



Cell 1 Regional Coastal Monitoring Programme Update Report 13: 'Partial Measures' Survey 2021



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**Scarborough Borough Council
June 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)			
	Hartlepool Headland to Saltburn Scar	Skinningrove	Hummersea Scar to Sandsend Ness	Sandsend Ness to Saltwick Nab
1 in 200 year	3.87	3.86	4.1	3.88
HAT	3.25	3.18	3.15	3.10
MHWS	2.65	2.68	2.65	2.60
MLWS	-1.95	-2.13	-2.15	-2.20

Water Level Parameter	Water Level (m AOD)			
	Saltwick Nab to Hundale Point	Hundale Point to White Nab	White Nab to Filey Brigg	Filey Brigg to Flamborough Head
1 in 200 year	3.88	3.93	3.93	4.04
HAT	3.10	3.05	3.05	3.10
MHWS	2.60	2.45	2.45	2.50
MLWS	-2.20	-2.35	-2.35	-2.30

Source: *River Tyne to Flamborough Head Shoreline Management Plan 2*. Royal Haskoning, February 2007.

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).

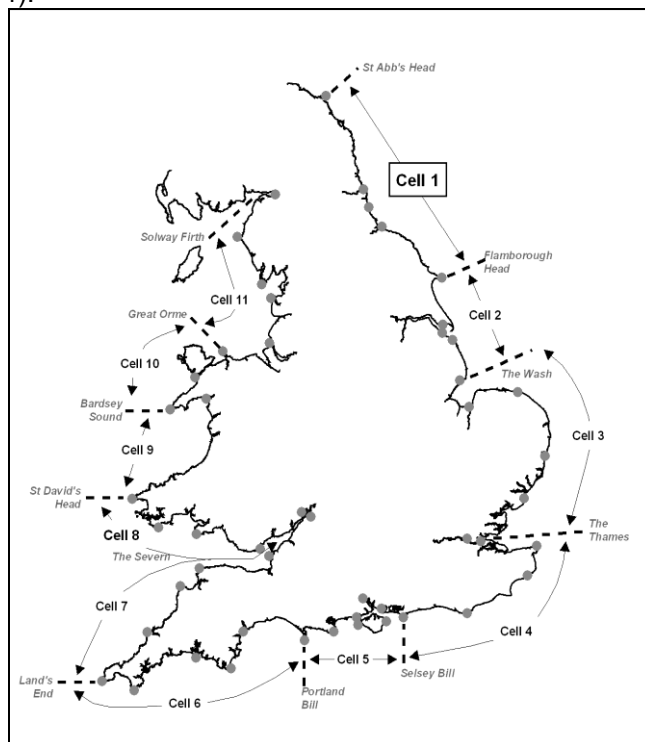


Figure 1 Sediment Cells in England and Wales

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 seabed 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.

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	Jun 09	-
2	2009/10	Sep-Dec 09	Mar 10	Feb-Mar 10	Jul 10	-
3	2010/11	Aug-Nov 10	Feb 11	Feb-Apr 11	Aug 11	Sep 11
4	2011/12	Oct-Nov 11	Feb 12	Mar-May 12	Jul 13	-
5	2012/13	Sep 12	Mar 13	Apr-May 13	May 13	-
6	2013/14	Oct-Nov 13	Feb 14	Mar-Apr 14	Jul 14	-
7	2014/15	Sep 14	Feb 15	Mar 15	Jul 15	-
8	2015/16	Sep 15	Feb 16	Mar-Apr 16	Jul 16	Jun 16
9	2016/17	Sep-Nov16	Feb 17	Feb-Apr 17	Jul 17	-
10	2017/18	Sep-Oct 17	Jan 18	Mar-May 18	Jun 18	-
11	2018/19	Sep-Oct 18	Mar 19	Mar-Apr 19	July 19	-
12	2019/20	Sep-Nov 19	Jan 20	Feb- Apr 20	Jun 20	-
13	2020/21	Nov-Dec 20	Mar 20	Mar-Apr 21	Jun 21	Expected Summer 2021

(*) The present report is **Update Report 13** and provides an analysis of the 2021 Partial Measures survey for Scarborough Council's frontage.

1. Introduction

1.1 Study Area

Scarborough Council's frontage extends from Staithes Harbour in the north, to Speeton in Filey Bay in the south. For the purposes of this report, it has been sub-divided into eight areas, namely:

- Staithes¹
- Runswick Bay
- Sandsend Beach, Uppang Beach and Whitby Sands
- Robin Hood's Bay
- Scarborough North Bay
- Scarborough South Bay
- Cayton Bay
- Filey Bay

1.2 Methodology

Along Scarborough Borough Council's frontage, the following surveying is undertaken:

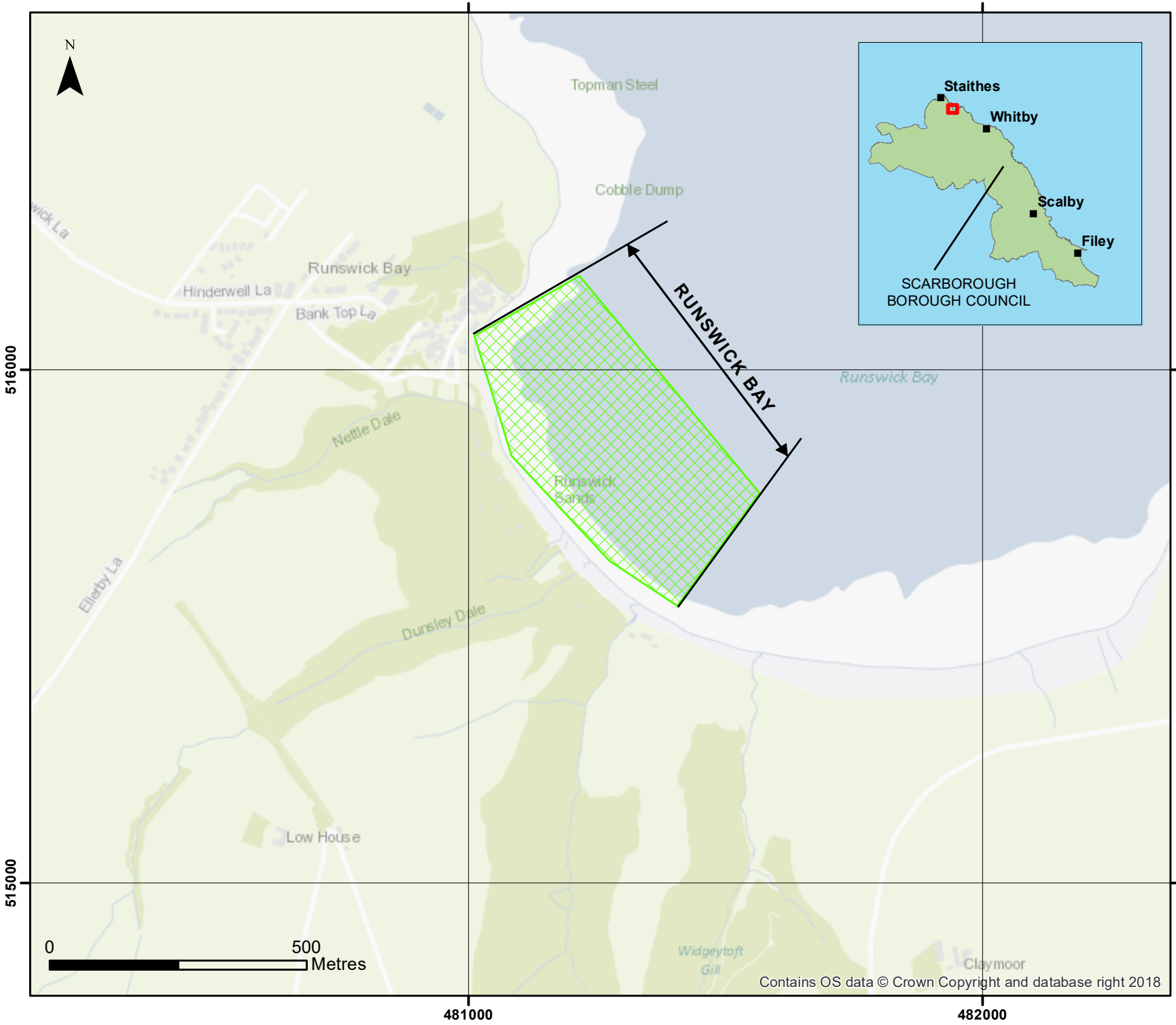
- Full Measures survey annually each autumn/early winter comprising:
 - Beach profile surveys along 20 transect lines
 - Topographic survey at Runswick Bay
 - Topographic survey along the Sandsend to Whitby frontage
 - Topographic survey at Robin Hood's Bay
 - Topographic survey at Scarborough North Bay
 - Topographic survey at Scarborough South Bay
 - Topographic survey at Cayton Bay
 - Topographic survey at Filey Bay
- Partial Measures survey annually each spring comprising:
 - Beach profile surveys along 20 transect lines
 - Topographic survey at Runswick Bay
 - Topographic survey at Robin Hood's Bay
 - Topographic survey at Filey Bay (Town coverage)
- Cliff top survey bi-annually at:
 - Staithes
 - Robin Hoods Bay (new addition Spring 2010)
 - Scarborough South Bay (new addition Spring 2010)
 - Cayton Bay
 - Filey

The location of these surveys is shown in Figure 2. The Partial Measures survey was undertaken along this frontage between 3rd March and 1st April 2021, more specifically:

- Runswick Bay – 3rd March 2021;
- Whitby – 30th March 2021;
- Robin Hood's Bay – 14th April 2021;
- Scarborough – 29th March 2021;
- Cayton Bay – 30th March 2021; and
- Filey – 31st March & 1st April 2021.

During this time weather conditions varied considerably; refer to the survey reports for details of the weather conditions over this survey period. Data from the present survey are presented in a processed form in the Appendices.

¹ The Staithes frontage straddles the boundary of jurisdiction of both Redcar & Cleveland Borough Council and Scarborough Borough Council.



Key

SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

(Indicative Survey Extents shown)

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

Figure 2 - Map 1

Scarborough Borough Council Frontage

Analytical Report
 Topo Surveys

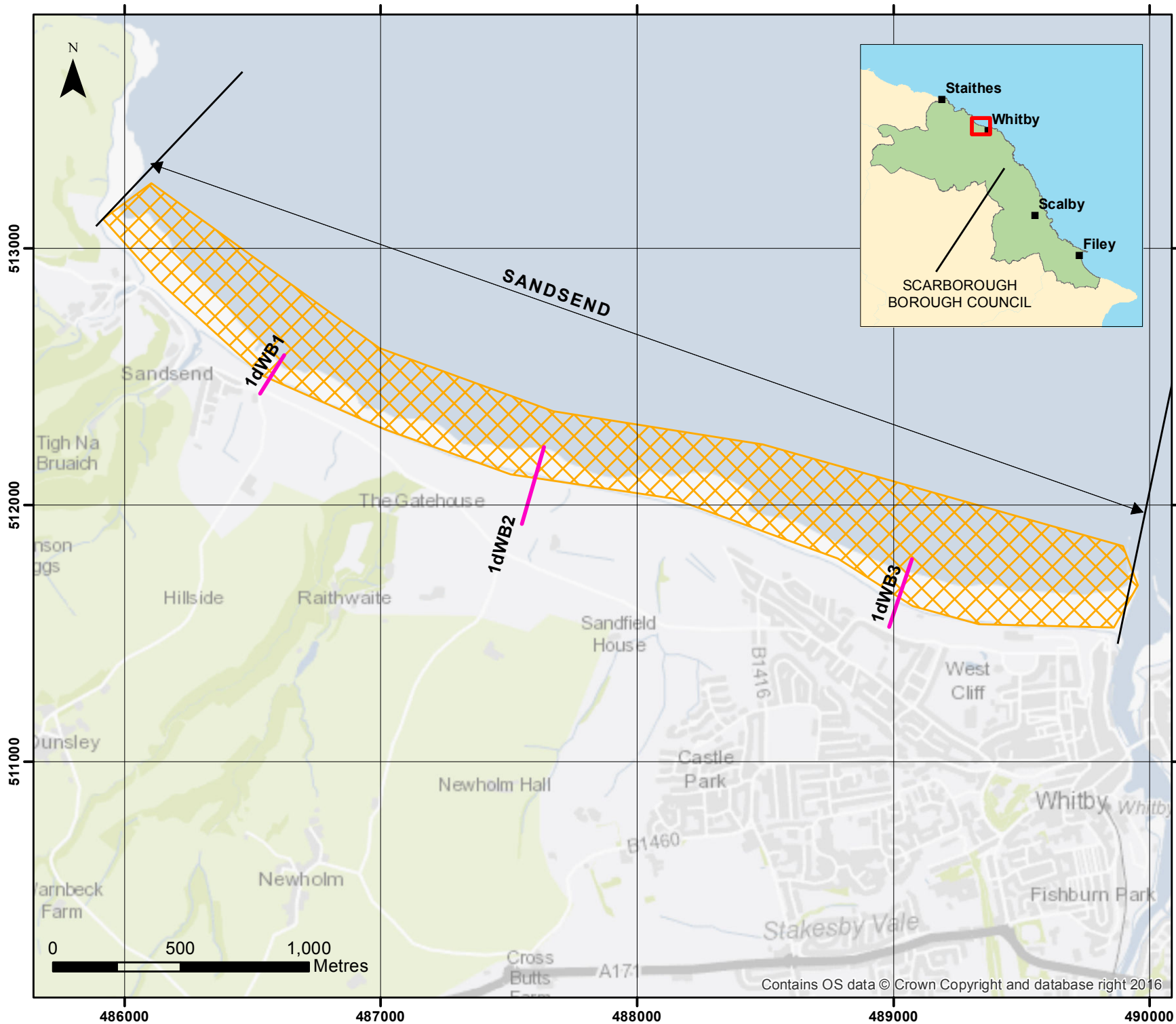
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Key

SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

(Indicative Survey Extents shown)

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

Figure 2 - Map 2

Scarborough Borough Council Frontage

Analytical Report
 Topo Surveys

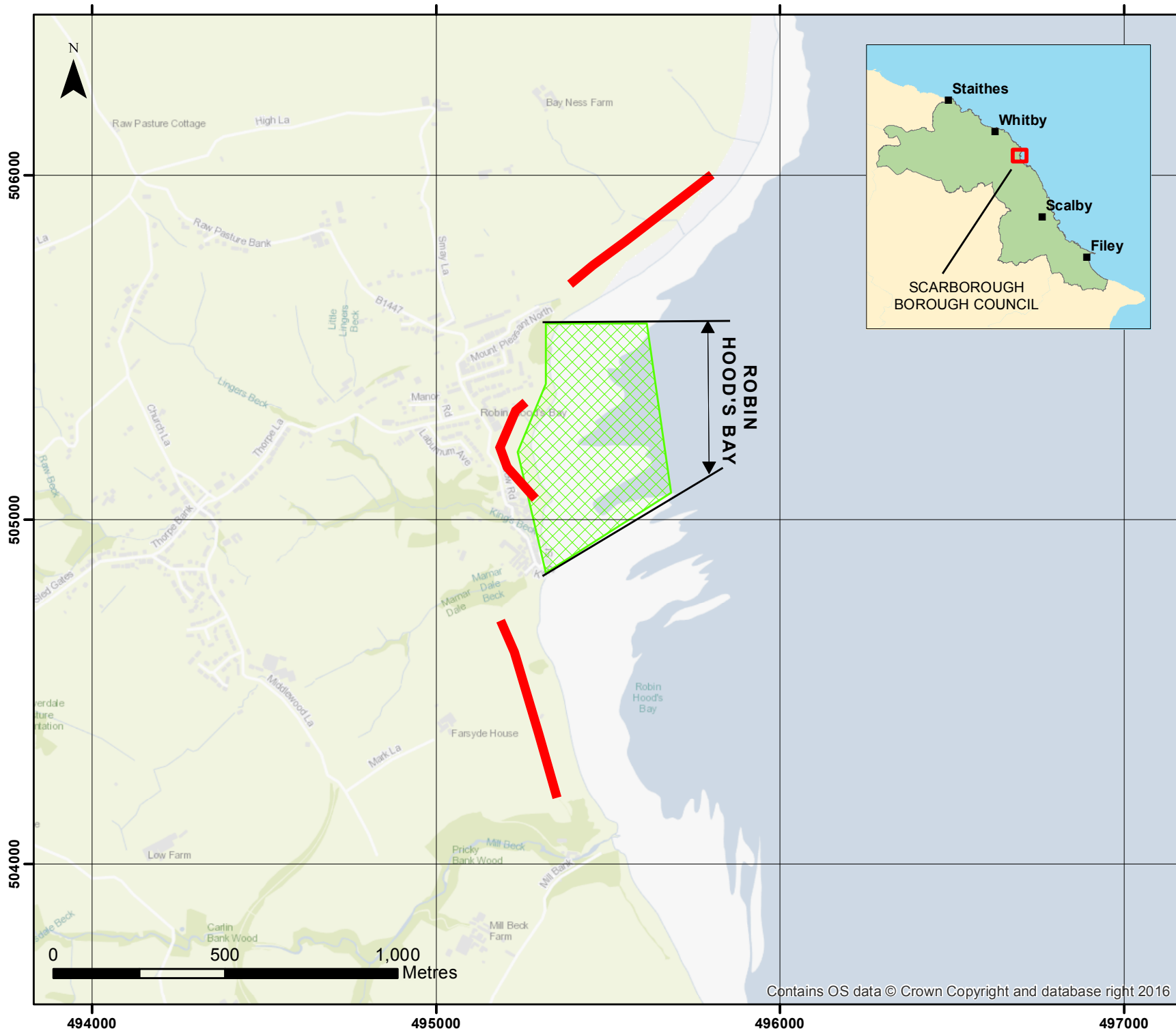
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Key

SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly

Cliff Top Monitoring Pegs

- @ 300 centres

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Figure 2 - Map 3

Scarborough Borough Council Frontage

Analytical Report
Topo Surveys

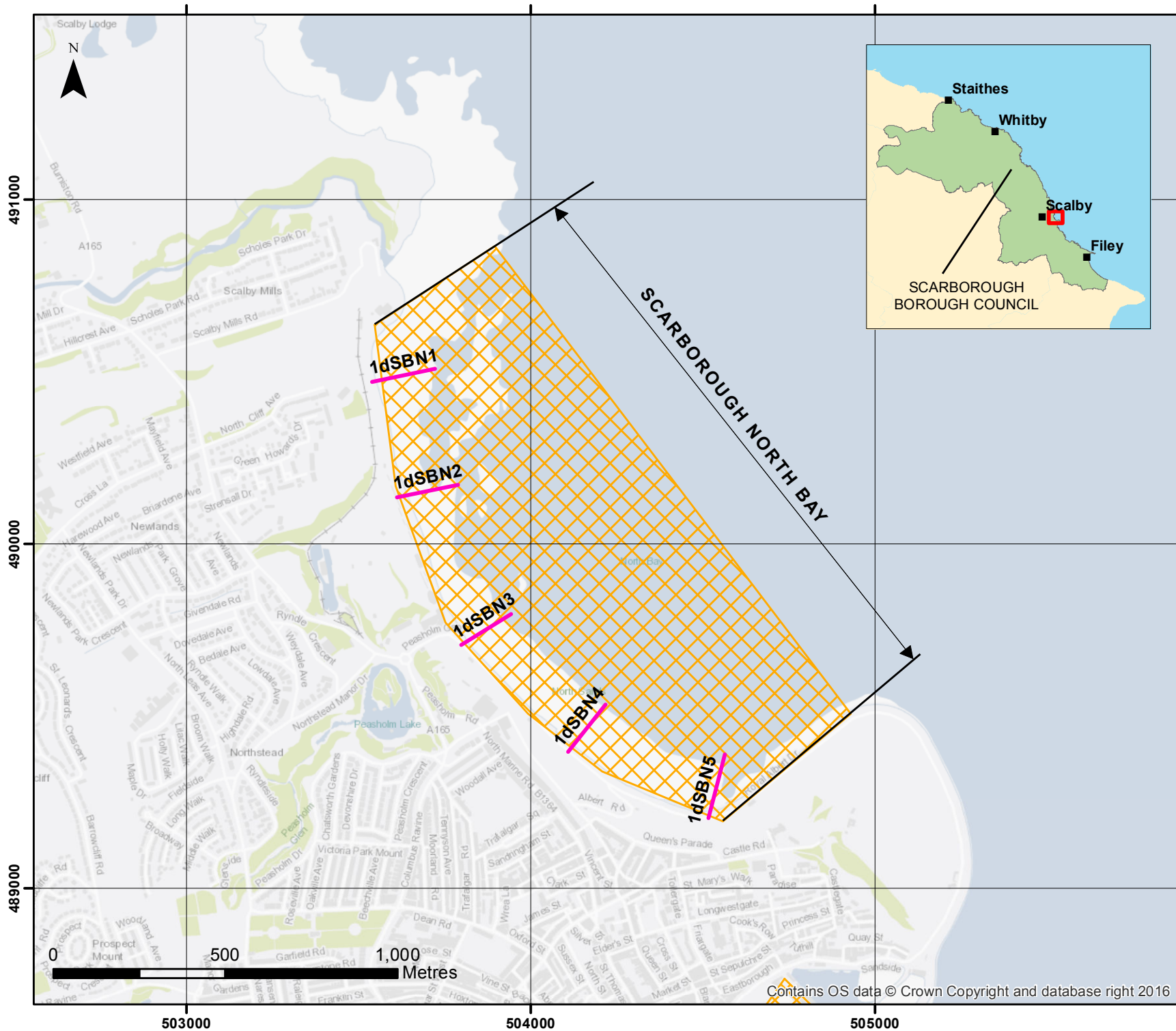
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Key

SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

(Indicative Survey Extents shown)

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

Figure 2 - Map 4

Scarborough Borough Council Frontage
 Analytical Report
 Topo Surveys

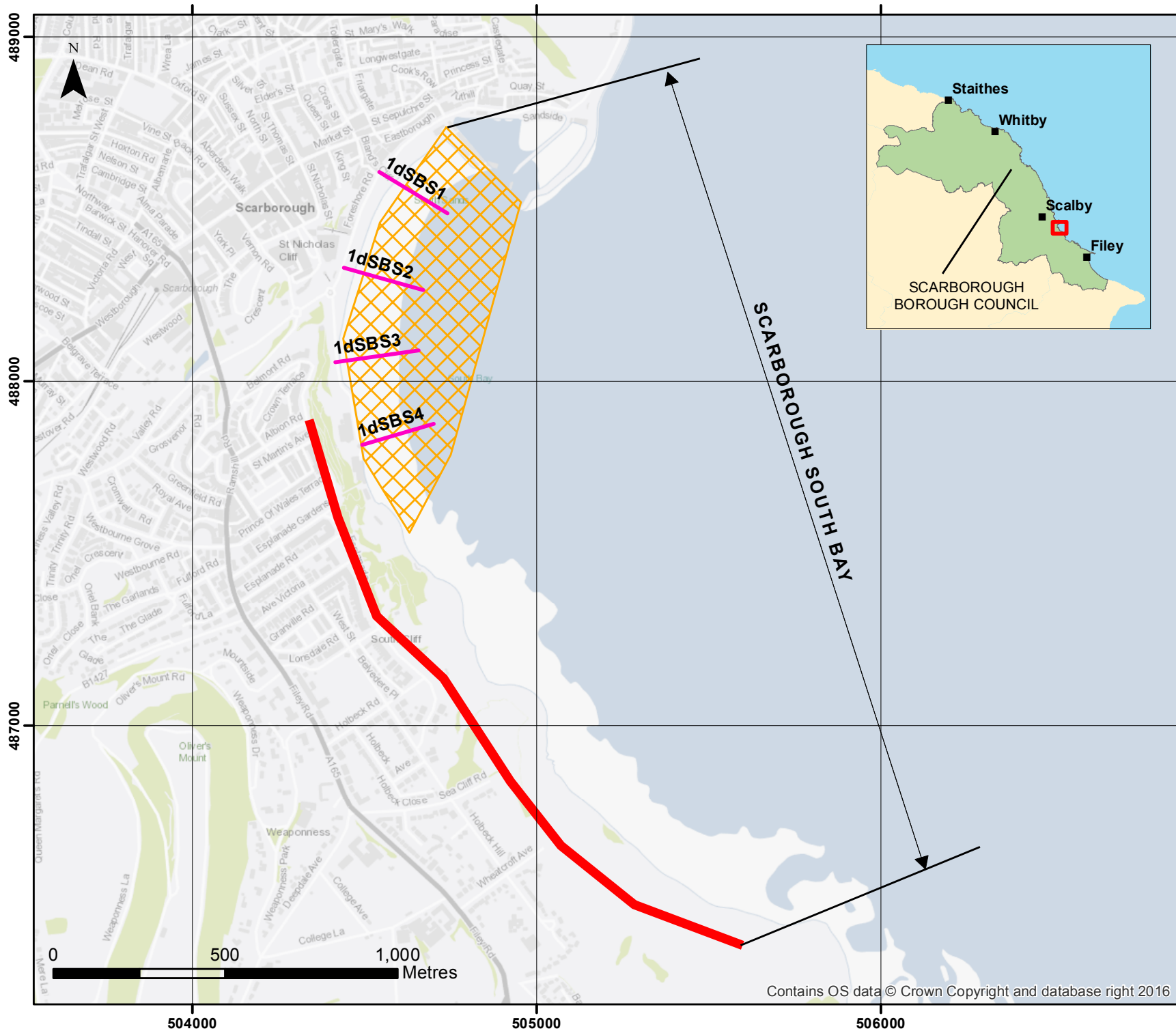
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Key

SURVEY LOCATIONS

Topographic Profiles

- Annual (Blue line)
- Bi-Annual (Pink line)

Topographic Surveys

- 6 monthly (Green grid)
- yearly (Orange grid)

Cliff Top Monitoring Pegs

- @ 300 centres (Red line)

(Indicative Survey Extents shown)

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

Figure 2 - Map 5

Scarborough Borough Council Frontage Analytical Report Topo Surveys

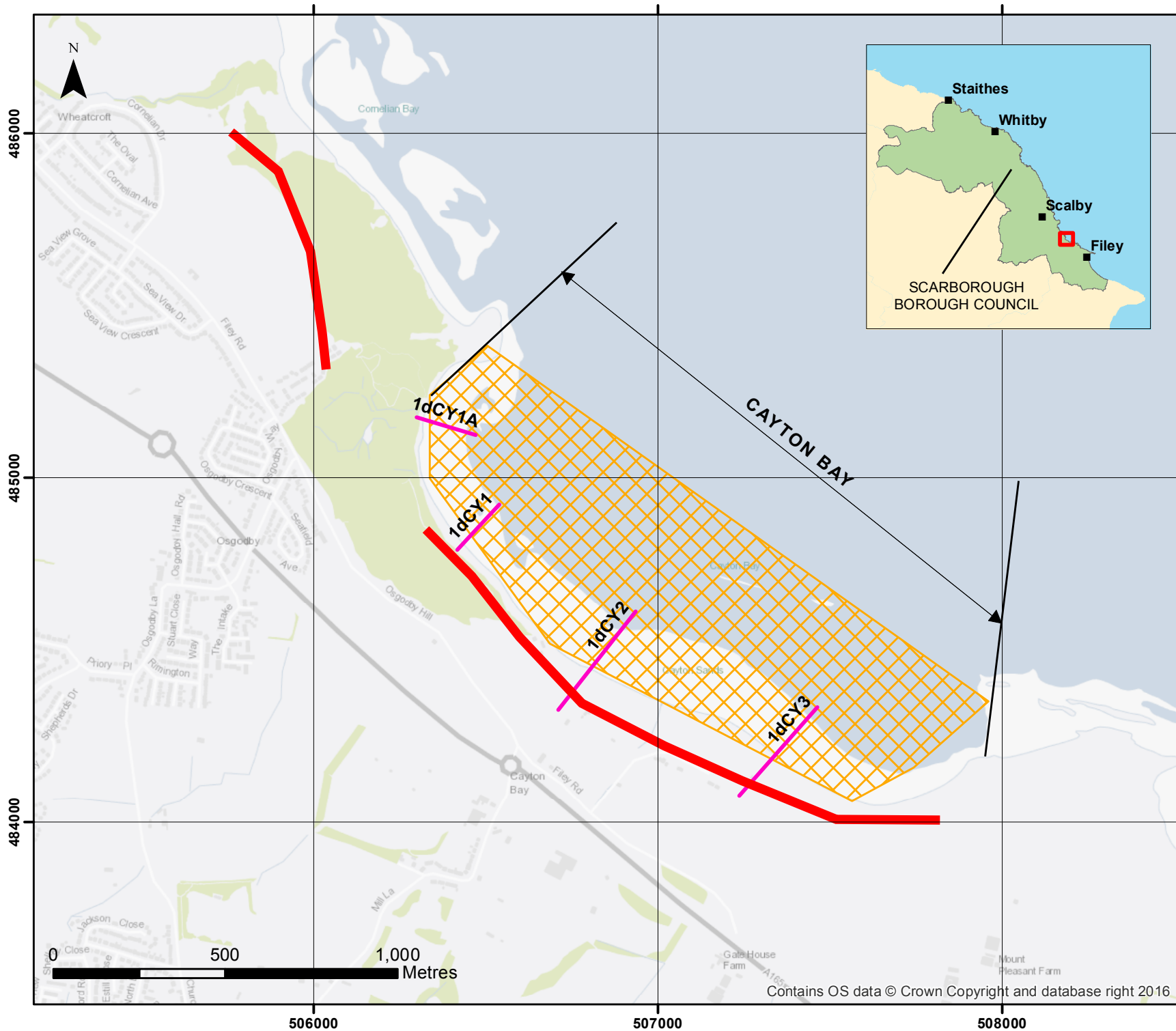
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Key

SURVEY LOCATIONS

Cliff Top Monitoring Pegs

█ @ 300 centres

Topographic Profiles

— Annual

— Bi-Annual

Topographic Surveys

6 monthly

yearly

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Figure 2 - Map 6

Scarborough Borough Council Frontage

Analytical Report
Topo Surveys

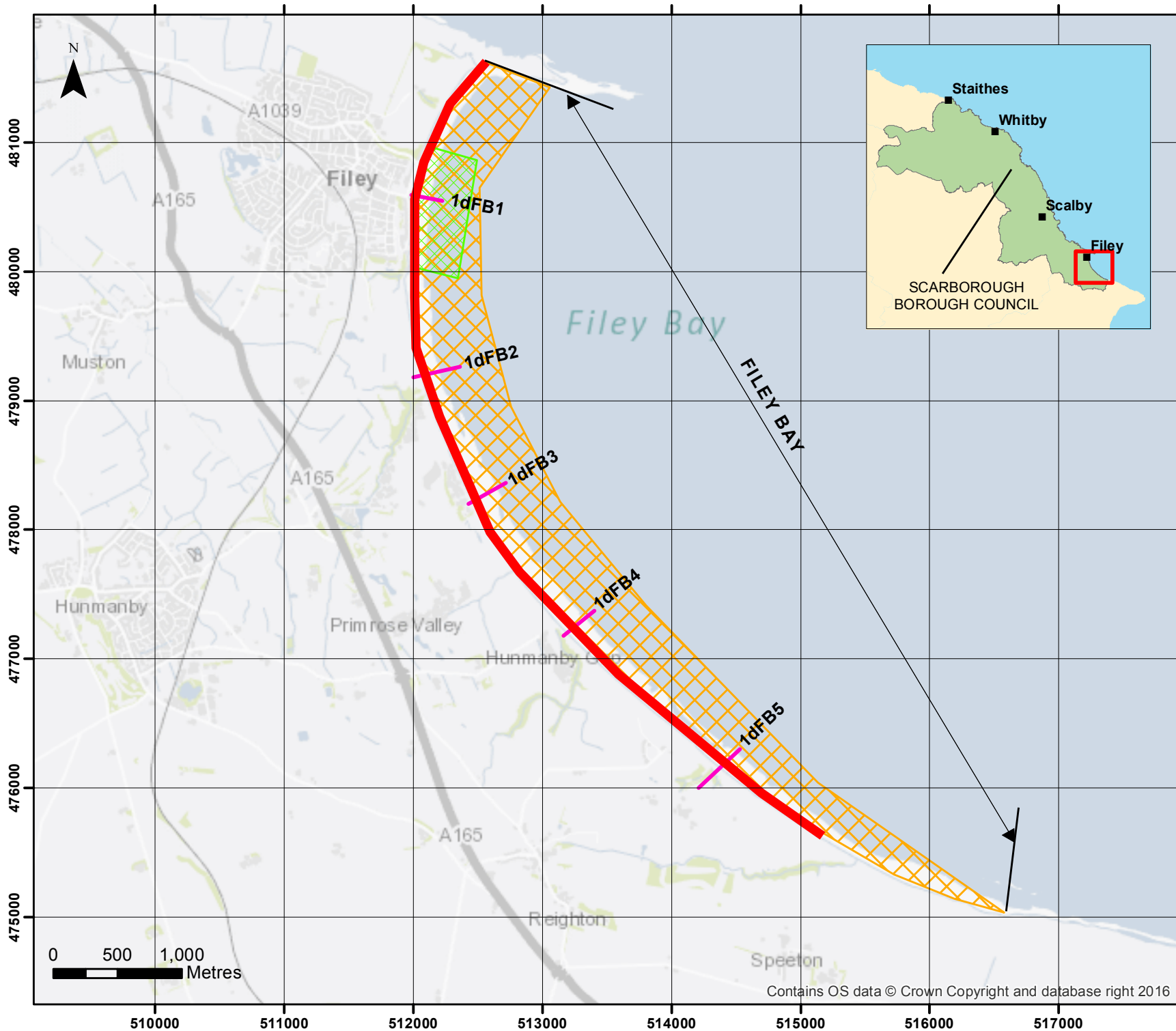
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Key

SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly

Cliff Top Monitoring Pegs

- @ 300 centres

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Figure 2 - Map 7

Scarborough Borough Council Frontage

Analytical Report
Topo Surveys

Drawing Scale at A4 1:40,000

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2. Analysis of Survey Data

2.1 Staithes

Survey Date	Description of Changes Since Last Survey	Interpretation
<p>22nd March 2021</p>	<p>Cliff-top Survey:</p> <p>Twenty ground control points have been established at Staithes for the purposes of cliff top monitoring. The separation between any two points is a nominal 100m. The cliff top surveys at Staithes are undertaken bi-annually. Data collection involves a distance offset measurement from the ground control point to the cliff edge along a fixed bearing.</p> <p>Appendix C provides results from the March 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 and the previous November 2020 survey. Calculated advances of the cliff line are also assumed to be error associated with difficulty precisely identify the cliff top, particularly where vegetation is present.</p> <p>The results provided in Appendix C show that the majority of the profiles show little or no erosion since the previous survey, with only 2 points experiencing erosion greater than the survey error (0.20m). These are located at Point 8 at Cowbar Nab in the west of the survey extent (0.94m) and Point 19 in the far east of the survey area (0.31m). Several points noted apparent 'accretion' of the cliff top (Points 12, 13, 16 and 18), this is likely to be due to difficulties in accurately identifying the cliff edge through vegetation.</p> <p>The long term recession rates show that two points at Staithes are greater than 0.2m/year (Point 1 along the road to the west of Staithes (0.53m) and Point 13 adjacent to the eastern breakwater at Staithes (0.20m).</p>	<p>The recorded changes to the cliff top between November 2020 and March 2021 are generally small. There has been two points which show retreat of the cliff top greater than the survey error (Point 8 and Point 19).</p> <p>Longer term trends: Table C1 in Appendix C presents the erosion rates calculated from the data collected since 2008. Points 1, 4, and 13 are the only locations with a significant recession rate, which ranges from 0.17 to 0.53m/yr.</p>

2.2 Runswick Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
<p>3rd March 2021</p>	<p>Topographic Survey:</p> <p>Runswick Bay is covered by a 6-monthly topographic survey. A consistently applied GIS processing routine has been used to create a digital ground model (DGM) (Appendix B - Map 1) and to calculate the differences between the current topographic survey (spring 2021) and the previous survey (autumn 2020) to highlight areas and amounts of erosion and deposition. In all cases, a 5m resolution raster grid has been used to identify areas of erosion and accretion (Appendix B – Map 4).</p> <p>Appendix B - Map 4 shows shore parallel areas of change across the survey extent. Across much of the upper and middle beach, erosion has been the dominant process. The mid to lower beach is dominated by accretion across the full extent of the survey, with some small patches of erosion in the north of the bay. The magnitude of change is greater in the south of the bay, reaching $\pm 1.5\text{m}$. In the central bay there is a sand bank like feature which has generally experienced accretion, although the changes in this location are limited to 0.25m. At the northern extent of the survey area change is patchier than the central and southern bay which shows even erosion / accretion across the beach profile.</p>	<p>The upper beach has experienced some drawdown of sediment toward the lower beach. The pattern indicates seasonal draw down. More extreme changes are noted to the south of the survey extent.</p> <p>Longer term trends: The data collected since 2008 indicate a general pattern of winter drawdown and spring recovery with no measurable net longer-term change. The trends from this survey are broadly comparable with observations since 2013.</p>

2.3 Sandsend Beach, Upgang Beach and Whitby Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
20 th March 2021	<p>Beach Profiles:</p> <p>The Sandsend, Upgang and Whitby frontage is covered by three beach profile lines for the Partial Measures survey (Appendix A). The profiles were surveyed in October 2020 (Full Measures) and in March 2021.</p> <p>Profile 1dWB1 is located around 400m south of Sandsend village. There has been some minor accretion of up to 0.1m at the toe of the Sandsend Road coastal defence to chainage 44m. Between chainage 44m and 115m there has been accretion of up to 0.7m, switching to erosion between chainage 115m-170m of up to 0.2m Seaward of chainage 170m there has been accretion of up to 0.4m. Overall, the profile is at a high level on the upper beach, and a medium level on the middle and lower beach compared to the range recorded from previous surveys.</p> <p>Profile 1dWB2 is located in the centre of Upgang beach. The survey report notes that two areas of the section were not measured due to dense vegetation on an area of the cliff face. The profile remained stable to the face of the cliff at 142m chainage. Directly at the toe of the cliff there has been minor accretion of up to 0.2m to chainage 144m. Between chainages 144m -184m the upper beach has lowered by up to 0.6m. The middle beach has accreted by up to 1.2m to chainage 246m, forming a small berm at chainage 200m. Seaward of chainage 246m, the beach has lowered by up to 0.6m. Overall the beach is at a medium – high level compared to the range recorded from previous surveys.</p> <p>Profile 1dWB3 is located on Whitby Sands, there has been up to 0.8m of accretion at the toe of the seawall to chainage 106m. From chainage 106m to 145m, the beach has lowered by up to 0.2m. Seawards of this point, the level of accretion remains at around 0.5m to the end of the survey at chainage 259m. Overall, the beach level is at a medium level compared to the range recorded from previous surveys.</p>	<p>Generally, the profiles are in the mid-range of previous survey results. The changes noted are generally in line with seasonal fluctuations previously noted.</p> <p>Longer term trends:</p> <p>The beach profiles appear to be reasonably stable showing only seasonal fluctuations.</p>

2.4 Robin Hood's Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
<p>14th March 2021</p>	<p>Topographic Survey:</p> <p>Data from the most recent topographic survey (Partial Measures, spring 2021) have been used to create a digital ground model (DGM) (Appendix B – Map 2) using a Geographical Information System (GIS). A difference plot has also been produced using the DGM (Appendix B – Map 5) from the last topographic survey (Full Measures, autumn 2020) and the most recent survey (spring 2021).</p> <p>The majority of the bay has seen very little change over the winter of 2020/21 ($\pm 0.1\text{m}$), associated with rocky outcrops that run perpendicular to the shore. The main patches of erosion are in the north of the survey extent on the upper beach and some localised patches on the upper beach fronting the village. There has been some accretion on the upper – mid beach directly fronting the northernmost slipway. The most significant area of change is in the centre of the survey extent where there has been a patch of erosion on the upper-mid beach of up to 1.25m.</p>	<p>The distribution of change is very patchy, with little change over the rock promontories in the bay and localised areas of erosion and accretion in the north and south of the survey extent. The loss of material at the base of the cliff is likely to be due to the ongoing erosion of debris from cliff failures.</p> <p>Longer term trends: The difference plots show a continuation of the trend of patchy distribution of erosion and accretion. Overall, the observed changes are of limited magnitude and within the range of changes previously seen. The long-term difference between autumn 2008 and spring 2021 shows stability.</p>
<p>14th April 2021</p>	<p>Cliff-top Survey:</p> <p>Thirteen ground control points have been established at Robin Hood's Bay since 3rd March 2010 to monitor cliff top recession. The separation between any two points is a nominal 200m and monitoring is undertaken bi-annually. Appendix C provides results from the April 2021 survey showing change since the last survey in November 2020 and the baseline survey in March 2010 (Appendix C- Map 2). The accuracy of the survey technique means change of less than 0.2m is assumed to be error. Calculated advances of the cliff line are also assumed to be error associated with difficulty precisely identify the cliff top, particularly where vegetation is present.</p> <p>Five of the monitoring points show erosion (of greater than 0.2m) since the previous survey. Points 1, 3 and 4, located adjacent to the Cleveland Way footpath north of Dungeon Hole at the northern end of the village have shown 0.71m, 0.3m and 0.82m of erosion, respectively. Point 5, adjacent to the village, has shown 1.02m of erosion, whilst Point 11 along the cliffs to the south of the survey extent has eroded by 0.95m.</p> <p>The survey report notes that Point 5 is located on a pile of deposited garden waste, and that Points 3, 4, 5 and 7 have undefined edges that are hard to distinguish. From inspecting the survey photographs it is</p>	<p>The cliff top has been largely stable since the previous survey in November 2020, with only one Point recording more than 1.0m erosion.</p> <p>Longer term trends: The erosion rates calculated from the changes since March 2010 show stability at most of the monitoring locations. The longer-term rates show that Point 1 has a recession rate of 0.54m/yr with other points having a rate of less than 0.1m/yr. This reflects localised and episodic cliff failure through rock fall.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>clear that the growth of vegetation in the spring can hinder accurate measurement in these locations. The recession recorded in spring 2021 when compared with the long-term change from March 2010 to the present survey, indicates a more balanced picture of long-term stability.</p> <p>Only Point 1 shows significant long-term erosion, with total erosion of 5.93m since the baseline survey in 2010 and a rate of 0.54m/yr.</p>	

2.5 Scarborough North Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
30 th November 2020	<p>Beach Profiles:</p> <p>Scarborough North Bay is covered by five beach profile lines for the Partial Measures survey (Appendix A) that are monitored biannually. The previous Full Measures survey was undertaken in November 2020.</p> <p>Profile 1dSBN1 is located around 200m south of the Sea Life Centre. There has been an increase in beach level of up to 0.7m immediately in front of the seawall from chainage 11m to chainage 88m, switching to a drop in beach level on the lower beach by up to 0.5m. Overall the upper and middle beach is at a high level, whereas the lower beach is at a low level when compared to the range recorded from previous surveys.</p> <p>Profile 1dSBN2 is located close to the former chair lift. The upper beach has lowered from the toe of the seawall at chainage 8m to chainage 55m by up to 0.8m. The middle and lower beach has accreted by up to 0.9m and has covered part of the previously exposed rocky platform between chainages 100-140m. Overall, the upper beach is at a low level, switching to a high level on the middle and lower beach compared to the range recorded from previous surveys.</p> <p>Profile 1dSBN3 is located near Royal Albert Drive. The beach has lowered from the toe of the seawall across the upper and lower beach by up to 1.0m, with a small section of accretion on the middle beach of less than 0.1m between chainages 73-84m. Overall, the beach is at a medium-low level compared to the range recorded from previous surveys.</p> <p>Profile 1dSBN4 is located at the northern end of Clarence Gardens. The upper and lower beach has experienced accretion of up to 0.2m between the toe of the seawall and the rocky outcrops at chainage 35m, and chainages 123-153m. The beach has lowered between the rocky outcrop at chainage 5m and 90m by up to 0.6m, and between chainage 103-123m by up to 0.2m. Beach levels are at a medium to low level on the upper to medium beach, and a high level on the lower beach compared to the range recorded from previous surveys. The results remain within the range recorded from previous surveys.</p> <p>Profile 1dSBN5 is located to the south of Clarence Gardens. There has been a drop in beach level at the toe of the seawall from chainage 28m to 30m by up to 0.4m. There has been relatively little change on the upper beach between chainages 30-56m. The middle beach has lowered by up to 0.2m between</p>	<p>The beach in North Bay has undergone varying levels of accretion and erosion since the previous survey, with the northern profiles exhibiting more accretion than the central and southern profiles. All profiles demonstrate trends which are indicative of seasonal draw-down processes.</p> <p>Longer term trends: The beach ranges from the higher to the lower end of the range of profiles, however all profiles shows that changes have been within the range of previously recorded surveys.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>chainages 56-97m, switching to accretion on the lower beach by up to 0.2m to the end of the survey. Overall, the profile is at a medium to high level compared to the range recorded from previous surveys, with little notable change since the previous survey.</p>	

2.6 Scarborough South Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
29 th March 2021	<p>Beach Profiles:</p> <p>Scarborough South Bay is covered by four beach profile lines for the Partial Measures survey (Appendix A). The profiles were last surveyed during the Full Measures survey of December 2020.</p> <p>Profile 1dSBS1 is located around 250m south of the West Pier. There has been 0.4m of accretion at the base of the sea defence from chainage 14m to 26m. From chainage 26m to chainage 100m the beach level has lowered up to 0.7m. The mid-lower beach, seaward of chainage 100m to the end of the survey at chainage 237m has accreted up to 0.6m. Overall the profile is at a medium-low level on the upper and middle beach compared to the range recorded from previous surveys, whilst the lower beach is at a high level.</p> <p>Profile 1dSBS2 is located on the shore fronting St Nicholas Cliff. At the toe of the sea wall there has been a minor accretion of up to 0.1m between chainages 4-7m. The upper and middle beach has lowered between chainages 7-128m by 0.3m. Seawards of chainage 128m, to the end of the survey at chainage 205m there has been accretion of between 0.2m and 0.4m. When compared with the range from previously recorded surveys, the upper and middle beach profile is generally at a medium level, whilst the lower beach is at a high level.</p> <p>Profile 1dSBS3 is located 250m north of the Scarborough Spa complex. At the base of the seawall the profile has lowered by up to 1.1m on the upper beach, and 0.3m on the middle beach. Seaward of this point, the lower beach has accreted by up to 0.2m to the end of the survey at chainage 210m. The profile is at a relatively low level when compared to the range recorded from previous surveys.</p> <p>Profile 1dSBS4 is located on the beach in front of the Scarborough Spa Complex. There has been no change at the toe of the seawall. The beach profile has lowered in its entirety, ranging from 0.5m on the upper beach, less than 0.1m on the middle beach, and 0.2m on the lower beach. A previously covered rock patch at chainage 28m is now exposed. Overall, the beach is at a low level compared to the range recorded from previous surveys.</p>	<p>All beach profiles are dominated by erosion, however, the trend is in line with seasonal fluctuations and profiles have tended to remain within the range of previously recorded surveys.</p> <p>The lower beach in profiles 1dSBS1, 1dSBS2 and 1dSBS3 show slight accretion on the lower beach indicative of beach draw-down processes.</p> <p>Longer term trends: The observed changes in the profiles in South Bay are consistent with the seasonal fluctuations of sediment with a bay system.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
29 th March 2021	<p>Cliff-top Survey:</p> <p>Thirteen cliff top monitoring control points have been established at Scarborough South Bay and from Cornelian Bay to Knipe Point. The separation between points is around 300m. The cliff top surveys at Scarborough South Bay are undertaken bi-annually. Appendix C provides results from the March 2010 baseline survey to March 2021, showing the distance from the ground control point to the edge of the cliff top along the defined bearing (Appendix C- Map 3). Error in the technique means change of less than 0.2m cannot be relied on. Calculated advances of the cliff line are also assumed to be error associated with difficulty precisely identify the cliff top, particularly where vegetation is present.</p> <p>The recorded changes between December 2020 and March 2021 were within the survey error of $\pm 0.2\text{m}$ for all but two points. Point 3 had experienced erosion outside this range, with 0.38m recorded in the spring 2021 survey. Point 6 experienced apparent accretion of 0.24m, however this is assumed to be due to difficulties in defining the cliff edge. Only Points 11 and 12 show significant erosion since the baseline survey in March 2010 of 3.59m and 2.91m respectively, this is equivalent to long term erosion rates of 0.33m/yr and 0.26m/yr.</p>	<p>Only one of the survey points has shown erosion outside of the survey tolerance over the course of winter 2020/21.</p> <p>Longer term trends: The recession rates for the longer term only show erosion at Points 11 and 12 of between 0.33 and 0.26m/yr. The rest of the study area has remained stable.</p>

2.7 Cayton Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
30 th March 2021	<p>Beach Profiles:</p> <p>Cayton Bay is covered by four beach profile lines for the Partial Measures survey (Appendix A). The previous survey was undertaken in December 2020.</p> <p>Profile 1dCY1A is located on the beach below Knipe Point at the north of the bay and was added to the programme in November 2015. There has been a slight seaward movement of the upper beach berm, with 0.5m of erosion between chainage 4m and 10m, extenuating a narrow channel / depression on the upper beach. The crest of the berm sits at chainage 12m, seawards of which, up to chainage 35m, accretion of up to 0.3m has partially covered the rocky outcrops on the upper beach. The mid and lower beach has been dominated by erosion. Between chainage 35m and the end of the survey at chainage 161m, the beach has lowered by between 0.1-0.6m. Overall the profile is at a medium – high level on the upper beach, except the narrow channel / depression which has now reached its lowest point recorded. The lower beach is at a low level, particularly seaward of chainage 107m which is at its lowest level recorded.</p> <p>Profile 1dCY1 is located on the beach in front of Tenants' Cliff in the north of the Bay. The survey report notes that <i>"the top of section 1 could not be measured due to dense vegetation"</i>. Between chainage 5m and 20m there has been some minor movement of material moving from the toe of the cliff onto the upper beach. From chainage 20m to 50m there has been accretion of up to 0.2m. These changes reflect the trend seen in previous surveys of material lost from the cliff face being redistributed from the toe of the cliff across the upper beach. Seawards of this point until chainage 108m the mid beach has lowered by up to 0.8m. The most seaward extent of the survey (from chainage 108m until the end of the survey at chainage 155m) has remained unchanged with the rock platform exposed as it was in the previous (autumn 2020) survey. The profile is at a high level on the upper beach but remains low on the mid-lower beach where the rock platform is exposed.</p> <p>Profile 1dCY2 is close to the former pumping station in the middle of Cayton Bay. The survey report notes that <i>"the middle of section 2 could not be measured due to the ground makeup, soft mud flows and unstable grass"</i>. There has been some accumulation of material at the toe of the cliff, indicating potential losses from the face of the cliff, however this reflects the long-term trend in this location. At the toe of the cliff at chainage 117m there has been up to 1.0m of accretion. The majority of the beach</p>	<p>With the exception of the most northerly profile (1dCY1A) the profiles show some accumulation of material at the toe of the cliffs, with redistribution of this material across the upper beach evident at some profiles. The majority of the profiles are dominated by erosion. The magnitude of changes in the spring 2021 Partial Measures survey is low and all beach profiles (except 1aCY1A where several sections are at their lowest levels recorded) remain within the bounds of the range from the previous surveys.</p> <p>Longer term trends:</p> <p>Following notably low levels in March 2018 and 2019 beach levels on the upper beach appear to be recovering, with the exception of the most northerly profile. There is evidence that material lost from the cliff face accumulates at the toe of the cliffs and is redistributed across the upper beach. Additional cliff failures will feed additional material onto the beach and drive erosion of the cliff top.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>profile seaward of this point has lowered evenly by up to 0.2m to chainage 282m. Seawards of this point to the end of the survey at chainage 325m there has been up to 0.2m of accretion. Overall, the profile is at a medium level compared to the range recorded from previous surveys.</p> <p>Profile 1dCY3 is located around 600m southeast of the pumping station. The survey report notes that <i>"the middle of section 3 could not be measured due to the ground makeup, soft mud flows and unstable grass"</i>. The cliffed part of the profile remains unchanged. From the toe of the cliff at 120m chainage to chainage 135m there has been accretion of up to 0.2m. Between chainage 135m to the end of the survey at chainage 292m there has been up to 0.4m of erosion. The majority of the beach is at a relatively medium-low level compared to the range recorded from previous surveys.</p>	
<p>30th March 2021</p>	<p>Cliff-top Survey:</p> <p>Eight ground control points have been established within Cayton Bay for the purposes of cliff top monitoring. The separation between any two points is typically around 300m. The cliff top surveys at Cayton Bay are undertaken bi-annually. Appendix C provides results from the March 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 and the previous December 2020 survey. The accuracy of the technique means results of less than 0.2m are not considered reliable.</p> <p>Dense vegetation means that point 2 has not been surveyed since the March 2018 survey. All remaining points have experienced change within the survey tolerance of $\pm 0.2\text{m}$.</p>	<p>No points have shown erosion outside of the survey tolerance, with the cliff top remaining stable since December 2020.</p> <p>Longer term trends: The recession rates show that Points 4 and 6 have the highest rates of 0.24 and 0.12m/yr. Due to the presence of dense vegetation at Point 2 it has not been possible to survey since March 2018. Historically this has been an area of activity.</p>

2.8 Filey Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
<p>31st March – 1st April 2021</p>	<p>Beach Profiles:</p> <p>Filey Bay is covered by five beach profile lines for the Partial Measures survey (Appendix A). The previous programmed survey (Full Measures) was undertaken in November 2020.</p> <p>Profile 1dFB1 is located in front of Filey town in the north of the bay. The beach level from the toe of the sea wall to chainage 130m has dropped by up to 0.5m. The lower beach has accreted by between 0.1-0.5m. The upper and mid-beach is at a medium level, whilst the lower beach is at a high level compared to the range recorded from previous surveys. The section between chainage 195m and 255m is at its highest level recorded.</p> <p>Profile 1dFB2 is located north of Primrose Valley Holiday Village. The surveyor was unable to measure the middle of section 1dFB2 between chainage 12m and 20m due to dense vegetation. There has been an accumulation of sediment at the toe of the cliff by up to 0.4m to chainage 75m. On the upper beach from chainage 75m to 186m there has been erosion of between 0.1m and 0.3m. The middle beach between chainages 186m to 262m has accreted by up to 0.1m. The lower beach between chainages 262-311m has lowered by up to 0.3m, switching to accretion seaward of this point by up to 0.2m. Overall the profile is at a medium to high level relative to the range recorded from previous surveys, and the beach between chainages 200-260m and 315-349m are at their highest levels recorded.</p> <p>Profile 1dFB3 is located in front of Flat Cliffs hamlet. The surveyor was unable to measure a small area of section 3 “<i>due to dense vegetation</i>”. The beach profile has generally lowered over the winter of 2020/2021 and formed an undulating beach profile. At the toe of the seawall there has been accretion of up to 0.3m, up to chainage 47m. From this point to the end of the survey at chainage 337m, the beach profile has generally lowered by between 0.2m on the upper beach, 0.5m on the middle beach and 0.4m on the lower beach. Accretion has occurred in two sections (between chainage 113-128m and 226-279m) by up to 0.3m. Overall the profile undulates between a high level and a low level relative to the range recorded from previous surveys. The section between chainage 115-129m is at its highest level recorded.</p> <p>Profile 1dFB4 is located near Humanby Gap. The survey report notes that “<i>the middle of section 4 is unable to be measured from chainage 4m to approx. 25m, due to the cliff face being unsafe</i>”. The upper</p>	<p>All of the profiles have remained relatively stable over the winter of 2020/21 with a general trend of erosion. There have been some areas of accretion, mostly at profile 1bFB1. A few isolated areas are at their lowest and highest levels record.</p> <p>Longer term trends:</p> <p>Past trends dominated by migrating sand bars continue to the present day.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>and middle beach has lowered between the cliff toe and chainage 160m by up to 0.5m. A hollow present during the autumn 2020 survey has infilled between chainages 160-207m by up to 0.6m forming a shallow berm at chainage 170m. Seaward of chainage 207m the beach level has dropped by up to 1.4m. The profile is at a medium level, with the crest of the lower beach berm between chainage 165m and 190m being the highest recorded level when compared with the range from previous surveys.</p> <p>Profile 1dFB5 is located close to Reighton Gap. The survey report notes that <i>“the middle of profile 5 was unable to be measured from chainage 65m to c. 208m, due to undergrowth and bushes”</i>. There has been very little change of the cliff toe between chainage 208-250m, whilst the upper beach between chainage 250m and 310m has lowered by up to 0.5m. A middle beach berm has formed at chainage 320m, with the accumulation of up to 0.4m. A lower beach berm present during the previous survey has migrated approximately 20m seaward. Overall, the profile is at a medium level compared to the range recorded from previous surveys.</p>	
<p>31st March - 1st April 2021</p>	<p>Topographic Survey:</p> <p>Data from the most recent topographic survey (Partial Measures, spring 2021) have been used to create a digital ground model (DGM) (Appendix B – Map 3) using a Geographical Information System (GIS). The topographic plot shows the gently sloping shore parallel bathymetry in front of Filey town. A difference plot has also been produced using the DGM (Appendix B – Map 6) comparing the last topographic survey (Full Measures, autumn 2020) to the present survey (spring 2021).</p> <p>There has been a narrow band of little change / accretion at the upper-most beach which transitions to a gradual pattern of erosion on the upper beach moving to little change across the middle beach and accretion on the lower beach. The majority of the survey extent has seen change limited to $\pm 0.75\text{m}$. In the south of the survey area, fronting Royal Parade there is a small localised area of accretion on the upper beach.</p>	<p>The localised erosion on the upper beach adjacent to the sea wall has been observed in previous surveys. Changes in this part of the beach are probably due to the refraction of wave energy on the hard defences through the winter. Overall, the beach has experienced a very uniform pattern of change over much of the survey area.</p> <p>Longer term trends:</p> <p>The erosion of the upper beach, close to the sea wall as observed over the winters of 2014/15 to 2016/17, 2018/19, 2019/20 and 2020/21 does not reflect the long-term trend between autumn 2008 and autumn 2016 that shows accretion on the upper beach and erosion on the lower beach. The atypical pattern seen in recent years is possibly a result of changes in wave climate.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
<p>12th-13th March 2020</p>	<p>Cliff-top Survey:</p> <p>Twenty-three ground control points were established within Filey Bay for the purposes of cliff top monitoring in November 2008. Additional points were added in September 2010 and March 2011 (as shown in Appendix C – Maps 5 and 6) taking the total number of ground control points in Filey Bay to 28. The maximum separation between points is 300m. The cliff top surveys at Filey Bay are undertaken bi-annually. Appendix C provides results from the April 2021 survey. The accuracy of the technique means results of less than 0.2m are not reliable. Furthermore, indications of an advancing cliff are erroneous and related to problems in precise identification of the cliff edge, particularly where vegetation is present.</p> <p>Between the November 2020 and the current survey, three of the 28 markers showed erosion greater than (or equal to) the survey error (0.2m) (Point 7, Point 13A and Point 16). The largest recorded erosion was located at Point 16 where 0.52m of erosion was recorded. The survey photographs from these areas show the headscarp of the soft till cliffs has slipped. The high level of activity along this frontage is possibly attributable to the extreme wet weather which was experienced throughout winter 2020/21, in which parts of the east coast experienced its wettest winter on record (Met Office, 2021).</p>	<p>Over the winter of 2020/21, three monitoring points showed erosion greater than the survey error, ranging between 0.24-0.52m.</p> <p>Longer term trends:</p> <p>The greatest long-term recession rate is seen at Point 7 at Muston Sands, where 0.41m/yr has been recorded. Point 13A has also recorded a high average recession rate of 0.26m/yr. Elsewhere Point 10, Point 14 and Point 17 have experienced 0.13m/yr, whilst Point 18 and Point 23 (near Reighton Gap) have experienced average recession rates of between 0.09-0.10m/yr.</p>

3. Problems Encountered and Uncertainty in Analysis

Individual Profiles

- At Whitby two areas of profile 1dWB2 were not measured due to dense vegetation on an area of the cliff face;
- At Scalby the cliff edge was very overgrown resulting in areas that were unable to be surveyed;
- At Cayton Bay:
 - the top of profile 1dCY1 cannot be measured due to dense vegetation;
 - the middle of profile 1dCY2 could not be measured due to the ground make-up, soft mud flows, and unstable grass;
 - the middle of profile 1dCY3 could not be measured due to the ground make-up, soft mud flows, unstable grass, and landslips;
 - Profile 1dCY3 was measured to cliff edge on top and as close to the cliff face at the bottom as possible.
- At Filey Bay:
 - the surveyor was unable to measure the middle of section 1dFB2 between chainage 12m and 20m due to dense vegetation.
 - the surveyor was unable to measure a small area of section 3 due to dense vegetation.
 - the middle of section 4 is unable to be measured from chainage 4m to approx. 25m, due to the cliff face being unsafe.
 - the middle of profile 5 was unable to be measured from chainage 65m to c. 208m, due to undergrowth and bushes.

Cliff Top Surveys

- At Robin Hoods Bay:
 - the dumping of waste vegetation at monitoring point 5 is a known source of error.
 - the survey report notes that VMPs 3, 4, 5, and 7 have undefined edges that are hard to distinguish.
- At Cayton Bay:
 - VMP2 was not surveyed due to dense vegetation prohibiting access.
- At Filey Bay:
 - VMPs 5, 12 and 13 were inaccessible due to heavy vegetation.

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

No changes are recommended at the present time.

5. Conclusions and Areas of Concern

- At Staithes, the recorded changes to the cliff top between November 2020 and March 2021 are generally small. There has been two points which shows retreat greater than the survey error.
- At Runswick Bay the upper beach has experienced drawdown of sediment toward the lower beach. The changes are in keeping with the longer-term trend of winter drawdown and spring recovery.
- At Sandsend, Uppang and Whitby, the profiles show seasonal fluctuation. Beach levels dropped at the toe of the new defence at Sandsend following the March 2018 severe storms ('Beast from the East'), exposing the concrete toe beam. These levels have recovered somewhat between 2019 – spring 2021.

- At Robin Hoods Bay, the distribution of change is highly variable. There has been little change over the rock promontories in the bay, and localised patches of erosion and accretion in the north and south of the survey extent. The cliff top has remained largely stable, with only one Point recording more than 1.0m erosion.
- At Scarborough North Bay, the northernmost profiles exhibit more accretion than the central and southern profiles. All profiles indicate a general trend of seasonal drawdown. The spring 2021 survey shows that changes have been within the range of previously recorded surveys.
- The profiles at Scarborough South Bay show erosion, however changes remain in line with seasonal fluctuations and the profiles remain within the range recorded from previous surveys. All profiles are generally within the range of recorded results and changes are generally in line with seasonal drawdown. Only one of the points has shown erosion outside of the survey tolerance over the course of winter 2020/21.
- The beach profiles in Cayton Bay are dominated by erosion. At some profiles there is an accumulation of material at the cliff toe caused by losses from the cliff face. The narrow channel / depression at profile 1dCY1A has continued to deepen since the previous survey and is now at its lowest point recorded. The cliff monitoring shows that no points underwent recession outside the survey tolerance of 0.2m over the winter of 2020/21.
- At Filey the profiles have generally remained stable, with a general trend of erosion since the previous survey. Profiles across the survey extent remain relatively smooth, except FB3 which shows an undulating beach profile with a middle and lower beach berm. All profiles remain largely within the range recorded from the previous surveys, with a few isolated areas experiencing the lowest and highest levels on record. The topographic difference plot shows a gradual transition of change within the bay from the upper-lower beach. The cliff survey notes three points of recession greater than the survey area, ranging between 0.24-0.52m. The largest area of recession is at Point 16 which has experienced 0.52m of erosion. The increased level of activity is possibly caused by the record wet winter of 2020/21 in the east of England which will have destabilised the upper reaches of these cliffs. The greatest long-term recession rate is seen at Point 7 at Muston Sands, where 0.41m/yr has been recorded.

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: 1dWB1

Date: 30/03/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

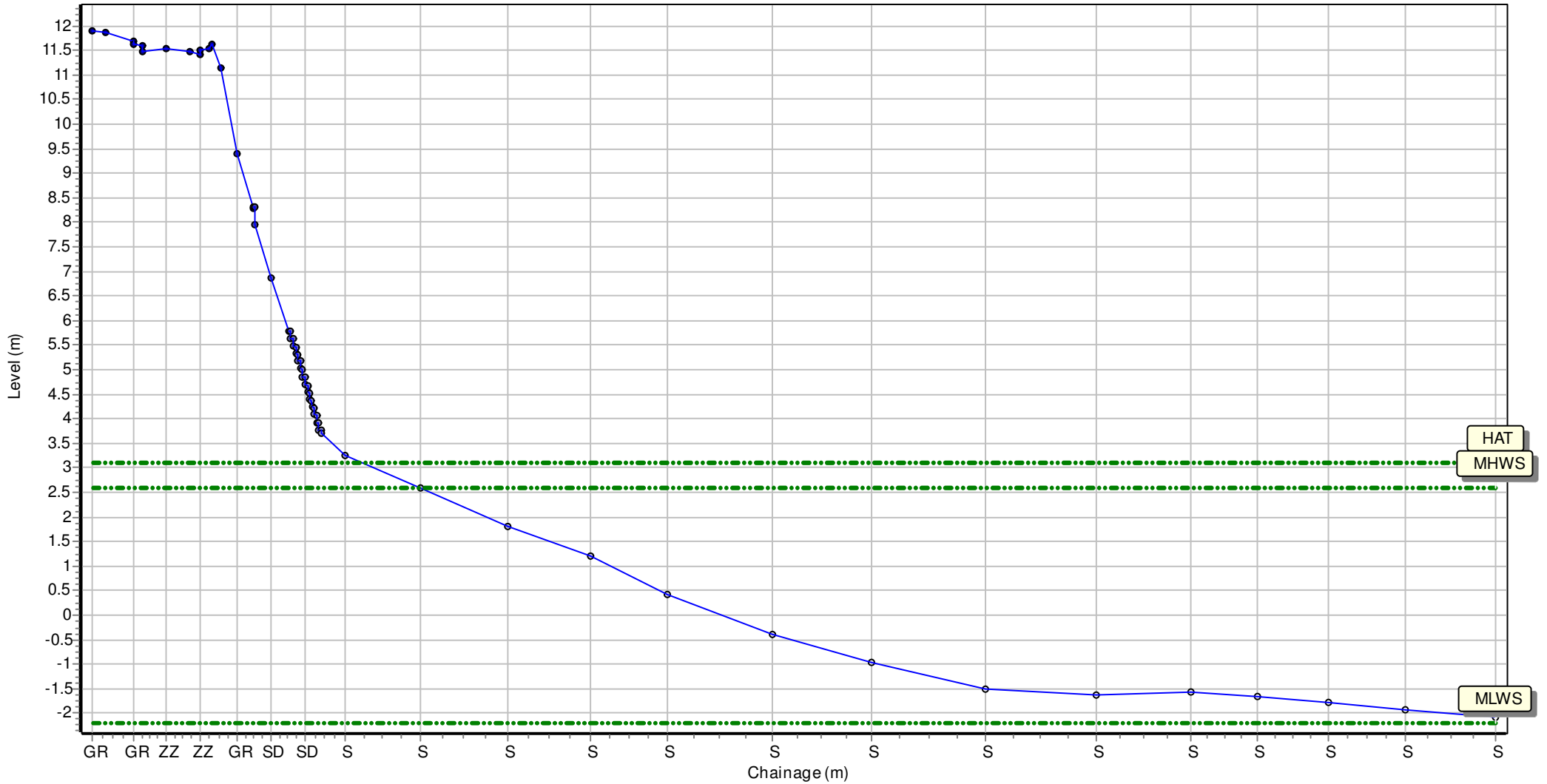
Sea State:

Visibility:

Rain:

Summary: 2021 Partial Measures Topo Survey

Easting: 486535.075 Northing: 512437.797 Profile Bearing: 32 ° from North



Beach Profile

Location: 1dWB2

Date: 30/03/2021 Inspector: AG

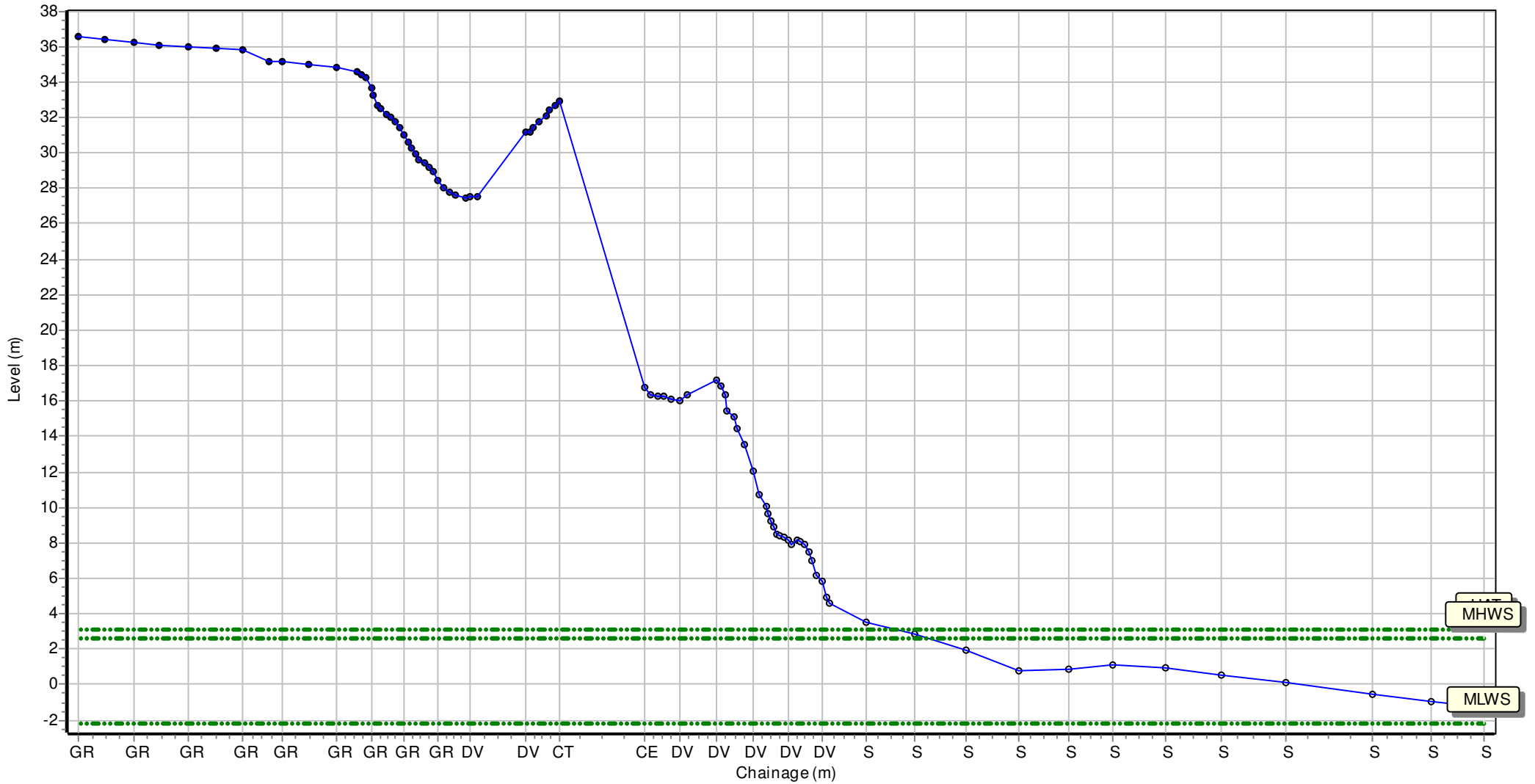
Low Tide: Low Tide Time:

Wind Sea State:

Visibility: Rain:

Summary: 2021 Partial Measures Topo Survey

Easting: 487550.221 Northing: 511927.902 Profile Bearing: 16 ° from North



Beach Profile

Location: 1dWB3

Date: 30/03/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

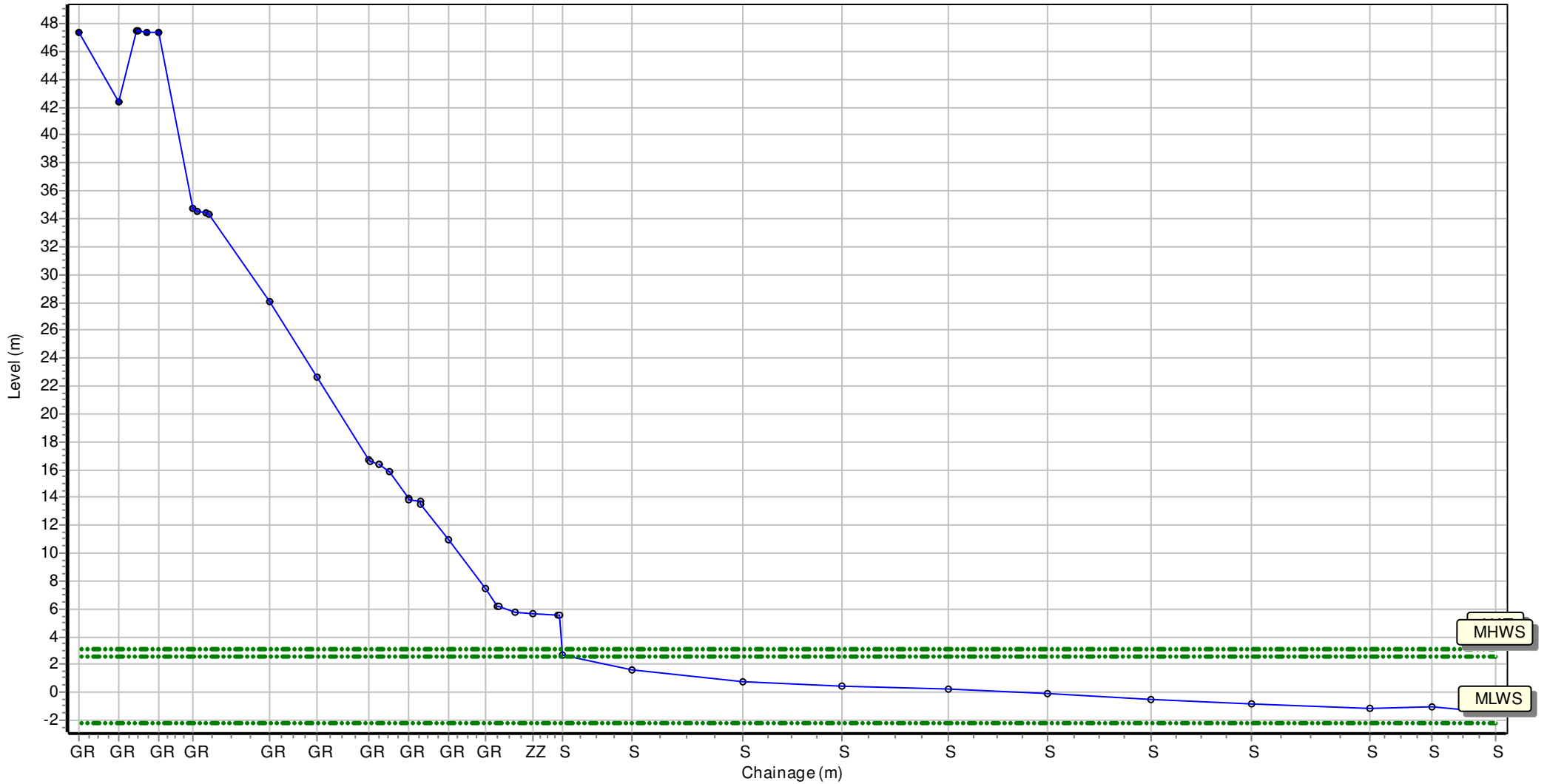
Sea State:

Visibility:

Rain:

Summary: 2021 Partial Measures Topo Survey

Easting: 488983.57 Northing: 511527.047 Profile Bearing: 19 ° from North



Beach Profile

Location: 1dSBN1

Date: 29/03/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

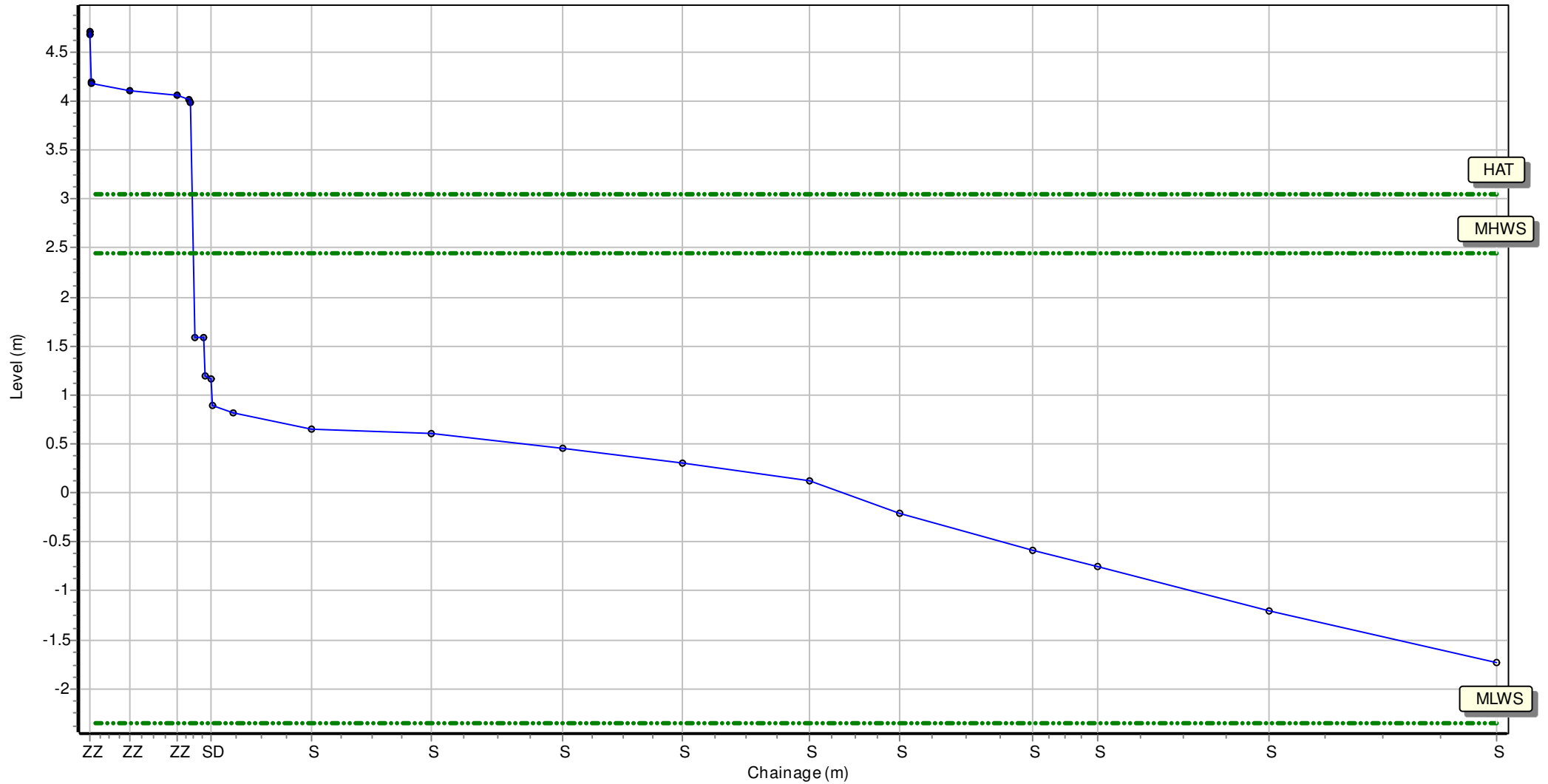
Sea State:

Visibility:

Rain:

Summary: 2021 Partial Measures Topo Survey

Easting: 503543.363 Northing: 490470.74 Profile Bearing: 79 ° from North



Beach Profile

Location: 1dSBN2

Date: 29/03/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

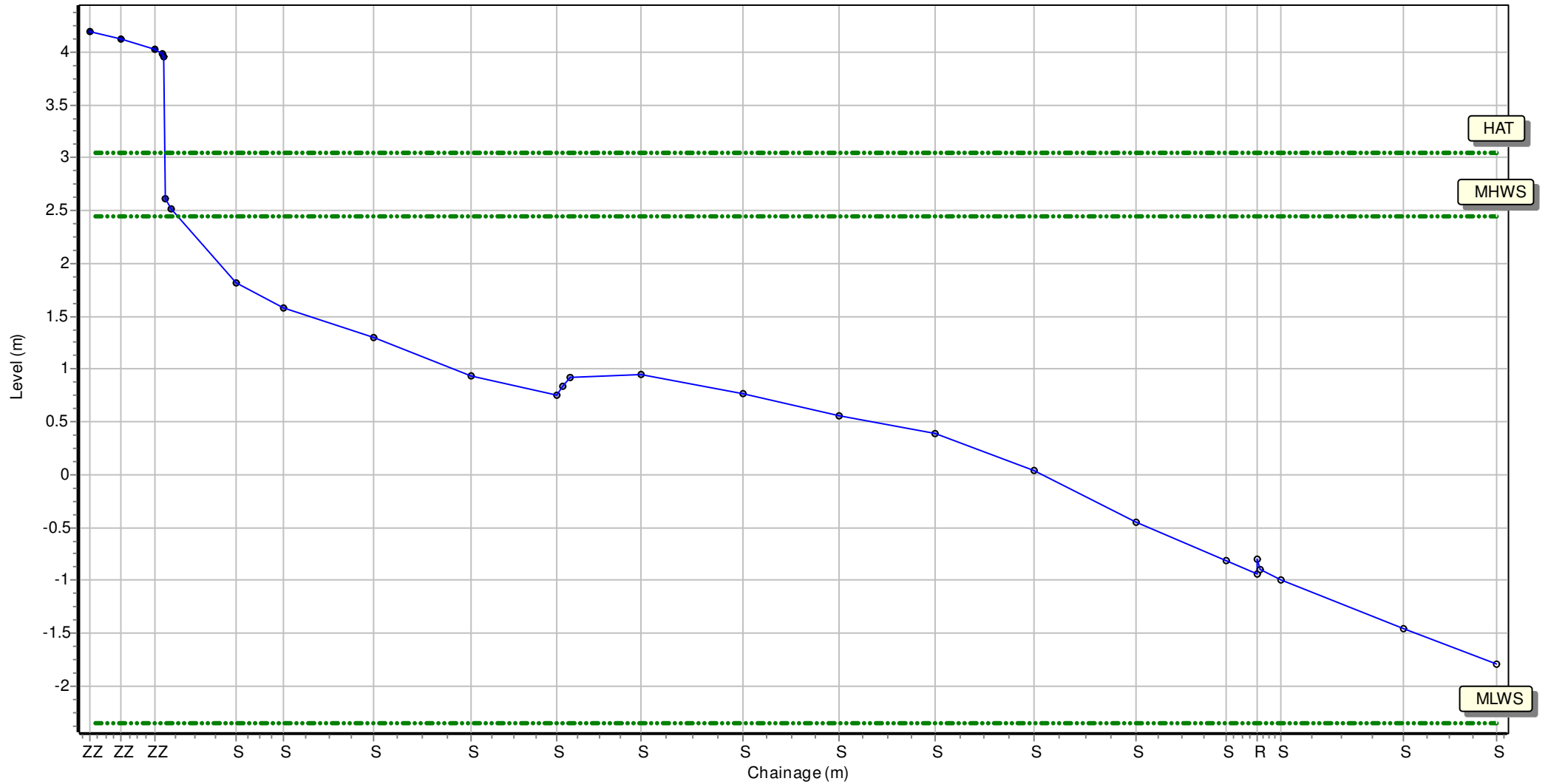
Sea State:

Visibility:

Rain:

Summary: 2021 Partial Measures Topo Survey

Easting: 503616.346 Northing: 490135.674 Profile Bearing: 78 ° from North



Beach Profile

Location: 1dSBN3

Date: 29/03/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

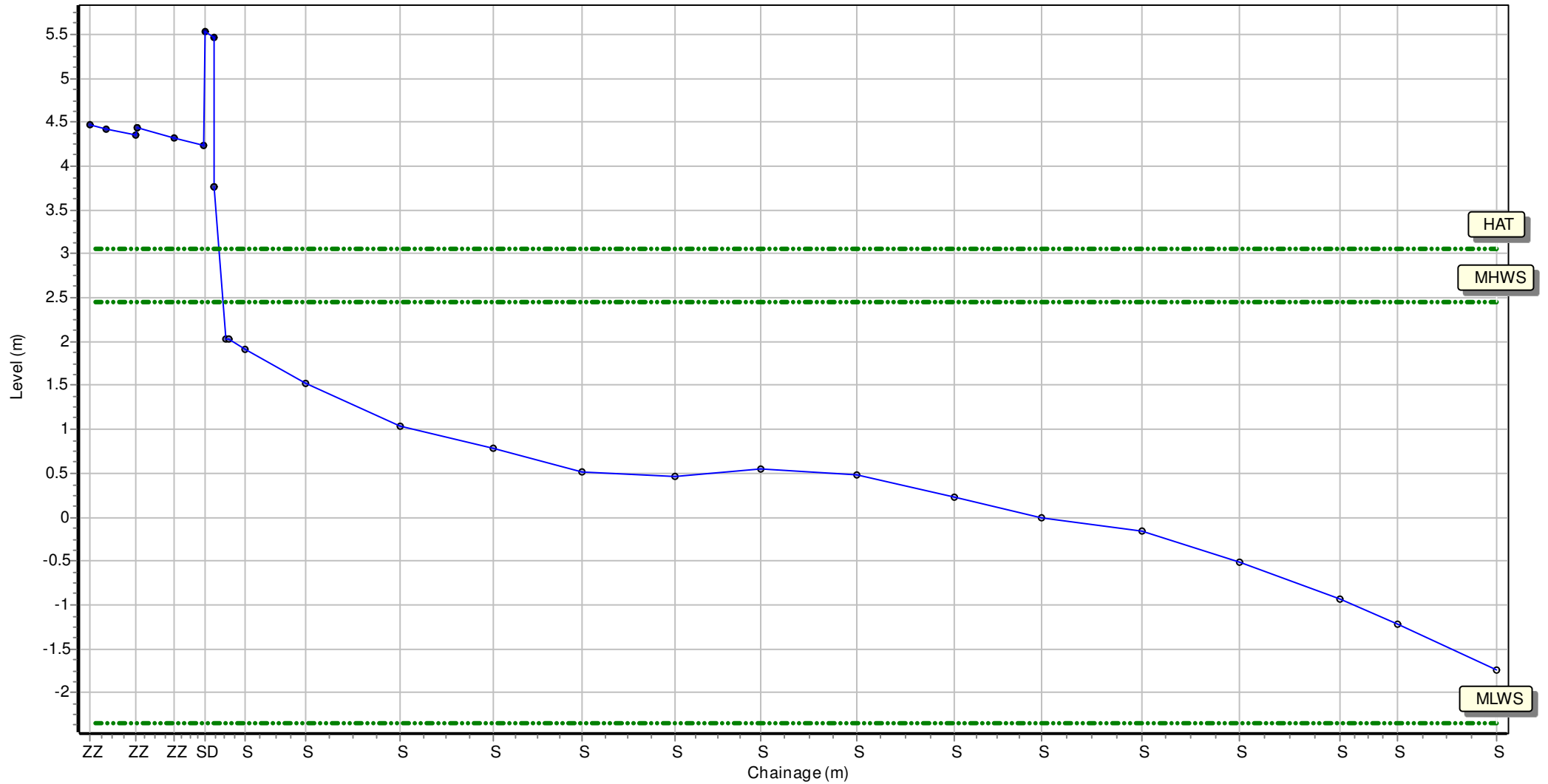
Sea State:

Visibility:

Rain:

Summary: 2021 Partial Measures Topo Survey

Easting: 503803.958 Northing: 489708.315 Profile Bearing: 58 ° from North



Beach Profile

Location: 1dSBN4

Date: 29/03/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

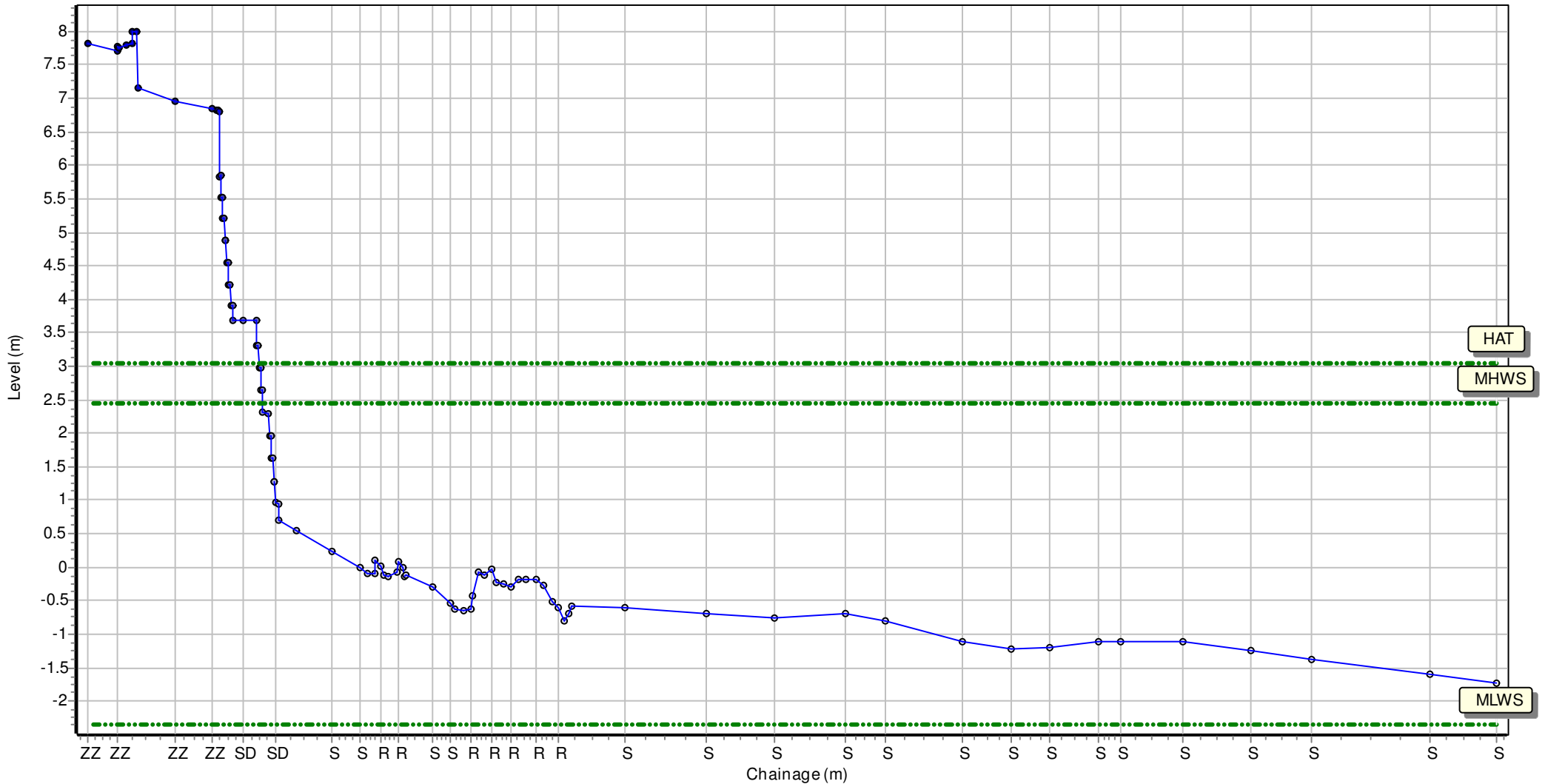
Sea State:

Visibility:

Rain:

Summary: 2021 Partial Measures Topo Survey

Easting: 504111.79 Northing: 489397.699 Profile Bearing: 38 ° from North



Beach Profile

Location: 1dSBN5

Date: 29/03/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

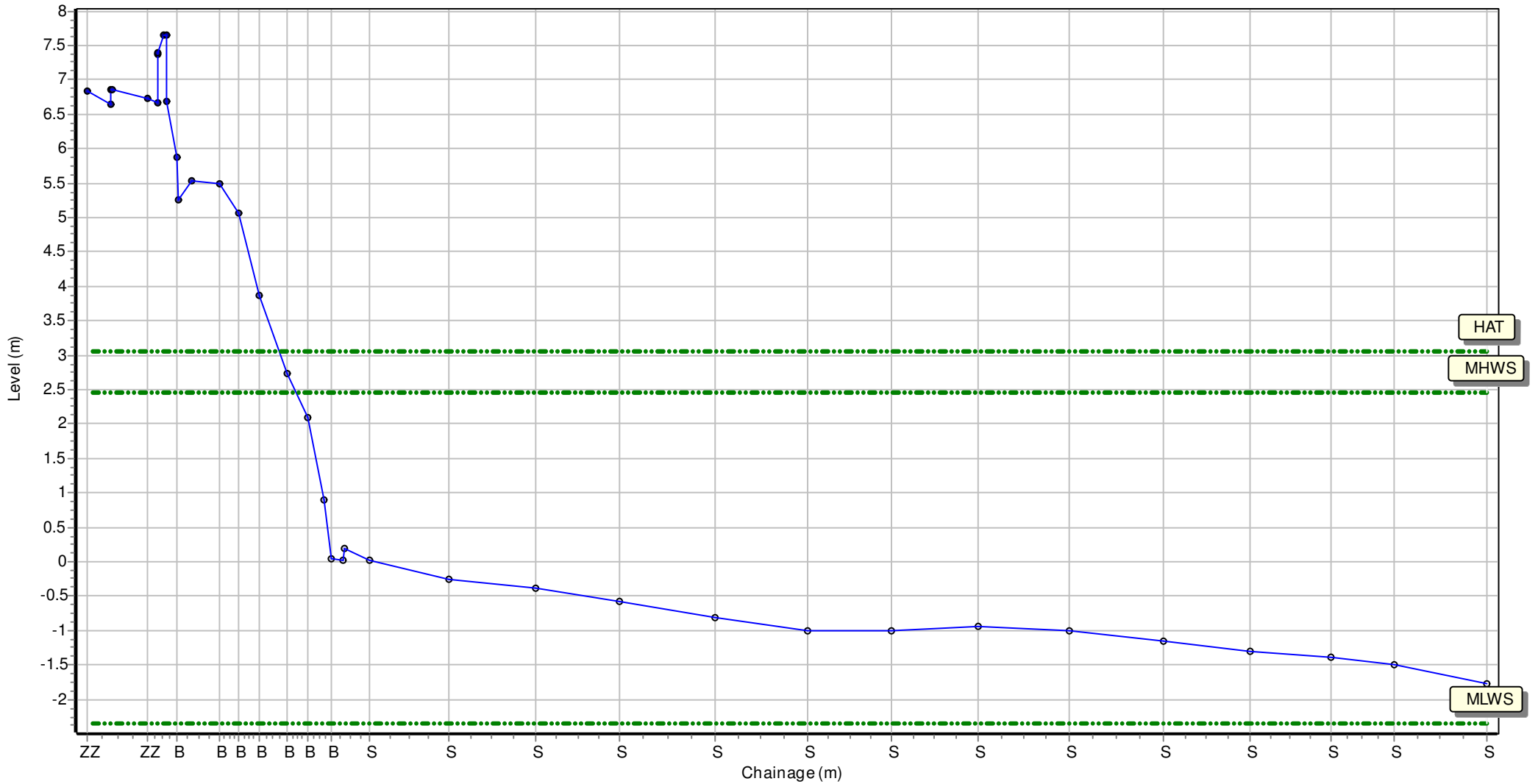
Sea State:

Visibility:

Rain:

Summary: 2021 Partial Measures Topo Survey

Easting: 504515.599 Northing: 489205.724 Profile Bearing: 14 ° from North



Beach Profile

Location: 1dSBS1

Date: 29/03/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

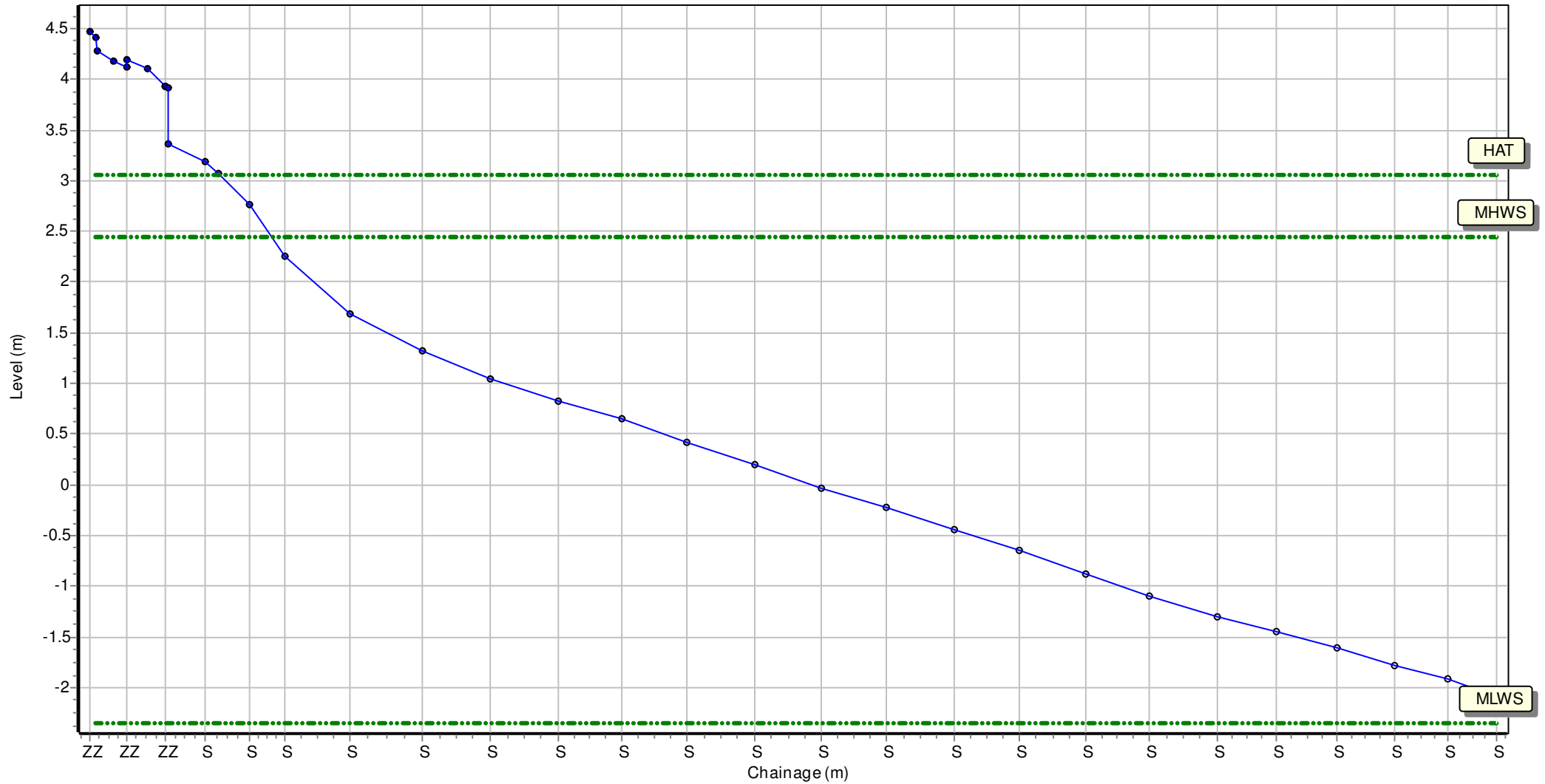
Sea State:

Visibility:

Rain:

Summary: 2021 Partial Measures Topo Survey

Easting: 504544.727 Northing: 488604.814 Profile Bearing: 120 ° from North



Beach Profile

Location: 1dSBS2

Date: 29/03/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

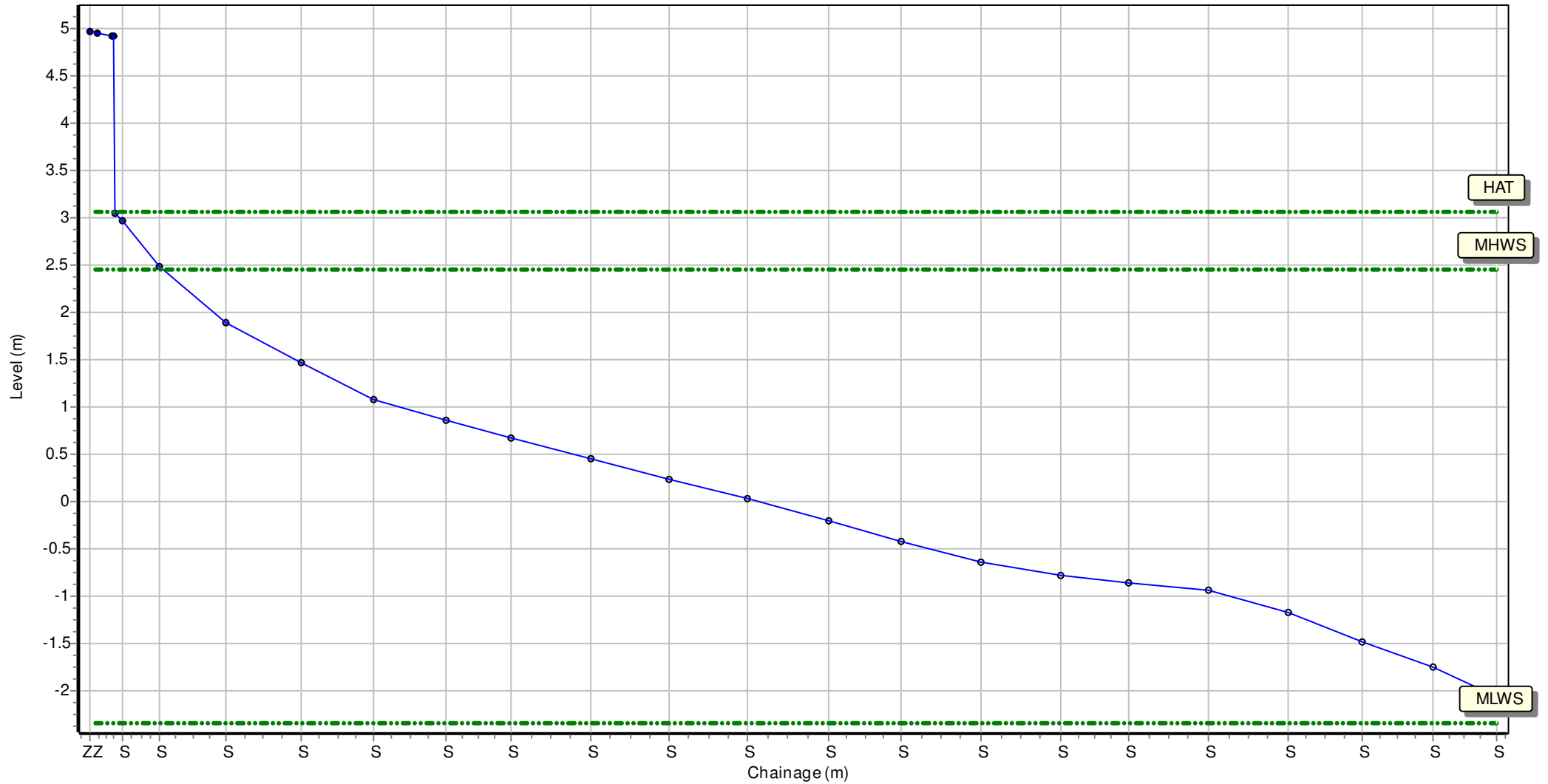
Sea State:

Visibility:

Rain:

Summary: 2021 Partial Measures Topo Survey

Easting: 504443.218 Northing: 488326.371 Profile Bearing: 105 ° from North



Beach Profile

Location: 1dSBS3

Date: 29/03/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

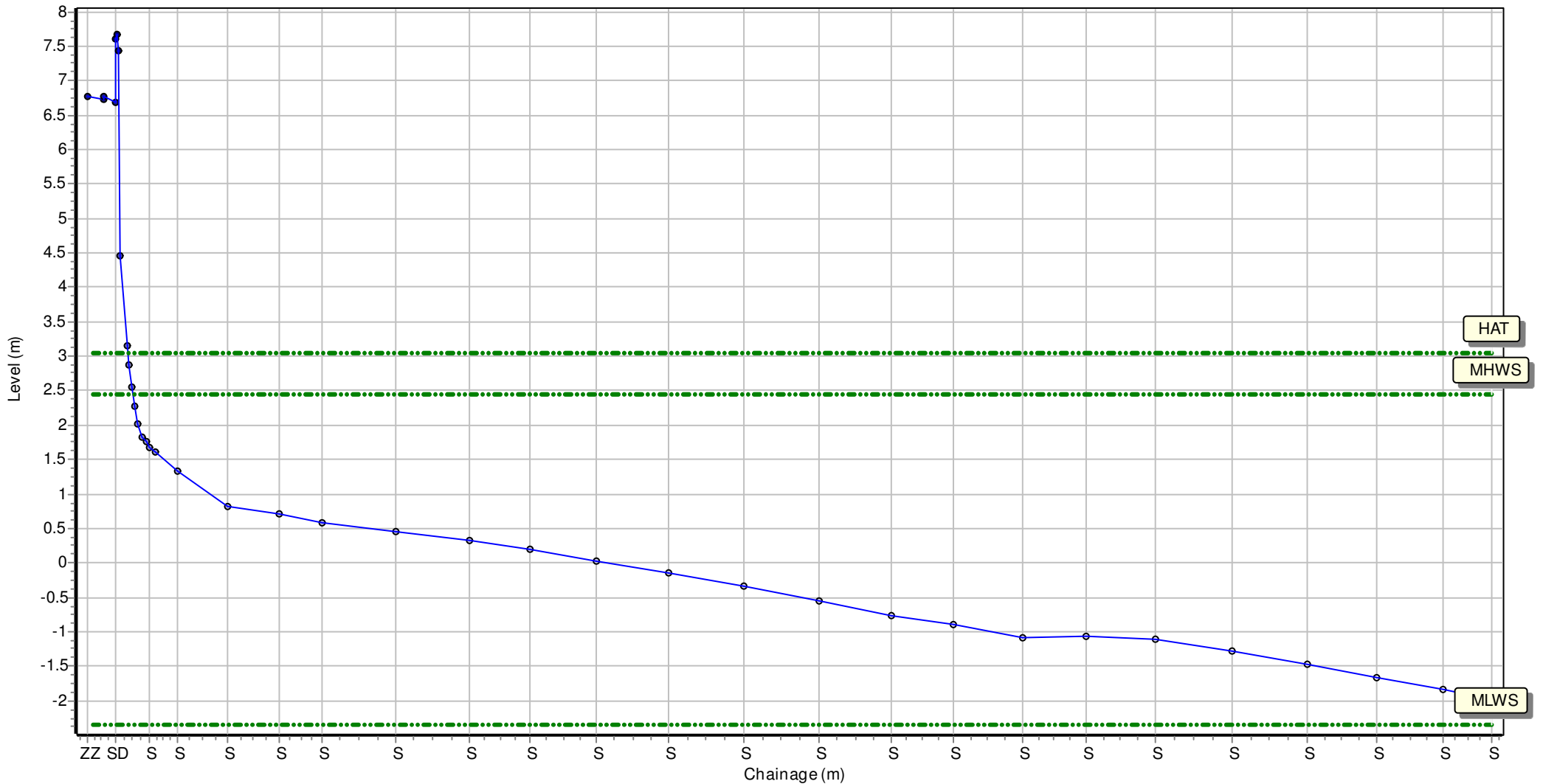
Sea State:

Visibility:

Rain:

Summary: 2021 Partial Measures Topo Survey

Easting: 504423.086 Northing: 488057.66 Profile Bearing: 83 ° from North



Beach Profile

Location: 1dSBS4

Date: 29/03/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

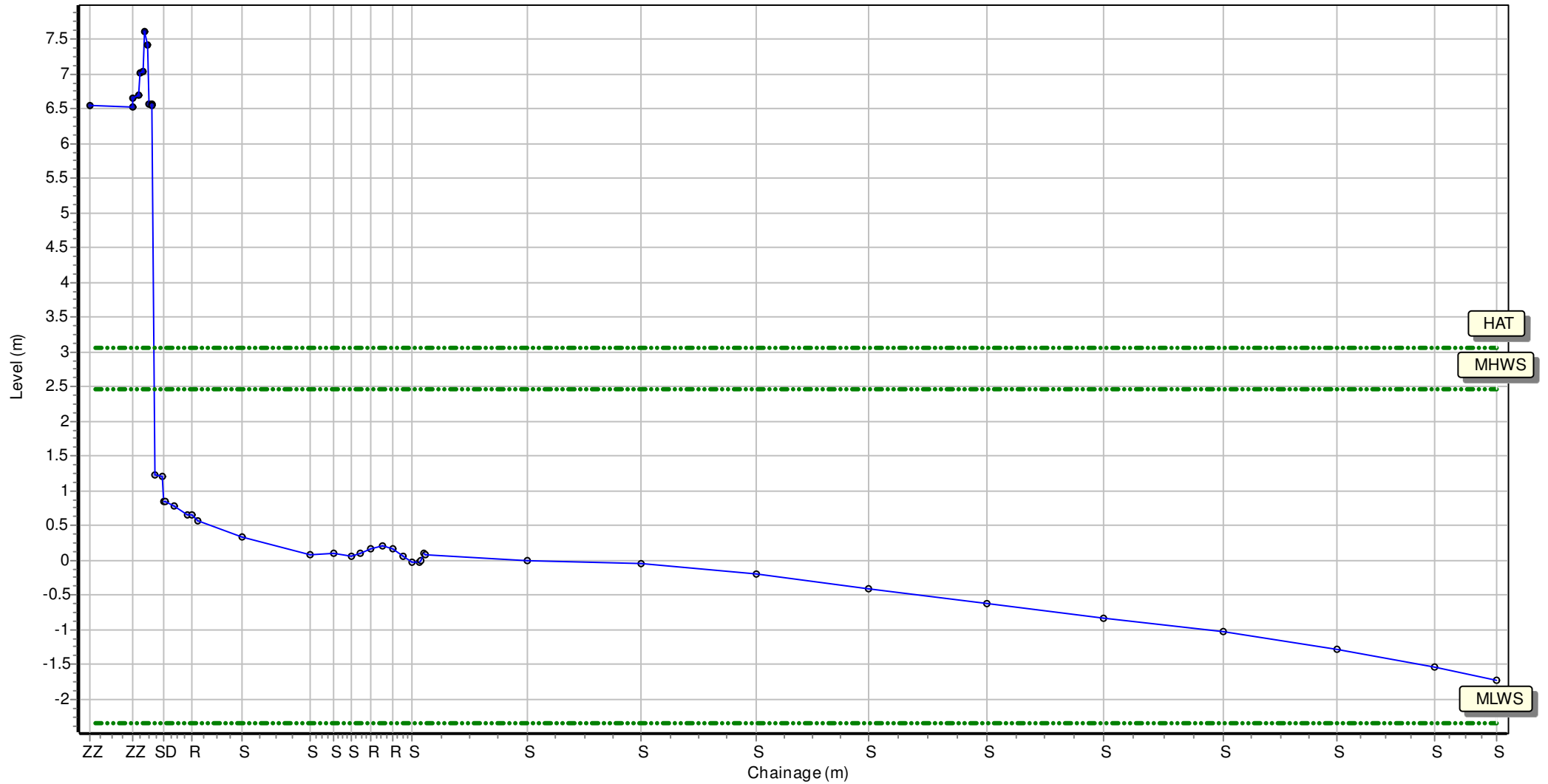
Sea State:

Visibility:

Rain:

Summary: 2021 Partial Measures Topo Survey

Easting: 504494.785 Northing: 487816.983 Profile Bearing: 74 ° from North



Beach Profile

Location: 1dCY1A

Date: 30/03/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

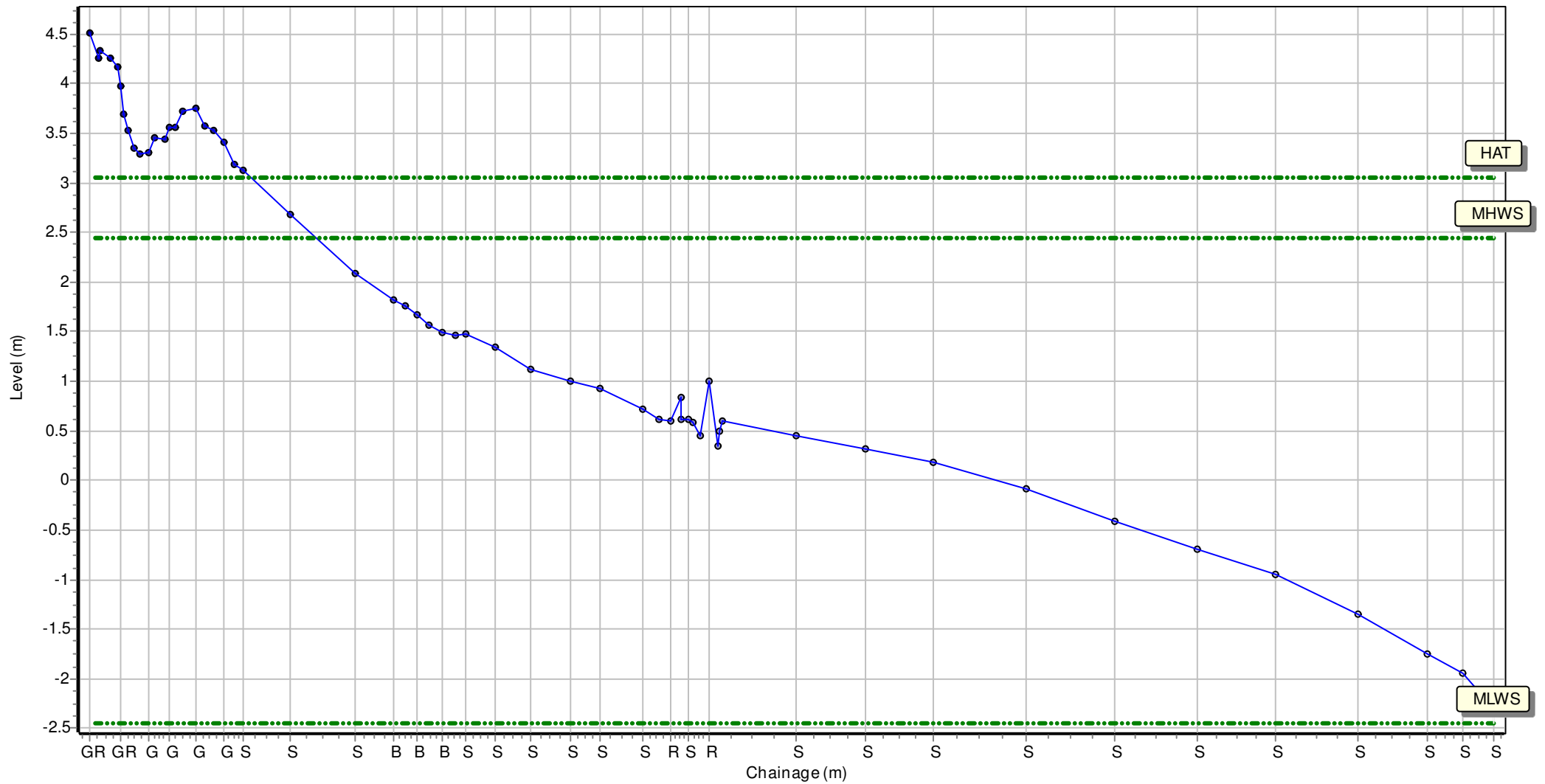
Sea State:

Visibility:

Rain:

Summary: 2021 Partial Measures Topo Survey

Easting: 506298.519 Northing: 485175.932 Profile Bearing: 107 ° from North



Beach Profile

Location: 1dCY1

Date: 30/03/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

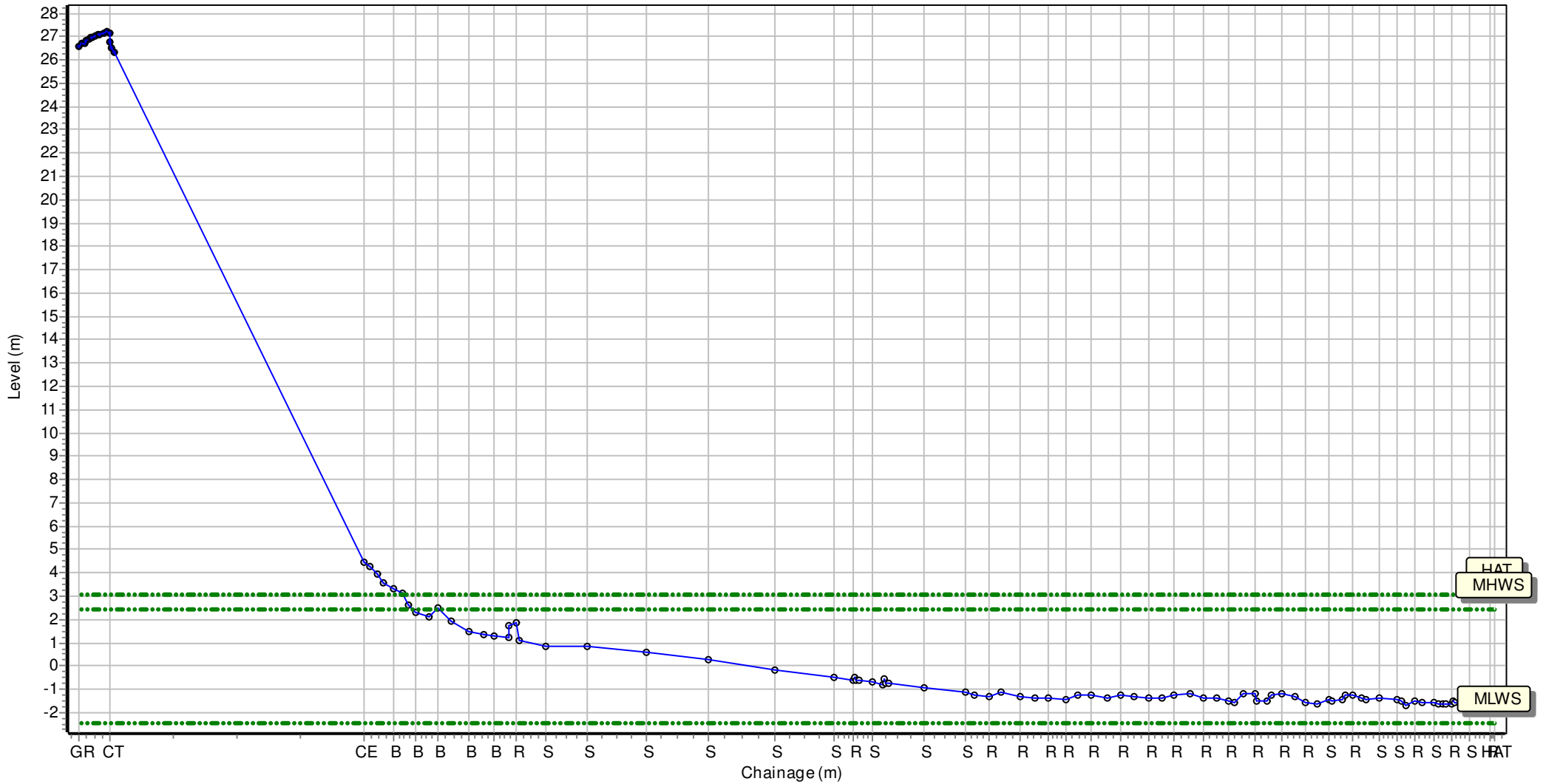
Sea State:

Visibility:

Rain:

Summary: 2021 Partial Measures Topo Survey

Easting: 506420.411 Northing: 484793.941 Profile Bearing: 43 ° from North



Beach Profile

Location: 1dCY2

Date: 30/03/2021 Inspector: AG

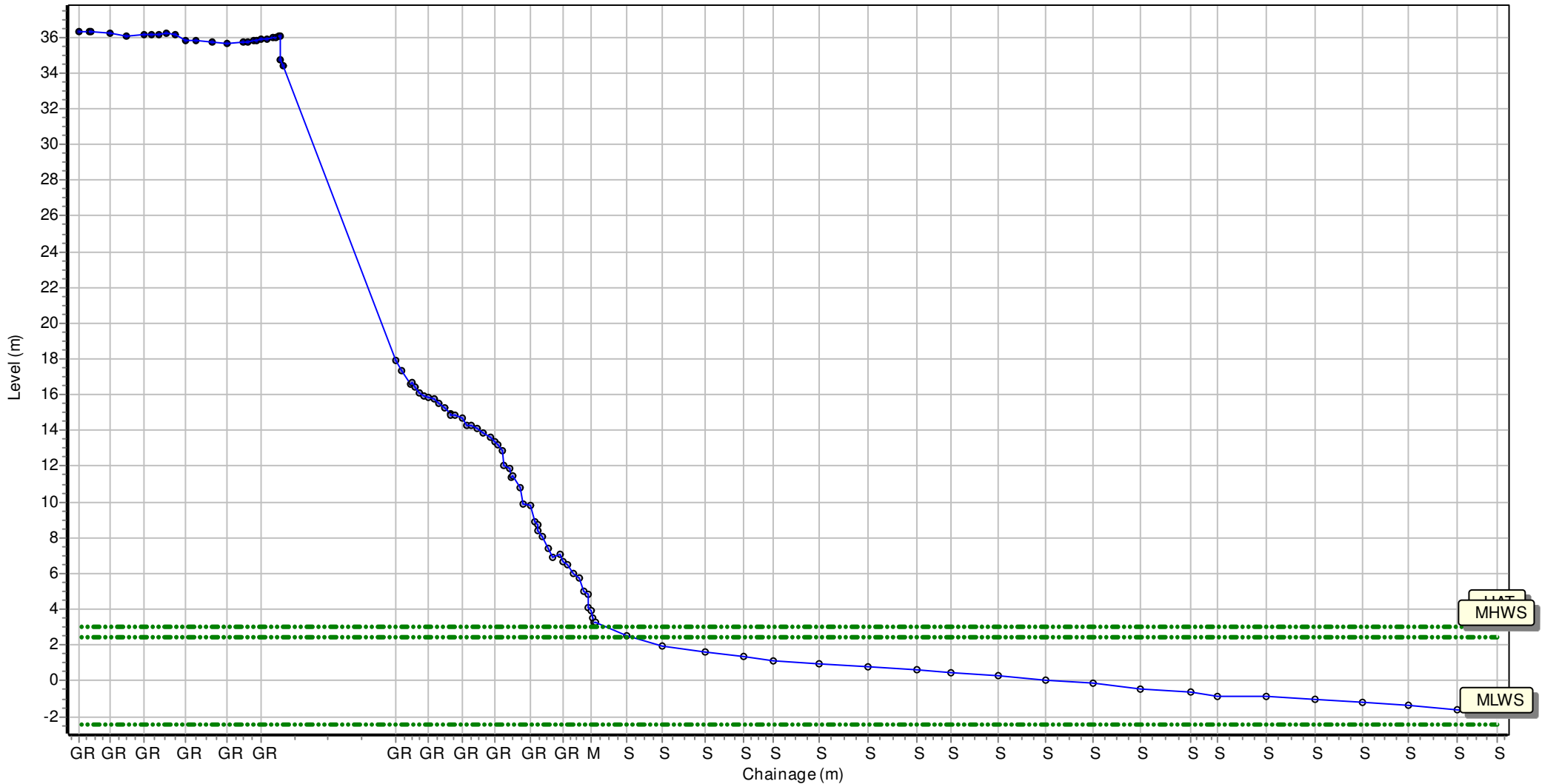
Low Tide: Low Tide Time:

Wind Sea State:

Visibility: Rain:

Summary: 2021 Partial Measures Topo Survey

Easting: 506712.583 Northing: 484325.966 Profile Bearing: 38 ° from North



Beach Profile

Location: 1dCY3

Date: 30/03/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

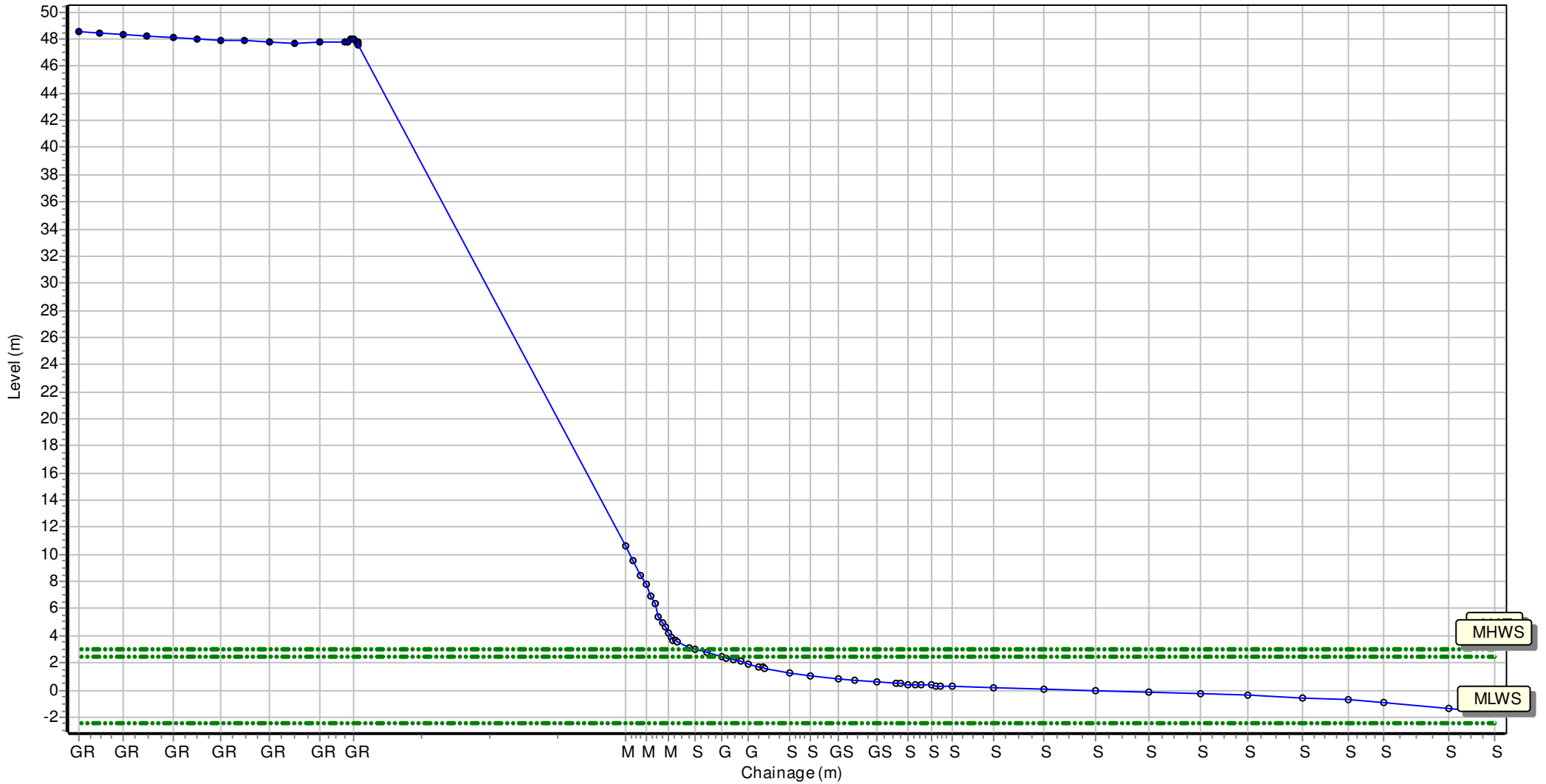
Sea State:

Visibility:

Rain:

Summary: 2021 Partial Measures Topo Survey

Easting: 507242.203 Northing: 484080.896 Profile Bearing: 42 ° from North



Beach Profile

Location: 1dFB1

Date: 01/04/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

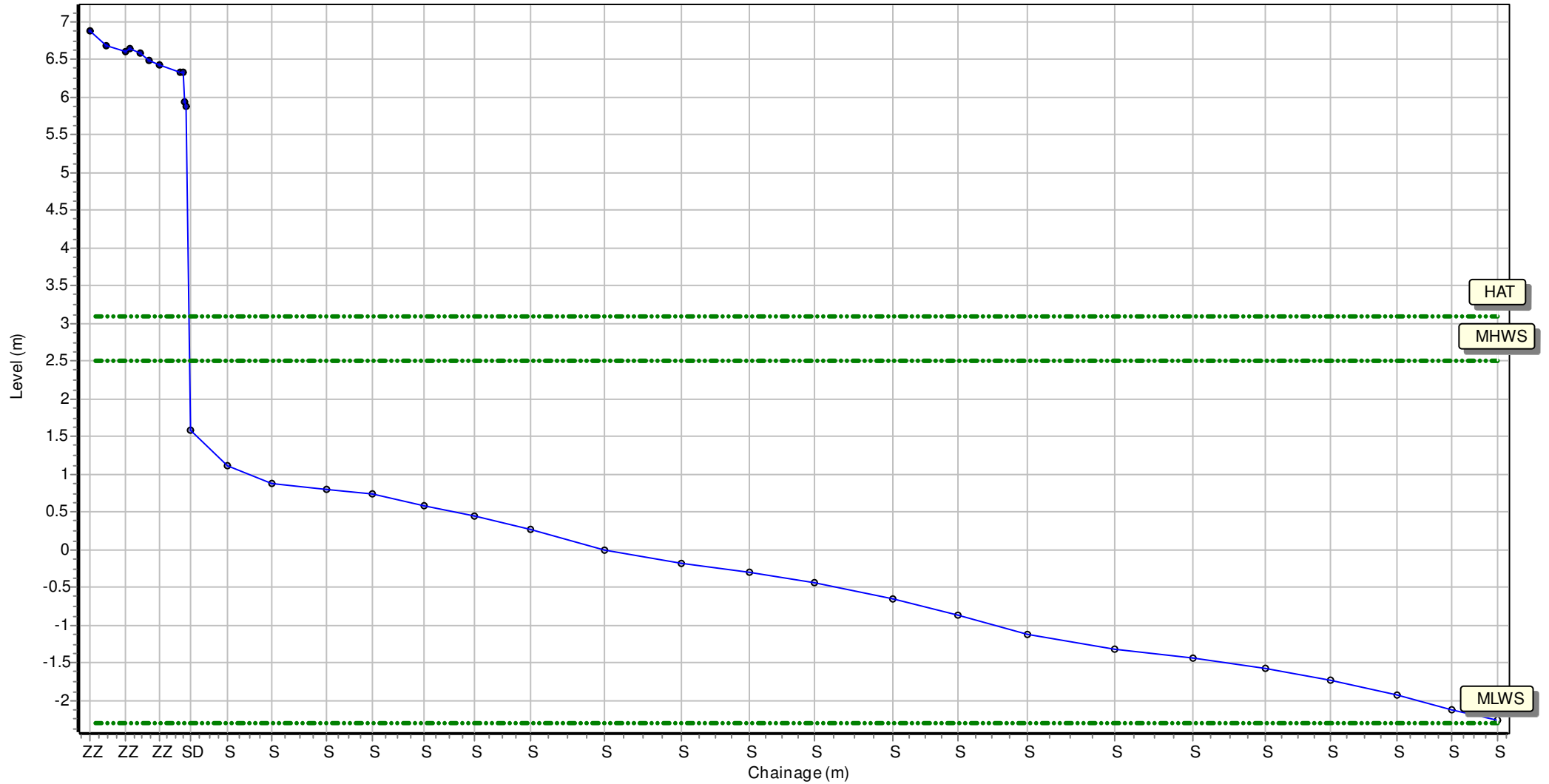
Sea State:

Visibility:

Rain:

Summary: 2021 Partial Measures Topo Survey

Easting: 511989.528 Northing: 480590.964 Profile Bearing: 100 ° from North



Beach Profile

Location: 1dFB2

Date: 01/04/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

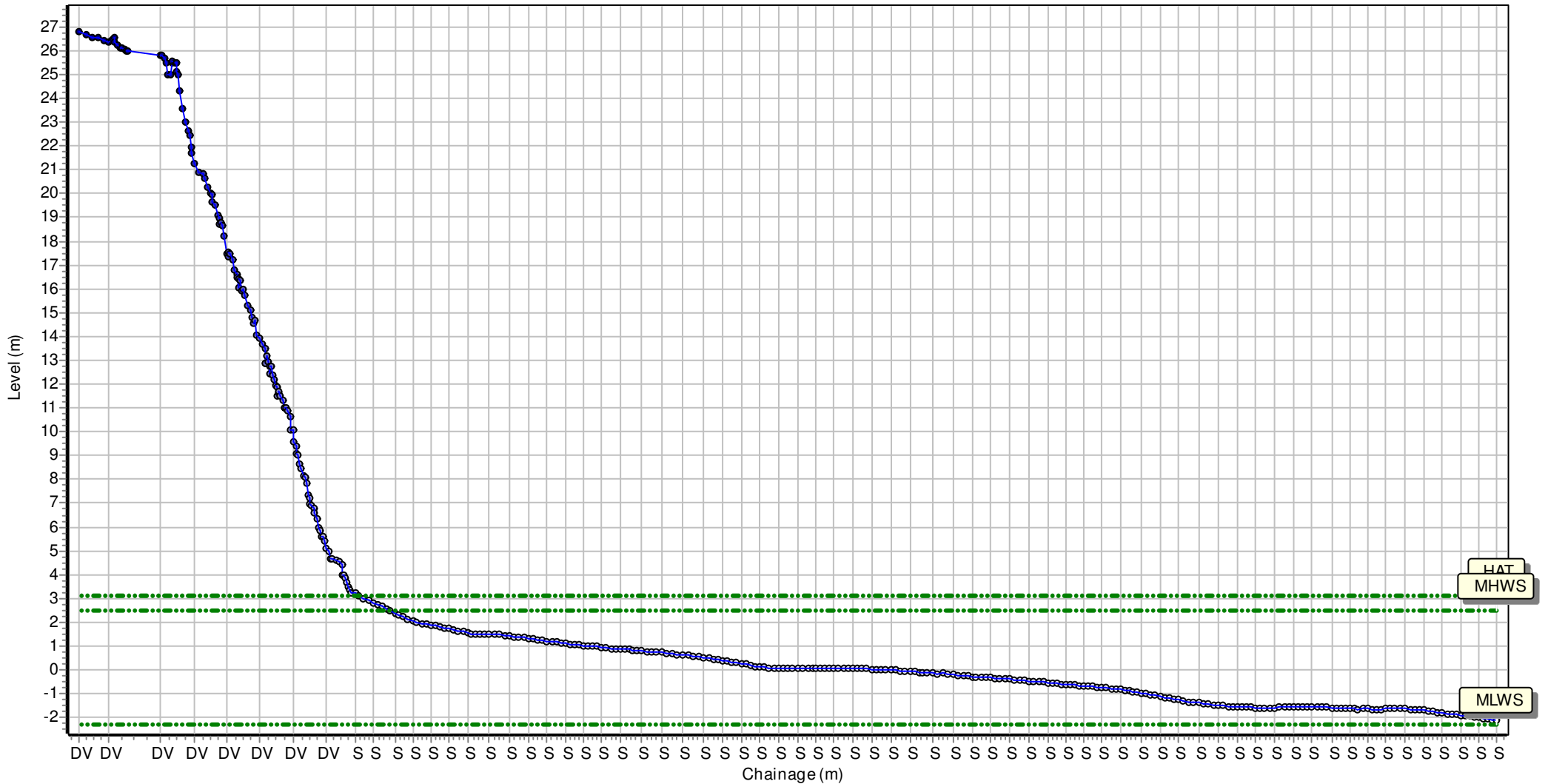
Sea State:

Visibility:

Rain:

Summary: 2021 Partial Measures Topo Survey

Easting: 512005.564 Northing: 479181.575 Profile Bearing: 77 ° from North



Beach Profile

Location: 1dFB4

Date: 01/04/2021

Inspector: AG

Low Tide:

Low Tide Time:

Wind

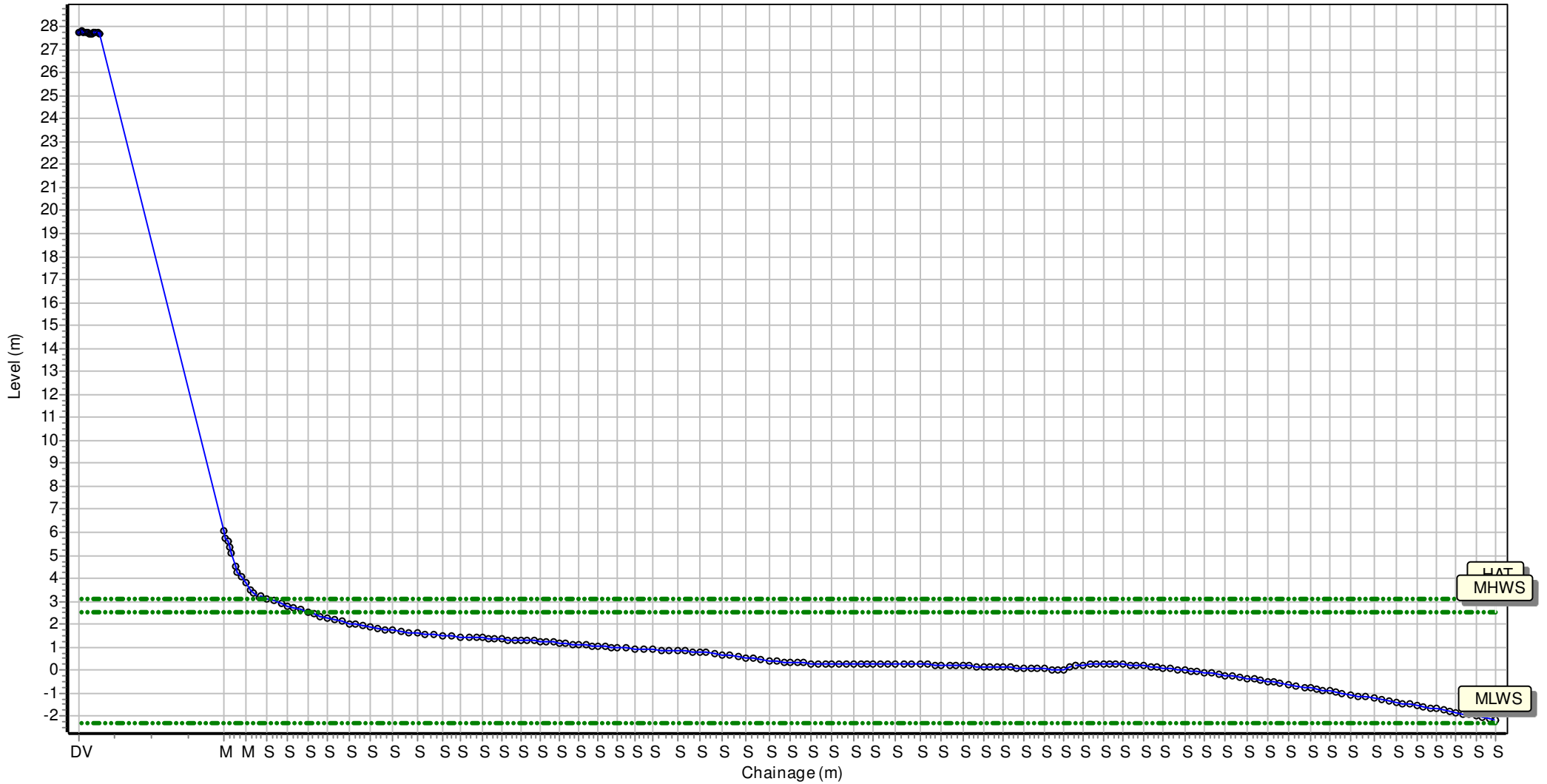
Sea State:

Visibility:

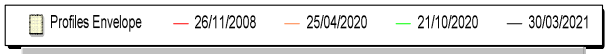
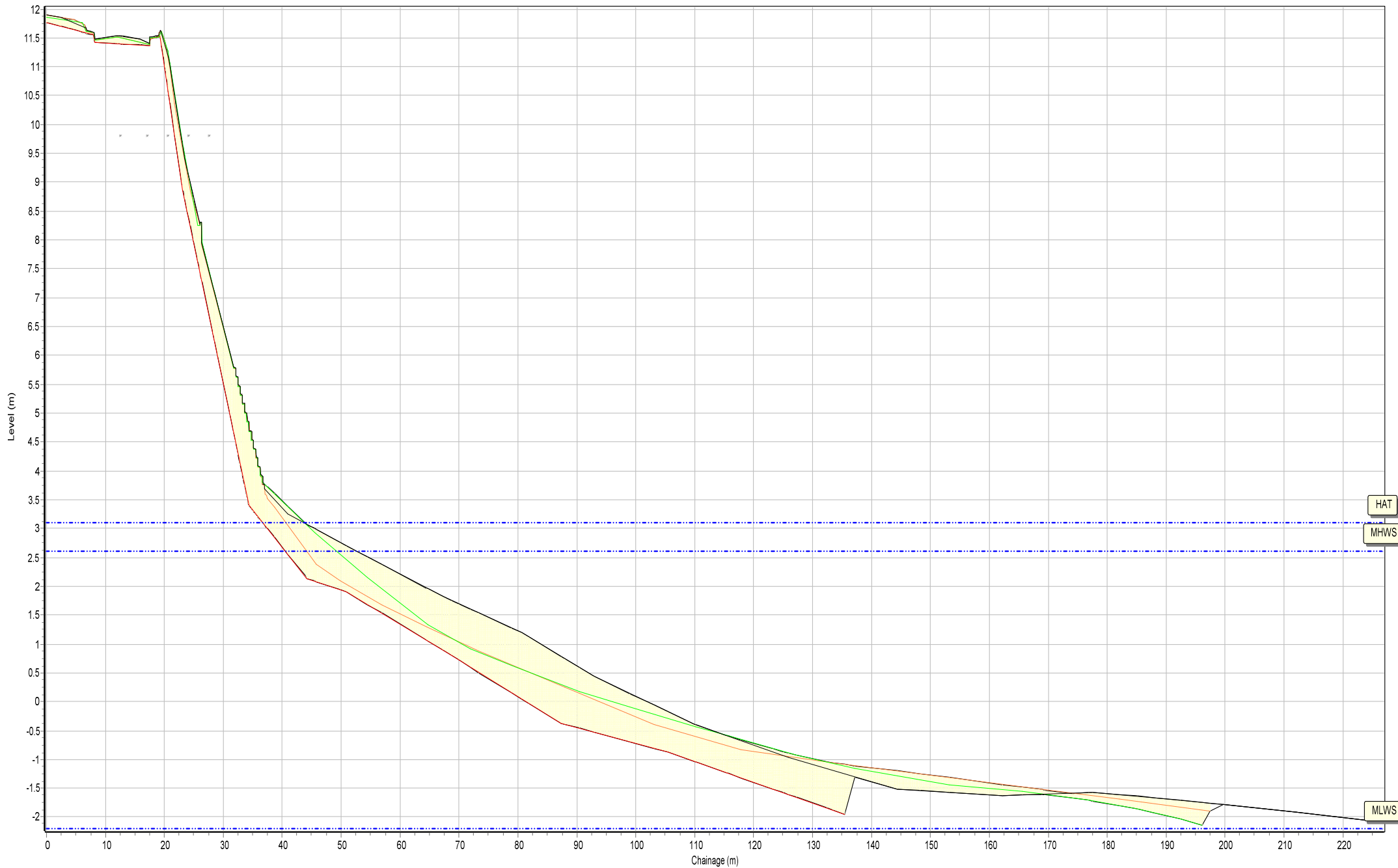
Rain:

Summary: 2021 Partial Measures Topo Survey

Easting: 513165.53 Northing: 477182.418 Profile Bearing: 51 ° from North



Beach Profiles: 1dWB1



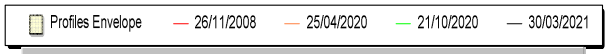
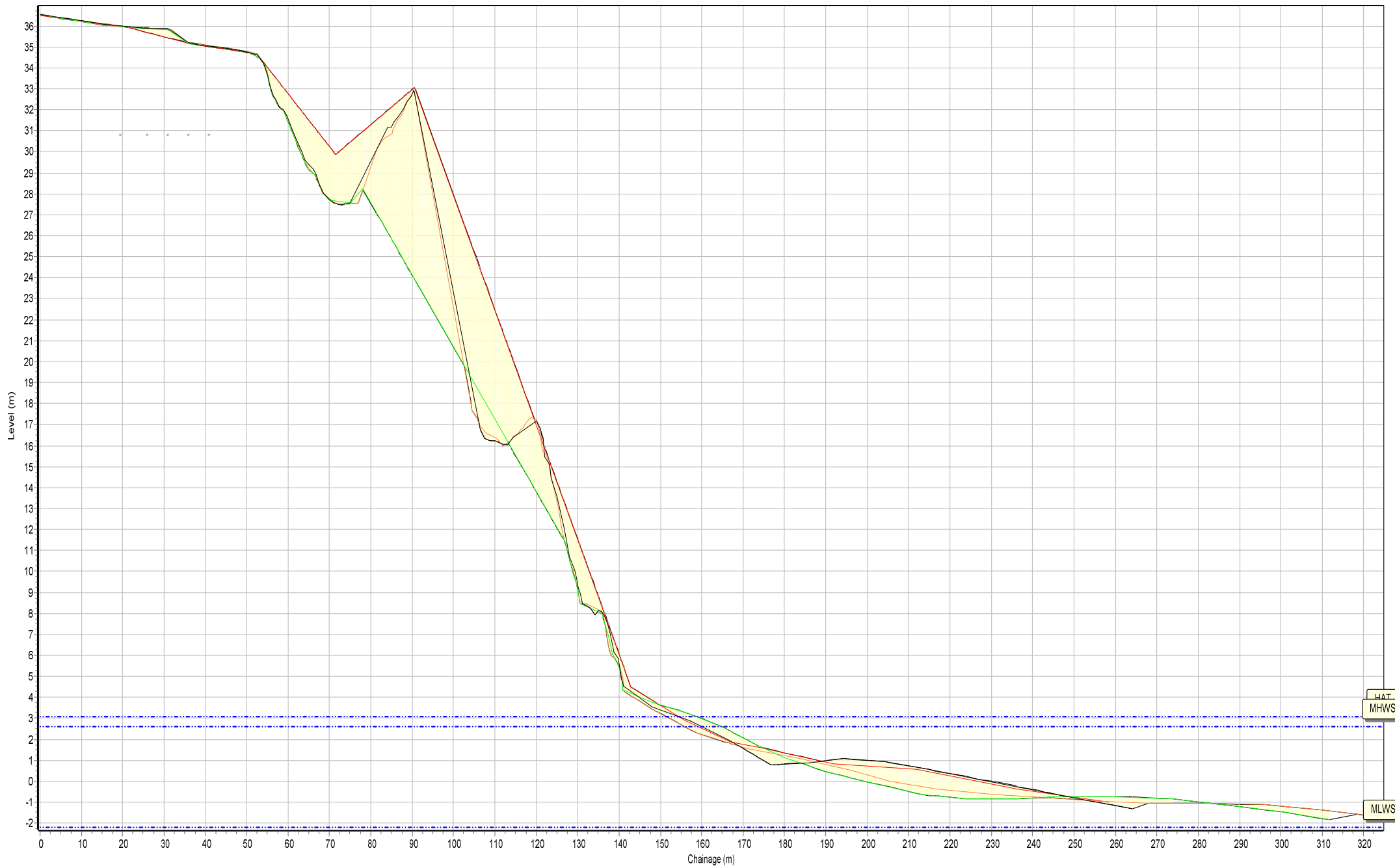
HAT

MHWS

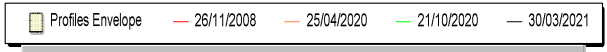
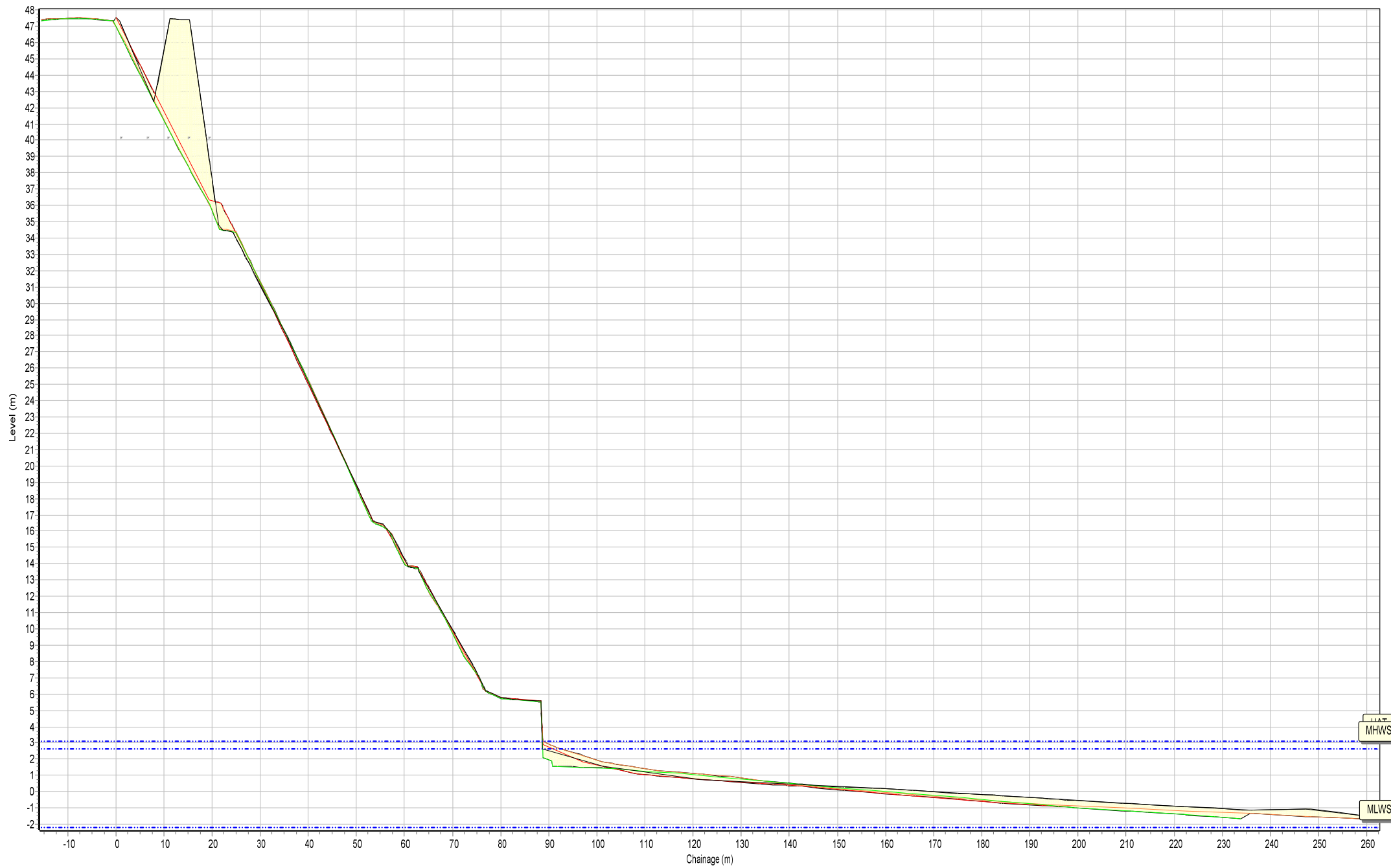
MLWS

SANDS

Beach Profiles: 1dWB2



Beach Profiles: 1dWB3

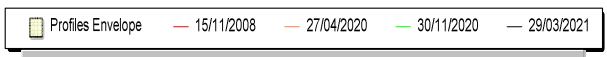
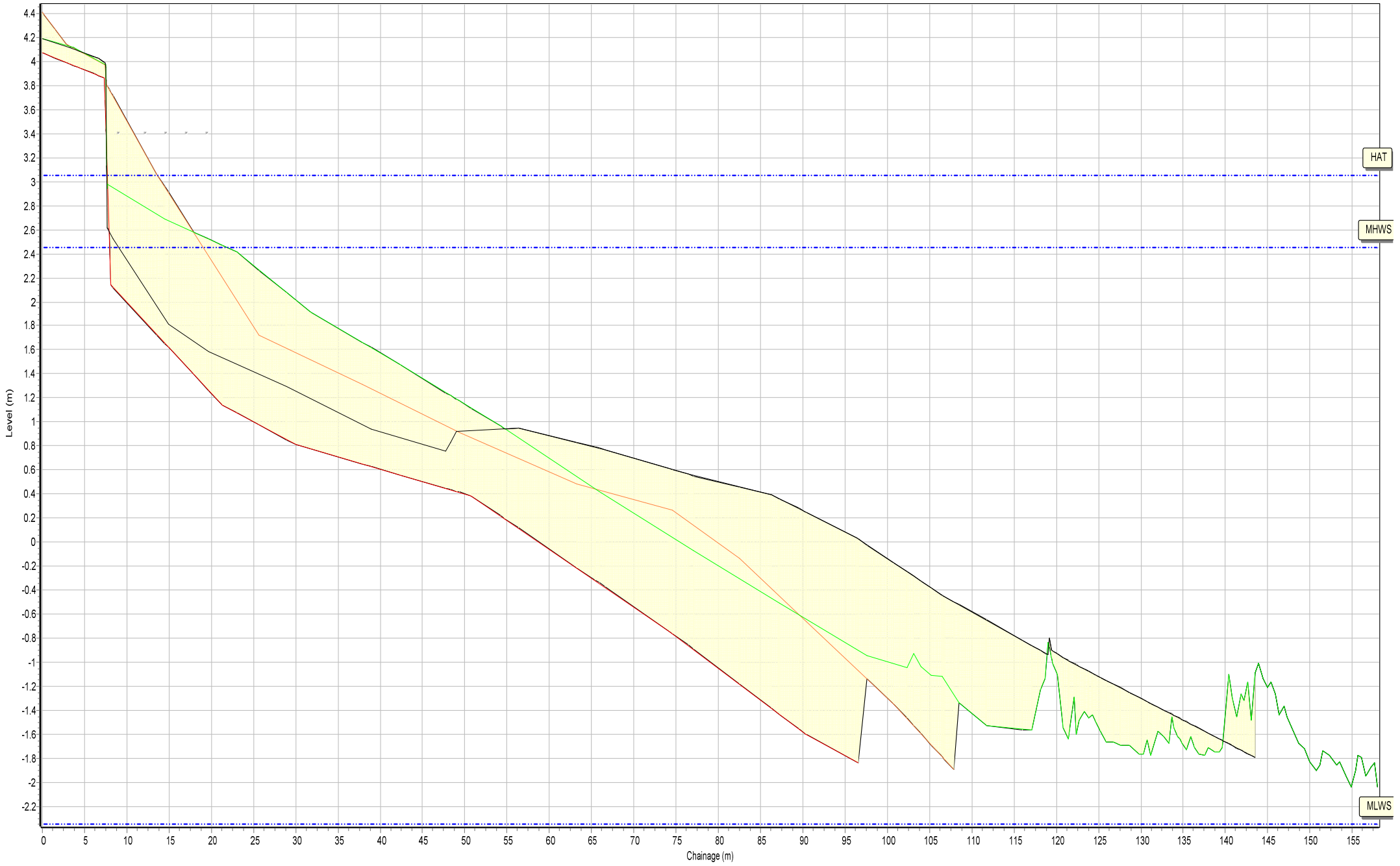


Beach Profiles: 1dSBN1

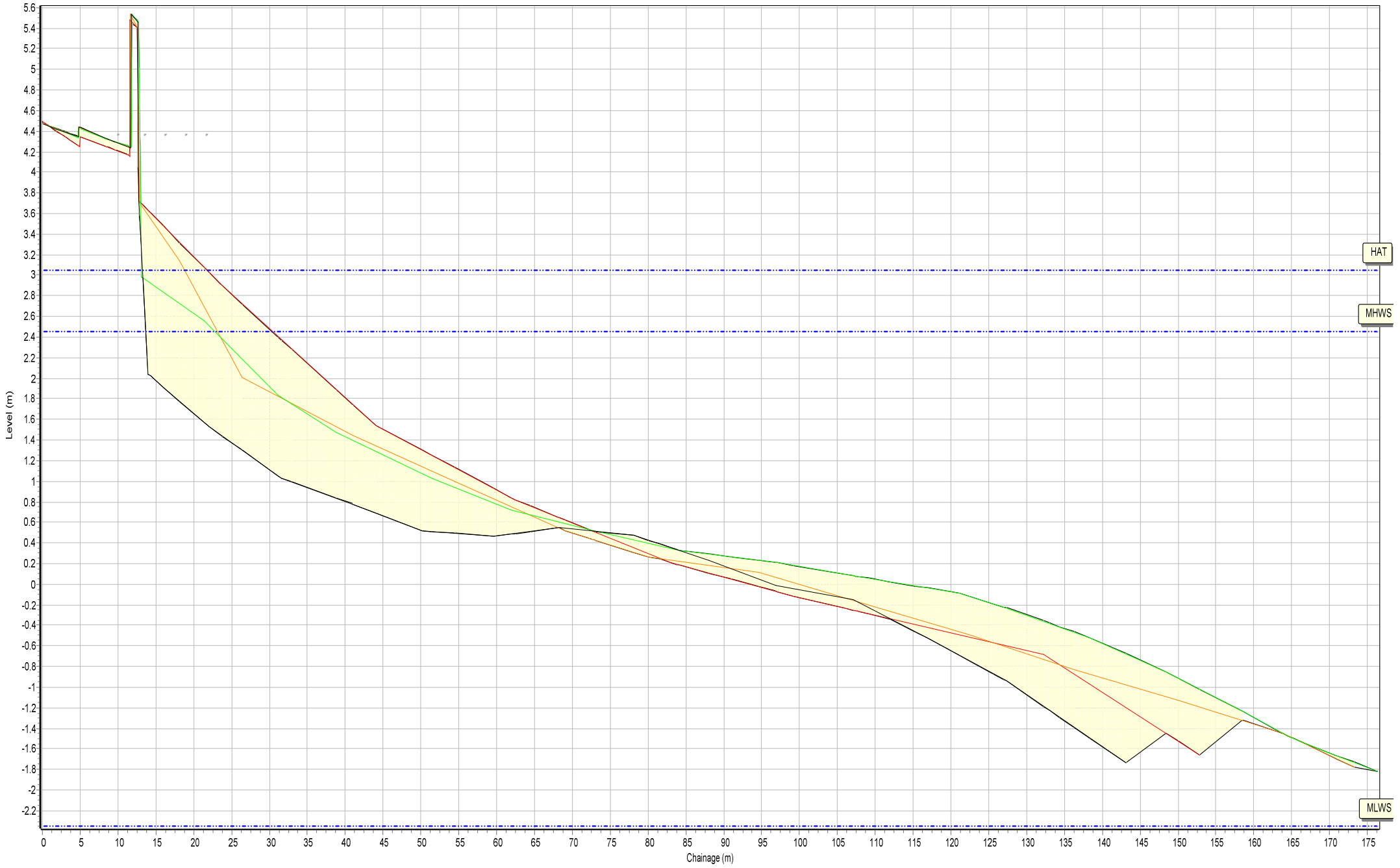


Profiles Envelope 15/11/2008 27/04/2020 30/11/2020 29/03/2021

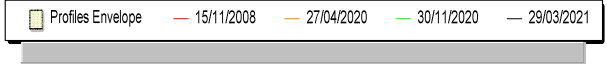
Beach Profiles: 1dSBN2



Beach Profiles: 1dSBN3



Beach Profiles: 1dSBN4



Beach Profiles: 1dSBN5



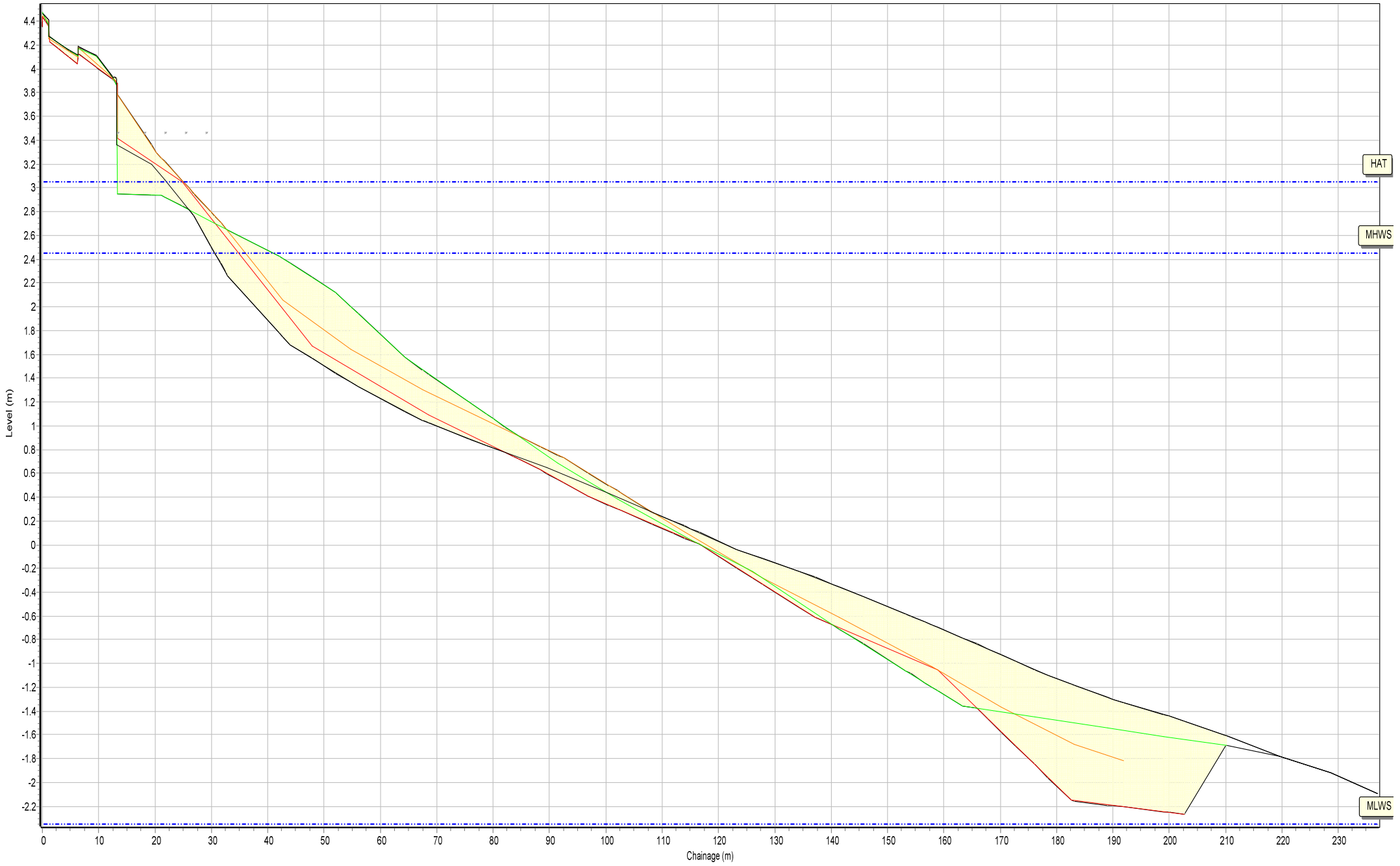
HAT

MHWS

MLWS

SANDS

Beach Profiles: 1dSBS1



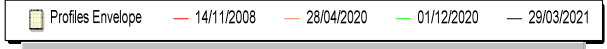
HAT

MHWS

MLWS

SANDS

Beach Profiles: 1dSBS2



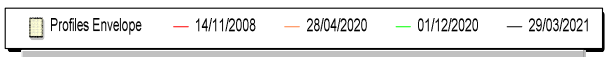
HAT

MLWS

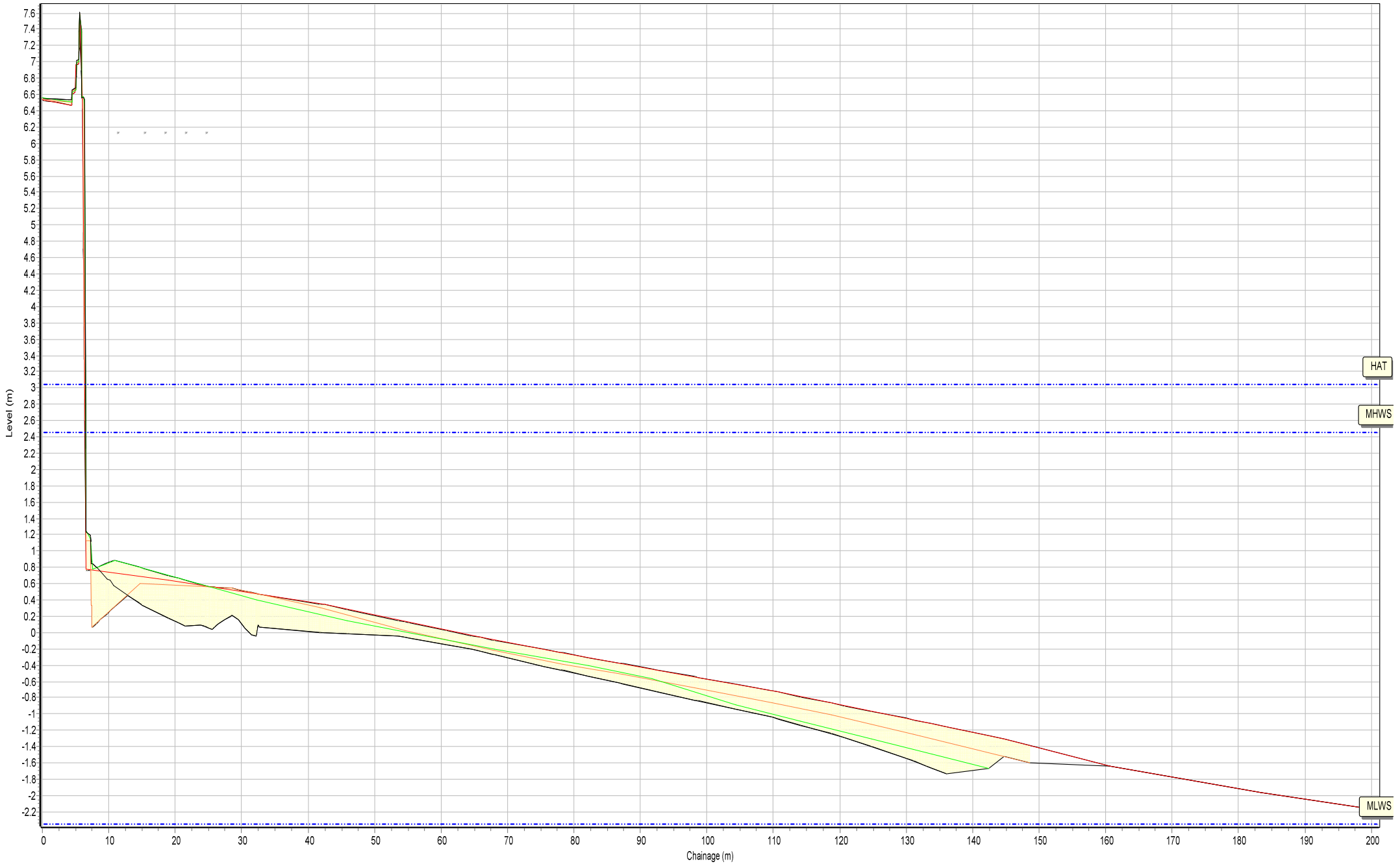
MLWS

SANDS

Beach Profiles: 1dSBS3



Beach Profiles: 1dSBS4



Profiles Envelope 14/11/2008 28/04/2020 01/12/2020 29/03/2021

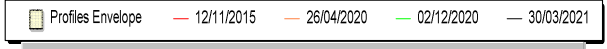
HAT

MHWS

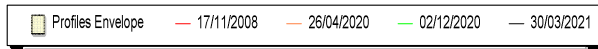
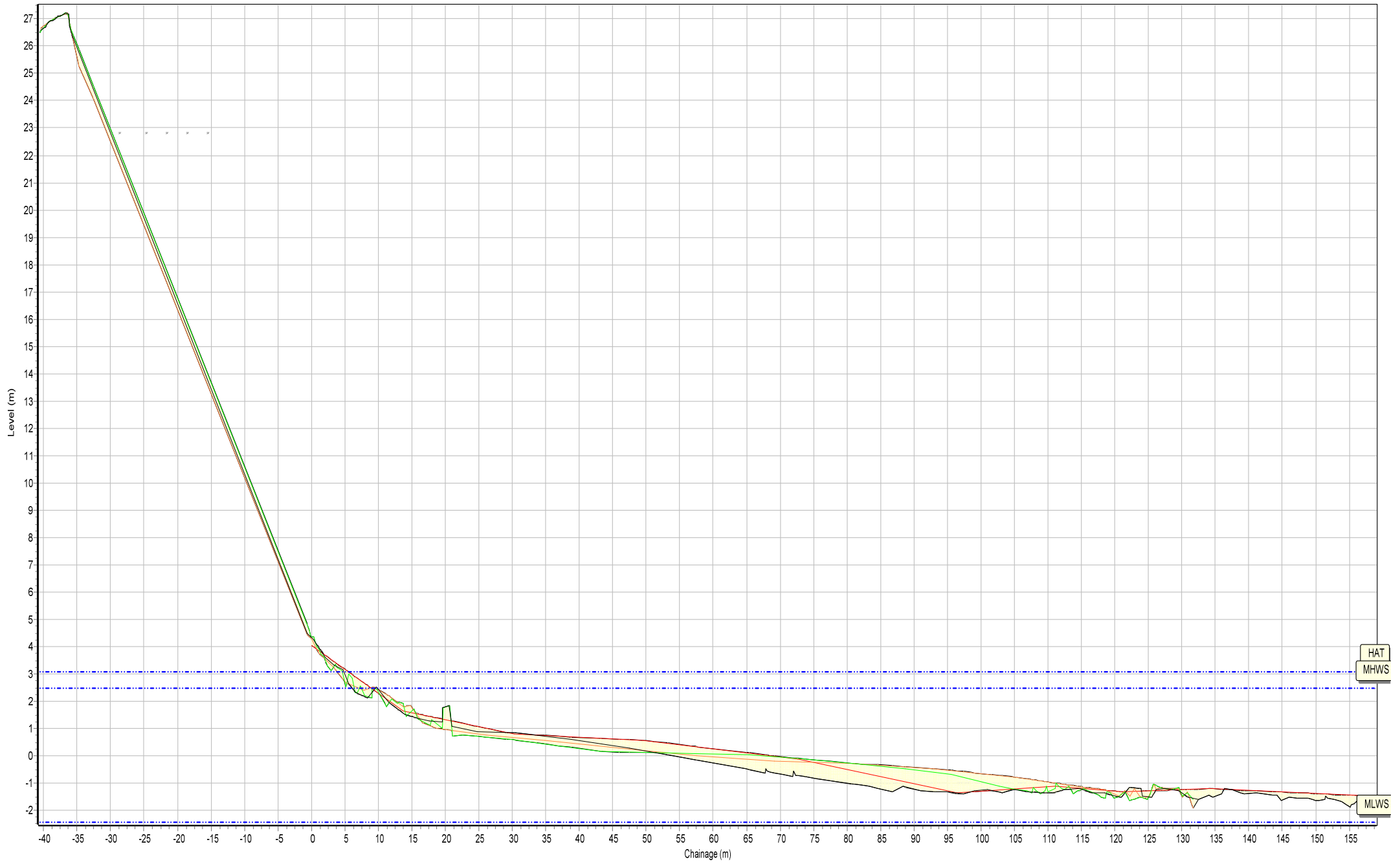
MLWS

SANDS

Beach Profiles: 1dCY1A



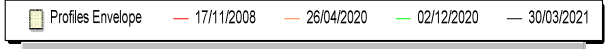
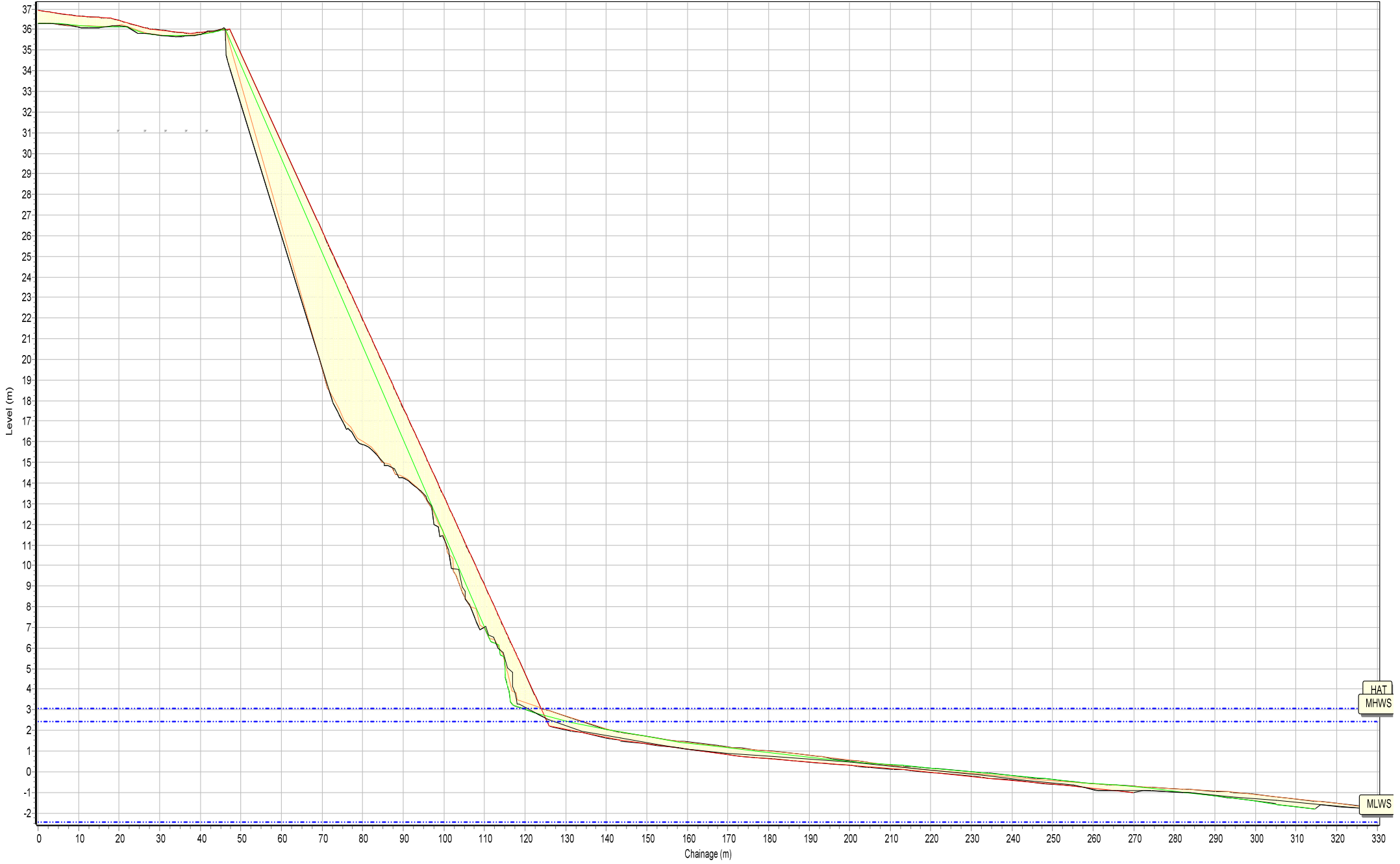
Beach Profiles: 1dCY1



HAT
MHWS

MLWS

Beach Profiles: 1dCY2

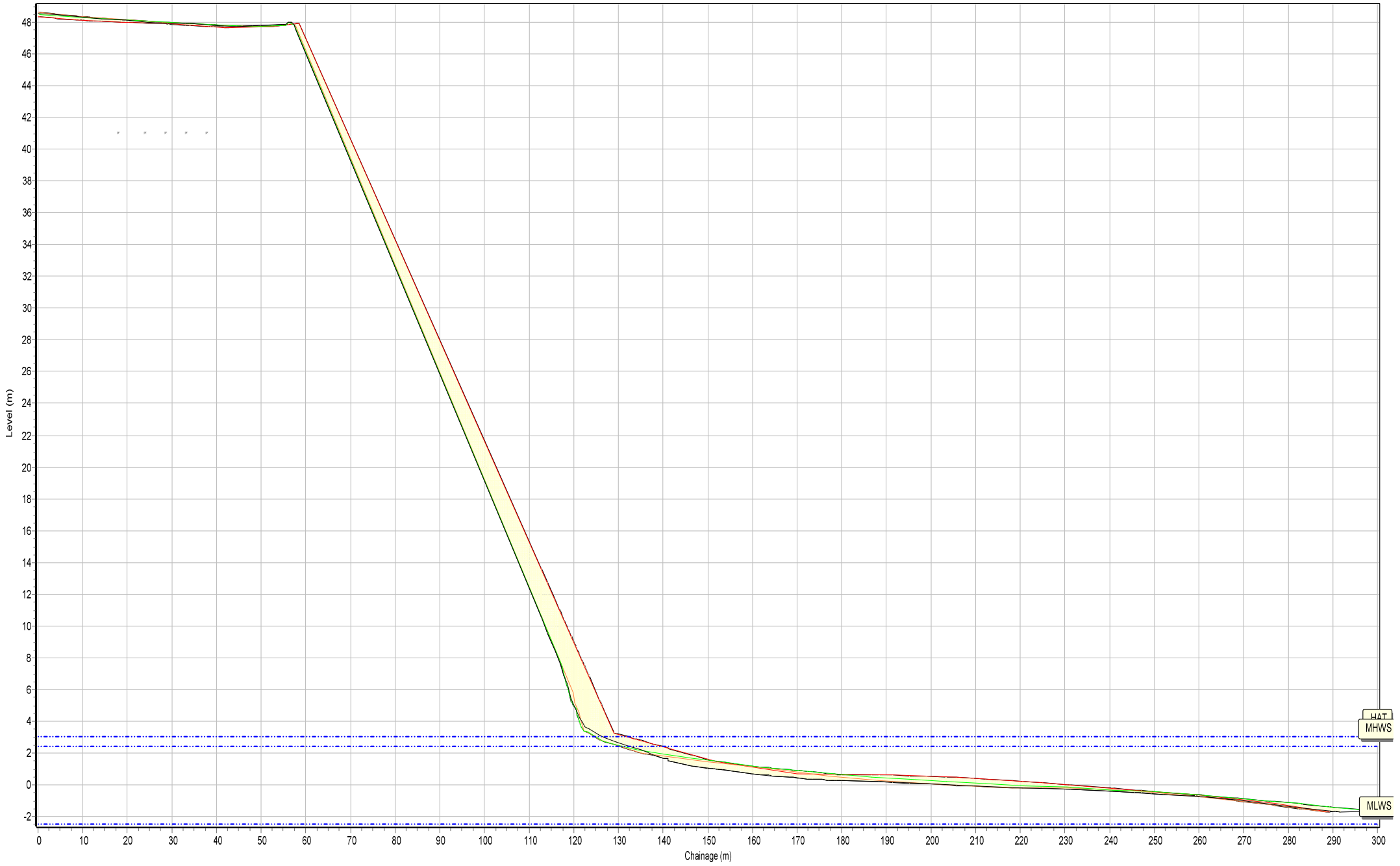


HAT
MHWS

MLWS

SANDS

Beach Profiles: 1dCY3

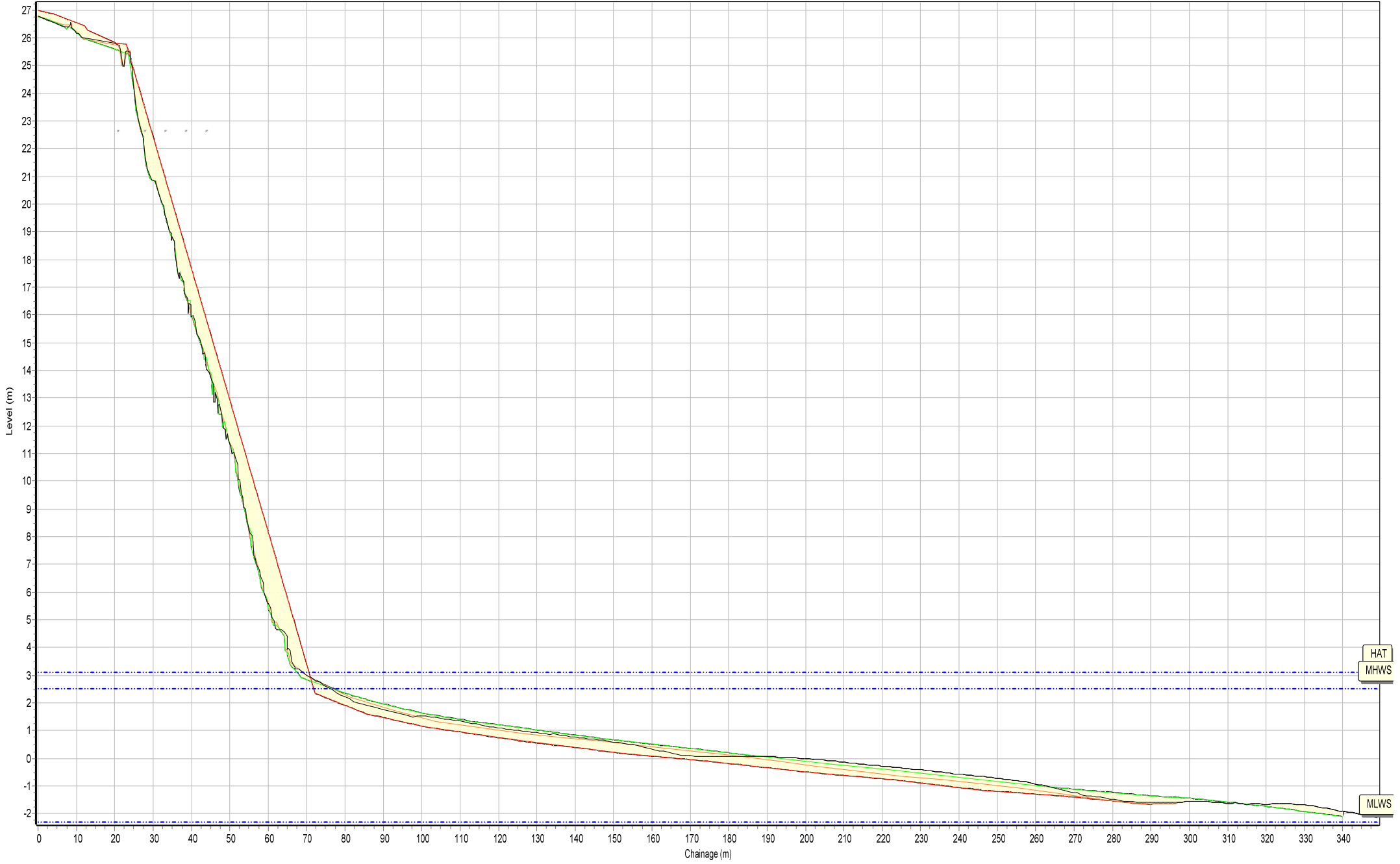


SANDS

Beach Profiles: 1dFB1



Beach Profiles: 1dFB2



Profiles Envelope 26/11/2008 13/03/2020 18/11/2020 01/04/2021

HAT
MHWS

MLWS

SANDS

Beach Profiles: 1dFB3



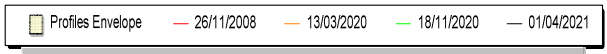
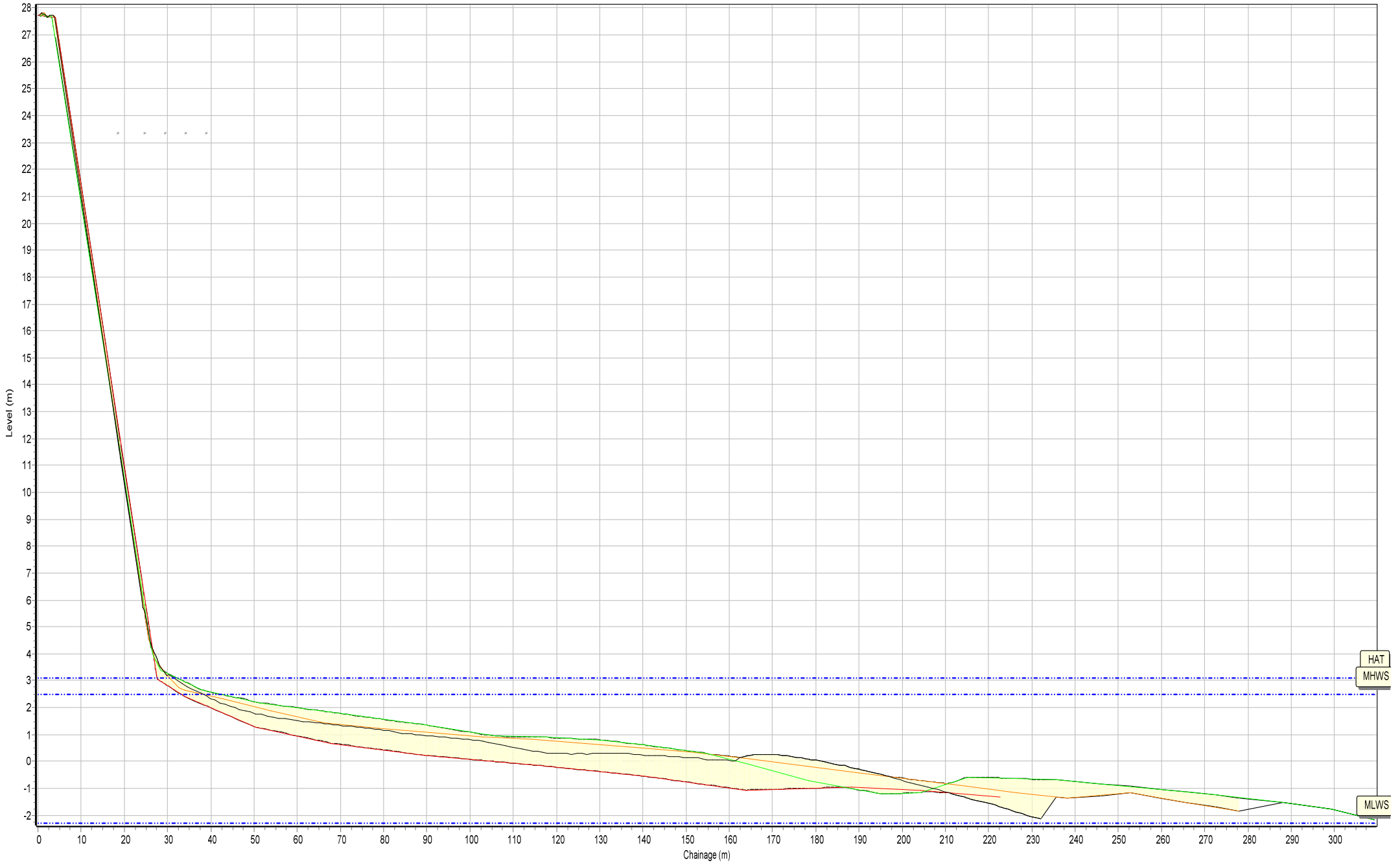
HAT

MLWS

MLWS

SANDS

Beach Profiles: 1dFB4

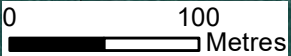
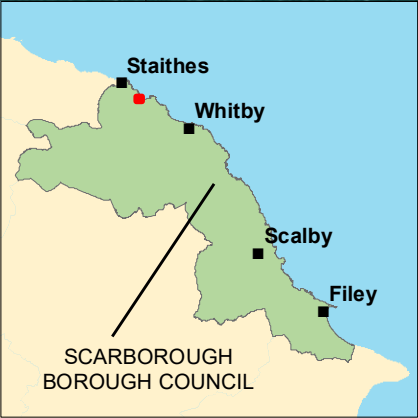
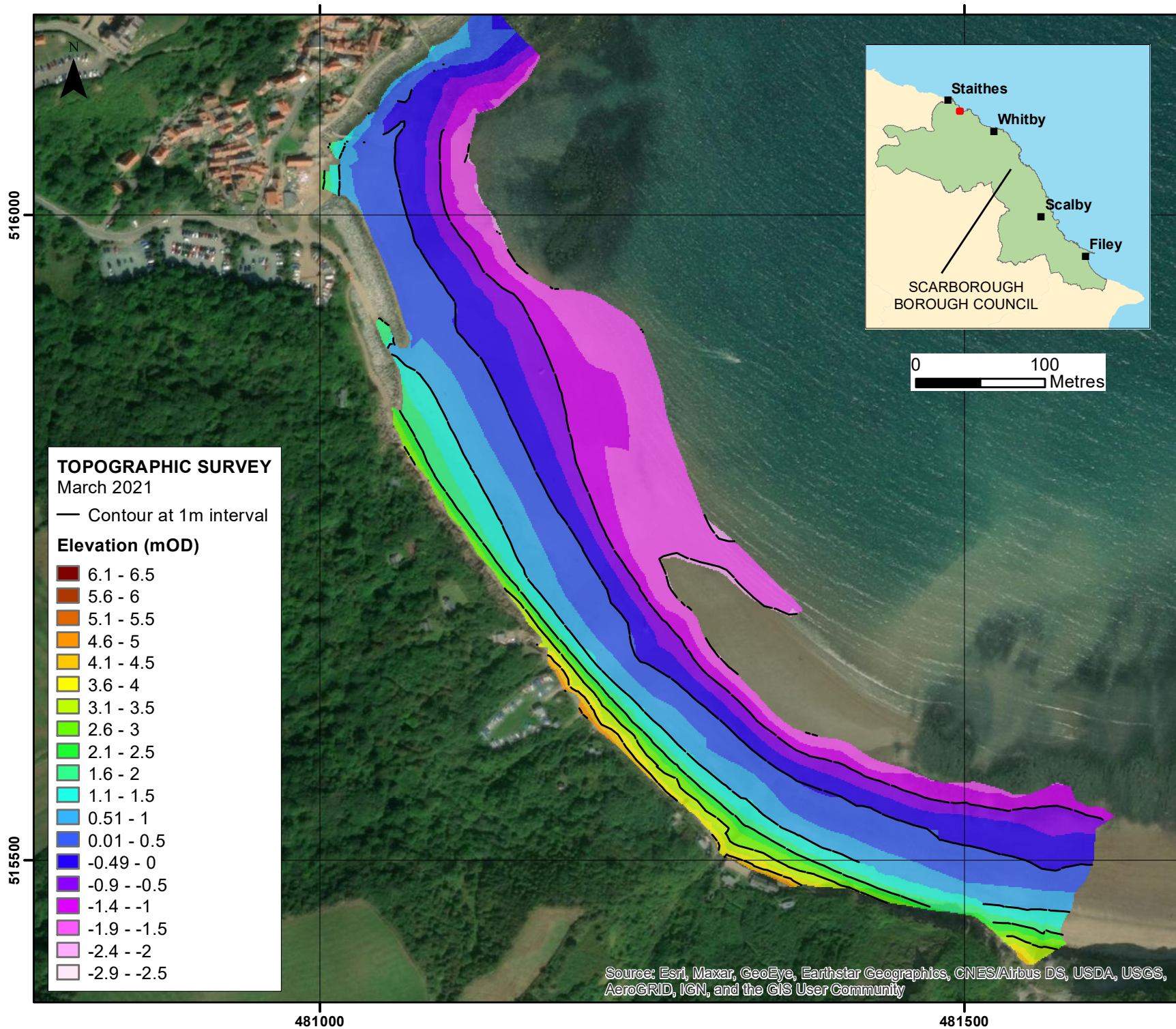


HAT
MHWS

MLWS

SANDS

Appendix B
Topographic Survey



Key

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

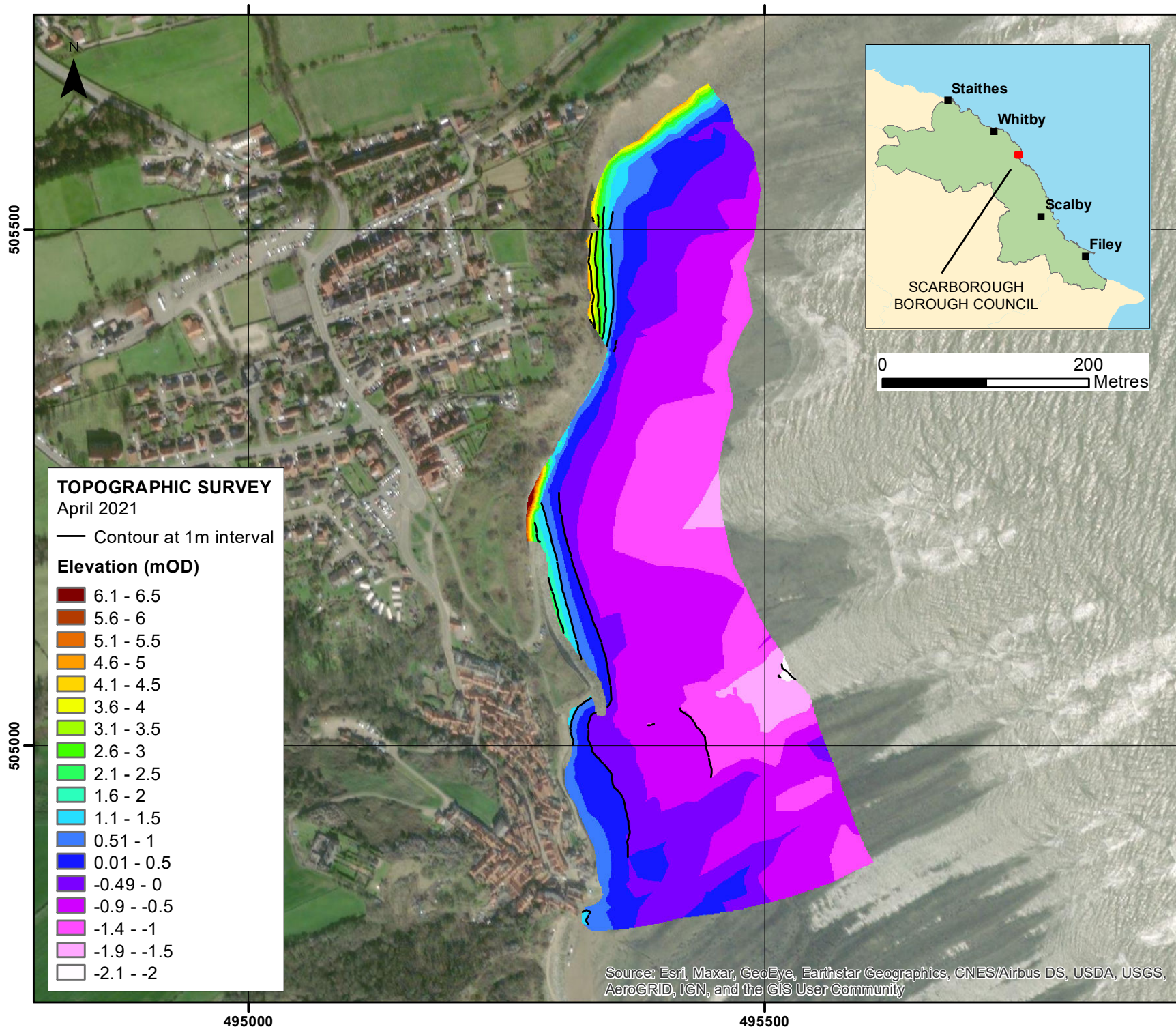
Appendix B - Map 1
RUNSWICK BAY
Scarborough Borough Council Frontage
Update Report
'Partial Measures' Survey 2021

Drawing Scale at A4 1:4,000

WATER
Royal HaskoningDHV
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NE1 4EE

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Fax: +44 (0)191 211 1313
www.royalhaskoningdhv.com





Key

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

Appendix B - Map 2

ROBIN HOOD'S BAY

Scarborough Borough Council Frontage

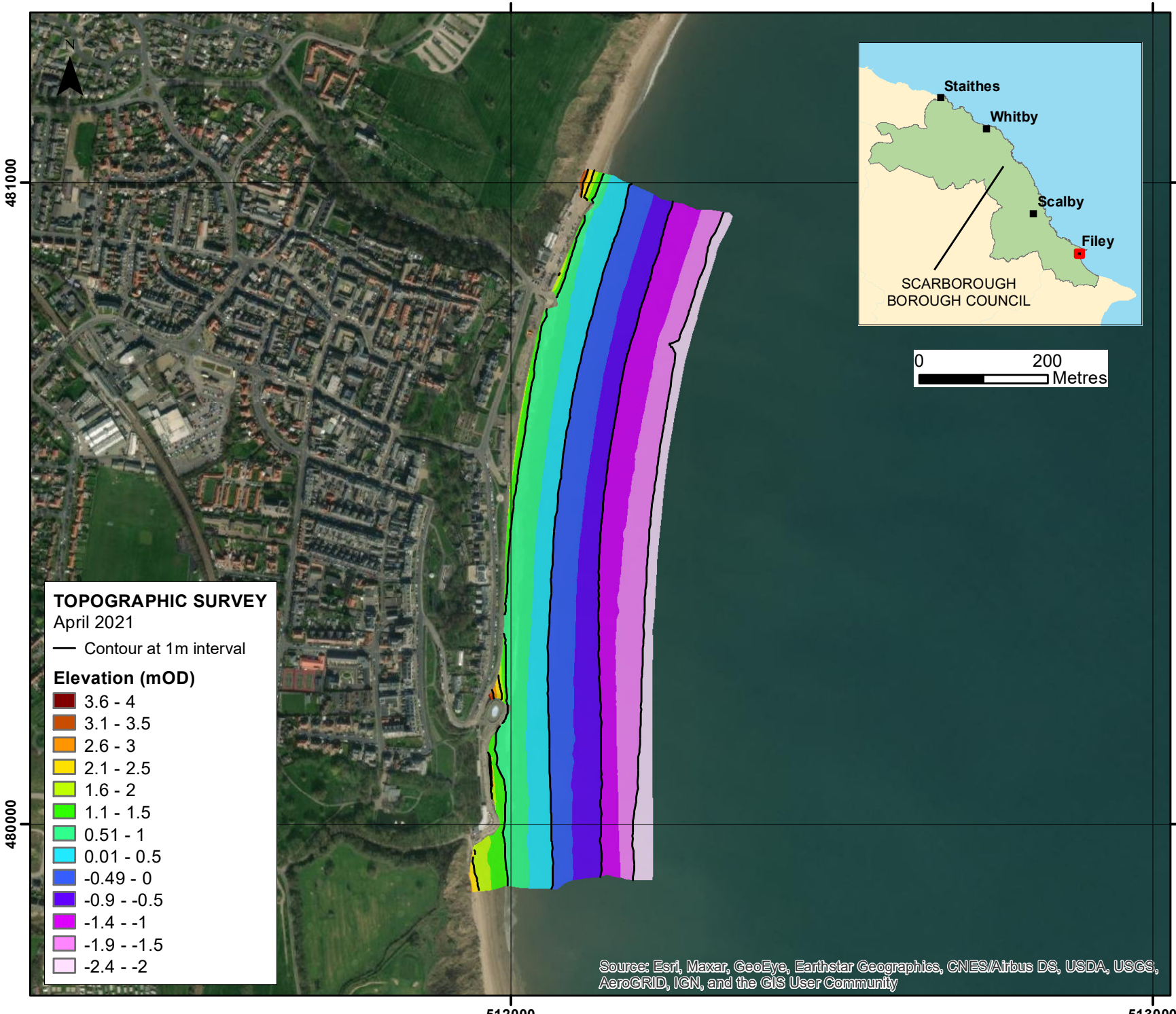
Update Report
'Partial Measures' Survey 2021

Drawing Scale at A4 1:5,000

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Newcastle upon Tyne
NE1 4EE

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www.royalhaskoningdhv.com





Key

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

Appendix B - Map 3

FILEY BAY

Scarborough Borough Council Frontage

Update Report
'Partial Measures' Survey 2021

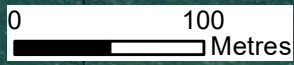
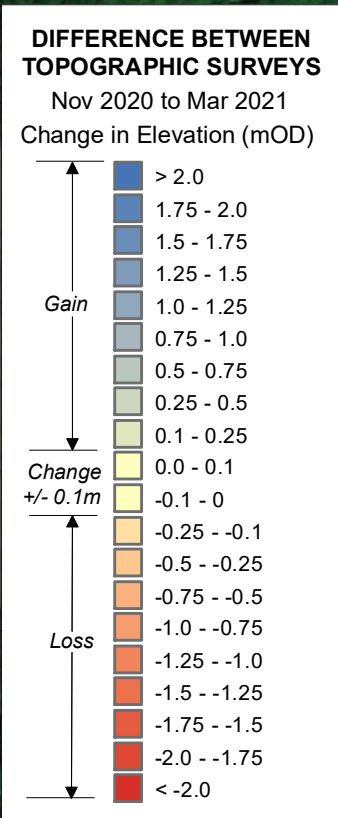
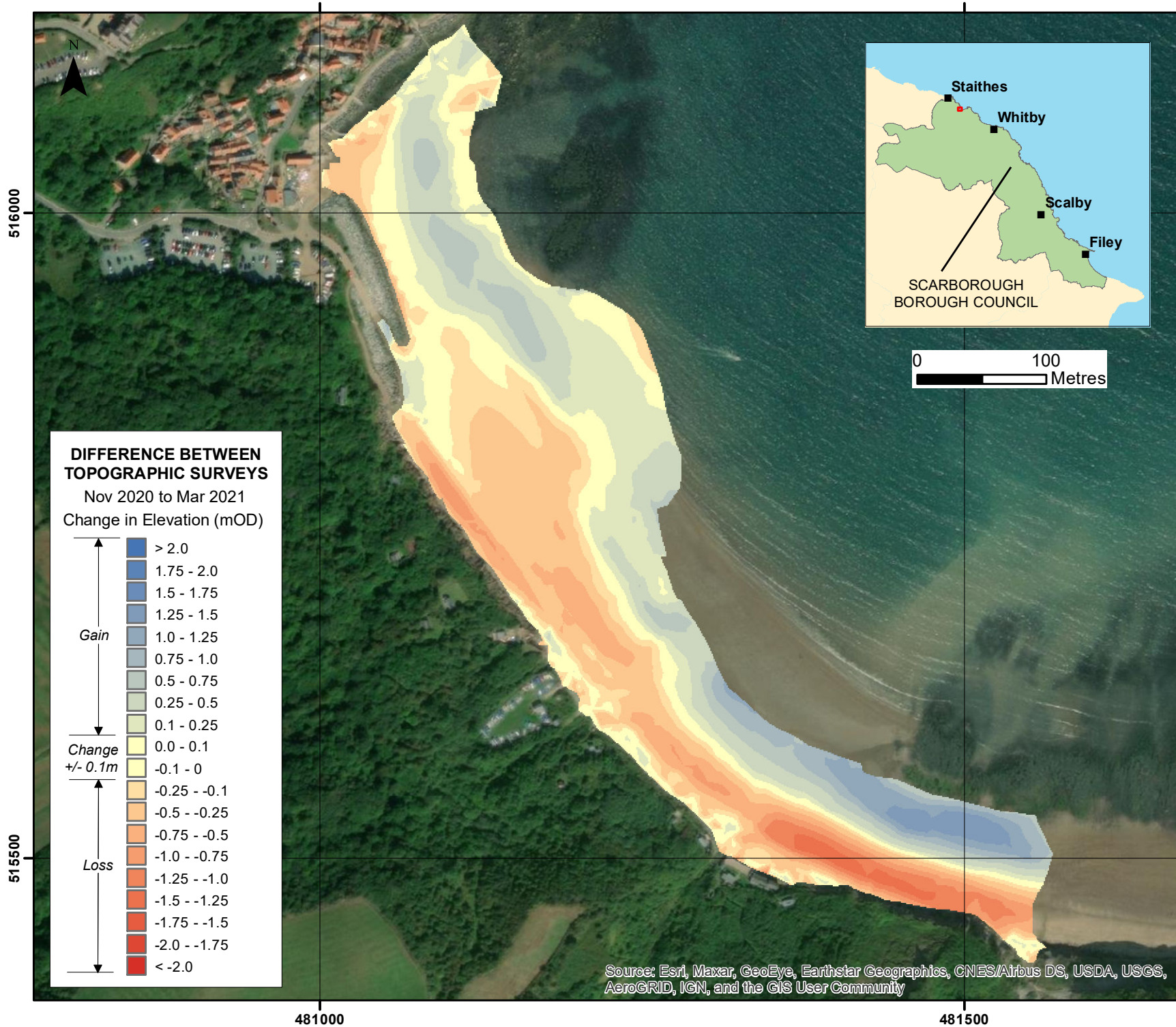
Drawing Scale at A4 1:8,000

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Key

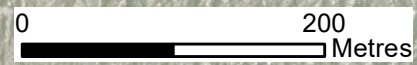
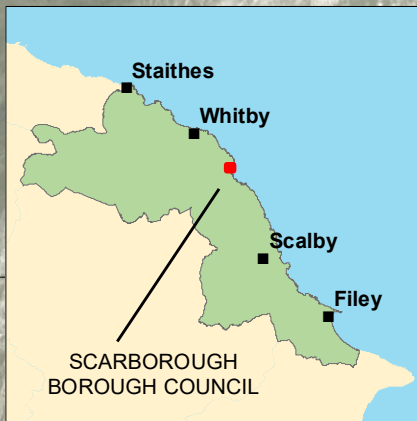
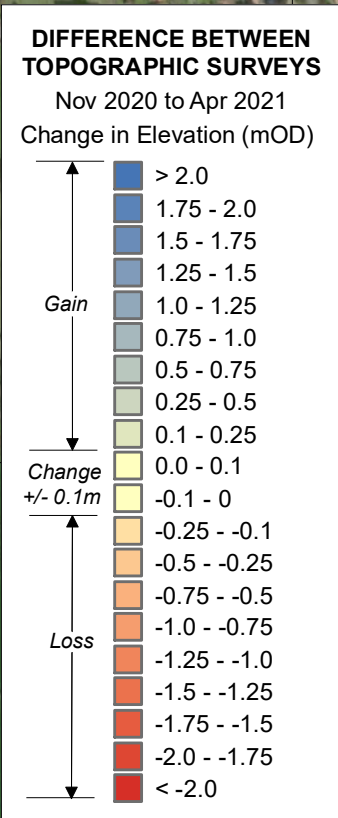
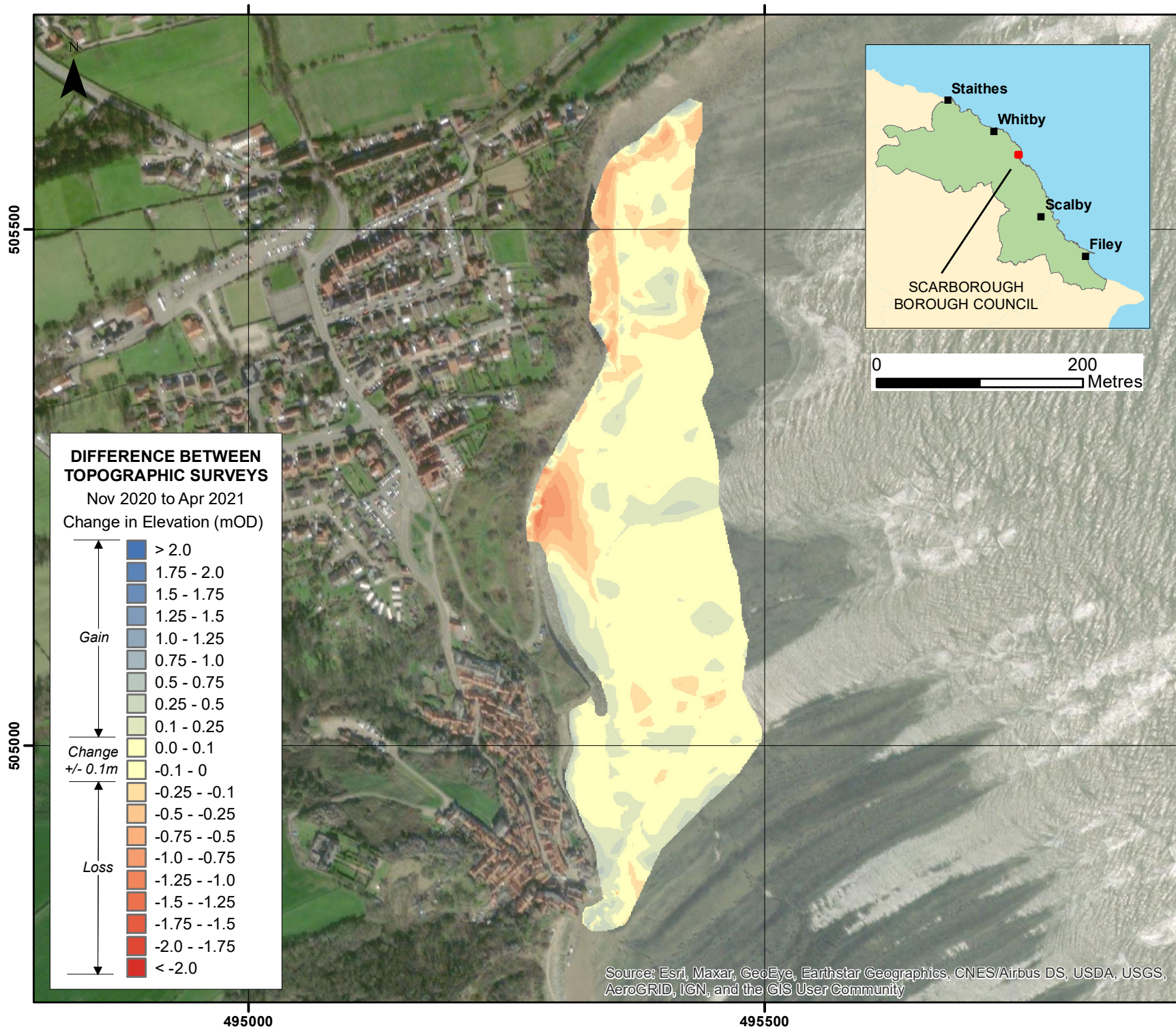
Client: North East Coastal Group
 Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 4
RUNSWICK BAY
Scarborough Borough Council Frontage
 Update Report
 'Partial Measures' Survey 2021
 Drawing Scale at A4 1:4,000

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 Fax: +44 (0)191 211 1313
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Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Key

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

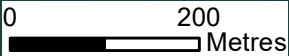
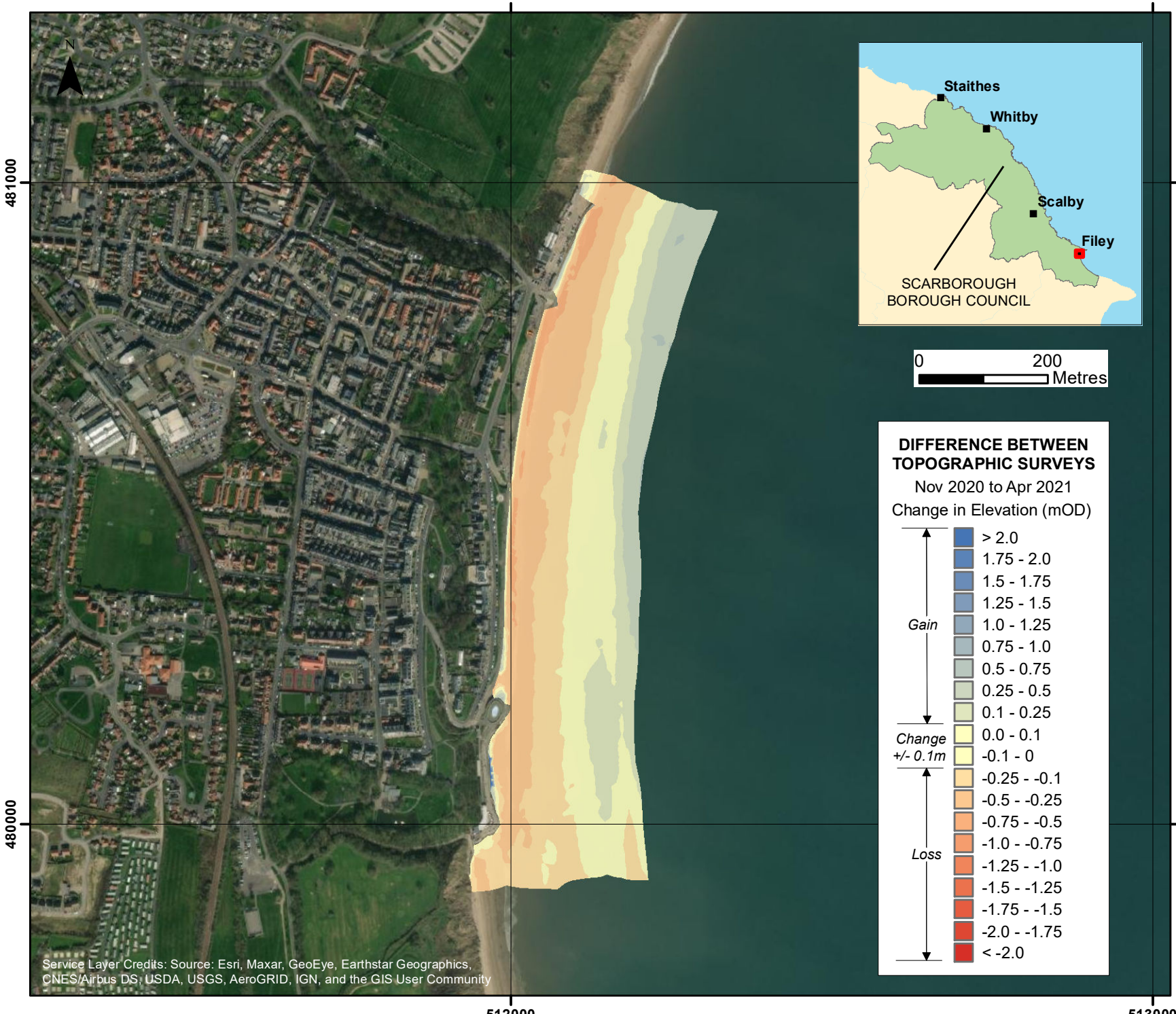
Appendix B - Map 5
ROBIN HOOD'S BAY
Scarborough Borough Council Frontage
 Update Report
 'Partial Measures' Survey 2021

Drawing Scale at A4 1:5,000

WATER
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www.royalhaskoningdhv.com

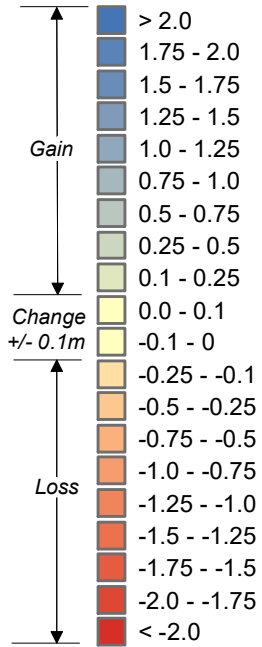
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



DIFFERENCE BETWEEN TOPOGRAPHIC SURVEYS

Nov 2020 to Apr 2021

Change in Elevation (mOD)



Key

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

Appendix B - Map 6

FILEY BAY

Scarborough Borough Council Frontage

Update Report
 'Partial Measures' Survey 2021

Drawing Scale at A4 1:8,000

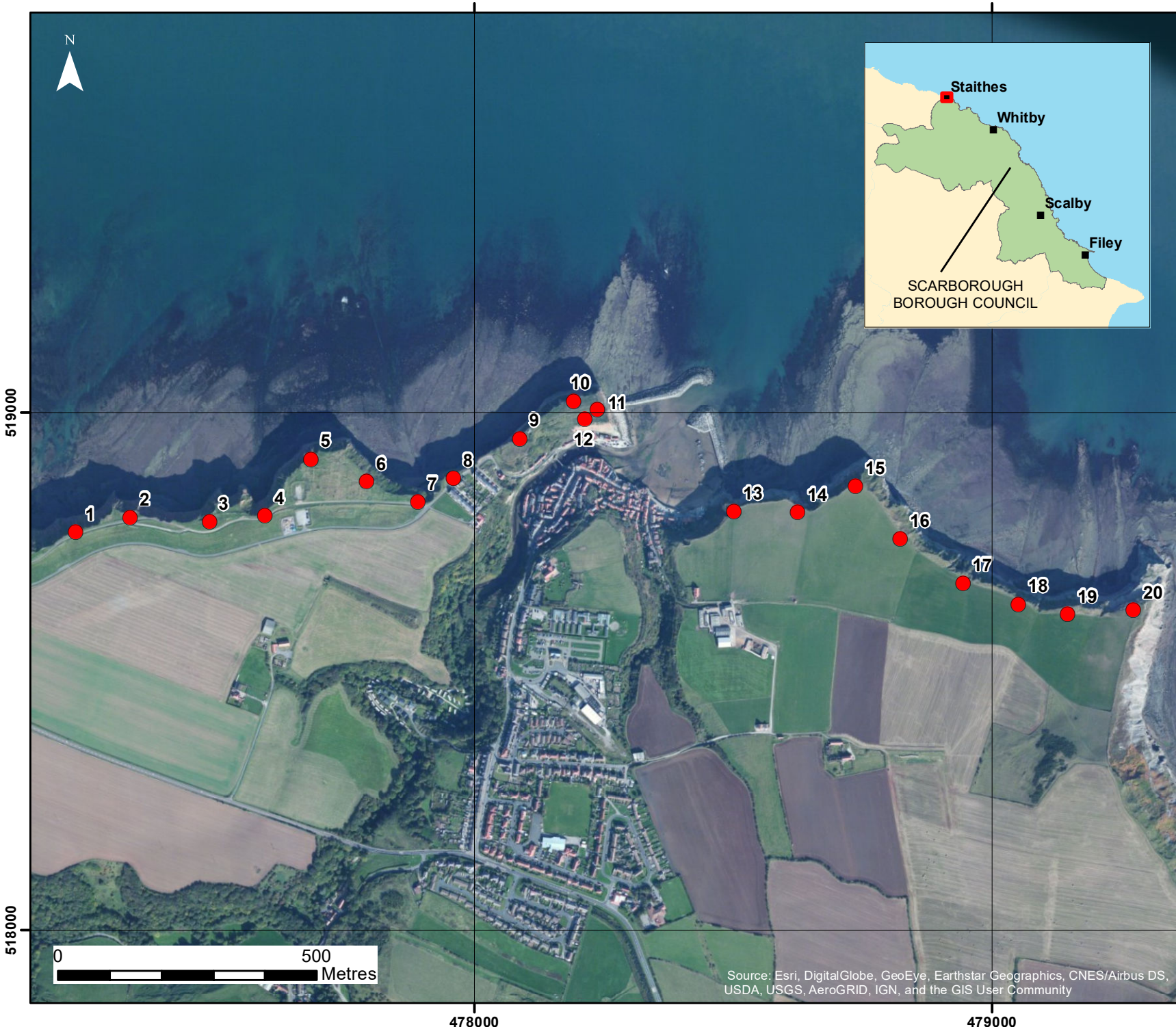
WATER
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 Newcastle upon Tyne
 NE1 4EE

Tel: +44 (0)191 211 1300
 Fax: +44 (0)191 211 1313
 www.royalhaskoningdhv.com



Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Appendix C
Cliff Top Survey



Key
 ● Cliff Top Survey Locations

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

Figure 3 - Map 1

STAITHES
Scarborough Borough Council Council Frontage

Cliff Top Survey Locations

Drawing Scale at A4 1:10,000

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www.royalhaskoningdhv.com



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Key
 ● Cliff Top Survey Locations

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

Figure 3 - Map 2

ROBIN HOOD'S BAY

**Scarborough
 Borough Council
 Council Frontage**

Cliff Top Survey Locations

Drawing Scale at A4 1:10,000

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 Newcastle upon Tyne
 NE1 4EE

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 Fax: +44 (0)191 211 1313
www.royalhaskoningdhv.com



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Key
 ● Cliff Top Survey Locations

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

Figure 3 - Map 3
SCARBOROUGH SOUTH BAY

**Scarborough
 Borough Council
 Council Frontage**

Cliff Top Survey Locations

Drawing Scale at A4 1:15,000

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 Marlborough House
 Marlborough Crescent
 Newcastle upon Tyne
 NE1 4EE

Tel: +44 (0)191 211 1300
 Fax: +44 (0)191 211 1313
 www.royalhaskoningdhv.com



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Key
 ● Cliff Top Survey Locations

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

Figure 3 - Map 4

CAYTON BAY
Scarborough Borough Council Council Frontage

Cliff Top Survey Locations

Drawing Scale at A4 1:10,000

WATER
 Royal HaskoningDHV
 Marlborough House
 Marlborough Crescent
 Newcastle upon Tyne
 NE1 4EE

Tel: +44 (0)191 211 1300
 Fax: +44 (0)191 211 1313
 www.royalhaskoningdhv.com



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Key
 ● Cliff Top Survey Locations

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

Figure 3 - Map 5

FILEY BAY NORTH

Scarborough Borough Council Council Frontage

Cliff Top Survey Locations

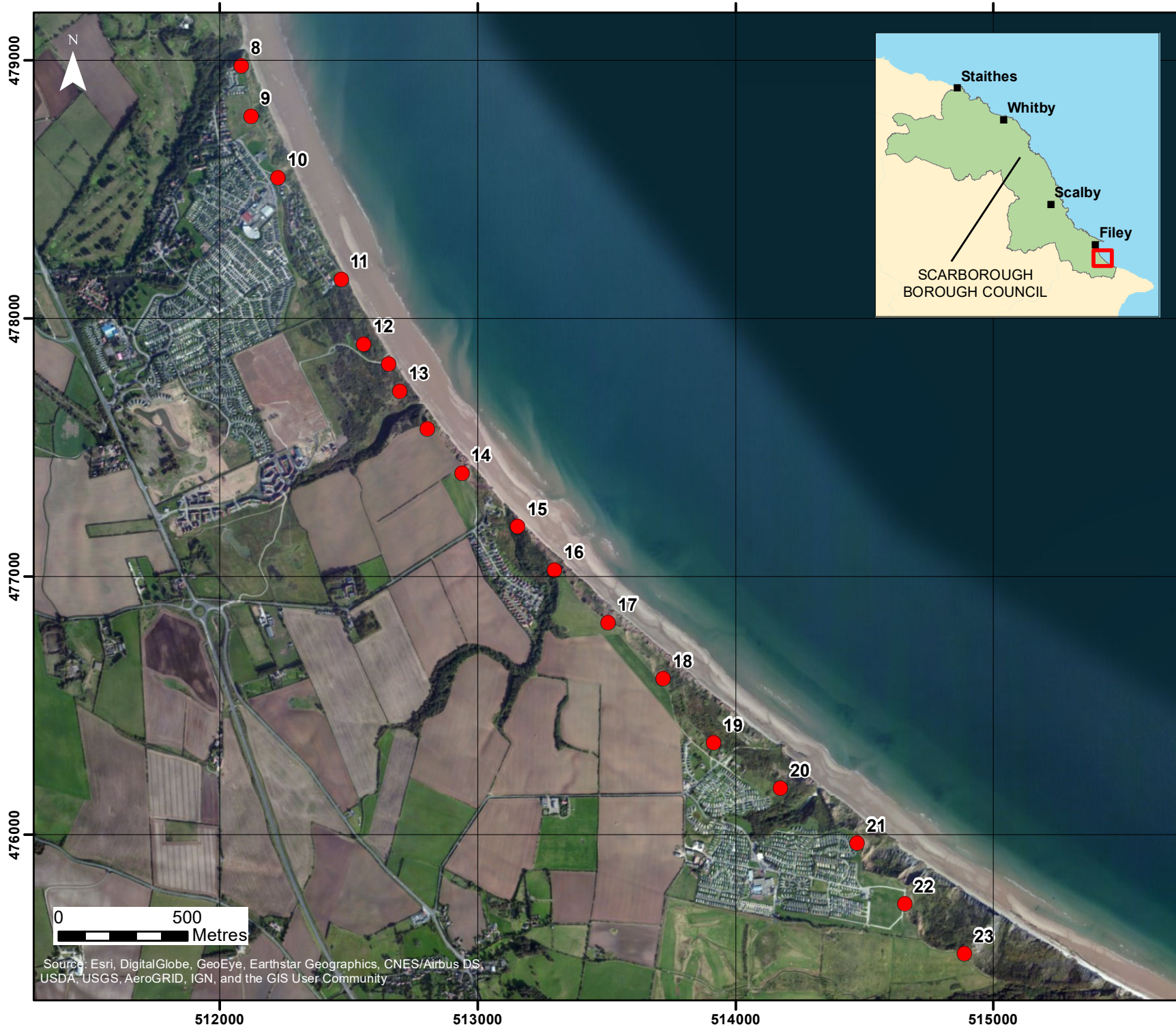
Drawing Scale at A4 1:15,000

WATER
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 Marlborough House
 Marlborough Crescent
 Newcastle upon Tyne
 NE1 4EE

Tel: +44 (0)191 211 1300
 Fax: +44 (0)191 211 1313
 www.royalhaskoningdhv.com



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



Key
 ● Cliff Top Survey Locations

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

Figure 3 - Map 6

FILEY BAY SOUTH

Scarborough Borough Council Council Frontage

Cliff Top Survey Locations

Drawing Scale at A4 1:20,000

WATER
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 Newcastle upon Tyne
 NE1 4EE

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 Fax: +44 (0)191 211 1313
 www.royalhaskoningdhv.com



Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Cliff Top Survey

Staithes

Twenty ground control points have been established at Staithes (Figure 3 - Map 1). 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
				Nov 2008	Nov 2020	March 2021	Nov 2008 – Mar 2021	Nov 2020 - Mar 2021	Nov 2008 – Mar 2021
1	477228	518769	320	1.90	-5.21	-5.05	-6.95	0.16	-0.53
2	477334	518798	0	10.90	10.57	10.59	-0.31	0.02	-0.02
3	477487	518789	350	7.10	7.99	8.02	0.92	0.03	0.07
4	477594	518801	340	5.90	3.72	3.7	-2.2	-0.02	-0.17
5	477683	518911	350	8.40	8.24	8.24	-0.16	0	-0.01
6	477792	518867	30	8.60	8.32	8.51	-0.09	0.19	-0.01
7	477891	518828	60	7.70	7.2	7.31	-0.39	0.11	-0.03
8	477959	518873	350	8.70	9.43	8.49	-0.21	-0.94	-0.02
9	478088	518950	350	7.60	7.94	7.91	0.31	-0.03	0.02
10	478191	519023	340	8.40	8.48	8.59	0.19	0.11	0.01
11	478237	519007	60	6.90	6.59	6.64	-0.26	0.05	-0.02
12	478213	518988	150	6.10	6.34	6.54	0.44	0.2	0.03

Ground Control Points				Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
13	478501	518809	15	11.40	8.47	8.78	-2.62	0.31	-0.20
14	478624	518807	20	7.50	7.45	7.32	-0.18	-0.13	-0.01
15	478737	518858	60	6.10	6.28	6.37	0.27	0.09	0.02
16	478823	518757	60	8.00	8.3	8.64	0.64	0.34	0.05
17	478944	518671	30	9.30	8.75	8.71	-0.59	-0.04	-0.05
18	479052	518630	20	9.20	9.03	9.27	0.07	0.24	0.01
19	479147	518610	0	14.20	14.34	14.03	-0.17	-0.31	-0.01
20	479274	518618	20	11.40	11.03	11.18	-0.22	0.15	-0.02

Cliff Top Survey

Robin Hoods Bay

Thirteen ground control points have been established at Robin Hoods Bay (Figure 3 - Map 2). The maximum separation between any two points varies along the coast, reflecting the degree of risk from the erosion. The cliff top surveys at Robin Hoods Bay 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 C2 provides baseline information about these ground control points and results from the 2010 (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 C2 – Cliff Top Surveys at Robin Hoods Bay

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
				Mar 2010	Nov 2020	Apr 2021	Mar 2010 - Apr 2021	Nov 2020 - Apr 2021	Mar 2010 - Apr 2021
1	495799.5	506002.2	130	11.60	6.38	5.67	-5.93	-0.71	-0.54
2	495549.2	505807.3	135	9.30	9.02	8.92	-0.38	-0.1	-0.03
3	495456.3	505740	130	5.00	5.24	4.94	-0.06	-0.3	-0.01
4	495389.9	505683.7	140	6.30	6.51	5.69	-0.61	-0.82	-0.06
5	495259.4	505342.5	130	11.30	13.18	12.16	0.86	-1.02	0.08
6	495231.2	505315.7	95	5.90	5.71	5.64	-0.26	-0.07	-0.02
7	495184.8	505210.7	85	6.40	7.13	7.34	0.94	0.21	0.09
8	495206.5	505153	75	5.00	5.01	5.07	0.07	0.06	0.01
9	495287.8	505060.5	80	4.30	4.25	4.46	0.16	0.21	0.01
10	495187.8	504708.8	70	3.10	2.20	2.32	-0.78	0.12	-0.07
11	495226.2	504615.7	120	3.80	3.90	2.95	-0.85	-0.95	-0.08
12	495297.5	504380.2	80	11.00	10.71	10.58	-0.42	-0.13	-0.04
13	495350.4	504193	55	3.70	3.66	3.7	0	0.04	0.00

Cliff Top Survey

Scarborough South Bay

Thirteen ground control points have been established at Scarborough South Bay (Figure 3 - Map 3). The maximum separation between any two points varies along the coast, reflecting the degree of risk from the erosion. The cliff top surveys at Scarborough South Bay 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 C3 provides baseline information about these ground control points and results from the 2010 (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 C3 – Cliff Top Surveys at Scarborough South Bay

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
				Mar 2010	Dec 2020	Mar 2021	Mar 2010 – Mar 2021	Dec 2020 – Mar 2021	Mar 2010 – Mar 2021
1	504339.5	487887.3	70	7.00	6.96	6.94	-0.06	-0.02	-0.01
2	504422.3	487603.7	80	4.80	4.56	4.81	0.01	0.25	0.00
3	504534.8	487318.3	40	15.10	15.24	14.86	-0.24	-0.38	-0.02
4	504730.2	487137.9	55	9.60	9.6	9.66	0.06	0.06	0.01
5	504922.9	486837.8	60	8.80	8.58	8.57	-0.23	-0.01	-0.02
6	50571.1	486652.1	75	3.80	3.61	3.85	0.05	0.24	0.00
7	505284.3	486480	35	7.00	6.67	6.86	-0.14	0.19	-0.01
8	505597.9	486363.4	30	8.60	8.39	8.56	-0.04	0.17	0.00
9	505758.6	486005.1	45	9.10	8.5	8.49	-0.61	-0.01	-0.06
10	505896	485889.6	15	14.80	14.7	14.68	-0.12	-0.02	-0.01
11	505990	485657.1	80	4.70	1.12	1.11	-3.59	-0.01	-0.33
12	506024.9	485421.8	55	6.10	3.16	3.19	-2.91	0.03	-0.26
13	506036	485315.3	90	7.00	6.99	7.05	0.05	0.06	0.00

Cliff Top Survey

Cayton Bay

Eight ground control points have been established at Cayton Bay (Figure 3 - May 4). The maximum separation between any two points varies along the coast, reflecting the degree of risk from the erosion.

The cliff top surveys at Cayton Bay 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 C4 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 C4 – Cliff Top Surveys at Cayton Bay

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
				Nov 2008	Dec 2020	Mar 2021	Nov 2008 – Mar 2021	Dec 2020 – Mar 2021	Nov 2008 – Mar 2021
1	506325.5	484849.7	50	4.00	3.66	3.71	-0.34	-0.05	-0.03
2	506459.4	484715.9	65	5.00	UTS	UTS	UTS	UTS	UTS
3	506597.4	484538.6	65	5.00	5.52	5.51	0.52	0.01	0.04
4	506778.1	484345.5	21	9.00	5.89	5.88	-3.11	0.01	-0.24
5	507018.6	484221.6	342	7.70	8.07	8.06	0.37	0.01	0.03
6	507242.3	484121.7	2	7.40	5.83	5.82	-1.57	0.01	-0.12
7	507518.2	484008.2	25	7.50	7.57	7.56	0.07	0.01	0.01
8	507818.7	484006	1	5.50	5.36	5.34	-0.14	0.02	-0.01

Cliff Top Survey

Filey Bay

Twenty-eight ground control points have been established in Filey Bay (Figure 3 - Map 5 & 6). The maximum separation between any two points varies along the coast, reflecting the degree of risk from the erosion.

The cliff top surveys at Filey Bay 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 C5 provides baseline information about these ground control points and results from the 2008 (baseline) (and 2011 baseline for profiles 12A and 24-27) 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 C5 – Cliff Top Surveys in Filey Bay

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
				Nov 2008/Mar 2011	Nov 2020	April 2021	Nov 2008/Mar 2011 – April 2021	Nov 2020 – Apr 2021	Nov 2008/Mar 2011 – Apr 2021
1	512444.9	481630.9	130	8.70	8.42	8.42	-0.28	0	-0.02
2	512306.7	481490.3	144	7.60	7.59	7.61	0.01	0.02	0.00
3	512153.6	481234.6	122	8.30	8.01	8.00	-0.3	-0.01	-0.02
4	512029.2	480959.9	115	7.40	7.17	7.17	-0.23	0	-0.02
5**	511895.4	479888	89	7.10	UTS	UTS	UTS	UTS	UTS
6	511908.5	479597.1	48	6.70	5.59	5.59	-1.11	0	-0.09
7	511991.4	479310.4	69	6.70	1.59	1.35	-5.35	-0.24	-0.41
8	512083.4	478981.5	66	10.20	9.65	9.64	-0.56	-0.01	-0.04
9	512121.3	478786.3	76	8.30	8.43	8.40	0.1	-0.03	0.01
10	512226.2	478547.9	74	7.50	5.83	5.84	-1.66	0.01	-0.13
11	512471.4	478153.5	53	6.60	6.86	6.85	0.25	-0.01	0.02
12**	512558.9	477901.9	66	7.70	UTS	UTS	UTS	UTS	UTS

Ground Control Points				Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
12A*	512655.8	477822.4	67	13.90	13.00	12.99	-0.91	-0.01	-0.09
13**	512697.6	477719	34	4.20	UTS	UTS	UTS	UTS	UTS
13A	512805.5	477572.1	32	13.42	10.48	10.00	-3.42	-0.48	-0.26
14	512939.4	477400.9	66	8.00	6.33	6.31	-1.69	-0.02	-0.13
15	513157	477192.7	51	5.20	4.60	4.60	-0.6	0	-0.05
16	513299.5	477024.6	30	7.70	6.51	5.99	-1.71	-0.52	-0.13
17	513507.7	476821.1	34	10.70	10.25	10.25	-0.45	0	-0.03
18	513721	476602.3	31	7.20	6.09	6.06	-1.14	-0.03	-0.09
19	513916.6	476354.1	51	6.60	6.47	6.33	-0.27	-0.14	-0.02
20	514174.8	476179.4	32	7.00	6.96	6.94	-0.06	-0.02	0.00
21	514471.5	475965.7	66	7.60	7.39	7.38	-0.22	-0.01	-0.02
22	514656.2	475728.8	101	8.10	7.68	7.67	-0.43	-0.01	-0.03
23	514889.5	475537.6	60	9.10	7.78	7.76	-1.34	-0.02	-0.10
24*	512603.7	481665.9	14	19.90	19.85	19.85	-0.05	0	0.00
25*	512607.1	481648.9	184	17.20	16.93	16.95	-0.25	0.02	-0.03
26*	512301.9	481825.5	18	11.00	10.79	11.00	0	0.21	0.00
27*	512475.8	481712.1	20	11.60	11.51	11.51	-0.09	0	-0.01

NOTE: *baseline for 12A and 24-27 is March 2011

**Surveyor's report has previously stated that 'VMPs 5, 12 and 13 were inaccessible due to heavy vegetation'