



**Cell 1 Regional Coastal Monitoring Programme
Analytical Report 1: 'Full Measures' Survey 2011**



**County Durham Council
Final Report**

October 2012

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Abbreviations and Acronyms

Acronym / Abbreviation	Definition
AONB	Area of Outstanding Natural Beauty
DGM	Digital Ground Model
HAT	Highest Astronomical Tide
LAT	Lowest Astronomical Tide
MHWN	Mean High Water Neap
MHWS	Mean High Water Spring
MLWS	Mean Low Water Neap
MLWS	Mean Low Water Spring
m	metres
ODN	Ordnance Datum Newlyn

Water Levels Used in Interpretation of Changes

Water Level Parameter	Water Level (m AOD)			
	River Tyne to Frenchman's Bay	Frenchman's Bay to Souter Point	Souter Point to Chourdon Point	Chourdon Point to Hartlepool Headland
1 in 200 year	3.41	3.44	3.66	3.91
HAT	2.85	2.88	3.18	3.30
MHWS	2.15	2.18	2.48	2.70
MLWS	-2.15	-2.12	-1.92	-1.90

Source: *River Tyne to Flamborough Head Shoreline Management Plan 2.*
Royal Haskoning, February 2007.

Glossary of Terms

Term	Definition
Beach nourishment	Artificial process of replenishing a beach with material from another source.
Berm crest	Ridge of sand or gravel deposited by wave action on the shore just above the normal high water mark.
Breaker zone	Area in the sea where the waves break.
Coastal squeeze	The reduction in habitat area which can arise if the natural landward migration of a habitat under sea level rise is prevented by the fixing of the high water mark, e.g. a sea wall.
Downdrift	Direction of alongshore movement of beach materials.
Ebb-tide	The falling tide, part of the tidal cycle between high water and the next low water.
Fetch	Length of water over which a given wind has blown that determines the size of the waves produced.
Flood-tide	Rising tide, part of the tidal cycle between low water and the next high water.
Foreshore	Zone between the high water and low water marks, also known as the intertidal zone.
Geomorphology	The branch of physical geography/geology which deals with the form of the Earth, the general configuration of its surface, the distribution of the land, water, etc.
Groyne	Shore protection structure built perpendicular to the shore; designed to trap sediment.
Mean High Water (MHW)	The average of all high waters observed over a sufficiently long period.
Mean Low Water (MLW)	The average of all low waters observed over a sufficiently long period.
Mean Sea Level (MSL)	Average height of the sea surface over a 19-year period.
Offshore zone	Extends from the low water mark to a water depth of about 15 m and is permanently covered with water.
Storm surge	A rise in the sea surface on an open coast, resulting from a storm.
Swell	Waves that have travelled out of the area in which they were generated.
Tidal prism	The volume of water within the estuary between the level of high and low tide, typically taken for mean spring tides.
Tide	Periodic rising and falling of large bodies of water resulting from the gravitational attraction of the moon and sun acting on the rotating earth.
Topography	Configuration of a surface including its relief and the position of its natural and man-made features.
Transgression	The landward movement of the shoreline in response to a rise in relative sea level.
Updrift	Direction opposite to the predominant movement of longshore transport.
Wave direction	Direction from which a wave approaches.
Wave refraction	Process by which the direction of approach of a wave changes as it moves into shallow water.

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 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.

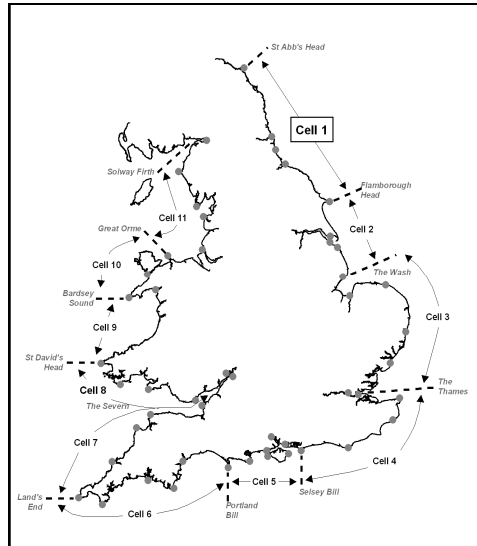


Figure 1 Sediment Cells in England and Wales

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:



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

The beach profile surveys, topographic surveys and cliff top recession surveys are undertaken as a 'Full Measures' survey in autumn/early winter every year. Some of these surveys are then repeated the following spring as part of a 'Partial Measures' survey.

Each year, an Analytical Report is produced for each individual authority, providing a detailed analysis and interpretation of the 'Full Measures' surveys.

This is followed by a brief Update Report for each individual authority, providing ongoing findings from the 'Partial Measures' surveys.

Annually, a Cell 1 Overview Report is also produced. This provides a region-wide summary of the main findings relating to trends and interactions along the entire Cell 1 frontage.

To date the following reports have been produced:

Table 1 Analytical, Update and Overview Reports Produced to Date

Year		Full Measures		Partial Measures		Cell 1 Overview Report
		Survey	Analytical Report	Survey	Update Report	
1	2008/09	Sep-Dec 08	May 09	Mar-May 09		-
2	2009/10	Sep-Dec 09	Mar 10	Feb-Mar 10	July 10	-
3	2010/11	Aug-Nov 10	Feb 11	Feb-Apr 11	Aug 1	Sep 11
4	2011/12	Sep 2011(*)	Aug 12			

(*) The present report is **Analytical Report 4** and provides an analysis of the 2011 Full Measures survey for County Durham Council's frontage.

In addition, separate reports are produced for other elements of the programme as and when specific components are undertaken, such as wave data collection, bathymetric and sea bed sediment data collection, aerial photography, and walk-over visual inspections.

For purposes of analysis, the Cell 1 frontage has been split into the sub-sections listed in the Table 2.

Table 2 Sub-divisions of the Cell 1 Coastline

Authority	Zone
Northumberland County Council	Spittal A
	Spittal B
	Goswick Sands
	Holy Island
	Bamburgh
	Beadnell Village
	Beadnell Bay
	Embelton Bay
	Boulmer
	Alnmouth Bay
	High Hauxley and Druridge Bay
	Lynemouth Bay
	Newbiggin Bay
	Cambois Bay
Blyth South Beach	
North Tyneside Council	Whitley Sands
	Cullercoats Bay
	Tynemouth Long Sands
	King Edward's Bay
South Tyneside Council	Littehaven Beach
	Herd Sands
	Trow Quarry (incl. Frenchman's Bay)
	Marsden Bay
Sunderland Council	Whitburn Bay
	Harbour and Docks
	Hendon to Ryhope (incl. Halliwell Banks)
Durham County Council	Featherbed Rocks
	Seaham
	Blast Beach
	Hawthorn Hive
Hartlepool Borough Council	Blackhall Colliery
	North Sands
	Headland
	Middleton
Redcar & Cleveland Borough Council	Hartlepool Bay
	Coatham Sands
	Redcar Sands
	Marske Sands
	Saltburn Sands
Scarborough Borough Council	Cattersty Sands (Skinningrove)
	Staithes
	Runswick Bay
	Sandsend Beach, Uppang Beach and Whitby Sands
	Robin Hood's Bay
	Scarborough North Bay
	Scarborough South Bay
	Cayton Bay
Filey Bay	

1. Introduction

1.1 Study Area

Durham County Council's frontage extends from Ryhope Dene to Crimdon Beck. For the purposes of this report and for consistency with previous reporting, it has been sub-divided into five areas, namely:

- Featherbed Rocks
- Seaham (Dawdon)
- Blast Beach
- Hawthorn Hive
- Blackhall Colliery

1.2 Methodology

Along Durham County Council's frontage, the following surveying is undertaken:

- Full Measures survey annually (since 2008) each autumn/early winter comprising:
 - Beach profile surveys along eight. transect lines
- Partial Measures survey annually (since 2009) each spring comprising:
 - Beach profile surveys along five. transect lines
- Cliff top survey bi-annually at:
 - Seaham (Dawdon)

The location of these surveys is shown in Figure 2. The 2011 Full Measures survey was undertaken along this frontage in September and October of 2011 when weather conditions were sunny and dry for Blackhall and Easington, with a calm sea state. For the Seaham survey the weather was breezy and drizzly and the sea state was moderate.

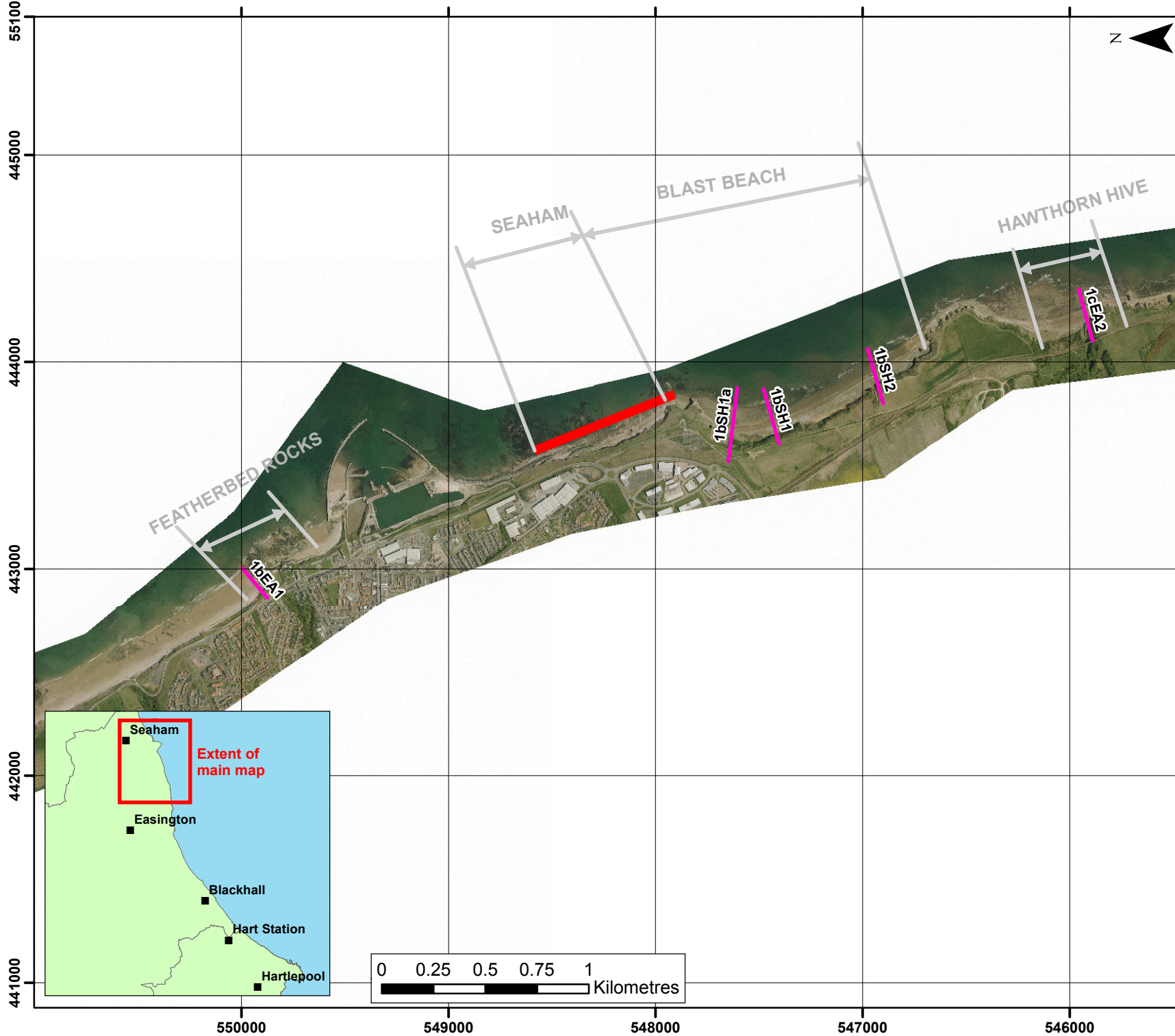
All data have been captured in a manner commensurate with the principles of the Environment Agency's *National Standard Contract and Specification for Surveying Services* and stored in a file format compatible with the software systems being used for the data analysis, namely SANDS and ArcGIS. This data collection approach and file format is comparable to that being used on other regional coastal monitoring programmes, such as in the South East and South West of England.

Upon receipt of the data from the survey team, they are quality assured and then uploaded onto the programme's website for storage and availability to others and also input to SANDS and GIS for subsequent analysis.

The Analytical Report is then produced following a standard structure for each authority. This involves:

- description of the changes observed since the previous survey and an interpretation of the drivers of these changes (Section 2);
- documentation of any problems encountered during surveying or uncertainties inherent in the analysis (Section 3);
- recommendations for 'fine-tuning' the programme to enhance its outputs (Section 4); and
- providing key conclusions and highlighting any areas of concern (Section 5).

Data from the present survey are presented in a processed form in the Appendices.



KEY

Topographic Profiles
 — Annual (blue line)
 — 6 monthly (pink line)

Topographic Surveys
 ☒ 6 monthly (green cross-hatch)
 ☒ yearly (orange cross-hatch)
 ☒ 5 yearly (brown cross-hatch)

Cliff Top Monitoring Pegs
 ■ 50m centres (purple square)
 ■ 100m centres (green square)
 ■ 300m centres (red square)

(Indicative Survey Extents shown)

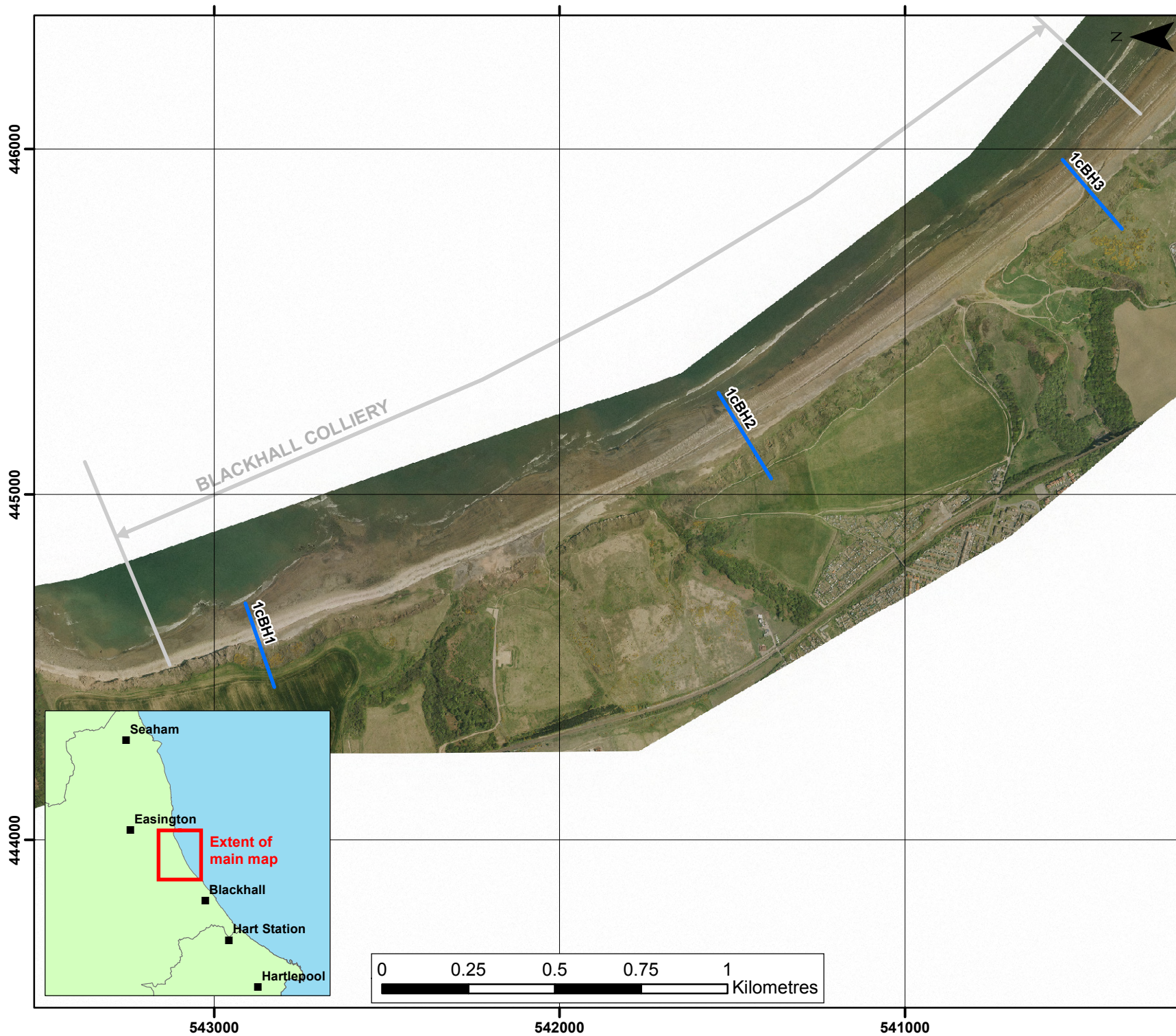
Client: North East Coastal Group
 Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Figure 2 - Map 1
Survey Locations
Featherbed Rocks to
Hawthorne Hive
Durham County Council

Analytical Report 4
 Full Measures Survey
 Winter 2011

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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 2
Survey Locations
Blackhall Colliery
Durham County Council**

Analytical Report 4
Full Measures Survey
Winter 2011



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2. Analysis of Survey Data

2.1 Featherbed Rocks

Survey Date	Description of Changes Since Last Survey	Interpretation
9 th Sept 2011	<p>Beach Profiles:</p> <p>One beach profile line, 1bEA1, is located at Featherbed Rocks (Appendix A). The profile line was relocated to its present position in March 2009. The profile extends across the cliff top, dipping slightly at the cliff edge to around 19mODN. It then drops down the cliff face to the toe of the cliff and then extends seawards across the promenade. The sea wall is then crossed, before the survey drops to beach level where a significant quantity of shingle has accumulated at the toe of the wall.</p> <p>The March 2011 and September 2011 profiles are very similar down to the HAT line. Below HAT the profiles vary so they have recorded erosion in some areas and accretion in other parts of the profile. Overall the profile is showing stability and the changes recorded are minimal. The profile has not varied greatly since April 2009.</p>	<p>The beach profile looks fairly stable overall with only minor changes since it was set up in 2009, principally to the shingle accumulation at the toe of the wall, which was high in the March and September 2011 surveys. The rocky nature of this foreshore means it is unlikely to undergo significant changes in morphology unless sediment is deposited upon it. As indicated in the previous report for 2010 although a veneer beach can be deposited over the rocky foreshore it tends to be subsequently stripped during storms.</p>

2.2 Seaham (Dawdon)

Survey Date	Description of Changes Since Last Survey	Interpretation
Oct 2011	<p>Cliff-top Survey:</p> <p>Three ground control points have been established along the cliff top at Dawdon (Figure B1). The separation between any two points is nominally 300m. These cliff top surveys are intended to inform on erosion rates of the undefended sea cliffs extending south of the rock armour revetment to the south of Seaham Harbour.</p> <p>The cliff top surveys at Dawdon are undertaken bi-annually. Measurements are taken from a fixed ground control point along a fixed bearing to the edge of the cliff top. Appendix B provides information about the ground control points and results from between the 2008 (baseline) cliff top survey and the current (September 2010) survey.</p>	<p>There is only three years of data over a limited geographical extent. As a result there is little confidence in delineating the long term trends.</p> <p>There has been recession along ground control points 1 and 3 by the order of 1m and 1.4m, respectively, since surveys began in November 2008. No significant change has occurred along ground control point 2.</p>

2.3 Blast Beach

Survey Date	Description of Changes Since Last Survey	Interpretation
9 th Oct 2011	<p>Beach Profiles:</p> <p>Blast Beach is covered by three beach profile lines (Appendix A).</p> <p>Profile 1bSH1a was added to the programme during the Full Measures survey in September 2010. It is located to the north of the previously-established SH1. All three profiles along Blast Beach exhibit similar forms, with a backing cliff, wide spoil beach with a distinct cliff at the eroding face of the colliery spoil and a gravel and sand foreshore extending down to the low water mark.</p> <p>1bSH1a has a very similar profile to the previous year down to the eroding face of the spoil deposit. The survey notes that they were unable to measure bottom of cliff on 1bSH1a due to vegetation. This is where there is a pond with vegetation at the toe of the cliff in a low spot in the colliery spoil. There has been some variability at the toe of the spoil cliff with the beach being 0.5m higher in October 2011 than in March 2011, showing accretion through the summer. Below the HAT level the beach has remained stable since 2009 with no great variability between the spring and autumn 2011 profiles.</p> <p>The width of the spoil beach along SH1a is around 60m, reducing to around 35m along SH1 and SH2.</p> <p>Profile 1bSH1 is similar to previous surveys to the beach crest at 75m. The beach crest has been eroding on the seaward side in recent year and the October 2011 survey shows evidence of continuation of that trend. Between March 2011 and October 2011 1m depth of material had been eroded from the beach close to the HAT level, resulting in a retreat of the HAT contour by almost 10m. The whole of the rest of the beach had been subject to erosion since the March 2011 survey. Overall the gradient of the beach has remained similar throughout the surveys.</p> <p>Profile 1bSH2 is largely similar to the previous surveys to the beach crest at 130m change. The crest in the beach has shown progressive erosion since 2009, with the crest retreating by around 12m. The beach below HAT has also being eroded with around 3m of retreat at the HAT contour, and the level of the beach is low compared to previous profiles. The beach has dropped by around 0.25 for much of the foreshore.</p>	<p>At present the cliffs at the back of Blast beach are inactive due to the protective stabilised spoil fronting the cliffs along profiles 1bSH1 and 1bSH2. The width of the spoil has now reduced from around 40m to around 35m. The spoil part of Profile SH1a remained reasonably stable since 2009. The sea cliffs will reactivate at some point the coming years, which will lead to a marked change in the coastal processes in this unit.</p>

2.4 Hawthorne Hive

Survey Date	Description of Changes Since Last Survey	Interpretation
<p>9th Sept 2011</p>	<p>Beach Profiles: One beach profile line, 1cEA2, is located at Hawthorne Hive (Appendix A). The outlet channel of Hawthorne Burn was slightly shallower than in the previous survey. The foreshore levels seaward of the channel had accreted by up to 0.5m since the March 2011 survey when the levels were notably low.</p>	<p>The levels on the foreshore have recovered since the very low levels observed in March 2011. The rest of the profile appears to be stable and the levels are comparable with the surveys carried out since 2008.</p>

2.5 Blackhall Colliery

Survey Date	Description of Changes Since Last Survey	Interpretation
26 th Sept 2011	<p>Beach Profiles:</p> <p>Blackhall Colliery is covered by three beach profile lines (Appendix A).</p> <p>1cBH1 is located near Horden Point and shows that about 1.5m of retreat has taken place at the MHWS level contour since the previous survey in September 2010. Above and below this level the retreat is greater, with about 4m of loss at the beach crest. The profile at this location is lower than has been recorded since November 2008. The beach beyond 175m chainage is unchanged from previous surveys.</p> <p>Profile 1cBH2 exhibits no change in the cliff profile, but the cliffed-edge of the spoil beach has eroded landwards by a further 3m since September 2010, leaving only around 45m to the cliff toe. The rate of erosion in the last year was lower than in the year before, when 10m was lost. The gradient of the intertidal zone has remained similar throughout the profiles.</p> <p>The profile 1cBH3 shows that since 2008 there has been progressive deepening of the outlet channel of Castle Eden Burn, which crosses the profile. On the upper beach there is landward cut-back, typically by around 5m, of the seaward slope of the profile. This cutback is comparable with the recession observed for this profile in the 2010 Full Measures Report.</p>	<p>The surveys show that the spoil beach along much of the Blackhall Colliery shore continues to provide effective protection to the backing cliffs. However, the spoil beach is eroding landwards at high rates of retreat (3 to 5m during 2011) so the relict cliffs are likely to become reactivated in the near future.</p>

3. Problems Encountered and Uncertainty in Analysis

The cliff top position surveys at Dawdon are assumed to have a limit of accuracy of $\pm 0.1\text{m}$ due to the techniques used. Whilst an annual erosion rate has been calculated from these cliff top survey data, it is really too early in the monitoring for this to be a meaningful rate at present. This will improve with longevity of the data record, however, to yield a more meaningful longer-term mean rate.

4. Recommendations for 'Fine-tuning' the Monitoring Programme

It is worthwhile considering increasing the surveys along Seaham Beach in view of the anticipated study to investigate and better manage accretion at the southern end of the frontage.

It is also worth considering adding an additional cliff top survey point to the north of Nose's Point where the spoil beach has only a narrow width fronting the cliff. This could suitably be located mid-way between points 2 and 3.

5. Conclusions and Areas of Concern

- The profile at Featherbed Rocks has shown little change since 2008.
- At Seaham cliffs there has been recession along ground control points 1 and 3 by the order of 1m and 1.4m, respectively, since surveys began in November 2008. No significant change has occurred along ground control point 2. Further years of data collection will help to understand the long term trends on these cliffs.
- At the Blast Beach and Blackhall a colliery spoil still prevents the sea from acting directly at the natural cliff toe. The spoil deposit is eroding quite rapidly and it is likely that the natural beach will reactivate in the coming years.
- At Hawthorne Hive the levels on the foreshore have recovered since the very low levels observed in March 2011.

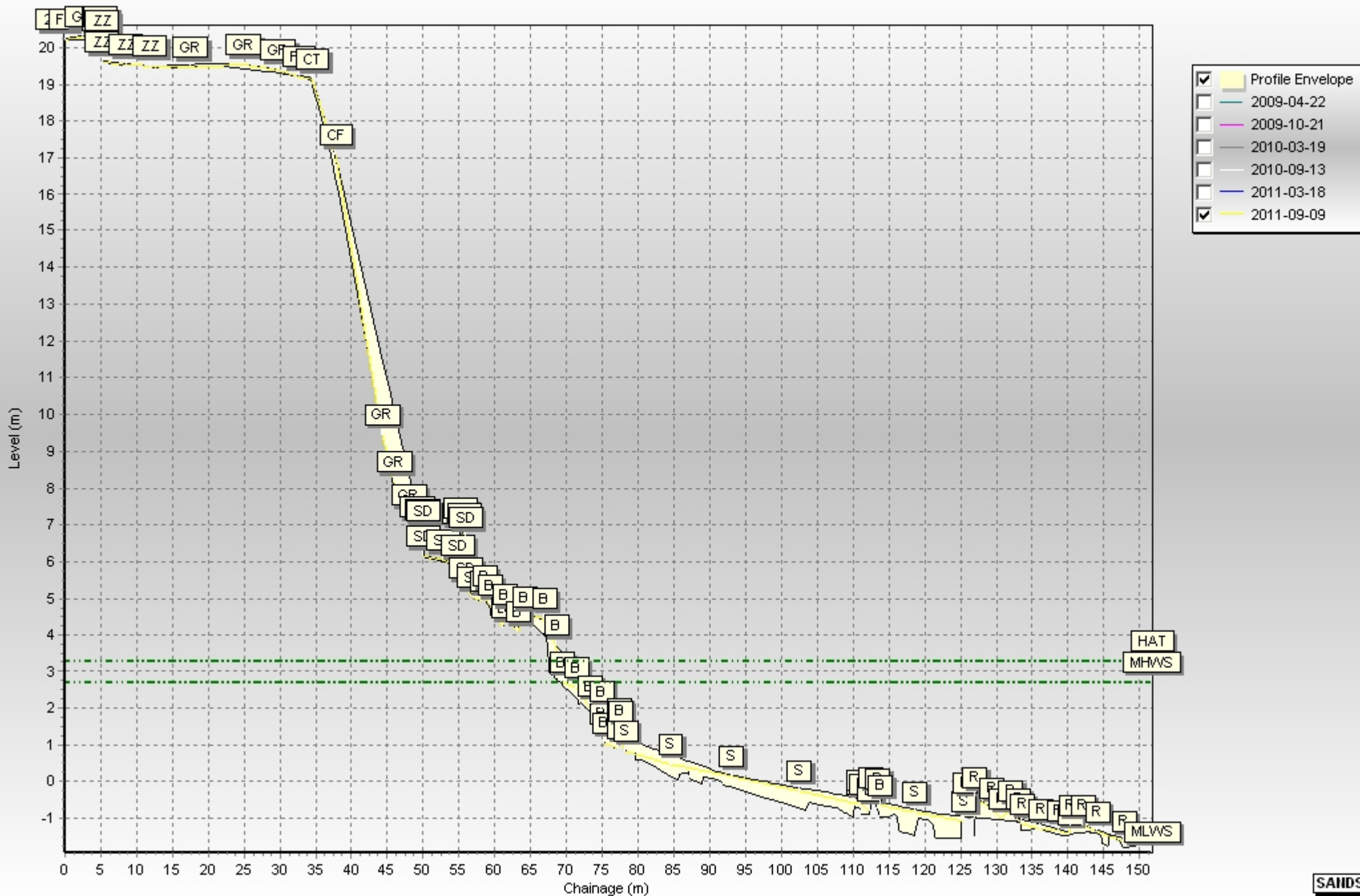
Appendices

Appendix A
Beach Profiles

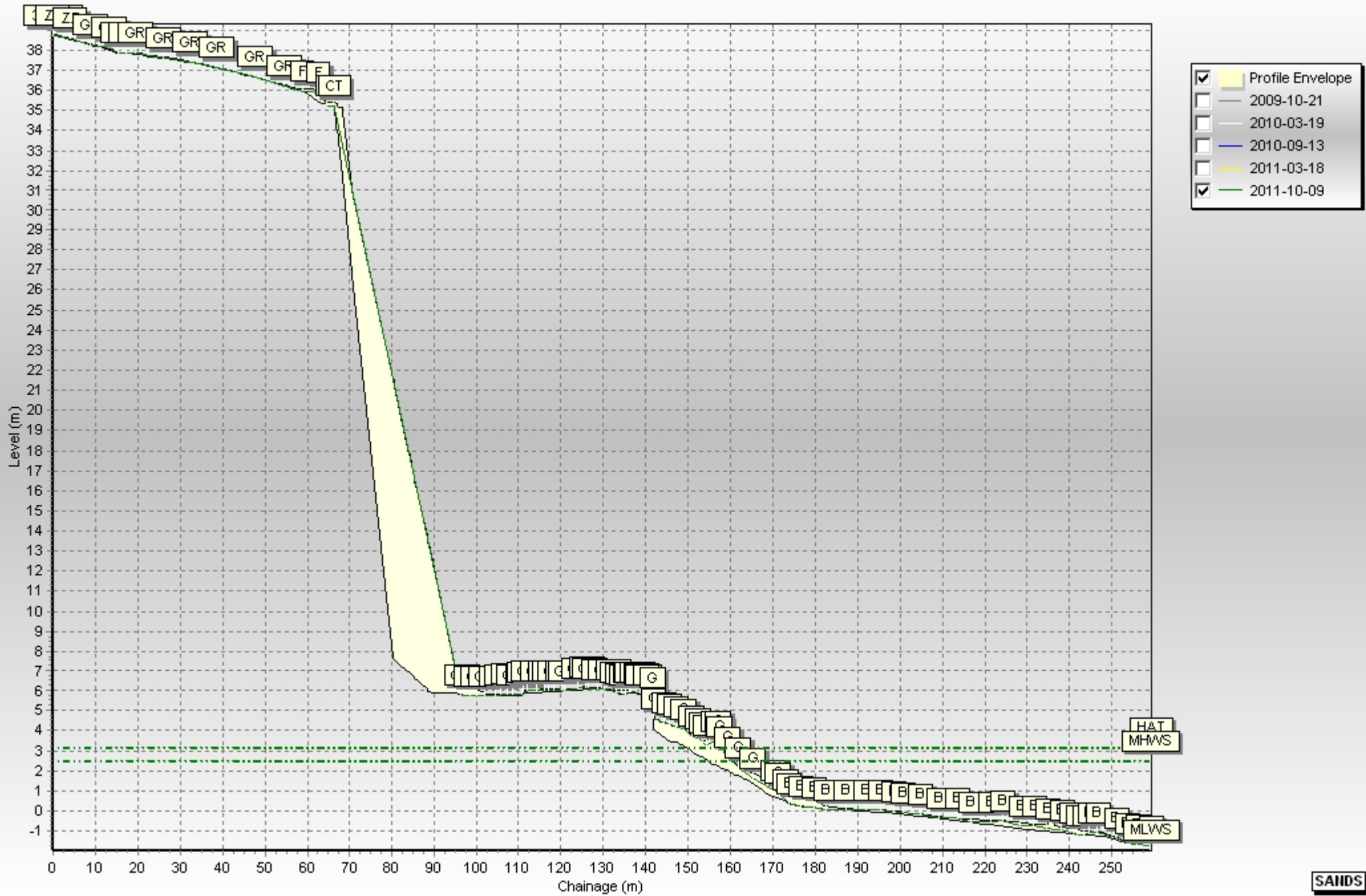
The following sediment feature codes are used on some profile plots:

Code	Description
S	Sand
M	Mud
G	Gravel
GS	Gravel & Sand
MS	Mud & Sand
B	Boulders
R	Rock
SD	Sea Defence
SM	Saltmarsh
W	Water Body
GM	Gravel & Mud
GR	Grass
D	Dune (non-vegetated)
DV	Dune (vegetated)
F	Forested
X	Mixture
FB	Obstruction
CT	Cliff Top
CE	Cliff Edge
CF	Cliff Face
SH	Shell
ZZ	Unknown

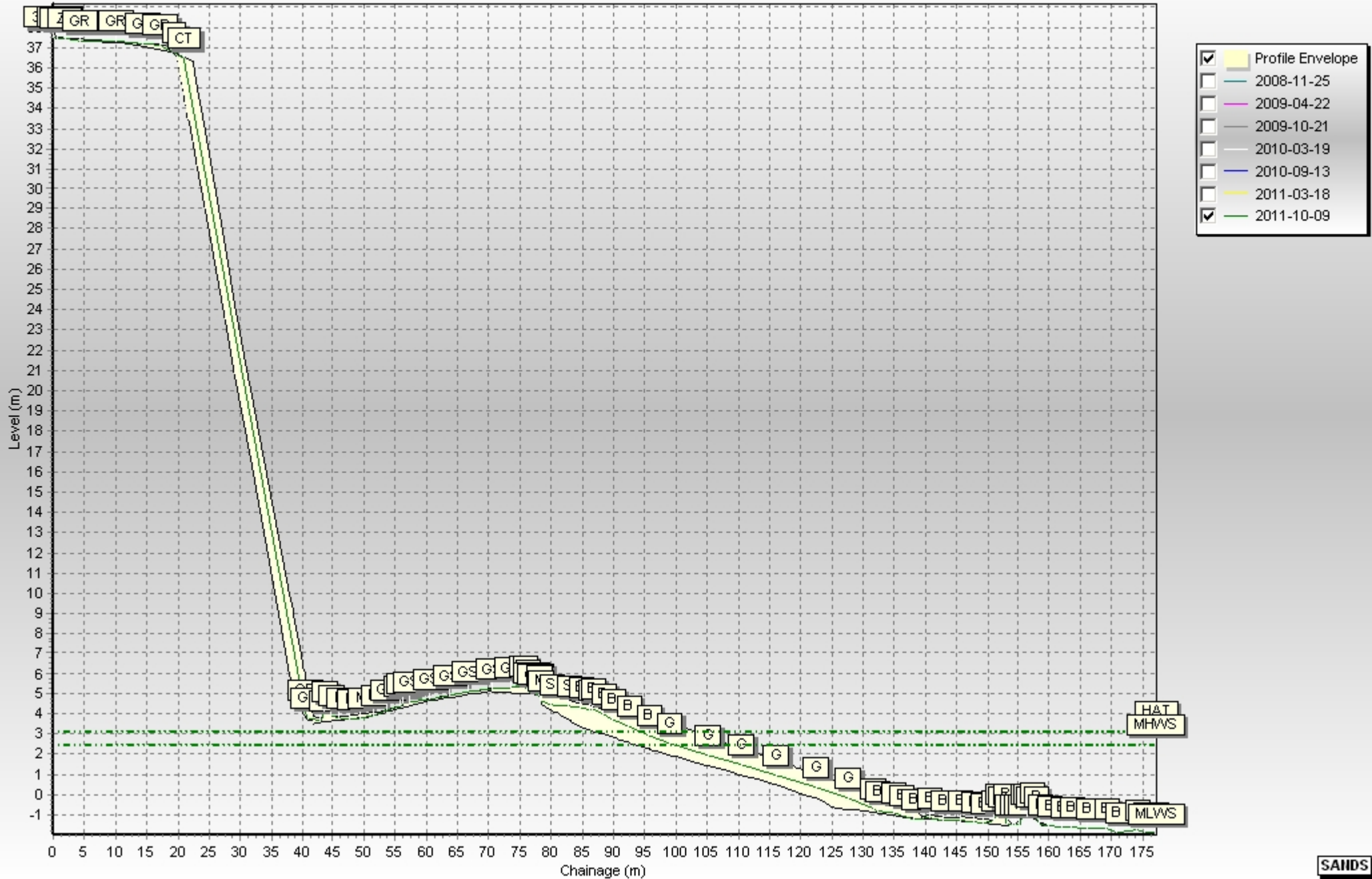
Beach Profiles: 1bEA1



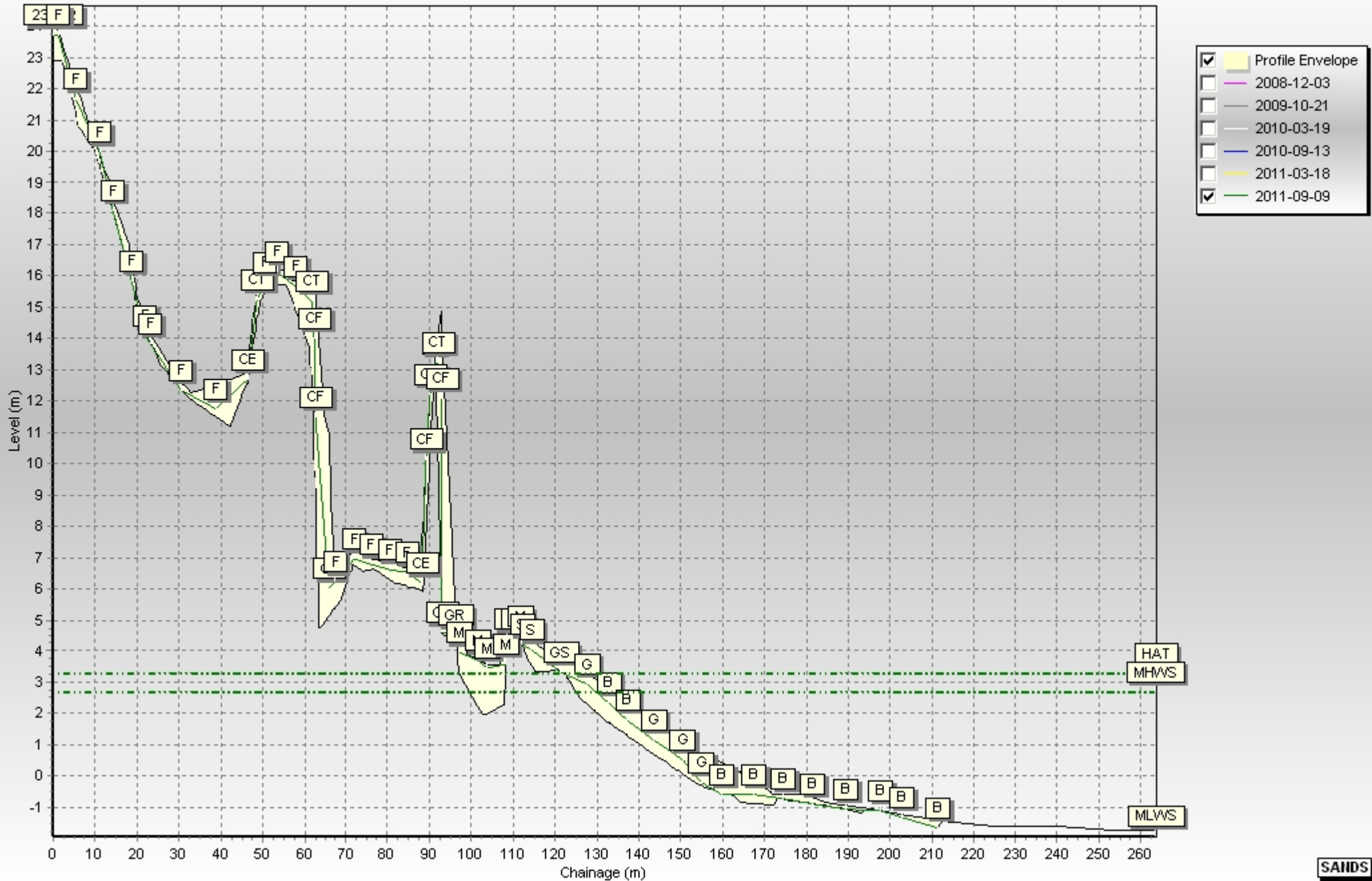
Beach Profiles: 1bSH1A



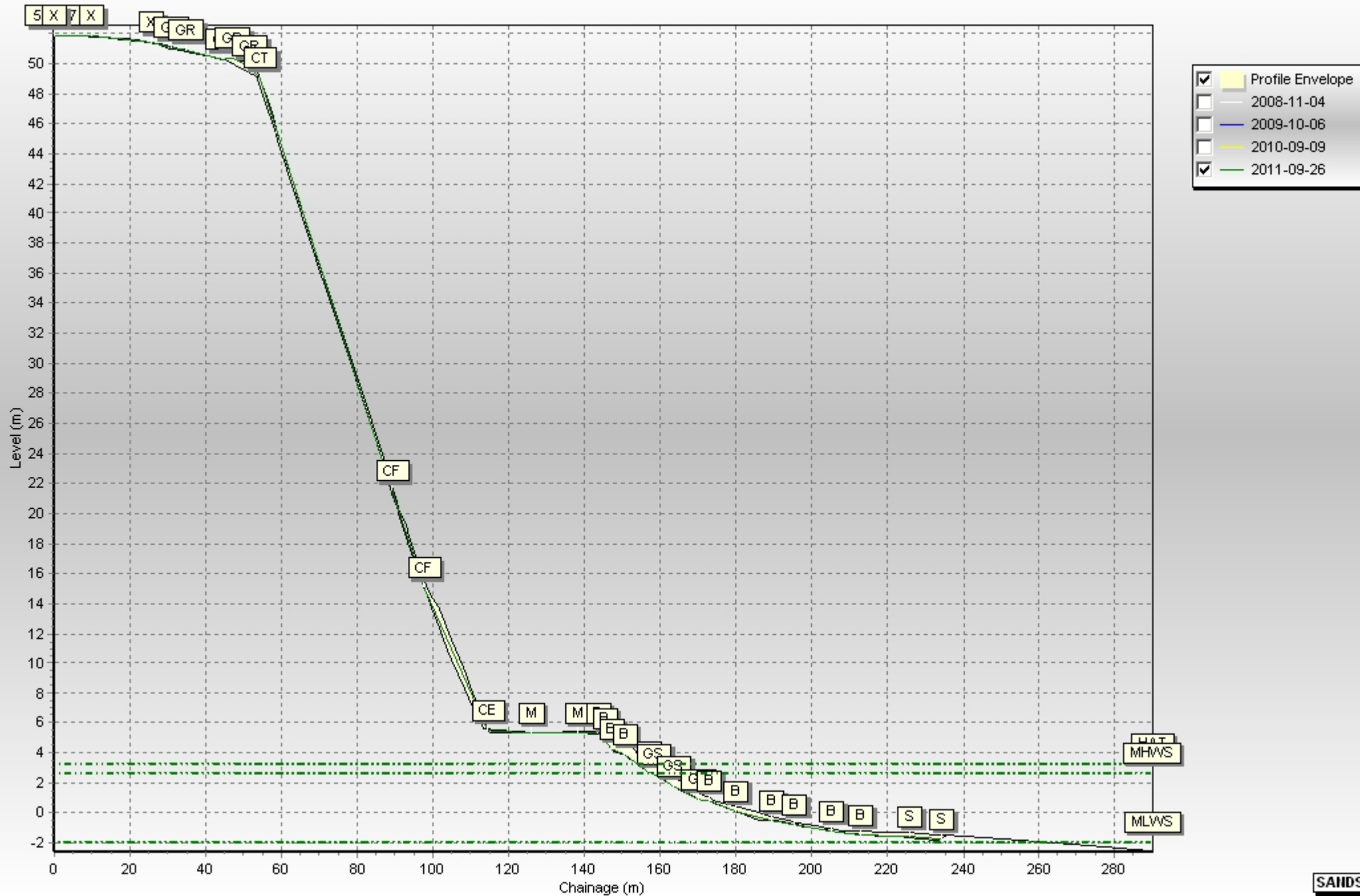
Beach Profiles: 1bSH1



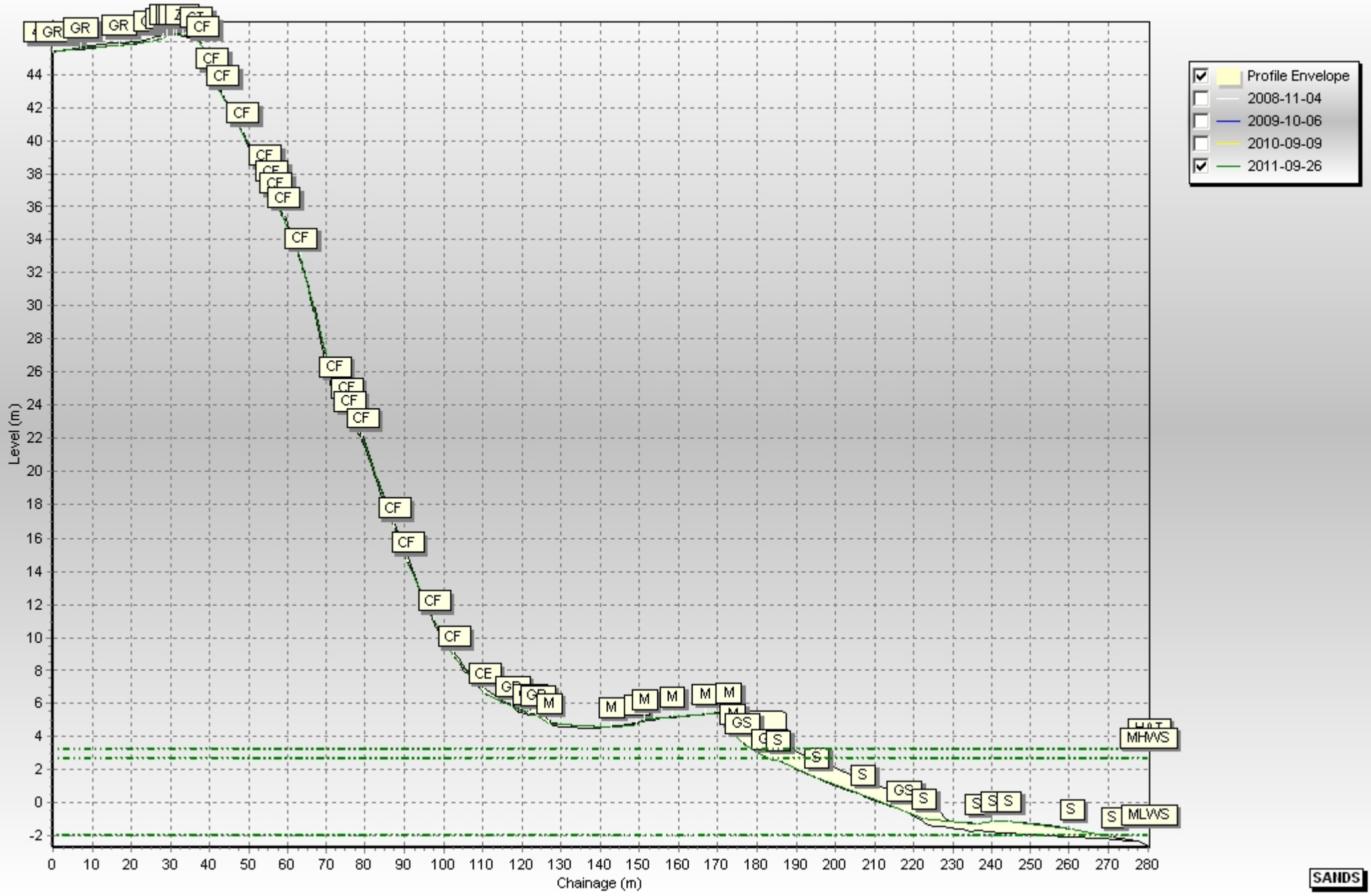
Beach Profiles: 1cEA2



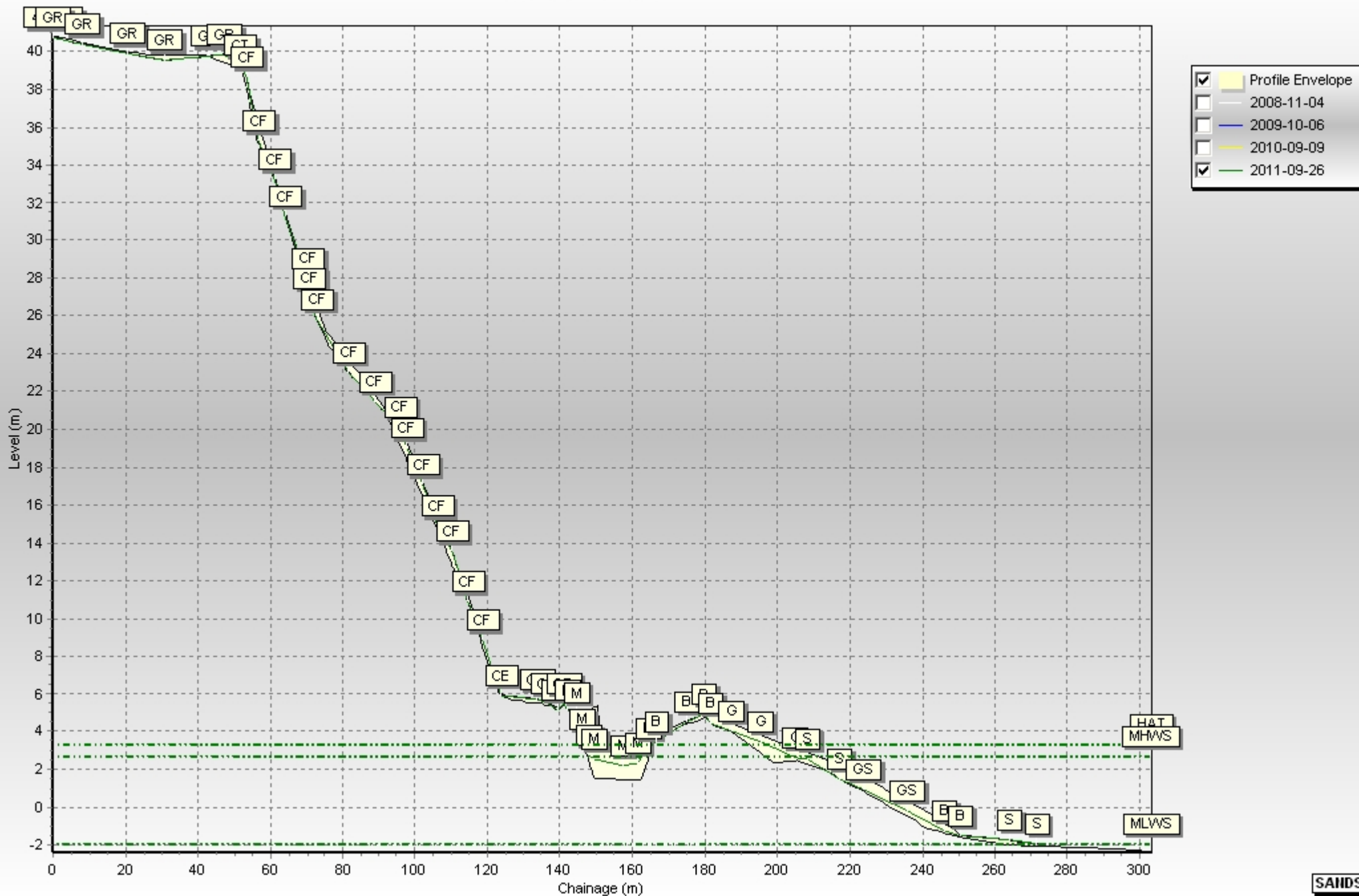
Beach Profiles: 1cBH1



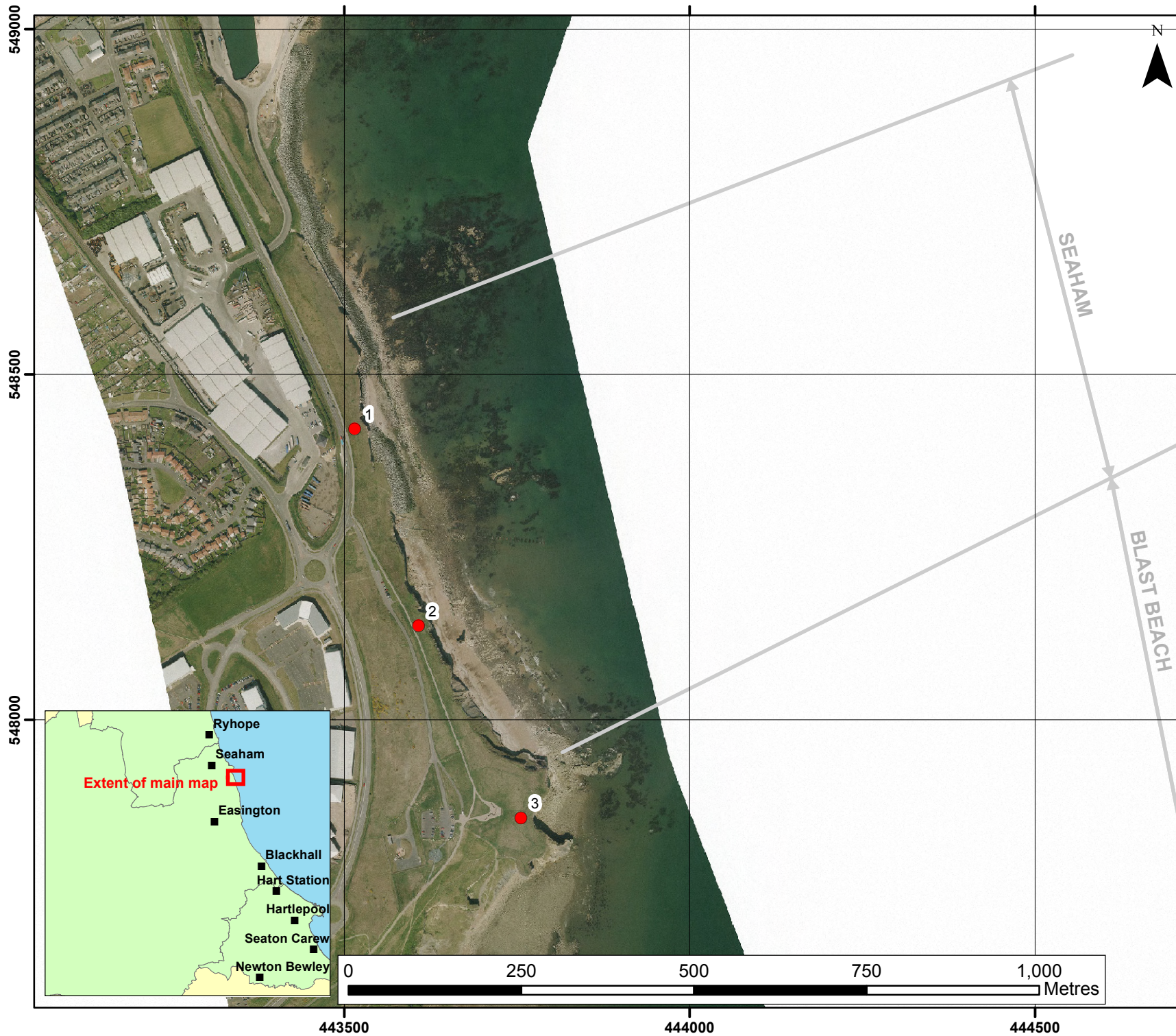
Beach Profiles: 1cBH2



Beach Profiles: 1cBH3



Appendix B
Cliff Top Survey



KEY

● Ground Control Points

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

**Appendix B - Map 1
 Ground Control Points
 Seaham
 Durham County Council**

Analytical Report 4
 Full Measures Survey
 Winter 2011



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

Cliff Top Survey

Seaham

Three ground control points have been established on the Seaham frontage (Figure B1). The maximum separation between any two points is nominally 300m.

The cliff top surveys at Seaham are undertaken annually. Measurements are taken from a fixed ground control point along a fixed bearing to the edge of the cliff top.

Table B1 provides baseline information about these ground control points and results from the 2008 (baseline) survey showing the position from the ground control point to the edge of the cliff top along the defined bearing. Future reports will show results from subsequent surveys and provide a means of assessing erosion since the baseline survey.

Table B1 – Cliff Top Surveys at Seaham

Ground Control Point Details				Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Bearing (°)	Baseline Survey (Nov 2008)	Previous Survey (March 2011)	Present Survey (Oct 2011)	Baseline (Nov 2008) to Present (Oct 2011)	Previous (March 2011) to Present (Oct 2011)	Baseline (Nov 2008) to Present (Oct 2011)
1	443515.4	548421.7	70	16.1	15.2	15.1	-1.0	-0.1	-0.4
2	443607.8	548136.3	90	13.3	13.5	13.2	-0.1	-0.3	0.0
3	443756.1	547858.5	95	14.8	13.6	13.4	-1.4	-0.2	-0.5