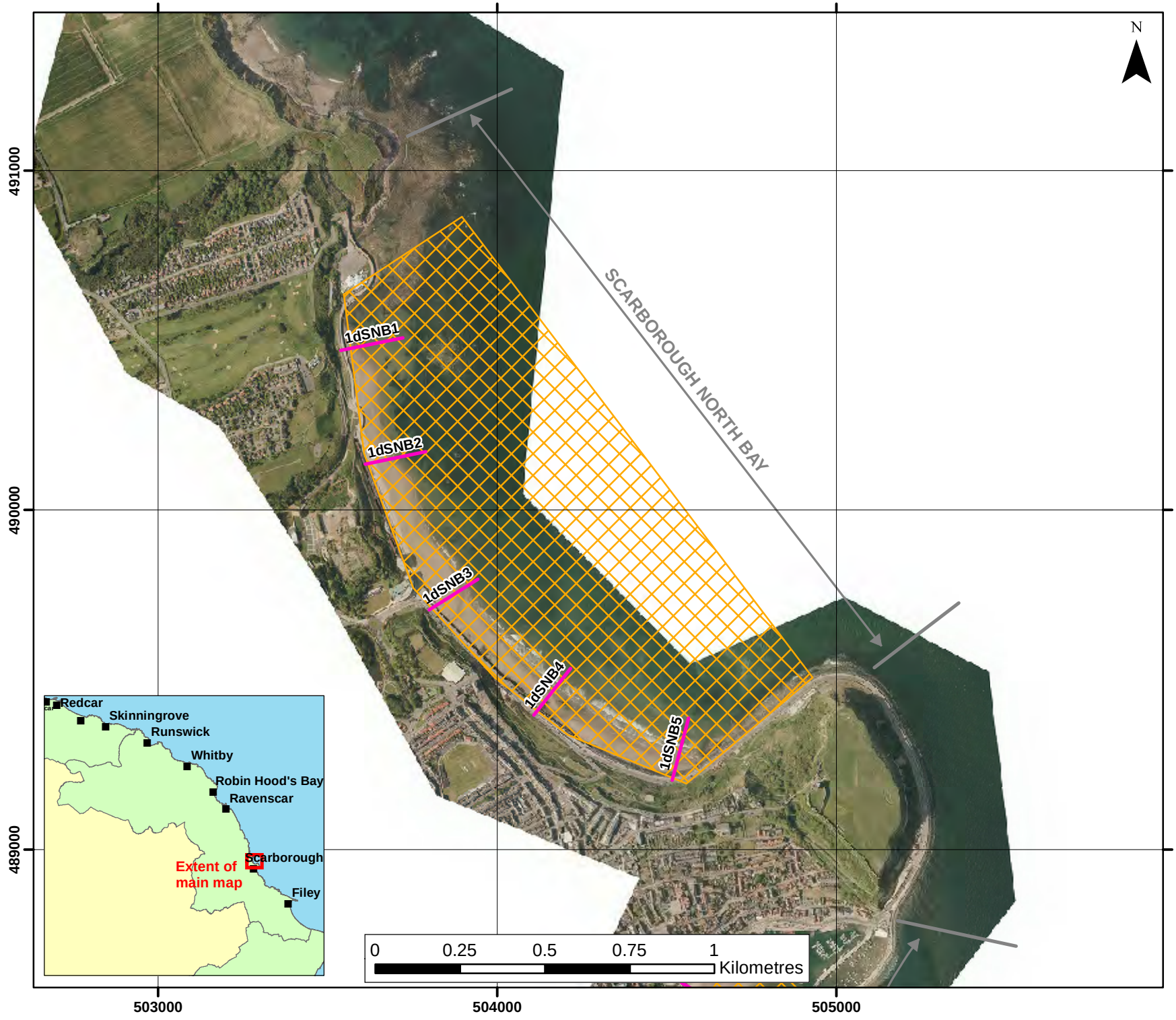

Profiles: 1dWB1
Level (m)
Chainage (m)
HAT
MHWS
MLWS
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-3
-3.5
20
40
60
80
100
120
140
160
180
200
220
240
260
2013-12-18
2013-12-09
2013-09
2012-09
2011-09
2010-11
2009-10
2008-11
Design Profile
Master Profile
Profile Envelope
SAIIDS

Profiles: 1dWB2




Profiles: 1dWB3
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2013-12-18
2013-12-09
2013-09
2012-09
2011-09
2010-11
2009-10
2008-11
Design Profile
Master Profile
Profile Envelope
SAIIDS



KEY

Topographic Profiles
- Annual
- 6 monthly

Topographic Surveys
- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs
- 50m centres
- 100m centres
- 300m centres

(Indicative survey extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Figure 2 - Map 5
Survey Locations
Scarborough North Bay
Scarborough Borough Council

Analytical Report 6
Full Measures Survey
Autumn 2013

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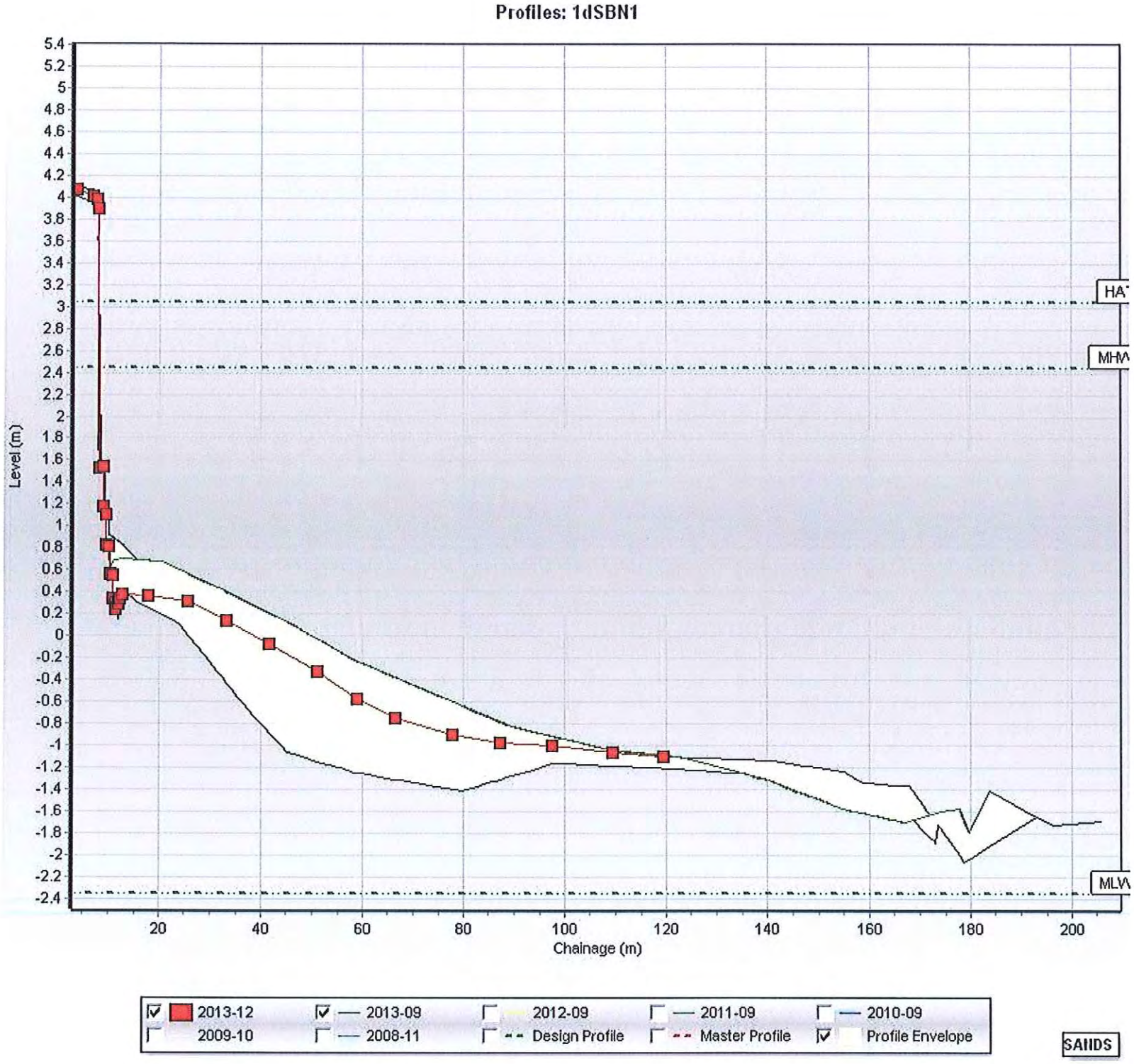
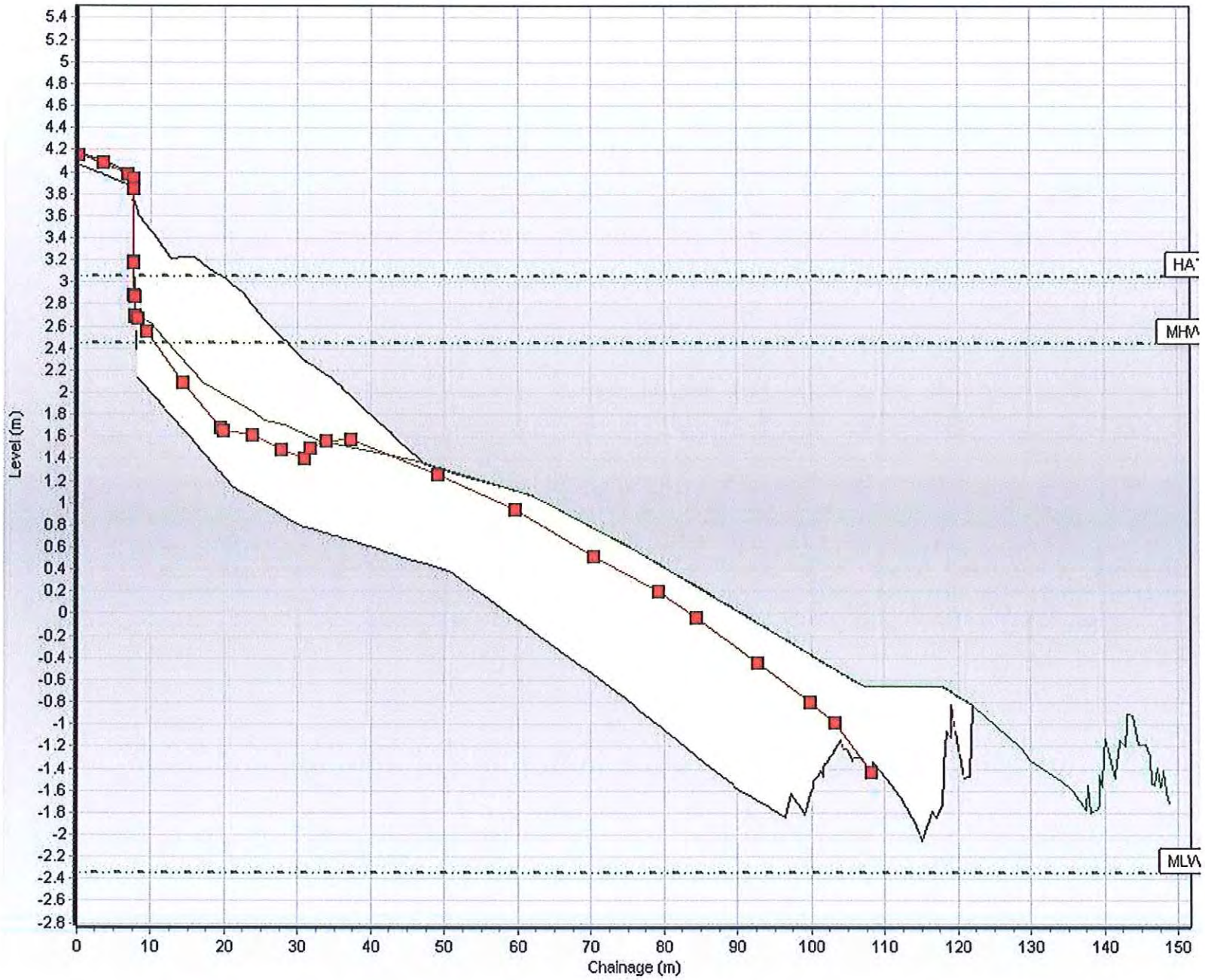

Profiles: 1dSBN1
Level (m)
Chainage (m)
HA
MHW
MLW
2013-12
2013-09
2012-09
2011-09
2010-09
2009-10
2008-11
Design Profile
Master Profile
Profile Envelope
SANDS

Profiles: 1dSBN2



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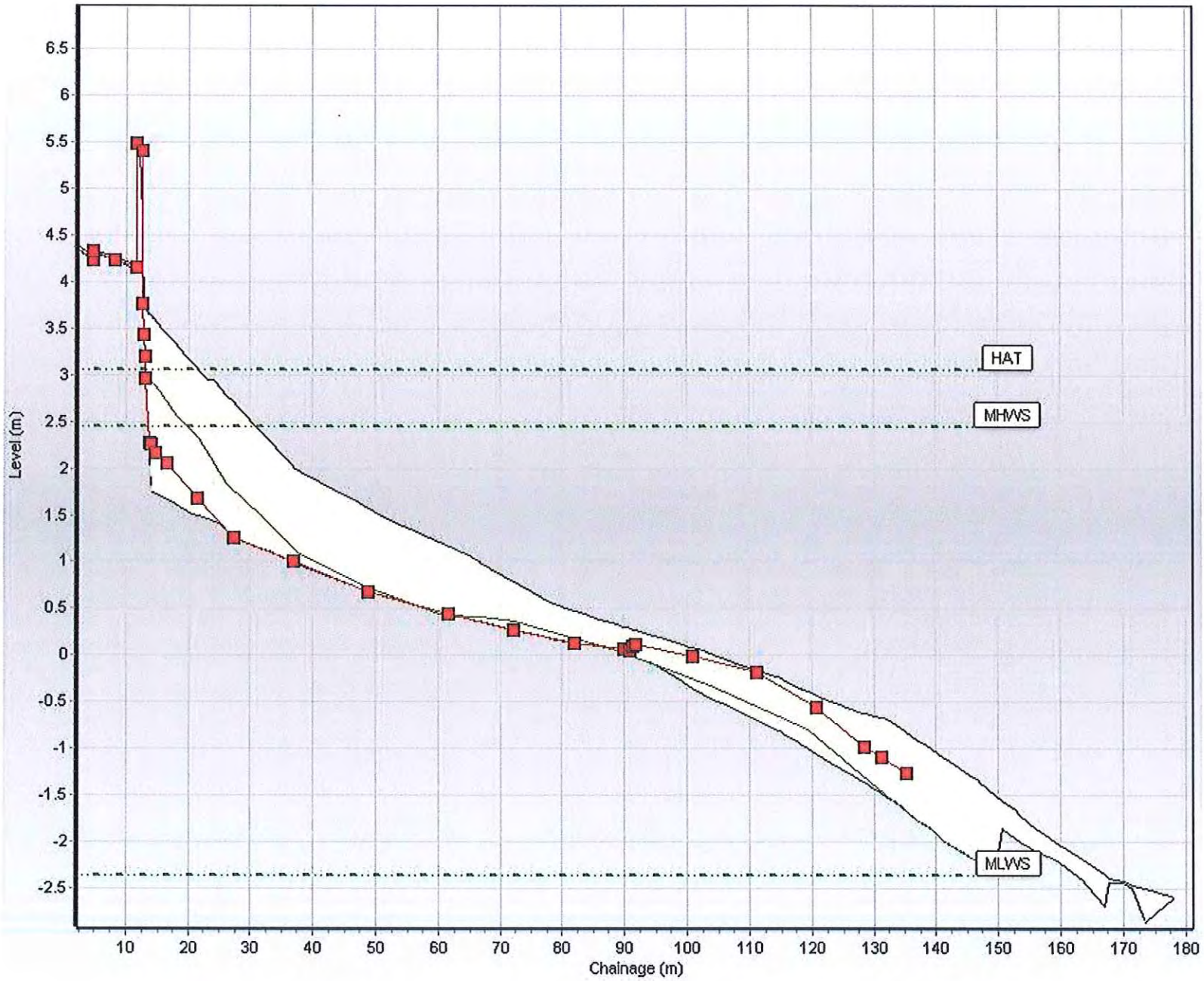

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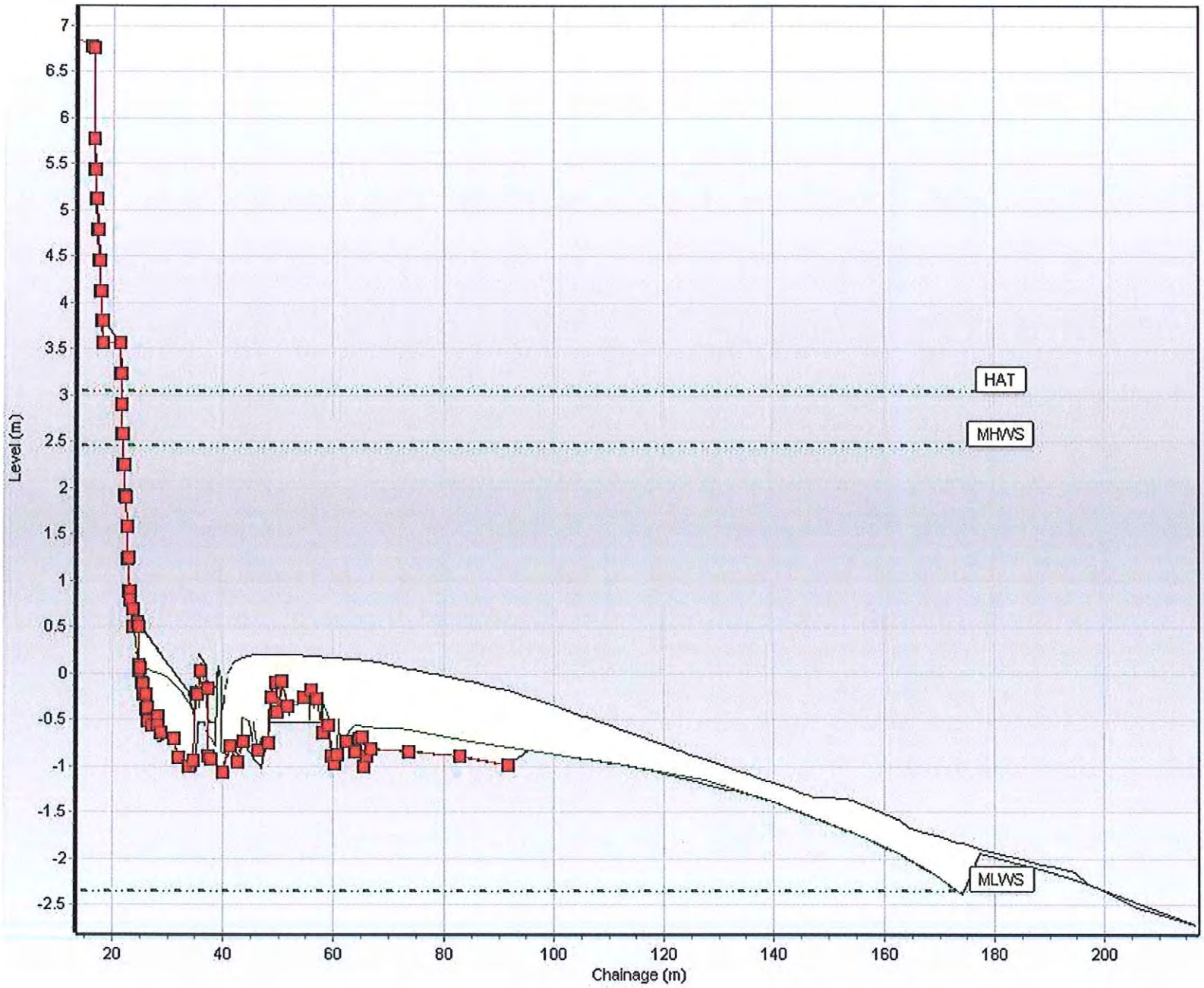

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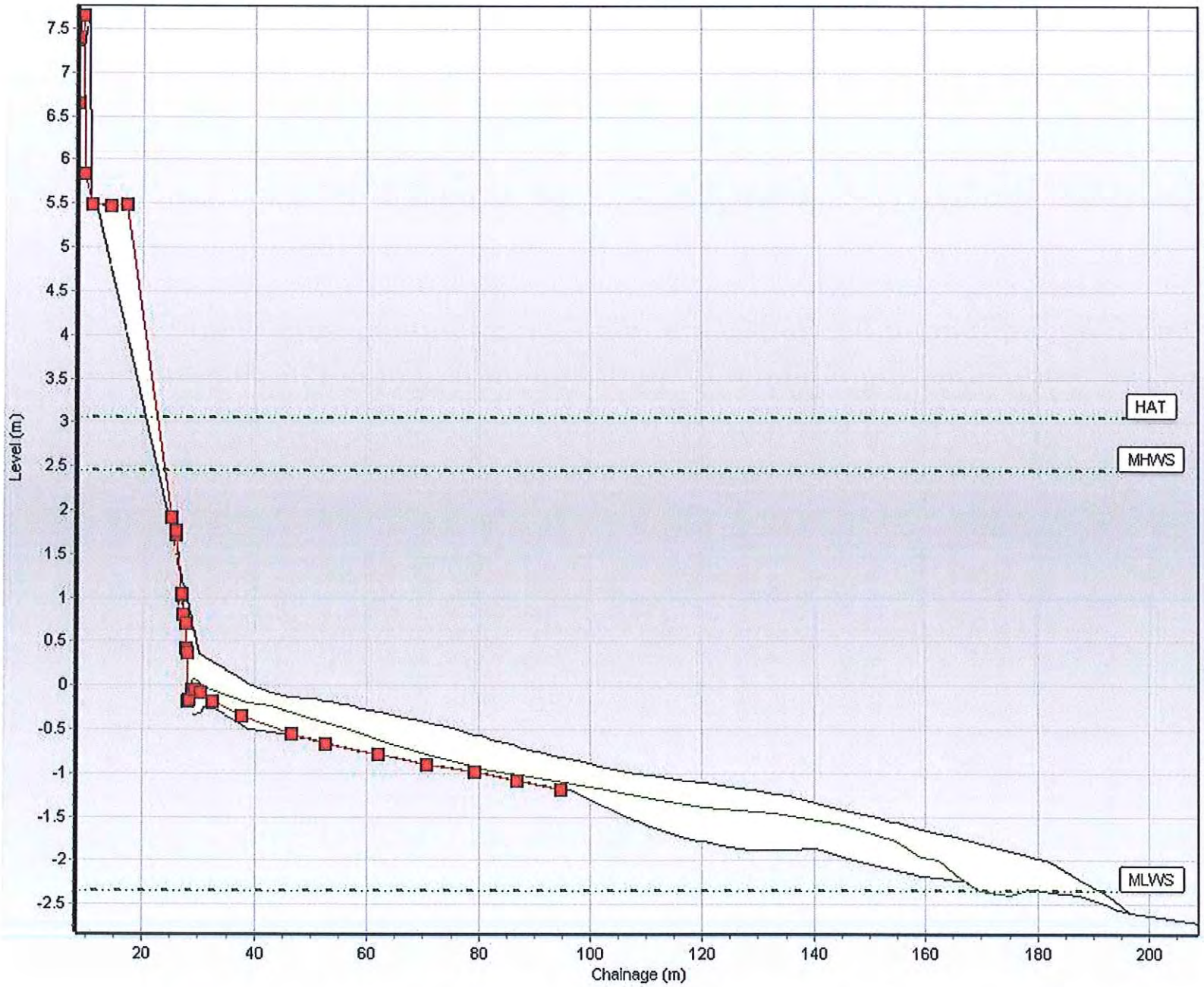
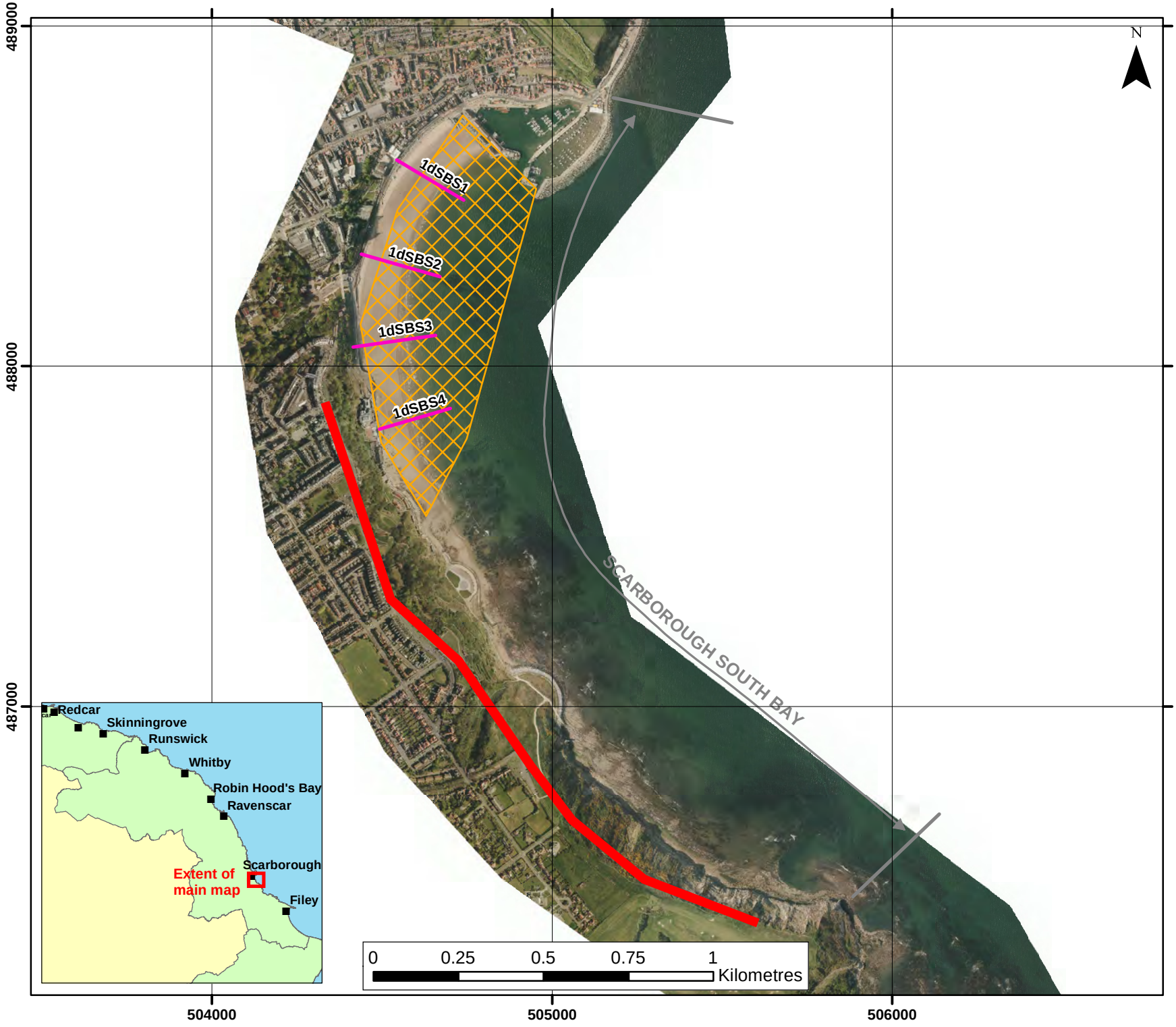


SAIIDS



KEY

Topographic Profiles
- Annual
- 6 monthly

Topographic Surveys
- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs
- 50m centres
- 100m centres
- 300m centres

(Indicative survey extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Figure 2 - Map 6
Survey Locations
Scarborough South Bay
Scarborough Borough Council

Analytical Report 6
Full Measures Survey
Autumn 2013

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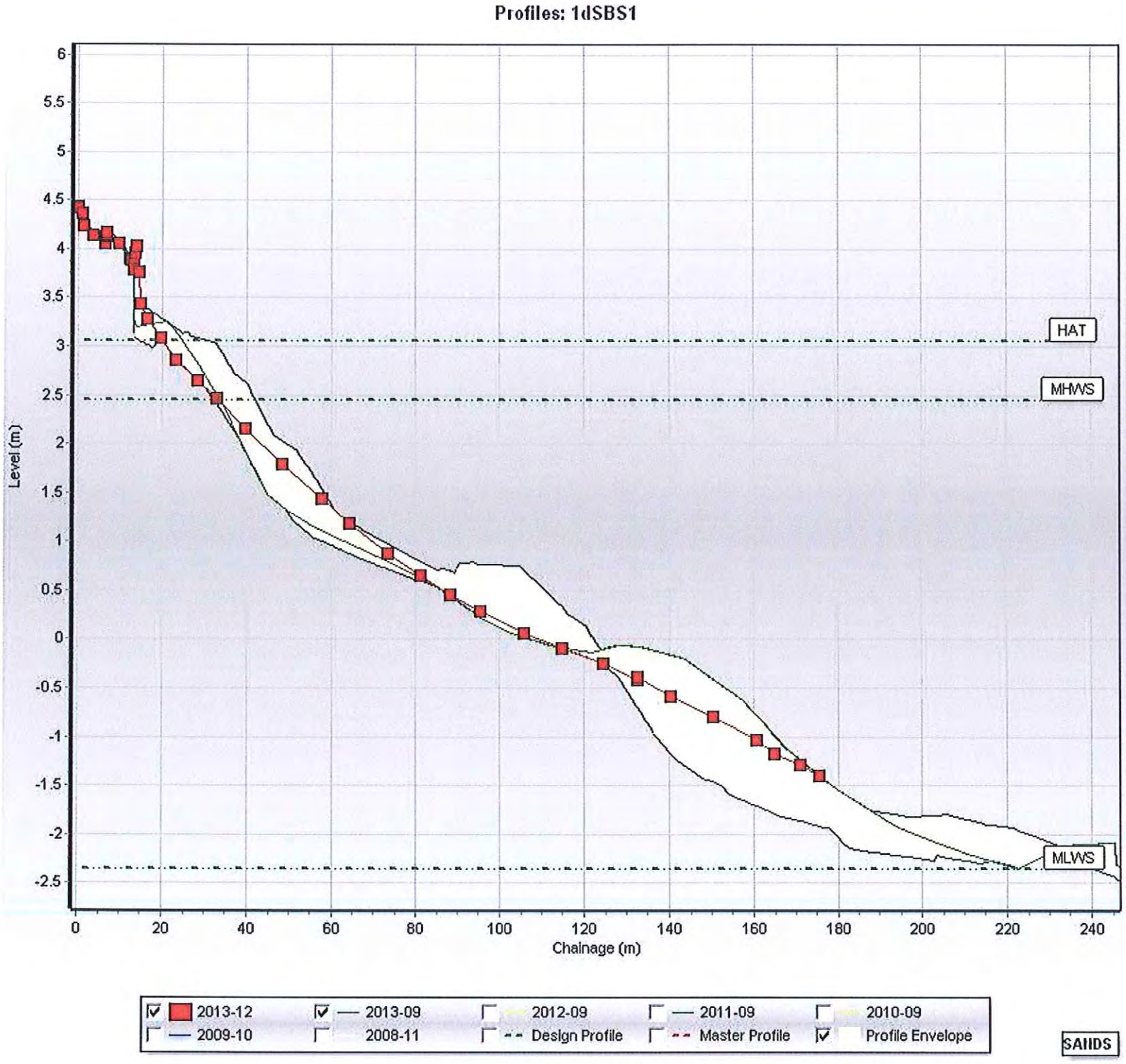
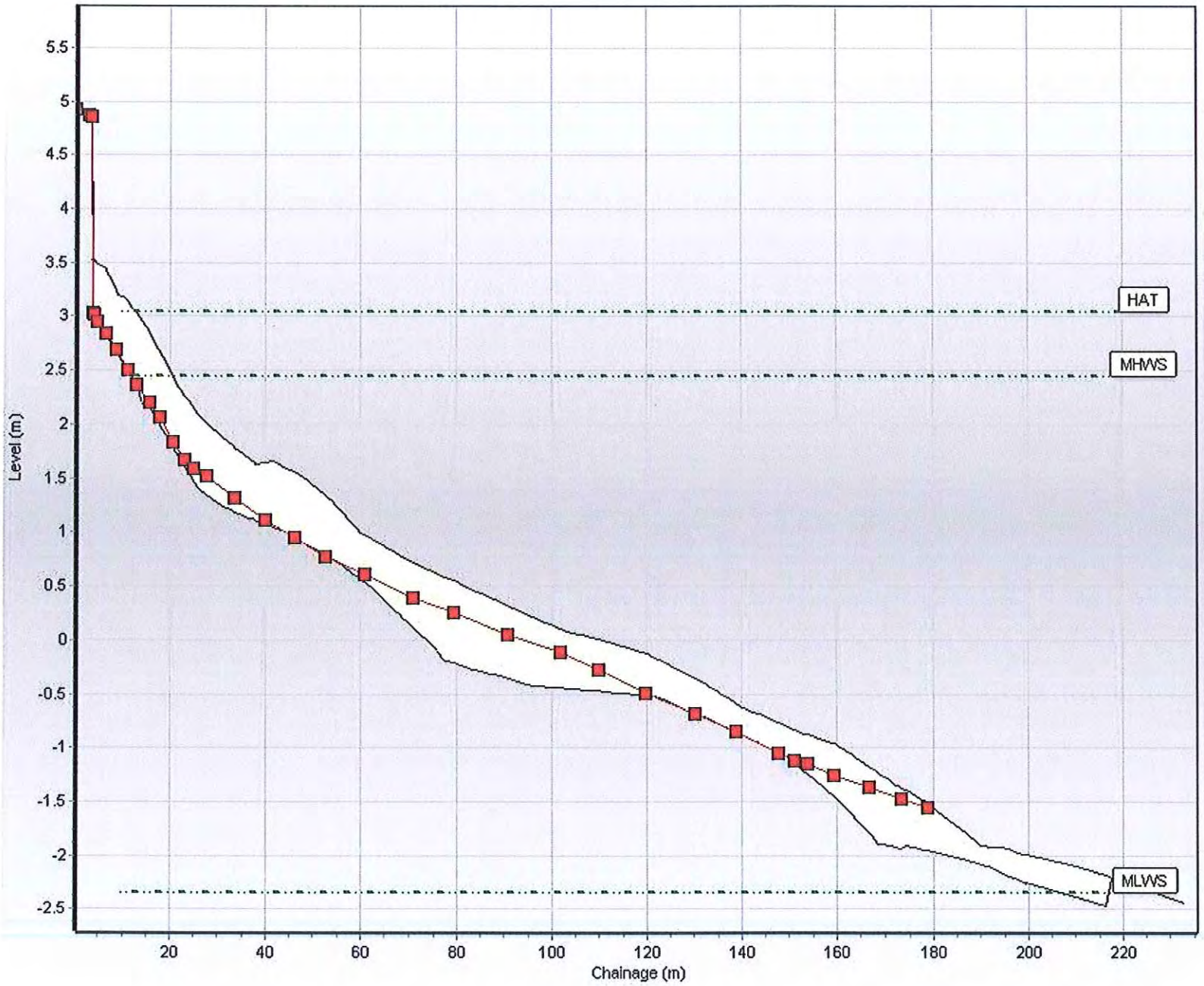
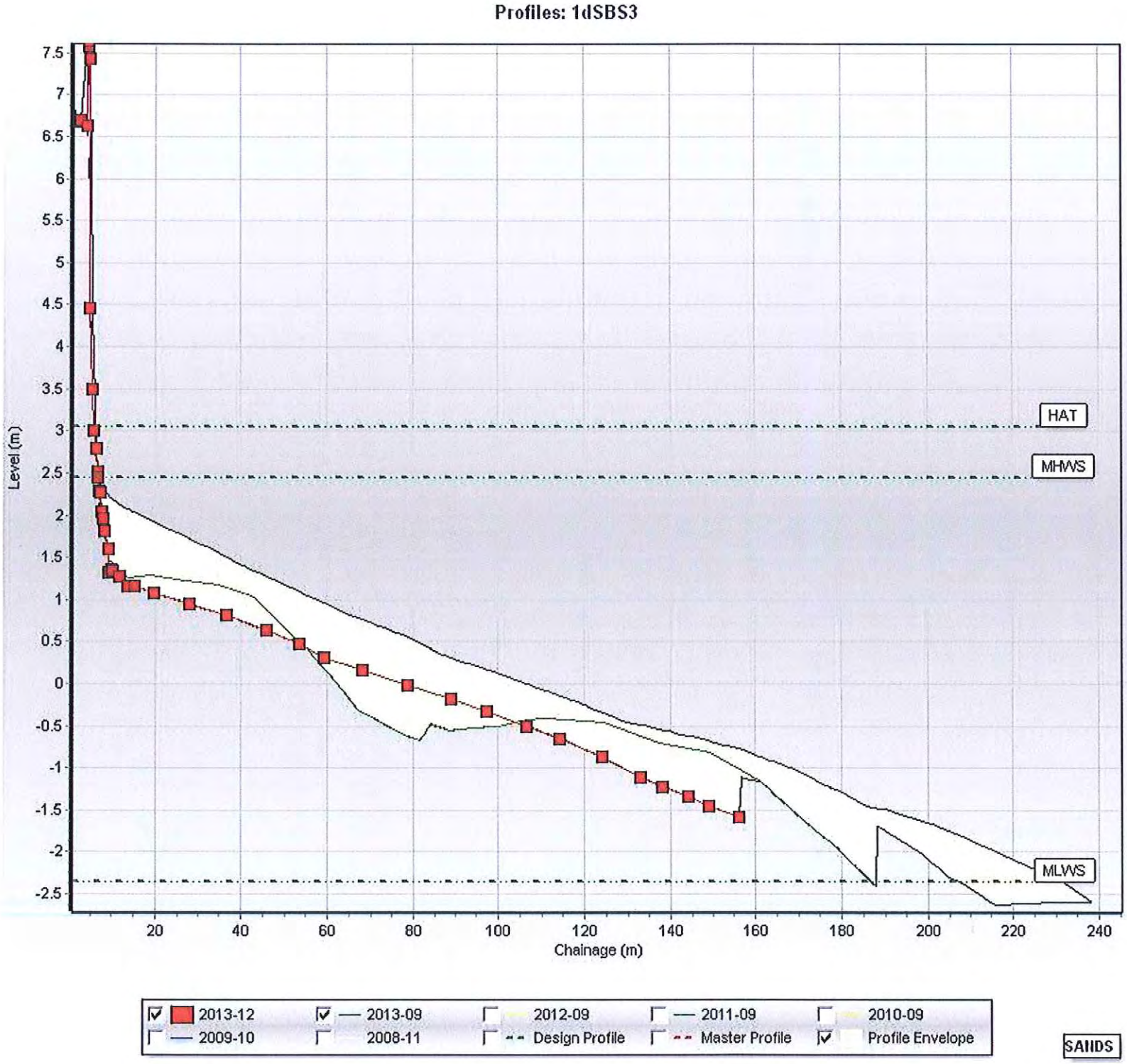
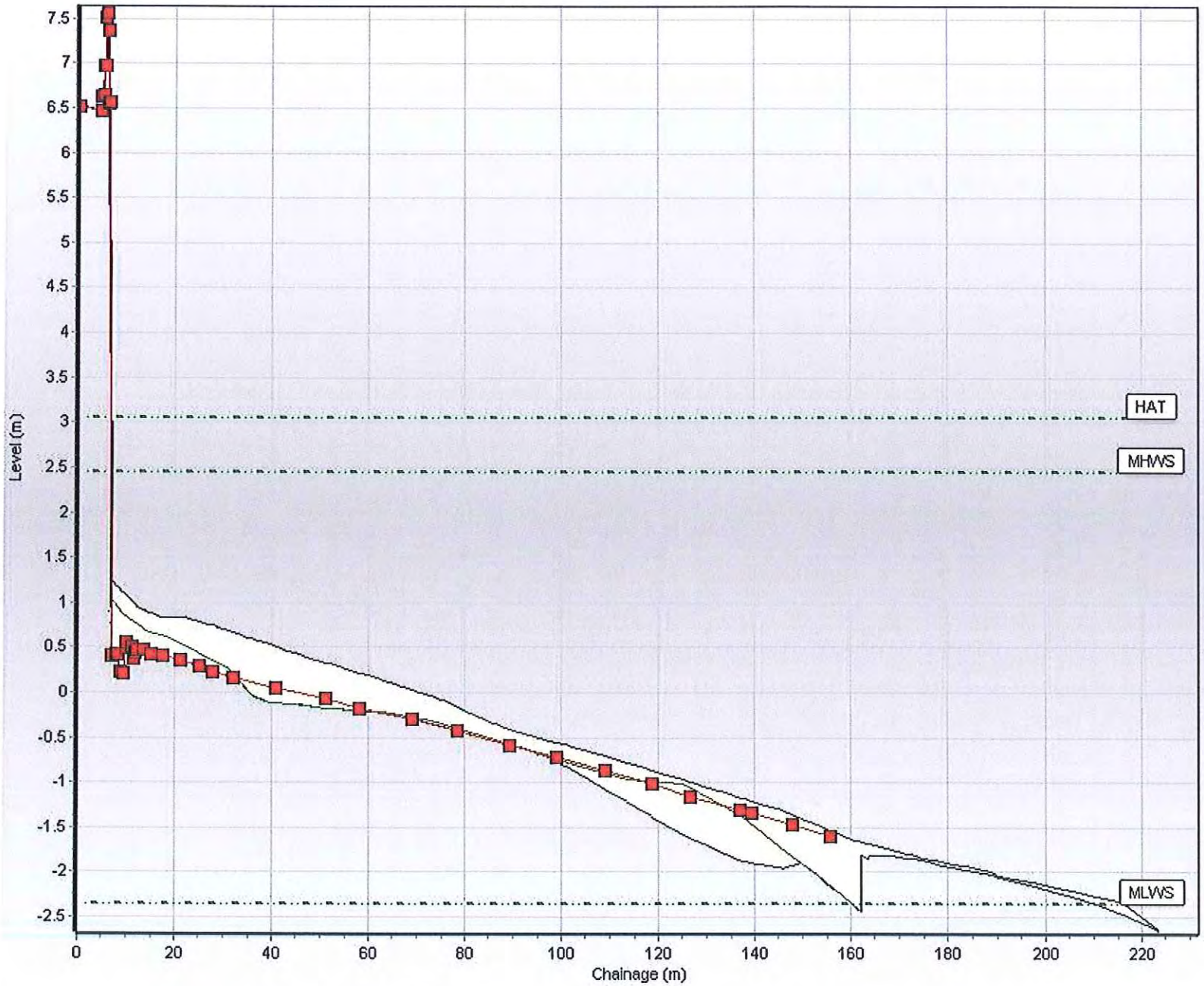

Profiles: 1dSBS1
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2013-12
2013-09
2012-09
2011-09
2010-09
2009-10
2008-11
Design Profile
Master Profile
Profile Envelope
SANDS

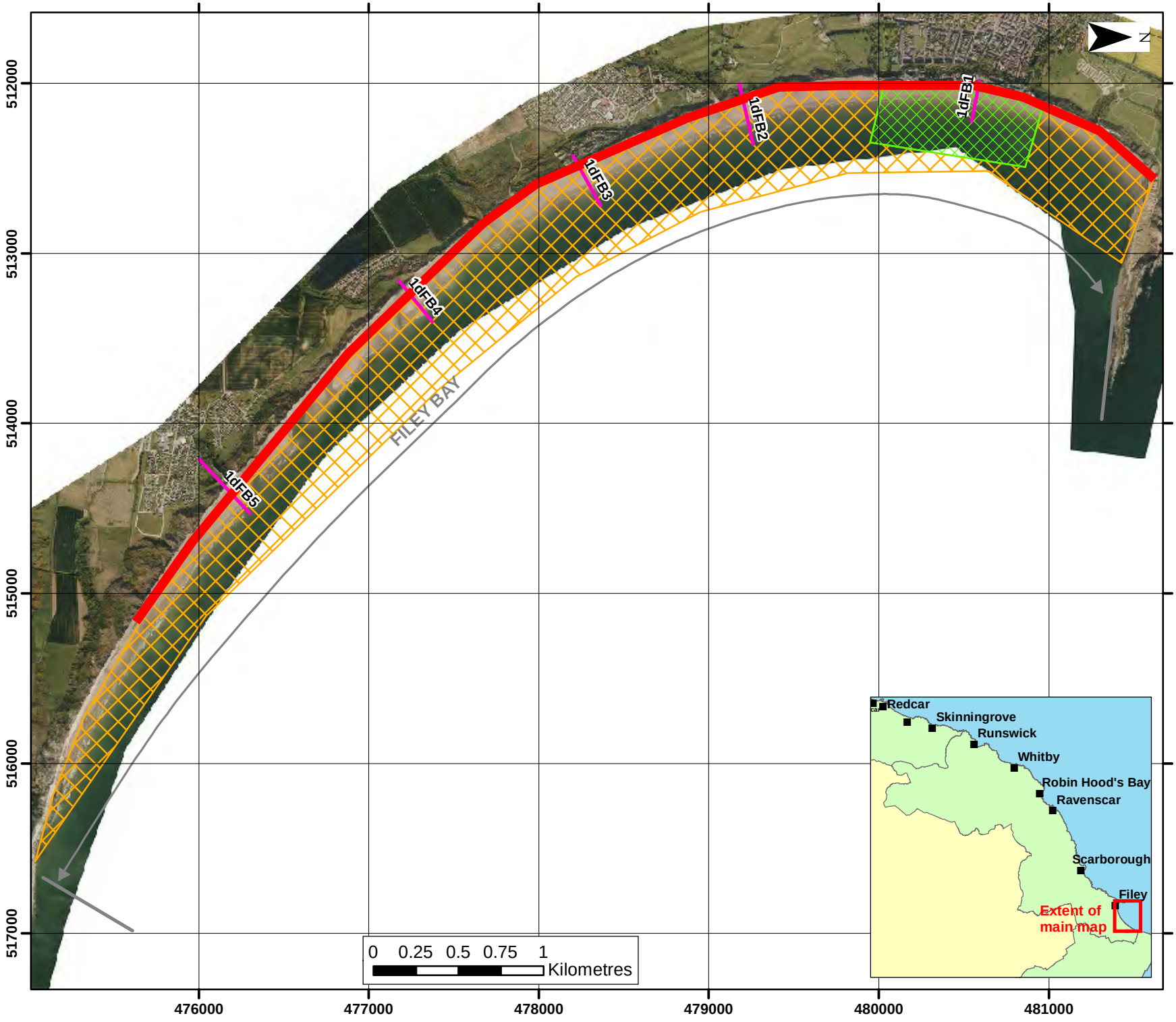
Profiles: 1dSBS2




Profiles: 1dSBS3
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2013-12
2013-09
2012-09
2011-09
2010-09
2009-10
2008-11
Design Profile
Master Profile
Profile Envelope
SANDS

Profiles: 1dSBS4





KEY

Topographic Profiles
- Annual
- 6 monthly

Topographic Surveys
- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs
- 50m centres
- 100m centres
- 300m centres

(Indicative survey extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Figure 2 - Map 8
Survey Locations
Filey
Scarborough
Borough Council

Analytical Report 6
Full Measures Survey
Autumn 2013

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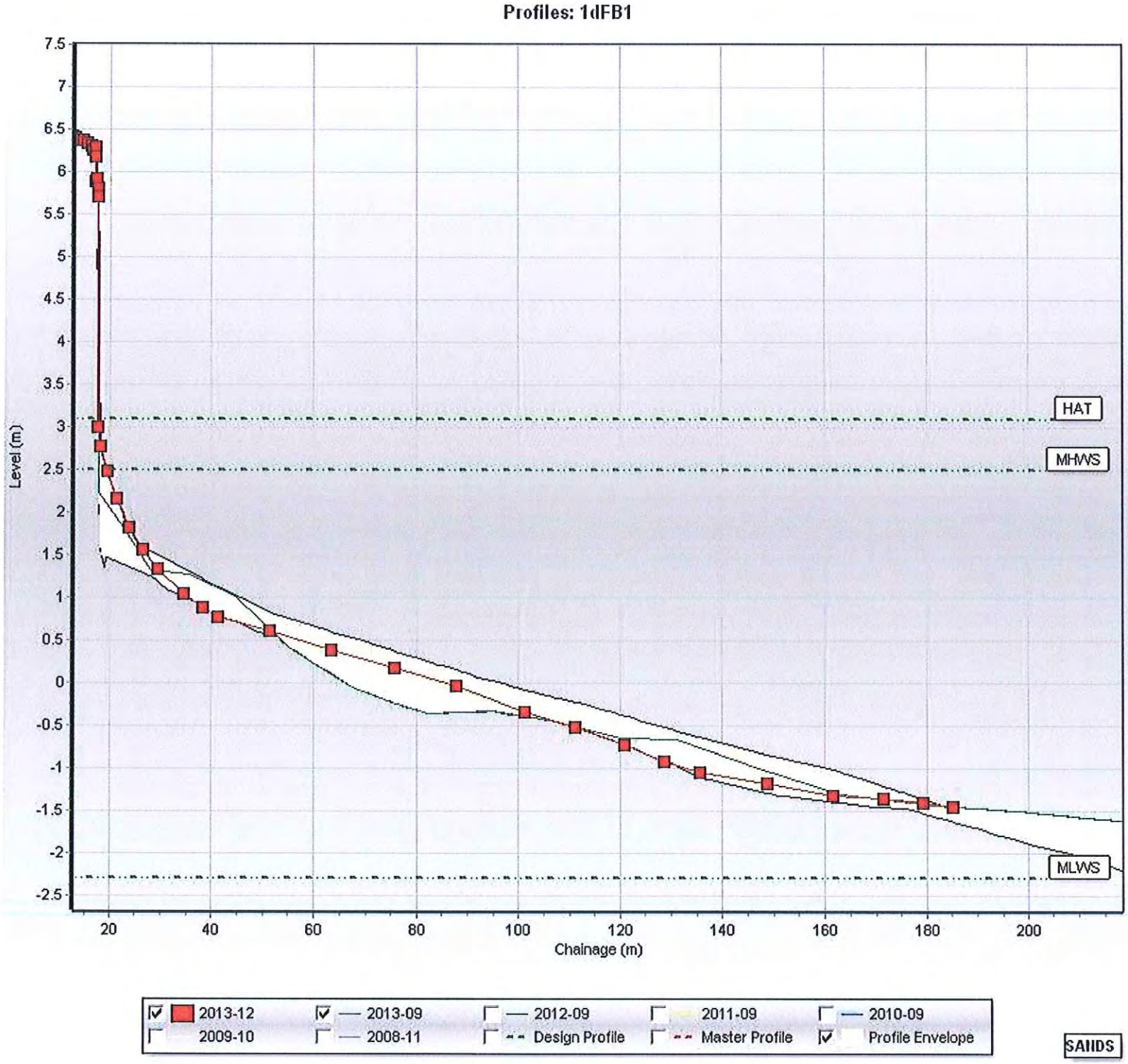
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Level (m)
Chainage (m)
HAT
MHWS
MLWS
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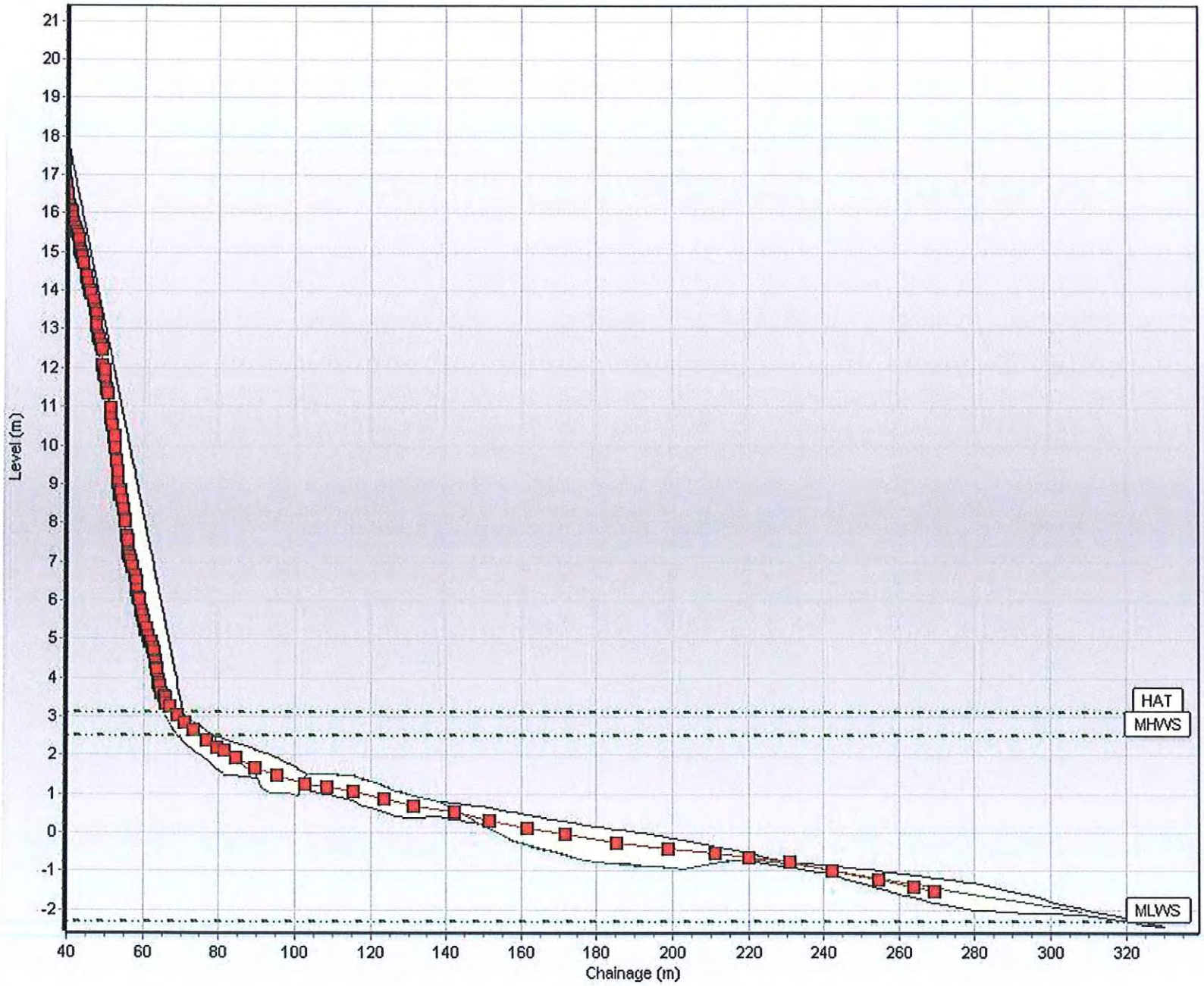
2013-09
2012-09
2011-09
2010-09
2009-10
2008-11
Design Profile
Master Profile
Profile Envelope
SANDS

Profiles: 1dFB2



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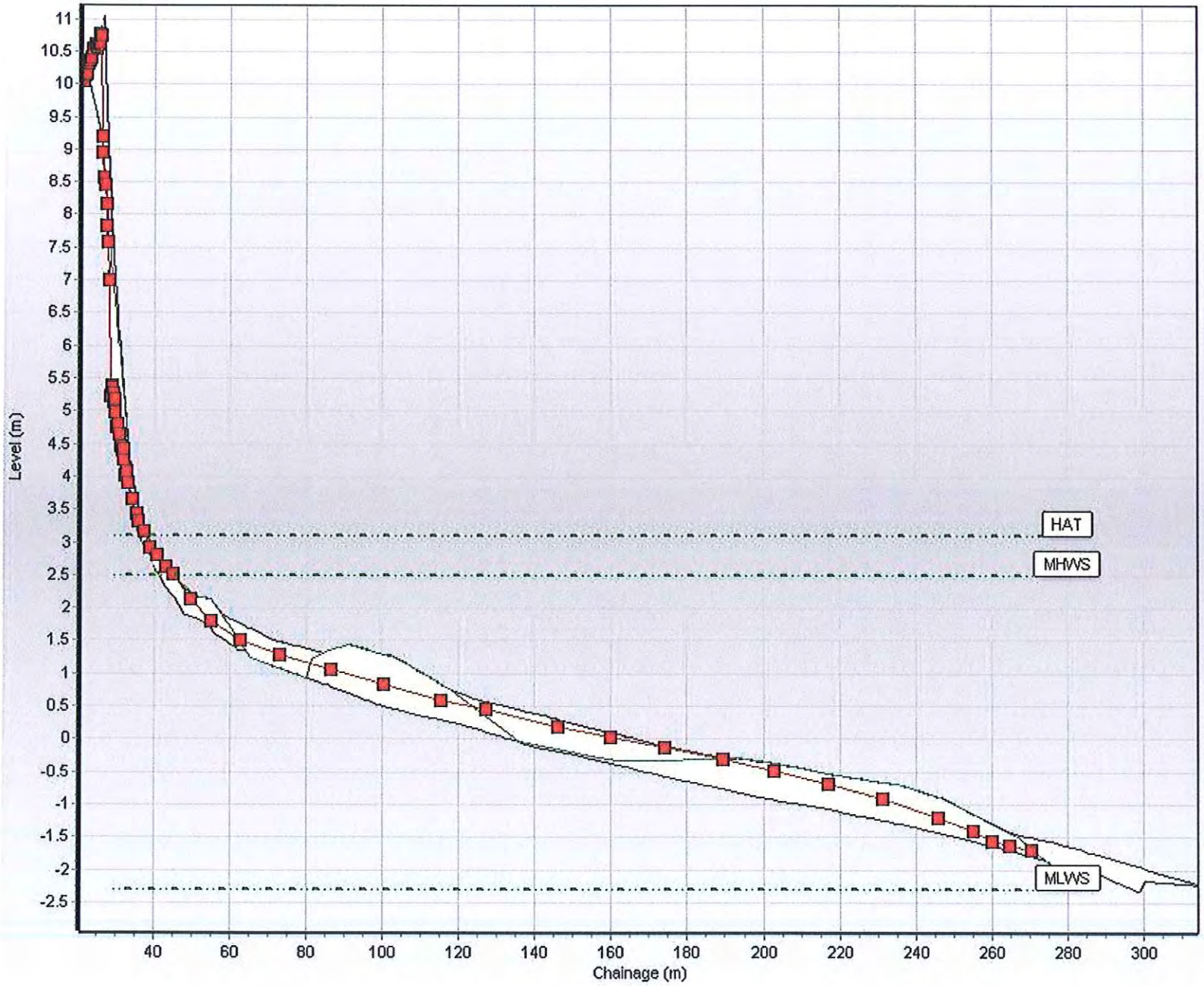
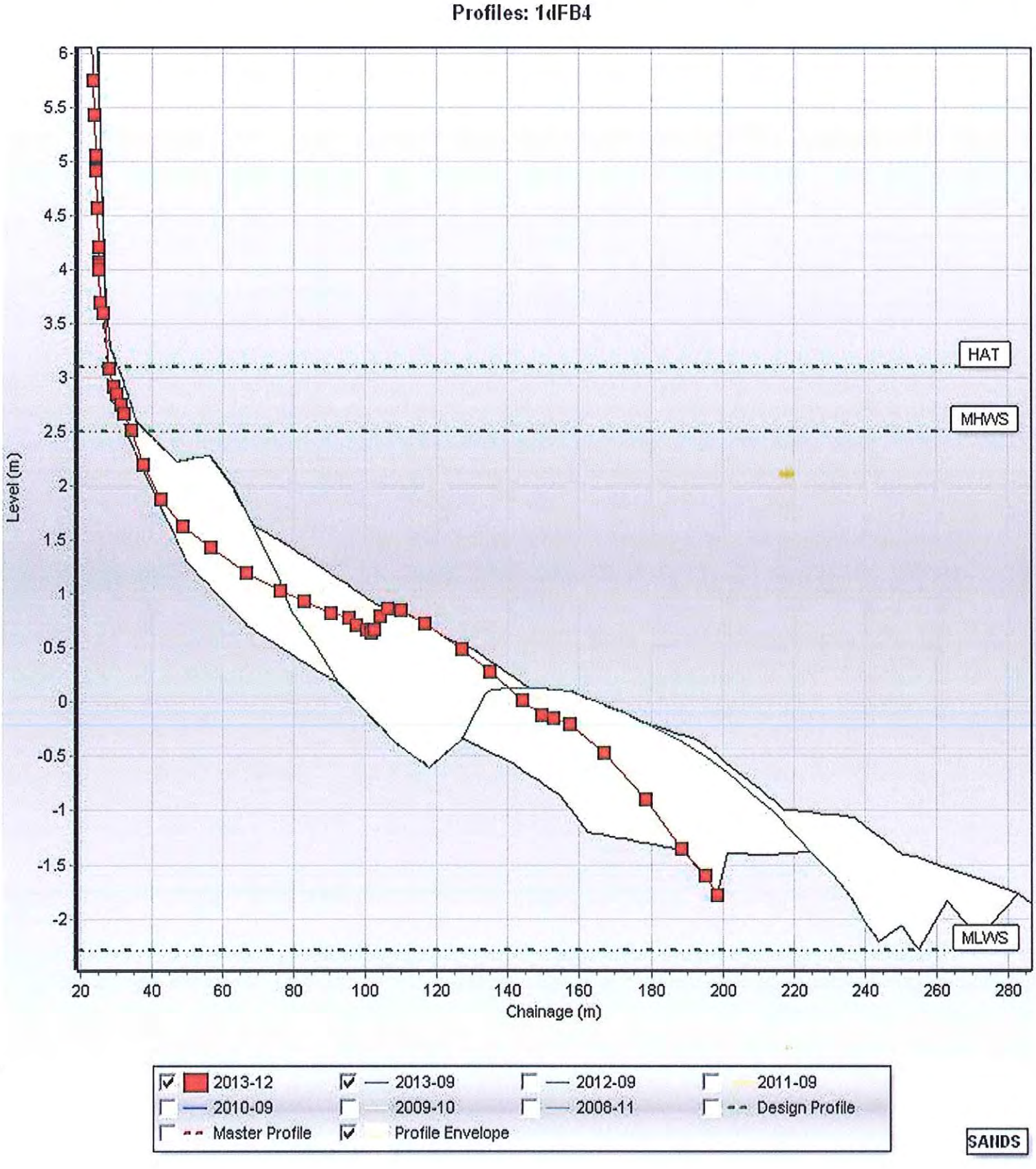
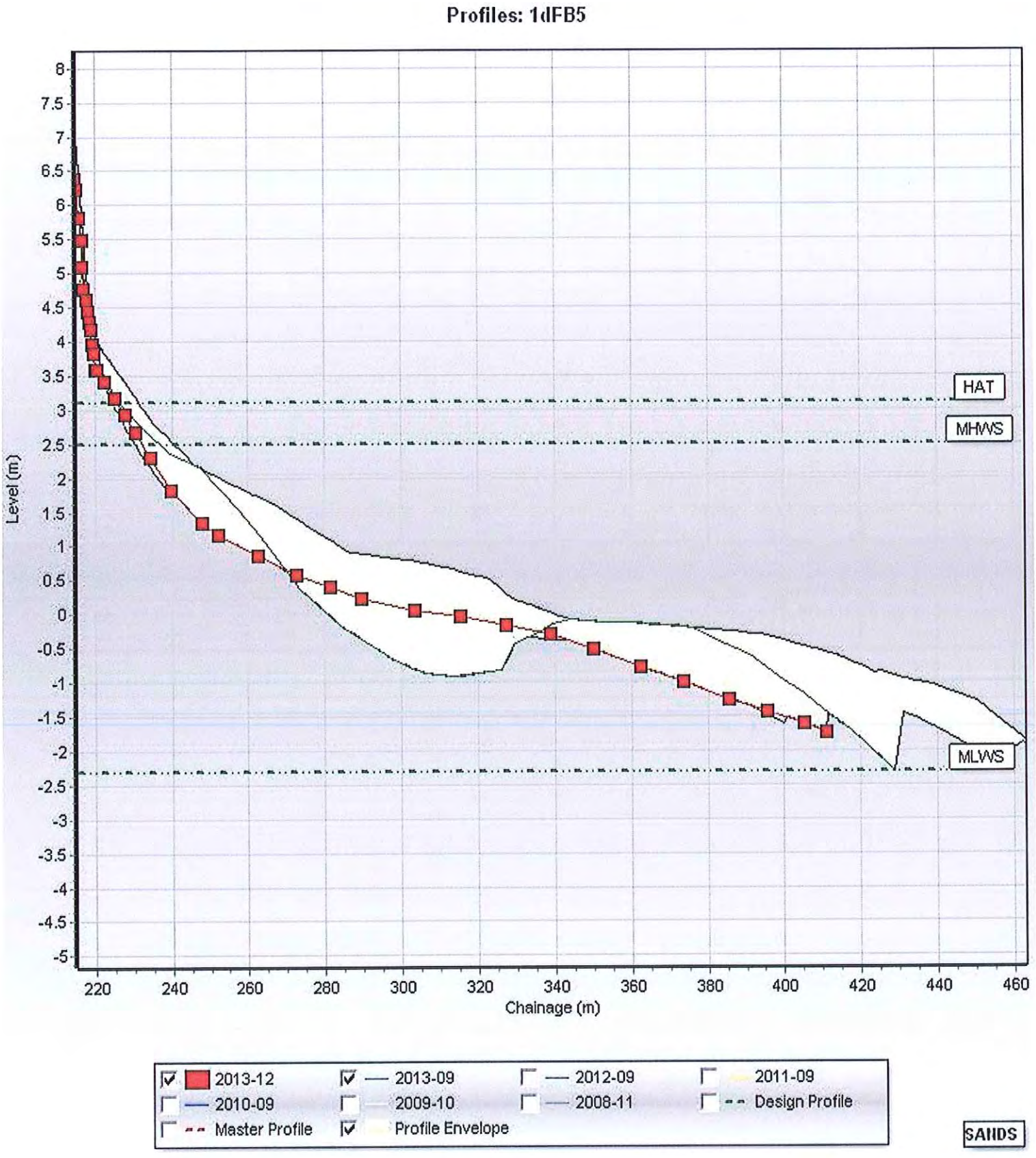



Profiles: 1dFB4
Level (m)
Chainage (m)
HAT
MHWS
MLWS
2013-12
2013-09
2012-09
2011-09
2010-09
2009-10
2008-11
Design Profile
Master Profile
Profile Envelope
SANDS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Level (m)
Chainage (m)
HAT
MHWS
MLWS
2013-12
2013-09
2012-09
2011-09
2010-09
2009-10
2008-11
Design Profile
Master Profile
Profile Envelope
SAIIDS