Cell 1 Regional Coastal Monitoring Programme Update Report 9: 'Partial Measures' Survey 2017

Hartlepool Council

July 2017

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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	**River Tyne to Frenchman's Bay**	**Frenchman's Bay to Souter Point**	**Souter Point to Chourdon Point**	**Chourdon Point to Hartlepool Headland**
1 in 200 year	3.41	3.44	3.66	3.91
HAT	2.85	2.88	3.18	3.30
MHWS	2.15	2.18	2.48	2.70
MLWS	-2.15	-2.12	-1.92	-1.90
	Water Level (m AOD)			
Water Level Parameter	**Hartlepool Headland to Saltburn Scar**	**Skinningrove**	**Hummersea Scar to Sandsend Ness**	**Sandsend Ness to Saltwick Nab**
1 in 200 year	3.87	3.86	4.1	3.88
HAT	3.25	3.18	3.15	3.10
MHWS	2.65	2.68	2.65	2.60
MLWS	-1.95	-2.13	-2.15	-2.20

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).

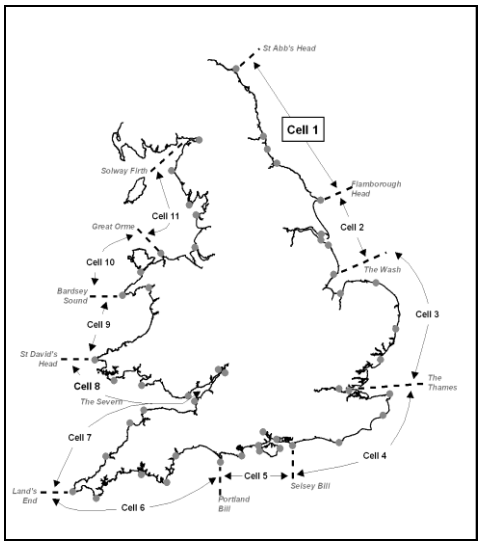


Figure 1 Sediment Cells in England and Wales

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

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

The beach profile surveys, topographic surveys and cliff top recession surveys are undertaken as a 'Full Measures' survey in autumn/early winter every year. Some of these surveys are then repeated the following spring as part of a 'Partial Measures' survey. 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	Sep-Oct 11	Oct 12	Mar-May 12	Oct 12	-
5	2012/13	Sep 12	Jan 13	Apr 13	May 13	-
6	2013/14	Sep-Oct 14	Feb 14	Mar 13	Jul 14	-
7	2014/15	Sep-Oct 14	Feb 15	Apr 15	Jun 15	-
8	2015/16	Aug 15	Feb 16	Apr 16	Jul 16	Jun 16
9	2016/17	Aug-Sep 16	Feb 17	Apr 17	Jul 17 (*)	

(*) The present report is **Update Report 9** and provides an analysis of the 2017 Partial Measures survey for Hartlepool Council's frontage.

1. Introduction

1.1 Study Area

Hartlepool Council's frontage extends from Crimdon Beck in the north to the North Gare Breakwater in the south. For the purposes of this report, it has been sub-divided into four areas, namely:

- North Sands
- Hartlepool Headland
- Middleton
- Hartlepool Bay

1.2 Methodology

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

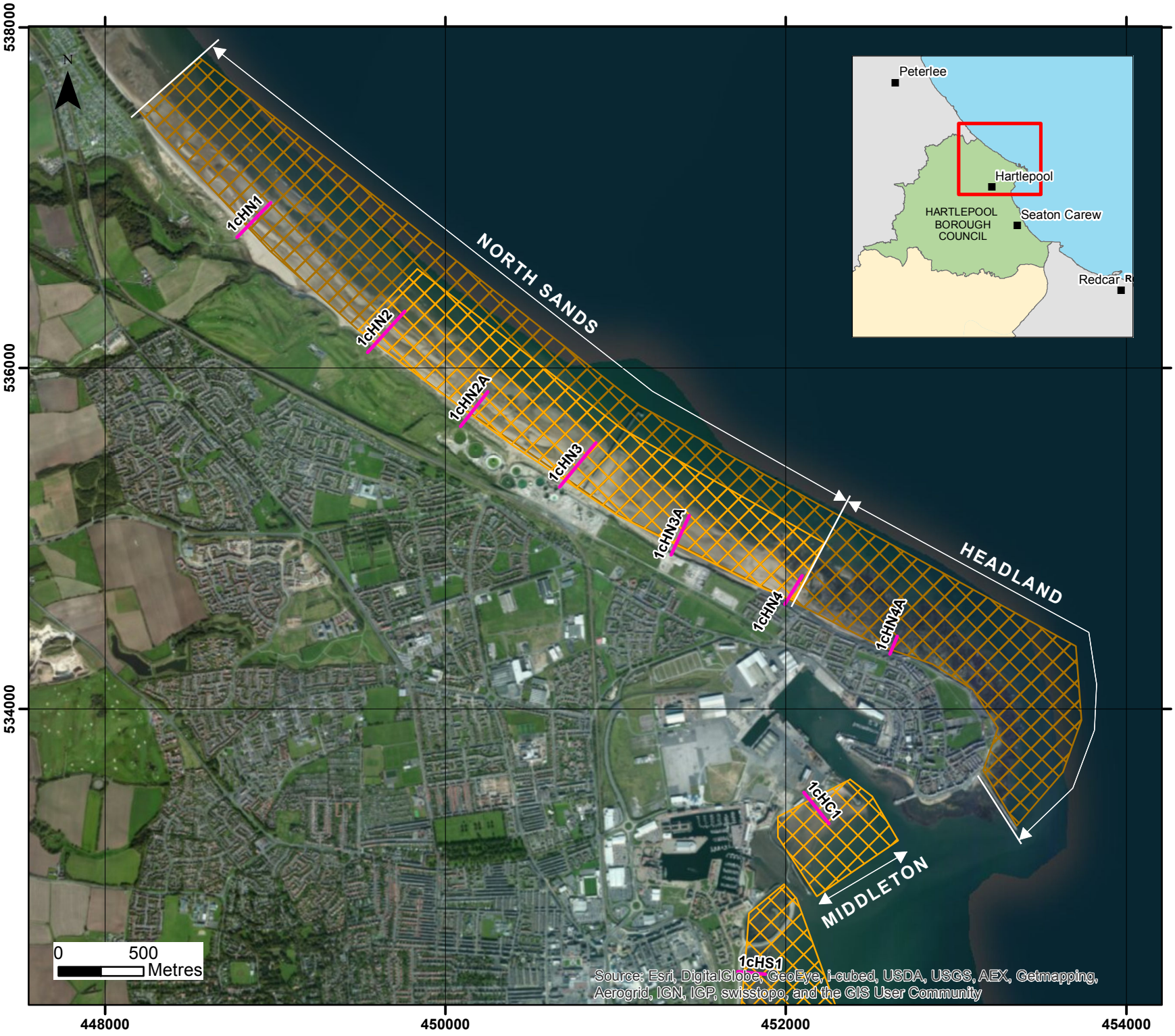
- Full Measures survey annually each autumn/early winter comprising:
    - Beach profile surveys along twelve transect lines
    - Topographic survey along part of North Sands (referred to as Hartlepool North)
    - Topographic survey along Middleton (referred to as Hartlepool Central)
    - Topographic survey along Hartlepool Bay (referred to as Hartlepool South)

- Partial Measures survey annually each spring comprising:
    - Beach profile surveys along twelve transect lines

- Additionally, every five years (starting with 2008 as the baseline year), the Full Measures survey at Hartlepool North is extended to fully cover the whole of North Sands and Hartlepool Headland with a topographic survey. This extends across the boundary of jurisdiction between Hartlepool Borough Council and Durham County Council.

The location of these surveys is shown in Figure 2. The Partial Measures survey was undertaken along this frontage between 1st and 2nd April 2017. During this time weather conditions were dry and sunny with a slight sea state, and a force 2/3 wind from the south-east.

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 Hartlepool Borough Council Frontage

Analytical Report
Topo Surveys

Drawing Scale at A4 1:30,000

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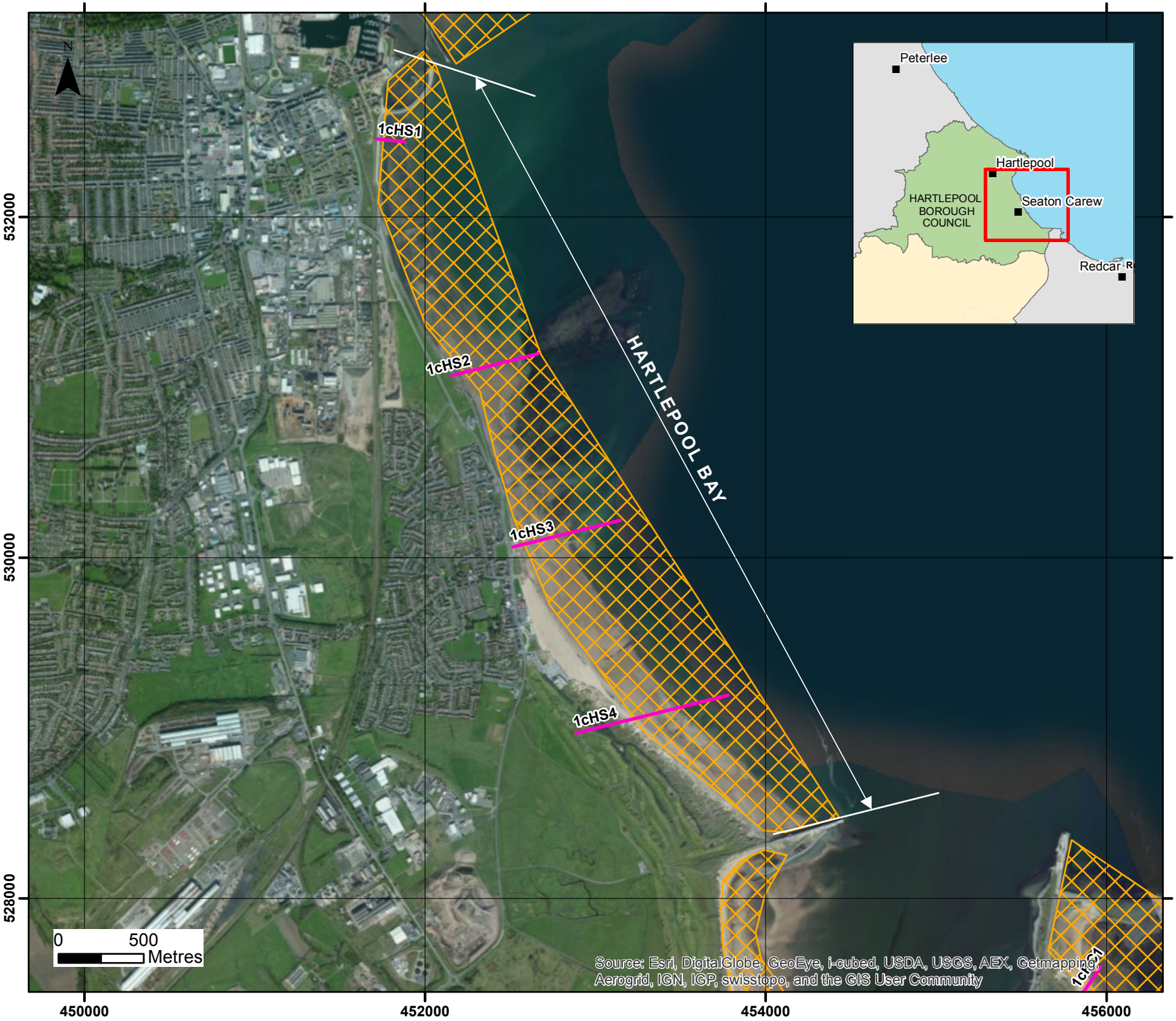

Key

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 2 Hartlepool Borough Council Frontage

Analytical Report
Topo Surveys

Drawing Scale at A4 1:30,000

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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 3 Hartlepool Borough Council Frontage

Analytical Report
Topo Surveys

Drawing Scale at A4 1:12,000

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2. Analysis of Survey Data

2.1 North Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
1st April 2017	**Beach Profiles:** North Sands is covered by four beach profile lines during the Partial Measures survey (Appendix A) that were last surveyed in August 2016. **Profile 1cHN1** is located within Durham County Council's jurisdiction, c. 400m north of the outfall of Crimdon Beck. It is reported here so changes can be interpreted in association with those observed elsewhere along North Sands. The beginning of the profile between 0m and 70m chainage covers dunes and has not changed. Between chainage 70m and 200m there has been erosion of up to 0.7m, but more typically 0.4m. This has removed the upper beach berm previously recorded at chainage 90m in the August 2016 survey. A lower beach berm has formed at chainage 220m, with accretion of up to 0.8m between chainage 200m and 295m. The toe of the beach seawards of 295m appears to have moved landwards by c.5m, with erosion of up to 0.3m. Overall the profile is at a medium-high level compared to the range recorded from previous surveys, particularly high in the vicinity of the lower beach berm between chainage 220m and 260m. Profile **1cHN2** covers the dune between chainage 0 and 50m. From chainage50m to 135m the beach level as dropped by up to 1.0m since August 2016. Between chainage 135m and 225m the beach has accreted by up to 1.1m. Seawards of 225m there has been erosion of up to 1m, moving the toe of the beach landwards by c.30m.The overall effect has been to create a flatter middle beach with a steeper lower beach. The beach profile is relatively low in the upper beach compared to the range recorded from previous surveys, medium-high in the middle beach (with highest recorded levels between chainage 175m to 195m), and medium-low in the lower beach, with the toe being amongst the lowest recorded levels. **Profile 1cHN2a** was established in October 2011 and runs through the dunes close to North Sands. The area of dunes to 75m chainage has remained stable since October 2011. At 75m the dune face is stable following the large loss between October 2013 and March 2014. The beach profile shows a general trend of erosion, with up to 0.8m erosion between chainage 75m and 115m, little chainage	The profiles are at or near the lowest elevation, with platforms exposed and berms previously exposed having been smoothed out. This pattern is typical of winter conditions; **Longer term trends:** Following dune erosion over the winter of 2013/14 the areas with dunes have remained stable. At HN1 and 2 the beach levels are medium-high compared with previous years. At HN2a the beach is in the middle of the range of profiles showing likely seasonal fluctuation. At profiles HN3a, 4 and 4a the beach is low compared with previous profiles for at least some of the profile. The fluctuation in the veneer beach continues so that parts of the shore platform in the south of the bay have become exposed.

Survey Date	Description of Changes Since Last Survey	Interpretation
	between chainage 115m to 160mof <0.2m, and up to 0.7m between chainage 160m and 245m. The only area of accretion is at the toe of the beach, seawards of chainage 245m, with accretion of up to 0.7m, extending the toe of the beach seawards by c.50m. Overall the beach is at a medium-low level compared to the range recorded from previous surveys, with the exception of the toe of the beach which is relatively high. At **Profile 1cHN3** there has been little change to the dunes, however the fore dune at 35m-40m chainage has accreted by 0.1m since August 2016. The upper beach between chainage 40m and 80m has dropped by up to 0.8m, removing the berm previously recorded at chainage 70m. Between chainage 80m and 160m the beach has accreted slightly by up to 0.2m. From chainage 160m to 250m the beach has eroded by up to 0.4m. The toe of the beach seawards of 250m shows accretion of 0.5m, extending the tow seawards by c.40m. Overall the profile is at a low level compared to the range recorded from previous surveys, particularly between chainages 40m-75m, 160-180m, and 215m-230m which have the lowest recorded levels. At **Profile 1cHN3a** the dune front at 20m chainage has remained stable since March 2014. Beyond 20m chainage the rest of the beach level has dropped by up to 0.6m since August 2016, creating a smoother profile. Overall the profile is at its lowest recorded level between chainage 20m and 140m, seawards of chainage 140m the profile is at a more medium level. **Profile 1cHN4** shows little change in the defended part of the profile. Between chainage 15m and 60m the sandy upper beach has increased in level by up to 0.4m. From 60m to the end of the survey at 200m chainage the rocks at the bottom of the beach are exposed (with some small patches of accumulated sand), which is common for this profile. From chainage 62m to 105m the exposed platform was previously covered by sand in the August 2016 survey. The upper beach is at a relatively medium level compared to the range recorded from the previous surveys, with the remainder of the profile at a relatively low level with the rock platform exposed. **Profile 1cHN4a** was established in October 2011. The defended part of the profile to 10m chainage has not changed since October 2011. The rocky shore platform is exposed over the remainder of the profile, which is due to a drop in beach level of up to 0.6m since the previous survey in August 2016 between chainage 10m and 40m. From chainage 40m seawards the rock platform remains exposed as it was in the previous survey. The profile is therefore at a relatively low level compared to the range recorded in previous surveys as no beach is present at all, with the rock platform exposed over the full profile.	

2.2 Middleton

Survey Date	Description of Changes Since Last Survey	Interpretation
2nd April 2017	**Beach Profiles:** Middleton is covered by one beach profile line during the Partial Measures survey (Appendix A). The profile was last surveyed in August 2016. At **Profile 1cHC1** the face of the defence at 50m chainage remained stable. Between chainage 50m and 80m the beach level has dropped by up to 0.7m since August 2016. Between chainage 80m and 145m there has been very little change, ±0.1m. Seawards of 145m there has been accretion of up to 0.4m. The effect of these changes is a flatter profile. The upper beach is at its lowest recorded level between chainage 50m and 75m, but at a more medium level through the middle beach and at a relatively high level in the lower beach.	The upper part of the beach was low compared to historical levels, but the seaward part of the beach is in the mid-high range of previous recorded levels. The decreasing of levels on the upper beach may be due to beach draw down or the impact of large waves reflecting off the seawall and scoring down. **Longer term trends:** The beach level at this location tends to fluctuate through the year, with the most variable area being adjacent to the sea wall where wave energy is reflected. There a pattern of seasonal variation, with lower levels typically recorded in the spring, following the period of winter storms. Recovery tends to occur by the autumn.

2.3 Hartlepool Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
2nd April 2017	**Beach Profiles:** Hartlepool Bay is covered by four beach profile lines during the Partial Measures survey (Appendix A). **Profile 1cHS1** is located c. 150m south of the root of the South Pier. The profile starts at the wall to the rear of the promenade and extends over the fronting concrete splash wall and down the sloping face of the rock armour revetment before reaching the beach. Very little change has occurred until 40m chainage, which is the toe of the sea wall, since September 2014. The upper beach between 40m and 95m chainage has dropped by 0.4m since August 2016. From chainage 95m seawards the beach has accreted by up to 0.3m, extending the toe of the beach seawards by c.15m. The upper beach is at a medium level compared to the range recorded from previous surveys, whilst the lower beach between chainage 95m and 145m is the highest recorded. **Profile 1cHS2** has shown the formation of two berms since the flat, mid-level beaches which were recorded in April and November 2015. The profile shows stability of the base of the seawall at 20m chainage, where there is some rock armour on the upper beach. Between chainage 25m and 260m there has been erosion of up to 0.3m. Seawards of chainage 260m there has been accretion of up to 0.5m, extending the toe of the beach seawards by c.40m, with the formation of a berm at chainage 290m. Overall the profile is at a relatively medium level compared to the range recorded from previous surveys. **Profile 1cHS3** shows no changes over the defended part of the profile up to 30m chainage. Between chainage 30m and 195m there has been erosion of up to 0.5m. Seawards of chainage 195m there has been accretion of up to 0.8m, extending the toe of the beach seawards by c.55m and making it flatter. Overall the profile is generally at a relatively medium level compared to the range recorded from previous surveys, with the lower beach being relatively high. **Profile 1cHS4** is located 1km north of the North Gare Breakwater, within the area of undefended dunes at Seaton Carew. The part of the profile dominated by dunes, to 290m chainage, has remained stable. The depression between the main body of dunes and the foredune at 300m chainage is deepening and has been since 2013. The photographs suggesting lowering may result from footpath erosion. The crest of the foredune at 320m chainage has remained stable since September 2016. Between chainage 340m	Overall the profiles show that the beach is at a relatively medium level in most places, with the profiles flattening compared to September 2016. At HS 1 there has been progressive accretion with the most recent profile being among the highest recorded for the lower beach. The dunes are in good condition. The foredune continues to accrete but erosion associated with a walkway is causing localised lowering in HS4 that may affect stability of the wider dune system in the long term. **Longer term trends:** Beach levels within Hartlepool Bay in April 2017 were at a medium level in comparison to previous surveys. The beach levels have been progressively increasing across the bay.

Survey Date	Description of Changes Since Last Survey	Interpretation
	and 450m the beach level has dropped by up to 0.7m, though the berm feature at chainage 380 remains present albeit at a lower level. From chainage 450m seawards there has been accretion of up to 0.6m infilling the depression between chainage 510m and 550m previously surveyed in September 2016. The overall effect of the changes is a flatter profile than that recorded in September 2016. Overall the profile is at a medium level compared to the range recorded by the previous surveys.	

3. Problems Encountered and Uncertainty in Analysis

Individual Profiles

- At Middleton there was no access to upper section on profile 1cHC1.
- Construction work was being carried out on new coastal defences to the east of profile 1cHN4A.
- The rest of the survey was completed without incident.

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

No changes are recommended at the present time.

5. Conclusions and Areas of Concern

- At North Sands the dunes are stable and the beaches are healthy, although the sand depletes as you move east towards the headland, with HN4 showing an exposure of the wave cut platform.
- At Middleton the upper beach level has dropped and the lower beach level has increased. The observed behaviour is likely to be due to beach draw down through the winter of 2016/17 and levels should recover through the summer.
- Hartlepool Bay has been subject to erosion on the upper beach but accretion on the lower beach. In the south of the bay at 1cHS4 the dunes are stable but people walking over them may affect their stability long term.

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

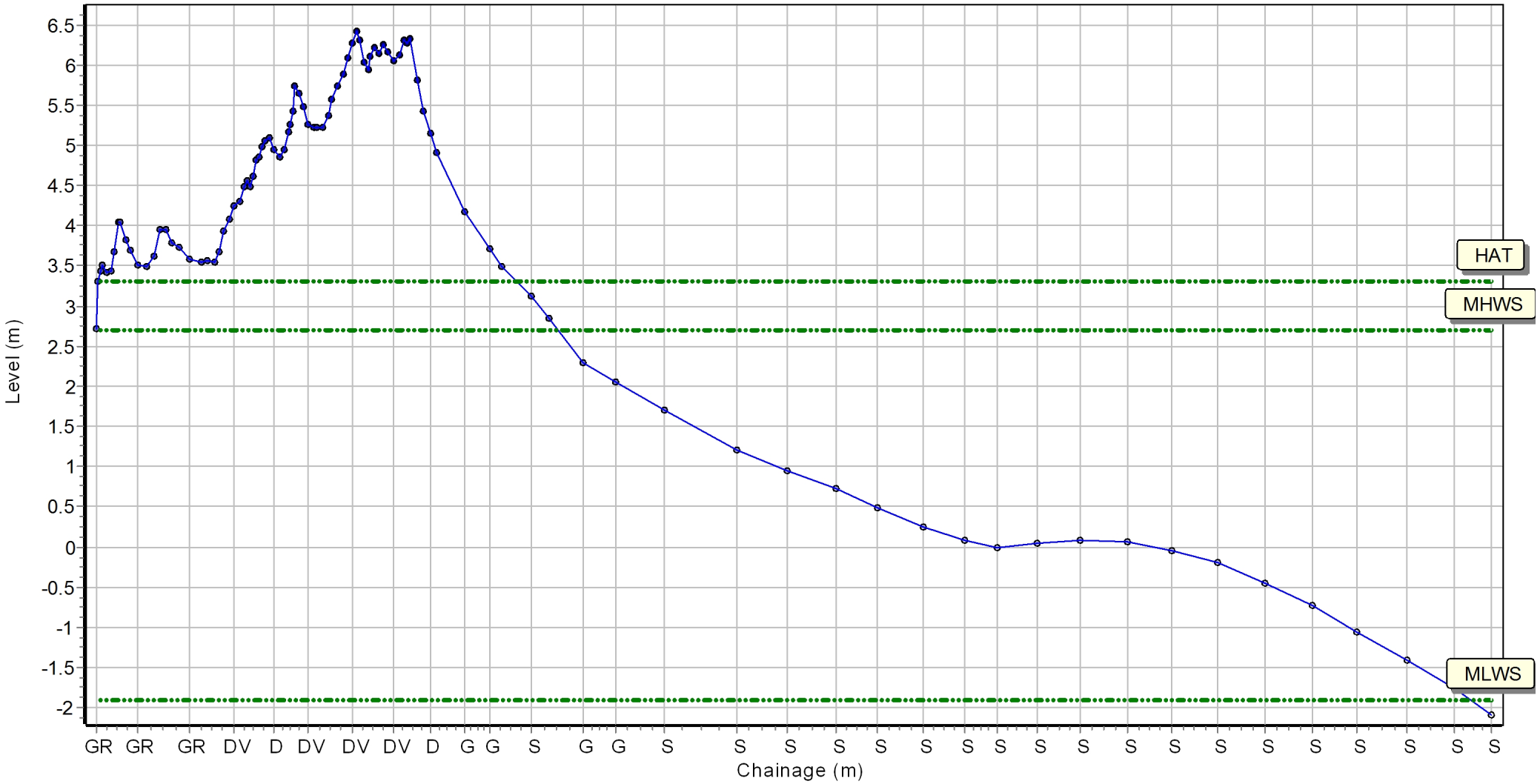
Location: **1cHN1**

Date: 01/04/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Partial Measures Topo Survey

Easting: 448779.624 **Northing:** 536767.42 **Profile Bearing:** 44 ° from North



Beach Profile

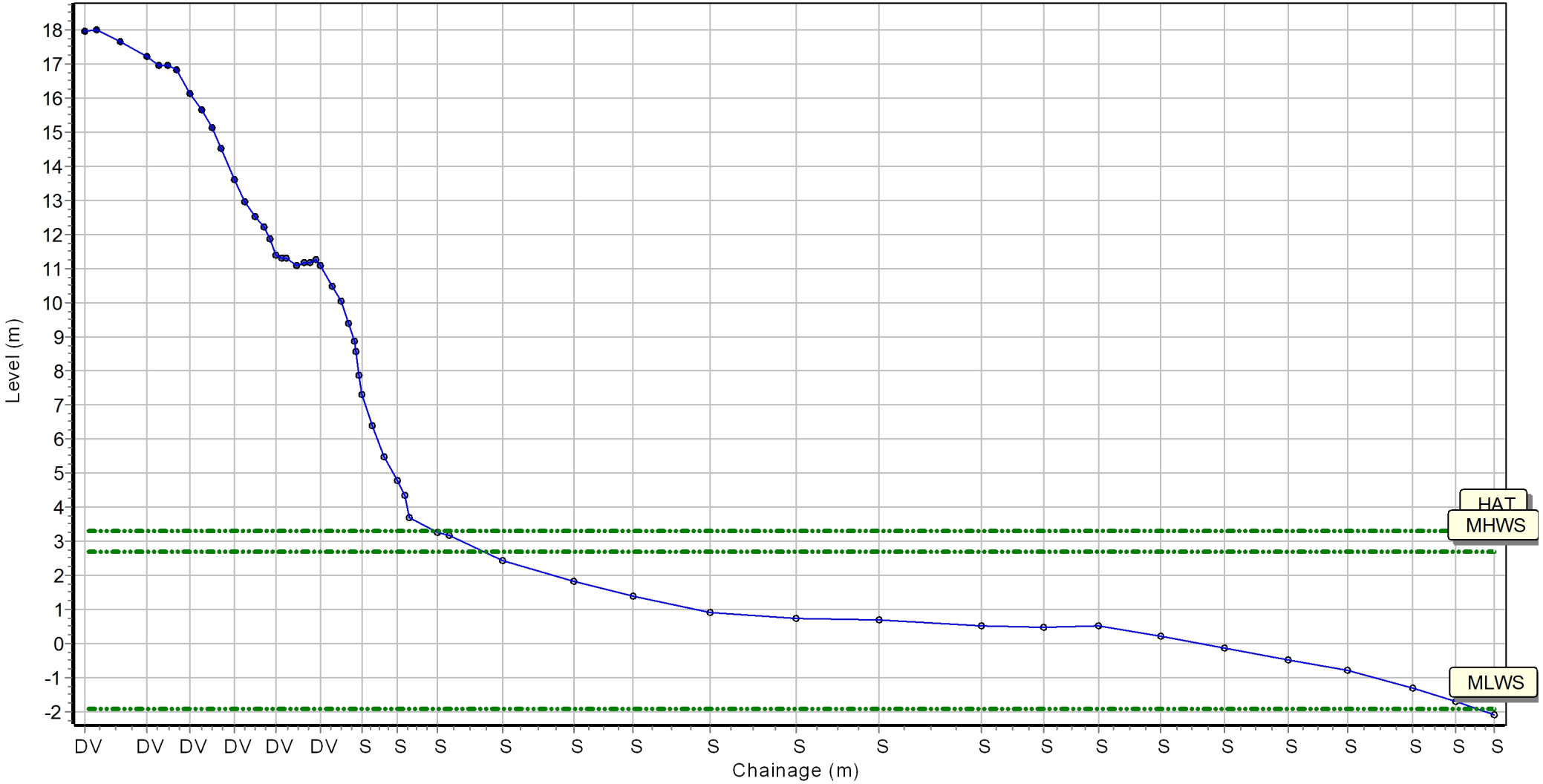
Location: **1cHN2**

Date: 01/04/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Partial Measures Topo Survey

Easting: 449547.217 **Northing:** 536095.458 **Profile Bearing:** 42 ° from North



Beach Profile

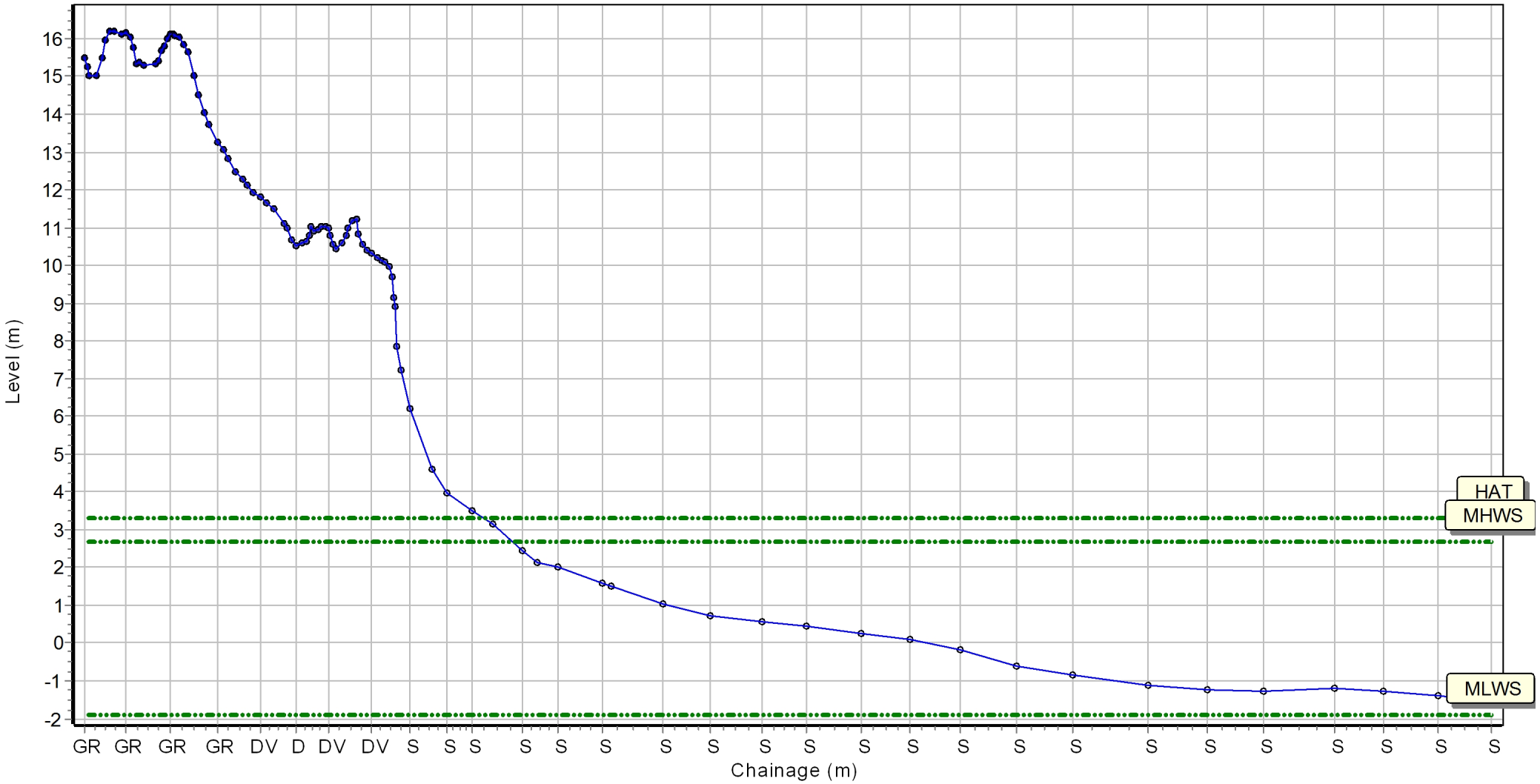
Location: **1cHN2A**

Date: 01/04/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Partial Measures Topo Survey

Easting: 450088.047 **Northing:** 535658.212 **Profile Bearing:** 39 ° from North



Beach Profile

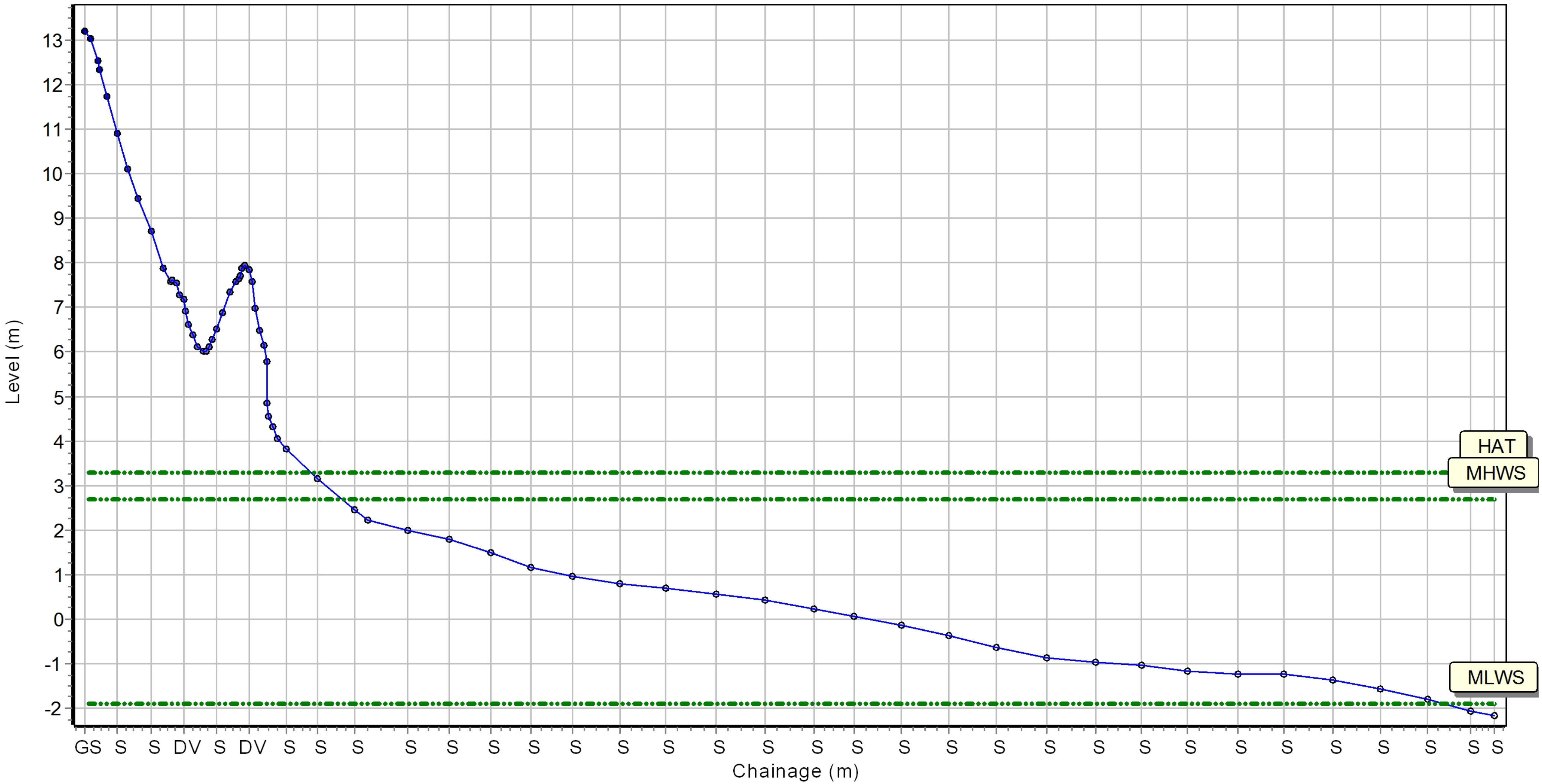
Location: **1cHN3**

Date: 01/04/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Partial Measures Topo Survey

Easting: 450674.424 **Northing:** 535305.141 **Profile Bearing:** 30 ° from North



Beach Profile

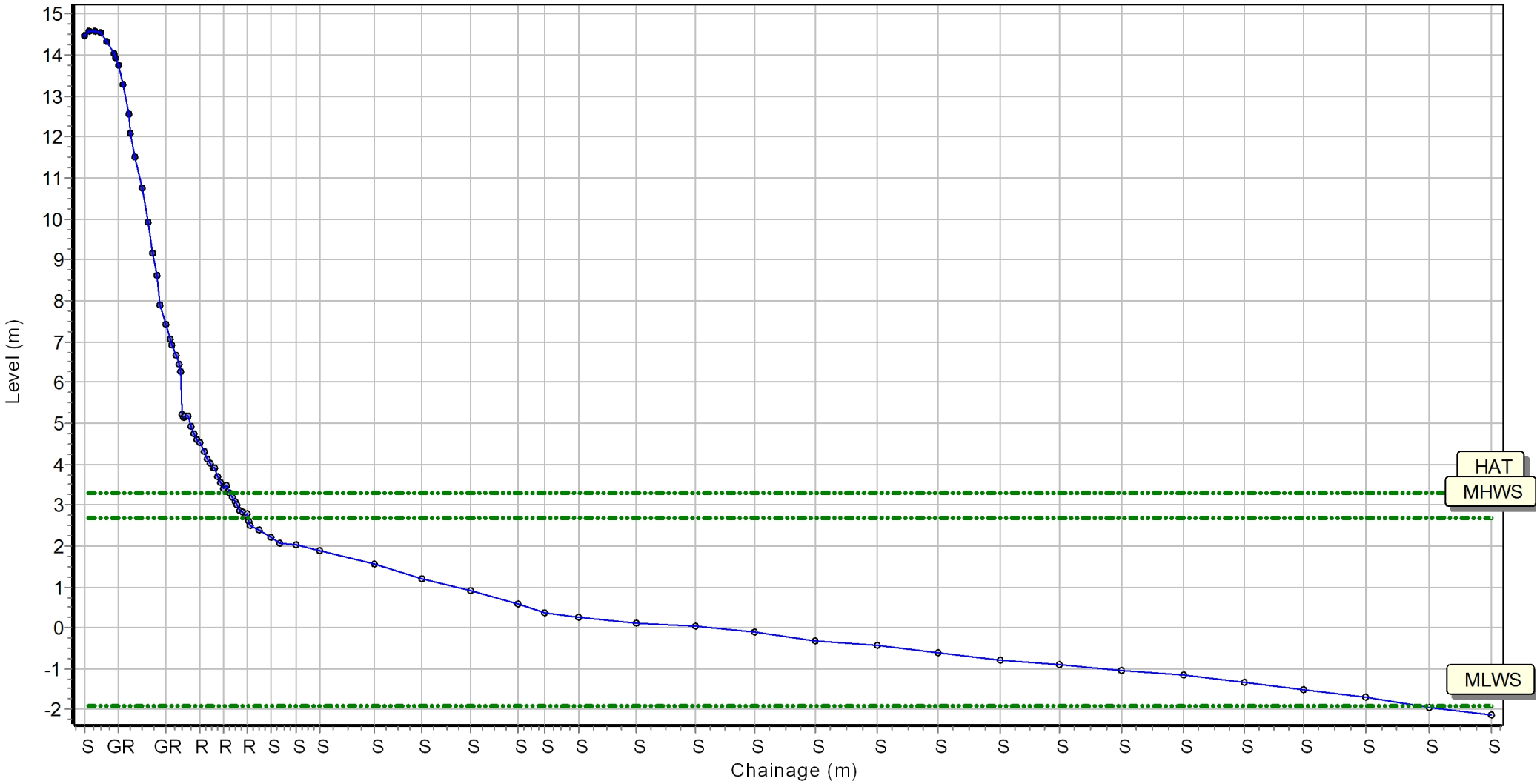
Location: **1cHN3A**

Date: 01/04/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Partial Measures Topo Survey

Easting: 451324.71 **Northing:** 534903.35 **Profile Bearing:** 25 ° from North



Beach Profile

Location: **1cHN4**

Date: 01/04/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Partial Measures Topo Survey

Easting: 451997.114 **Northing:** 534616.627 **Profile Bearing:** 25 ° from North

Beach Profile

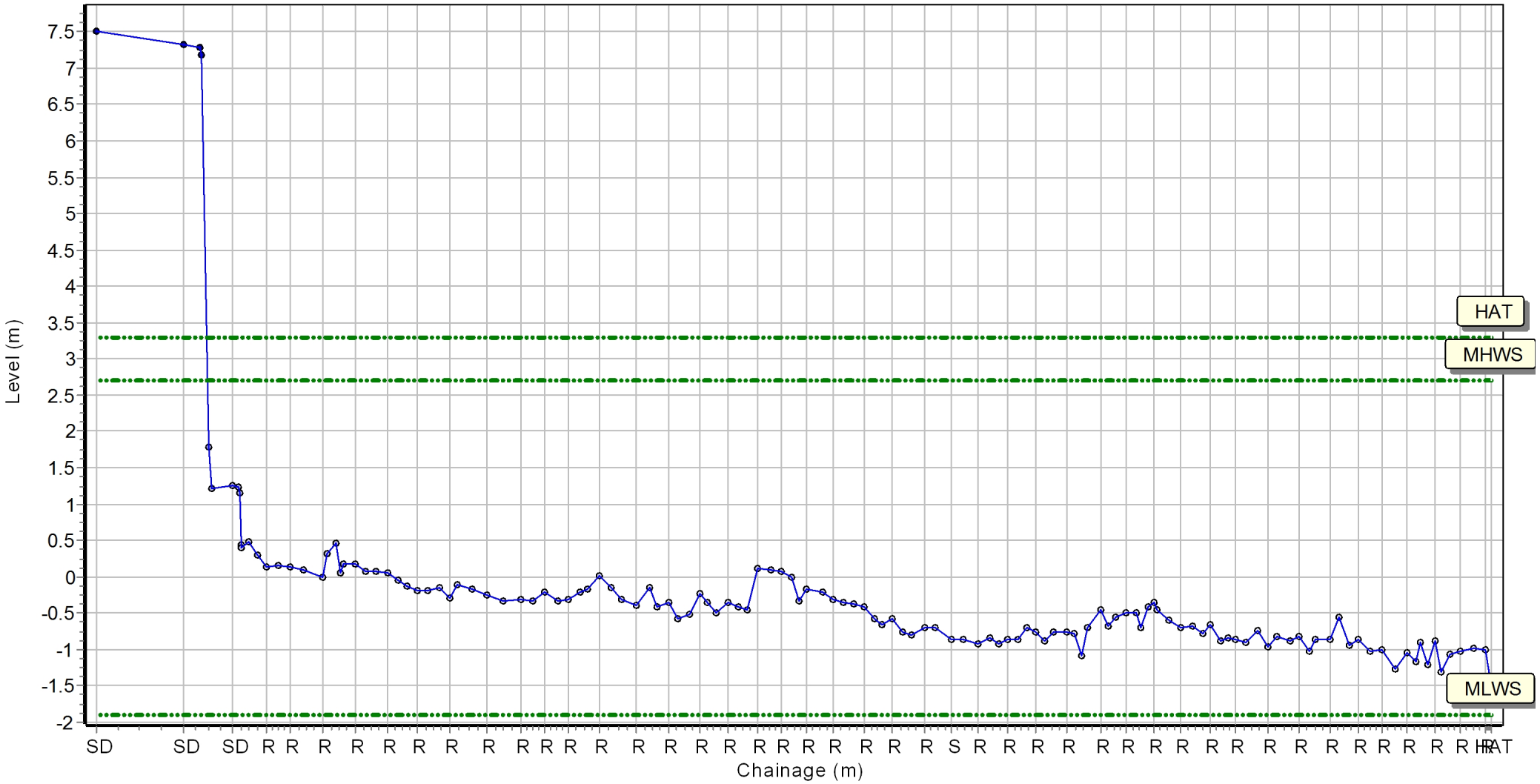
Location: **1cHN4A**

Date: 01/04/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Partial Measures Topo Survey

Easting: 452610.565 **Northing:** 534321.038 **Profile Bearing:** 23 ° from North



Beach Profile

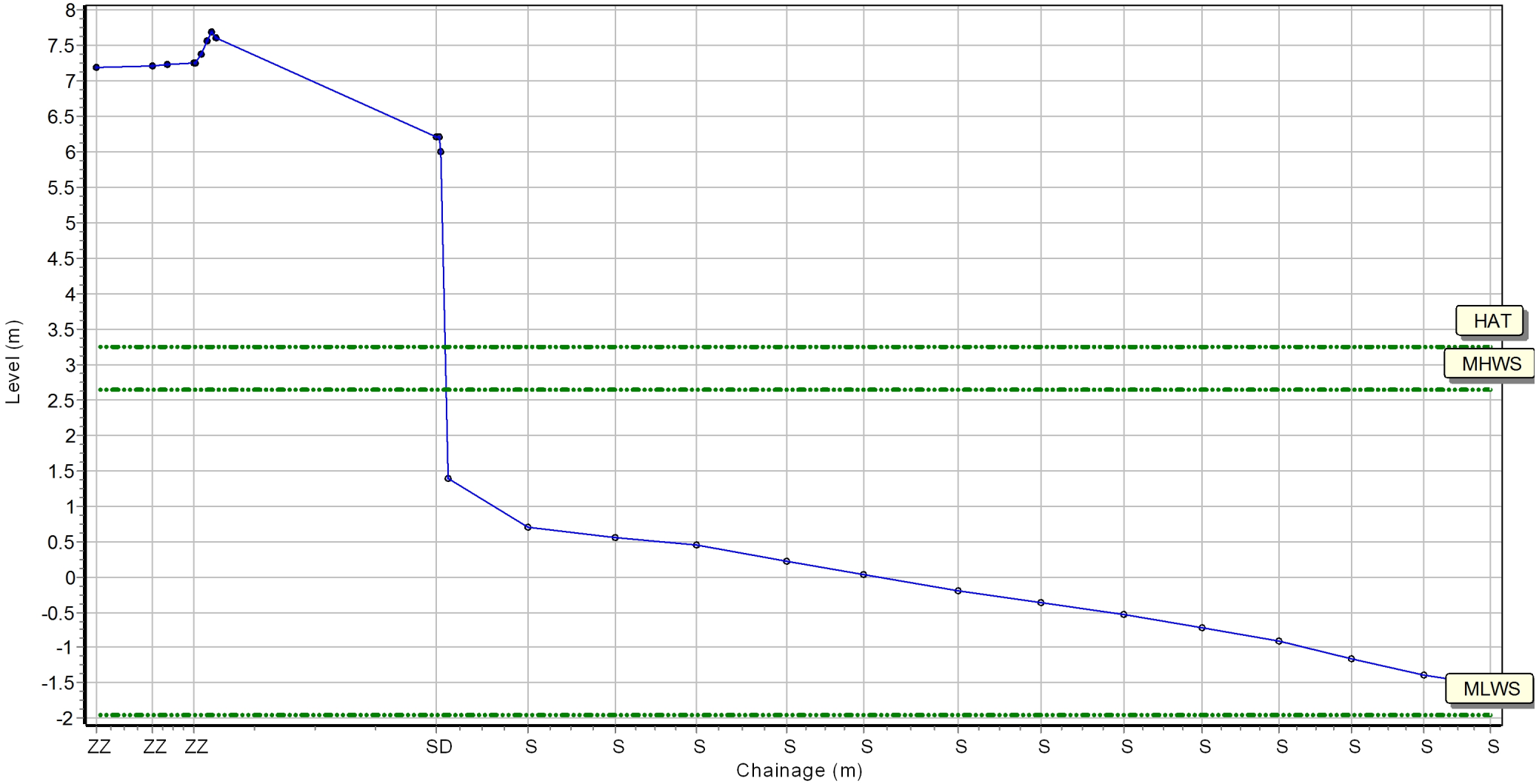
Location: **1cHC1**

Date: 02/04/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Partial Measures Topo Survey

Easting: 452108.075 **Northing:** 533506.119 **Profile Bearing:** 150 ° from North



Beach Profile

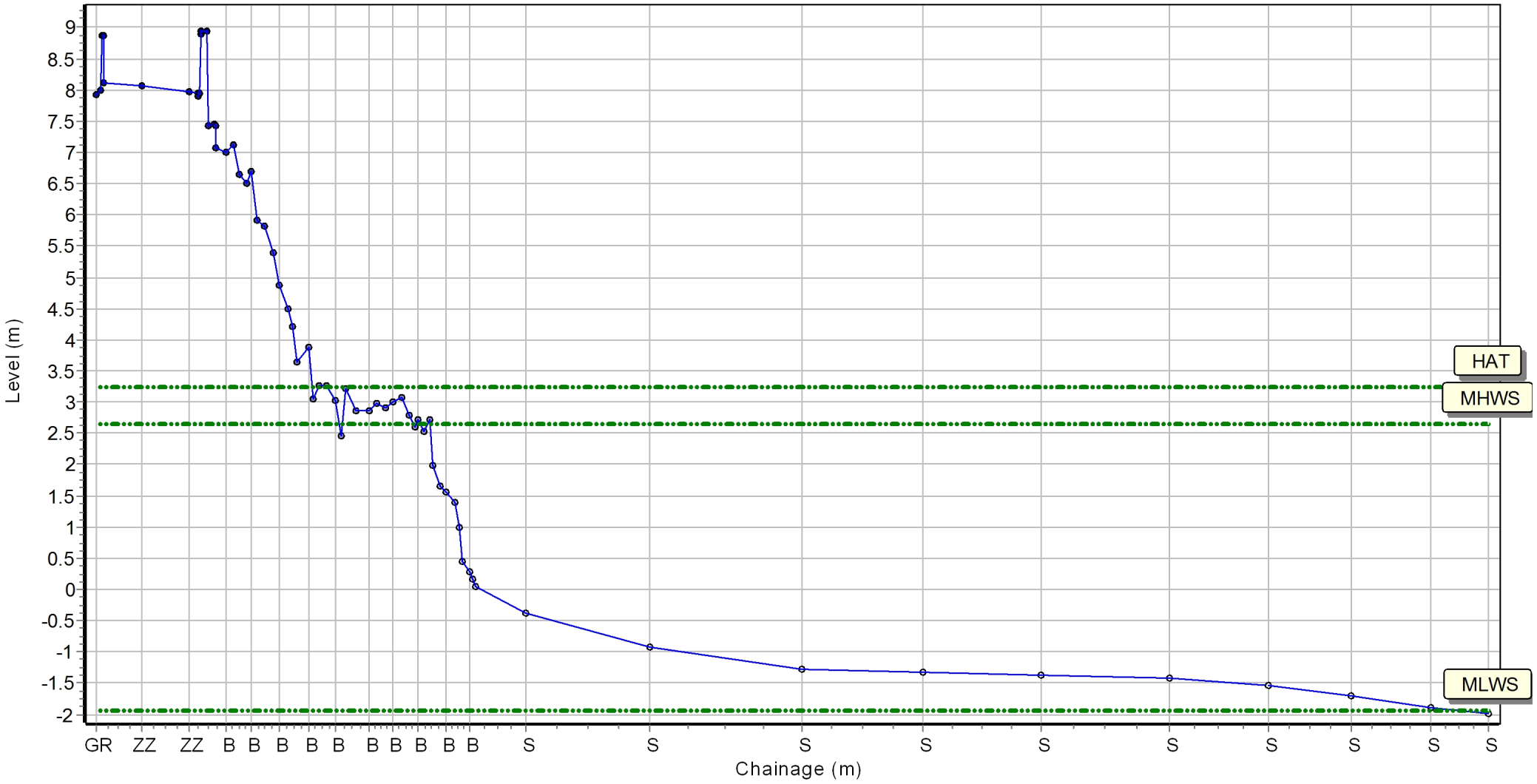
Location: **1cHS1**

Date: 02/04/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Partial Measures Topo Survey

Easting: 451718 **Northing:** 532455 **Profile Bearing:** 95 ° from North



Beach Profile

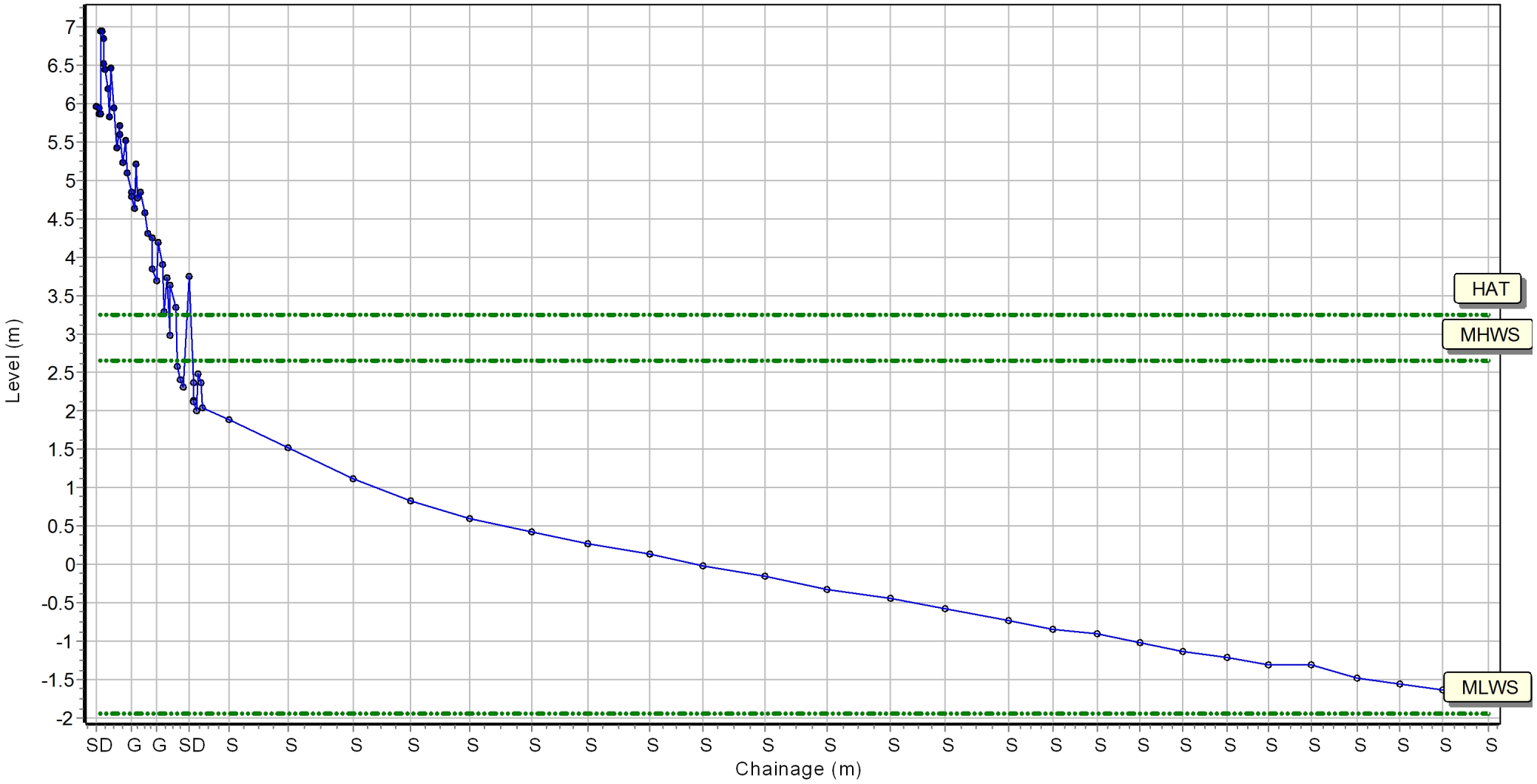
Location: **1cHS2**

Date: 02/04/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Partial Measures Topo Survey

Easting: 452160.59 **Northing:** 531071.39 **Profile Bearing:** 77 ° from North



Beach Profile

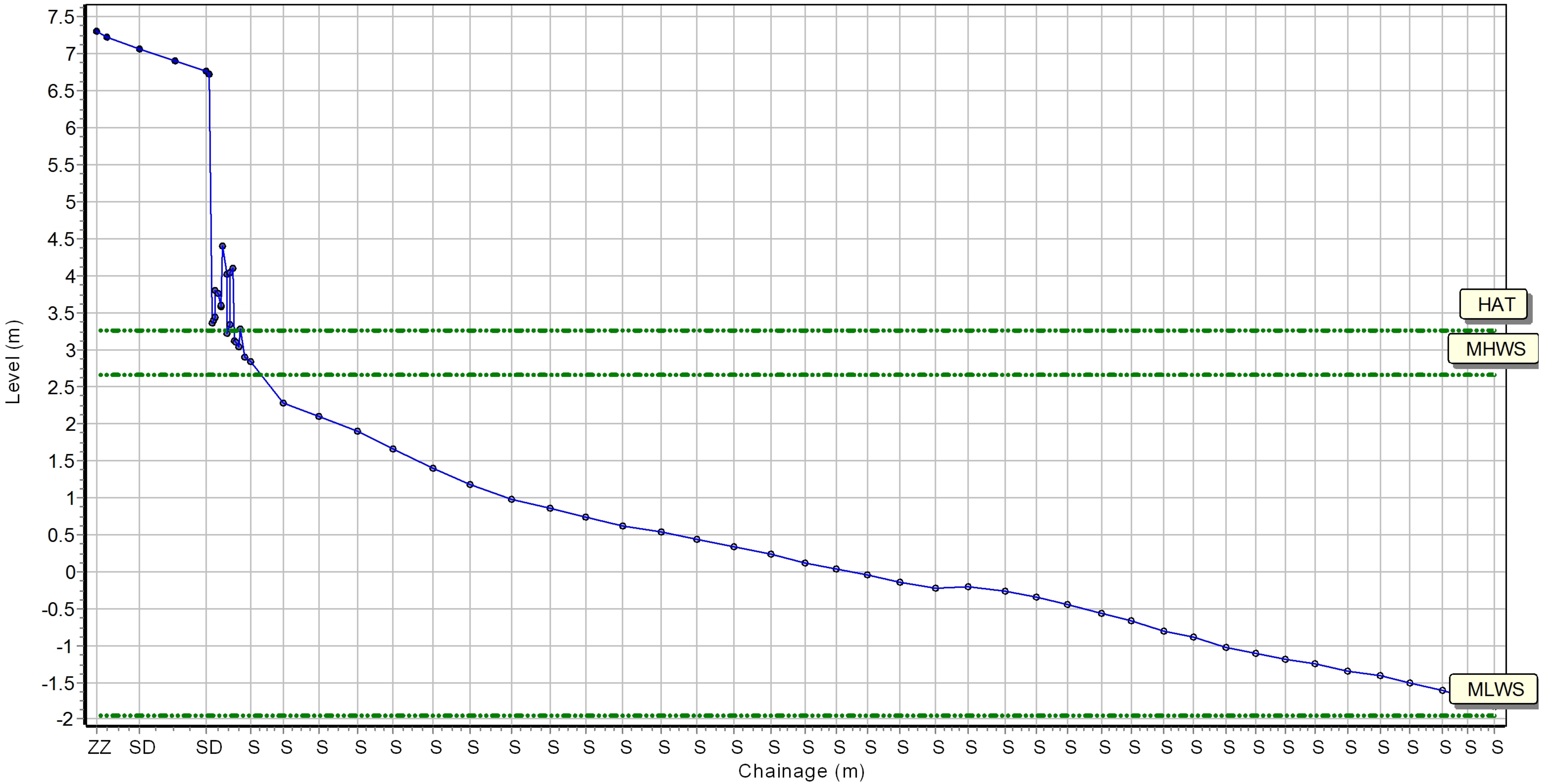
Location: 1cHS3

Date: 02/04/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Partial Measures Topo Survey

Easting: 452517.25 **Northing:** 530064.57 **Profile Bearing:** 76 ° from North



http://www.sandsuser.com

SANDS

Beach Profile

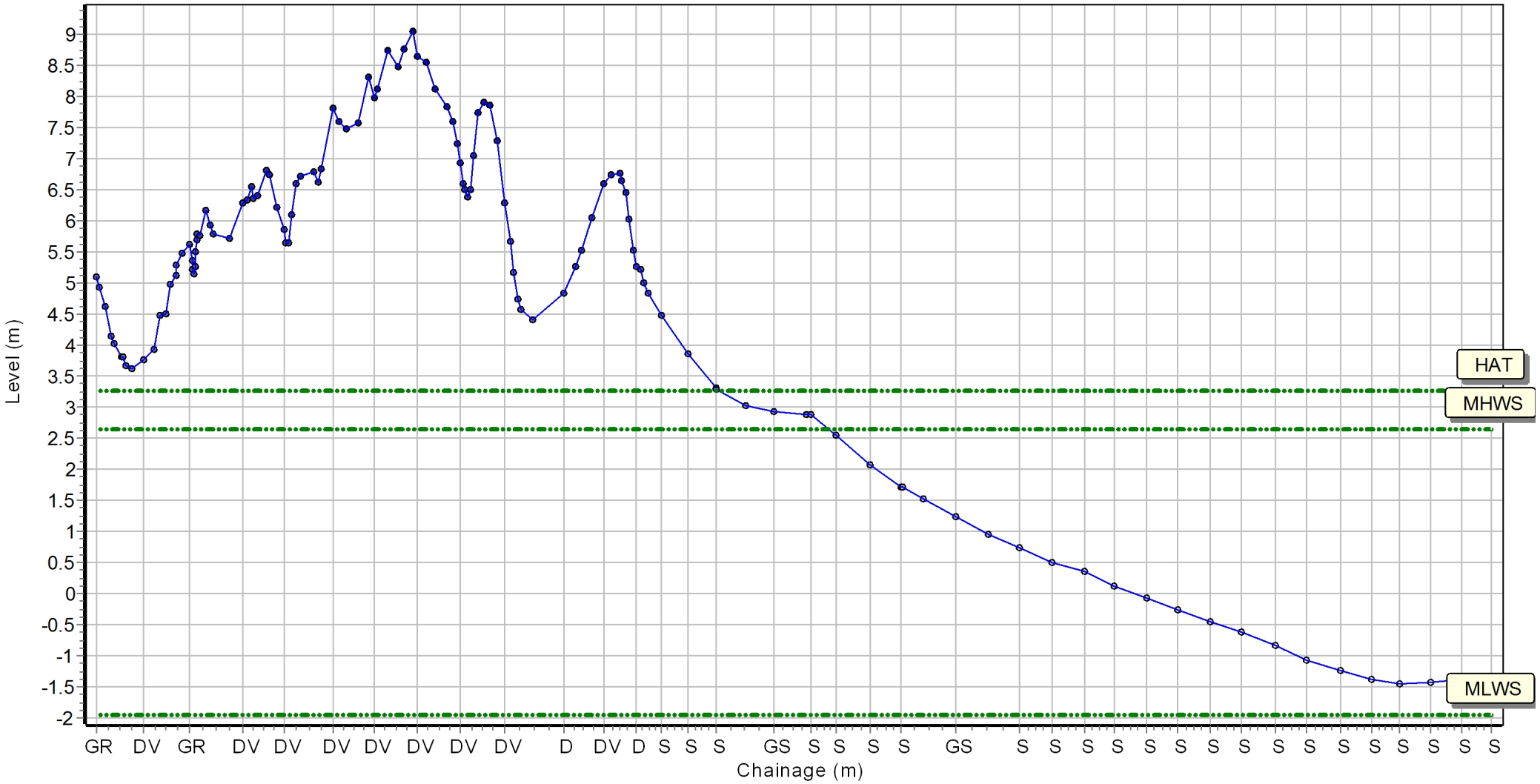
Location: **1cHS4**

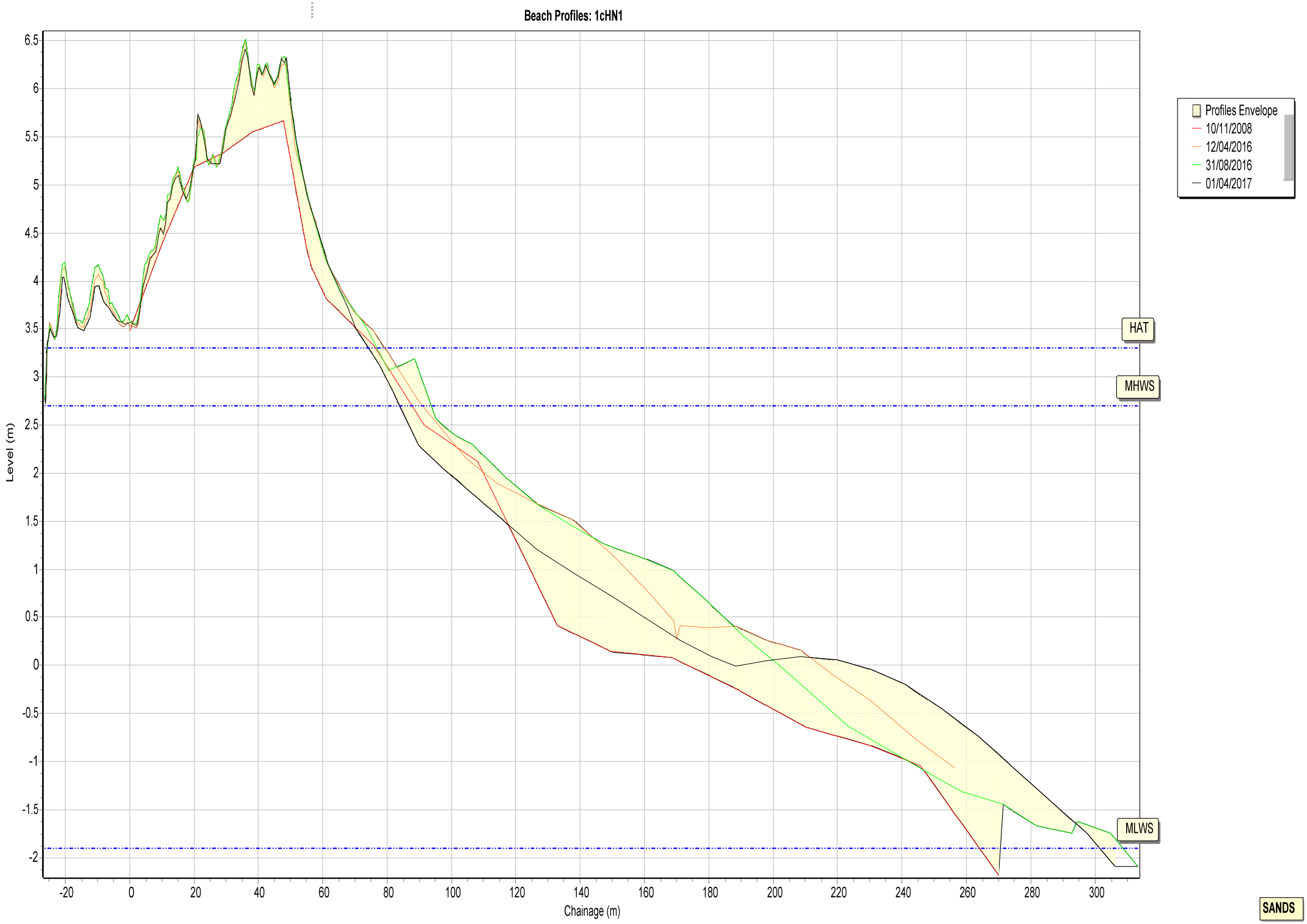
Date: 02/04/2017 **Inspector:** AG **Low Tide:** **Low Tide Time:**

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

Summary: 2017 Partial Measures Topo Survey

Easting: 452889 **Northing:** 528971 **Profile Bearing:** 76 ° from North

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Profiles Envelope
10/11/2008
12/04/2016
31/08/2016
01/04/2017
HAT
MHWS
MLWS
SANDS
Level (m)
Chainage (m)
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
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0.5
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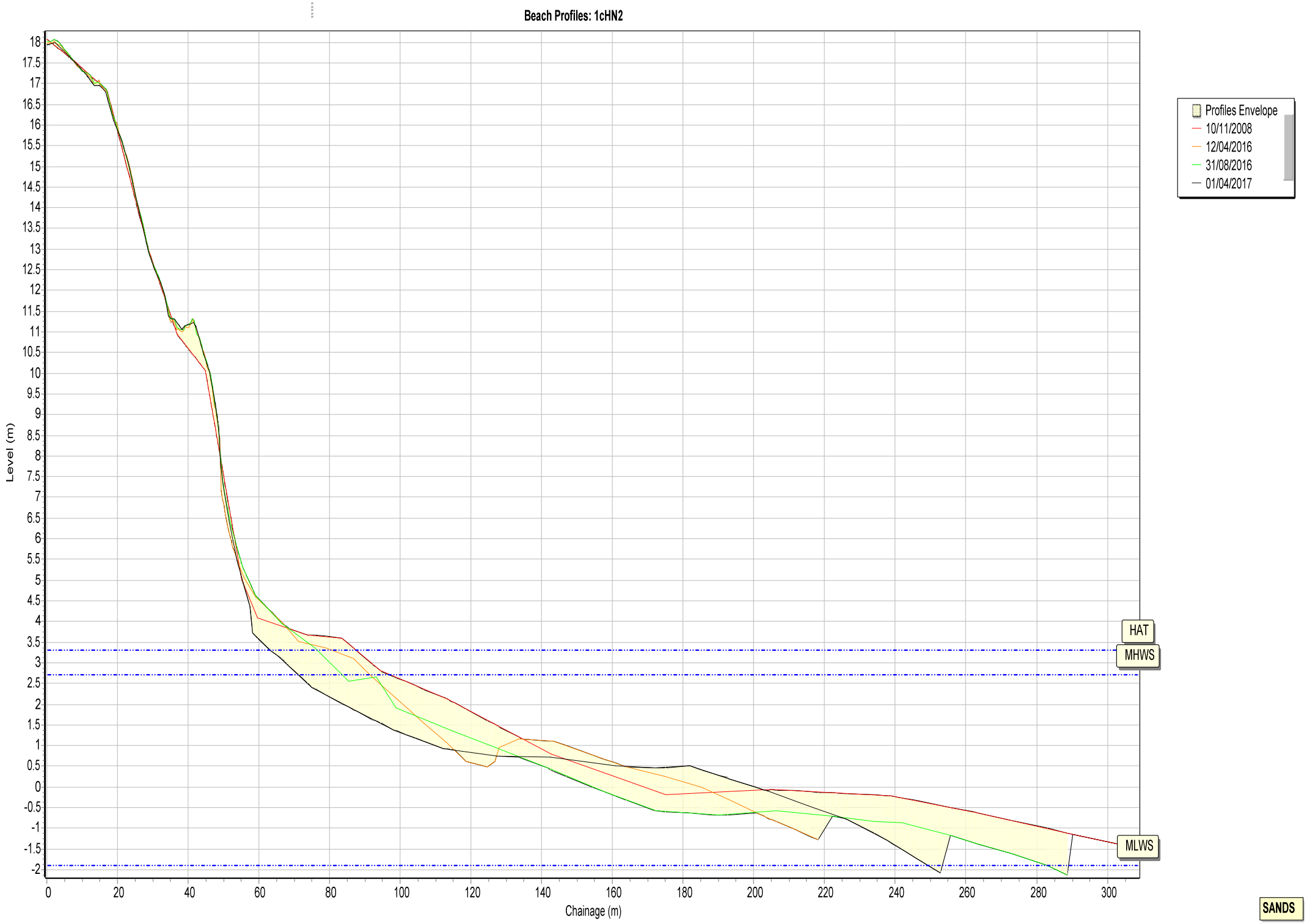
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01/04/2017
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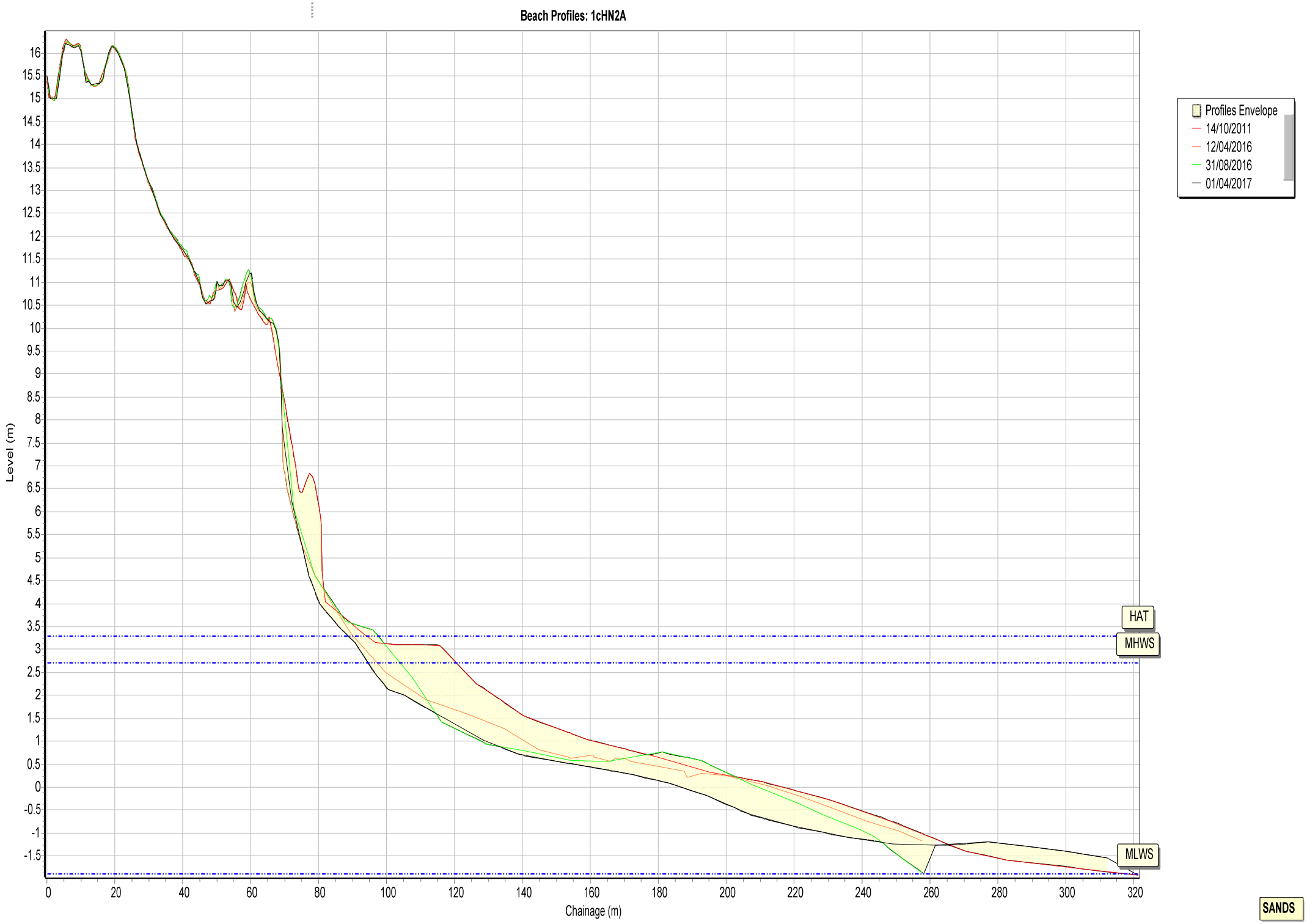
MHWS
MLWS
Level (m)
Chainage (m)
SANDS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MLWS
Level (m)
Chainage (m)
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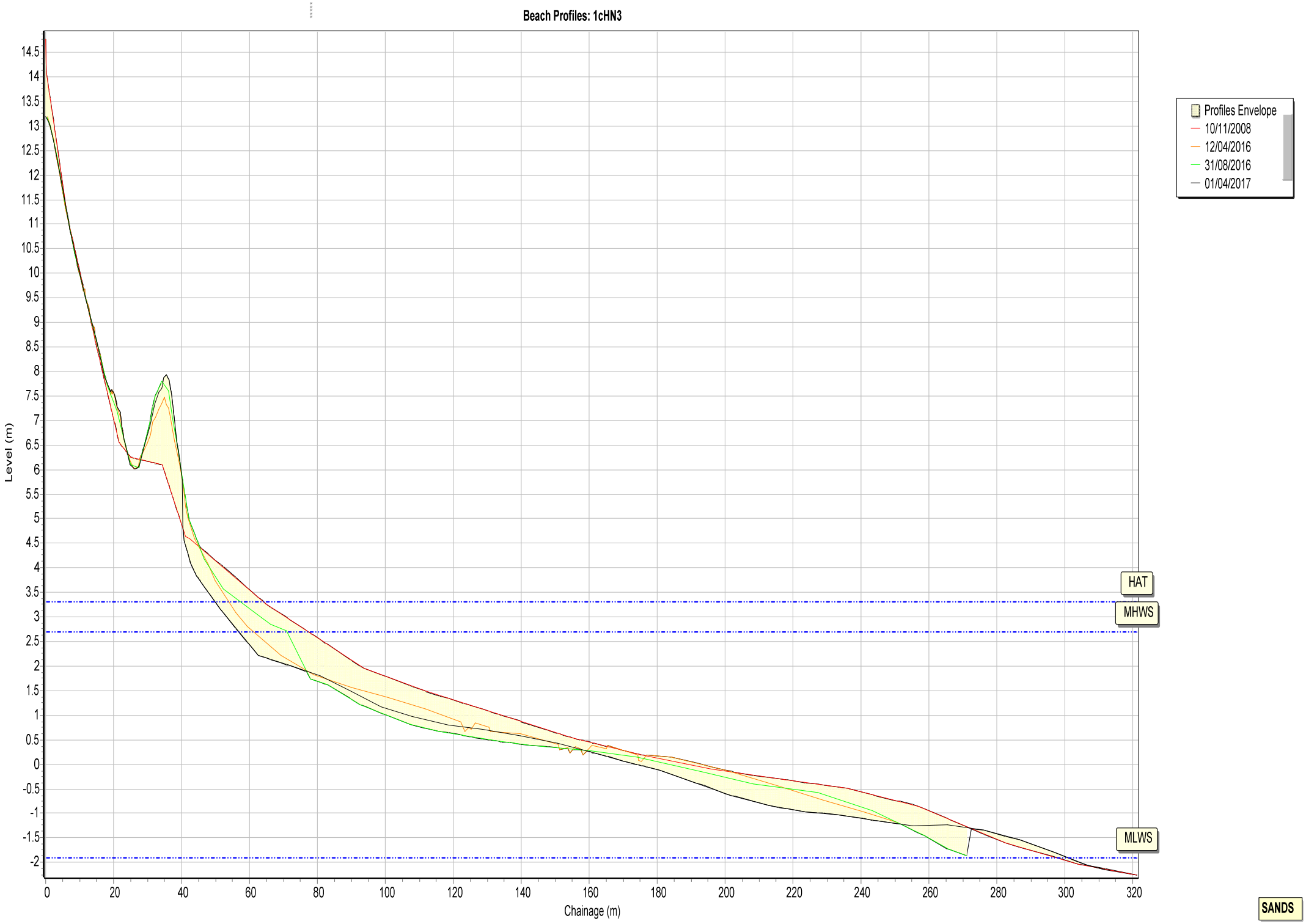
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31/08/2016
01/04/2017
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MHWS
MLWS
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Chainage (m)
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13.5
13
12.5
12
11.5
11
10.5
10
9.5
9
8.5
8
7.5
7
6.5
6
5.5
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4.5
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3.5
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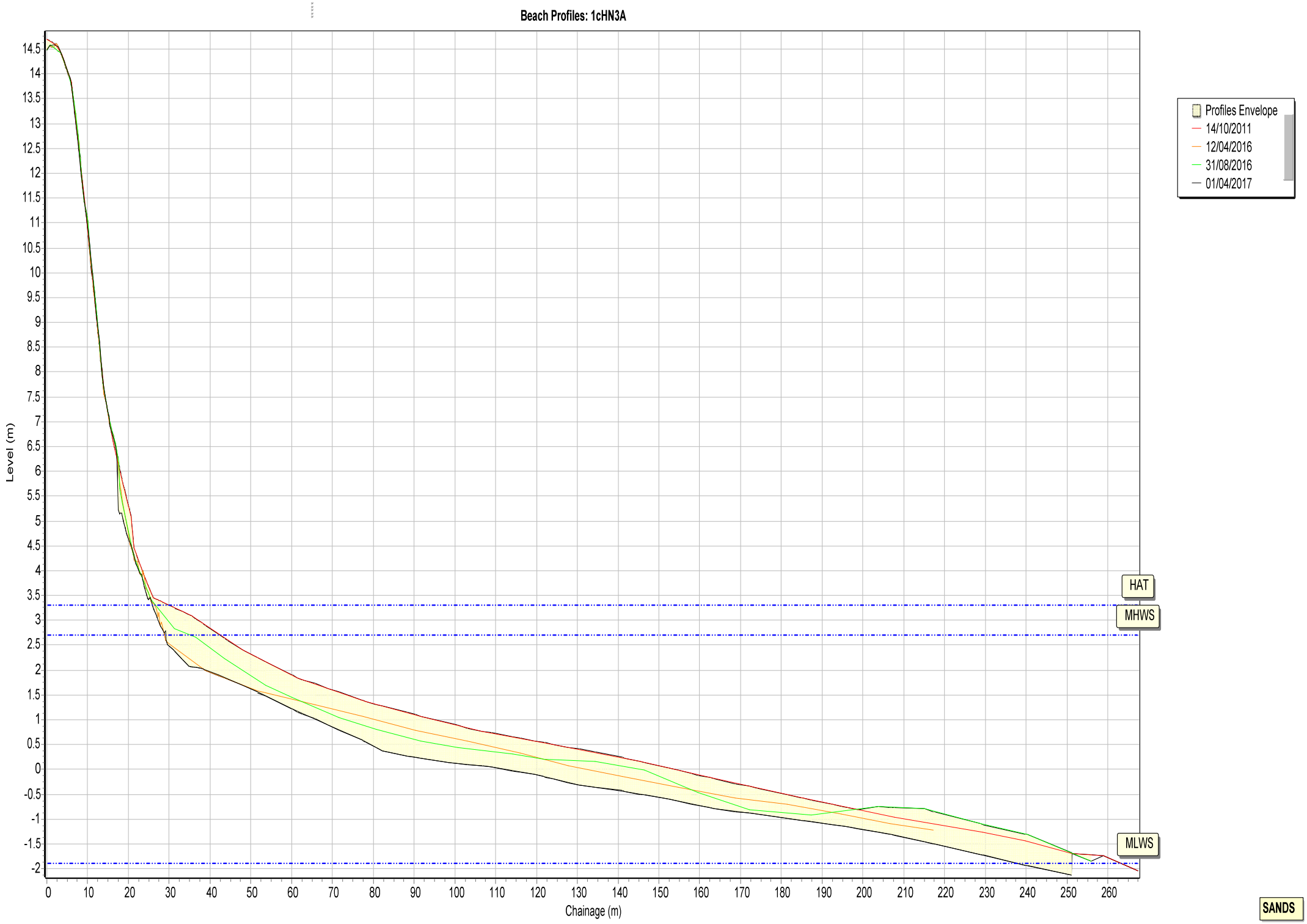
SANDS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01/04/2017
HAT
MHWS
MLWS
SANDS
Level (m)
Chainage (m)
14.5
14
13.5
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12.5
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11.5
11
10.5
10
9.5
9
8.5
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7.5
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6.5
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250
260


Beach Profiles: 1cHN4
Profiles Envelope
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12/04/2016
31/08/2016
01/04/2017
HAT
MHWS
MLWS
SANDS
Level (m)
Chainage (m)
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7.5
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6.5
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5.5
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4.5
4
3.5
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2.5
2
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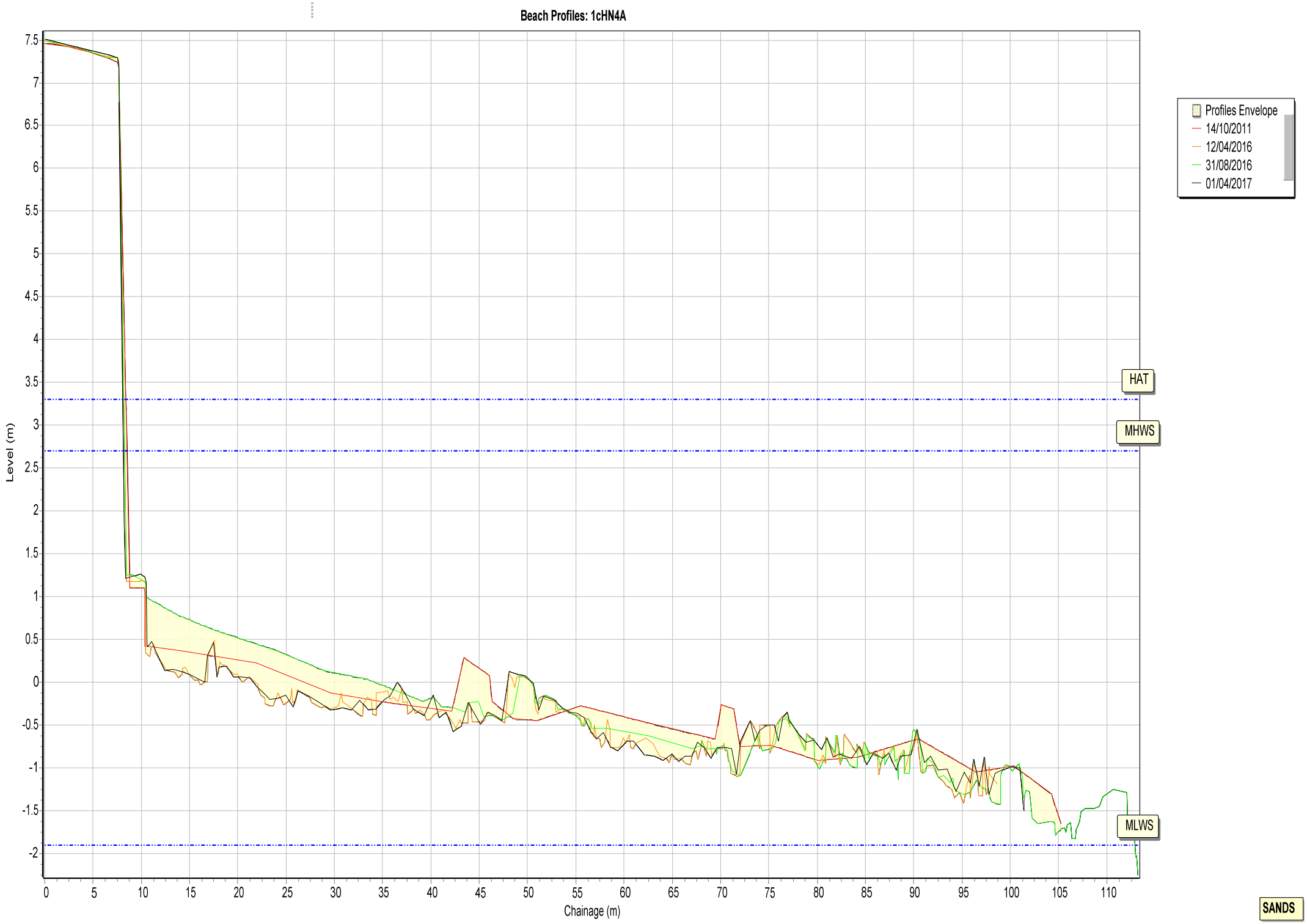
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31/08/2016
01/04/2017
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MHWS
MLWS
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6.5
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5.5
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4.5
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1.5
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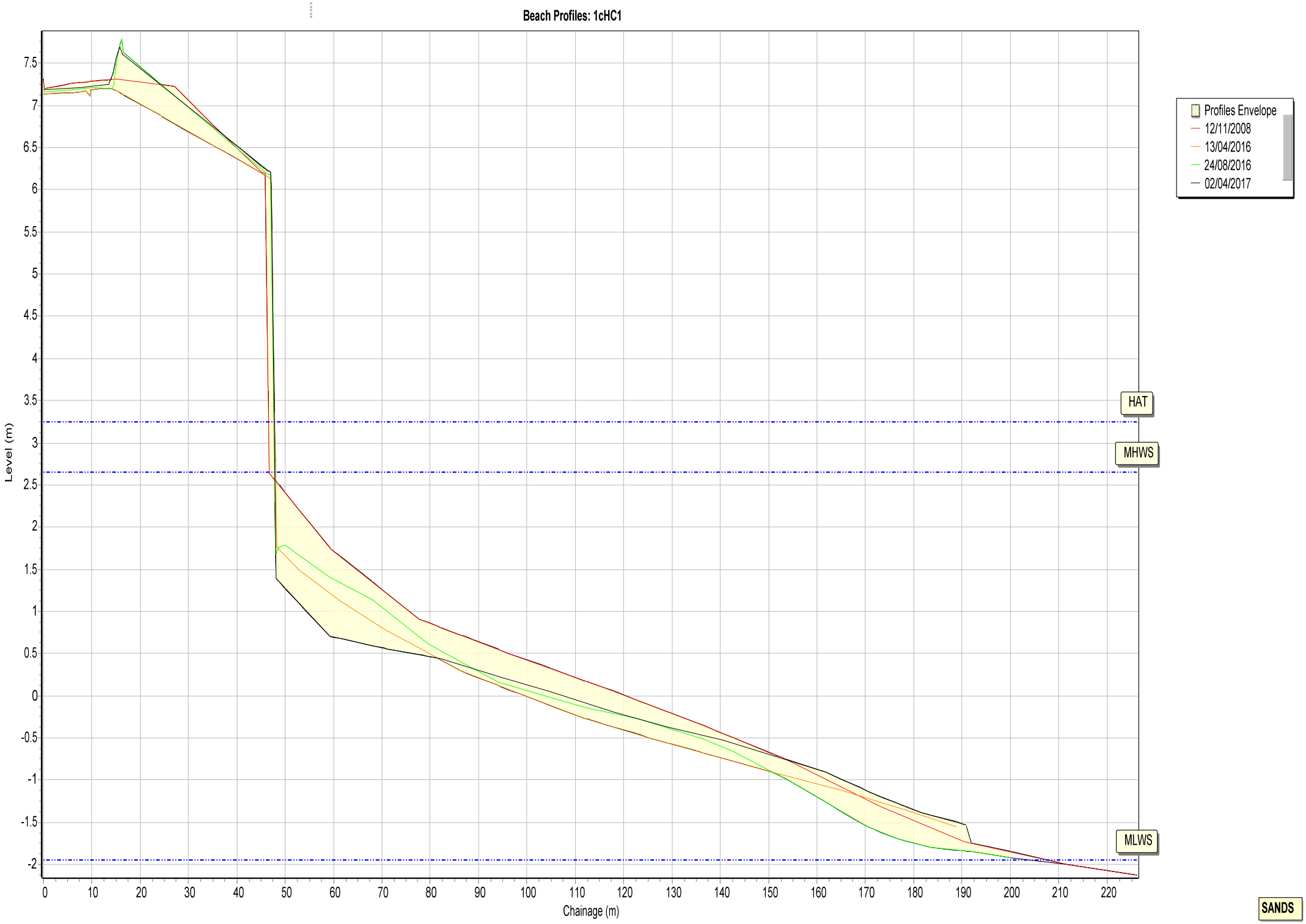
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02/04/2017
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MLWS
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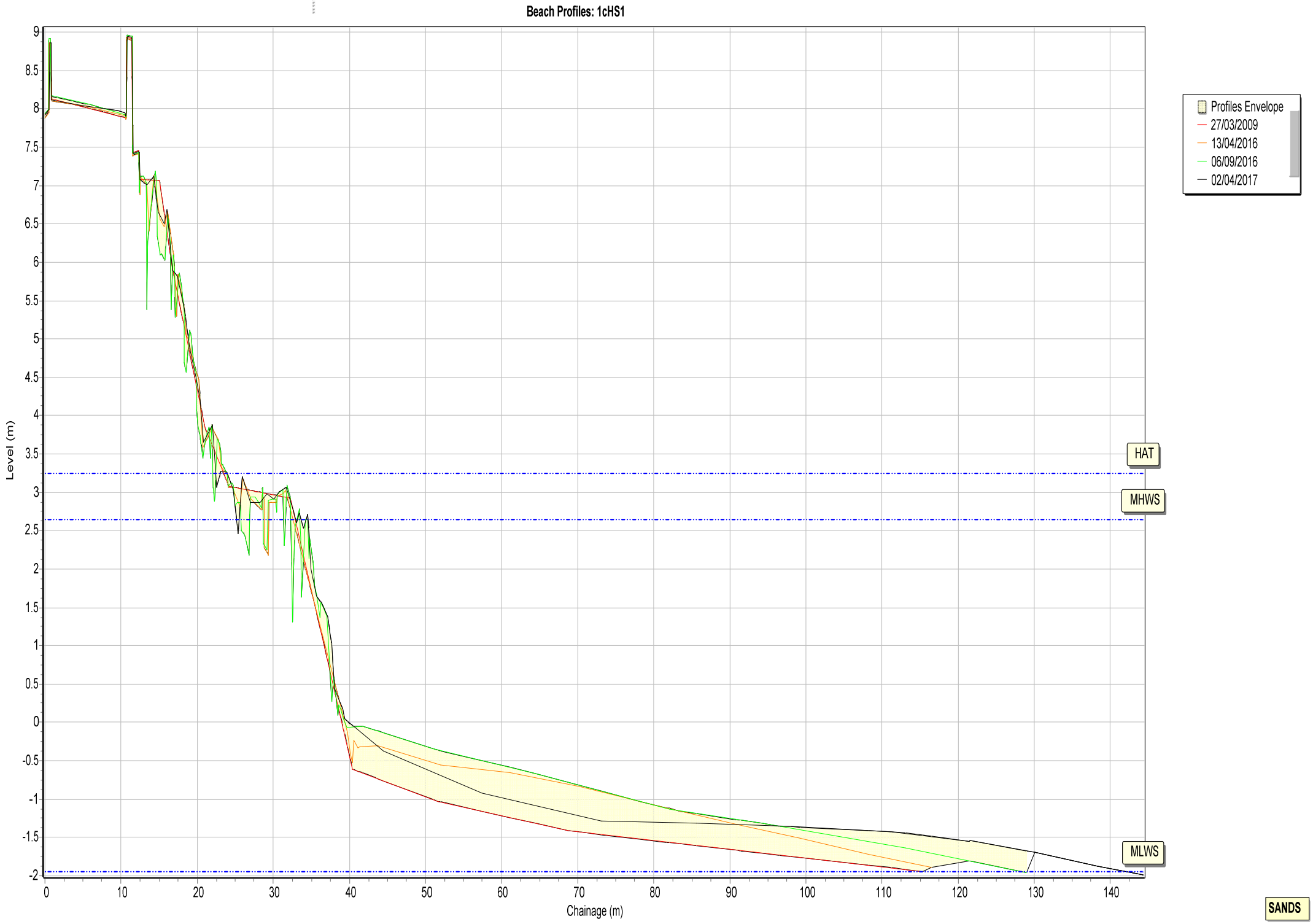
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06/09/2016
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MHWS
MLWS
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6.5
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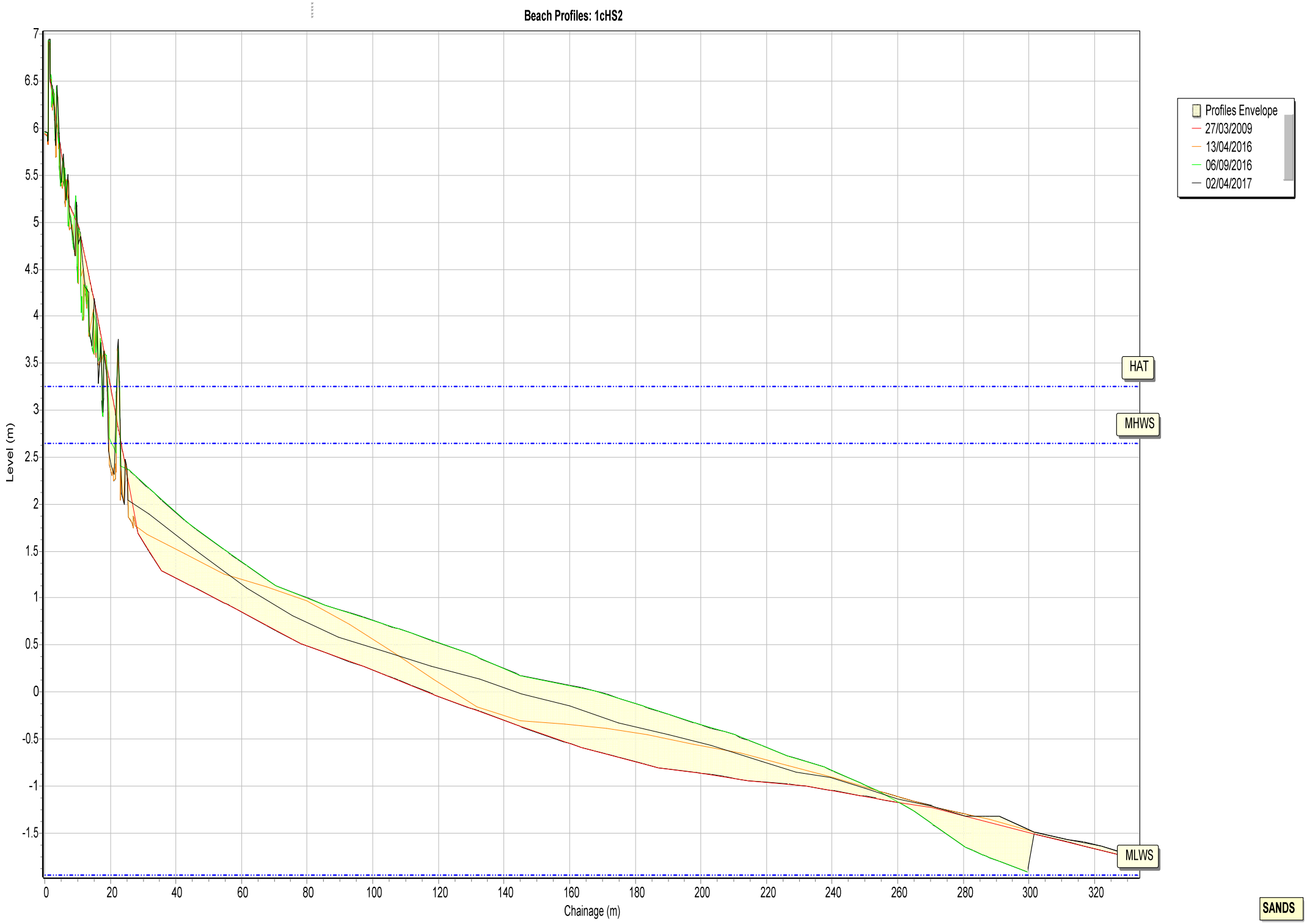
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Chainage (m)
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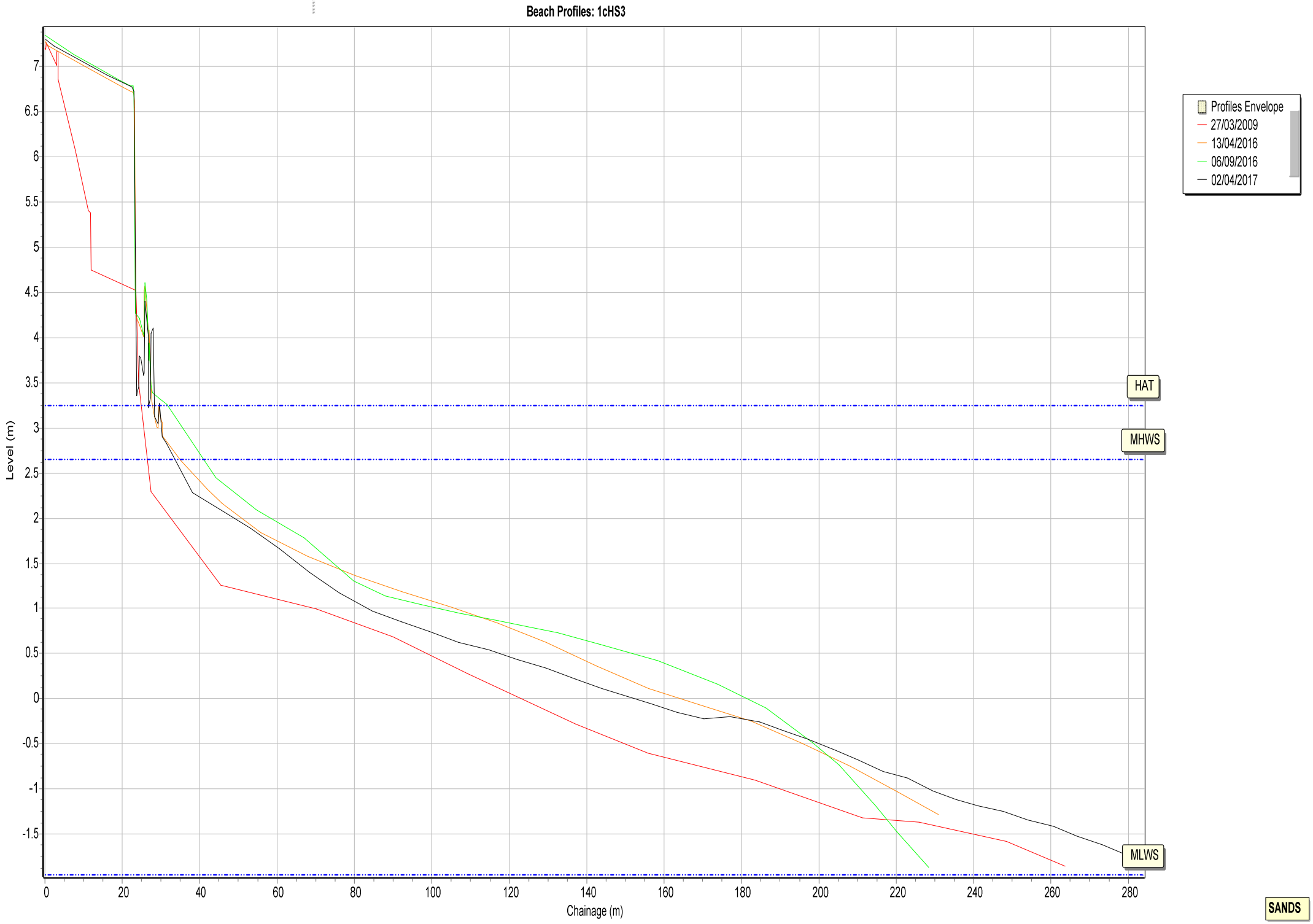
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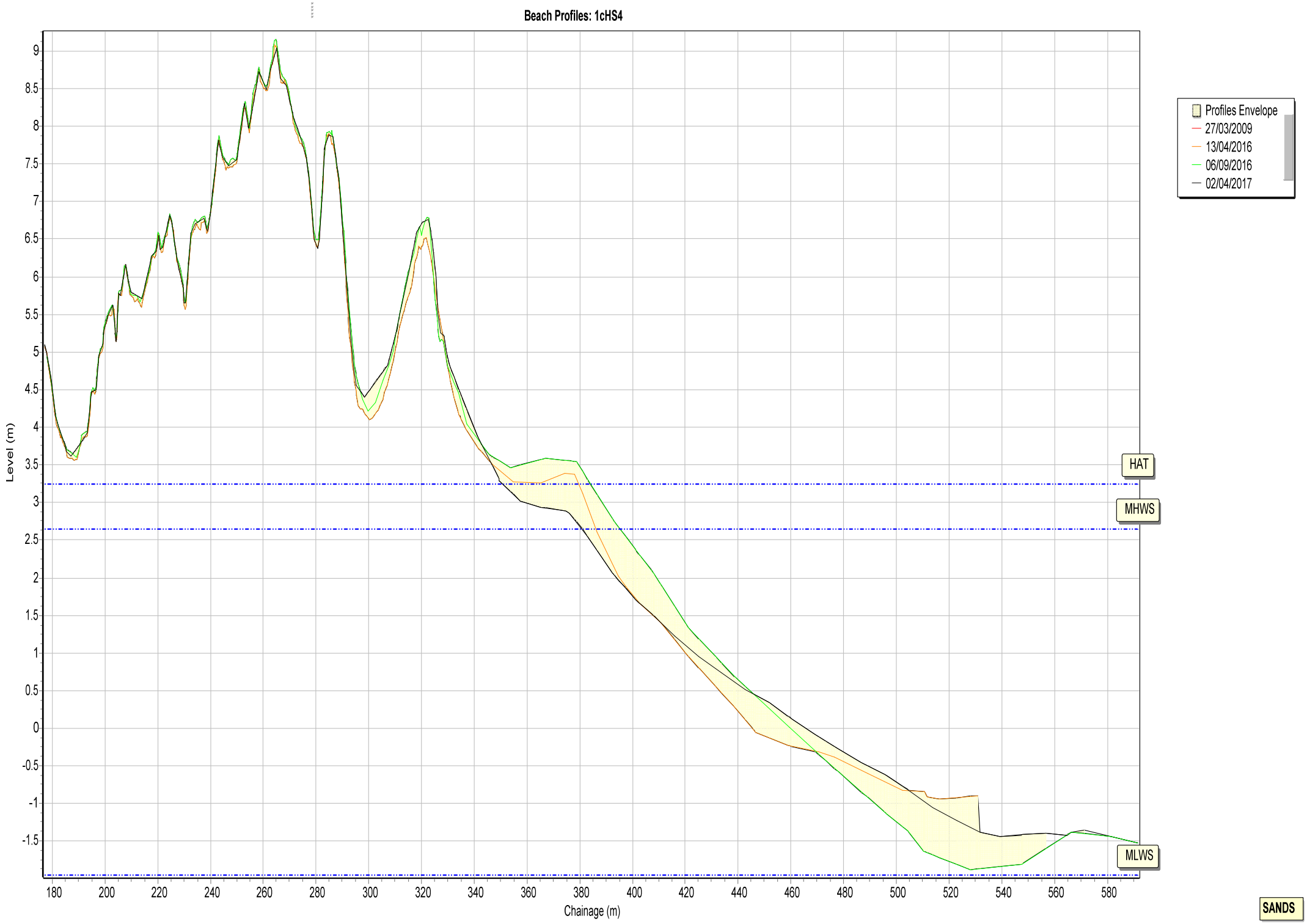
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