



Cell 1 Regional Coastal Monitoring Programme Analytical Report 14: 'Full Measures' Survey 2021

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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.

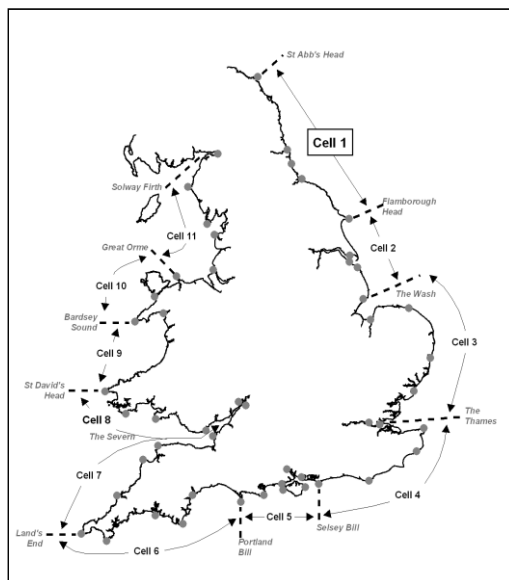


Figure 1 Sediment Cells in England and Wales

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



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

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

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

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

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

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

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			

(*) The present report is **Analytical Report 14** and provides an analysis of the 2021 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, Uppgang Beach and Whitby Sands
	Robin Hood's Bay
	Scarborough North Bay
	Scarborough South Bay
	Cayton Bay
	Filey Bay

1. Introduction

1.1 Study Area

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 9th September 2021 (Whitburn Bay), 9th November 2021 (Sunderland Harbour and Docks) and the 4th October 2020 (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.

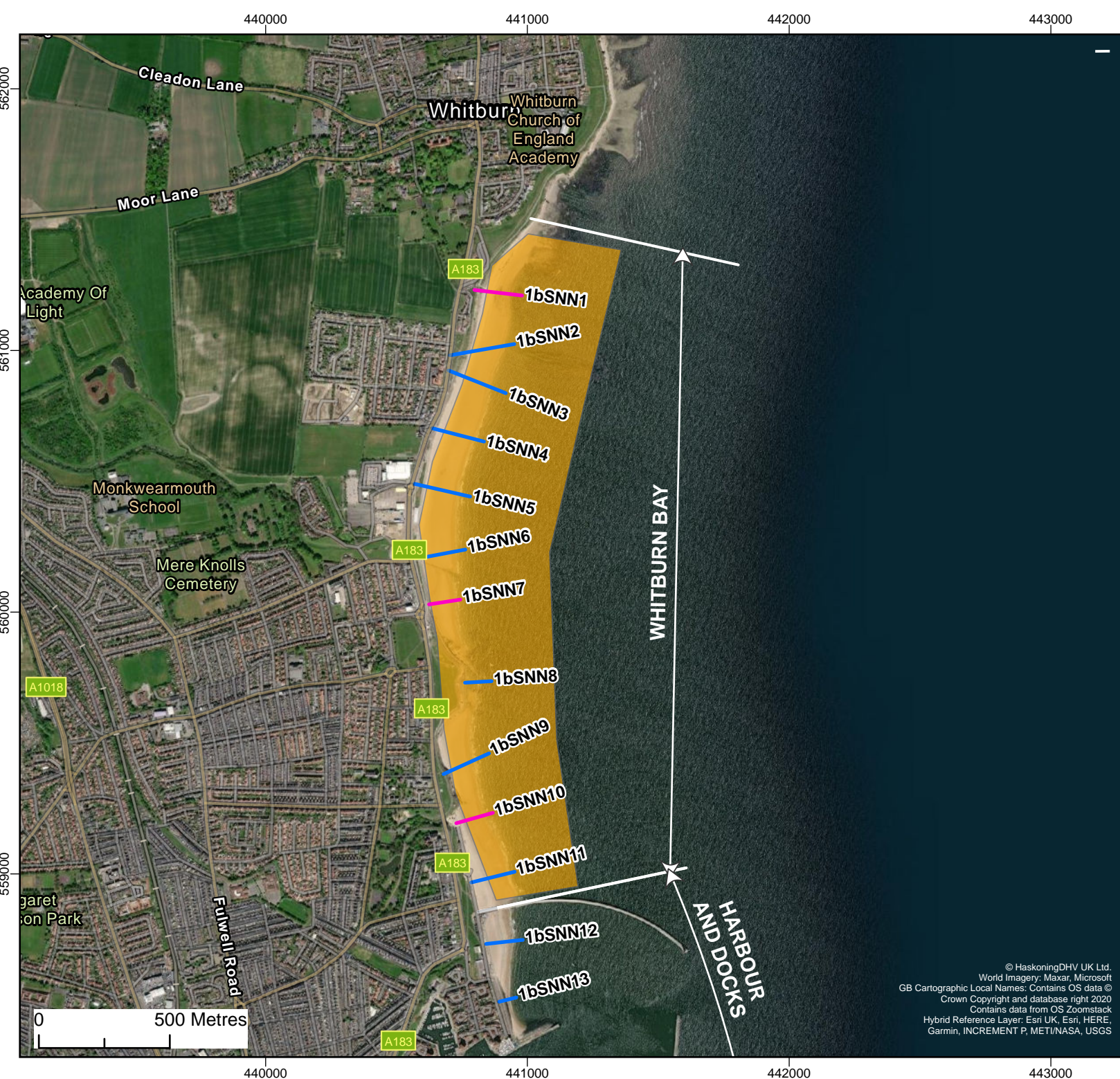
All data have been captured in a manner commensurate with the principles of the Environment Agency's *National Standard Contract and Specification for Surveying Services* and stored in a file format compatible with the software systems being used for the data analysis, namely SANDS and ArcGIS. This data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

Topographic Area

- 6 monthly (Light Green)
- yearly (Orange)
- 5 yearly (Light Purple)

● 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

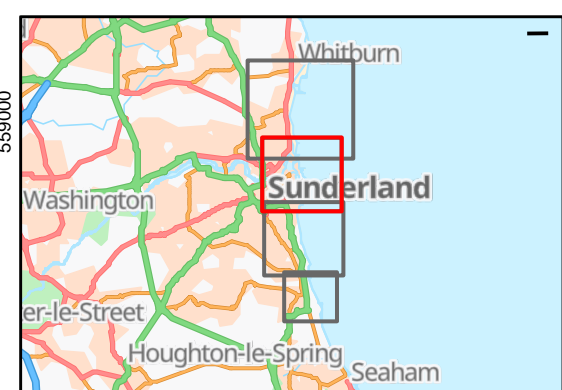


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Hybrid Reference Layer: Esri UK, Esri, HERE,
Garmin, INCREMENT P, METI/NASA, USGS



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:

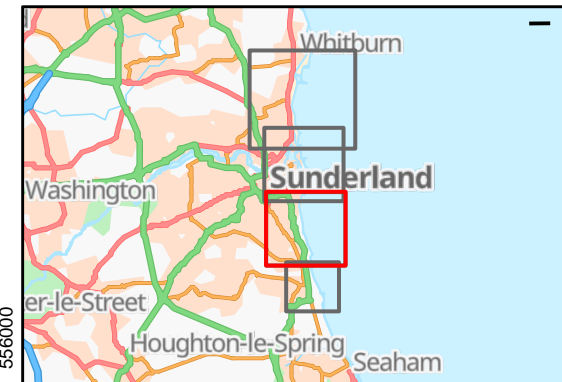
Survey Report

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

Co-ordinate system: British National Grid



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Contributors: Esri UK, Esri, HERE, Garmin,
INCREMENT P, METI/NASA, USGS



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

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



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

Figure 2 - Map 4

HENDON TO RYHOPE (SOUTH)

Sunderland City Council Frontage

Report:

Survey Report

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	n/a	TC	NJC	A4	1:10,000

Co-ordinate system: British National Grid

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Hybrid Reference Layer: Esri Community Maps Contributors, Esri
UK, Esri, HERE, Garmin, INCREMENT P, METI/NASA, USGS

2. Analysis of Survey Data

2.1 Whitburn Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
9 th Sept 2021	<p>Beach Profiles:</p> <p>Whitburn Bay is covered by eleven beach profile lines for the Full Measures survey (Appendix A). The previous survey was the Partial Measures survey undertaken in March 2020 and the previous Full Measures survey was undertaken in November 2019. Profiles 1bSNN1, 1bSNN7 and 1bSNN10 were last surveyed during the Partial Measures spring survey, 2021. The remaining profiles were last surveyed during the Full Measures autumn survey, 2020.</p> <p>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, except at chainage 20m where 0.4m of erosion has occurred. At the toe of the dunes there has been accretion of 0.2m to chainage 45m which increases across the upper and middle beach by up to 1.0m to chainage 177m. Between chainage 177m-180m the lower beach has lowered by up to 0.8m, before switching to accretion at the end of the survey by up to 0.4m. Overall, the beach level is at high level (reaching its highest level recorded between chainages 45-56m and 102-118m) compared to the range recorded from previous surveys.</p> <p>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.</p> <p>At profile 1bSNN2, the dune has remained stable since the last survey, with accumulation of 0.2m of sediment at the dune toe. The entire beach profile has accreted by up to 0.3m on the upper beach, 0.2m on the middle beach and 1.2m on the lower beach. Overall, the profile is at a high level recorded from previous surveys, with the majority of the profile being the highest on record.</p> <p>At 1bSNN3, the dunes remain stable since the previous survey, showing accretion of <0.1m. The dune toe has accreted by up to 0.8m to chainage 83m. The middle beach has lowered by up to 0.8m to chainage 232m, switching to accretion on the lower beach seaward of chainage 232m by up to</p>	<p>Along the length of Whitburn Bay profiles have undergone variable change since the previous survey. Although the majority of beach profiles are within the range of previous recorded surveys, several sections along the bay are now at their highest levels recorded.</p> <p>Longer term trends: All the profiles in Whitburn Bay are at medium to high levels compared to earlier surveys in the record, except at profile 1bSNN8 which is at a low level. The beaches show frequent fluctuation in levels due to sediment being naturally redistributed across the shoreface.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>0.3m. Overall, the upper beach is at a high level compared to the range recorded from the previous surveys, particularly between chainages 58-70m which is at its highest level recorded. The middle and lower beach level is at a low level, particularly between chainages 100-175m.</p> <p>Profiles 1bSNN4 to 1bSNN6 are between the shoreline opposite the southern edge of South Bents housing estate and Parsons Rock.</p> <p>Profile 1bSNN4 shows the beach has generally gone accretion across the profile, by between 0.2m on the upper and lower beach and 0.1m on the middle beach. The majority of the beach is at a high level compared to the range recorded from previous surveys, particularly between chainage 60-90m which is at its highest level recorded. The lower beach is at a medium level.</p> <p>At profile 1bSNN5, from the toe of the sea wall to chainage 200m the beach has eroded by up to 0.6m. Seaward of chainage 200m the beach has risen by up to 0.2m. The beach is at a medium level when compared to the range recorded from previous surveys.</p> <p>At profile 1bSNN6, the beach from the toe of the sea wall to chainage 94m has risen by up to 0.2m. Seaward of chainage 94m, the lower beach has lowered by up to 0.2m. The profile is at a high level compared to the range recorded from previous surveys, particularly from the toe of the seawall to chainage 95m which is at its highest level recorded.</p> <p>Profile 1bSNN7 is at Seaburn, just to the north of Parson's Rocks. There has been accretion from the toe of the sea wall across the beach profile to the end of the survey at chainage 170m. Overall, the profile is at a medium-high level compared to the range recorded from previous surveys</p> <p>Profile 1bSNN8 extends across Parsons Rocks. The beach at the toe of the seawall to chainage 17m has lowered by up to 1.1m. The rock patch has undergone relatively little change, except for some small sections of accretion by up to 0.4m. Overall, the profile is at a low level compared to the range recorded from previous surveys.</p> <p>Profile 1bSNN9 drops from the cliff top to the foreshore at Roker. The survey report notes that the start of this profile was not measured due to unsafe access. The upper beach from the toe of the cliff to chainage 32m has lowered by up to 0.1m. Seaward of chainage 32m the beach has accreted by up to 0.2m to the end of the survey. The profile is at a medium level compared to the range recorded from previous surveys.</p>	

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>Profile 1bSNN10 is located approximately mid-way between Parson's Rocks and Roker Pier. Between the toe of the seawall and chainage 24m the beach has lowered by between 0.1-0.7m. The middle beach has accreted by up to 0.3m to chainage 130m, before switching to erosion on the lower beach by up to 0.4m to the end of the survey. Overall, the beach is at a medium level compared to the range recorded in previous surveys.</p> <p>Profile 1bSNN11 is located to the south of Whitburn. The beach level has undergone little change between the toe of the sea wall and chainage 18m. Between chainage 18-28m the beach has accreted by up to 0.2m. The upper beach between chainage 28-90m has lowered by up to 0.4m. The majority of the profile between chainage 90-217m has accreted by up to 0.2m. Seaward of chainage 217m the beach has lowered by up to 0.2m to the end of the survey. The beach is at a medium-high level compared to the range recorded from previous surveys.</p>	
Nov 2021	<p>Topographic Survey:</p> <p>Whitburn Bay, between the Bents and Roker Pier, is covered by an annual topographic survey which commenced in September 2009.</p> <p>Data from the most recent topographic survey (Full Measures, autumn 2021) 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 2020) and the present survey.</p> <p>The north of the survey area has undergone high magnitude erosion on the upper-middle beach (1.5-1.75m) with accretion on the lower beach with patches of little change (± 0.1m). The central survey area is dominated by low magnitude erosion (0.5-0.75m) with small patches of accretion on the upper beach. The south of the survey area is dominated by accretion (0.5m) surrounded by areas of little change. There are isolated patches of erosion and accretion around Parsons Rocks. .</p>	<p>The topographic survey shows that since the last survey, accretion has dominated in the east and west of the bay, with erosion across the middle beach.</p> <p>Longer term trends: The most recent topographic survey is in line with topographic trends seen since autumn 2009, showing a dominant trend of accretion with isolated areas of erosion in the north and south of the bay and around Parsons Rocks.</p>

3.2 Sunderland Harbour and Docks

Survey Date	Description of Changes Since Last Survey	Interpretation
9 th November 2021	<p>Beach Profiles:</p> <p>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 2020.</p> <p>1bSNN12 and 1bSNN13 are both located within the shelter of Roker Pier.</p> <p>At profile 1bSNN12, there has been variable change across the beach profile. The beach at the toe of the seawall has lowered by <0.1m to chainage 14m. The upper beach between chainages 14-48m has accreted by up to 0.1m. The beach between chainages 48-74m has lowered by up to 0.2m, before switching to accretion between chainages 74-100m by up to 0.2m. Seaward of this point the beach has lowered by up to 0.2m. Overall, the beach profile is at a medium-high level on the upper and middle beach compared to the range recorded from previous surveys, while the lower beach is at a low level.</p> <p>At 1bSNN13, there has been accretion across the beach profile between the rock armour revetment and chainage 24m by up to 0.2m. Seaward of chainage 24m, the beach has lowered by up to 0.6m. Overall, the profile is at a high level on the upper and middle beach, dropping to a medium level on the lower beach compared to the range recorded from previous surveys.</p> <p>1bSNC1 and 1bSNC2 are located within the shelter of New South Pier.</p> <p>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.</p> <p>Profile 1bSNC2 starts at the crest of New South Pier and drops several metres to foreshore level. The beach level has dropped between the toe of the seawall and the end of the survey. Erosion ranges from 0.4m at the toe of the seawall to <0.1m across the middle and lower beach. Overall, the upper beach profile is at a low level whilst the middle and lower beach are at a medium level compared to the range recorded from previous surveys.</p> <p>1bSNC3 to 1bSNC6 are on the seaward face of the dock.</p>	<p>Within the breakwaters north of the River Wear, beach levels are dominated by erosion at profiles 1bSNN12 and 1bSNN13, except for small sections on the middle beach of both profiles which accreted.</p> <p>Between the breakwaters at profile 1bSNC2, the level of entire beach profile has fallen. Profile 1bSNC1 was not analysed as it does not cover any beach.</p> <p>Outside of the breakwaters, 1bSNC4 and 1bSNC6 are dominated by erosion, whilst 1bSNC5 has accreted.</p> <p>Within the breakwaters, either side of the former South Outlet of the docks, there has been very limited change, except along the gravel backshore at 1bSNC9 which has accreted.</p> <p>Longer term trends: Within the breakwaters to the north and south of the River Wear, beach levels are generally at a medium-high level, except the lower beach of 1bSNN12 and upper beach of 1bSNC2 which are at a low level compared to earlier surveys.</p> <p>Outside of the harbour breakwaters, the beach levels fluctuate significantly over time. Profiles 1bSNC4 and 1bSNC5 are generally at a medium-low level since surveys began. Profile 1bSNC3 was not analysed as it does not cover any beach.</p> <p>Within the breakwaters either side of the former South Outlet of the docks, long term change is small at 1bSNC7 and 1bSNC9. At profile 1bSNC8, the</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>Profile 1bSNC3 extends from the dockyard across a back flood wall, which has a crest level of around 7.2mOD, and promenade to the main seaward dock wall, which has a crest level of 7.55mOD. The profile then extends down the seaward face of the wall into deep water. As there is no beach present, this profile has not been analysed.</p> <p>Profiles 1bSNC4 and 1bSNC5 extend from the rock armoured revetment across the short width of foreshore down to low water.</p> <p>At profile 1bSNC4, the beach levels show erosion across the beach profile by up to 1.0m on the upper beach, tapering to 0.4m on the middle and lower beach. The beach is at a medium to low level compared to the range recorded from previous surveys.</p> <p>At profile 1bSNC5, there has been some movement in boulder position on the upper beach to chainage 12m. The rest of the beach has accreted by <0.1m on the upper and middle beach and up to 0.5m on the lower beach. Overall, the beach is at a medium level compared to the range recorded from previous surveys.</p> <p>Profile 1bSNC6 extends across the revetment and seawall. The beach level has lowered across the entire profile by up to 0.5m from the toe of the sea wall to the end of the survey. The beach levels remain at a high level compared to the range recorded from previous surveys.</p> <p>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.</p> <p>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.</p> <p>Profile 1bSNC8 crosses the boulders and rubble. From chainage 35m seaward of the boulders and rubble, the beach level has undergone negligible change (<±0.1m) and has not recovered to the levels seen between 2009 – 2012. Overall, the profile is at a medium to low level.</p> <p>Profile 1bSNC9 extends from the dock facilities and crosses a short length of concrete wall and sheetpiling before extending across the sand and gravel backshore and foreshore to reach and cross a boulder mound that is towards the seaward end of the south west breakwater. The report notes the start of this profile was not surveyed as it is unsafe to access. The profile shows accretion across the</p>	<p>long-term trend has been lowering beach levels since surveys began in October 2009.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	gravel backshore by up to 0.2m. There are apparent changes in height of the boulder mound in places. The profile remains high relative to earlier surveys, particularly between 60-105m which is at its highest level recorded.	

3.3 Hendon to Ryhope (incl. Halliwell Banks)

Survey Date	Description of Changes Since Last Survey	Interpretation
4 th Oct 2021	<p>Beach Profiles:</p> <p>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 2020 and the previous Partial Measures survey was undertaken in spring 2021.</p> <p>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.</p> <p>1bSNS7 to 1bSNS10 are located along the defended coastal slopes at south Hendon, which rise in elevation to higher defended cliffs at 1bSNS11.</p> <p>Profile 1bSNS7 extends across a seawall and concrete revetment, which is fronted by a foreshore comprised of large pebbles and coarse shingle. There has been a lowering of the beach profile seaward of the revetment by up to 0.7m. The rocks at chainage 70m remain unchanged. Overall, the beach profile is at a medium-low level compared to the range recorded from previous surveys.</p> <p>Profile 1bSNS8 extends across the seawall, rock revetment and beach. There has been accretion from the toe of the rock revetment to the end of the survey by up to 0.7m. Overall, the beach is at a high level compared to the range recorded from previous surveys.</p> <p>At profile 1bSNS9, there has been movement of boulders from the toe of the revetment to chainage 30m. The upper and middle beach has accreted by up to 0.2m to chainage 78m before switching to erosion on the lower beach by up to 0.4m. The upper and middle beach profile is at a high level compared to the range recorded from previous surveys, while the lower beach is at a medium level.</p> <p>At profile 1bSNS10, there has been accretion from the toe of the revetment at chainage 22m to the end of the survey by up to 1.0m. There is no change seaward of the rock patch at chainage 39m.</p>	<p>Along the length of south Hendon, profiles 1bSNS7 to 1bSNS11 generally show accretion, except profile 1bSBS7, the lower beach of 1bSNS9 and the upper beach of 1bSNS11 which has fallen since the previous survey. There is no clear direction of sediment movement between the previous full measures survey and the most recent survey in autumn 2021.</p> <p>At Grangetown (south Hendon to Salterfen Rocks), beach levels have predominantly accreted. The southern profiles exhibit negligible change, except the lower beach of profile 1bSNS18 which has fallen since the previous survey.</p> <p>Between Salterfen Rocks and the landfill at Halliwell banks (profiles 1bSNS20 to 1bSNS25), the cliff top has remained largely stable, however the cliff toe has retreated at the majority of profiles since the previous survey. Beach levels have mostly accreted, except on the lower beach of profile 1bSNS24. There is no clear movement of sediment in either direction.</p> <p>The toe of the cliffs at the landfill site (1bSNS26 to 1bSNS32), have remained relatively stable since the previous survey. All profiles show accretion across the entire survey extent.</p> <p>To the south of Halliwell Banks, around Pincushion, the position of the cliff toe has generally shown a seaward movement however this is likely to be a data artefact due to interpolation between limited</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>The beach profile is at a high level across the majority of the profile compared to the range recorded from previous surveys.</p> <p>At profile 1bSNS11, there is negligible change in the cliff profile. Beach levels have lowered between the cliff toe and chainage 70m by up to 1.0m across the upper beach. The middle and lower beach has undergone accretion by up to 1.0m to the end of the survey. The beach profile is at a medium-high level compared to the range recorded from previous surveys.</p> <p>Profiles 1bSNS12 to 1bSNS36 are located along the undefended cliffs between Grangetown and Ryhope Dene.</p> <p>Profiles SNS12 to SNS19 are between the end of the Hendon sea wall and Salterfen Rocks. Cliff top levels are typically between 20m and 22mOD. They are highest along the profiles further north, dropping in the centre and then increasing again to the south. Several profiles show a seaward movement of the cliff toe however this is likely to be a data artefact due to interpolation between limited data points and inaccessibility of the cliff toe due to unsafe conditions. Where this occurs, the cliff toe position is not analysed.</p> <p>Profile 1bSNS12 extends from the cliff across the boulder foreshore. There have been minor changes in position of boulders recorded to chainage 70m. The beach seaward of this point has accreted by up to 0.4m. Overall, the profile is at a its highest level recorded.</p> <p>At profile 1bSNS13, the upper beach has accreted by up to 0.2m to chainage 35m. Between chainage 35-80m the beach has lowered by up to 0.3m. Seaward of chainage 80m there has been accretion by up to 0.3m across the lower beach profile. The beach profile is at a medium-high level compared to previous surveys.</p> <p>At profile 1bSNS14, the cliff top has remained stable since the previous survey, however the cliff toe has receded landward by approximately 3.0m. The upper beach to chainage 72m has accreted by up to 0.4m. Seaward of this point the middle and lower beach has lowered by up to 0.2m. The rock patch remains exposed between chainages 95-117m. The beach profile is at a medium-high level compared to the range recorded from previous surveys.</p> <p>At profile 1bSNS15, there has been relatively little change in position of the cliff toe. The beach has accreted at the toe by up to 0.6m to chainage 80m. Seaward of this point the beach has lowered by</p>	<p>data points and inaccessibility of the cliff toe due to unsafe conditions. There has been erosion across the majority of the beach profiles, except at 1bSNS33 which shows accretion.</p> <p>Longer term trends: Along the length of south Hendon, beach levels are generally at a medium-high level, except 1bSNS7 which is at a medium-low level compared to the range recorded from previous surveys.</p> <p>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.</p> <p>Between Salterfen Rocks and the landfill at Halliwell banks (profiles 1bSNS20 to 1bSNS25), the cliff toe at the majority of profiles has receded and many have now reached their most landward position since surveys began. Beach levels are relatively low across all profiles.</p> <p>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 level compared to previous records.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>up to 0.6m, exposing more rocks seaward of chainage 93m. Overall, the beach profile is at medium-high level, particularly between chainages 72-82m which is at its highest level recorded.</p> <p>At profile 1bSNS16, there has been no change to the beach level since the last survey (autumn 2020). The cliff top has receded approximately 6m since 2009 but the cliff toe has only receded around 1.0m 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.</p> <p>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.</p> <p>At 1bSNS17, there are no changes to the profile since the previous October 2020 survey.</p> <p>At 1bSNS18, the cliff toe appears to have eroded landward by 4.0m. There has been accretion on the upper beach by up to 0.6m to the rocks at chainage 70m. Seaward of the rocks at chainage 83m the lower beach has eroded by up to 0.6m, exposing more rocks at the end of the survey. Overall, the profile is at a low level compared to the range recorded from previous surveys. There has been negligible change in the cliff top position since surveys began.</p> <p>At 1bSNS19, the rocky foreshore remains unchanged. The cliff toe has receded by 2.0m since the previous survey (autumn 2020).</p> <p>At profile 1bSNS20, there has been erosion at the cliff toe by up to 4.0m. The rest of the beach profile has remained unchanged since the previous survey. Overall, the beach is at a relatively low level compared to the range recorded from previous surveys.</p> <p>At 1bSNS21, there has been no change in the position of the cliff since the last survey. There has been a landward retreat of 1.0m since the previous survey. There has been negligible change from the toe of the cliff to chainage 74m. The beach seaward of this point to chainage 125m has accreted by up to 0.6m. The lower beach has eroded by up to 0.2m. Overall, the profile is at a low level on the upper beach compared to the range recorded from previous surveys, and a medium-high level on the lower beach.</p>	<p>To the south of Halliwell Banks at profiles 1bSNS33 to 1bSNS36, beach levels are generally at a medium level except 1bSNS36 which is at a low level compared to previous surveys.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>At profile 1bSNS22, there has been no change in position of the cliff top since the previous survey. The shore platform remains unchanged between chainages 50m and 115m. The survey extends further than the previous survey, exposing more rocks to chainage 126m. Overall the upper beach profile is at a low level compared to the range recorded from previous surveys, however the lower beach is at a high level. The cliff toe is at its most landward position recorded.</p> <p>At profile 1bSNS23, the cliff toe has receded by 5.0m, which is now its at its most landward position since September 2009. The beach has accreted by up to 0.2m on the upper and middle beach, and 0.6m on the lower beach which has now covered up a previously exposed rock patch. The upper beach is at a low level compared to the range recorded from earlier surveys, whilst the lower beach is at a high level. The cliff toe is at its most landward position recorded.</p> <p>At profile 1bSNS24, the cliff top has receded by <0.5m, and the cliff toe has receded by up to 2.0m since the previous survey. The upper beach has lowered by up to 0.4m to chainage 74m, switching to accretion on the lower beach by up to 0.6m. Overall, the profile is at its lowest level recorded on the upper beach to chainage 75m. The middle and lower beach is at a medium level compared to the range recorded from previous surveys. The cliff top and cliff toe is at its most landward position recorded.</p> <p>At profile 1bSNS25, there has been a landward movement of the cliff toe by up to 1.0m. The upper beach level has lowered by up to 0.6m at the cliff toe and up to 0.1m on the middle beach to chainage 73m. Seaward of chainage 73m the beach has risen by 0.4m to the rock platform at chainage 87m. There has been negligible change to the position of the rock platform. The beach profile is at a medium-low level compared to the range recorded from previous surveys, and the cliff toe is at one of its most landward positions recorded.</p> <p>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.</p> <p>Profiles 1bSNS26 to 1bSNS32 have all behaved in a similar way. The top of the cliff shows little movement between spring and autumn 2020. All profiles show accretion of between 0.2-1.0m across the beach profile. Overall, the profiles are at a medium level compared to the range recorded from previous surveys.</p>	

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>Profiles 1bSNS33 to 1bSNS36 are located around the Pincushion Headland.</p> <p>At profile 1bSNS33, there has been accretion across the upper beach profile by up to 1.0m at the cliff toe and across the upper beach and 0.8m on the middle and lower beach. Overall, the profile is at a medium to high level compared to the range recorded from previous surveys.</p> <p>At profile 1bSNS34, the cliff toe shows a further recession of <0.5m, with a total recession of up to 3.0m since 2009. The rest of the profile has changed little since the previous survey.</p> <p>At profile 1bSNS35, the cliff toe shows minimal recession since the previous survey. The beach at the toe of the cliff has accreted by up to 0.4m to chainage 41m. Between chainage 41-80m the rocks have not changed position. The lower beach profile has lowered by up to 0.2m to the end of the survey. Overall, the profile is at a relatively medium level compared to the range recorded from previous surveys.</p> <p>Profile 1bSNS36 shows the upper beach has lowered from the toe of the cliff to the rock platform at chainage 72m by up to 0.6m. There has been negligible change seaward of that point. The profile remains at a low level compared to the range recorded from the previous surveys.</p>	
November 2021	<p>Topographic Survey:</p> <p>Hendon to Ryhope is covered by an annual topographic survey between the Hendon Sea Wall and Ryhope Dene, which commenced in autumn 2009.</p> <p>Data from the most recent topographic survey (Full Measures, autumn 2021) have been used to create a DGM (Appendix B – Map 2) using a GIS. A difference plot has also been produced using the DGM (Appendix B – Map 4) produced from the last produced topographic survey (Full Measures, autumn 2020) and the present survey.</p> <p>The topographic survey shows the beach is dominated by accretion across the majority of the survey extent (up to 1-1.25m towards the southern end). The northernmost part of the survey shows a patchy pattern of erosion and accretion limited to ± 0.5m. A patch of erosion is also found on the lower beach of the central survey area, and on the upper beach at the southernmost survey extent, however the magnitude is relatively low.</p>	<p>The short-term change plot does not show a clear pattern of sediment movement, with accretion dominating across the majority of the bay. Isolated areas of erosion are of relatively low magnitude (0.5m).</p>

<p>November 2021</p>	<p>Cliff Top Survey:</p> <p>Cliff top survey data collected between the baseline survey (spring 2009) and the present Full Measures survey (autumn 2020) is documented here.</p> <p>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 $\pm 0.2\text{m}$ due to the technique used.</p> <p>Results show that since the Partial Measures (April 2021) survey, apparent erosion greater than the error has occurred at 2 locations; GCP3 and GCP5 with an average loss of 1.8m recorded (with a maximum loss of 3.42m at GCP5). Since surveys began in March 2009 (or September 2009 for 28A, 28B, and 28C) erosion greater than the survey error has occurred at around 87.5% of the GCPs, where total losses are 12.26m at their greatest (at GCP25), and more typically less than 7m. The long-term erosion rates are up to 1.02m/yr (GCP25), with up to 0.5m/yr. being more typical.</p>	<p>The cliffs have remained generally stable over the most recent survey period across the majority of the survey points, with 6.25% of points recording erosion greater than the survey error.</p> <p>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.</p>
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4. Problems Encountered and Uncertainty in Analysis

Individual Profiles

- The survey report notes that the beginning of profile 1bSNN9 was unsafe to access at the time of the survey.
- Onshore winds restricted the survey depth achievable on the south beach (09/11/21).

Topographic Survey

- No problems were encountered.

Cliff Top Surveys

- No problems were encountered.

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

- No recommendations have been made.

6. Conclusions and Areas of Concern

- At Whitburn Bay, the majority of beach profiles are within the range of previous recorded surveys. Several sections along the bay are now at their highest level recorded. 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 predominantly accreted since the previous survey in spring 2021. The recorded profiles, topographic survey and cliff-top survey present no causes for specific concern. Ongoing cliff erosion is of a similar magnitude to previous surveys, with only two points undergoing erosion greater than the survey error since spring 2021.
- At Hendon to Ryhope (incl. Halliwell Banks), the greatest amount of cliff top erosion recorded to have taken place between March 2009 and November 2021 was 12.26m at GCP25 which is on the northern border of the landfill site. Since the last survey, the greatest erosion has been at GCP5, where the cliff edge has receded 3.42m. However, as noted above, 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

Beach Profile

Location: 1bSNN1

Date: 09/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

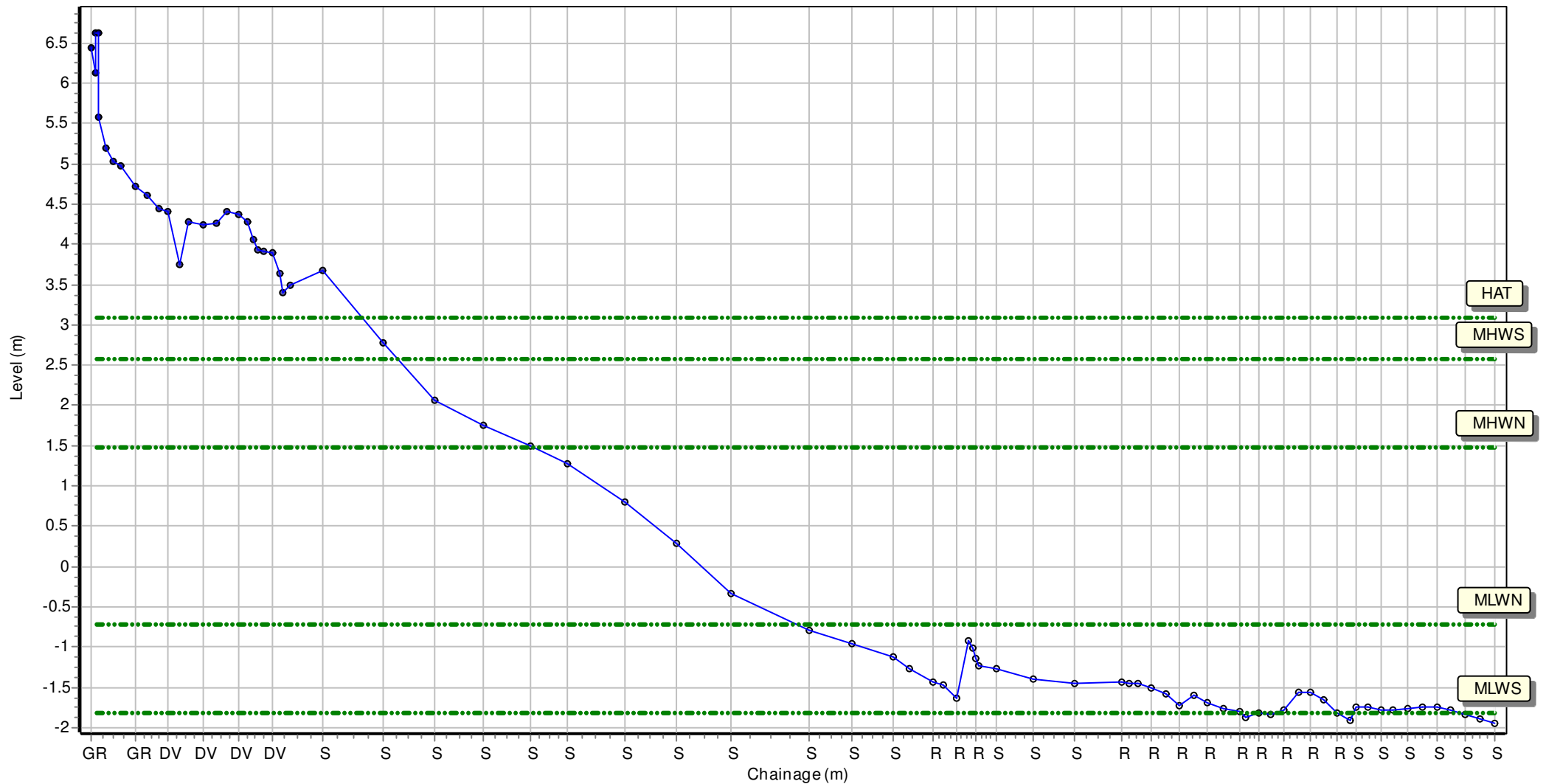
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNN2

Date: 09/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

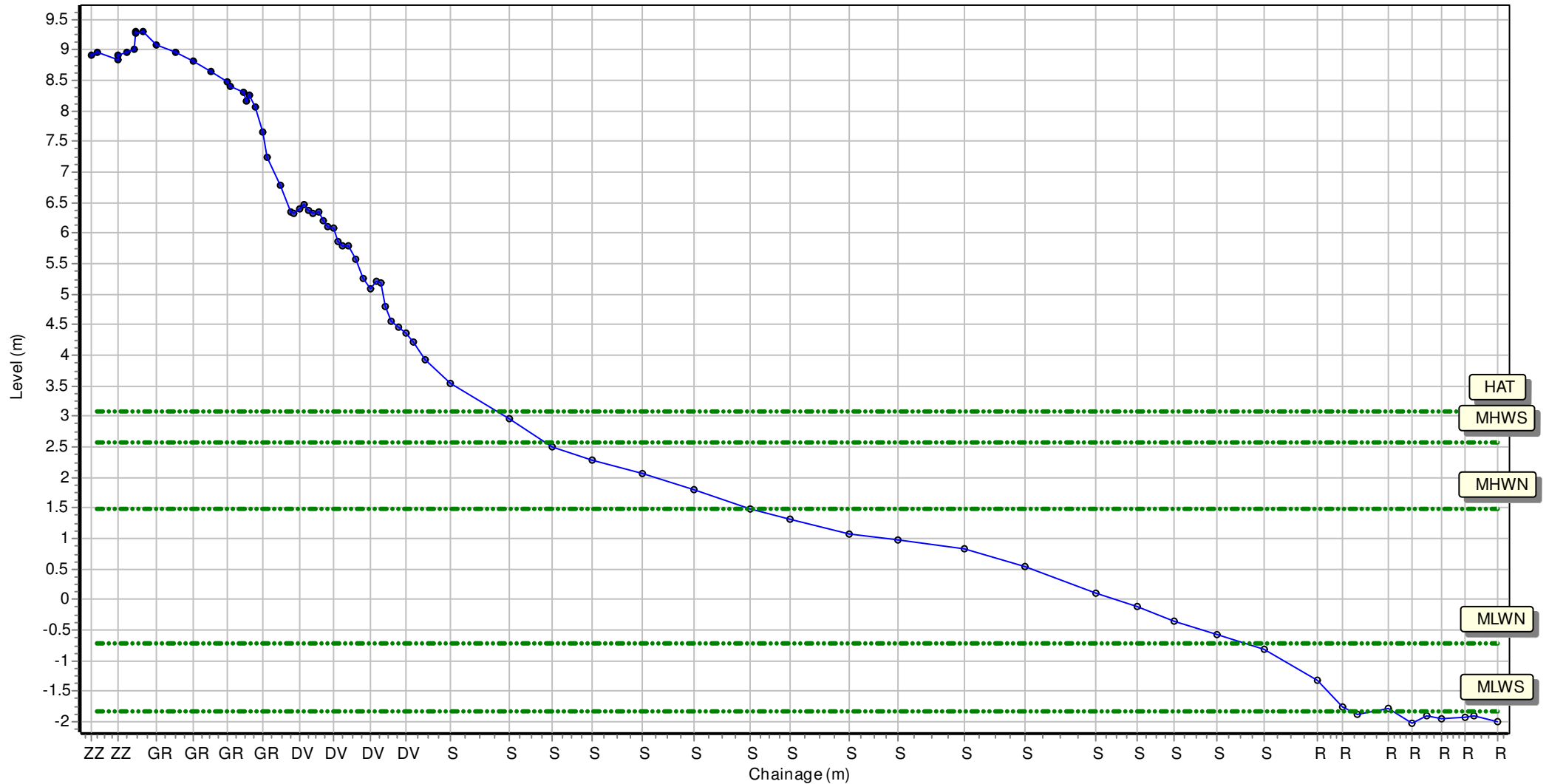
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNN3

Date: 09/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

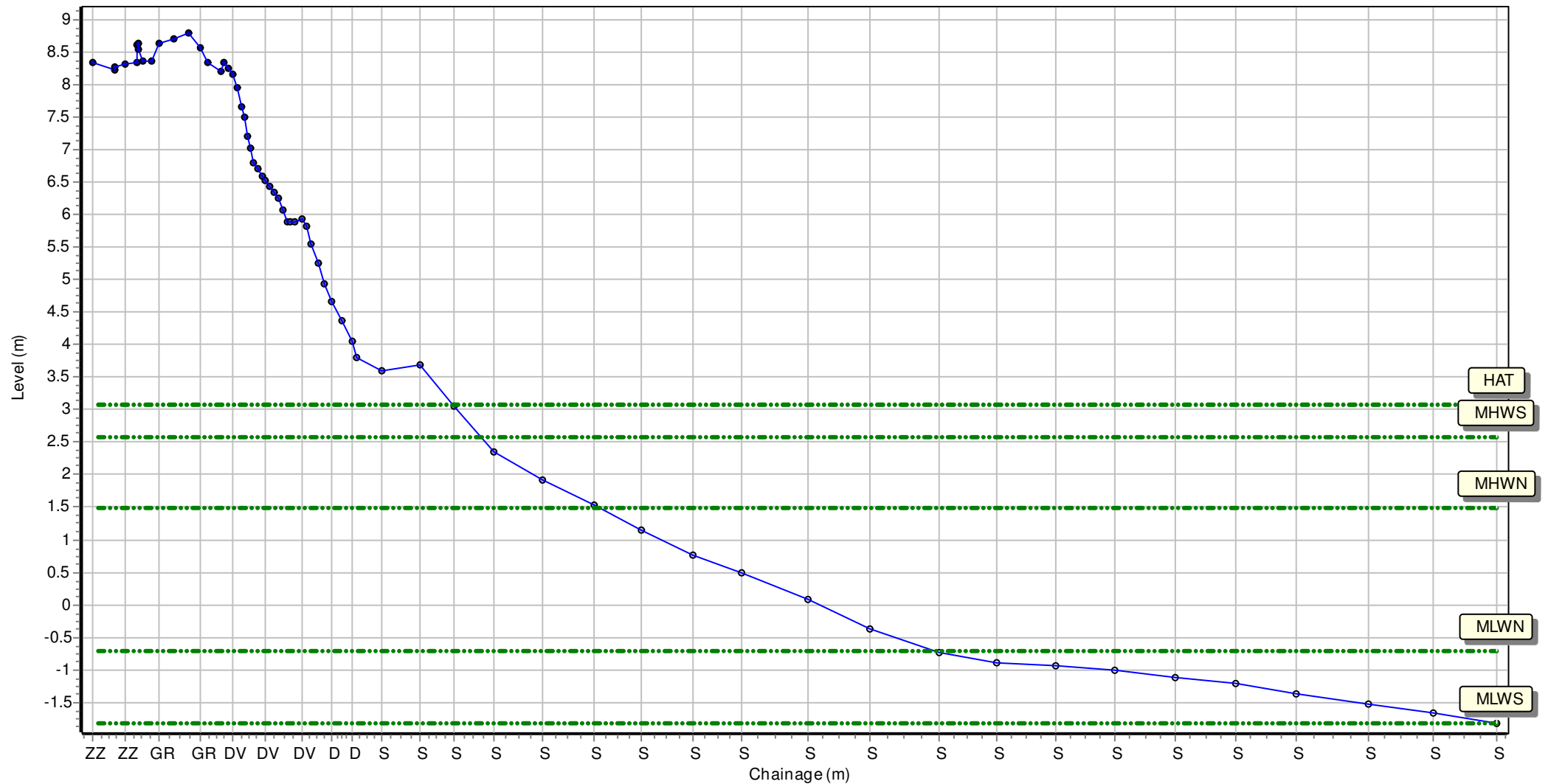
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNN4

Date: 09/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

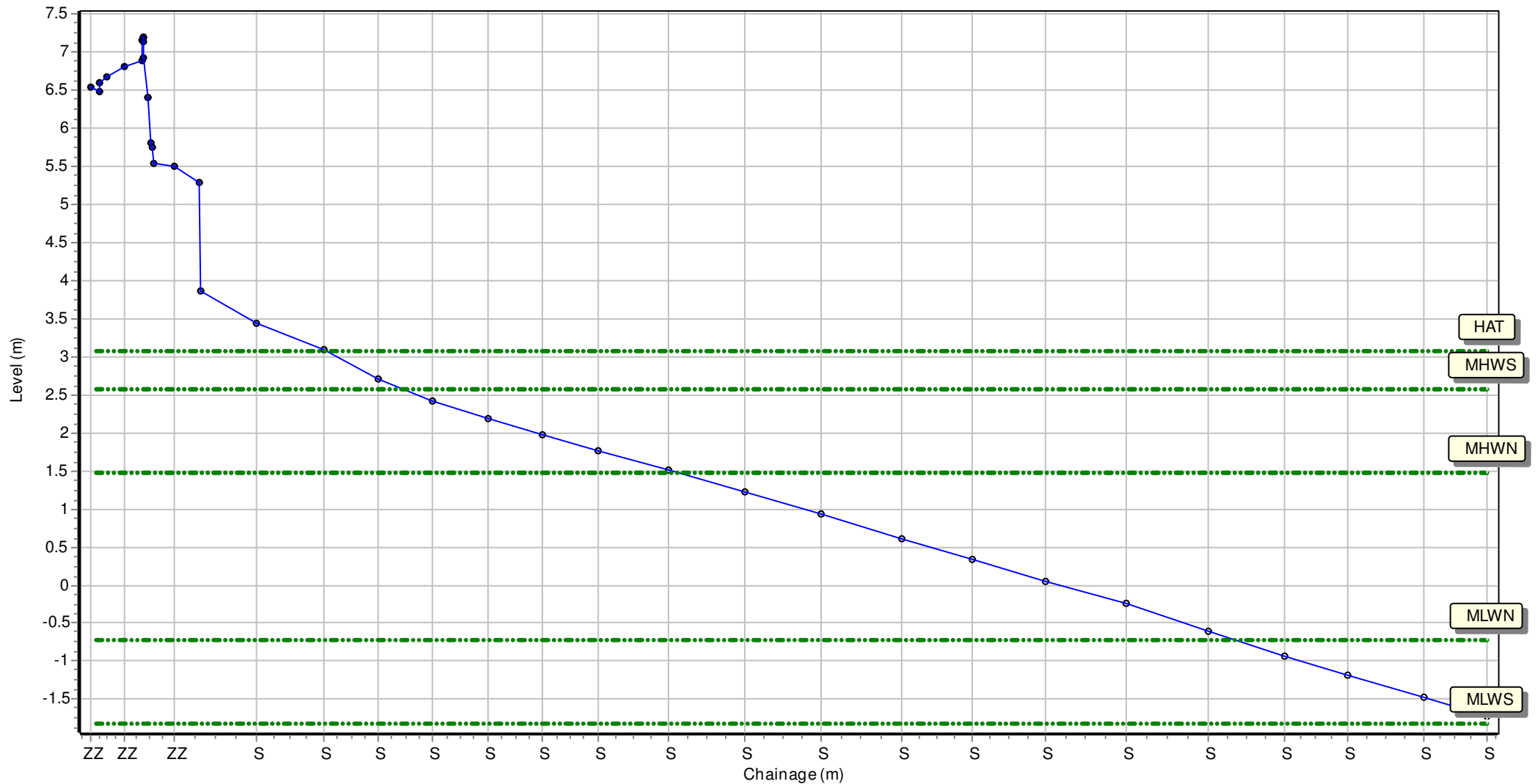
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Location: 1bSNN5

Low Tide Time:

Rain:

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



Beach Profile

Location: 1bSNN6

Date: 09/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

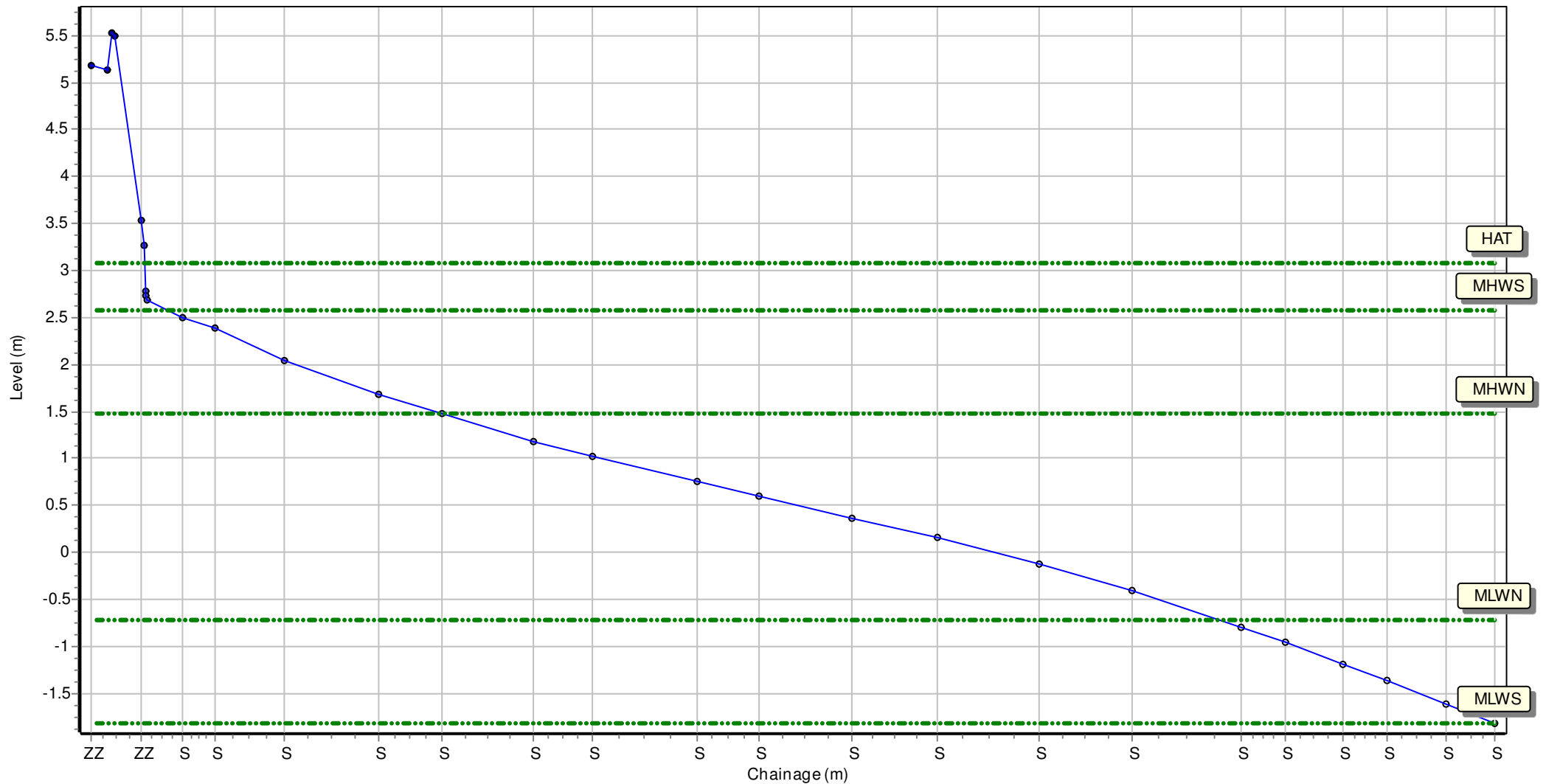
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNN7

Date: 09/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

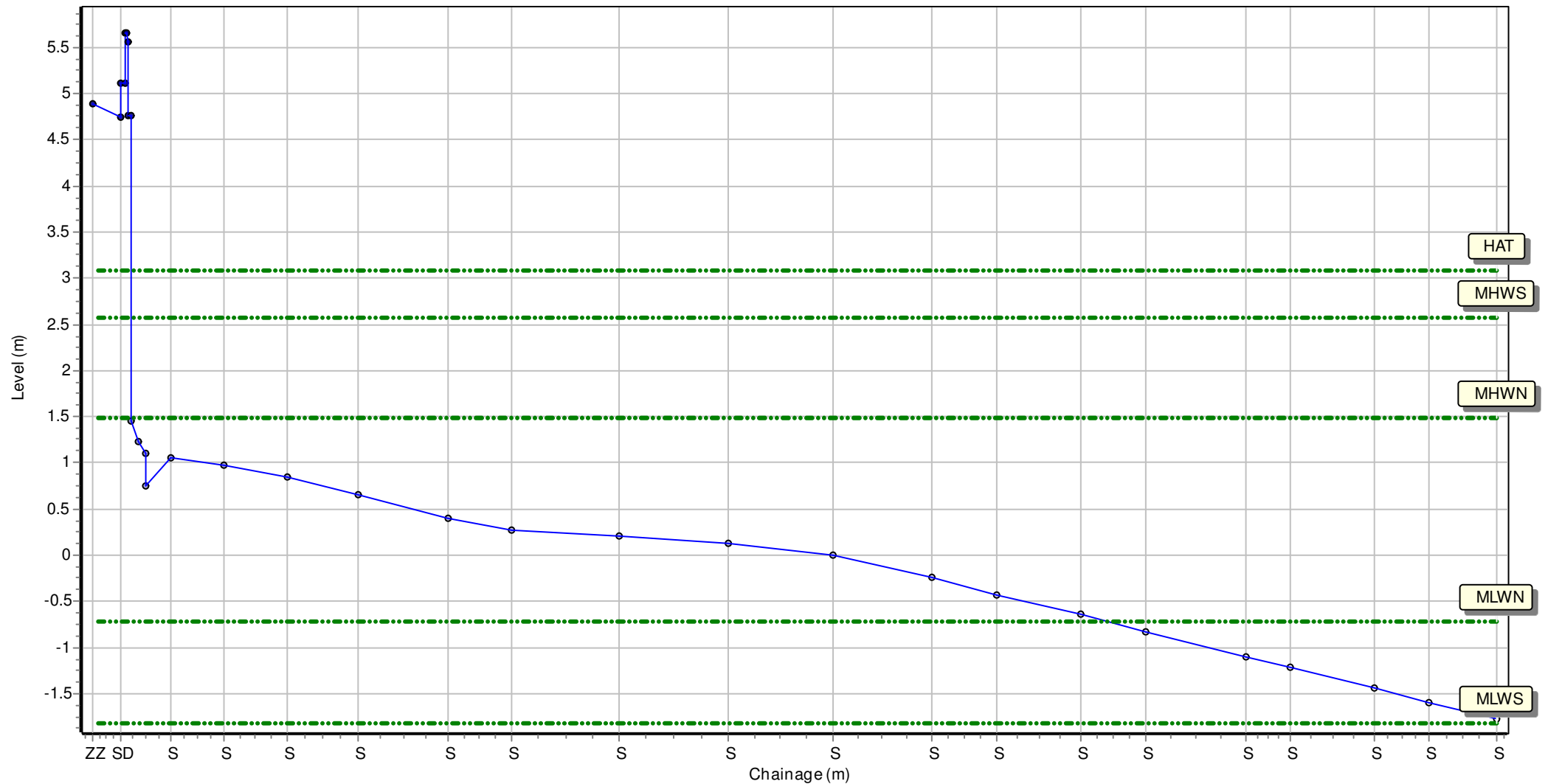
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNN9

Date: 09/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

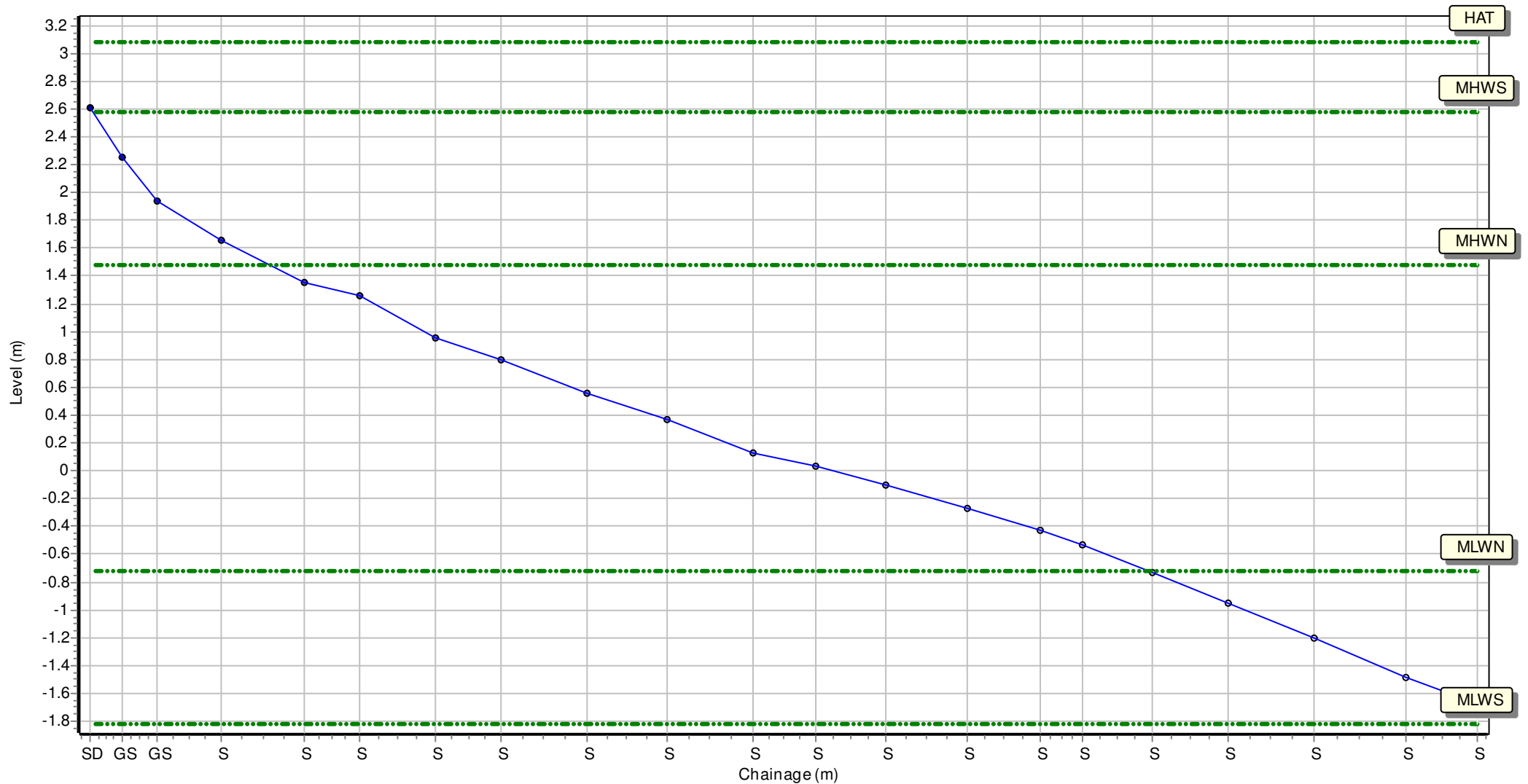
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNN10

Date: 09/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

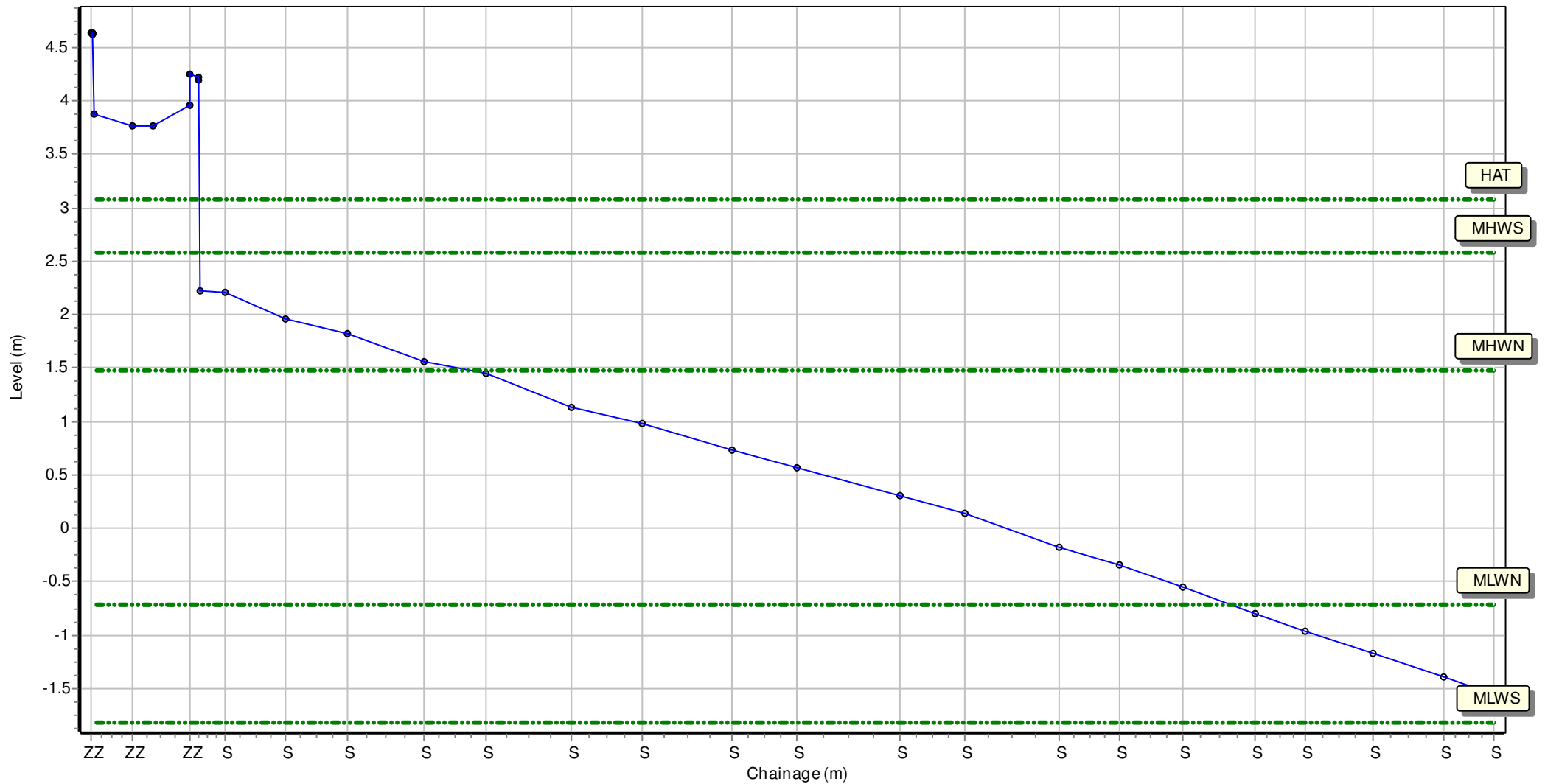
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNN12

Date: 09/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

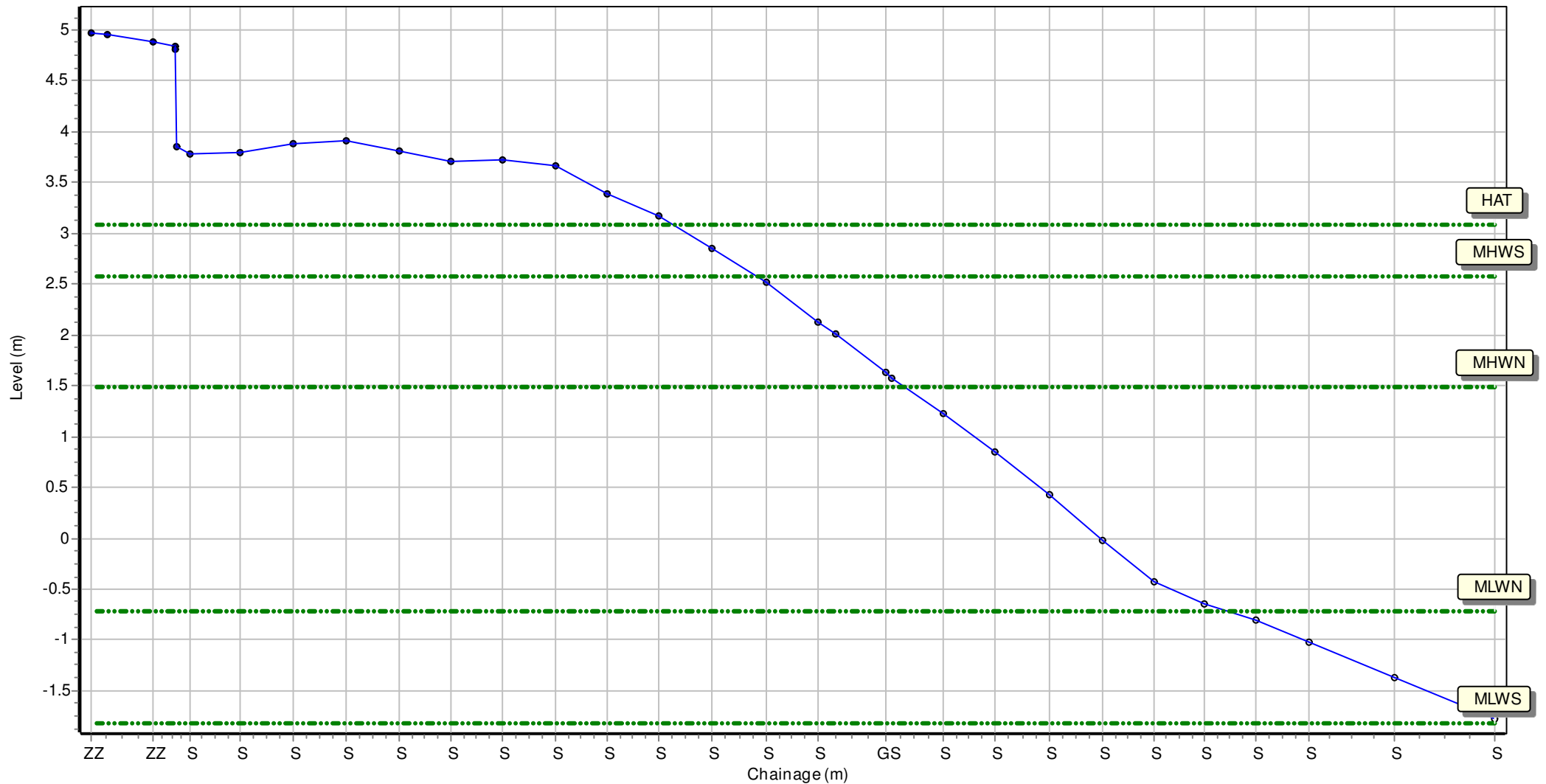
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNN13

Date: 09/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

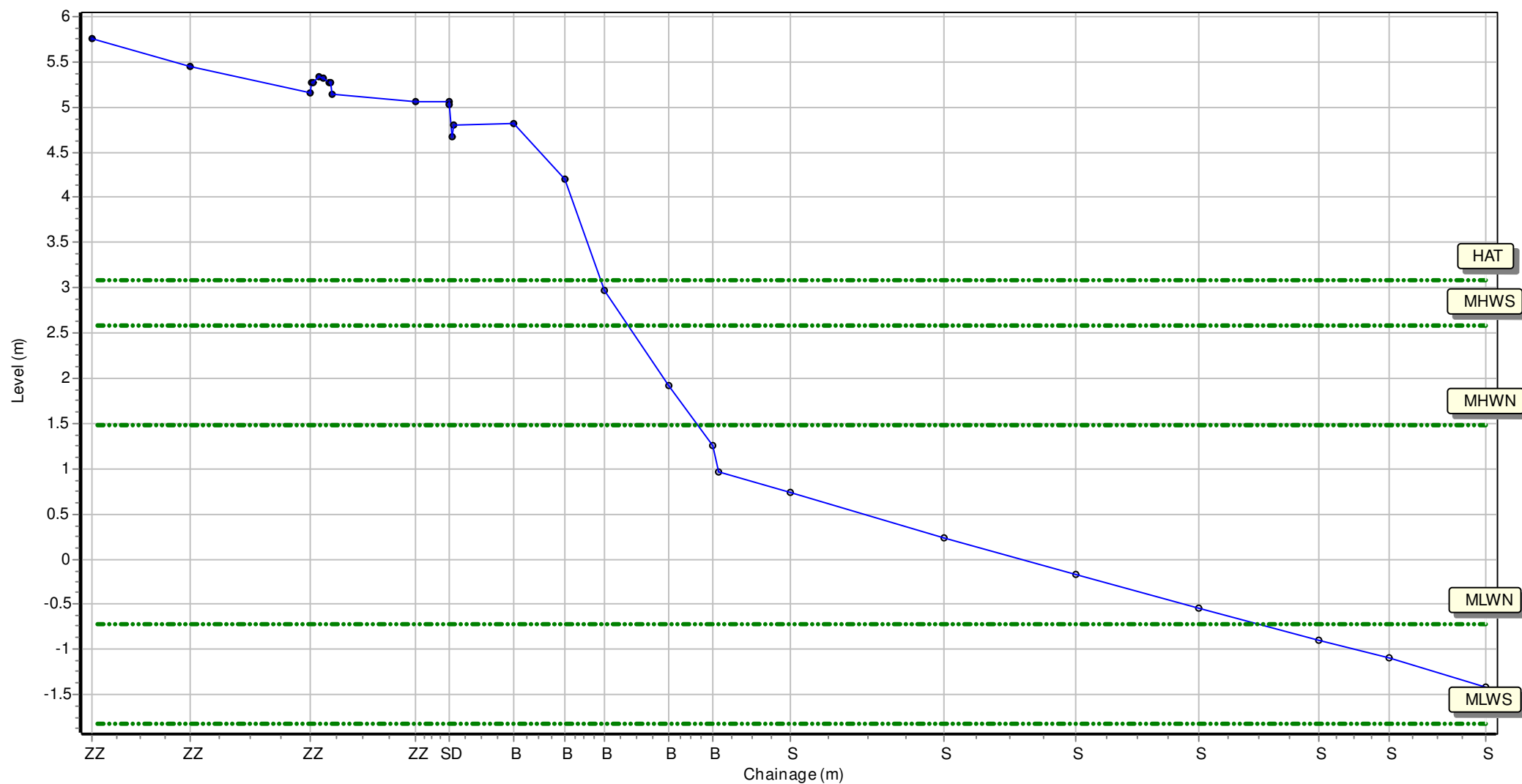
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNC1

Date: 05/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

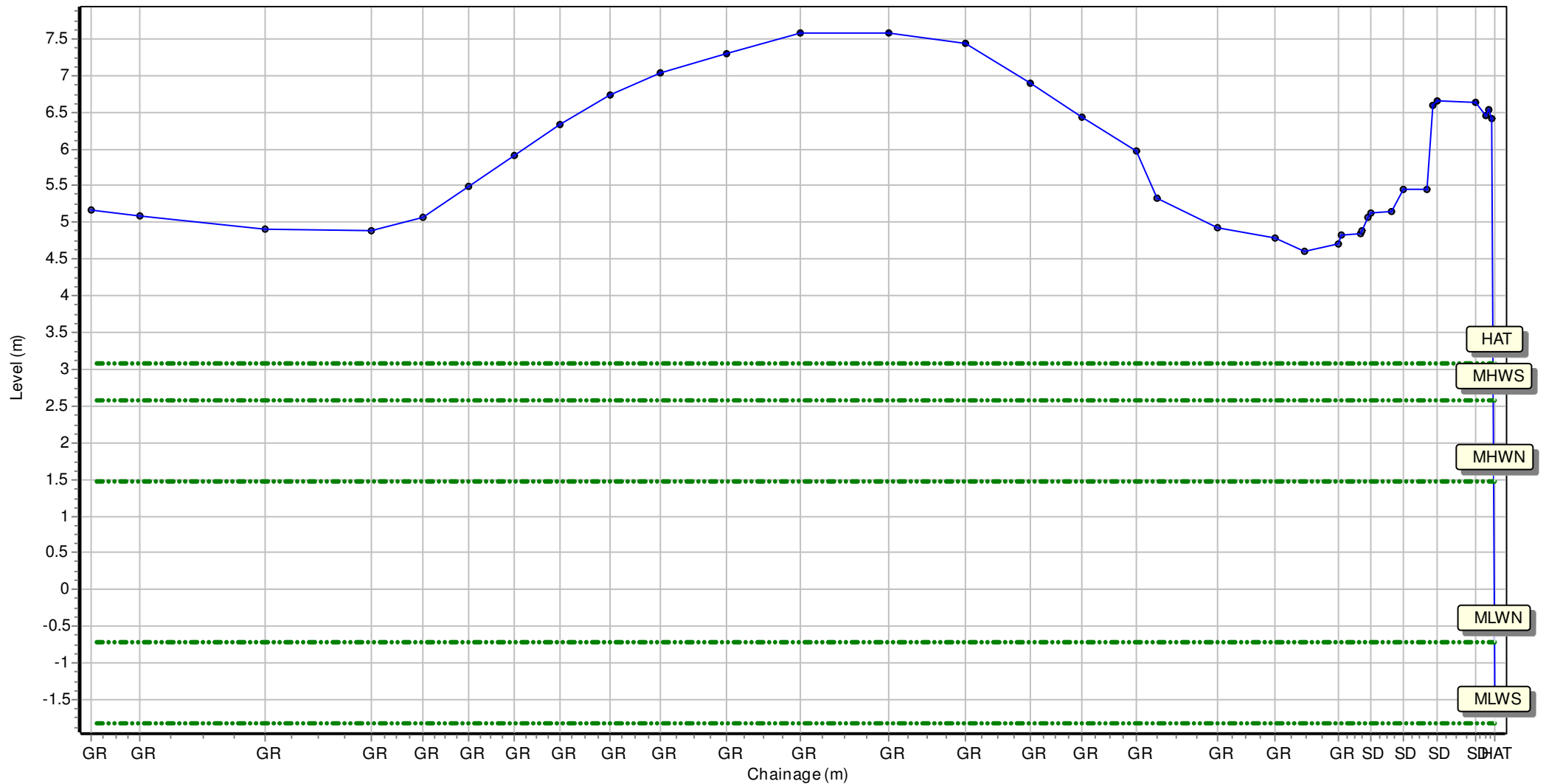
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNC2

Date: 05/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

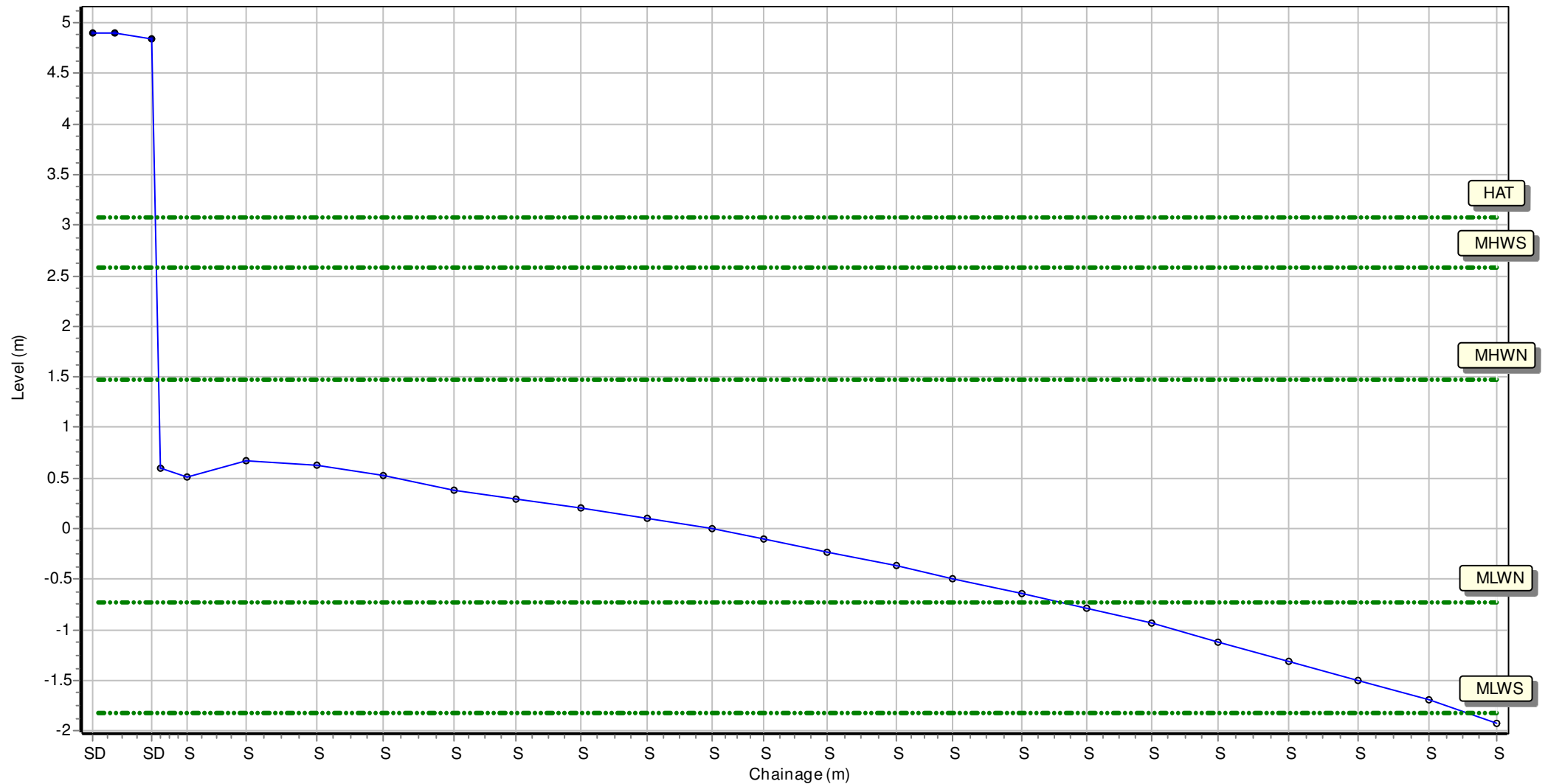
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Location: 1bSNC3

Low Tide Time:

Rain:

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



Beach Profile

Location: 1bSNC4

Date: 05/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

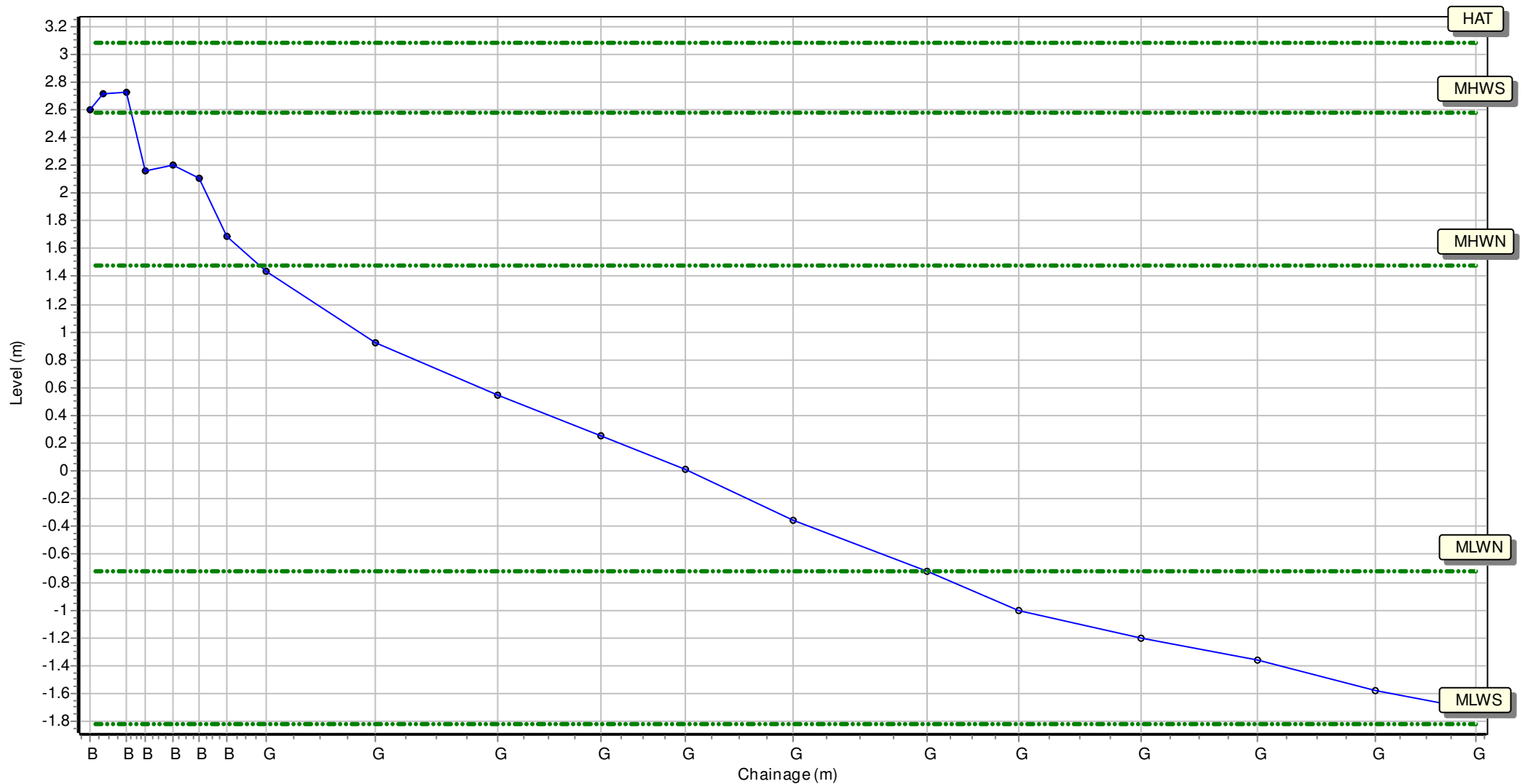
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNC5

Date: 05/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

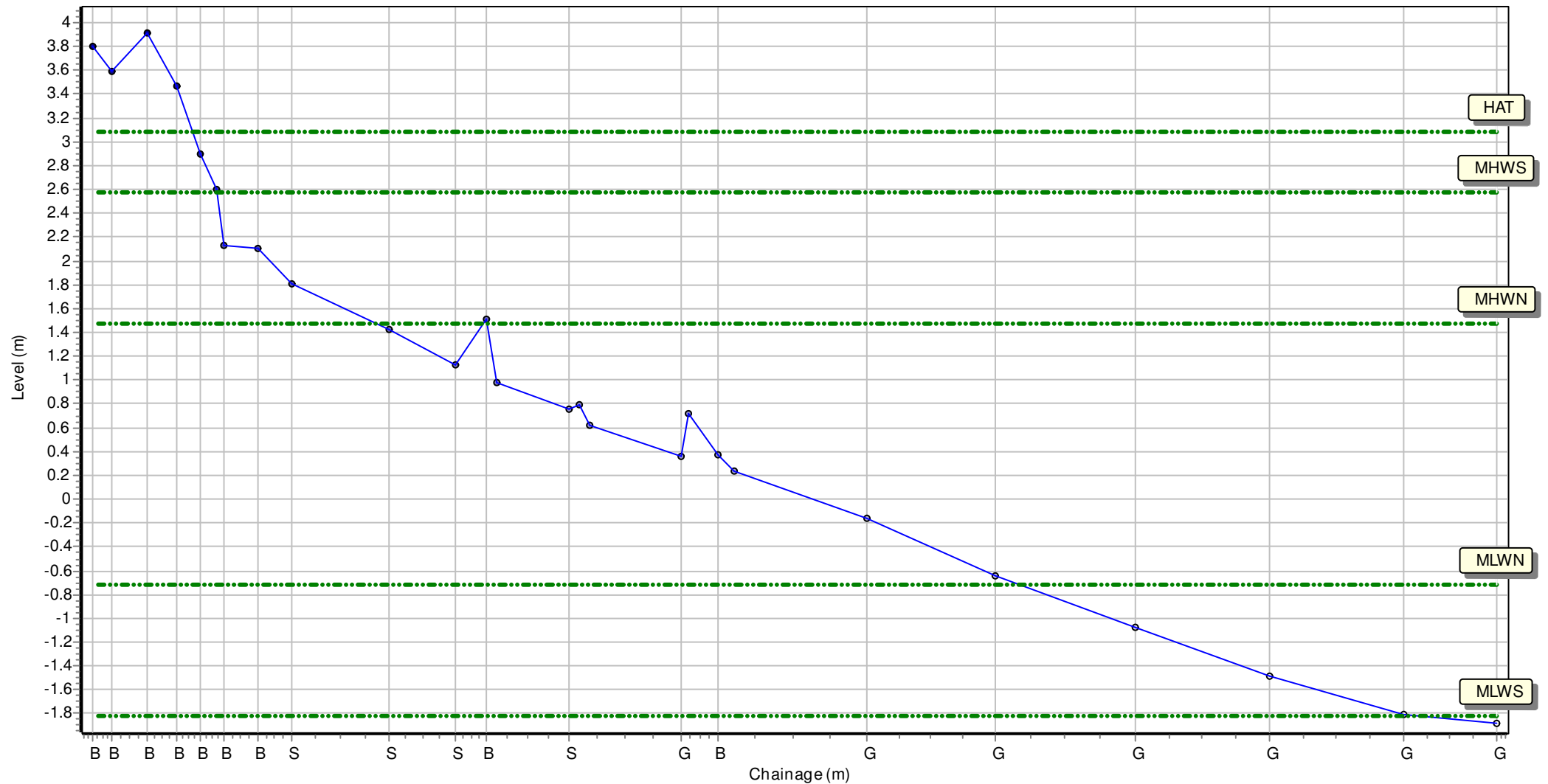
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNC6

Date: 05/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

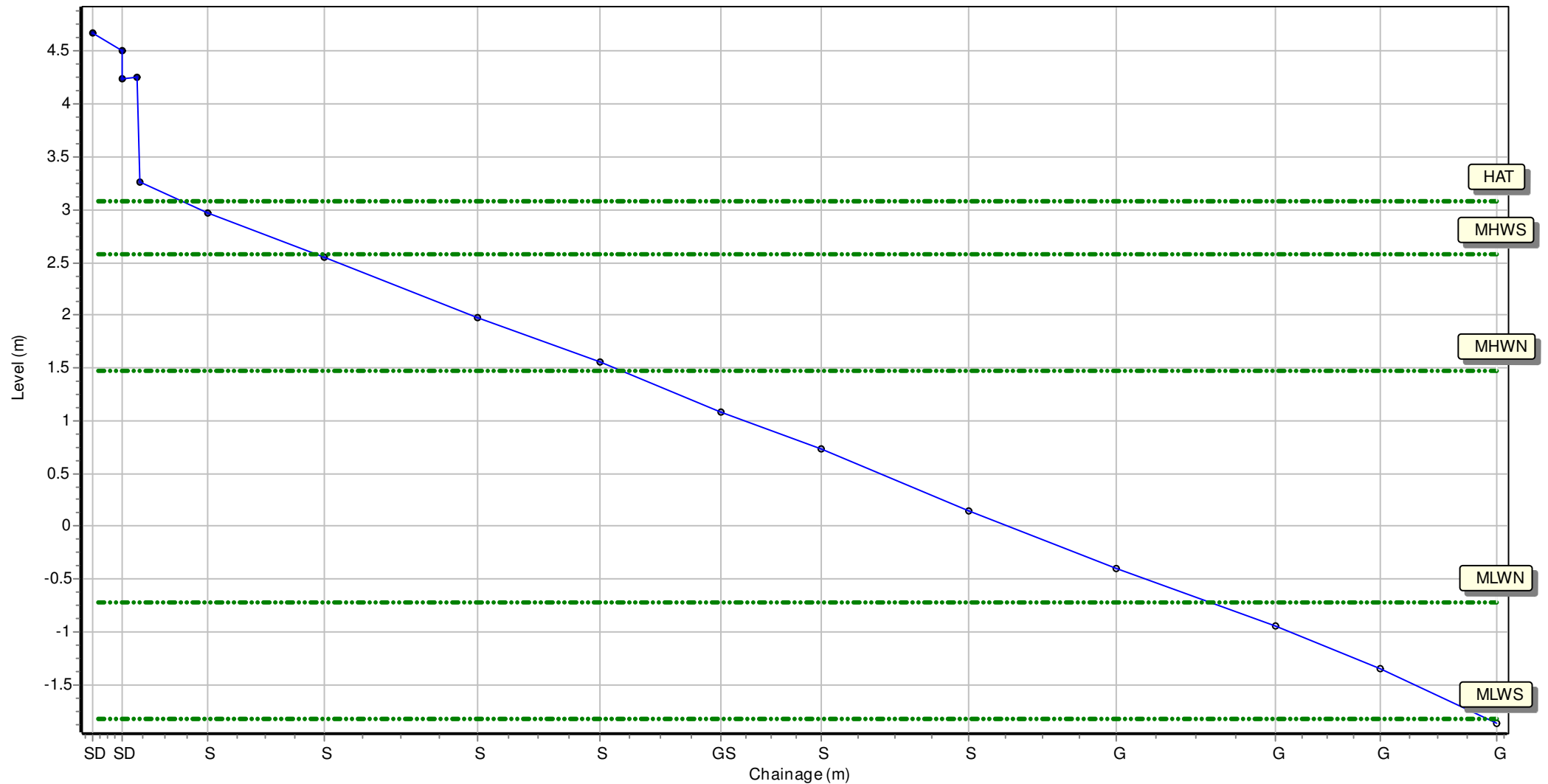
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNC7

Date: 05/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

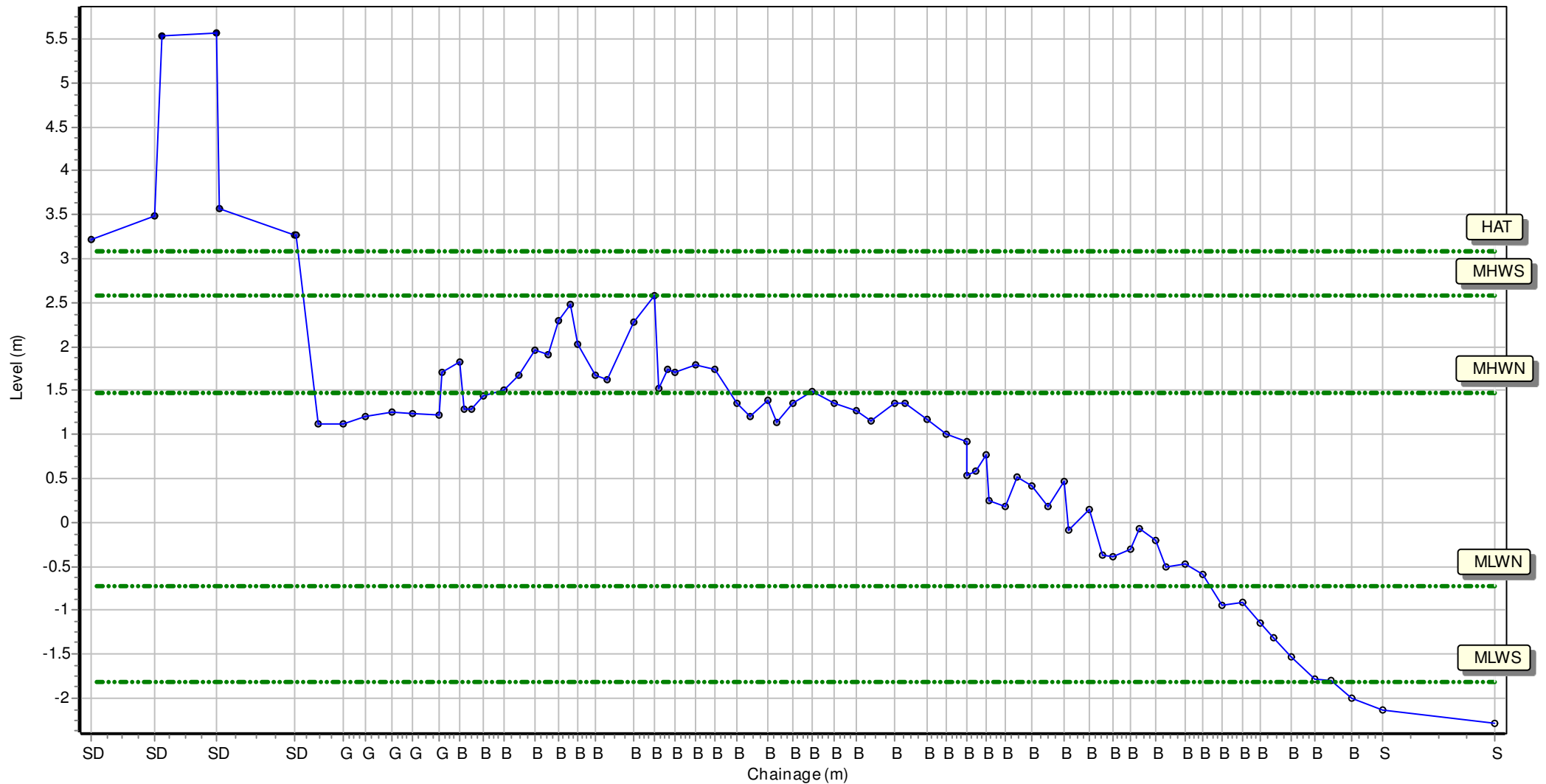
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNC8

Date: 05/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

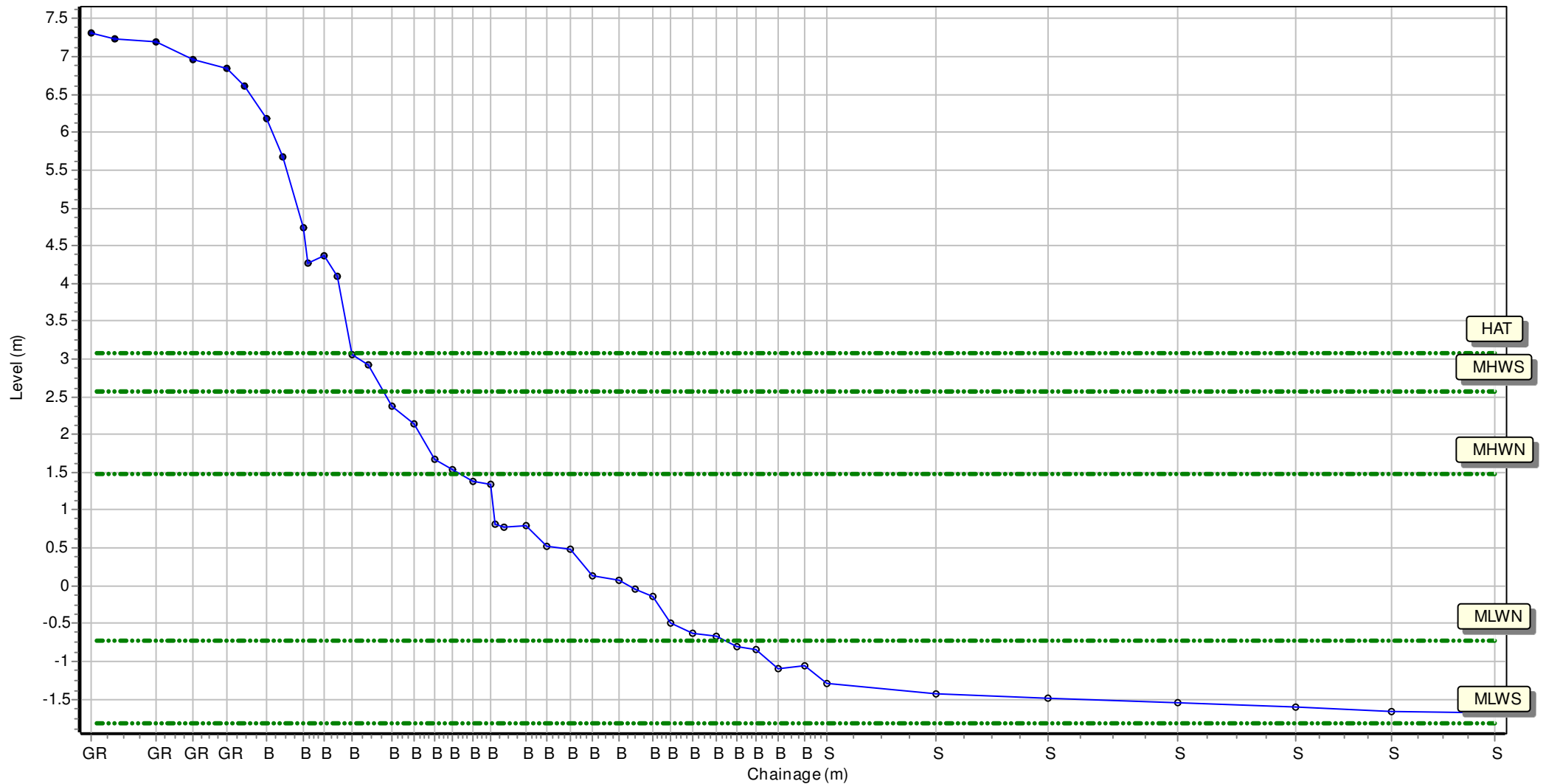
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNS7

Date: 19/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

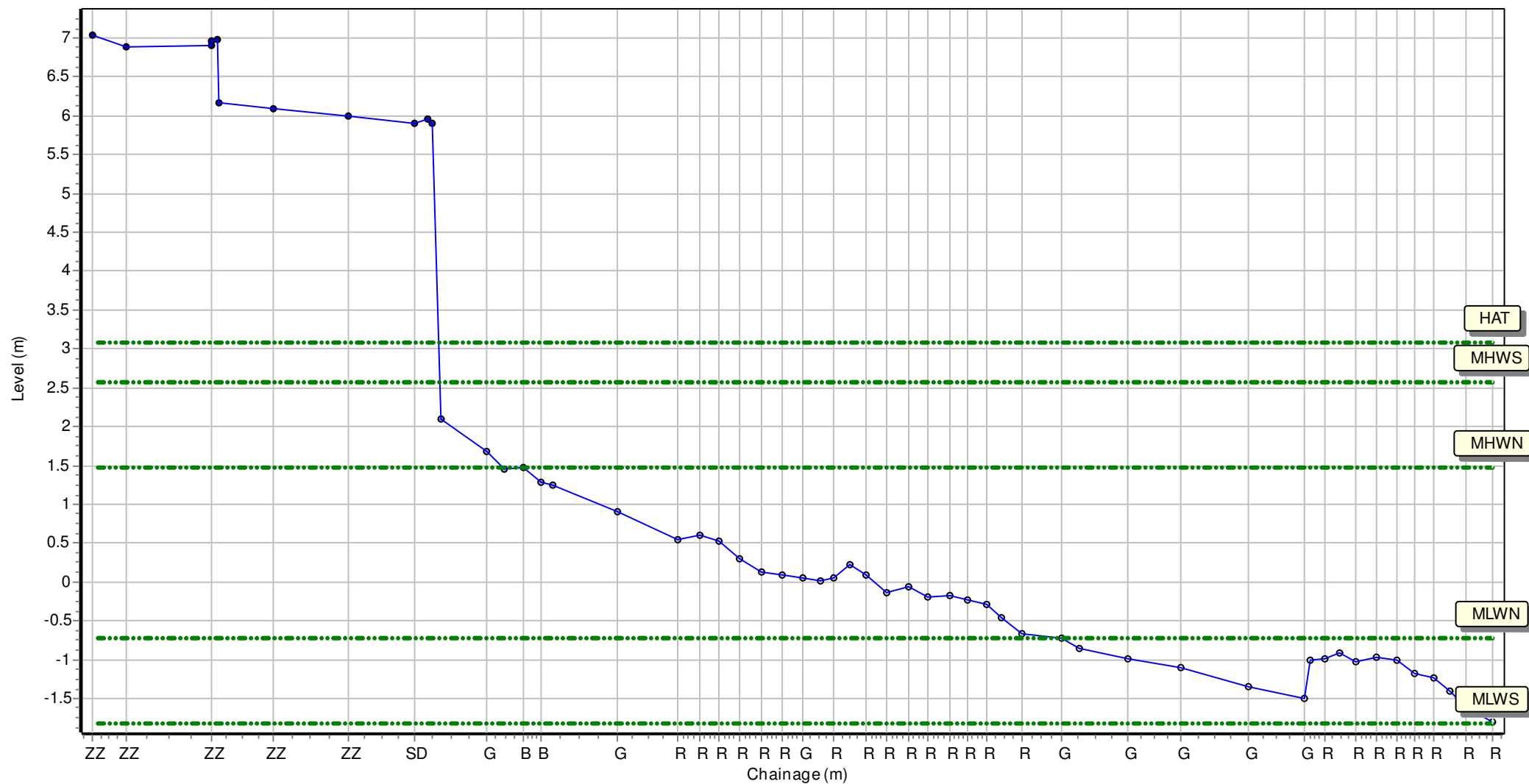
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNS9

Date: 19/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

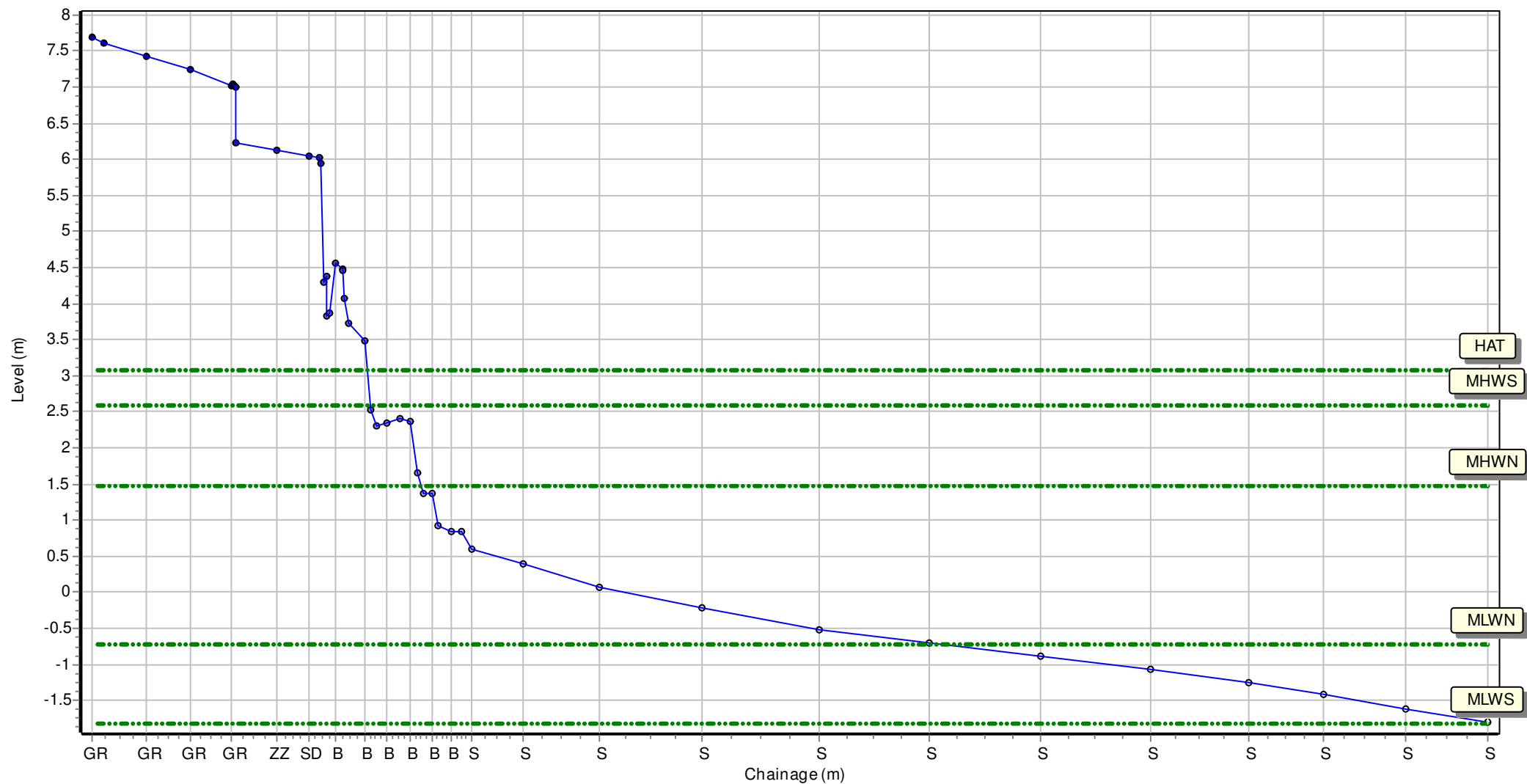
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNS10

Date: 19/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

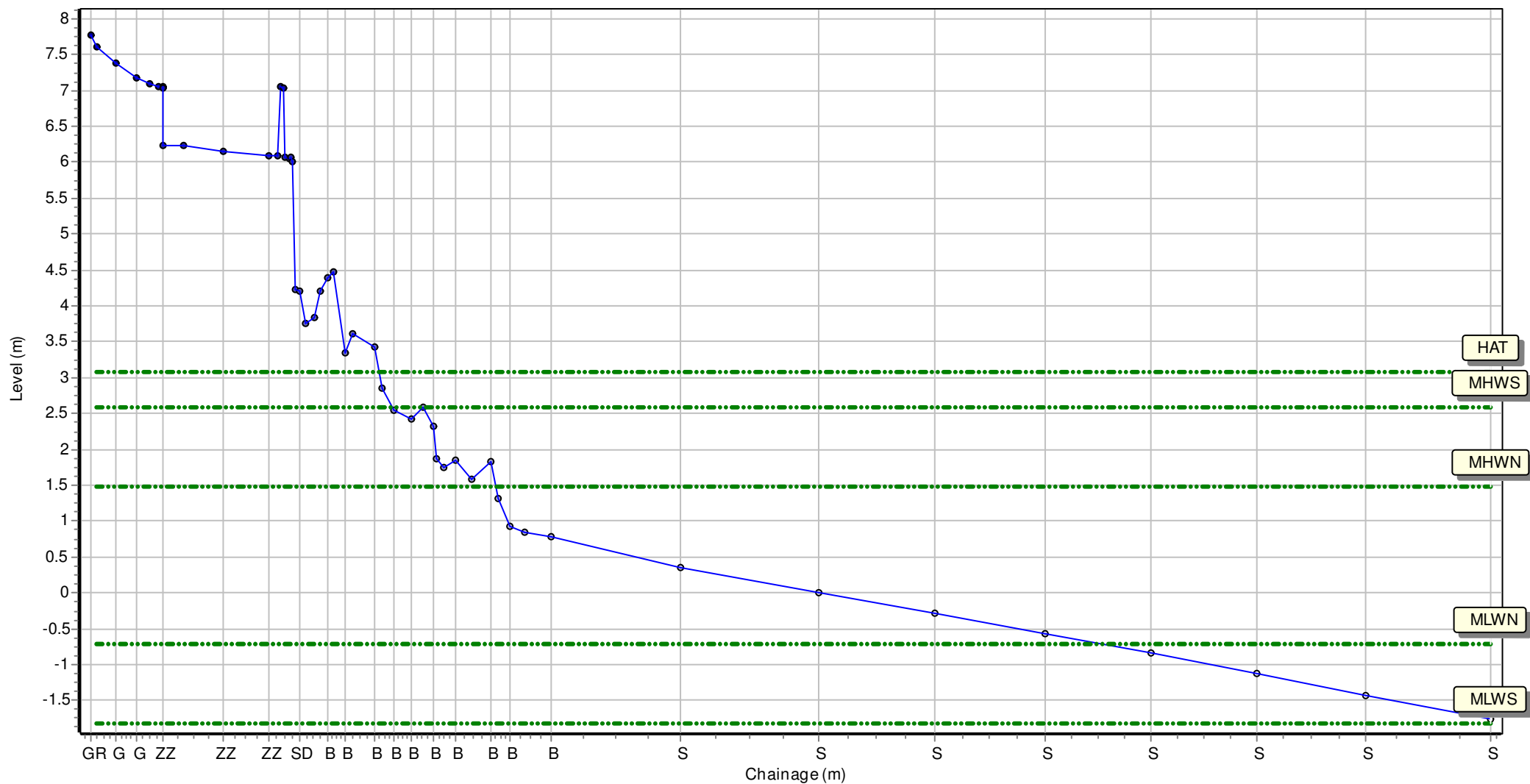
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNS11

Date: 19/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

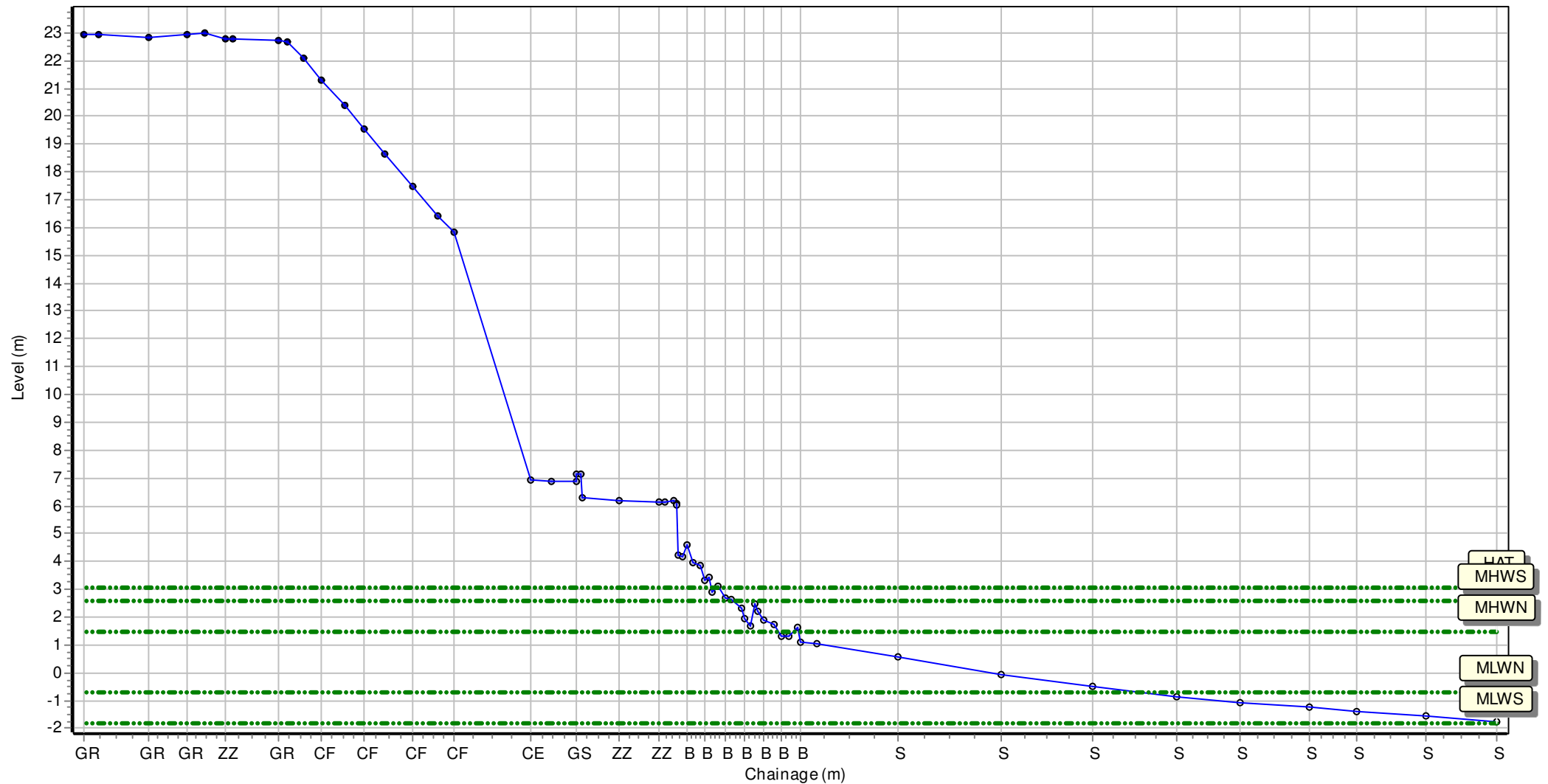
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNS12

Date: 19/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

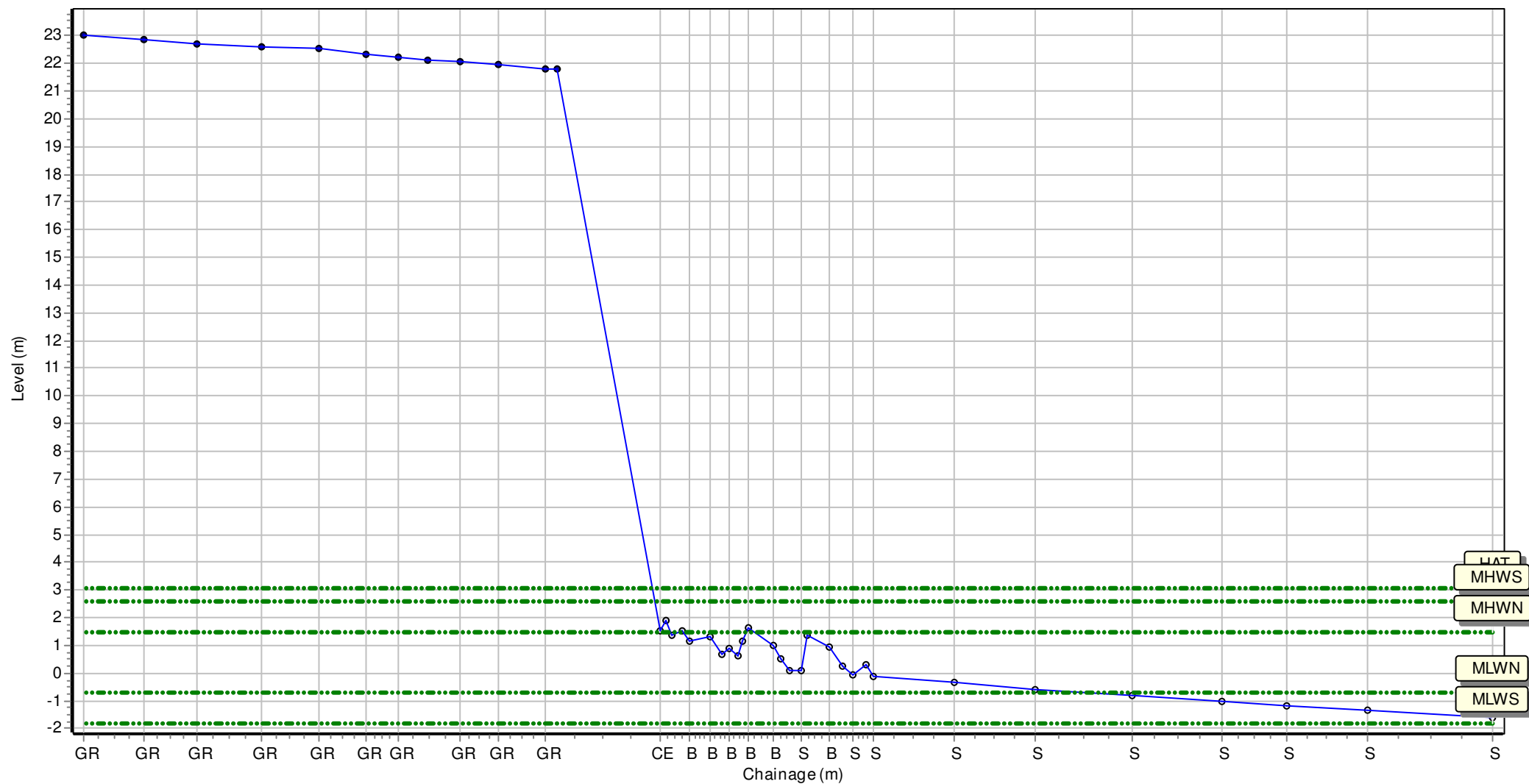
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNS13

Date: 19/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

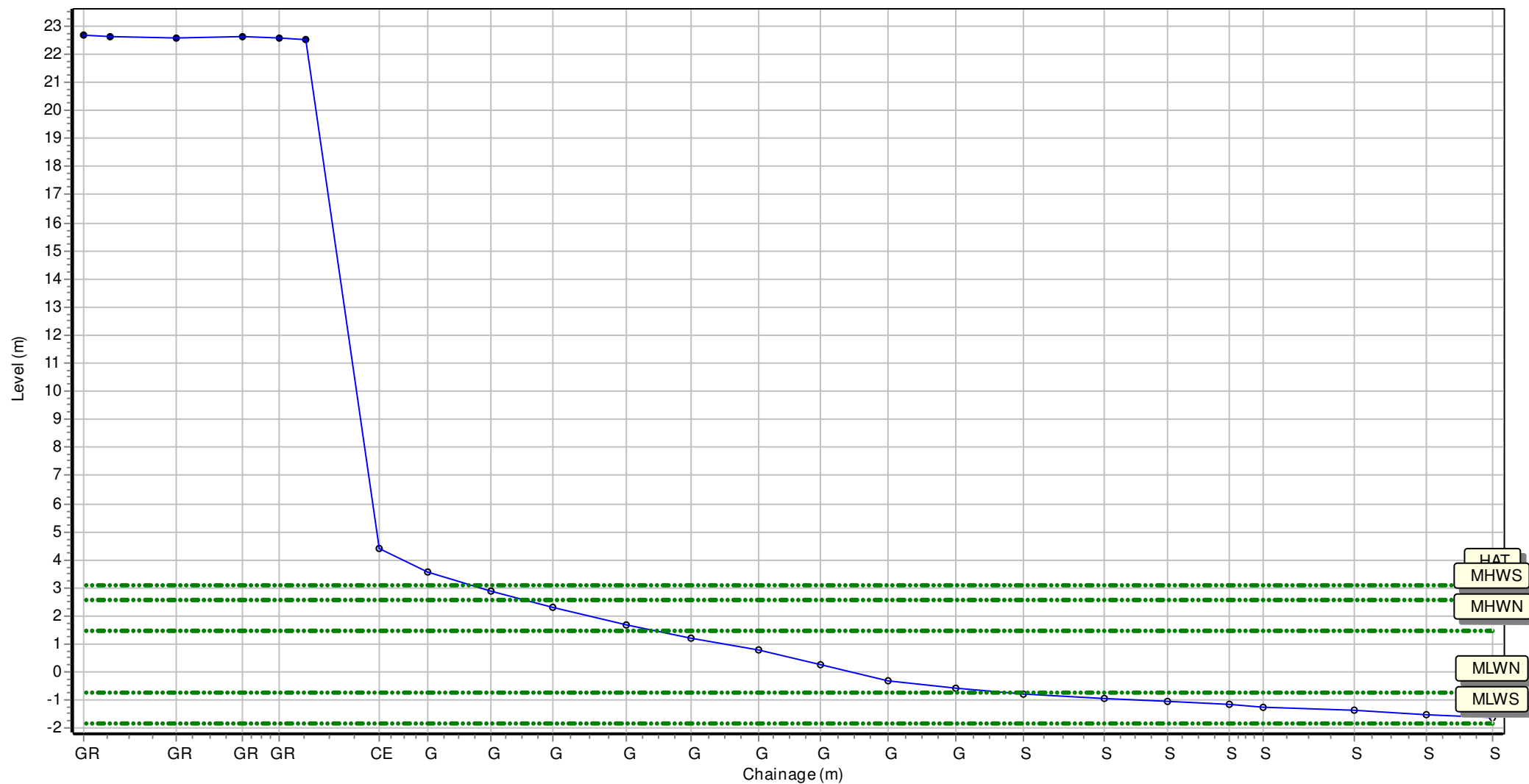
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNS14

Date: 19/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

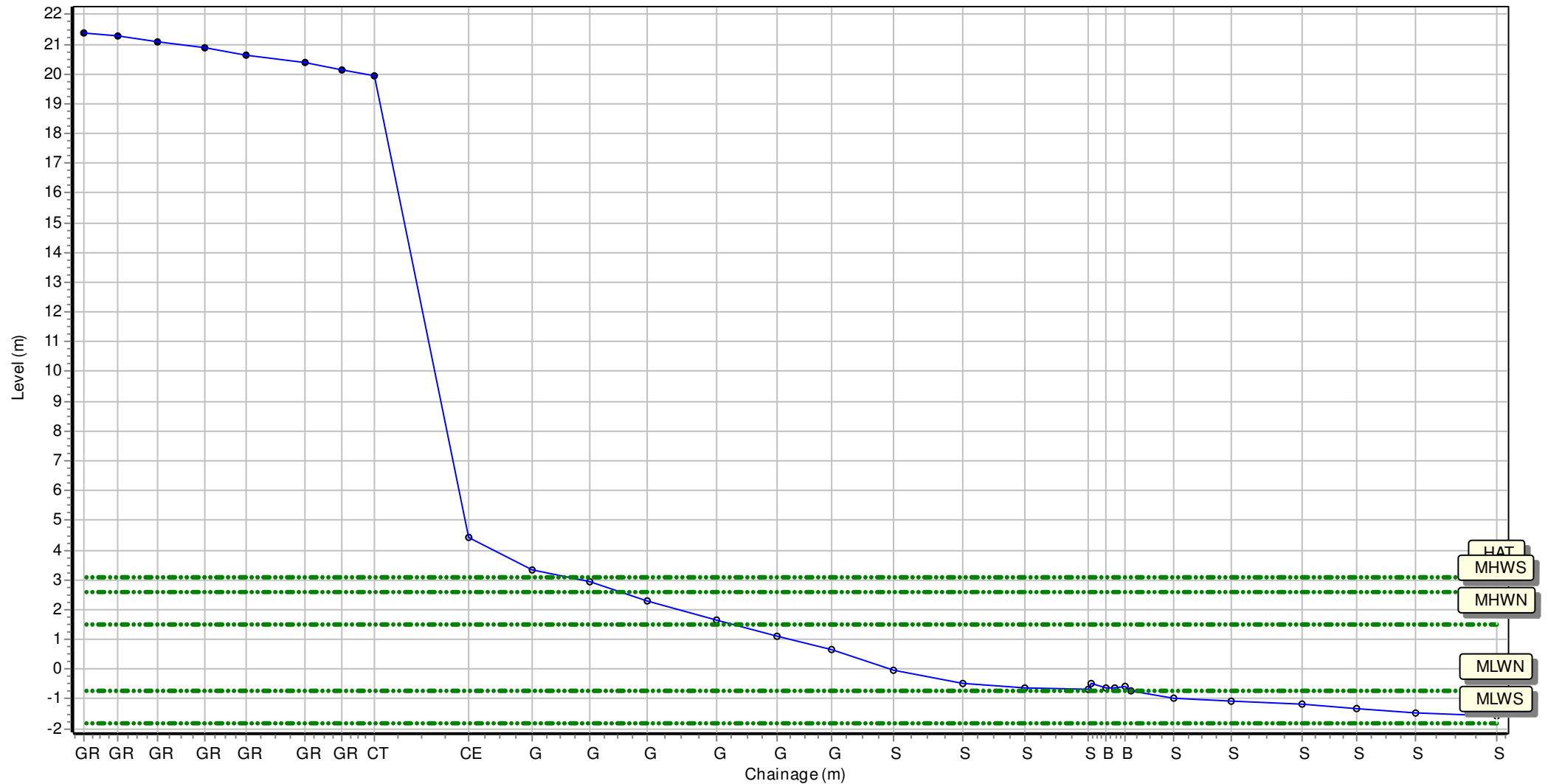
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNS15

Date: 19/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

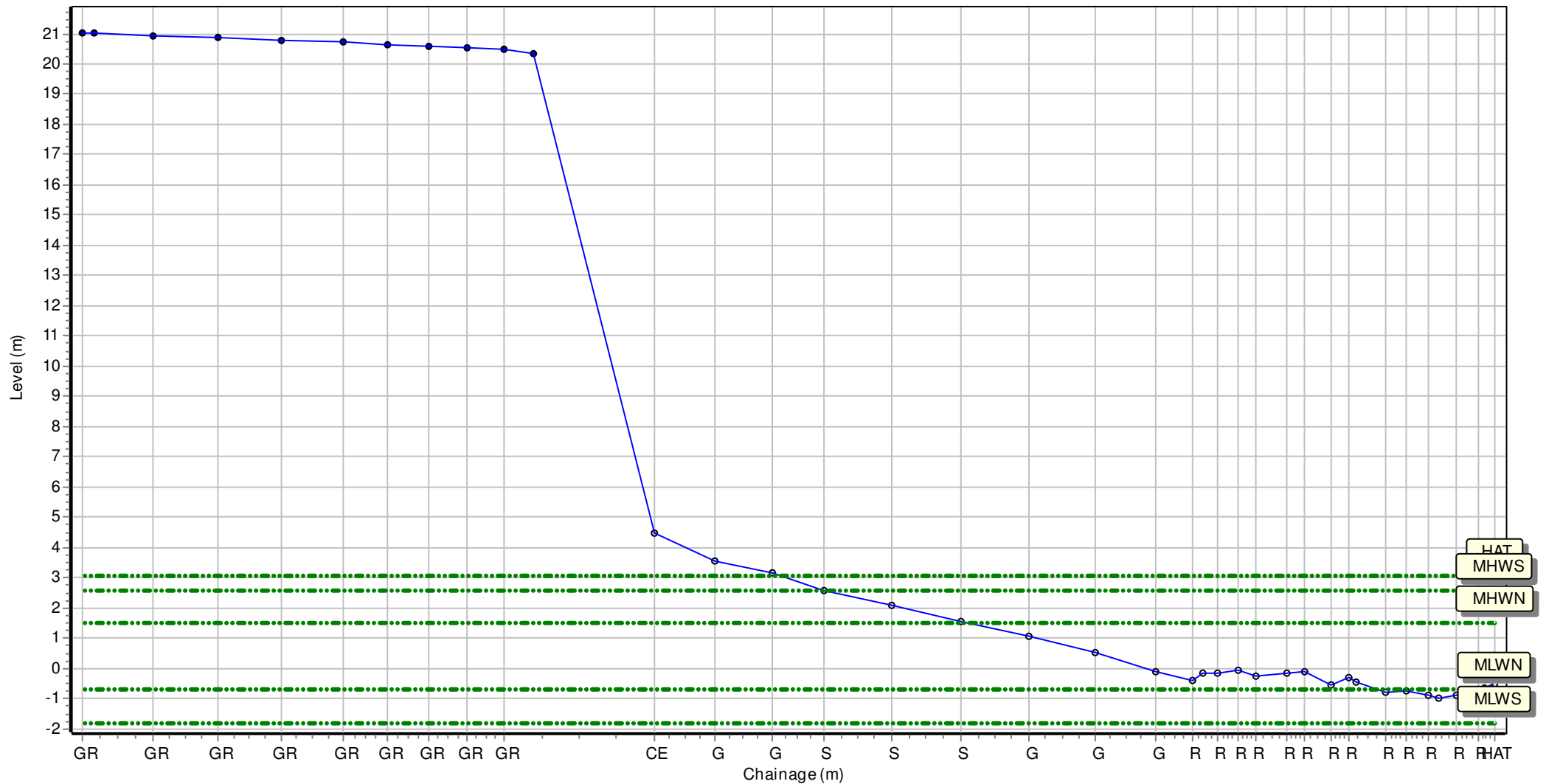
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNS16

Date: 19/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

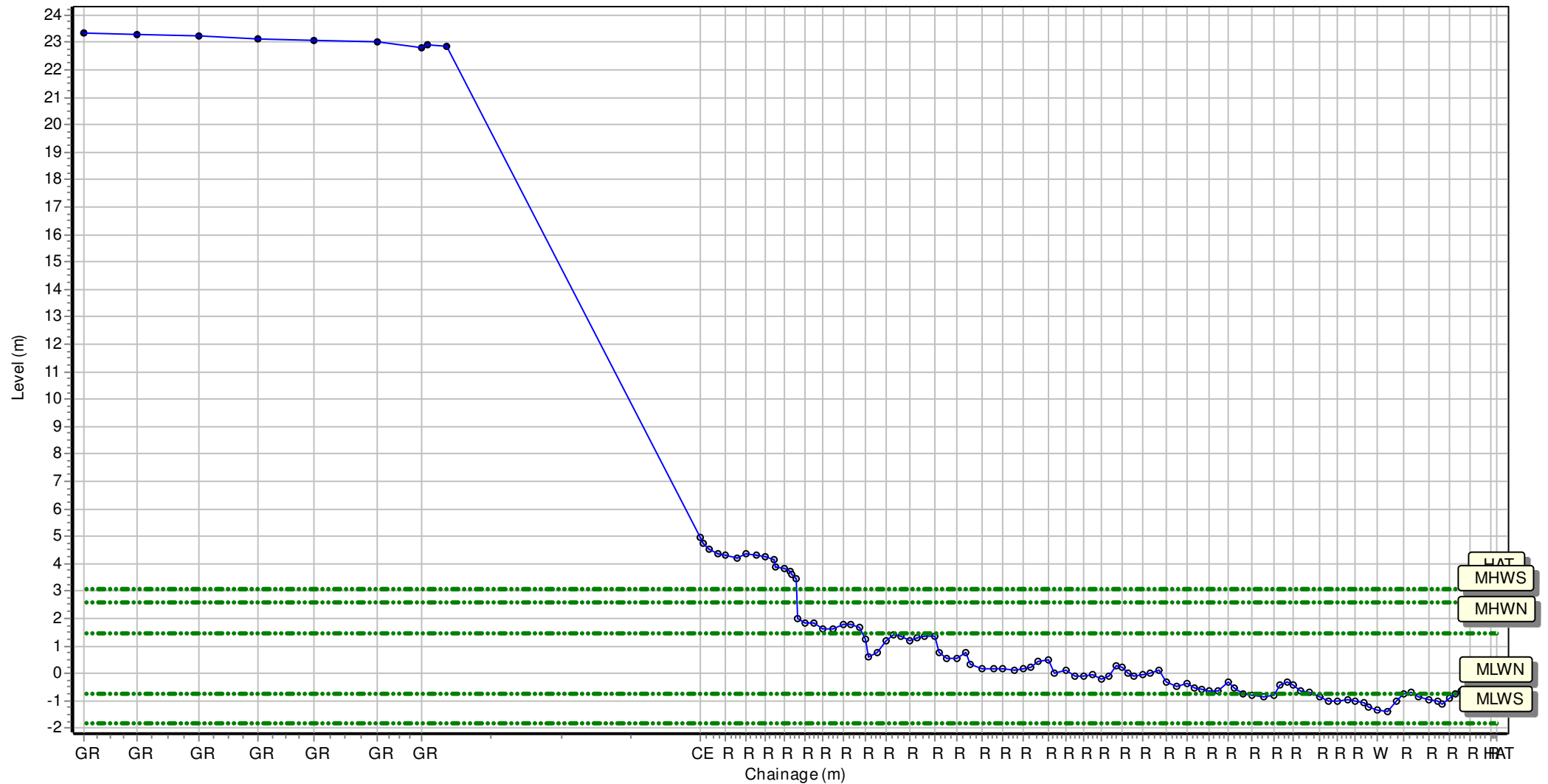
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNS17

Date: 19/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

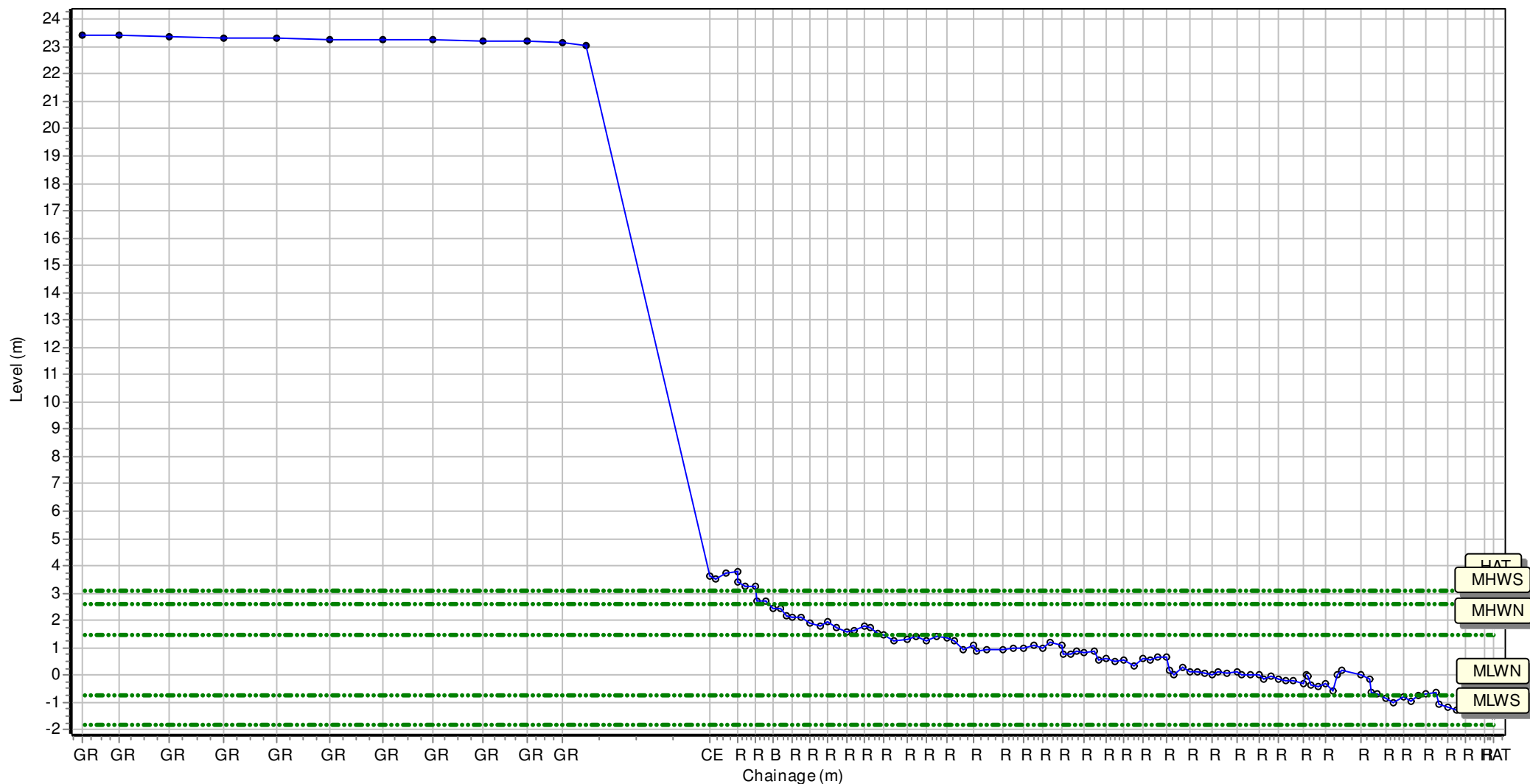
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNS20

Date: 19/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

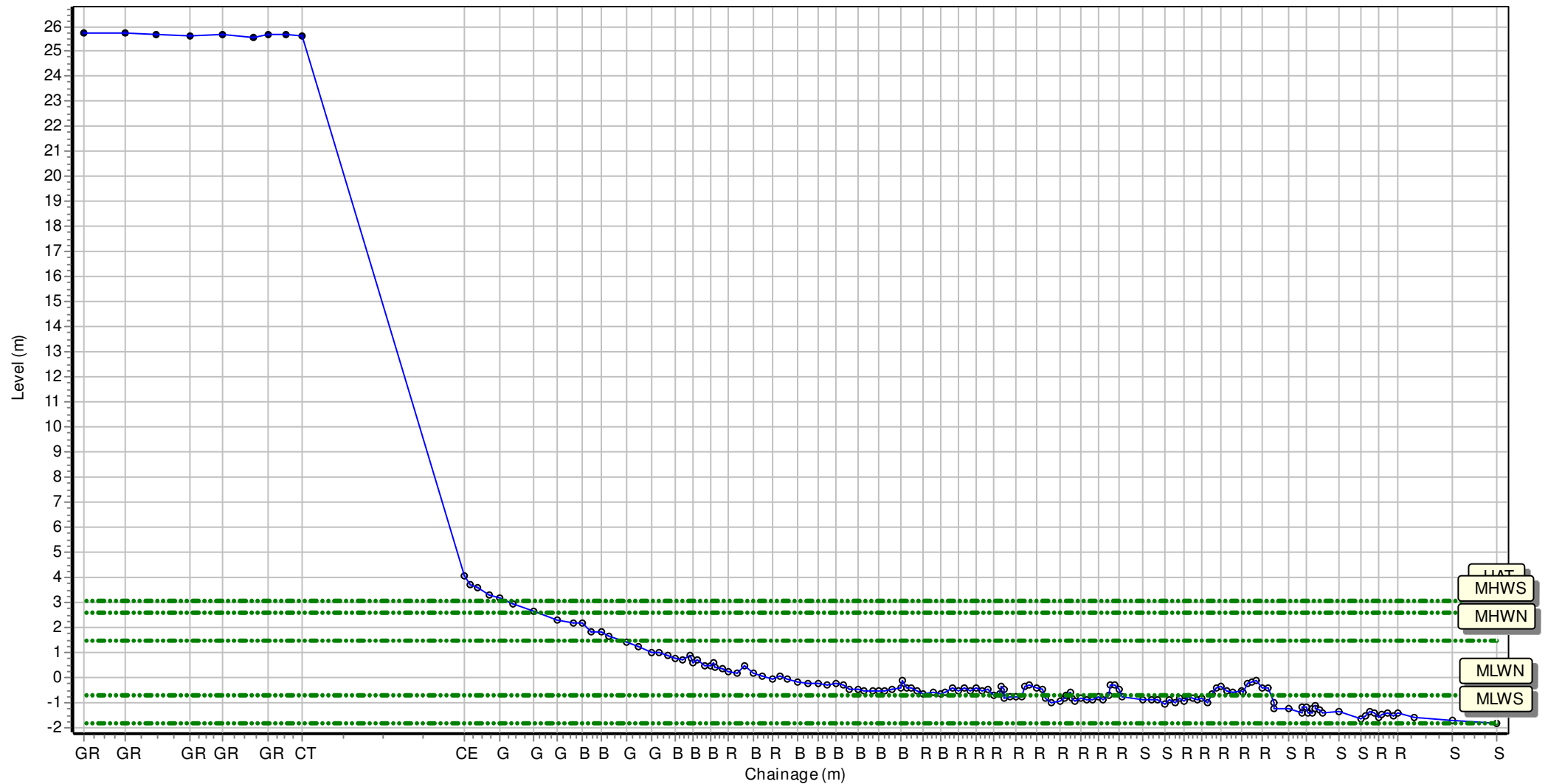
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNS21

Date: 19/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

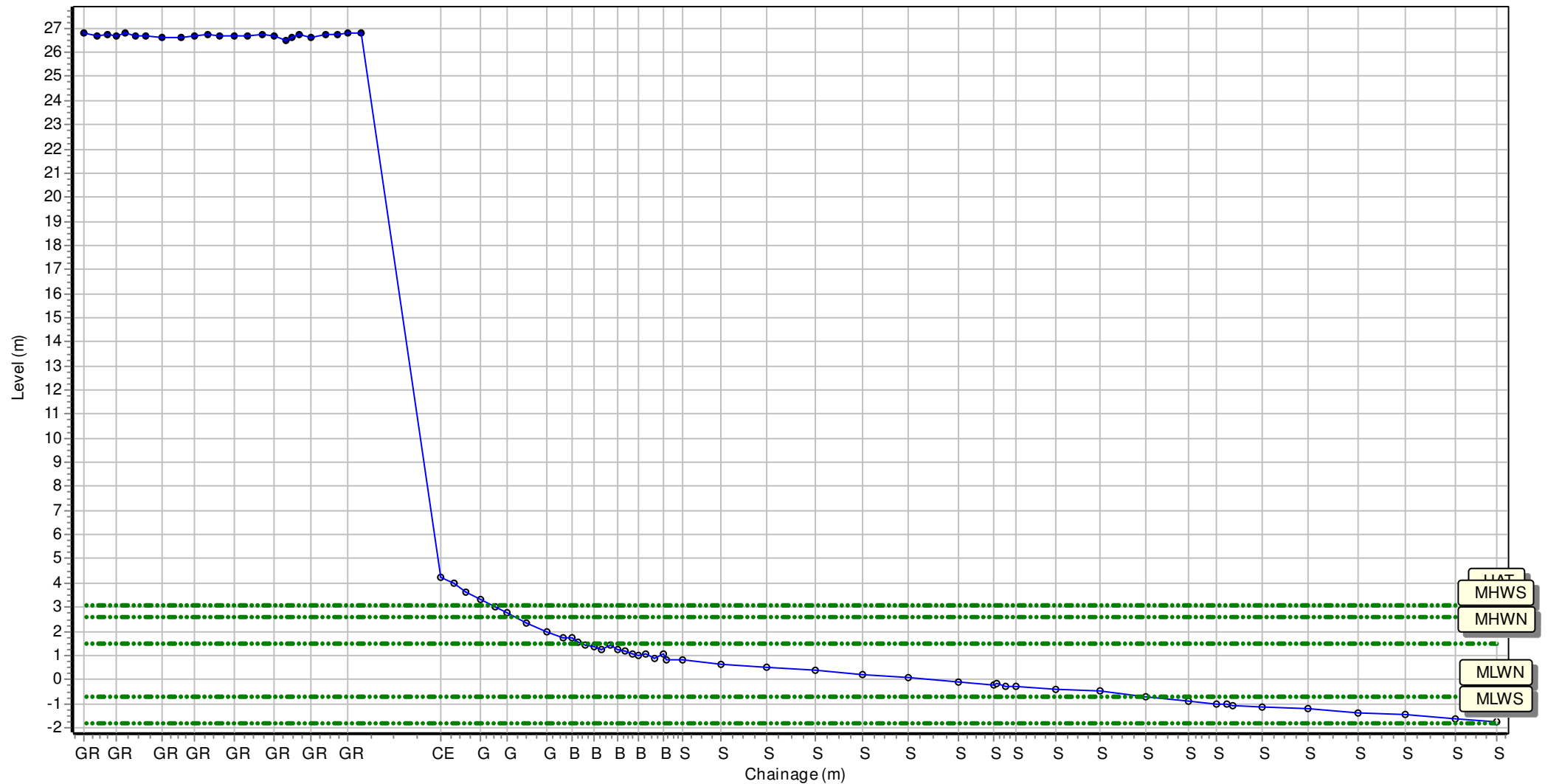
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Location: 1bSNS22

Date: 19/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

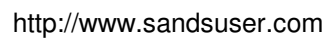
Sea State:

Visibility:

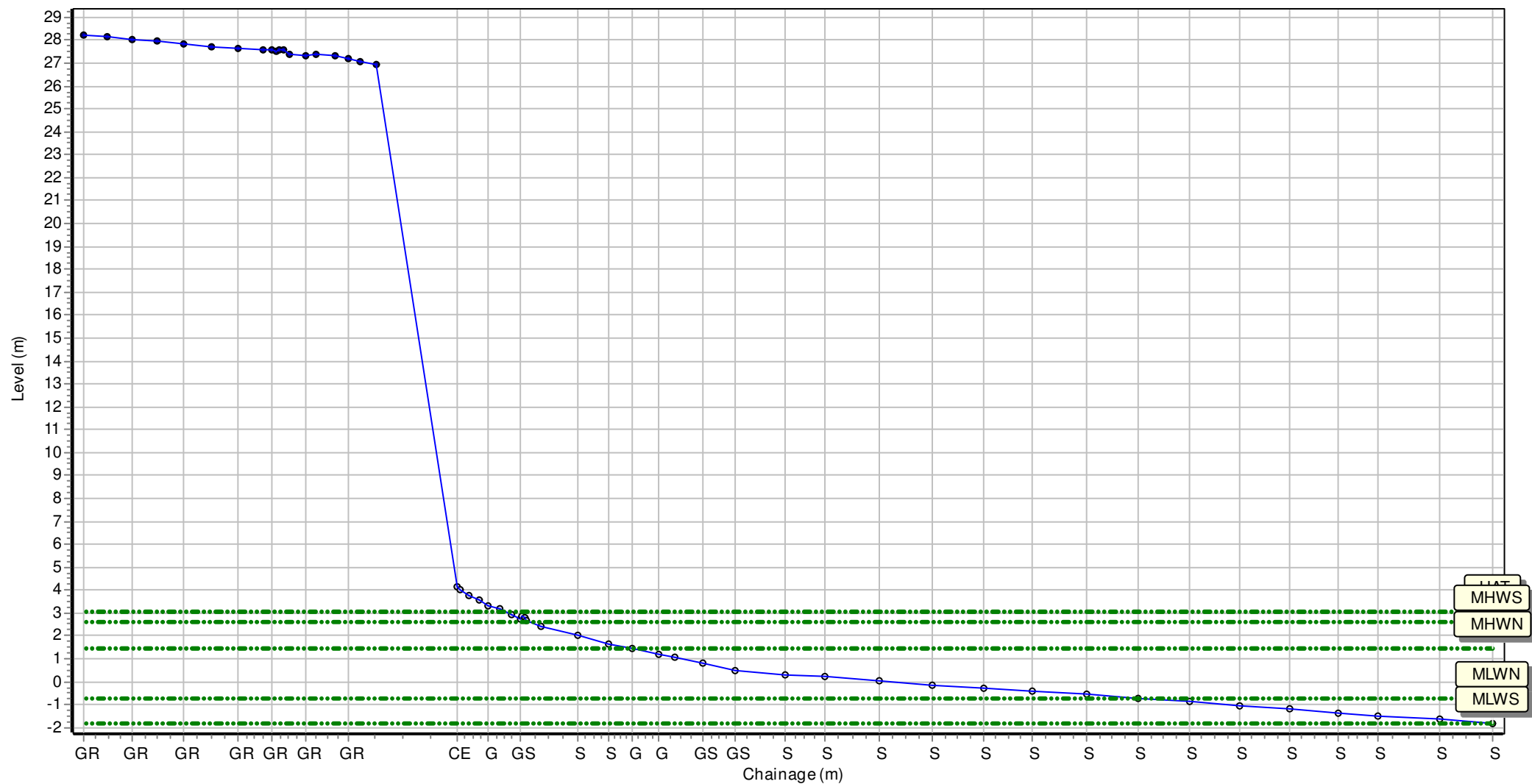
Rain:

Summary: 2021 Full Measures Topo Survey

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



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



Beach Profile

Location: 1bSNS24

Date: 19/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

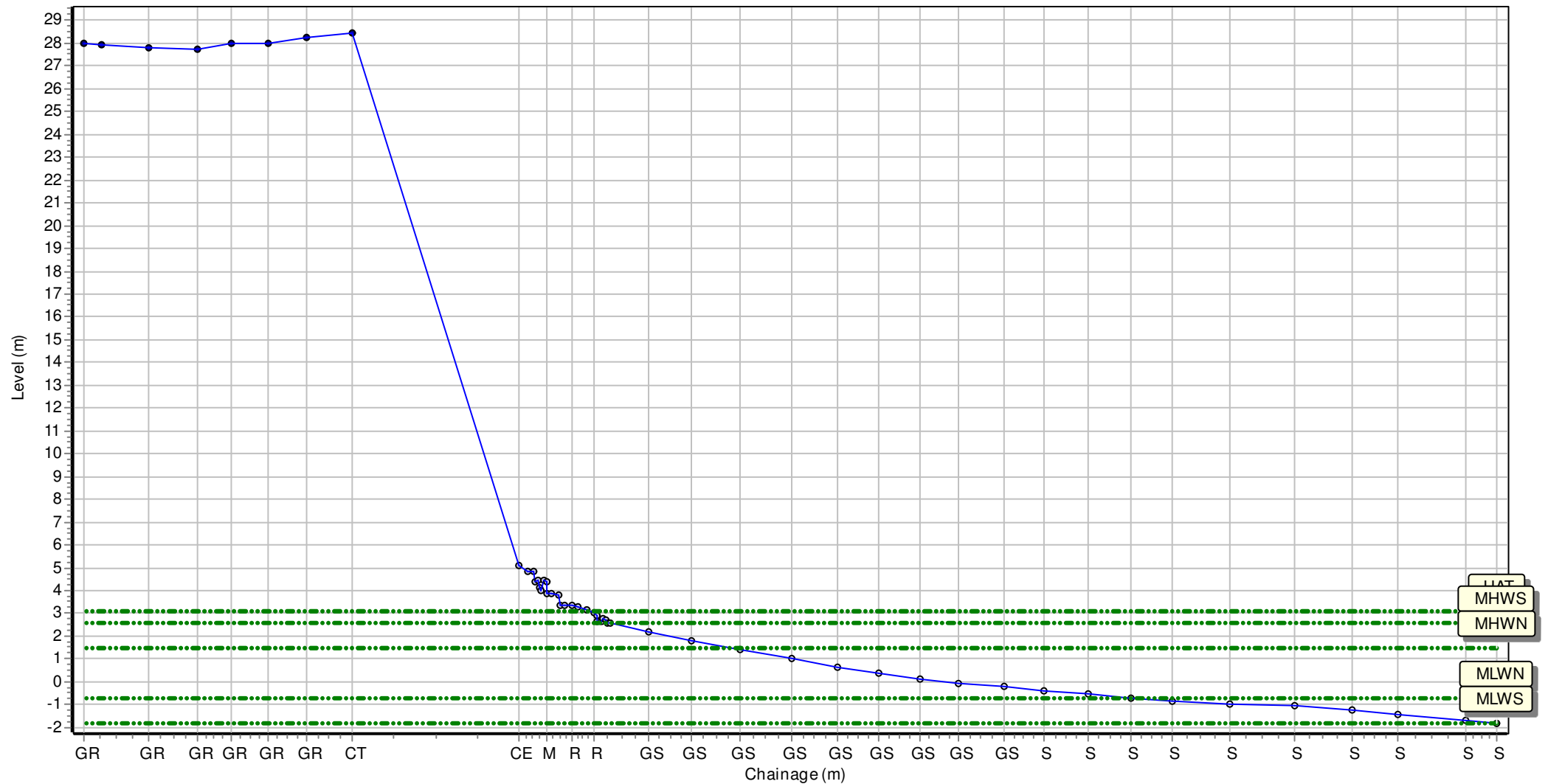
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNS25

Date: 19/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

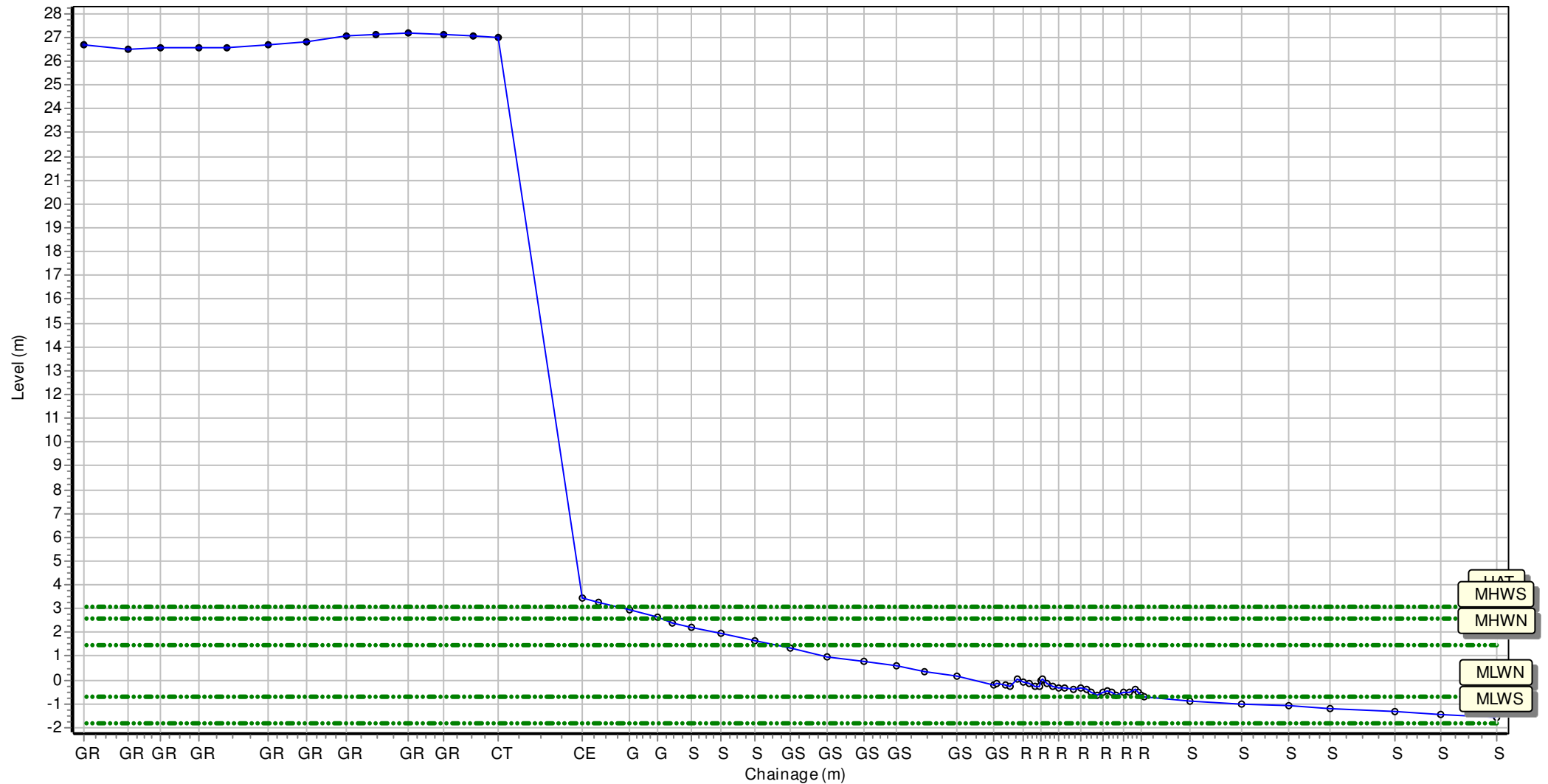
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNS27

Date: 19/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

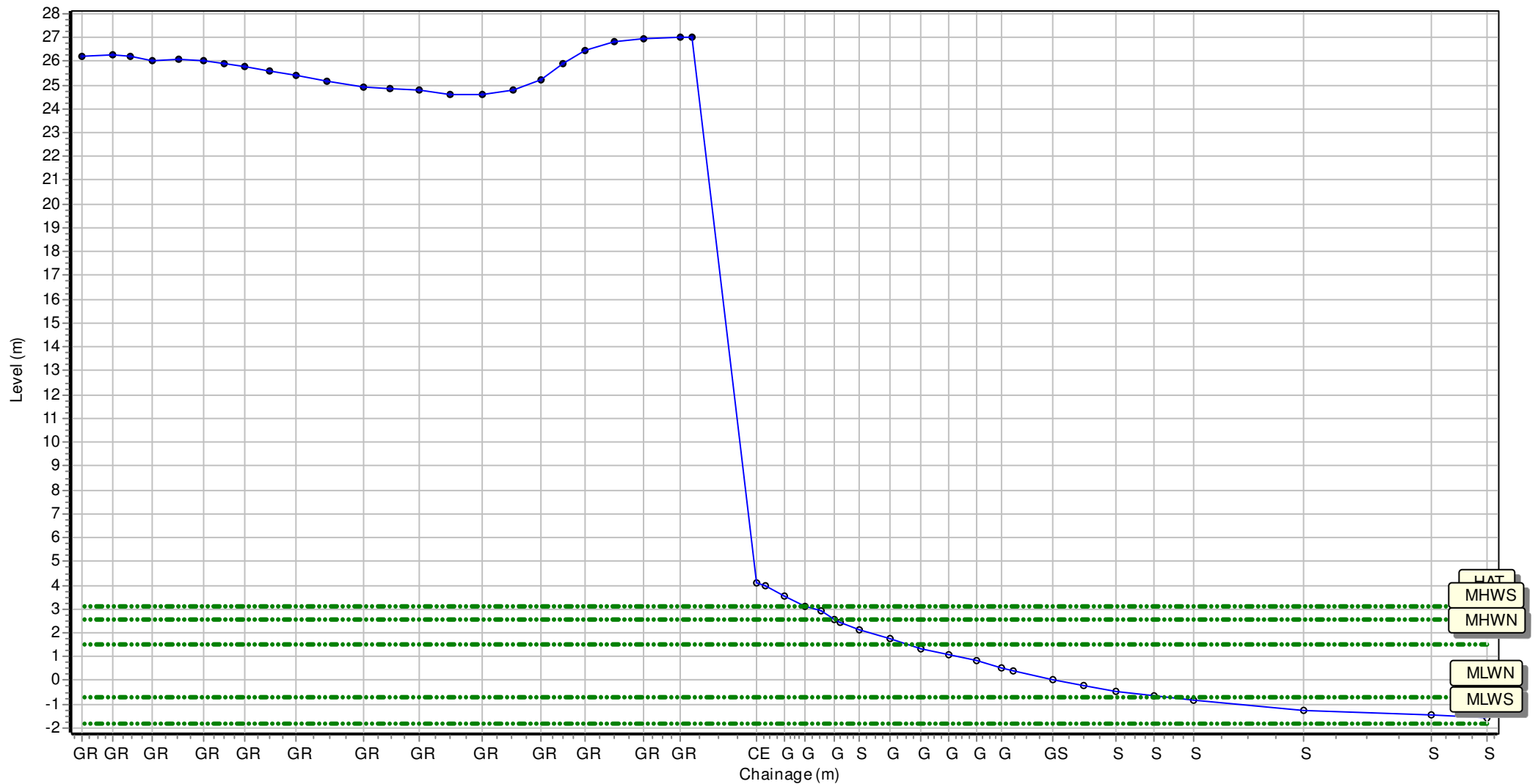
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNS29

Date: 19/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

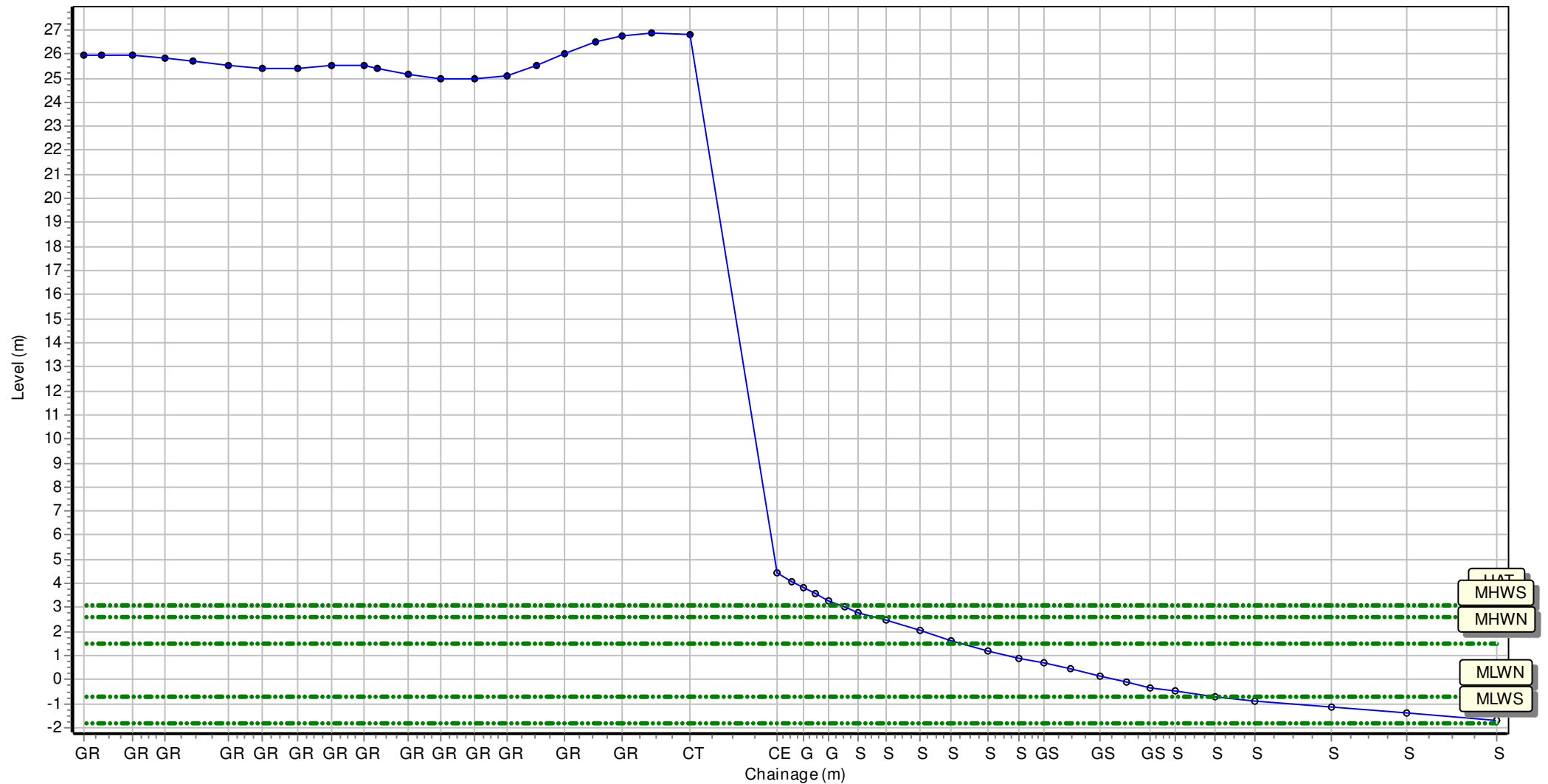
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNS30

Date: 19/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

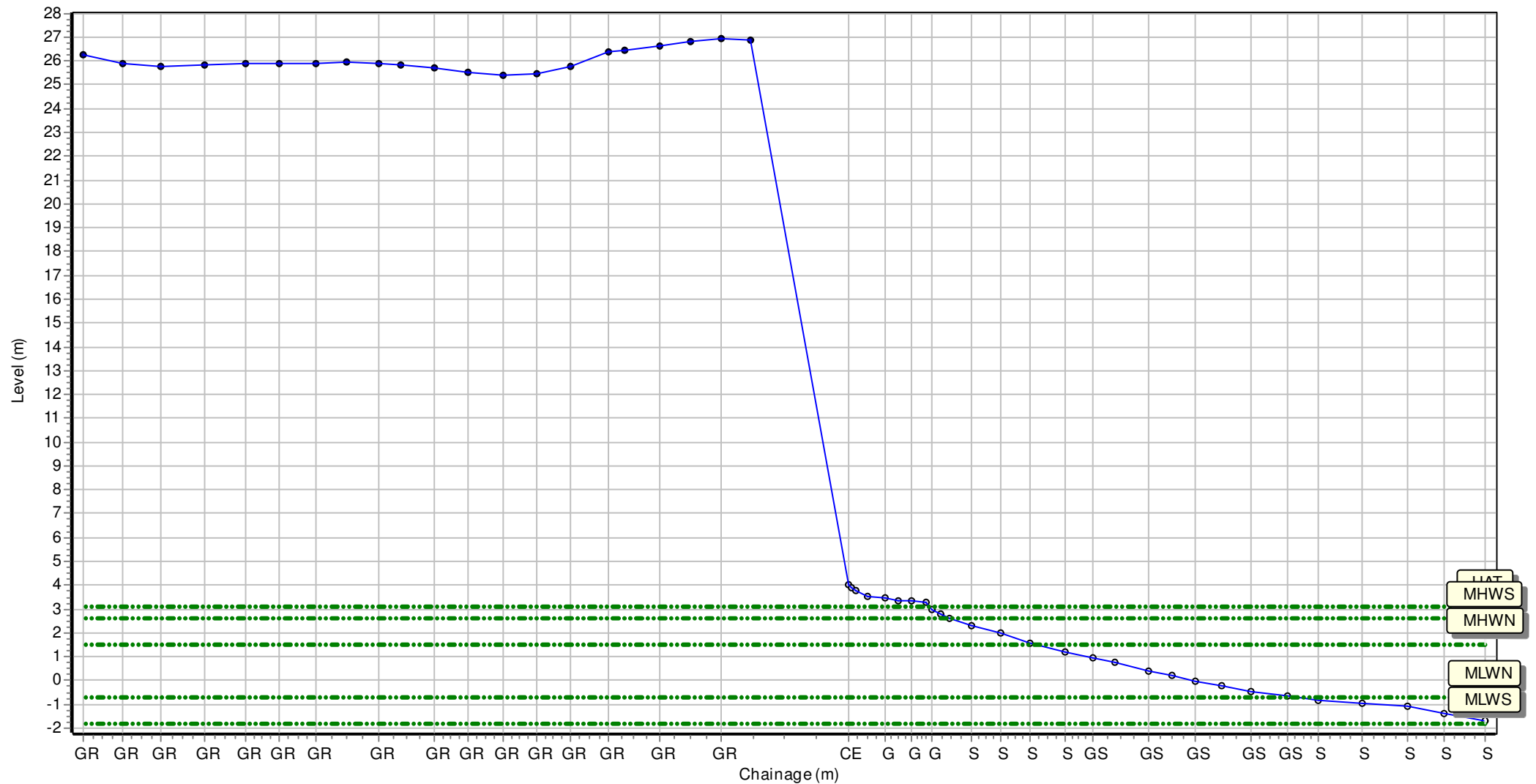
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNS31

Date: 19/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

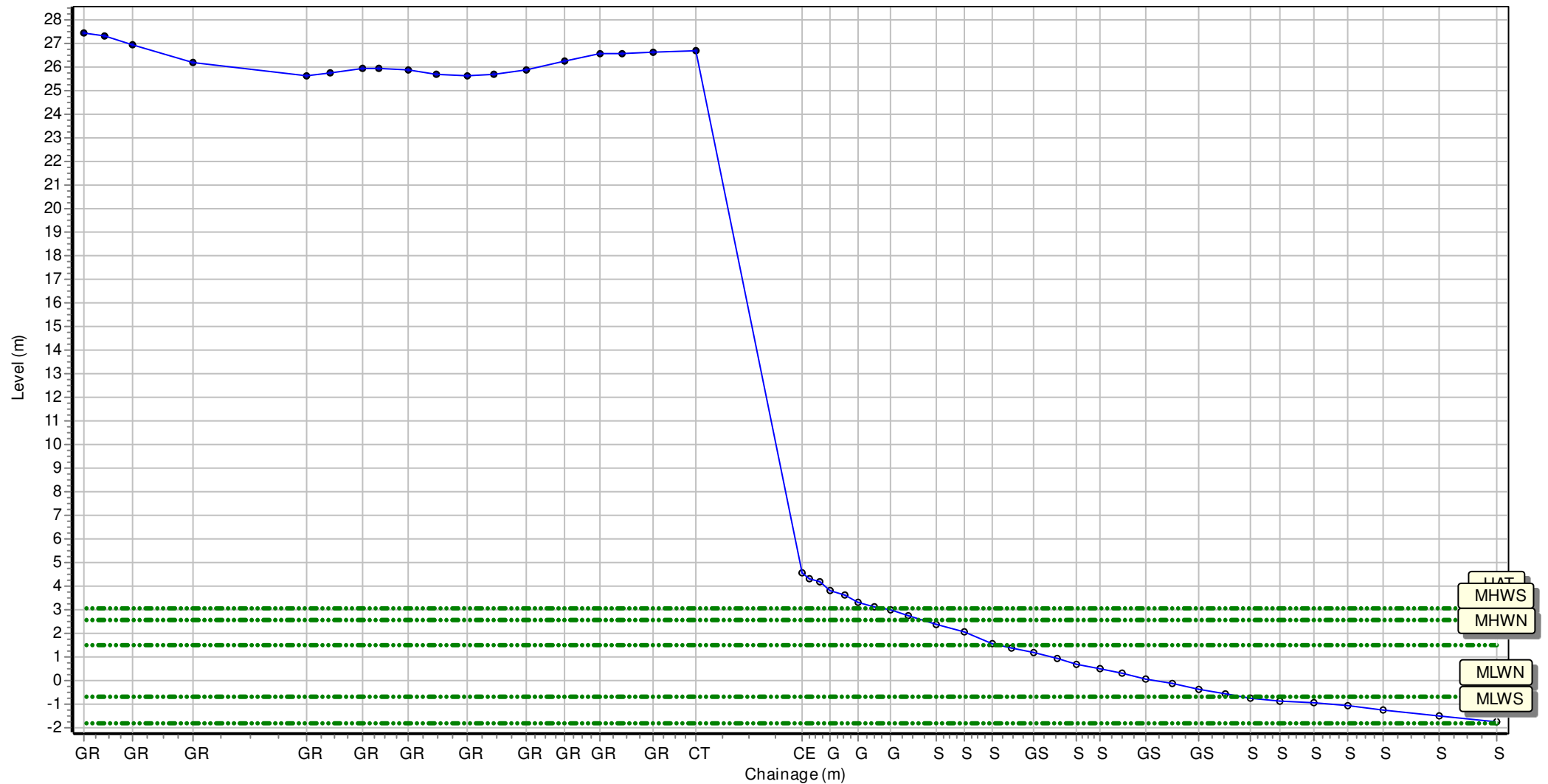
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNS32

Date: 19/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

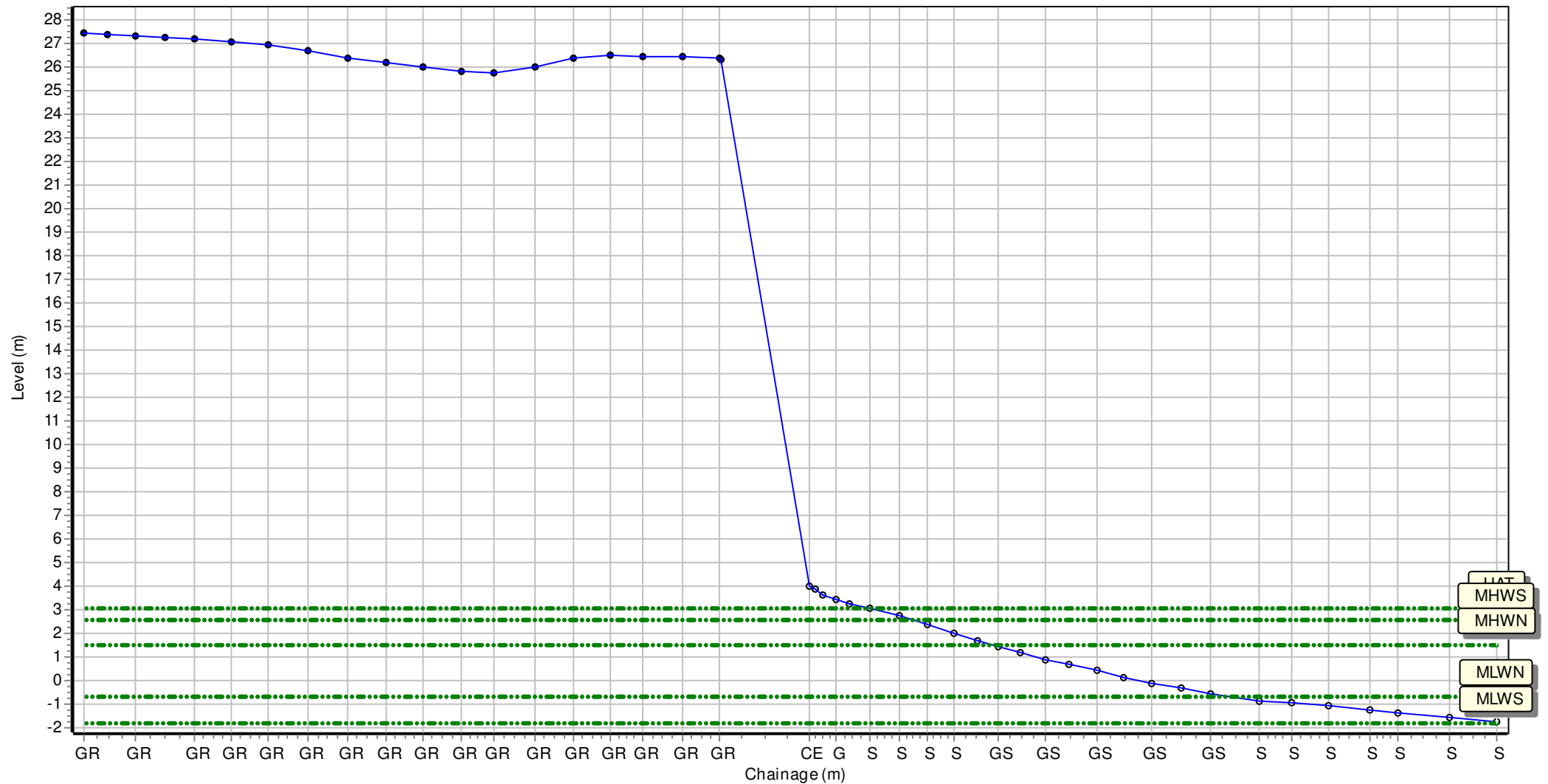
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNS33

Date: 19/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

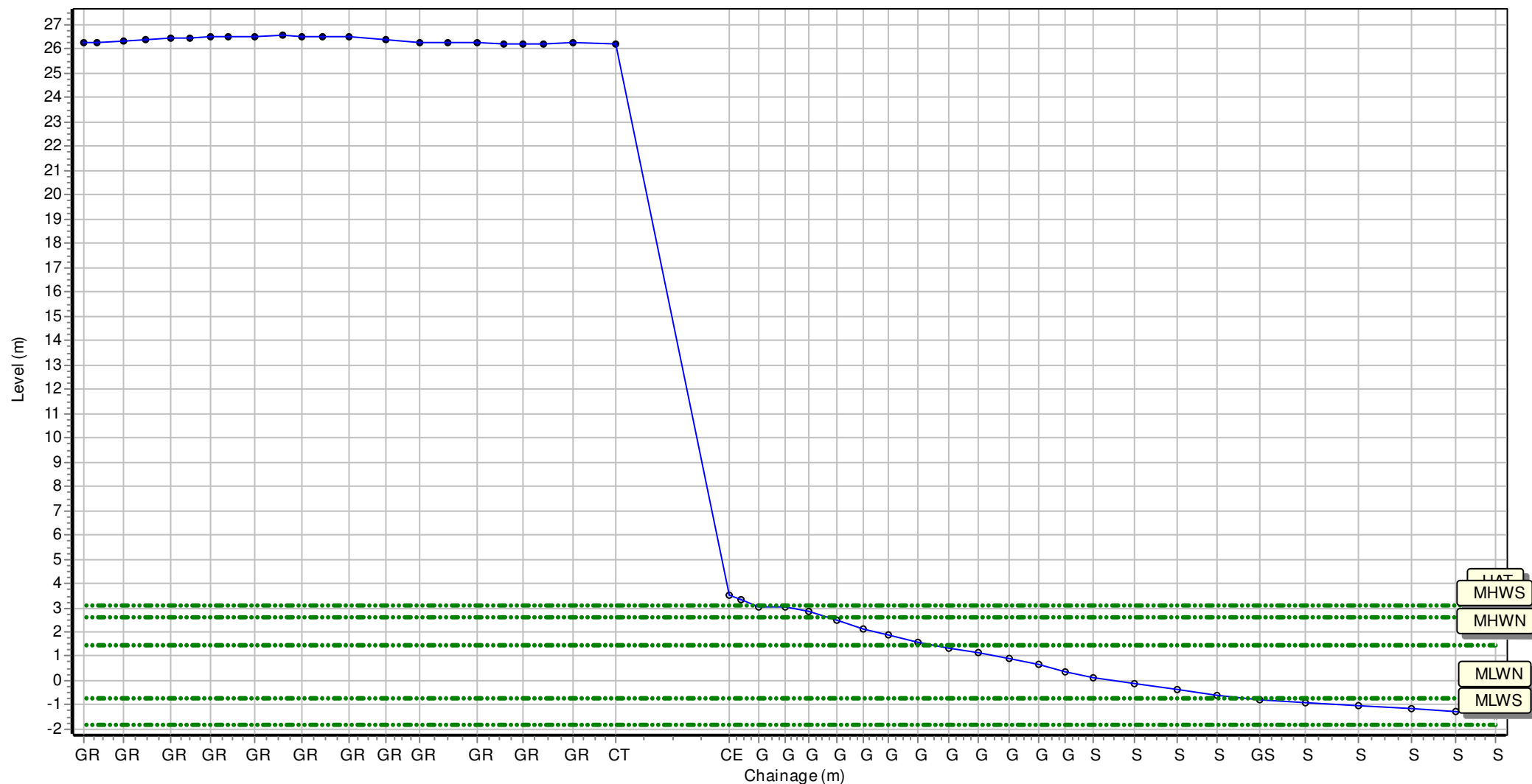
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNS34

Date: 19/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

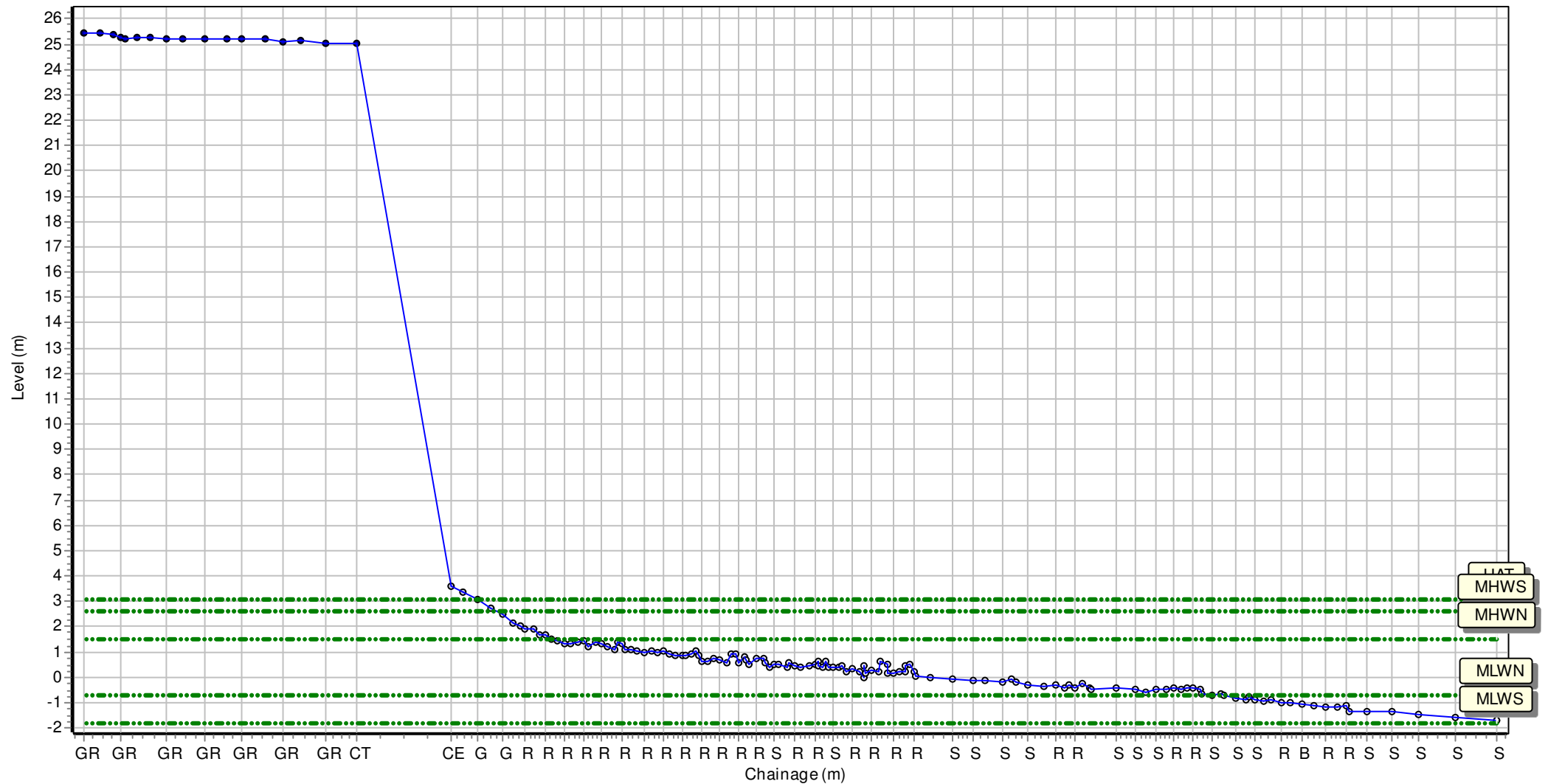
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNS35

Date: 19/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

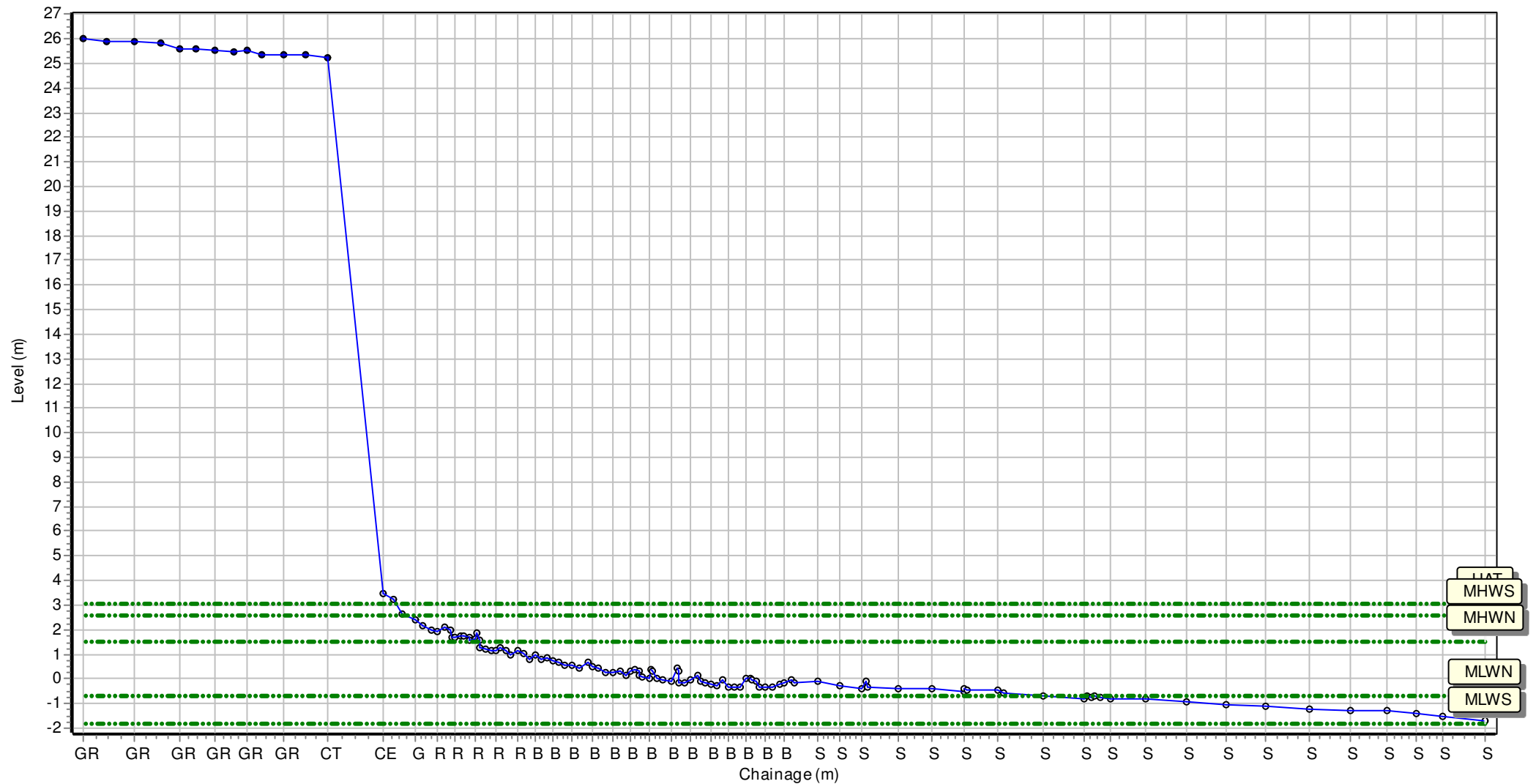
Sea State:

Visibility:

Rain:

Summary: 2021 Full Measures Topo Survey

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



Beach Profile

Location: 1bSNS36

Date: 19/11/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

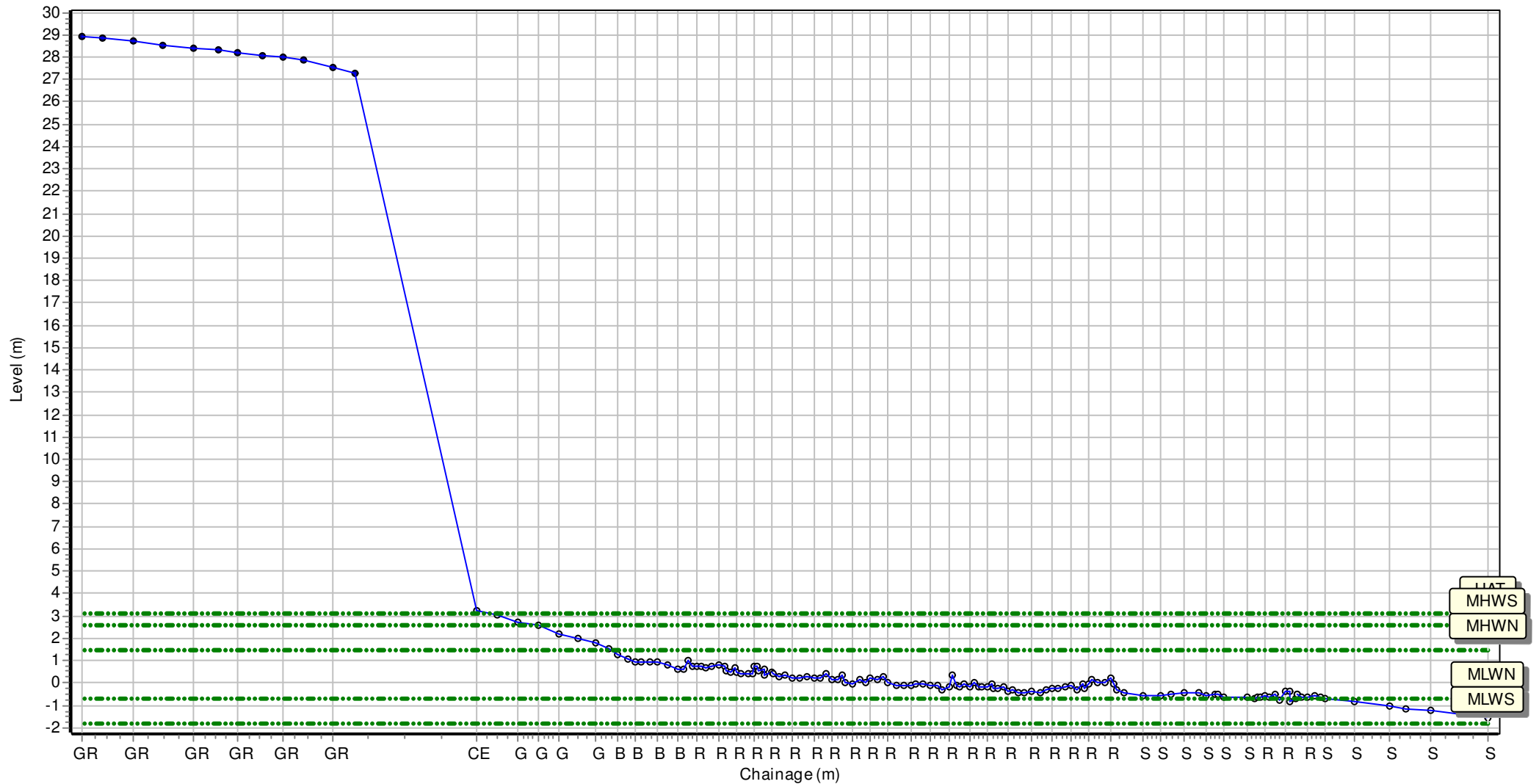
Sea State:

Visibility:

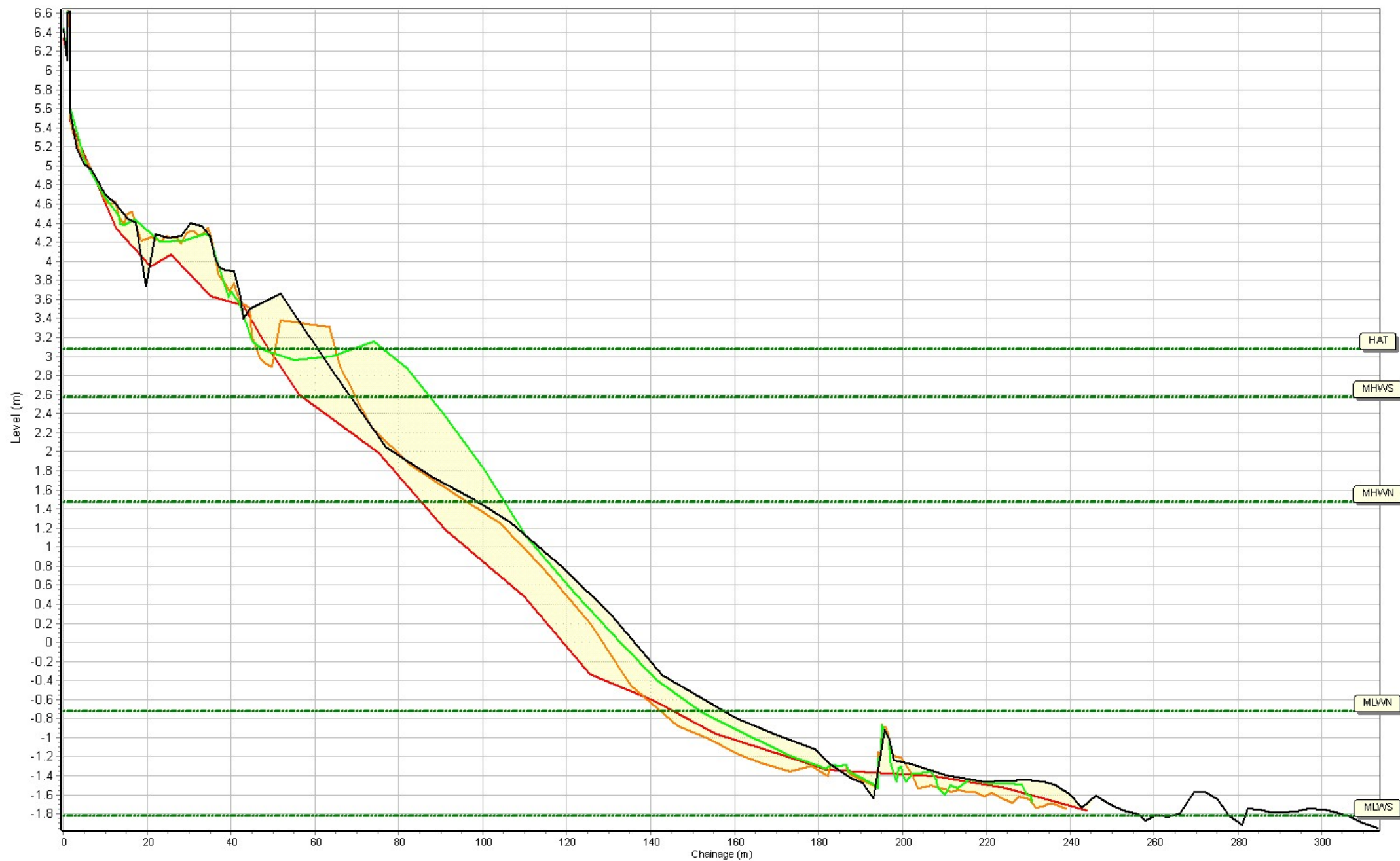
Rain:

Summary: 2021 Full Measures Topo Survey

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

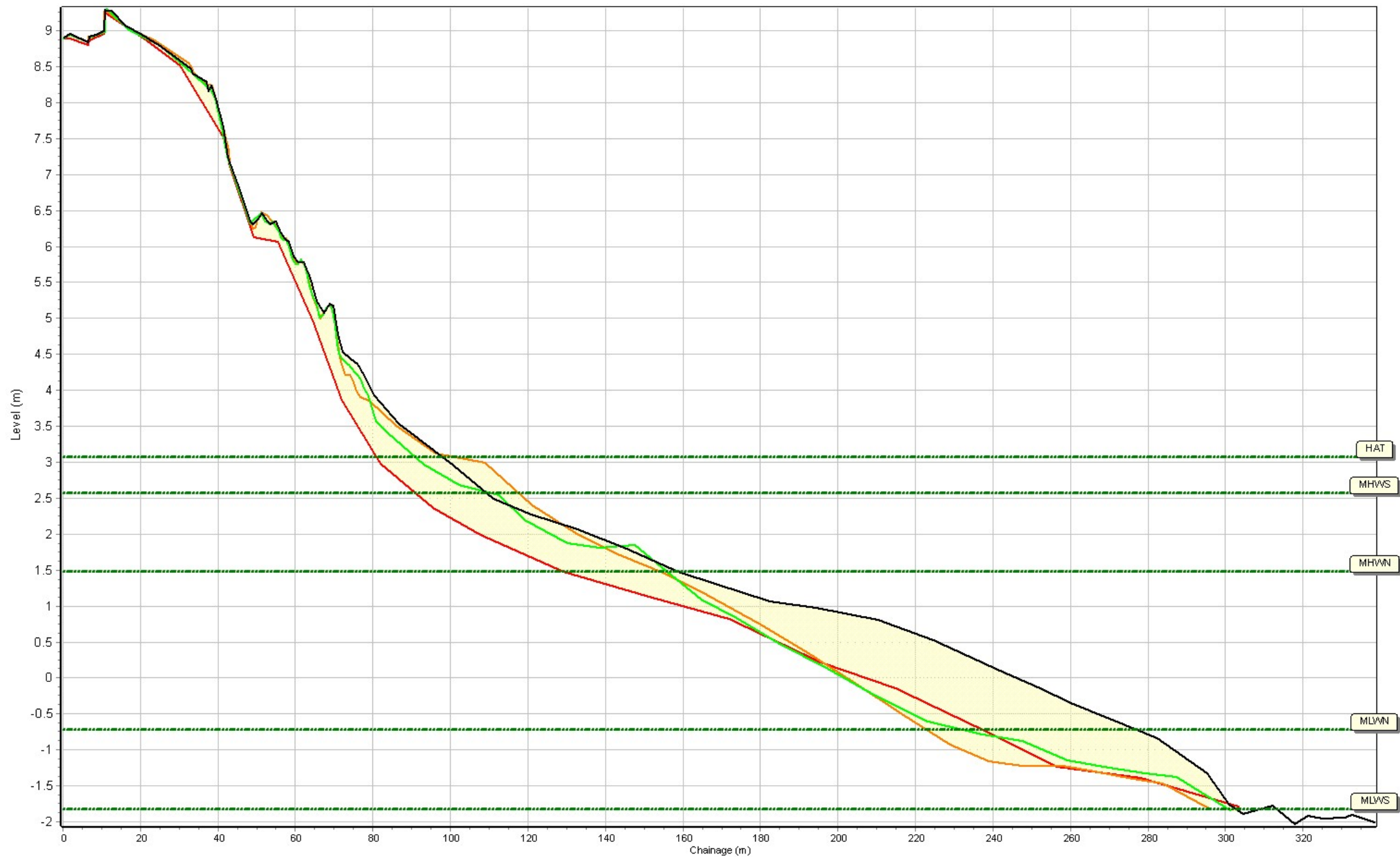


Profiles: 1bSNN1



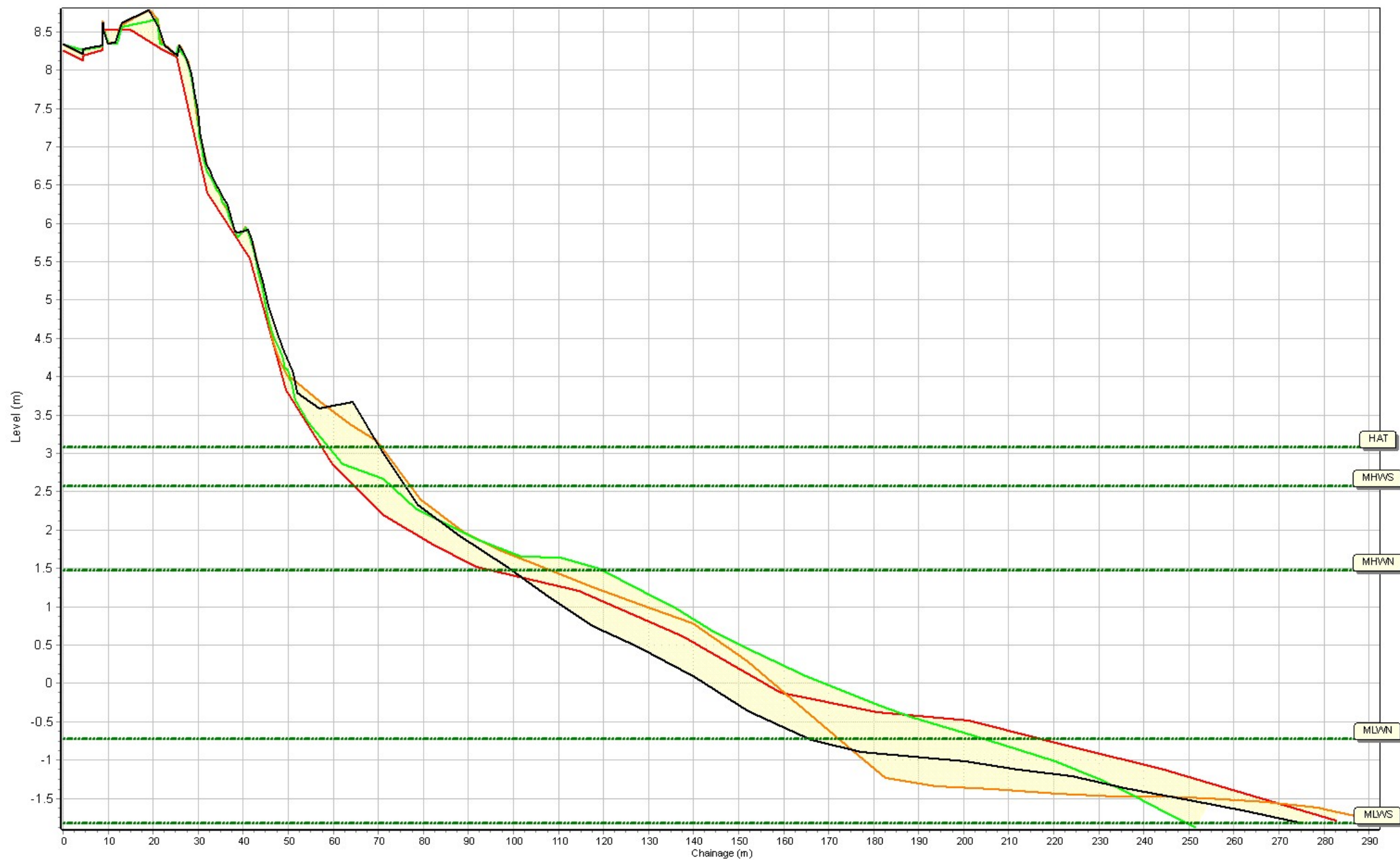
☒ Profile Envelope
 ☒ 2009-09
 ☒ 2019-11
 ☒ 2020-09
 ☒ 2021-11

Profiles: 1bSNN2



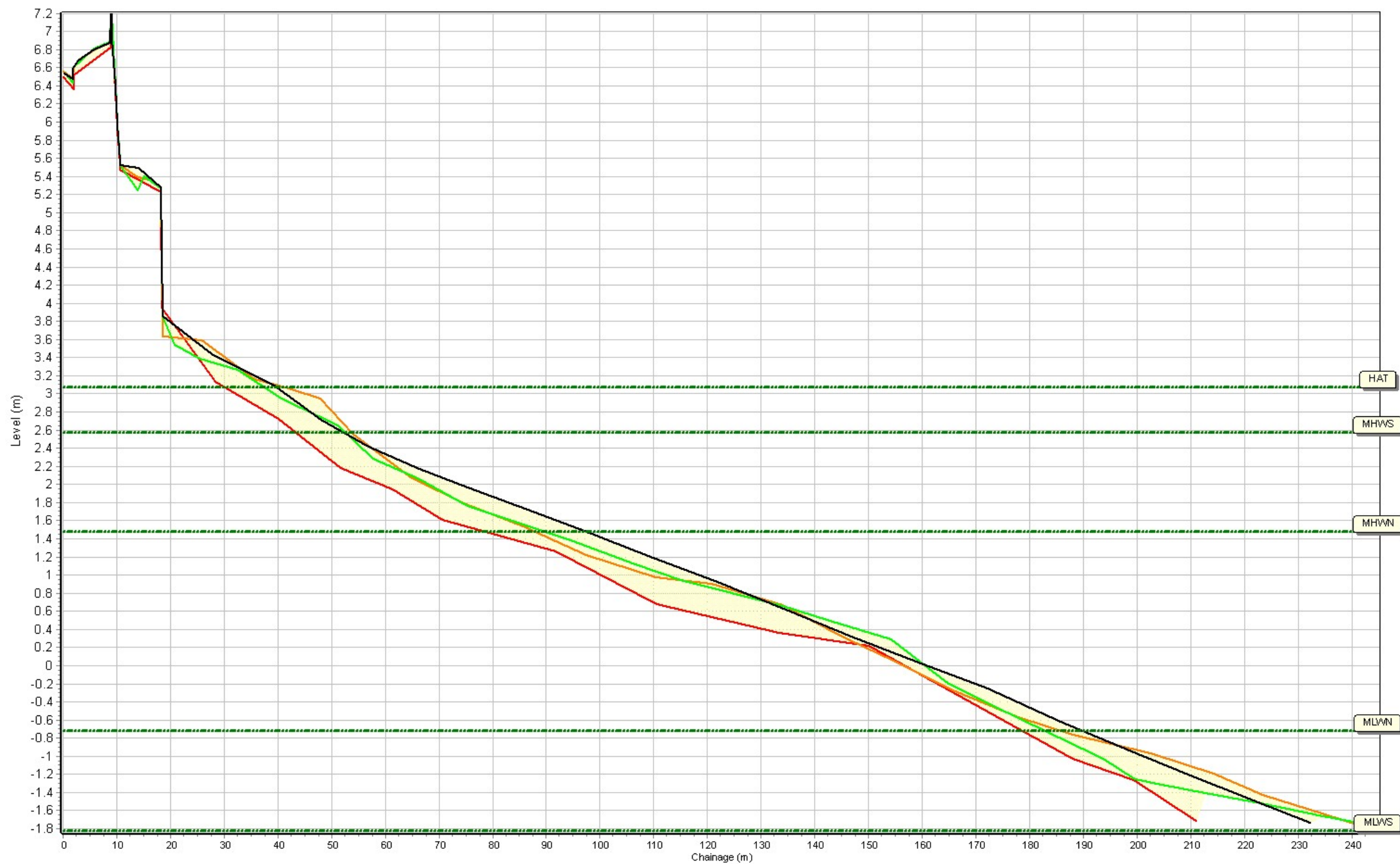
☒ Profile Envelope
 ☒ 2009-09
 ☒ 2019-11
 ☒ 2020-09
 ☒ 2021-11

Profiles: 1bSNN3



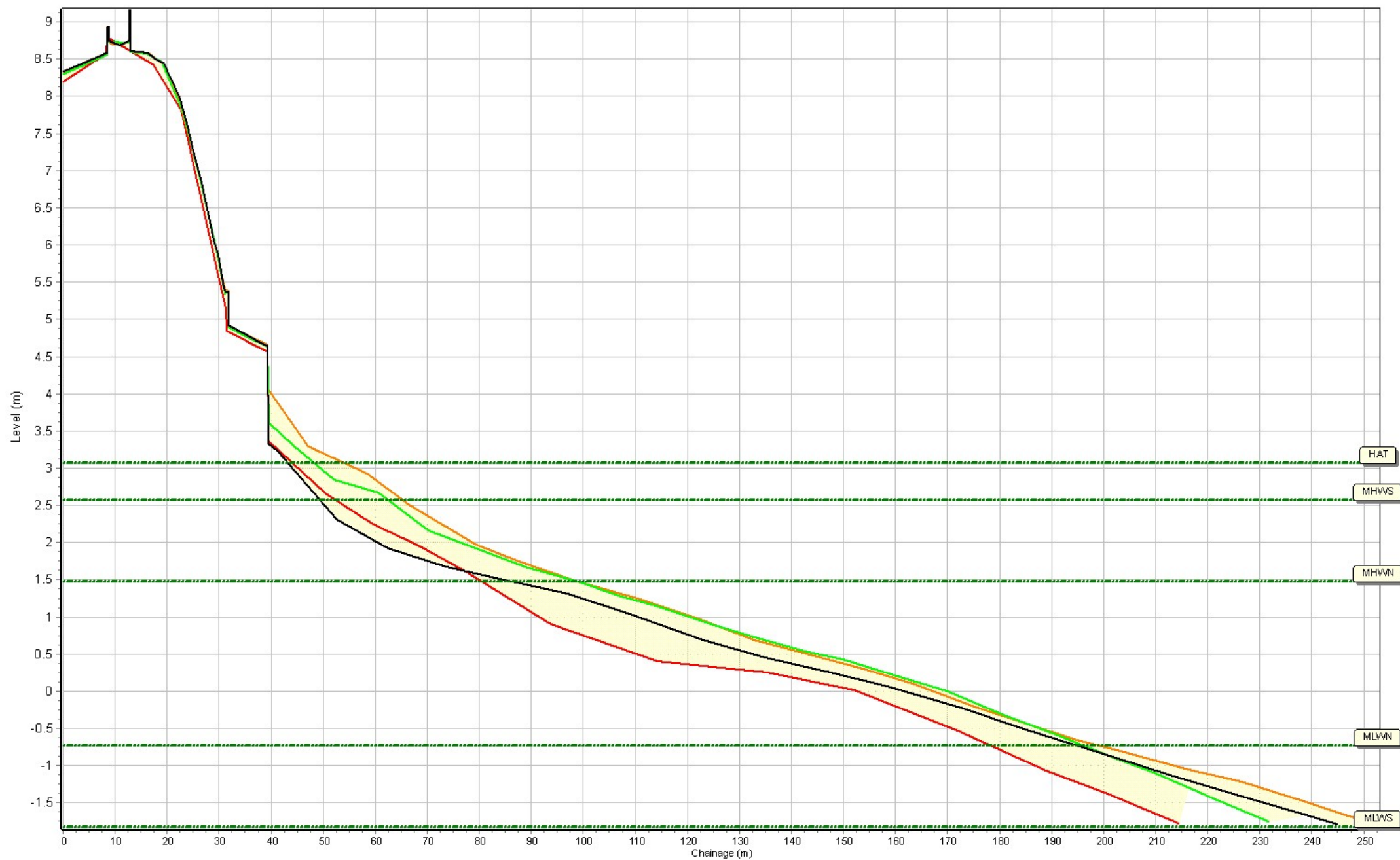
☒ Profile Envelope
 ☒ 2009-09
 ☒ 2019-11
 ☒ 2020-09
 ☒ 2021-11

Profiles: 1bSNN4



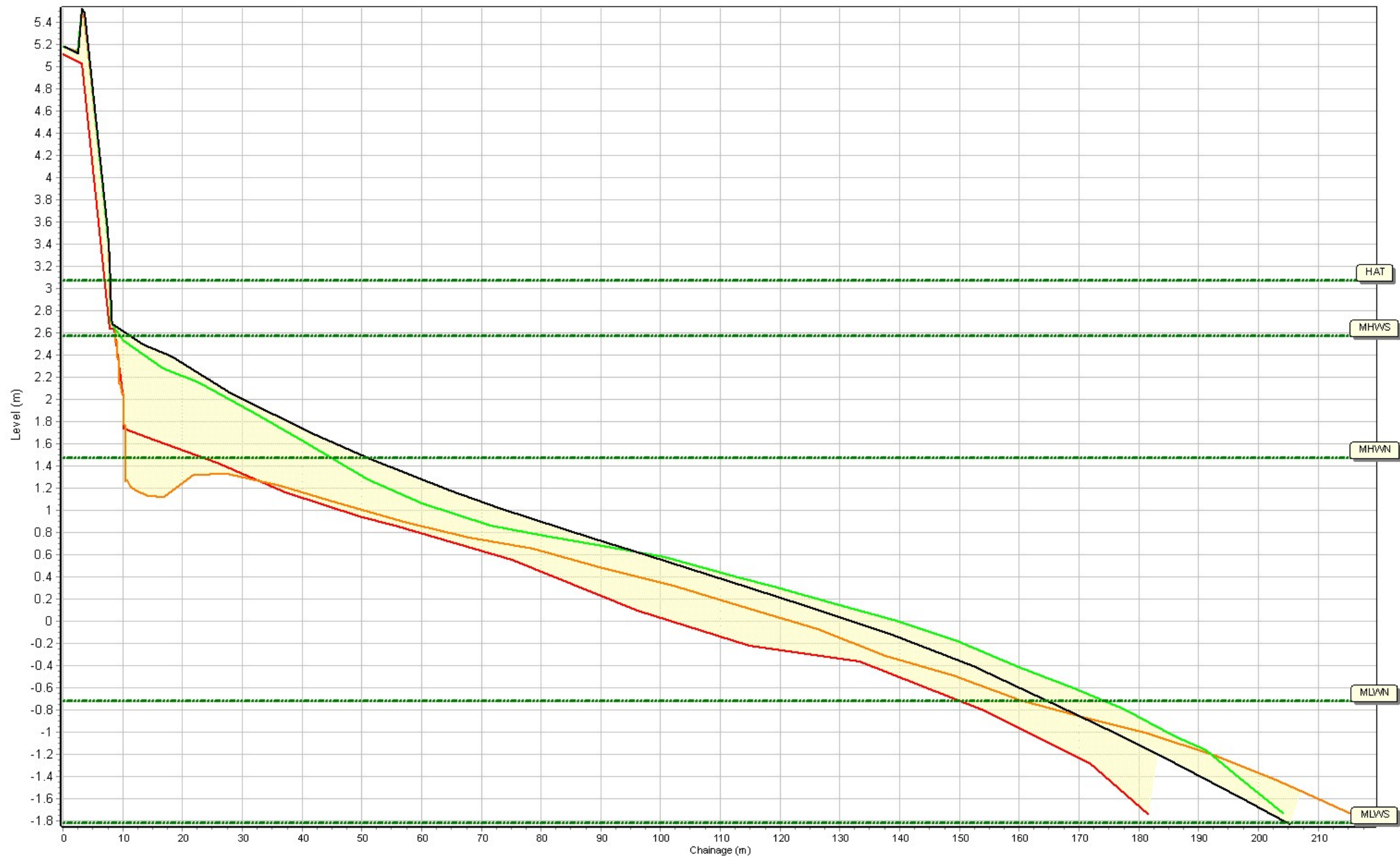
☒ Profile Envelope
 ☒ 2009-09
 ☒ 2019-11
 ☒ 2020-09
 ☒ 2021-11

Profiles: 1bSNN5



☒ Profile Envelope
 ☒ 2009-09
 ☒ 2019-11
 ☒ 2020-09
 ☒ 2021-11

Profiles: 1bSNN6



☒ Profile Envelope
 ☒ 2009-09
 ☒ 2019-11
 ☒ 2020-09
 ☒ 2021-11

Profiles: 1bSNN7



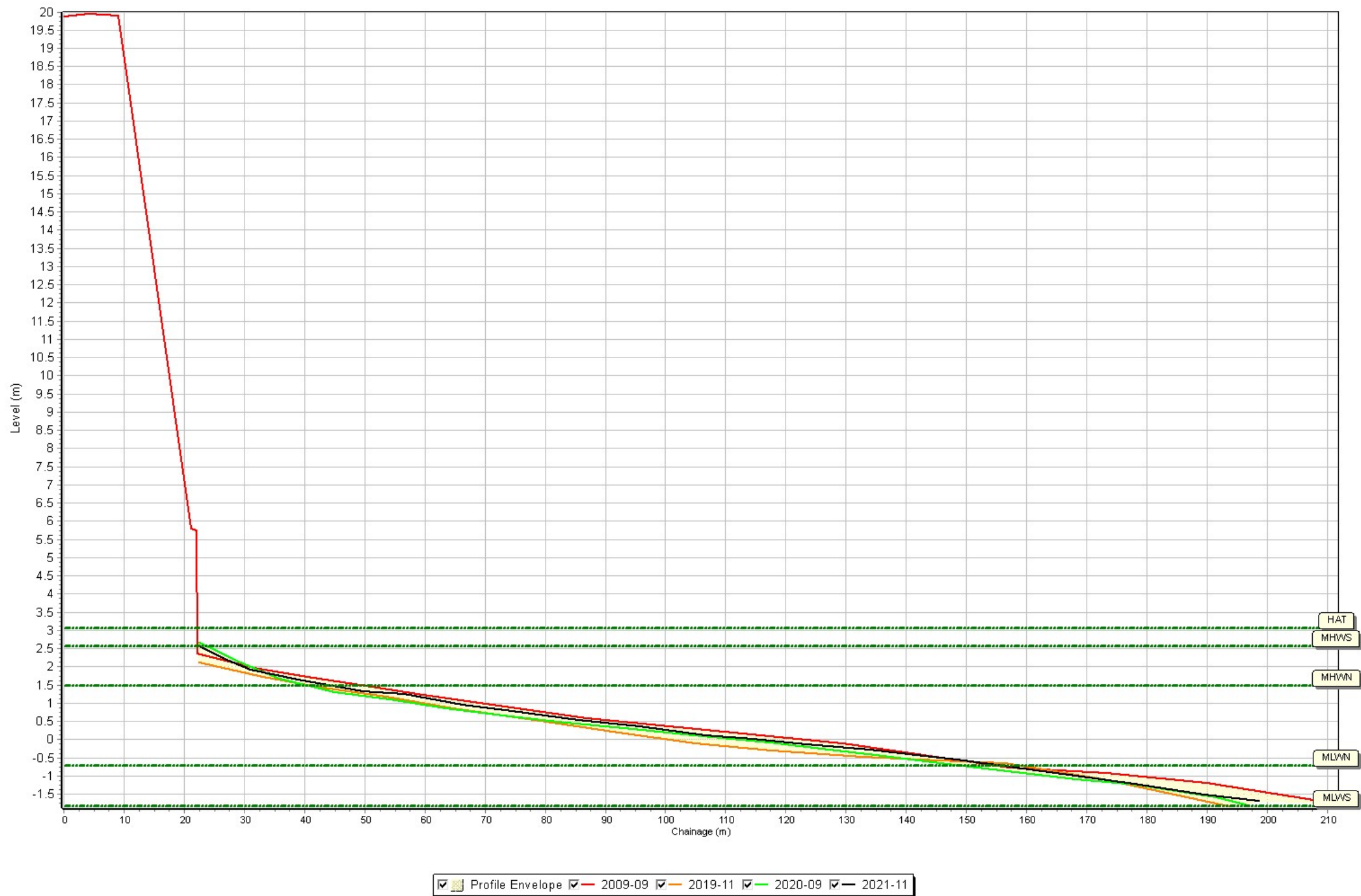
☒ Profile Envelope
 ☒ 2009-09
 ☒ 2019-11
 ☒ 2020-09
 ☒ 2021-11

Profiles: 1bSNN8

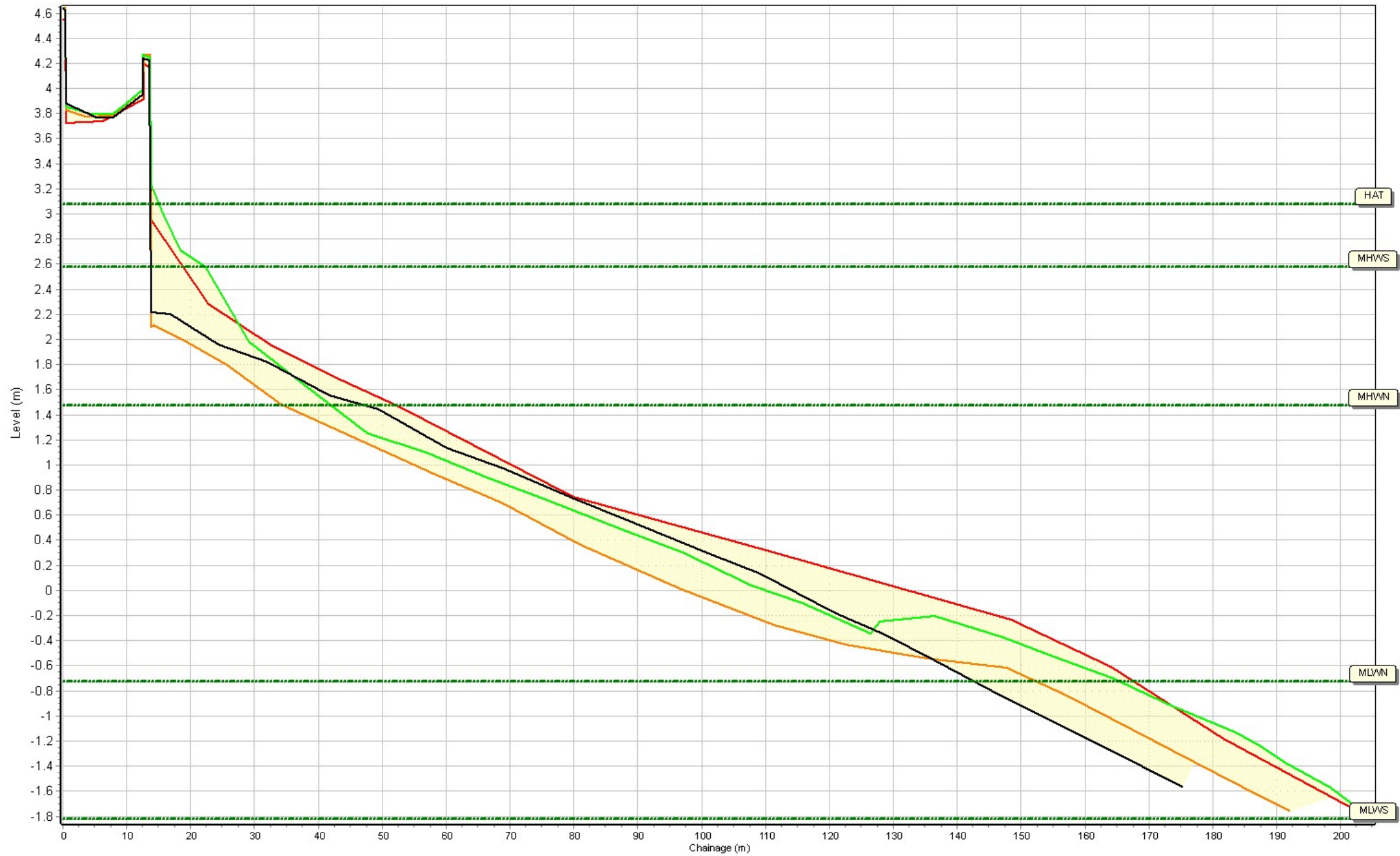


☒ Profile Envelope
 ☒ 2009-09
 ☒ 2019-11
 ☒ 2020-09
 ☒ 2021-11

Profiles: 1bSNN9

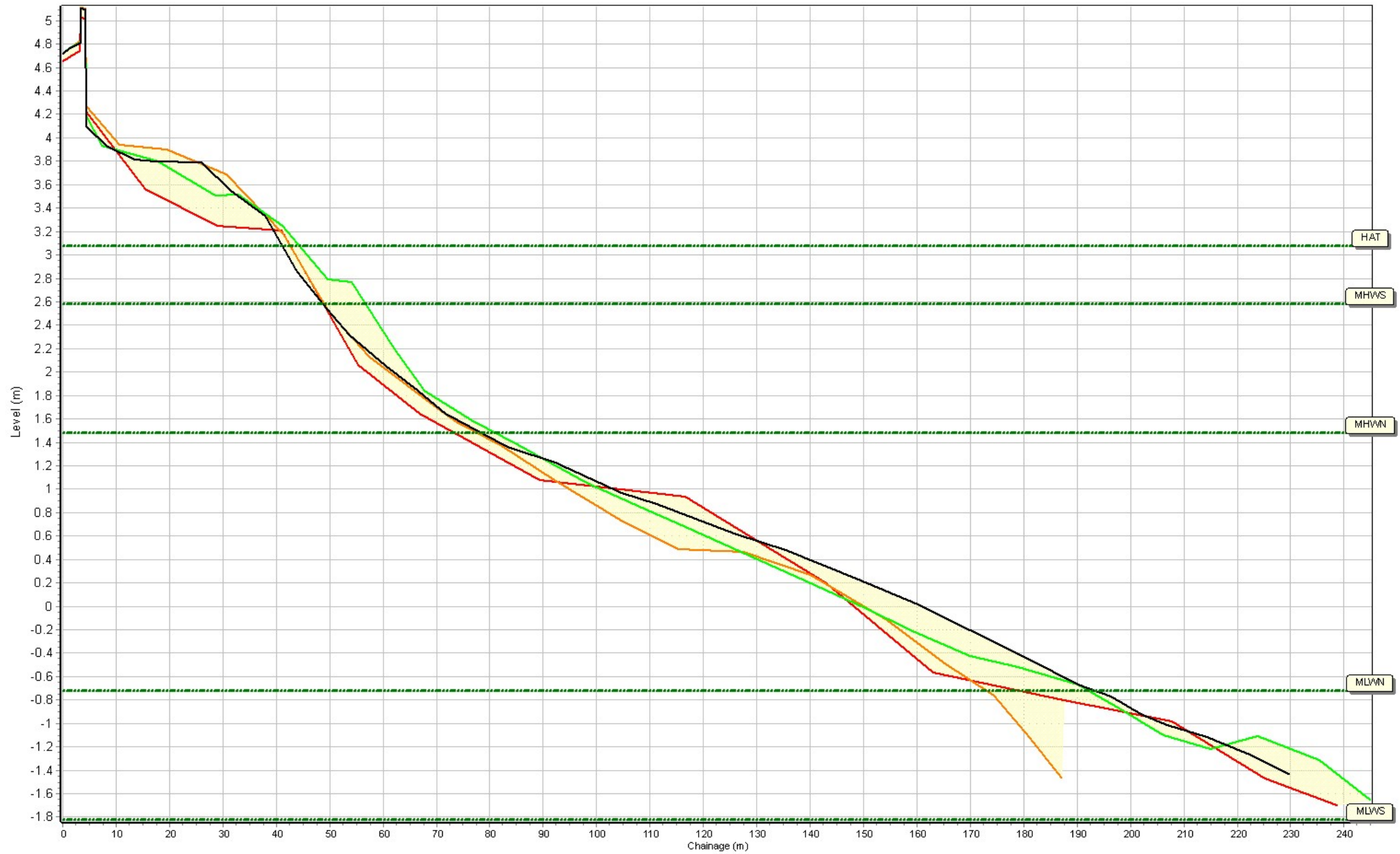


Profiles: 1bSNN10



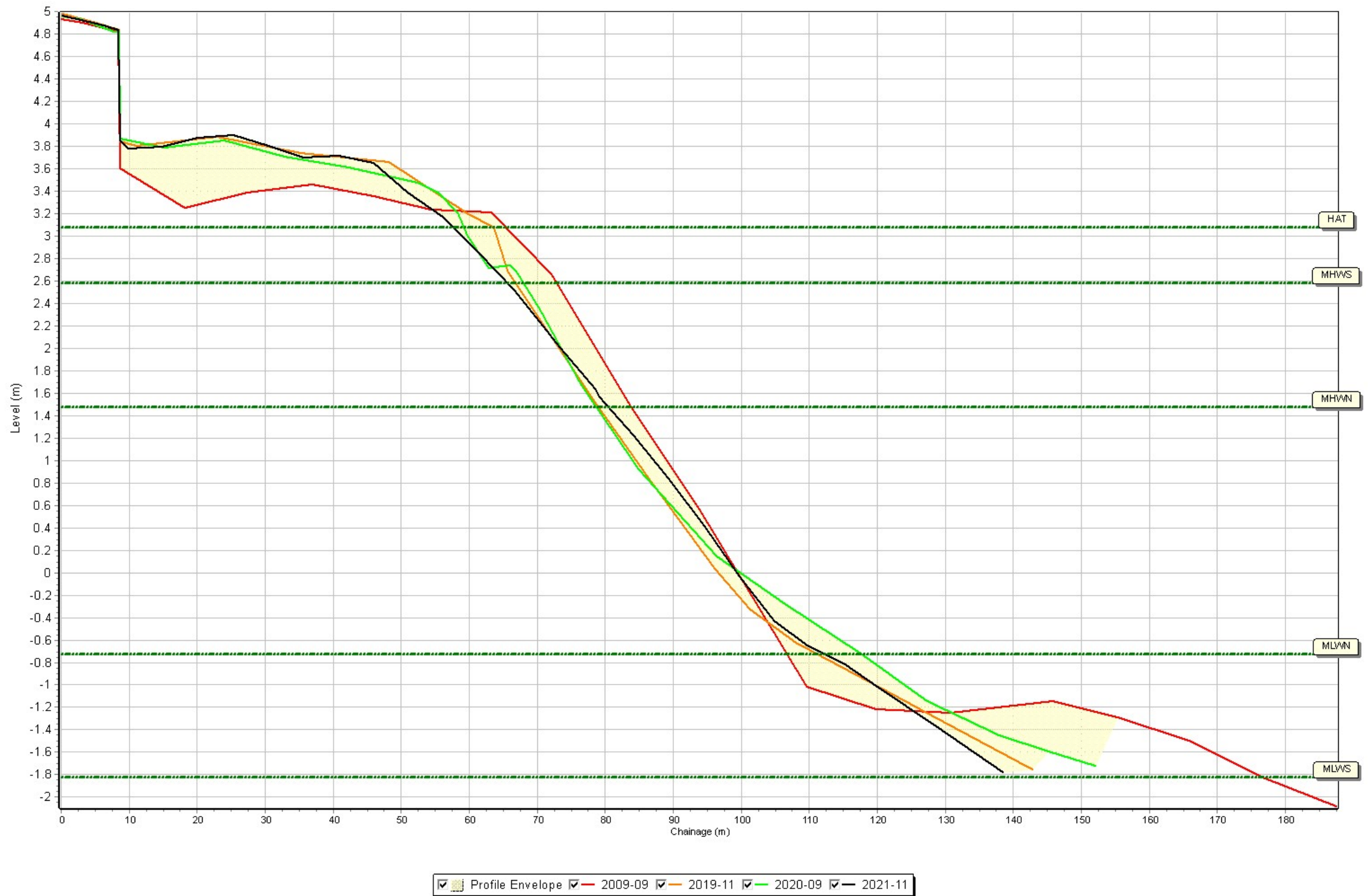
☒ Profile Envelope
 ☒ 2009-09
 ☒ 2019-11
 ☒ 2020-09
 ☒ 2021-11

Profiles: 1bSNN11



☒ Profile Envelope
 ☒ 2009-09
 ☒ 2019-11
 ☒ 2020-09
 ☒ 2021-11

Profiles: 1bSNN12



Profiles: 1bSNN13



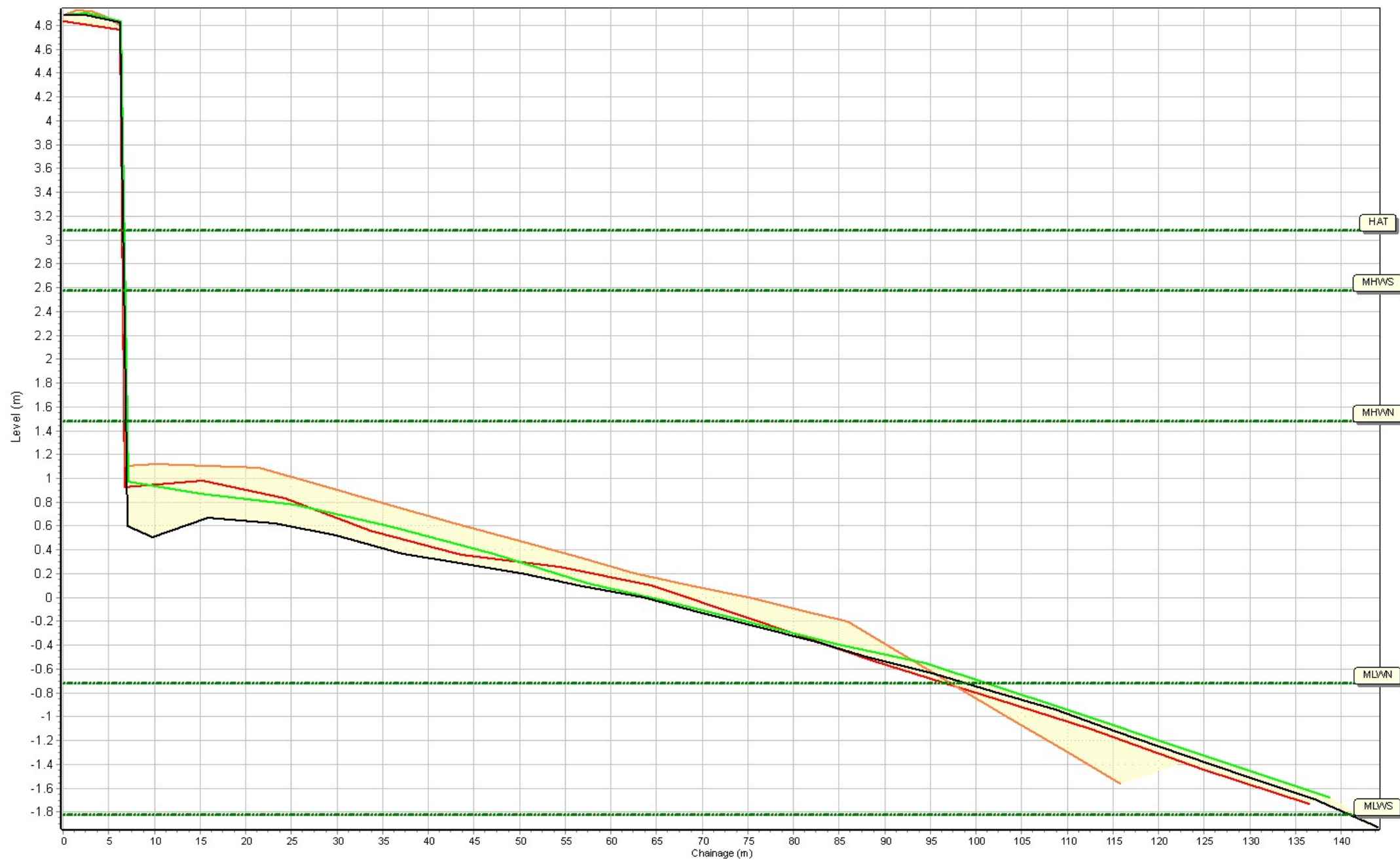
☒ Profile Envelope
 ☒ 2009-09
 ☒ 2019-11
 ☒ 2020-09
 ☒ 2021-11

Profiles: 1bSNC1



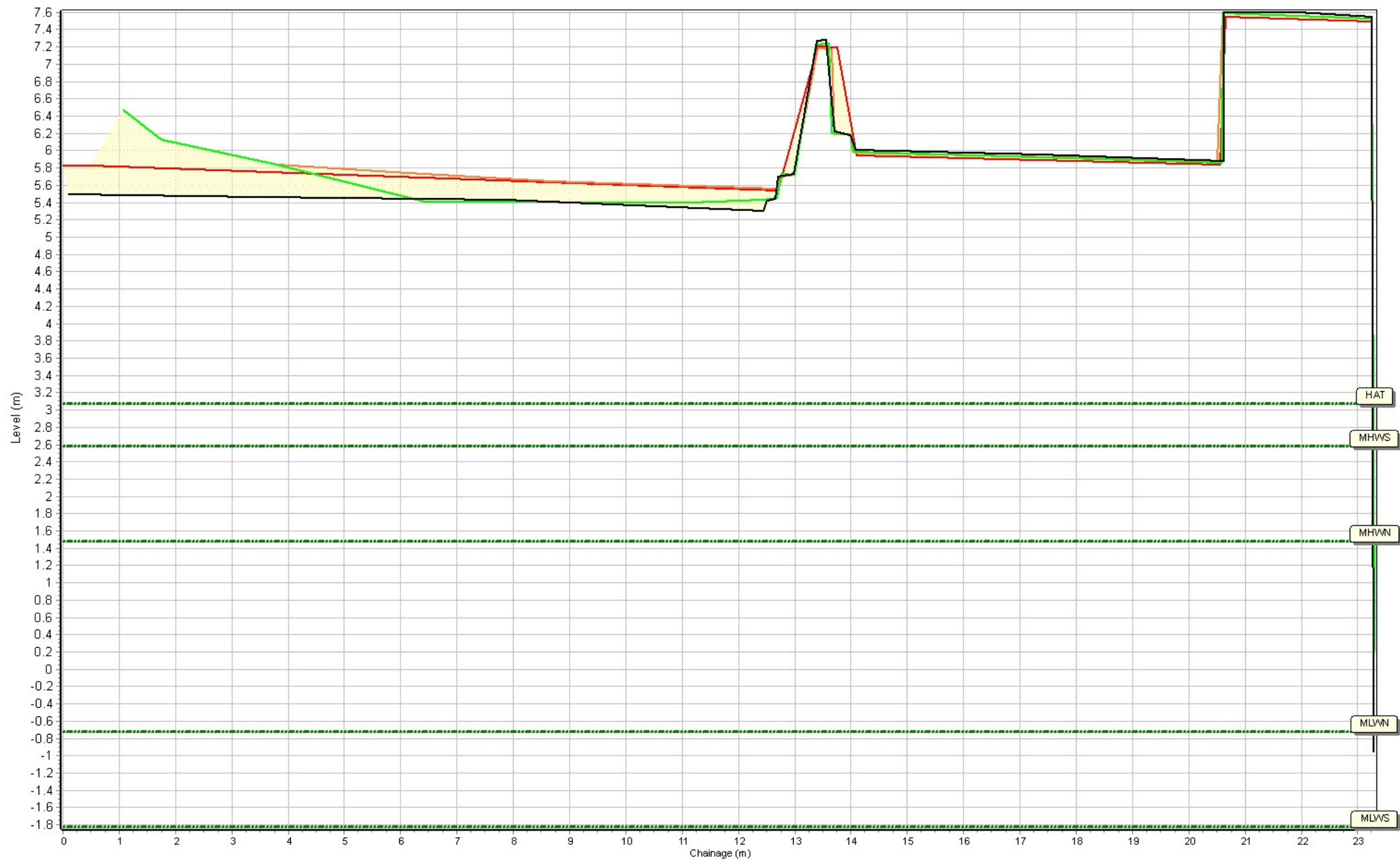
☒ Profile Envelope
 ☒ 2009-10
 ☒ 2019-09
 ☒ 2020-09
 ☒ 2021-11

Profiles: 1bSNC2



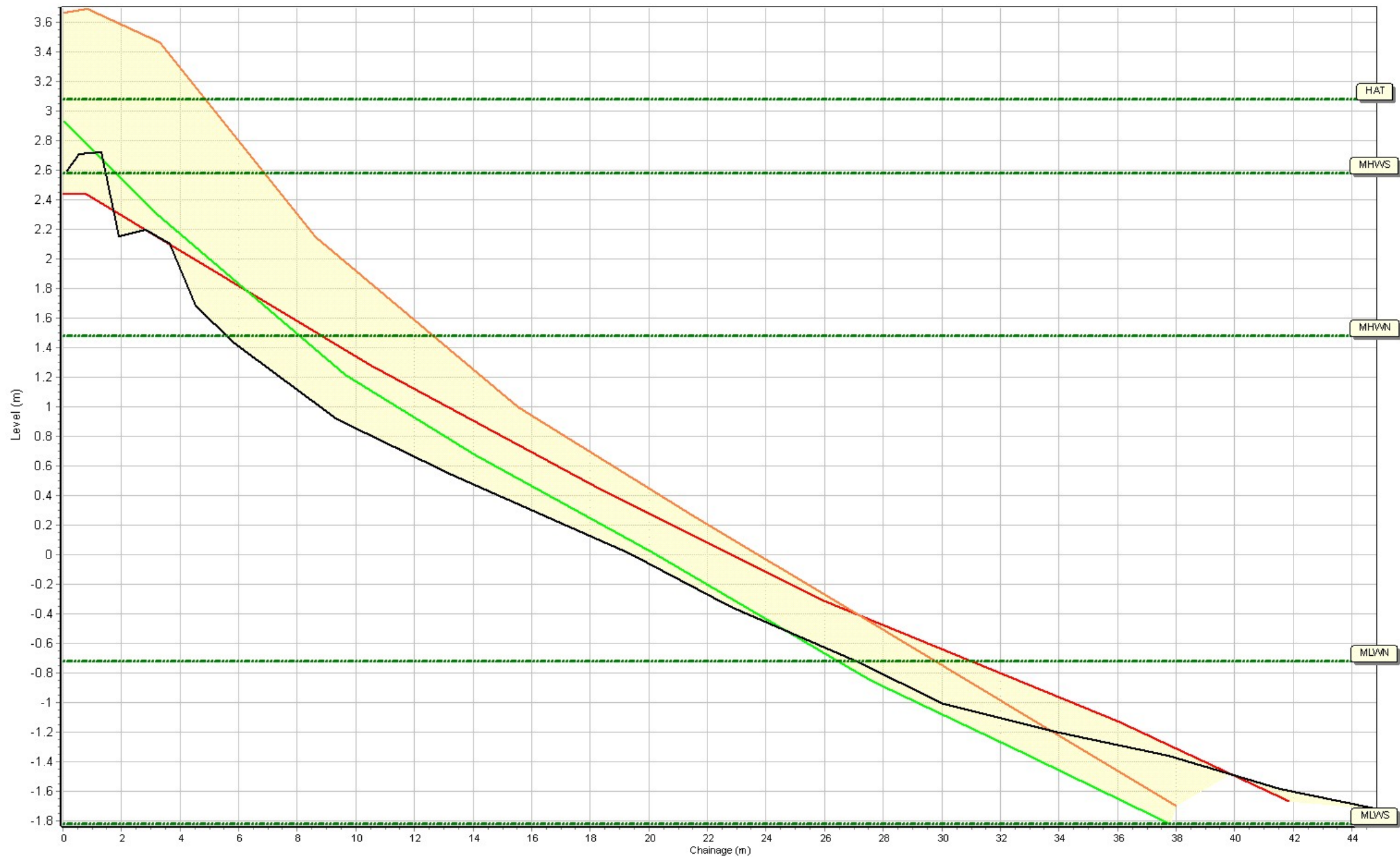
☒ Profile Envelope
 ☒ 2009-10
 ☒ 2019-09
 ☒ 2020-09
 ☒ 2021-11

Profiles: 1bSNC3



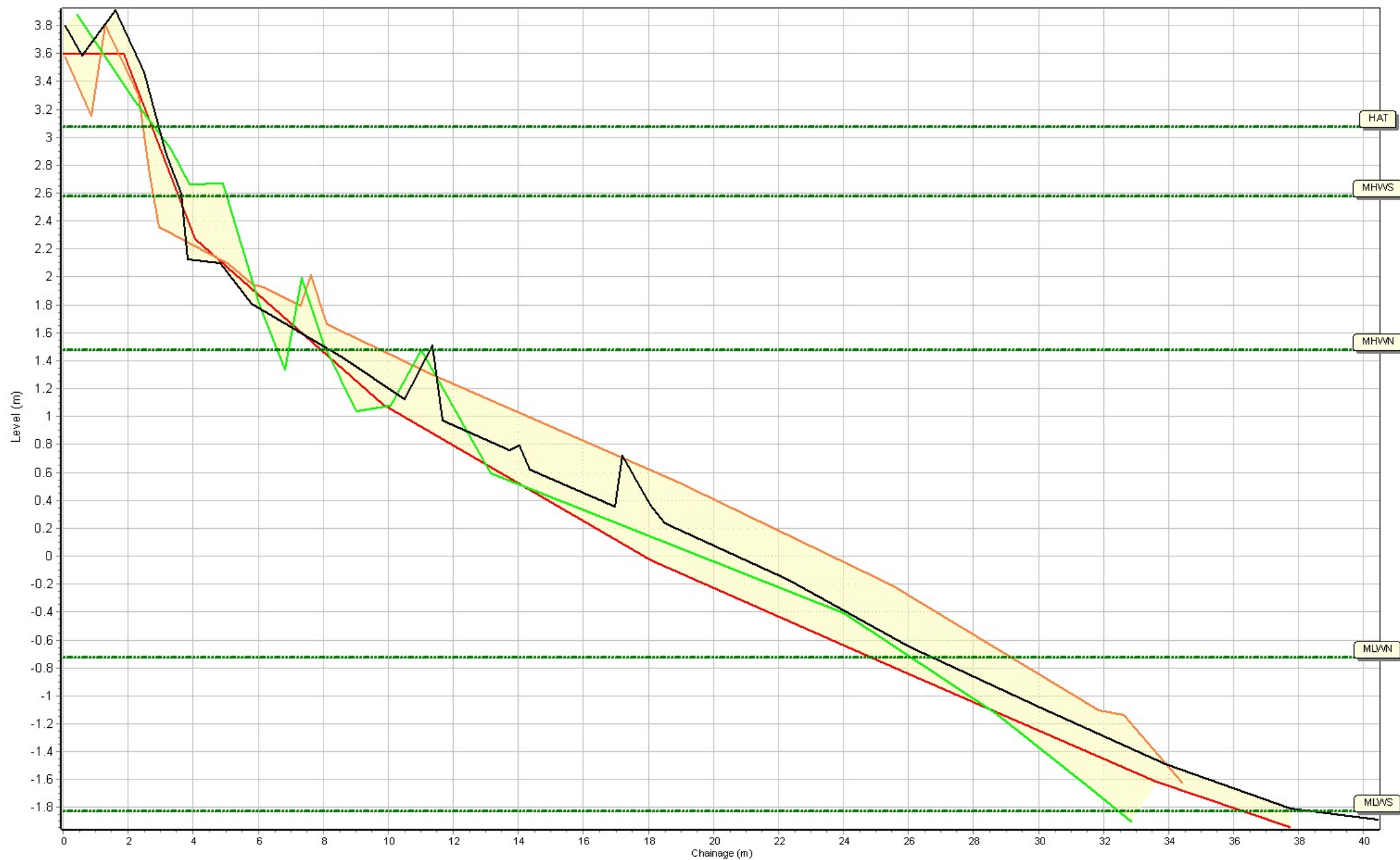
☒ Profile Envelope
 ☒ 2009-10
 ☒ 2019-09
 ☒ 2020-09
 ☒ 2021-11

Profiles: 1bSNC4



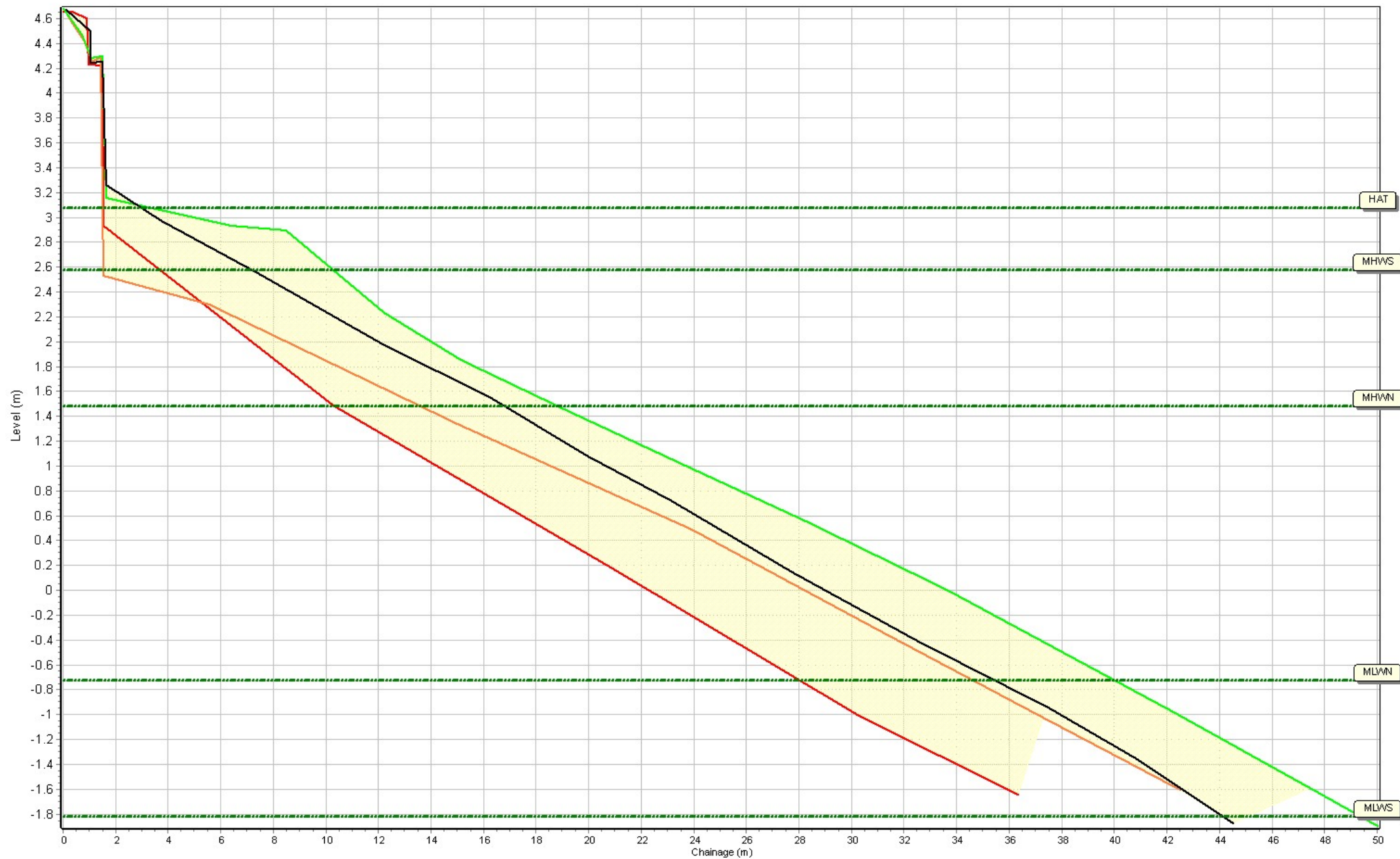
☒ Profile Envelope
 ☒ 2009-10
 ☒ 2019-09
 ☒ 2020-09
 ☒ 2021-11

Profiles: 1bSNC5



☒ Profile Envelope
 ☒ 2009-10
 ☒ 2019-09
 ☒ 2020-09
 ☒ 2021-11

Profiles: 1bSNC6



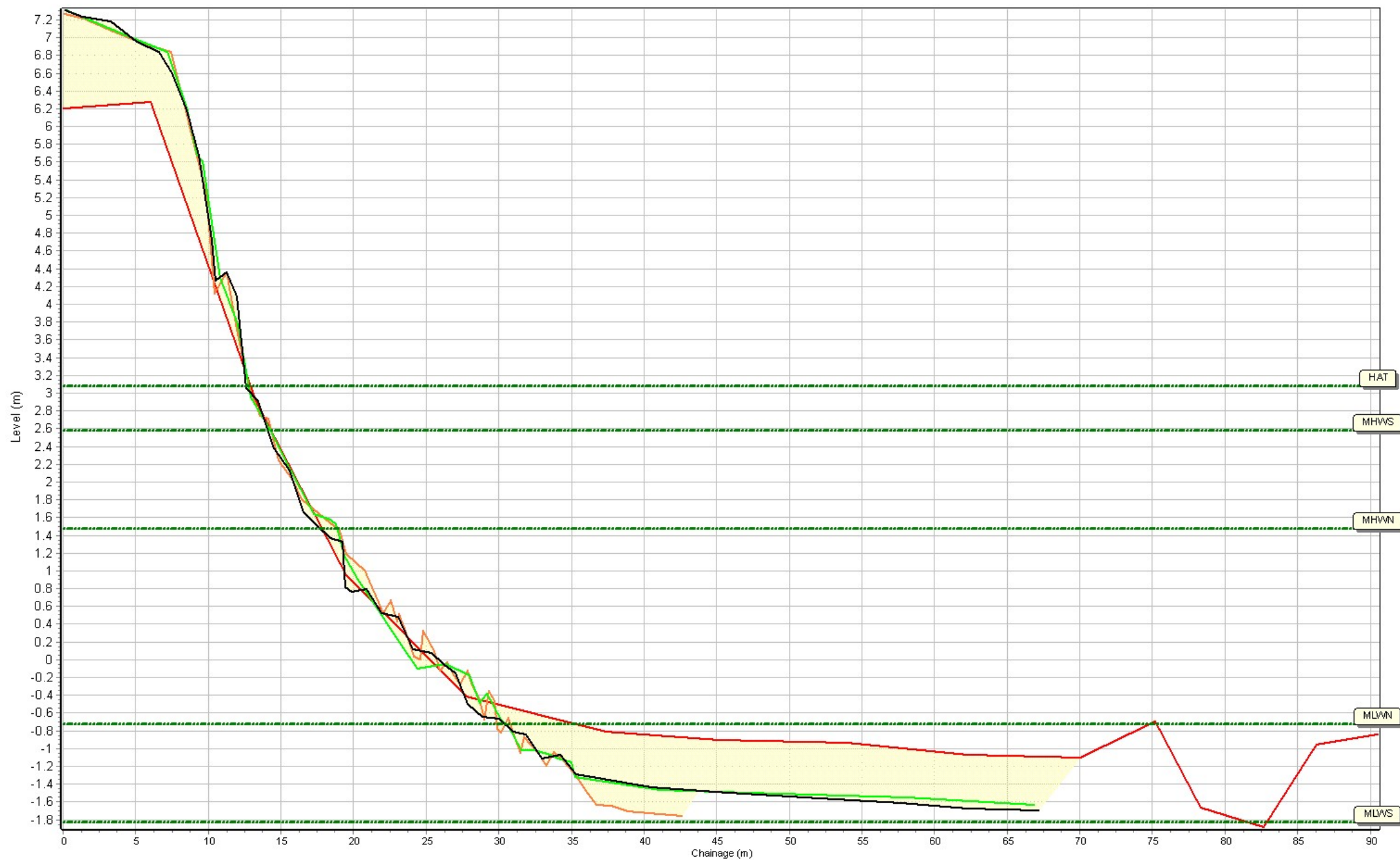
☒ Profile Envelope
 ☒ 2009-10
 ☒ 2019-09
 ☒ 2020-09
 ☒ 2021-11

Profiles: 1bSNC7



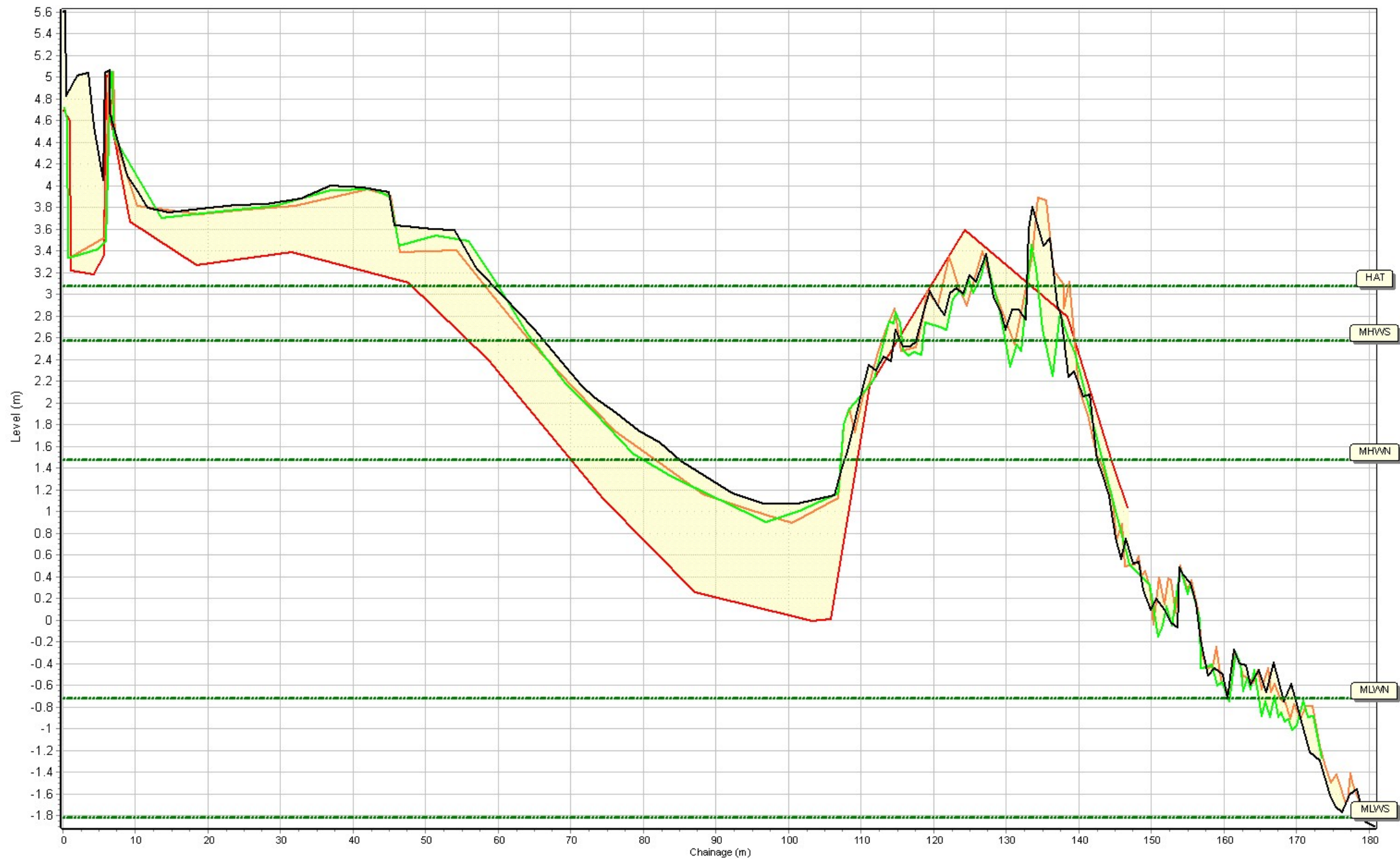
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Profiles: 1bSNC8



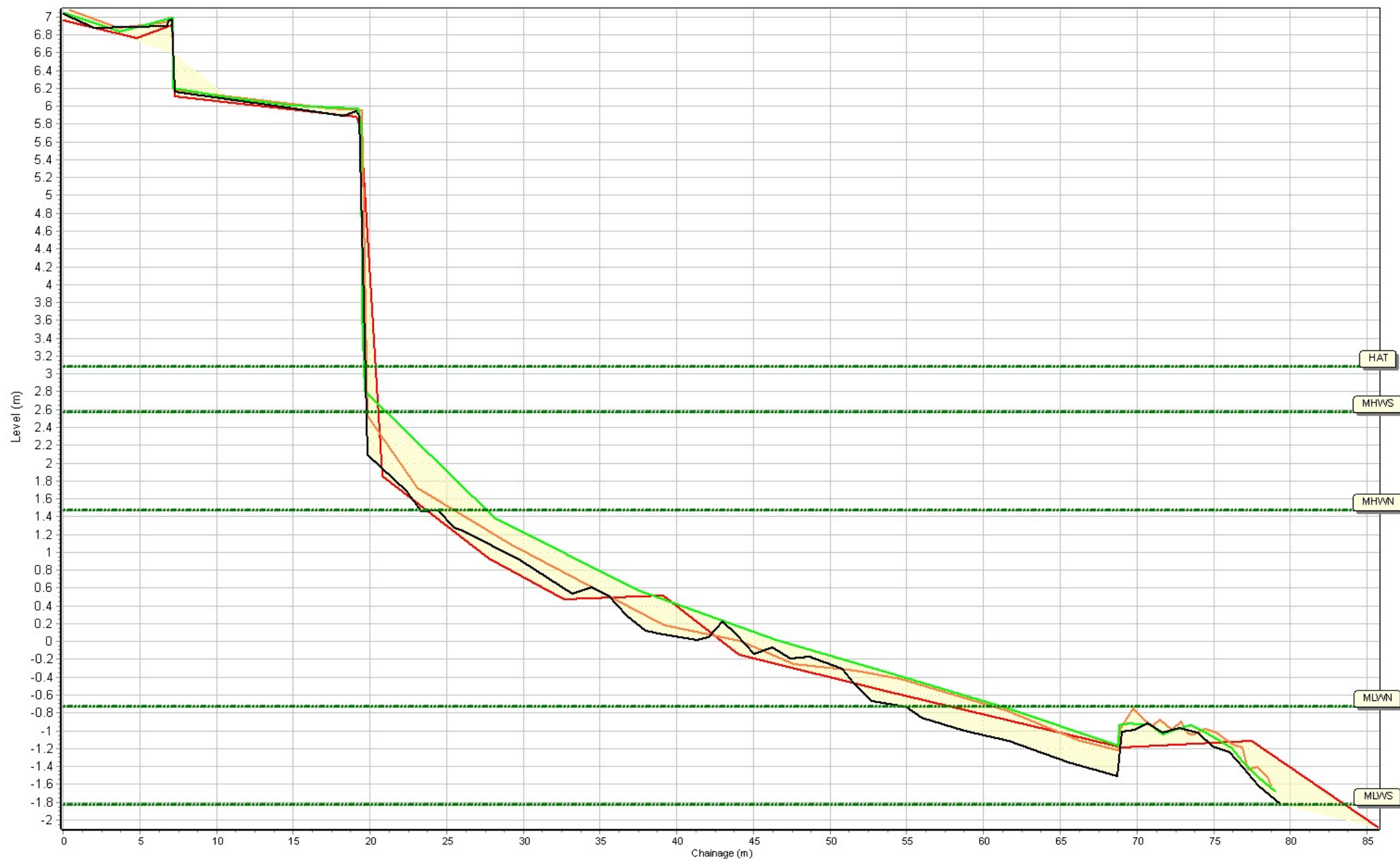
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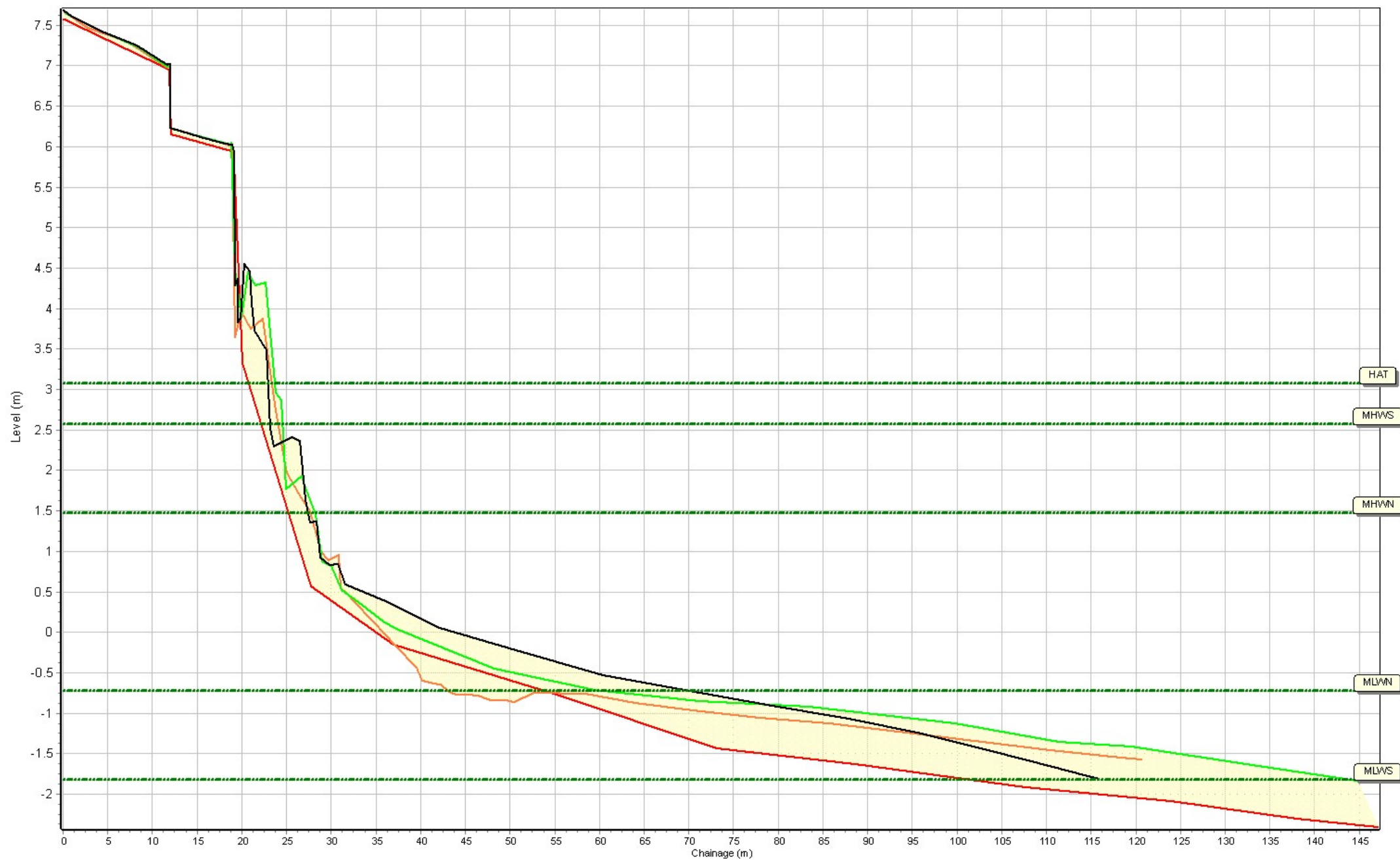
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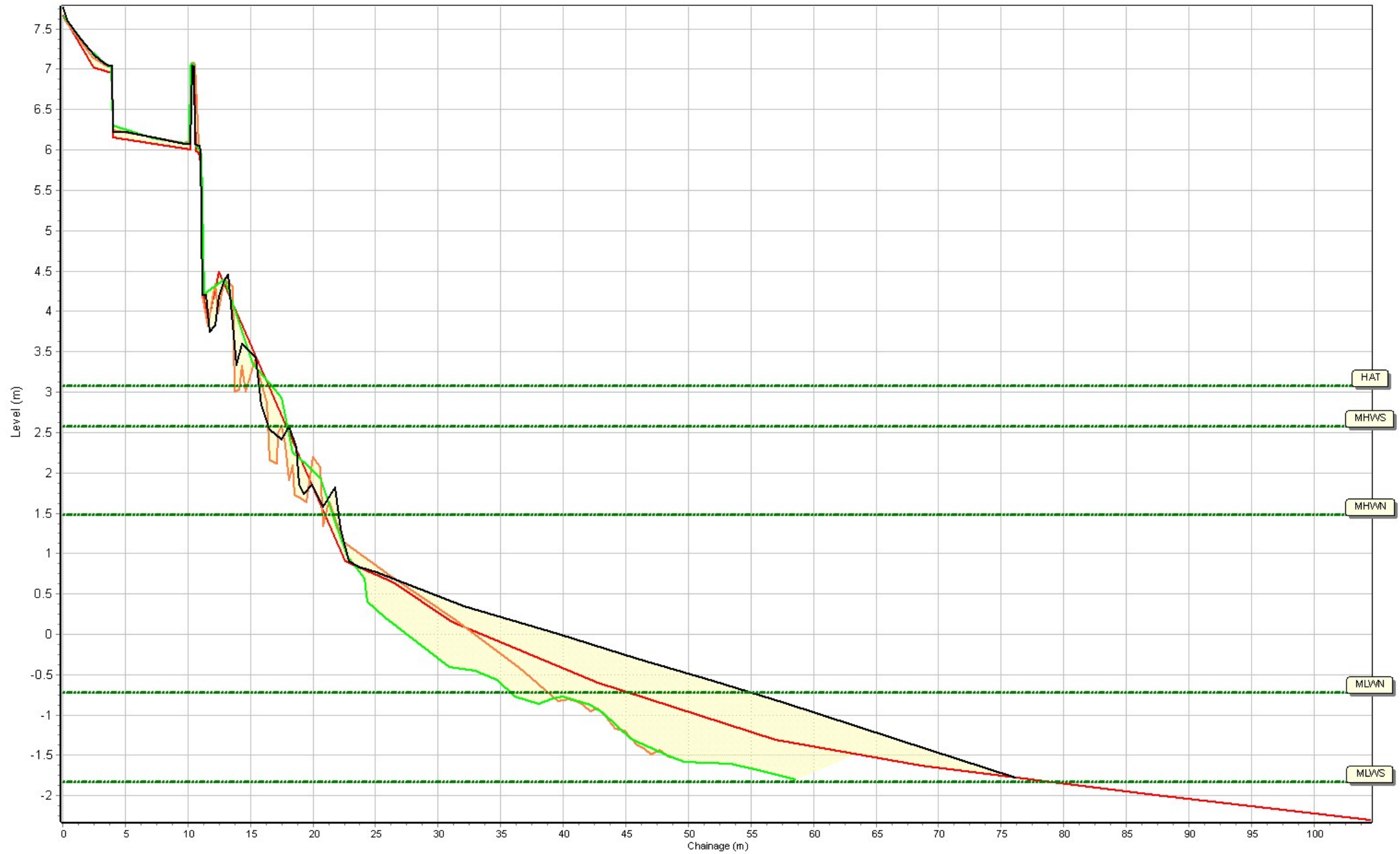
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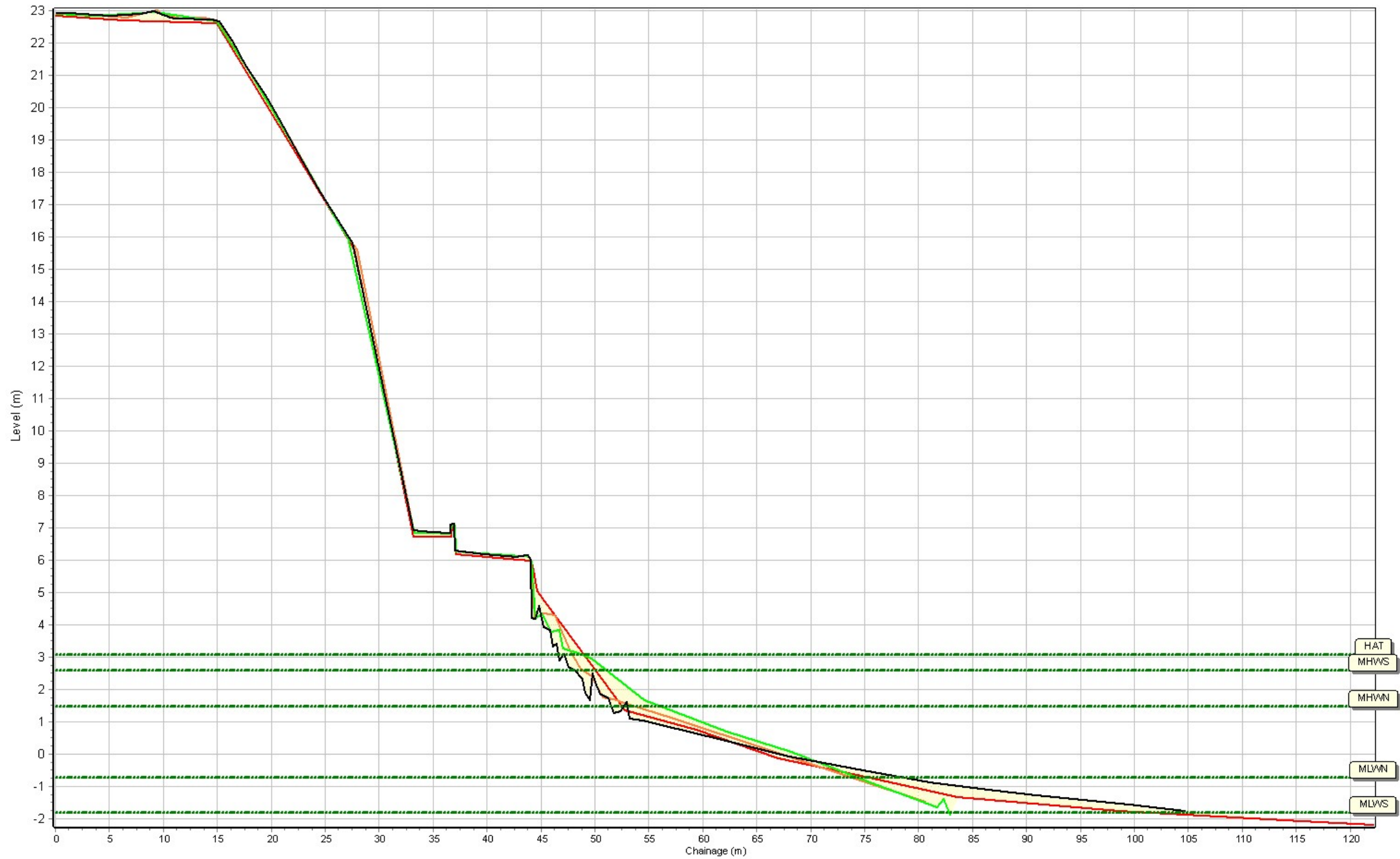
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Profiles: 1bSNS10



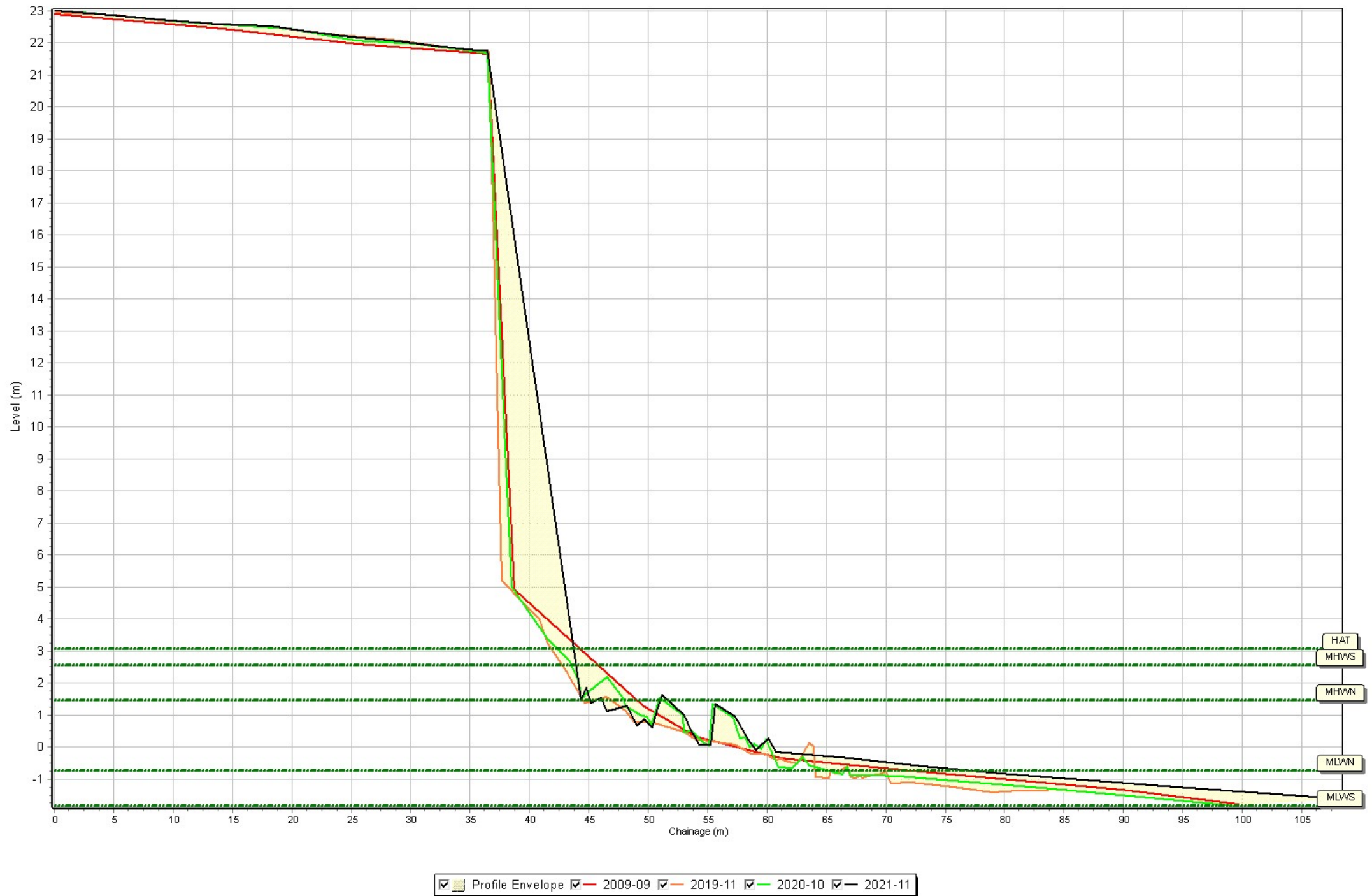
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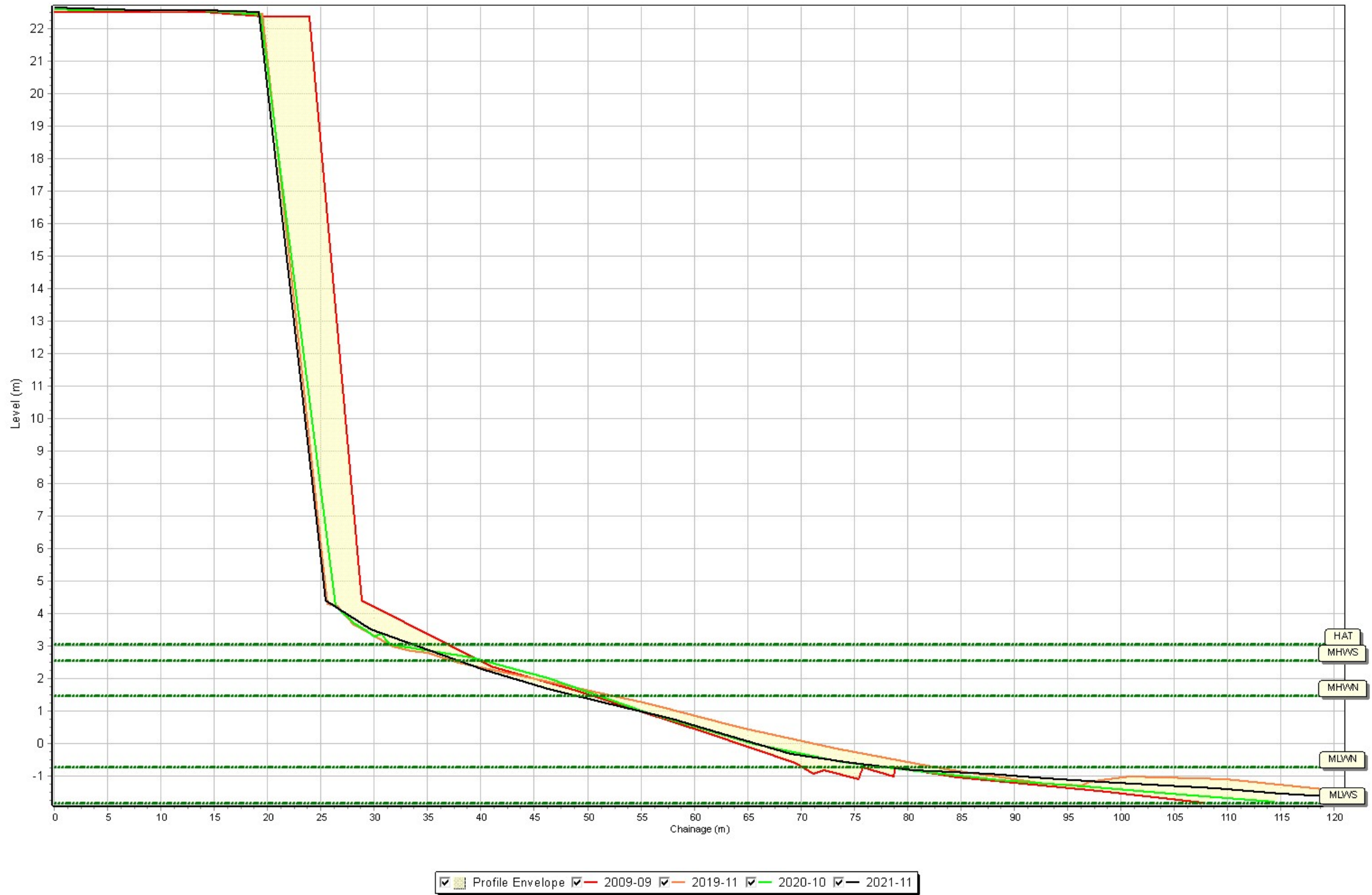


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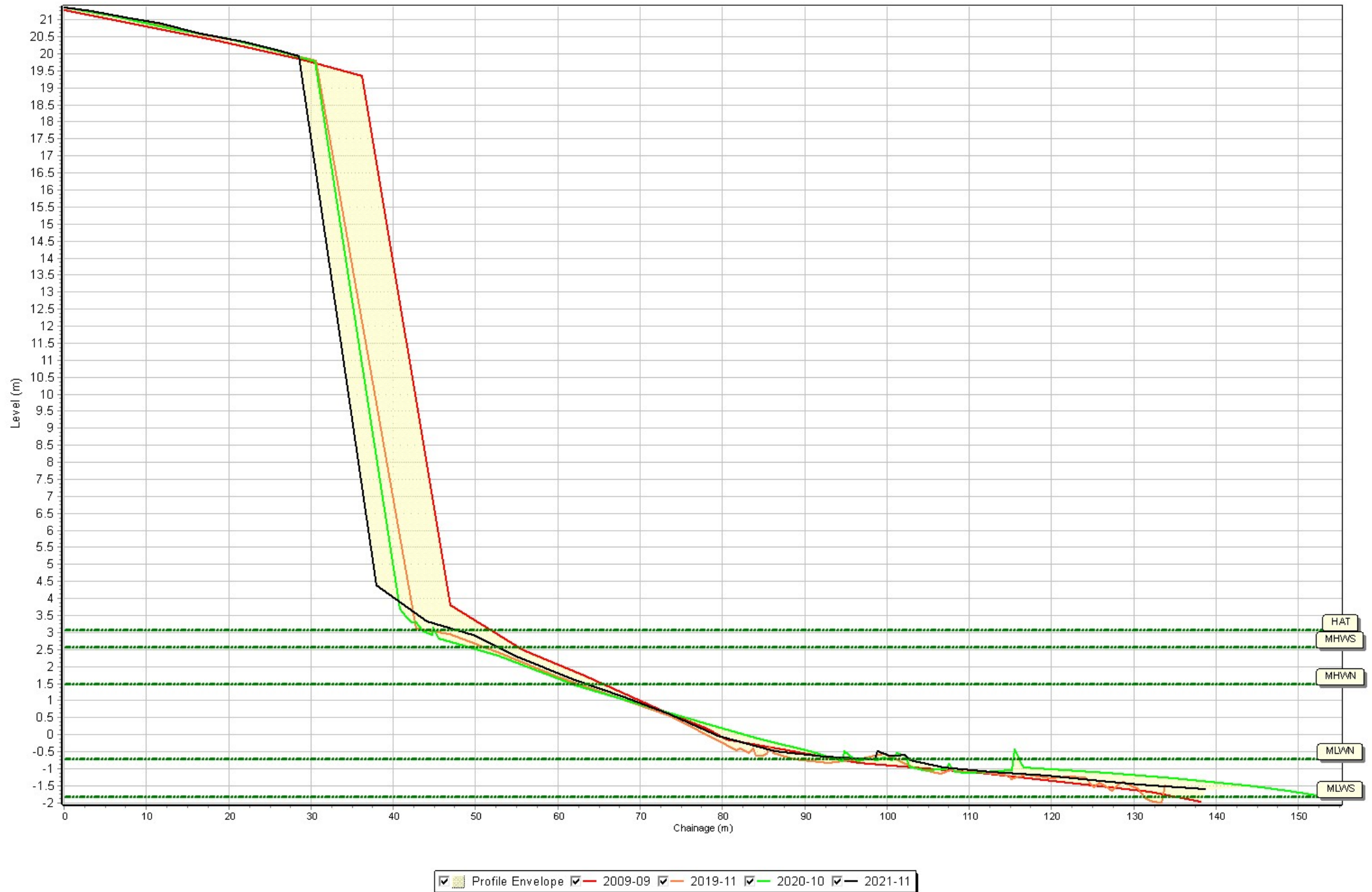
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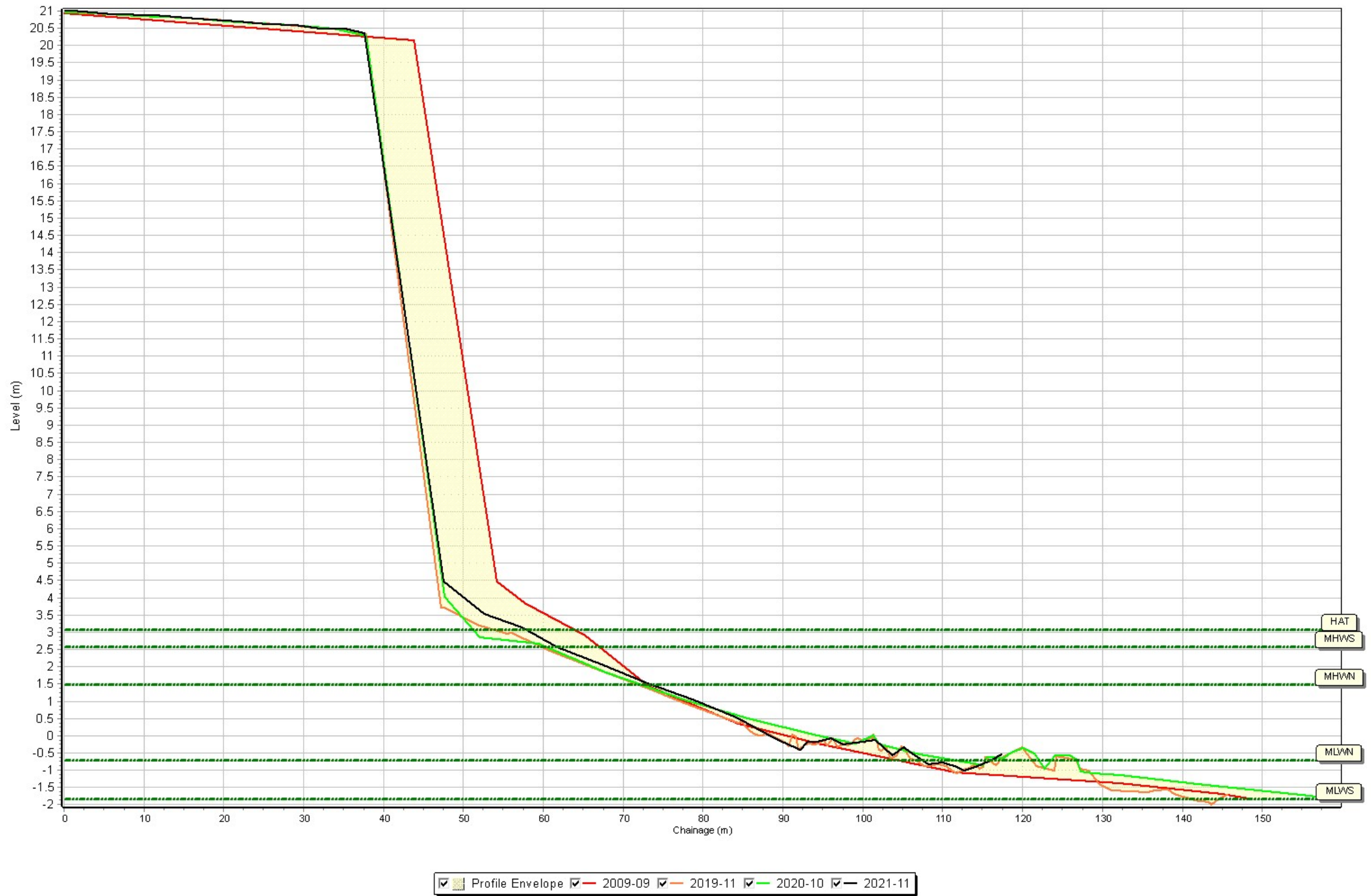
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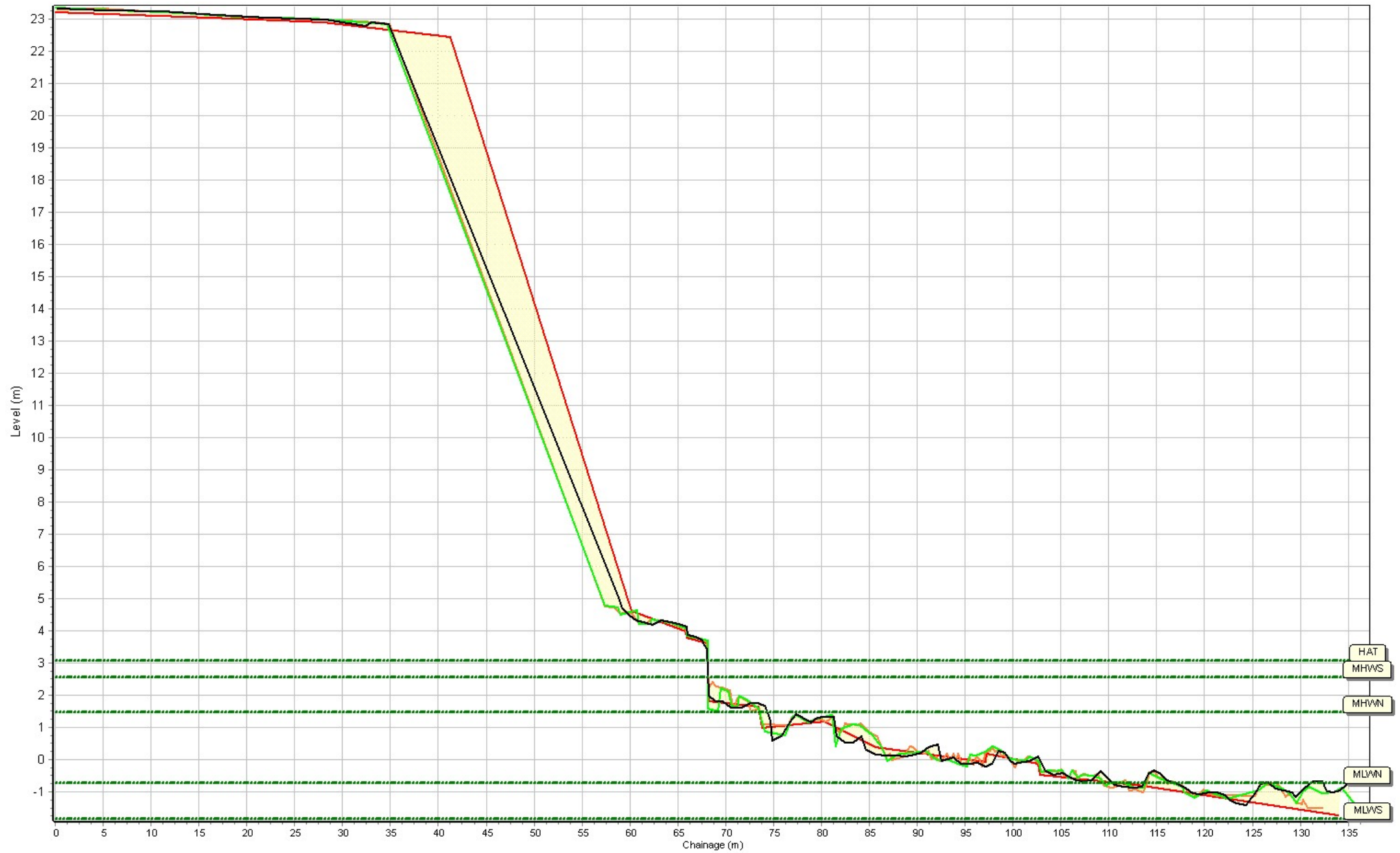
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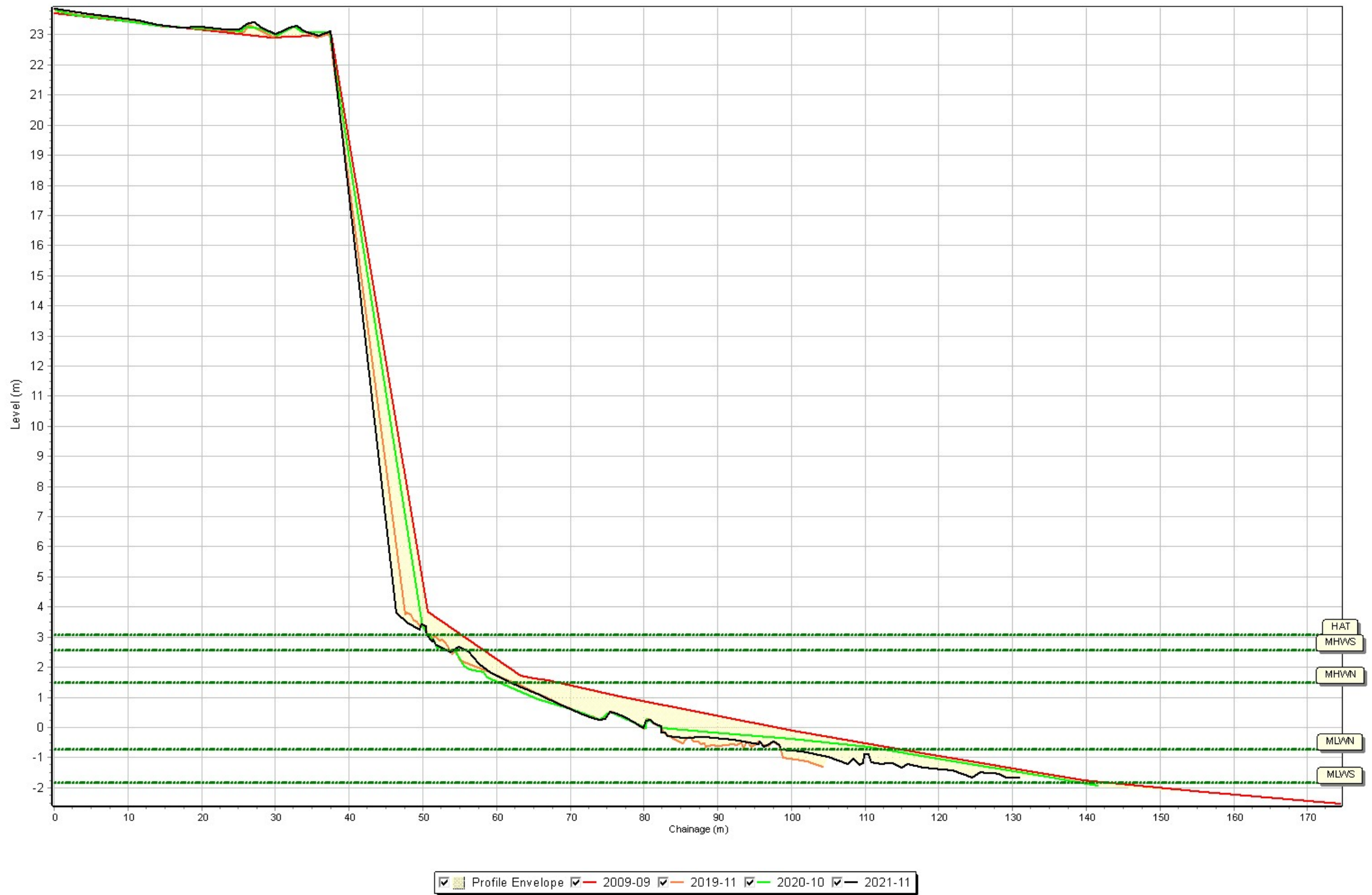
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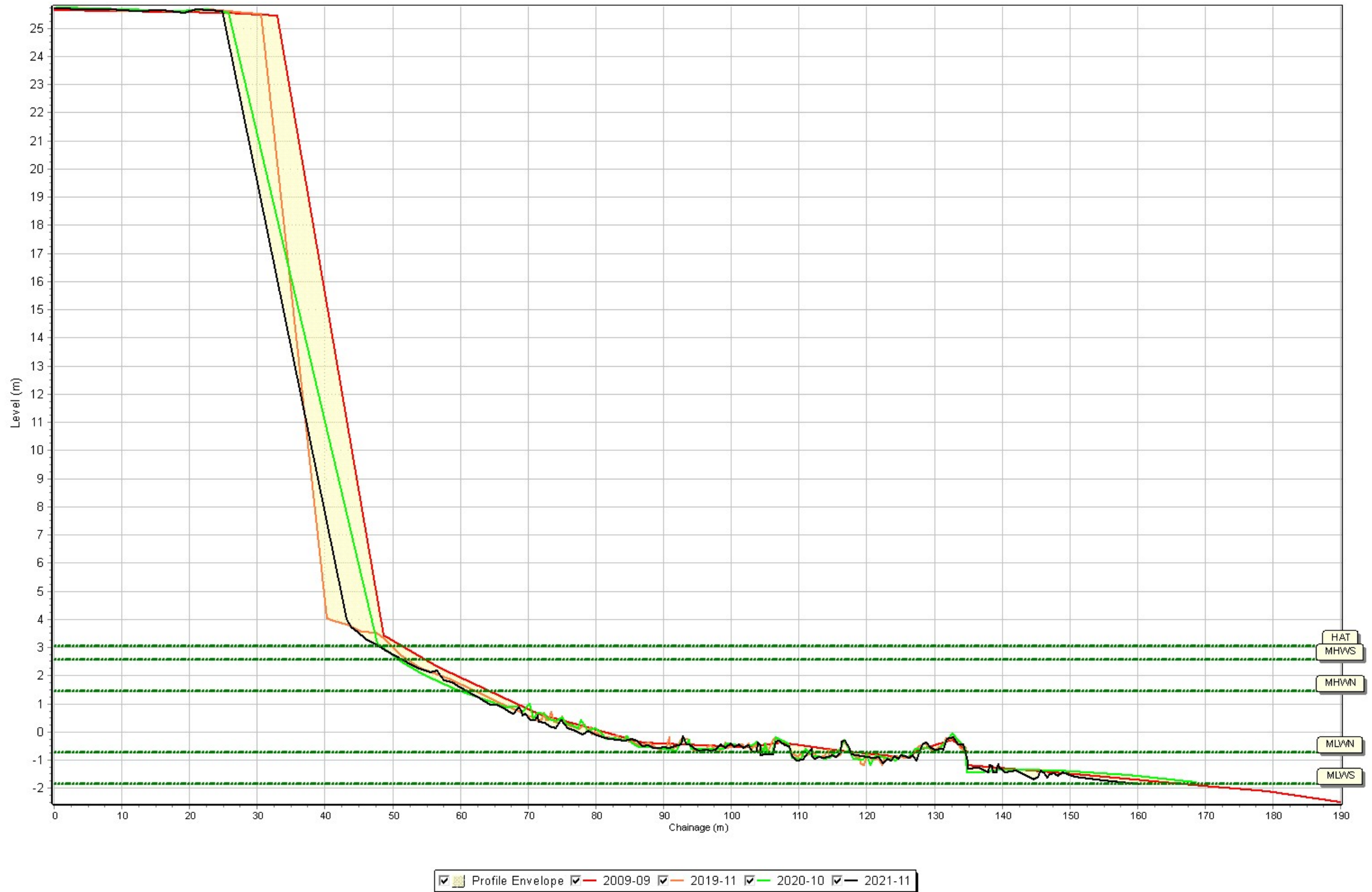


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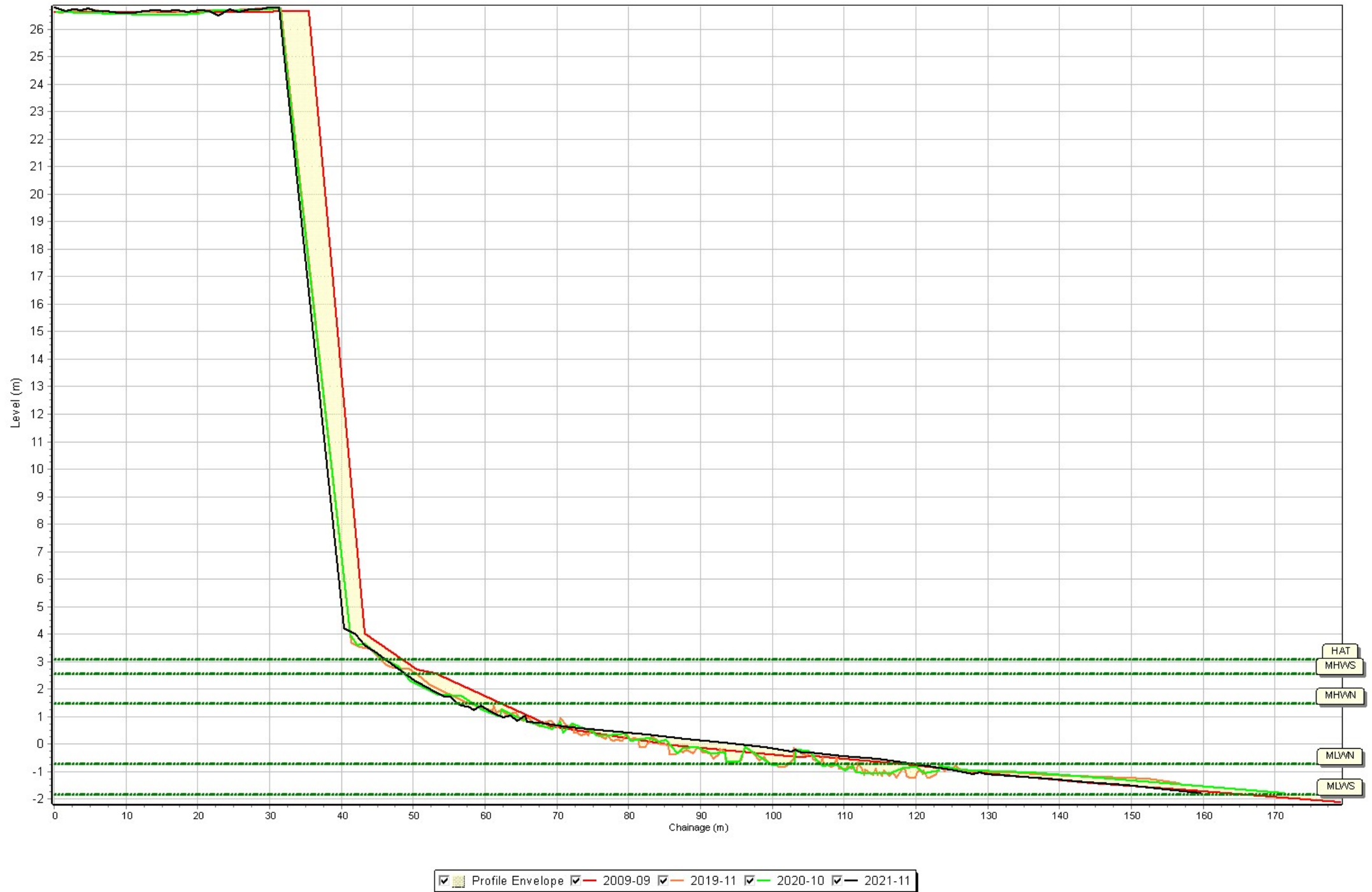


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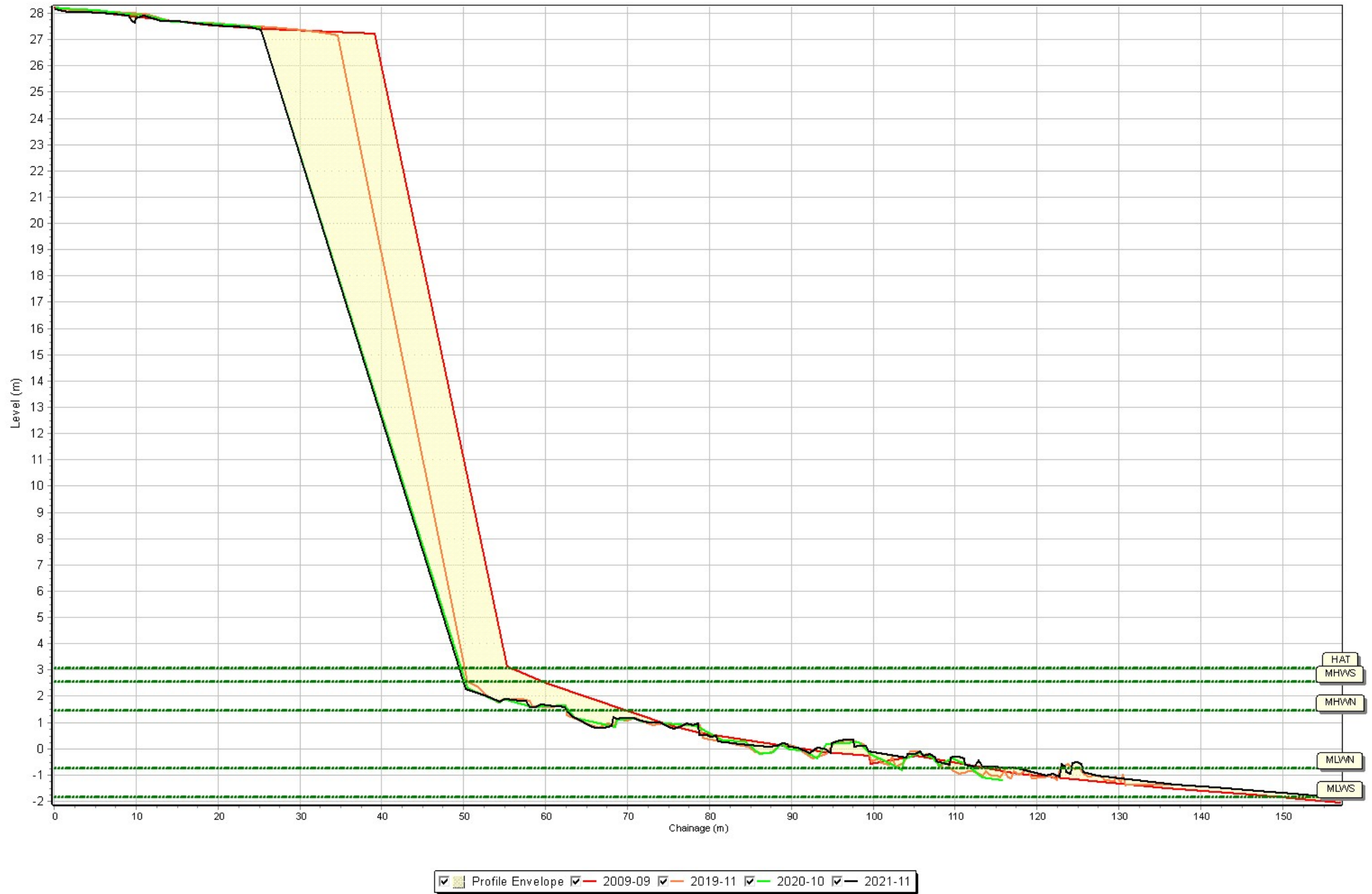
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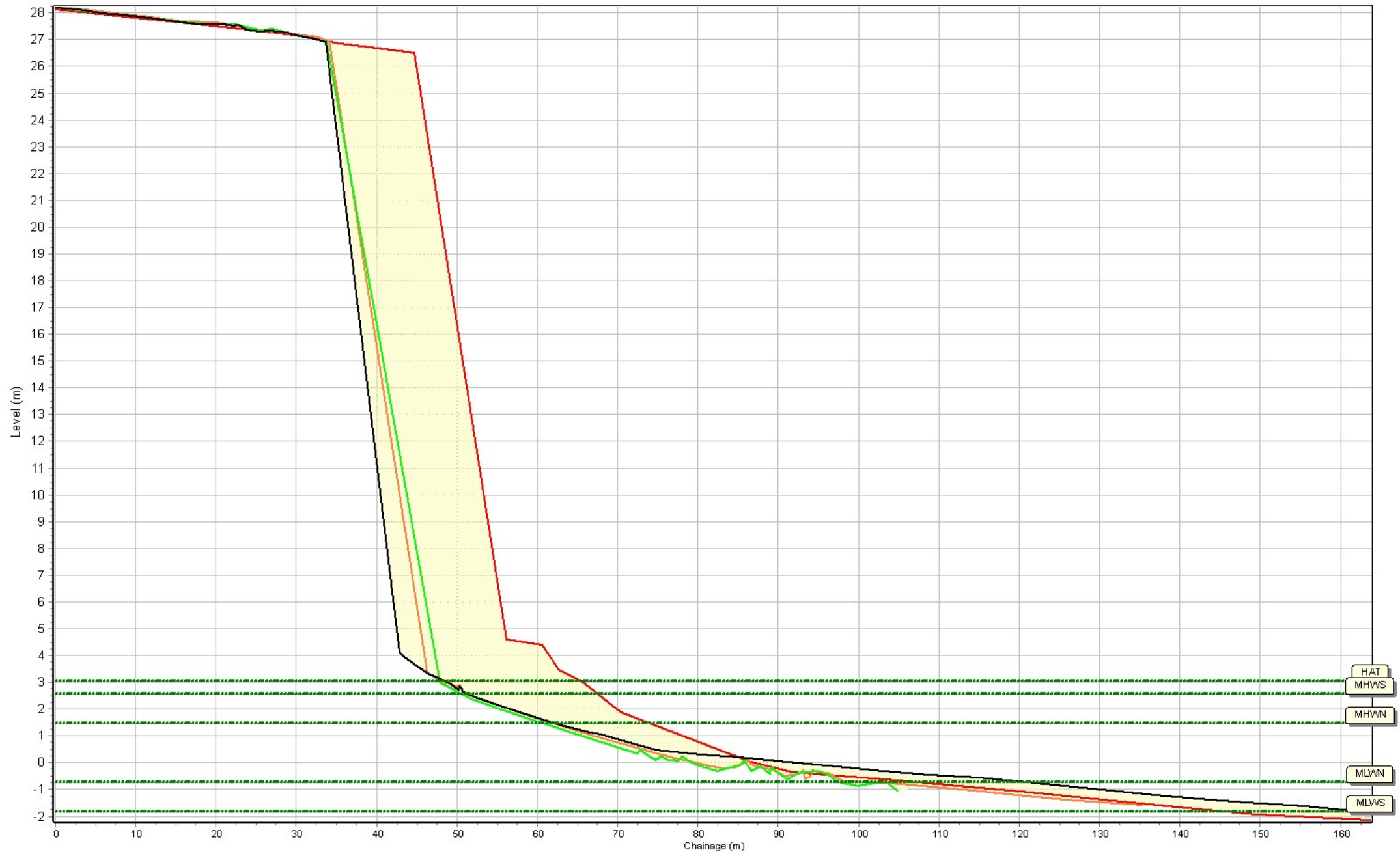
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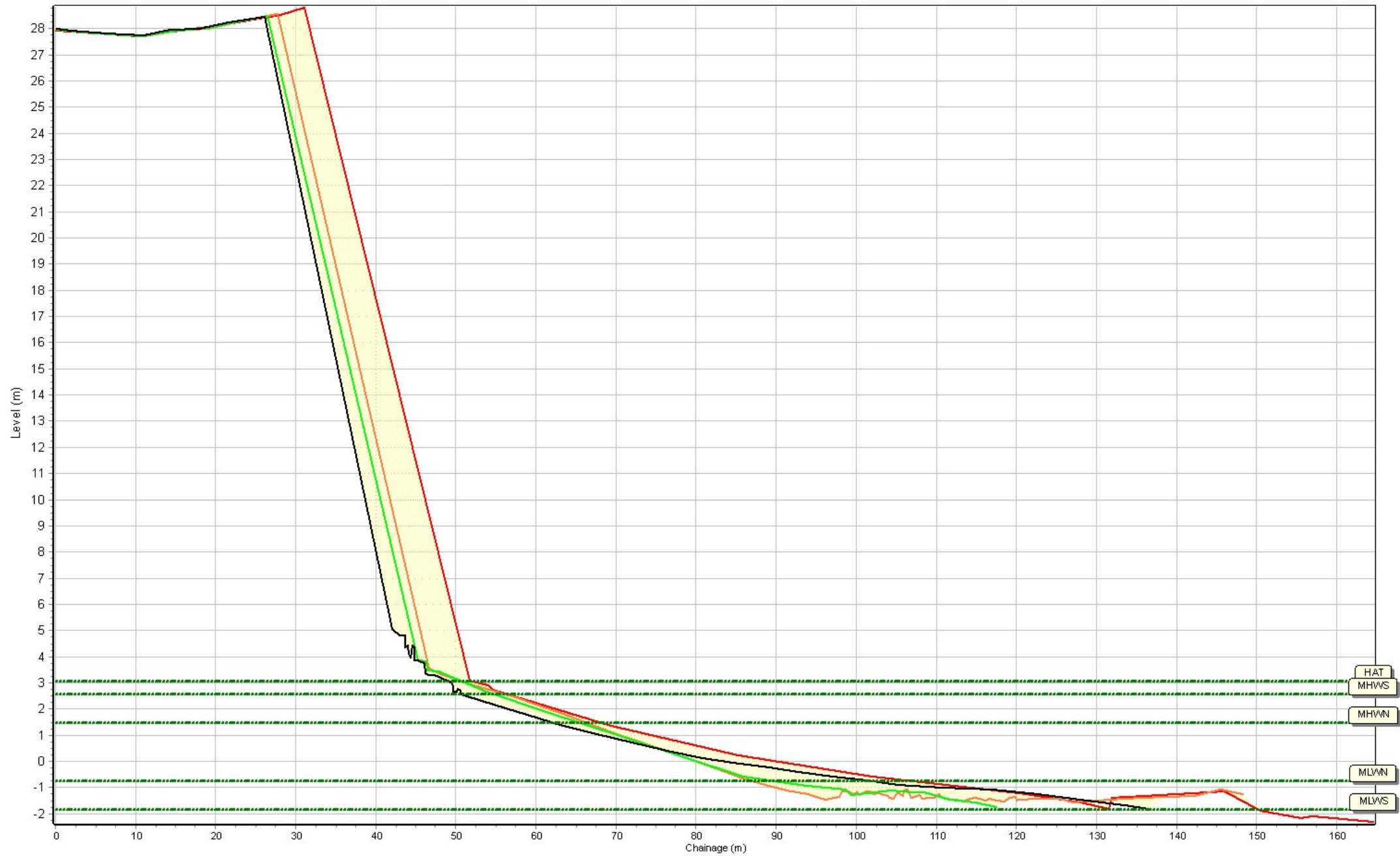


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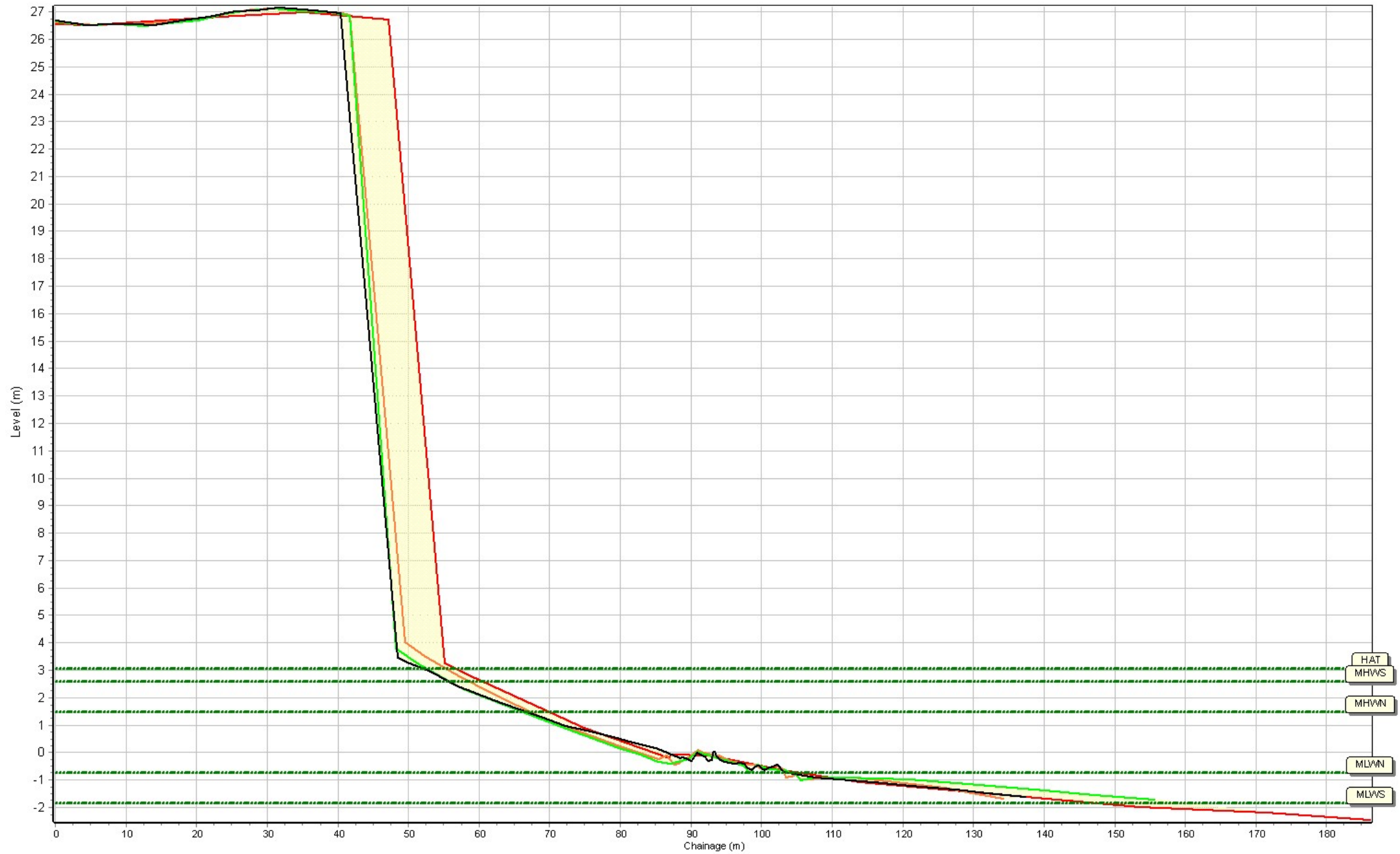
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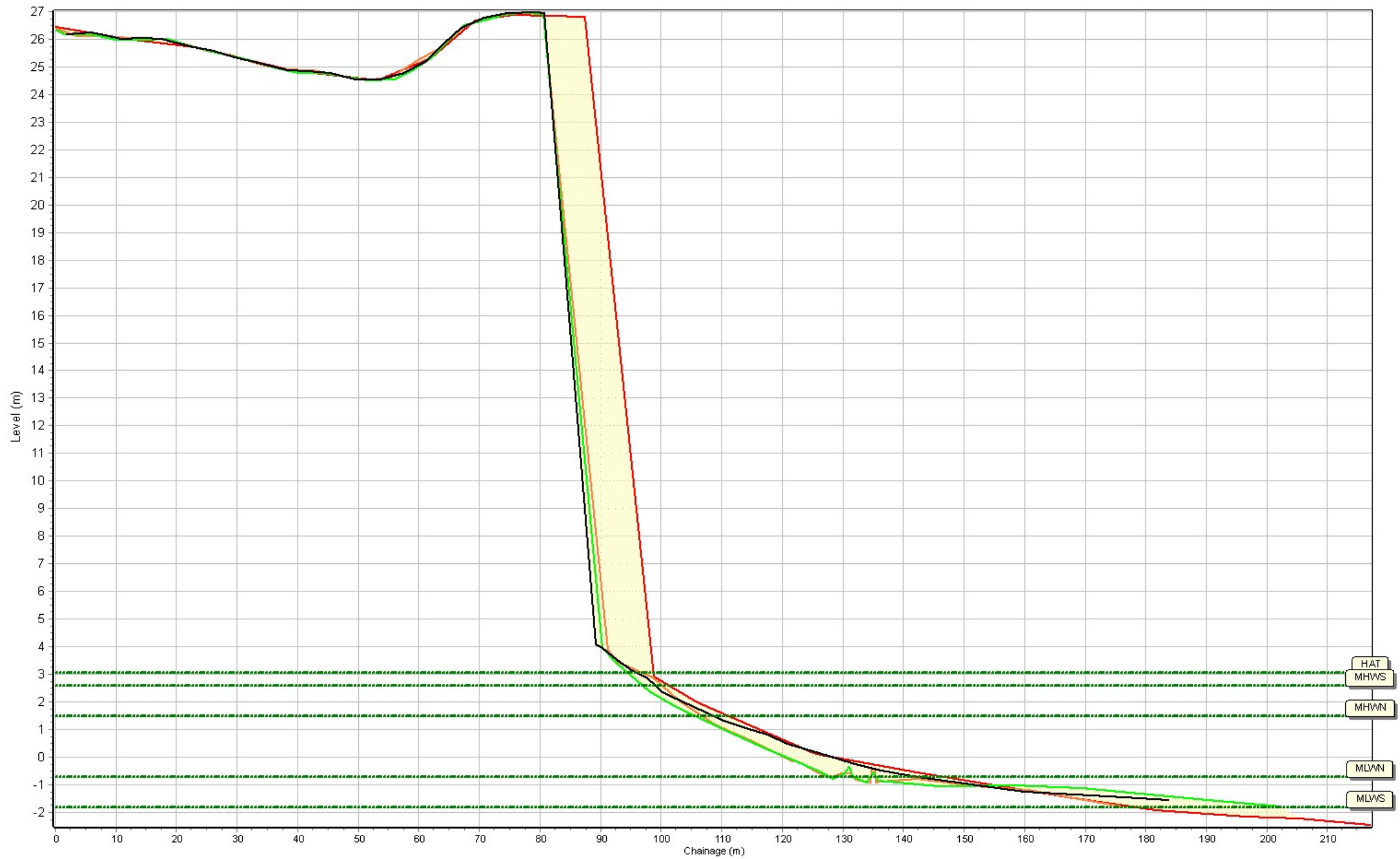
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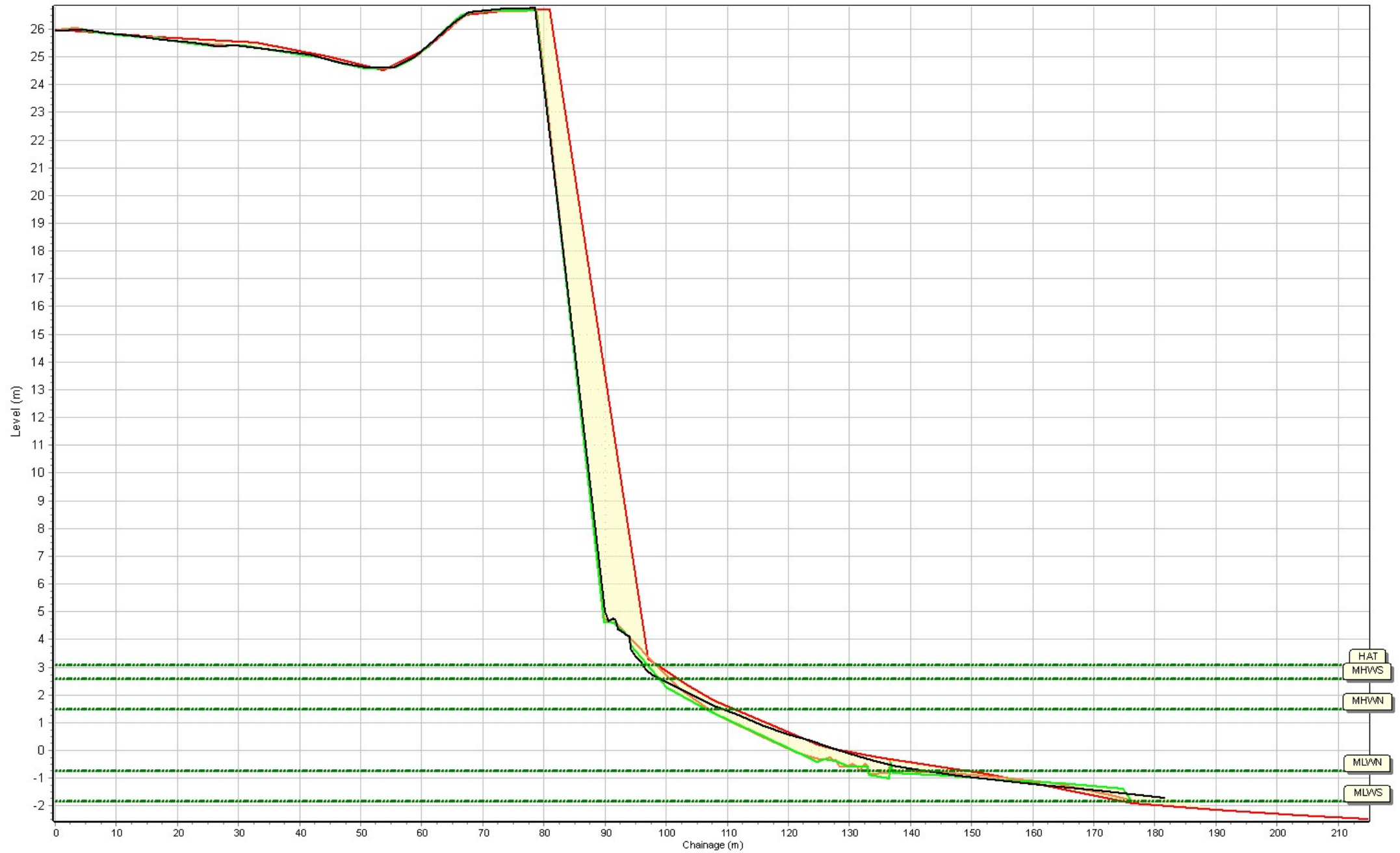
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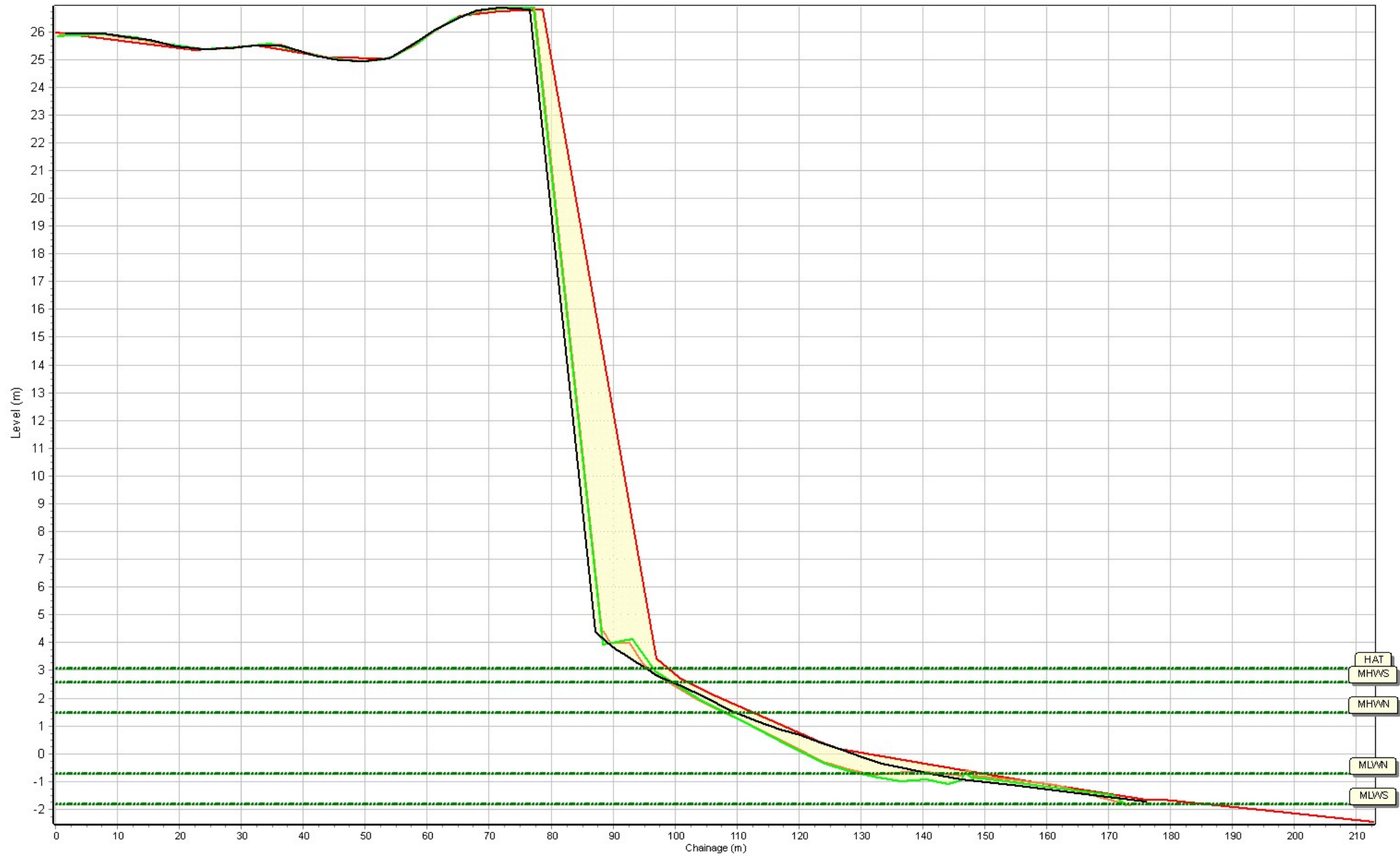
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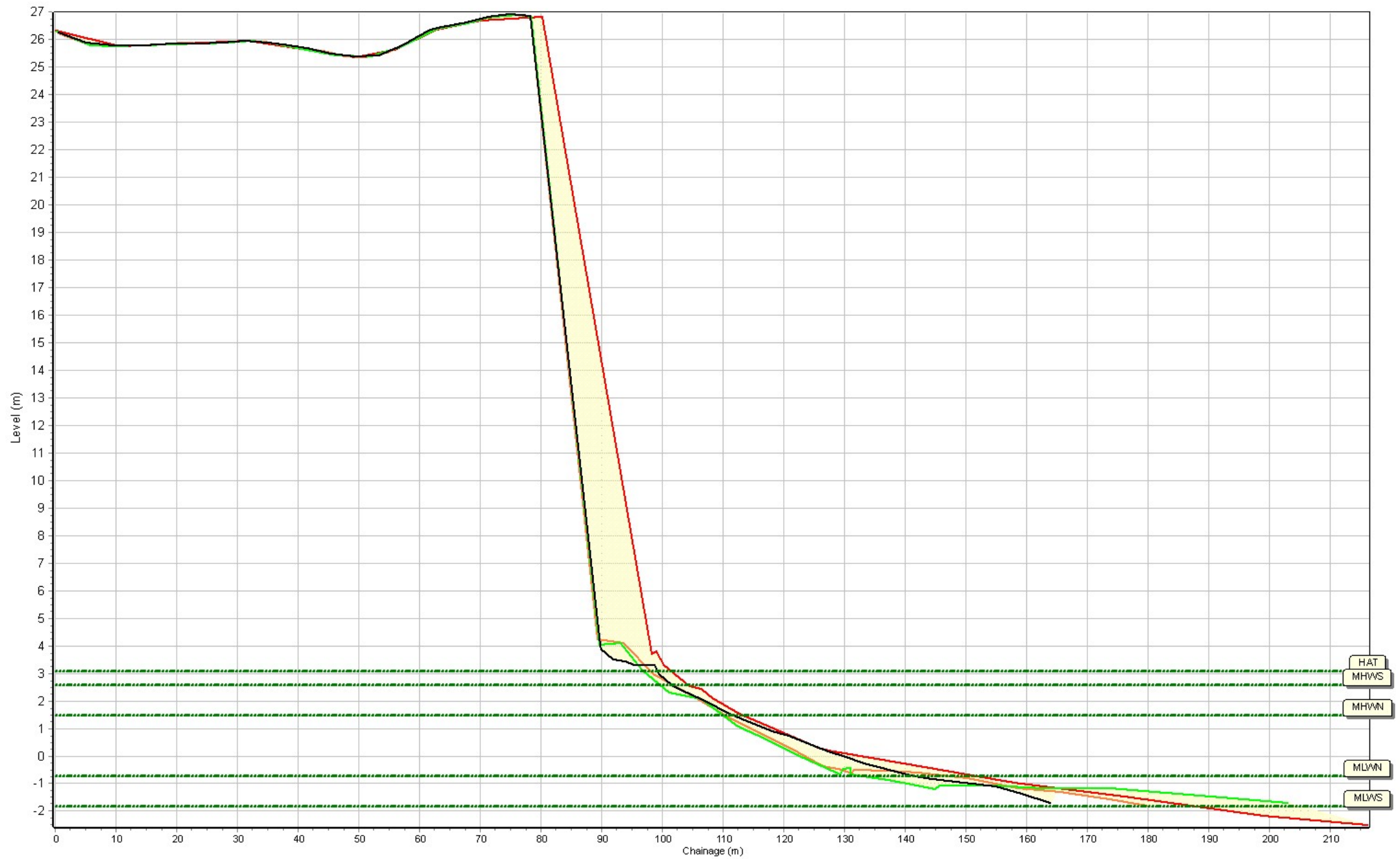
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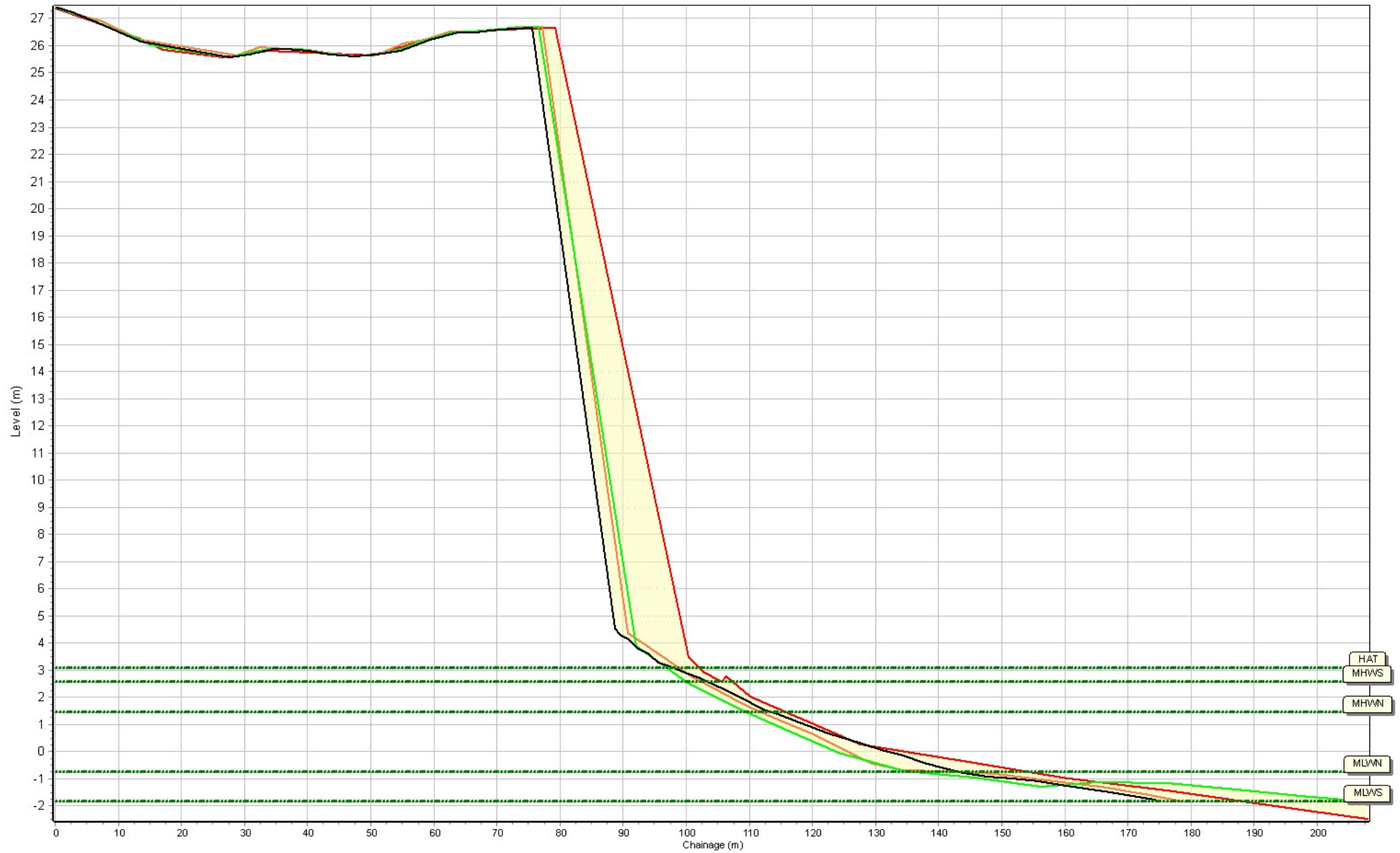
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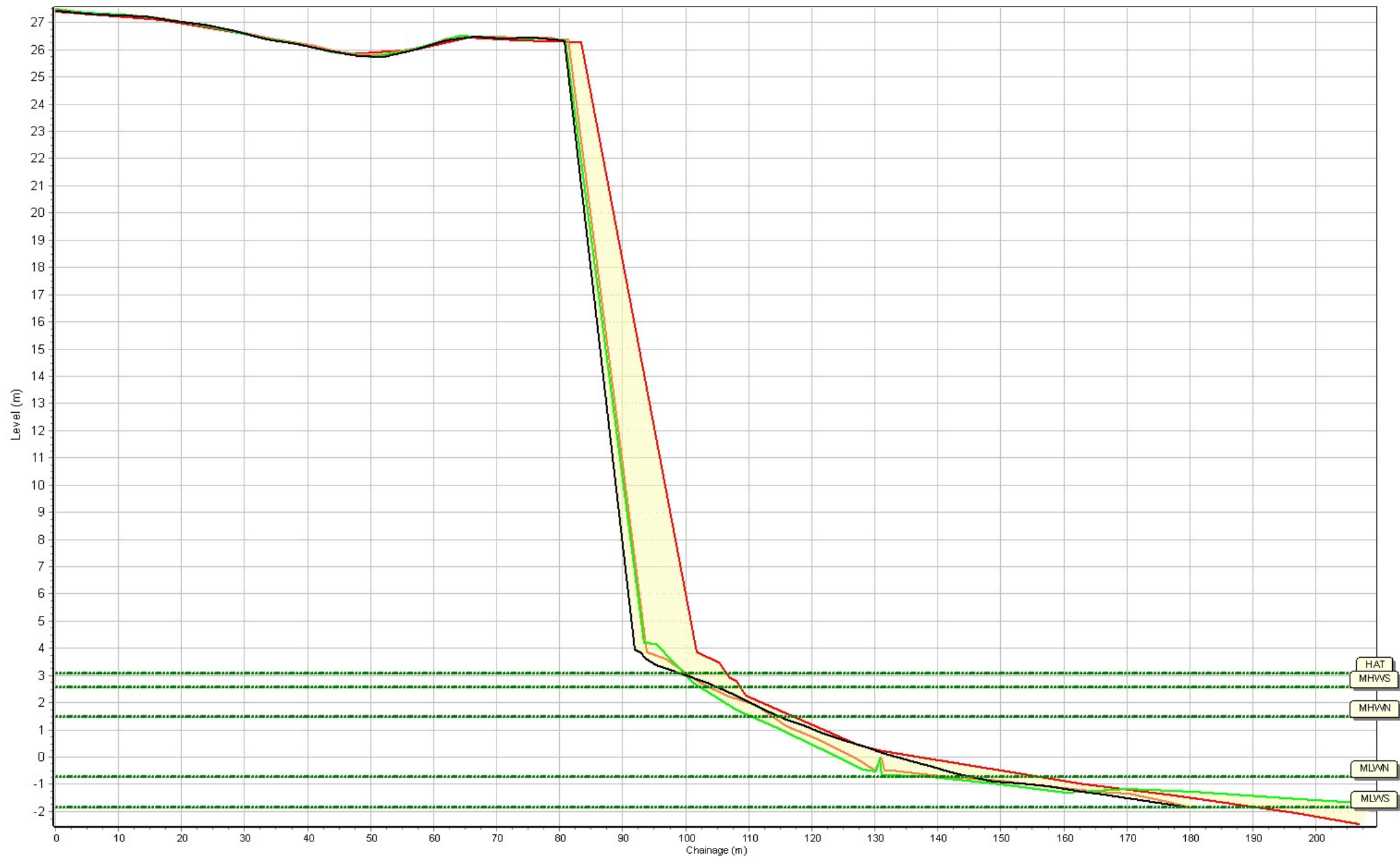
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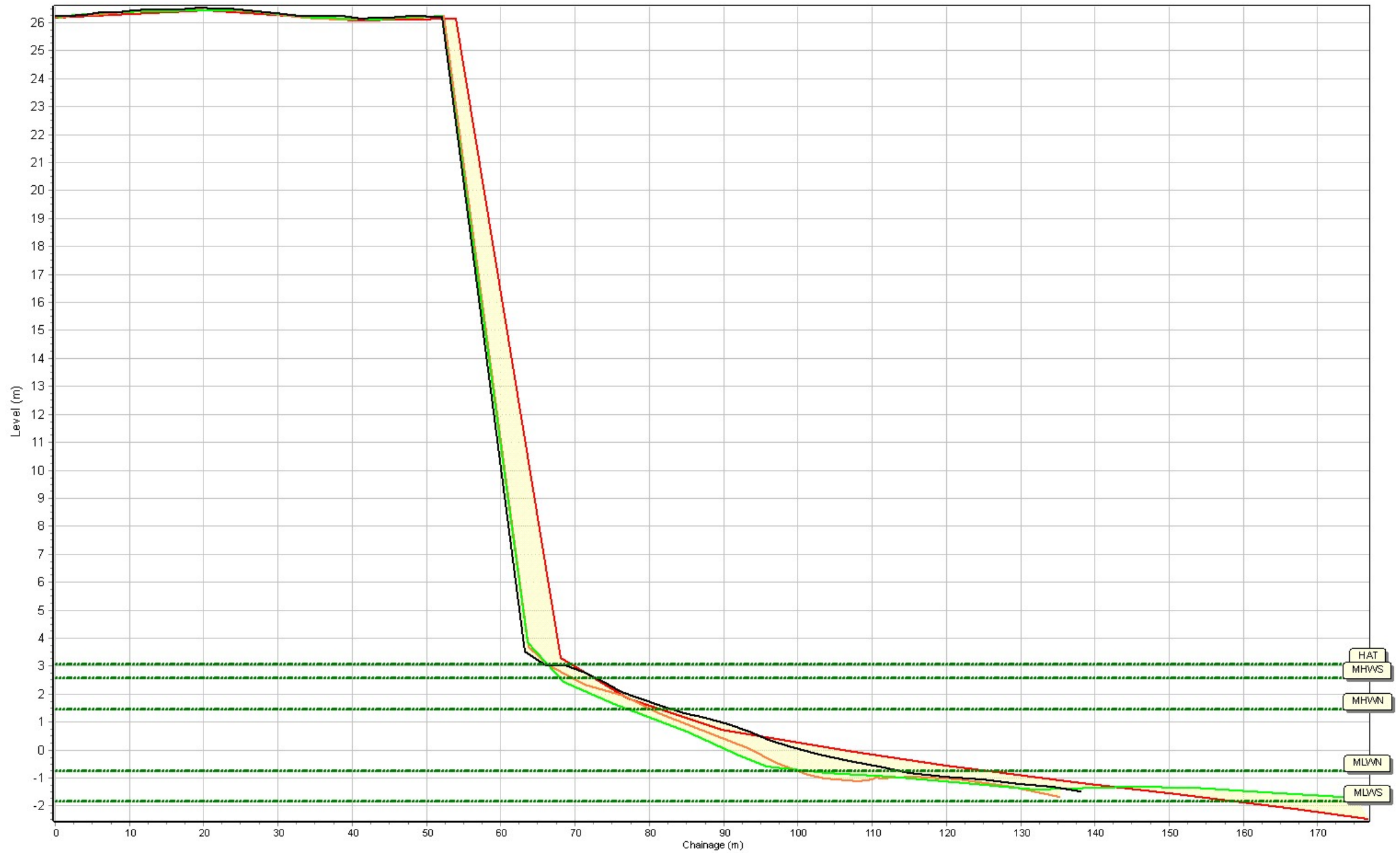
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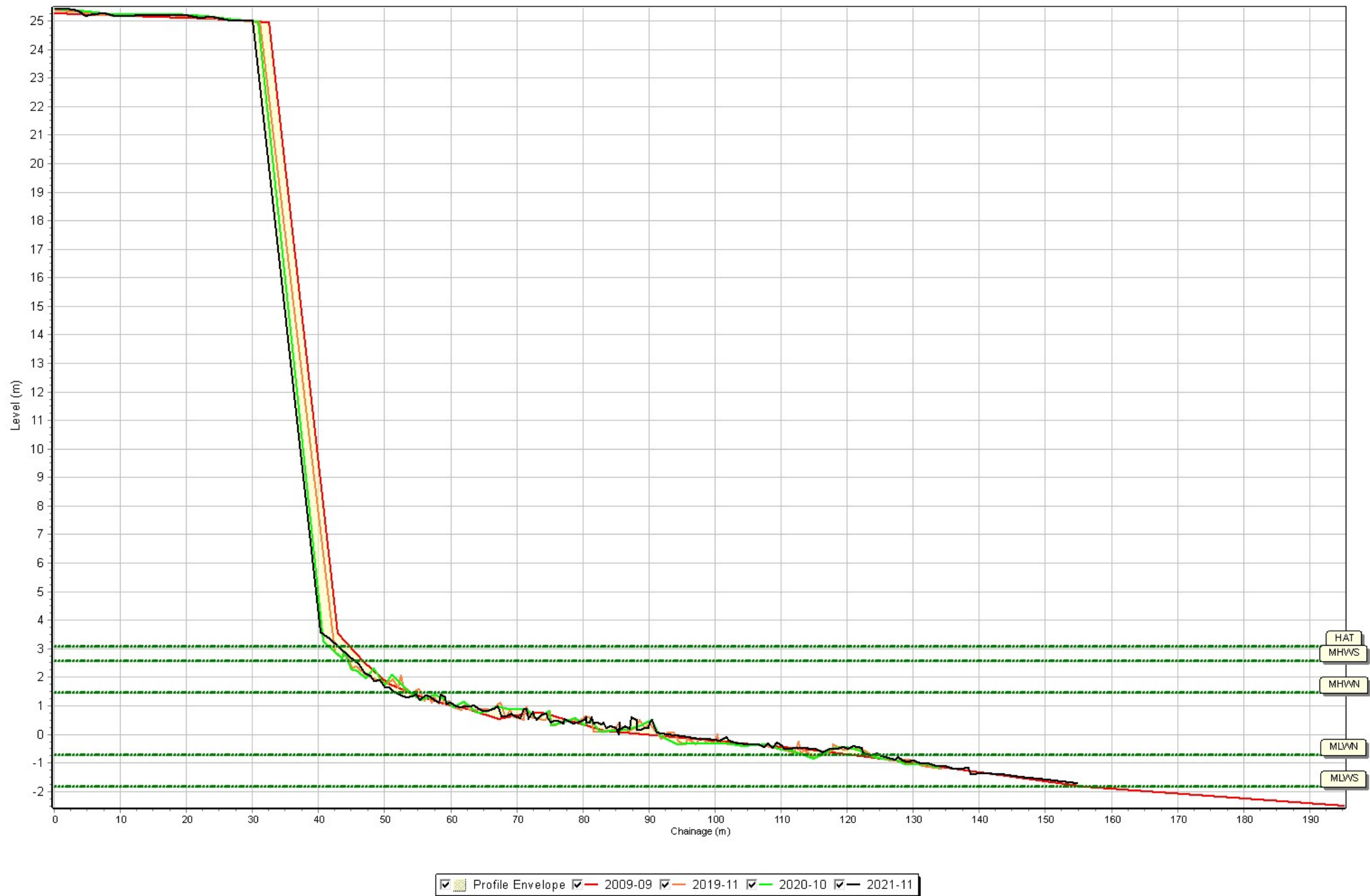
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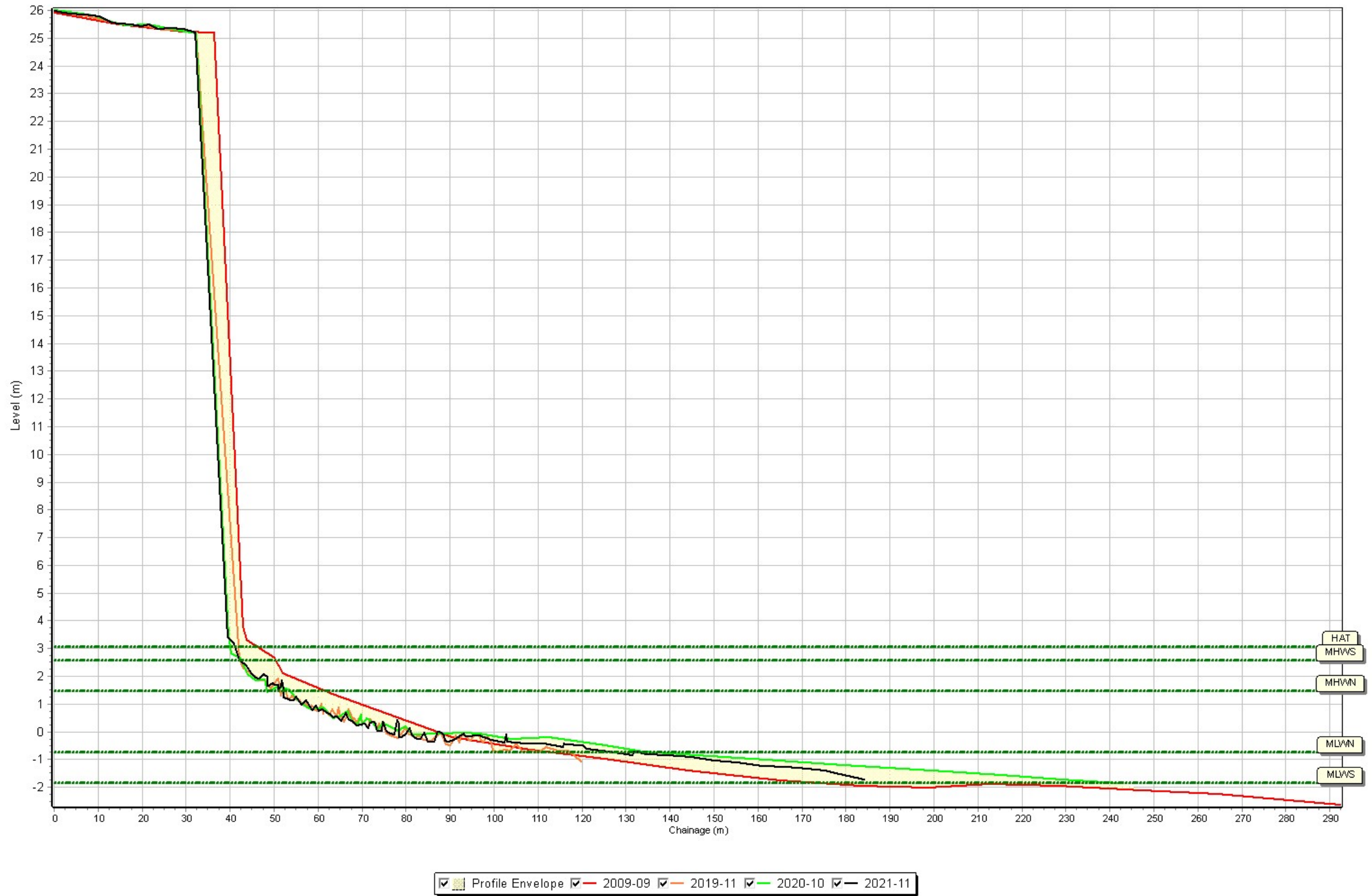


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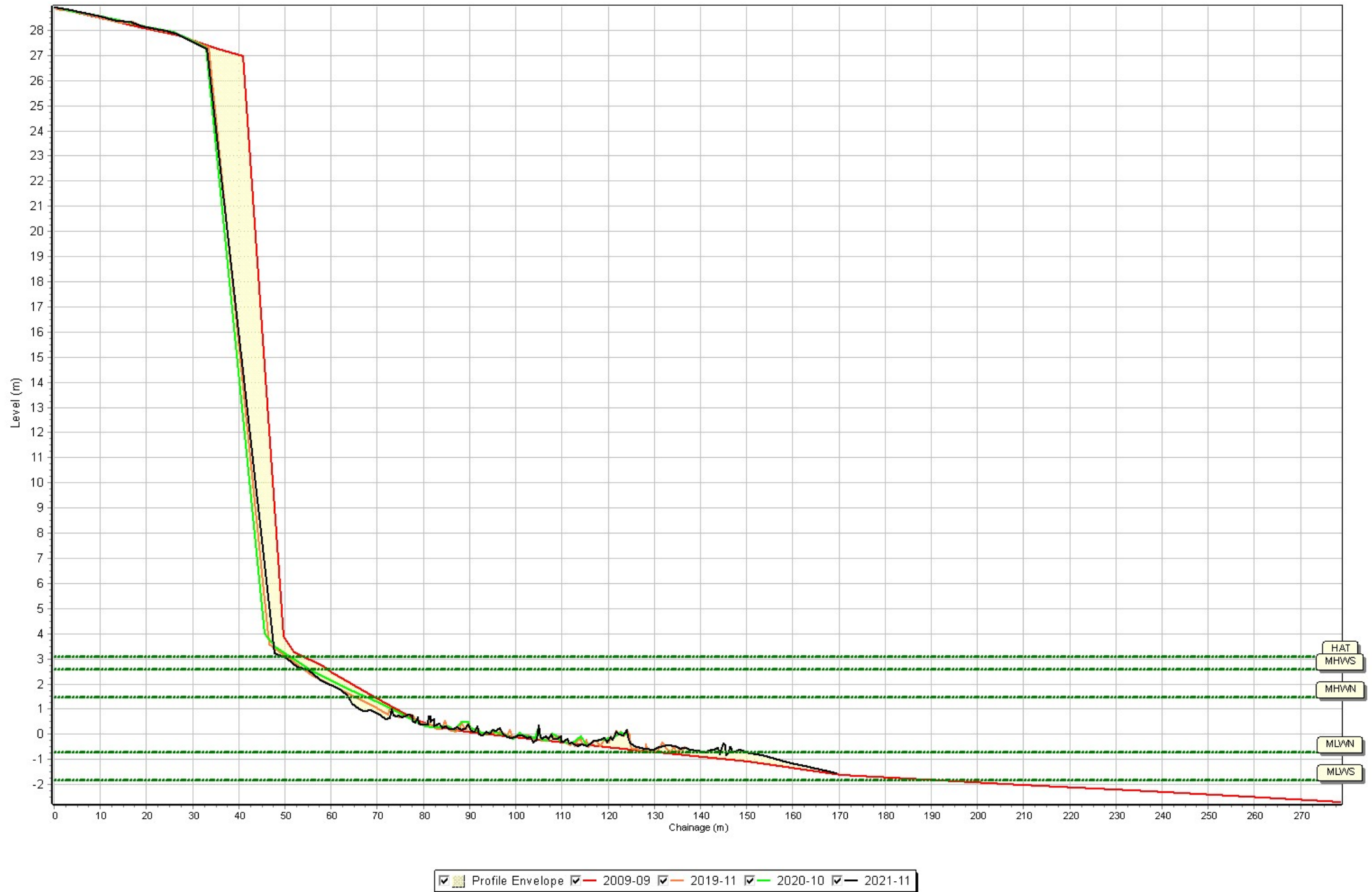
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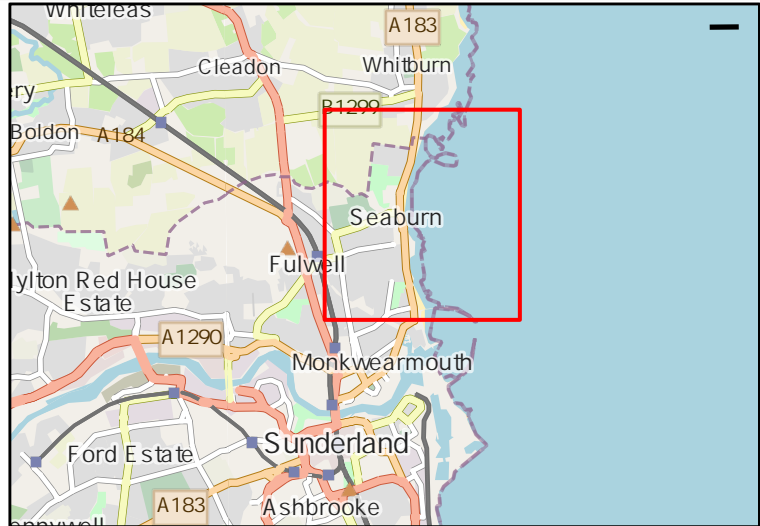


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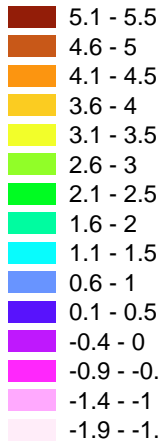
Appendix B

Topographic Survey

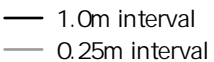


TOPOGRAPHIC SURVEY (November 2021)

Elevation (mOD)



Contours (mOD)*



* Contours only cover sandy beach areas.

Client:

North East
Coastal Group

Project:

Cell 1 Regional Coastal
Monitoring Programme

Title:

Appendix B - Map 1
SUNDERLAND NORTH
Sunderland City Council Frontage

Report:

Analytical Report
'Full Measures' Survey 2021

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	15/12/2021	TC	NJC	A3	1:10,000

Co-ordinate system: British National Grid





TOPOGRAPHIC SURVEY (November 2021)

Elevation (mOD)	Contours (mOD)*
2.6 - 3	1.0m interval
2.1 - 2.5	0.25m interval
1.6 - 2	
1.1 - 1.5	
0.6 - 1	
0.1 - 0.5	
-0.4 - 0	
-0.9 - -0.5	
-1.4 - -1	
-1.8 - -1.5	

* Contours only cover sandy beach areas.

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

Title:

Appendix B - Map 2

SUNDERLAND SOUTH

Sunderland City Council Frontage

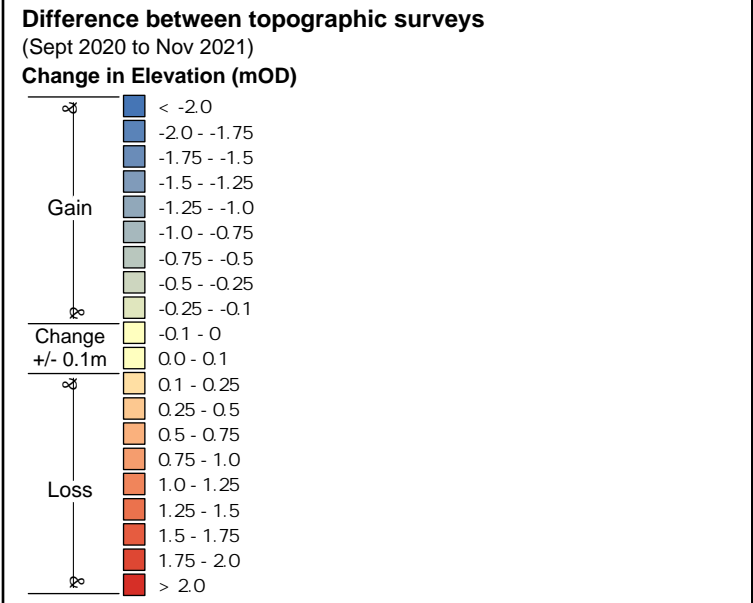
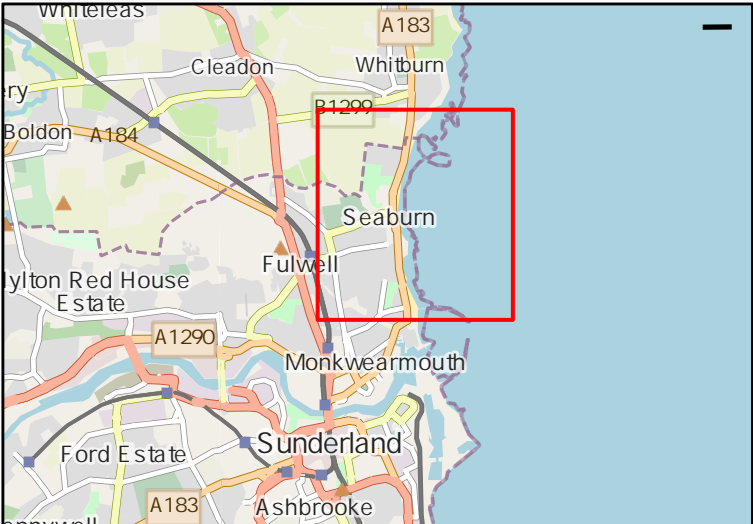
Report:

Analytical Report
'Full Measures' Survey 2021

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





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

Title:

Appendix B - Map 3

SUNDERLAND NORTH

Sunderland City Council Frontage

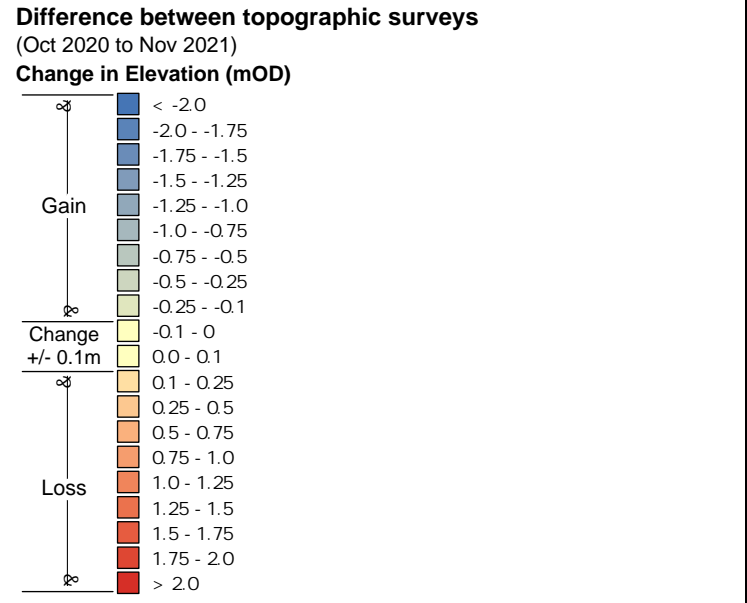
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Analytical Report
'Full Measures' Survey 2021

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Co-ordinate system: British National Grid





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

Title:

Appendix B - Map 4

SUNDERLAND SOUTH

Sunderland City Council Frontage

Report:

Analytical Report
'Full Measures' Survey 2021

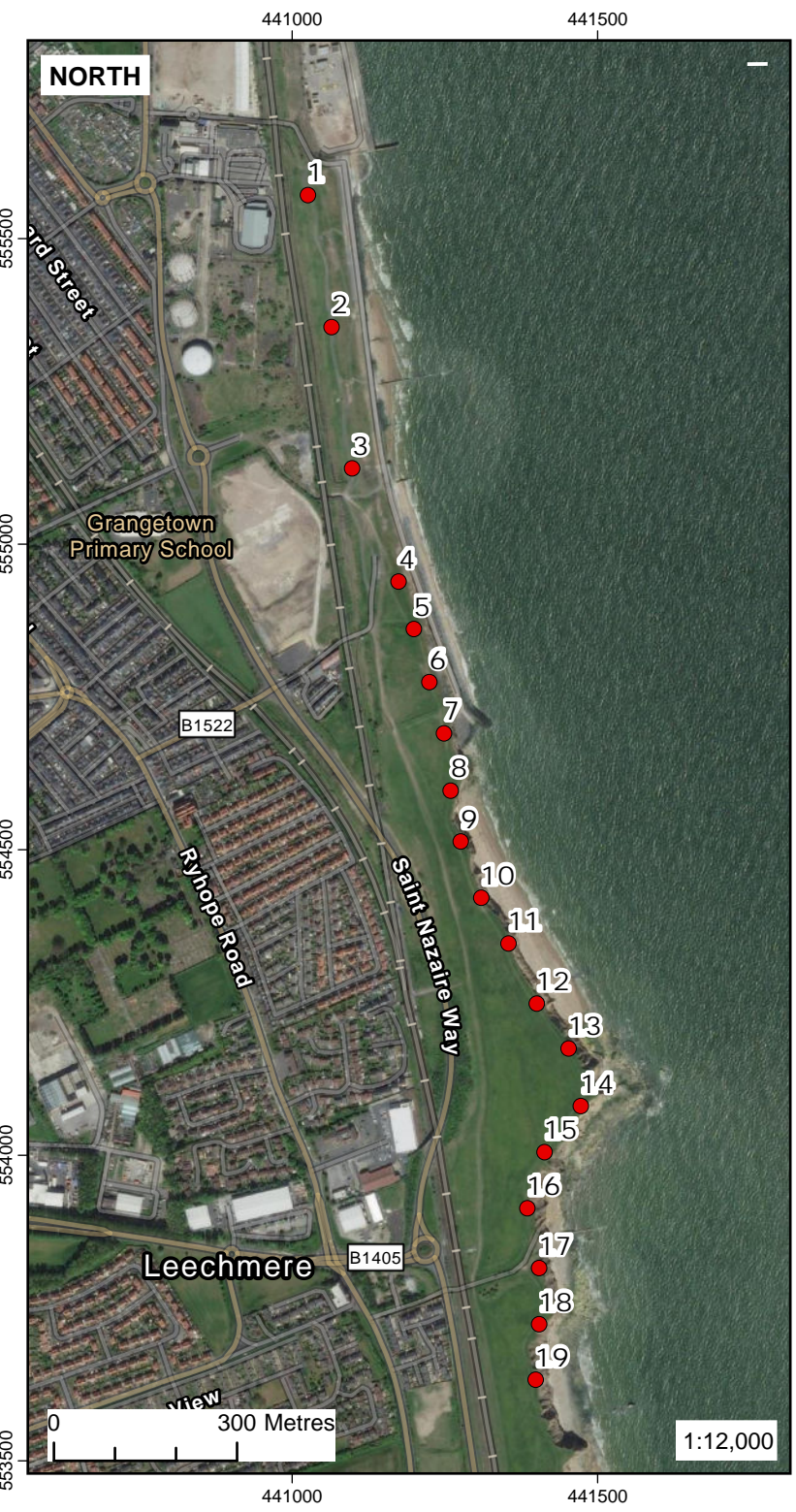
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Co-ordinate system: British National Grid



Appendix C

Cliff Top Survey



SURVEY LOCATIONS

- Cliff Top Survey Points

© HaskoningDHV UK Ltd.
World Imagery: Maxar, Microsoft
GB Cartographic Local Names: Contains OS data © Crown Copyright and database right 2020
Contains data from OS Zoomstack
Hybrid Reference Layer: Esri Community Maps Contributors, Esri UK, Esri, HERE, Garmin, INCREMENT P, METI/NASA, USGS

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

Royal HaskoningDHV
Enhancing Society Together

North East Coastal Observatory

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 2021	November 2021	Mar 2009 - Nov 2021	Apr 2021 - Nov 2021	Mar 2009 - Nov 2021
1	441025.7	555571.1	75	8.16	8.43	8.21	0.05	0.22	0.00
2	441064.4	555355.1	85	7.09	6.06	5.06	-2.03	1	-0.17
3	441098	555124	82	10.01	10.09	10.32	0.31	-0.23	0.03
4	441174	554938.7	65	10.3	10.53	10.48	0.18	0.05	0.02
5	441199.1	554861.1	65	7.71	7.54	10.96	3.25	-3.42	0.27
6	441224.5	554774.2	71	10.83	10.79	10.94	0.11	-0.15	0.01
7	441248.4	554690.3	74	10.18	10.34	10.43	0.25	-0.09	0.02
8	441259.3	554596.6	101	10.08	9.51	9.47	-0.61	0.04	-0.05
9	441275.8	554513.4	66	10.52	5.69	5.7	-4.82	-0.01	-0.40
10	441309.4	554421.3	58	8.77	1.16	1.2	-7.57	-0.04	-0.63
11	441354	554346.5	68	8.2	2.17	0.65	-7.55	1.52	-0.63
12	441400.2	554248.2	56	6.17	5.69	5.59	-0.58	0.1	-0.05
13	441452.3	554174.7	63	11.61	5.88	5.51	-6.1	0.37	-0.51

Ground Control Points				Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
14	441472.3	554080.5	127	7.33	5.79	5.81	-1.52	-0.02	-0.13
15	441413	554005.1	122	7.84	7.73	7.75	-0.09	-0.02	-0.01
16	441384.8	553913.3	90	9.89	7.02	7.01	-2.88	0.01	-0.24
17	441404.1	553815.5	93	6.32	5.66	5.85	-0.47	-0.19	-0.04
18	441404.1	553723.6	119	8.1	3.02	2.19	-5.91	0.83	-0.49
19	441398.5	553632.8	78	8.23	3.88	3.99	-4.24	-0.11	-0.35
20	441438.3	553452.9	71	10.09	5.35	5.28	-4.81	0.07	-0.40
21	441506.1	553256.1	62	8.57	3.53	3.56	-5.04	0.03	-0.42
22	441550.1	553158.7	103	6.57	3.08	3.06	-3.51	0.02	-0.29
23	441585.2	553076.5	64	8.11	3.54	3.48	-4.63	0.06	-0.39
24	441624.4	552870.7	69	7.53	2.34	2.16	-5.37	0.18	-0.45
25	441689.1	552758	70	14.58	2.32	2.32	-12.26	0	-1.02
26	441715	552713.3	54	12.87	2.58	2.49	-10.38	0.09	-0.87
27	441749.2	552674.4	62	14.56	2.89	2.52	-12.04	0.37	-1.00
28	441776.6	552629.9	57	8.62	2.56	2.45	-6.17	0.11	-0.51
28A	441798.6	552586.3	56	13.63	6.15	6.15	-7.48	0	-0.62
28B	441817.4	552542.4	64	12.3	8.49	8.39	-3.91	0.1	-0.33
28C	441852.2	552502.6	52	13.11	12.31	12.45	-0.66	-0.14	-0.06
29	441880.1	552471.6	83	15.46	14.57	14.54	-0.92	0.03	-0.08
30	441921.4	552269	97	8.55	4.27	4.21	-4.34	0.06	-0.36
31	441853.1	552094	75	11.2	2.15	2.1	-9.1	0.05	-0.76
32	441883.3	551988.5	96	9.82	2.62	2.54	-7.28	0.08	-0.61