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

Sunderland City Council

January 2024

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

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Abbreviations and Acronyms

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

Water Levels Used in Interpretation of Changes

Water Level Parameter	Water Level (m AOD)
	Whitburn Bay to Ryhope
HAT	3.08
MHWS	2.58
MHWN	1.48
MLWN	-0.72
MLWS	-1.82

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.
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.

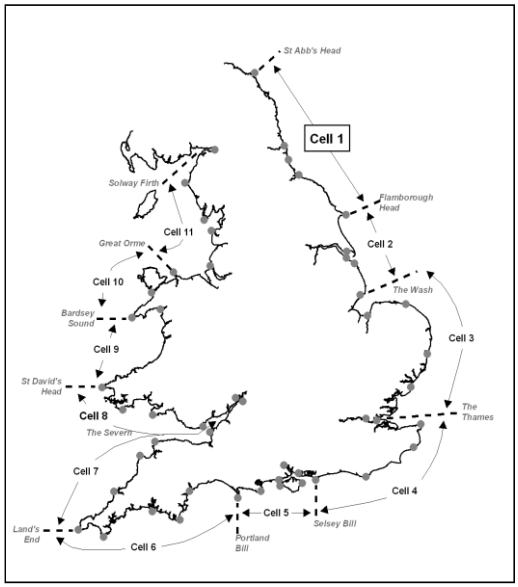


Figure 1 Sediment Cells in England and Wales

The programme commenced in its present guise in September 2008[1] 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.

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	Mar 20	Apr 20	
13	2020/21	Sep-Oct 20	Jan 21	Mar-Apr 21	May 21	Jun 21
14	2021/22	Nov 21	Feb 22	Apr 22	Jun 22	
15	2022/23	Oct-Nov 22	Feb 23	Apr 23	May 23	
16	2023/24	Sep 23	Jan 24(*)			

(*) The present report is **Analytical Report 16** and provides an analysis of the 2023 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 18-19th September 2023 (Whitburn Bay), 1st September 2023 (Sunderland Harbour and Docks) and the 22nd – 28th September 2023 (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.

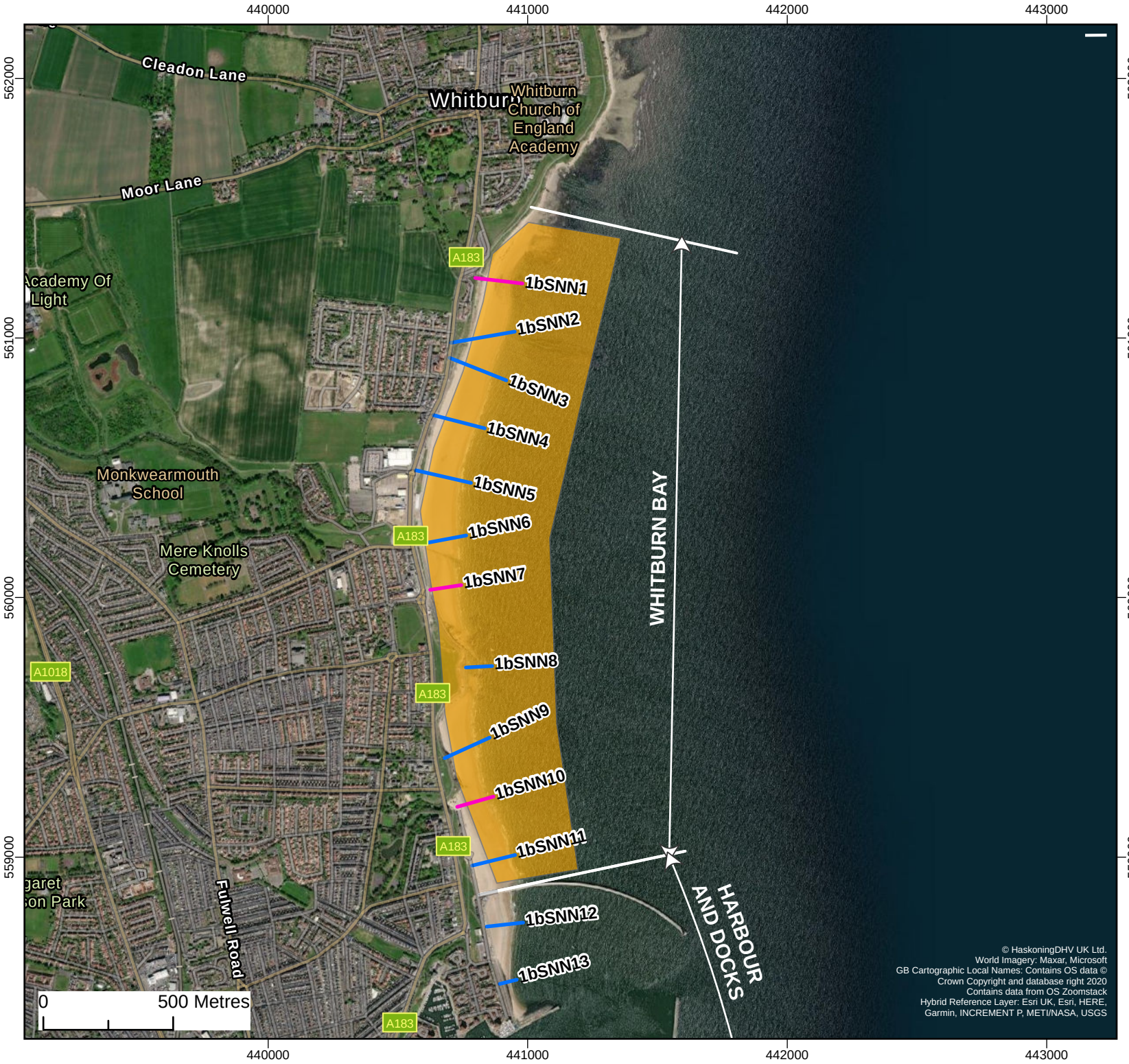
All data have been captured in a manner commensurate with the principles of the Environment Agency's *National Standard Contract and Specification for Surveying Services* and stored in a file format compatible with the software systems being used for the data analysis, namely SANDS and ArcGIS. This data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

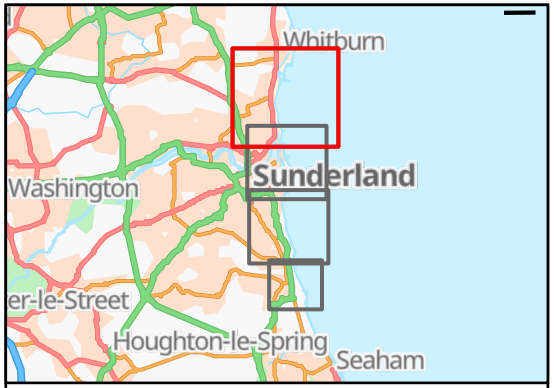
Upon receipt of the data from the survey team, they are quality assured and then uploaded onto the programme's website for storage and availability to others and also input to SANDS and GIS for subsequent analysis.

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.





SURVEY LOCATIONS

Topographic Profile

- Annual
- Bi-Annual

Topographic Area

- 6 monthly
- yearly
- 5 yearly

- Cliff Top Survey Points (refer to Figure 3 for details)

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

Title:

Figure 2 - Map 1

WHITBURN BAY

Sunderland City Council Frontage

Report: Survey Report

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	n/a	TC	NJC	A4	1:20,000

Co-ordinate system: British National Grid

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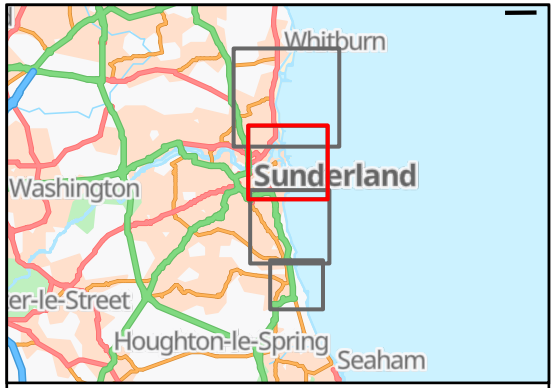

SURVEY LOCATIONS

Topographic Profile

- Annual
- Bi-Annual

Topographic Area

- 6 monthly
- yearly
- 5 yearly

- Cliff Top Survey Points (refer to Figure 3 for details)

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

Title:

Figure 2 - Map 2

HARBOUR AND DOCKS

Sunderland City Council Frontage

Report: Survey Report

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

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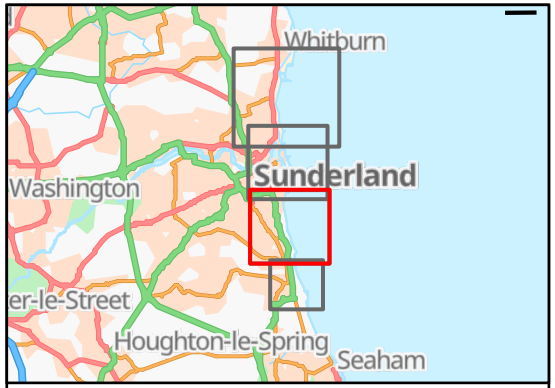

SURVEY LOCATIONS

Topographic Profile

- Annual
- Bi-Annual

Topographic Area

- 6 monthly
- yearly
- 5 yearly

- Cliff Top Survey Points (refer to Figure 3 for details)

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

Title:

Figure 2 - Map 3

HENDON TO RYHOPE (NORTH)

Sunderland City 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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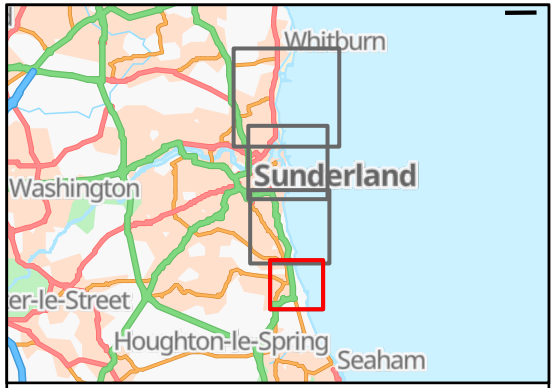

SURVEY LOCATIONS

Topographic Profile

- Annual
- Bi-Annual

Topographic Area

- 6 monthly
- yearly
- 5 yearly

- Cliff Top Survey Points
  (refer to Figure 3 for details)

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

Title:

Figure 2 - Map 4

HENDON TO RYHOPE (SOUTH)

Sunderland City Council Frontage

Report:

Survey Report

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

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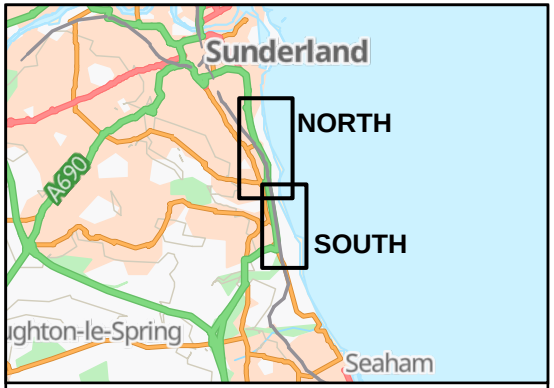

SURVEY LOCATIONS

- Cliff Top Survey Points

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

Title:

Figure 3 - Map 1

HENDON TO RYHOPE

Sunderland City Council Frontage

Report: Survey Report

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	n/a	TC	NJC	A4	as shown

Co-ordinate system: British National Grid

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2. Analysis of Survey Data

2.1 Whitburn Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
19th Nov 2023	**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 April 2022 and the previous Full Measures survey was undertaken in November 2022. Profiles **1bSNN1**, **1bSNN7** and **1bSNN10** were last surveyed during the Partial Measures spring survey, 2023. The remaining profiles were last surveyed during the Full Measures autumn survey, 2022. **1bSNN1** is immediately south of Sunderland City Council's northern boundary. There are small sections of accretion and erosion on the dunes landward of 40m chainage, limited to ±0.1m. The beach profile at the dune toe has lowered by up to 0.8m to chainage 65m. The upper beach between chainages 65-111m and lower beach between chainages 140-160m has risen by up to 0.4m. The middle beach between chainages 111-140m has lowered by up to 0.1m. Overall, the beach level is at medium-high level 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 **1bSNN2**, the dune has remained stable since the last survey, with only a small amount of erosion occurring by up to 0.1m to chainage 80m. The beach at the dune toe has risen by up to 0.2m between chainages 80-111m. Seaward of chainage 111m has lowered by up to 0.7m. Overall, the profile is at a medium-high level recorded from previous surveys. At **1bSNN3**, the dunes remain stable since the previous survey, showing accretion by up to 0.1m. The upper and middle beach to chainage 210m has risen by up to 0.4m, whilst the lower beach has lowered by up to 0.3m. Overall, the beach profile is at a medium-high level compared to the range recorded from the previous surveys.	Along the length of Whitburn Bay profiles have undergone variable change since the previous survey. The majority of beach profiles are within the range of previous recorded surveys. **Longer term trends:** All the profiles in Whitburn Bay are at medium to high levels compared to earlier surveys in the record. 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
	Profiles **1bSNN4** to **1bSNN6** are between the shoreline opposite the southern edge of South Bents housing estate and Parsons Rock. Profile **1bSNN4** shows the beach has generally lowered by 0.2m across the profile, except on the middle beach between chainages 105-170m which has risen by up to 0.3m. Overall, the upper and lower beach is at a medium level, whilst the middle beach is at a high level compared to the range recorded from previous surveys. At profile **1bSNN5**, from the toe of the sea wall to chainage 46m the beach profile has fallen by 0.2m. A small berm has formed between chainages 46-74m with the accumulation of sediment up to 0.6m. The beach profile alternates between erosion and accretion for the remaining beach profile, limited to ±0.4m. Overall, the beach is at a medium-high level when compared to the range recorded from previous surveys. At profile **1bSNN6**, the beach from the toe of the sea wall to chainage 90m has lowered by up to 1.8m which now exposes the toe of the sea wall and is at its second lowest level recorded (the lowest being recorded in the autumn 2019 survey). The middle beach between chainages 90-185m has risen by up to 0.2m. The lower beach seaward of chainage 185m has lowered by less than 0.1m. The profile is at a low level on the upper beach, rising to a high level across the rest of the beach profile compared to the range recorded from previous surveys Profile **1bSNN7** is at Seaburn, just to the north of Parson's Rocks. The upper beach between chainages 7-60m has risen by up to 0.4m. Seaward of this point, the middle beach has lowered by up to 0.1m and the lower beach has lowered by up to 0.5m. Overall, the profile is at a high level compared to the range recorded from previous surveys, particularly between chainages 18-44m which is at its highest level recorded. Profile **1bSNN8** extends across Parsons Rocks. The beach profile remains stable and has exhibited little change except for differences in rock location between the two surveys. Overall, the profile is at a medium level compared to the range recorded from previous surveys. Profile **1bSNN9** drops from the cliff top to the foreshore at Roker. The upper beach from the toe of the cliff to chainage 36m has risen by up to 0.5m. The middle-upper beach between chainages 36-75m has lowered by up to 0.2m. Seaward of chainage 75m the middle and lower beach has lowered by up to 0.2m. Overall, the profile is at a high level compared to the range recorded from previous surveys.	

Survey Date	Description of Changes Since Last Survey	Interpretation
	Profile **1bSNN10** is located approximately mid-way between Parson's Rocks and Roker Pier. Between the toe of the seawall and chainage 16m, the beach has risen by up to 0.3m. The middle-upper beach between chainages 16-36m has lowered by up to 0.1m. The middle beach between chainage 36-160m has risen by up to 0.3m, switching to erosion on the lower beach by up to 0.4m. Overall, the beach is at a medium-high level compared to the range recorded in previous surveys. Profile **1bSNN11** is located to the south of Whitburn. The beach level has alternated between erosion and accretion, but has generally risen by up to 0.3m on the upper beach, 0.1m on the middle beach and 0.4m on the lower beach. Short sections of erosion are found on the middle-upper and middle-lower beach by up to 0.1m. The beach ranges between a medium-high level compared to the range recorded from previous surveys, particularly between chainages 34-50m and 98-108m which are at their highest levels recorded.	
Sept 2023	**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 2023) 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 2022) and the present survey. The most northerly survey extent has undergone patchy erosion by up to 1.25m. To the south of this, there has been high magnitude erosion across the beach profile (0.75-1.5m). The central beach is dominated by shore-parallel bands of accretion and erosion, generally limited to ±0.75m. The south of the survey area has generally undergone little change (±0.1m), with only a few narrow bands of accretion on the middle and lower beach. There are isolated patches of erosion and accretion around Parsons Rocks.	The topographic survey shows that since the last survey, erosion has dominated in the north of the survey area, accretion in the south, with shore-parallel bands of erosion and accretion in the central survey area. **Longer term trends:** The most recent topographic survey is generally 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.

2.2 Sunderland Harbour and Docks

Survey Date	Description of Changes Since Last Survey	Interpretation
19th Sept 2023	**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 2022. **1bSNN12** and **1bSNN13** are both located within the shelter of Roker Pier. At profile **1bSNN12**, there has been minimal change from the toe of the seawall and chainage 60m. The beach between chainages 60-77m has lowered by up to 0.2m and between chainage 116-140m by up to 0.4m. The middle beach between chainages 77-116m has risen by up to 0.4m. Overall, the beach profile is at a medium-high level on the upper and lower beach compared to the range recorded from previous surveys, while the middle beach is at a low level. At **1bSNN13**, the beach profile has lowered from the toe of the rock armour revetment to chainage 32m by up to 0.1m. The middle beach between chainages 32-41m has risen by up to 0.1m, switching to erosion on the lower beach by up to 0.3m. Overall, the profile is at a high 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, this profile has not been analysed. Profile **1bSNC2** starts at the crest of New South Pier and drops several metres to foreshore level. The beach level has fallen from the toe of the seawall across the upper beach to chainage 35m by up to 0.4m and on the lower beach seaward of chainage 112m by up to 0.1m. The middle beach between chainages 35-112m has risen by up to 0.2m. Overall, the upper and lower beach profile is at a medium level whilst the middle beach is at a high level compared to the range recorded from previous surveys. **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. The	Within the breakwaters north of the River Wear, beach levels alternate between erosion and accretion, with the lower beach generally lowering. Between the breakwaters at profile 1bSNC2, the level of the beach profile has generally risen on the middle beach, whilst the upper and lower beach have lowered. Profile 1bSNC1 was not analysed as it does not cover any beach. Outside of the breakwaters, beach levels across profiles 1bSNC4 and 1bSNC5 have lowered, whilst the beach level across profile 1bSNC6 has risen. Within the breakwaters, either side of the former South Outlet of the docks, the beach profile has generally lowered, except for small sections at profile 1bSNC9 which has risen. **Longer term trends:** Within the breakwaters to the north and south of the River Wear, beach levels are generally at a medium-high level. Outside of the harbour breakwaters, the beach levels fluctuate significantly over time with some sections at their lowest levels recorded. Profile 1bSNC3 was not analysed as it does not cover any beach. Within the breakwaters either side of the former South Outlet of the docks, long term change is small at 1bSNC7 and 1bSNC9, however there is a gradual rise in beach profile at 1bSNC9, which is now at one its highest levels recorded. At profile 1bSNC8, the

Survey Date	Description of Changes Since Last Survey	Interpretation
	profile then extends down the seaward face of the wall into deep water. As there is no beach present, this profile has not been analysed. The survey report notes that construction work is being carried out next to this profile to extend the revetment. This is part of the ongoing Stonehill Wall scheme. 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 level has lowered across the entire profile by up to 0.2m on the upper beach, 0.5m on the middle beach and 0.8m on the lower beach. Overall, the beach is at a medium-low level compared to the range recorded from previous surveys. At profile **1bSNC5**, there has been some movement in boulder position but the beach profile has lowered by up to 0.5m on the upper beach, 0.9m on the middle beach and 0.7m on the lower beach. Overall, the beach is at a low level compared to the range recorded from previous surveys, reaching one of its lowest levels recorded at the toe of the seawall. Profile **1bSNC6** extends across the revetment and seawall. The beach level has risen across the beach profile by up to 0.8m on the upper beach, 0.6m on the middle beach and 0.4m on the lower beach. . The beach levels are at a high level compared to the range recorded from previous surveys. Profiles **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. Profile **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. From chainage 35m seaward of the boulders and rubble, the beach level has lowered by up to 0.3m. Overall, the profile is at a low level. Profile **1bSNC9** extends from the dock facilities and crosses a short length of concrete wall and sheet piling 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 report notes the start of this profile was not surveyed as it is unsafe to access. The profile has predominantly risen across the gravel backshore by up to 0.1m. The beach between chainages 50-106m has risen by up to 0.3m.There are apparent changes in height of the boulder mound in places. The profile remains	long-term trend has been lowering beach levels since surveys began in October 2009 and the autumn 2023 survey is the second lowest recorded level, with autumn 2019 the lowest level.

Survey Date	Description of Changes Since Last Survey	Interpretation
	high compared to earlier surveys, with the majority of the profile at its highest level recorded compared to previous surveys.	

2.3 Hendon to Ryhope (incl. Halliwell Banks)

Survey Date	Description of Changes Since Last Survey	Interpretation
28th Sep 2023	**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 **1bSNS33** are surveyed every 6 months. The previous Full Measures survey was undertaken in autumn 2022 and the previous Partial Measures survey was undertaken in spring 2023. **1bSNS1** to **1bSNS6** are located along the sea wall protecting the Hendon Sewage Treatment Works. The profiles typically include a section along the concrete deck, wall crest (which varies in elevation between around 7.0mOD in the north and 7.6mOD in the south after the dog-leg in the wall position), near-vertical seaward face of the wall, and sloping rock armour revetment. These profiles have now been removed from the survey. **1bSNS7** to **1bSNS10** are located along the defended coastal slopes at south Hendon, which rise in elevation to higher defended cliffs at **1bSNS11**. Profile **1bSNS7** extends across a seawall and concrete revetment, which is fronted by a foreshore comprised of large pebbles and coarse shingle. The upper beach between the toe of the revetment and chainage 33m has lowered by up to 0.3m. The rocks seaward of chainage 33m remain largely unchanged. Overall, the beach profile is at a medium-low level compared to the range recorded from previous surveys. Profile **1bSNS8** extends across the seawall, rock revetment and beach. The beach level at the toe of the rock revetment across the upper to middle beach at chainage 75m has risen by up to 0.5m. Seaward of chainage 75m has lowered by up to 0.6m. Overall, the beach is at a high level on the upper to middle beach and medium level on the lower beach compared to the range recorded from previous surveys. At profile **1bSNS9**, there has been movement of boulders from the toe of the revetment to chainage 30m. The rest of the beach profile has lowered by 0.2m on the upper beach, 0.5m on the middle beach and 0.6m on the lower beach. Overall, the profile is at a medium-low level compared to the range recorded from previous surveys, while the lower beach is at a medium level.	Along the length of south Hendon, profiles have generally lowered, except the upper beach of profile 1bSNS8 where the upper beach has risen. There is no clear direction of sediment movement between the previous full measures survey and the most recent survey in autumn 2023. At Grangetown (south Hendon to Salterfen Rocks), beach levels have predominantly risen. Between Salterfen Rocks and the landfill at Halliwell banks (profiles 1bSNS20 to 1bSNS25), the cliff top has remained largely stable, except at 1bSNS23 where it has retreated by 2.0m. Beach levels have fluctuated along this section with no clear movement of sediment in either direction. The toe of the cliffs at the landfill site (1bSNS26 to 1bSNS32), have remained relatively stable since the previous survey. All profiles have lowered on the upper and lower beach and risen on the middle beach. To the south of Halliwell Banks, around Pincushion, the position of the cliff toe has remained stable. The beach profiles have mostly lowered across this section and exposed some more rocky patches across the beach. **Longer term trends:** Along the length of south Hendon, beach levels are generally at a medium-

Survey Date	Description of Changes Since Last Survey	Interpretation
	At profile **1bSNS10**, the upper and lower beach has lowered by up to 0.5m on the upper beach and 0.2m on the lower beach. The middle beach between chainages 40-59m has risen by up to 0.1m. The beach profile is at a medium-high level across the majority of the profile compared to the range recorded from previous surveys. At profile **1bSNS11**, there is negligible change in the cliff profile. Beach levels have lowered from the cliff toe across the upper and middle beach by up to 0.4m to chainage 74m. The lower beach has risen by up to 0.4m covering a previously exposed boulder from the previous survey. The beach profile is at a medium level compared to the range recorded from previous surveys. Profiles **1bSNS12** to **1bSNS36** are located along the undefended cliffs between Grangetown and Ryhope Dene. Profiles 1b**SNS12** to 1b**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. The cliff toe has receded landward by approximately 1.0m since the previous survey. There have been minor changes in position of boulders recorded to chainage 64m. The beach profile seaward of chainage 64m has risen by up to 0.1m on the upper beach, 0.1m on the middle beach and 0.3m on the lower beach. Overall, the profile is at a high level recorded compared to the previous surveys. At profile **1bSNS13**, the beach at the toe of the cliff has risen by up to 0.2m to chainage 40m. A small section between chainages 40-54m has lowered by up to 0.2m. Seaward of this point, the beach has risen by up to 0.6m on the middle beach and approximately 0.1m on the lower beach. The beach profile is at a high level for the majority of the profile, particularly between chainages 35-40m and seaward of 60m. The rest of the beach is at a medium-high level compared to previous surveys. At profile **1bSNS14**, the cliff toe has receded landward by approximately 0.5m. The beach at the toe of the cliff has risen by up to 0.2m on the upper beach, 1.0m on the middle beach and 0.1m on the lower beach. The rock patch at chainage 100-119m is now covered. The cliff is at its most landward	high level 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). Beach levels are relatively medium across all profiles, except at profile 1bSNS20 is at a low level, particularly between chainages 54-66m which is at its lowest level recorded. At the landfill site (profiles 1bSSN26 to 1bSSN32), the cliff position has generally remained in the same position. Beach levels are generally at a medium-low level compared to previous records. To the south of Halliwell Banks at profiles 1bSNS33 to 1bSNS36, beach levels are generally at a medium level.

Survey Date	Description of Changes Since Last Survey	Interpretation
	position recorded, and the beach at the cliff toe is at its lowest level recorded. The rest of the beach profile is at a medium-high level compared to the range recorded from previous surveys, particularly between chainages 75-115m which is at its highest position recorded. At profile **1bSNS15**, the beach at the cliff toe has lowered by up to 0.8m. The upper beach to chainage 64m has lowered by up to 0.4m. The beach seaward of chainage 64m has risen by up to 0.8m and now covers up a patch of rock previously exposed between chainages 82-118m. Overall, the beach profile is at medium-high level compared to the previous survey recorded, particularly between chainages 85-115m which is at its highest level recorded. At profile **1bSNS16**, the cliff top has retreated by 1.0m since the previous survey, whilst there has been relatively little change to the beach level since the last survey (autumn 2022). In some sections, sediment has accumulated between rocks by up to 0.4m. The cliff top has receded approximately 7m since 2009 but the cliff toe has only receded around 2.0m 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 toe of the cliffs appears to have moved seaward however this could be due to erosion of material from the cliffs onto the upper beach. There are no other changes to the profile since the previous November 2022 survey. At **1bSNS18**, the cliff toe has receded landward by 1.0m. The upper beach, between exposed rocks has risen by up to 0.2m. The middle and lower beach has risen by up to 0.4m covering some previously exposed rocks. Overall, the cliff top and cliff toee remains at one of its most landward positions recorded. . The rest of the beach profile is at a medium-high level compared to the range recorded from previous surveys. At **1bSNS19**, the rocky foreshore remains unchanged. The cliff toe appears to have prograded by 5.0m since the previous survey (autumn 2022), however this could be due erosion of material from the cliffs onto the upper beach.	

Survey Date	Description of Changes Since Last Survey	Interpretation
	At profile **1bSNS20**, the cliff toe also appears to have prograded by approximately 1.0m. The rest of the beach profile has generally risen by up to 0.4m on the upper beach, 0.2m on the middle beach and 0.5m on the lower beach. One section of erosion occurs between chainages 52-66m by up to 0.4m. Overall, the upper beach is at a low level, particularly between chainages 54-66m which is at its lowest level recorded. The rest of the beach profile is at a medium level compared to the range recorded from previous surveys. At **1bSNS21**, the dune toe has prograded by up to 2.0m since the previous survey. Seaward of this point, the beach has alternated between erosion and accretion generally limited to ±0.1m. Overall, the beach is at a medium level compared to the range recorded from previous surveys. At profile **1bSNS22**, the cliff toe has retreated by up to 2.0m. The shore platform remains largely unchanged. Overall, the beach profile is at a low level on the upper and middle beach, but a high level on the lower beach compared to the range recorded from previous surveys. At profile **1bSNS23**, the cliff top has retreated by up to 2.0m, whilst the cliff toe has prograded seaward by up to 2.0m. The beach profile has generally risen by up to 0.4m, covering up previously exposed rocks between chainage 61-86m. Overall, the beach profile is at a medium-high level compared to the range recorded from previous surveys. At profile **1bSNS24**, the cliff top has retreated by approximately 0.5m, and the cliff toe has remained stable. The beach from the cliff toe to chainage 80m has lowered by up to 0.5m, whilst the middle and lower beach has risen by up to 0.2m. Overall, the upper beach profile is at its lowest level recorded (between chainages 44-78m). The middle and lower beach is at a medium-high level. The cliff top is at its most landward position recorded. At profile **1bSNS25**, the beach at the cliff toe and middle beach have risen by up to 0.8m. The middle-upper beach (between chainages 58-80m) and lower beach (seaward of chainage 128m) have lowered by up to 0.6m. A patch of rocks between chainage 89-104m has been covered up since the previous survey. Overall, the upper beach is at a low level, middle beach is at a medium level and lower beach is at a high 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.	

Survey Date	Description of Changes Since Last Survey	Interpretation
	Profiles **1bSNS26** to **1bSNS32** have all behaved in a similar way. The top of the cliff shows little movement between spring and autumn 2023, with a maximum retreat of approximately 1.0m at 1bSNS31 and 1bSNS30. All profiles show alternating sections of erosion and accretion of between 0.1-0.4m across the beach profile. Overall, the profiles are at a medium-low level compared to the range recorded from previous surveys. Profiles **1bSNS33** to **1bSNS36** are located around the Pincushion Headland. At profile **1bSNS33**, the upper beach has lowered by up to 1.0m to chainage 93m, before switching to accretion on the middle beach by up to 0.8m between chainages 93-140m. The beach seaward of this point has undergone relatively little change of <0.1m. Overall, the upper beach profile is at a medium-low level and a medium-high level on the lower beach compared to the range recorded from previous surveys. At profile **1bSNS34,** the beach at the cliff toe has lowered by up to 0.4m to chainage 56m. The rest of the beach profile has changed little since the previous survey. Overall, the profile is generally at a medium level compared to the range recorded from previous surveys. At profile **1bSNS35**, the beach at the cliff toe has lowered by up to 0.3m. The rest of the beach profile has lowered by up to 0.8m and revealed rocks and boulders. The profile is at a similar position as autumn 2021 survey. Overall, the profile is at a medium level on the upper and middle beach, and a high level on the lower beach compared to the range recorded from previous surveys. At profile **1bSNS36**, there has been an accumulation of sediment at the toe of the cliff by up to 1.0m to chainage 65m. The beach between 65-95m remains similar to the previous survey (exposing a rock patch). The beach seaward of chainage 95m has lowered by up to 0.4m, exposing more rocks to chainage 175m. Overall, the cliff toe and beach level remain at one of its lowest levels recorded. The rest of the beach is at a medium level compared to the range recorded from the previous surveys.	
September 2023	**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 2023) have been used to create a DGM (Appendix B – Map 2) using a GIS. A difference plot has also been produced using the	The short-term change plot does not show a clear pattern of sediment movement. The beach has predominantly undergone accretion / little change with erosion limited to the central beach.

Survey Date	Description of Changes Since Last Survey	Interpretation
	DGM (Appendix B – Map 4) produced from the last produced topographic survey (Full Measures, autumn 2022) and the present survey. The topographic survey shows the northern part of the beach in the northern survey extent has undergone patchy erosion and accretion limited to ± 0.5m. This gradually transitions to little change across the middle-upper beach (<±0.1m), followed by accretion across the beach profile in the lee of the groyne. Immediately south of the groyne, the beach has eroded across the profile by up to 0.75m, moving to erosion on the upper beach and accretion on the lower beach. The south of the survey extent has accreted across the beach profile by up to 1.0m.	
September 2023	**Cliff Top Survey:** Cliff top survey data collected between the baseline survey (spring 2009) and the present Full Measures survey (autumn 2023) is documented here. 32 ground control points (GCPs) (numbered 1-32) were established along the cliff top between Hendon and Ryhope in March 2009, with a further three (28A, 28B and 28C) added in September 2009. Note: the numbering of ground control points is not intended to correlate with that of the beach profile lines. Measurements are taken from each ground control point along a fixed bearing to the edge of the cliff top. These cliff top surveys are undertaken bi-annually and are intended to inform on erosion rates of the sea cliffs extending from the defended industrial areas at Hendon southwards along the undefended cliffs to Ryhope Dene. Appendix C – Table C1 provides results from the cliff top survey, showing the position from the ground control point to the edge of the cliff top along a defined bearing. The results from the cliff top monitoring are anticipated to have an accuracy of ±0.2m due to the technique used. Results show that since the Partial Measures (April 2023) survey, apparent erosion greater than the error has occurred at 8 locations; GCP14, 23, 24, 25, 27, 28B, 31 and 32 with an average loss of -0.4m recorded (with a maximum loss of 1.01m 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 80% of the GCPs, where total losses are 12.79m at their greatest (at GCP25), and more typically less than 7m. The long-term erosion rates are up to 0.91m/yr (GCP25), with up to 0.5m/yr. being more typical.	The cliffs have remained generally stable over the most recent survey period across the majority of the survey points, with the majority of points recording erosion lower than the survey error (77%). **Longer term trends:** The data indicates that the fastest erosion since 2009 is concentrated in three broad sections; a) the northern part of the developing embayment between the southern extent of the sea defences and Salterfen Rocks, b) throughout the majority of Halliwell Banks and c) to the south of Pincushion rocks. Recession is least, as might be expected, along the defended sections and at the promontories of Salterfen Rocks and Pincushion Rocks.

3. Problems Encountered and Uncertainty in Analysis

Individual Profiles

- The survey report notes that the beginning of profile 1bSNC9 was unsafe to access at the time of the survey
- An area at the north of Whitburn Bay beach was unsafe to survey due to heavy wet mud.

Topographic Survey

- No problems were encountered.

Cliff Top Surveys

- No problems were encountered.

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

- It is recommended that Profile 1bSNC1 can be removed from the survey as there is no beach present.

5. Conclusions and Areas of Concern

- At Whitburn Bay, the majority of beach profiles are within the range of previous recorded surveys. 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), beach levels have undergone variable change since the previous survey in spring 2023, with no clear pattern of sediment movement. The recorded profiles, topographic survey and clifftop survey present no causes for specific concern. There is ongoing cliff erosion, with 8 points undergoing erosion greater than the survey error since spring 2023. Since the last survey, the greatest erosion has been at GCP28B, where the cliff edge has receded 1.01m. The greatest amount of cliff top erosion recorded to have taken place between March 2009 and September 2023 was 12.79m at GCP25 which is on the northern border of the landfill site. However, as noted previously, the numbering of GCPs does not correlate with that of the beach profile lines.

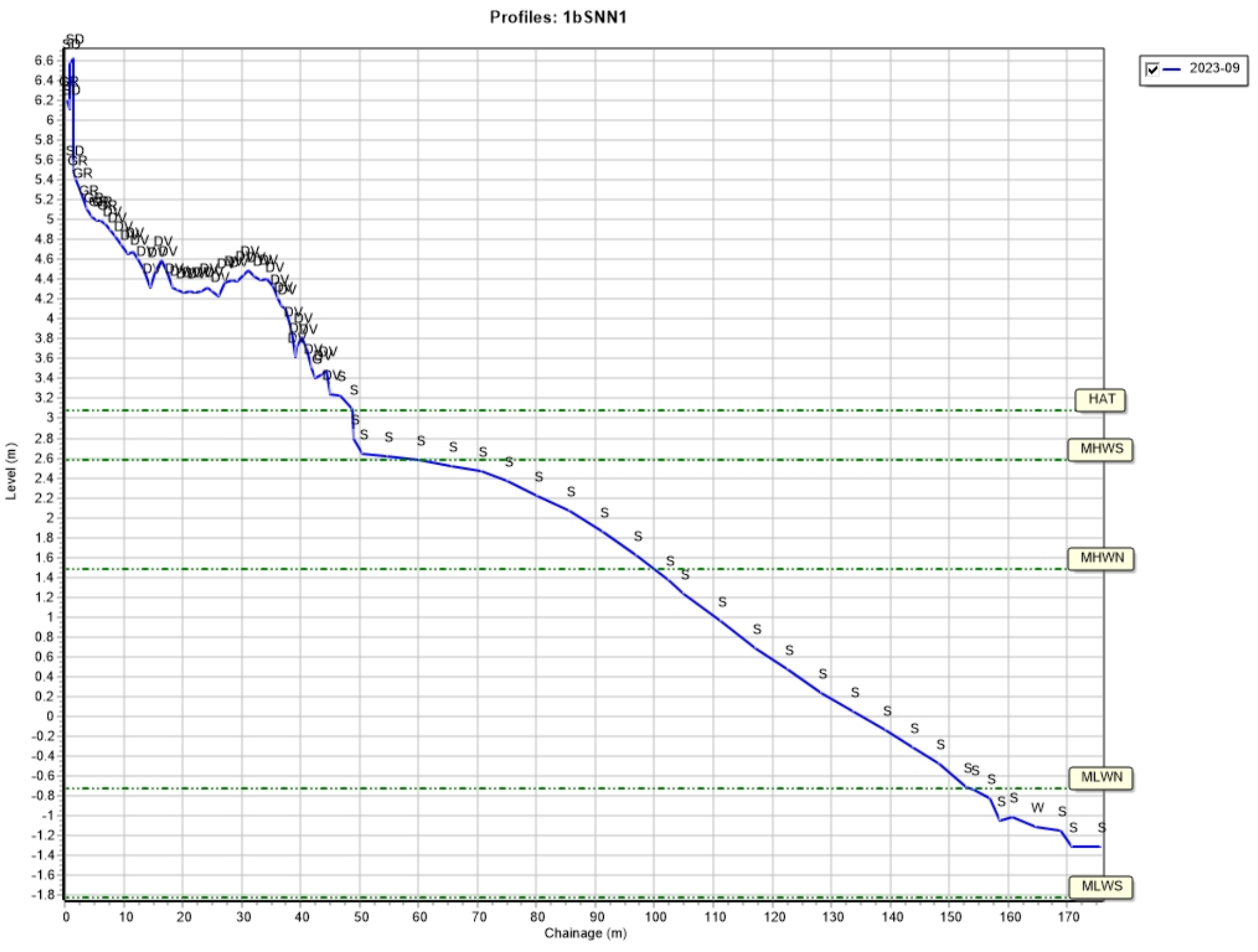
Appendices

Appendix A

Beach Profiles

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

Code	Description
S	Sand
M	Mud
G	Gravel
GS	Gravel & Sand
MS	Mud & Sand
B	Boulders
R	Rock
SD	Sea Defence
SM	Saltmarsh
W	Water Body
GM	Gravel & Mud
GR	Grass
D	Dune (non-vegetated)
DV	Dune (vegetated)
F	Forested
X	Mixture
FB	Obstruction
CT	Cliff Top
CE	Cliff Edge
CF	Cliff Face
SH	Shell
ZZ	Unknown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2023-09
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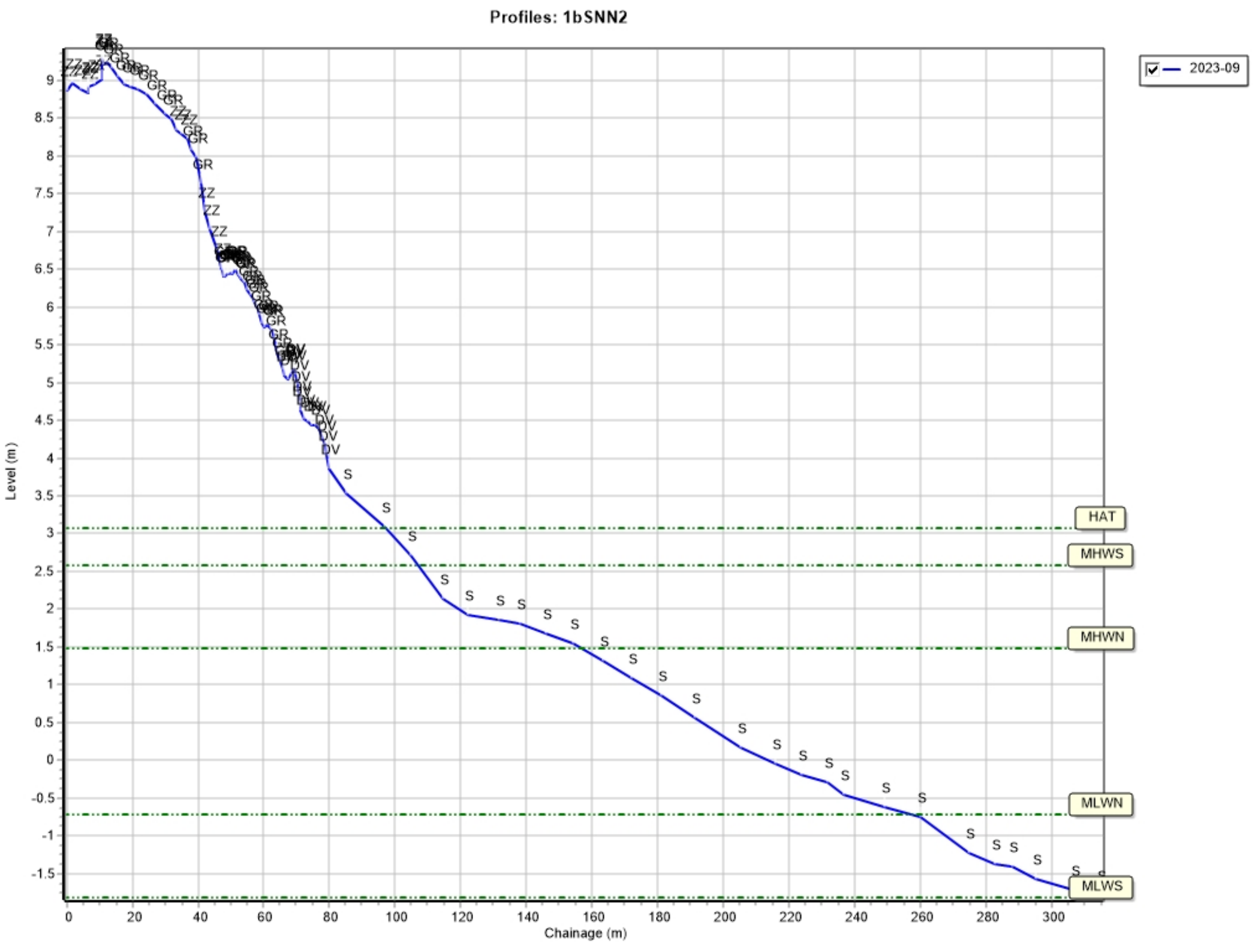
MHWS
MHWN
MLWN
MLWS
Level (m)
Chainage (m)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2023-09
Level (m)
Chainage (m)
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MHWN
MLWN
MLWS
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8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
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-1.5
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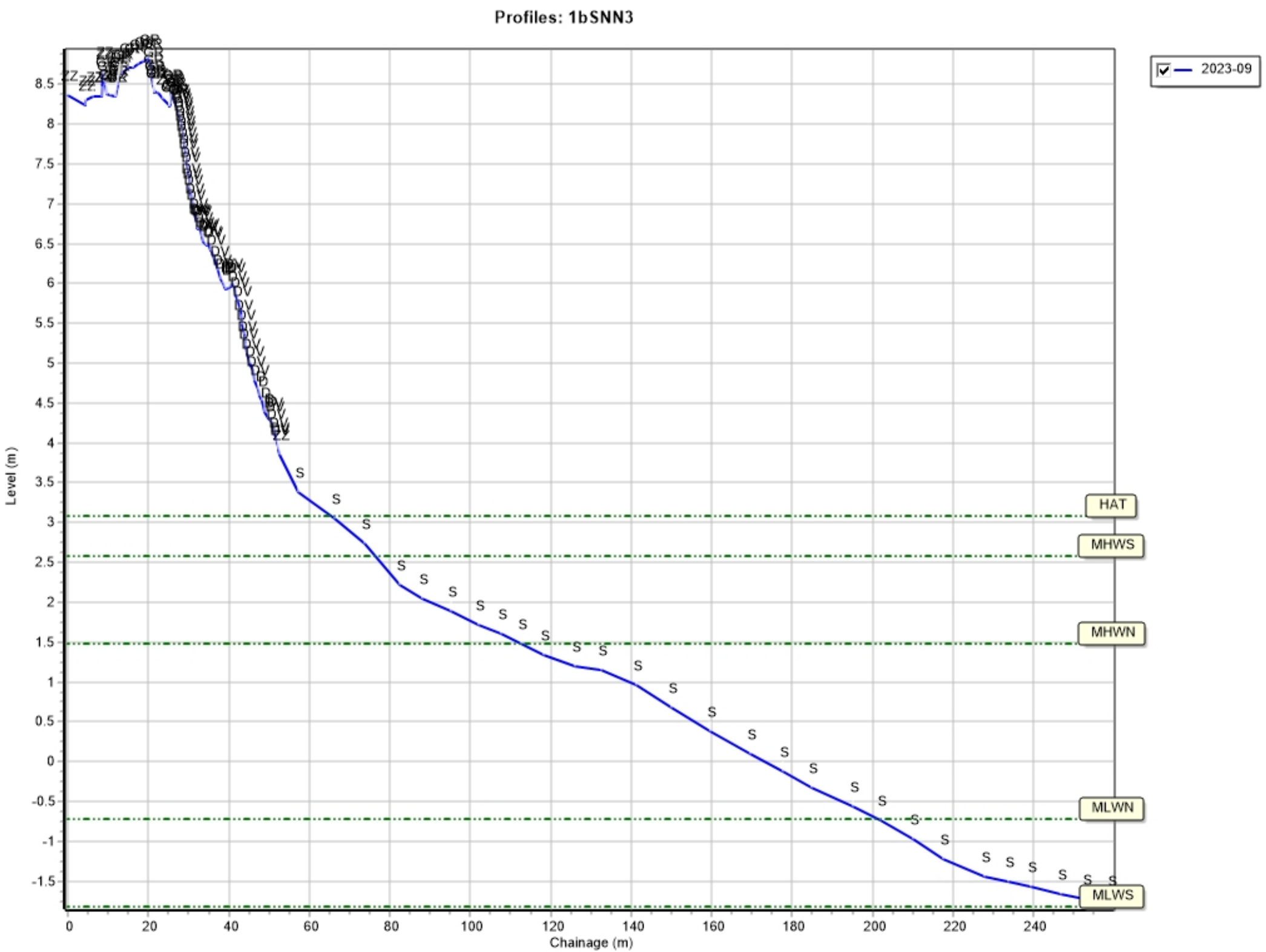
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300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2023-09
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MHWS
MHWN
MLWN
MLWS
Level (m)
Chainage (m)
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8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
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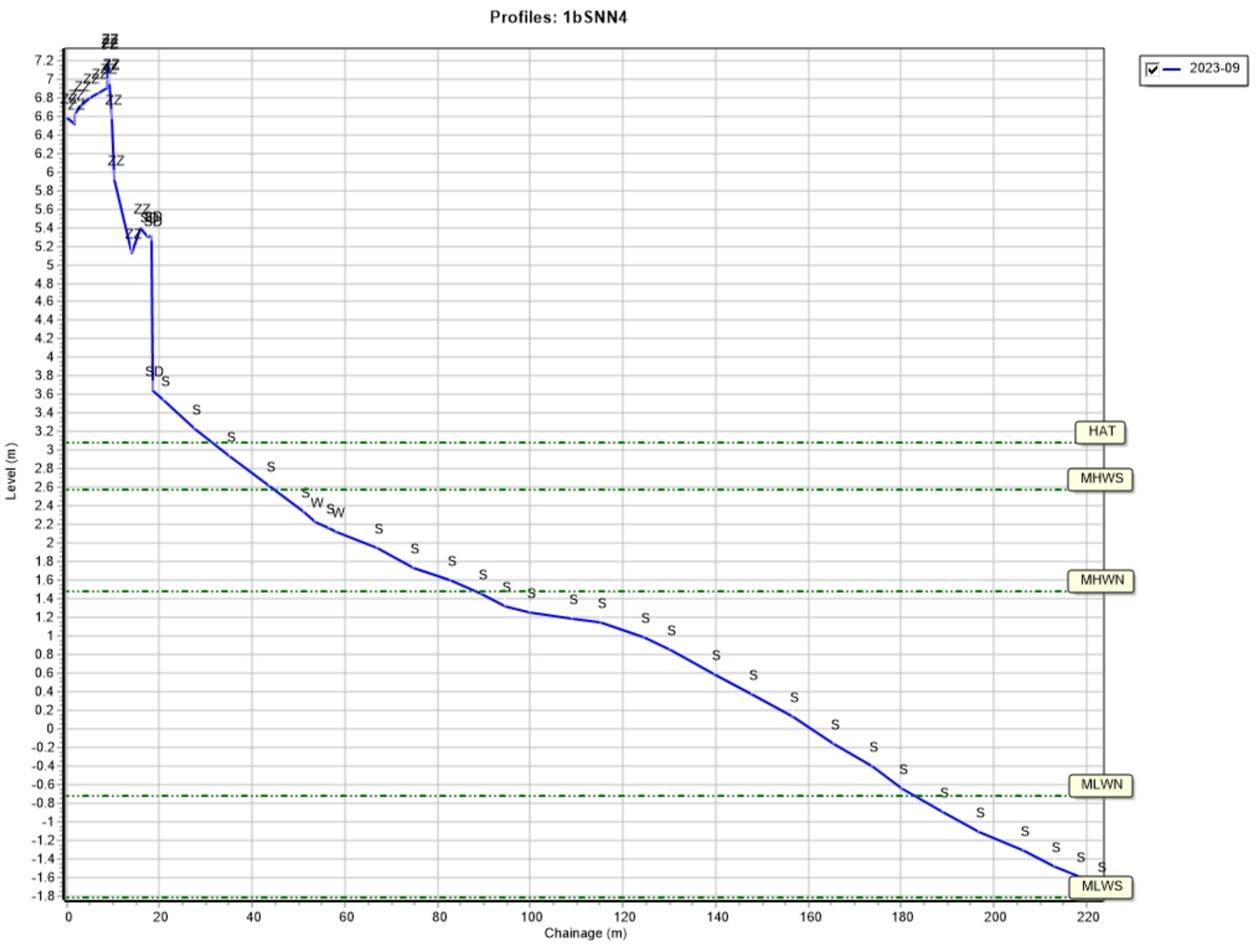
-1
-1.5
0
20
40
60
80
100
120
140
160
180
200
220
240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2023-09
HAT
MHWS
MHWN
MLWN
MLWS
Level (m)
Chainage (m)
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7
6.8
6.6
6.4
6.2
6
5.8
5.6
5.4
5.2
5
4.8
4.6
4.4
4.2
4
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
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-1.6
-1.8
0
20
40
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80
100
120
140
160
180
200
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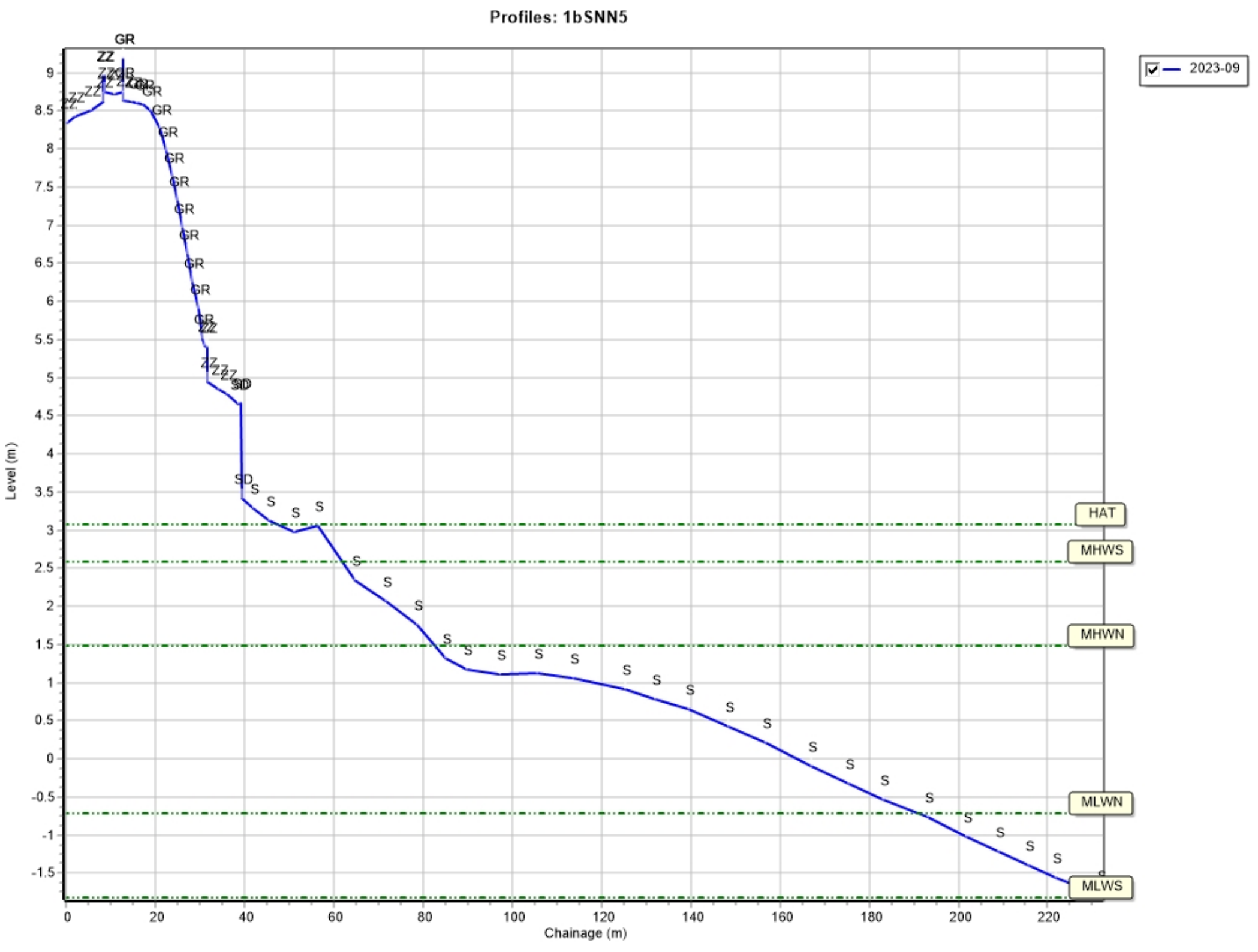
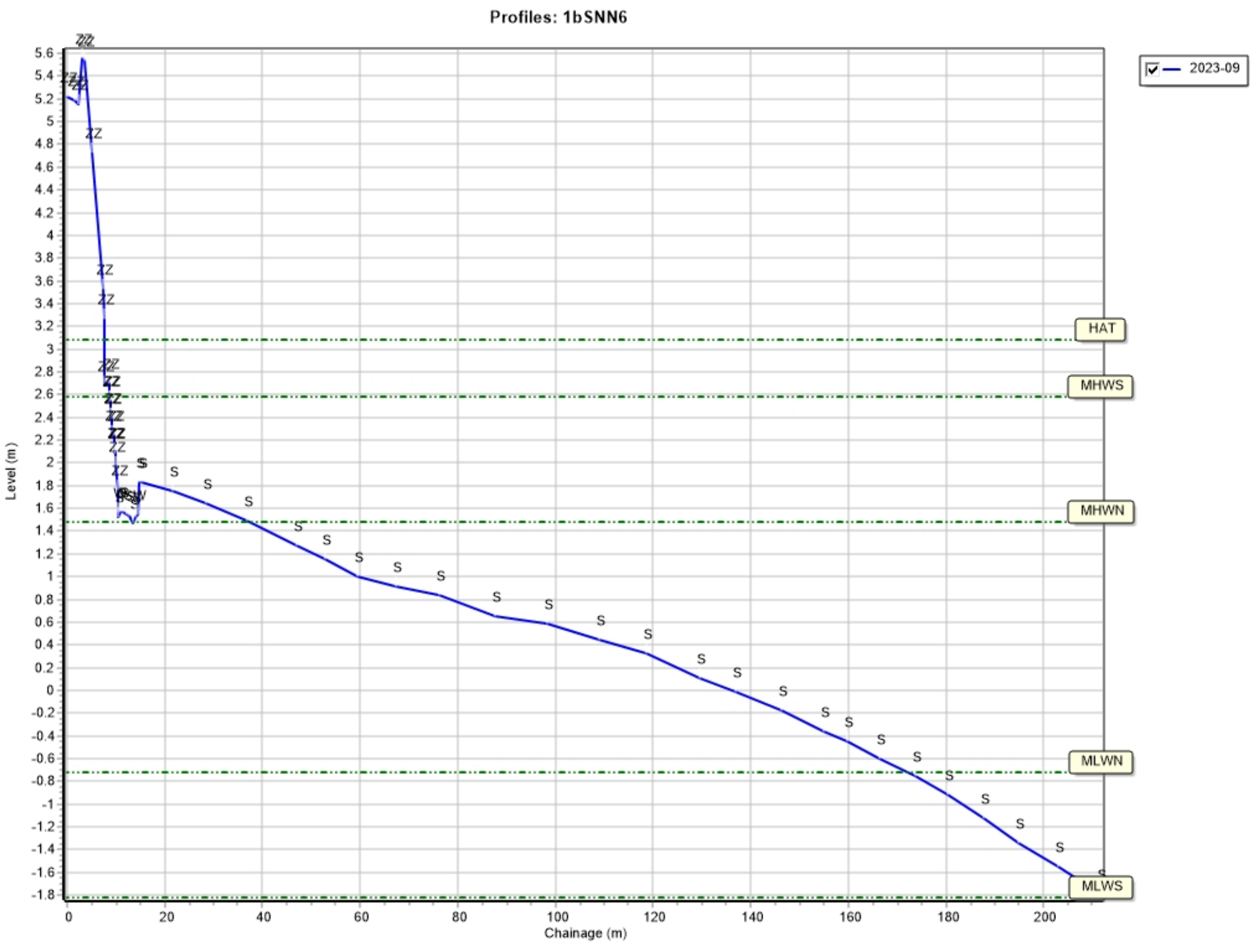

Profiles: 1bSNN5
2023-09
Level (m)
Chainage (m)
HAT
MHWS
MHWN
MLWN
MLWS
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
0
20
40
60
80
100
120
140
160
180
200
220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2023-09
HAT
MHWS
MHWN
MLWN
MLWS
Level (m)
Chainage (m)
5.6
5.4
5.2
5
4.8
4.6
4.4
4.2
4
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
-1.6
-1.8
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20
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60
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140
160
180
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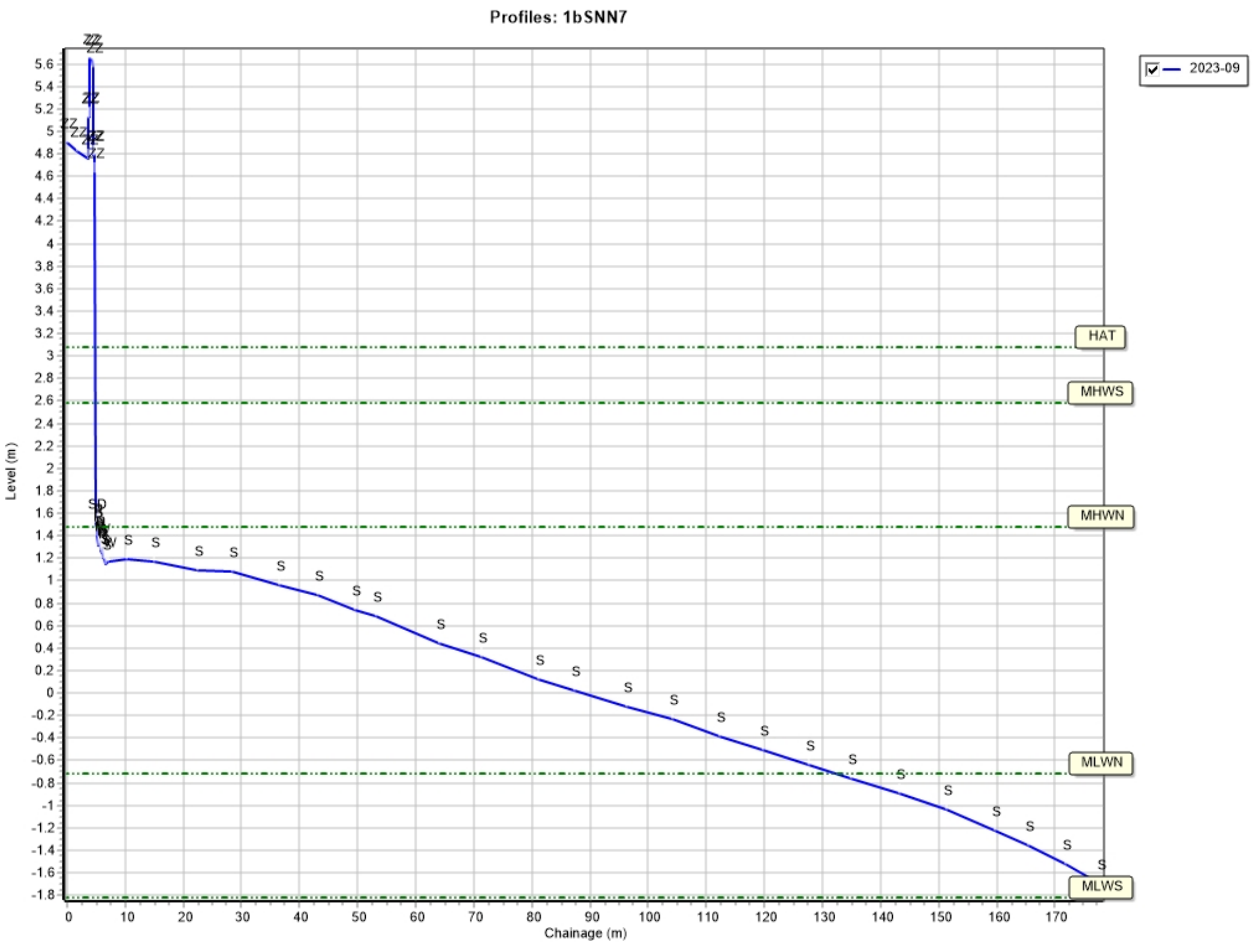
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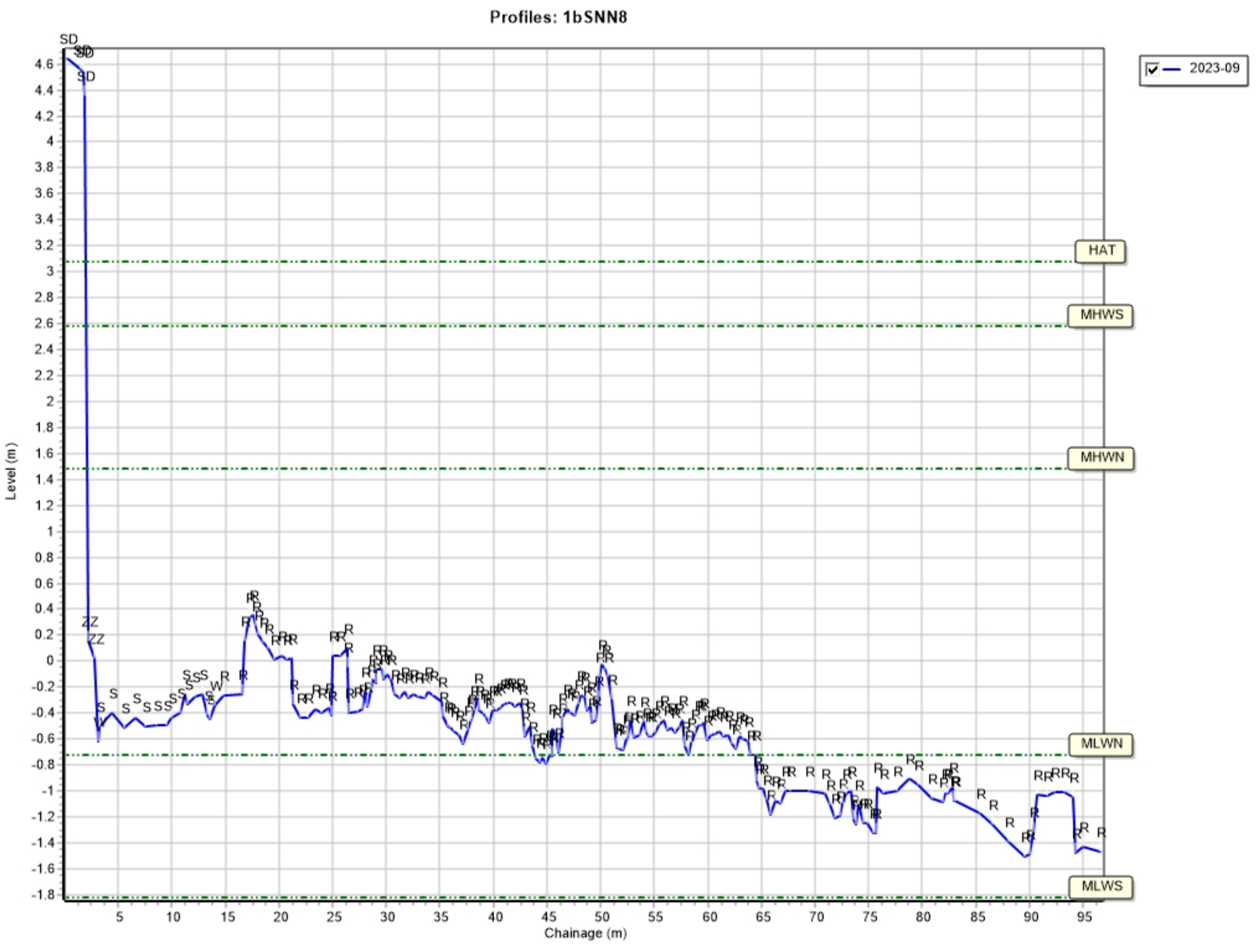
MHWN
MLWN
MLWS
Level (m)
Chainage (m)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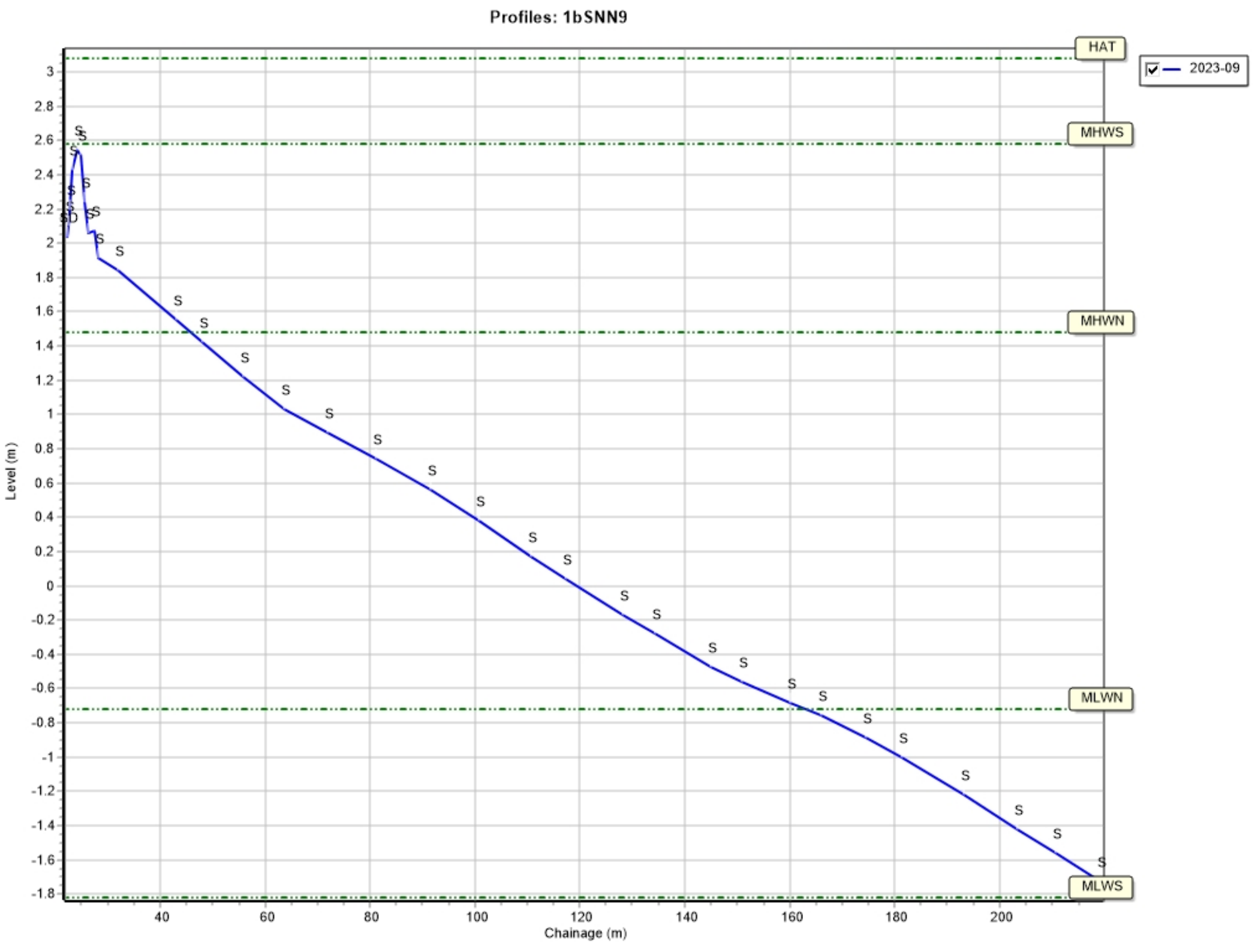
MLWN
MLWS
Level (m)
Chainage (m)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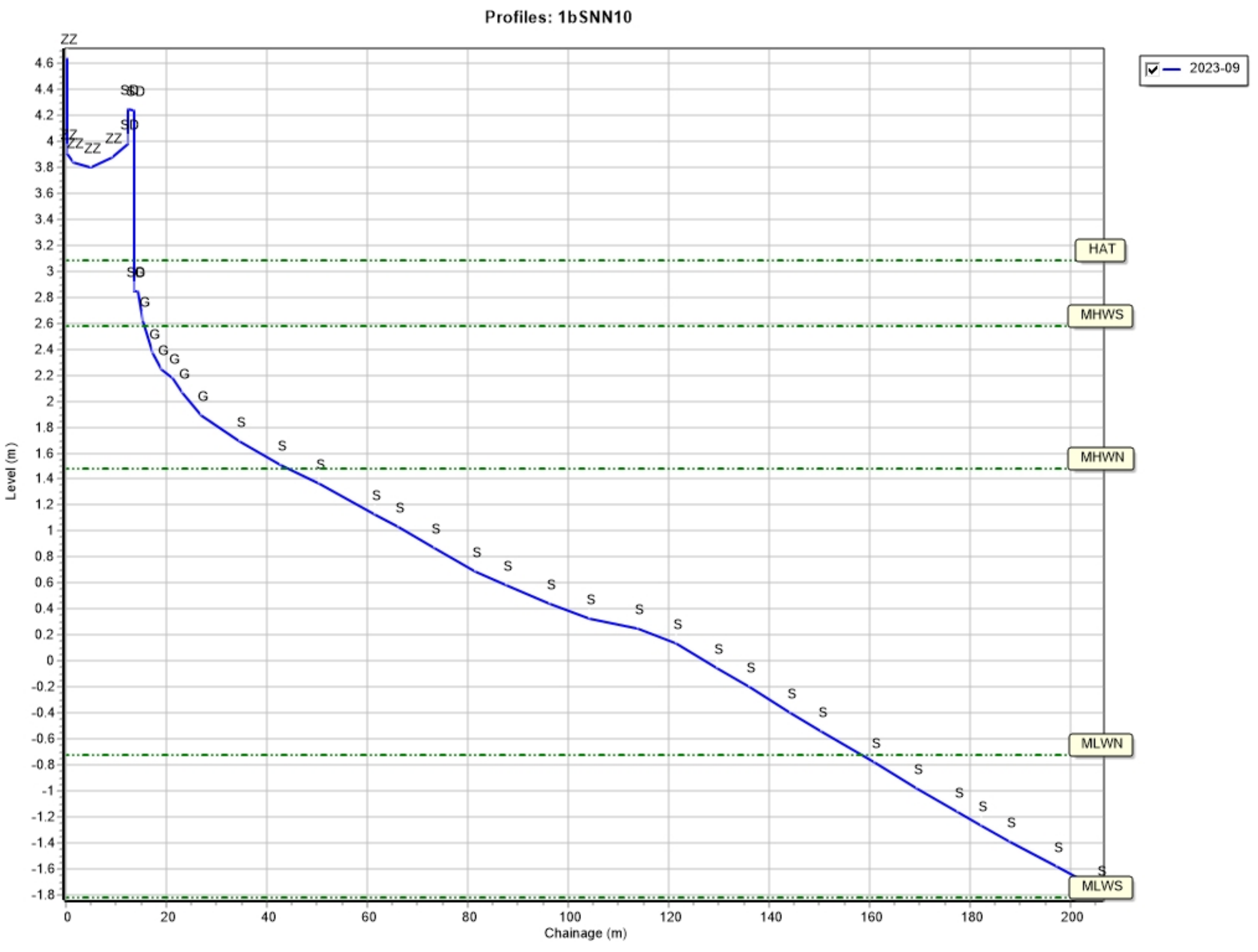
MLWS
2023-09
Level (m)
Chainage (m)
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
-1.6
-1.8
40
60
80
100
120
140
160
180
200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2023-09
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MHWN
MLWN
MLWS
Level (m)
Chainage (m)
4.6
4.4
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4
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
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-1.8
0
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60
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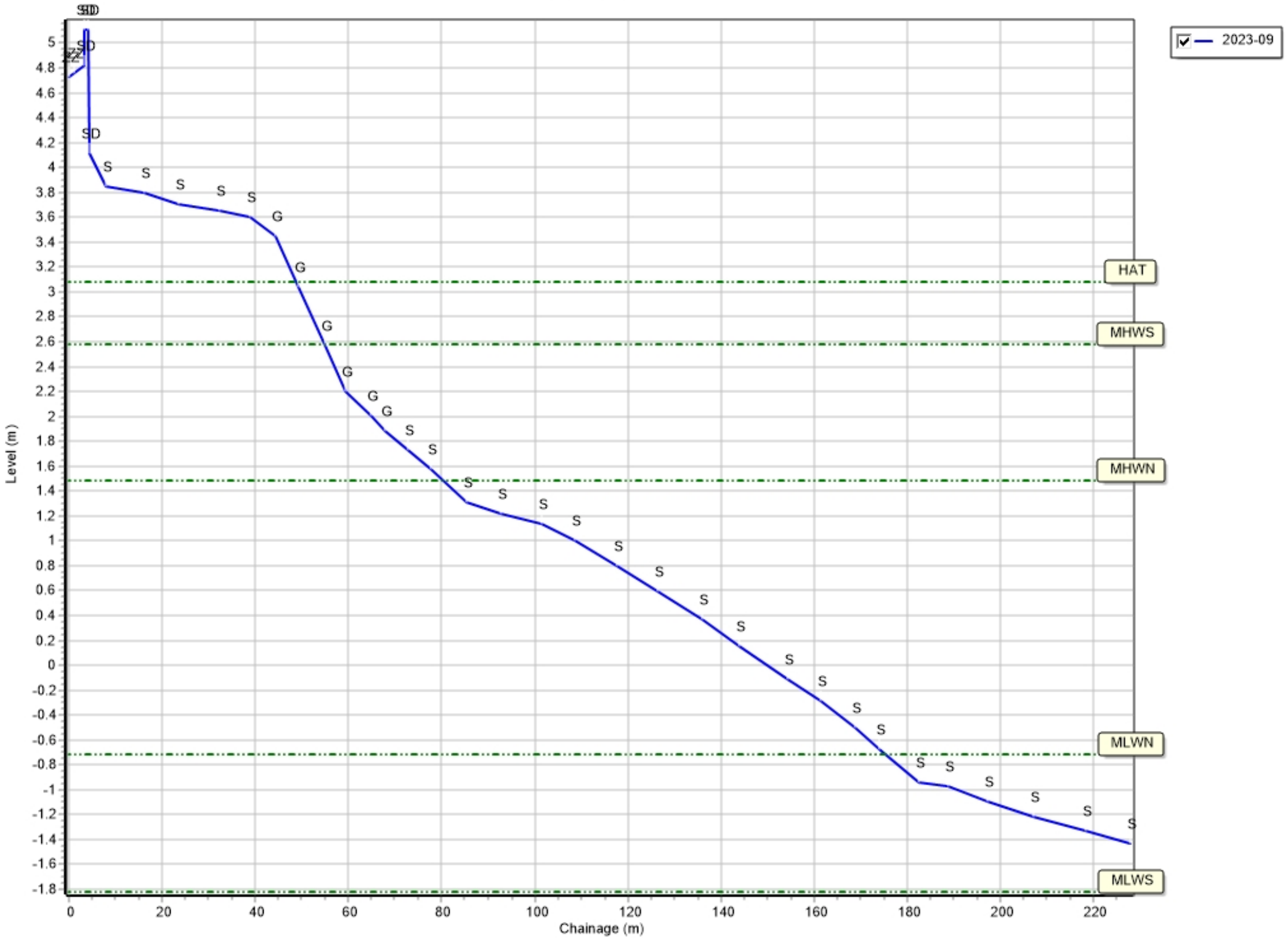
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2023-09
HAT
MHWS
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MLWN
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Level (m)
Chainage (m)
0
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40
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80
100
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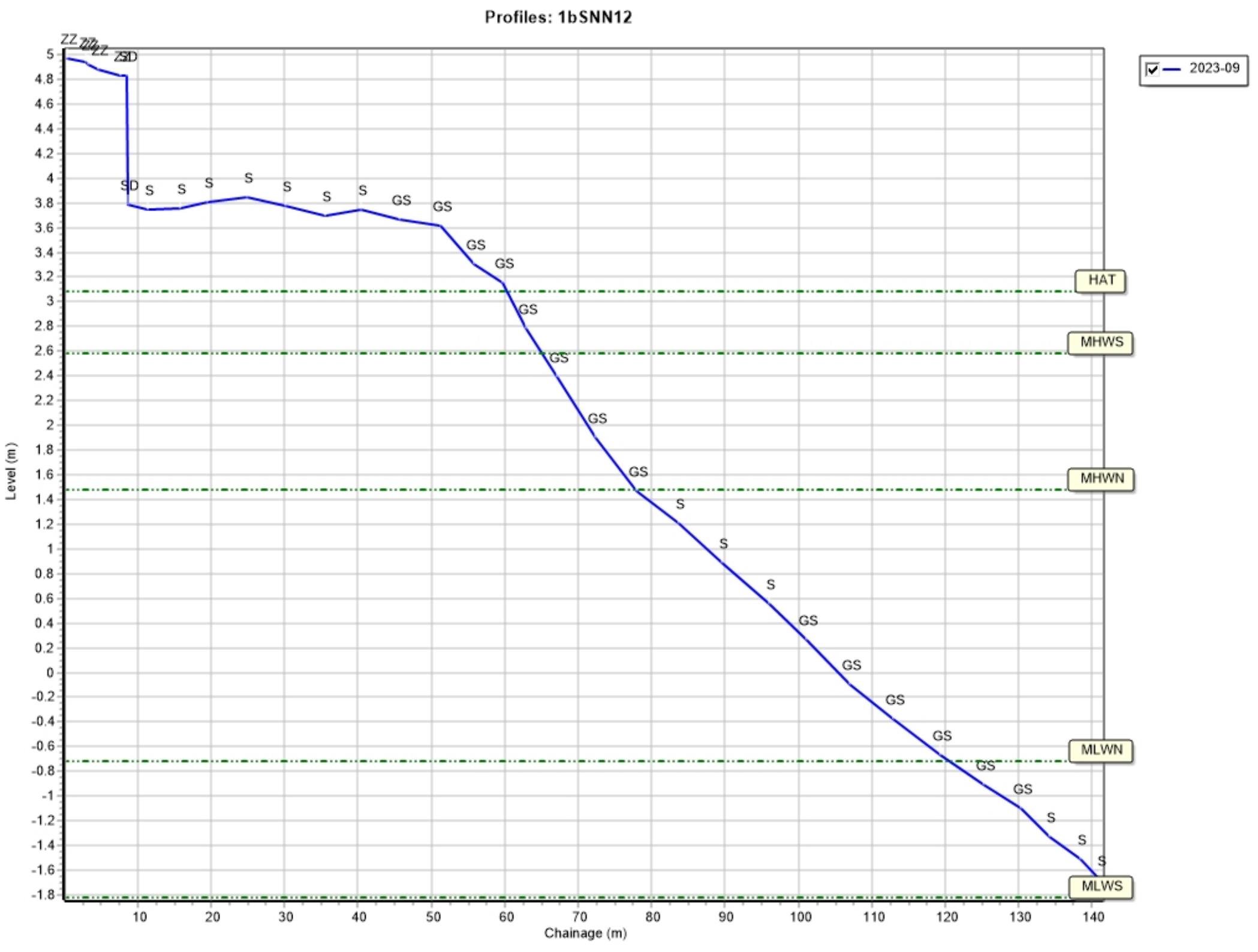
140
160
180
200
220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2023-09
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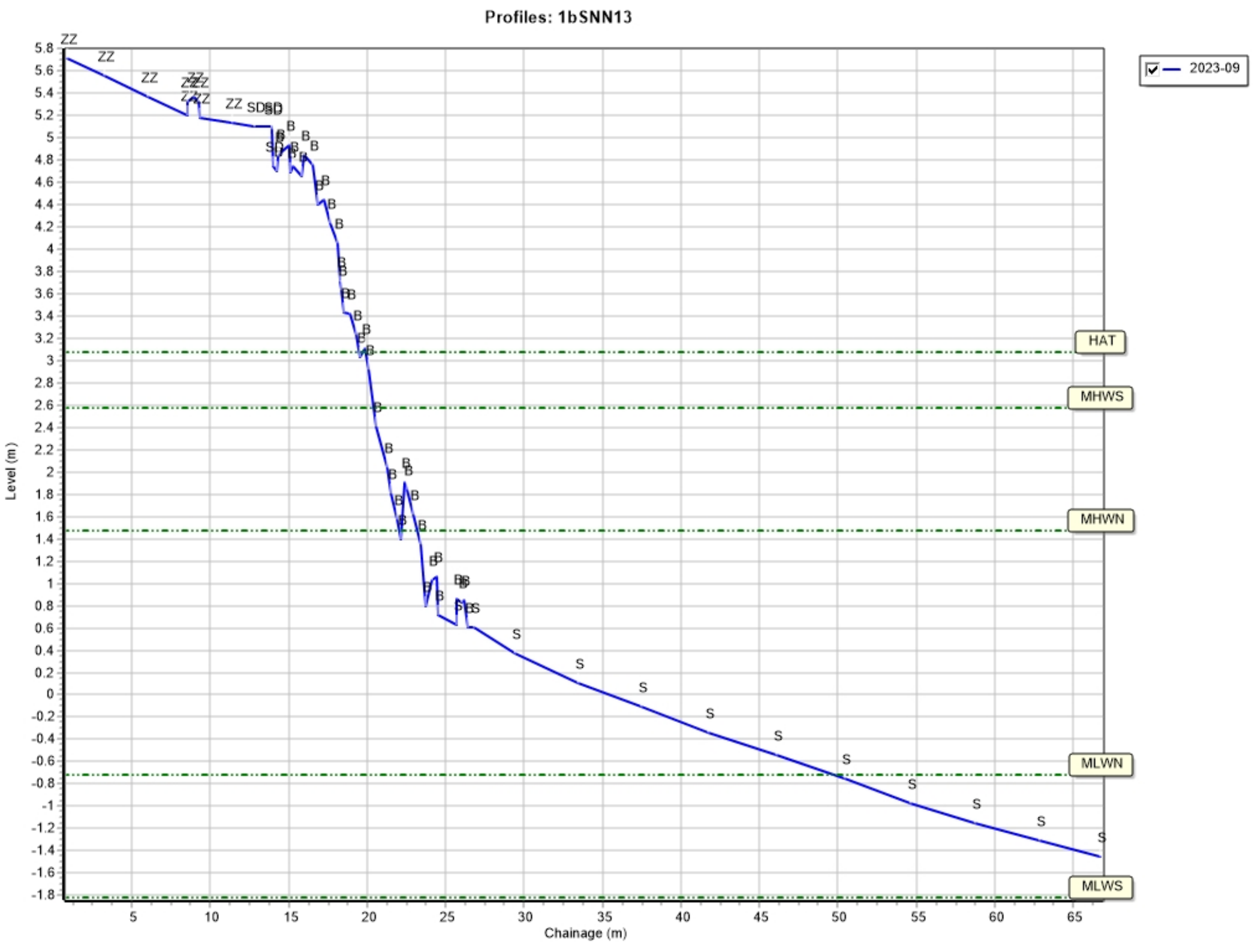
MLWN
MLWS
Level (m)
Chainage (m)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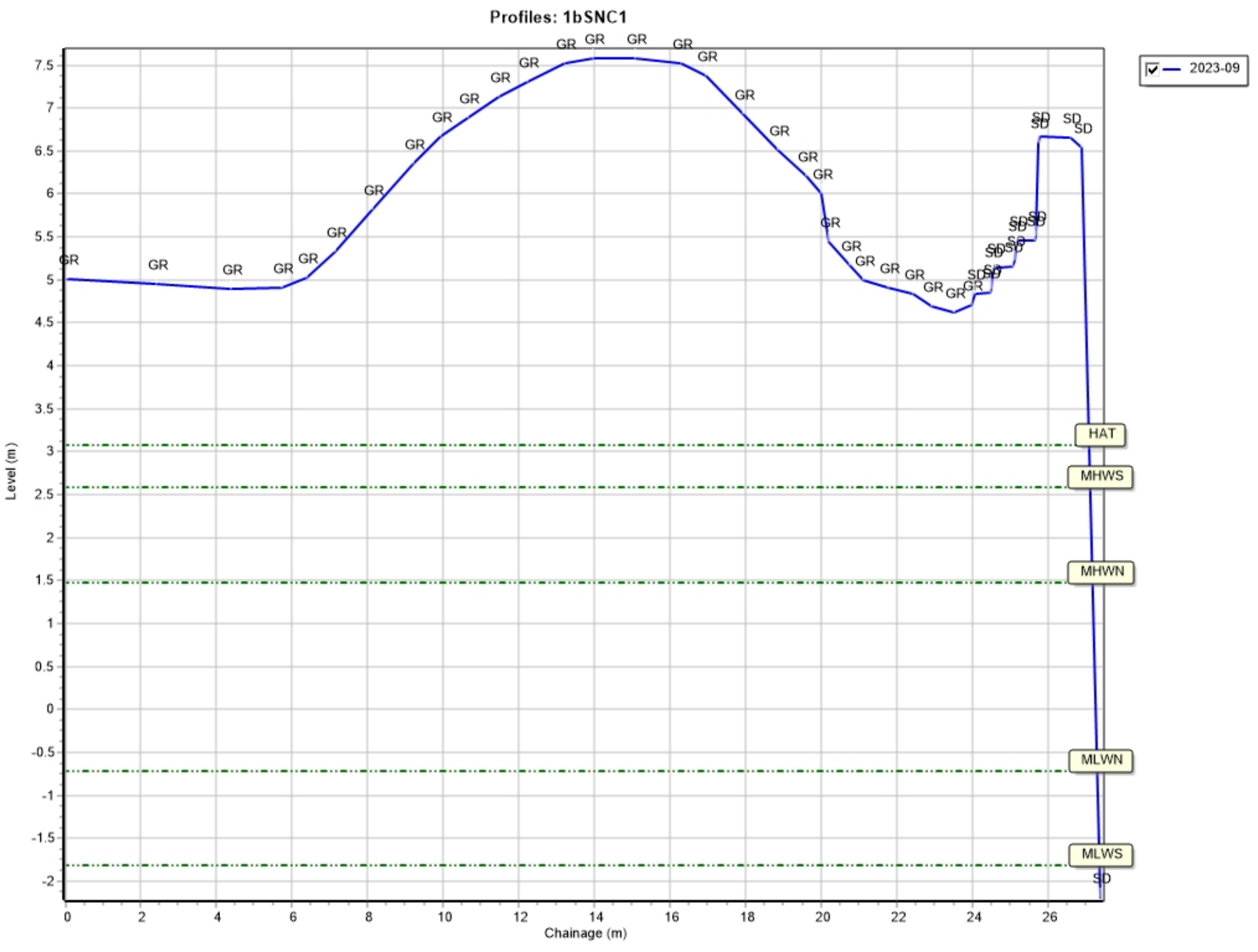
MHWN
MLWN
MLWS
Level (m)
Chainage (m)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2023-09
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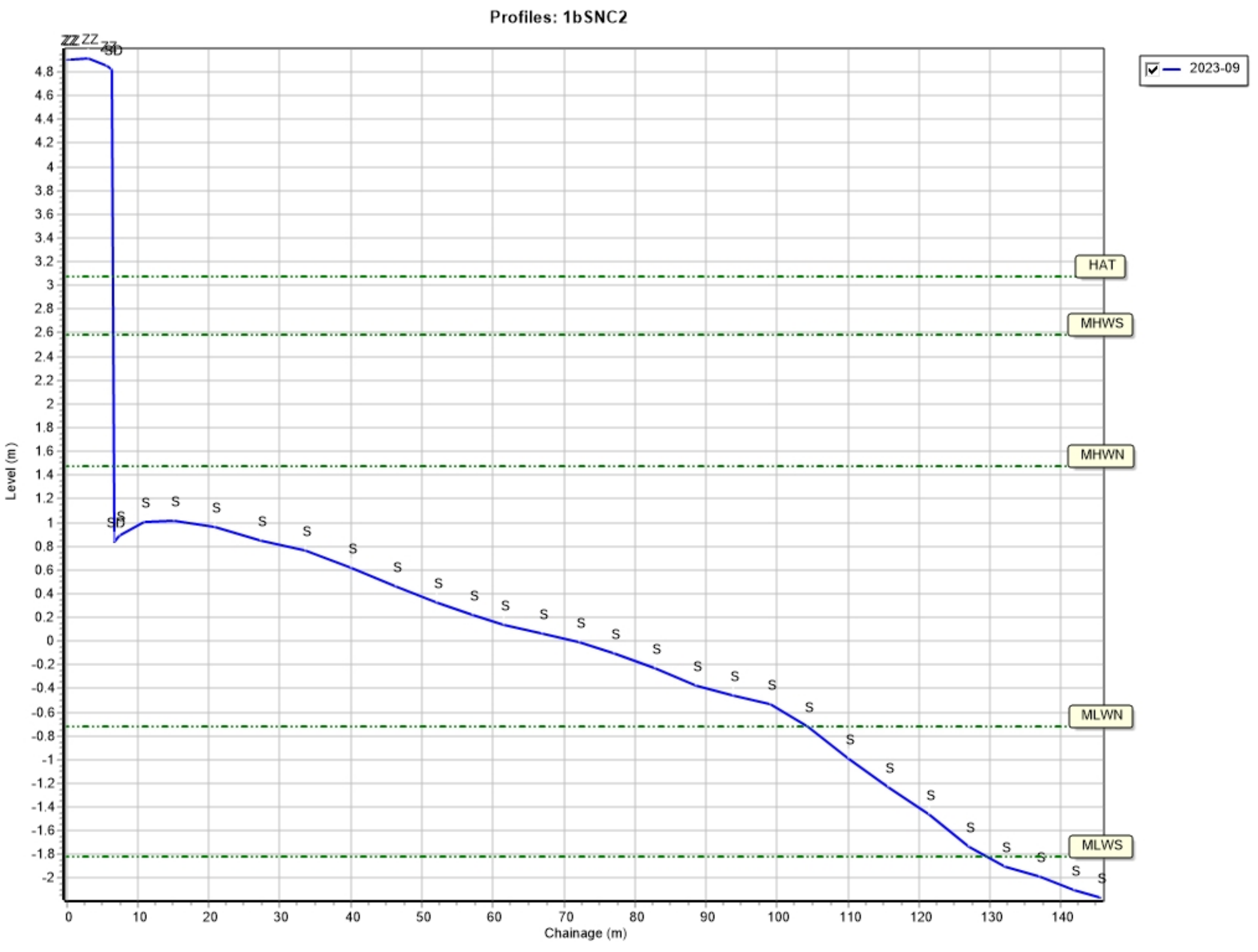
MHWN
MLWN
MLWS
Level (m)
Chainage (m)
GR
SD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2023-09
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MHWS
MHWN
MLWN
MLWS
Level (m)
Chainage (m)
4.8
4.6
4.4
4.2
4
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
-1.6
-1.8
-2
0
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30
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50
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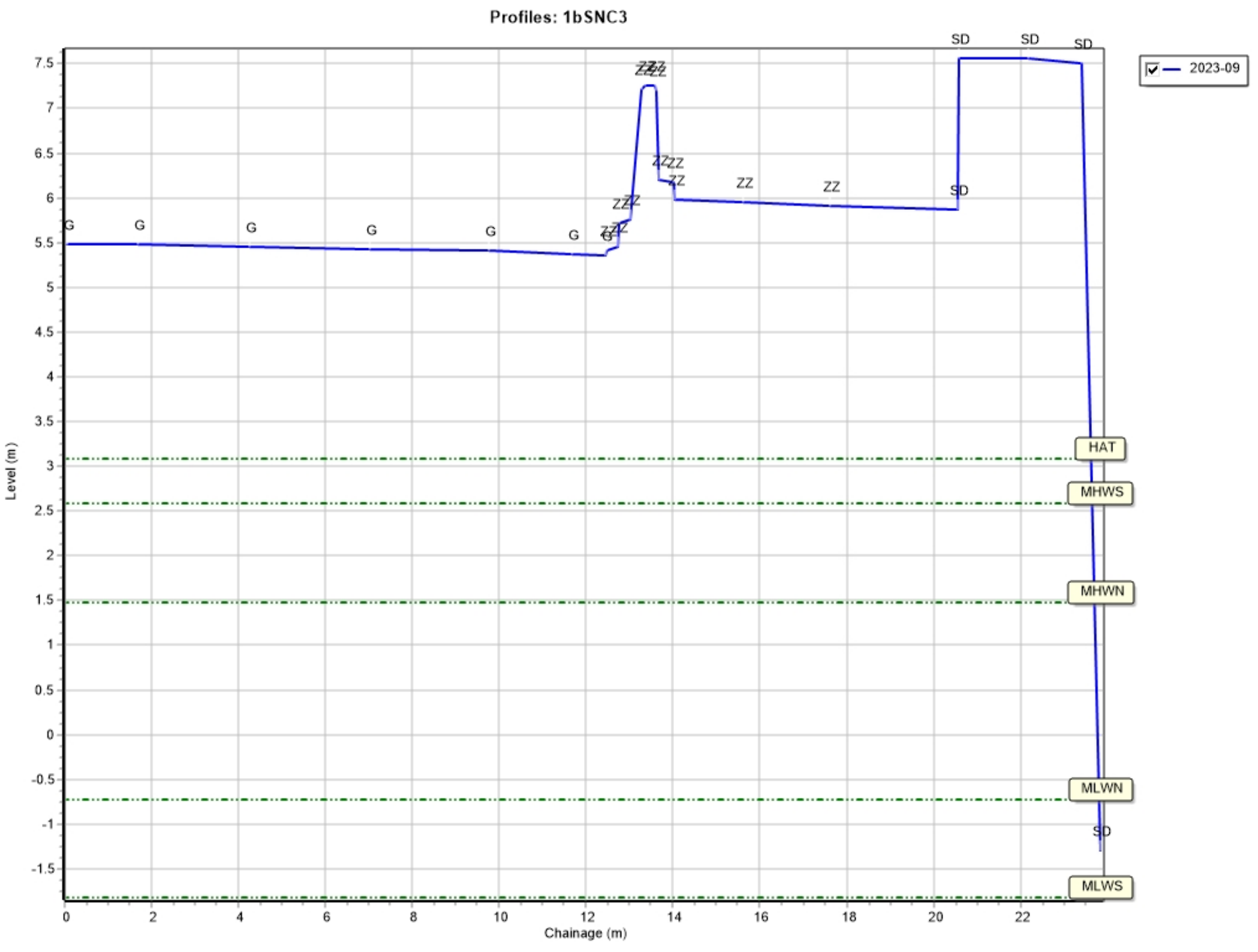
70
80
90
100
110
120
130
140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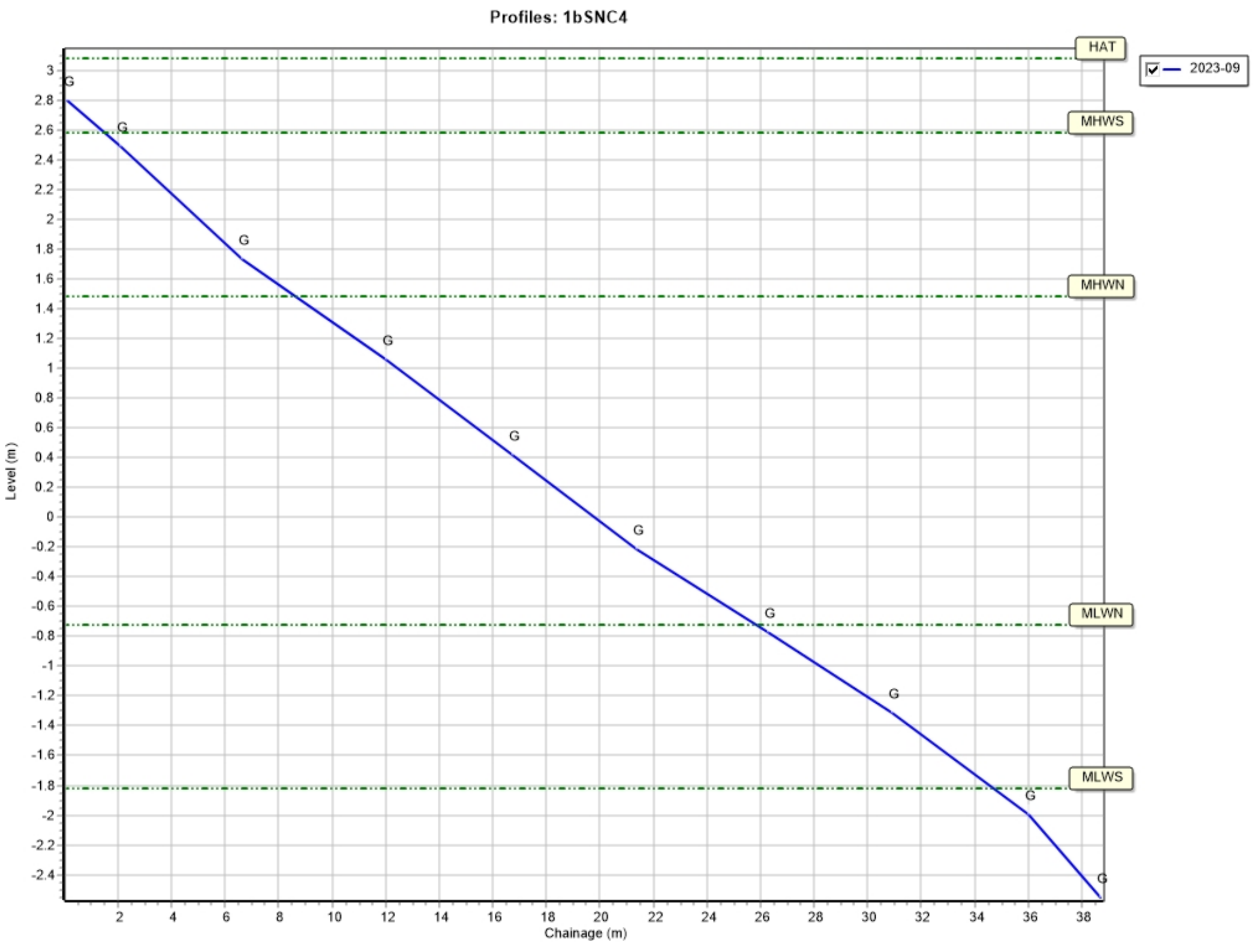
2023-09
Level (m)
Chainage (m)
HAT
MHWS
MHWN
MLWN
MLWS
SD
G
ZZ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HAT
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MHWN
MLWN
MLWS
2023-09
Level (m)
Chainage (m)
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
-1.6
-1.8
-2
-2.2
-2.4
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20
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26
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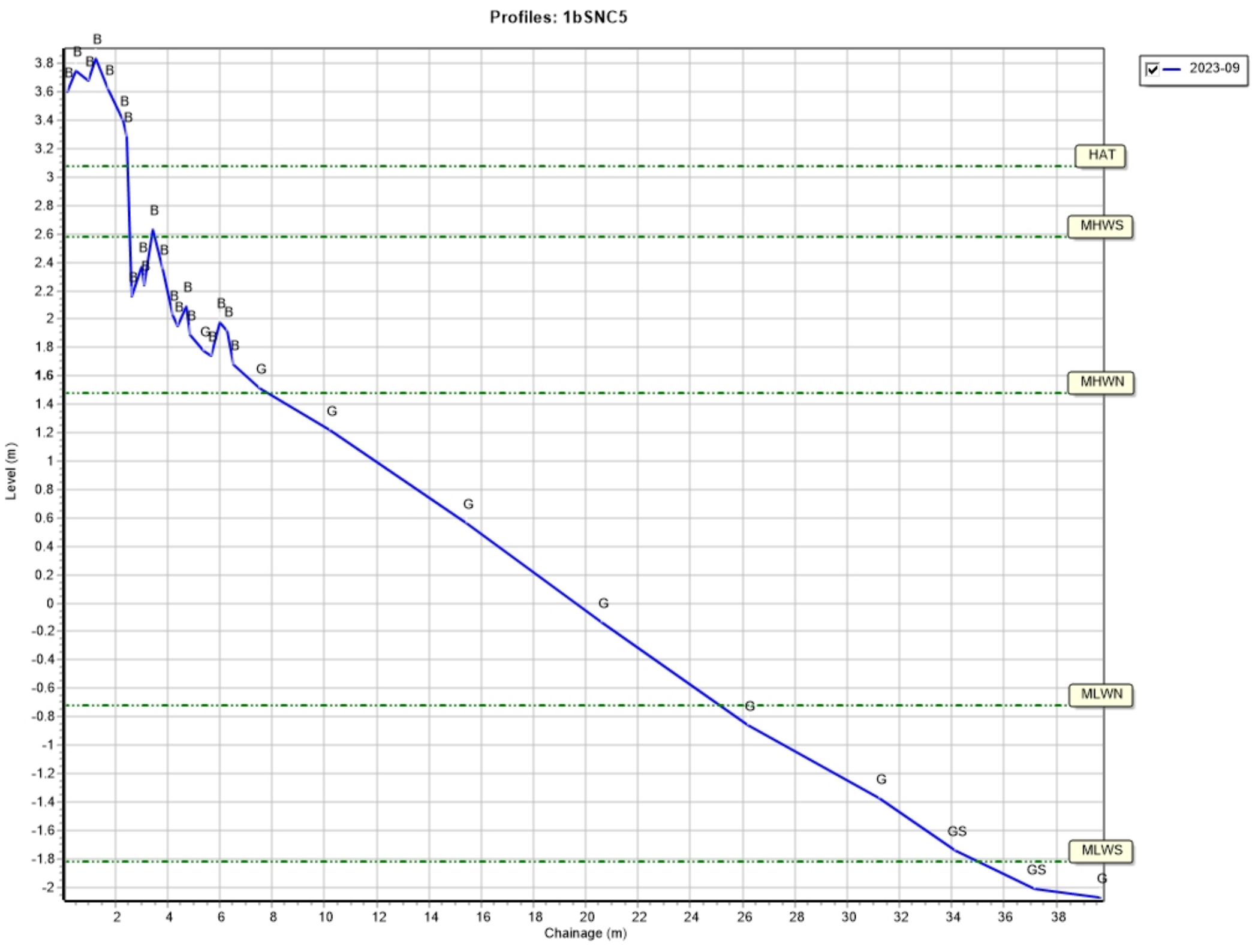
36
38
G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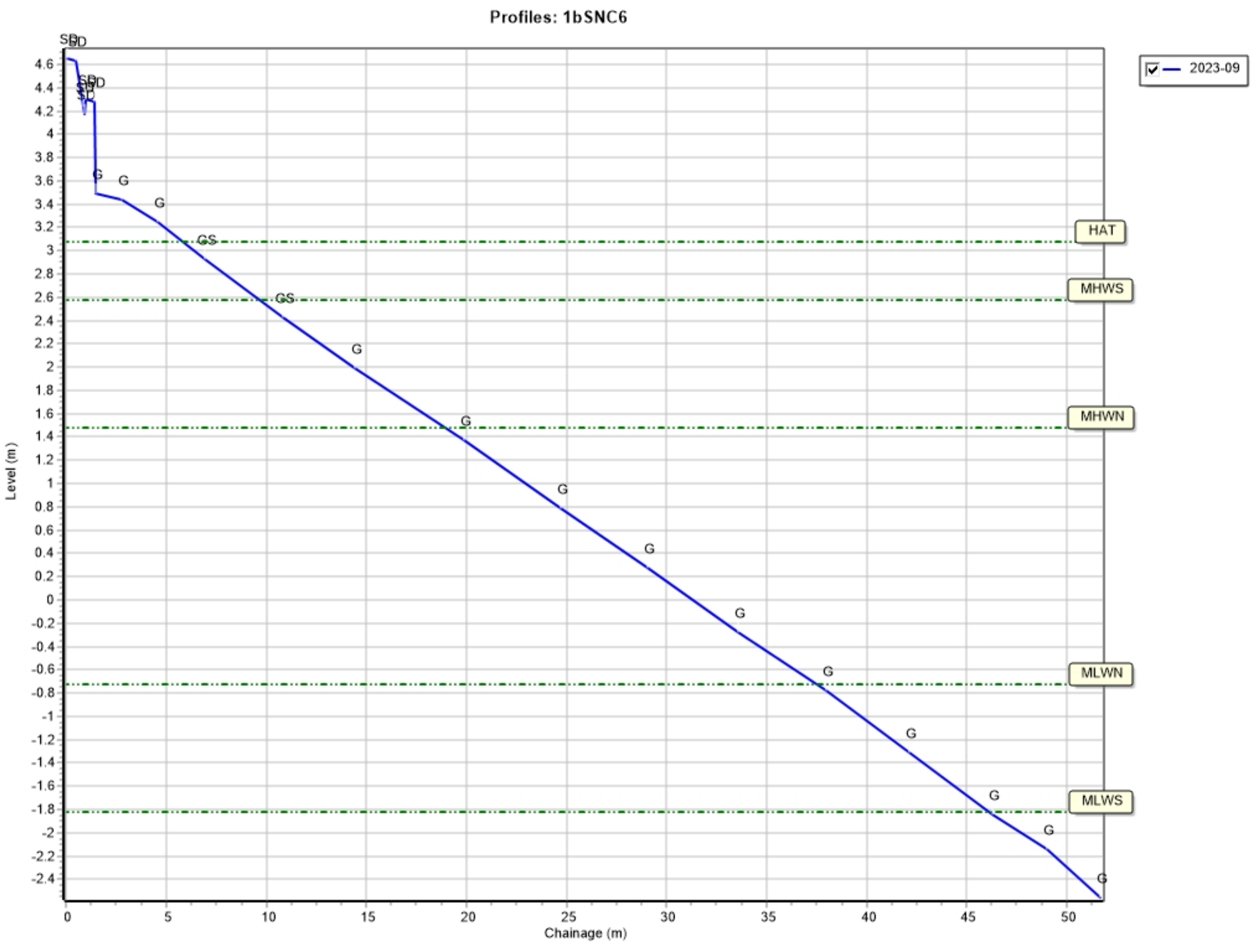
2023-09
HAT
MHWS
MHWN
MLWN
MLWS
Level (m)
Chainage (m)


Profiles: 1bSNC6
2023-09
HAT
MHWS
MHWN
MLWN
MLWS
Level (m)
Chainage (m)
4.6
4.4
4.2
4
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
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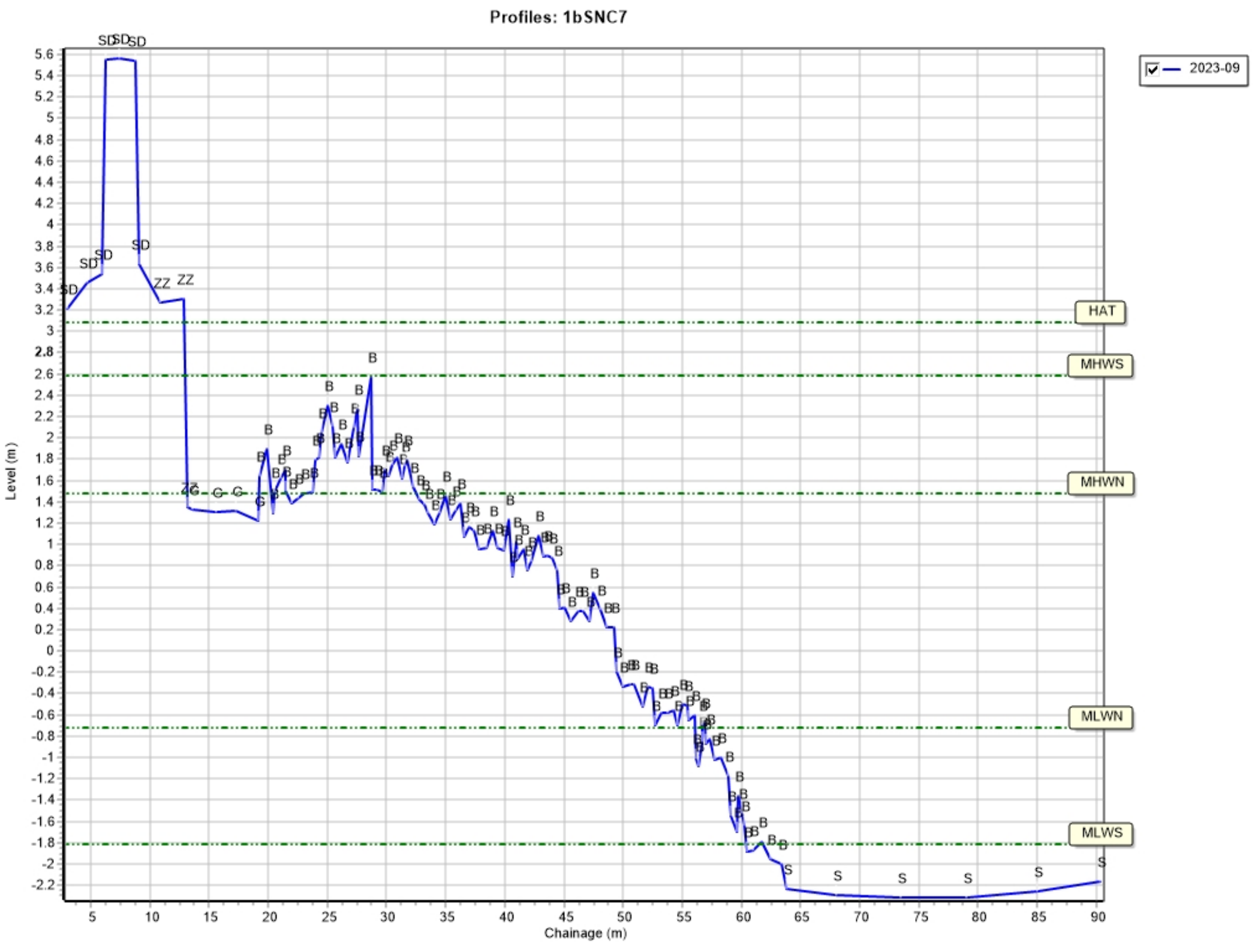
45
50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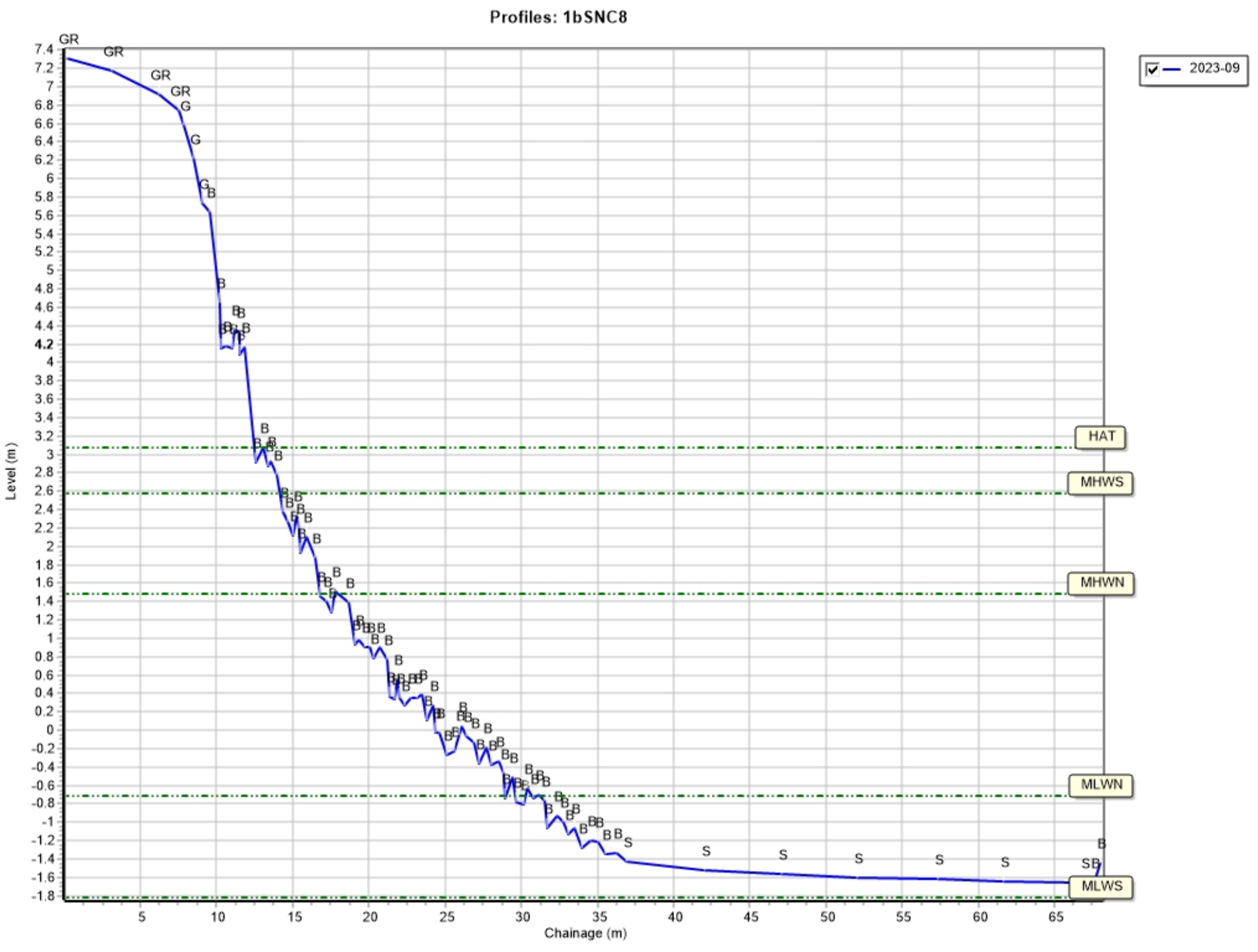
2023-09
HAT
MHWS
MHWN
MLWN
MLWS
Level (m)
Chainage (m)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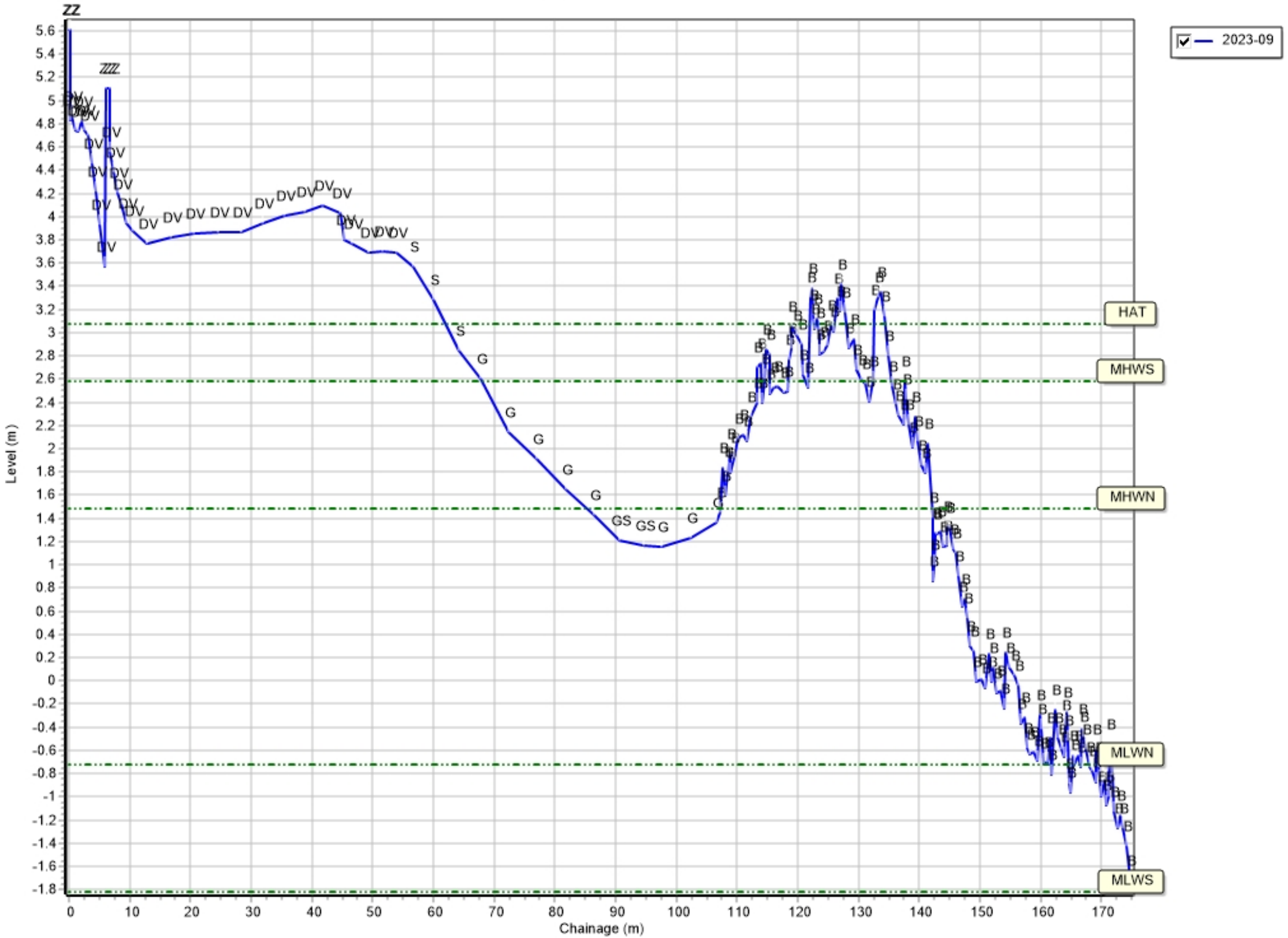
HAT
MHWS
MHWN
MLWN
MLWS
Level (m)
Chainage (m)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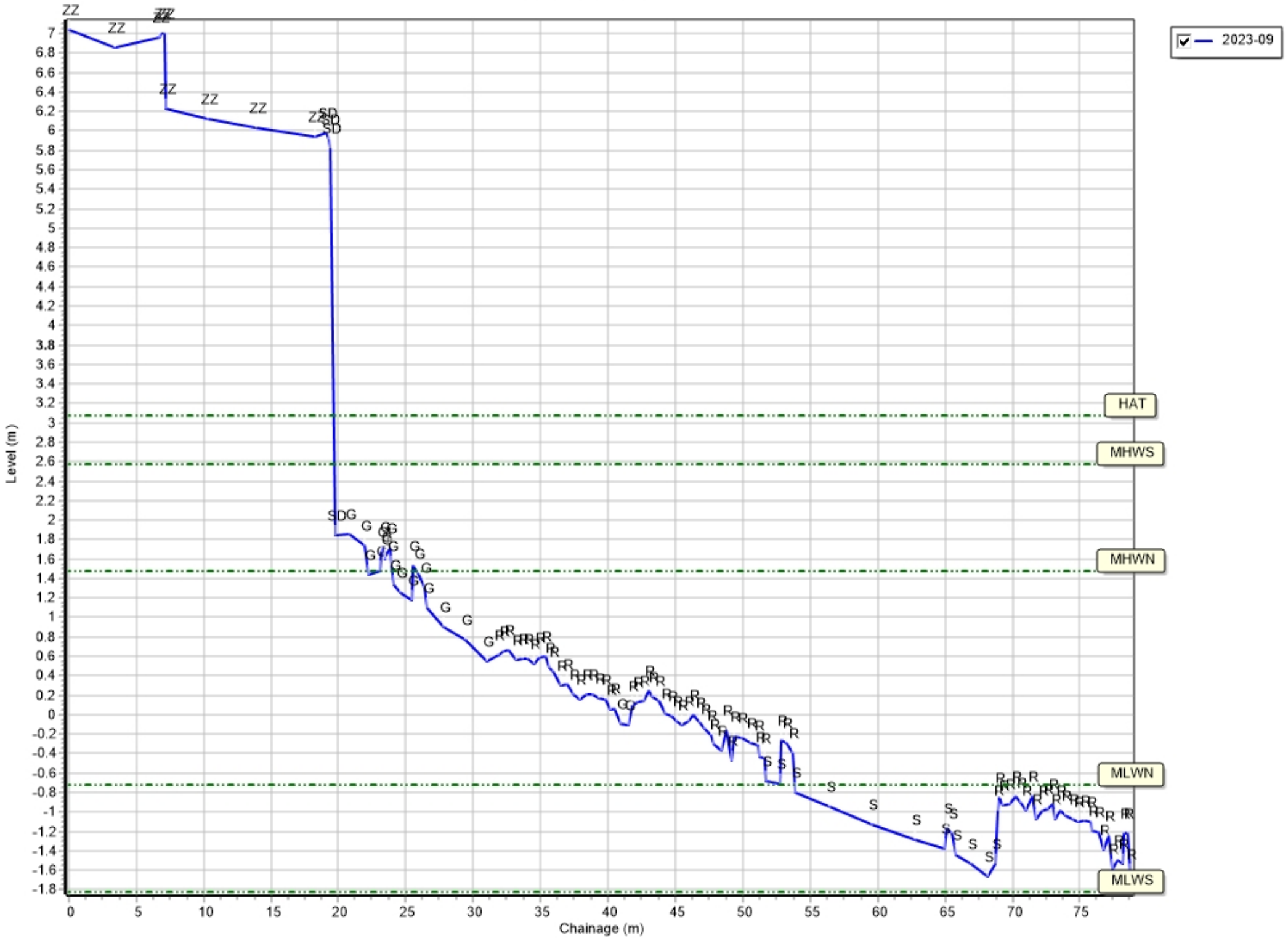
MHWS
MHWN
MLWN
MLWS
Level (m)
Chainage (m)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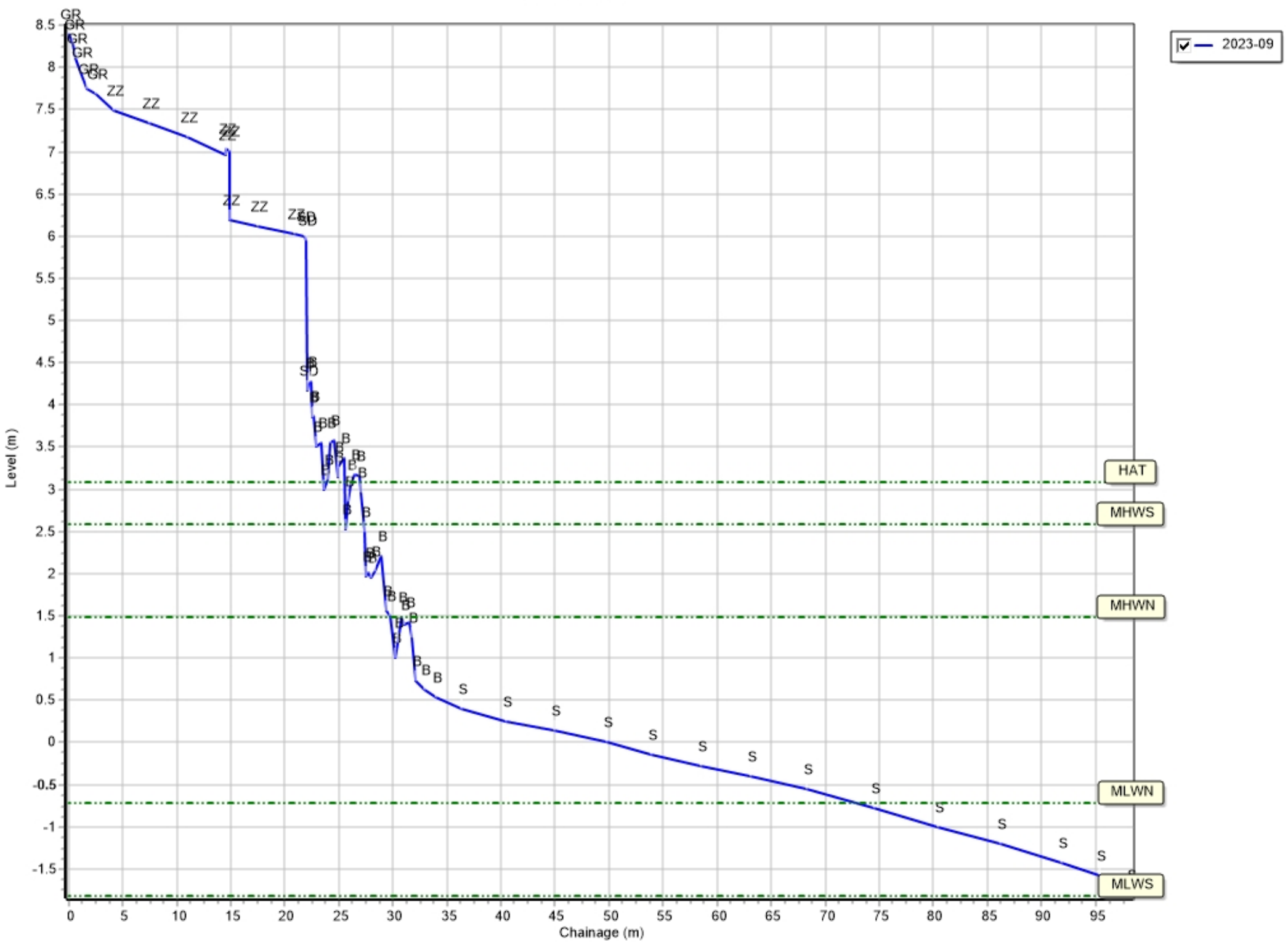
2023-09
HAT
MHWS
MHWN
MLWN
MLWS
Level (m)
Chainage (m)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2023-09
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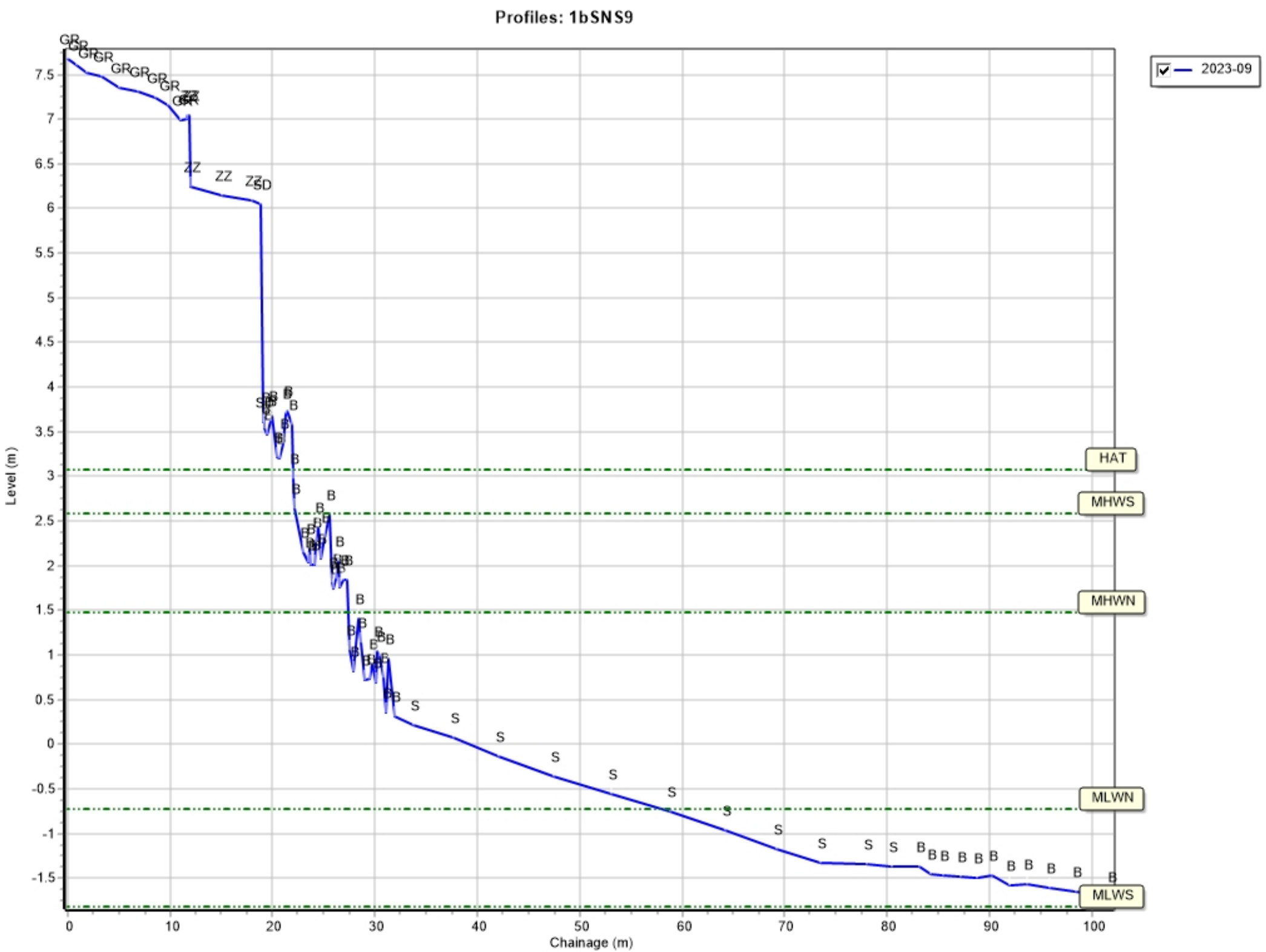
MHWN
MLWN
MLWS
Level (m)
Chainage (m)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2023-09
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MLWN
MLWS
Level (m)
Chainage (m)
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7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
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-1
-1.5
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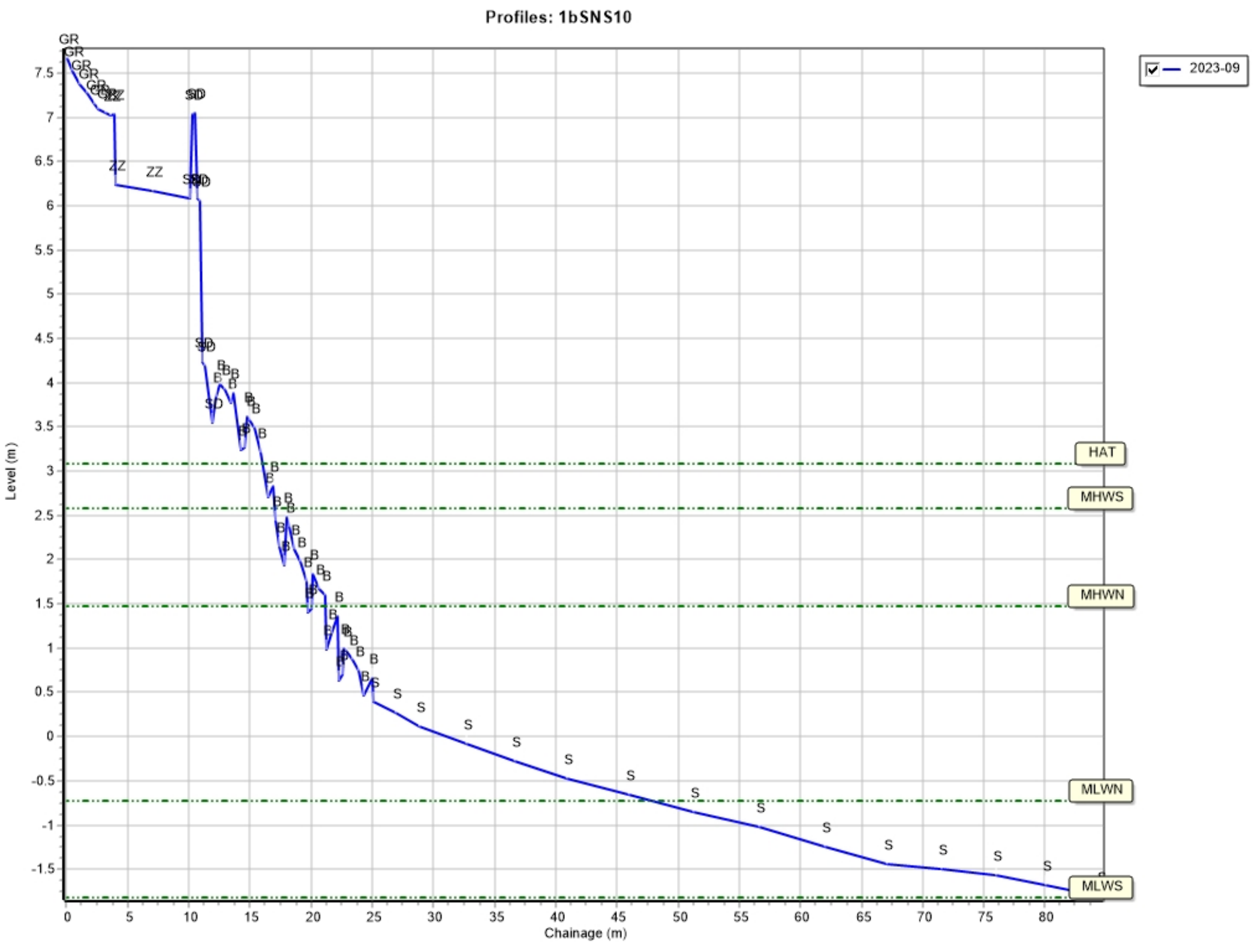
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Level (m)
Chainage (m)
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6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
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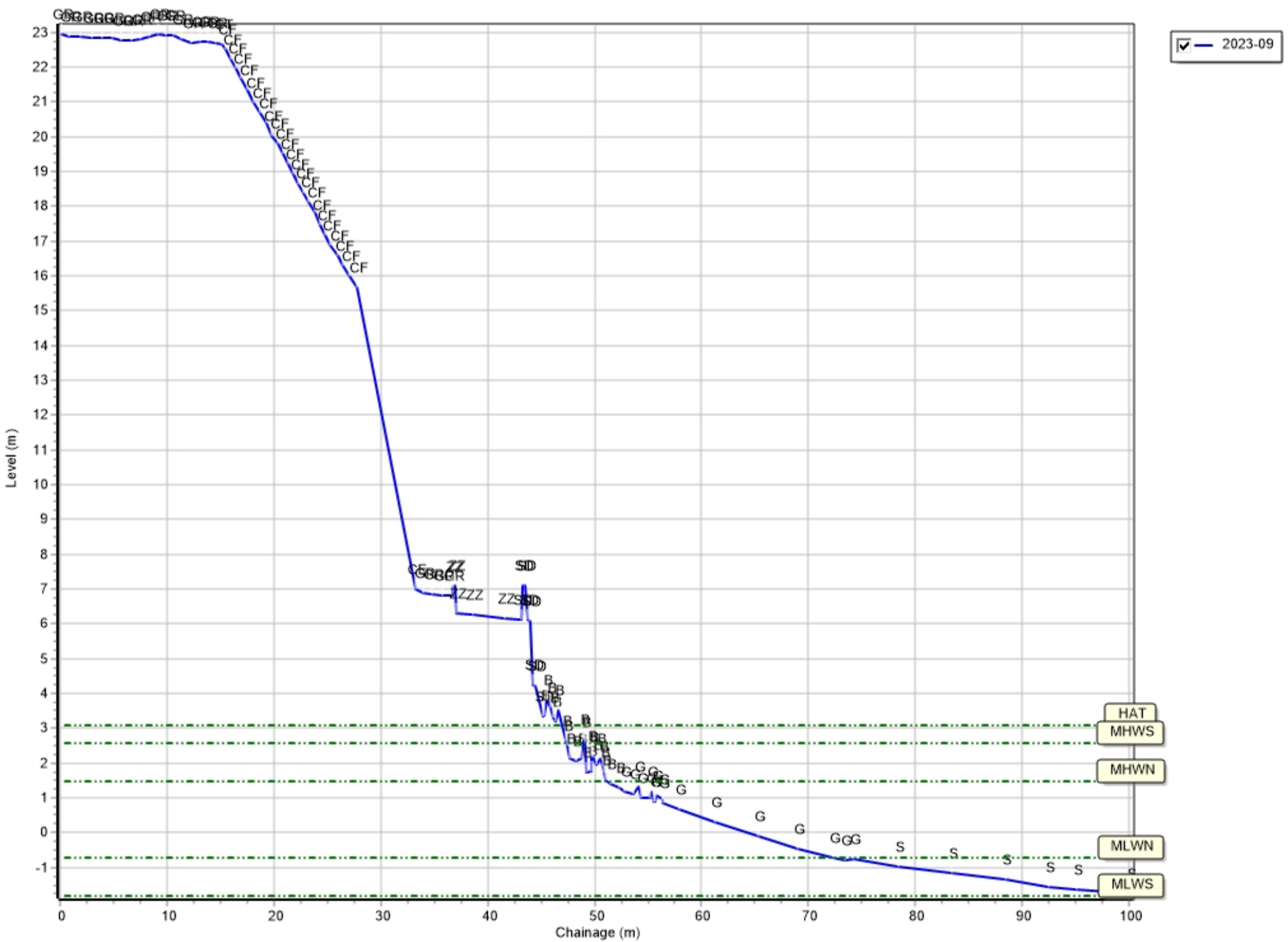
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2023-09
Level (m)
Chainage (m)
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MHWN
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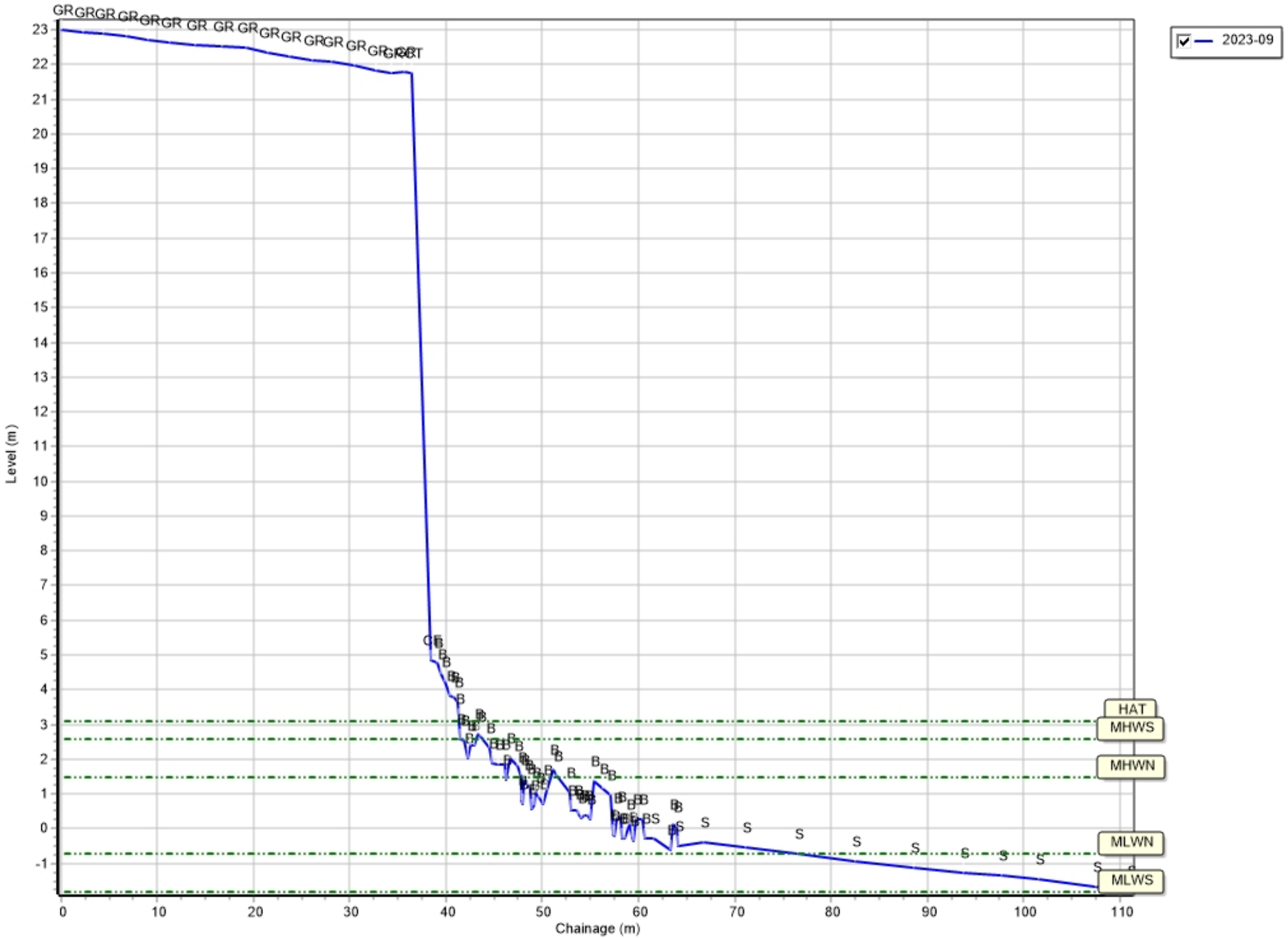
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2023-09
Level (m)
Chainage (m)
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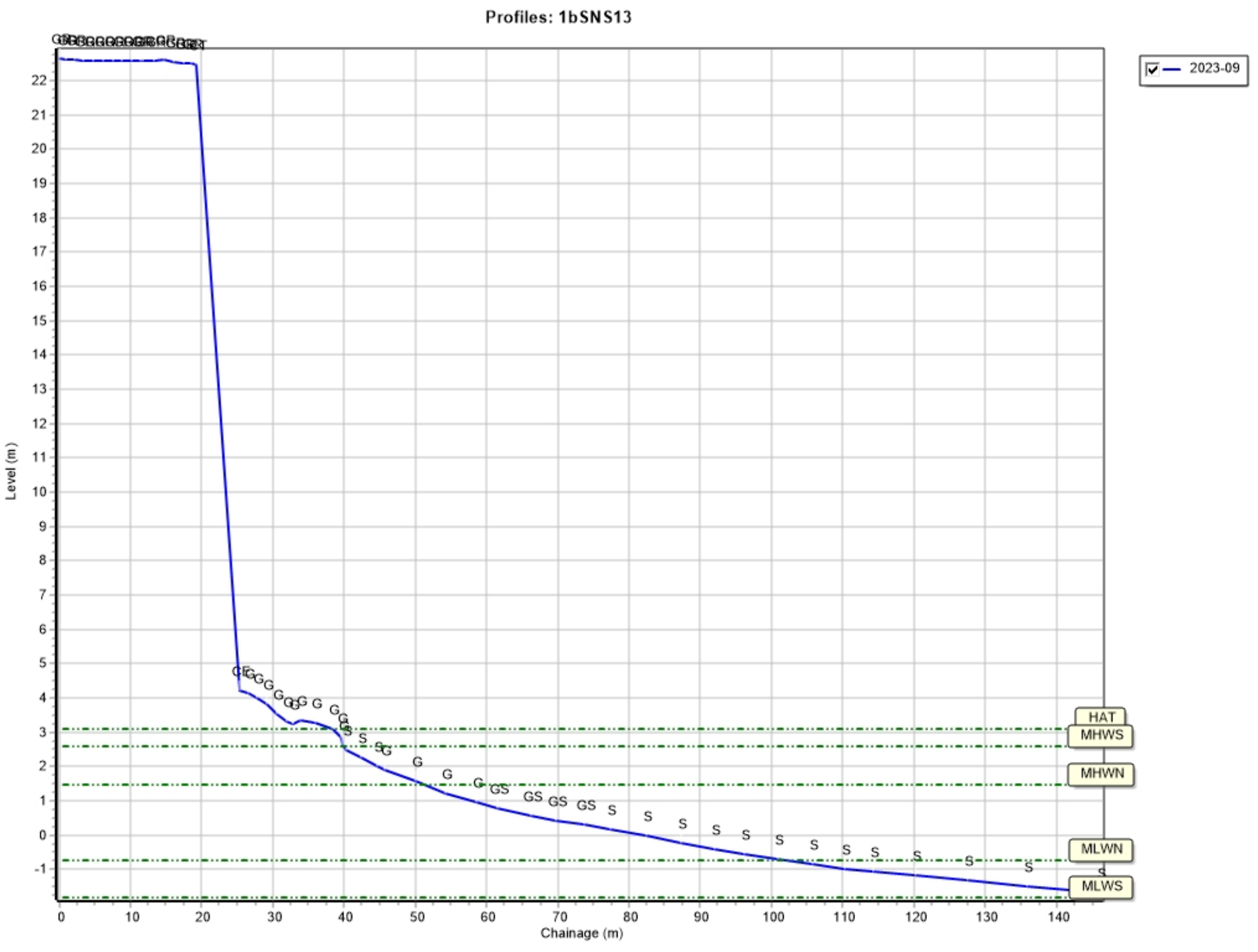
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2023-09
Level (m)
Chainage (m)
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MHWN
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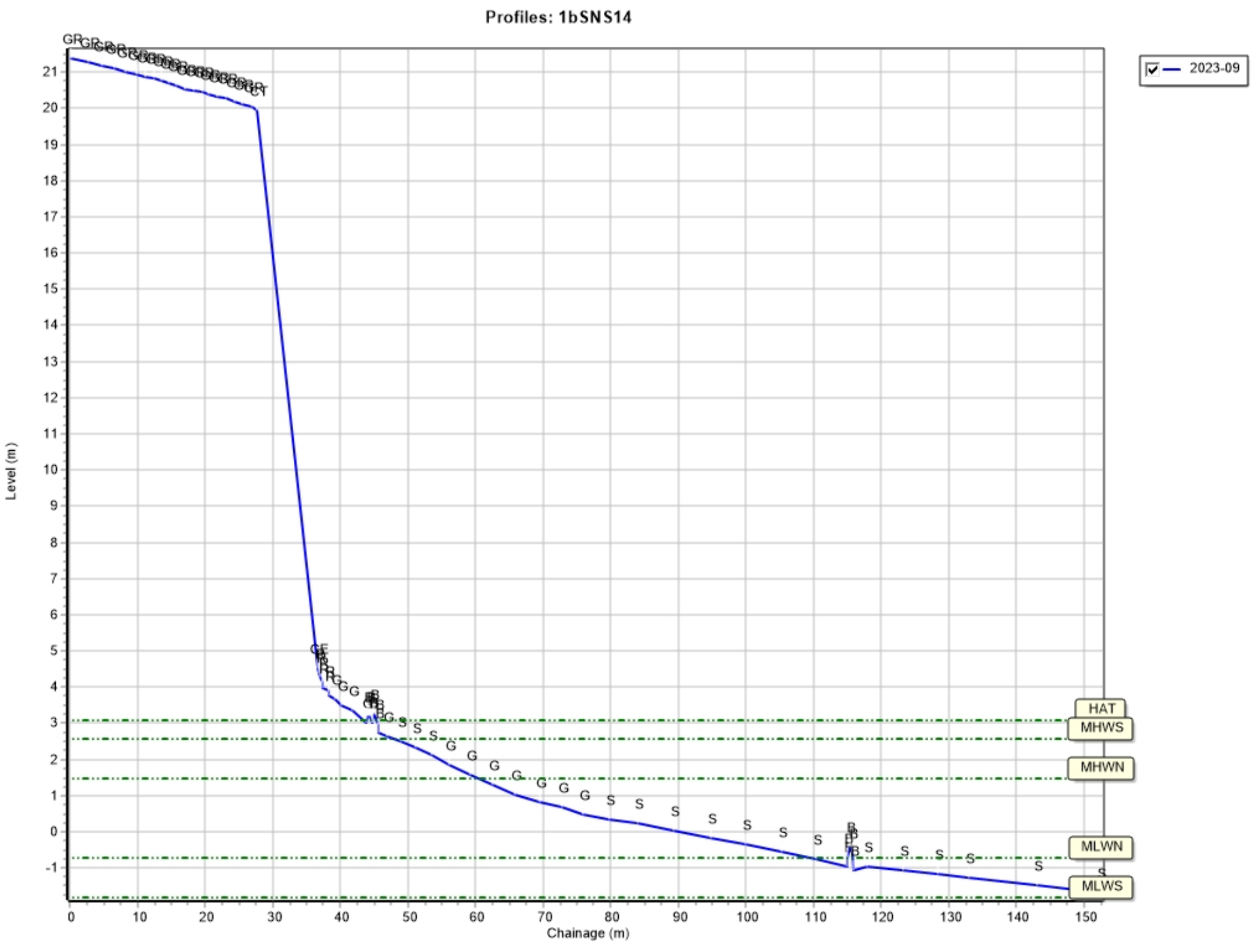
MLWS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Level (m)
Chainage (m)
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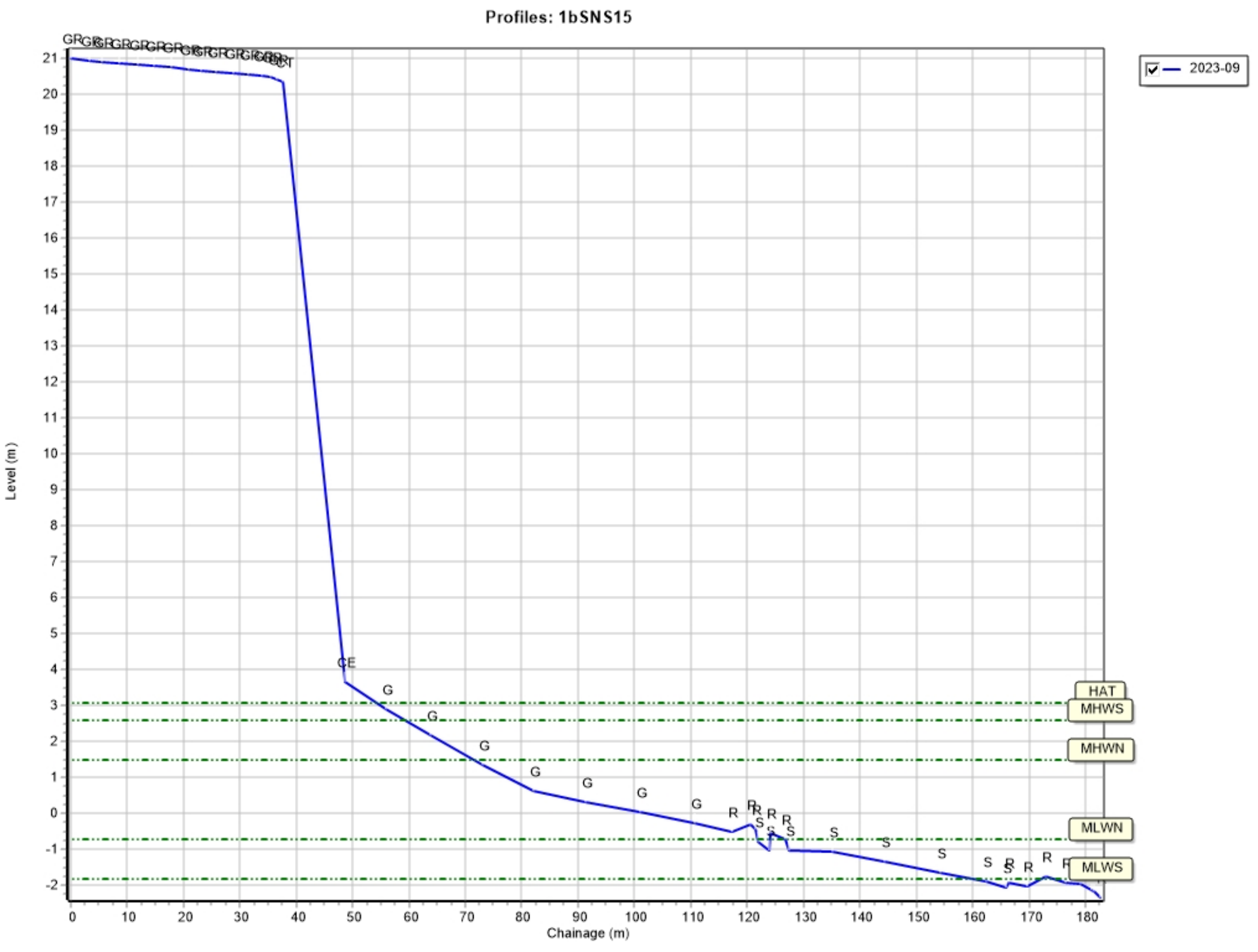
MHWN
MLWN
MLWS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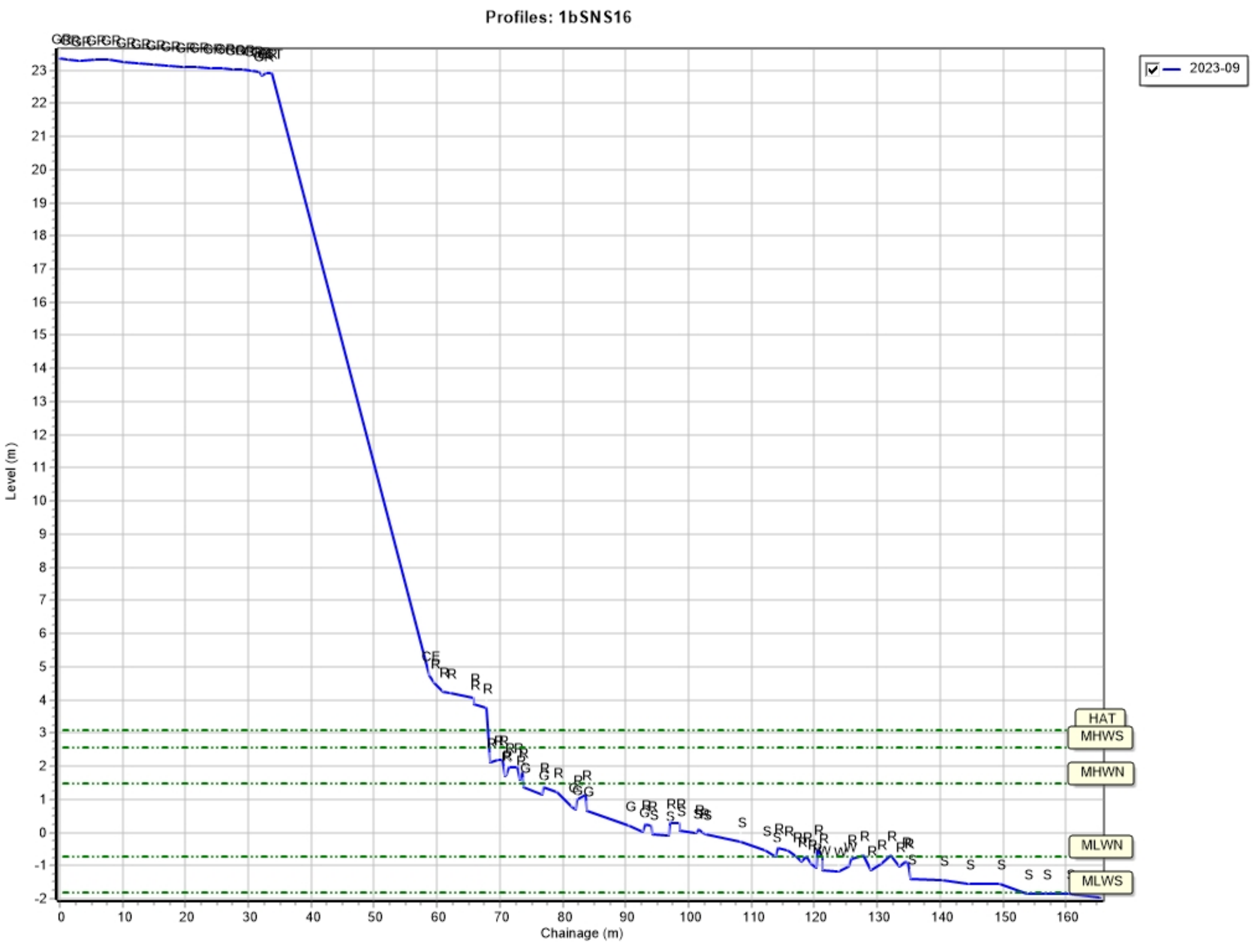
2023-09
Level (m)
Chainage (m)
HAT
MHWS
MHWN
MLWN
MLWS
CE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2023-09
Level (m)
Chainage (m)
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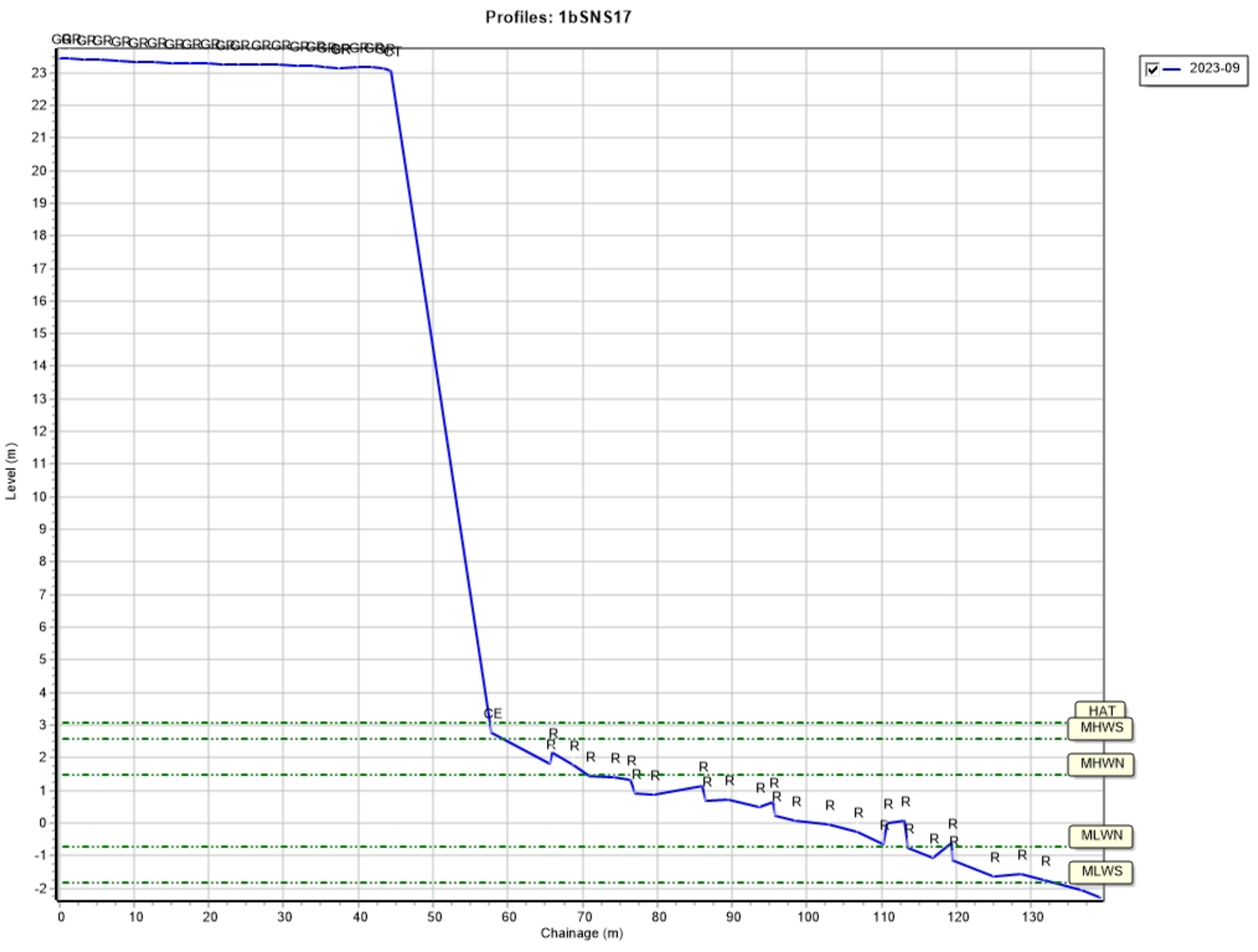
MHWS
MHWN
MLWN
MLWS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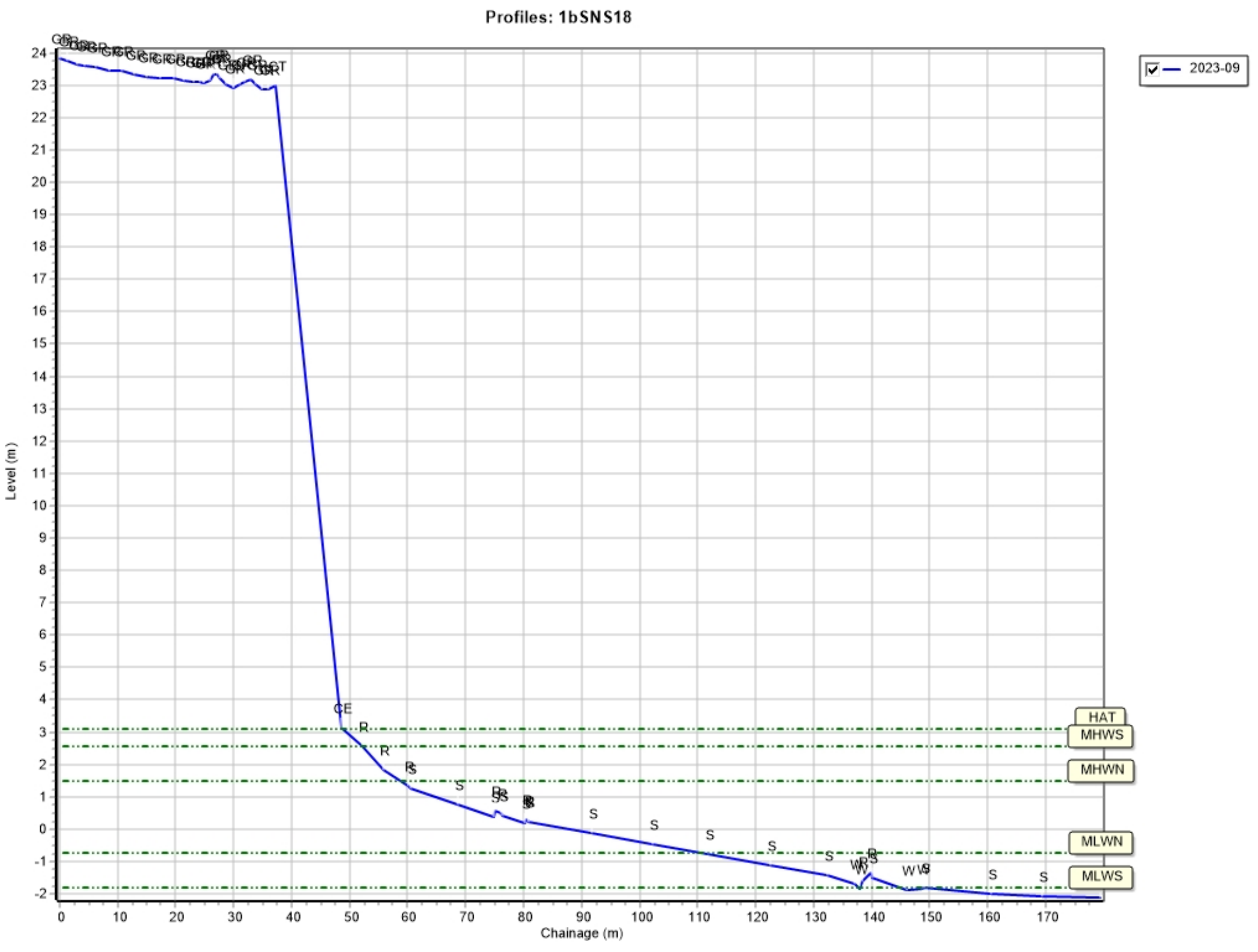
2023-09
Level (m)
Chainage (m)
CE
HAT
MHWS
MHWN
MLWN
MLWS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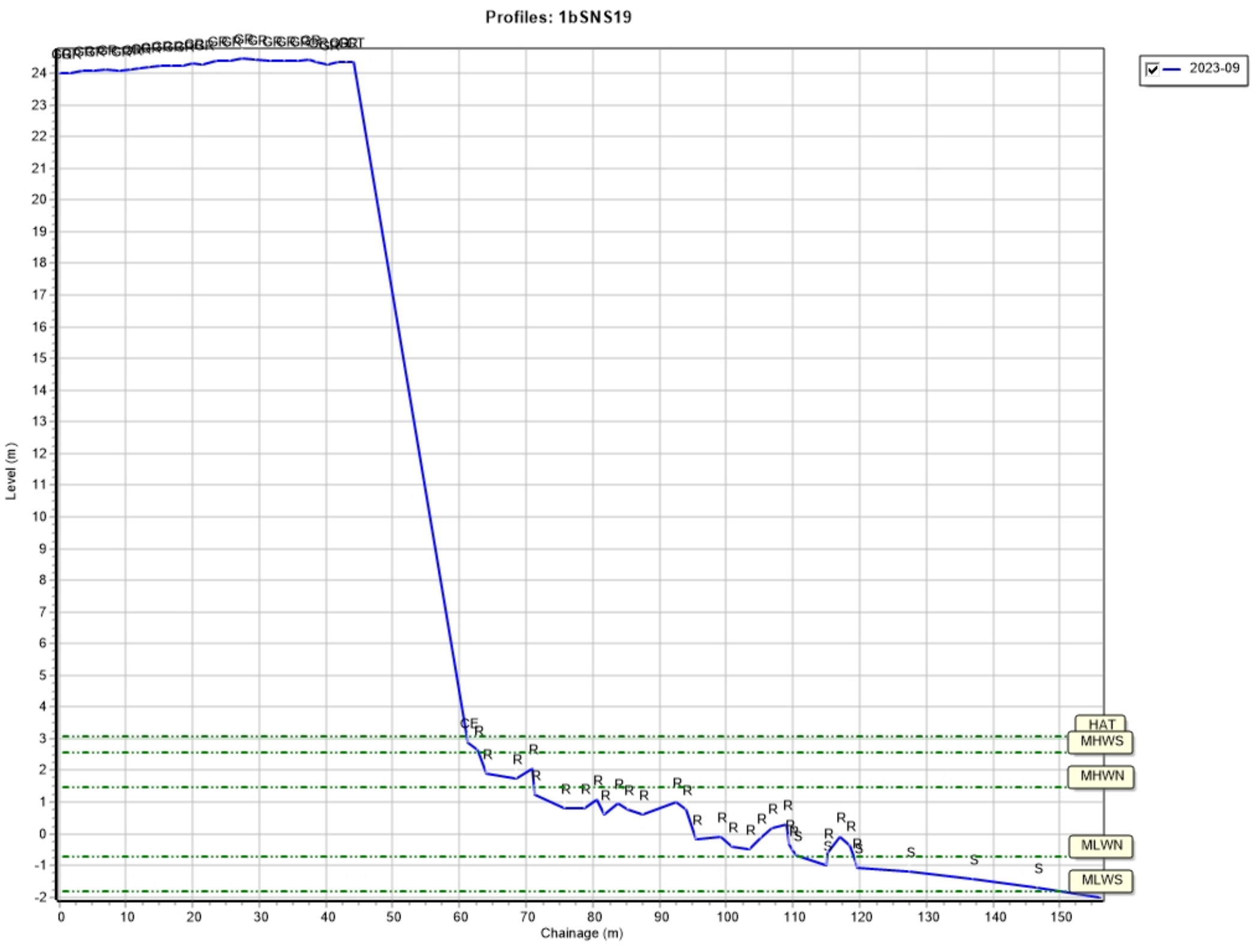
Level (m)
Chainage (m)
HAT
MHWS
MHWN
MLWN
MLWS
CE
R
S
W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2023-09
Level (m)
Chainage (m)
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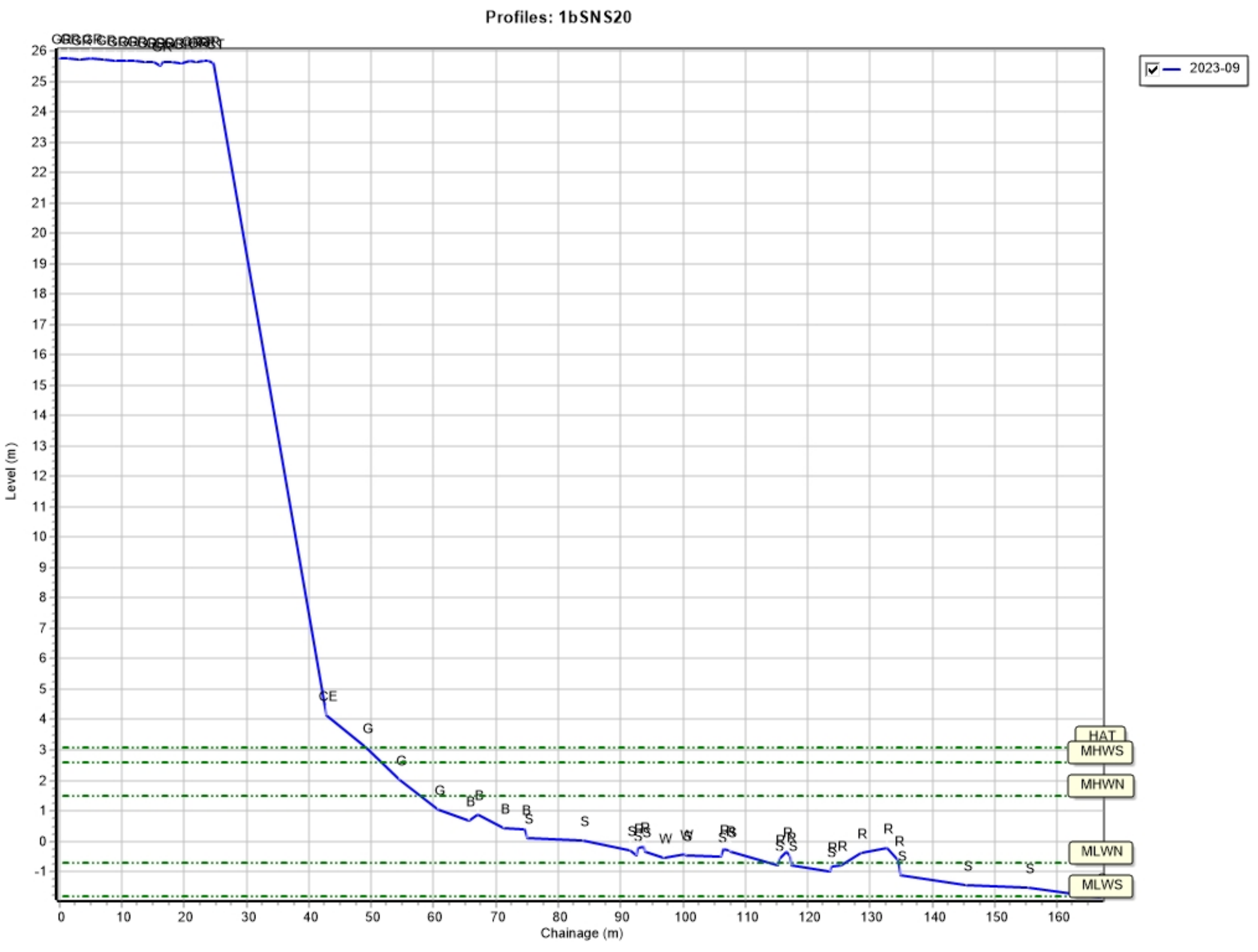
MHWN
MLWN
MLWS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2023-09
Level (m)
Chainage (m)
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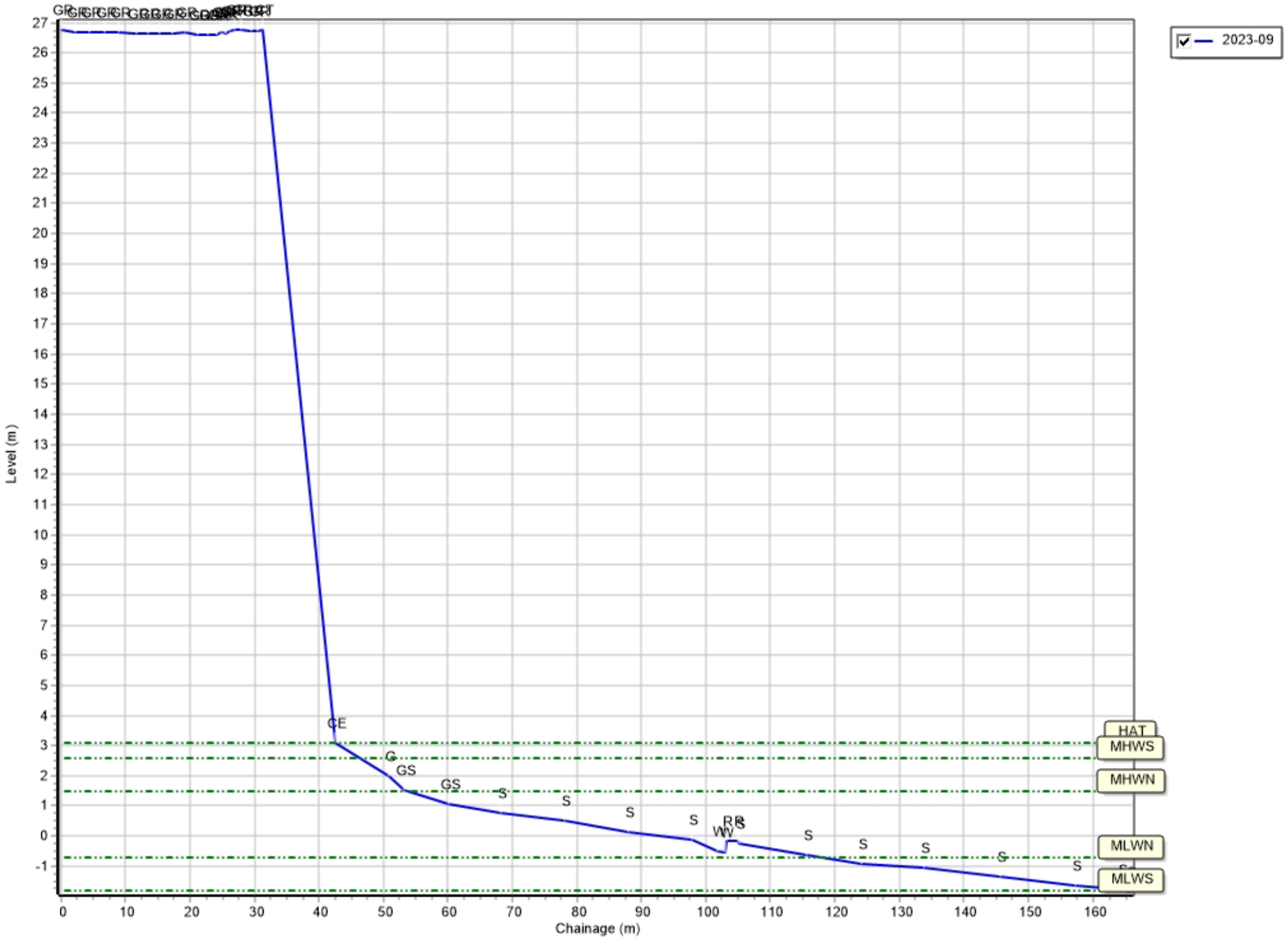
MHWN
MLWN
MLWS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2023-09
Level (m)
Chainage (m)
HAT
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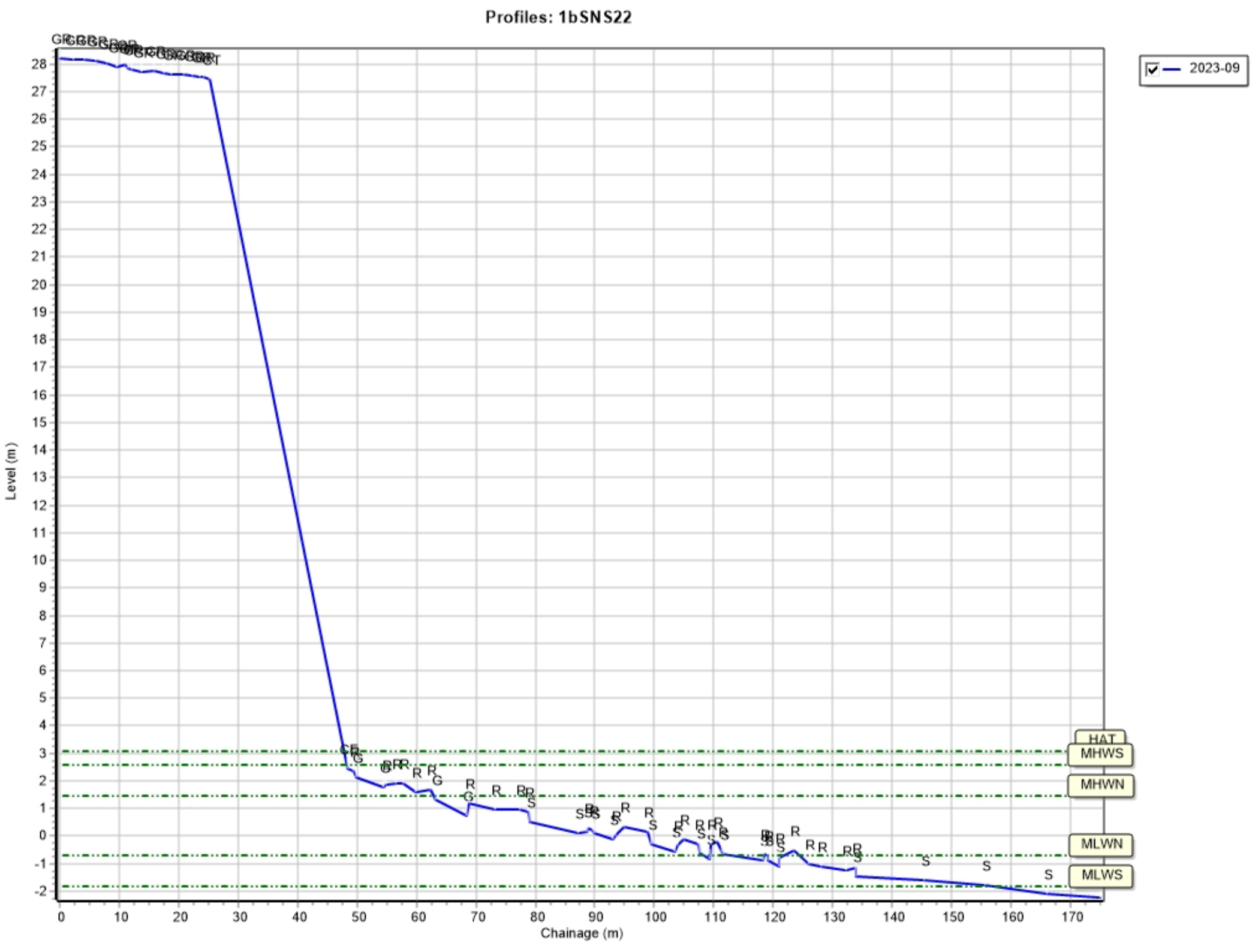
MHWN
MLWN
MLWS
CE
GS
S
RB
W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2023-09
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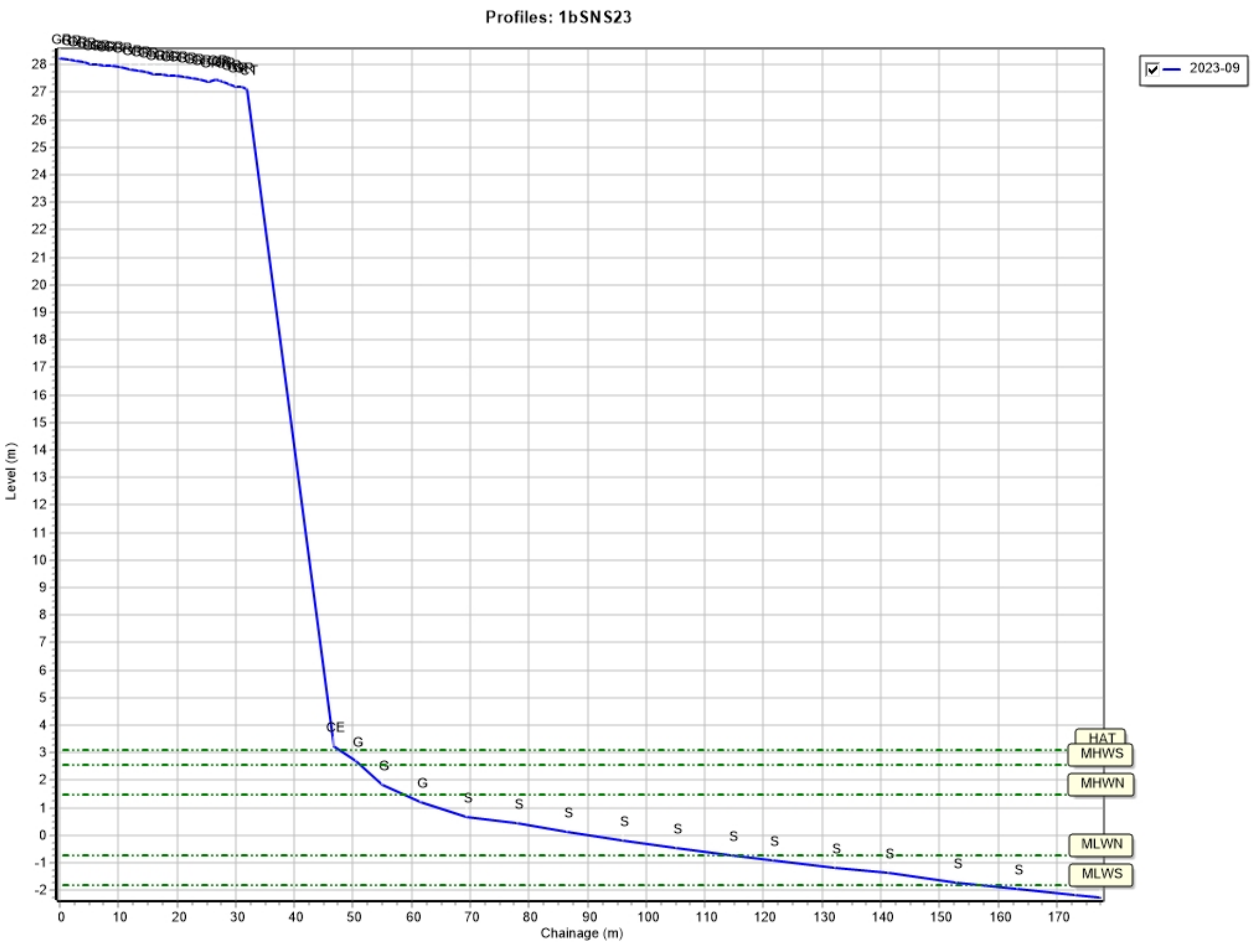
MLWN
MLWS
Level (m)
Chainage (m)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2023-09
Level (m)
Chainage (m)
HAT
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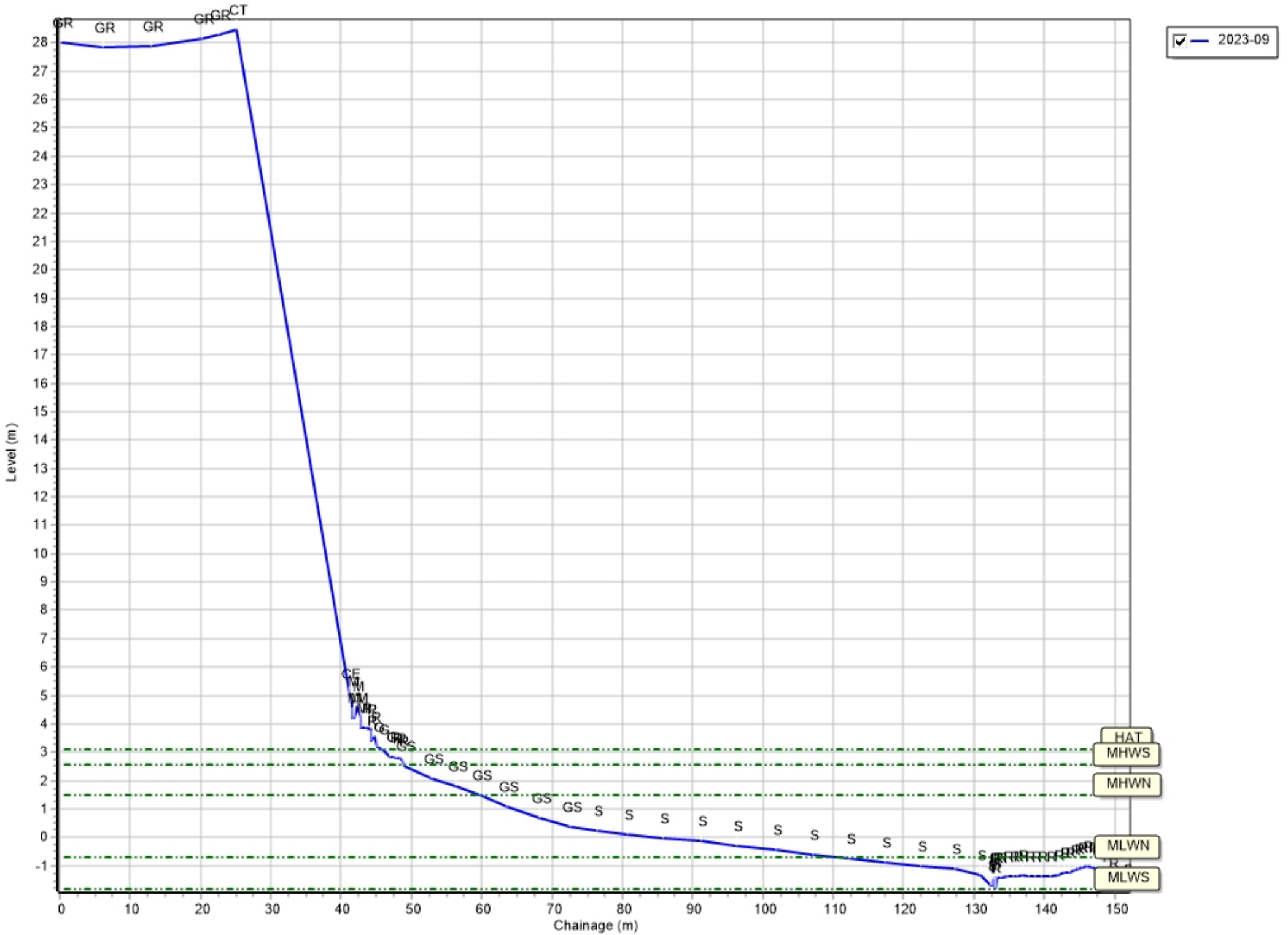
MHWN
MLWN
MLWS
CE
G
S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2023-09
Level (m)
Chainage (m)
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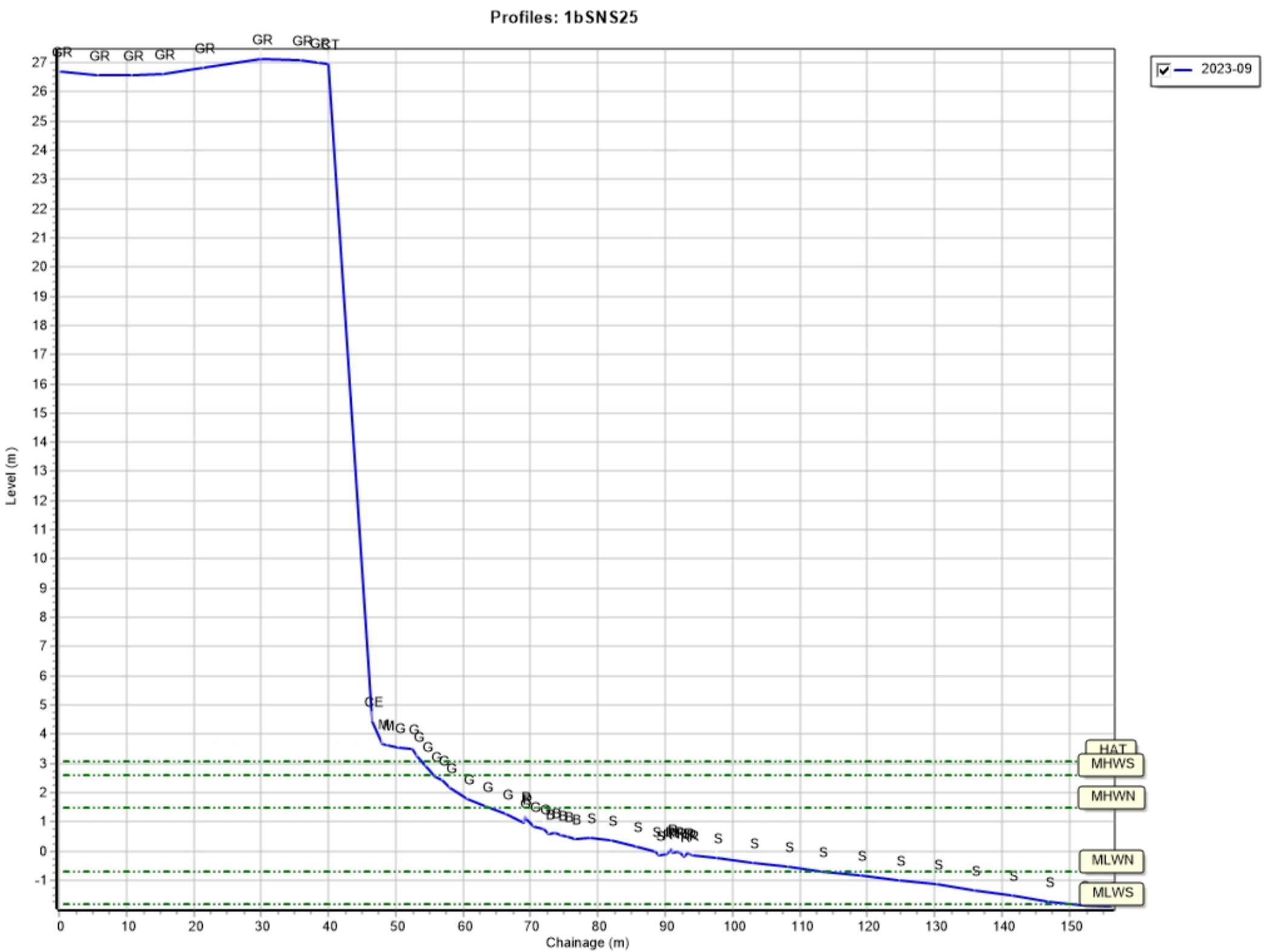
MHWN
MLWN
MLWS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2023-09
Level (m)
Chainage (m)
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MLWN
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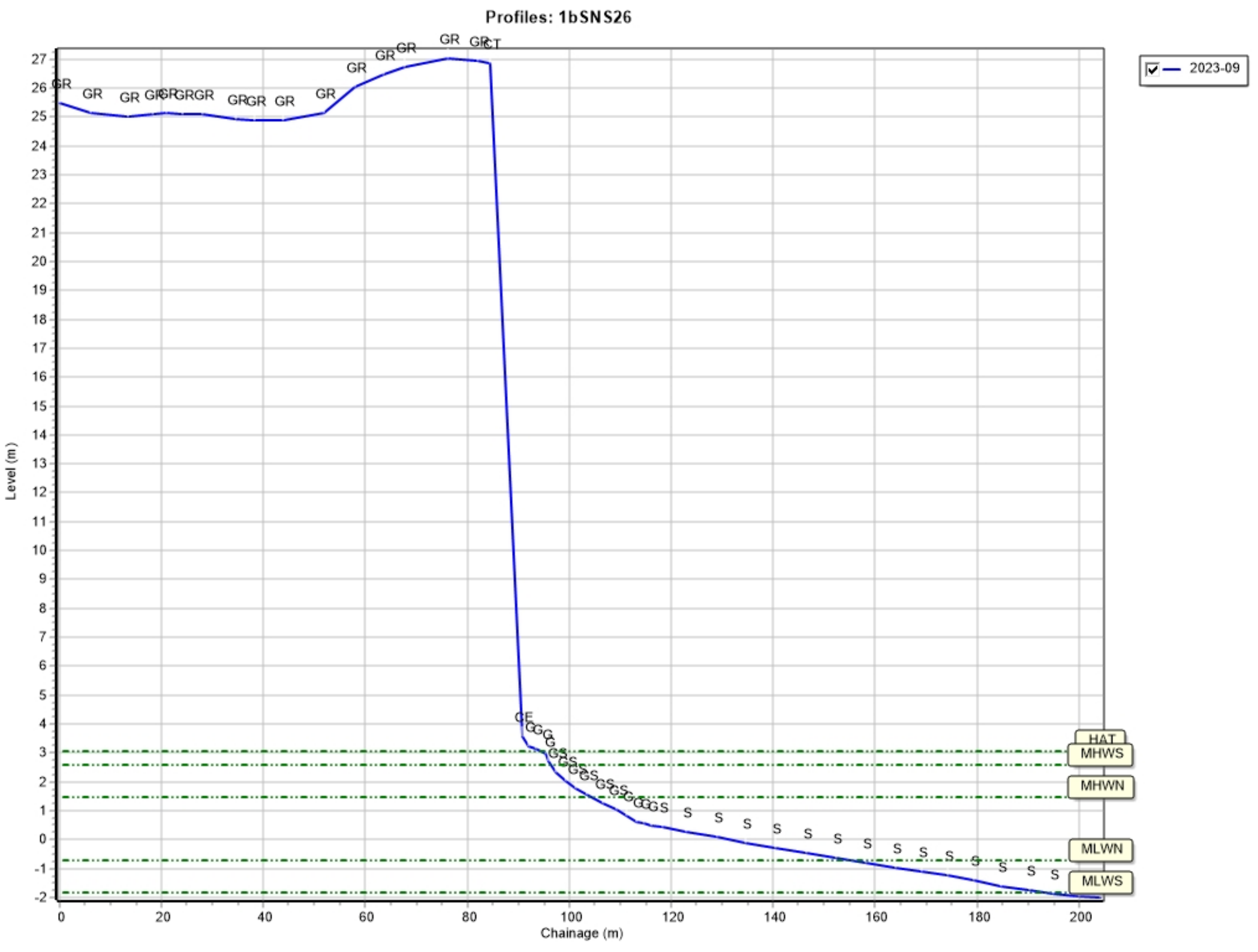
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Level (m)
Chainage (m)
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MLWN
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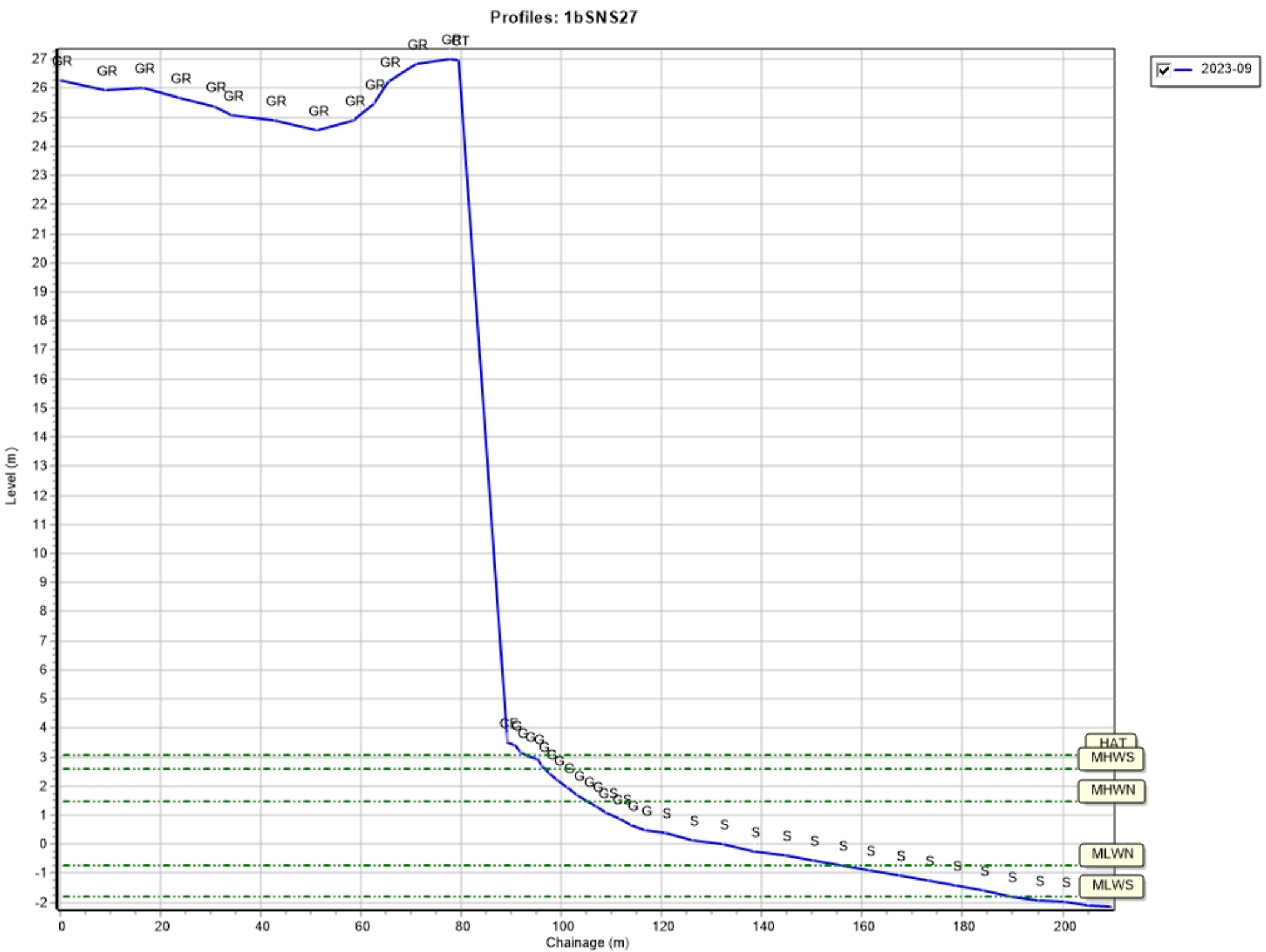
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2023-09
Level (m)
Chainage (m)
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MHWS
MHWN
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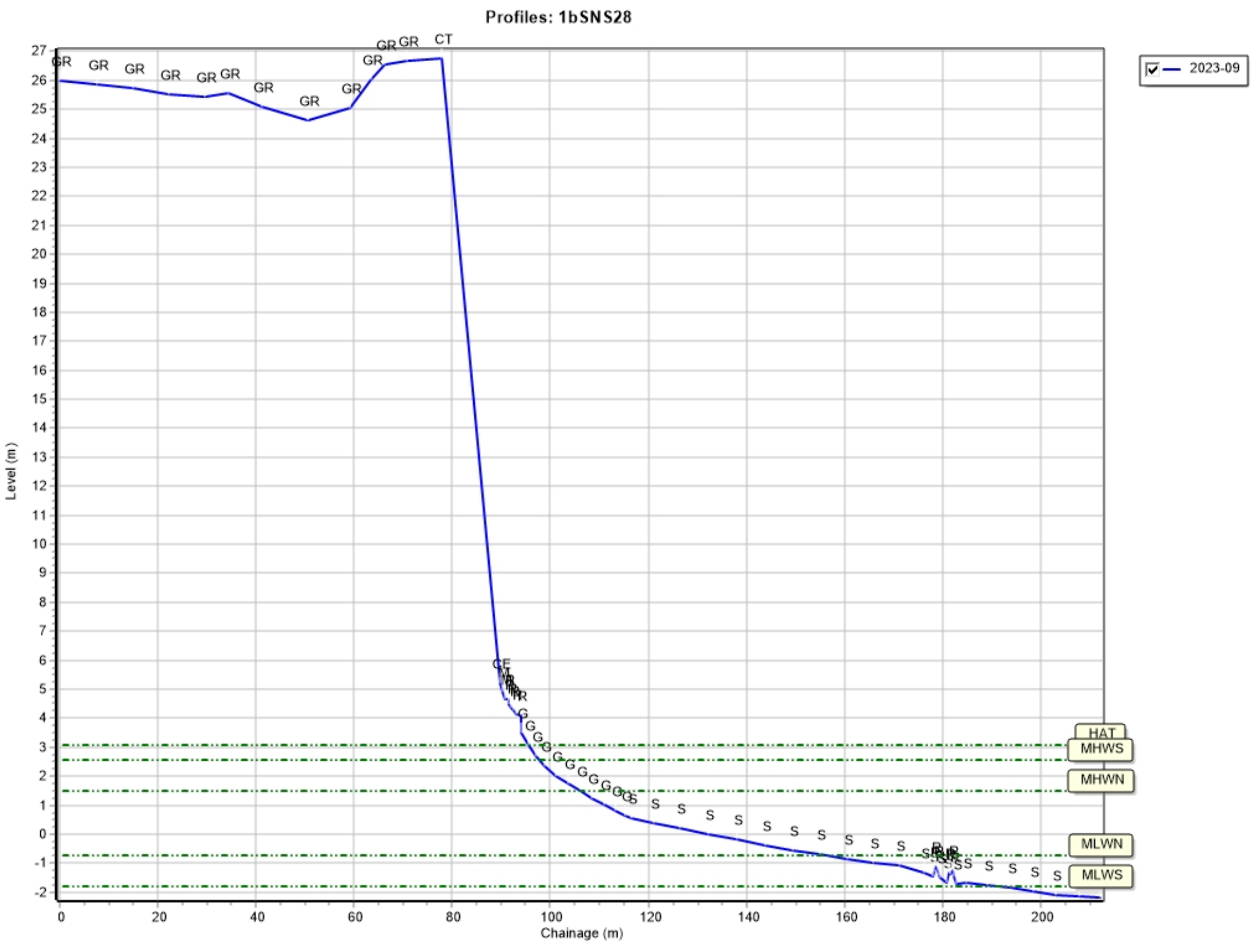
MLWS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2023-09
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Chainage (m)
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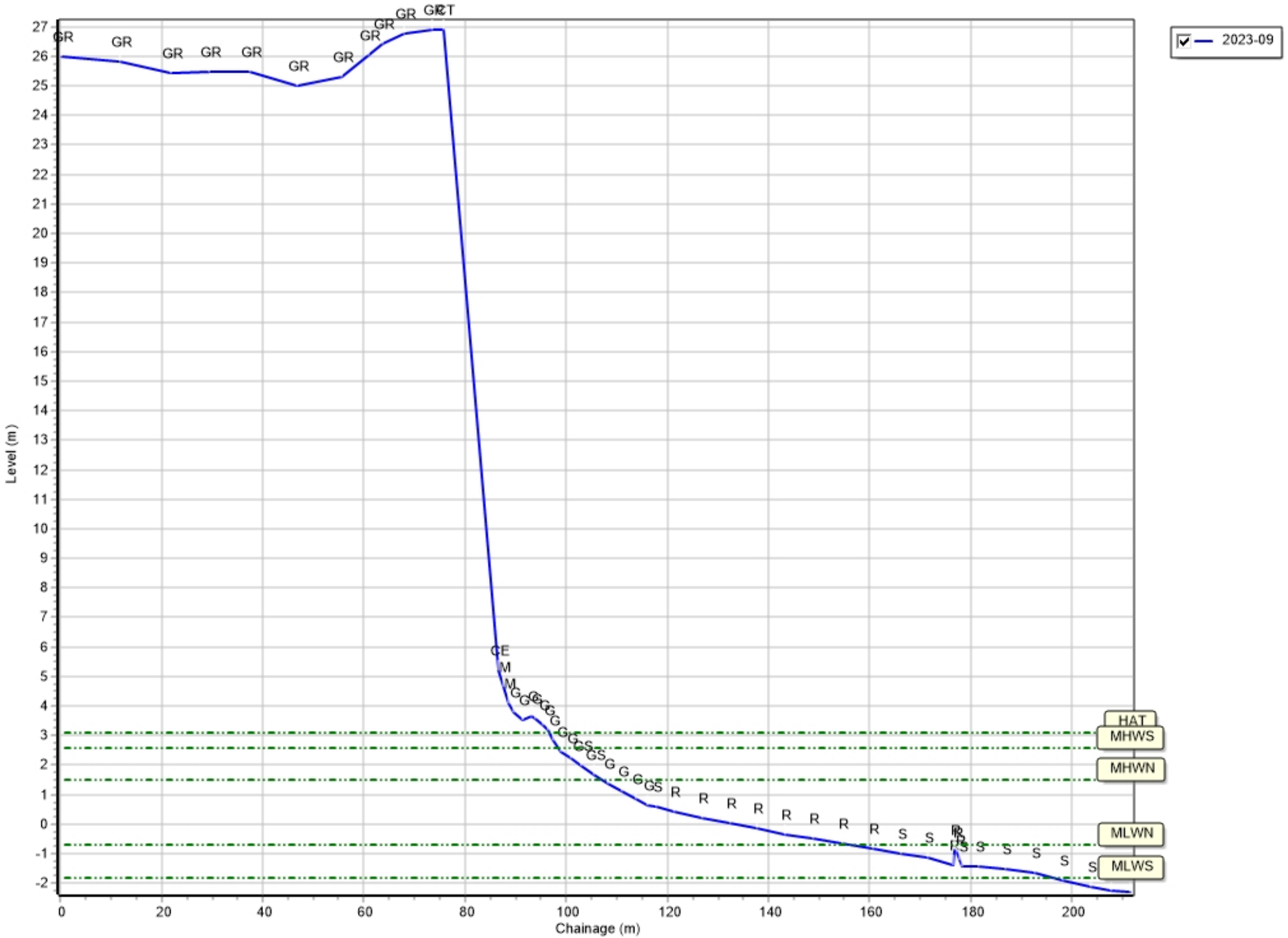
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2023-09
Level (m)
Chainage (m)
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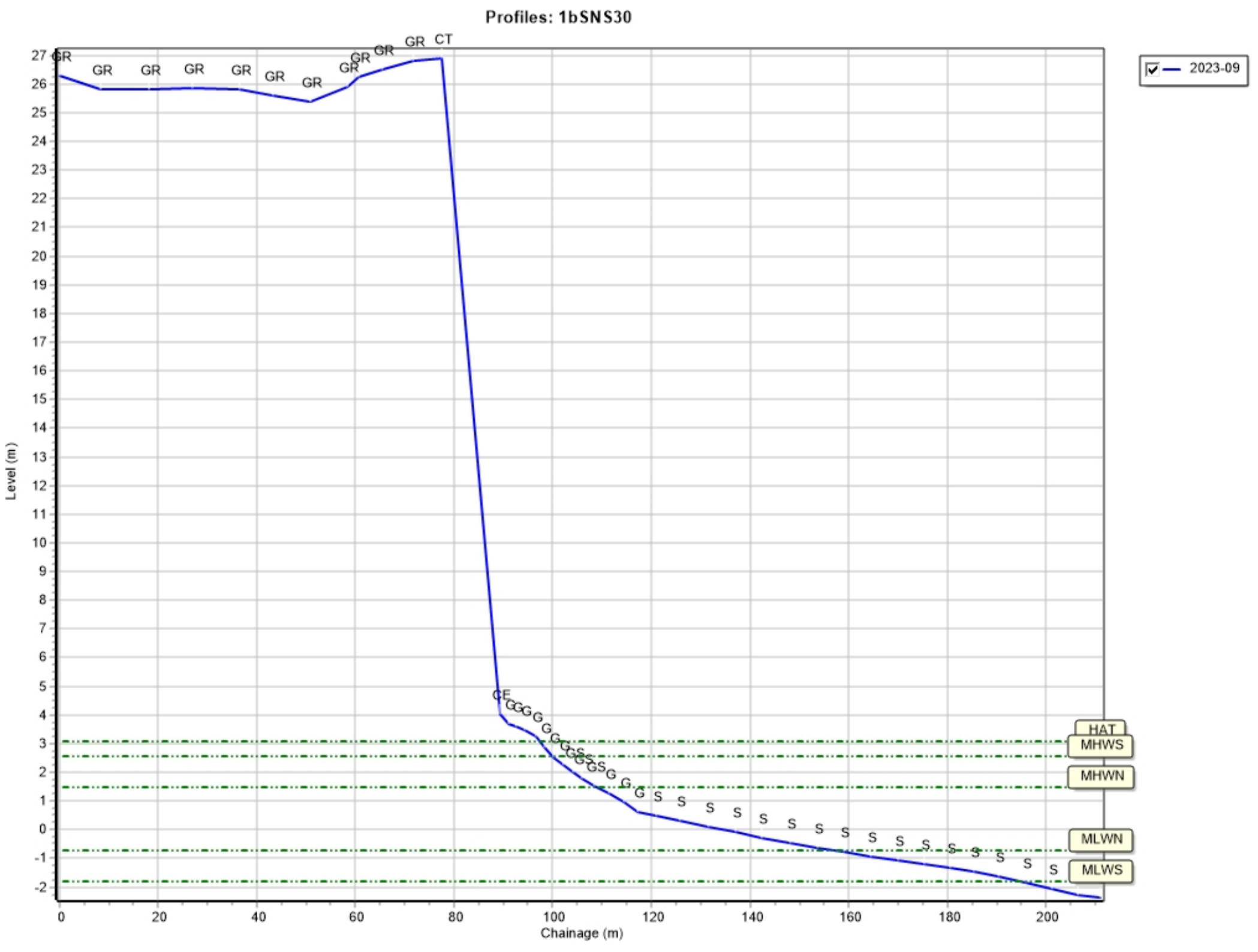
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2023-09
Level (m)
Chainage (m)
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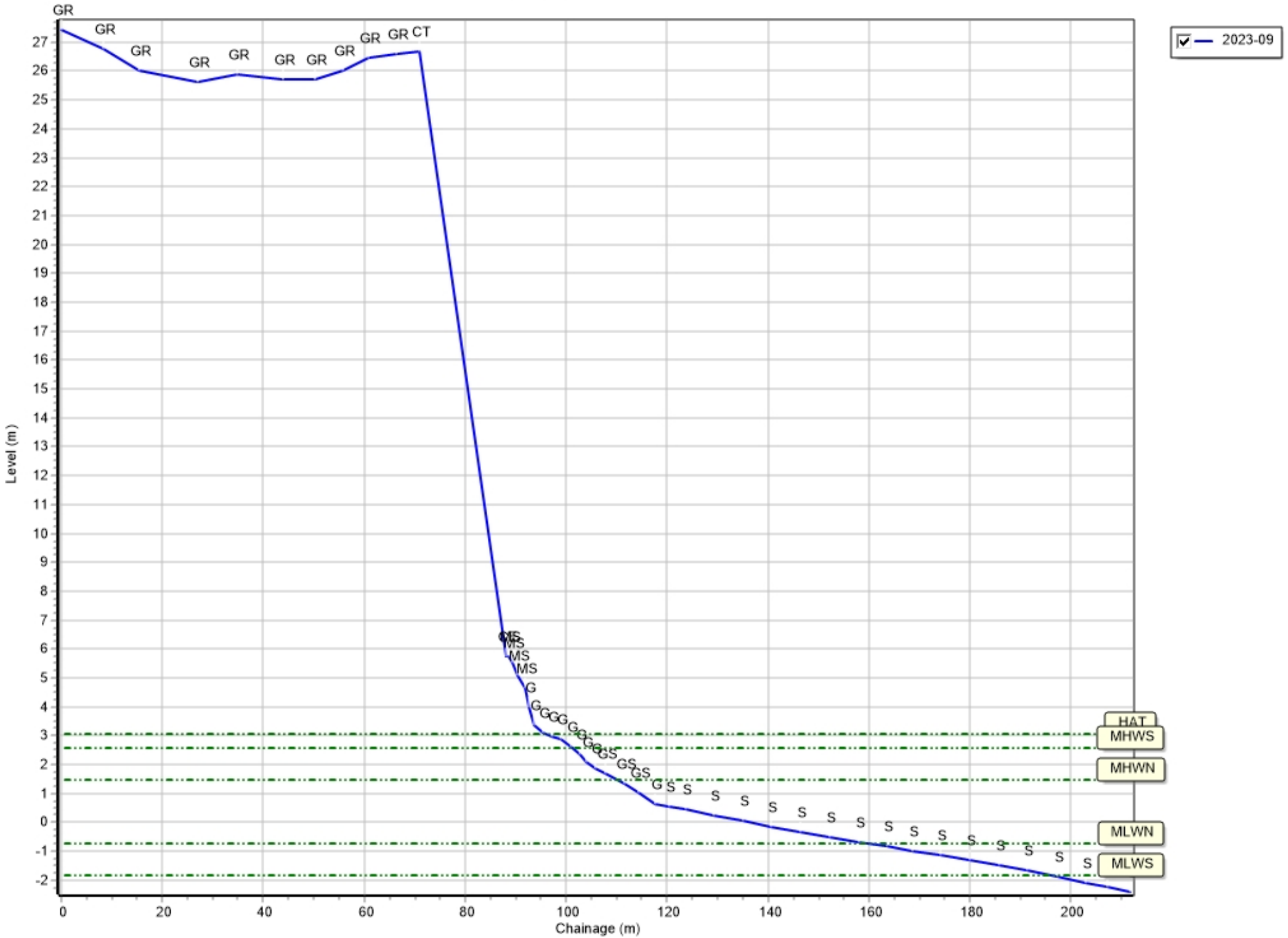
MHWN
MLWN
MLWS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2023-09
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Chainage (m)
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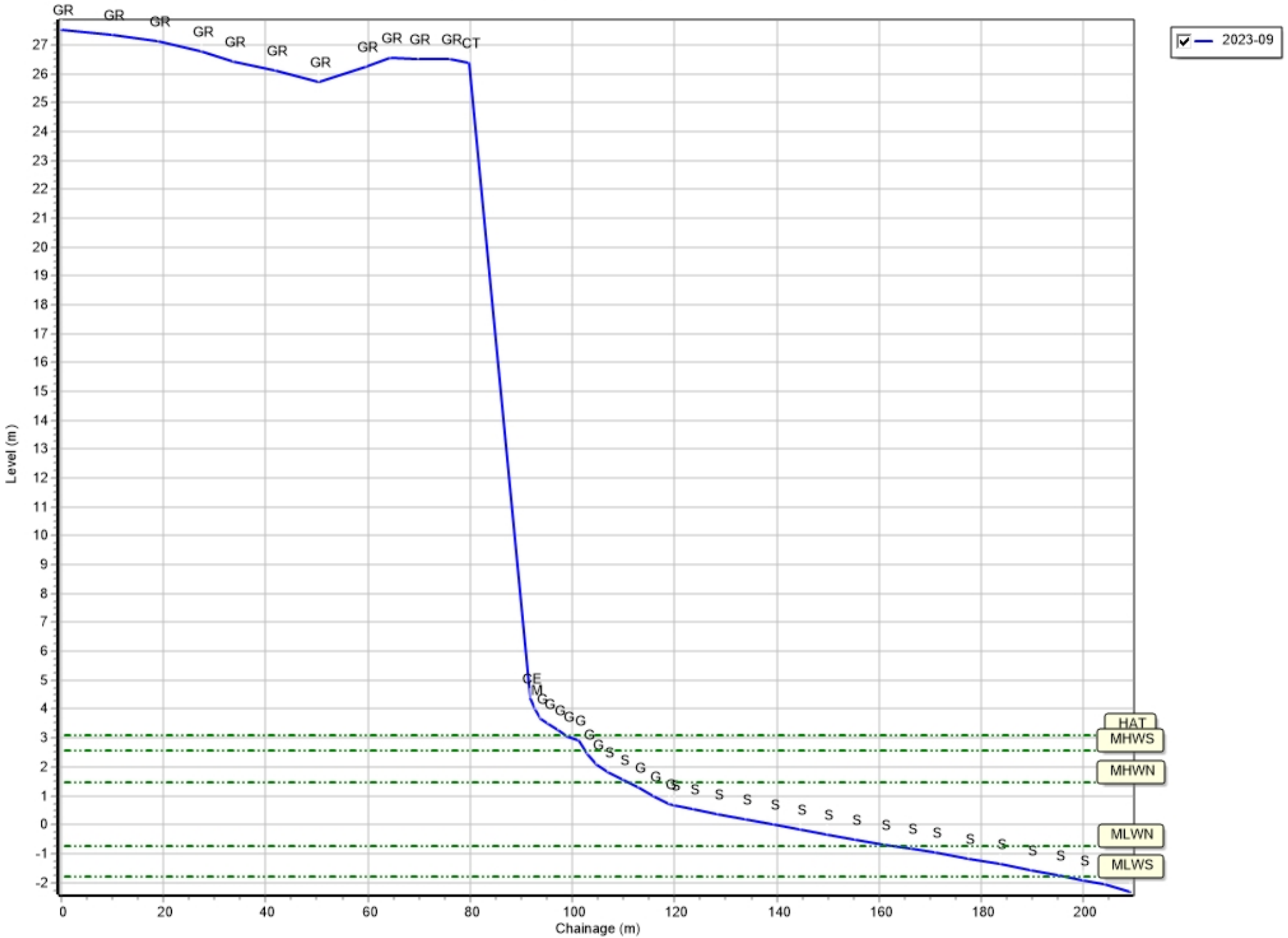
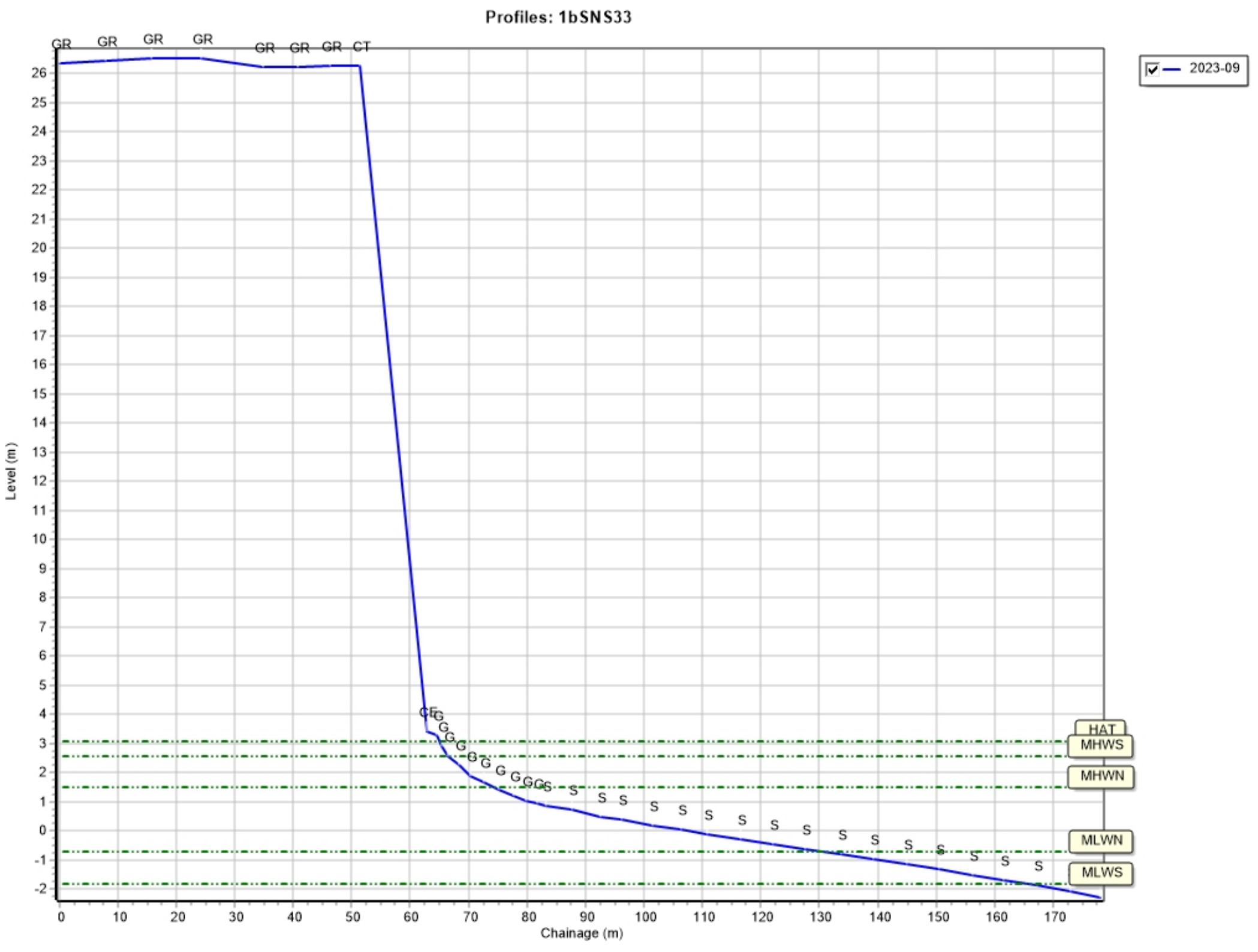
MHWS
MHWN
MLWN
MLWS

Profiles: 1bSNS32

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2023-09
HAT
MHWS
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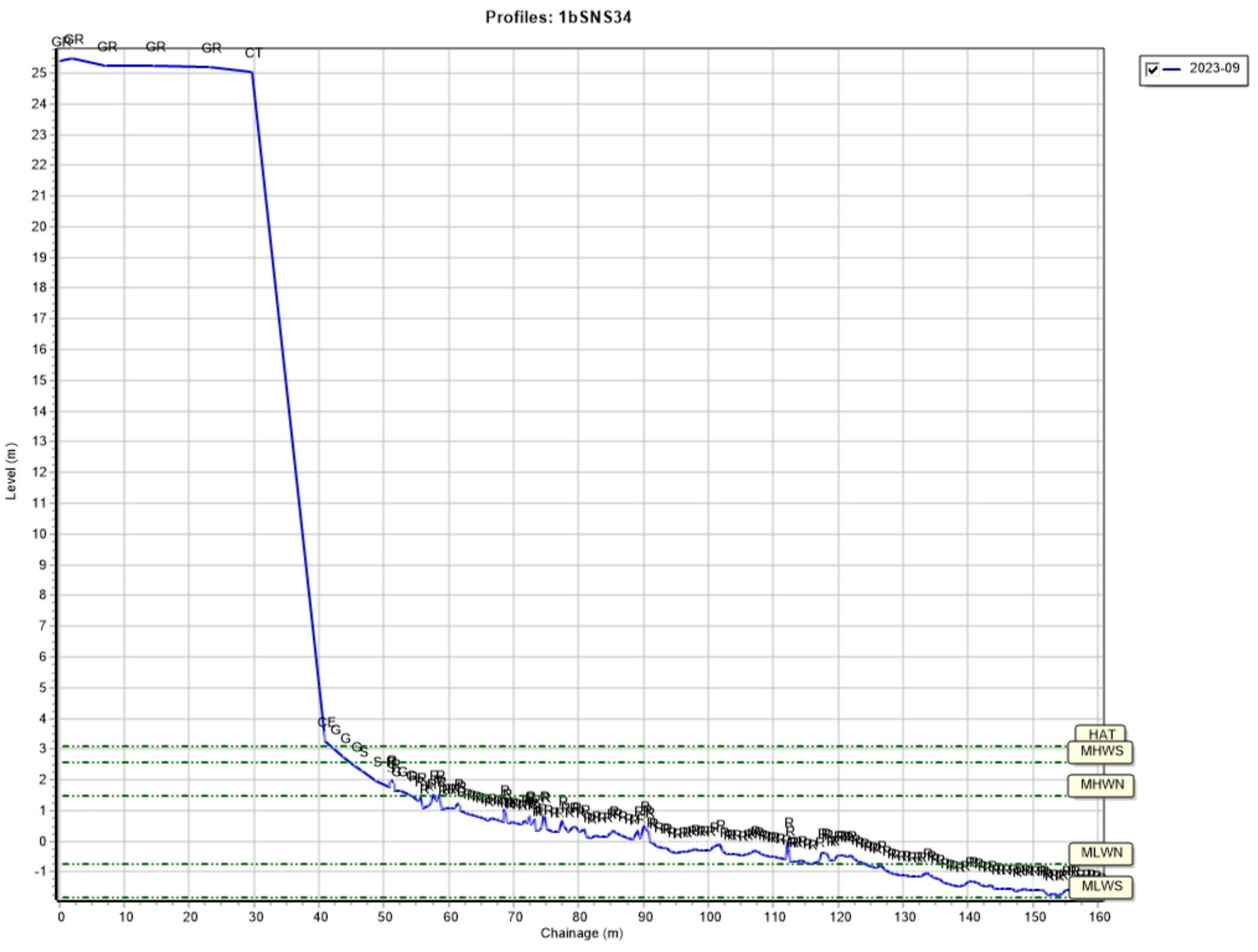
MLWN
MLWS
Level (m)
Chainage (m)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CT
2023-09
HAT
MHWS
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Level (m)
Chainage (m)
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24
23
22
21
20
19
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17
16
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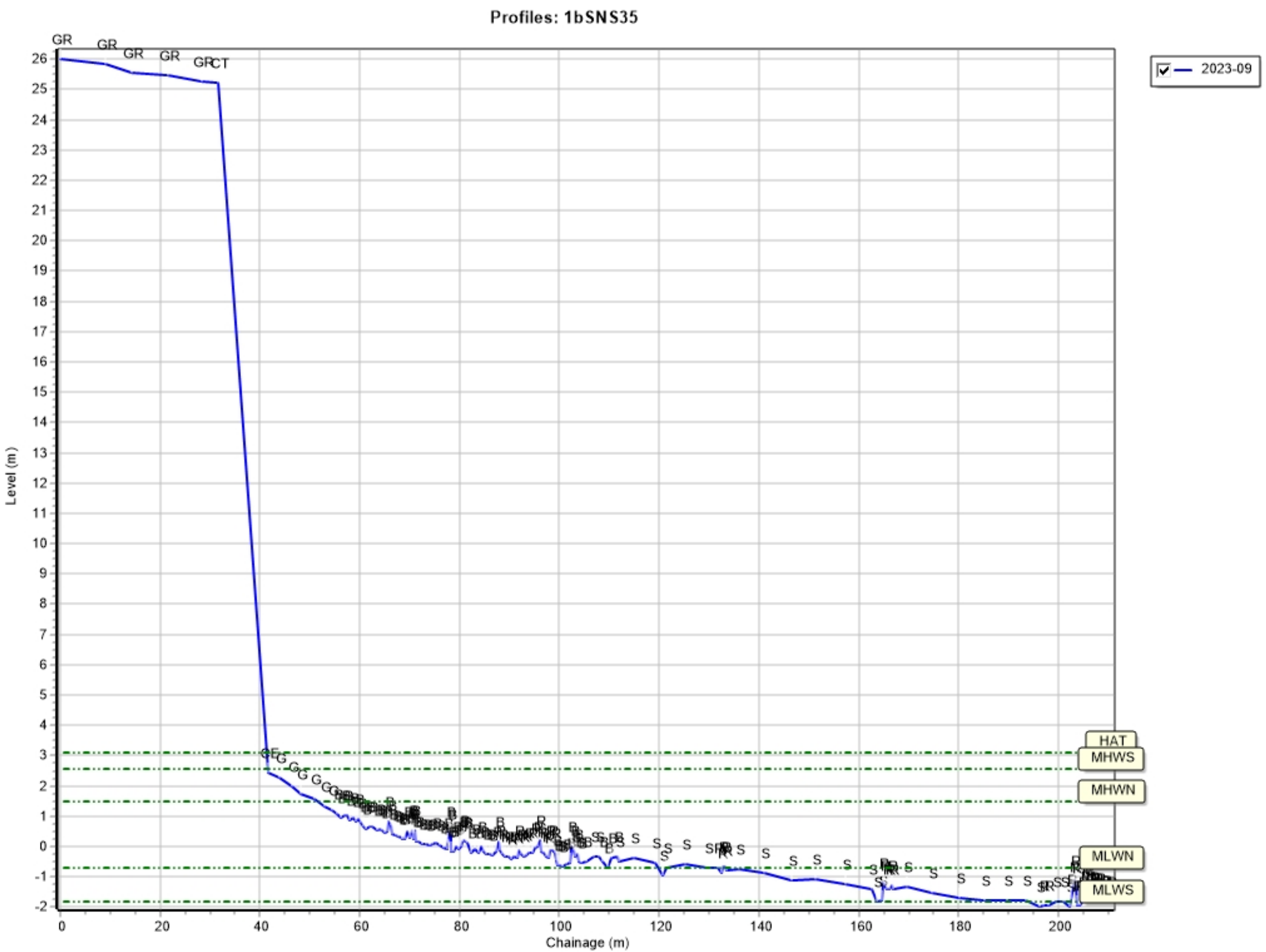
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Chainage (m)
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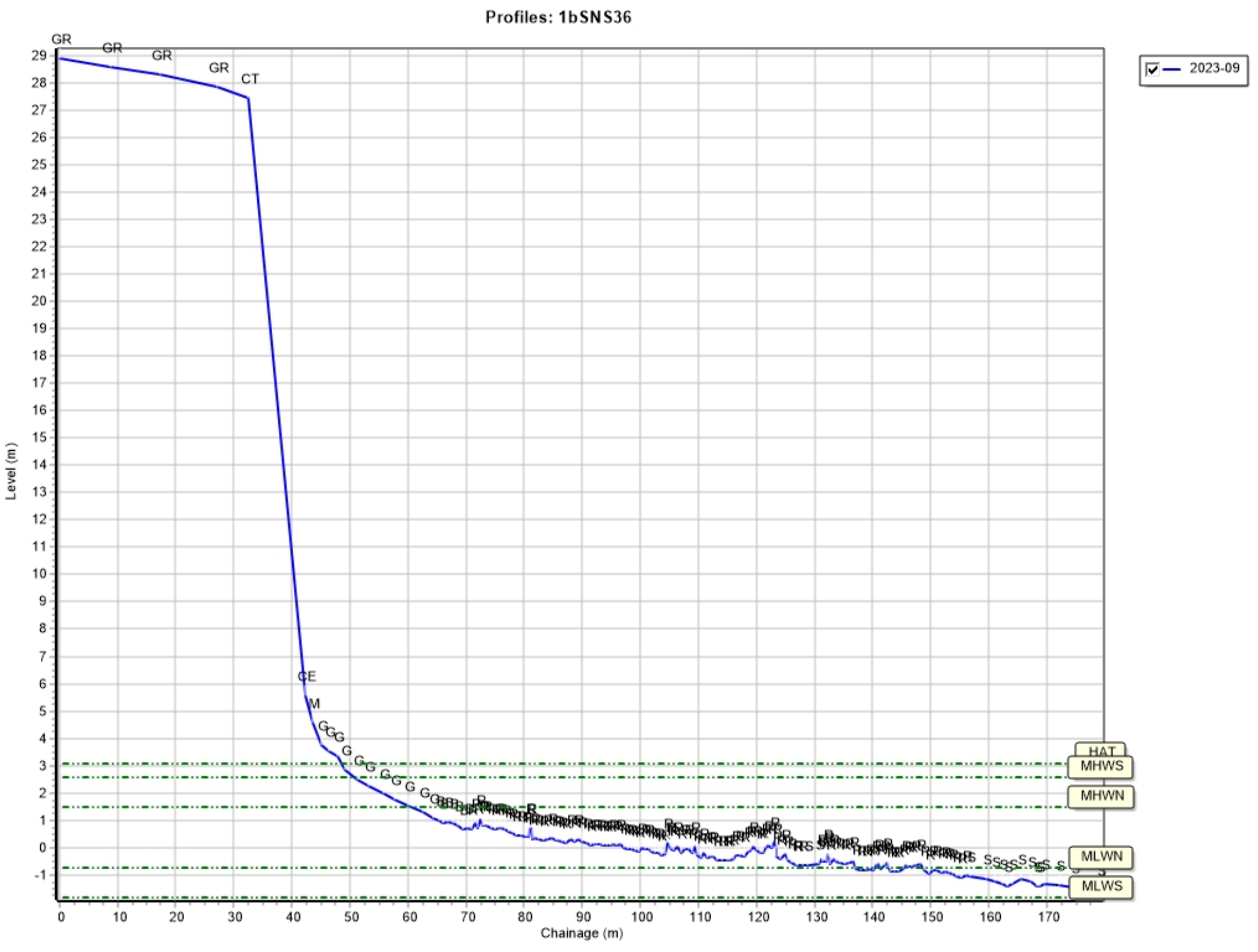
MLWS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CE
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2023-09
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Level (m)
Chainage (m)
29
28
27
26
25
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22
21
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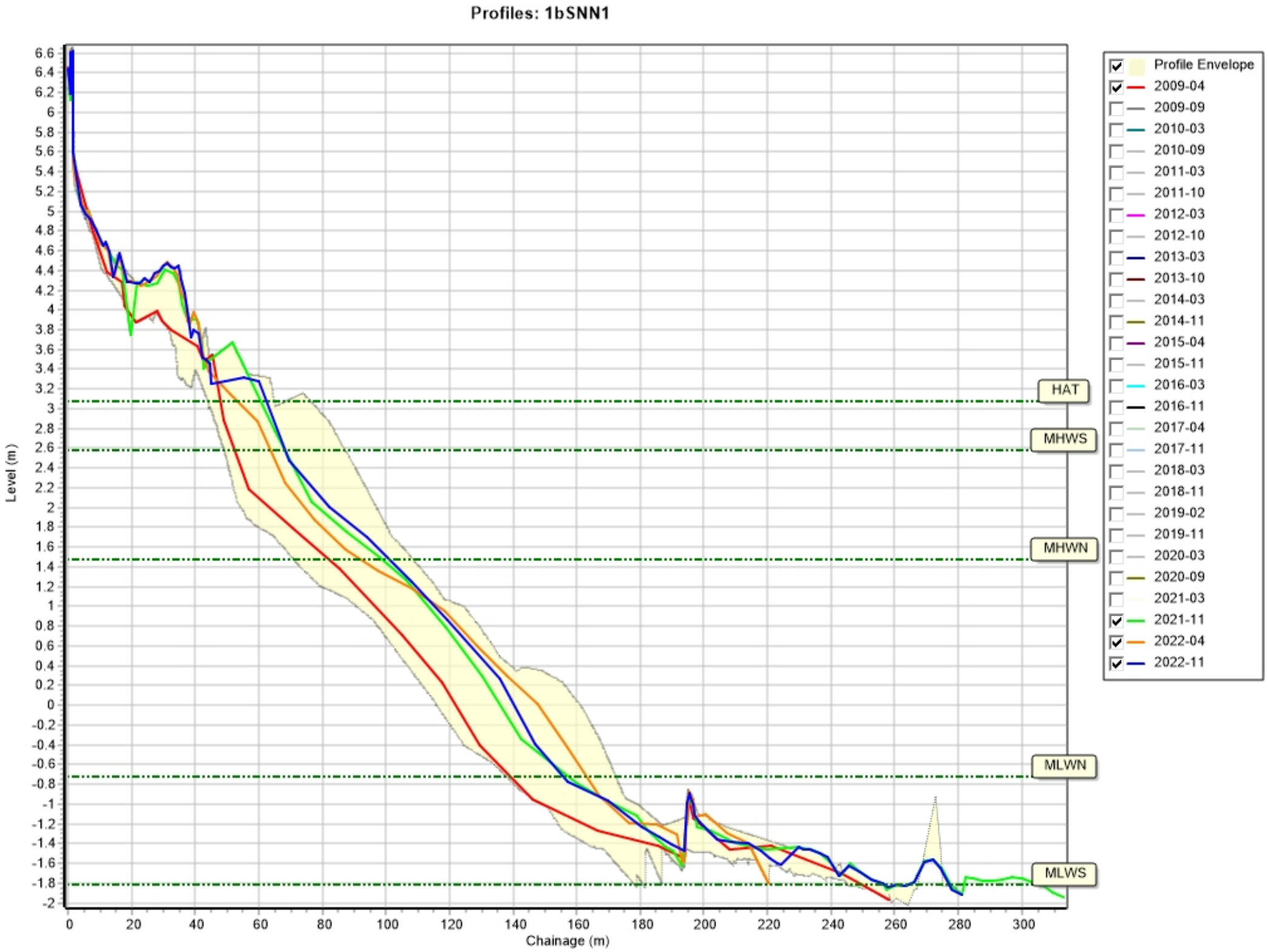
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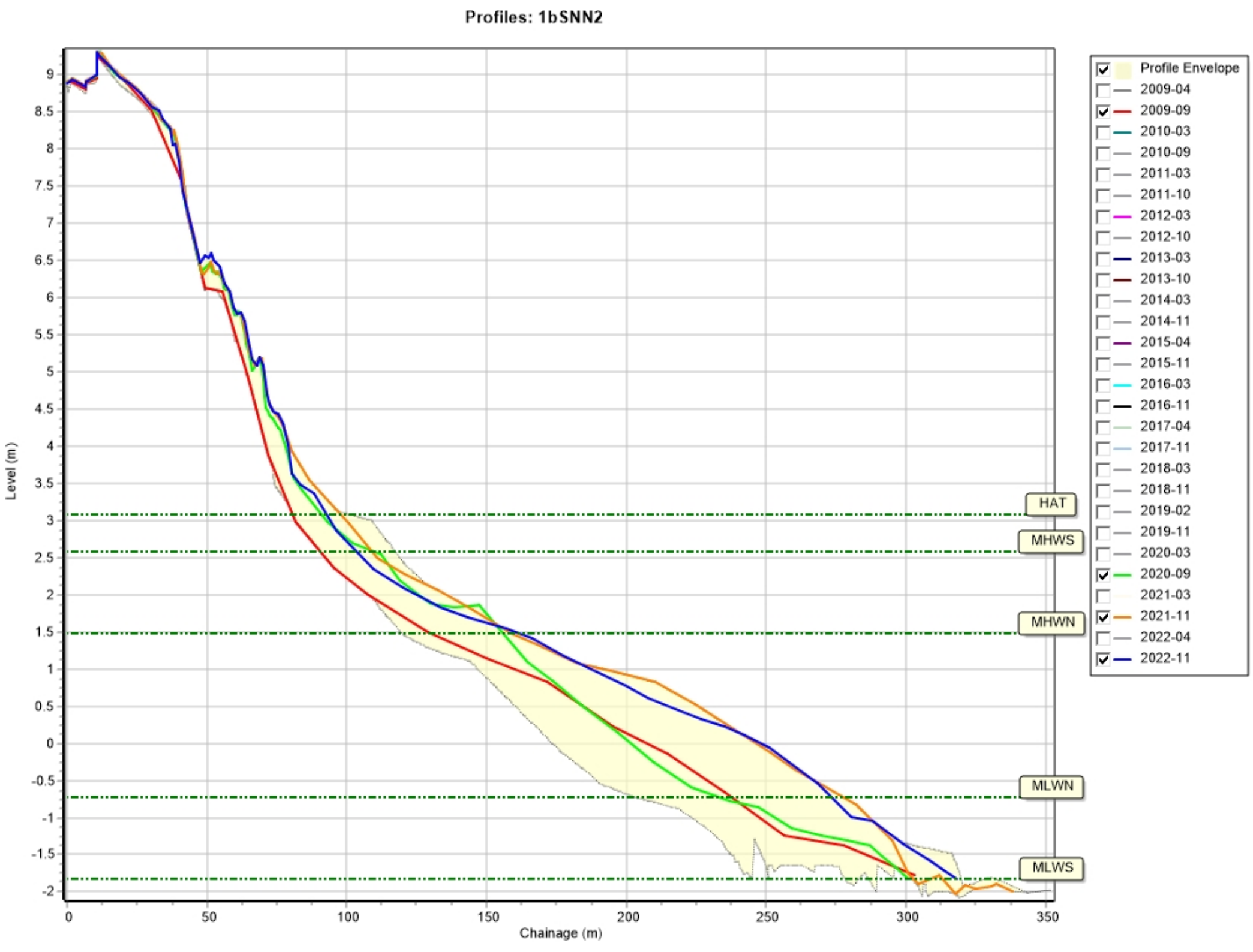
Profiles: 1bSNN2
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6.5
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Profile Envelope
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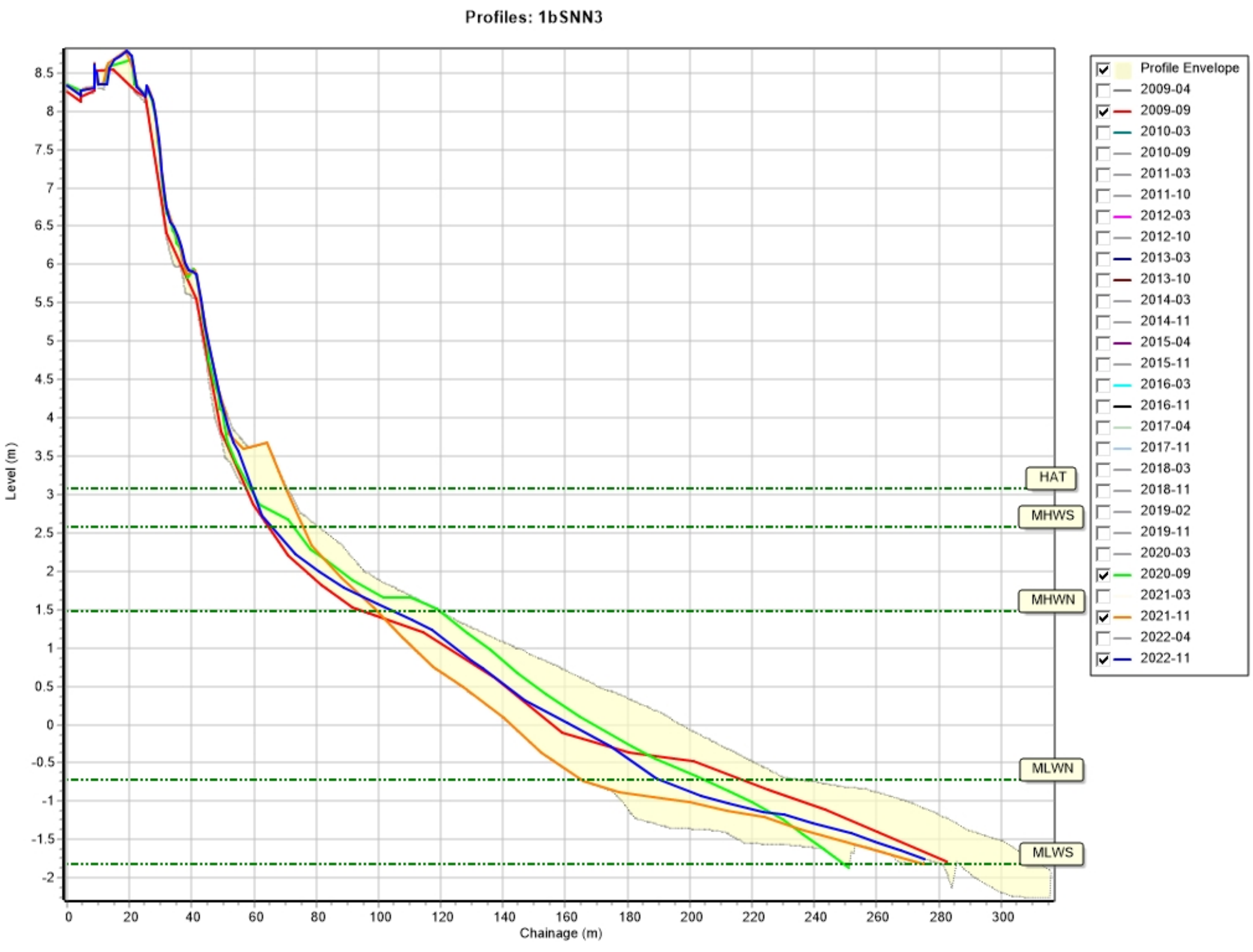
2022-11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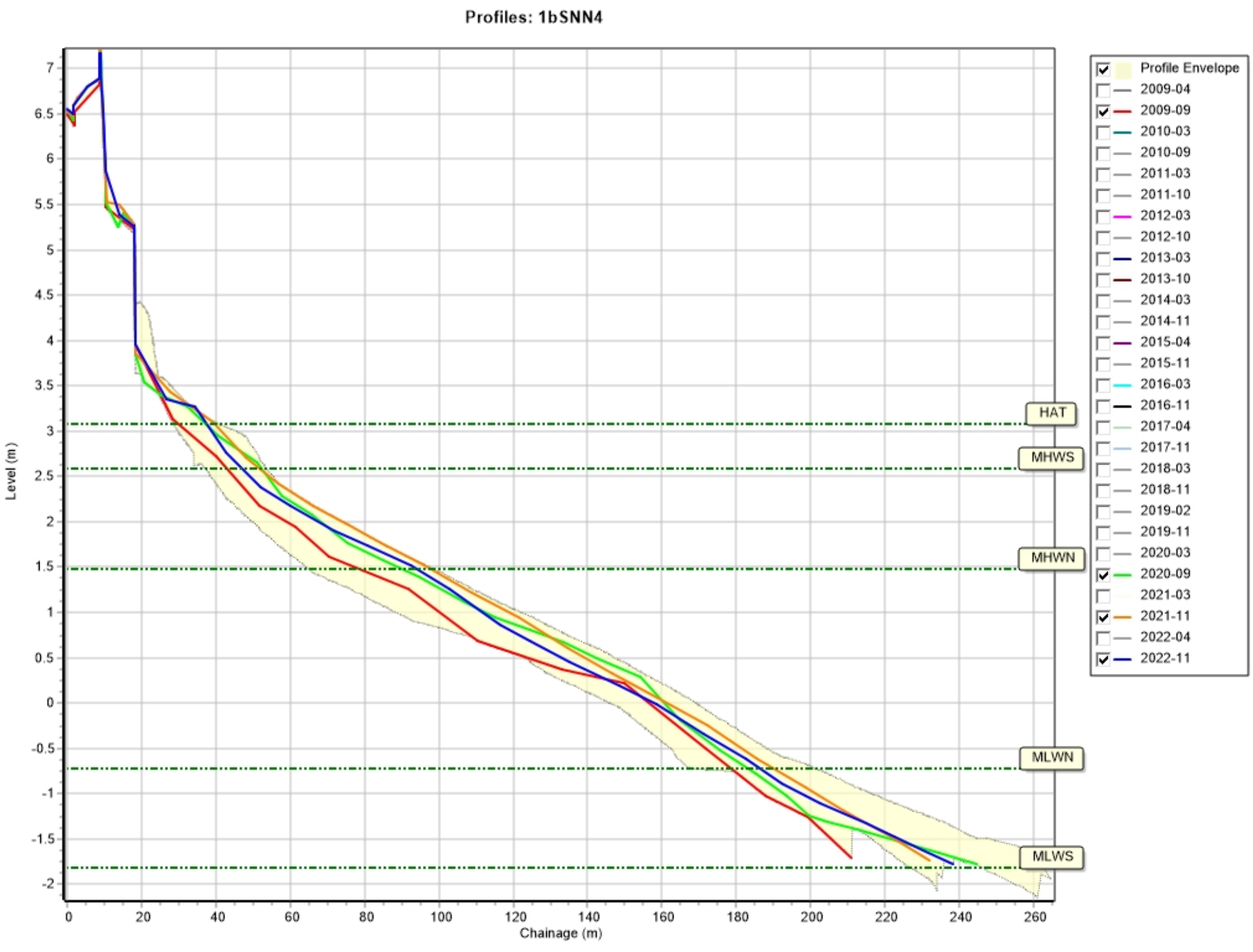
2022-11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Profile Envelope
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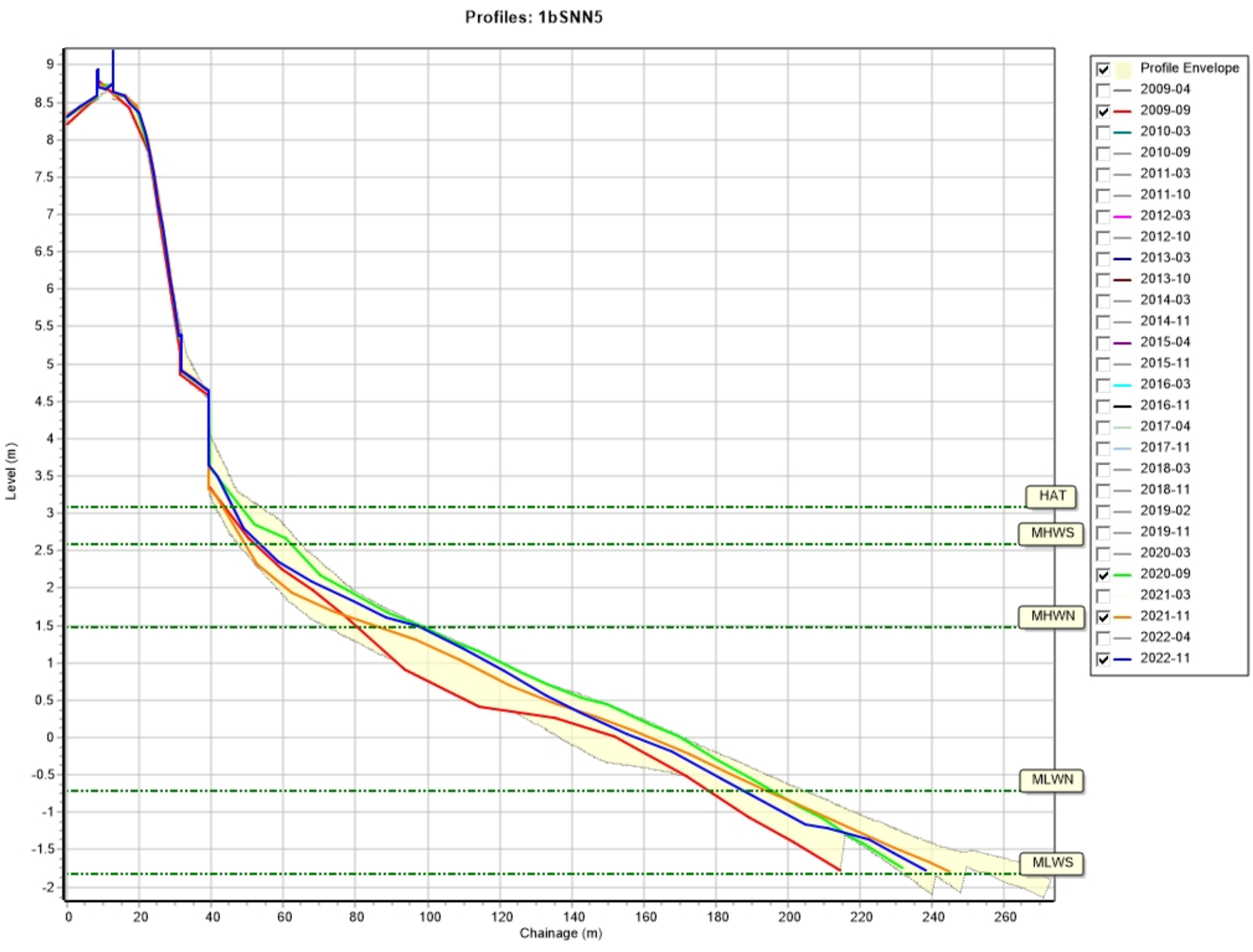
2022-04
2022-11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Chainage (m)
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MHWN
MLWN
MLWS
Profile Envelope
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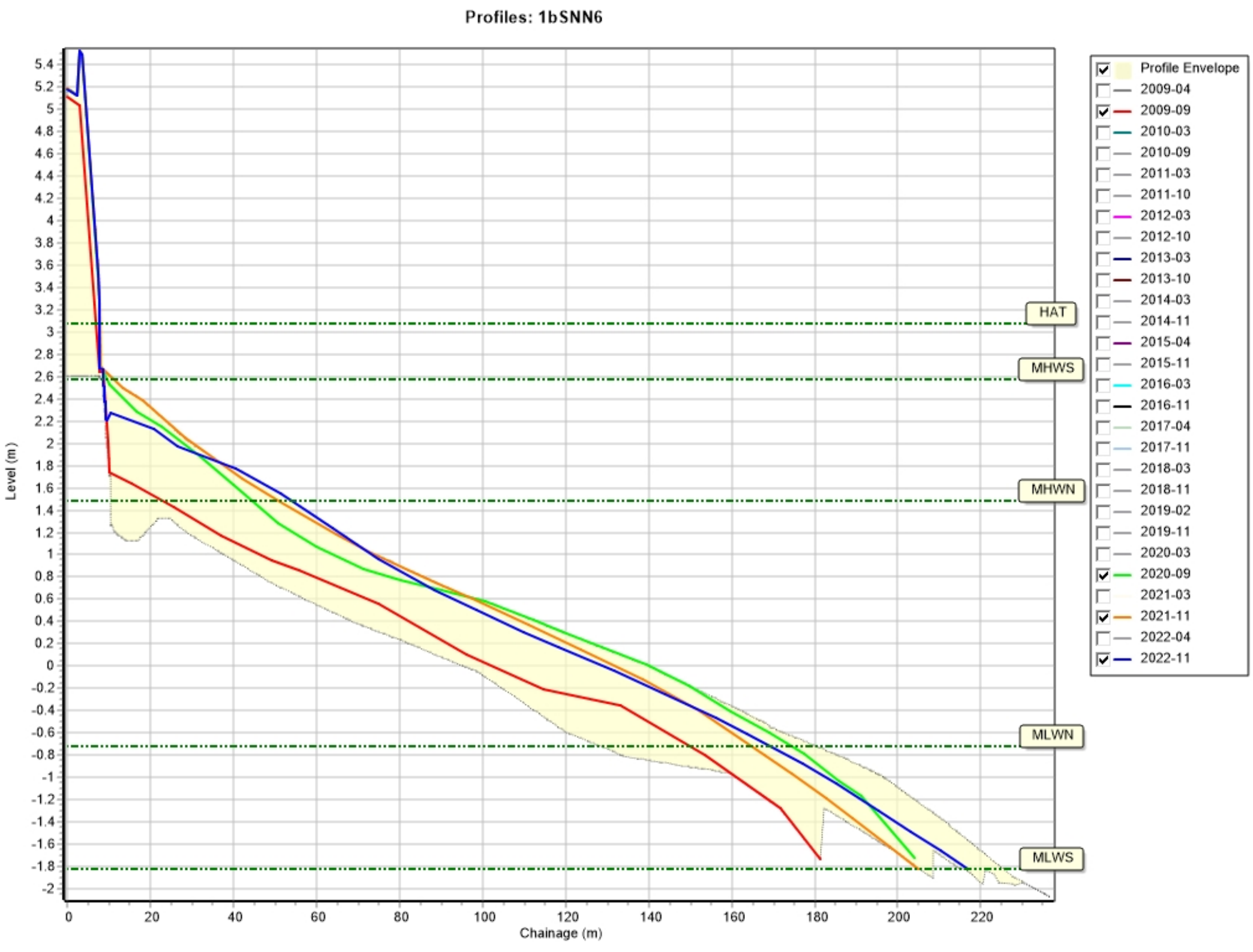
Profiles: 1bSNN6
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Chainage (m)
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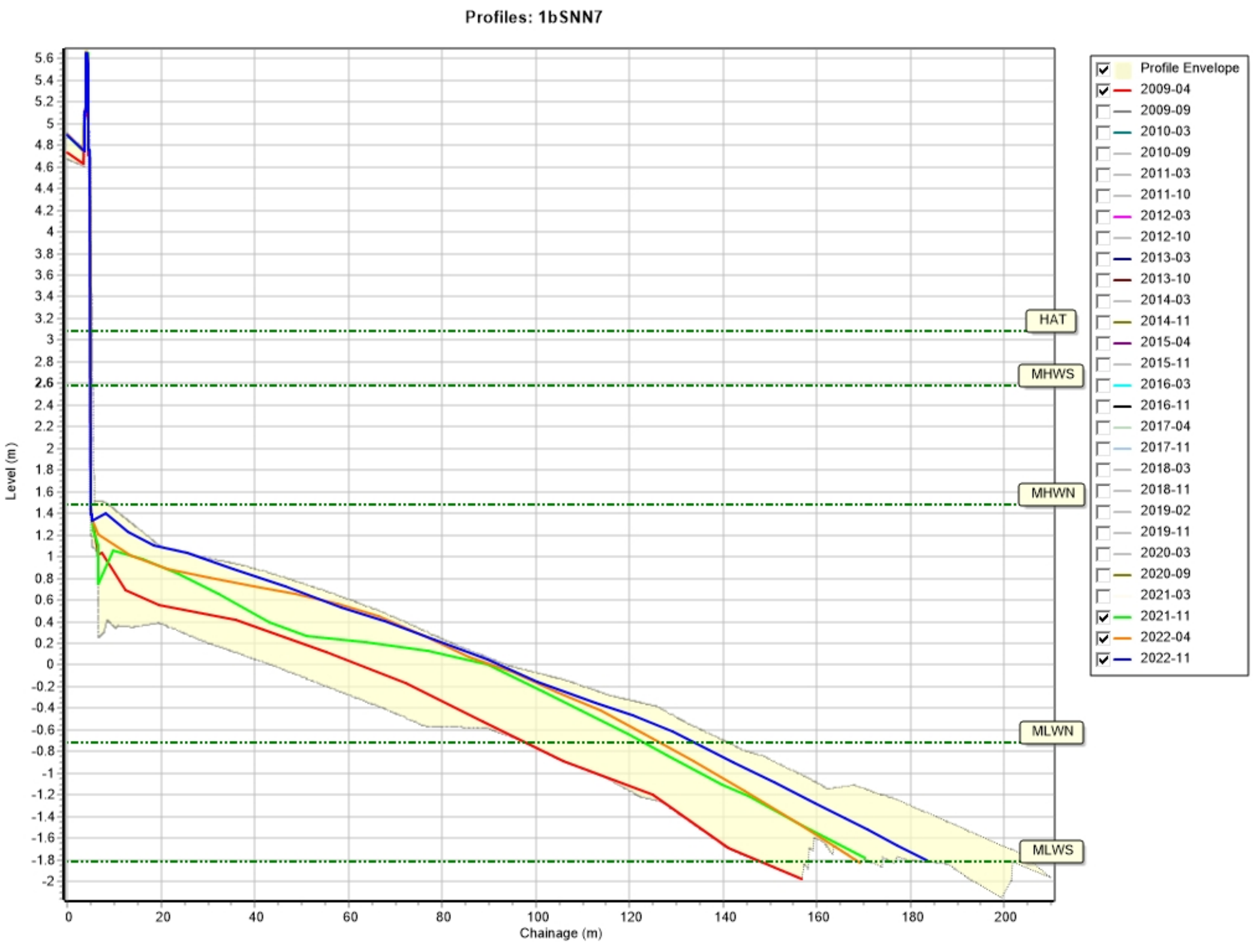
Profiles: 1bSNN7
Level (m)
Chainage (m)
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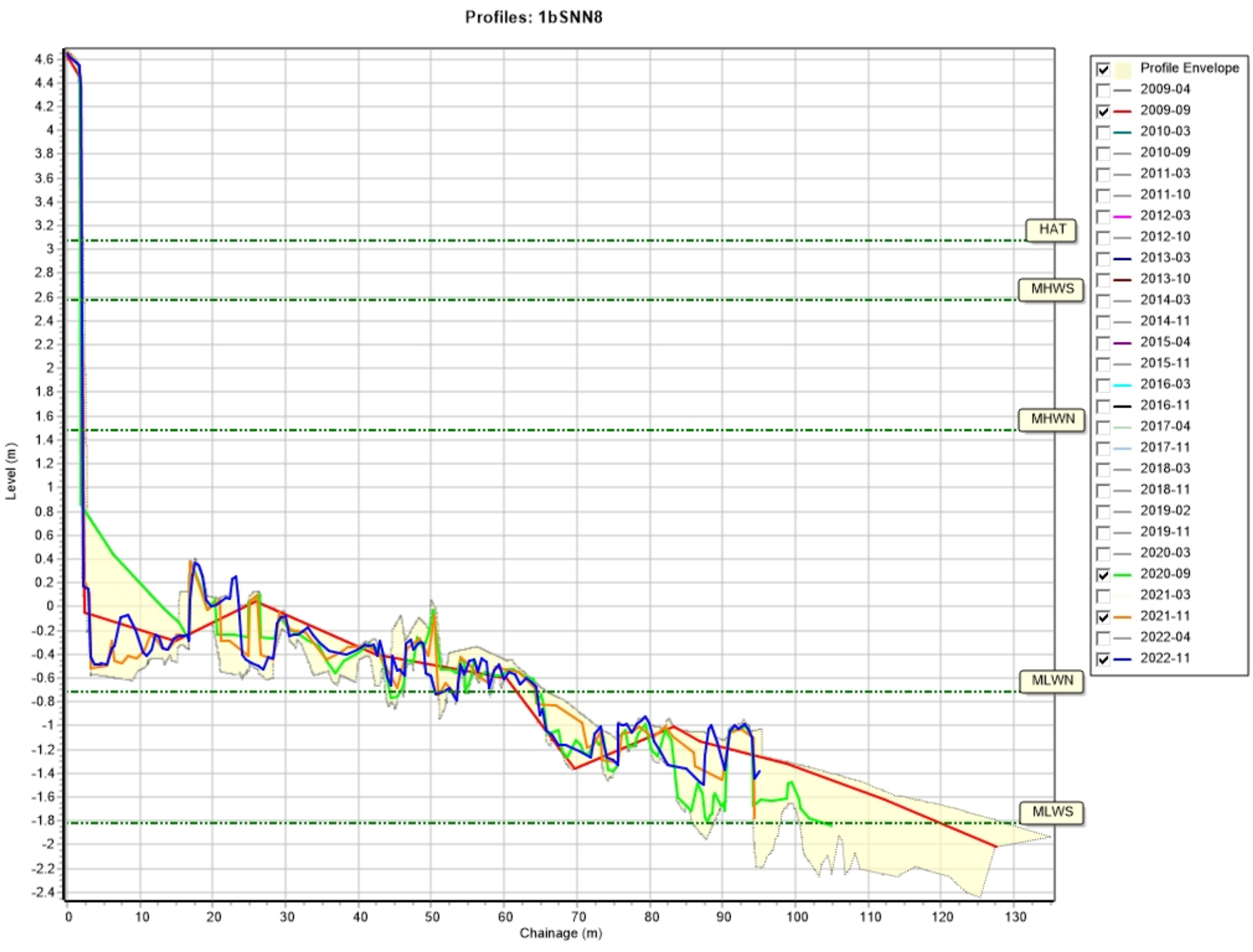
2022-11


Profiles: 1bSNN8
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MLWS
Profile Envelope
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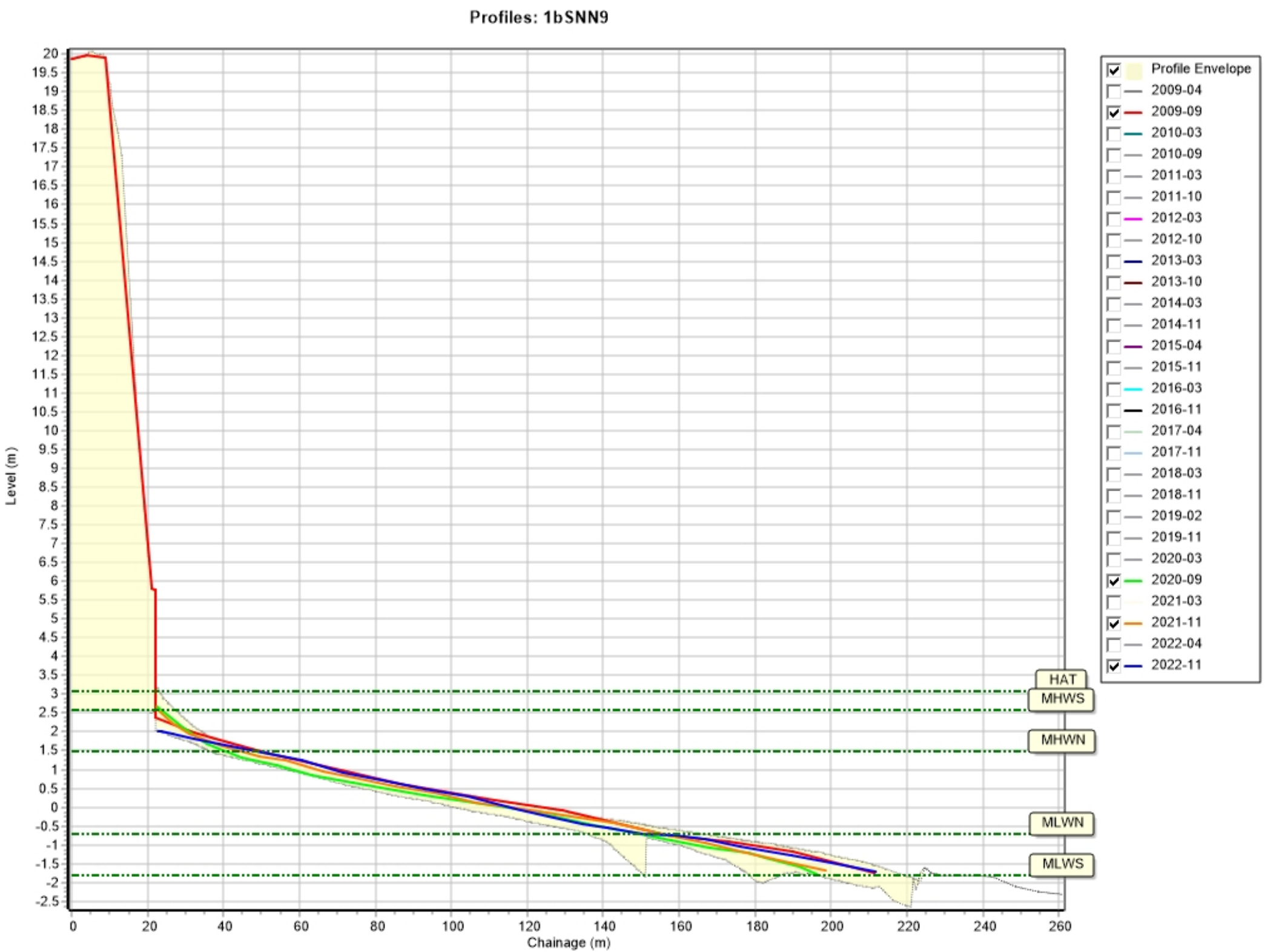
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Profile Envelope
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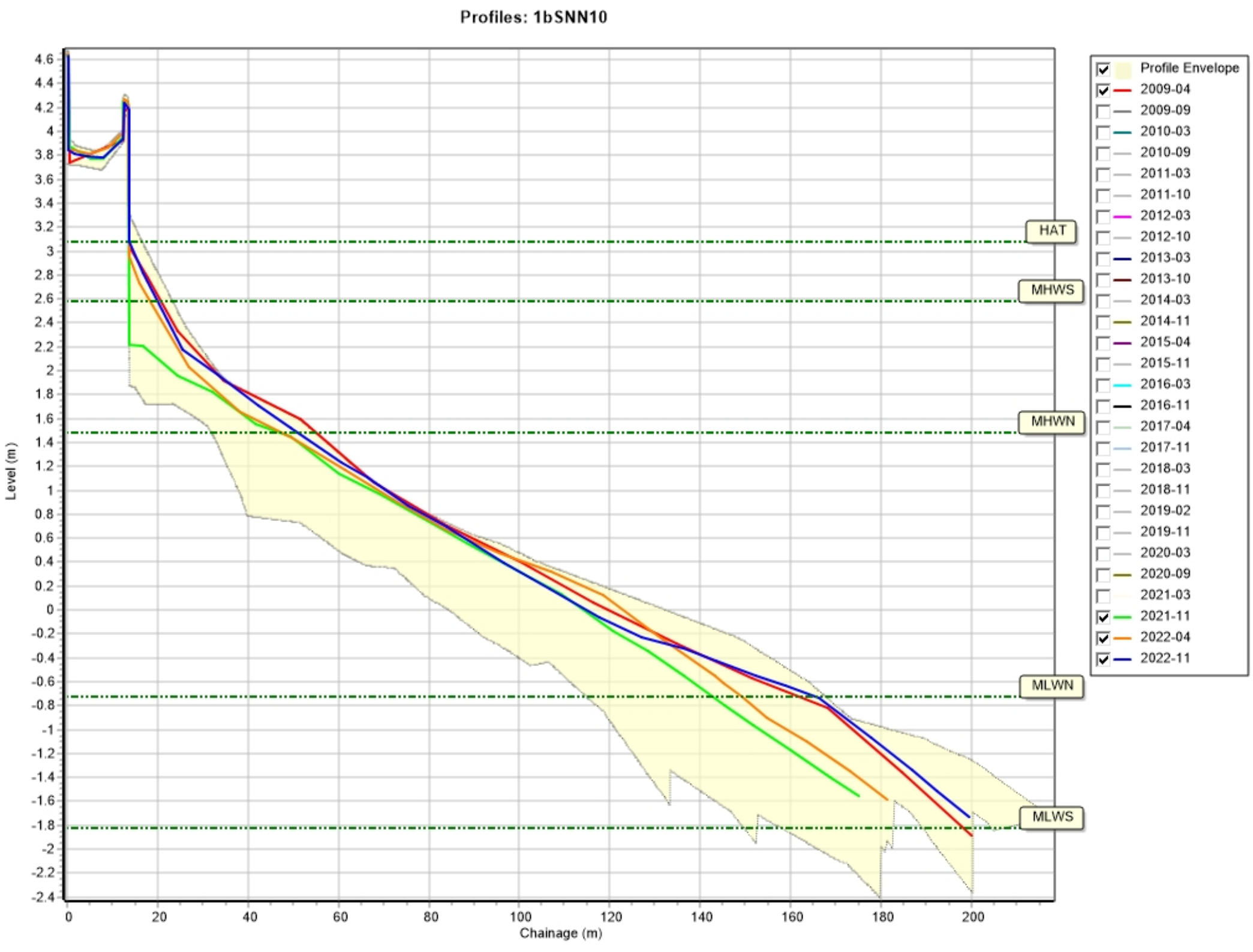
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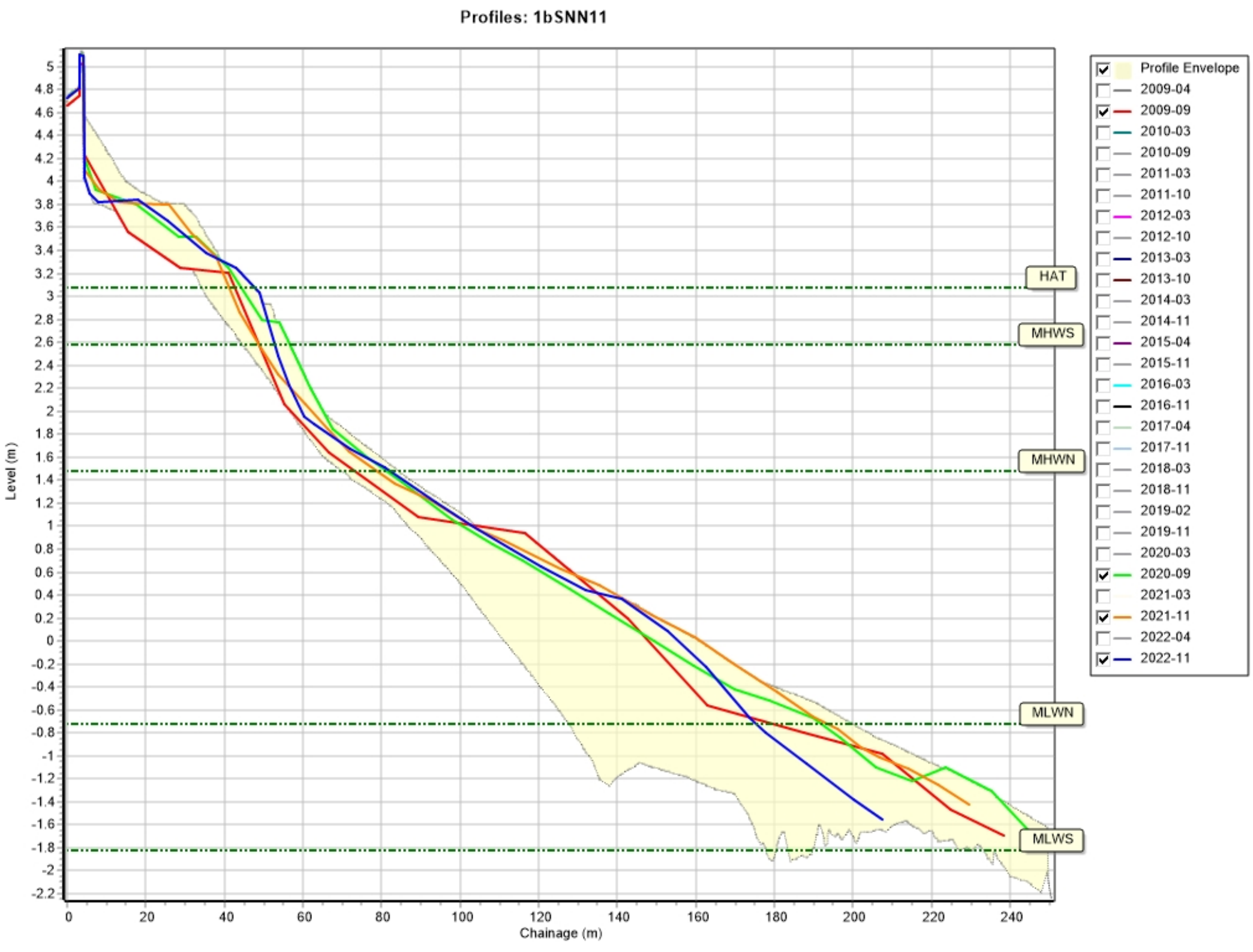
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Profile Envelope
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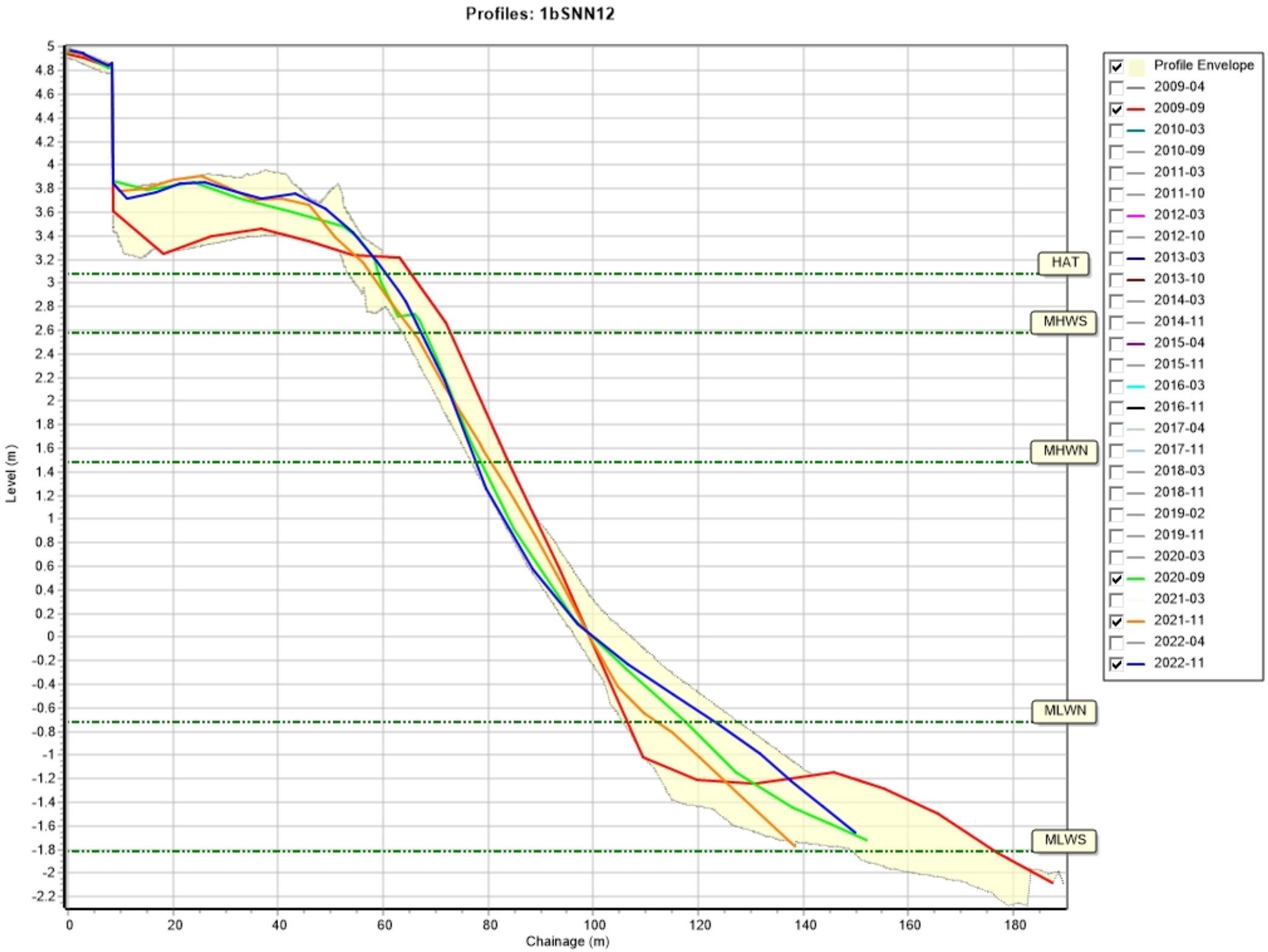
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Chainage (m)
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Profile Envelope
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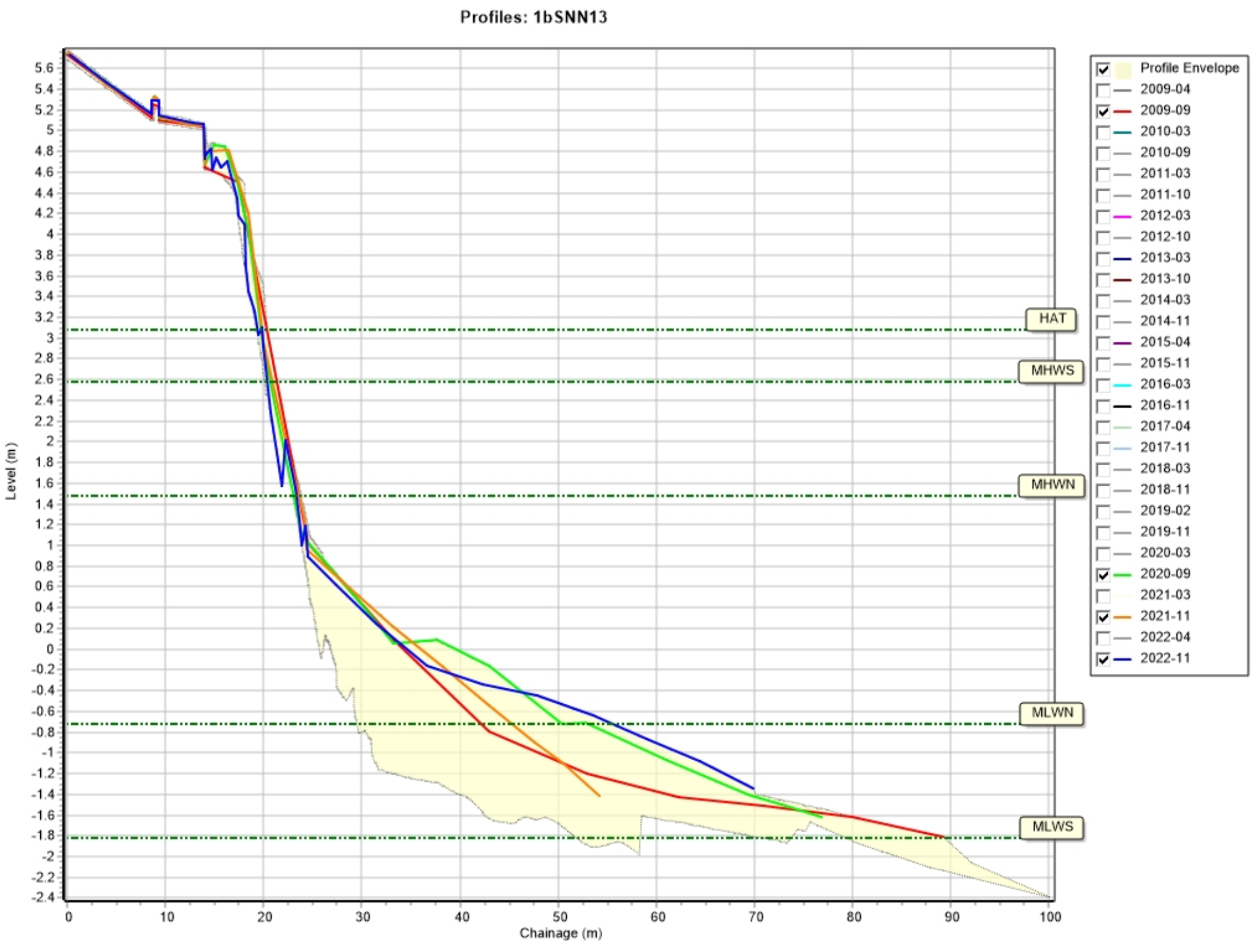
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Chainage (m)
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Profile Envelope
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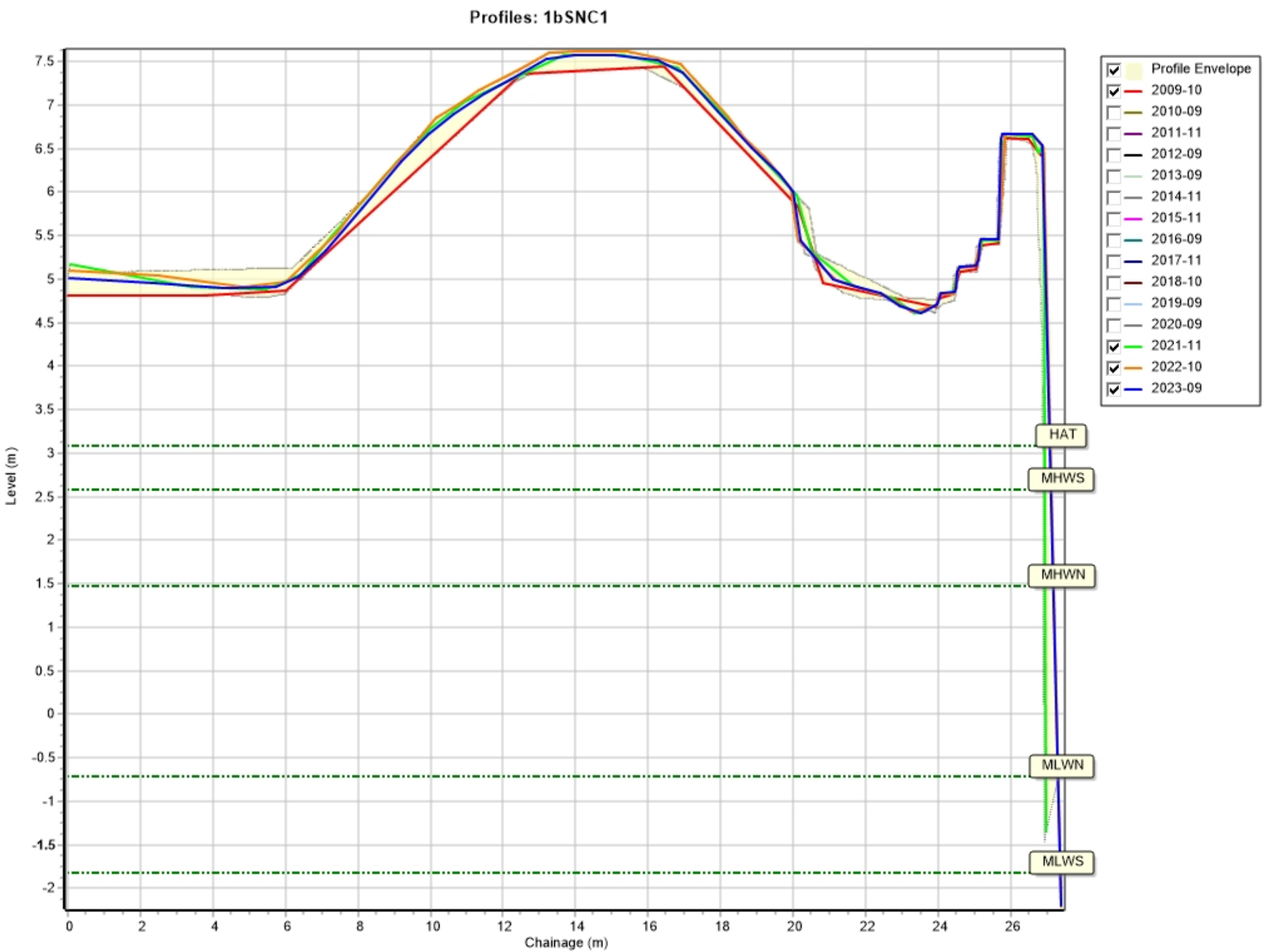
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HAT
MHWS
MHWN
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MLWS
Level (m)
Chainage (m)
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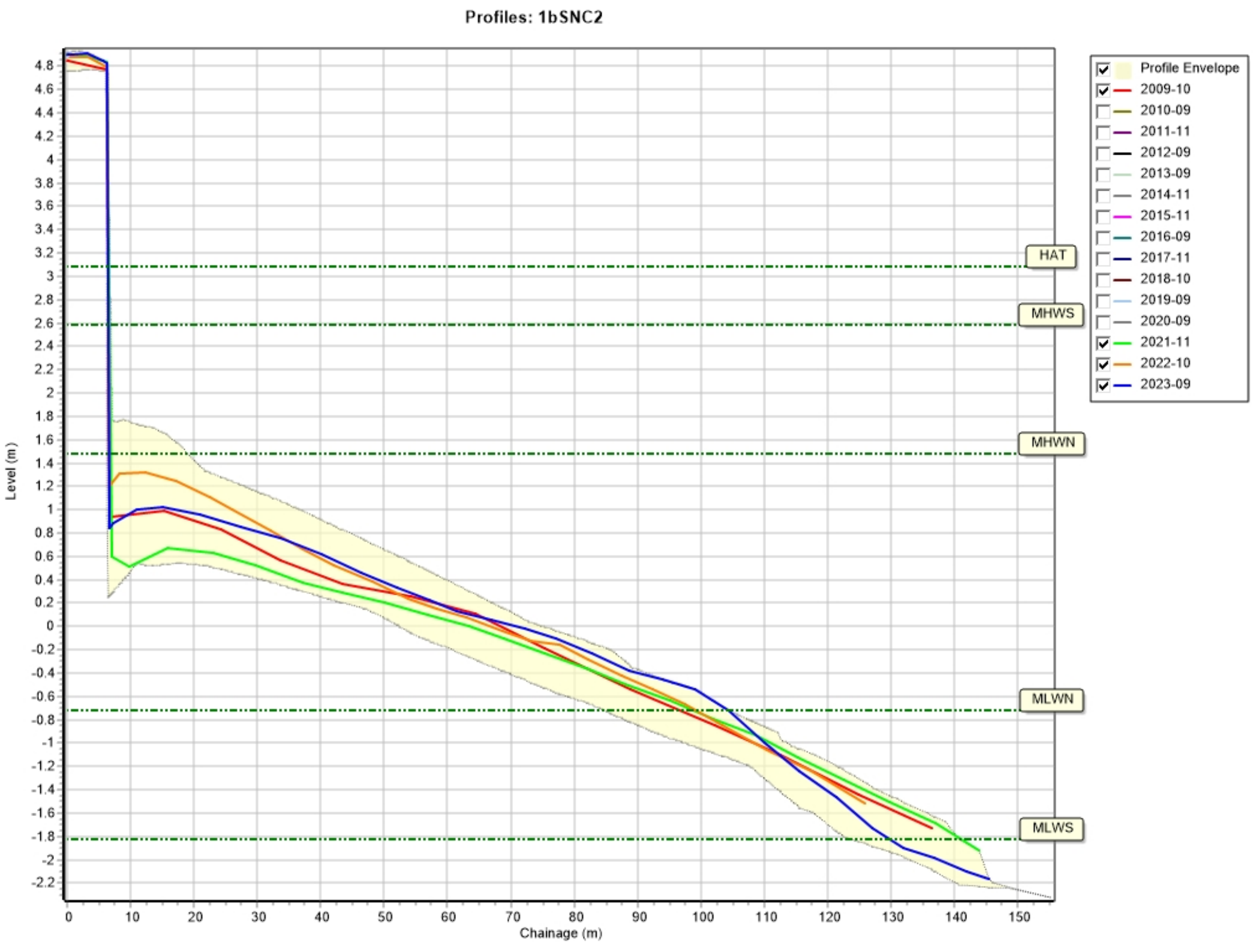
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2022-10
2023-09
HAT
MHWS
MHWN
MLWN
MLWS
Level (m)
Chainage (m)
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3.8
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3.4
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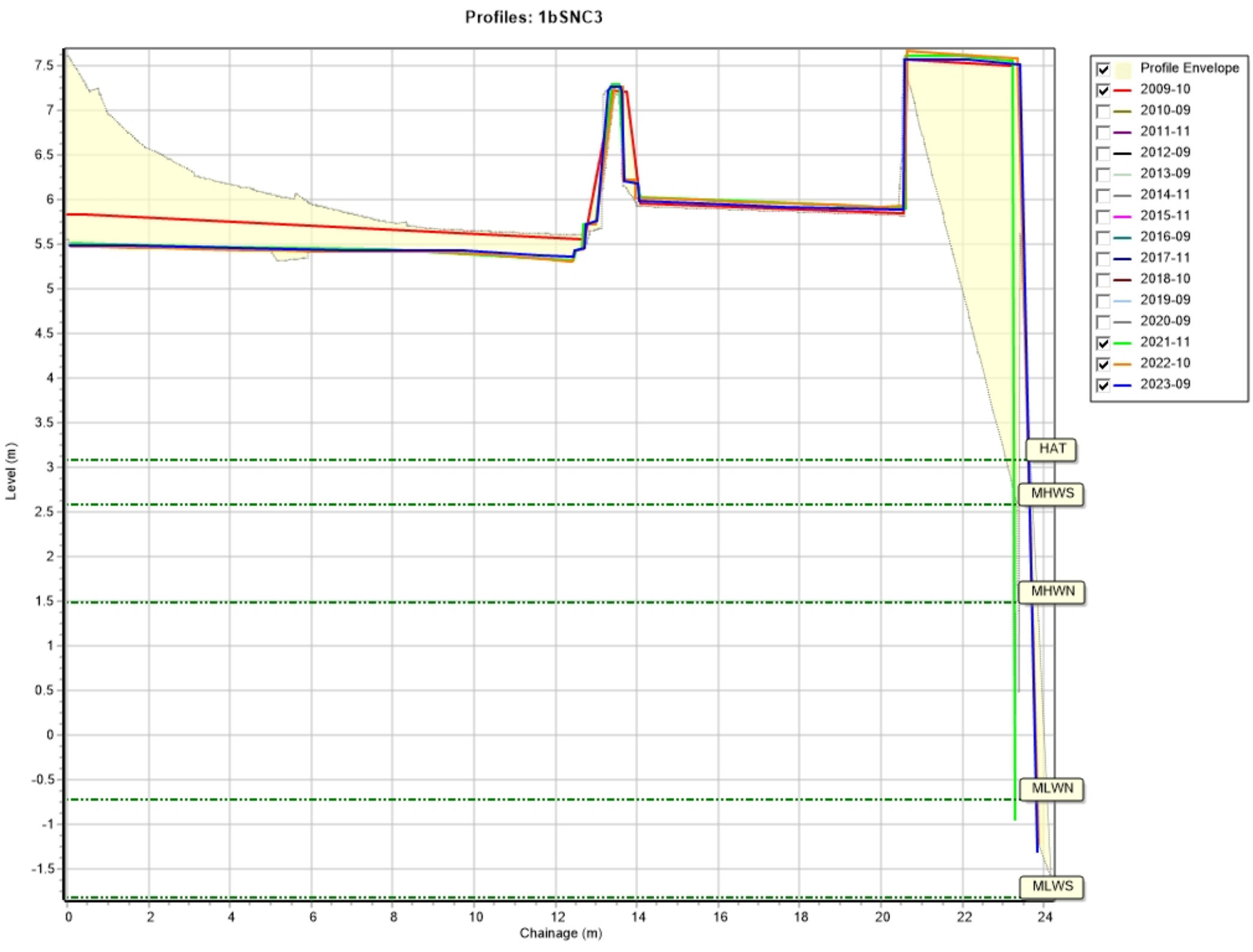
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2023-09
HAT
MHWS
MHWN
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MLWS
Level (m)
Chainage (m)
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6.5
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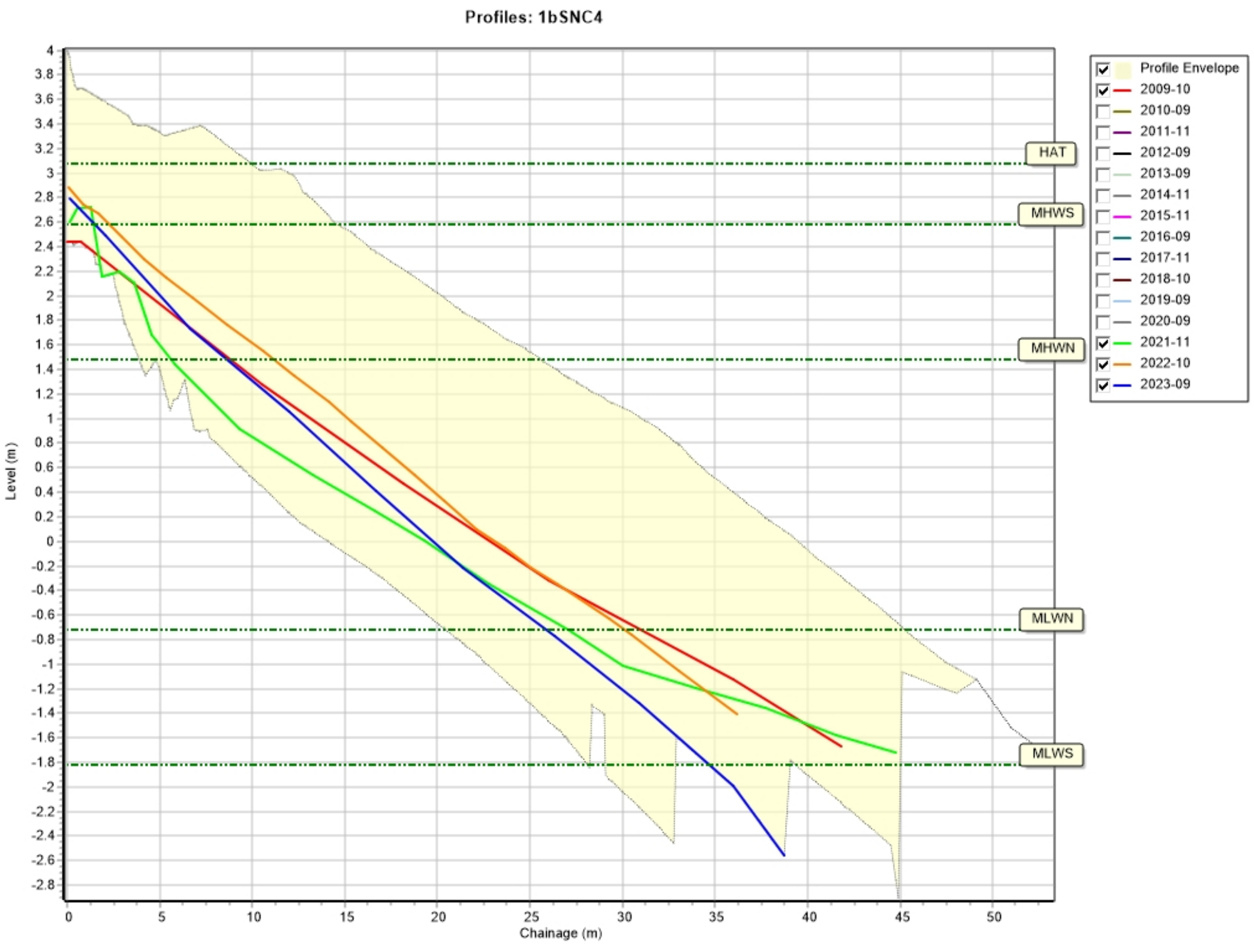
Profiles: 1bSNC4
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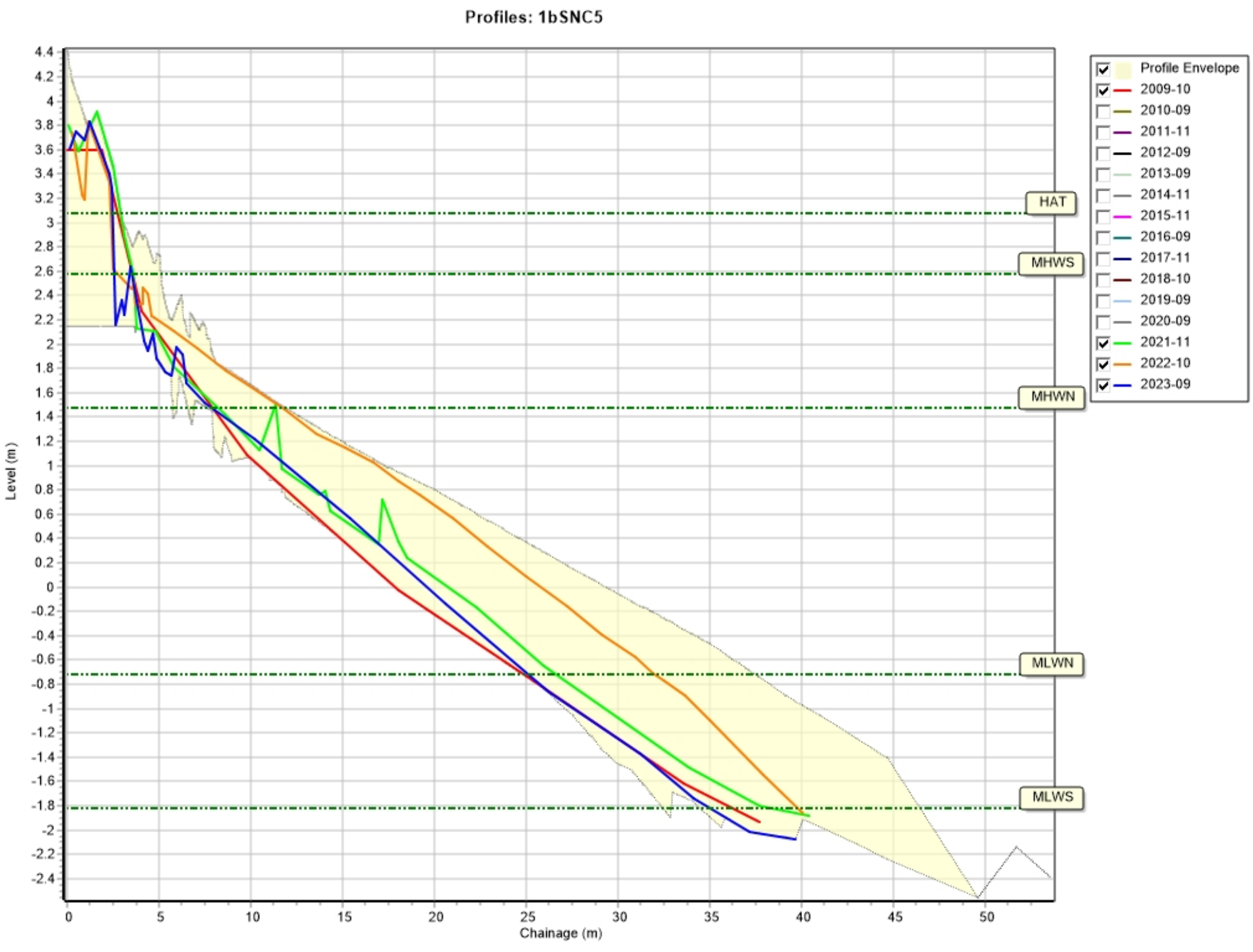
2023-09


Profiles: 1bSNC5
Level (m)
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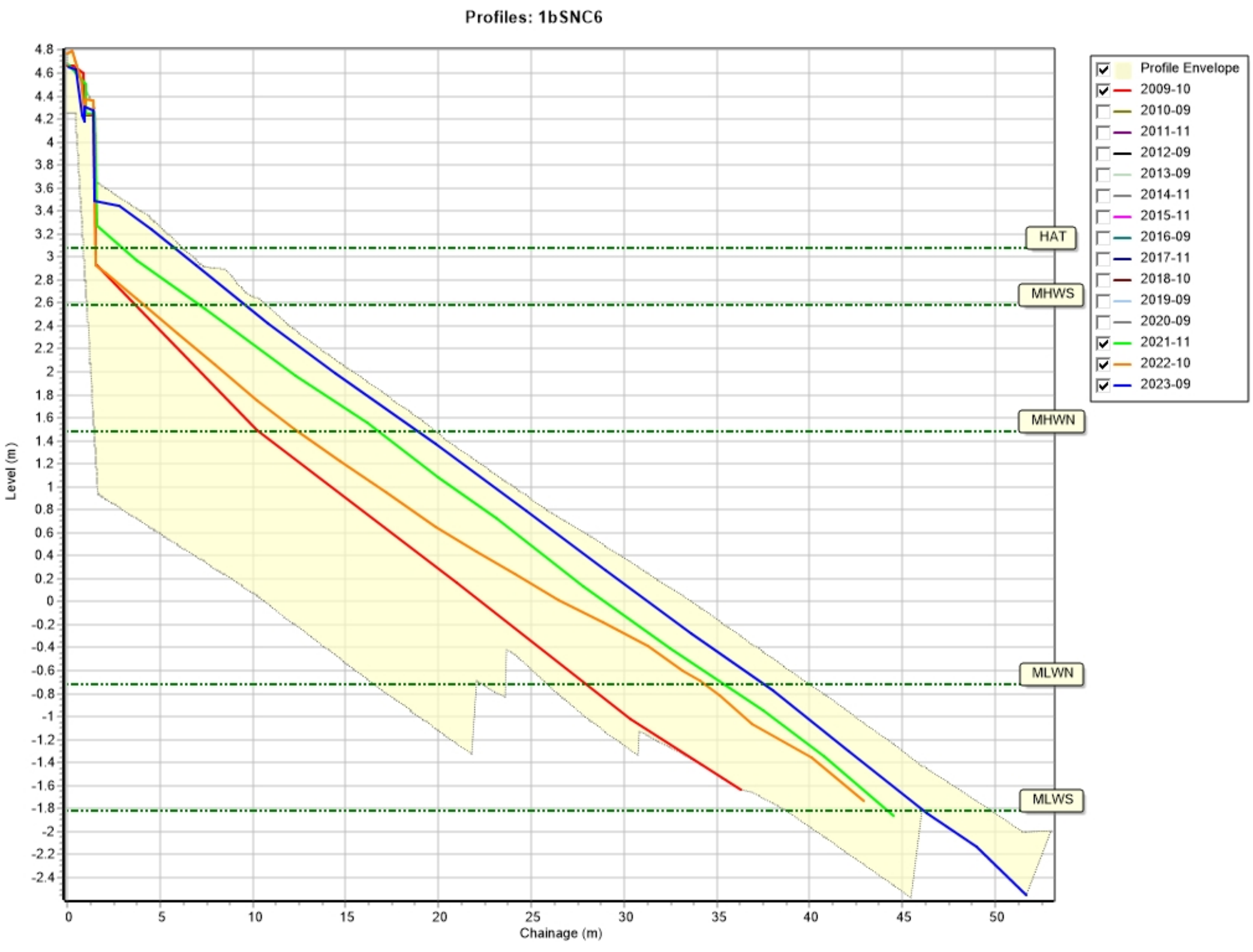
Profiles: 1bSNC6
Level (m)
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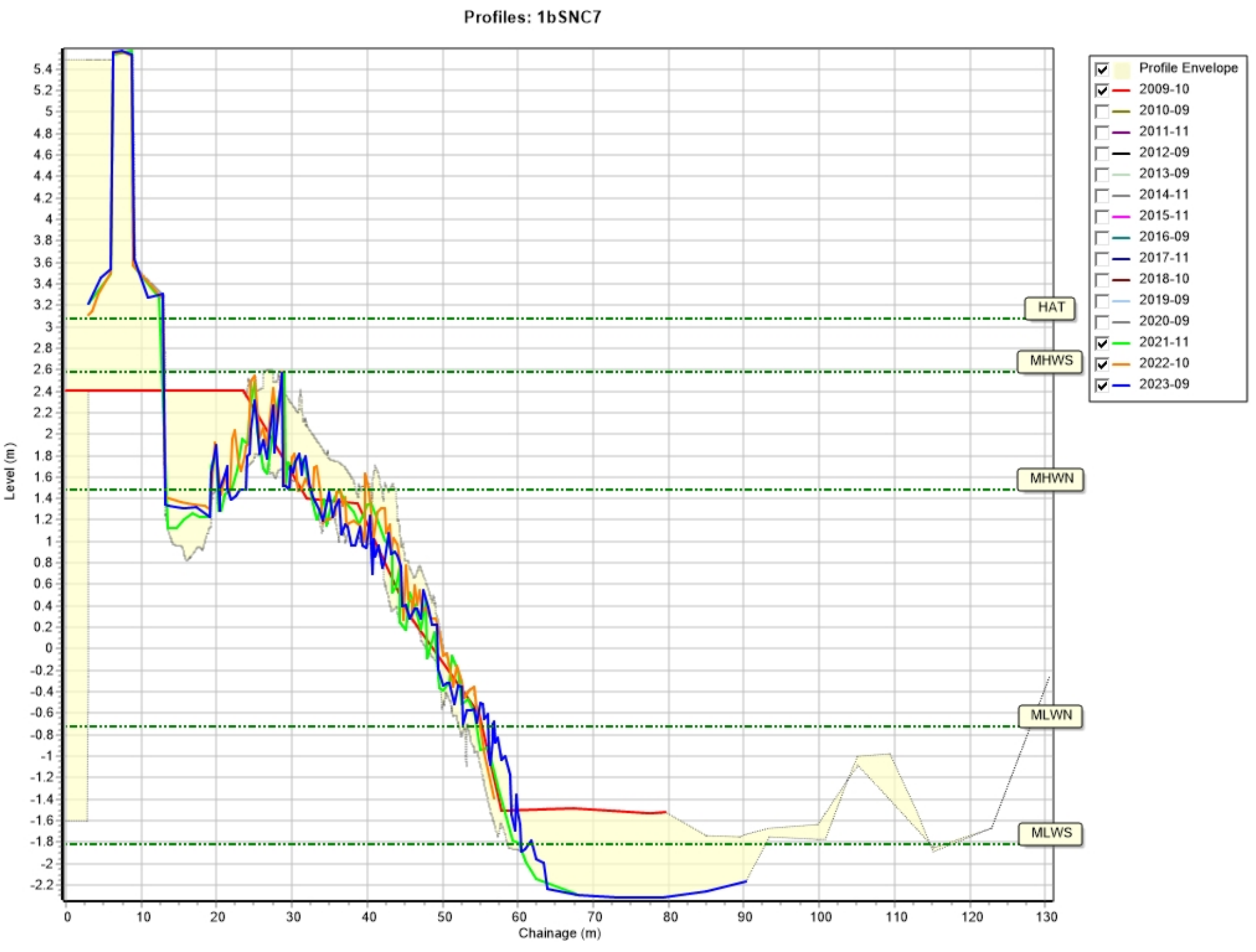
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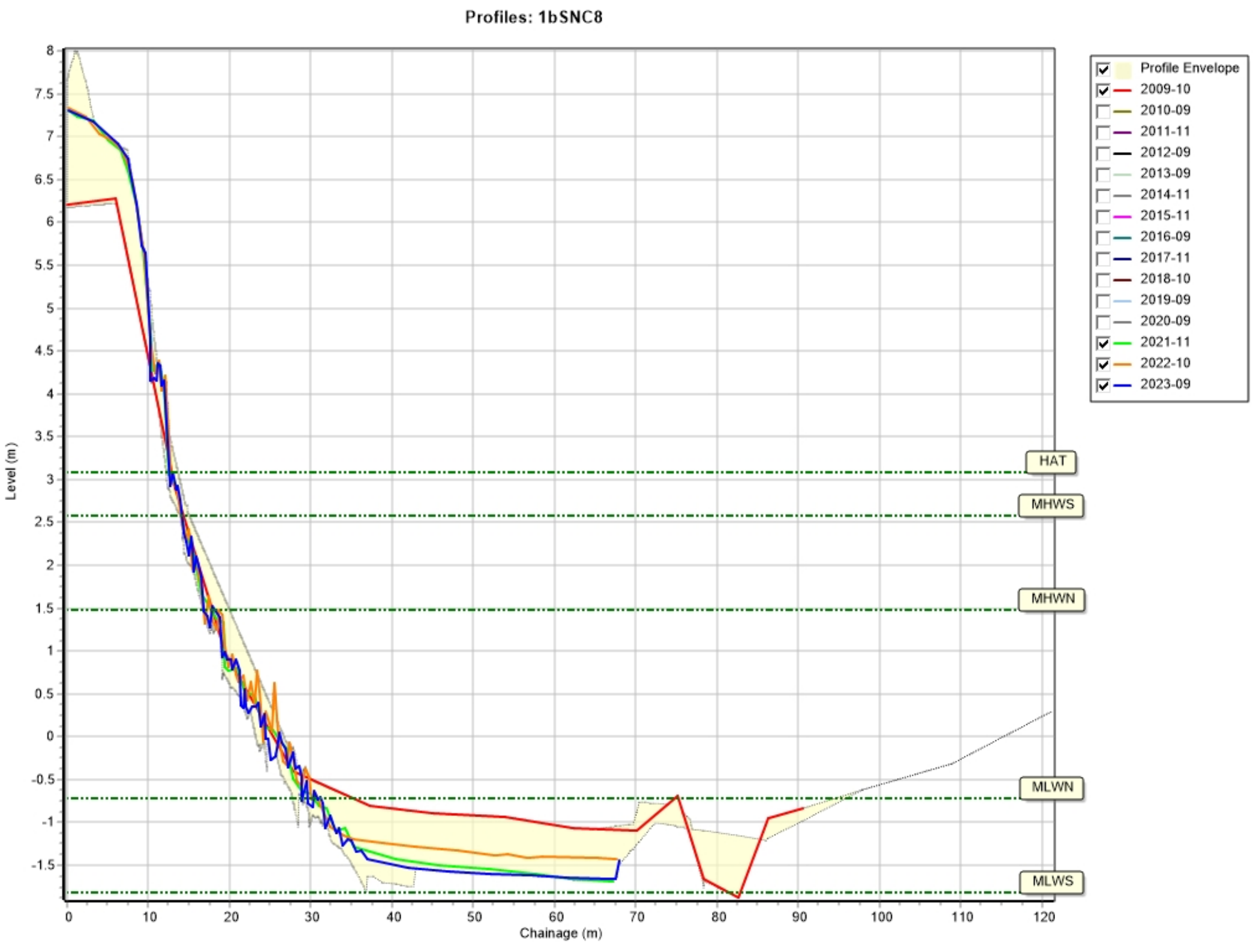
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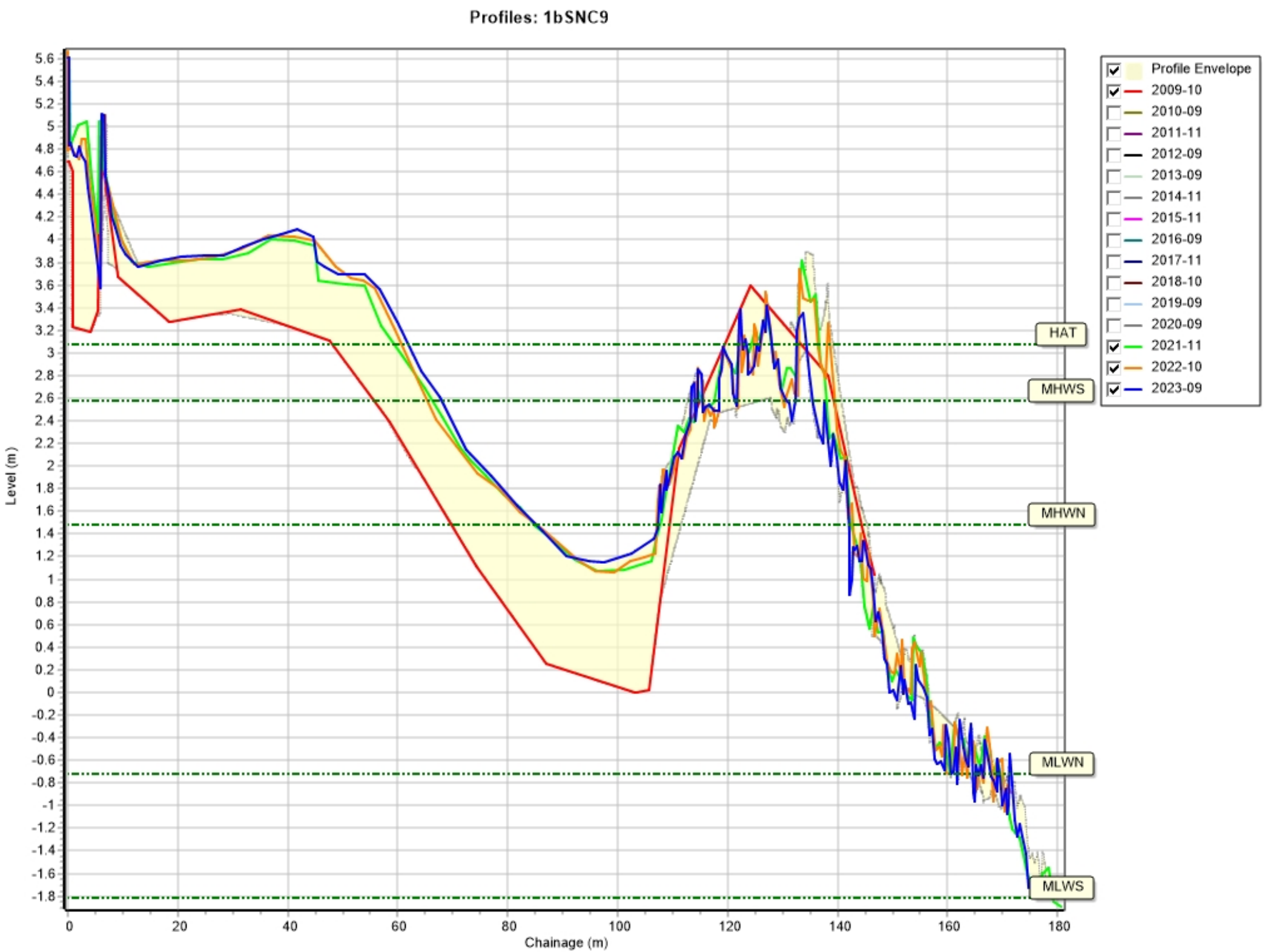
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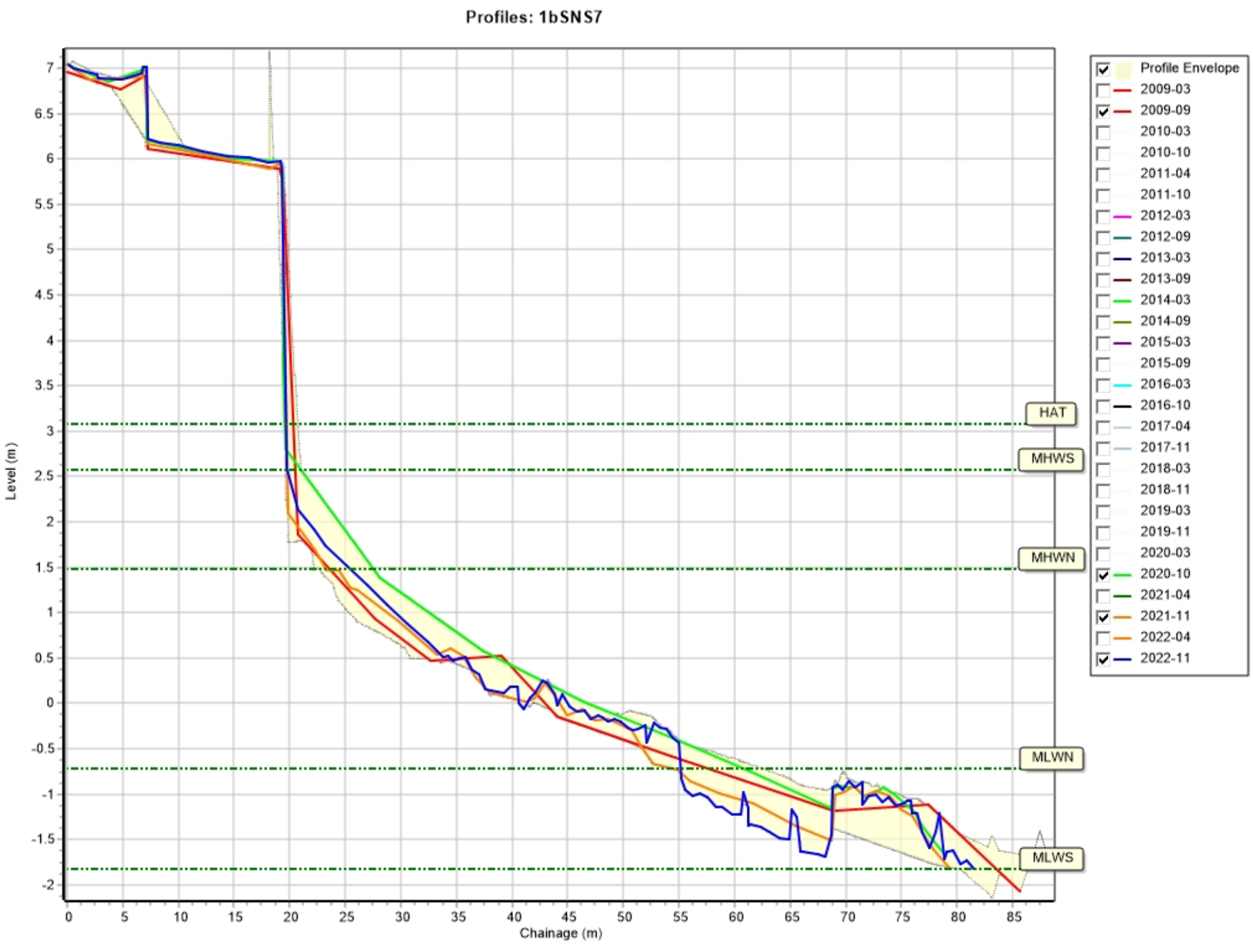
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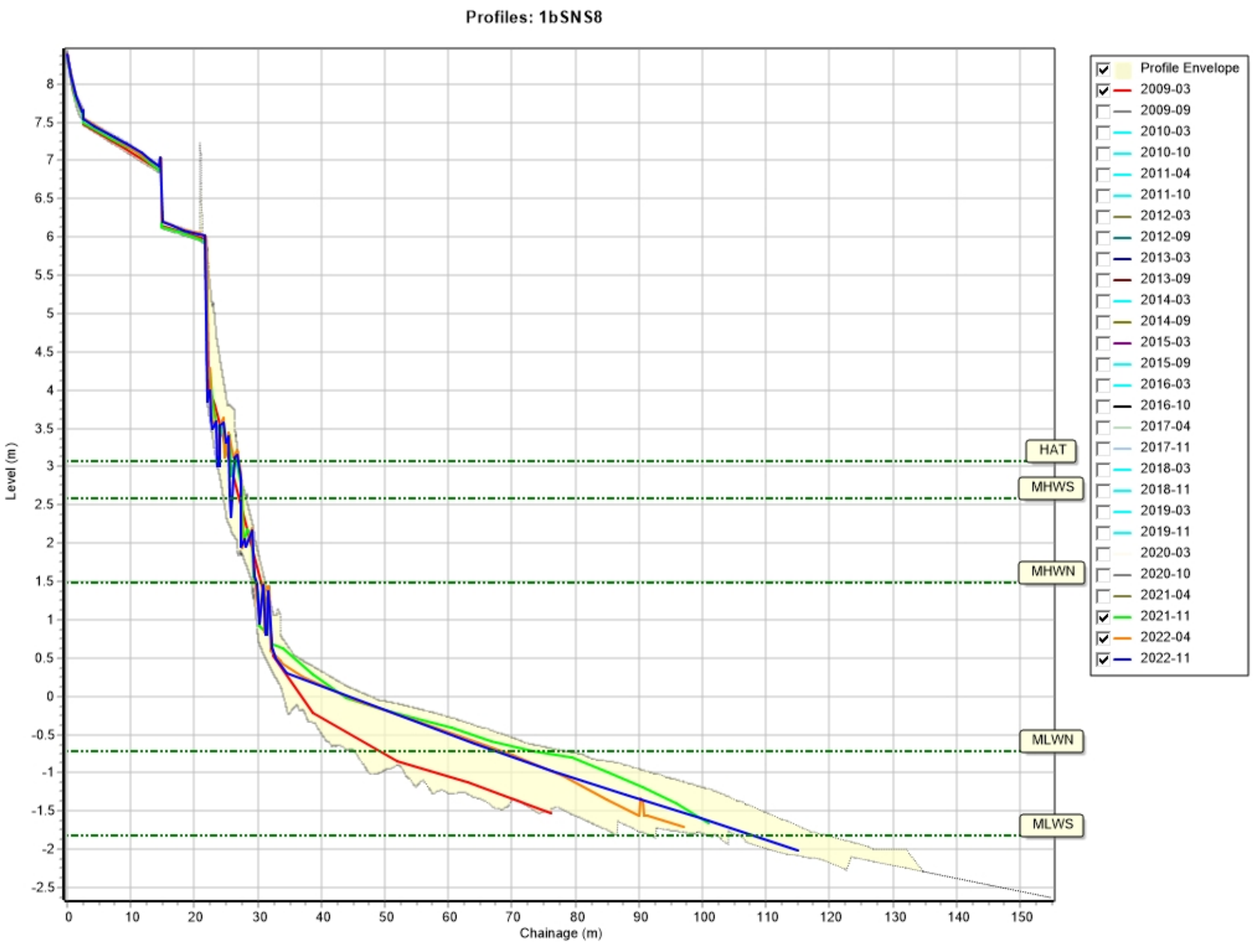
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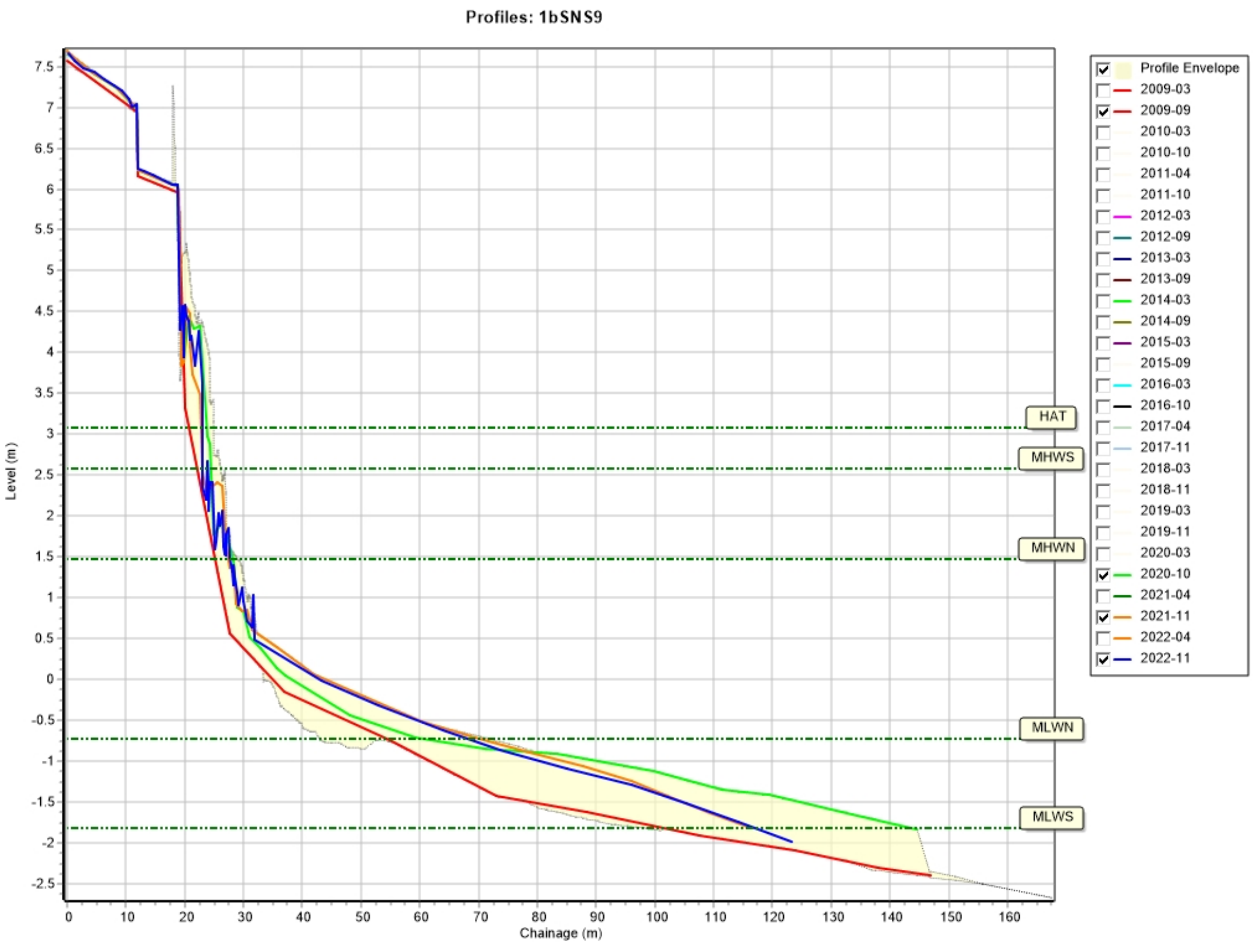
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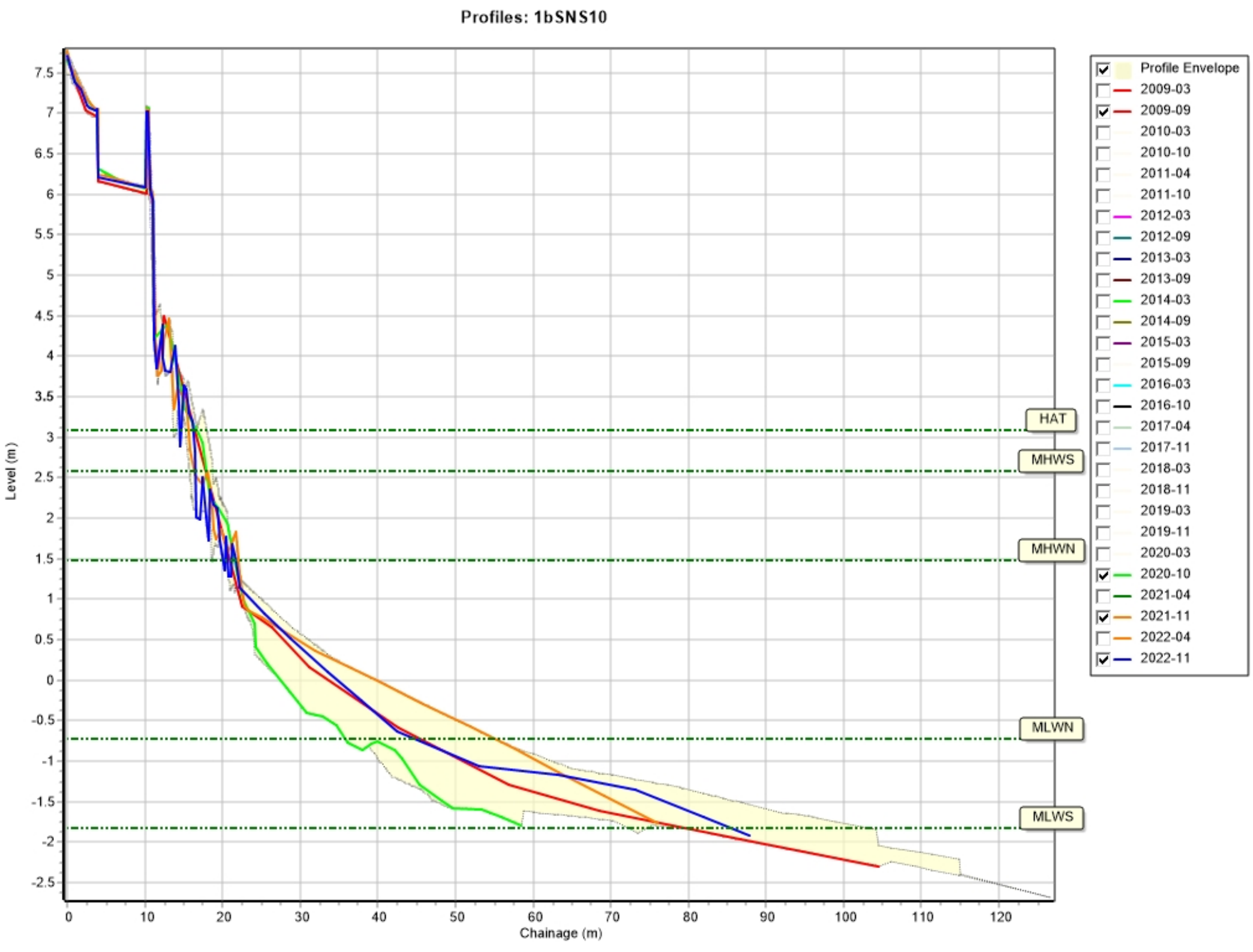
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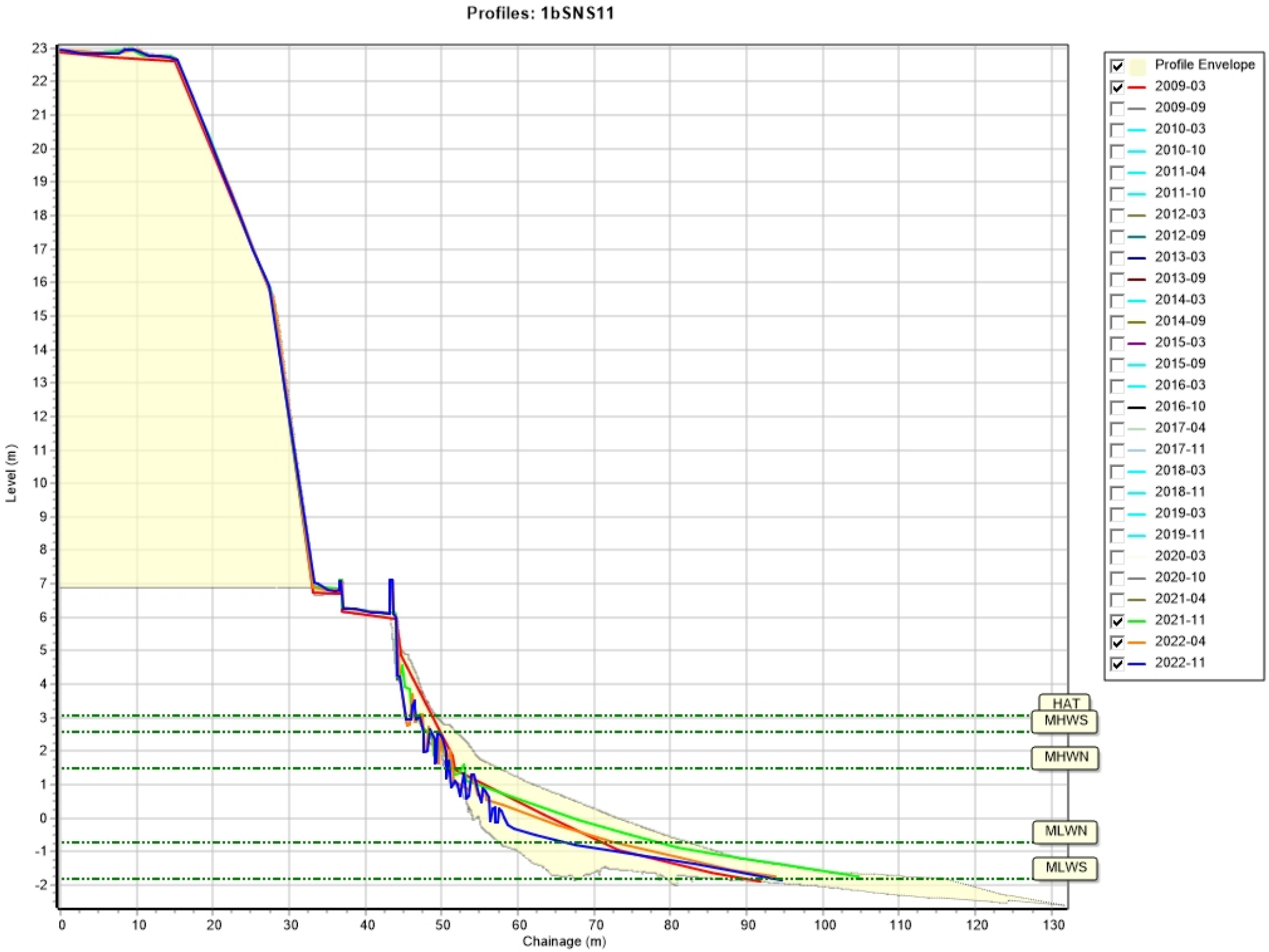
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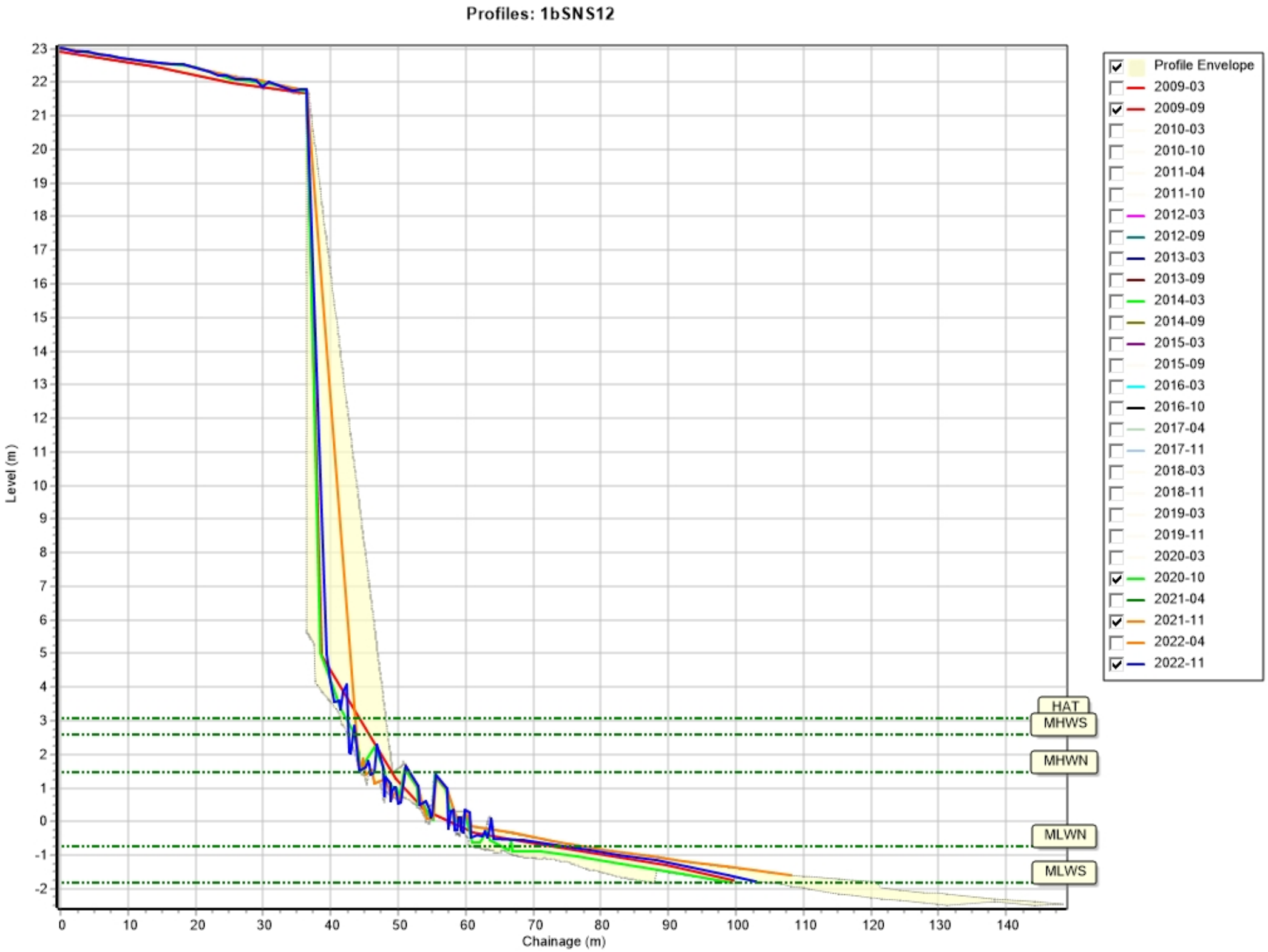
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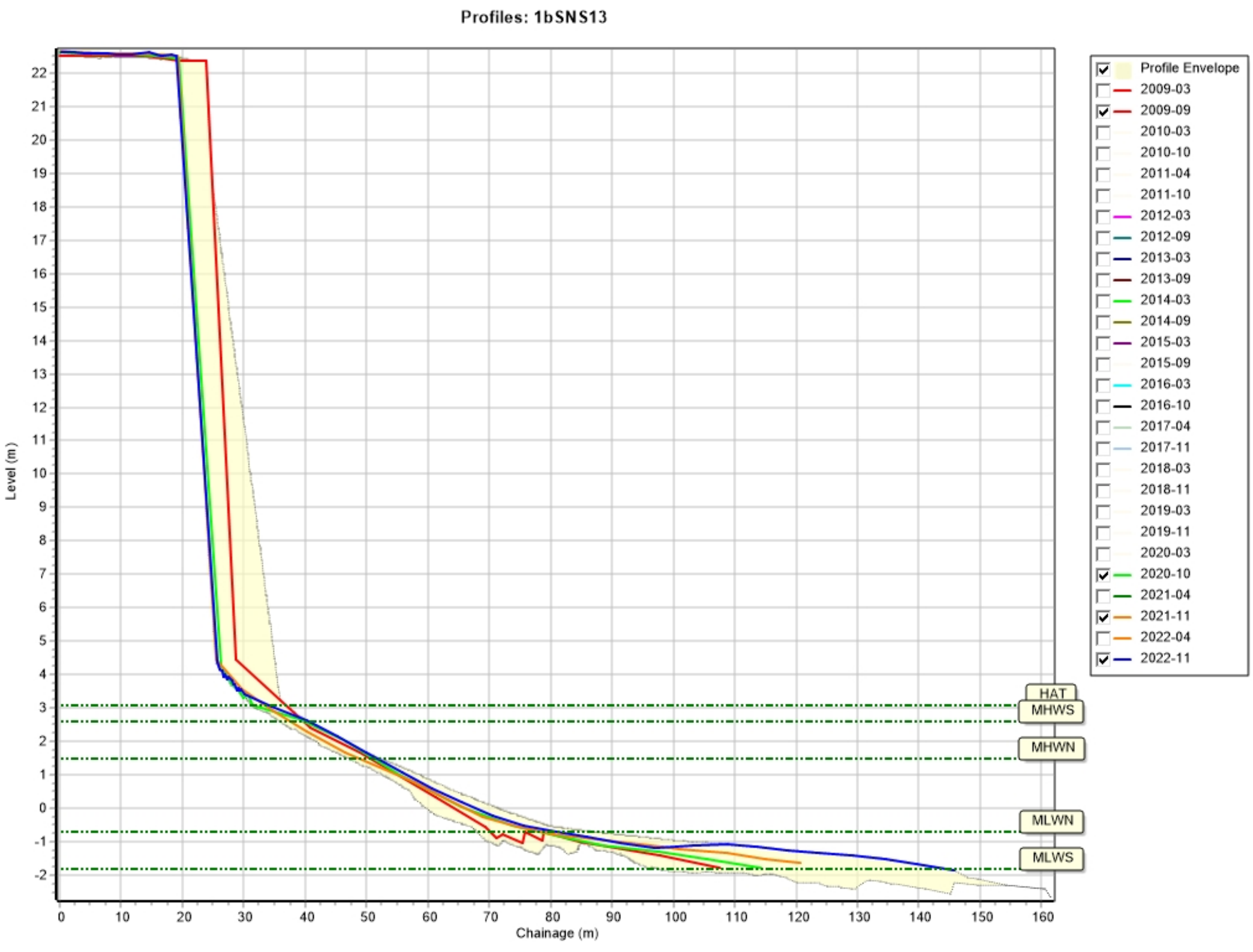
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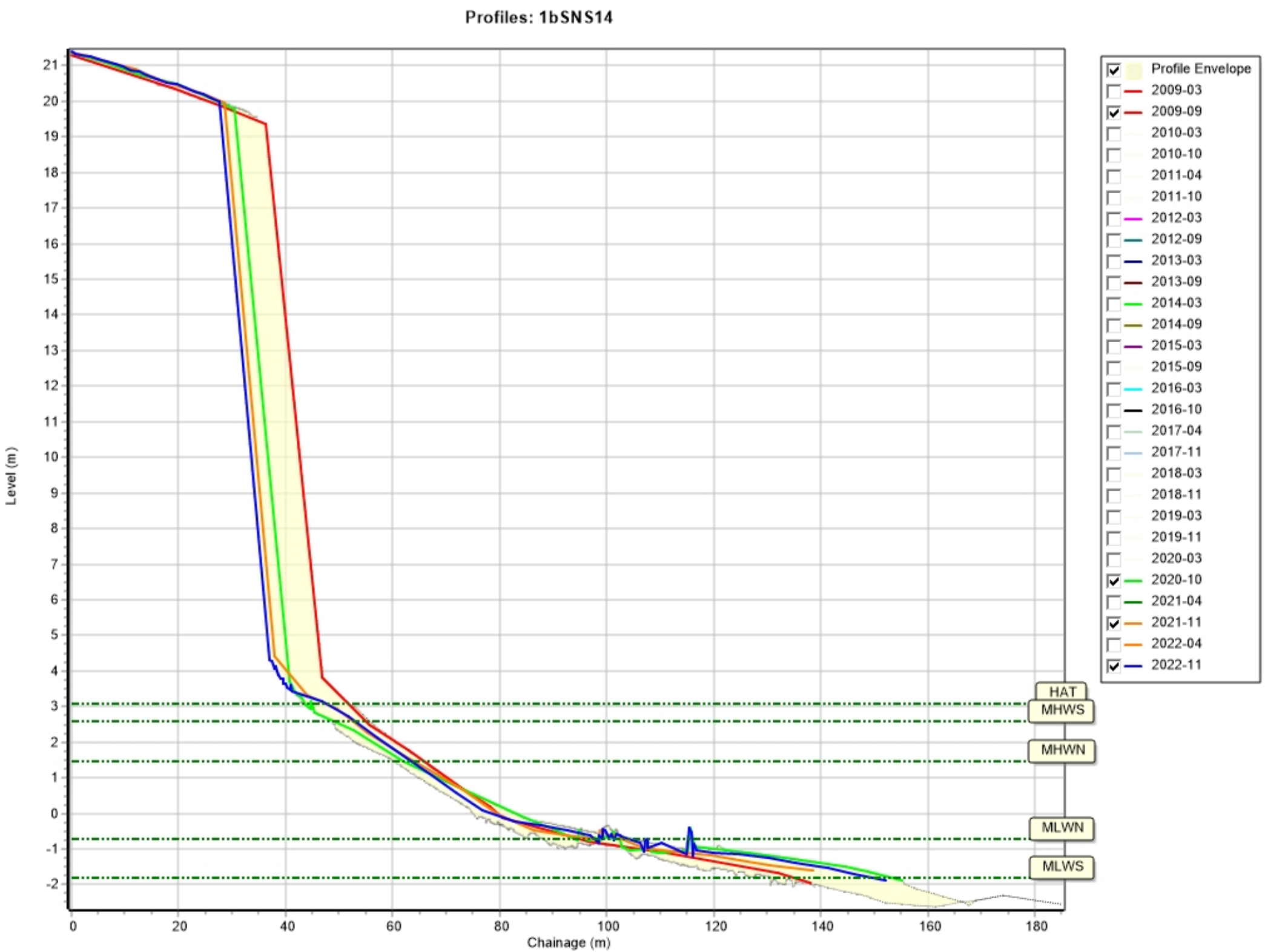
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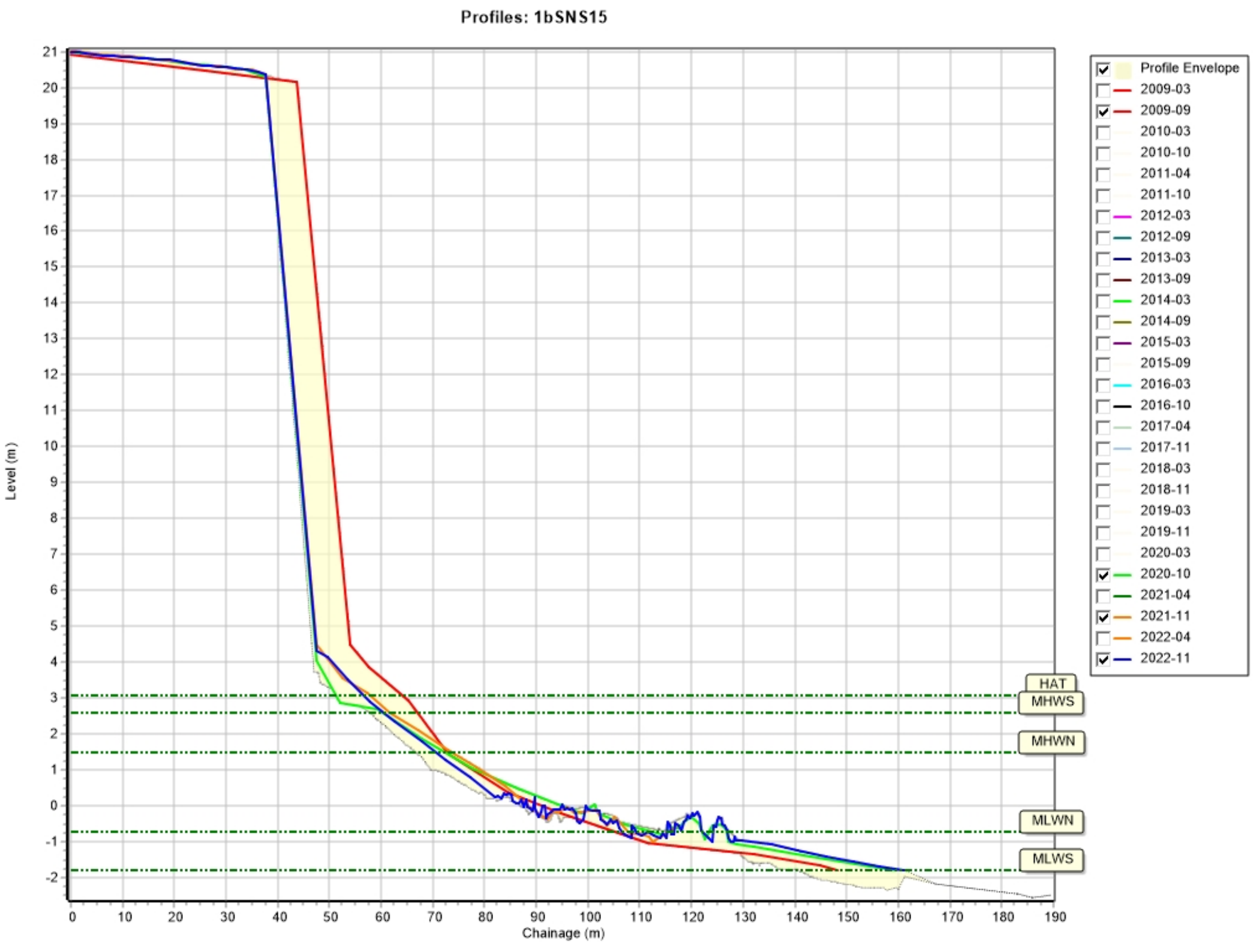
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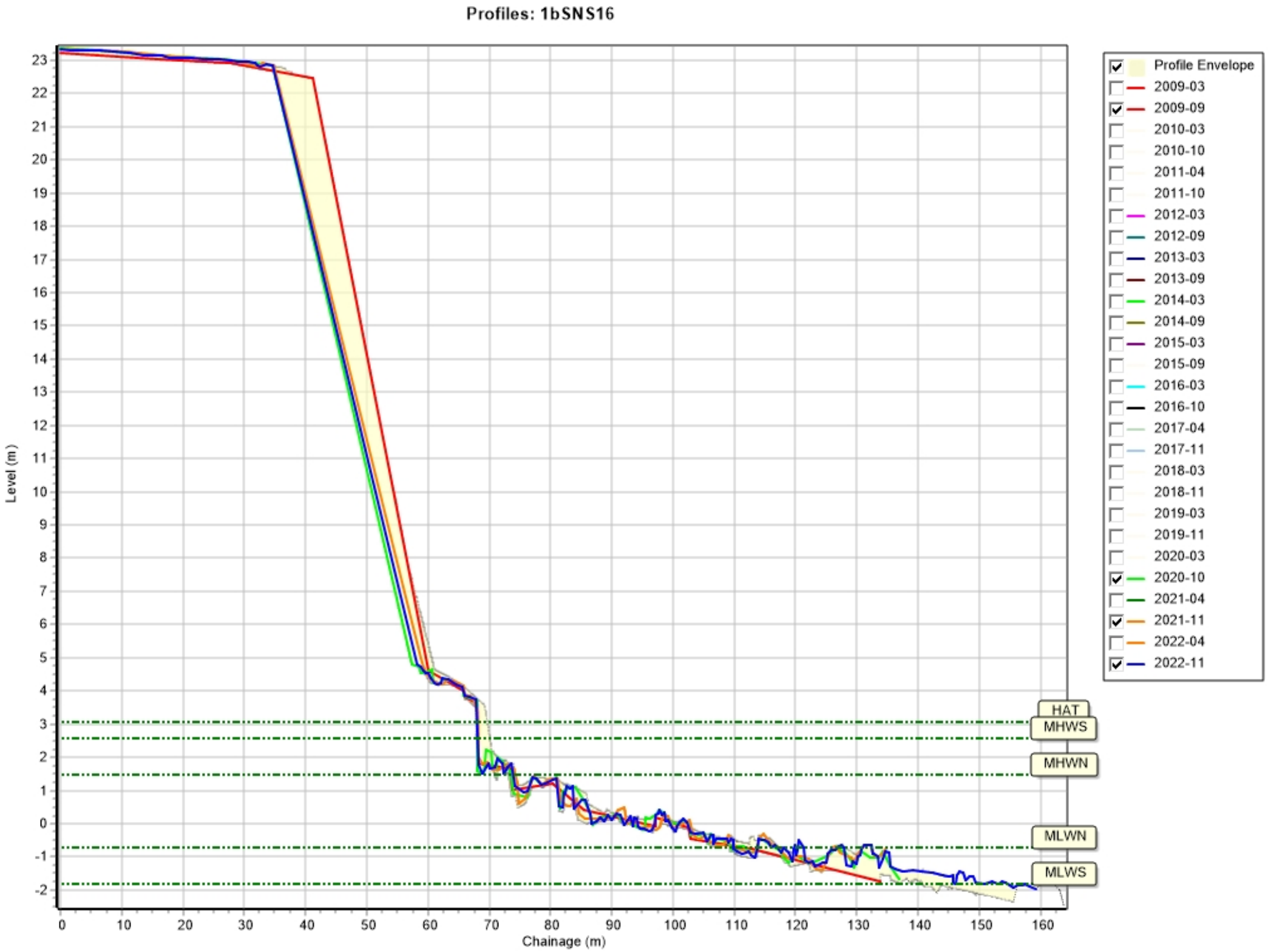
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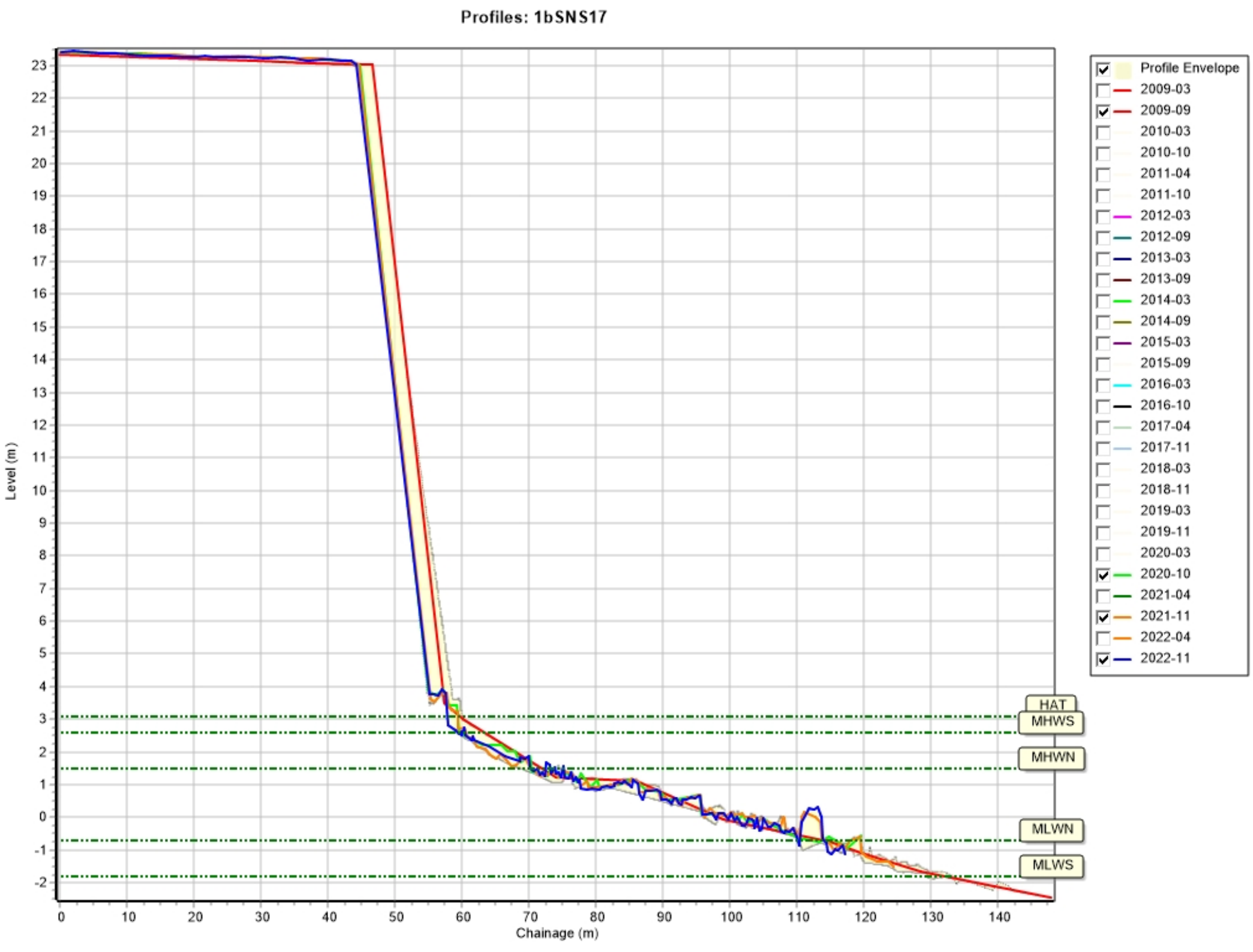
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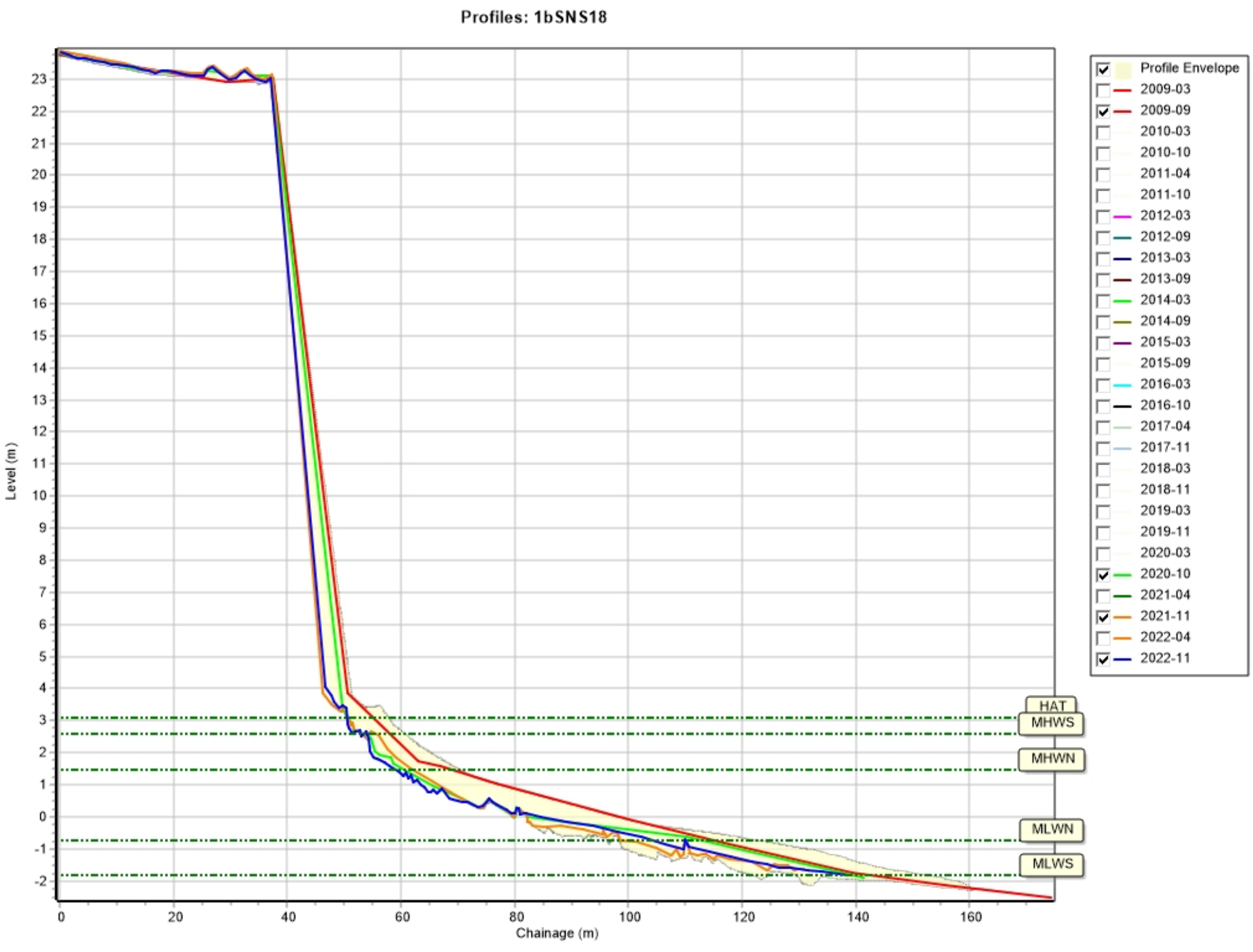
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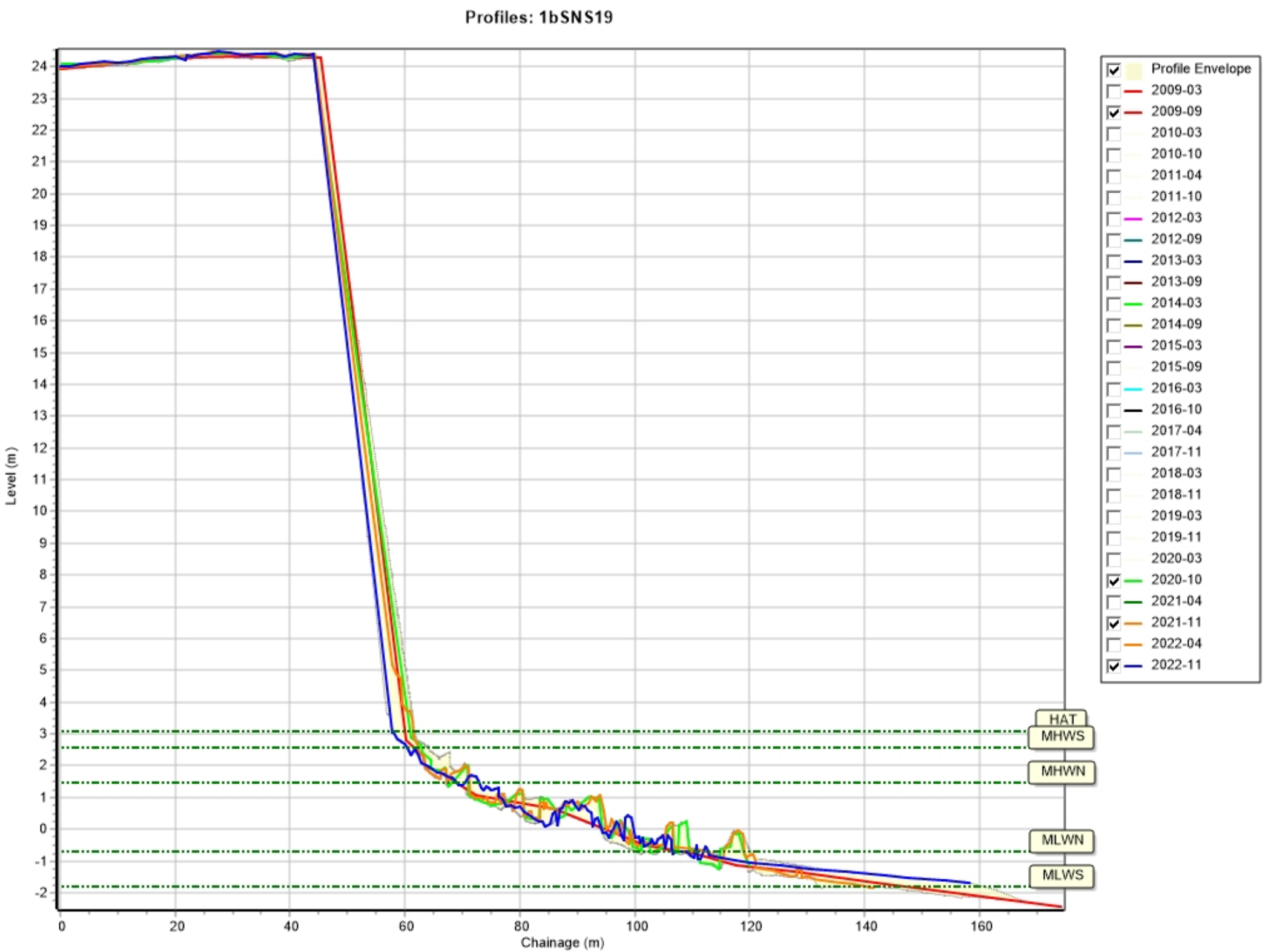
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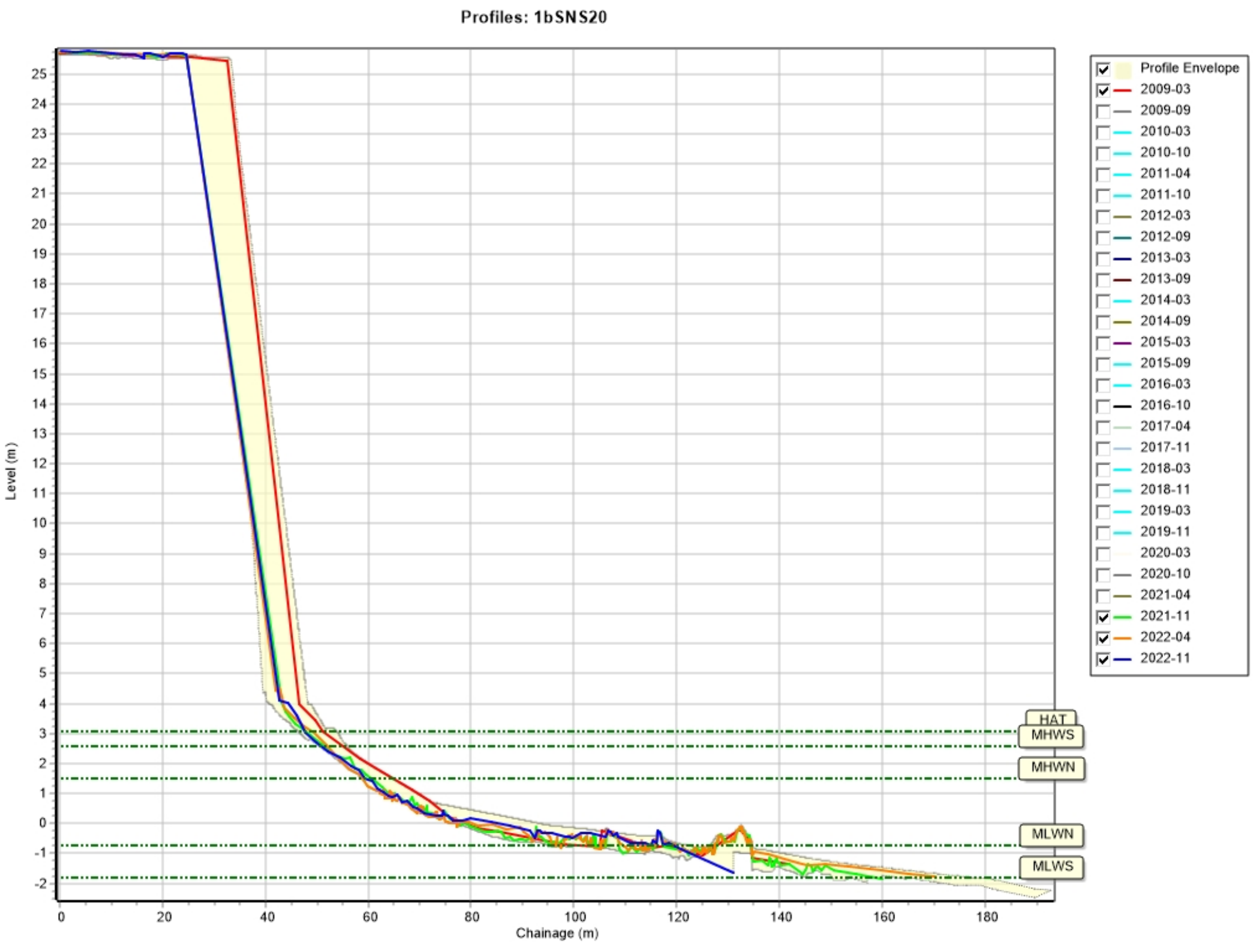
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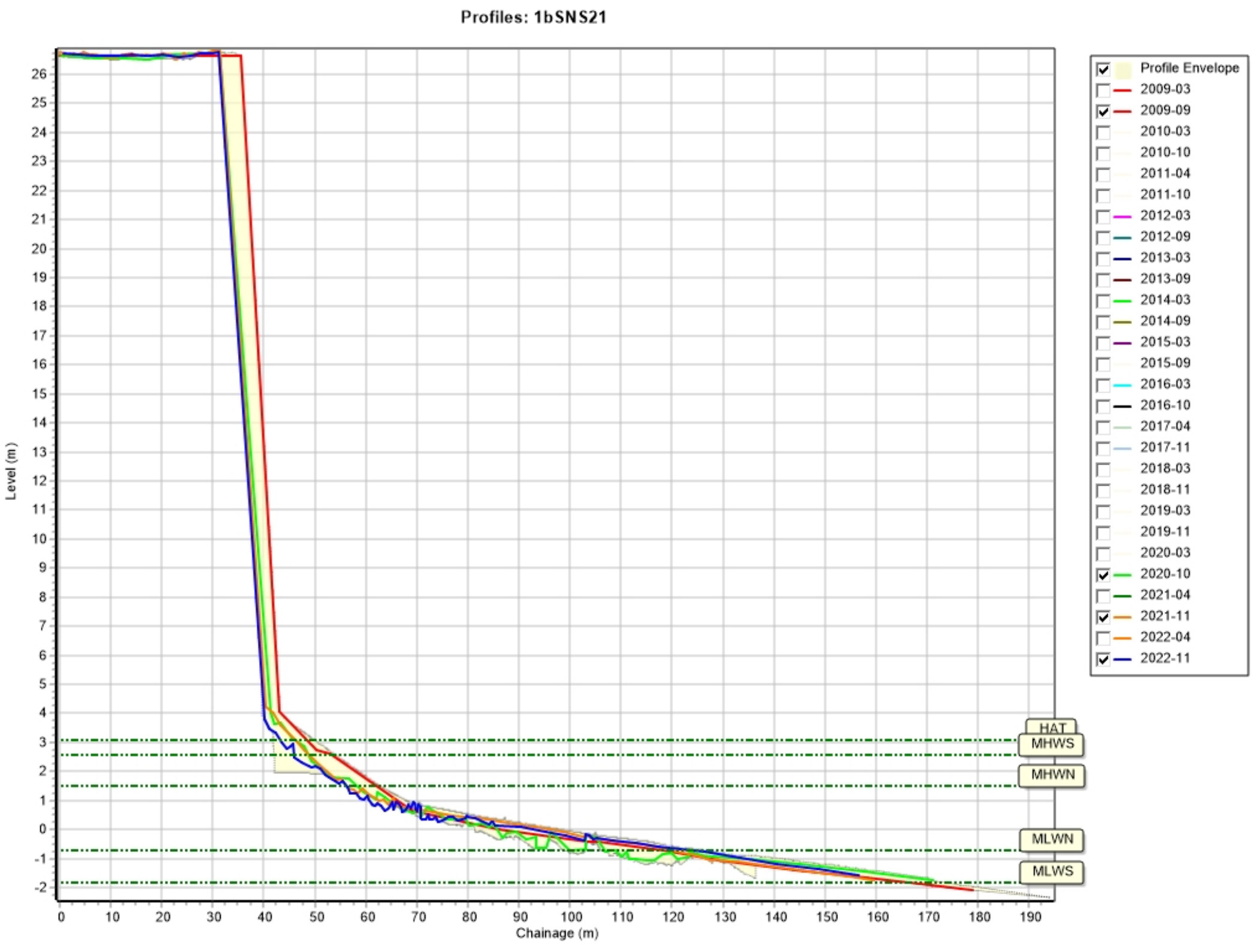
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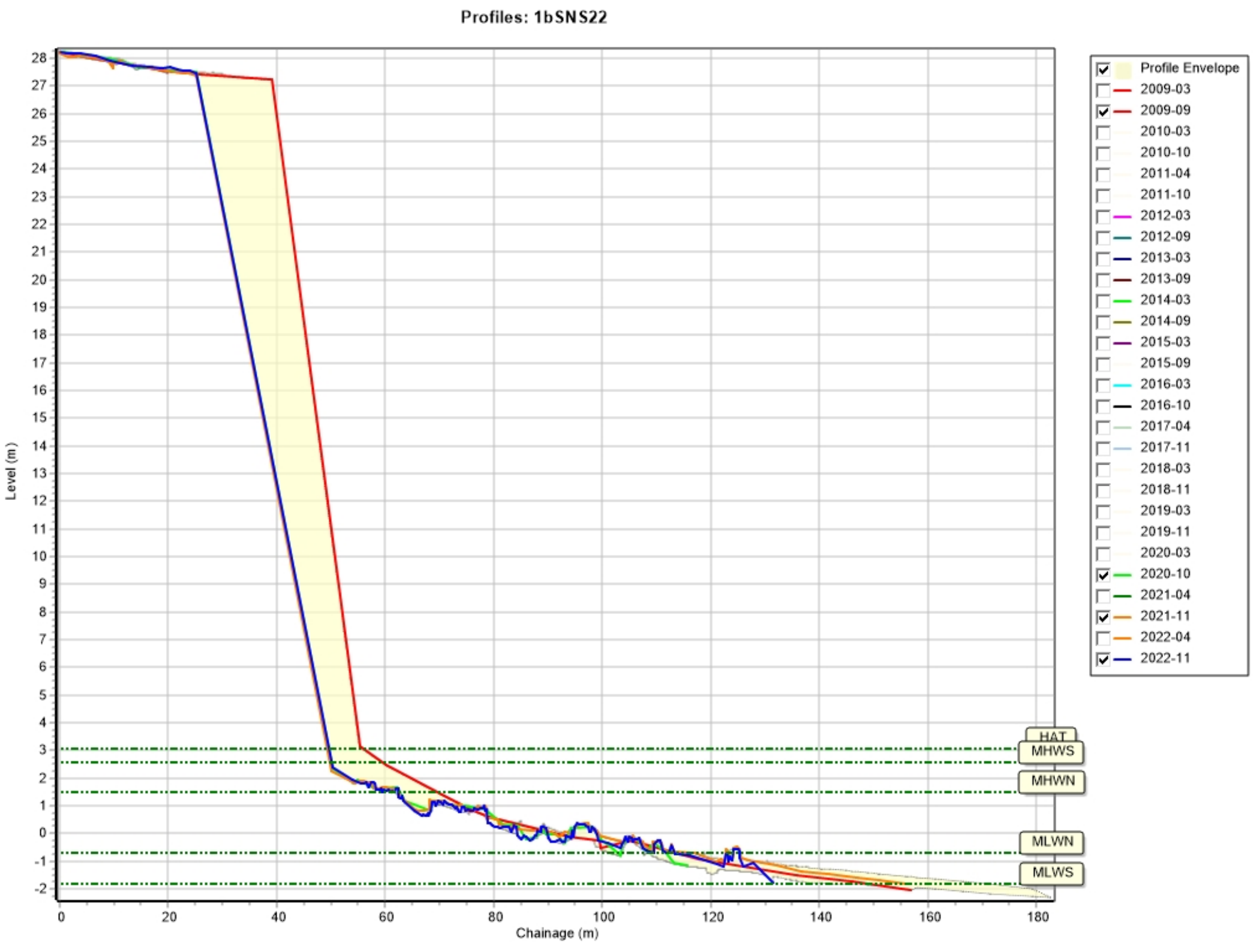
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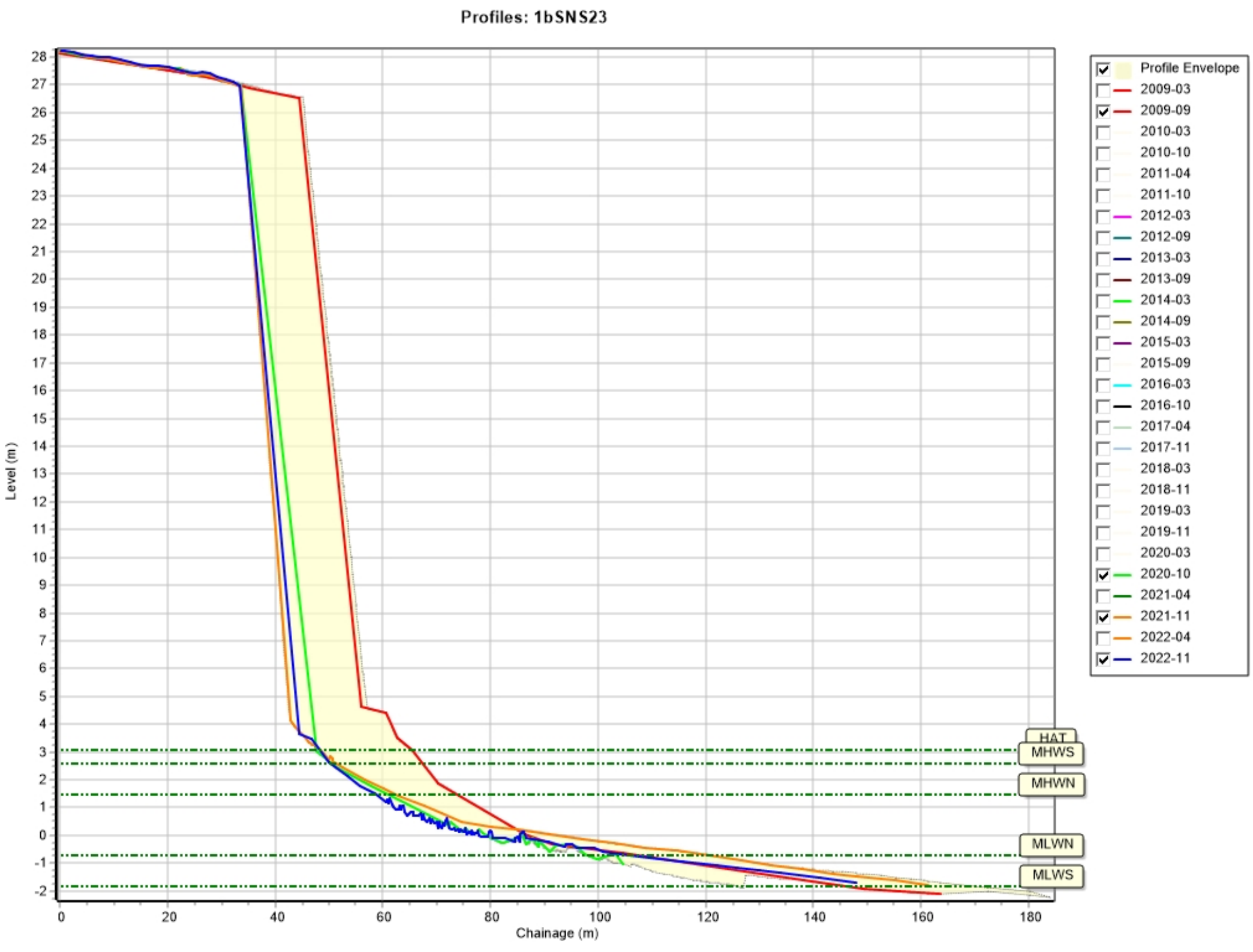
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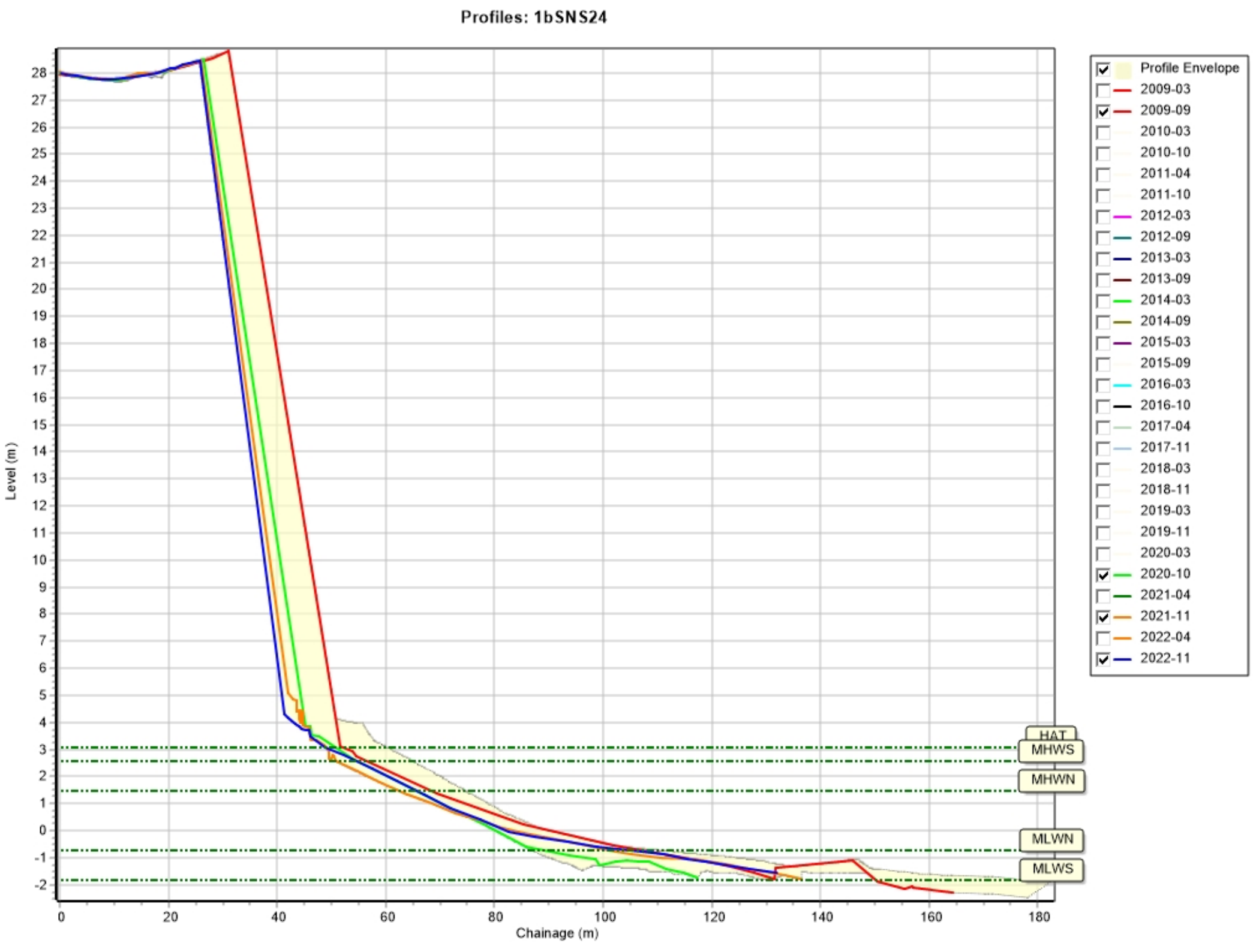
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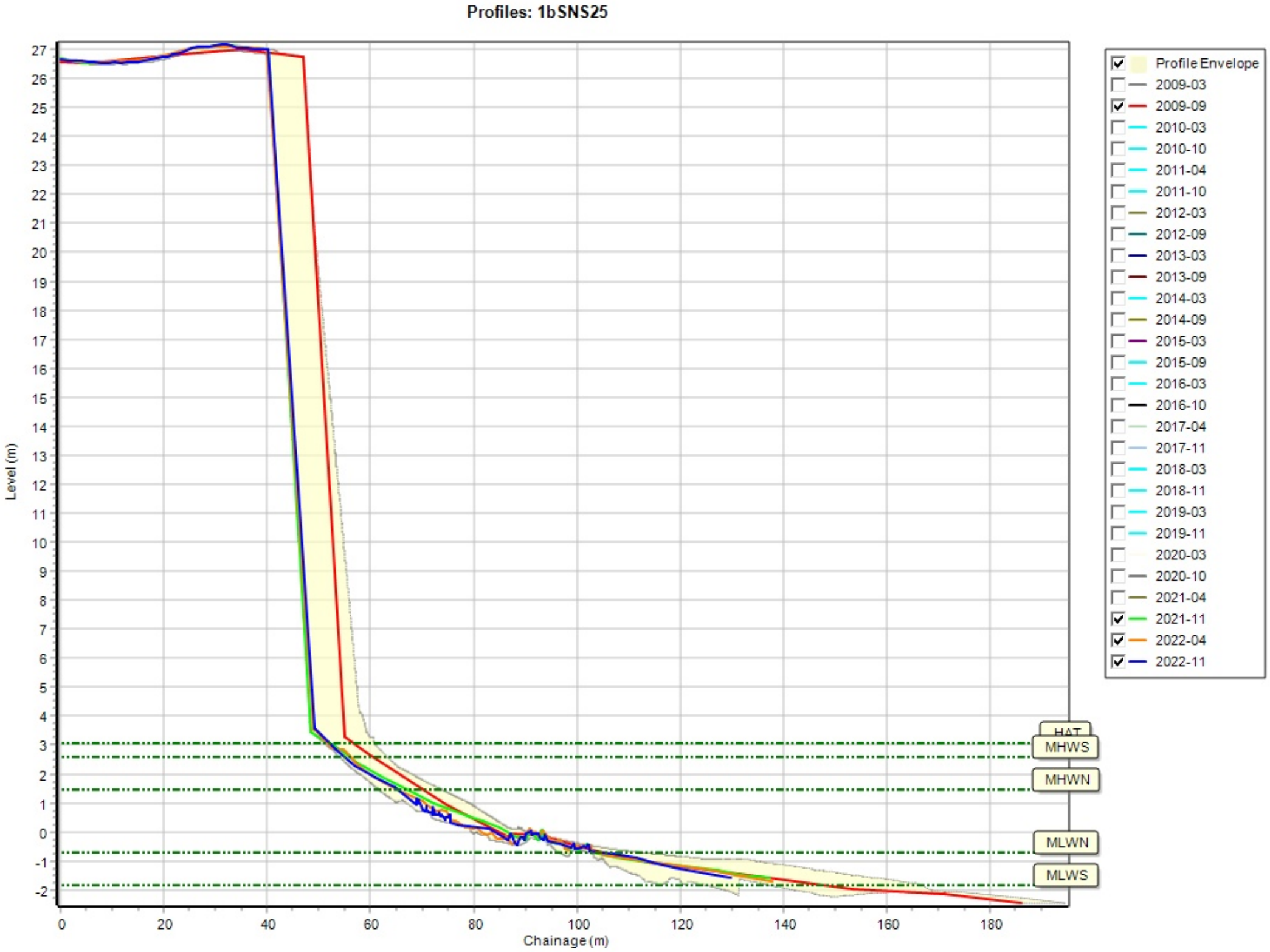
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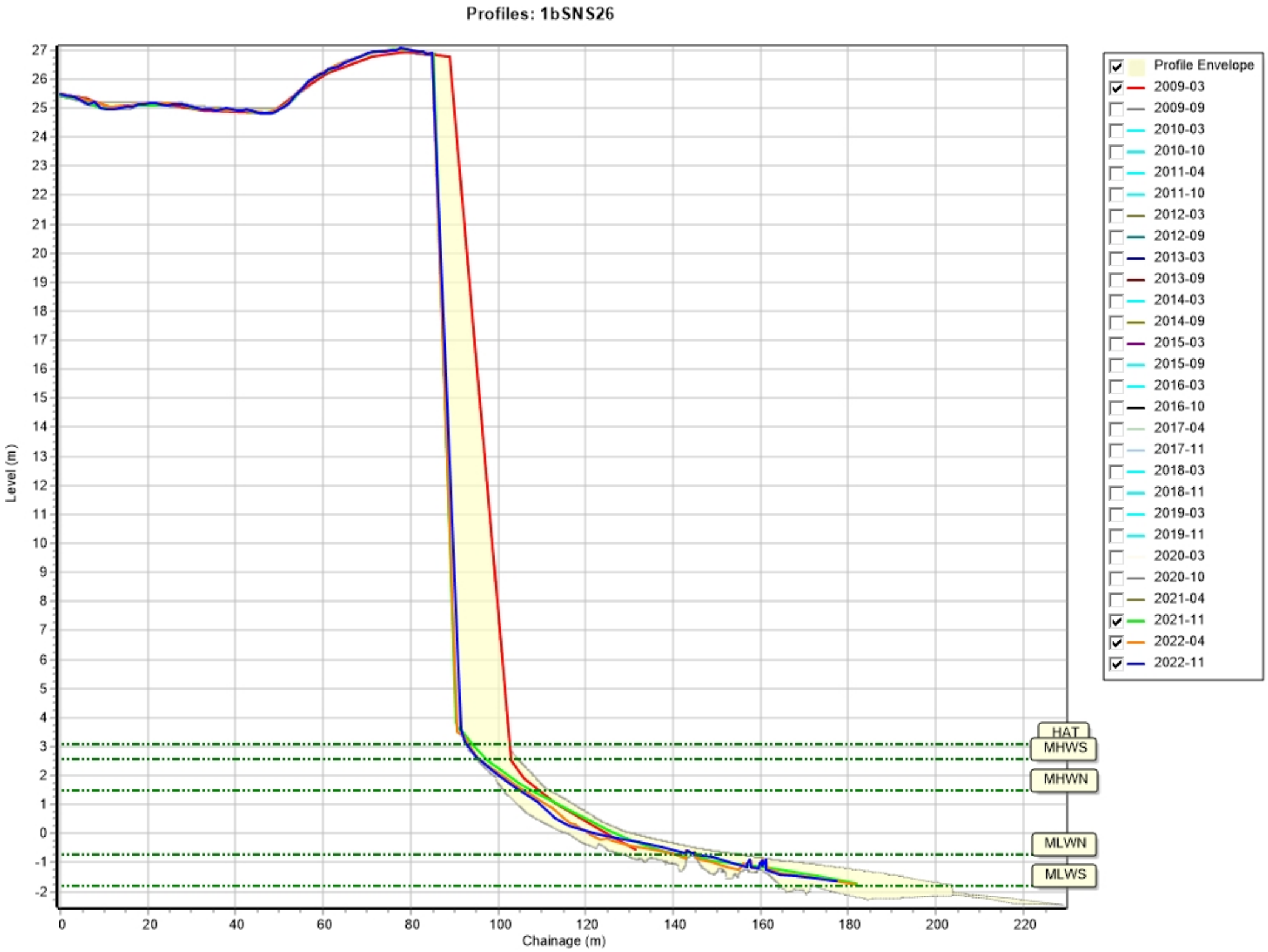
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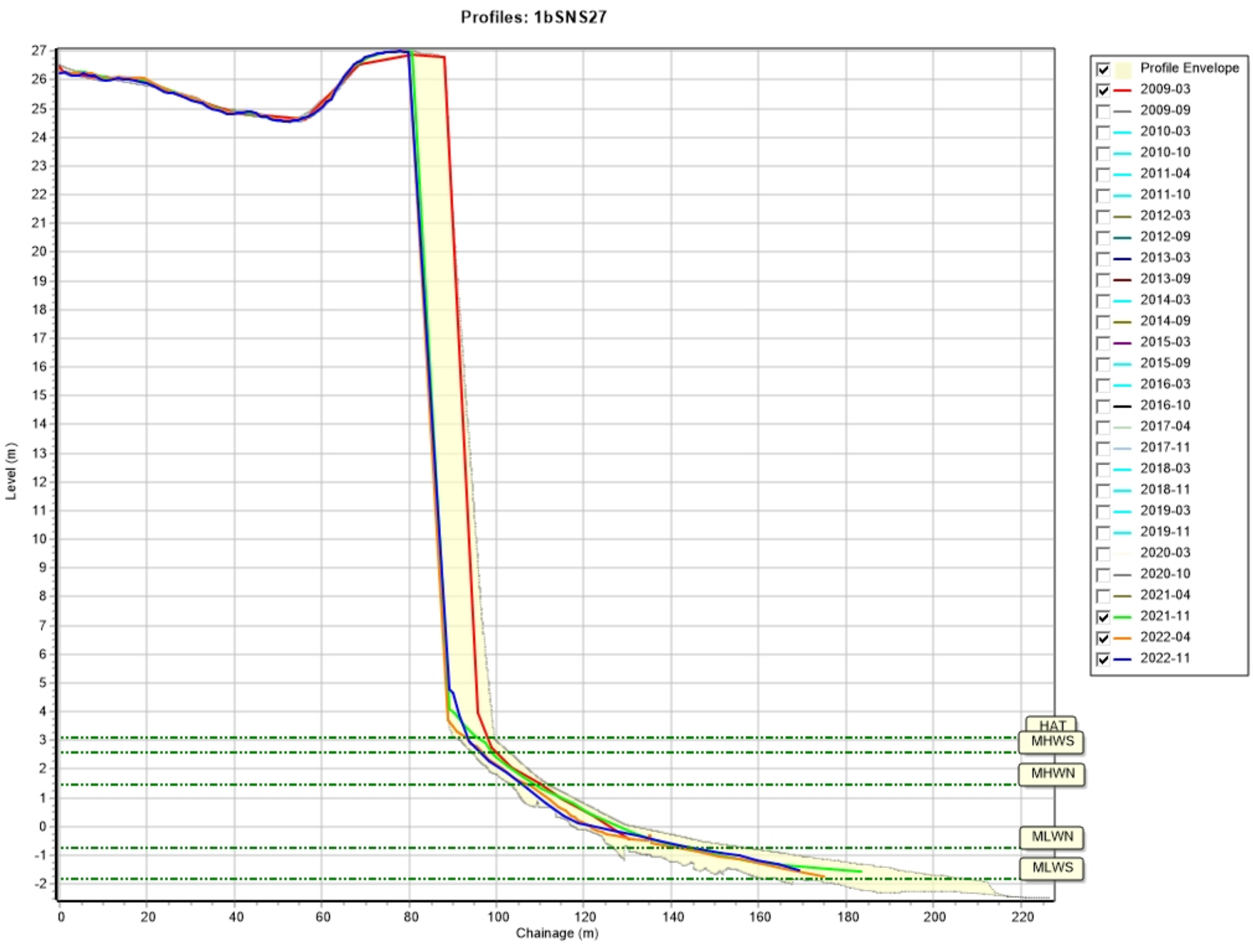
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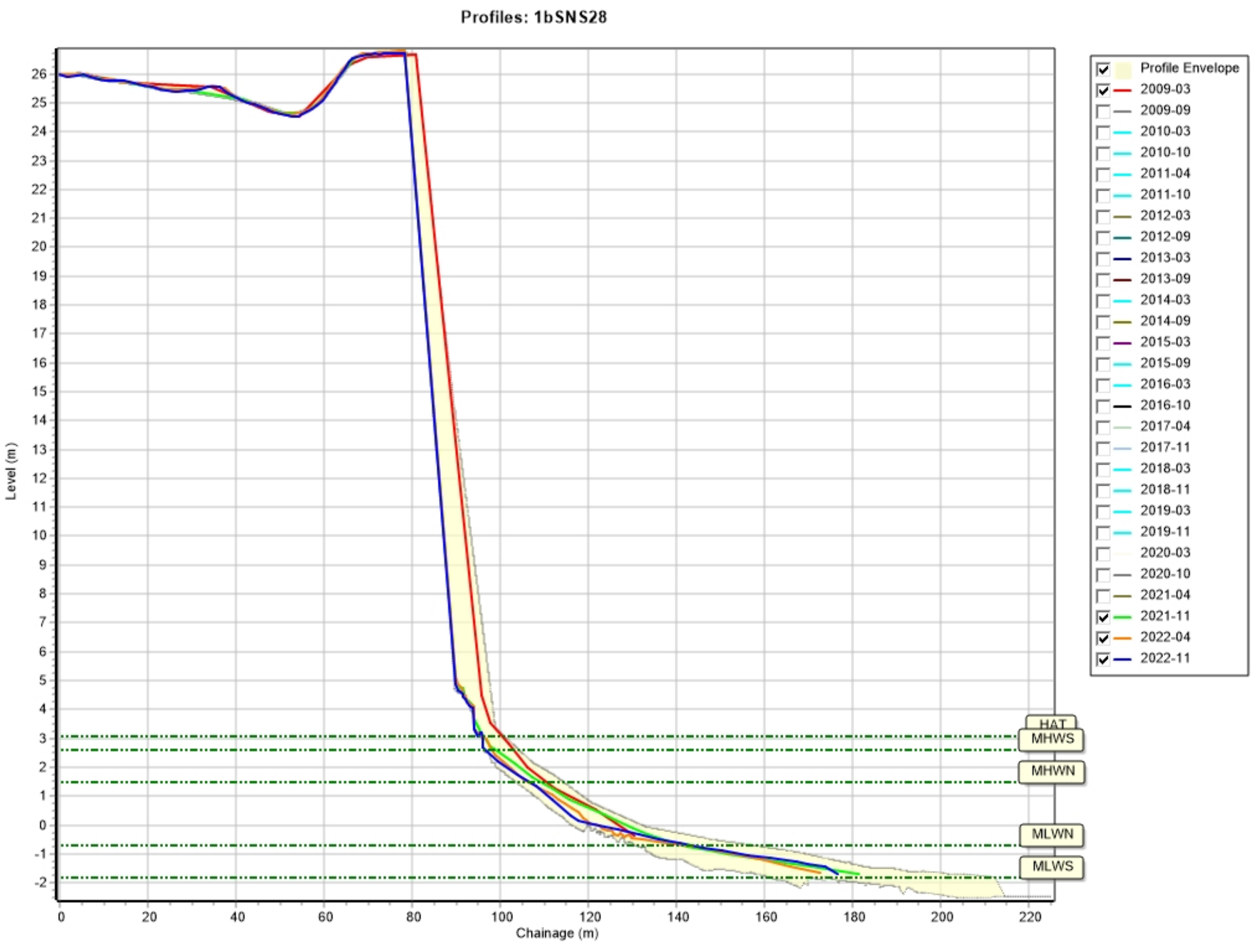
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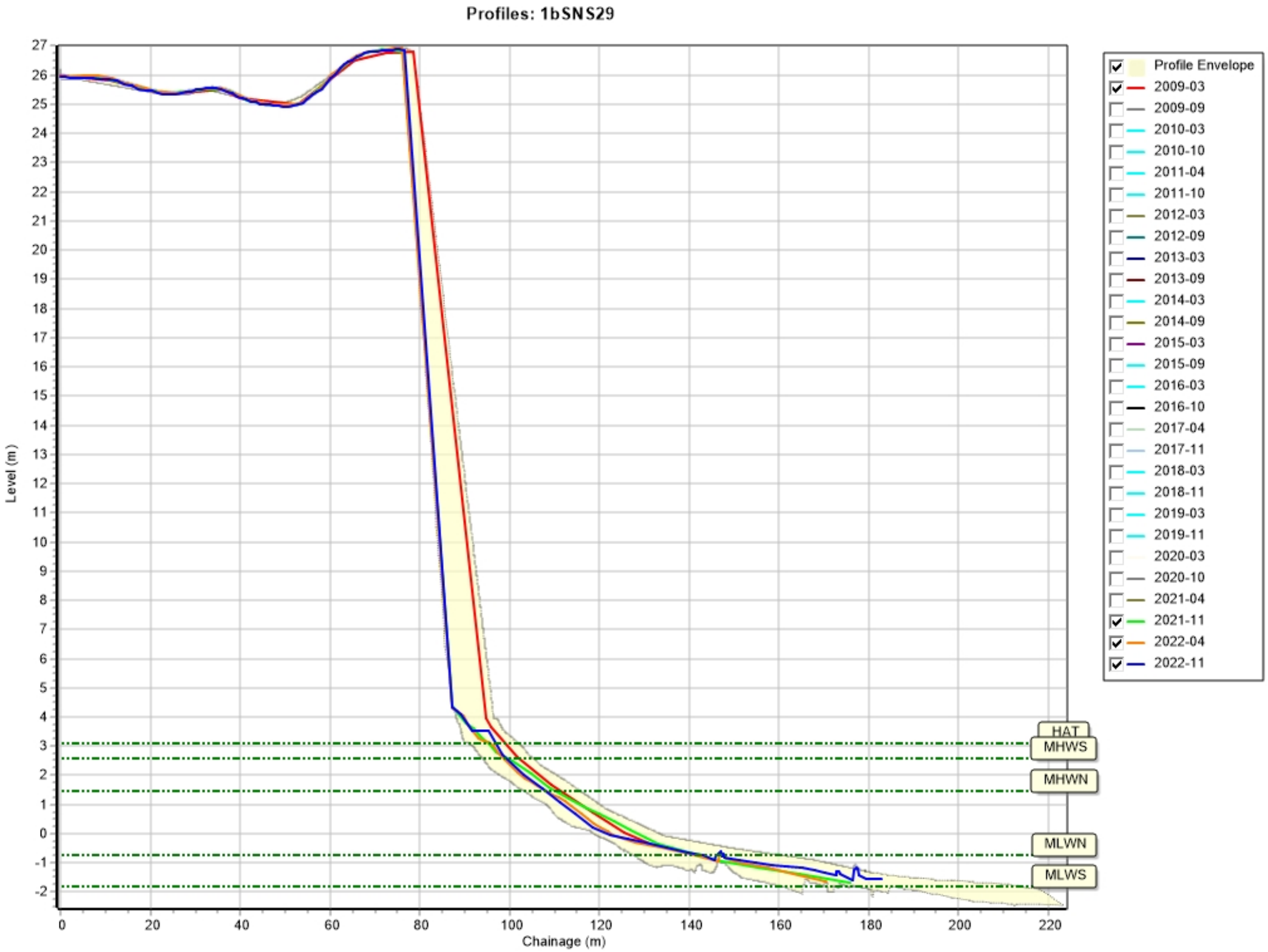
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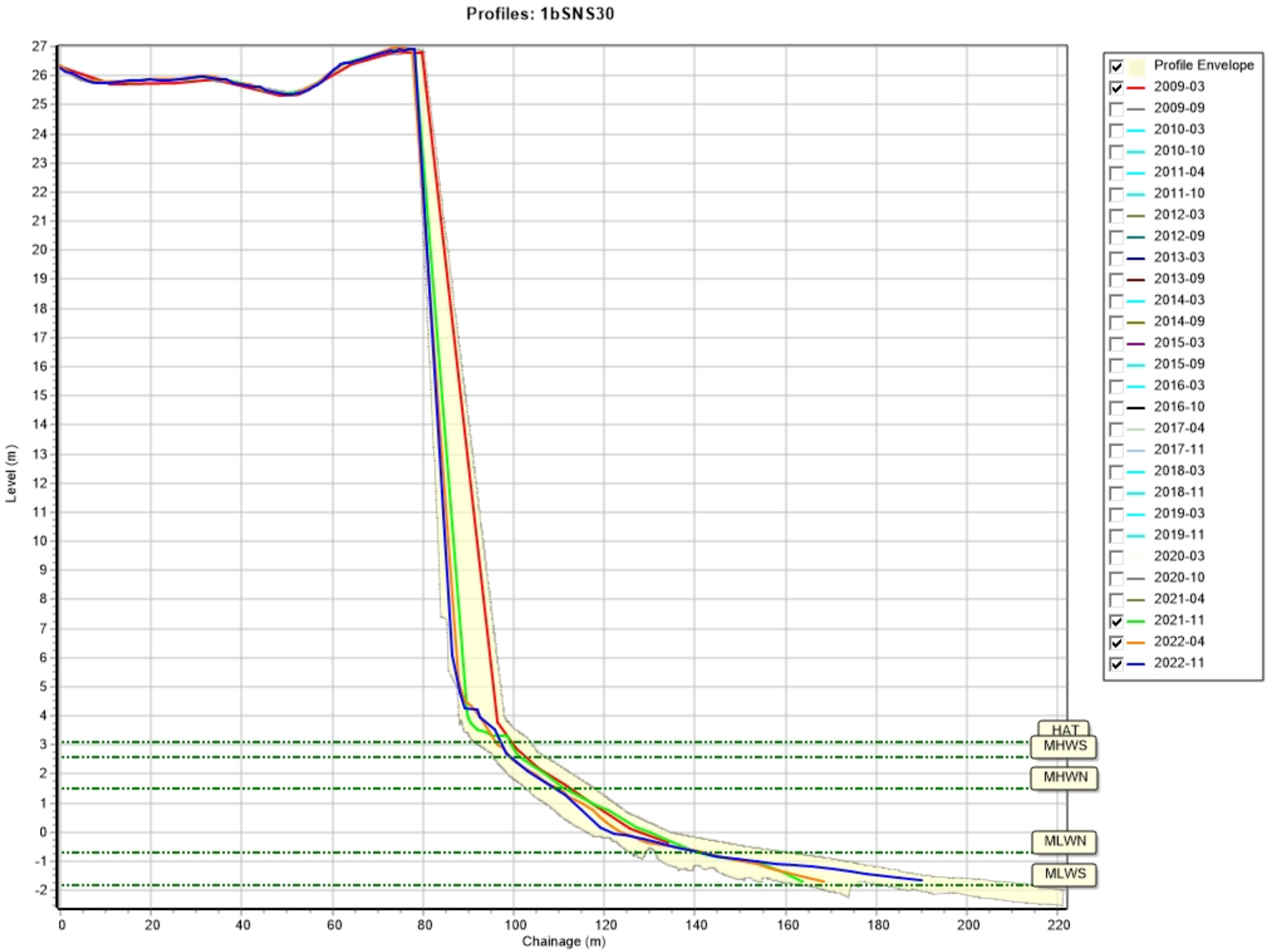
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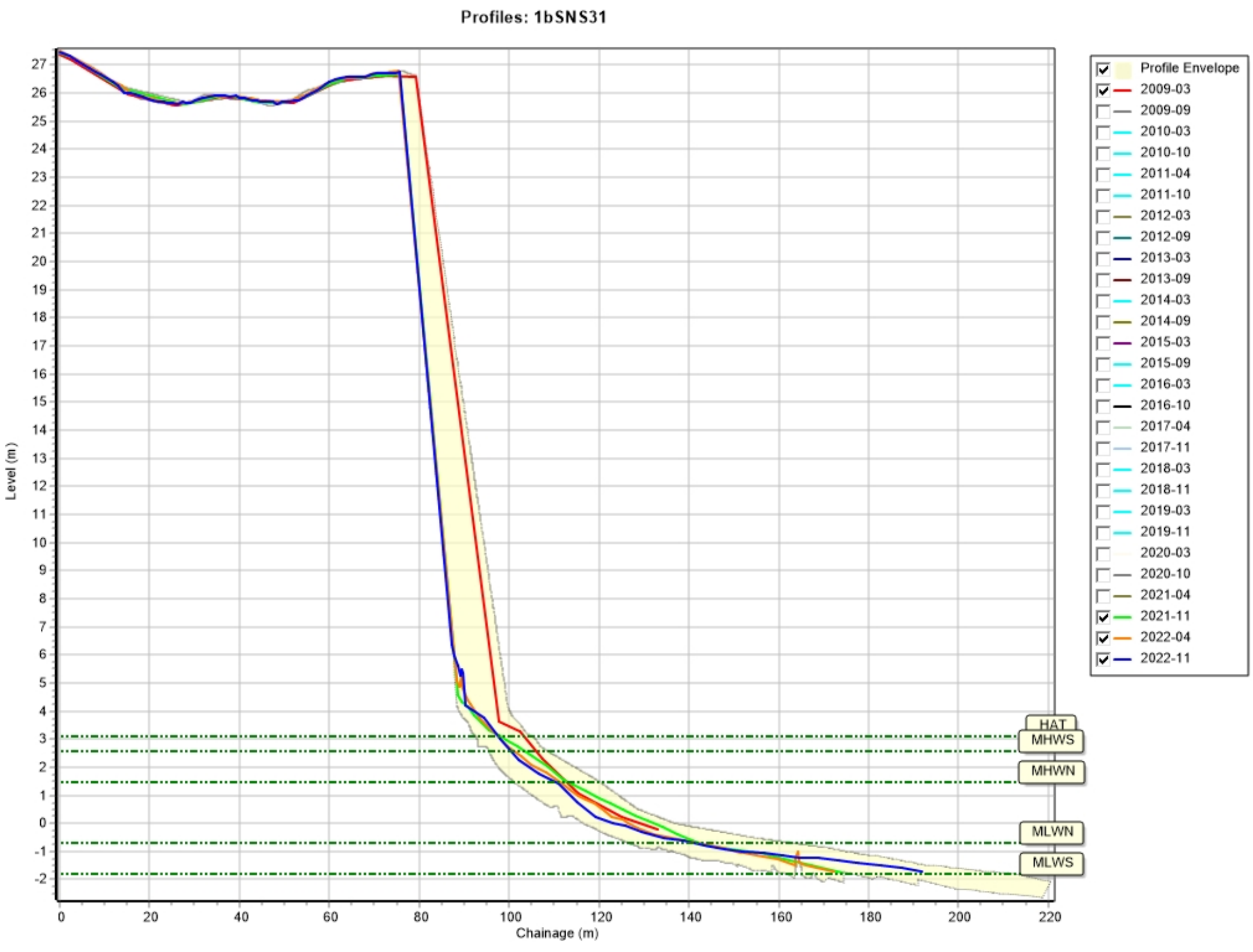
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18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
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MHWN
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MLWS
Profile Envelope
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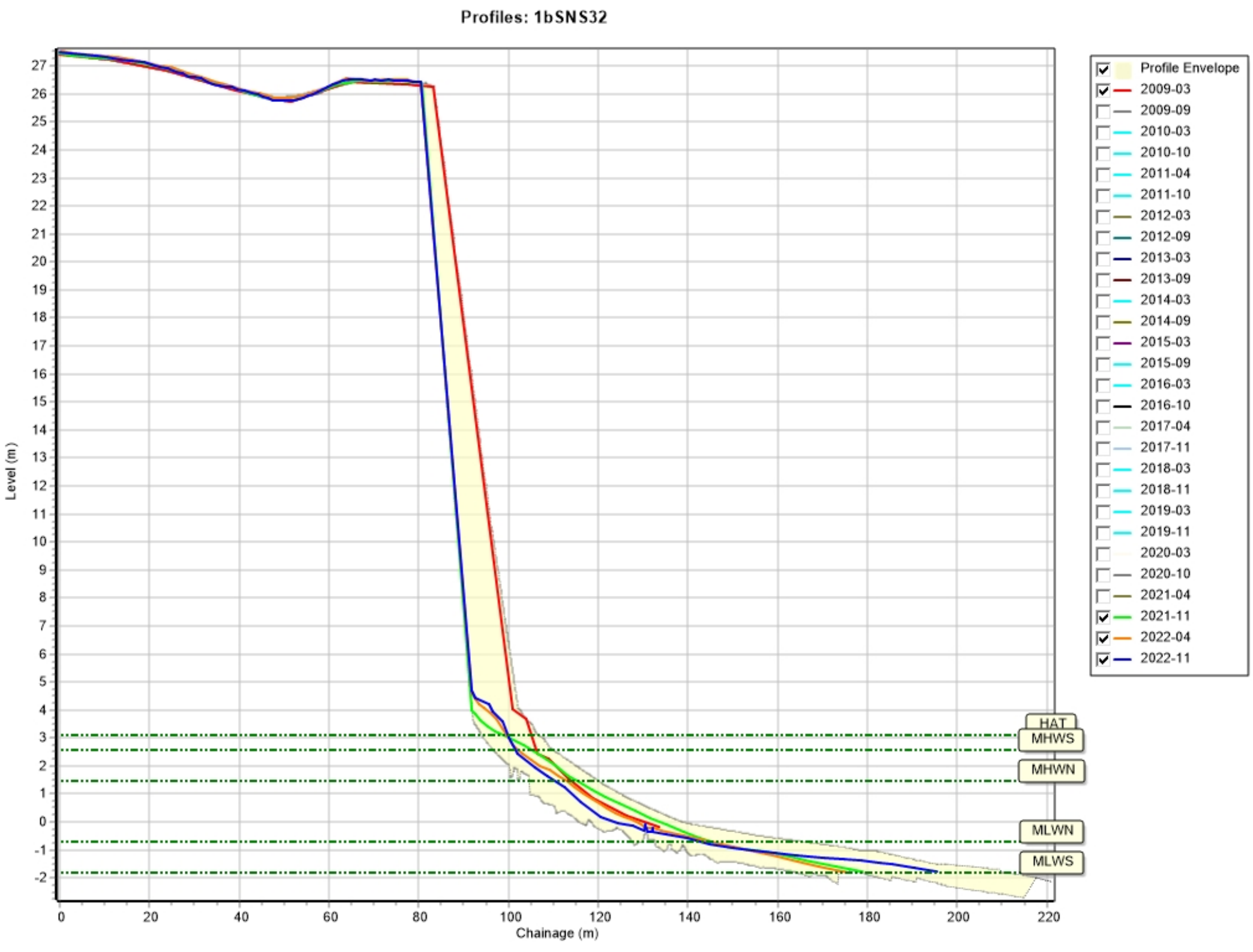
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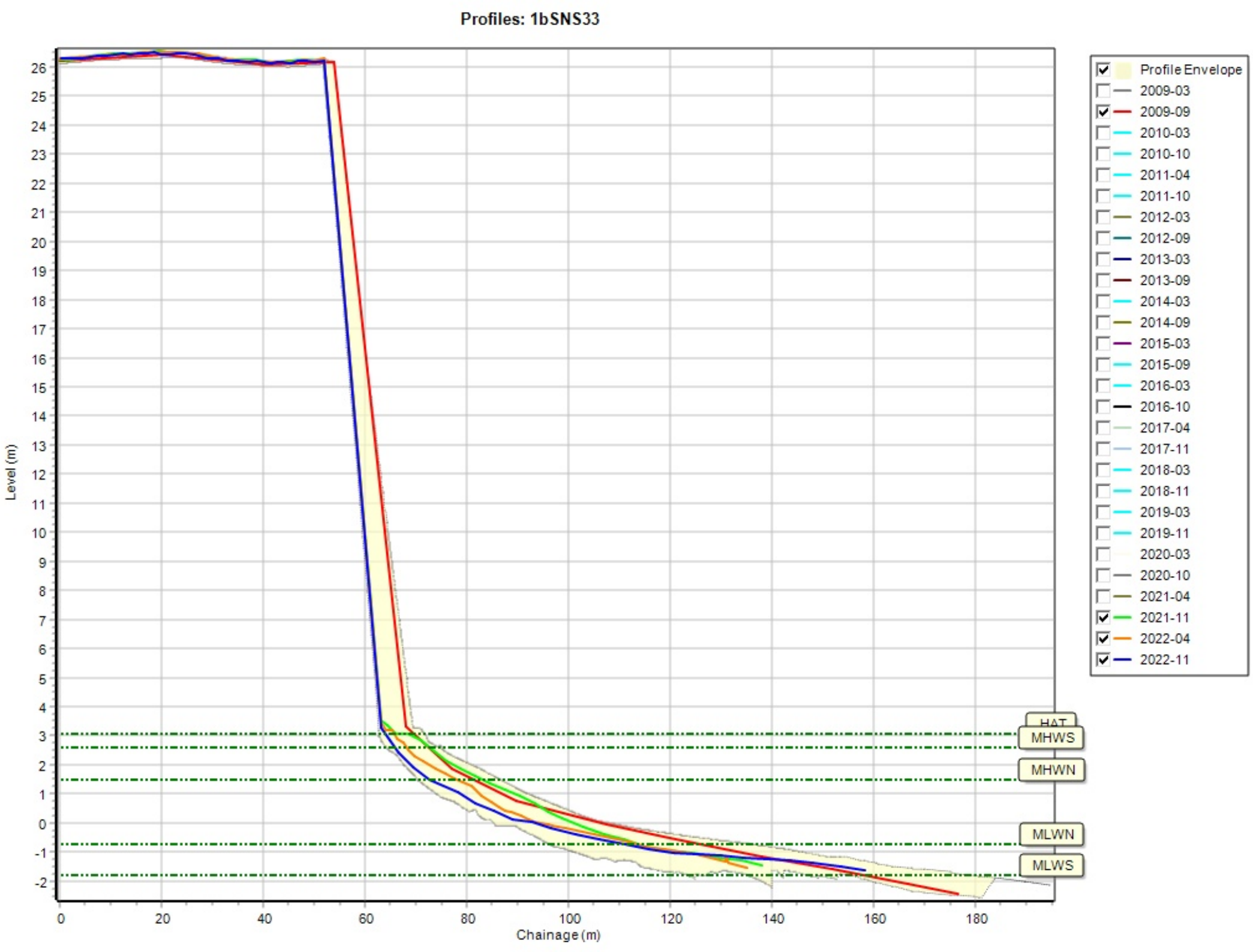
2022-11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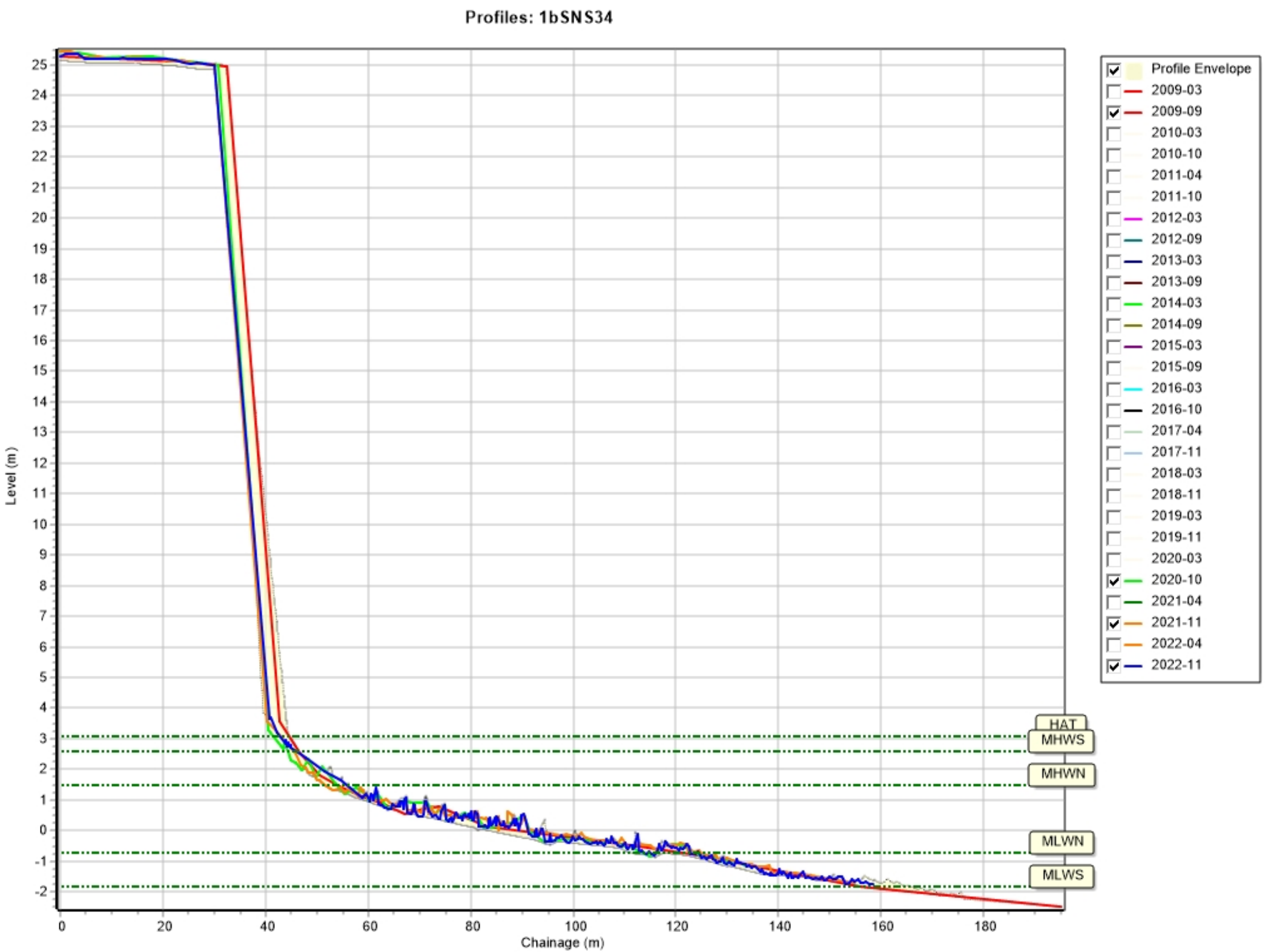
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Profile Envelope
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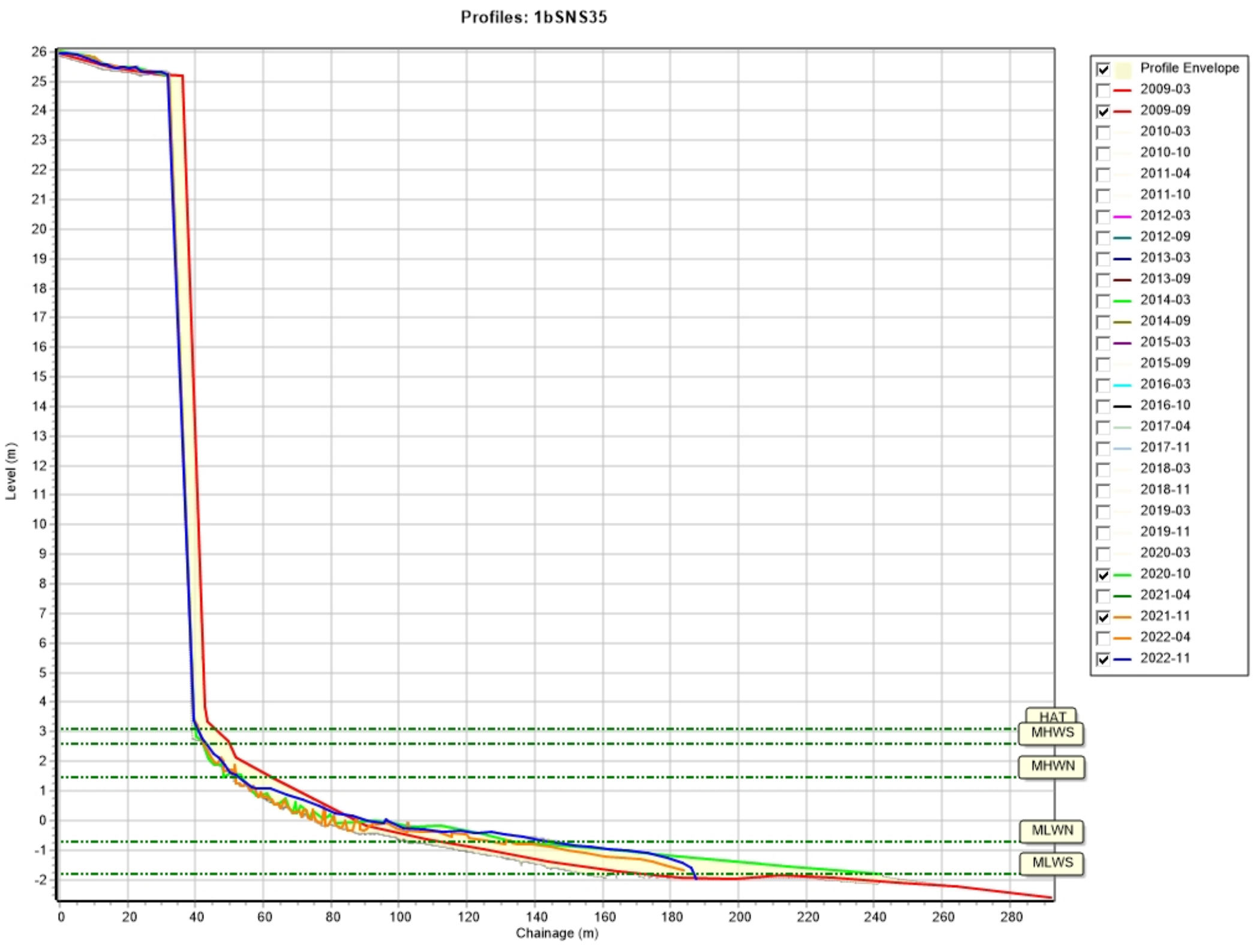
2022-11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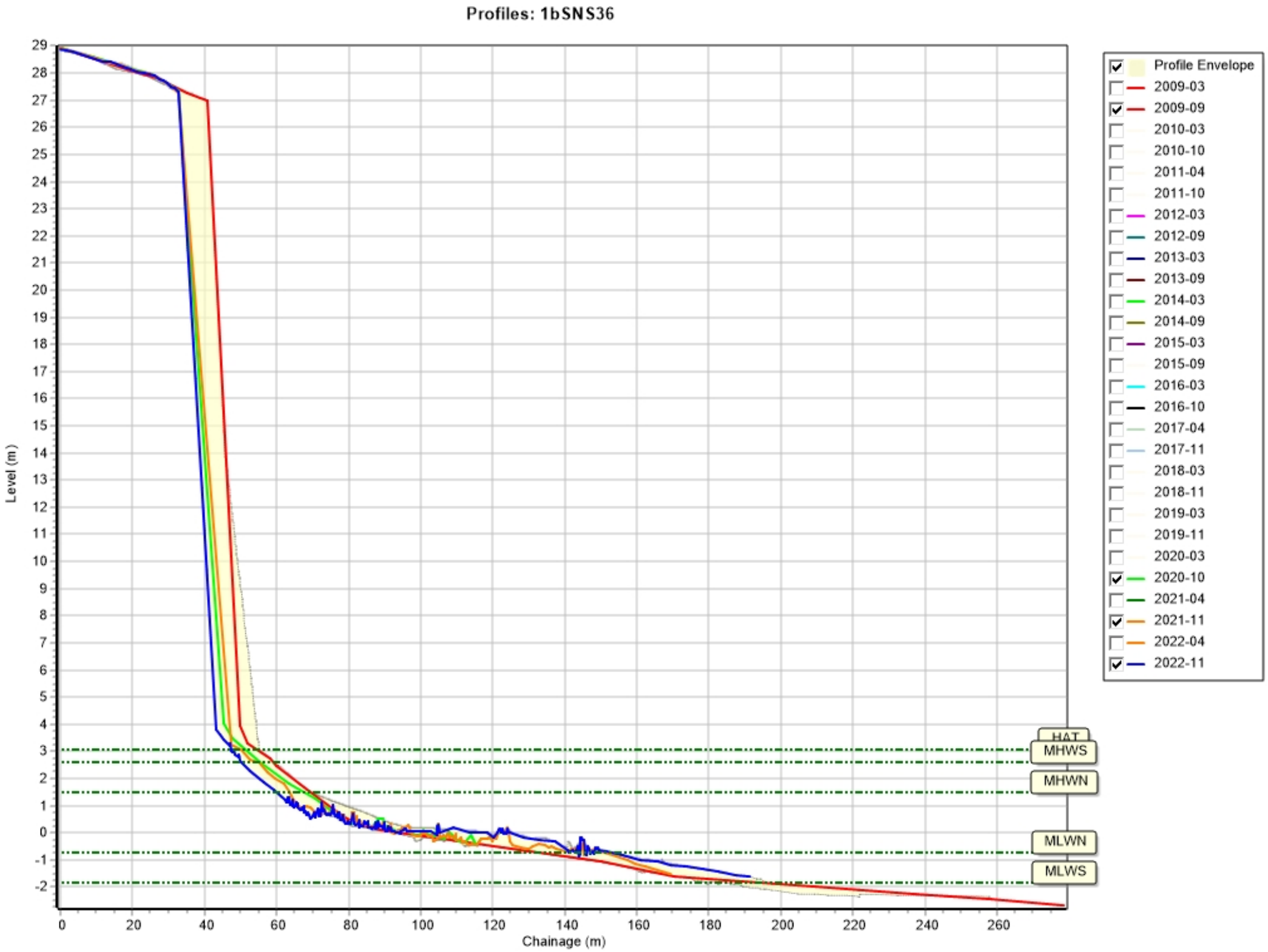
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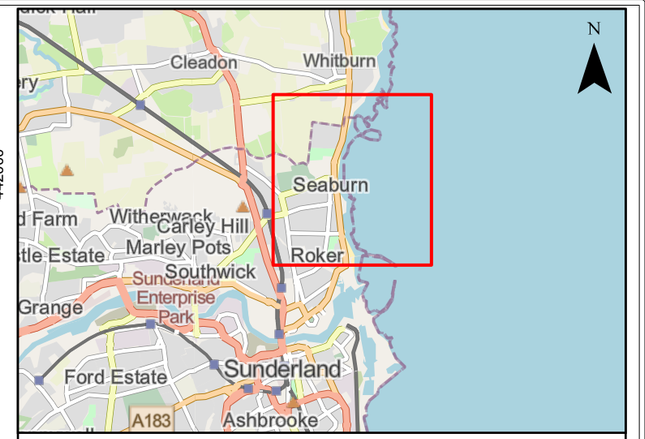
MLWS

Appendix B

Topographic Survey



TOPOGRAPHIC SURVEY (September 2023)

Elevation (mOD)

- -1.8 - -1.5
- -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

Contours (mOD)*

- 1.0m interval
- 0.25m interval

* Contours only cover sandy beach areas.

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

Title:

Appendix B - Map 1

SUNDERLAND NORTH

Sunderland City Council Frontage

Report:

Analytical Report
'Full Measures' Survey 2023

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

Co-ordinate system: British National Grid

Royal HaskoningDHV
Enhancing Society Together

North East Coastal Observatory

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TOPOGRAPHIC SURVEY (September 2023)

Elevation (mOD)

⬜ -1.9 - -1.5
🟪 -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

Contours (mOD)*

— 1.0m interval
— 0.25m interval

* Contours only cover sandy beach areas.

Client:
North East Coastal Group

Project:
Cell 1 Regional Coastal Monitoring Programme

Title:

Appendix B - Map 2

SUNDERLAND SOUTH

Sunderland City Council Frontage

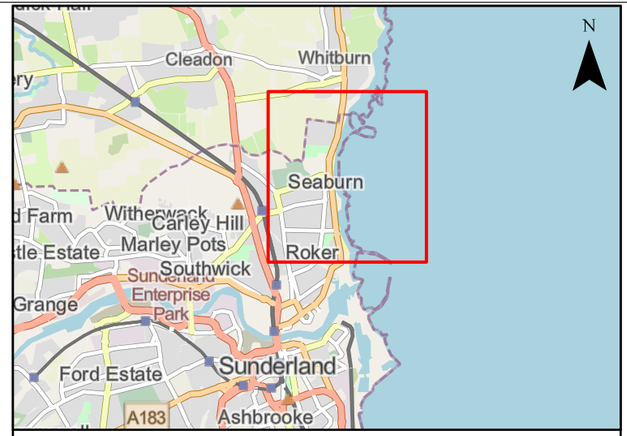
Report:
Analytical Report
'Full Measures' Survey 2023

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	15/12/2023	TC	AS	A3	1:5,000

Co-ordinate system: British National Grid

Royal HaskoningDHV
Enhancing Society Together

North East Coastal Observatory



Difference between topographic surveys
(Nov 2022 to Sept 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
Loss	-0.25 - -0.1
	-0.5 - -0.25
	-0.75 - -0.5
	-1 - -0.75
	-1.25 - -1
	-1.5 - -1.25
	-1.75 - -1.5
	-2 - -1.75
	<-2

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Title:

Appendix B - Map 3

SUNDERLAND NORTH

Sunderland City Council Frontage

Report: Analytical Report 'Full Measures' Survey 2023

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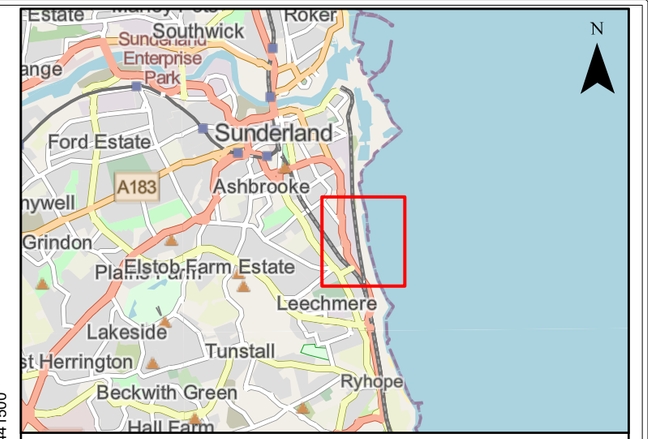
Co-ordinate system: British National Grid

Royal HaskoningDHV
Enhancing Society Together

North East Coastal Observatory



Difference between topographic surveys
(Nov 2022 to Sept 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
Loss	-0.25 - -0.1
	-0.5 - -0.25
	-0.75 - -0.5
	-1 - -0.75
	-1.25 - -1
	-1.5 - -1.25
	-1.75 - -1.5
	-2 - -1.75
	<-2

Client:
North East Coastal Group

Project:
Cell 1 Regional Coastal Monitoring Programme

Title:

Appendix B - Map 4

SUNDERLAND SOUTH

Sunderland City Council Frontage

Report:
Analytical Report
'Full Measures' Survey 2023

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	15/12/2023	TC	AS	A3	1:5,000

Co-ordinate system: British National Grid

Royal HaskoningDHV
Enhancing Society Together

North East Coastal Observatory

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	April 2023	September 2023	Mar 2009 – Sep 2023	Apr 2023 – Sep 2023	Mar 2009 – Sep 2023
1	441025.7	555571.1	75	8.16	8.03	8.08	-0.08	0.05	-0.01
2	441064.4	555355.1	85	7.09	4.82	4.94	-2.15	0.12	-0.15
3	441098	555124	82	10.01	10.08	10.18	0.17	0.1	0.01
4	441174	554938.7	65	10.3	10.23	10.12	-0.18	-0.11	-0.01
5	441199.1	554861.1	65	7.71	10.89	10.75	3.04	-0.14	0.22
6	441224.5	554774.2	71	10.83	10.75	10.82	-0.01	0.07	0.00
7	441248.4	554690.3	74	10.18	10.29	10.48	0.3	0.19	0.02
8	441259.3	554596.6	101	10.08	9.17	9.5	-0.58	0.33	-0.04
9	441275.8	554513.4	66	10.52	5.71	5.65	-4.87	-0.06	-0.35
10	441309.4	554421.3	58	8.77	1.13	1.12	-7.65	-0.01	-0.55
11	441354	554346.5	68	8.2	-0.2	-0.26	-8.46	-0.06	-0.60
12	441400.2	554248.2	56	6.17	5.62	5.64	-0.53	0.02	-0.04
13	441452.3	554174.7	63	11.61	5.36	5.18	-6.43	-0.18	-0.46

Ground Control Points				Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
14	441472.3	554080.5	127	7.33	5.31	-2.32	-0.302	-0.17	-0.17
15	441413	554005.1	122	7.84	7.43	7.66	-0.18	0.23	-0.01
16	441384.8	553913.3	90	9.89	6.83	6.89	-3	0.06	-0.21
17	441404.1	553815.5	93	6.32	5.58	5.65	-0.67	0.07	-0.05
18	441404.1	553723.6	119	8.1	2.66	2.76	-5.34	0.1	-0.38
19	441398.5	553632.8	78	8.23	3.75	3.89	-4.34	0.14	-0.31
20	441438.3	553452.9	71	10.09	5.18	5.15	-4.94	-0.03	-0.35
21	441506.1	553256.1	62	8.57	-3.64	-3.66	-12.23	-0.02	-0.87
22	441550.1	553158.7	103	6.57	2.09	2.09	-4.48	0	-0.32
23	441585.2	553076.5	64	8.11	2.05	1.63	-6.48	-0.42	-0.46
24	441624.4	552870.7	69	7.53	1.44	1.14	-6.39	-0.3	-0.46
25	441689.1	552758	70	14.58	2.03	1.79	-12.79	-0.24	-0.91
26	441715	552713.3	54	12.87	2.28	2.1	-10.77	-0.18	-0.77
27	441749.2	552674.4	62	14.56	2.46	2.08	-12.48	-0.38	-0.89
28	441776.6	552629.9	57	8.62	2.47	2.37	-6.25	-0.1	-0.45
28A	441798.6	552586.3	56	13.63	5.45	5.4	-8.23	-0.05	-0.59
28B	441817.4	552542.4	64	12.3	8.03	7.02	-5.28	-1.01	-0.38
28C	441852.2	552502.6	52	13.11	12.39	12.3	-0.81	-0.09	-0.06
29	441880.1	552471.6	83	15.46	14.5	14.33	-1.13	-0.17	-0.08
30	441921.4	552269	97	8.55	3.95	3.83	-4.72	-0.12	-0.34
31	441853.1	552094	75	11.2	2.12	1.85	-9.35	-0.27	-0.67
32	441883.3	551988.5	96	9.82	2.39	2.05	-7.77	-0.34	-0.56