Cell 1 Regional Coastal Monitoring Programme Analytical Report 7: 'Full Measures' Survey 2014

South Tyneside Council Final Report

February 2015

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Authors	
Emma Allan	CH2MHILL Halcrow
Dr Paul Fish – Review of Draft	CH2MHILL Halcrow
Dr Andy Parsons – Approval of Final	CH2MHILL Halcrow

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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
		2.88
HAT	2.85	2.18
MHWS	2.15	-2.12
MLWS	-2.15	

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.

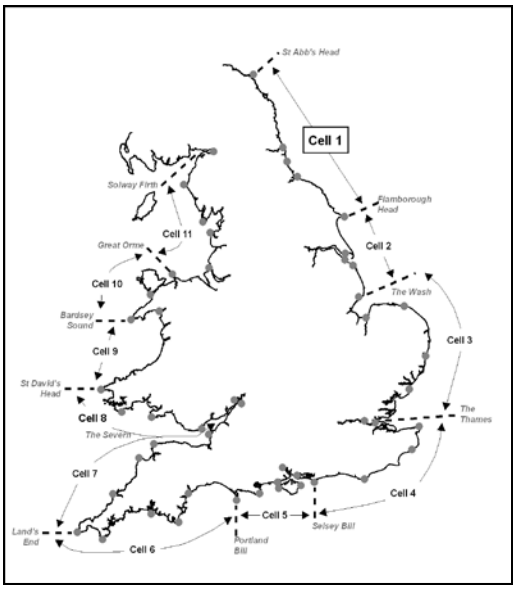

Figure 1 Sediment Cells in England and Wales

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
North Tyneside Council
South Tyneside Council
Northumberland Coast AONB
Sunderland City Council
Durham County Council
Redcar & Cleveland Borough Council
Hartlepool Borough Council
Scarborough Borough Council
East Riding of Yorkshire Council
A great place to live, work & play
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 (rebranded as CH2M HILL since 2013).

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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	Mar - May 12	Feb 13	-
5	2012/13	Nov 12	Mar 13	Mar 13	June 13	
6	2013/2014	Nov 13	Feb 14	Apr 14	Jul 14	
7	2014	Nov 14	Feb 15 (*)			

(*) The present report is **Analytical Report 7** and provides an analysis of the 2014 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	Spittal A
	Spittal B
	Goswick Sands
	Holy Island
	Bamburgh
	Beadnell Village
	Beadnell Bay
	Embelton Bay
	Boulmer
	Alnmouth Bay
	High Hauxley and Druridge Bay
	Lynemouth Bay
	Newbiggin Bay
	Cambois Bay
	Blyth South Beach
North Tyneside Council	Whitley Sands
	Cullercoats Bay
	Tynemouth Long Sands
	King Edward's Bay
South Tyneside Council	Littehaven Beach
	Herd Sands
	Trow Quarry (incl. Frenchman's Bay)
	Marsden Bay
Sunderland Council	Whitburn Bay
	Harbour and Docks
	Hendon to Ryhope (incl. Halliwell Banks)
Durham County Council	Featherbed Rocks
	Seaham
	Blast Beach
	Hawthorn Hive
	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)
	Staithes
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 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)

*Please note that the 2008 surveys at beach profiles 1bSS11, 1bSS12 and 1bSS13 were found to be undertaken at a different location to all the profiles surveyed since then. For this reason, the 2008 profiles have been extracted from analysis undertaken herein.

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 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. Therefore, cliff top survey data collected from Full Measures survey (autumn 2011) going forward is presented in this report.

The location of these surveys is shown in Figure 2. The Full Measures survey was undertaken along this frontage between 24th and 27st November 2014. During this time the 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.

1.3 Uncertainties in data and analysis

While uncertainty due to survey accuracy or systematic error is likely to be present in all datasets, the work is carefully managed to ensure data are as accurate as possible and results are not misleading. Error may arise from the limits of precision of survey techniques used, from low accuracy measurements being taken or from systematic failings of equipment.

For beach profiles and topographic surveys, all incoming data are checked allowing systematic errors to be identified, and removed from plots and subsequent analysis. The accuracy of these surveys is not known, but it is likely that all measurements are correct to ±0.1m. Therefore, changes less than ±0.1m are ignored and greyed out in the topographic change plots. For cliff top erosion surveys, there are commonly problems in precisely recognising the cliff edge due to vegetation growth and the convex shape of the feature. Errors can manifest themselves as results that suggest the cliff edge has advanced, which is very unlikely unless a toppling failure has been initiated, but the block has not yet fully detached. The accuracy of cliff top surveys are also unknown, but it is assumed that each measurement is accurate to ±0.1m.

These limits of accuracy mean that comparison of annual or biannual data can be of limited value if the measured change is less than or equal to the assumed error. However, all results become more significant over longer time periods when the errors in measurement in years 1 and *x* are averaged over the monitoring period:

$$\text{Error rate of change per year} = \frac{\text{Error in first measurement} + \text{Error in last measurement}}{\text{Years between measurements}}$$

The effect of averaging error over different monitoring periods is summarised in Table 3, which assumes that each annual survey is accurate to 0.1m.

Table 3 Error bands for long-term calculations of change.

Years between surveys	Error bands in inter-survey comparison (±m/yr)
1	0.200
2	0.100
3	0.067
4	0.050
5	0.040
5	0.033
7	0.029
8	0.025
9	0.022
10	0.020

While considering the uncertainty in comparing and analysing change between monitoring data sets it is also relevant to raise caution about drawing conclusions about short or longer term trends. Clearly the longer the data set the more confidence that can be given to likely ranges of beach changes and trends in change. Potential for seasonal, annual and longer term cycles need to be considered. Studies of long term monitoring data sets for other coastal and estuarial data have established that there are long period cyclical trends related to the 18.6 years lunar nodal cycle which need to be accounted for. Simply put this means that although the Cell 1 monitoring programme now has data in some locations up to 11 years, another 8 to 10 years of consistent data is needed before confidence can be given in trends from the analysis. In the context of this report “Longer Term Trends” are mentioned in each section and it should be noted that this is based on simple visual interpretation of the available data since the current programme began, and is generally based on only 5 to 10 years of data.

2. Wave Data and Interpretation.

2.1 Introduction

Wave monitoring data relevant to the Cell 1 Regional Coastal Monitoring Programme is available from one offshore regional wave buoy located at Tyne and Tees and three regional wave buoys, which are further inshore at Newbiggin, Whitby and Scarborough. The Tyne Tees buoy is managed by Cefas as part of the WaveNet system, while the three inshore buoys is managed by Scarborough BC as part of the Cell 1 monitoring programme.

An assessment of baseline wave data is presented in the 2011 Wave Data Analysis Report, which reviewed all readily available data in the region. The present wave data update report provides an update to the baseline with analysis of the wave data collected under the programme for 2012, 2013 and 2014. In order to help put the beach and cliff changes discussed in this report into context, analysed storm data for the wave buoys is presented in this section.

The longest consistent relevant wave data record in the Cell 1 region is from the WaveNet Tyne Tees buoy deployed under the national coastal monitoring programme by Cefas. Data has been downloaded from WaveNet and loaded into SANDS for analysis alongside the beach and cliff monitoring data and is presented in Table 4 below.

To aid interpretation of the results in Table 4 alternate years have been shaded and the storm with the largest peak wave height each year has been highlighted in bold. The annual storm with the highest wave energy at peak has also been highlighted in bold red text as this depends on wave period as well as wave height and so is not always the same as the largest wave height, e.g. in 2007 and 2008.

Table 4: SANDS Storm Analysis at Tyne/Tees WaveNet Buoy

General Storm Information					At Peak			
Start Time	**End Time**	**Duration (Hours)**	**Peak of Storm**	**Mean Direction Vector (Degrees)**	**Hs (m)**	**Tp (s)**	**Direction (Degrees)**	**Energy @ Peak (KJ/m/s)**
19/03/2007 10:30	21/03/2007 05:30	43	20/03/2007 14:30	78.2	6.2	12.4	23	1.7E+04
25/06/2007 20:30	26/06/2007 13:30	17	26/06/2007 10:00	77.3	4.4	8.6	23	4.0E+03
26/09/2007 03:00	27/09/2007 05:00	26	26/09/2007 19:00	79.7	4.6	11.6	6	**7.8E+03**
08/11/2007 20:00	12/11/2007 15:00	91	09/11/2007 08:30	77.7	**6.2**	**13.3**	**6**	1.9E+04
19/11/2007 03:30	25/11/2007 21:30	162	23/11/2007 05:00	76.8	4.9	10.7	17	7.6E+03
08/12/2007 03:00	10/12/2007 14:30	59.5	08/12/2007 03:30	82.9	4.1	10.7	17	5.4E+03
03/01/2008 10:30	04/01/2008 01:30	15	03/01/2008 23:30	14.6	4.2	9.1	62	4.2E+03
01/02/2008 15:00	02/02/2008 09:30	18.5	02/02/2008	80.1	6.0	13.8	17	1.9E+04
10/03/2008 08:30	10/03/2008 12:30	4	10/03/2008 11:00	307.5	4.6	8.1	141	3.8E+03
17/03/2008 15:00	25/03/2008 03:00	180	22/03/2008 05:00	82.1	**7.9**	**12.4**	**6**	2.7E+04
05/04/2008 22:00	07/04/2008 05:00	31	06/04/2008 19:00	83.1	4.6	11.7	6	7.9E+03
20/07/2008 16:00	21/07/2008 09:30	17.5	20/07/2008 23:30	76.0	4.2	9.9	11	4.9E+03
03/10/2008 03:00	03/10/2008 20:30	17.5	03/10/2008 16:30	76.7	4.7	11.4	23	**8.1E+03**
21/11/2008 04:00	25/11/2008 12:30	104.5	22/11/2008 11:30	75.8	6.0	13.1	11	1.7E+04

General Storm Information					At Peak			
Start Time	**End Time**	**Duration (Hours)**	**Peak of Storm**	**Mean Direction Vector (Degrees)**	**Hs (m)**	**Tp (s)**	**Direction (Degrees)**	**Energy @ Peak (KJ/m/s)**
10/12/2008 12:00	13/12/2008 18:00	78	13/12/2008 08:00	332.1	4.9	8.4	129	4.7E+03
31/01/2009 16:30	03/02/2009 09:00	64.5	02/02/2009 22:00	7.2	5.8	9.6	84	8.7E+03
23/03/2009 22:30	28/03/2009 20:30	118	28/03/2009 16:30	89.4	5.3	8.4	6	5.4E+03
10/07/2009 01:30	10/07/2009 02:30	1	10/07/2009 01:30	78.7	4.2	10.0	11	5.0E+03
29/11/2009 20:30	30/11/2009 15:00	18.5	30/11/2009 00:30	72.7	**6.0**	**9.4**	**11**	9.0E+03
17/12/2009 10:30	18/12/2009 05:00	18.5	17/12/2009 19:30	26.3	5.4	10.7	68	**9.4E+03**
30/12/2009 09:00	30/12/2009 23:00	14	30/12/2009 12:30	7.7	5.1	7.6	90	4.1E+03
06/01/2010 05:30	06/01/2010 11:00	5.5	06/01/2010 06:30	63.6	4.2	10.7	11	5.7E+03
29/01/2010 10:30	30/01/2010 00:30	14	29/01/2010 22:30	81.9	5.4	8.6	6	6.0E+03
26/02/2010 22:30	27/02/2010 02:30	4	27/02/2010 01:00	72.4	4.6	8.5	17	4.2E+03
19/06/2010 07:00	20/06/2010 08:30	25.5	19/06/2010 20:00	69.2	5.4	10.7	23	**9.4E+03**
29/08/2010 14:00	30/08/2010 06:30	16.5	30/08/2010 01:00	92.8	4.7	8.6	6	4.7E+03
06/09/2010 22:30	07/09/2010 16:00	17.5	07/09/2010 15:30	353.2	4.6	8.8	90	4.5E+03
17/09/2010 07:00	17/09/2010 18:30	11.5	17/09/2010 08:30	80.7	4.7	11.0	11	7.5E+03
24/09/2010 03:00	26/09/2010	45	24/09/2010 10:00	71.6	5.3	10.2	11	8.0E+03
20/10/2010 02:00	24/10/2010 16:30	110.5	20/10/2010 10:00	78.2	4.2	11.2	17	6.4E+03
08/11/2010 14:00	09/11/2010 20:30	30.5	09/11/2010 10:00	3.0	**5.6**	**8.8**	**73**	6.9E+03
17/11/2010 11:00	17/11/2010 18:30	7.5	17/11/2010 12:00	322.4	4.7	7.7	129	3.7E+03
29/11/2010 19:30	02/12/2010 08:30	61	29/11/2010 21:00	11.8	5.1	9.4	56	6.3E+03
16/12/2010 15:00	17/12/2010 06:30	15.5	17/12/2010 03:30	79.1	4.6	10.5	17	6.4E+03
23/07/2011 14:00	24/07/2011 11:00	21	24/07/2011 03:00	67.1	**4.7**	**10.7**	**17**	**7.2E+03**
24/10/2011 18:30	25/10/2011 09:30	15	25/10/2011 09:30	348.5	4.1	9.5	79	4.2E+03
09/12/2011 08:30	09/12/2011 10:00	1.5	09/12/2011 08:30	84.0	4.1	11.9	6	6.7E+03
05/01/2012 16:00	06/01/2012 05:00	13	06/01/2012 03:00	79.0	4.6	10.5	17	6.4E+03
03/04/2012 13:30	04/04/2012 10:30	21	03/04/2012 17:30	25.1	5.6	8.1	56	5.9E+03
24/09/2012 08:30	25/09/2012 10:30	26	25/09/2012 01:30	16.7	4.7	10.3	62	6.6E+03
26/10/2012 16:30	27/10/2012 14:30	22	26/10/2012 23:00	79.4	4.9	12.8	11	1.1E+04
05/12/2012 16:00	15/12/2012 01:30	225.5	14/12/2012 19:30	18.4	5.4	8.8	96	6.4E+03
20/12/2012 06:00	21/12/2012 14:30	32.5	20/12/2012 23:00	348.4	5.6	9.5	96	8.0E+03
18/01/2013 18:30	22/01/2013 06:00	83.5	21/01/2013 10:00	9.2	6.7	9.4	84	1.1E+04
06/02/2013 08:00	07/02/2013 06:00	22	06/02/2013 12:30	81.6	5.4	10.0	11	8.2E+03
07/03/2013 21:00	10/03/2013 21:30	72.5	08/03/2013 04:00	24.6	4.9	9.0	73	5.4E+03
18/03/2013 09:00	25/03/2013 00:30	159.5	23/03/2013 14:30	5.1	6.0	10.2	90	1.0E+04

General Storm Information					At Peak			
Start Time	**End Time**	**Duration (Hours)**	**Peak of Storm**	**Mean Direction Vector (Degrees)**	**Hs (m)**	**Tp (s)**	**Direction (Degrees)**	**Energy @ Peak (KJ/m/s)**
23/05/2013 18:00	24/05/2013 12:00	18	23/05/2013 22:30	77.5	6.7	10.5	17	1.4E+04
10/09/2013 13:00	10/09/2013 19:30	6.5	10/09/2013 14:00	79.3	4.4	9.2	11	4.6E+03
09/10/2013 22:30	11/10/2013 09:00	34.5	10/10/2013 17:00	79.8	5.4	10.7	22	9.4E+03
29/11/2013 22:30	30/11/2013 06:30	8	30/11/2013 00:30	84.5	5.6	10.7	11	1.0E+04
05/12/2013 14:00	07/12/2013 04:30	38.5	06/12/2013 20:00	80.8	4.7	14.3	6	1.3E+04
27/12/2013 09:30	27/12/2013 12:30	3	27/12/2013 10:00	249.3	4.1	6.1	202	1.8E+03
05/02/2014 04:00	05/02/2014 18:00	14	05/02/2014 05:30	318.4	4.4	7.8	129	3.3E+03
12/02/2014 20:00	14/02/2014 19:00	47	12/02/2014 21:00	275.6	4.6	7.5	141	3.2E+03
21/10/2014 22:00	22/10/2014 01:30	3.5	21/10/2014 23:00	84.4	4.4	9.6	6	5.0E+03

The storms mostly arrive from the north to northeast direction, 0 to 40 degrees, which has the longest fetch, but there are also a significant number of storms from other directions, particularly 80 to 140 degrees.

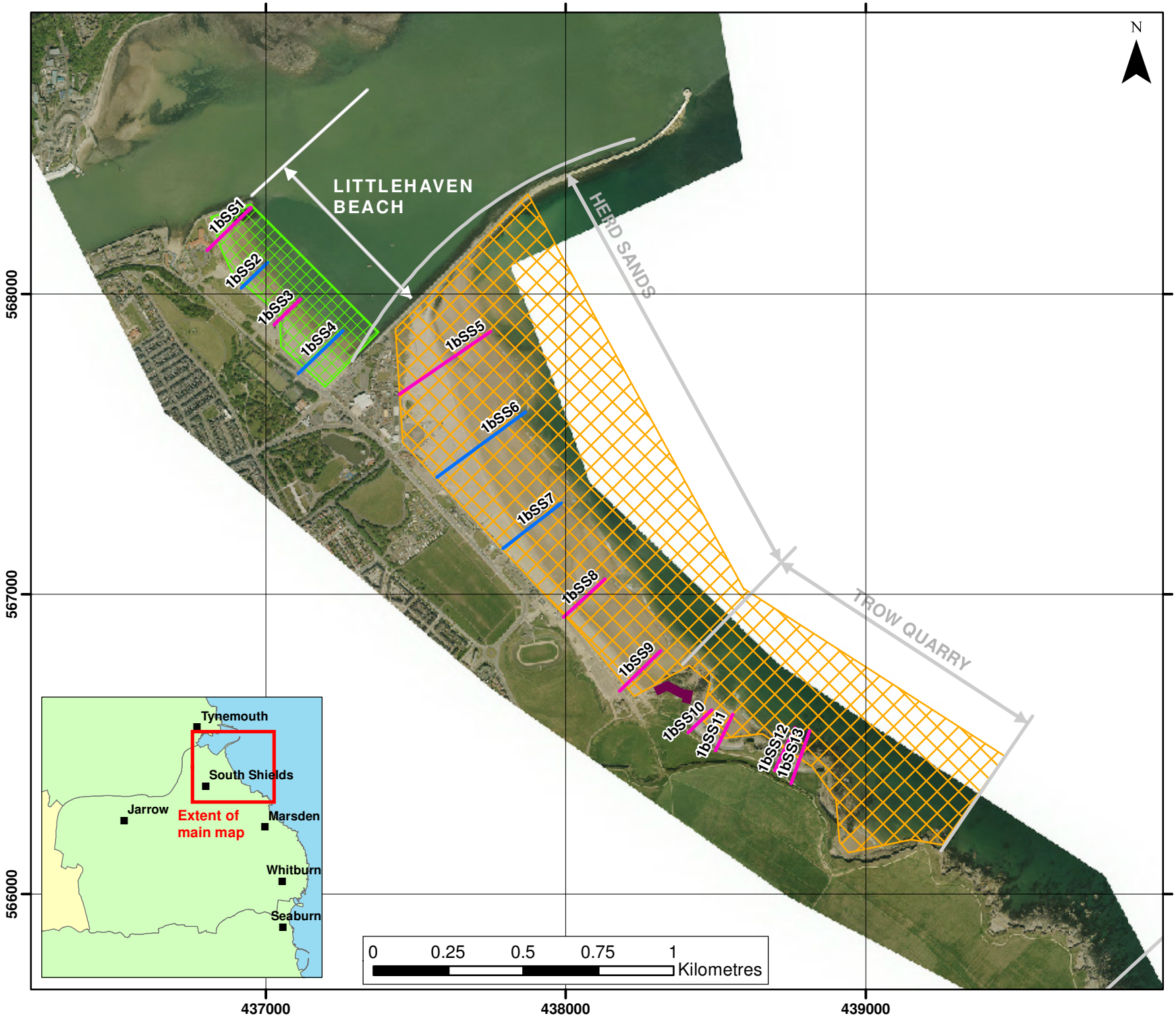
Comparing the annual storm records it can be seen that 2010 had the most storms (13). In 2010 the largest storm had an incident direction of 73 degrees which is unusual. We might therefore expect that the alongshore drift on the Cell 1 beaches in 2010 may have been atypical with unusual changes from the storm conditions. This was noted in several of the 2010 Full Measures reports.

The years with the fewest storms was 2011 and 2014. This was reflected by a combination of accretion and overall stability recorded within the annual Full Measures reports.

The winter of 2012 to 2013 appears to have suffered with larger storms than usual, with the second largest peak wave height (7.3m) recorded on 23rd March 2013. The longest duration storm in the record was from 5th to 15th December 2012 (226.5 hours).

The storm on the 5th and 6th December 2013, was particularly notable. Although this event did not have such large waves as the 23rd March 2013 storm, it had a high peak energy and exceptionally long wave period at 14.3 seconds. The 6th December storm was also accompanied by a significant storm surge with recorded water levels around 1.75m higher that predicted tides in some locations. The combined high water levels and large waves causing significant damage to many coastal defences and beaches in the north east.

The 2014 storms did appear to have an influence on beach behaviour, as shown by the profile analysis included within this report, with the movement of material across and along the beach. Dune toe erosion was more dominant than in previous years and could be explained by particularly high tides rather than storm erosion alone.



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 Beach to Trow Quarry South Tyneside Council

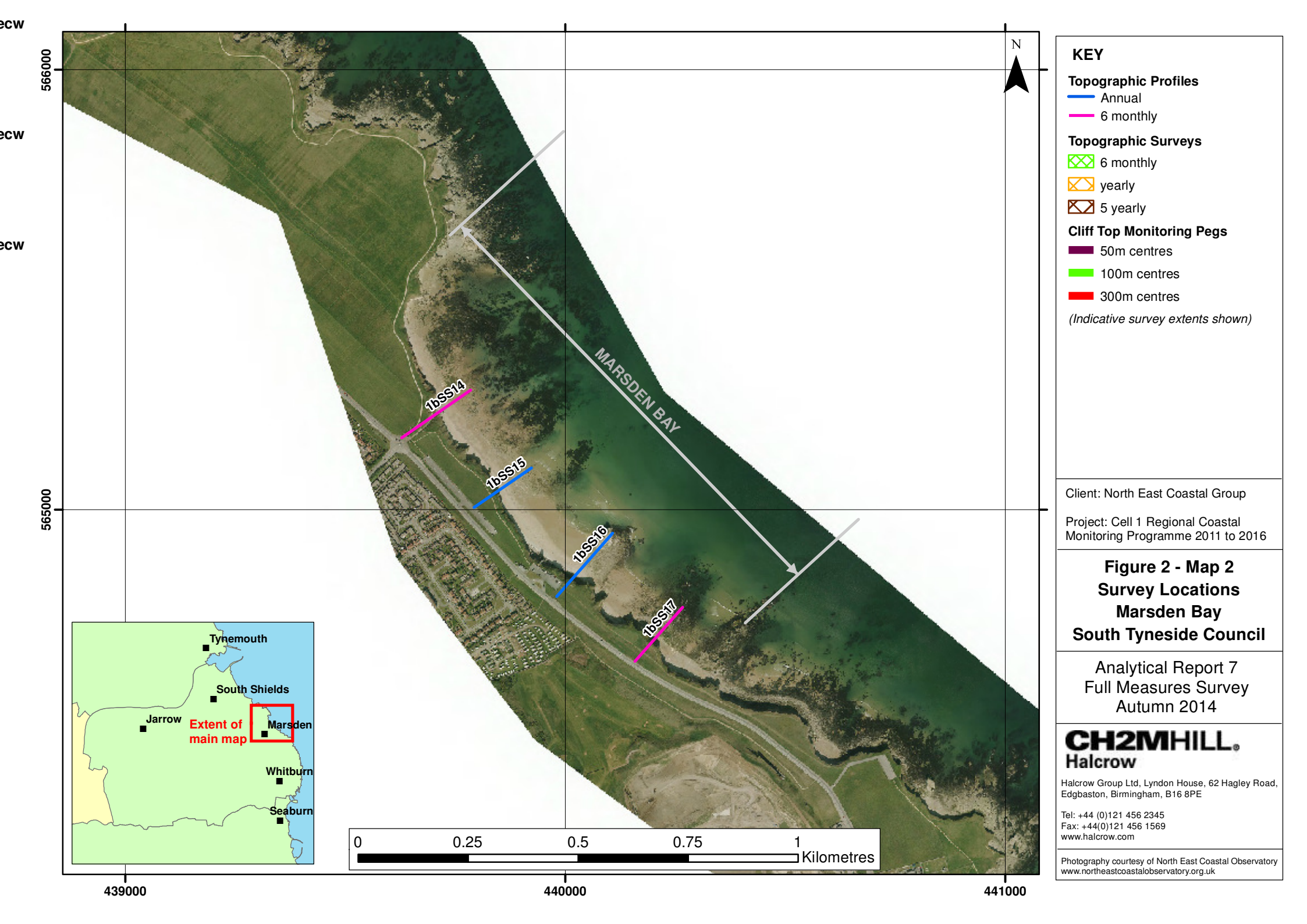
Analytical Report 7
Full Measures Survey
Autumn 2014

CH2MHILL Halcrow

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

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


ecw
ecw
ecw
566000
565000
439000
440000
441000
N
MARSDEN BAY
1bSS14
1bSS15
1bSS16
1bSS17
Tynemouth
South Shields
Jarrow
Extent of main map
Marsden
Whitburn
Seaburn
0
0.25
0.5
0.75
1
Kilometres
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
Marsden Bay
South Tyneside Council
Analytical Report 7
Full Measures Survey
Autumn 2014
CH2MHILL
Halcrow
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
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www.northeastcoastalobservatory.org.uk

3. Analysis of Survey Data

3.1 Littlehaven Beach

Survey Date	Description of Changes Since Last Survey	Interpretation
Nov 2014	**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). The previous survey was the Partial Measures survey undertaken in April 2014 and the previous Full Measures survey was undertaken in November 2013. Profiles 1bSS1 and 1bSS3 were last surveyed during the Partial Measures spring survey, 2014. Profiles 1bSS2 and 1bSS4 were last surveyed during the Full Measures autumn survey, 2013. Profile **1bSS1** is located to the north of Littlehaven beach, in the lee of a rocky outcrop and South Groyne. The dunes have remained stable since the last survey. Beach levels have increased by up to 0.2m across the beach. Profiles **1bSS2 to 1bSS4** extend seawards from the new sea wall that was completed since the Full Measures survey in Autumn 2013. At profile **1bSS2**, beach levels from the seawall to a chainage of 65m have fallen by 0.1m to 0.2m, but seaward of there, they have increased by 0.2m. Beach material is likely to have been redistributed from the upper beach during the winter/autumn months of the past year. At profile **1bSS3**, the beach profile shows a general increase in beach levels, particularly above HAT where the beach berm is approximately 0.5m higher than in the previous survey. Elsewhere across the profile, levels have increased by approximately 0.2m. At profile **1bSS4**, beach levels between the seawall and a chainage of 110m have fallen to form a rounder berm, but exposing more of the underlying rock (refer to Plates 1 and 2). Seaward of a chainage of 110m, beach levels have increased by approximately 0.3m. Material is likely to have been redistributed from the upper to lower beach during the winter/autumn months of the past year.	The beach at Littlehaven has had some time to adjust since since construction of the new seawall. The beach to the north, at profile **1bSS1,** has remained stable over the summer months. The beaches to the south have experienced a trend of upper beach lowering and lower beach accretion, which is likely to represent typical seasonal changes occurring in the winter/autumn months of the past year. **Longer term trends:** Generally, the beach profiles are within the bounds of previous surveys, showing no discernible trend and no clear evidence that the beach has been affected by the construction works. Some locations have beach levels at the highest since records began in November 2008: 1) Profile 1bSS2 – Seward of a chainage of 80m. 2) Profile 1bSS3 – the beach berm. At profile 1bSS4, the beach levels are the lowest recorded on the upper beach at a chainage of 80m, and in line with HAT. It is likely that this is a result of wave action on the beach, which is comprised of sand and rock.

Survey Date	Description of Changes Since Last Survey	Interpretation
Nov 2014	**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, autumn 2014) have been used to create a DGM (Appendix B – Map 1a) using 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 2013) and the present survey. In particular, the difference plot shows: (i) general stability, with elevation increase and decrease being less than 0.2m across the beach (ii) a wide band of small elevation increase along the very upper beach, beach elevation decrease along the middle beach and beach elevation decreased along the lower beach; (iii) a tendency for beach elevation decrease at the very northern and southern corners of the bay. **Longer Term Topographic Trends Autumn 2010 to Autumn 2013:** The long term difference plot (Appendix B – Map 1c) shows a general pattern for beach accretion at the very north end of the bay. Along the remaining length of the bay, there is a distinct band of beach erosion along the middle beach and accretion along the lower beach. The southern end of the bay is dominated by erosion.	Comparison of the present topographic survey with the previous Partial Measures (spring, 2014) shows that the beach is generally stable with bands of elevation along the very upper beach, beach elevation decrease along the middle beach and beach elevation decreased along the lower beach. This is likely to be reflecting an ongoing redistribution of material from the upper to lower beach. **Long term topographic trends Autumn 2010 to Autumn 2013:** The plot shows a general pattern for beach accretion at the very north end of the bay and erosion at the southern end of the bay. There is a distinct band of erosion along the middle beach and accretion along the lower beach. This could reflect an ongoing redistribution of material from the upper to lower beach as well as a net drift movement of material from south to north.

Plate 1 – Survey photograph 1bSS4_20140428_N7

Plate 2 – Survey photograph 1bSS4_20141124_N7

3.2 Herd Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
Nov 2014	**Beach Profiles:** Herd Sands is covered by five beach profile lines for the Full Measures survey (Appendix A). The previous survey was the Partial Measures survey in March 2013 and previous to that the Full Measures survey was completed in November 2012. Profiles 1bSS5, 1bSS8 to 1bSS9 were last surveyed during the Partial Measures spring survey, 2014. Profiles 1bSS6 and 1bSS7 were last surveyed during the Full Measures autumn survey 2013. Profile **1bSS5** is located to the north of Herd Sands and is in the lee of the breakwater. Sand fences were constructed on these dunes in 2012 to encourage accretion. The dunes have largely retained a similar form to the previous survey, showing that the defences are helping to stabilise the dunes although as observed from the survey photograph in Plate 3, they have in places fallen down. Beach levels have increased across most of the profile by approximately 0.2m, and this is reflected by the survey photographs from the current survey and the previous survey (Plates 4 and 5) which show the previously exposed tarmac and path fencing is now buried, as well as the formation of a small berm on the lower beach around a chainage of 180m. However, on the middle beach between a chainage of 200m and 280m beach levels have fallen by approximately 0.2m. It is likely that redistribution of material from the middle to lower beach occurred in the autumn months. At profile **1bSS6**, the most seaward dune ridge has increased in width and height since the last survey. Above MHWS, the upper beach has translated landwards, resulting in a narrower but wider profile. The survey photographs show accretion around the dune fencing. Seaward of MHWS, beach levels have increased (by over 1m in places) to form a flatter and smoother profile. Profile **1bSS7** is located at the centre of Herd Sands. At profile **1bSS7**, the beach profile shows substantial accretion of beach levels of 2m with the formation of two large berms, one just above HAT and one seaward of a chainage of 160m. The survey photographs were reviewed but there is no clear evidence of this increase. At profile **1bSS8**, beach levels immediately in front of the seawall have fallen by approximately 0.5m, but the beach has built upwards and outwards to form a wider profile (see Plates 6 and 7, which show photos from the previous and present survey). Further, beach levels between a chainage of 70m and	To the northern and southern ends of Herd Sands, the beach profiles have remained stable, with a redistribution of material towards the upper and lower beach. At the centre of Herd Sands, the beach profiles show the beaches to have significantly accreted, particularly on the upper and lower beach. Beach levels were particularly low at 1bSS5 in the previous Full Measures and a ship wreck was partially revealed. The current surveys indicates slight recovery from this historic low. **Longer term trends:** The beach to the north at profile 1bSS5 shows little change from previous surveys. However, at profiles 1bSS6, 1bSS7 and 1bSSS9, beach levels are on the upper beach the highest recorded since surveys began in November 2008. Conversely, beach levels to the south of Herd Sands at profile 1bSS9, beach levels on the middle beach are the lowest observed since surveys began in November 2008.

Survey Date	Description of Changes Since Last Survey	Interpretation
	170m have also increased by up to 0.5m to form a convex profile. Profile **1bSS9** is located to the south of Herd Sands. Beach levels have increased at the toe of the dune above MHWS by approximately 0.5m. Seaward of MHWS, across most of the profile, beach levels have decreased by 0.5m making a more concave shape. A small berm has formed around 130m chainage. Material has likely to have been redistributed from the middle of the beach to the upper and lower parts during the summer and autumn months.	
Nov 2014	**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, autumn 2013) have been used to create a DGM (Appendix B – Map 2a) using GIS. A difference plot has also been produced using the DGM (Appendix B – Map 2b) produced from the last topographic survey (Full Measures, autumn 2011) and the present survey. The difference plot shows a general increase in beach elevation across Herd Sand particularly to the north, with pockets of beach elevation decrease concentrated along the backshore, northern and southern extents of the bay and the lower beach. **Longer Term Topographic Trends Autumn 2010 to Autumn 2014:** The long term difference plot (Appendix B – Map 2c) shows overall accretion in the most northern third of the bay, with a band of beach elevation increase greater than 2m along the middle beach. Beach elevation decrease is concentrated at the southern end of the bay and to the lower beach, with changes in the order of 1m.	Comparison of the present topographic survey with the previous Full Measures (autumn, 2013) shows an overall pattern of accretion with pockets of beach elevation decrease concentrated along the backshore, northern and southern extents of the bay and the lower beach. **Longer term topographic trends Autumn 2010 to Autumn 2014:** shows overall accretion in the most northern third of the bay, with a particularly clear band of beach elevation increase of greater than 2m along the middle beach, which relates to a berm. Beach elevation decrease is concentrated at the southern end of the bay and to the lower beach, with changes in the order of 1m. It is possible that eroded material is being redistributed to form a sand bar along the beach.

Plate 3 – Survey photograph 1bSS5_20141124_N6

Plate 4 – Survey photograph 1bSS5_20141124_N7

Plate 5 – Survey photograph 1bSS5_20140428_N7

Plate 6 – Survey photograph 1bSS8_20141124_N3

Plate 7 – Survey photograph 1bSS8_20140429_N2

3.3 Trow Quarry (incl. Frenchman's Bay)

Survey Date	Description of Changes Since Last Survey	Interpretation
Nov 2014	**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 Bat. The previous survey was the Partial Measures survey undertaken in April 2014. Profiles **1bSS10** and **1bSS11** are located in Graham's Bay. At profile **1bSS10** the backshore has remained stable. Beach levels have fallen across the beach and in particular at the toe of the rock revetment by approximately 0.5m. This is evident from the survey photographs (see plates 8 and 9), which show large cobbles not previously exposed. Seaward of a chainage of 85m, beach levels have increased by up to 0.5m suggesting a draw-down of material during the recent autumn months. New spikes in the profile data in the vicinity of the boulders on the lower beach (chainage 60m) may reflect movement of the boulders or subtly different points along the profile being recorded in each survey. At profile **1bSS11**, the profile has remained stable. The small changes in level between a chainage of 30m and 40m are most likely attributable to the movement of cobbles rather than a change in beach level. Profile **1bSS12** and **1bSS13** are located in Southern Bay. At both locations the beach profile has remained stable since the previous survey.	At both Graham's Bay and Southern Bay, the cliff and rock revetment have remained stable. At Graham's Bay, the beach to the north has fallen in level, with draw-down of material, but to the south the beach has remained fairly stable. At Southern Bay, the rocky foreshore has generally retained the same form and position. **Longer term trends:** Overall the beach at Graham's Bay and Southern Bay has retained the same form and position since November 2008/March 2009 when surveys began. Movement to the north of Grahams Bay at profile 1bSS10 is within the bounds of previous surveys.
Nov 2014	**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, autumn 2014) have been used to create a DGM (Appendix B – Map 2a) using GIS. A difference plot has also been produced using the DGM (Appendix B – Map 2b) produced from the last topographic survey (Full Measures, autumn 2013) and the present survey. The difference plot shows a complex pattern of change in beach elevation with small areas of up to 2m change on and around the headlands that separate Graham's Sand and Southern Bay, and Herd Sands from Trow Quarry. This may reflect movement of cobbles, but is more likely caused by data interpolation	**Topographic Survey:** The difference plot shows a sporadic change in beach elevation with no clear trends. **Longer Term Topographic Trends Autumn 2010 to Autumn 2014:** There are pockets of beach elevation reduction and increase interspersed across the beach. The increase in elevation on and around the headlands that separate Graham's Sand and Southern Bay, and Herd Sands form Trow Quarry, is likely to be due to the data interpolation methods used

Survey Date	Description of Changes Since Last Survey	Interpretation
	errors. **Longer Term Topographic Trends Autumn 2010 to Autumn 2014:** The long term difference plot (Appendix B – Map 2c) shows the net change in beach levels between autumn 2010 and autumn 2014. The pattern and magnitude of change is very similar to that seen over the short term, with are pockets of beach elevation reduction and increase across the beach. The increase in elevation on and around the headlands that separate Graham's Sand and Southern Bay, and Herd Sands from Trow Quarry can be attributed to the data interpolation method used. The plot for Frenchman's Bay shows beach elevation decrease along the upper beach and beach elevation increase across the middle and lower beach suggesting a redistribution of sediment across the beach.	to create the difference grids. The plot for Frenchman's Bay shows beach elevation decrease along the upper beach and beach elevation increase across the middle and lower beach suggesting a redistribution of sediment across the beach. This may be an ongoing trend or a seasonal change, ongoing analysis of the survey data will clarify this.
Nov 2014	**Cliff-top Survey:** Cliff top survey data collected for baseline survey (autumn, 2011) and bi-annual surveys since then, including the present Full Measures survey (autumn, 2014) is presented in this report. Six ground control points (numbered points 1 to 6) were established along the cliff top at Trow Point in 2008 to monitor cliff erosion at the site of a former landfill. Note: the numbering of ground control points is not intended to correlate with that of the beach profile lines and reference should be made to Appendix C – Map 1 for the location of ground control points. Measurements are taken from each ground control point along a fixed bearing to the edge of the cliff top. The results from the cliff top monitoring are anticipated to have an accuracy of ±0.1m due to the technique used. The results from the cliff top survey are presented in Appendix C – Table C1, showing the position from the ground control point to the edge of the cliff top along a defined bearing. Results show that erosion of up to 0.2m was recorded at two locations (points 1 and 3). Over the long-term, from September 2011 to present, erosion is too low to be recorded.	Results show that erosion greater than the survey accuracy was recorded at two points since the last survey, with up to 0.2m loss measured. The total change over the long term (i.e. since Sept 2011) is too low to record a rate of erosion greater than 0.0 m/yr.

Plate 8 – Survey photograph 1bSS10_20141124_N4

Plate 9 – Survey photograph 1bSS10_20140429_N3

3.4 Marsden Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
Nov 2014	**Beach Profiles:** Marsden Sands is covered by four beach profile lines for the Full Measures survey (Appendix A). The previous survey was the Partial Measures survey in April 2014 and previous to that the Full Measures survey was completed in November 2013. Profiles 1bSS14 and 1bSS17 were last surveyed during the Partial Measures spring survey, 2014. Profiles 1bSS15 and 1bSS16 were last surveyed during the Full Measures autumn survey, 2013. Profile **1bSS14** is located to the north of the bay and covers the cliff and the former lifeguard station adjacent to the Redwell Steps. The cliff has retained the same form and position since the last survey. Beach levels on the upper beach have fallen by 0.5m to 1m since the last survey exposing the step at the toe of the seawall (see plates 10 and 11). The material on the beach at this location has changed as sand on the beach has been removed to leave a veneer of coarse shingle and cobbles; a trend that has continued since the last Full Measures survey in 2013. Beach levels seaward of a chainage of 140m have increased by approximately 0.5m to 1m and is likely that material draw-down from the upper beach in the recent autumn months. At profile **1bSS15** the profile suggests that the cliff has advanced seawards, however the survey photographs do not reflect this change. Beach levels have fallen across the profile by approximately 1m, resulting in exposure of the underlying rock. At Profile **1bSS16** the profile suggests that the cliff has advanced seawards, however the survey photographs do not reflect this change. The profile shows beach levels at the toe of the cliff to have increased but seaward of a chainage of 75m, beach levels have fallen to form a narrower upper beach and lower middle and lower beach. The survey photographs show that the rocky beach at the toe of the cliff has narrowed and the sandy veneer across the middle beach has disappeared to expose the underlying rock (refer to Plates 12 and 13), Profile **1bSS17** is located to the south of the bay. The profile suggests that the cliff has advanced seawards, however the survey photographs do not reflect this change and it is likely to be due to survey methods employed and access issues. Beach levels have remained stable since the last survey.	To the north of Marsden Bay, the cliff has retained the same form and position as the previous surveys. Along the north and central section of Marsden Bay beach levels have either fallen across the profile or there has been redistribution of material from the upper to the middle/lower beach. This is typical of autumn/winter behaviour. To the south of Marsden Bay, the beach has remained stable since the last survey. **Longer term trends: To the north and south of Marsden Bay,** the overall changes are within the bounds of changes observed since the first survey in November 2008. The exception is at profile 1bSS14, where beach levels seaward of chainage 135m are the highest since surveys began. At the centre of the bay, around a chainage of 90m (approximately middle/lower beach) levels are the lowest since surveys began.

Plate 10 – Survey photograph 1bSS14_20141127_N7

Plate 11 – Survey photograph 1bSS14_20140429_N9

Plate 12 – Survey photograph 1bSS16_20141127_N6

Plate 13 – Survey photograph 1bSS16_20131121_N7

4. Problems Encountered and Uncertainty in Analysis

Individual Profiles

The survey report notes the following, but with no reference to a particular survey location:

- Step in sand running for most of the main bay.
- Sand encroaching on promenade path in the middle of the main bay.
- Fresh rock fall visible in Frenchman's Bay.

Topographic Survey

No comments from the present survey.

Cliff Top Surveys

Surveying any cliff top is difficult due to the need for a consistent interpretation of the cliff edge in successive surveys, which can be challenging, especially when vegetation is thick. For these reasons, it has been assumed that any changes of ±0.2m may be considered as being within the accuracy of the surveying technique and that any indication of an advancing cliff line is error.

No cliff recession has been recorded at Trow Quarry since records began, but visual inspection indicates that small rock falls have occurred. The data reflects the episodic nature of rock falls through time and the uneven distribution of events along the cliff.

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

No changes are recommended at the present time.

6. Conclusions and Areas of Concern

- At Littlehaven Beach, the recorded profiles and topographic survey present no causes for concern, although at profile 1bSS4, the beach levels are the lowest recorded on the upper beach at a chainage of 80m, and in line with HAT. It is likely that this is a result of wave action on the beach, which is comprised of sand and rock.
- Herd Sands, the recorded profiles present no causes for concern, although at profile 1bSS9, beach levels on the middle beach are the lowest observed since surveys began in November 2008.
- At Trow Quarry, the recorded profiles show no causes for concern. The cliffs to the north west of Trow Headland appear to have been stable and the data does not indicate cause for concern.
- At most of Marsden Bay, the recorded profiles present no causes for concern, although those along the central part of Marsden Sands are near their lowest recorded level.

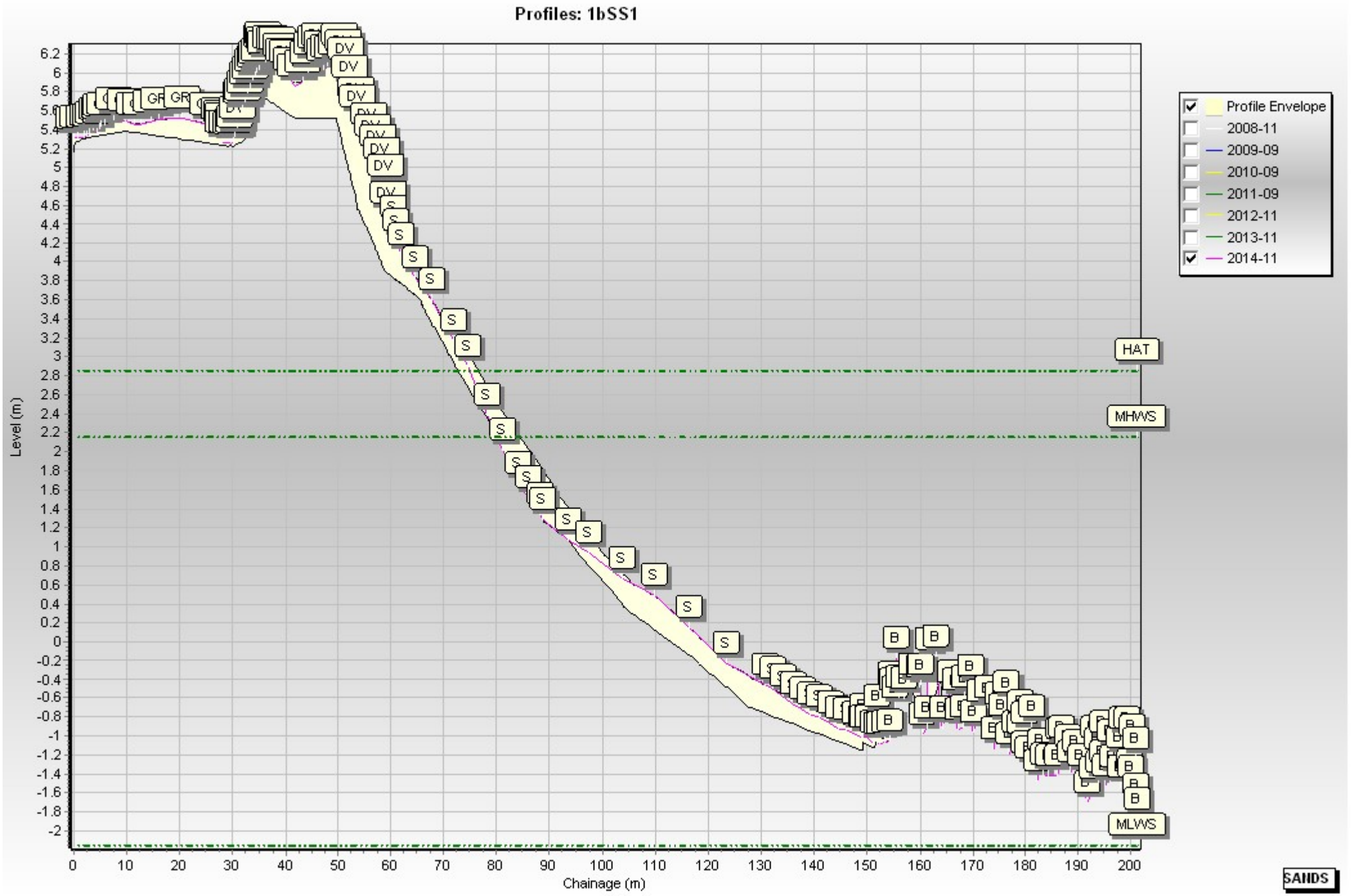
Appendices

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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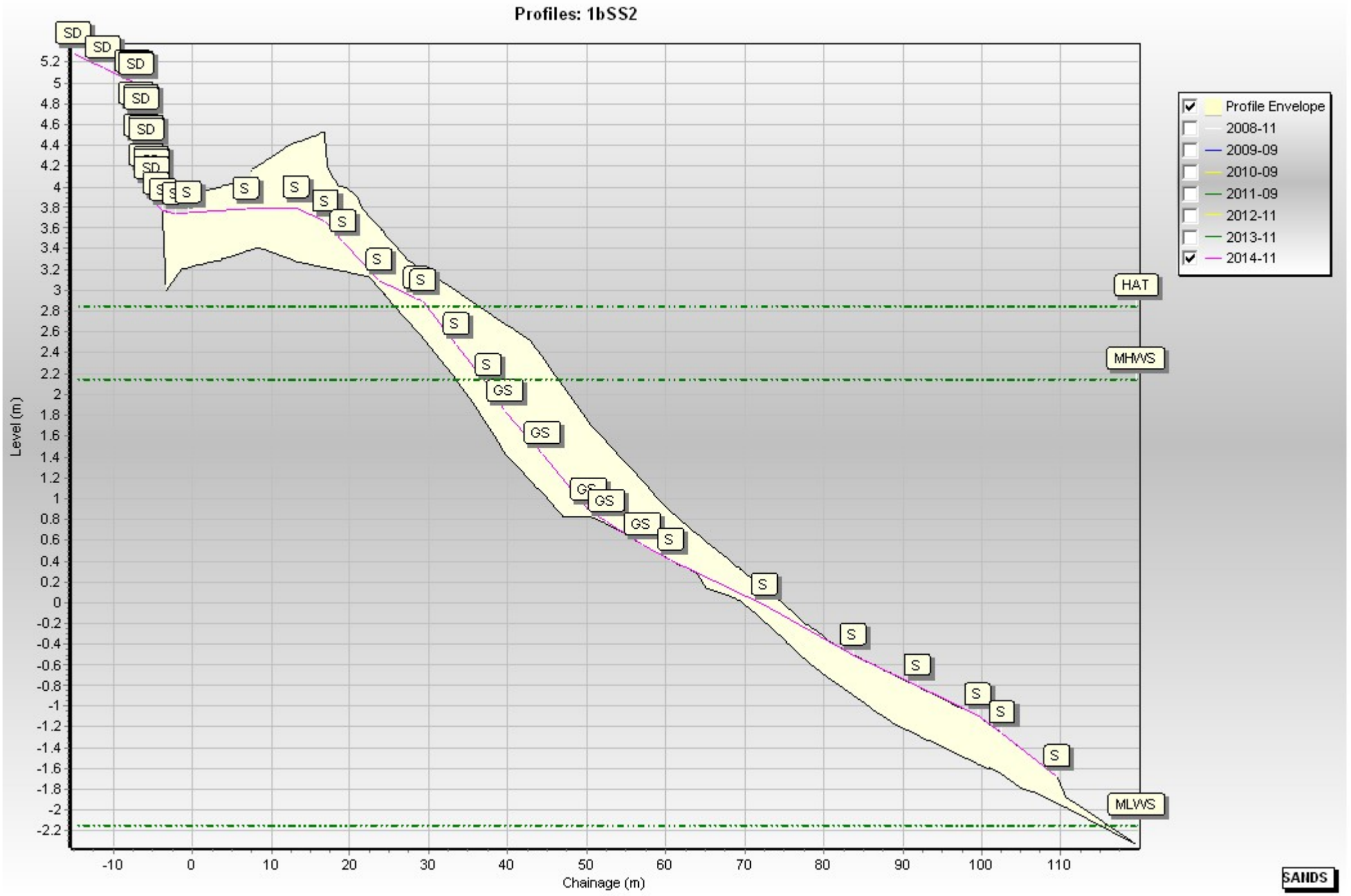
Profile Envelope
2008-11
2009-09
2010-09
2011-09
2012-11
2013-11
2014-11
HAT
MHWS
MLWS
Level (m)
Chainage (m)
SANDS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Profile Envelope
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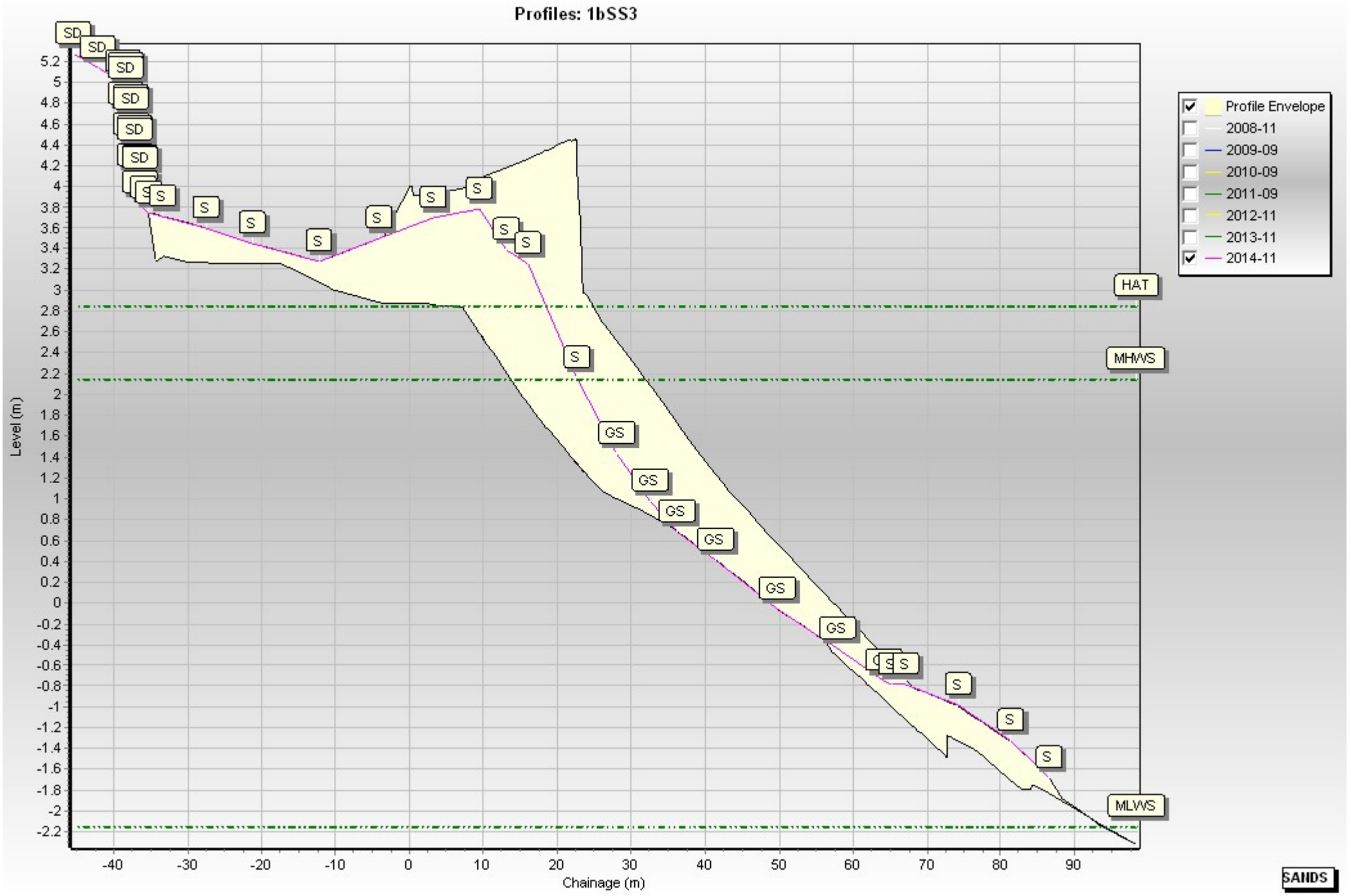
2009-09
2010-09
2011-09
2012-11
2013-11
2014-11
HAT
MHWS
MLWS
Level (m)
Chainage (m)
SANDS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Profile Envelope
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2009-09
2010-09
2011-09
2012-11
2013-11
2014-11
HAT
MHWS
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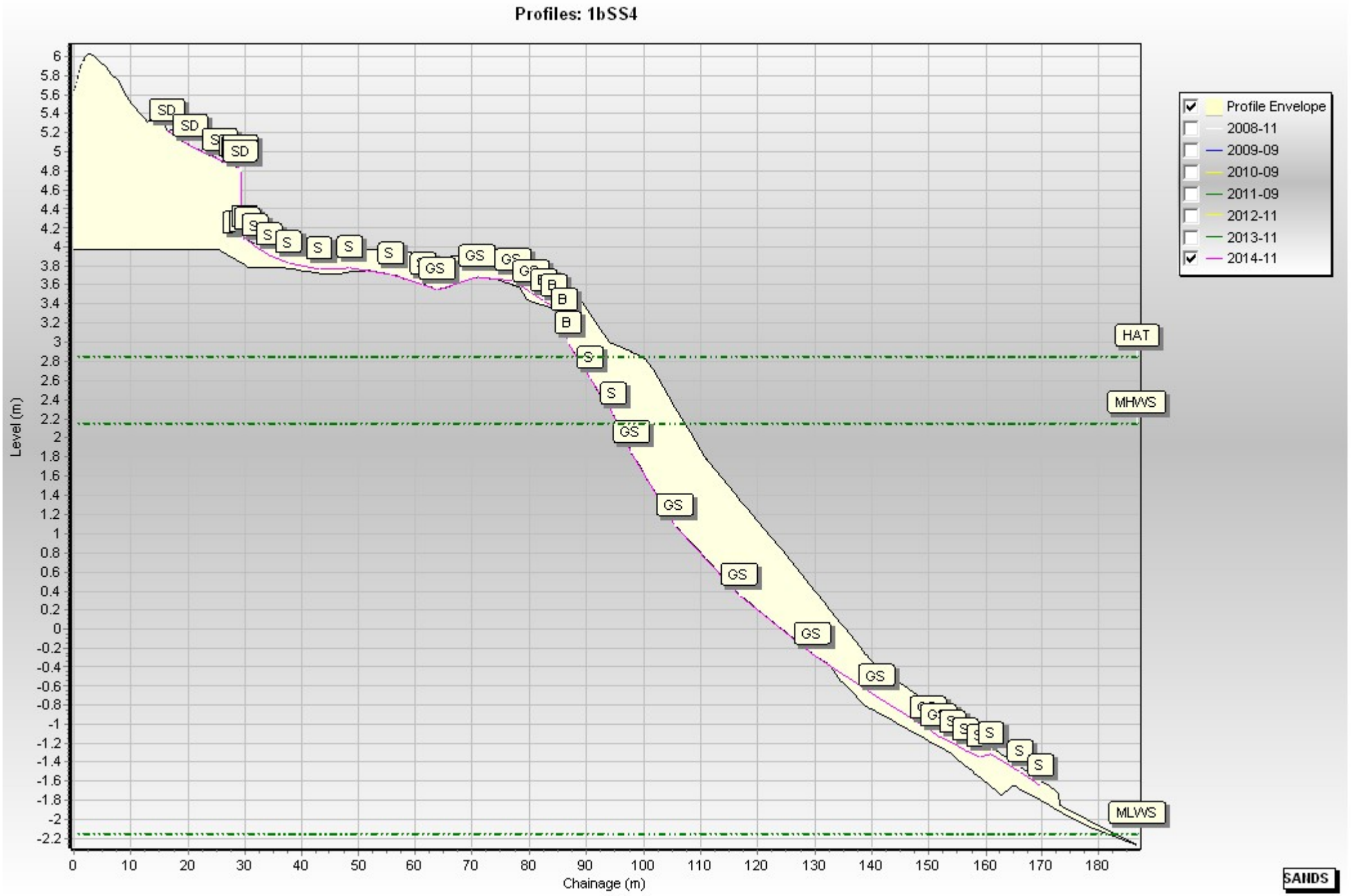
GS
Level (m)
Chainage (m)
SANDS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Profile Envelope
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2009-09
2010-09
2011-09
2012-11
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2014-11
HAT
MHWS
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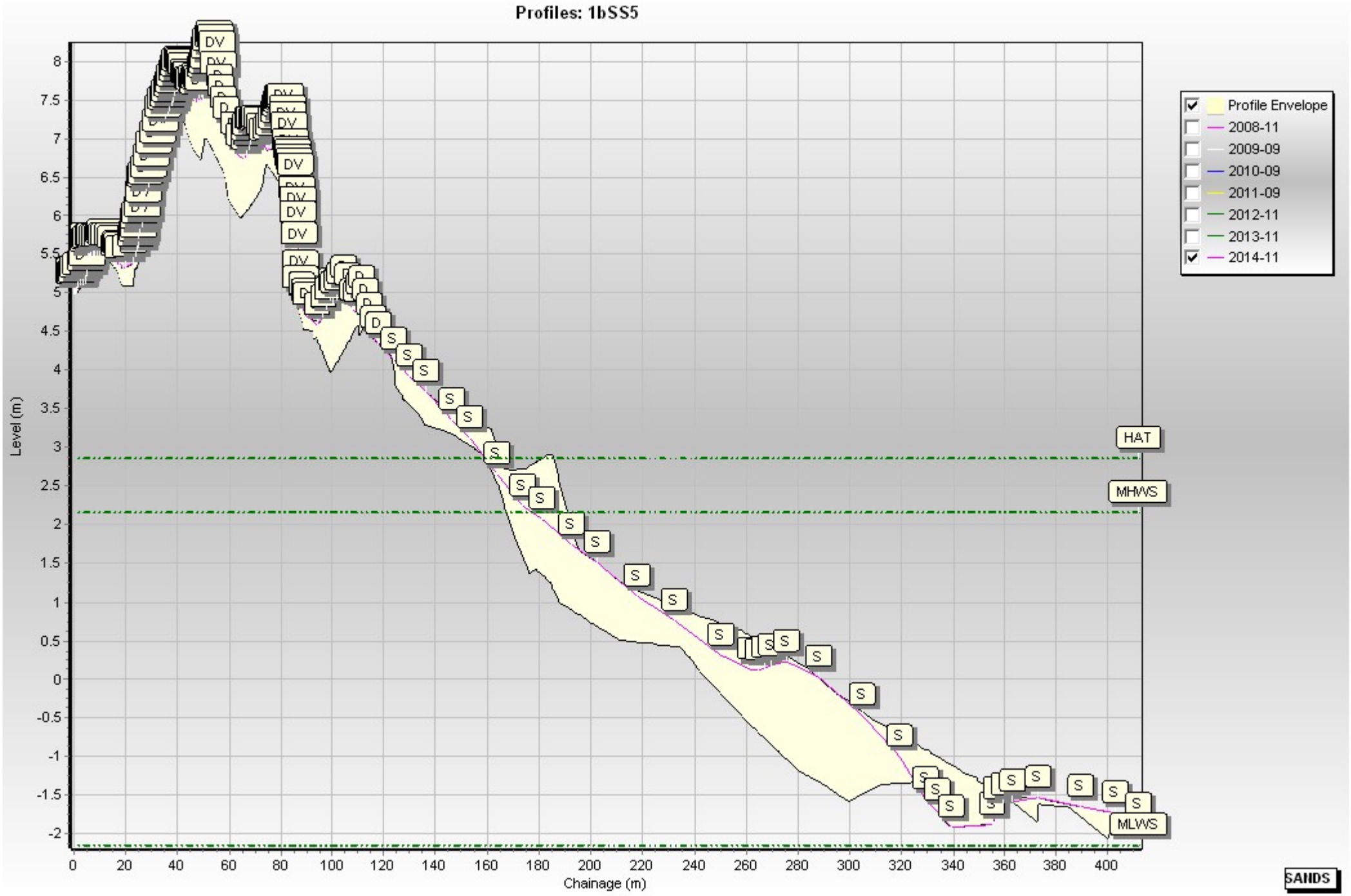
B
Level (m)
Chainage (m)
SANDS


Profiles: 1bSS5
Profile Envelope
2008-11
2009-09
2010-09
2011-09
2012-11
2013-11
2014-11
HAT
MHWS
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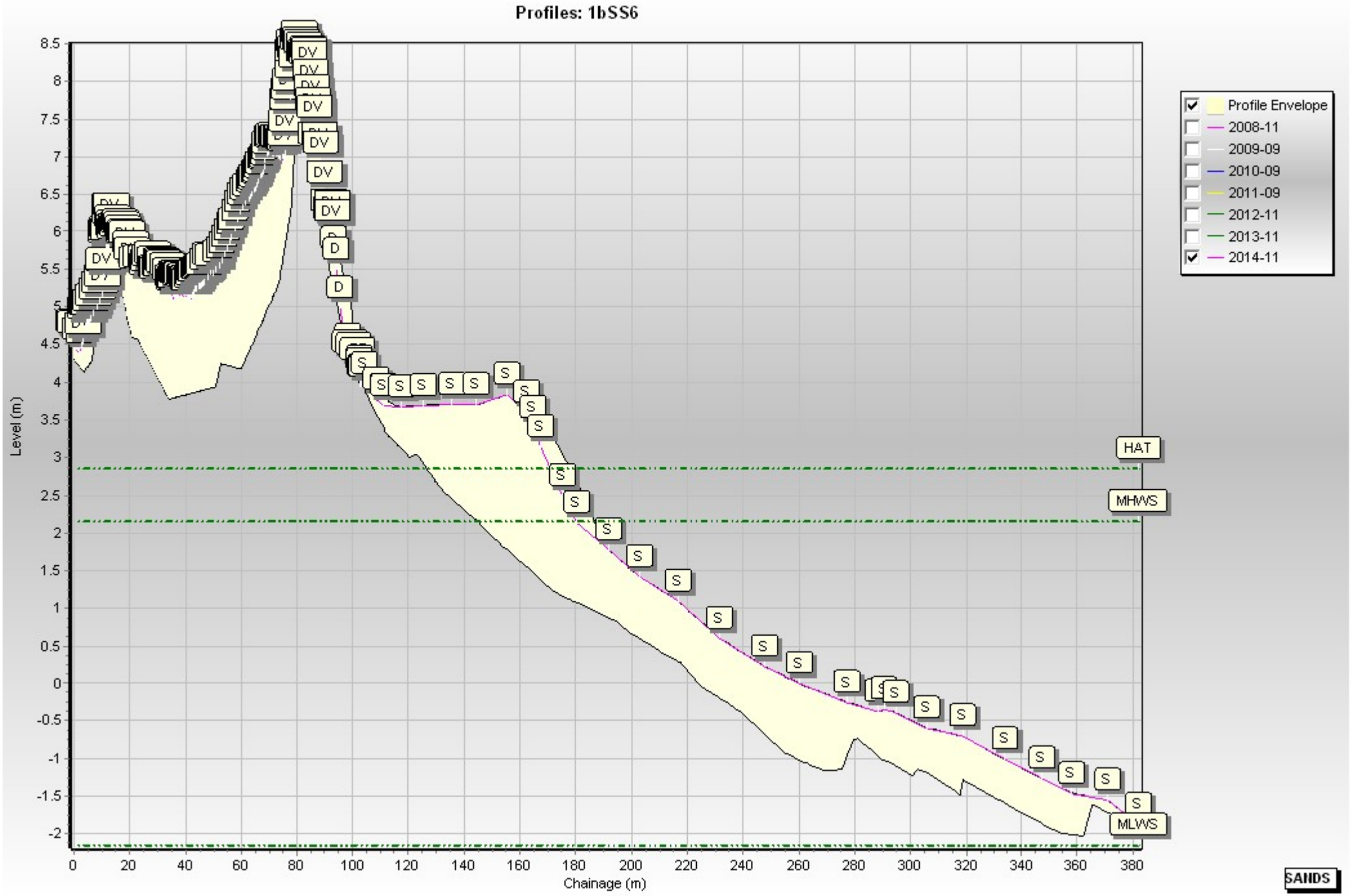
S
Level (m)
Chainage (m)
SANDS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Profile Envelope
2008-11
2009-09
2010-09
2011-09
2012-11
2013-11
2014-11
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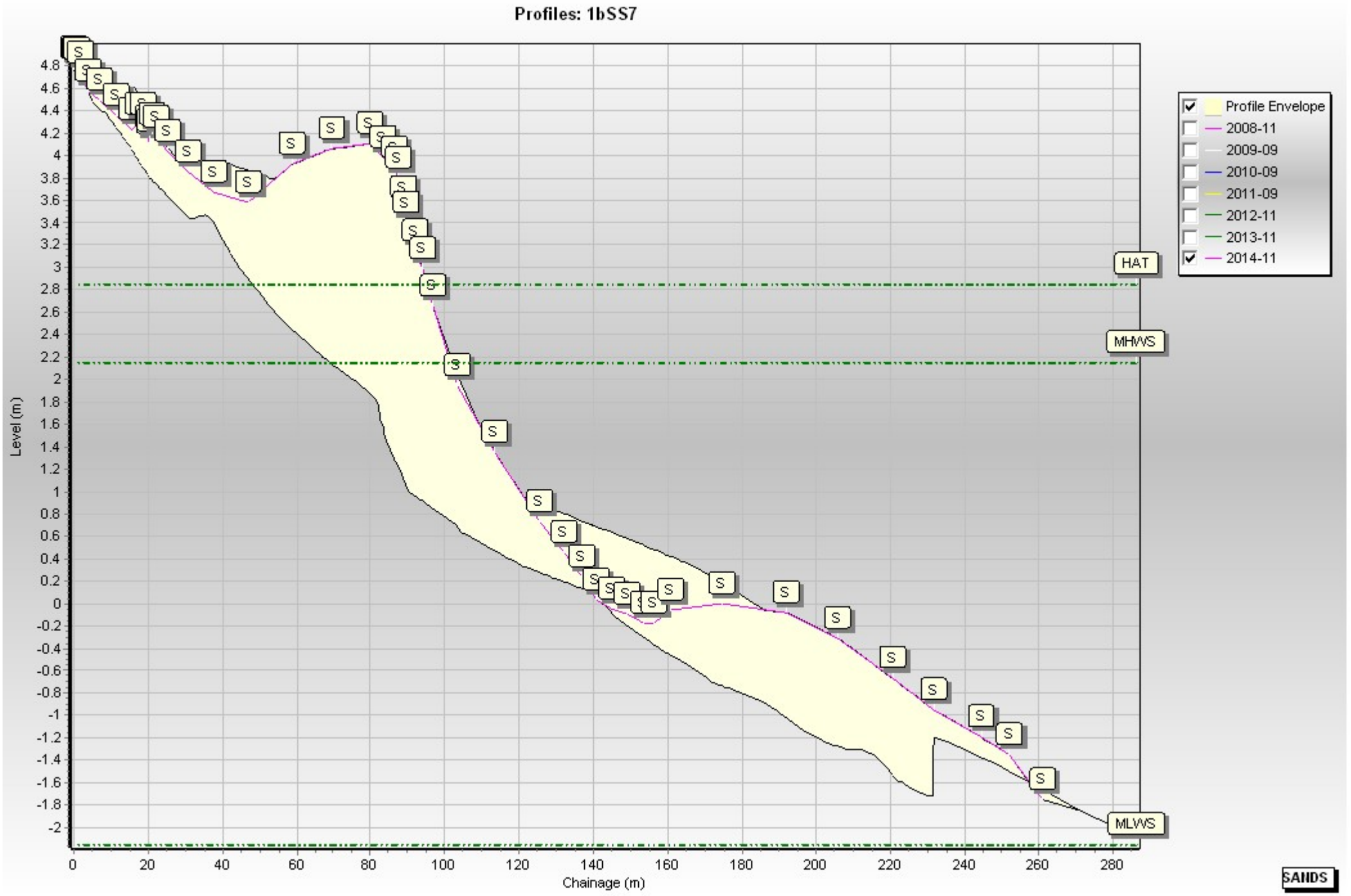
MHWS
MLWS
Level (m)
Chainage (m)
SANDS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Profile Envelope
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2009-09
2010-09
2011-09
2012-11
2013-11
2014-11
HAT
MHWS
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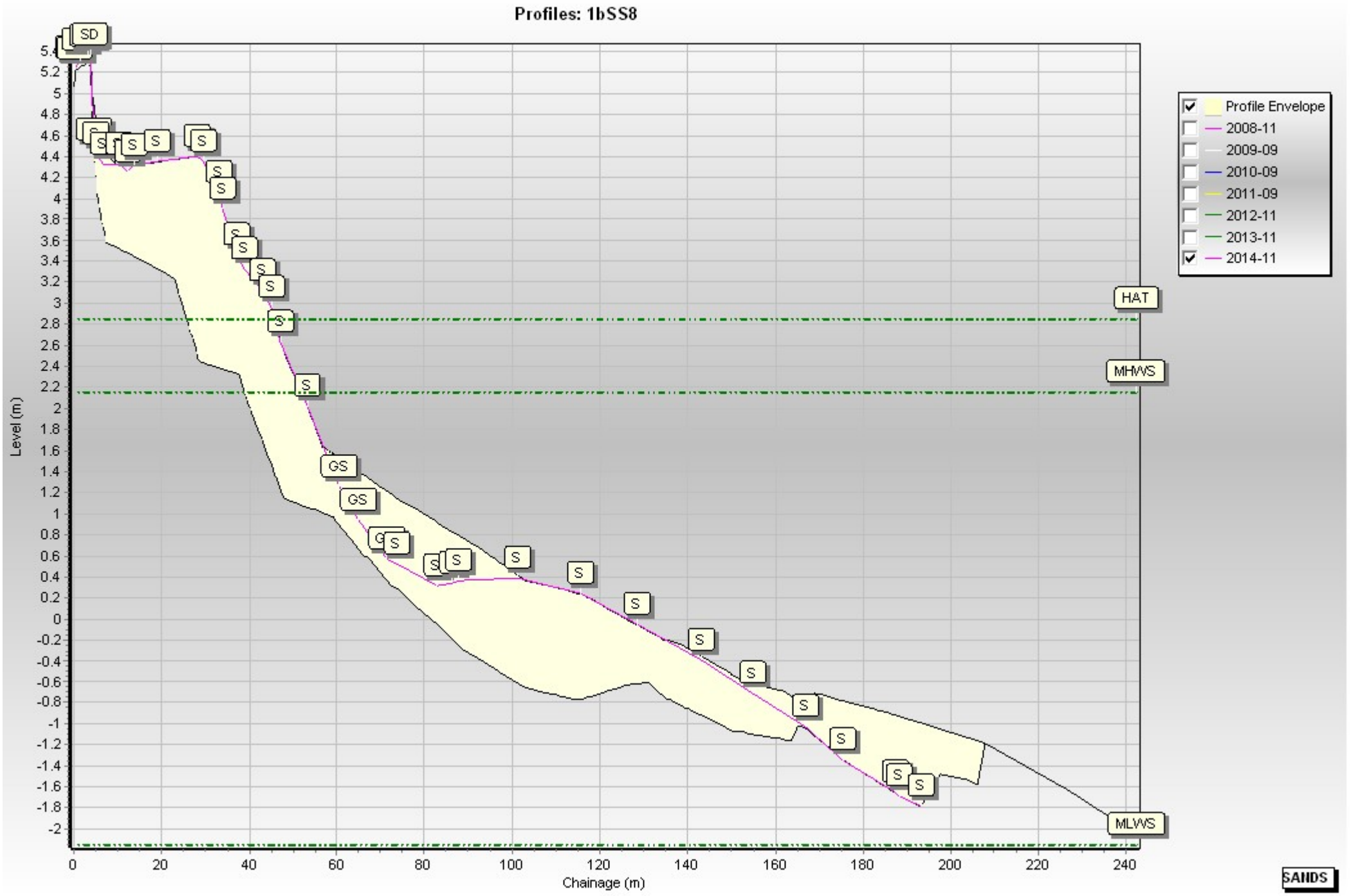
Level (m)
Chainage (m)
SANDS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2010-09
2011-09
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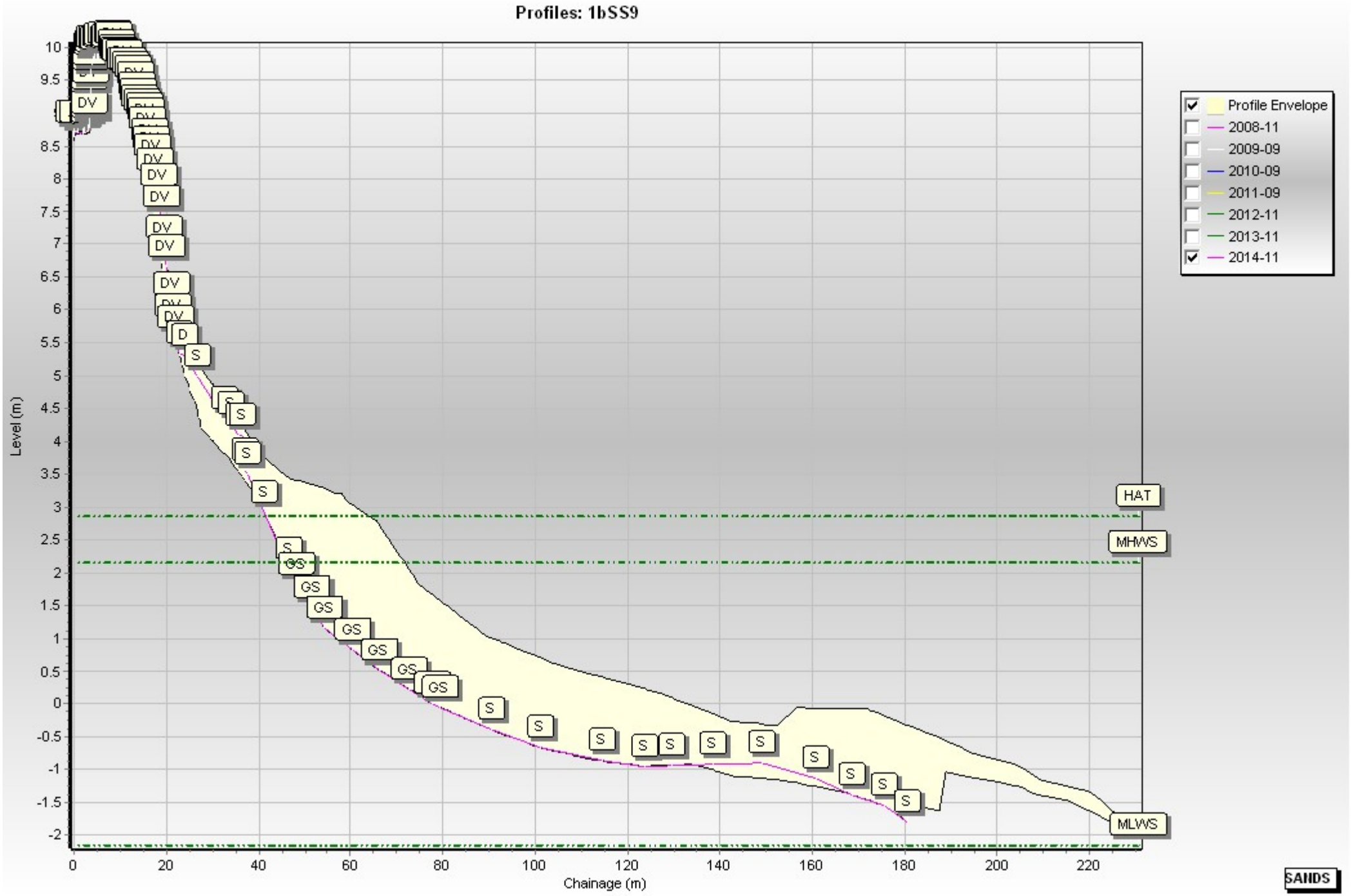
2013-11
2014-11
HAT
MHWS
MLWS
SD
S
GS
Level (m)
Chainage (m)
SANDS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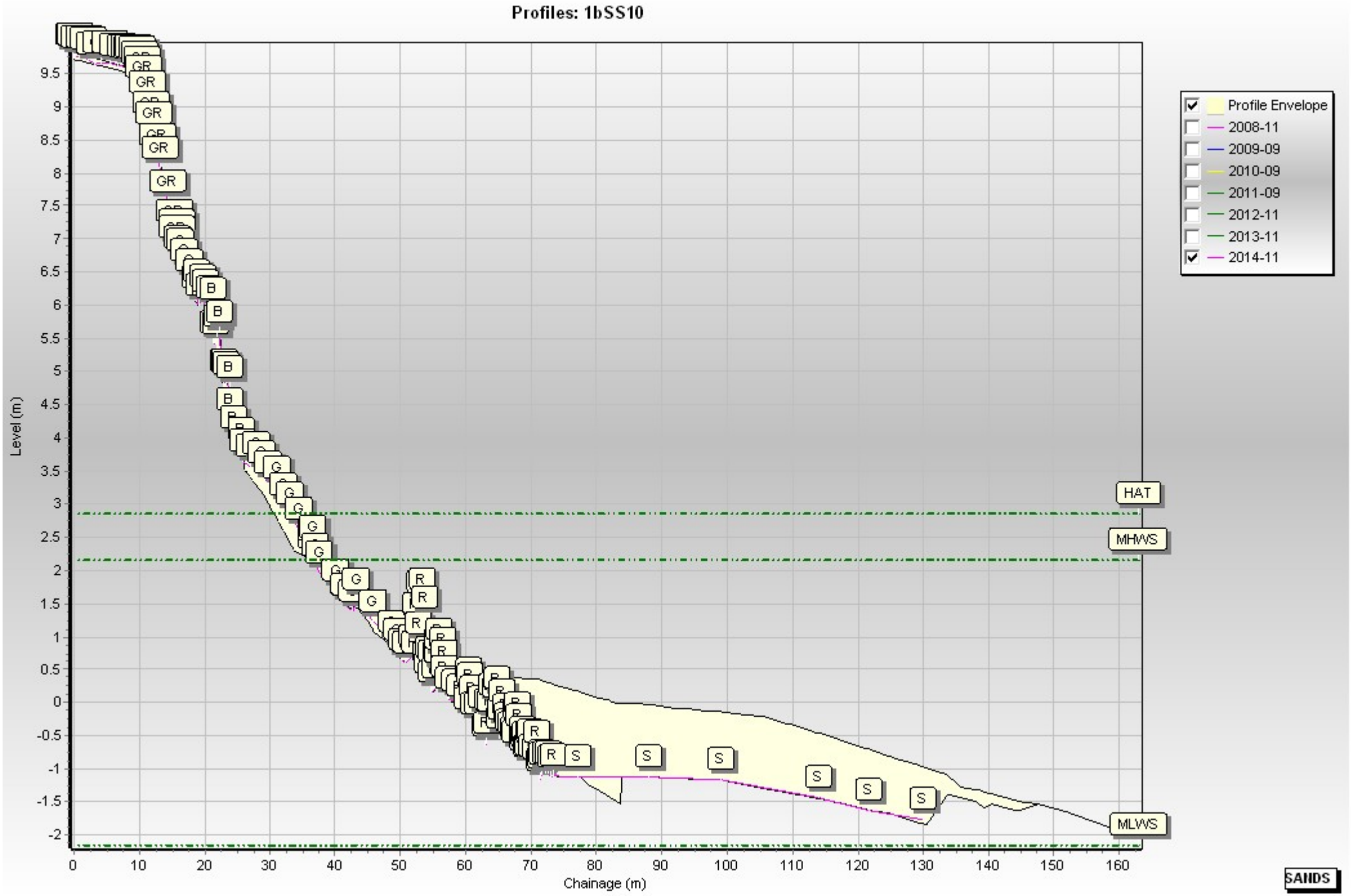
MHWS
MLWS
DV
D
S
GS
SANDS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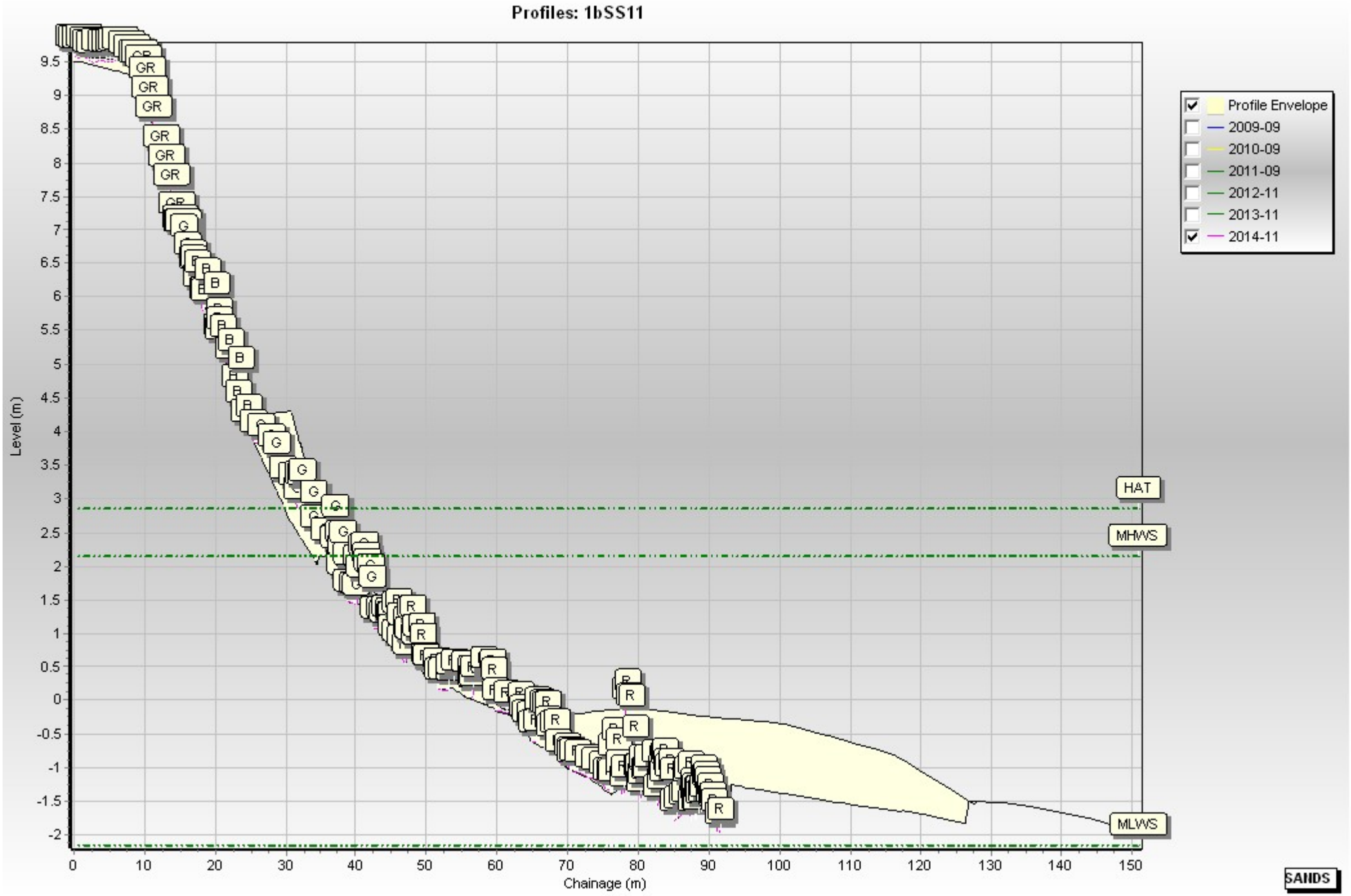
2011-09
2012-11
2013-11
2014-11
HAT
MHWS
MLWS
Level (m)
Chainage (m)
SANDS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HAT
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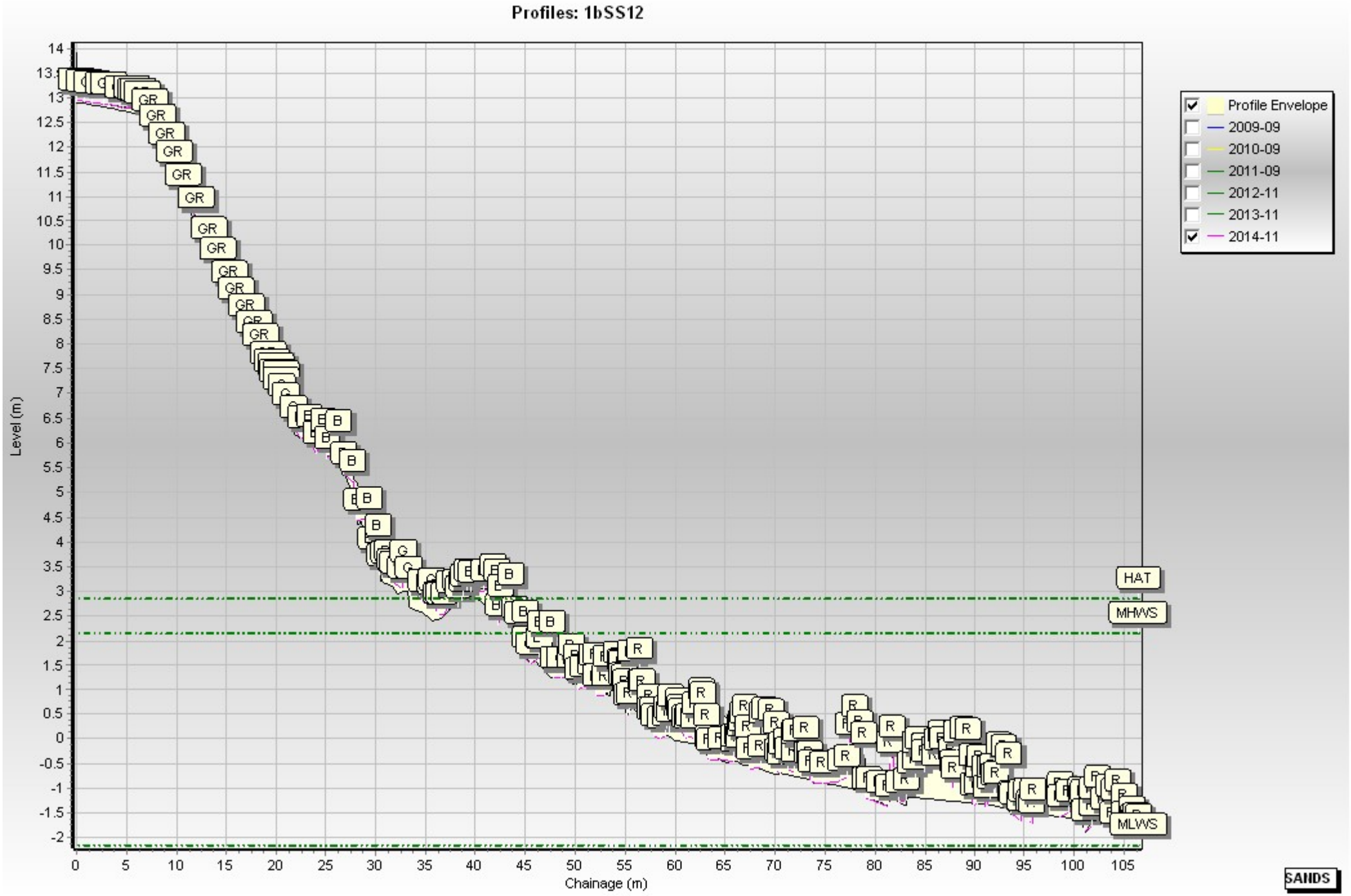
MLWS
Level (m)
Chainage (m)
SANDS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2014-11
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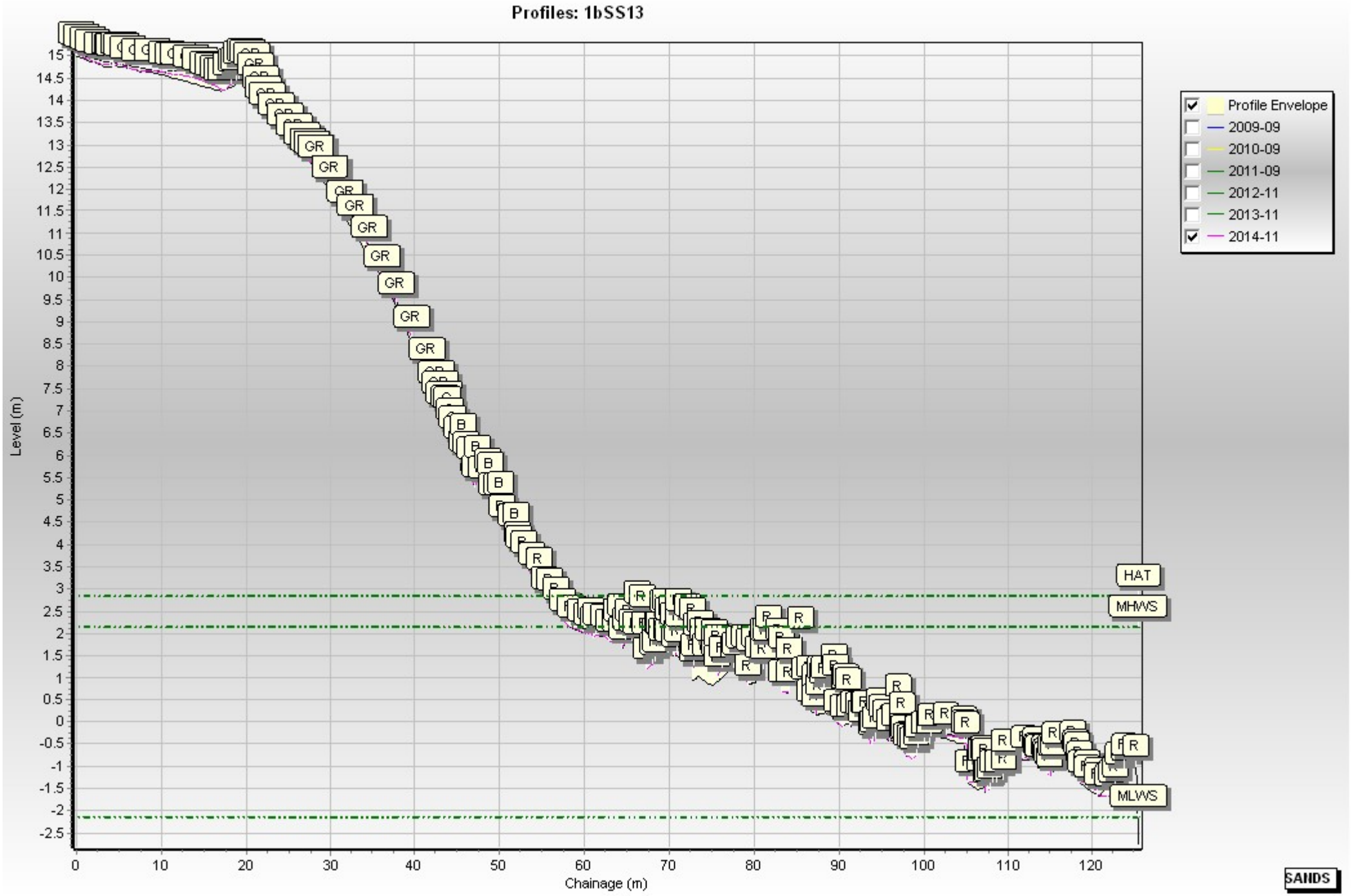
MLWS
Level (m)
Chainage (m)
SANDS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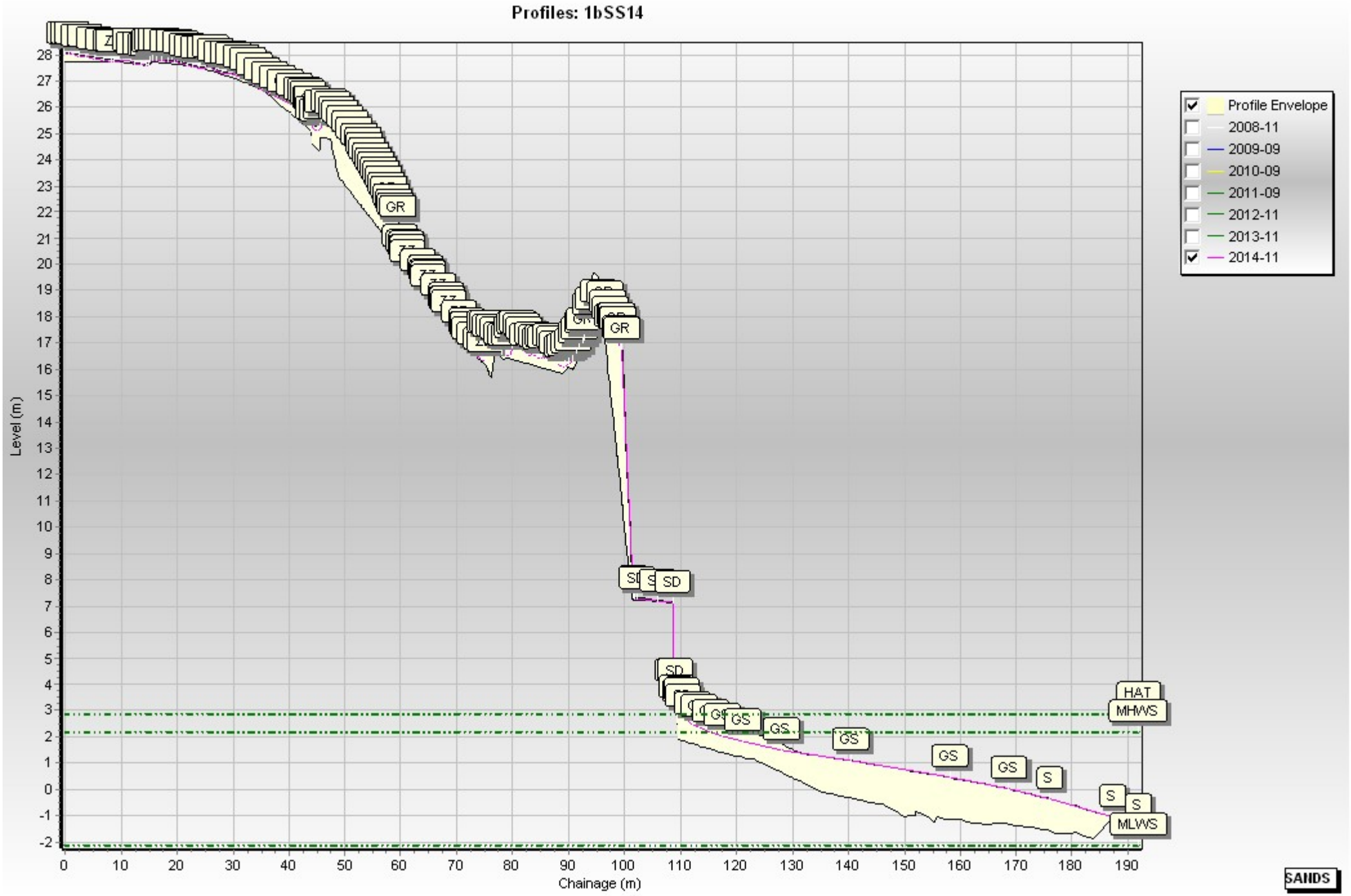
HAT
MHWS
MLWS
GR
B
R
Level (m)
Chainage (m)
SAIDS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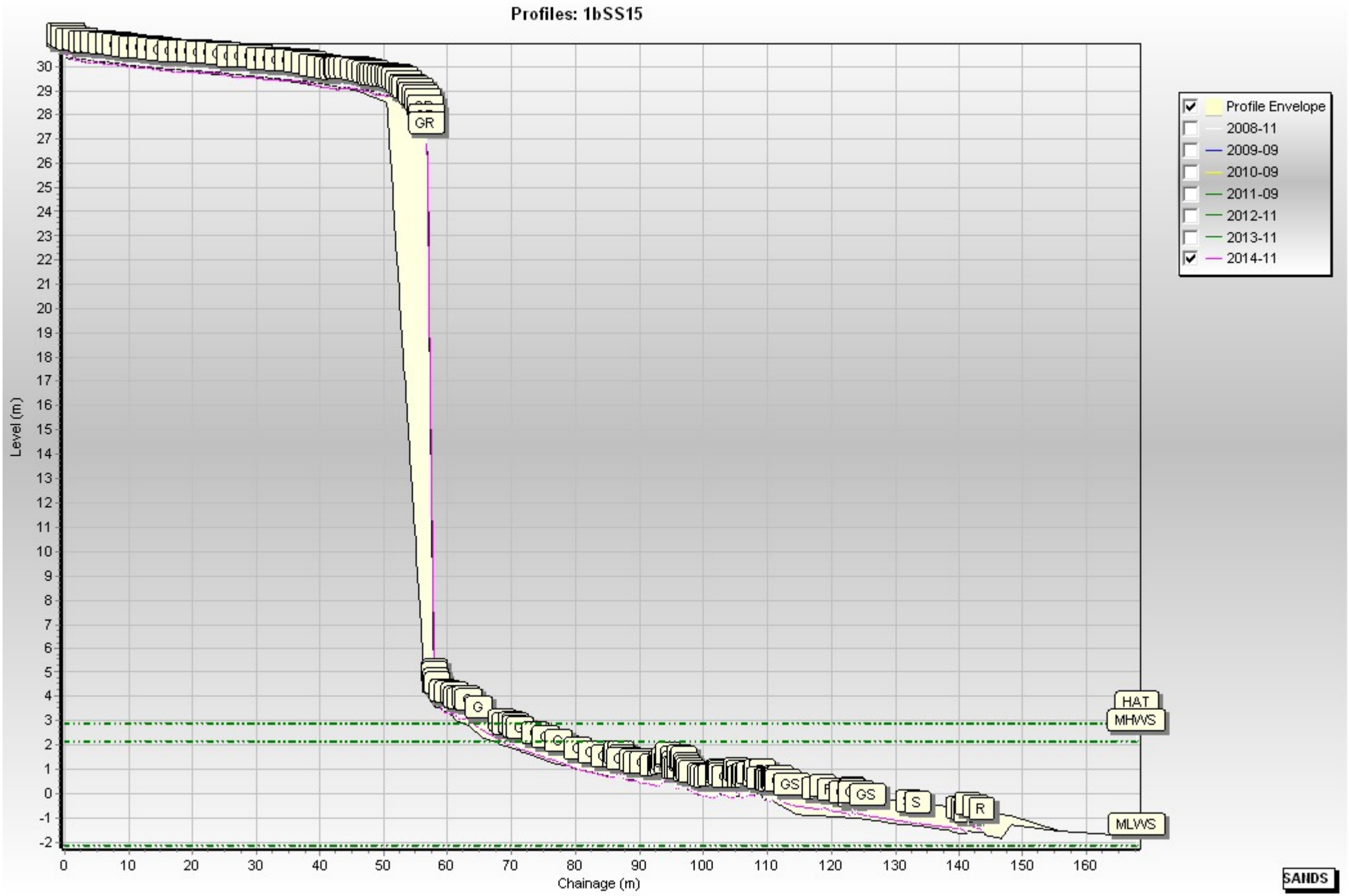
Level (m)
Chainage (m)
GR
SD
GS
S
HAT
MHWS
MLWS
SANDS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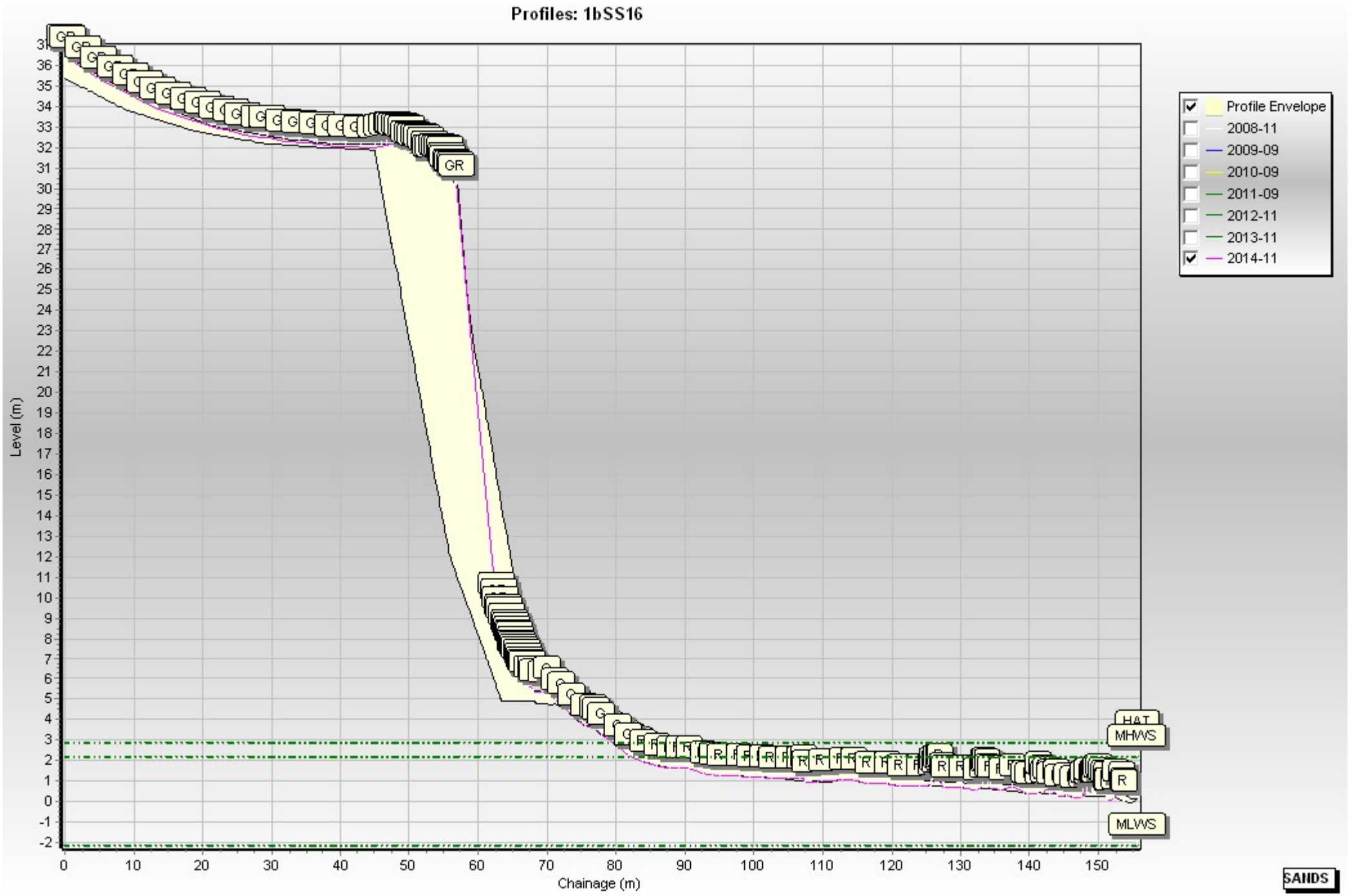
2011-09
2012-11
2013-11
2014-11
GR
G
GS
S
R
HAT
MHWS
MLWS
Level (m)
Chainage (m)
SANDS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2011-09
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2013-11
2014-11
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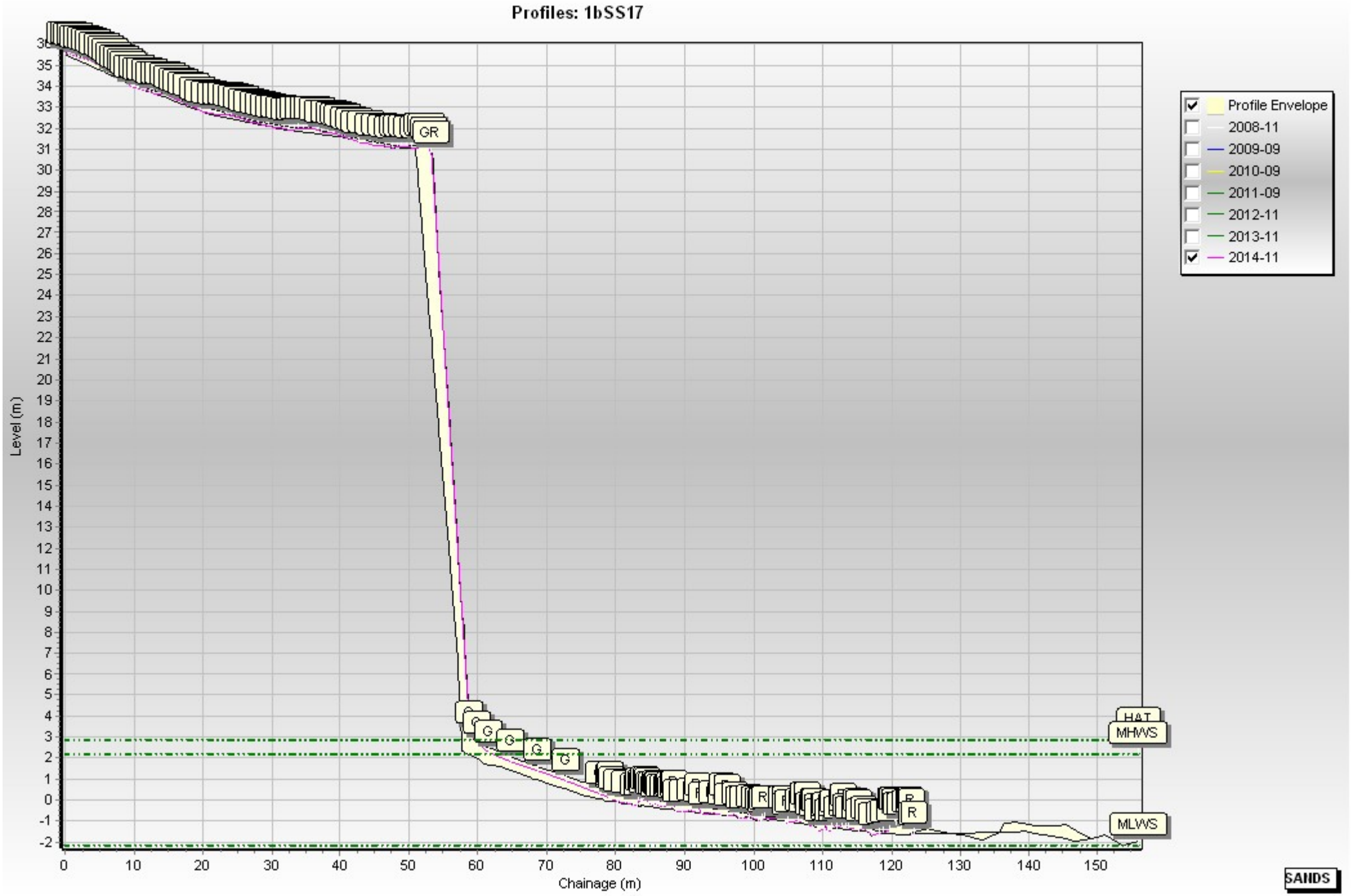
HAT
MHWS
R
MLWS
Level (m)
Chainage (m)
SANDS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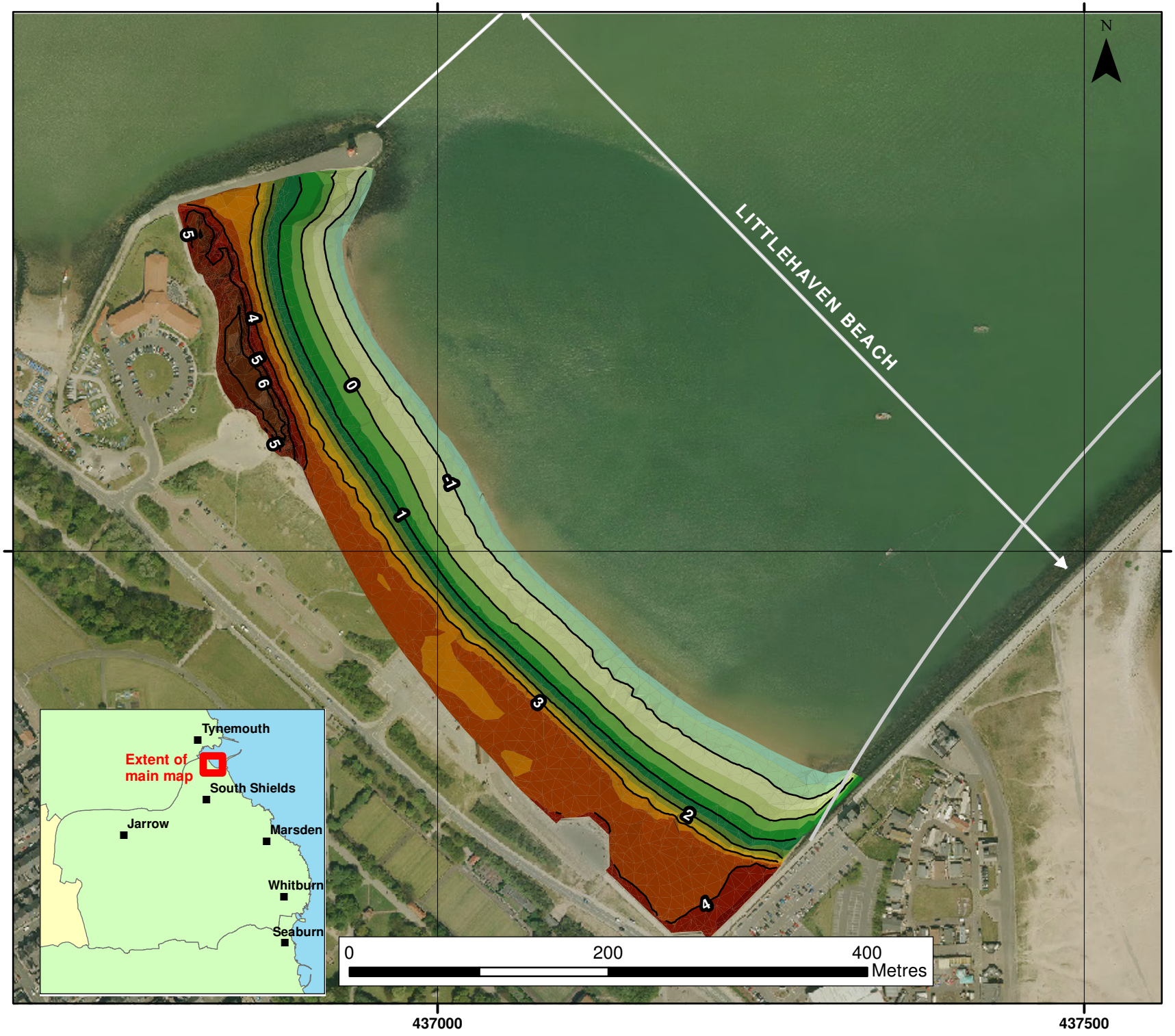
2009-09
2010-09
2011-09
2012-11
2013-11
2014-11
GR
G
R
HAT
MHWS
MLWS
Level (m)
Chainage (m)
SANDS

Appendix B

Topographic Survey



KEY

Elevation (m OD)

9.5 - 10	3.5 - 4
9 - 9.5	3 - 3.5
8.5 - 9	2.5 - 3
8 - 8.5	2 - 2.5
7.5 - 8	1.5 - 2
7 - 7.5	1 - 1.5
6.5 - 7	0.5 - 1
6 - 6.5	0 - 0.5
5.5 - 6	-0.5 - 0
5 - 5.5	-1 - -0.5
4.5 - 5	-1.5 - -1
4 - 4.5	-2 - -1.5
	-2.5 - -2

Contour 1m

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B - Map 1a
Topographic Survey
Littlehaven Beach
SouthTyneside Council

Analytical Report 7
Fulll Measures Survey
Autumn 2014

CH2MHILL
Halcrow

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

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

KEY Spring 2014 and Autumn 2014
Change in elevation (m)

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

Contours of change

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

Appendix B- Map 1b
Short-term Elevation Change
Littlehaven
SouthTyneside Council

Analytical Report 7
Full Measures Survey
Autumn 2014

CH2MHILL
Halcrow

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

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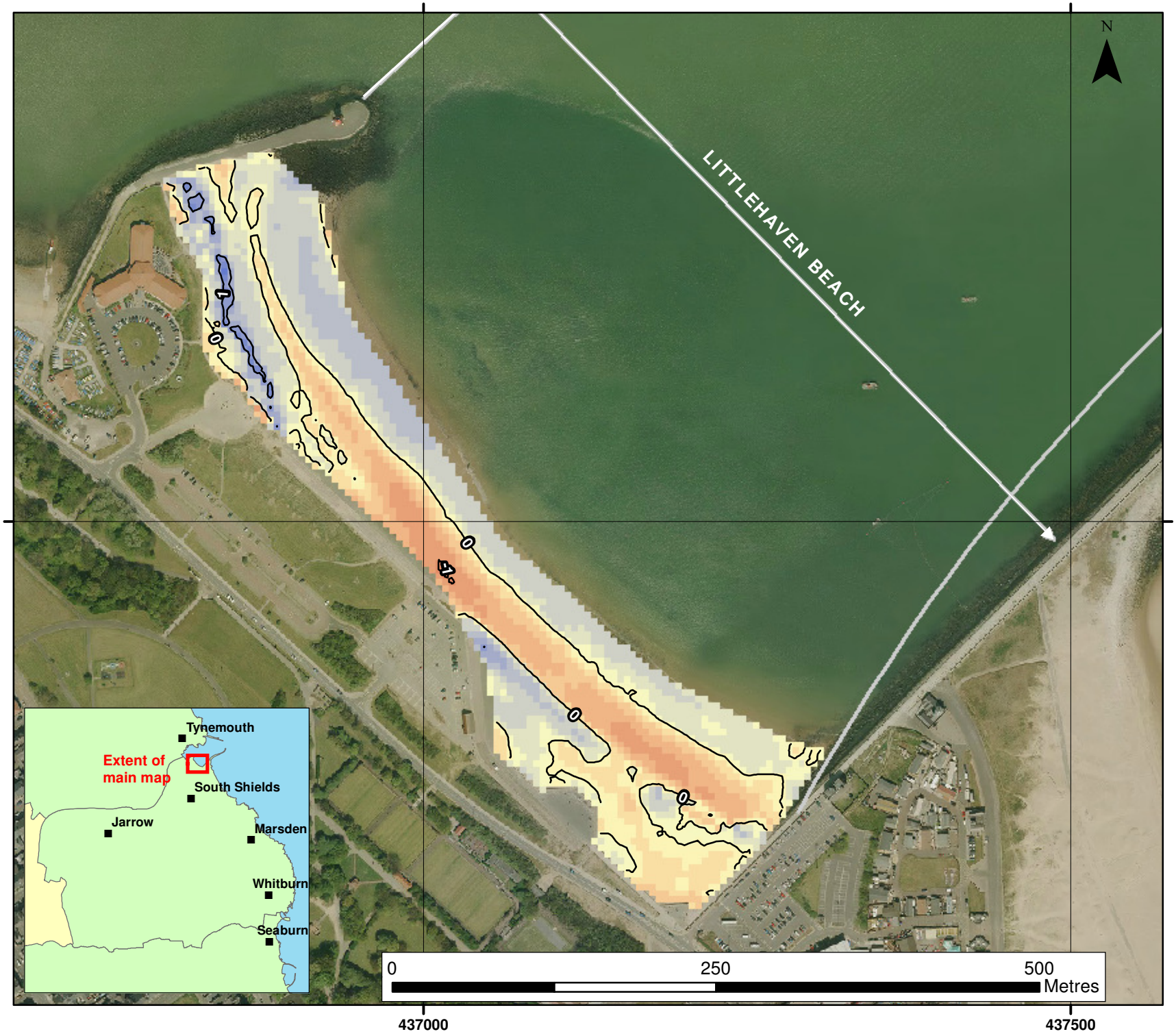
www.northeastcoastalobservatory.org.uk



KEY Autumn 2010 and Autumn 2014
Change in elevation (m)

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

Contours of change

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

Appendix B- Map 1c
Long-term Elevation Change
Littlehaven
SouthTyneside Council

Analytical Report 7
Full Measures Survey
Autumn 2014

CH2MHILL
Halcrow

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

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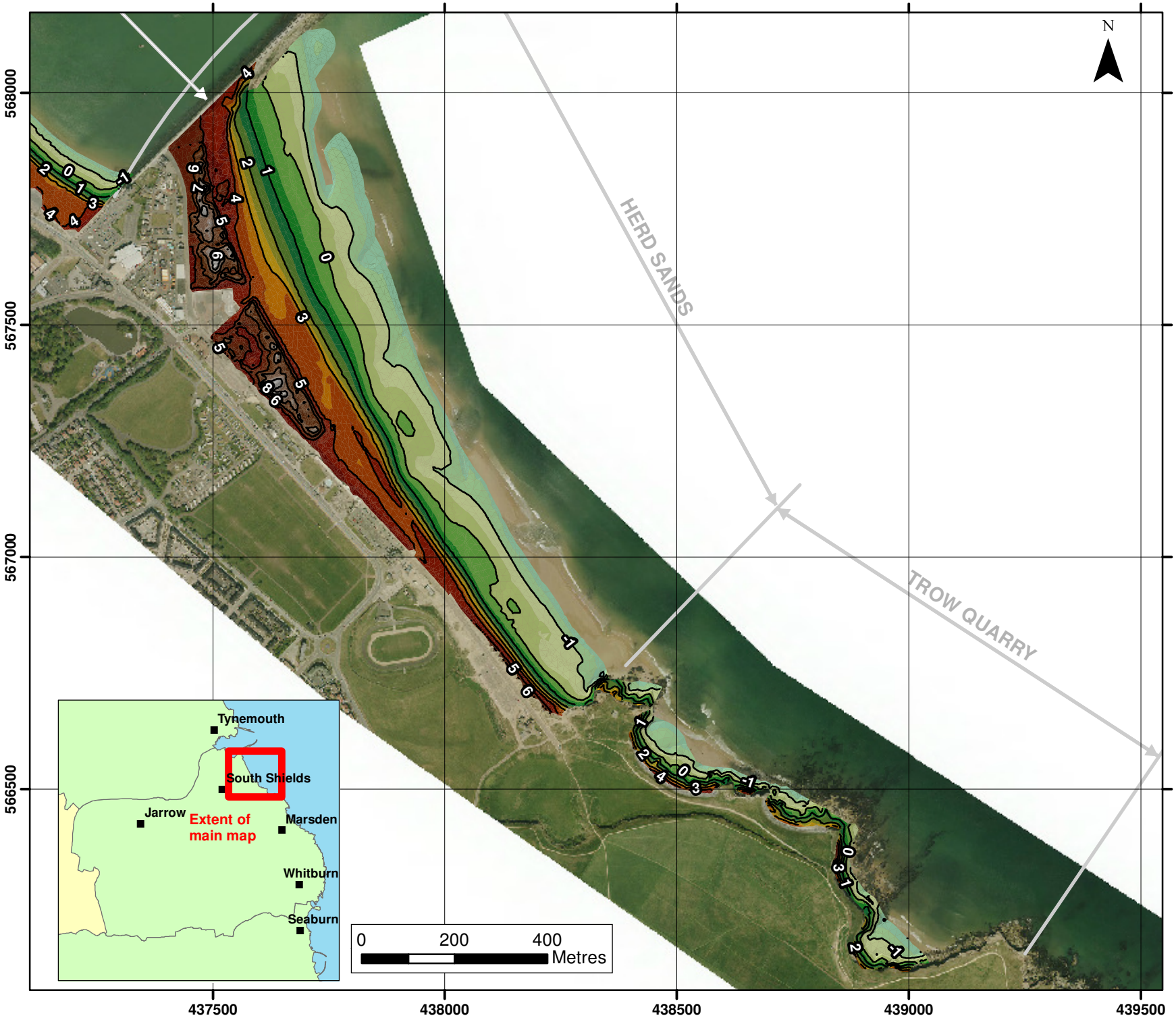

KEY

Elevation (m OD)

- 9.5 - 10
- 9 - 9.5
- 8.5 - 9
- 8 - 8.5
- 7.5 - 8
- 7 - 7.5
- 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
- -2.5 - -2
- Contour 1m

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
South Tyneside Council

Analytical Report 7
Full Measures Survey
Autumn 2014

CH2MHILL
Halcrow

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

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www.northeastcoastalobservatory.org.uk

KEY Autumn 2013 and Autumn 2014 Change in elevation (m)

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

Contours of change

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

Appendix B- Map 2b Short-term Elevation Change Herd Sands and Trow Quarry SouthTyneside Council

Analytical Report 7
Full Measures Survey
Autumn 2014

CH2MHILL Halcrow

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

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KEY Autumn 2010 and Autumn 2014 Change in elevation (m)

- <-2
- -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
- 0 - 0.1
- 0.1 - 0.25
- 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

Loss

Change < 0.1 m

Gain

Contours of change

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

Appendix B- Map 2c Long-term Elevation Change Herd Sands and Trow Quarry SouthTyneside Council

Analytical Report 7
Full Measures Survey
Autumn 2014

CH2MHILL Halcrow

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

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www.northeastcoastalobservatory.org.uk

Appendix C

Cliff Top Survey

Cliff Top Survey

Trow Quarry

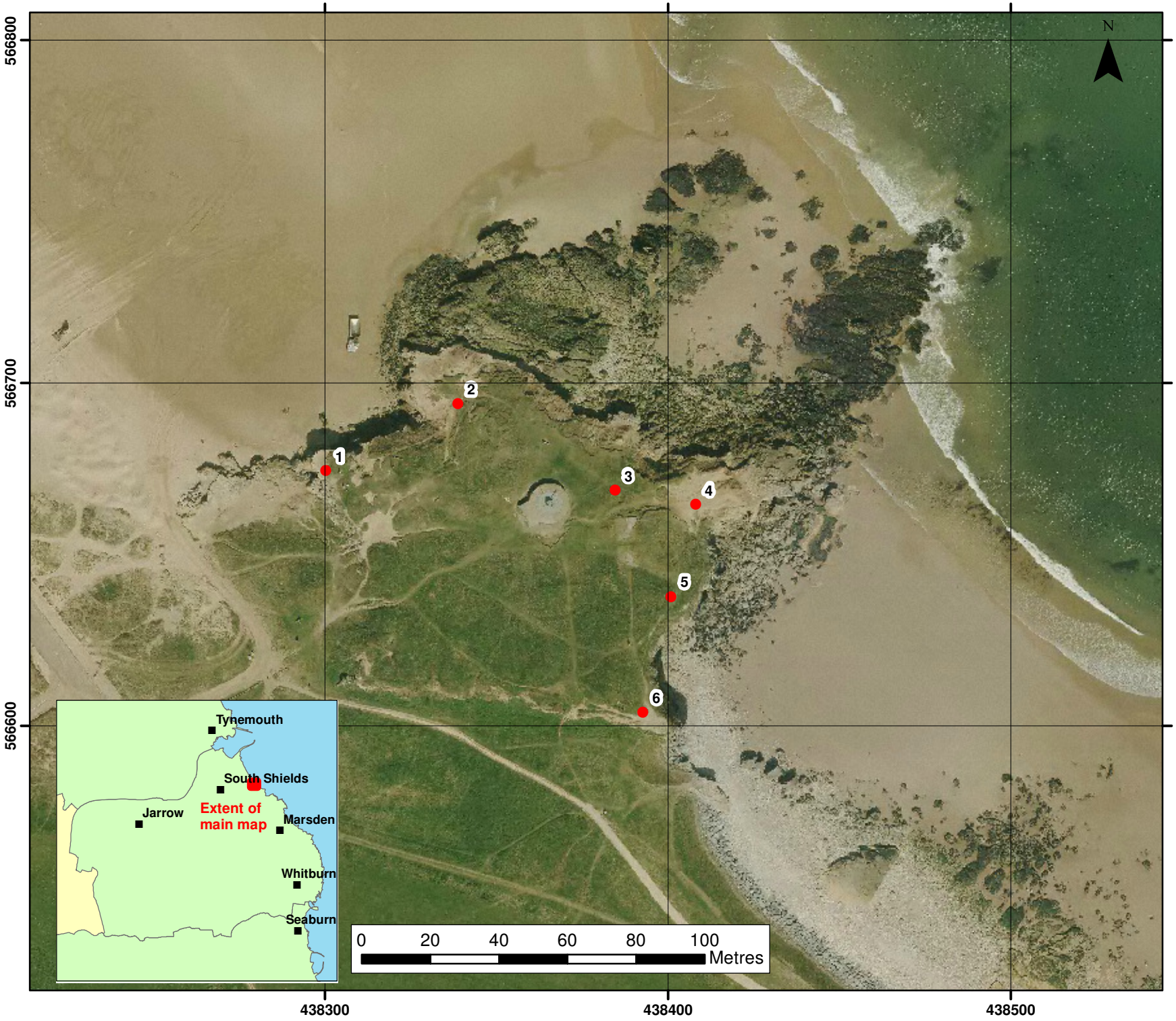
Six ground control points have been established at Trow Quarry (Figure C1). The maximum separation between any two points varies along the coast, reflecting the degree of risk from the erosion.

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

Table C1 provides baseline information about these ground control points and results from the 2011 (baseline) survey showing the position from the ground control point to the edge of the cliff top along the defined bearing. Future reports will show results from subsequent surveys and provide a means of assessing erosion since the baseline survey.

Table C1 – Cliff Top Surveys at Trow Quarry

Ground Control Point Details	Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Baseline Survey (Sept 2011)	Previous Survey (April 2014)	Present Survey (Nov 2014)	Baseline (Sept 2011) to Present (Nov 2014)	Previous Survey (April 2014) to Present (Nov 2014)	Baseline (Sept 2011) to Present (Nov 2014)
1	7.0	7.0	6.9	-0.1	-0.1	0.0
2	9.4	9.3	9.3	-0.1	0.0	0.0
3	7.0	7.1	6.9	-0.1	-0.2	0.0
4	10.5	10.5	10.7	0.3	0.3	0.1
5	7.0	7.6	7.6	0.6	0.1	0.2
6	10.2	10.1	10.3	0.1	0.1	0.0



KEY

- Cliff top survey locations

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix C- Map 1
Cliff Top Survey
Trow Quarry
South Tyneside Council

Analytical Report 7
Full Measures Survey
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CH2MHILL
Halcrow

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

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