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

South Tyneside Council

South Tyneside Council
Final Report

October 2012

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Abbreviations and Acronyms

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

Water Levels Used in Interpretation of Changes

Water Level Parameter	Water Level (m AOD)	
	River Tyne to Frenchman's Bay	Frenchman's Bay to Souter Point
HAT	2.85	2.88
MHWS	2.15	2.18
MLWS	-2.15	-2.12

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

Glossary of Terms

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

Preamble

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

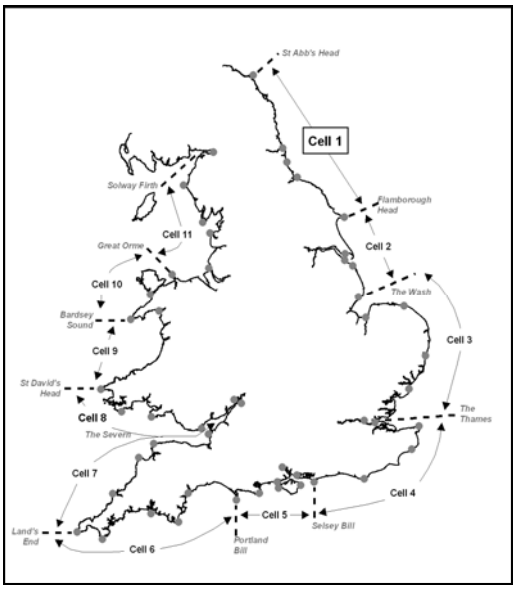


Figure 1 Sediment Cells in England and Wales

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

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	Sept 2011	Oct 12 (*)			

(*) The present report is **Analytical Report 4** and provides an analysis of the 2011 Full Measures survey for South Tyneside 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

South Tyneside Council's frontage extends from the mouth of the River Tyne Estuary to the outfall south of Whitburn. For the purposes of this report and for consistency with previous reporting, it has been sub-divided into four areas, namely:

- Littehaven Beach
- Herd Sands
- Trow Quarry (incl. Frenchman's Bay)
- Marsden Bay

1.2 Methodology

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

- Full Measures survey annually each autumn/early winter comprising:
    - Beach profile surveys along 17 transect lines (commenced 2008)
    - Topographic survey along Littlehaven Beach (commenced 2010)
    - Topographic survey along Herd Sands (commenced 2008)
    - Topographic survey along Trow Quarry (commenced 2008)

- Partial Measures survey annually each spring comprising:
    - Beach profile surveys along 11 transect lines (commenced 2008)
    - Topographic survey along Littlehaven Beach (commenced 2010)

- Cliff top survey bi-annually at:
    - Cliff top survey at Trow Quarry (incl. Frenchman's Bay) (commenced 2008)

For all cliff-top surveys prior to Full Measures 2011, data was reported separately in Trow Quarry Coastal Defence Scheme - Monitoring Plan Year 2 (available from South Tyneside Council). The data was saved in '.kmz' format for plotting and comparison in GoogleEarth. For the present survey report, this data have 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 photograph and shown to be of variable to poor quality, whereby the 'cliff line' is often incorrectly defined and comparison to the 2010 aerial photography shows the accuracy is too low to make meaningful interpretations of coastal change.

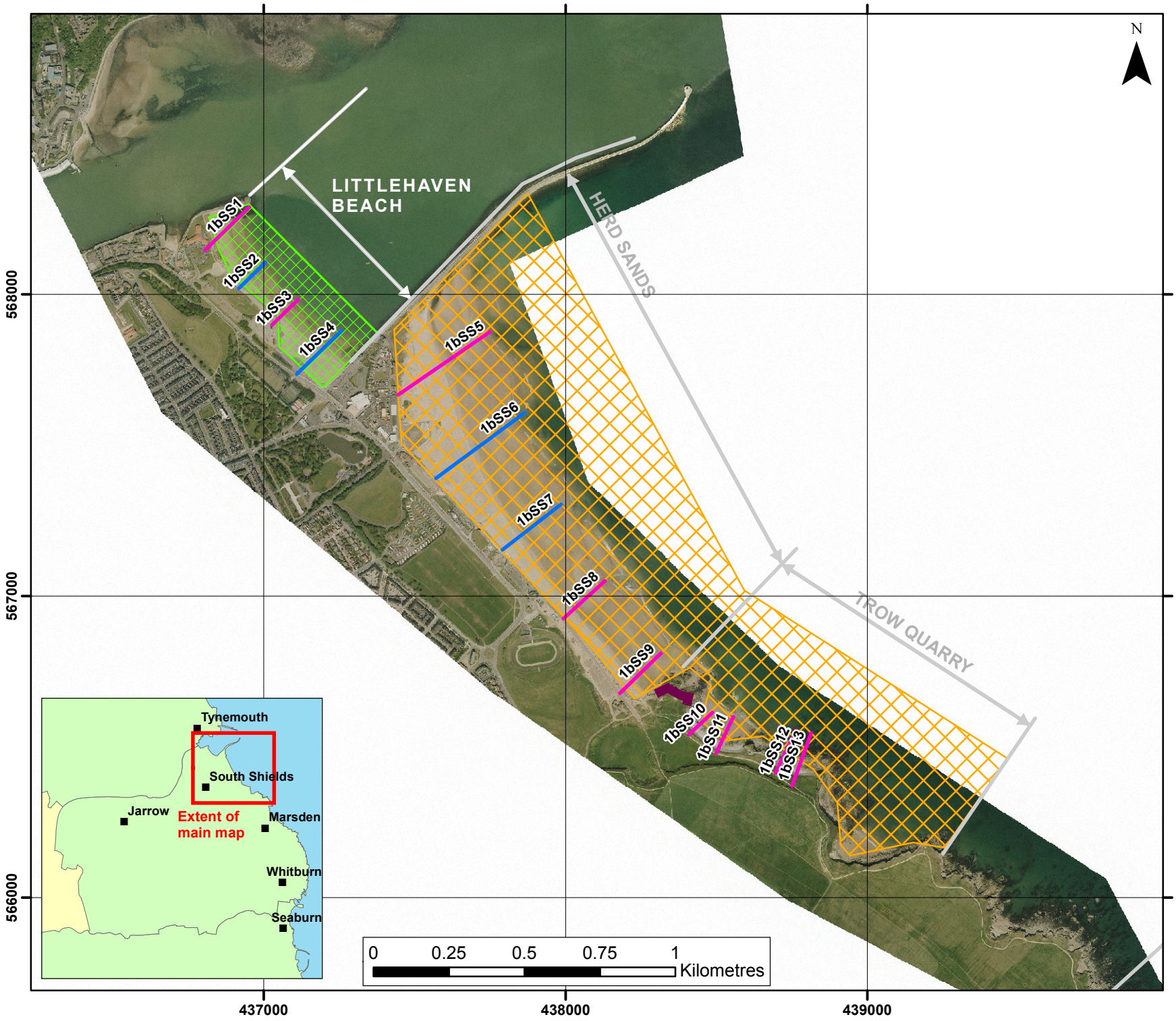
The location of these surveys is shown in Figure 2. The Full Measures survey was undertaken along this frontage between 12th September 2011 and 16th September 2011. During this time weather conditions varied considerably. Refer to the survey reports for details of the weather conditions over this survey 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

Figure 2- Map 1
Survey Locations
Littlehaven to Trow Quarry
South Tyneside Council

Analytical Report 4
Full Measures Survey
Winter 2011

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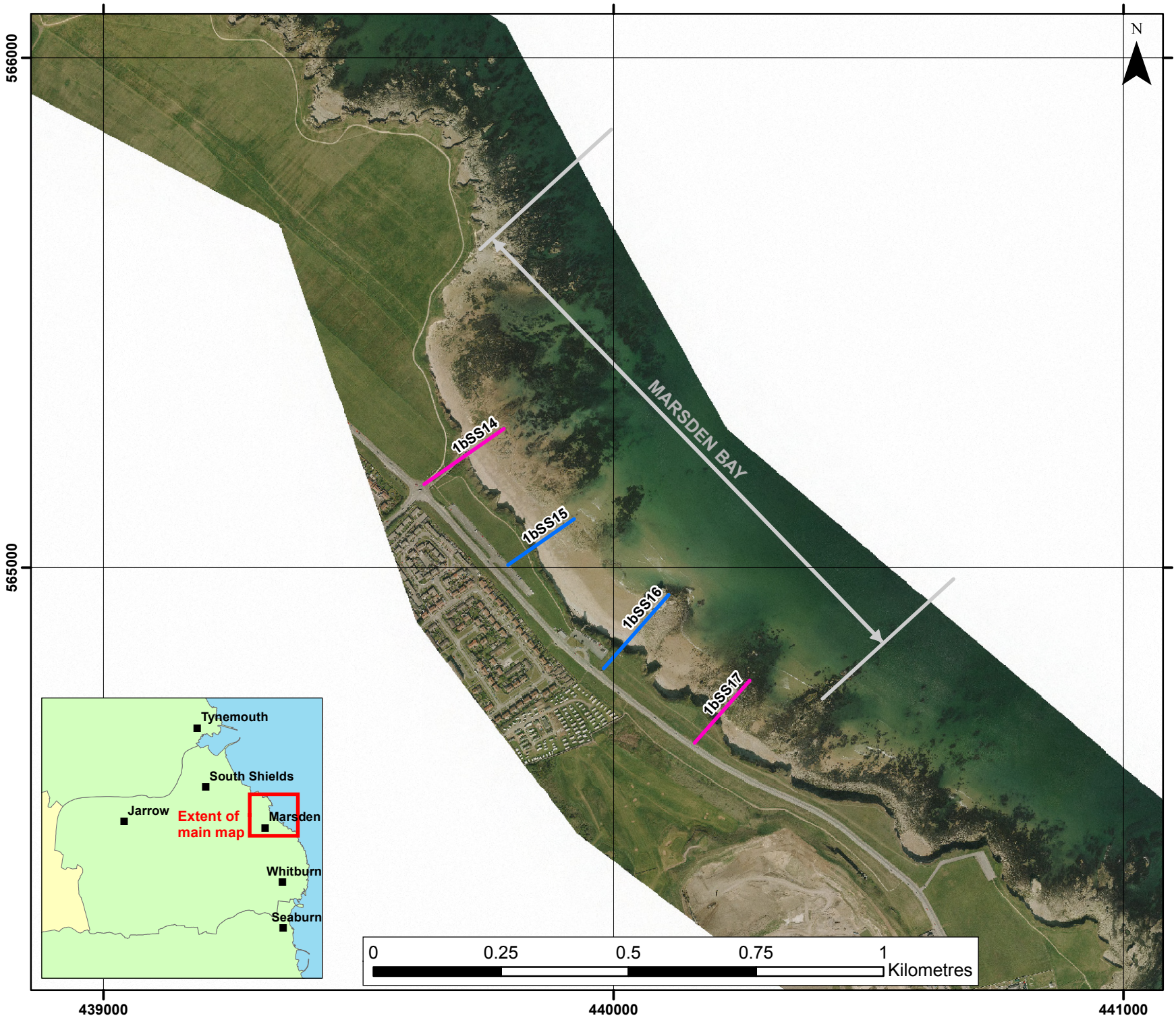

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(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Figure 2 - Map 2
Survey Locations
Marsden Bay
South Tyneside Council

Analytical Report 4
Full Measures Survey
Winter 2011

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2. Analysis of Survey Data

2.1 Littehaven Beach

Survey Date	Description of Changes Since Last Survey	Interpretation
Sept 2011	**Beach Profiles:** Littlehaven Beach is covered by four beach profile lines for the Full Measures survey, spaced between South Groyne and South Pier (Appendix A). Profile **1aSS1** is located to the north of Littlehaven Beach, in the lee of the rocky area surrounding South Groyne. The dunes have been subject to movement with a reduction in height by up to 0.1m across the back, top and face of the dunes. Beach levels across the profile have also reduced in the order of 0.1m to 0.2m. The greatest change is around MHWS. At **1bSS2** to the north of Littlehaven Beach, beach levels increased across the profile by approximately 0.1-0.3m. The increase was greatest between a level of 0m and -0.6m (a chainage of 70m and 85m). Profile **1bSS3** extends seawards from the protruding section of Littlehaven Sea Wall. From the toe of the seawall, beach levels have increased across the profile by 0.3m since the last survey (partial measures, spring 2011). Profile **1bSS4** is located to the south of Littlehaven Beach, adjacent to the breakwater. Since the last survey (full measures, winter 2010) the beach at 1bSS4 has been mobile. From the seawall out to a chainage of 70m (height of 3.8m), beach levels have reduced. The greatest reduction of 0.2m occurred at the toe of the seawall. From a level of 3.8 to MHWS beach levels increased by 0.2m. This increase represents the redistribution of material through cross-shore transport and the resultant seaward movement of the beach berm and the progradation of the beach. Beach levels around MWHS remained the same, however, seaward of 115m chainage, beach levels increase across the profile by up to 0.2m.	Littlehaven Beach is fairly steeply sloping beach, and with the exception of the beach in the south is mostly of continuous gradient from the dune / seawall out to MLWS. The northern section of the beach has experienced some erosion with a fall in beach levels and reduction in dune height, however, this is by a relatively small amount. The middle section of the beach has accreted since the last surveys (partial measures, spring 2011 and full measures, winter 2011). The southern section of the beach is the most dynamic, with erosion at the toe and progradation of the foreshore. These changes are likely to be driven by cross-shore process, including wind and wave action. The breakwater is also likely to influence beach processes at this location. **Longer term trends:** Littlehaven Beach has retained the same form and general position since the survey in November 2008. There has been significant variability in beach level in front of the protruding section of Littlehaven sea wall, with the maximum recoded erosion of about 1m occurring over winter 2009/10.

Survey Date	Description of Changes Since Last Survey	Interpretation
Sept 2011	**Topographic Survey:** Littlehaven Beach is covered by bi-annual topographic survey between the South Groyne and the South Pier, which commenced in March 2010. Data from the most recent topographic survey (full measures, winter 2011) have been used to create a 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) the northern end of the beach has experienced a small reduction in beach elevation; (ii) the centre and southern sections of the beach have experienced small increases in beach elevation; and (iii) beach elevation has reduced particularly along the backshore (i.e. the toe of the seawall) in the most southern section of the beach. The profile and topographic survey for the beaches in the vicinity of profile 1bSS4 show that beach levels / at the toe have fallen. The survey photograph (Plate 1) does not suggest this is affecting the integrity of the seawall since relative beach levels are still high.	Generally beach elevation changes are in the region of 0 to +/-0.5m. There has been a slight decrease in beach elevation on the middle and lower beach to the north of the beach and an increase elsewhere. Beach elevation has reduced particularly along the backshore (i.e. the toe of the seawall) in the most southern section of the beach.

Plate 1 – Survey photograph 1bSS4_20110916_N4.JPG

2.2 Herd Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
Sept 2011	**Beach Profiles:** Herd Sands is covered by five beach profile lines for the Full Measures survey (Appendix A). Profile **1bSS5** is located to the north of Herd Sands and is located in the lee of the South Pier breakwater. With the exception of a loss of material from the dune top around a height of 7.2m (chainage 250m), the dunes have largely retained a similar form since the last survey (partial measures, spring 2011). Beach levels have increased around HAT and reduced around MHWS to a level of 0.6m (chainage 210m). The form of the profile shows the landward movement of a berm from MHWS to HAT. From a chainage of 220m beach levels have increased. The survey photograph (Plate 2) shows the exposure of the tarmac Donkey Track beneath the dunes and sand being blow across it. Since the last survey (full measures, winter 2010) the beach at profile **1bSS6** has been very active. Beach levels between the primary and secondary dune ridge increased by up to 0.7m. This is continuation of the trends observed since winter 2008. The survey photograph (Plate 3 and Plate 4) shows that the dune fencing present at this location is now buried, indicating that this management measure has contributed to the accretionary patterns observed and have therefore been successful. Beach levels have increased substantially (in the region of 1m) between HAT and MHWS. Given the magnitude of change and the profile form, this is likely to be a new dune forming. Between a chainage of 190m and 260m, beach levels have fallen in the region of 0.2m. Profile **1bSS7** is located at the centre of Herd Sands. **At 1bSS7** beach levels between 0m to 40m and 80m to 200m chainage have fallen. From a height of 3.4m to MHWS, beach levels have increased and the profile is convex. It is therefore likely that this is a berm or dune formed from material eroded and redistributed from the middle and lower beach to the upper beach by cross-shore transport. At **1bSS8** beach levels at the toe of the promenade revetment have reduced. From HAT to a level of 0.6m, beach levels have increased by 0.4m, however seaward of this they have reduced to form a flatter beach but of a similar gradient. Similarly to 1bSS7, this change is likely to be caused by redistribution of beach material from the middle/lower beach to the upper beach by cross-shore transport processes (i.e. wind and waves).	The beach at Herd Sands is very dynamic. Since the last survey, the dunes have accreted, whilst the beaches have demonstrated a significant redistribution of material across the beach. Wind blown transport is a dominant mechanism behind this movement, evident from the patterns of dune growth and the survey photographs. The northern section of the bay is accreting quite substantially, evident by the on-shore migration of the beach berm and a reduction in beach levels across the middle/lower beach and new dune formation. At the centre of the beach at profile 1bSS7, the beach and dunes have demonstrated a phase of berm/dune building at HAT (full measures (September), 2009), flattening (full measures (September), 2009) and now, building with the formation of the berm/dune at HAT. The survey photograph shows the seawall, fronted by an area of sand with tyre tracks and seaward of that dune fencing. It is possible that the fall in beach levels in front of the promenade is caused by vehicular erosion, or works in the area associated with the promenade regeneration, whilst the berm has been formed as result of trapping by the dune fencing. At the southern section of the bay, beach levels have reduced on the middle/lower beach but increased on the upper as material has been transported across the beach by wind and wave activity.

Survey Date	Description of Changes Since Last Survey	Interpretation
	Profile **1bSS9** is located to south of Herd Sands. The dune face has retained the same form and position since the last survey (partial measures, spring 2011). From the dune toe to a height of 0.5m, beach levels have increased and the beach has grown upwards and outwards indicating some progradation and accretion. Between 90m and 150m beach levels have reduced. This redistribution of this material is likely to have been transported by cross-shore transport to the upper beach. From chainage 155m beach levels have increased. The survey photograph (Plate 5) shows the encroachment of sand from the back of the dunes onto the promenade indicating that the dunes are migrating landwards (i.e. rolling back).	
Sept 2011	**Topographic Survey:** Herd Sands is covered by an annual topographic survey between the South Pier and Trow Point, which commenced in November 2008. 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 topographic survey (full measures, winter 2011) and the present survey. In particular, the difference plot shows an overall reduction in elevation across the beach with a defined band of increased elevation that follows the planform of the beach. The previous survey (full measures, winter 2010) shows a band of beach elevation increase within the lower beach. Landwards of this is a band of beach elevation reduction. The material that formed the increase could be that which now forms the linear band observed in the present survey, indicating its onshore migration.	The topographic survey shows a distinct pattern, with a general reduction in beach levels across the lower and middle beach and a band of accretion along the upper beach. These findings support those of the beach profile analysis. The linearity of the band of accretion suggests that cross-shore transport is consistent along the length of the beach. In addition, the magnitude of the increase in elevation suggests this band is a significant feature and could represent the formation of a dune ridge. Survey photographs provide evidence that the dunes are dynamic, migrating landwards (via roll back) and also continually building with ongoing dune management.

Plate 2 – Survey photograph 1bSS5_20110916_N6.JPG

Plate 3 – Survey photograph 1bSS6_20110916_N1.JPG

Plate 4 – Survey photograph 1bSS6_20110916_N2.JPG

Plate 5 – Survey photograph 1bSS9_20110916_N1.JPG

2.3 Trow Quarry (incl. Frenchman's Bay)

Survey Date	Description of Changes Since Last Survey	Interpretation
Sept 2011	**Beach Profiles:** Trow Quarry is covered by four beach profile lines for the Full Measures survey (Appendix A), two in Graham's Sand and two in Southern Bay. Profiles **1bSS10** and **1bSS11** are located in Graham's Bay. At profile **1bSS10** the back shore has remained stable. From MHWS to a level of 0.5m, beach levels have increased by 0.5m and from a level of 0.5m to -1m beach levels reduced by 0.5m. These changes are likely to represent the redistribution of material from the middle to upper beach. At profile **1bSS11** the back shore has remained stable. The beach predominantly comprised of boulder and rock and the changes observed at this profile are more likely to relate to the movement of boulder / rock rather than an increase or decrease in beach levels. Profiles **1bSS12** and **1bSS13** are located in Southern Bay. At both locations, the back shore has remained stable. The beach predominantly comprised of boulder and rock and the changes observed at this profile are more likely to relate to the movement of boulder / rock rather than an increase or decrease in beach levels.	At both Graham's Sand and Southern Bay, the cliff and rock revetment have remained stable. The northern part Graham's Sand has shown some movement, with the redistribution of material from the middle to upper beach. The southern section of Graham's Sand and Southern Bay, the rocky foreshore has generally retained the same form and position with some movement of sporadic boulders and rocks. **Longer term trends:** Overall the beach has retained the same form and position since November 2008.
Sept 2011	**Topographic Survey:** Trow Quarry is covered by an annual topographic survey within Graham's Sand, Southern Bay and Frenchman's Bay, which commenced in November 2008. 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 2a) produced from the last produced topographic survey (full measures, winter 2010) and the present survey. In particular, the difference plot shows: (i) a sporadic change in beach elevation; and (ii) an increase in elevation on and around the headlands that separate Graham's Sand and Southern Bay and Southern Bay and Frenchman's Bay, suggesting accretion of sediment. However, the latter changes are assumed to be artificial due different survey extents and the data interpolation used to create the difference grids	The observations made from the beach profiles are reflected in the topographic survey. In addition, the topographic survey also shows an increase in elevation on and around the headlands that separate Graham's Sand and Southern Bay and Southern Bay and Frenchman's Bay. While this suggests accretion, it is not real and is an artefact of the difference calculation near the edge of the survey data.

Survey Date	Description of Changes Since Last Survey	Interpretation
Sept 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). A review of this data shows that the data accuracy is too low to allow meaningful interpretations of coastal change to be made for a number of reasons: (i) the surveyed 'cliff line' is in many places a vegetation limit and not a geomorphological feature that indicates erosion; (ii) in many cases the resolution of the line is too low to allow meaningful comparison to the cliff features visible in the aerial photograph; and (iii) the accuracy of all the data is low, meaning that in many places the cliff top is indicated to have advanced when compared to the 2010 aerial photography.	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.

2.4 Marsden Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
Sept 2011	**Beach Profiles:** Marsden Bay is covered by four beach profile lines for the Full Measures survey (Appendix A). Profile **1bSS14** is located to the north of the bay and covers the cliffs and former lifeguard station adjacent to the Redwell Steps. At profile **1bSS14** the cliff has retained the same form and position since the last survey (partial measures, spring 2011). Beach levels seaward of MHWS have lowered by approximately 0.3m across the profile. At profile **1bSS15** the cliff has retained the same form and position since the last survey (full measures, winter 2010). There does appear to be a change in the cliff slope at the toe, but this is attributed to interpolation errors inherent in the survey technique rather than actual change. Beach levels have reduced in the order of 1m around MHWS, but they have increased from an elevation of 1m (chainage 90m) seaward. This suggests that material has been redistributed across the profile from the upper to the middle/lower beach. At profile **1bSS16** the beach profiles, as shown in Appendix A have straight lines between the points which make it appear that the cliff face has retreated by up to 5m, however, the survey does not cover the face of the cliff and the surveyed points are different (as noted in the previous full measures, winter 2010 report) and it is more likely that the cliffs have remained stable. Beach levels around MHWS have fallen by approximately 0.5m. At profile **1bSS17** the cliff has retained the same form and position since the last survey (partial measures, spring 2011). Beach levels from a level of 0m (85m chainage) have fallen by approximately 0.1-0.2m. Seaward of there, beach levels have not changed.	The cliffs in Mardsen Bay have not changed significantly. There is an apparent growth of the cliffs from the plots of the survey data, but this is attributed to the survey and plotting technique rather than actual change. To the north of the Marsden Bay there has been a small level of erosion and beach flattening. This trend was observed in the previous survey. The beach at the centre of the bay has moved with the cross-shore movement of material from the upper to lower beach. Draw down like this occurs during storms and could explain this trend of movement. To the south of the Bay, beach levels have fallen slightly. **Longer term trends:** Although beach movements are observed since the last survey, the overall change is within the bounds of changes observed since the first survey in November 2008.

3. Problems Encountered and Uncertainty in Analysis

Individual Profiles – problems with survey data collection:

At South Shields, strong winds and heavy seas hindered data collection near low water level.

At profile 1bSS16, the lack of consistent survey data at the top and toe of the cliff over the past few surveys has produced plots of the cliff profile that does not represent the cliff as seen 'on-the-ground'. Therefore no analysis or interpretation has been made of the section of profile that covers the cliff.

Cliff Top Surveys:

For all cliff-top surveys prior to Full Measures 2011, data was reported separately in Trow Quarry Coastal Defence Scheme - Monitoring Plan Year 2 (available from South Tyneside Council). Although cliff top data is available for surveys prior to the Full Measures 2011, the accuracy of the data is such that no reliable interpretation can be made. For this reason, the 'kmz' files are not presented or analysed as part of the present report. For the present Full Measures 2011 survey, the cliff top survey data has been plotted as a line on the 2010 aerial photograph which revealed that accuracy is too low to allow meaningful interpretations of coastal change to be made: the surveyed 'cliff line' is in many places a vegetation limit and not a geomorphological feature that indicates erosion; in many cases the resolution of the line is too low to allow meaningful comparison to the cliff features visible in the aerial photograph; and the accuracy of all the data is low, meaning that in many places the cliff top is indicated to have advanced when compared to the 2010 aerial photography.

Consideration needs to given to the benefit of continuing with cliff top surveys in their current format, particularly if features with no geomorphological significance are being surveyed mistakenly. If the quality of the surveys can be improved, it is possible that a more reliable pattern of change will be determined over the longer term, when the impact of other survey errors will be minimised.

However, in the short term, more reliable 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. These 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

No further changes are recommended at the present time.

5. Conclusions and Areas of Concern

- At Little Haven Beach, the recorded profiles generally present no causes for concern. The profile and topographic survey for the beaches in the vicinity of profile 1bSS4 show that beach levels at the toe have fallen. The survey photograph does not suggest this is affecting the integrity of the seawall since beach levels are still high enough to cover the wall's foundations.
- At Herd Sand, the recorded profiles, topographic survey and survey photographs suggest that the dunes are accreting and rolling back onto the promenade behind. The survey photographs show that the previously installed dune fencing is now buried and therefore shows that this technique has been successful. However, once the fences are buried, unless vegetation can become established on the dunes there is nothing to intercept the movement of sand across the beach and the dunes are likely to migrate landwards at a faster rate. Ongoing beach management is required in this area in order build dunes and control sand blow. It is assumed that this material is cleared or will need to be cleared in the future. An increased rate of dune migration may require more frequent clearing or a larger volume of material to be moved. It is important that this material is recycled and

returned back to the beach, rather than being removed permanently from the system to ensure that a natural sediment balance is maintained into the future.

- At Trow Quarry, the recorded profiles and topographic survey present no causes for concern.
- At Marsden Bay, the recorded profiles present no causes for concern.

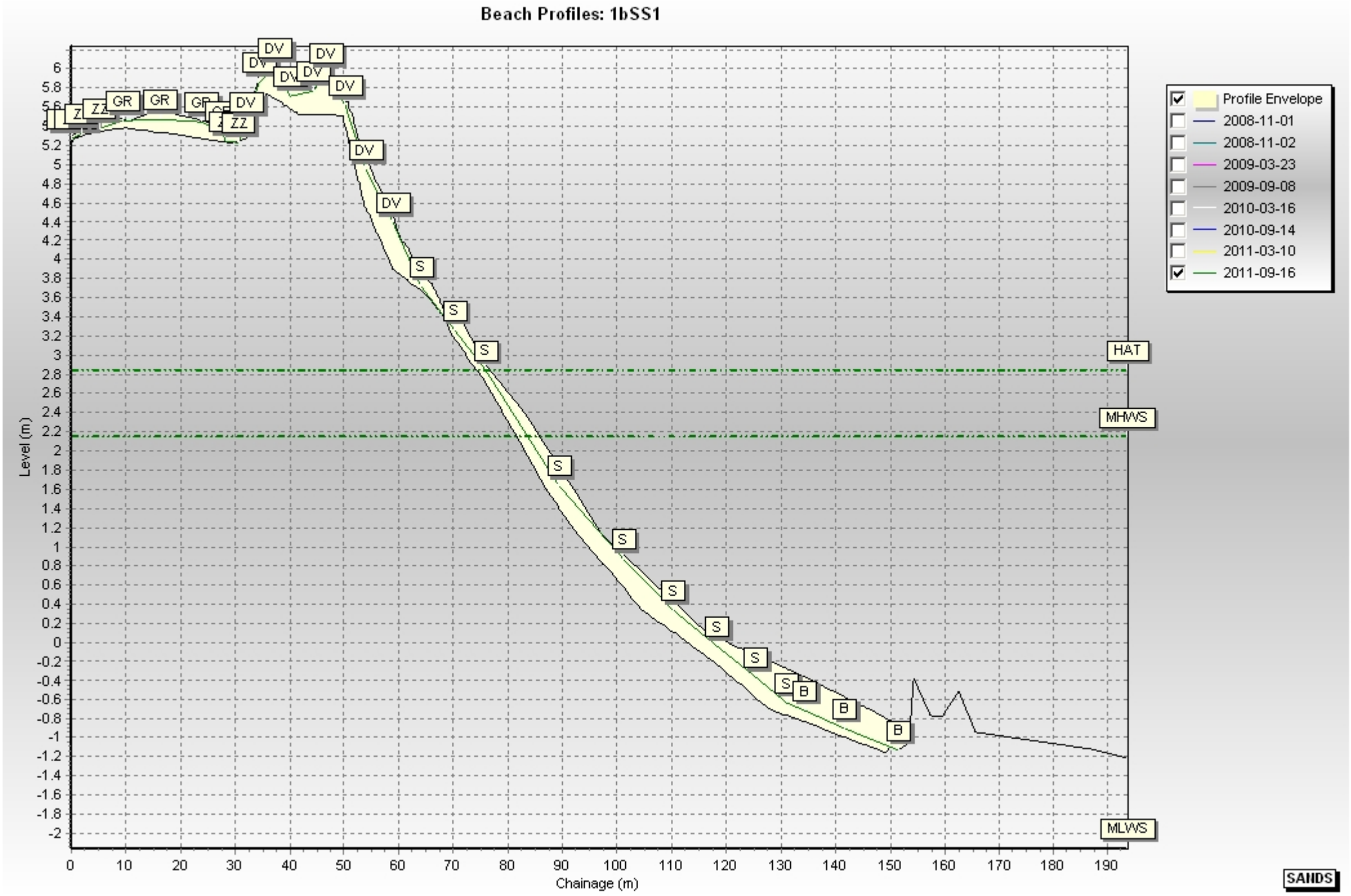
Appendices

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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MHWS
MLWS
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2009-03-23
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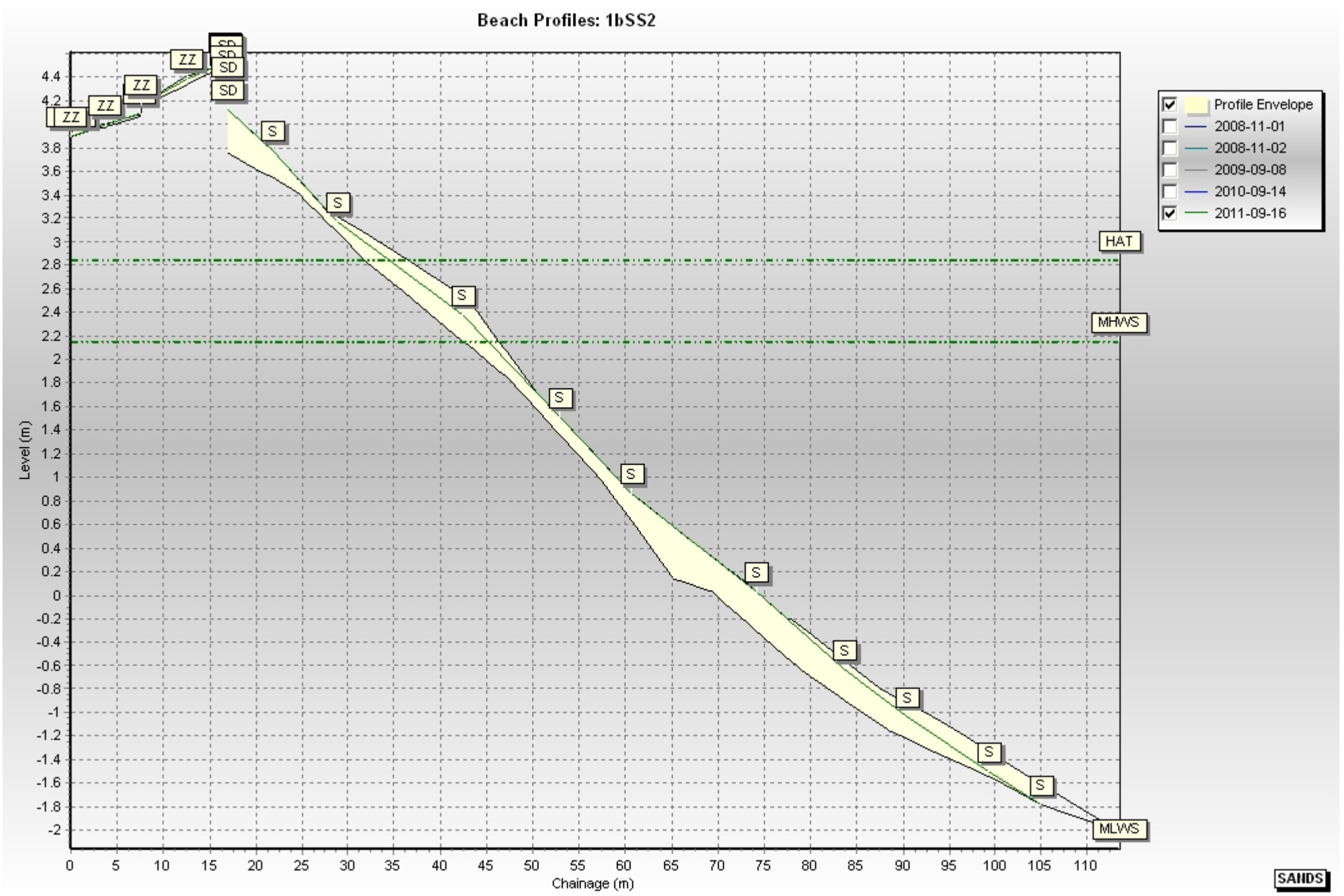
2010-09-14
2011-03-10
2011-09-16
SANDS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Chainage (m)
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S
HAT
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MLWS
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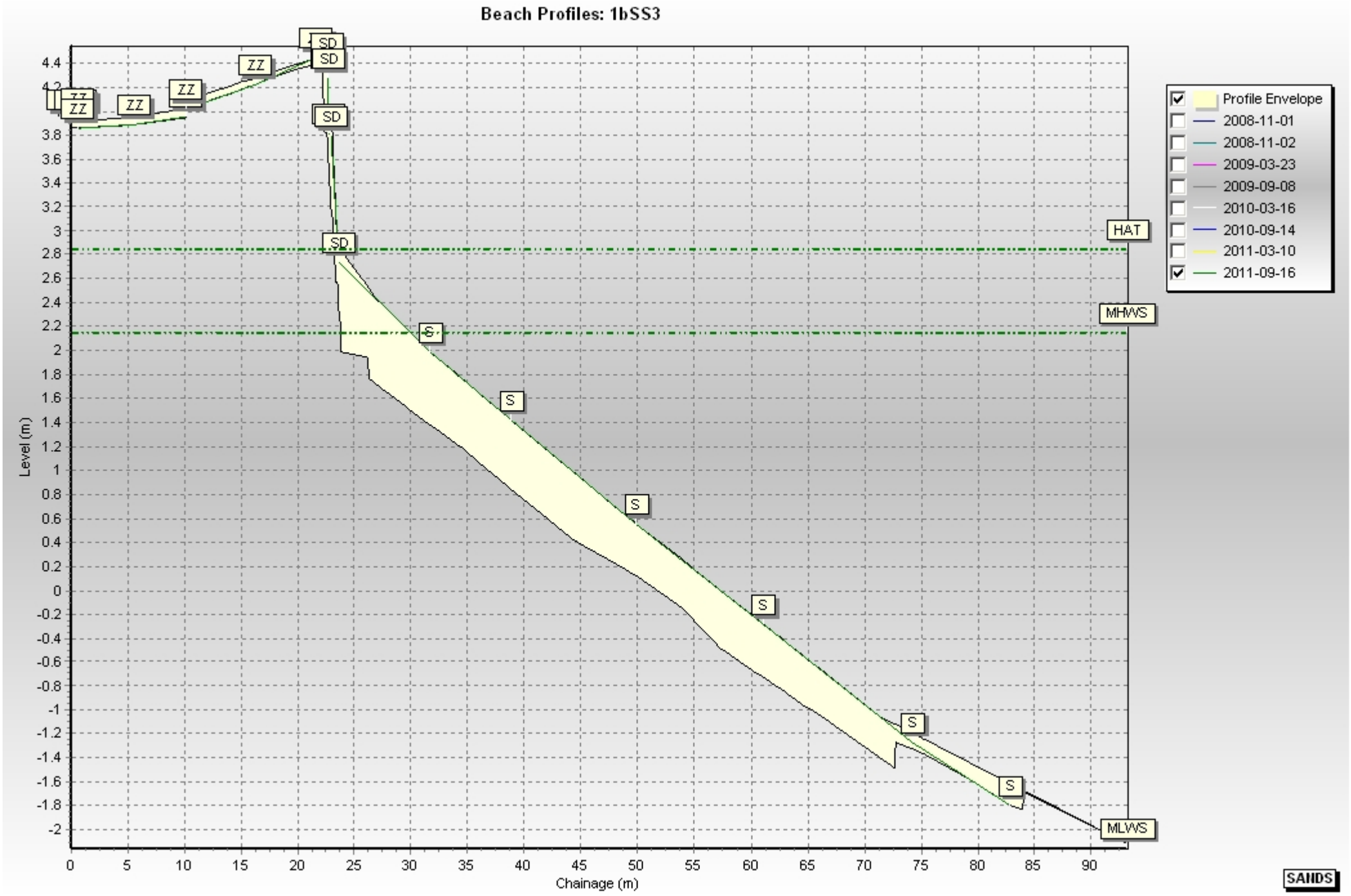
2009-09-08
2010-09-14
2011-09-16
SANDS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Chainage (m)
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MLWS
ZZ
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S
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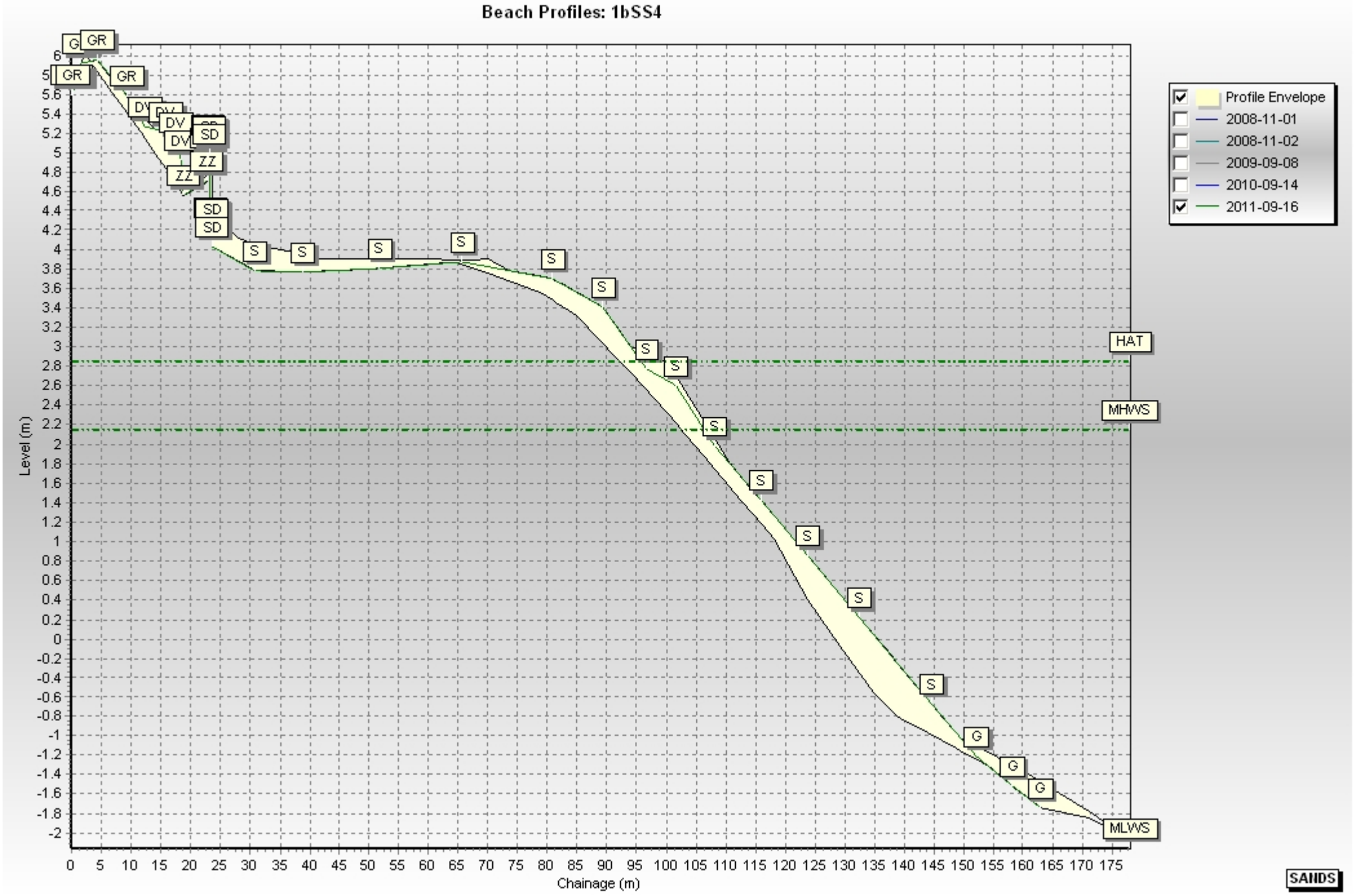
2010-03-16
2010-09-14
2011-03-10
2011-09-16
SANDS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2010-09-14
2011-09-16
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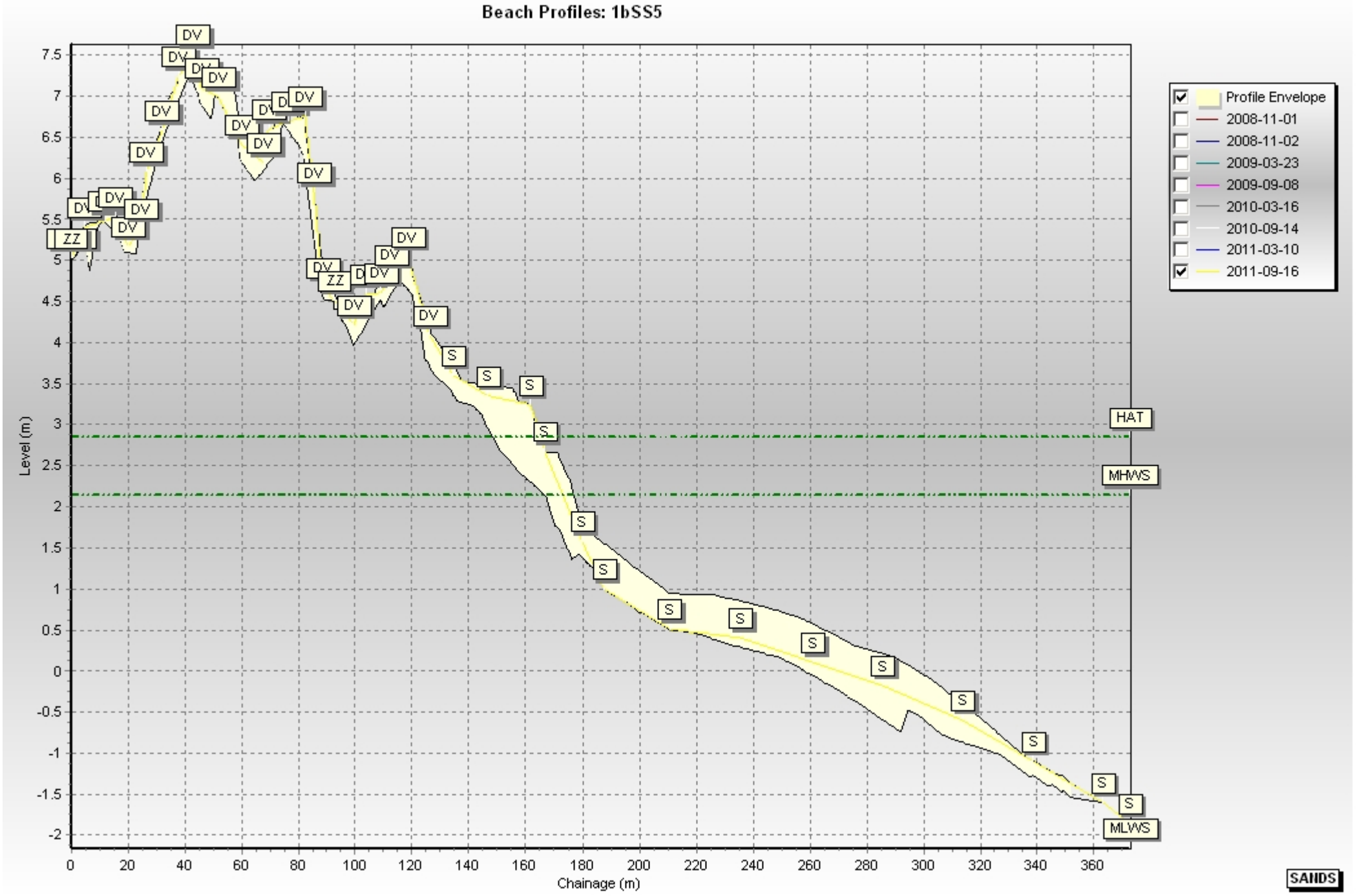
MLWS
Level (m)
Chainage (m)
SANDS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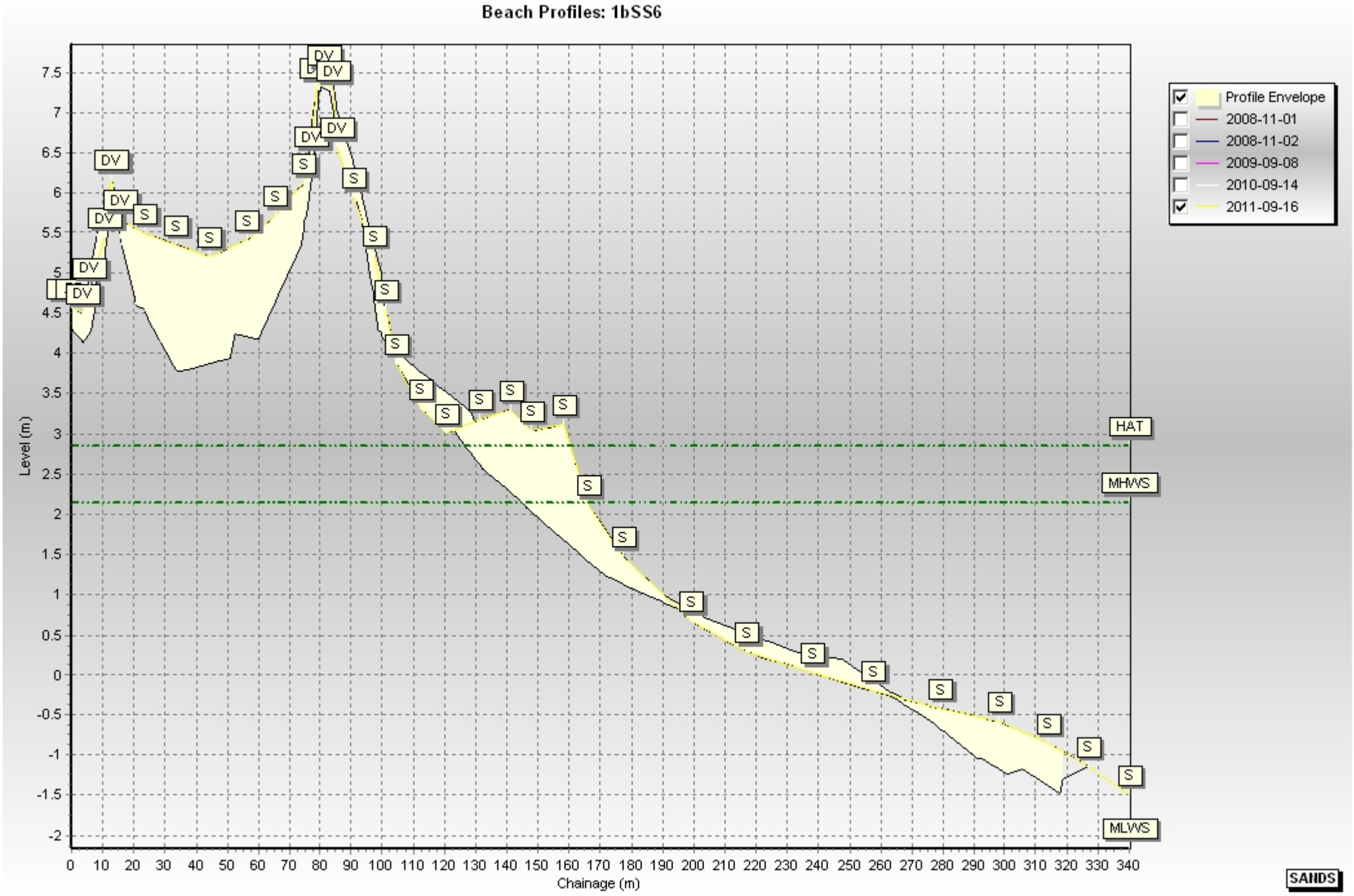
MHWS
MLWS
Level (m)
Chainage (m)
SANDS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MLWS
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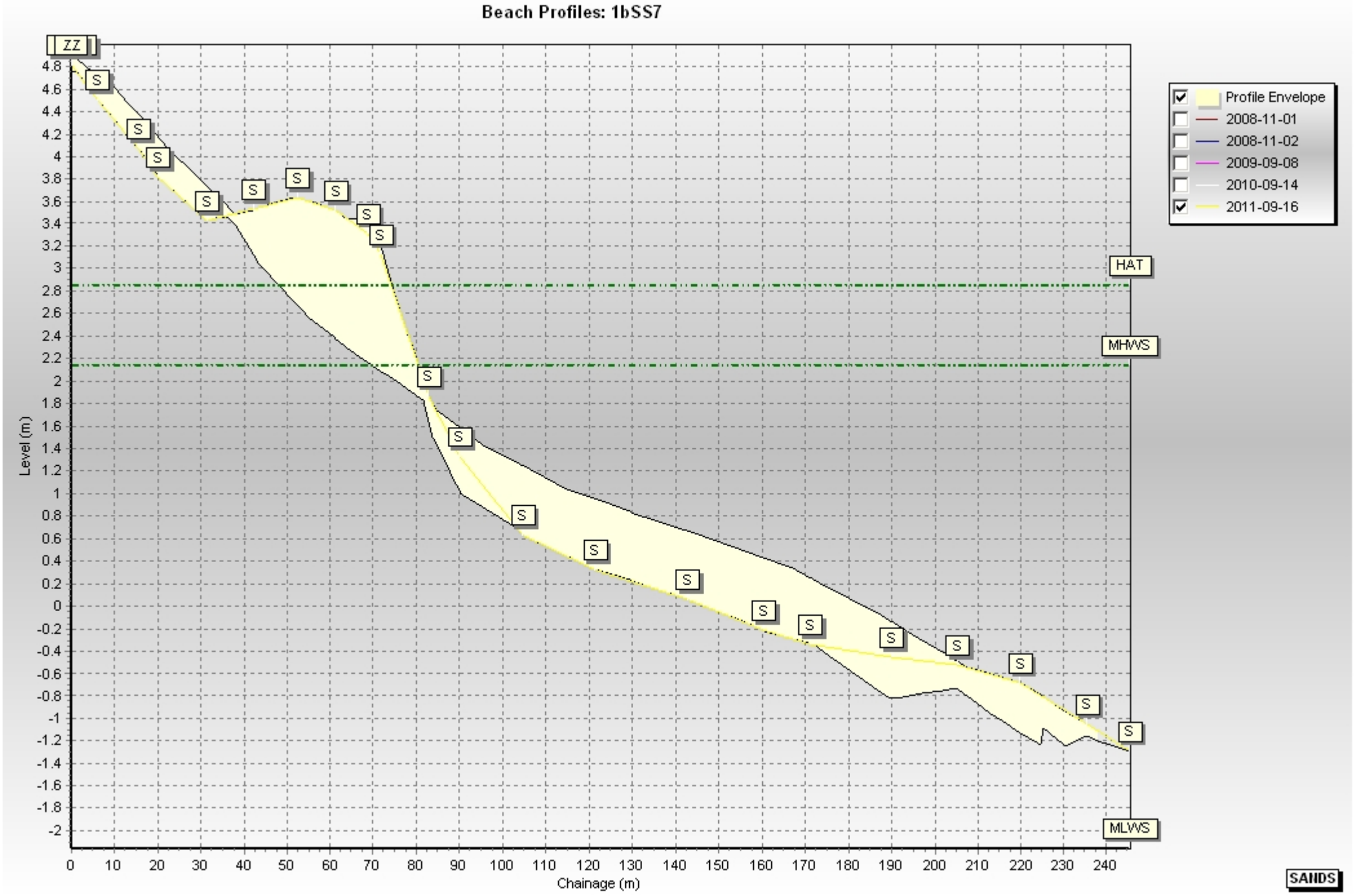
Chainage (m)
SANDS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ZZ
S
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MHWS
MLWS
Profile Envelope
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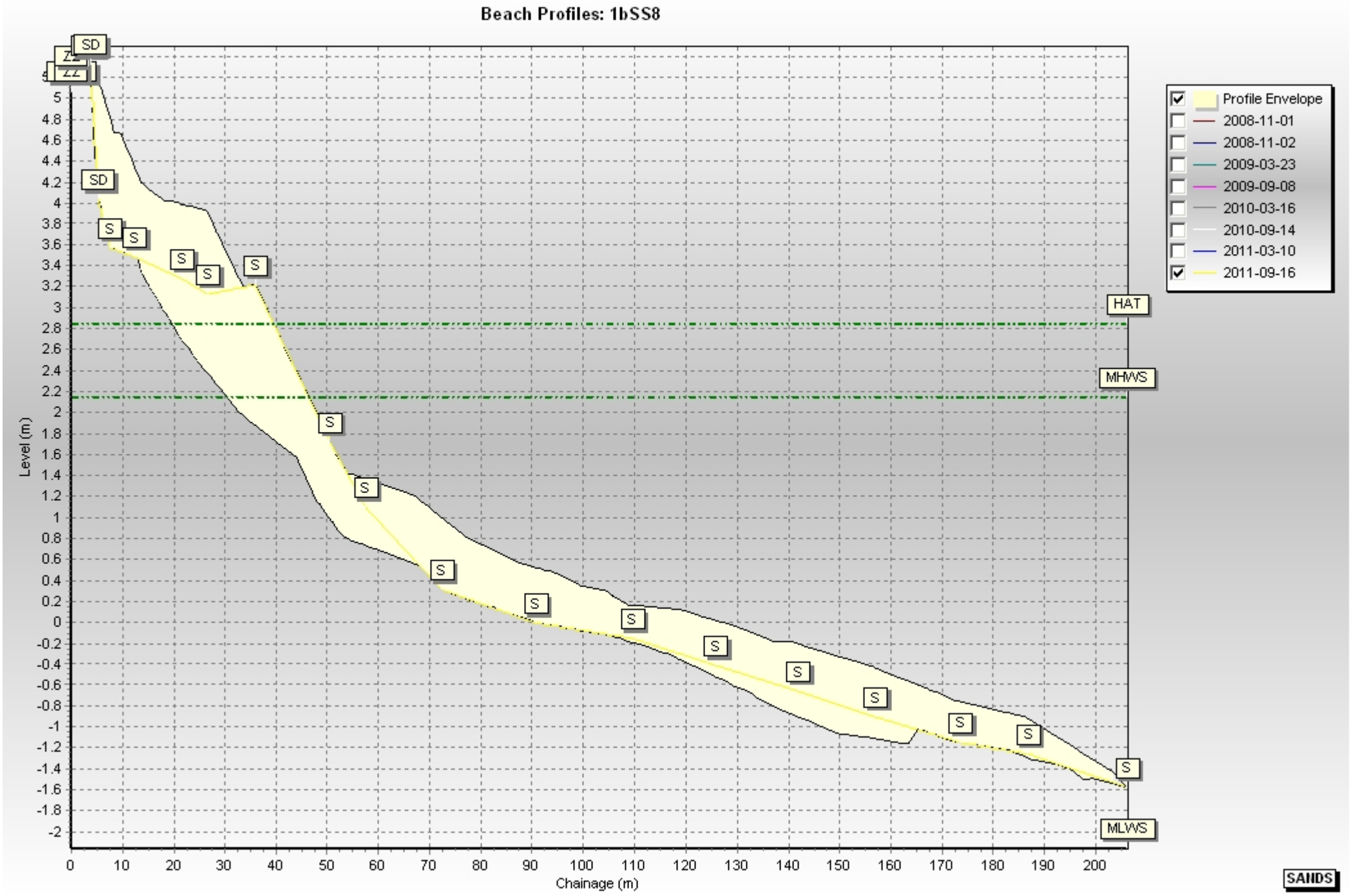
2011-09-16
Level (m)
Chainage (m)
SANDS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2011-09-16
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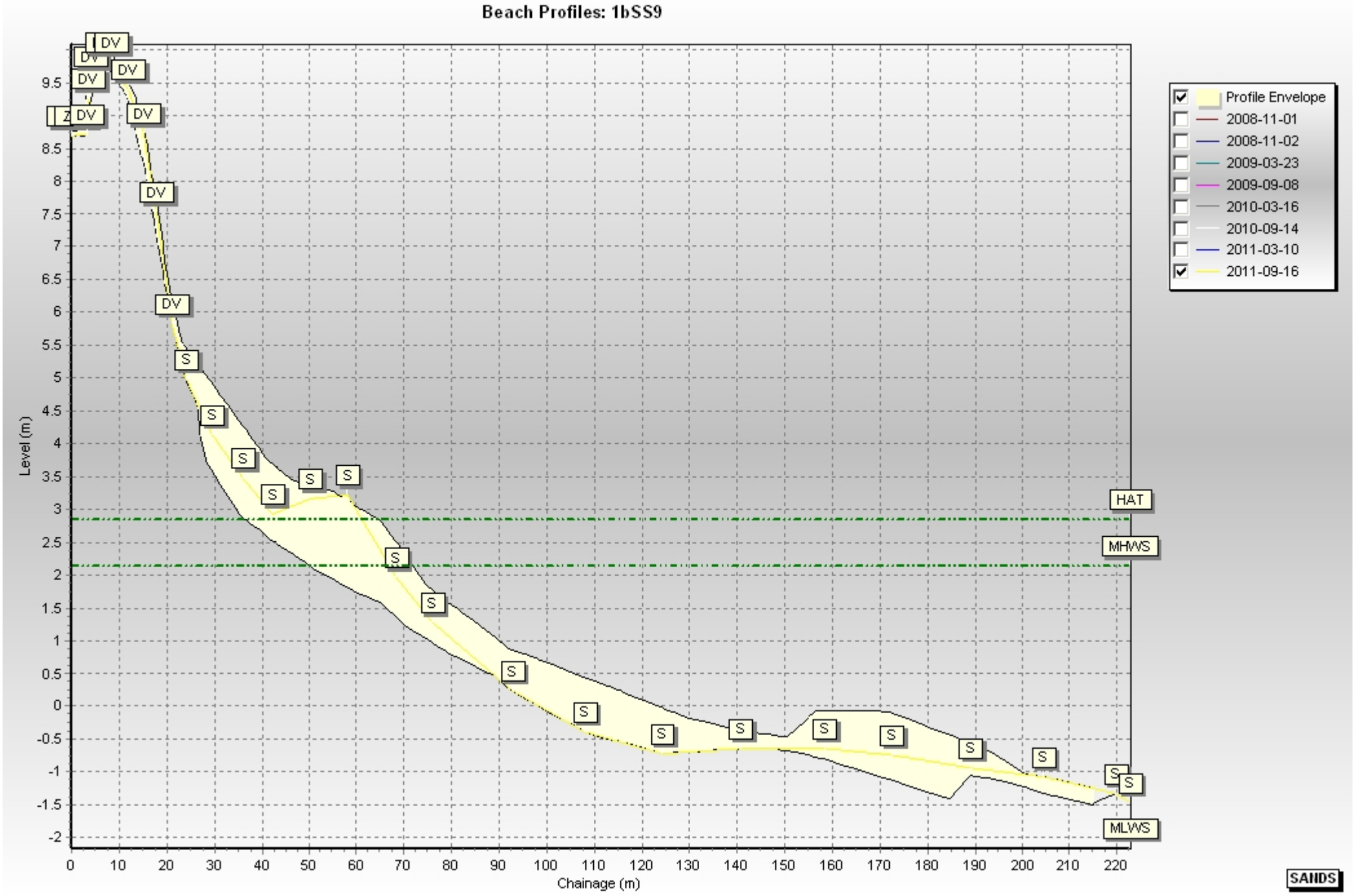
MHWS
MLWS
SD
S
Level (m)
Chainage (m)
SANDS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2009-03-23
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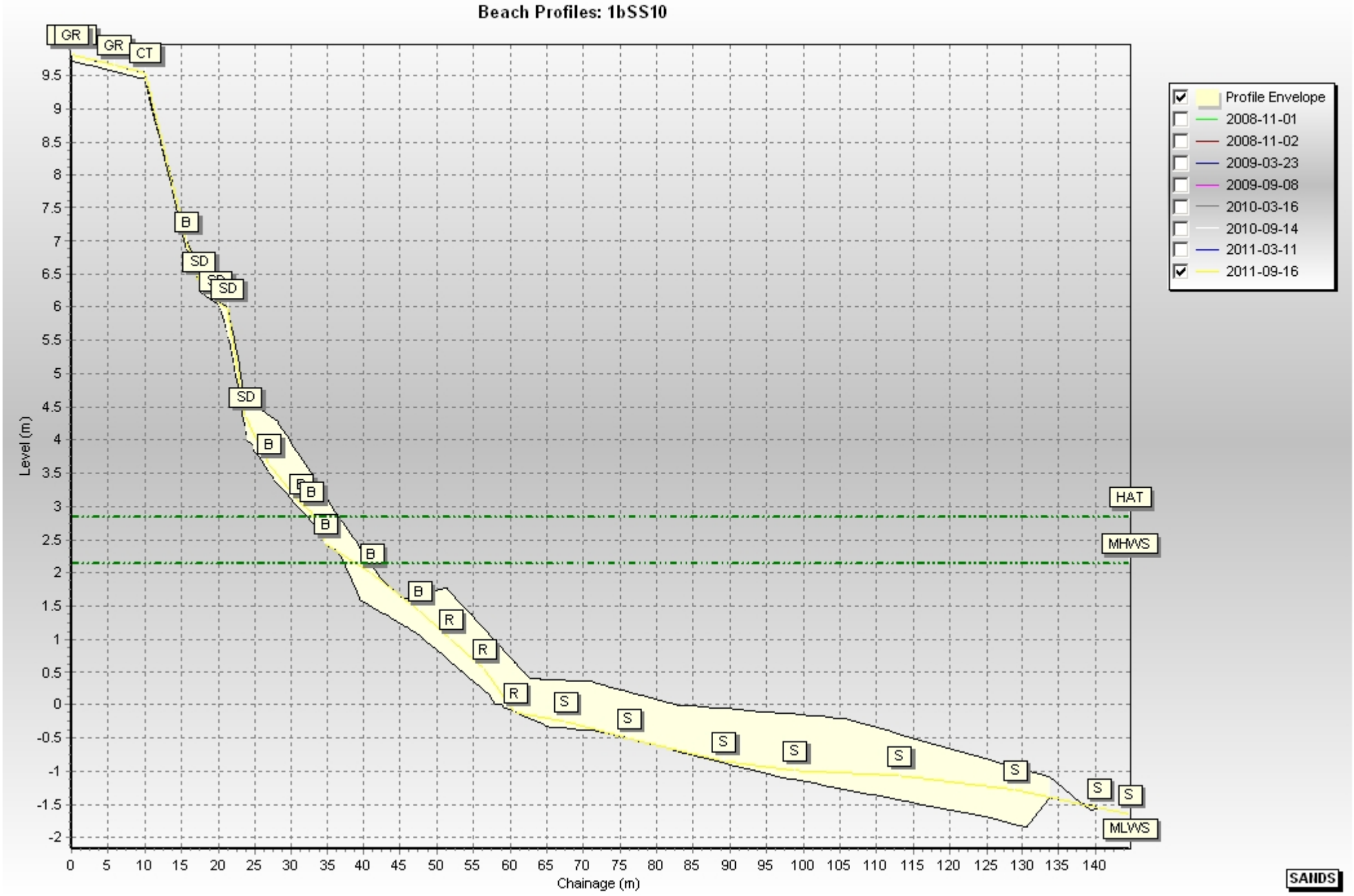
2010-03-16
2010-09-14
2011-03-10
2011-09-16
HAT
MHWS
MLWS
DV
S
Level (m)
Chainage (m)
SANDS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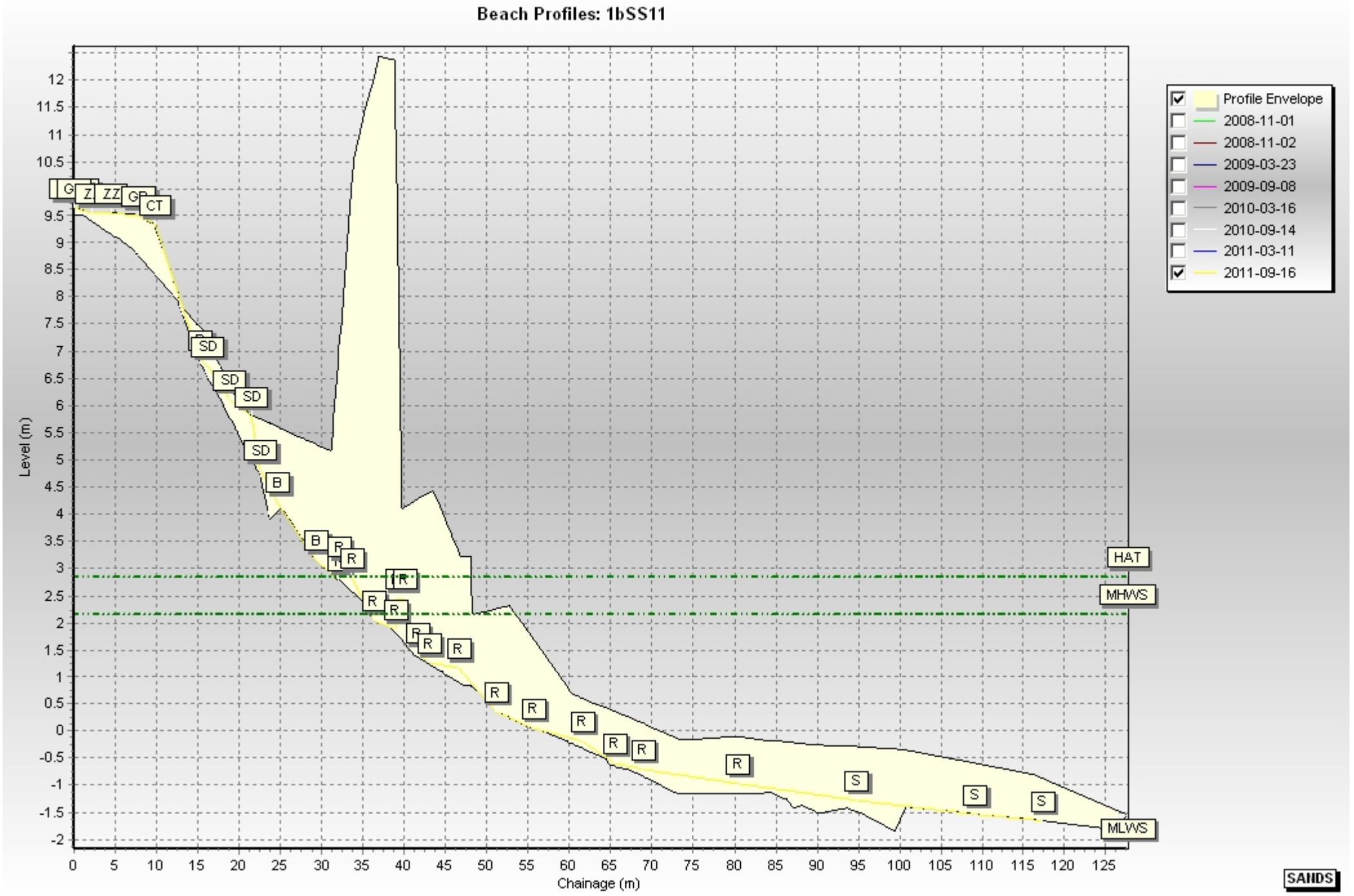
2011-09-16
HAT
MHWS
MLWS
Level (m)
Chainage (m)
SANDS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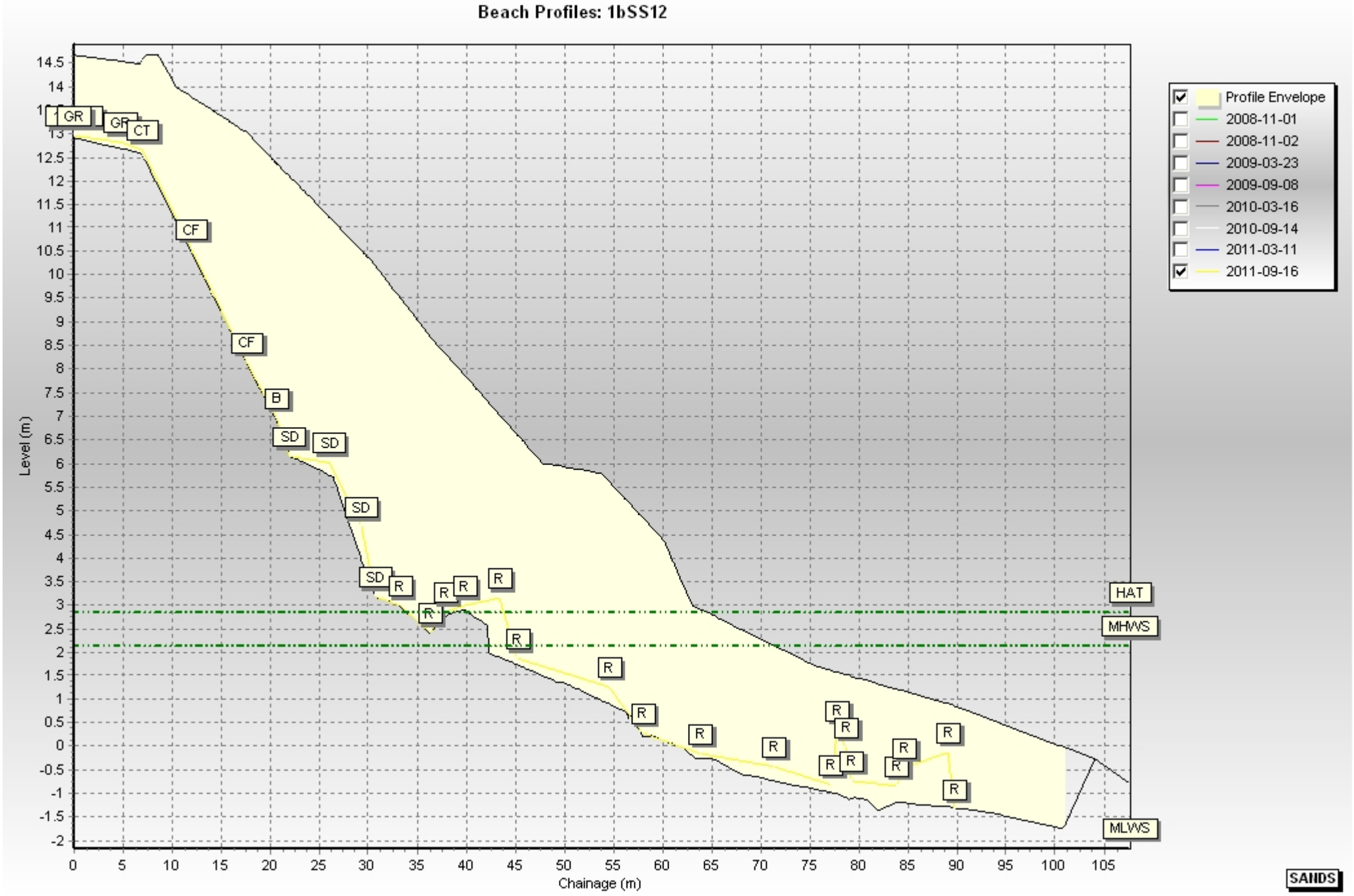
2011-03-11
2011-09-16
Level (m)
Chainage (m)
HAT
MHWS
MLWS
SANDS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2010-09-14
2011-03-11
2011-09-16
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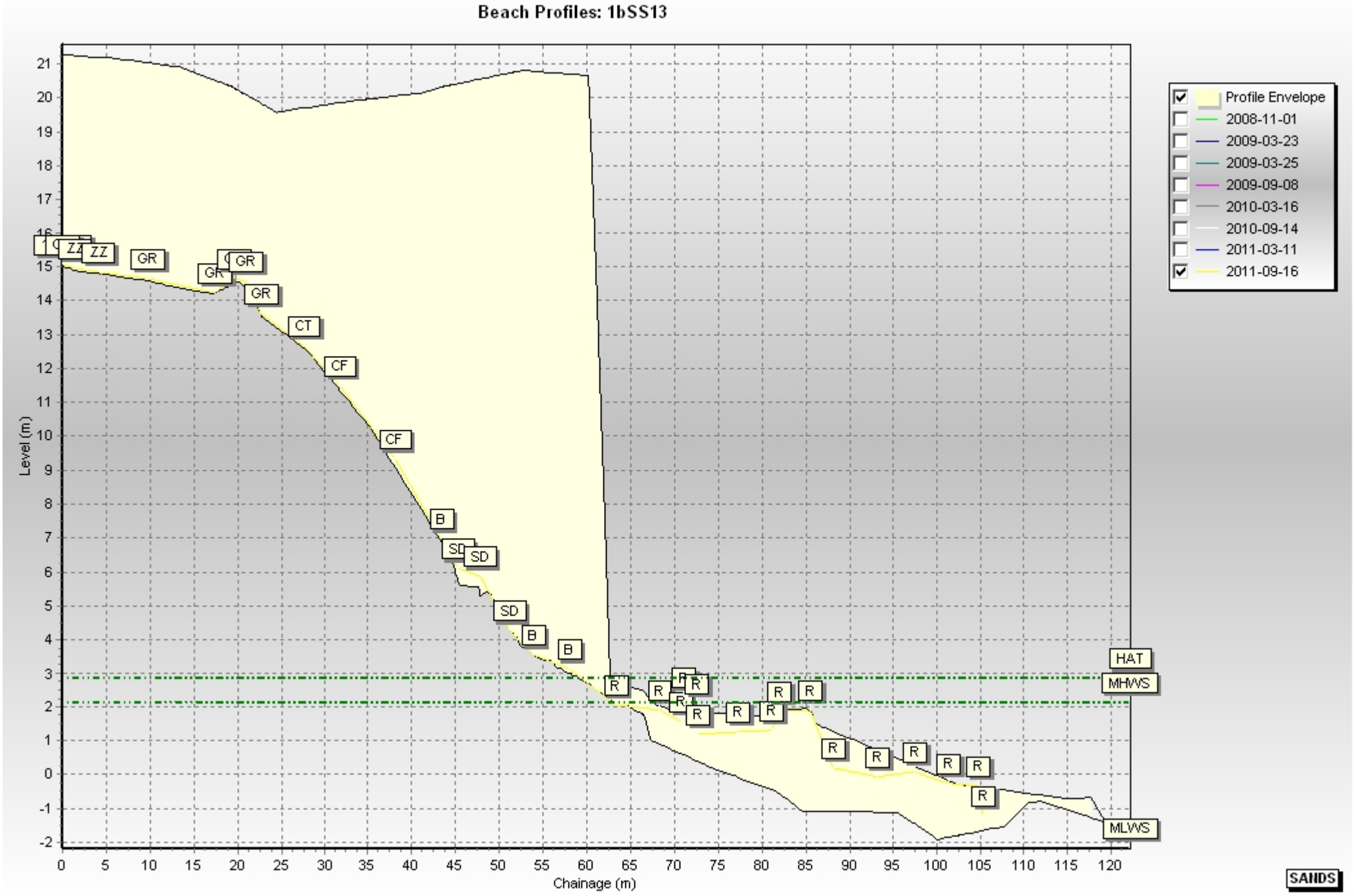
MHWS
MLWS
GR
GR
CT
CF
CF
B
SD
SD
SD
SD
R
SANDS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Chainage (m)
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CT
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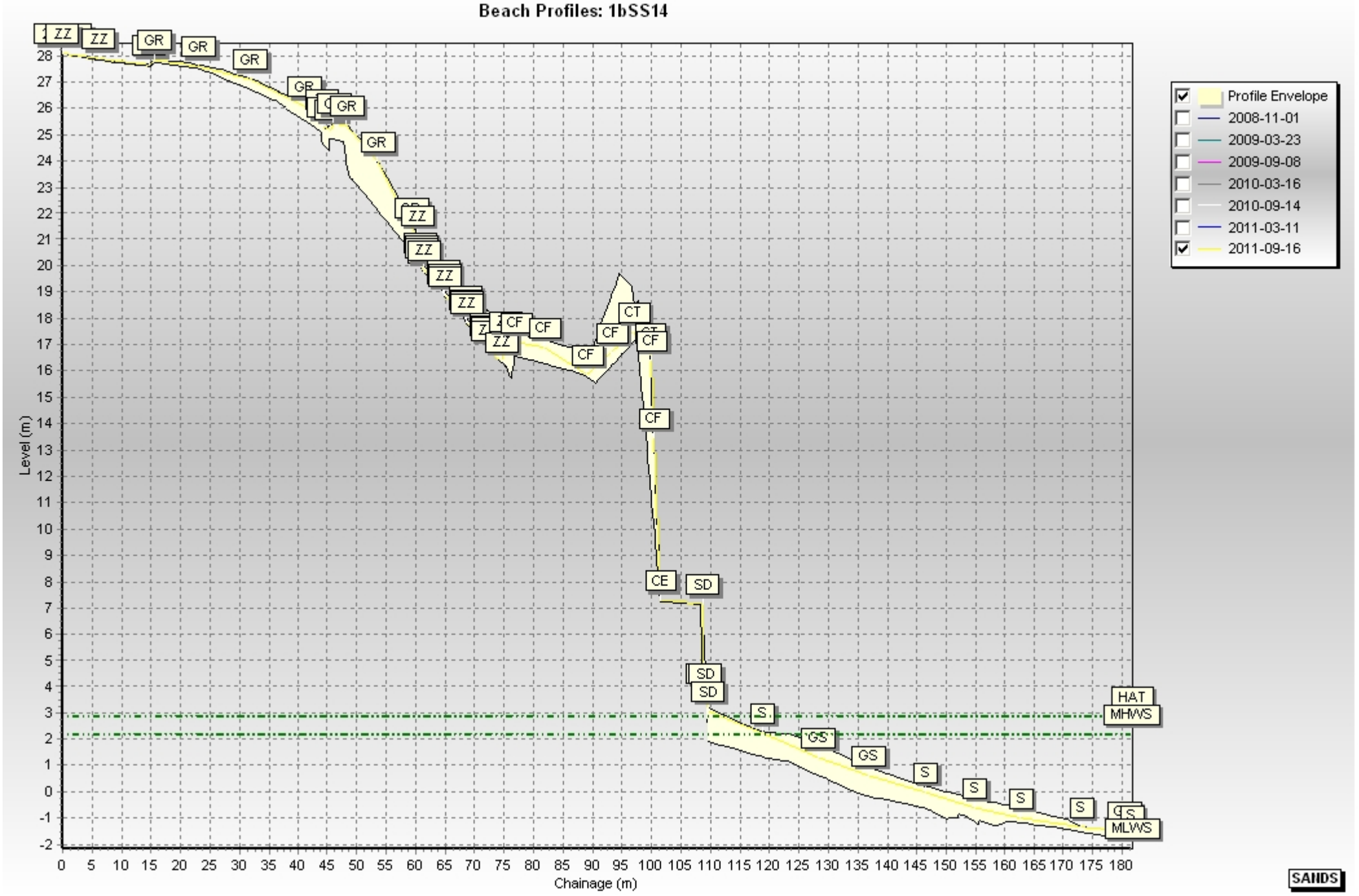
B
SD
R
SANDS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Chainage (m)
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2011-09-16
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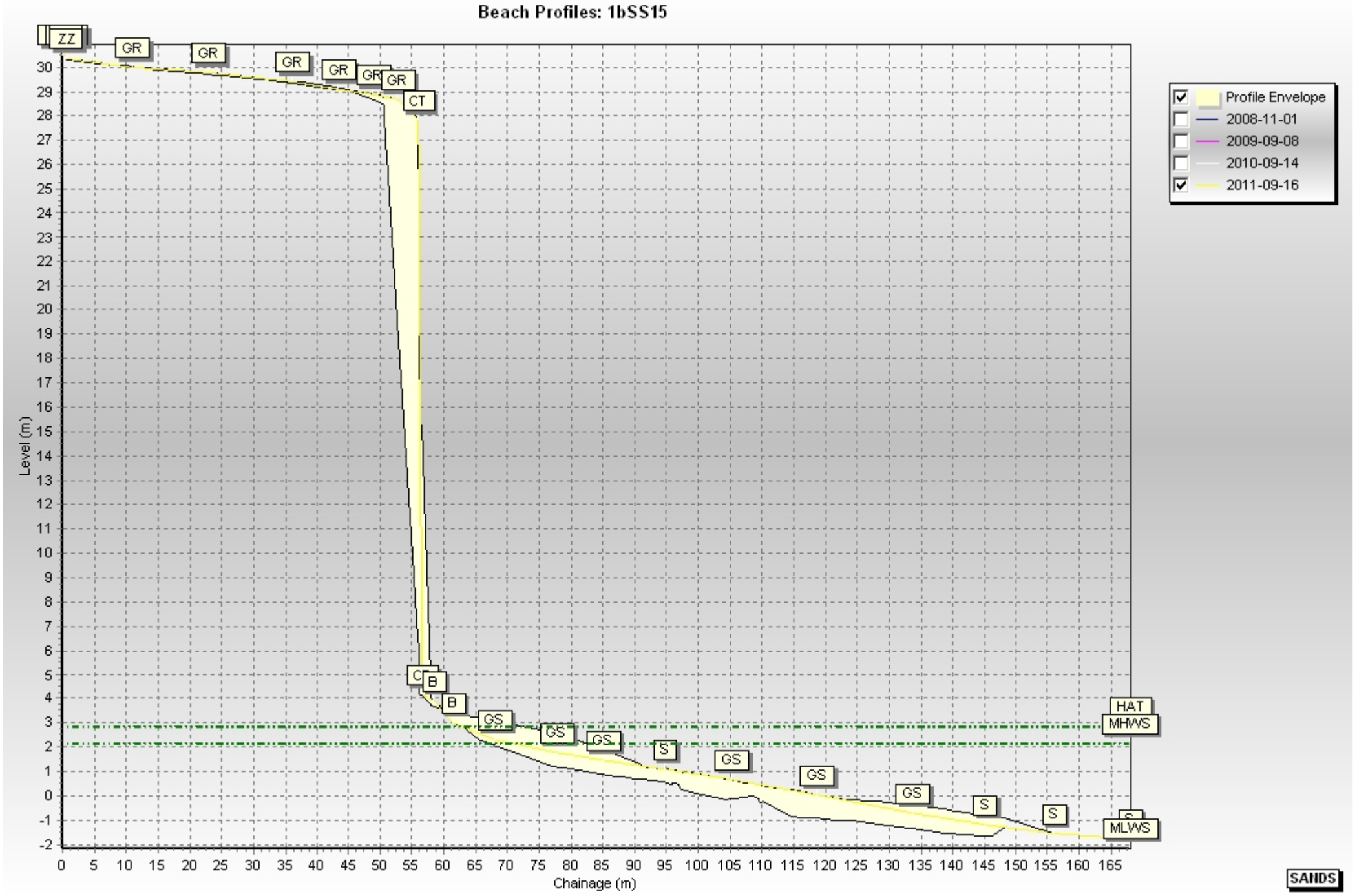
MHWS
MLWS
SANDS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GS
GS
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S
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GS
GS
S
S
HAT
MHWS
MLWS
Profile Envelope
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2011-09-16
Level (m)
Chainage (m)
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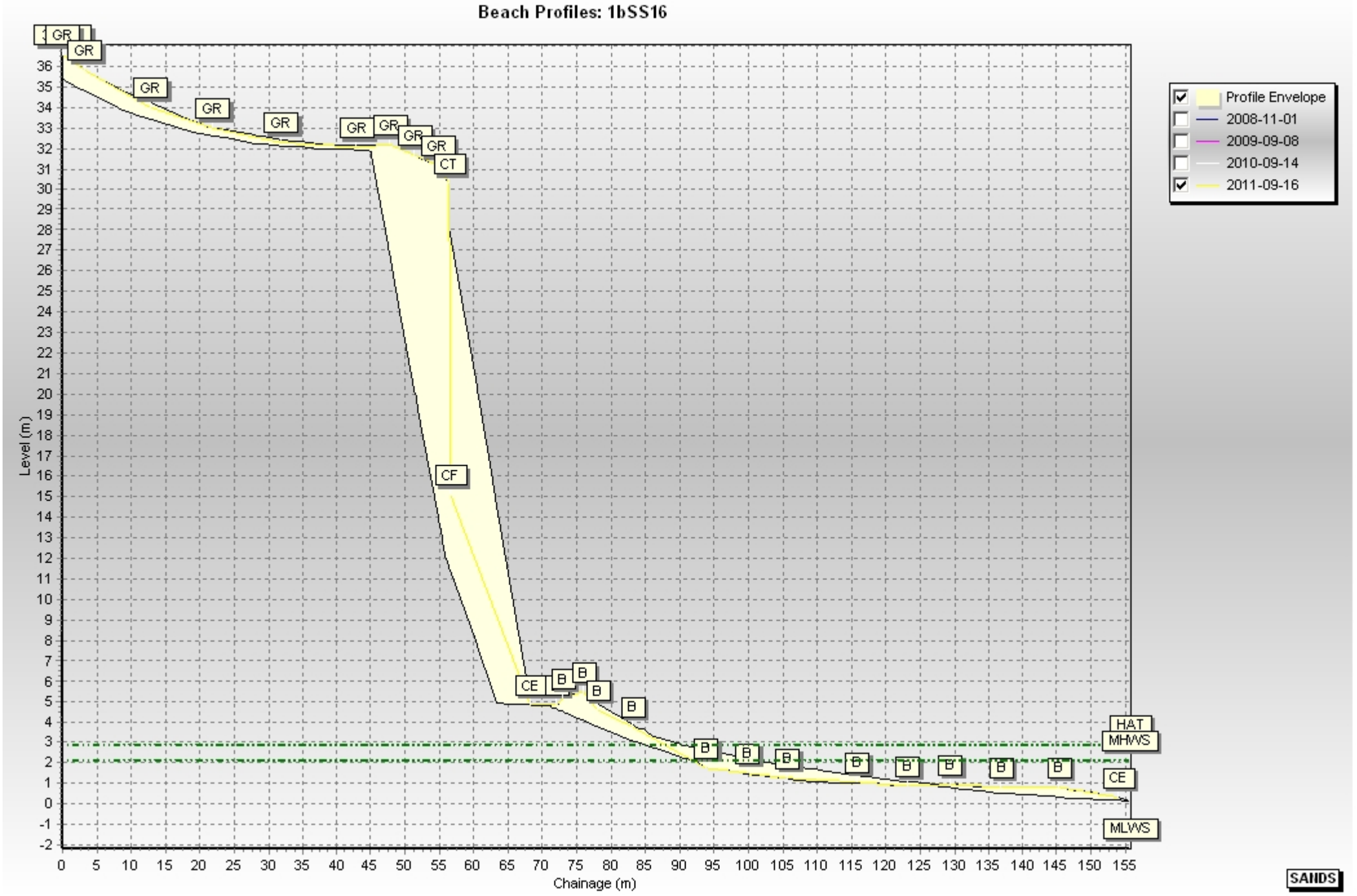
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Chainage (m)
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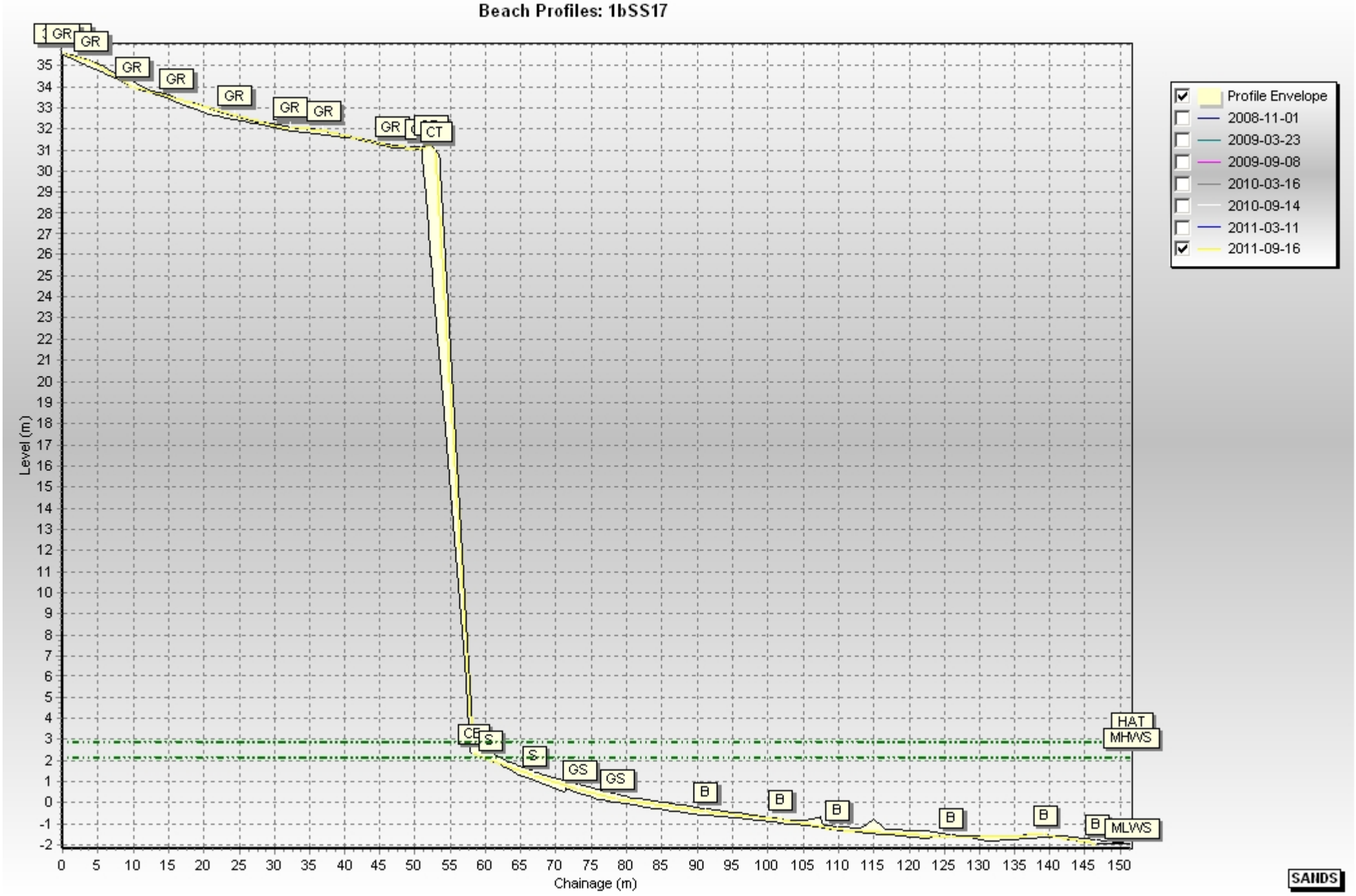
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2011-09-16
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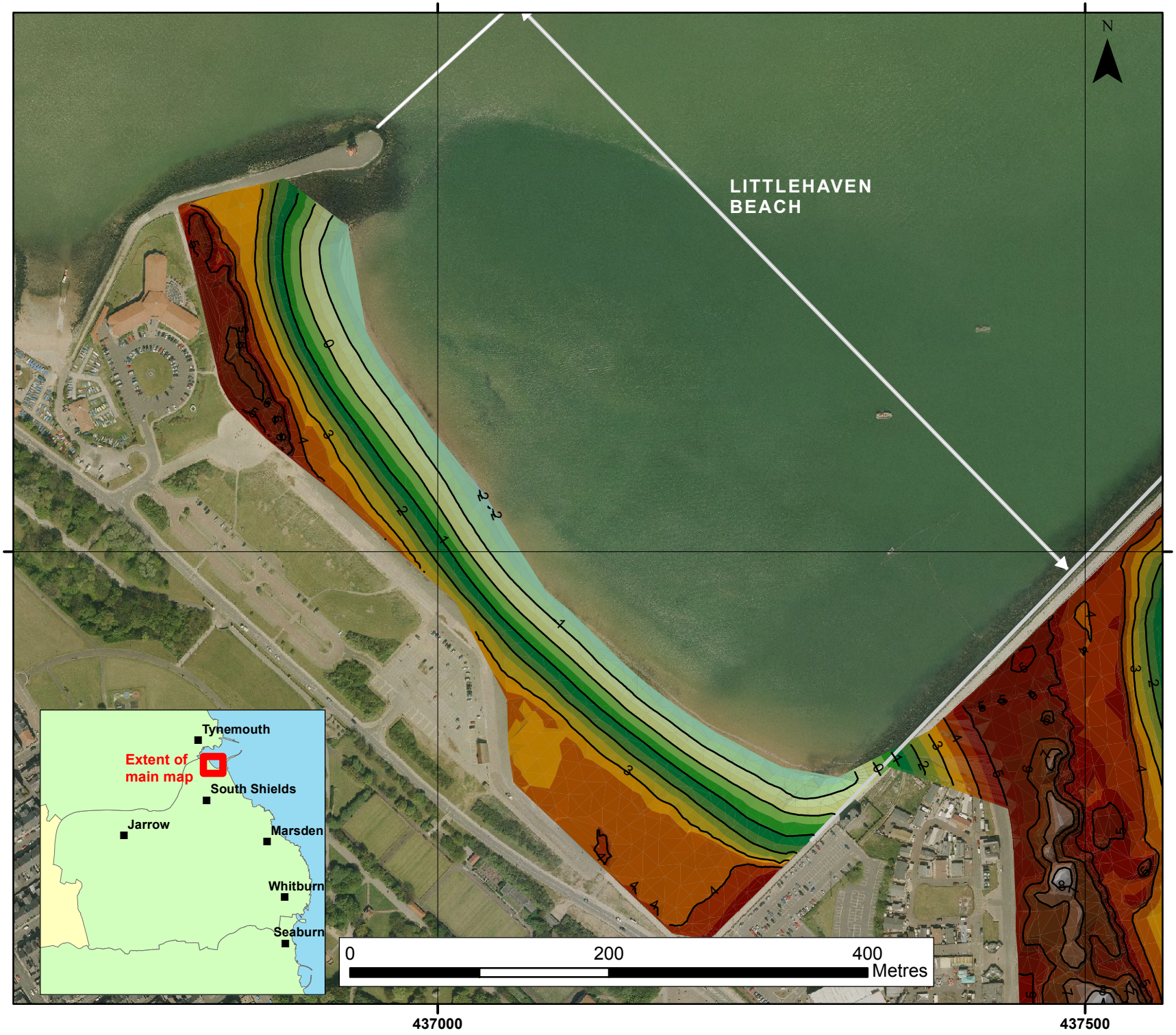
CT
CB
S
GS
B
HAT
MHWS
MLWS
SANDS

Appendix B

Topographic Survey



KEY

Elevation (m OD)	
10 - 10.5	3 - 3.5
9.5 - 10	2.5 - 3
9 - 9.5	2 - 2.5
8.5 - 9	1.5 - 2
8 - 8.5	1 - 1.5
7.5 - 8	0.5 - 1
7 - 7.5	0 - 0.5
6.5 - 7	-0.5 - 0
6 - 6.5	-1 - -0.5
5.5 - 6	-1.5 - -1
5 - 5.5	-2 - -1.5
4.5 - 5	-2.5 - -2
4 - 4.5	1m Contour
3.5 - 4	

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B- Map 1a
Topographic Survey
Littlehaven
SouthTyneside Council

Analytical Report 4
Full Measures Survey
Winter 2011

Halcrow
A CH2M HILL COMPANY

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

Tel: +44 (0)121 456 2345
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 1b Topographic Difference Littlehaven SouthTyneside Council

Analytical Report 4
Full Measures Survey
Winter 2011

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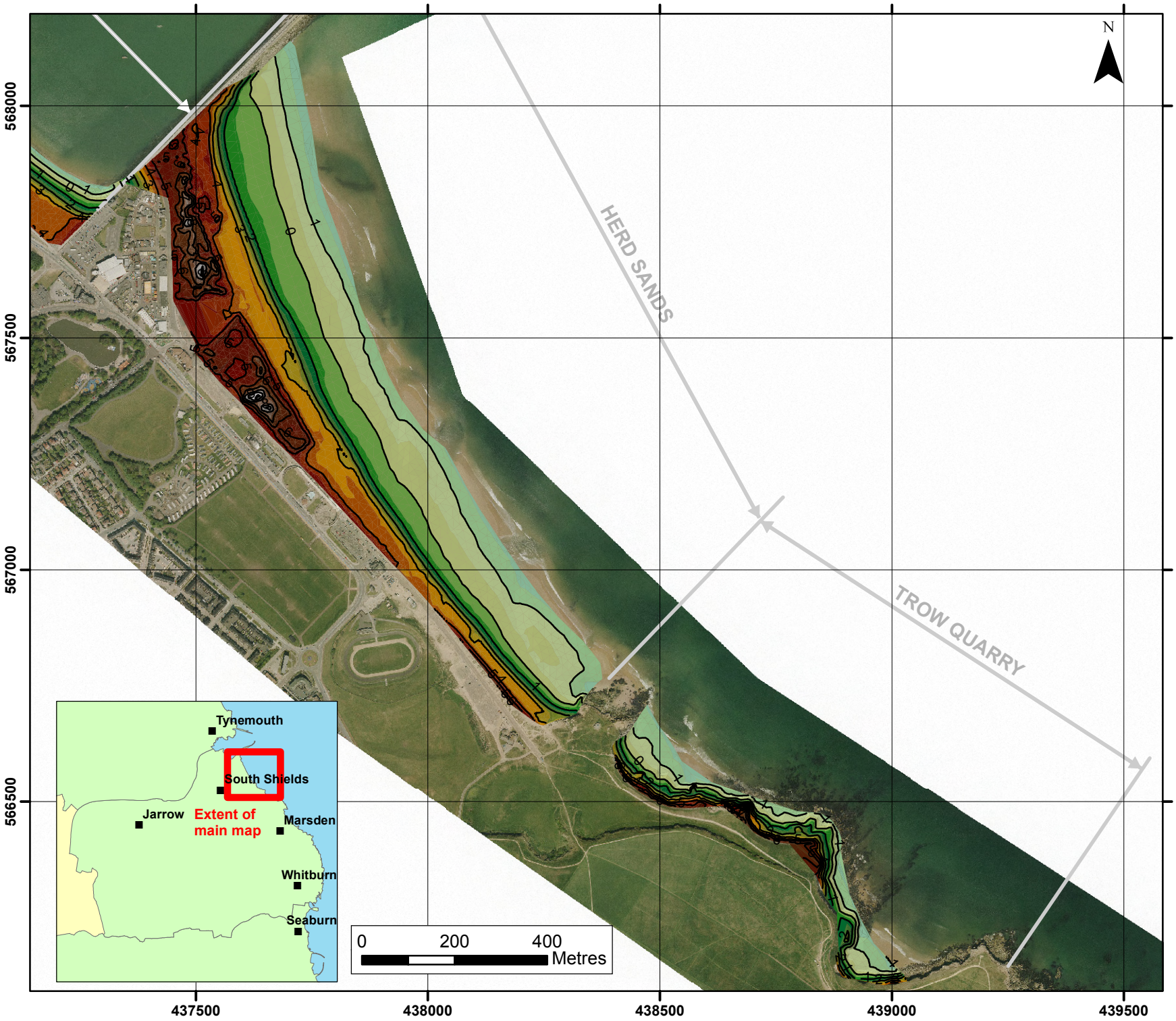
Fax: +44(0)121 456 1569
www.halcrow.com



KEY

Elevation (m OD)	
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9 - 9.5	2.5 - 3
8.5 - 9	2 - 2.5
8 - 8.5	1.5 - 2
7.5 - 8	1 - 1.5
7 - 7.5	0.5 - 1
6.5 - 7	0 - 0.5
6 - 6.5	-0.5 - 0
5.5 - 6	-1 - -0.5
5 - 5.5	-1.5 - -1
4.5 - 5	-2 - -1.5
4 - 4.5	-2.5 - -2
	1m Contour

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B-Map 2a
Topographic Survey
Herd Sands and Trow Quarry
SouthTyneside Council

Analytical Report 4
Full Measures Survey
Winter 2011

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

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	
0.25 - 0.5	
0.5 - 0.75	
0.75 - 1	
1 - 1.25	Gain
1.25 - 1.5	
1.5 - 1.75	
1.75 - 2	
>2	

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B- Map 2b Topographic Difference Herd Sands and Trow Quarry SouthTyneside Council

Analytical Report 4
Full Measures Survey
Winter 2011

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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
Trow Quarry
SouthTyneside Council

Analytical Report 4
Full Measures Survey
Winter 2011

Halcrow
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Fax: +44(0)121 456 1569
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