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

Redcar and Cleveland Borough Council

December 2021

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Abbreviations and Acronyms

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

Water Levels Used in Interpretation of Changes

Water Level Parameter	Water Level (m AOD)
	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.

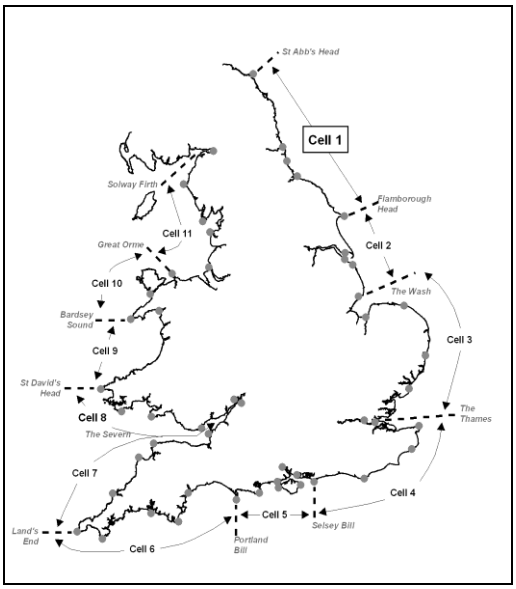


Figure 1 Sediment Cells in England and Wales

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.

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 (*)			

* The present report is **Analytical Report 14** and provides an analysis of the 2021 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 September and October 2021. The weather and sea state varied, for further details please refer to the Survey Report from Academy Geomatics.

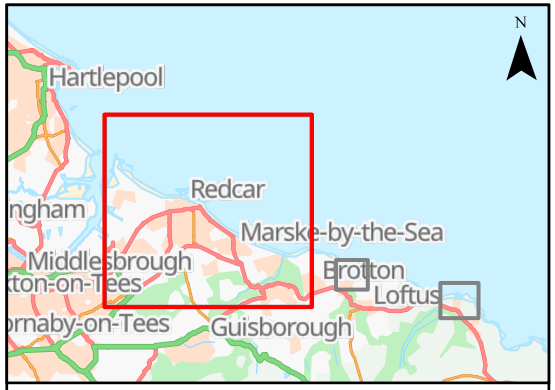
All data have been captured in a manner commensurate with the principles of the Environment Agency's *National Standard Contract and Specification for Surveying Services* and stored in a file format compatible with the software systems being used for the data analysis, namely SANDS and ArcGIS. This data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

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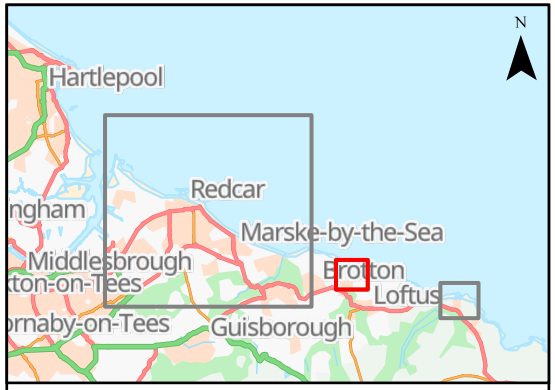

SURVEY LOCATIONS

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 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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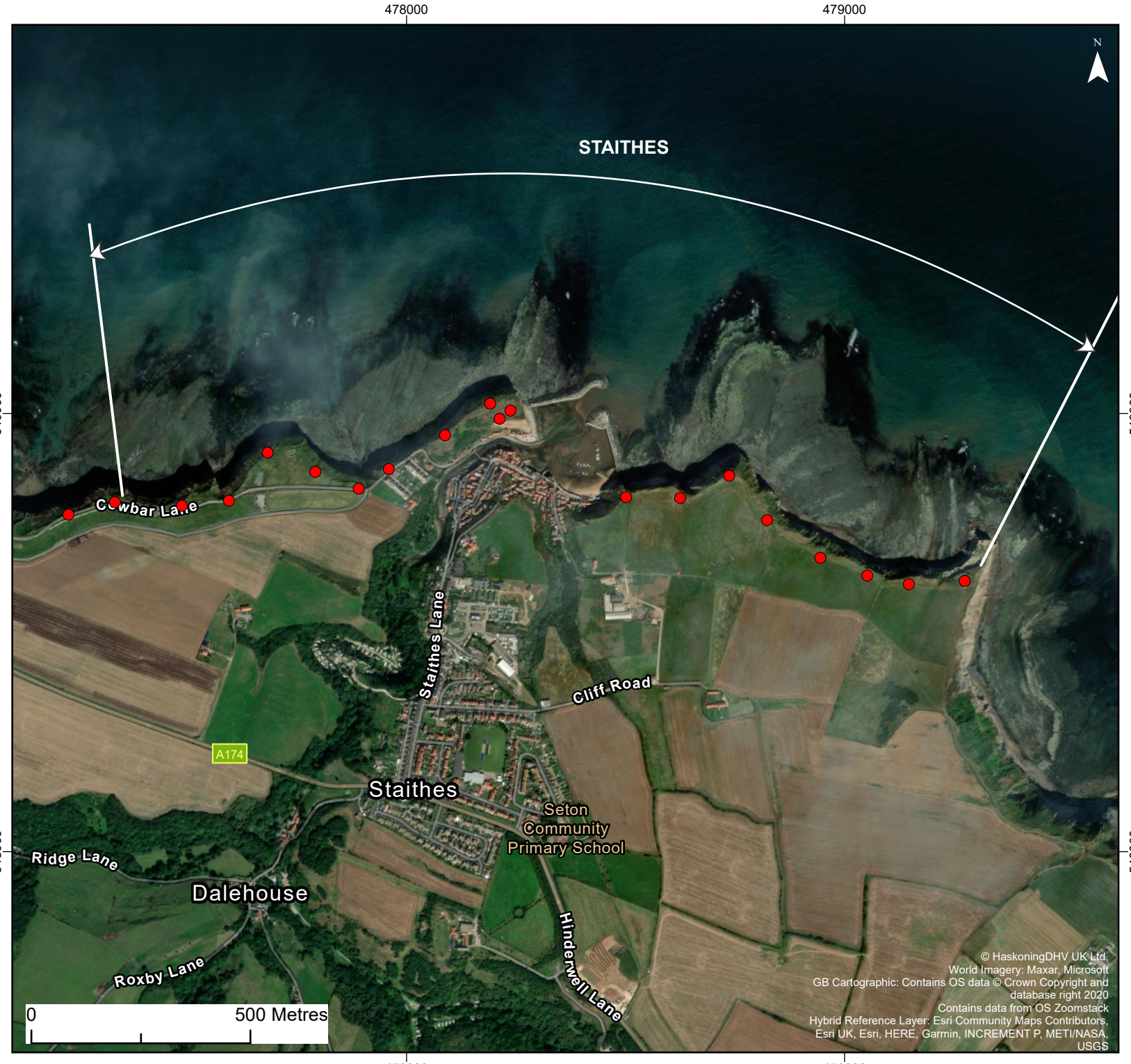

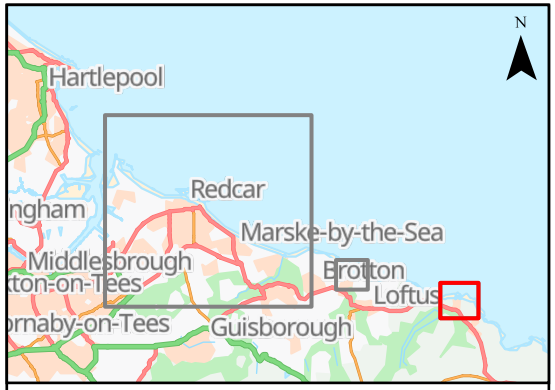

SURVEY LOCATIONS

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:
0	n/a	TC	NJC	A4	1:12,000

Co-ordinate system: British National Grid

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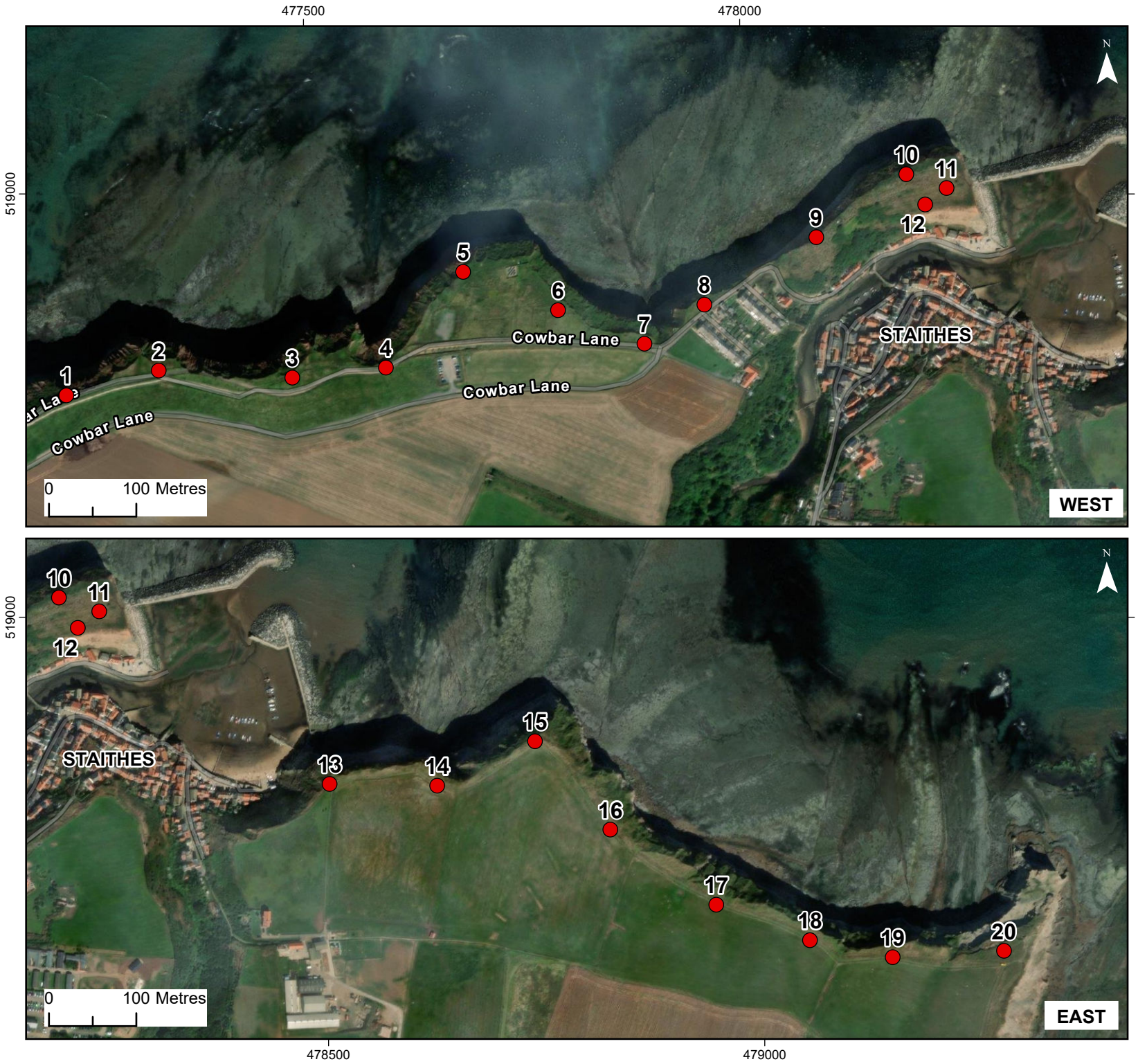

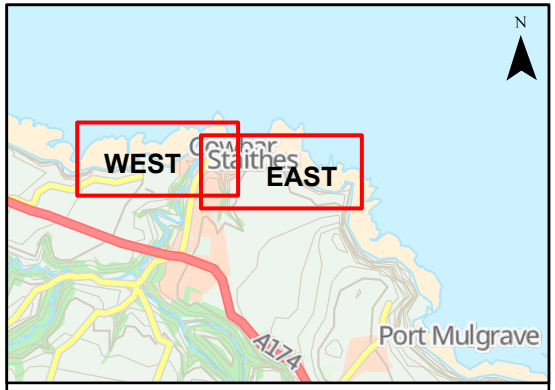

SURVEY LOCATIONS

- 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
October 2021	**Beach Profiles:** Coatham Sands is covered by four beach profile lines during the Full Measures survey (RC1 to RC4; Appendix A). 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. The foredune has undergone accretion in level of 0.2m at its crest. The beach profile itself is split into two areas of distinct change. From chainage 107m, at the toe of the dune, to chainage 221m, the beach has accreted by up to 0.95m in level. At chainage 221m, the change switches to erosion which continues to chainage 302m.The magnitude of erosion is up to 1.1m reduction in level. . The upper beach level is at its highest level when compared to the range recorded from previous surveys, whereas the lower beach level is at a medium level. At Profile **1cRC2,** the dunes continue to remain stable, with changes in level limited to ±0.1m The face and toe of foredune has accreted since the last survey, resulting in the dune advancing seaward ~1m. The upper beach, between chainages 130m and 230m has also accreted by up to 0.25m in level. At chainage 260m, there has been accretion of 0.5m in level, resulting in flattening of a berm observed in the previous survey. There has also been accretion of the lower beach On average, the profile is at a high level when compared with the range recorded in previous surveys, most notably on the dunes and upper beach. Profile **1cRC3** shows stable dunes with some accretion leading to an increase in level of up to 0.2m in level at the crest of the foredune. From the toe of the dune at chainage 55m across the upper and mid – beach to chainage 167m the profile has experienced accretion, raising the beach level by 0.2.m. At chainage 167m the accretion increases to 0.45m until chainage 228m forming a shallow berm. The lower beach has also experience accretion. Overall, the profile is at a high level when compared with the range recorded from previous surveys. In particular the section between chainages 192m and 212m is at the highest level on record.	Overall, the dunes have remained stable at Coatham Sands since the previous partial measures survey. The beach profiles vary along the bay. To the North, the profile (1cRC1) has experienced a high magnitude of change. The central profiles show a general trend of low level accretion and the most southern profile (1cRC4) shows a general trend of erosion, particularly at the lower beach.. The topographic survey difference plots show a similar trend along most of the bay with the most intense change occurring to the North. The topographic survey paints a slightly different picture along the central area, where erosion is the dominant process broken up with low level accretion. It is clear the central profiles (1cRC2 and 1cRC3) are located in these minority areas of accretion which would be misleading if analysing the profiles alone. To the south, the magnitude of erosion is much less, correlating with what was observed in profile 1cRC4. **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. The topographic survey plot for 2021 indicates a slight deviation from this trend with net erosion. However, the magnitude of change has been low and is in line with the range of previously recorded results.

Survey Date	Description of Changes Since Last Survey	Interpretation
	Profile **1cRC4** is the beginning of the defended section at Redcar. There has been accretion against the seawall from chainage 12m to 28m increasing the beach level by 0.5m An upper beach berm has migrated landward by approximately 15m. Between chainages 90m and 250m, the beach has largely remained stable with erosion/accretion in level limited to ±0.1m. From chainage 250m onwards, the lower beach has eroded, steepening the beach profile. On average, the profile is at a low level compared to the previous surveys	
October 2021	**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 (Autumn 2021) survey and the earlier topographic survey (Autumn 2020), as shown in Appendix B – Map 6, to identify areas of erosion and accretion. The topographic difference plot shows that the survey area has largely remained stable over the 12 month period. The prominent colour observed on the map is a pale yellow, corresponding with little (±0.1m) to no change in level. Notable areas where change has occurred include just south of South Gare Breakwater, where the upper beach is noted to have accreted by up to 1.5m in level, correlating with a matching band of erosion on the lower beach. The largest change across the survey area is a swathe of erosion in the centre of bay that increases in intensity from the upper beach through to the lower beach, limited to 1.5m change in level.	

2.2 Redcar Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
October 2021	**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,** there has been steepening of the upper beach at the toe of the defence, with an accretion of 0.65m in level evident at the toe. From chainages 32m to 83, the profile has largely remained stable with local accretion evident. Then, between chainages 83m and 146m chainage, the beach has eroded by 0.45m in level exposing more of the rocky foreshore. The lower beach from chainage 180m onwards has eroded by 0.15m in level, resulting in the end of the profile retreating landwards 8m. When compared with the range recorded from previous surveys, the profile is at a medium level. At profile **1cRC6,** the beach profile has remained largely stable. The upper beach profile is unchanged from the seawall to chainage 100m. From chainage 100m to chainage 200m, the beach levels have increased by 0.1m in level. The lower beach has steepened resulting the end of the profile shifting approximately 30m landwards. When compared with the range recorded from previous surveys, the October 2021 profile is generally at a medium level with the exception of the upper beach which is at a low level. Profile **1cRC7** has experienced very little change on the dune frontage, chainage 0 to 67m, since the previous survey. At the toe of the dunes and upper beach, between chainage 67m and 135m there is a small increase in level of 0.1m. Between chainages 135m and 190m, a beach hollow has been filled in, creating an uninterrupted smooth middle beach. Overall, the beach is at a medium level compared with the range recorded from previous surveys.	All three of the profiles show erosion of the lower beach in 2021. The upper and middle beach are largely dominated by low level accretion. The topographic change plot between Mar 2021 and October 2021 broadly reflects this pattern with the upper beach largely dominated by accretion. The most intense change is observed adjacent to Redcar Rocks The pattern of change between Autumn 2020 and Autumn 2021 shows slightly more variability with the area dominated by erosion. **Longer term trends**: The beach levels are generally at a medium to high level compared to previous years, suggesting recovery since the storms and surge of winter 2013/14. A slight exception to this is Profile 1cRC5 which is at its lowest on the middle beach 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.
October 2021	**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	

Survey Date	Description of Changes Since Last Survey	Interpretation
	and so the contours are distorted by the rocky foreshore. The shore-parallel contours to the south of 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 (Autumn 2020) and the most recent (Spring 2021) topographic survey, as shown in Appendix B – Maps 7 and 11, to identify areas of erosion and accretion. Between Spring 2021 and Autumn 2021 the magnitude and pattern of change is varied across the survey area. Between West Scar and Redcar rocks, the beach has experienced a high magnitude of change highlighted by the intense colours. The upper beach has accreted by up to 1.75m in level, before switching to similar magnitude of erosion on the lower reaches of the beach. To the south of Redcar Rocks the change is dominated by accretion, but at a lower magnitude as the west. . The pattern of change between Autumn 2020 and Autumn 2021 varies to that observed in the comparison over the summer months. The general trend shows a net loss across the survey area, particularly to the south of Redcar Rocks that is dominated by a low level erosion limited to 1m in level. The area of the most significant erosion (up to 1.5m in level) is again noted between West Scar and Redcar Rocks. Bands of accretion, parallel to the shoreline can be observed, in sections of the beach fronting the stray, this are mainly limited to the upper and middle beach.	

2.3 Marske Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
October 2021	**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. The beach has accreted consistently over the length of the profile since the last survey, maintaining a flat shelf in the mid-beach. On the upper beach, between chainages 55m and 120m, the change is limited to 0.2m in level, increasing to 0.45m in level along the middle section (chainages 165m to 220m) . The beach profile is at a medium level compared with the range of previously recorded surveys.	Both profiles at Marske Sands have experienced accretion associated with migrating berms. Profile 1cRC7 at The Stray has also experienced a low level of erosion at the lower beach but despite this is at a high level when compared with the range recorded in previous surveys. At Profile 1cRC8 accretion has dominated and shore parallel berms have developed across the beach. The difference plot for Autumn 2020 to Autumn 2021 shows a band of erosion on the mid-beach with accretion generally dominating the upper beach and slower beach. **Longer term trends:** Current beach profiles are medium compared with the range of previously recorded results. Recorded changes are due to the movement of bars on the beach, which is also shown on the topographic difference plots.
October 2021	**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 GIS has also been used to calculate the differences between the Autumn 2020 and Autumn 2021 topographic survey, as shown in Appendix B – Map 8. The topographic contours are generally shore parallel except at the outfalls of small, culverted streams. Since the previous topographic survey in Autumn 2020, accretion and erosion has occurred in wide broadly shore parallel bands. The upper beach has experienced accretion across much of the survey extent, particular fronting Marske by the Sea. The mid-beach and lower beach have varied between bands of erosion and accretion. The most intense change has occurred in front of cliff house where the magnitude of change is up to ±1.75m.	

2.4 Saltburn Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
October 2021	**Beach Profiles:** Saltburn Sands is covered by one beach profile during the Full Measures survey (RC9; Appendix A). At profile **1cRC9**, there has no change across the defended section of the profile (chainage 0m to 21m). At the toe of the seawall the beach profile has slackened, resulting in a local drop of material of 0.5m at the seawall itself but with net gain of material across the 25m of beach. From Chainage 48m to 240m there has been a consistent accretion in level of 0.4m across the whole profile. Overall, the beach is at a medium level compared to the range recorded from previous surveys.	The beach showed a general trend of accretion at profile 1cRC9. This is also echoed in the difference plot between the last partial measures survey in Spring 2021 and the present full measures survey in Autumn 2021 which shows a wide scale accretion across the majority of the bay. The difference plot between the last full measures survey in Autumn 2020 and the present full measures survey in Autumn 2021 shows low levels of accretion dominating the upper beach. Much of the middle and lower beach have remained stable, expect the odd area of erosion towards the lower beach. **Longer term trends**: The April 2021 beach level was one of the lowest recorded profile since 2008, suggesting ongoing progressive erosion. Although beach levels appear to have generally recovered, the trend of increasing erosion through the winter months with some recovery over the summer is leading to the progressive erosion and drawdown of the beach. This pattern has been experienced for several years.
October 2021	**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 slightly indented opposite Skelton Beck, where the stream has eroded the foreshore. The GIS has also been used to calculate the differences over the six month period between Spring 2021 and Autumn 2021 topographic survey, as shown in Appendix B – Map 12, and the change since the last full measures survey in Autumn 2020, to identify areas of net erosion and accretion (Appendix B – Map 9). When comparing the difference plot from Autumn 2020 to Autumn 2021 the magnitude of change across Saltburn Sands is generally low. In the west of this survey extent, between Agar's Gap and Hazel Grove, there has generally been minor accretion at the toe of the cliffs with some patches of erosion at the lower beach. However, the majority of the beach has remained stable., At the mouth of Skelton Beck there has been accretion in increasing magnitude towards the upper beach. East of the Skelton beck has experienced no significant change. The magnitude of change over the previous twelve months is limited to ±1.25m in topographic level. The six month difference plot, which displays the change between Spring 2021 and November 2021, shows a wide scale accretion across the survey area. The area between Agar's Gap and Hazel Grove	

Survey Date	Description of Changes Since Last Survey	Interpretation
	has increased in level by up to 1m in level across the frontage, with a particular increase at Agars Gap. Similar to the annual comparison there has been focus of accretion at the mouth of Skelton Beck and again, similar to the annual comparison, limited change to the east. .	

2.5 Cattersty Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
October 2021	**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 Spring 2021 and Autumn 2021 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 vast majority of beach has been dominated by accretion up to 1m in level. There has been a narrow band of erosion of at the toe of the cliffs at the northern extent of the survey area and at the lower beach adjacent to the breakwater. Accretion again dominates the area of sands between the breakwater and the modified fishtail groyne at a magnitude of +1m change in level, with some minor erosion on the lower beach. To the East of the fishtail groyne, the upper beach at the rock armour, has experience patches of erosion.	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. Short term change, over the preceding six-monthly shows similar beach behaviour either side of the breakwater with accretion being the dominant process. **Longer term trends**: The magnitude of changes experienced over the summer of 2021 has generally been similar to previous years. There has again been accretion in the mouth of the Beck Previously it was reported that there had been erosion around the modified rock structures. This area has remained stable in 2021. 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
September 2021	**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 March 2021 and November 2021, 7 of the 20 ground control points experienced retreat of over 0.1m. Of these 7, a total of 3 points, 7, 10 and 13, experienced between 0.1m and 0.2m of erosion (0.11m, 0.11m and 0.11m (respectively). Two points (point 15 and 18) experienced between 0.2m and 0.3m of erosion (0.25m and 0.21m respectively). One point (point 1) experienced between 0.3 and 0.4m (0.35m). Only one point (point 16) experienced over 0.5m of erosion (0.55m). Points 5 and 12 appeared to show apparent advancements of over 0.1m (0.31m and 0.14m respectively). It is speculated that this is due to vegetation cover inhibiting a clear measurement to the cliff edge in previous surveys and that it is far less likely to be a toppling cliff edge. 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 (near the eastern breakwater) show average erosion rate of above 0.1m/yr.; 0.61m, 0.18m and 0.23m respectively. Appendix C provides results from the October 2021 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 7.3m between the November 2008 baseline and October 2021, resulting in a long-term average recession rate of 0.59m/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. This area is above the eastern breakwater and is known to have experienced rock falls previously. The coastal path is now 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 were accessible again in 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 dunes have remained stable since the previous partial measures survey. The beach profiles vary along the bay. To the North, the profile (1cRC1) has experienced a high magnitude of change. The central profiles show a general trend of low level accretion and the most southern profile (1cRC4) shows a general trend of erosion, particularly at the lower beach.
- At Redcar Sands the area has largely been dominated by erosion. The area between Redcar Rocks and West Scar continues to experience the highest magnitude of change. This said the beach levels are at medium level when compared to range recorded in previous surveys indicating a redistribution of available sediment, rather than a long term persistent trend.
- At Marske Sands, the 2021 beach profiles show there has been a mixture of erosion and accretion, typically in alternating shore parallel bands. Accretion generally dominates the upper and lower beach, with erosion in between, again indicating a redistribution of available sediment on the beach face.
- The beach at Saltburn Sands was dominated by accretion over the summer of 2021. It was previously reported that the trend of winter erosion and summer recovery appeared to be leading to a net loss form the beach as summer recovery was not compensating fully for the winter drawdown. In contrast, it appears in 2021 that the beach has remained stable over the year with some areas of low magnitude erosion and accretion evident. This trend should be continued to be monitored.
- The Cattersty Sands difference model shows that accretion was the most dominant process between the Spring 2021 and Autumn 2021 surveys. Accretion dominated the mid and lower beach west of the breakwater and also between the breakwater and the modified rock structures. Some erosion was recorded, particularly on the upper beach west of the breakwater and to the far east of the survey extent at the base of the cliffs.
- The measurements of the Cowbar and Staithes cliff top show erosion of between 0.1 and 1.1m over the summer of 2020 at seven stations. The largest amount of erosion occurred at Post 16 (0.52m. Stations 7, 10 and 13 experienced erosion of between 0.1m and 0.2m, whilst Station 1, 15 and 18 experienced erosion of between 0.2m and 0.4m. Station 1 is an area of longstanding concern, and the erosion recorded in 2021 is in keeping with the general trend of retreat. The long term trends indicate that it is only Stations 1, 4 and 13 which are experiencing a sustained average recession rate of over 0.1m/yr. This frontage is the subject of the ongoing Staithes Strategic Appraisal Report (StAR) which seeks to further investigate issues and risks relating to coastal erosion.

Appendices

Appendix A

Beach Profiles

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

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

Beach Profile

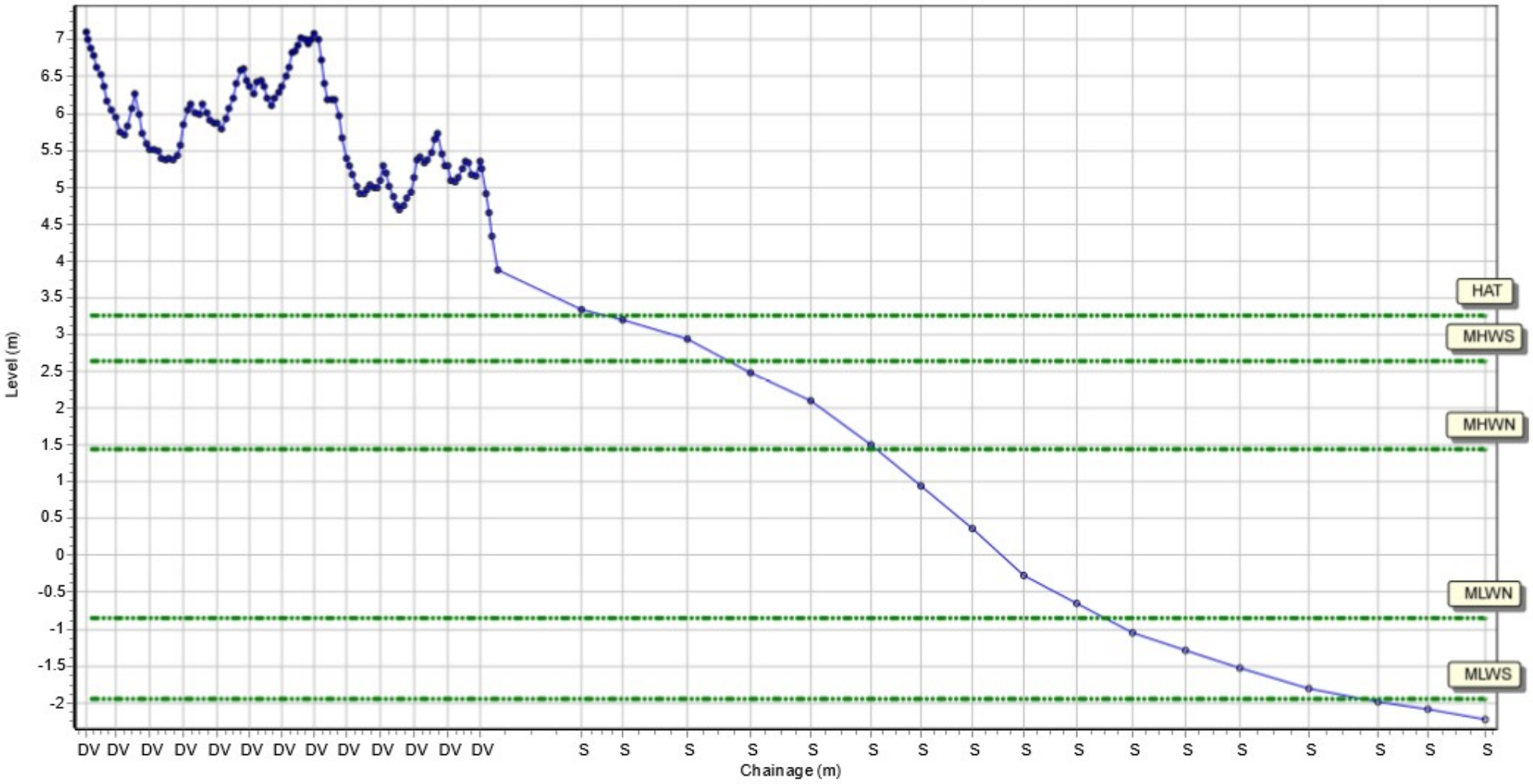
Location: 1cRC1

Date: 07/10/2021 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2021 Full Measures Topo Survey

Easting: 455811.436 **Northing:** 527373.402 **Profile Bearing:** 34 ° from North



Beach Profile

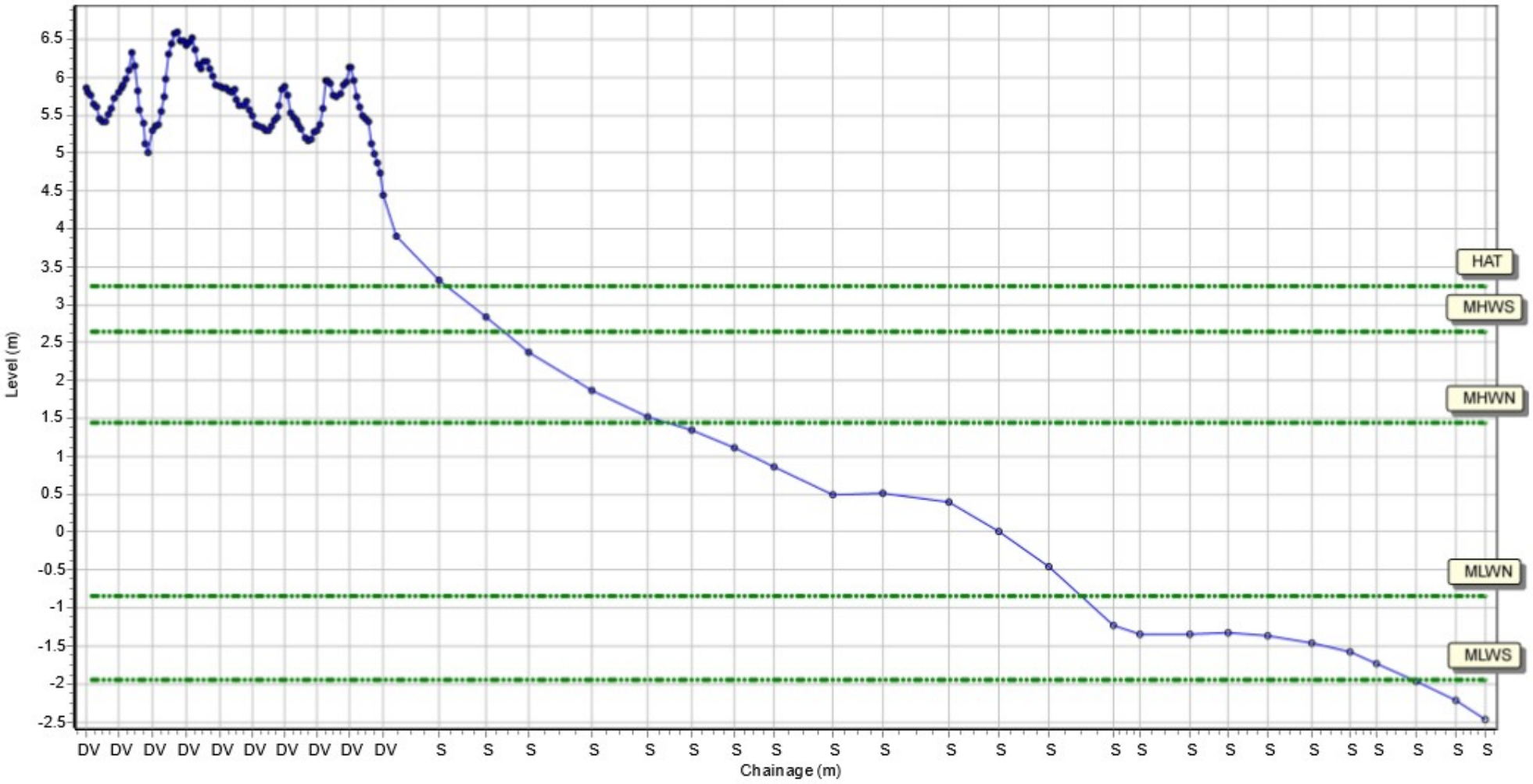
Location: 1cRC2

Date: 07/10/2021 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2021 Full Measures Topo Survey

Easting: 456633.253 **Northing:** 526599.577 **Profile Bearing:** 34 ° from North



Beach Profile

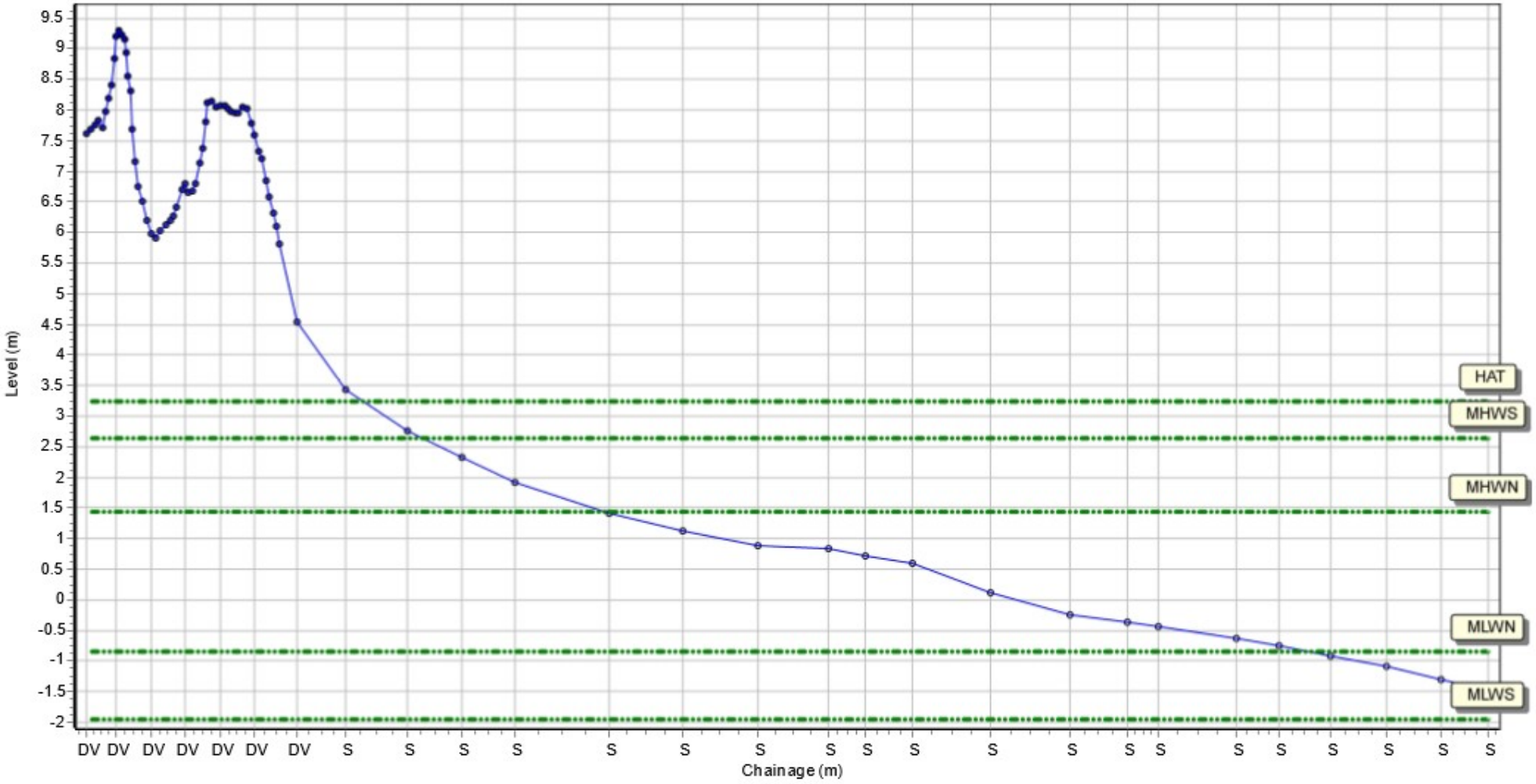
Location: 1cRC3

Date: 07/10/2021 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2021 Full Measures Topo Survey

Easting: 457706.365 **Northing:** 525898.597 **Profile Bearing:** 28 ° from North



Beach Profile

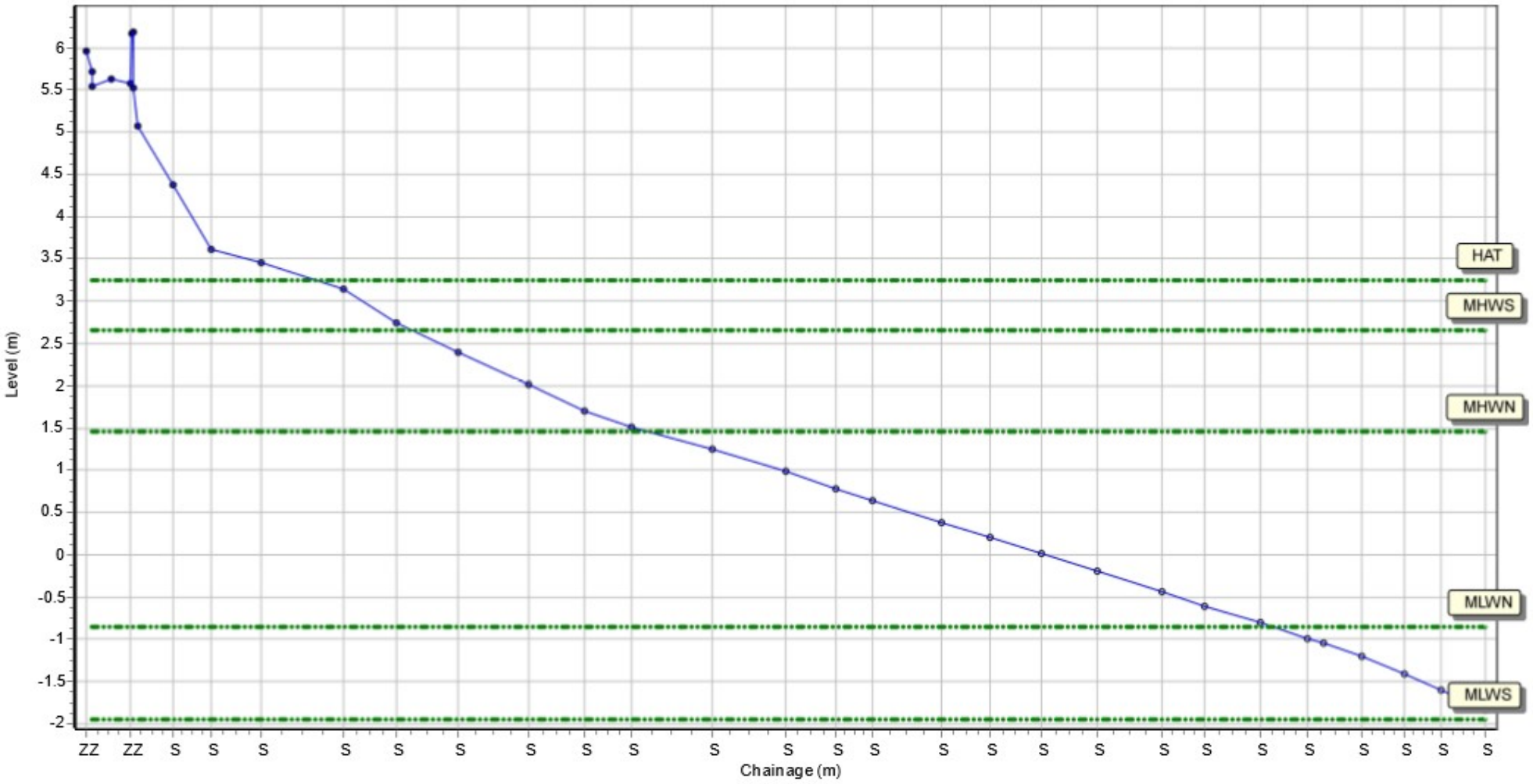
Location: 1cRC4

Date: 07/10/2021 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2021 Full Measures Topo Survey

Easting: 459337.597 **Northing:** 525336.99 **Profile Bearing:** 13 ° from North



Beach Profile

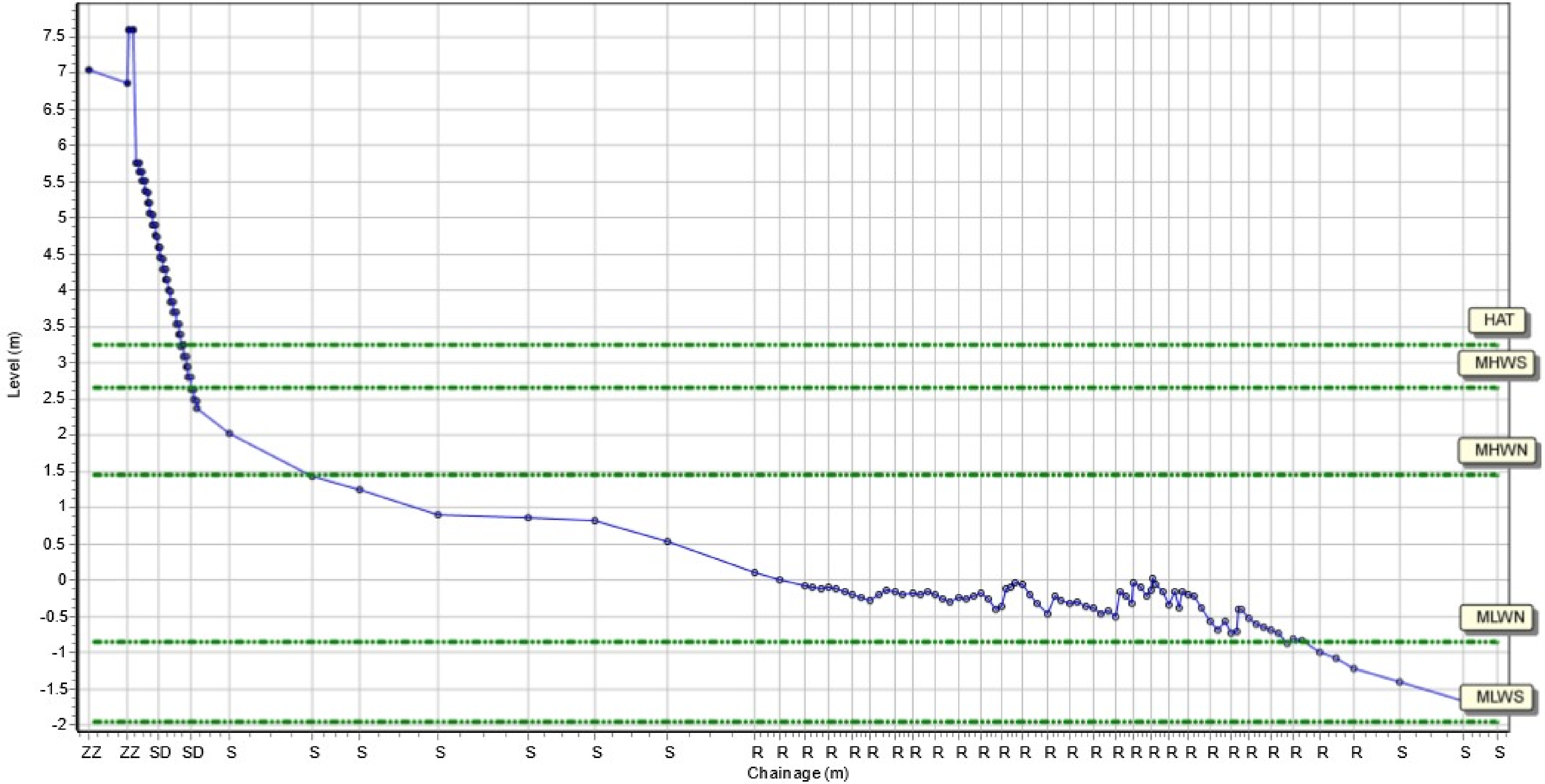
Location: **1cRC5**

Date: 07/10/2021 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2021 Full Measures Topo Survey

Easting: 460845.21 **Northing:** 525146.997 **Profile Bearing:** 26 ° from North



http://www.sandsuser.com

SANDS

Beach Profile

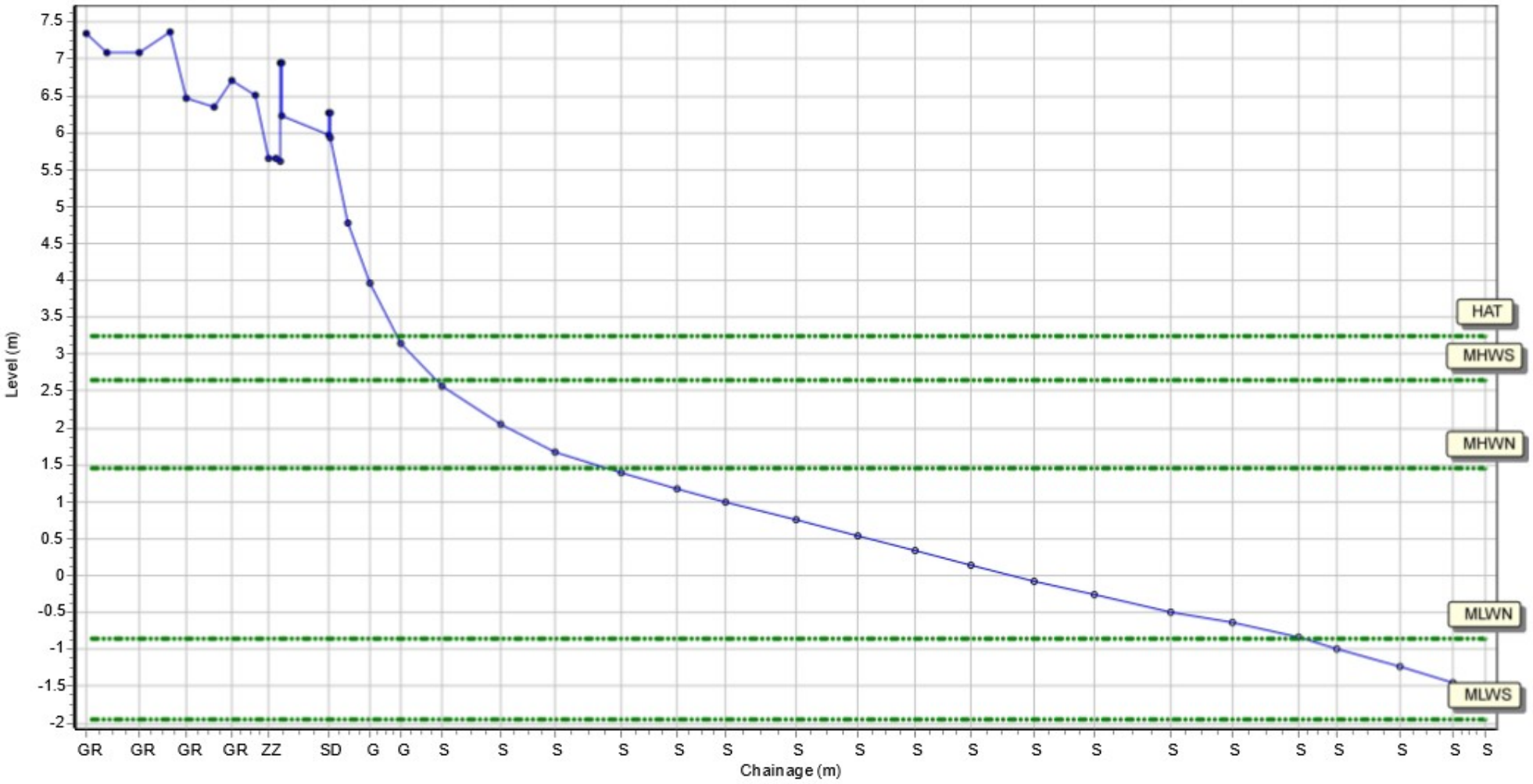
Location: 1cRC6

Date: 07/10/2021 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2021 Full Measures Topo Survey

Easting: 461776.835 **Northing:** 524269.592 **Profile Bearing:** 39 ° from North



Beach Profile

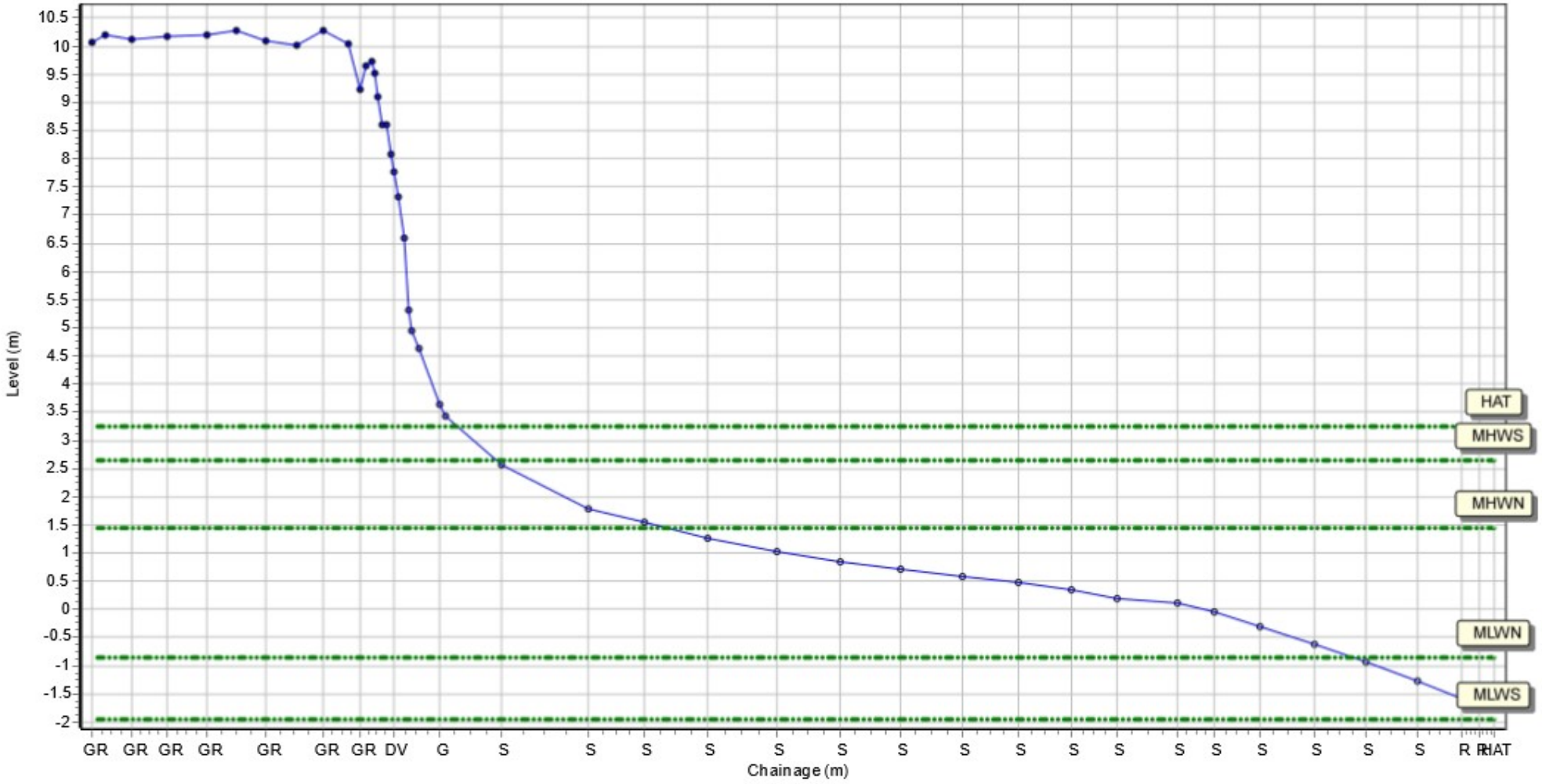
Location: 1cRC7

Date: 07/10/2021 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2021 Full Measures Topo Survey

Easting: 462568.453 **Northing:** 523568.436 **Profile Bearing:** 37 ° from North



Beach Profile

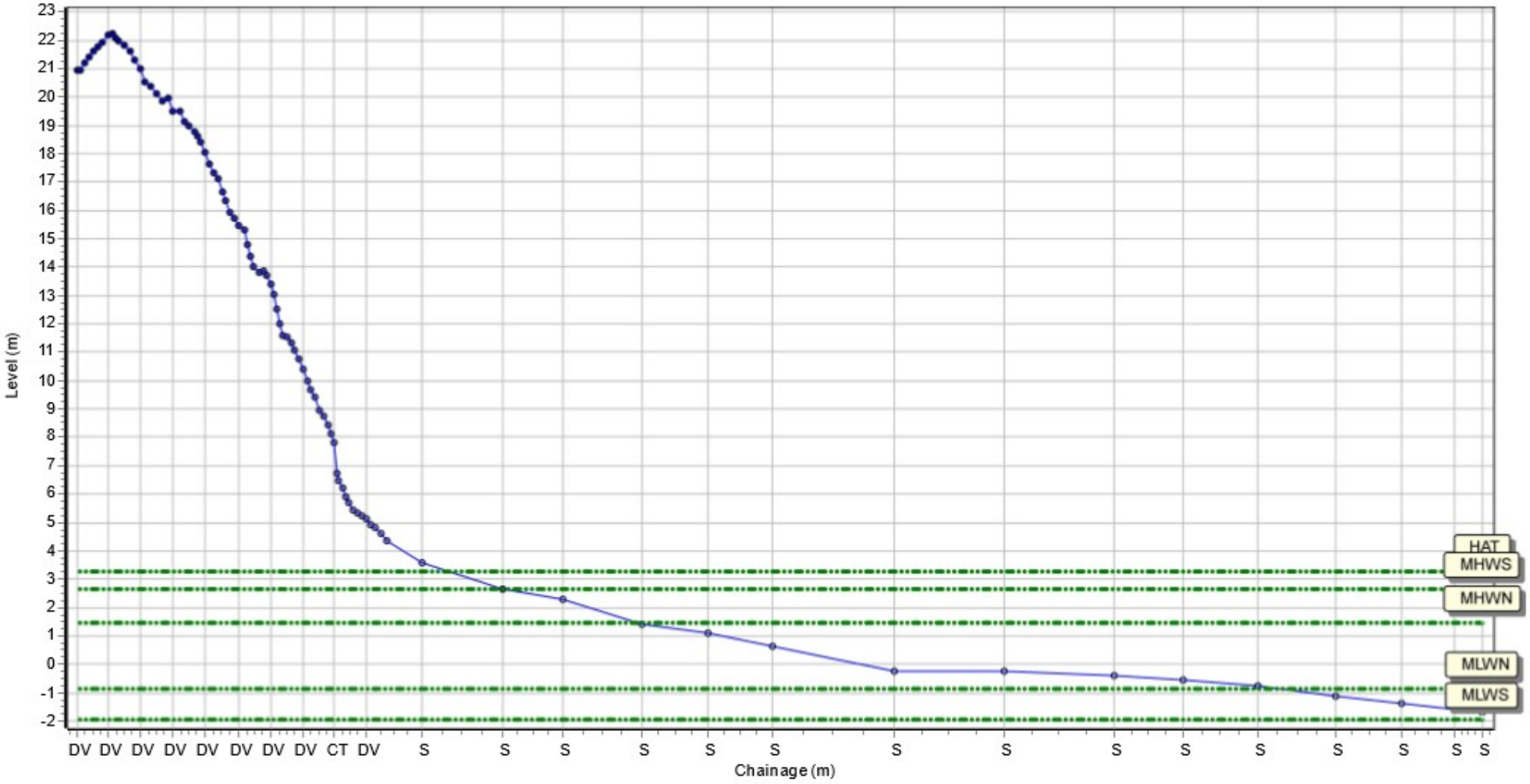
Location: 1cRC8

Date: 07/10/2021 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

Summary: 2021 Full Measures Topo Survey

Easting: 464245.579 **Northing:** 522578.097 **Profile Bearing:** 28 ° from North



Beach Profile

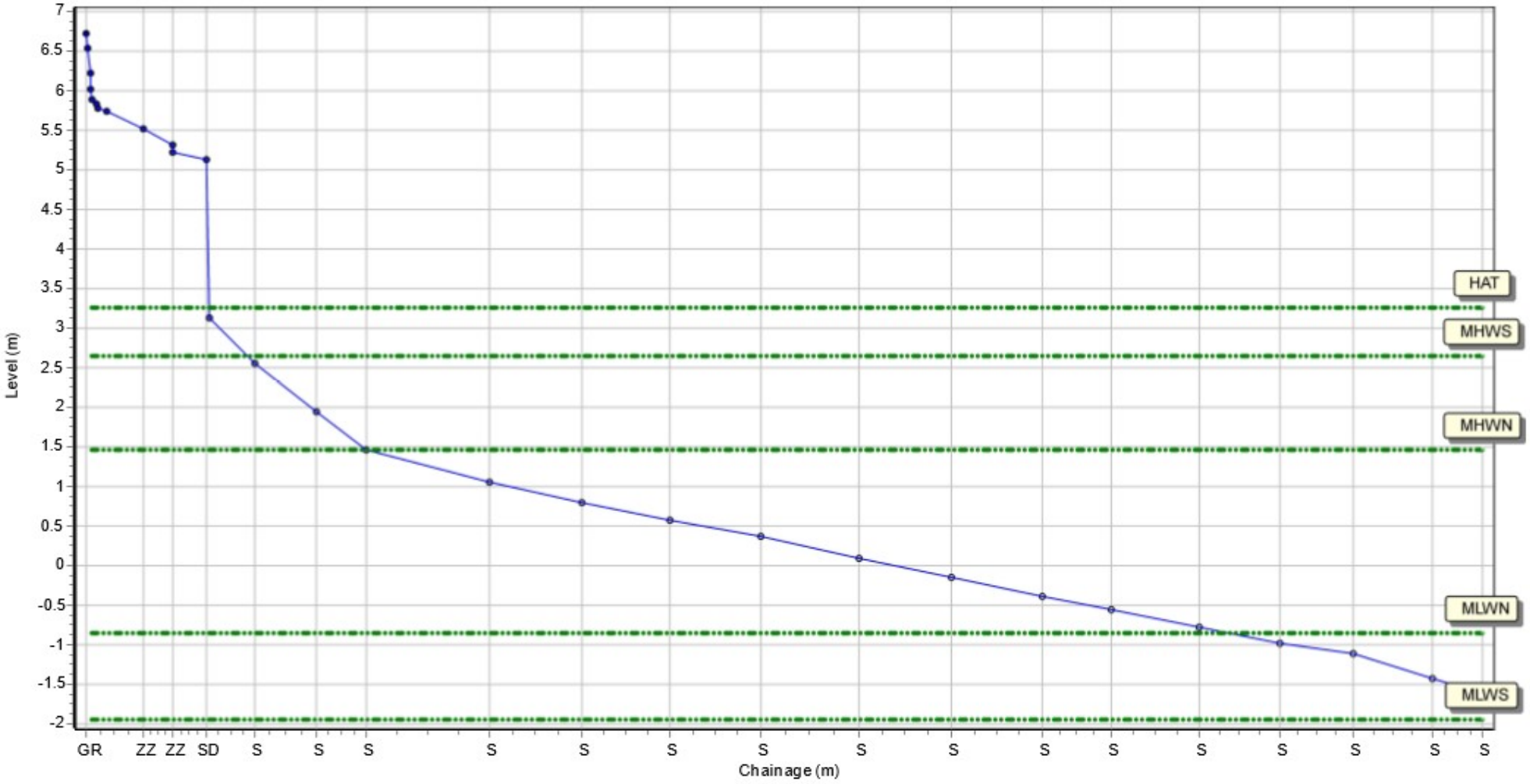
Location: 1cRC9

Date: 07/10/2021 **Inspector:** AG **Low Tide:** **Low Tide Time:**

Wind **Sea State:** **Visibility:** **Rain:**

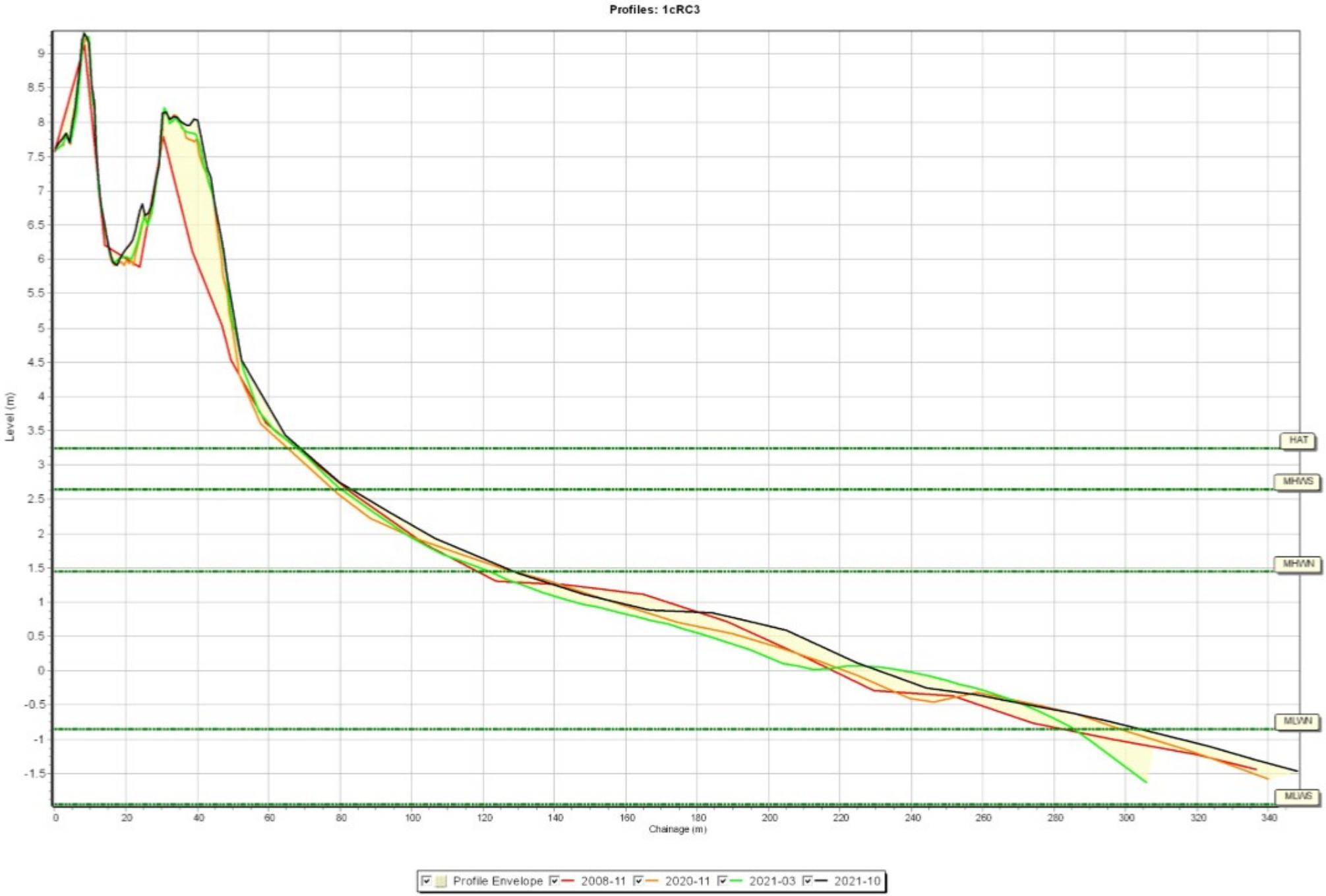
Summary: 2021 Full Measures Topo Survey

Easting: 466477.532 **Northing:** 521748.87 **Profile Bearing:** 22 ° from North




Profiles: 1cRC1
Level (m)
Chainage (m)
HAT
MHWS
MHWN
MLWN
MLWS
Profile Envelope
2008-11
2020-11
2021-03
2021-10


Profiles: 1cRC2
Level (m)
Chainage (m)
HAT
MHWS
MHWN
MLWN
MLWS
Profile Envelope
2008-11
2020-11
2021-03
2021-10


Profiles: 1cRC3
Level (m)
Chainage (m)
HAT
MHWS
MHWN
MLWN
MLWS
Profile Envelope
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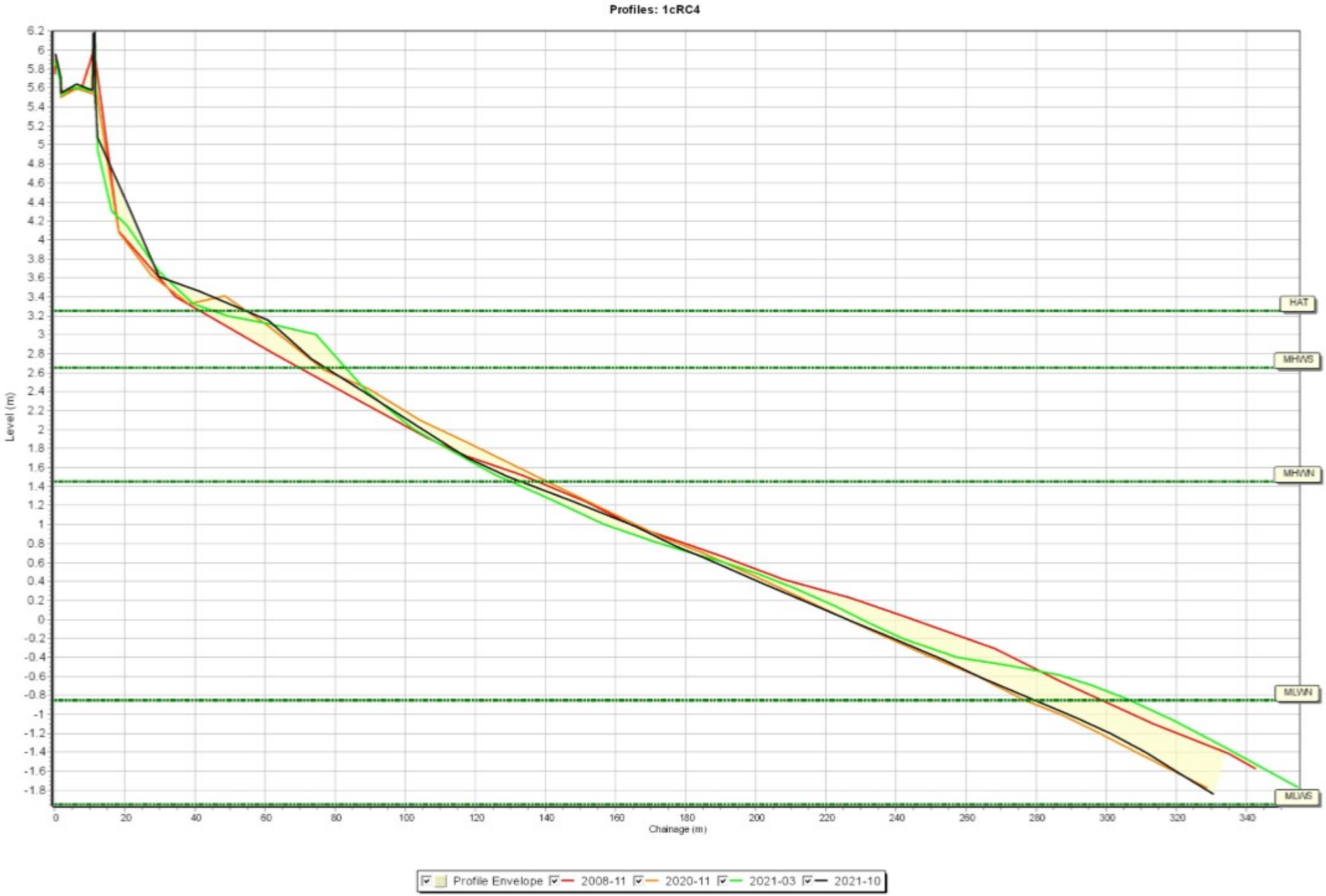
2020-11
2021-03
2021-10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Level (m)
Chainage (m)
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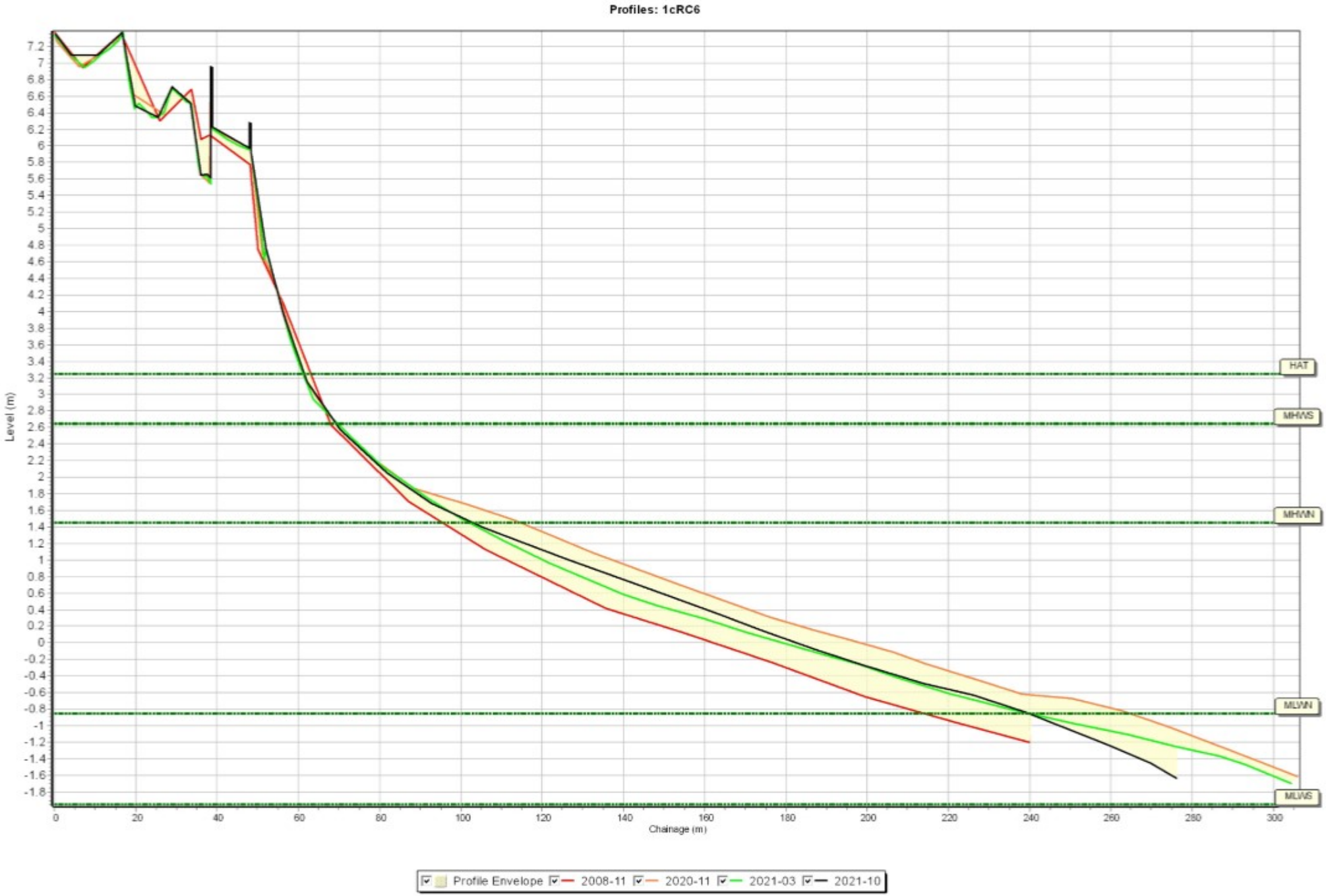
MHWS
MHWN
MLWN
MLWS
Profile Envelope
2008-11
2020-11
2021-03
2021-10


Profiles: 1cRC5
Level (m)
Chainage (m)
HAT
MHWS
MHWN
MLWN
MLWS
Profile Envelope
2008-11
2020-11
2021-03
2021-10


Profiles: 1cRC6
Level (m)
Chainage (m)
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Profile Envelope
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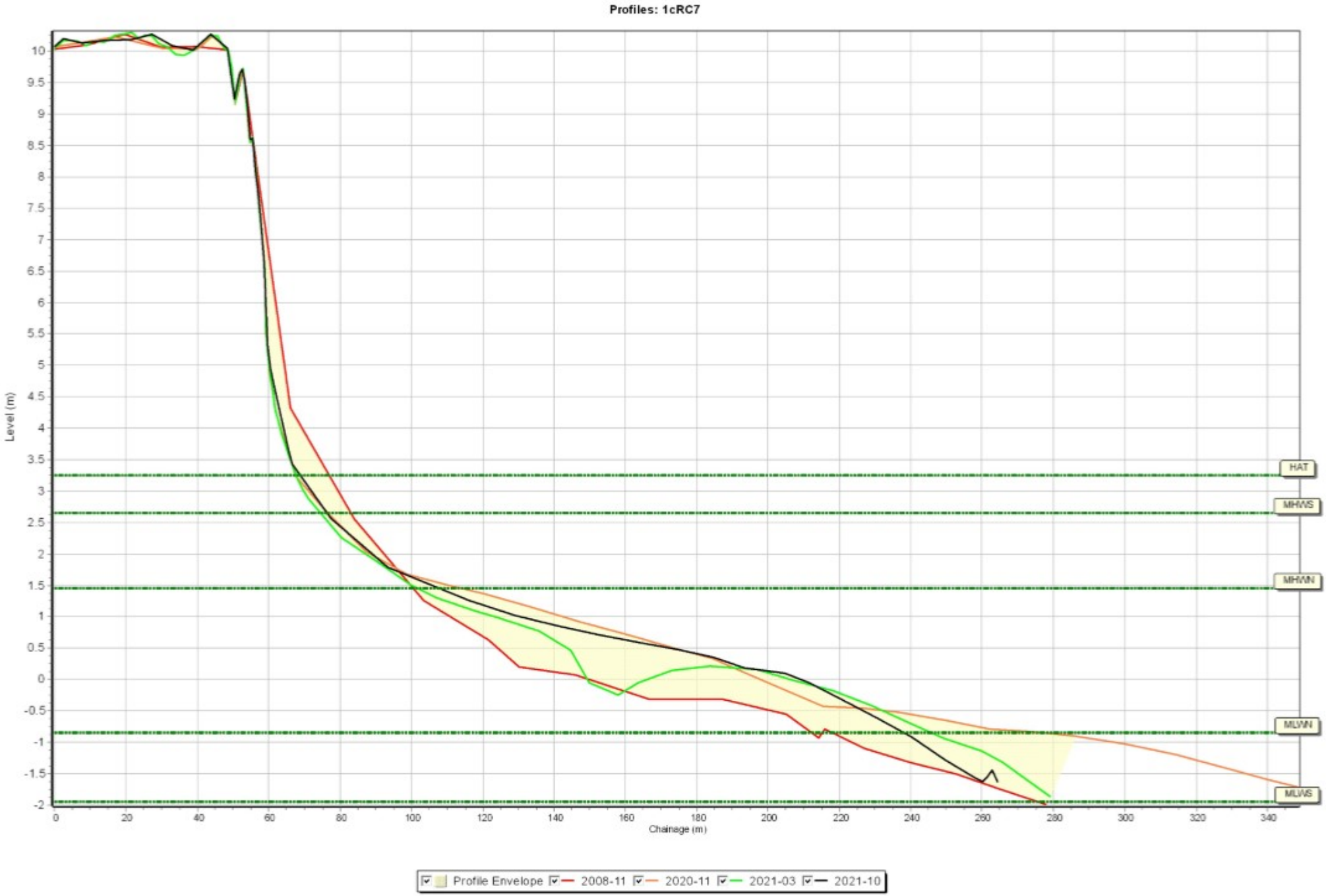
2020-11
2021-03
2021-10


Profiles: 1cRC7
Level (m)
Chainage (m)
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MHWS
MHWN
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MLWS
Profile Envelope
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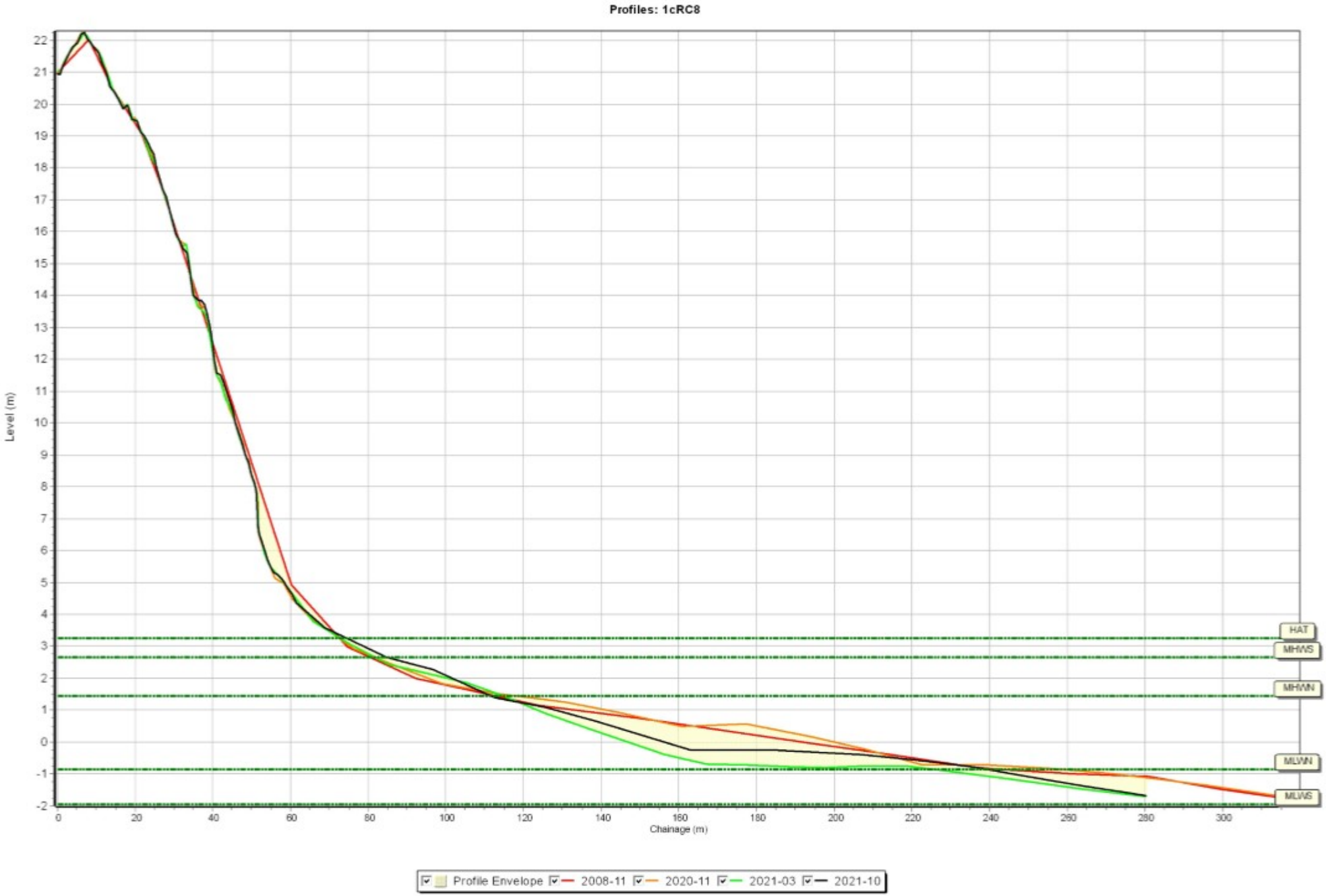
2020-11
2021-03
2021-10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Profile Envelope
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2020-11
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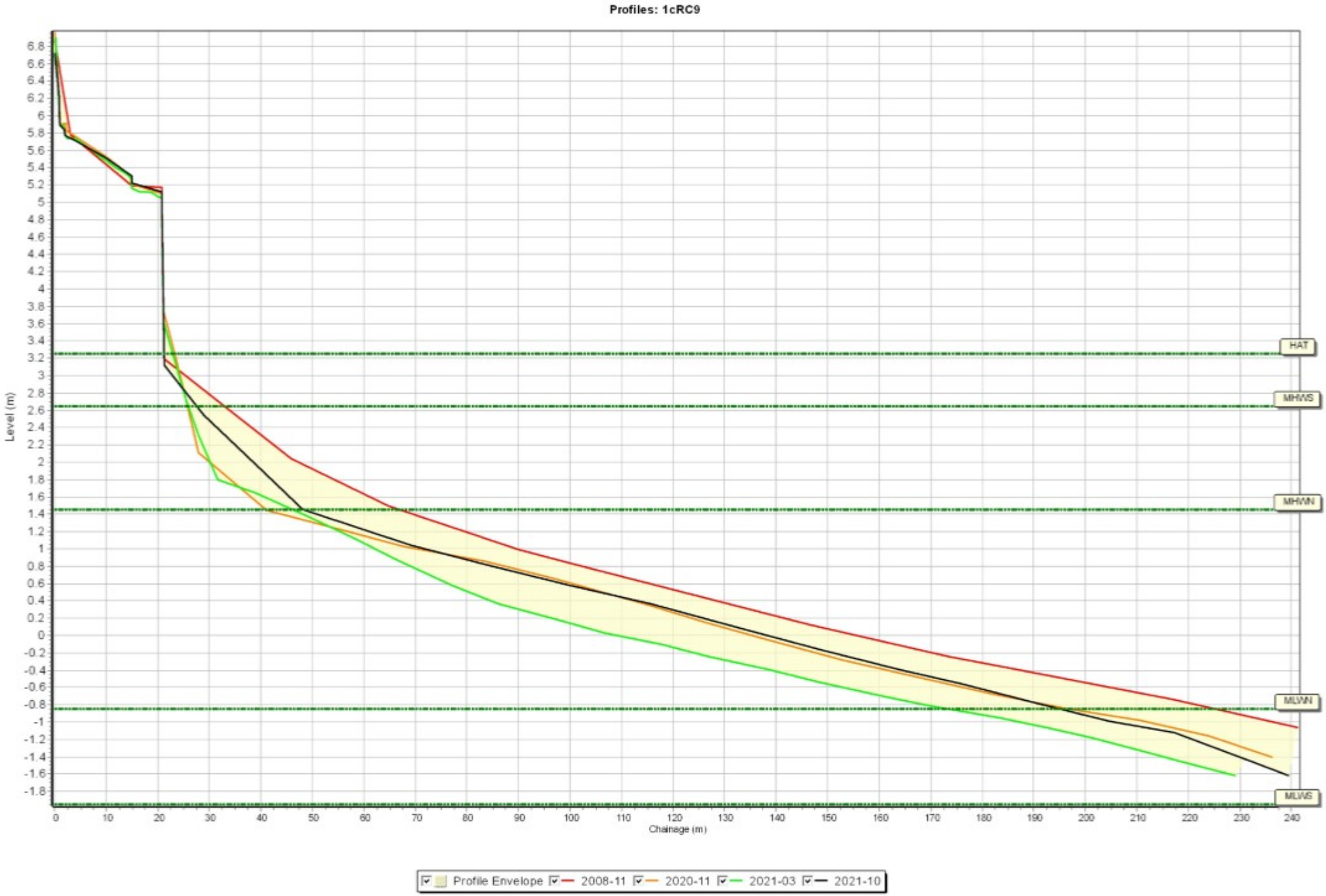
2021-10


Profiles: 1cRC9
Level (m)
Chainage (m)
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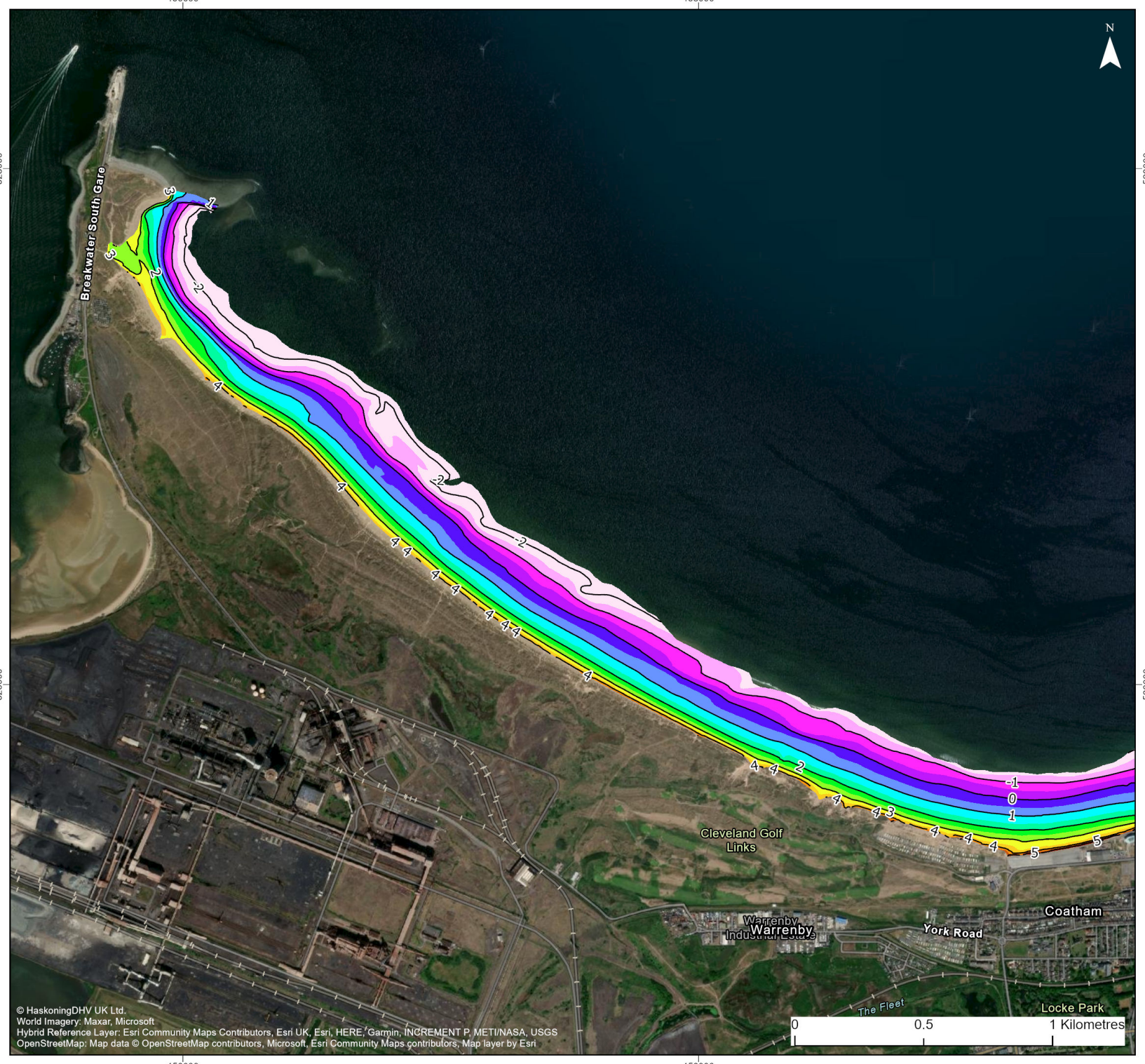
MHWN
MLWN
MLWS
Profile Envelope
2008-11
2020-11
2021-03
2021-10

Appendix B

Topographic Survey



TOPOGRAPHIC SURVEY (October 2021)

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
- 0.6 - 1
- 0.1 - 0.5
- -0.4 - 0
- -0.9 - -0.5
- -1.4 - -1
- -1.7 - -1.5

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:

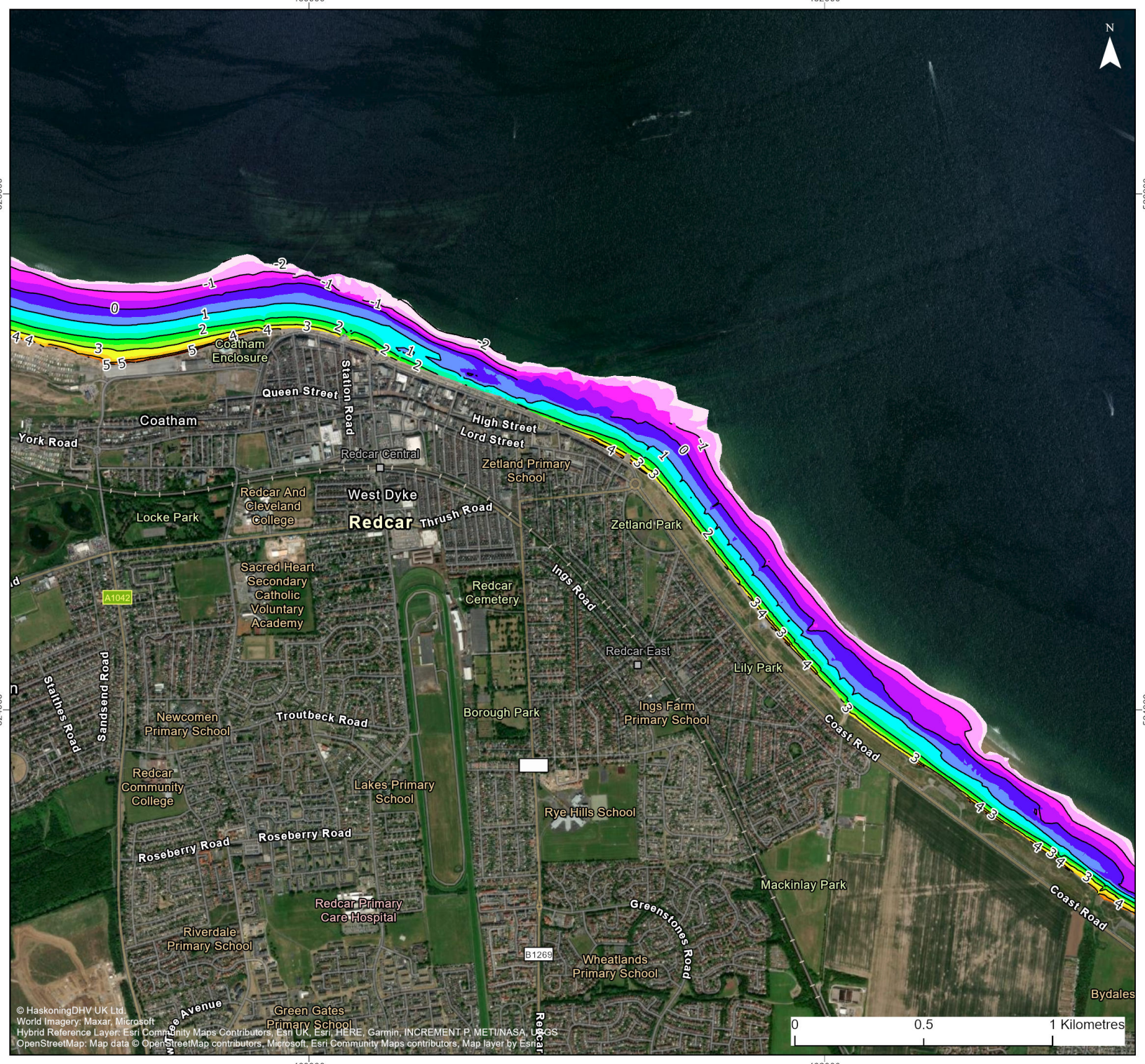
Analytical Report
'Full Measures' Survey 2021

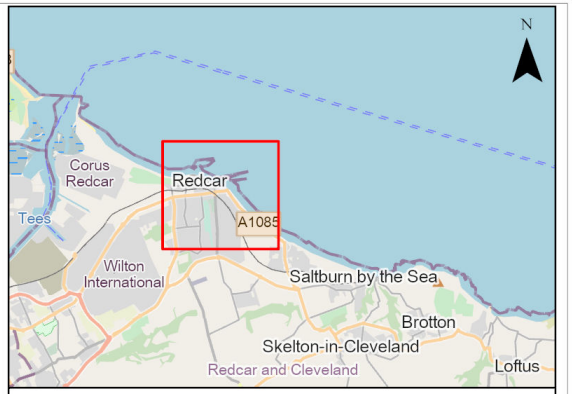
Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	04/11/2021	TC	NJC	A3	1:15,000

Co-ordinate system: British National Grid

Royal HaskoningDHV
Enhancing Society Together

North East Coastal Observatory





TOPOGRAPHIC SURVEY (October 2021)

Elevation (mOD)	Contours (mOD)*
5.1 - 5.5	1.0m interval
4.6 - 5	
4.1 - 4.5	* Contours only cover sandy beach areas.
3.6 - 4	
3.1 - 3.5	
2.6 - 3	
2.1 - 2.5	
1.6 - 2	
1.1 - 1.5	
0.6 - 1	
0.1 - 0.5	
-0.4 - 0	
-0.9 - -0.5	
-1.4 - -1	
-1.7 - -1.5	

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 2021

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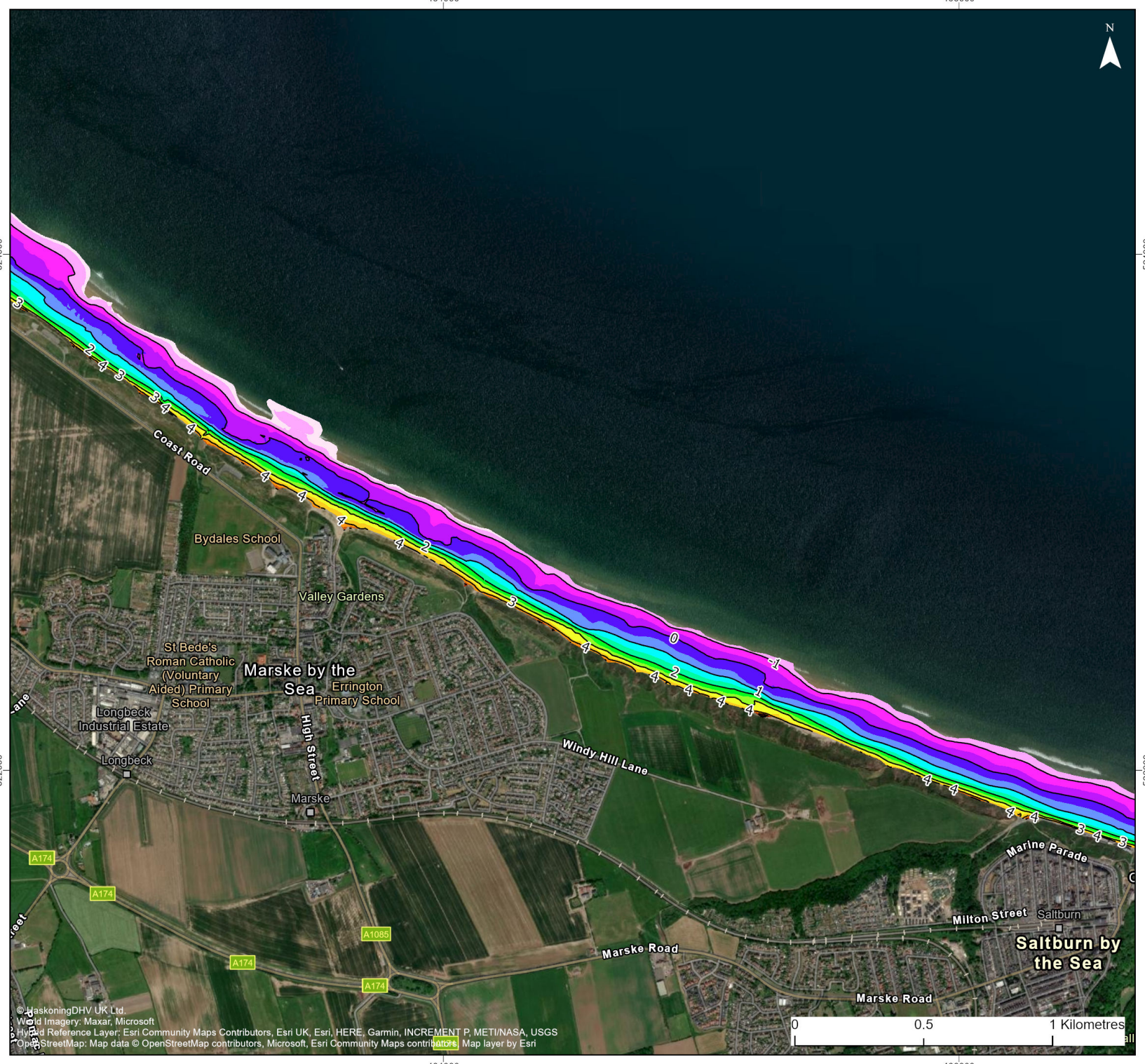
Co-ordinate system: British National Grid

Royal HaskoningDHV
Enhancing Society Together

North East Coastal Observatory



TOPOGRAPHIC SURVEY (October 2021)

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
- 0.6 - 1
- 0.1 - 0.5
- -0.4 - 0
- -0.9 - -0.5
- -1.4 - -1
- -1.7 - -1.5

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 3

MARSKE SANDS

Redcar and Cleveland Borough Council Frontage

Report:

Analytical Report
'Full Measures' Survey 2021

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	04/11/2021	TC	NJC	A3	1:15,000

Co-ordinate system: British National Grid

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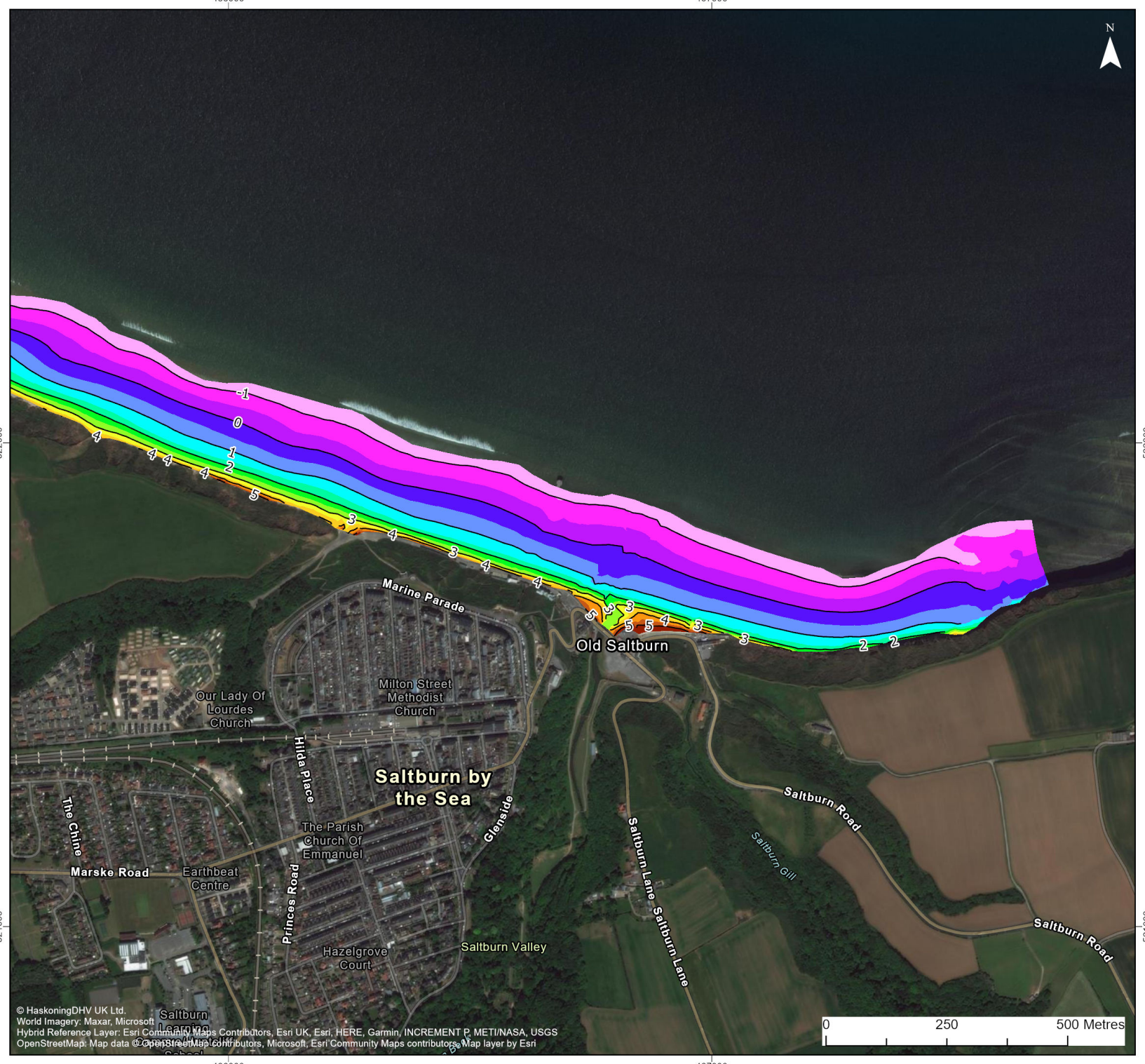

TOPOGRAPHIC SURVEY (October 2021)

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
- 0.6 - 1
- 0.1 - 0.5
- -0.4 - 0
- -0.9 - -0.5
- -1.4 - -1
- -1.7 - -1.5

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 4

SALTBURN SANDS

Redcar and Cleveland Borough Council Frontage

Report:

Analytical Report
'Full Measures' Survey 2021

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	04/11/2021	TC	NJC	A3	1:8,000

Co-ordinate system: British National Grid

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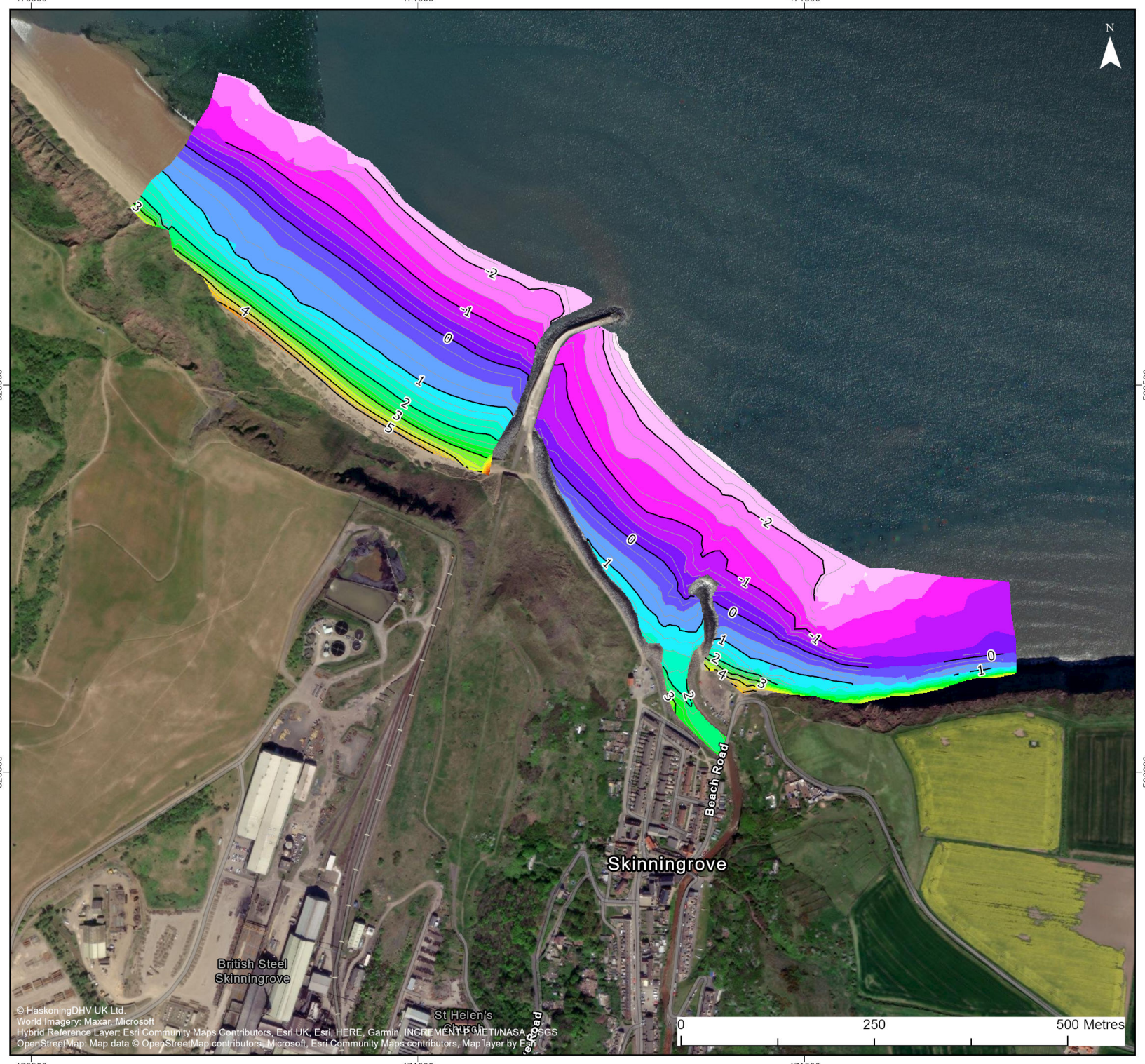

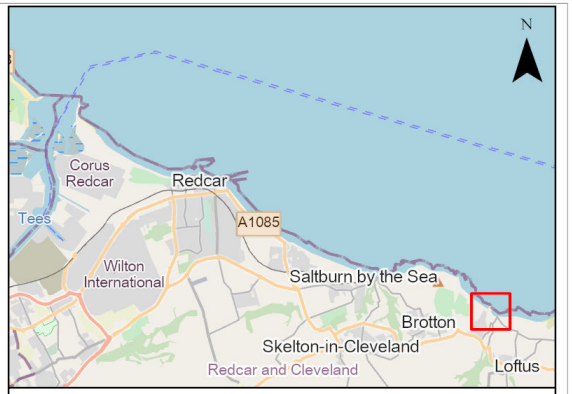

TOPOGRAPHIC SURVEY (October 2021)

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
- 0.6 - 1
- 0.1 - 0.5
- -0.4 - 0
- -0.9 - -0.5
- -1.4 - -1
- -1.9 - -1.5
- -2.4 - -2
- -2.8 - -2.5

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 5

CATTERSTY SANDS (SKINNINGROVE)

Redcar and Cleveland Borough Council Frontage

Report:

Analytical Report
'Full Measures' Survey 2021

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	04/11/2021	TC	NJC	A3	1:5,000

Co-ordinate system: British National Grid

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Difference between topographic surveys
(Nov 2020 to Oct 2021)
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 6

COATHAM SANDS

Redcar and Cleveland Borough Council Frontage

Report:
Analytical Report
'Full Measures' Survey 2021

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	04/11/2021	TC	NJC	A3	1:15,000

Co-ordinate system: British National Grid

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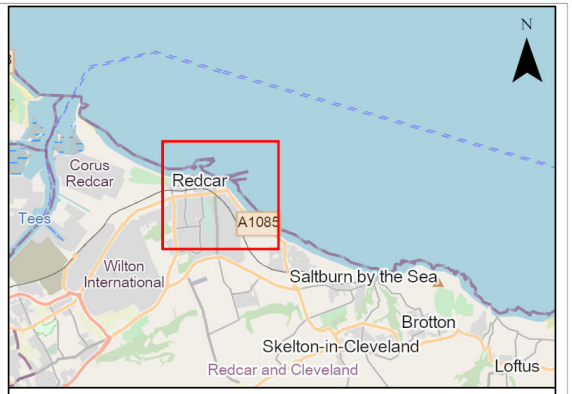

Difference between topographic surveys
(Nov 2020 to Oct 2021)
Change in Elevation (mOD)

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 2021

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	04/11/2021	TC	NJC	A3	1:15,000

Co-ordinate system: British National Grid

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Difference between topographic surveys
(Nov 2020 to Oct 2021)
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 8

MARSKE SANDS

Redcar and Cleveland Borough Council Frontage

Report:
Analytical Report
'Full Measures' Survey 2021

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	04/11/2021	TC	NJC	A3	1:15,000

Co-ordinate system: British National Grid

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North East Coastal Observatory

Difference between topographic surveys
(Nov 2020 to Oct 2021)
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 9

SALTBURN SANDS

Redcar and Cleveland Borough Council Frontage

Report:
Analytical Report
'Full Measures' Survey 2021

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	04/11/2021	TC	NJC	A3	1:8,000

Co-ordinate system: British National Grid

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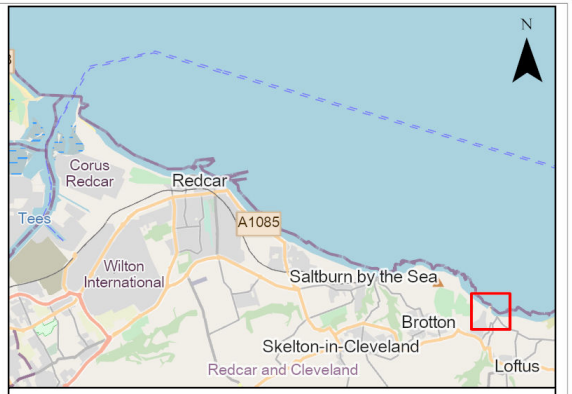

Difference between topographic surveys
(Mar 2021 to Oct 2021)
Change in Elevation (mOD)

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 2021

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	04/11/2021	TC	NJC	A3	1:5,000

Co-ordinate system: British National Grid

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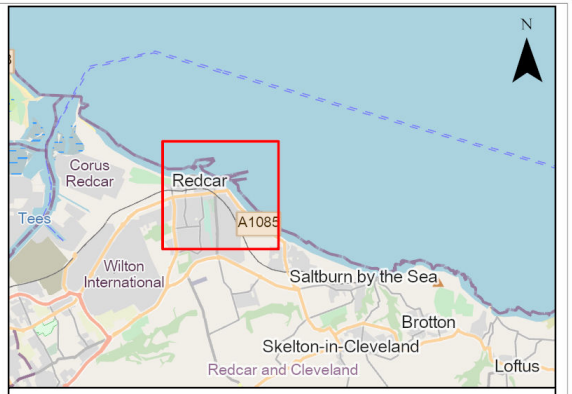

Difference between topographic surveys
(Mar 2021 to Oct 2021)
Change in Elevation (mOD)

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 2021

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
0	04/11/2021	TC	NJC	A3	1:15,000

Co-ordinate system: British National Grid

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Difference between topographic surveys
(Mar 2021 to Oct 2021)
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 2021

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

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North East Coastal Observatory

Appendix C

Cliff Top Survey

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	March 2021	Oct 2021	Nov 2008 - Oct 2021	March 2021 - Oct 2021	Nov 2008 - Oct 2021
1	477228	518769	320	1.90	-5.05	-5.40	7.30	0.35	0.61
2	477334	518798	0	10.90	10.59	10.58	0.32	0.01	0.03
3	477487	518789	350	7.10	8.02	7.96	-0.86	0.06	0.00
4	477594	518801	340	5.90	3.70	3.74	2.16	-0.04	0.18
5	477683	518911	350	8.40	8.24	8.55	-0.15	-0.31	0.00
6	477792	518867	30	8.60	8.51	8.54	0.06	-0.03	0.01
7	477891	518828	60	7.70	7.31	7.20	0.50	0.11	0.04
8	477959	518873	350	8.70	8.49	8.56	0.14	-0.07	0.01
9	478088	518950	350	7.60	7.91	8.05	-0.45	-0.14	0.00
10	478191	519023	340	8.40	8.59	8.48	-0.08	0.11	0.00
11	478237	519007	60	6.90	6.64	6.66	0.24	-0.02	0.02
12	478213	518988	150	6.10	6.54	6.56	-0.46	-0.02	0.00
13	478501	518809	15	11.40	8.78	8.67	2.73	0.11	0.23
14	478624	518807	20	7.50	7.32	7.27	0.23	0.05	0.02

15	478737	518858	60	6.10	6.37	6.12	-0.02	0.25	0.00
16	478823	518757	60	8.00	8.64	8.12	-0.12	0.52	0.00
17	478944	518671	30	9.30	8.71	8.78	0.52	-0.07	0.04
18	479052	518630	20	9.20	9.27	9.06	0.14	0.21	0.01
19	479147	518610	0	14.20	14.03	13.94	0.26	0.09	0.02
20	479274	518618	20	11.40	11.18	11.10	0.30	0.08	0.03

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.