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Cell 1 Regional Coastal Monitoring Programme Analytical Report 4: 'Full Measures' Survey 2011

Northumberland County Council
Final Report

NORTHUMBERLAND
Northumberland County Council

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)		
	Berwick upon Tweed	Holy Island	North Sunderland
HAT	2.8	2.8	2.8
MHWS	2.2	2.4	2.4
MLWS	-1.9	-1.8	-1.7
Water Level Parameter	**Water Level (m AOD)**		
	Amble	**Blyth**	**River Tyne**
HAT	3.1	3.1	3.1
MHWS	2.4	2.4	2.4
MLWS	-1.9	-1.8	-1.9

Source: *Scottish Border to River Tyne Shoreline Management Plan 2.* Royal Haskoning, May 2009.

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.

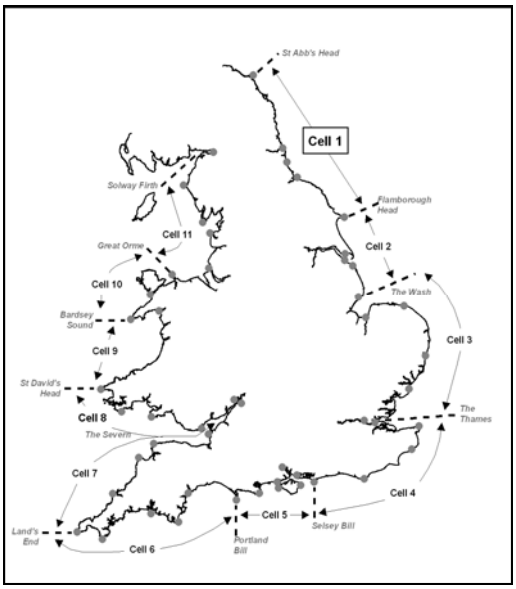


Figure 1 Sediment Cells in England and Wales

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:

Northumberland County Council

Northumberland Coast AONB – Celebrating 50 Years – Area of Outstanding Natural Beauty

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

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	Sept-Dec 08	May 09	Mar-May 09		-
2	2009/10	Sept-Dec 09	Mar 10	Feb-Mar 10	Jul 10	-
3	2010/11	Aug-Nov 10	Feb 11	Feb-Apr 11	Aug 11	Sept 11
4	2011/12	Oct-Nov 11	Oct 12 (*)			

(*) The present report is **Analytical Report 4** and provides an analysis of the 2011 Full Measures survey for Northumberland 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	Sandstell Point (Spittal A)
	Spittal (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
	Sunderland Harbour and Docks
	Hendon to Ryhope (incl. Halliwell Banks)
Durham County Council	Featherbed Rocks
	Seaham
	Blast Beach
	Hawthorn Hive
	Blackhall Colliery
Hartlepool Borough Council	North Sands
	Headland
	Middleton
	Hartlepool Bay
Redcar & Cleveland Borough Council	Coatham Sands
	Redcar Sands
	Marske Sands
	Saltburn Sands
	Cattersty Sands (Skinningrove)
Scarborough Borough Council	Staithes
	Runswick Bay
	Sandsend Beach, Upgang Beach and Whitby Sands
	Robin Hood's Bay
	Scarborough North Bay
	Scarborough South Bay
	Cayton Bay
	Filey Bay

1. Introduction

1.1 Study Area

Northumberland Council's frontage extends from the Scottish Border in the north to Hartley (just south of Blythe) in the south. For the purposes of this report and for consistency with previous reporting, it has been sub-divided into 15 areas, namely:

- Sandstell Point (Spittal A)
- Spittal (Spittal B)
- Goswick Sands
- Holy Island
- Bamburgh
- Beadnell Village
- Beadnell Bay
- Embleton Bay
- Boulmer
- Alnmouth Bay
- High Hauxley and Druridge Bay
- Lynemouth Bay
- Newbiggin-by-the-Sea
- Cambois
- Blyth South Beach

1.2 Methodology

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

Full Measures survey annually each autumn/early winter comprising:

- Beach profile surveys along 78 transect lines (commenced 2002)
- Beach profile surveys along an additional 10 transect lines (commenced 2007)
- Beach profile surveys along an additional 26 transect lines (commenced 2010)
- Topographic survey along Holy Island (commenced 2004)
- Topographic survey along Alnmouth Bay (commenced 2005)
- Topographic survey along Sandstell Point (commenced 2009)
- Topographic survey along Newbiggin Bay (commenced 2010)

Partial Measures survey annually each spring comprising:

- Beach profile surveys along 29 transect lines (since 2002)
- Beach profile surveys along an additional 10 transect lines (commenced 2007)
- Beach profile surveys along an additional 1 transect line (commenced 2010)
- Beach profile surveys along an additional 2 transect lines (commenced 2011)
- Topographic survey along Alnmouth Bay (commenced 2005)
- Topographic survey along Sandstell Point (commenced 2009)
- Topographic survey along Newbiggin Bay (commenced 2010)

Cliff top survey (bi-annually) at:

- Cliff top survey at Lynemouth Bay (commenced 2007)
- Cliff top survey at Cambois Bay (Sandy Bay) (commenced 2007)
- Cliff top survey at Cambois Bay (Cambois) (commenced 2009)

For all cliff-top surveys prior to Full Measures 2011, the data was saved in '.kmz' format for plotting and comparison in GoogleEarth. For the present survey report, this data has been visualised in GIS, which revealed the quality was variable and reliable interpretations of cliff

change could not be made. For this reason, the 'kmz' files are not presented or analysed as part of the present report. The survey data collected for the Full Measures 2011 survey has also been plotted in GIS as a line on the 2010 aerial map, however, for the reasons outlined above, a comparison with the equivalent previous data has not been completed.

The location of these surveys is shown in Figure 2. The Full Measures survey was undertaken along this frontage between 4th and 5th October 2011 (Cambois cliff top survey), 10th to 14th October 2011, 17th October 2011 (Holy Island topographic survey), 25th to 28th October 2011, 31st October 2011 (Newbiggin topographic survey), 7th to 11th November 2011, 13th November 2011 (Sandstell Point (Spittal A) and Spittal (Spittal B) topographic survey), 28th to 29th November 2011 (Alnmouth topographic survey) and the 14th November 2011. During this time weather conditions varied considerably; refer to the survey reports for details of the weather conditions over this survey period.

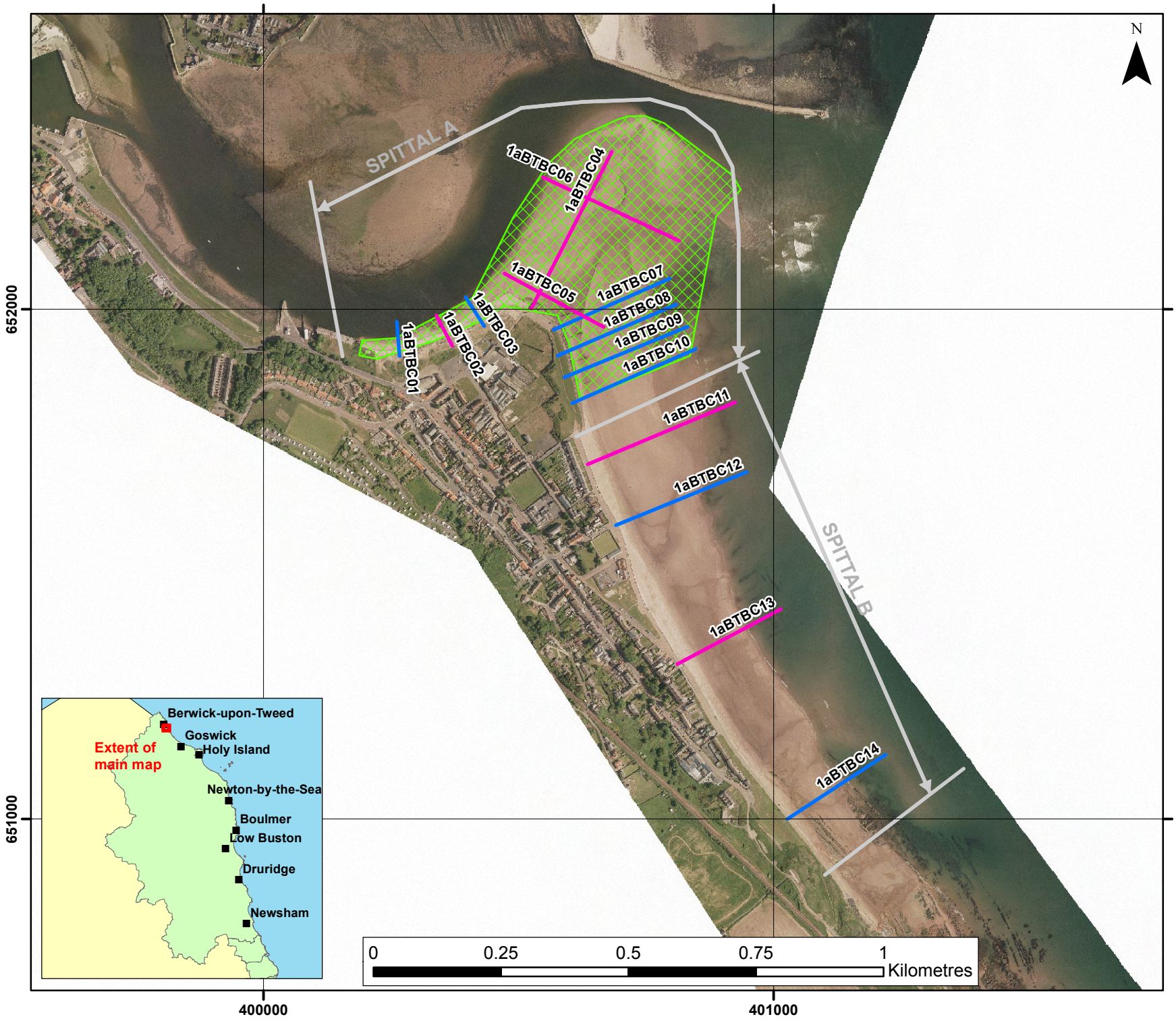
All data have been captured in a manner commensurate with the principles of the Environment Agency's *National Standard Contract and Specification for Surveying Services* and stored in a file format compatible with the software systems being used for the data analysis, namely SANDS and ArcGIS. This data 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
- 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

Survey Locations
Berwick
Northumberland
County Council

Analytical Report 4
Full Measures Survey
Winter 2011

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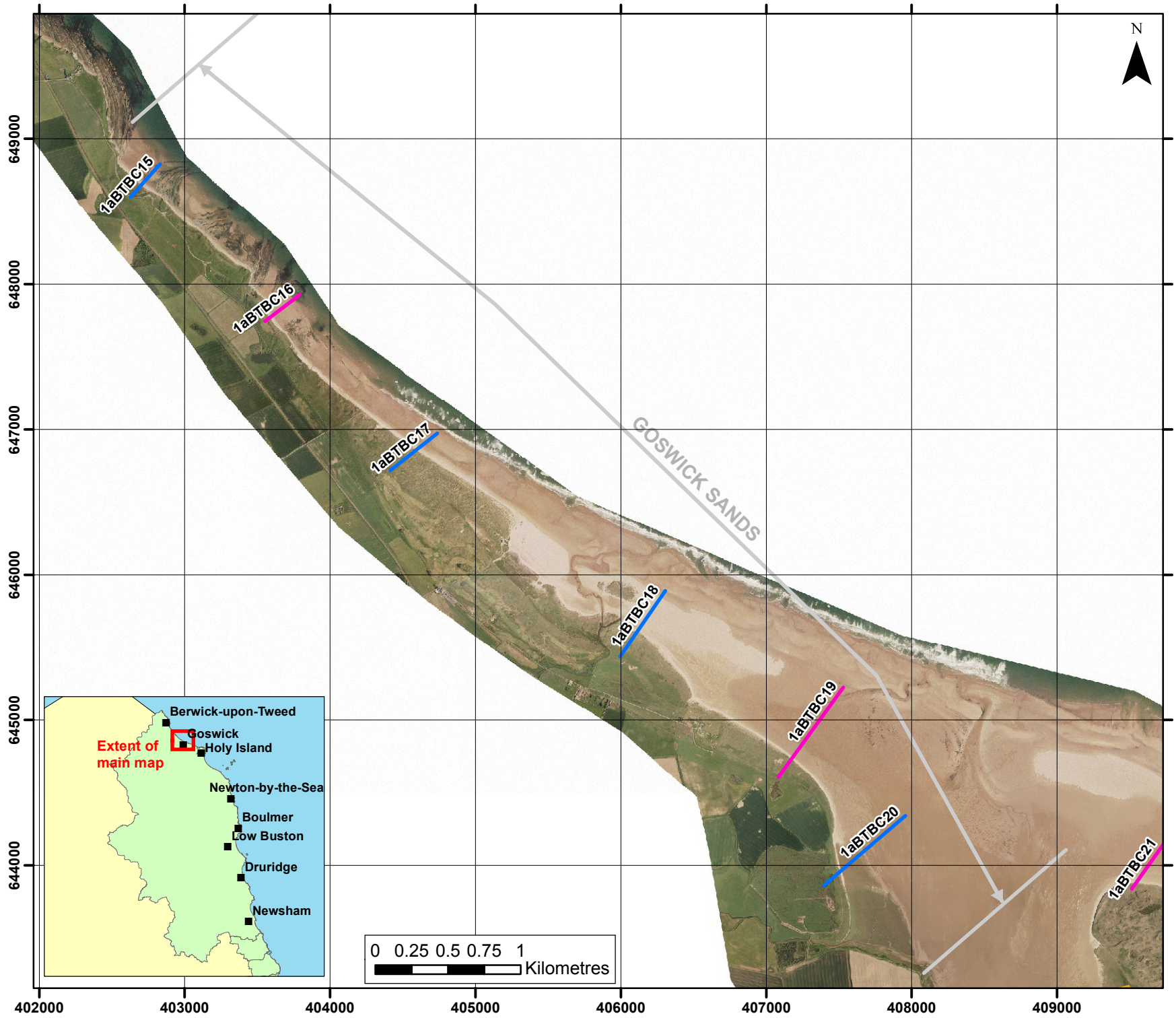

KEY

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
Goswick Sands
Northumberland County Council

Analytical Report 4
Full Measures Survey
Winter 2011

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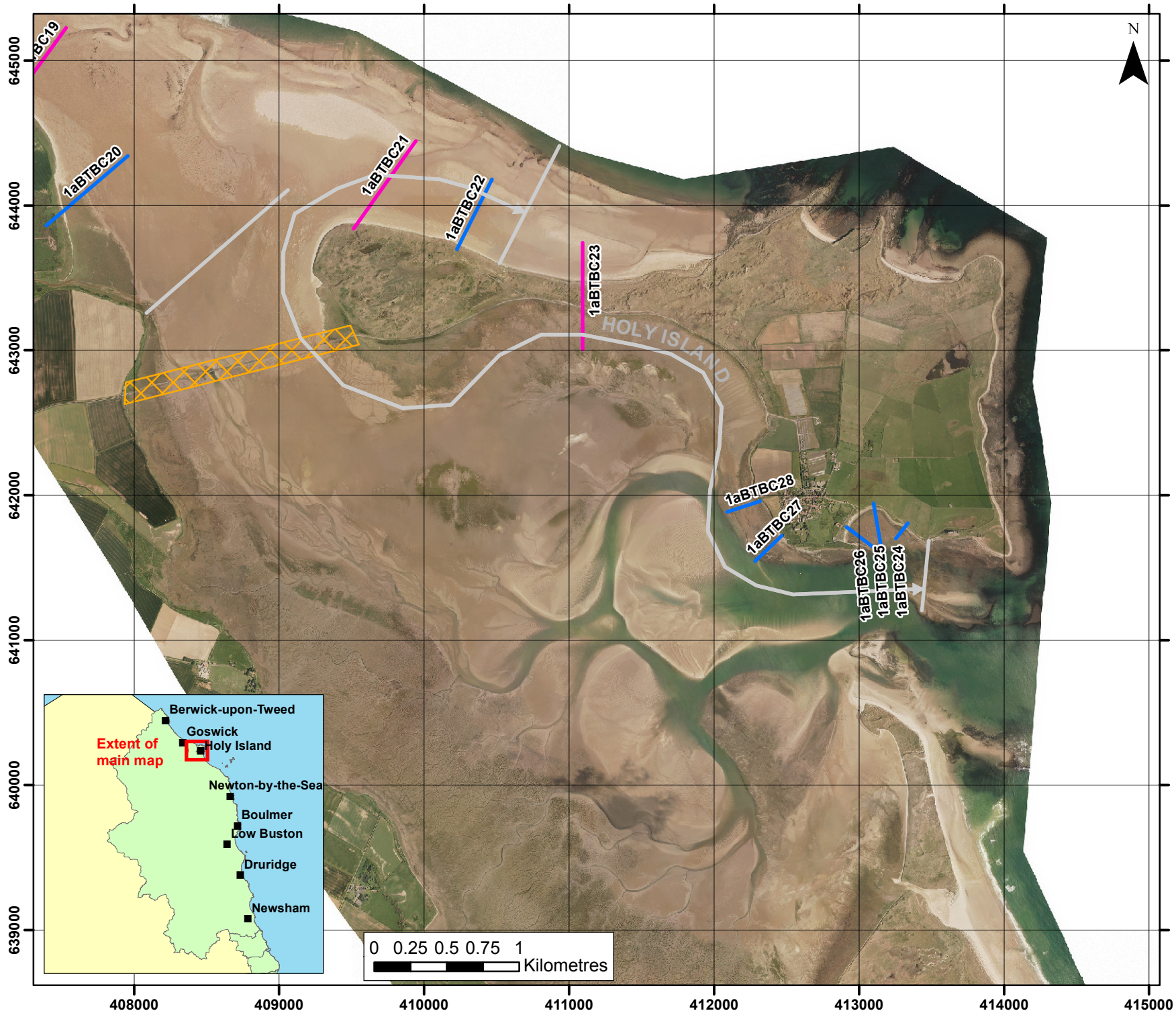

KEY

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 3
Survey Locations
Holy Island
Northumberland
County Council

Analytical Report 4
Full Measures Survey
Winter 2011

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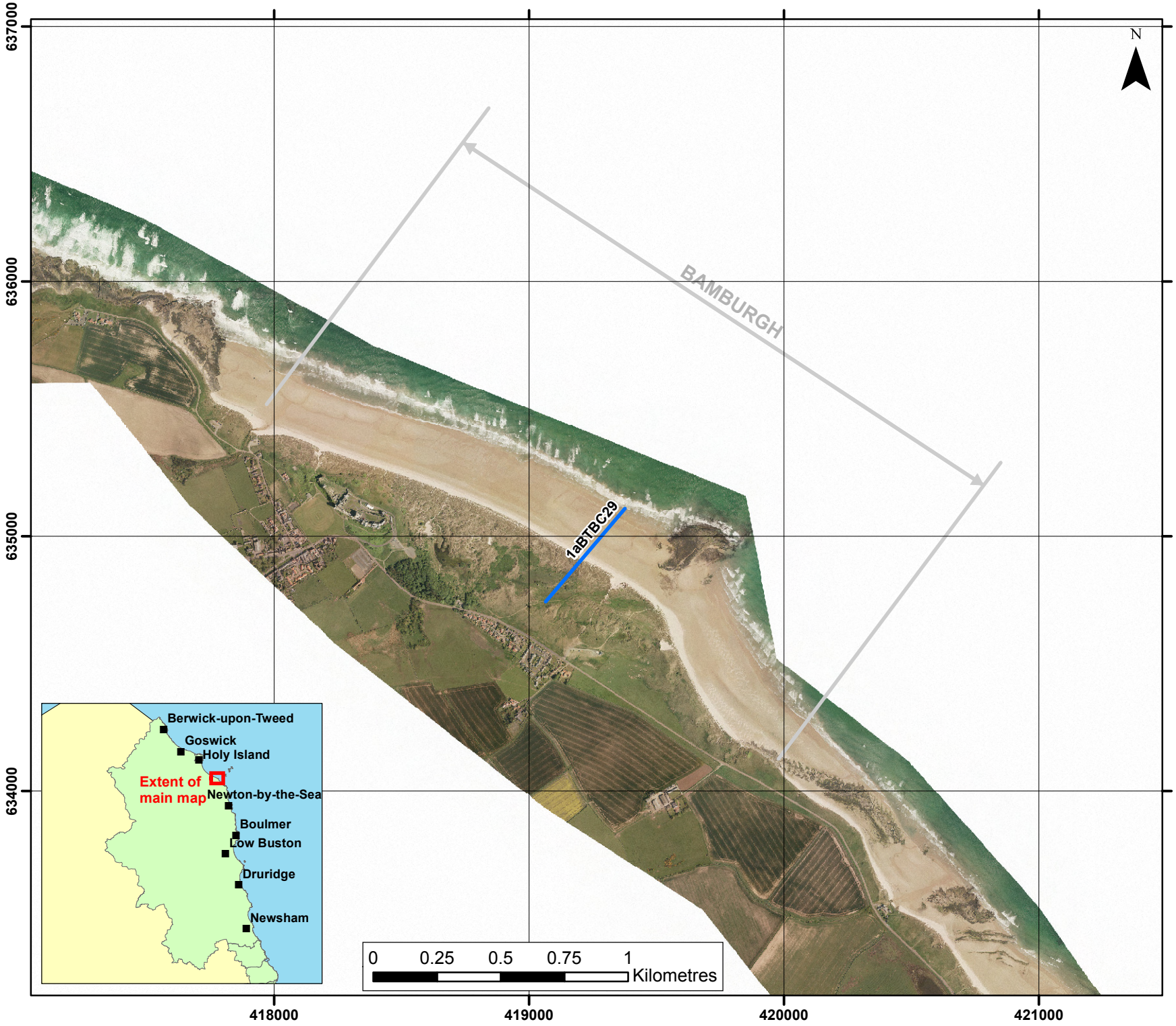

KEY

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 4
Survey Locations
Bamburgh
Northumberland
County Council

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Winter 2011

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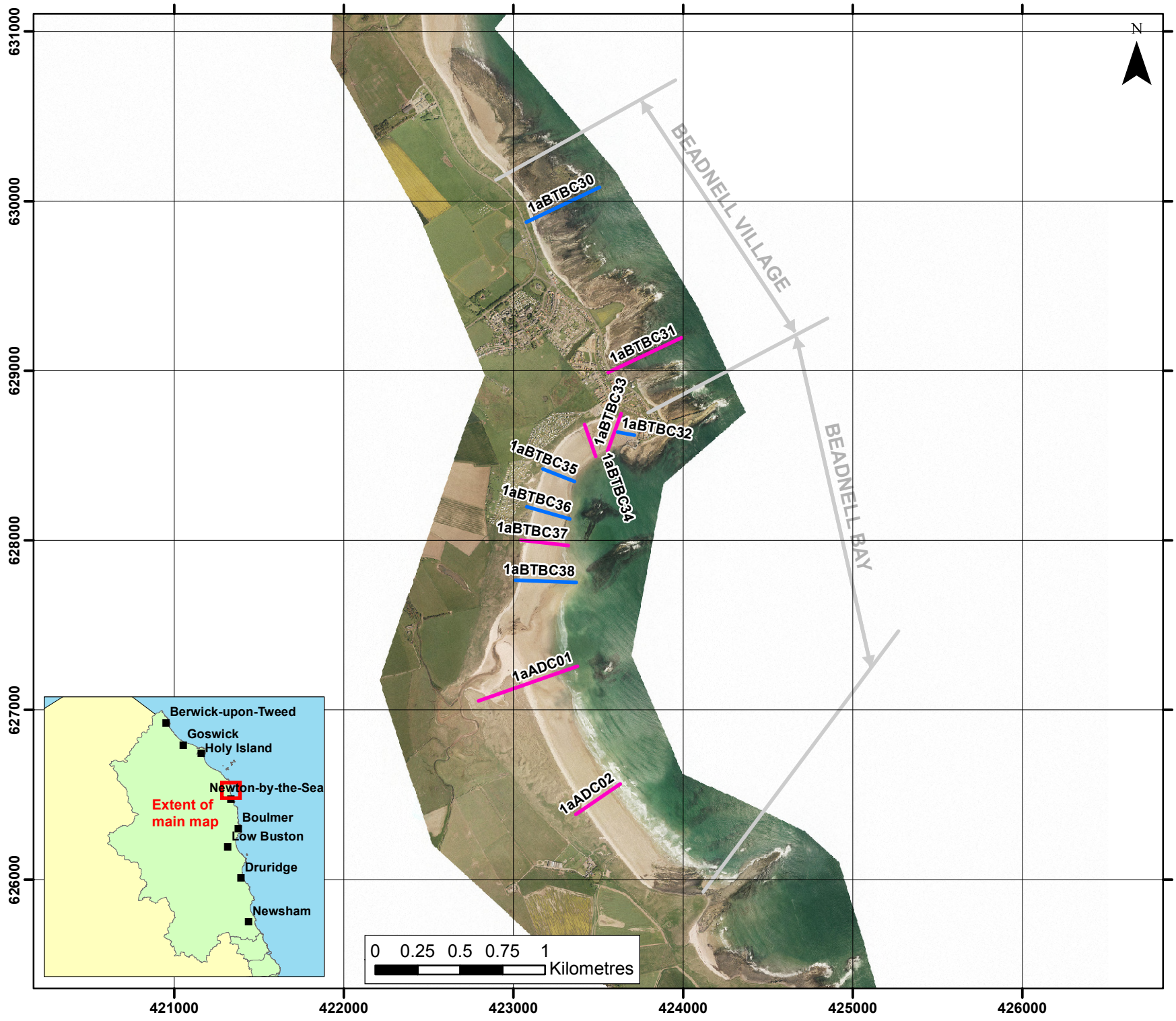

KEY

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 5
Survey Locations
Beadnell
Northumberland
County Council

Analytical Report 4
Full Measures Survey
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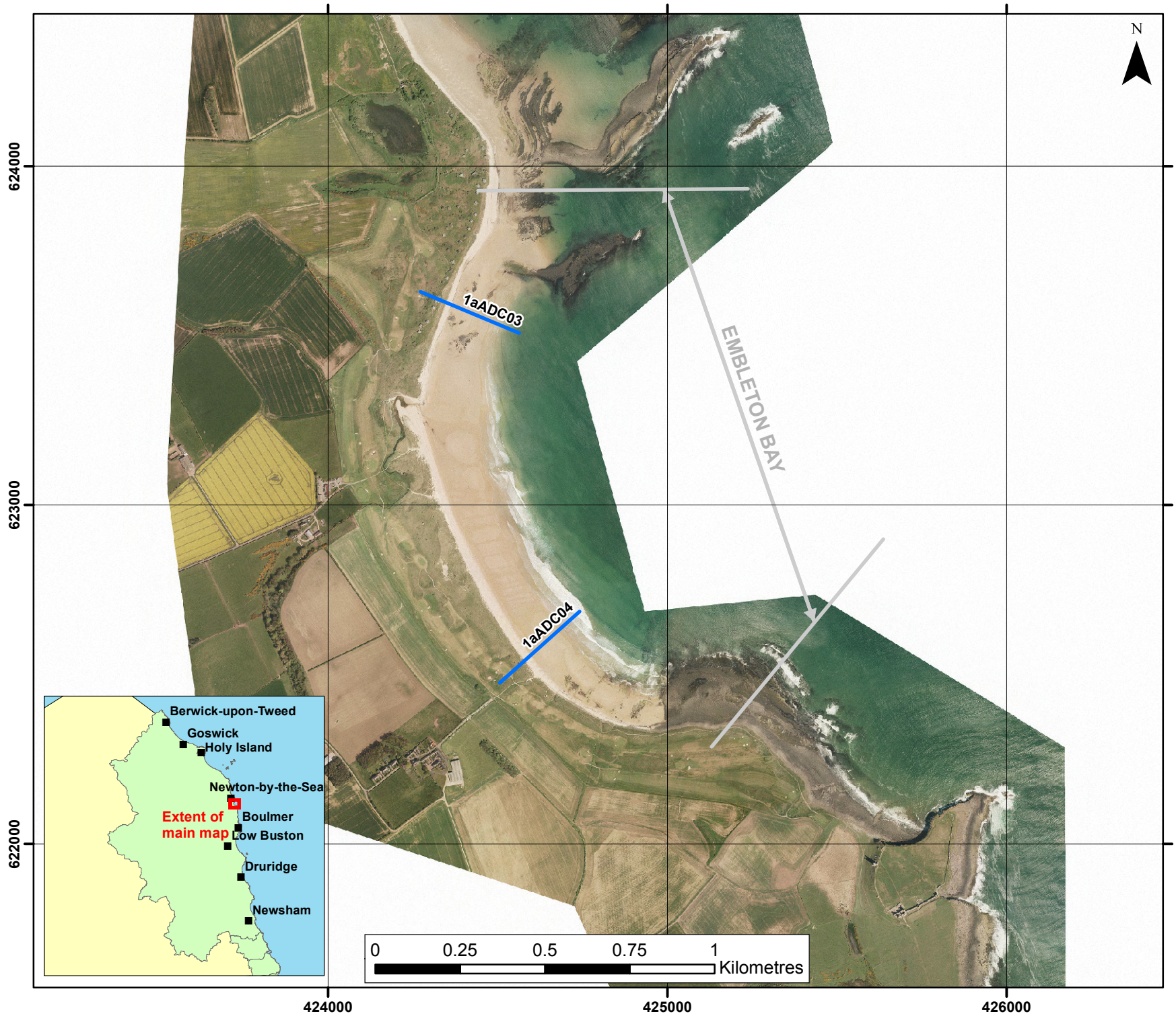

KEY

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 6
Survey Locations
Embleton Bay
Northumberland County Council

Analytical Report 4
Full Measures Survey
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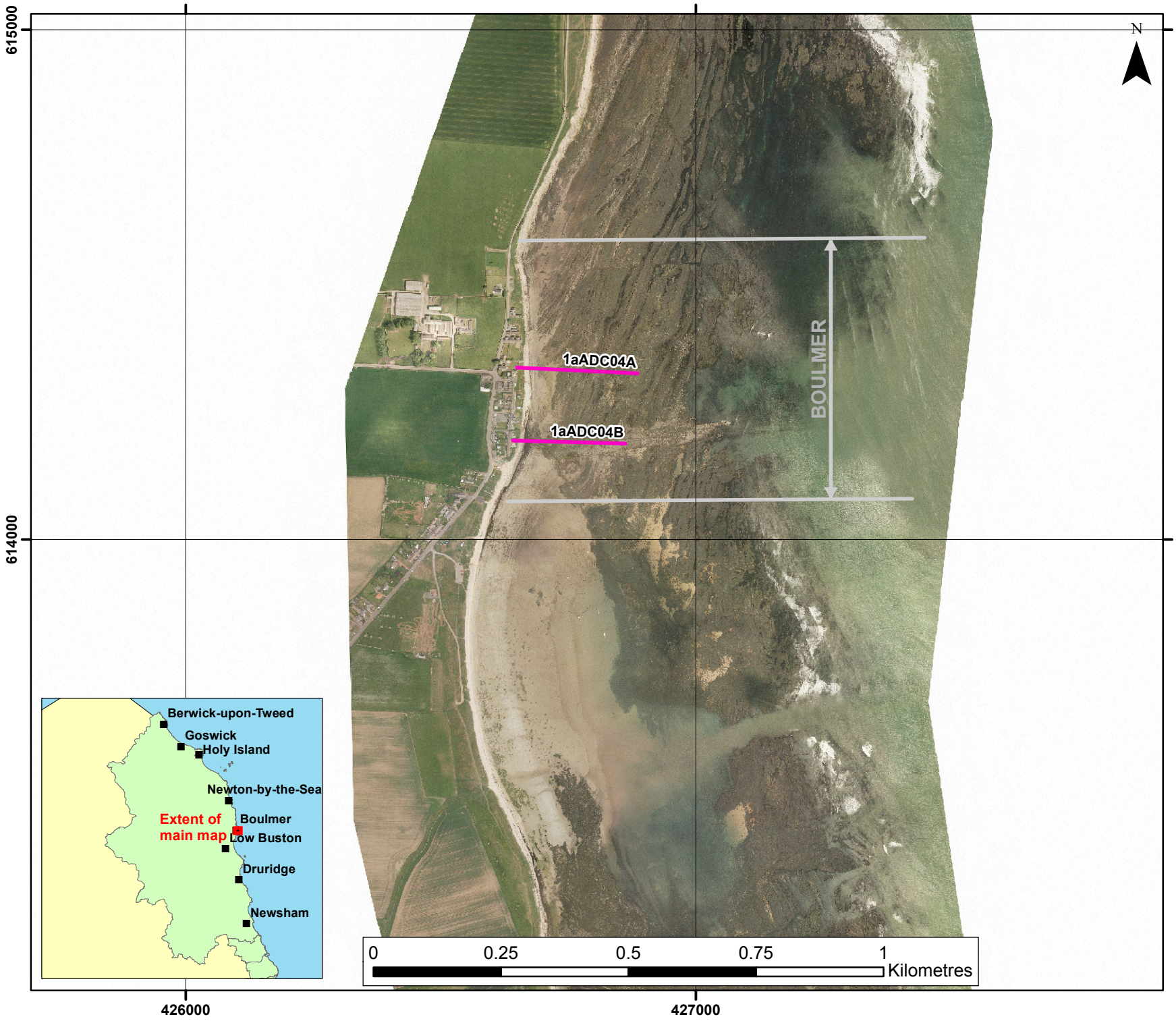

KEY

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 7
Survey Locations
Boulmer
Northumberland
County Council

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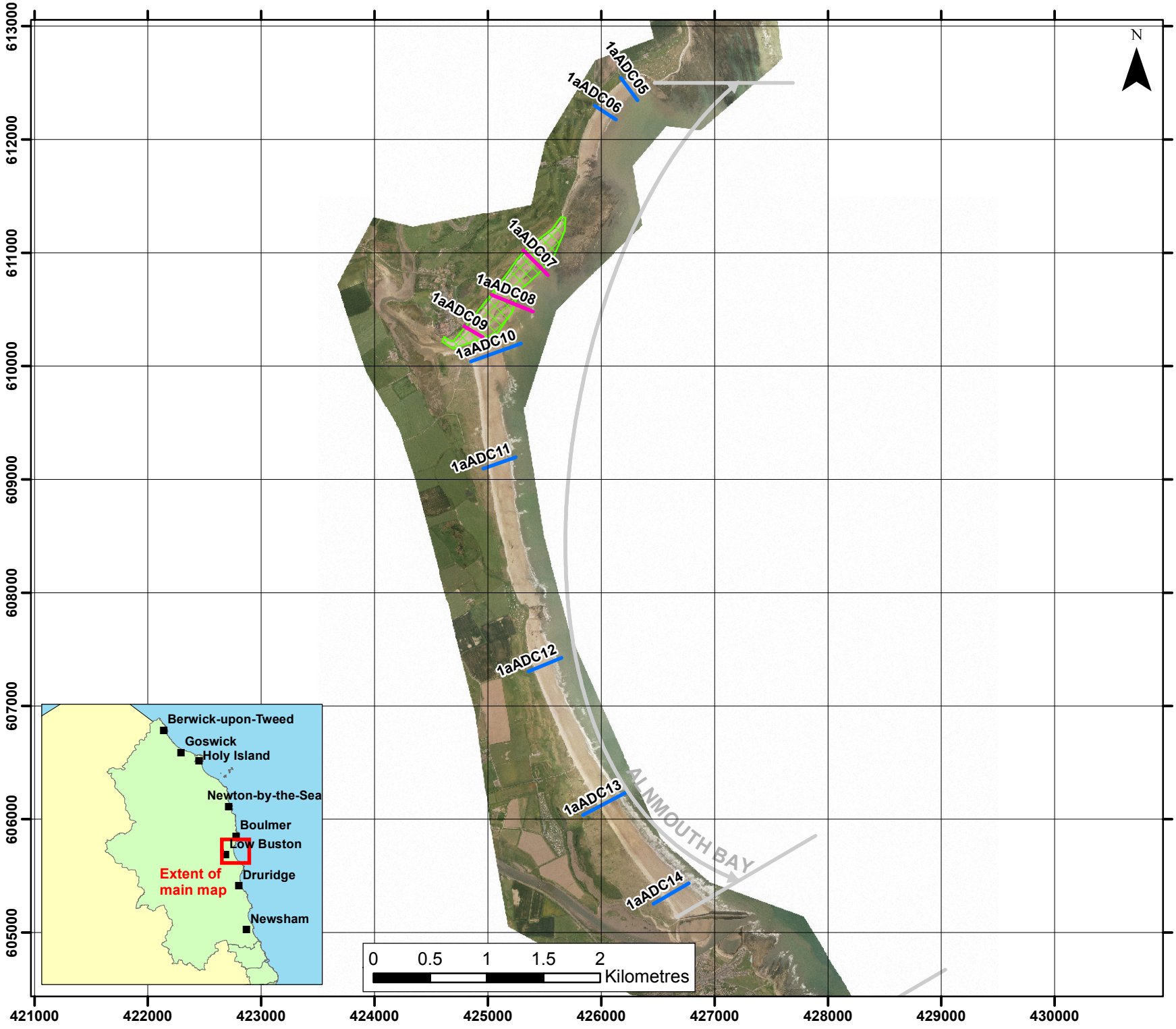

KEY

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 8
Survey Locations
Alnmouth
Northumberland
County Council

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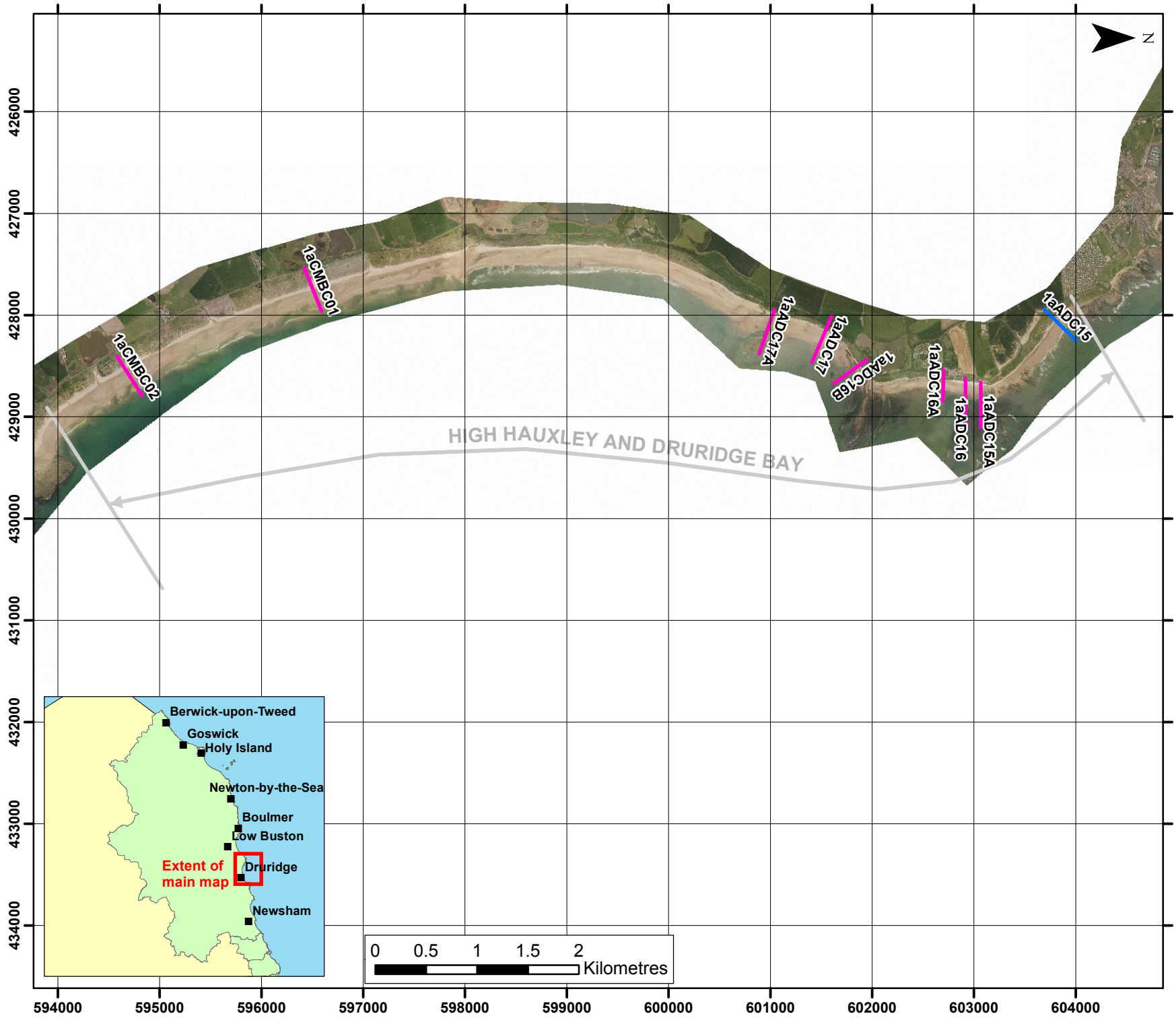

KEY

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 9
Survey Locations
High Hauxley & Druridge Bay
Northumberland County Council

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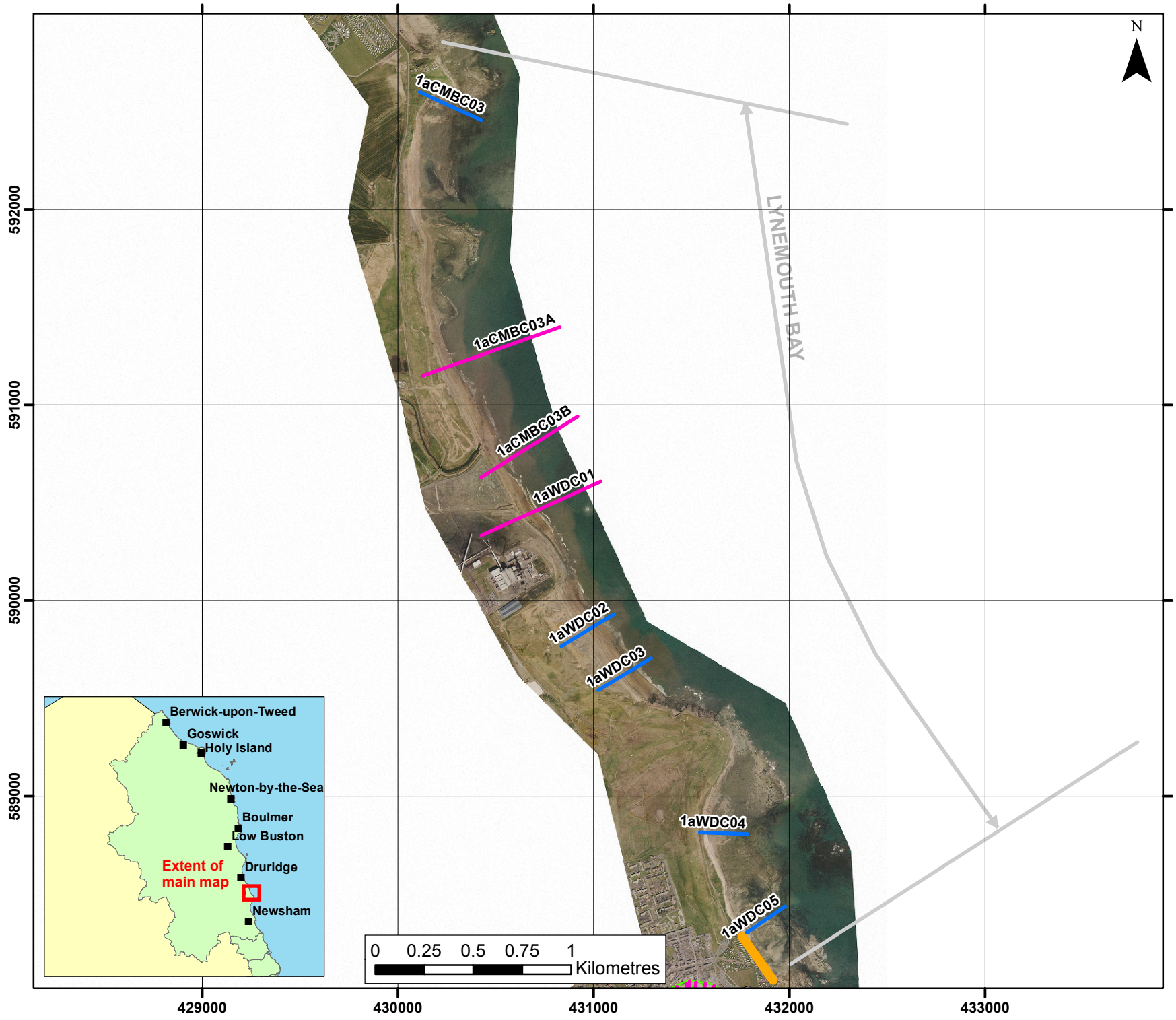

KEY

Topographic Profiles
- Annual
- 6 monthly

Topographic Surveys
- 6 monthly
- yearly
- 5 yearly

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

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Figure 2 - Map 10
Survey Locations
Lynemouth Bay
Northumberland County Council

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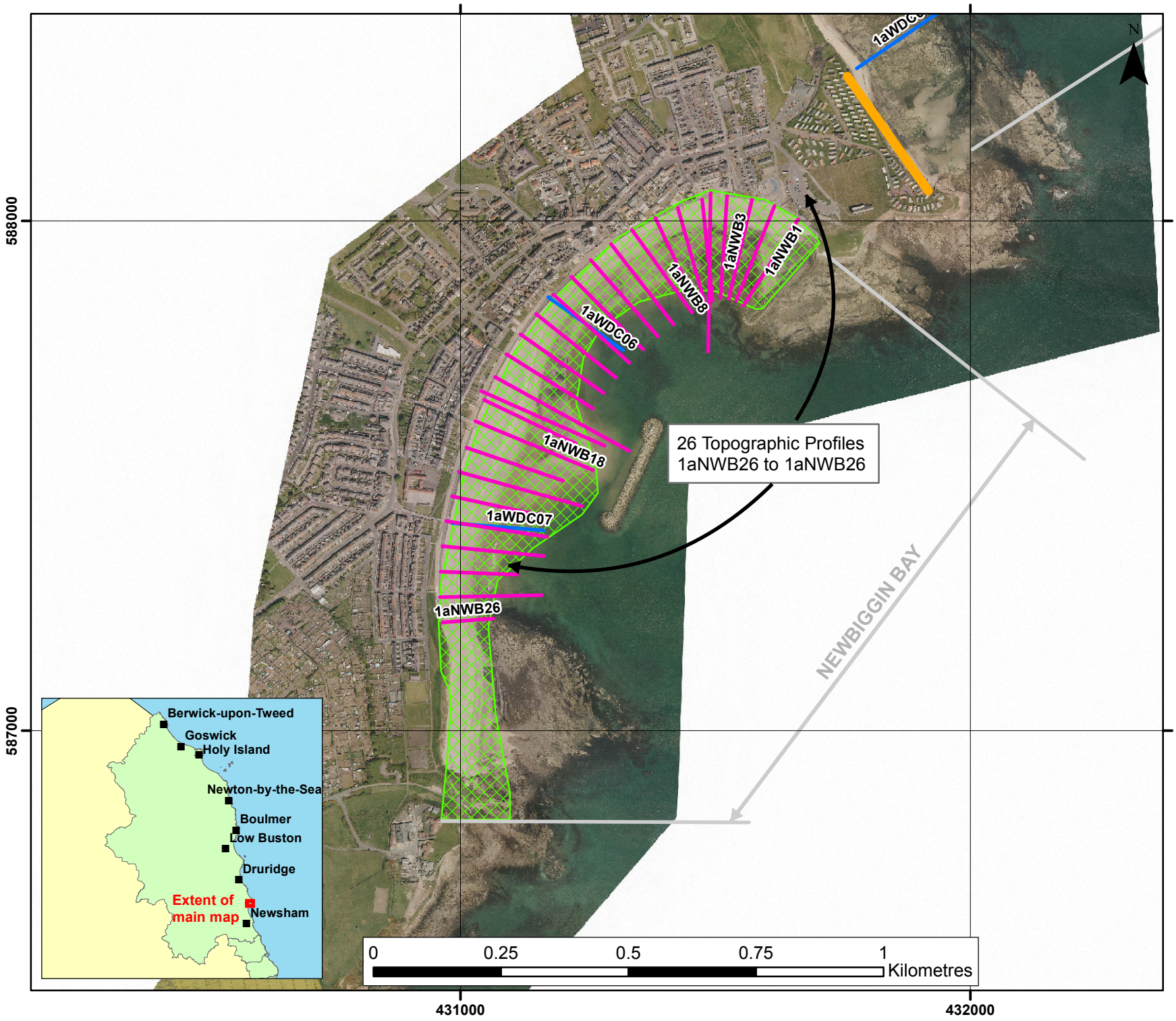

KEY

Topographic Profiles
- Annual
- 6 monthly

Topographic Surveys
- 6 monthly
- yearly
- 5 yearly

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

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Figure 2 - Map 11
Survey Locations
Newbiggin
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County Council

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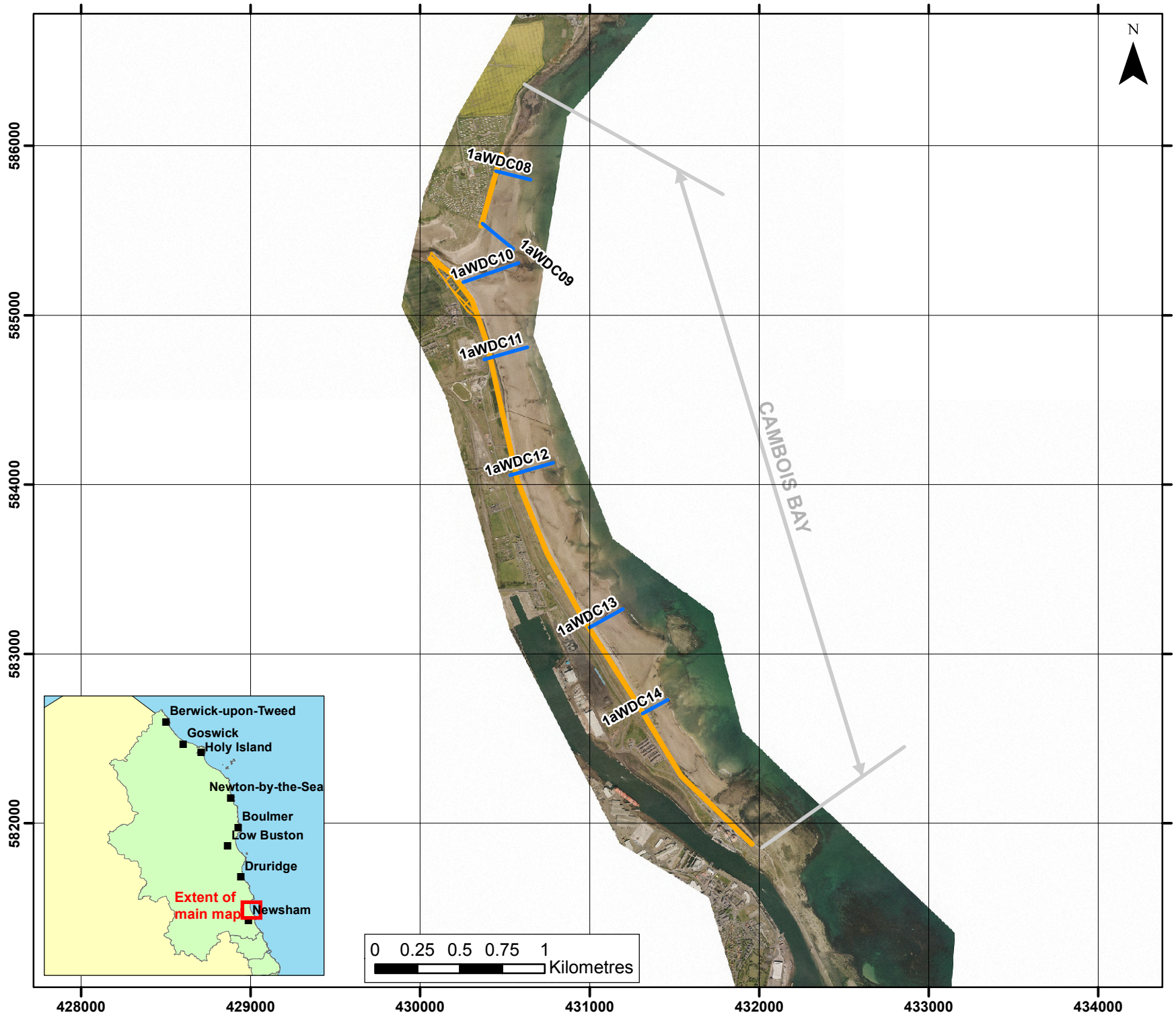

KEY

Topographic Profiles

- Annual
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Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs

- 50m centres
- 100m centres
- 300m centres
- Cliff Top Edge Survey

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Figure 2 - Map 12
Survey Locations
Cambois Bay
Northumberland County Council

Analytical Report 4
Full Measures Survey
Winter 2011

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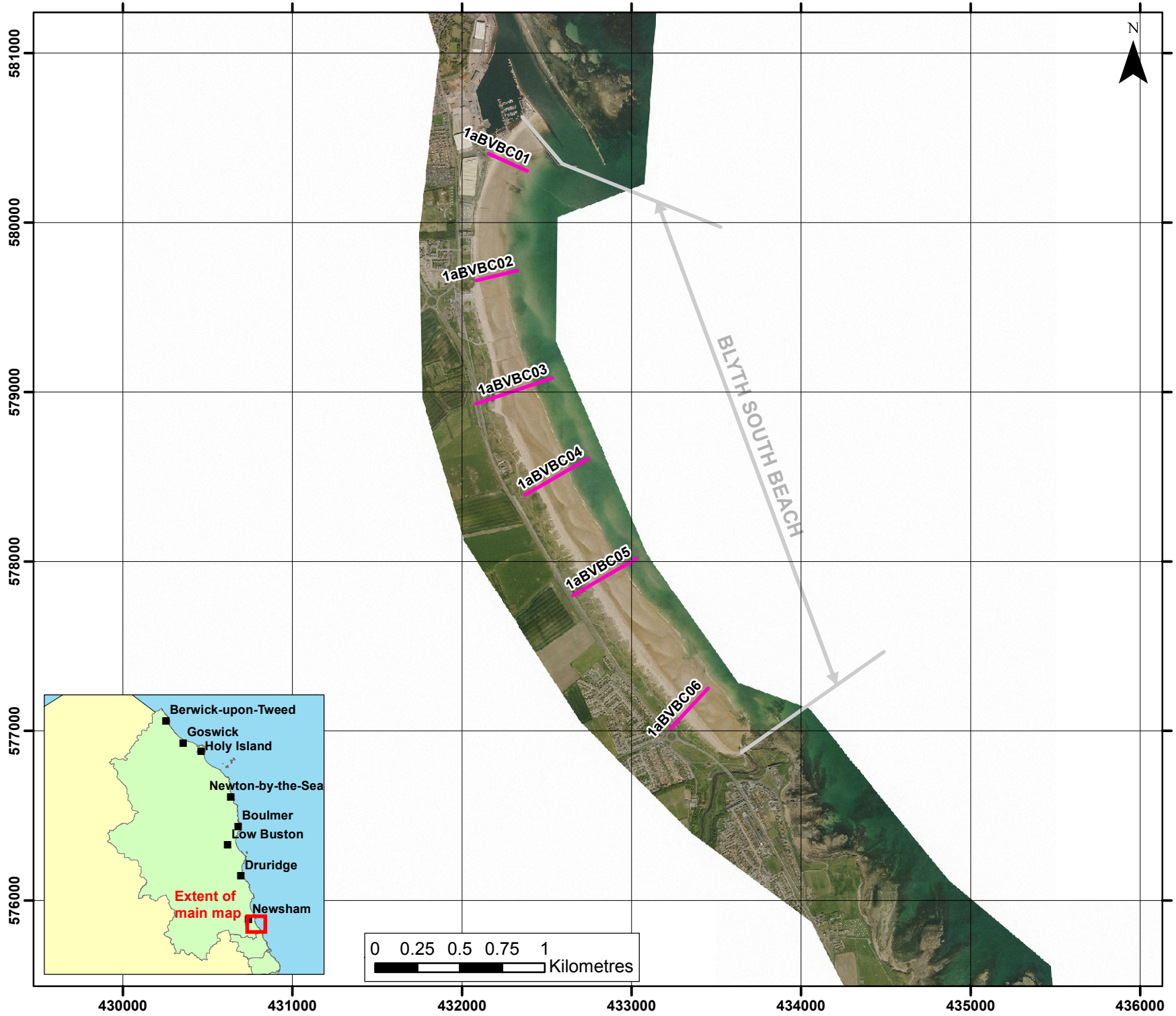

KEY

Topographic Profiles
- Annual
- 6 monthly

Topographic Surveys
- 6 monthly
- yearly
- 5 yearly

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

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Figure 2 - Map 13
Survey Locations
Blyth South Beach
Northumberland County Council

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2. Analysis of Survey Data

2.1 Sandstell Point (Spittal A)

Survey Date	Description of Changes Since Last Survey	Interpretation
Oct 2011	**Beach Profiles:** Sandstell Point is covered by ten beach profile lines for the Full Measures survey (Appendix A). Profiles **1aBTBC01** to **1aBTBC03** are located on the southern bank of the River Tweed in front of the dunes. At profile **1aBTBC01** the beach form has remained the same, but levels have reduced slightly, in the order of 0.2m from HAT to a chainage of 60m. At profile 1aBTBC02, the dunes have not changed form or position. Beach levels have increased above HAT, to from two small berms at chainages 42m and 48m. Seaward of MHWS, beach levels have fallen across the length of the profile by up to 0.3m. With the exception of a small increase in levels at the dune toe, beach levels have reduced across the profile length by up to 1.2m. Profiles **1aBTBC04** (longitudinal section) and **1aBTBC05** and **1aBTBC06** (both cross-sections) cover the spit at Sandstell Point. Profile 1aBTBC04 (Plate 1) is showing a significant increase in beach levels from 0m to 180m chainage to form a large bank that has formed around HAT/MHWS and is 180m wide. This accretion was also observed in the previous full measures report (winter 2011), where it is noted '*significant change between March 2010 and September 2010 with major accretion seaward of a chainage of around 140m forming a large new bank feature which had been absent from surveys in several recent years.*' The bank in the present survey is located landwards of the one observed in the winter 2011 survey. Seaward of this beach levels have fluctuated since the previous survey showing alternating patterns of a fall-rise-fall-rise in beach levels out to sea. This suggests that the foreshore is dynamic. **1aBTBC05** and **1aBTBC06** are transects across the spit, from west to east, with the river channel on the left-hand side of the plot and the open sea on the right-hand side of the plot. The latest profile shows some significant changes in beach levels. However, when this is compared to previous surveys, it is clear that the beach material moves around significantly over the seasons and it is difficult to discern a long-term trend.	The dunes along the south bank of the River Tweed have remained stable since the last survey. There has been accretion at the dune toe, however, beach levels have fallen to an increasing degree from west to east. **Longer term trends:** The previous full measures report links this erosion to the movement of the main channel of the River Tweed towards the southern bank as it adopts a more sinuous flow route around Sandstell Point spit. The survey photograph for the longitudinal section (1aBTBC04, 1aBTBC05 and 1aBTBC06) shows an uneven beach comprised of a series of banks. These banks lie beneath MHWS and are likely to migrate in response to changes in tidal flows and waves in the entrance of the Tweed Estuary and may also be influenced by large freshwater flows. A significant change has occurred at profile 1aBTBC04 with an increased in beach levels to form a bank. This is a similar pattern to that observed in winter 2011 (full measures survey) and suggests that it may be a seasonal feature that forms in response to storms. The northern end of Sandstell Point is very dynamic and likely to be influenced by tidal flows in and out of the Tweed Estuary. This is evident by the presence of bars, banks and troughs. Ripples within the trough,

Survey Date	Description of Changes Since Last Survey	Interpretation
	Profiles **1aBTBC07** to **1aBTBC10** are located along the open coast, at the intersection of the southern side of the spit at Sandstell Point and northern end of Spittal Beach. The changes observed for this frontage are repeated for each survey from north to south: (i) increase in beach levels between a height of 4m and 1m, however, this does not correspond to features on the beach and it is thought that this is actually the rock revetment; (ii) drop in beach levels around a height of 0.6m to form a concave form. The survey photographs (Plate 2 and Plate 3) shows the presence of ripples and ponded water and it is likely that this feature is a trough or runnel; (iii) seaward, at a height of -0.8m beach levels have increased. The profile shape here is a dome indicating the formation of a bar.	observed from the survey photographs, suggest that the channel is formed by waves and tides funnelling along the beach.
Nov 2011	**Topographic Survey:** Due to the significant changes that have been observed from the beach profiles along the spit at Sandstell Point, and the three dimensional nature of these changes, a topographic survey was introduced to the monitoring programme in November 2009. Data from the most recent topographic survey (full measures, winter 2011) have been used to create a digital ground model (DGM) (Appendix B – Map 1a) using a Geographical Information System (GIS). A difference plot has also been produced using the DGM (Appendix B – Map 1b) produced from the last produced topographic survey (partial measures, spring 2011) and the present survey. In particular, the difference plot shows: (i) an increase in beach elevation seaward of the dunes around the u-bend of the River Tweed; (ii) a significant increase in beach levels at the landward end of profile 1aBTBC04; (iii) a reduction in beach levels around the tip of the Spittal headland up to 2m; and (iv) adjacent to that a band of accretion (approximately 100m x 500m) orientated north to south that extends along the length of the spit.	The topographic survey shows a band of increased elevation (i.e. accretion) around the landward end of the spit, which is fronted by a band of reduced elevation (i.e. erosion). It is likely that the material eroded from the zone of reduced elevation is deposited in the zone of increased elevation to form a bank. This change is reflected in the beach profiles for the same areas, where this accretion reflects the bank that is likely to have formed under storm conditions. **Longer term trends:** A comparison of the topographic survey to the two previous surveys shows that the linear formations observed in November 2011 and similar to those observed in October 2011. This suggests that there could be trend in the behaviour of the spit. Between the winter and summer months the spit is likely to be subject to storms where the resultant waves and currents act to move the material around. Over the summer calmer conditions lead to the formation of berms and troughs (or in the case of 1aBTBC04, a bank), as seen in the present survey.

Plate 1 – Survey photograph 1aBTBC04_20111013_W3.JPG

Plate 2 – Survey photograph 1aBTBC10_20111013_N6.JPG

Plate 3 – Survey photograph 1aBTBC10_20111013_N7.JPG

2.2 Spittal (Spittal B)

Survey Date	Description of Changes Since Last Survey	Interpretation
Oct 2011	**Beach Profiles:** Spittal B is covered by four beach profile lines for the Full Measures survey (Appendix A). At profile **1aBTBC11** there has been a significant increase in beach levels, of up to 1.8m, between a chainage of 10m and 60m. This is accompanied by a similar reduction in beach levels between a chainage of 60m and 130m. This indicates cross-shore movement of beach material from the middle to upper beach. The survey photograph (Plate 4) shows accumulation of material up to the underside of the seawall bullnose. The beach at profile **1aBTBC12** has behaved similarly to 1aBTBC11, with a significant increase in beach levels, up to 1.6m, between a chainage of 0m and 60m. This is accompanied by a similar reduction in beach levels of up to 1m seaward of a chainage of 60m. Profile **1aBTBC13** is the most dynamic of all profiles along this frontage. The pattern of beach level change from the toe of the seawall to seaward is: increase (0.2m), reduction (0.2), increase (up to 1m, chainage 35m-80m) and reduction (up to 0.4m). This suggests a cross-shore movement of material across the beach. At profile **1aBTBC14** there has been substantial accretion across the length of the profile, which is in the order of 1m at a chainage of 55m. This is possibly recovery of material following a significant reduction in beach levels in 2008 (full measures, winter 2008).	There are significant cross-shore processes operating along this coastline. To the north end of the Spittal Beach at 1aBTBC11 and 1aBTBC12, there is a redistribution of beach material from the middle beach to the upper beach. This cross-shore transport is likely to be driven by waves and wind-blow processes. If sand is blown over the crest of the seawall onto the promenade and it is not returned to the beach, this could represent a permanent loss of material from the system. At the centre of Spittal beach, the beach is more dynamic with alternating areas of erosion and accretion. The survey photograph shows a small amount of accretion against the toe of the seawall. The observed increase in levels between 35m-80m chainage is infilling of the trough (its formation was described in the previous (2011) full measures report). To the south, the beach has accreted significantly. **Longer term trends:** The previous (2011) full measures report relates the changes previously observed to changes occurring at the estuary, Given the proximity of the mouth of the River Tweed to this frontage, it is likely that the changes again this year observed are related to an interaction of waves and currents flowing from and into the estuary.

Plate 4 – Survey photograph 1aBTBC11_20111013_Up.JPG

2.3 Goswick Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
Nov 2011	**Beach Profiles:** Goswick Sands are covered by six beach profile lines for the Full Measures survey (Appendix A). The profiles along this frontage extend from **1aBTBC15** to **1aBTBC20** in a north to south direction. The seaward face of the dunes along the length of Goswick Sands have not changed form or position since the last survey (combination of full measures, winter 2010 and partial measures, spring 2010). At profile **1aBTBC15** there has been a fall in beach levels by up to 0.5m around MHWS, however, from a level of 1.5m (a chainage of 130m) beach levels have increased across the profile in the order of 0.5m. At profile **1aBTBC16** there has been a slight increase in levels at the dune toe, however seaward of MHWS beach levels have fallen across the profile, particularly at a chainage of 140m where the fell by up to 0.5m and there is a hollow in the profile. Beach levels at **1aBTBC17** increased across the profile in the order of 0.5m since the last survey (full measures, winter 2010). At profile **1aBTBC18** beach levels between a chainage of 350m and 450m have reduced by approximately 0.2m, however seawards of this beach levels have increased with the formation of a berm at MHWS. At profile **1aBTBC19** beach levels from the dune toe (MHWS) to a chainage of 50m have reduced by approximately 0.1m. At profile **1aBTBC20** beach levels from the dune toe (MHWS) to a chainage of 50m have reduced by approximately 0.1m.	To the north of Goswick Sands at Cocklawburn Beach, there has been lowering of the dune toe, but accretion of the beach, suggesting movement of sediment through the beach/dune system perhaps in response to a storm. Between Far Sker and Cheswick Black Rocks, beach levels have fallen, however, beach levels are still higher than previous surveys recorded since the last full measures survey, October 2010). Opposite Cheswick, beach levels have increased. Comparison with the 2009 profiles shows that this increase could be a return to previous beach levels following an erosional period. To the south, opposite Goswick, beach levels have fallen above the MHWS line, but a berm has formed at MHWS and beach levels seaward of this point have increased. This indicates: (i) an element of cross-shore transport and potential draw down during a storm; (ii) the possible progradation of the beach in response to an increase in the supply of sediment; (iii) dynamic conditions brought about by the presence of the nearshore dunes. To the south of Goswick Sands, beach levels have fallen across the profile, although this is by a small amount. Overall beach levels are similar to previous surveys.

2.4 Holy Island

Survey Date	Description of Changes Since Last Survey	Interpretation
Nov 2011	**Beach Profiles:** Holy Island is covered by eight beach profile lines for the Full Measures surveys (Appendix A). **1aBTBC21** to **1aBTBC23** are located on the north-west side of the island, along The Snook. Profile 1aBTBC21 shows little change since the last survey (partial measures, spring 2011). The dunes at profiles 1aBTBC22 and 1aBTBC23 have not changed form or position. Beach levels have also changed little. However, the berm at MHWS has flattened and in the case of 1aBTBC22 it has migrated seawards. Beach levels on the foreshore have increased at both locations. **1aBTBC24** to **1aBTBC28** are located on the south side of the island in the vicinity of the castle and priory. **1aBTBC27** extends out to, and across, the small island upon which the remains of a chapel stand. All profiles show very little change since the previous survey. The survey report for Holy Island notes that '*Holy Island harbour was reasonably firm sand, as usually is very soft mud*'.	The dunes, sandy foreshore and sand flats around Holy Island remain very stable in both form and position, which is a repeat of the trend observed in previous surveys (refer to full measures, winter 2010). Profiles 1aBTBC22 and 1aBTBC23 on the north-west and north-side of the island are showing a progradation of the beach seaward, suggesting that this coastline is receiving more sediment than it is loosing onshore, offshore or alongshore. This behaviour is typical of shorelines in the lee of an island or an intercepting structure for longshore drift and incident waves.
Oct 2011	**Topographic Survey:** Holy Island causeway and a defined width of adjacent sand flats are covered by an annual topographic survey, which commenced in October 2004. The purpose of this survey was to determine whether raising the level of the causeway had any adverse accretionary or erosional impacts on the adjacent sand flats. Data from the most recent topographic survey (full measures, winter 2011)) have been used to create a DGM (Appendix B – Map 2a) using a Geographical Information System (GIS). A difference plot has also been produced using the DGM (Appendix B – Map 2b) produced from the last produced topographic survey (partial measures, spring 2011) and the present survey. In particular, the difference plot shows an overall reduction in levels 0 to -0.1 with localised areas of loss in the region of -0.1 to -0.5m; and gain in the region of +0.1 to +0.25m The areas of beach elevation loss are most prominent to the centre of the causeway, at the location of the channel. Areas of gain are located on the eastern side of the causeway, in the lee of the marsh.	As observed from the difference plot and as noted in the survey report for Holy Island, levels have increased on the eastern side of the causeway. This is likely to be a continuation of the trends observed in the last survey (full measures, winter 2010). The previous survey notes '…*most changes are associated with the natural variations in position of the South Low channel, but there is also a distinct zone to the east of the channel where modest net accretion to both the north and the south of the causeway. Since there remain numerous lengths of sandflat immediately adjacent to the causeway which show no significant net change over the past 6 years, this must be considered as a natural trend and not directly attributable to the causeway raising*.'

2.5 Bamburgh

Survey Date	Description of Changes Since Last Survey	Interpretation
Nov 2011	**Beach Profiles:** Bamburgh is covered by one beach profile line for the Full Measures survey (Appendix A). Profile **1aBTBC29** located approximately 750m south-east of the castle. The dune has not changed form or position. Generally beach levels have increased across the profile by 0.2m, however, this increases to 0.2-0.3m around a level of -0.4m (chainage of 450m), where the profile takes a more domed shaped. Along a small length of the profile, adjacent to the dome, between 430m and 450m chainage, beach levels have fallen. This suggests the presence of a bar/trough or ridge/runnel feature.	The present survey suggests that the dunes have remained stable since the last survey. The overall form of the beach profile is similar to the previous surveys, however, the beach is more dynamic having been subject to cross-shore movement of beach material.

2.6 Beadnell Village

Survey Date	Description of Changes Since Last Survey	Interpretation
Nov 2011	**Beach Profiles:** Beadnell Village is covered by two beach profile lines for the Full Measures survey (Appendix A). **1aBTBC30** is around 300m to the north of the village. The dune has not changed form or position. Beach levels at the dune toe have increased by up to 0.2m, however seaward of MHWS, beach levels have reduced consistently across the profile by approximately 0.1m. **1aBTBC31** is in Nacker Hole and extends across the promenade and seawall. The dune has not changed from or position. Conversely, beach levels have increased across the profile by approximately 0.1m when compared to 1aBTBC30.	The dune has remained stable. There has been a small increase in beach levels at the dune toe and the beach to the north of this section. However, to the south there has been a general lowering of the beach profile out to MLWS. It is possible that material eroded from the beach could have been redistributed by wind-blown transport to the upper beach / dune toe. The overall form of the beach is very similar to past surveys.

2.7 Beadnell Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
Nov 2011	**Beach Profiles:** Beadnell Bay is covered by nine beach profile lines for the Full Measures survey (Appendix A). **1aBTBC32** to **1aBTBC34** are located to the north of Beadnell Bay, in Beadnell Harbour. BTBC32 is immediately in the lee of Beadnell Harbour. The dunes at a1aBTBC32 and 1aBTBC34 have not changed from or position. At 1aBTBC33, the profile shows erosion of the dune face, however, the survey photograph (Plate 5) shows the dune to be well vegetated and stable. At all profiles there has been an increase in beach levels at the toe of the dune erosion to mid-way across the profile and a reduction in beach levels from a level of approximately 0.8m to seawards. **1aBTBC35** to **1aBTBC38** are located between Burn Carrs and the outfall of Brunton Burn/Long Nanny. Since the last survey (partial measures, spring 2011), with the exception of 1aBTBC37, the dune face has not changed from or position. At **1aBTBC37**, the bottom of the dune has accreted out by approximately 2m. This is also acknowledged in the survey report for the North East Coast, which notes '*sand accumulation at foot of dune*'. Beach levels at **1aBTBC35** and **1aBTBC36** have changed very little, with only a slight reduction in beach levels of 0.1-0.2m at the dune toe at **1aBTBC35**. At profiles **1aBTBC37** and **1aBTBC38**, a reduction in beach levels is equated with an increase in levels and vice-versa in a seaward direction to form an undulating profile. This demonstrates the cross-shore movement and redistribution of material by waves. This pattern is particularly pronounced at profile **1aBTBC38**, which is reflective of the proximity and influence of the outfall of Brunton Burn/Long Nanny on tidal currents, sediment transport and therefore beach dynamics. **1aADC01** and **1aADC02** are located along the frontage to the south of the outfall of Brunton Burn/Long Nanny. Since the last survey (partial measures, spring 2011), the dune face has eroded by approximately 0.5m; a continuation of historical trends. At profile **1aADC01**, beach levels reduced by approximately 0.2m between MHWS and a chainage of approximately 300m. Seaward of there, beach levels increased by approximately 0.2m. This suggests the cross-shore movement of material from the upper to lower beach. At profile **1aADC02**, beach levels reduced by approximately 0.2-0.3m around MHWS, but have remained relatively stable seaward to MWLS.	In the lee of Beadnell harbour the dunes are stable. Beach levels have increased from the beach toe out to the middle of the profile, seaward of which beach levels have reduced. Material eroded from the lower beach could be redistributed to the middle and upper beach by wind-blown transport. Generally the dunes and beaches in the north of Beadnell Bay are stable. There is evidence of some cross-shore movement, likely to be instigated through wind-blown transport or waves. The beach at profiles 1aBTBC37 and 1aBTBC38 undulates slightly along the length of the profile. To the south of Beadnell Bay, the dune face is eroding, a continuation of trends observed in previous surveys. Generally the beaches are stable, with some erosion of the beach at the dune toe and some cross-shore movement at profile 1aADC01, which is likely to be a result of wave and tidal currents relating to the proximity of the beach to the outfall of Brunton Burn/Long Nanny.

Plate 5 – Survey photograph 1aBTBC33_20111114_E3.JPG

2.8 Embleton Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
Nov 2011	**Beach Profiles:** Embleton Bay is covered by two beach profile lines for the Full Measures survey (Appendix A). **1aADC03** is located towards the north of the bay, north of Embletonburn Mouth. **1aADC04** is located towards the south of the bay. At both locations the dunes have not changed form or position. Beach levels have increased up to 0.5m at the toe of the dune (located around HAT/MHWS), but reduced up to 0.3m across the remainder of the profile.	The dunes at Embleton Bay are stable. Beach levels at the toe of dune have increased, but the beach has lowered seaward of MHWS to MLWS. It is possible that some of the sand eroded from the lower beach has been transported by waves / wind-blown process and become deposited at the toe of the dunes.

2.9 Boulmer

Survey Date	Description of Changes Since Last Survey	Interpretation
Nov 2011	**Beach Profiles:** Boulmer is covered by two beach profile lines for the Full Measures survey (Appendix A). These were added to the programme in October 2007. At profiles **1aADC04A** and **1aADC04B** the dunes have not changed form or position. Beach levels have increased at both locations in the order of 0.2m from the dune to at HAT seawards to the exposed rock foreshore. Beach levels have also increased slightly over the rocky foreshore by approximately 0.1-0.2m.	The dunes at Boulmer are stable and beach levels have increased since the last survey. **Longer term trends:** To the north of Boulmer, the beach levels are the highest they have been since 17th February 2010. To the south of the Boulmer, beach levels are the highest recorded.

2.10 Alnmouth Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
Oct 2011	**Beach Profiles:** Alnmouth Bay is covered by ten beach profile lines for the Full Measures survey (Appendix A). **1aADC05** and **1aADC06** are located in the small pocket beach that is situated between the rock outcrops of Seaton Point and Marden Rocks. Both profiles exhibited very minor change since the previous survey (full measures, winter 2010). At **1aADC05**, there was a drop in beach levels at the toe. At both profile locations, beach levels have dropped, but adjacent to is an increase in beach levels, indicating some cross-shore movement of material. **1aADC07**, **1aADC08** and **1aADC09** are located to the north of Alnmouth Bay between Marden Rocks and the mouth of the River Aln Estuary. The front face of the dunes has remained stable since the last survey (partial measures, spring 2011). Beach levels at all locations have increased from the dune toe out to a chainage of 60m. At 1aADC07, beach levels reduced between a chainage of 60m and 100m, but increased between 100m and 260m resulting in a shallowing of the beach profile. At **1aADC08** from a chainage of 60m, peaks and troughs in beach level have fluctuated in elevation by up to 1m in a seawards direction. At **1aADC09** there has been a slight oscillation of the beach profile to form a flatter beach out to 100m chainage. At 100m there has been a drop in beach levels by 0.4m, but from 120m to seawards, beach levels have increased. **1aADC10** to **1aADC14** are located between the south bank of the River Aln Estuary and the north breakwater of Warkworth Harbour at the mouth of the River Coquet Estuary. With the exception of profile **1aADC10**, the dunes have not changed in position or form since the last survey (partial measures, spring 2011). At **1aADC10** the face of the dunes and the dune toe has retreated by 3m. The changes observed at **1aADC10** are similar to those at 1aADC08 with fluctuating changes in beach level associated with sand bar migration in the Aln Estuary channel. Beach levels across profiles 1aADC11 to 1aADC14 have increased out to a chainage of 200m.	The beaches to the north of Alnmouth Bay are dynamic, evident by the cross-shore movement of material and, as shown by the survey photographs for profiles 1aADC07 to 1aADC09, the formation of bars and troughs along the beach. The photographs also show ripples on beach. Their asymmetric and non-parallel form suggests they are formed by currents, and also contribute to the dynamic patterns observed here. The channel of the Aln Estuary flows out to sea across these beaches and is likely to account for much of the beach changes observed here. The beach at Alnmouth Bay between the entrances to Aln Estuary and the North Pier of Warkworth Harbour at the River Coquet Estuary is accreting and beach profiles have adjusted to a slightly less concave profile since the last survey. Similar to beaches north of the Aln Estuary, the beach immediately to the south is dynamic and is likely to be affected by channel movements and flow into and from the channel.

Survey Date	Description of Changes Since Last Survey	Interpretation
Nov 2011	**Topographic Survey:** The northern part of Alnmouth Bay (to the north of the River Aln estuary) is covered by bi-annual topographic survey, which commenced in April 2005. Data from the most recent topographic survey (full measures, winter 2011) have been used to create a DGM (Appendix B – Map 3a) using a Geographical Information System (GIS). A difference plot has also been produced using the DGM (Appendix B – Map 3b) produced from the last produced topographic survey (partial measures, spring 2011) and the present survey. The difference plot shows an overall increase in beach levels with two linear bands of reduced levels that run parallel to the shore in a north-east to south-west direction. Approximately 250m offshore is what appears to be a further linear band of increased beach levels. The pattern of elevation change is very similar to that observed from the full measures winter 2011 survey, where there are linear bands of elevation increase and decrease that are orientated parallel to the shoreline. This pattern is very similar to that of a bar and trough/ridge and runnel geomorphological sequence, where sediment is deposited and shaped by waves and currents as it flows (swash and backwash) over the intertidal beach. It is likely that bars and troughs have formed along this coastline as waves break oblique to the shoreline, there is interaction between the breaking waves and the flow of currents in and out of the Aln River and the affects of the headland/rock outcrop to the north of Almnouth Bay.	The findings of the topographic survey support the findings of the beach profile analysis, which indicate that the beach to the north of the Aln River is dynamic with regular migration of sand bars. Sediment movement is a result of the interaction between waves and tidal currents and the influence of the headland/rock outcrop to the north and the River Aln to the south. The beach is defined by bands or apparent erosion and accretion (increases and decreases in elevation). This pattern is a repeat of the winter 2011 survey and shows migrating sand bars, with no net change in beach sediment volume. Similar to Sandstall Point (Spittal A), the beach form is continually changing as a result of the interaction between waves and tidal currents and the influence of the headland/rock outcrop to the north and the River Aln to the south. Between the winter and summer months the beach is likely to be subject to storms where the resultant waves and currents act to move the material, predominantly in an offshore direction. Over the summer calmer conditions lead to the formation of berms and troughs seen in the present survey.

2.11 High Hauxley & Druridge Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
Oct 2011 to Nov 2011	**Beach Profiles:** High Hauxley to Druridge Bay is covered by nine beach profile lines for the Full Measures survey (Appendix A). Four of these (with 'A' or 'B' suffixes) were added to the programme in October 2007. Profile **1aADC15** extends across the extensive dunes at Amble Links and foreshore. The dunes along this profile have remained stable since the last survey (full measures, winter 2010). The upper beach, which is comprised of gravel and extends from the dune toe to 0m (chainage approximately 140m), has flattened out since the last survey. Beach levels at the toe the dunes have increased, but increases in levels seaward of this point and the berm present in the last survey, have disappeared. Below an elevation of 0m, there is fluctuating pattern of change, with lowering between a chainage of 150m and 190m, and rising levels from a chainage of 190m. This suggests cross-shore movement of material in bars. **1aADC15A**, **1aADC16** and **1aADC16A** are located around Hauxley Haven. The dunes at all three profiles have remained largely unchanged since the last survey. At profile **1aADC15A**, beach levels have increased across the whole profile in the region of 0.2m. The rocky lower shore is unchanged. At profile **1aADC16**, there has been a fall in beach levels between HAT and 1m, however, seaward of this to MLWS (and the rocky foreshore), beach levels have increased in the region of 0.1m to 0.2m. At profile **1aADC16A**, with the exception of a small increase in beach levels at the toe of the rock revetment and around MLWS on the rocky foreshore, beach levels have fallen by approximately 0.2m. **1aADC16B**, **1aADC17** and **1aADC17A** are located to the north of Druridge Bay, between Bondi Carrs and Hadston Carrs and extend seawards from Togston Links. Generally no change to the dunes was observed since the last survey. At **1aADC16B** beach levels have fallen at the toe of the dunes and across the profile. The survey photograph (Plate 6) for this profile shows only a thin veneer of sand over a rock/boulder shore platform. At **1aADC17** beach levels have increased at the toe of the dune by up to 0.4m, however, the survey photograph (Plate 7) shows erosion of the shoreline / dune toe. Across the remainder of the profile beach levels have fallen slightly, in the region of 0.1m. At **1aADC17** beach levels have fallen at the toe of the dune, increased by approximately 0.2m between a chainage of 40m and 140m, and reduced seaward of 140m.	The dunes at profile location 1aADC15 have remained stable over the past year. Accretion at the toe of the dunes is likely to be deposition of wind blown sand. The survey photograph shows the presence of seaweed, which will assist in this deposition. Beach material eroded from around the 0m levels is likely to have been redistributed lower in the profile. This cross-shore movement is likely to have occurred during a recent storm. At Hauxley Haven, the dunes have remained stable. However, with the exception of 1aADC15A, the beach is showing evidence of cross-shore movement, with the redistribution of material from the upper/middle beach to the lower beach. This is likely to have occurred under storm conditions. The survey photograph shows large amounts of seaweed spread across the beach, which also suggests a recent storm. It is possible that beach material eroded from 1aADC15A during the storm has been moved north towards 1aADC15A, 1aADC16. Between Bondi Carrs and Hadston Carrs, the shoreline and dunes are experiencing erosion. The low till cliffs that form the coastline in this location are being actively eroded, causing the capping of dune sand to slump to the beach below and be rapidly reworked into the beach system (Plate 7). Despite the shoreline erosion, the beaches are relatively stable, with only small changes to the beach levels, which can

Survey Date	Description of Changes Since Last Survey	Interpretation
	1aCMBC01 and **1aCMBC02** are located in the southern section of Druridge Bay. Since the last survey (partial measures, spring 2011), the dunes have remained stable, with some accretion on the seaward face of the dunes at **1aCMBC02**. The beach at both locations has experienced some re-profiling. At **1aCMBC01** beach levels at the toe of the dunes has increased and the upper beach berm has prograded seaward so the berm is now located further seaward and lower down the profile. Between 260m and 280m, beach levels have fallen by 0.4m, but seawards of this beach levels have increased to form a domed profile. The survey photograph (Plate 8) shows some ponding of water in the lee of a large bar. At **1aCMBC02** beach levels below MHWS have fallen in the order of 0.5m, but increased beyond a level of 0.5m and a chainage of 320m.	be attributed to a cross-shore shift of material in response to tides and waves. The southern central part of Druridge Bay is accreting, evident by a prograding shoreline. The large bar and trough have formed where sediment carried shoreward meets with sand withdrawn from the beach by backwash. The bar and trough are likely to migrate and break-down as weather conditions change over time.

Plate 6 – Survey photograph 1aADC16B_20111026_N8.JPG

Plate 7 – Survey photograph 1aADC17_20111026_N3.JPG

Plate 8 – Survey photograph 1aCMBC01_20111109_N19.JPG

2.12 Lynemouth Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
Oct 2011	**Beach Profiles:** Lynemouth Bay is covered by six beach profile lines for the Full Measures survey (Appendix A). Two of these, profiles CMBC03A and CMBC03B, were added to the programme in October 2007. **1aCMBC03** is located just to the south of Snab Point. The profile extends across the cliff and the rock platform below. The profile has not exhibited any change since the last surveys indicating a stable cliff and rocky shore. **1aCMBC03A** is located opposite Lynemouth and extends across the extensive slag banks before reaching the foreshore. A line of boulders exists along the upper beach around HAT. The slag bank has not experienced any change since the last survey (partial measures, spring 2011). Beach levels dropped by approximately 0.5m between a chainage of 100m and 110m. This area is located between the boulders and the top of the gravel berm that marks the start of the lower beach (Plate 9). The lower beach between a chainage of 130m and 160m has also experienced a reduction in beach levels in the region of 0.2m. **1aCMBC03B** is located to the north of Lynemouth Power Station and extends across the extensive slag banks before reaching the foreshore. The process of slag bank erosion has been progressively ongoing for some years. The most recent survey reveals further cut back of the seaward edge of the bank in the region of 5m between March and November 2011. Seaward of MHWS, beach levels have fallen by approximately 1m across the length of the profile. **1aWDC01** extends from seaward of the rock revetment down to low water across the extensive slag banks. Beach levels have fallen since the last survey, by up to 0.5m at the toe of the revetment. **1aWDC02** is located to the south of the Power Station. Since the last survey (full measures, winter 2010), the dunes, the muddy backshore (slag bank) and upper boulder beach (chainage 0m to 170m) have not experienced any significant change. Seaward of the boulder beach, at HAT (3m), chainage 180m, beach levels have increased to form a berm. Between MHWS and MLWS (190m to 220m chainage, beach levels have fallen by up to 035m. This indicates cross-shore movement of material to the upper beach.	The north of Lynemouth Bay (between Snab Point and Headagee), the cliffs, beach and rocky foreshore has remained stable. Between Headagee and Lynemouth Power Station, erosion of the upper beach could be attributed to use of vehicles, as tyre tracks were observed during the survey (Plate 9). To the north of Lynemouth Power Station, in the centre of the Bay, there has been significant erosion, with cut-back of the slag banks and lowering of the beach. The survey report notes that at profile 1aCMBC03B '*previously graded profile has been eroded to form cliff face'*. Between Lynemouth Power Station and Beacon Point, in front of the dunes and slag bank, the berm on the upper beach has accreted, whilst middle and lower foreshore levels have fallen. The previous full measures report (winter 2010) attributes this to the landward movement of material from the lower to upper beach by overwashing. To the south, between Beacon Point and Newbiggin Point, the cliffs that line the backshore appear to have remained unchanged. Accretion at the toe, but a reduction in beach levels between MHWS and the exposed rock platform has led to the development of a more concave beach.

Survey Date	Description of Changes Since Last Survey	Interpretation
	1aWDC03 is located to the south of the Power Station and to the north of Beacon Point. The pattern seen at 1aWDC02 is repeated, with a general reduction in beach levels in the order of 0.5m across the beach profile from HAT to seawards. **1aWDC04** and **1aWDC05** are located between Beacon Point and Newbiggin Point. At profile 1aWDC04, the cliffs have remained relative stable. Beach levels have increased at the toe down to MHWS. Between MHWS and a level of -0.2m, beach levels have reduced to form a more concave beach. The lower beach has experienced little change and the rock remains exposed. At 1aWDC05, the cliff has remained stable. Beach levels have increased at the toe down to MHWS. Between MHWS and a level of 2m, beach levels have reduced to form a more concave beach. The lower beach has experienced little change and the rock remains exposed.	
Oct 2011	**Cliff-top Survey:** This is the first year that the cliff top survey data has been plotted as a line on the 2010 aerial map, so a comparison with equivalent previous data has not been completed. This will be done for the partial measures (spring, 2012) and will be completed on a bi-annual basis thereafter. Data from the most recent cliff top survey (full measures, winter 2011) has been plotted onto aerial imagery (refer to Appendix C – Map 1, 2a, 2b and 2c).	This is the first year that the cliff top survey data has been plotted as a line on an aerial map, so a comparison with previous data has not been completed.

Plate 9 – Survey photograph 1aCMBC03A_20111108_N7.jpg

2.13 Newbiggin-by-the-Sea

Survey Date	Description of Changes Since Last Survey	Interpretation
Oct 2011	**Beach Profiles:** Newbiggin-by-the-Sea is covered by six beach profile lines for the Full Measures survey (Appendix A). Two of these, profiles WDC05A and WDC06A, were added to the programme in October 2007 specifically to help assess the performance of the capital scheme involving beach replenishment and construction of an offshore breakwater. In addition a further 26 profiles (1aNWB1 to 1aNWB26) have been surveyed since September 2010 as part of a full topographic survey of Newbiggin Bay. These profiles are not analysed here, however, the findings of the topographic survey are presented below. **1aWDC05A** is in the north of Newbiggin Bay. The profile for winter 2011 shows a significant drop in beach levels between the seawall and a chainage of 60m (i.e. to MHWS) by as much as 1.4m since the last survey, resulting in flattening of a berm. This is the first significant drop in beach levels since autumn/winter 2008 (full measures survey). Between a chainage of 60m and 80m, beach levels have increased by up to 0.5m, however, 80m and 105m chainage, beach levels have fallen by up to 0.4m. No change in the exposed rock on the lower foreshore was observed. This significant change, together with those at other profiles is believed to relate to the beach management works to re-profile the nourished beaches, which was undertaken in the last 3 weeks of September 2011. **1aWDC06** is located in the centre of Newbiggin Bay. Since winter 2008 (full measures), beach levels out to a chainage of 50m have been falling. Since the last survey (partial measures, spring 2011), beach levels between HAT and a chainage of 35m have continued to fall so that the revetment steps are now exposed. However seawards of the fourth step down, beach levels have increased. This suggests some cross-shore movement of sediment, from the upper beach to the lower beach, probably by artificial reprofiling. **1aWDC06A** is located in the centre of Newbiggin Bay. The profile gradient and form has changed little over time. The berm on the upper beach around HAT was flattened sometime before September 2009 has remained this way since. Since the last survey (partial measures, spring 2011), beach levels have fallen at the toe of the seawall. The berm at HAT has extended upwards and outwards, as has the	Since the last survey (partial measures, spring 2011), the northern and southern ends of Newbiggin Bay have experienced a drop in beach levels from the toe of the hard defences out to a level of approximately 1.4m. There are understood to have been beach management works to re-profile the nourished beaches shortly before the surveys, The amount of apparent removal of upper beach material is greatest along the north and north-western extents of the bay and has resulted in the exposure of the concrete stepped revetment. The survey report also notes '*sea wall structure in Newbiggin Bay is visible due to sand loss*'. The survey report for Newbiggin notes that '*large quantities of sea weed deposited on beach plateau and a tractor was clearing this and boat ramp for access*'. It is noted that depending on where this is disposed to such a process could result in permanent removal of sand from the beach. West and south-west of Down Over Rocks, the lower beach has accreted. This also provides evidence of cross-shore movement as beach material is transported from the upper beach to the lower beach, or from offshore. Accretion is greatest on the lower beach of profile 1aWDC06 and can be attributed to the presence of the offshore breakwater.

Survey Date	Description of Changes Since Last Survey	Interpretation
	beach from MHWS to 180m chainage. Seawards of there, beach levels have fallen. **1aWDC07** is located in towards the south of Newbiggin Bay. Since the last survey (partial measures, spring 2011), beach levels in front of the seawall and above HAT have fallen to form a wider and flatter beach. Between MHWS and MLWS there have been an increase in beach levels in the order of 0.2m to a chainage of 55m and a reduction in beach levels in the order of 0.2m to a chainage of 75m.	Beach levels along profile 1aWDC06A have increased across the profile since the last survey, which is attributed to accretion resulting from the protection afforded by the offshore breakwater. The accretionary nature of this profile suggests that the offshore breakwater is functioning as expected stabilising the salient in its lee.
Oct 2011	**Topographic Survey:** Newbiggin-by-the-Sea is covered by bi-annual topographic survey, which commenced in September 2010 specifically to help assess the performance of the capital scheme that was constructed in 2007, which involved beach replenishment and an offshore breakwater. The topographic survey comprises a series of 26 beach profiles plus additional intervening spot heights. Prior to incorporation in the programme, these surveys were undertaken on occasions between 2007 and 2010 as part of the scheme development. Data from the most recent topographic survey (full measures, winter 2011) have been used to create a DGM (Appendix B – Map 4a) using a Geographical Information System (GIS). A difference plot has also been produced using the DGM (Appendix B – Map 4b) produced from the last produced topographic survey (partial measures, spring 2011) and the present survey. The topographic survey shows areas of both gain and loss across the beach. However there are some noticeable differences at the following locations: (i) in the north-west of the bay, there has been drop in elevation towards the back of the beach around MHWS; (ii) to the north-centre of the bay, there has been a significant increase in beach elevation; (iii) the plan-shape of the beach shows that beach material has been trapped in the lee of the breakwater to form a salient – there has been a fall in elevation at the tip of the salient, but overall across it, beach elevation has increased; (iv) between the breakwater and Spital Cars (rock outcrop) beach elevation has increased; and (v) beach elevation between the back shore and Spital Cars has fallen.	The previous survey report (partial measures, spring 2011) notes that a sand recycling scheme is to be instigated later in 2011 to restore design profiles in the centre of the bay, where erosion is occurring, and reduce accumulating sand levels in the north of the bay. Northumberland County Council undertook beach re-profiling during the last 3 weeks of September in 2011. The present beach topographic survey was undertaken on the 31st October 2011. Therefore the patterns observed from the topographic survey are likely to reflect the redistribution of material on the beach due to the re-profiling undertaken as part of the beach management measures implemented at Newbiggin. The findings of the topographic survey show that the beach either side of the breakwater is accreting, in particular to the north-east. However, due to the beach management activities it is not possible to ascertain which changes are due to natural processes and which relate to the re-profiling works. Beach elevation has been reduced along the back of the beach to the north-east and south-west, where there had previously been accretion. This is as observed from the beach profiles.

2.14 Cambois Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
Oct 2011	**Beach Profiles:** Cambois Bay is covered by seven beach profile lines for the Full Measures survey (Appendix A). Profiles 1aWDC08 and 1aWDC09 are located to the north of the River Wansbeck estuary in front of Sandy Bay Caravan Park. **1aWDC08** extends from the cliff across the rock revetment onto the foreshore. There are no significant changes in the cliff top position or cliff face at this profile. Beach levels from the toe of the rock revetment to a chainage of 65m have increased since the last survey (full measures, winter 2010) up to 0.4m. However, seaward of this, beach levels have fallen by up to 0.5m. As a result, the beach has steepened. **1aWDC09** extends from the cliffs at the very southern end of the Caravan Park. The cliff face has eroded since the last survey (full measures, winter 2010), with recession in the order of 1m approximately 1m up from the toe of the cliff. This is in line with ongoing trends and erosion since April 2002 is now in the order of 11m. Beach levels are seen to increase at the toe of the cliff, around MHWS. This is likely to be an accumulation of the material eroded from the cliff above. Beach levels on the middle of the beach (level of1m to 0m, and 50 to 150m chainage), have increased, with a reduction at c160m chainage. **Profiles 1aWDC10 to 1aWDC14 are all located along Cambois Bay, between the River Wansbeck and River Blyth estuaries.** **1aWDC10** is located on the southern side of the Wansbeck Estuary, just to the south of Cambois House. The cliff face has not been measured as part of the survey. Beach levels have increased across the profile length since the last survey (full measures, winter 2010). This is by as much as 1m at the toe of the cliff and around MHWS, which has formed a berm at this location. The increase in beach levels, in the order of 1m, is greatest at 100m and 40m chainage, which reflects the formation of berms at these locations. **1aWDC11** extends across the rock revetment fronting the now disused foundry. The beach here is defined by a narrow and steeper upper beach, which fronts the rock revetment; seaward of which is a slightly concave section of beach that contains standing water; and seaward of that is a gently sloping	Between 1aWDC08 and 1aWDC09, beach levels at the toe of the cliff have increased. At 1aWDC08, this is likely to be movement of existing beach material, however, at 1aWDC09, this could be comprised of new material eroded from the cliffs above. Scour around a line of rocks that crop out in a shore-parallel strip on the beach has formed a runnel. Landward of the rocks, the beach is higher and more convex, and has accreted over the past year. Seaward of the rocks, the beach is flatter and steeper. A similar to trend to that observed north of the River Wansbeck is observed to the south. Overall, beach levels have increased, with accretion at the toe of revetment in the north and the dunes to the centre and south of the Cambois Bay. A change to the gradient of the beach is observed, with shallowing and flattening of the beach. Profiles 1aWDC11 and 1aWDC13 show signs of onshore movement of material from MLWS to landward. Together these patterns reflect the weather conditions of the summer, when the sea state is calmer and material is moved back onshore after the winter storms. Material is likely to accrete at the toe of the rock/dunes as a result of cross-shore transport under waves and tides and wind.

Survey Date	Description of Changes Since Last Survey	Interpretation
	beach. Beach levels immediately seawards of the revetment have increased by approximately 0.5m. Between a chainage of 55m and 65m beach levels have lowered in the order of 0.3m. Between a chainage of 75m and 115m, beach levels have increased, to form a beach domed in cross-section. Seawards, beach levels have reduced. It is possible that these changes reflect the onshore movement of material from the lower beach to the middle beach. **1aWDC12** is situated approximately mid-way along Cambois Bay. Since the last survey (full measures, winter 2010), the dune face has eroded landward by as much as 1.5m. Beach levels have increased significantly (by up to 1m at chainage 80) to form a shallower and flatter beach profile. At **1aWDC13** there has been no change to the dune face. Between MHWS to a level of -0.3m (135m chainage), beach levels have increased. Seaward of 135m chainage, beach levels have fallen. This has created a beach of similar gradient, but gently sloping to MLWS. Similarly, to 1aWDC11, these changes could reflect the onshore movement of material from the lower beach to the middle beach. The beach at **1aWDC14** is largely similar to that in winter 2010. The key differences are an increase in beach levels of approximately 0.6m at the toe of the dunes, around MHWS out to 60m chainage; and 0.6m between 80m and 120m chainage. The uneven profile reflects the exposure of the underlying bedrock, first observed in September 2010.	
Oct 2011	**Topographic Survey:** Cambois Bay is covered by a new survey. The survey was first undertaken as part of this present full measures survey in October 2011 and will be completed annually thereafter. Data from the most recent topographic survey (full measures, winter 2011) have been used to create a DGM (Appendix B – Map 5a) using a Geographical Information System (GIS).	This is the first year of survey, so a difference plot has not been created.
Oct 2011	**Cliff-top Survey:** This is the first year that the cliff top survey data has been plotted as a line on the 2010 aerial map, so a comparison with equivalent previous data has not been completed. Data from the most recent cliff top survey (full measures, winter 2011) has been plotted onto aerial imagery (refer to Appendix C – Map 1).This is the first year that the cliff top survey data has been plotted as a line on the 2010 aerial map, so a comparison with previous data has not been completed. This will	This is the first year that the cliff top survey data has been plotted as a line on an aerial map, so a comparison with previous data has not been completed.

Survey Date	Description of Changes Since Last Survey	Interpretation
	be done for the partial measures (spring, 2012) and will be completed on a bi-annual basis thereafter. Data from the most recent cliff top survey (full measures, winter 2011) has been plotted onto aerial imagery (refer to Appendix C – Map 2a, 2b and 2c).	

2.15 Blyth South Beach

Survey Date	Description of Changes Since Last Survey	Interpretation
Oct 2011 to Nov 2011	**Beach Profiles:** Blyth South Beach is covered by six beach profile lines for the Full Measures survey (Appendix A). **1aBVBC01** is located towards the north of South Beach, in front of the area of land owned by Port of Blyth. Since the last survey (partial, spring 2011), some erosion at the dune toe has occurred. The beach levels on the upper beach (between approximately 0.6m and 3.0m) have increased, forming a berm at beyond the erosion zone at dune toe. Beach levels below this have fallen. This suggests that the beach has narrowed and steepened. Beach levels at **1aBVBC02** have increased across the profile since the last survey (partial, spring 2011), from the dune toe to MLWS. A small berm is present at MHWS. At **1aBVBC03** the seaward face of the dunes did not show signs of erosion. Beach levels increased at the toe of the dunes down to MHWS. From MHWS to 0.5m beach levels have fallen, but the gradient of the beach has not changed. Lower beach levels have changed slightly, indicating some flattening of the profile. Beach levels at **1aBVBC04** across the profile since the last survey (partial, spring 2011). Similarly to 1aBVBC03, there has been considerable accretion at the toe of the dunes, around HAT and MHWS. This could be related to ongoing beach management. The increase in beach levels reduce in a seaward direction before increasing again at a chainage of 130m to form a berm that slopes out to MLWS. At **1aBVBC05**, similarly to 1aBVBC03 and 1aBVBC04, there has been considerable accretion at the toe of the dunes, around HAT and MHWS since the last survey (partial, spring 2011). This could be related to ongoing beach management. Beach levels have increased to a chainage of 150m At 180 to 200m chainage, beach levels have increased in height to form a small berm. Profile **1aBVBC06** is located at the southern end of the beach, towards Seaton Sluice. Generally, there has been little change to the dunes and the upper beach since the last survey (partial, spring 2011). Between MHWS and MLWS beach levels have increased, with some shallowing of the beach gradient around 150m chainage and a berm around 270m chainage.	The surface, width and sea-ward-face of the sand dunes along the back of Blyth South beach have shown little signs of movement between spring 2011 and winter 2011. Along the length of this frontage, beach levels have increased. These trends are likely to be related to ongoing dune management activities, in addition to a natural re-building during the summer period in response to calm conditions. At the toe of the dunes, between HAT and MHWS, beach material has accumulated to from a wider and shallower upper beach. Between MHWS and MLWS, beach levels have increased and generally flattened, although the extent of this pattern reduces in a southerly direction. These trends are likely to be related to ongoing dune management activities, as described below. At a level of -0.5m, a berm is present on all profiles. As described in the previous full measures report, the berm reduces in width and height towards the south in response to dominant wave conditions. At Blyth South Beach, there have been ongoing beach management and dune repairs since 2002, including using recycled Christmas trees to create sand traps, within the damaged areas of the dunes system. Restoration areas are then usually planted up with Marram Grass the following January if enough sand has accreted. In some years there has also been occasional recycling of sand to the toe of damaged

Survey Date	Description of Changes Since Last Survey	Interpretation
		areas of dunes from both the Blyth Harbour and Seaton Sluice end of the beach.

3. Problems Encountered and Uncertainty in Analysis

Individual Profiles – problems with survey data collection:

At profile 1aBTBC28, the cliff was too steep to measure.

At profile 1aBTBC33, there is a gap in the survey data due to bushes on top of dunes.

Profile 1aBTBC34 was taken from a new start point as the fence is now gone. The section is taken over the dune instead.

Profile 1aBTBC35 was taken from a new start point from the current section start point, which is on edge of the dune. The survey is now taken further up by next dune.

Profile 1aWDC01 was measured from the fence to include revetment.

At 1aWDC05A, between a chainage of 0m and 55m, beach levels have dropped by up to 2m. Comparison with the previous profiles shows this is significant change away from the trends of recorded for all previous profiles and it therefore appears to relate to the recent beach re-profiling works.

Profile 1aWDC10 was taken further back over the dunes and the section ends at the river.

Topographic Survey

At Newbiggin-by-the-Sea, the surveyors were unable to measure the start of section 9 due to presence of a cabin.

Cliff Top Surveys

Surveying the cliff top along Cambois Bay is more difficult than the similar surveys at Newbiggin Caravan Park and Sandy Bay Caravan Park because the cliff edge is less distinct and hard to precisely define due to vegetation coverage and its smooth, degraded form. Consequently a long-term record is required before results from this surveying technique become truly meaningful.

At Cambois, undergrowth at north end of cliff top hindered surveying and access to the very north end of cliff line was limited due to construction work.

For all cliff-top surveys prior to Full Measures 2011, the data was saved in '.kmz' format for plotting and comparison in GoogleEarth. For the present survey report, this data has been visualised in GIS, which revealed the quality was variable and reliable interpretations of cliff change could not be made. For this reason, the 'kmz' files are not presented or analysed as part of the present report. The survey data collected for the Full Measures 2011 survey has also been plotted in GIS as a line on the 2010 aerial map, however, for the reasons outlined above, a comparison with the equivalent previous data has not been completed. A comparison will be completed for the partial measures (spring, 2012) and repeated on a bi-annual basis thereafter.

In addition to the analysis of beach profiles, assessments of cliff recession will be derived from analysis of time-series remote sensing data. A high quality baseline survey, comprising LiDAR and aerial photography, was collected in 2010, a repeat survey was completed in Sept/Oct 2012 and a second repeat survey is planned for 2014. This data will be analysed to give more accurate information on the behaviour of the cliffs in a separate report.

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

It is recommended that records of beach management activities at Newbiggin and any other locations such as Cambois and Blyth South beach should be kept and made available for incorporation into the next full measures reports in order to form a complete record.

It is suggested that volumetric analysis of overall changes should be considered to be added to the programme at certain locations such as Newbiggin to establish losses or gains of material within the bay, making valuable use of the survey data, as simple visual interpretation is not possible in areas where extensive beach management works have been undertaken.

5. Conclusions and Areas of Concern

- At Sandstell Point (Spittal A), the recorded profiles and topographic survey present no causes for concern.
- At Spittal (Spittal B), the recorded profiles present no causes for concern.
- At Goswick Sands, the recorded profiles present no causes for concern.
- At Holy Island, the recorded profiles and topographic survey present no causes for concern.
- At Bamburgh, the recorded profiles present no causes for concern.
- At Beadnell Village, the recorded profiles present no causes for concern.
- At Beadnell Bay, the recorded profiles present no causes for concern.
- At Embleton Bay, the recorded profiles present no causes for concern.
- At Boulmer, the recorded profiles present no causes for concern.
- At Alnmouth Bay, the recorded profiles and topographic survey present no causes for concern.
- At High Hauxley & Druridge Bay, between Bondi Carrs and Hadston Carrs (profiles 1aADC16B to 1aADC17A), the low till cliff and overlying dunes are experiencing erosion. The cliff toe is being cut-back and undermined and the dune material above then slumps to the beach below. Along the rest of the frontage, the recorded profiles present no causes for concern.
- At Lynemouth Bay, between Headagee and Lynemouth Power Station (profiles 1aCMBC03A and 1aCMBC03B), erosion of the upper beach could be attributed to vehicles being driving across the beach.
- To the north of Lynemouth Power Station, in the centre of the Bay, there has been significant erosion, with cut-back of the slag banks and lowering of the beach. The survey report notes that at profile 1aCMBC03B 'previously graded profile has been eroded to form cliff face'. The previous survey report (partial measures, spring 2011) noted that '*the slag banks that were previously being eroded at a rapid rate along parts of Lynemouth Bay have been mechanically re-graded to a shallower slope angle, with some of the material contributing to notable accretion on the foreshore. Continued monitoring will be necessary to determine whether this has been successful in slowing or arresting the recession rates*'. These observations may be related to beach regrading work.
- Elsewhere along Lynemouth Bay, the recorded profiles and the cliff top survey present no causes for concern.
- At Newbiggin-by-the-Sea, the topographic survey shows erosion to the north of the beach and accretion in the centre. The previous survey report (partial measures, spring 2011) noted that '*a sand recycling scheme is to be instigated later in 2011 to restore design profiles in the centre of the bay, where erosion is occurring, and reduce accumulating sand levels in the north of the bay'*. The patterns observed from the topographic survey may reflect this.
- The survey report for Newbiggin notes that '*large quantities of sea weed deposited on beach plateau and a tractor was clearing this and boat ramp for access*'. This process could result in the permanent removal of sediment from the beach.
- Elsewhere along Newbiggin Bay, the recorded profiles present no causes for concern.
- At Cambois, the recorded profiles and the cliff top survey present no causes for concern.
- At Blyth South Beach, the previous survey report (partial measures, spring 2011) noted concerns relating to '*high exposure conditions in the central sections of Blyth South Beach. The most recent survey shows notable lowering of the foreshore directly at the toe*

of the dunes, which could lead to dune erosion'. The present survey has found beach levels to increase thereby negating previous concerns at this time. A combination of beach management activities may have contributed to this accretion, however, it is not known how much of the accretion seen is natural or the result of beach management / recycling works to move beach sand from the ends of the beach back to low spots at the toe of the dunes.

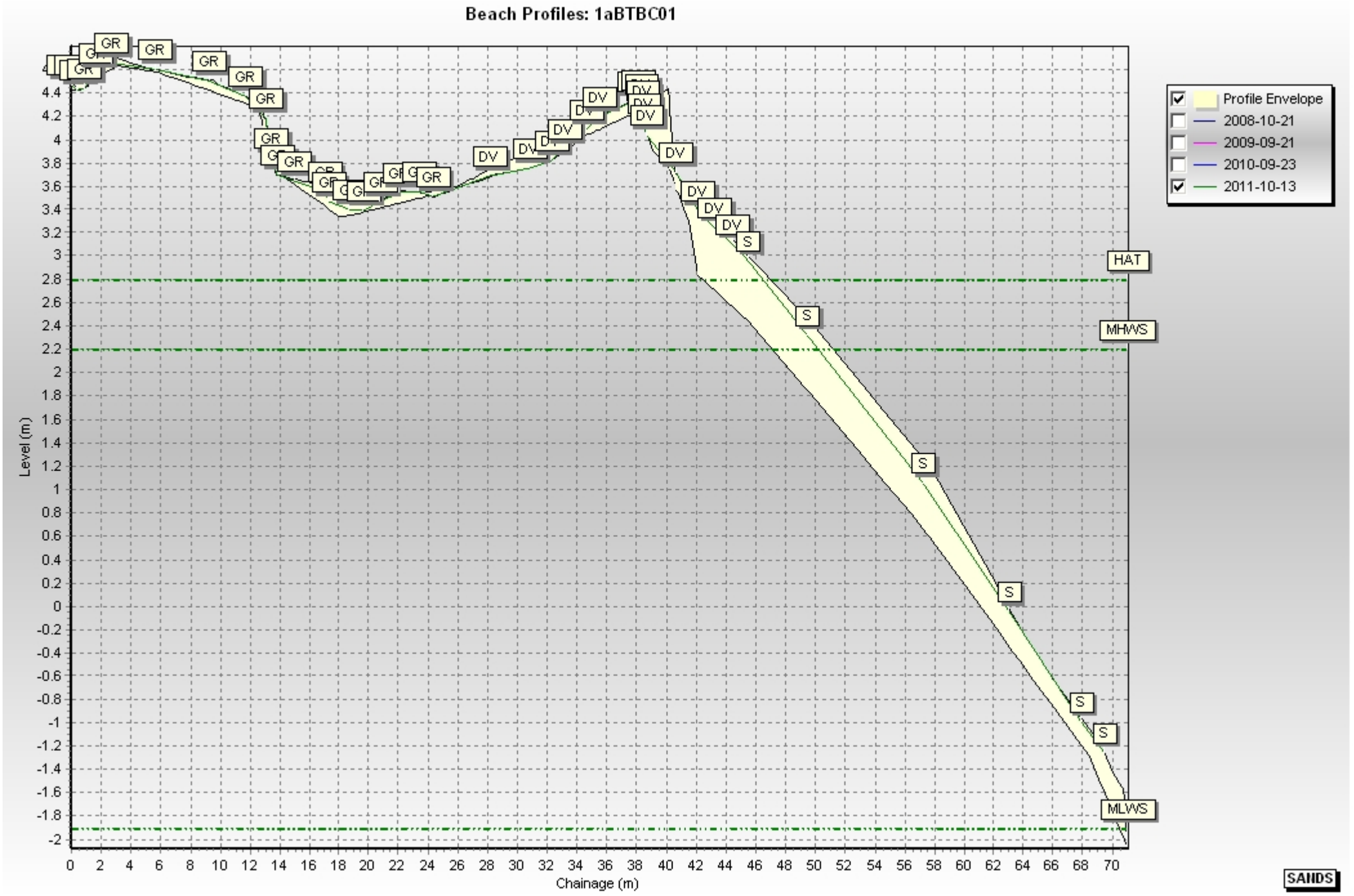
Appendices

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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Chainage (m)
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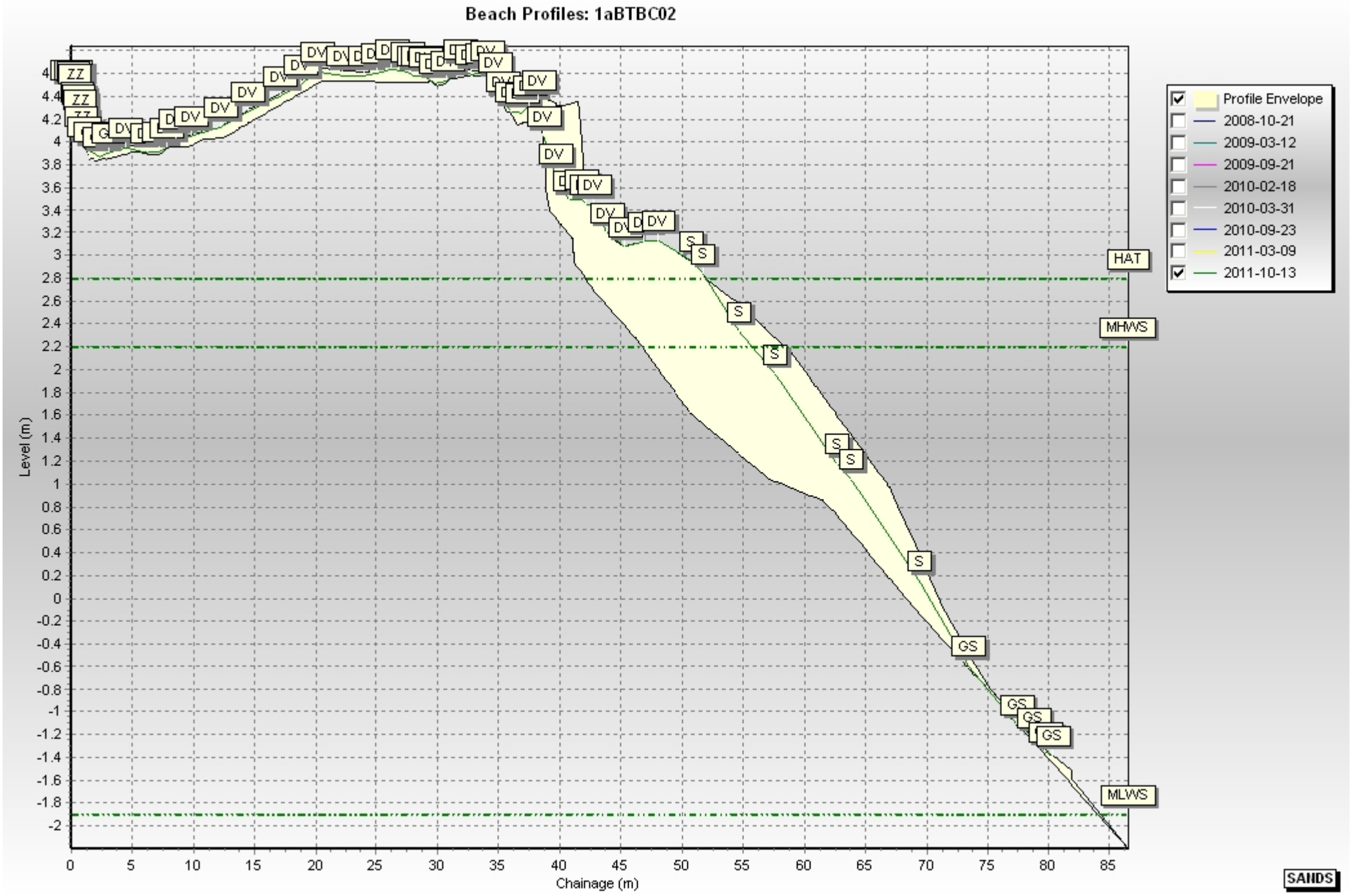
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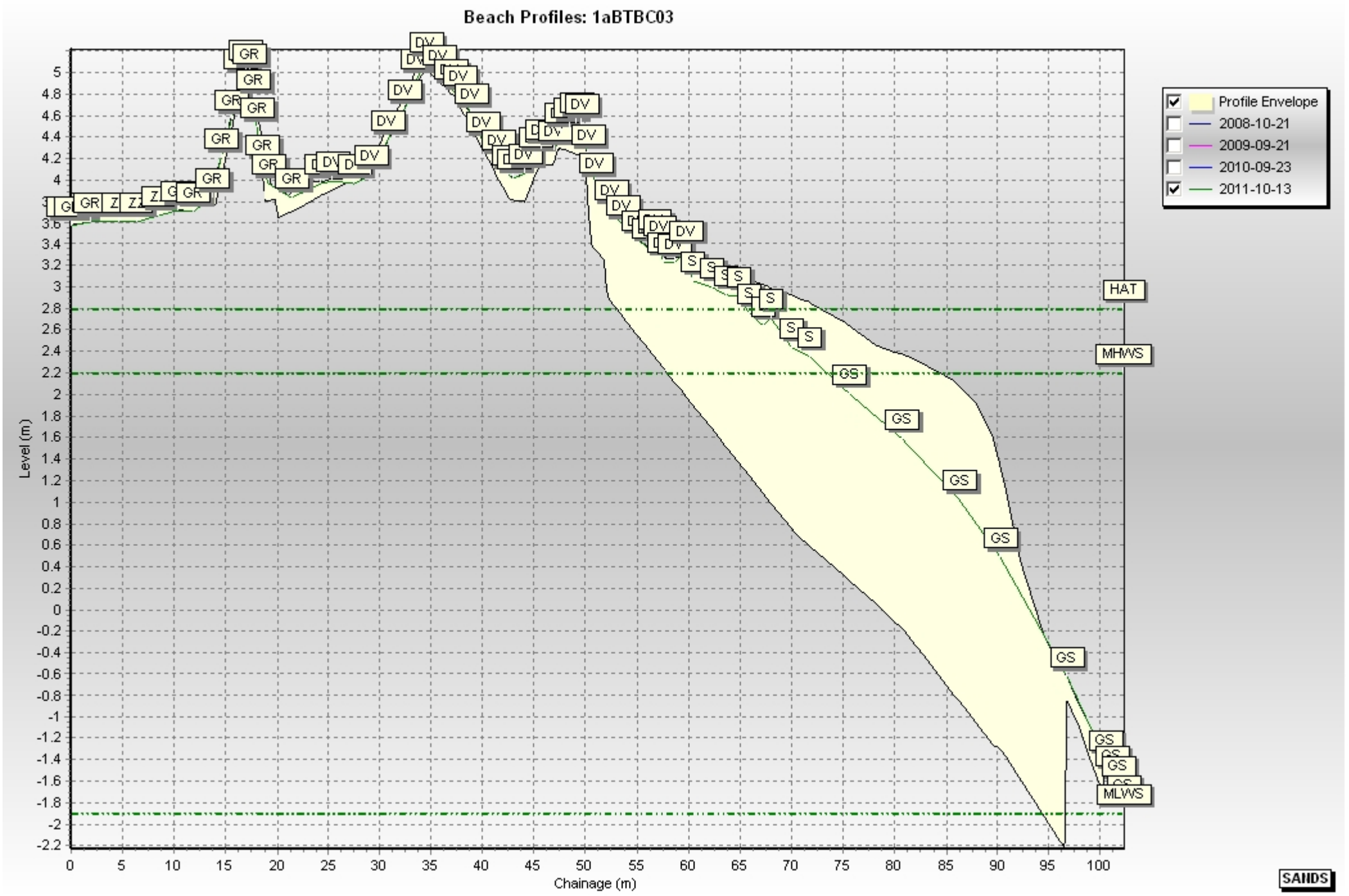
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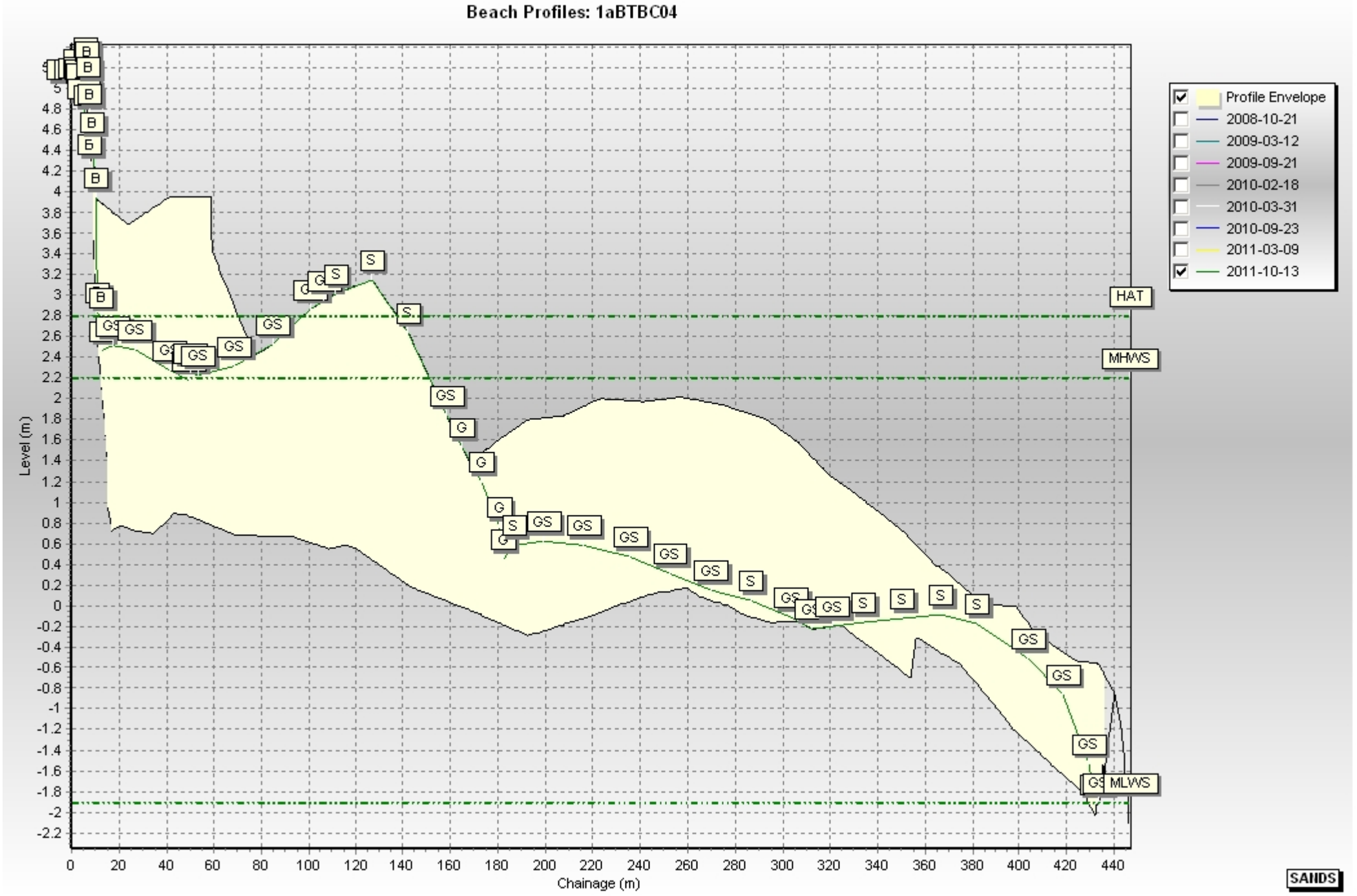
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Chainage (m)
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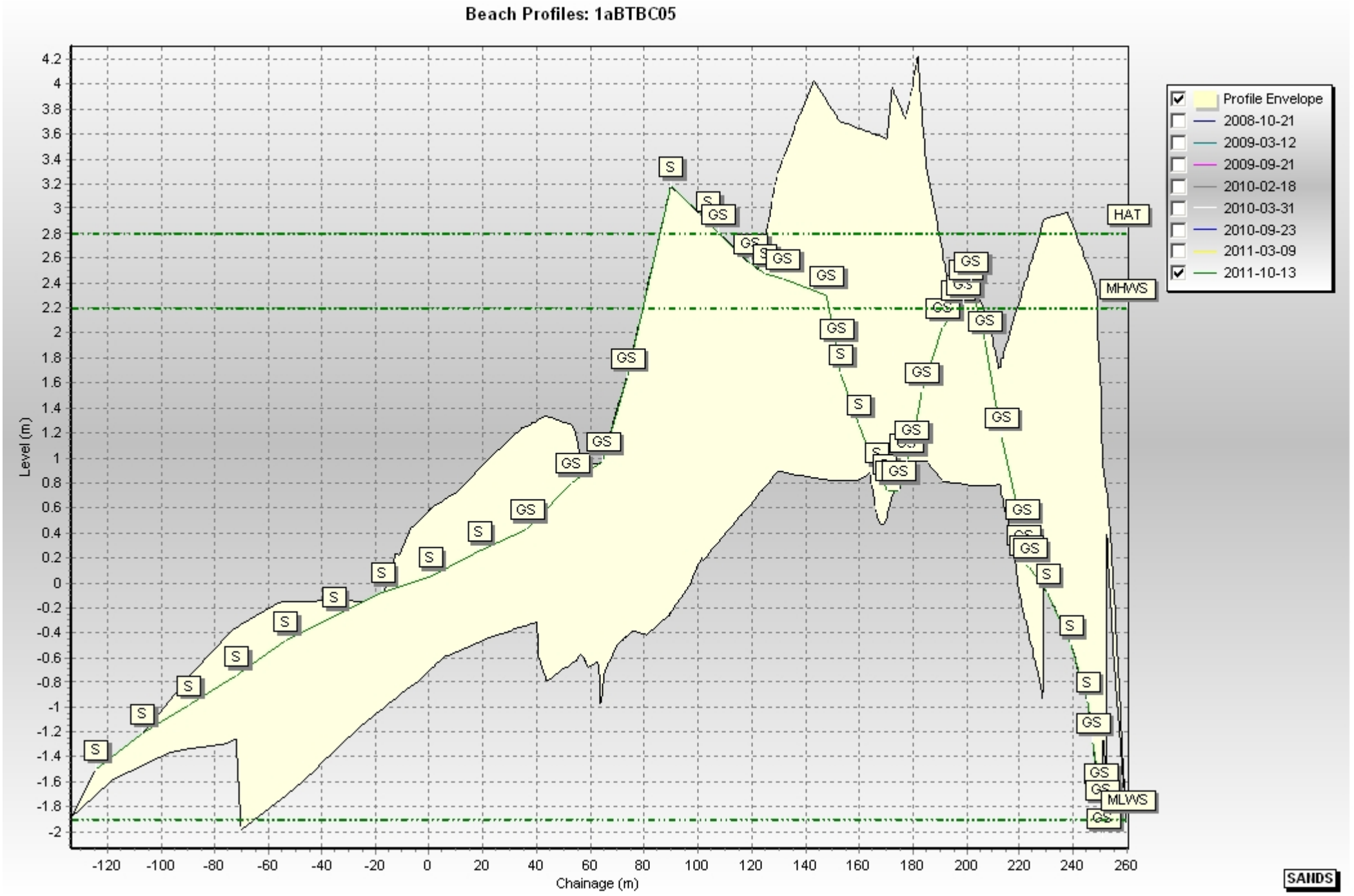
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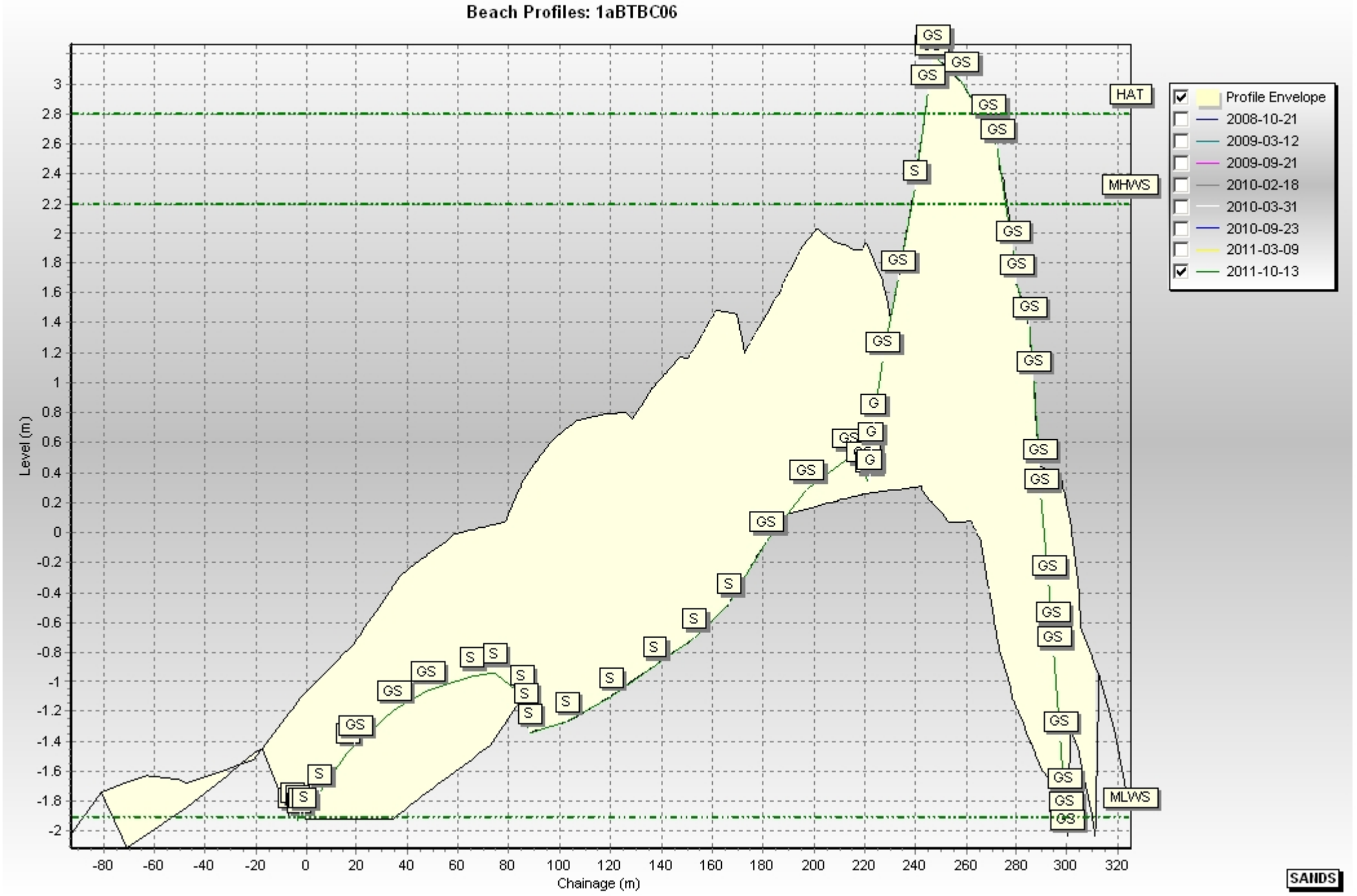
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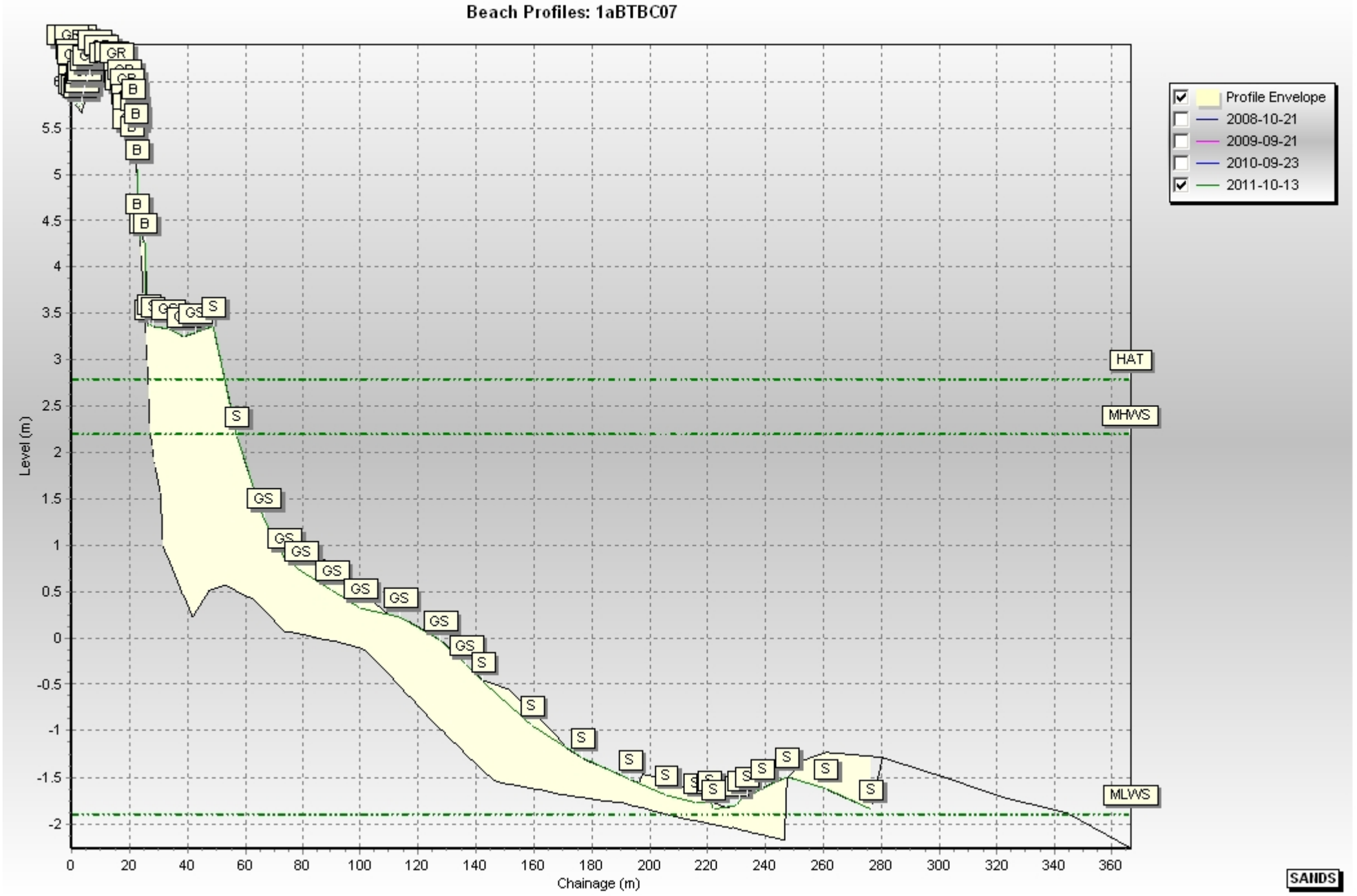
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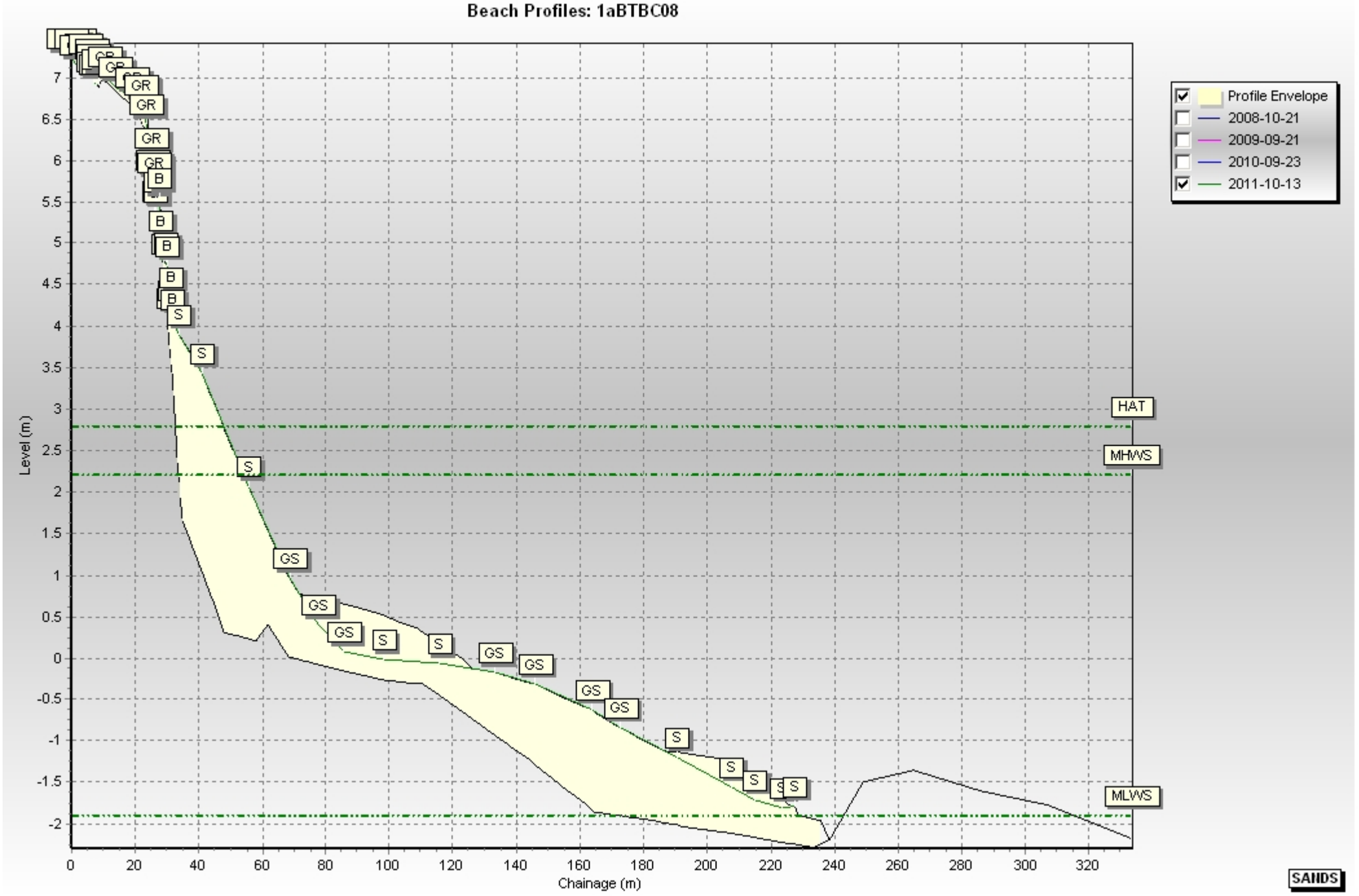
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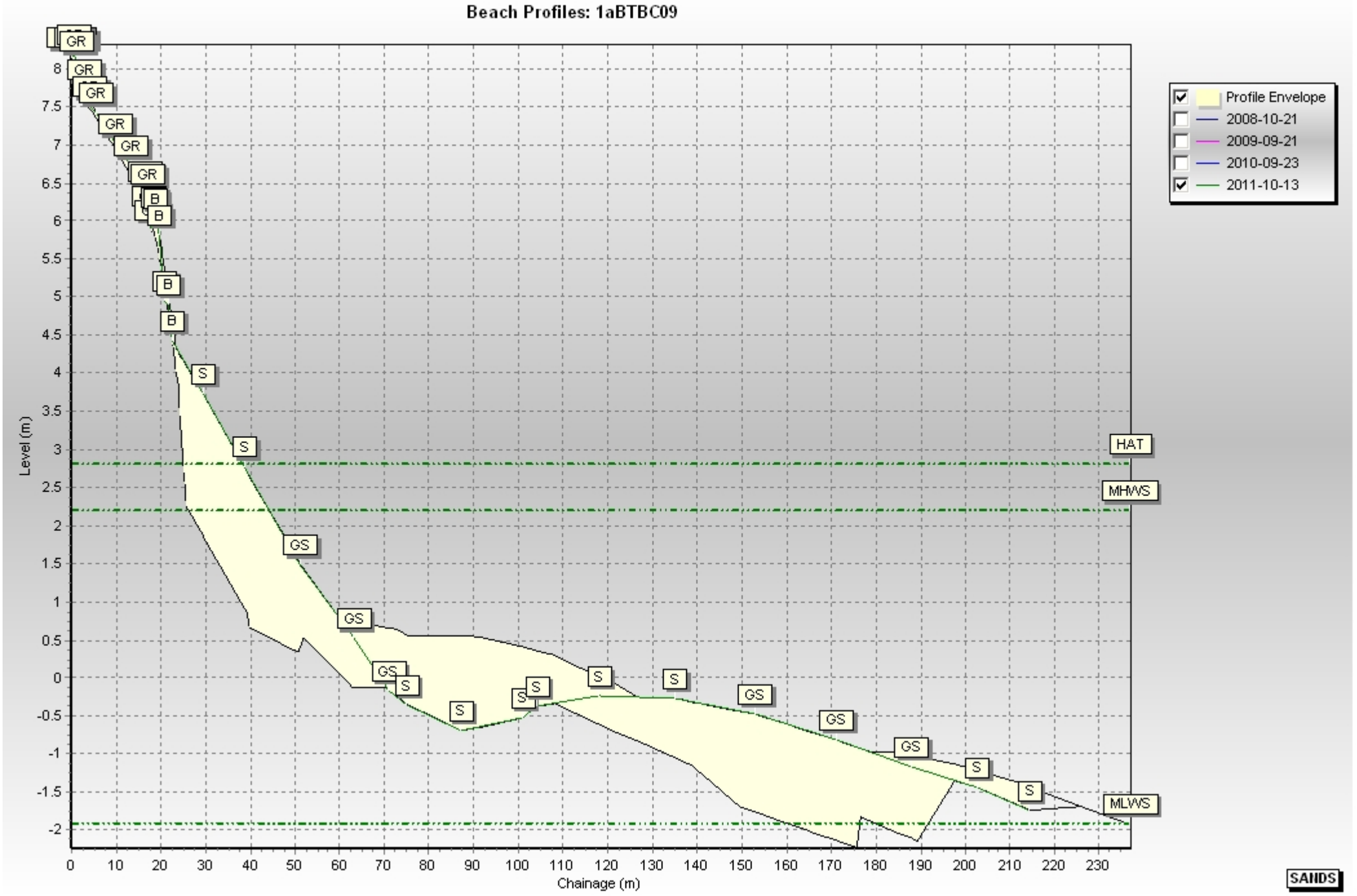
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Chainage (m)
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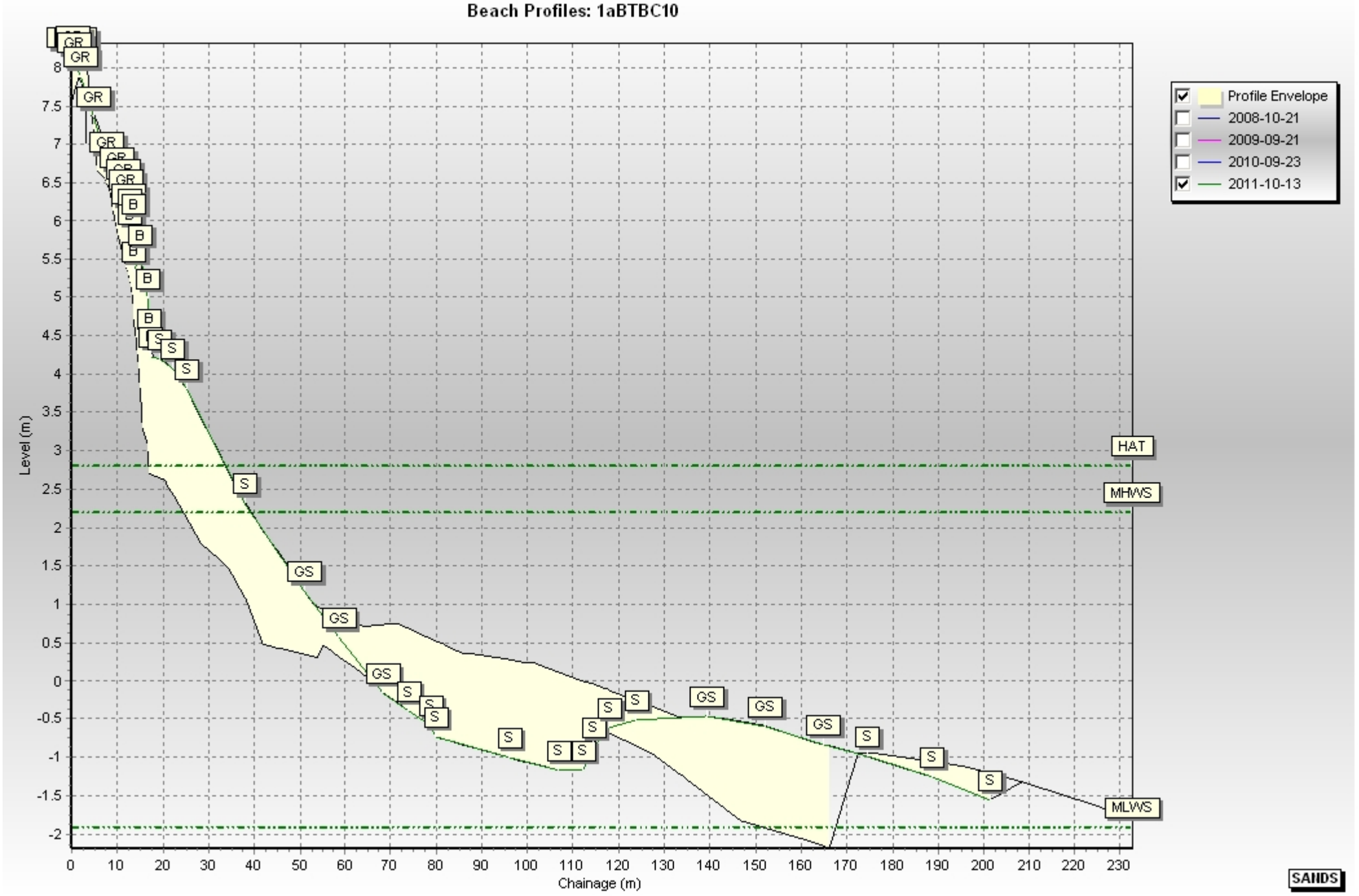
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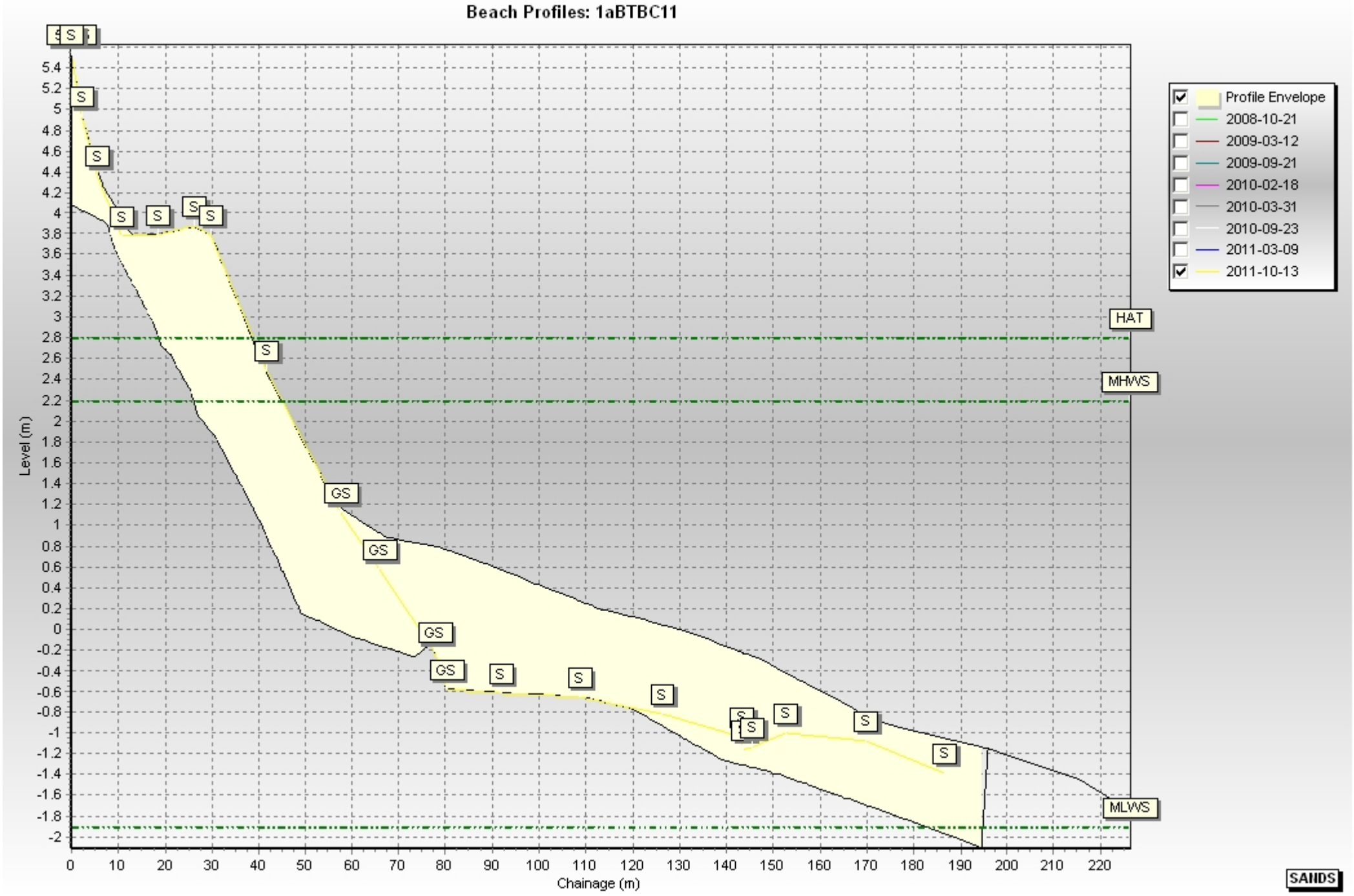
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Chainage (m)
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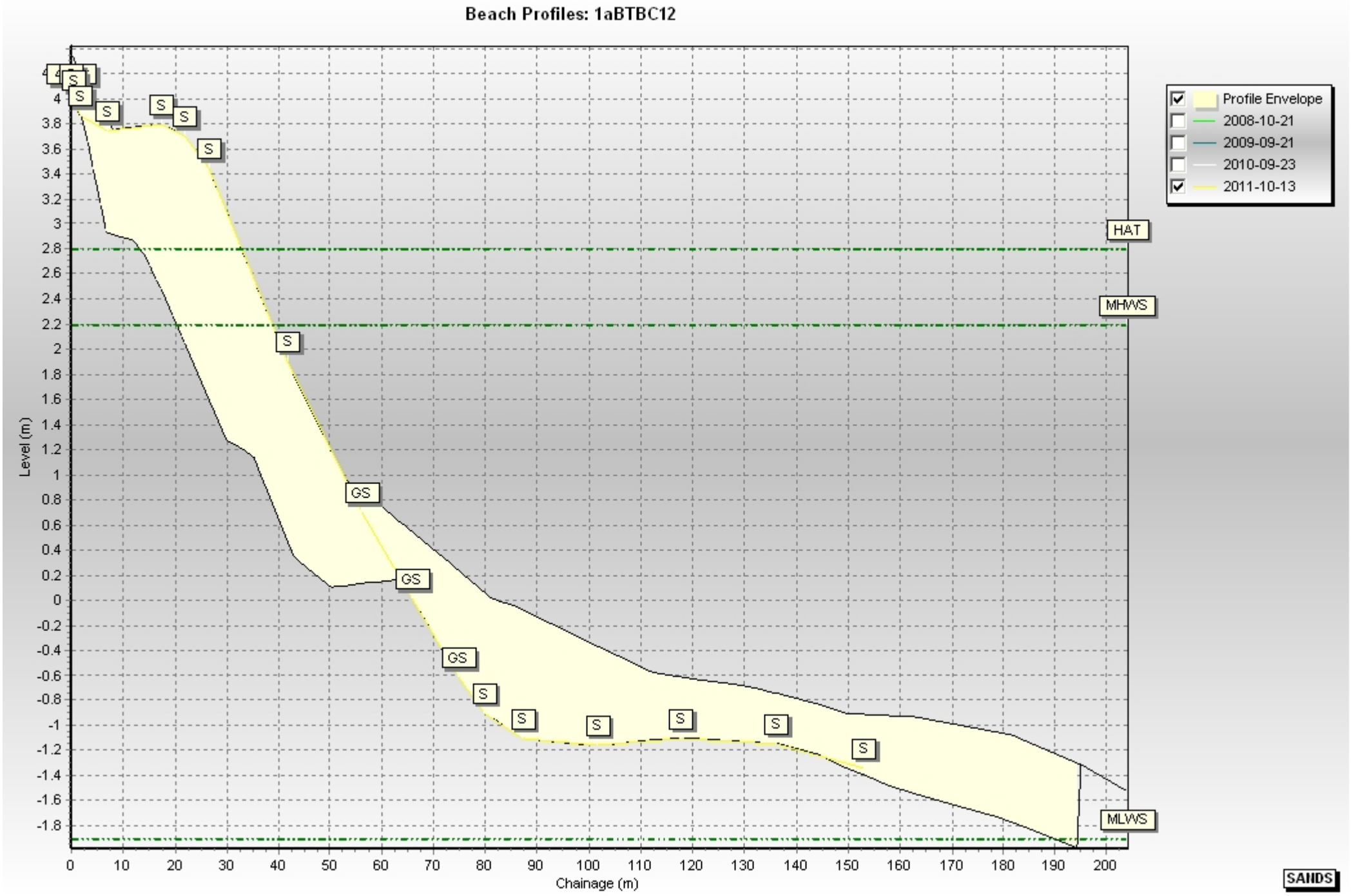
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Chainage (m)
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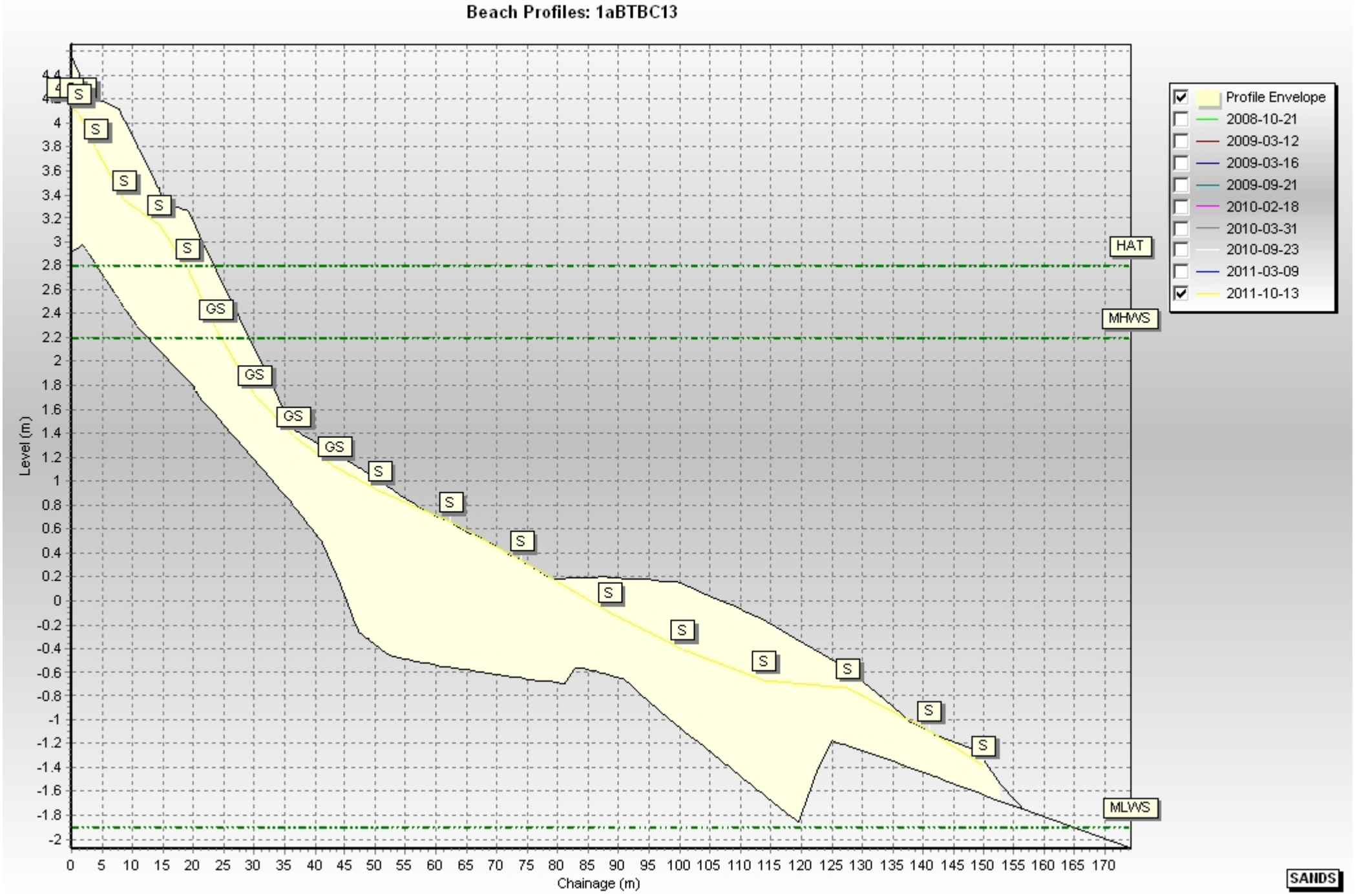
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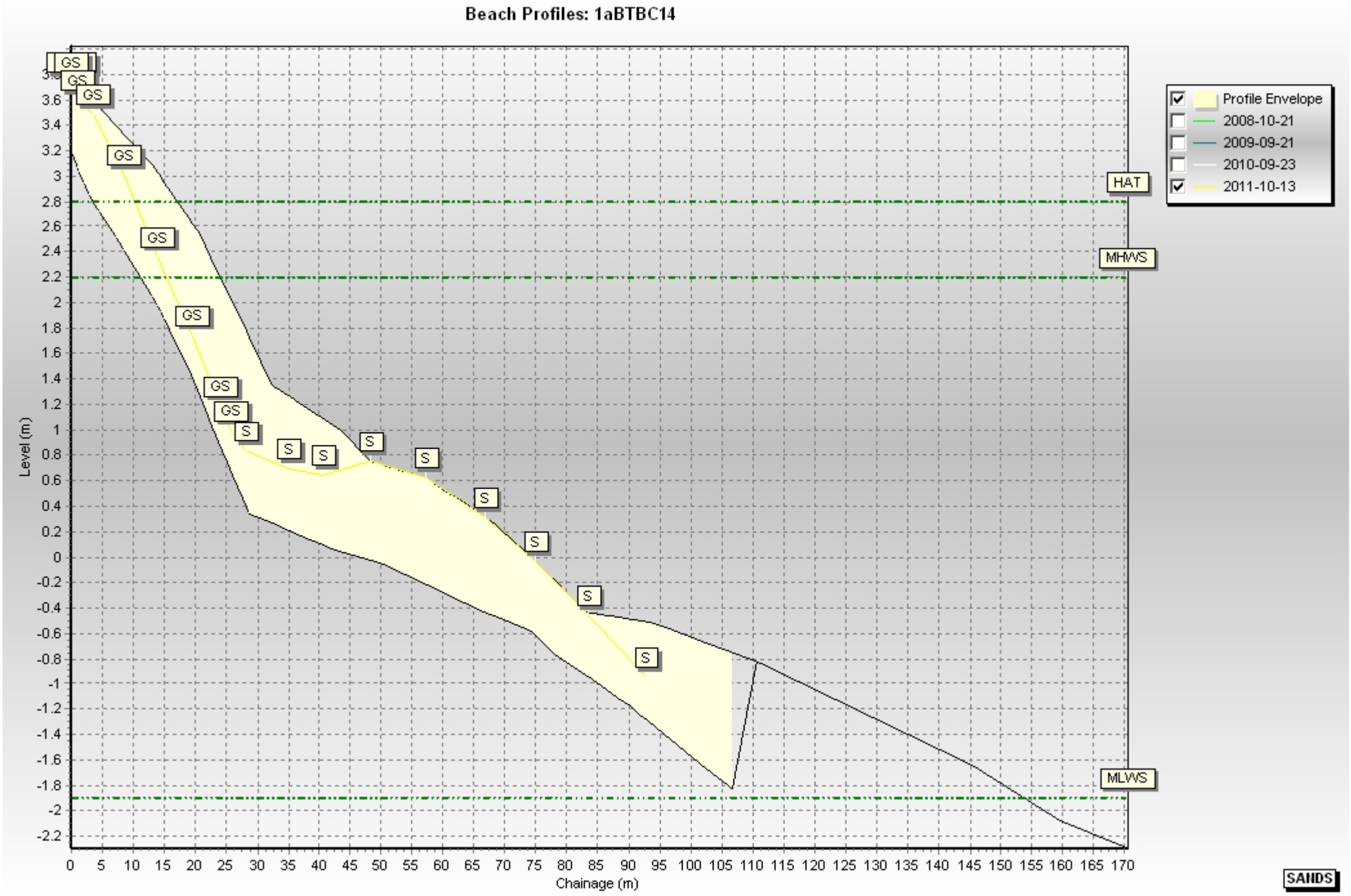
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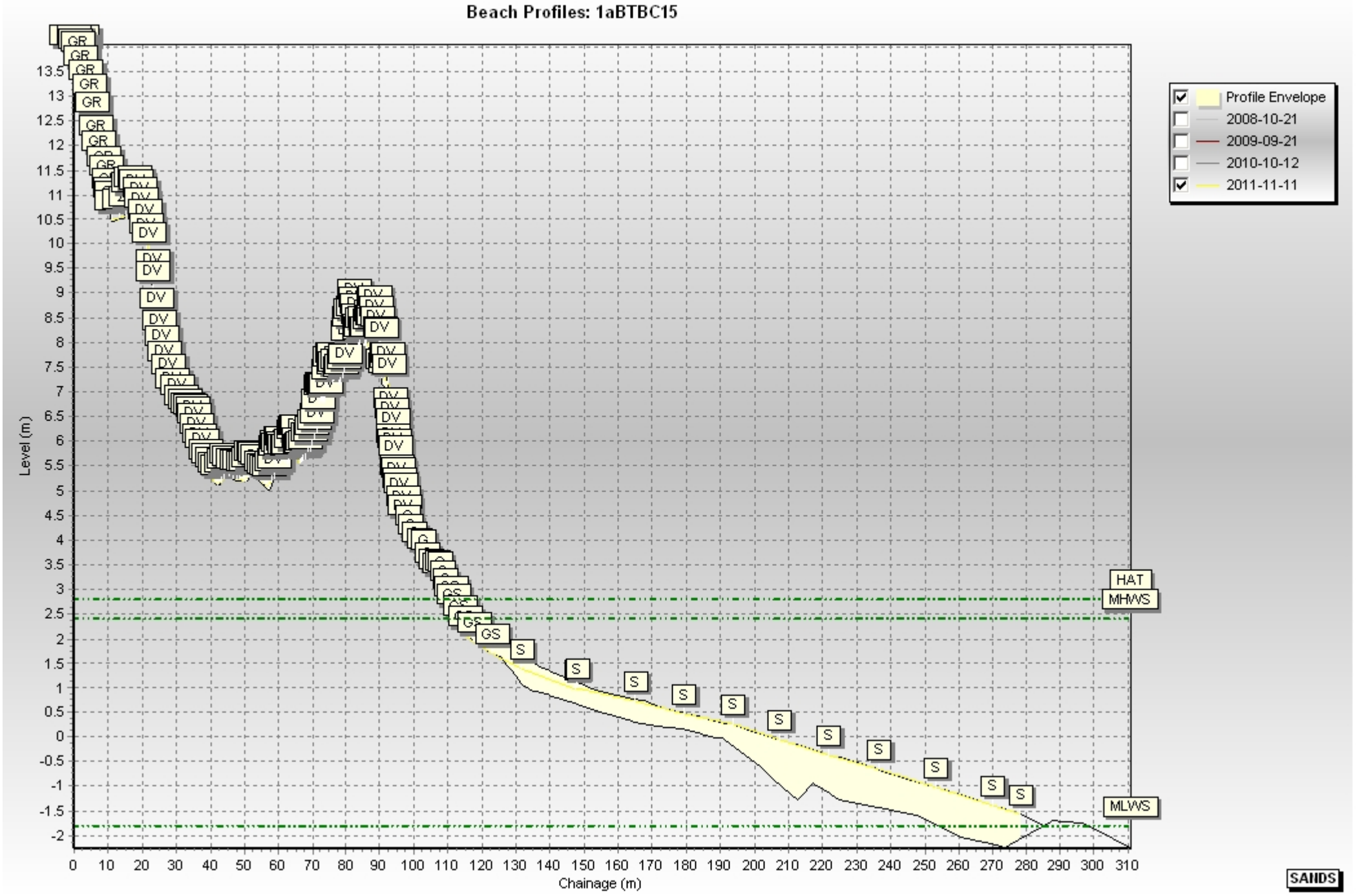
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GS
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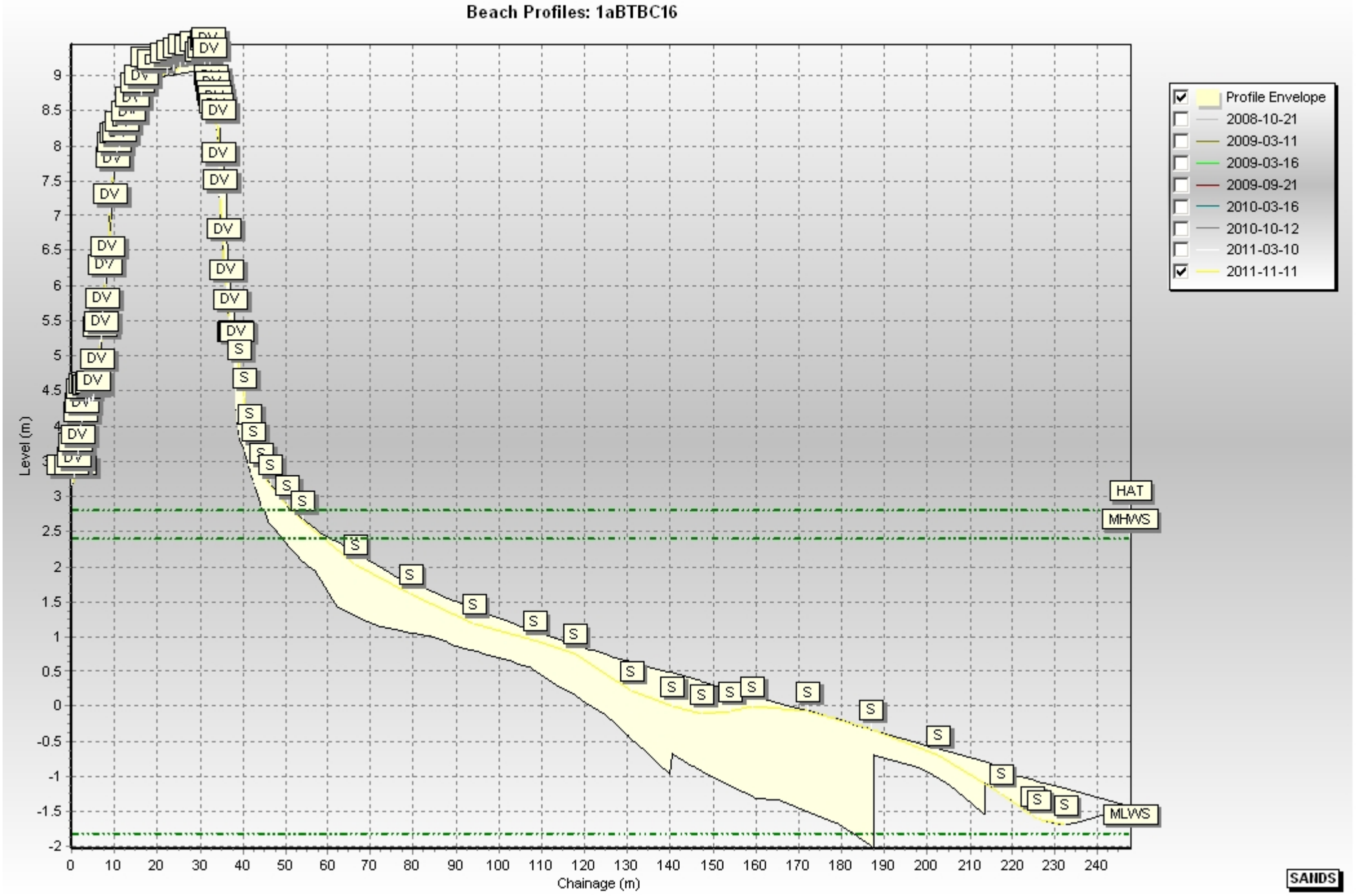
SANDS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Chainage (m)
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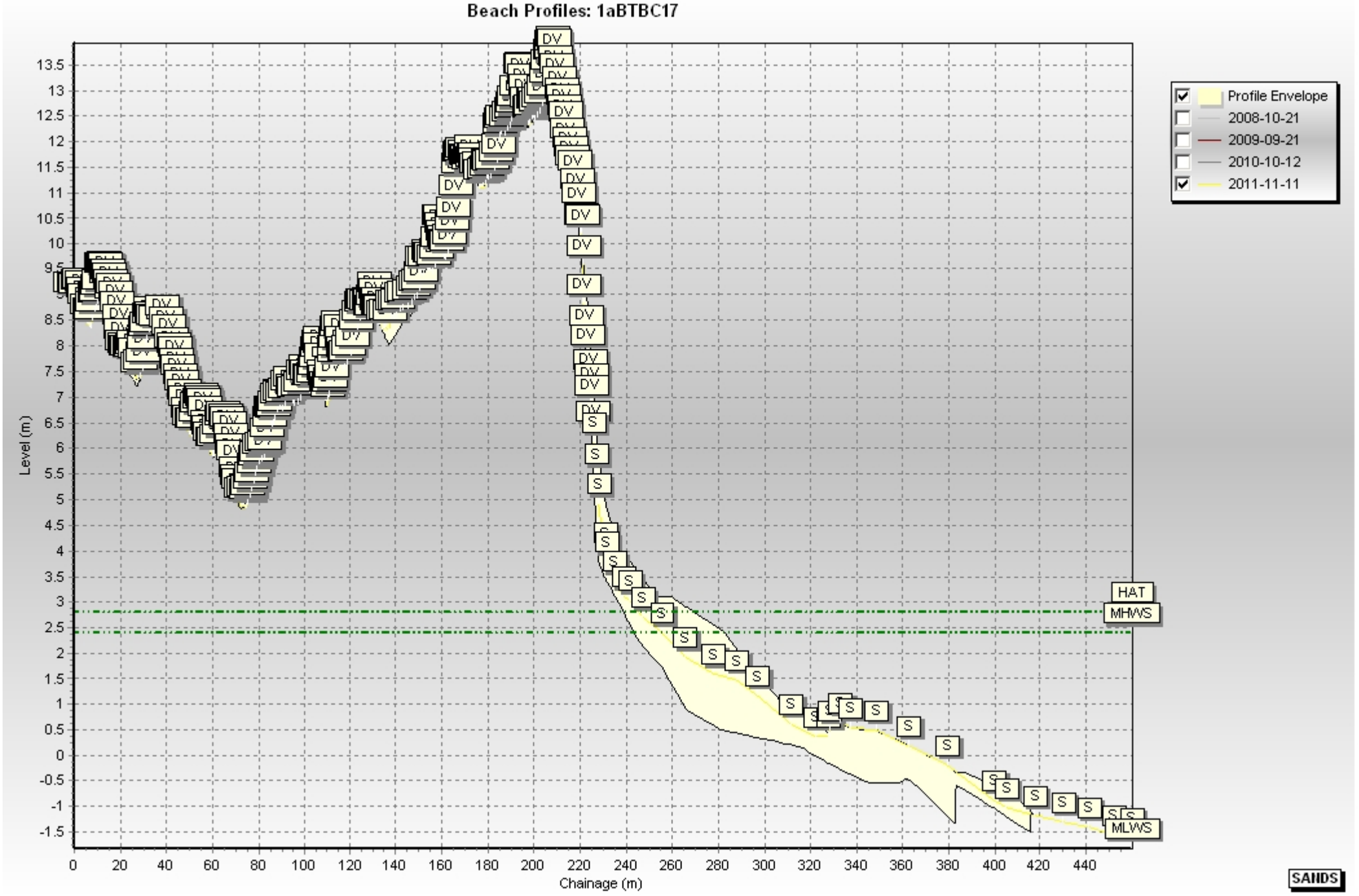
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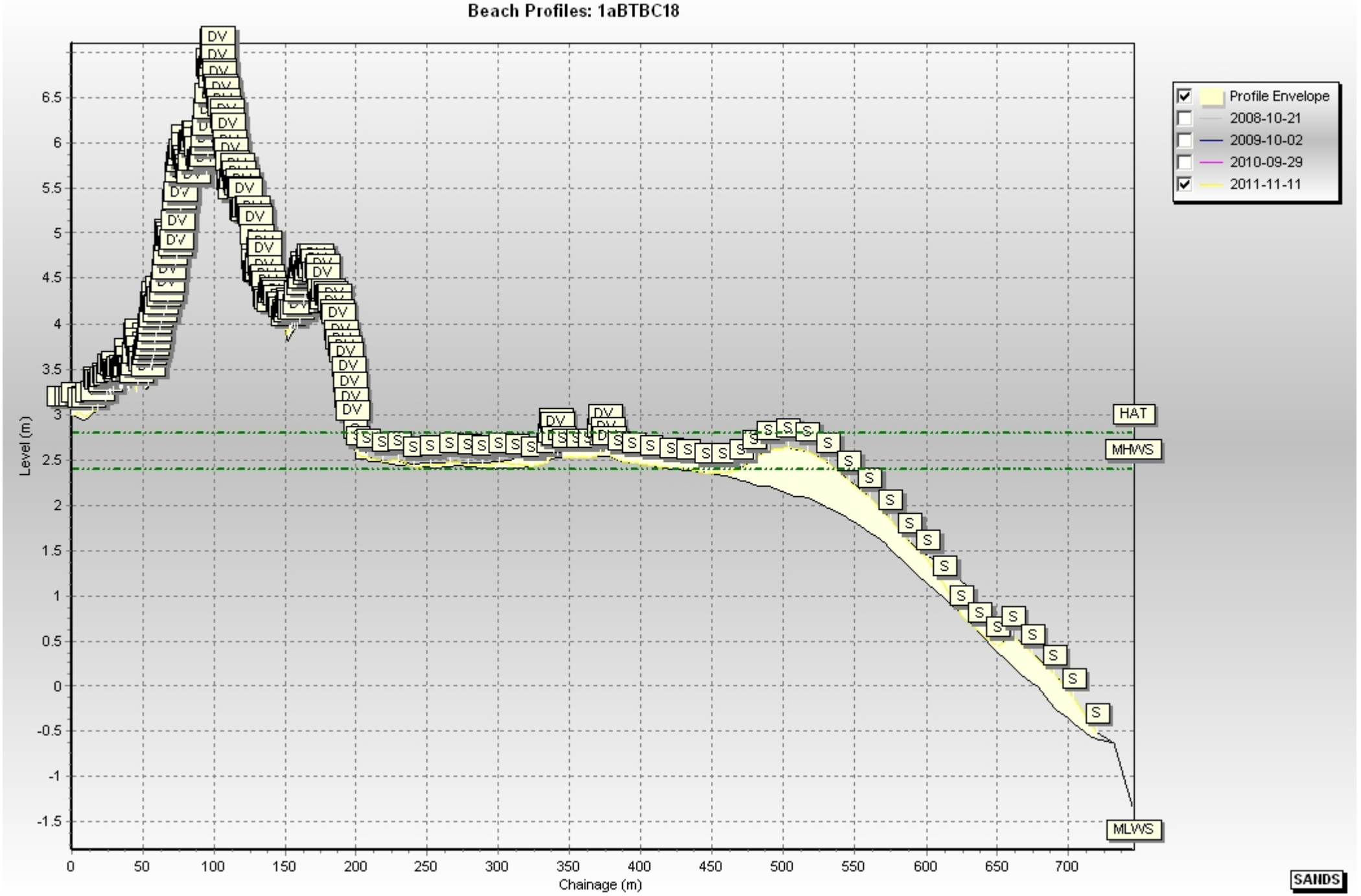
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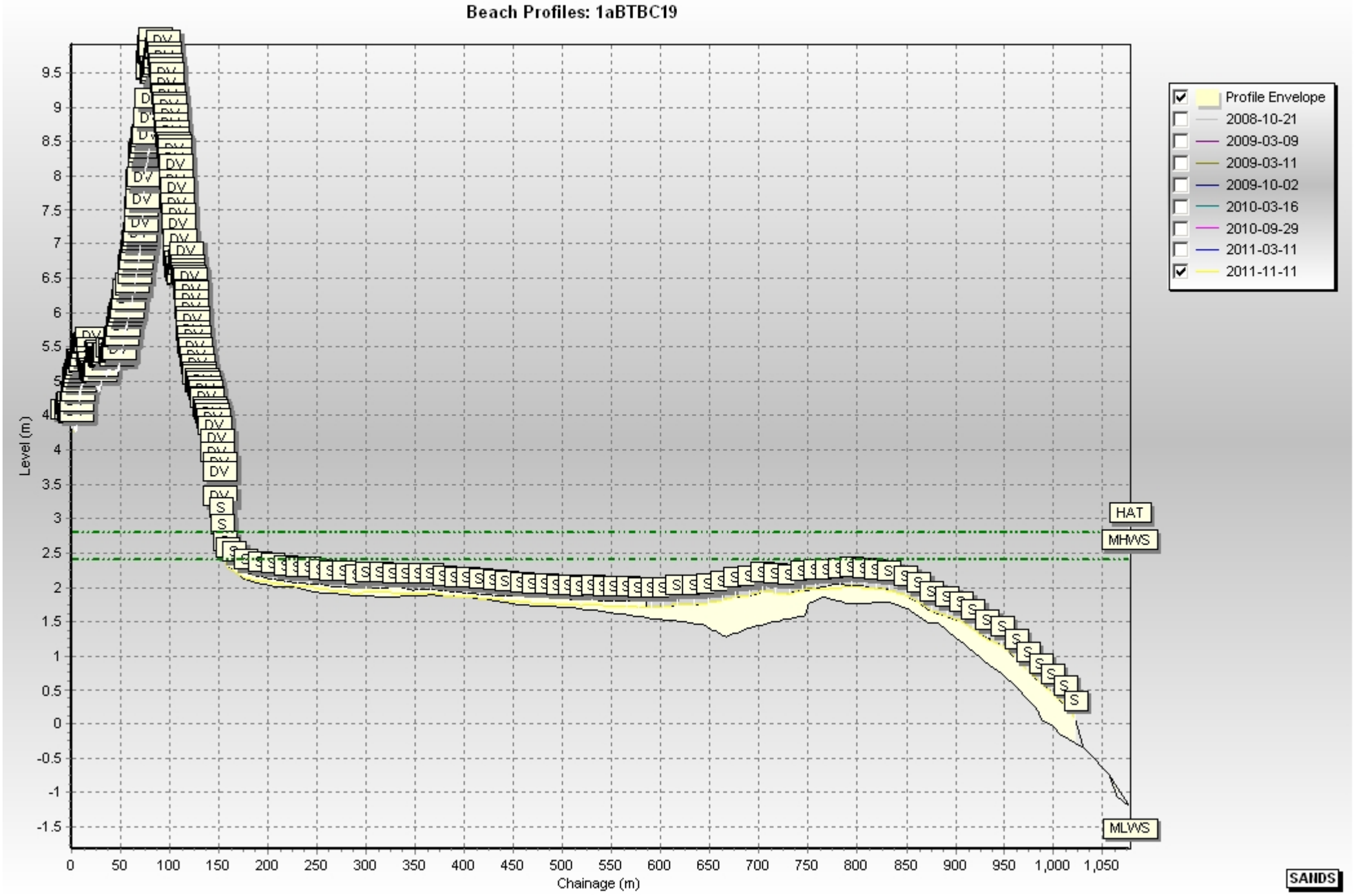
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Level (m)
Chainage (m)
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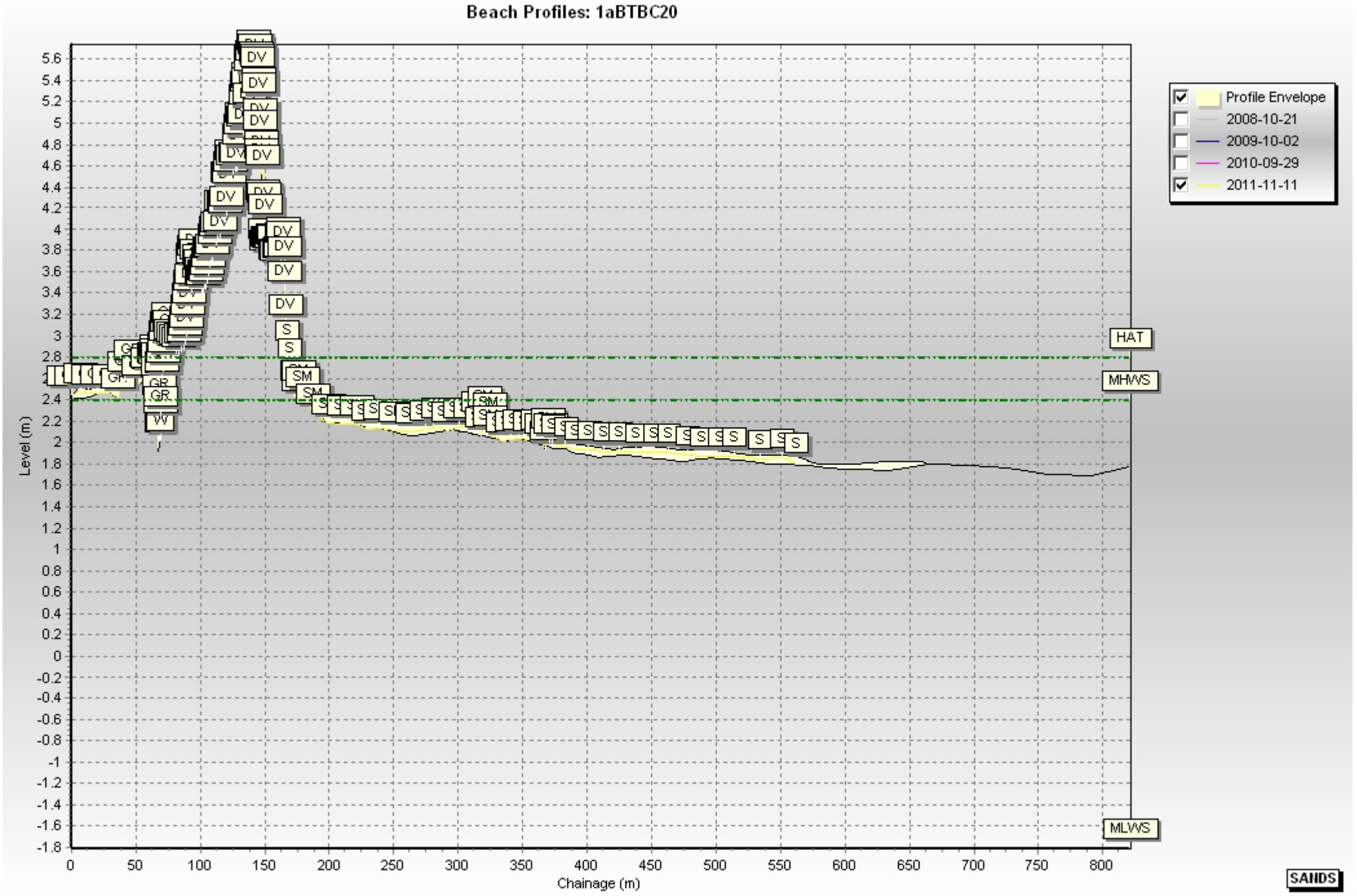
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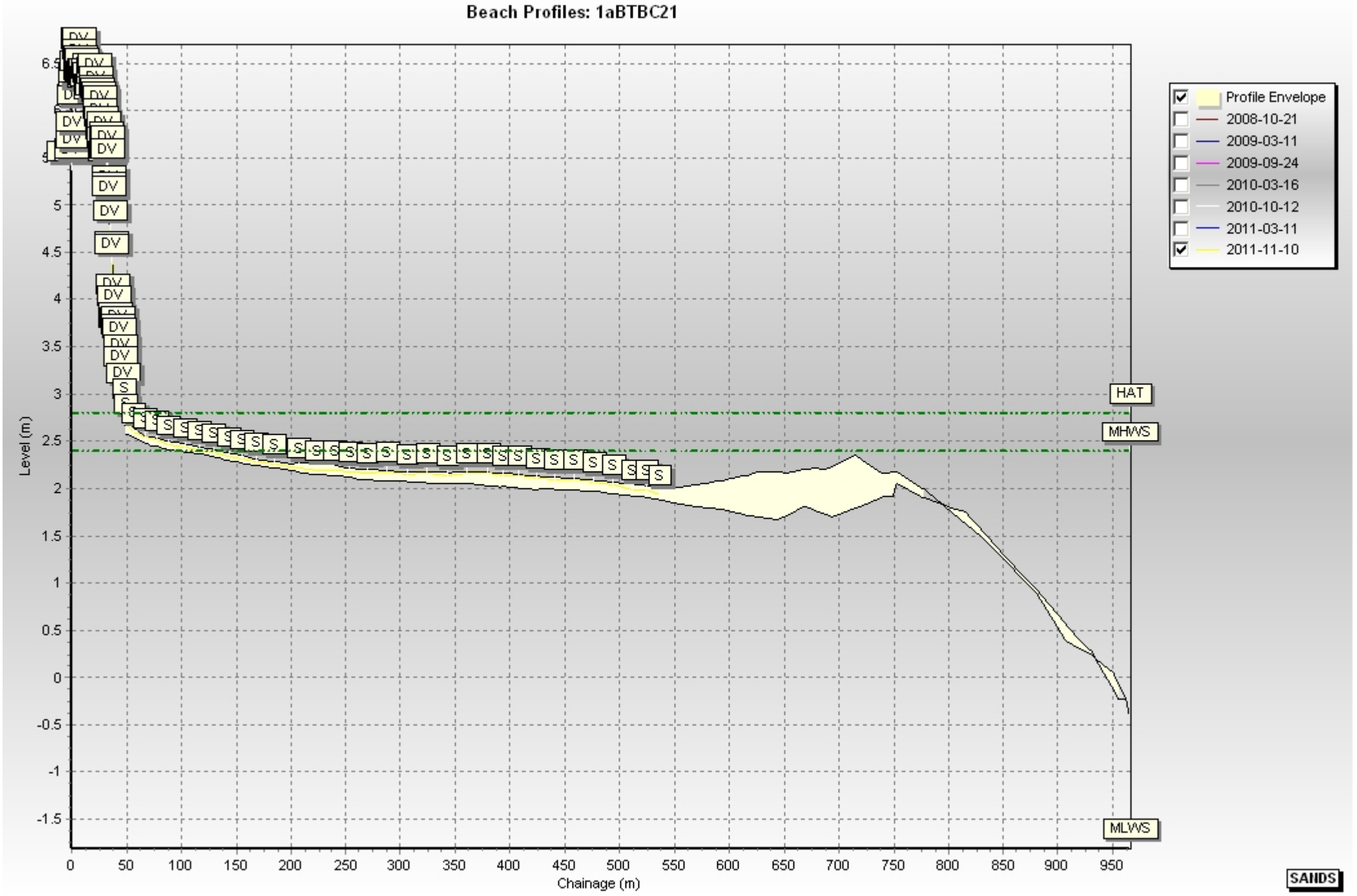
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Chainage (m)
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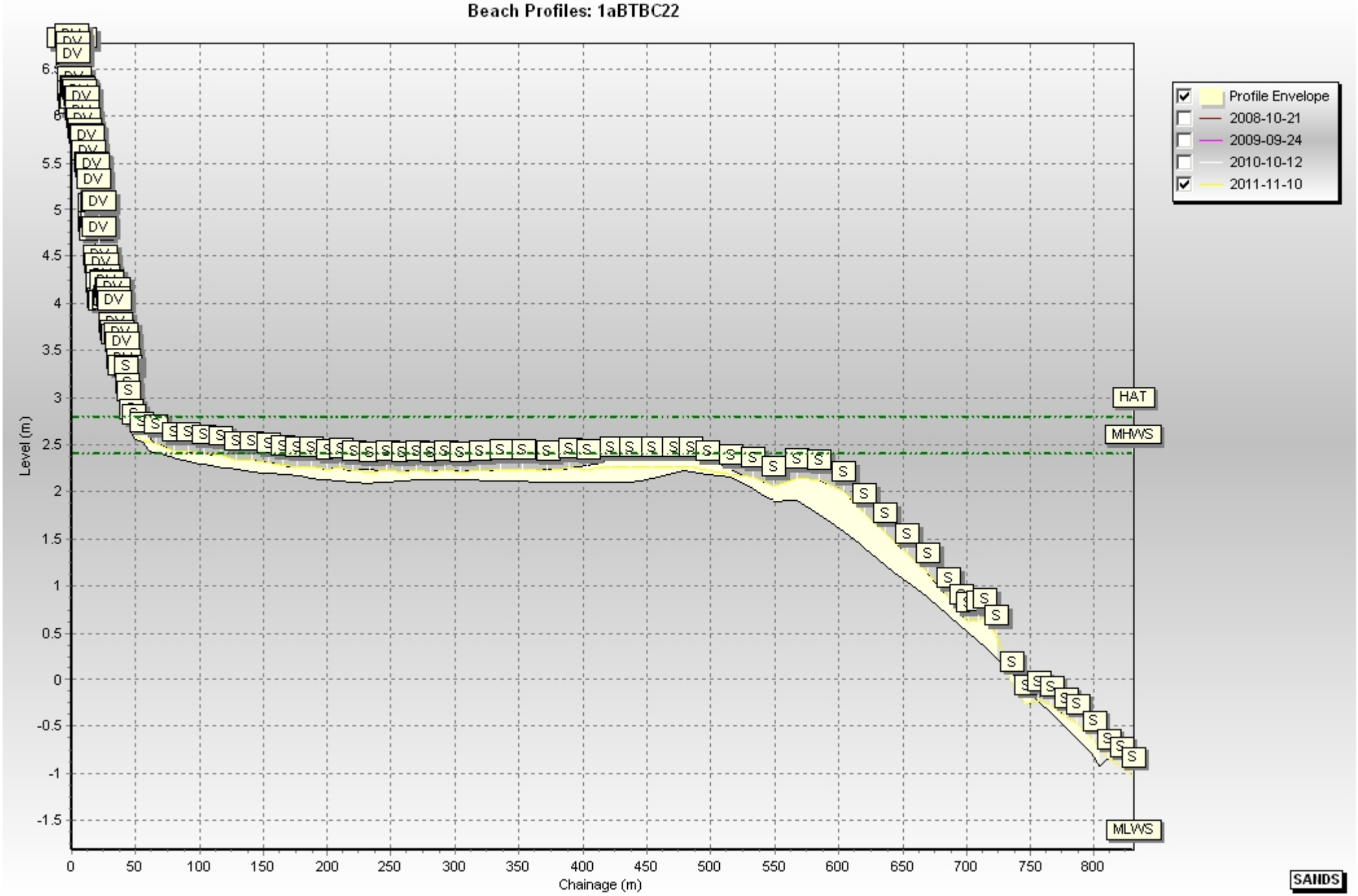
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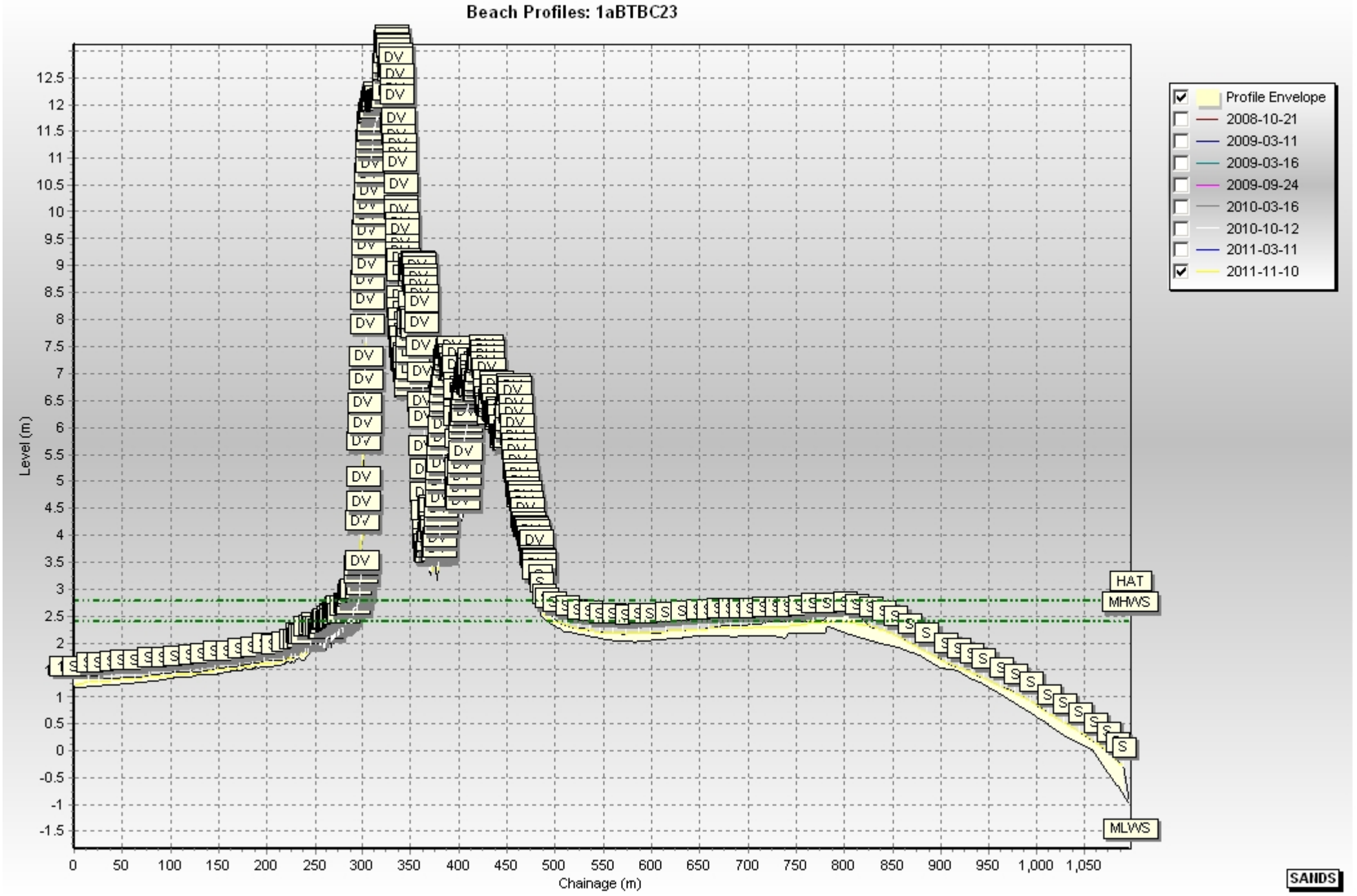
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Chainage (m)
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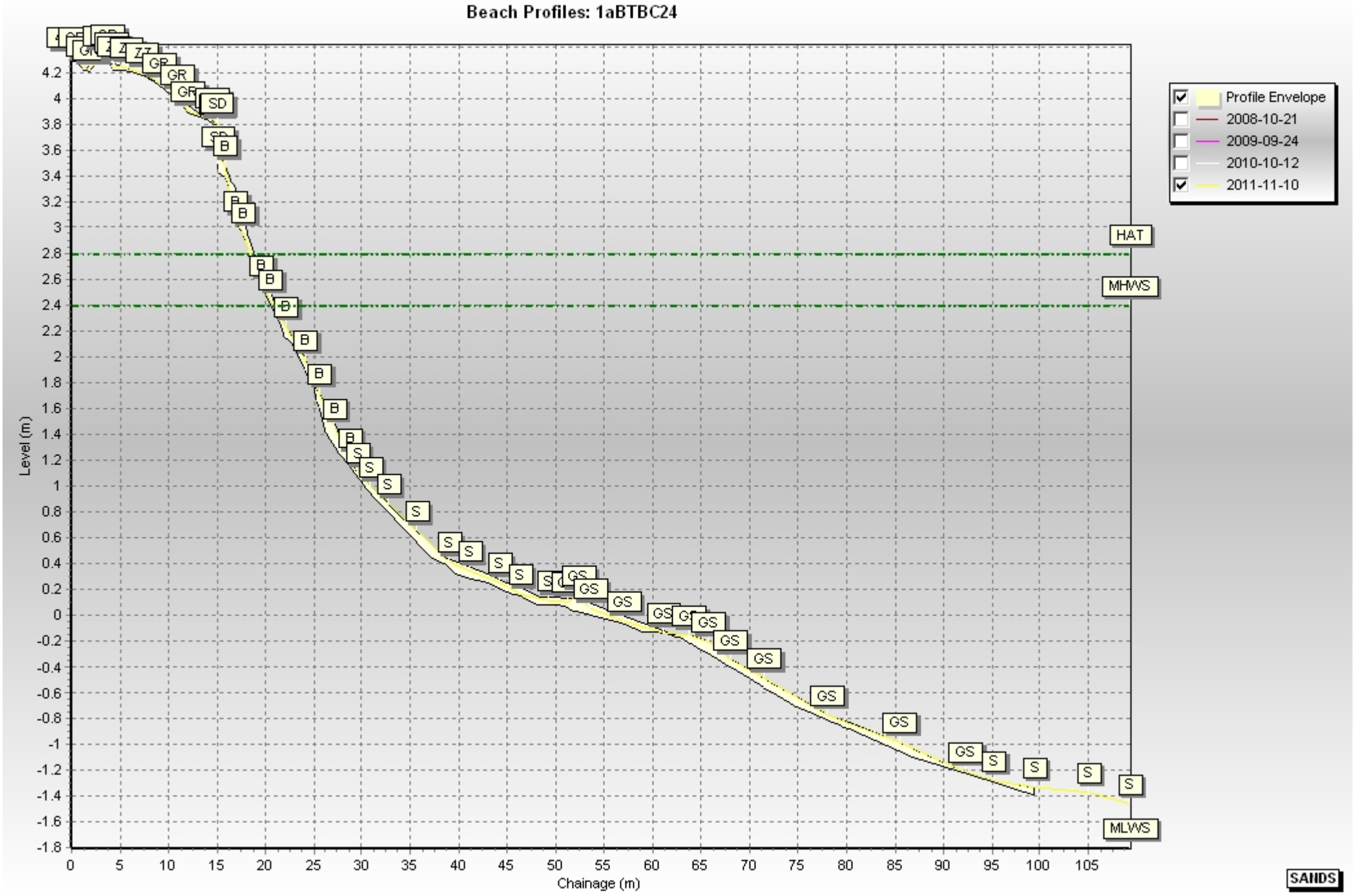
MLWS
DV
S
SANDS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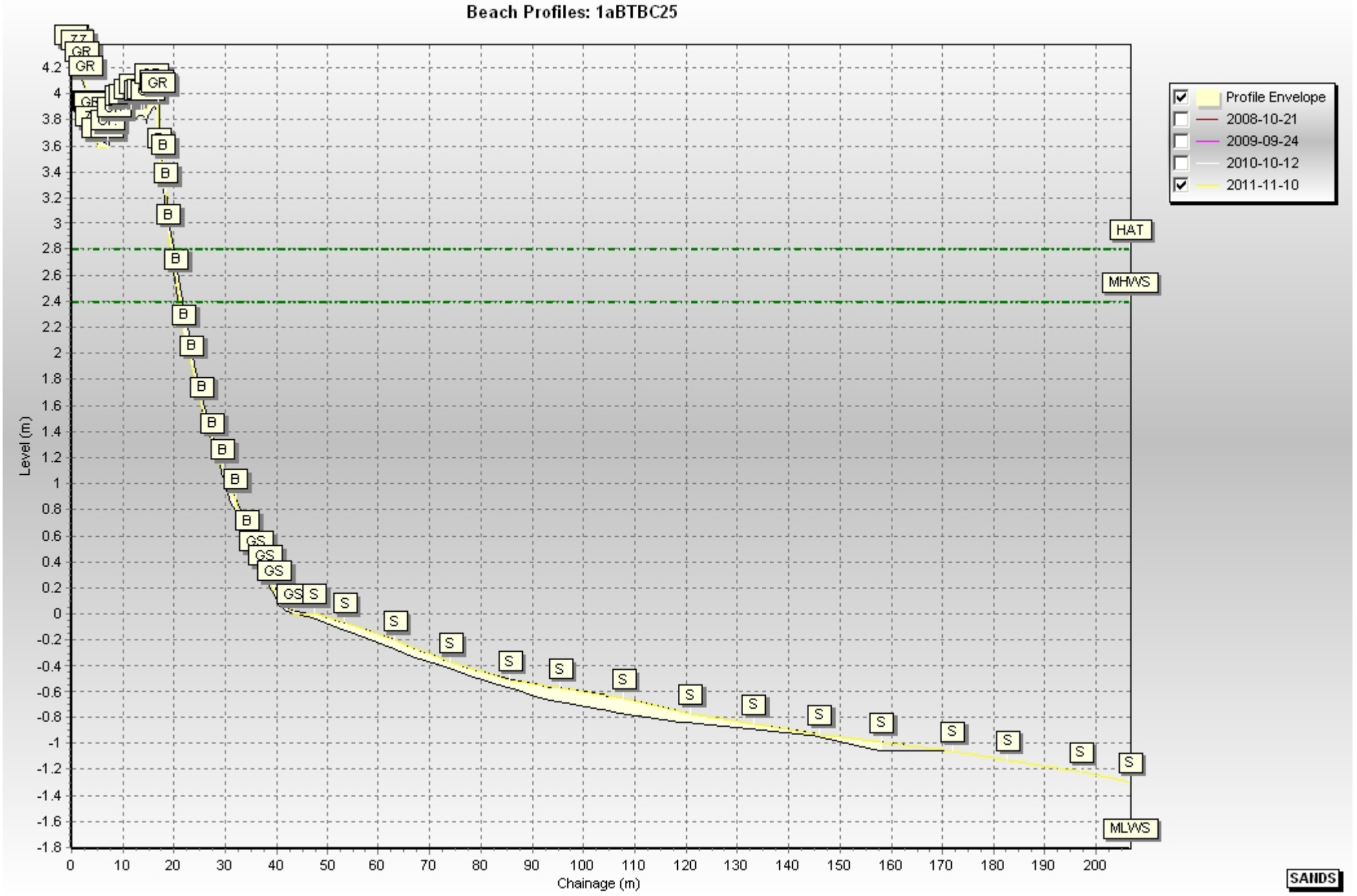
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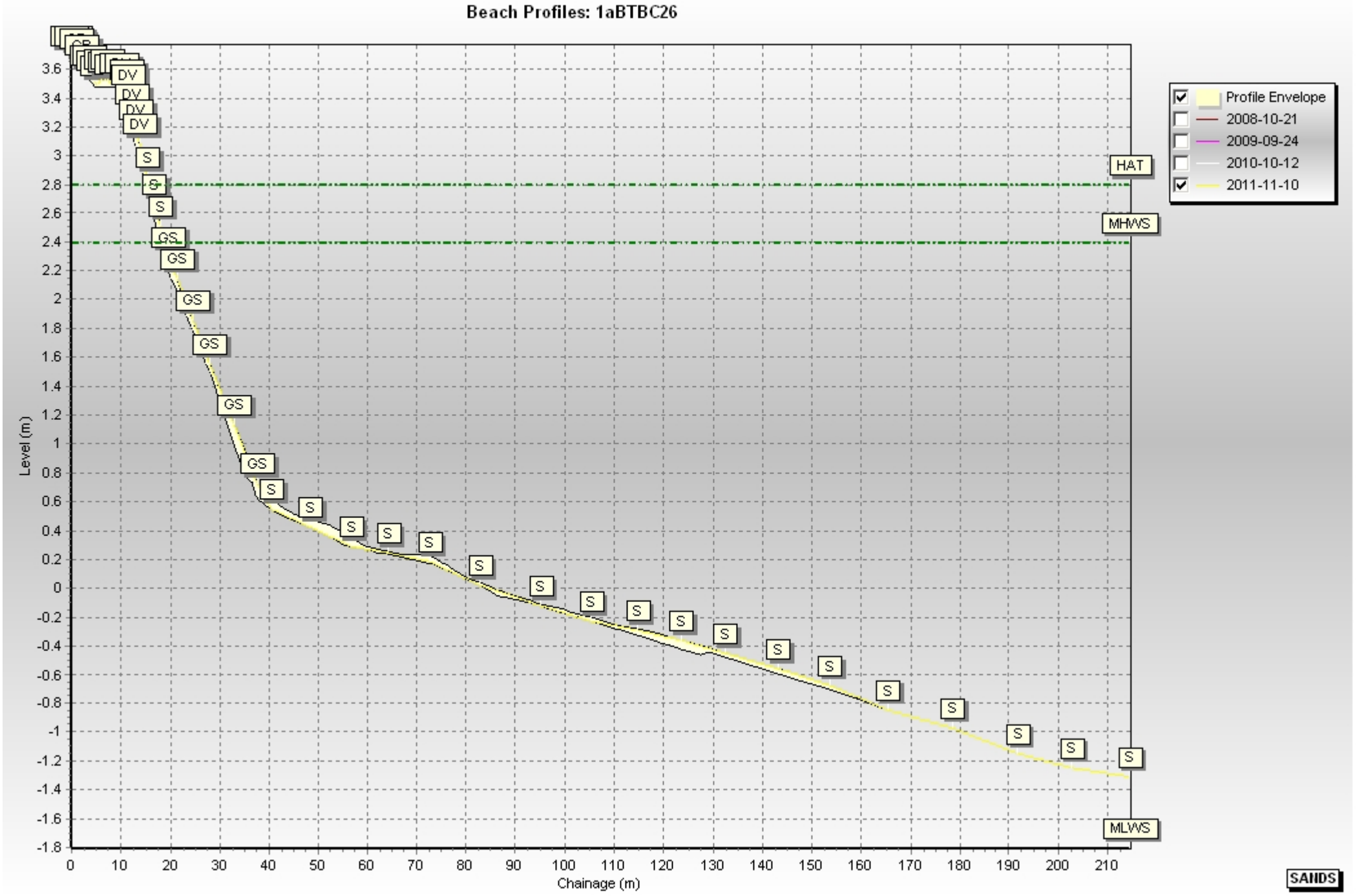
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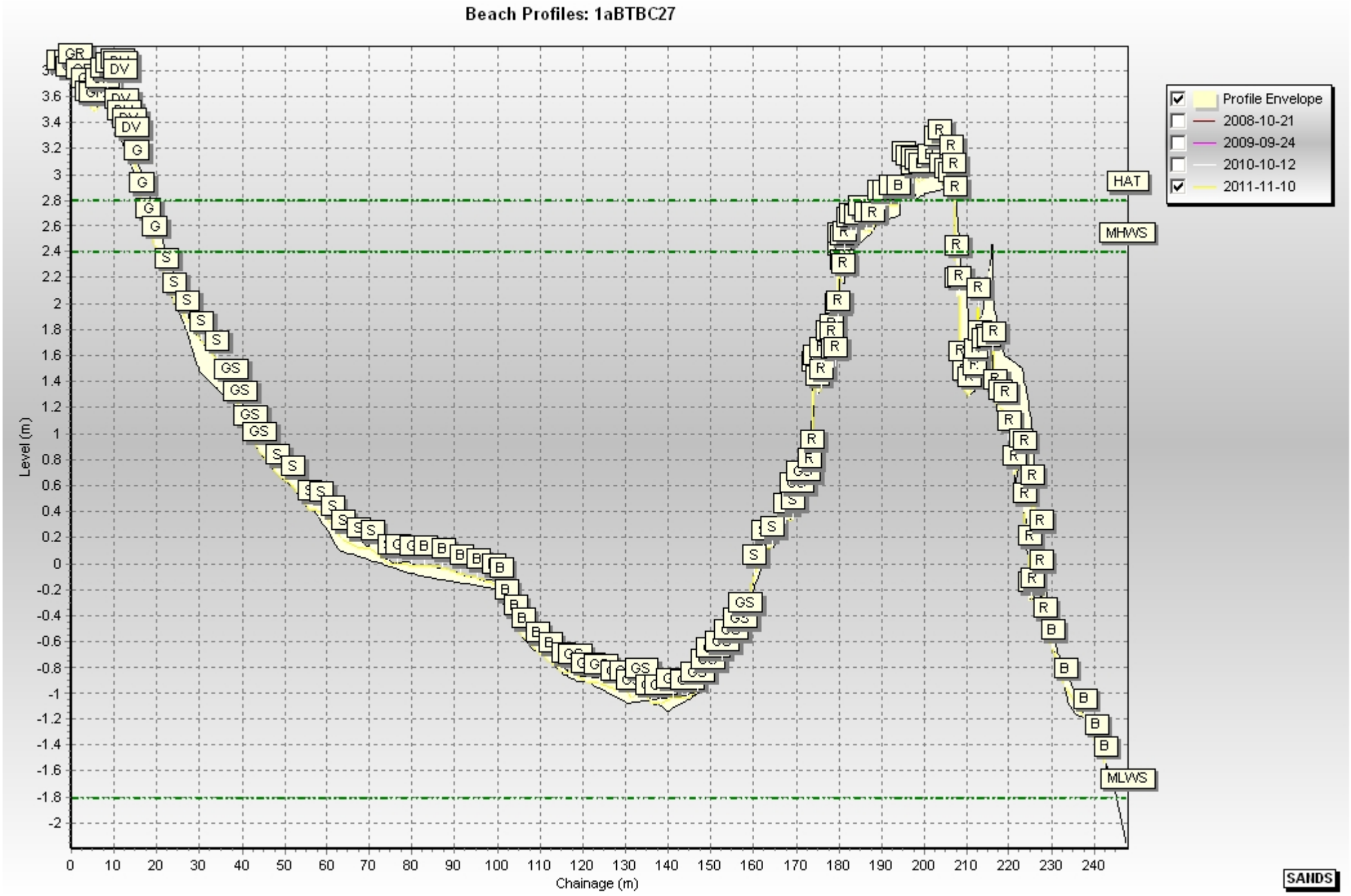
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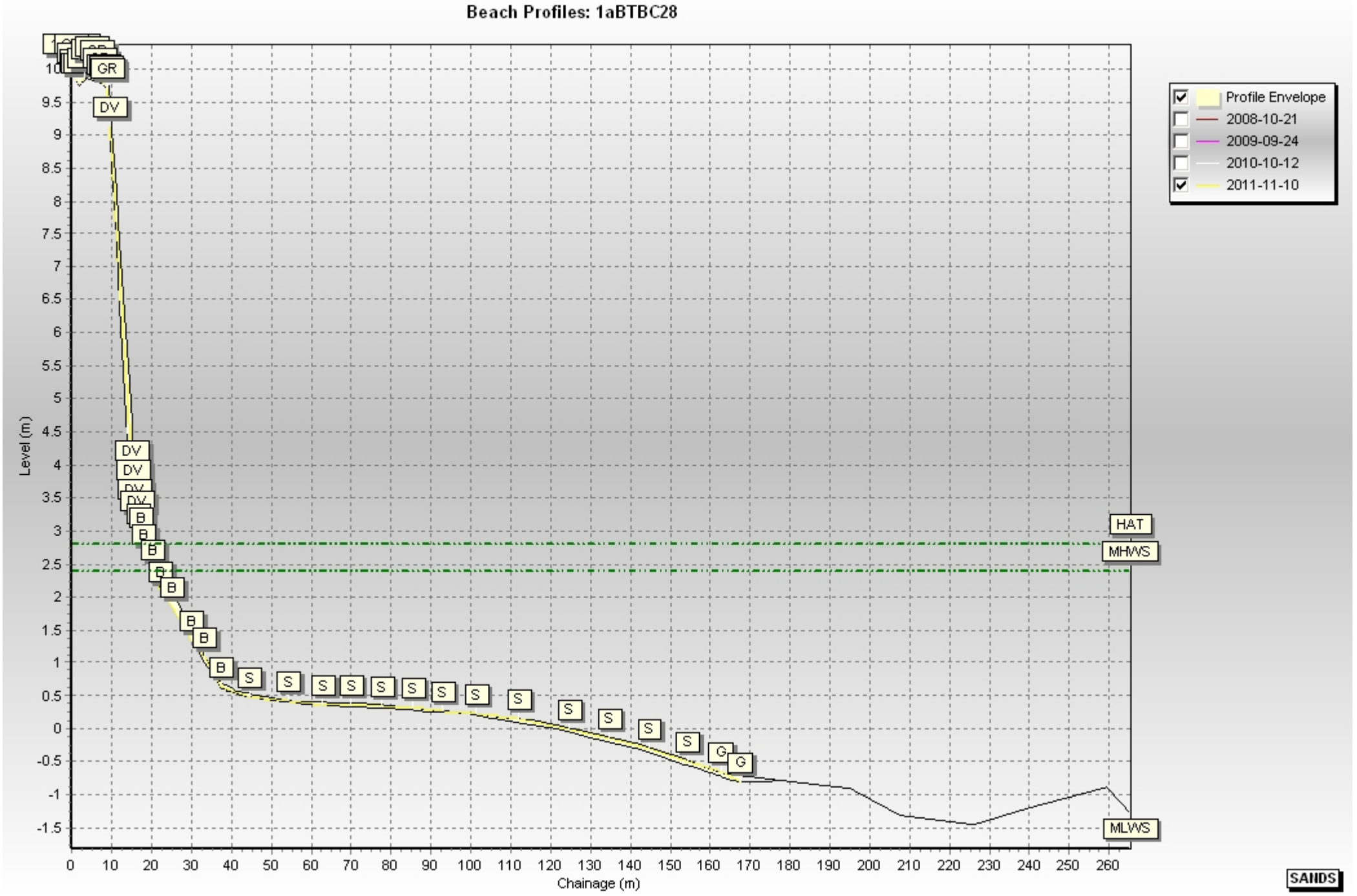
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Chainage (m)
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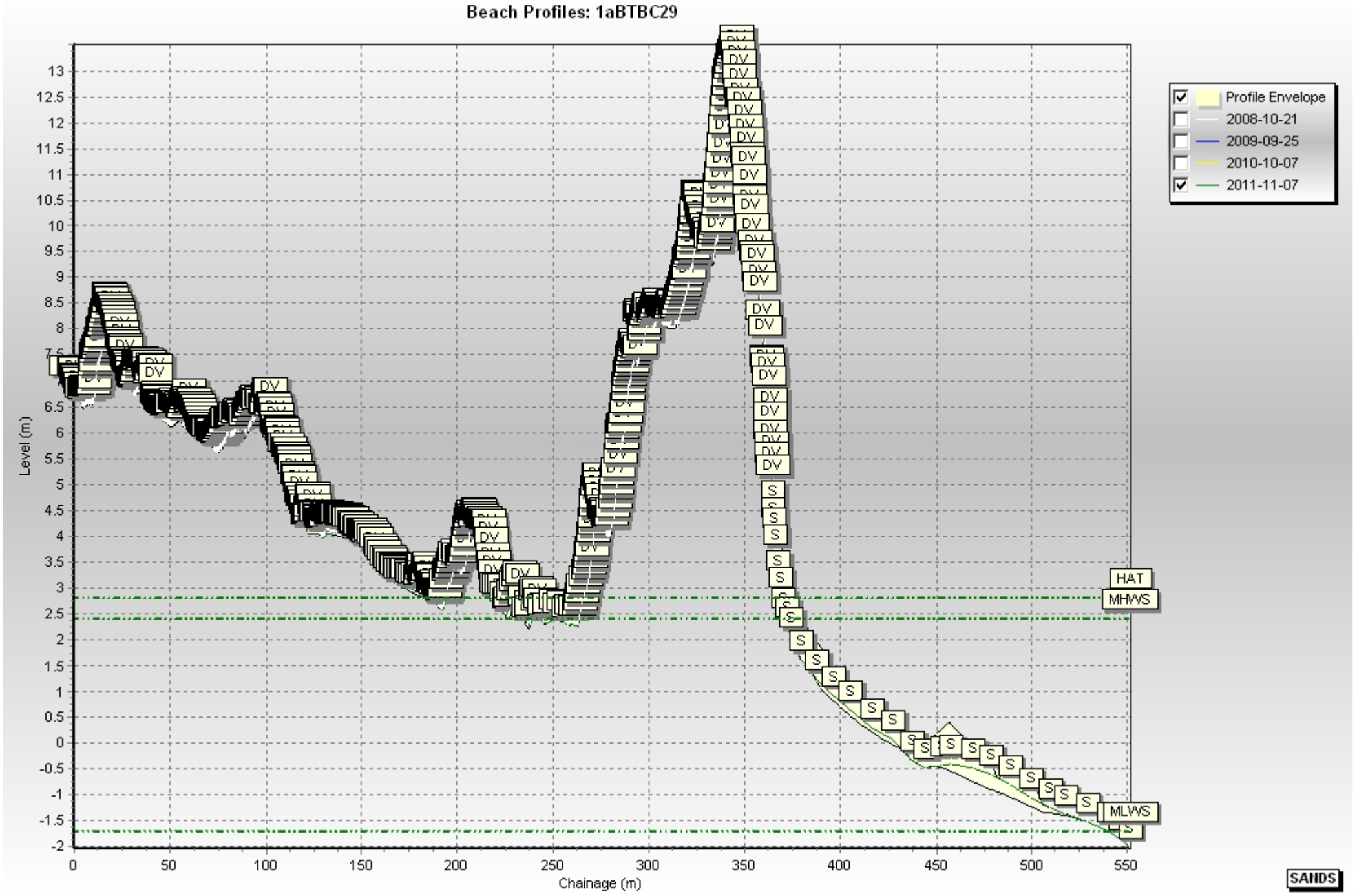
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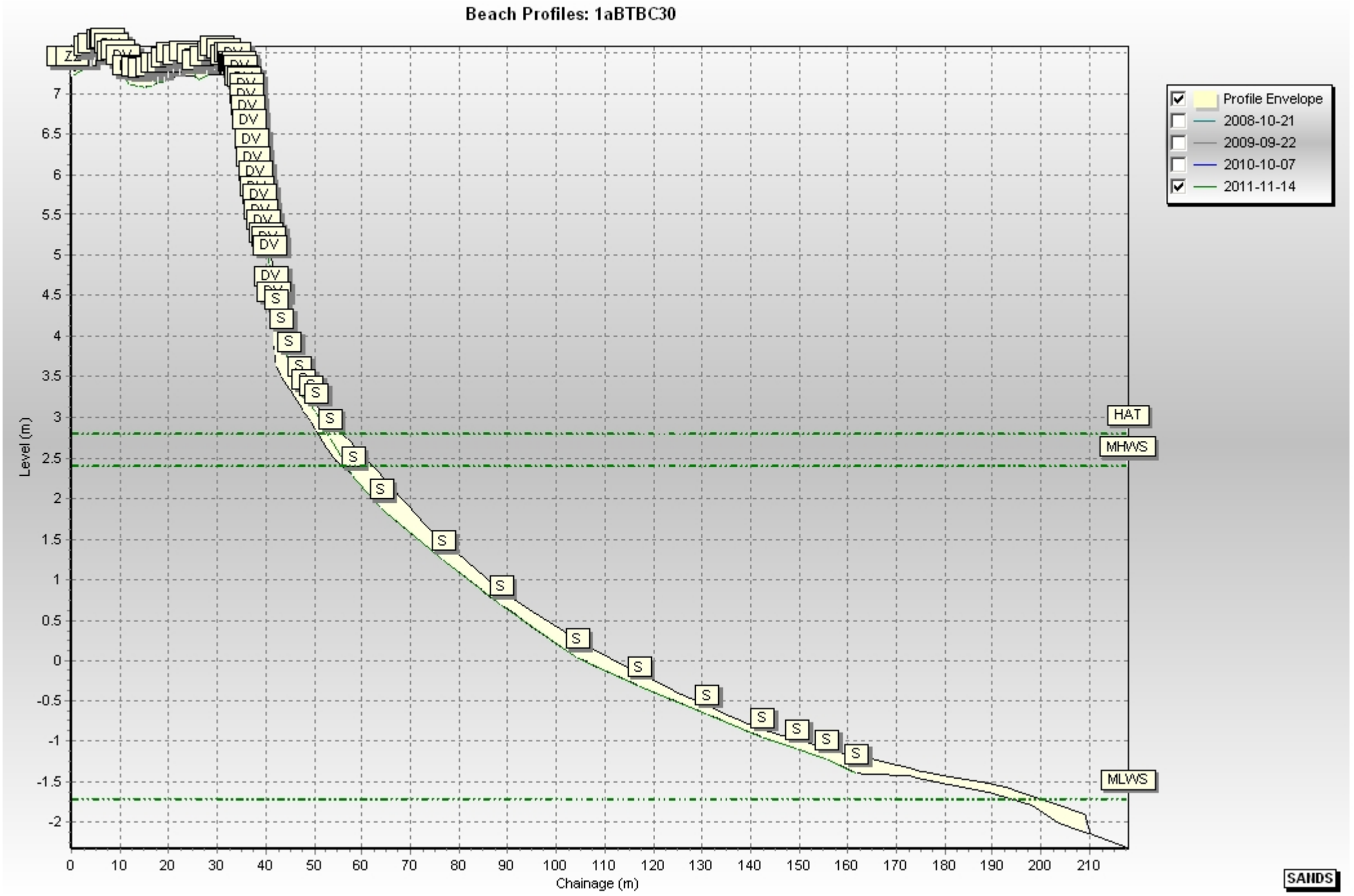
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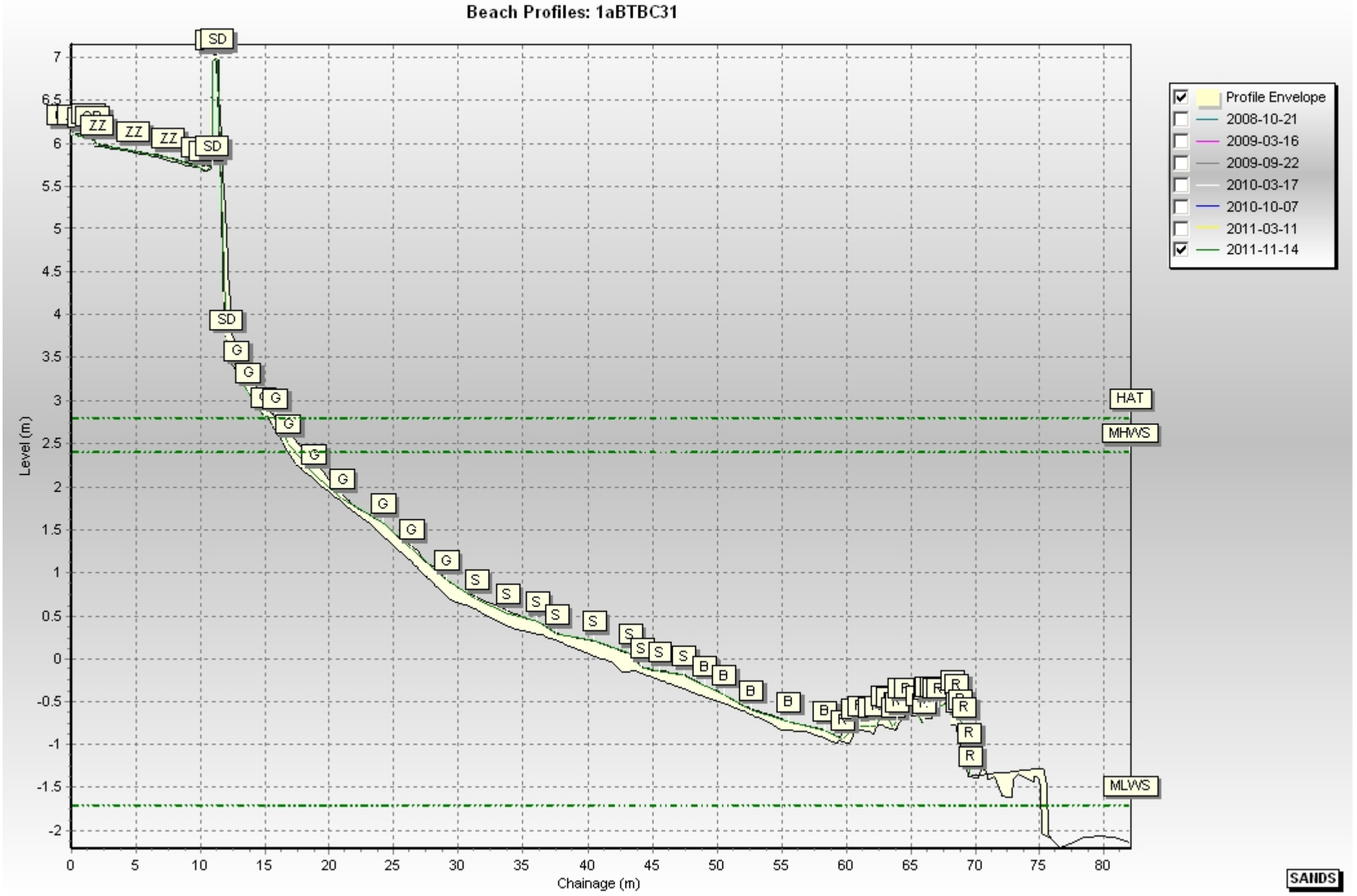
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Chainage (m)
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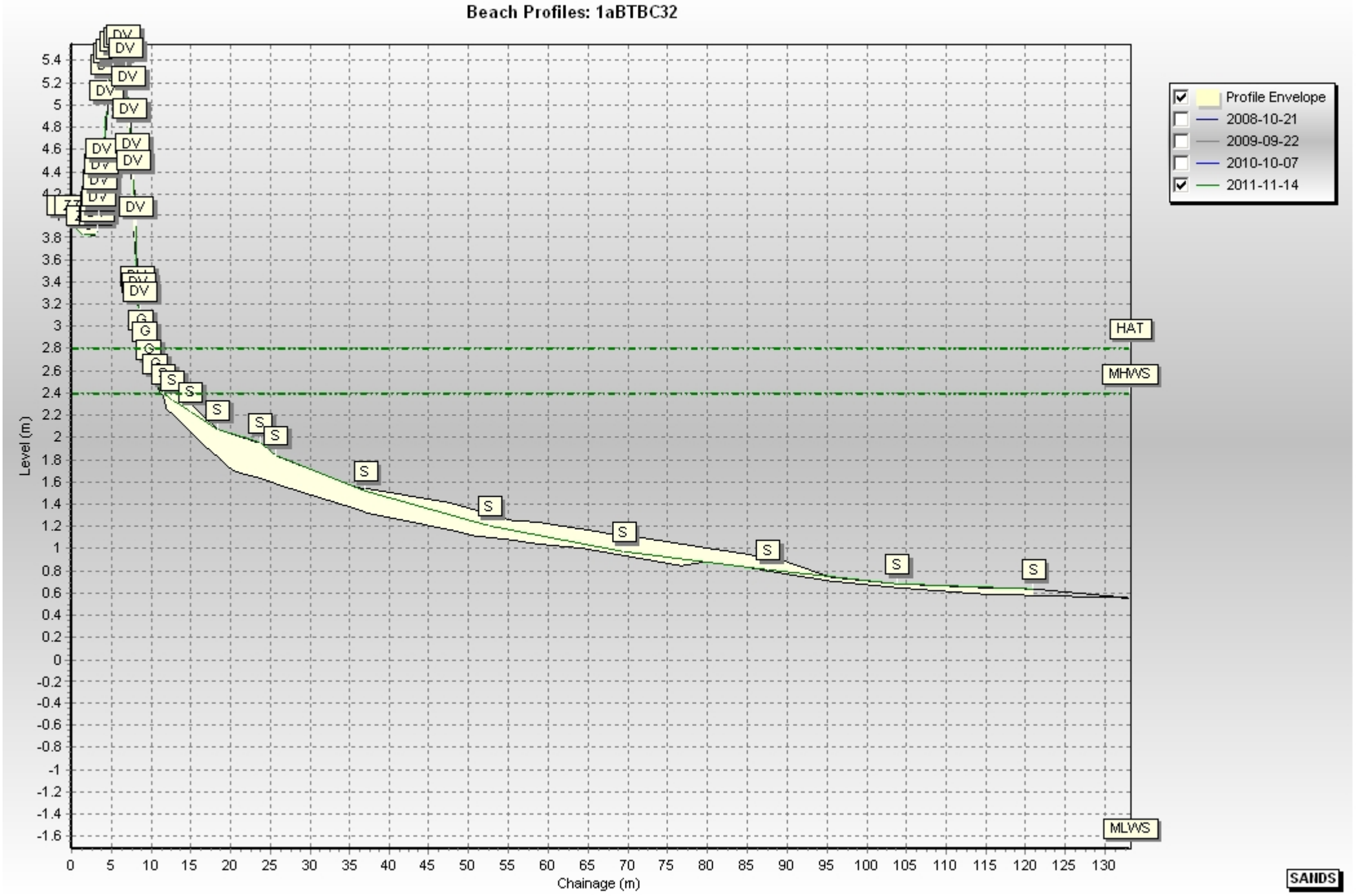
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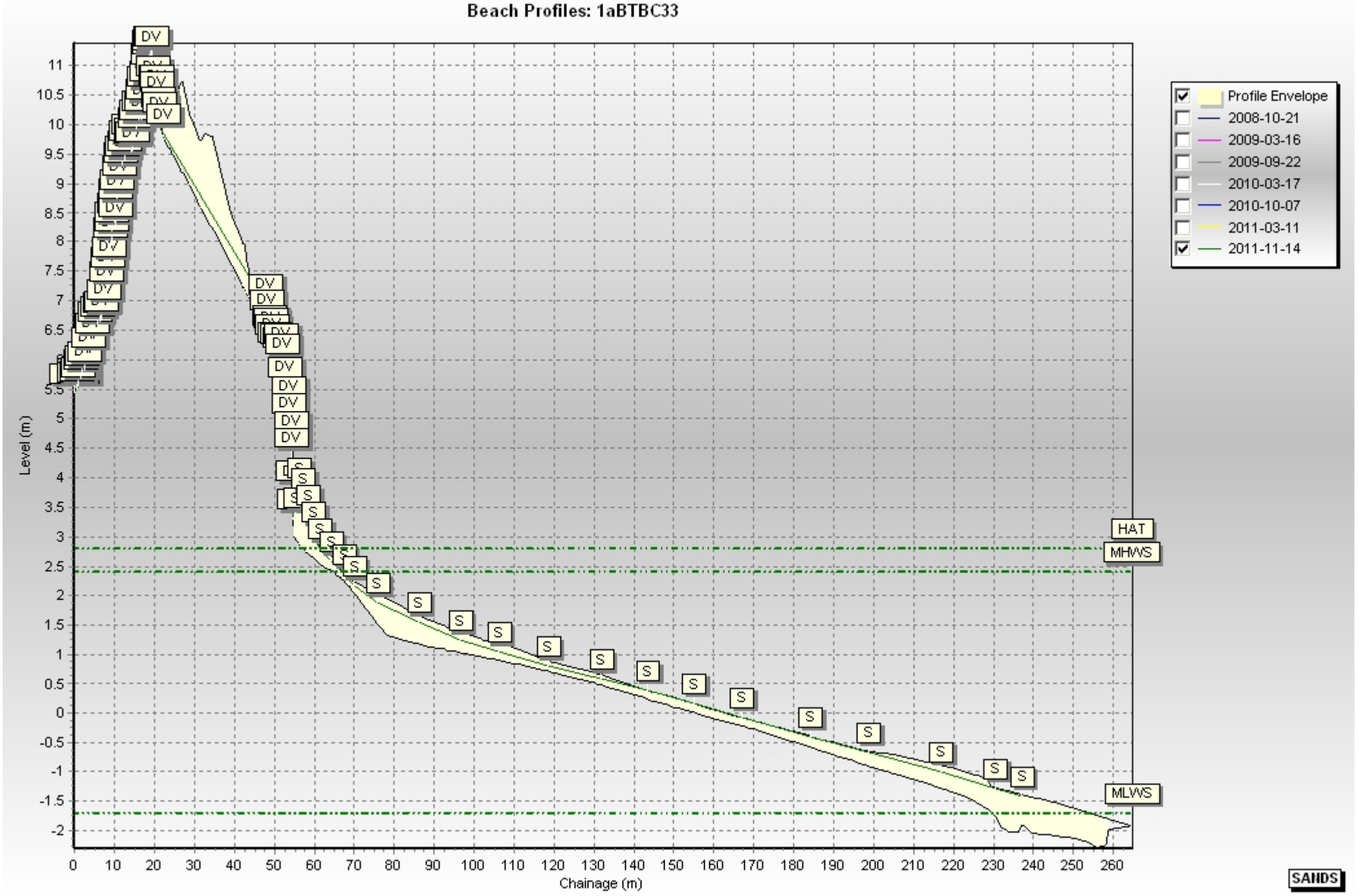
SANDS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MLWS
DV
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Level (m)
Chainage (m)
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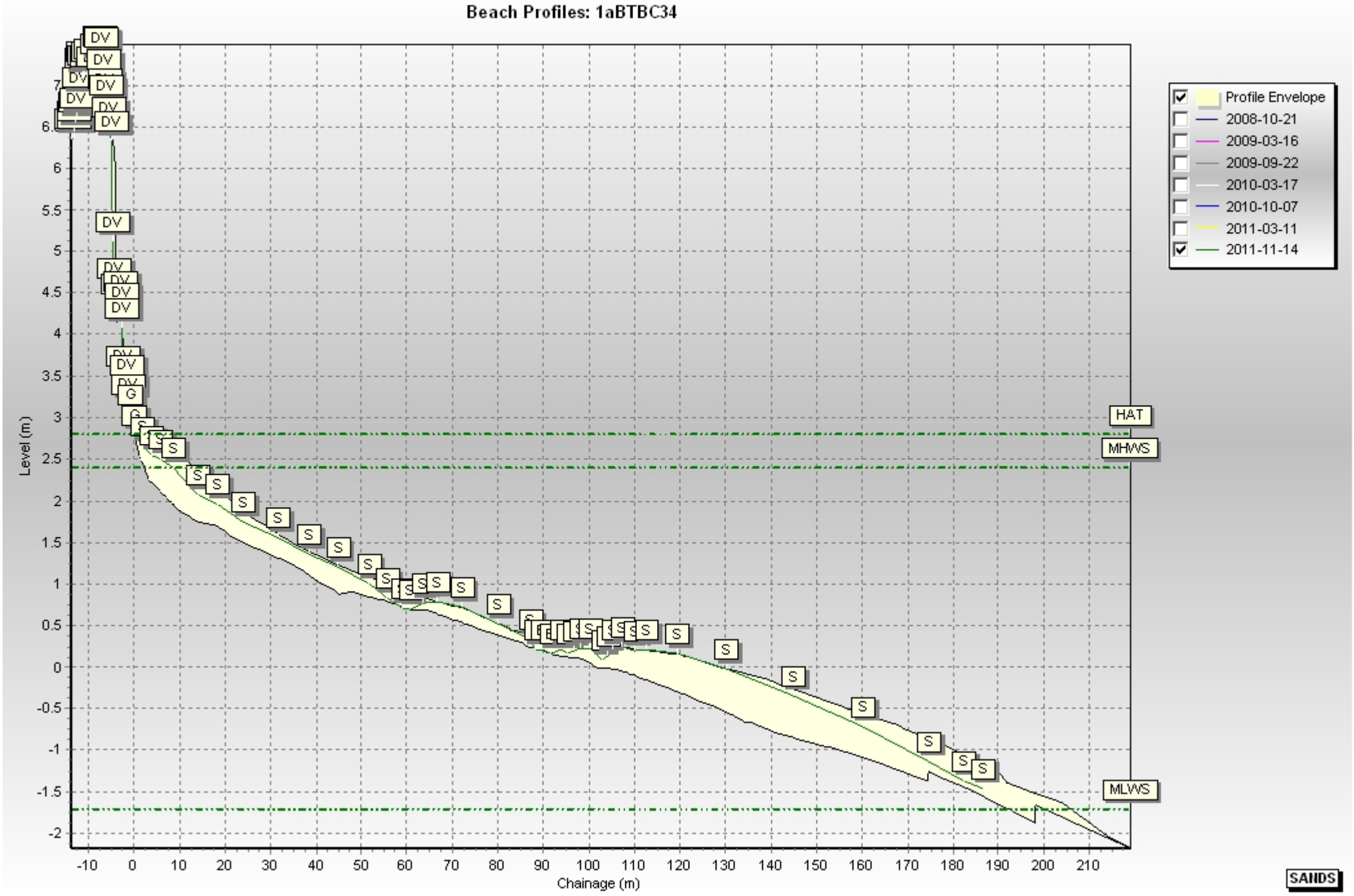
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Chainage (m)
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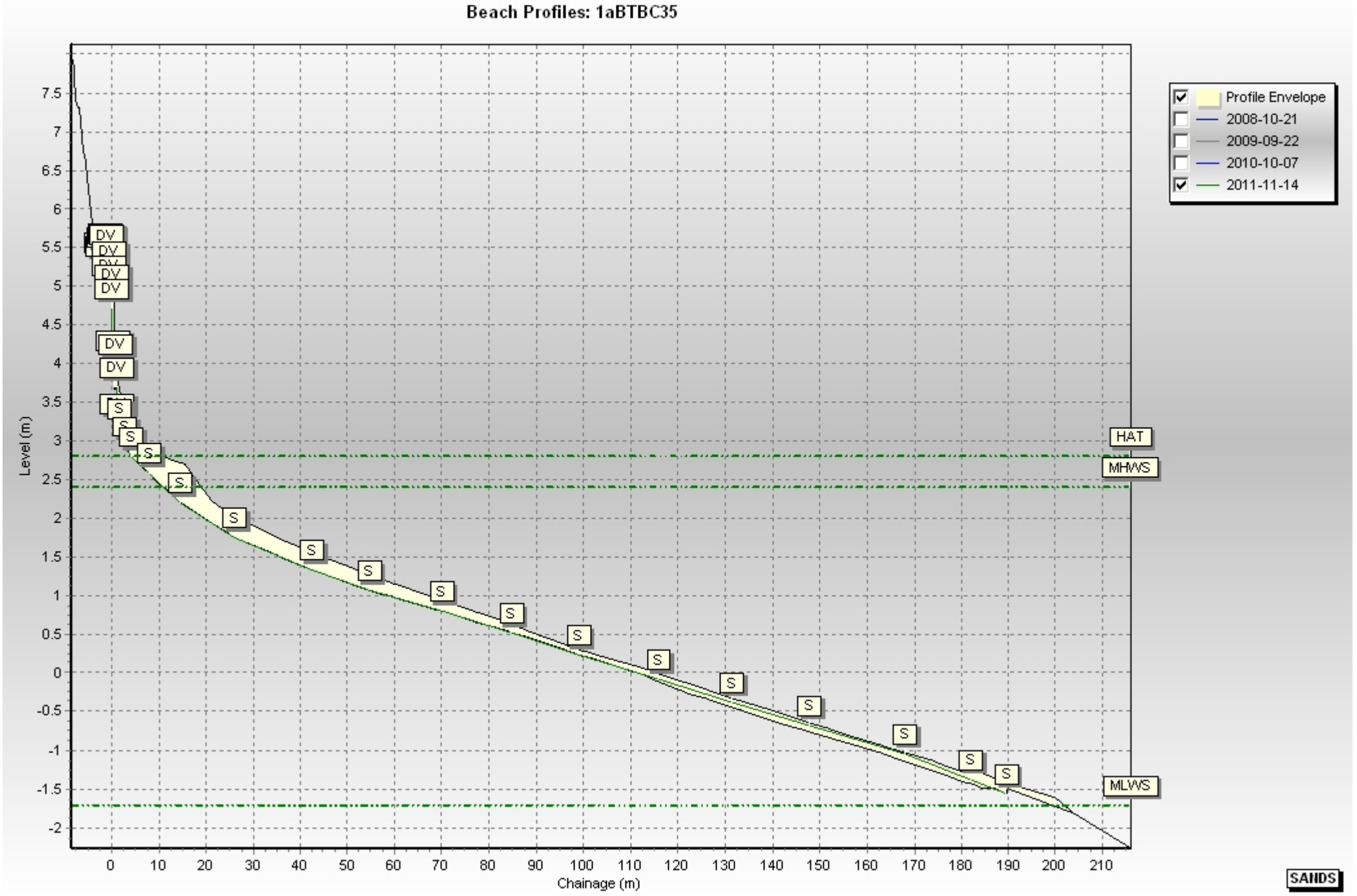
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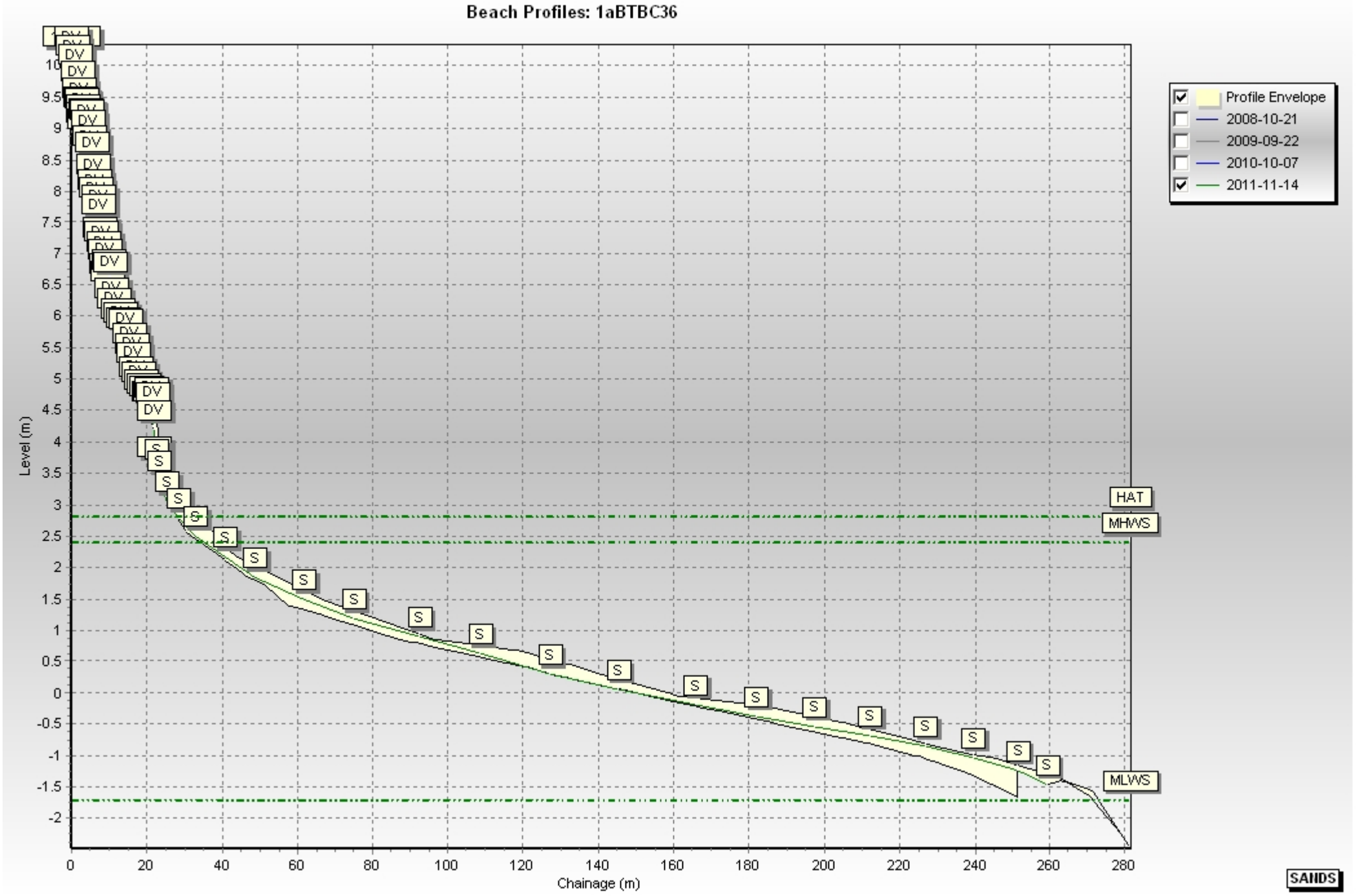
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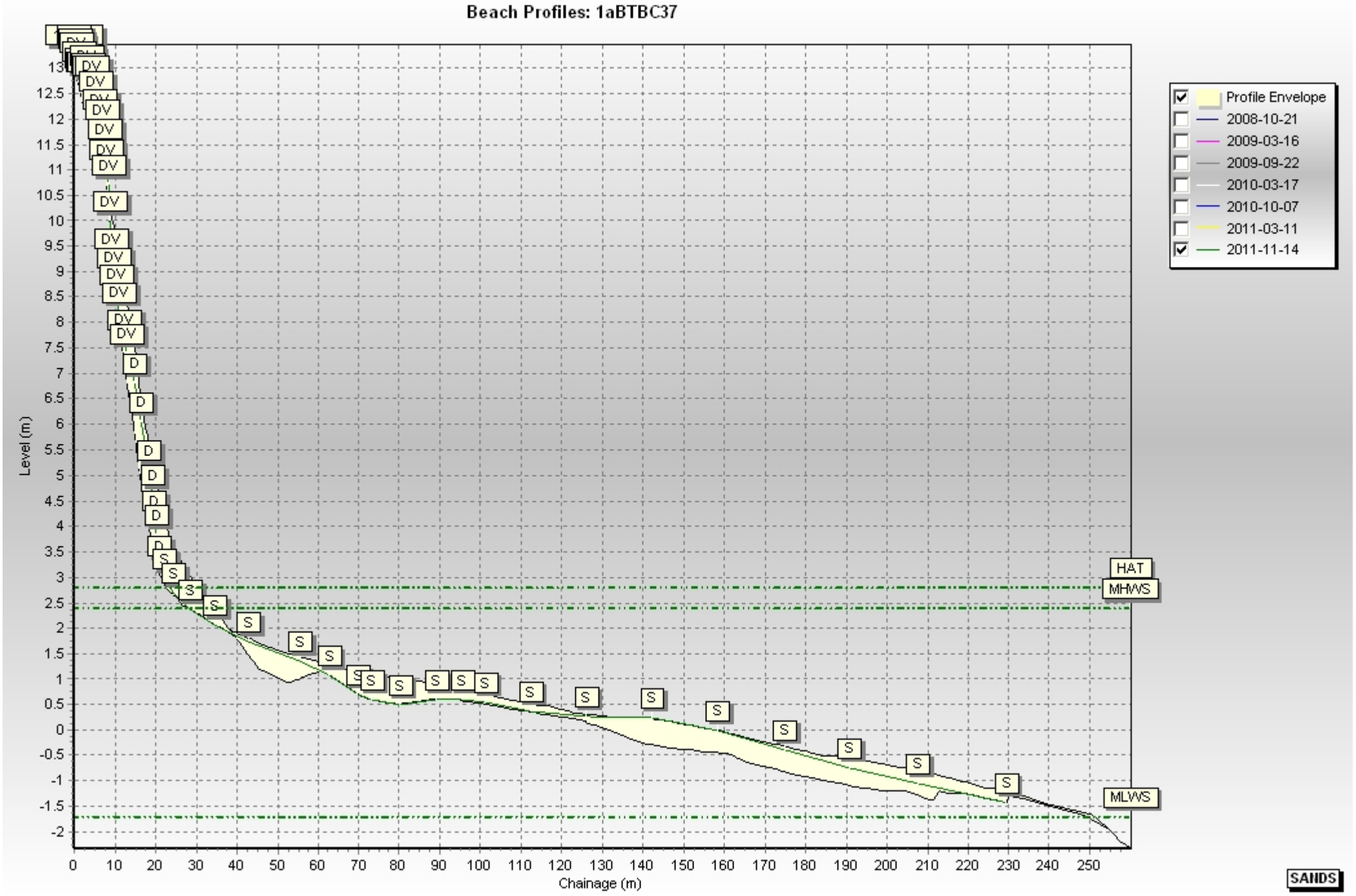
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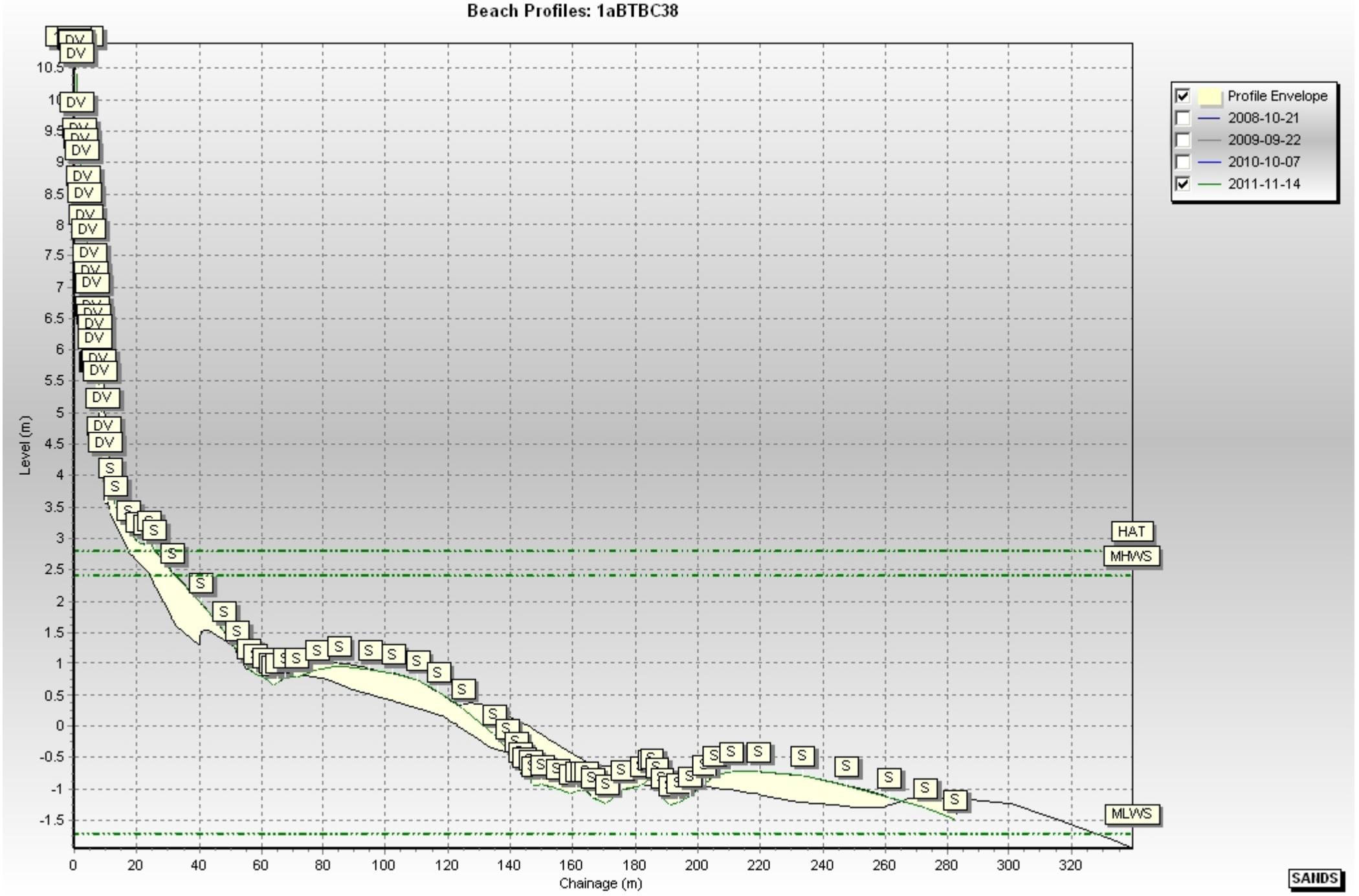
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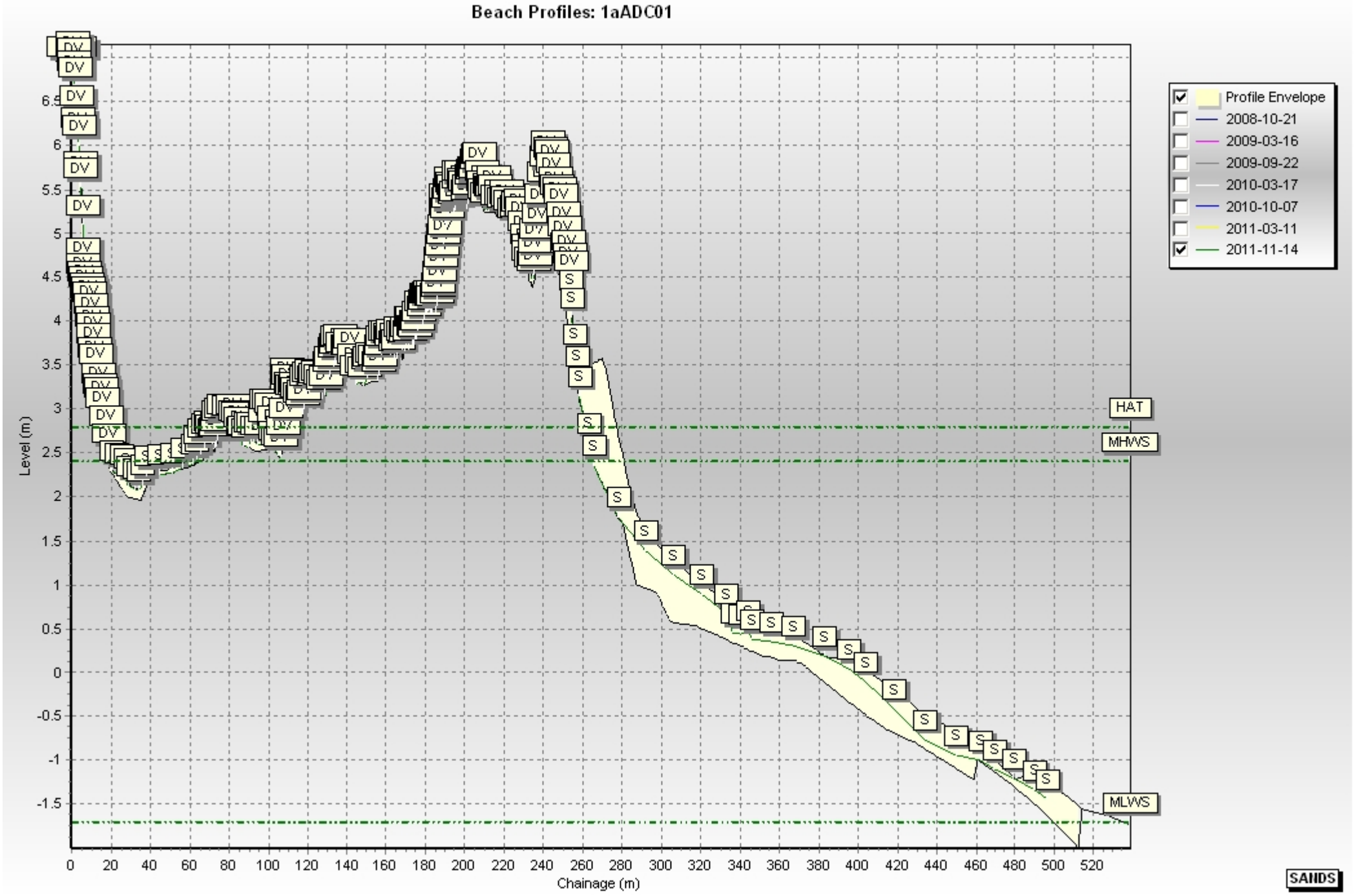
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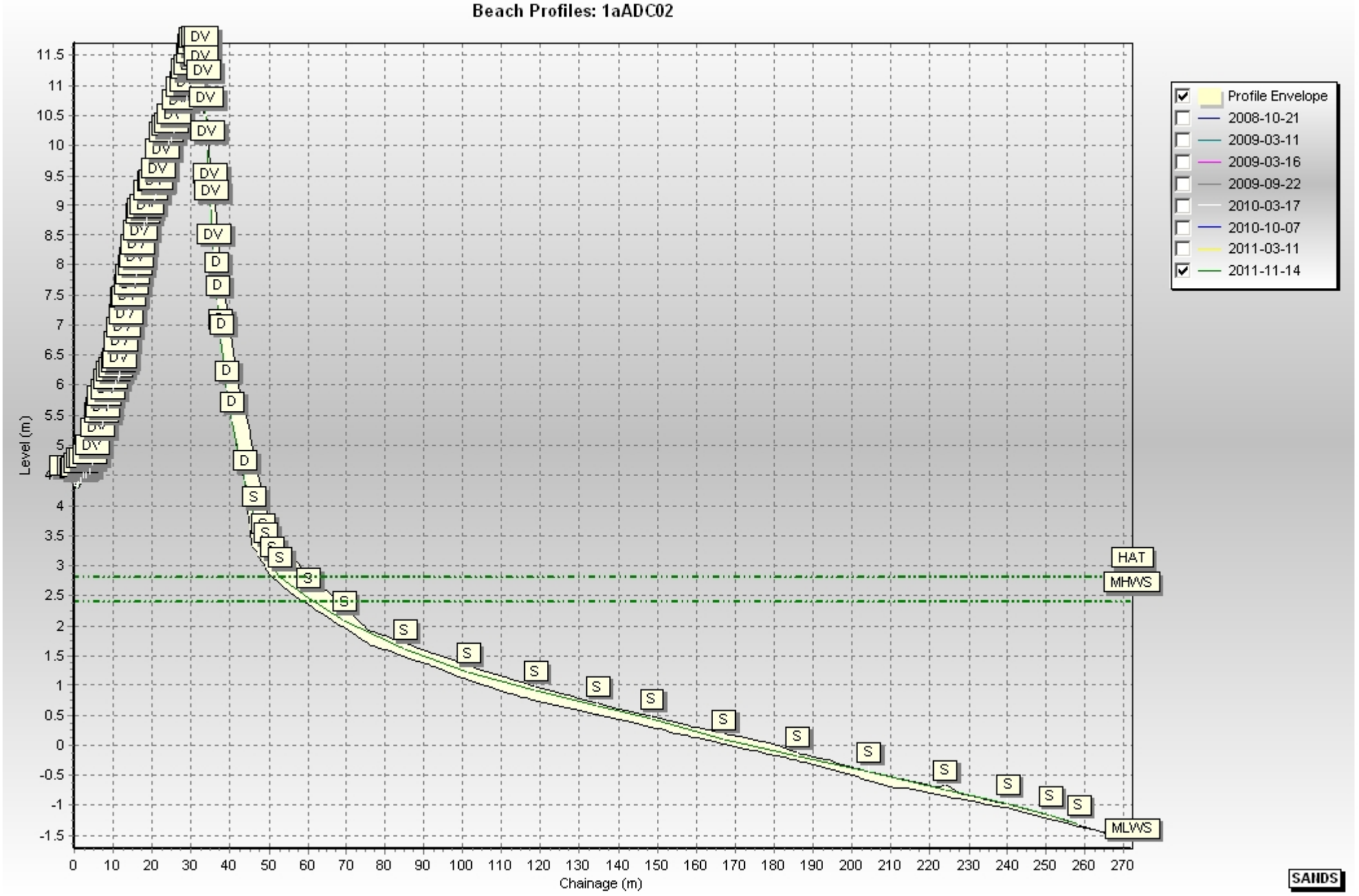
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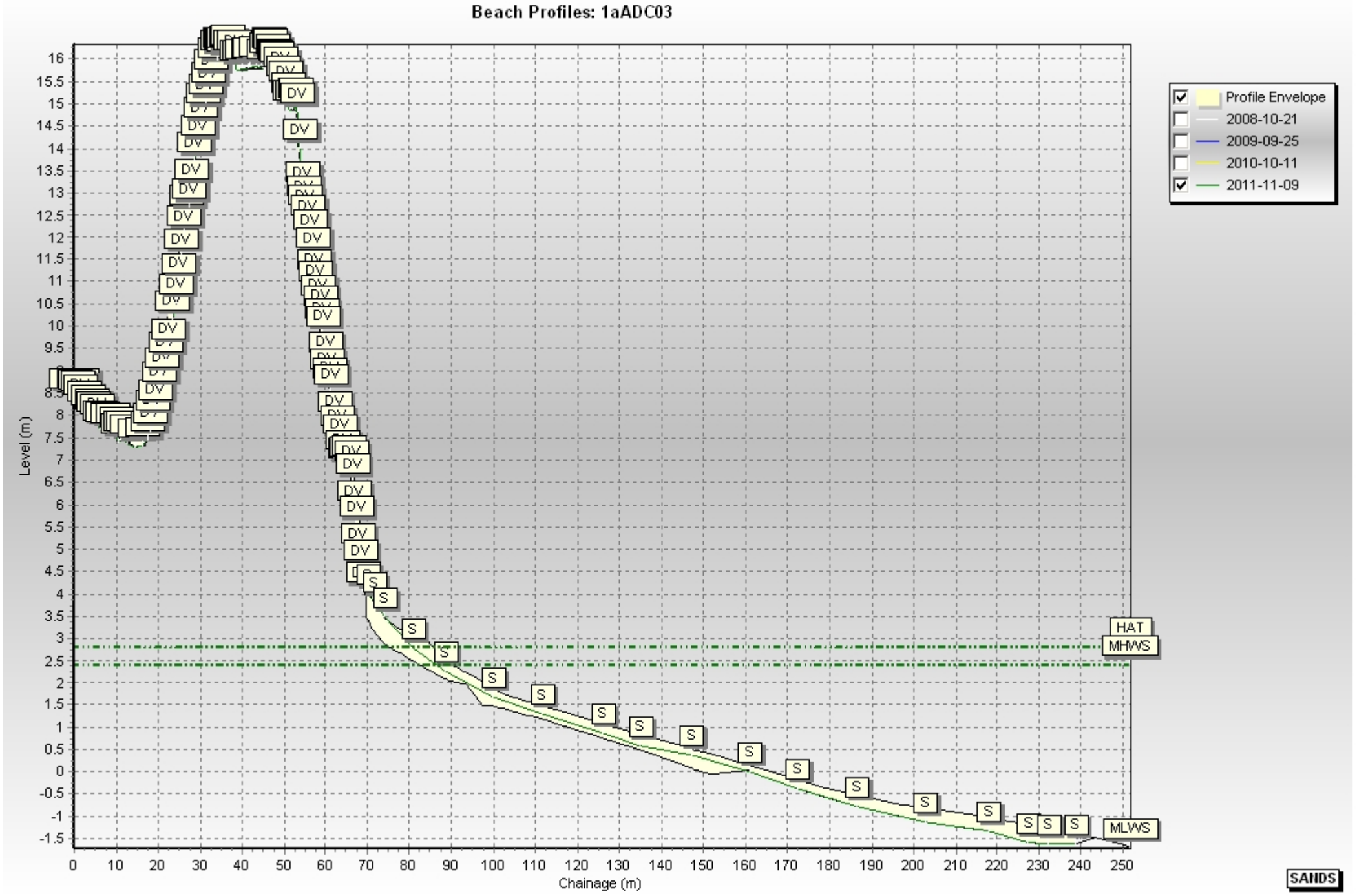
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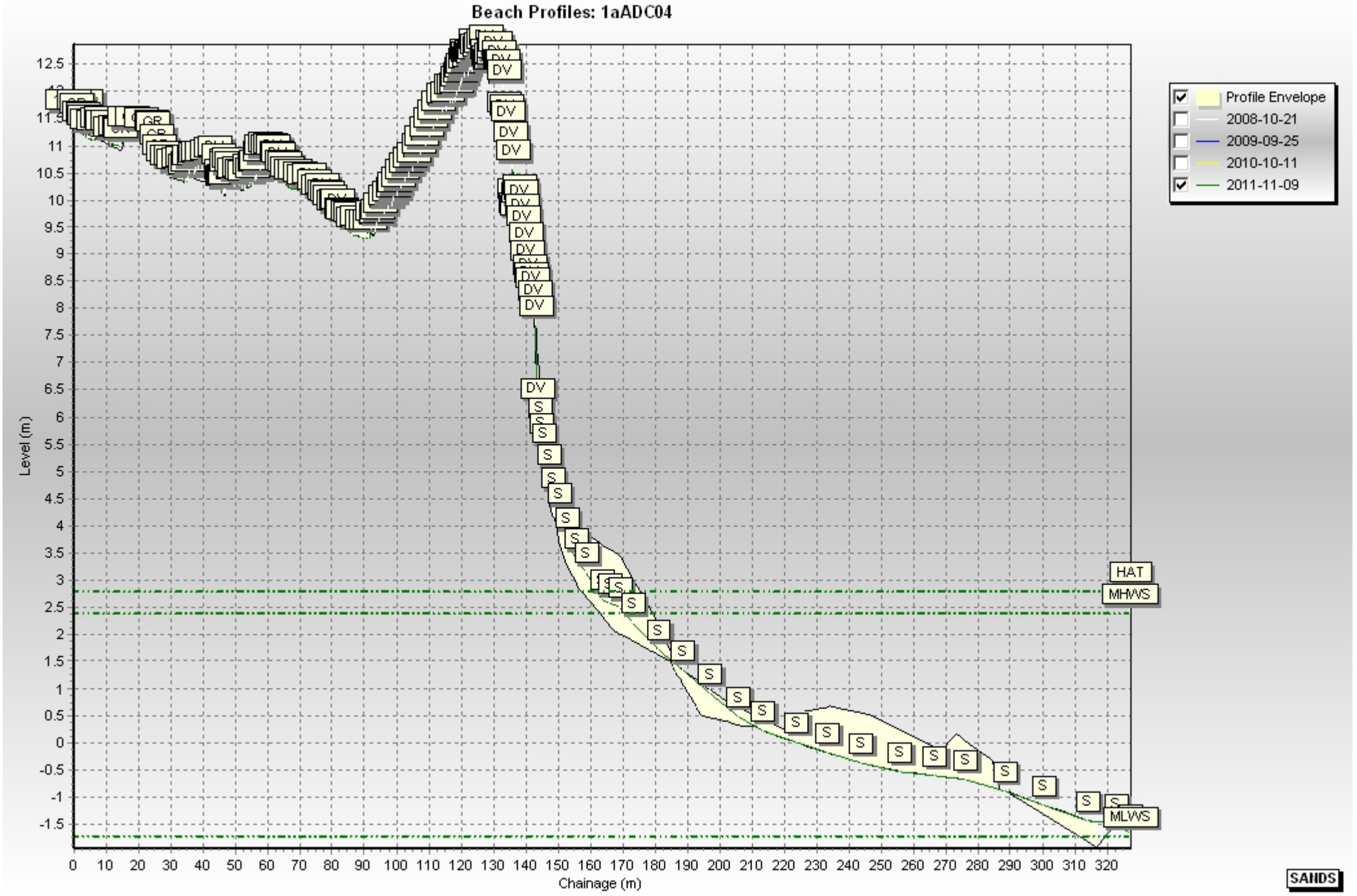
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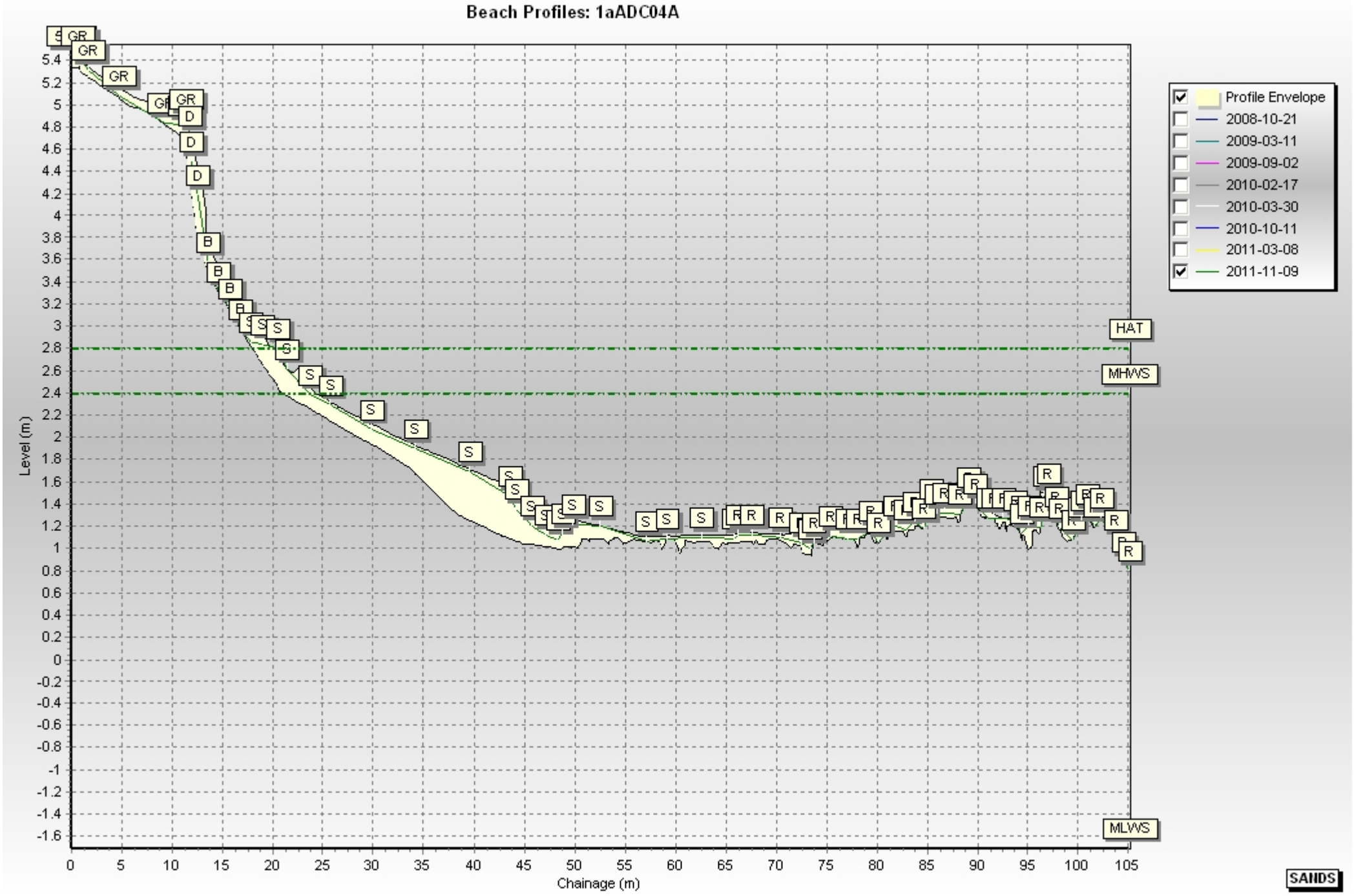
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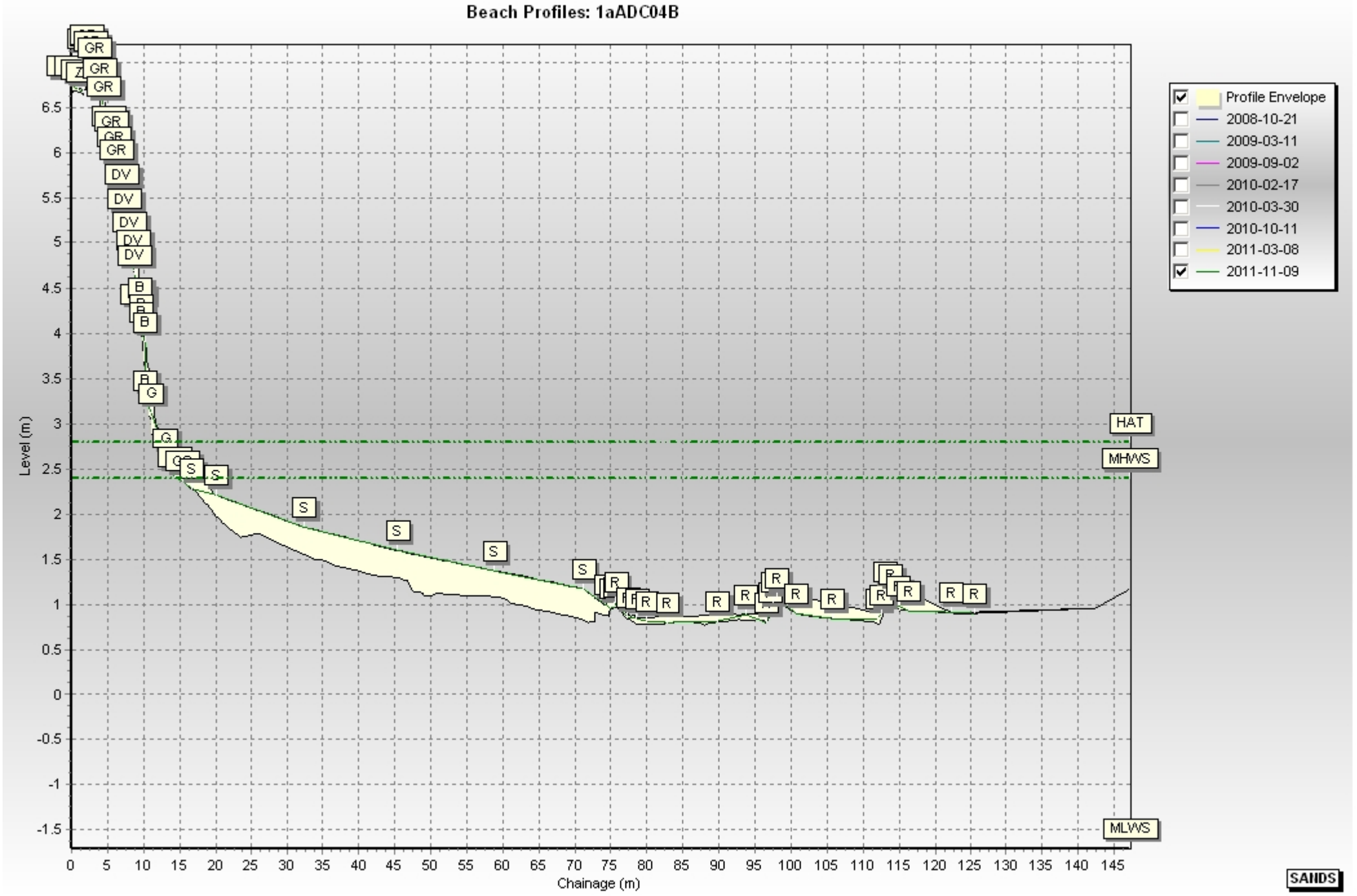
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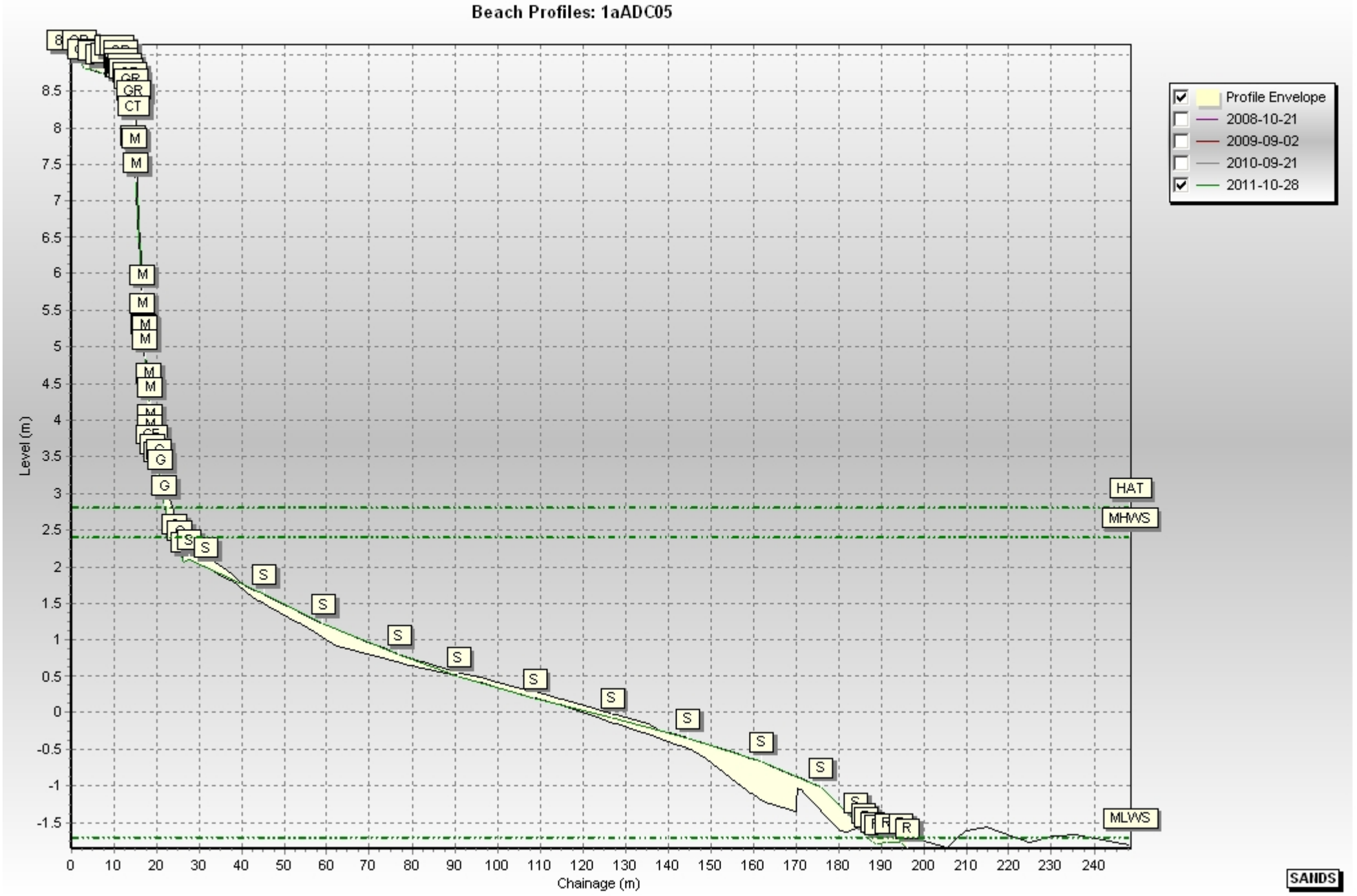
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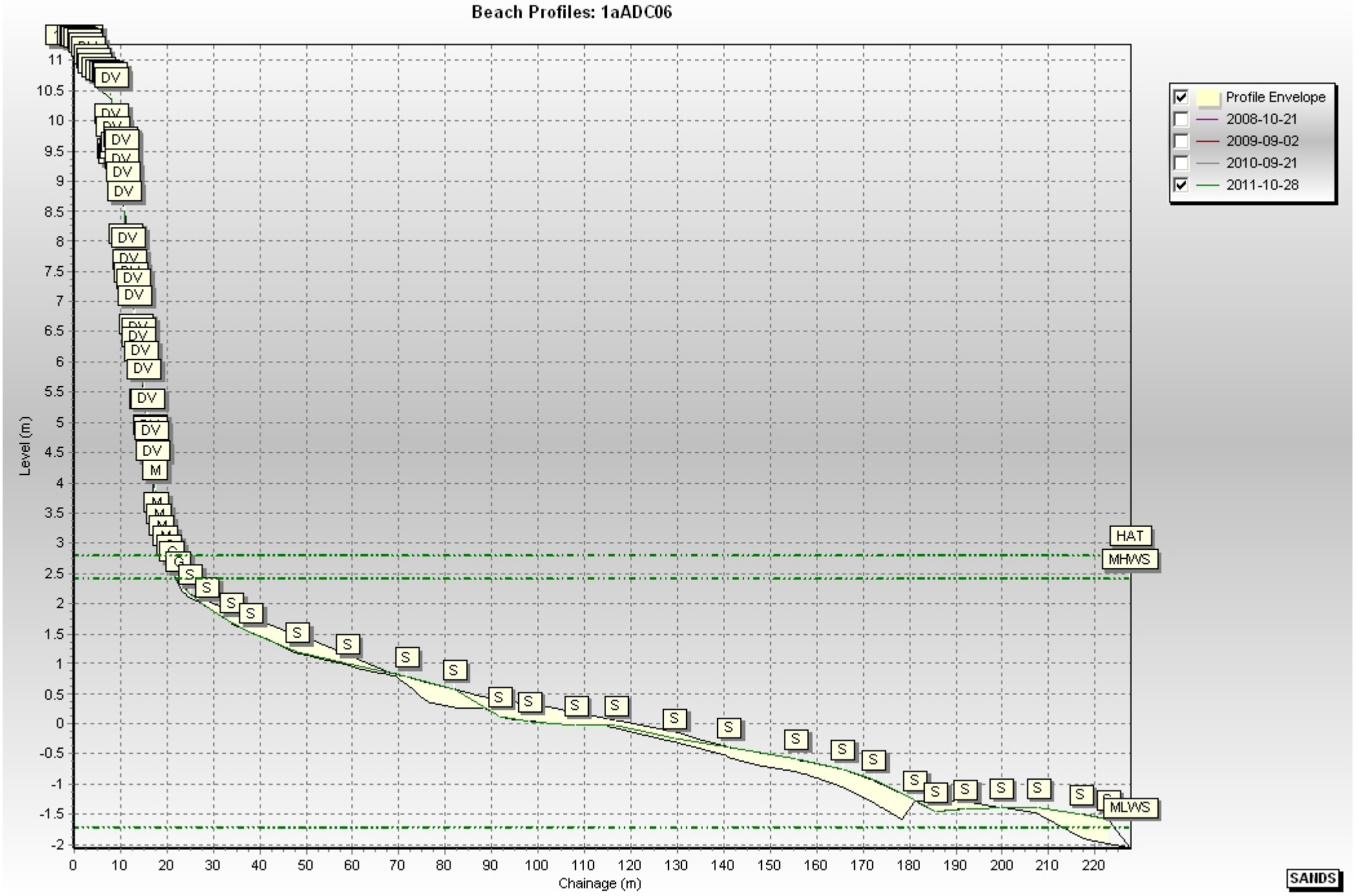
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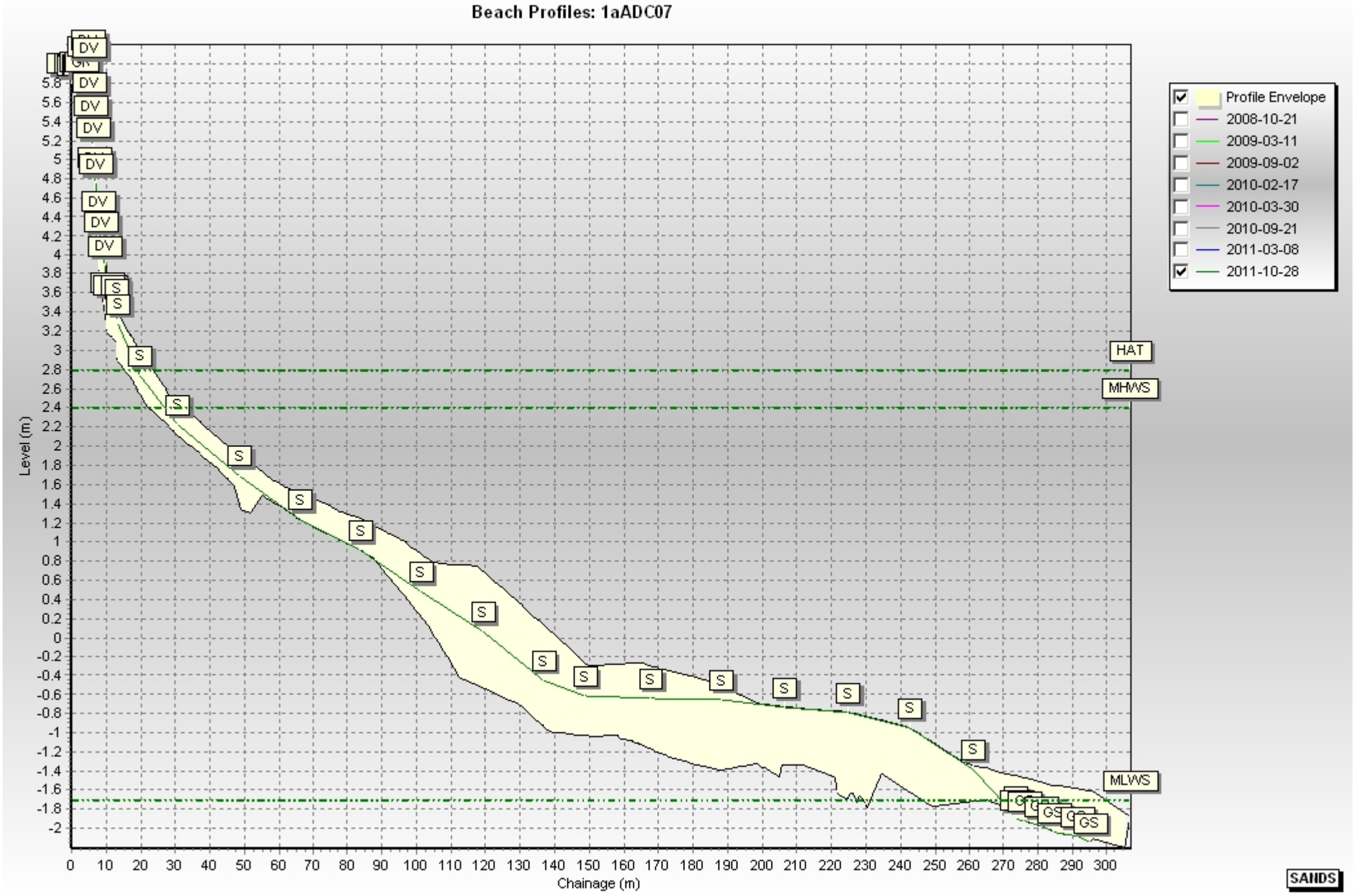
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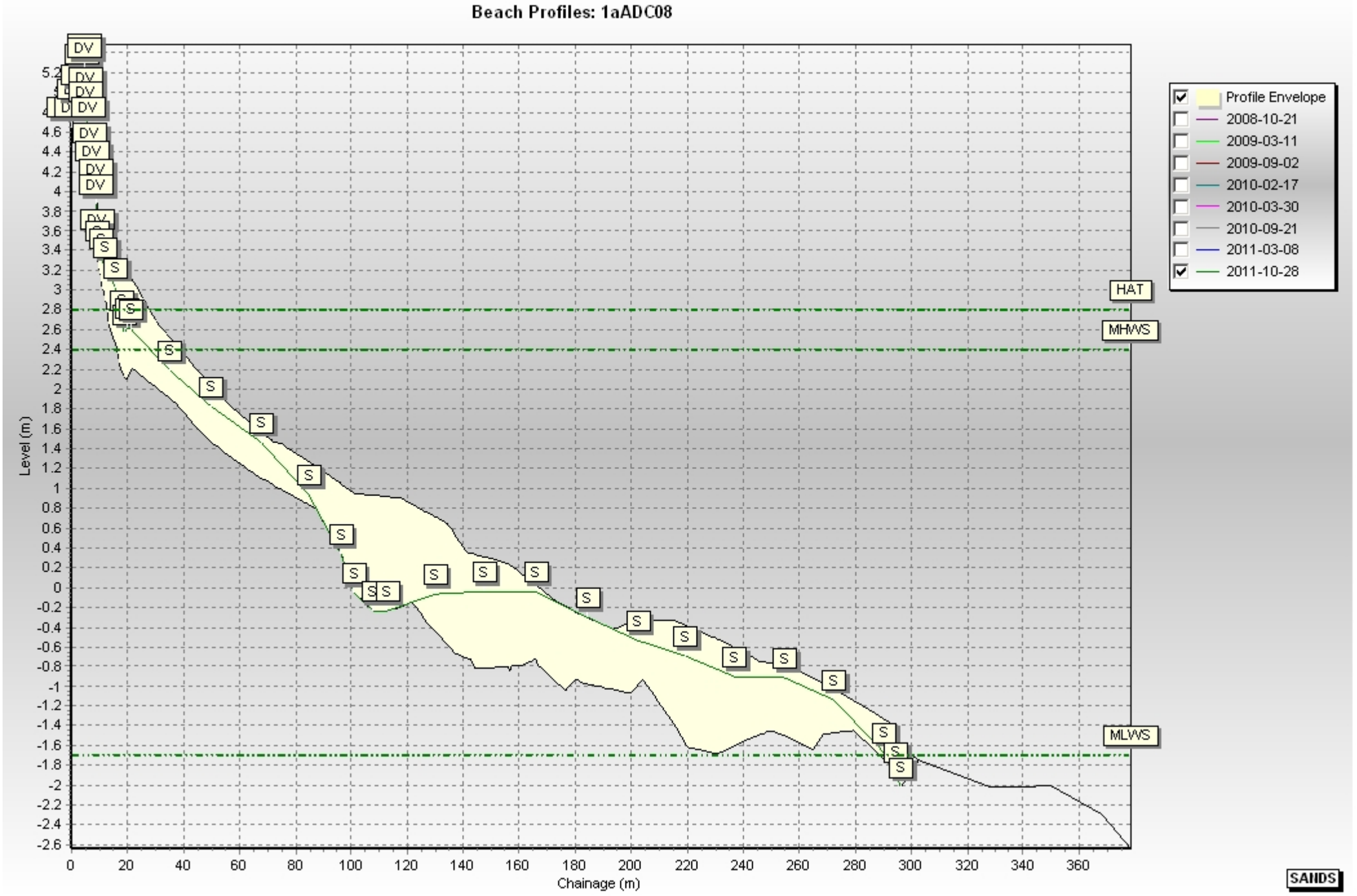
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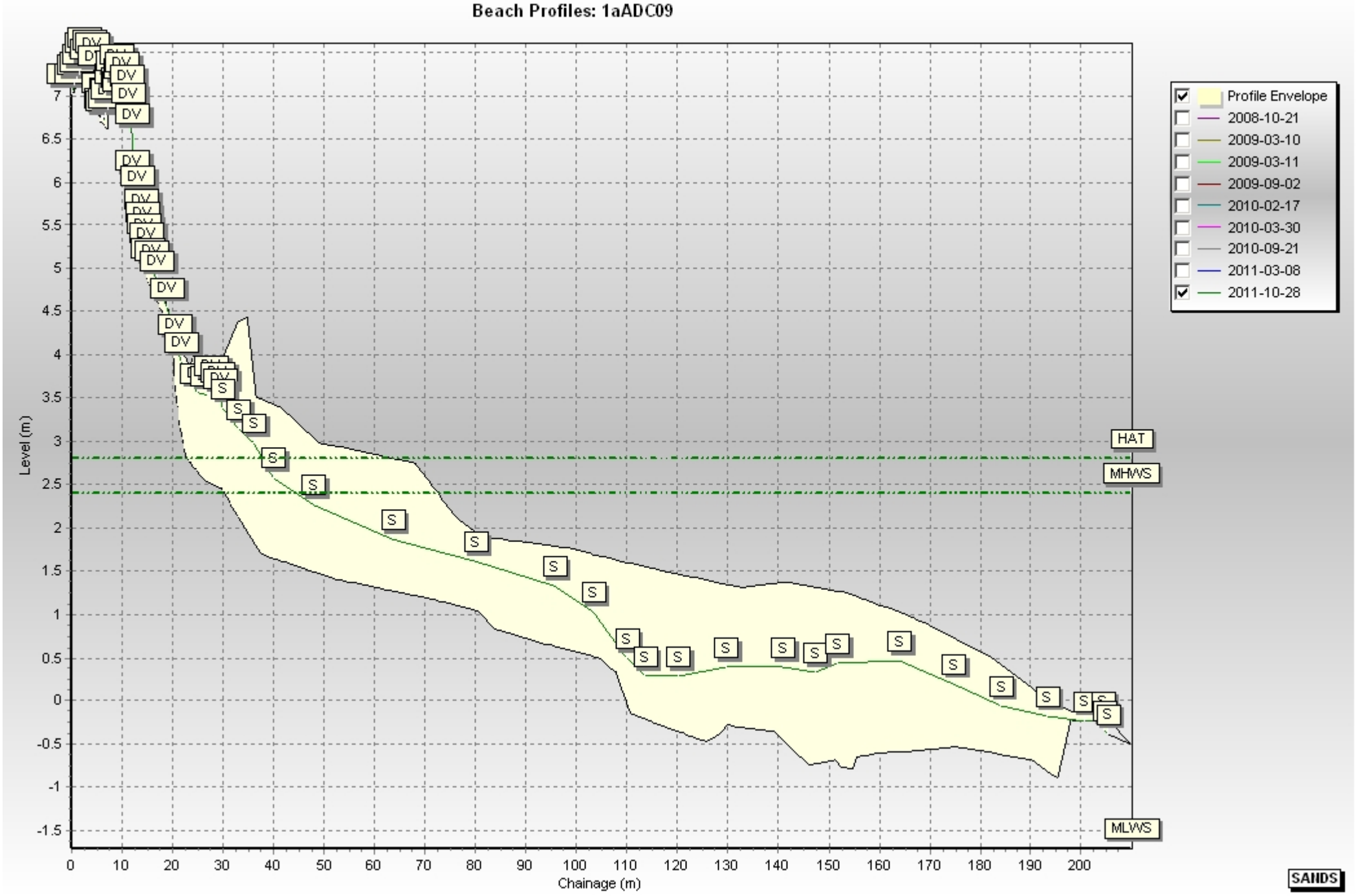
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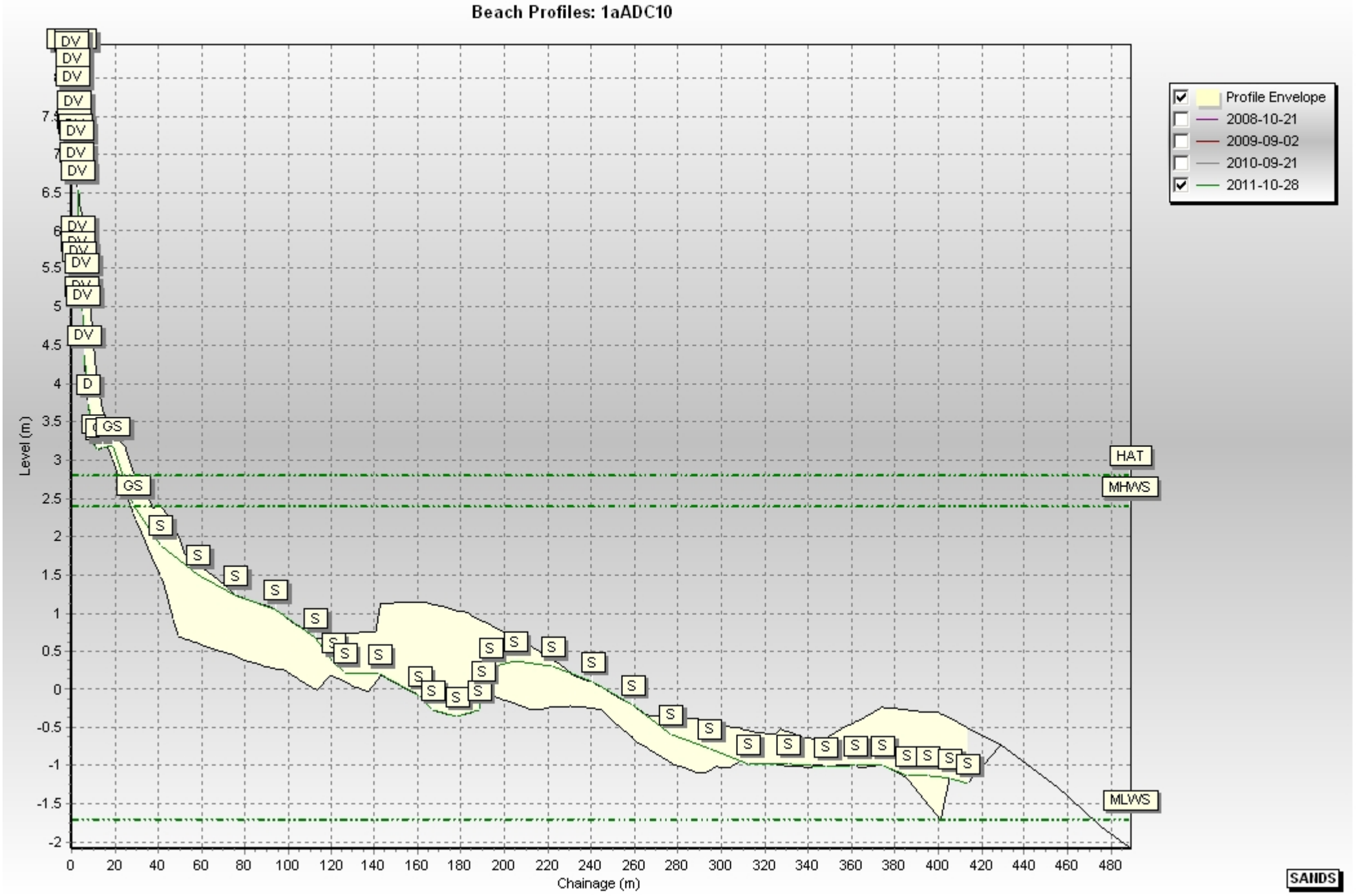
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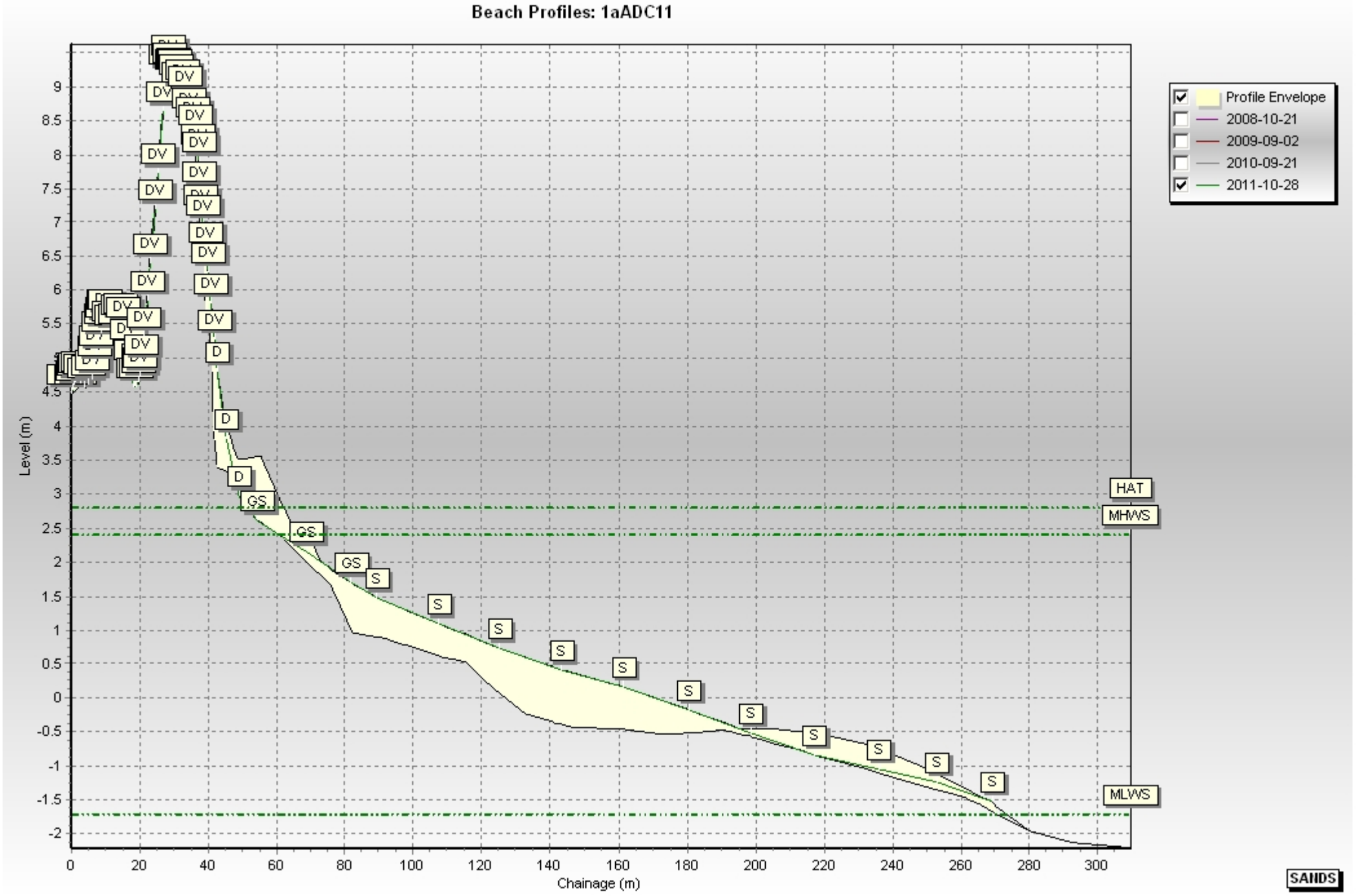
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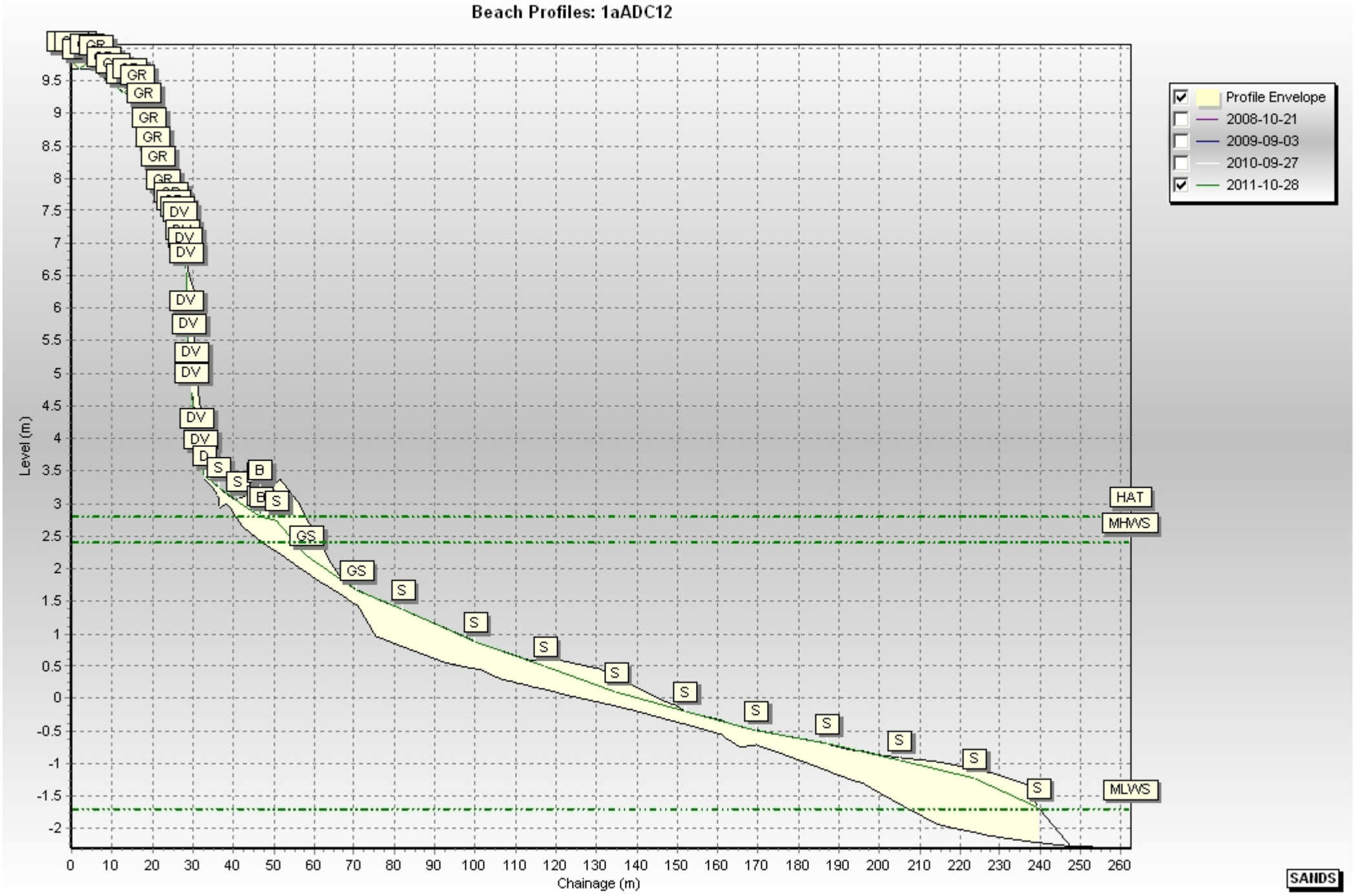
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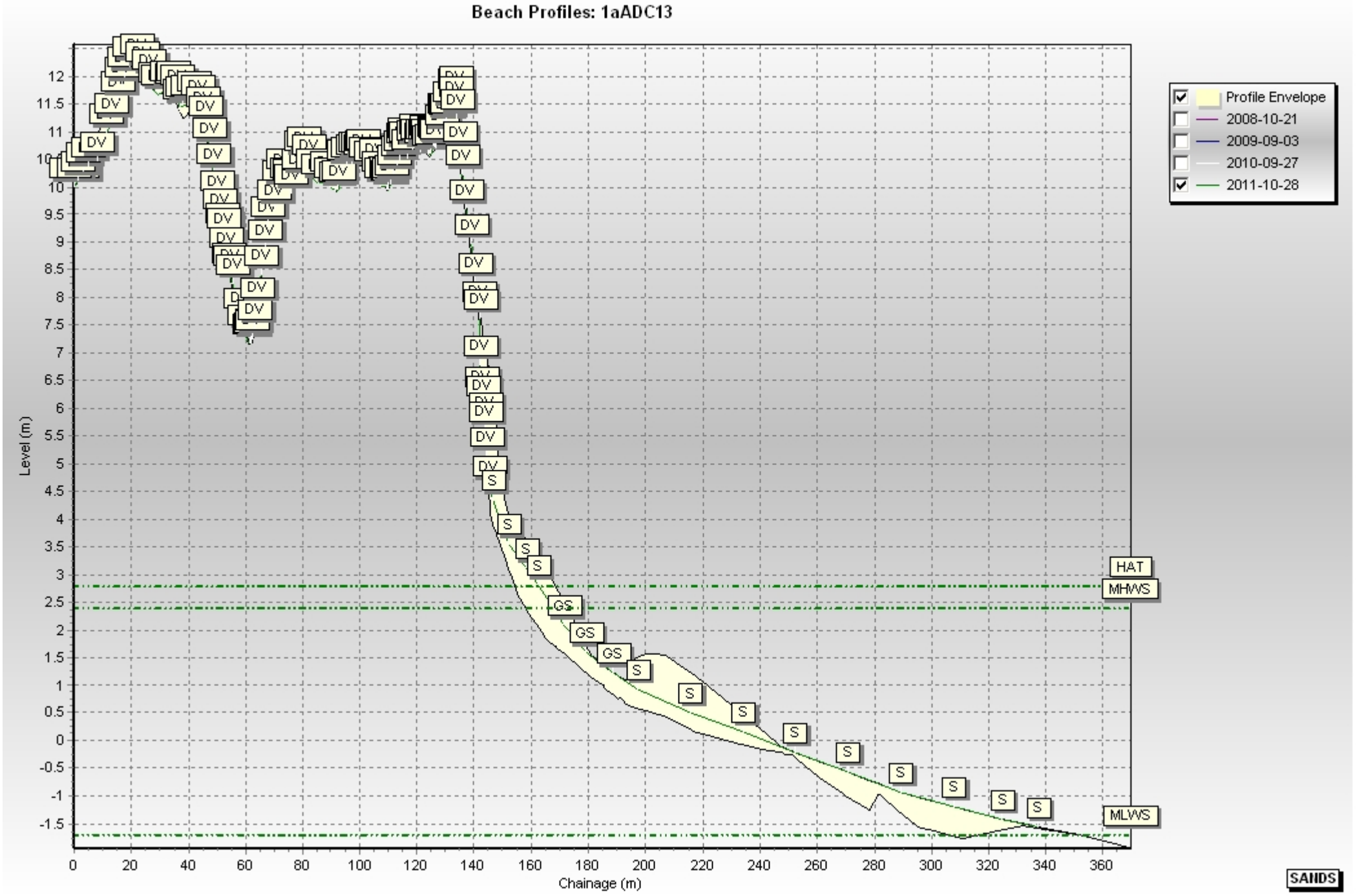
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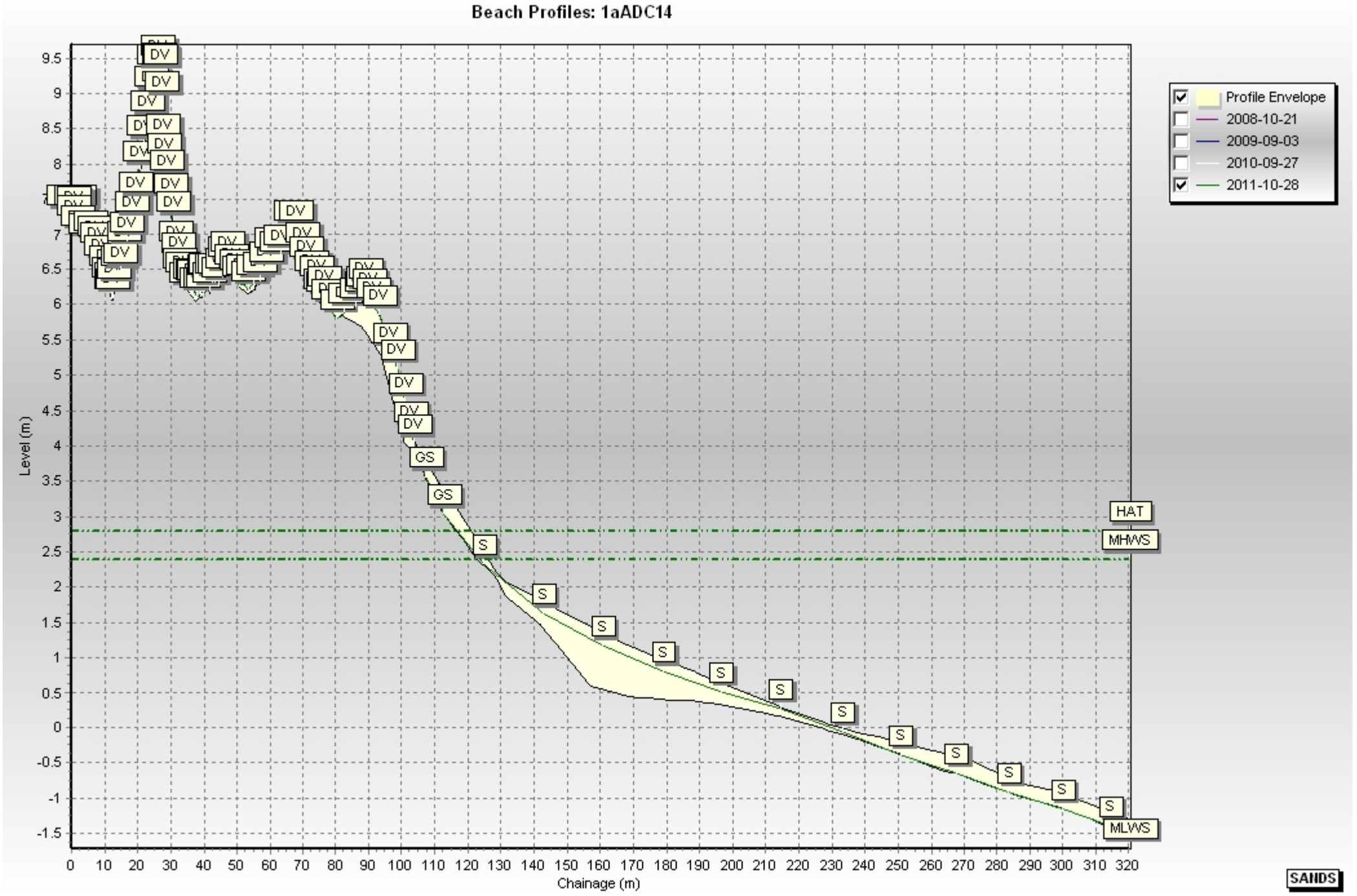
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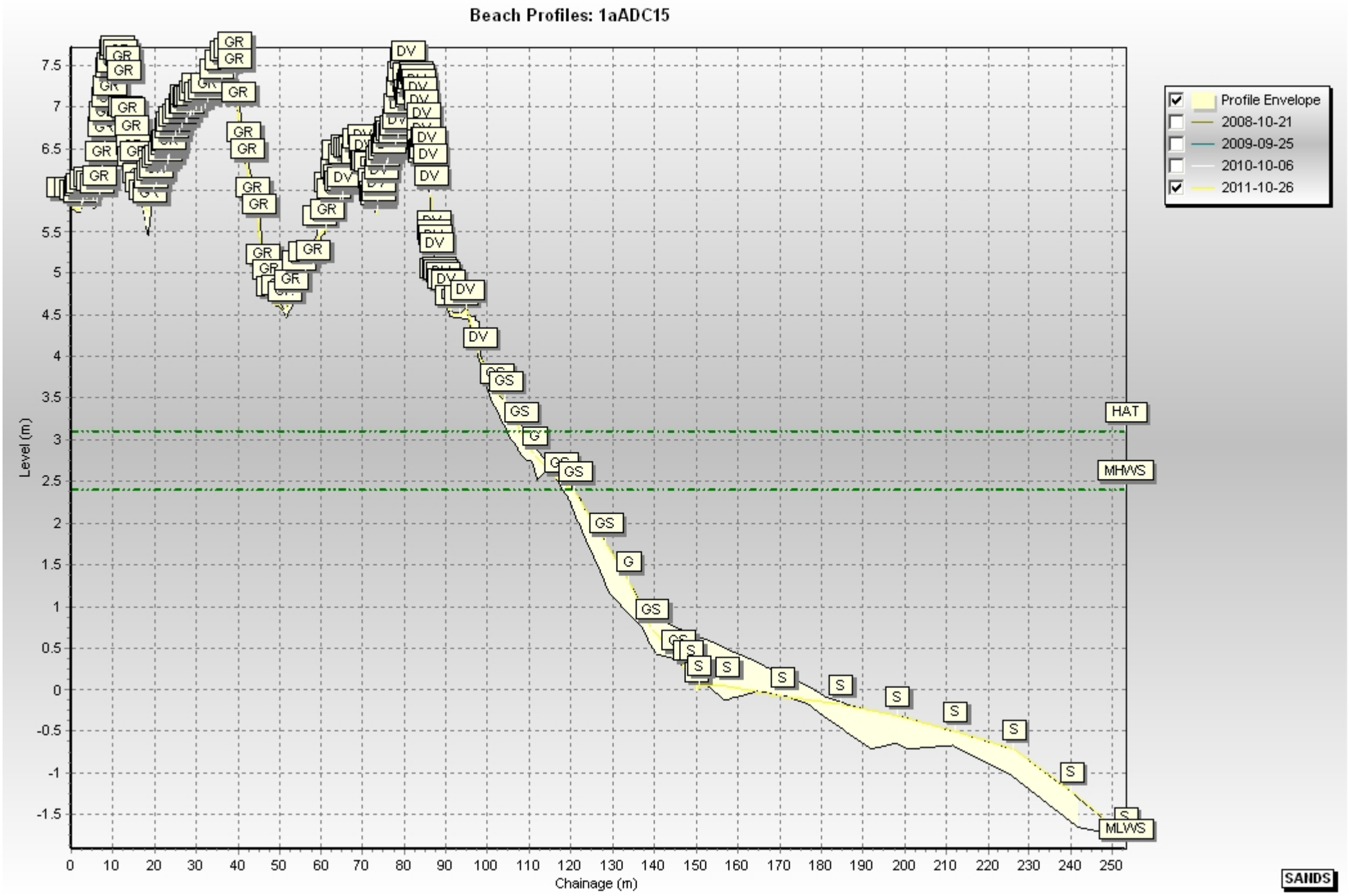
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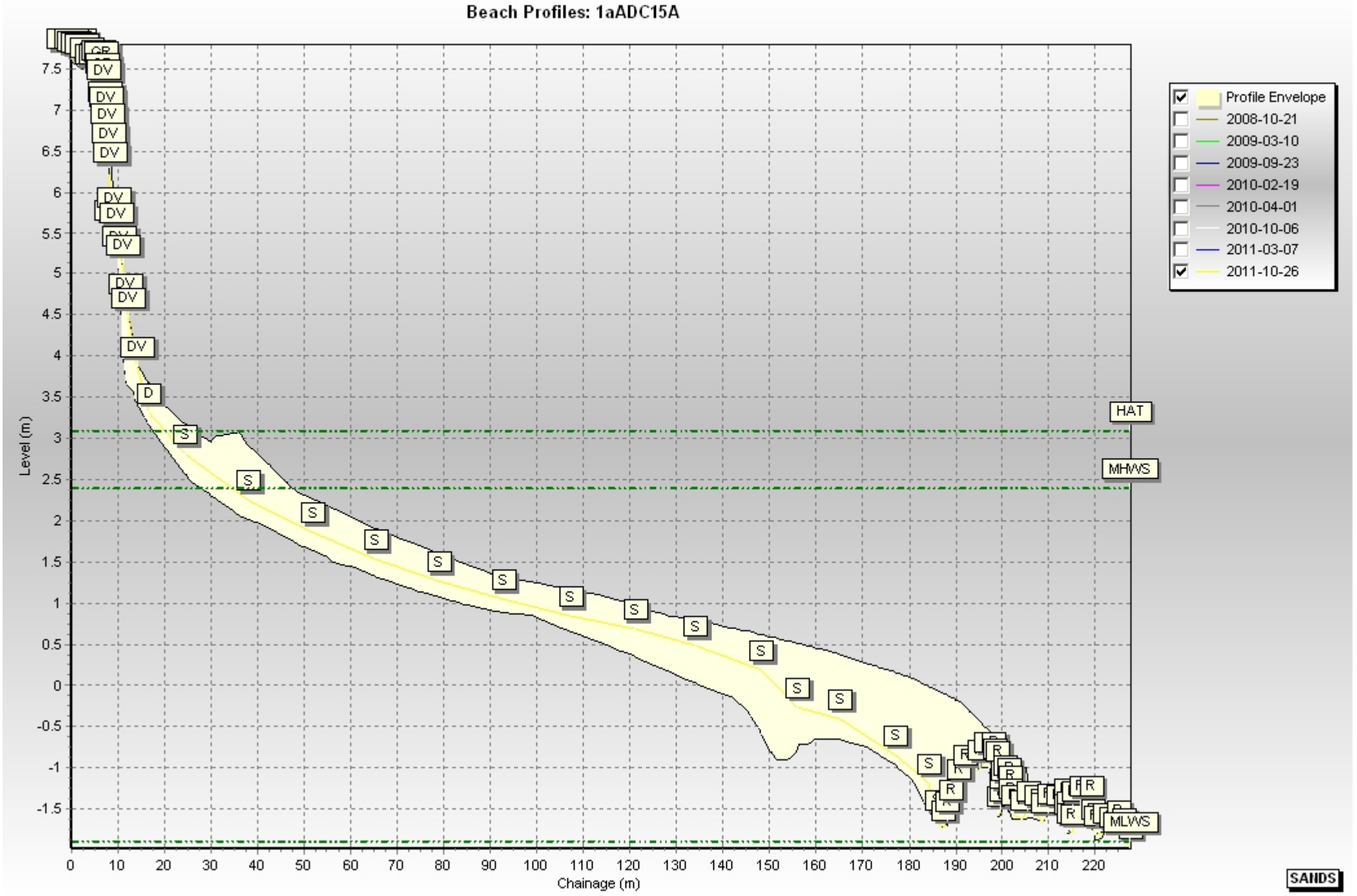
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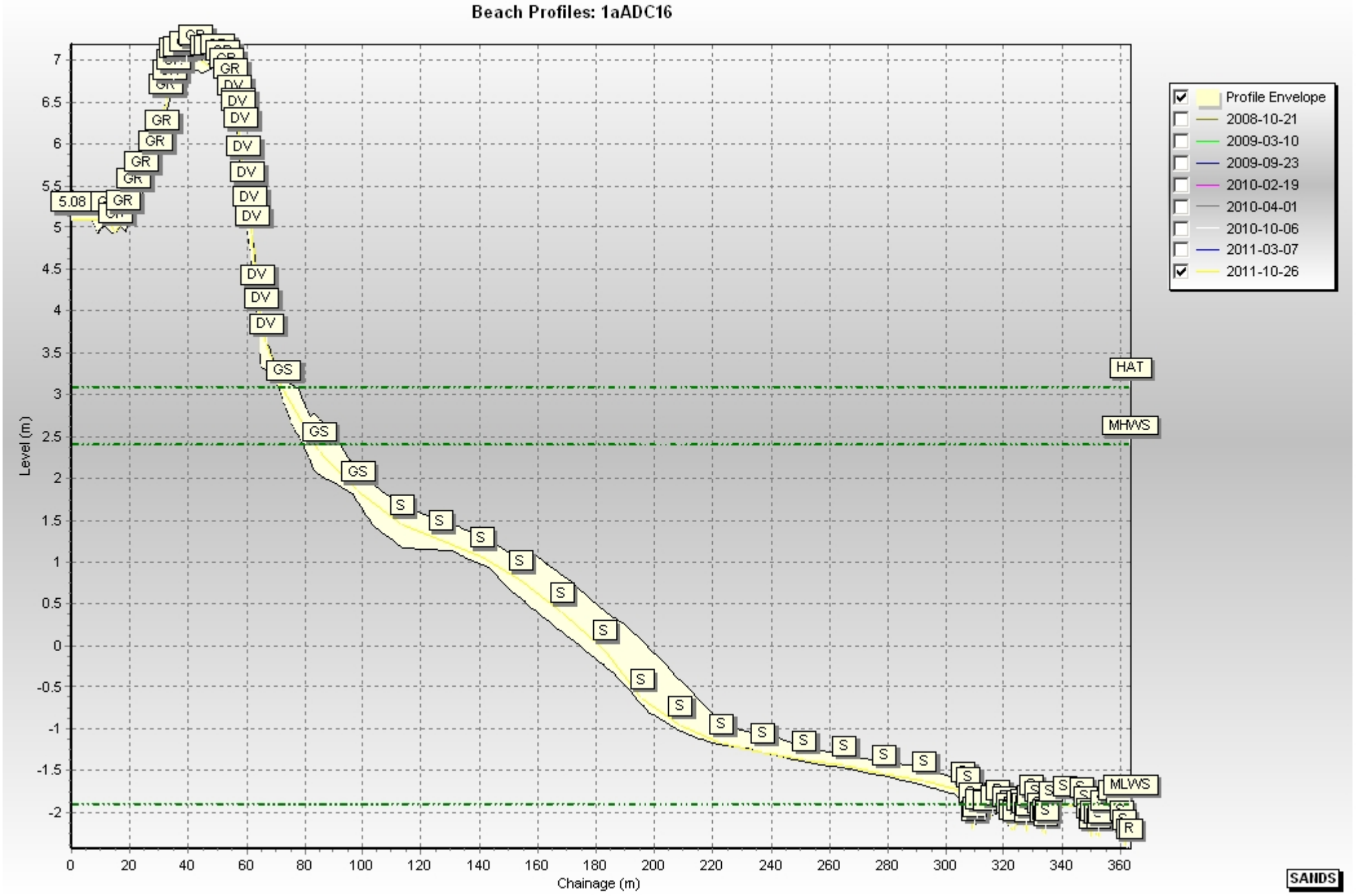
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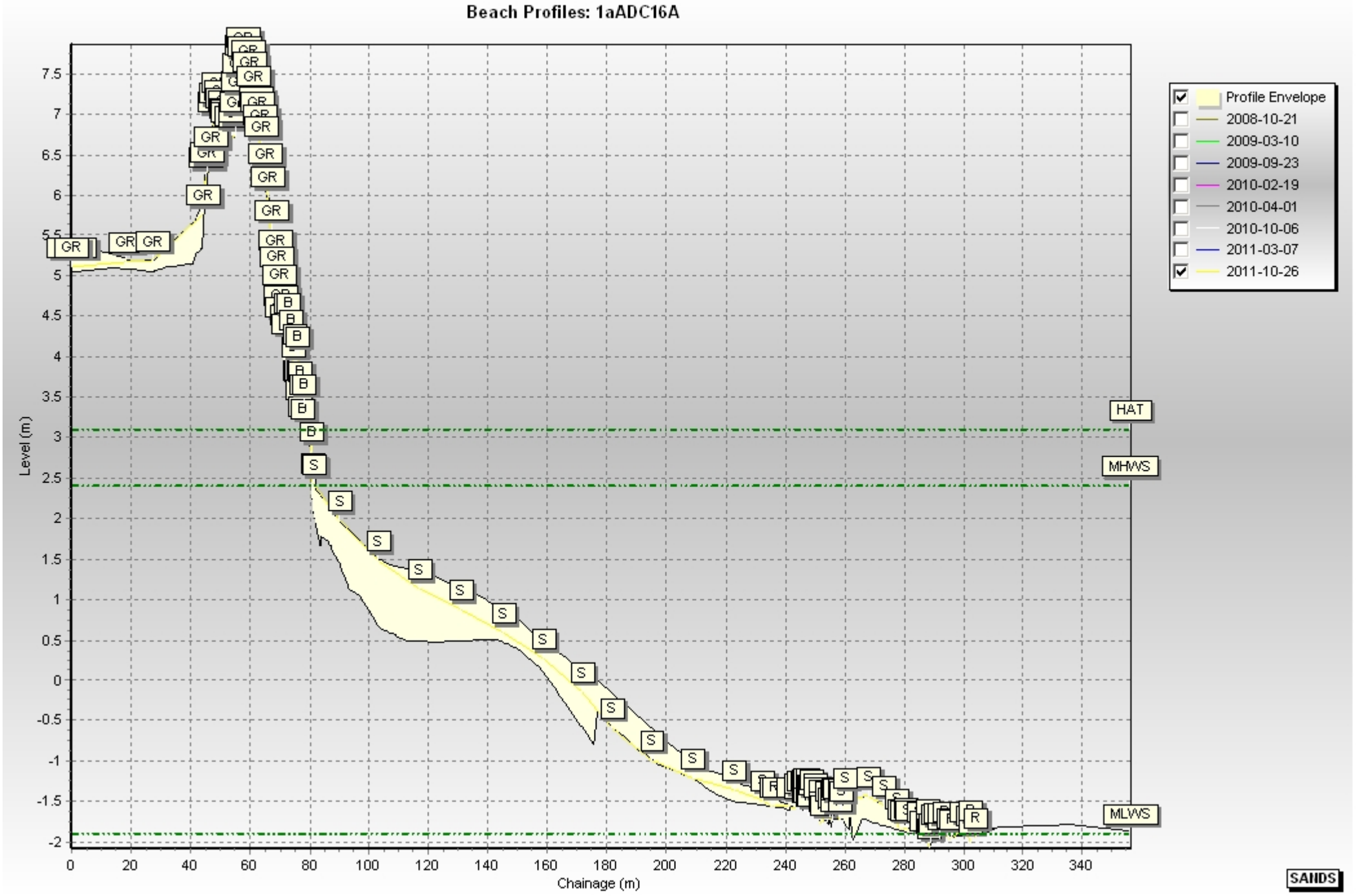
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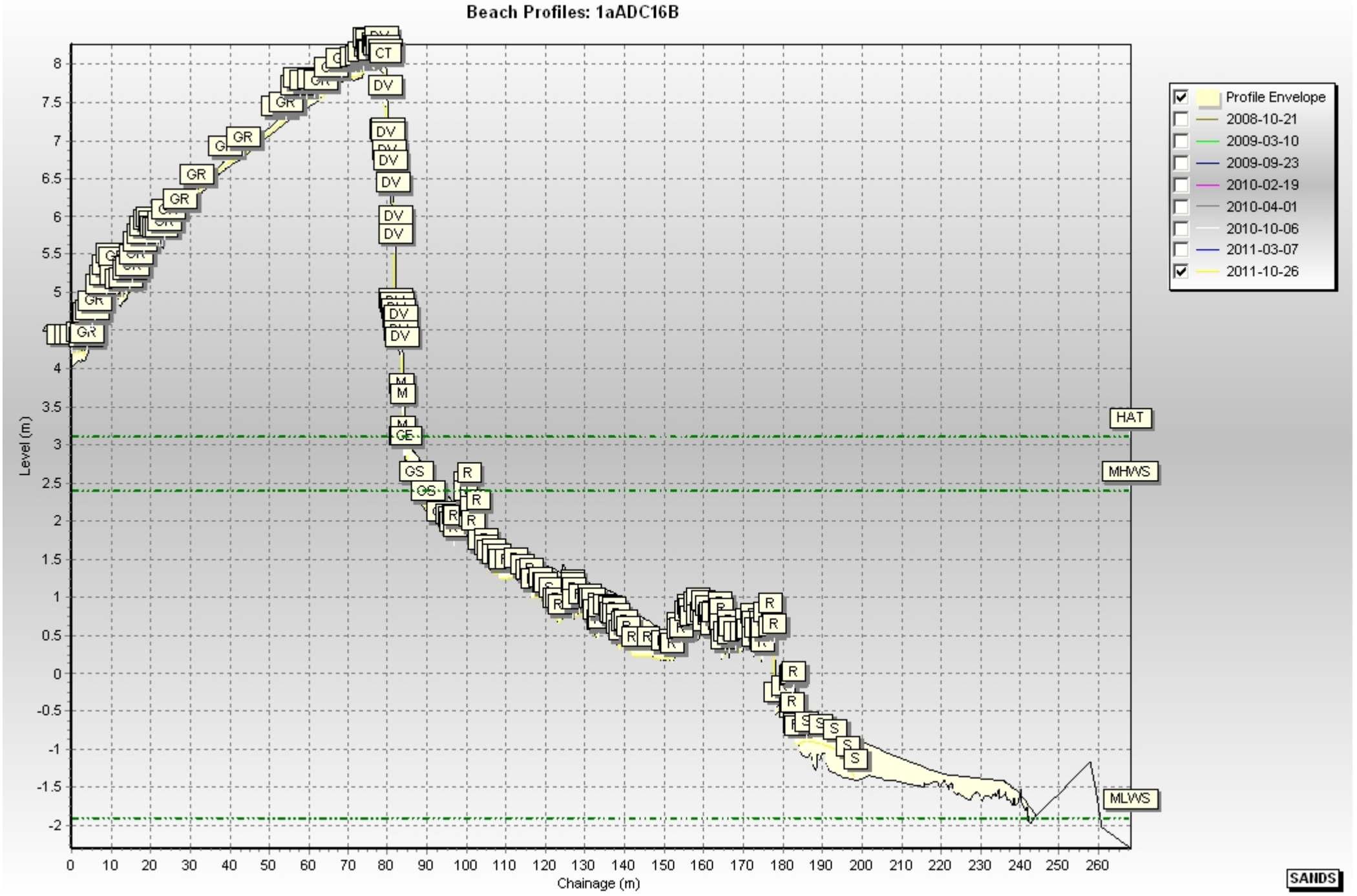
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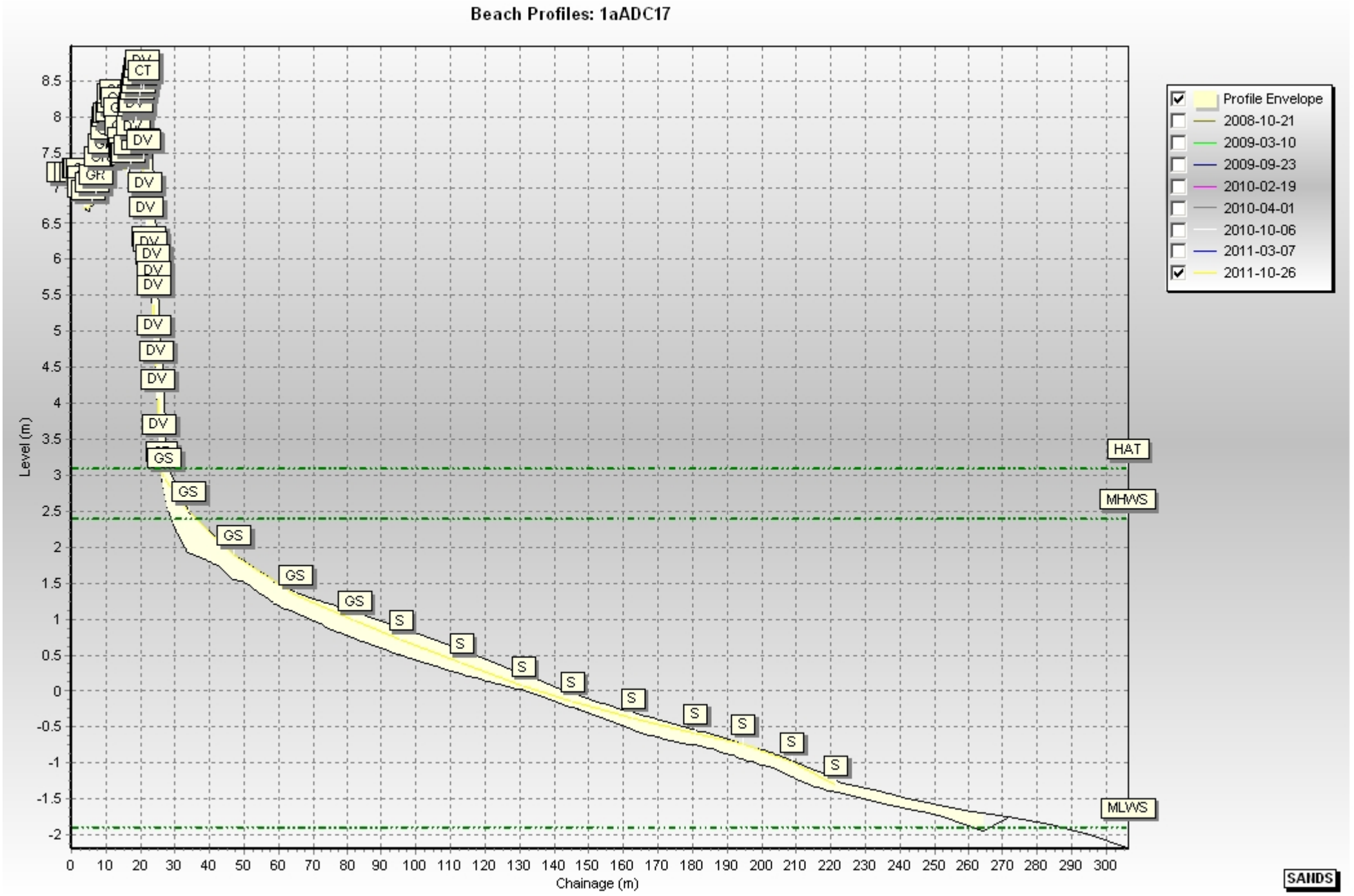
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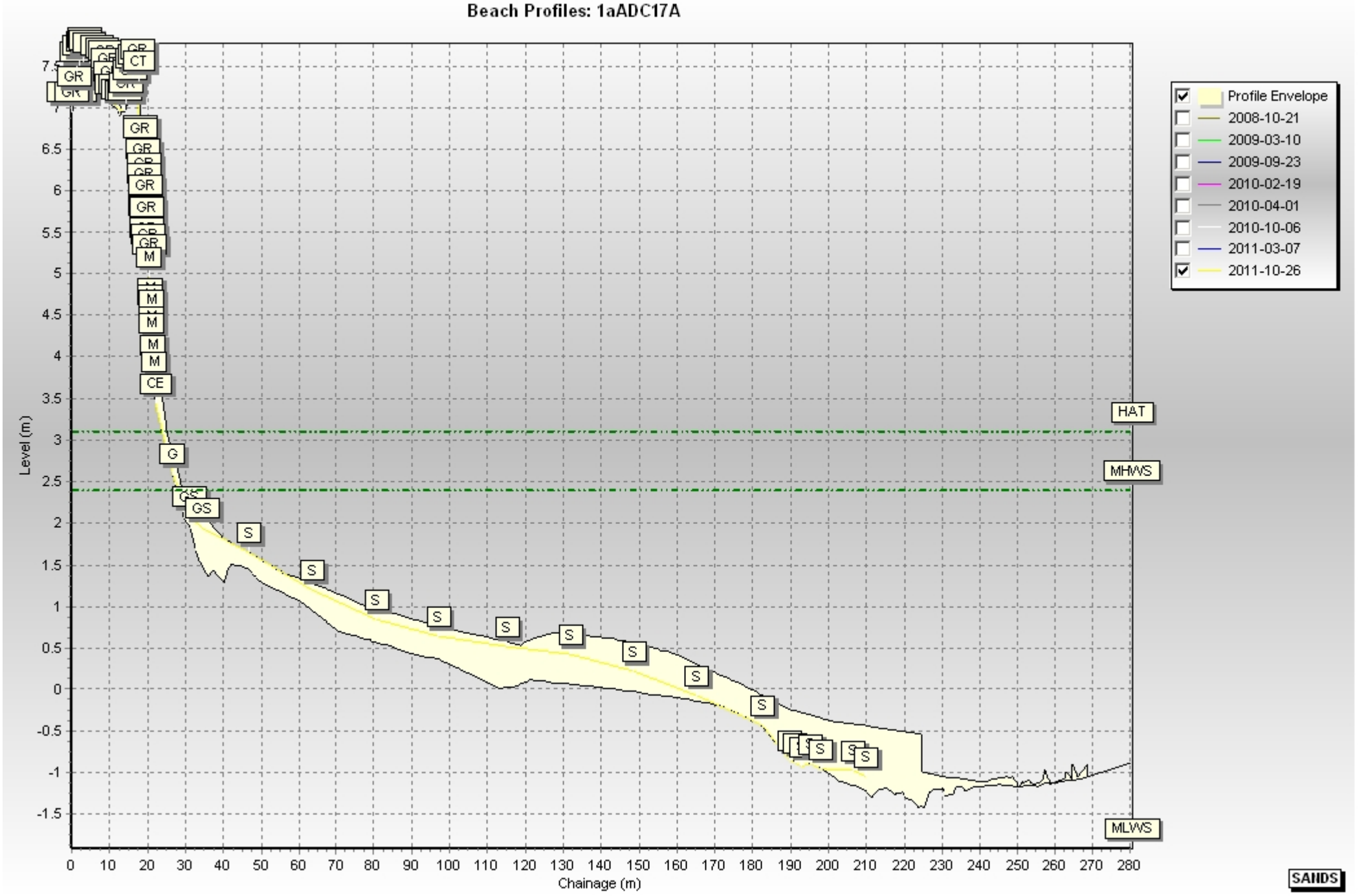
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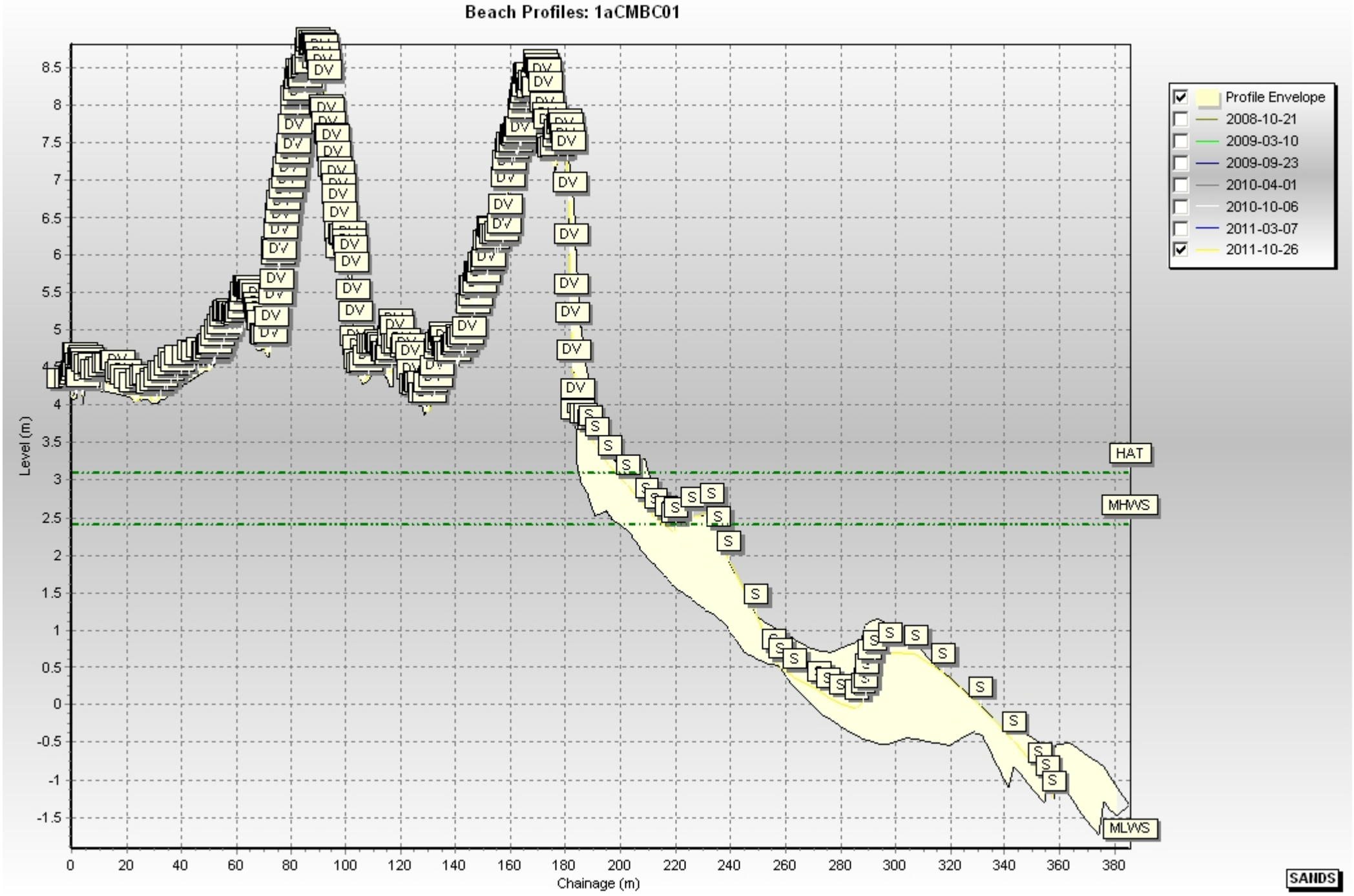
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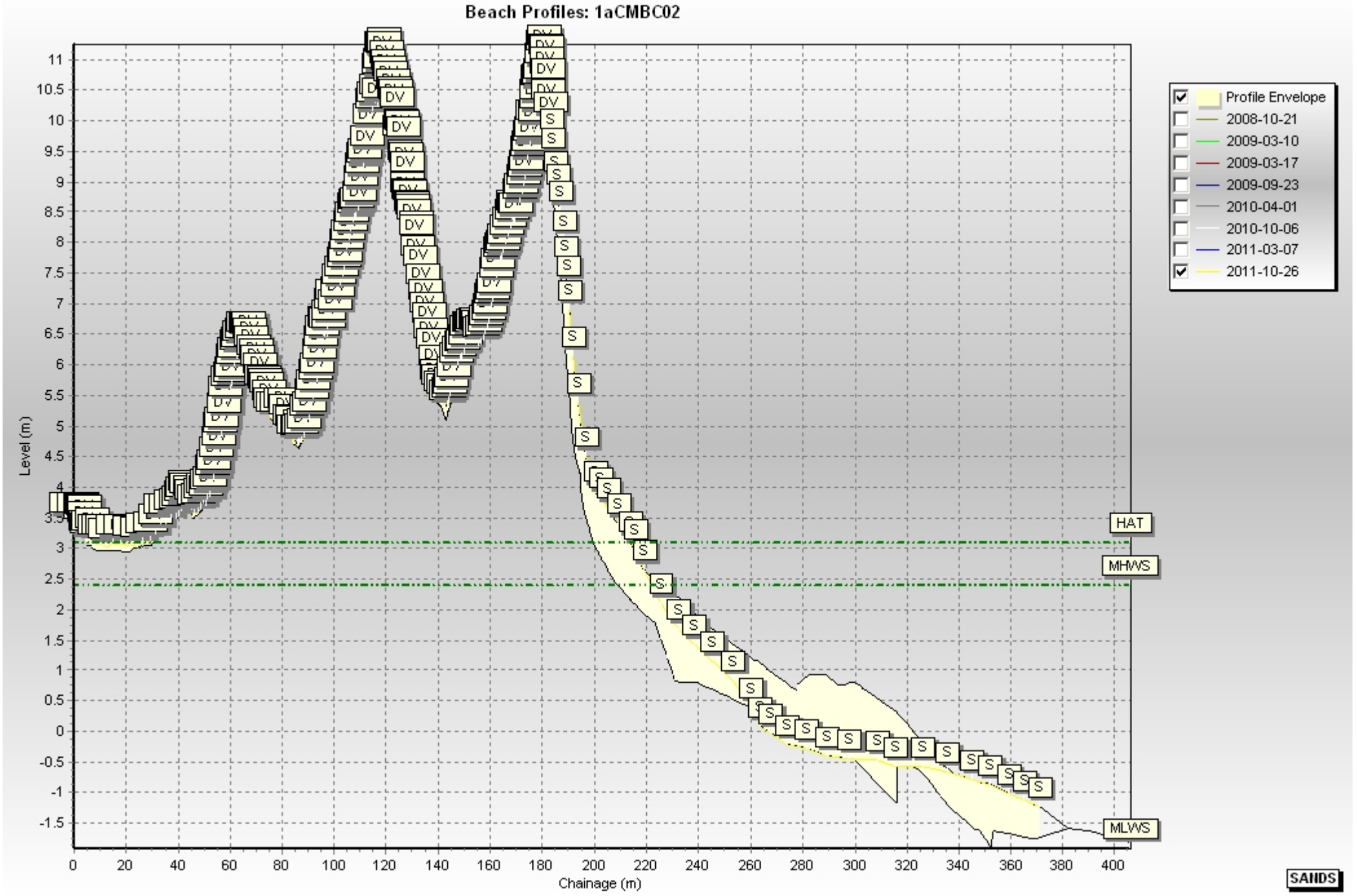
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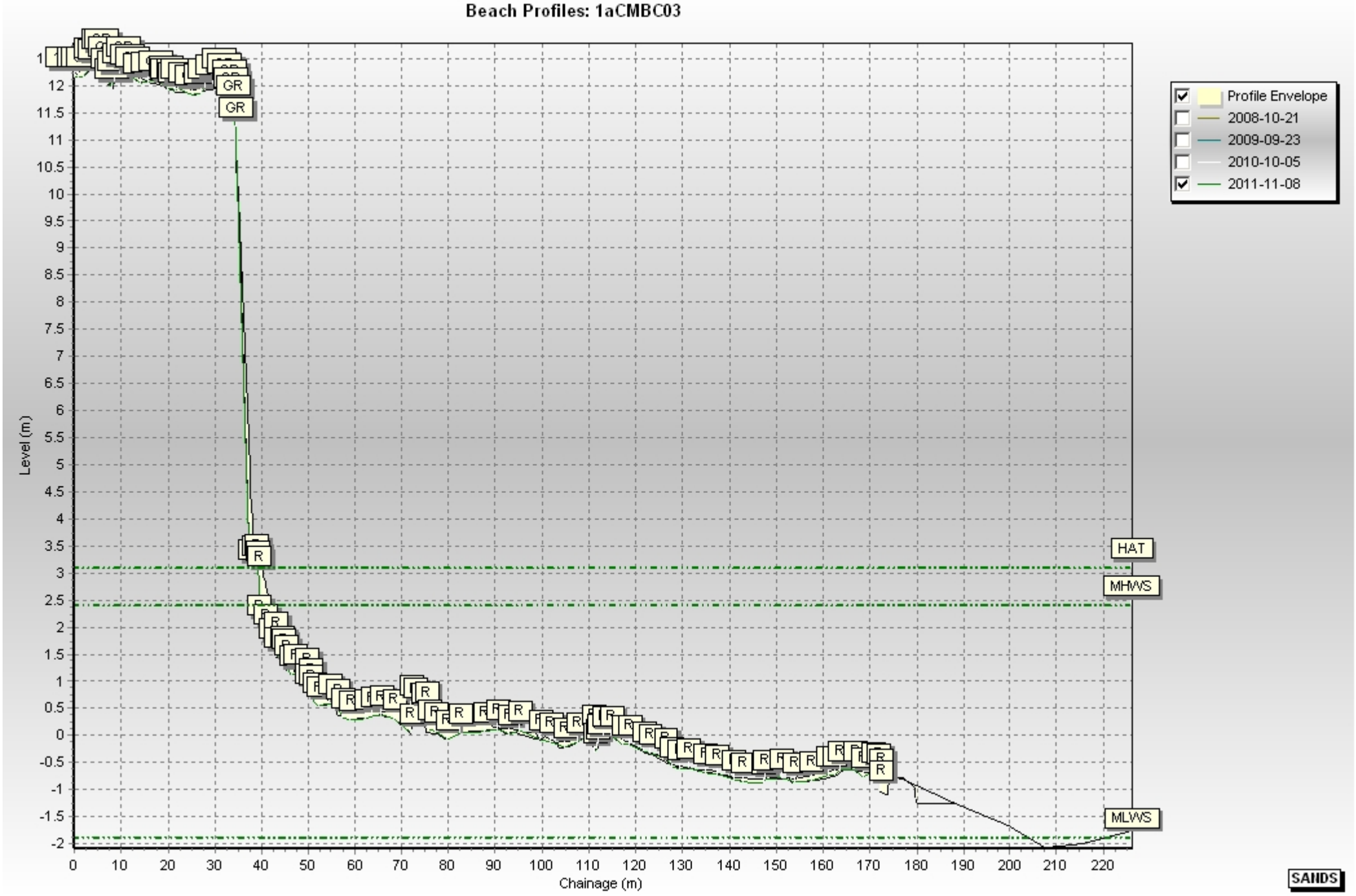
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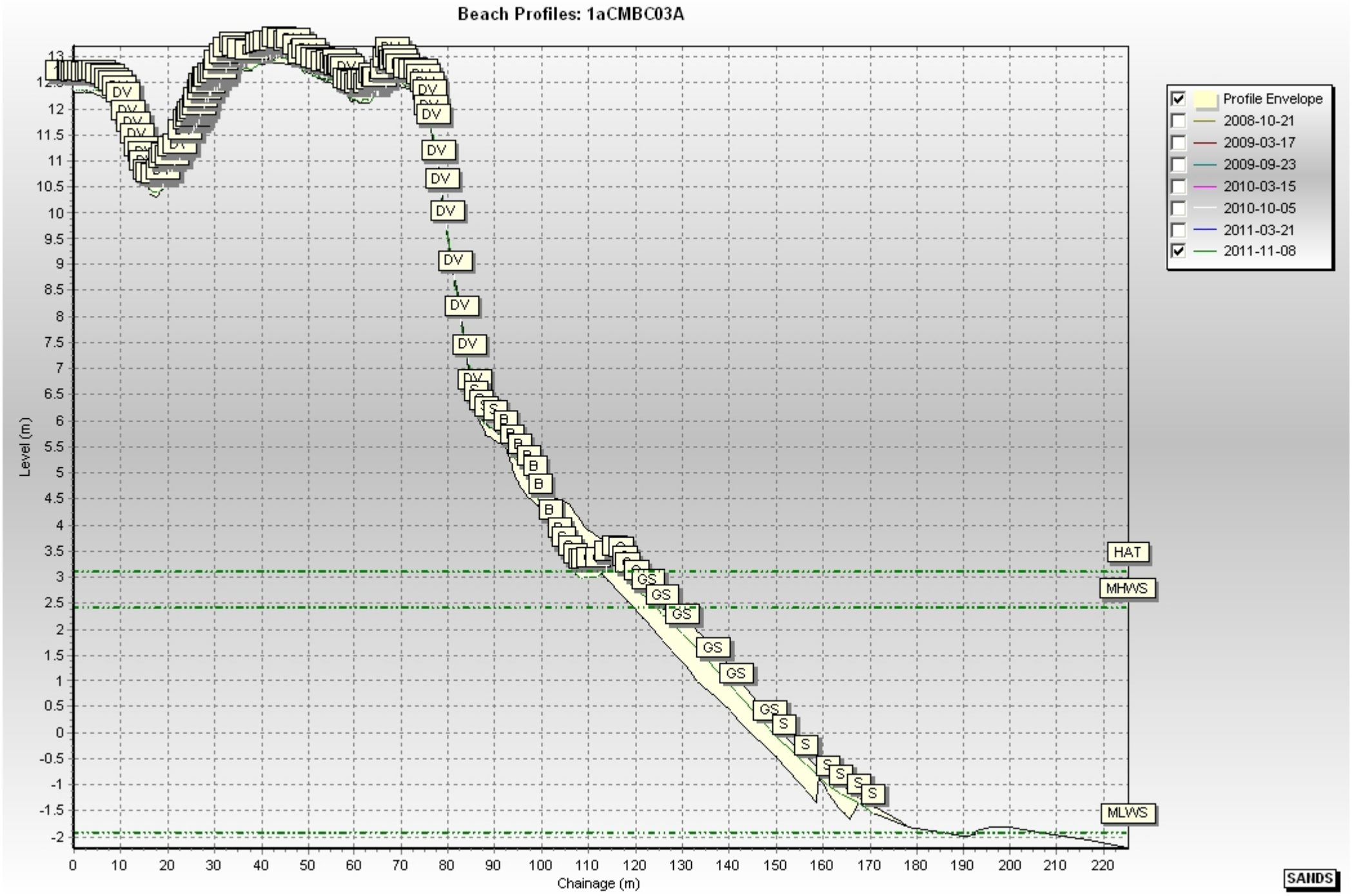
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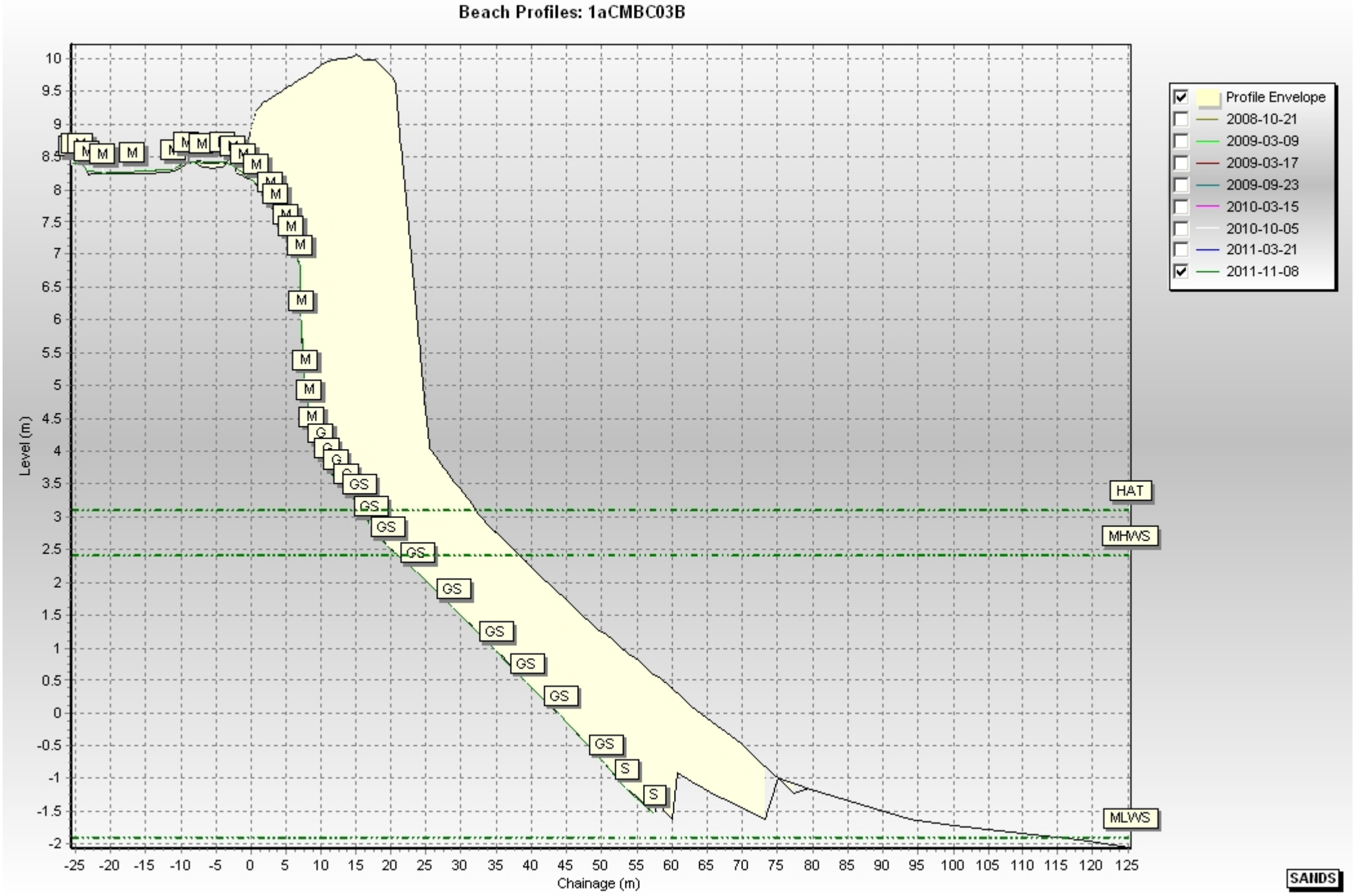
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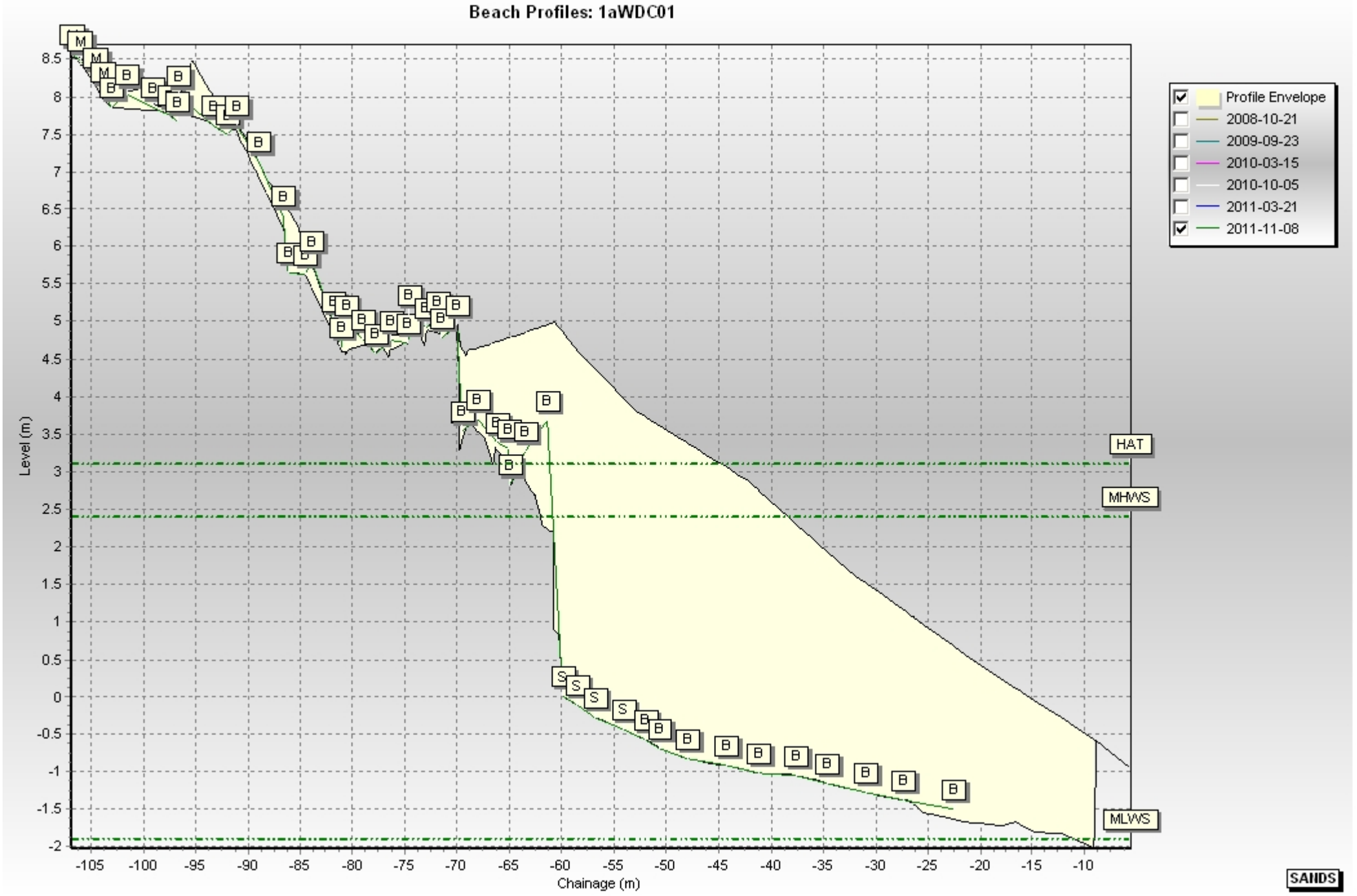
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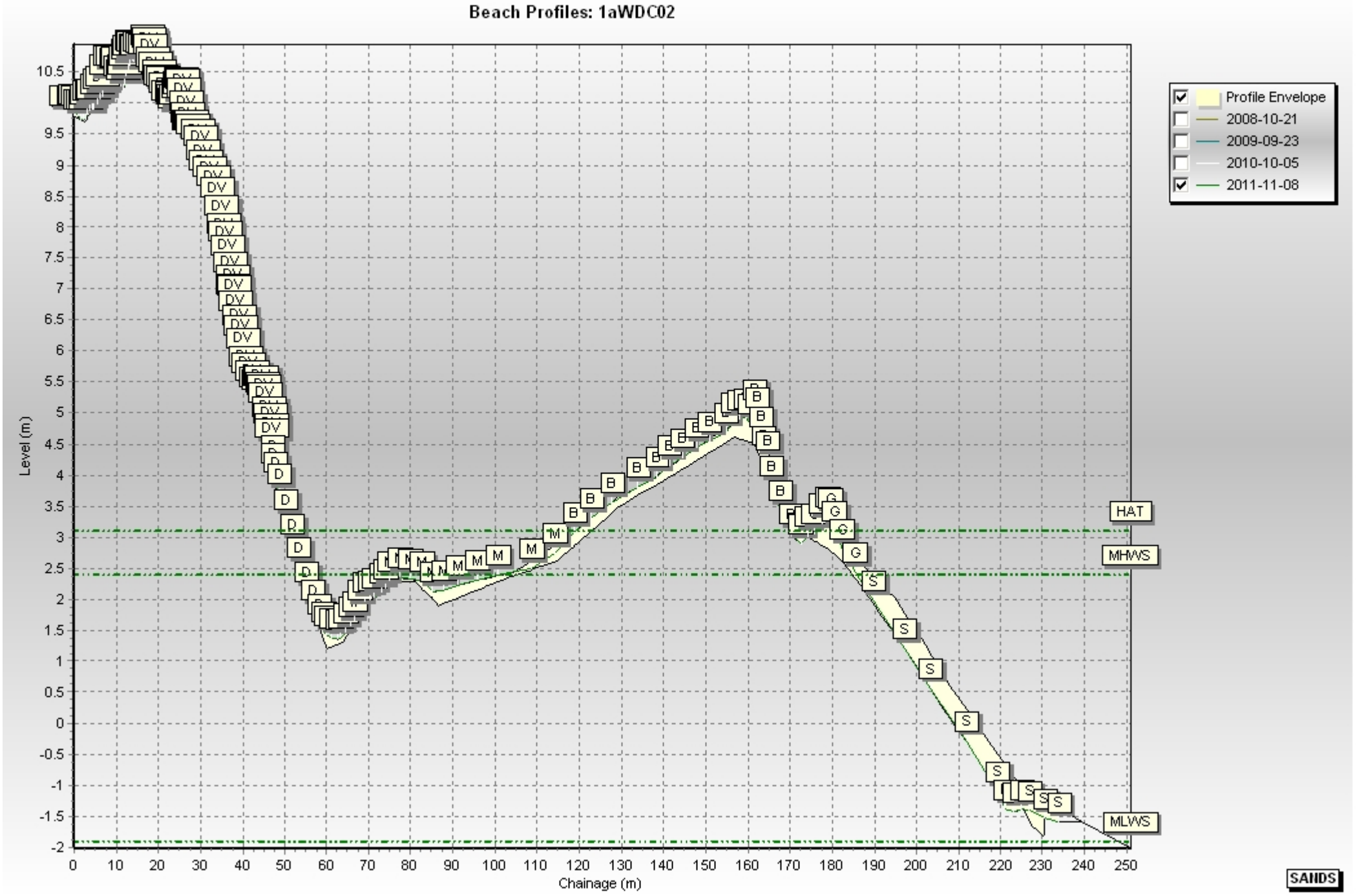
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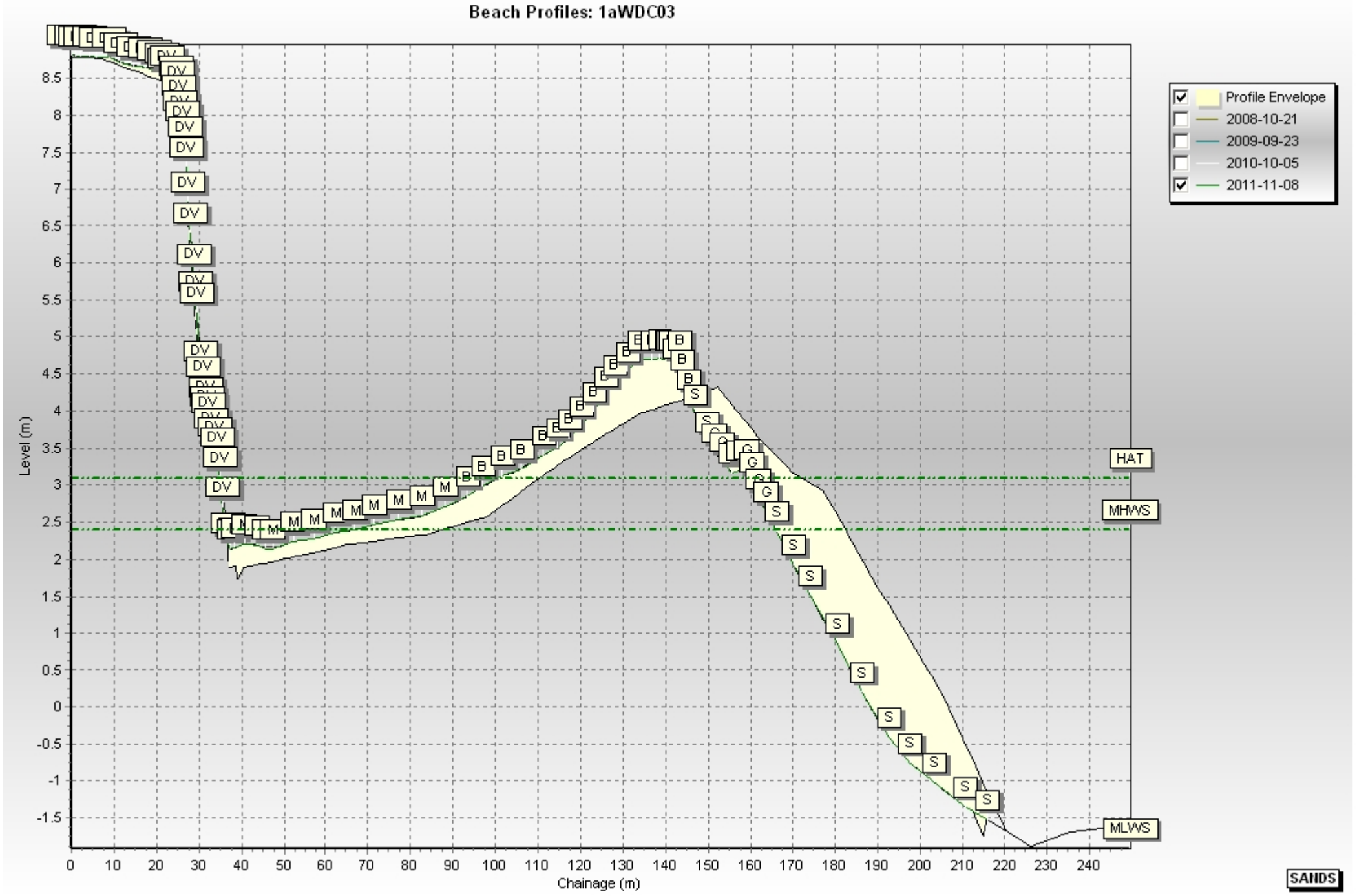
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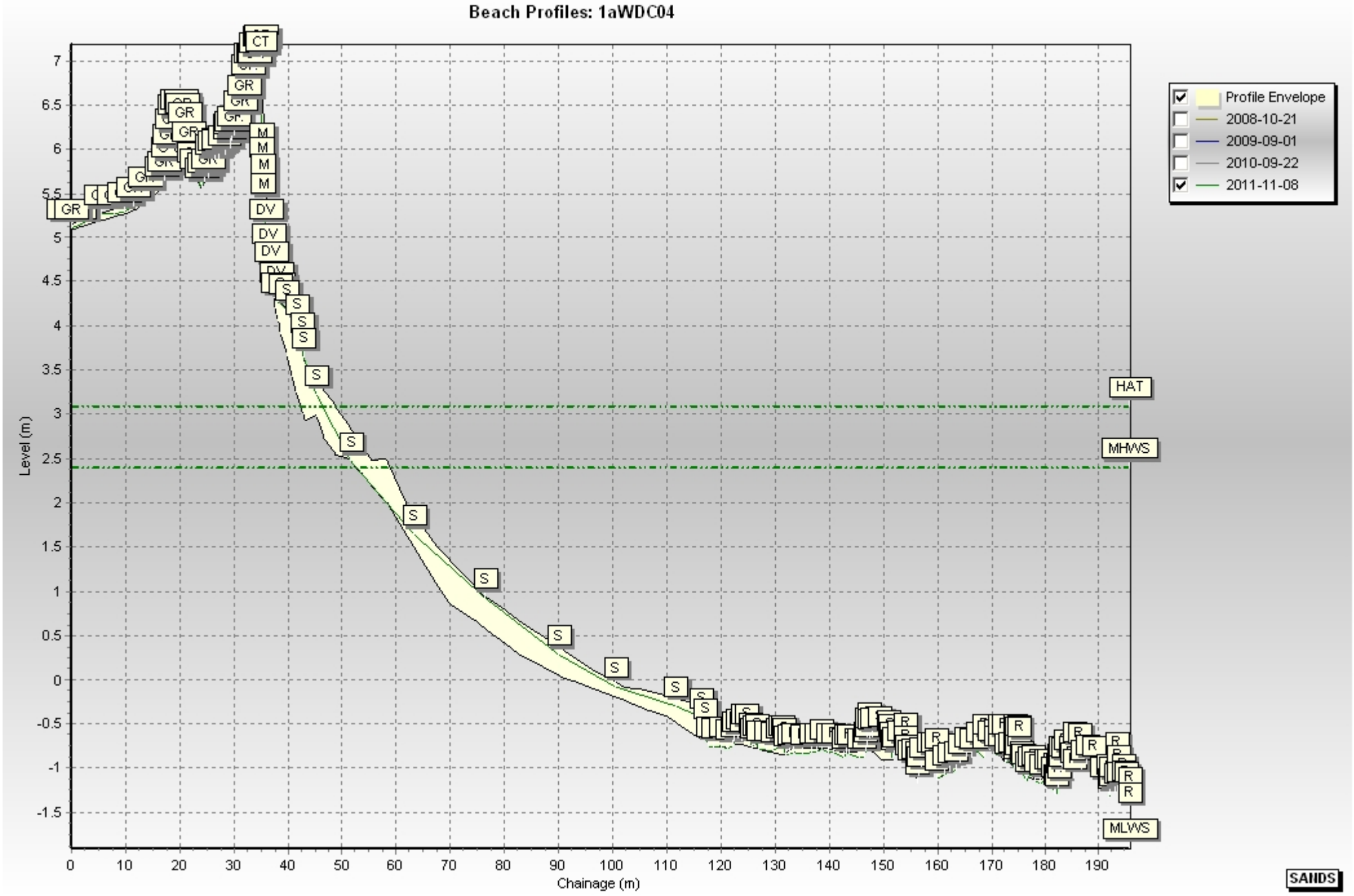
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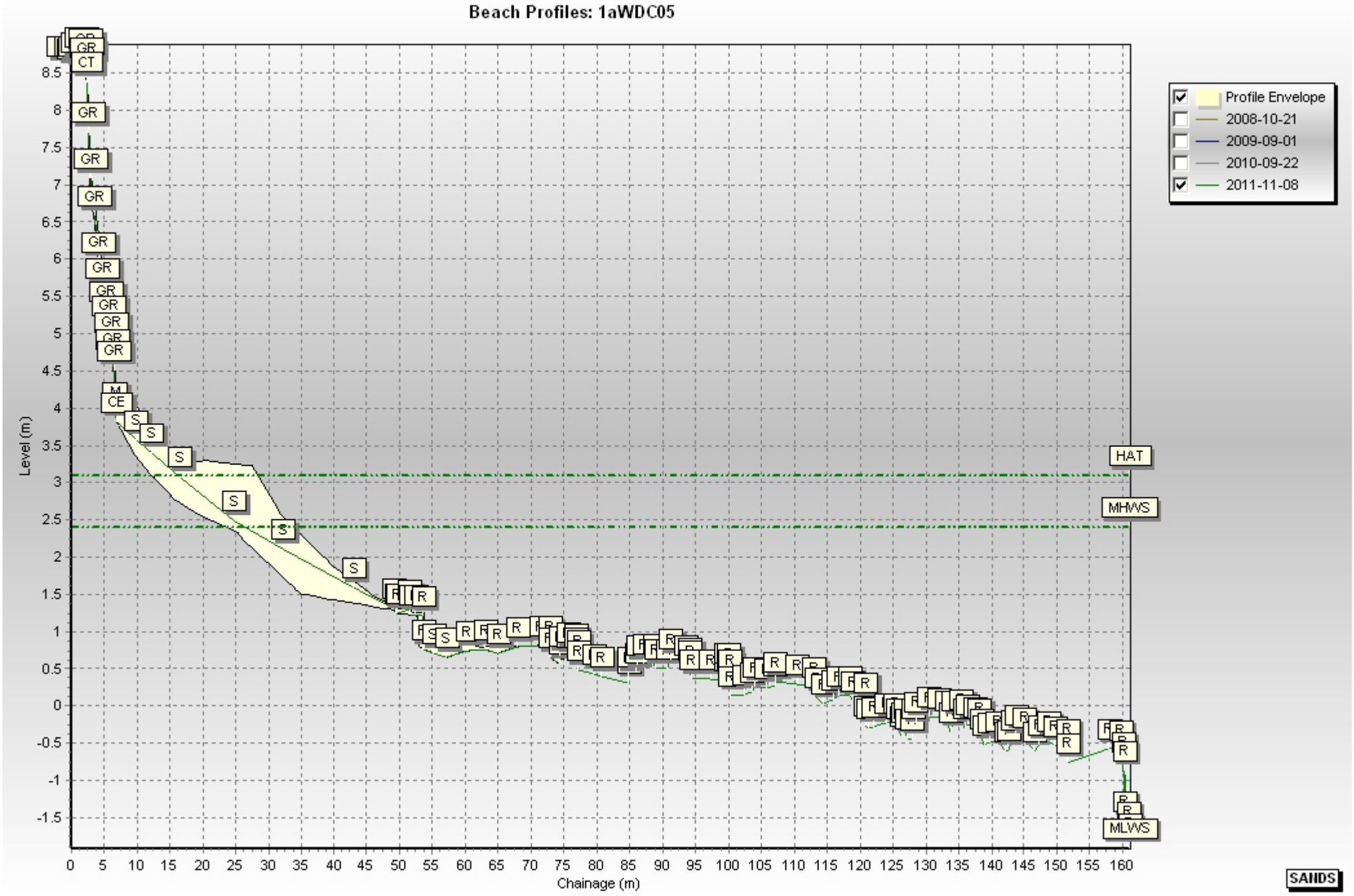
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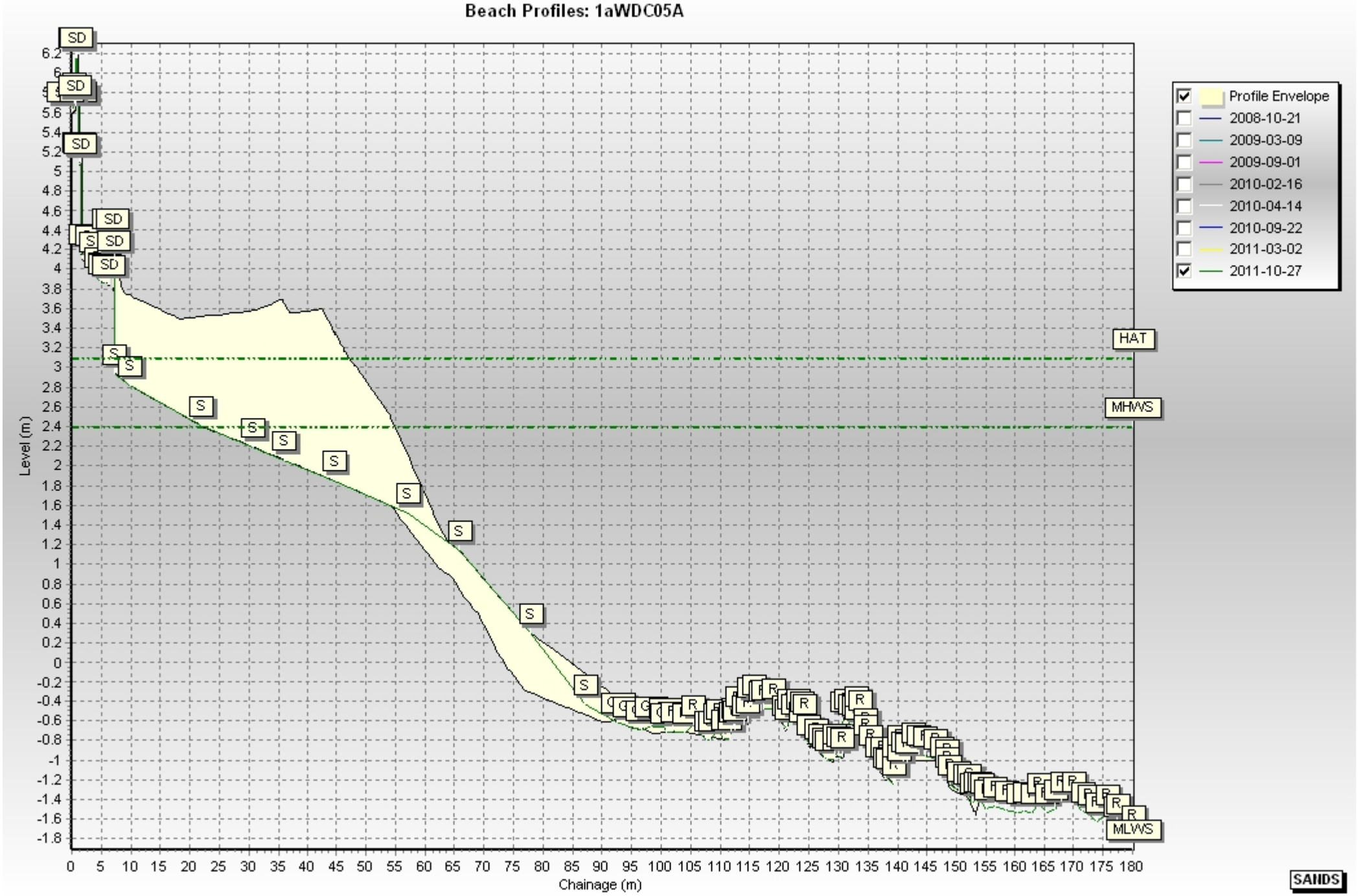
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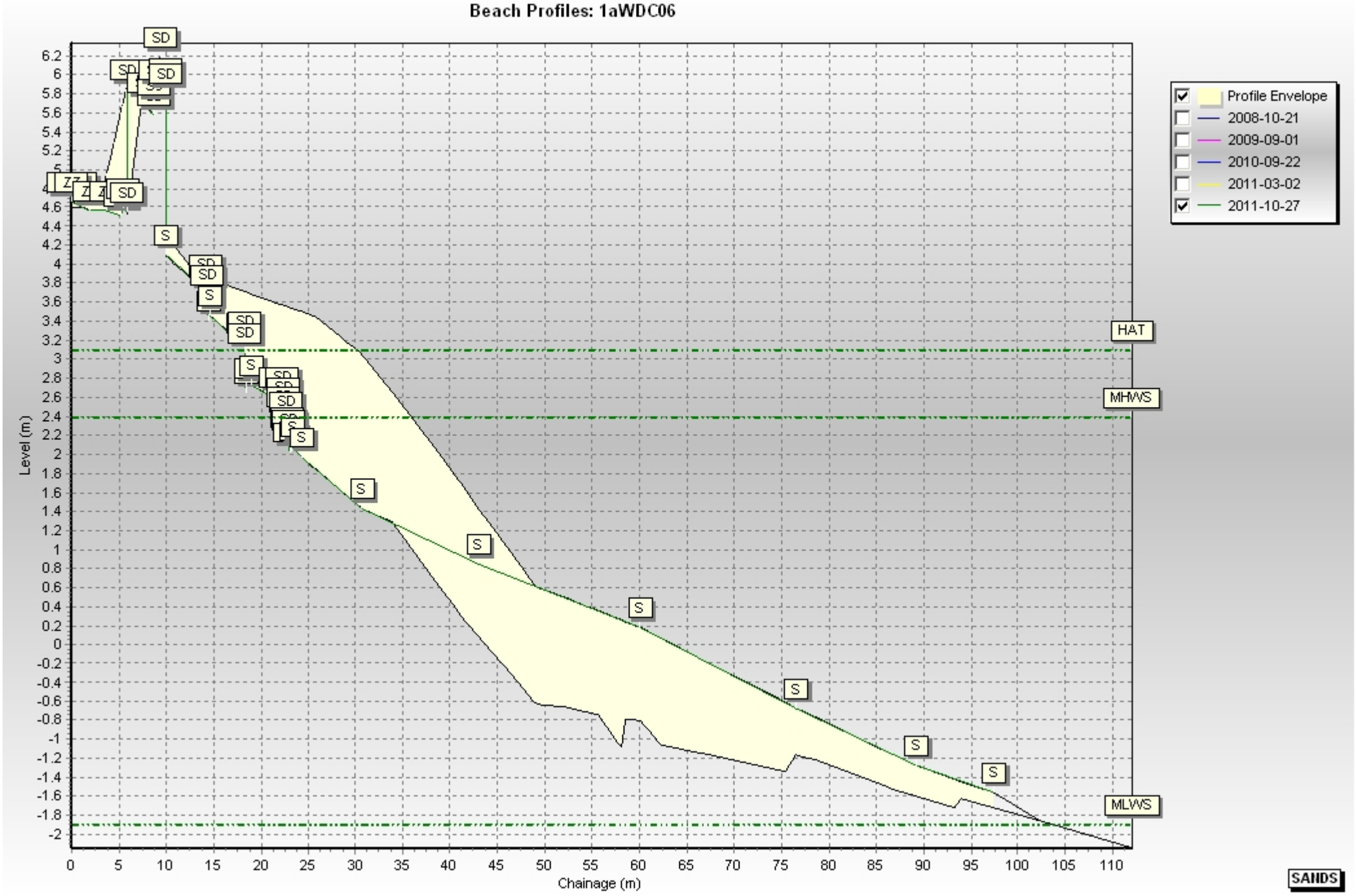
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Chainage (m)
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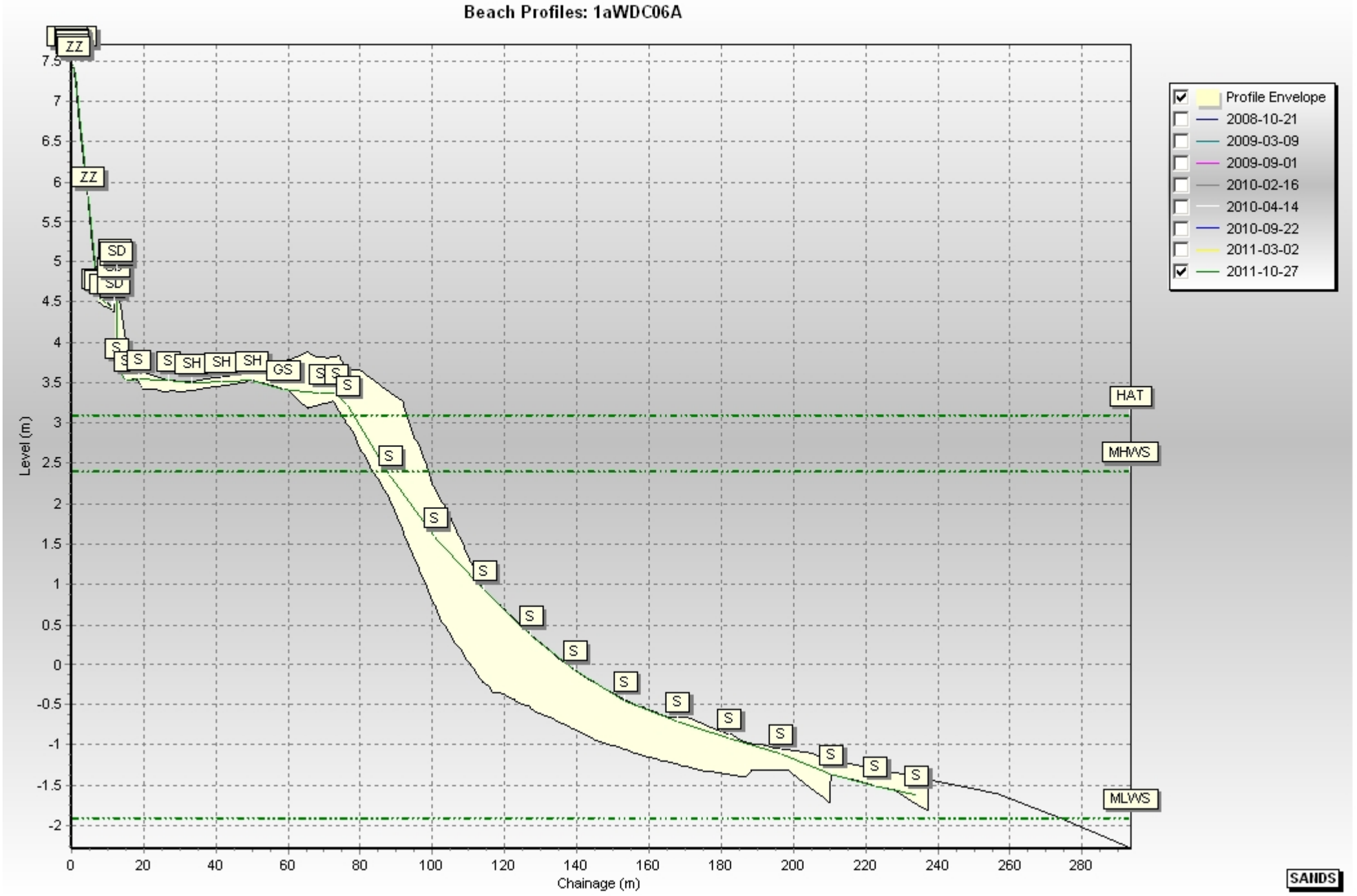
S
SANDS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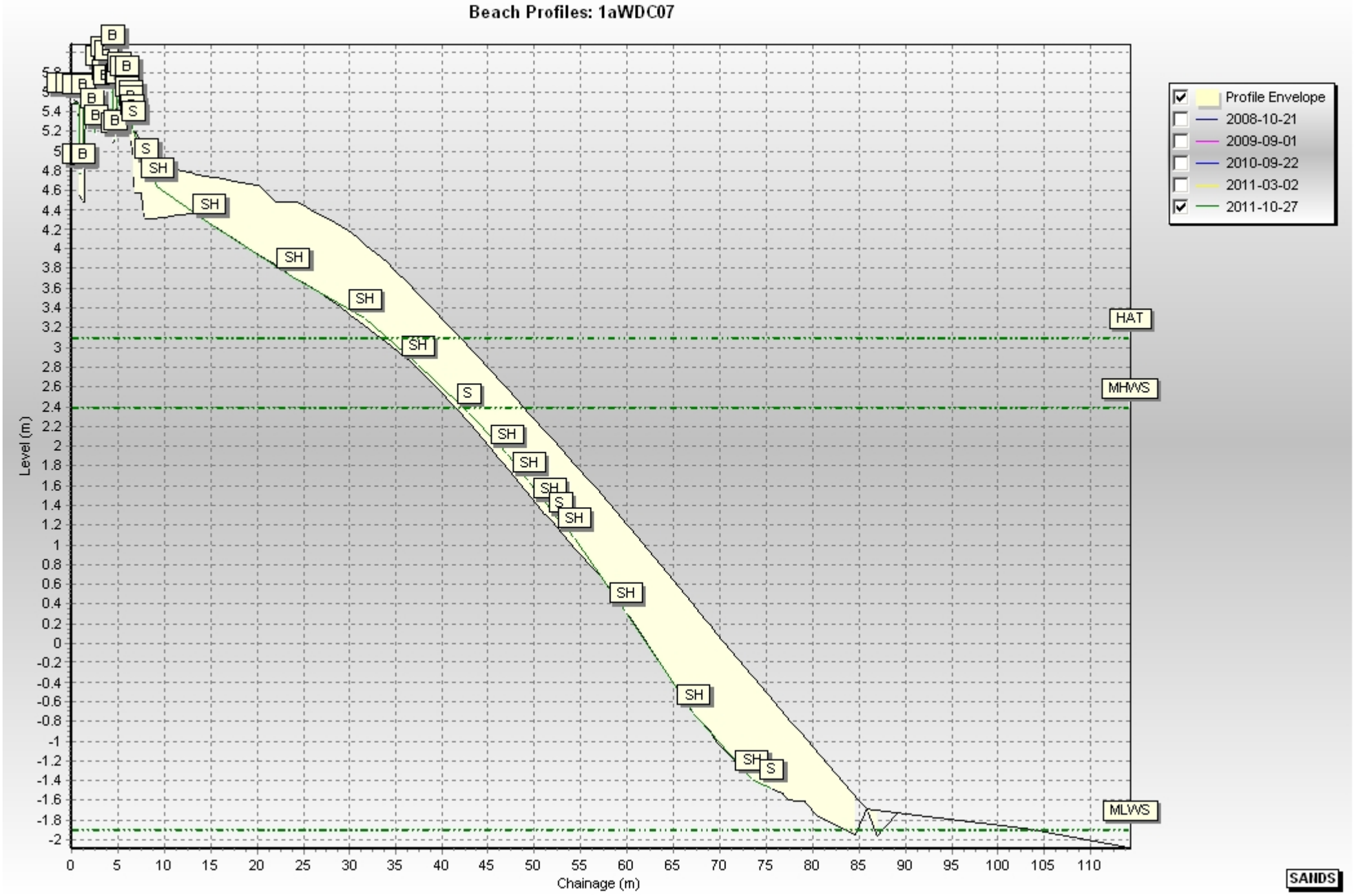
2009-03-09
2009-09-01
2010-02-16
2010-04-14
2010-09-22
2011-03-02
2011-10-27
HAT
MHWS
MLWS
Level (m)
Chainage (m)
ZZ
SD
S
SH
GS
SANDS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2010-09-22
2011-03-02
2011-10-27
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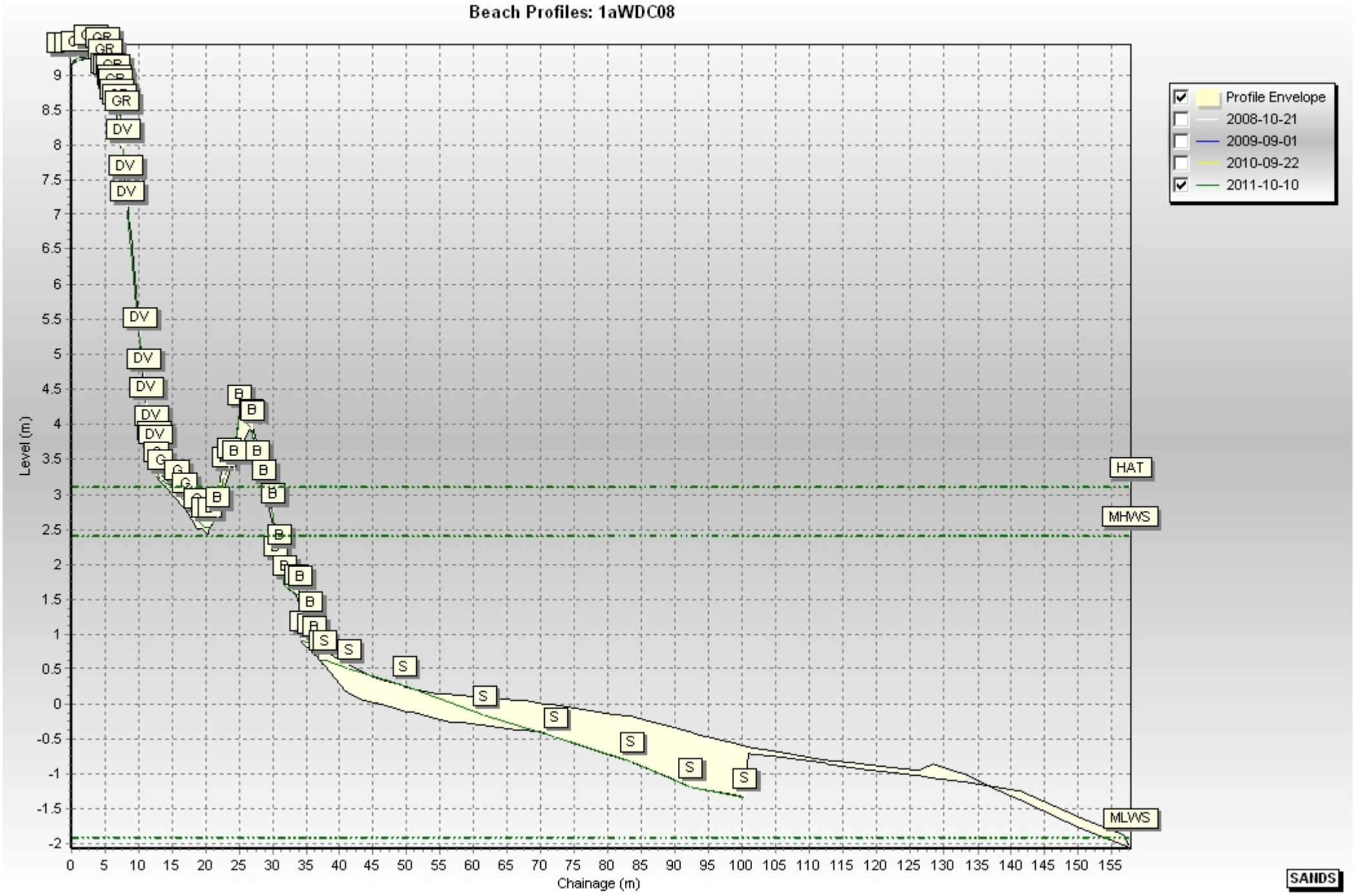
MLWS
Level (m)
Chainage (m)
SANDS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2010-09-22
2011-10-10
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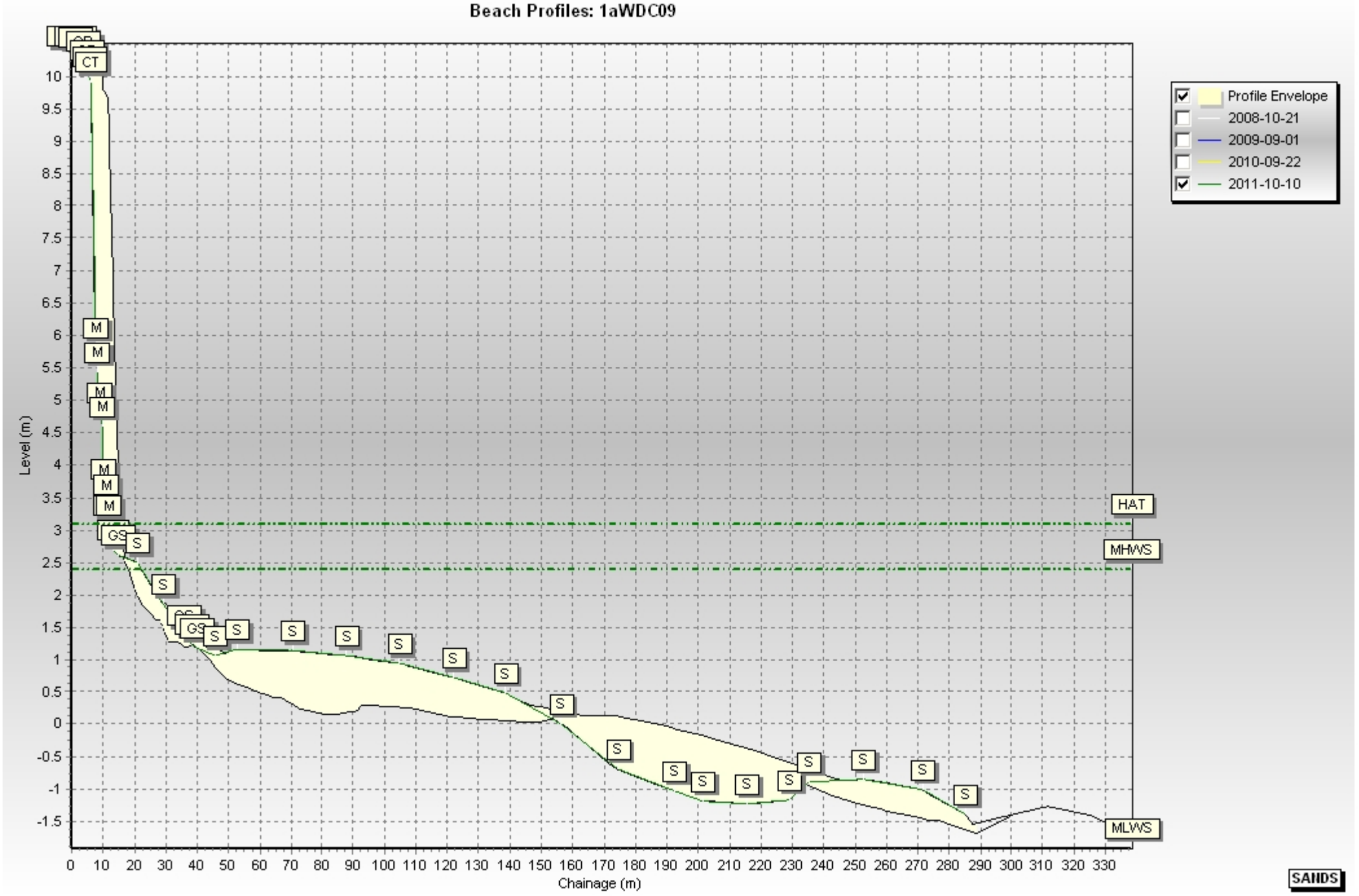
MHWS
MLWS
Level (m)
Chainage (m)
SANDS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2010-09-22
2011-10-10
Level (m)
Chainage (m)
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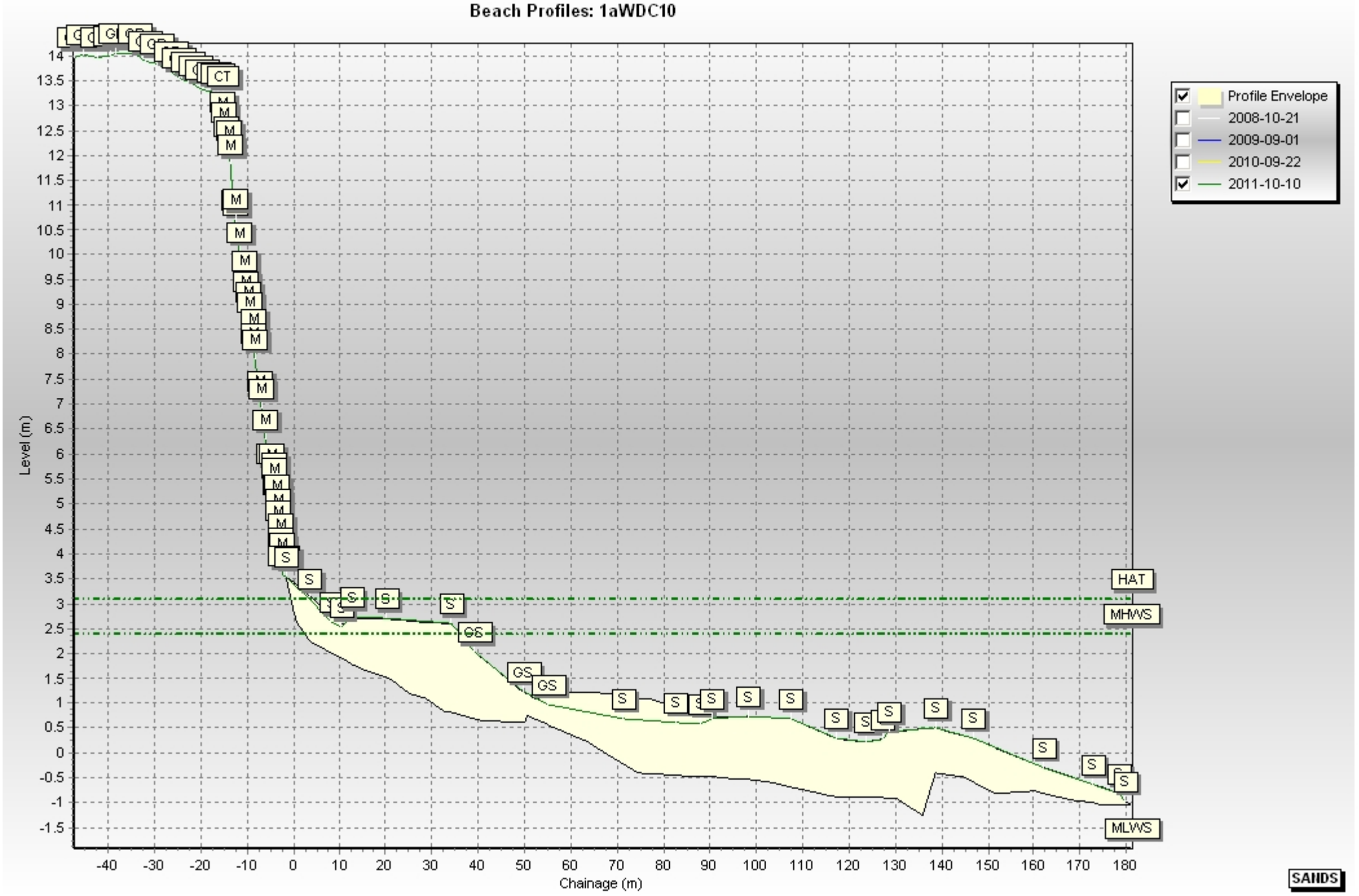
MHWS
MLWS
CT
M
GS
S
SANDS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Profile Envelope
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2011-10-10
Level (m)
Chainage (m)
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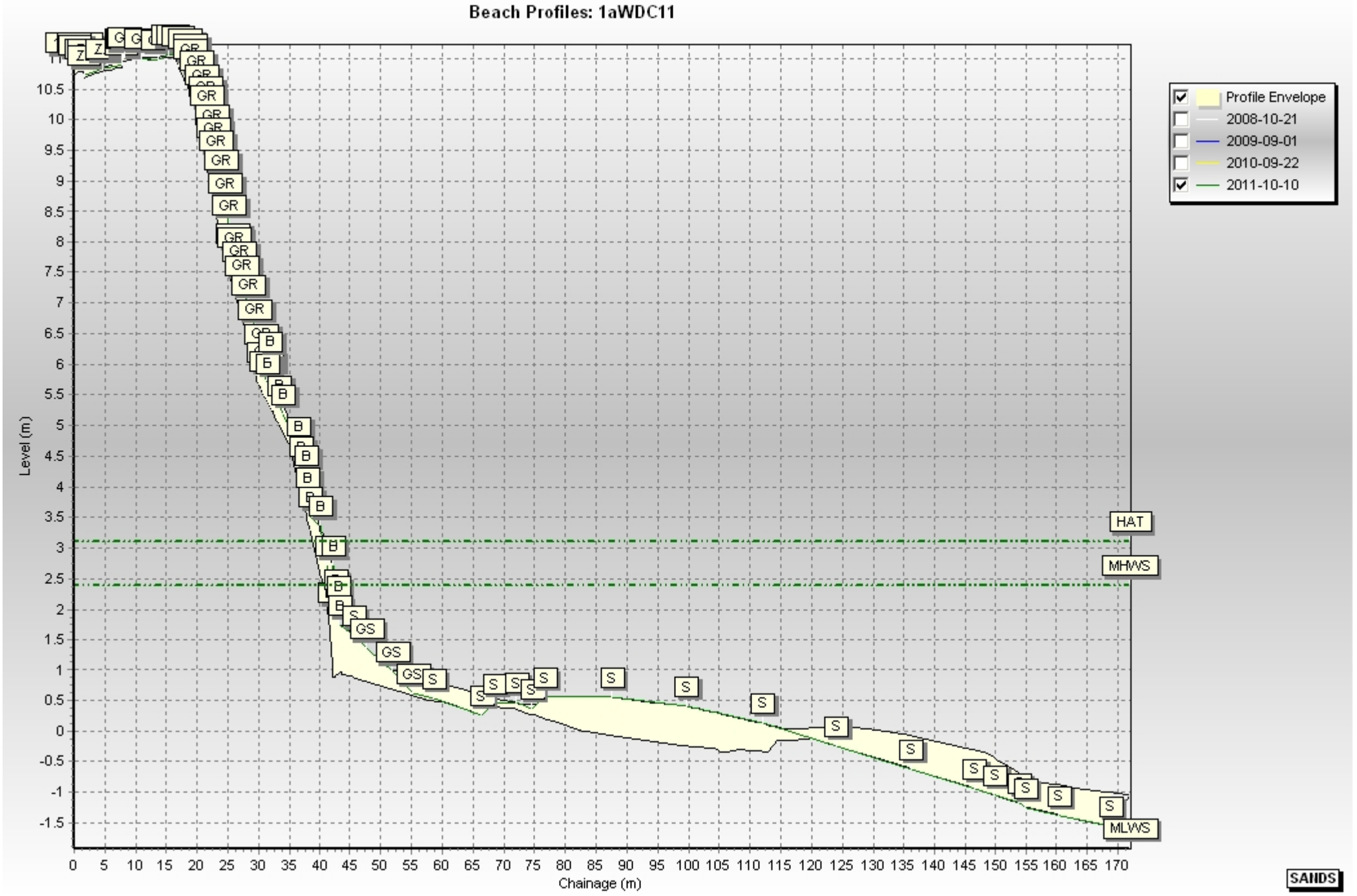
MHWS
MLWS
SANDS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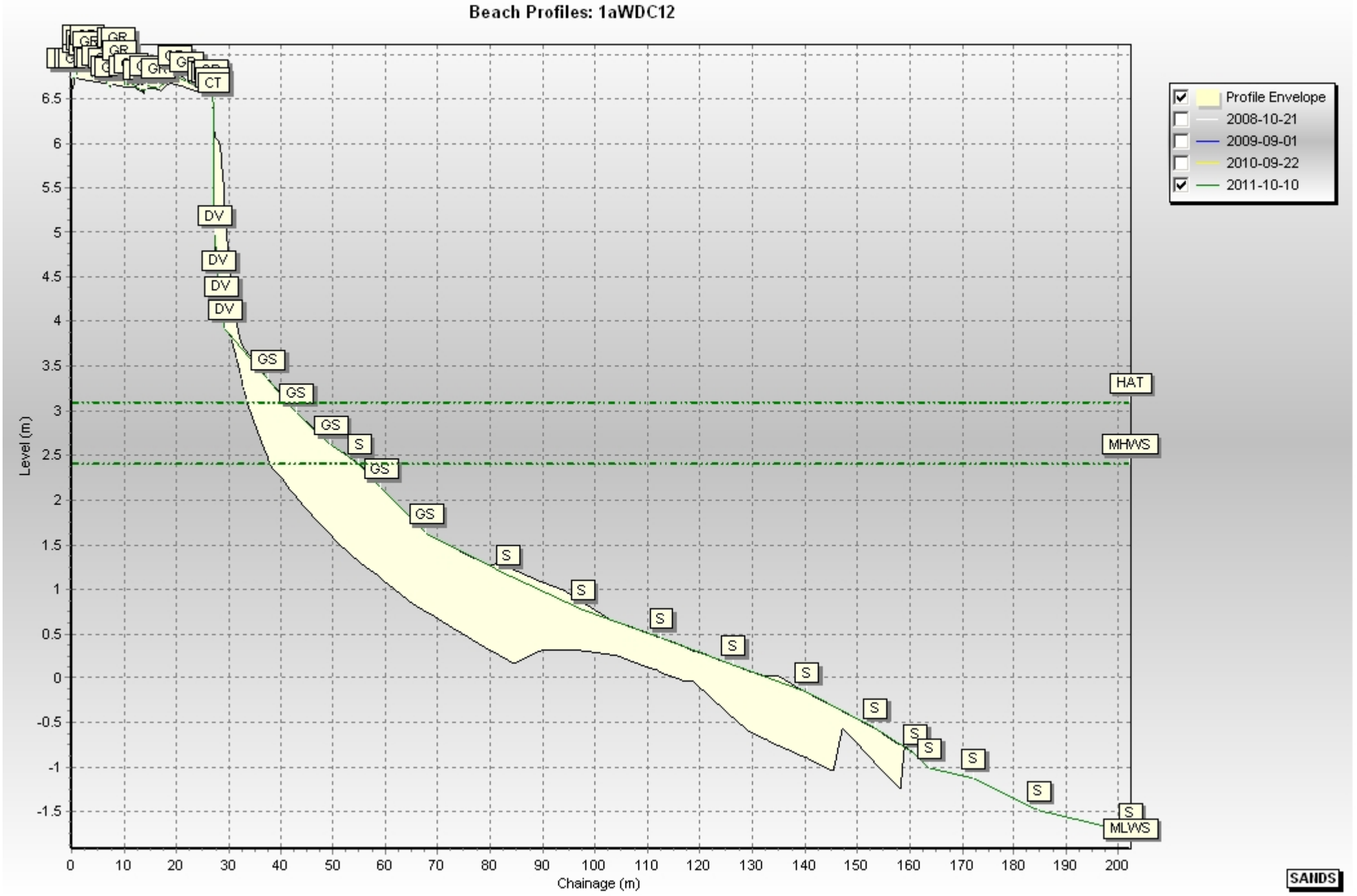
2010-09-22
2011-10-10
HAT
MHWS
MLWS
Level (m)
Chainage (m)
SANDS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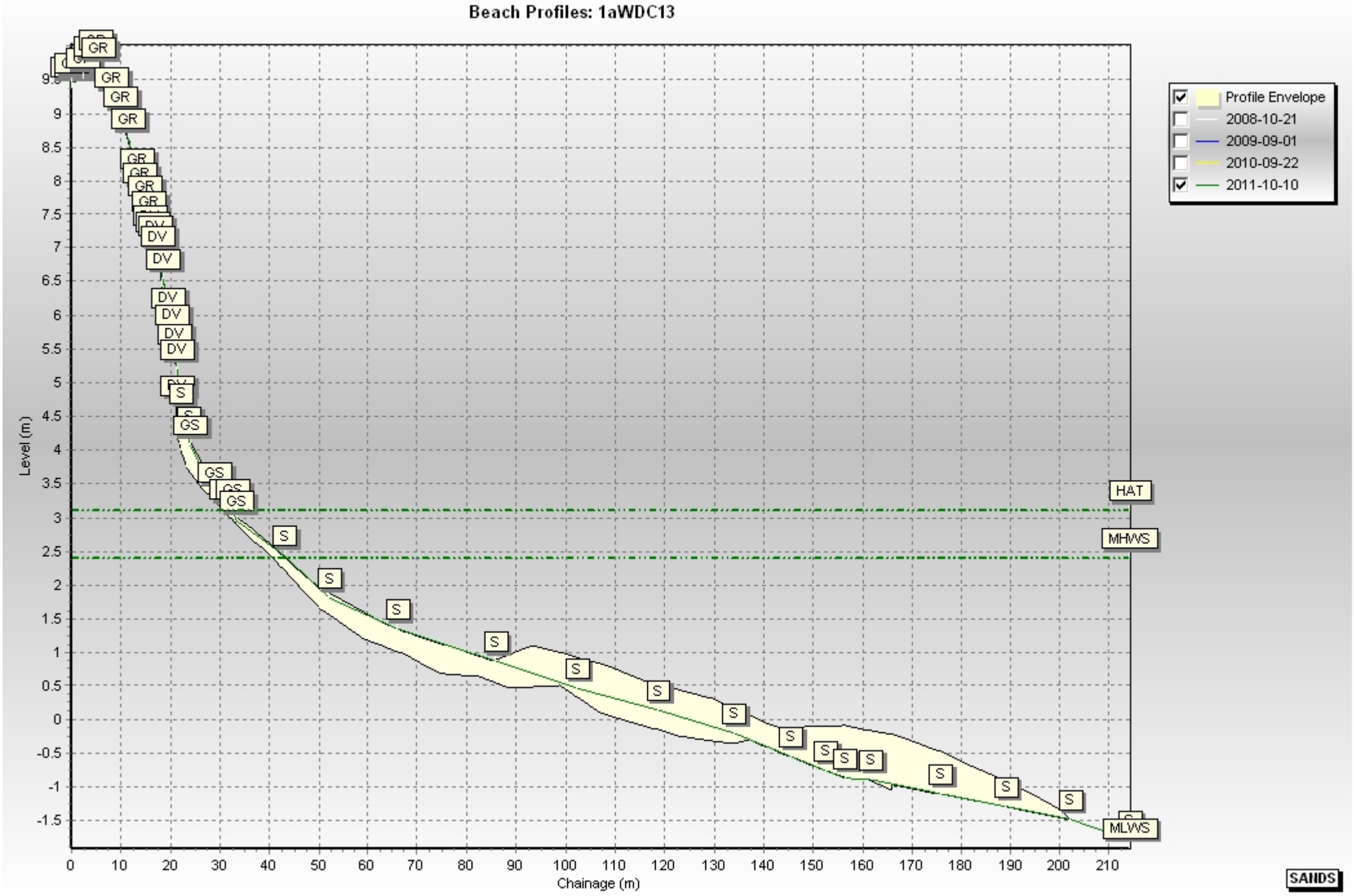
2009-09-01
2010-09-22
2011-10-10
CT
DV
DV
DV
DV
GS
GS
GS
S
GS
GS
S
S
S
S
S
S
S
S
S
S
HAT
MHWS
MLWS
Level (m)
Chainage (m)
SANDS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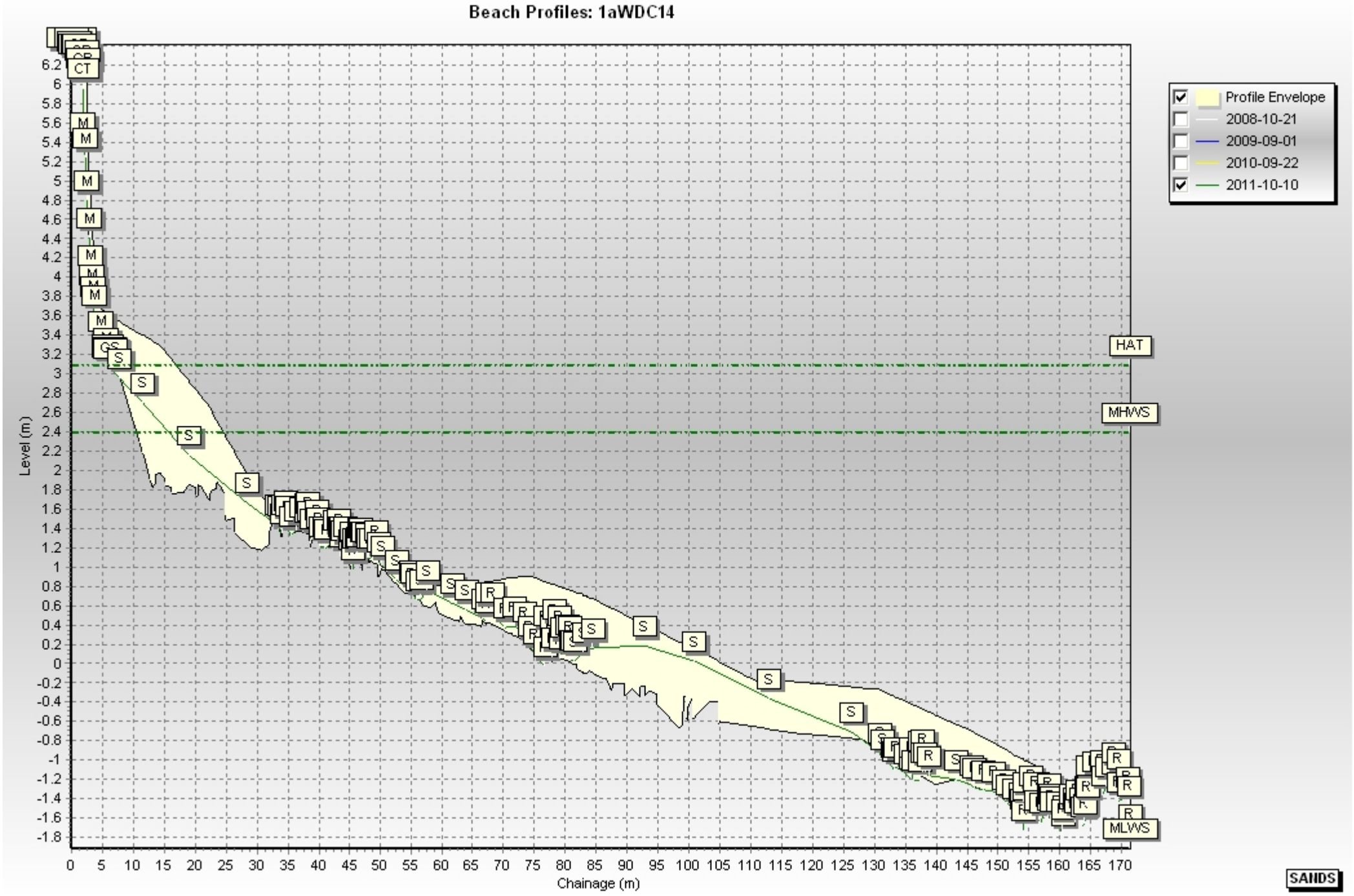
2011-10-10
HAT
MHWS
MLWS
Level (m)
Chainage (m)
SANDS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2010-09-22
2011-10-10
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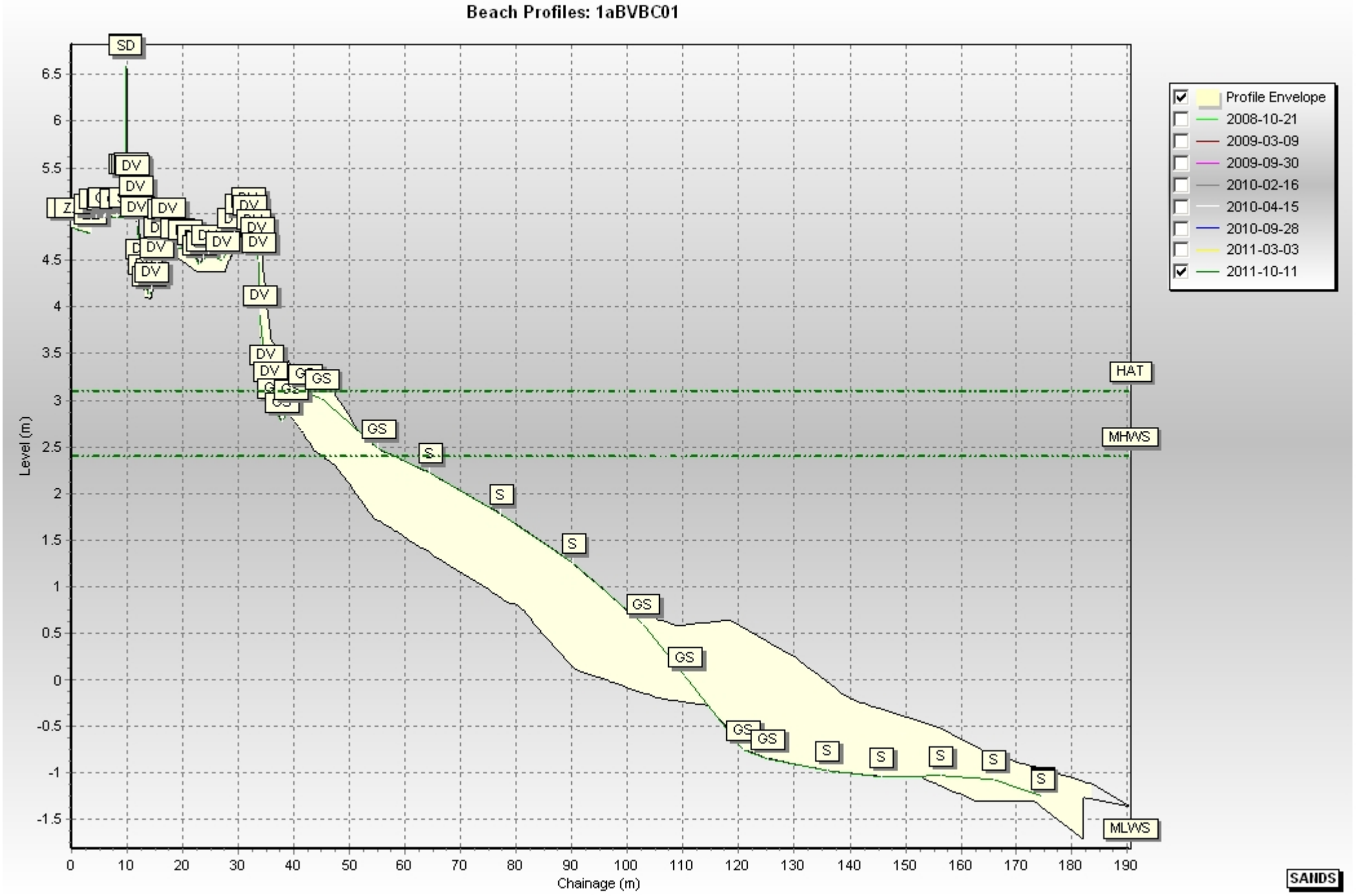
MHWS
MLWS
Level (m)
Chainage (m)
SANDS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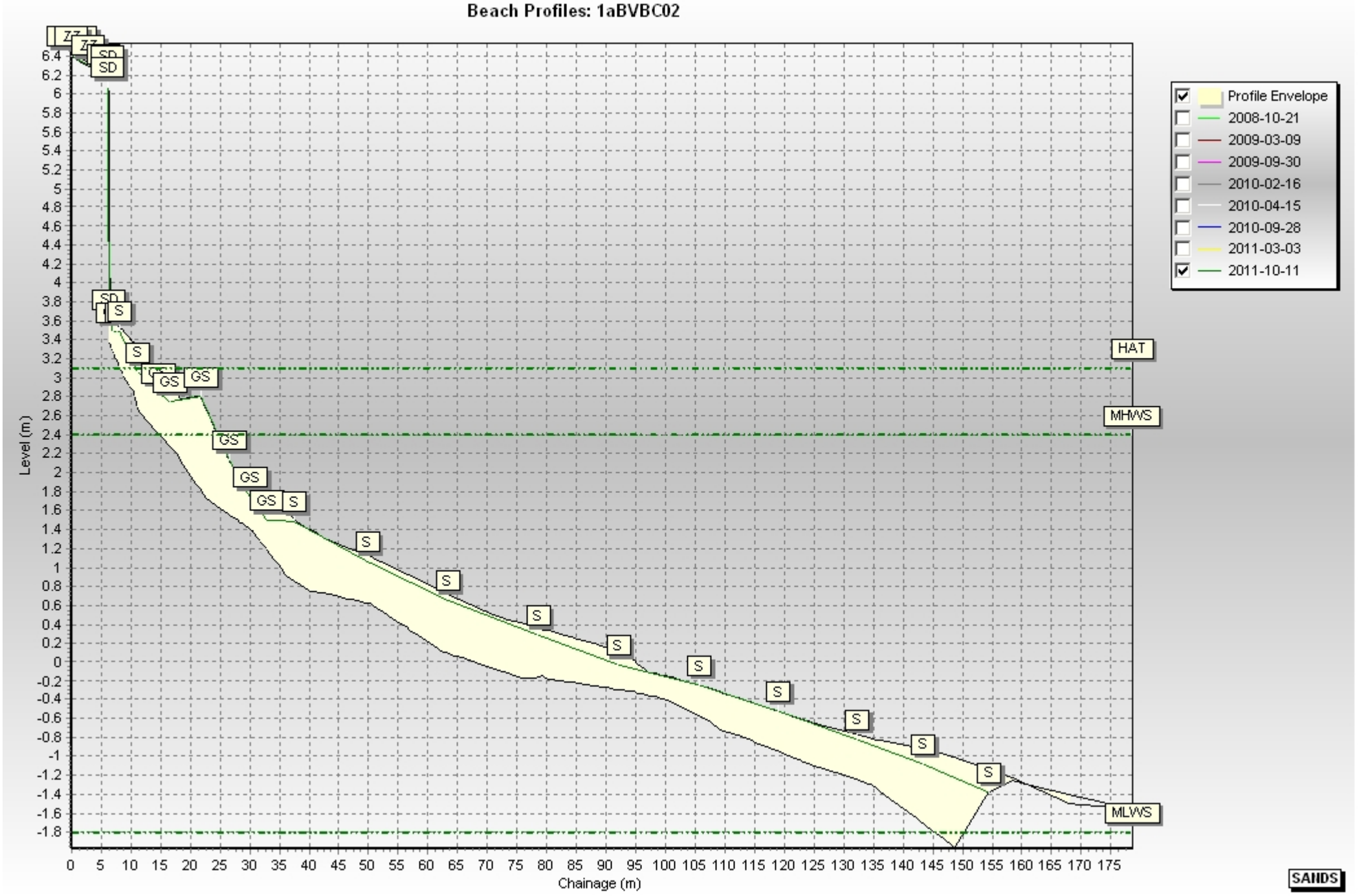
Profile Envelope
2008-10-21
2009-03-09
2009-09-30
2010-02-16
2010-04-15
2010-09-28
2011-03-03
2011-10-11
HAT
MHWS
MLWS
SD
DV
GS
S
Level (m)
Chainage (m)
SANDS


Beach Profiles: 1aBVBC02
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2009-03-09
2009-09-30
2010-02-16
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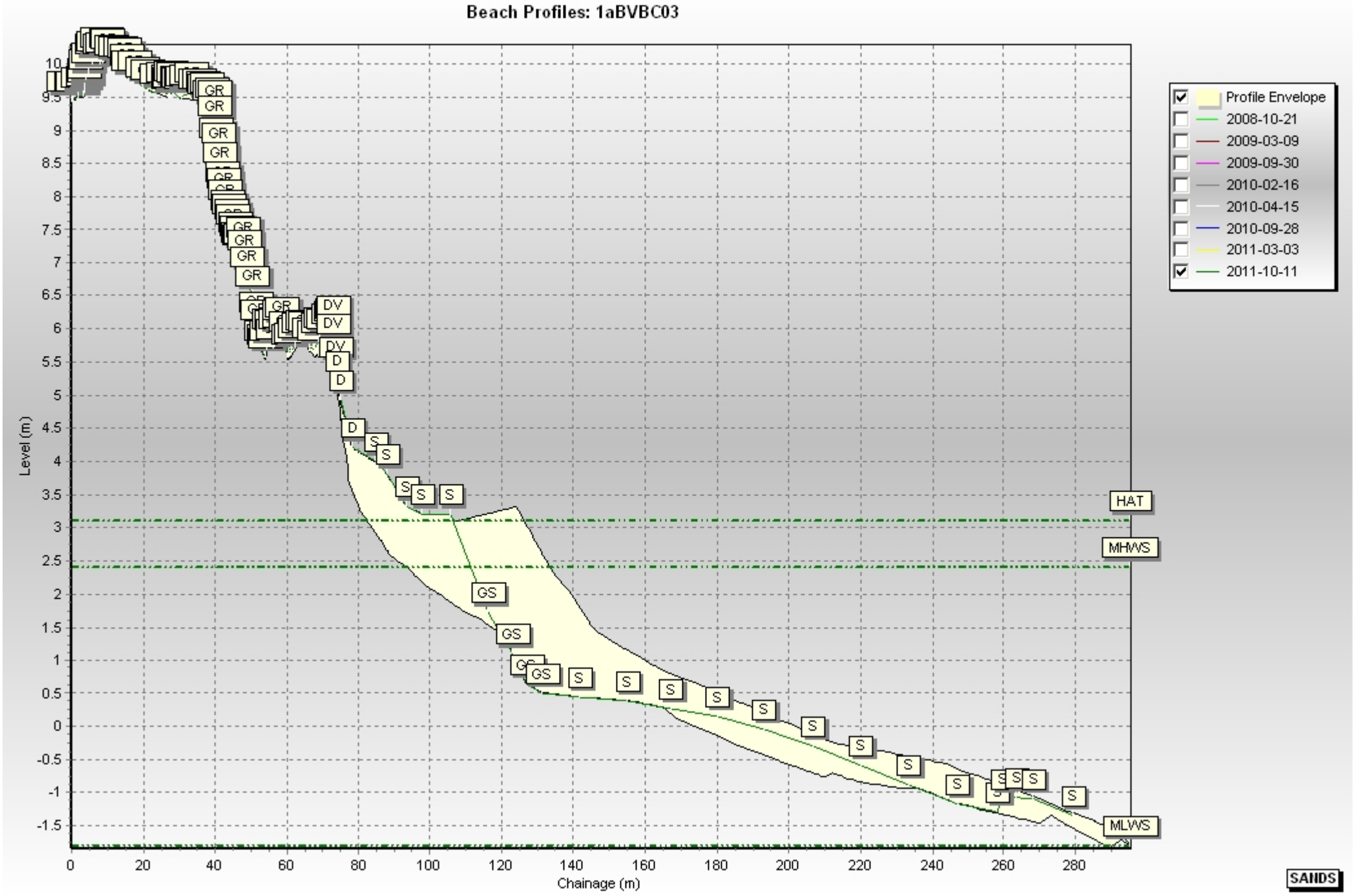
2011-03-03
2011-10-11
HAT
MHWS
MLWS
Level (m)
Chainage (m)
SANDS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Level (m)
Chainage (m)
Profile Envelope
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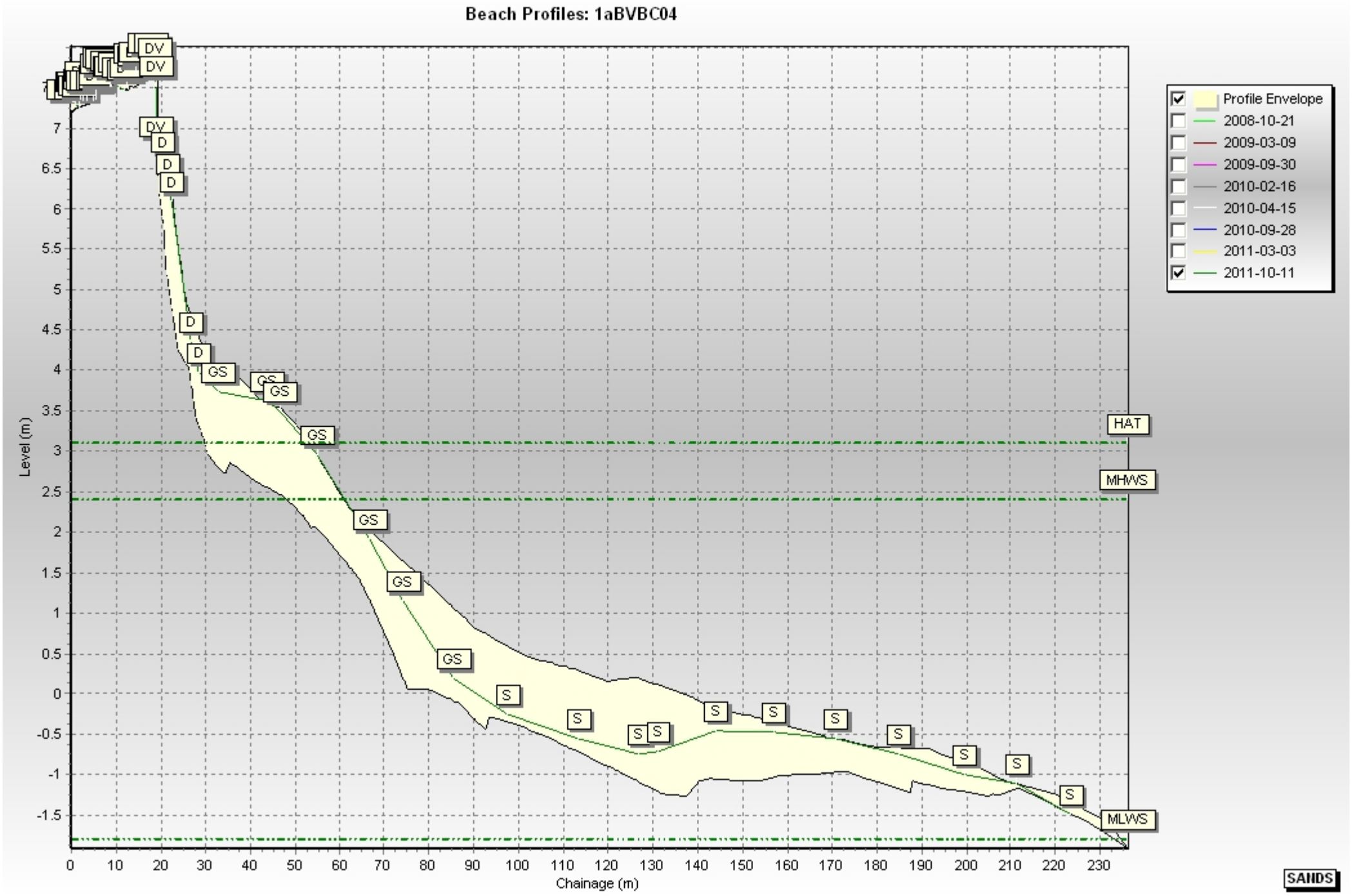
2009-03-09
2009-09-30
2010-02-16
2010-04-15
2010-09-28
2011-03-03
2011-10-11
HAT
MHWS
MLWS
GR
DV
D
S
GS
SANDS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Profile Envelope
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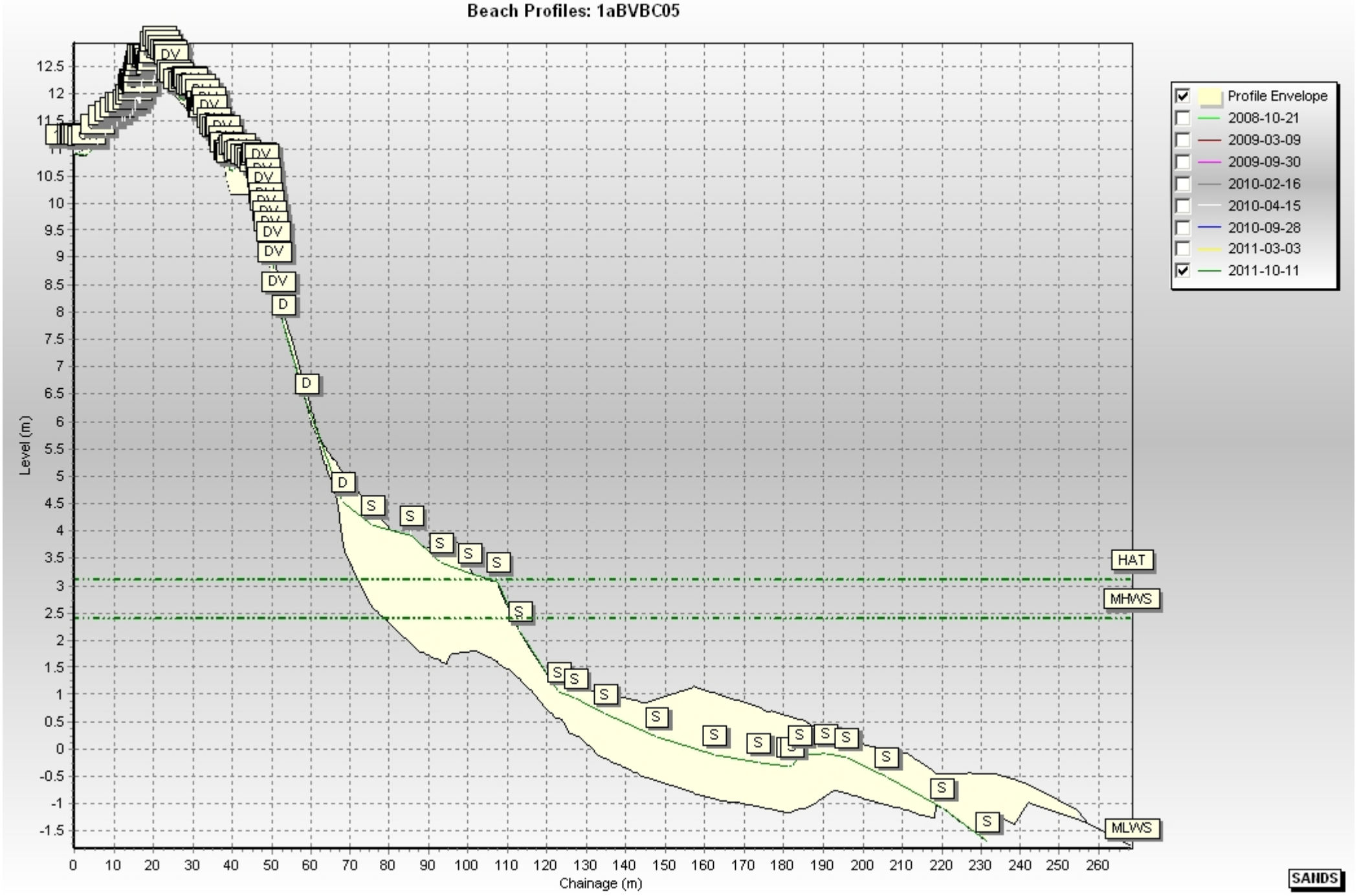
2009-03-09
2009-09-30
2010-02-16
2010-04-15
2010-09-28
2011-03-03
2011-10-11
HAT
MHWS
MLWS
Level (m)
Chainage (m)
SANDS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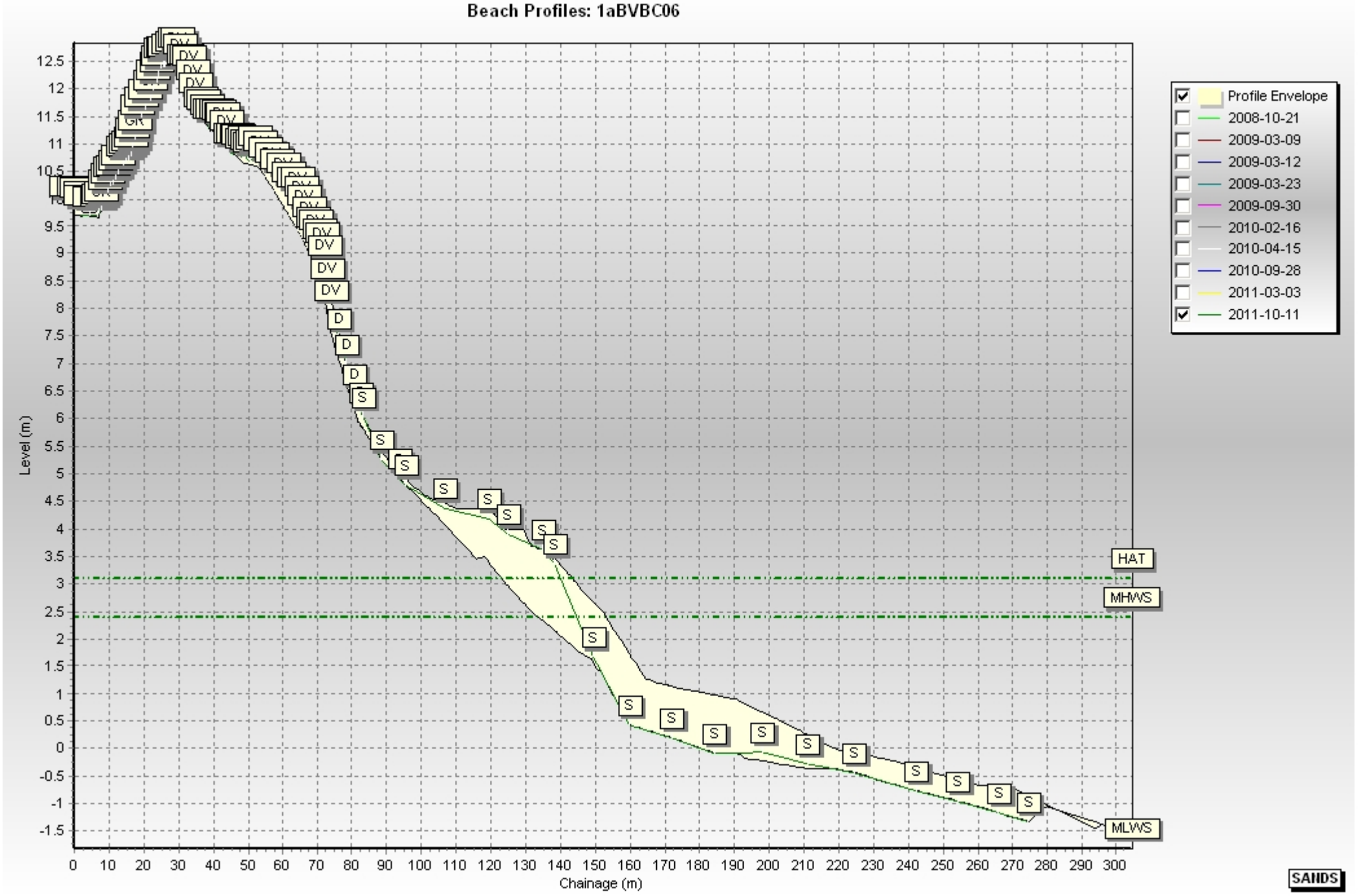
Level (m)
Chainage (m)
Profile Envelope
2008-10-21
2009-03-09
2009-09-30
2010-02-16
2010-04-15
2010-09-28
2011-03-03
2011-10-11
HAT
MHWS
MLWS
SANDS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Level (m)
Chainage (m)
Profile Envelope
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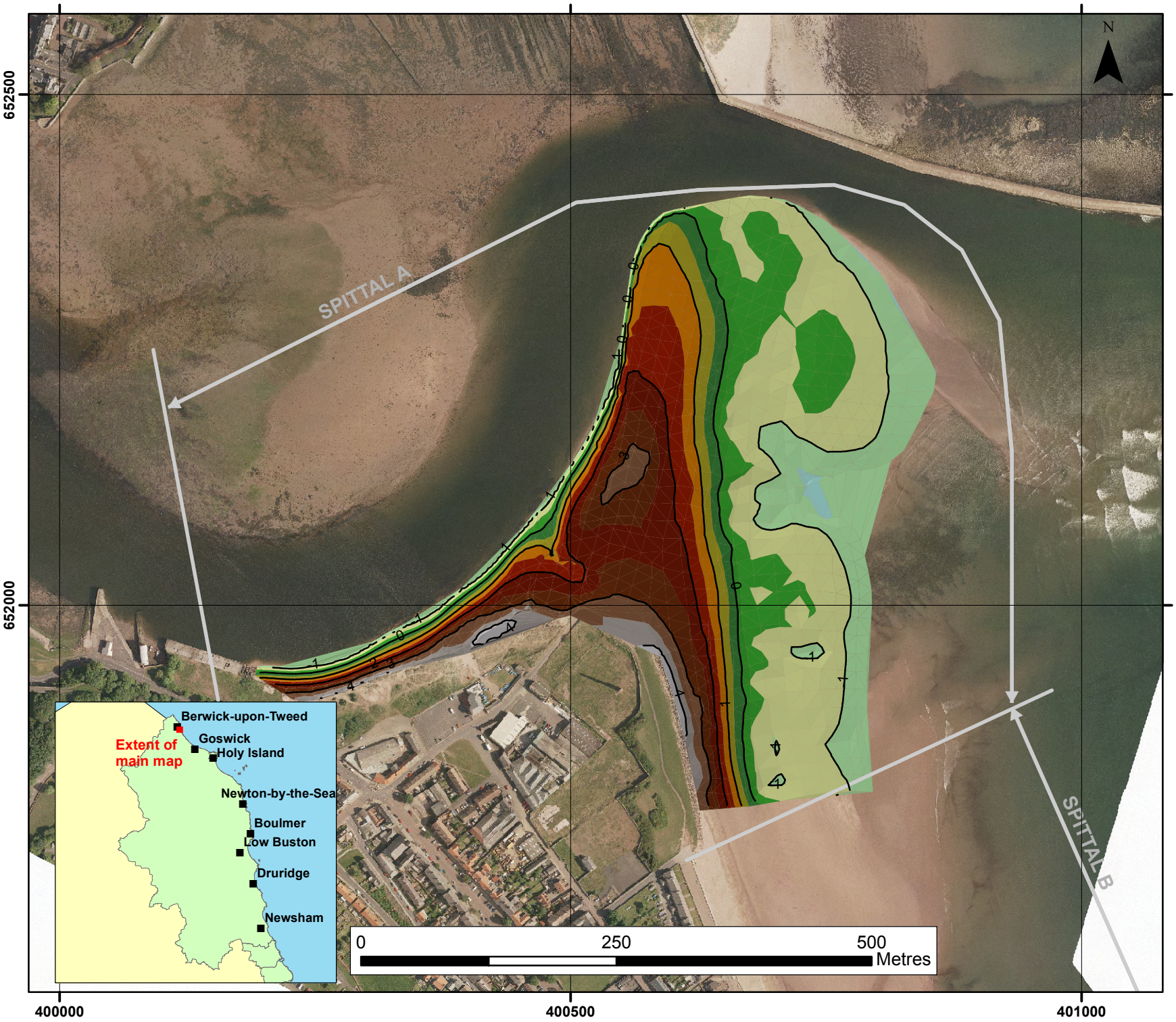
2009-03-09
2009-03-12
2009-03-23
2009-09-30
2010-02-16
2010-04-15
2010-09-28
2011-03-03
2011-10-11
HAT
MHWS
MLWS
SANDS

Appendix B

Topographic Survey



KEY

Elevation (mOD)

- 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
- -2 - -1.5
- Contours (1m intervals)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B- Map 1a Topographic Survey Berwick Northumberland County Council

Analytical Report 4
Full Measures Survey
Winter 2011

Halcrow
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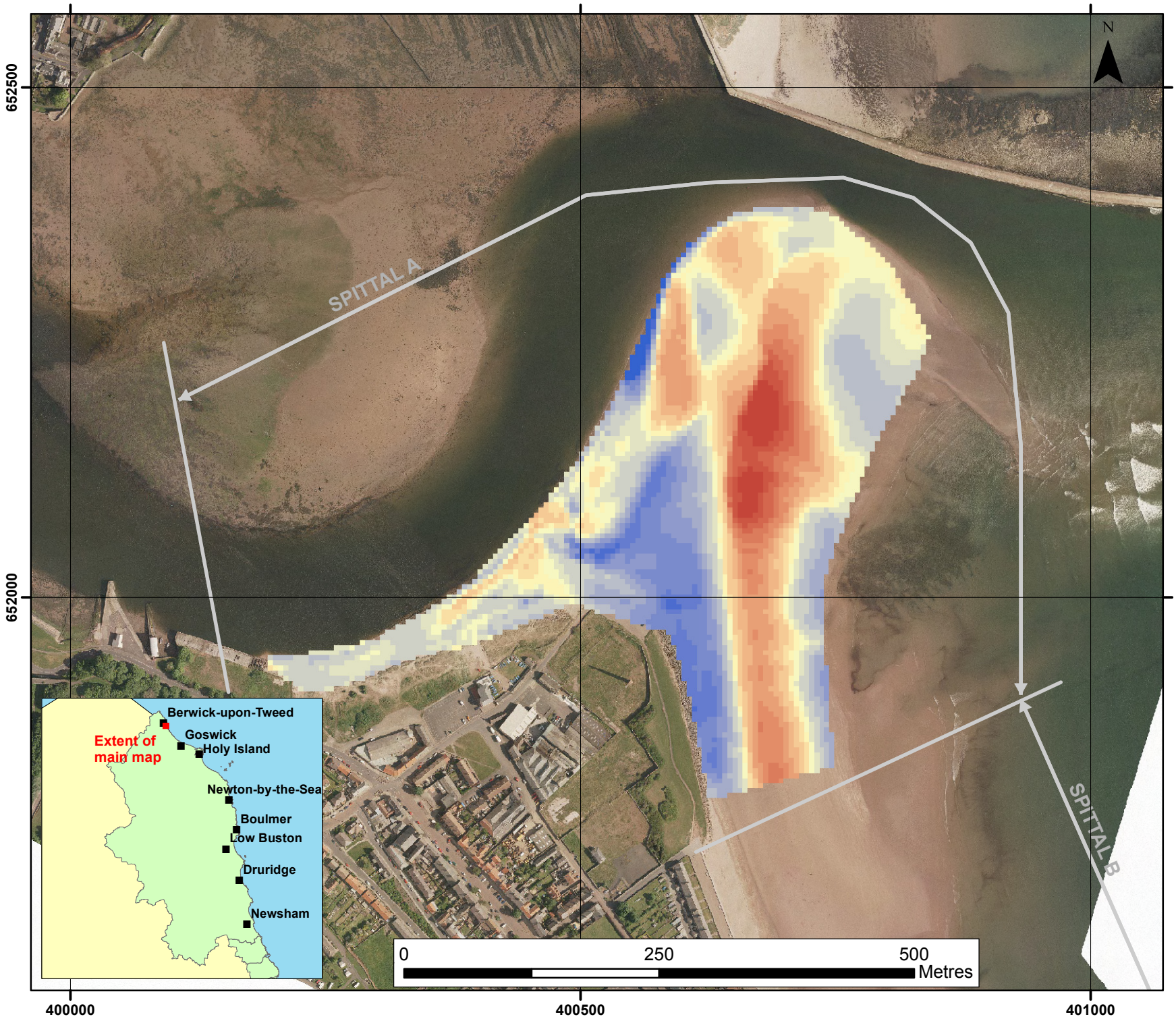
www.halcrow.com



KEY Spring 2011 and Winter 2011
Change in elevation (m OD)

<-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	

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B - Map 1b
Topographic Difference
Berwick
Northumberland
County Council

Analytical Report 4
Full Measures Survey
Winter 2011

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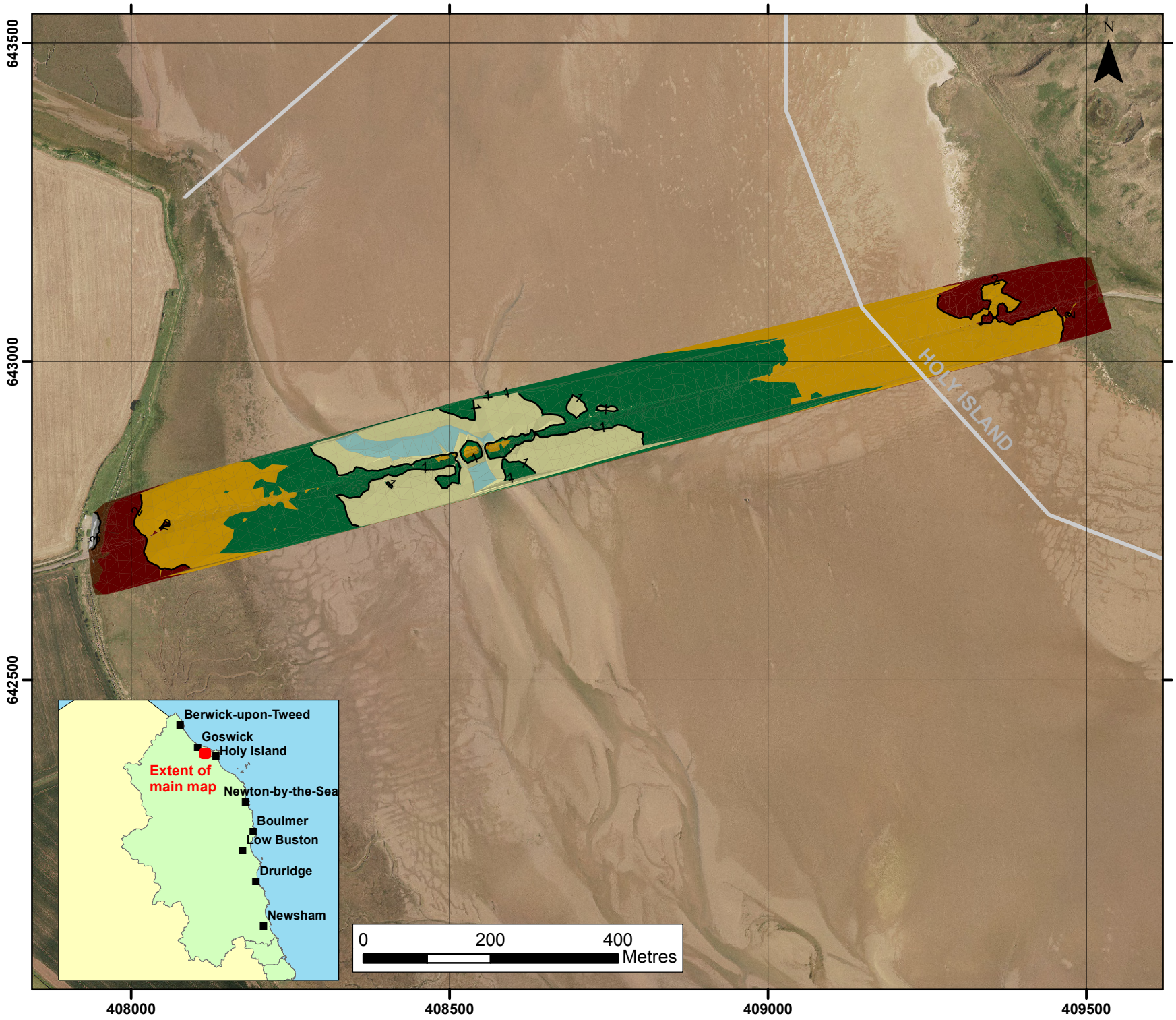

KEY

Elevation (mOD)

- 3.5 - 4
- 3 - 3.5
- 2.5 - 3
- 2 - 2.5
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0 - 0.5
- Contours (1m)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B - Map 2a
Topographic Survey
Holy Island
Northumberland County Council

Analytical Report 4
Full Measures Survey
Winter 2011

Halcrow
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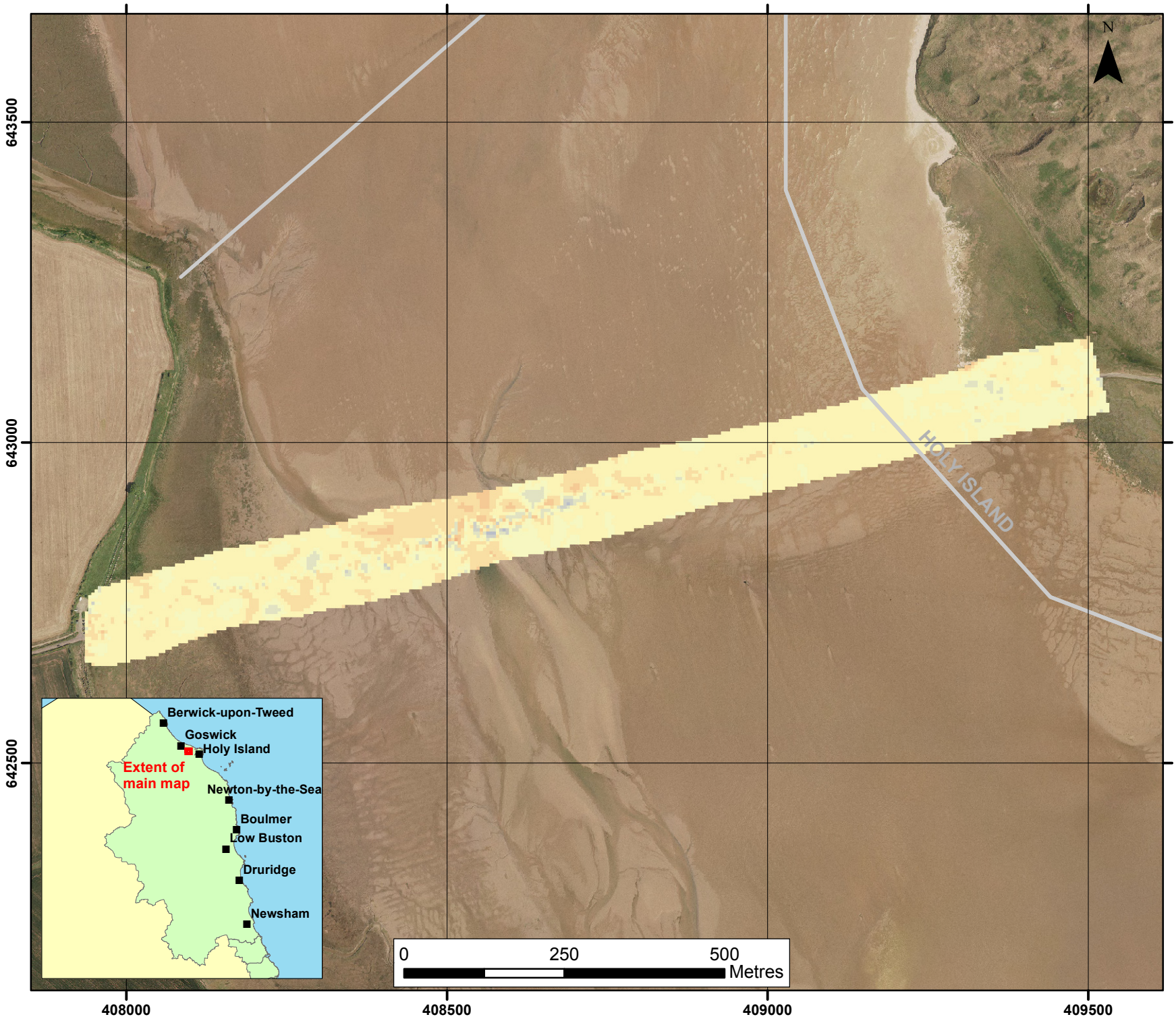

KEY Winter 2010 and Winter 2011
Change in elevation (m OD)

<-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	

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B- Map 2b
Topographic Difference
Holy Island
Northumberland
County Council

Analytical Report 4
Full Measures Survey
Winter 2011

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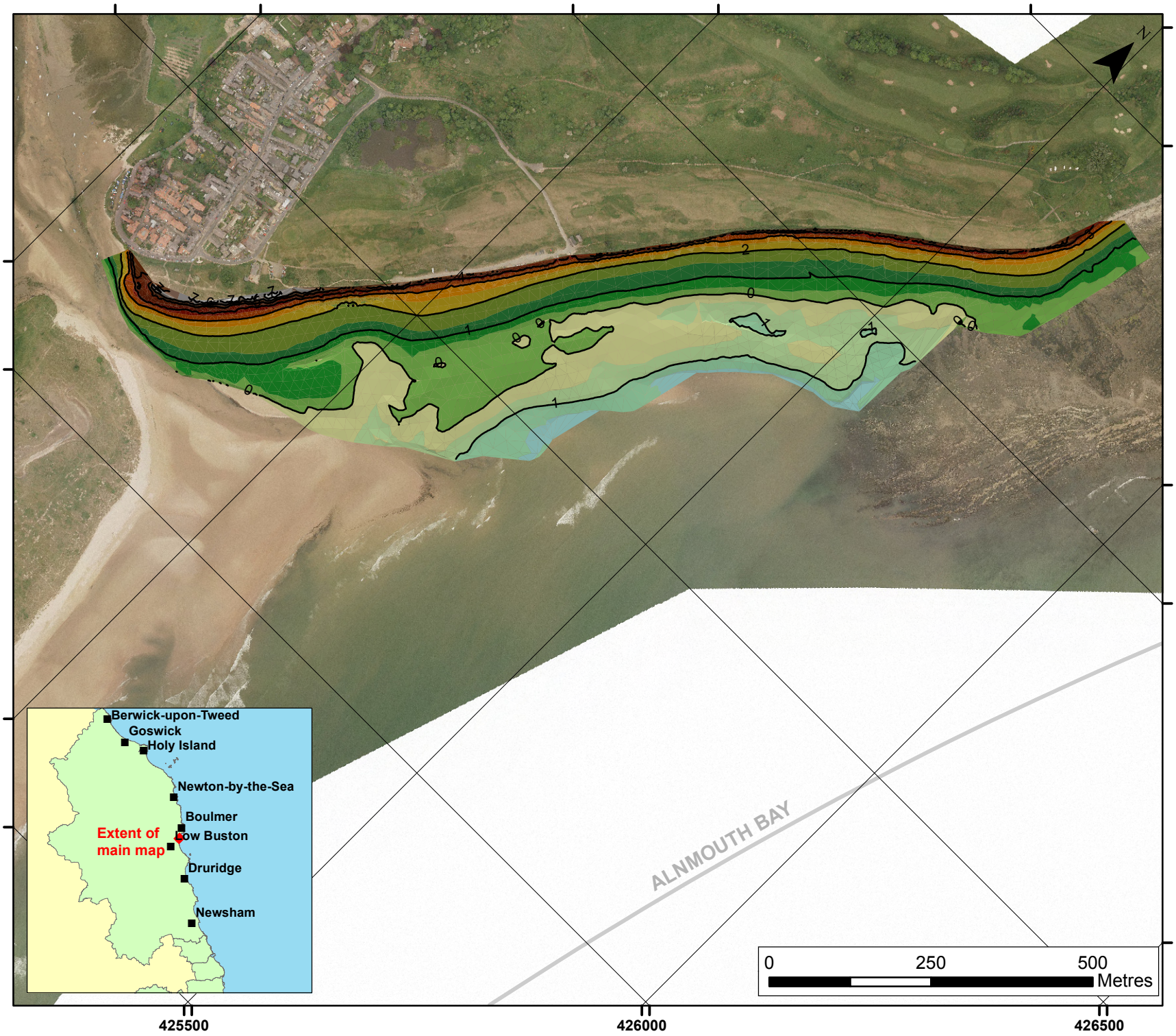

KEY

Contours (1m intervals)

Elevation (mOD)

8 - 8.5	3 - 3.5
7.5 - 8	2.5 - 3
7 - 7.5	2 - 2.5
6.5 - 7	1.5 - 2
6 - 6.5	1 - 1.5
5.5 - 6	0.5 - 1
5 - 5.5	0 - 0.5
4.5 - 5	-0.5 - 0
4 - 4.5	-1 - -0.5
3.5 - 4	-1.5 - -1
	-2 - -1.5

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B- Map 3a
Topographic Survey
Alnmouth
Northumberland
County Council

Analytical Report 4
Full Measures Survey
Winter 2011

Halcrow
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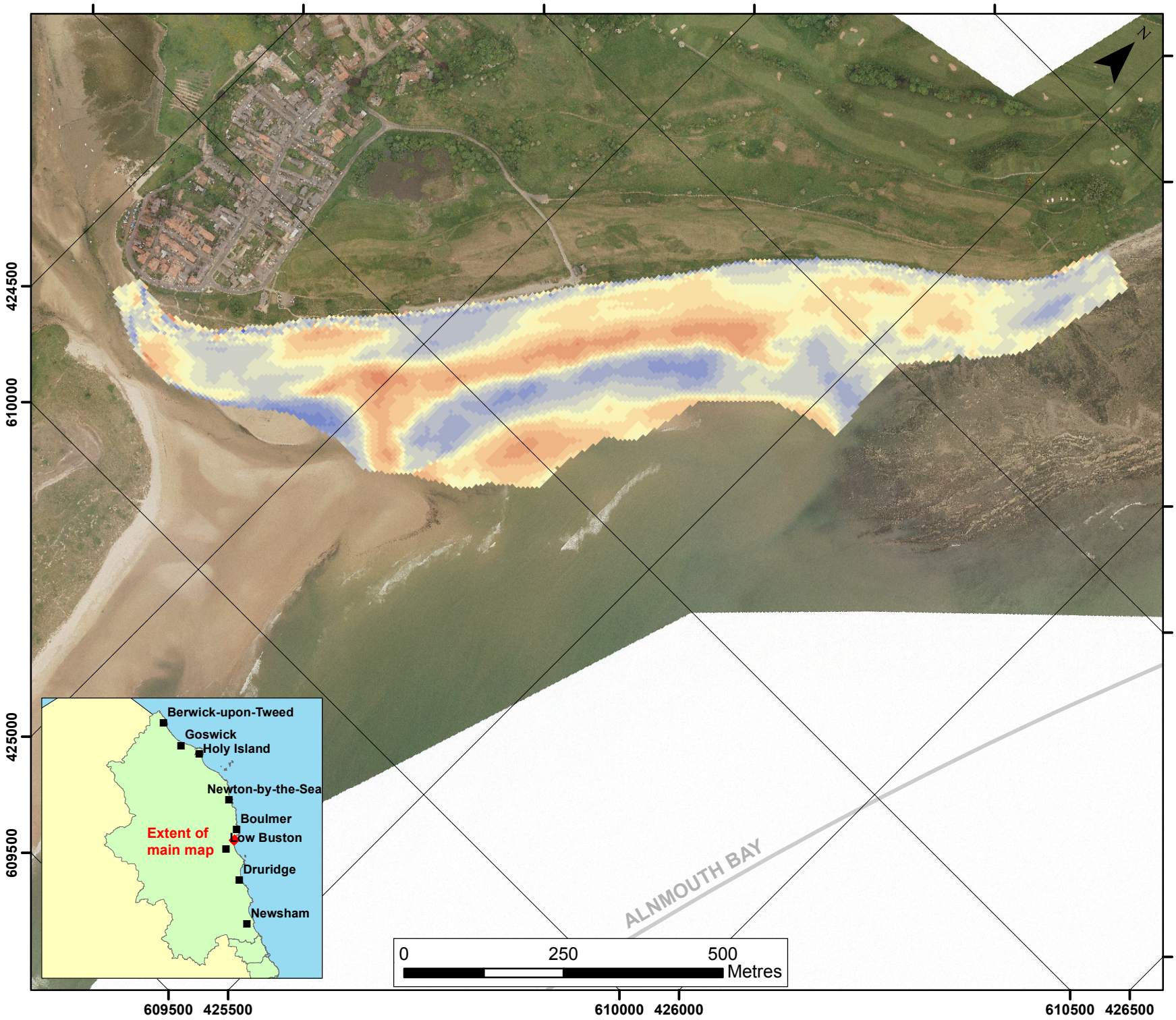

KEY Spring 2011 and Winter 2011
Change in elevation (m OD)

<-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	

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B- Map 3b
Topographic Difference
Alnmouth
Northumberland County Council

Analytical Report 4
Full Measures Survey
Winter 2011

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www.halcrow.com

KEY

Elevation (mOD)

- 6.5 - 7
- 6 - 6.5
- 5.5 - 6
- 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
- -2 - -1.5
- Contours (1m)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B- Map 4a
Topographic Survey
Newbiggin Bay
Northumberland County Council

Analytical Report 4
Full Measures Survey
Winter 2011

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

KEY Spring 2011 and Winter 2011 Change in elevation (m OD)

<-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	

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B Map 4b
Topographic Difference
Newbiggin
Northumberland County Council

Analytical Report 4
Full Measures Survey
Winter 2011

Halcrow
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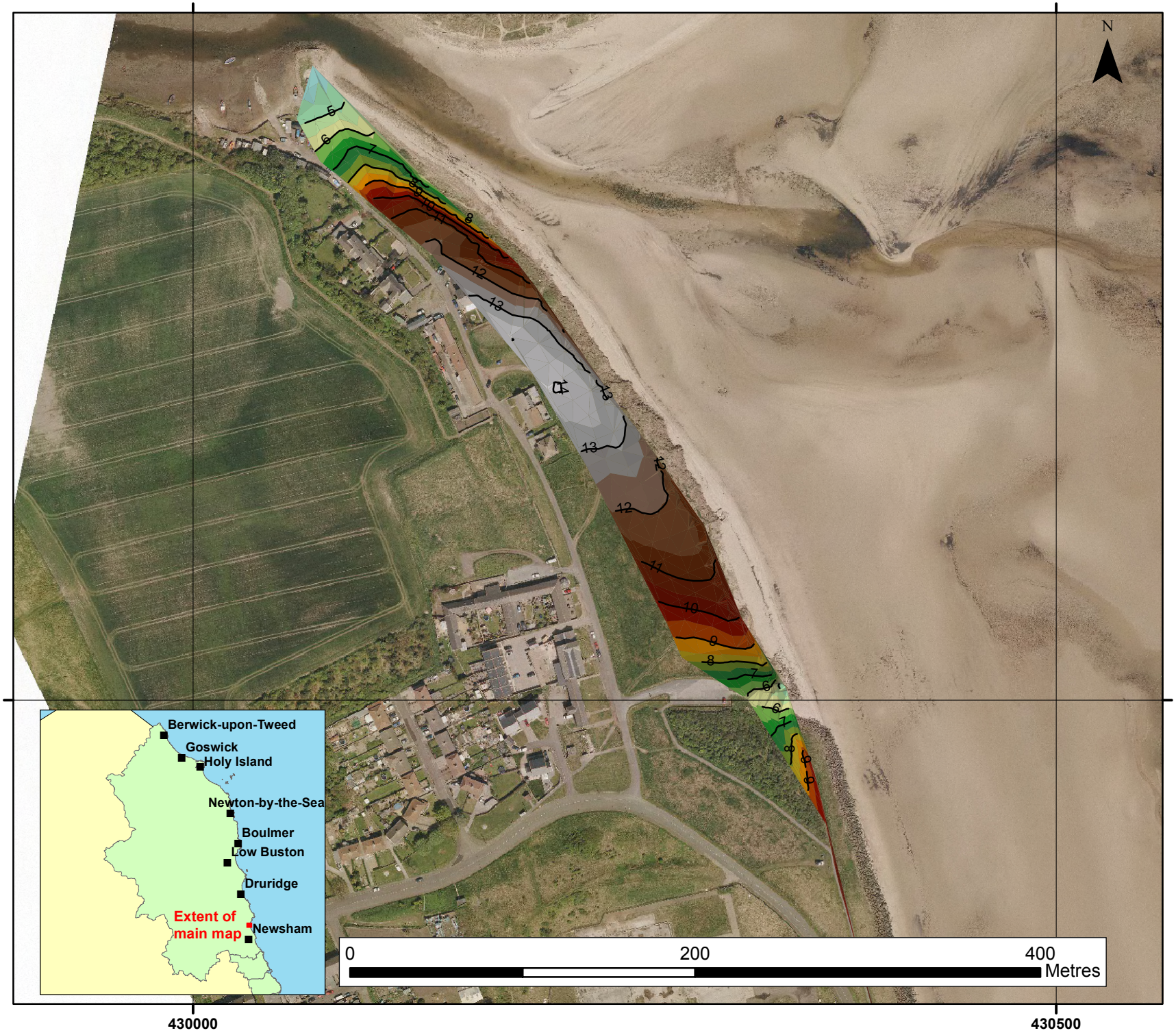
www.halcrow.com



KEY

Elevation	
14 - 14.5	9 - 9.5
13.5 - 14	8.5 - 9
13 - 13.5	8 - 8.5
12.5 - 13	7.5 - 8
12 - 12.5	7 - 7.5
11.5 - 12	6.5 - 7
11 - 11.5	6 - 6.5
10.5 - 11	5.5 - 6
10 - 10.5	5 - 5.5
9.5 - 10	4.5 - 5
	4 - 4.5

Contours (1m)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B- Map 5a
Topographic Survey
Cambois Bay
Northumberland County Council

Analytical Report 4
Full Measures Survey
Winter 2011

Halcrow
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Appendix C

Cliff Top Survey

KEY

Cliff Top (winter 2011)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix C- Map 1
Cliff Top Survey
Lynemouth Bay
Northumberland
CountyCouncil

Analytical Report 4
Full Measures Survey
Winter 2011

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

KEY

Cliff Top (winter 2011)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix C- Map 2a
Cliff Top Survey
Cambois Bay
Northumberland
CountyCouncil

Analytical Report 4
Full Measures Survey
Winter 2011

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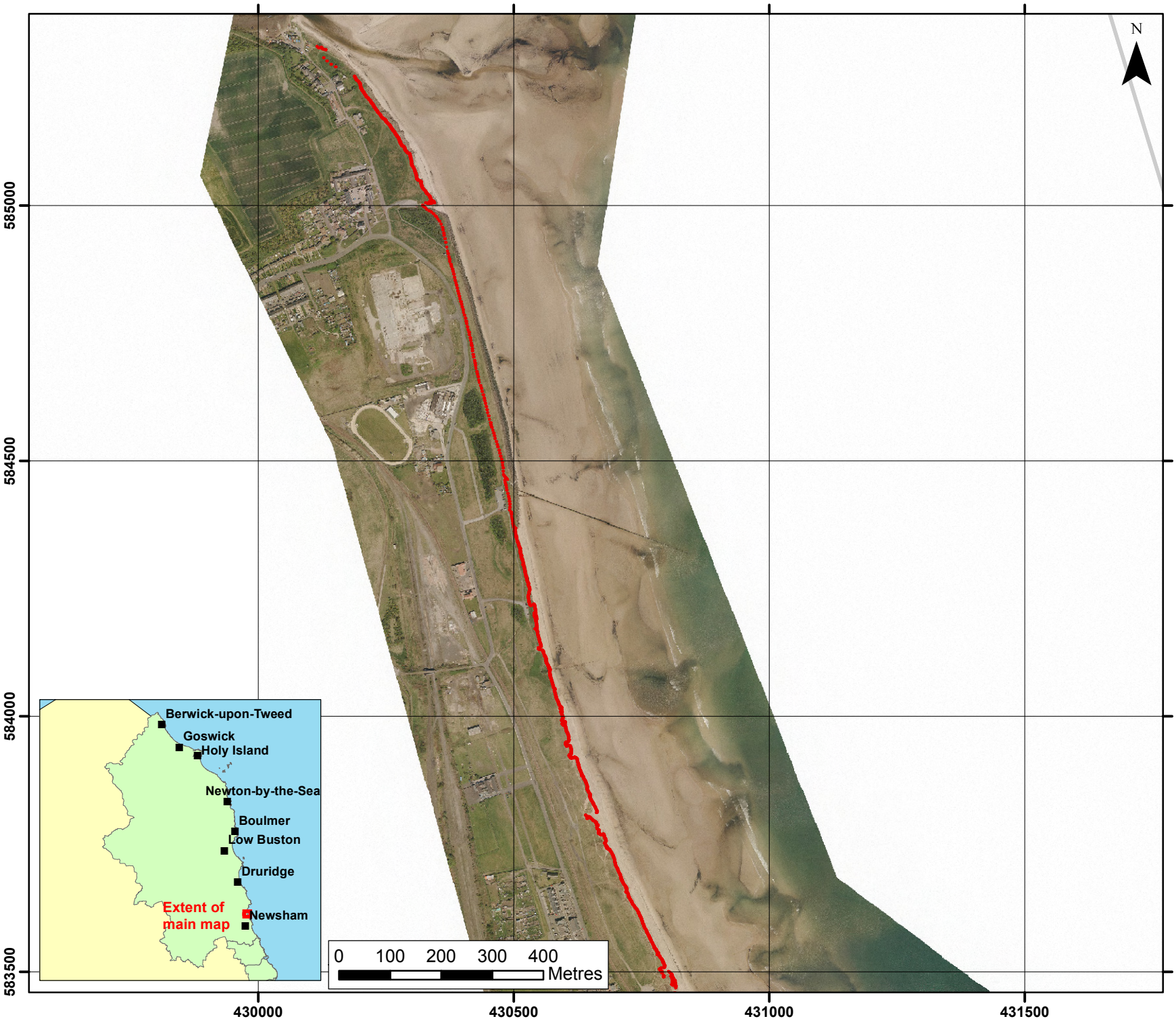
Fax: +44(0)121 456 1569
www.halcrow.com

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



KEY

Cliff Top (winter 2011)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix C- Map 2b
Cliff Top Survey
Cambois Bay
Northumberland
CountyCouncil

Analytical Report 4
Full Measures Survey
Winter 2011

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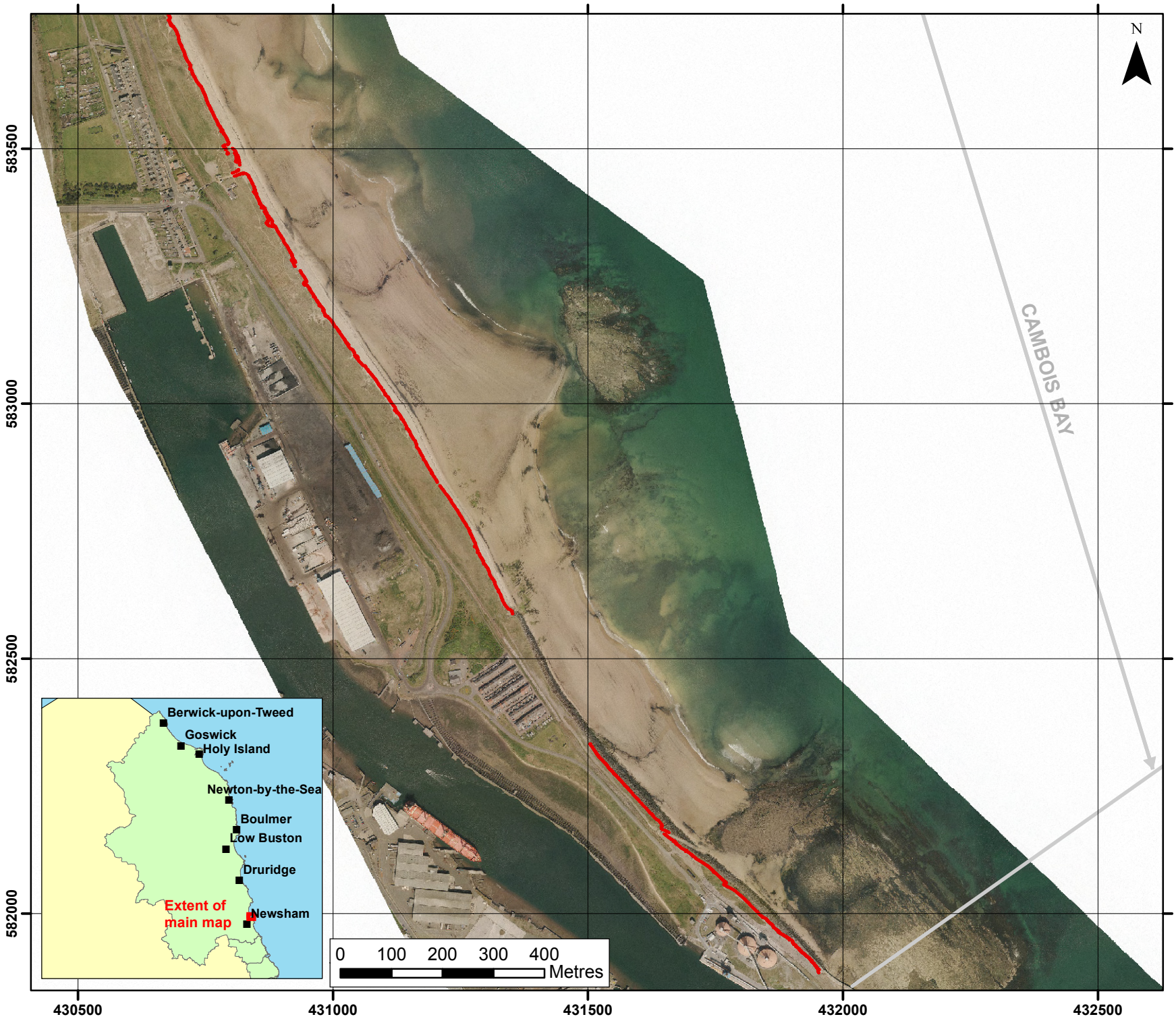
Fax: +44(0)121 456 1569
www.halcrow.com



KEY

Cliff Top (winter 2011)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix C- Map 2c
Cliff Top Survey
Cambois Bay
Northumberland
CountyCouncil

Analytical Report 4
Full Measures Survey
Winter 2011

Halcrow
A CH2M HILL COMPANY

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Fax: +44(0)121 456 1569
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