Cell 1 Regional Coastal Monitoring Programme Analytical Report 11: 'Full Measures' Survey 2018

Sunderland City Council

February 2019

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Authors	
Alix Scullion	Royal HaskoningDHV
Dr Nick Cooper – Review & Approval	Royal HaskoningDHV

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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 (m AOD)
Water Level Parameter	**Souter Point to Chourdon Point**
HAT	3.18
MHWS	2.48
MLWS	-1.92

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

Glossary of Terms

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

Preamble

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

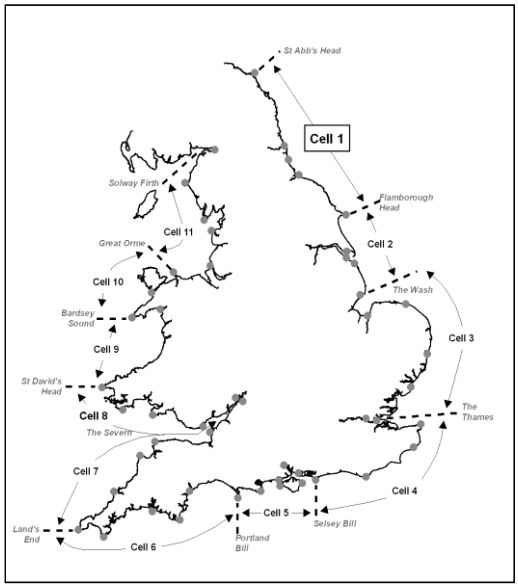


Figure 1 Sediment Cells in England and Wales

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

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

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

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

Each year, an Analytical Report is produced for each individual authority, providing a detailed analysis and interpretation of the 'Full Measures' surveys. This is followed by a brief Update Report for each individual authority, providing ongoing findings from the 'Partial Measures' surveys.

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

Table 1 Analytical, Update and Overview Reports Produced to Date

Year		Full Measures		Partial Measures		Cell 1 Overview Report
		Survey	Analytical Report	Survey	Update Report	
1	2008/09	Sep-Dec 08	May 09	Mar-May 09		-
2	2009/10	Sep-Dec 09	Mar 10	Feb-Mar 10	Jul 10	-
3	2010/11	Aug-Nov 10	Feb 11	Feb-Apr 11	Aug 11	Sep 11
4	2011/12	Oct-Nov 11	Oct 12	Mar-May 12	Oct 12	-
5	2012/13	Sep-Oct 12	Mar 13	Mar 13	Jun 13	-
6	2013/14	Sep-Oct 13	Feb 14	Mar 14	Jul 14	-
7	2014/15	Sep & Nov 14	Feb 15	Mar – Apr 15	Jul 15	
8	2015/16	Sep & Nov 15	Feb 16	Mar 16	Jul 16	Jun 16
9	2016/17	Sep-Nov 16	Feb 17	Apr 17	Jul 17	
10	2017/18	Oct-Nov 17	Mar 18	Mar 18	May 18	
11	2018/19	Oct-Nov 18	Feb 19 (*)			

(*) The present report is **Analytical Report 11** and provides an analysis of the 2018 Full Measures survey for Sunderland City 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

Sunderland City Council's frontage extends from The Bents to Ryhope. For the purposes of this report and for consistency with previous reporting, it has been sub-divided into three areas, namely:

- Whitburn Bay
- Sunderland Harbour and Docks
- Hendon to Ryhope (including Halliwell Banks)

1.2 Methodology

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

- Full Measures survey annually each autumn comprising:
    - Beach profile surveys along 52 transect lines (commenced 2009)
    - Topographic survey at Whitburn Bay (commenced 2009)
    - Topographic survey at Hendon to Ryhope (including Halliwell Banks) (commenced 2009)
- Partial Measures survey annually each spring comprising:
    - Beach profile surveys along 13 transect lines (commenced 2009)
- Cliff top survey bi-annually at:
    - Hendon to Ryhope (including Halliwell Banks) (commenced 2009)

The location of these surveys is shown in Figure 2. The Full Measures survey was undertaken along this frontage on the 21st and 22nd November 2018 (Whitburn Bay), 13th October 2018 (Sunderland Harbour and Docks) and between the 1st and 7th November 2018 (Hendon to Ryhope (incl. Halliwell Banks)). During this time weather conditions varied considerably. Refer to the survey reports for details of the weather conditions over this survey period.

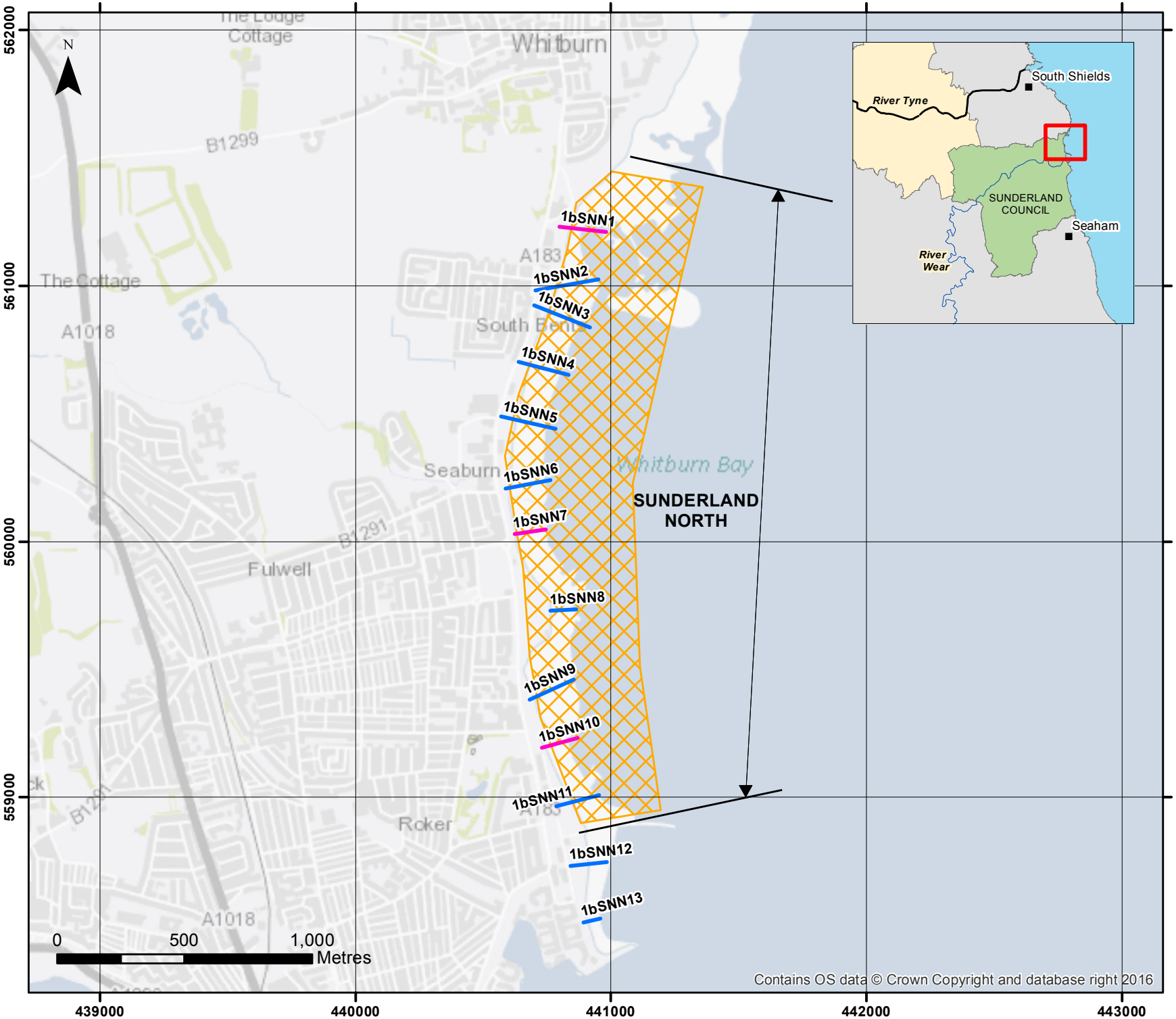
All data have been captured in a manner commensurate with the principles of the Environment Agency's *National Standard Contract and Specification for Surveying Services* and stored in a file format compatible with the software systems being used for the data analysis, namely SANDS and ArcGIS. This data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

SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Figure 2 - Map 1 Sunderland Council Frontage

Analytical Report
Topo Surveys

Drawing Scale at A4 1:20,000

WATER
Royal HaskoningDHV
Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE

Tel: +44 (0)191 211 1300
Fax: +44 (0)191 211 1313
www.royalhaskoningdhv.com

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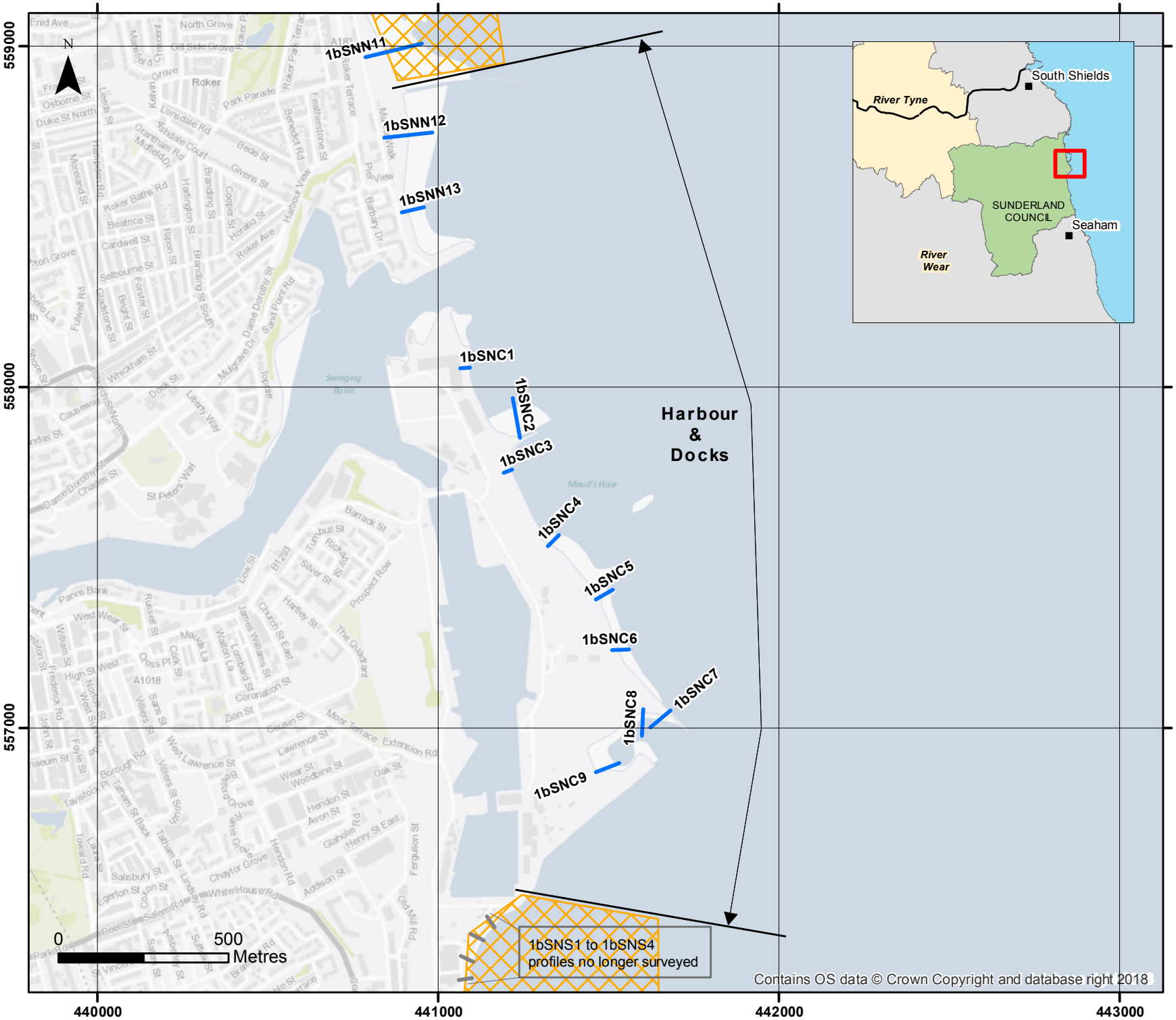

Key

SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual
- Discontinued

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Figure 2 - Map 2 Sunderland Council Frontage

Analytical Report
Topo Surveys

Drawing Scale at A4 1:15,000

WATER
Royal HaskoningDHV
Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE

Tel: +44 (0)191 211 1300
Fax: +44 (0)191 211 1313
www.royalhaskoningdhv.com

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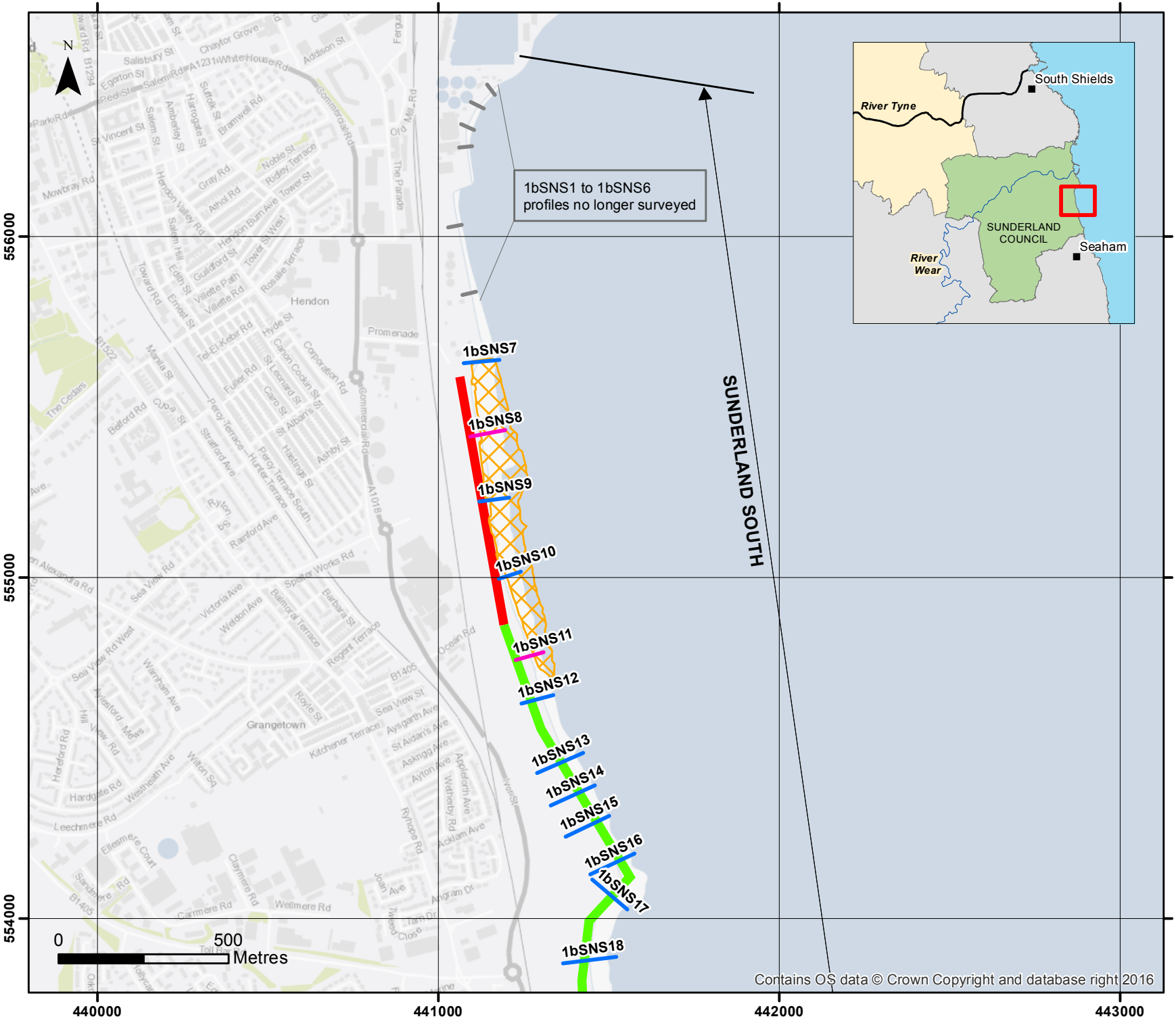

Key

SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual
- Discontinued

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs

- @ 100
- @ 300

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Figure 2 - Map 3 Sunderland Council Frontage

Analytical Report
Topo Surveys

Drawing Scale at A4 1:15,000

WATER
Royal HaskoningDHV
Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE

Tel: +44 (0)191 211 1300
Fax: +44 (0)191 211 1313
www.royalhaskoningdhv.com

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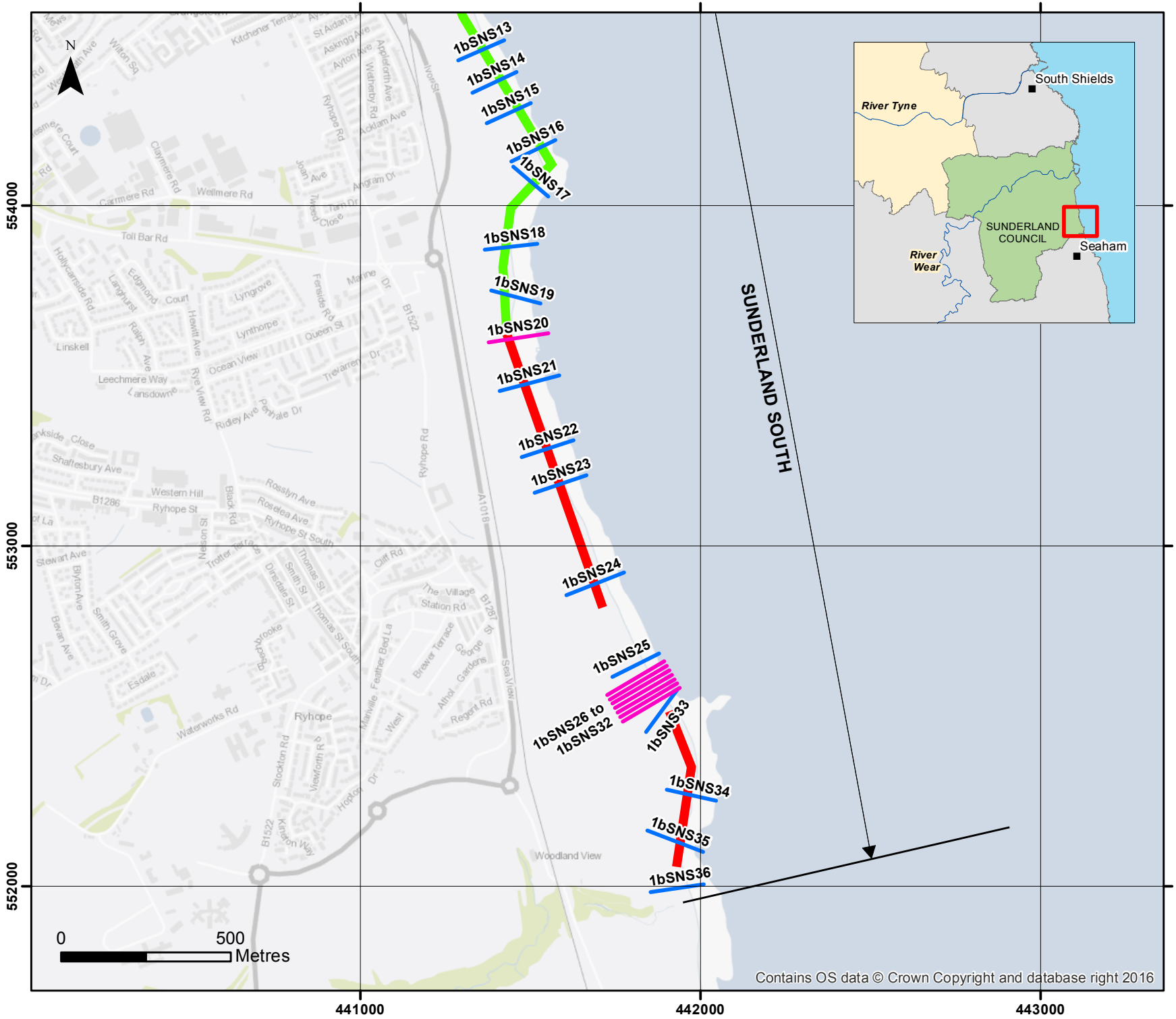

Key

SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Cliff Top Monitoring Pegs

- @ 100
- @ 300

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Figure 2 - Map 4 Sunderland Council Frontage

Analytical Report
Topo Surveys

Drawing Scale at A4 1:15,000

WATER
Royal HaskoningDHV
Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE

Tel: +44 (0)191 211 1300
Fax: +44 (0)191 211 1313
www.royalhaskoningdhv.com

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2. Analysis of Survey Data

2.1 Whitburn Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
21st – 22nd November 2018	**Beach Profiles:** Whitburn Bay is covered by eleven beach profile lines for the Full Measures survey (Appendix A). The previous survey was the Partial Measures survey undertaken in March 2018 and the previous Full Measures survey was undertaken in November 2017. Profiles 1bSNN1, 1bSNN7 and 1bSNN10 were last surveyed during the Partial Measures spring survey, 2018. The remaining profiles were last surveyed during the Full Measures autumn survey, 2017. **1bSNN1** is immediately south of Sunderland City Council's northern boundary. The profile is unchanged above HAT (40m chainage), with negligible sections of erosion and accretion. Between 39m chainage and 130m chainage the level of the beach has accreted by up to 0.3m since March 2018. Between 130m and 180m chainage the profile has eroded by 0.3m. Overall, the beach level is at medium-high levels compared to the range recorded from previous surveys. Profiles **1bSNN2** and **1bSNN3** are located towards the north of Whitburn Bay and extend across scrubland before reaching the upper gravel foreshore and then dropping across the lower sandy foreshore towards the rocky outcrop of Whitburn Steel. At profile **1bSSN2**, the dune has remained stable since the last survey, whilst the toe of the dunes has accreted by 0.2m to chainage 82m. The upper beach has seen small amounts of erosion up to 0.1m between chainage 82m and 116m. On the middle beach to lower beach there has been erosion of up to 0.25m. The toe of the beach shows erosion of 1.2m. Overall the profile is at a medium to high level compared to the range recorded from previous surveys, with the section between chainage 69m to 82m being the highest on record. At **1bSNN3**, the dunes remain unchanged since the previous survey, whilst the toe of the dunes has accreted by 0.5m to chainage 56m. The upper to middle beach from chainage 56m to 205m has eroded by up to 0.4m. The beach toe from chainage 205m to 250m shows erosion of up to 0.15m.	Along the length of Whitburn Bay profiles have been dominated by erosion since the spring 2018 survey, with particularly high rates of erosion on the lower foreshore. Although the majority of beach profiles are within the range of previous recorded surveys, the beach toe at profile 1bSNN9 and upper beach of profile 1bSNN6 are at their lowest level recorded, whilst the upper beach at 1bSNN2 is at its highest level recorded. Additionally, the beach toe at 1bSNN10 is at its most landward position since surveys began. **Longer term trends:** All the profiles in the north of Whitburn Bay (1bSNN1 – 1bSNN5) are at medium/high levels compared to earlier surveys in the record, whereas profiles south of this (1bSNN6 – 1bSNN11) are at a medium to low level. The beaches show frequent fluctuation in levels due to sediment being naturally redistributed across the shoreface.

Survey Date	Description of Changes Since Last Survey	Interpretation
	Overall, the beach is at a medium to high level compared to the range recorded from the previous surveys. Profiles **1bSNN4** to **1bSNN6** are between the shoreline opposite the southern edge of South Bents housing estate and Parsons Rock. Profile **1bSNN4** shows erosion of the small accumulation of gravelly sands at the toe of the seawall by up to 0.5m. There has been little change on the upper beach from chainage 25m to 57m, with a small amount of erosion of up to 0.1m. Between chainage 57m and 170m there has been erosion of 0.3m, which decreases in the lower beach to approximately 0.05m. Similar to previous surveys in the north, the beach toe has eroded by up to 0.25m. The majority of the beach is at recorded medium-high level compared to the range recorded from previous surveys. At profile **1bSNN5**, the beach profile has eroded by up to 0.4m, except at the beach toe where a small amount of accretion has occurred at chainage 246m of up to 0.2m. The beach is at a medium level compared to the range recorded from previous surveys At profile **1bSNN6**, beach levels have decreased by 0.6m across the whole beach, reaching its lowest level recorded from previous surveys between chainages 25m and 96m. The rest of the profile is at a low level compared to the range recorded from previous surveys. **1bSNN7** is at Seaburn, just to the north of Parson's Rocks. Beach levels have decreased across the profile to chainage 110m compared to the March 2018 survey. Seaward of chainage 110m, there has been negligible accretion of up to 0.05m. Overall, the profile is at a medium-low level compared to the range recorded from previous surveys. Profile **1bSNN8** extends across Parsons Rocks. There are no discernible changes across most of the profile since the previous Full Measures survey in 2017, The autumn 2018 survey did not extend to the lower foreshore and so a comparison of previous surveys was not possible. Profile **1bSNN9** drops from the cliff top to the foreshore at Roker. The upper beach from the toe of the cliff to chainage 77m has eroded by up to 0.3m. From chainage 77m to 125m there has been minor accretion of 0.15m across the middle beach. The toe of the beach has eroded by 1.1m and is now at its lowest level recorded. the rest of the profile is at a medium-low level compared to the range recorded from previous.	

Survey Date	Description of Changes Since Last Survey	Interpretation
	1bSNN10 is located approximately mid-way between Parson's Rocks and Roker Pier. There has been accretion of 1.0m at the toe of the seawall. Between chainage 25m and 86m there has been a small amount of accretion limited to less than ±0.05m. Seawards of chainage 86m, there is significant erosion of up to 1.2m at the toe of the beach, which is at its most landward position compared to previous surveys. Overall the beach is at a medium level in the upper and middle beach, and a low level in the lower beach compared to the range recorded in previous surveys. **1bSNN11** is located to the south of Whitburn. There has been varying amounts of small erosion and accretion of ±0.08m on the upper beach from the seawall to chainage 22m. The beach level has decreased across the rest of the profile by up to 0.4m,.Overall the beach is at a medium-low level compared to the range recorded from the previous surveys.	
21st – 22nd November 2018	**Topographic Survey:** Whitburn Bay, between the Bents and Roker Pier, is covered by an annual topographic survey which commenced in September 2009. Data from the most recent topographic survey (Full Measures, autumn 2017) have been used to create a digital ground model (DGM) (Appendix B – Map 1) using GIS. A difference plot has also been produced using the DGM (Appendix B – Map 2) produced from the last produced topographic survey (Full Measures, autumn 2016) and the present survey. The majority of the beach is dominated by erosion. There are some patchy areas of accretion particularly in the north of the bay and around Parsons Rocks in the central-south section of the bay.	The topographic survey shows that since the last survey, erosion has dominated across the bay, with some patches of erosion occurring in the north and around Parsons Rocks. **Longer term topographic trends Autumn 2009 to Autumn 2018:** In contrast to previous plots, Autumn 2017-18 shows a dominant trend of erosion, with isolated areas of accretion in the north of the bay and around Parsons Rocks.

3.2 Sunderland Harbour and Docks

Survey Date	Description of Changes Since Last Survey	Interpretation
13th October 2018	**Beach Profiles:** Sunderland Harbour and Docks is covered by eleven beach profile lines (Appendix A), all surveyed annually. The previous survey was the Full Measures survey undertaken in autumn 2017. **1bSNN12** and **1bSNN13** are both located within the shelter of Roker Pier. At profile **1bSNN12**, there has been accretion at the toe of the sea wall of 0.45m, which has reached its highest level recorded. The upper beach has shown variable erosion and accretion, however, seaward of chainage 50m the beach level has decreased by up to 0.6m. Overall the upper beach profile is at its highest level compared to the range recorded from previous surveys, the middle beach is at a medium level and the lower beach profile is at a low level compared to the range recorded from previous surveys. At **1bSNN13**, the gradient has steepened. There has been erosion of the entire beach profile seaward of chainage 25m, with up to 1.2m of sediment removed from the upper beach, exposing the toe the bottom part of the rock armour revetment. The middle to lower beach has eroded by between 0.2-0.8m. Overall the profile is at a medium-low level compared to the range recorded from previous surveys, with the toe of the rock revetment at its most exposed since records began. **1bSNC1** and **1bSNC2** are located within the shelter of New South Pier. Profile **1bSNC1** starts at the seaward edge of the dock building and extends across an earth mound before reaching the stepped landward face of the dock wall. The profile then drops from the wall crest directly into deep water. As there is no beach present and due to difficulties in access, profile **1bSNC1** has been removed from the survey programme from 2018 onwards. Profile **1bSNC2** starts at the crest of New South Pier and drops several metres to foreshore level. The beach level has risen between the toe of the seawall and 70m chainage by up to 0.6m. Seaward of this, there has been erosion of up to 0.3m. The profile is medium level compared to the range recorded from previous surveys. **1bSNC3** to **1bSNC6** are on the seaward face of the dock.	Within the breakwaters north of the River Wear, beach trends vary with cross-shore movement of material at profile 1bSNN12 and profile steepening at profile 1bSNN13. Between the breakwaters, the level of the upper foreshore has risen, whilst the middle and lower beach has fallen by 0.3m. Outside of the breakwaters, the beach has shown recovery of material at profile 1bSNC4 and 1bSNC5, with a loss of material at profile 1bSNC6. Within the breakwaters, either side of the former South Outlet of the docks there has been very limited change. **Longer term trends:** Within the breakwaters to the north and south of the River Wear, the beach levels are medium-low level compared to earlier surveys, except at profile 1bSNN12 where the beach level at the toe of the sea wall has reached its highest level recorded, whilst the toe of the revetment at profile 1bSNN13 is at its lowest level recorded. Outside of the harbour breakwaters, the beach levels fluctuate significantly over time. The surveys suggest the redistribution of sediment from the south of the embayment to the north of the embayment, with the northerly and central profiles (1bSNC4 and 1bSNC5) accreting across the beach since previous surveys

Survey Date	Description of Changes Since Last Survey	Interpretation
	Profile **1bSNC3** extends from the dockyard across a back flood wall, which has a crest level of around 7.2mOD, and promenade to the main seaward dock wall, which has a crest level of 7.55mOD. The profile then extends down the seaward face of the wall into deep water. As there is no beach present and due to difficulties in access, profile **1bSNC3** has been removed from the survey programme from 2018 onwards. Profiles **1bSNC4** and **1bSNC5** extend from the rock armoured revetment across the short width of foreshore down to low water. At profile **1bSNC4**, the beach levels show some signs of recovery with accretion of up to 0.5m, however they are still 1.1m lower than 2015 levels. The beach remains at a low level compared to the range recorded from previous surveys. At profile **1bSNC5**, beach levels seaward of the revetment have accreted slightly throughout the beach profile, with accretion of up to 0.3m. There is evidence of movement of the revetment, with a rock recorded approximately 4m further landwards. The beach is at a medium level compared to the range recorded from previous surveys. **1bSNC6** extends across the revetment and seawall. The beach level has continued to erode by up to 0.4m from the wall to the toe of the beach. The beach levels are at a high level compared to the range recorded from previous surveys. **1bSNC7** to **1bSNC9** are within the shelter of North East Pier and South West Breakwater in the former South Outlet, parts of which have been in-filled with tipped rubble. **1bSNC7** is a section across North East Pier. There has been no discernible change in the overall profile. Small apparent changes will be artefacts of the placement of survey points along the profile. Profile **1bSNC8** crosses the boulders and rubble. There has been no discernible change in the overall profile. Profile **1bSNC9** extends from the dock facilities and crosses a short length of concrete wall and sheetpiling before extending across the sand and gravel backshore and foreshore to reach and cross a boulder mound that is towards the seaward end of the south west breakwater. The profile shows a small amount (up to 0.4m) of erosion on the landward side of the berm above HAT. From chainages	and the southerly profile, 1bSNC6, eroding across the entire beach. Within the breakwaters either side of the former South Outlet of the docks, long term change is small at 1bSNC7 and 1bSNC8. At profile 1bSNC9, the long-term trend is increasing beach levels between the concrete wall and the boulder mound with the current levels between chainages 72m and 105m being at their highest recorded levels since surveys began in October 2009.

Survey Date	Description of Changes Since Last Survey	Interpretation
	72m to 105m the beach is recorded at its highest level since records began. The profile remains high relative to earlier surveys.	

3.3 Hendon to Ryhope (incl. Halliwell Banks)

Survey Date	Description of Changes Since Last Survey	Interpretation
1st – 7th November 2018	**Beach Profiles:** Hendon to Ryhope is covered by thirty-six beach profile lines (Appendix A). Most profiles are measured annually, but profiles 1bSNS4, 1bSNS8, 1bSNS11, 1bSNS20 and 1bSNS26 to 1bSNS32 are surveyed every 6 months. The previous Full Measures survey was undertaken in autumn 2017 and the previous Partial Measures survey was undertaken in spring 2018. **1bSNS1** to **1bSNS6** are located along the sea wall protecting the Hendon Sewage Treatment Works. The profiles typically include a section along the concrete deck, wall crest (which varies in elevation between around 7.0mOD in the north and 7.6mOD in the south after the dog-leg in the wall position), near-vertical seaward face of the wall, and sloping rock armour revetment. These profiles have now been removed from the survey. **1bSNS7** to **1bSNS10** are located along the defended coastal slopes at south Hendon, which rise in elevation to higher defended cliffs at **1bSNS11**. Profile **1bSNS7** extends across a seawall and concrete revetment, which is fronted by a foreshore comprised of large pebbles and coarse shingle. The profile shows no discernible changes since the November 2017 survey, with a small rock recorded at chainage 29m. Overall, the beach profile is at a medium level compared to the range recorded from previous surveys. Profile **1bSNS8** extends across the seawall, rock revetment and beach. There has been erosion of 0.35m at the toe of the revetment between chainage 34m and 45m. Between chainage 45m and 69m, there has been small amounts of accretion of up to 0.15m, covering up previously exposed rocks. Seawards of chainage 80m, there has been accretion of up to 0.25m resulting in a flatter lower beach gradient. Overall, the beach is at a low level compared to the range recorded from previous surveys. At profile **1bSNS9**, there has been erosion from the toe of the revetment at chainage 34m to the lower foreshore by up to 0.4m. The profile is at a medium level compared to the range recorded from previous surveys. At profile **1bSNS10**, there has been accretion of up to 0.6m from the toe of the revetment at chainage 23m until chainage 50m. Seawards of chainage 50m there has been erosion of up to 0.6m,	Along the length of south Hendon, profiles 1bSNS7 to 1bSNS10 show erosion at the toe of the coastal defence structures, whilst 1bSNS10 and 1bSNS11 have shown accretion. In general, the northern profiles are dominated by erosion, whilst the southern profiles are dominated by accretion. This is the opposite pattern of movement of sediment in the bay as the previous full measures survey. At Grangetown (south Hendon to Salterfen Rocks), beach level changes are dominated by erosion. Between Salterfen Rocks and the landfill at Halliwell banks (profiles 1bSNS20 to 1bSNS25), the cliff has largely been eroding since the previous survey, with the cliff top at the majority of profiles now at their most landward position since surveys began. Beach levels across the rocky platform have remained largely stable, with only minor erosion of sediment infilling hollows from the previous survey. There is no clear movement of sediment in either direction. There have been variable changes at the toe of the cliffs at the landfill site (1bSNS26 to 1bSNS32), reflecting the ongoing erosion processes. The cliff top has reached its most landward position at profiles 1bSNS26 and 1bSNS27. The profiles generally show erosion of up to 0.4m in the upper sections, with the middle and lower beach exhibiting negligible change. To the south of Halliwell Banks, around Pincushion, the cliff top has receded by up to 2m at profiles

Survey Date	Description of Changes Since Last Survey	Interpretation
	steepening the gradient of the beach profile. Whilst the upper beach is at a relatively high level compared to the range recorded from previous surveys, the middle to lower beach is at a medium to low level record from previous surveys. At profile **1bSNS11**, there is negligible change in the cliff profile. Beach levels have increased across the profile by up to 1.2m between the toe of the sea defences and 101m chainage. The upper beach is at a medium level compared to the range recorded from previous surveys, whilst the lower beach is at a high level compared to previous surveys. **1bSNS12** to **1bSNS36** are located along the undefended cliffs between Grangetown and Ryhope Dene. Profiles **SNS12** to **SNS19** are between the end of the Hendon sea wall and Salterfen Rocks. Cliff top levels are typically between 20m and 22mOD. They are highest along the profiles further north, dropping in the centre and then increasing again to the south. Profile **1bSNS12** extends from the cliff across the boulder foreshore. There are apparent changes in the cliff in the survey profile, but this is likely to be a data artefact due to interpolation between limited data points and inaccessibility of the cliff toe due to unsafe conditions. There has been erosion of up to 0.2m across the full beach profile. Overall the profile is at a high level compared to previous surveys. At profile **1bSNS13**, the majority of the cliff face has not changed in form since the previous survey. There has been erosion across the profile of up to 0.9m, exposing the rock platform previously exposed in the November 2017 survey. The beach profile is at a low level compared to previous surveys. At profile **1bSNS14**, the cliff top has remained stable since the previous survey. There has been slight accretion on the upper beach of less than 0.3m to chainage 69m. Between chainage 69m and 105m there has been negligible change. The rock platform has become exposed from chainage 105m and continues to chainage 139m. The beach profile is at a relatively medium level compared to the range recorded from previous surveys. At profile **1bSNS15**, the cliff has remained stable since the previous survey, however it has receded c.6m in total since 2009. Beach levels have decreased by up to 0.5m between the cliff toe and chainage 83m. There has been very little change across the rock platform between chainage 82m	1bSNS26 and 1bSNS and is now at its most landward position since surveys began. There has been accretion on the lower foreshore around the south of the headland. **Longer term trends:** Along the length of south Hendon, beach levels are generally at a medium to low level throughout. At Grangetown (south Hendon to Salterfen Rocks), the cliff top position has not changed substantially compared to the last survey, but since 2009 the cliff tops have receded several metres at some locations. Despite the most recent survey periods showing limited change at the cliff top, there has been erosion of the talus deposits at the cliff toe, indicating that the in-situ bedrock will once again be exposed to wave action and therefore more liable to undercutting and subsequent cliff retreat. Between Salterfen Rocks and the landfill at Halliwell banks (profiles 1bSNS20 to 1bSNS25), the cliff top at all profiles except profile 1bSNS21 has reached its most landward position since surveys began. Beach levels are relatively low across all profiles. At the landfill site (profiles 1bSSN26 to 1bSSN32), the cliff position has generally remained in the same position, except at profiles 1bSNS26 and 1bSNS27 where it has reached its most landward position since surveys began. The cliff toe along this section has varied between receding by 1m and receding by a maximum of 4m at profile 1bSNS32. The upper beach along this section mostly underwent erosion of

Survey Date	Description of Changes Since Last Survey	Interpretation
	and 129m. Seawards of the rock platform at chainage 129m there has been erosion of up to 0.6m. The beach is at a medium to low level compared to earlier surveys. At profile **1bSNS16**, there has been no discernible change to beach level since the last survey (autumn 2017). The cliff top has receded approximately 6m since 2009 but the cliff toe has only receded around 2m over the same period. Survey photos indicate this may be to do with the variable erosivity of the sandy upper cliff and more clay rich (glacial till) lower cliff. Profiles **1bSNS17** to **1bSNS36** extend between Salterfen Rocks and Ryhope Dean/Pincushion Rocks along Shirley Banks and Halliwell Banks. Profiles between 1bSNS17 and 1bSNS25 typically exhibit a characteristic cliff height of between 23m and 29mOD, with beaches at the toe typically at levels between 3.1m and 4.6mOD. At **1bSNS17**, the cliff top appears to have receded by 0.5m since the previous survey (November 2017). There are no discernible changes in the profile since the previous November 2017 survey. At **1bSNS18**, the profile shows the beach levels from the toe of the cliff to chainage 72m have dropped by up to 0.4m. There has been no change in beach level of the underlying rocky platform. Overall the profile is at a low level compared to the range recorded from previous surveys, with the section between chainages 52m and 72m being the lowest on record. There has been no change in the cliff top position since surveys began. At **1bSNS19**, the rocky foreshore remains unchanged. The cliff top has receded 0.5m since 2009. At profile **1bSNS20**, the cliff top has receded by 0.5m (reaching its most landward position). The cliff top has receded around 1.5m since 2009. There is negligible change across the rocky platform across the rest of the profile. Overall the changes are minor and within the range of beach levels seen in previous surveys, though the beach is at a low-medium level. At **1bSNS21**, there has been no change in the position of the cliff since the last survey. There has been erosion of 0.5m at the toe of the cliff to chainage 52m.There has been a reduction in beach levels of up to 0.5m between chainage 75m and 135m, exposing boulders which had previously been covered by a veneer of sand in the autumn 2017 survey. The toe of the beach seawards of chainage 130m shows minor erosion of up to 0.3m. Overall the profile is at a medium level compared to the range recorded from previous surveys.	0.4m. Beach levels across the middle to lower beach exhibit negligible change and are within the bounds of previous surveys. To the south of Halliwell Banks at profiles 1bSNS33 and 1bSNS35, the cliff top has receded by up to 2m and is now at its most landward position. Changes across the beach are within the bounds of previous surveys.

Survey Date	Description of Changes Since Last Survey	Interpretation
	At profile **1bSNS22**, the cliff top and toe has receded by up to 0.2m since the previous survey and is now at its most landward position since surveys began. The shore platform remains unchanged between chainages 58m and 111m. Seaward of 111m, there has been erosion of up to 0.3m of sediment infilled hollows since the previous survey in November 2017. Overall the profile is at a low level compared to the range recorded from previous surveys, with the cliff toe at its most landward position recorded. At profile **1bSNS23**, the cliff top has receded by 1m, which is now its at its most landward position since September 2009. There has been negligible change across the rock platform. The toe of the beach from chainage 96m has eroded by 0.3m. The cliff top and upper beach are at their lowest on record and the middle and lower beach are at a low level compared to the earlier surveys. At **1bSNS24**, the cliff top has receded slightly compared to the previous survey in November 2017, whilst the rest of the cliff face has retreated, with the cliff toe 5m landward of its previous position in November 2017 (and now at its most landward position since surveys began in 2009). There has been accretion of up to 0.6m on the upper beach between chainages 49m and 76m. Between chainages 76m and 136m there has been erosion of up to 0.8m, exposing a rocky outcrop. The lower foreshore seaward of chainage 136m has not changed since the previous survey. Overall the profile is at a low level compared to the range recorded from previous surveys, with the cliff face at its most landward position since September 2009. At profile **1bSNS25**, there has been no change to the cliff face. There has been minor erosion on the upper beach of up to 0.4m. There has been negligible change to position of the rocky outcrop. The cliff and beach profile are at a low level compared to the range recorded from previous surveys. Profiles **1bSNS26** to **1bSNS32** are located at Halliwell Banks specifically to assess risks from erosion at a former land fill. Cliff height is between 26m and 27mOD, with beaches at the toe typically at levels between 3.3m and 3.9mODN. Profiles **1bSNS26** to **1bSNS32** have all behaved in a similar way. The top of the cliff shows little movement except at profile **1bSNS26** and **1bSNS27** where it has retreated by 1m, reaching its most landward position since surveys began. However, the cliff toe shows variable movement from receding by around 1m to a maximum of 4m at profile **1bSNS32**; this reflects the ongoing erosional processes. Most profiles show erosion of 0.4m on the upper beach, except profiles **1bSNS30** and **1bSNS31** which show a small amount of accretion on the upper beach of around 0.1m. The middle to	

Survey Date	Description of Changes Since Last Survey	Interpretation
	lower beach of all profiles exhibit negligible change. Overall, the profiles are at a low level compared to the range recorded from previous surveys. Profiles **1bSNS33** to **1bSNS36** are located around the Pincushion Headland. At profile **1bSNS33**, the cliff top and face has receded by 0.5m (now at its most landward position), whilst the toe has generally retained the same form and position since the last survey. There has been very little change on the upper and middle beach to chainage 94m, with a small amount of erosion up to 0.1m. A rock outcrop is exposed seawards of chainage 94m on the lower foreshore. Overall, the profile is at a low level compared to the range recorded from previous surveys. At Profile **1bSNS34,** the profile has changed little since the previous survey. Profile **1bSNS35** shows a retreat of the cliff top by c.2m, with a loss of up to 0.4m of material at the toe of the cliff. A small berm has formed between chainages 42m and 51m, with an accumulation of 0.9m of material. A veneer of sediment has covered up previously exposed rocks between chainages 51m and 80m. There is negligible change in beach level from chainages 80m to 115m. Between 115m and 130m, there has been erosion of material, exposing a rocky outcrop. The beach toe has eroded by 0.6m.The cliff top is at its most landward position, whilst the rest of the profile is at a relatively medium level compared to the range recorded from previous surveys. Profile **1bSNS36** shows there has been a small accumulation of material on the upper beach of up to 0.2m. Between chainage 70m and 148m the exposed rock platform remains unchanged. Seawards of chainage 148m there has been a loss of up to 0.4m of sand covering the previously exposed rock platform. The majority of the profile remains at a medium level compared to the range recorded from the previous surveys	
November 2018	**Topographic Survey:** Hendon to Ryhope is covered by an annual topographic survey between the Hendon Sea Wall and Ryhope Dene, which commenced in autumn 2009. Data from the most recent topographic survey (Full Measures, autumn 2018) have been used to create a DGM (Appendix B – Map 2) using a GIS. A difference plot has also been produced using the	The short-term change plot indicates that there has been a net southerly movement of sediment but change has been limited (±0.5m).

Survey Date	Description of Changes Since Last Survey	Interpretation
	DGM (Appendix B – Map 4) produced from the last produced topographic survey (Full Measures, autumn 2017) and the present survey. The survey shows a clear pattern of erosion in the north of the bay, though this is generally of low magnitude (±0.5m). The lower half of the beach is dominated by low levels of accretion across the middle beach with some small patches of erosion at the toe of revetment and towards the lower beach.	
November 2018	**Cliff Top Survey:** Cliff top survey data collected between the baseline survey (spring 2009) and the present Full Measures survey (autumn 2018) is documented here. 32 ground control points (numbered 1-32) were established along the cliff top between Hendon and Ryhope in March 2009, with a further three (28A, 28B and 28C) added in September 2009. Note: the numbering of ground control points is not intended to correlate with that of the beach profile lines. Measurements are taken from each ground control point along a fixed bearing to the edge of the cliff top. These cliff top surveys are undertaken bi-annually and are intended to inform on erosion rates of the sea cliffs extending from the defended industrial areas at Hendon southwards along the undefended cliffs to Ryhope Dene. Appendix C – Table C1 provides results from the cliff top survey, showing the position from the ground control point to the edge of the cliff top along a defined bearing. Results show that since the Partial Measures (March 2018) survey apparent erosion greater than the error has occurred at 8 locations, GCP8, GCP9, GCP13, GCP19, GCP23, GCP24, GCP28A and GCP31 with an average loss of 0.98m recorded (with a maximum loss of 2.25m at GCP13). Since surveys began in March 2009 (or September 2009 for 28A, 28B, and 28C) erosion greater than the survey error has occurred at around 80% of the ground control points, where total losses are 10.94m (at location 27) at their greatest, and more typically less than 5m. The long-term erosion rates are up to 1.56m/yr. (location 27), with up to 0.53m/yr. being more typical.	The cliffs have remained generally stable over the most recent survey period across the majority of the survey points, with 23% of points recording erosion greater than the survey error. **Longer term trends:** The data indicates that the fastest erosion since 2009 is concentrated in three broad sections; a) the northern part of the developing embayment between the southern extent of the sea defences and Salterfen Rocks, b) throughout the majority of Halliwell Banks and c) to the south of Pincushion rocks. Recession is least, as might be expected, along the defended sections and at the promontories of Salterfen Rocks and Pincushion Rocks

4. Problems Encountered and Uncertainty in Analysis

Individual Profiles

The survey report notes that the beginning of profile 1bSNN9 was unsafe to access at the time of the survey. Additionally, the southern beach at Whitburn Bay was undergoing grading at the time of surveying (21st November 2018).

The survey also noted that at profile 1bSNS31, a section of cliff had slumped.

Topographic Survey

The southern part of the beach in Whitburn Bay was being graded at the time of survey on the 21st November 2018.

Cliff Top Surveys

No problems were encountered.

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

Based upon recommendations made by the surveyors in 2017, profiles 1bSNC1 and 1bSNC3 have been removed from the programme. These profiles did not cover any beach and were difficult and dangerous for the surveyors to access.

6. Conclusions and Areas of Concern

- At Whitburn Bay, the majority of beach profiles are within the range of previous recorded surveys, the beach toe at profile **1bSNN9** and upper beach of profile **1bSNN6** are at their lowest level recorded, whilst the upper beach at **1bSNN2** is at its highest level recorded. Additionally, the beach toe at **1bSNN10** is at its most landward position since surveys began. The recorded profiles and topographic survey present no causes for concern.
- At Sunderland Harbour and Docks, the recorded profiles present no causes for concern.
- At Hendon to Ryhope (incl. Halliwell Banks), the recorded profiles, topographic survey and clifftop survey present no causes for concern. Ongoing cliff erosion is of a similar magnitude to previous surveys.
- At Hendon to Ryhope (incl. Halliwell Banks), the greatest amount of erosion recorded to have taken place between March 2009 and November was 10.94m at Point 27 which is on the northern border of the landfill site. Since the last survey, the greatest erosion has been at Point 13 (undefended glacial cliffs north of Salterfen Rocks), where the cliff edge has receded 2.25m.

Appendices

Appendix A

Beach Profiles

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

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

Beach Profile

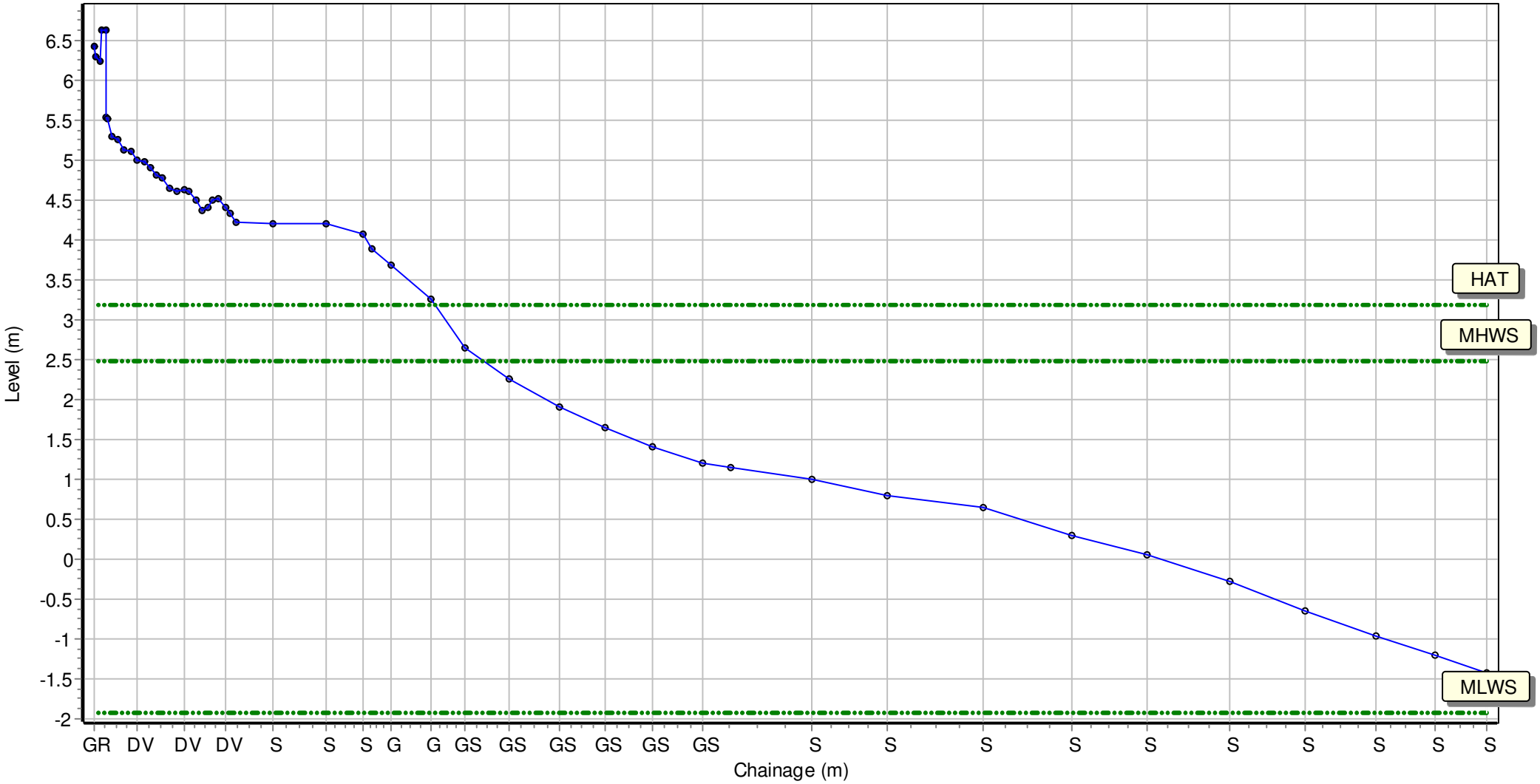
Location: **1bSNN1**

Date: 07/03/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Partial Measures Topo Survey

Easting: 440797.428 **Northing:** 561231.249 **Profile Bearing:** 97 ° from North



Beach Profile

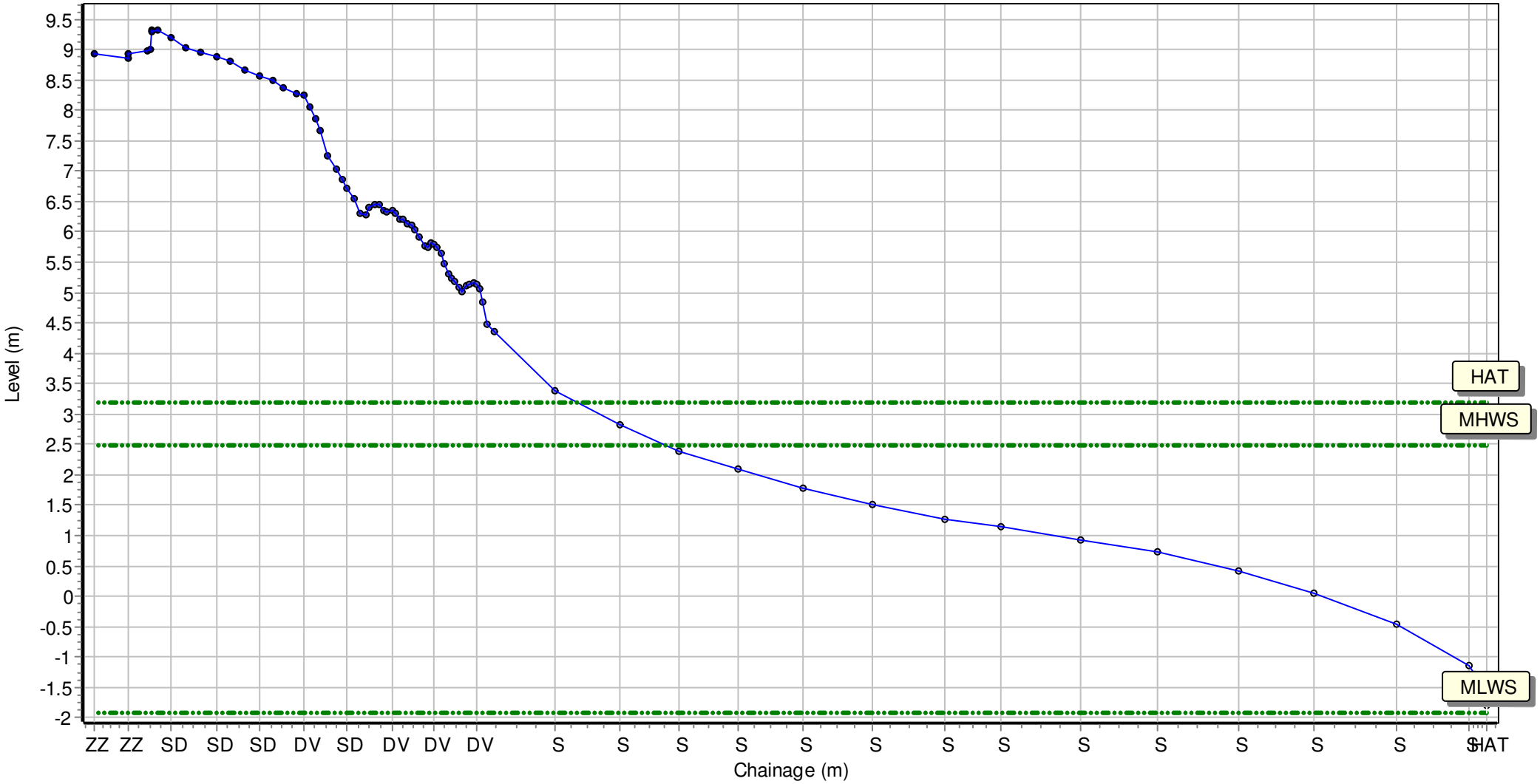
Location: **1bSNN2**

Date: 22/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 440704.168 **Northing:** 560981.14 **Profile Bearing:** 80 ° from North



Beach Profile

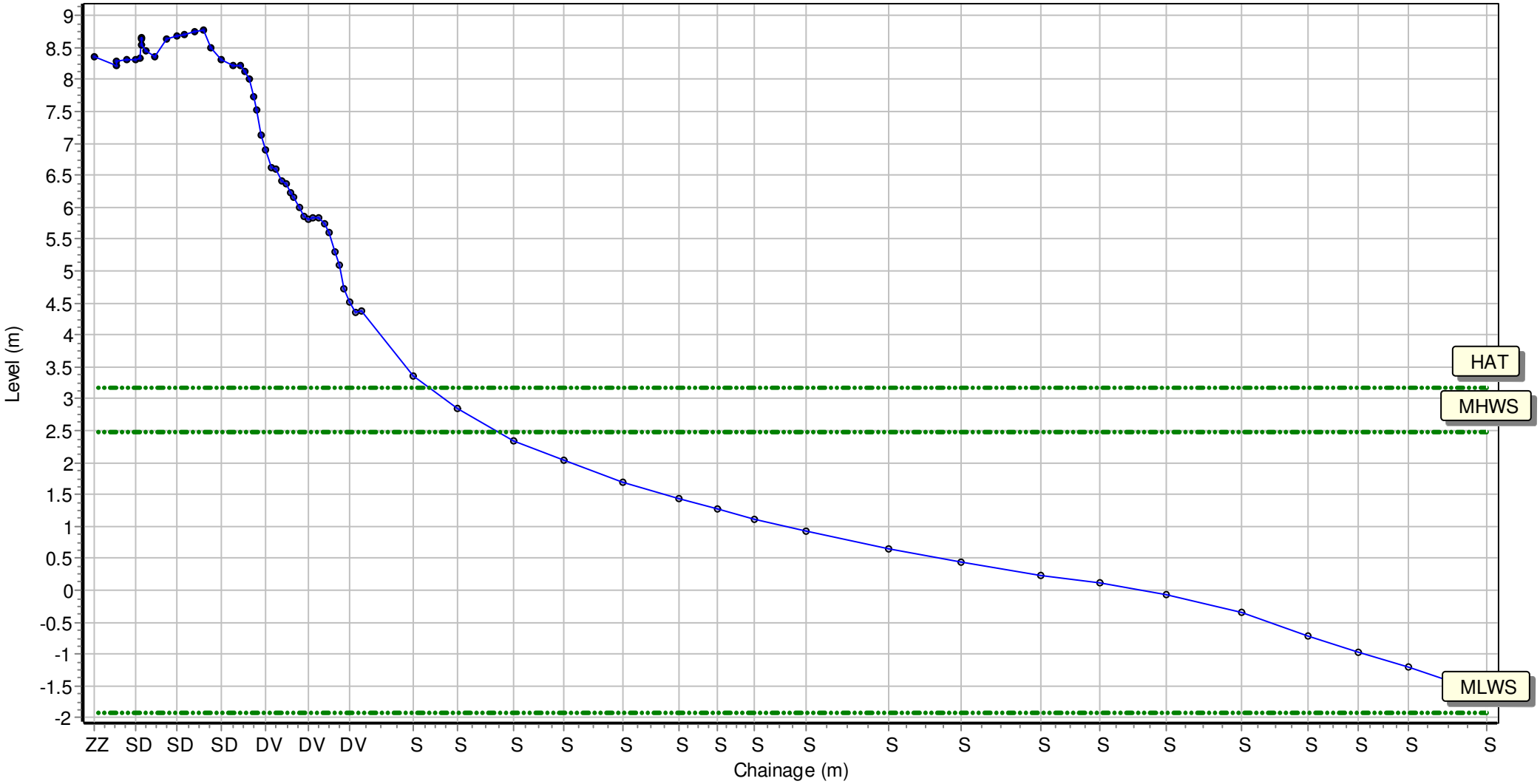
Location: **1bSNN3**

Date: 22/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 440698.999 **Northing:** 560923.727 **Profile Bearing:** 112 ° from North



Beach Profile

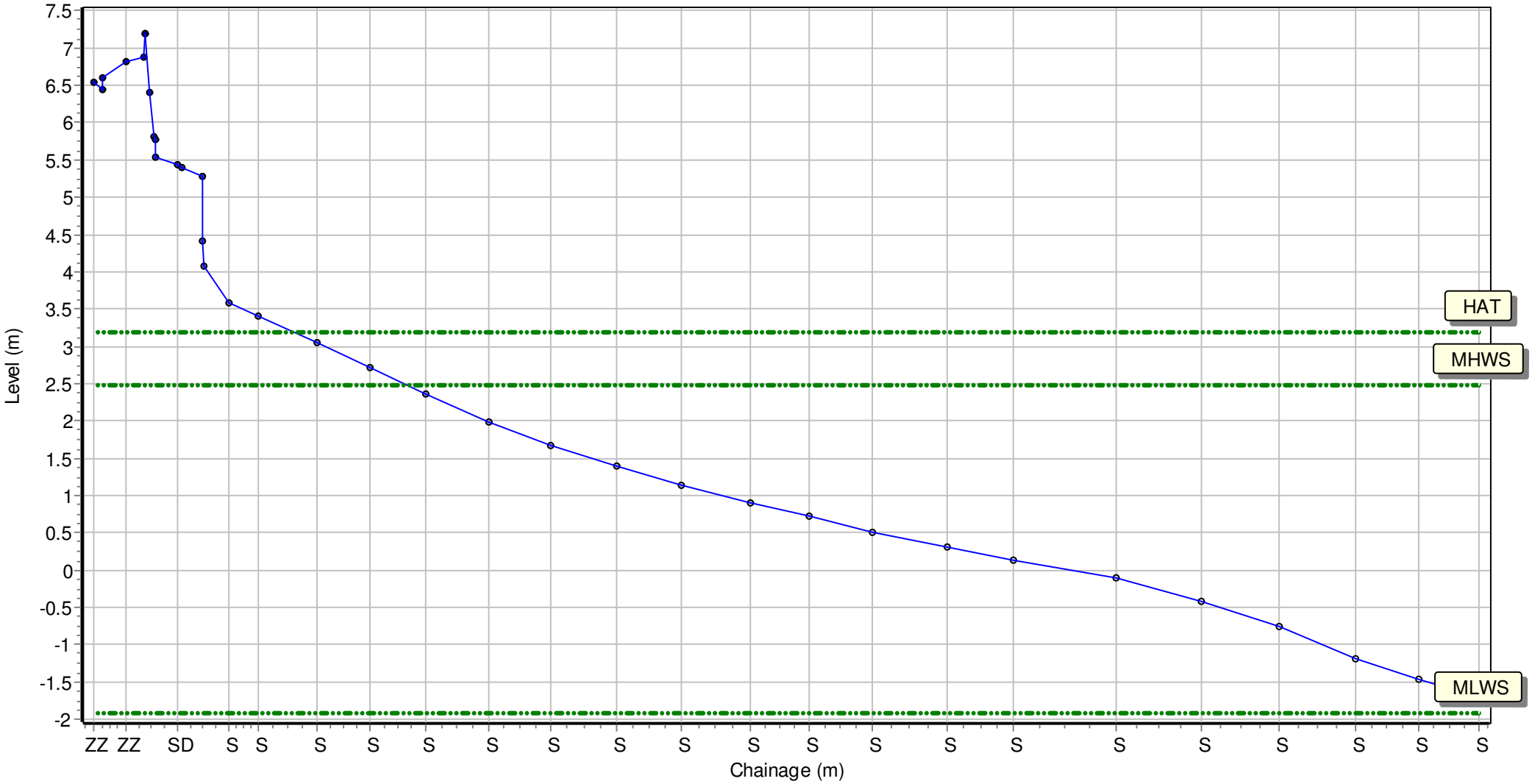
Location: **1bSNN4**

Date: 22/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 440637.004 **Northing:** 560702.72 **Profile Bearing:** 104 ° from North



Beach Profile

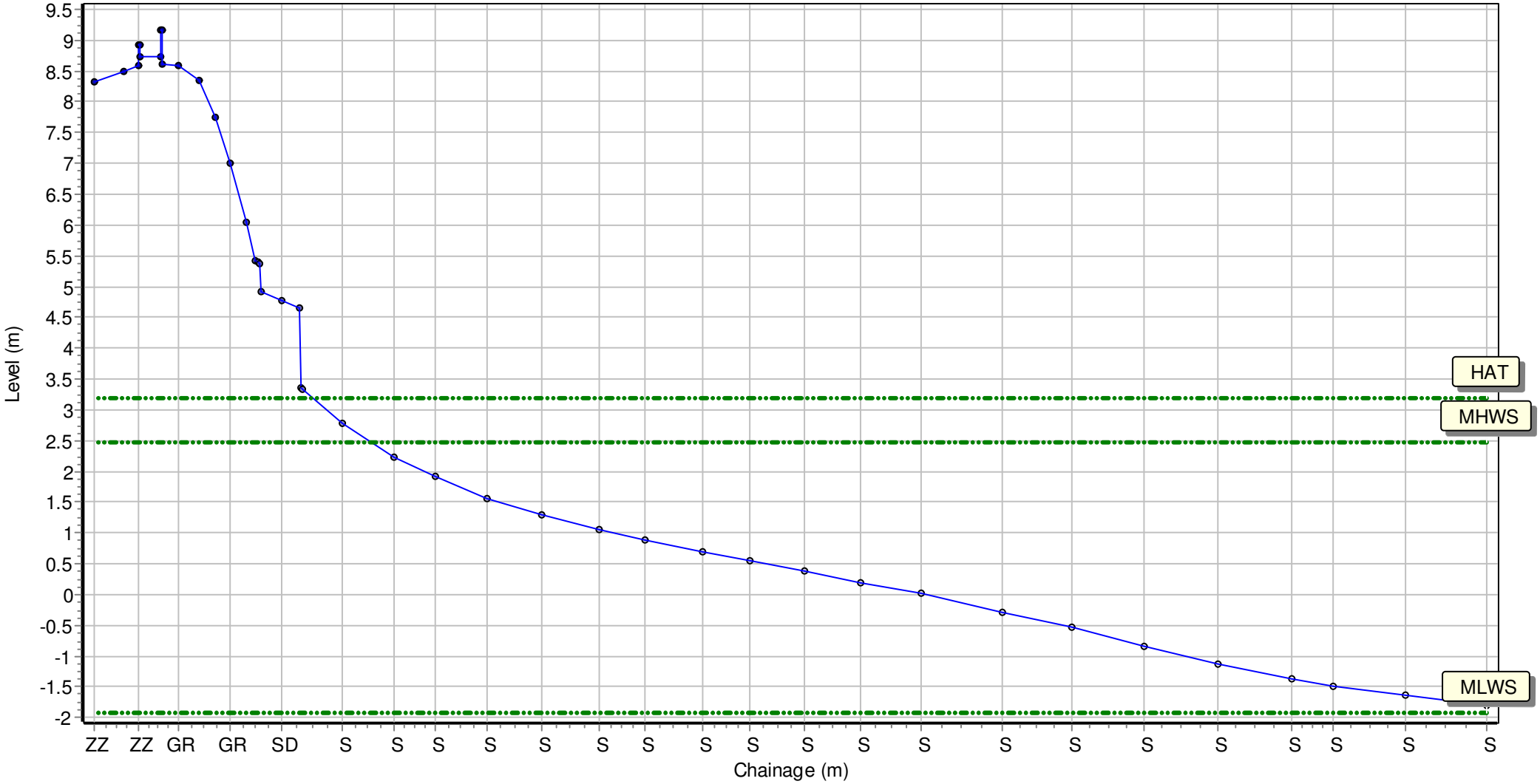
Location: **1bSNN5**

Date: 22/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 440568.694 **Northing:** 560490.321 **Profile Bearing:** 103 ° from North



Beach Profile

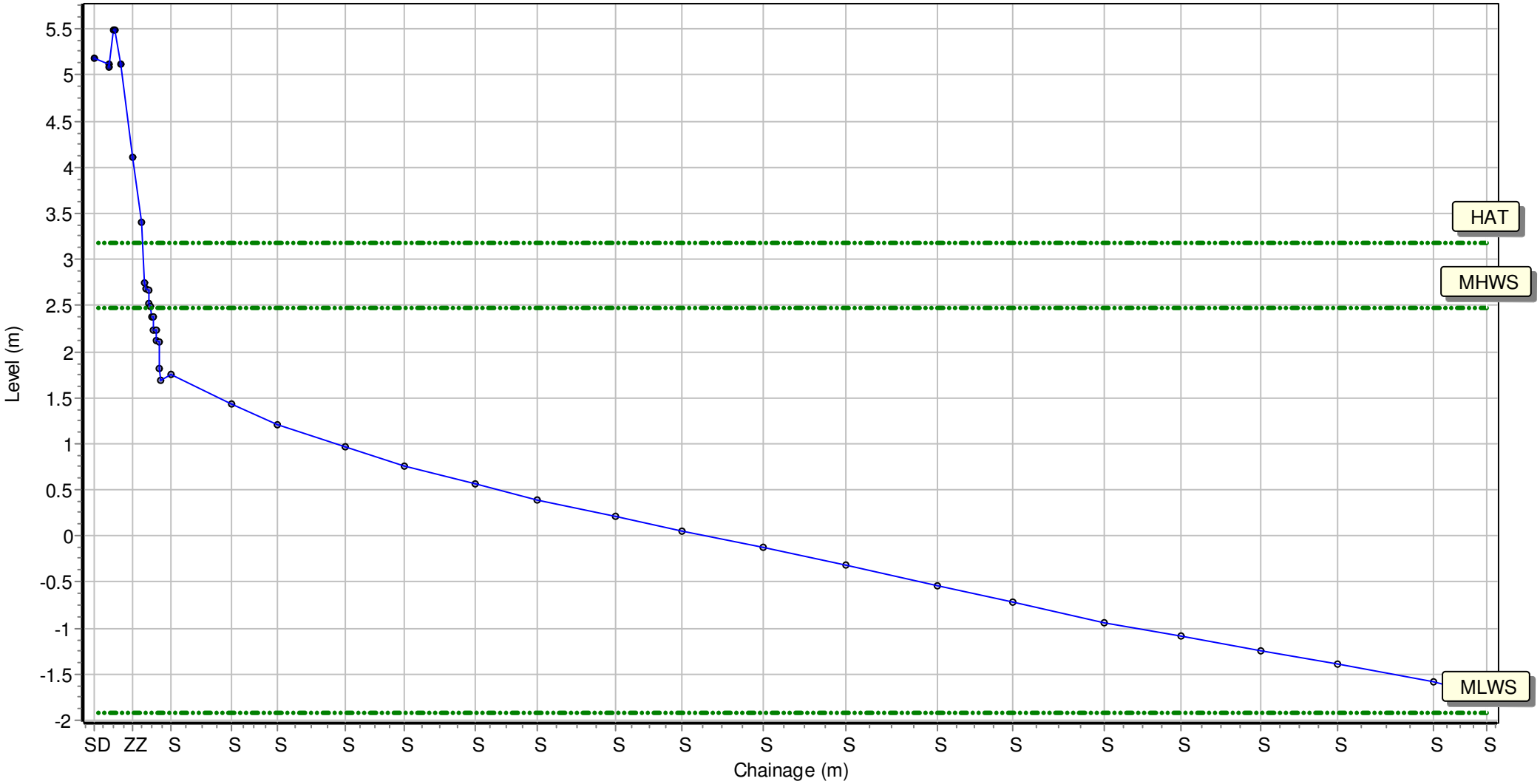
Location: **1bSNN6**

Date: 22/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 440586.486 **Northing:** 560206.172 **Profile Bearing:** 79 ° from North



Beach Profile

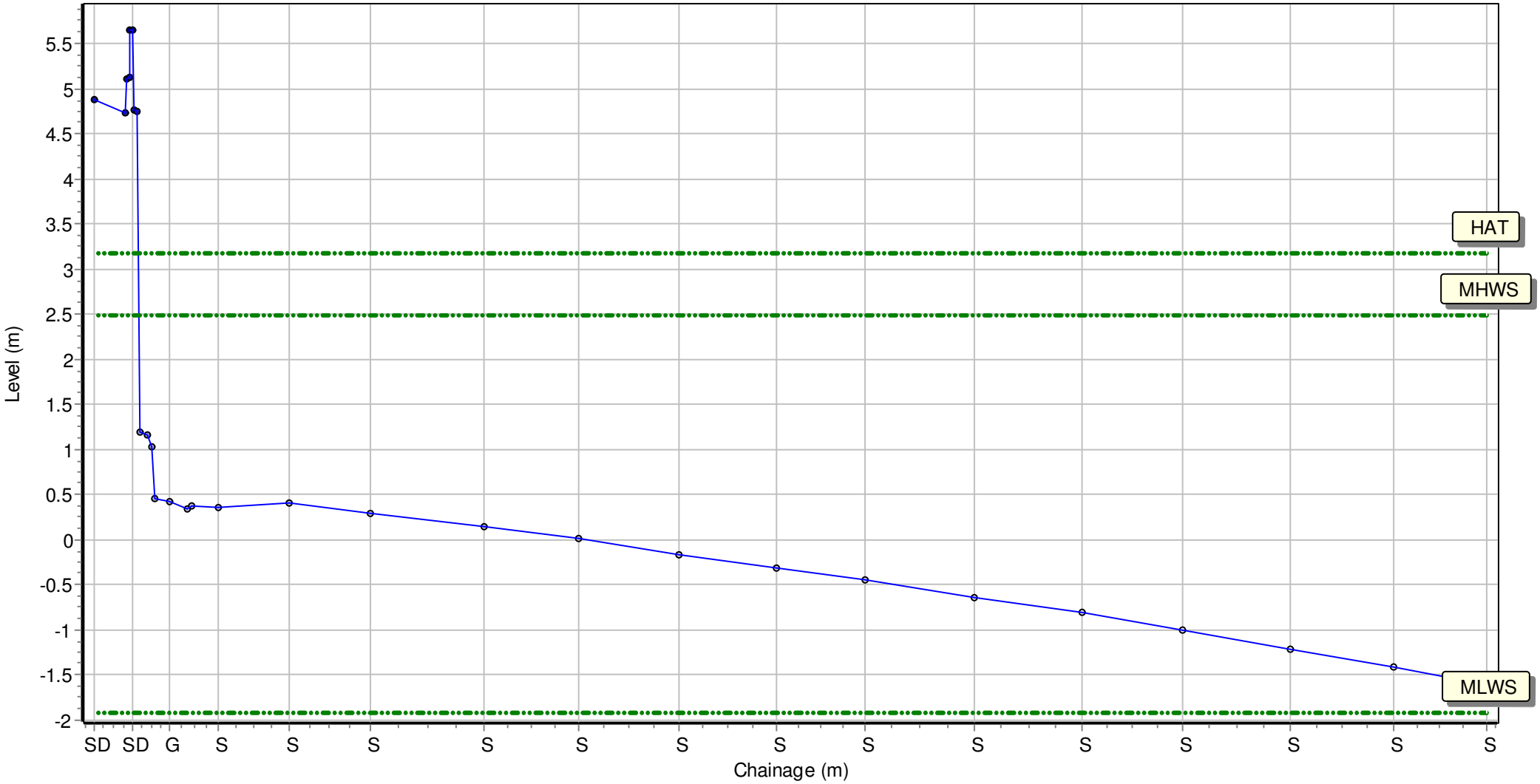
Location: **1bSNN7**

Date: 22/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 440623.795 **Northing:** 560029.932 **Profile Bearing:** 81 ° from North



Beach Profile

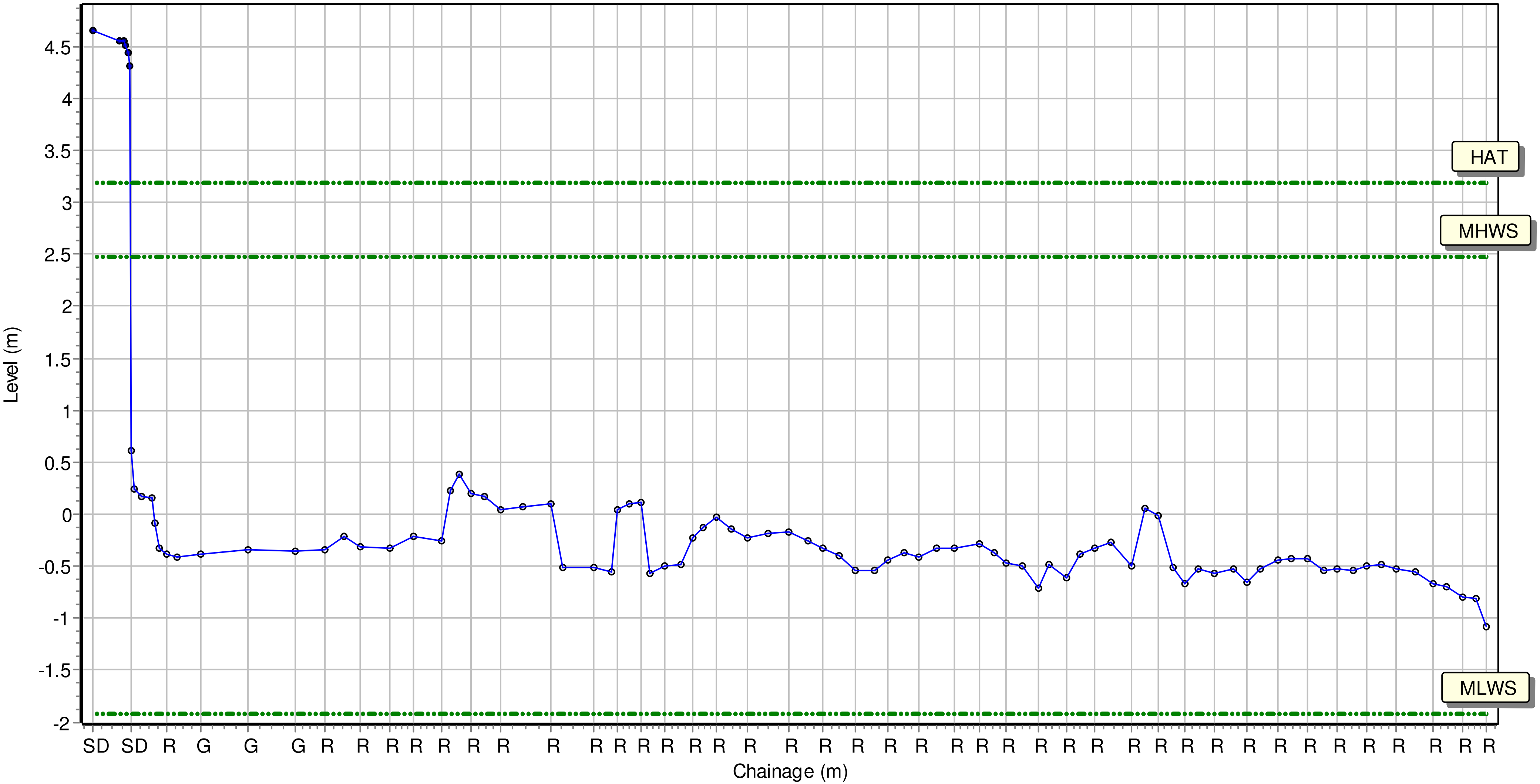
Location: 1bSNN8

Date: 22/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 440761.57 **Northing:** 559730.278 **Profile Bearing:** 87 ° from North



http://www.sandsuser.com

SANDS

Beach Profile

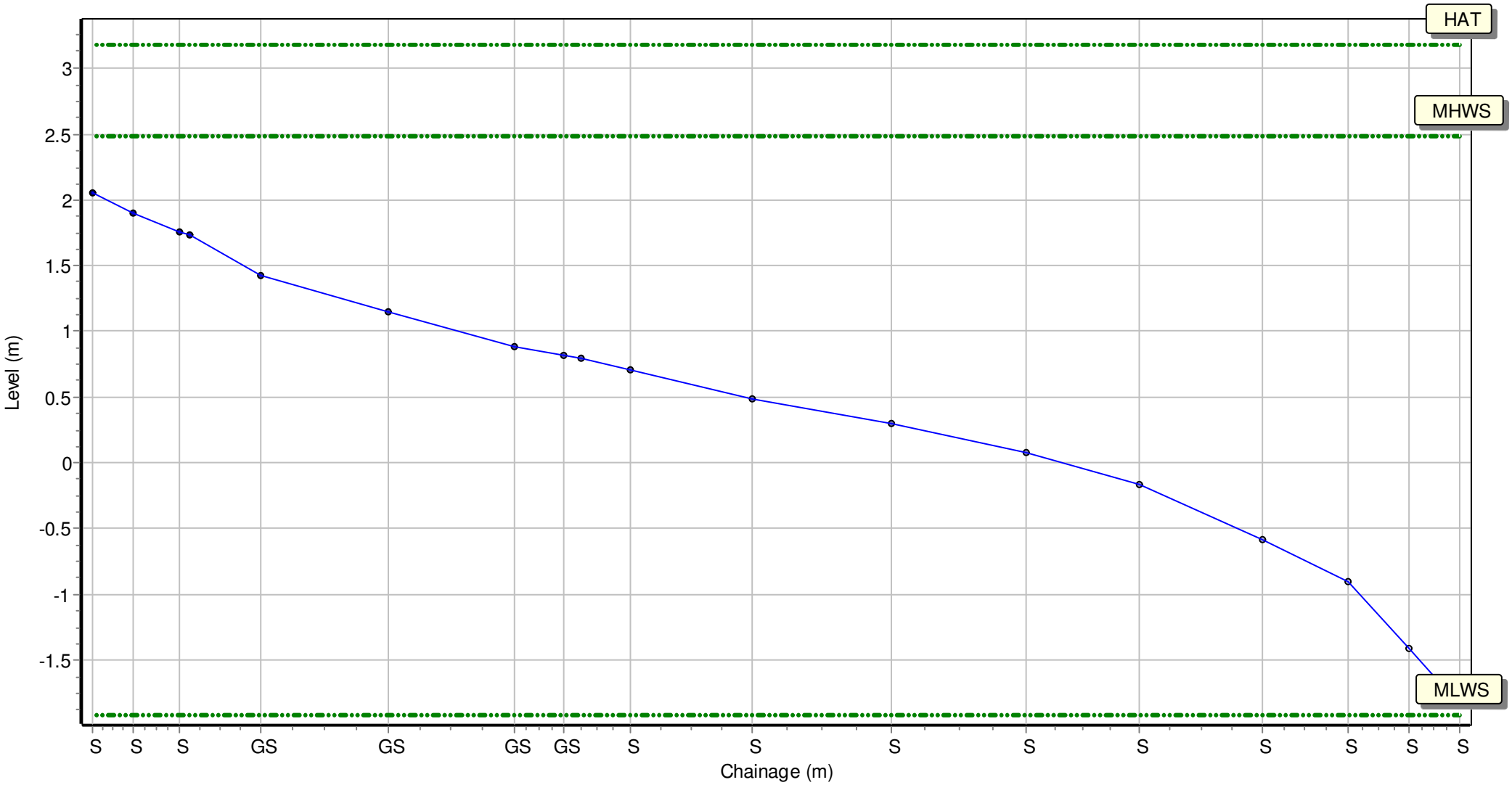
Location: **1bSNN9**

Date: 22/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 440680.051 **Northing:** 559381.258 **Profile Bearing:** 65 ° from North



Beach Profile

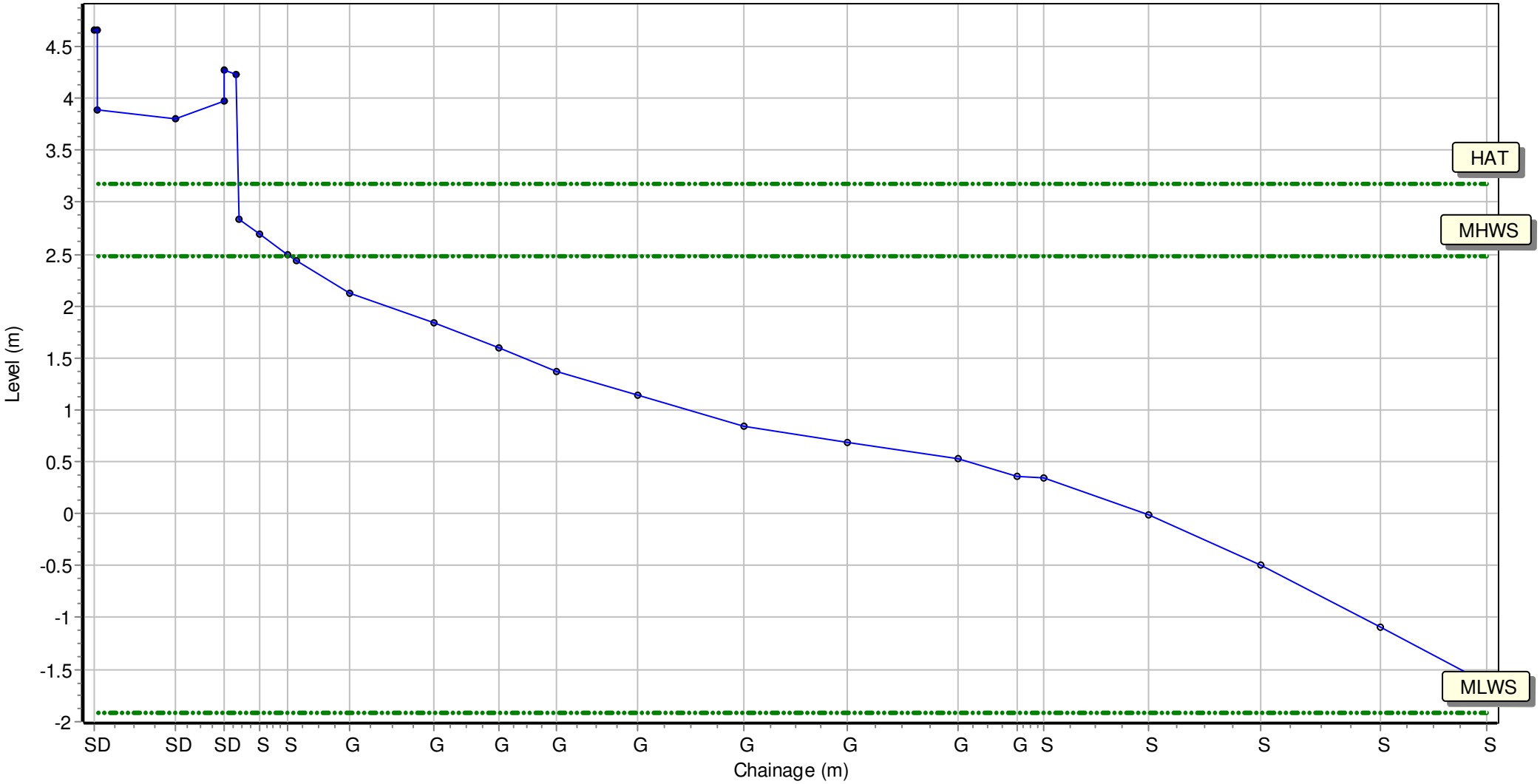
Location: **1bSNN10**

Date: 22/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 440728.714 **Northing:** 559193.372 **Profile Bearing:** 74 ° from North



Beach Profile

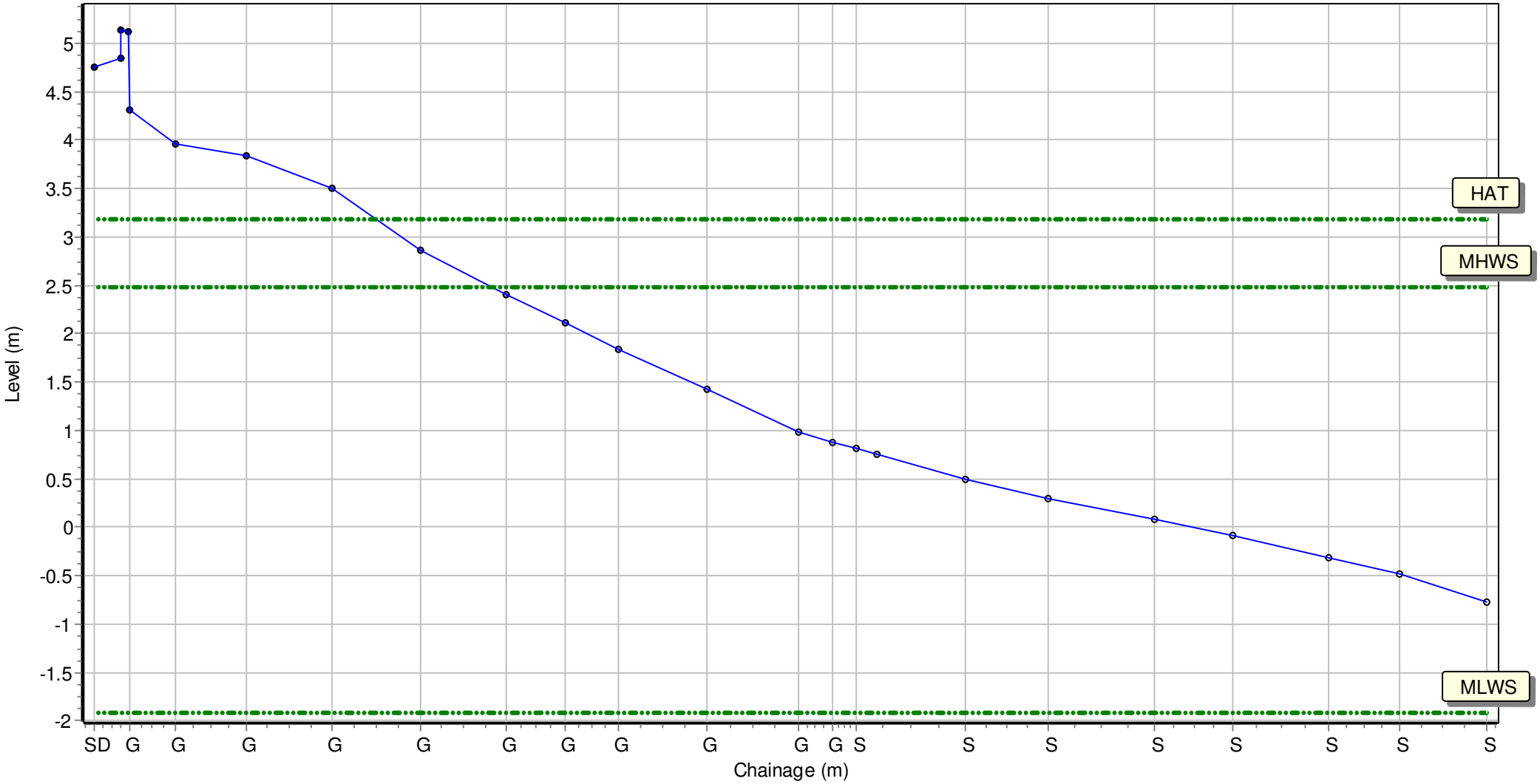
Location: **1bSNN11**

Date: 22/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 440785.596 **Northing:** 558966.827 **Profile Bearing:** 76 ° from North



Beach Profile

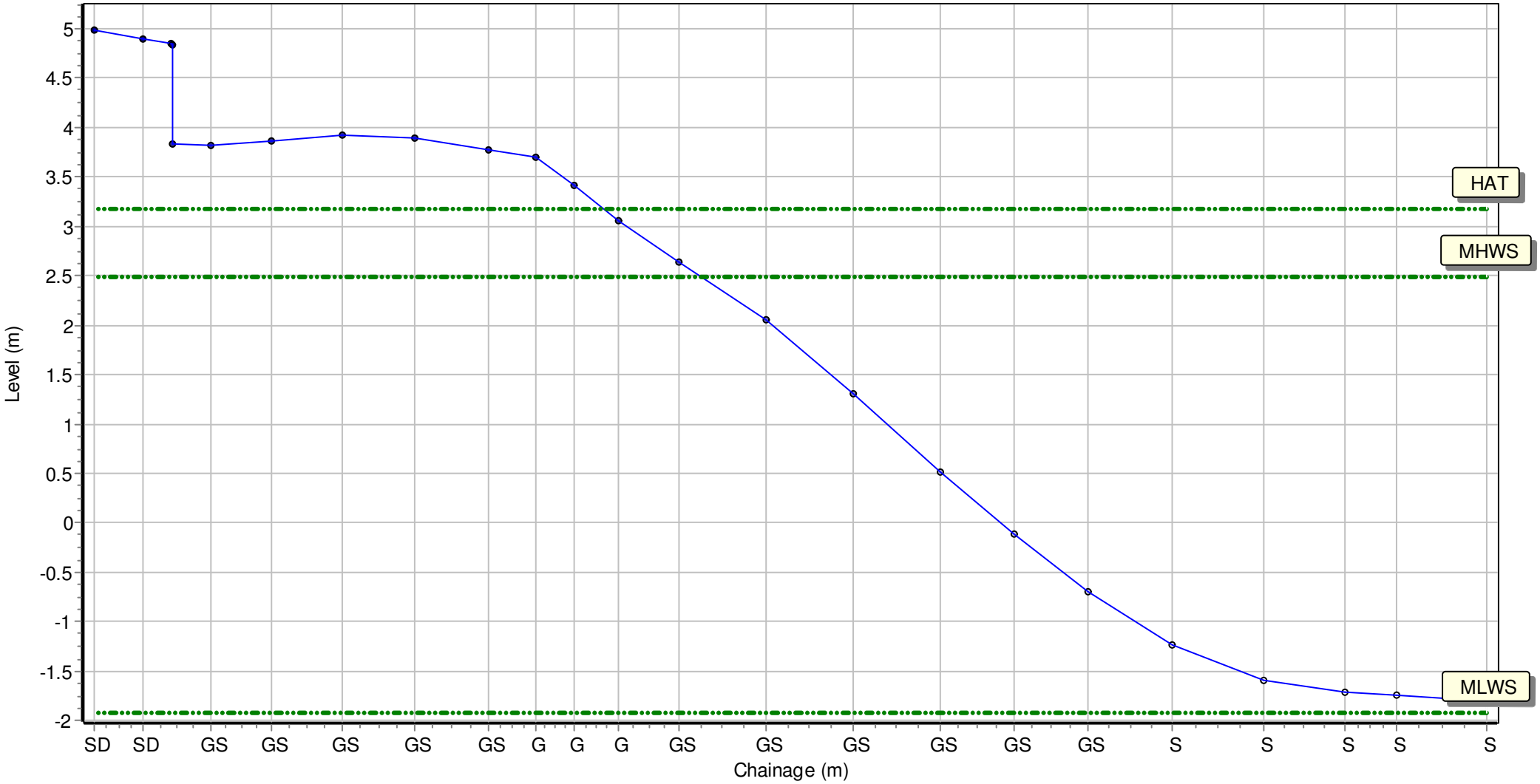
Location: **1bSNN12**

Date: 22/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 440842.281 **Northing:** 558732.094 **Profile Bearing:** 84 ° from North



Beach Profile

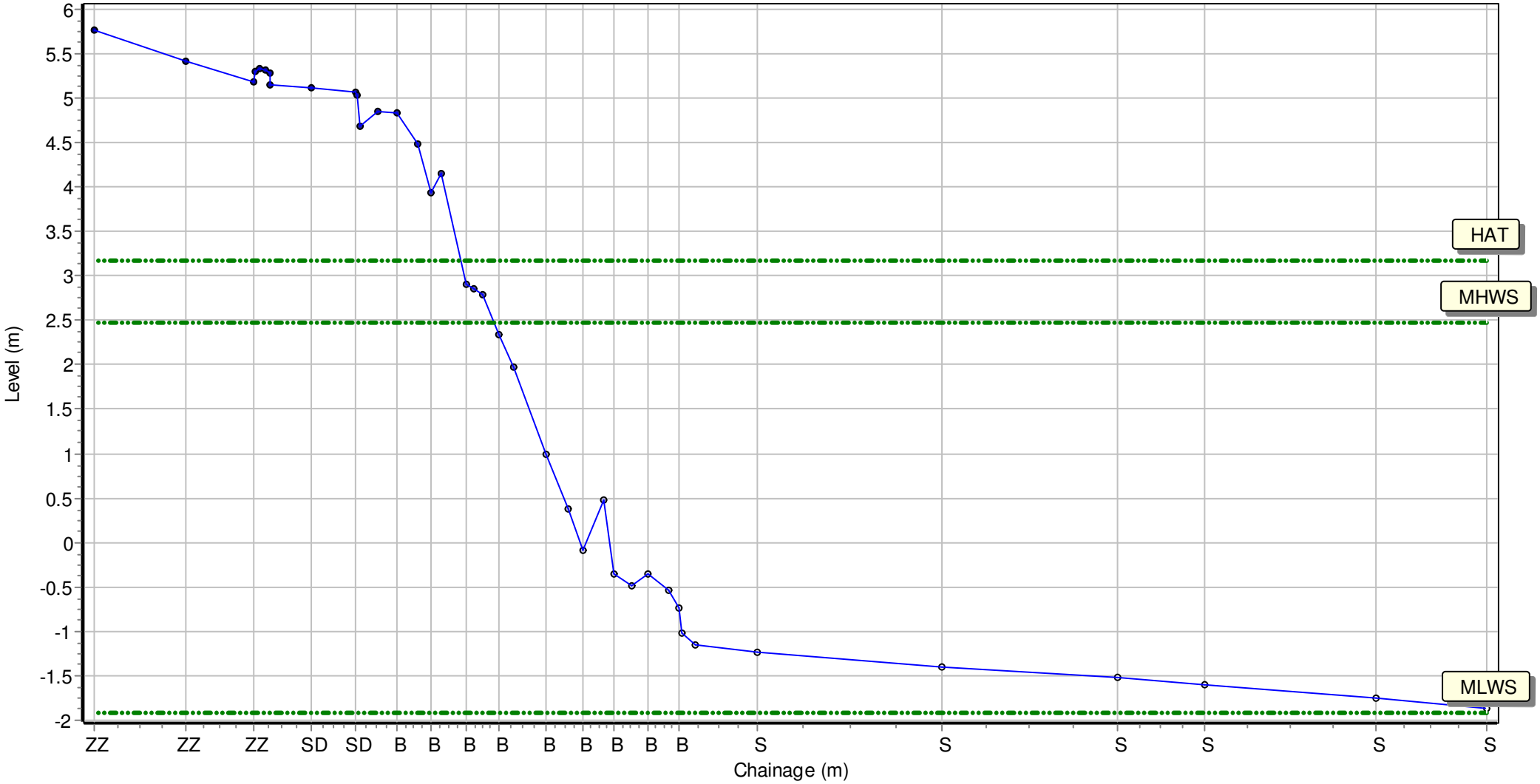
Location: **1bSNN13**

Date: 22/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 440892.257 **Northing:** 558511.587 **Profile Bearing:** 76 ° from North



Beach Profile

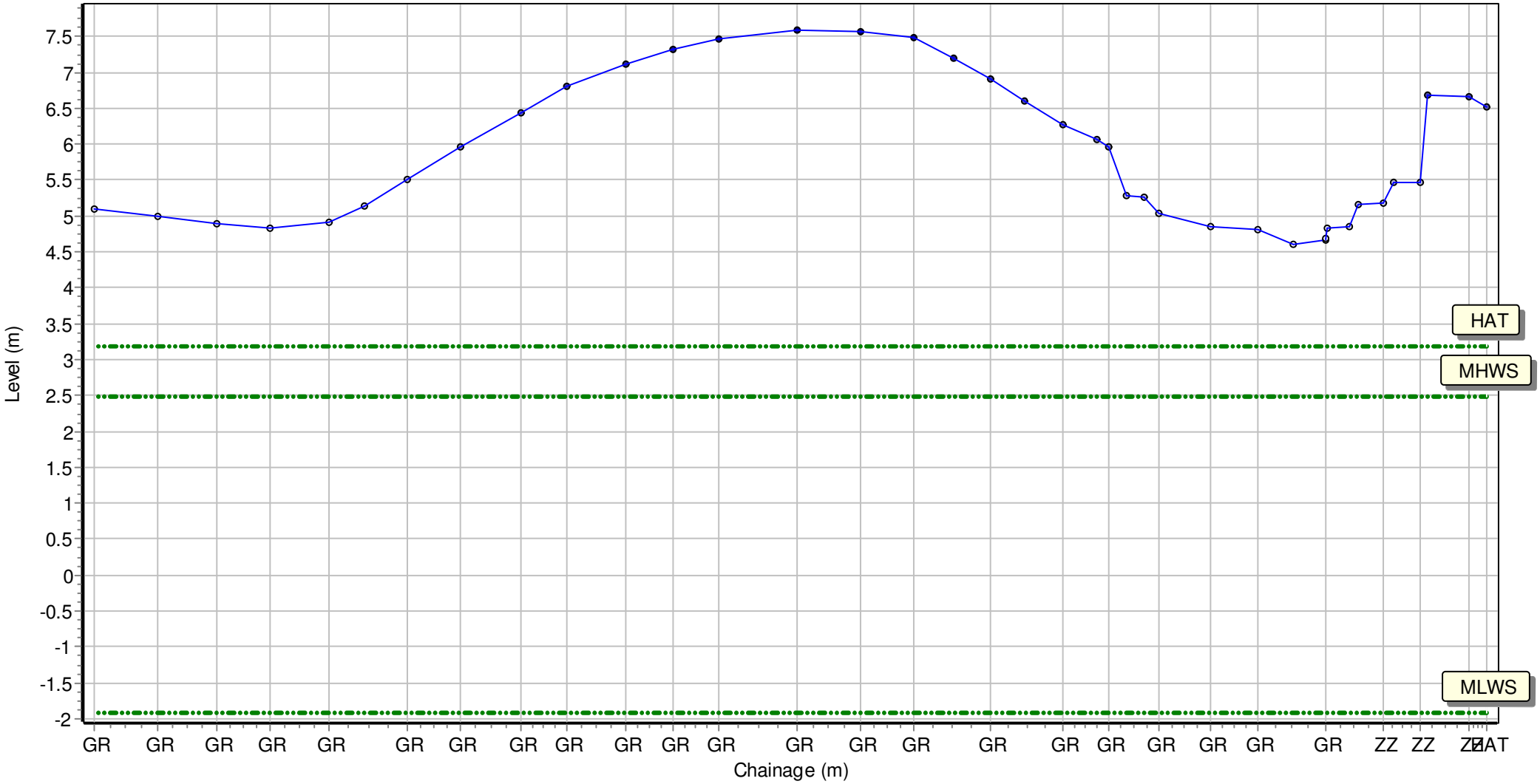
Location: **1bSNC1**

Date: 13/10/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441063.908 **Northing:** 558055.488 **Profile Bearing:** 87 ° from North



Beach Profile

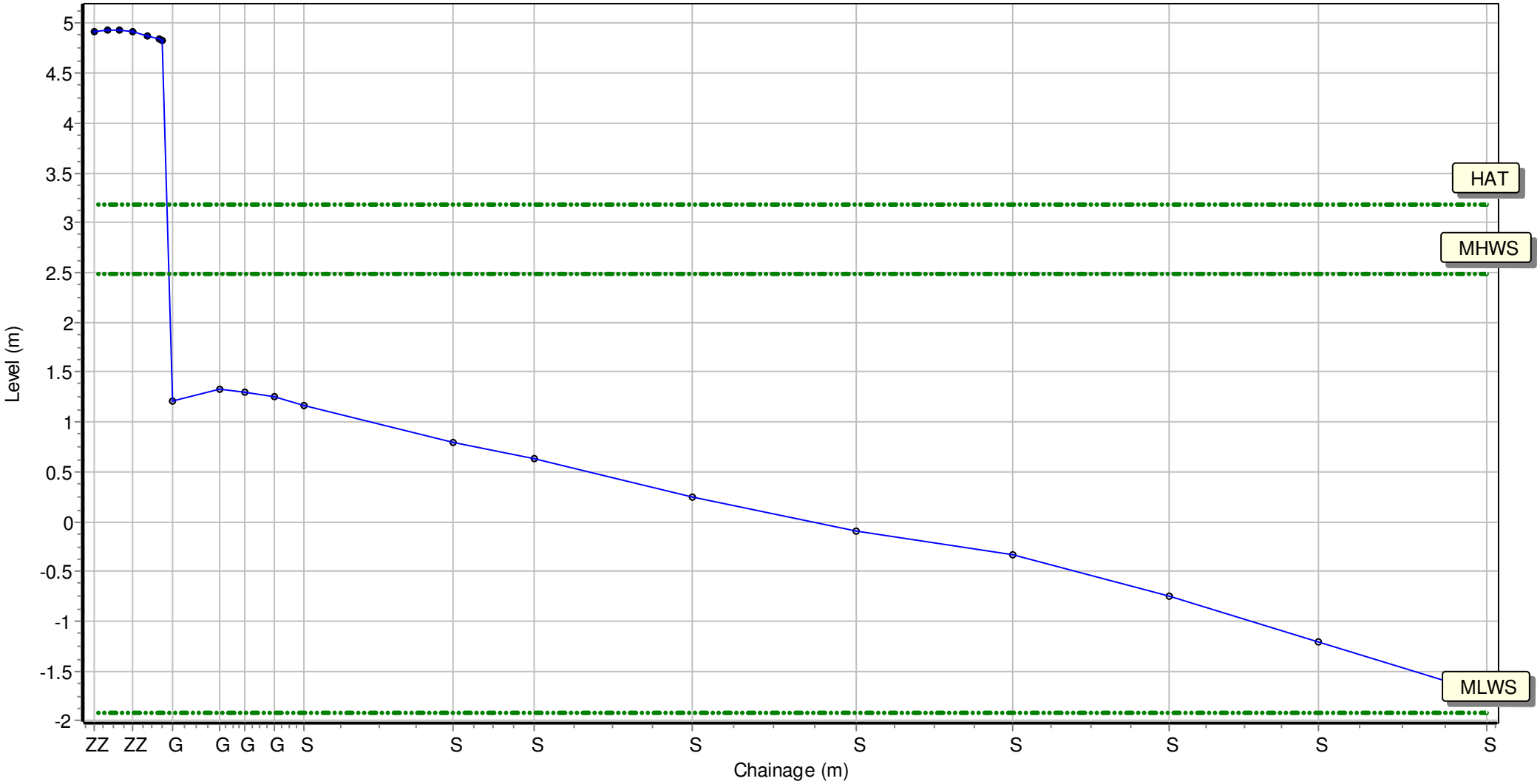
Location: **1bSNC2**

Date: 13/10/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441240.27 **Northing:** 557850.776 **Profile Bearing:** 349 ° from North



Beach Profile

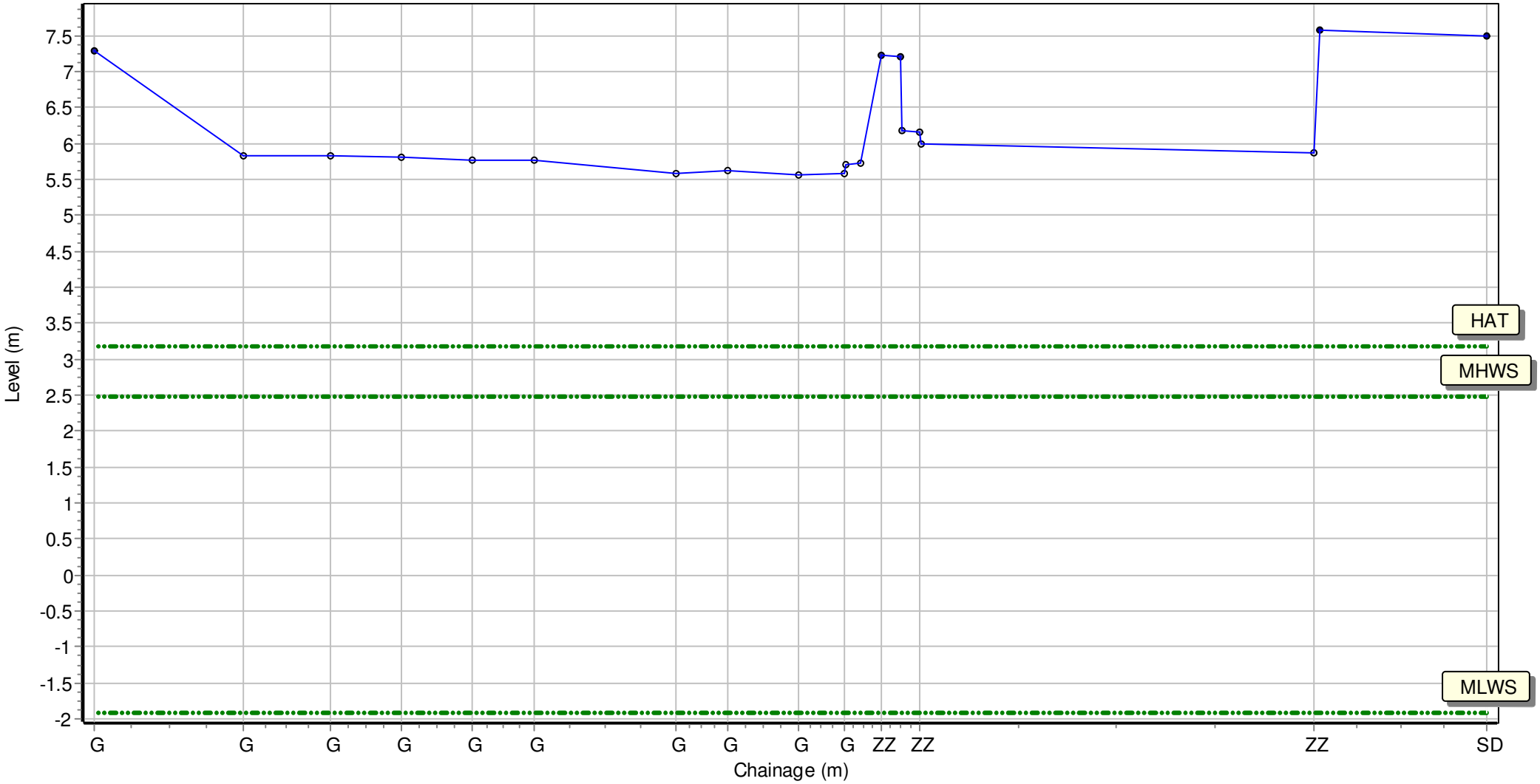
Location: **1bSNC3**

Date: 13/10/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441192.226 **Northing:** 557747.746 **Profile Bearing:** 70 ° from North



Beach Profile

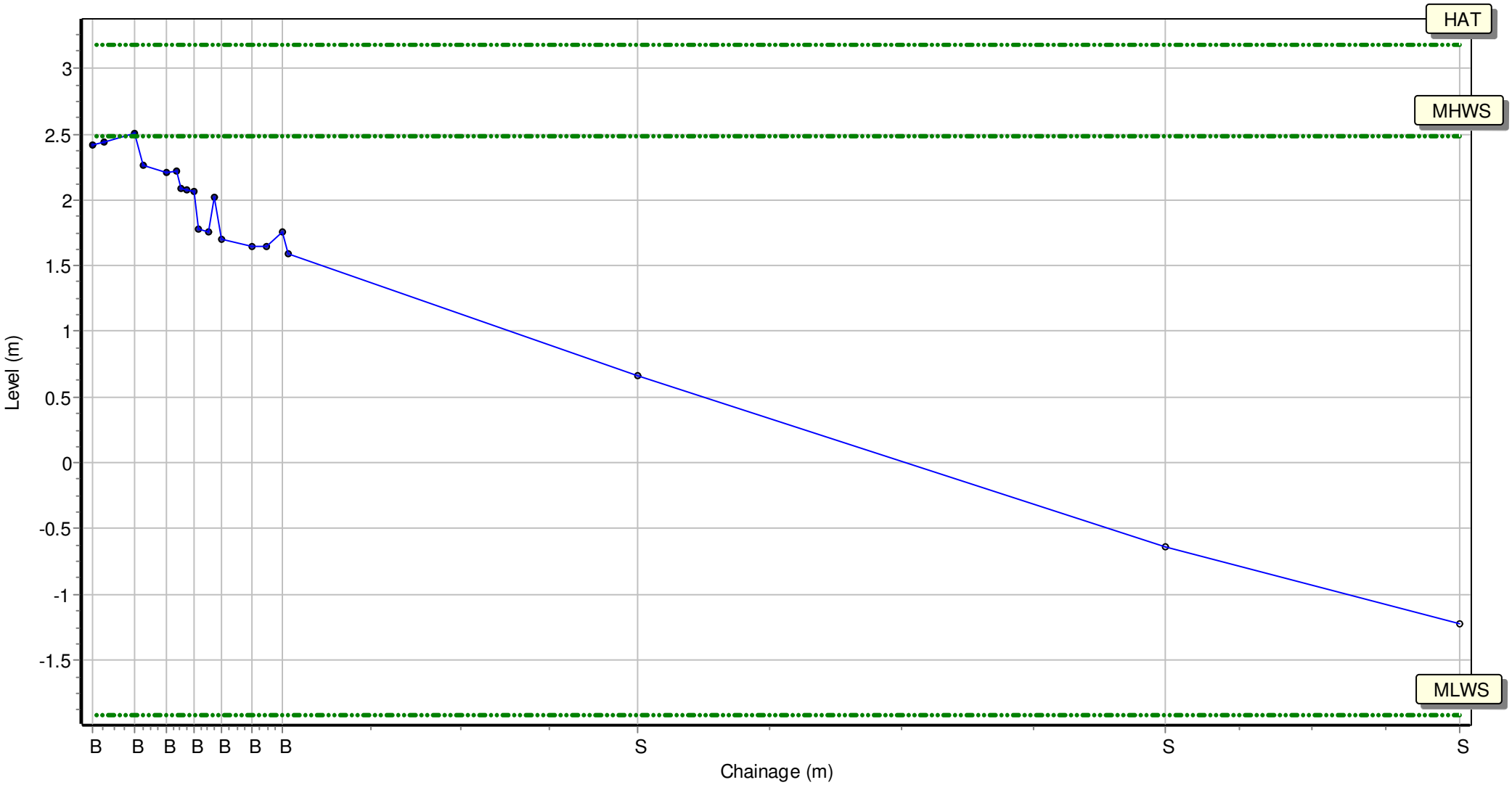
Location: **1bSNC4**

Date: 13/10/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441321.27 **Northing:** 557533.237 **Profile Bearing:** 45 ° from North



Beach Profile

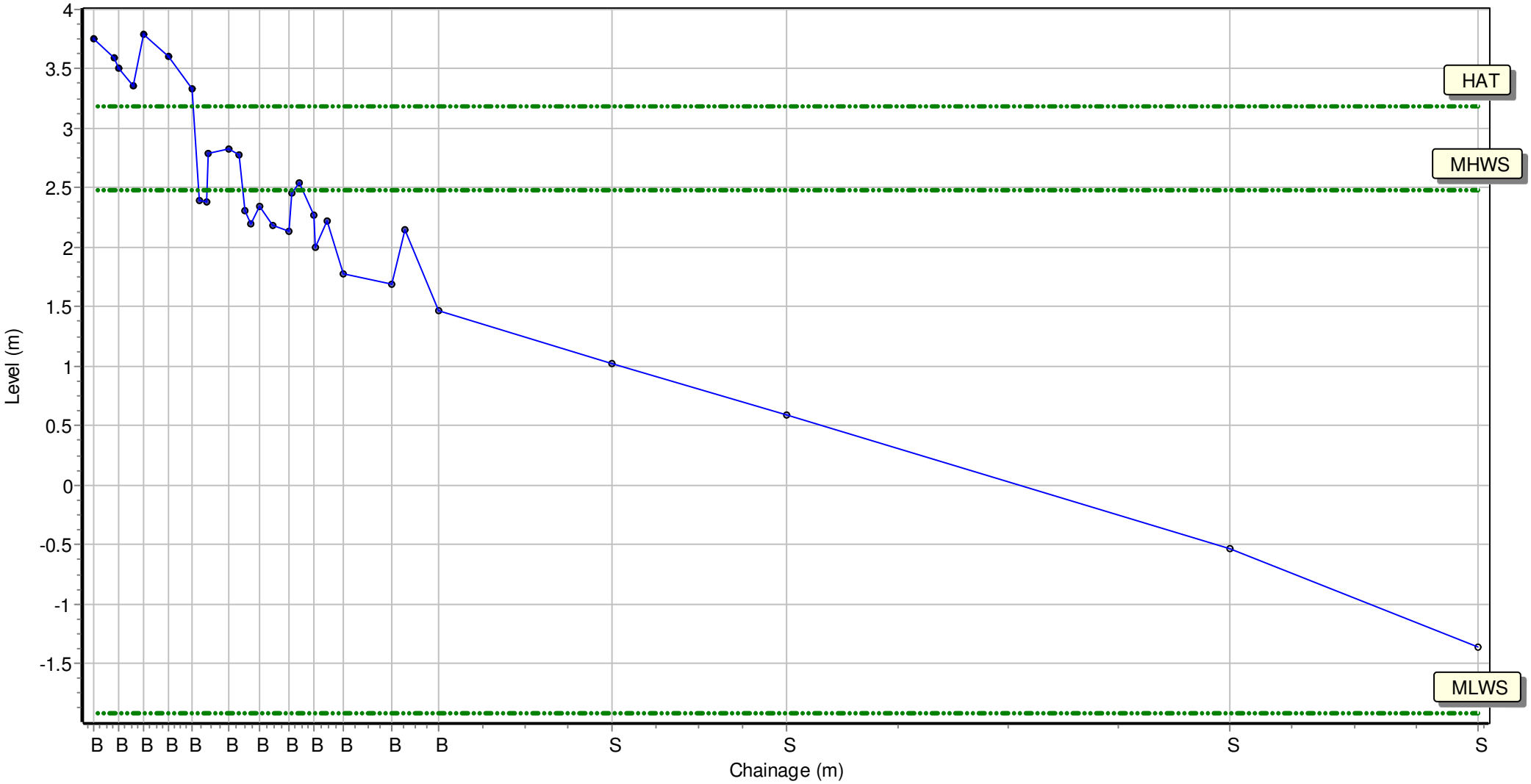
Location: **1bSNC5**

Date: 13/10/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441463.58 **Northing:** 557376.22 **Profile Bearing:** 58 ° from North



Beach Profile

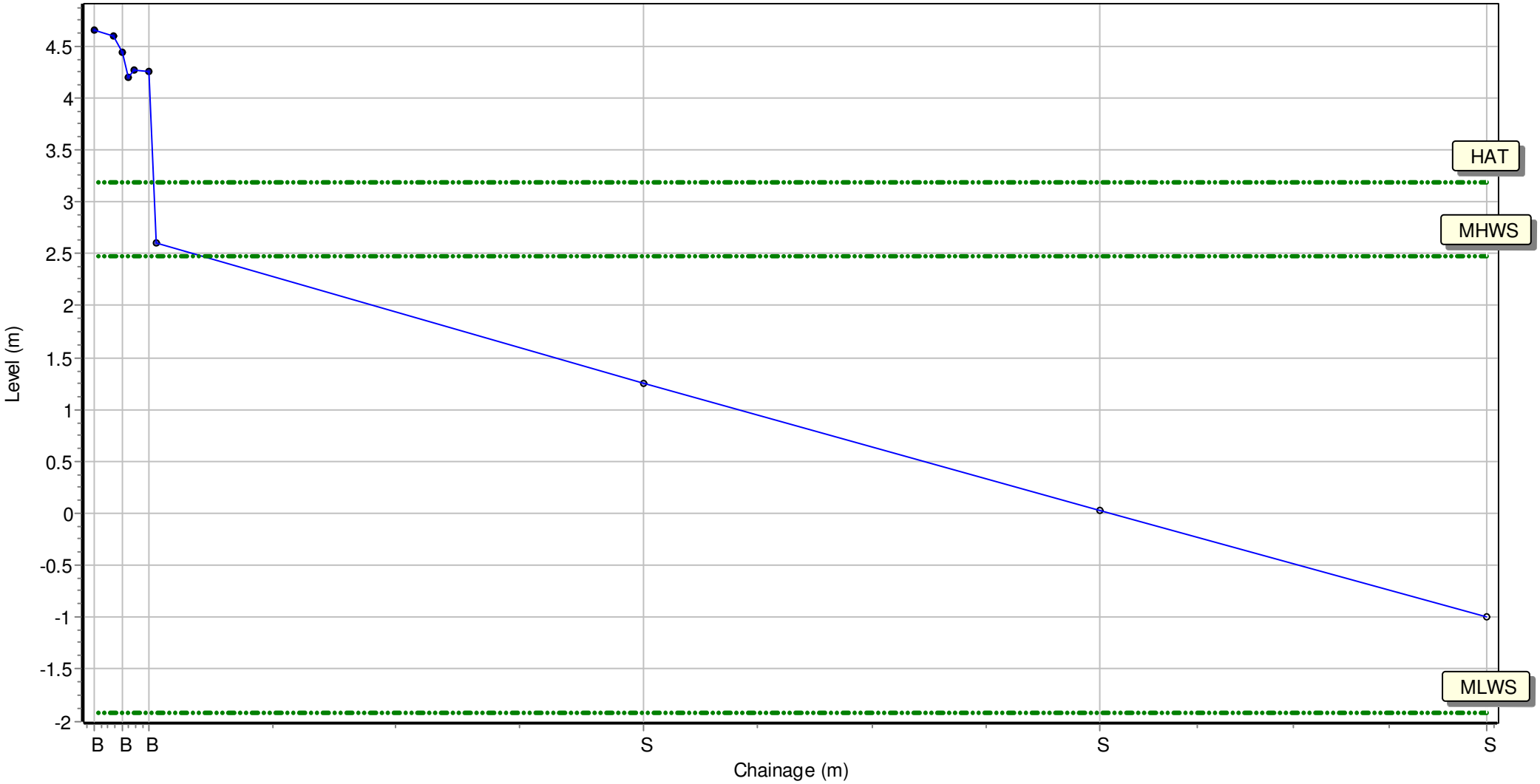
Location: **1bSNC6**

Date: 13/10/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441511.013 **Northing:** 557229.014 **Profile Bearing:** 88 ° from North



Beach Profile

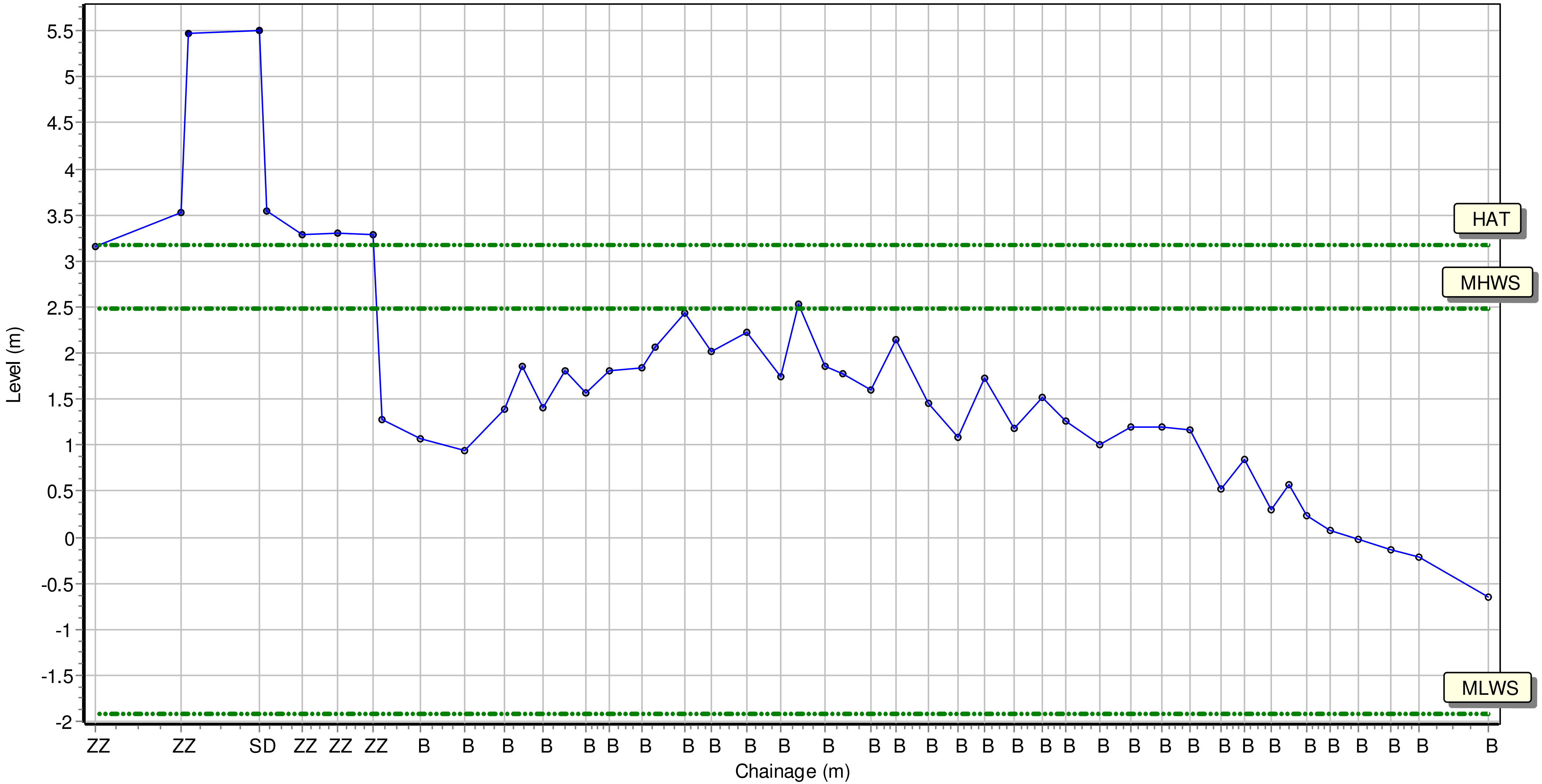
Location: 1bSNC7

Date: 13/10/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441682.28 **Northing:** 557051.345 **Profile Bearing:** 230 ° from North



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Beach Profile

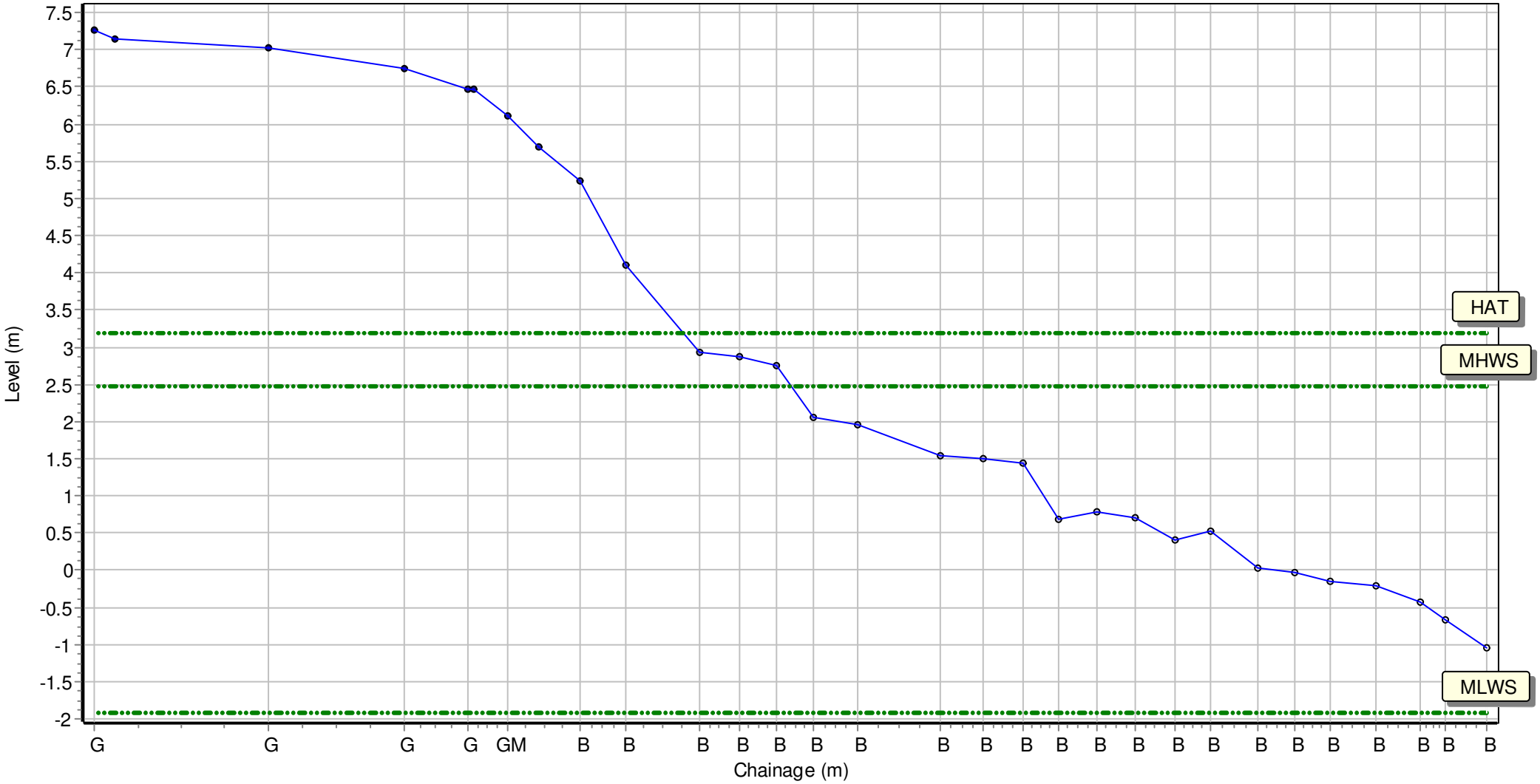
Location: **1bSNC8**

Date: 13/10/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441601.437 **Northing:** 557055.604 **Profile Bearing:** 183 ° from North



Beach Profile

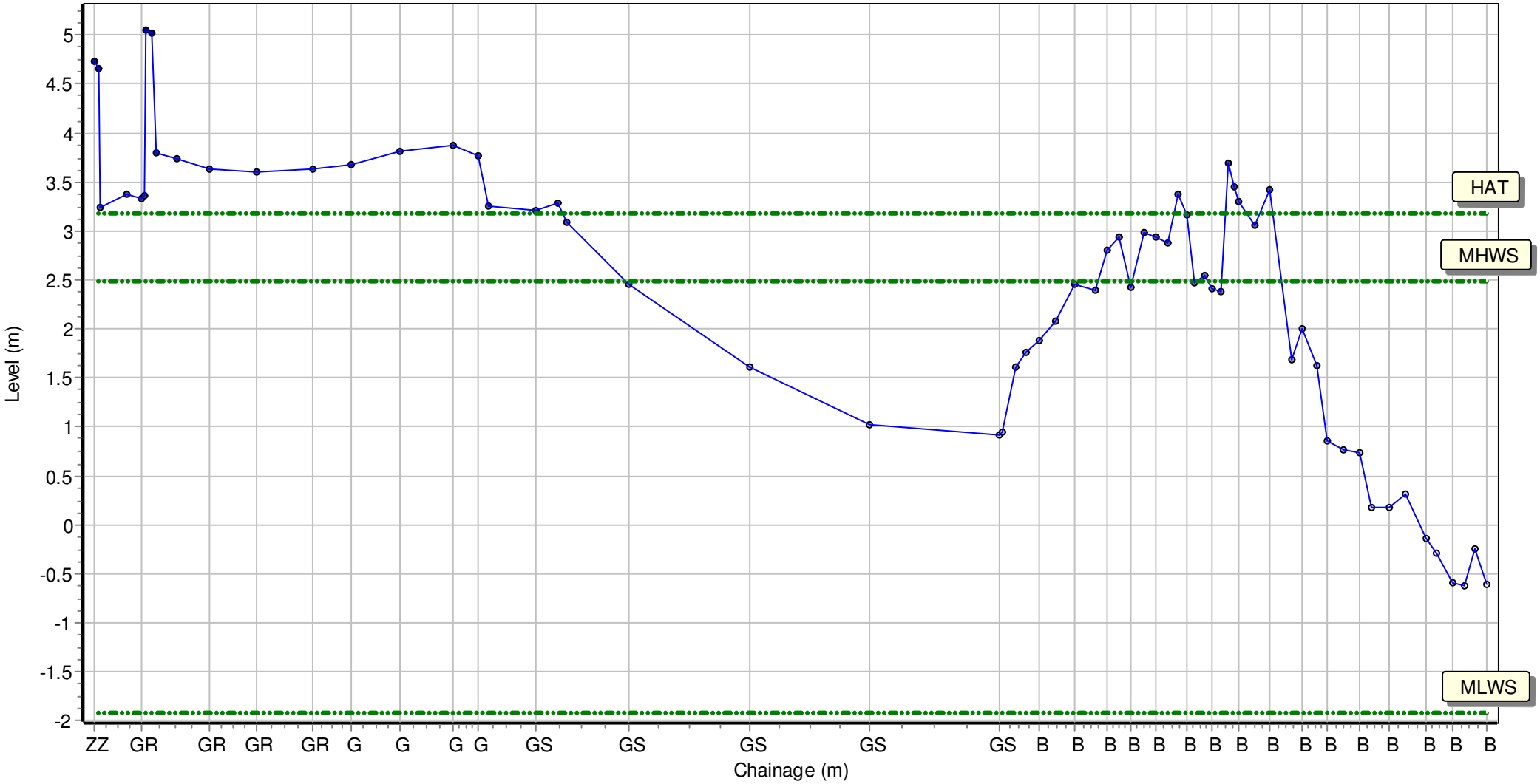
Location: **1bSNC9**

Date: 13/10/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441461.898 **Northing:** 556870.487 **Profile Bearing:** 70 ° from North



Beach Profile

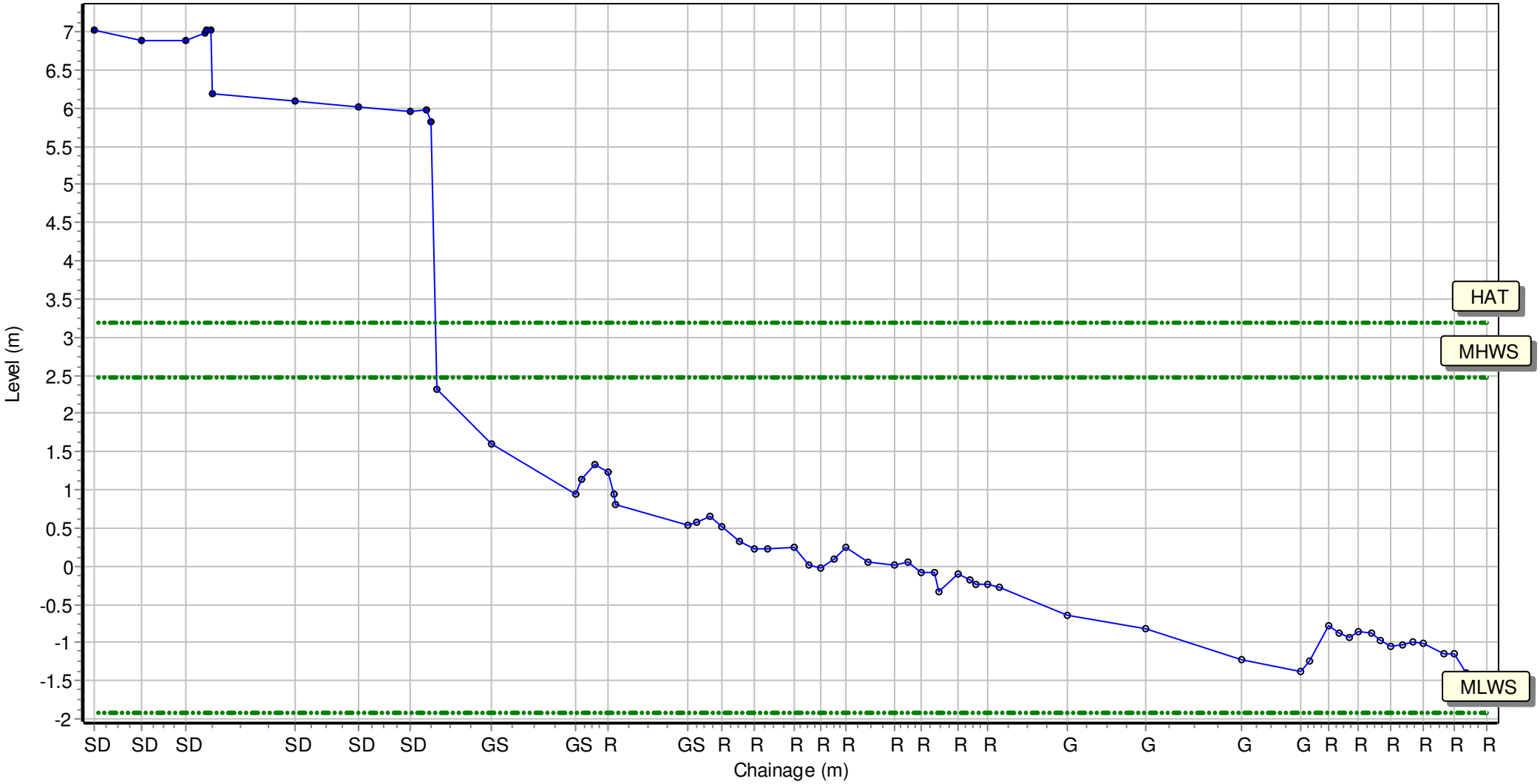
Location: **1bSNS7**

Date: 07/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441073.036 **Northing:** 555629.712 **Profile Bearing:** 85 ° from North



Beach Profile

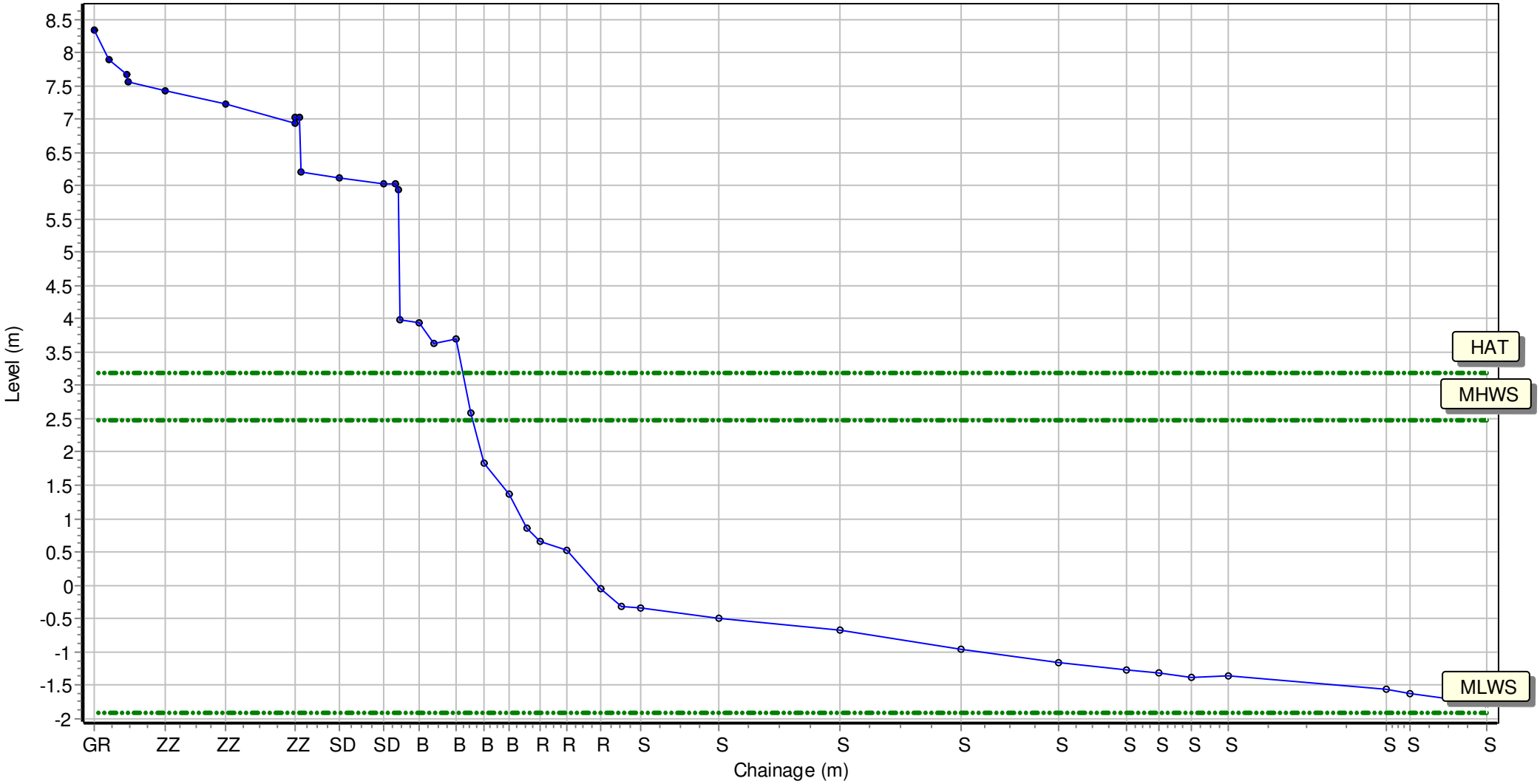
Location: **1bSNS8**

Date: 07/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441092.263 **Northing:** 555414.414 **Profile Bearing:** 80 ° from North



Beach Profile

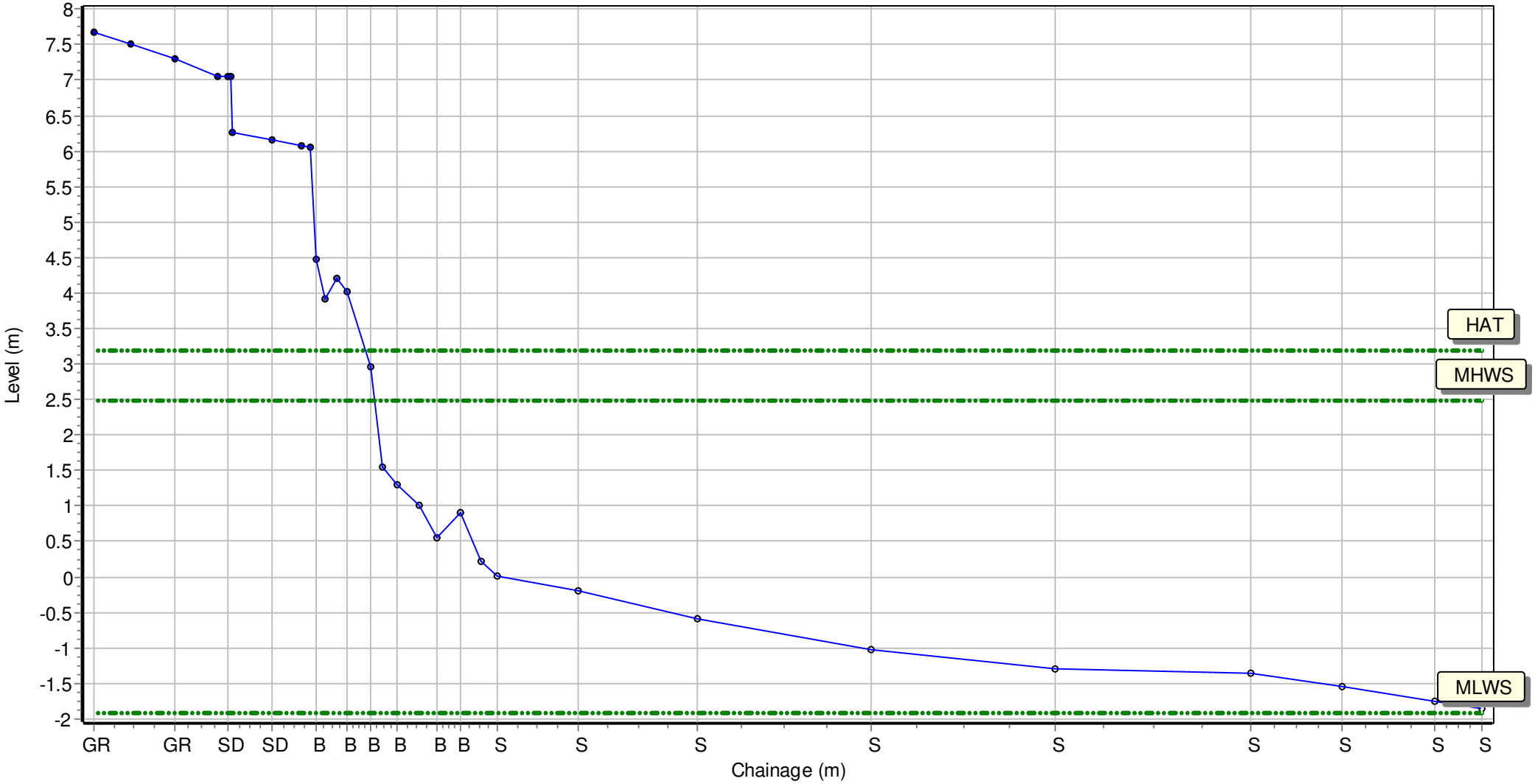
Location: **1bSNS9**

Date: 07/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441118.722 **Northing:** 555223.928 **Profile Bearing:** 82 ° from North



Beach Profile

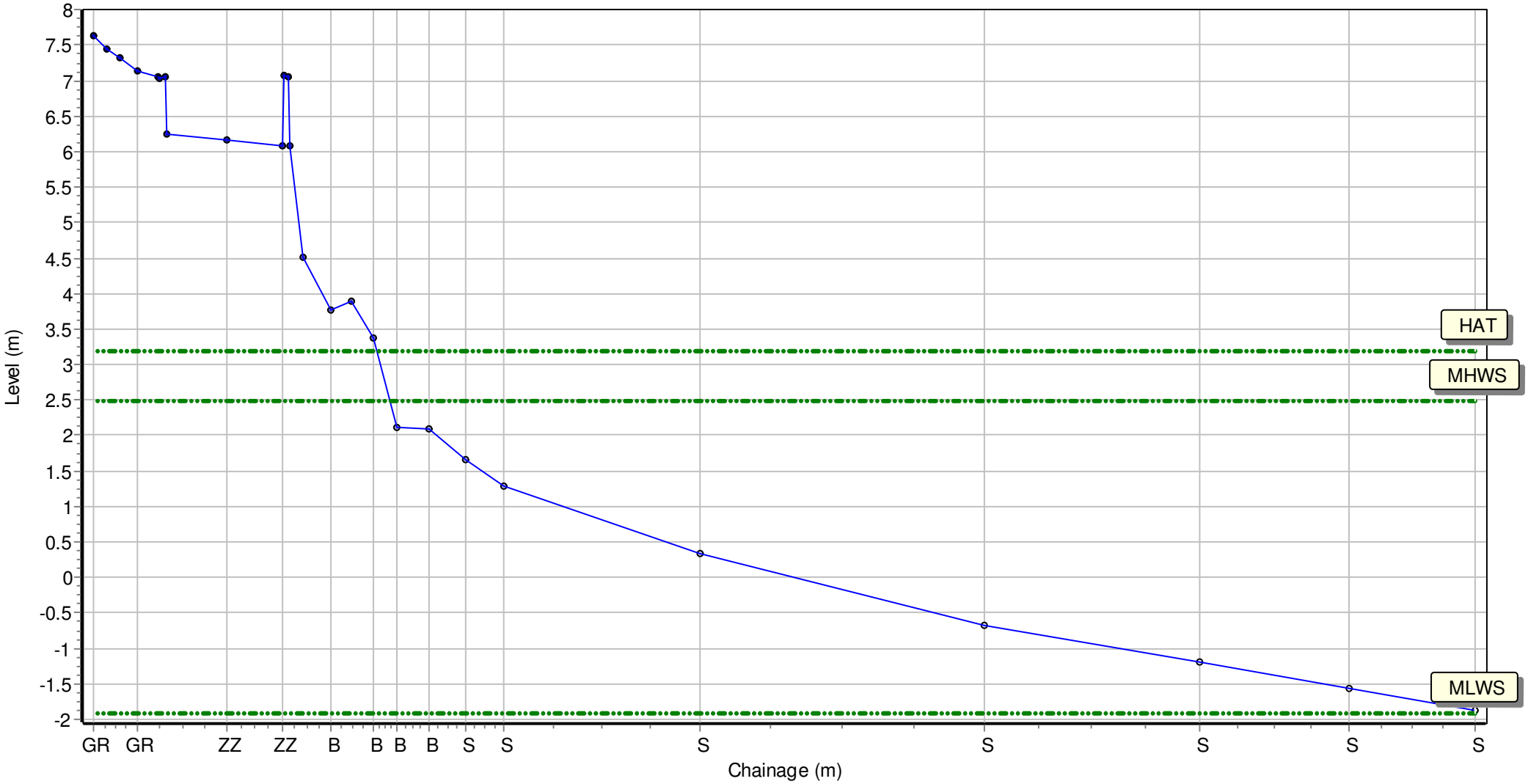
Location: **1bSNS10**

Date: 07/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441176.256 **Northing:** 554997.913 **Profile Bearing:** 73 ° from North



Beach Profile

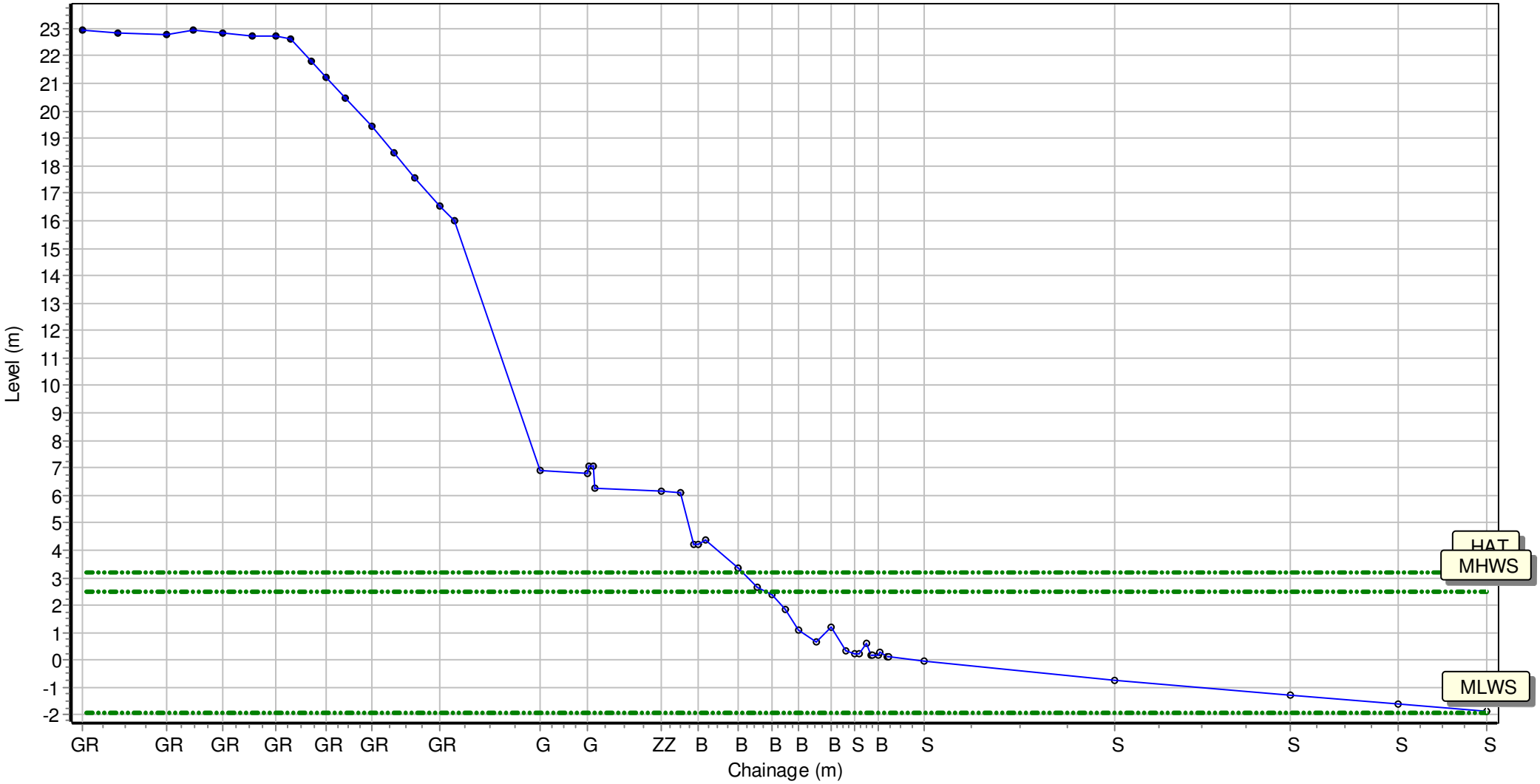
Location: **1bSNS11**

Date: 07/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441225.182 **Northing:** 554759.021 **Profile Bearing:** 75 ° from North



Beach Profile

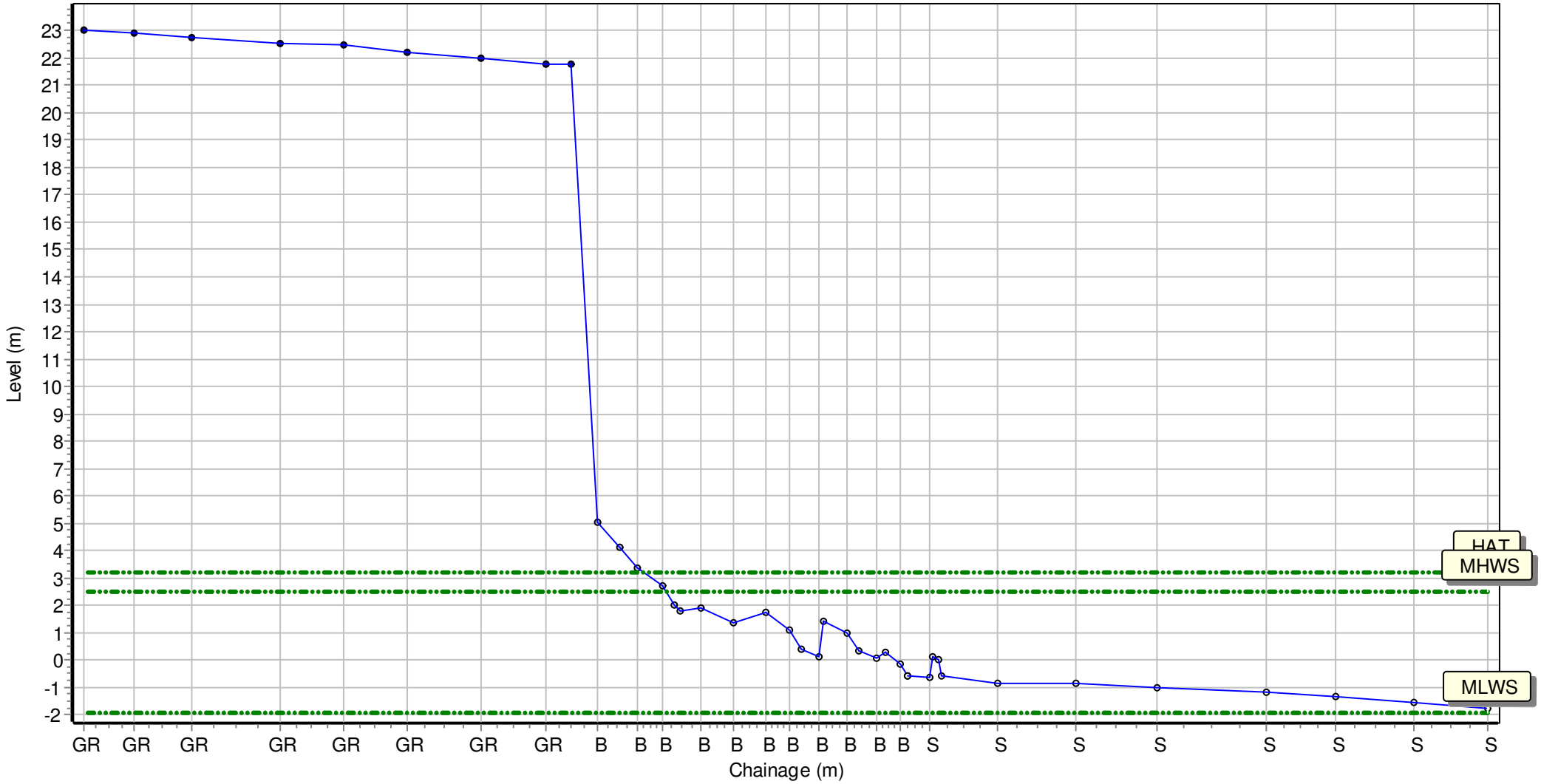
Location: **1bSNS12**

Date: 07/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441242.249 **Northing:** 554630.678 **Profile Bearing:** 75 ° from North



Beach Profile

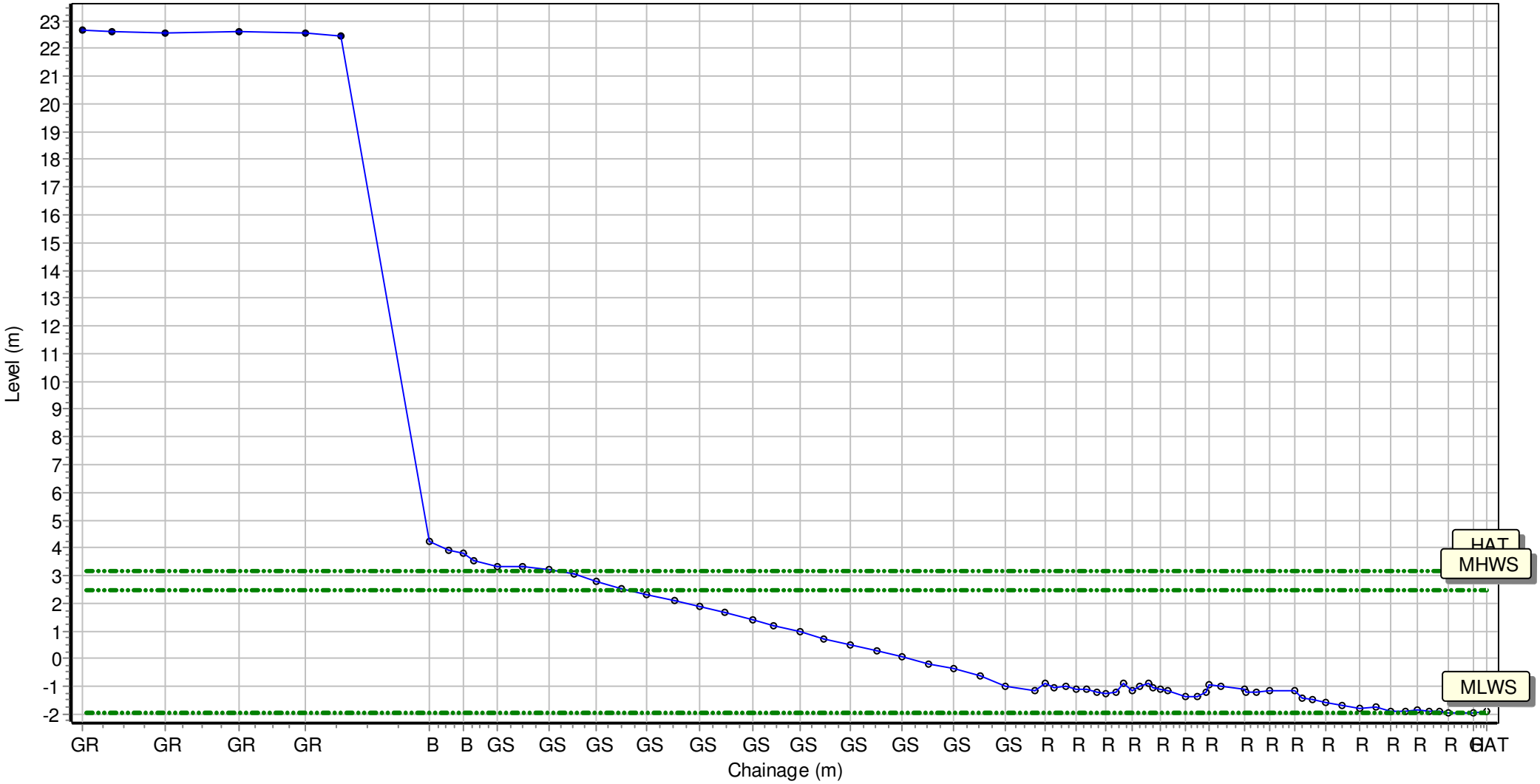
Location: **1bSNS13**

Date: 07/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441288.083 **Northing:** 554427.126 **Profile Bearing:** 66 ° from North



Beach Profile

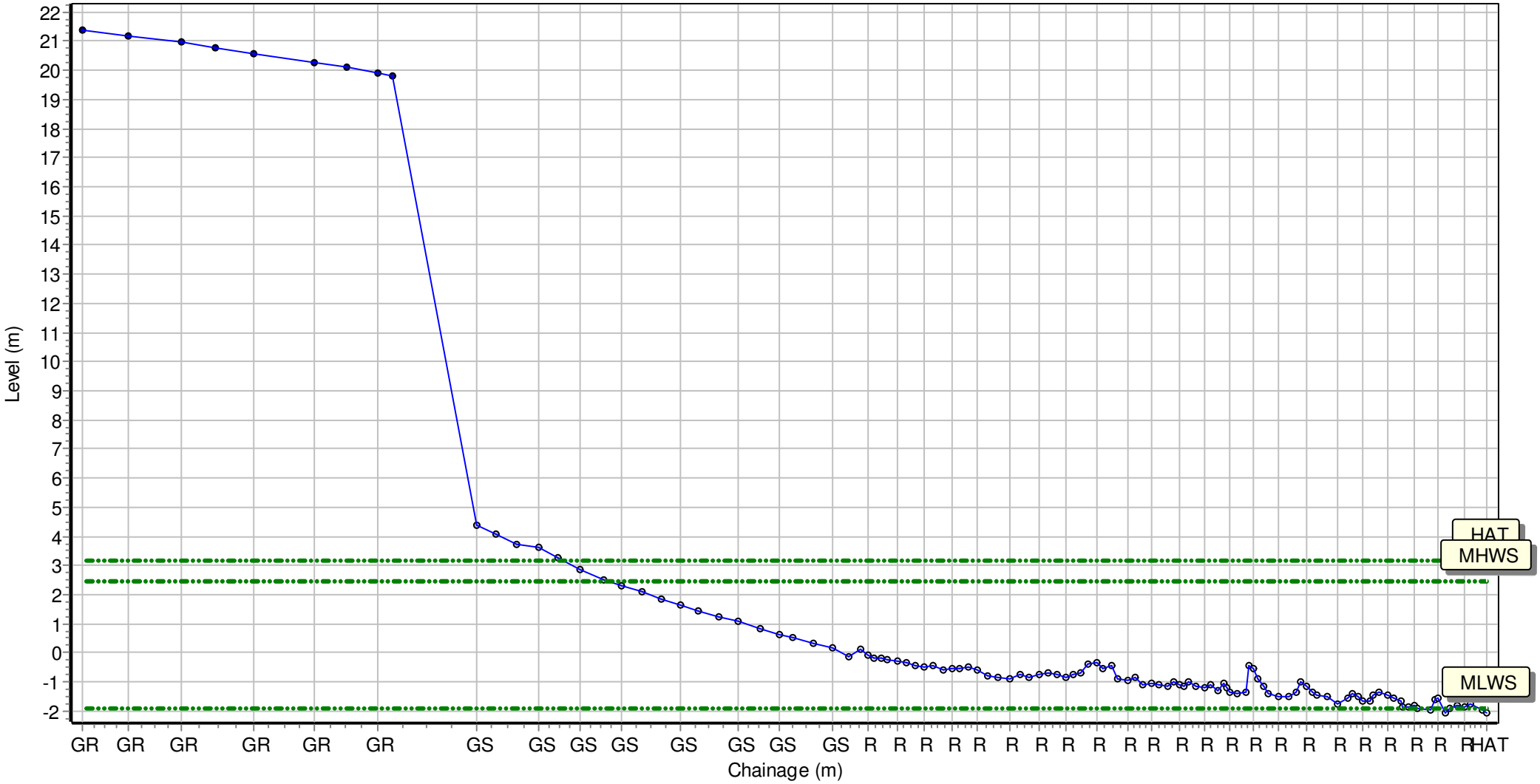
Location: **1bSNS14**

Date: 07/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441329.465 **Northing:** 554332.663 **Profile Bearing:** 65 ° from North



Beach Profile

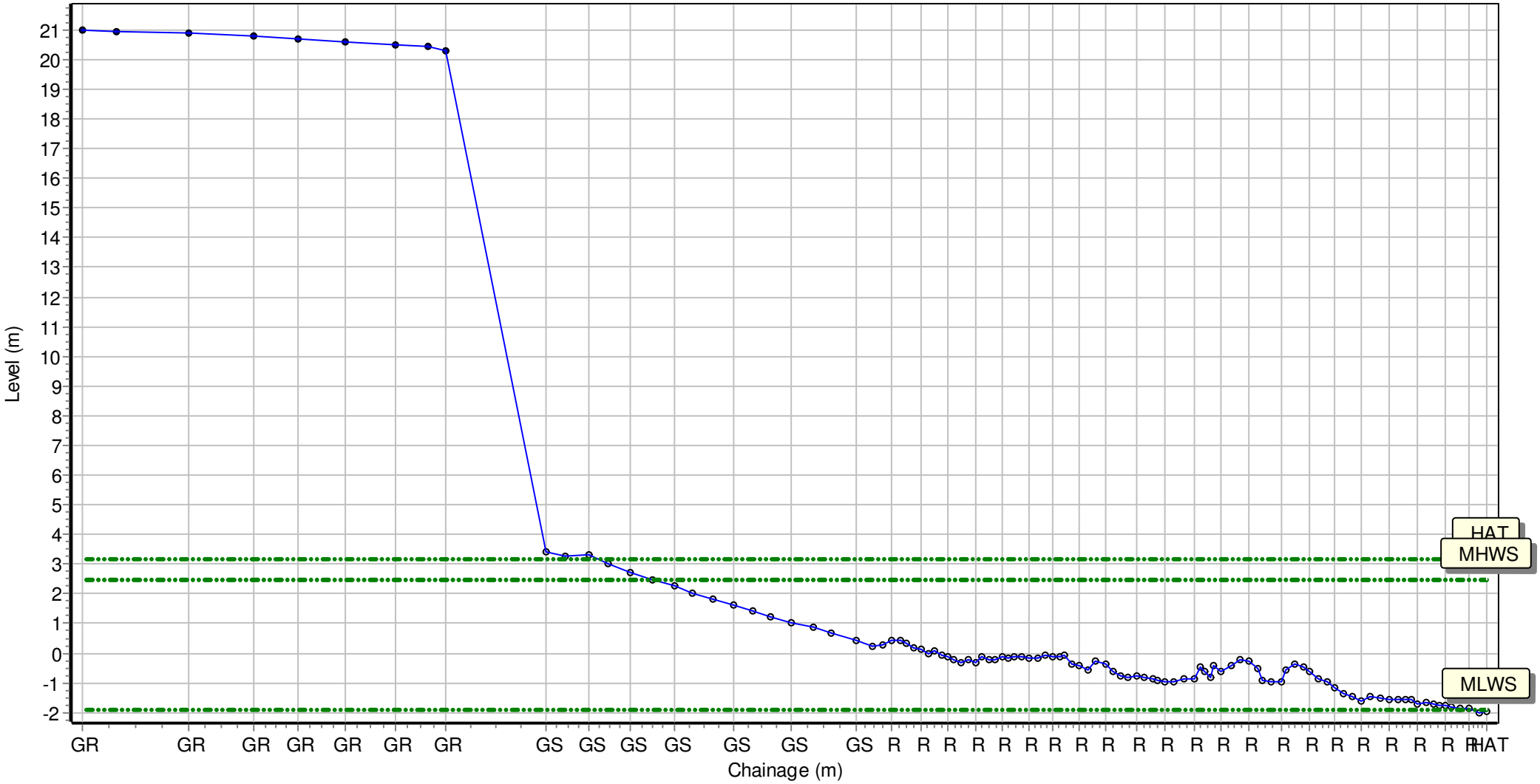
Location: **1bSNS15**

Date: 07/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441371.425 **Northing:** 554241.889 **Profile Bearing:** 65 ° from North



Beach Profile

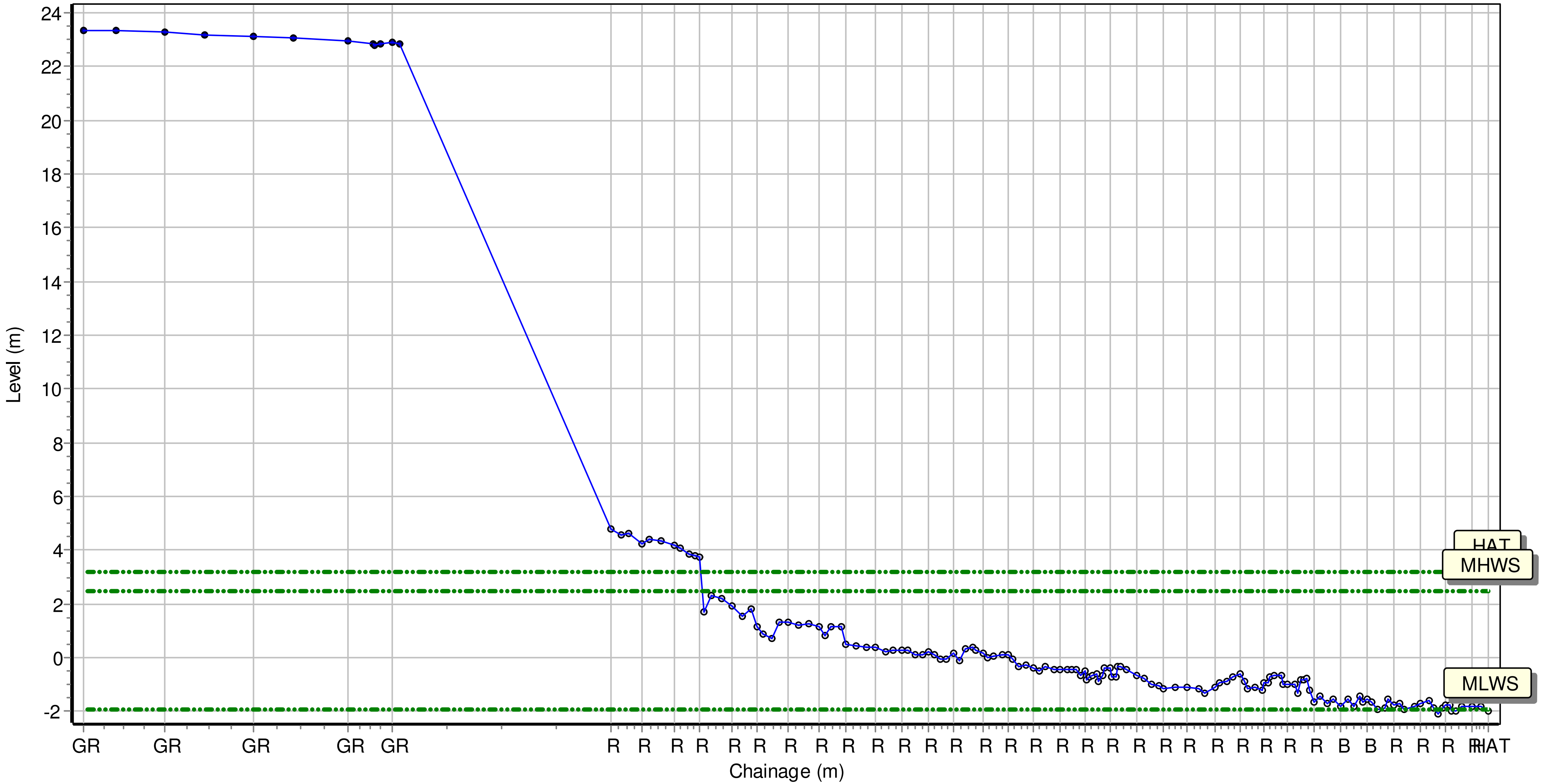
Location: **1bSNS16**

Date: 07/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441444.352 **Northing:** 554130.231 **Profile Bearing:** 64 ° from North



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Beach Profile

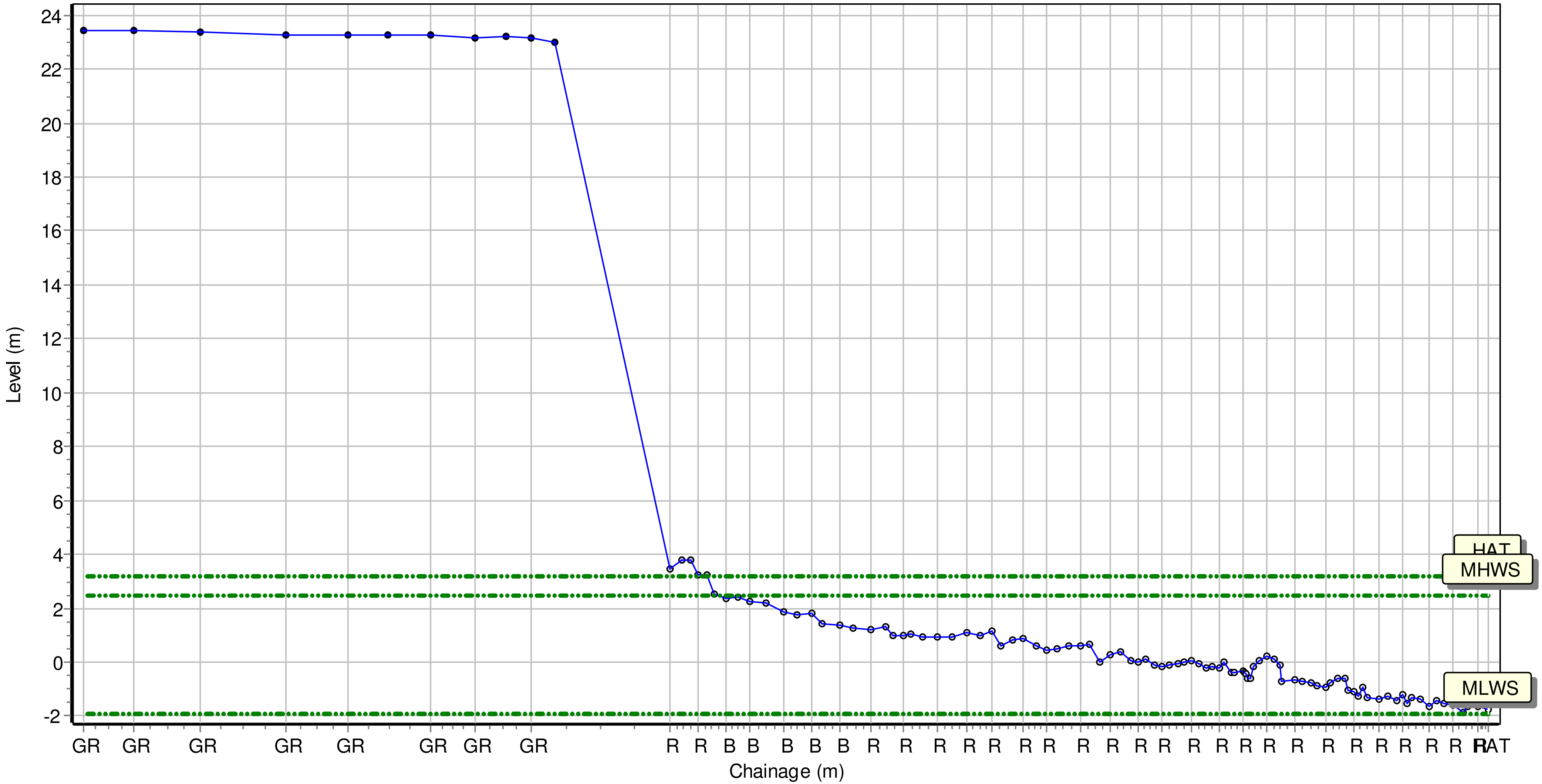
Location: 1bSNS17

Date: 07/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441450.289 **Northing:** 554115.925 **Profile Bearing:** 131 ° from North



http://www.sandsuser.com

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Beach Profile

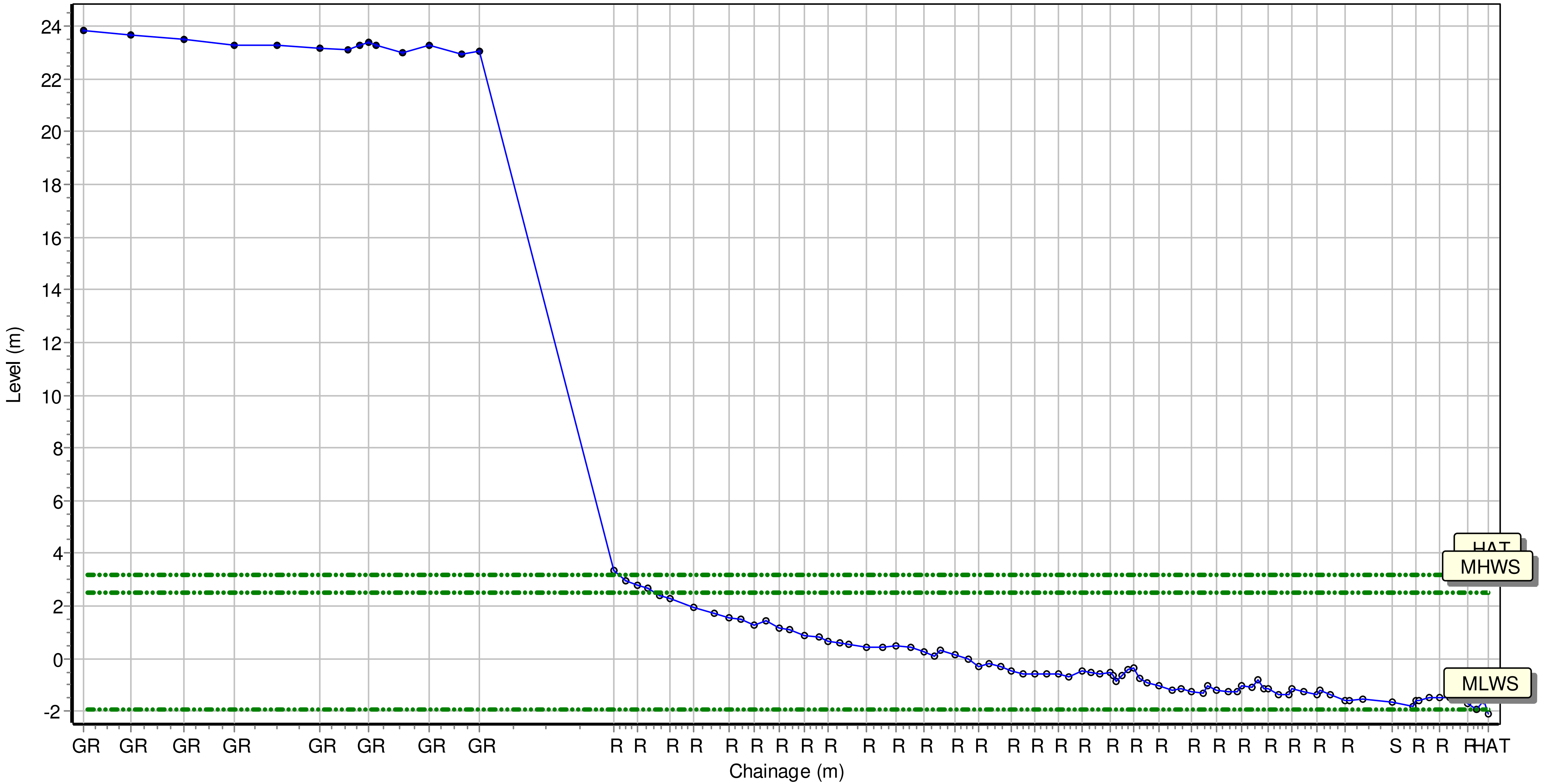
Location: **1bSNS18**

Date: 07/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441365.488 **Northing:** 553870.605 **Profile Bearing:** 83 ° from North



Beach Profile

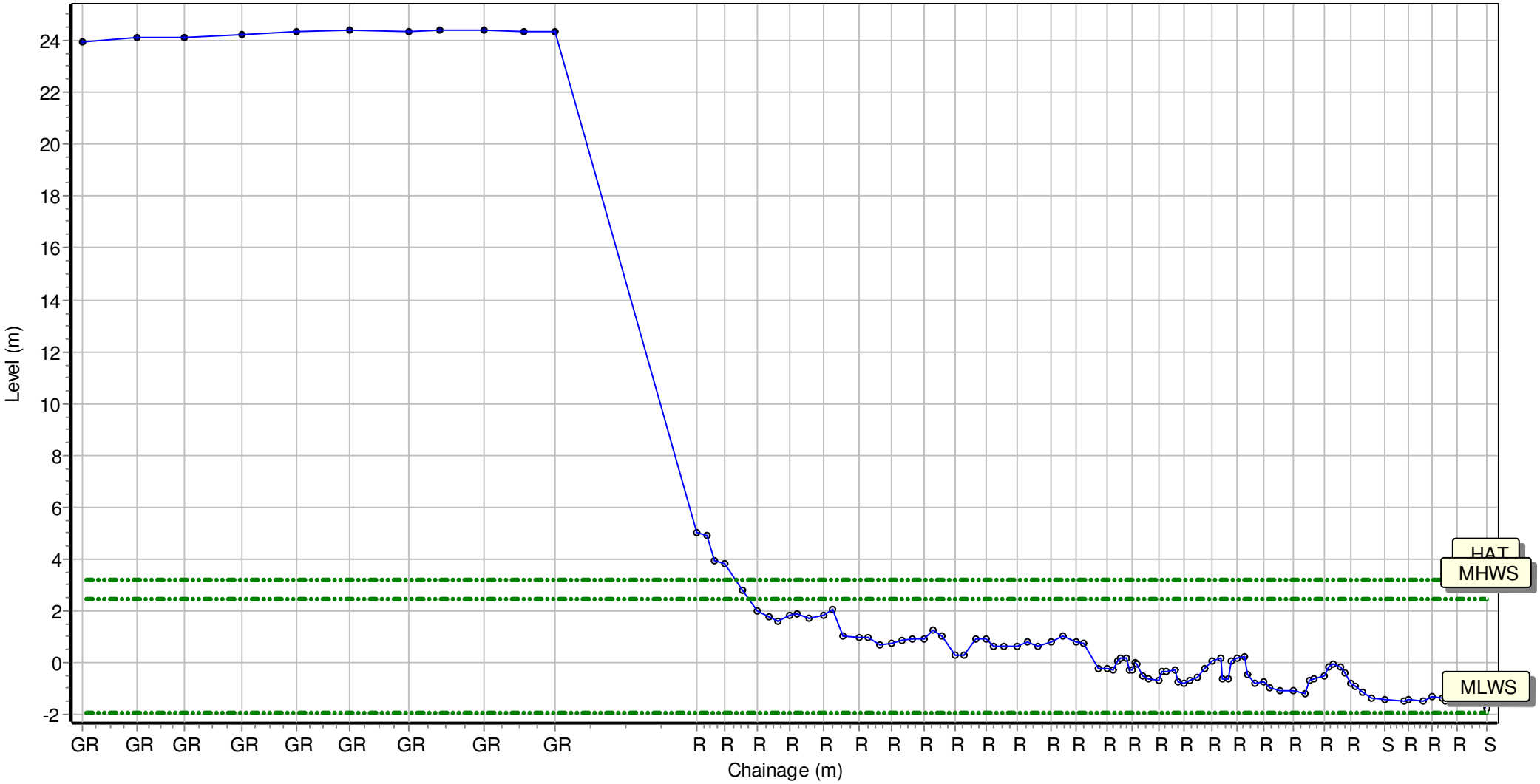
Location: **1bSNS19**

Date: 07/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441384.336 **Northing:** 553752.319 **Profile Bearing:** 105 ° from North



Beach Profile

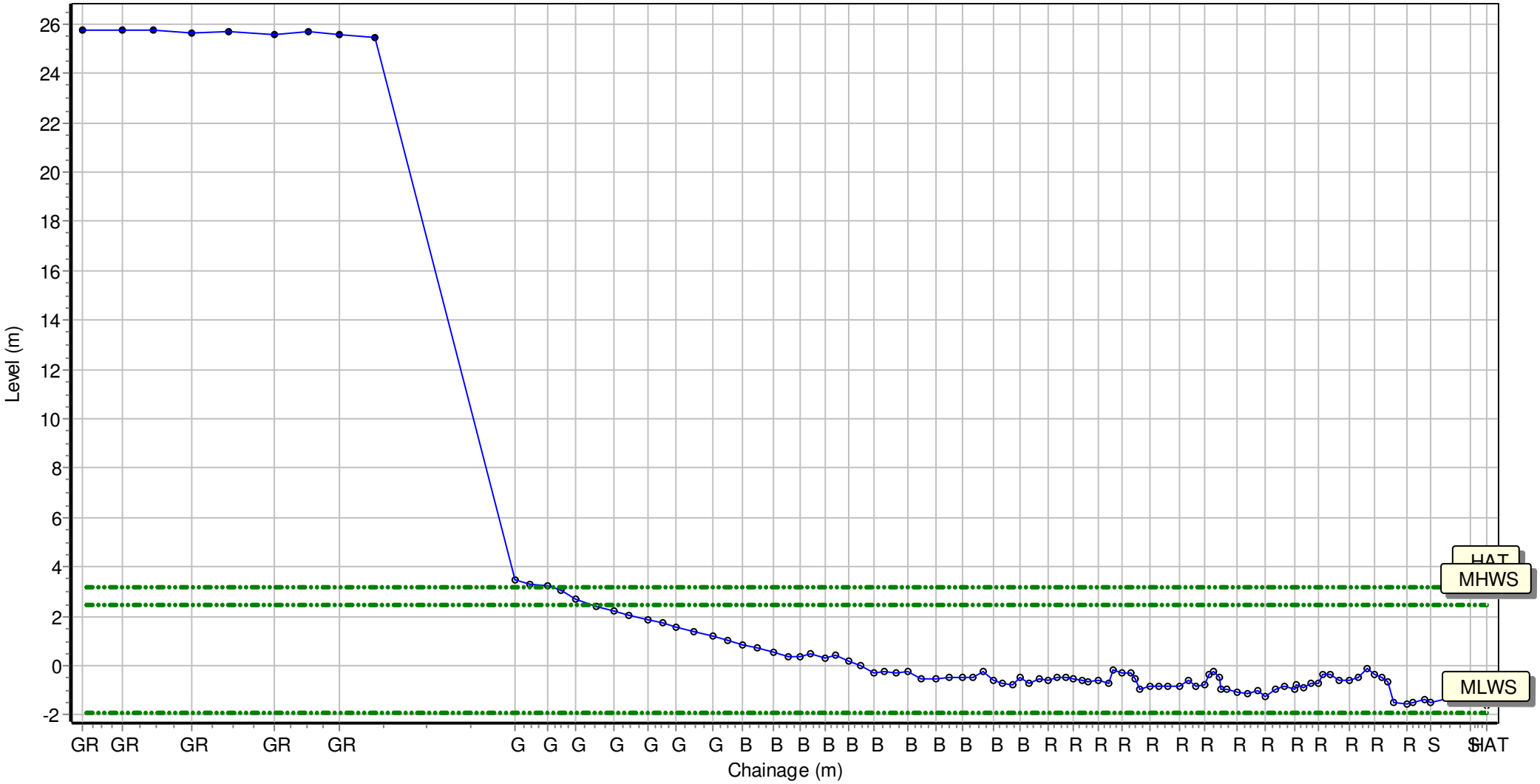
Location: **1bSNS20**

Date: 07/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441378.054 **Northing:** 553599.123 **Profile Bearing:** 81 ° from North



Beach Profile

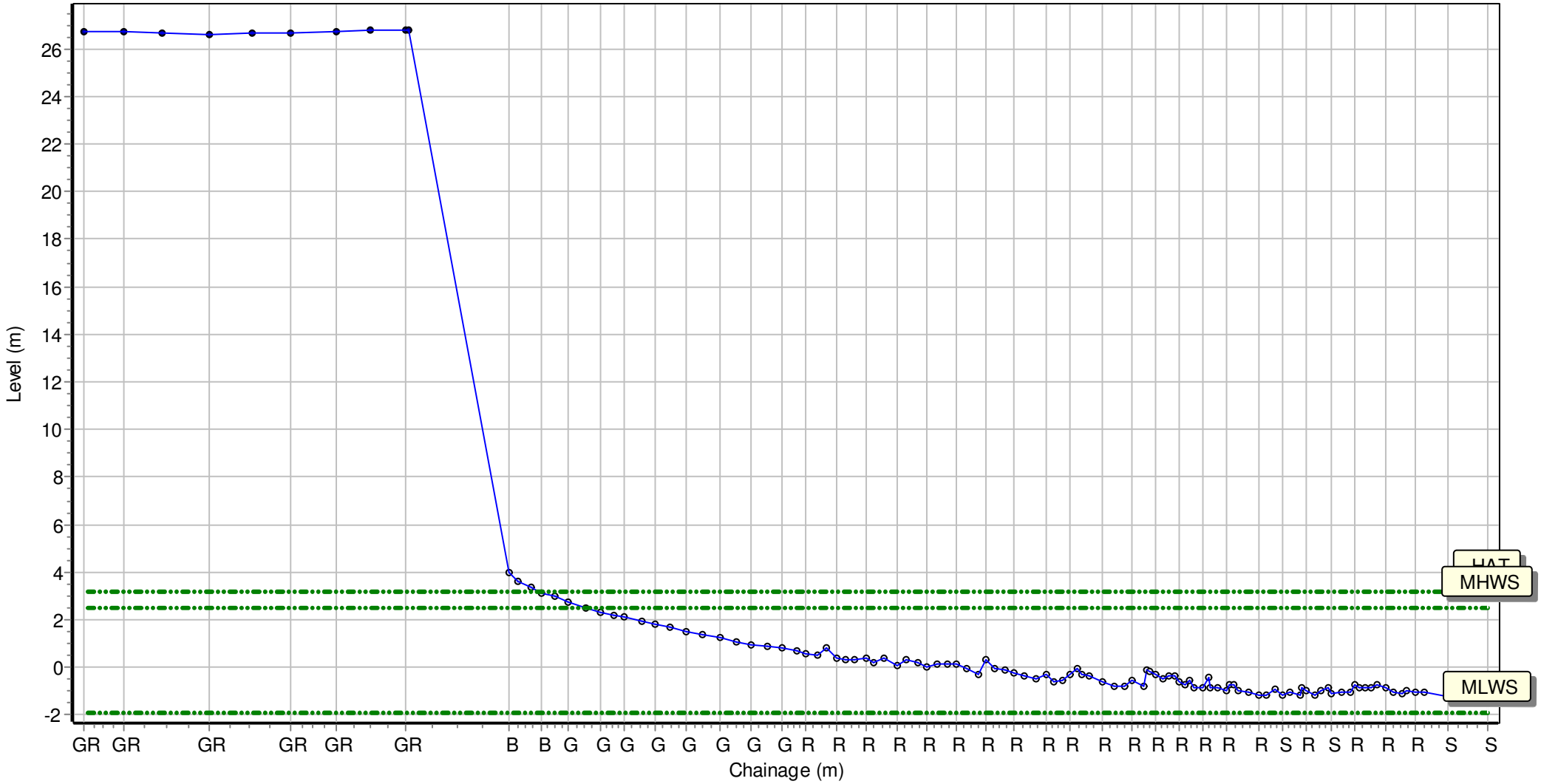
Location: **1bSNS21**

Date: 07/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441410.506 **Northing:** 553455.364 **Profile Bearing:** 75 ° from North



Beach Profile

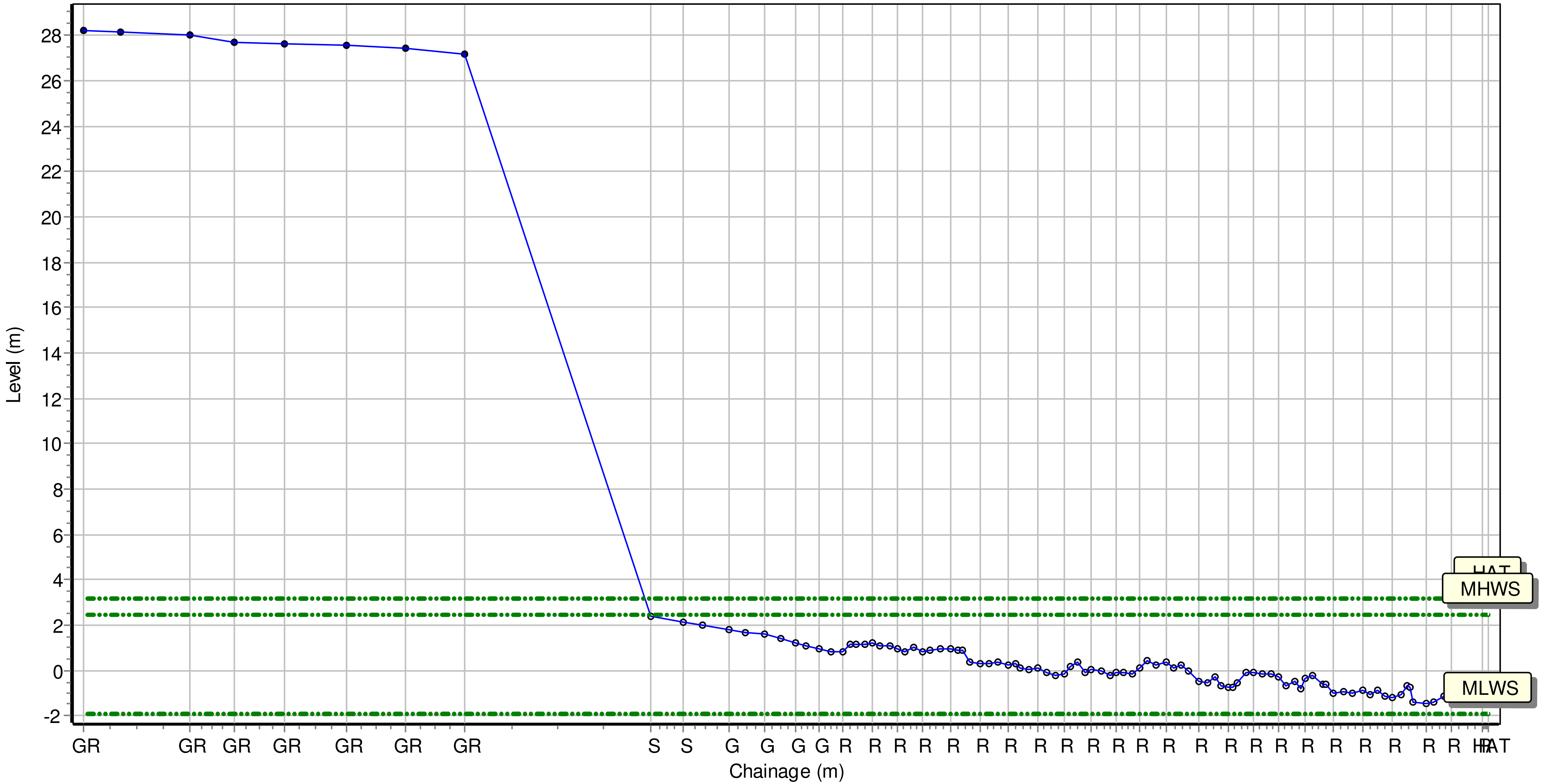
Location: 1bSNS22

Date: 07/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441474.364 **Northing:** 553262.39 **Profile Bearing:** 72 ° from North



Beach Profile

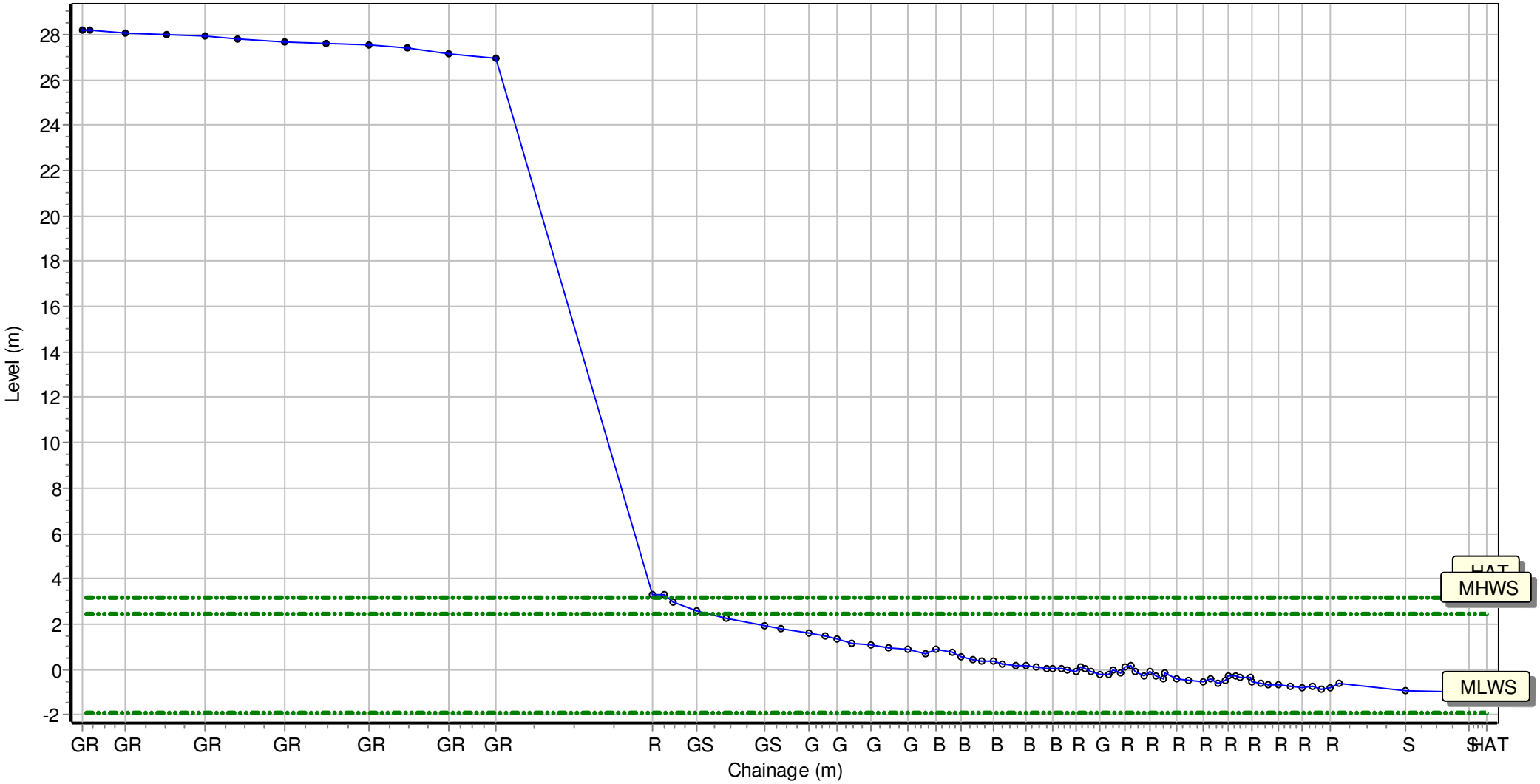
Location: **1bSNS23**

Date: 07/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441513.099 **Northing:** 553157.01 **Profile Bearing:** 71 ° from North



Beach Profile

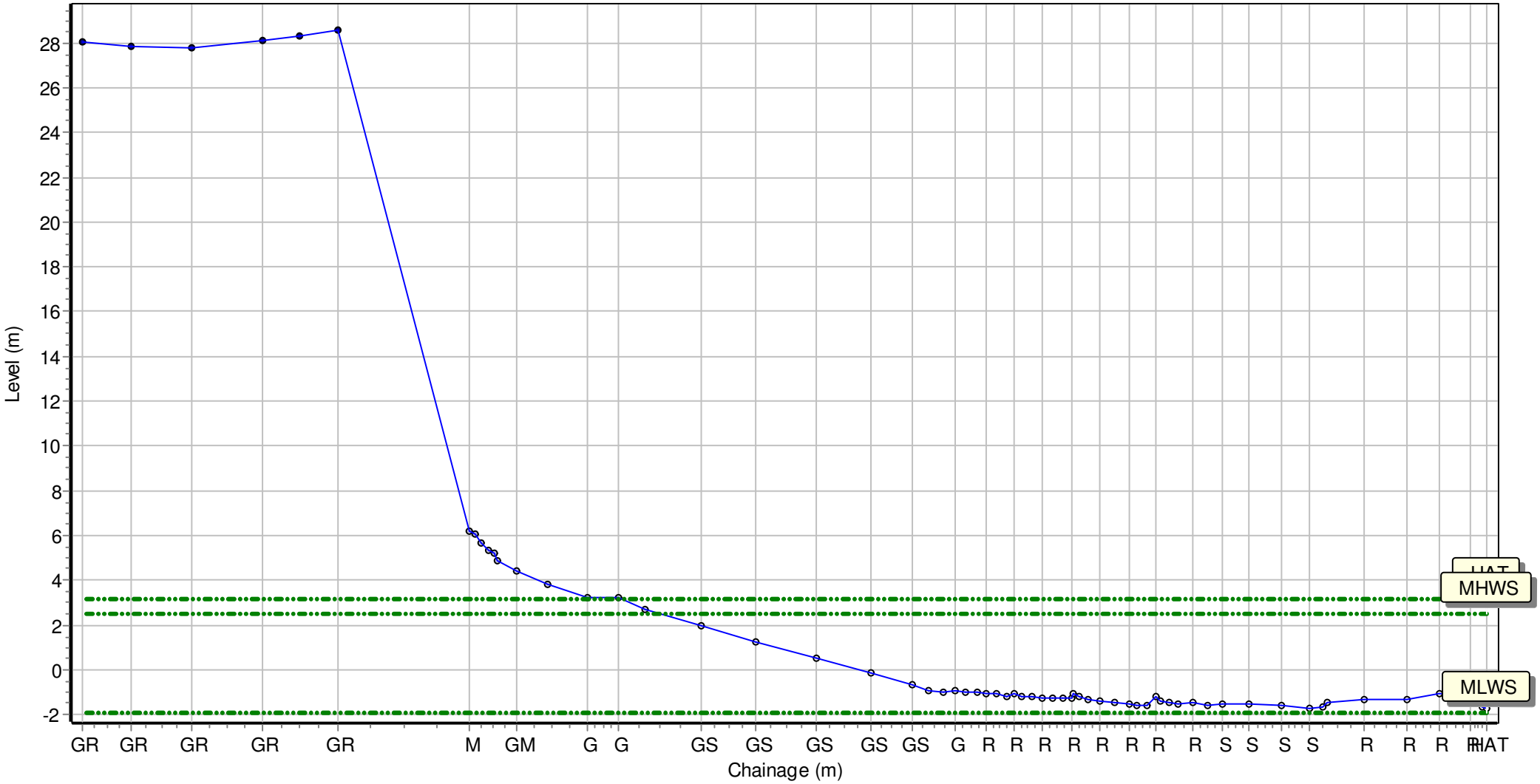
Location: **1bSNS24**

Date: 07/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441605.914 **Northing:** 552855.516 **Profile Bearing:** 68 ° from North



Beach Profile

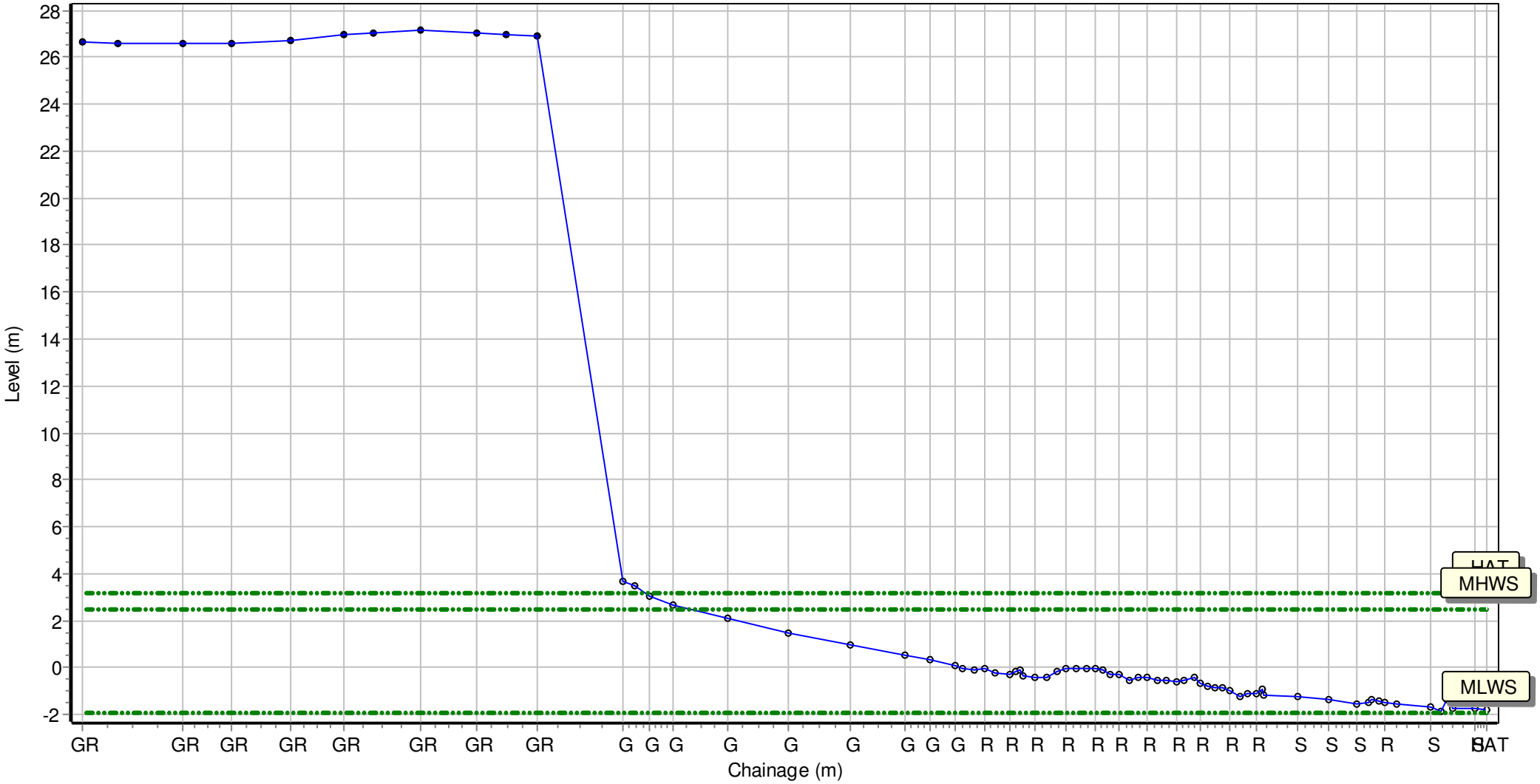
Location: **1bSNS25**

Date: 07/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441740.614 **Northing:** 552616.135 **Profile Bearing:** 64 ° from North



Beach Profile

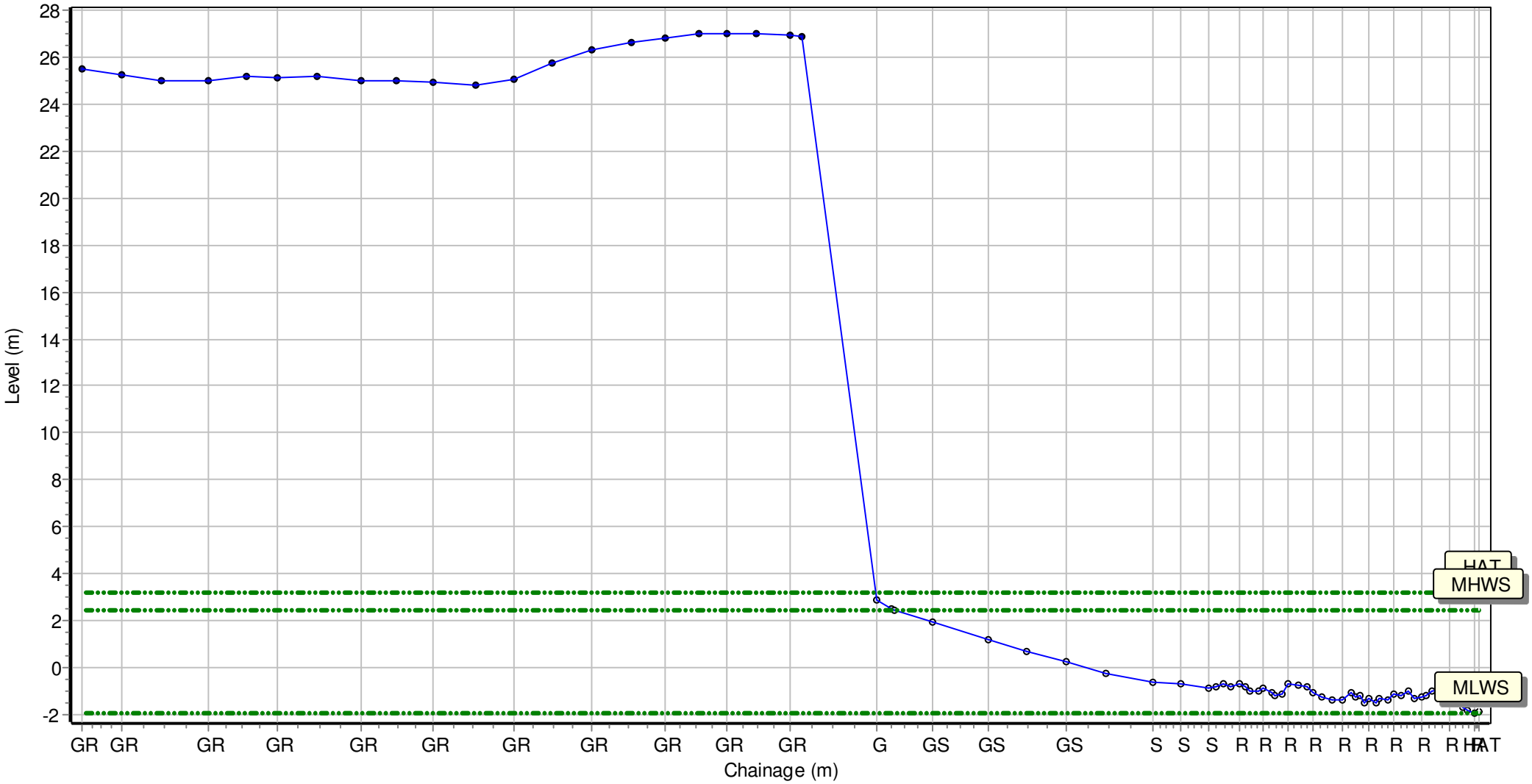
Location: **1bSNS26**

Date: 07/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441726.053 **Northing:** 552563.41 **Profile Bearing:** 60 ° from North



Beach Profile

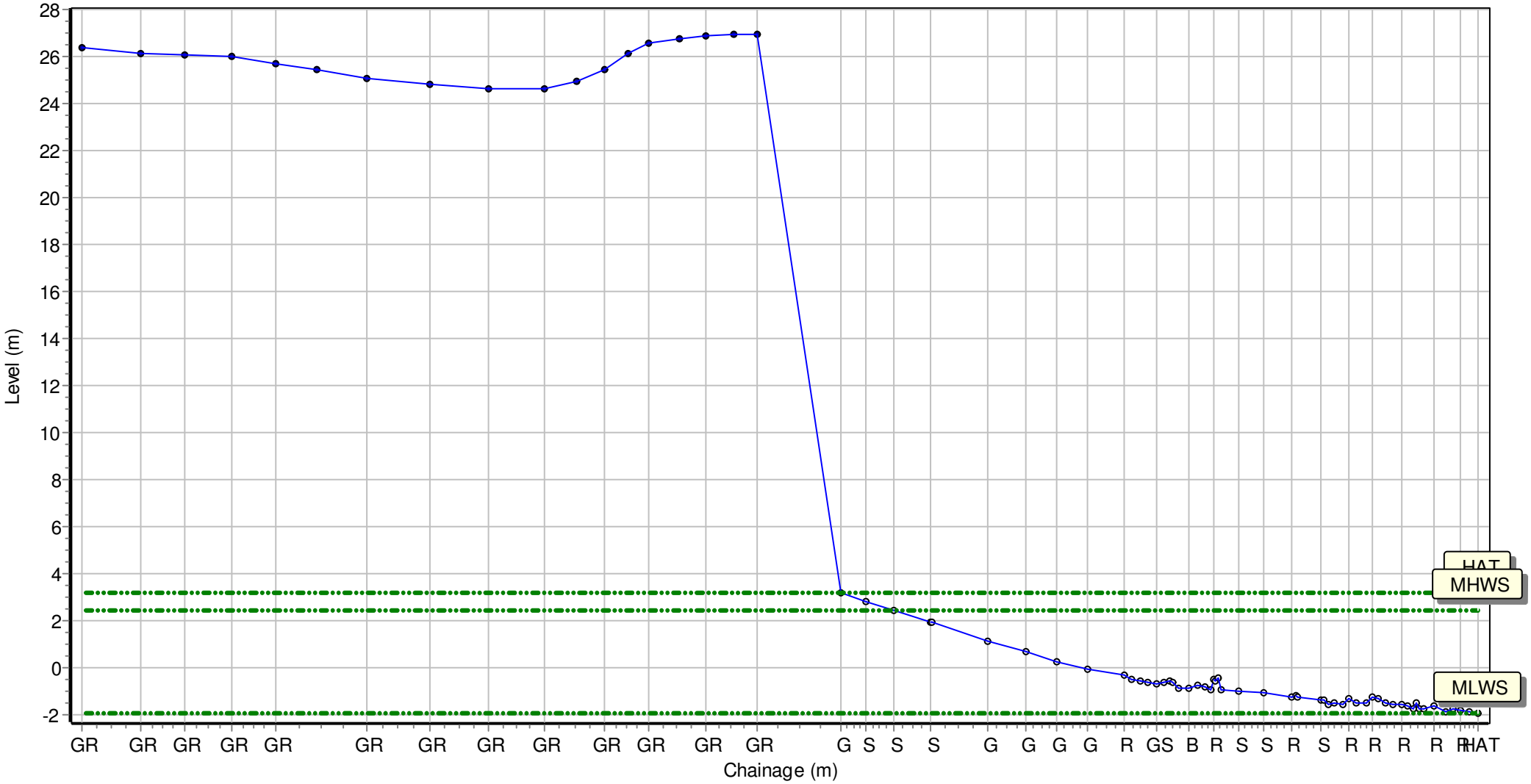
Location: **1bSNS27**

Date: 07/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441733.63 **Northing:** 552550.463 **Profile Bearing:** 60 ° from North



Beach Profile

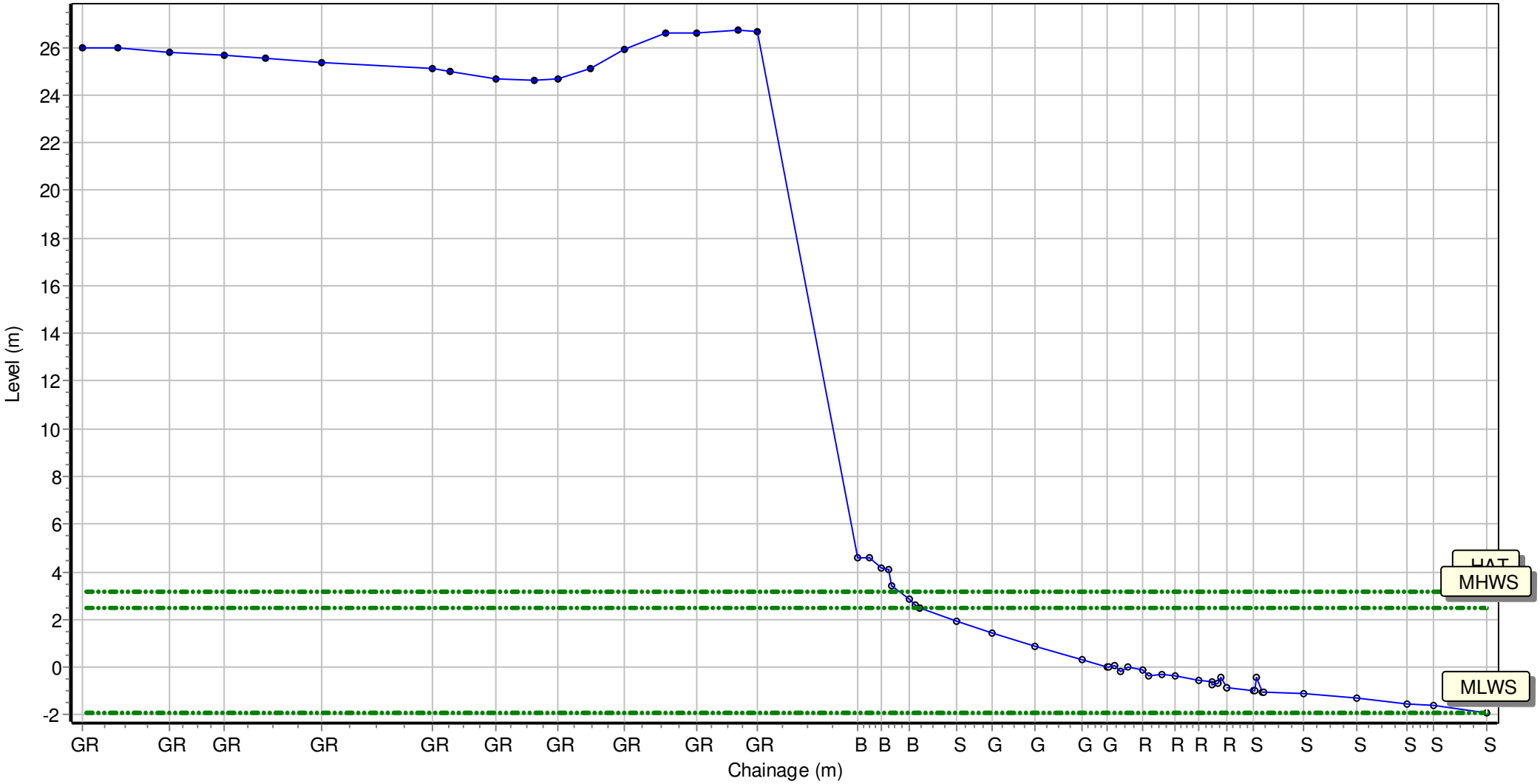
Location: **1bSNS28**

Date: 07/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441741.207 **Northing:** 552537.517 **Profile Bearing:** 60 ° from North



Beach Profile

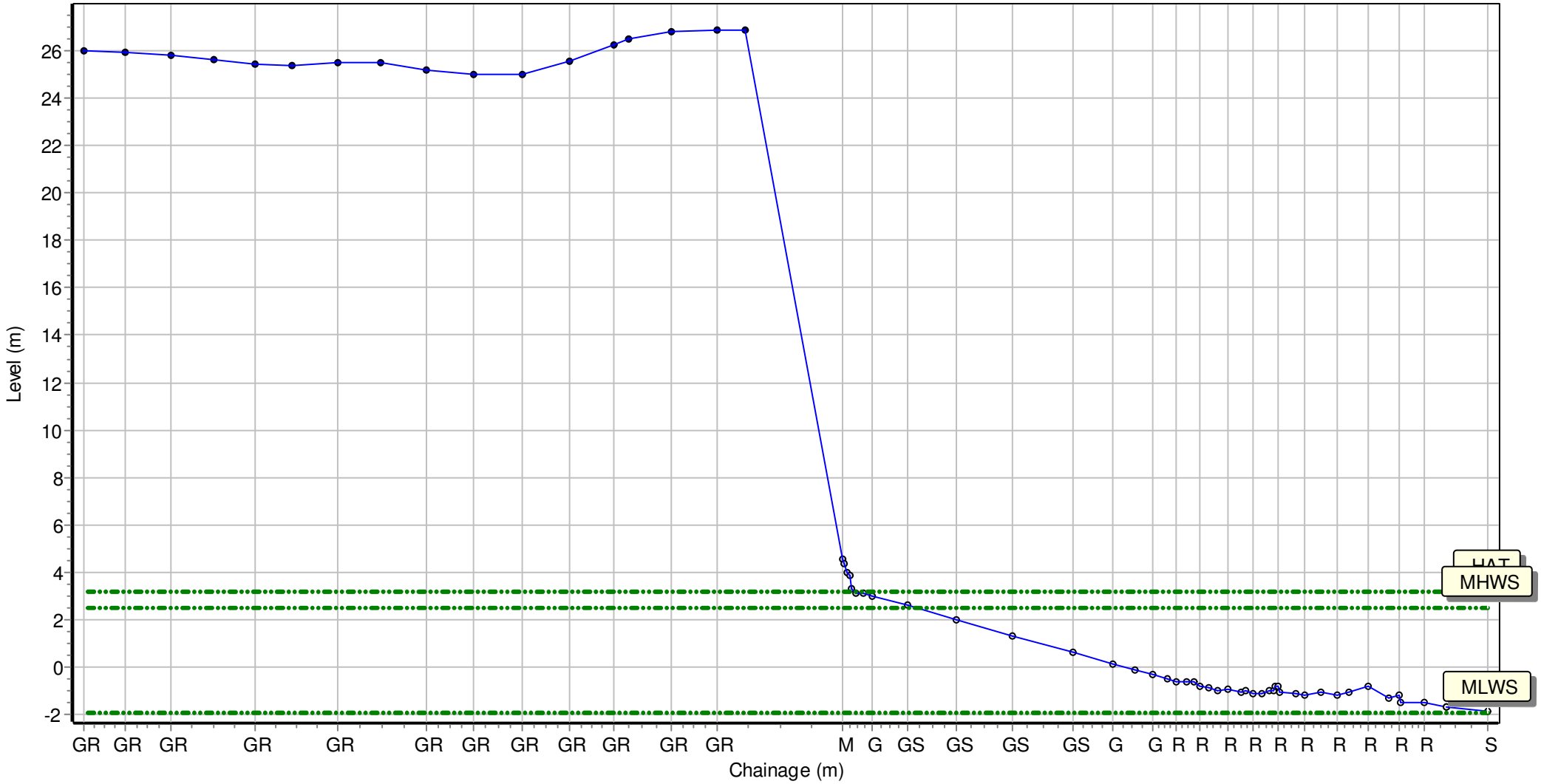
Location: **1bSNS29**

Date: 07/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441748.776 **Northing:** 552524.571 **Profile Bearing:** 60 ° from North



Beach Profile

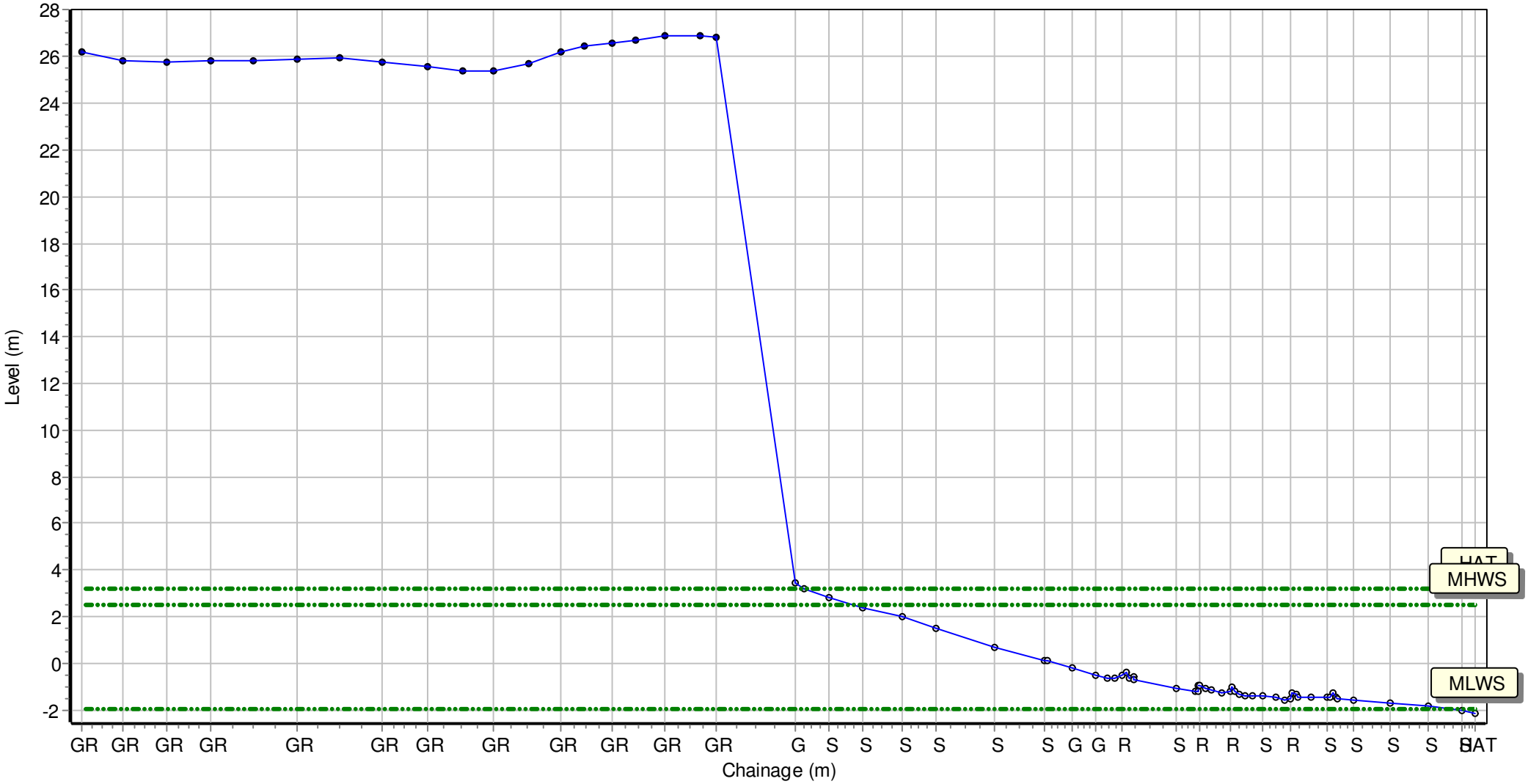
Location: **1bSNS30**

Date: 07/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441756.353 **Northing:** 552511.624 **Profile Bearing:** 60 ° from North



Beach Profile

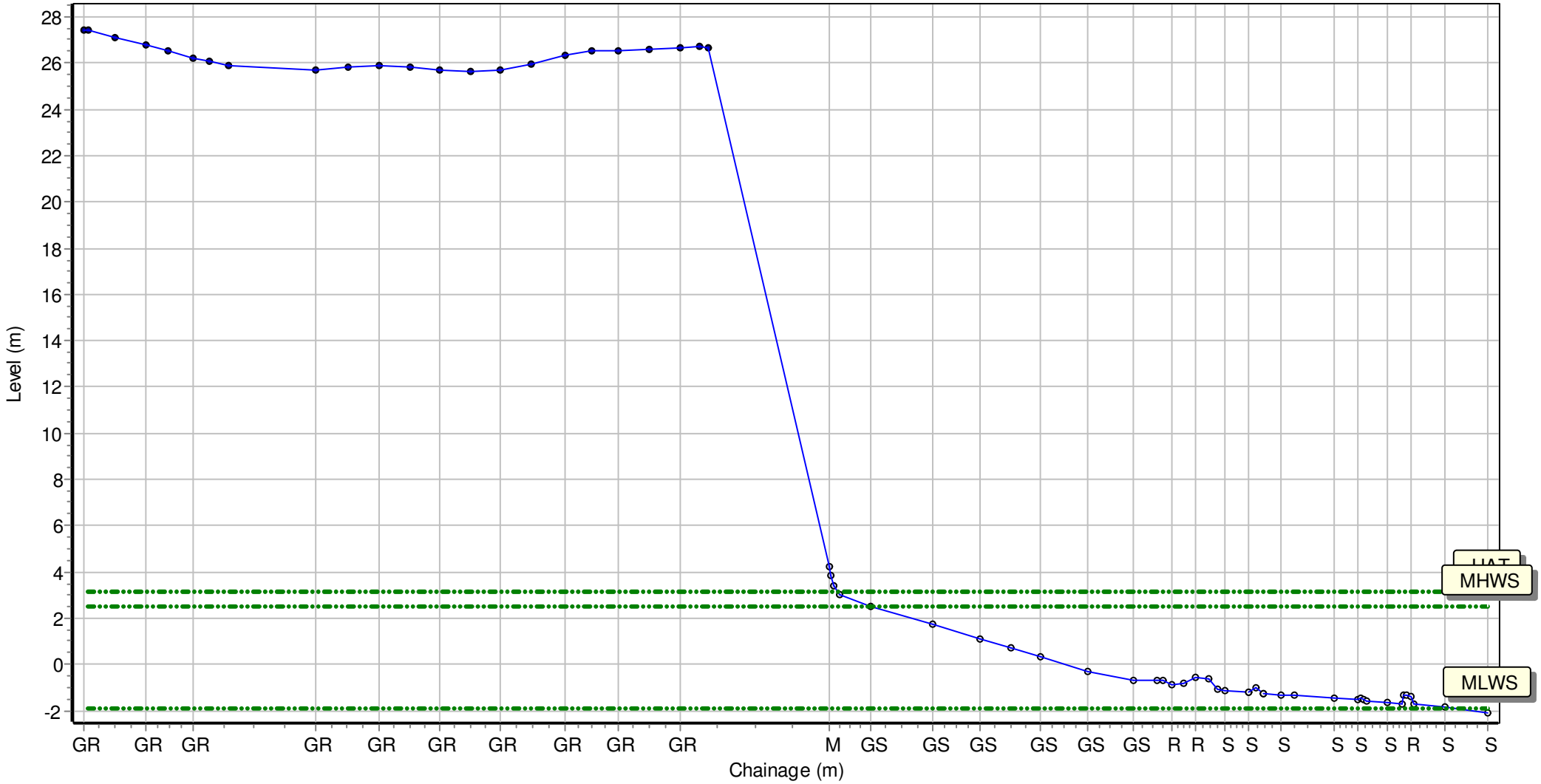
Location: **1bSNS31**

Date: 07/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441763.931 **Northing:** 552498.678 **Profile Bearing:** 60 ° from North



Beach Profile

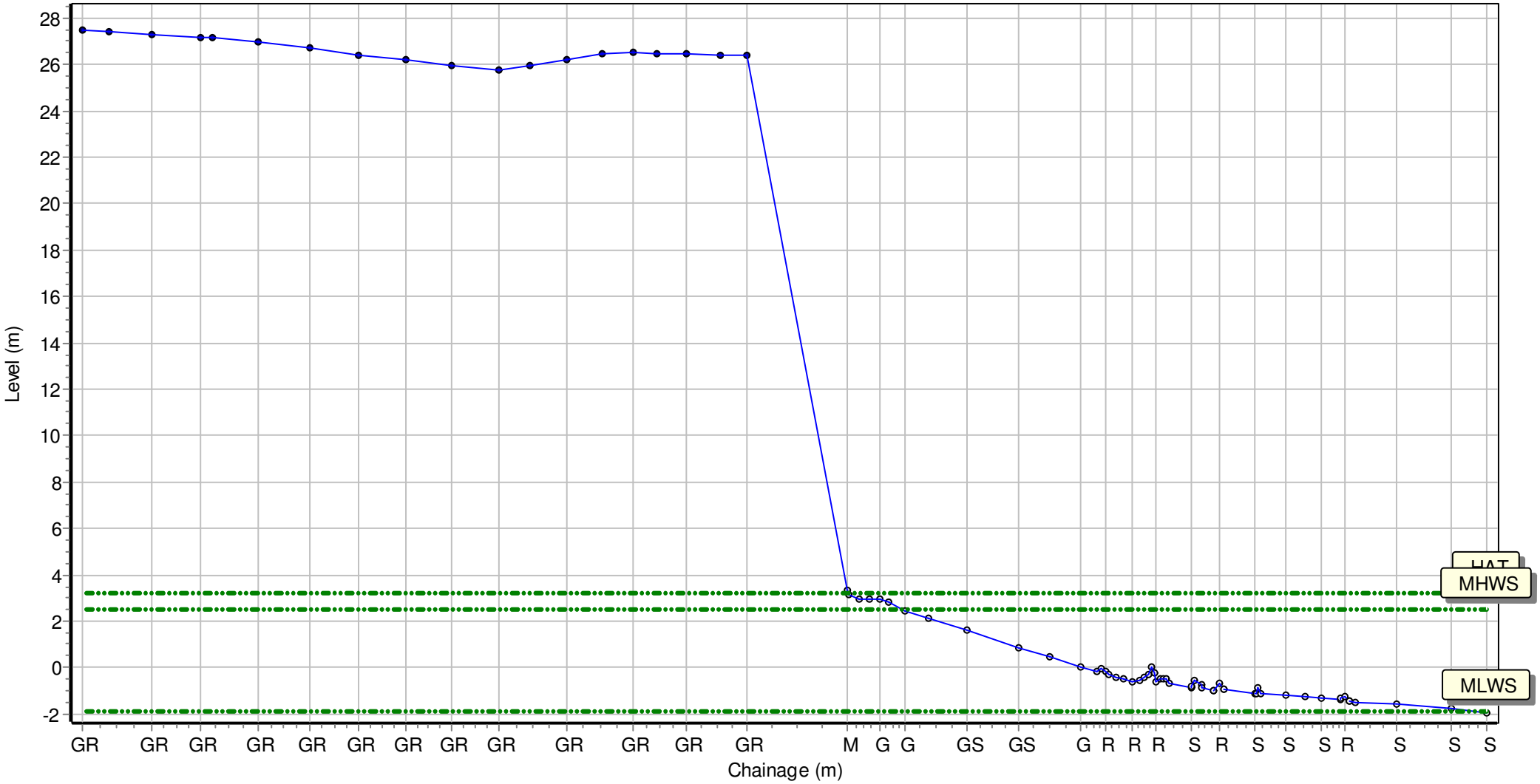
Location: **1bSNS32**

Date: 07/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441771.5 **Northing:** 552485.732 **Profile Bearing:** 60 ° from North



Beach Profile

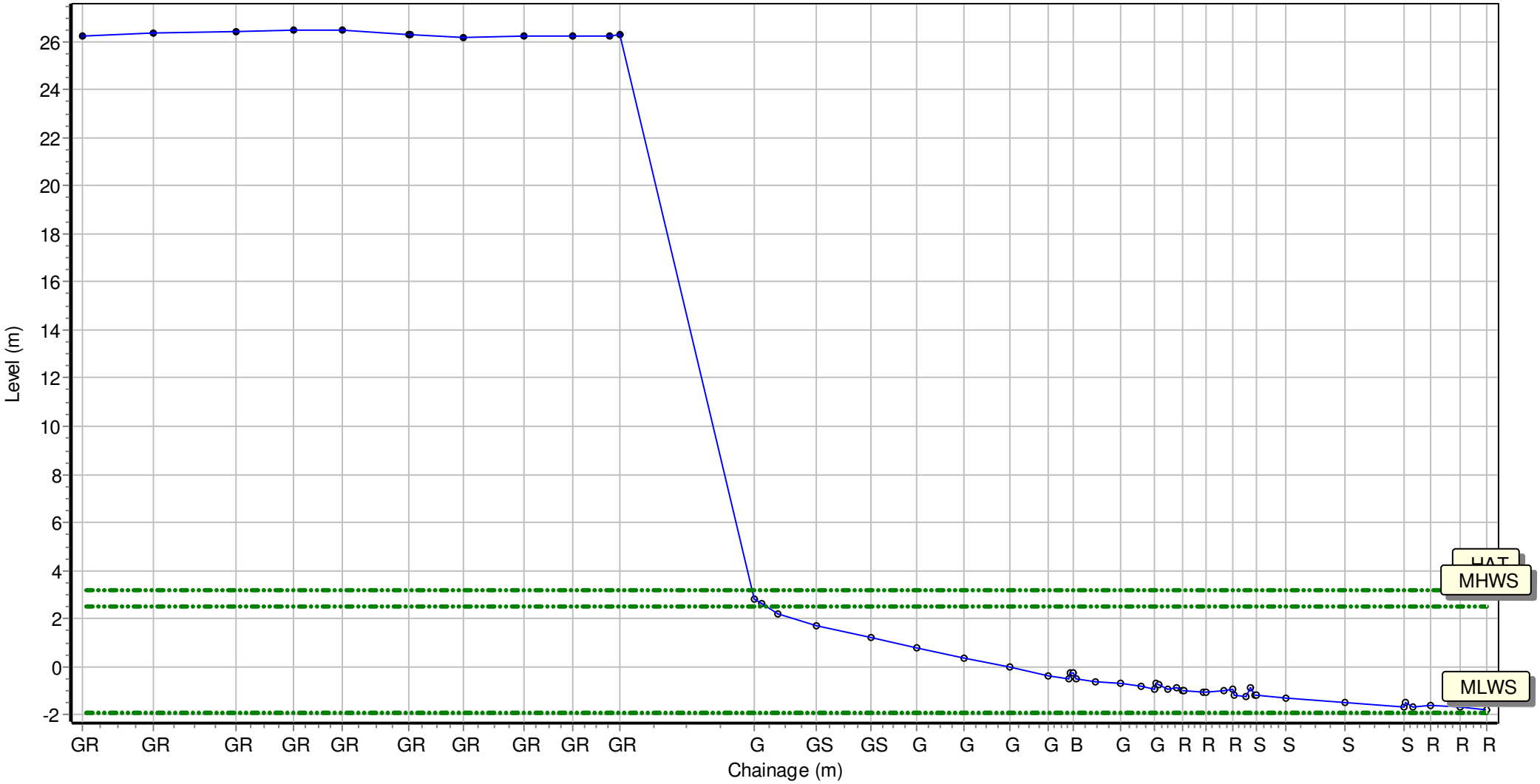
Location: **1bSNS33**

Date: 07/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441841.104 **Northing:** 552454.571 **Profile Bearing:** 37 ° from North



Beach Profile

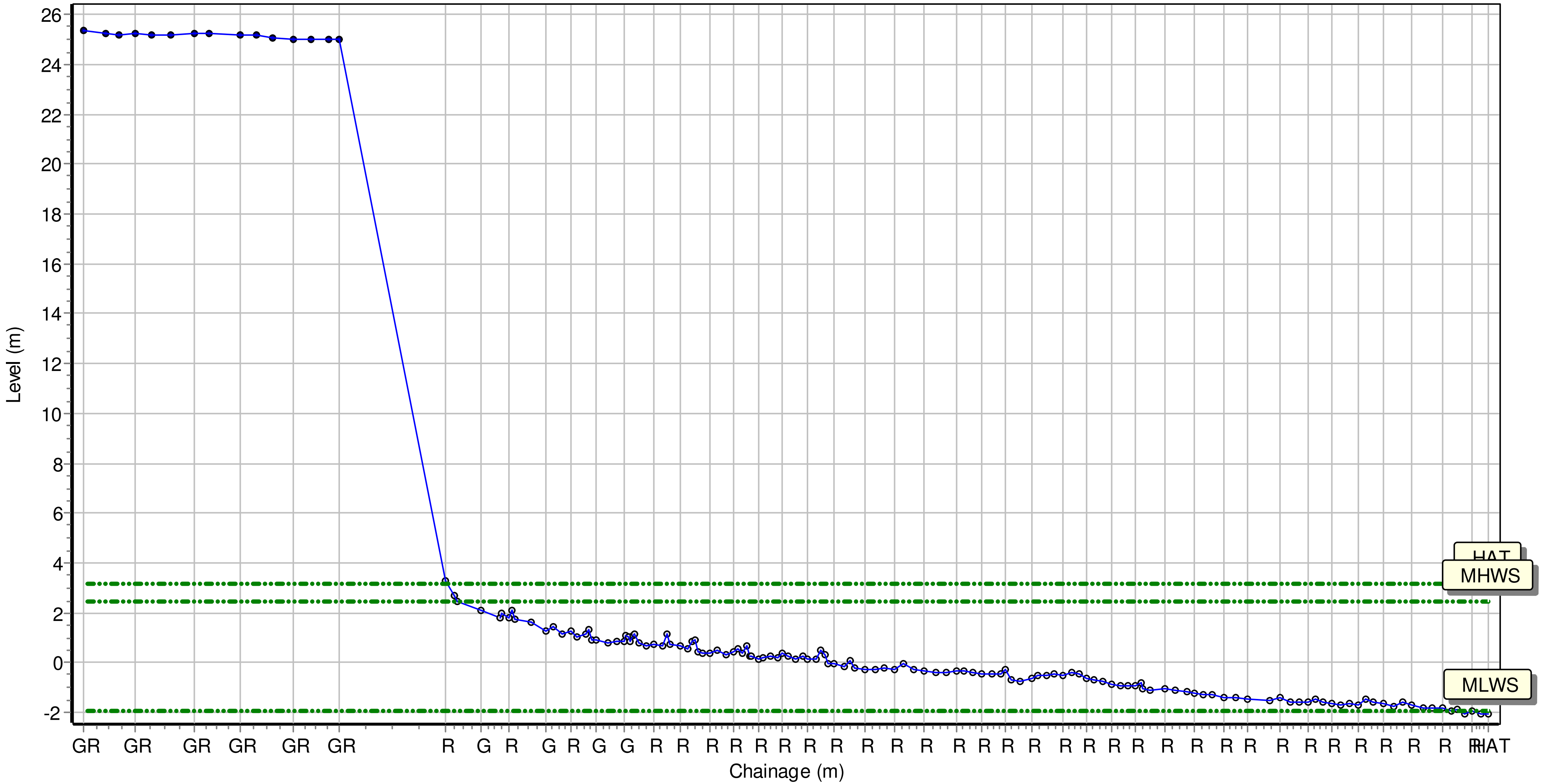
Location: 1bSNS34

Date: 07/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441901.161 **Northing:** 552284.09 **Profile Bearing:** 102 ° from North



Beach Profile

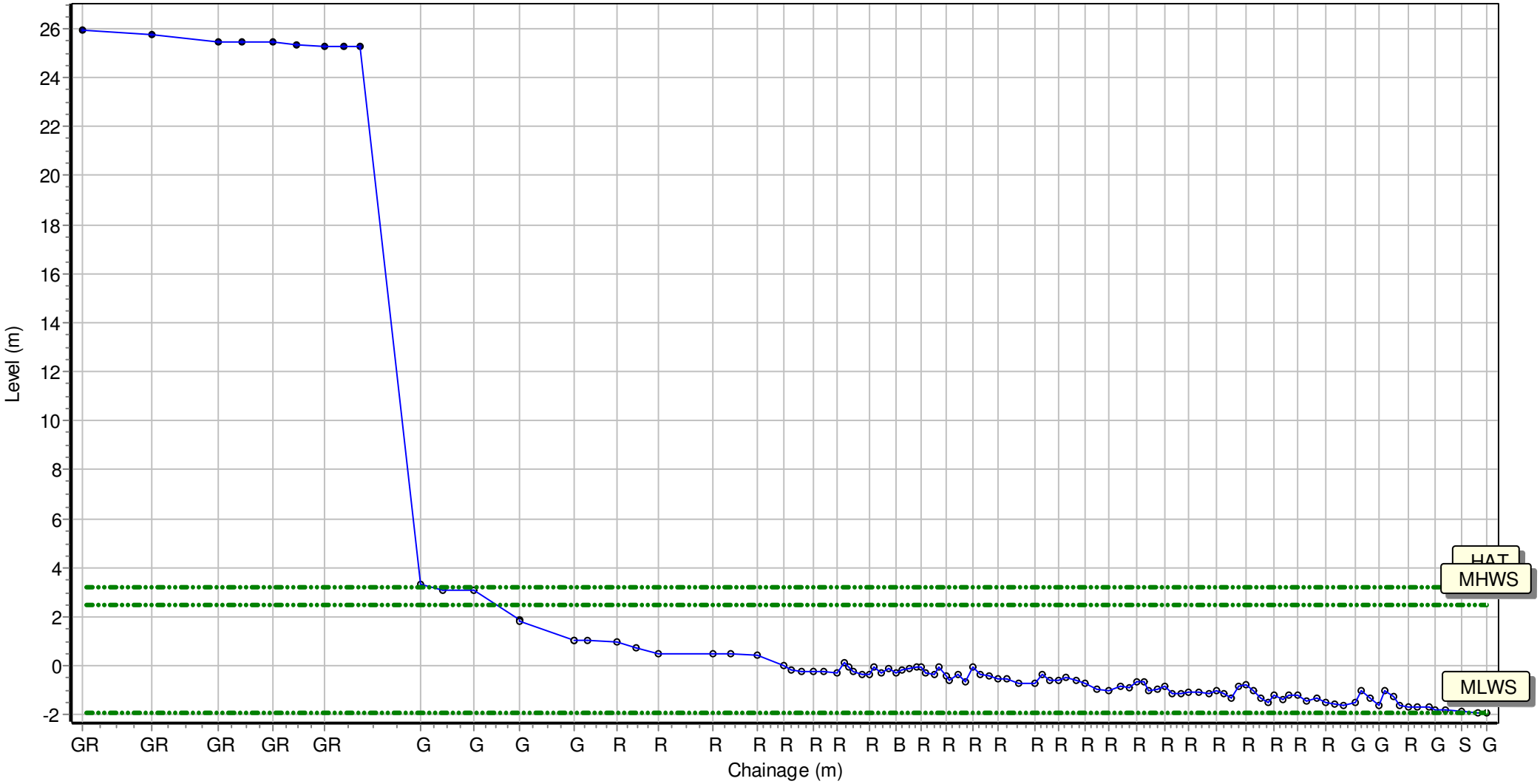
Location: **1bSNS35**

Date: 07/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2018 Full Measures Topo Survey

Easting: 441844.023 **Northing:** 552163.994 **Profile Bearing:** 111 ° from North



Beach Profile

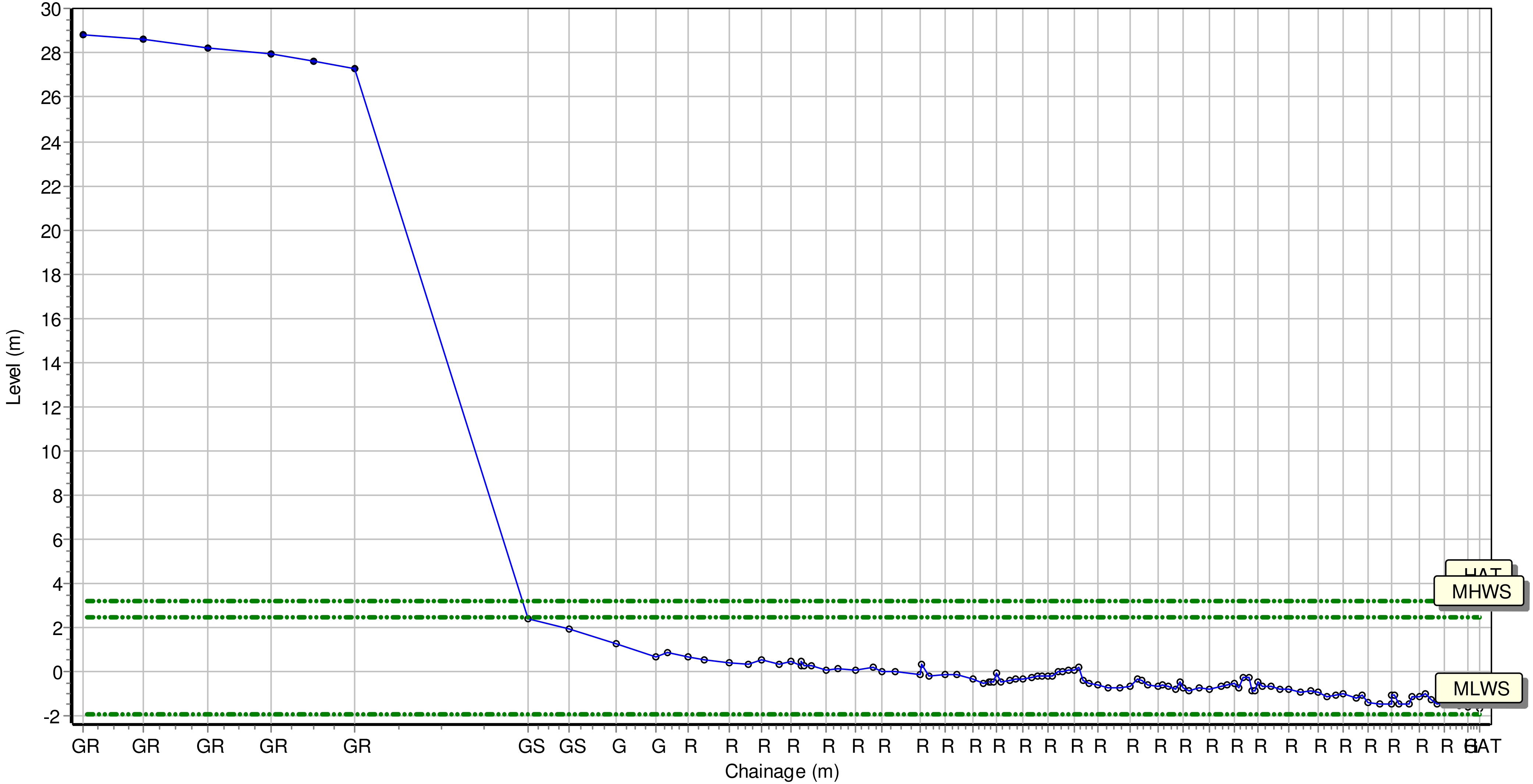
Location: **1bSNS36**

Date: 07/11/2018 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

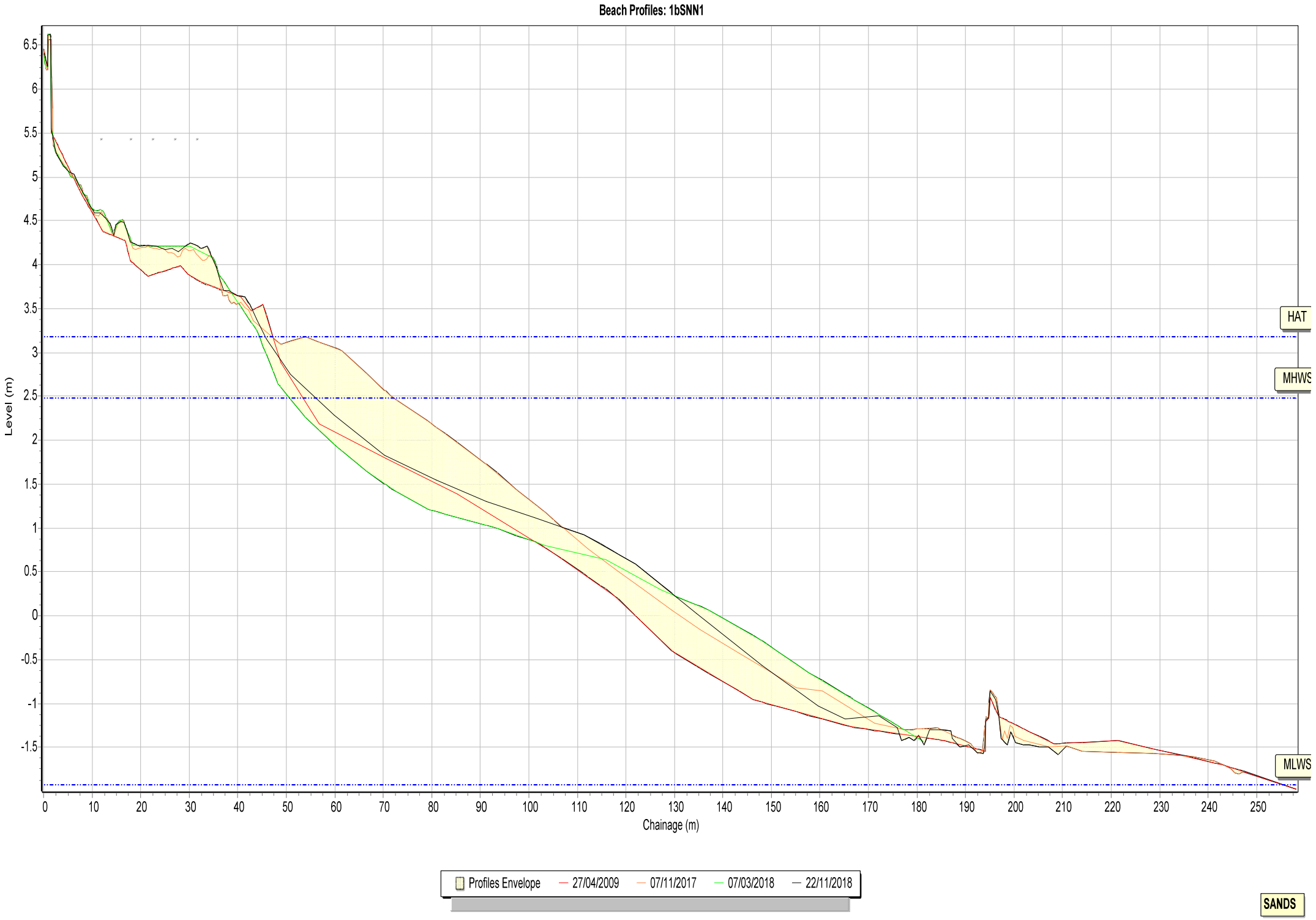
Summary: 2018 Full Measures Topo Survey

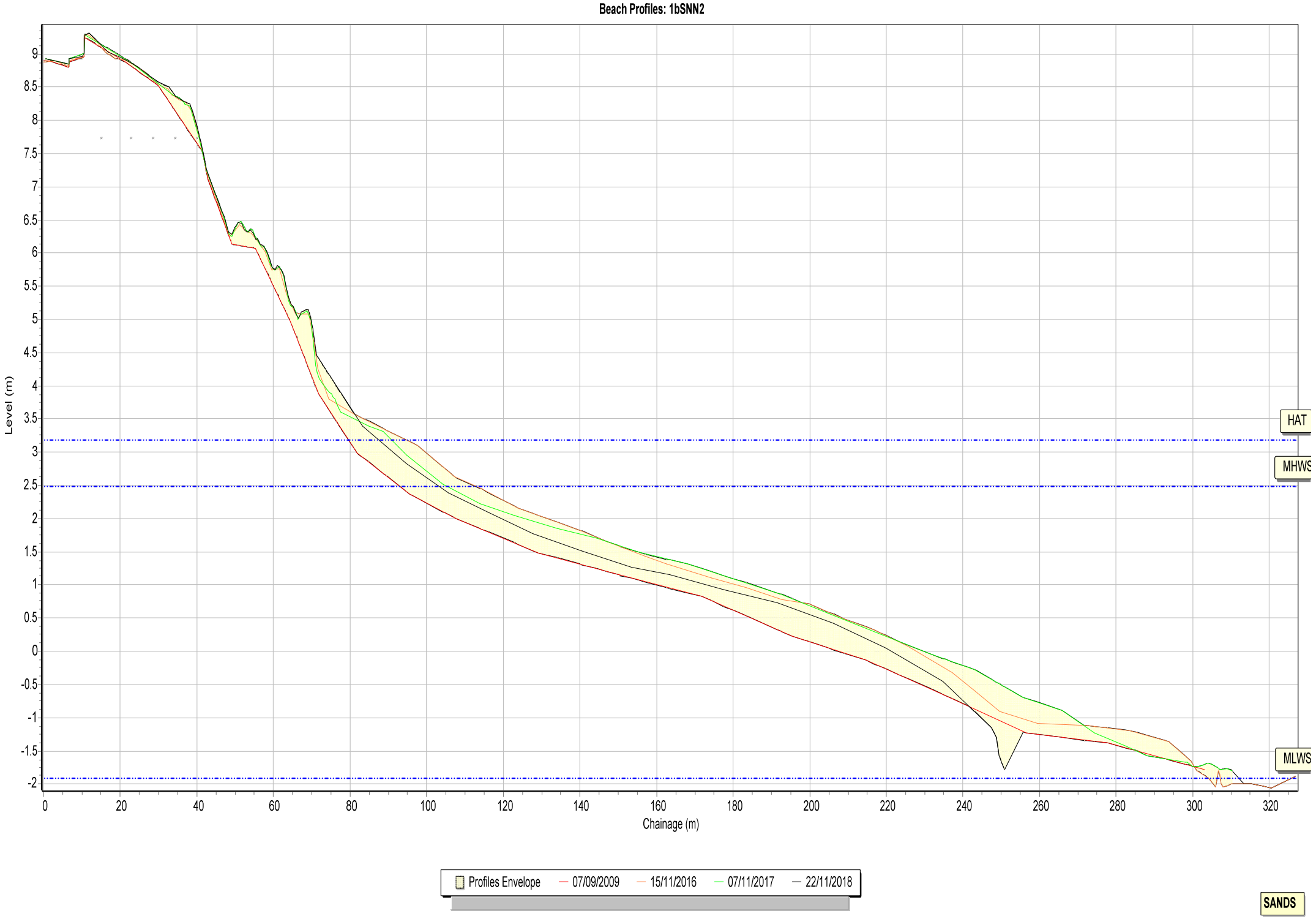
Easting: 441853.315 **Northing:** 551983.836 **Profile Bearing:** 81 ° from North

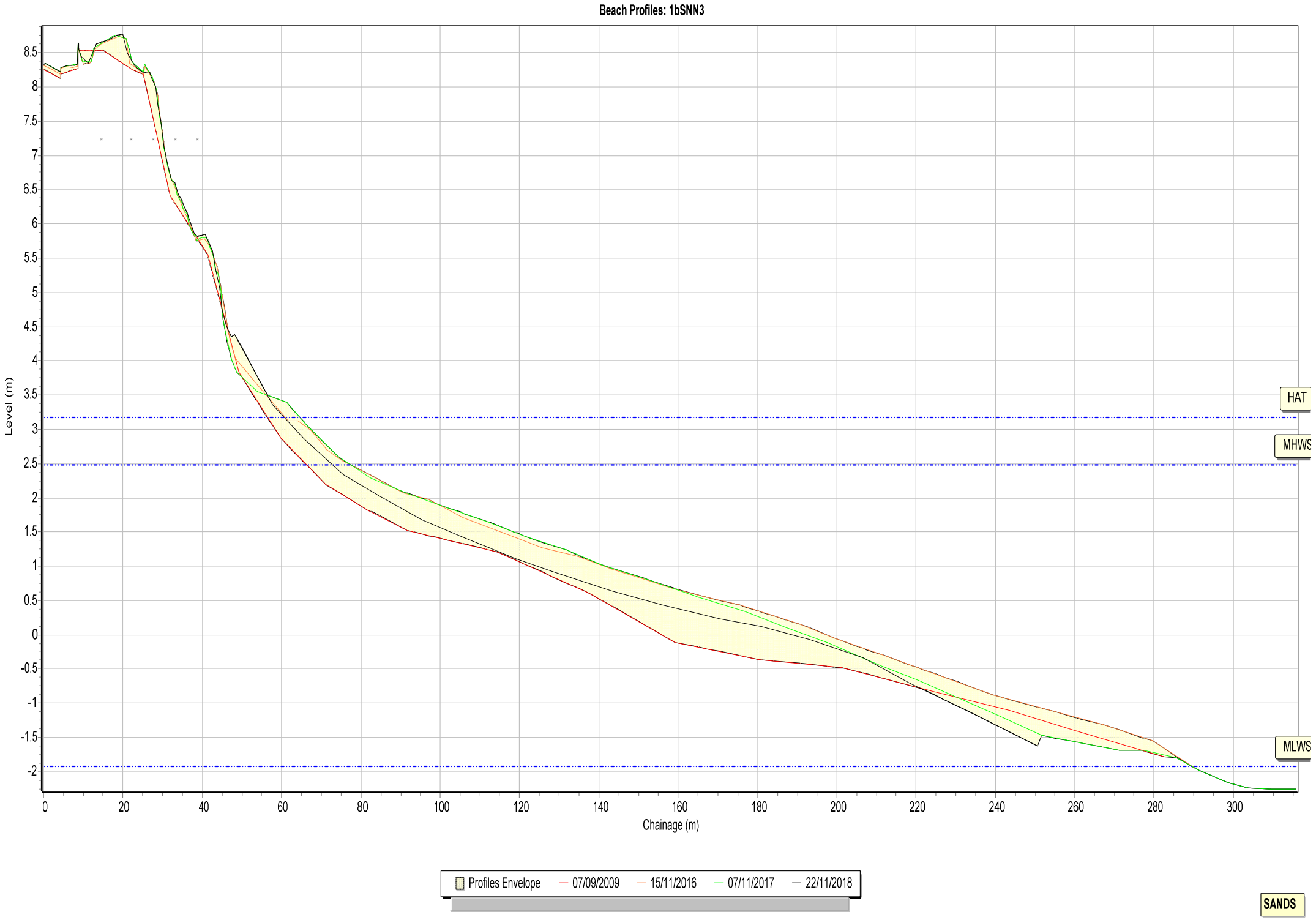


http://www.sandsuser.com

SANDS


Beach Profiles: 1bSNN1
Level (m)
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
HAT
MHWS
MLWS
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
Chainage (m)
Profiles Envelope
27/04/2009
07/11/2017
07/03/2018
22/11/2018
SANDS


Beach Profiles: 1bSNN2
Level (m)
Chainage (m)
HAT
MHWS
MLWS
Profiles Envelope
07/09/2009
15/11/2016
07/11/2017
22/11/2018
SANDS


Beach Profiles: 1bSNN3
Level (m)
8.5
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7.5
7
6.5
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5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
HAT
MHWS
MLWS
0
20
40
60
80
100
120
140
160
180
200
220
240
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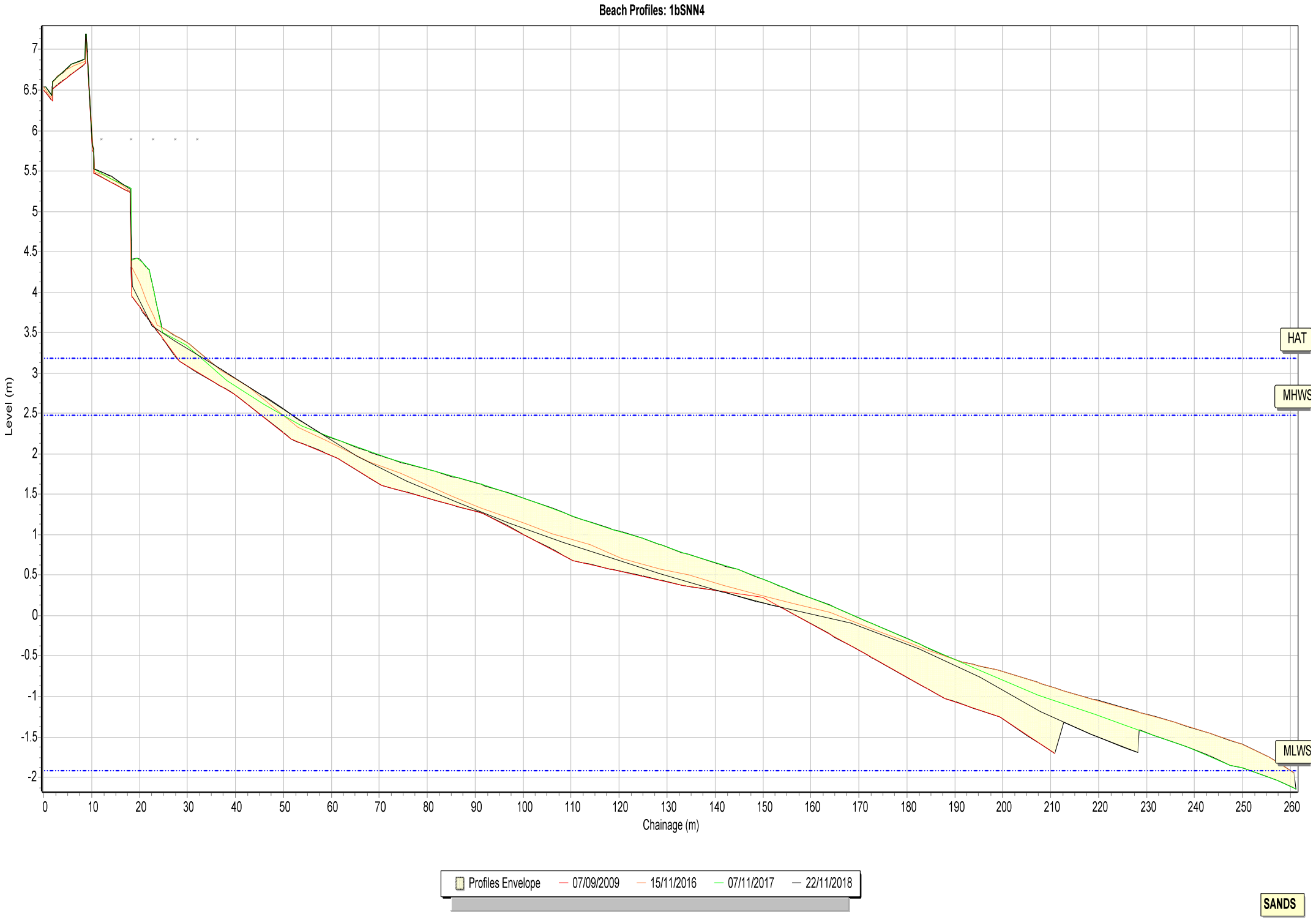
280
300
Chainage (m)
Profiles Envelope
07/09/2009
15/11/2016
07/11/2017
22/11/2018
SANDS


Beach Profiles: 1bSNN4
Level (m)
Chainage (m)
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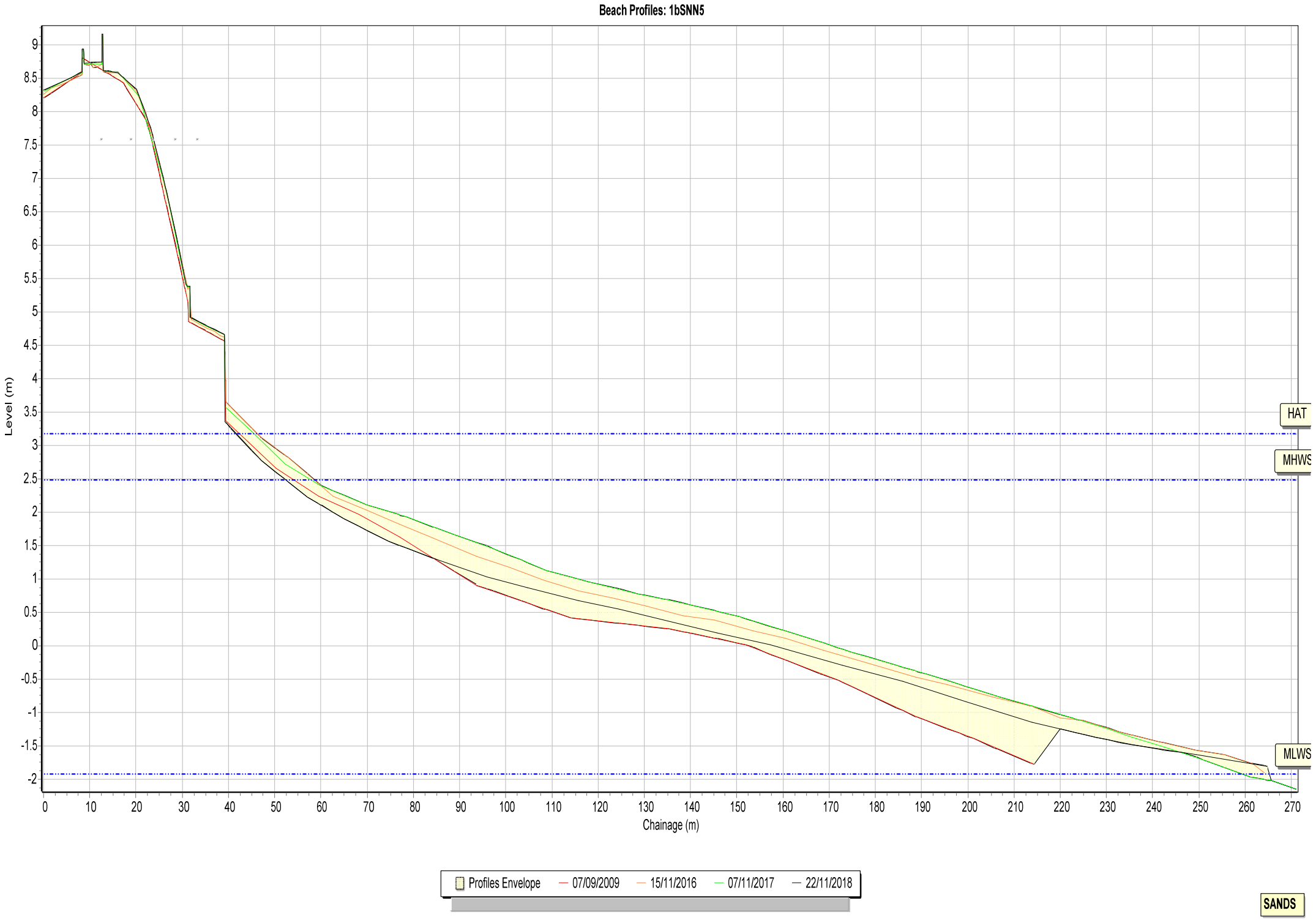
MHWS
MLWS
Profiles Envelope
07/09/2009
15/11/2016
07/11/2017
22/11/2018
SANDS


Beach Profiles: 1bSNN5
Level (m)
Chainage (m)
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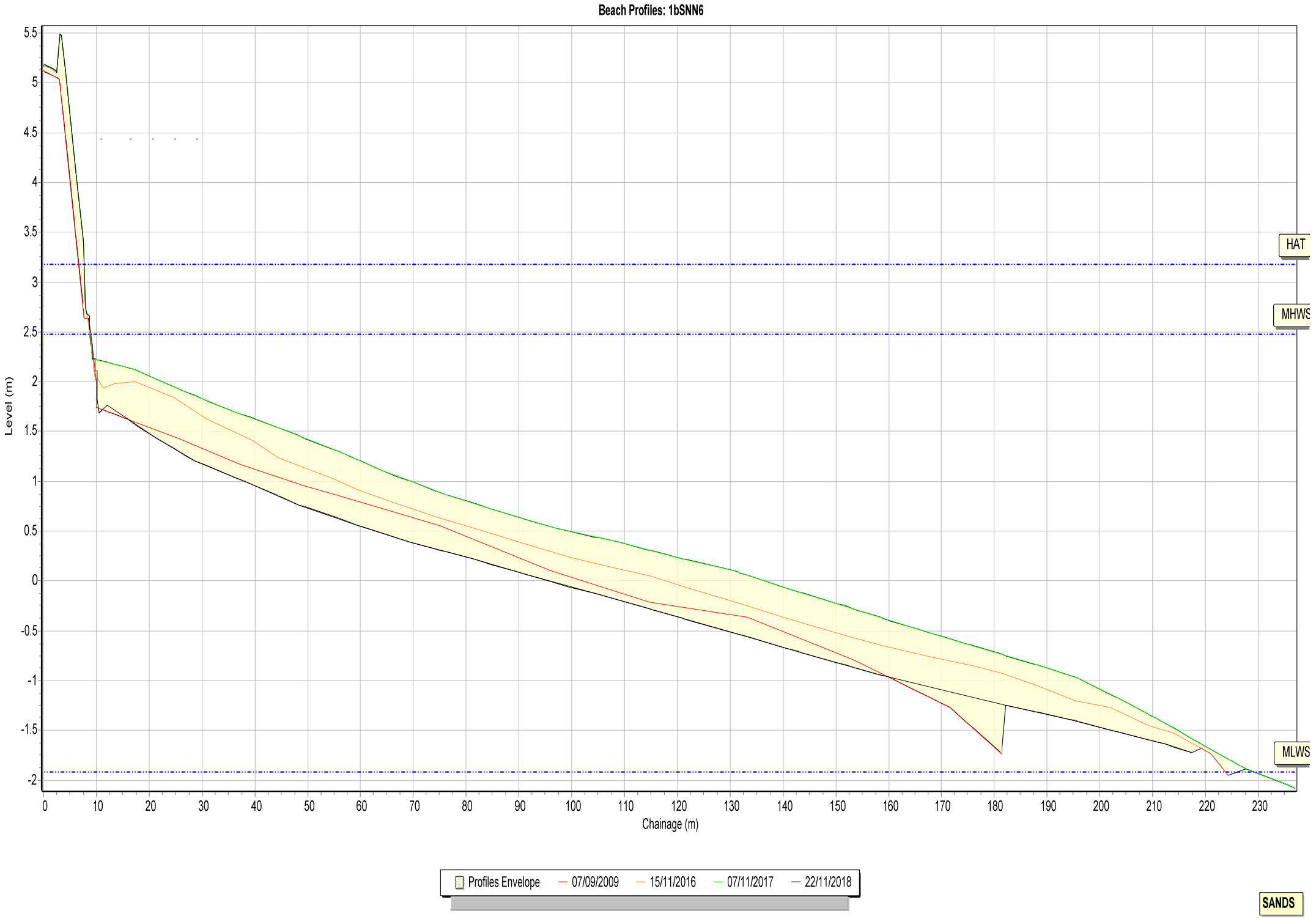
MHWS
MLWS
Profiles Envelope
07/09/2009
15/11/2016
07/11/2017
22/11/2018
SANDS


Beach Profiles: 1bSNN6
Level (m)
Chainage (m)
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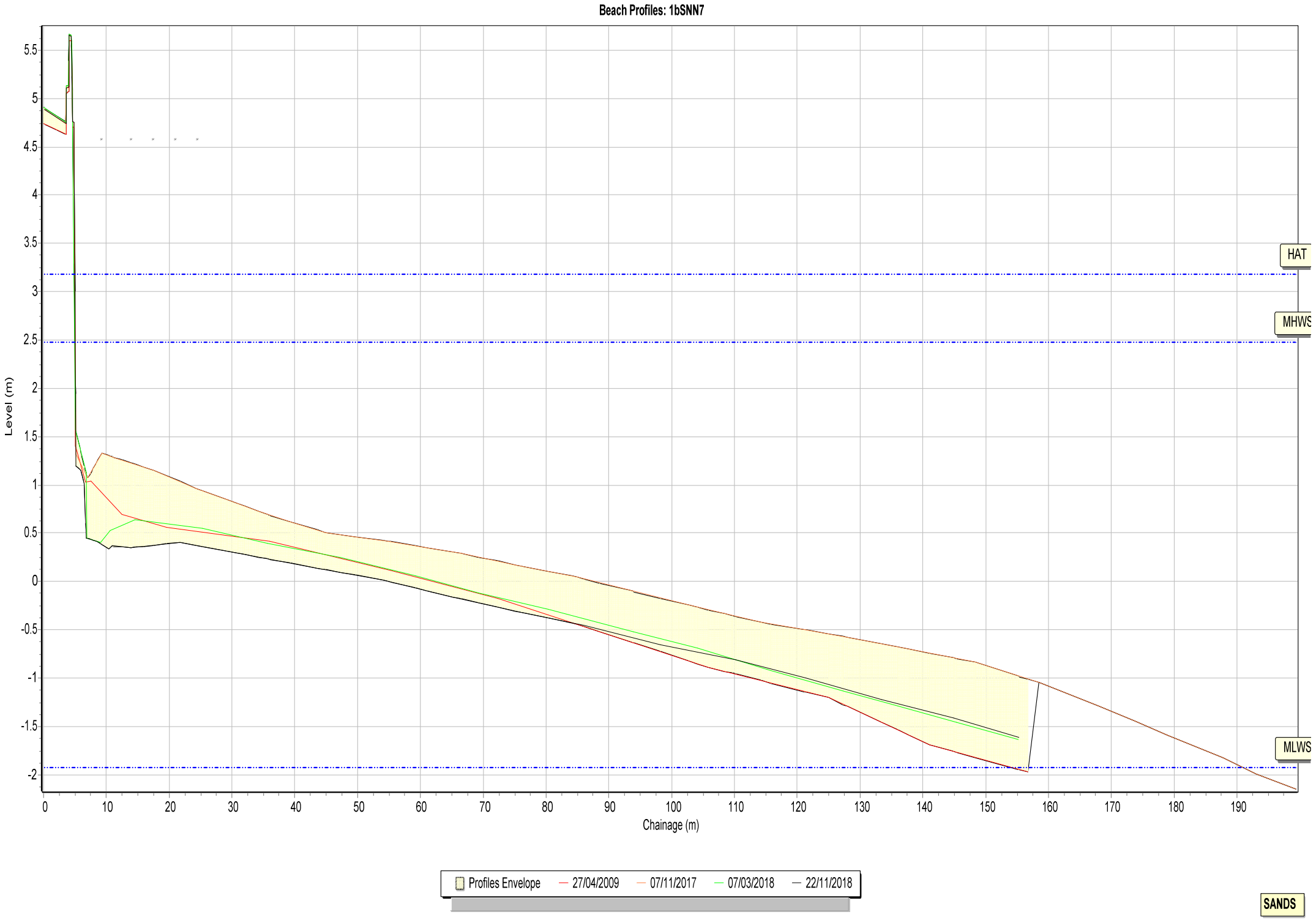
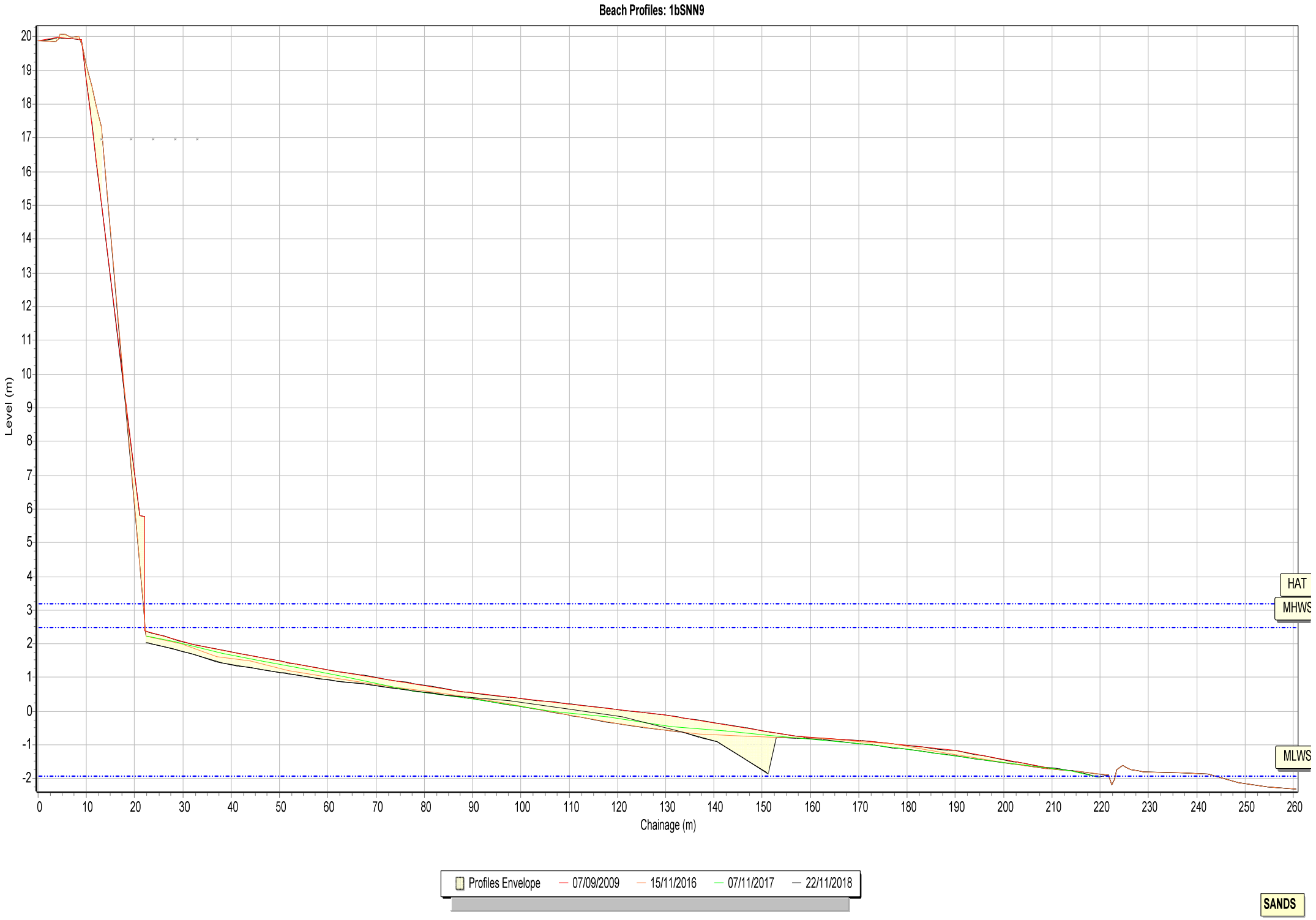
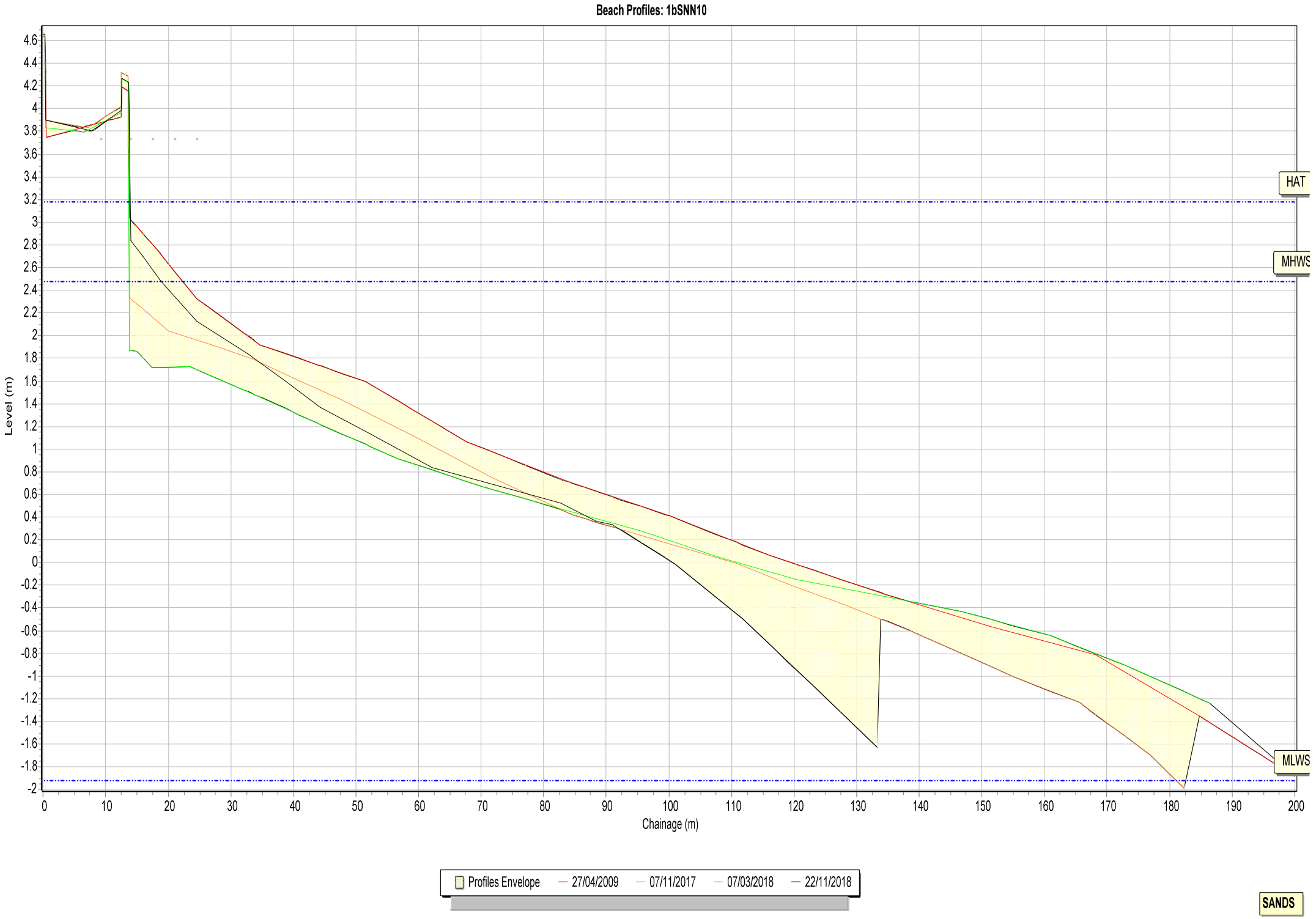
MHWS
MLWS
Profiles Envelope
07/09/2009
15/11/2016
07/11/2017
22/11/2018
SANDS

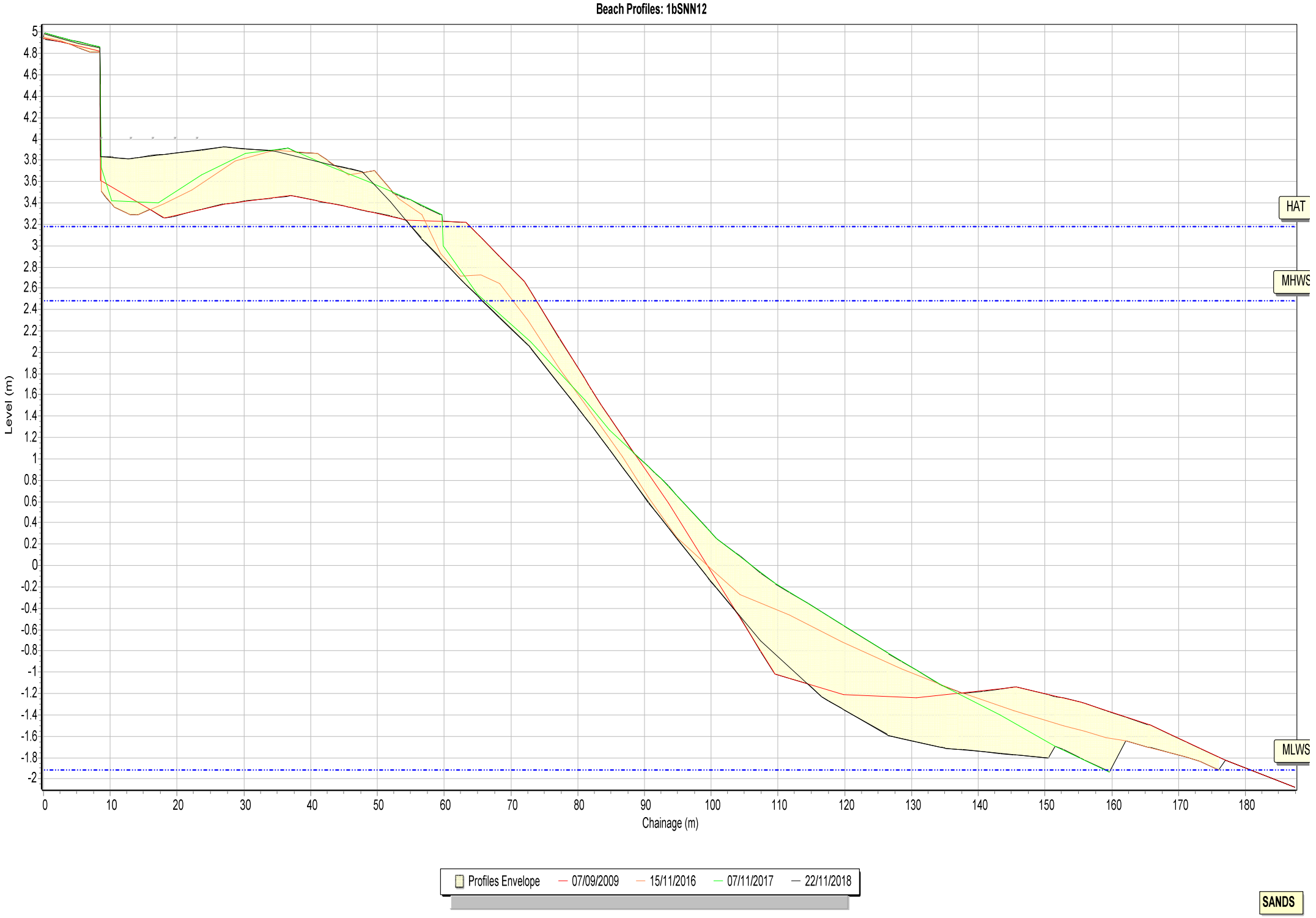

Beach Profiles: 1bSNN7
Level (m)
Chainage (m)
HAT
MHWS
MLWS
Profiles Envelope
27/04/2009
07/11/2017
07/03/2018
22/11/2018
SANDS

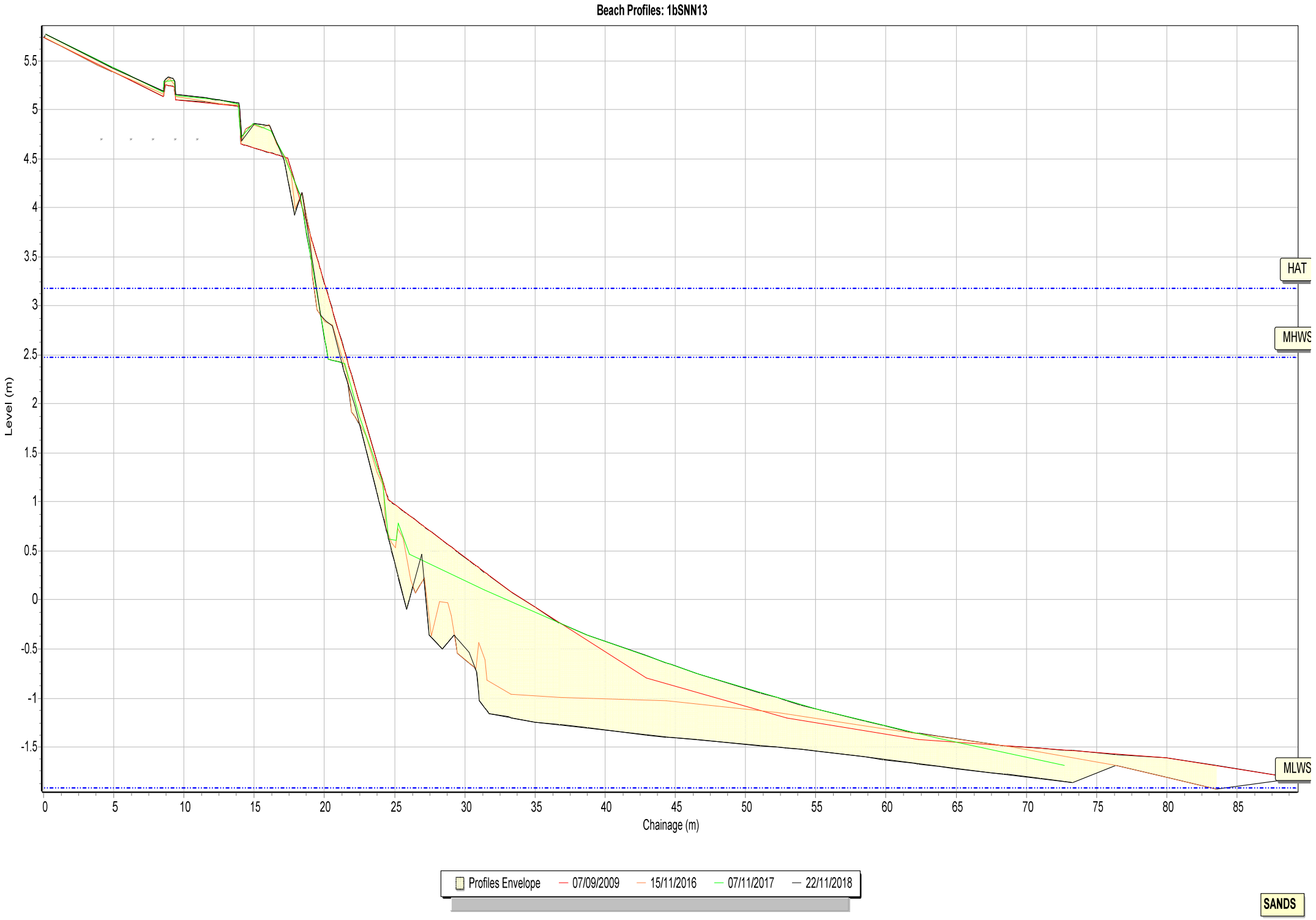

Beach Profiles: 1bSNN8
Level (m)
Chainage (m)
HAT
MHWS
MLWS
Profiles Envelope
07/09/2009
15/11/2016
07/11/2017
22/11/2018
SANDS

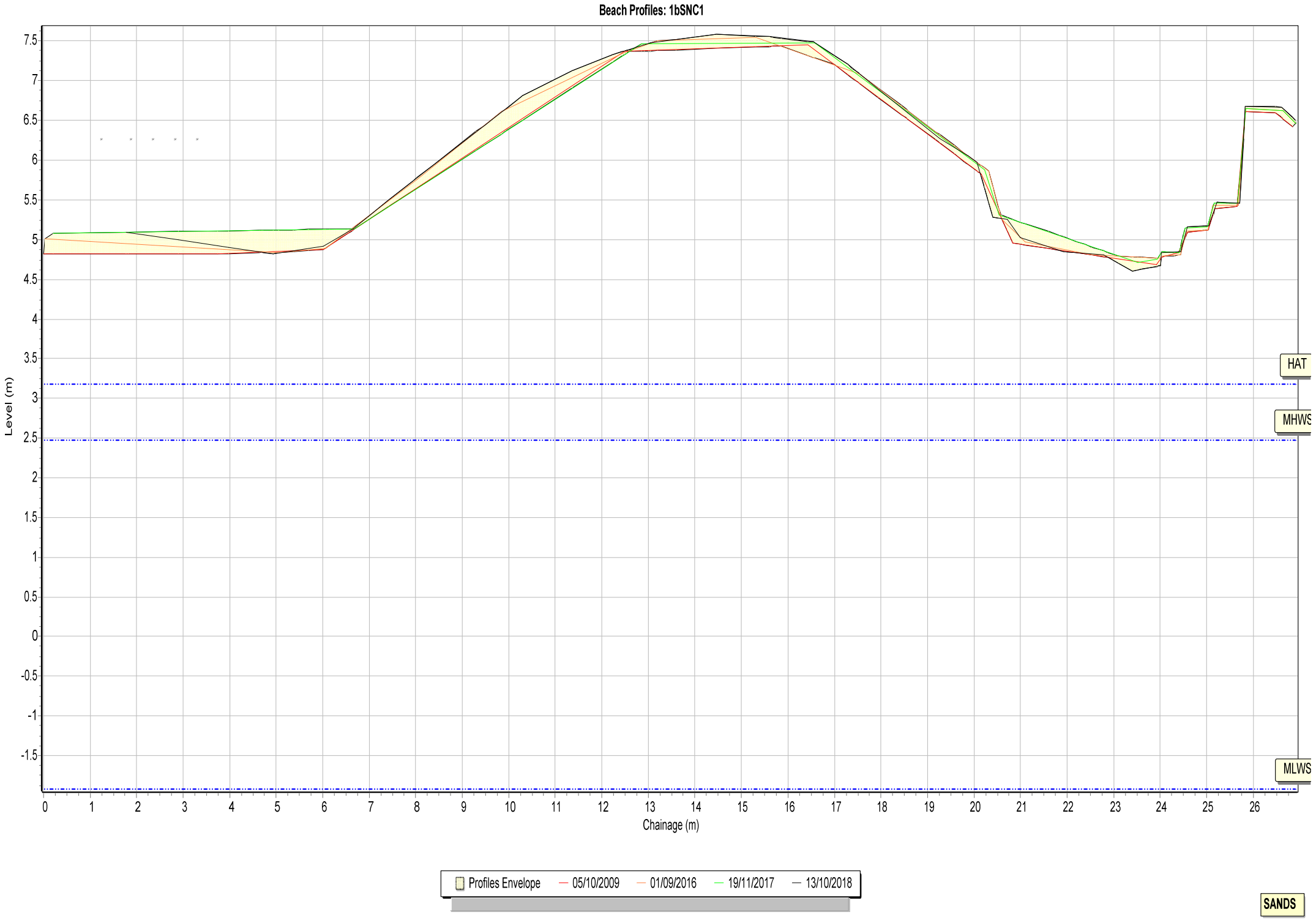

Beach Profiles: 1bSNN9
Level (m)
Chainage (m)
HAT
MHWS
MLWS
Profiles Envelope
07/09/2009
15/11/2016
07/11/2017
22/11/2018
SANDS

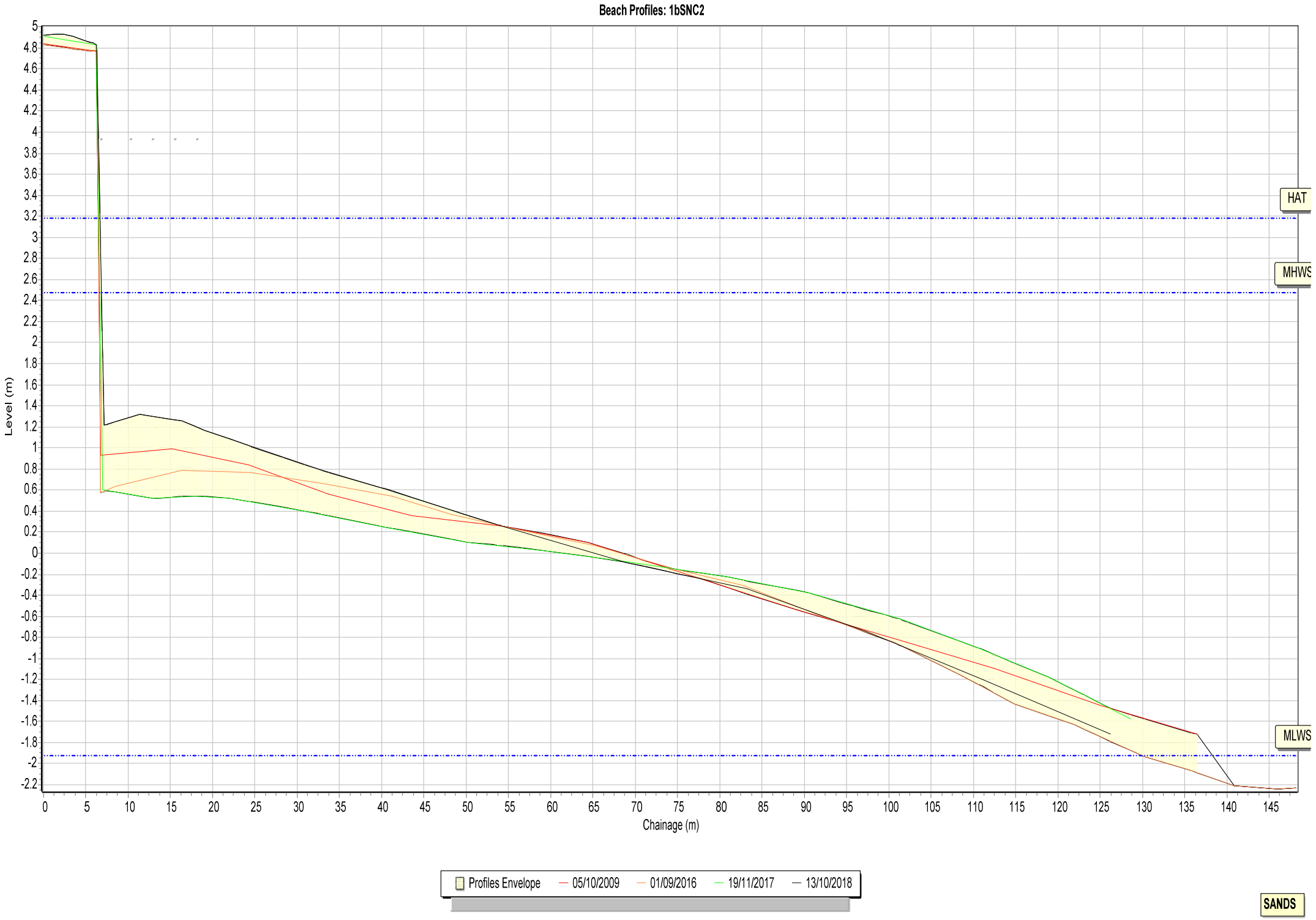

Beach Profiles: 1bSNN10
Level (m)
Chainage (m)
HAT
MHWS
MLWS
Profiles Envelope
27/04/2009
07/11/2017
07/03/2018
22/11/2018
SANDS


Beach Profiles: 1bSNN11
Level (m)
Chainage (m)
HAT
MHWS
MLWS
Profiles Envelope
07/09/2009
15/11/2016
07/11/2017
22/11/2018
SANDS


Beach Profiles: 1bSNN12
Level (m)
Chainage (m)
HAT
MHWS
MLWS
Profiles Envelope
07/09/2009
15/11/2016
07/11/2017
22/11/2018
SANDS


Beach Profiles: 1bSNN13
Level (m)
Chainage (m)
HAT
MHWS
MLWS
Profiles Envelope
07/09/2009
15/11/2016
07/11/2017
22/11/2018
SANDS


Beach Profiles: 1bSNC1
Level (m)
Chainage (m)
HAT
MHWS
MLWS
Profiles Envelope
05/10/2009
01/09/2016
19/11/2017
13/10/2018
SANDS


Beach Profiles: 1bSNC2
Level (m)
Chainage (m)
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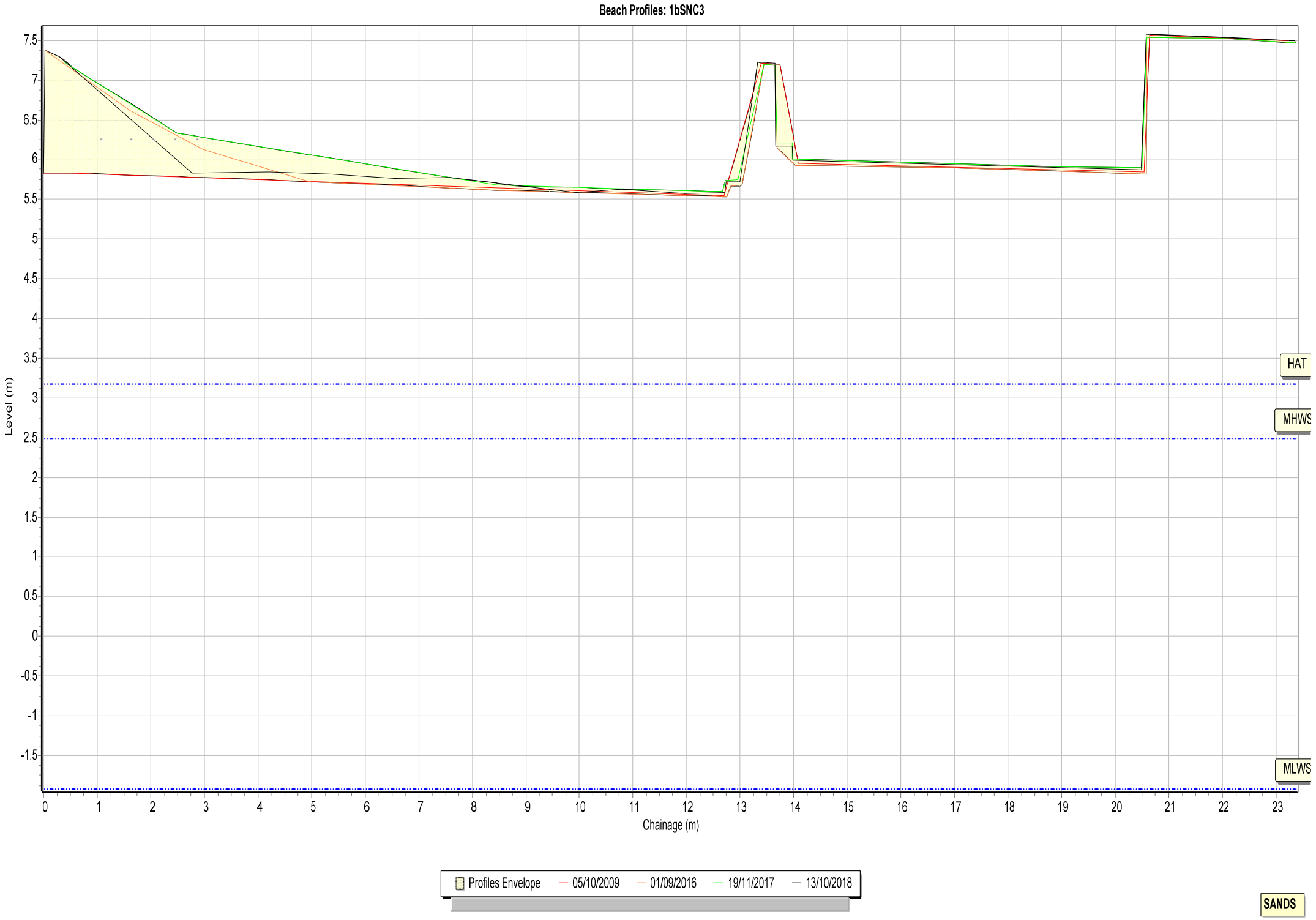
MHWS
MLWS
Profiles Envelope
05/10/2009
01/09/2016
19/11/2017
13/10/2018
SANDS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2
1.5
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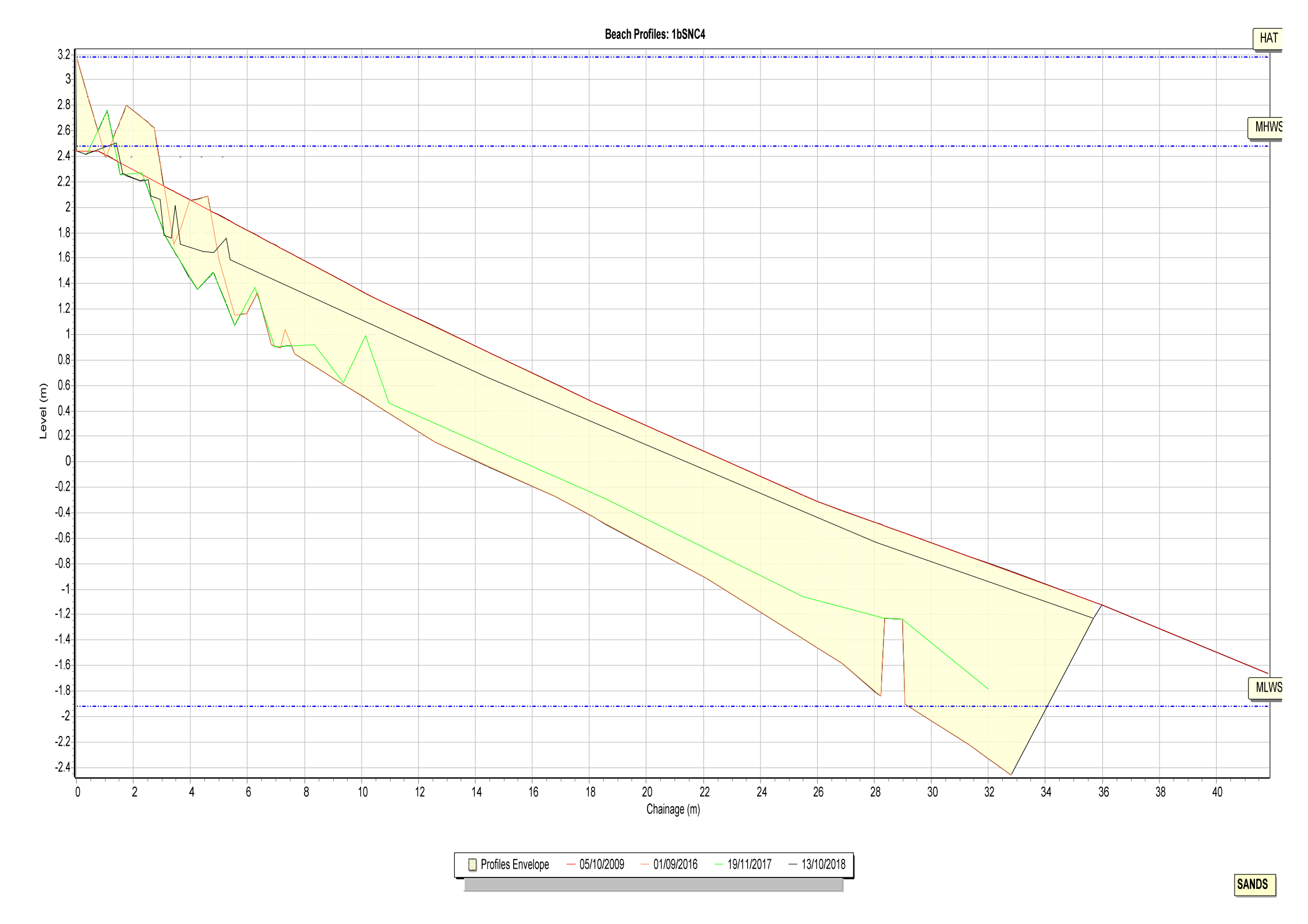
0.5
0
-0.5
-1
-1.5
HAT
MHWS
MLWS
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
Chainage (m)
Profiles Envelope
05/10/2009
01/09/2016
19/11/2017
13/10/2018
SANDS


Beach Profiles: 1bSNC4
HAT
MHWS
MLWS
SANDS
Level (m)
Chainage (m)
3.2
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2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
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-1.6
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-2
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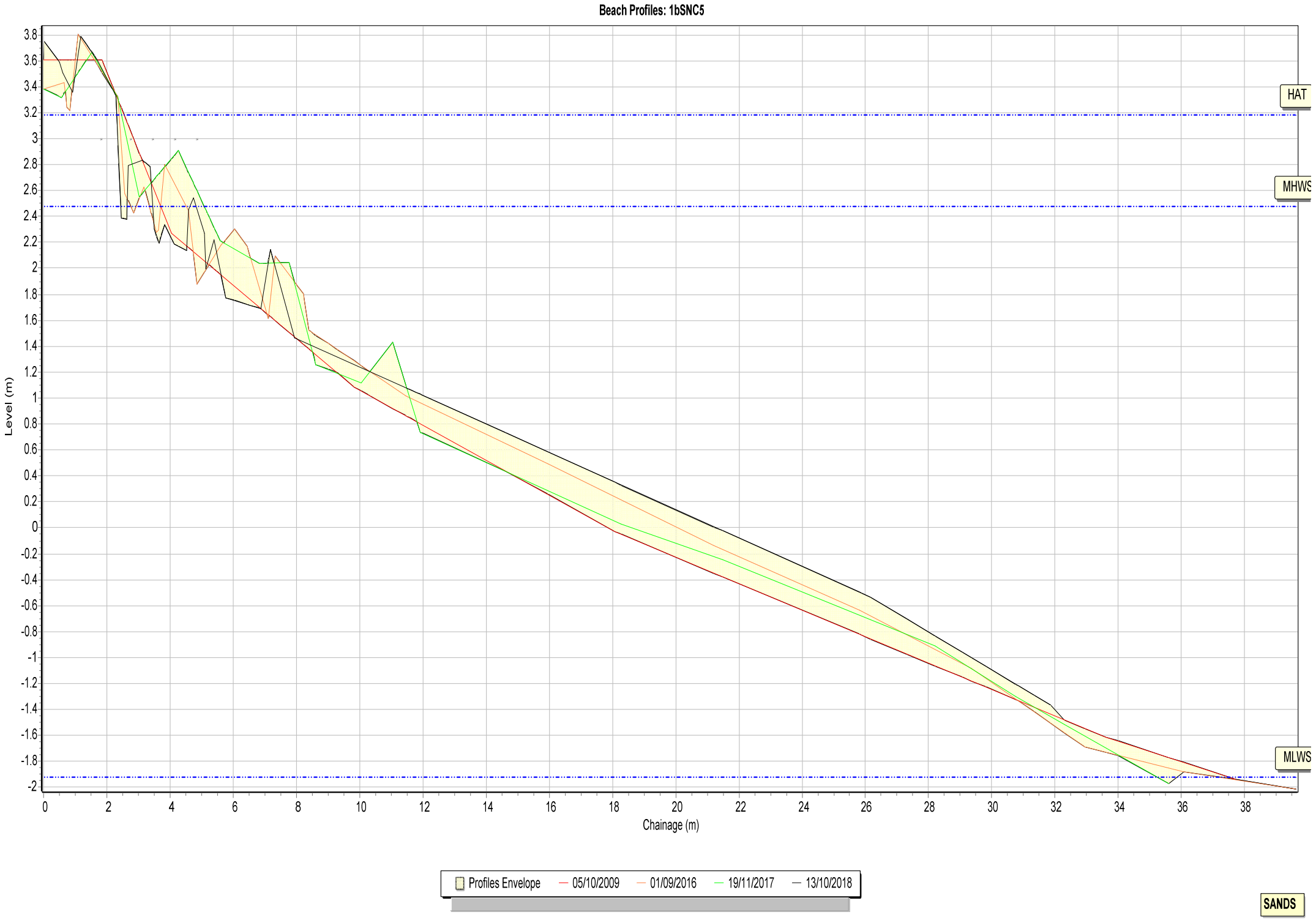
Profiles Envelope
05/10/2009
01/09/2016
19/11/2017
13/10/2018


Beach Profiles: 1bSNC5
Level (m)
Chainage (m)
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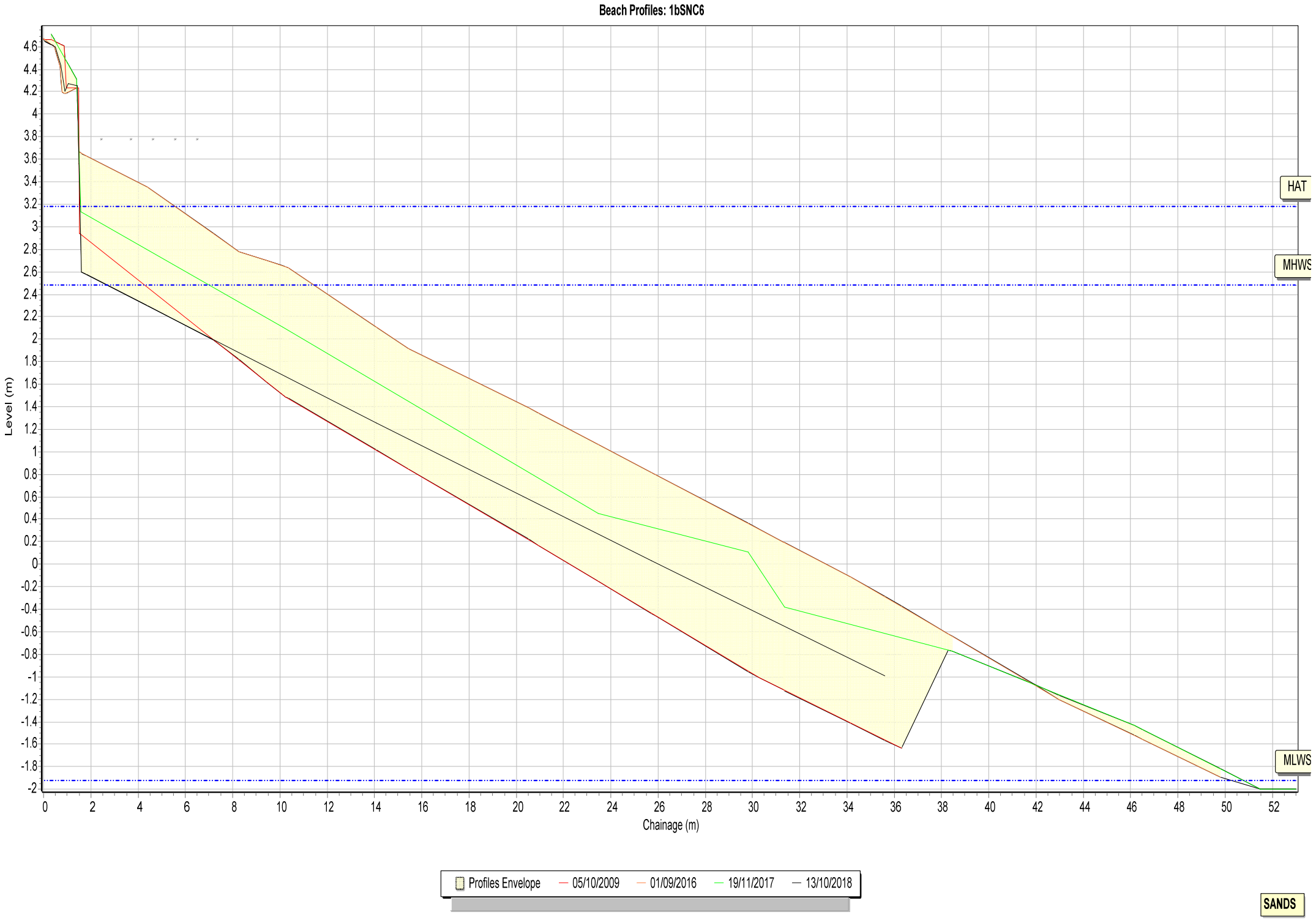
MHWS
MLWS
Profiles Envelope
05/10/2009
01/09/2016
19/11/2017
13/10/2018
SANDS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Chainage (m)
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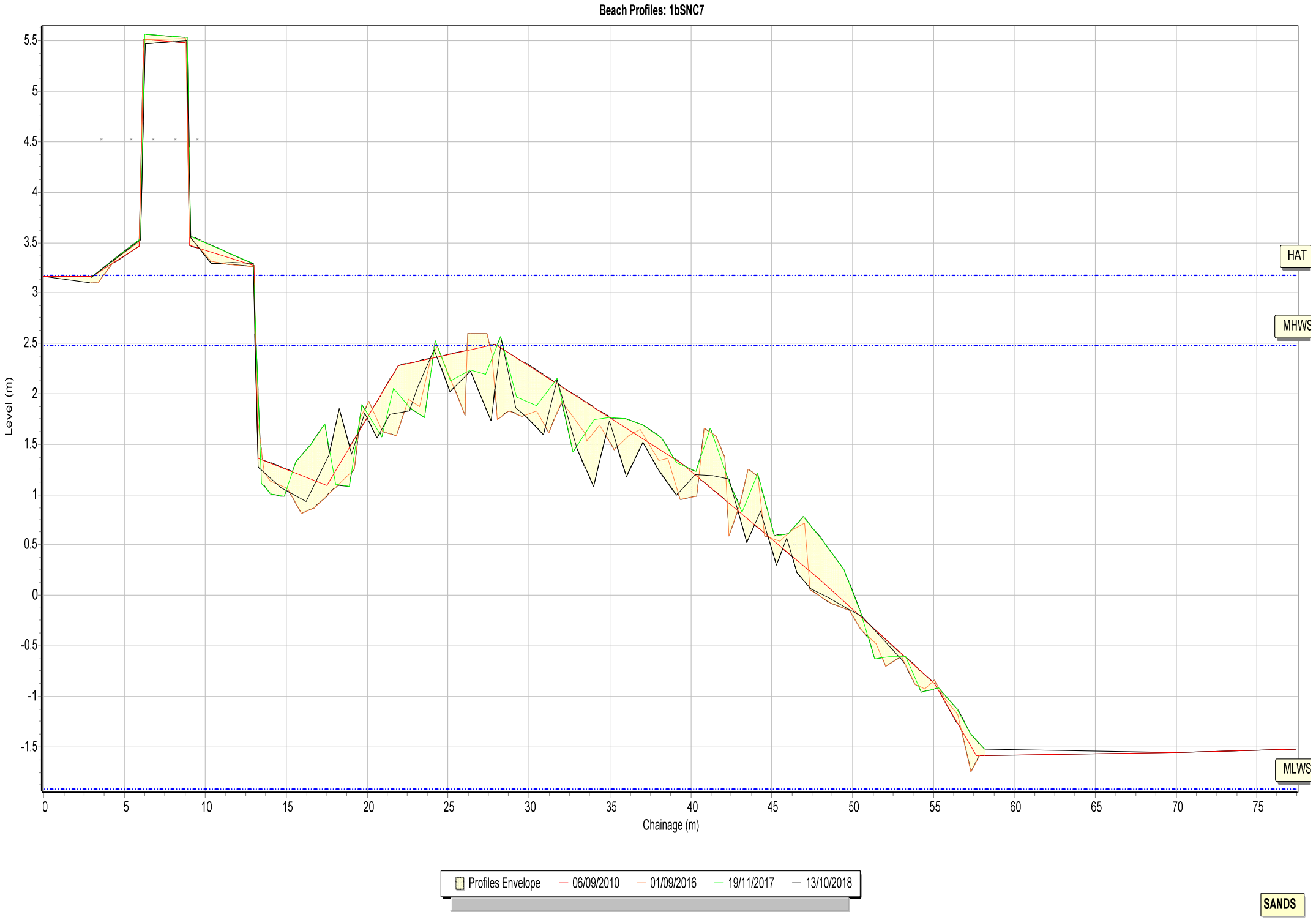
MHWS
MLWS
Profiles Envelope
05/10/2009
01/09/2016
19/11/2017
13/10/2018
SANDS


Beach Profiles: 1bSNC7
Level (m)
Chainage (m)
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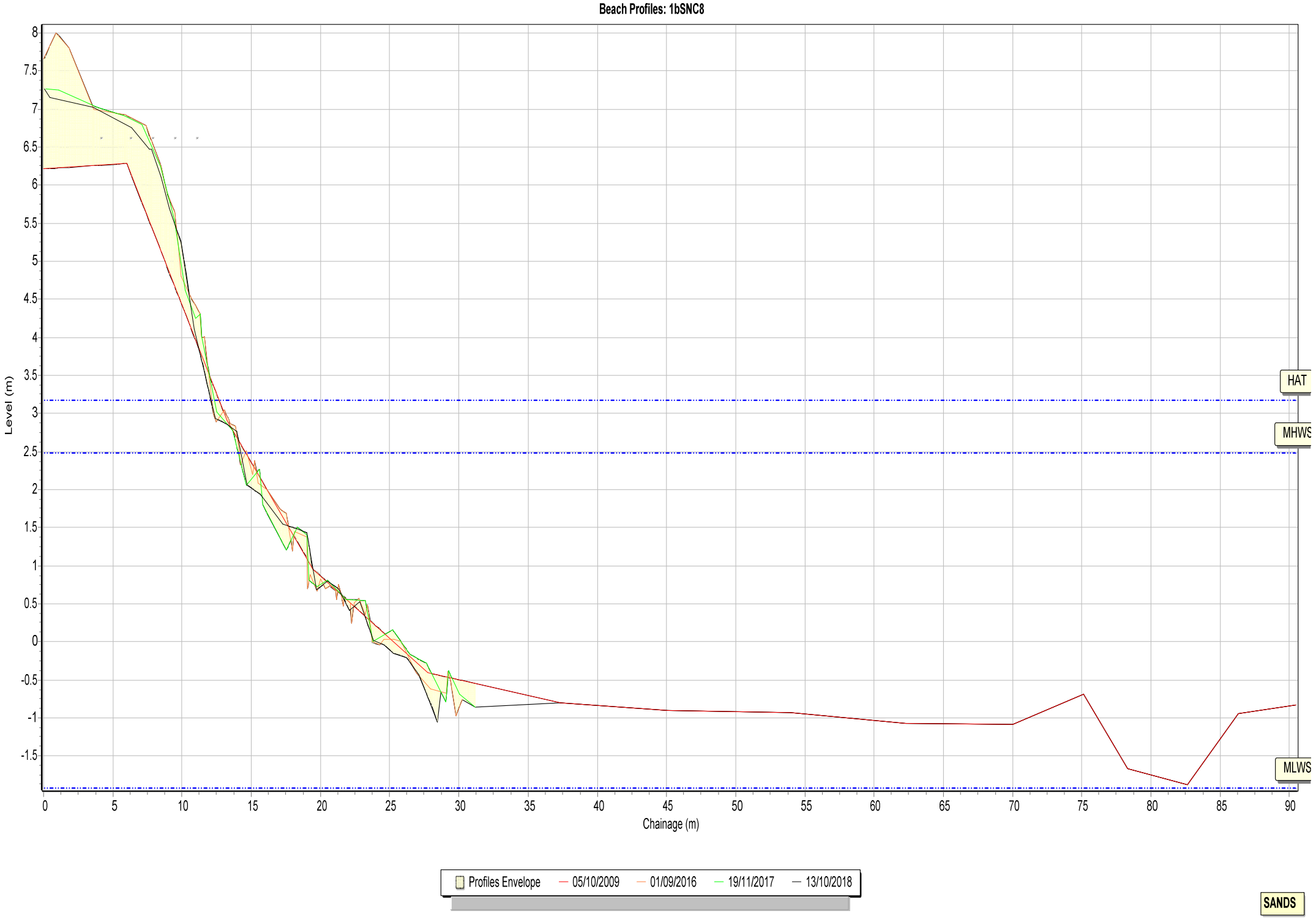
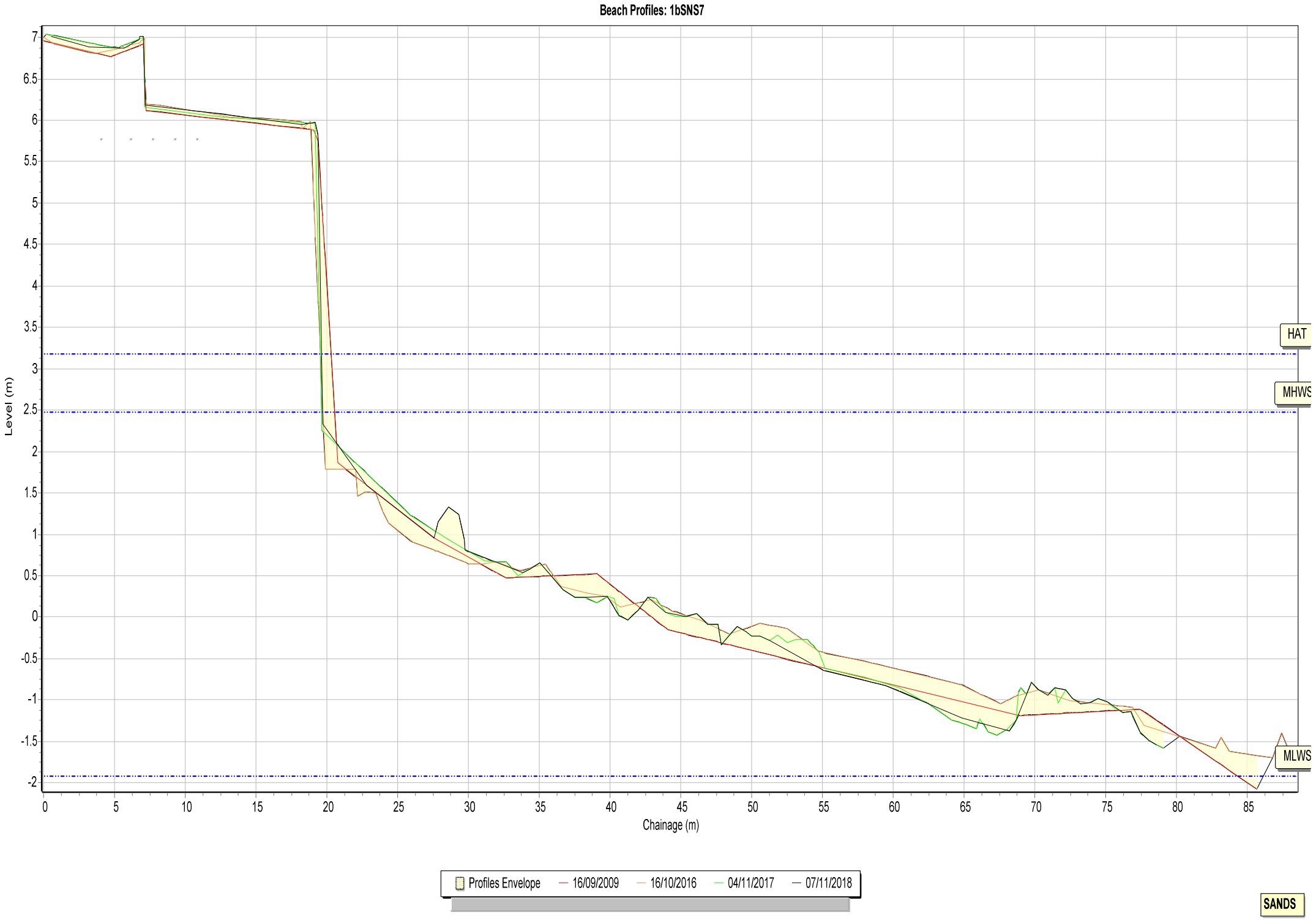
MHWS
MLWS
Profiles Envelope
06/09/2010
01/09/2016
19/11/2017
13/10/2018
SANDS


Beach Profiles: 1bSNC8
Level (m)
Chainage (m)
HAT
MHWS
MLWS
Profiles Envelope
05/10/2009
01/09/2016
19/11/2017
13/10/2018
SANDS


Beach Profiles: 1bSNC9
Level (m)
Chainage (m)
HAT
MHWS
MLWS
Profiles Envelope
05/10/2009
01/09/2016
19/11/2017
13/10/2018
SANDS


Beach Profiles: 1bSNS7
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Chainage (m)
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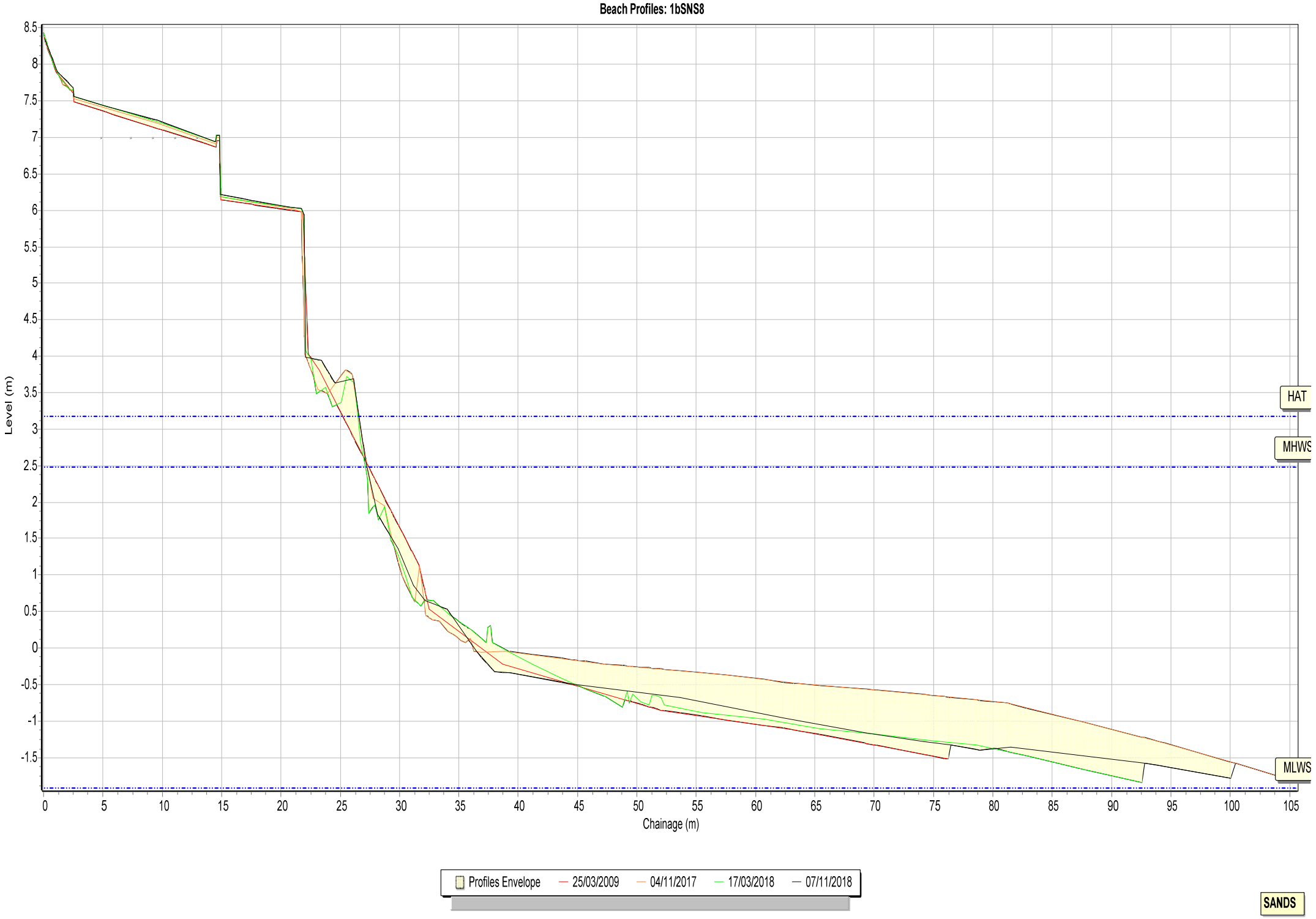
MHWS
MLWS
Profiles Envelope
16/09/2009
16/10/2016
04/11/2017
07/11/2018
SANDS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6.5
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5.5
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4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
HAT
MHWS
MLWS
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15
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35
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45
50
55
60
65
70
75
80
85
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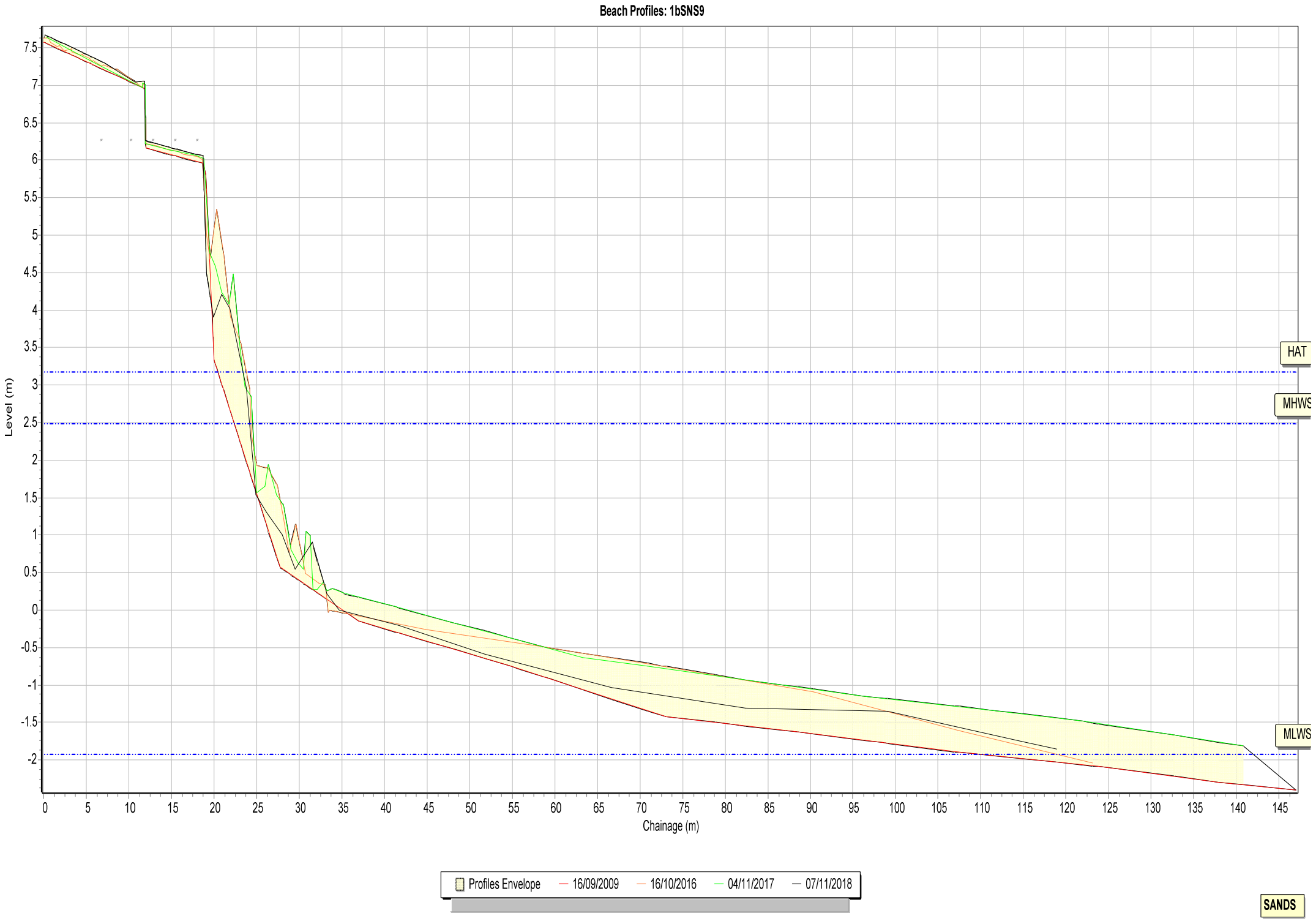
105
Chainage (m)
Profiles Envelope
25/03/2009
04/11/2017
17/03/2018
07/11/2018
SANDS


Beach Profiles: 1bSNS9
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Chainage (m)
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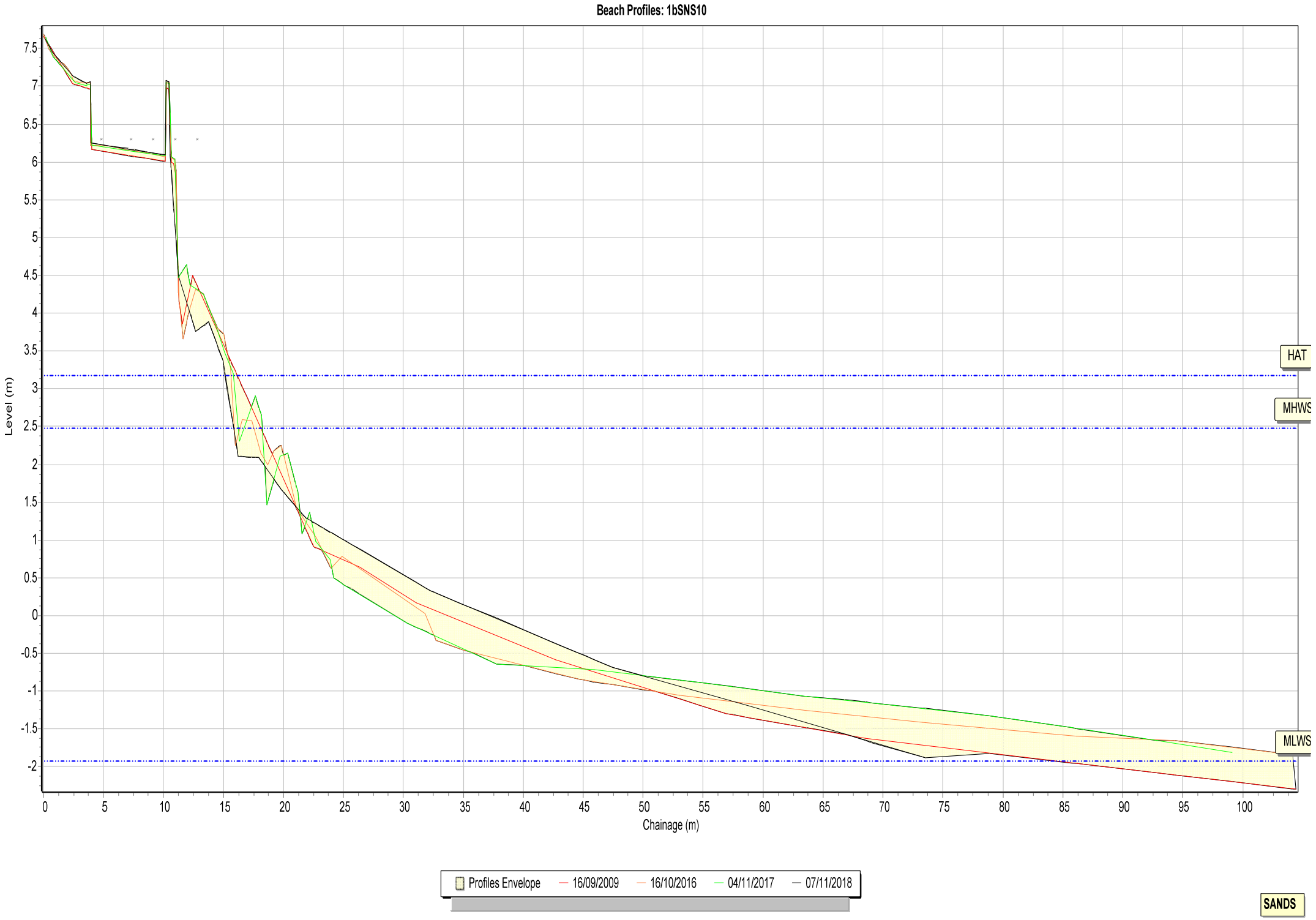
MHWS
MLWS
Profiles Envelope
16/09/2009
16/10/2016
04/11/2017
07/11/2018
SANDS


Beach Profiles: 1bSNS10
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Chainage (m)
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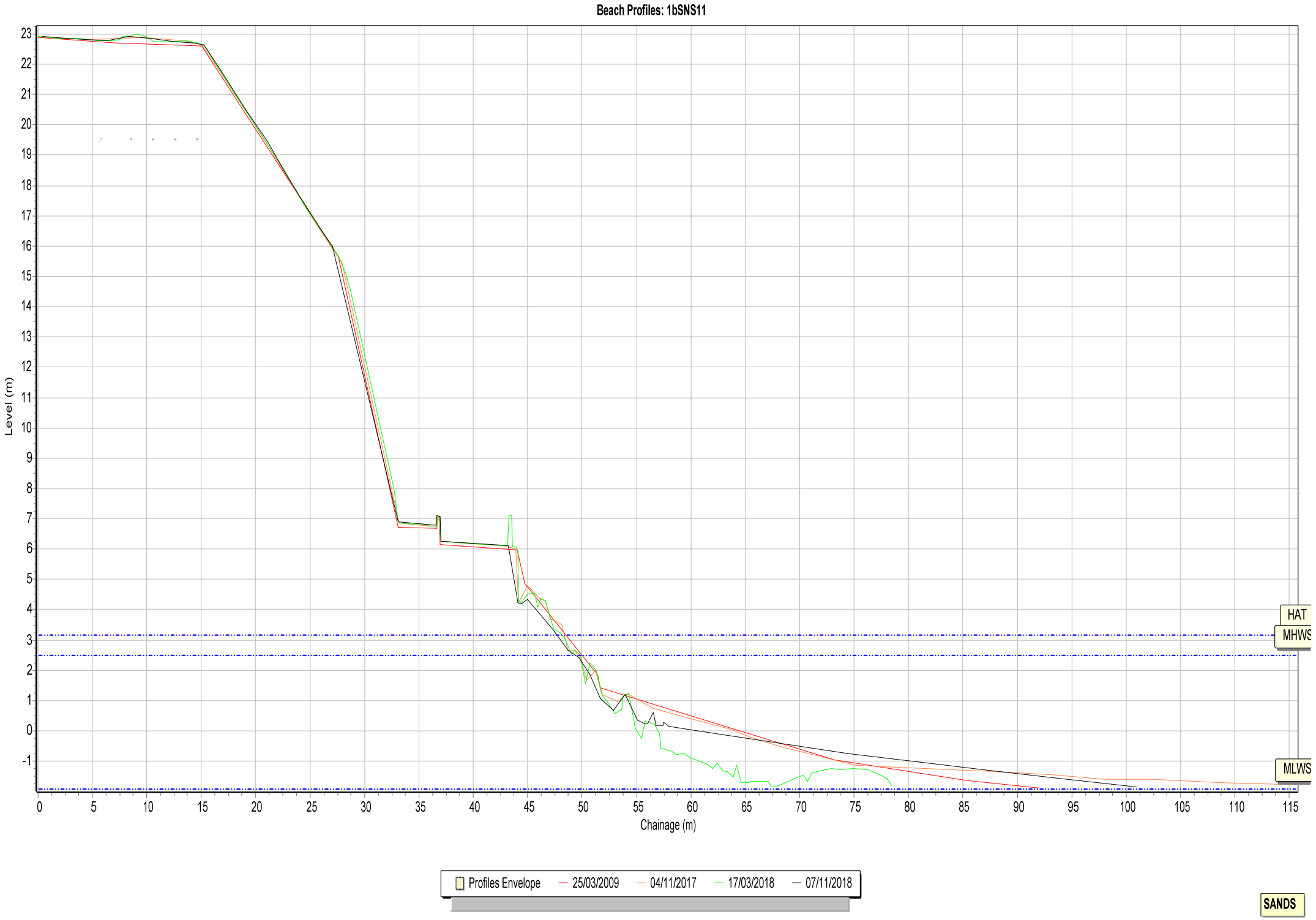
MHWS
MLWS
Profiles Envelope
16/09/2009
16/10/2016
04/11/2017
07/11/2018
SANDS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Chainage (m)
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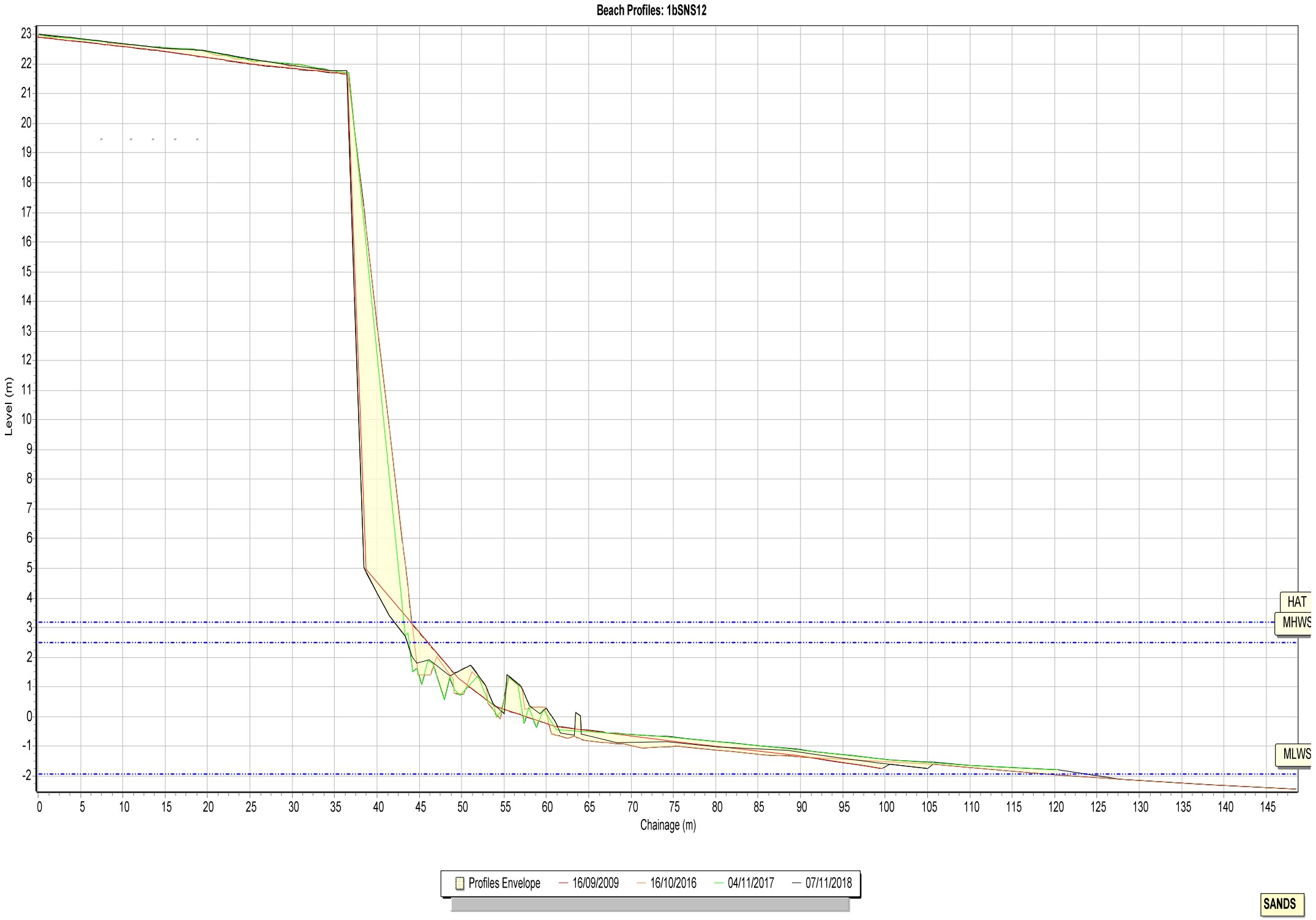
MHWS
MLWS
Profiles Envelope
25/03/2009
04/11/2017
17/03/2018
07/11/2018
SANDS


Beach Profiles: 1bSNS12
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Chainage (m)
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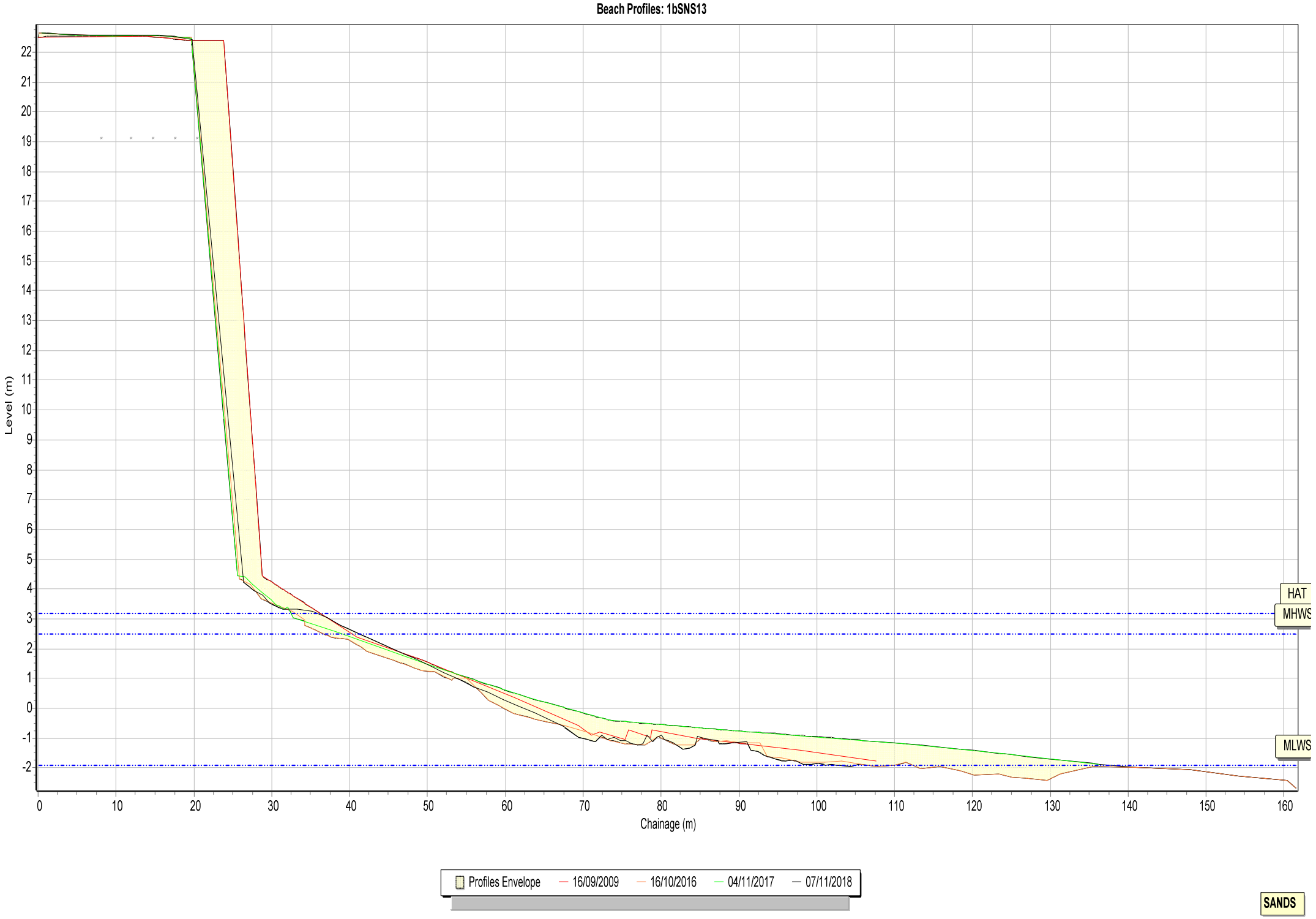
MLWS
Profiles Envelope
16/09/2009
16/10/2016
04/11/2017
07/11/2018
SANDS


Beach Profiles: 1bSNS13
Level (m)
Chainage (m)
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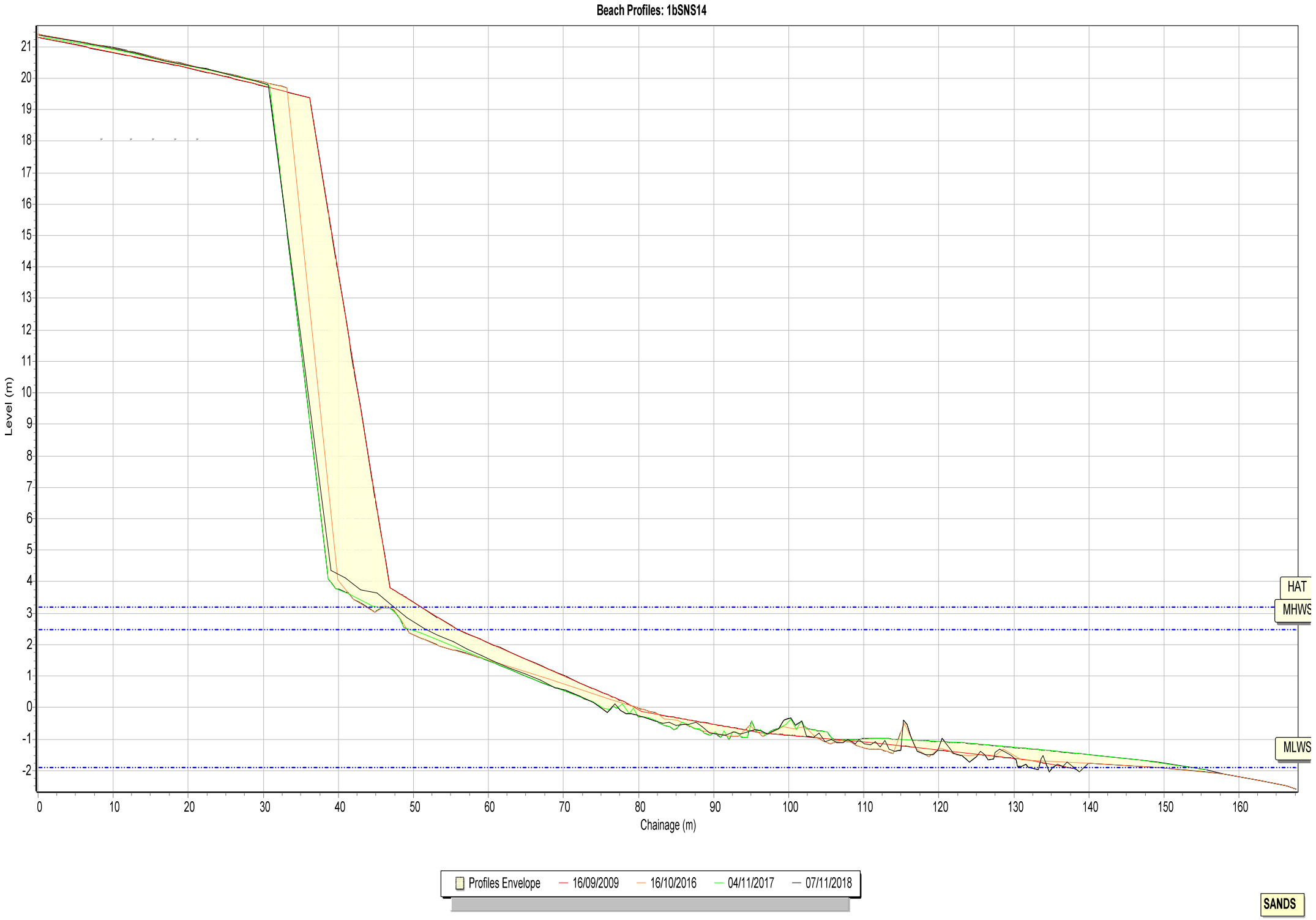
MLWS
Profiles Envelope
16/09/2009
16/10/2016
04/11/2017
07/11/2018
SANDS


Beach Profiles: 1bSNS14
Level (m)
Chainage (m)
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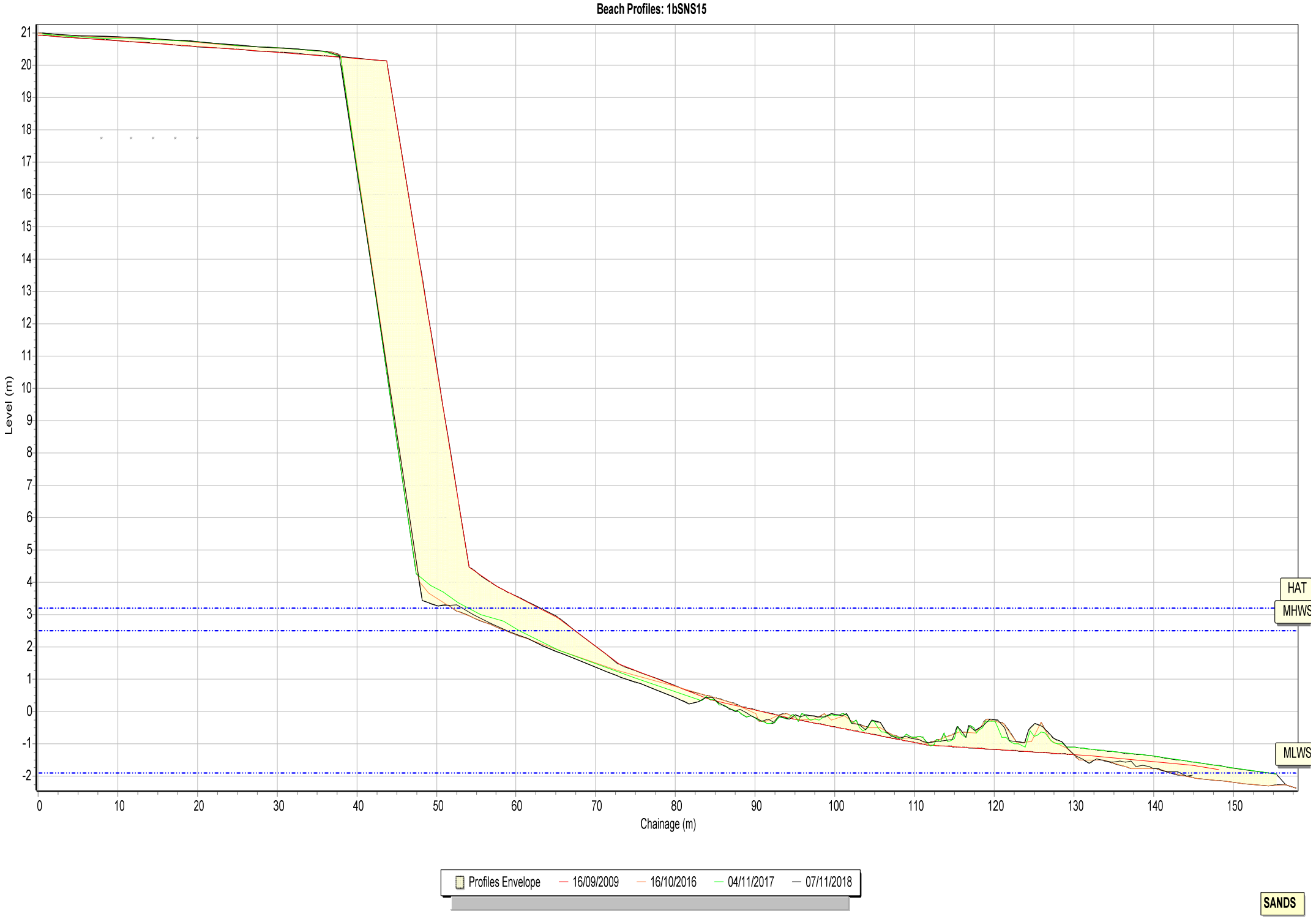
MHWS
MLWS
Profiles Envelope
16/09/2009
16/10/2016
04/11/2017
07/11/2018
SANDS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6
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-1
-2
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30
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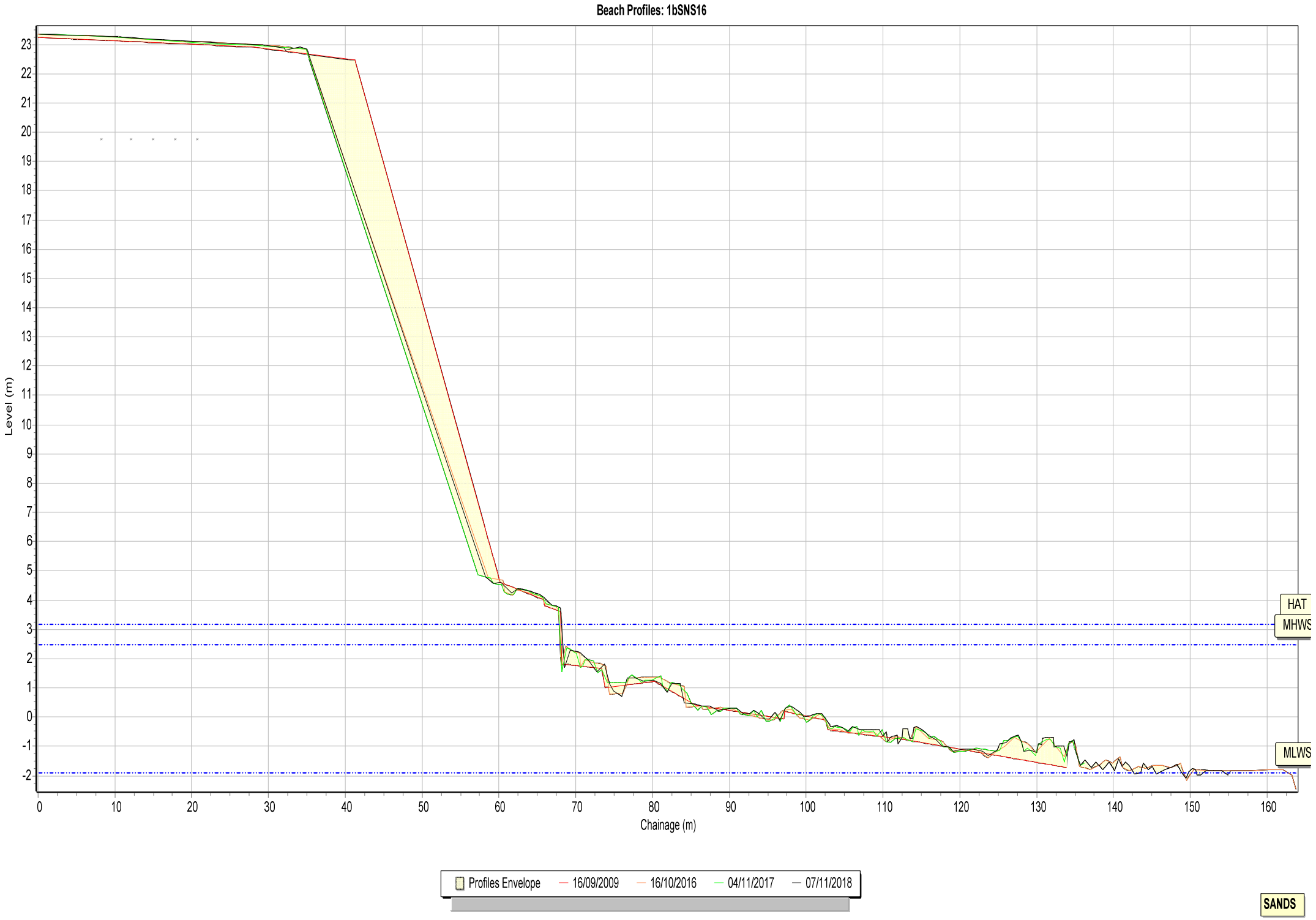
50
60
70
80
90
100
110
120
130
140
150
Chainage (m)
HAT
MHWS
MLWS
Profiles Envelope
16/09/2009
16/10/2016
04/11/2017
07/11/2018
SANDS


Beach Profiles: 1bSNS16
Level (m)
Chainage (m)
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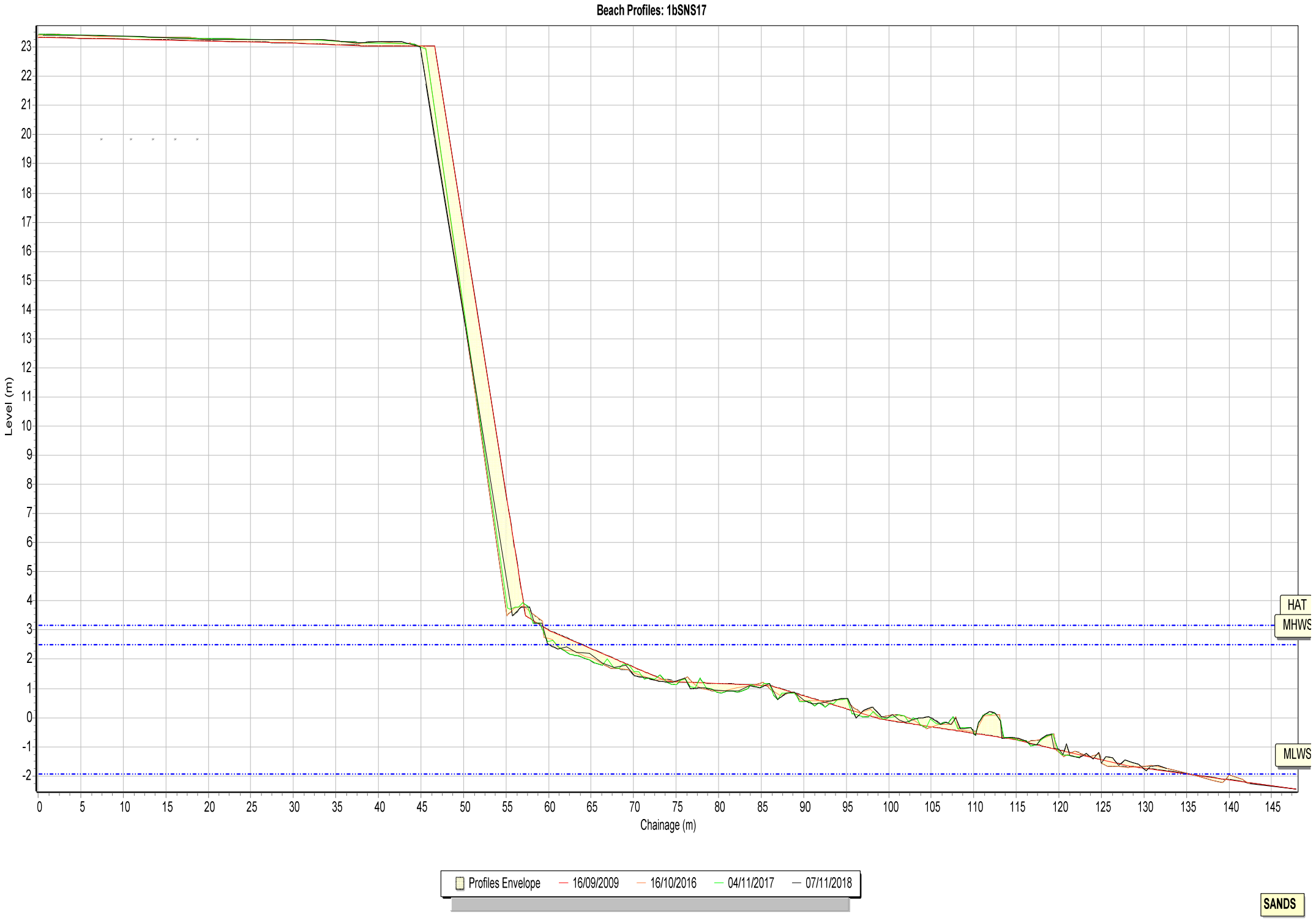
MHWS
MLWS
Profiles Envelope
16/09/2009
16/10/2016
04/11/2017
07/11/2018
SANDS


Beach Profiles: 1bSNS17
Level (m)
Chainage (m)
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MHWS
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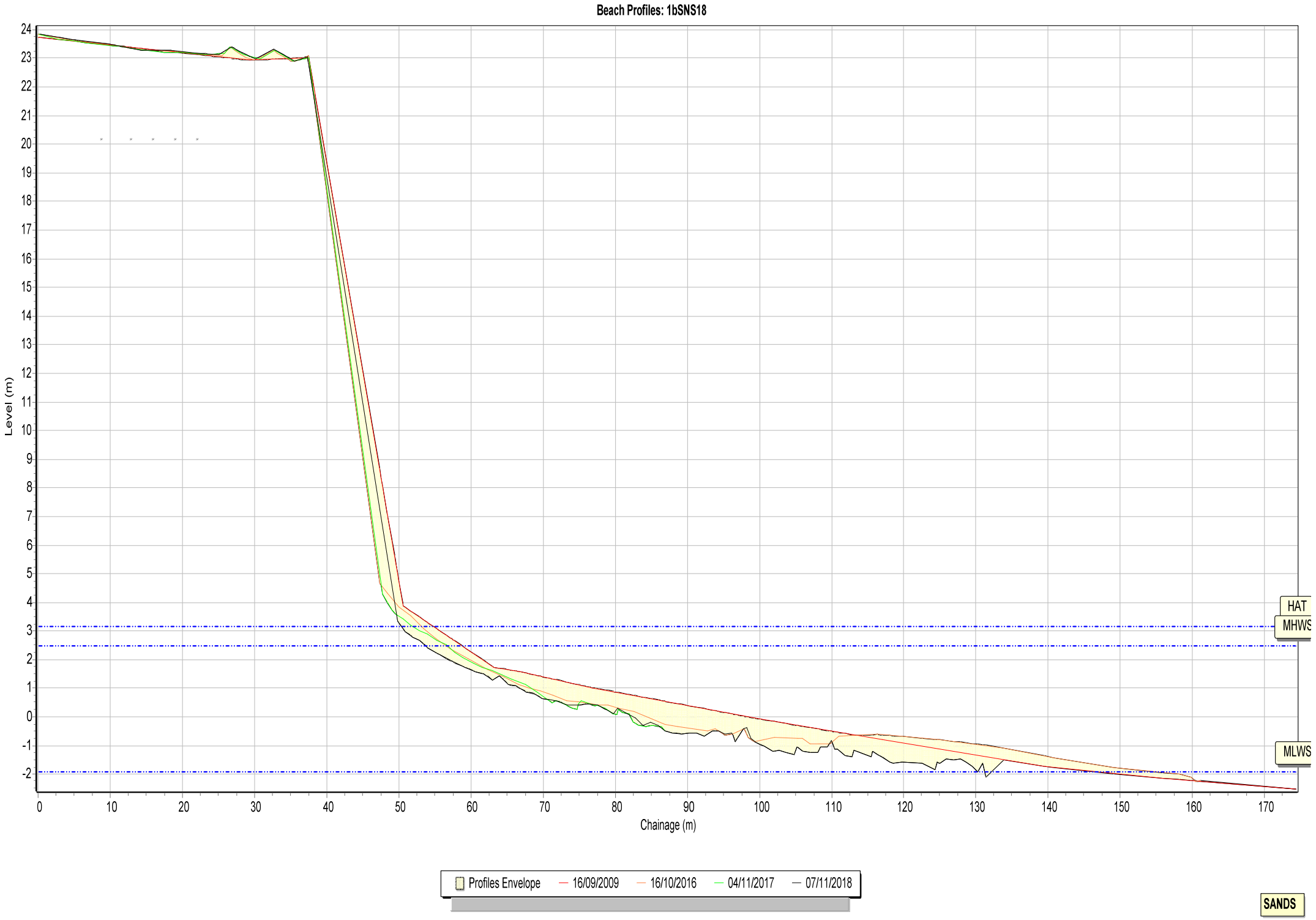
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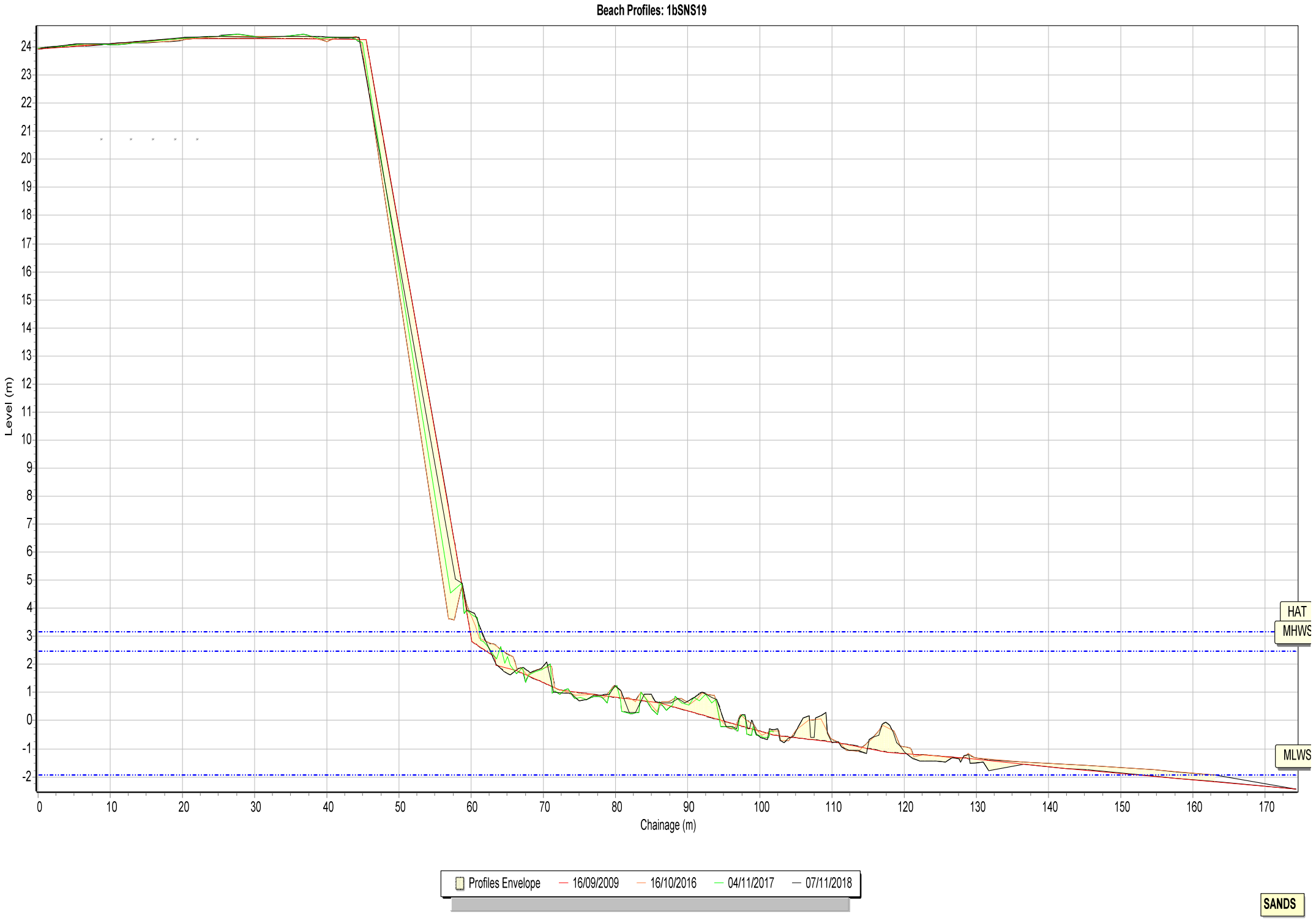
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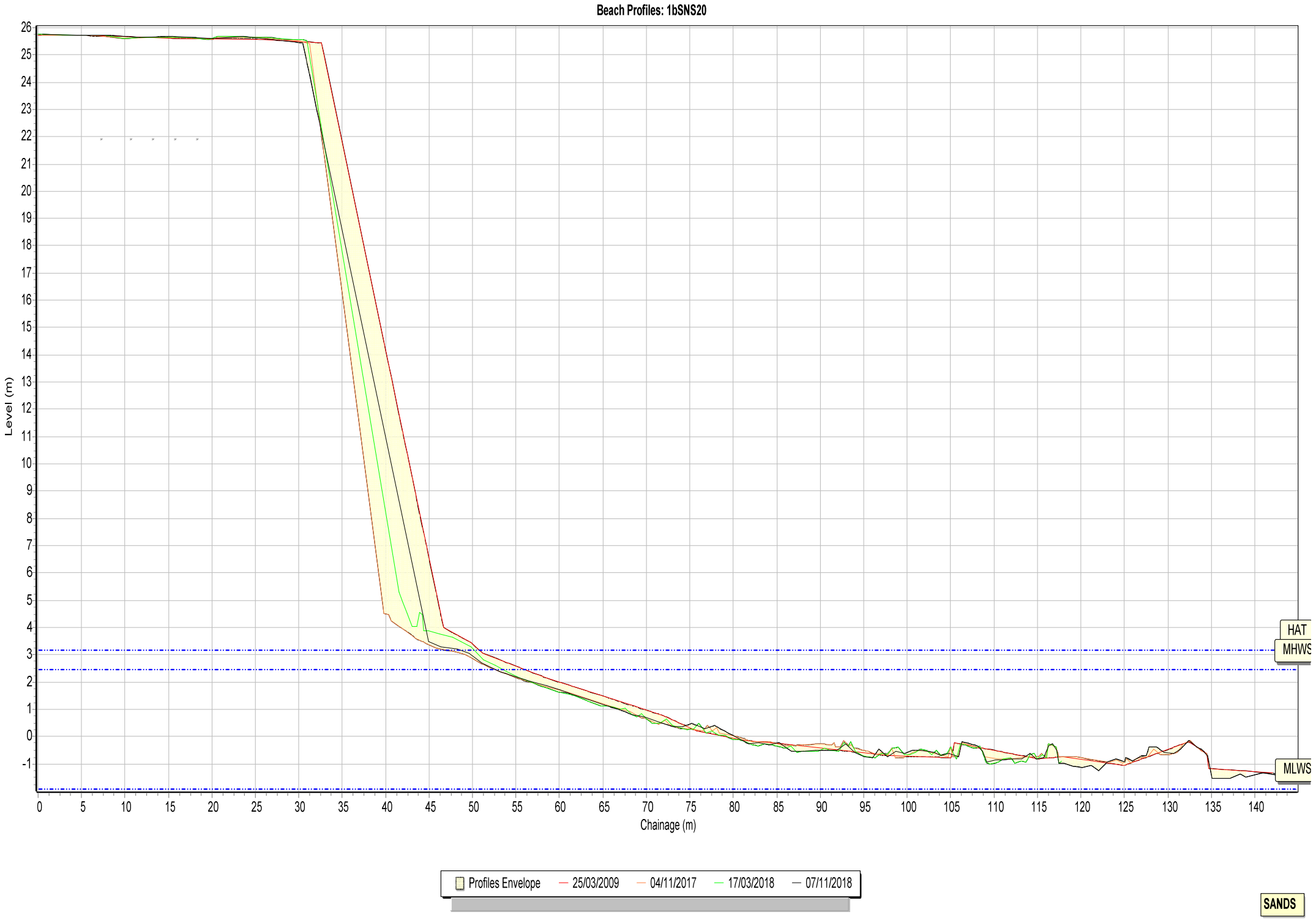
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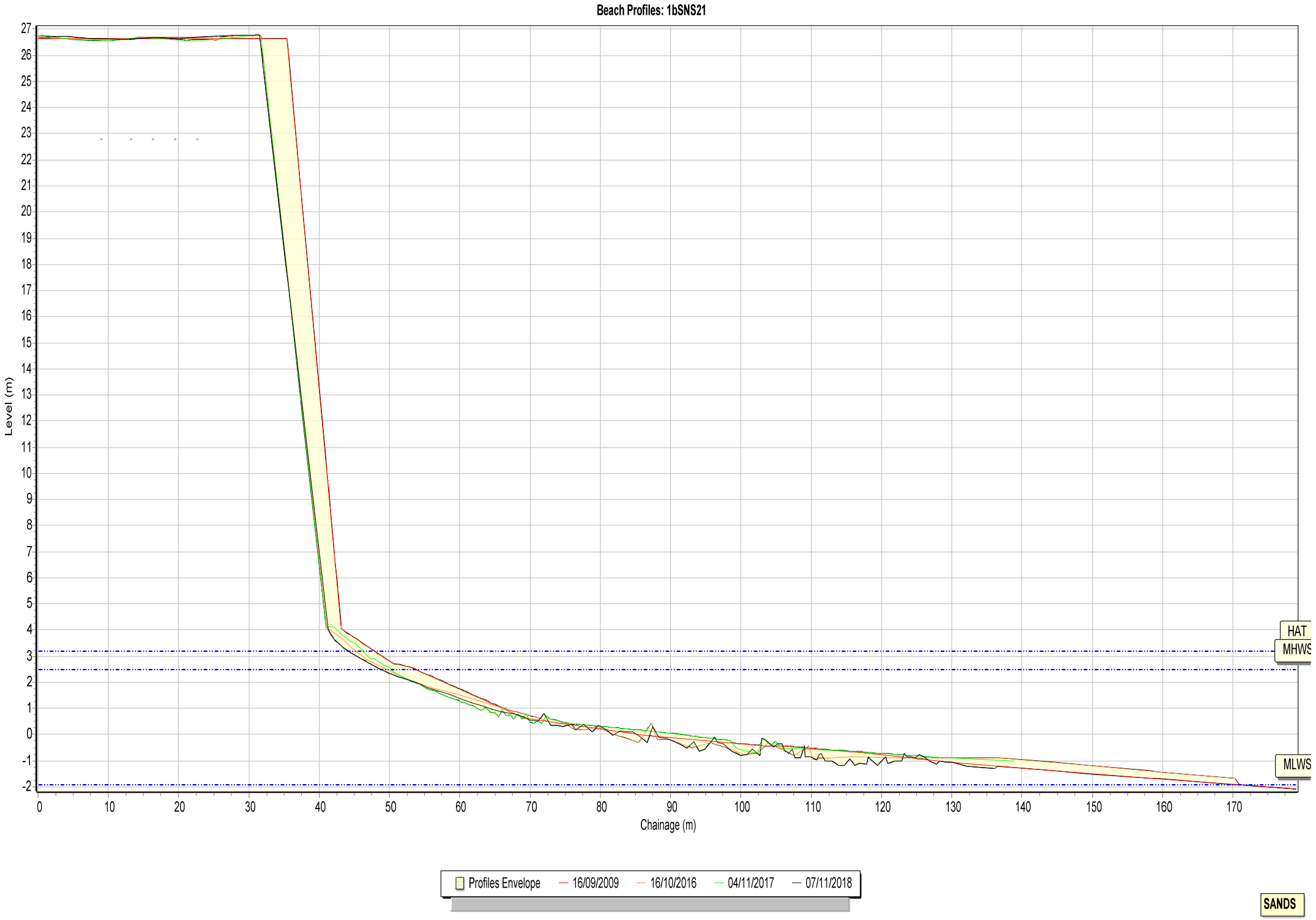
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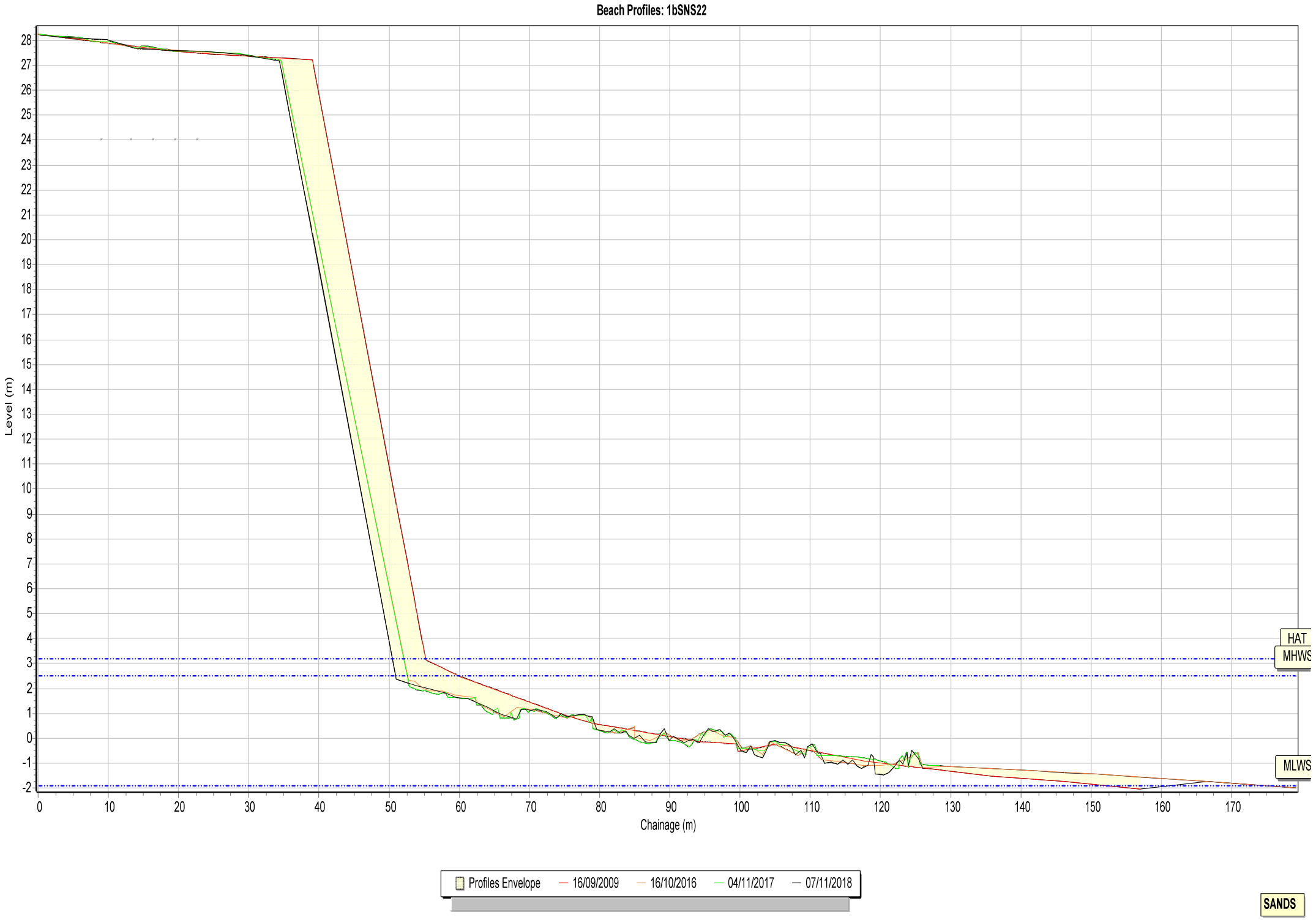
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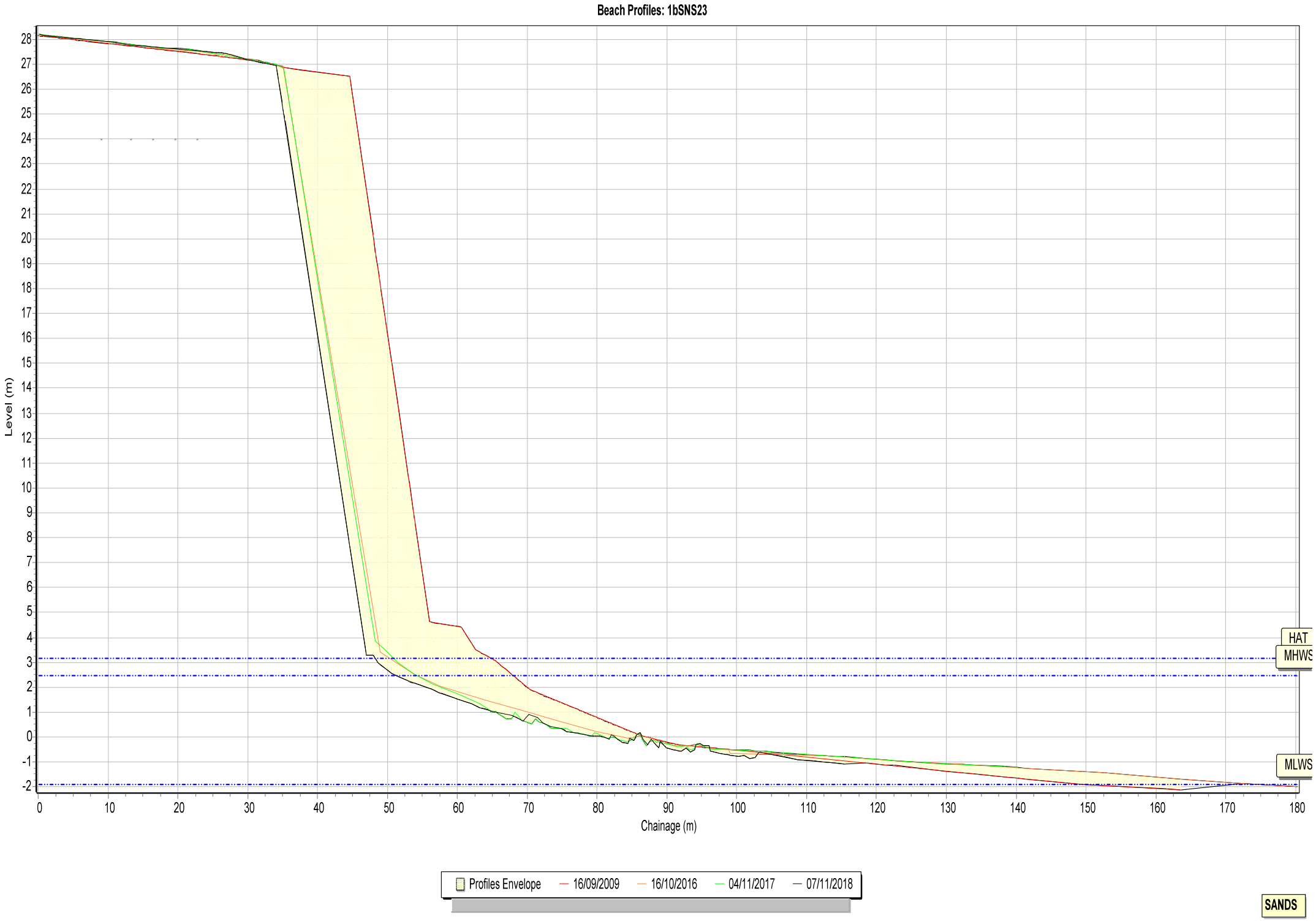
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04/11/2017
07/11/2018
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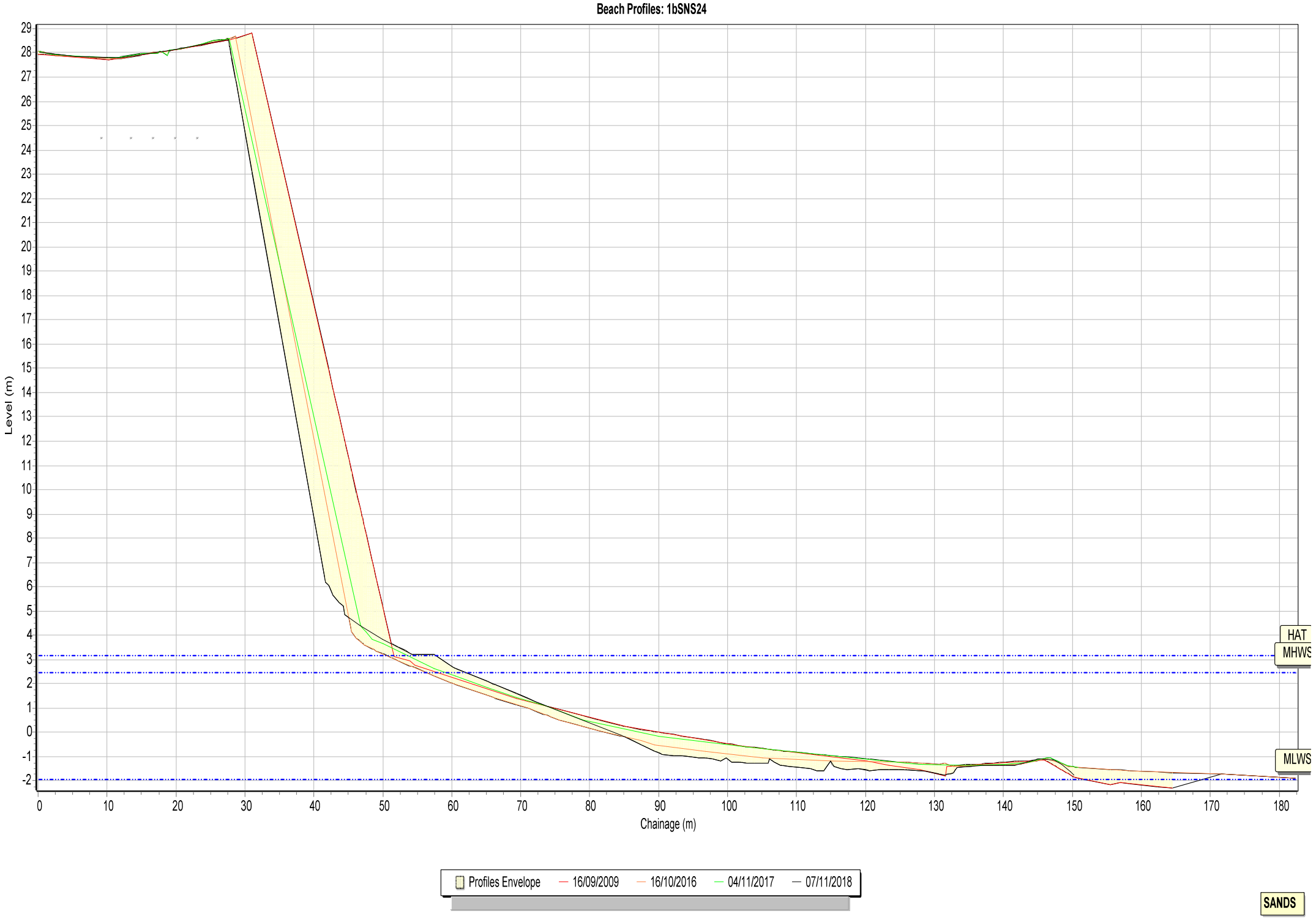
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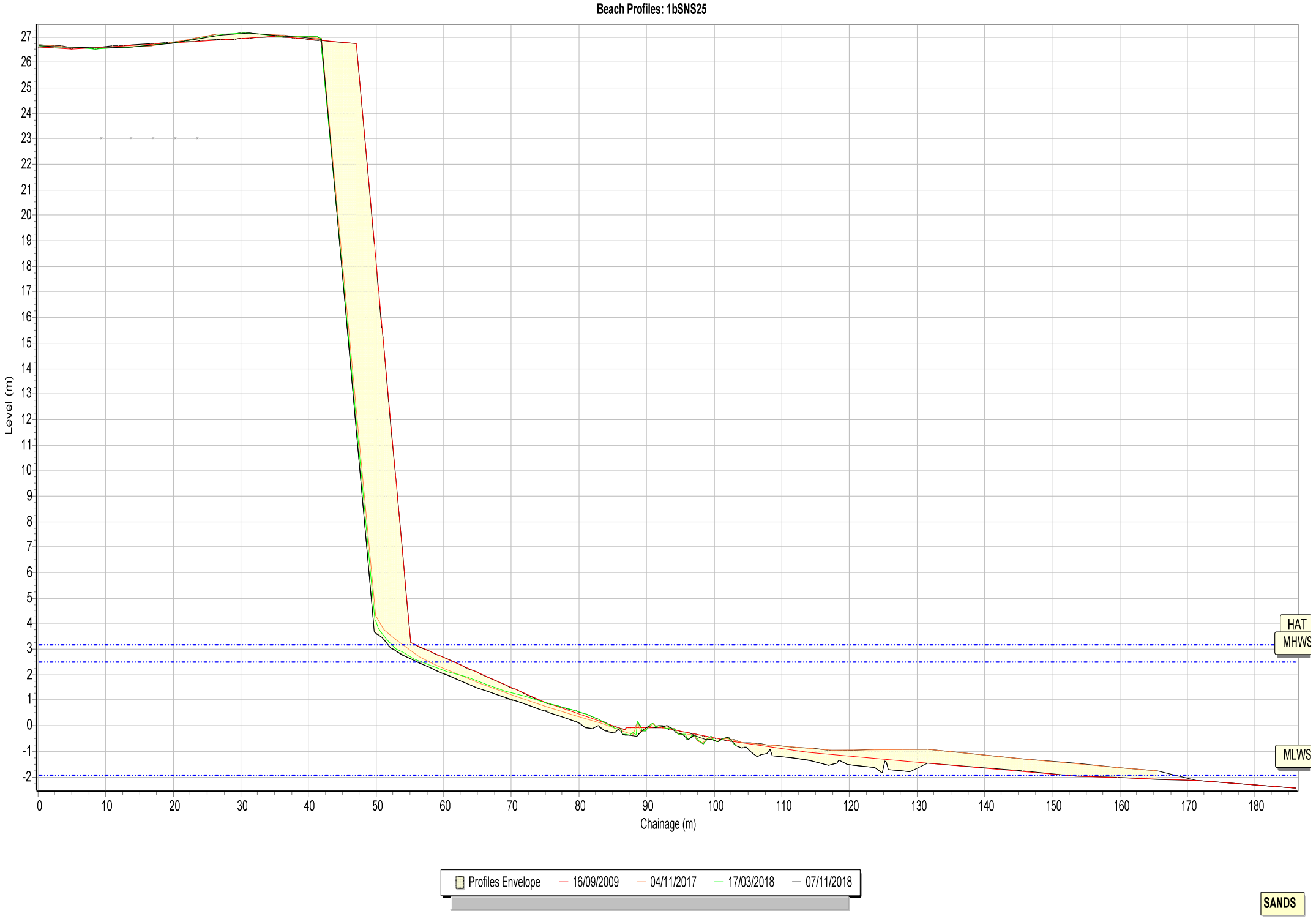
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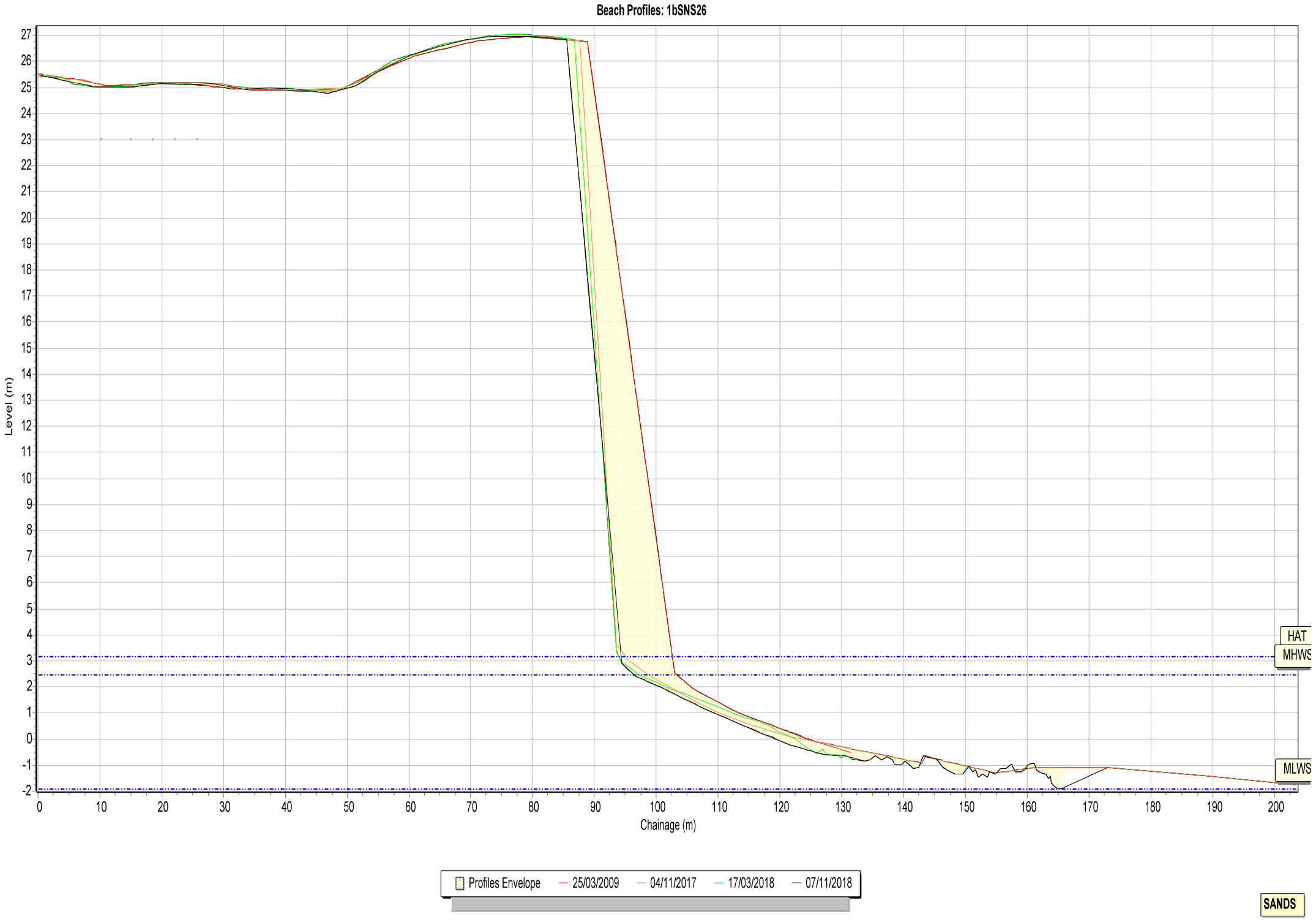
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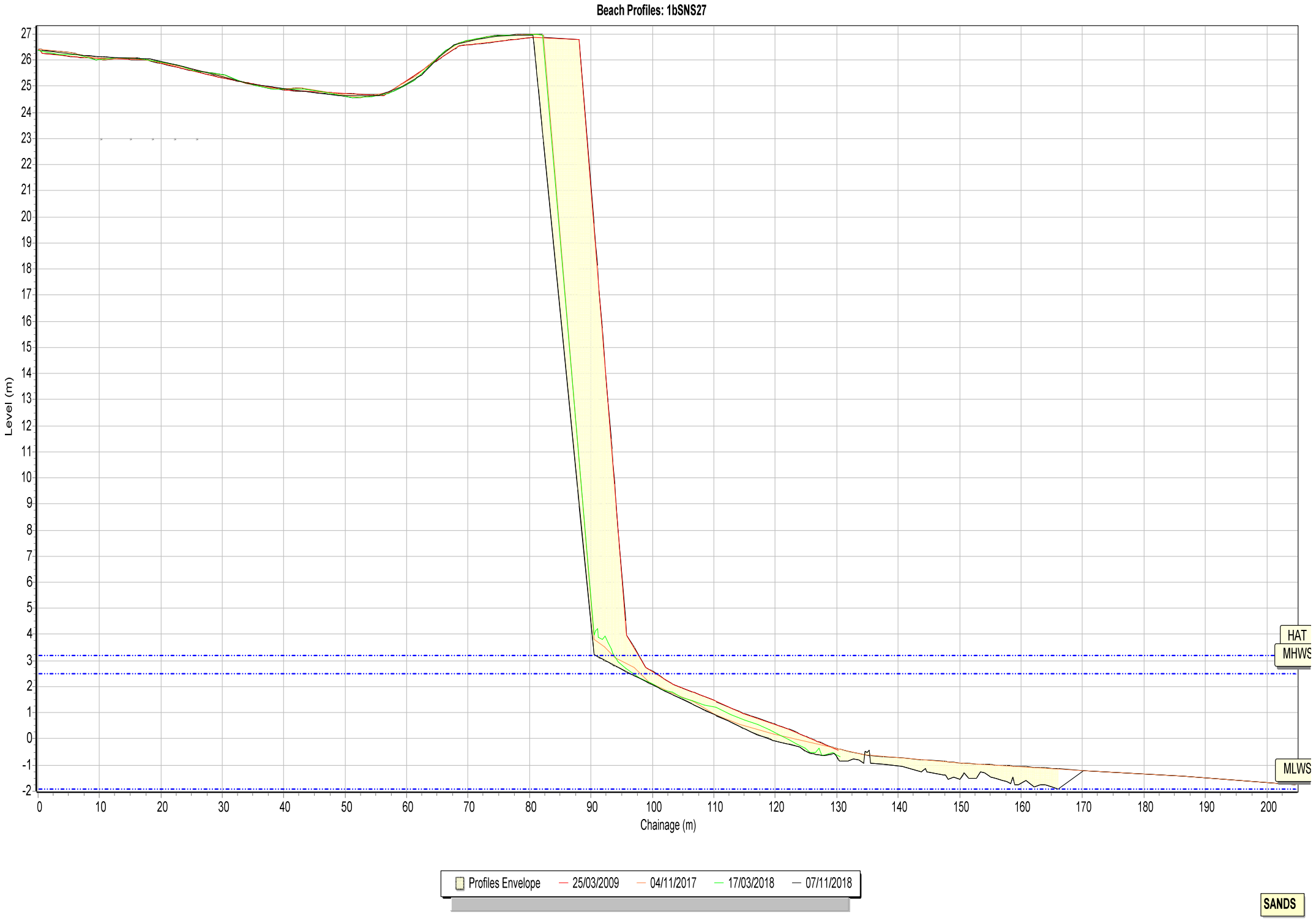
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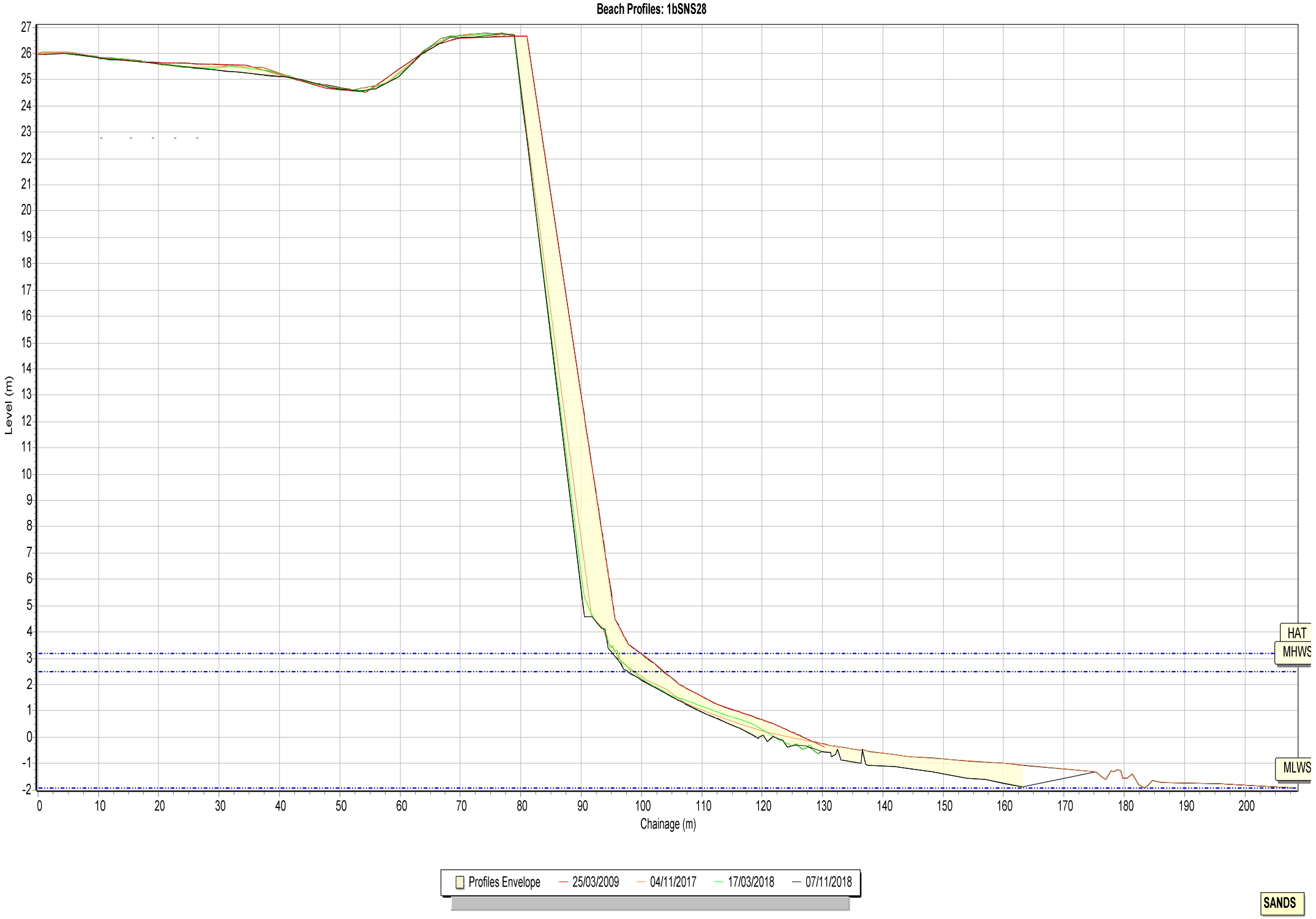
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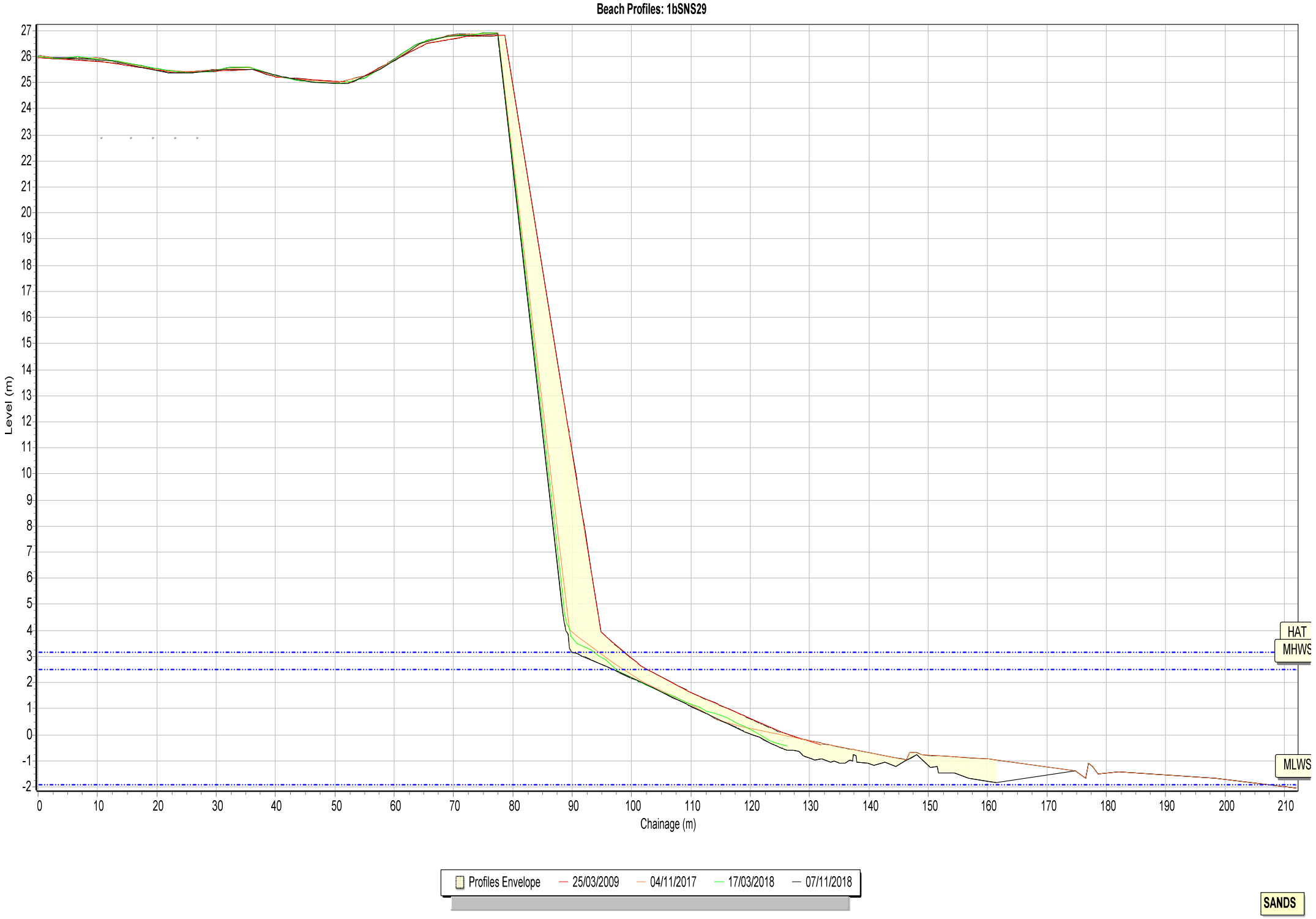
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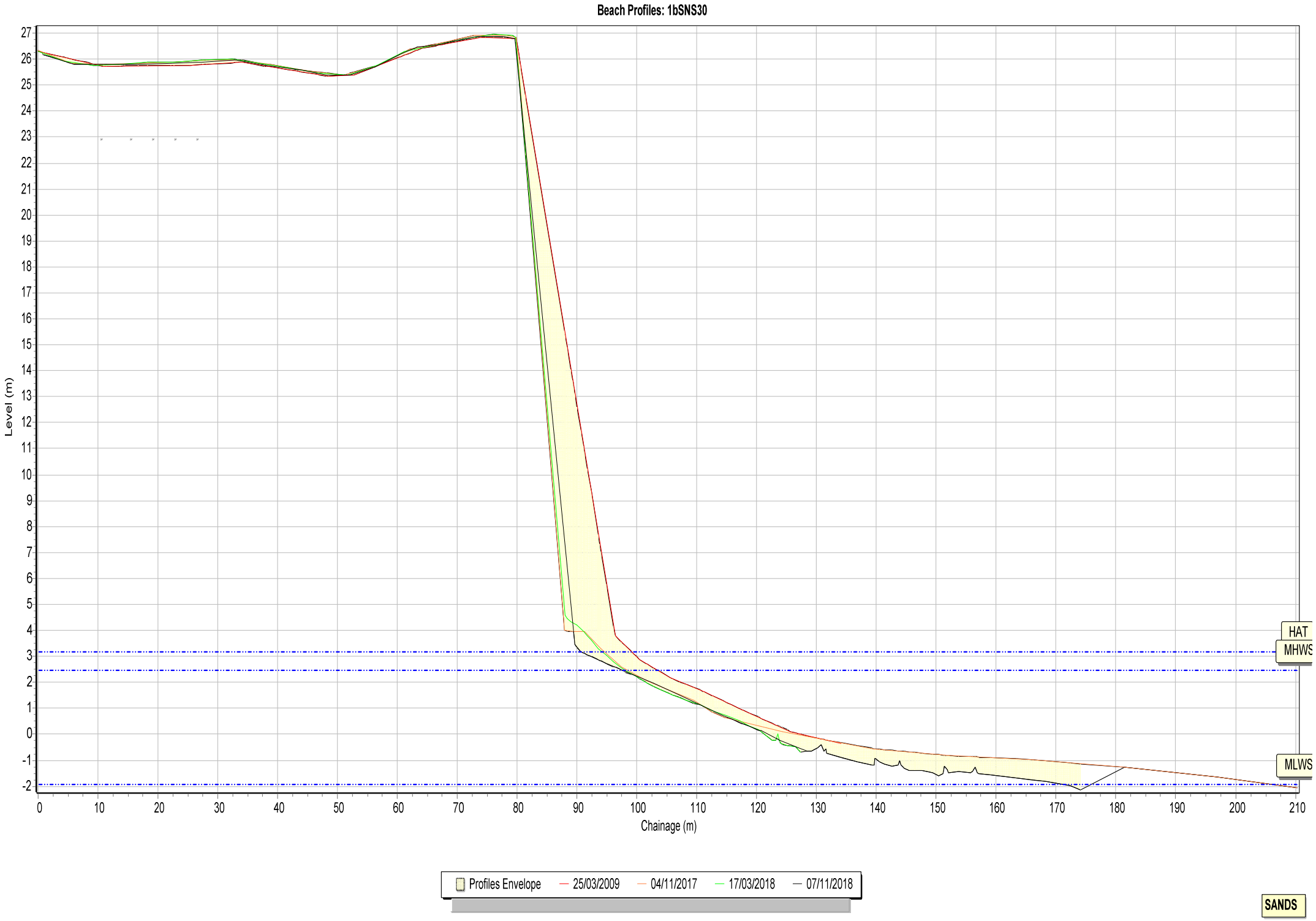
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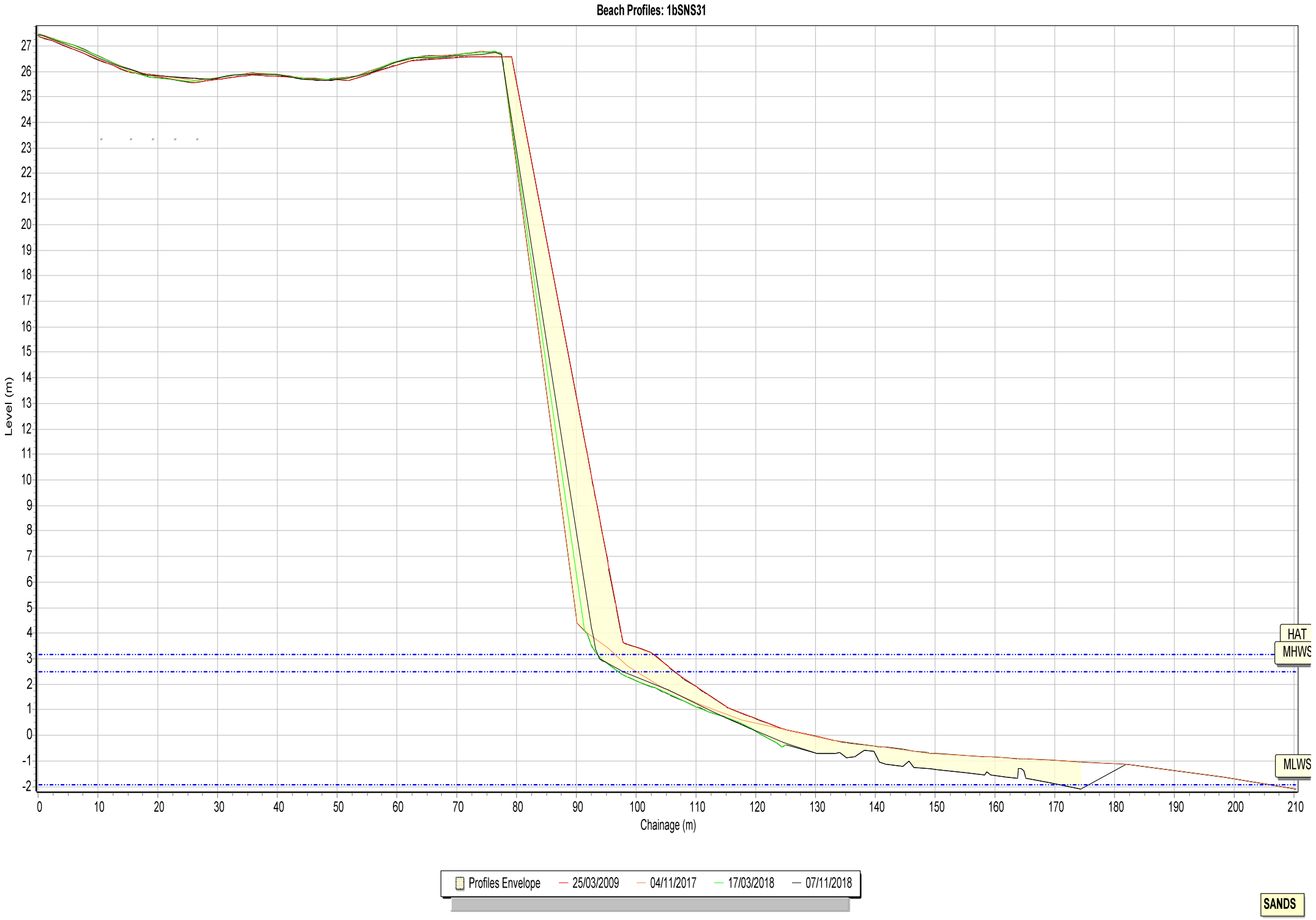
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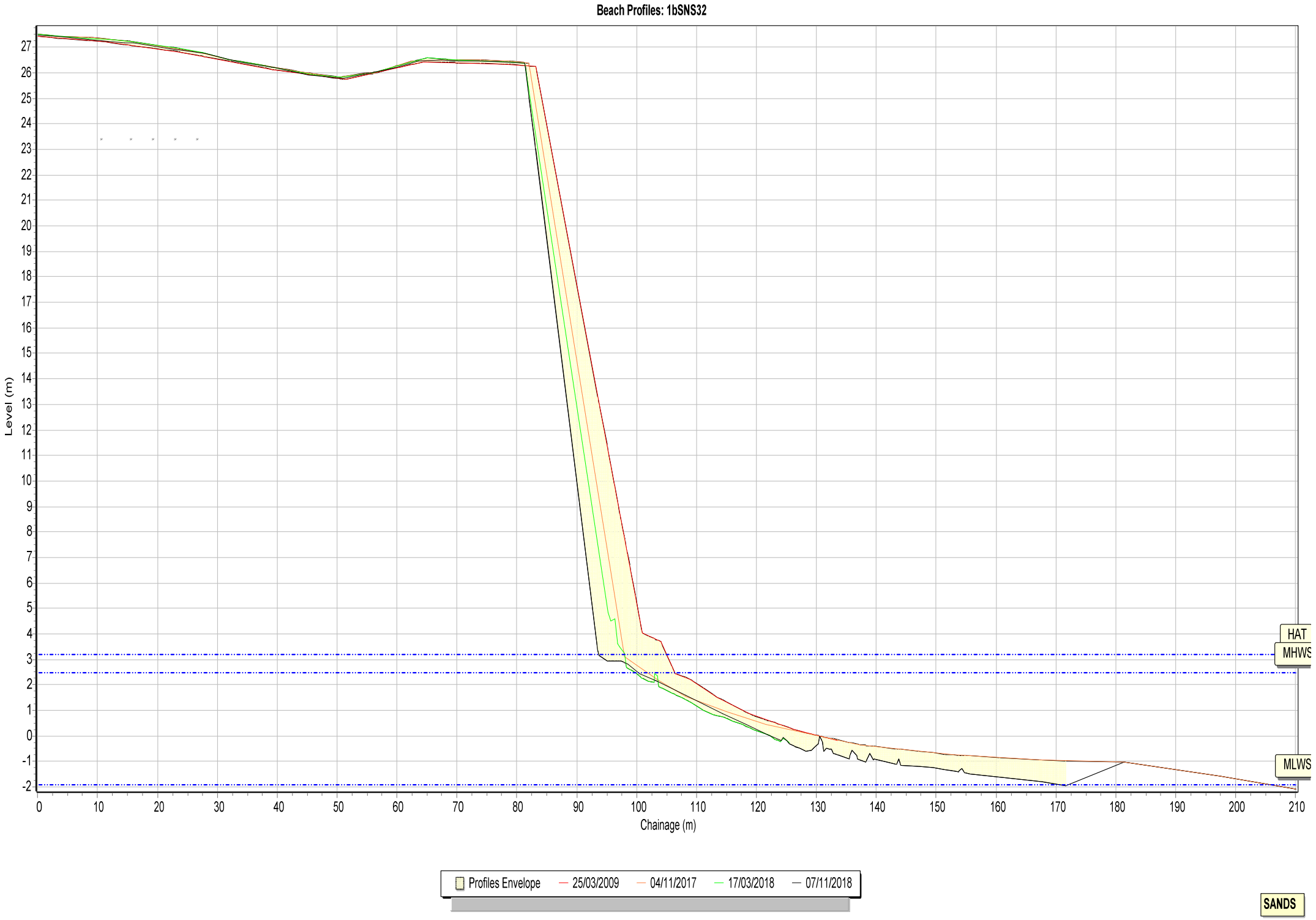
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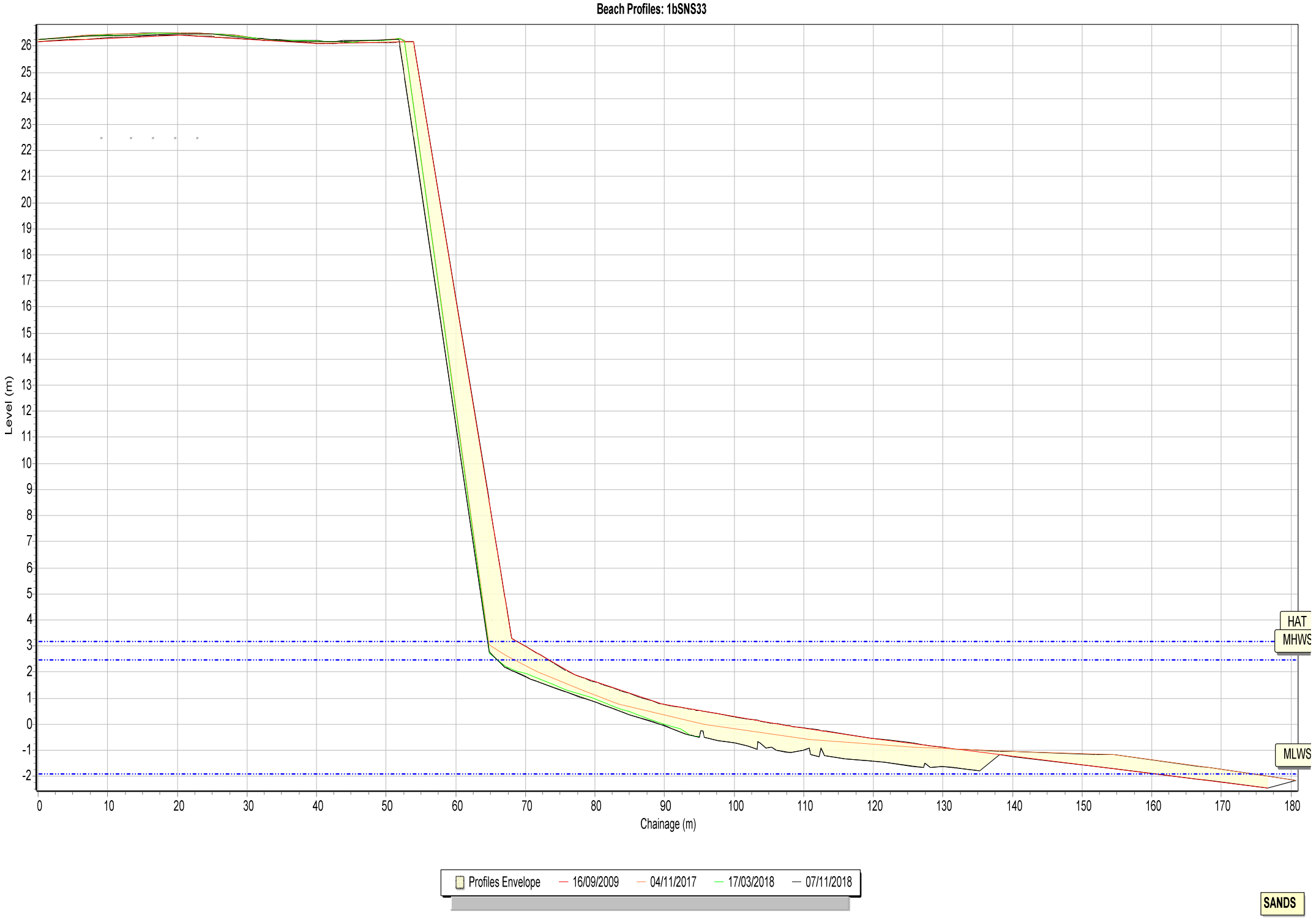
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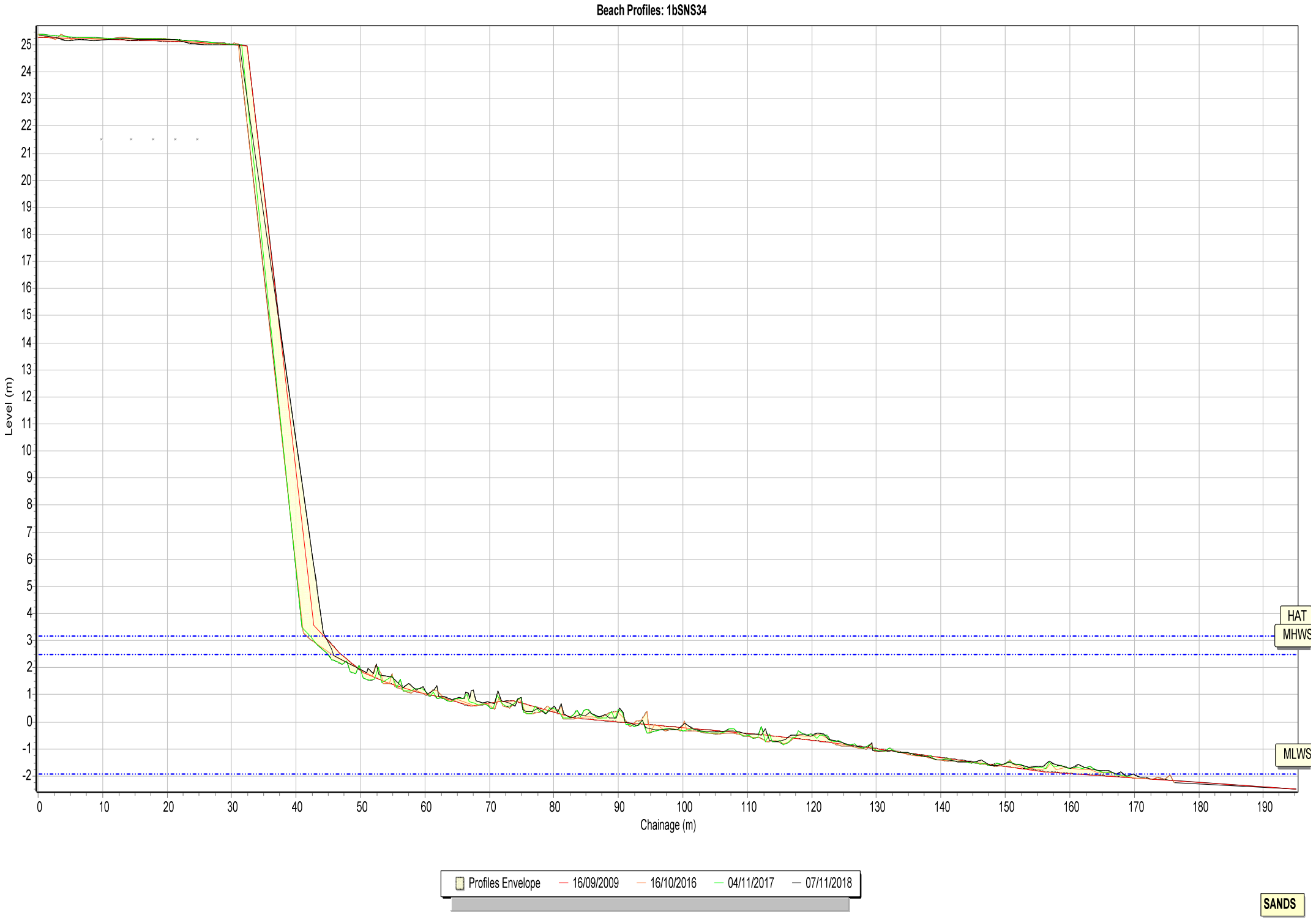
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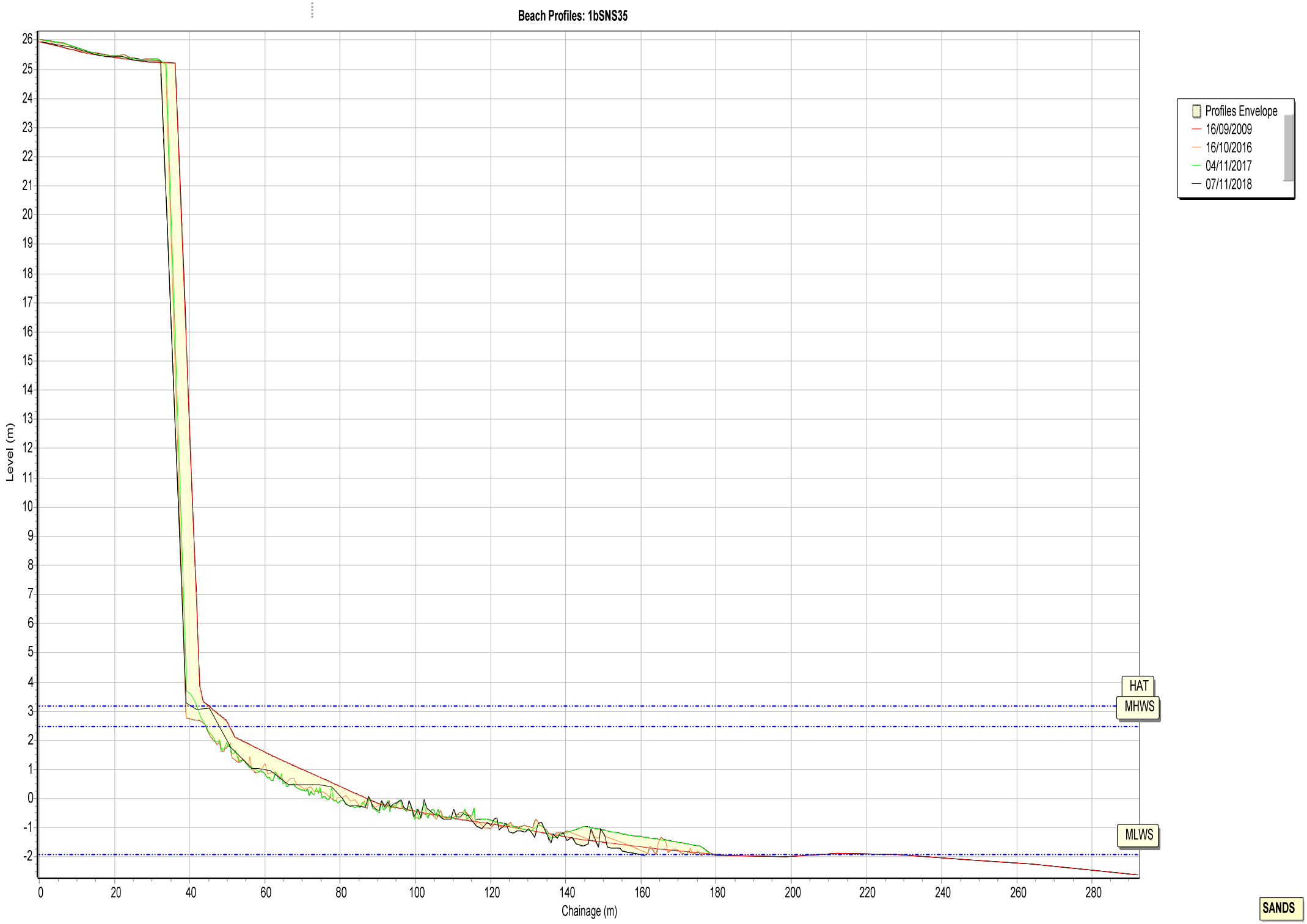
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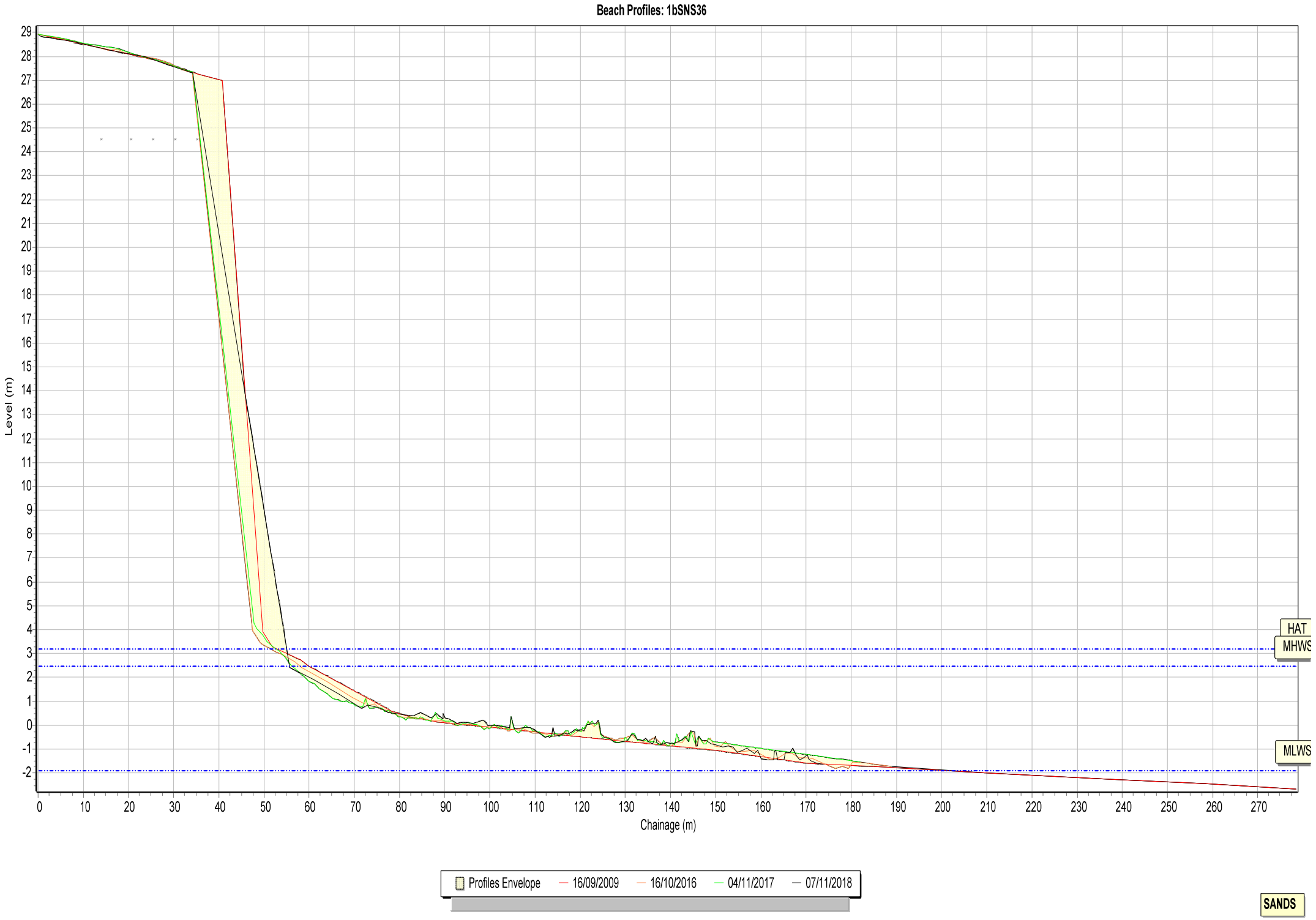
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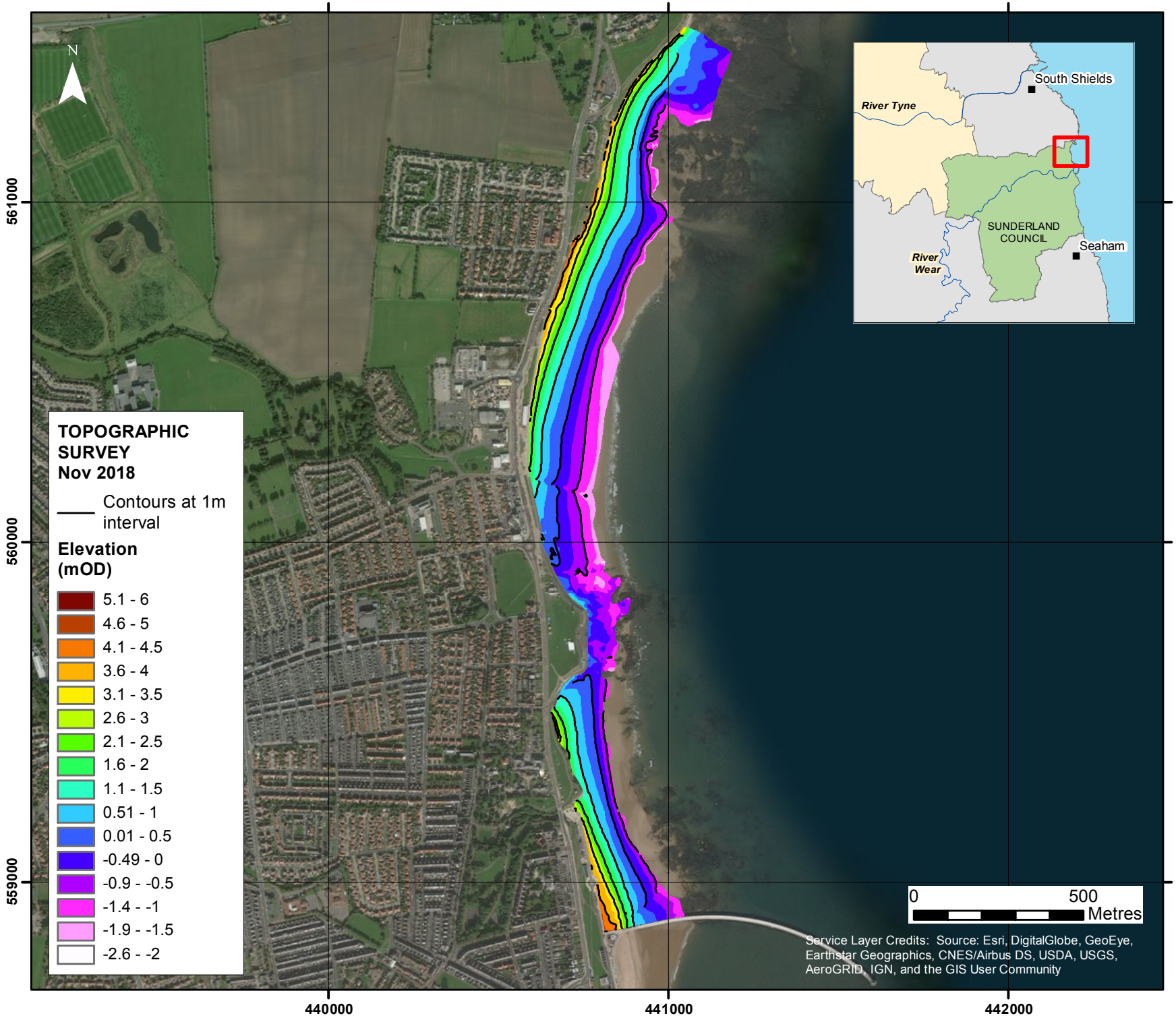
270
Chainage (m)
HAT
MHWS
MLWS
Profiles Envelope
16/09/2009
16/10/2016
04/11/2017
07/11/2018
SANDS

Appendix B

Topographic Survey



Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 1

SUNDERLAND NORTH

Sunderland Council Frontage

Analytical Report
'Full Measures' Survey 2018

Drawing Scale at A4 1:15,000

WATER
Royal HaskoningDHV
Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE

Tel: +44 (0)191 211 1300
Fax: +44 (0)191 211 1313
www.royalhaskoningdhv.com

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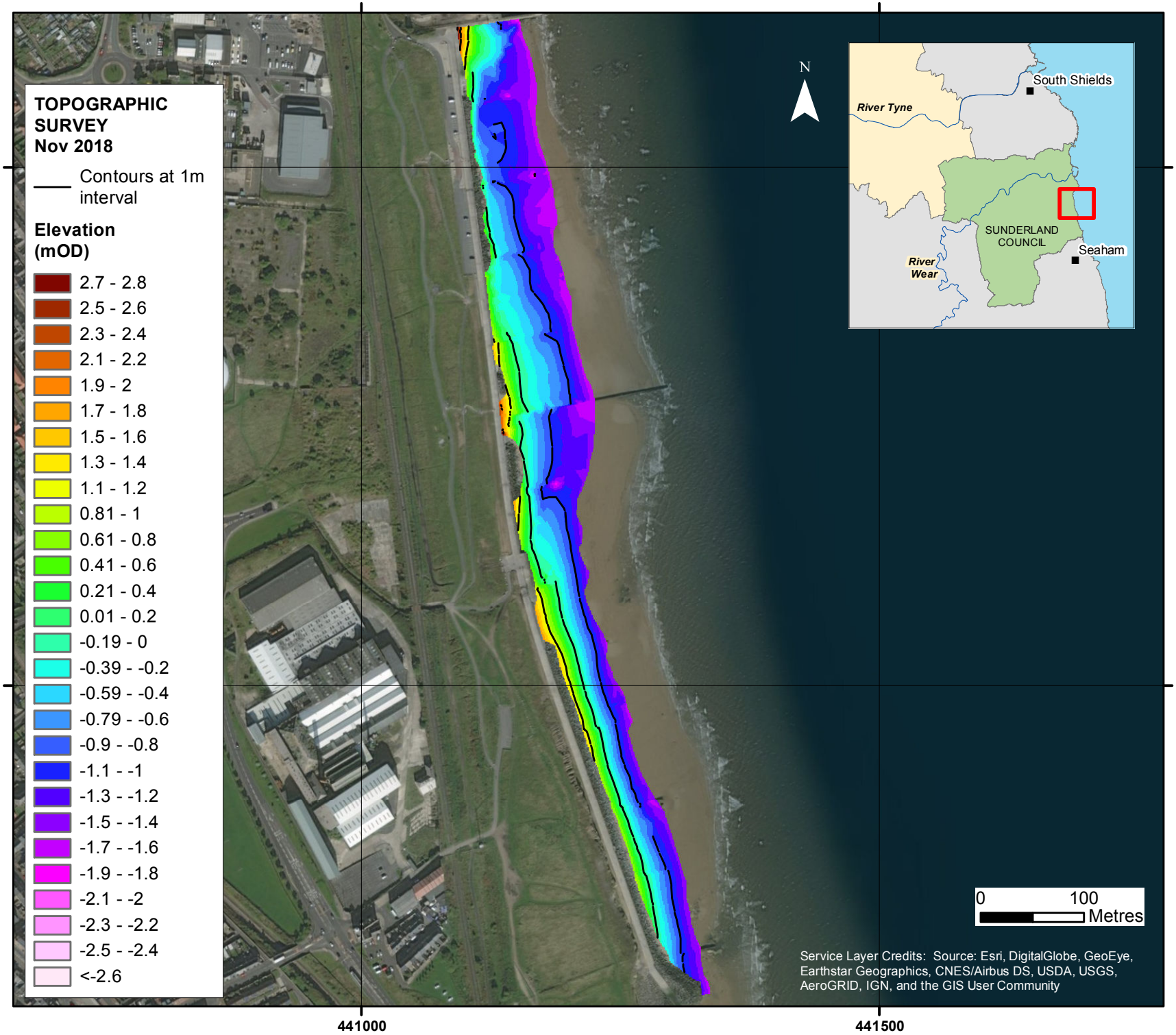

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 2

SUNDERLAND SOUTH

Sunderland Council Frontage

Analytical Report
'Full Measures' Survey 2018

Drawing Scale at A4 1:5,000

WATER
Royal HaskoningDHV
Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE

Tel: +44 (0)191 211 1300
Fax: +44 (0)191 211 1313
www.royalhaskoningdhv.com

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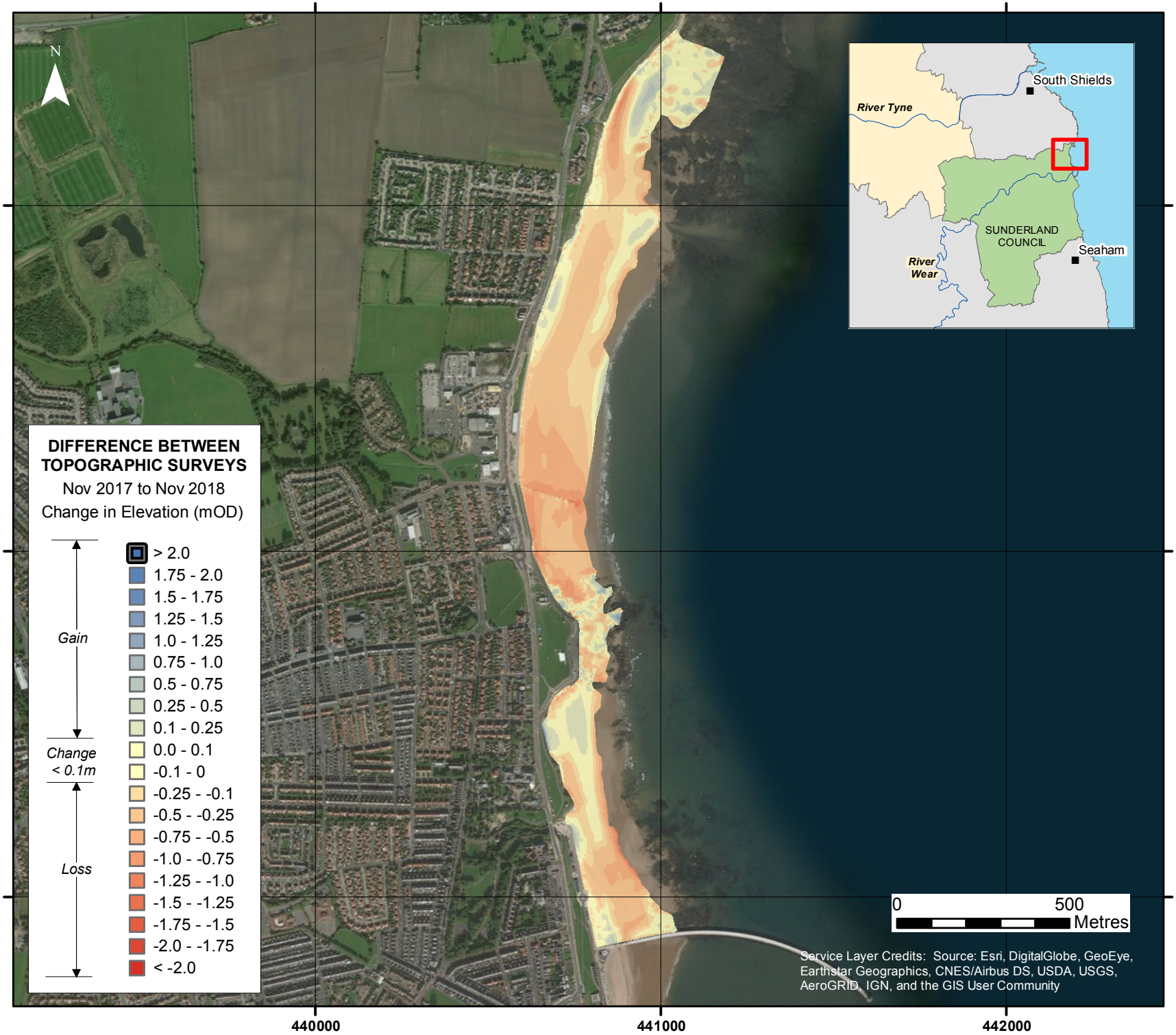

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 3

SUNDERLAND NORTH

Sunderland Council Frontage

Analytical Report
'Full Measures' Survey 2018

Drawing Scale at A4 1:15,000

WATER
Royal HaskoningDHV
Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE

Tel: +44 (0)191 211 1300
Fax: +44 (0)191 211 1313
www.royalhaskoningdhv.com

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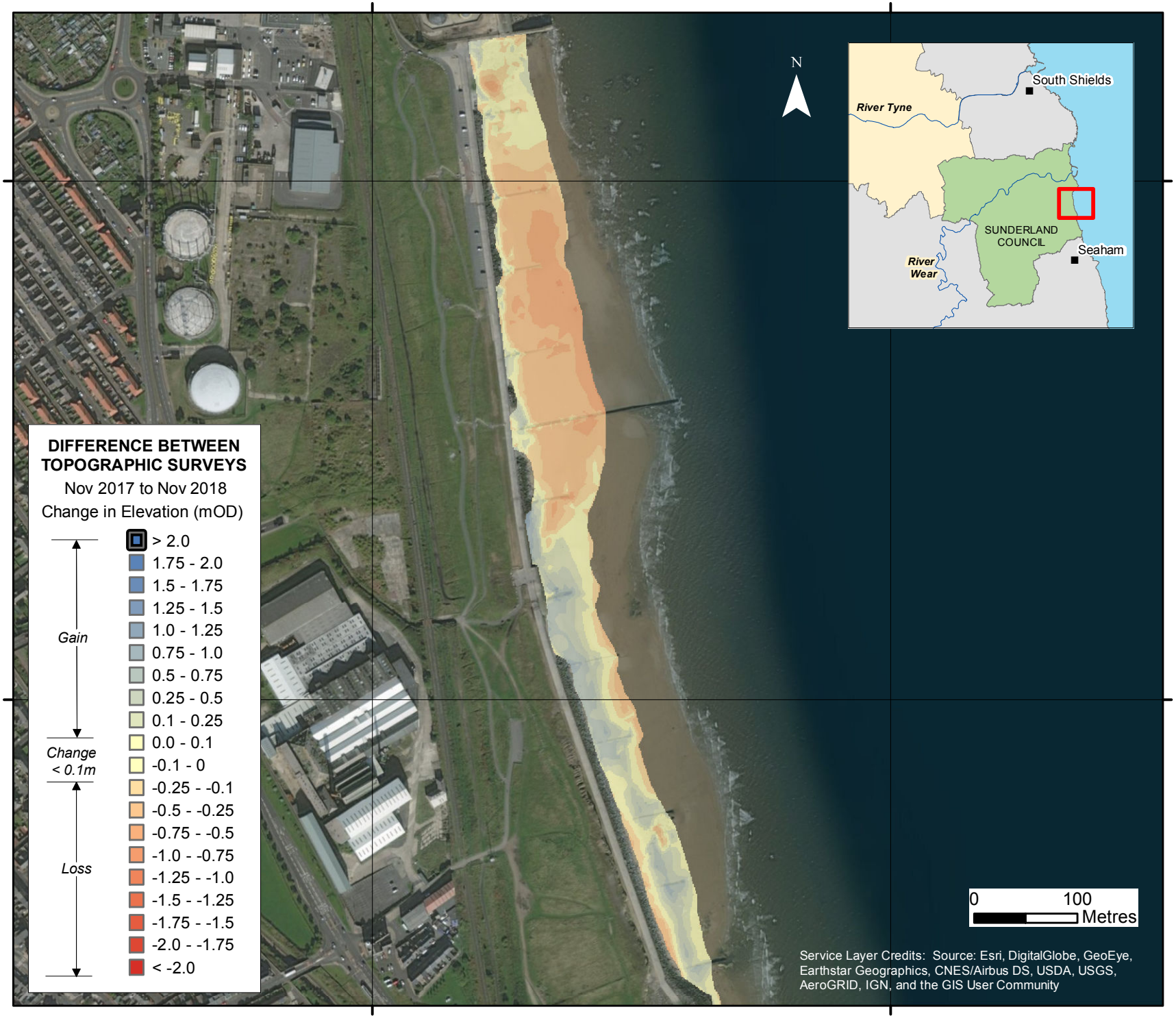

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 4

SUNDERLAND SOUTH

Sunderland Council Frontage

Analytical Report
'Full Measures' Survey 2018

Drawing Scale at A4 1:5,000

WATER
Royal HaskoningDHV
Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE

Tel: +44 (0)191 211 1300
Fax: +44 (0)191 211 1313
www.royalhaskoningdhv.com

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Appendix C

Cliff Top Survey

Cliff Top Survey

Hendon and Ryhope

Thirty-two ground control points have been established between Hendon and Ryhope. The maximum separation between any two points varies along the coast, reflecting the degree of risk from the erosion.

The cliff top surveys between Hendon and Ryhope 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 2009 (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 between Hendon and Ryhope

Ground Control Points				Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Bearing	Baseline Survey	Previous Survey	Present Survey	Baseline to Present	Previous to Present	Baseline to Present
			(°)	March 2009	March 2018	November 2018	Mar 2009 - Nov 2017	Mar 2018 - Nov 2018	Mar 2009 - Nov 2017
1	441025.7	555571.1	75	8.16	8.23	8.31	0.15	0.08	0.02
2	441064.4	555355.1	85	7.09	5.31	5.25	-1.84	-0.06	-0.26
3	441098	555124	82	10.01	10.35	10.35	0.34	0	0.05
4	441174	554938.7	65	10.3	10.44	10.46	0.16	0.02	0.02
5	441199.1	554861.1	65	7.71	10.88	11.02	3.31	0.14	0.47
6	441224.5	554774.2	71	10.83	10.94	10.9	0.07	-0.04	0.01
7	441248.4	554690.3	74	10.18	10.48	10.35	0.17	-0.13	0.02
8	441259.3	554596.6	101	10.08	9.83	9.62	-0.46	-0.21	-0.07
9	441275.8	554513.4	66	10.52	6.41	6.04	-4.48	-0.37	-0.64
10	441309.4	554421.3	58	8.77	1.35	1.31	-7.46	-0.04	-1.07
11	441354	554346.5	68	8.2	4	3.91	-4.29	-0.09	-0.61
12	441400.2	554248.2	56	6.17	5.83	5.78	-0.39	-0.05	-0.06
13	441452.3	554174.7	63	11.61	8.66	6.41	-5.2	-2.25	-0.74

14	441472.3	554080.5	127	7.33	6.12	6.2	-1.13	0.08	-0.16
15	441413	554005.1	122	7.84	7.89	7.85	0.01	-0.04	0.00
16	441384.8	553913.3	90	9.89	7.61	7.57	-2.32	-0.04	-0.33
17	441404.1	553815.5	93	6.32	5.98	5.84	-0.48	-0.14	-0.07
18	441404.1	553723.6	119	8.1	3.31	3.19	-4.91	-0.12	-0.70
19	441398.5	553632.8	78	8.23	4.47	4.19	-4.04	-0.28	-0.58
20	441438.3	553452.9	71	10.09	5.58	5.52	-4.57	-0.06	-0.65
21	441506.1	553256.1	62	8.57	1.58	1.59	-6.98	0.01	-1.00
22	441550.1	553158.7	103	6.57	3.33	3.37	-3.2	0.04	-0.46
23	441585.2	553076.5	64	8.11	5.53	4.64	-3.47	-0.89	-0.50
24	441624.4	552870.7	69	7.53	3.48	3.21	-4.32	-0.27	-0.62
25	441689.1	552758	70	14.58	6.75	6.66	-7.92	-0.09	-1.13
26	441715	552713.3	54	12.87	10.63	10.46	-2.41	-0.17	-0.34
27	441749.2	552674.4	62	14.56	3.46	3.62	-10.94	0.16	-1.56
28	441776.6	552629.9	57	8.62	4.2	4.16	-4.46	-0.04	-0.64
28A	441798.6	552586.3	56	13.63	7.93	6.08	-7.55	-1.85	-1.08
28B	441817.4	552542.4	64	12.3	11.32	11.18	-1.12	-0.14	-0.16
28C	441852.2	552502.6	52	13.11	12.52	12.38	-0.73	-0.14	-0.10
29	441880.1	552471.6	83	15.46	15.23	15.1	-0.36	-0.13	-0.05
30	441921.4	552269	97	8.55	6.48	6.41	-2.14	-0.07	-0.31
31	441853.1	552094	75	11.2	5.83	4.09	-7.11	-1.74	-1.02
32	441883.3	551988.5	96	9.82	3.7	3.72	-6.1	0.02	-0.87