North East Coastal Observatory

Royal HaskoningDHV
Enhancing Society Together

Cell 1 Regional Coastal Monitoring Programme Analytical Report 12: 'Full Measures' Survey 2019

Sunderland City Council

Sunderland City Council

January 2020

Contents

Appendices

List of Figures

List of Tables

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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.

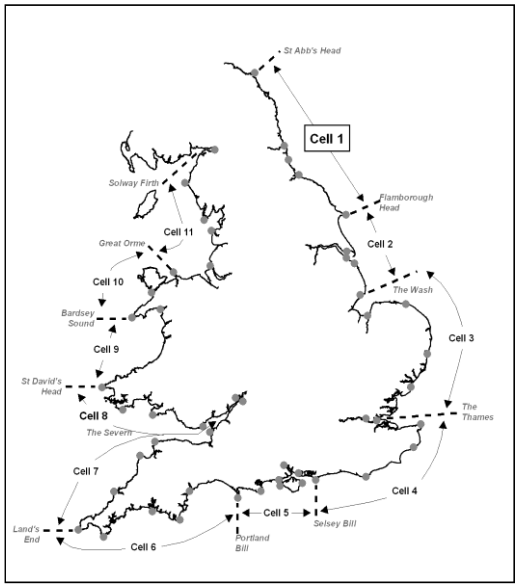


Figure 1 Sediment Cells in England and Wales

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
- LiDAR Surveys
- walk-over cliff and coastal defence asset 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	Feb-Mar 19	May 19	
12	2019/20	Sep-Nov 19	Jan 20			

(*) The present report is **Analytical Report 12** and provides an analysis of the 2019 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 14th and 15th November 2019 (Whitburn Bay), 4th September 2019 (Sunderland Harbour and Docks) and between the 7th November and 13th November 2019 (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.

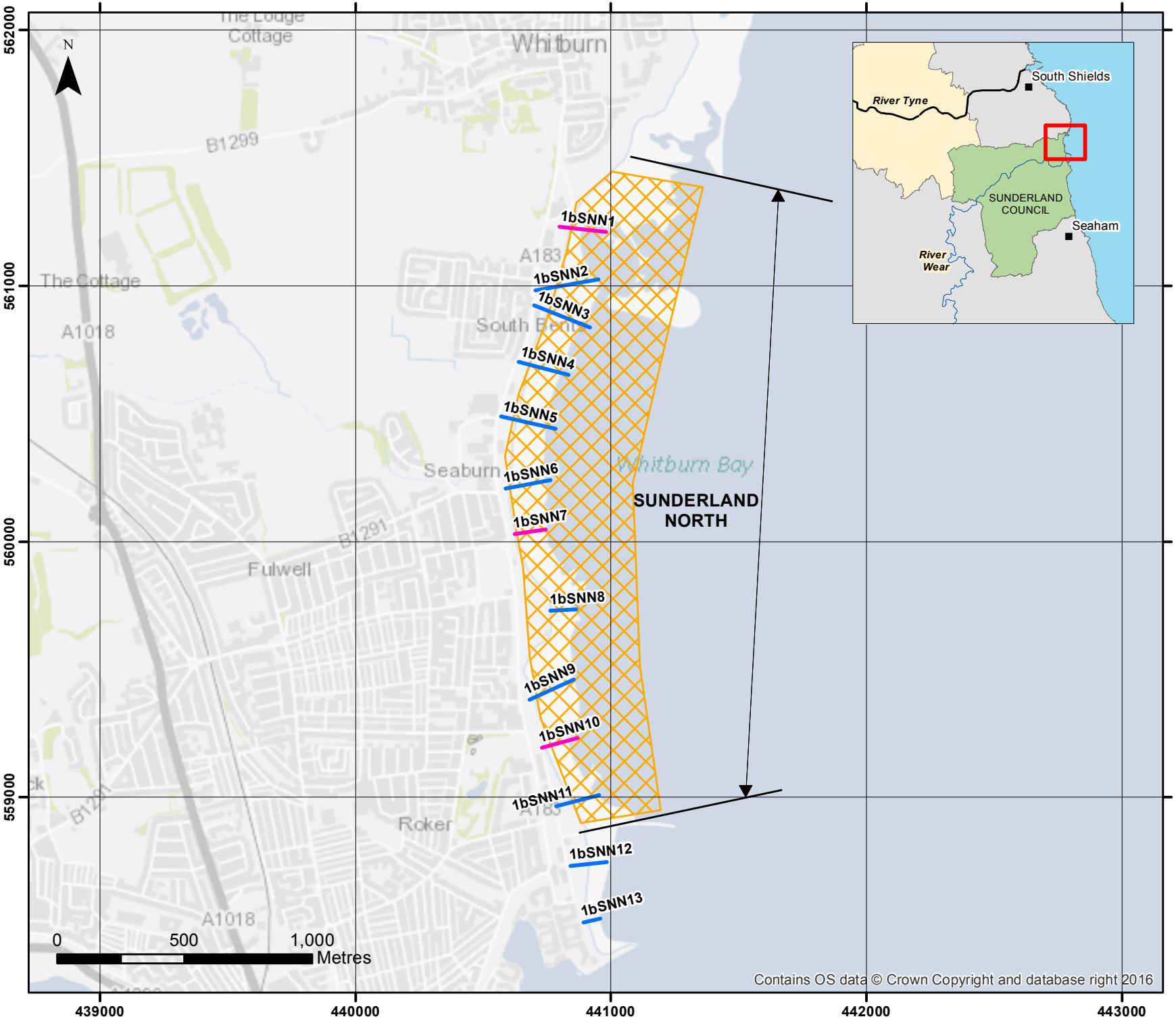
All data have been captured in a manner commensurate with the principles of the Environment Agency's *National Standard Contract and Specification for Surveying Services* and stored in a file format compatible with the software systems being used for the data analysis, namely SANDS and ArcGIS. This data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

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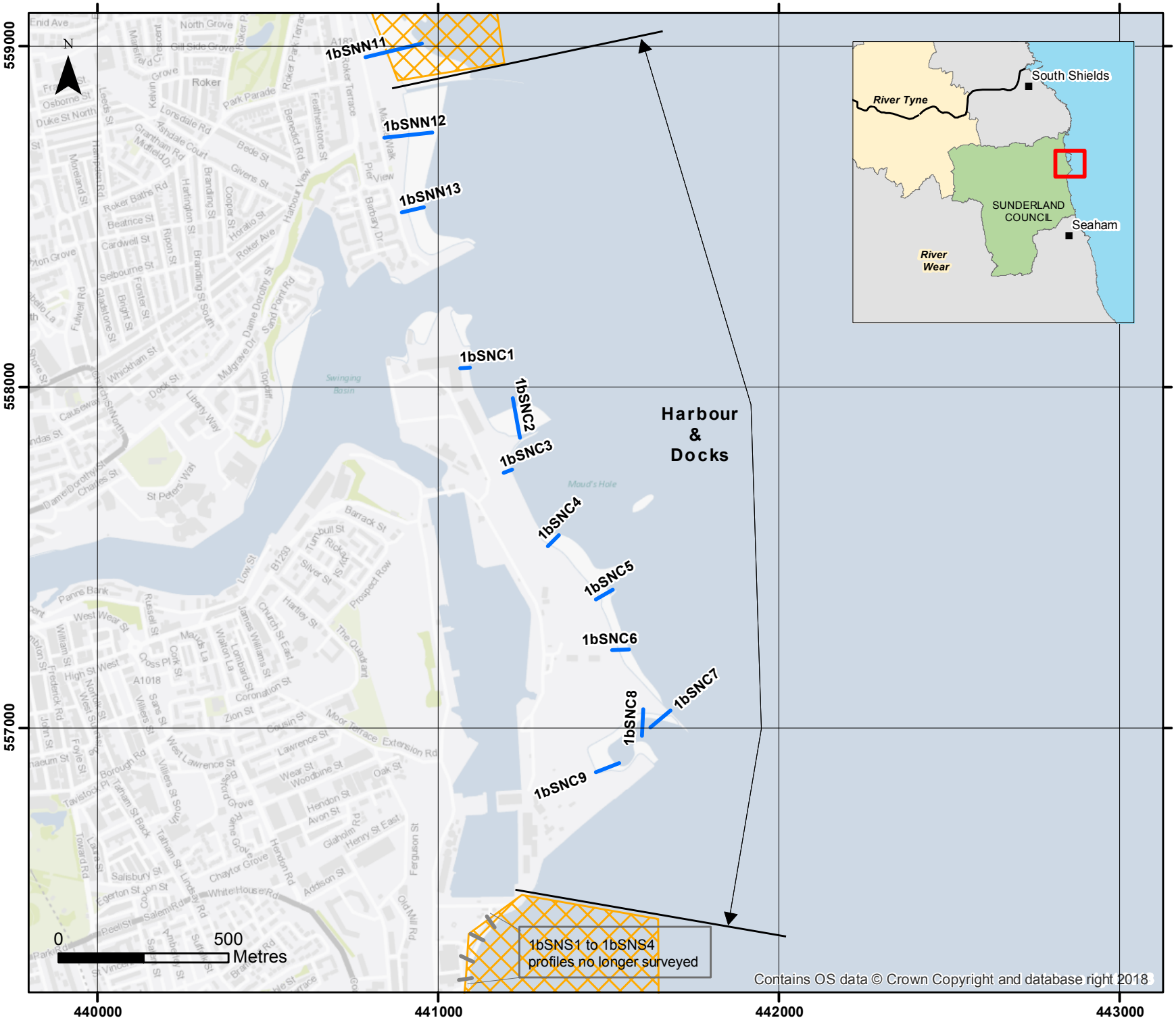

Key

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

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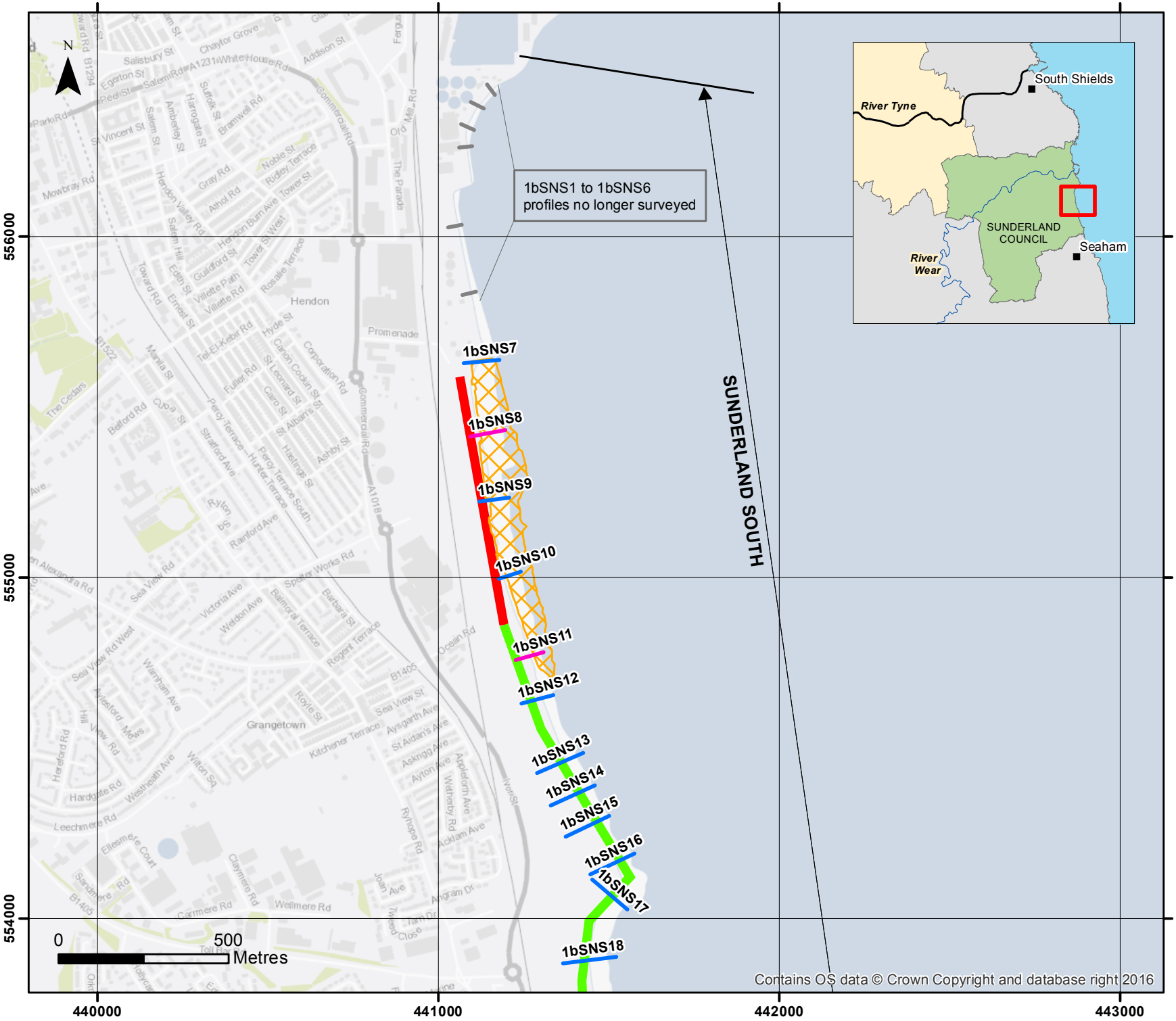

Key

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

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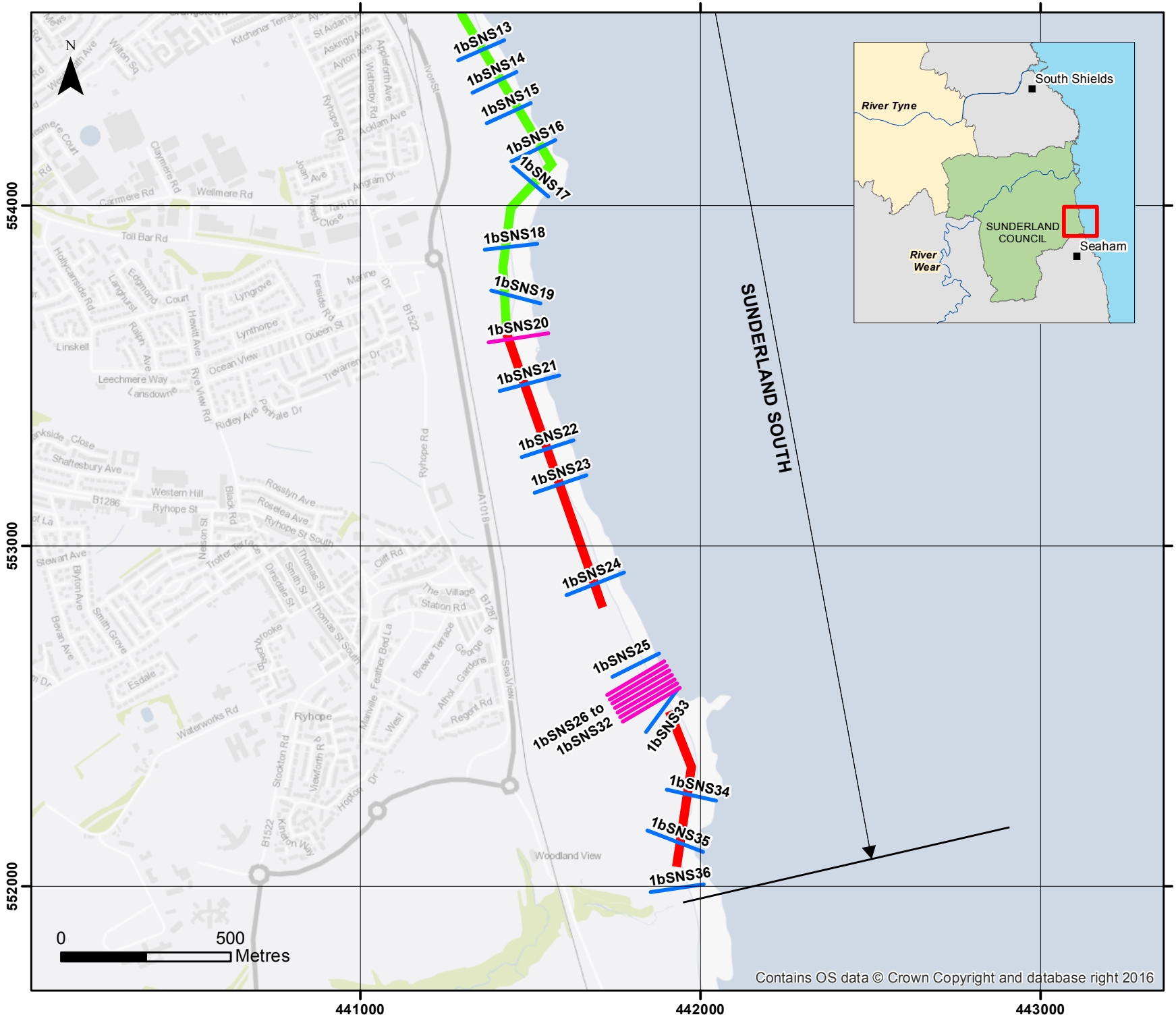

Key

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

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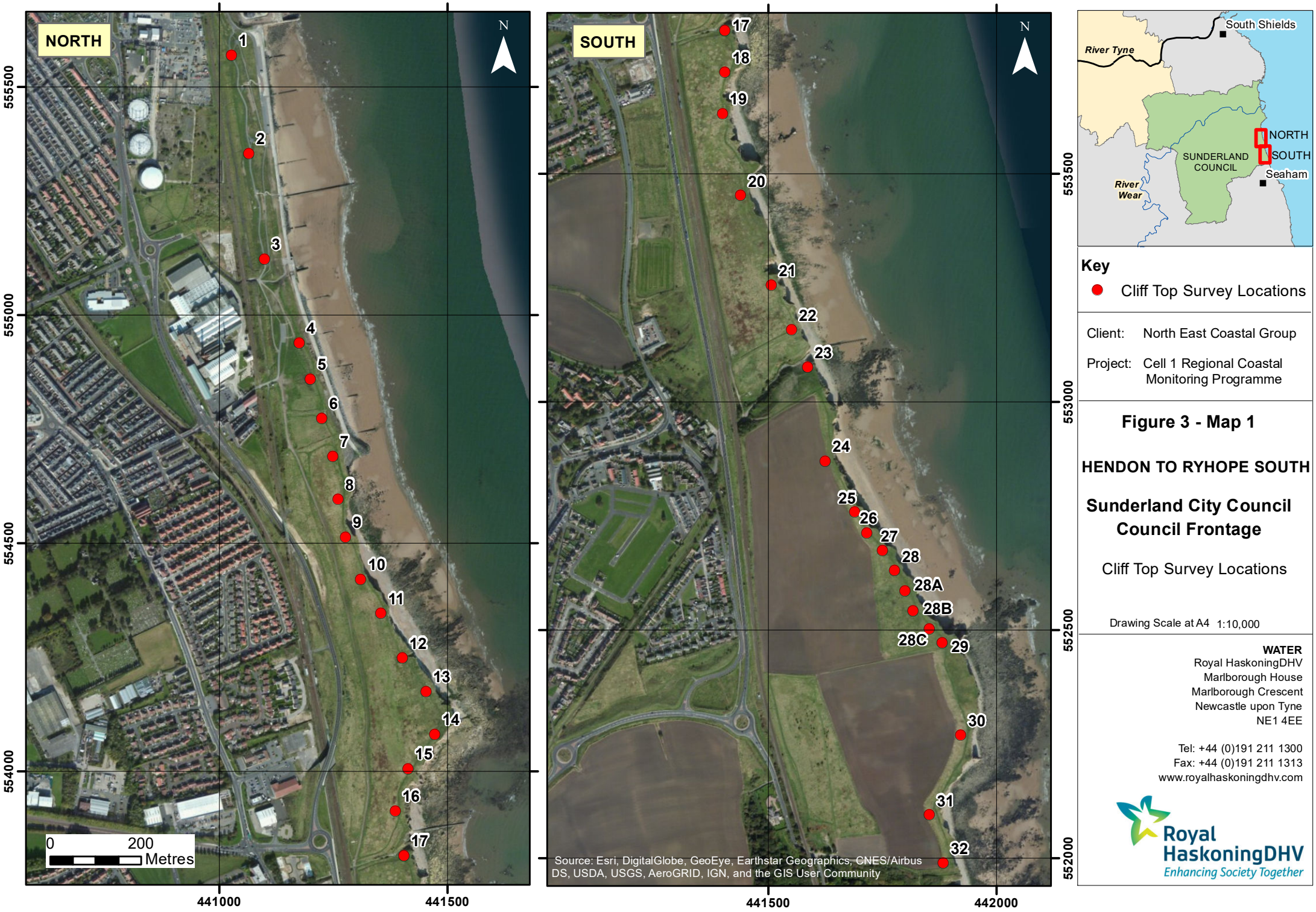

Key

Cliff Top Survey Locations

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Figure 3 - Map 1

HENDON TO RYHOPE SOUTH

Sunderland City Council Council Frontage

Cliff Top Survey Locations

Drawing Scale at A4 1:10,000

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2. Analysis of Survey Data

2.1 Whitburn Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
14th-15th November 2019	**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 2019 and the previous Full Measures survey was undertaken in November 2018. Profiles 1bSNN1, 1bSNN7 and 1bSNN10 were last surveyed during the Partial Measures spring survey, 2019. The remaining profiles were last surveyed during the Full Measures autumn survey, 2018. **1bSNN1** is immediately south of Sunderland City Council's northern boundary. The profile is unchanged above HAT (45m chainage), with negligible sections of erosion and accretion. Between 45m chainage and 150m chainage, there has been erosion of 0.2m. The rest of the profile has predominantly accreted, by up to 0.6m on the upper beach and 0.2m on the middle to lower beach. The profile at the beach toe extends further than the previous spring survey, exposing rocks from chainage 170m to 240m. Overall, the beach level is at medium-high level on the upper and middle beach (reaching its highest level recorded between chainages 52m and 64m) and at a low level on the lower beach 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. The upper beach to chainage 170m has accreted by up to 0.5m, whilst the middle beach has eroded by up to 0.6m to chainage 245m. The toe of the beach has accreted by 1.0m and extended by 45m. Overall the profile is at a high level on the upper beach compared to the range recorded from previous surveys, with the section between chainage 100m to 135m being the highest on record. The middle and lower beach are at a low level compared to the range recorded from previous surveys.	Along the length of Whitburn Bay profiles have been dominated by accretion since the spring 2019 survey. Although the majority of beach profiles are within the range of previous recorded surveys, several sections along the bay are now at their highest levels recorded: 52-64m chainage at 1bSNN1, 100-135m at 1bSNN2, 54-74m at 1bSNN3, 24-64m at 1bSNN4, 40-125m at 1bSNN5 and 164-204m at 1bSNN7. Likewise, there are a couple of sections recorded at their lowest level: 165-210m at 1bSNN3 and 10-24m at 1bSNN6. **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. Profiles south of this (1bSNN6 – 1bSNN11) are generally at a medium to low level, although profiles 6 and 7 show medium to high levels. 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
	At **1bSNN3**, the dunes remain unchanged since the previous survey, whilst the beach has accreted from the toe of the dunes to chainage 142m by up to 0.5m. The lower beach shows erosion of up to 1.2m, leading to a steeper profile. Overall, the beach is at a medium to high level on the upper and middle beach, particularly between chainages 54m to 74m which is now at its highest level recorded compared to the range recorded from the previous surveys. The lower beach level is now at its lowest level recorded between chainages 165m and 210m. 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 0.4m. There has been accretion across the upper and middle beach of up to 0.3m, switching to erosion between chainages 153m and 199m by up to 0.3m. Seaward of 199m, there has been accretion of 0.15m to the end of the beach profile. The majority of the beach is at a medium-high level compared to the range recorded from previous surveys, particularly between chainages 24m and 64m which is at its highest level recorded. At profile **1bSNN5**, the beach profile has accreted by up to 0.7m, except at the beach toe where a small amount of erosion has occurred seaward of chainage 242m by up to 0.1m. The beach is at a high level compared to the range recorded from previous surveys, particularly between the toe of the seawall and chainage 125m which is at its highest level recorded. At profile **1bSNN6**, beach level has decreased by 0.6m from the toe of the seawall to chainage 24m. The rest of the beach profile has increased by up to 0.4m, except at the beach toe where a small amount of erosion has occurred seaward of chainage 210m by up to 0.1m. The profile is at a high level compared to the range recorded from previous surveys, except at the toe of the seawall to chainage 24m which is at its lowest level recorded. Profile **1bSNN7** is at Seaburn, just to the north of Parson's Rocks. Beach levels have increased across the profile to chainage 115m by up to 0.6m. The beach level has eroded by up to 0.2m between chainages 115m and 160m, switching to accretion seaward of chainage 160m by up to 0.3m. Overall, the profile is at a medium-high level compared to the range recorded from previous surveys, particularly between chainages 164m and 204m which is at its highest level recorded	

Survey Date	Description of Changes Since Last Survey	Interpretation
	Profile **1bSNN8** extends across Parsons Rocks. There are no discernible changes across most of the profile since the previous Full Measures survey in 2018. Profile **1bSNN9** drops from the cliff top to the foreshore at Roker. The survey report notes that the start of this profile was not measured due to unsafe access. The upper beach from the toe of the cliff to chainage 69m has accreted by up to 0.1m. From chainage 69m to 128m there has been minor accretion of 0.2m across the middle beach. The toe of the beach has accreted by 1.2m. The profile is at a medium-low level compared to the range recorded from previous surveys. Profile **1bSNN10** is located approximately mid-way between Parson's Rocks and Roker Pier. There has been erosion of 0.8m at the toe of the seawall. Between chainage 38m and the end of the profile there has been accretion by up to 0.4m across the middle beach and 1.1m on the lower beach. Overall, the beach is at a low level on the upper beach, and a medium-low level on the middle and lower beach compared to the range recorded in previous surveys. Profile **1bSNN11** is located to the south of Whitburn. There has been varying amounts of accretion by up to 0.3m across the beach profile. Overall the beach is at a high level on the upper beach and medium-low level on the middle and lower beach compared to the range recorded from the previous surveys.	
14th-15th November 2019	**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 2019) 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 3) produced from the last produced topographic survey (Full Measures, autumn 2018) and the present survey. The majority of the beach is dominated by low levels of accretion. Areas of accretion are concentrated on the lower beach of the northern bay and on the middle beach of the southern bay. There are isolated patches of erosion and accretion around Parsons Rocks.	The topographic survey shows that since the last survey, accretion has dominated across the bay, with areas of accretion concentrated on the lower half of the northern bay and middle beach of the southern bay. Change is limited to ±0.1m. **Longer term topographic trends Autumn 2009 to Autumn 2019:** The most recent topographic survey is in line with topographic trends seen since autumn 2009, showing a dominant trend of accretion with isolated areas of erosion in the north and south of the bay and around Parsons Rocks.

3.2 Sunderland Harbour and Docks

Survey Date	Description of Changes Since Last Survey	Interpretation
4th September 2019	**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 2018. **1bSNN12** and **1bSNN13** are both located within the shelter of Roker Pier. At profile **1bSNN12**, the beach profile has remained relatively stable at the toe of the seawall, with a small amount of erosion of the upper beach berm by up to 0.15m to chainage 50m. Accretion has occurred between chainages 50m and 72m by up to 0.3m. The beach level has decreased across the middle beach by up to 0.1m, switching to accretion seaward of chainage 104m by up to 0.4m. Overall the beach profile is at a medium level compared to the range recorded from previous surveys. At **1bSNN13**, there has been accretion across the entire beach profile seaward of chainage 25m, with up to 0.8m of sediment accumulating on the upper beach, covering the toe of the rock armour revetment. Overall the profile is at a medium level compared to the range recorded from previous surveys. **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 dropped between the toe of the seawall and 23m chainage by up to 0.2m. Between 23m and 99m there has been accretion of up to 0.2m. Seaward of this, there has been erosion of up to 0.2m. The profile is medium-high level compared to the range recorded from previous surveys, particularly between chainages 74m and 90m which is at its highest level recorded. **1bSNC3** to **1bSNC6** are on the seaward face of the dock. 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.	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, at profile 1bSNC1 the level of the upper and lower foreshore has risen, whilst the middle beach has fallen by 0.2m. The pattern is in reverse at profile 1bSNC2. Outside of the breakwaters, the beach has shown recovery of material at profile 1bSNC4, 1bSNC5 and 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, beach levels are at a medium level compared to earlier surveys, except at profile 1bSNC2 where the beach level between 74-90m has reached its highest level recorded. Outside of the harbour breakwaters, the beach levels fluctuate significantly over time. The autumn 2019 survey shows all profiles generally show recovery since the previous spring 2019 survey, with several profiles accreting across the entire shore face. Within the breakwaters either side of the former South Outlet of the docks, long term change is small

Survey Date	Description of Changes Since Last Survey	Interpretation
	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 1.1m across the upper and middle beach to chainage 31m, however they are still 0.8m lower than 2015 levels. The beach toe has eroded seaward of chainage 31m by up to 0.2m. The beach remains at a medium level compared to the range recorded from previous surveys. At profile **1bSNC5**, beach levels seaward of the revetment have accreted throughout the beach profile by up to 0.2m. There is evidence of movement of the toe of the revetment, with no rocks recorded between chainages 3-8m. 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 accreted across the entire profile by up to 0.2m from the seawall 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 an accretion (up to 0.2m) across the majority of the profile. From chainages 65m to 95m the beach is recorded at its highest level since records began. The profile remains high relative to earlier surveys.	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 65m and 95m being at their highest recorded levels since surveys began in October 2009.

3.3 Hendon to Ryhope (incl. Halliwell Banks)

Survey Date	Description of Changes Since Last Survey	Interpretation
7th – 13th November 2019	**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 2018 and the previous Partial Measures survey was undertaken in spring 2019. **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. There has been accretion of sediment across the profile, by up to 0.2m on the upper and lower beach. The rocks at chainage 70m remain unchanged. 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 movement of the rock revetment from the seawall to chainage 34m. At the toe of the revetment, beach levels have lowered by 0.4m to chainage 50m. Seaward of 50m, there has been accretion across the middle and lower beach by up to 0.8m, extending the beach toe by 12m. Overall, the beach is at a low level at the toe of the revetment compared to the range recorded from previous surveys, and a relatively high level across the rest of the beach profile 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 chainage 56m by up to 0.4m. Seaward of chainage 34m, the beach profile has risen by up to 0.3m. The profile is at a low level on the upper beach, particularly between chainage 40m and 52m which is now at its	Along the length of south Hendon, profiles 1bSNS7 to 1bSNS9 generally show accretion across the entire beach profile, whilst 1bSNS10 and 1bSNS11 have shown erosion. In general, the northern profiles are dominated by accretion, whilst the southern profiles are dominated by erosion. This is the opposite pattern of sediment movement in the bay as the previous full measures survey. At Grangetown (south Hendon to Salterfen Rocks), beach level changes are dominated by low levels of accretion to the north, and negligible change to the south. Between Salterfen Rocks and the landfill at Halliwell banks (profiles 1bSNS20 to 1bSNS25), the cliff has largely been eroding since the previous survey. Beach levels across the upper beach have generally accreted, except at profile 1bSNS24 which shows erosion across the beach profile. 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. All profiles show accretion across the beach profile by up to 1.0m in the upper sections, with the middle and lower beach exhibiting 0.2-0.5m. To the south of Halliwell Banks, around Pincushion, there has been variable change in the position of the cliff toe, however this is attributed to data artefact due

Survey Date	Description of Changes Since Last Survey	Interpretation
	lowest level recorded compared to the range recorded from previous surveys. The middle and lower beach are at a medium to high level compared to the range recorded from previous surveys. At profile **1bSNS10**, there has been erosion from the toe of the revetment at chainage 23m to the end of the survey by up to 0.8m. Whilst the upper beach is at a relatively high level compared to the range recorded from previous surveys, the middle and lower beach is at a low level compared to the range recorded from previous surveys. At profile **1bSNS11**, there is negligible change in the cliff profile. Beach levels have decreased across the profile by up to 0.8m between the toe of the sea defences and 80m chainage. The beach profile is at a high level compared to the range recorded from 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. Several profiles show a seaward movement of the cliff toe however 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. Where this occurs, the cliff toe position is not analysed. Profile **1bSNS12** extends from the cliff across the boulder foreshore. There has been erosion of up to 0.8m across the full beach profile. Overall the profile is at a low level compared to previous surveys. At profile **1bSNS13**, the upper beach has eroded by up to 0.4m to chainage 46m. Seaward of chainage 46m there has been accretion of up to 1.0m across the beach profile, leading to a smoother beach gradient. The beach profile is at a low level on the upper beach, particularly between chainages 26-34m which is now at its lowest level recorded. The rest of the beach profile is at a high level compared to previous surveys, particularly between chainages 46-80m and 102-118m which are now at their highest levels recorded. At profile **1bSNS14**, the cliff top has remained stable since the previous survey. There has been accretion on the upper beach by up to 0.3m to chainage 80m. Between chainage 80m and 135m there has been negligible change across the rock platform. The beach profile is at a relatively medium level compared to the range recorded from previous surveys.	to interpolation between limited data points and inaccessibility of the cliff toe due to unsafe conditions. There has been accretion across the beach profile at 1bSNS33, however the rest of the profiles show negligible change across the profile. **Longer term trends:** Along the length of south Hendon, beach levels vary between low to high levels compared to the range recorded from previous surveys. 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 toe at the majority of profiles (except profile 1bSNS24) has receded and many have now reached their 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. The cliff toe along this section has shown a seaward movement at all profiles, however this is likely to be a data artefact due to interpolation

Survey Date	Description of Changes Since Last Survey	Interpretation
	At profile **1bSNS15**, the cliff toe has receded by 1.0m, moving landward by c.7m in total since 2009. Beach levels have increased by up to 0.3m between the cliff toe and chainage 83m. There has been very little change across the rock platform between chainage 82m and 129m. The beach is at a medium level compared to earlier surveys. At profile **1bSNS16**, there has been no discernible change to beach level since the last survey (autumn 2018). 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 toe appears to have receded by 1.0m since the previous survey (November 2018). There are no discernible changes in the profile since the previous November 2018 survey. At **1bSNS18**, the cliff toe appears to have receded by 2.0m. There are no discernible changes in the profile since the previous November 2018 survey. Overall the profile is at a low level compared to the range recorded from previous surveys. 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 toe has receded by 2.0m. The cliff top has receded around 3.0m since 2009. There has been accretion by up to 0.3m between the cliff toe and the rock platform at chainage 68m. Overall the changes are within the range of beach levels seen in previous surveys and are 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 0.2m from the cliff toe to chainage 42m.There has been accretion on the upper beach to chainage 54m by up to 0.4, forming two small berms at chainages 44m and 49m. There has been a reduction in beach level between chainage 42m and the rock platform at chainage 61m by up to 0.1m. The toe of the beach seawards of chainage 130m shows accretion by up to 0.2m, extending the	between limited data points and inaccessibility of the cliff toe due to unsafe conditions. The upper and middle beach along this section showed accretion, tapering out in the lower beach. Beach levels across this section are within the bounds of previous surveys. To the south of Halliwell Banks at profiles 1bSNS33 to 1bSNS35, changes across the beach are within the bounds of previous surveys.

Survey Date	Description of Changes Since Last Survey	Interpretation
	beach toe by 20m. Overall the profile is at a low level compared to the range recorded from previous surveys. At profile **1bSNS22**, the cliff toe has receded by less than 1.0m since the previous survey and is now at its most landward position since surveys began. There has generally been erosion of the upper beach by up to 0.1m. The shore platform remains unchanged between chainages 58m and 111m. 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 accretion across the upper beach by up to 0.2m, with negligible change across the rock platform. The beach is at a low level compared to the range recorded from earlier surveys, whilst the cliff toe is at its most landward position recorded. At **1bSNS24**, there has been erosion of up to 0.4m on the upper beach between the cliff toe and chainage 98m. There has been negligible change across the rock platform. Overall the profile is at a low level compared to the range recorded from previous surveys, with the section between chainage 70-92m at its lowest level since September 2009. At profile **1bSNS25**, there has been a landward movement of the cliff toe by 0.5m. The upper beach level has risen by up to 0.3m to chainage 66m, switching to erosion on the middle to lower beach by up to 0.2m. There has been negligible change to position of the rock platform. The beach toe extends beyond the rock platform to chainage 134m. The beach profile is at a medium 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 between spring and autumn 2018. All profiles show accretion of between 0.2-1.0m on the upper beach. The middle to lower beach of all profiles exhibit negligible change. Overall, the profiles are at a medium to low level compared to the range recorded from previous surveys. Profiles **1bSNS33** to **1bSNS36** are located around the Pincushion Headland.	

Survey Date	Description of Changes Since Last Survey	Interpretation
	At profile **1bSNS33**, there has been accretion across the beach profile by up to 0.6m and the beach toe has extended by 28m. Overall, the profile is at a medium level compared to the range recorded from previous surveys. At Profile **1bSNS34,** the cliff toe shows a recession of 3m. The rest of the profile has changed little since the previous survey. Profile **1bSNS35** shows a loss of up to 0.8m of material at the toe of the cliff. Sediment between rocks has been removed since the previous survey in spring 2019.The profile is at a relatively low level compared to the range recorded from previous surveys. Profile **1bSNS36** shows negligible change across the entire beach survey. The profile remains at a low 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 2019) have been used to create a DGM (Appendix B – Map 2) using a GIS. A difference plot has also been produced using the DGM (Appendix B – Map 4) produced from the last produced topographic survey (Full Measures, autumn 2018) and the present survey. The survey shows accretion dominates in the northern part of the bay, concentrated on the middle to lower beach. There is a large band of erosion occurring from the centre of the bay southward, tapering out along the lower shoreface, whilst accretion dominates on the middle and upper beach of the most southerly part of the bay.	The short-term change plot does not show a clear pattern of sediment movement, with accretion dominating in the north and south of the bay and erosion dominating in the centre of the bay. All change is generally of relatively low magnitude (±0.75m).
November 2019	**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	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

Survey Date	Description of Changes Since Last Survey	Interpretation
	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 2019) survey apparent erosion greater than the error has occurred at 8 locations; GCP7, GCP8, GCP18, GCP21, GCP28B, GCP30, GCP31 and GCP32 with an average loss of 0.64m recorded (with a maximum loss of 1.48m at GCP28B). Since surveys began in March 2009 (or September 2009 for 28A, 28B, and 28C) erosion greater than the survey error has occurred at around 89% of the ground control points, where total losses are 11.6m (at location 27) at their greatest, and more typically less than 5m. The long-term erosion rates are up to 1.13m/yr. (location 27), with up to 0.5m/yr. being more typical.	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.

Topographic Survey

No problems were encountered.

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. Several sections along the bay are now at their highest level recorded, including 52-64m chainage at 1bSNN1, 100-135m at 1bSNN2, 54-74m at 1bSNN3, 24-64m at 1bSNN4, 40-125m at 1bSNN5 and 164-204m at 1bSNN7. There are also a couple of sections at their lowest levels recorded, including 165-210m at 1bSNN3 and 10-24m at 1bSNN6. 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 2019 was 11.26m at Point 27 which is on the northern border of the landfill site. Since the last survey, the greatest erosion has been at Point 28B (cliffs at the landfill site), where the cliff edge has receded 1.48m.

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

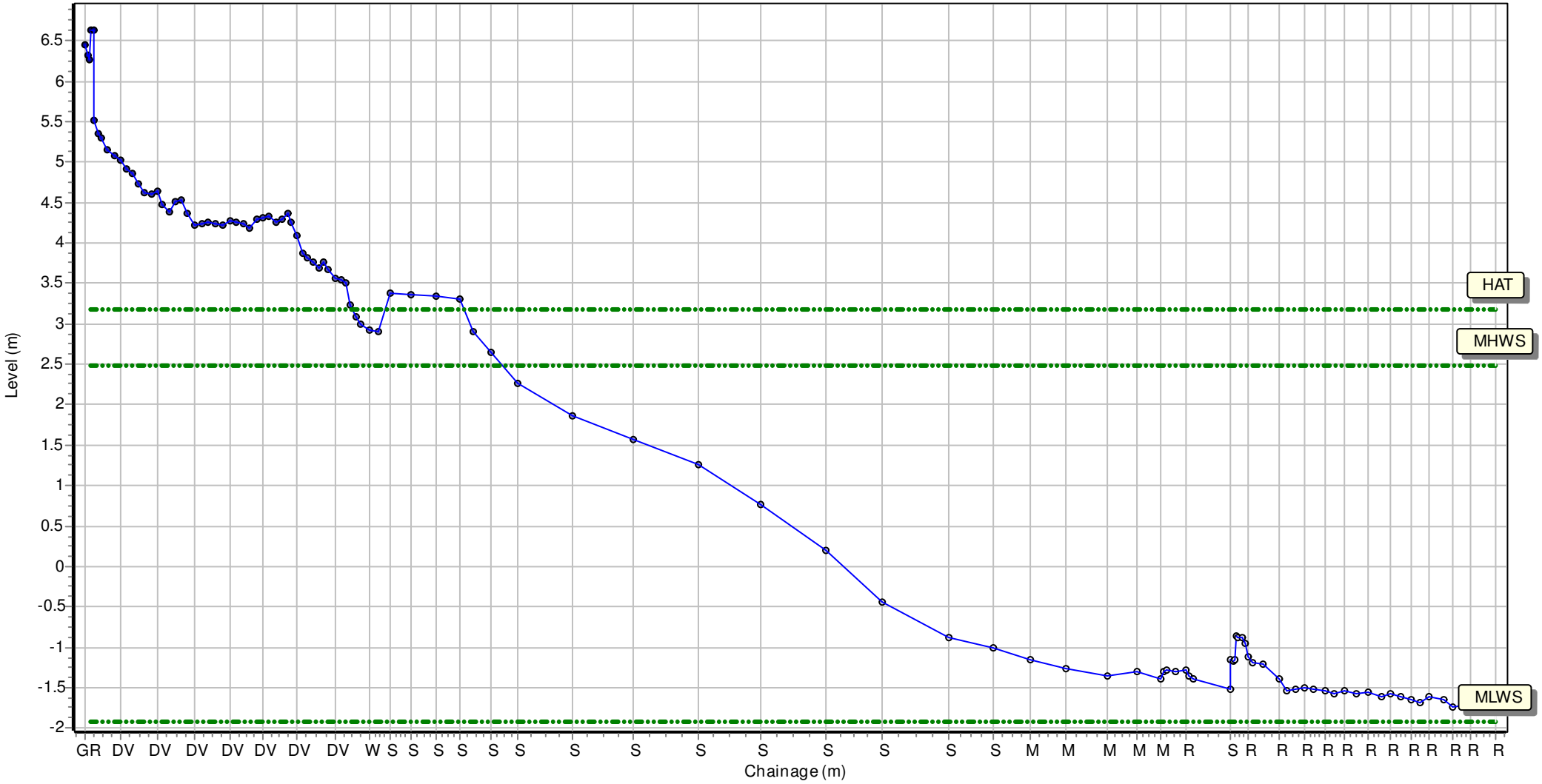
Location: **1bSNN1**

Date: 15/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

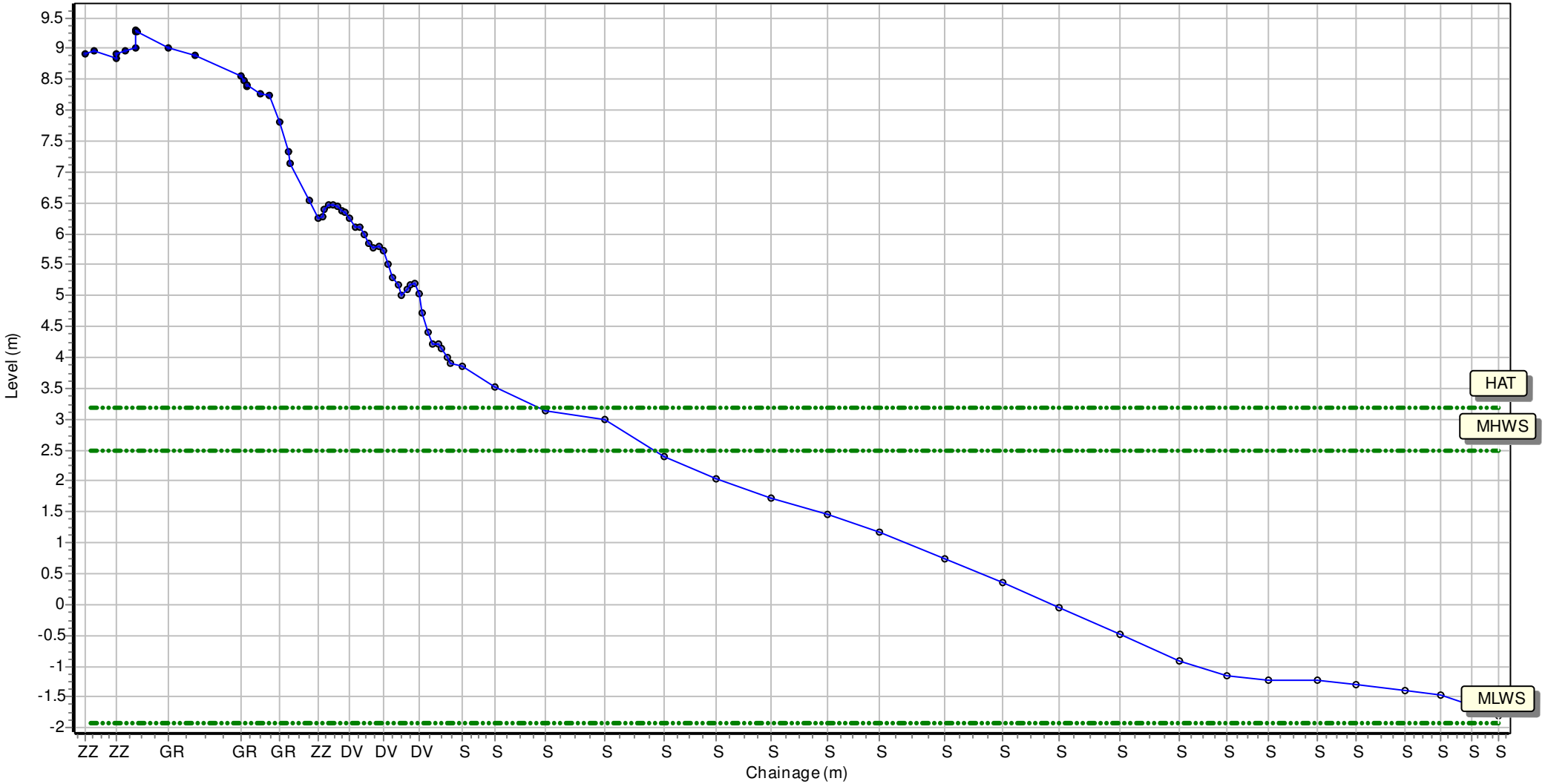
Location: **1bSNN2**

Date: 15/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

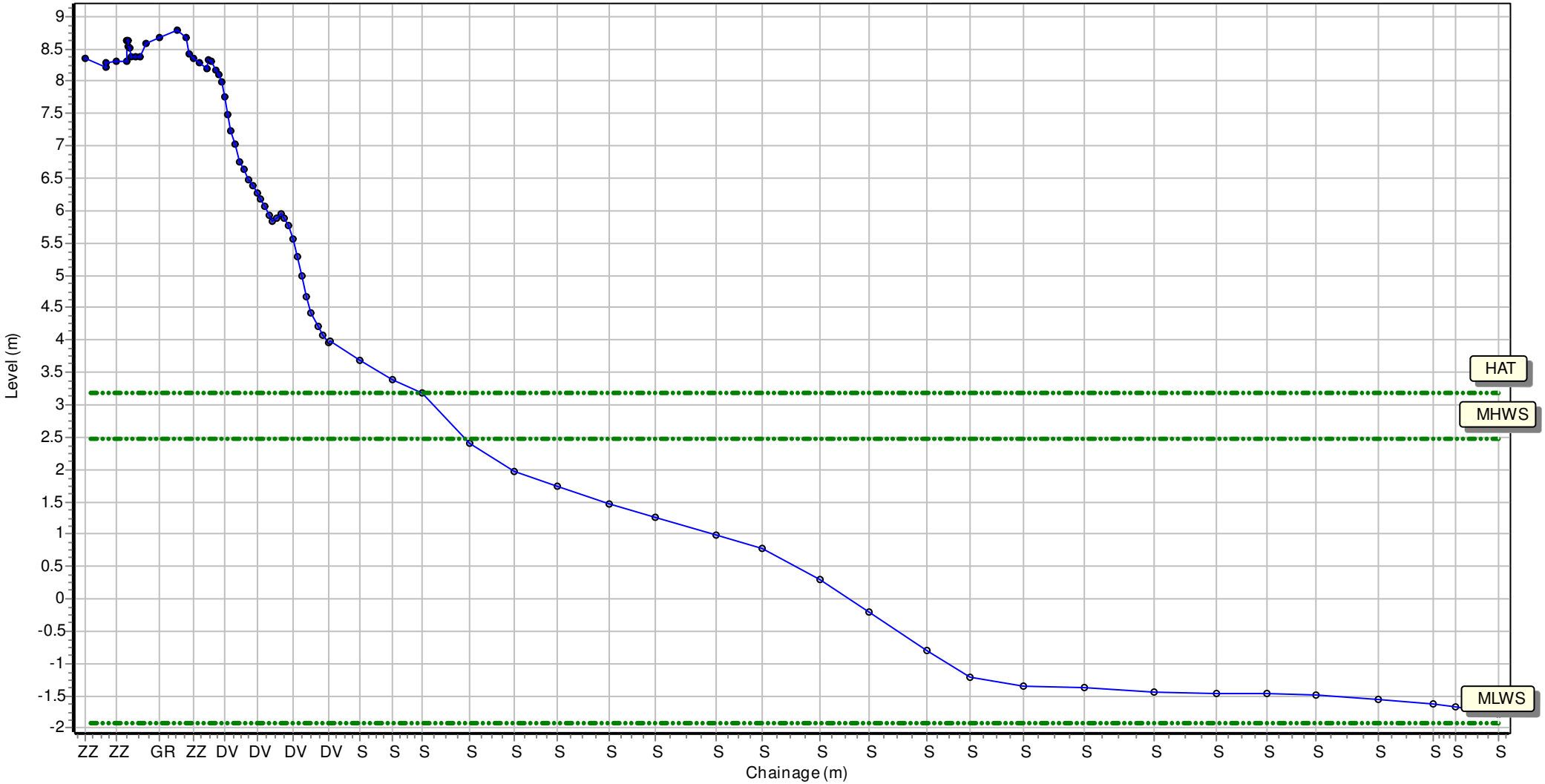
Location: **1bSNN3**

Date: 15/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

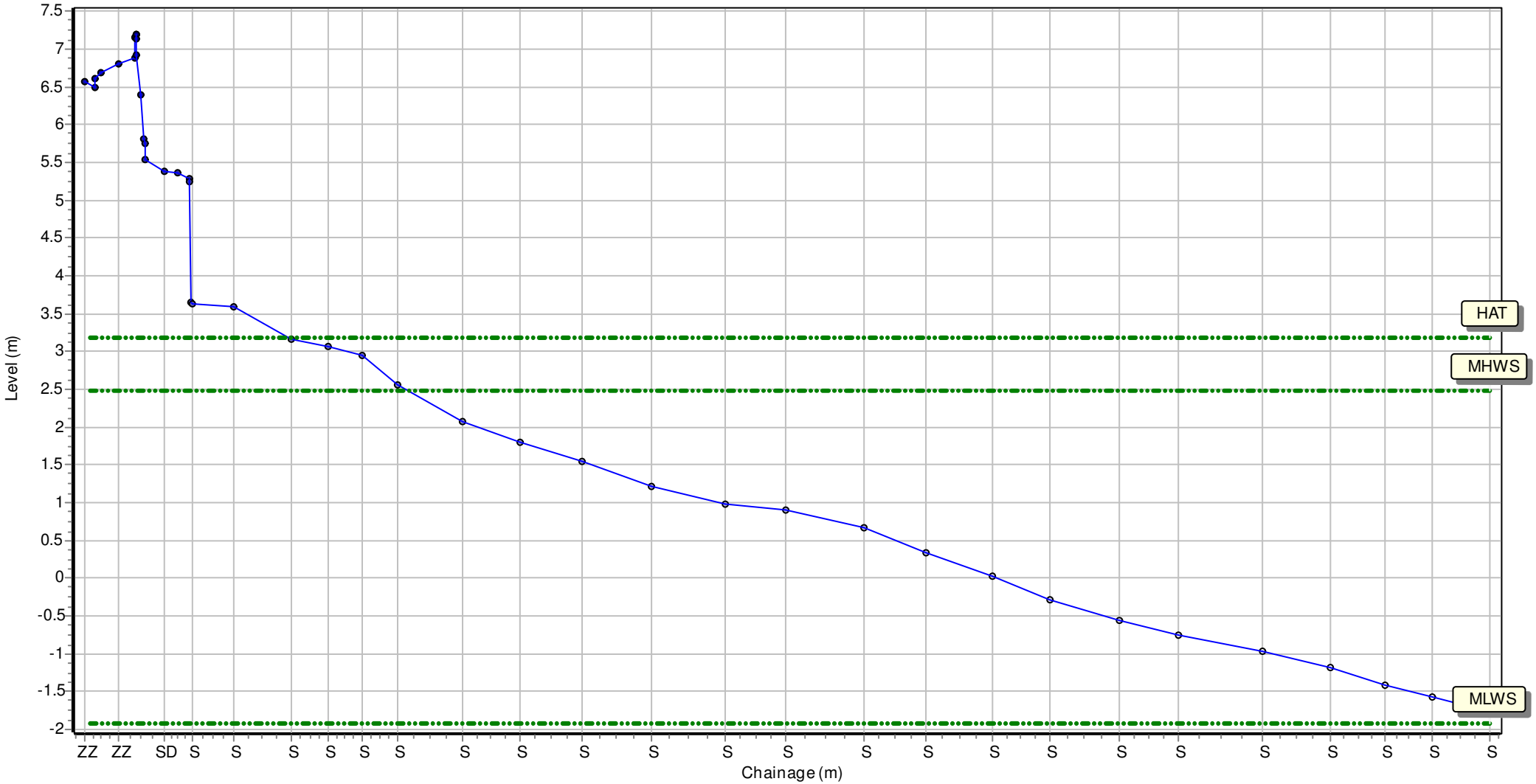
Location: **1bSNN4**

Date: 15/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

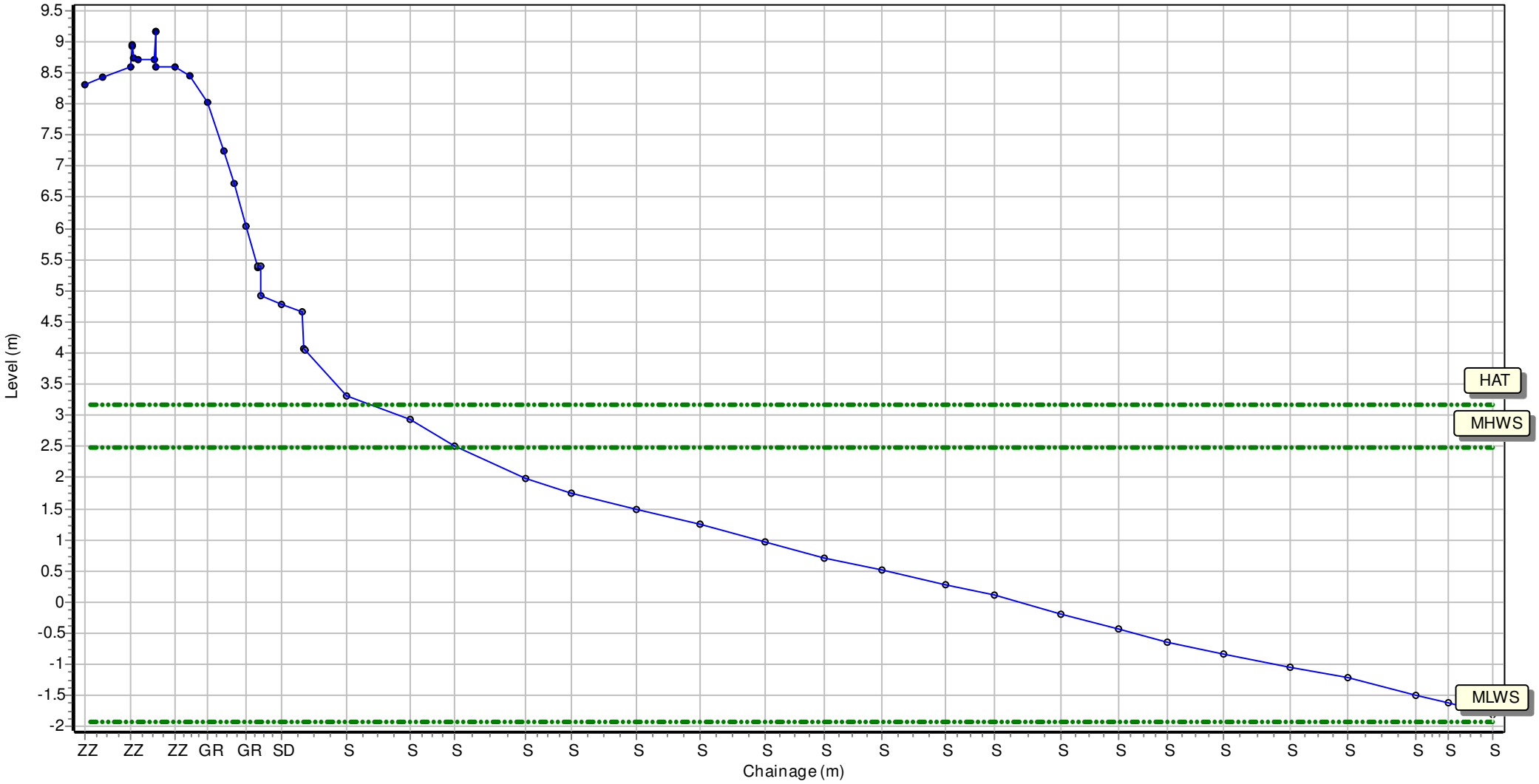
Location: **1bSNN5**

Date: 15/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

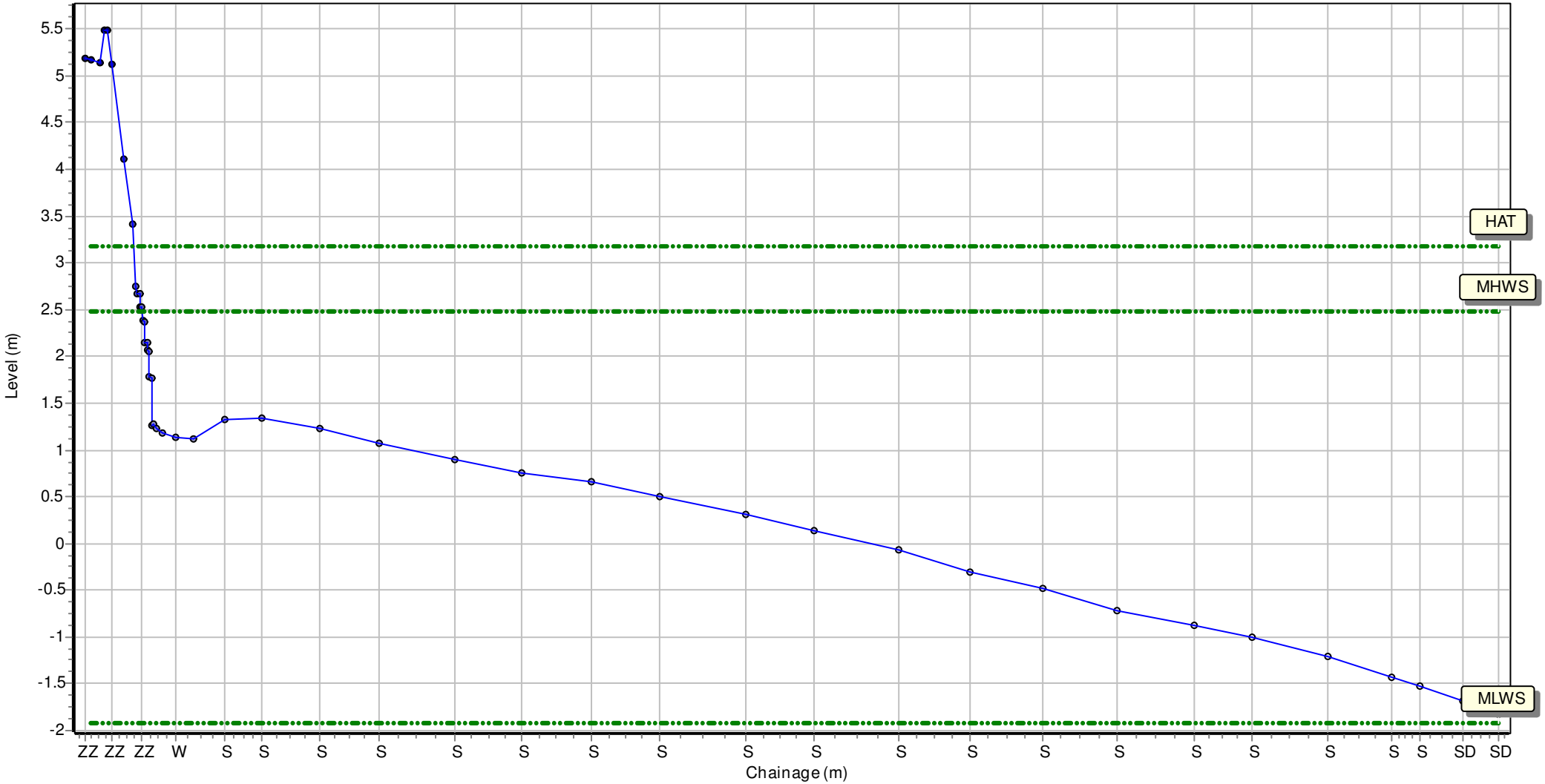
Location: **1bSNN6**

Date: 15/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

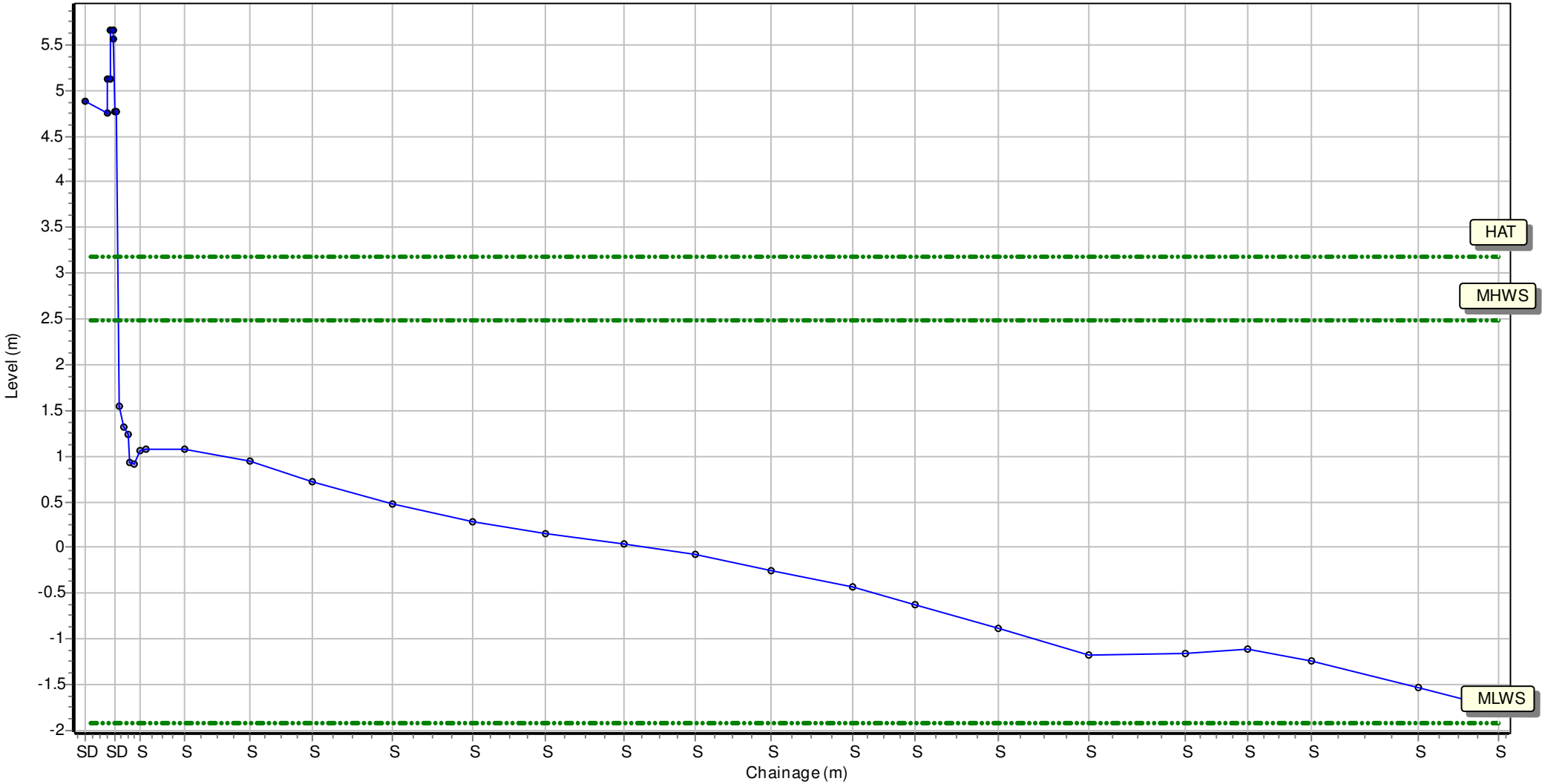
Location: **1bSNN7**

Date: 15/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

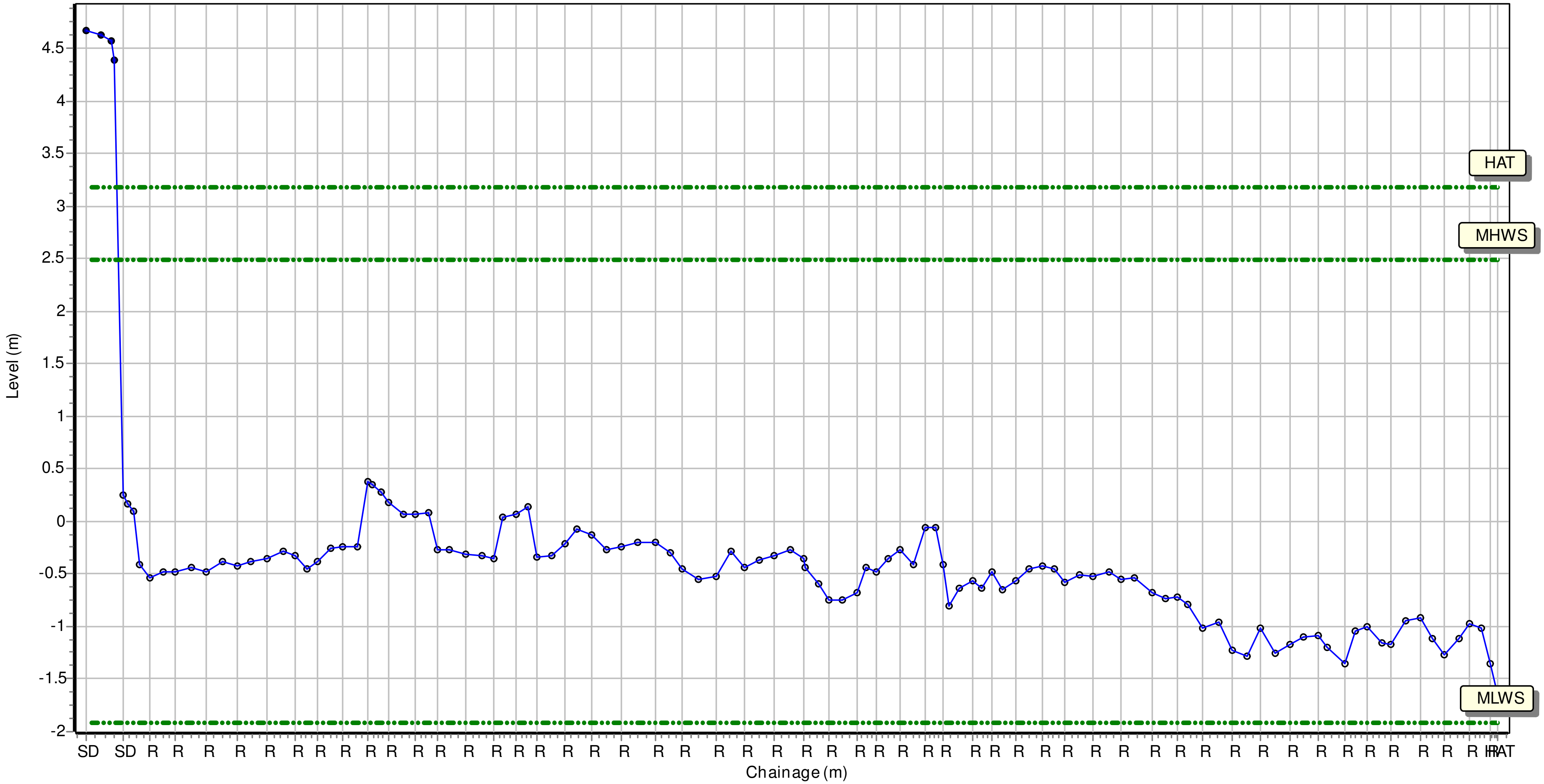
Location: 1bSNN8

Date: 15/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

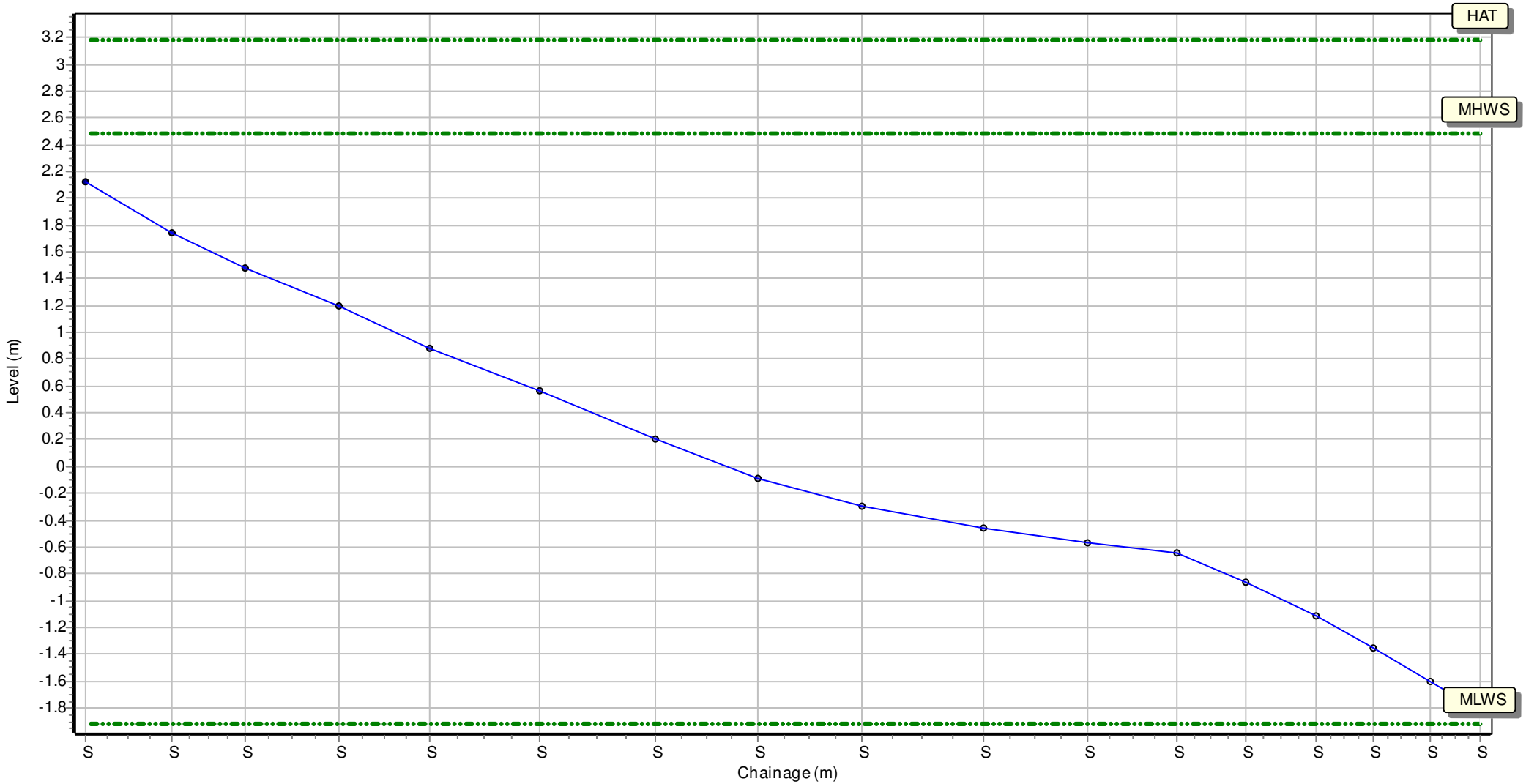
Location: **1bSNN9**

Date: 15/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

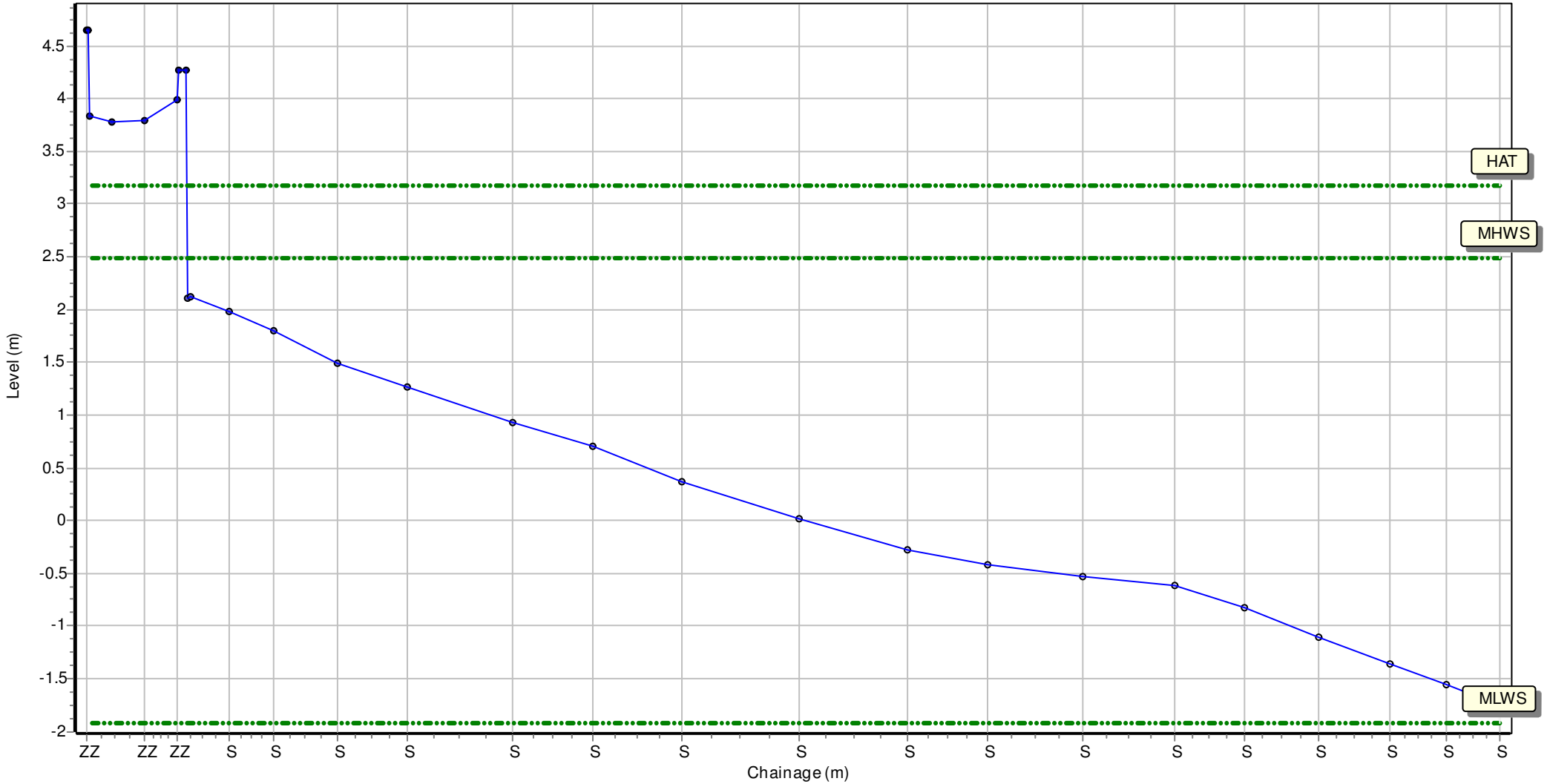
Location: **1bSNN10**

Date: 15/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

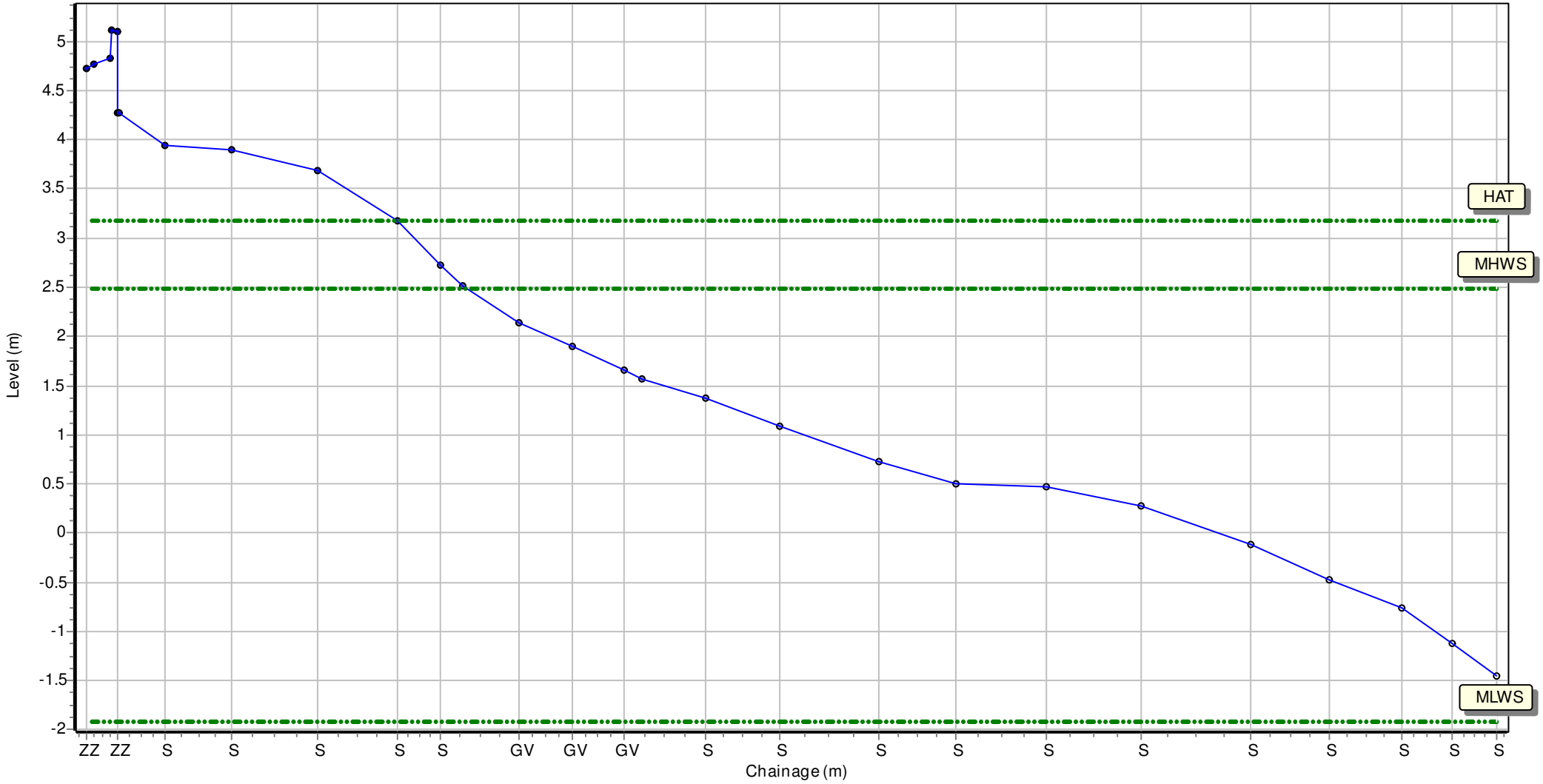
Location: **1bSNN11**

Date: 15/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

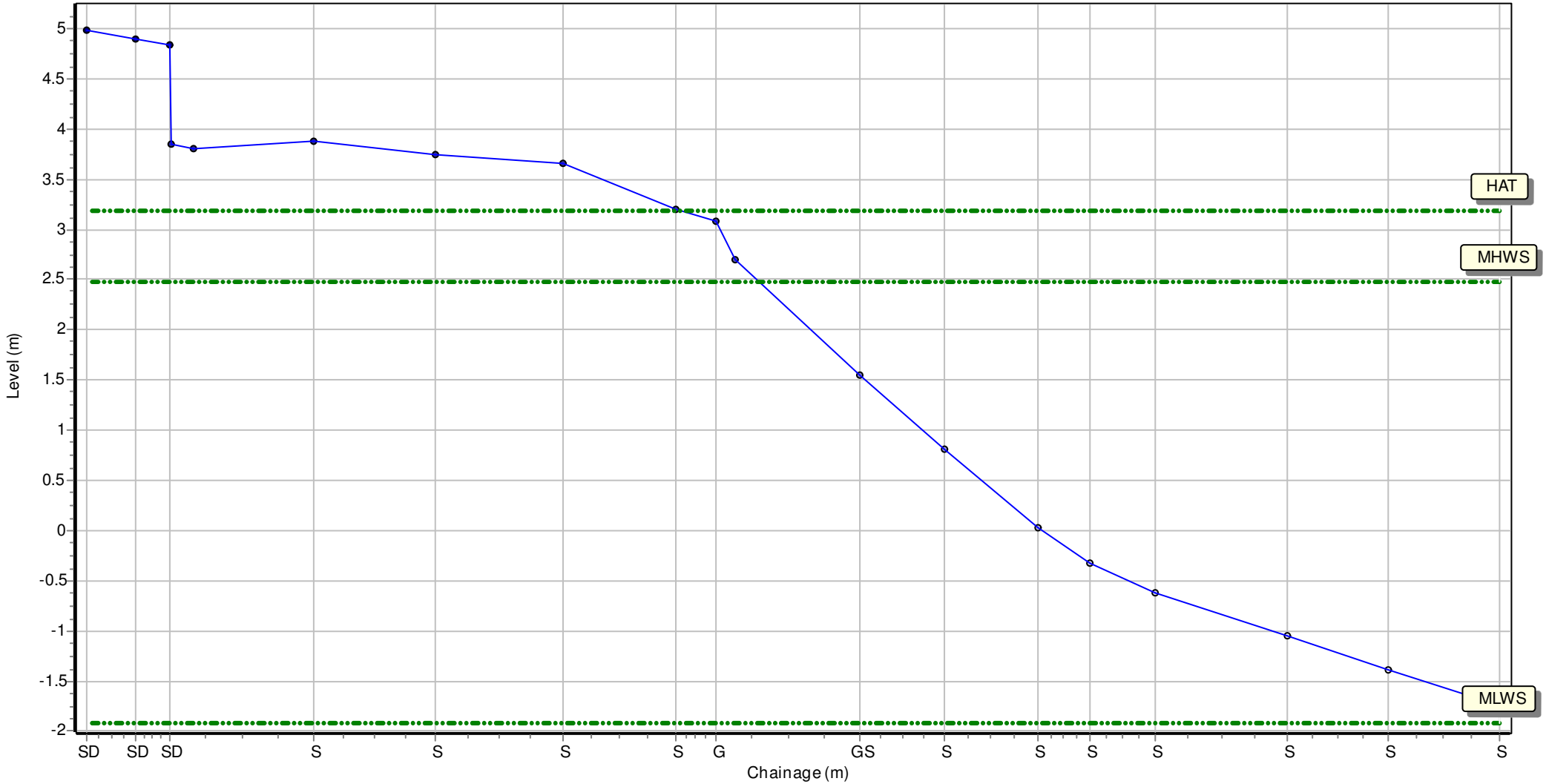
Location: **1bSNN12**

Date: 15/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

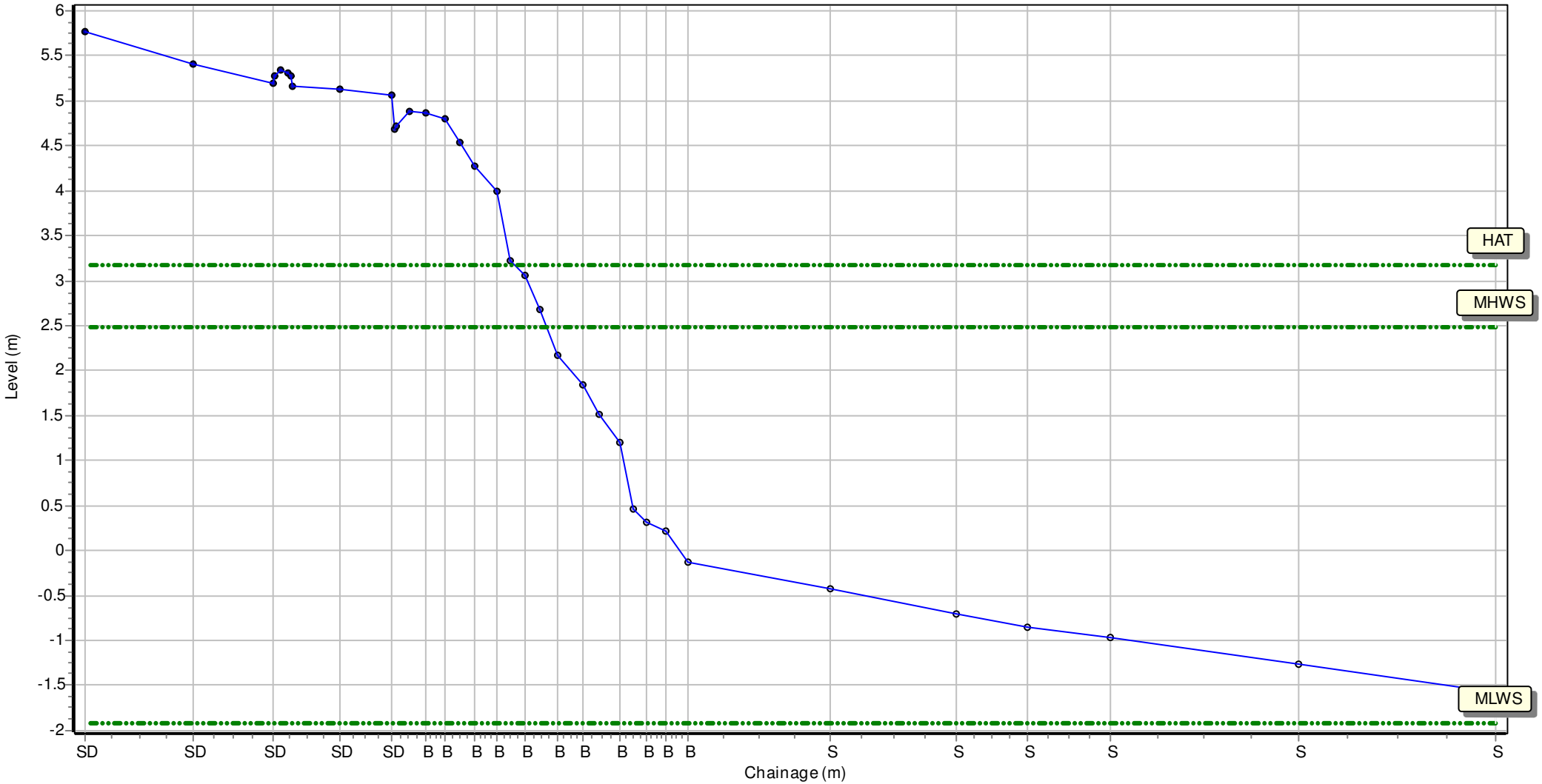
Location: **1bSNN13**

Date: 15/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

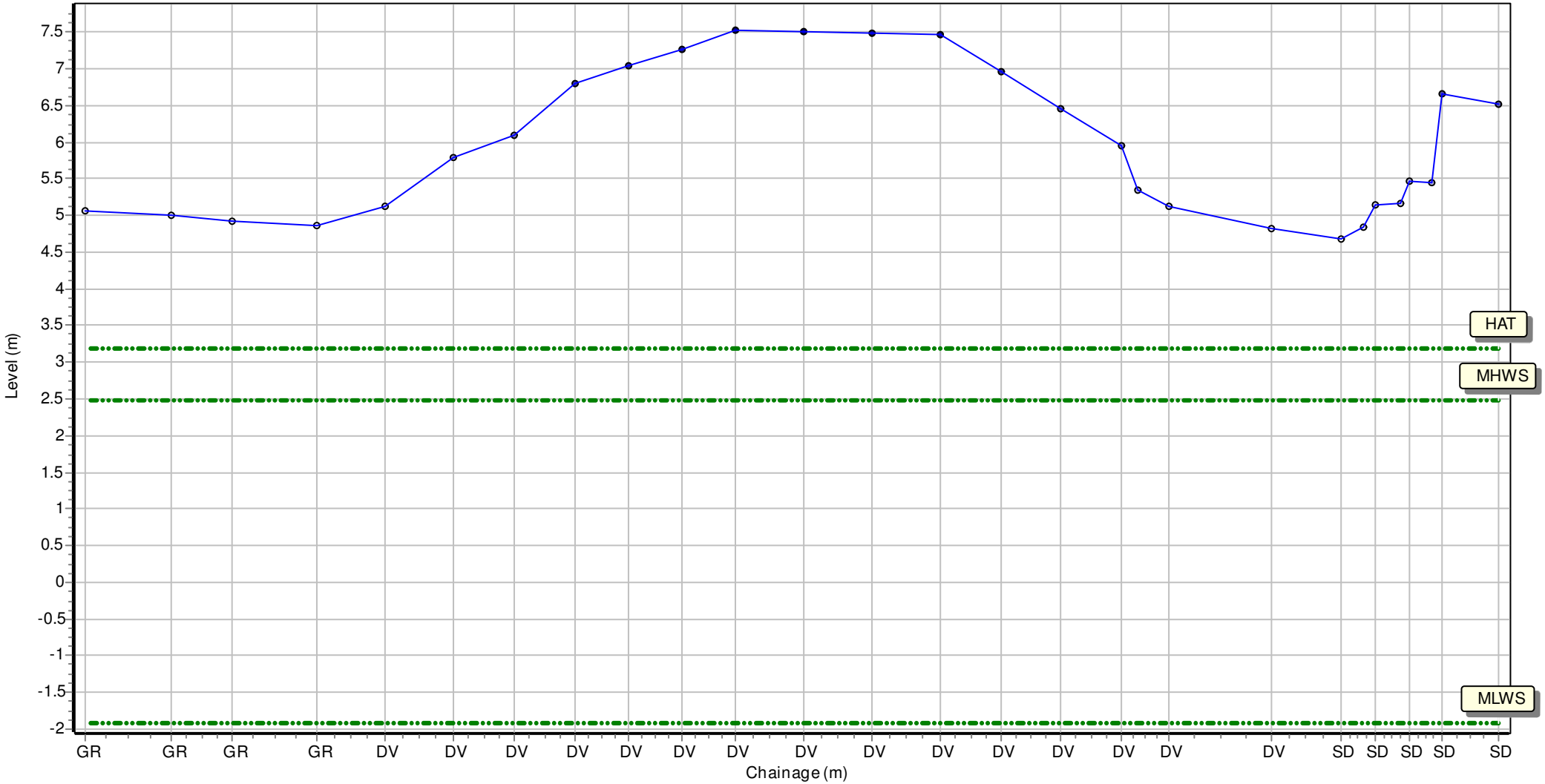
Location: **1bSNC1**

Date: 04/09/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

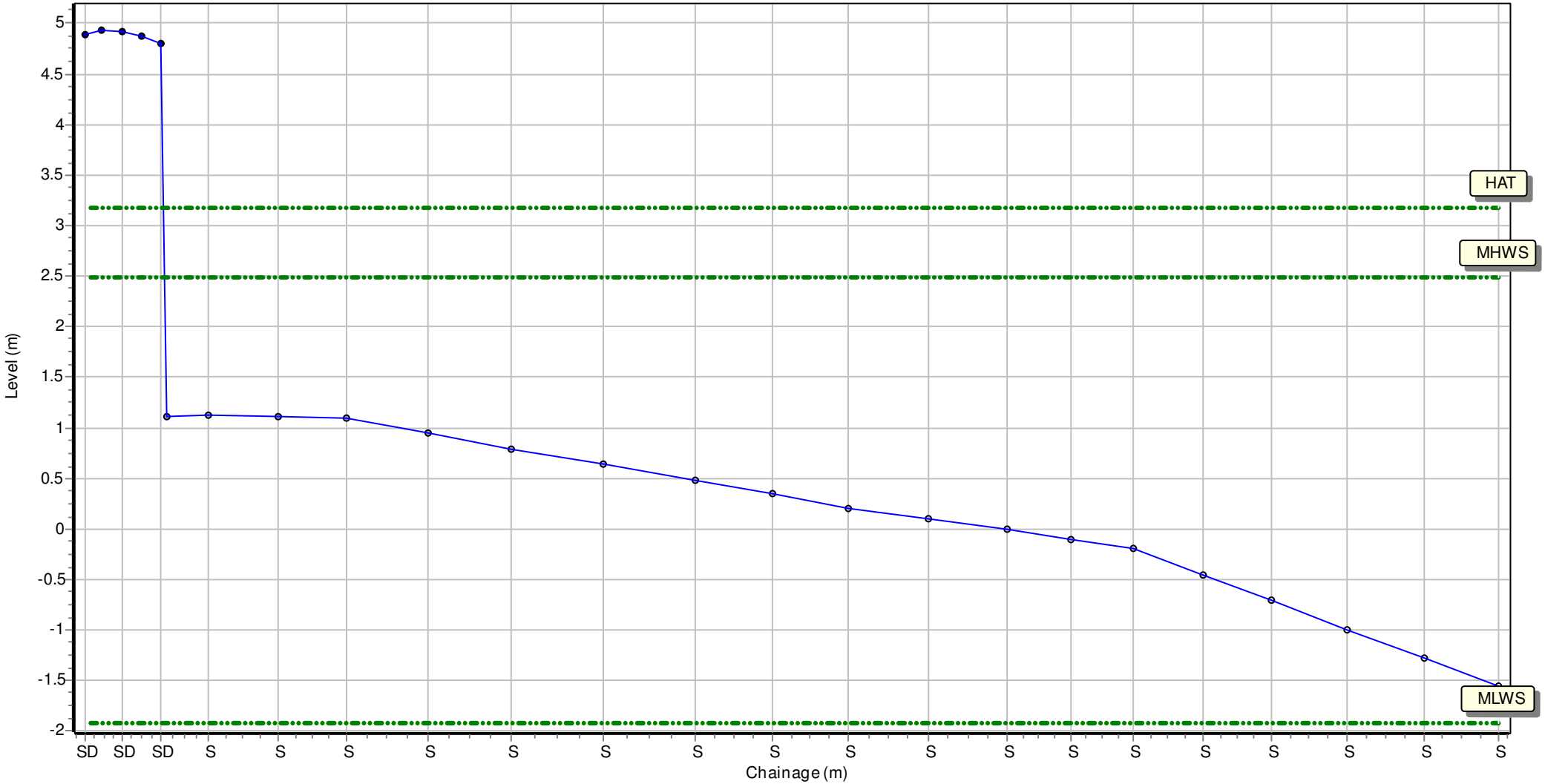
Location: **1bSNC2**

Date: 04/09/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

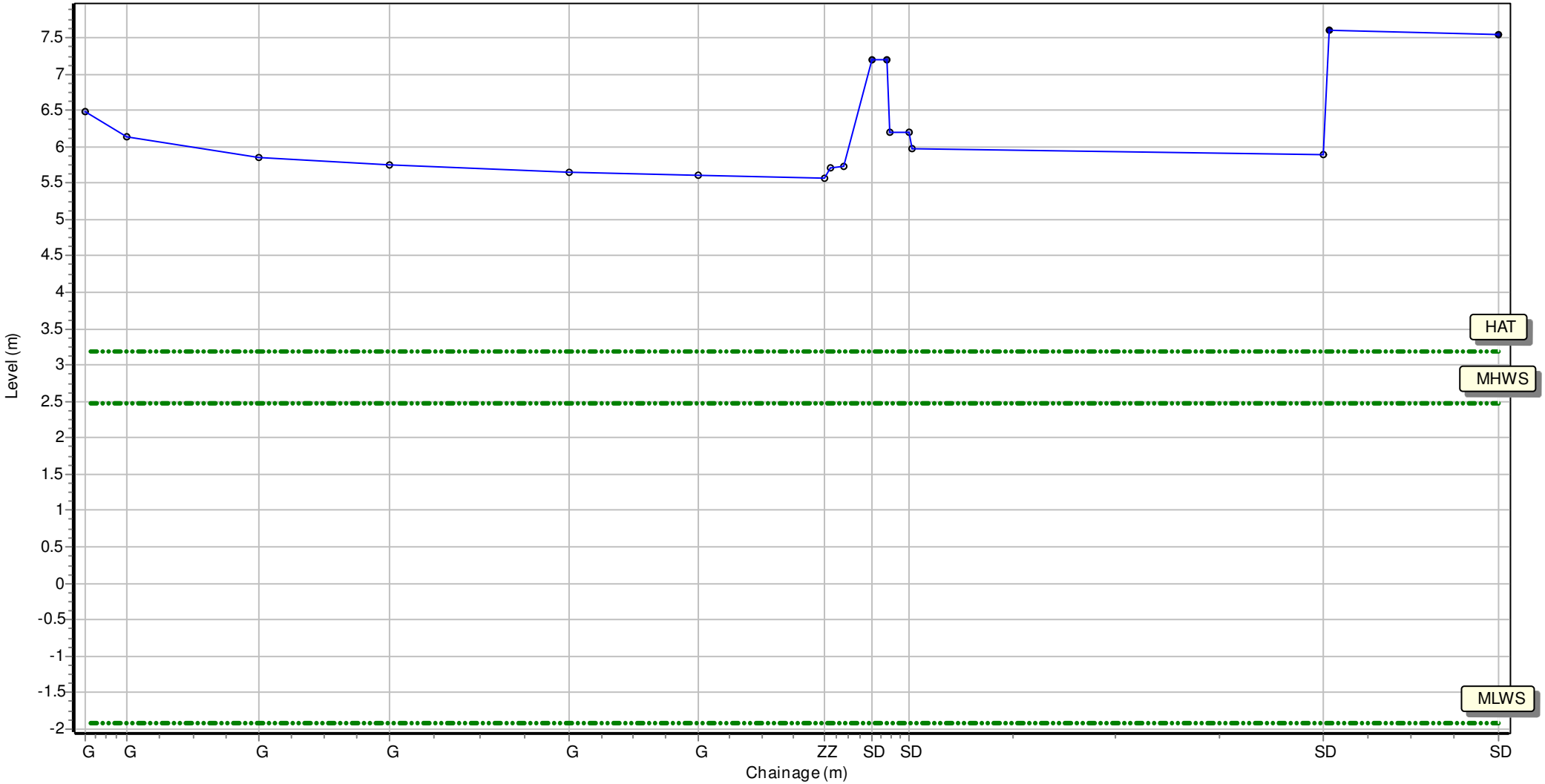
Location: **1bSNC3**

Date: 04/09/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

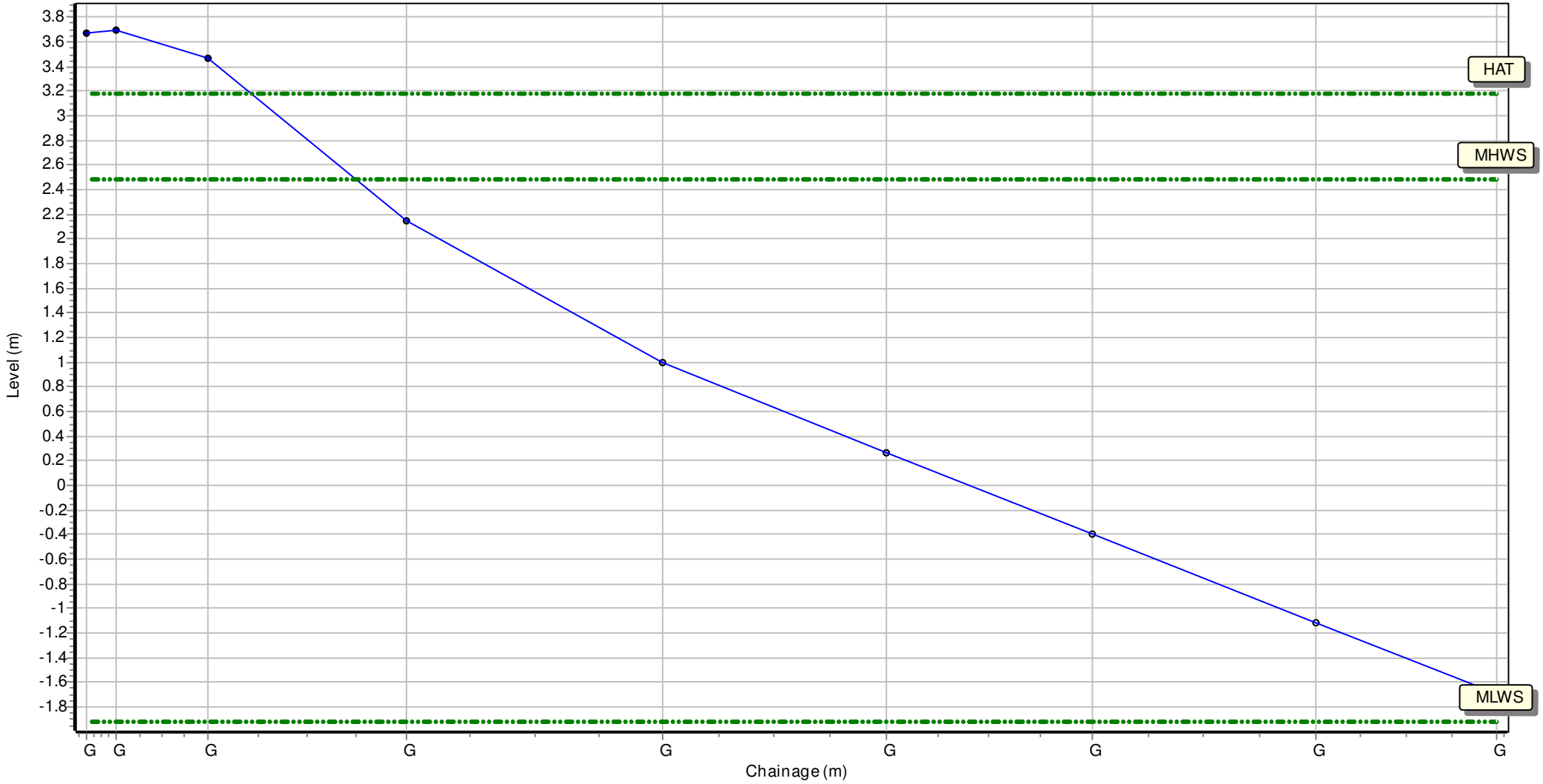
Location: **1bSNC4**

Date: 04/09/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

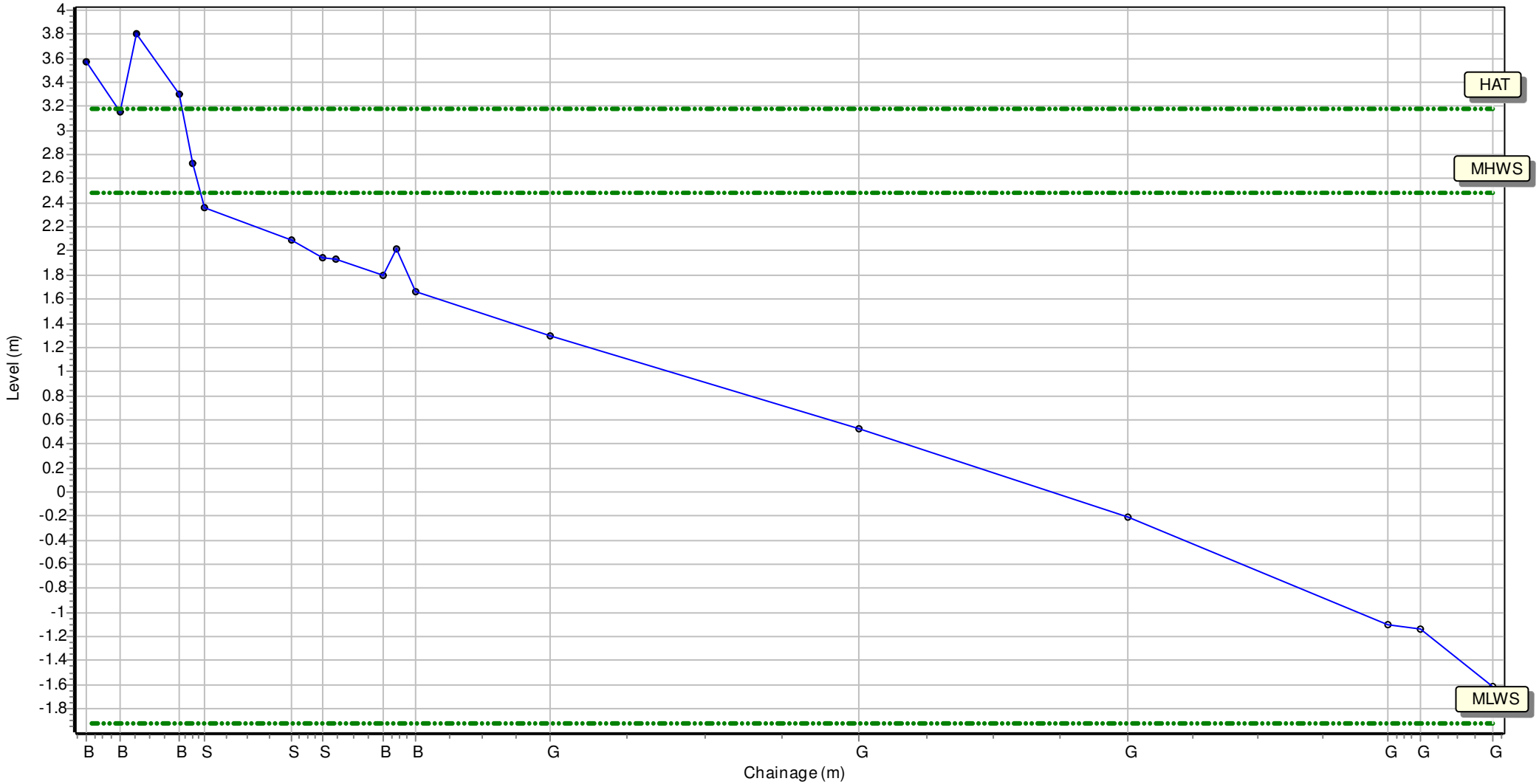
Location: **1bSNC5**

Date: 04/09/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

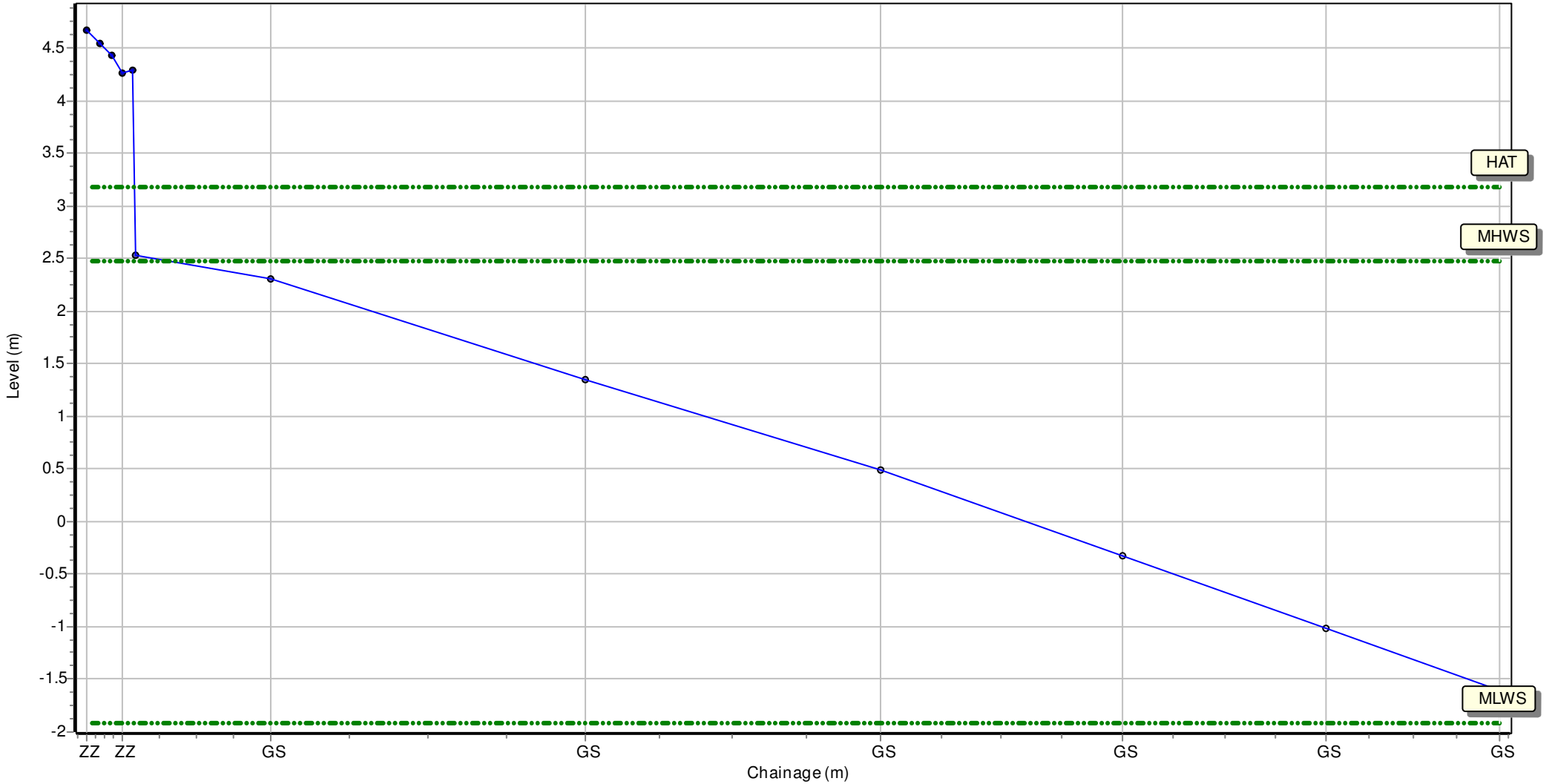
Location: **1bSNC6**

Date: 04/09/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

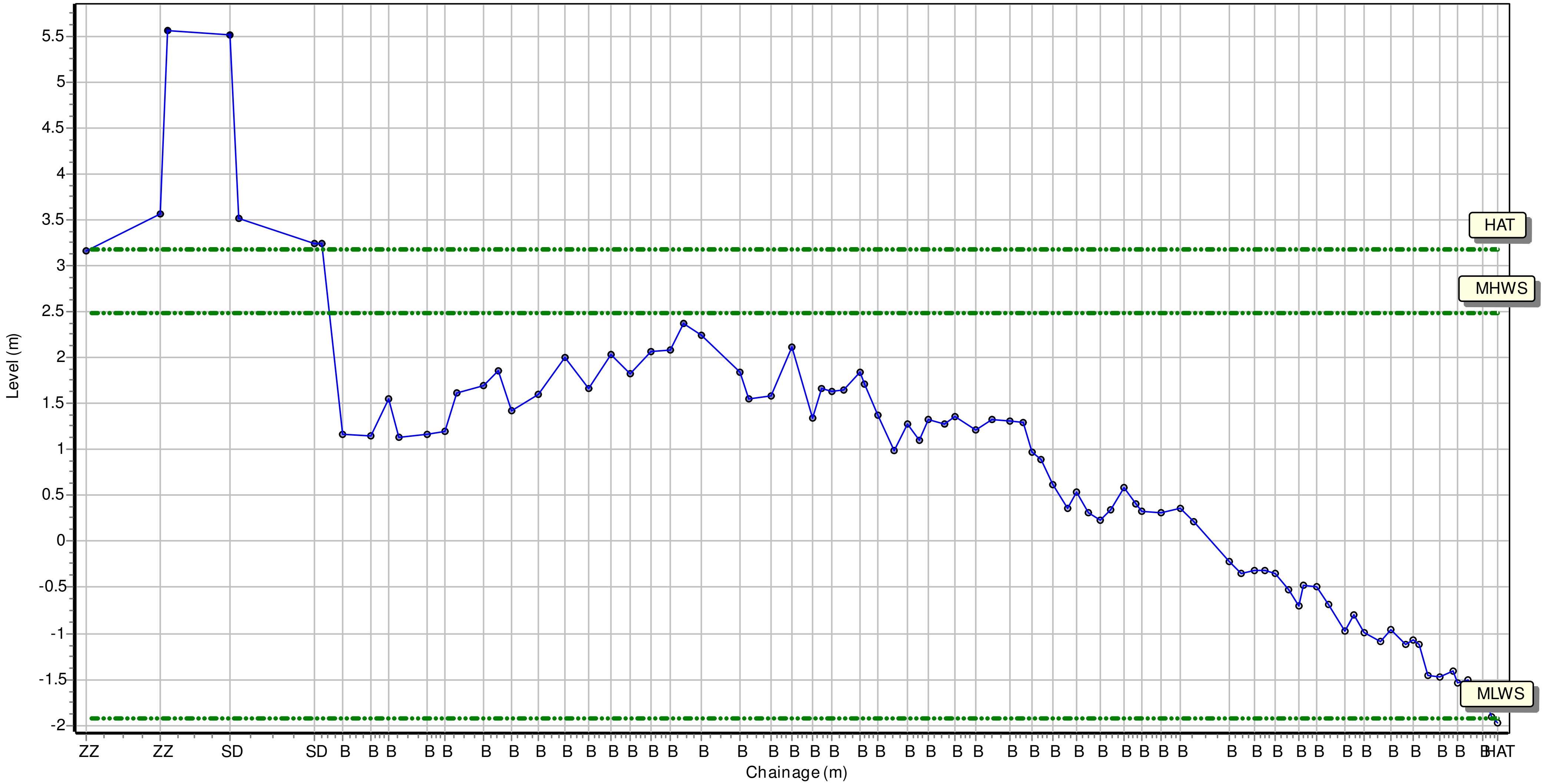
Location: 1bSNC7

Date: 04/09/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



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Beach Profile

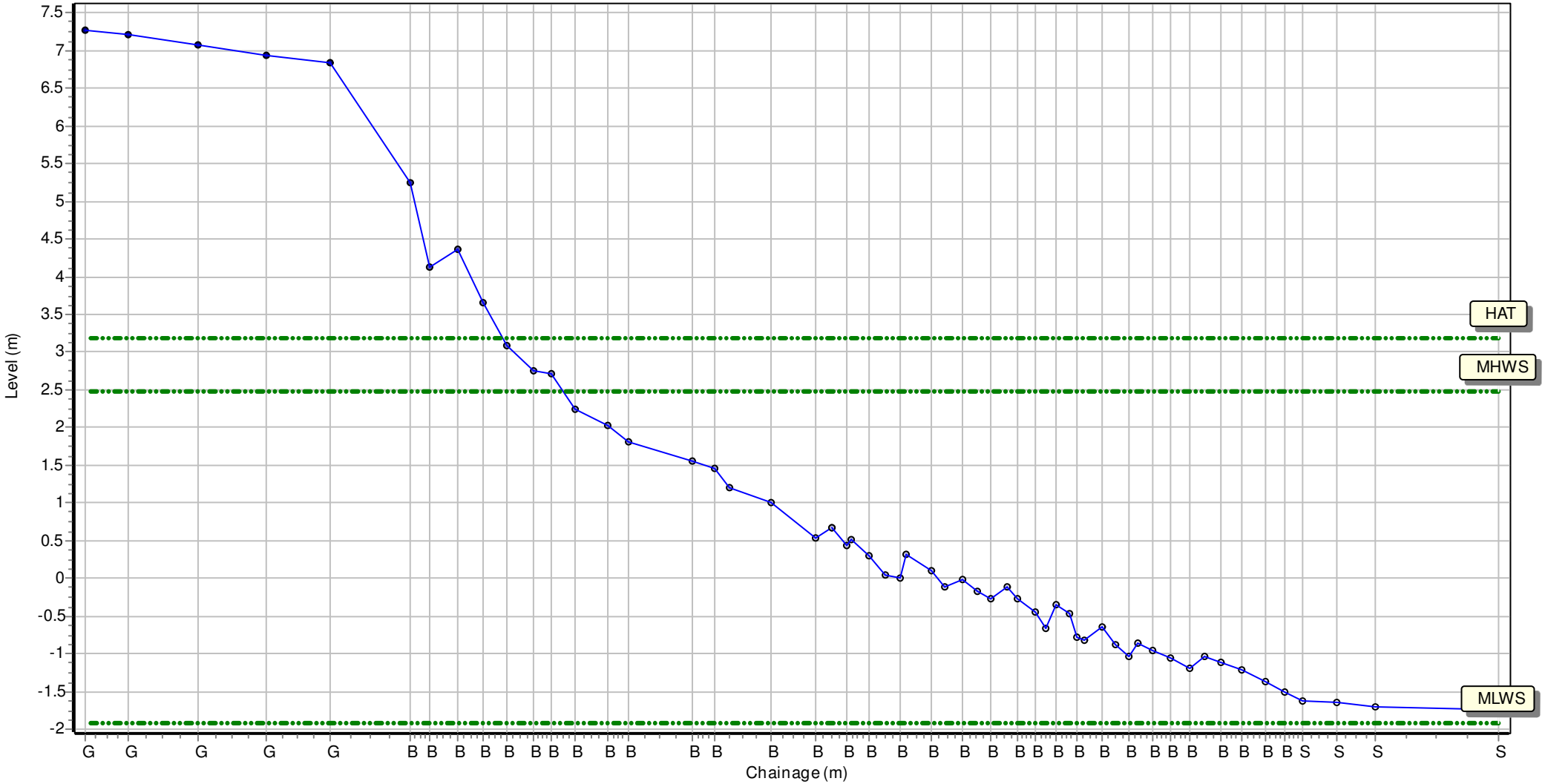
Location: **1bSNC8**

Date: 04/09/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

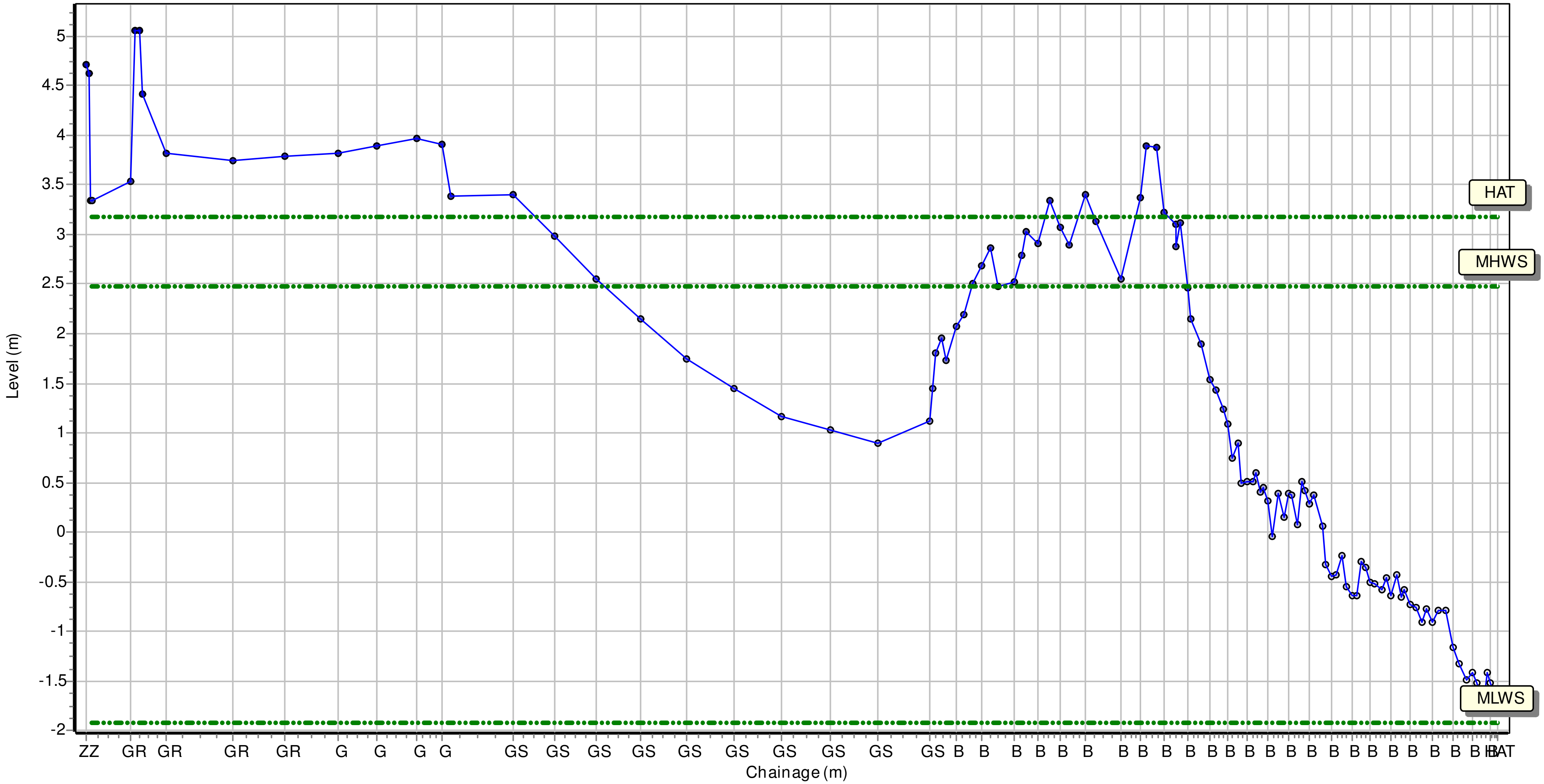
Location: **1bSNC9**

Date: 04/09/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



http://www.sandsuser.com

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Beach Profile

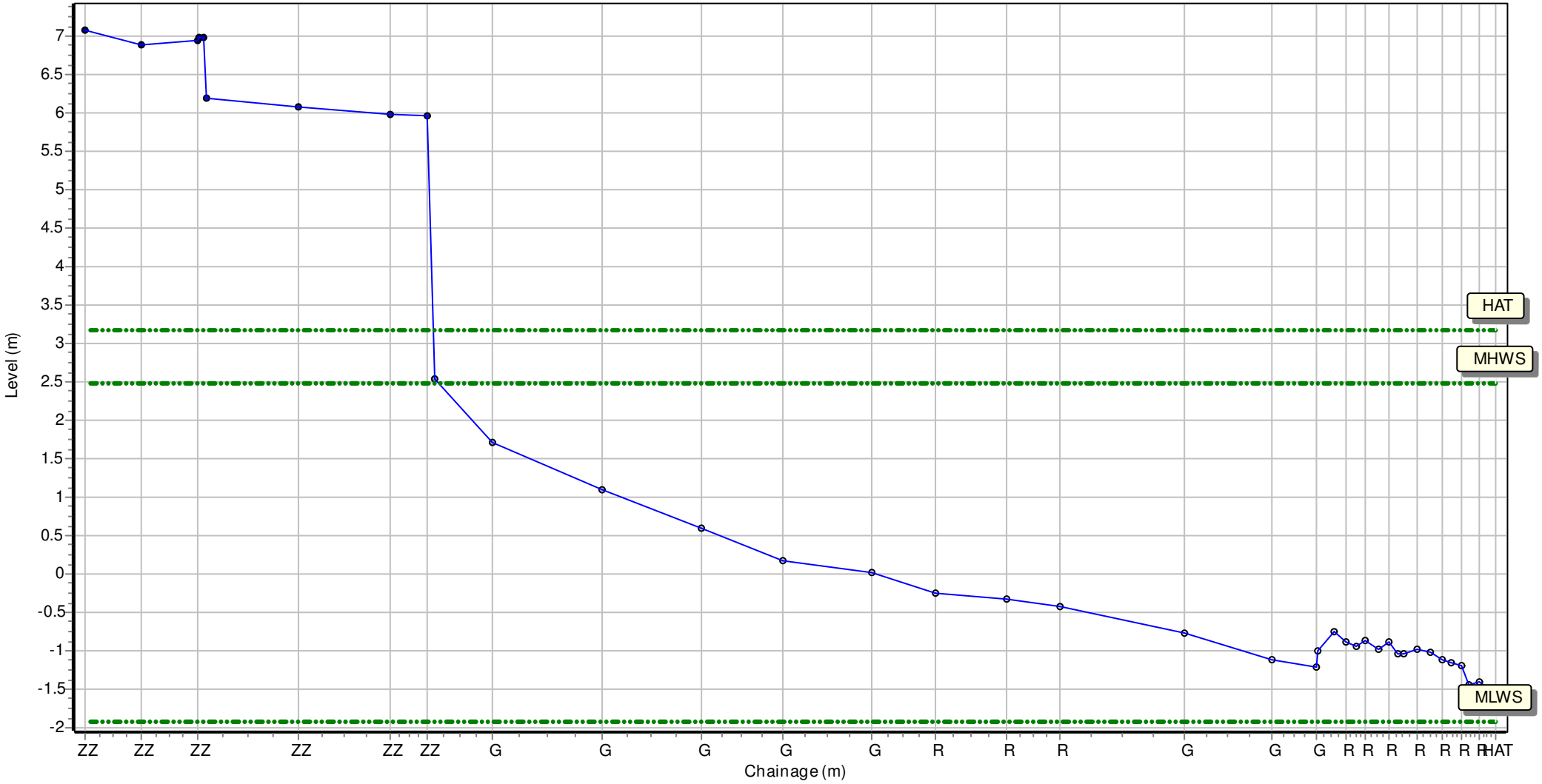
Location: **1bSNS7**

Date: 13/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

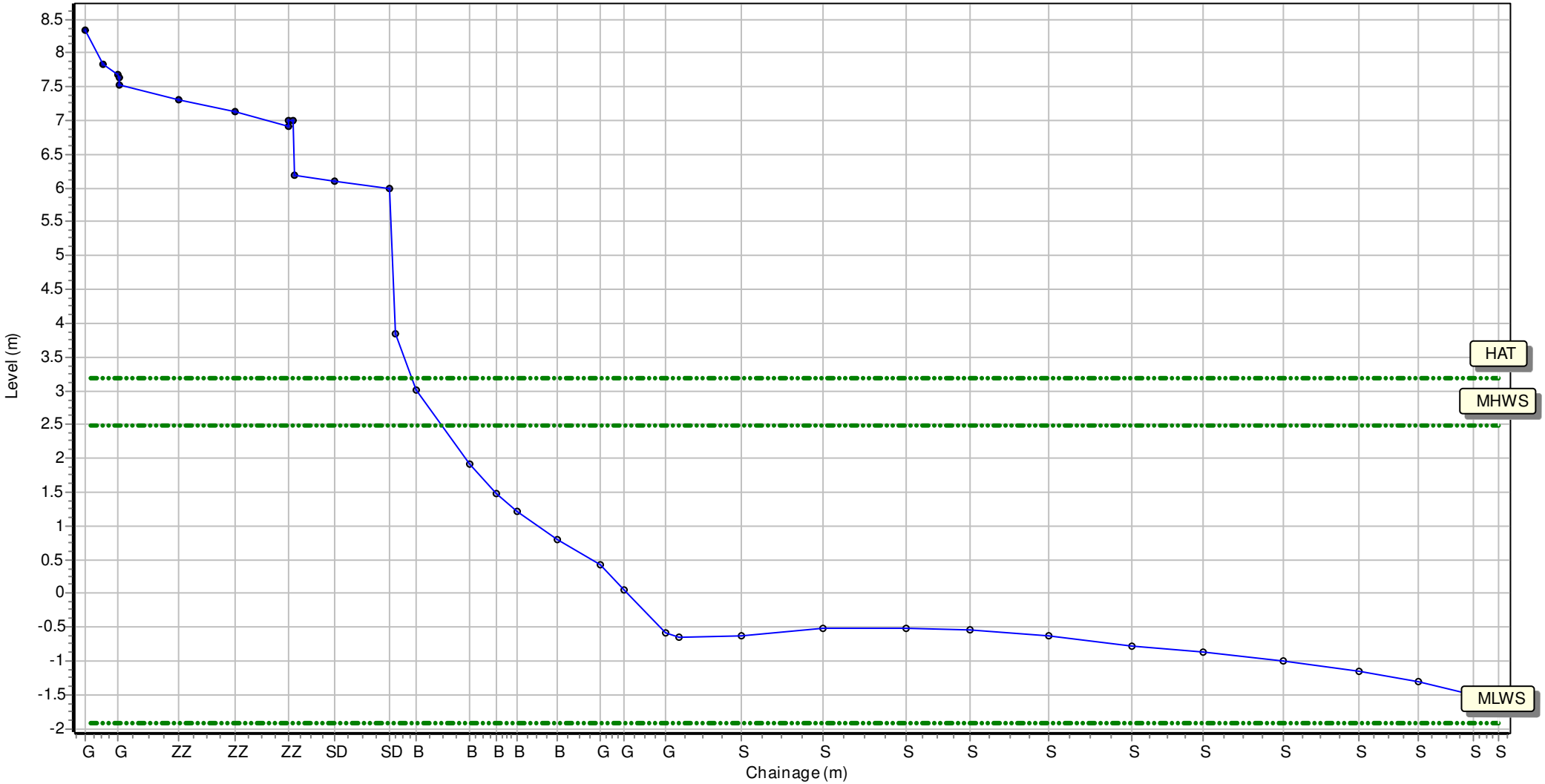
Location: **1bSNS8**

Date: 13/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

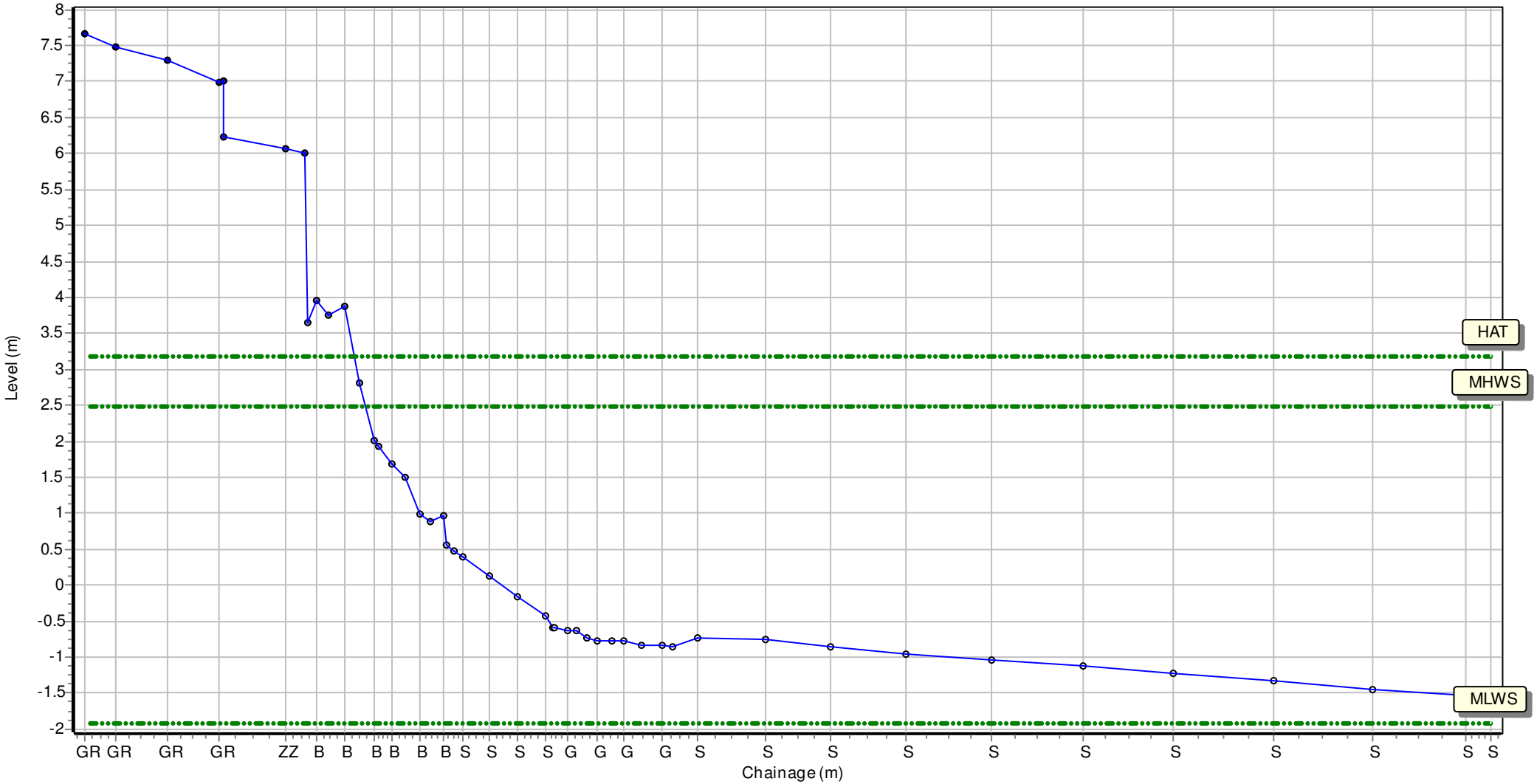
Location: **1bSNS9**

Date: 13/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

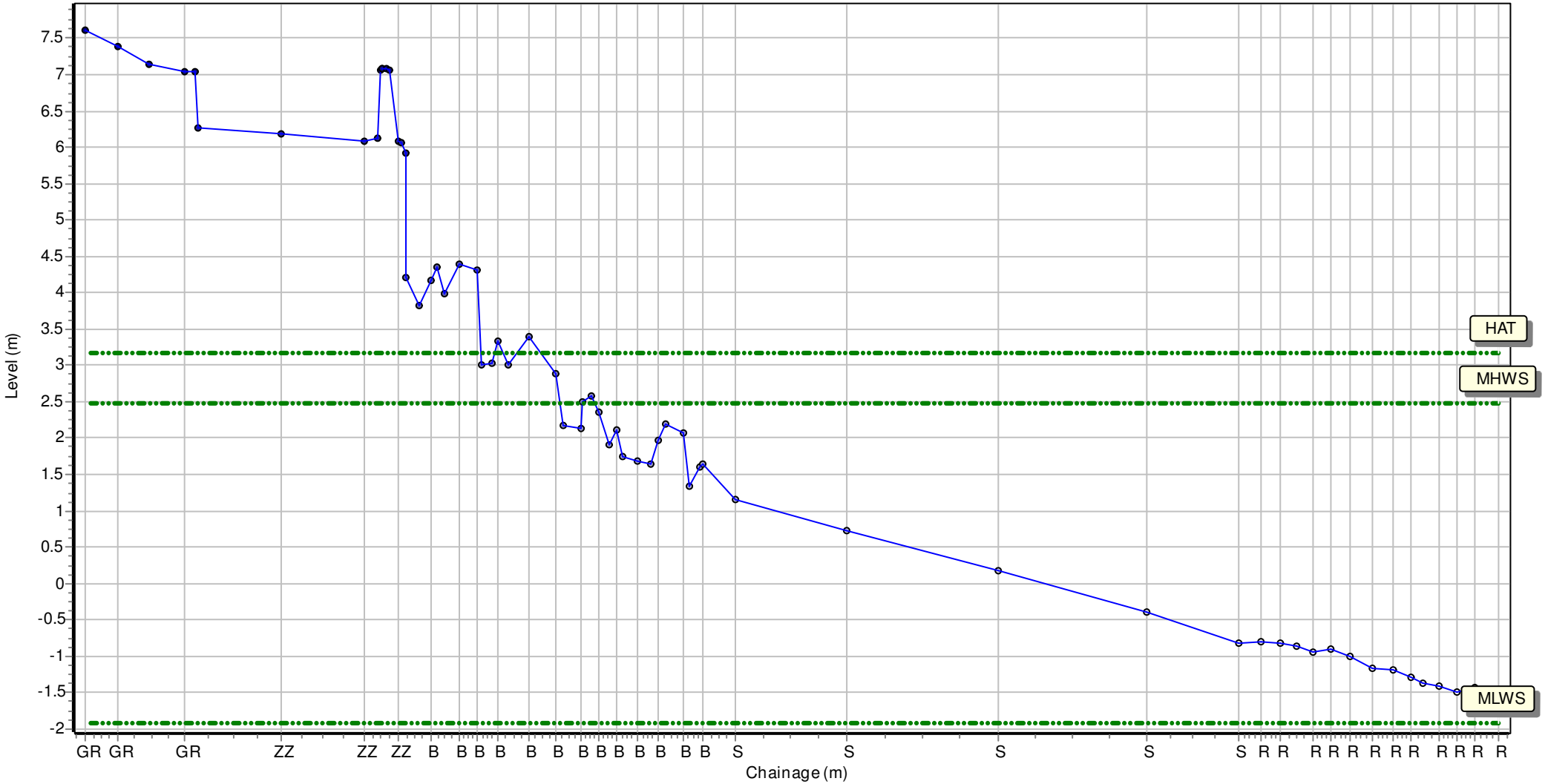
Location: **1bSNS10**

Date: 13/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

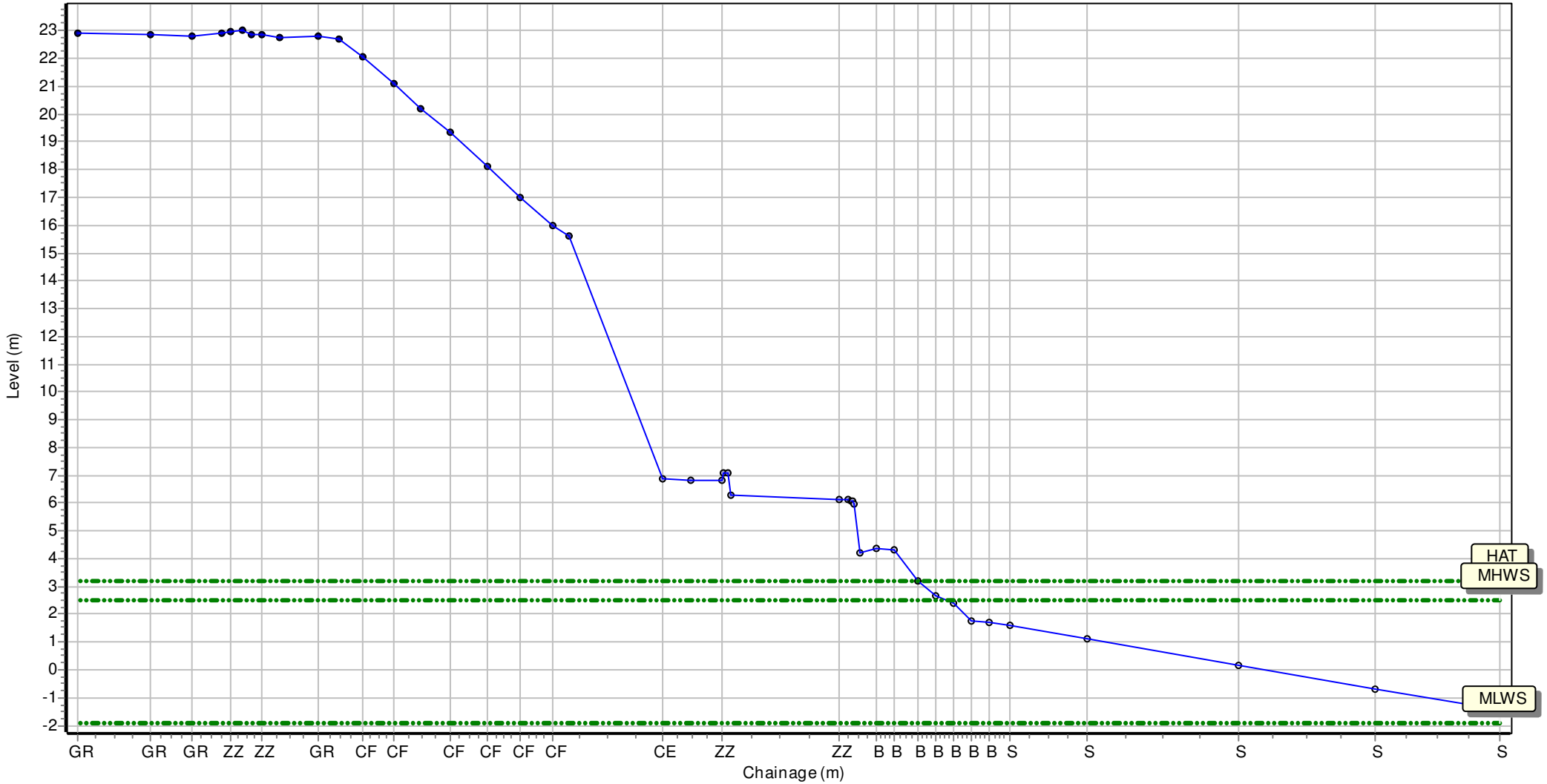
Location: **1bSNS11**

Date: 13/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

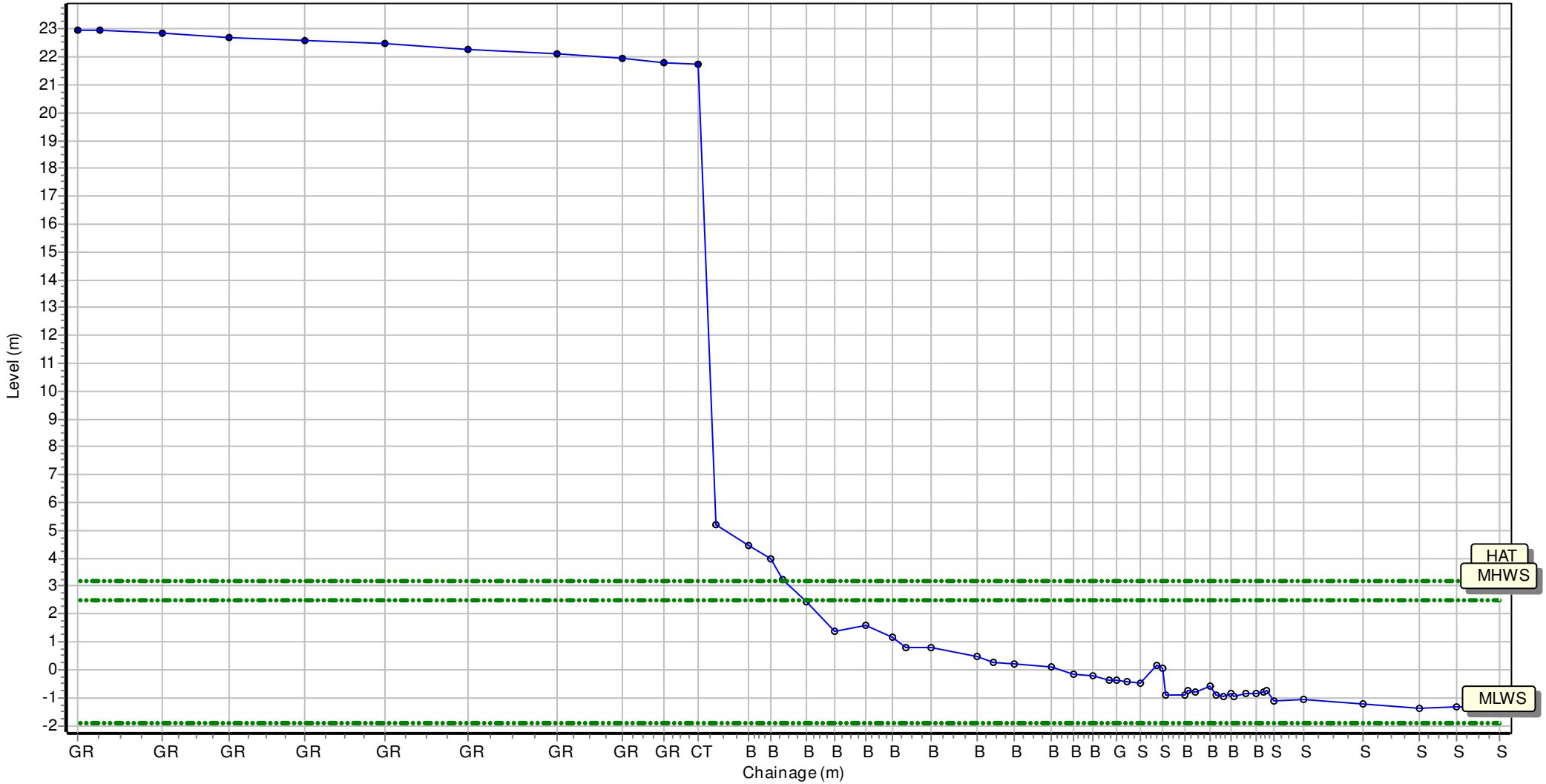
Location: **1bSNS12**

Date: 13/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

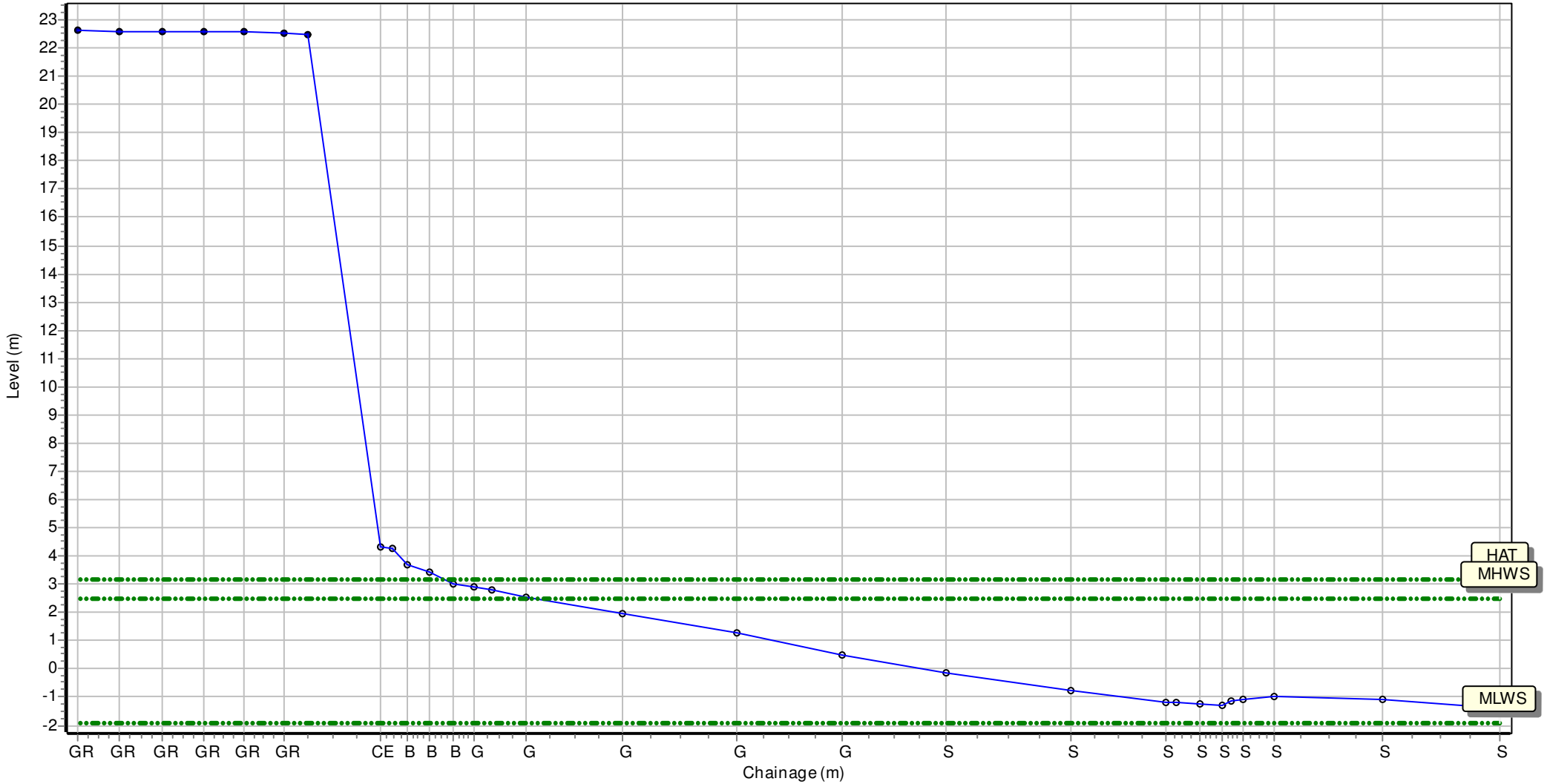
Location: **1bSNS13**

Date: 13/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

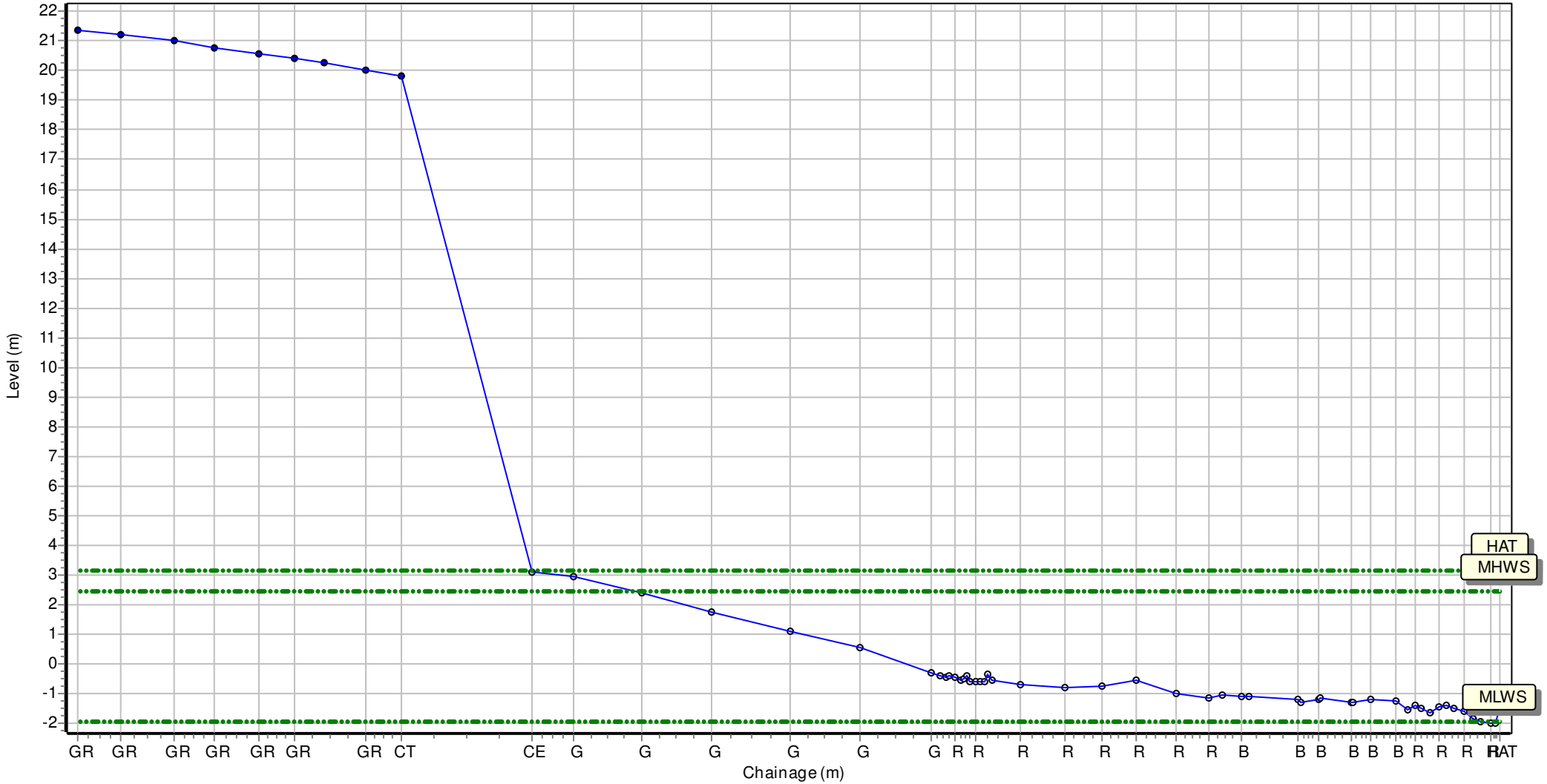
Location: **1bSNS14**

Date: 13/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

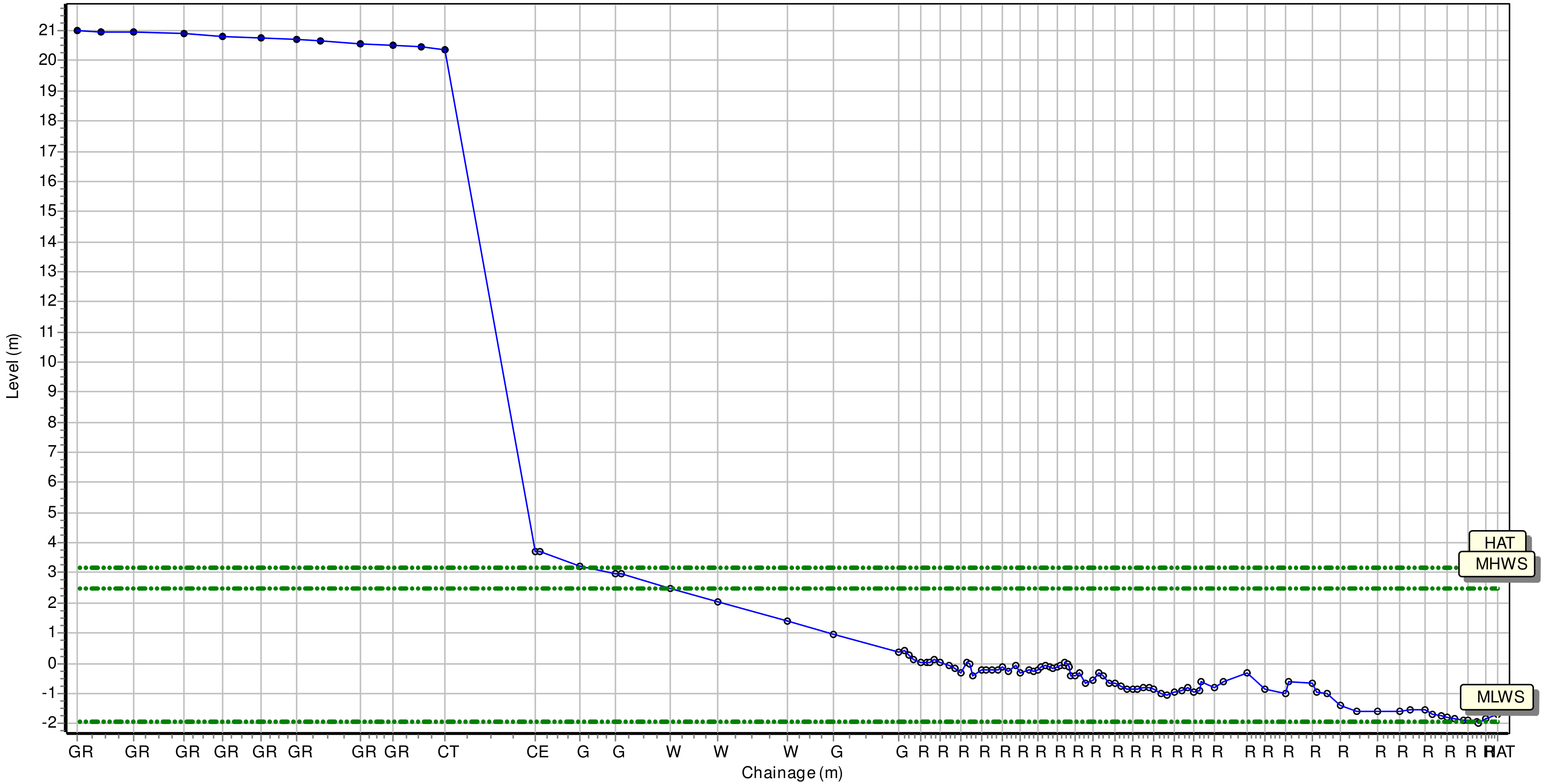
Location: 1bSNS15

Date: 13/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



http://www.sandsuser.com

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Beach Profile

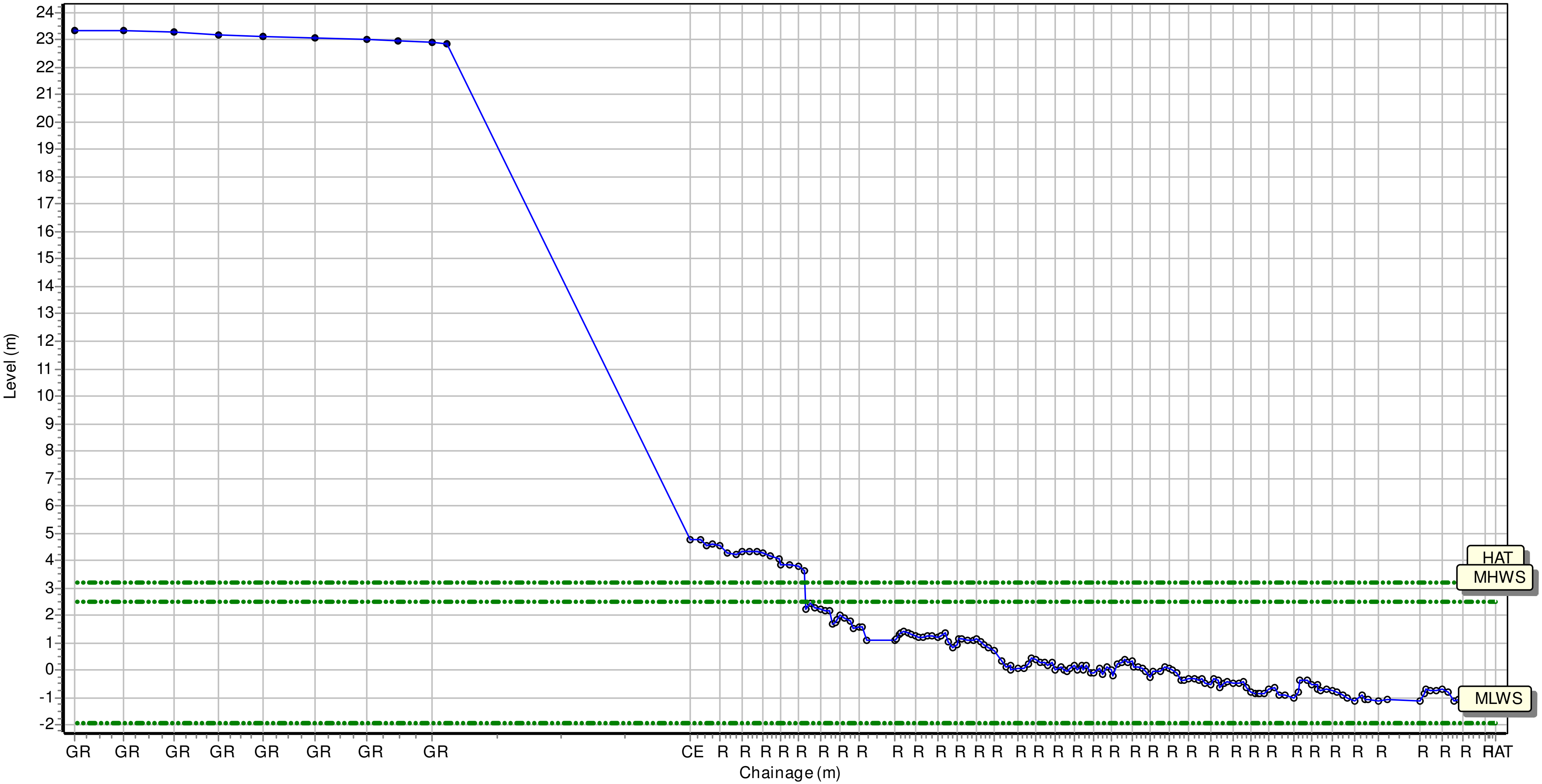
Location: 1bSNS16

Date: 13/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

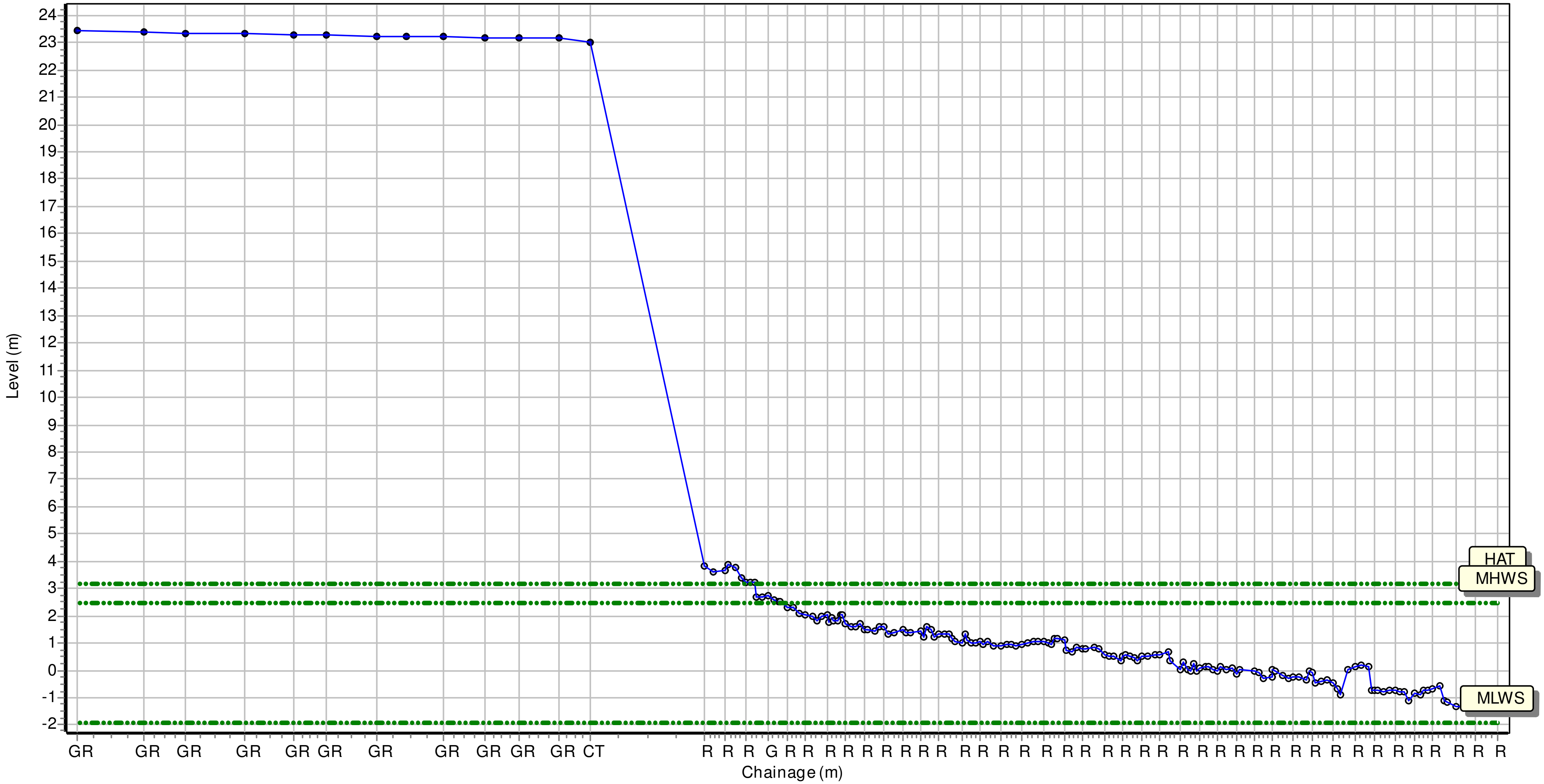
Location: 1bSNS17

Date: 13/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



http://www.sandsuser.com

SANDS

Beach Profile

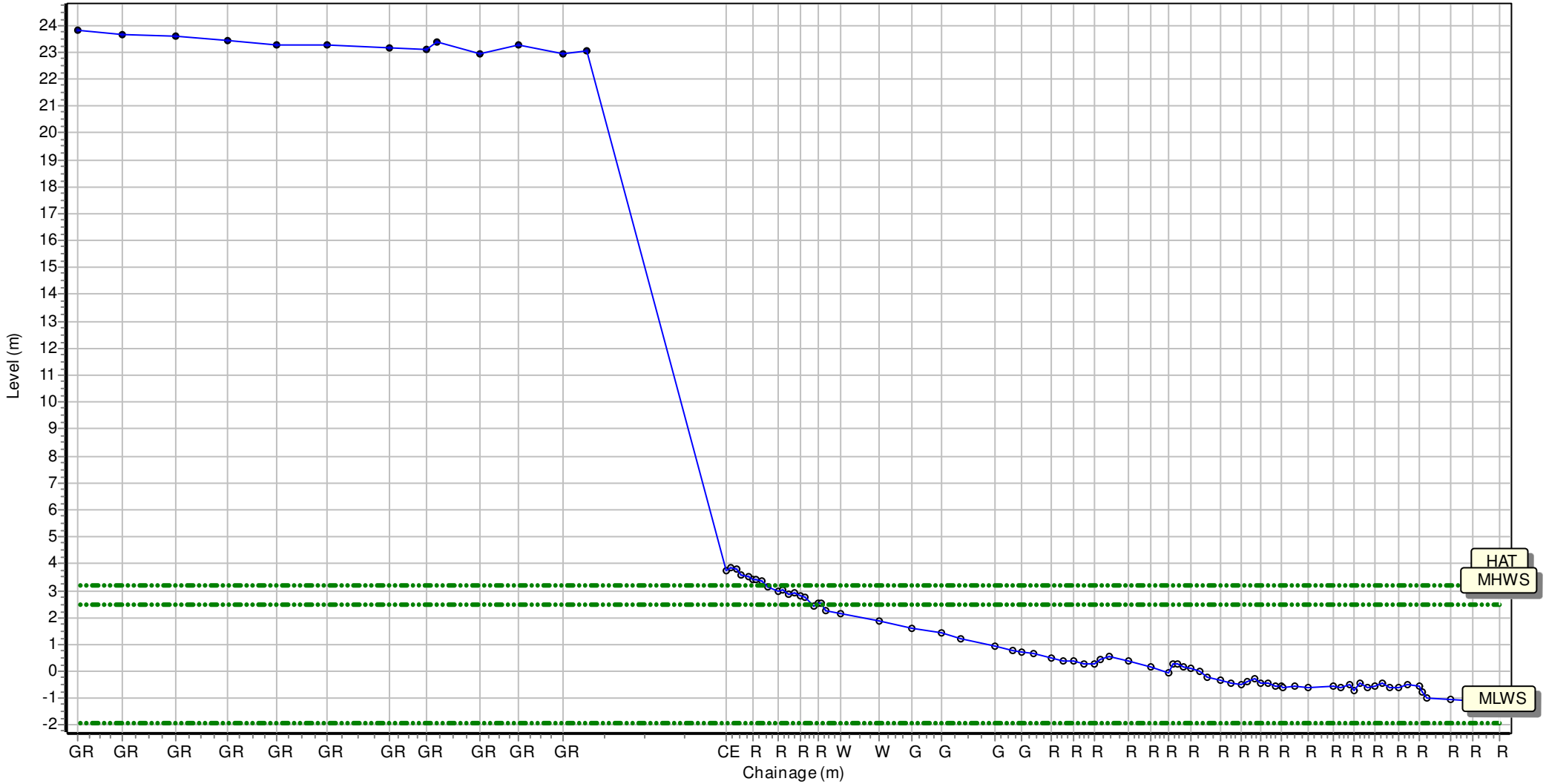
Location: **1bSNS18**

Date: 13/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

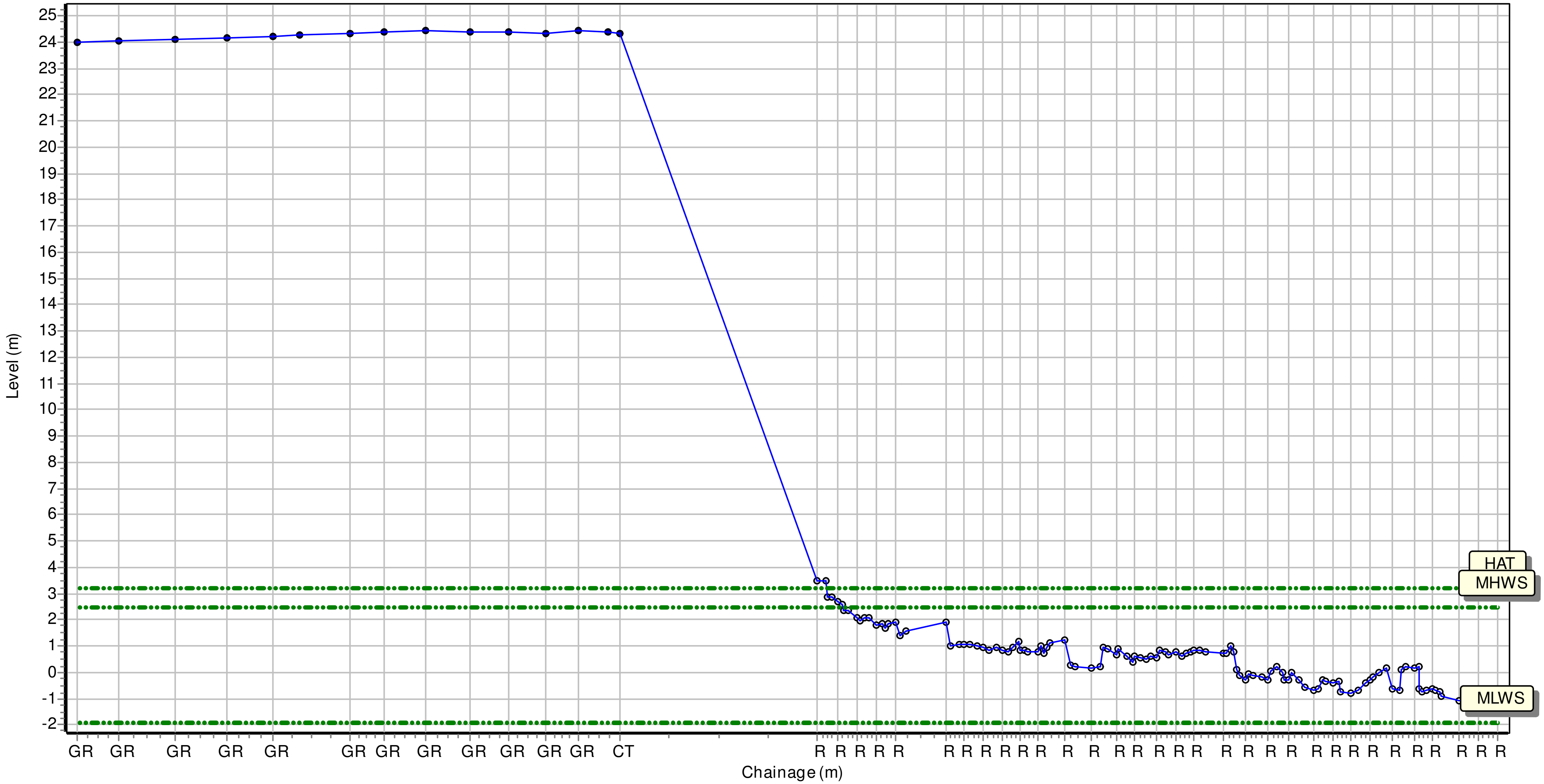
Location: 1bSNS19

Date: 13/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



http://www.sandsuser.com

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Beach Profile

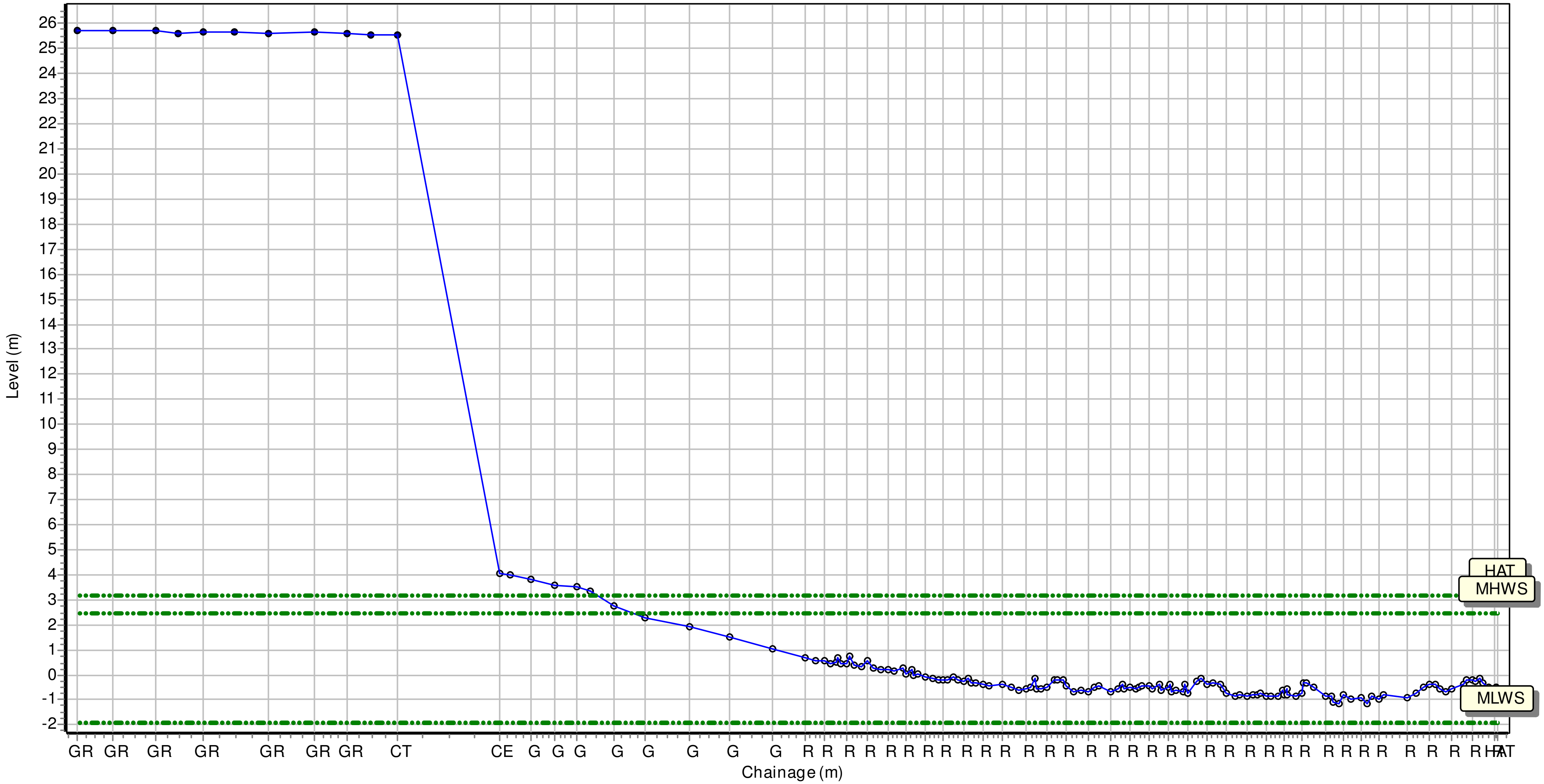
Location: 1bSNS20

Date: 13/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

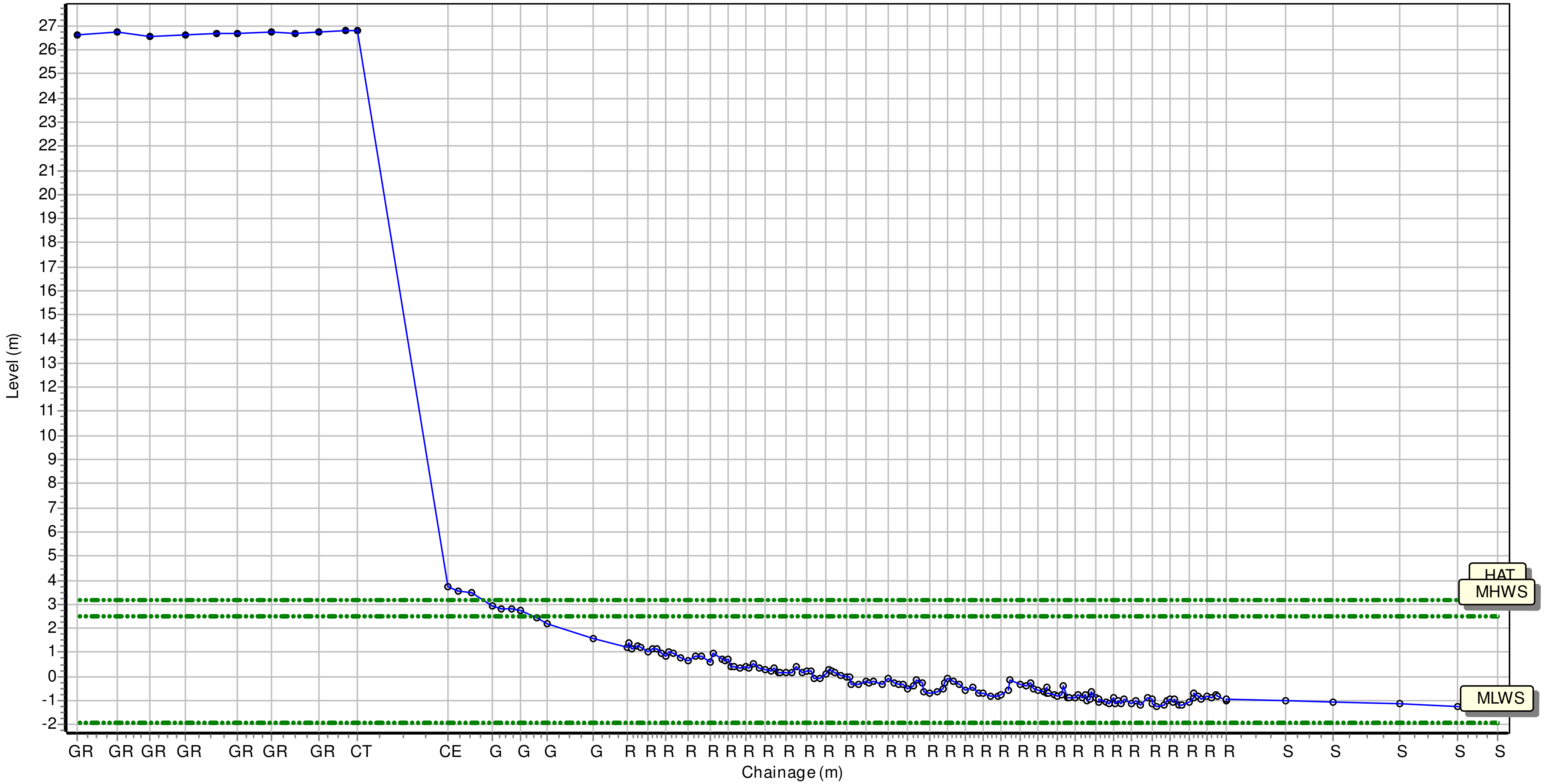
Location: 1bSNS21

Date: 13/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

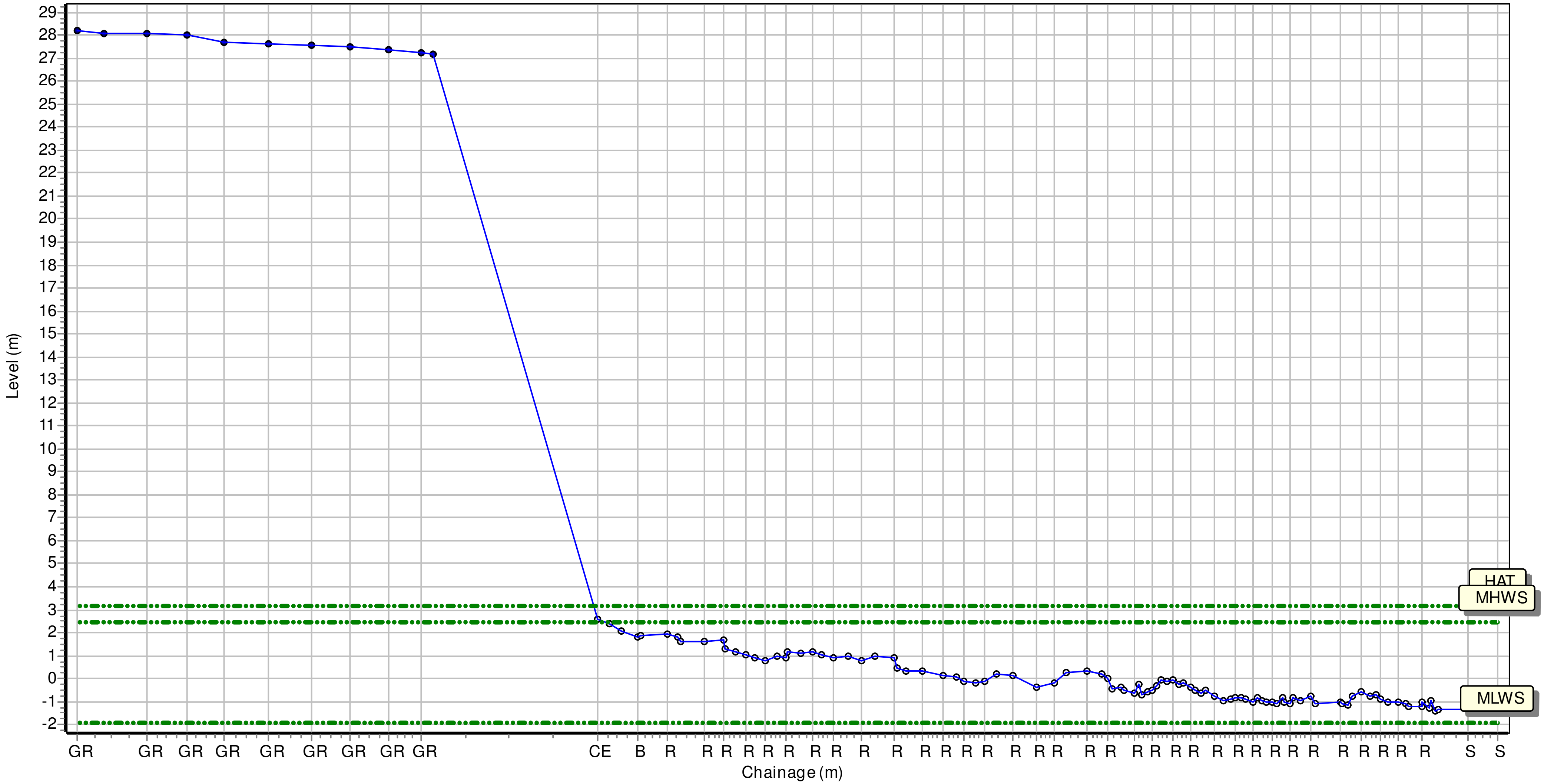
Location: **1bSNS22**

Date: 13/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

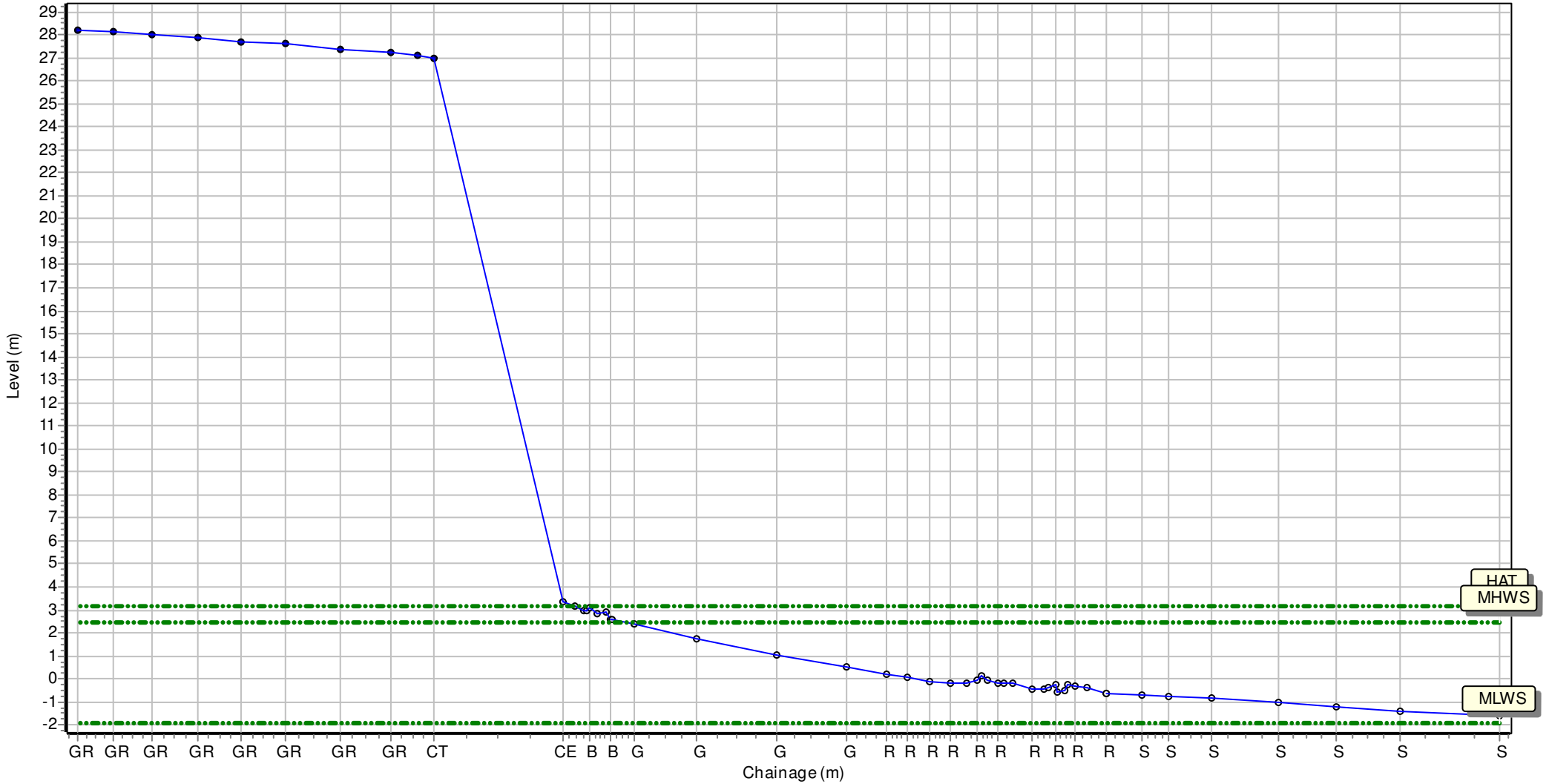
Location: **1bSNS23**

Date: 13/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

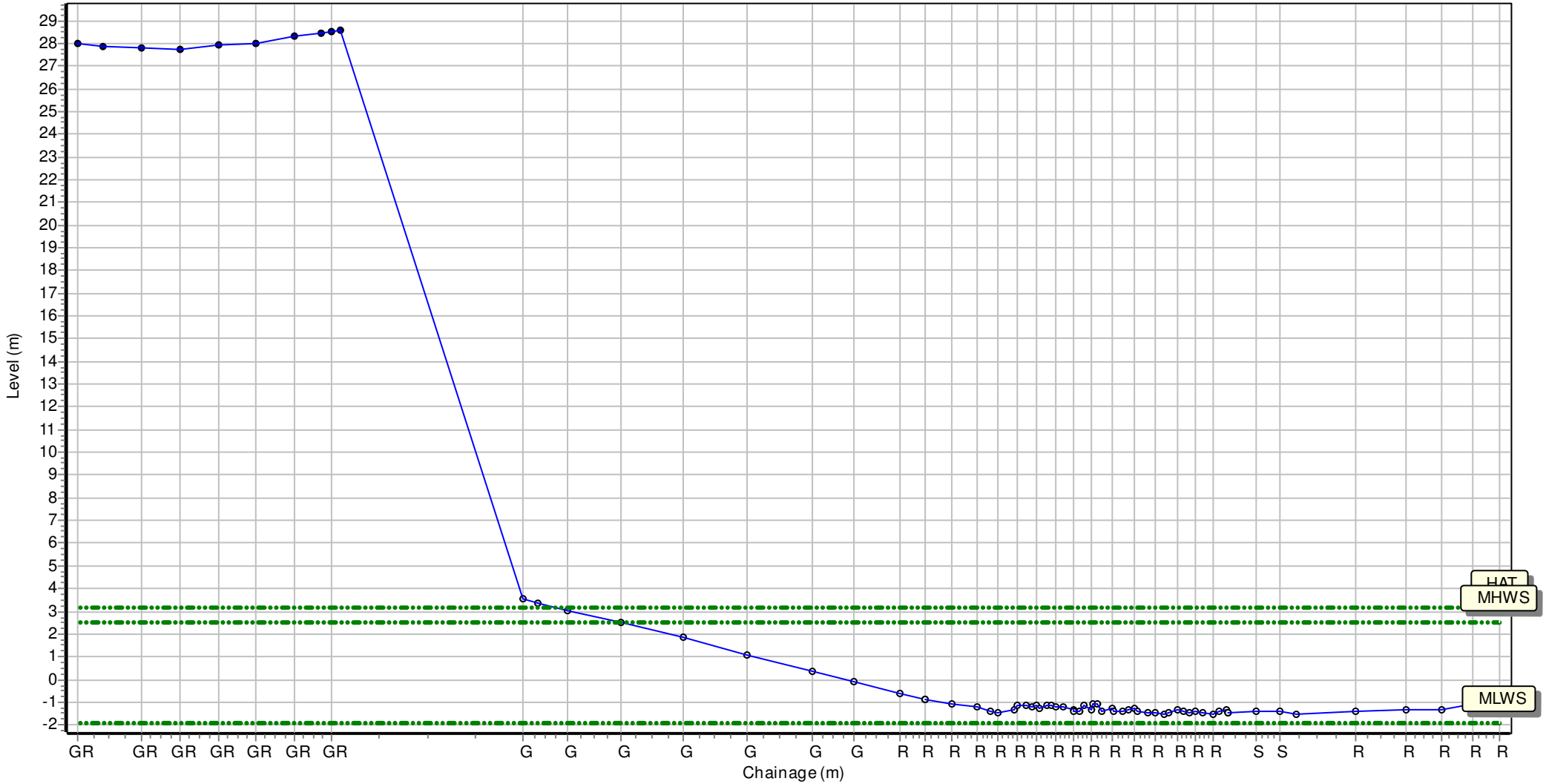
Location: **1bSNS24**

Date: 13/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

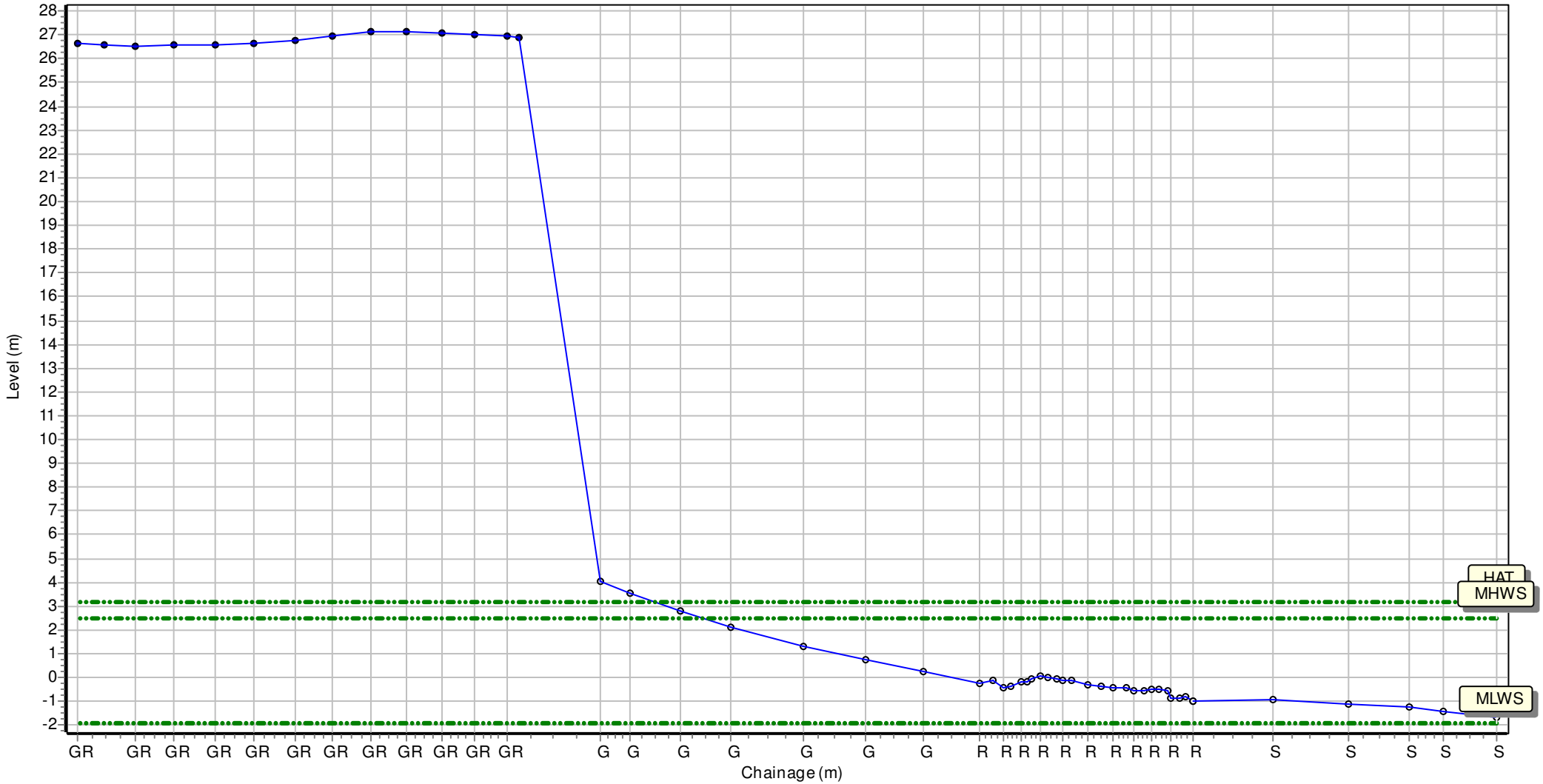
Location: **1bSNS25**

Date: 13/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

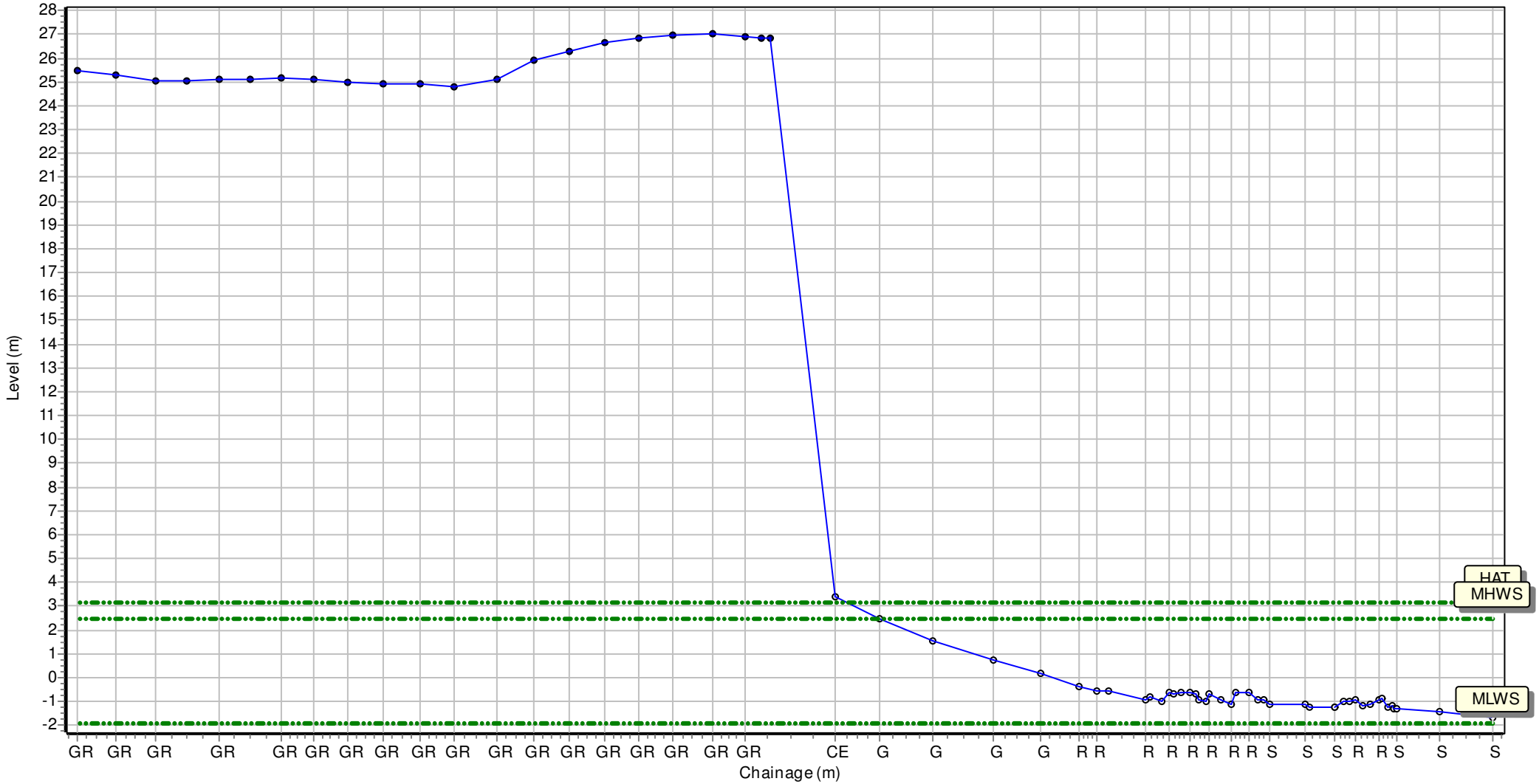
Location: **1bSNS26**

Date: 13/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

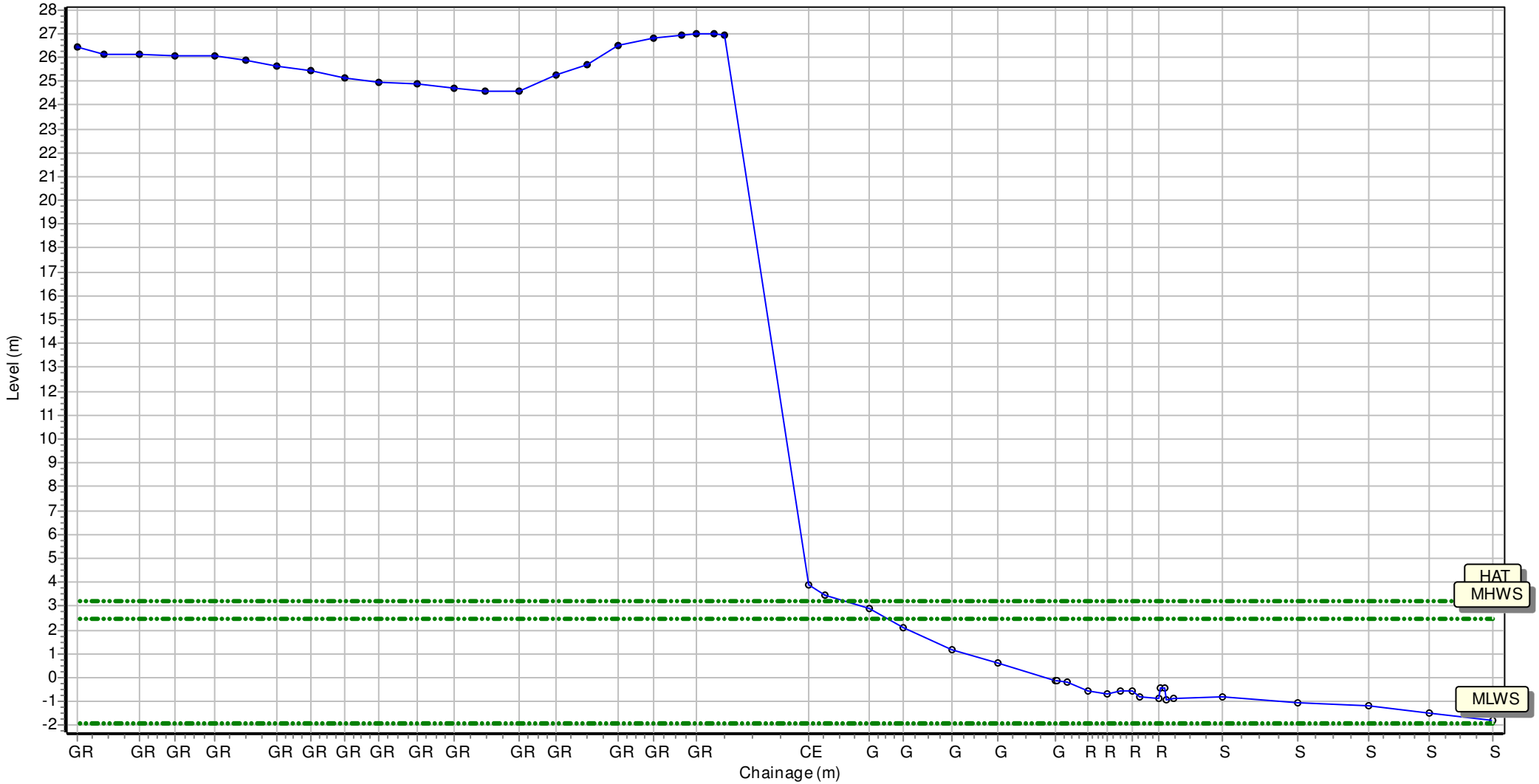
Location: **1bSNS27**

Date: 13/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

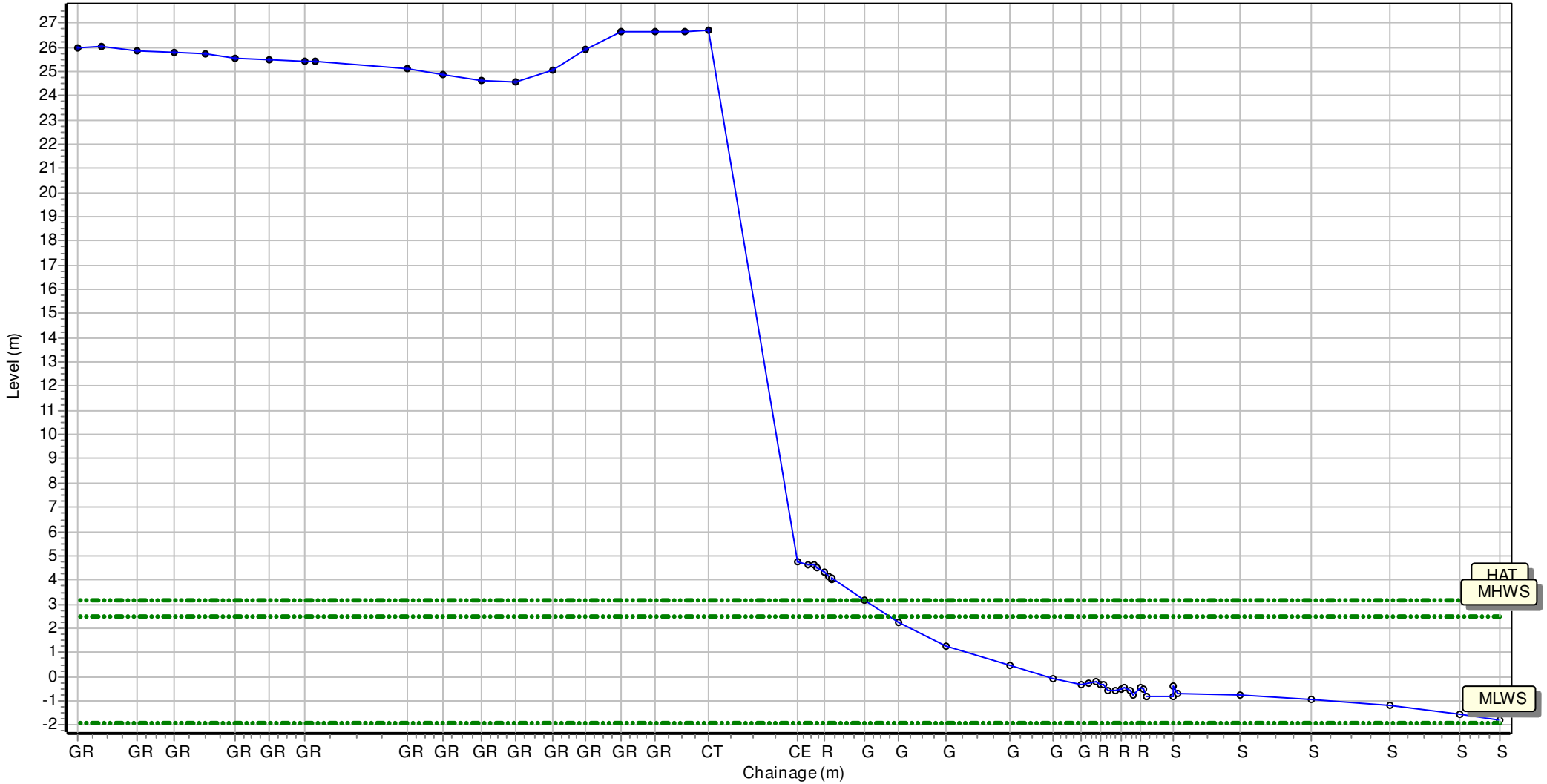
Location: **1bSNS28**

Date: 13/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

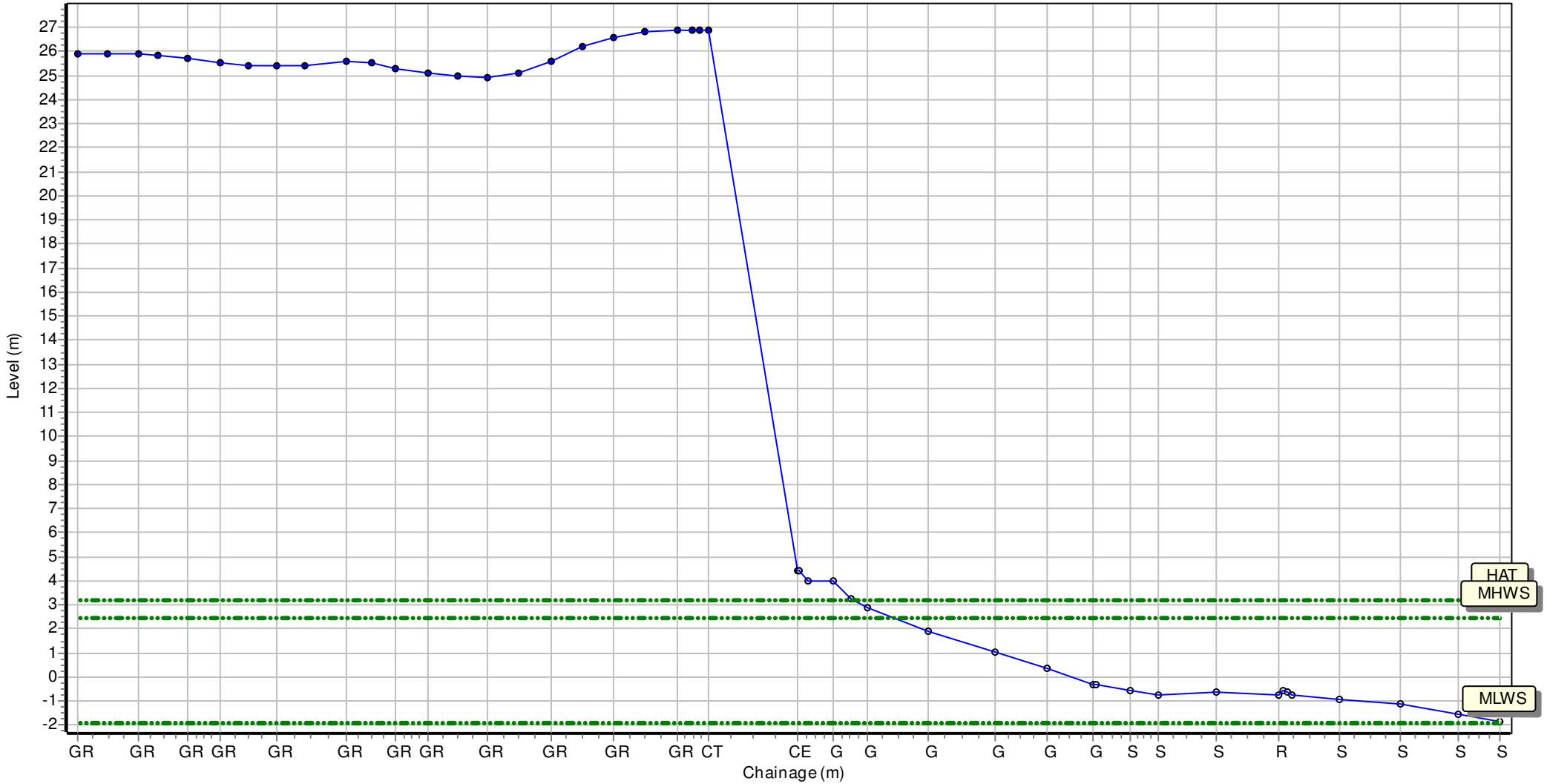
Location: **1bSNS29**

Date: 13/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

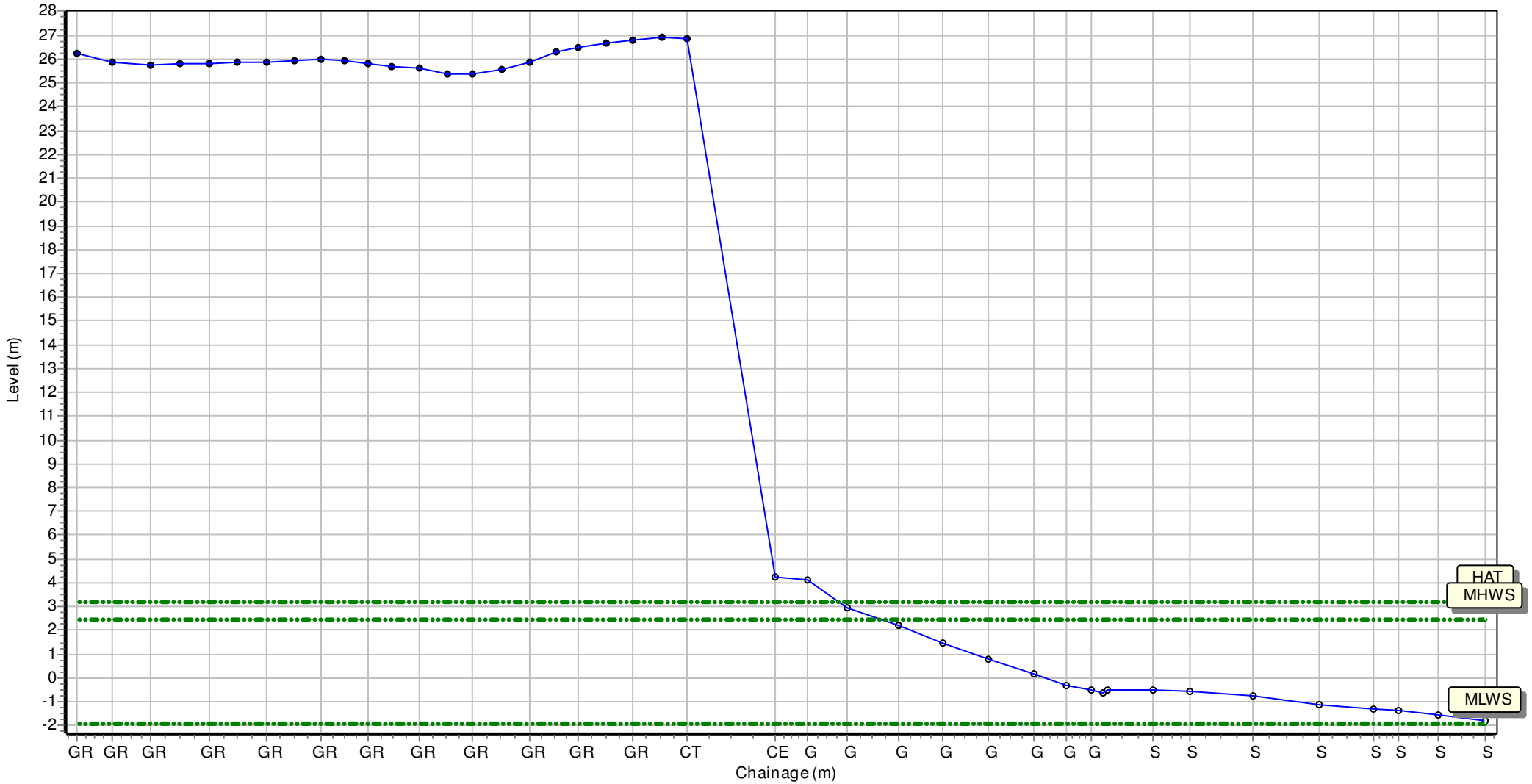
Location: **1bSNS30**

Date: 13/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

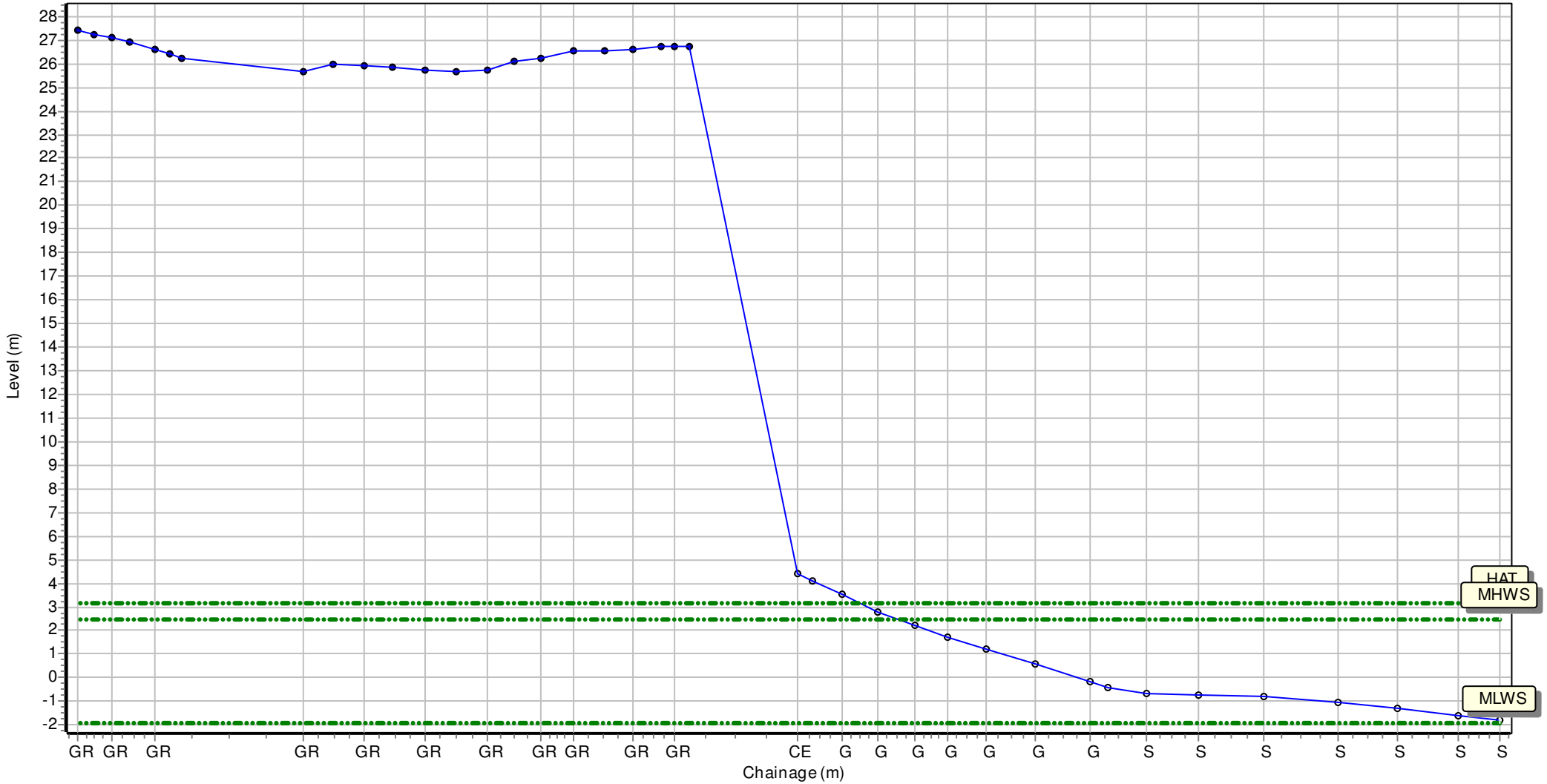
Location: **1bSNS31**

Date: 13/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

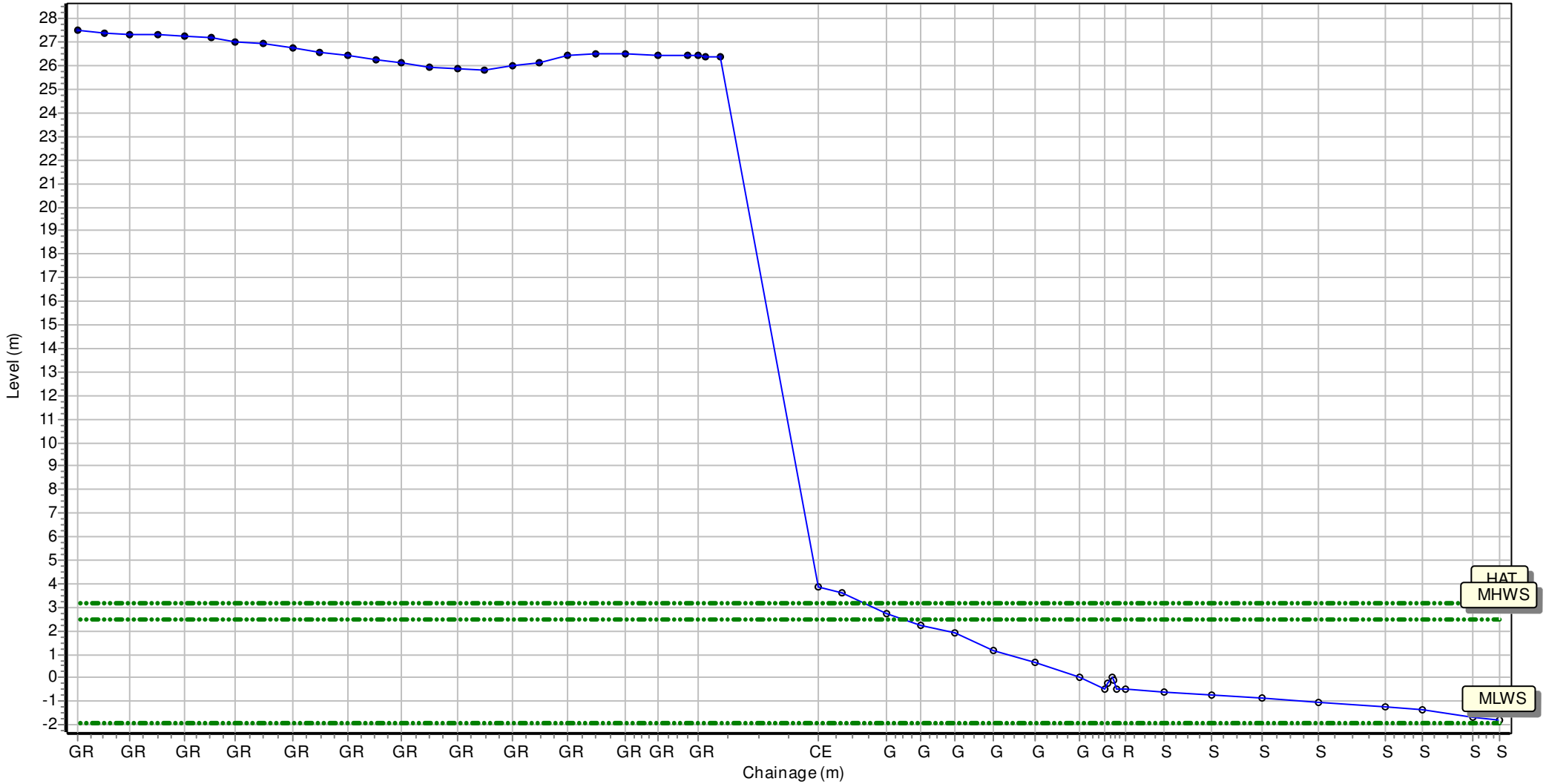
Location: **1bSNS32**

Date: 13/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

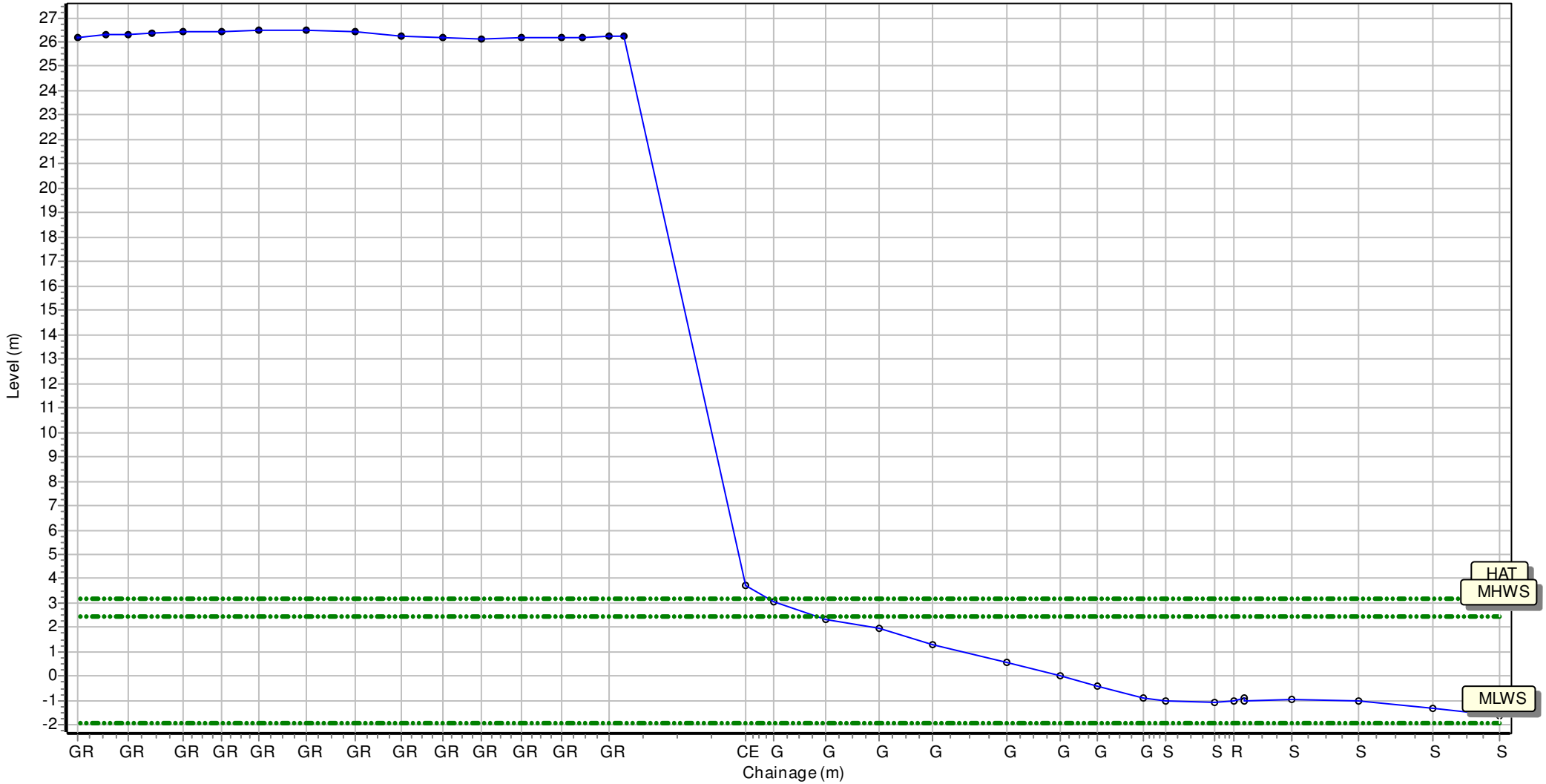
Location: **1bSNS33**

Date: 13/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

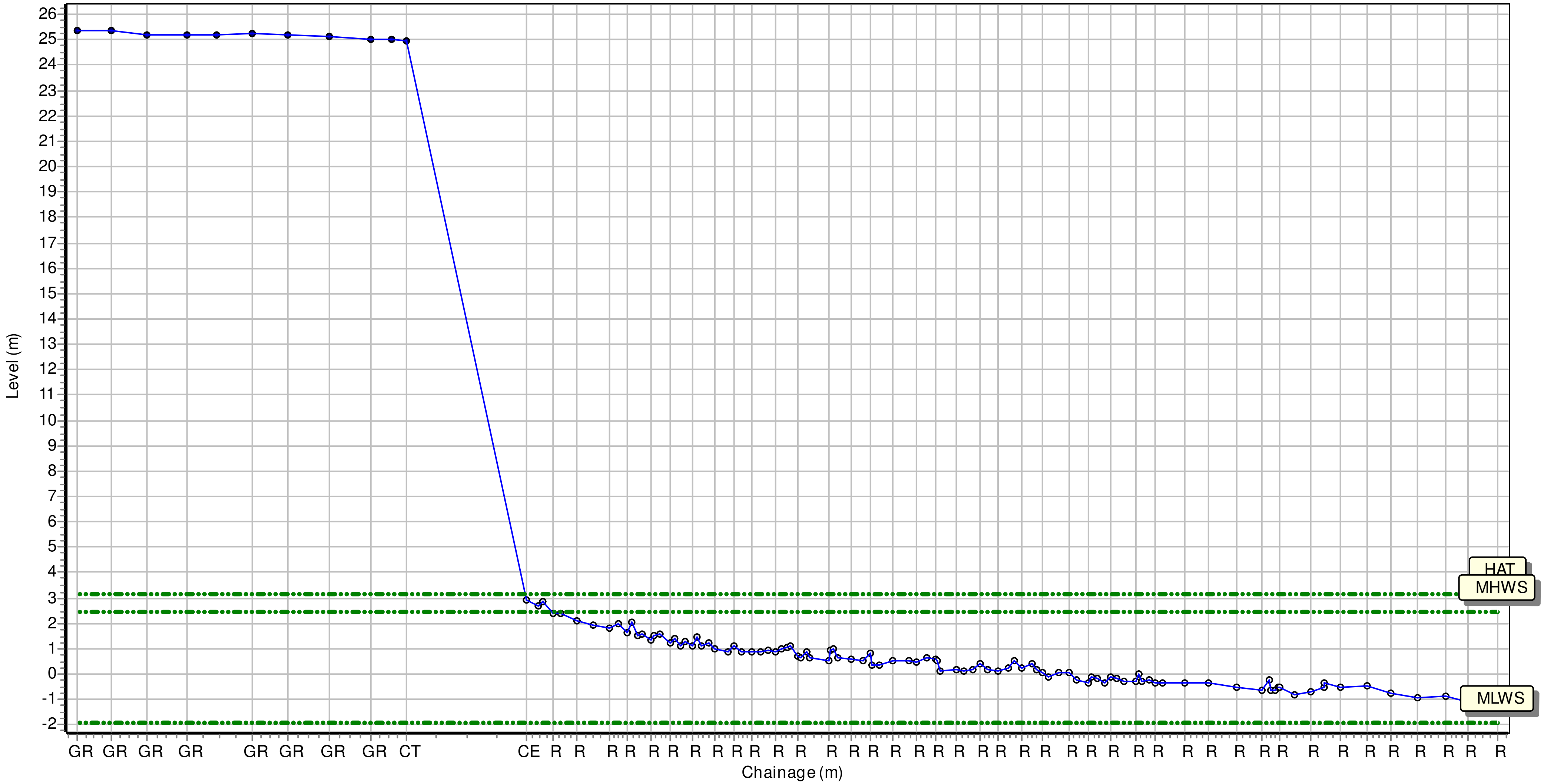
Location: **1bSNS34**

Date: 13/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

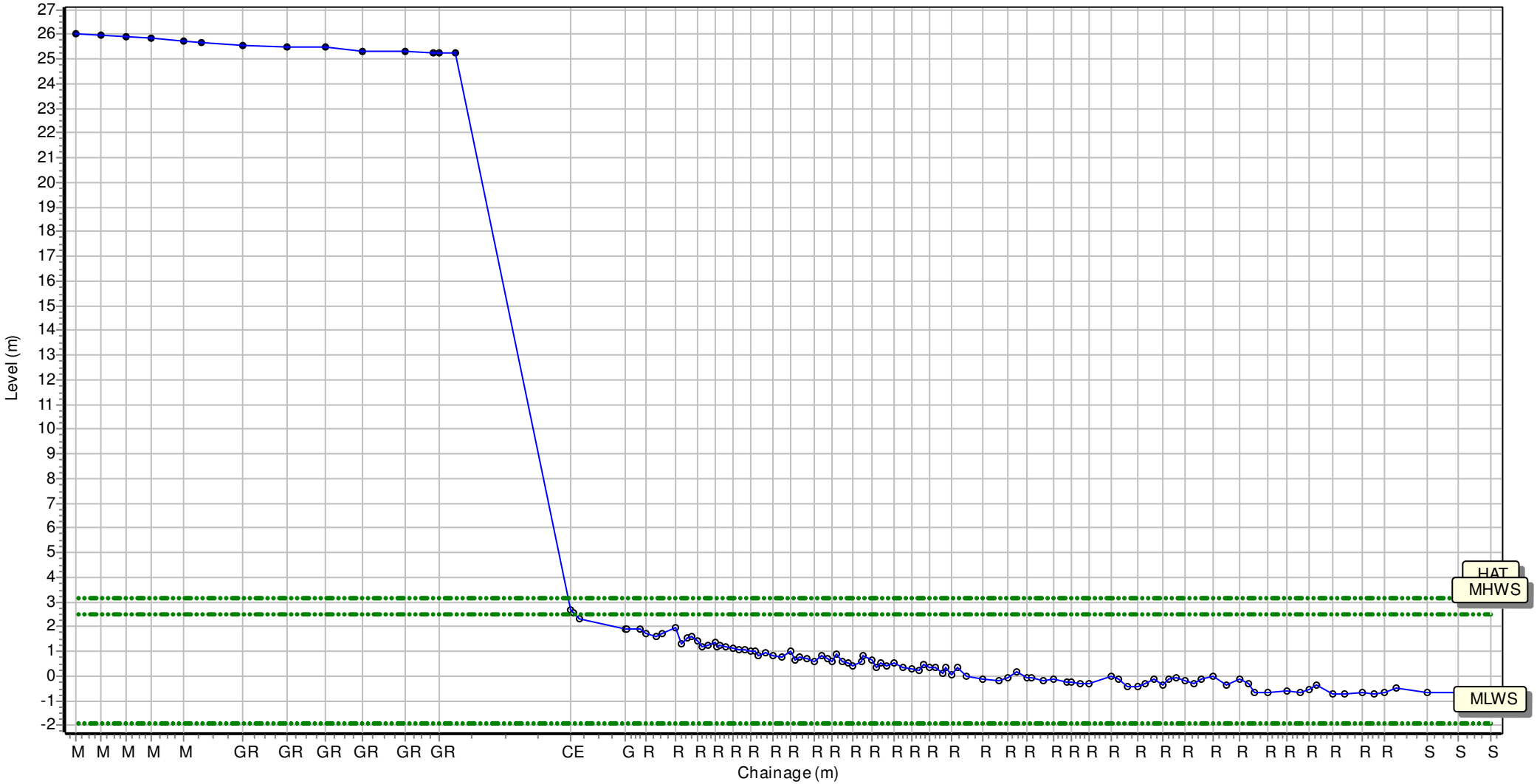
Location: **1bSNS35**

Date: 13/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2019 Full Measures Topo Survey

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



Beach Profile

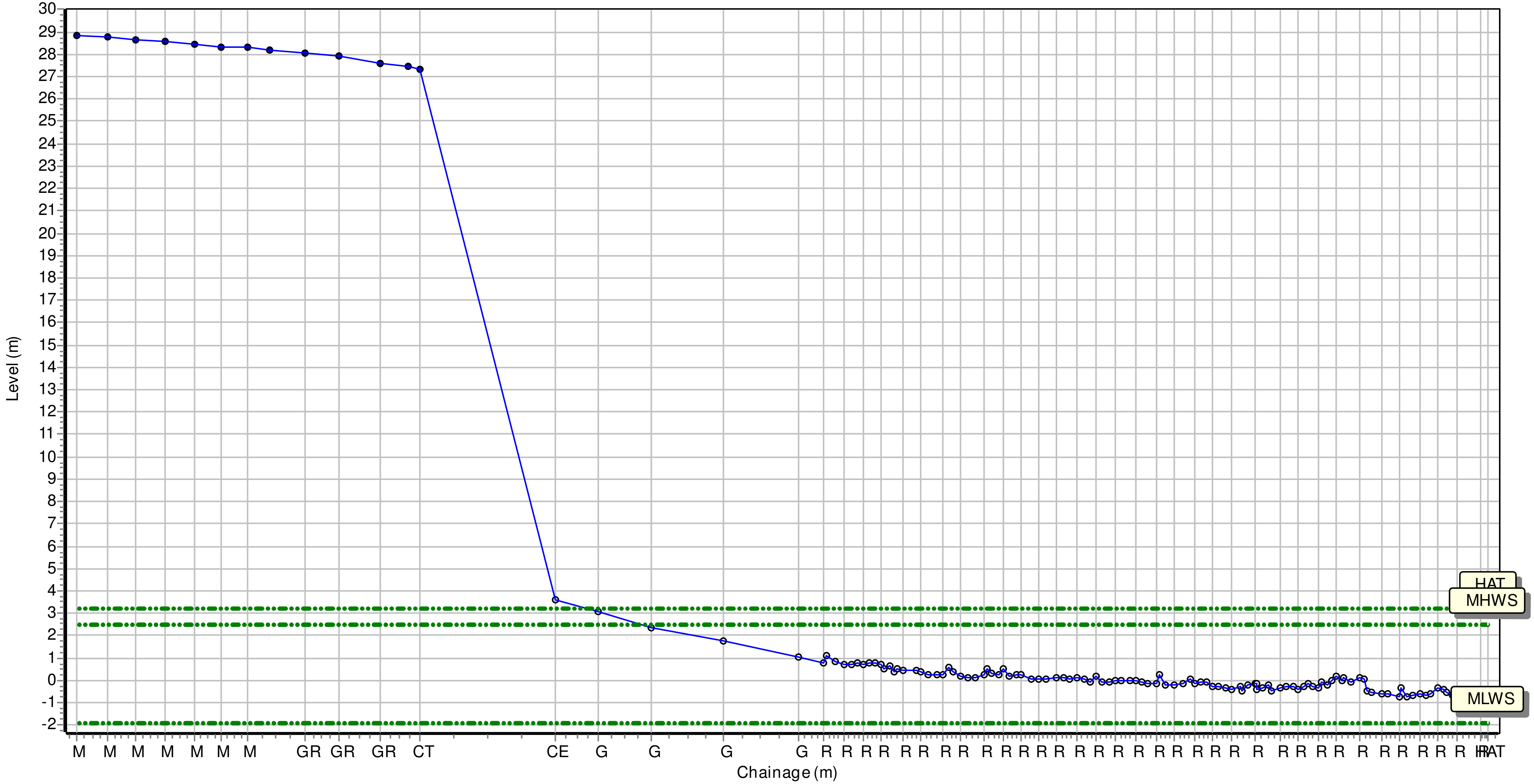
Location: **1bSNS36**

Date: 13/11/2019 **Inspector:** AG **Low Tide:** **Low Tide Time:**

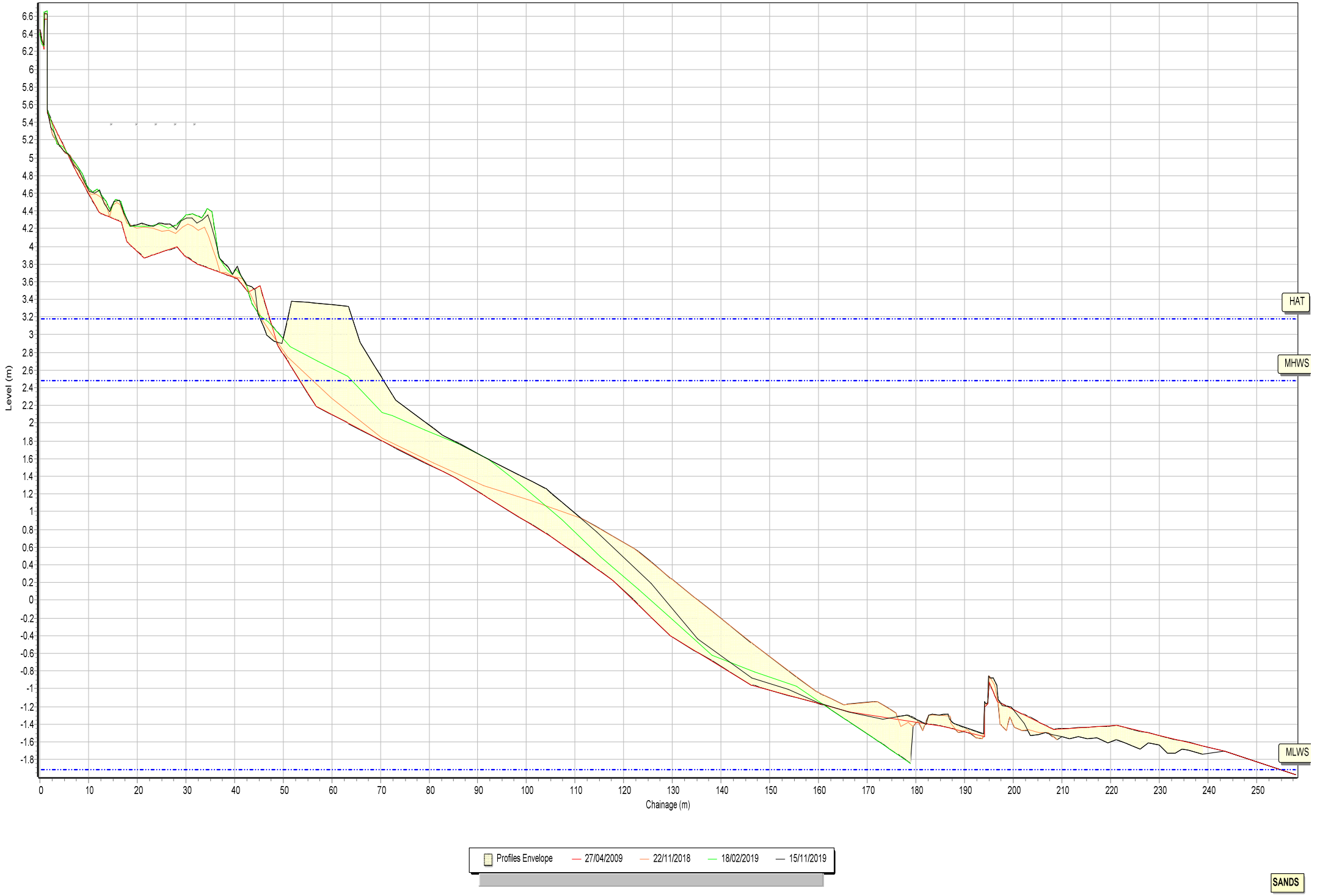
Wind **Sea State:** **Visibility:** **Rain:**

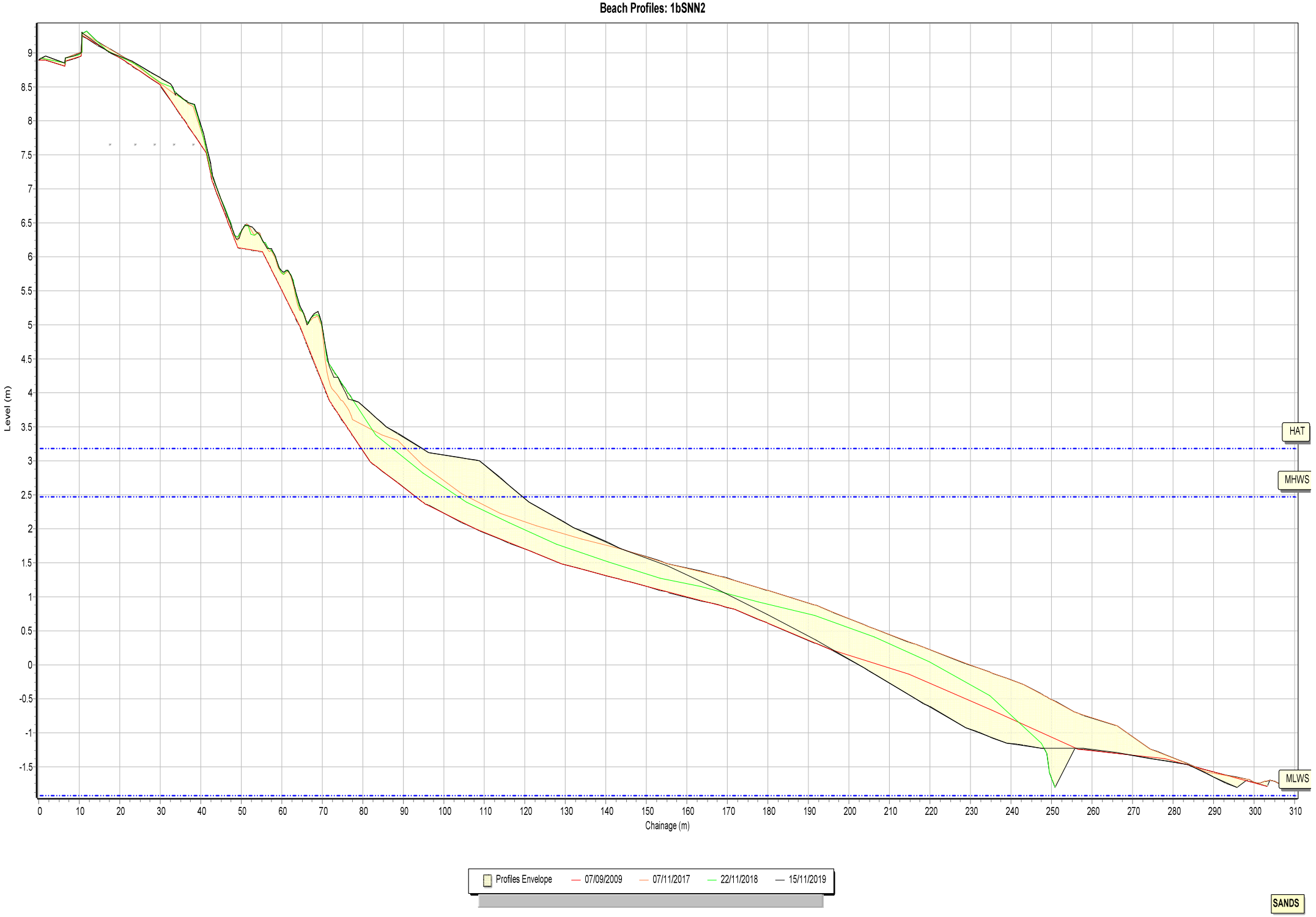
Summary: 2019 Full Measures Topo Survey

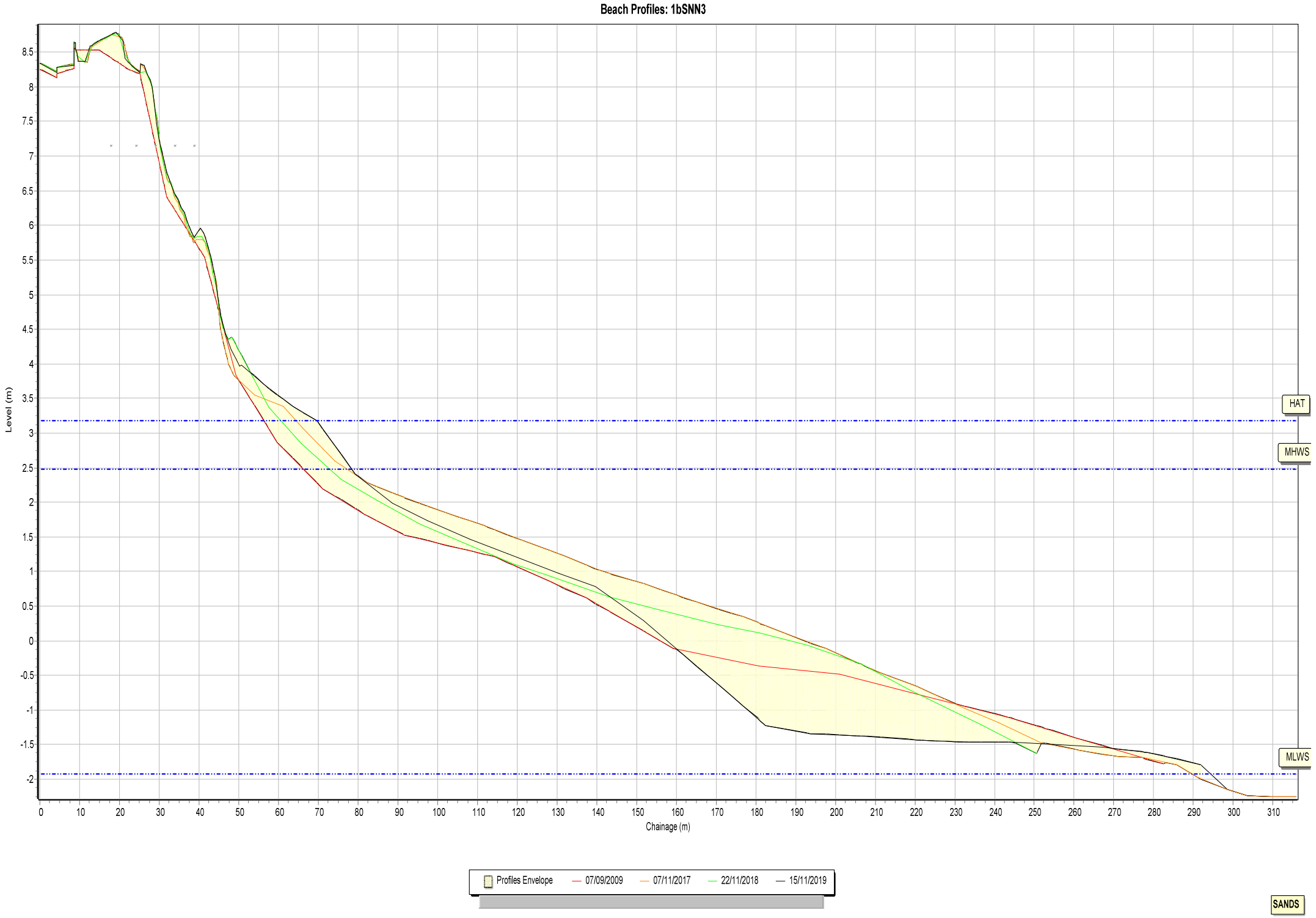
Easting: 441853.315 **Northing:** 551983.836 **Profile Bearing:** 81 ° from North



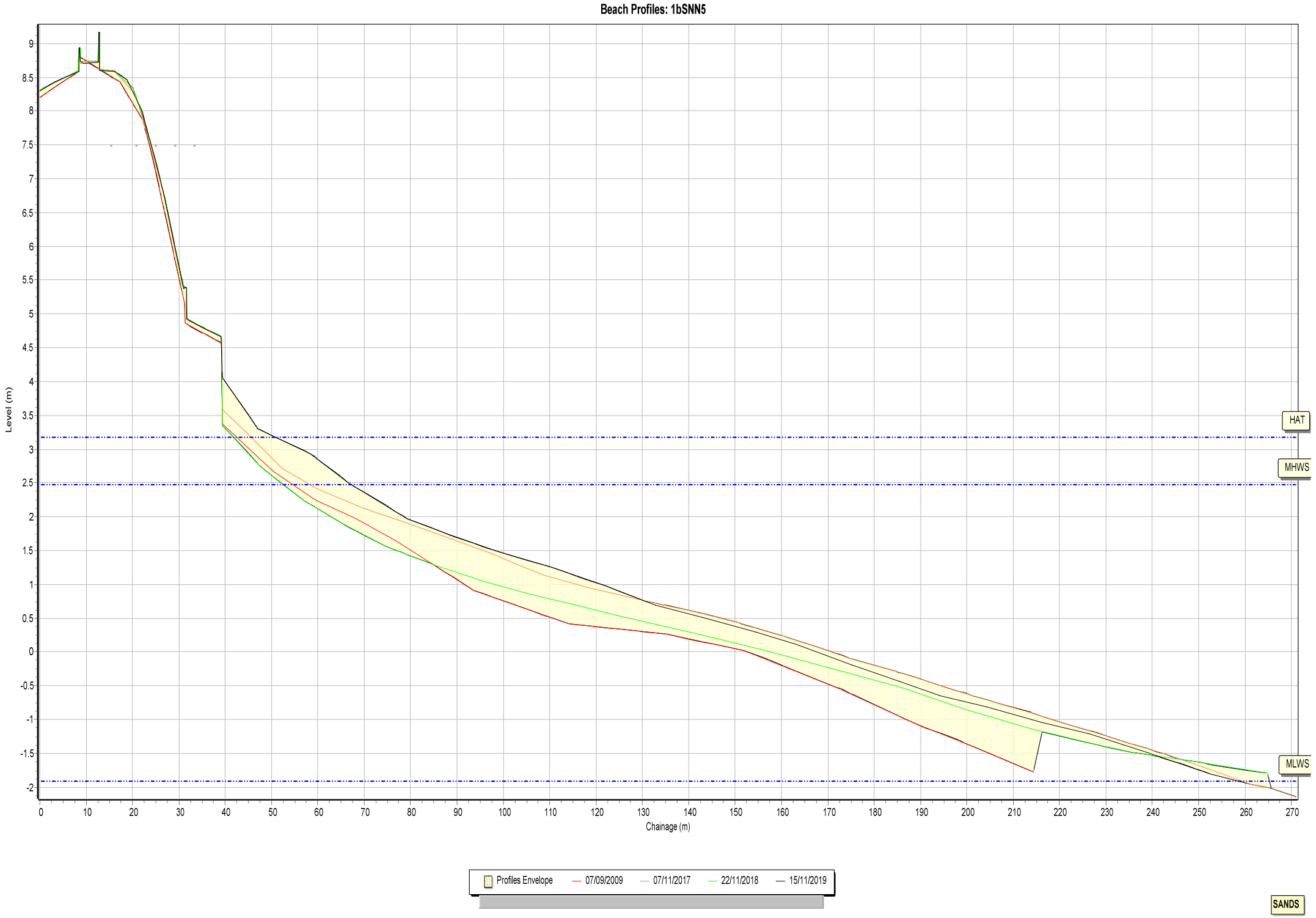
Beach Profiles: 1bSNN1




Beach Profiles: 1bSNN2
Level (m)
Chainage (m)
HAT
MHWS
MLWS
Profiles Envelope
07/09/2009
07/11/2017
22/11/2018
15/11/2019
SANDS


Beach Profiles: 1bSNN3
Level (m)
Chainage (m)
HAT
MHWS
MLWS
Profiles Envelope
07/09/2009
07/11/2017
22/11/2018
15/11/2019
SANDS


Beach Profiles: 1bSNN4
Level (m)
Chainage (m)
HAT
MHWS
MLWS
Profiles Envelope
07/09/2009
07/11/2017
22/11/2018
15/11/2019
SANDS


Beach Profiles: 1bSNN5
Level (m)
Chainage (m)
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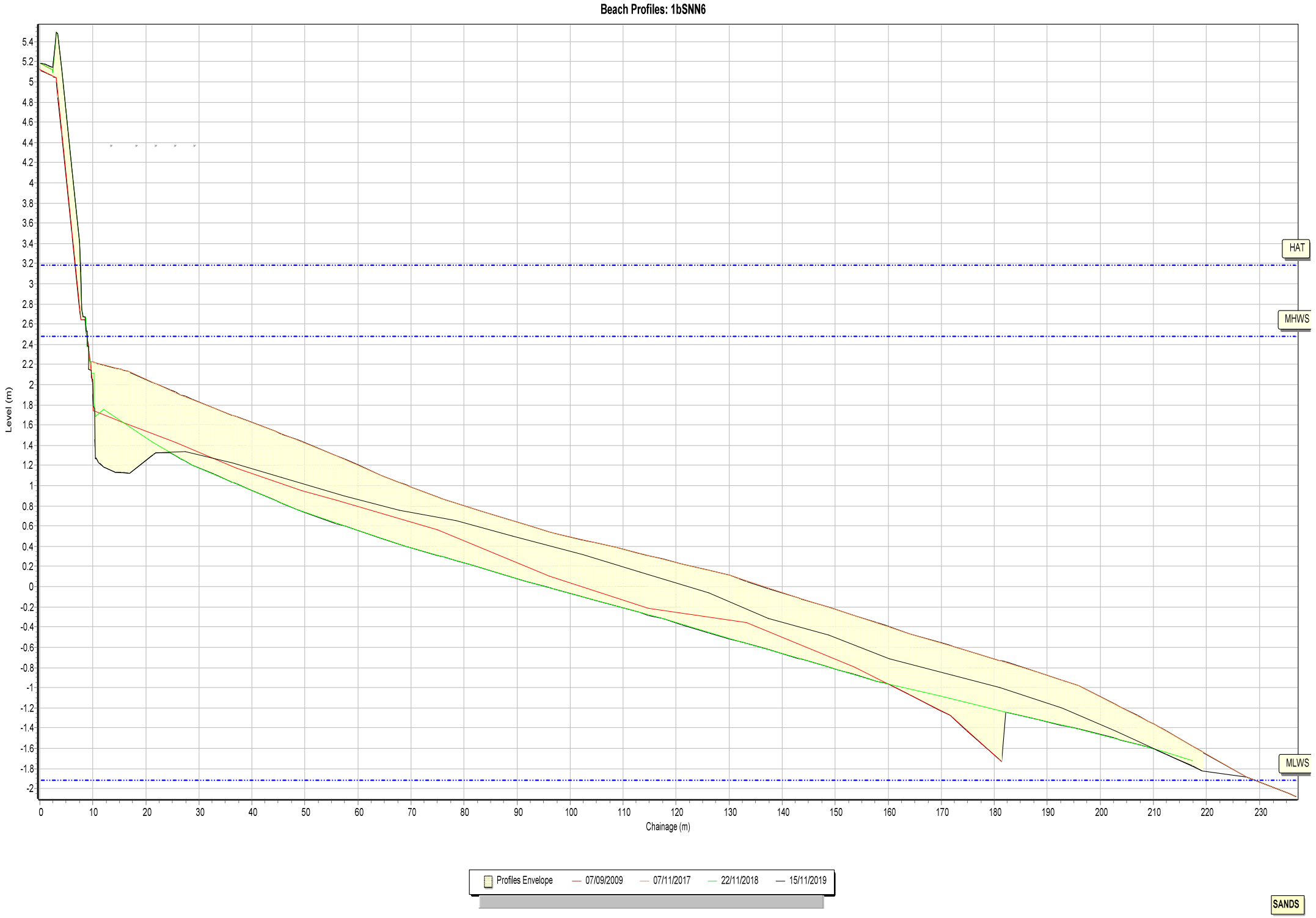
MHWS
MLWS
Profiles Envelope
07/09/2009
07/11/2017
22/11/2018
15/11/2019
SANDS


Beach Profiles: 1bSNN6
Level (m)
Chainage (m)
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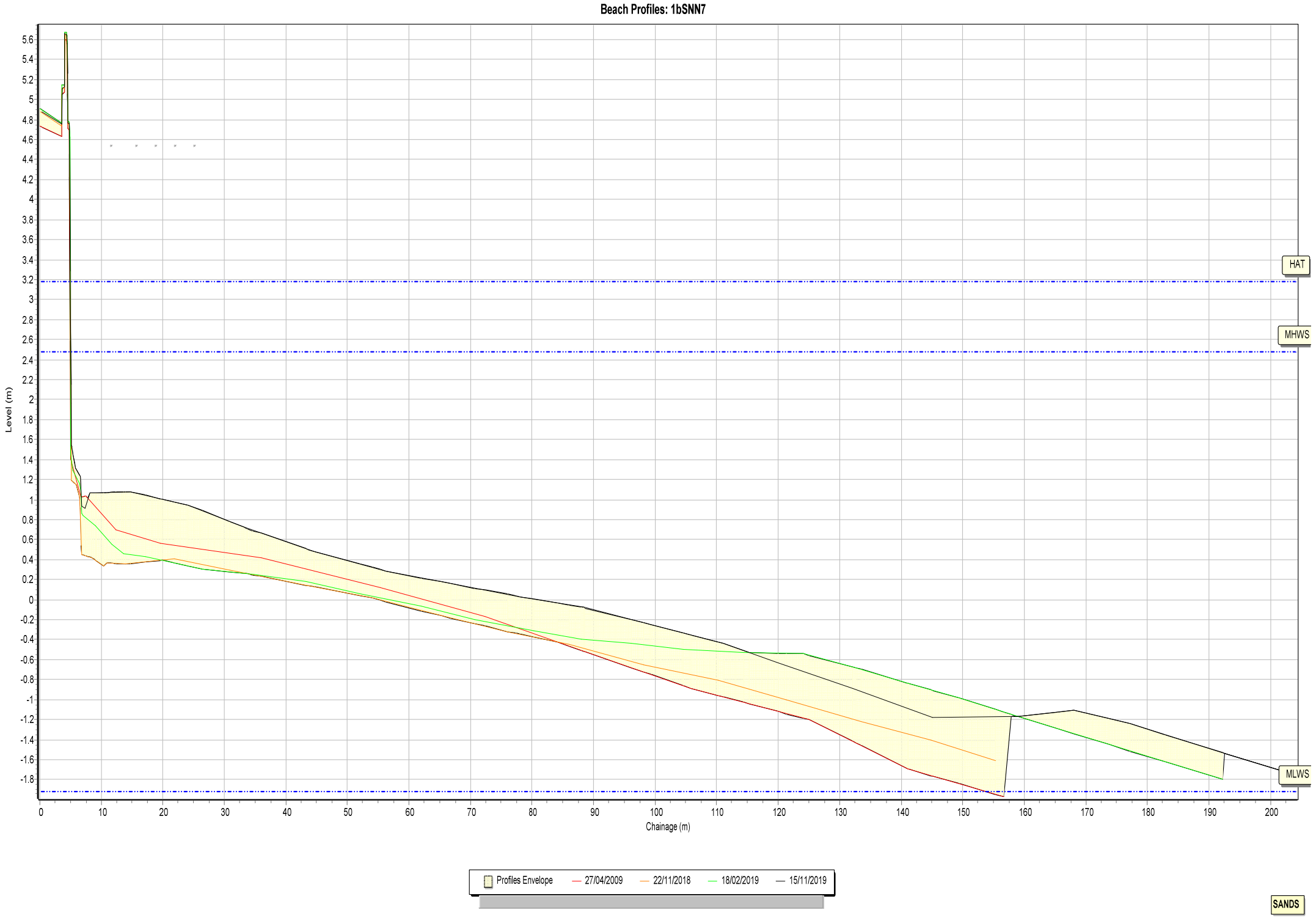
MHWS
MLWS
Profiles Envelope
07/09/2009
07/11/2017
22/11/2018
15/11/2019
SANDS


Beach Profiles: 1bSNN7
Level (m)
Chainage (m)
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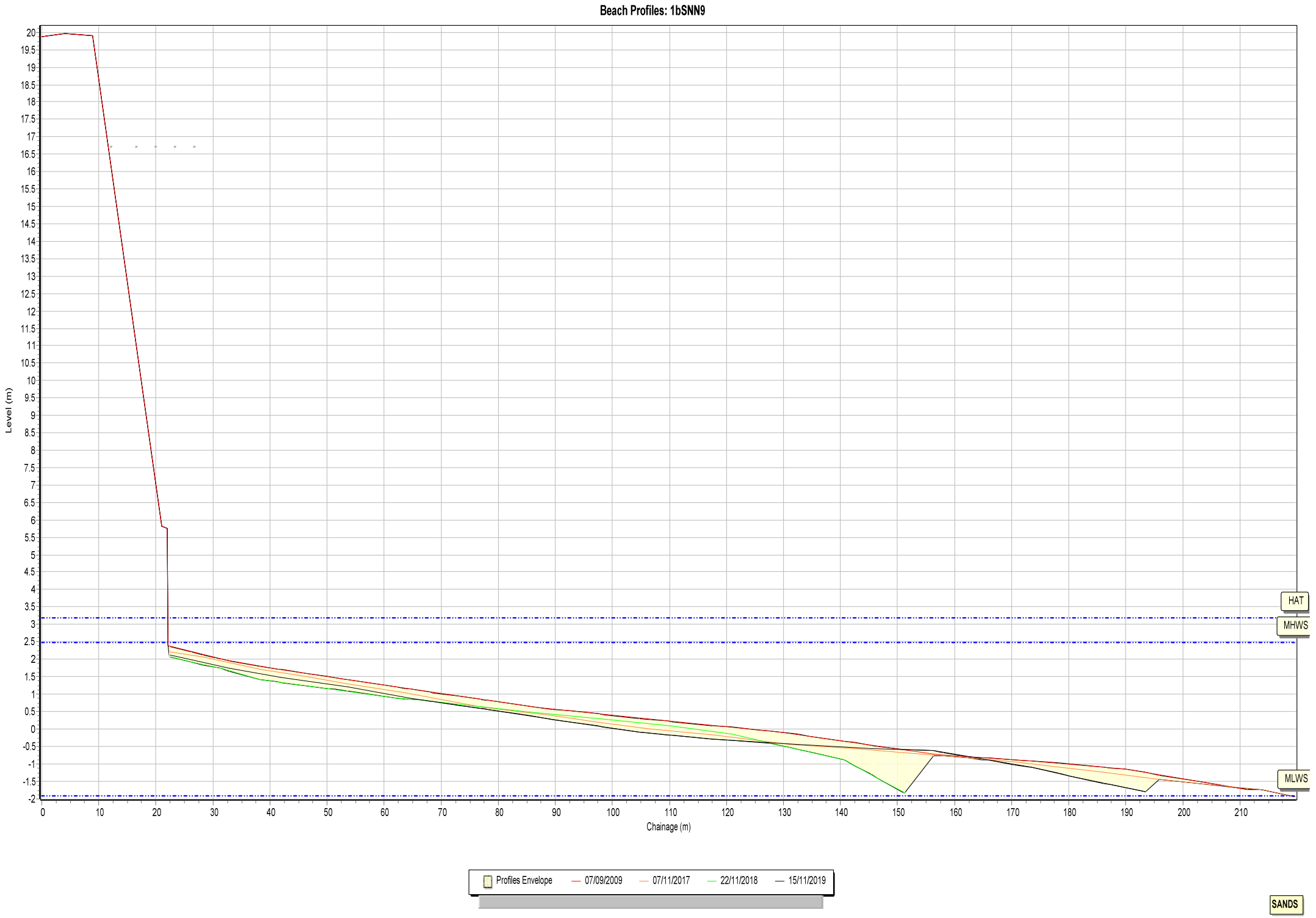
MHWS
MLWS
Profiles Envelope
27/04/2009
22/11/2018
18/02/2019
15/11/2019
SANDS


Beach Profiles: 1bSNN8
Level (m)
Chainage (m)
HAT
MHWS
MLWS
Profiles Envelope
07/09/2009
07/11/2017
22/11/2018
15/11/2019
SANDS


Beach Profiles: 1bSNN9
Level (m)
Chainage (m)
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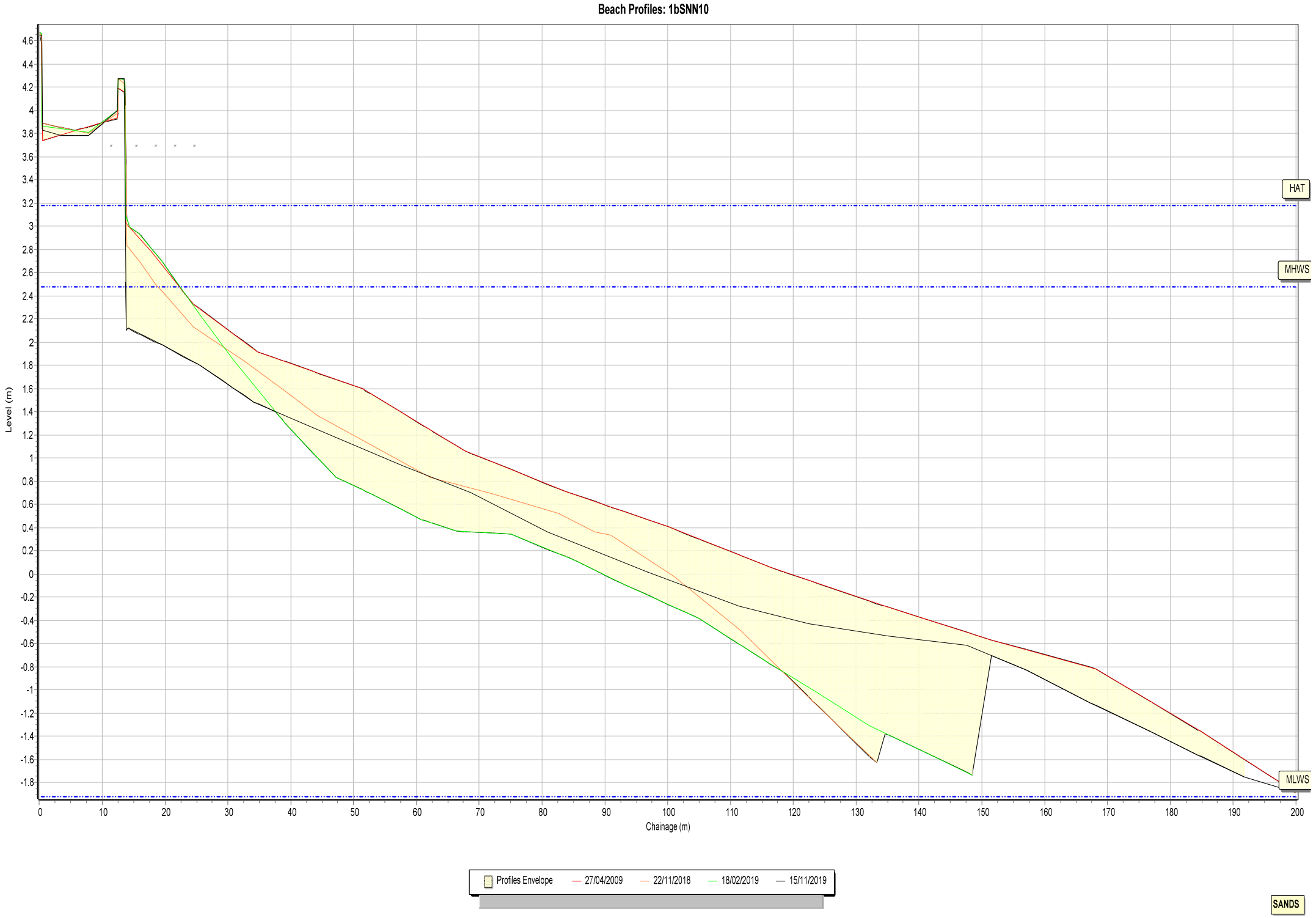
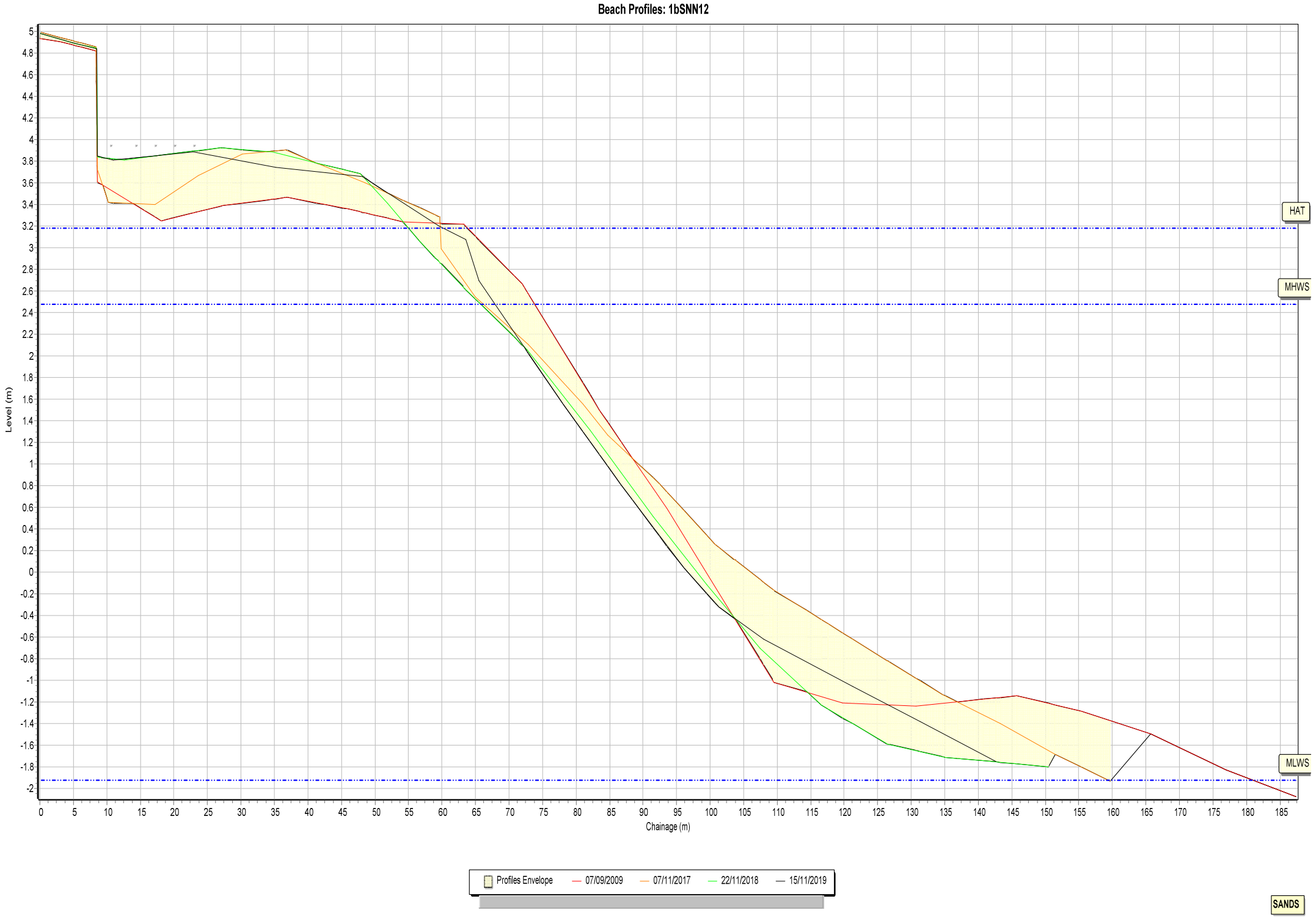
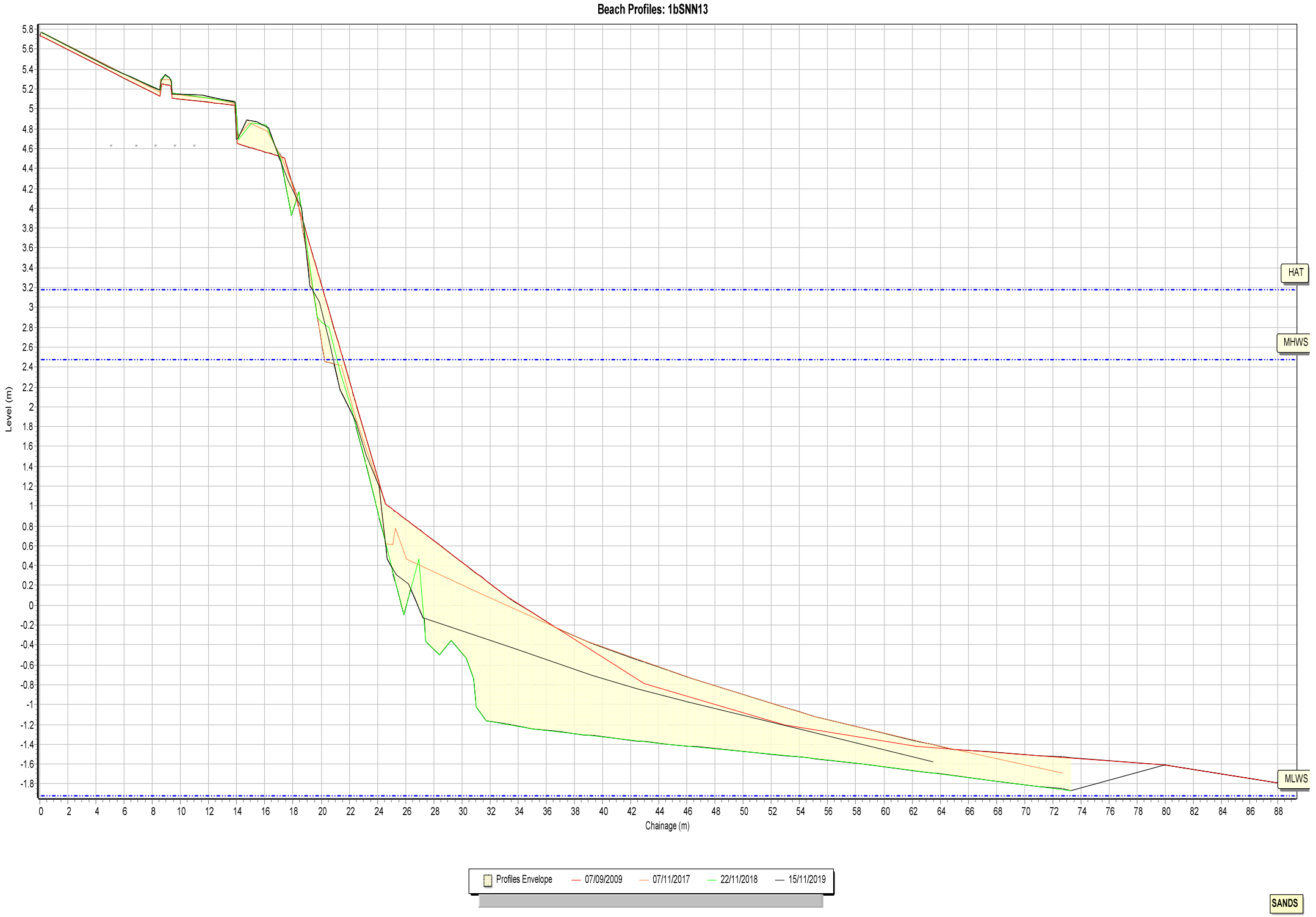
MHWS
MLWS
Profiles Envelope
07/09/2009
07/11/2017
22/11/2018
15/11/2019
SANDS


Beach Profiles: 1bSNN10
Level (m)
Chainage (m)
HAT
MHWS
MLWS
Profiles Envelope
27/04/2009
22/11/2018
18/02/2019
15/11/2019
SANDS


Beach Profiles: 1bSNN11
Level (m)
Chainage (m)
HAT
MHWS
MLWS
Profiles Envelope
07/09/2009
07/11/2017
22/11/2018
15/11/2019
SANDS


Beach Profiles: 1bSNN12
Level (m)
Chainage (m)
HAT
MHWS
MLWS
Profiles Envelope
07/09/2009
07/11/2017
22/11/2018
15/11/2019
SANDS


Beach Profiles: 1bSNN13
Level (m)
Chainage (m)
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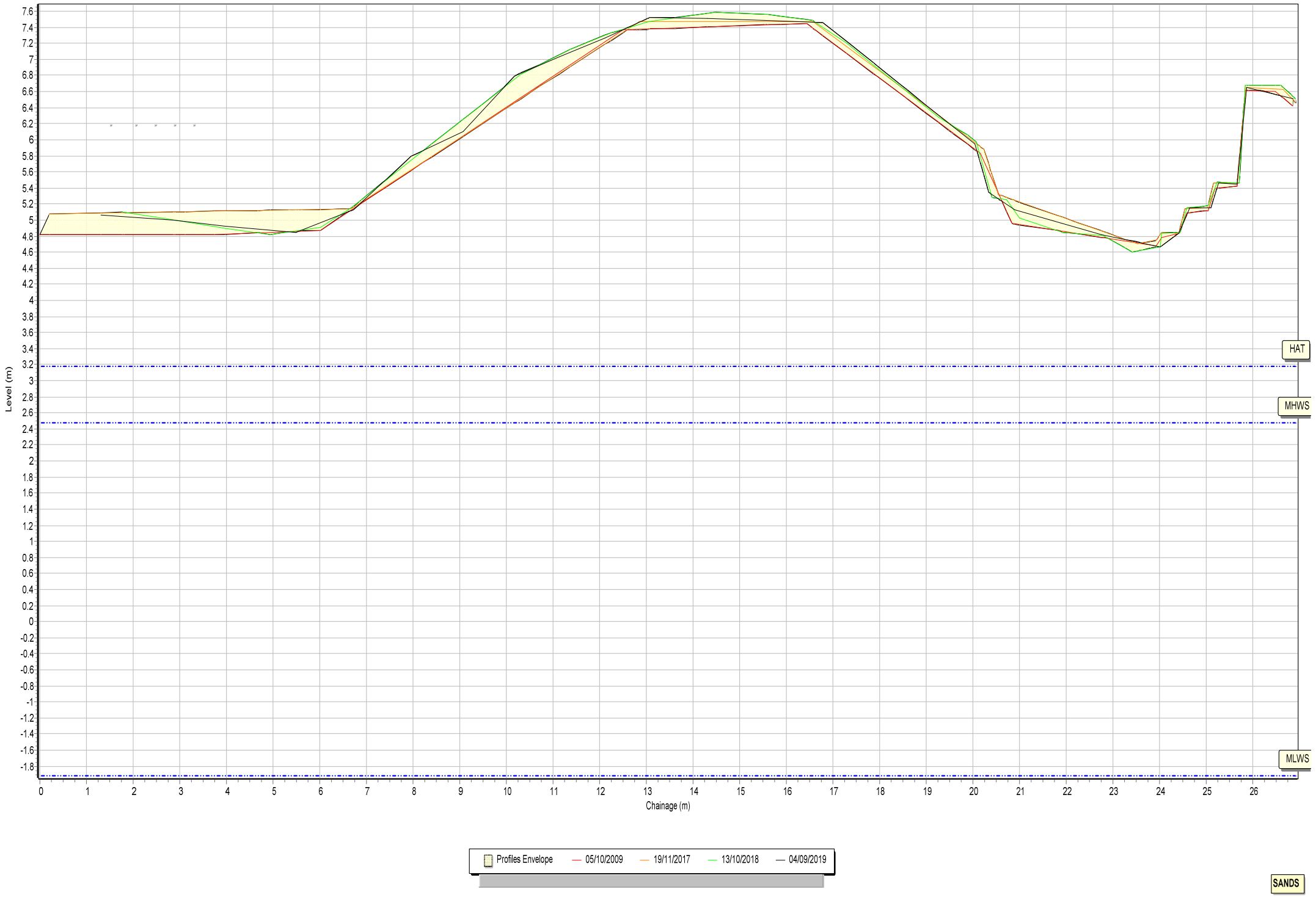
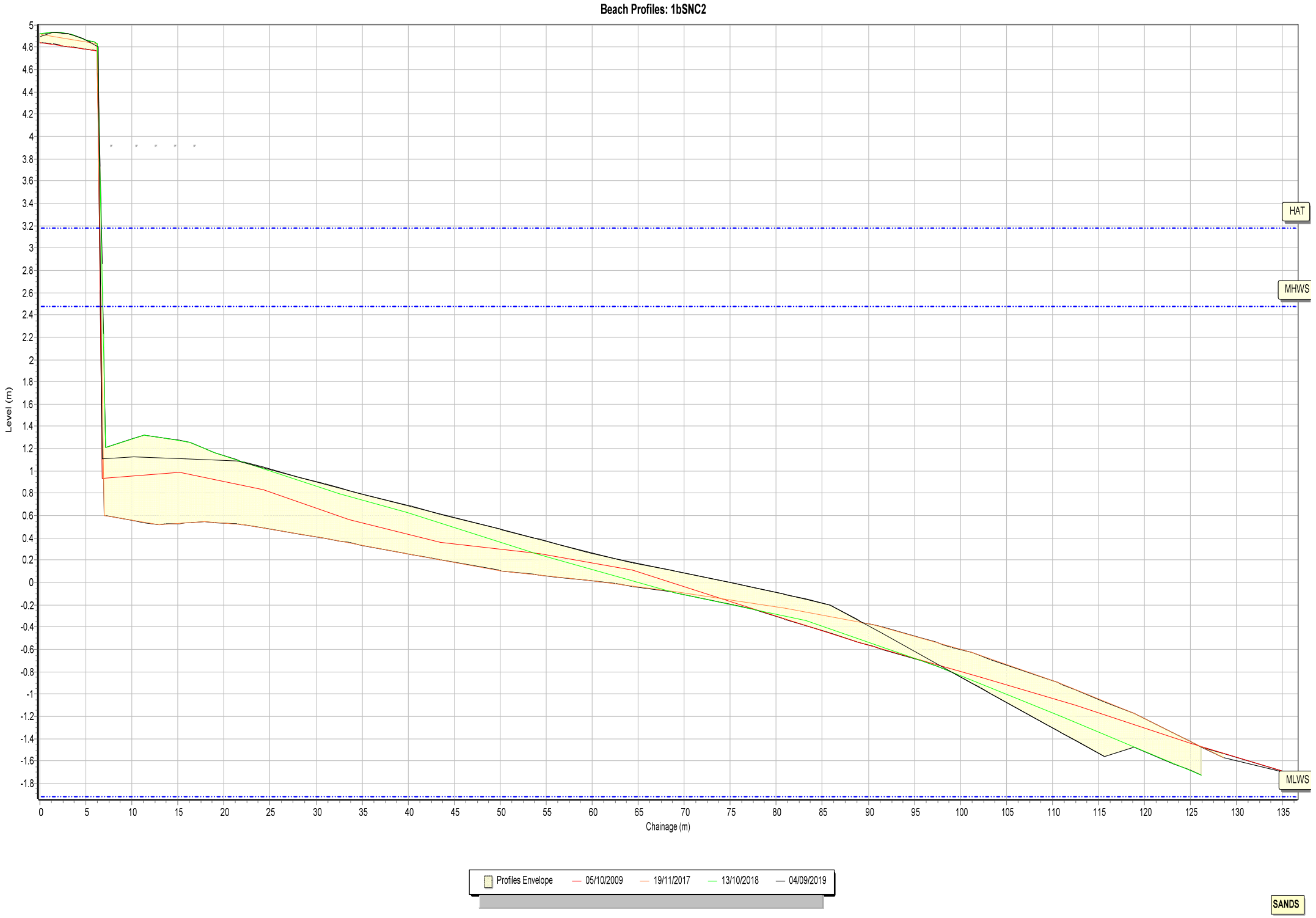
MHWS
MLWS
Profiles Envelope
07/09/2009
07/11/2017
22/11/2018
15/11/2019
SANDS


Beach Profiles: 1bSNC1
Level (m)
Chainage (m)
HAT
MHWS
MLWS
Profiles Envelope
05/10/2009
19/11/2017
13/10/2018
04/09/2019
SANDS


Beach Profiles: 1bSNC2
Level (m)
Chainage (m)
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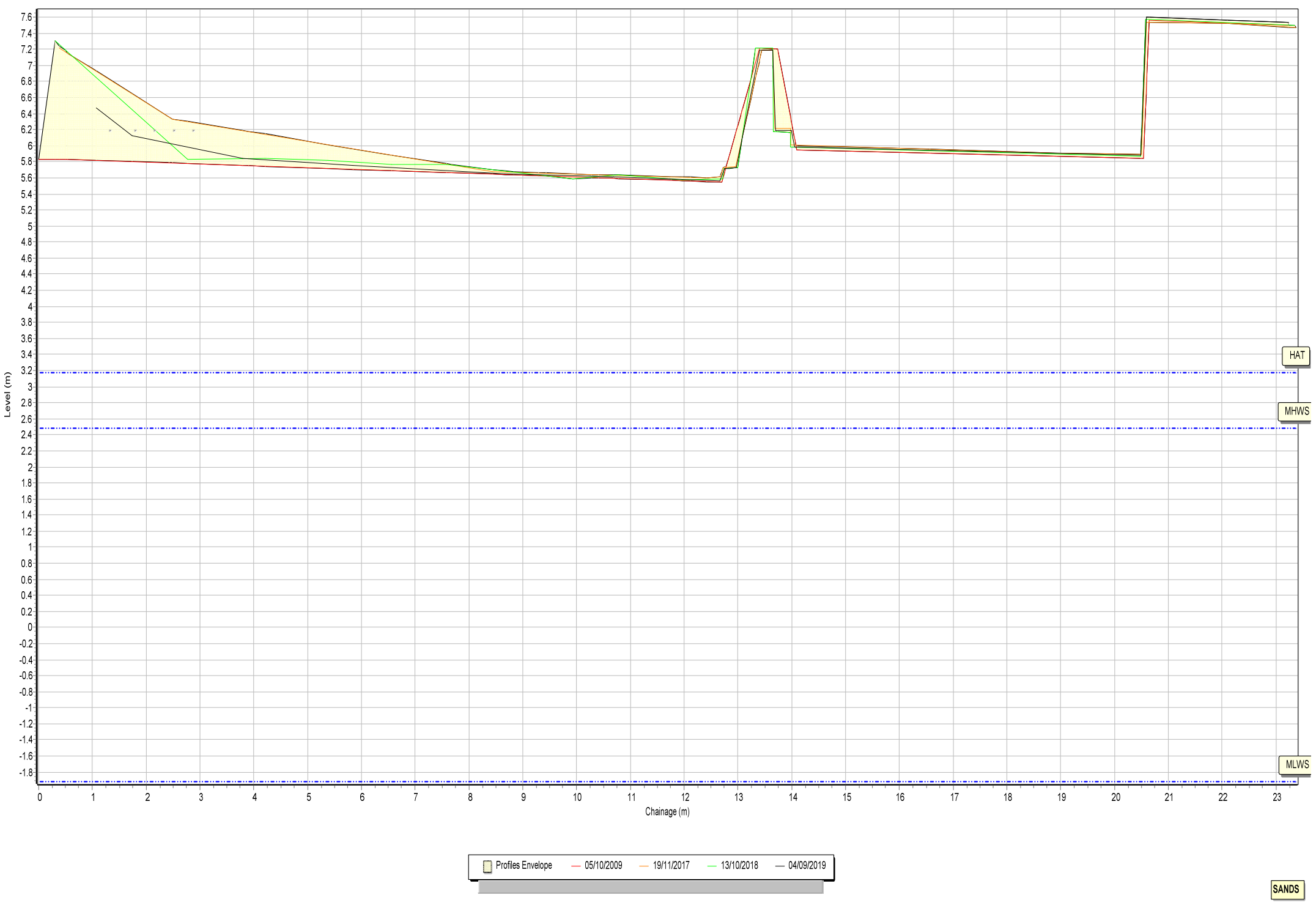
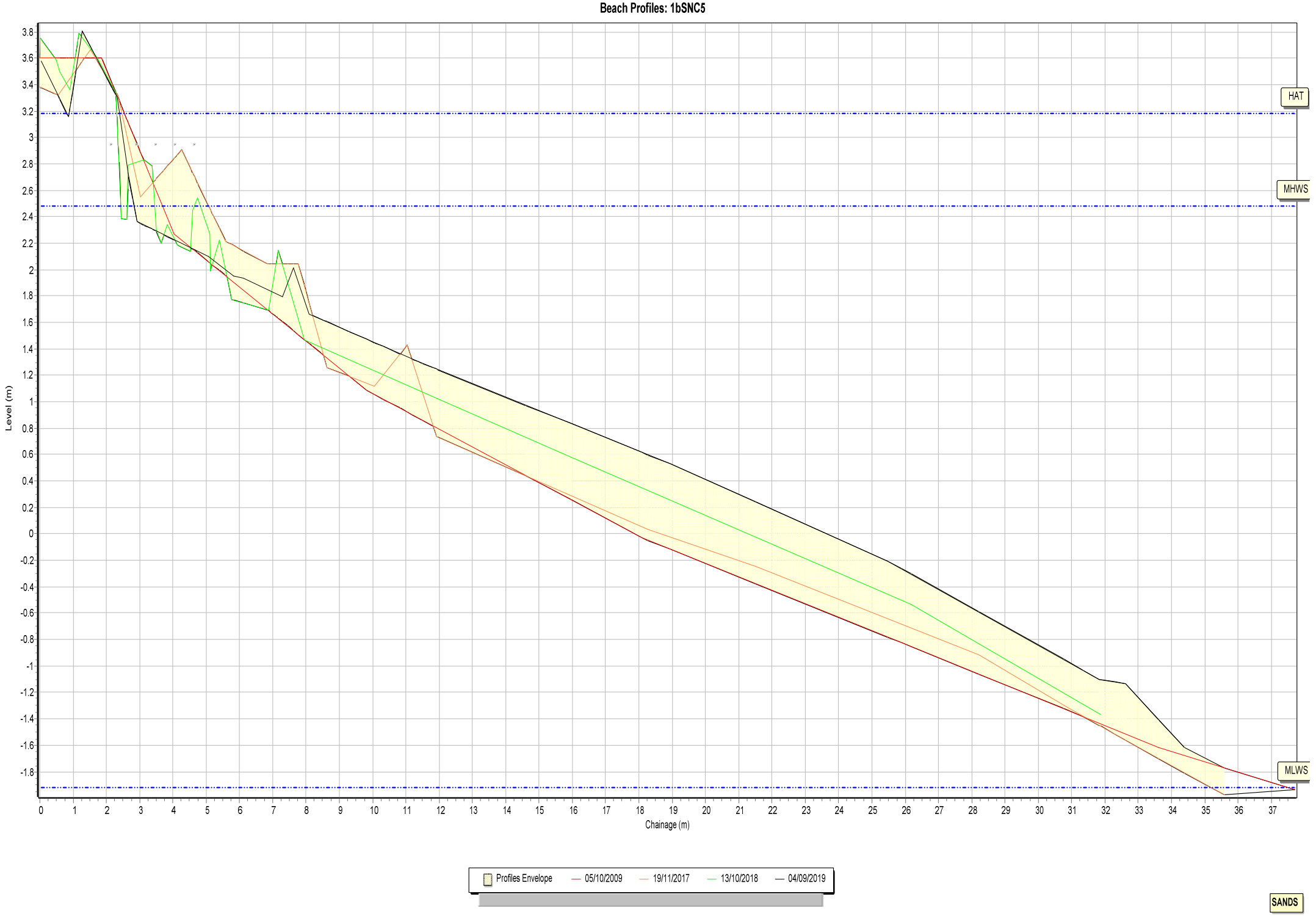
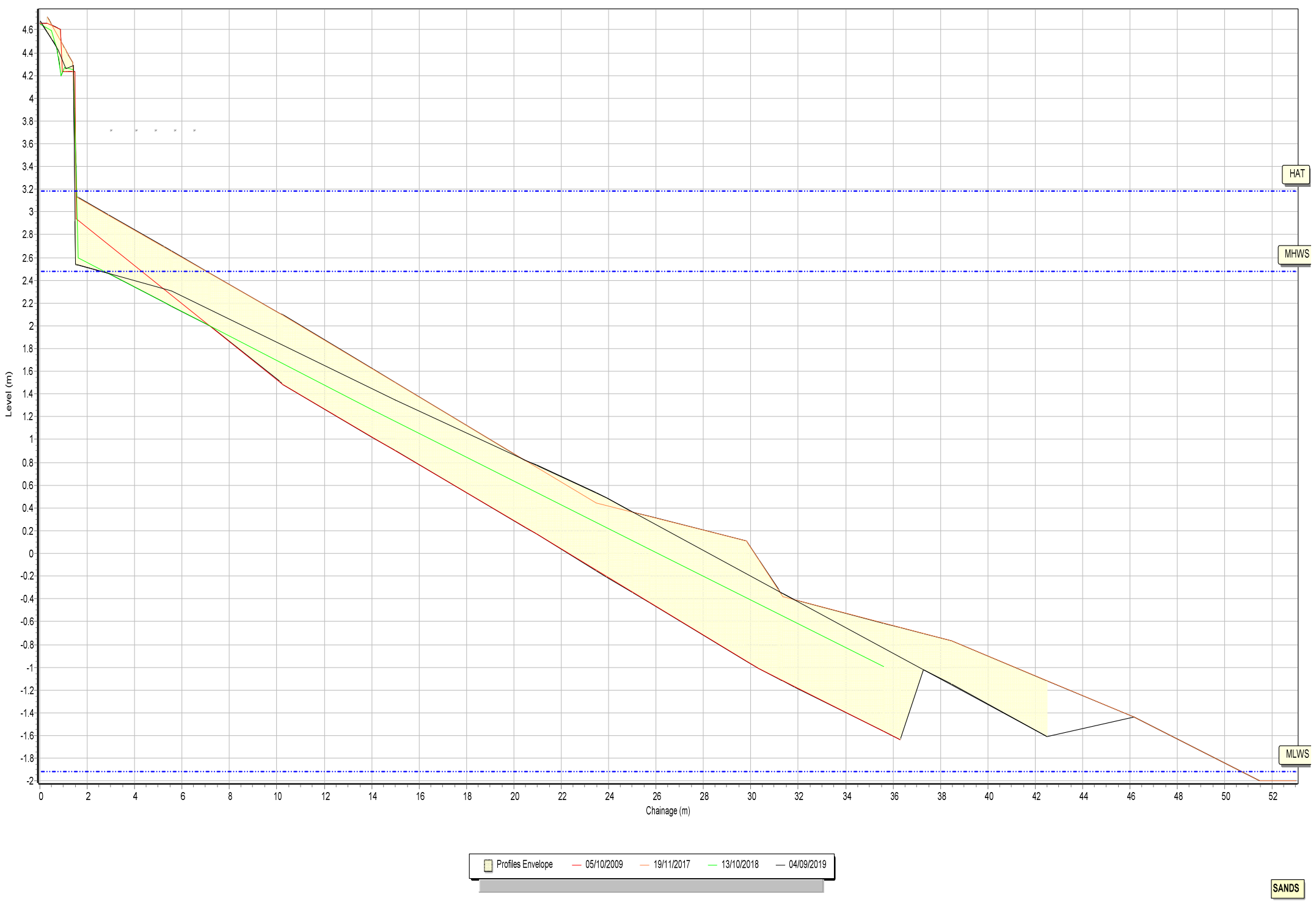
MHWS
MLWS
Profiles Envelope
05/10/2009
19/11/2017
13/10/2018
04/09/2019
SANDS


Beach Profiles: 1bSNC3
Level (m)
Chainage (m)
HAT
MHWS
MLWS
Profiles Envelope
05/10/2009
19/11/2017
13/10/2018
04/09/2019
SANDS

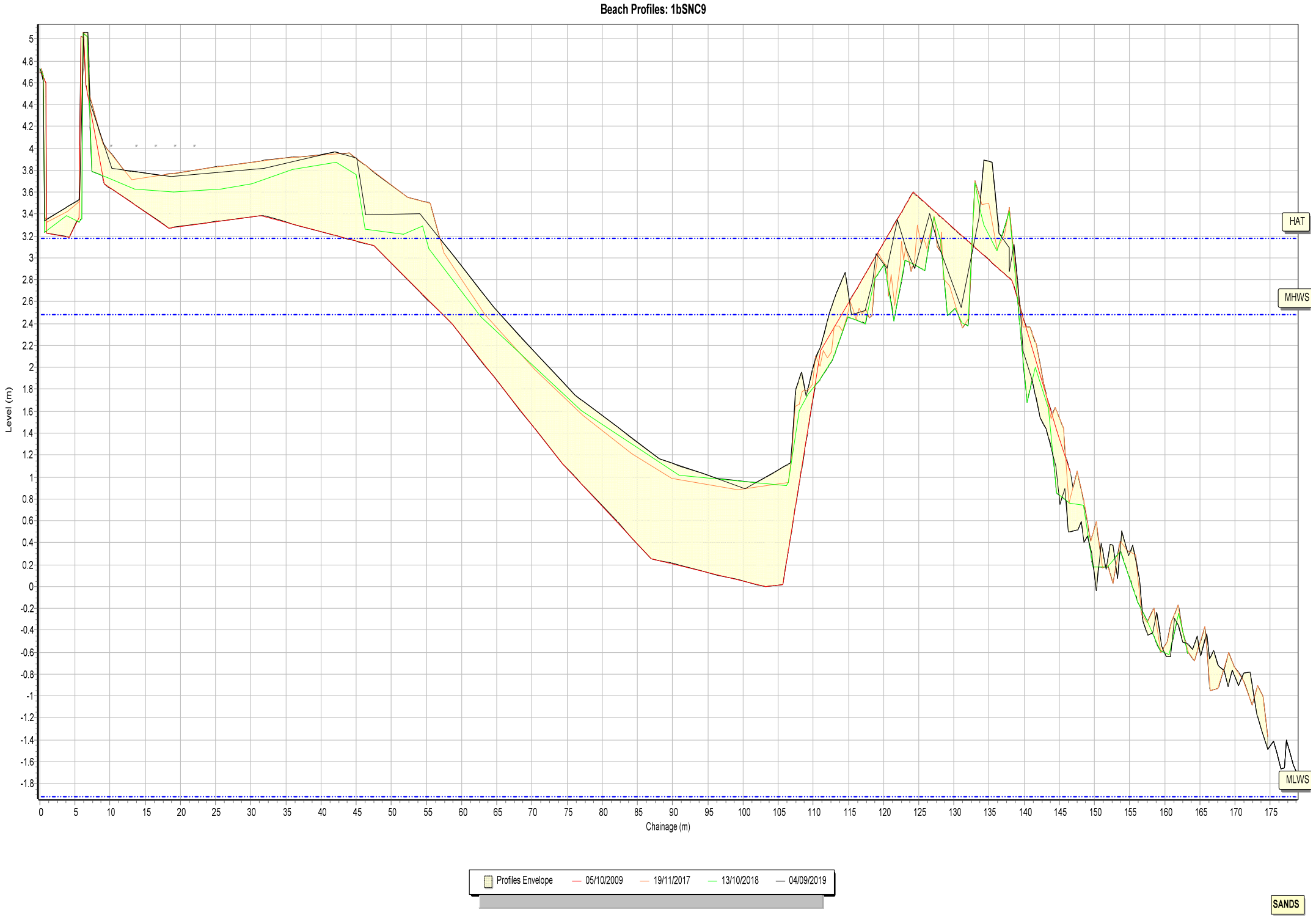

Beach Profiles: 1bSNC4
HAT
MHWS
MLWS
SANDS
Level (m)
Chainage (m)
Profiles Envelope
05/10/2009
19/11/2017
13/10/2018
04/09/2019


Beach Profiles: 1bSNC5
Level (m)
Chainage (m)
HAT
MHWS
MLWS
Profiles Envelope
05/10/2009
19/11/2017
13/10/2018
04/09/2019
SANDS


Beach Profiles: 1bSNC6
Level (m)
Chainage (m)
HAT
MHWS
MLWS
Profiles Envelope
05/10/2009
19/11/2017
13/10/2018
04/09/2019
SANDS


Beach Profiles: 1bSNC7
Level (m)
Chainage (m)
HAT
MHWS
MLWS
Profiles Envelope
05/10/2009
19/11/2017
13/10/2018
04/09/2019
SANDS

Beach Profiles: 1bSNC8


Beach Profiles: 1bSNC9
Level (m)
Chainage (m)
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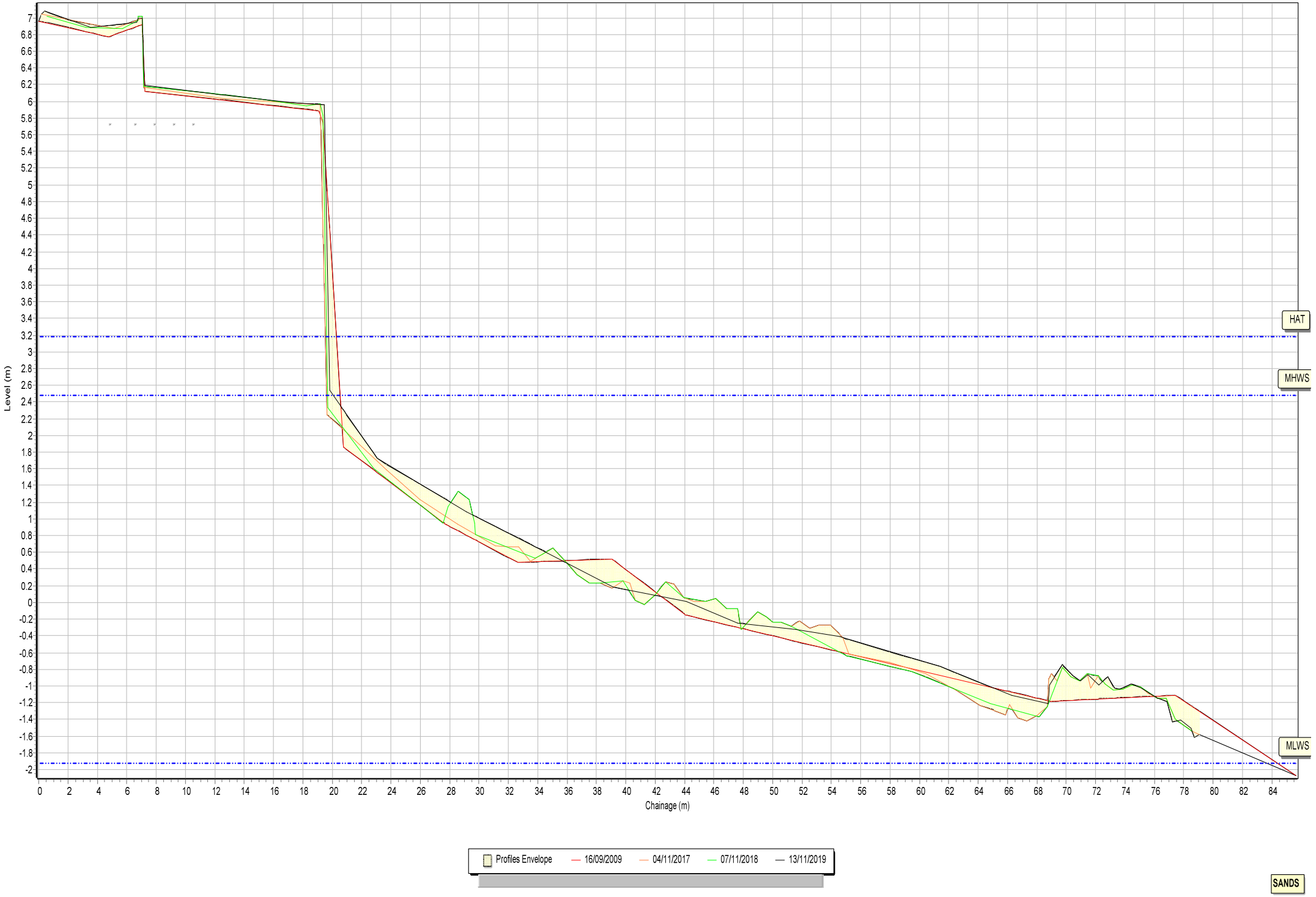
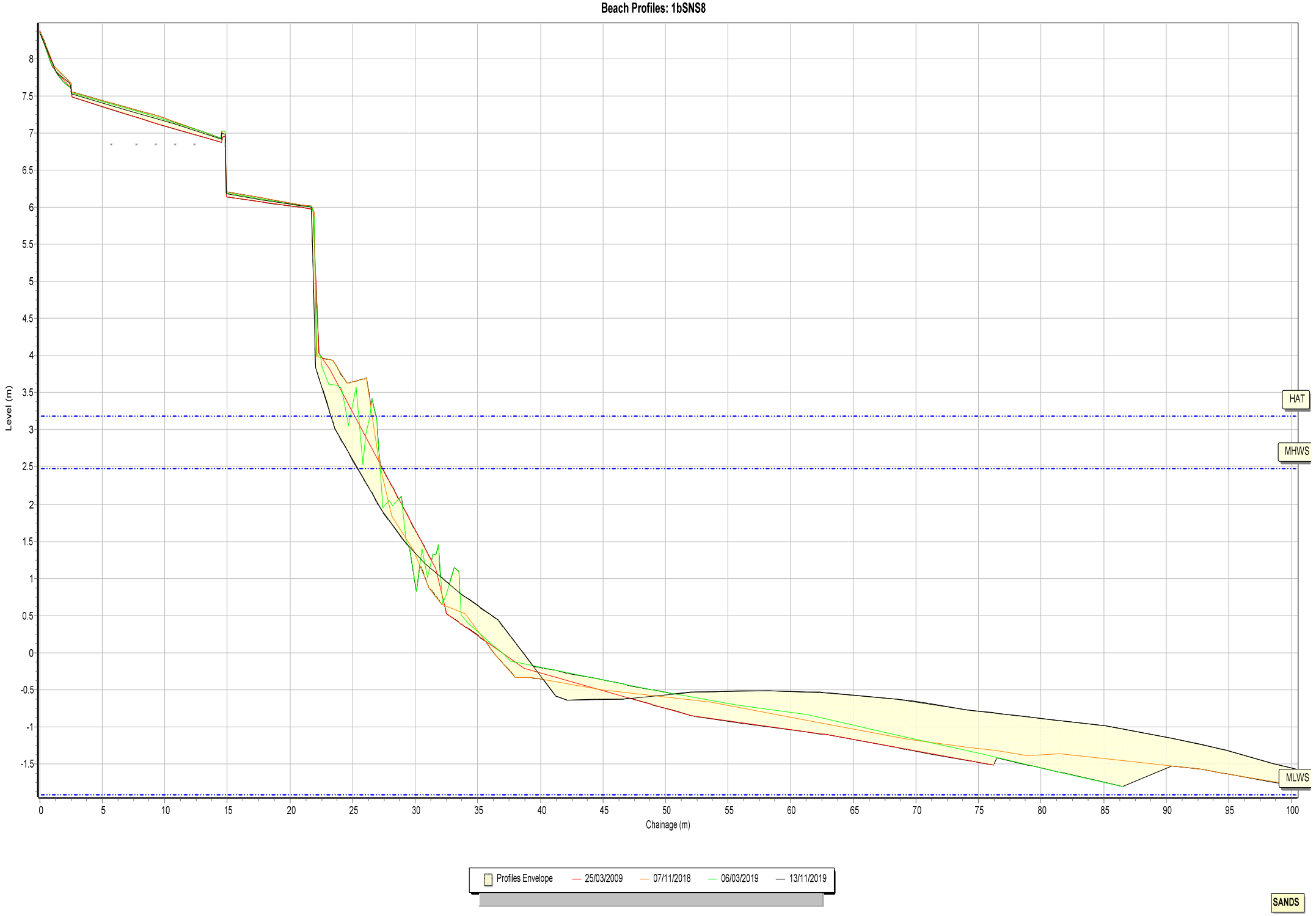
MHWS
MLWS
Profiles Envelope
05/10/2009
19/11/2017
13/10/2018
04/09/2019
SANDS

Beach Profiles: 1bSNS7




Beach Profiles: 1bSNS8
Level (m)
Chainage (m)
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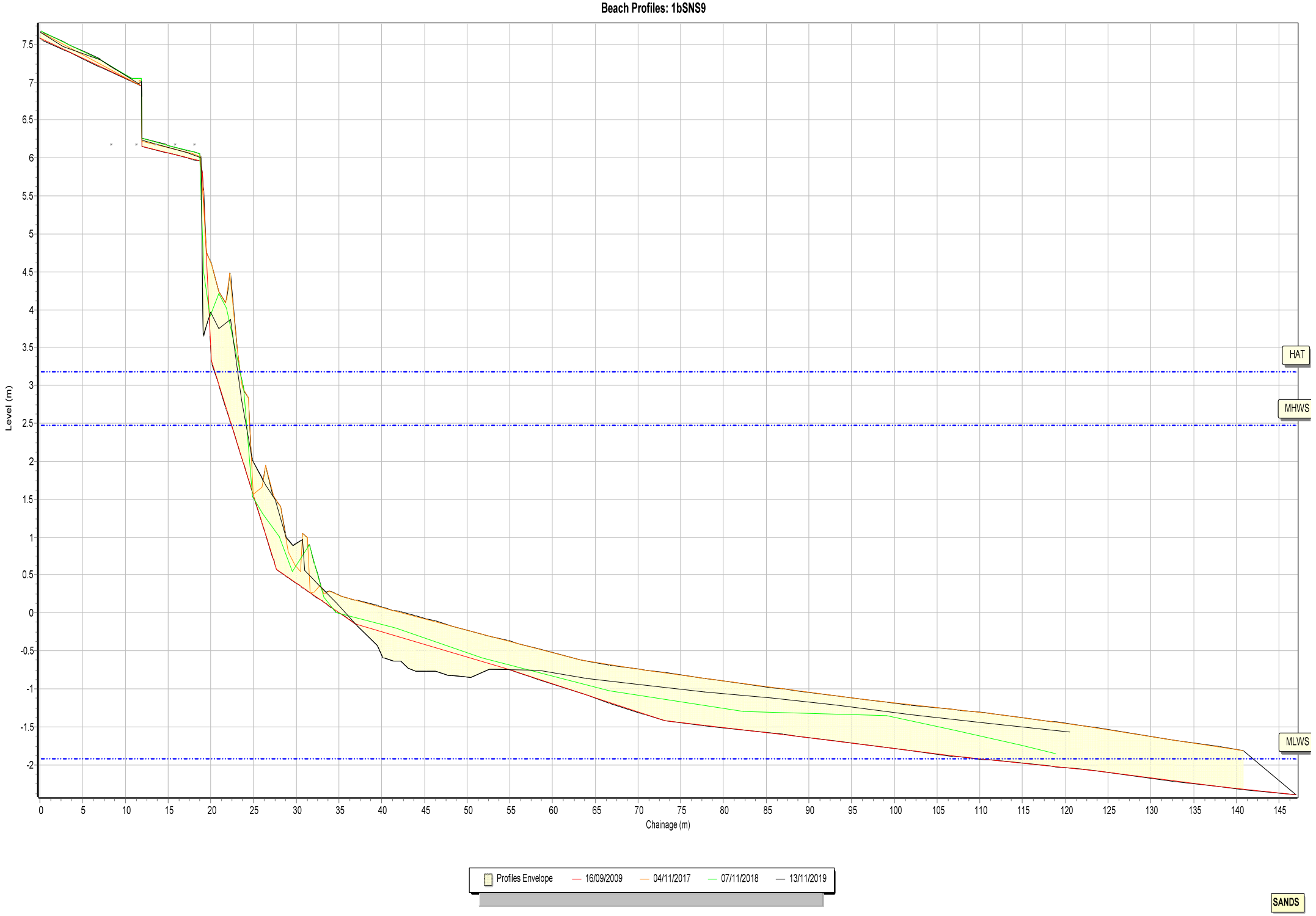
MHWS
MLWS
Profiles Envelope
25/03/2009
07/11/2018
06/03/2019
13/11/2019
SANDS


Beach Profiles: 1bSNS9
Level (m)
Chainage (m)
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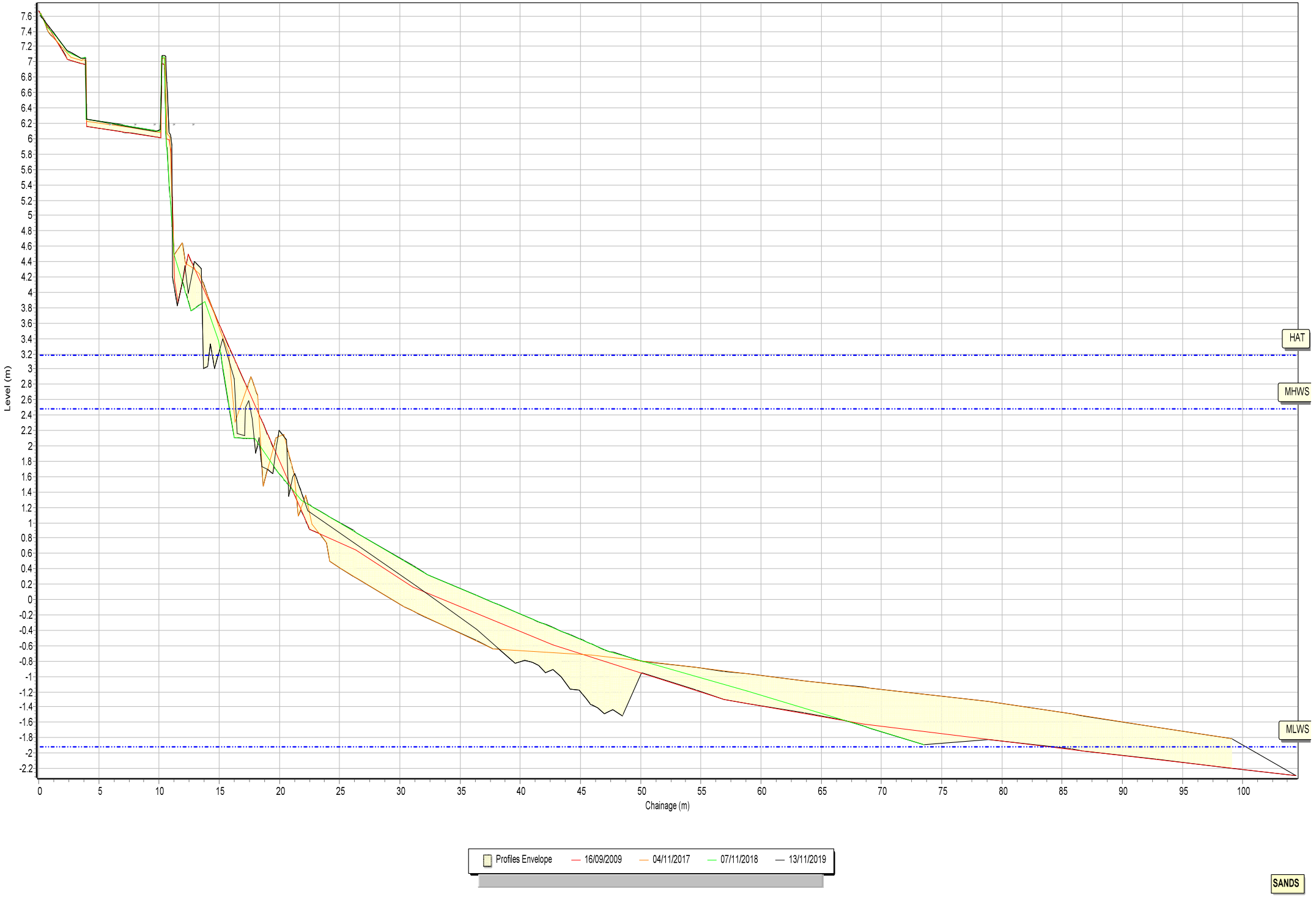
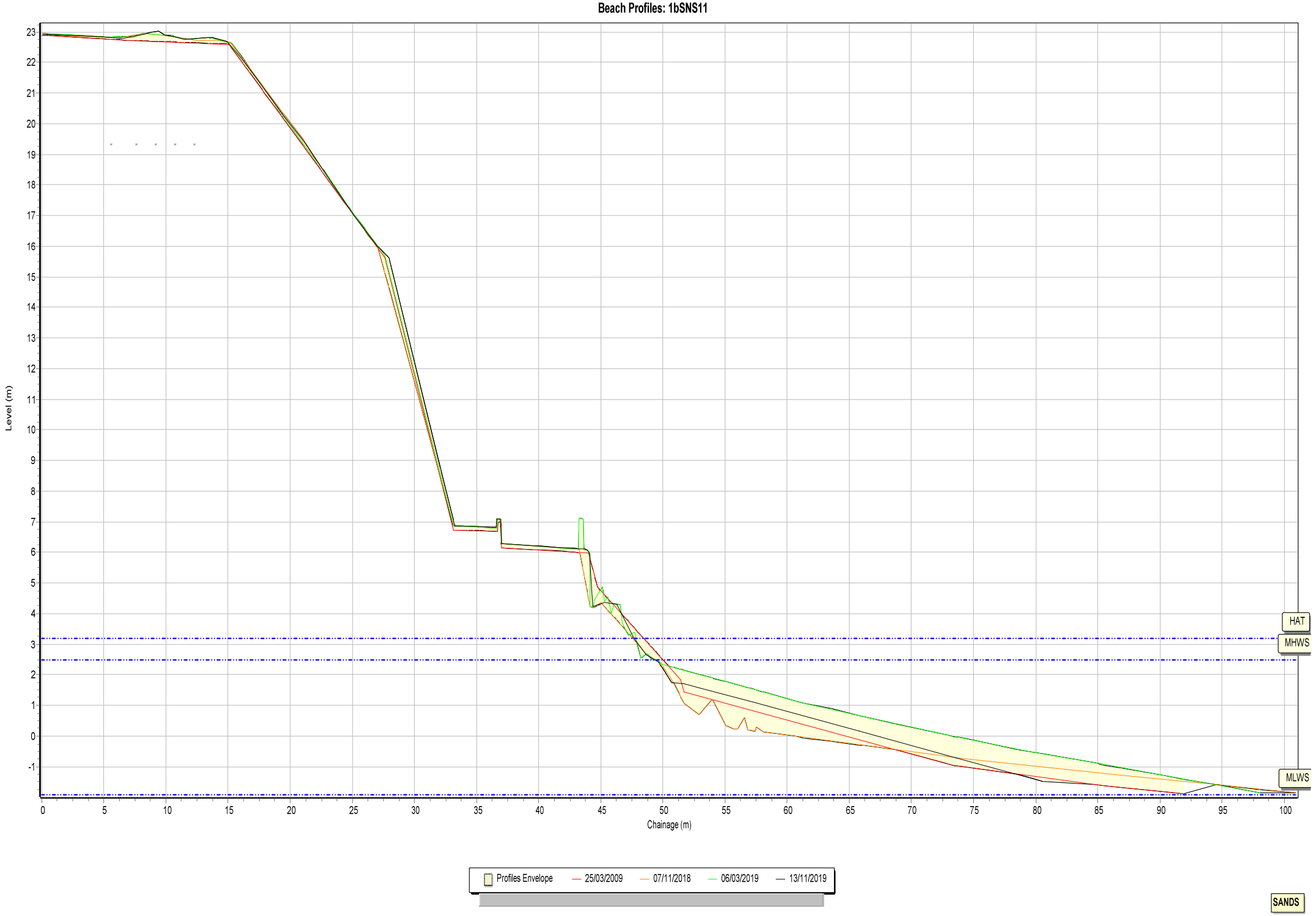
MHWS
MLWS
Profiles Envelope
16/09/2009
04/11/2017
07/11/2018
13/11/2019
SANDS

Beach Profiles: 1bSNS10

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Level (m)
Chainage (m)
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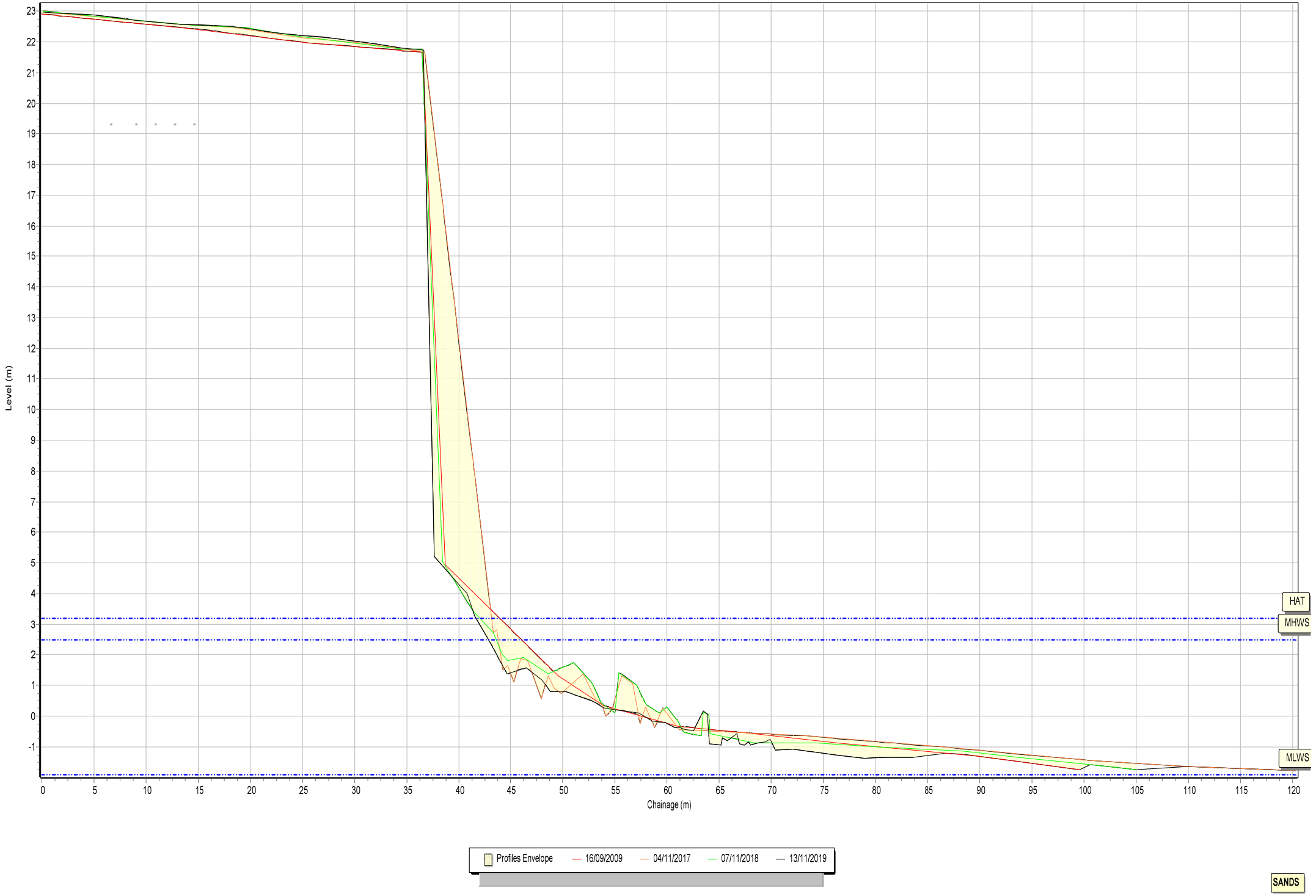
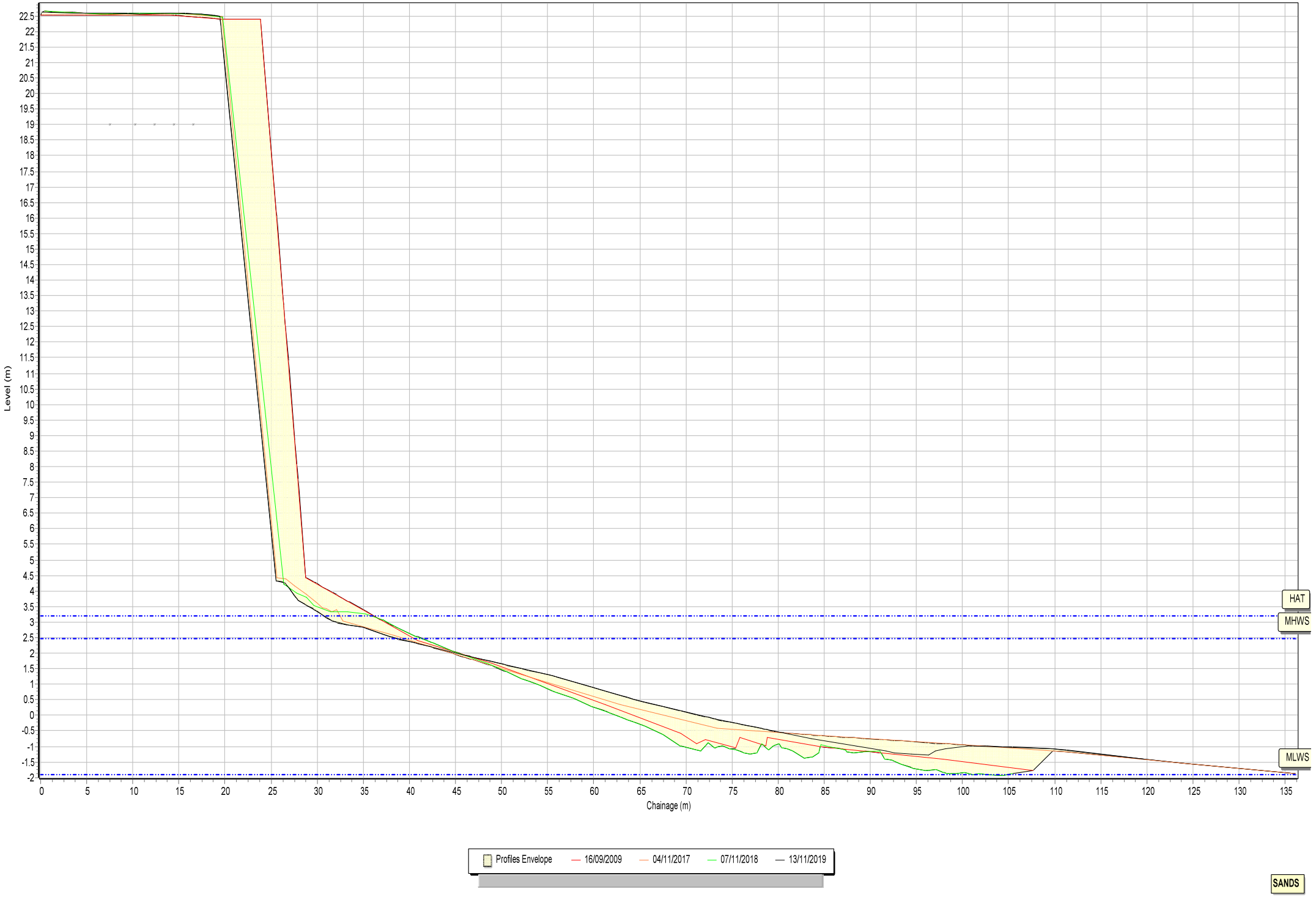
MHWS
MLWS
Profiles Envelope
25/03/2009
07/11/2018
06/03/2019
13/11/2019
SANDS

Beach Profiles: 1bSNS12



Beach Profiles: 1bSNS13



Beach Profiles: 1bSNS14


Beach Profiles: 1bSNS15
Level (m)
Chainage (m)
HAT
MHWS
MLWS
Profiles Envelope
16/09/2009
04/11/2017
07/11/2018
13/11/2019
SANDS


Beach Profiles: 1bSNS16
Level (m)
Chainage (m)
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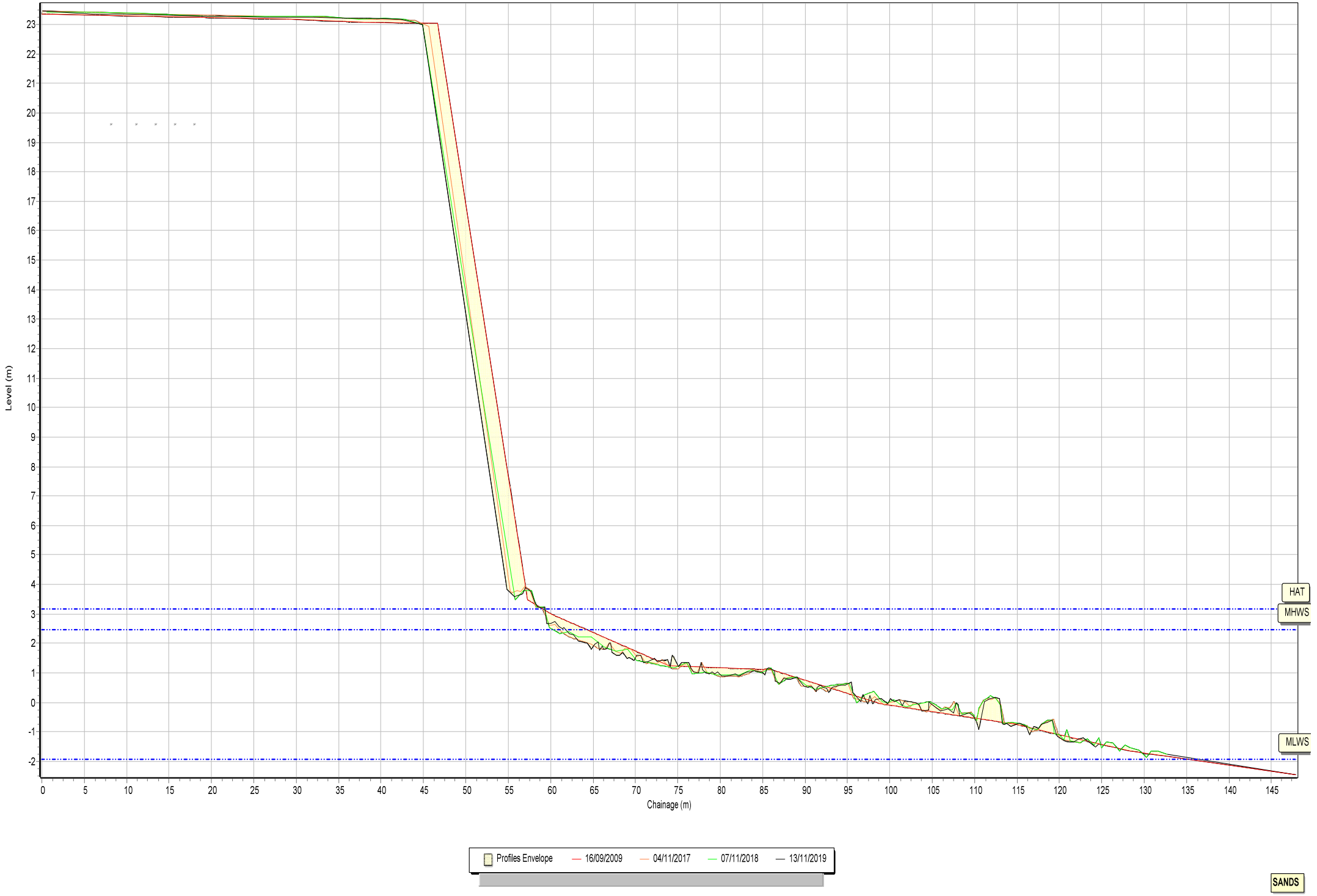
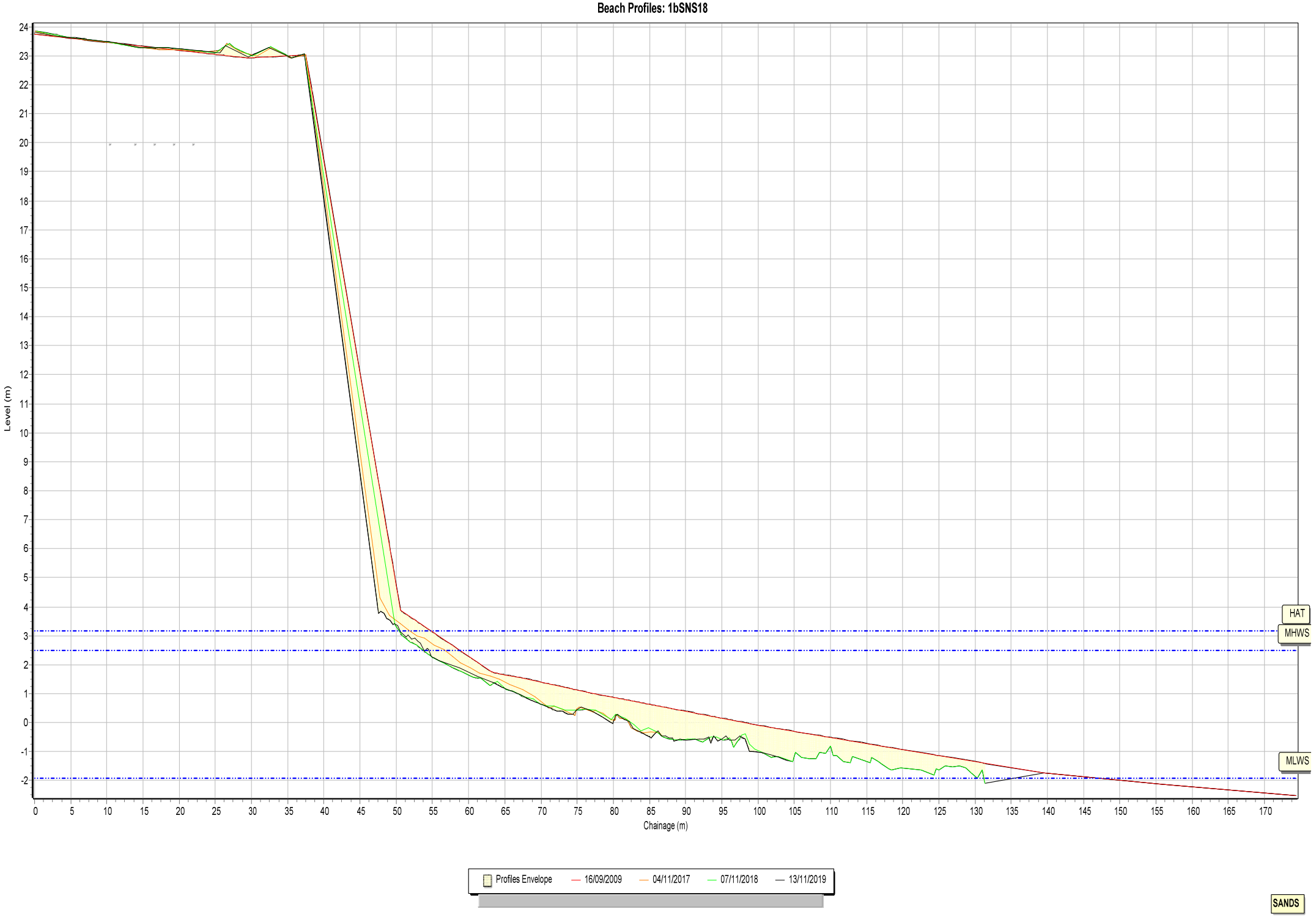
MHWS
MLWS
Profiles Envelope
16/09/2009
04/11/2017
07/11/2018
13/11/2019
SANDS

Beach Profiles: 1bSNS17

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Chainage (m)
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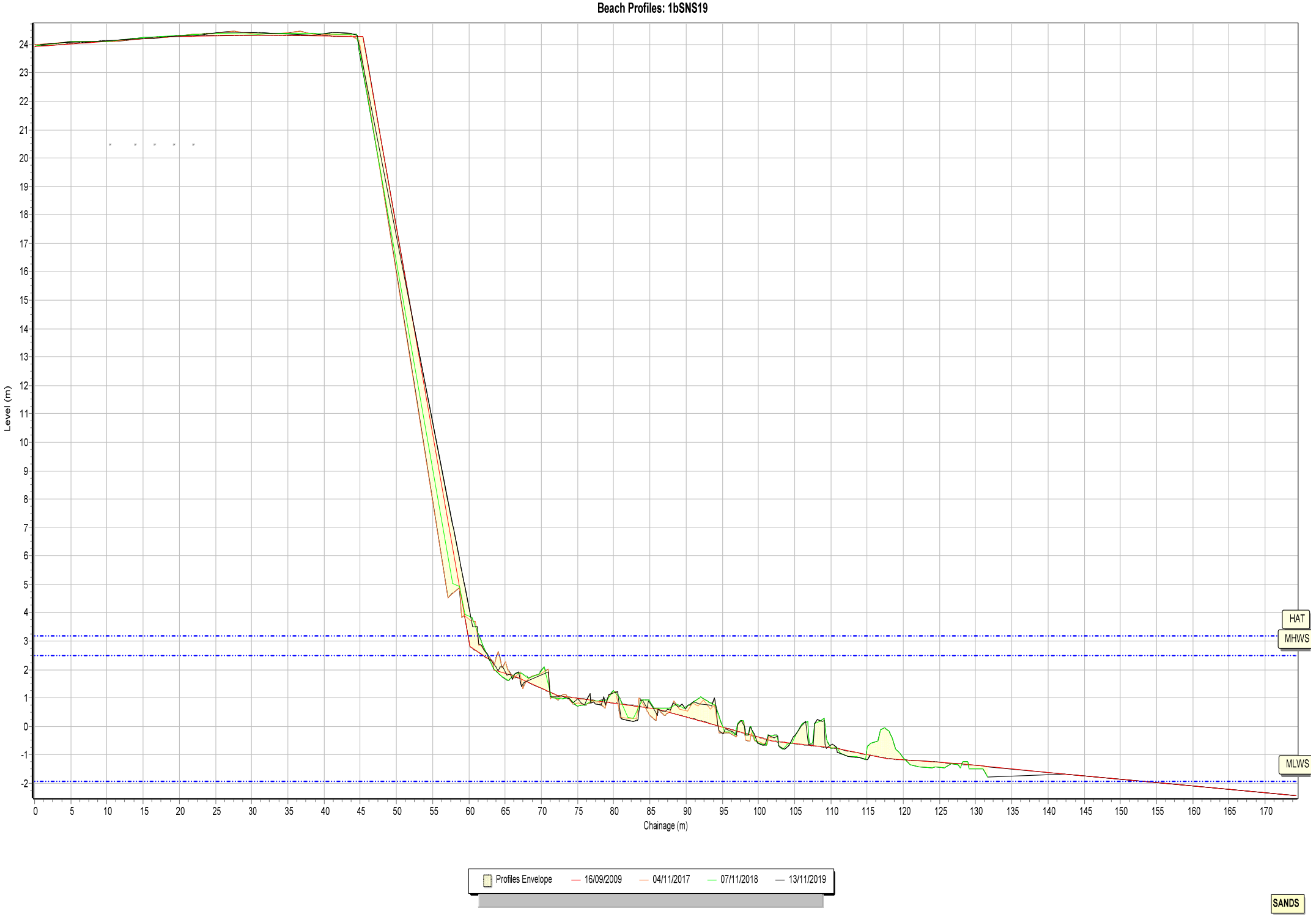
MHWS
MLWS
Profiles Envelope
16/09/2009
04/11/2017
07/11/2018
13/11/2019
SANDS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Level (m)
Chainage (m)
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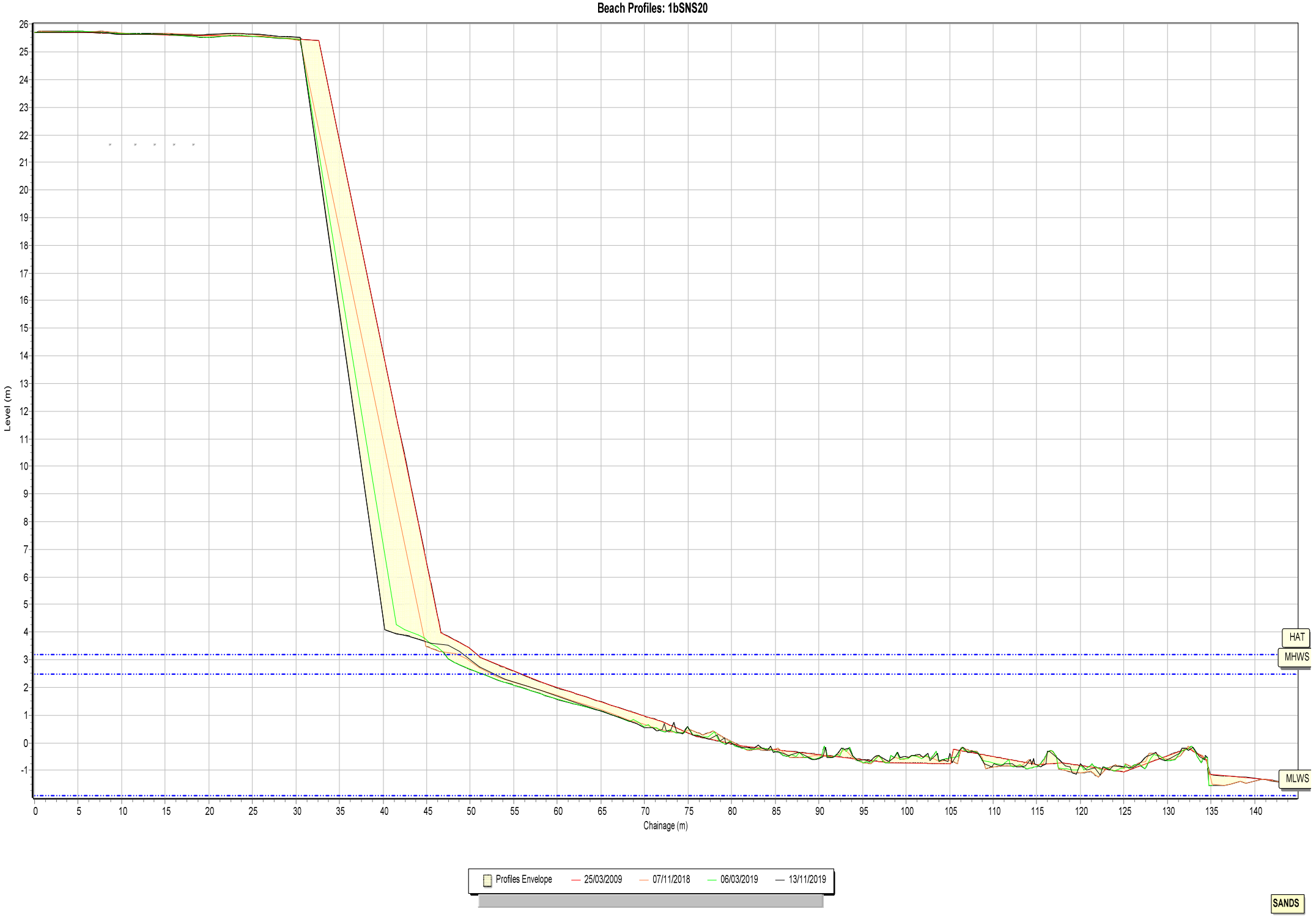
MHWS
MLWS
Profiles Envelope
16/09/2009
04/11/2017
07/11/2018
13/11/2019
SANDS


Beach Profiles: 1bSNS20
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Chainage (m)
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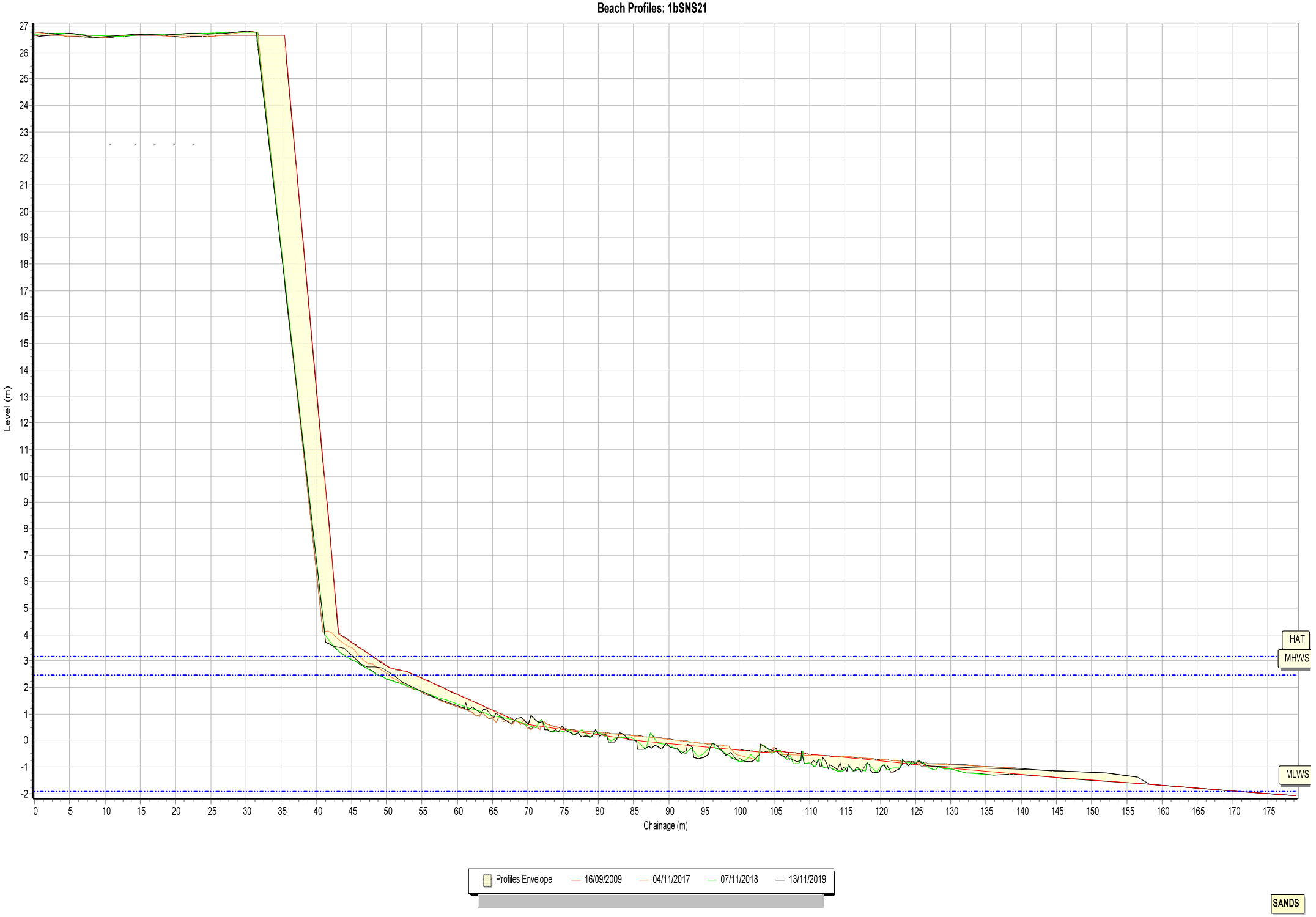
MHWS
MLWS
Profiles Envelope
25/03/2009
07/11/2018
06/03/2019
13/11/2019
SANDS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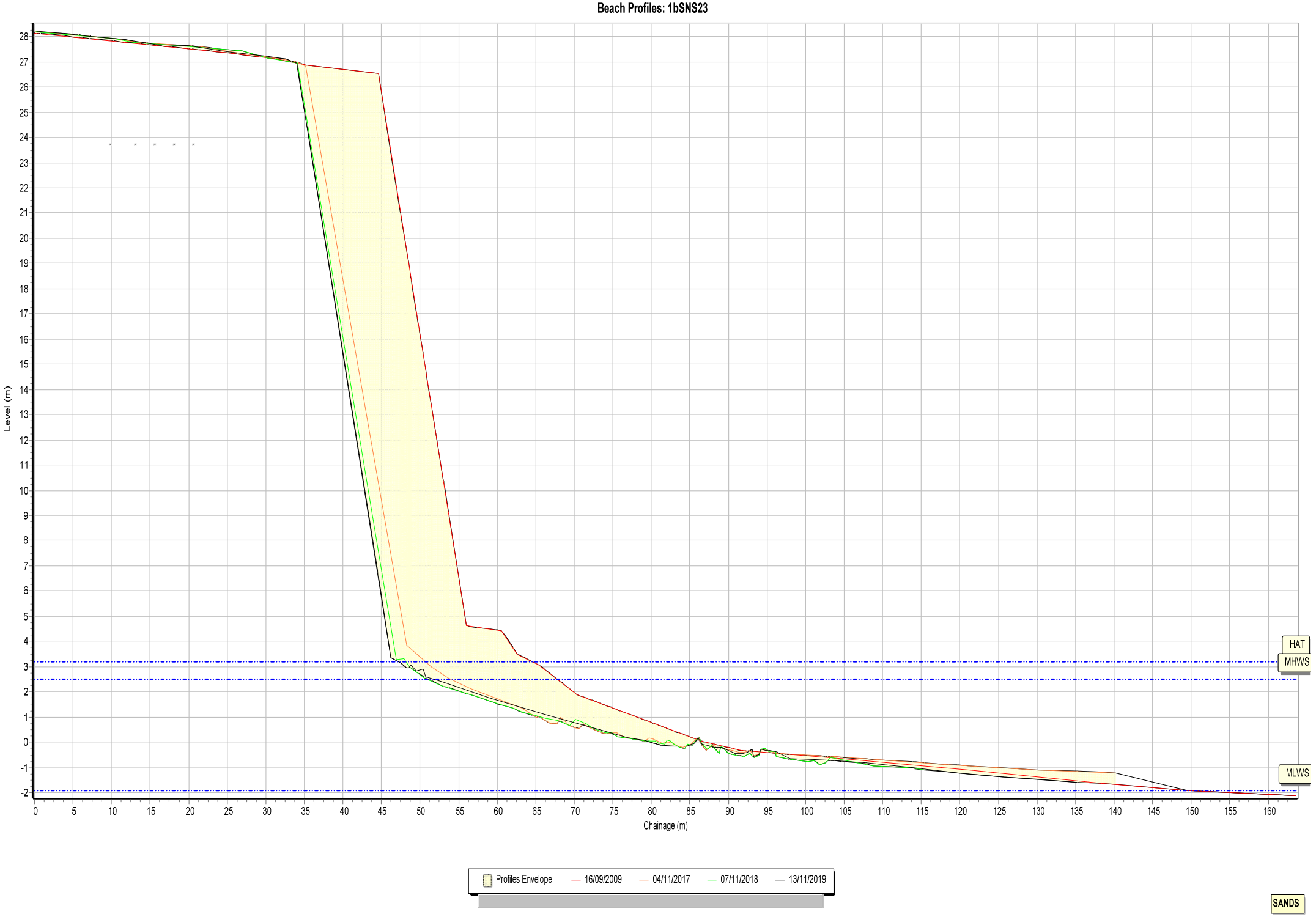
Level (m)
Chainage (m)
HAT
MHWS
MLWS
Profiles Envelope
16/09/2009
04/11/2017
07/11/2018
13/11/2019
SANDS


Beach Profiles: 1bSNS22
Level (m)
Chainage (m)
HAT
MHWS
MLWS
Profiles Envelope
16/09/2009
04/11/2017
07/11/2018
13/11/2019
SANDS


Beach Profiles: 1bSNS23
Level (m)
Chainage (m)
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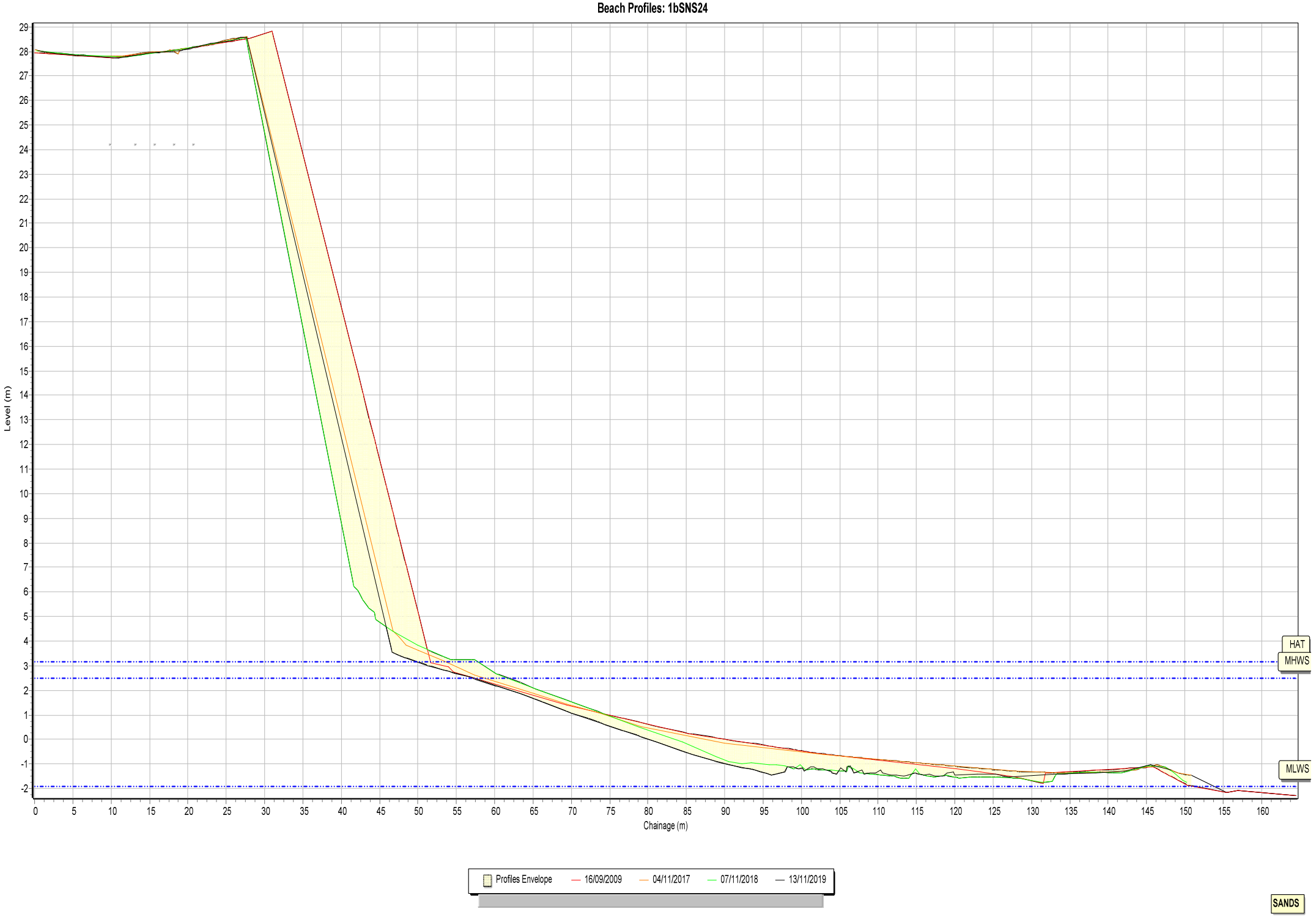
MHWS
MLWS
Profiles Envelope
16/09/2009
04/11/2017
07/11/2018
13/11/2019
SANDS


Beach Profiles: 1bSNS24
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Chainage (m)
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MLWS
Profiles Envelope
16/09/2009
04/11/2017
07/11/2018
13/11/2019
SANDS

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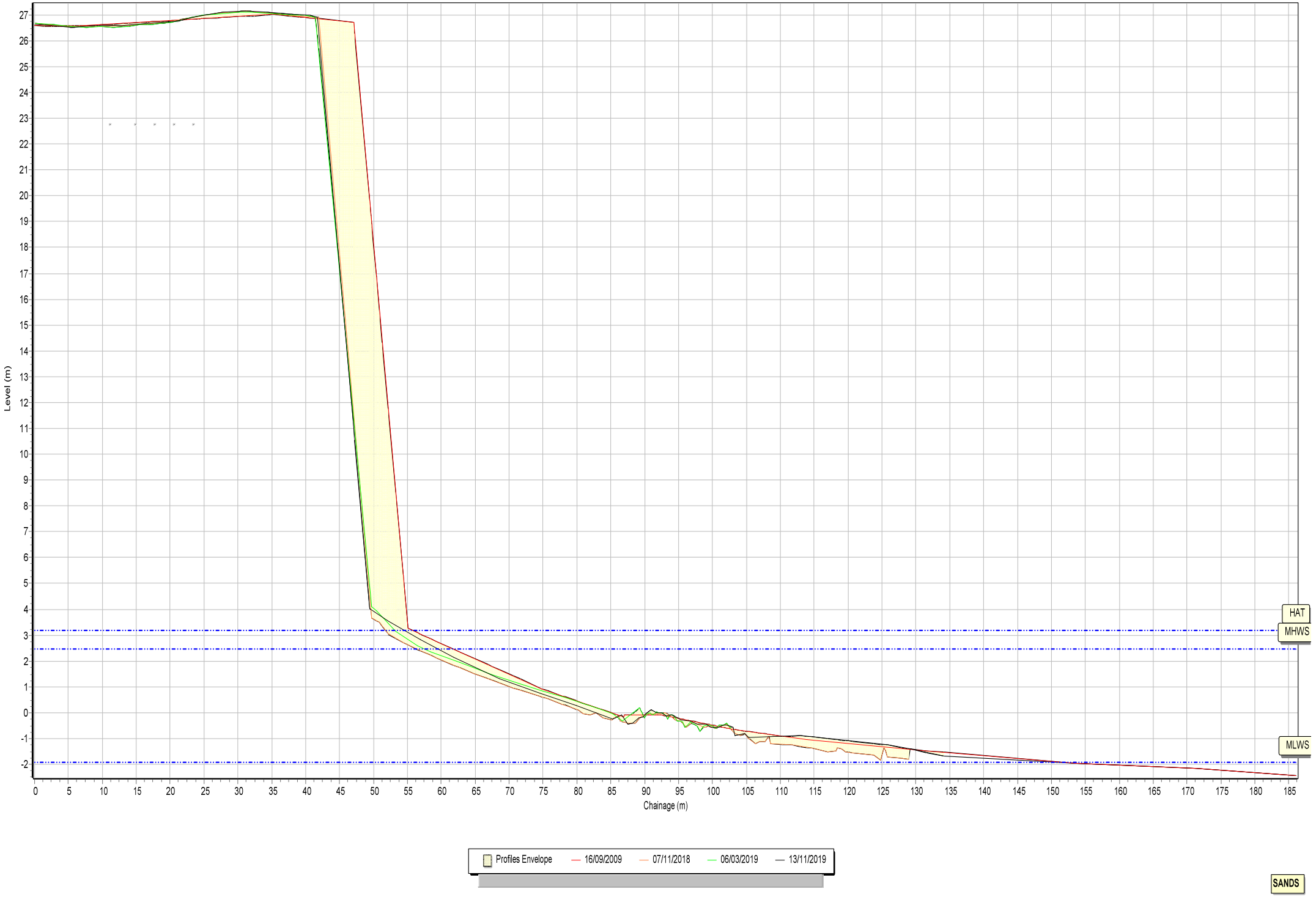

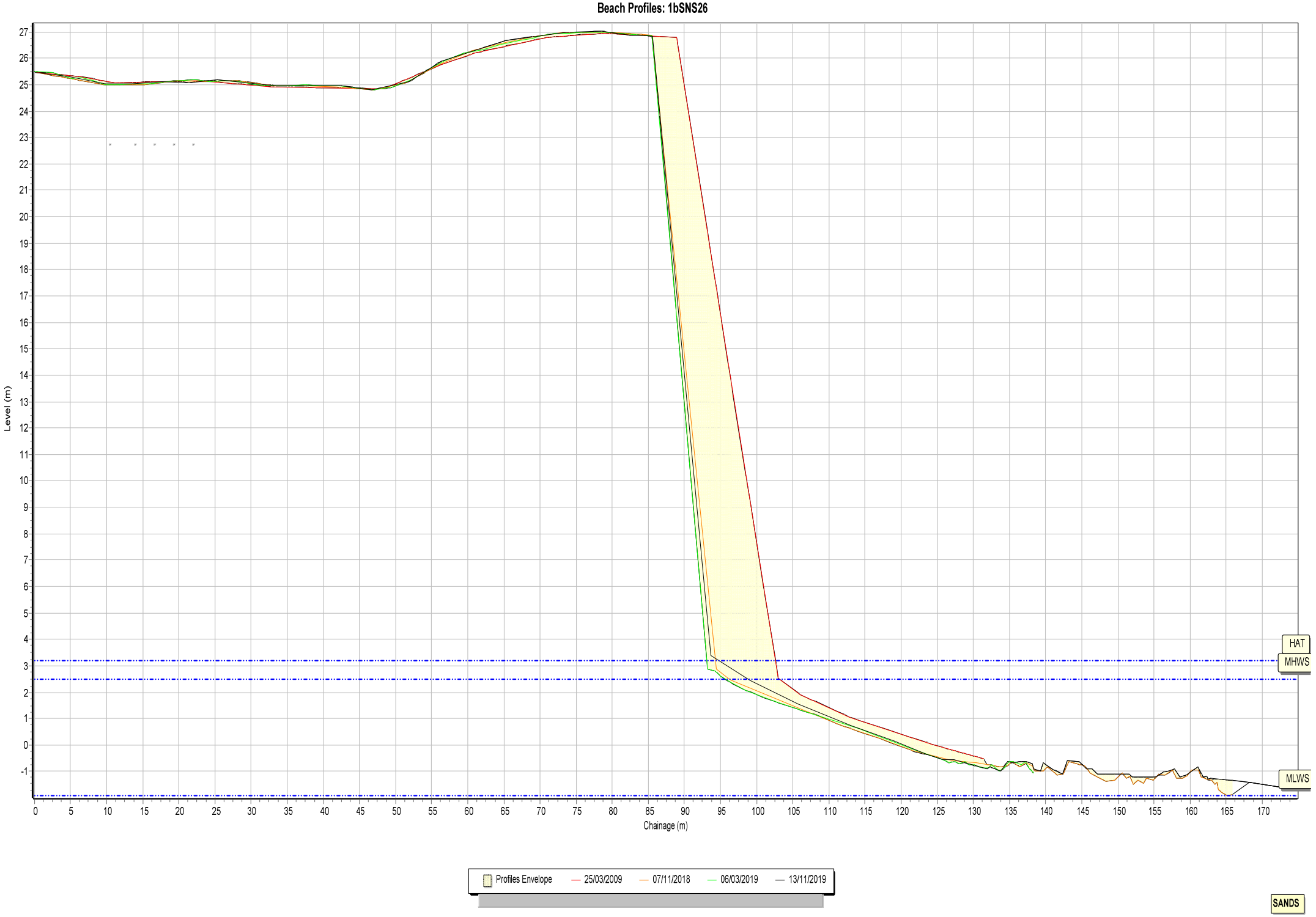
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13/11/2019
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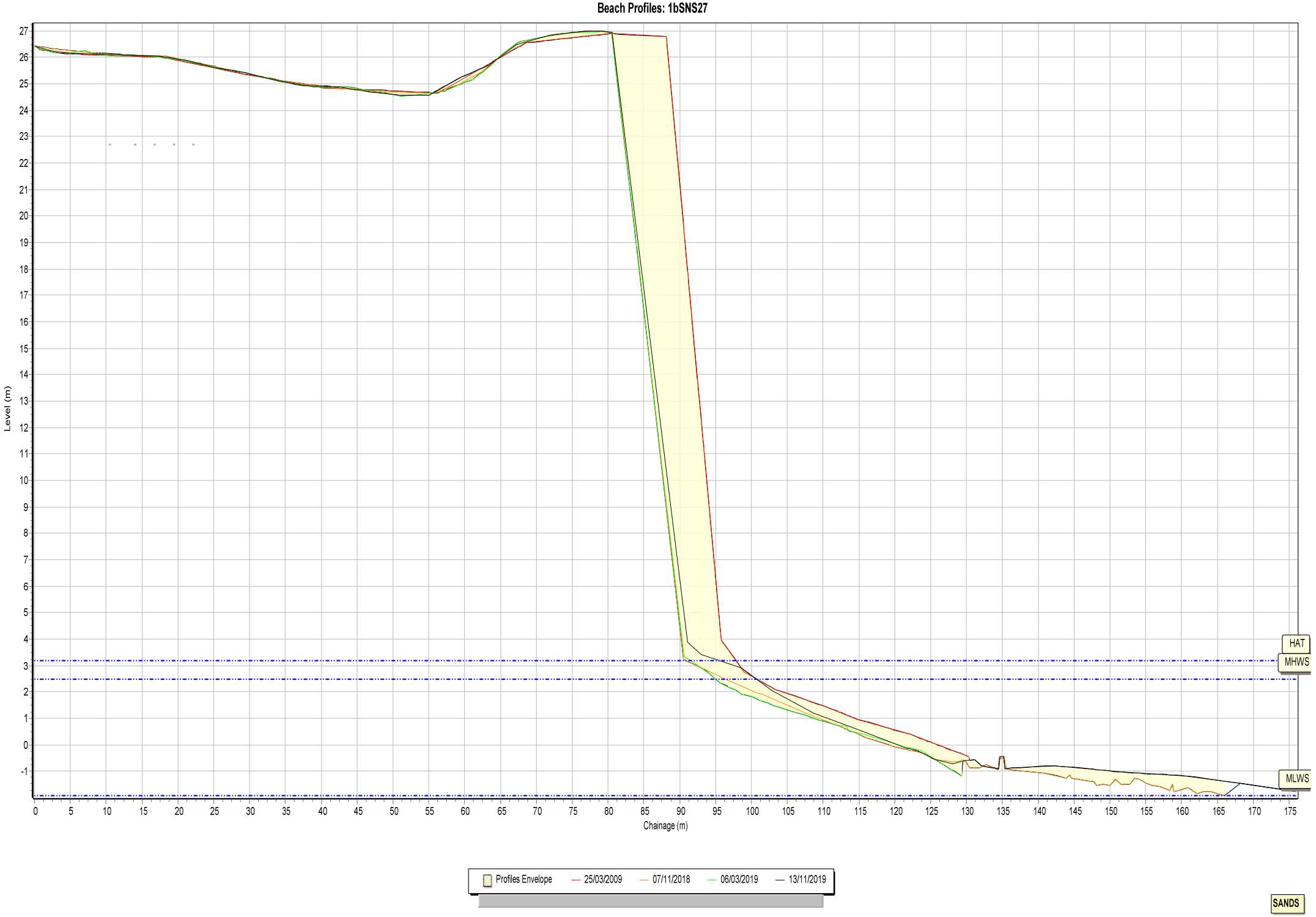
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13/11/2019
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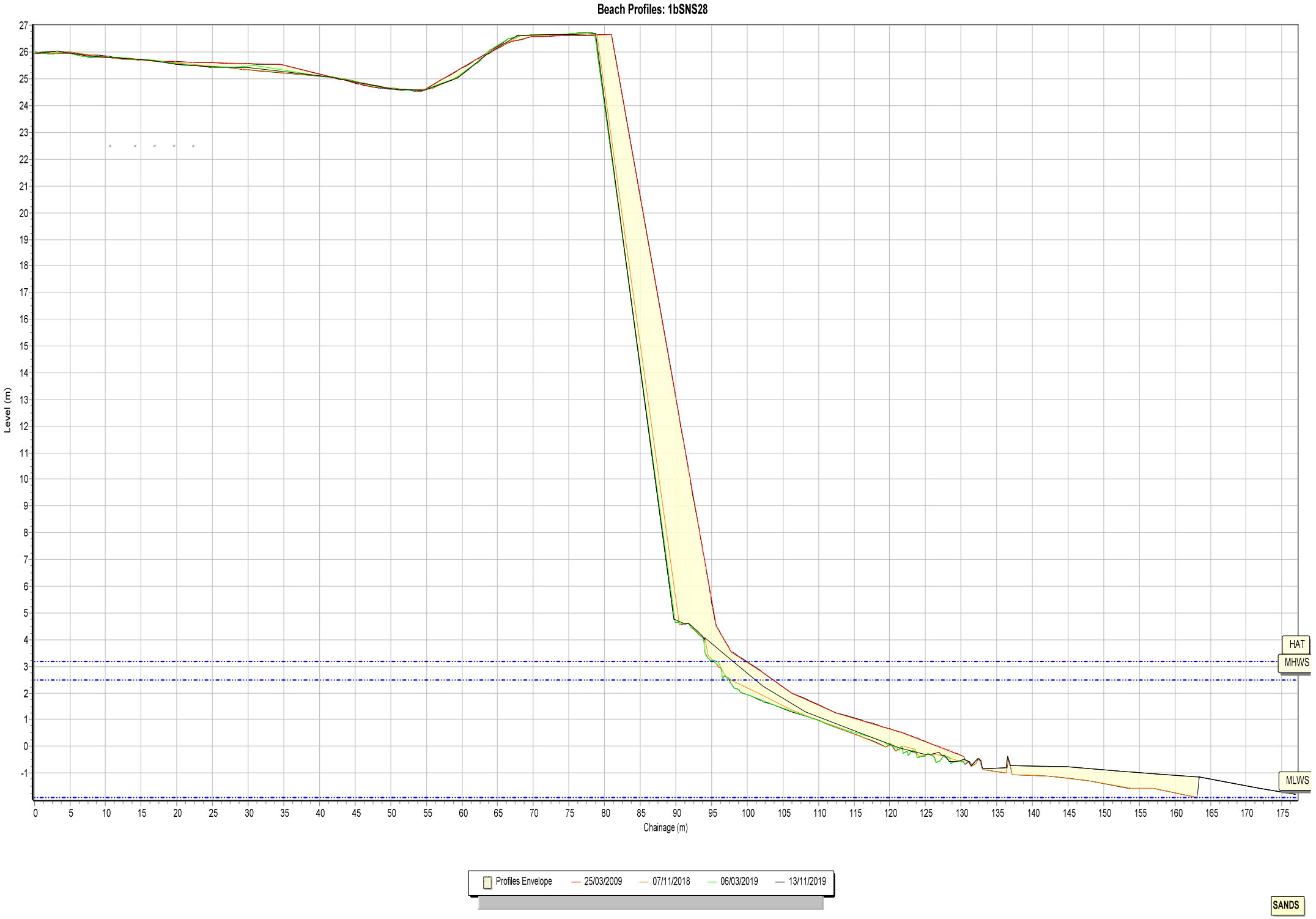
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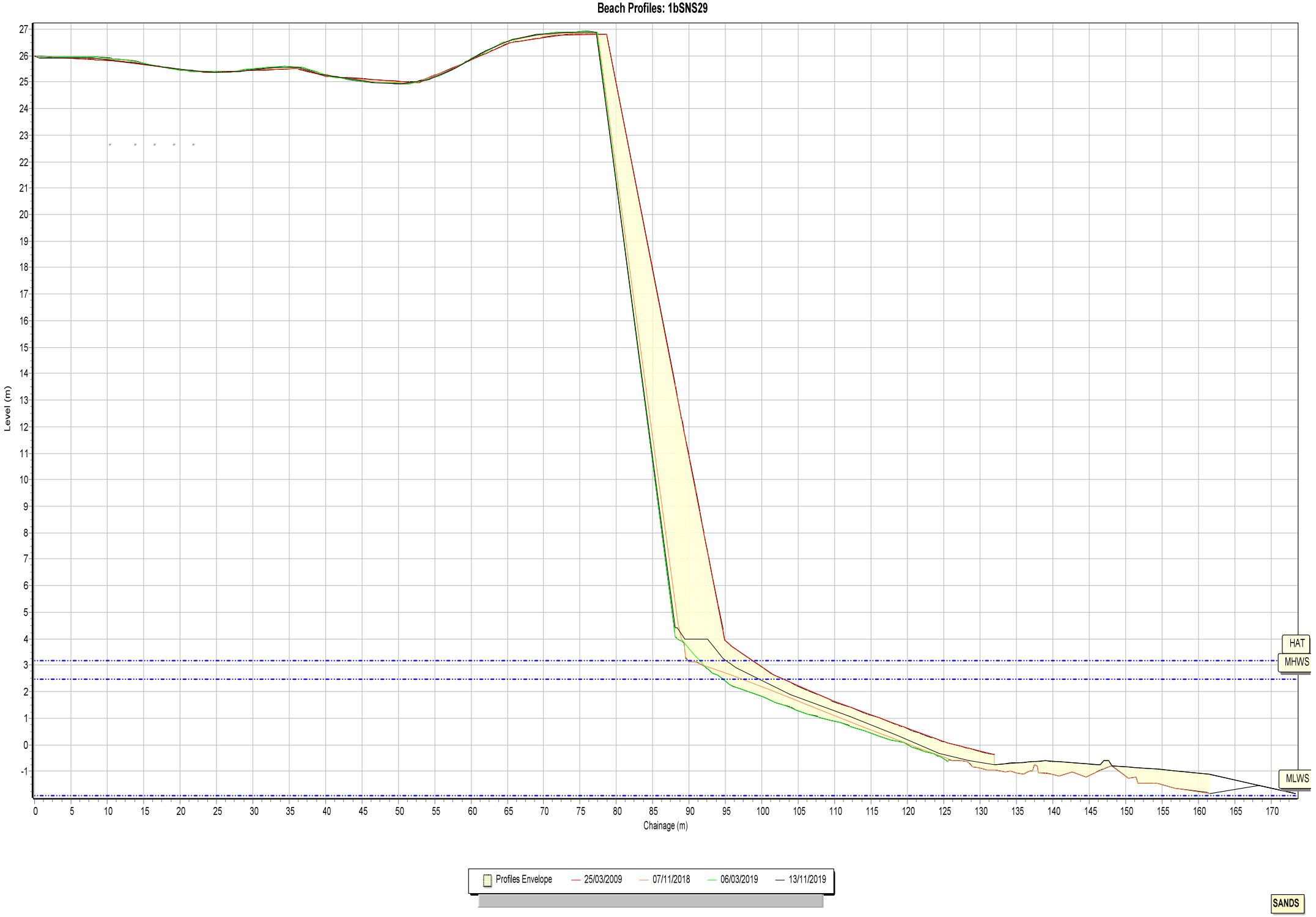
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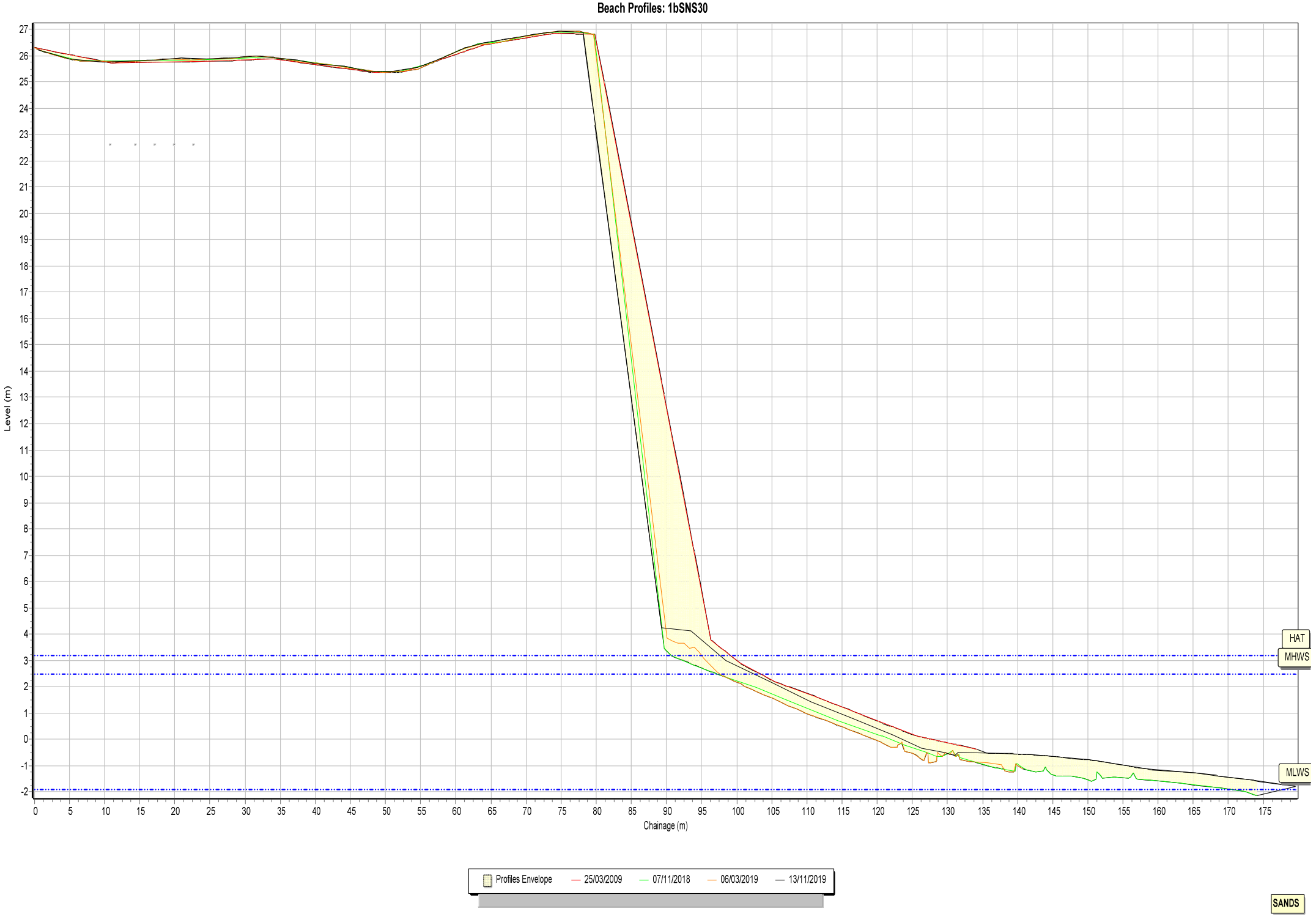
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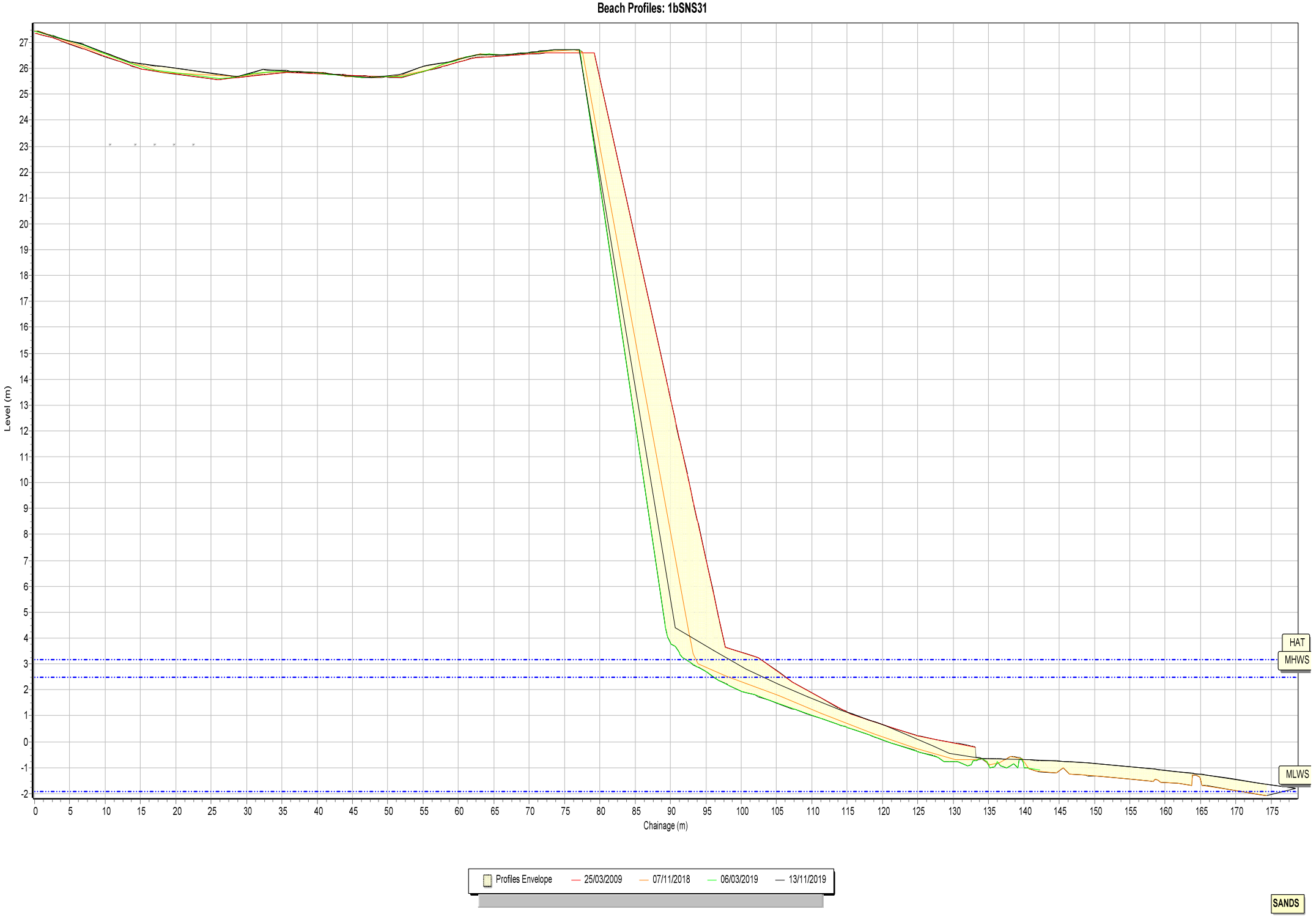
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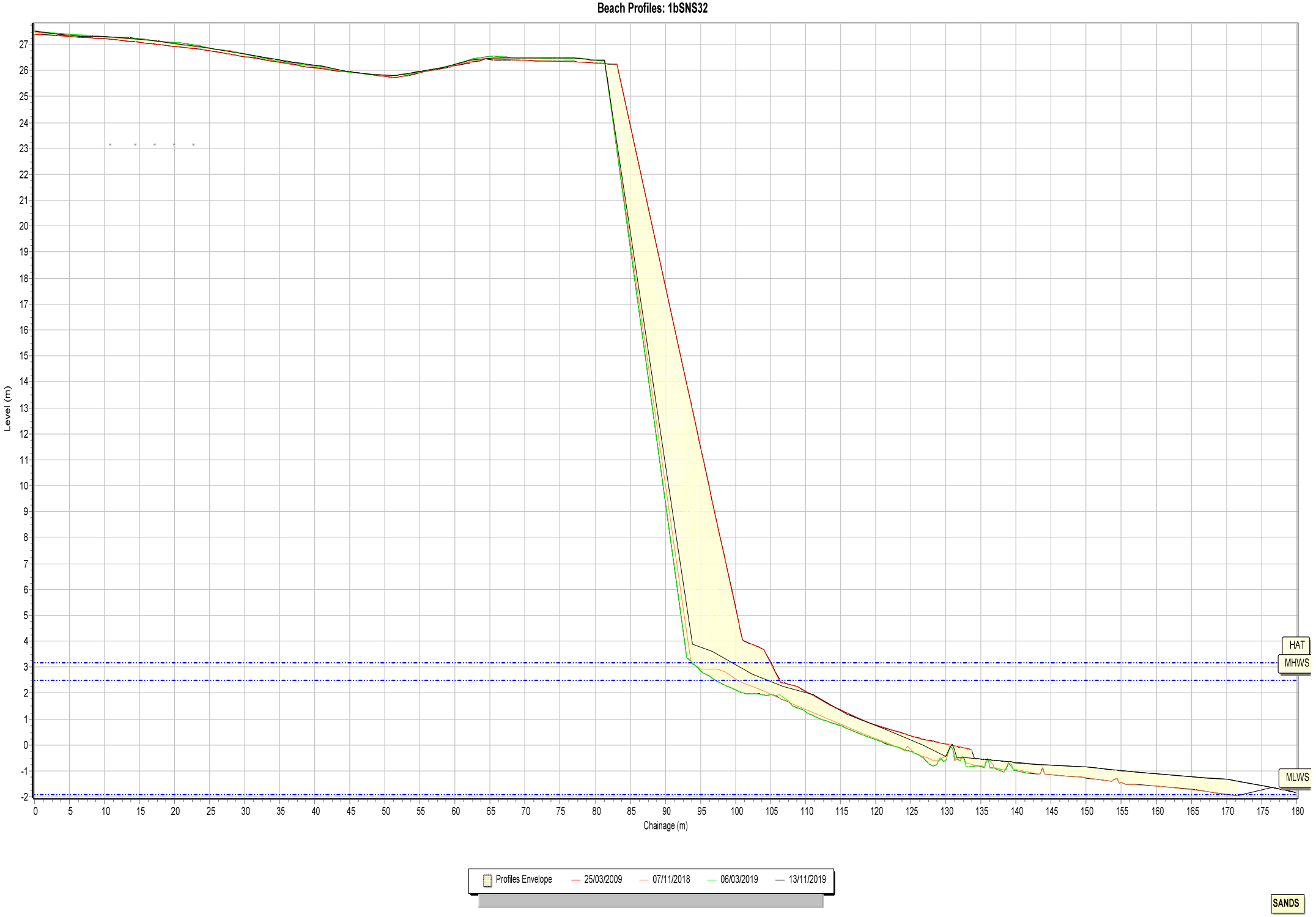
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13/11/2019
SANDS

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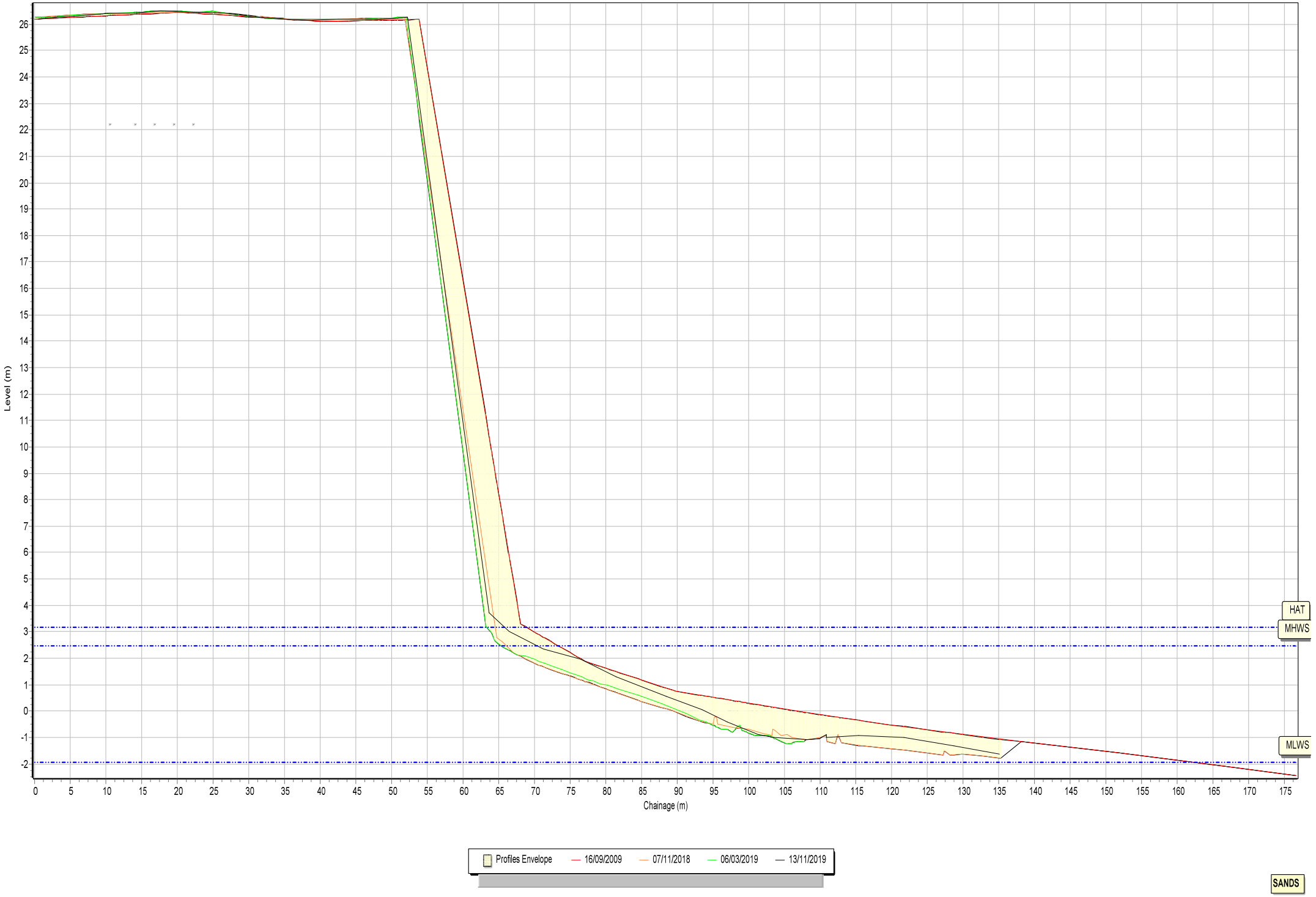

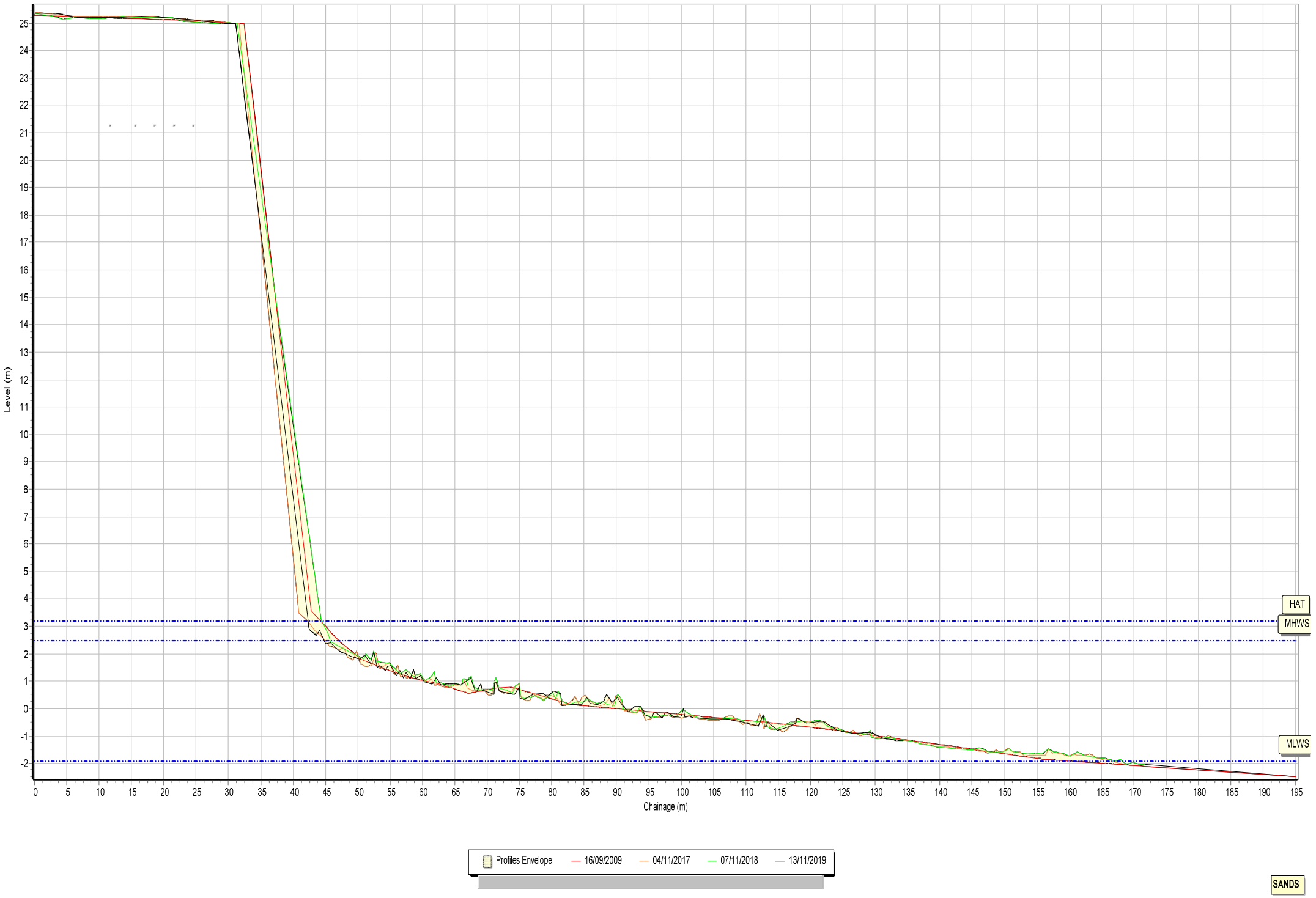
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Profiles Envelope
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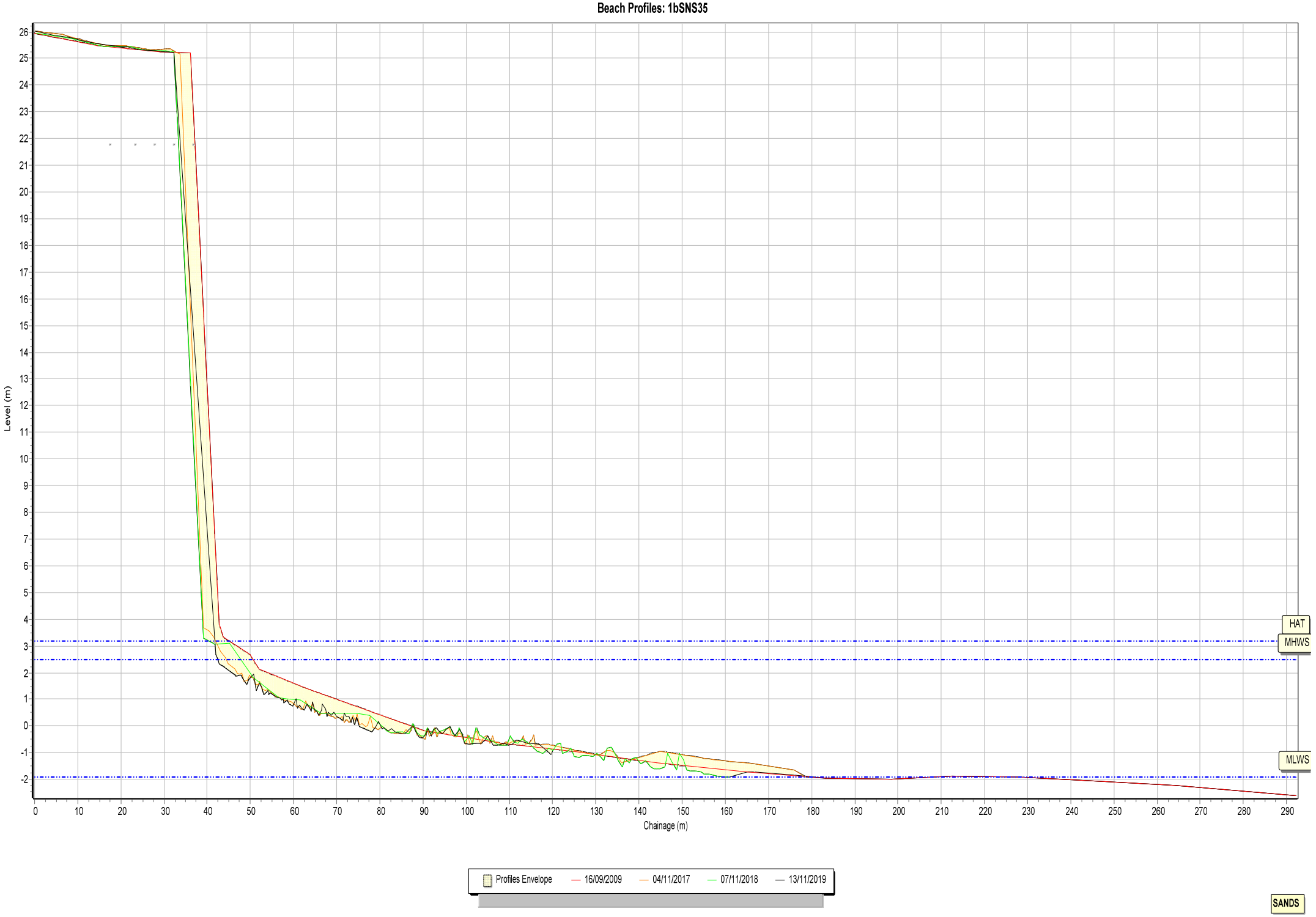
04/11/2017
07/11/2018
13/11/2019
SANDS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04/11/2017
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13/11/2019
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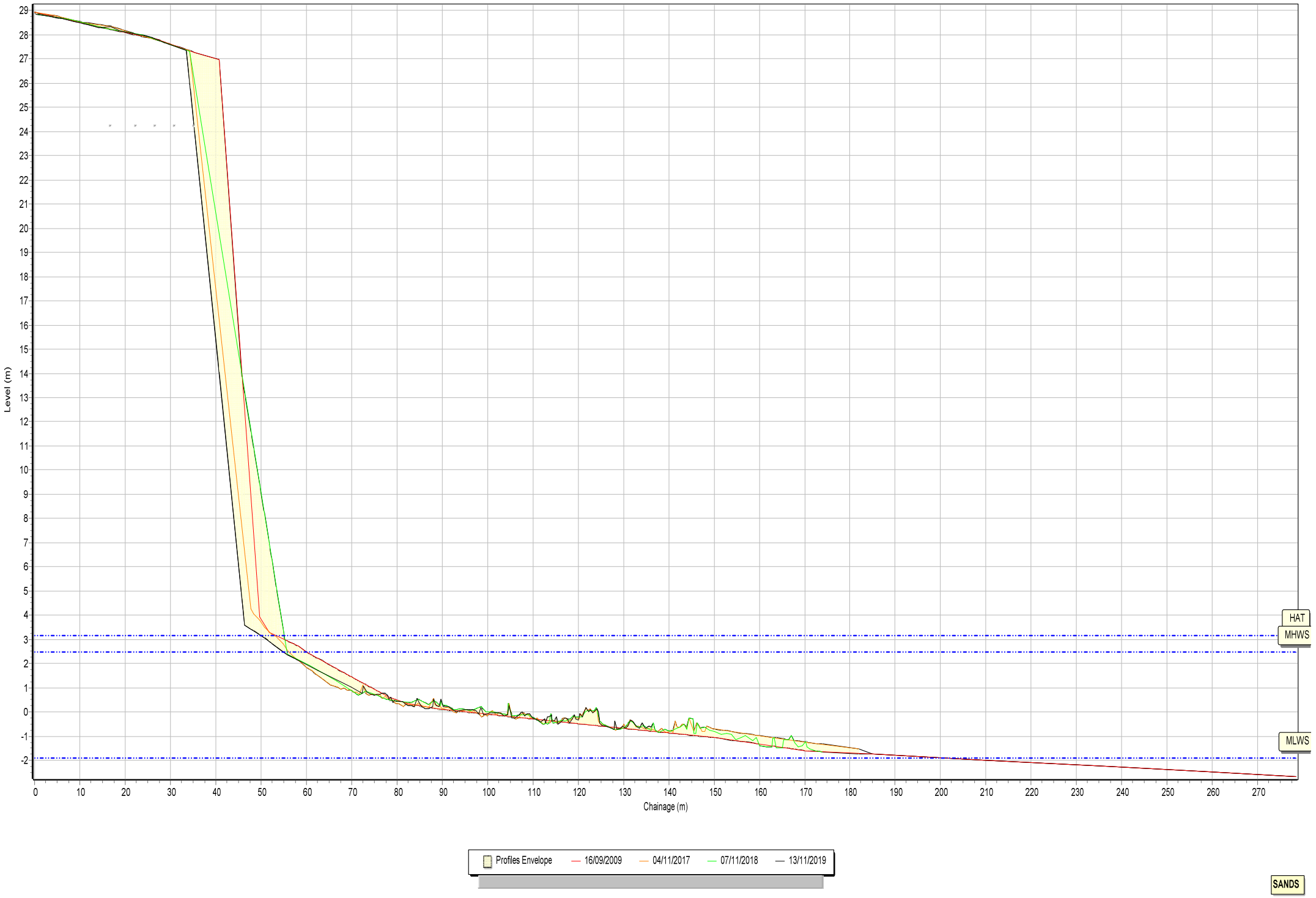
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MLWS
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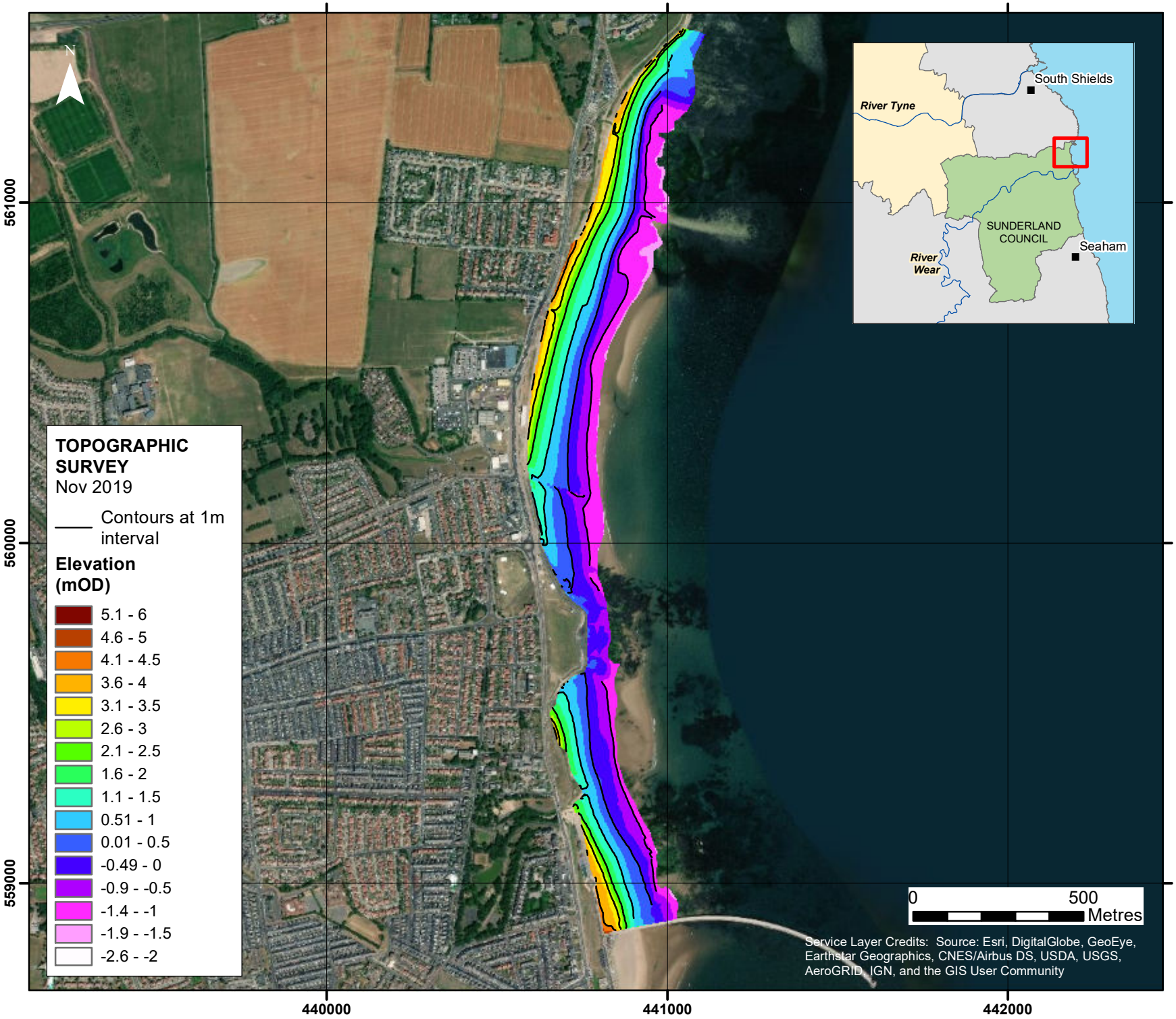
16/09/2009
04/11/2017
07/11/2018
13/11/2019
SANDS

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 2019

Drawing Scale at A4 1:15,000

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

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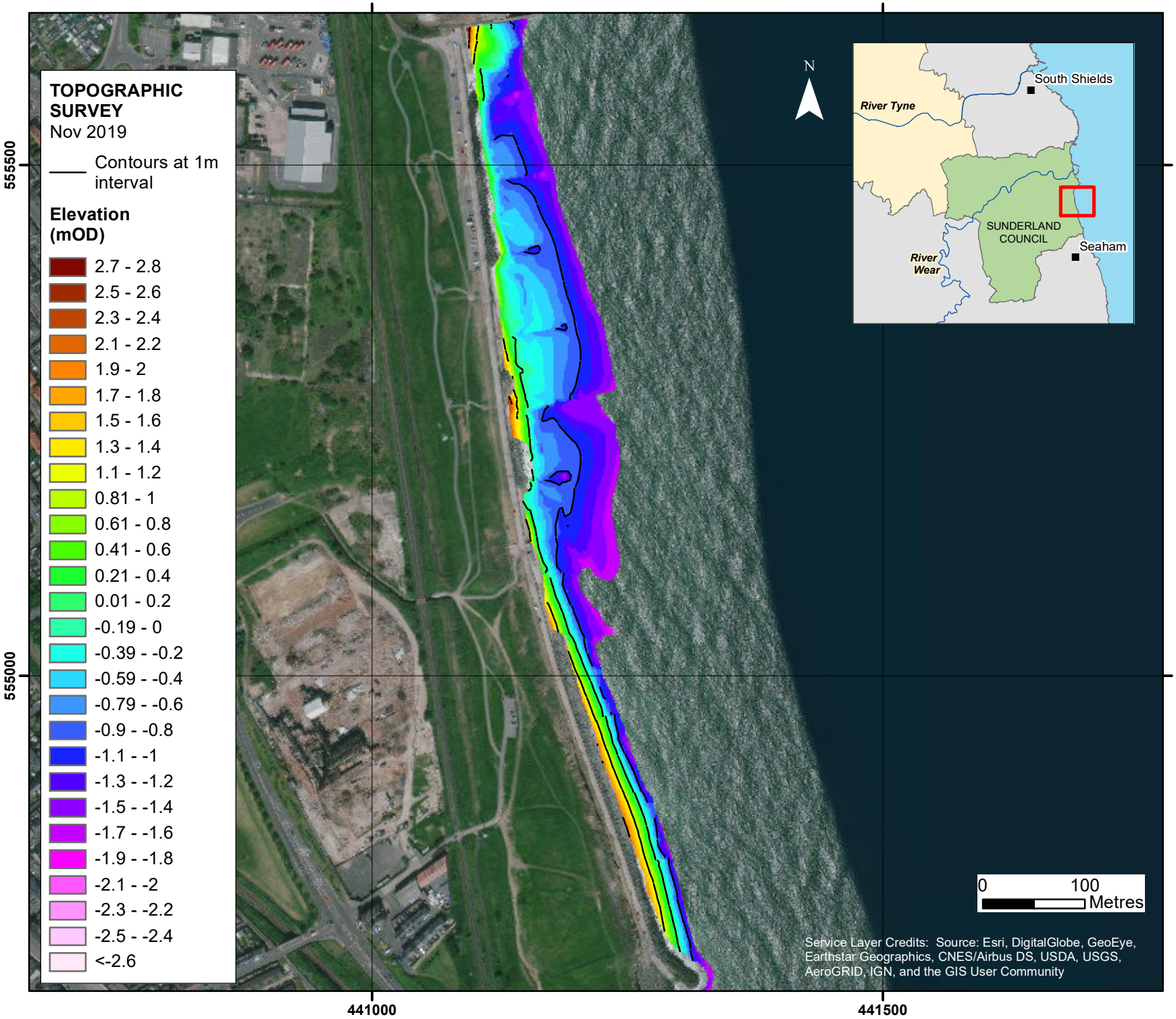

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 2

SUNDERLAND SOUTH

Sunderland Council Frontage

Analytical Report
'Full Measures' Survey 2019

Drawing Scale at A4 1:5,000

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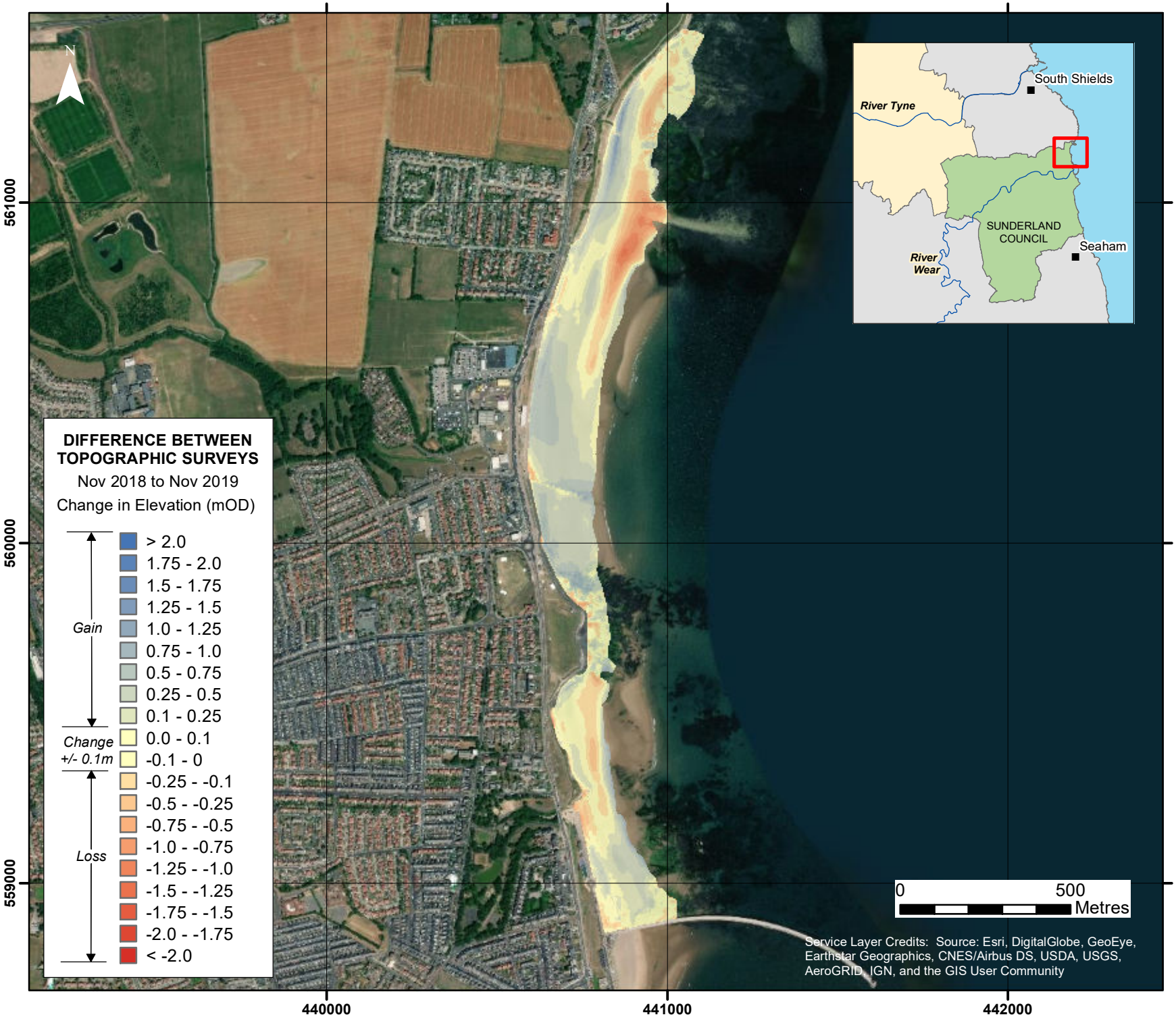

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 3

SUNDERLAND NORTH

Sunderland Council Frontage

Analytical Report
'Full Measures' Survey 2019

Drawing Scale at A4 1:15,000

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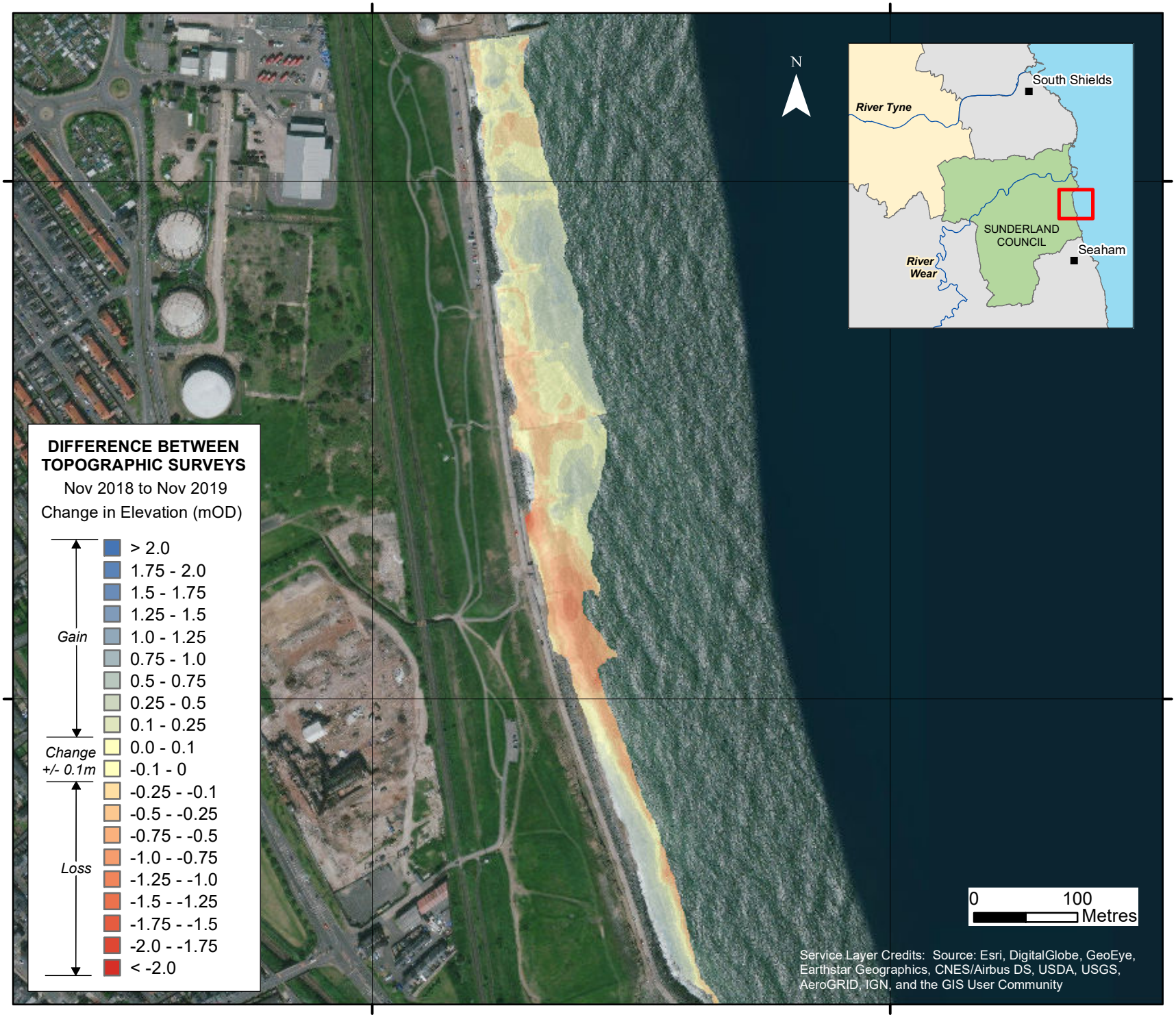

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 4

SUNDERLAND SOUTH

Sunderland Council Frontage

Analytical Report
'Full Measures' Survey 2019

Drawing Scale at A4 1:5,000

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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 (see **Figure 3**). 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 2019	November 2019	Mar 2009 - Nov 2019	Mar 2019 - Nov 2019	Mar 2009 - Nov 2019
1	441025.7	555571.1	75	8.16	8.28	8.2	0.04	-0.08	0.00
2	441064.4	555355.1	85	7.09	5.37	5.31	-1.78	-0.06	-0.18
3	441098	555124	82	10.01	10.31	10.29	0.28	-0.02	0.03
4	441174	554938.7	65	10.3	10.55	10.54	0.24	-0.01	0.02
5	441199.1	554861.1	65	7.71	10.79	10.89	3.18	0.1	0.32
6	441224.5	554774.2	71	10.83	10.87	10.89	0.06	0.02	0.01
7	441248.4	554690.3	74	10.18	10.57	10.16	-0.02	-0.41	0.00
8	441259.3	554596.6	101	10.08	9.69	9.55	-0.53	-0.14	-0.05
9	441275.8	554513.4	66	10.52	5.94	5.88	-4.64	-0.06	-0.46
10	441309.4	554421.3	58	8.77	1.19	1.29	-7.48	0.1	-0.75
11	441354	554346.5	68	8.2	3.64	3.63	-4.57	-0.01	-0.46
12	441400.2	554248.2	56	6.17	5.83	5.77	-0.4	-0.06	-0.04
13	441452.3	554174.7	63	11.61	6.4	6.39	-5.22	-0.01	-0.52

14	441472.3	554080.5	127	7.33	6.04	6.1	-1.23	0.06	-0.12
15	441413	554005.1	122	7.84	7.86	7.77	-0.07	-0.09	-0.01
16	441384.8	553913.3	90	9.89	7.46	7.39	-2.5	-0.07	-0.25
17	441404.1	553815.5	93	6.32	5.8	5.76	-0.56	-0.04	-0.06
18	441404.1	553723.6	119	8.1	3.23	3.08	-5.02	-0.15	-0.50
19	441398.5	553632.8	78	8.23	4.16	4.15	-4.08	-0.01	-0.41
20	441438.3	553452.9	71	10.09	5.53	5.56	-4.53	0.03	-0.45
21	441506.1	553256.1	62	8.57	1.54	1.38	-7.19	-0.16	-0.72
22	441550.1	553158.7	103	6.57	3.27	3.24	-3.33	-0.03	-0.33
23	441585.2	553076.5	64	8.11	4.67	4.73	-3.38	0.06	-0.34
24	441624.4	552870.7	69	7.53	3.11	3.02	-4.51	-0.09	-0.45
25	441689.1	552758	70	14.58	6.58	6.68	-7.9	0.1	-0.79
26	441715	552713.3	54	12.87	10.35	10.37	-2.5	0.02	-0.25
27	441749.2	552674.4	62	14.56	3.03	3.3	-11.26	0.27	-1.13
28	441776.6	552629.9	57	8.62	4.11	4.18	-4.44	0.07	-0.44
28A	441798.6	552586.3	56	13.63	6.14	6.11	-7.52	-0.03	-0.75
28B	441817.4	552542.4	64	12.3	10.91	9.43	-2.87	-1.48	-0.29
28C	441852.2	552502.6	52	13.11	12.43	12.42	-0.69	-0.01	-0.07
29	441880.1	552471.6	83	15.46	15.08	15.13	-0.33	0.05	-0.03
30	441921.4	552269	97	8.55	6.38	5.08	-3.47	-1.3	-0.35
31	441853.1	552094	75	11.2	3.2	2.39	-8.81	-0.81	-0.88
32	441883.3	551988.5	96	9.82	3.4	2.74	-7.08	-0.66	-0.71