Cell 1 Regional Coastal Monitoring Programme
Analytical Report 15: 'Full Measures' Survey 2022

Redcar and Cleveland
Borough Council
January 2023

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Authors	
Tom Ward	Royal HaskoningDHV
Dr Nick Cooper – Review and Approval	Royal HaskoningDHV

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Abbreviations and Acronyms

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

Water Levels Used in Interpretation of Changes

Water Level Parameter	Water Level (m AOD)
	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.

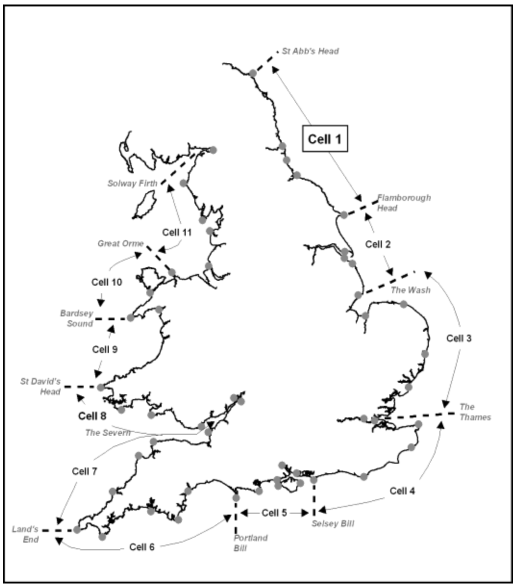


Figure 1 Sediment Cells in England and Wales

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:

[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	Sep-Oct 11	Oct 12	Mar-May 12	Feb 13	
5	2012/13	Sep 12	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	Oct-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	Apr 22	Jul 22	
15	2022/23	Oct 22	Jan 23 (*)			

* The present report is **Analytical Report 15** and provides an analysis of the 2022 Full Measures survey for Redcar and Cleveland Borough Council's frontage.

In addition, separate reports are produced for other elements of the programme as and when specific components are undertaken, such as wave data collection, bathymetric and 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 sections listed in Table 2.

Table 2 Sub-divisions of the Cell 1 Coastline

Authority	Zone
Northumberland County Council	Spittal A
	Spittal B
	Goswick Sands
	Holy Island
	Bamburgh
	Beadnell Village
	Beadnell Bay
	Embelton Bay
	Boulmer
	Alnmouth Bay
	High Hauxley and Druridge Bay
	Lynemouth Bay
	Newbiggin Bay
	Cambois Bay
	Blyth South Beach
North Tyneside Council	Whitley Sands
	Cullercoats Bay
	Tynemouth Long Sands
	King Edward's Bay
South Tyneside Council	Littehaven Beach
	Herd Sands
	Trow Quarry (incl. Frenchman's Bay)
	Marsden Bay
Sunderland Council	Whitburn Bay
	Harbour and Docks
	Hendon to Ryhope (incl. Halliwell Banks)
Durham County Council	Featherbed Rocks
	Seaham
	Blast Beach
	Hawthorn Hive
	Blackhall Colliery
Hartlepool Borough Council	North Sands
	Headland
	Middleton
	Hartlepool Bay
Redcar & Cleveland Borough Council	Coatham Sands
	Redcar Sands
	Marske Sands
	Saltburn Sands
	Cattersty Sands (Skinningrove)
Scarborough Borough Council	Staithes
	Runswick Bay
	Sandsend Beach, Upgang Beach and Whitby Sands
	Robin Hood's Bay
	Scarborough North Bay
	Scarborough South Bay
	Cayton Bay
	Filey Bay

1. Introduction

1.1 Study Area

Redcar & Cleveland Borough Council's frontage extends from the South Gare breakwater at the mouth of the River Tees to Cowbar Nab, Staithes. For the purposes of this report, report and for consistency with previous reporting, it has been sub-divided into six areas, namely:

- Coatham Sands
- Redcar Sands
- Marske Sands
- Saltburn Sands
- Cattersty Sands (Skinningrove)
- Staithes

The Staithes frontage straddles the boundary of jurisdiction of Redcar & Cleveland Council and Scarborough Borough Council and therefore reporting has been duplicated in both reports.

1.2 Methodology

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

- Full Measures survey annually (since 2008) 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 along Cattersty Sands

- Partial Measures survey annually each spring (since 2009) comprising:
    - Beach profile surveys along nine transect lines
    - Topographic survey along Redcar Sands
    - Topographic survey along Saltburn Sands
    - Topographic survey along Cattersty Sands

- Cliff top survey annually at:
    - Staithes

The Full Measures survey was undertaken along this frontage between 10th October 2022 and 28th October 2022. The weather and sea state varied, for further details please refer to the Survey Report from Academy Geomatics.

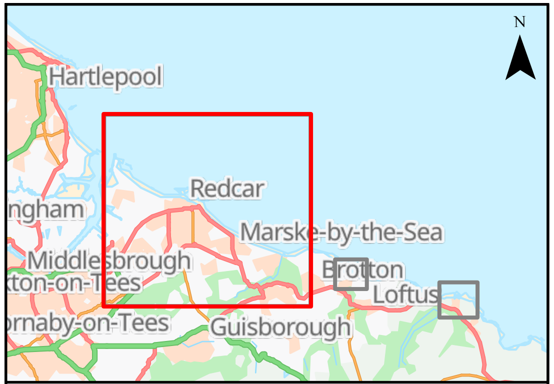
All data have been captured in a manner commensurate with the principles of the Environment Agency's *National Standard Contract and Specification for Surveying Services* and stored in a file format compatible with the software systems being used for the data analysis, namely SANDS and ArcGIS. This data collection approach and file format is comparable to that being used on other regional coastal monitoring programmes, such as in the South East and South West of England.

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

The Analytical Report is then produced following a standard structure for each authority. This involves:

- description of the changes observed since the previous survey and an interpretation of the drivers of these changes (Section 2);
- documentation of any problems encountered during surveying or uncertainties inherent in the analysis (Section 3);
- recommendations for 'fine-tuning' the programme to enhance its outputs (Section 4); and
- providing key conclusions and highlighting any areas of concern (Section 5).

Data from the present survey are presented in a processed form in the Appendices.



SURVEY LOCATIONS

Topographic Profile

- Annual
- Bi-Annual

Topographic Area

- 6 monthly
- yearly
- 5 yearly

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

Client: North East Coastal Group

Project: 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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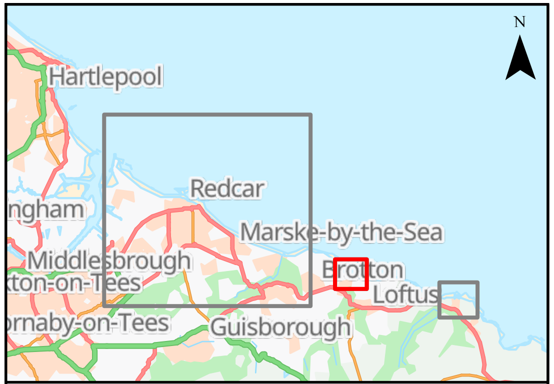

SURVEY LOCATIONS

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:
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Co-ordinate system: British National Grid

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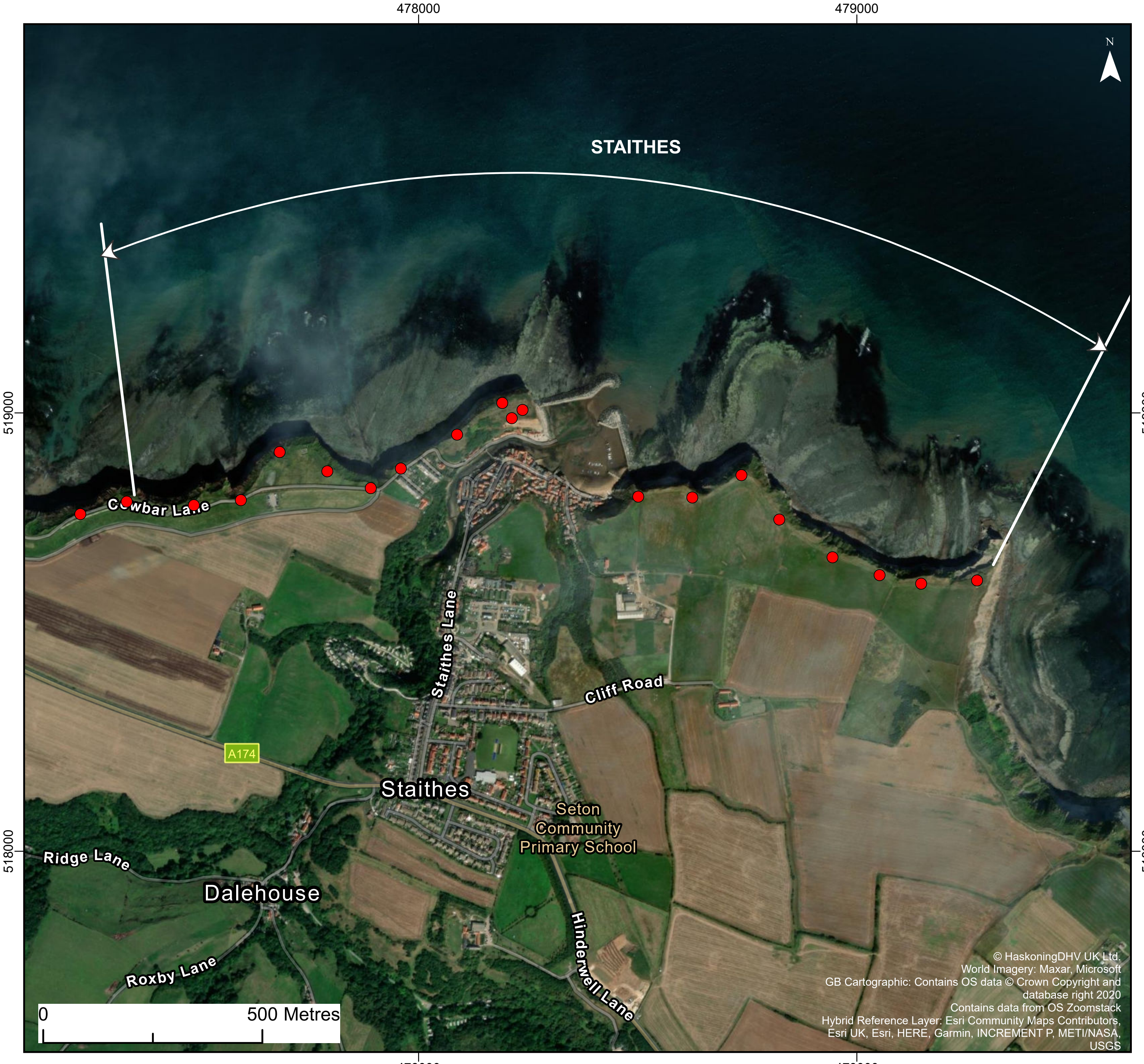

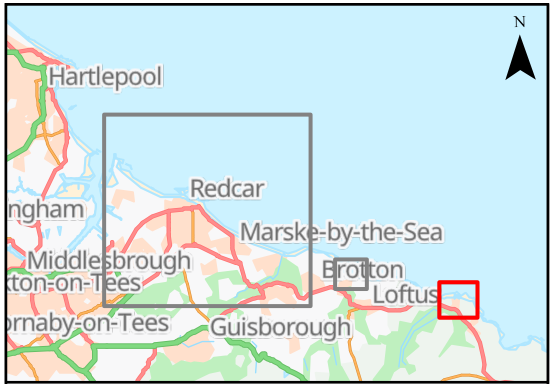

SURVEY LOCATIONS

Topographic Profile
- Annual
- Bi-Annual

Topographic Area
- 6 monthly
- yearly
- 5 yearly

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

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

Title:

Figure 2 - Map 3

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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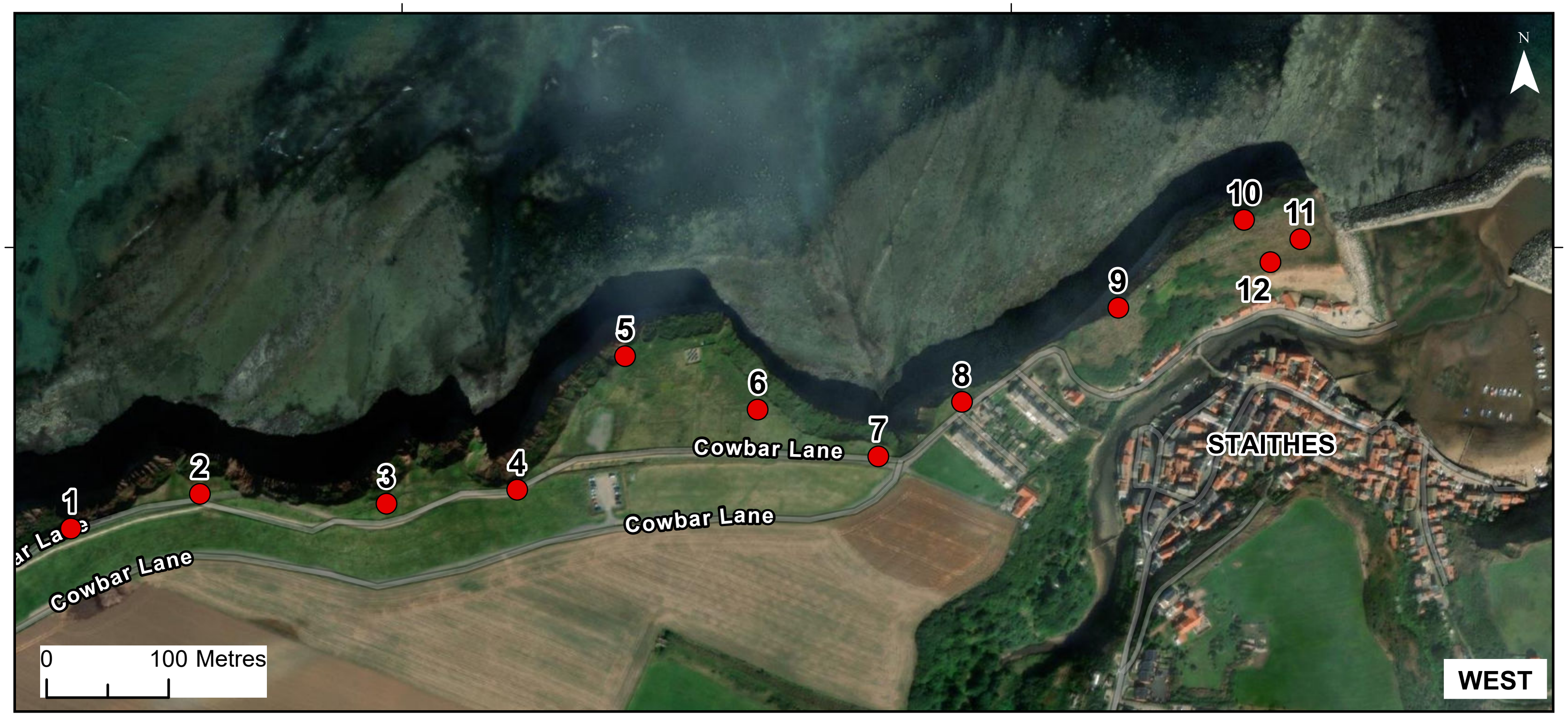

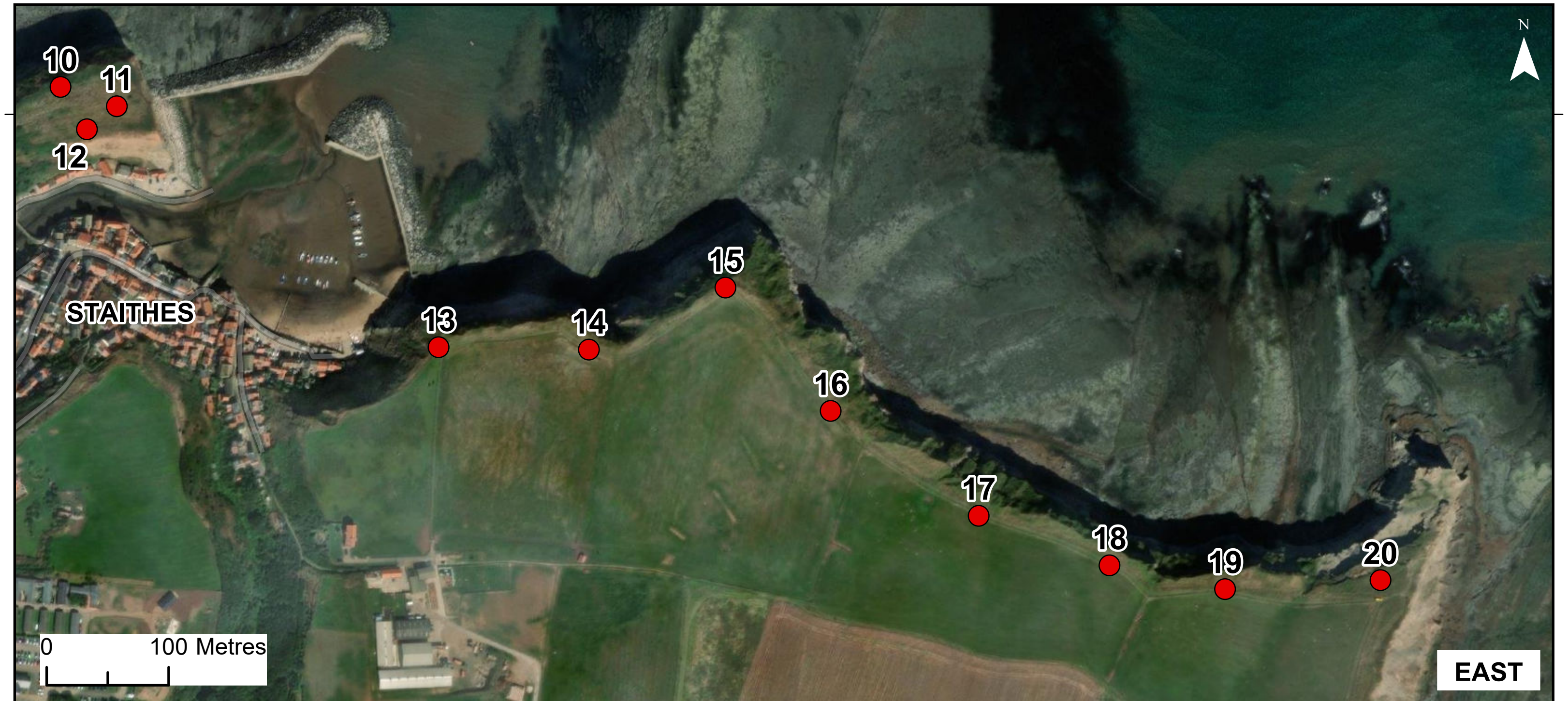

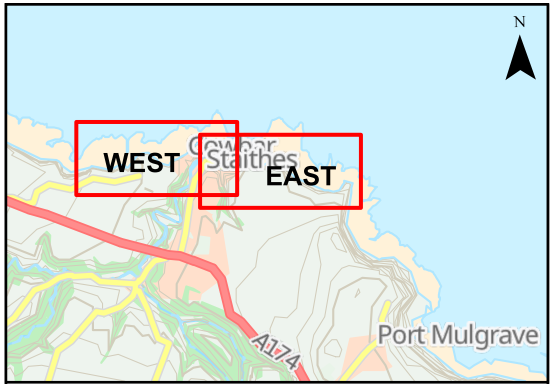

SURVEY LOCATIONS

● 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:
0	n/a	TC	NJC	A4	1:6,000

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
10th- 12th October 2022	**Beach Profiles:** Coatham Sands is covered by four beach profile lines (RC1 to RC4; Appendix A) that are monitored twice yearly. The previous inspection was in April 2022. Profile **1cRC1** is located approximately 300m south of the South Gare breakwater, in the lee of the German Charlies slag banks. The upper profile is dominated by dune ridges, which have remained stable since the 2009 surveys. Between chainage 110m and 170m, a berm has formed on the upper beach resulting in an increase in level of 0.5m. Accretion has also occurred between chainage 172m and 217m at a level of up to 0.3m. Seaward of chainage 217m, the lower beach has eroded at a consistent level of 0.2m. Overall, the beach is at a high level when compared to the range of the previous surveys. At Profile **1cRC2,** the dunes continue to remain relatively stable with a net overall accretion across the system. The only notably change is the dune depression behind the foredune has been partially infilled with sediment, resulting locally in 0.7m increase in level. On the upper beach, between chainages 109m and 134m, a berm has formed locally increasing the level by 0.25m. Seawards of the berm, the beach has remained stable with the lower extents showing minor erosion and the upper extents minor accretion. The change is limited to ±0.1m. Overall, the beach is at a high level when compared to the range of the previous surveys, particular across the upper beach. Profile **1cRC3** is covered by dunes up to chainage 55m. The dune has remained stable since the previous survey, with some low level accretion (+0.3m) occurring on the landward slope of the foredune. On the upper and middle beach, between chainages 55m and 262m, the beach has accreted in a consistent manor by 0.2m in level. Seaward of chainage 262m, the beach profile has smoothened out removing two berms previously present. This has resulted in alternating lengths of erosion and accretion with the change in level limited to ±0.5m. Overall, the beach is at a high level when compared to the range of the previous surveys, particular across the upper beach.	Since the April 2022 surveys, the profiles along Coatham Sands show that the frontage has been dominated by accretion. All four of the profiles have experienced an increase in level across the upper beach and as a result have high to very high beach levels when compared to the range of previous surveys. The topographic survey difference plot shows a more balanced pattern of change over the full year with an approximately equal area of accretion and erosion, suggesting the winter months were dominated by erosion. **Longer term trends**: With the exception of 2018, there appears to have been a general trend of net accretion observed in the Autumn analysis over the years. This is offset with a general erosion in the spring analysis following the winter months.

Survey Date	Description of Changes Since Last Survey	Interpretation
	Profile **1cRC4** is the beginning of the defended section at Redcar. At the toe of the seawall the beach level has dropped 0.4m in level over the first 4m. Seaward of this, the beach has uniform gradient that has been dominated by accretion across its whole length. The magnitude of accretion is between 0.1m and 0.2m in level. Overall, the beach is at a medium to low level when compared to the range of the previous surveys.	
10th- 12th October 2022	**Topographic Survey:** Coatham Sands is covered by an annual topographic survey extending from the South Gare Breakwater, although the survey is contiguous with the 6-monthly Redcar Sands survey. Data have been used to create a DGM (Appendix B – Map 1) using GIS. This shows that the beach contours recorded in Autumn 2021 remain shore parallel along the frontage, with a gentle beach slope. The beach is narrower and steeper to the north west of the subtle promontory around 1km SE of the breakwater and of shallower gradient further south-east. The GIS has also been used to calculate the differences between the current topographic (October 2021 survey and the earlier topographic survey (October 2022), as shown in Appendix B – Map 6, to identify areas of erosion and accretion. The topographic difference plot shows that the frontage can be broadly split into alternating lengths, between 500m and 1500m long, of erosion and accretion. The magnitude of change varies across the frontage but appears greatest at the subtle promontory just south of the breakwater and fronting the Cleveland Golf Links (±1.5m). The pattern of change highlights the process of shifting sands from north to south along this frontage.	

2.2 Redcar Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
10th- 12th October 2022	**Beach Profiles:** Redcar Sands is covered by three beach profile lines during the Full Measures survey (RC5 to RC7; Appendix A), with RC7 being approximately on the boundary with the Marske Sands area. At profile **1cRC5,** the beach levels at the toe of the stepped defence (chainage 20m) have dropped 0.6m in level since the April 2022 survey, revealing the concrete apron below the steps. The reduction in levels continue to chainage 114m, exposing an additional length of rocky foreshore between chainages 47m and 86m. Seawards of chainage 114m, the rocky foreshore remains exposed. When compared with the range recorded from previous surveys, the profile is at a very low level, particularly at the toe of the defence where it is the lowest on record. At profile **1cRC6,** the section is defended up to chainage 52m and has remained unchanged over this length. Seaward of the defended section, the beach has remained largely stable up to chainage 230m, with change limited to accretion of <0.1m. Seaward of chainage 230m, the beach profile has steepened resulting in a decrease in level towards the end of the profile (0.15m at chainage 336m). When compared with the range recorded from previous surveys, the October 2021 profile is at a high level. Profile **1cRC7** has experienced very little change on the cliff top, face and upper beach up until chainage 74m. Seawards of chainage 74m, shifting sands have created alternating lengths of erosion and accretion up until chainage 300m. The magnitude of change is minor and limited to 0.3m. Between chainages 305m and 321m the bedrock remains exposed. The berm seaward of the exposed rock has shifted landward 20m since the previous survey. When compared to the range of the previous surveys, the upper beach and lower beach is the lowest on record whilst the middle section is at a high level.	The pattern of change across the profiles varies with progression south. The most northern of the three profiles (1cRC5) is dominated by erosion, 1cRC6 has largely remained stable and 1cR7 the most southernly at Redcar sands, has generally accreted. This indicates a general movement of sediment south over the year. This supported by the topographic survey comparison of the same time period that shows south of Redcar Rocks, the shore connected groynes have trapped sediment on the north size, with a very local drop in sediment on the south side, again highlighting the movement of sediment south. **Longer term trends**: There is an overall trend of sediment moving from north to south along Redcar sands. Beach levels remains at a medium level highlighting recovery since the storms and surge of winter 2013/14, although remain low between Redcar rocks where the rocky foreshore is exposed. The new hard defences at Redcar have affected the patterns of accretion on the upper beach due to the introduction of a less reflective seawall.
10th- 12th October 2022	**Topographic Survey:** Redcar Sands is covered by a six-monthly topographic survey. Data have been used to create a DGM (Appendix B – Map 2) using GIS. The plot shows shore-parallel contours for most of the frontage with the exception of the section between the Redcar Rocks and West Scar where there is less sediment and so the contours are distorted by the rocky foreshore. The shore-parallel contours to the south of	

Survey Date	Description of Changes Since Last Survey	Interpretation
	Redcar Rocks are locally indented where beach groynes are affecting sediment movement. The GIS has also been used to calculate the differences between the current topographic survey (Autumn 2021) and the previous full measures survey (October 2021) and the most recent (April 2022) topographic survey, as shown in Appendix B – Maps 7 and 11, to identify areas of erosion and accretion. The pattern of change between the October 2021 and October 2022 is similar to that of the connecting Coatham Sands, with distinct blocks of alternating change occurring along the frontage. The beach adjacent to West Scar has accreted, before switching to erosion up to Redcar Rocks. South of Redcar Rocks, along the Stray (with the beach groynes) the beach has again accreted before eroding at Mill Howle. Generally, the magnitude of change is similar throughout, with pockets of high magnitude at West Scar and Mill Howle (±1.5m).	

2.3 Marske Sands

<table>
<tr><th>Survey Date</th><th>Description of Changes Since Last Survey</th><th>Interpretation</th></tr>
<tr><td>10th- 12th October 2022</td><td>Beach Profiles:

Marske Sands is covered by two beach profile lines during the Full Measures survey (RC7 to RC8; Appendix A), with RC7 being approximately on the boundary with the Redcar Sands area.

Profile 1cRC7 is located along The Stray and has been discussed in Section 2.2.At profile 1cRC8, there is no significant change to the face of the cliff and upper beach up until chainage 78m. Between chainage 78m and 134m, the profile has experienced alternating bands of erosion and accretion associated with shifting sands. The magnitude of change is minimal, limited to ±0.2m. Seawards of chainage 134m, the lower beach has accreted consistently to the end of the profile by a magnitude of up to 0.3m in level. Generally, the profile is a medium level when compared to the range of the previous surveys, with the exception of sections of the lower beach which are at a high level.</td><td rowspan="2">In the 6 months since the previous profile survey (April 2022), both profiles at Marske Sands appear to show an overall net accretion across the beach indicating a general summer recovery.

Longer term trends: Current beach profiles are at a medium level compared with the range of previously recorded results having recovered from the particularly low levels after winter 20/21. Recorded changes are largely due to the movement of bars on the beach, which is also shown on the topographic difference plots.</td></tr>
<tr><td>10th- 12th October 2022</td><td>Topographic Survey:

Marske Sands is covered by an annual topographic survey. This survey is contiguous with the Redcar Sands and Saltburn Sands topographic surveys that are both surveyed six-monthly. Data have been used to create a DGM (Appendix B – Map 3) using GIS. The figure shows that the topographic contours are generally shore parallel on the upper and middle beach, but become less uniform on the lower beach as the profile plateaus.

The GIS has also been used to calculate the differences between the October 2021 and October 2022 topographic survey, as shown in Appendix B – Map 8. This shows that since the previous topographic survey, accretion and erosion has again occurred in broadly shore parallel bands. The toe of the cliffs and the upper beach has been dominated by erosion of a magnitude up to 1.5m. The mid and lower beach is more varied in the change, with accretion largely dominating but with sporadic pockets of erosion. The intensity of change is generally similar across the frontage.</td></tr>
</table>

2.4 Saltburn Sands

<table>
<tr><th>Survey Date</th><th>Description of Changes Since Last Survey</th><th>Interpretation</th></tr>
<tr><td>10th – 12th October 2022</td><td>Beach Profiles:

Saltburn Sands is covered by one beach profile during the Full Measures survey (RC9; Appendix A).

At profile 1cRC9, there has been no change across the defended section of the profile (chainage 0m to 21m). At the toe of the seawall, the beach has locally accreted by 0.3m. Seawards of the seawall, the profile shows alternating lengths of erosion and accretion albeit at a low magnitude. Across the upper beach between chainages 24m and 66m the beach has lowered slightly by 0.1m. Between chainages 66m and 217m the profile has accreted by up to 0.2m, before switching back to erosion to chainage 259m. The lower beach has slackened resulting in an increase in level of 0.2m at the end of the profile. Overall, the beach is at a medium level compared to the range recorded from previous surveys.</td><td rowspan="2">The beach showed a general trend of accretion at profile 1cRC9, particularly across the middle portion of the beach, indicating some recovery since the erosion over winter 2021. This is also echoed in the difference plot between the last partial measures survey in Spring 2022 and the present full measures survey in Autumn 2022 which shows a wide scale accretion across the majority of the bay.

Longer term trends:, The trend of increasing erosion through the winter months with some recovery over the summer appears to be leading to the progressive erosion and drawdown of the beach. This pattern has been experienced for several years.</td></tr>
<tr><td>10th – 12th October 2022</td><td>Topographic Survey:

Saltburn Sands is covered by a six-monthly topographic survey, although the survey is contiguous with the Marske Sands topographic survey that is surveyed annually. Data have been used to create a DGM (Appendix B – Map 4) using a GIS software package. This shows that the beach contours are shore parallel and gently shelving for the majority of the frontage. The contours are distorted where Skelton Beck outfalls across the foreshore.

The GIS has also been used to calculate the differences over the six month period between April 2022 and October 2022 topographic survey, as shown in Appendix B – Map 12, and the change since the last full measures survey in October 2021, to identify areas of net erosion and accretion (Appendix B – Map 9).

The six-month difference plot (between April 2022 and October 2022) shows that accretion has dominated the frontage, with large shoreline parallel swathes evident particular on the middle sections of the beach. At the toe of the Saltburn Beach Cliffs, a narrower band erosion has occurred, albeit at a low magnitude (-1.0m). At the mouth of Skelton Beck, the pattern of change is more erratic, with small patches of accretion and erosion observed. When comparing the difference plot from Autumn 2020 to Autumn 2021, the pattern of change is broadly similar to that observed in the 6-monthly difference plot</td></tr>
</table>

Survey Date	Description of Changes Since Last Survey	Interpretation
	with accretion being the dominant process on the middle and lower beach. Erosion is again observed along the toe of the cliffs, however, it more wide scale and at a greater magnitude (-1.5m) than the 6-monthly plot. To the east of Skelton Beck erosion has dominated fronting Huntcliff Nature Reserve.	

2.5 Cattersty Sands (Skinningrove)

Survey Date	Description of Changes Since Last Survey	Interpretation
28th October 2022	**Topographic Survey:** Cattersty Sands is covered by a six-monthly topographic survey. Data have been used to create a DGM (Appendix B – Map 4) using a GIS package. 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, so the gradient is shallower. 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 GIS has also been used to calculate the differences between April 2022 and October 2022 topographic surveys and is presented as DGM (as shown in Appendix B – Map 10), to identify areas of net erosion and accretion. The difference plot shows a mixture of accretion and erosion across Cattersty Sands. To the west of the breakwater, the beach is divided into two clear areas of change. The upper beach has been dominated by accretion whereas the lower beach has been dominated by erosion. The magnitude of change is limited to ±1.25m. To the east of the breakwater, the pattern of change is more varied. Accretion has dominated to the east of the modified fish tail groyne and at the tip of the groyne, with the exception of at the toe of the cliff where the change is more erratic over the rock armour revetment. Minor erosion has occurred at the root of the of the breakwater at a magnitude of 0.5m.	**Longer term trends**: The topographic change data shows Cattersty Sands is very dynamic, influenced by coastal and fluvial processes, along with the breakwater and the shorter rock armour groyne. As such the long term pattern of change is convoluted, broadly following seasonal fluctuations of winter drawdown and summer recovery.

2.6 Staithes

Survey Date	Description of Changes Since Last Survey	Interpretation
18th October 2022	**Cliff-top Survey:** Twenty ground control points have been established at Cowbar and Staithes for biannual cliff top monitoring. Locations 12 to 20 are in the Scarborough Borough Council area. The separation between any two points is around 100m. Data collection involves a distance offset measurement from the ground control point to the cliff edge along a fixed bearing. Between April 2022 and November 2022, 7 of the 20 ground control points experienced retreat of over 0.1m. Of these 7, a total of 4 points, 12, 14, 8 and 11 experienced between 0.1m and 0.2m of erosion (0.11m, 0.14m, 0.16m and 0.2m respectively). Two points (point 19 and 18) experienced between 0.2m and 0.4m of erosion (0.27m and 0.37m respectively). Only one point (point 13) experienced over 0.5m of erosion (0.50m). Calculation of longer-term erosion rates based on the recorded change between 2008 and 2020 indicates that 17 of the 20 posts on the frontage recorded a change rate within a range of ±0.1m/year. Points 1, 4, and 13 show average erosion rate of above 0.1m/yr, experiencing 0.52m, 0.18m and 0.23m respectively. Appendix C provides results from the October 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.	**Longer term trends**: Table C1 shows that survey location 1 has shown the greatest total erosion with a loss of 7.26m between the November 2008 baseline and October 2022, resulting in a long-term average recession rate of 0.52m/yr. Location 4 has also showed progressive erosion with an average recession rate of 0.18m/year. Both of these stations are located adjacent the old Cowbar Lane which in places has now collapsed entirely. Location 13 has also experienced ongoing erosion of with an average recession rate of 0.23m/year. In the months between April and October 2022 it was Point 13 that experienced the most significant change highlighting further the activity in this location. This area is above the eastern breakwater and is known to have experienced rock falls previously. The coastal path remains at risk of being undermined at this point.

3. Problems Encountered and Uncertainty in Analysis

Cliff Top Surveys

The cliff top surveys at Staithes are assumed to have a limit of accuracy of ± 0.1m due to the techniques used. In previous surveys, it was reported that posts 9 to 12 were inaccessible due to a landslip on the headland; these posts have been accessible again since 2021.

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

There are no current recommendations for 'fine-tuning' the monitoring programme.

5. Conclusions and Areas of Concern

- At Coatham Sands, the profiles show that the frontage has been dominated by accretion since the April 2022 surveys. All four of the profiles have experienced an increase in level across the upper beach and as a result have high to very high beach levels when compared to the range of previous surveys. This increase is generally in line with longer term trends of seasonal fluctuations.
- At Redcar Sands, the profiles indicate a general movement of sediment south over the year. This supported by the topographic survey comparison of the same time period that shows south of Redcar Rocks, the shore connected groynes have trapped sediment on the north side, with a very local drop in sediment on the south side, again highlighting the movement of sediment south. In the 6 months since the previous profile survey (April 2022), both profiles at Marske Sands appear to show an overall net accretion across the beach indicating a general summer recovery.
- At Saltburn Sands, the beach has showed a general trend of accretion, particularly across the middle and lower portion of the beach, indicating some recovery since the erosion over winter 2021. The profile remains within the envelope of previous surveys.
- At Cattersty Sands, the topographic difference plot shows that overall, there has been a slight net accretion across the frontage, associated with summer recovery. However, it also highlights the complex pattern of change that occurs locally due to the influence of coastal and river processes and the presence of the breakwater and groyne.
- The measurements of the Cowbar and Staithes cliff top show that between April 2022 and October 2022, seven of the twenty ground control points experienced retreat of over 0.1m. Of these seven, a total of four points, 12, 14, 8 and 11 experienced between 0.1m and 0.2m of erosion (0.11m, 0.14m, 0.16m and 0.2m respectively). Two points (point 19 and 18) experienced between 0.2m and 0.4m of erosion (0.27m and 0.37m respectively). Only one point (point 13) experienced over 0.5m of erosion (0.50m). The long-term trends indicate that Points 1, 4 and 13 are experiencing a sustained average recession rate of over 0.1m/yr.

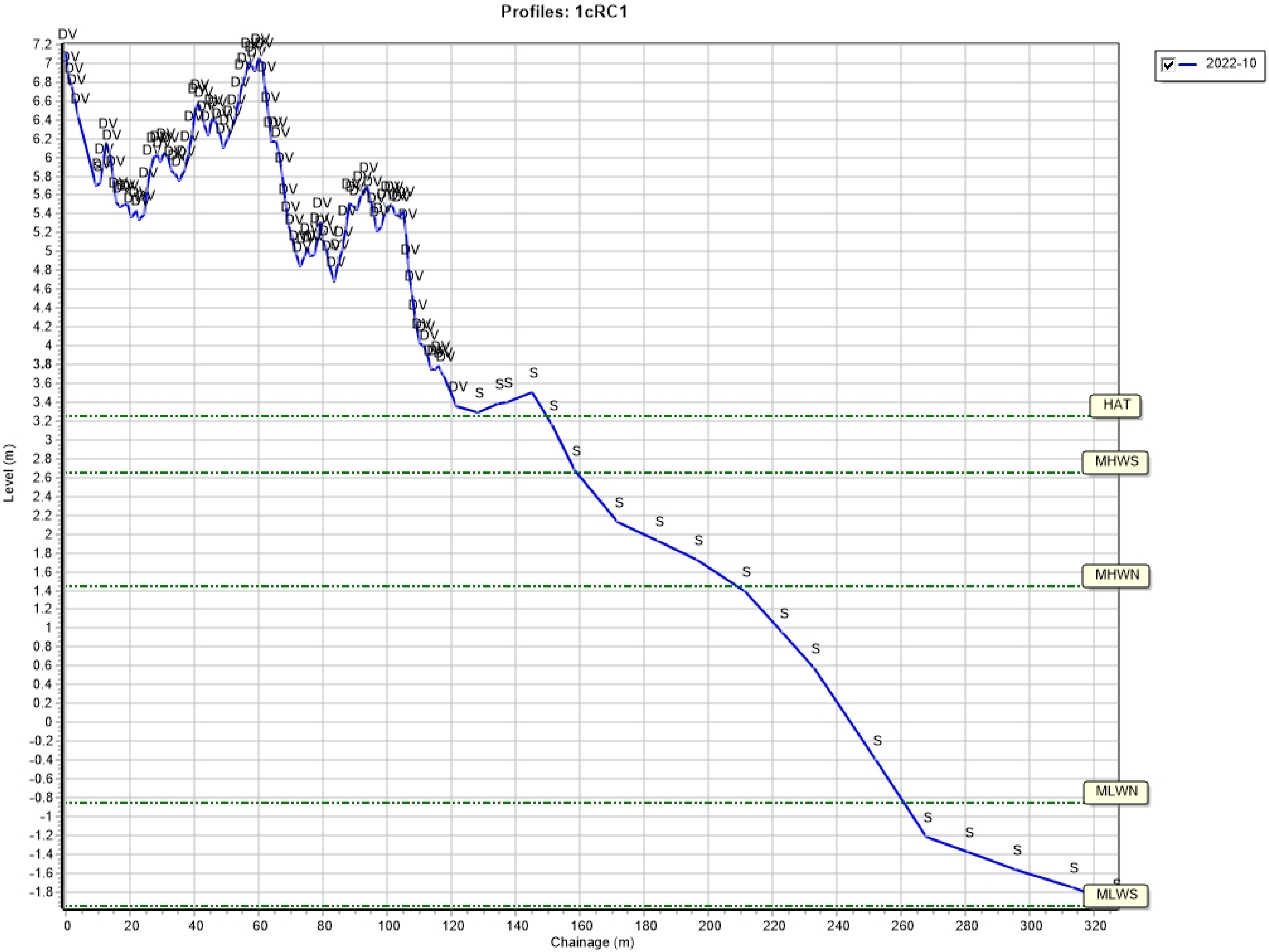
Appendices

Appendix A

Beach Profiles

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

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



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Chainage (m)
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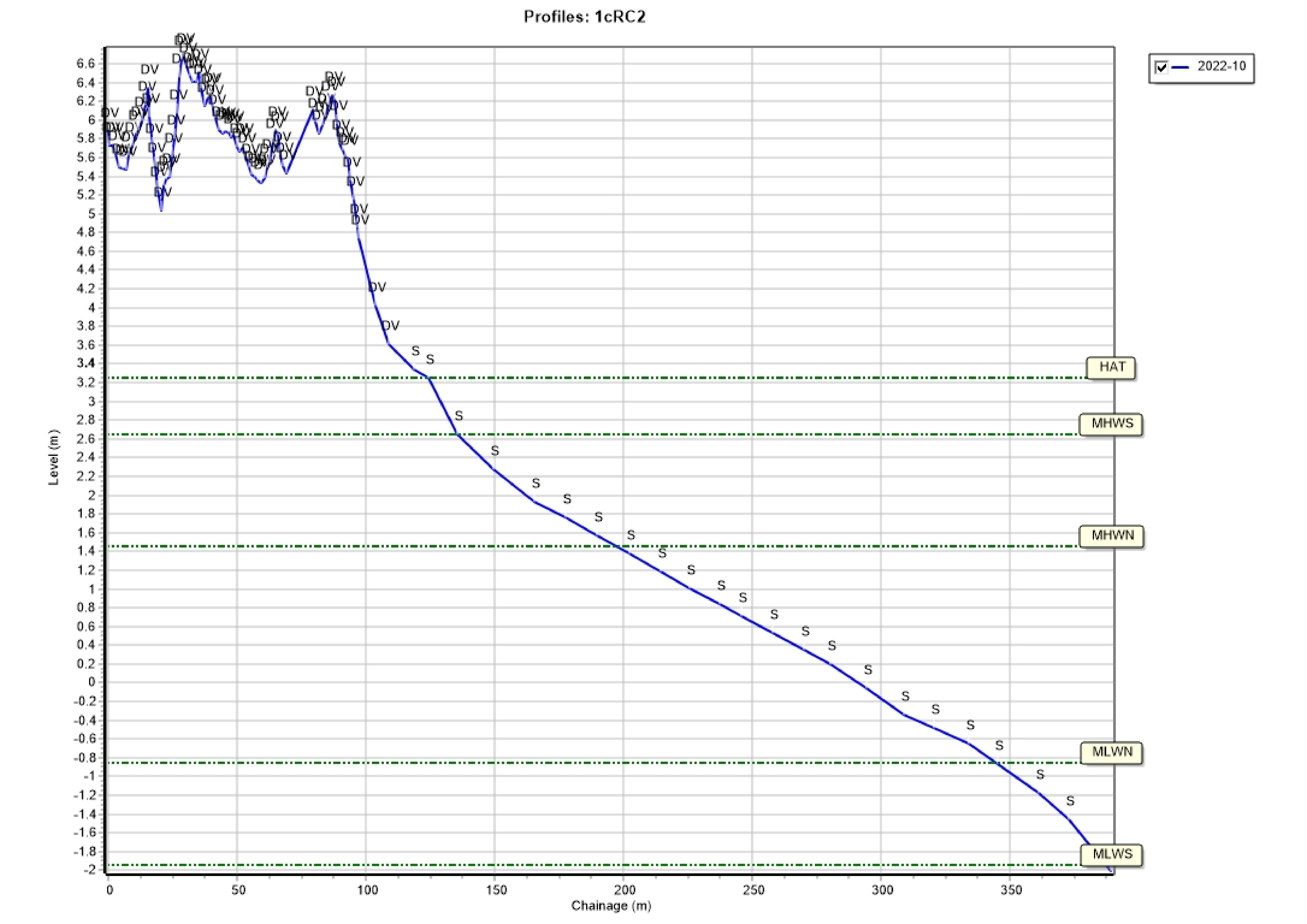
MHWN
MLWN
MLWS



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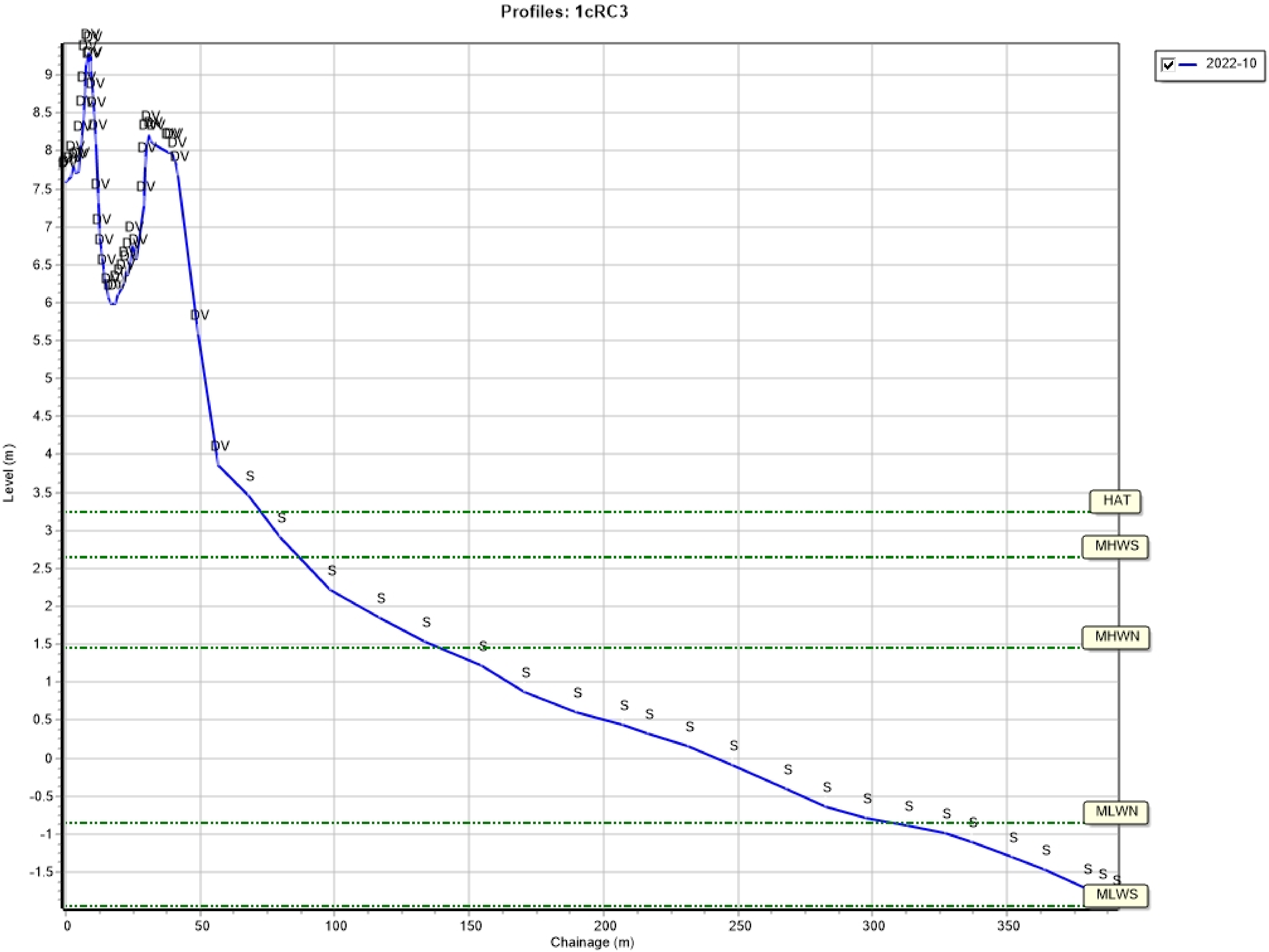
MLWS
Level (m)
Chainage (m)



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Chainage (m)
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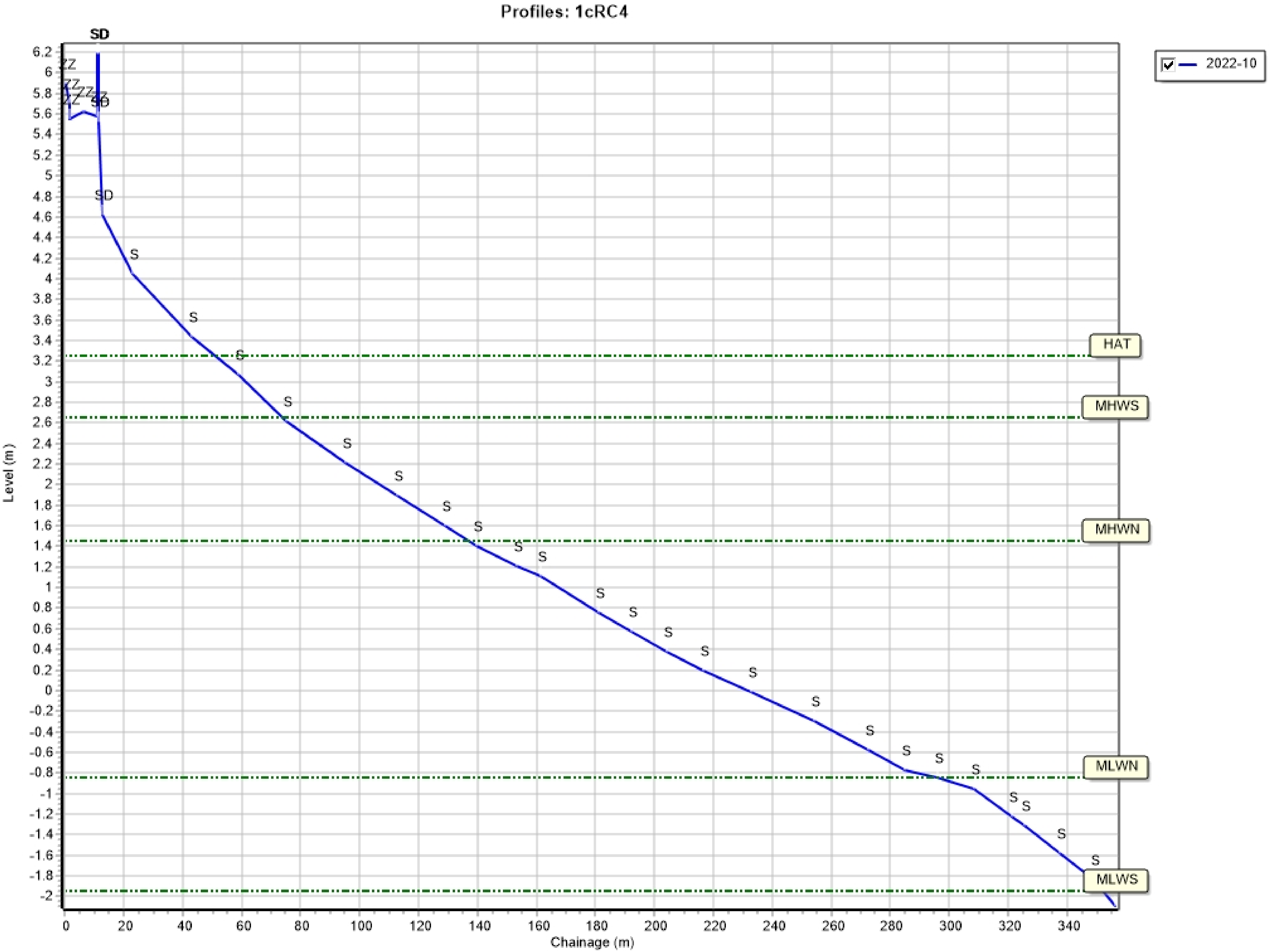
MHWN
MLWN
MLWS
DV
S



Profiles: 1cRC4
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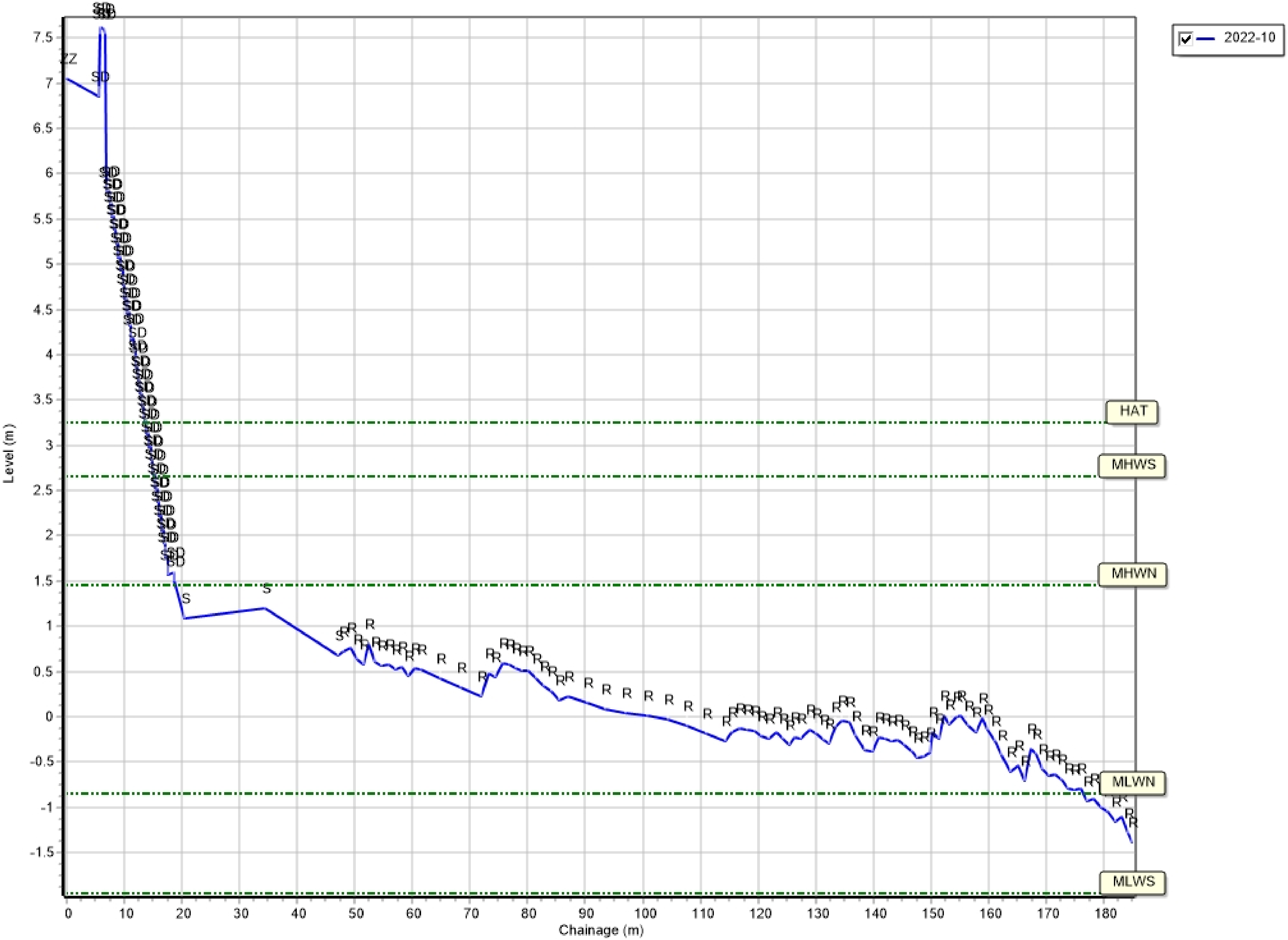
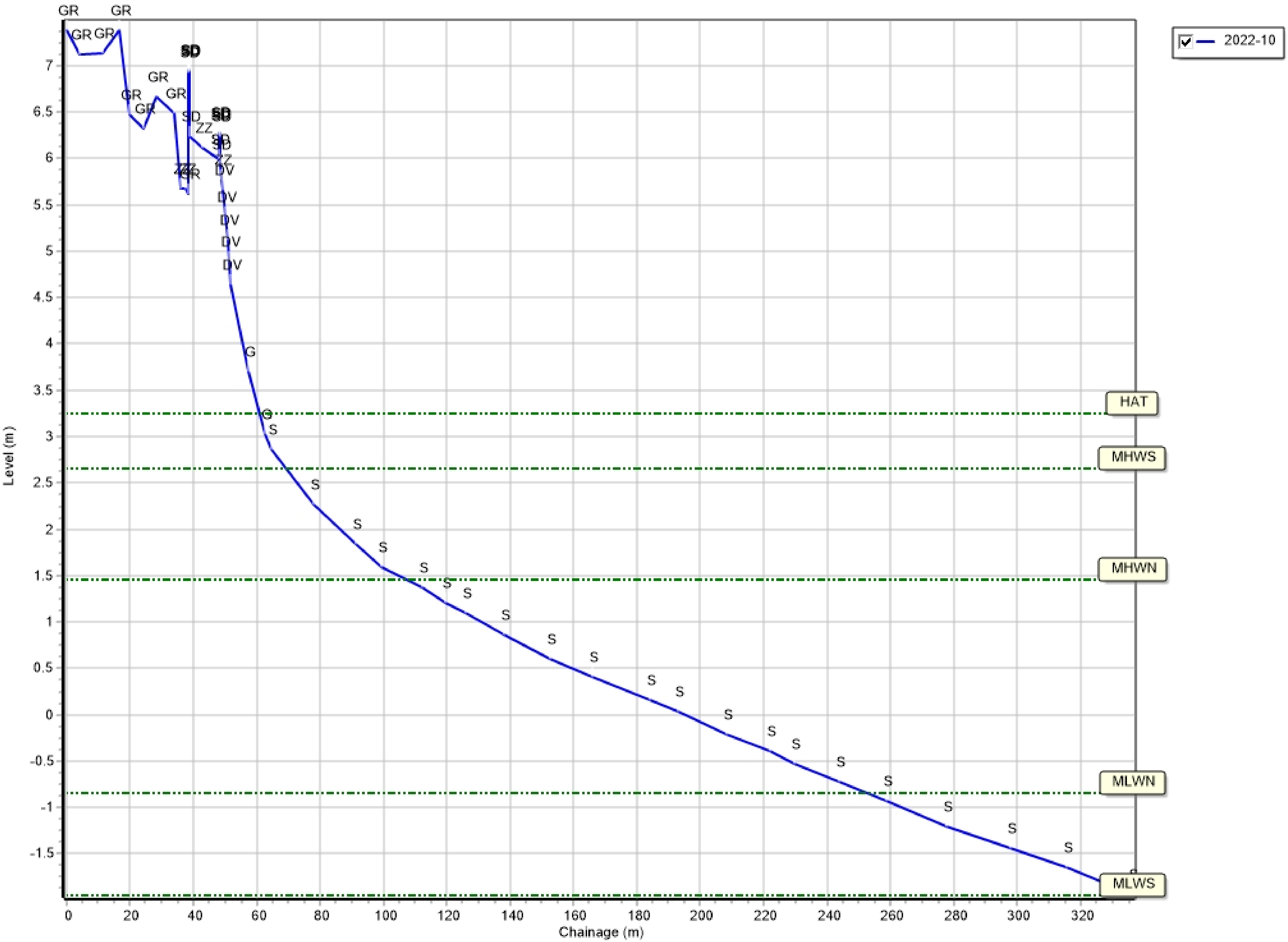
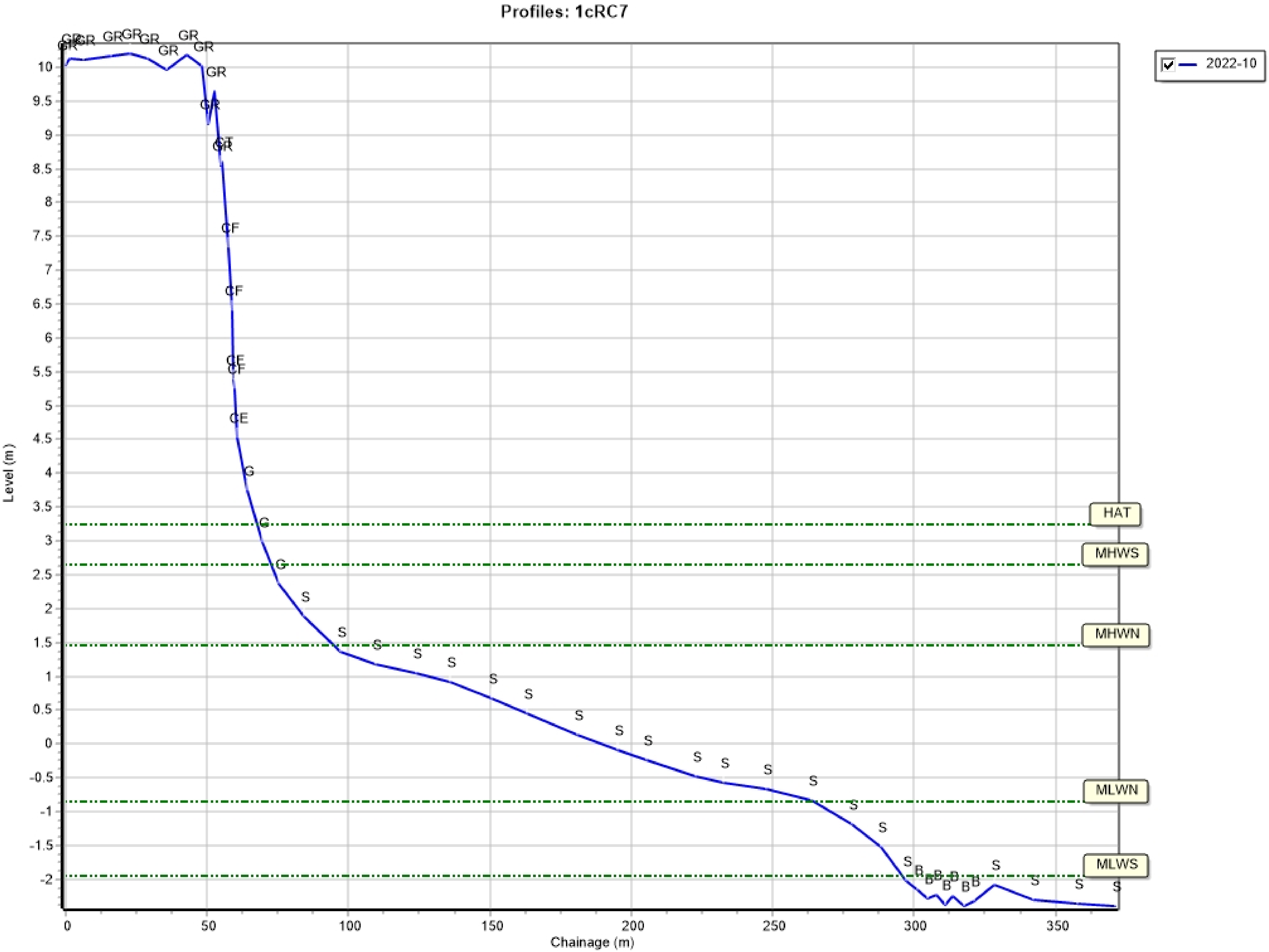
MHWN
MLWN
MLWS
Level (m)
Chainage (m)
SD
ZZ
S

Profiles: 1cRC5



Profiles: 1cRC6





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Level (m)
Chainage (m)
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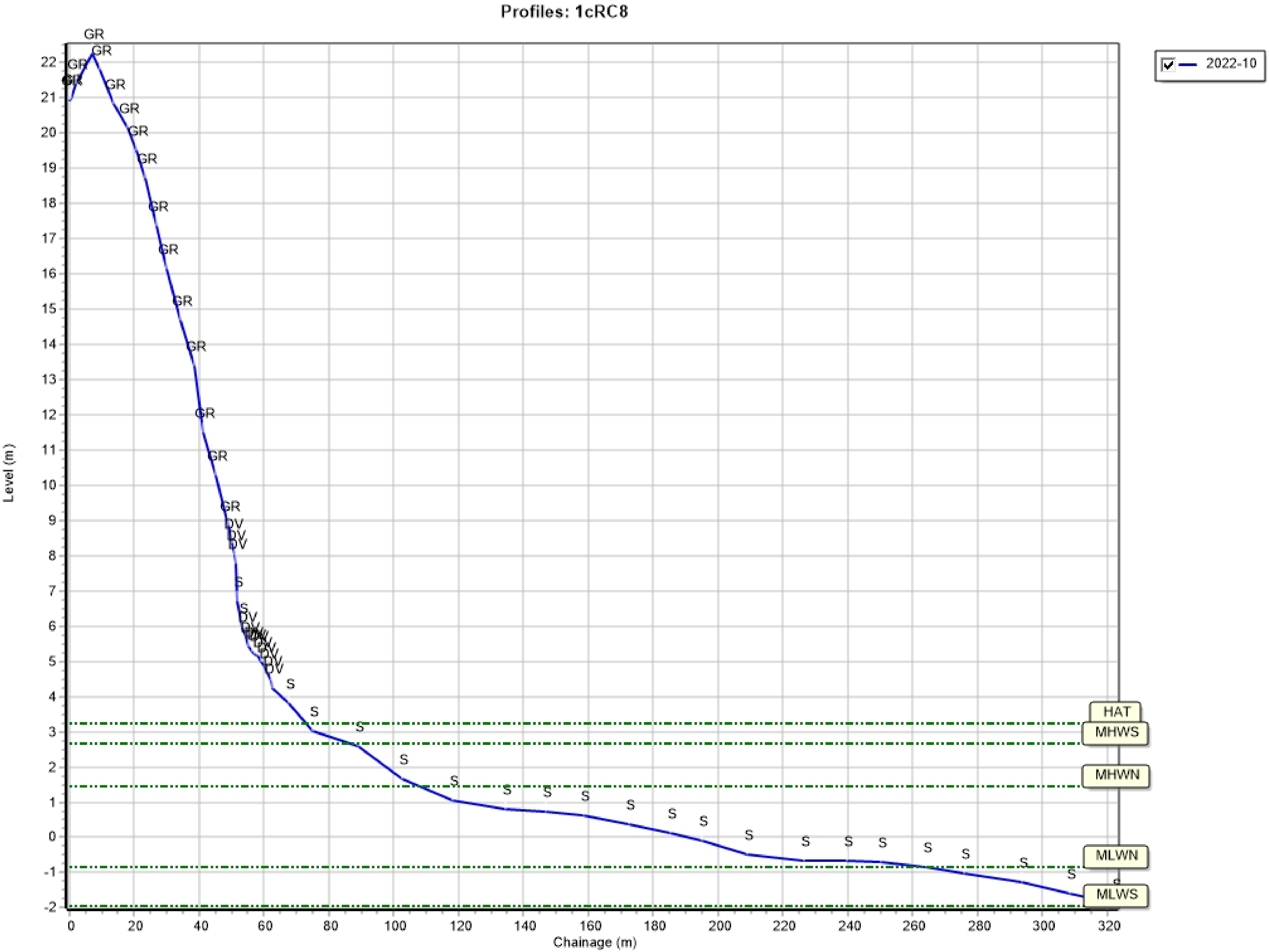
MHWS
MHWN
MLWN
MLWS



Profiles: 1cRC8
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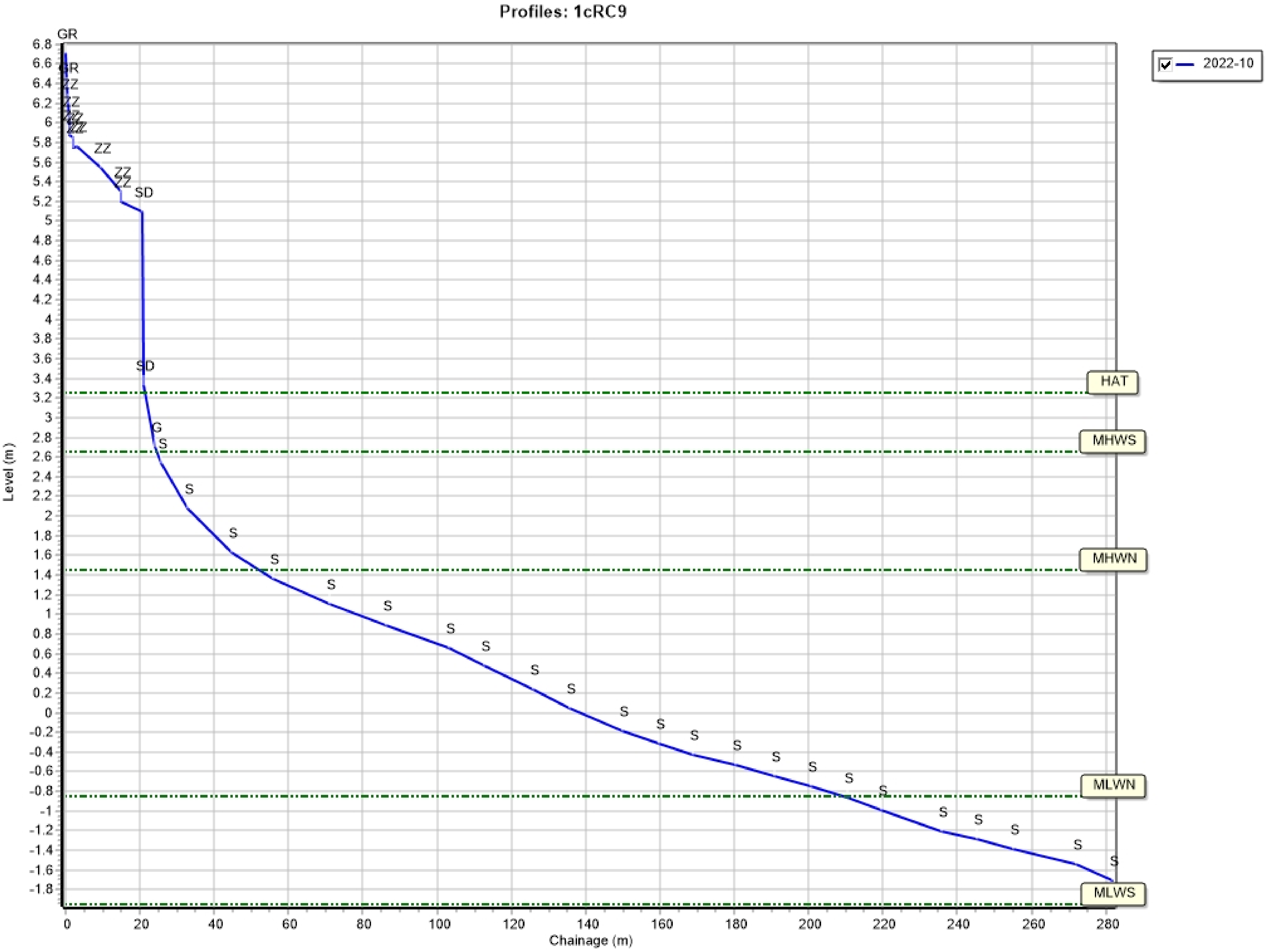
Level (m)
Chainage (m)
HAT
MHWS
MHWN
MLWN
MLWS
GR
DV
S



Profiles: 1cRC9
2022-10
HAT
MHWS
MHWN
MLWN
MLWS
GR
ZZ
SD
G
S
Level (m)
Chainage (m)

Profiles: 1cRC1
Level (m)
Chainage (m)
HAT
MHWS
MHWN
MLWN
MLWS
Profile Envelope
2008-11
2009-04
2009-09
2010-04
2010-11
2011-04
2011-10
2012-03
2012-10
2013-03
2013-10
2014-04
2014-10
2015-04
2015-10
2016-04
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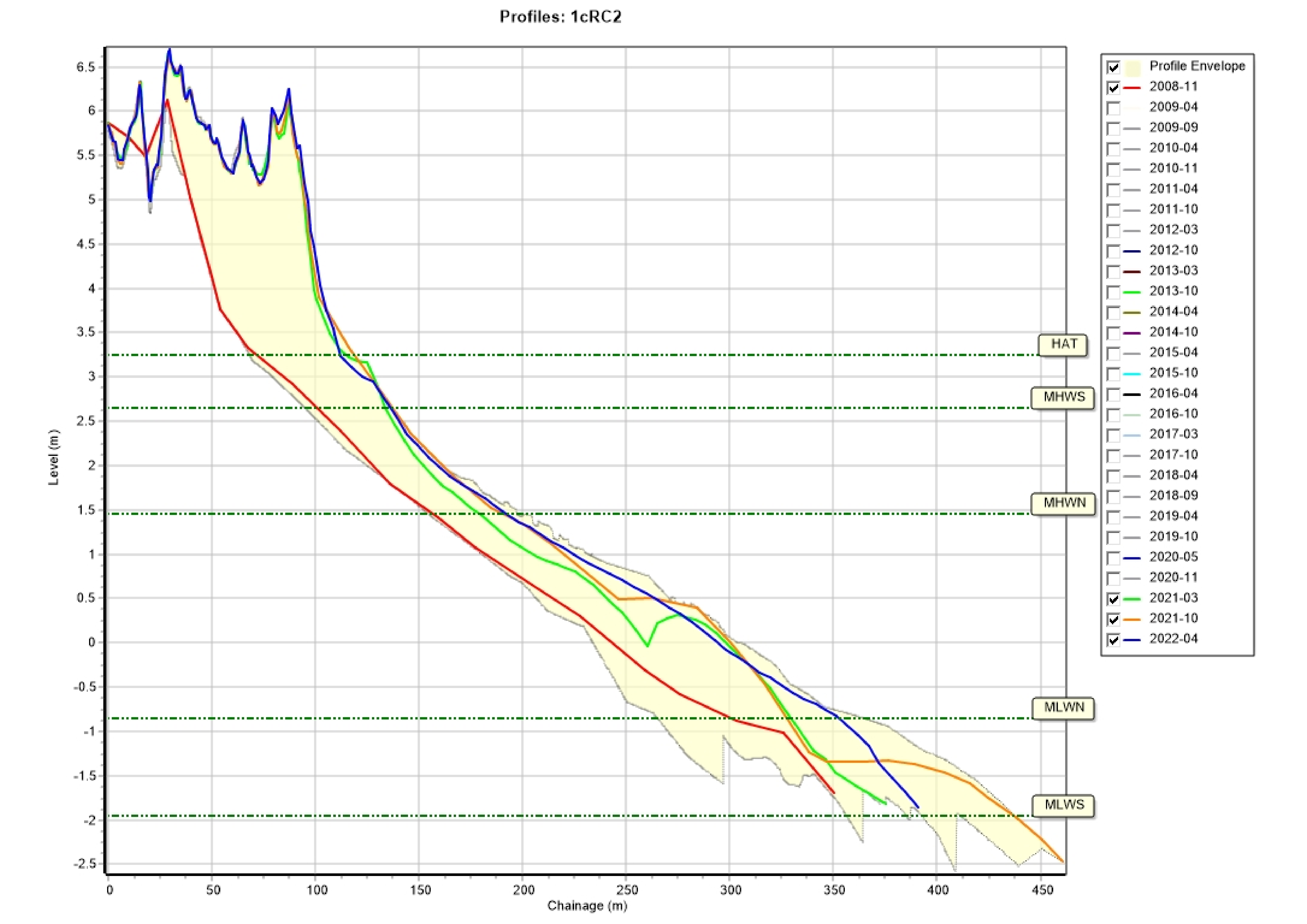
2021-10
2022-04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Chainage (m)
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MHWN
MLWN
MLWS
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2010-04
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2011-10
2012-03
2012-10
2013-03
2013-10
2014-04
2014-10
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2015-10
2016-04
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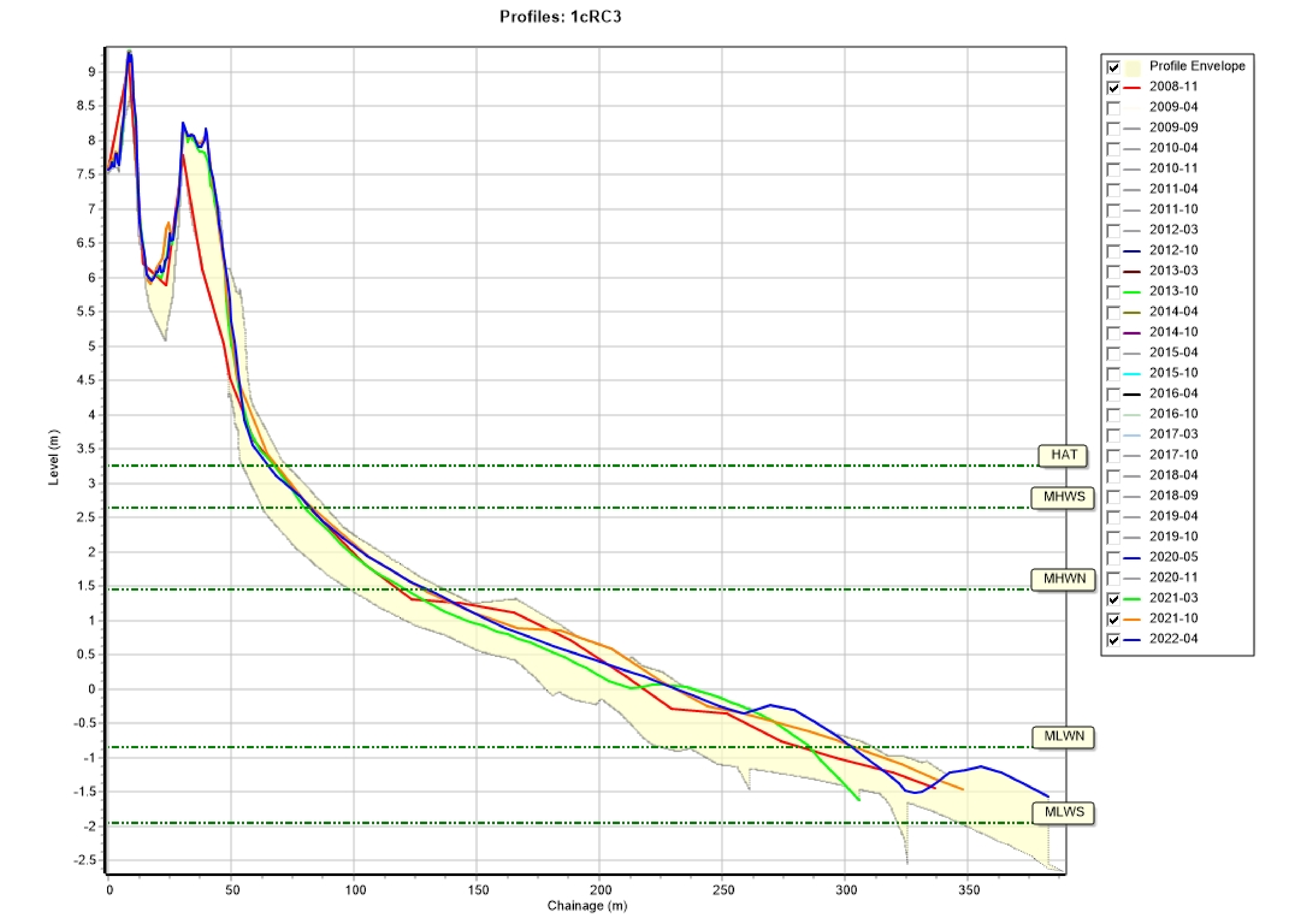
2021-10
2022-04



Profiles: 1cRC3
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Chainage (m)
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MHWN
MLWN
MLWS
Profile Envelope
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2009-09
2010-04
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2011-04
2011-10
2012-03
2012-10
2013-03
2013-10
2014-04
2014-10
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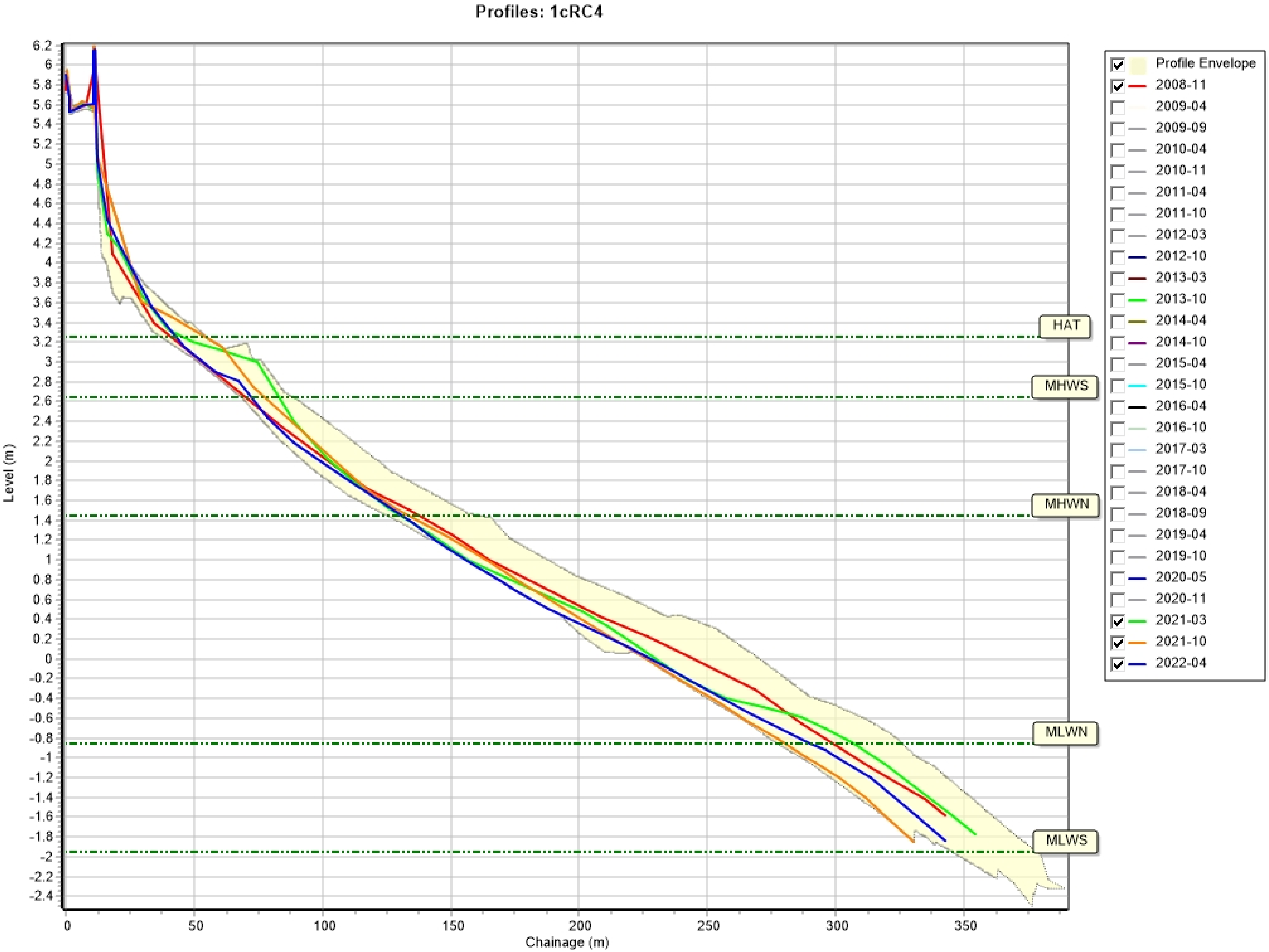
2021-10
2022-04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Chainage (m)
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MLWN
MLWS
Profile Envelope
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2010-11
2011-04
2011-10
2012-03
2012-10
2013-03
2013-10
2014-04
2014-10
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2016-04
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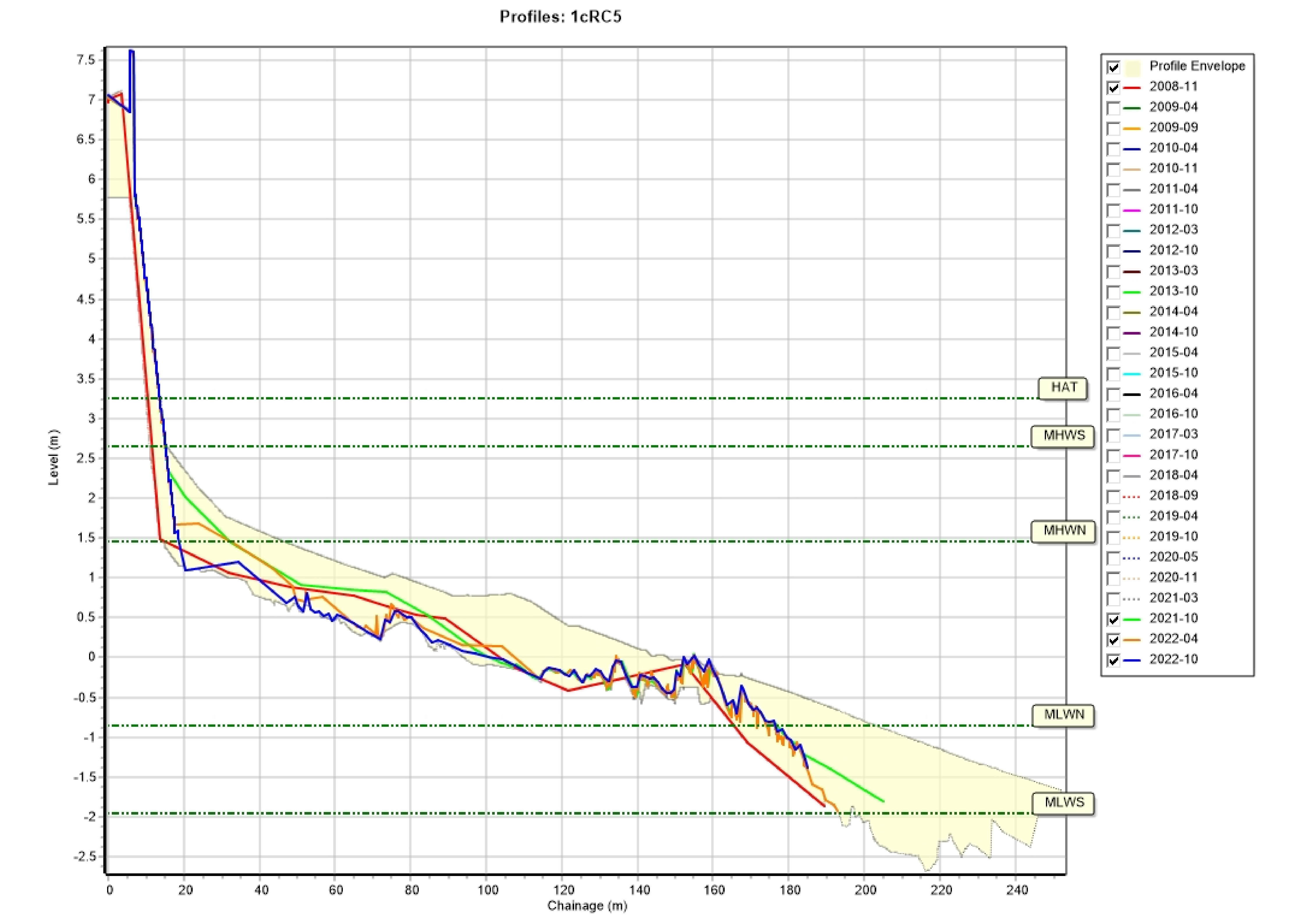
2021-10
2022-04



Profiles: 1cRC5
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Chainage (m)
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MHWN
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MLWS
Profile Envelope
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2011-10
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2013-10
2014-04
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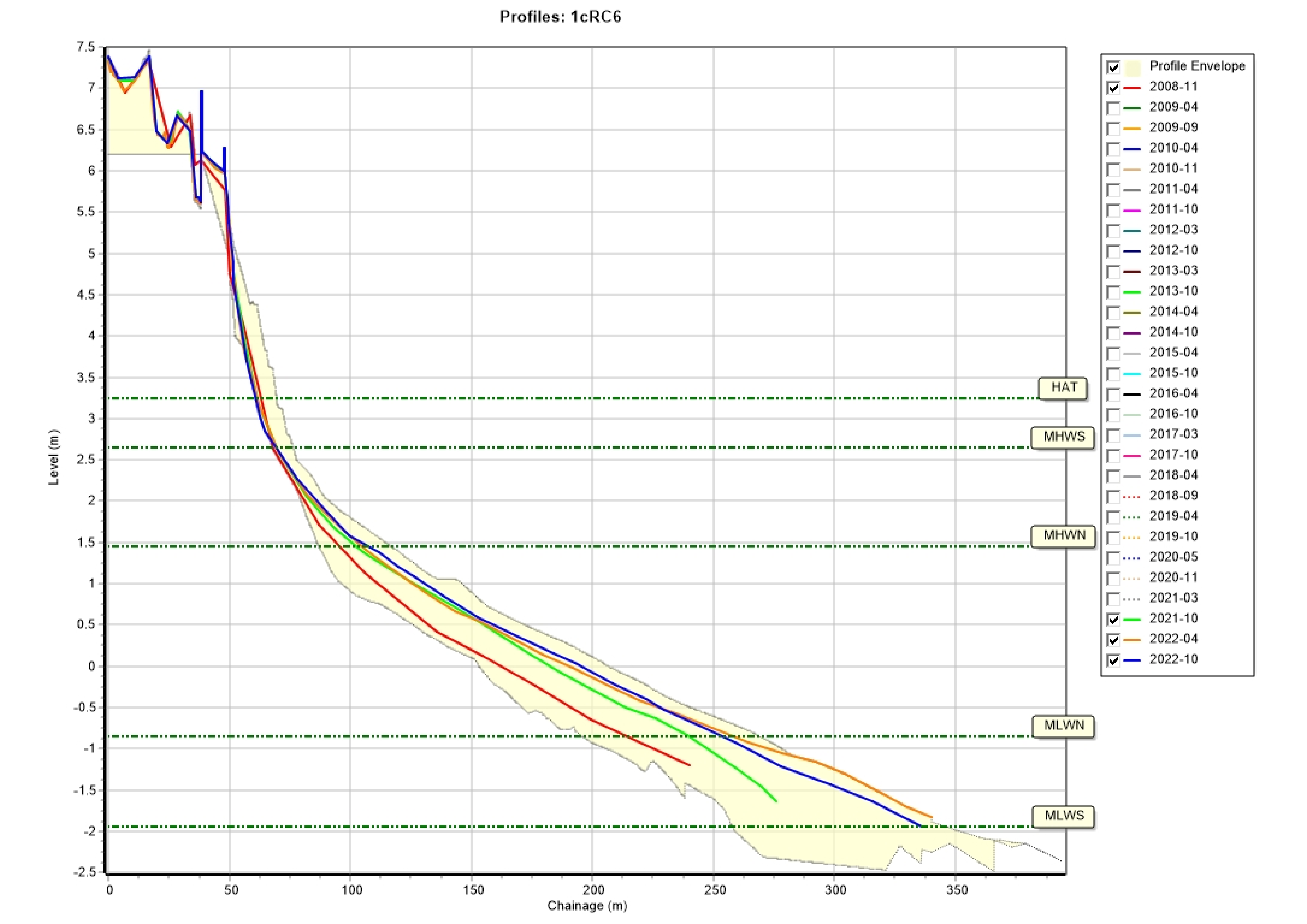
2022-04
2022-10



Profiles: 1cRC6
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Chainage (m)
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6.5
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5.5
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4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
0
50
100
150
200
250
300
350
HAT
MHWS
MHWN
MLWN
MLWS
Profile Envelope
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2009-04
2009-09
2010-04
2010-11
2011-04
2011-10
2012-03
2012-10
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2013-10
2014-04
2014-10
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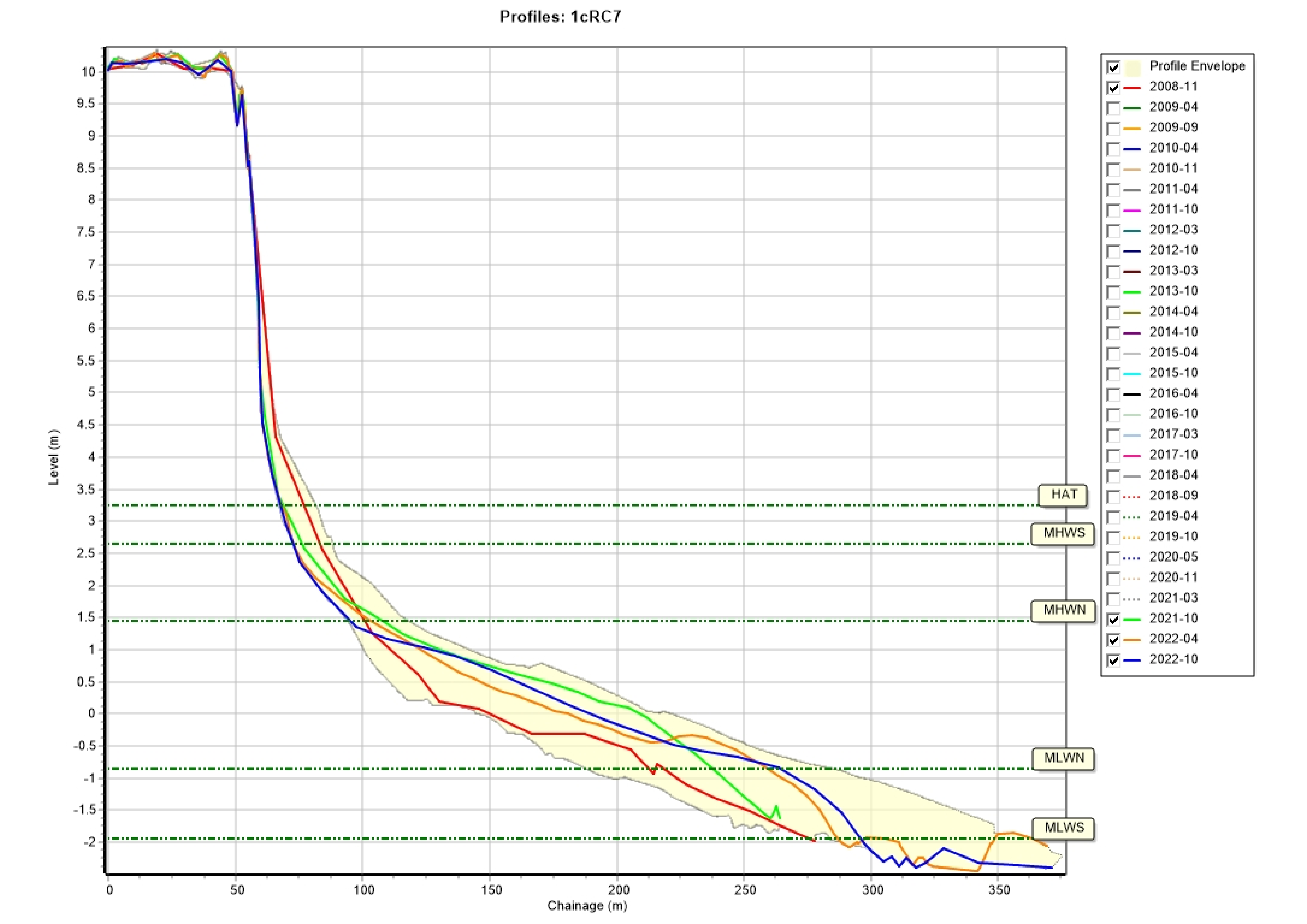
2022-04
2022-10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Chainage (m)
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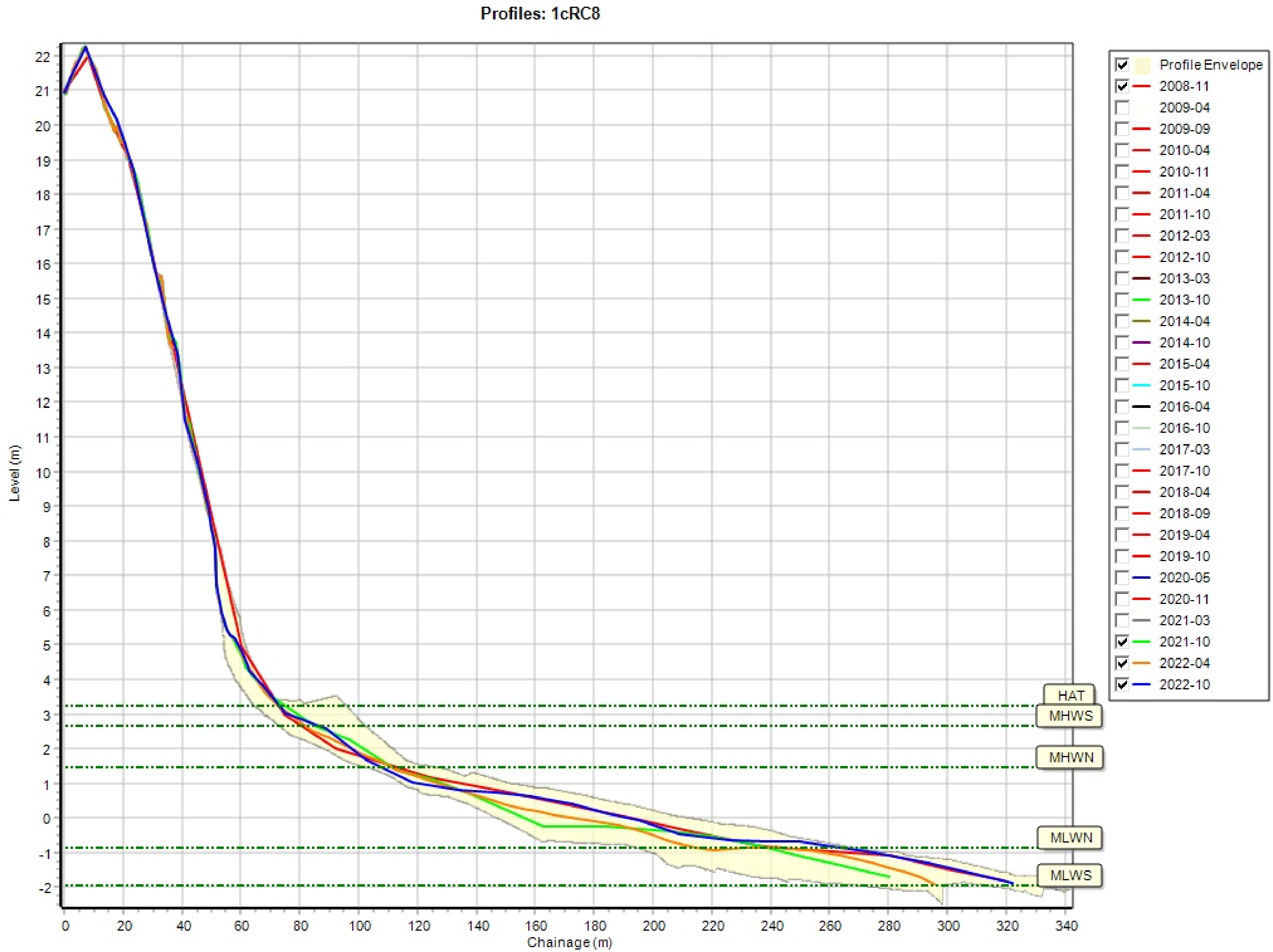
2022-10



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6
5
4
3
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1
0
-1
-2
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
HAT
MHWS
MHWN
MLWN
MLWS
Profile Envelope
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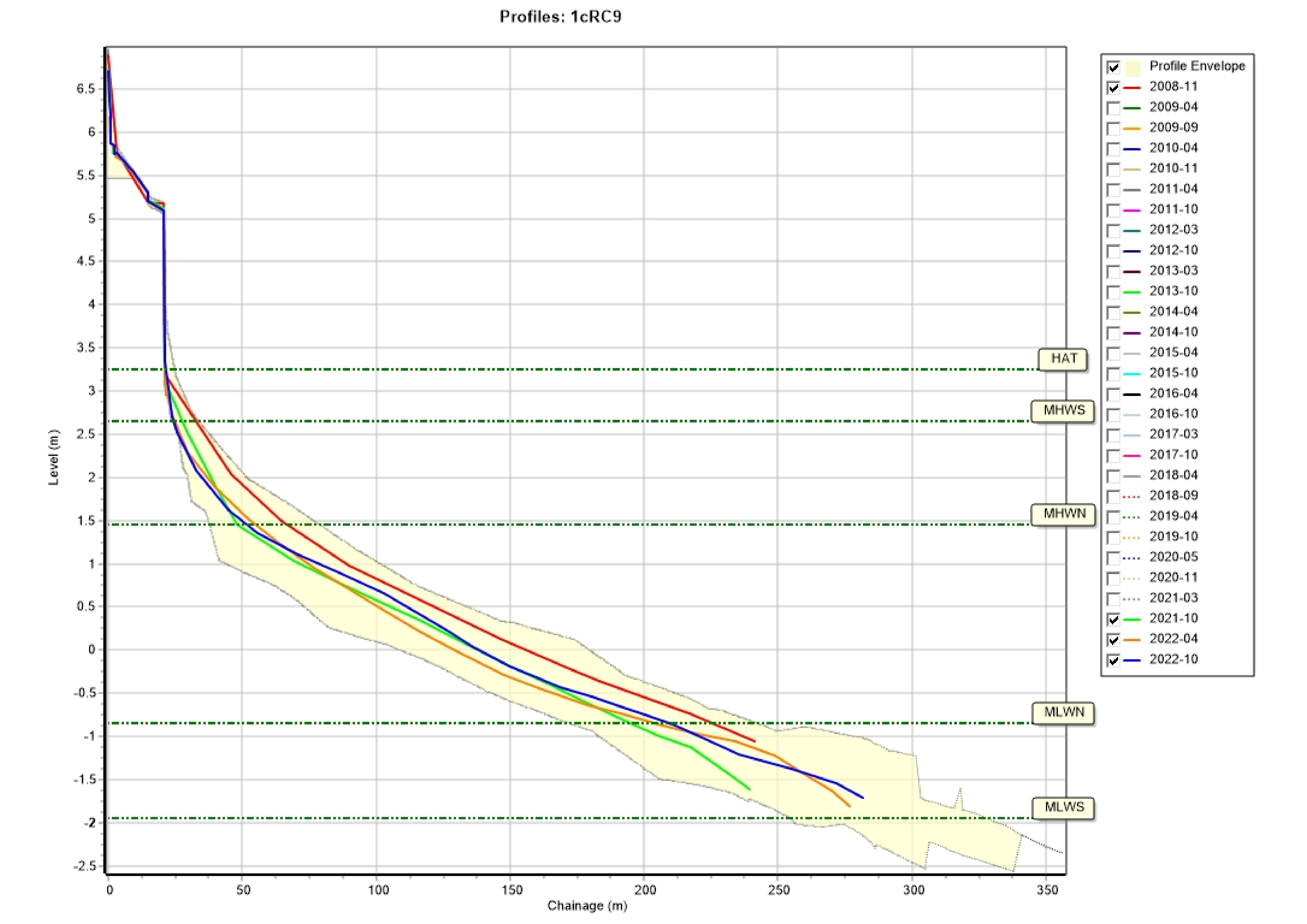
2022-04
2022-10



Profiles: 1cRC9
Level (m)
Chainage (m)
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MLWN
MLWS
Profile Envelope
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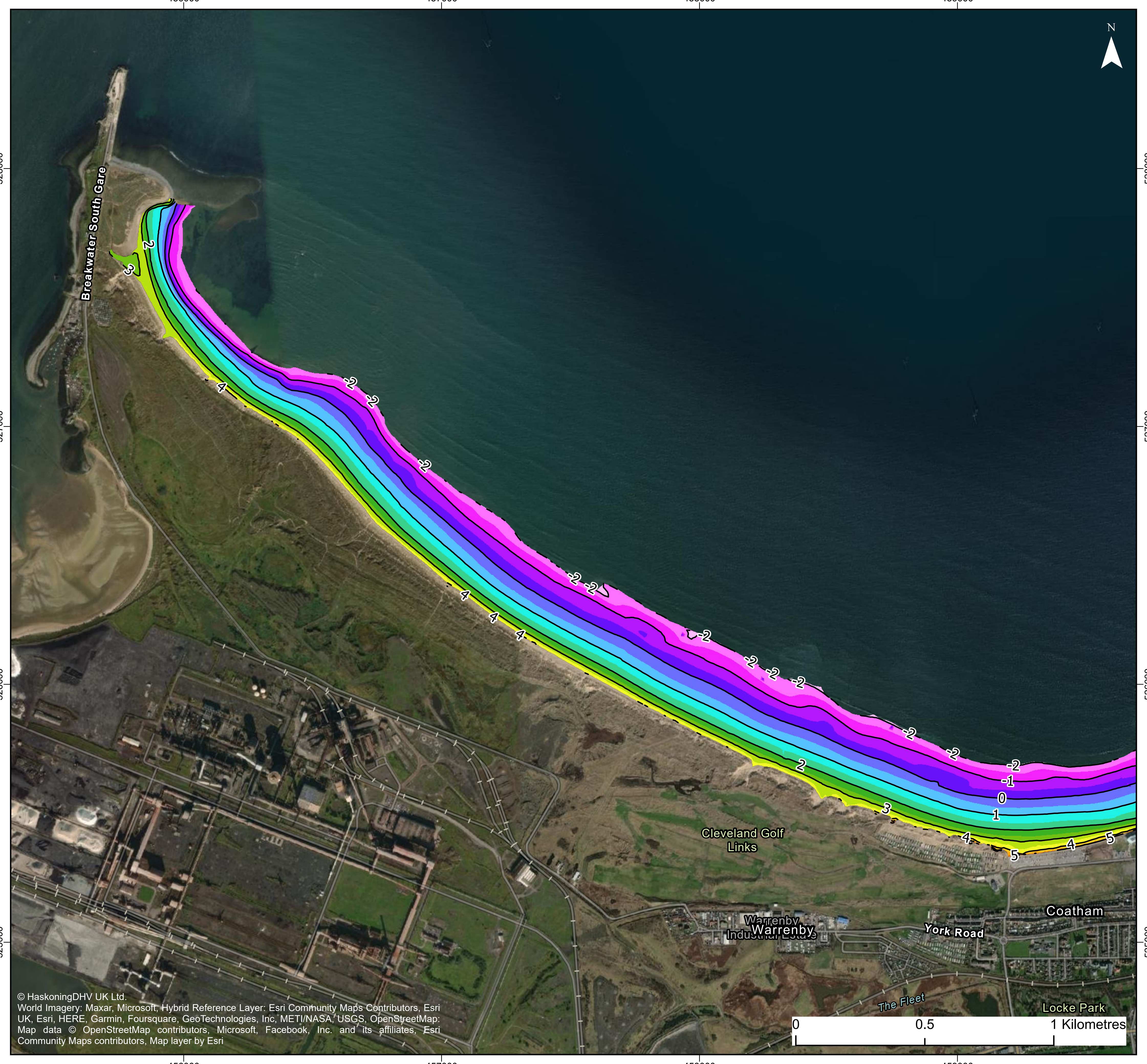
2022-04
2022-10

Appendix B

Topographic Survey



TOPOGRAPHIC SURVEY (October 2022)

Elevation (mOD)
- -2.4 - -2.5
- -2.4 - -2
- -1.9 - -1.5
- -1.4 - -1
- -0.9 - -0.5
- -0.4 - 0
- 0.1 - 0.5
- 0.6 - 1
- 1.1 - 1.5
- 1.6 - 2
- 2.1 - 2.5
- 2.6 - 3
- 3.1 - 3.5
- 3.6 - 4
- 4.1 - 4.5
- 4.6 - 5
- 5.1 - 5.5
- 5.6 - 6
- 6.1 - 6.5

Contours (mOD)*
- 1.0m interval

* Contours only cover sandy beach areas.

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

Title:

Appendix B - Map 1

COATHAM SANDS

Redcar and Cleveland Borough Council Frontage

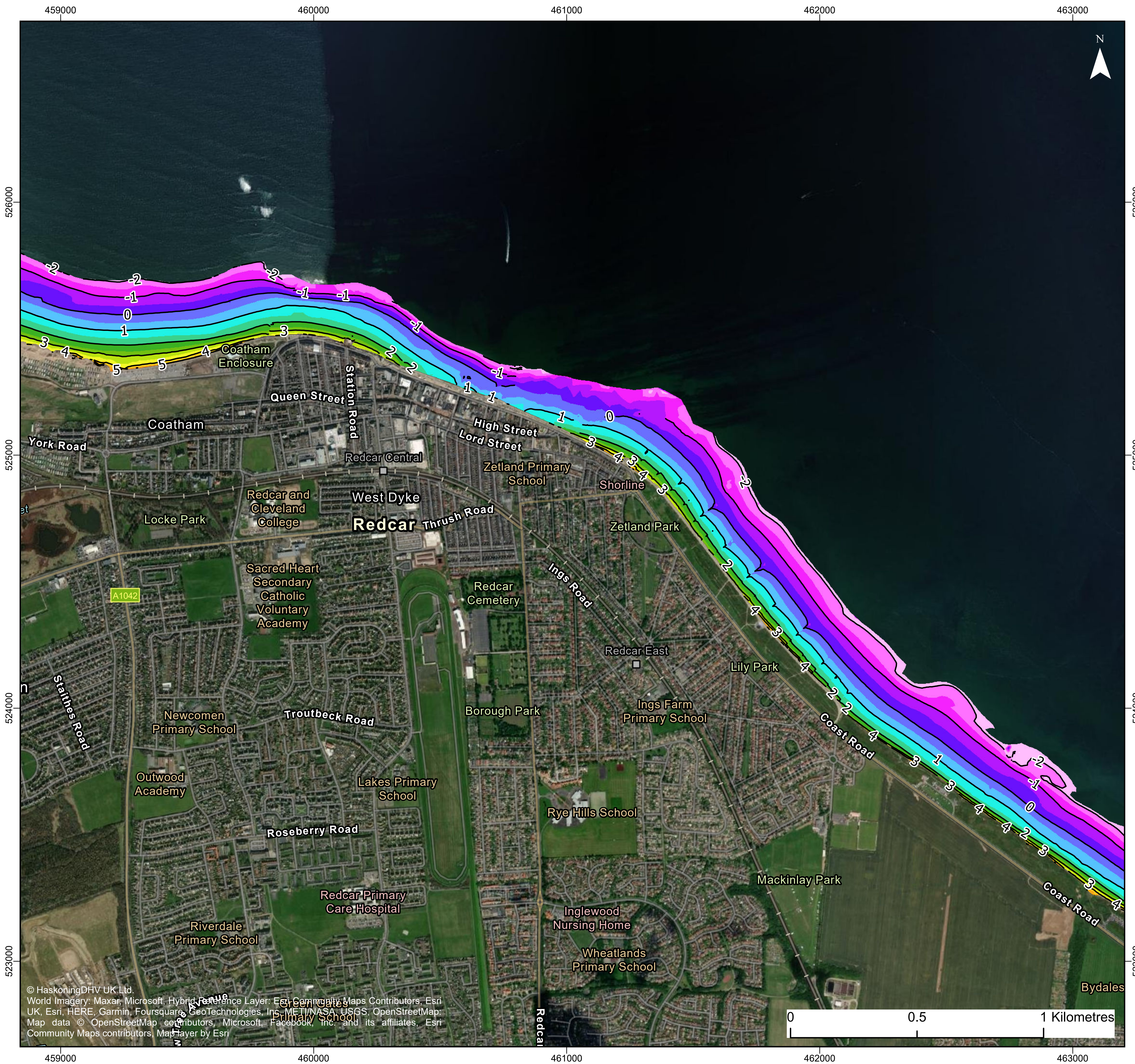
Report:
Analytical Report
'Full Measures' Survey 2022

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	15/12/2022	TC	TW	A3	1:15,000

Co-ordinate system: British National Grid

Royal HaskoningDHV
Enhancing Society Together

North East Coastal Observatory



TOPOGRAPHIC SURVEY (October 2022)

Elevation (mOD)

- -2.4 - -2.5
- -2.4 - -2
- -1.9 - -1.5
- -1.4 - -1
- -0.9 - -0.5
- -0.4 - 0
- 0.1 - 0.5
- 0.6 - 1
- 1.1 - 1.5
- 1.6 - 2
- 2.1 - 2.5
- 2.6 - 3
- 3.1 - 3.5
- 3.6 - 4
- 4.1 - 4.5
- 4.6 - 5
- 5.1 - 5.5
- 5.6 - 6
- 6.1 - 6.5

Contours (mOD)*

- 1.0m interval

* Contours only cover sandy beach areas.

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

Title:

Appendix B - Map 2

REDCAR SANDS

Redcar and Cleveland Borough Council Frontage

Report: Analytical Report 'Full Measures' Survey 2022

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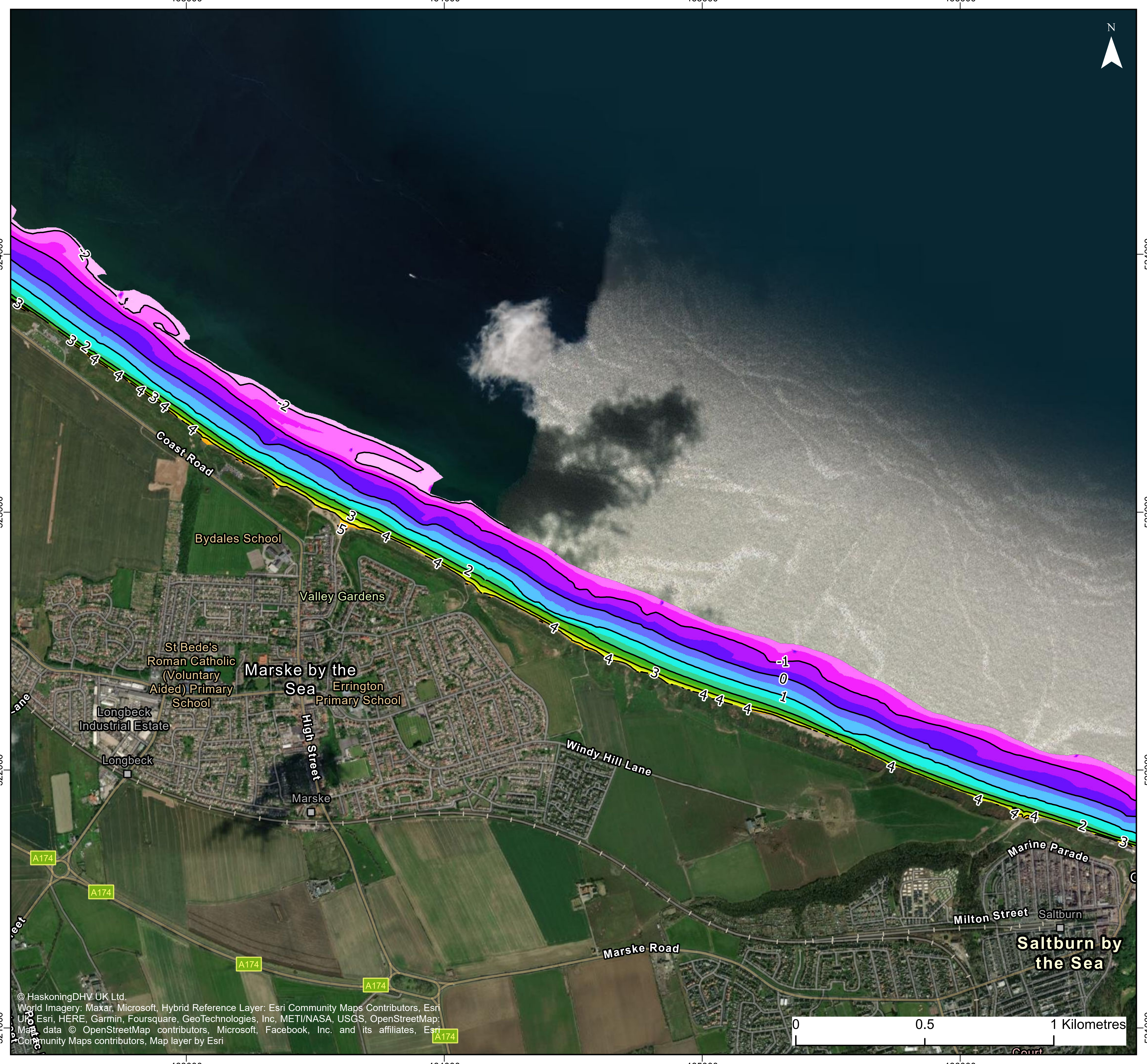
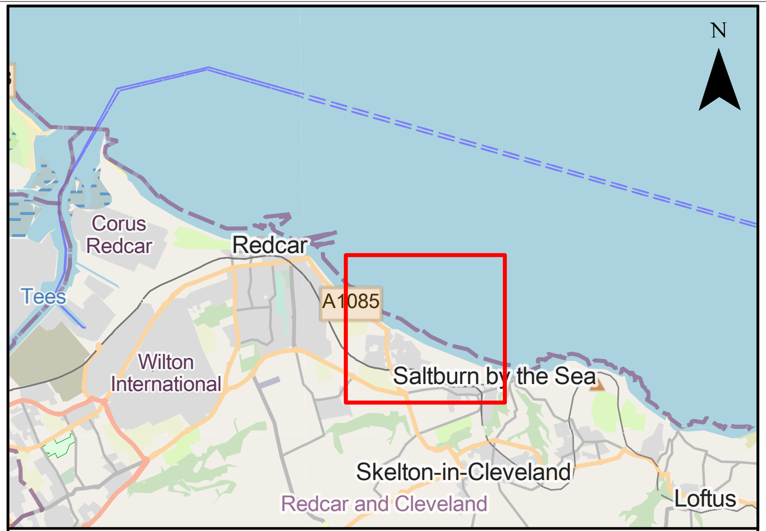
Co-ordinate system: British National Grid

Royal HaskoningDHV *Enhancing Society Together*

North East Coastal Observatory





TOPOGRAPHIC SURVEY (October 2022)

Elevation (mOD)

- -2.4 - -2.5
- -2.4 - -2
- -1.9 - -1.5
- -1.4 - -1
- -0.9 - -0.5
- -0.4 - 0
- 0.1 - 0.5
- 0.6 - 1
- 1.1 - 1.5
- 1.6 - 2
- 2.1 - 2.5
- 2.6 - 3
- 3.1 - 3.5
- 3.6 - 4
- 4.1 - 4.5
- 4.6 - 5
- 5.1 - 5.5
- 5.6 - 6
- 6.1 - 6.5

Contours (mOD)*

1.0m interval

* Contours only cover sandy beach areas.

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Title:

Appendix B - Map 3

MARSKE SANDS

Redcar and Cleveland Borough Council Frontage

Report: Analytical Report 'Full Measures' Survey 2022

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	15/12/2022	TC	TW	A3	1:15,000

Co-ordinate system: British National Grid

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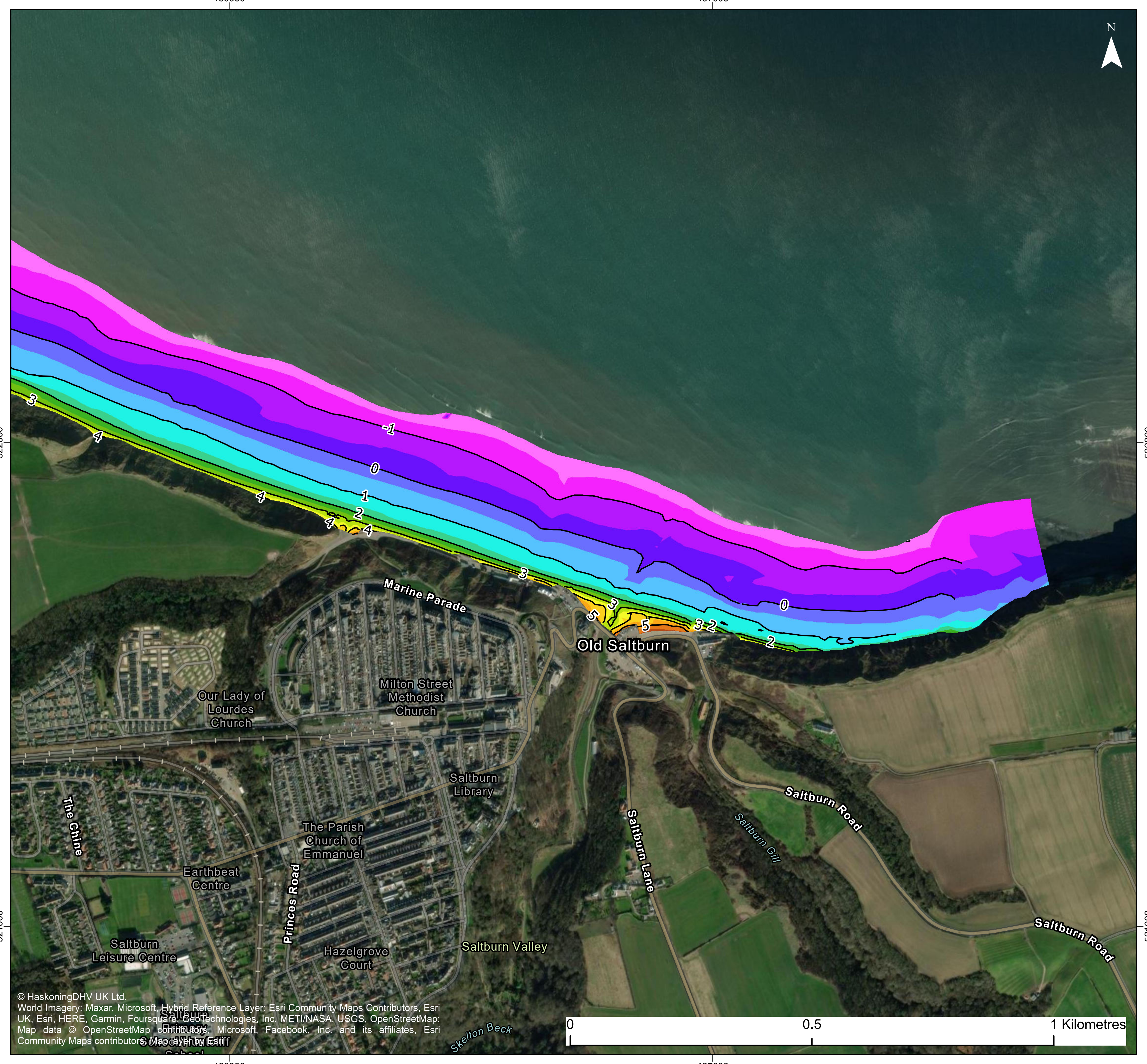

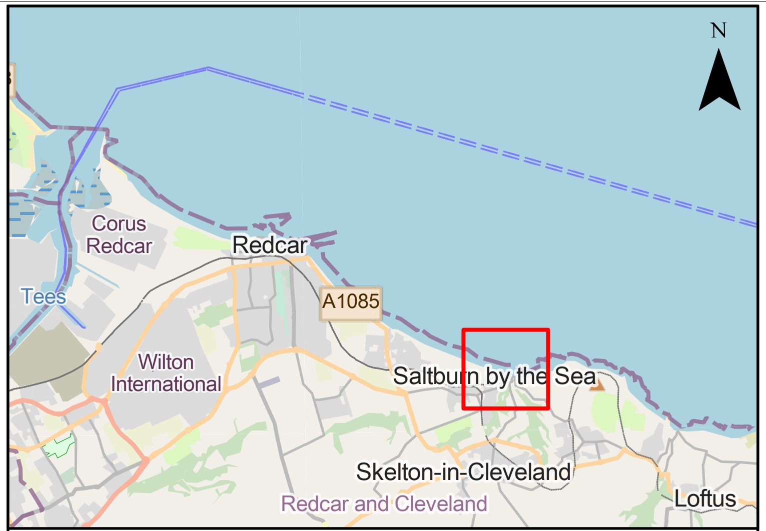

TOPOGRAPHIC SURVEY (October 2022)

Elevation (mOD)

- -2.4 - -2.5
- -2.4 - -2
- -1.9 - -1.5
- -1.4 - -1
- -0.9 - -0.5
- -0.4 - 0
- 0.1 - 0.5
- 0.6 - 1
- 1.1 - 1.5
- 1.6 - 2
- 2.1 - 2.5
- 2.6 - 3
- 3.1 - 3.5
- 3.6 - 4
- 4.1 - 4.5
- 4.6 - 5
- 5.1 - 5.5
- 5.6 - 6
- 6.1 - 6.5

Contours (mOD)*

1.0m interval

* Contours only cover sandy beach areas.

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Title:

Appendix B - Map 4

SALTBURN SANDS

Redcar and Cleveland Borough Council Frontage

Report: Analytical Report 'Full Measures' Survey 2022

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	15/12/2022	TC	TW	A3	1:8,000

Co-ordinate system: British National Grid

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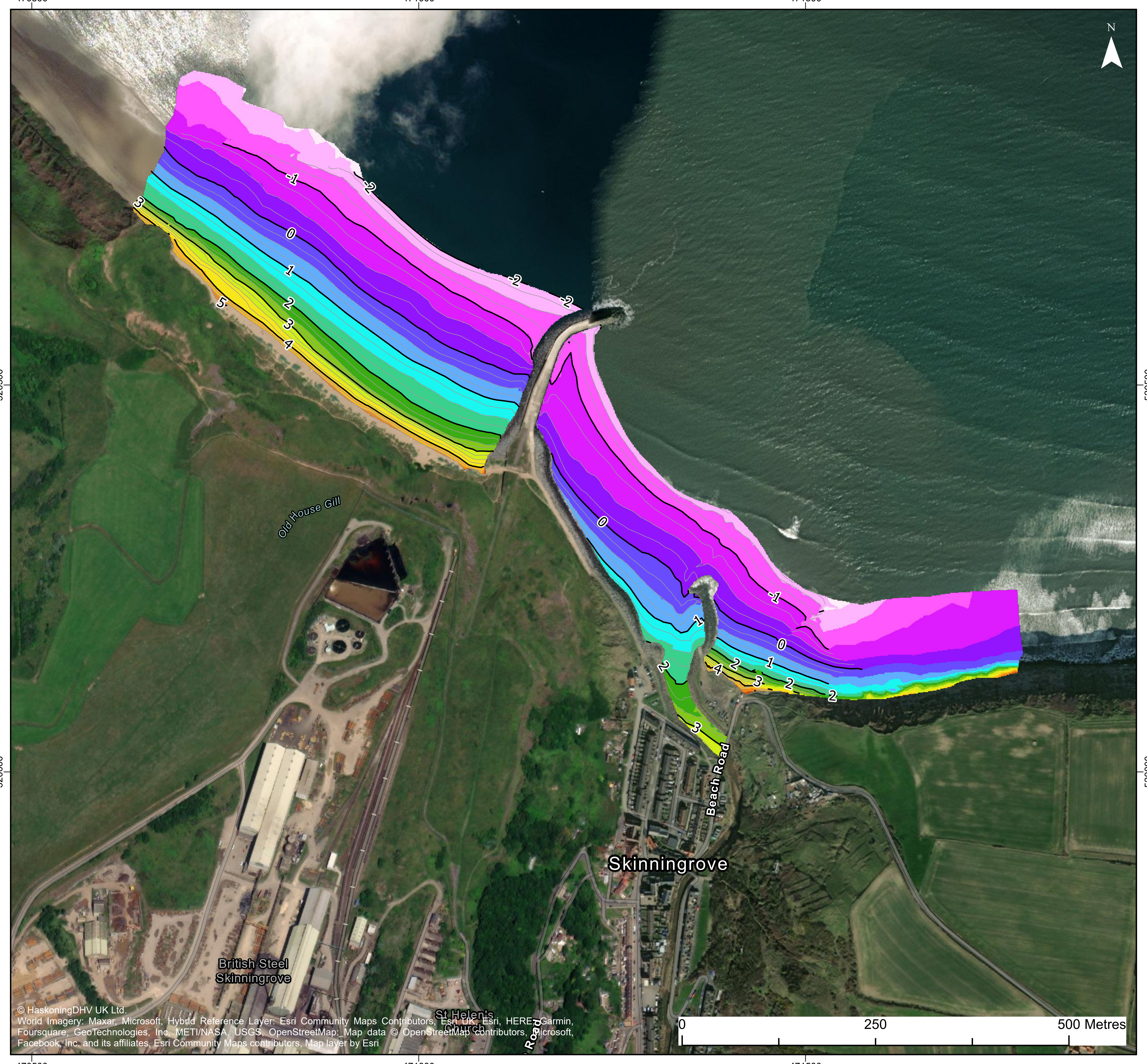
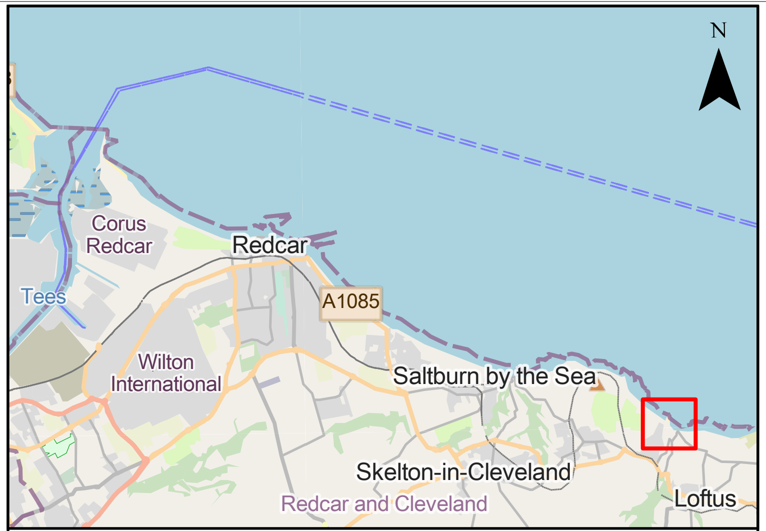
North East Coastal Observatory





TOPOGRAPHIC SURVEY (October 2022)

Elevation (mOD)

- -2.3 - -2
- -1.9 - -1.5
- -1.4 - -1
- -0.9 - -0.5
- -0.4 - 0
- 0.1 - 0.5
- 0.6 - 1
- 1.1 - 1.5
- 1.6 - 2
- 2.1 - 2.5
- 2.6 - 3
- 3.1 - 3.5
- 3.6 - 4
- 4.1 - 4.5
- 4.6 - 5
- 5.1 - 5.5
- 5.6 - 6

Contours (mOD)*

- 1.0m interval
- 0.25m interval

* Contours only cover sandy beach areas.

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Title:

Appendix B - Map 5

CATTERSTY SANDS (SKINNINGROVE)

Redcar and Cleveland Borough Council Frontage

Report: Analytical Report 'Full Measures' Survey 2022

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	15/12/2022	TC	TW	A3	1:5,000

Co-ordinate system: British National Grid

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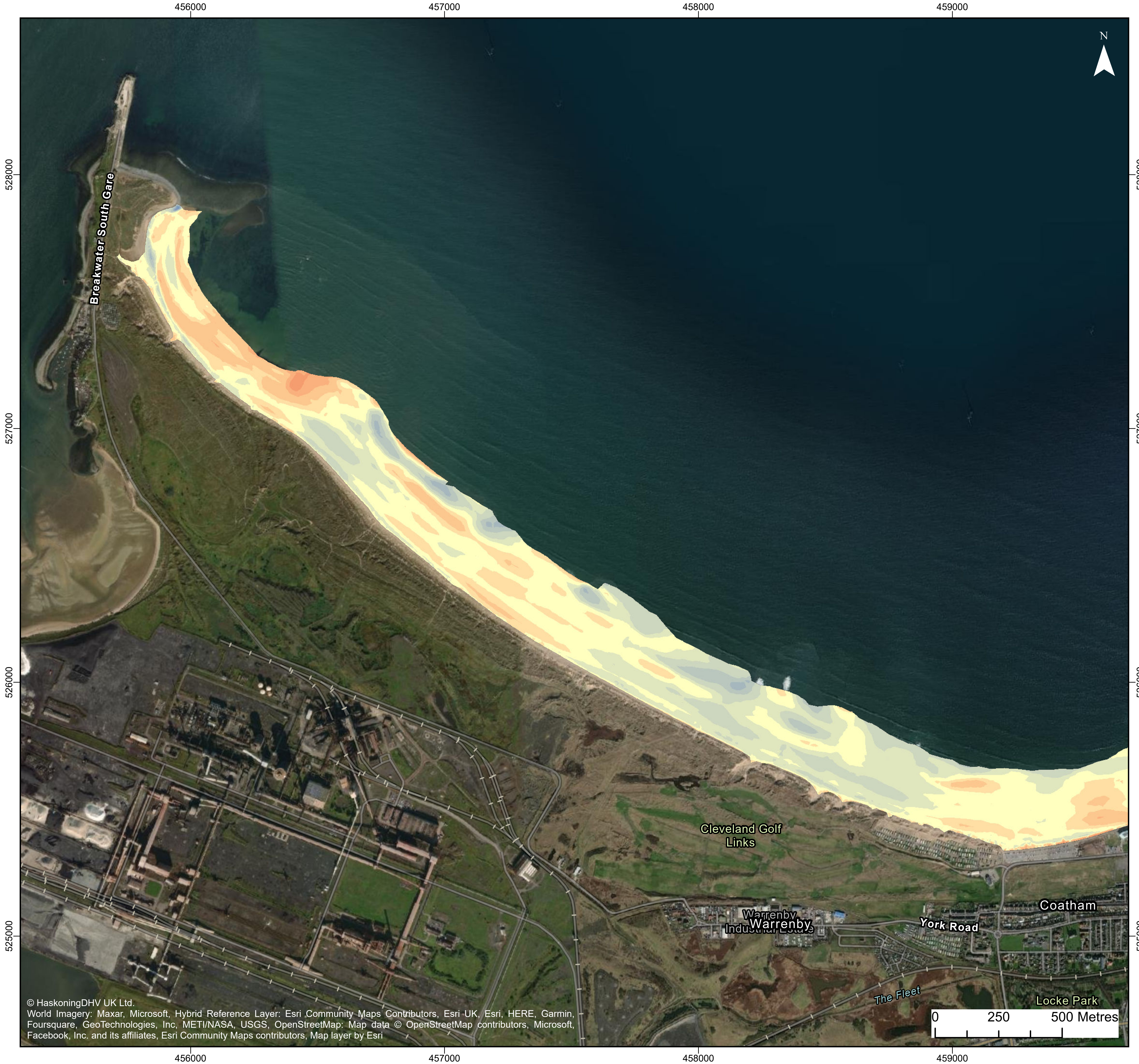

Difference between topographic surveys
(Oct 2021 to Oct 2022)
Change in Elevation (mOD)

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

COATHAM SANDS

Redcar and Cleveland Borough Council Frontage

Report: Analytical Report 'Full Measures' Survey 2022

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	15/12/2022	TC	TW	A3	1:15,000

Co-ordinate system: British National Grid

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Difference between topographic surveys
(Oct 2021 to Oct 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:	Project:
North East Coastal Group	Cell 1 Regional Coastal Monitoring Programme

Title:

Appendix B - Map 7

REDCAR SANDS

Redcar and Cleveland Borough Council Frontage

Report:
Analytical Report
'Full Measures' Survey 2022

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	15/12/2022	TC	TW	A3	1:15,000

Co-ordinate system: British National Grid

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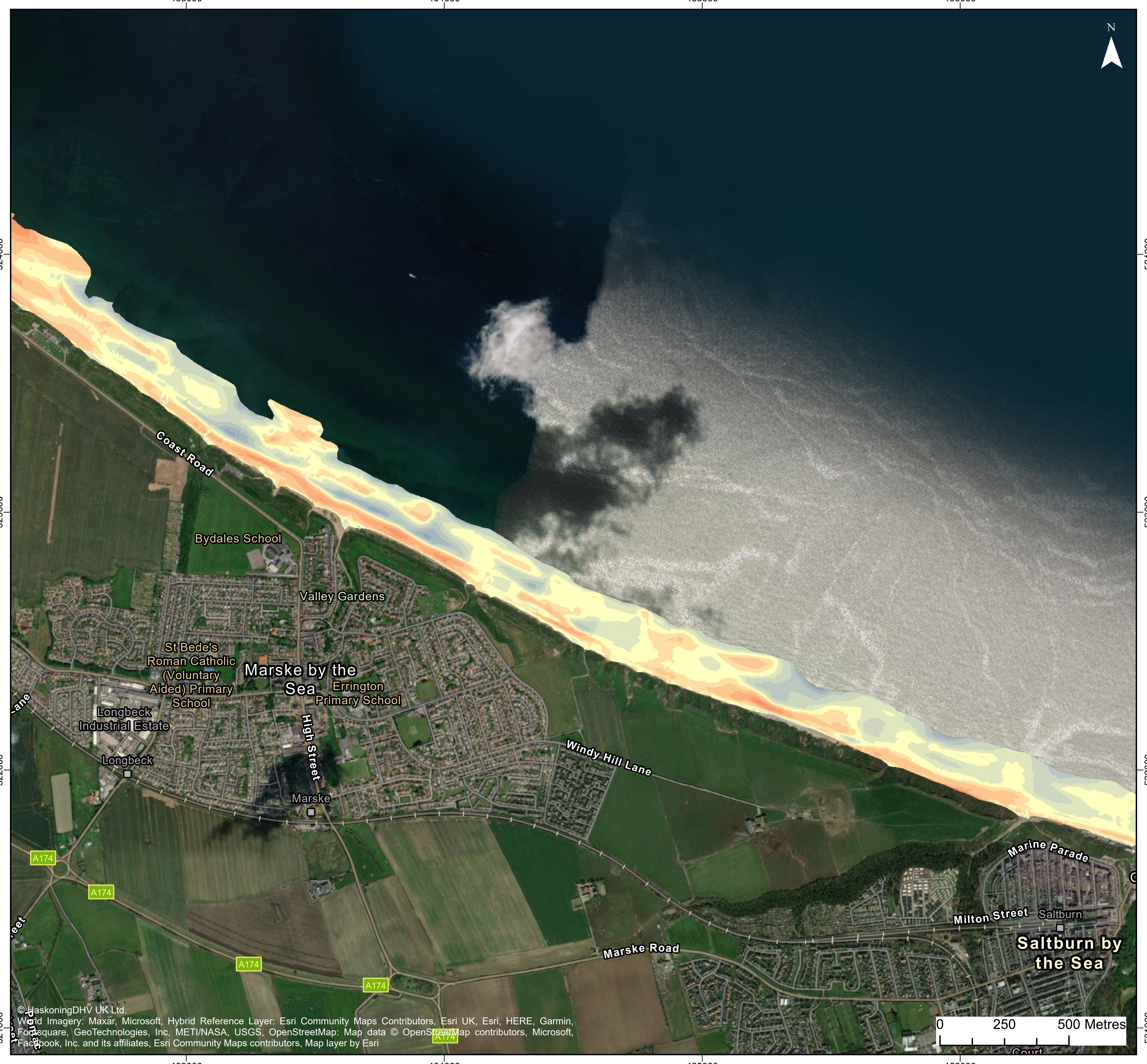

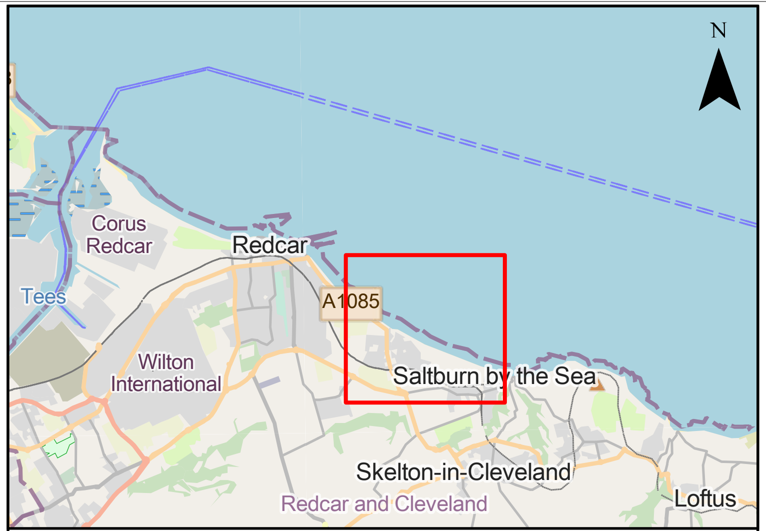

Difference between topographic surveys
(Oct 2021 to Oct 2022)
Change in Elevation (mOD)

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 8

MARSKE SANDS

Redcar and Cleveland Borough Council Frontage

Report: Analytical Report 'Full Measures' Survey 2022

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	15/12/2022	TC	TW	A3	1:15,000

Co-ordinate system: British National Grid

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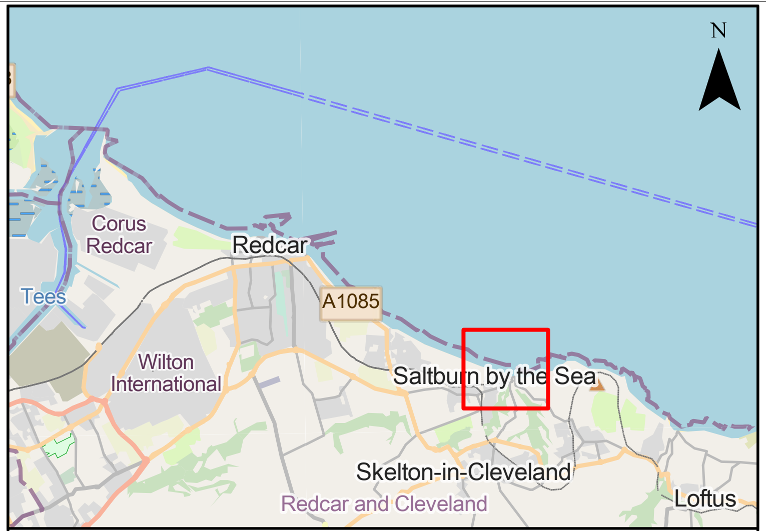

Difference between topographic surveys
(Oct 2021 to Oct 2022)
Change in Elevation (mOD)

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 9

SALTBURN SANDS

Redcar and Cleveland Borough Council Frontage

Report:
Analytical Report
'Full Measures' Survey 2022

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	15/12/2022	TC	TW	A3	1:8,000

Co-ordinate system: British National Grid

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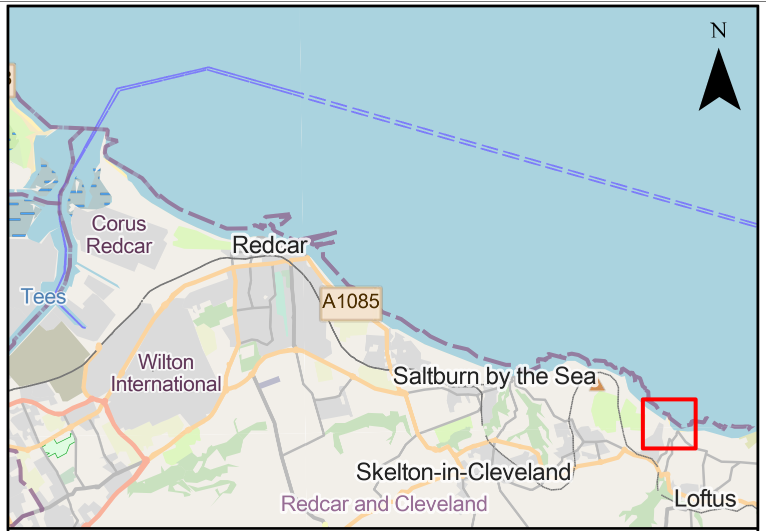
470500 471000 471500

520500

520000

470500 471000 471500



Difference between topographic surveys
(Apr 2022 to Oct 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:	Project:
North East Coastal Group	Cell 1 Regional Coastal Monitoring Programme

Title:

Appendix B - Map 10

CATTERSTY SANDS (SKINNINGROVE)

Redcar and Cleveland Borough Council Frontage

Report:
Analytical Report
'Full Measures' Survey 2022

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	15/12/2022	TC	TW	A3	1:5,000

Co-ordinate system: British National Grid

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Difference between topographic surveys
(Apr 2022 to Oct 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:	Project:
North East Coastal Group	Cell 1 Regional Coastal Monitoring Programme

Title:

Appendix B - Map 11

REDCAR SANDS

Redcar and Cleveland Borough Council Frontage

Report:
Analytical Report
'Full Measures' Survey 2022

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	15/12/2022	TC	TW	A3	1:15,000

Co-ordinate system: British National Grid

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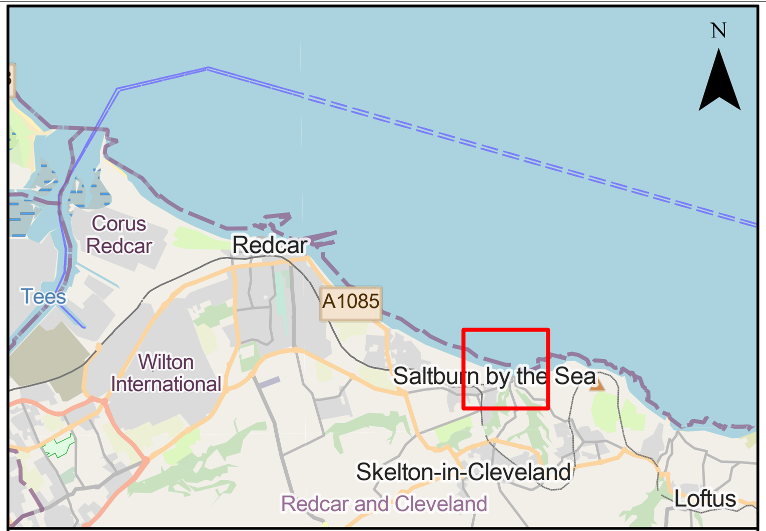

Difference between topographic surveys
(Apr 2022 to Oct 2022)
Change in Elevation (mOD)

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

Title:

Appendix B - Map 12

SALTBURN SANDS

Redcar and Cleveland Borough Council Frontage

Report:
Analytical Report
'Full Measures' Survey 2022

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	15/12/2022	TC	TW	A3	1:8,000

Co-ordinate system: British National Grid

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Cliff Top Survey

Staithes

Twenty ground control points have been established within Staithes. The maximum separation between any two points is nominally 100m.

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 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	April 2022	Oct 2022	Nov 2008 - Oct 2022	Apr 2022 - Oct 2022	Nov 2008 - Oct 2022
1	477228	518769	320	1.90	-5.35	-5.36	7.26	0.01	0.52
2	477334	518798	0	10.90	10.71	10.65	0.25	0.06	0.02
3	477487	518789	350	7.10	8.07	8.03	-0.93	0.04	0.00
4	477594	518801	340	5.90	3.47	3.41	2.49	0.06	0.18
5	477683	518911	350	8.40	8.25	8.21	0.19	0.04	0.01
6	477792	518867	30	8.60	8.50	8.45	0.15	0.05	0.01
7	477891	518828	60	7.70	7.30	7.25	0.45	0.05	0.03
8	477959	518873	350	8.70	8.52	8.36	0.34	0.16	0.02
9	478088	518950	350	7.60	7.90	7.86	-0.26	0.04	0.00
10	478191	519023	340	8.40	8.58	8.58	-0.18	0.00	0.00
11	478237	519007	60	6.90	6.69	6.49	0.41	0.20	0.03
12	478213	518988	150	6.10	6.55	6.44	-0.34	0.11	0.00
13	478501	518809	15	11.40	8.67	8.17	3.23	0.50	0.23
14	478624	518807	20	7.50	7.35	7.26	0.24	0.09	0.02
15	478737	518858	60	6.10	6.38	6.24	-0.14	0.14	0.00

16	478823	518757	60	8.00	8.65	8.64	-0.64	0.01	0.00
17	478944	518671	30	9.30	8.70	8.62	0.68	0.08	0.05
18	479052	518630	20	9.20	9.27	8.90	0.30	0.37	0.02
19	479147	518610	0	14.20	14.04	13.77	0.43	0.27	0.03
20	479274	518618	20	11.40	11.18	11.15	0.25	0.03	0.02

Note: It is assumed that the accuracy of cliff top monitoring using this technique is ±0.1m. Therefore, observed changes have been altered by this amount prior to calculation of an erosion rate. Erosion rates are not calculated where the cliff line shows advance. This is likely to be the product of differing survey interpretation, and far less likely to be a toppling cliff edge.