



Cell 1 Regional Coastal Monitoring Programme Analytical Report 16: 'Full Measures' Survey 2023



**Hartlepool Borough Council
January 2024**

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Abbreviations and Acronyms

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

Water Levels Used in Interpretation of Changes

Water Level Parameter	Water Level (m AOD)	Water Level (m AOD)
	North Sands to Middleton	Hartlepool Bay
HAT	3.30	3.25
MHWS	2.70	2.65
MHWN	1.50	1.45
MLWN	-0.90	-0.85
MLWS	-1.90	-1.95

Source: UKHO Admiralty Tide Tables, 2020

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.
Ebbtide	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.
Floodtide	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.

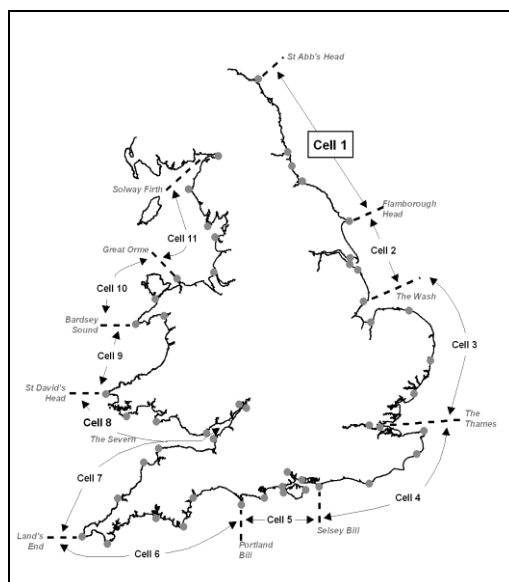


Figure 1 Sediment Cells in England and Wales

The programme commenced in its present guise in September 2008¹ and is managed by Scarborough Borough Council on behalf of the North East Coastal Observatory. It is funded by the Environment Agency, working in partnership with the following organisations:



¹ Prior to 2008, coastal monitoring was undertaken on a consistent basis across Northumberland and North Tyneside as part of the (then) Northumbrian Coastal Authorities Group's monitoring programme which commenced in 2002, whilst several authorities between the River Tyne and Flamborough Head undertook their own local monitoring programmes.

Royal HaskoningDHV has been appointed to provide Analytical Services in relation to the present phase of the Cell 1 Regional Coastal Monitoring Programme, between 2016 - 2027.

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.

At the end of each phase of the programme, 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		Post Storm		Cell 1 Overview Report
		Survey	Analytical Report	Survey	Update Report	Survey	Post Storm Report	
1	2008/09	Sep-Dec 08	May 09	Mar-May 09		-	-	-
2	2009/10	Sep-Dec 09	Mar 10	Feb-Mar 10	July 10	-	-	-
3	2010/11	Aug-Nov 10	Feb 11	Feb-April 11	Aug 11	-	-	Sept 11
4	2011/12	Sep-Oct 11	Oct 12	Mar-May 12	Feb 13	-	-	-
5	2012/13	Sep 2012	Feb 13	April 13	May 13	-	-	-
6	2013/14	Sep-Oct 13	Feb 14	March 14	July 14	-	-	-
7	2014/15	Sep-Oct 14	Feb 15	April 15	Jun 15	-	-	-
8	2015/16	August 15	Feb 16	April 16	July 16	-	-	Jun 16
9	2016/17	Aug-Sep 16	Feb 17	Apr 17	Jul 17	-	-	-
10	2017/18	Sep-Nov 17	Feb 18	Mar 18	May 18	-	-	-
11	2018/19	Aug-Oct 18	Feb 19	Feb 19	May 19	-	-	-
12	2019/20	Sep-Oct 19	Nov 19	May 20	Jul 20	-	-	-
13	2020/21	Sep-Oct 20	Feb 21	Apr 21	May 21	-	-	Aug 21
14	2021/22	Sep 21	Nov 21	Apr 22	Jun 22	-	-	-
15	2022/23	Sep-Oct 22	Jan 23	Apr 23	Jun 23	-	-	-
16	2023/24	Sep-Oct 23	Jan 24	-	-	Nov 23	Dec 23	-

(*) The present report is **Analytical Report 16** and provides an analysis of the 2023 Full Measures survey for Hartlepool Borough 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 seabed sediment data collection, aerial photography, and walk-over visual inspections. For purposes of analysis, the Cell 1 frontage has been split into the sections listed in 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
	North Gare
Redcar & Cleveland Borough Council	Coatham Sands
	Redcar Sands
	Marske Sands
	Saltburn Sands
	Cattersty Sands (Skinningrove)
Scarborough Borough Council	Staithes
	Runswick Bay
	Sandsend Beach, Uppgang Beach and Whitby Sands
	Robin Hood's Bay
	Scarborough North Bay
	Scarborough South Bay
	Cayton Bay
	Filey Bay

1. Introduction

1.1 Study Area

Hartlepool Borough 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 Borough 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 or 'HN')
 - Topographic survey along Middleton (referred to as Hartlepool Central or 'HC')
 - Topographic survey along Hartlepool Bay (referred to as Hartlepool South or 'HS')
- Partial Measures survey annually each spring comprising:
 - Beach profile surveys along twelve transect lines.
- Previously the Full Measures topographic survey at Hartlepool North was extended every five years to fully cover the whole of North Sands and Hartlepool Headland. As off 2023, these additional areas will also be survey annually as part of the Full Measure surveys.

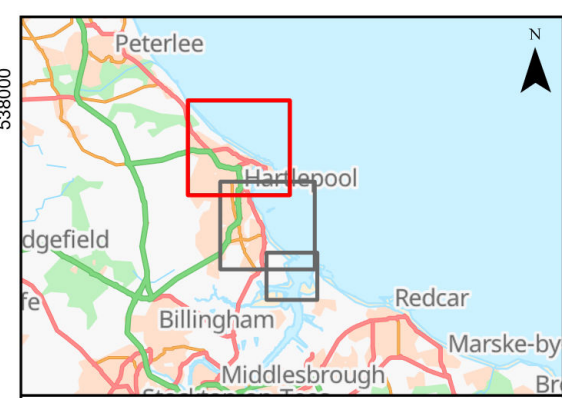
The location of these surveys is shown in Figure 2. The 2023 Full Measures survey was undertaken along this frontage between 5th September and 16th October. The survey reports from Academy Geomatics document details of the weather conditions over this survey period.

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.



SURVEY LOCATIONS

Topographic Profile

- Annual (Blue line)
- Bi-Annual (Pink line)

Topographic Area

- 6 monthly (Light Green)
- yearly (Yellow)
- yearly since 2023 (Yellow with grid pattern)

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 Contains data from OS Zoomstack, World Imagery: Maxar, Microsoft, Hybrid Reference Layer: Esri UK, Esri, HERE, Garmin, Foursquare, GeoTechnologies, Inc, METI/NASA, USGS

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

Title:

Figure 2 - Map 1

NORTH SANDS, HEADLAND, MIDDLETON

Hartlepool Borough Council Frontage

Report:

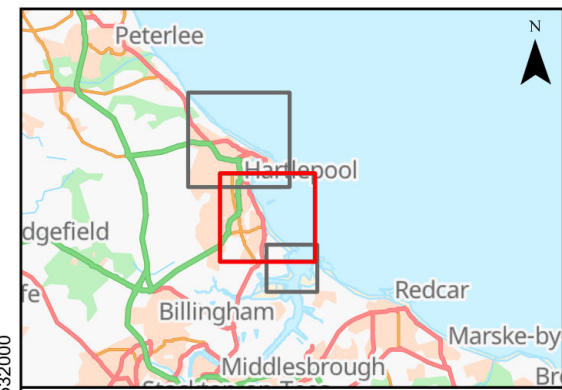
Survey Report

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	n/a	TC	NJC	A4	1:30,000

Co-ordinate system: British National Grid

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SURVEY LOCATIONS

Topographic Profile

- Annual (Blue line)
- Bi-Annual (Pink line)

Topographic Area

- 6 monthly (Light Green)
- yearly (Yellow)
- yearly since 2023 (Yellow with cross-hatch pattern)

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

Title:

Figure 2 - Map 2

HARTLEPOOL BAY

Hartlepool Borough Council Frontage

Report:

Survey Report

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	n/a	TC	NJC	A4	1:28,000

Co-ordinate system: British National Grid

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SURVEY LOCATIONS

Topographic Profile

- Annual
- Bi-Annual

Topographic Area

- 6 monthly
- yearly
- yearly since 2023

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

Title: **Figure 2 - Map 3**
NORTH GARE
Hartlepool Borough Council Frontage

Report: **Survey Report**

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	n/a	TC	NJC	A4	1:15,000

Co-ordinate system: British National Grid

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2. Analysis of Survey Data

2.1 North Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
<p>2nd – 4th October 2023</p>	<p>Beach Profiles:</p> <p>North Sands and Hartlepool Headland is covered by six beach profile lines during the Full Measures survey (Appendix A). They were last surveyed in April 2023. In addition, profile 1cHN1 (which is located within Durham County Council's area of responsibility, about 400m north of the outfall of Crimdon Beck), is reported here so changes can be interpreted in association with those observed elsewhere along North Sands.</p> <p>At profile 1cHN1, chainage 0m to 60m encompasses dunes that have overall remained unchanged with the exception of a length of accretion between chainage 16m and 29m up to 0.3m in level. Seaward of the foredune the beach has been dominated by accretion. Two berms have formed between chainages 74m and 90m and chainages 155m and 191m that have locally increased levels by 0.5m and 0.45m respectively. Seawards of chainage 293m the beach profile steepens significantly, resulting in a drop in level of 0.6m at chainage 311m. When compared to the range of previous surveys, the foredune is at the highest level on record whilst the beach itself is generally at a high level.</p> <p>At profile 1cHN2, there has been no change across the dune system up until the toe of the foredune at chainage 56m. Between chainage 56m and chainage 84m, a shallow berm has formed up to 0.45m in height. The middle section of beach has been dominated by erosion, dropping by 0.2m in level between chainages 84m and 213m. A short length of no change is then followed by the formation of second berm on the lower extends of the profile, 0.5m in height. The profile generally remains at a medium level when compared to the range of the previous survey. The berms that formed on the upper and lower beach are at a high level although remain within the range envelope.</p> <p>Profile 1cHN2A was established in October 2011 and runs through the dunes close to North Sands. The profile is unchanged across the dune system up until the crest of the foredune at chainage 67m. The seaward face of the foredune has accreted by up to 0.5m in level. On the upper beach, a berm 1m in height, has formed between chainages 74m and 119m. A drop in level of up to 0.35m is then observed between chainage 120m and 180m, before again switching to accretion across the lower beach. The accretion has across the upper and lower beach has resulted in the profile in these places being at the</p>	<p>North Sands appears to have been dominated by accretion since the previous survey. All five profiles show the formation of two berms (one against the toe of dunes and one on the lower beach) suggesting a period of beach recovery. The profiles generally remain with envelope of the previous surveys.</p> <p>Change around The Headland has been limited. Overall, it appears the limited material present has been transported landward, with both profiles (1cHN4 and 1cHN4A) locally recording the highest beach level up against the toe of the structure before steeply dropping back to normal levels. The exposed rocky foreshore still dominates both profiles.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>highest level on record when compared to the range of the previous survey.</p> <p>At profile 1cHN3, the dunes up to chainage 47m have remained stable. A berm, 1.2m in height, has formed across the upper beach between chainages 47m and 80m. A short length of negligible erosion (-0.1m) is then followed by the formation of second berm (possibly the berm observed previously shifting landward). This berm is now between chainage 114m and 203m and has resulted in an increase level up to 0.55m. The profile remains within the envelope of the previous survey with the exception of the crest of the upper berm which is at the highest level on record for that chainage.</p> <p>At profile 1cHN3A the dune face has again remained unchanged. The toe of the dune is protected by an informal cobble / brick berm which has remained stable. The beach at the toe of the berm has accreted by 0.45m. Accretion is also observed across the whole beach in varying in magnitude, the change is dominated by the formation of berms. The accretion peaks in magnitude at chainage 140m with an increase in level of 0.5m. The profile is at medium to high when compared to the range of the previous surveys.</p> <p>Profile 1cHN4 is defended by a seawall up to chainage 15m. The beach at the toe of the seawall has initially accreted by 0.85m in level tapering to no change by chainage 43m. A short length of no change is then followed erosion between chainages 62m and 147m. The rocky foreshore is now exposed from chainage 110m. The beach at the toe of the seawall is the highest level on record whereas the rest of the beach is at a medium to low level.</p> <p>Profile 1cHN4a is defended by a seawall up to chainage 9m. Between the seawall and exposed rocky shore the beach material appears to have been distributed landward since the previous inspection. At the toe of the wall, the beach has accreted by up to 1.2m in level, tapering to no change at chainage 22m. Whereas between chainage 22m and 42m, the beach has eroded by up to 0.3m in level. The rocky shore platform remains exposed seawards of chainage 47m. At the toe of the seawall the profile is at its highest level on record, the rest of the profile is at a medium level compared to the range of the previous surveys.</p>	

Survey Date	Description of Changes Since Last Survey	Interpretation
<p>2nd – 4th October 2023</p>	<p>Topographic Survey:</p> <p>North Sands is covered by an annual topographic survey. Data from the 2023 Full Measures survey have been used to create a DGM (Appendix B – Map 1) using a GIS package. The plot shows, as per the previous surveys, the majority of the frontage is characterised by shore-parallel contours, except in the vicinity of outfalls, groynes, and the pier where contours change direction.</p> <p>The GIS has also been used to calculate the differences between the September 2022 and October 2023 topographic surveys to identify areas of net erosion and accretion (Appendix B – Map 5). The figure shows a distinct pattern of shoreline parallel bands of accretion on the upper and lower beach bisected by a shoreline parallel band of erosion across the middle beach. The magnitude change of is greatest across the upper beach experiencing accretion of up to +1.5m.</p>	<p>The difference plot at North Sands shows alternating bands of erosion and accretion running parallel to the shoreline associated with shifting sandbars. A pattern typical for this frontage.</p>

2.2 Middleton

Survey Date	Description of Changes Since Last Survey	Interpretation
<p>5th October 2023</p>	<p>Beach Profiles:</p> <p>Middleton is covered by one beach profile line (1cHC1) that is monitored on a bi-annual basis. (Appendix A). The survey report again notes that there was no access to the upper section of the profile. From the toe of the seawall, at chainage 48m, to chainage 150m the beach has consistently accreted by 0.3m in level. Seawards of chainage 150m, the beach profile steepens resulting in a drop in level of 0.45m by chainage 187m. Between chainage 73 and 144m the beach is at the highest level on record since the surveying began.</p>	<p>The change observed is typical of seasonal fluctuations of sediment movements, moving from lower extents of the beach to the upper extents in the calmer summer months (compared to drawdown in the winter caused by more destructive waves).</p> <p>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 is 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.</p>
<p>5th October 2023</p>	<p>Topographic Survey:</p> <p>The frontage is covered by an annual topographic survey between Middleton Jetty and North Pier. Data from the 2023 Full Measures survey have been used to create a DGM (Appendix B – Map 1) using GIS software. Beach contours indicate a steeper beach in the east than the west with a build of sediment occurring on the upper beach in the lee of the breakwater. The contours were noted previously to be locally distorted by pipelines and groynes, particularly on the lower foreshore. However, this is not visible in this inspection, possibly due to accretion in those locations.</p> <p>The GIS has also been used to calculate the differences between the September 2022 and October 2023 topographic surveys, as shown in Appendix B – Map 4, to identify areas of net erosion and accretion. The plot shows that the most significant changes have occurred in the eastern half of the bay where, in the lee of the Jetty, erosion of up to -1.0m has dominated. A similar sized band of accretion adjacent to this suggests the material has redistributed locally in this area. The western half of the beach has remained more stable with only local, low magnitude (up to -0.5m) swathes of erosion visible.</p>	<p>Middleton Bay has again remained largely stable. The change appears to be limited to the shifting of sands locally opposed to the cross shore movement of sands to and from the offshore zone.</p>

2.3 Hartlepool Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
12 th – 13 th October 2023	<p>Beach Profiles:</p> <p>Hartlepool Bay is covered by four beach profile lines during the Full Measures survey (Appendix A). The profiles were last surveyed in April 2023. The October 2023 survey report notes ‘<i>Heavy onshore winds restricted the depth of survey achievable at the South end of the job.</i>’</p> <p>Profile 1cHS1 is located approximately 150m south of the root of the South Pier. The profile starts at the wall to the rear of the promenade and extends across the promenade, over the fronting concrete splash wall and down the sloping face of the rock armour revetment before reaching the beach. No significant change has occurred until 40m chainage, which is the toe of the sea defences, since 2014. At the toe of the rock armour, the beach has increased by 0.35m in level, gradually tapering to no change by chainage 100m. Seawards of this point, the beach continues its steeper gradient resulting in a drop in level of 0.1m at chainage 109m. The beach is at a high level when compared to the range of the previous surveys.</p> <p>At profile 1cHS2, the first 26m are covered by rock revetment and have experienced no change. At the toe of the structure beach levels have accreted by 0.25m in level. This accretion is consistent across the beach except for a 20m length between chainages 200m and 220m where the beach has experienced no change. Compared to the range of the previous surveys, the beach is at a medium level.</p> <p>Profile 1cHS3 shows no changes over the defended part of the profile up to chainage 28m. From the toe of the revetment, beach levels have accreted by up to 0.9m, tapering to no change by chainage 76m. Seawards of chainage 76m, the change alternates between erosion and accretion due to the formation of shallow berm across the beach. The magnitude of change is limited to ± 0.4m. The profile remains within the range envelope of the previous surveys.</p> <p>The profile 1cHS4 is located further south, around 1km north of the North Gare breakwater in an area of undefended dunes at Seaton Sands. The survey report again noted that dense thorn bushes restricted the start of the section. The profile covers approximately 325m of dunes before the beach. The dune section has generally remained stable since the previous survey with change limited to ± 0.1m. From the toe of the foredune at chainage 349m, to chainage 395m, the beach has accreted by up to 0.8m in level.</p>	<p>The Hartlepool Bay frontage is split into two smaller bays by a slight promontory at Carr House Sands between Hartlepool and Seaton Carew, the pattern of change across the two bays appears to have varied.</p> <p>The northern bay has been dominated by accretion since the previous surveys, with both profiles experiencing an increase in level (albeit at a low magnitude) across the whole profile indicating a period of recovery.</p> <p>The pattern of change across the southern profiles is more varied due to the shifting of berms across the profile, this has resulted in alternating lengths of accretion and erosion.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>This is proceeded by erosion up to 0.3m in magnitude up to chainage 475m. Seawards of 475m, the beach has accreted by up to 0.4m in level. This profile is at the lowest level on record between chainages 395m to 430m but generally at a high level elsewhere, such is the variation of change across the profile.</p> <p>Topographic Survey:</p> <p>Hartlepool Bay is covered by an annual topographic survey between the South Pier and the North Gare Breakwater. Data from the 2023 Full Measures survey have been used to create a DGM (Appendix B – Map 2 & Map 3) using a GIS software package.</p> <p>The plot shows the two smaller bays within the larger Hartlepool Bay frontage. These smaller bays are separated by a slight promontory at Carr House Sands between Hartlepool and Seaton Carew. The beach contours are generally shore parallel, except where linear features (e.g., outfalls) and rock outcrops are present, such as in the northern part of Seaton Sands. Elevations at the rear of the beach are lowest in the north of the survey area near South Pier and higher further south at North Gare resulting much steeper upper beach,</p> <p>The GIS has also been used to calculate the differences between the October 2022 and October 2023 topographic surveys to identify areas of erosion and accretion, shown in Appendix B – Map 8 & Map 9. The plot show that the north of the bay has been dominated by shoreline parallel bands of accretion of up to 0.5m. The bands of accretion are interspersed with areas of no change. Along Seaton Sands, the change is more varied. The beach fronting Seaton Carew Golf Club is generally dominated by accretion, with the most intense change (up to +1.0m) occurring on the upper beach. At the start of defended section, fronting the Seaview car park, the beach has experienced little change. This then progresses into an area up to the slight promontory that has been dominated erosion. The most intense of which has occurred at the squeeze point with Little Scar rocks (-1.0m)</p>	

2.4 North Gare

Survey Date	Description of Changes Since Last Survey	Interpretation
<p style="text-align: center;">16th October 2023</p>	<p>Topographic Survey:</p> <p>North Gare is covered by an annual topographic survey between the North Gare Breakwater and the Seaton on Tees Channel. The area is designated as the Teesmouth National Nature Reserve. Surveys have been carried out since Autumn 2011.</p> <p>Data from the 2023 Full Measures survey have been used to create a DGM (Appendix B – Map 3) using GIS software. This DGM has then been compared against the October 2022 DGM (Appendix B – Map 8) to identify areas of net erosion and accretion.</p> <p>As was highlighted in the 2022, on the south aspect of the North Gare breakwater there has been a progressive redistribution of cobble berm from the tip of the North Gare towards the root. This redistribution reached a point in 2022 where the corner of the of beach, in the lee of the breakwater, was cut off from the rest of the bay. In October 2023, the centre of the cobble berm has shifted landward with a break now observed. The survey report notes that ‘revetment rocks at (the) North end have been moved to allow access to the cut off area of beach”, it is unclear whether the surveyors have created this break to allow access or whether they move rocks more locally. The change behind the berm, in the cut off beach, is varied with patches of erosion and accretion observed albeit at a low magnitude. It is thought that if the berm remains that sediment will continue to build behind it and eventually dunes will begin to develop.</p> <p>The pattern of change across North Gare Sands is also varied but appears to balance suggesting a degree of stability. A large swathe of erosion up to +0.75m in magnitude dominates the centre of the bay, with smaller areas of erosion and accretion observed elsewhere. The change is generally in shoreline parallel bands with the exception of the beach in the lee of the breakwater (fronting the cobble berm). The flat area to the rear of the beach has experienced negligible change.</p> <p>The area of most significant change has occurred on the south beach on the banks of the river teas where erosion up to 2m is observed. It is unclear whether this is true change or whether it is distortion due to being of the edge of the survey extents.</p>	<p>The cobble berm continues to be redistributed from the tip of North Gare to the root. A break in the berm in the centre has led to varied change in the cut off beach behind. Change across North Gare Sands is modest, with areas of accretion and erosion generally appears to balance.</p>

3. Problems Encountered and Uncertainty in Analysis

Beach profile HN1 is located within Durham County Council's area of responsibility but has been reported here so changes can be interpreted in association with those observed elsewhere along North Sands, along HN2, HN3 and HN4.

At Middleton, there was no access to the upper section of profile 1cHC1.

At Hartlepool Bay, dense thorn bushes restricted the start of profile 1cHS4 and heavy onshore winds restricted the depth of survey achievable at the southern end.

At North Gare, ground levels within the salt marsh area at the southeast corner were taken on foot to avoid disturbing wildlife. The survey report also notes that the revetment rocks at North end have been moved to allow access to the cut off area of beach. It is unclear if the surveyors moved the rocks or if another party required access previously.

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

No further 'fine-tuning' is recommended at the present time.

5. Conclusions and Areas of Concern

- North Sands appears to have been dominated by accretion since the previous survey. All five profiles show the formation of two berms (one against the toe of dunes and one on the lower beach) suggesting a period of beach recovery. The profiles generally remain within envelope of the previous surveys.
- At The Headland change has been limited. Overall, it appears the limited material present has been transported landward, with both profiles (1cHN4 and 1cHN4A) locally recording the highest beach level up against the toe of the structure before steeply dropping back to normal levels. The exposed rocky foreshore still dominates both profiles.
- At Middleton, the change observed is typical of seasonal fluctuations of sediment movements, moving from lower extents of the beach to the upper extents in the calmer summer months (compared to drawdown in the winter caused by more destructive waves).
- The Hartlepool Bay frontage is split into two smaller bays by a slight promontory at Carr House Sands between Hartlepool and Seaton Carew, the pattern of change across the two bays appears to have varied. The northern bay has been dominated by accretion since the previous surveys, with both profiles experiencing an increase in level (albeit at a low magnitude) across the whole profile indicating a period of recovery. The pattern of change across the southern profiles is more varied due to the shifting of berms across the profile, this has resulted in alternating lengths of accretion and erosion.
- Change across North Gare Sands is modest, with areas of accretion and erosion generally appearing to balance. The cobble berm continues to be redistributed from the tip of North Gare to the root. A break in the berm in the centre has led to varied change in the cut off beach behind.

Appendices

Appendix A
Beach Profiles

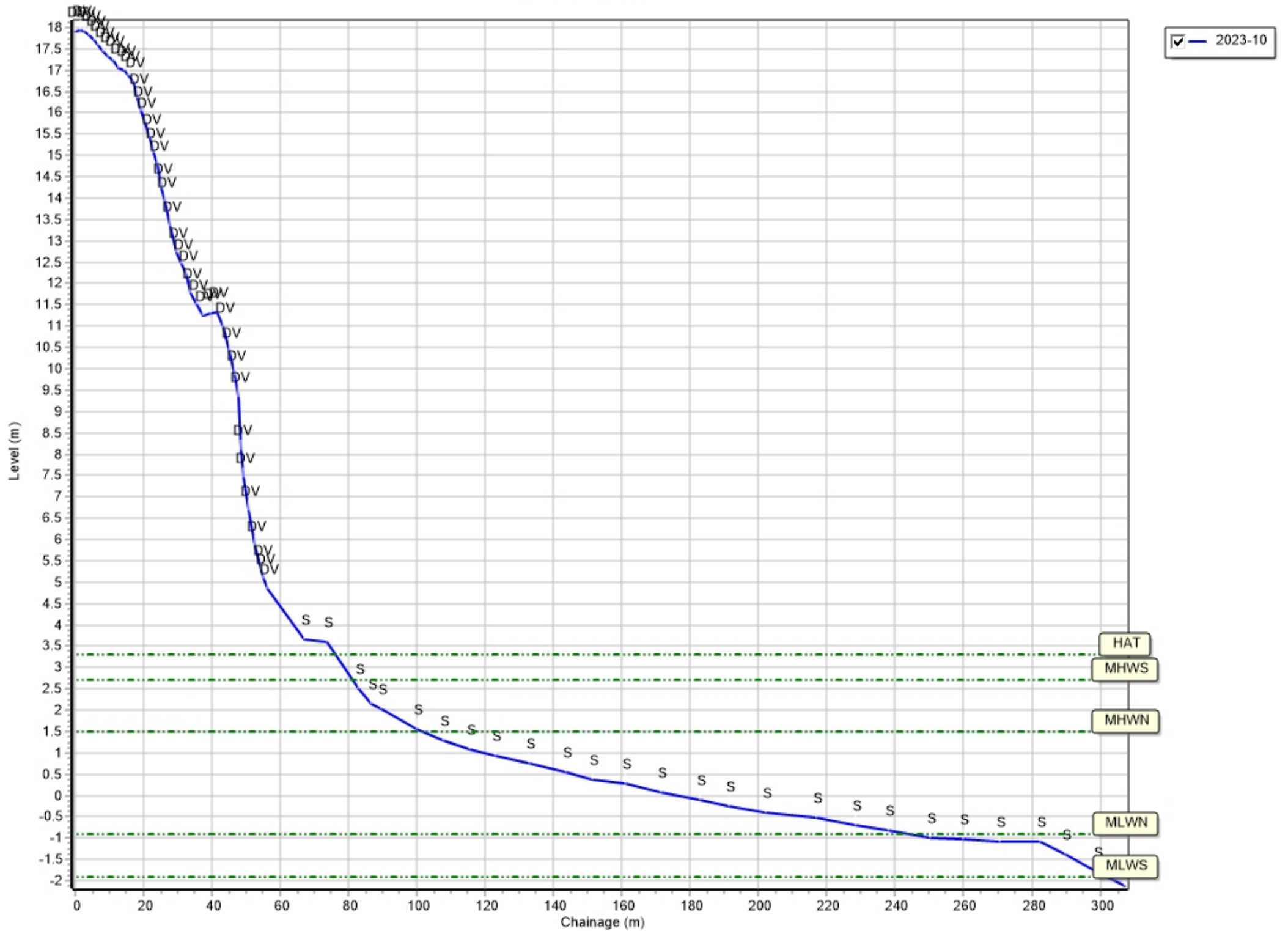
The following sediment feature codes are used on some profile plots:

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

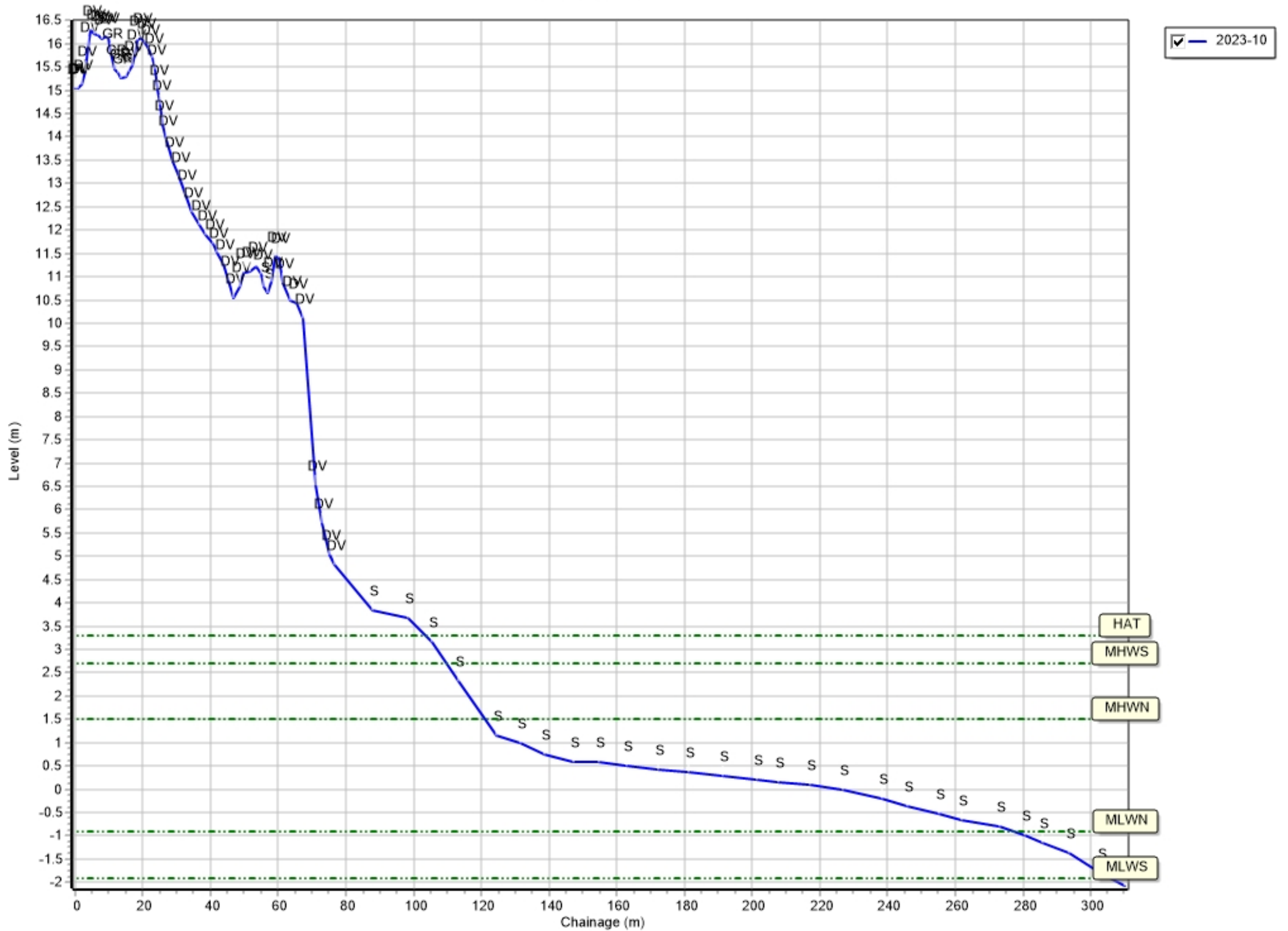
Profiles: 1cHN1



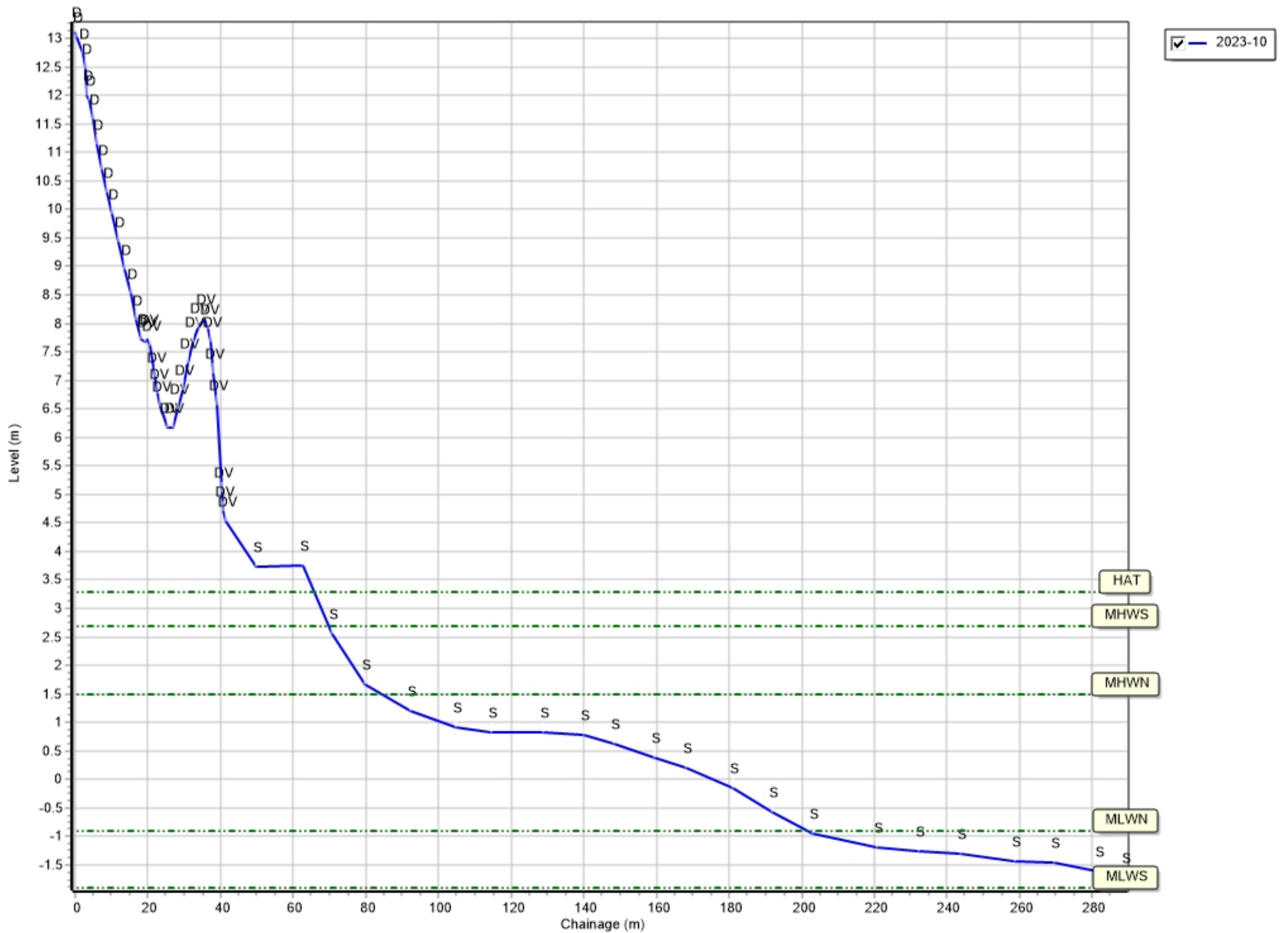
Profiles: 1cHN2



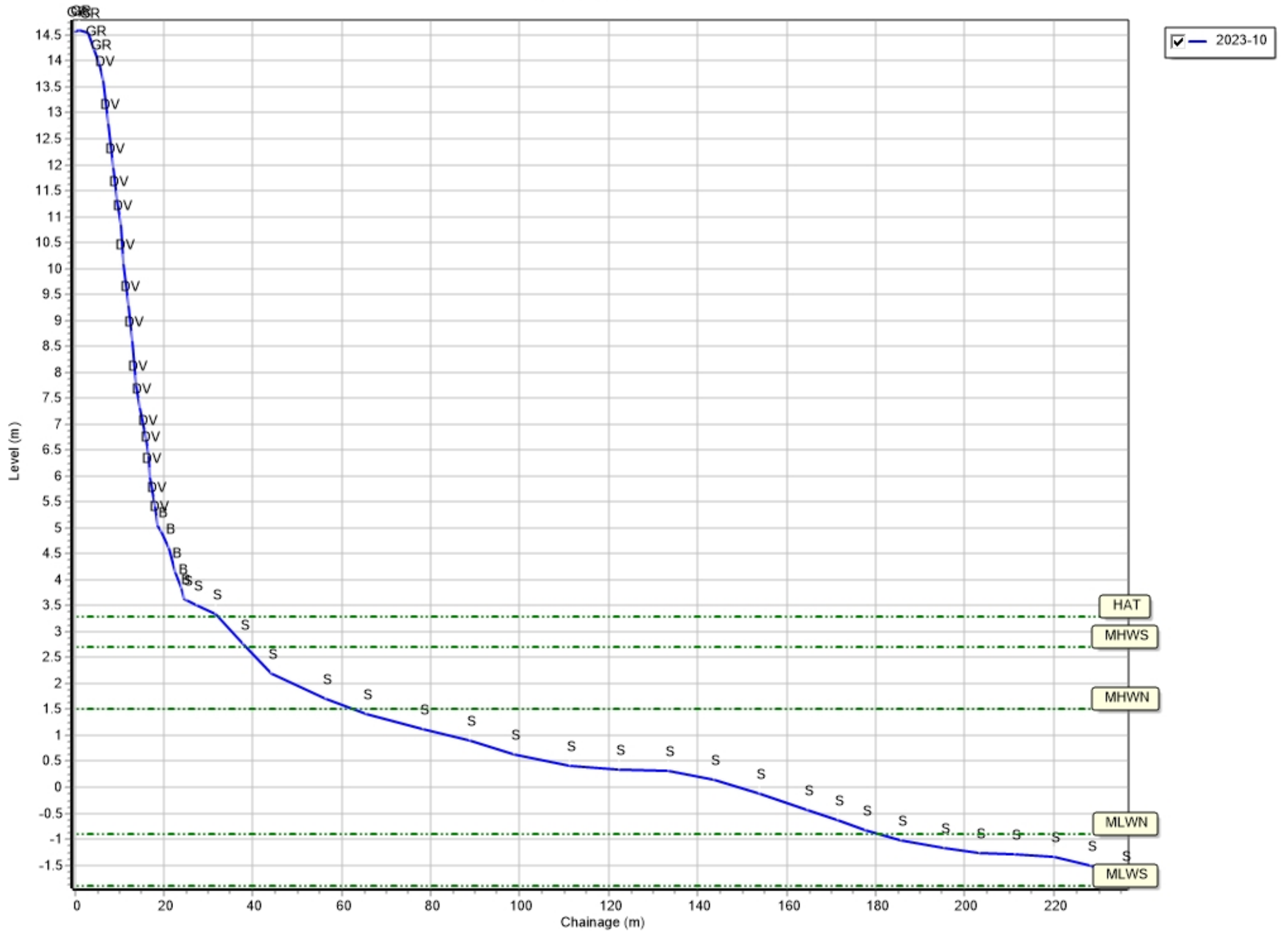
Profiles: 1cHN2A



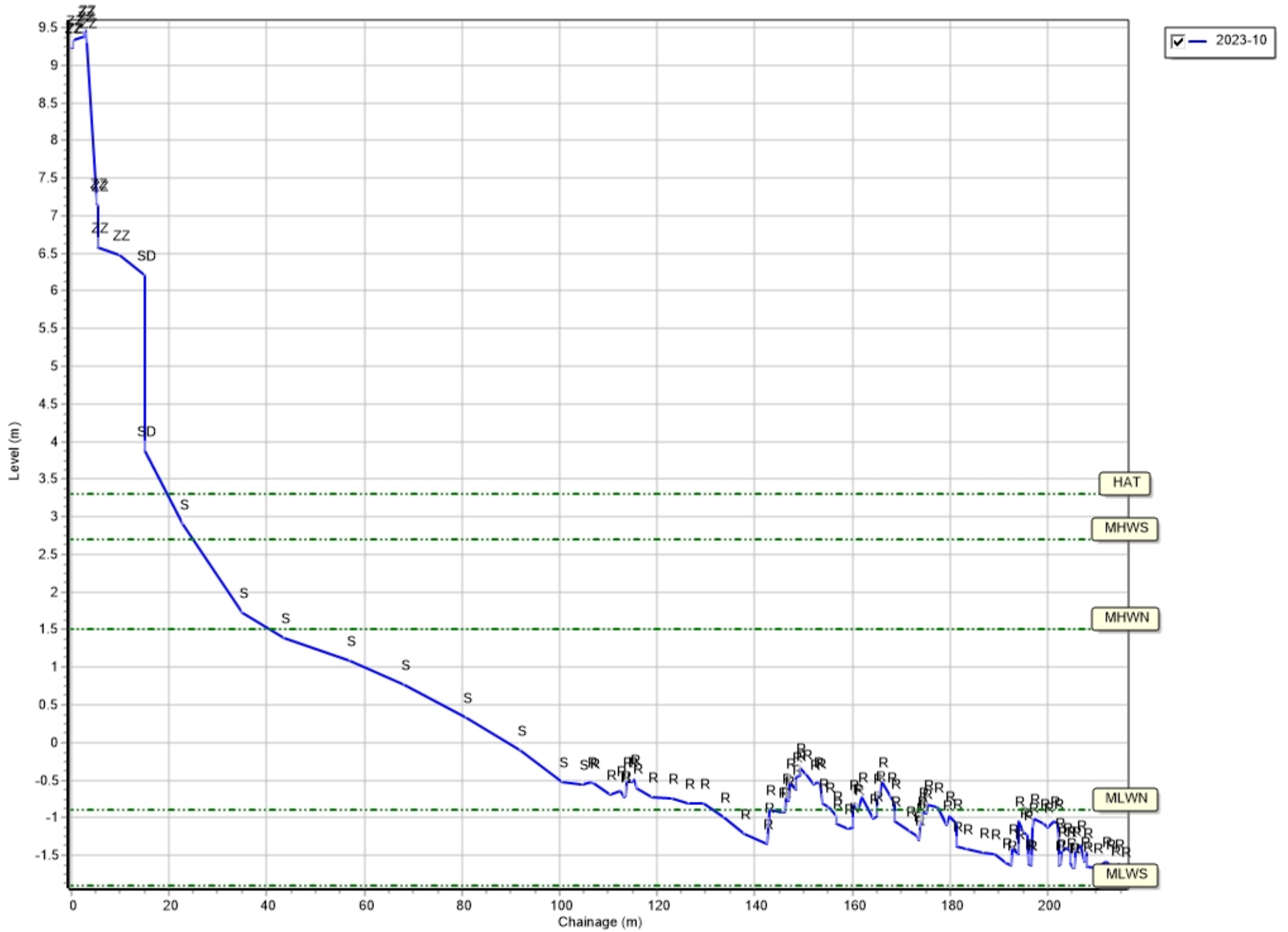
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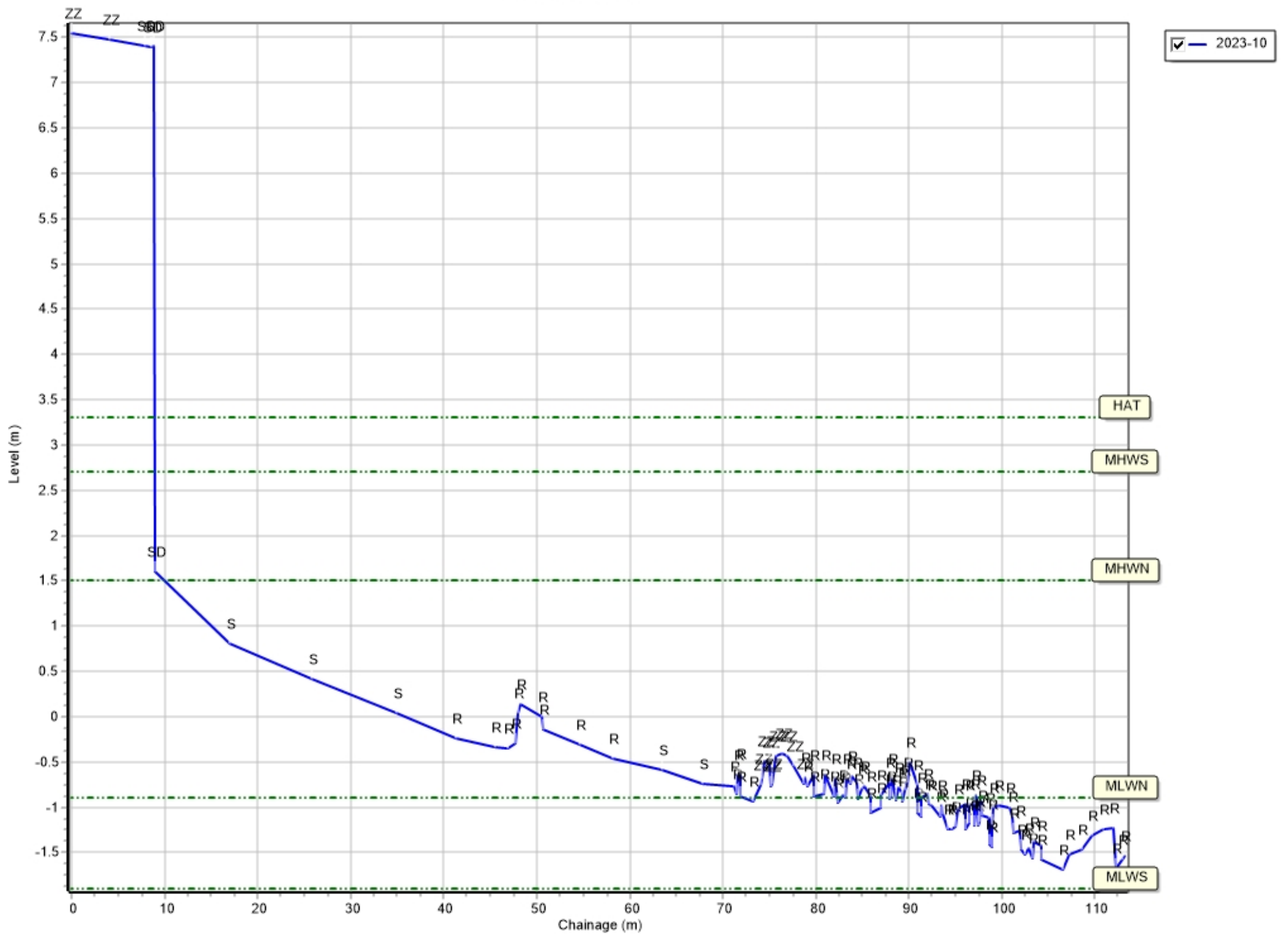
Profiles: 1cHN3A



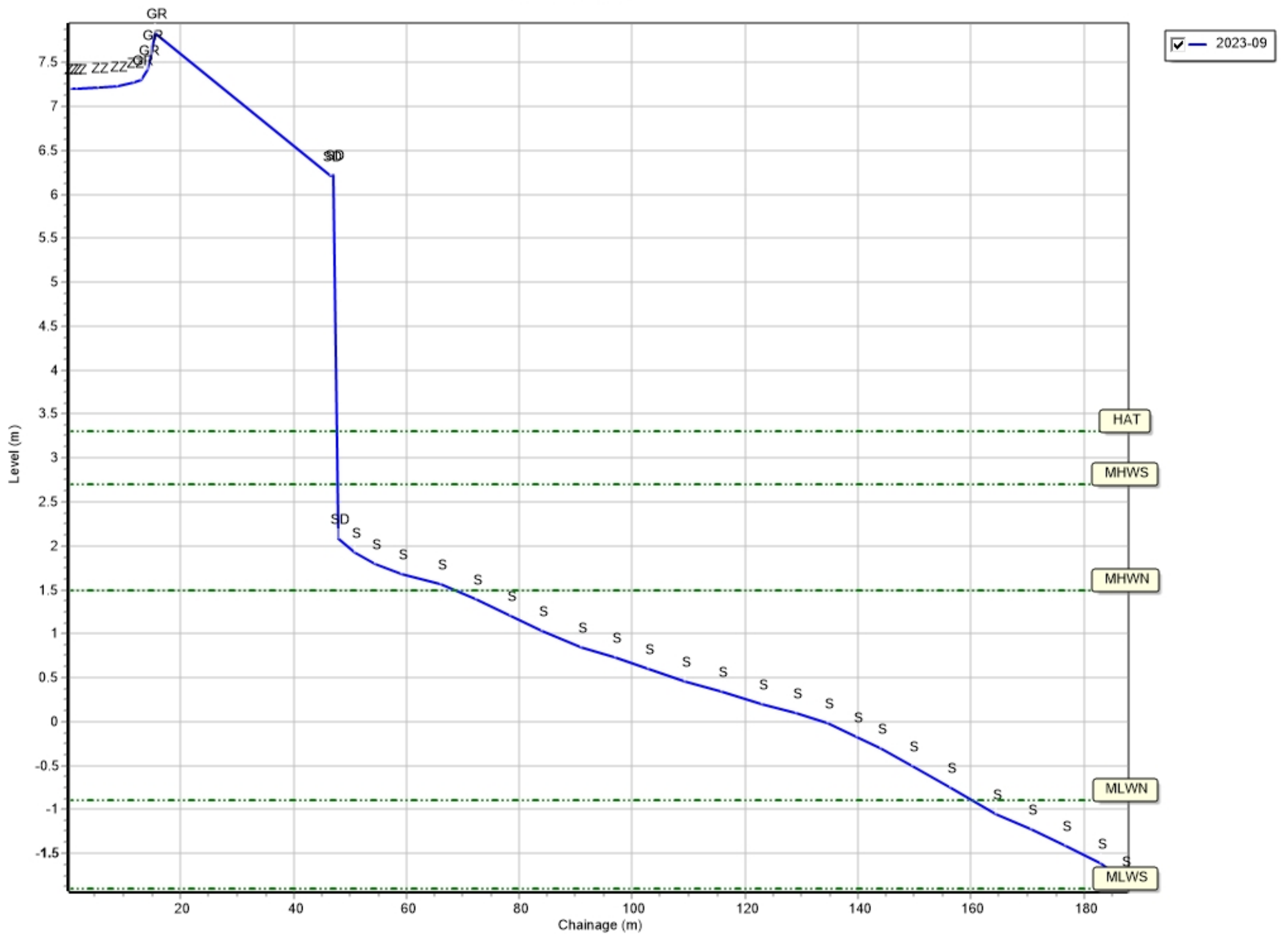
Profiles: 1cHN4



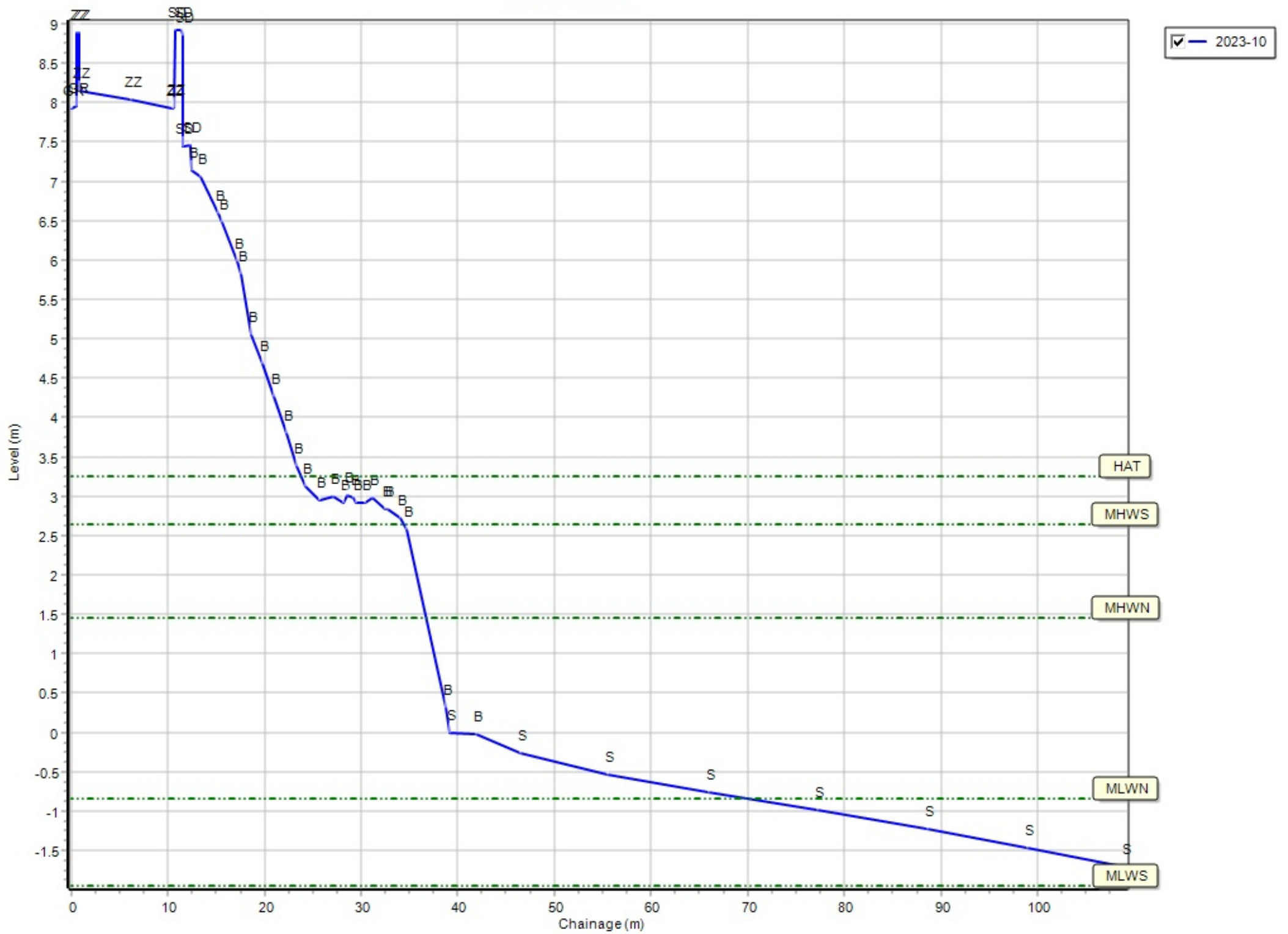
Profiles: 1cHN4A



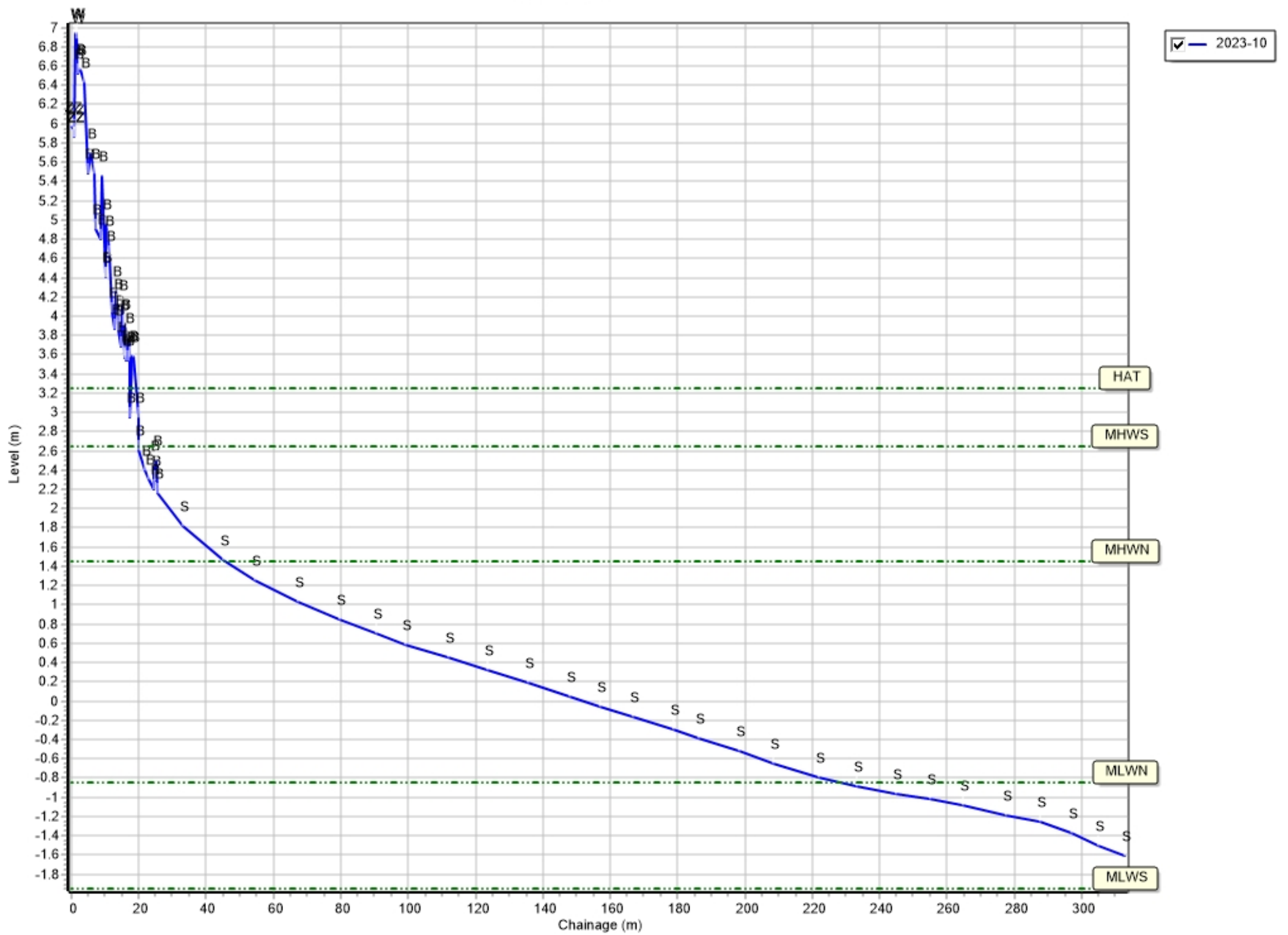
Profiles: 1cHC1



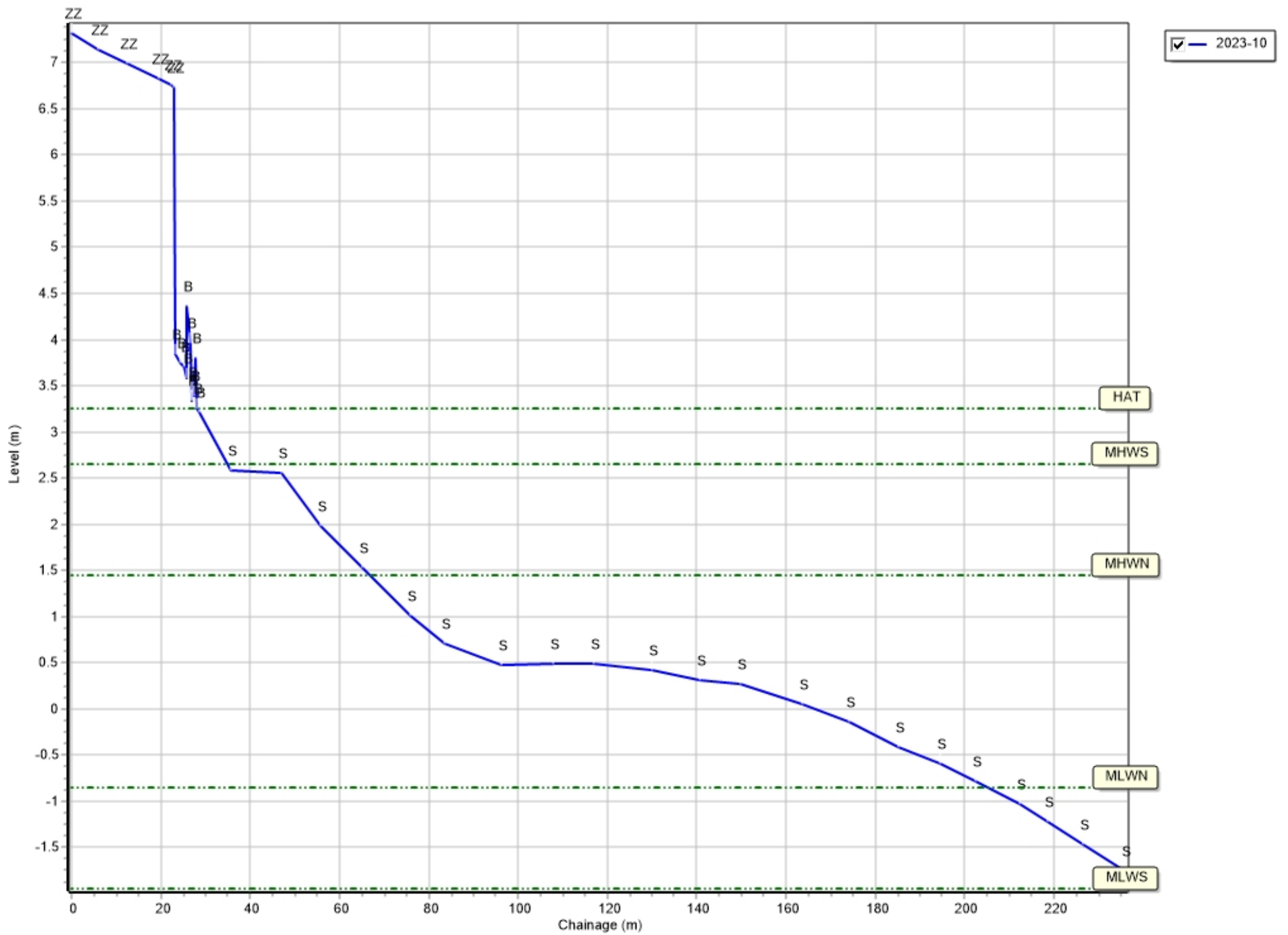
Profiles: 1cHS1



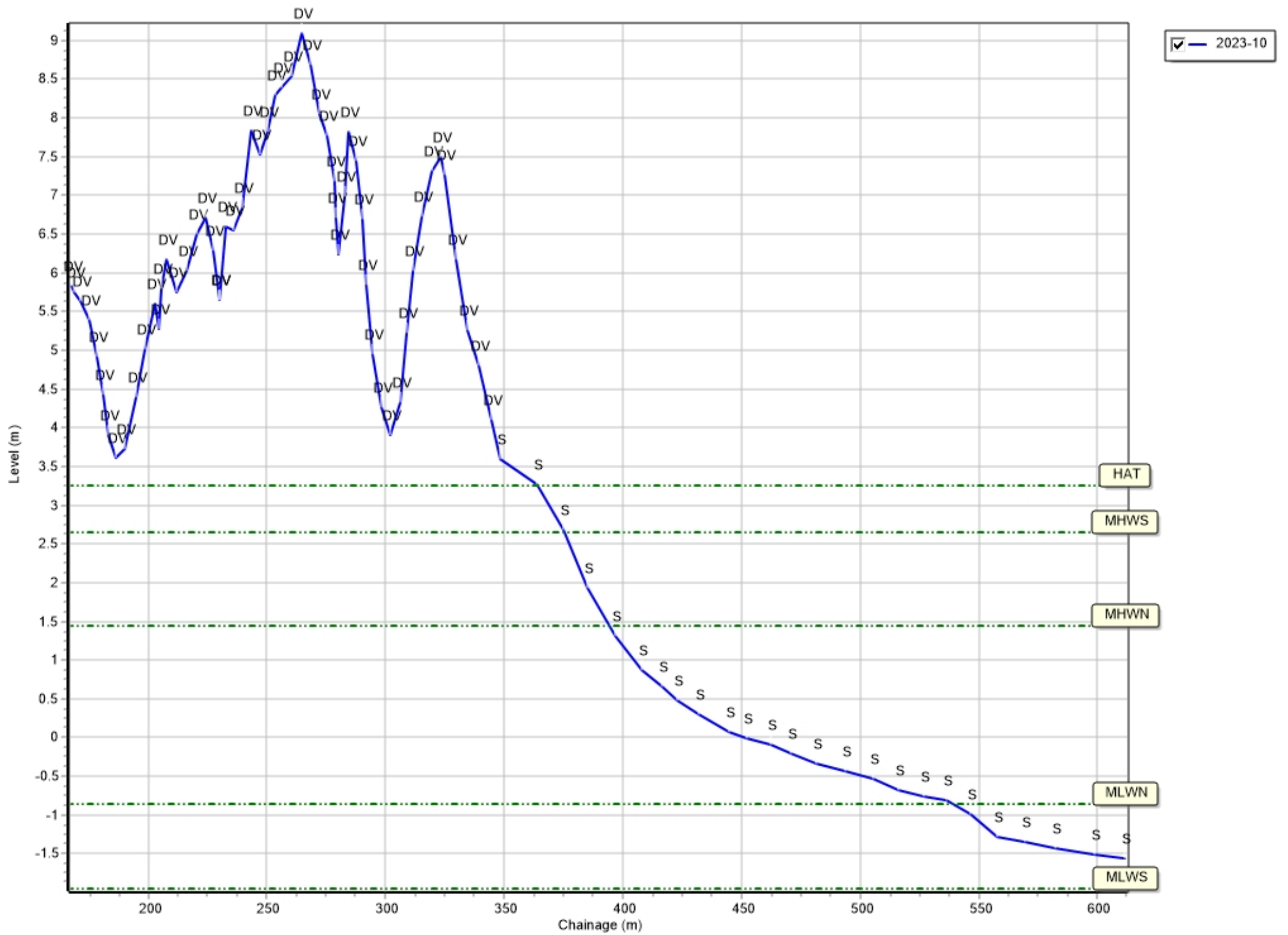
Profiles: 1cHS2



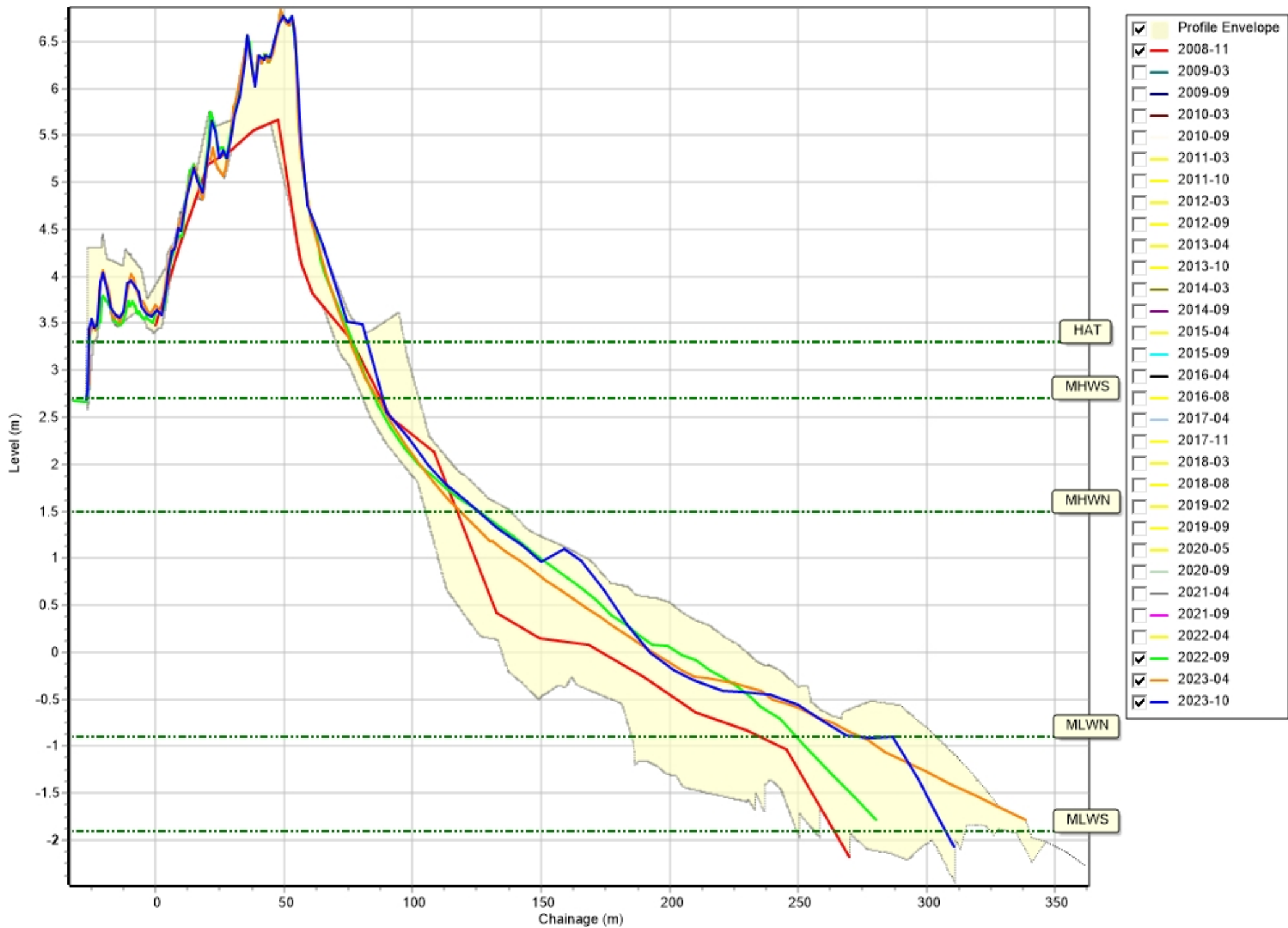
Profiles: 1cHS3



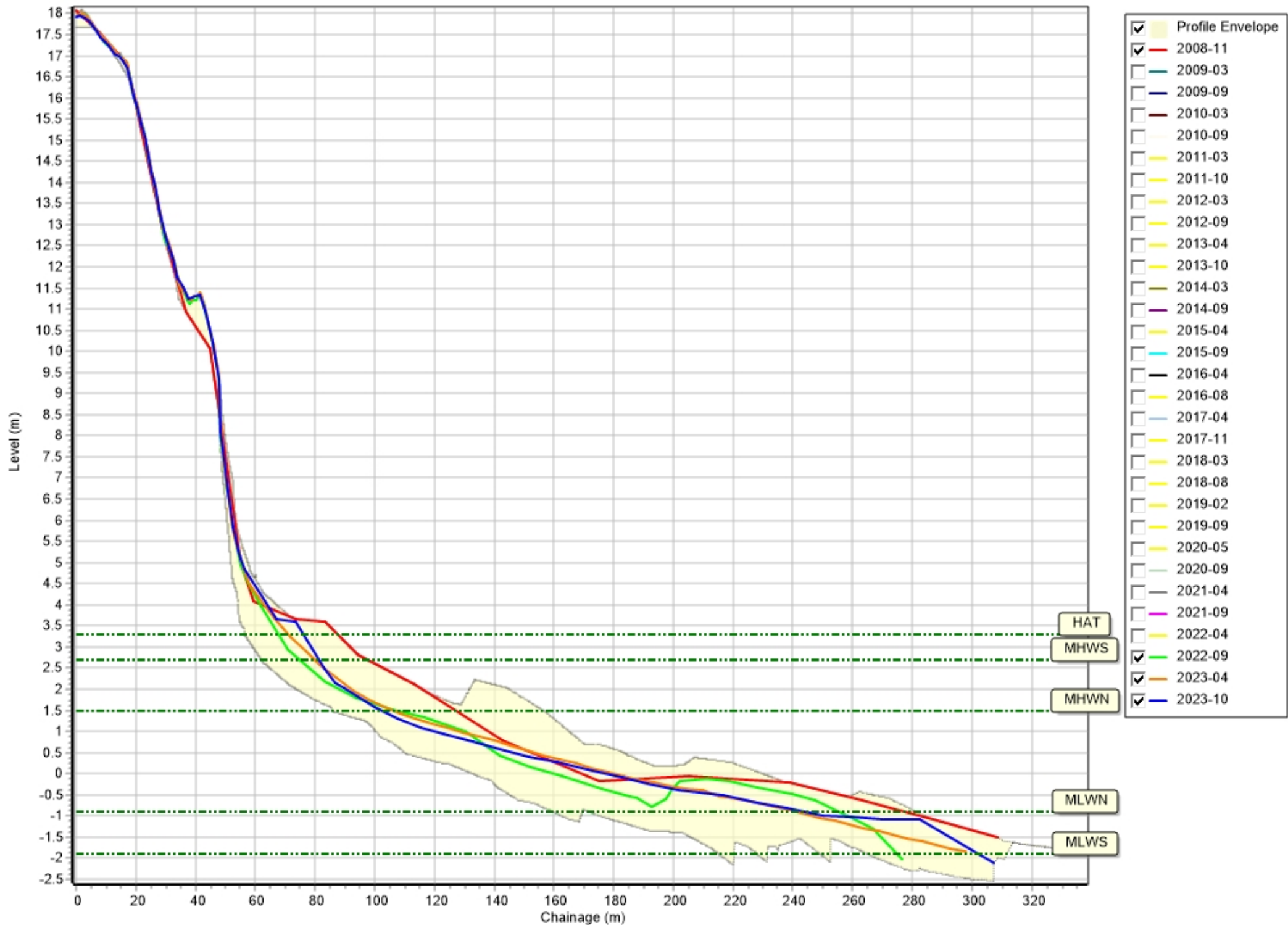
Profiles: 1cHS4



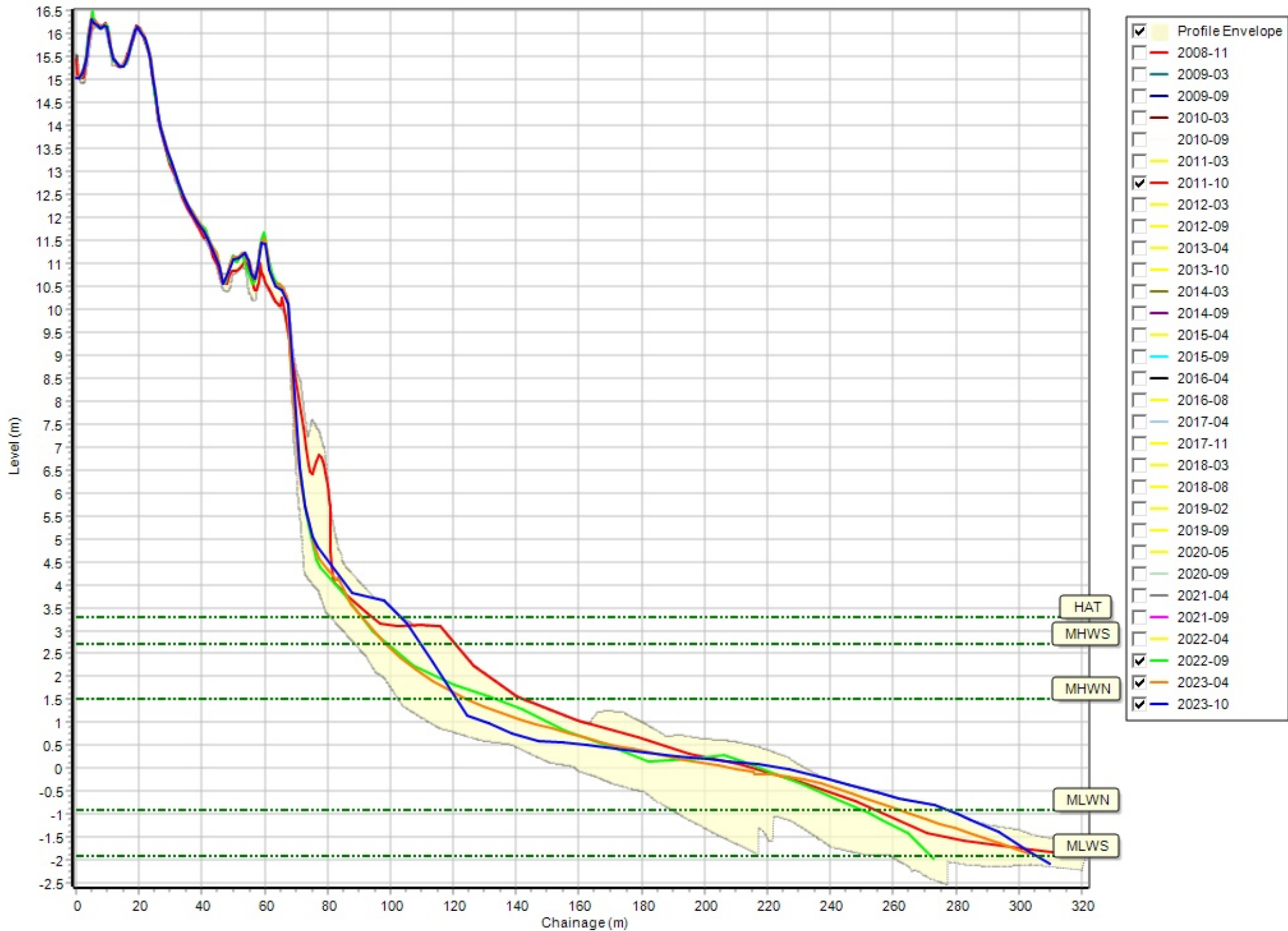
Profiles: 1cHN1



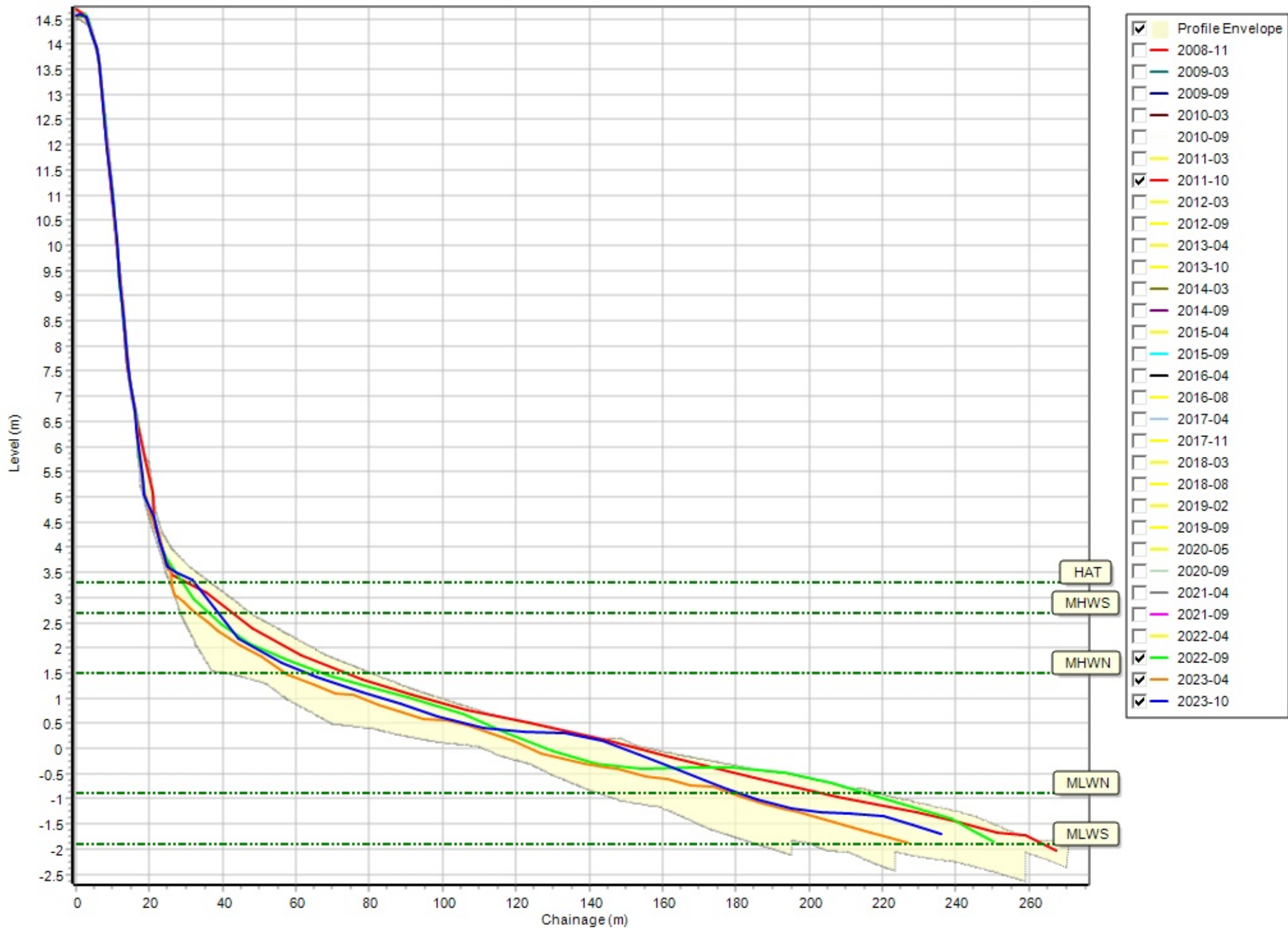
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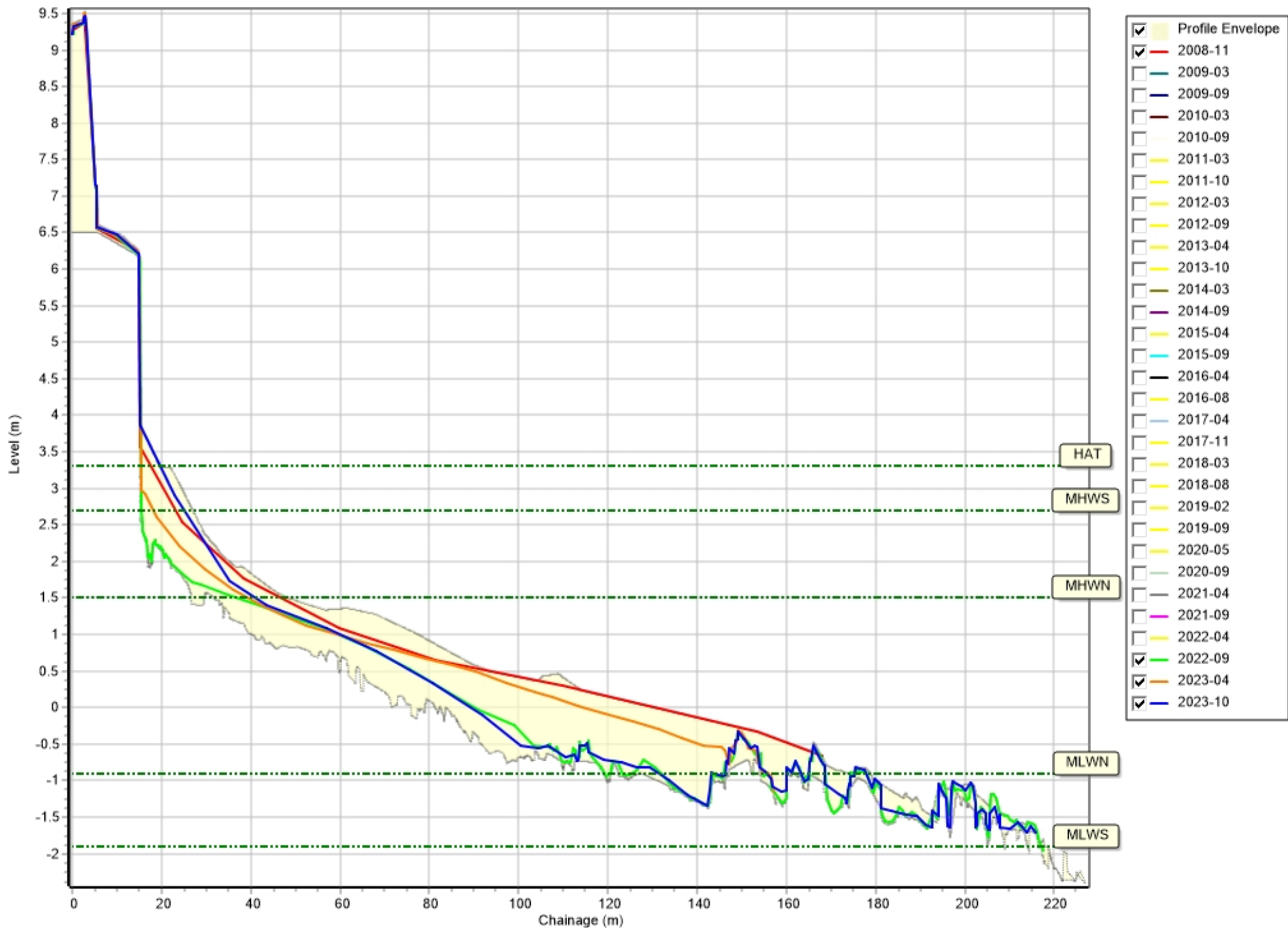
Profiles: 1cHN2A



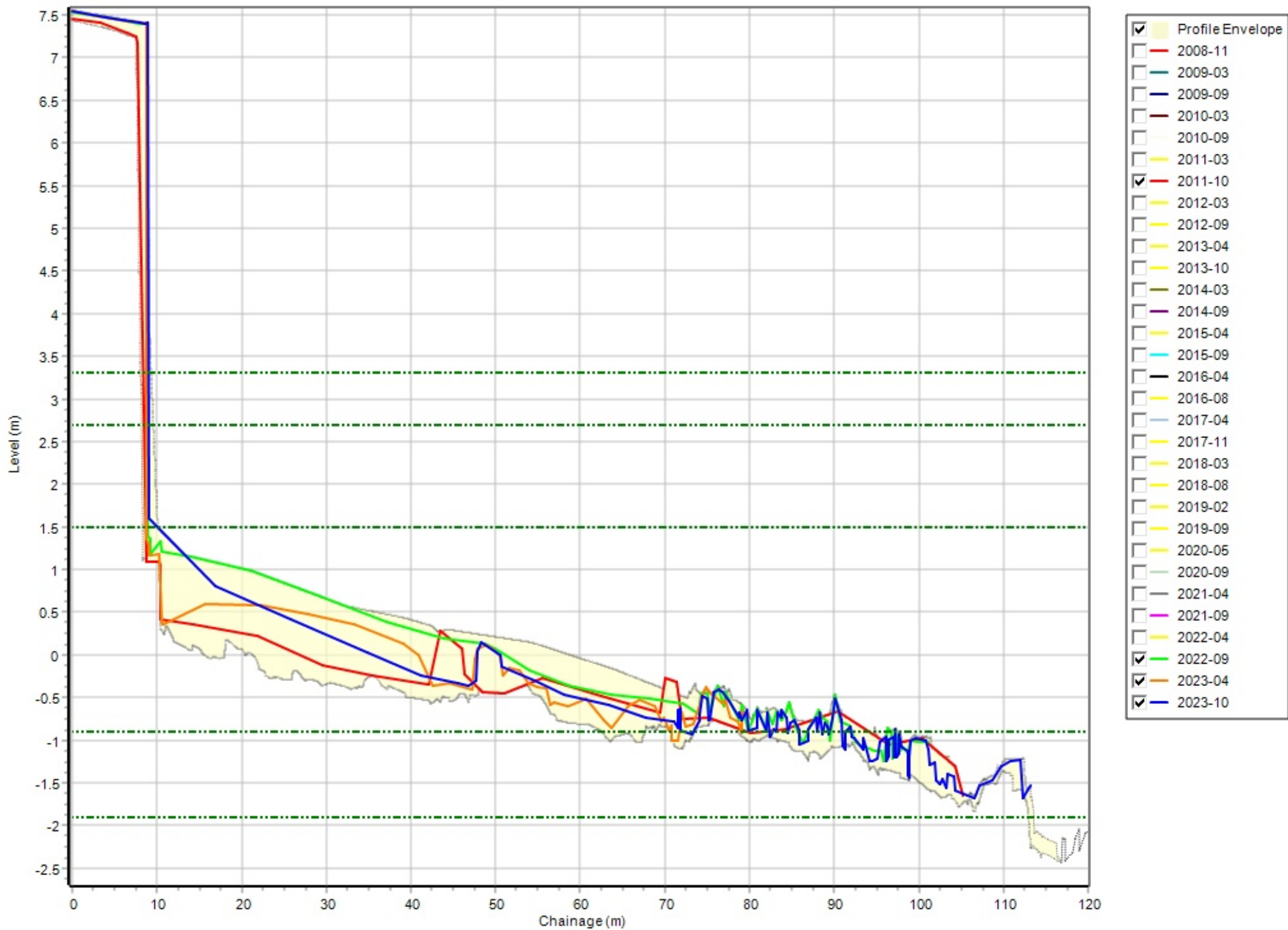
Profiles: 1cHN3A



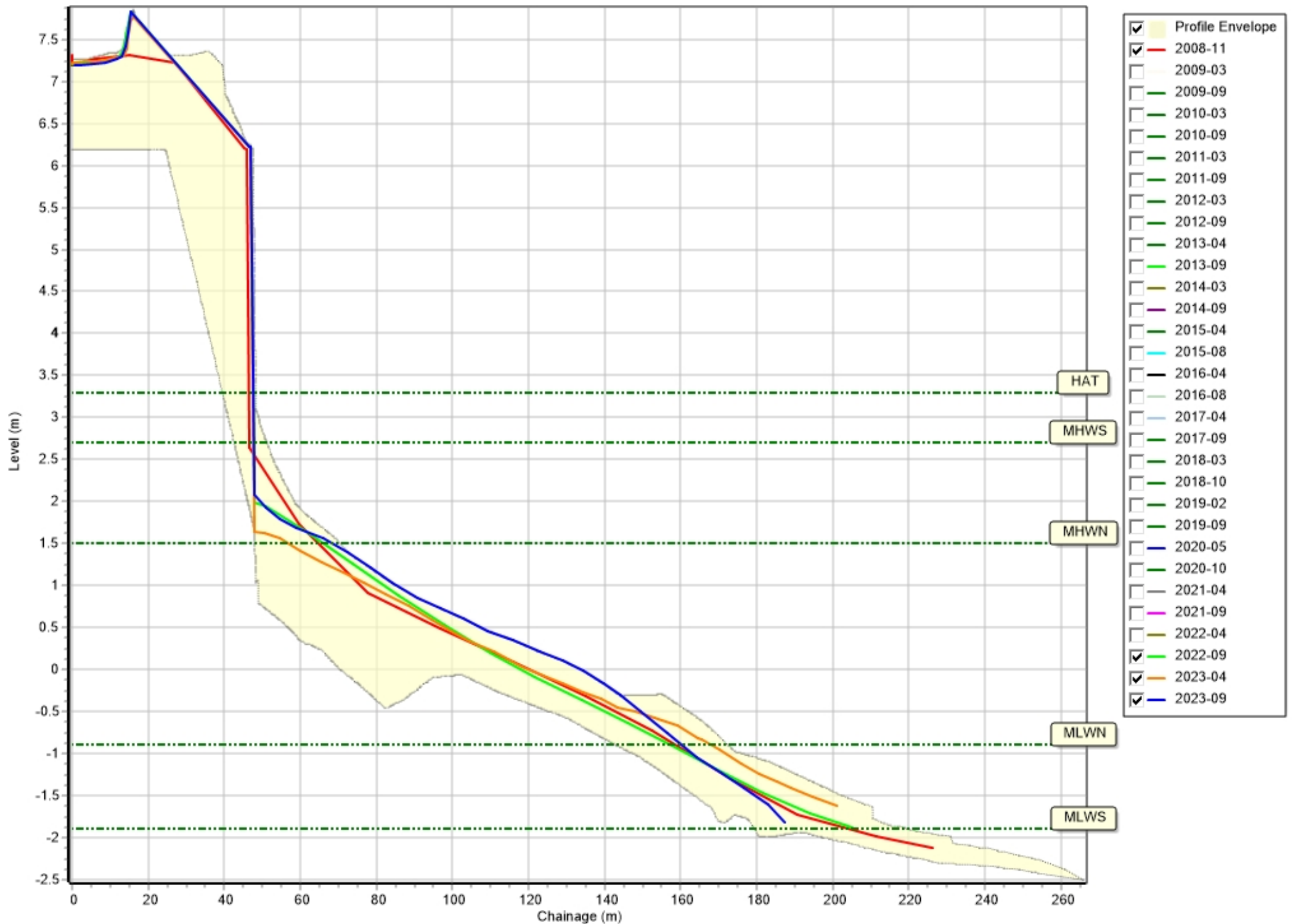
Profiles: 1cHN4



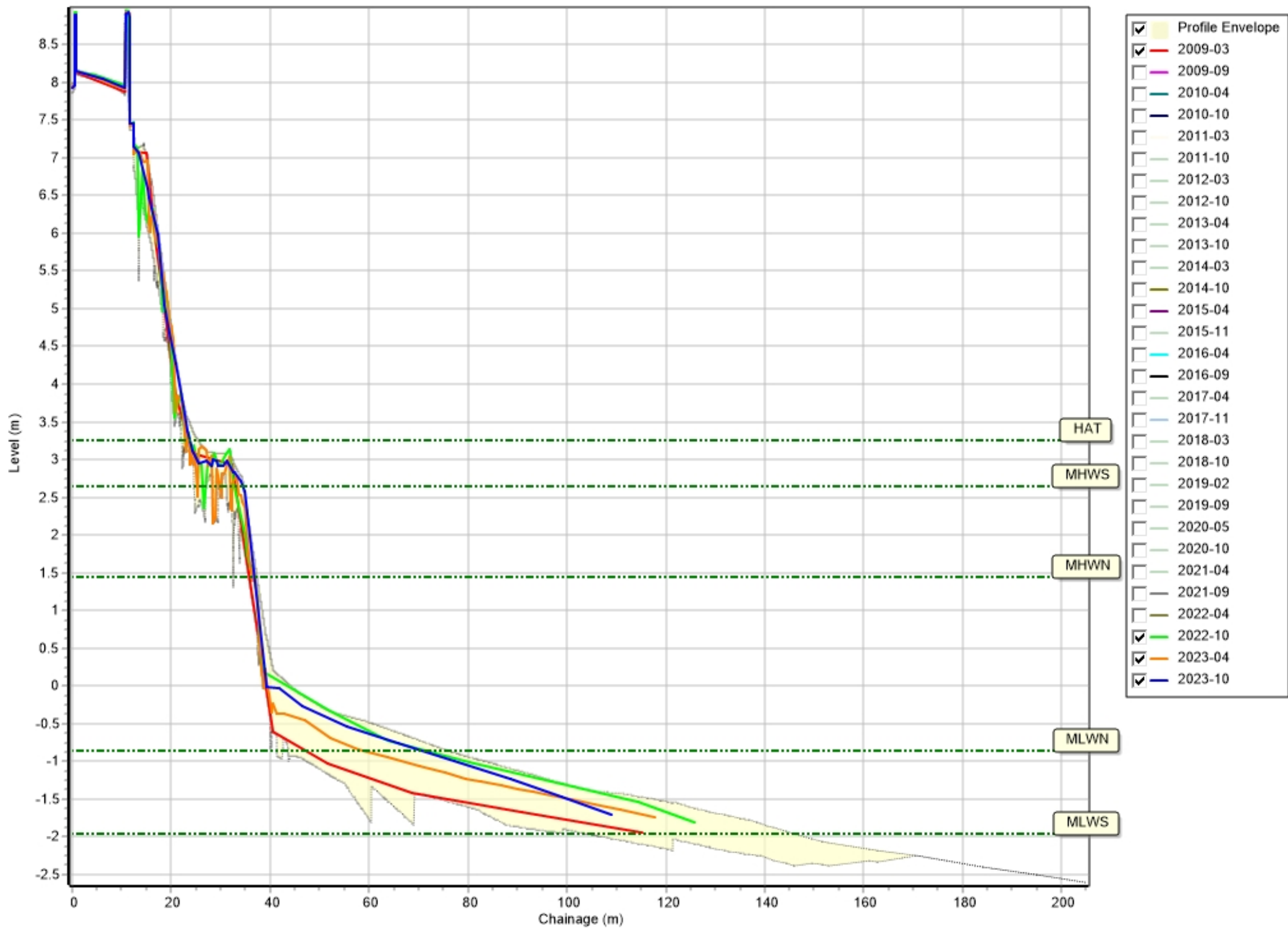
Profiles: 1cHN4A



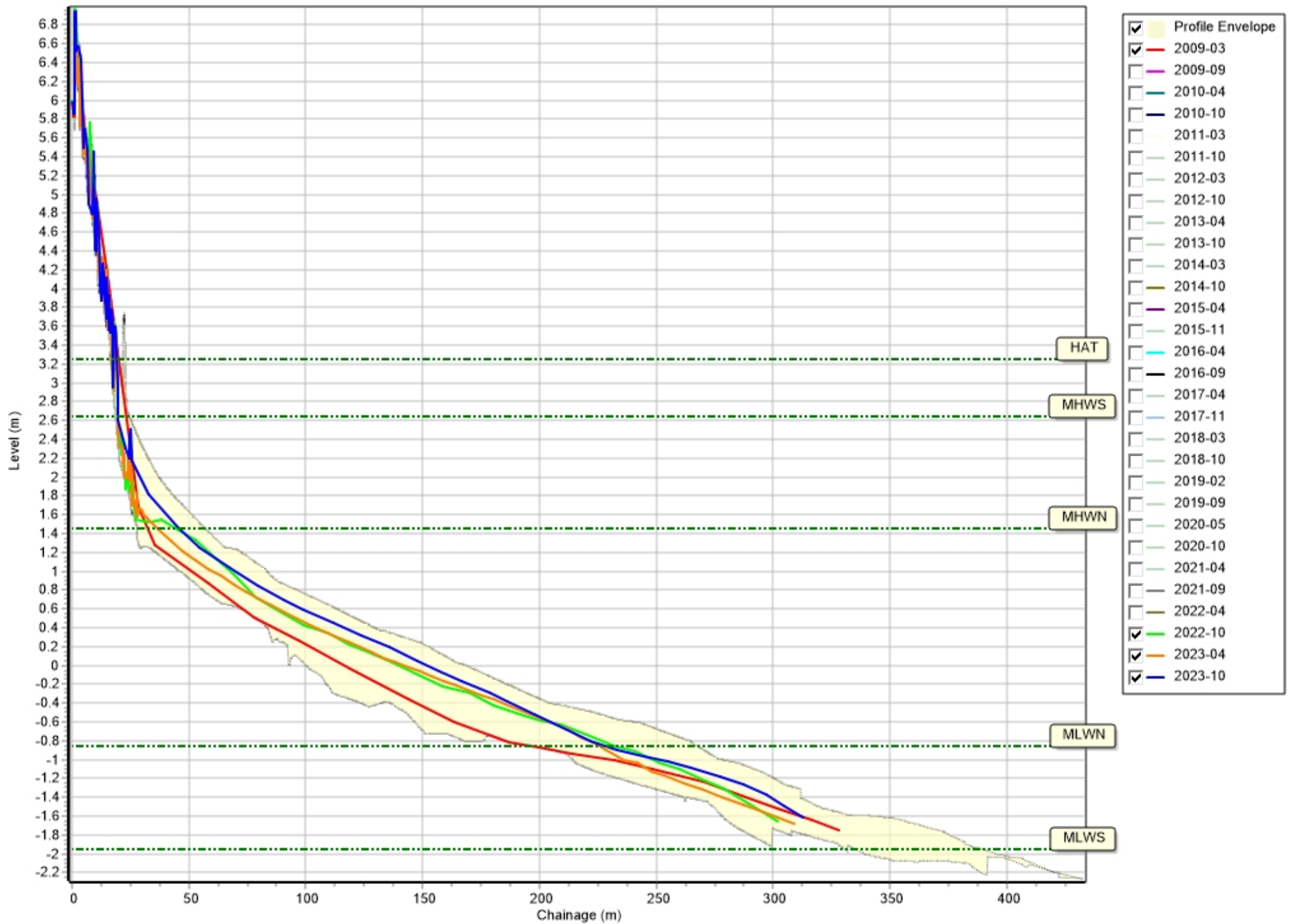
Profiles: 1cHC1



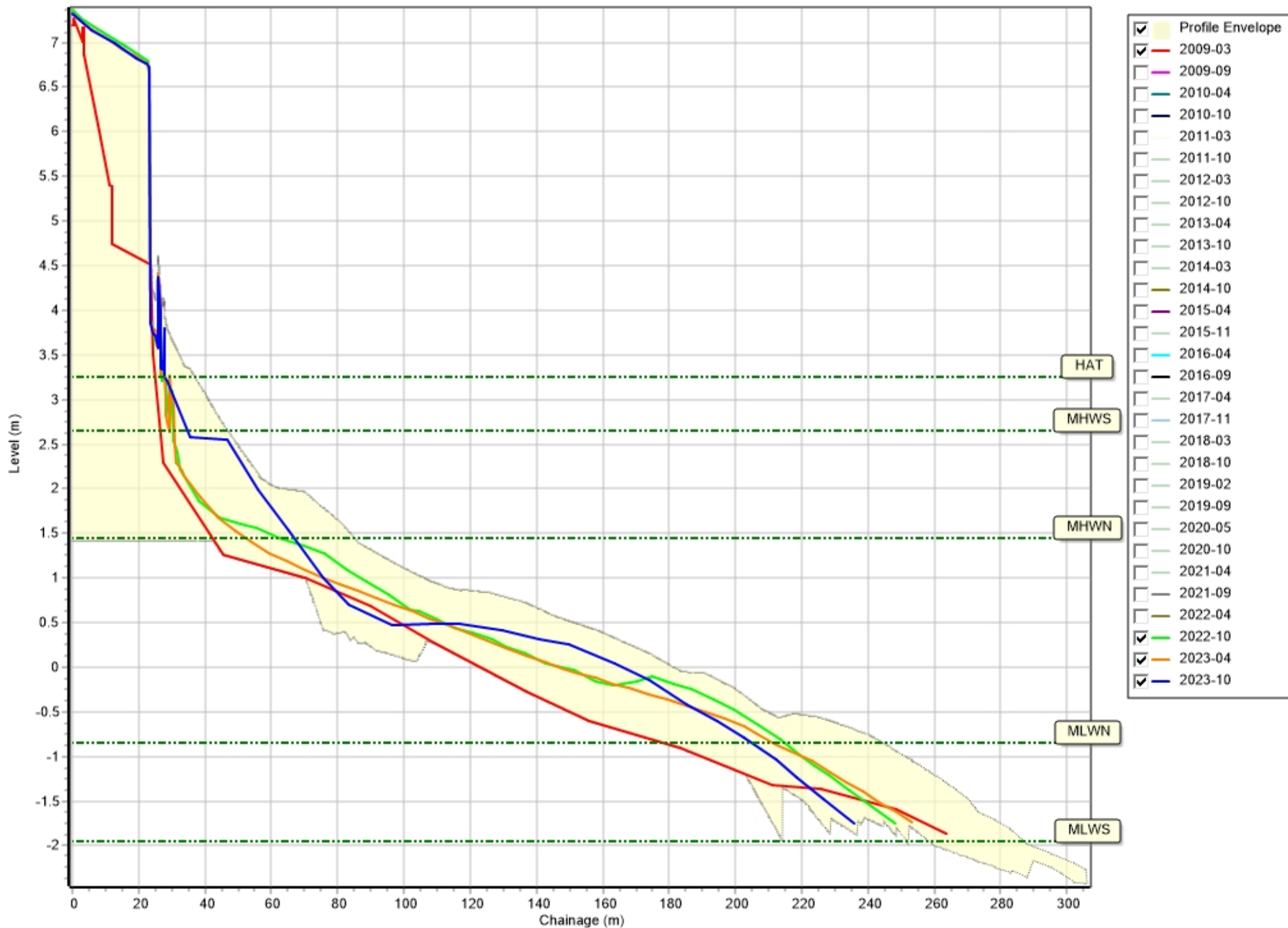
Profiles: 1cHS1



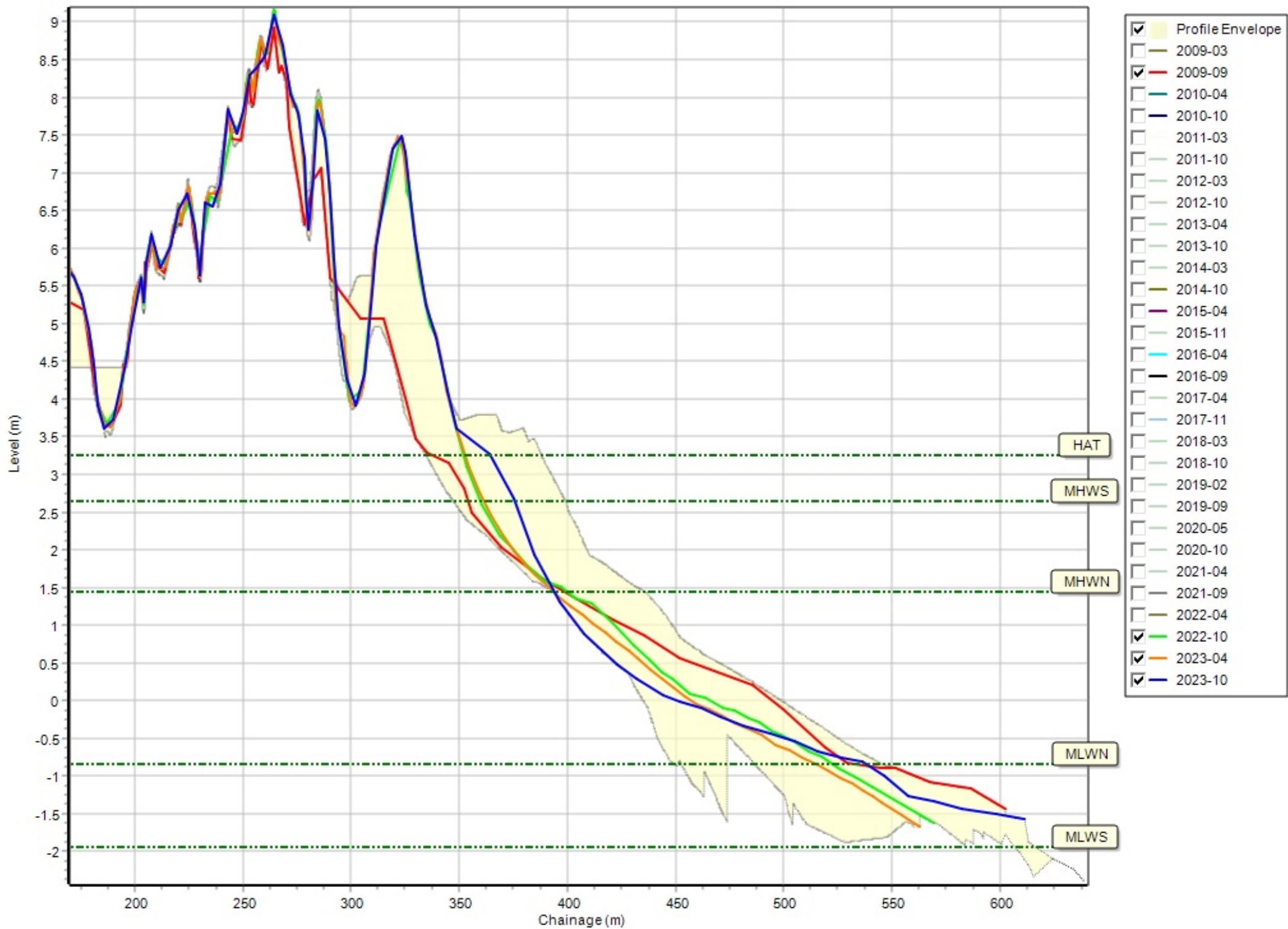
Profiles: 1cHS2



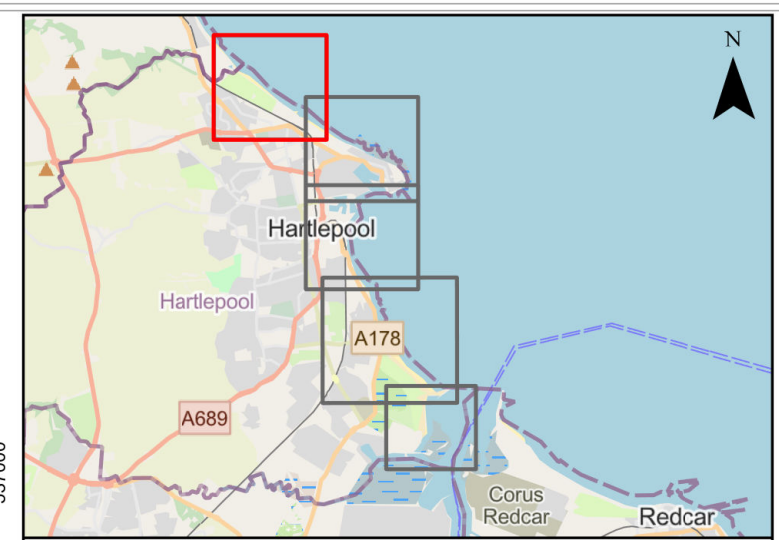
Profiles: 1cHS3



Profiles: 1cHS4



Appendix B
Topographic Survey



TOPOGRAPHIC SURVEY (October 2023)

Elevation (mOD)	Contours (mOD)*
-2.1 -- -2	— 1.0m interval
-1.9 -- -1.5	— 0.25m interval
-1.4 -- -1	
-0.9 -- -0.5	
-0.4 - 0	
0.1 - 0.5	
0.6 - 1	
1.1 - 1.5	
1.6 - 2	
2.1 - 2.5	
2.6 - 3	
3.1 - 3.5	
3.6 - 4	
4.1 - 4.5	
4.6 - 5	
5.1 - 5.5	
5.6 - 6	
6.1 - 6.5	

* Contours only cover sandy beach areas.

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

Title:

Appendix B - Map 1

NORTH SANDS

Hartlepool Borough Council Frontage

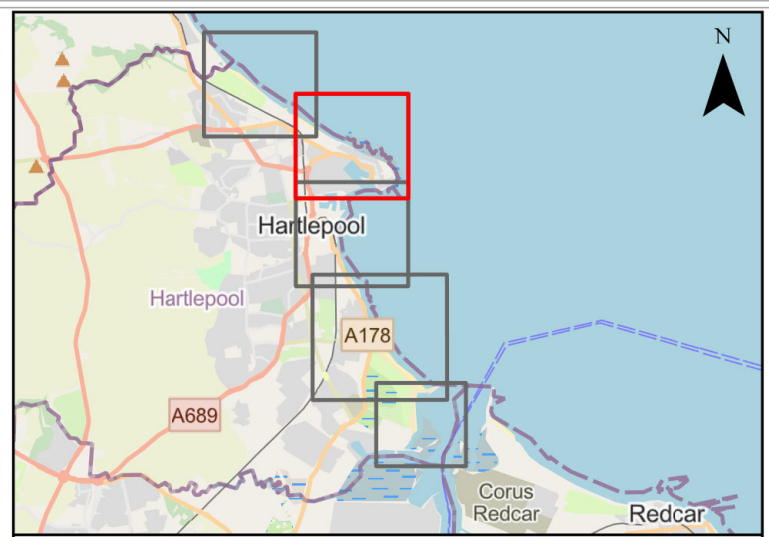
Report:

Analytical Report
'Full Measures' Survey 2023

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	15/12/2023	TC	TW	A3	1:10,000

Co-ordinate system: British National Grid



TOPOGRAPHIC SURVEY (October 2023)

Elevation (mOD)	Contours (mOD)*
-2.1 -- -2	— 1.0m interval
-1.9 -- -1.5	— 0.25m interval
-1.4 -- -1	
-0.9 -- -0.5	
-0.4 - 0	
0.1 - 0.5	
0.6 - 1	
1.1 - 1.5	
1.6 - 2	
2.1 - 2.5	
2.6 - 3	
3.1 - 3.5	
3.6 - 4	
4.1 - 4.5	
4.6 - 5	
5.1 - 5.5	
5.6 - 6	
6.1 - 6.5	

* Contours only cover sandy beach areas.

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

Title:

Appendix B - Map 2

NORTH SANDS / HEADLAND

Hartlepool Borough Council Frontage

Report:

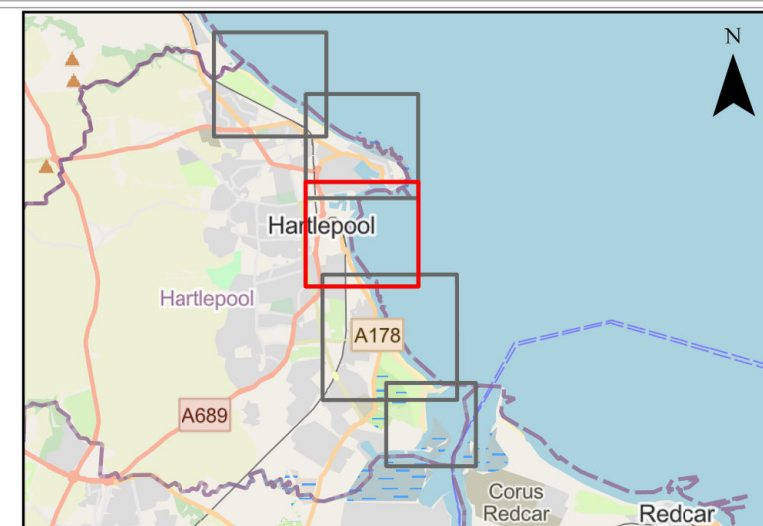
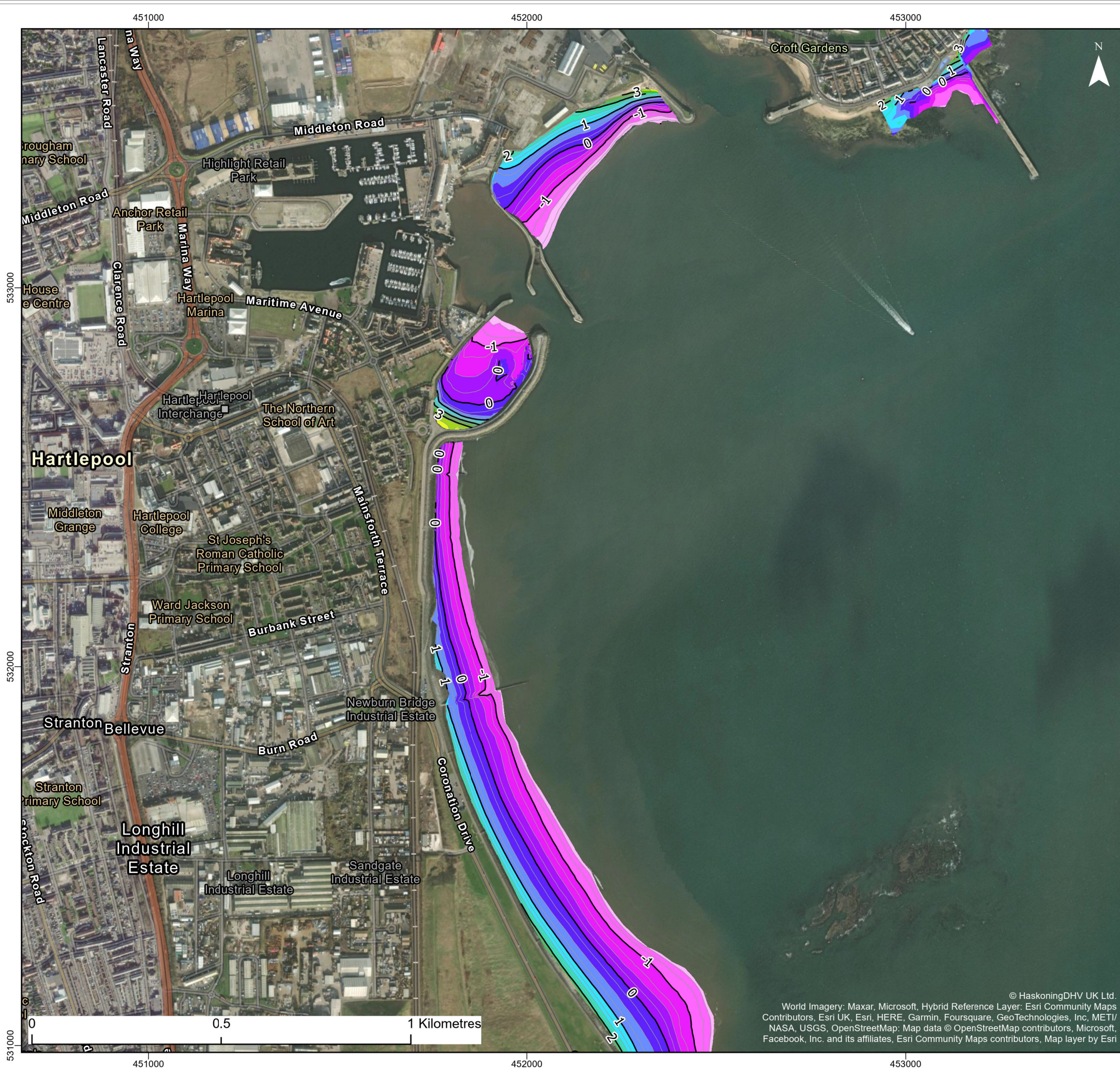
Analytical Report
'Full Measures' Survey 2023

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	15/12/2023	TC	TW	A3	1:10,000

Co-ordinate system: British National Grid



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TOPOGRAPHIC SURVEY (Sept/Oct 2023)

Elevation (mOD)	Contours (mOD)*
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-1.9 - -1.5	— 0.25m interval
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-0.9 - -0.5	
-0.4 - 0	
0.1 - 0.5	
0.6 - 1	
1.1 - 1.5	
1.6 - 2	
2.1 - 2.5	
2.6 - 3	
3.1 - 3.5	
3.6 - 4	
4.1 - 4.5	
4.6 - 5	
5.1 - 5.5	
5.6 - 6	
6.1 - 6.5	

* Contours only cover sandy beach areas.

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

Title:

Appendix B - Map 3

MIDDLETON AND HARTLEPOOL BAY (NORTH)

Hartlepool Borough Council Frontage

Report:

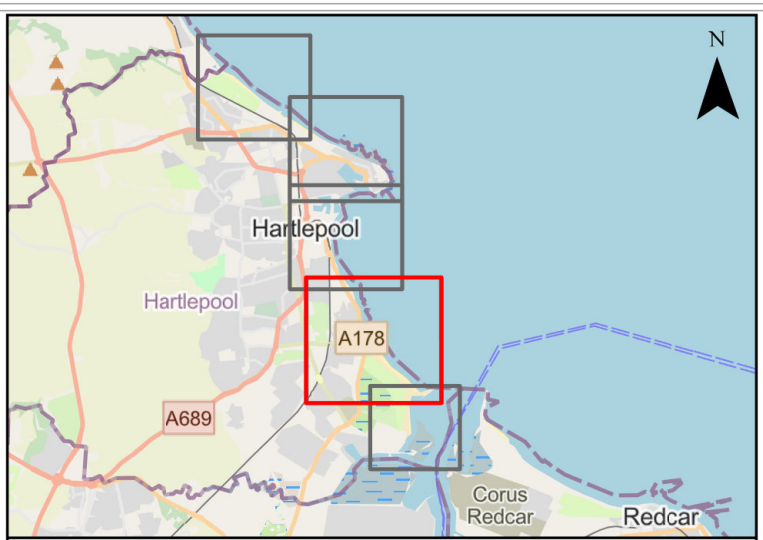
Analytical Report
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Revision:	Date:	Drawn:	Checked:	Size:	Scale:
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Co-ordinate system: British National Grid



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TOPOGRAPHIC SURVEY (October 2023)

Elevation (mOD)	Contours (mOD)*
-2.1 - -2	— 1.0m interval
-1.9 - -1.5	— 0.25m interval
-1.4 - -1	
-0.9 - -0.5	* Contours only cover sandy beach areas.
-0.4 - 0	
0.1 - 0.5	
0.6 - 1	
1.1 - 1.5	
1.6 - 2	
2.1 - 2.5	
2.6 - 3	
3.1 - 3.5	
3.6 - 4	
4.1 - 4.5	
4.6 - 5	
5.1 - 5.5	
5.6 - 6	
6.1 - 6.5	

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

Title:

Appendix B - Map 4

HARTLEPOOL BAY (SOUTH)

Hartlepool Borough Council Frontage

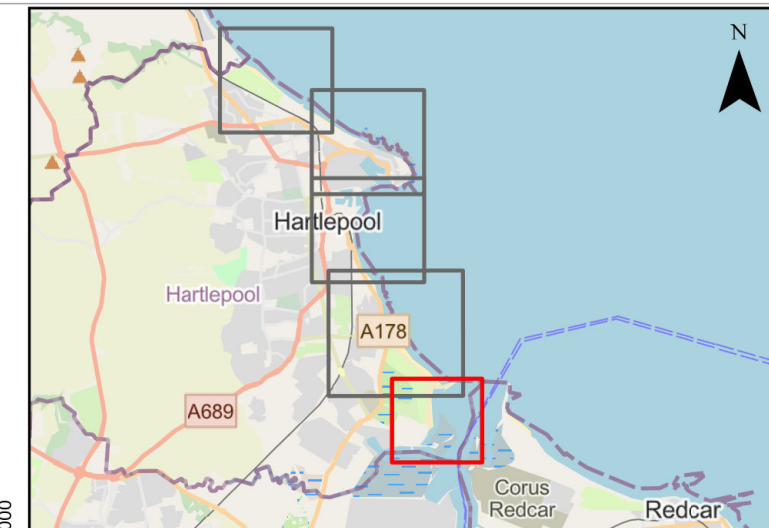
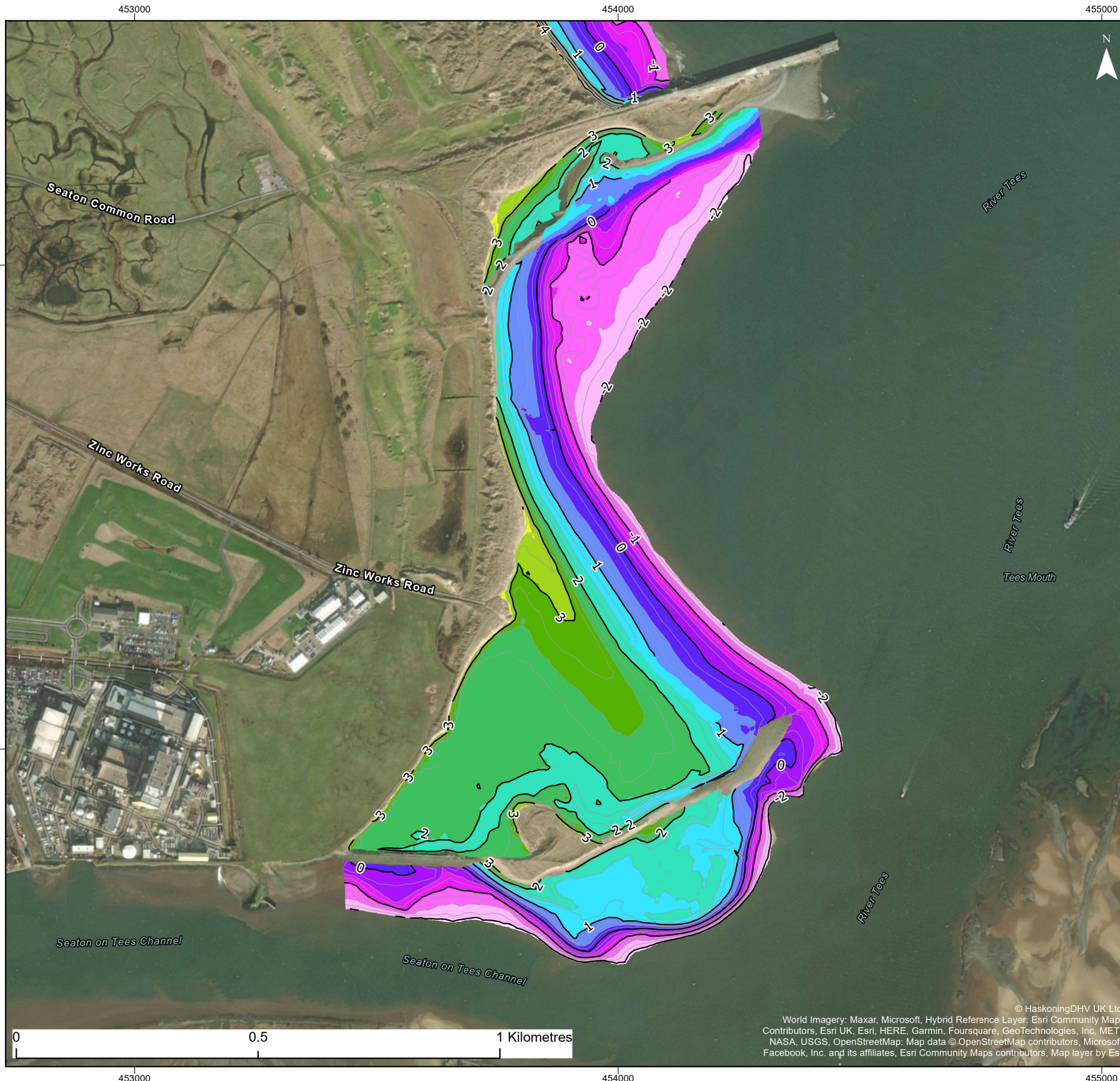
Report:

Analytical Report
'Full Measures' Survey 2023

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	15/12/2023	TC	TW	A3	1:12,000

Co-ordinate system: British National Grid

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TOPOGRAPHIC SURVEY (October 2023)

Elevation (mOD)	Contours (mOD)*
-2.1 -- -2	— 1.0m interval
-1.9 -- -1.5	— 0.25m interval
-1.4 -- -1	
-0.9 -- -0.5	
-0.4 - 0	
0.1 - 0.5	
0.6 - 1	
1.1 - 1.5	
1.6 - 2	
2.1 - 2.5	
2.6 - 3	
3.1 - 3.5	
3.6 - 4	
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4.6 - 5	
5.1 - 5.5	
5.6 - 6	
6.1 - 6.5	

* Contours only cover sandy beach areas.

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

Title:

Appendix B - Map 5

NORTH GARE

Hartlepool Borough Council Frontage

Report:

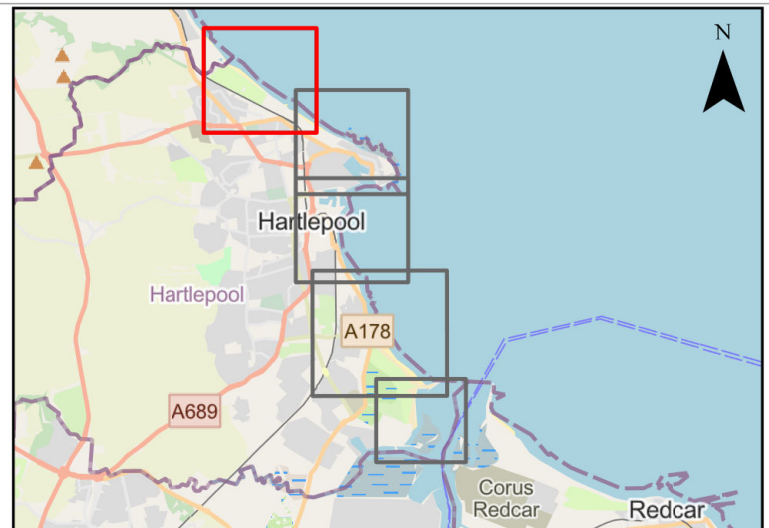
Analytical Report
'Full Measures' Survey 2023

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Co-ordinate system: British National Grid

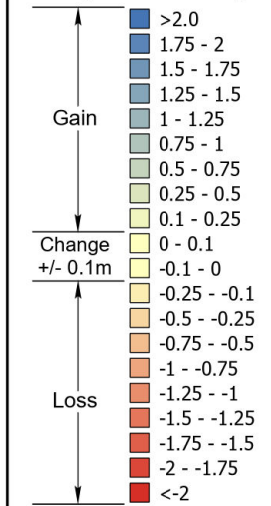


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Difference between topographic surveys
(Sept 2022 to Oct 2023)

Change in Elevation (mOD)



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

Title:

Appendix B - Map 6

NORTH SANDS

Hartlepool Borough Council Frontage

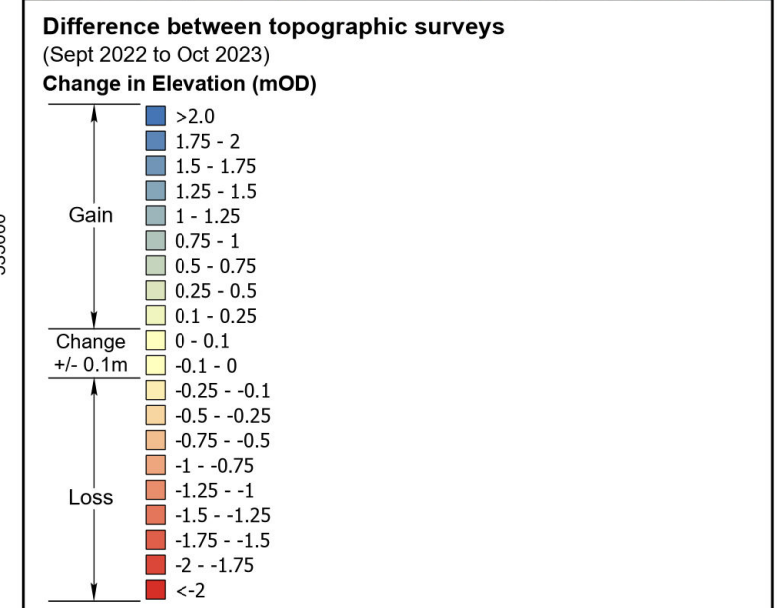
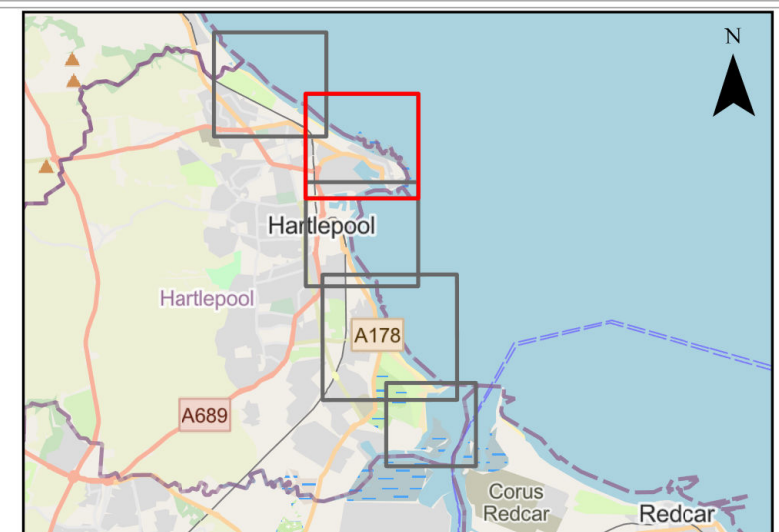
Report:

Analytical Report
'Full Measures' Survey 2023

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
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Co-ordinate system: British National Grid





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

Title:

Appendix B - Map 7

NORTH SANDS / HEADLAND

Hartlepool Borough Council Frontage

Report:

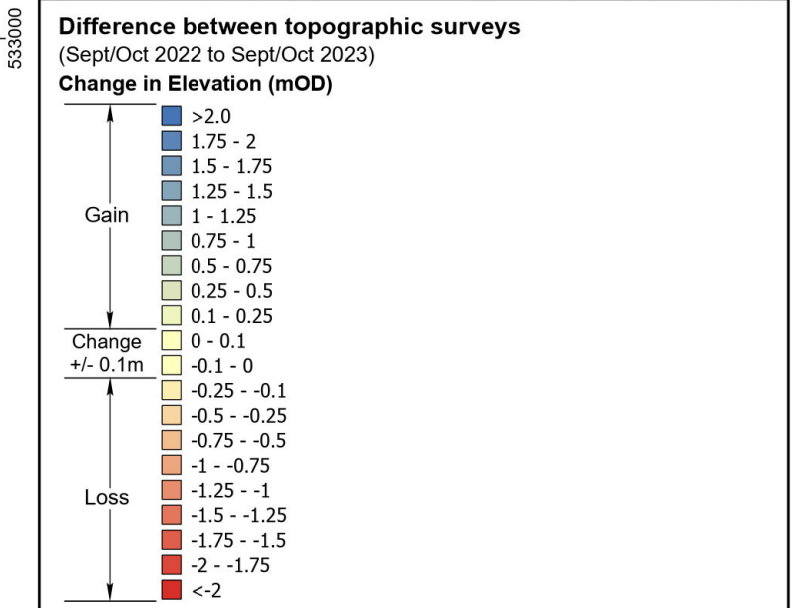
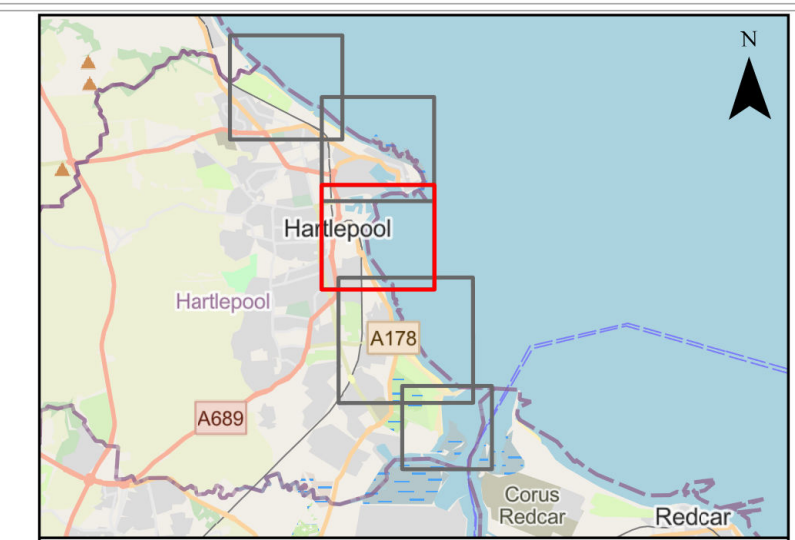
Analytical Report
'Full Measures' Survey 2023

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	15/12/2023	TC	TW	A3	1:10,000

Co-ordinate system: British National Grid



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Client: North East Coastal Group	Project: Cell 1 Regional Coastal Monitoring Programme
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Title:
Appendix B - Map 8
MIDDLETON AND HARTLEPOOL BAY (NORTH)
Hartlepool Borough Council Frontage

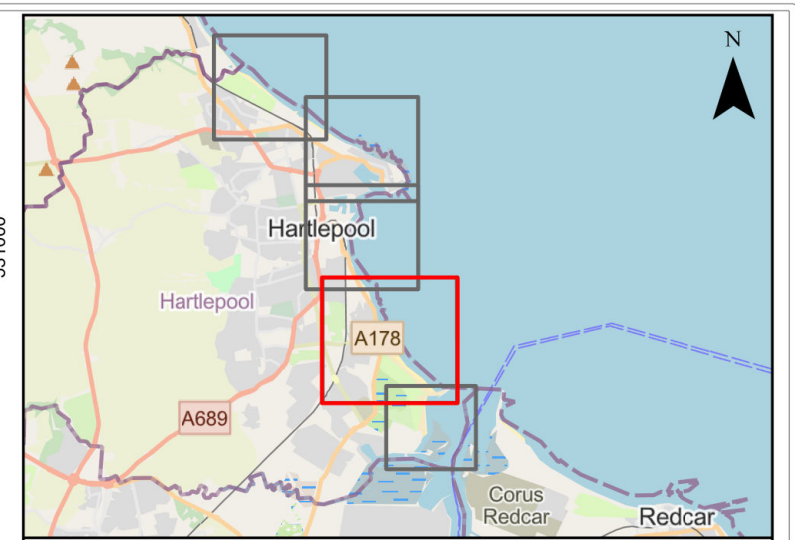
Report:
Analytical Report
'Full Measures' Survey 2023

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	15/12/2023	TC	TW	A3	1:10,000

Co-ordinate system: British National Grid

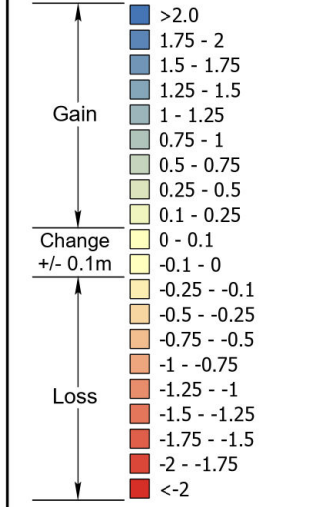


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Difference between topographic surveys
(Oct 2022 to Oct 2023)

Change in Elevation (mOD)



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

Title:

Appendix B - Map 9

HARTLEPOOL BAY (SOUTH)

Hartlepool Borough Council Frontage

Report:

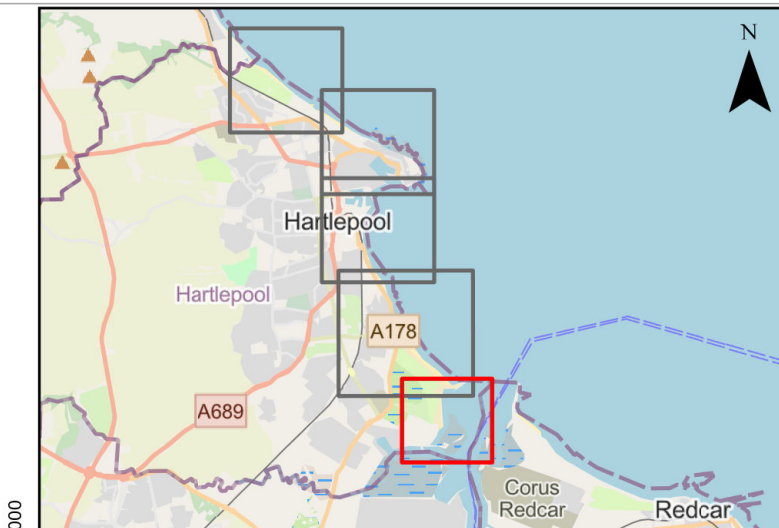
Analytical Report
'Full Measures' Survey 2023

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	15/12/2023	TC	TW	A3	1:12,000

Co-ordinate system: British National Grid



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Difference between topographic surveys
(Oct 2022 to Oct 2023)

Change in Elevation (mOD)

Gain	>2.0
	1.75 - 2
	1.5 - 1.75
	1.25 - 1.5
	1 - 1.25
	0.75 - 1
	0.5 - 0.75
	0.25 - 0.5
	0.1 - 0.25
Change +/- 0.1m	0 - 0.1
	-0.1 - 0
	-0.25 - -0.1
	-0.5 - -0.25
	-0.75 - -0.5
	-1 - -0.75
Loss	-1.25 - -1
	-1.5 - -1.25
	-1.75 - -1.5
	-2 - -1.75
	<-2

Shingle Ridge Alignment

- October 2022 (Black line)
- September 2021 (Purple line)
- October 2023 (Green line)

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

Title:

Appendix B - Map 10

NORTH GARE

Hartlepool Borough Council Frontage

Report:

Analytical Report
'Full Measures' Survey 2023

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	15/12/2023	TC	TW	A3	1:8,000

Co-ordinate system: British National Grid



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