North East Coastal Observatory

SCARBOROUGH BOROUGH COUNCIL

Royal HaskoningDHV
Enhancing Society Together

Cell 1 Regional Coastal Monitoring Programme Update Report 14: 'Partial Measures' Survey 2022

REDCAR & CLEVELAND BOROUGH COUNCIL

Redcar and Cleveland Council

July 2022

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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)
	Coatham Sands to Saltburn Sands
HAT	3.25
MHWS	2.65
MHWN	1.45
MLWN	-0.85
MLWS	-1.95

Source: UKHO Admiralty Tide Tables, 2020

Glossary of Terms

Term	Definition
Beach nourishment	Artificial process of replenishing a beach with material from another source.
Berm crest	Ridge of sand or gravel deposited by wave action on the shore just above the normal high water mark.
Breaker zone	Area in the sea where the waves break.
Coastal squeeze	The reduction in habitat area which can arise if the natural landward migration of a habitat under sea level rise is prevented by the fixing of the high water mark, e.g. a sea wall.
Downdrift	Direction of alongshore movement of beach materials.
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.

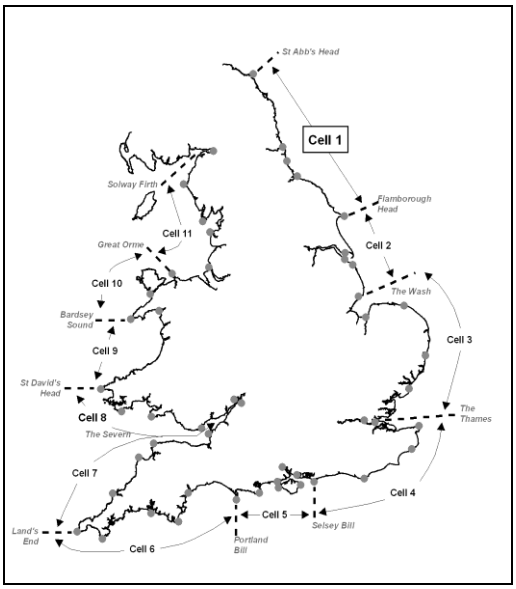

Figure 1 Sediment Cells in England and Wales

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:

Northumberland County Council
North Tyneside Council
South Tyneside Council
Sunderland City Council
Durham County Council
Redcar & Cleveland Borough Council
Hartlepool Borough Council
Scarborough Borough Council
East Riding of Yorkshire Council
Environment Agency
Natural England
The National Trust

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

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

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

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

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

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

At the end of each phase of the programme, a Cell 1 Overview Report is also produced. This provides a region-wide summary of the main findings relating to trends and interactions along the entire Cell 1 frontage. To date the following reports have been produced:

To date the following reports have been produced:

Table 1 Analytical, Update and Overview Reports Produced to Date

Year		Full Measures		Partial Measures		Cell 1 Overview Report
		Survey	Analytical Report	Survey	Update Report	
1	2008/09	Sep-Dec 08	May 09	Mar-May 09		
2	2009/10	Sep-Dec 09	Mar 10	Feb-Mar 10	Jul 10	
3	2010/11	Aug-Nov 10	Feb 11	Feb-Apr 11	Aug 11	Sep 11
4	2011/12	Sep-Oct 11	Oct 12	Mar-May 12	Feb 13	
5	2012/13	Sep 2012	Mar 13	Feb- Mar 13	May 13	
6	2013/14	Oct-Nov 13	Feb 14	Mar-Apr 14	Jul 14	
7	2014/15	Sep-Oct 14	Feb 15	Mar-Apr	Jul 15	
8	2015/16	Sep-Oct 15	Feb 16	Mar 16	Jul 16	Jun 16
9	2016/17	Sep-Nov 16	Feb 17	Mar 17	Jul 17	
10	2017/18	Oct 17	Mar 18	Mar-May 18	Jun 18	
11	2018/19	Sep 18	Mar 19	Mar-Apr 19	May 19	
12	2019/20	Sep-Nov 19	Jan 20	Mar–May 20	Aug 20	
13	2020/21	Oct-Dec 20	Feb 21	Mar 21	May 21	Aug 21
14	2021/22	Sep-Oct 21	Dec 21	April 22	Jul 22 (*)	

(*) The present report is **Update Report 14** and provides an analysis of the 2022 Partial Measures survey for Redcar and Cleveland Council's frontage.

1. Introduction

1.1 Study Area

South Gare Breakwater at the mouth of the River Tees estuary to Cowbar Nab at Staithes. For the purposes of this report, it has been sub-divided into six areas, namely:

- Coatham Sands
- Redcar Sands
- Marske Sands
- Saltburn Sands
- Cattersty Sands (Skinningrove)
- Staithes[2]

1.2 Methodology

Along Redcar & Cleveland Borough Council's frontage, the following surveying is undertaken:

- Full Measures survey annually each autumn/early winter comprising:
    - Beach profile surveys along nine transect lines
    - Topographic survey along Coatham Sands
    - Topographic survey along Redcar Sands
    - Topographic survey along Marske Sands
    - Topographic survey along Saltburn Sands
    - Topographic survey at Skinningrove along Cattersty Sands

- Partial Measures survey annually each spring comprising:
    - Beach profile surveys along nine transect lines
    - Topographic survey along Redcar Sands
    - Topographic survey along Saltburn Sands
    - Topographic survey at Skinningrove along Cattersty Sands

- Cliff top survey (biannually) at:
    - Staithes

The location of these surveys is shown in Figure 2 and 3. The Partial Measures survey was undertaken along this frontage between 19th and 21st April at Redcar (Coatham Sands, Redcar Sands, Markse Sands and Saltburn Sands), 22th March at Skinningrove and 25th April at Staithes. During the surveys the weather was varied with varying sea states. Specific weather conditions are detailed in the survey reports.

Processed data from the present survey are presented in the Appendices.

[2] The Staithes frontage straddles the boundary of jurisdiction of Redcar & Cleveland Borough Council and Scarborough Borough Council

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

COATHAM SANDS TO SALTBURN SANDS

Redcar and Cleveland Borough Council Frontage

Report: Survey Report

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	n/a	TC	NJC	A4	1:65,000

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

CATTERSTY SANDS (SKINNINGROVE)

Redcar and Cleveland Borough 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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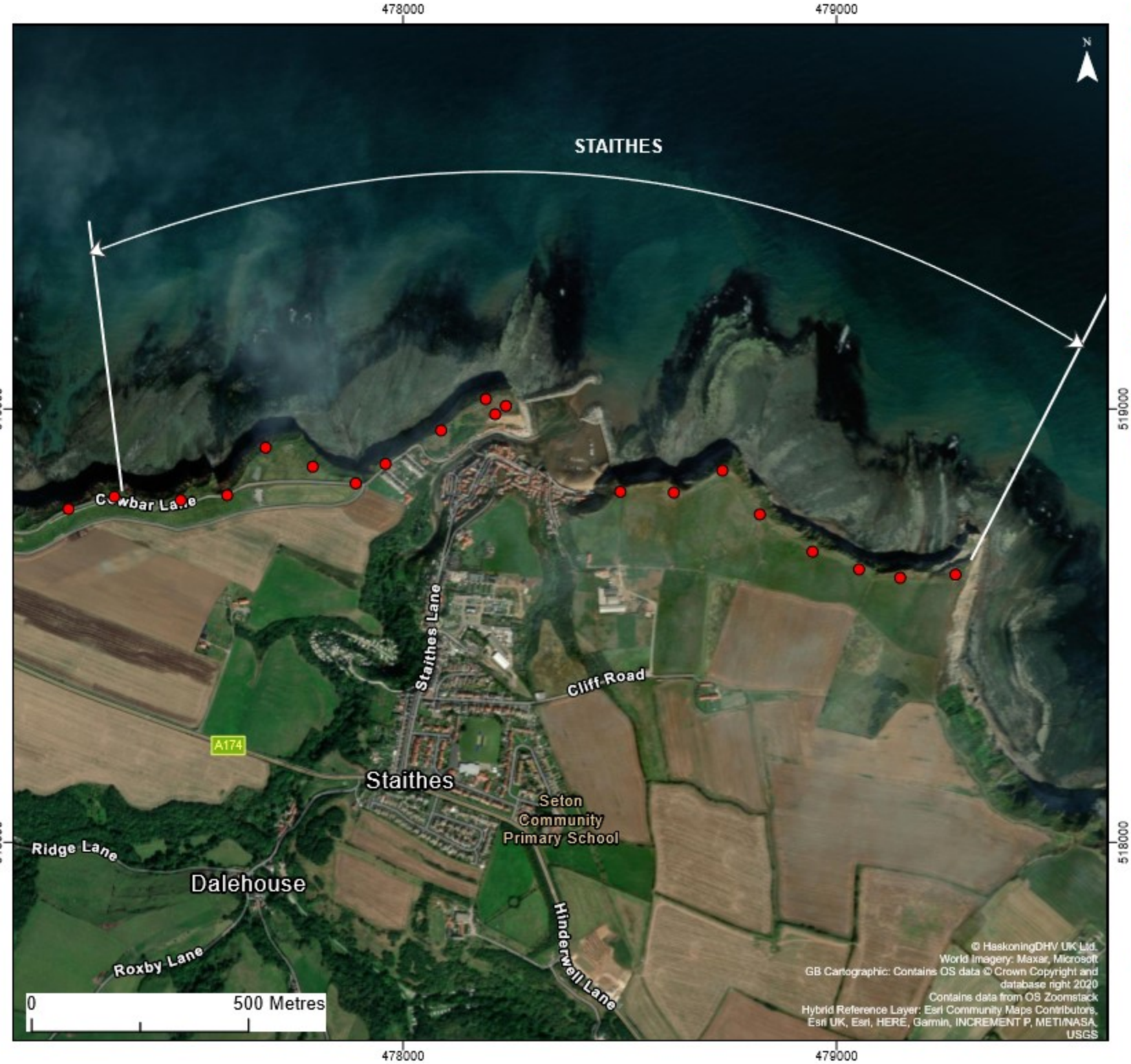

SURVEY LOCATIONS

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

STAITHES

Redcar and Cleveland Borough 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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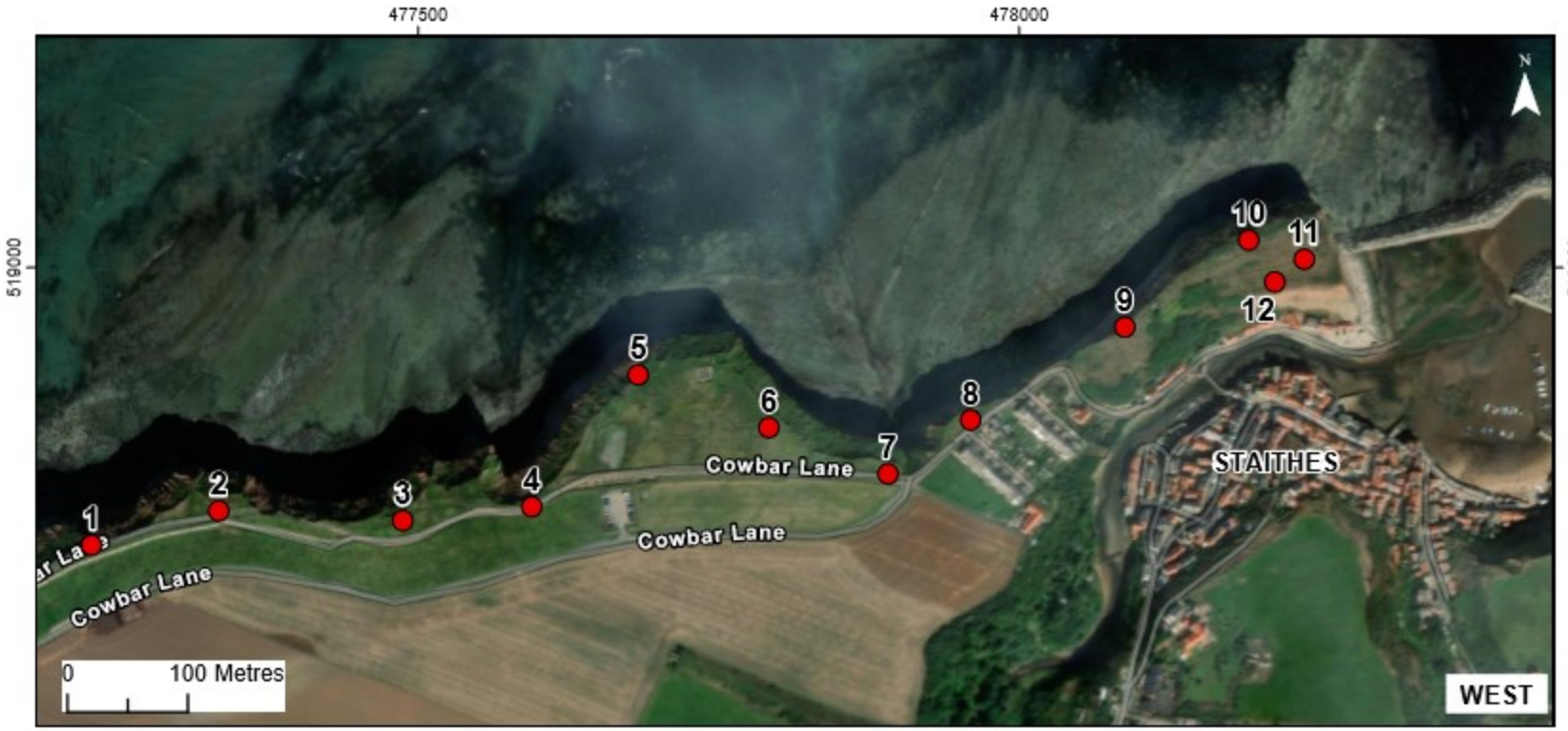

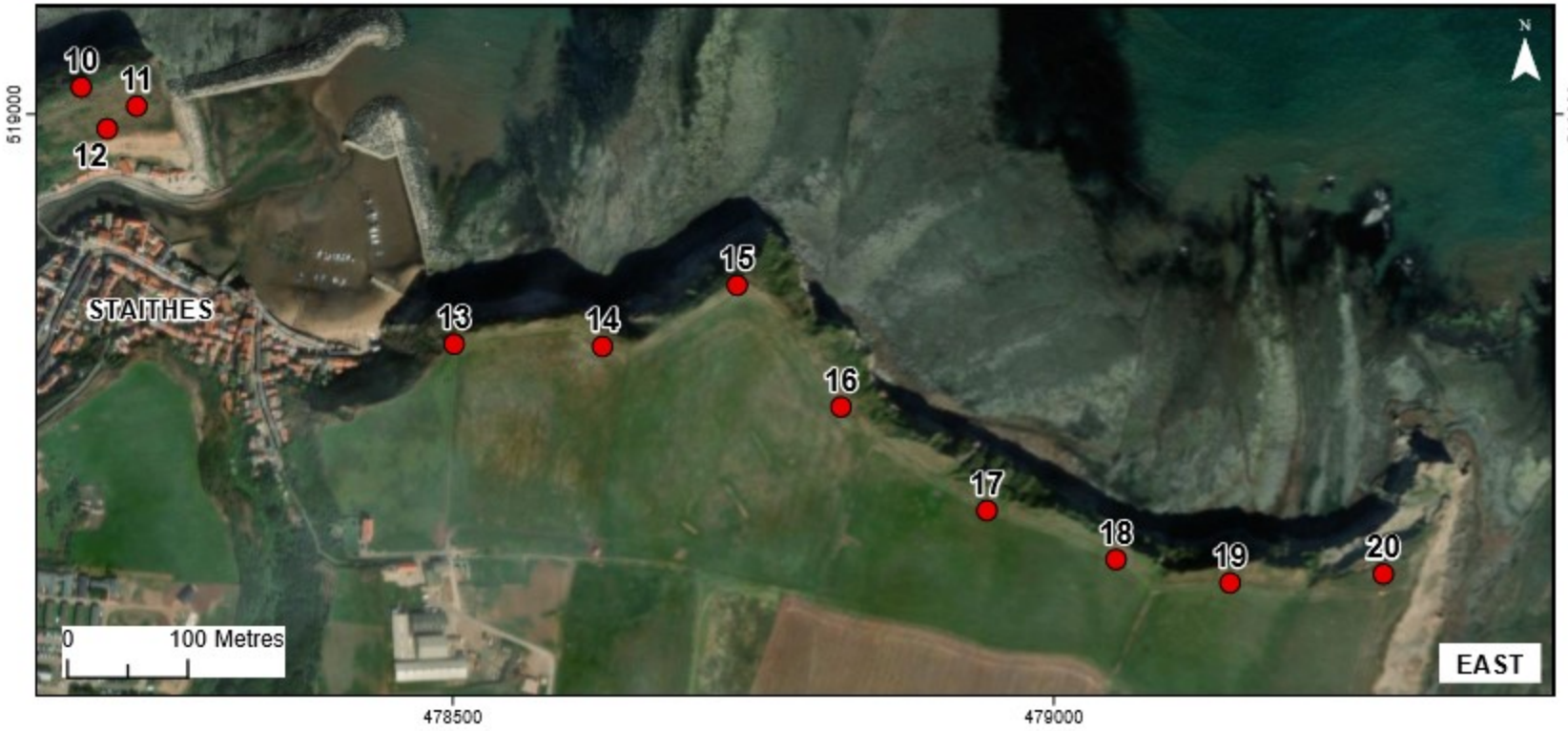

SURVEY LOCATIONS

- Cliff Top Survey Points

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

Title:

Figure 3 - Map 1

STAITHES

Redcar and Cleveland Borough 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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2. Analysis of Survey Data

2.1 Coatham Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
19th – 21st April 2022	**Beach Profiles:** Coatham Sands is covered by four beach profiles during the Partial Measures survey (1cRC1 to 1cRC4; Appendix A) that were last surveyed in autumn 2021. **Profile 1cRC1** is located 300m southeast of the South Gare Breakwater, in the lee of the German Charlies slag banks. The upper profile to 105m chainage is dominated by dunes that have remained stable since 2009. The highest dune (chainage 60m) is unchanged since October 2013. The beach appears to have experienced a general draw down of material from the upper beach to the mid and lower beach. From the toe of the foredune to chainage 215m, the beach has dropped in level since October 2021 by a magnitude up to 0.45m. Between chainage 215m and 260m the beach has accreted by 0.55m in level. Overall, the profile remains at a high level compared to the range of previously recorded results. At **profile 1cRC2** the face of the foredune has advanced seaward approximately 1m. The crest has also accreted by 0.1m in level. The rear dunes have remained largely stable. The majority of the upper beach, between chainage 102m to 210m, is unchanged, except a small length of erosion at 115m. The lower beach profile has smoothened out causing alternating lengths of accretion and erosion where several beach berms were observed previously. The magnitude of change is limited to ±0.55m. Overall the beach is at a very high level compared to the range recorded from previous surveys. **Profile 1cRC3** showed the main dune has remained stable since April 2014, with little change again observed to chainage 52m since October 2021. At the toe of the dunes, the upper beach from chainage 52m to chainage 80m has decreased in level by 0.3m. Between chainages 80m and 150m the beach has experienced negligible change. Seaward of chainage 150m it appears there has been some drawdown of material with a drop in level occurring to chainage 240m and an increase in level between 260m and 302m of similar magnitude (0.25m). Overall, the profile remains at a high level compared to the range of previously recorded results.	Since the previous survey in October 2021, there has been a relatively small change across the profiles, particular the two central profiles. There is a general trend of drawdown of material from the upper and middle sections of the beach to the lower sections. With all four profiles experiencing accretion along the lower profile, albeit at varying magnitudes All four profiles show the dunes have remained stable over winter 2021/22 with either no change or minor accretion observed. **Longer term trends:** All beach profiles at Coatham show the dunes are stable or accreting on their seaward extent. The beaches to the west show a typical longer-term trend of progressive accretion. The beaches in the centre and to the east have a more fluctuating long-term pattern.

Survey Date	Description of Changes Since Last Survey	Interpretation
	Profile 1cRC4 is located at the beginning of the defended section at Coatham and Redcar. There has been no change in the profile up to the seawall at chainage 12m. The steep upper beach, between chainage 12m and 30m, has been eroded dropping in level by up to 0.3m. Seawards of chainage 30m, the beach profile has generally slackened. This is as a result of a minor drop in level between chainage 30m to 215m and a similar magnitude accretion seaward of chainage 215m. The profile remains at a low level when compared to the range recorded from previous surveys.	

2.2 Redcar Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
19th – 21st April 2022	**Beach Profiles:** Redcar Sands is covered by three beach profiles (1cRC5 to 1cRC7; Appendix A), with 1cRC7 being approximately on the boundary with the Marske Sands area. They were last surveyed in October 2021. At **profile 1cRC5** the sea defences constructed in 2012 remain unchanged as far as 18m chainage. The beach levels at the toe of the structure have dropped by 0.55m in level since the previous inspection exposing more of the stepped revetment. Beach levels have also dropped between 44m and 96m exposing the rock foreshore platform. Seaward of chainage 110m the rock foreshore remains exposed. Overall, the beach levels at a low level when compared to the range of previous surveys. **Profile 1cRC6** has experienced negligible change landward of chainage 150m since the last survey due, in part, to the presence of the sea defence up to 55m. Seaward of chainage 150m, the lower beach has accreted by 0.6m in level causing the profile to slacken. Overall, the beach is at medium level when compared the range previous surveys, except the very lower beach which at the highest level on record. **Profile 1cRC7** is undefended. The profile has not changed landward of chainage 65m since the last survey. Between chainages 70m and 223m, the beach levels have dropped, by 0.1m on the upper beach and 0.4m on the mid beach. There has been a rise in level between chainages 223m and 288m, suggesting a winter draw down of sediment. The lower foreshore has been exposed seaward of chainage 288m. Overall, the beach is at medium level when compared the range previous surveys, except the very lower beach which at the lowest level on record.	Beach levels remain low between Coatham Rocks and Redcar Rocks, with further erosion exposing additional rocky foreshore. The eastern profiles appear to demonstrate drawdown of material from the upper beach to the lower beach typical of winter conditions. **Longer term trends:** Profiles 1cRC5 and 1cRC7 show movement of beach berms across the profile.
	Topographic Survey: Redcar Sands is covered by a 6-monthly topographic survey. Data have been used to create a DGM (Appendix B – Map 1) using a GIS. The DGM shows that the beach topography is broadly parallel to the shore, although there is a slight embayment with a slightly steeper beach between the two headlands at Coatham Rocks and Redcar Rocks. The contours around Redcar Rocks are distorted due to the exposed rocky foreshore. The GIS has also been used to calculate the differences between the current topographic survey (autumn 2020) and the most recent (April 2021) topographic survey, as shown in Appendix B – Map 4,	The topographic difference plots shows that despite apparent wide scale change across Redcar Sands, there appears to be a balance between accretion and erosion suggesting the volume of sediment has remained stable.

Survey Date	Description of Changes Since Last Survey	Interpretation
	to identify areas of erosion and accretion. The difference plot shows that over winter 21/22, change has been inconsistent across Redcar Sands. At the eastern extent, at the transition to Marske Sands, the beach profile has been dominated by erosion by up to -1.5m on the lower beach. At Redcar Rocks there is patchy low level accretion (+1.0m), characteristic of the rocky foreshore. Between Redcar Rocks and Coatham Rocks the beach has experience intense erosion in the mid beach (-1.75m) with some accretion occurring in the upper and lower extents. At the western extents, at the transition to Coatham Sands, the beach has again been dominated by erosion.,	

2.3 Marske Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
19th – 21st April 2022	**Beach Profiles:** Marske Sands is covered by two beach profiles during the Partial Measures survey (1cRC7 to 1cRC8; Appendix A). 1cRC7 is on the boundary with the Redcar Sands area. **Profile 1cRC7** is located along The Stray and has been discussed in Section 2.2. **Profile 1cRC8** is located to the south of Church Howle at Marske By the Sea. The first 55m of the profile are covered by dunes which have remained in unchanged since the previous survey in autumn 2021. The beach, seaward of chainage 50m, has generally remained stable also. There is alternating lengths of accretion and erosion caused by the smoothening of the profile, but the majority of these areas of change are limited to ±0.1m in level, with the maximum change occurring at chainage 220m with a drop of 0.4m. Overall, the profile is generally at a medium level when compared to the range recorded from previous surveys	The beach and dunes appear to have remained stable over winter 2021/22. Some evidence of beach drawndown is observed in profile 1cRC7. **Longer term trends:** The beach and dunes have been recovering since the exceptionally stormy winter of 2013/14 causing record lows The beach levels in April 2022 were at medium level.

2.4 Saltburn Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
19th – 21st April 2022	**Beach Profiles:** Saltburn Sands is covered by one beach profile (1cRC9; Appendix A). **Profile 1cRC9** is covered by a sea defence as far as chainage 20m and has experienced no change over this defended length. At the toe of the sea defence up to chainage 42m the beach level has dropped by 0.2m in level. For the majority of the beach, between chainages 42m and 183m, the profile has remained largely stable with minor change limited to ±0.15m. Seawards of chainage 183m, the lower beach has accreted by up to 0.5m in level. The beach is at a medium level when compared to the range of previous surveys.	The profile has remained largely stable over winter 21/22. Accretion of the lower beach suggest a slight draw down of material. **Longer term trends:** The profile plots show net erosion, although there are periods of recovery.
	Topographic Survey: Saltburn Sands is covered by a 6-monthly topographic survey. Data have been used to create a DGM (Appendix B – Map 2). The beach topography consists of shore parallel contours, with a small change at the mouth of the channel. This DGM has been compared against the previous (autumn 2021) survey in Appendix B – Map 5. The difference plot comparing the DGMs shows that over winter 21/22, erosion has dominated the upper and mid beach, alternating to accretion across the lower beach. The anomaly to this pattern is the section of beach fronting the beach huts where accretion has dominated both the lower beach and the upper beach, with minor accretion again occurring in the mid beach. The magnitude of change varies across the frontage with the most intense change (±1.25m) occurring at the western extent, eastern extent and at the mouth of Skelton Beck.	

2.5 Cattersty Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
22nd April 2022	**Topographic Survey:** Cattersty Sands is covered by a 6-monthly topographic survey. Data have been used to create a DGM (Appendix B – Map 3). The beach is steeper to the west of the breakwater than the east, but in both areas the gradient is relatively smooth. East of the breakwater, the beach is punctuated by Kilton Beck and the harbour. Immediately east of the former fishtail groyne (which has since been modified to a rock breakwater arm), the stream has cut a channel, which is most deeply incised at its landward extent. The survey report notes that "*strong onshore winds restricted the depth which was achievable on the day*". The April 2022 DGM has been compared against the previous (autumn 2021) survey in Appendix B – Map 8. To the west of the breakwater, there is three distinct bands of shoreline parallel change, with accretion evident on the upper and lower beach and erosion evident in the mid beach. The magnitude of change is most intense at the very western extents at ±1.5m. Between the breakwater and the reconfigured river mouth rock armour accretion has dominated the lower beach. At the mouth itself, erosion is dominant with change limited to -1.25m. In the bay to the east of the rock armour, small scale accretion (+1.0m) is evident on the upper beach and at the toe of the adjacent cliffs with erosion again controlling the lower beach.	The data plot shows that there has been a mixture of accretion and erosion throughout the frontage, with neither process dominating. Accretion is observed to the west of the breakwater on the upper and lower beach and also at the toe of the cliffs to the east. Erosion has dominated on either side of the reconfigured river mouth rock armour. **Longer term trends:** Although not observed during this survey, the long-term trend shows that on the north-west side of the breakwater there is erosion on the upper beach and accretion on the lower beach. On the south-east side of the breakwater there is a long-term pattern of accretion on the mid beach with erosion in the channel mouth. The winter erosion dominates the overall behaviour of the beach but the calmer weather in the summer months should lead to some accretion. If the erosion of the upper beach continues it is likely to drive cliff failures which would add material to the upper beach for redistribution.

2.6 Staithes

Survey Date	Description of Changes Since Last Survey	Interpretation
25th April 2022	**Cliff-top Survey:** Twenty ground control points have been established at Staithes for the purposes of cliff top monitoring. The separation between any two points is a nominal 100m. The cliff top surveys at Staithes are undertaken bi-annually. Data collection involves a distance offset measurement from the ground control point to the cliff edge along a fixed bearing. Appendix C provides results from the April 2022 survey, showing the distance from the ground control point to the edge of the cliff top along the defined bearing and changes in position since the November 2008 baseline survey and the previous October 2021 survey. The results provided in Appendix C show that the majority of the profiles show little or no erosion since the previous survey, with only 2 points experiencing erosion greater than the survey error (0.20m). These are Point 4 (0.27m) and Point 5 (0.30m), both located to the west of the survey extent. 12 of the 20 survey points noted apparent 'accretion' of the cliff top, this is likely to be due to difficulties in accurately identifying the cliff edge through vegetation. The long term recession rates show that three points at Staithes are now greater than 0.2m/year (Point 1 along the road to the west of Staithes (0.6m), Point 4 (0.20m) and Point 13 adjacent to the eastern breakwater at Staithes (0.23m)).	The recorded changes to the cliff top between October 2021 and April 2022 are generally small. There has been two points which show retreat of the cliff top greater than the survey error (Point 4 and Point 5). **Longer term trends:** Table C1 in Appendix C presents the erosion rates calculated from the data collected since 2008. Points 1, 4, and 13 are the only locations with a significant recession rate, which ranges from 0.20 to 0.60m/yr.

3. Problems Encountered and Uncertainty in Analysis

Topographic Survey

- The survey report at Cattersty notes that strong onshore winds restricted the depth which was achievable on the day.

Cliff Top Surveys

- The cliff top surveys at Staithes are assumed to have an accuracy of ± 0.2 m due to the methodology.
- Survey points 9 to 12 at Staithes were previously cordoned off by the National Trust due to a landslip on the headland. However, access to these points has been permitted since spring 2020.

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

- No further recommendations are made at this stage for the fine-tuning of the monitoring programme.

5. Conclusions and Areas of Concern

- At Coatham Sands, there has been a relatively small change across the profiles, particular the two central profiles. There is a general trend of drawdown of material from the upper and middle sections of the beach to the lower sections. With all four profiles experiencing accretion along the lower profile, albeit at varying magnitudes
- Along Redcar Sands, beach levels remain low between Coatham Rocks and Redcar Rocks, with further erosion exposing additional rocky foreshore. The eastern profiles appear to demonstrate drawdown of material from the upper beach to the lower beach typical of winter conditions.
- At Marske Sands, the beach and dunes appear to have remained stable over winter 2021/22
- At Saltburn Sands, the profile has remained largely stable over winter 2021/22. Accretion of the lower beach suggest a slight draw down of material.
- Across Cattersty Sands, the data plot shows that there has been a mixture of accretion and erosion throughout the frontage, with neither process dominating. Accretion is observed to the west of the breakwater on the upper and lower beach and also at the toe of the cliffs to the east. Erosion has dominated on either side of the reconfigured river mouth rock armour.
- At Staithes, the recorded changes to the cliff top between October 2021 and April 2022 are generally small. There has been two points which show retreat of the cliff top greater than the survey error (Point 4 and Point 5).

Appendices

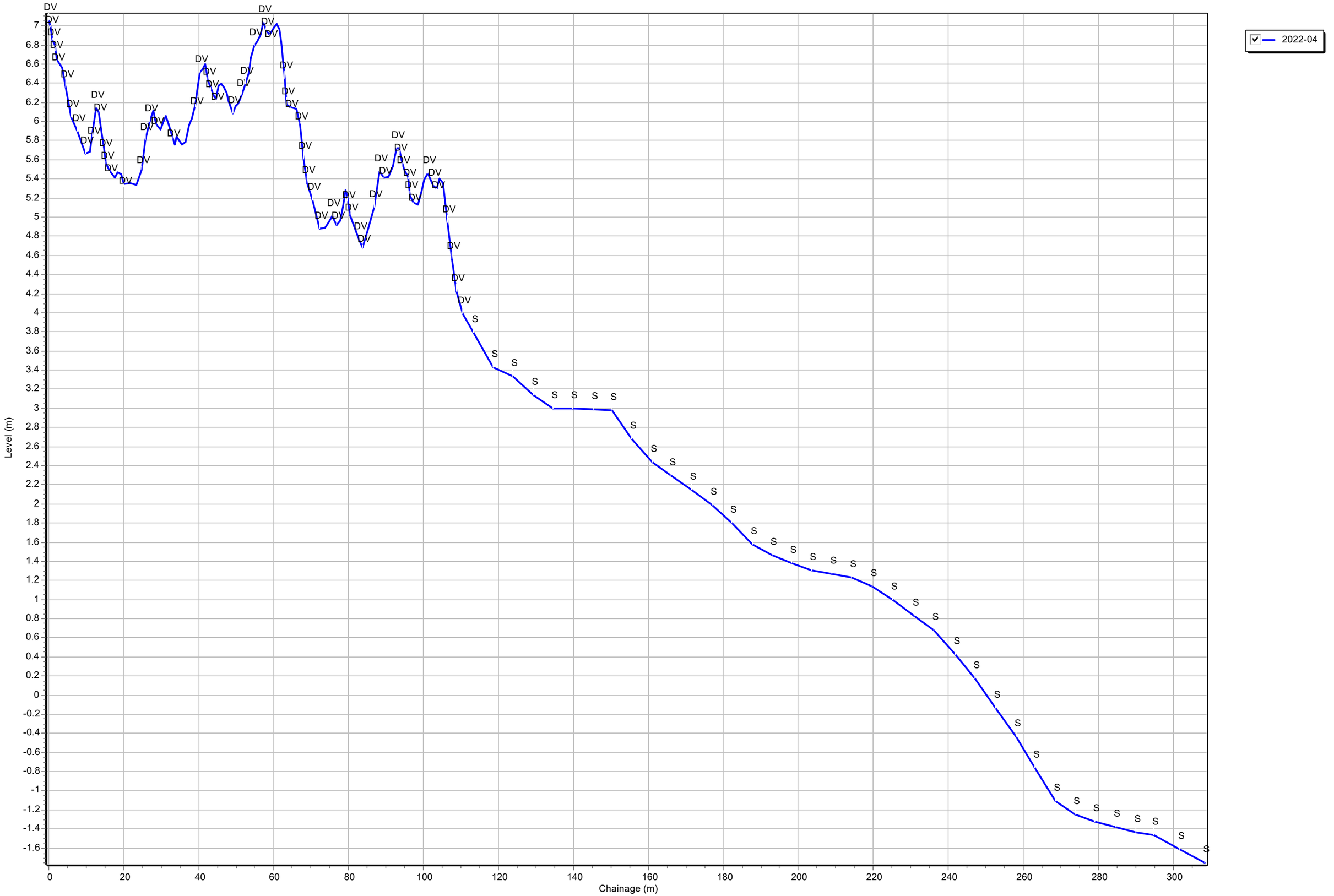
Appendix A

Beach Profiles

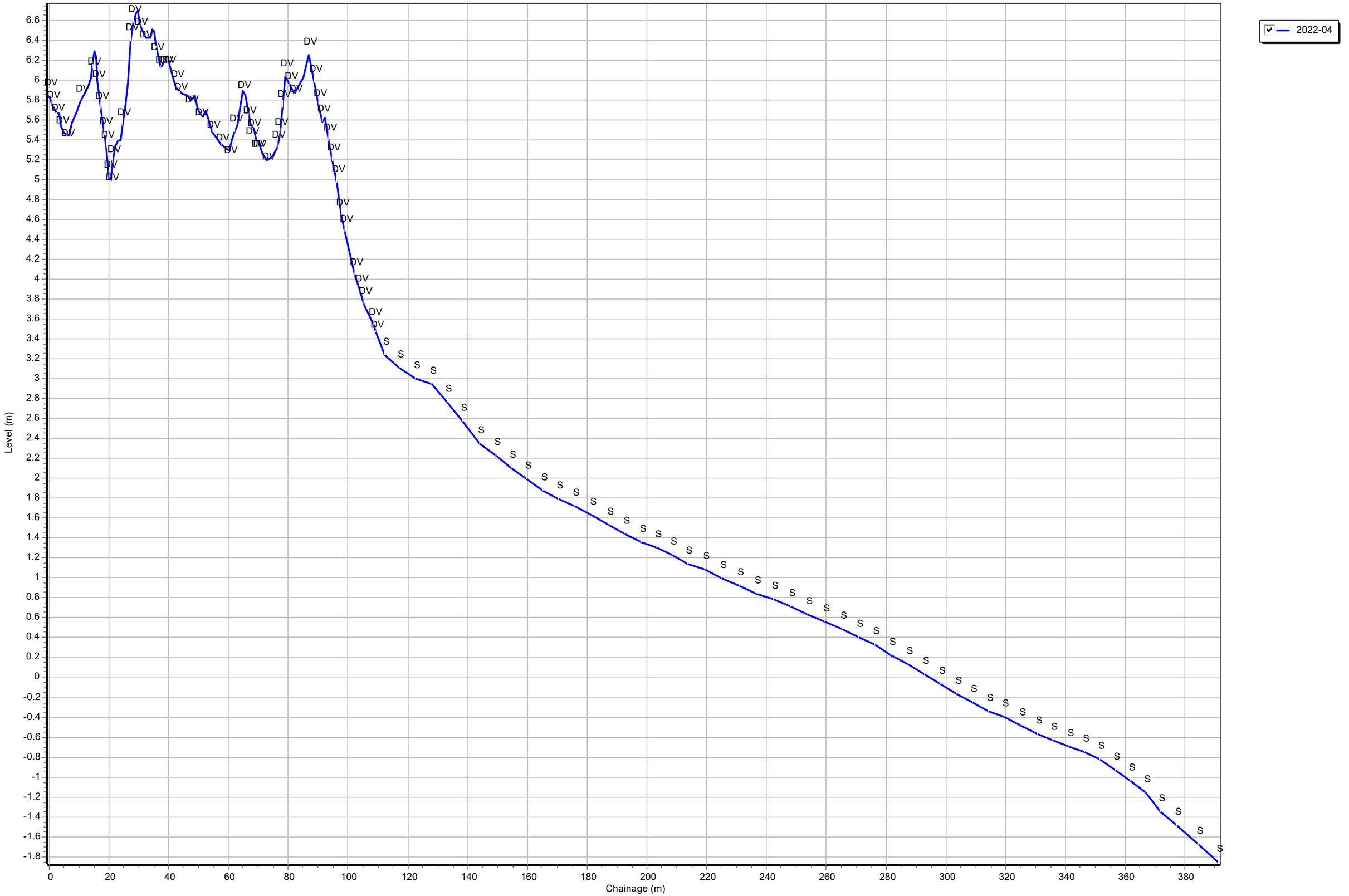
The following sediment feature codes are used on some profile plots:

Code	Description
S	Sand
M	Mud
G	Gravel
GS	Gravel & Sand
MS	Mud & Sand
B	Boulders
R	Rock
SD	Sea Defence
SM	Saltmarsh
W	Water Body
GM	Gravel & Mud
GR	Grass
D	Dune (non-vegetated)
DV	Dune (vegetated)
F	Forested
X	Mixture
FB	Obstruction
CT	Cliff Top
CE	Cliff Edge
CF	Cliff Face
SH	Shell
ZZ	Unknown

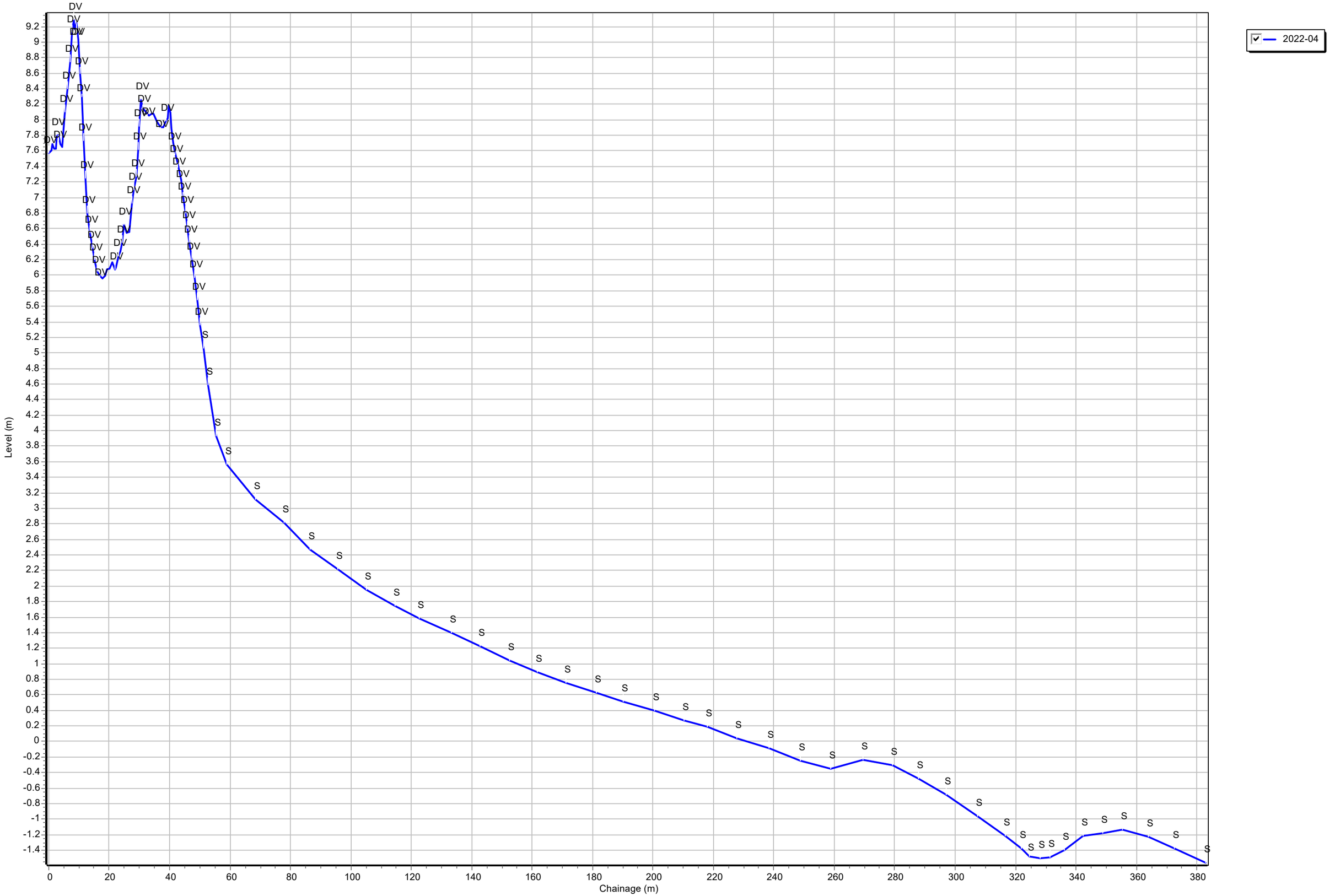
Profiles: 1cRC1



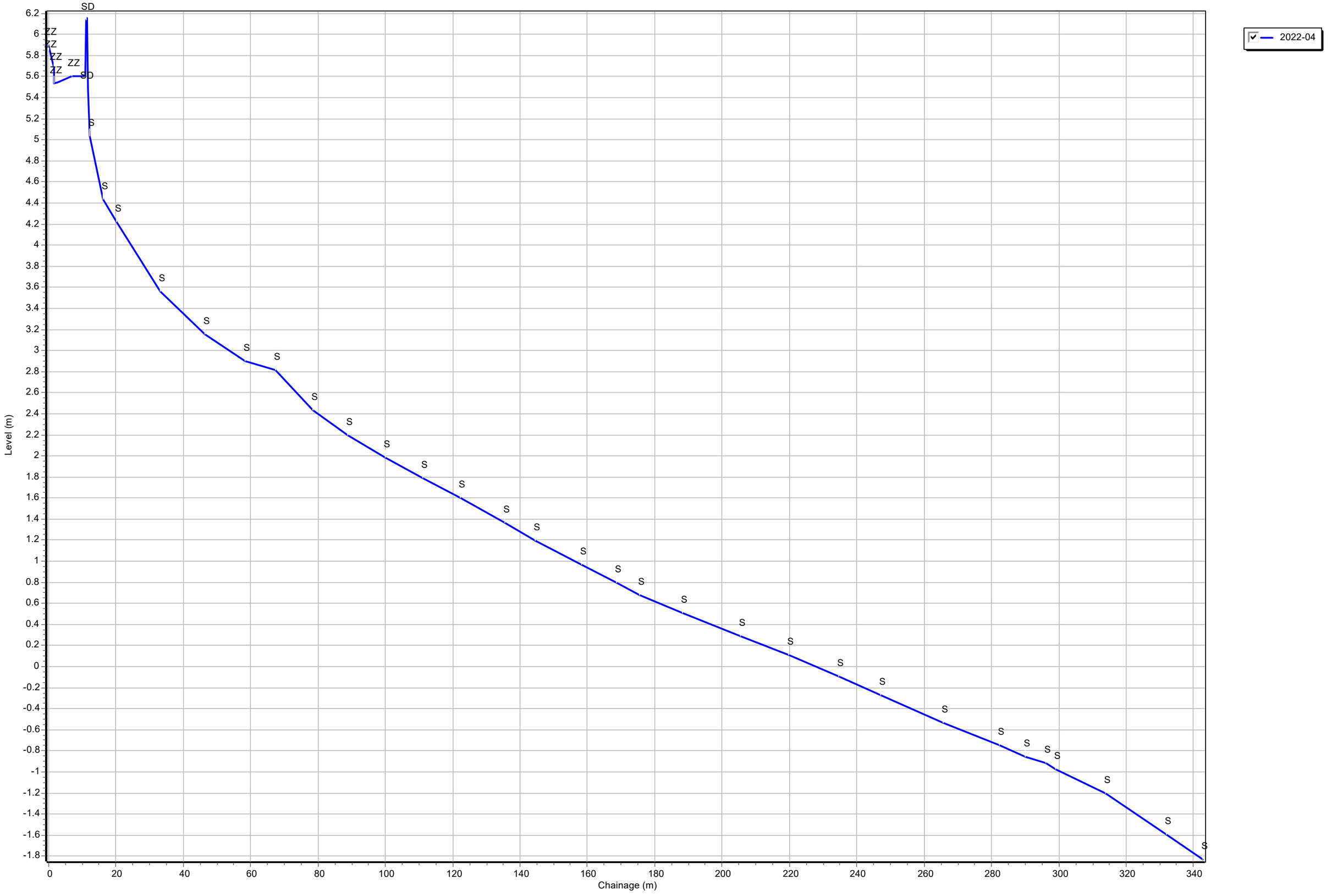
Profiles: 1cRC2



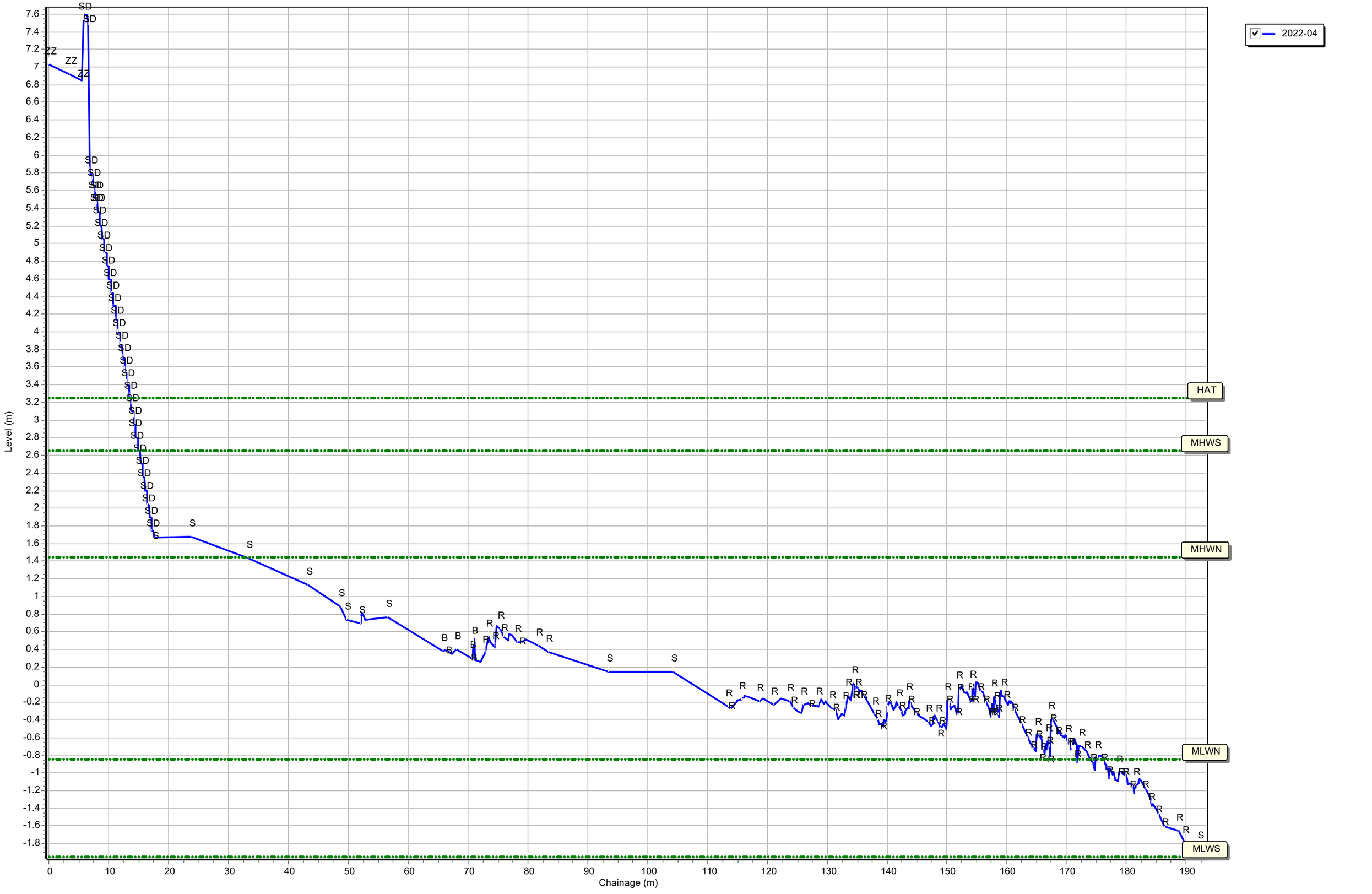
Profiles: 1cRC3



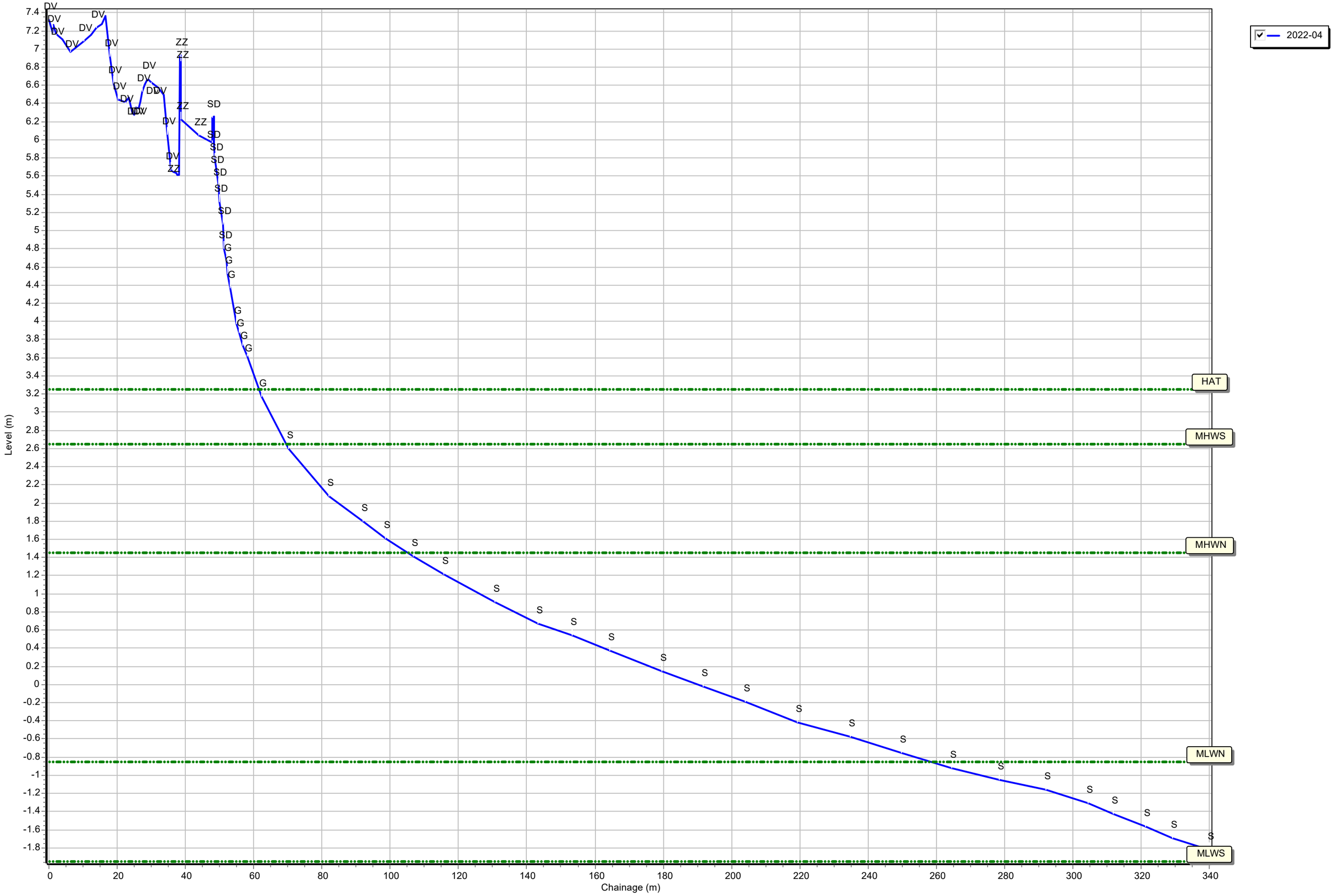
Profiles: 1cRC4



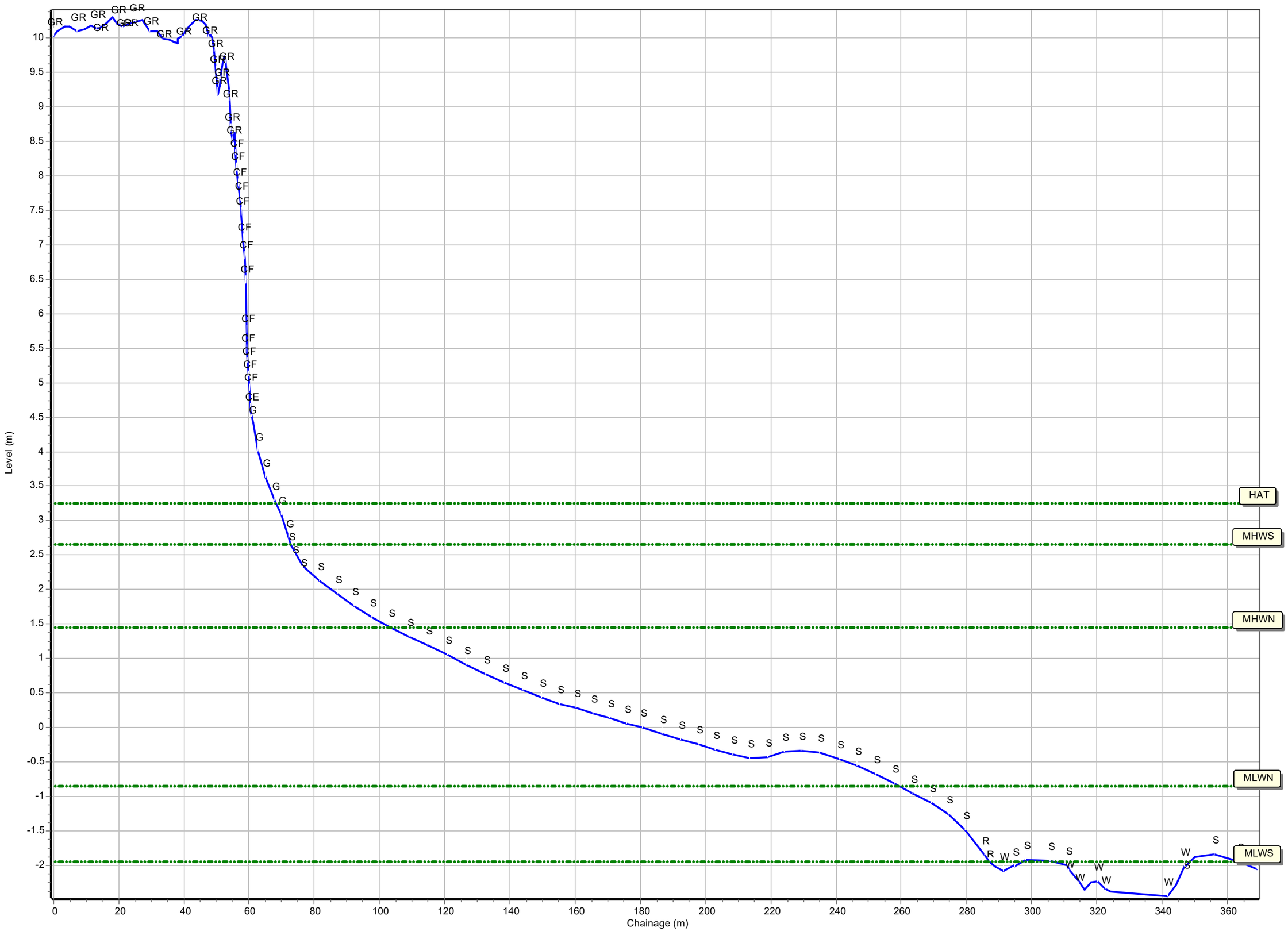
Profiles: 1cRC5



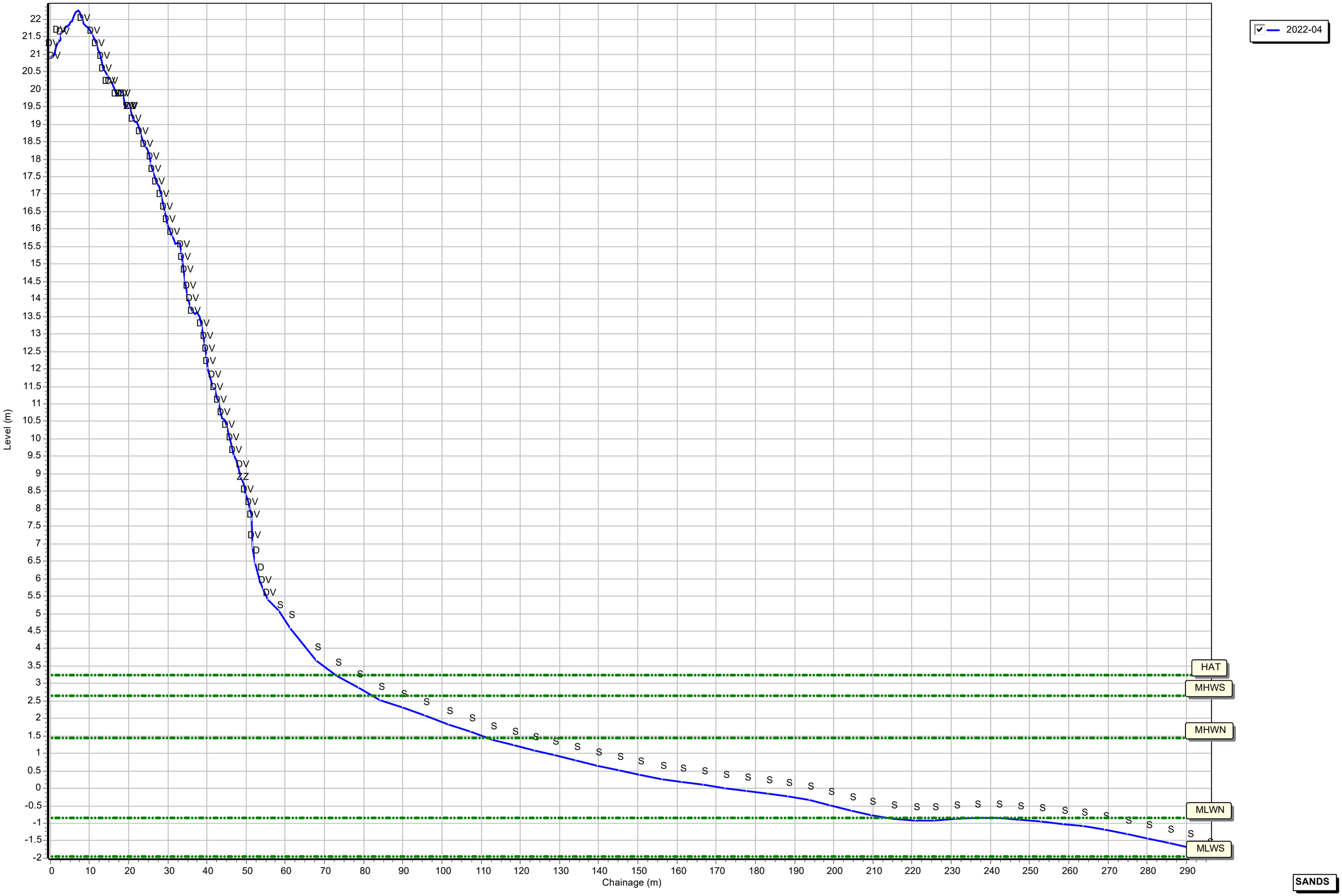
Profiles: 1cRC6



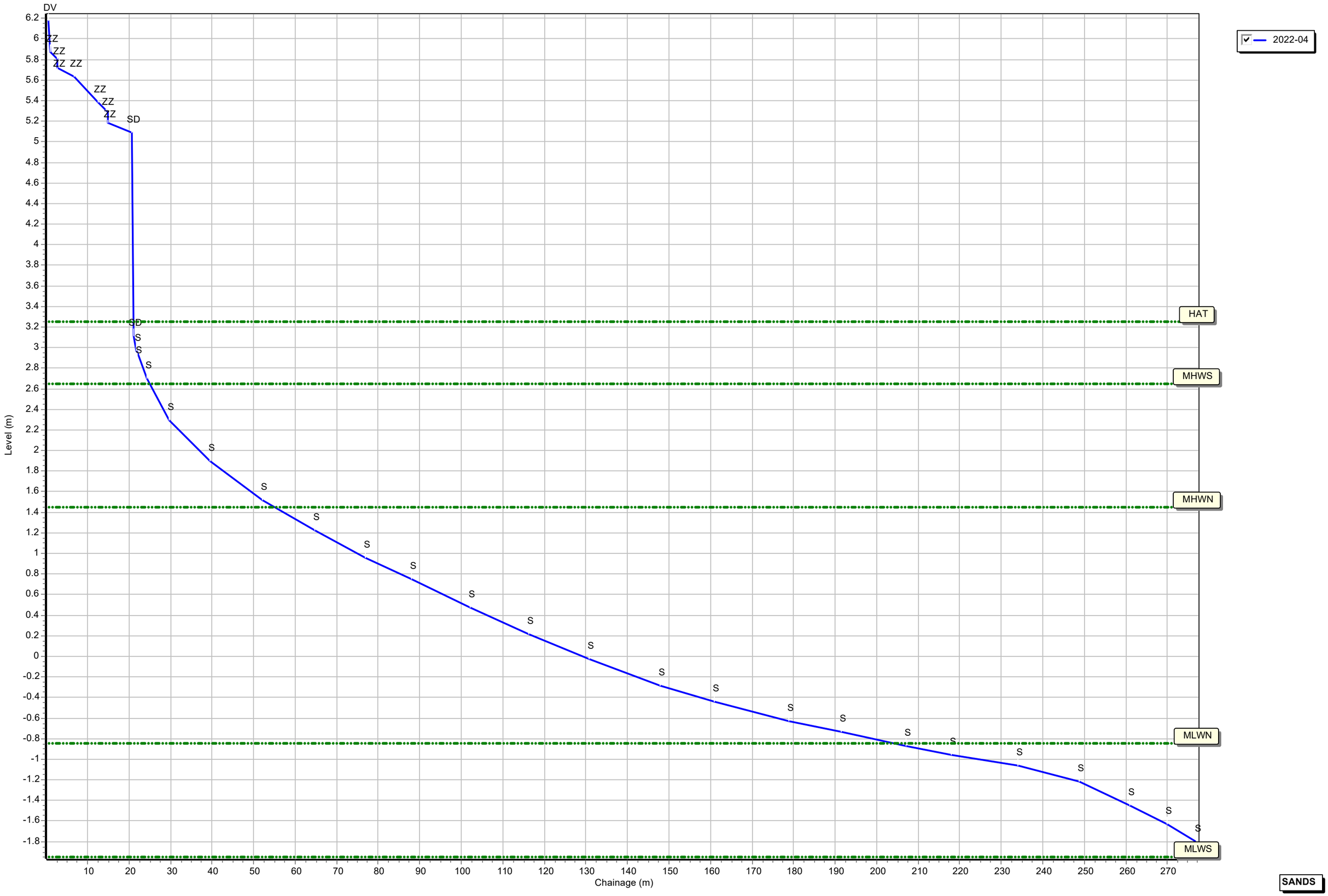
Profiles: 1cRC7



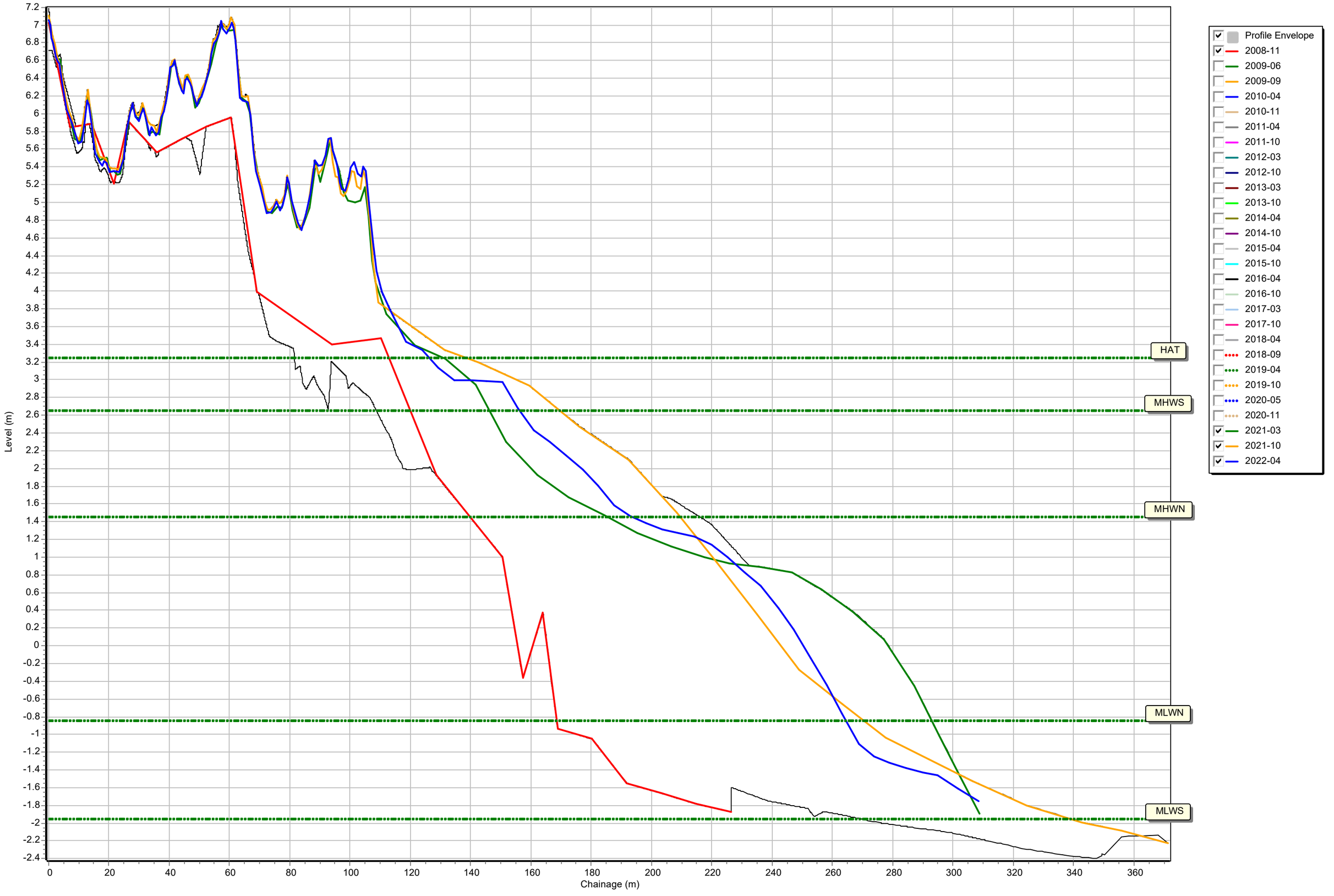
Profiles: 1cRC8



Profiles: 1cRC9

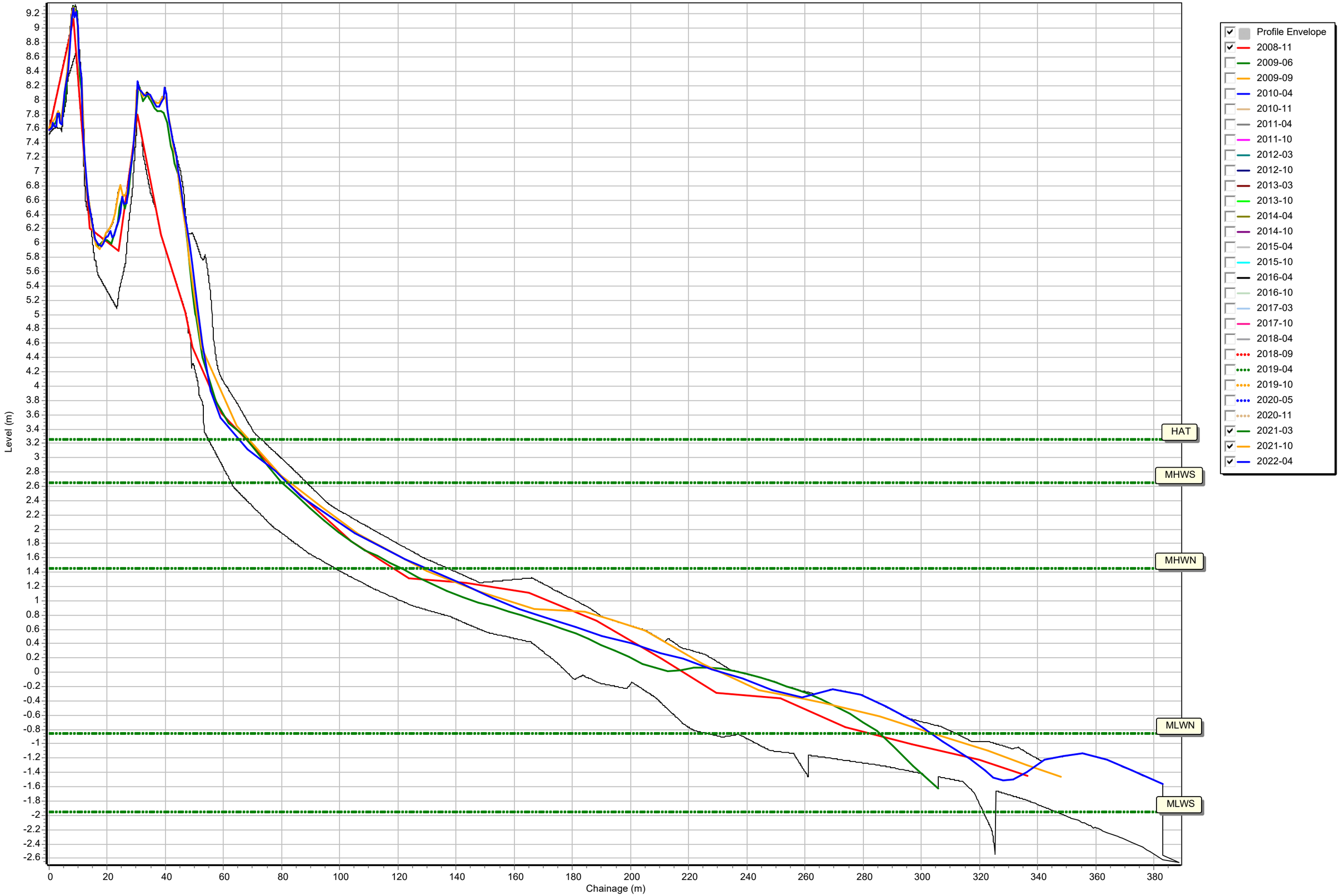


Profiles: 1cRC1

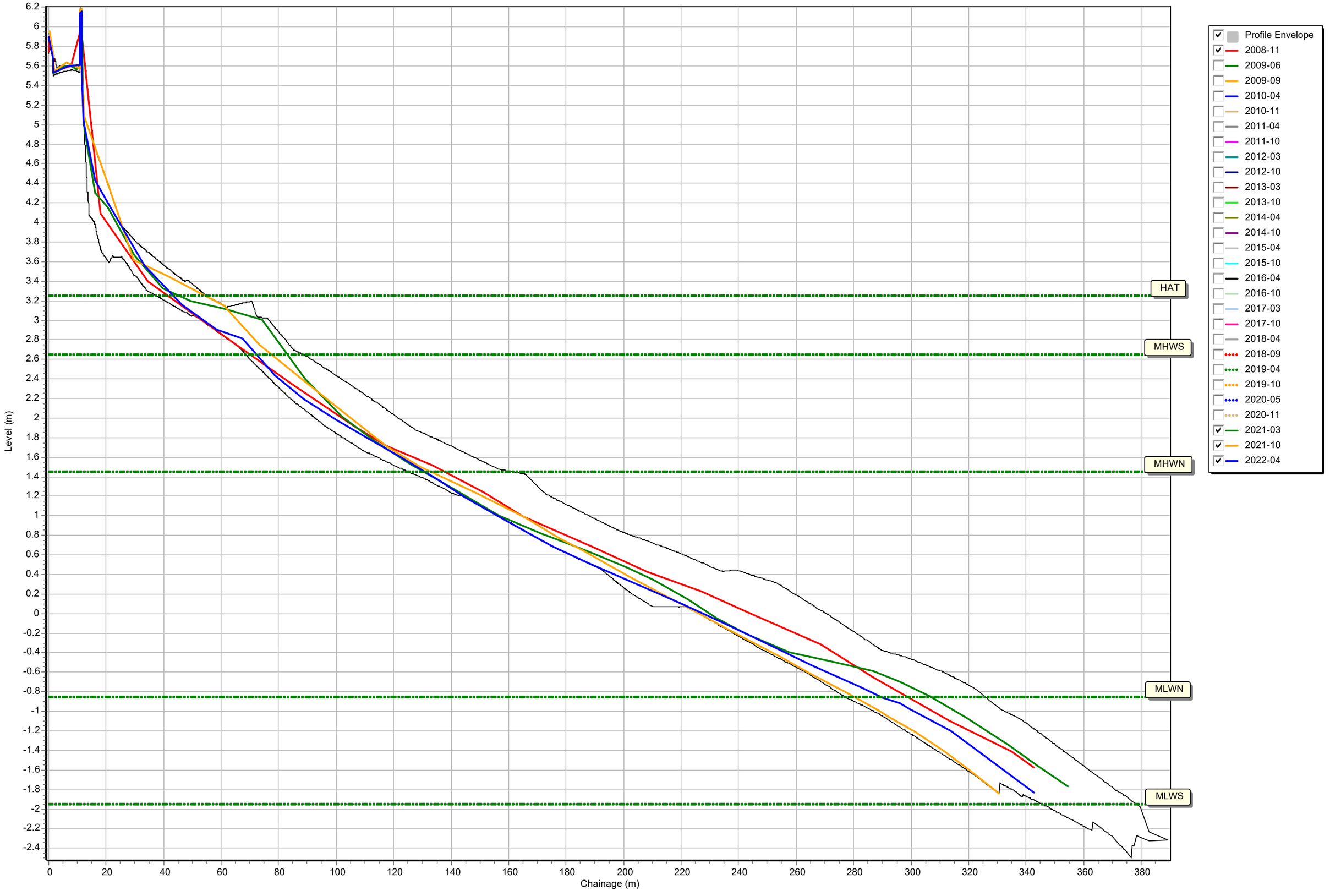


Profiles: 1cRC2

Profiles: 1cRC3

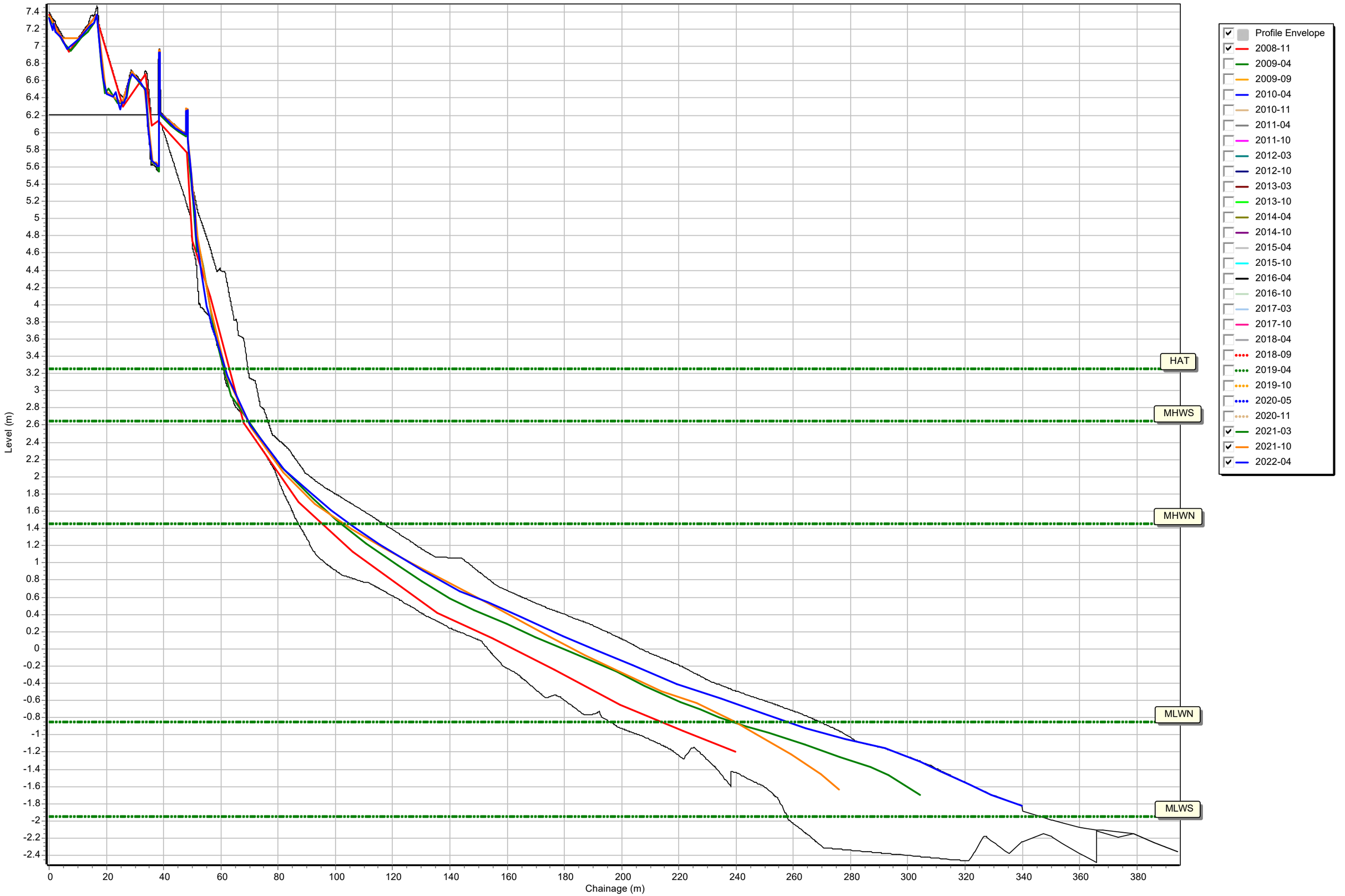


Profiles: 1cRC4

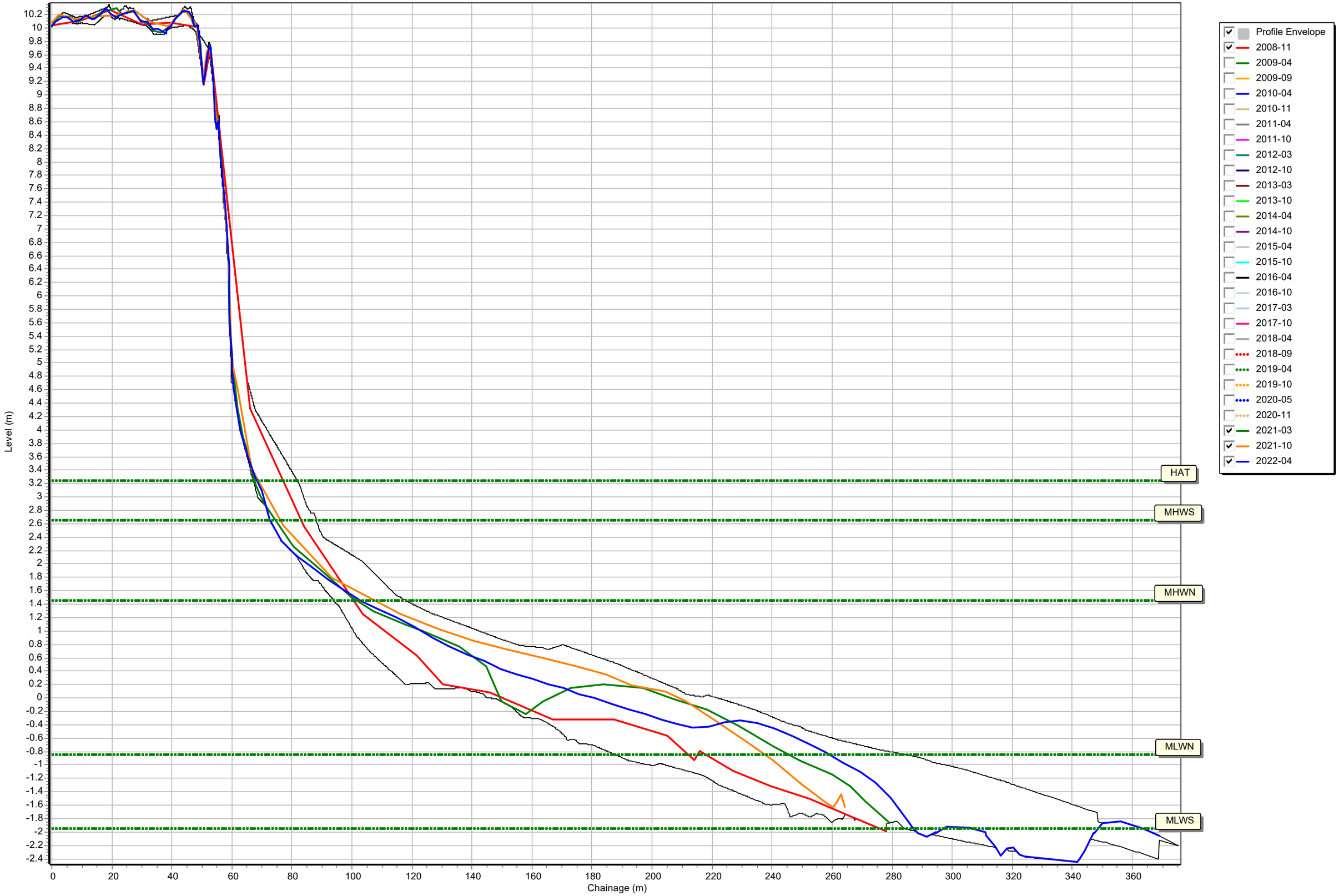


Profiles: 1cRC5

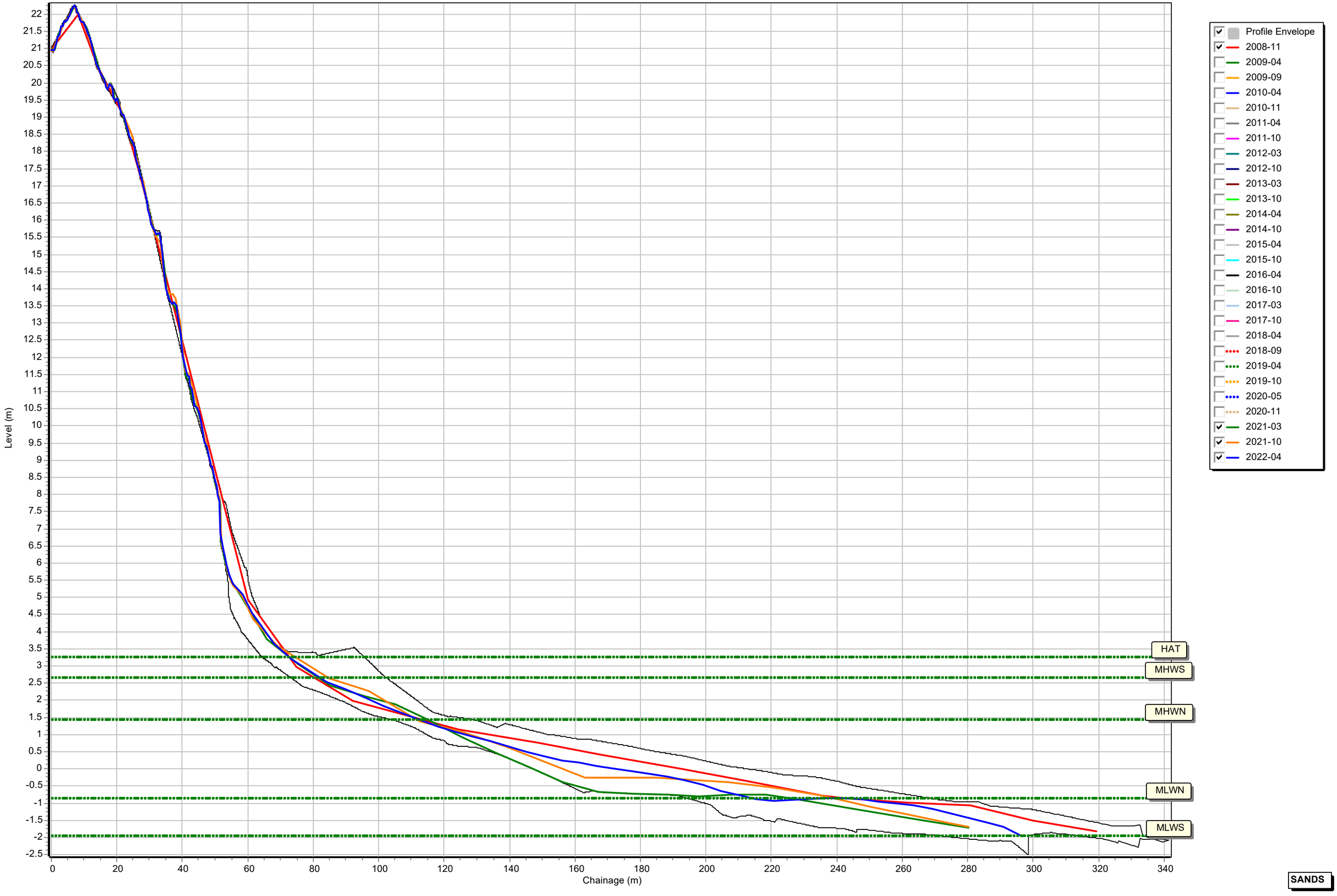
Profiles: 1cRC6



Profiles: 1cRC7



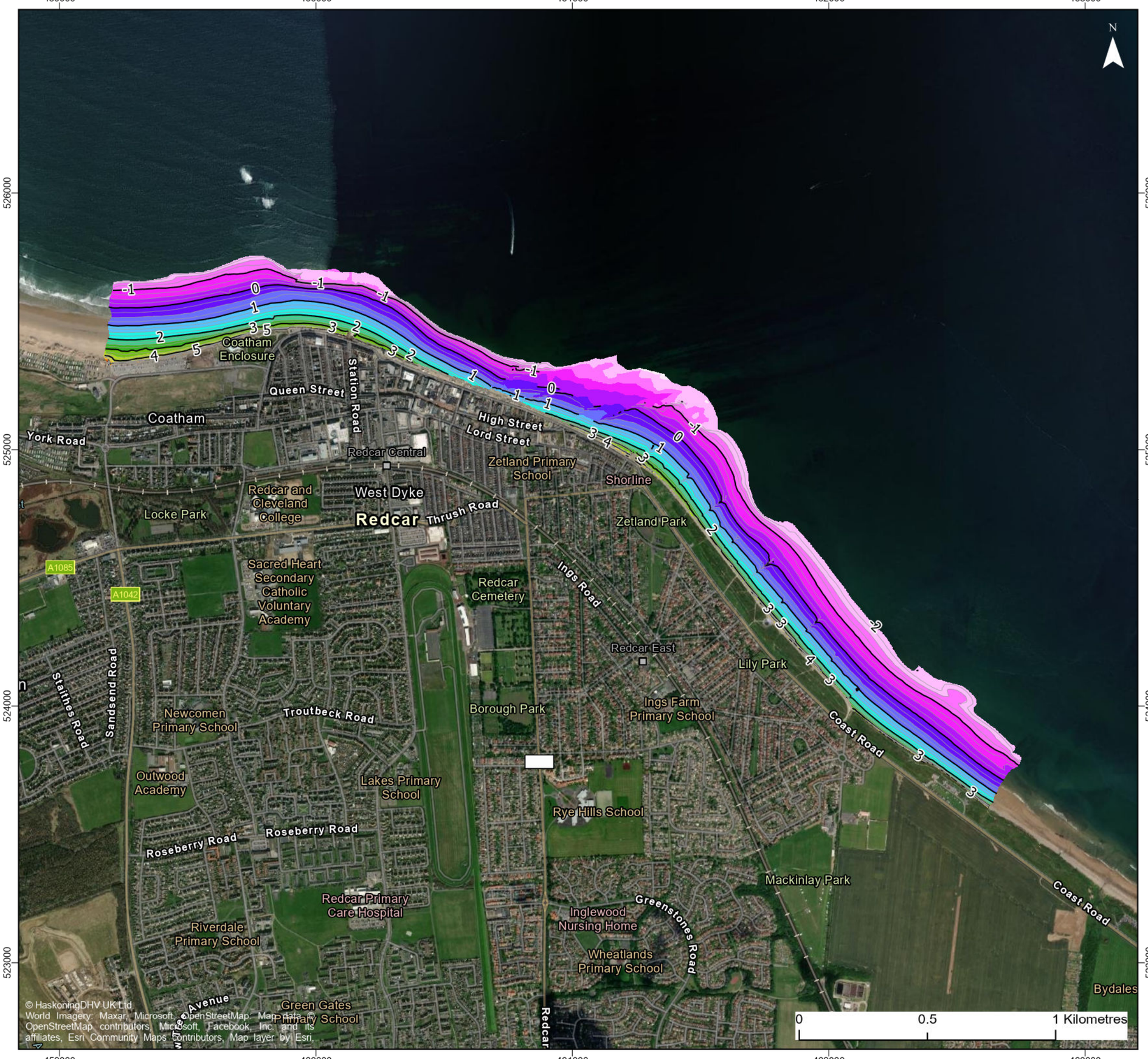
Profiles: 1cRC8



Profiles: 1cRC9

Appendix B

Topographic Survey



TOPOGRAPHIC SURVEY (April 2022)

Elevation (mOD)

- 6.6 - 7
- 6.1 - 6.5
- 5.6 - 6
- 5.1 - 5.5
- 4.6 - 5
- 4.1 - 4.5
- 3.6 - 4
- 3.1 - 3.5
- 2.6 - 3
- 2.1 - 2.5
- 1.6 - 2
- 1.1 - 1.5
- 0.51 - 1
- 0.01 - 0.5
- -0.49 - 0
- -0.9 - -0.5
- -1.4 - -1
- -1.9 - -1.5
- -2.1 - -2

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

REDCAR SANDS

Redcar and Cleveland Borough Council Frontage

Report:

Update Report
'Partial Measures' Survey 2022

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	13/06/2022	TC	NJC	A3	1:15,000

Co-ordinate system: British National Grid

Royal HaskoningDHV
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TOPOGRAPHIC SURVEY (April 2022)

Elevation (mOD)

- 5.6 - 6
- 5.1 - 5.5
- 4.6 - 5
- 4.1 - 4.5
- 3.6 - 4
- 3.1 - 3.5
- 2.6 - 3
- 2.1 - 2.5
- 1.6 - 2
- 1.1 - 1.5
- 0.51 - 1
- 0.01 - 0.5
- -0.49 - 0
- -0.9 - -0.5
- -1.4 - -1
- -1.9 - -1.5
- -2

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 2

SALTBURN SANDS

Redcar and Cleveland Borough Council Frontage

Report:

Update Report
'Partial Measures' Survey 2022

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	13/06/2022	TC	NJC	A3	1:8,000

Co-ordinate system: British National Grid

Royal HaskoningDHV
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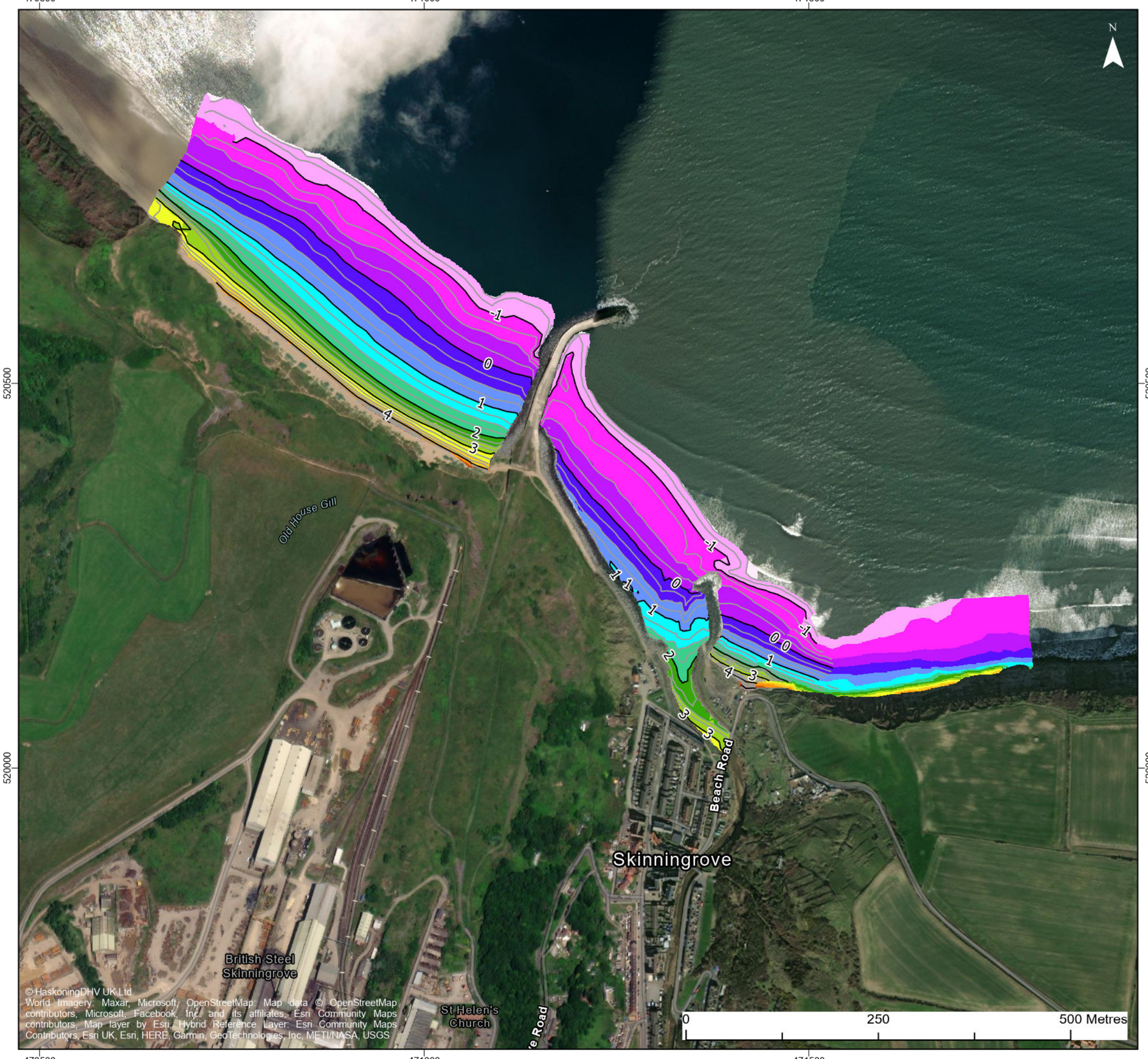
North East Coastal Observatory



TOPOGRAPHIC SURVEY (April 2022)

Elevation (mOD)

- 5.1 - 5.5
- 4.6 - 5
- 4.1 - 4.5
- 3.6 - 4
- 3.1 - 3.5
- 2.6 - 3
- 2.1 - 2.5
- 1.6 - 2
- 1.1 - 1.5
- 0.51 - 1
- 0.01 - 0.5
- -0.49 - 0
- -0.9 - -0.5
- -1.4 - -1
- -1.6 - -1.5

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 3

CATTERSTY SANDS (SKINNINGROVE)

Redcar and Cleveland Borough Council Frontage

Report:

Update Report
'Partial Measures' Survey 2022

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	13/06/2022	TC	NJC	A3	1:5,000

Co-ordinate system: British National Grid

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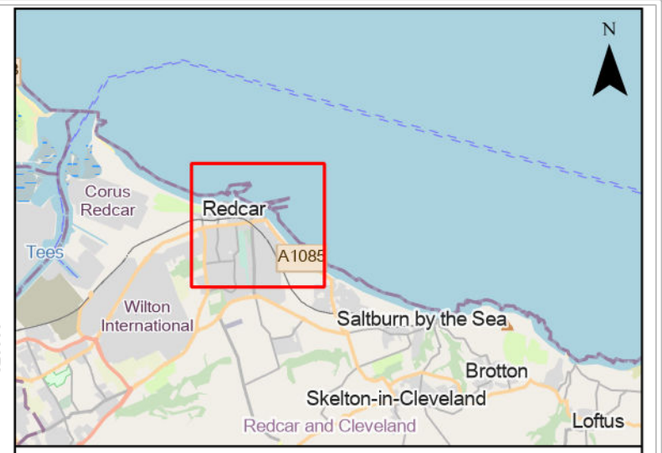

Difference between topographic surveys
(Oct 2021 to Apr 2022)
Change in Elevation (mOD)

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

REDCAR SANDS

Redcar and Cleveland Borough Council Frontage

Report: Analytical Report 'Full Measures' Survey 2021

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	13/06/2022	TC	NJC	A3	1:15,000

Co-ordinate system: British National Grid

Royal HaskoningDHV
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North East Coastal Observatory

Difference between topographic surveys
(Oct 2021 to Apr 2022)
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 5

SALTBURN SANDS

Redcar and Cleveland Borough Council Frontage

Report: Analytical Report 'Full Measures' Survey 2021

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	13/06/2022	TC	NJC	A3	1:8,000

Co-ordinate system: British National Grid

Royal HaskoningDHV
Enhancing Society Together

North East Coastal Observatory

Difference between topographic surveys
(Oct 2021 to Apr 2022)
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 6

CATTERSTY SANDS (SKINNINGROVE)

Redcar and Cleveland Borough Council Frontage

Report: Analytical Report 'Full Measures' Survey 2021

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	13/06/2022	TC	NJC	A3	1:5,000

Co-ordinate system: British National Grid

Royal HaskoningDHV
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North East Coastal Observatory

Appendix C

Cliff Top Survey

Cliff Top Survey

Twenty ground control points have been established at Staithes (Figure 3 – Map 1). The maximum separation between any two points varies along the coast, reflecting the degree of risk from the erosion. The cliff top surveys at Staithes 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 November 2008 (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 at Staithes

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
STAITHES				Nov 2008	Oct 2021	April 2022	Nov 2008 - April 2022	Oct 2021 - Apr 2022	Nov 2008 - April 2022
1	477228	518769	320	1.90	-5.40	-5.35	7.25	-0.05	0.60
2	477334	518798	0	10.90	10.58	10.71	0.19	-0.13	0.02
3	477487	518789	350	7.10	7.96	8.07	-0.97	-0.11	0.00
4	477594	518801	340	5.90	3.74	3.47	2.43	0.27	0.20
5	477683	518911	350	8.40	8.55	8.25	0.15	0.30	0.01
6	477792	518867	30	8.60	8.54	8.50	0.10	0.04	0.01
7	477891	518828	60	7.70	7.20	7.30	0.40	-0.10	0.03
8	477959	518873	350	8.70	8.56	8.52	0.18	0.04	0.02
9	478088	518950	350	7.60	8.05	7.90	-0.30	0.15	0.00
10	478191	519023	340	8.40	8.48	8.58	-0.18	-0.10	0.00
11	478237	519007	60	6.90	6.66	6.69	0.21	-0.03	0.02
12	478213	518988	150	6.10	6.56	6.55	-0.45	0.01	0.00
13	478501	518809	15	11.40	8.67	8.67	2.73	0.00	0.23
14	478624	518807	20	7.50	7.27	7.35	0.15	-0.08	0.01
15	478737	518858	60	6.10	6.12	6.38	-0.28	-0.26	0.00
16	478823	518757	60	8.00	8.12	8.65	-0.65	-0.53	0.00
17	478944	518671	30	9.30	8.78	8.70	0.60	0.08	0.05
18	479052	518630	20	9.20	9.06	9.27	-0.07	-0.21	0.00
19	479147	518610	0	14.20	13.94	14.04	0.16	-0.10	0.01
20	479274	518618	20	11.40	11.10	11.18	0.22	-0.08	0.02