



**Cell 1 Regional Coastal Monitoring Programme
Update Report 2: 'Partial Measures' Survey 2010**



A great place to live, work & play

**Scarborough Borough Council
Final Report**

July 2010

Abbreviations and Acronyms

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

Water Levels Used in Interpretation of Changes

Water Level Parameter	Water Level (m ODN)			
	River Tyne to Frenchman's Bay	Frenchman's Bay to Souter Point	Souter Point to Chourdon Point	Chourdon Point to Hartlepool Headland
1 in 200 year	3.41	3.44	3.66	3.91
HAT	2.85	2.88	3.18	3.30
MHWS	2.15	2.18	2.48	2.70
MLWS	-2.15	-2.12	-1.92	-1.90

Water Level Parameter	Water Level (m ODN)			
	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 ODN)			
	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 inter-tidal 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 300 km of the north east coastline, from the Scottish Border (just south of St. Abb's Head) to Flamborough Head in East Yorkshire.

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
- walk-over 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	June 09	-
2	2009/10	Sep-Dec 09	Mar 10	Feb-Mar 10	July 10 ^(*)	-

(*) The present report is **Update Report 2** and provides an analysis of the 2010 Partial Measures survey for Scarborough Borough Council's frontage. It is intended as a brief update of the key findings from this survey to maintain an understanding of ongoing changes.

1. Introduction

1.1 Study Area

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

- Staithes¹
- Runswick Bay
- Sandsend Beach, Upgang 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 no. 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 no. 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 1. This information has also previously been provided in a digital file, which can be opened in Google Earth.

The current Partial Measures survey along this frontage was undertaken between February and March 2010. During the surveys at Runswick Bay, Robin Hoods Bay, Scarborough North & South Bays, Cayton Bay, & Filey Bay the weather was fine and dry, with a calm sea state. In contrast, the weather at the Sandsend to Whitby frontage was wet and windy with a rough sea state. At Staithes, the weather was overcast and damp with a calm sea state.

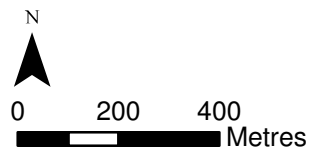
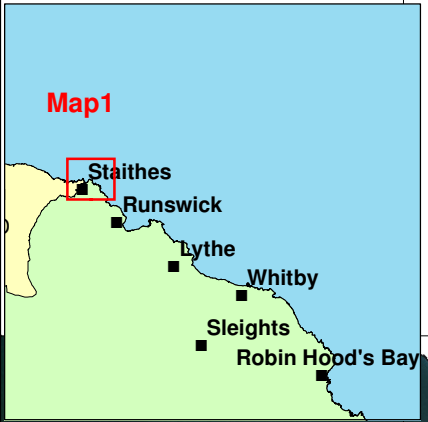
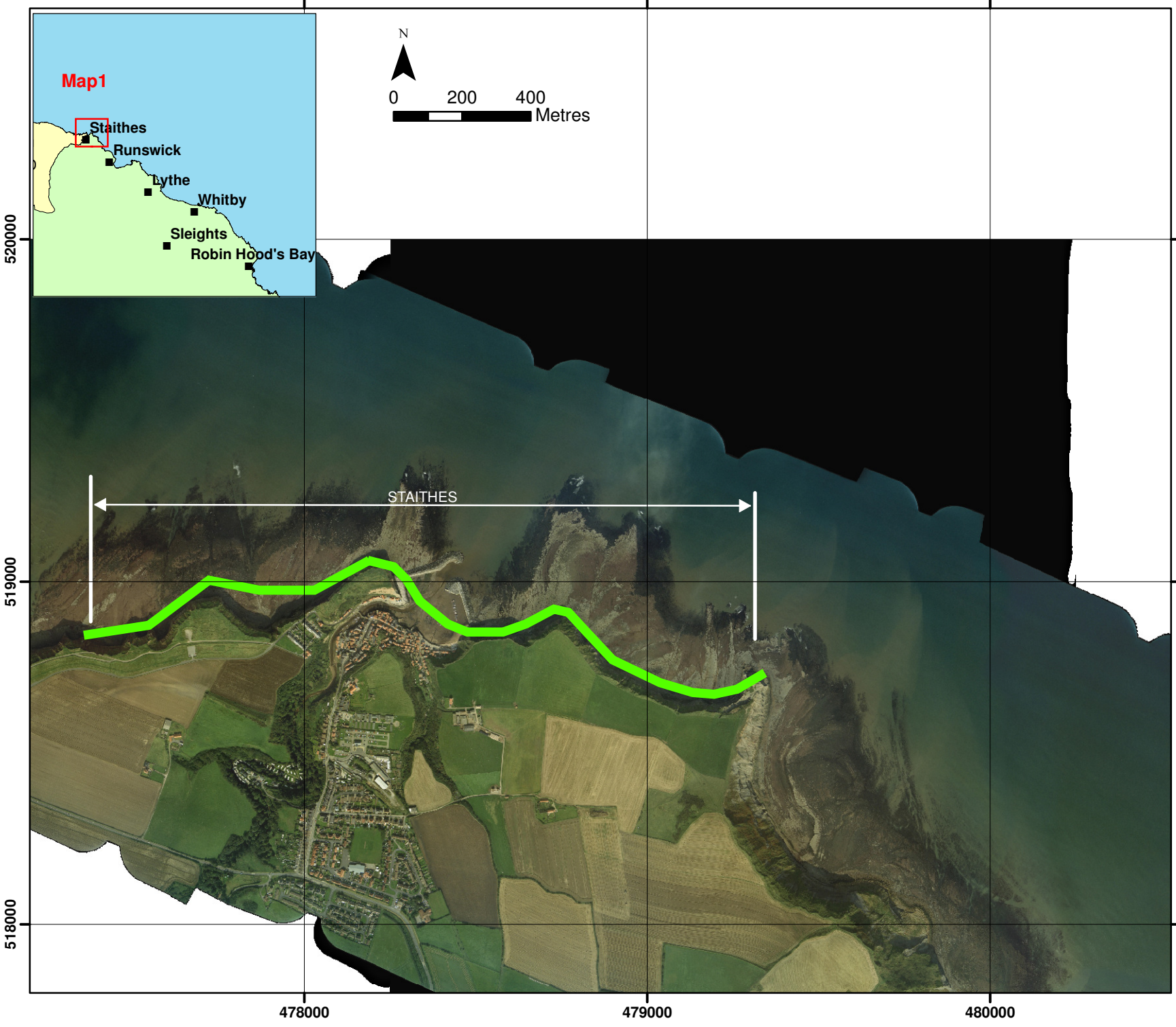
The Update Report presents the following:

- description of the changes observed since the previous survey and an interpretation of the drivers of these changes (Section 2);

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

- 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
- 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 Profiles**
- Annual (Blue line)
 - Bi-Annual (Magenta line)
- Topographic Surveys**
- 6 monthly (Green cross-hatch)
 - yearly (Orange cross-hatch)
 - 5 yearly (Brown cross-hatch)
- Cliff Top Monitoring Pegs**
- @ 50 centres (Purple bar)
 - @ 100 centres (Green bar)
 - @ 300 centres (Red bar)
- (Indicative Survey Extents shown)*

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

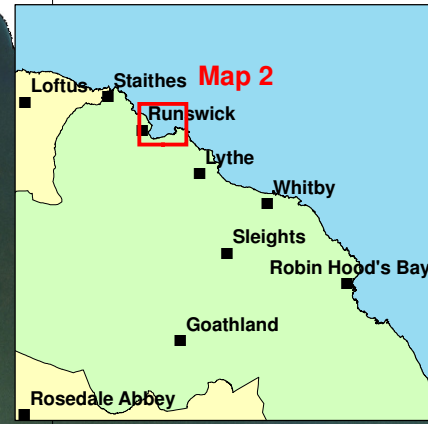
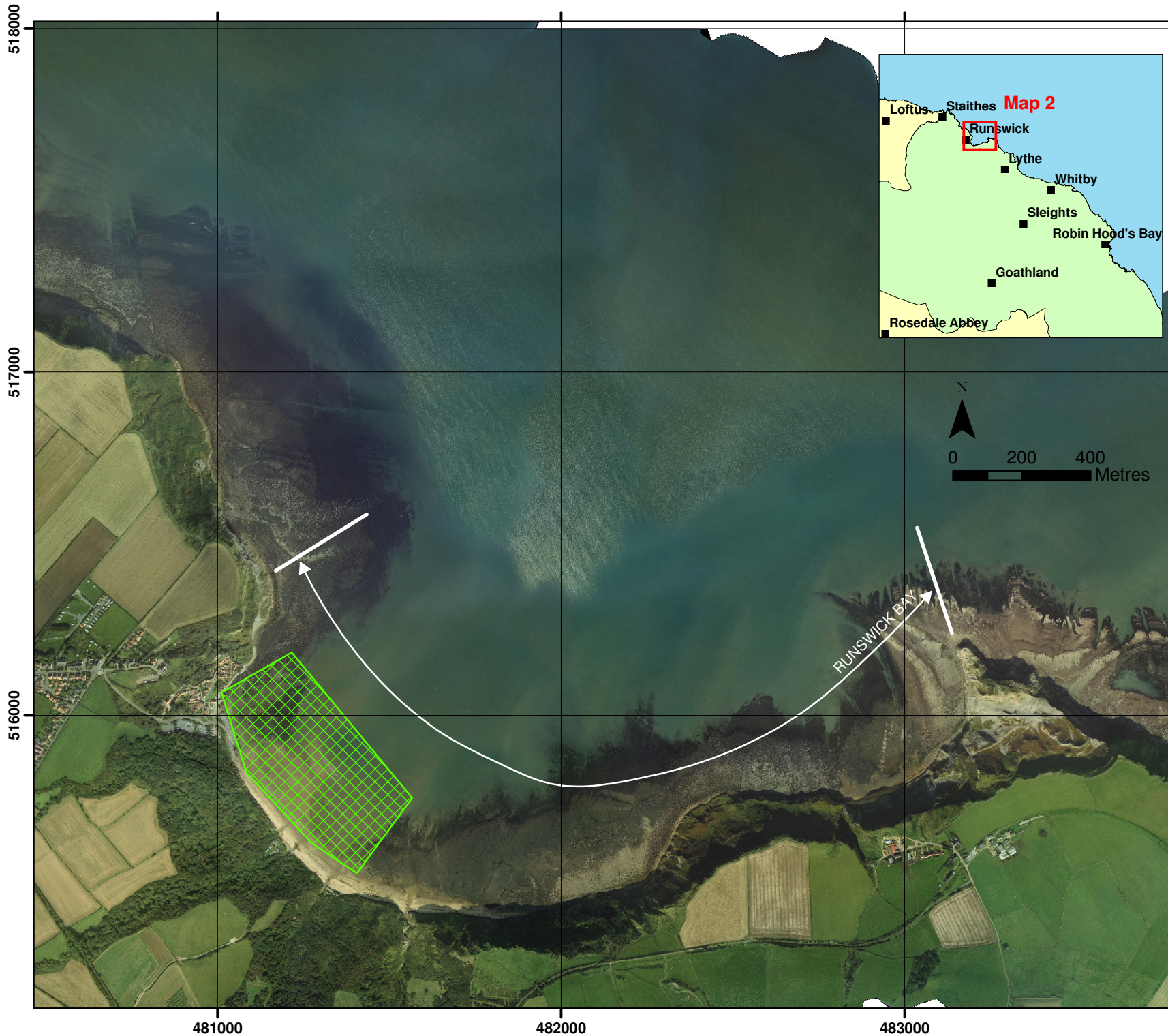
**Figure 1 - Map 1
 Scarborough
 Borough Council Frontage**

Update Report 2
 'Partial Measures' Survey 2010
 Drawing Scale 1:15,000 at A4

Drawn by: ES	Date: 01/06/2010
Checked by: RJ	Date: 01/06/2010
Approved by: RJ	Date: 01/06/2010

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- SURVEY LOCATIONS**
- Topographic Profiles**
- Annual
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- @ 50 centres
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 - @ 300 centres
- (Indicative Survey Extents shown)*

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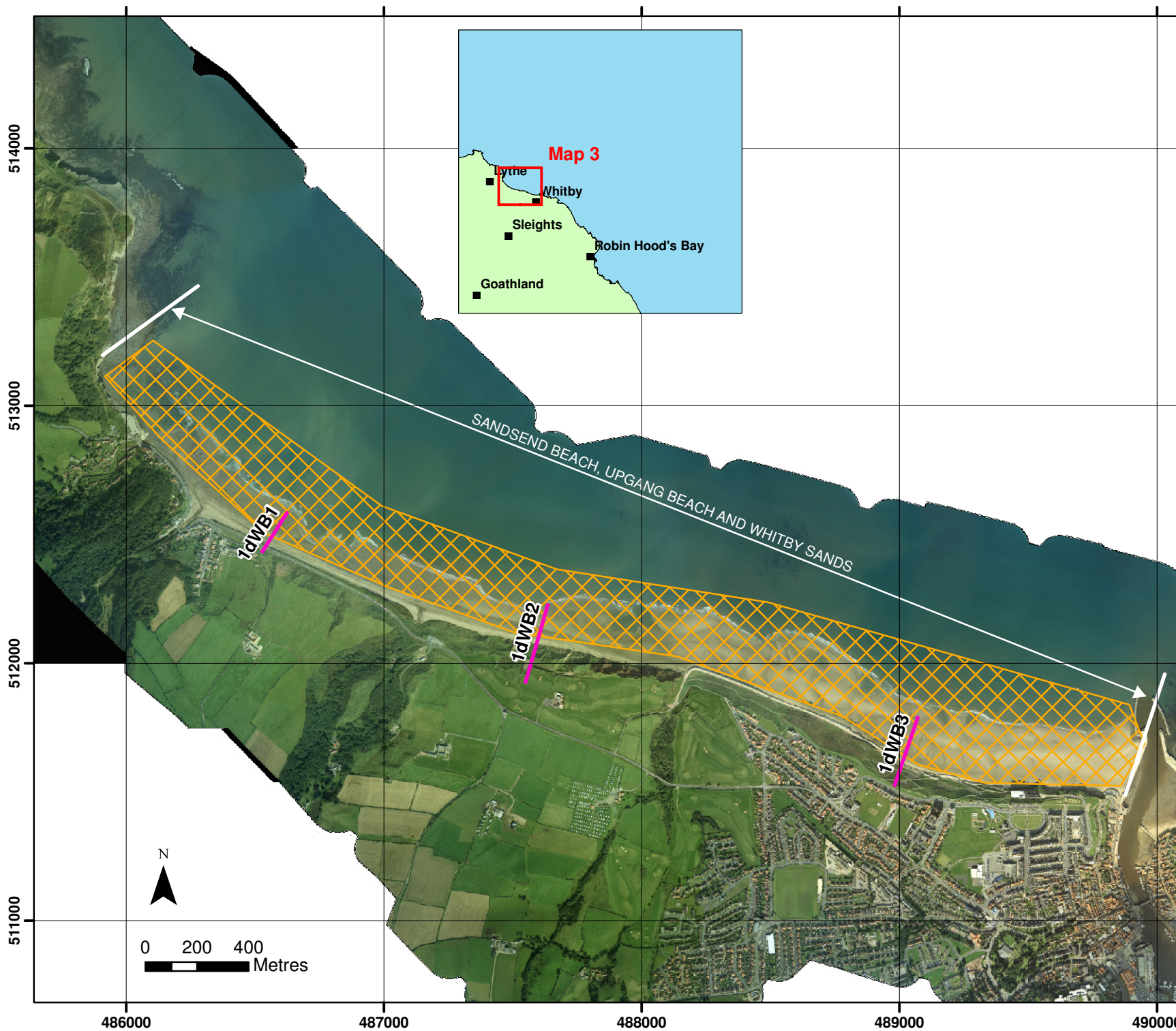
**Figure 1 - Map 2
 Scarborough
 Borough Council Frontage**

Update Report 2
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SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs

- @ 50 centres
- @ 100 centres
- @ 300 centres

(Indicative Survey Extents shown)

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Project: Cell 1 Regional Coastal Monitoring Programme

Figure 1 - Map 3 Scarborough Borough Council Frontage

Update Report 2
'Partial Measures' Survey 2010

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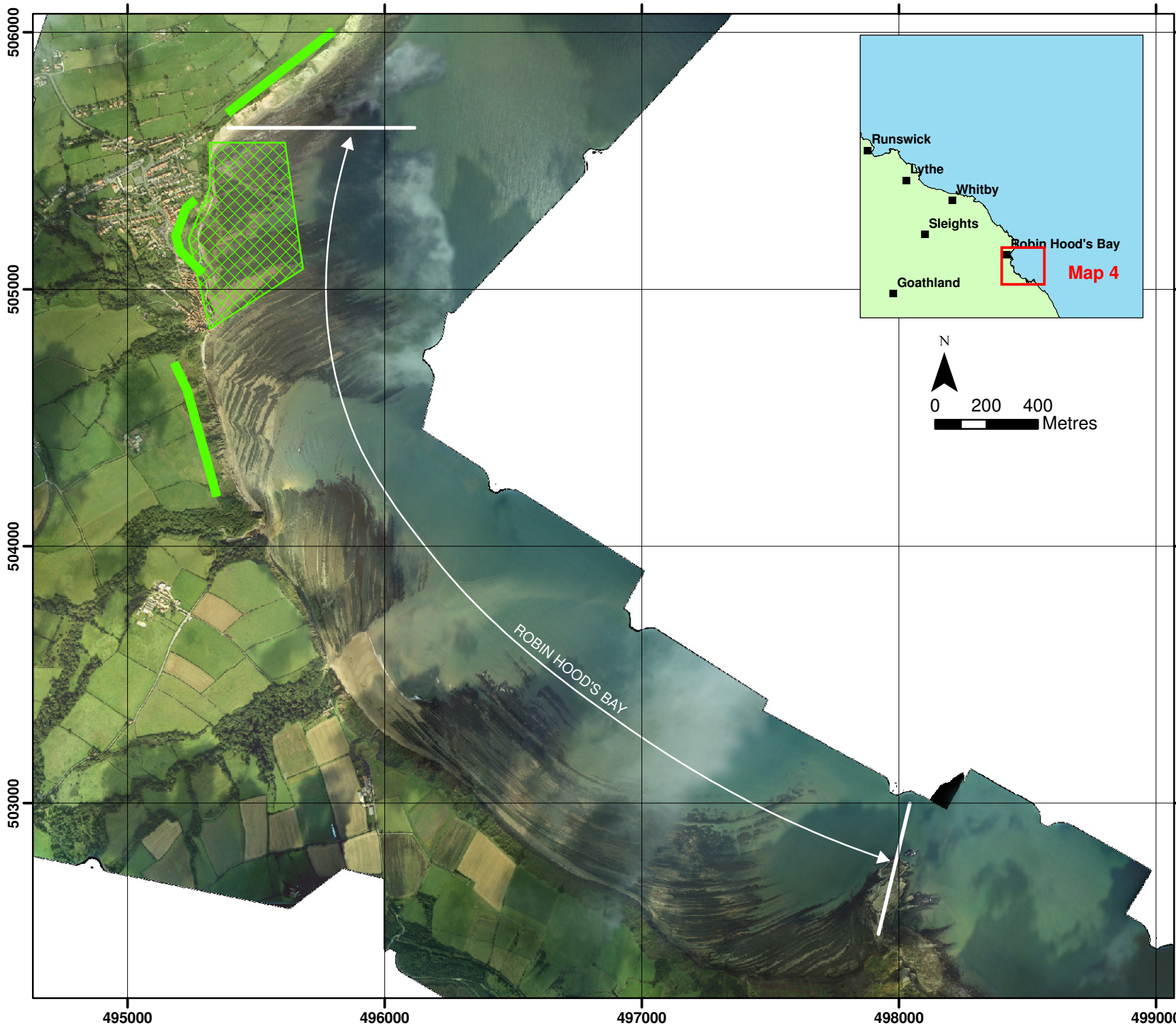


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SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs

- @ 50 centres
- @ 100 centres
- @ 300 centres

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

**Figure 1 - Map 4
Scarborough
Borough Council Frontage**

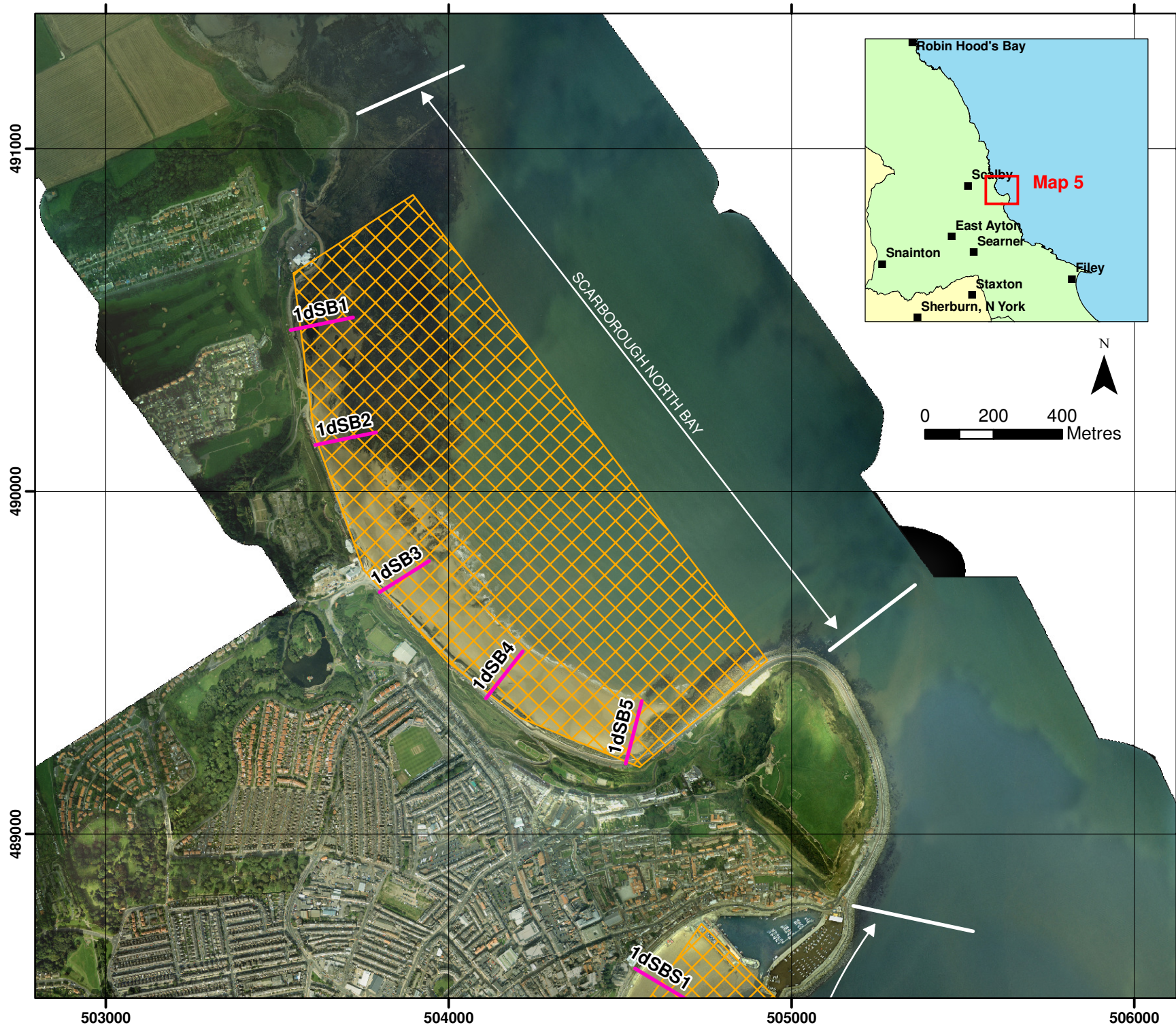
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SURVEY LOCATIONS

Topographic Profiles
 — Annual (Blue line)
 — Bi-Annual (Pink line)

Topographic Surveys
 ▨ 6 monthly (Green cross-hatch)
 ▨ yearly (Yellow cross-hatch)
 ▨ 5 yearly (Orange cross-hatch)

Cliff Top Monitoring Pegs
 ■ @ 50 centres (Purple square)
 ■ @ 100 centres (Green square)
 ■ @ 300 centres (Red square)

(Indicative Survey Extents shown)

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

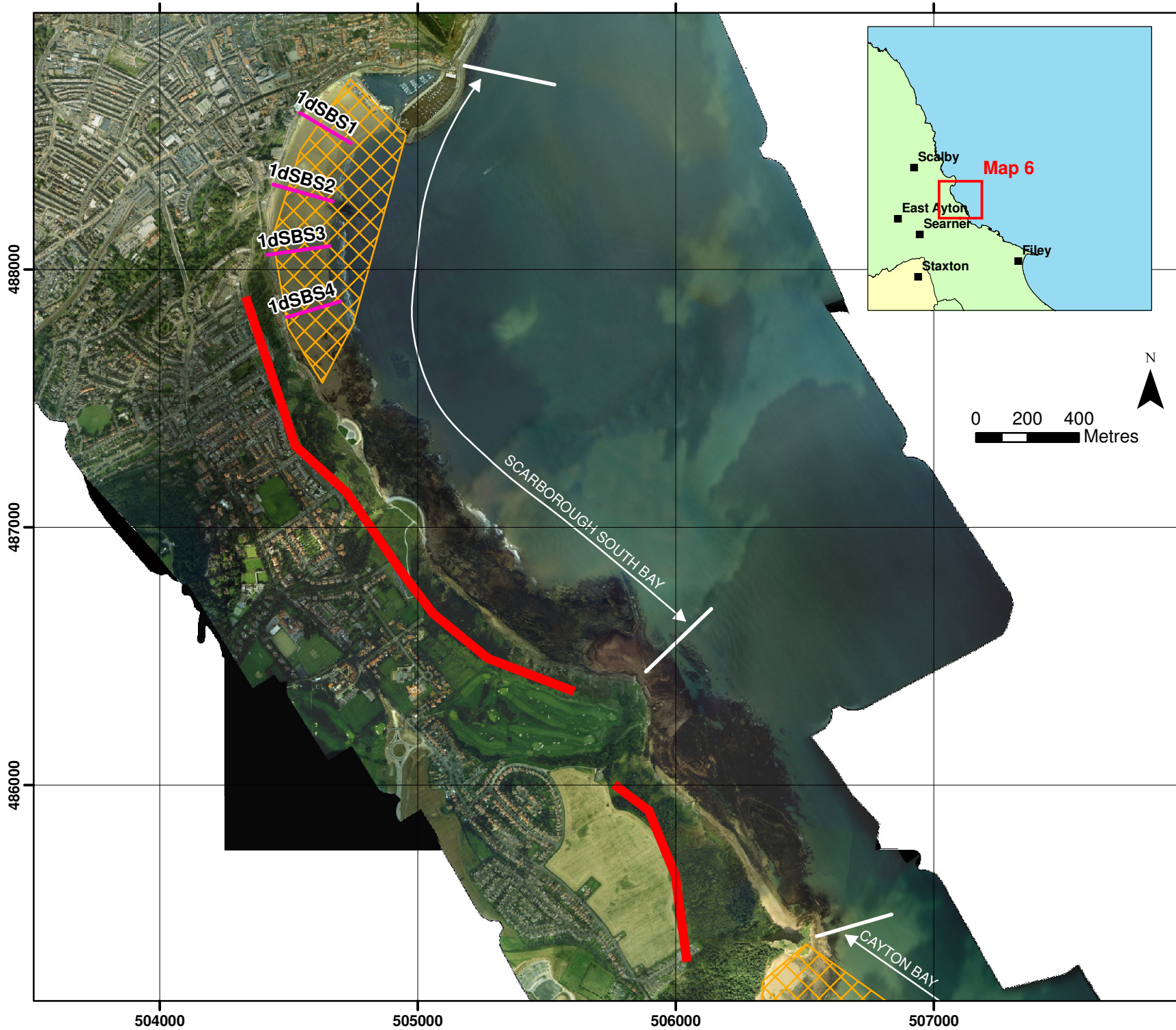
Figure 1 - Map 5
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Borough Council Frontage
 Update Report 2
 'Partial Measures' Survey 2010

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SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs

- @ 50 centres
- @ 100 centres
- @ 300 centres

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

**Figure 1 - Map 6
Scarborough
Borough Council Frontage**

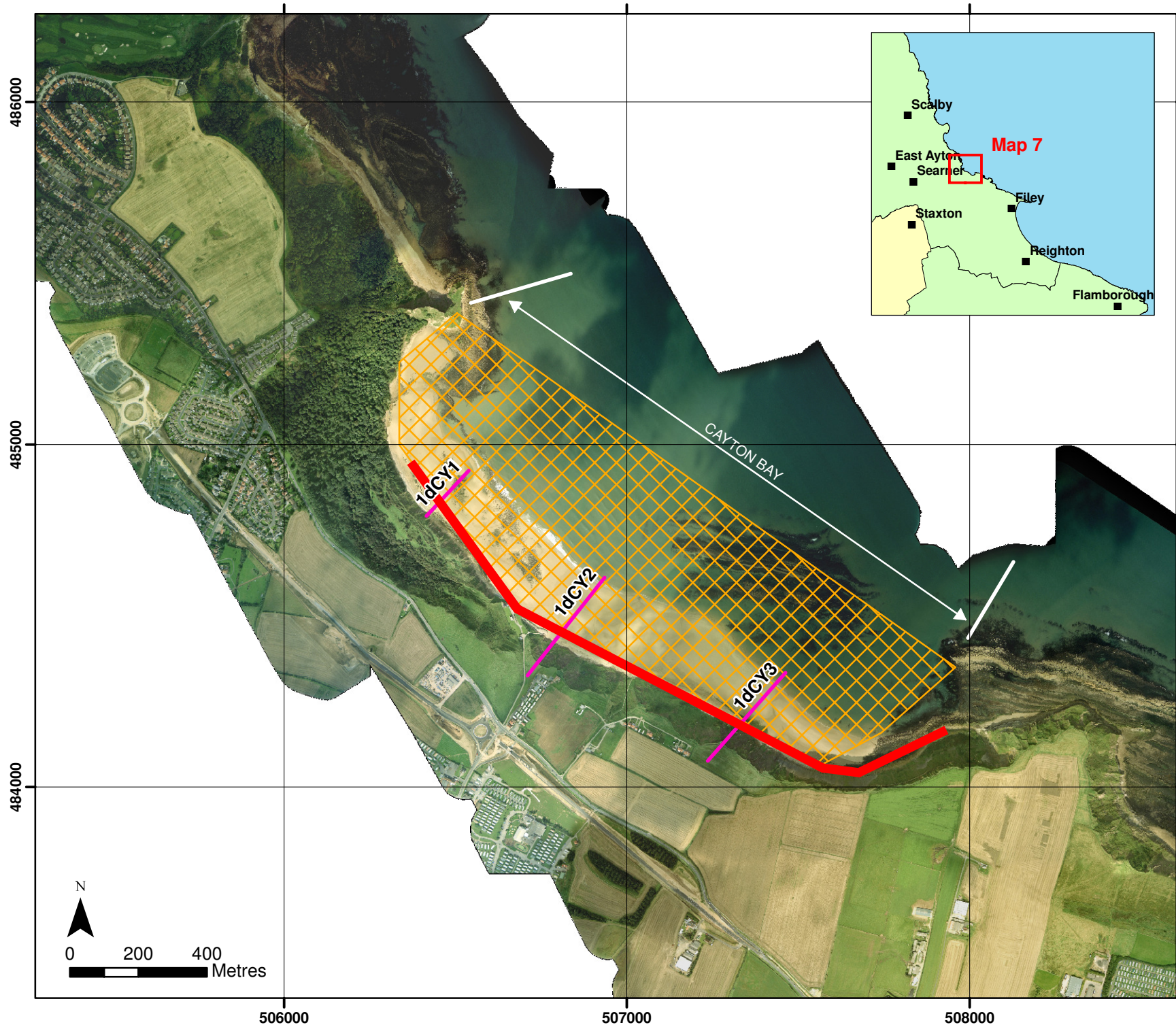
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'Partial Measures' Survey 2010

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SURVEY LOCATIONS

Topographic Profiles

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- Bi-Annual (Pink line)

Topographic Surveys

- 6 monthly (Green cross-hatch)
- yearly (Orange cross-hatch)
- 5 yearly (Brown cross-hatch)

Cliff Top Monitoring Pegs

- @ 50 centres (Purple square)
- @ 100 centres (Green square)
- @ 300 centres (Red square)

(Indicative Survey Extents shown)

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

**Figure 1 - Map 7
 Scarborough
 Borough Council Frontage**

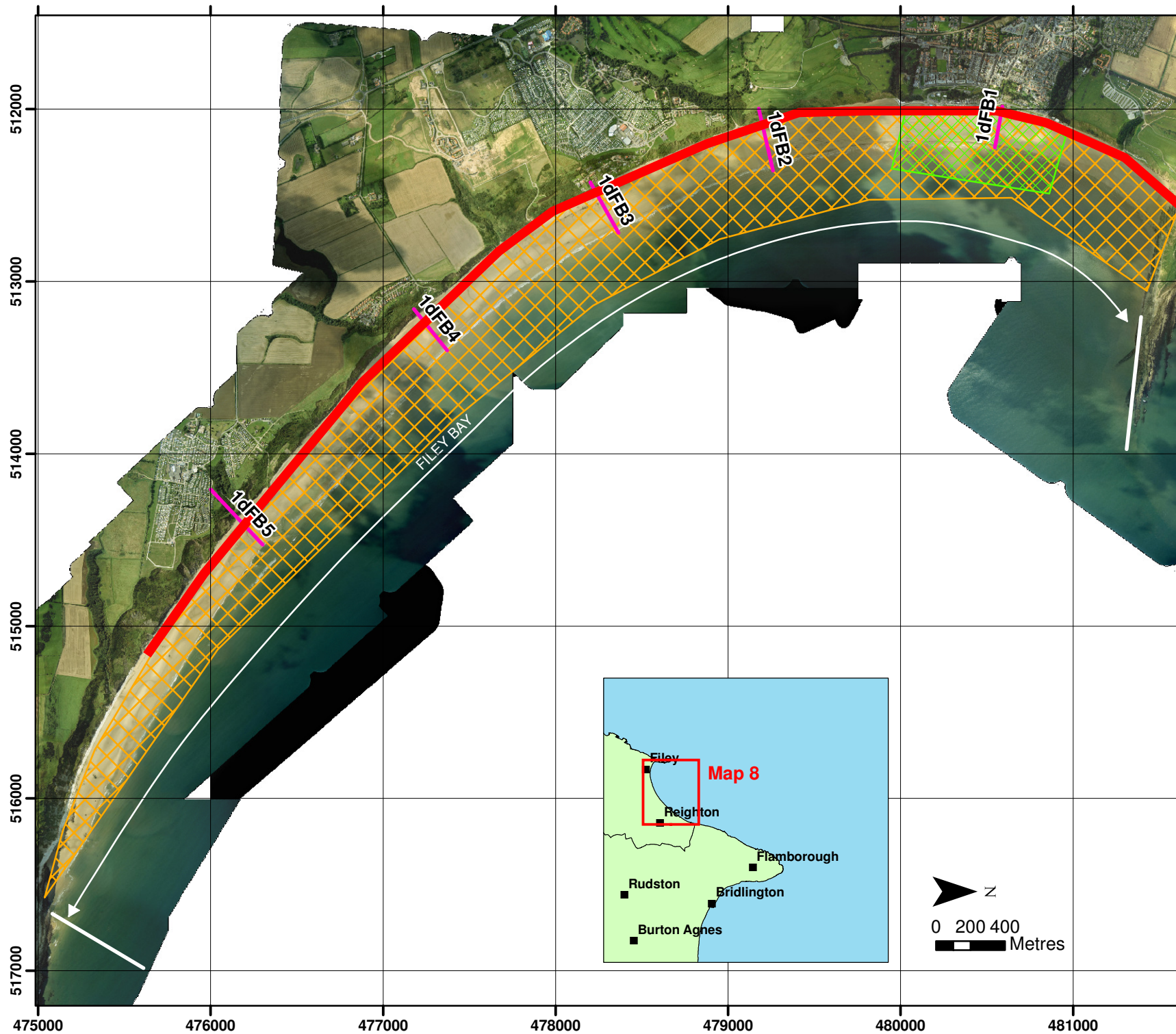
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SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs

- @ 50 centres
- @ 100 centres
- @ 300 centres

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

**Figure 1 - Map 8
Scarborough
Borough Council Frontage**

Update Report 2
'Partial Measures' Survey 2010

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2. Analysis of Survey Data

2.1 Staithes

Survey Date	Description of Changes Since Last Survey	Interpretation
02-2010	<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 typically around 100 m (although occasionally less). 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 February 2010 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.</p>	<p>When survey accuracy is taken into consideration, eight of the twenty points have shown no change since the November 2008 survey, indicating local stability of the cliff face. Five locations (points 2, 4, 5, 6, 13) have shown cliff line recession ranging 0.2- 2.1 m (± 0.1 m due to survey accuracy). Points 2, 4, and 13, have consistently registered cliff erosion in each full and partial measures report to date. Less consistent, but repeated, recession measurements are also determined for points 1 & 5. These survey locations are principally located in the west adjacent to Cow Bar Lane. The specific processes responsible for this recessional change would need to be determined by a dedicated field inspection. Seven locations (points 3, 9, 10, 12, 16, 17, 19) have shown an increase in distance to the cliff edge (0.2- 2.3 m). It is noted that points 3, 10, 12 (all in the west) have consistently registered an advancing cliff line; whilst possibly representing a toppling failure the far more likely scenario is different interpretation of the cliff edge between comparative surveys.</p>

2.2 Runswick Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
02-2010	<p>Topographic Survey:</p> <p>Runswick Bay is covered by a 6-monthly topographic survey. Data have been used to create a DGM (Appendix B - Map 1) using a Geographic Information System (GIS) computer software package.</p> <p>The GIS has also been used to calculate the differences between the current topographic survey DGM (February 2010) and the earlier topographic survey DGM (October 2009), with 5m raster grids (as shown in Appendix B – Map 2), to identify areas of erosion and accretion. Appendix B - Map 2 reveals a linear band of erosion at the head of the beach, and a clear depositional band running parallel to this at the seaward extent of the survey, indicating a reduced beach angle. The pattern of change to the north of the rock armour defences, around Runswick Bay village itself, is more complicated. Here there are areas of slight change interspersed with areas of minor erosion and deposition.</p>	<p>The beach at Runswick Bay has experienced migration of material seawards, and some shore parallel erosion at the head of the beach over the 2009-2010 winter period - which is typical of a storm dominated system. This is in contrast to the onshore movement of material recorded through the 2009 summer period, and suggests a seasonal cycle of onshore (swell dominated) and offshore (storm dominated) beach material movement.</p>

2.3 Sandsend Beach, Upgang Beach and Whitby Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
03-2010	<p>Beach Profiles:</p> <p>The frontage spanning Sandsend Beach, Upgang Beach, and Whitby Sands is covered by three beach profile lines, spaced between Sandsend and Whitby West Cliff (Appendix A).</p> <p>WB 1- The beach level has risen since the last survey, by up to 0.9 m along its surveyed length. The greatest accumulations occur at the toe and the head of the beach. The beach gradient has changed little since the previous survey.</p> <p>WB 2- The cliff face has shown negligible change, although fresh sediment exposures are locally evident in the survey photos. The beach shows significant accretion between c. 145 to 200 m chainage, with a gain of up to c. 1.4 m. The beach elevation at this location (3.7 m ODN) is in excess of MHWS at 2.6 m ODN, and therefore affords increased protection to the cliff toe. From c. 200 m there is an area of erosion of up to c. 1.4 m. Consequently there is a notable increase in overall beach gradient.</p> <p>WB 3- The stabilised face of Whitby West Cliff demonstrates negligible change, other than that anticipated with inter survey accuracy. The upper beach between c. 90 and 160 m chainage shows erosion of up to 1 m, reducing the beach elevation to below MHWS (2.6 m ODN). Seawards of 160 m chainage the beach surface is similar to that existing during October 2009. Consequently there has been a slight reduction in beach gradient.</p>	<p>WB 1- The increased beach level has reduced exposure of the seawall toe.</p> <p>WB 2- The accumulation of material at the upper beach has reduced the exposure of the cliff toe.</p> <p>WB 3- The slight erosion of the upper beach is typical of a winter beach profile adjustment. There is increased exposure of the seawall toe.</p> <p>Taken together these profiles suggest beach head accretion towards Sandsend, and beach head degradation towards Whitby. This would contrast the net south easterly sediment transfer reported in the March 2010 full measures report. The latter has the benefit of a spatially extensive topographic survey, which is not performed during the partial measures survey for this frontage. The interpreted change in long shore sediment transfer, from a small number of beach profiles alone, should therefore be viewed with caution.</p>

2.4 Robin Hood's Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>Topographic Survey:</p> <p>Robin Hood's Bay is covered by a 6-monthly topographic survey. Data have been used to create a DGM (Appendix B - Map 3) using a GIS computer software package.</p> <p>The GIS has also been used to calculate the differences between the current topographic survey DGM (March 2010) and the earlier topographic survey DGM (September 2009), with 5m raster grids (as shown in Appendix B – Map 4), to identify areas of erosion and accretion. Appendix B - Map 4 reveals broad areas of insignificant change (+/- 0.1 m) across this frontage during the winter of 2009-2010. In addition the plot shows a number of localised erosional and depositional hotspots, including areas of intense erosion underlying the cliffs at Dungeon Hole and West Scar.</p>	<p>The areas of lower magnitude erosion & deposition are scattered throughout the bay, in no discernable pattern. This is likely to be a consequence of both the relative erosional resistance of the rock platforms and the limited sediment supply to the bay. In contrast, the erosional hotspots are likely to correspond to more mobile and local pockets of sand.</p> <p>This interpretation is consistent with those previously provided for Robin Hood's Bay.</p>
03-2010	<p>Cliff Top Survey:</p> <p>Thirteen ground control points have been established at Robin Hood's Bay (on 3 March 2010) for the purposes of cliff top monitoring. The separation between any two points is around 200m. The cliff top surveys at Robin Hood's Bay 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 2010 (baseline) survey, showing the distance from the ground control point to the edge of the cliff top along the defined bearing (Appendix C- Map 2). Future reports will show results from subsequent surveys, and the data will provide a means of quantifying erosion since the baseline survey.</p>	<p>No change can be currently reported. These measurements will help manage risks posed by cliff instability, and may in due course assist in the evaluation of climate change impacts.</p>

2.5 Scarborough North Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
03-2010	<p>Beach Profiles:</p> <p>Scarborough North Bay is covered by five beach profile lines, spaced between the Oceanarium at Scalby Mills to Clarence Gardens (Appendix A).</p> <p>SBN 1- The whole profile lies below MHWS (2.45 m ODN). It has experienced accretion between 12-55 m chainage (maximum 0.25 m), little change between 55-85 m chainage, and erosion between 85-130 m chainage (maximum 0.30 m). The upper and middle beach has therefore steepened. The survey did not extend as far seaward as previous surveys.</p> <p>SBN 2- The upper beach adjoining the seawall, between c. 8 and 45 m chainage, has experienced significant erosion of up to 1.8 m. The beach elevation in this location (maximum 1.60 m) is now below MHWS (2.45 m ODN). Seaward of 45 m chainage significant deposition of up to 1.25 m has occurred. These changes have collectively reduced the beach profile gradient.</p> <p>SBN 3- The top of the beach has experienced significant erosion, with lowering of the beach surface by up to 3.1m between chainage c. 12-90 m. This has exposed a greater extent of the seawall and access ramp to wave attack. The beach elevation in this location (maximum 0.50 m) is now below MHWS (2.45 m ODN). Between chainage c. 90-155 m there has been accretion of up to 0.5 m.</p> <p>SBN 4- The beach profile has experienced an overall loss of material. Between chainage c. 35- 60 m the uneven topography includes rock platform and boulder deposits where the survey profile shows large stretches of negligible change, interspersed with zones of erosion (40- 48 m chainage, c. 0.75m) and deposition (52- 58 m chainage, c. 0.2 m). Seaward of this the beach level has dropped by up to 0.6 m. The beach toe has changed little. The overall beach gradient is slightly reduced.</p> <p>SBN 5- The beach profile has eroded slightly along the majority of its length (c. 35-125 m chainage, 0.2 m), since the previous survey. There has been deposition of material of up to 0.4 m at the toe of the beach. There has been little change in gradient.</p>	<p>SBN 1- Shows moderate accretion fronting the seawall, and a reduction of beach elevation down profile. These changes may slightly increase protection to this built structure. At the toe of the beach (chainage 100m onwards), the limited recent survey data suggests that the beach is considerably lower than in previous surveys, in which it had been steadily accreting.</p> <p>SBN 2- Throughout previous surveys, there had been a steady accretion across the whole beach, but especially at the head. However, the most recent survey indicates a marked change in profile shape, with significant erosion immediately in front of the seawall.</p> <p>SBN 3- Shows significant erosion in front of the seawall, some of this material is deposited on the lower beach, but most is lost from the profile axis. These changes bring about a marked alteration in the profile shape.</p> <p>SBN 4- Past the rock platform, there has been a seaward transfer of beach sediments. This is a typical winter beach profile adjustment.</p> <p>SBN 5- Indicates a seaward transfer of beach sediments. Wave energy impacting the sea defences is unlikely to be significantly different.</p> <p>Taken together these profiles suggest a seaward transfer of beach materials, especially in the centre of the Bay (SBN 2- 4). No Long-shore changes are</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
		readily discernable from these profile data, being better identified by the full measures topographic survey at this location.

2.6 Scarborough South Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
03-2010	<p>Beach Profiles:</p> <p>Scarborough South Bay is covered by four beach profile lines, situated between the Old Harbour in the north, to The Spa Complex in the south (Appendix A).</p> <p>SBS 1- The beach levels have generally remained stable since the previous survey. However, the previously undulating profile has flattened in a typical storm response, leading to individual areas of accretion / erosion of up to 0.4 m. The overall gradient of the resulting beach profile has changed little.</p> <p>SBS 2- The beach profile has experienced notable erosion beneath the seawall (chainage c. 5- 65 m), with lowering of up to c. 0.8m. Beyond c. 65 m chainage the beach profile has changed little since the previous survey, with maximum erosion and accretion of less than 0.2 m. Beach gradient has reduced slightly.</p> <p>SBS 3- The beach fronting the seawall has been further eroded. Consequently the beach level (1.17 m ODN) is now further below MHWS of 2.45 m ODN. Between c. 10 and 90 m chainage erosion of c. 0.9 m (maximum) occurs. Further seaward there has been little change in the beach profile, with accretion up to 0.2 m. Beach gradient has reduced since the previous survey.</p> <p>SBS 4- Erosion of up to 0.8 m has occurred between the seawall toe and 90 m chainage; this has revealed a rock platform, which in combination with pools in the sandy beach surface accounts for the irregular beach profile. Seawards of 95 m chainage accretion of up to c. 0.7 m has occurred. Overall beach gradient has lessened slightly since the previous survey</p>	<p>SBS 1- There has been little overall change in the beach profile.</p> <p>SBS 2- There has been a notable reduction of beach sediments fronting the seawall; otherwise the beach profile shows little change.</p> <p>SBS 3- There has been a notable reduction of beach sediments fronting the seawall, and a slight gain in elevation down profile. These changes are typical of winter season morphodynamics. Future surveys will confirm whether the erosion at the base of the seawall is a seasonal- or a longer-term trend.</p> <p>SBS 4- There has been a reduction in the beach level fronting the seawall, and a moderate gain in elevation down profile. These changes are typical of winter season morphodynamics.</p> <p>Taken together these profiles suggest a seaward transfer of beach materials, especially in the centre and south of the Bay (SBS 2- 4). No Long-shore changes are readily discernable from these profile data, being better identified by the full measures topographic survey at this location.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>Cliff Top Survey:</p> <p>Thirteen ground control points have been established at Scarborough South Bay- extending through Cornelian Bay, to Knipe Point within Cayton Bay (on 1 March 2010) for the purposes of cliff top monitoring. The separation between any two points is around 300m. The cliff top surveys at Scarborough South Bay 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 2010 (baseline) survey, showing the distance from the ground control point to the edge of the cliff top along the defined bearing (Appendix C- Map 3). Future reports will show results from subsequent surveys, and the data will provide a means of quantifying erosion since the baseline survey.</p>	<p>No change can be currently reported. These measurements will help manage risks posed by cliff instability, and may in due course assist in the evaluation of climate change impacts.</p>

2.7 Cayton Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
03-2010	<p>Beach Profiles:</p>	
	<p>Cayton Bay is covered by three beach profile lines, spaced between Tenants' Cliff and the south of Cayton Sands (Appendix A).</p>	<p>CY 1- Shows active rockfall (cliff recession) at the rear of the beach, and typical winter season beach profile morphodynamics.</p>
	<p>CY 1- The cliff face is largely vegetated and shows no change. From c. 0 to 5 m chainage there is a slight elevation gain; this may correspond with a previously reported active rockfall debris cone. Between c. 15 and 70 m chainage the beach has experienced erosion of up to c. 1 m, exposing further boulders and in-situ rock which account for the irregular profile. Seawards of c. 70 m chainage the beach has accreted, by up to a maximum of 0.5m.</p>	<p>CY 2- Shows slight change to the cliff profile, and typical winter season beach profile morphodynamics. CY 3- Shows slight change to the cliff profile, and a significant loss of material from the intertidal zone.</p>
	<p>CY 2- The cliff top shows minor recession between surveys, and the exposed cliff toe has been eroded (c. 117-130 m chainage) with recession of up to 5 m at the 3 m AOD contour. The beach profile shows two zones of change: (1) erosion between c. 130- 240 m chainage, maximum c. 0.5 m; and (2) accretion from 270 m chainage onwards, maximum 0.3 m. The overall beach gradient has reduced slightly as a result.</p>	<p>Taken together these profiles suggest a seaward transfer of beach materials. No Long-shore changes are readily discernable from these profile data, being better identified by the full measures topographic survey at this location.</p>
<p>CY 3- The survey of the cliff face remains interpolated. However, the surveyed cliff toe has retreated by c. 3 m (see survey photos- not appended here). The beach profile has lowered throughout the majority of the intertidal zone, up to a maximum of 0.9 m, and has experienced progradation at the beach toe. The resulting beach gradient is slightly reduced</p>		

Survey Date	Description of Changes Since Last Survey	Interpretation
	<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 300 m. The cliff top surveys at Cayton Bay 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 2010 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.</p>	<p>When survey accuracy is taken into consideration, two of the eight points have shown no change since the November 2008, indicating general stability of the cliff face amongst these survey localities. Two locations (points 1 & 2) have shown cliff line recession ranging 0.5- 5.1 m (± 0.1 m due to survey accuracy). Point 1 has consistently registered cliff erosion in each full and partial measures report to date. Less consistent, but repeated, recession measurements are also determined for point 2. These survey locations are principally located in the north adjacent in Tenants' Cliff. Active rockfalls on this seacliff are reported by beach profile CY1, although a dedicated field inspection would be required to establish if rockfall accounts for the recorded recession at these cliff top survey locations. Four locations (points 3, 5, 7 & 8) have shown an increase in distance to the cliff edge (0.3 to 1.3 m). It is noted that points 3 & 5 (in the centre of the Bay) have on more than one occasion registered an advancing cliff line; whilst possibly representing a toppling failure the far more likely scenario is different interpretation of the cliff edge between comparative surveys.</p>

2.8 Filey Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
03-2010	<p>Beach Profiles:</p> <p>Filey Bay is covered by five beach profile lines, spaced between Filey Sands and Speeton Sands (Appendix A).</p>	
	<p>FB 1- There has been marked change in the level of the beach fronting the seawall, and a smoothing of the beach profile, even though the overall beach gradient shows no change (0.018 m m^{-1}). There have been two main areas of change: erosion between c. 18-100 m chainage (maximum c. 0.5 m); and accretion between c. 100-185 m chainage (maximum c. 0.4 m).</p>	<p>FB 1- The profile shows zones of accretion and erosion. The latter is more extensive fronting the seawall, and will therefore reduce protection against wave attack. The beach profile morphodynamics are typical of the winter season.</p>
	<p>FB 2- Both cliff top and toe have been static since the last survey. There has been loss of beach materials which previously accumulated at the toe of the cliff, with lowering of up to 1.1 m compared to the previous profile. Seaward of 110 m chainage the beach profile has flattened since the last survey, with areas of accretion and erosion of up to 0.5 m and 0.3 m respectively. The overall beach gradient has experienced little change.</p>	<p>FB 2- This shows a smoothing of the beach profile, and a reduction in beach protection to the cliff toe. The beach profile morphodynamics are typical of the winter season.</p>
	<p>FB 3- The upper cliff remains unchanged, although the toe shows signs of ongoing active instability (see survey team photos, not appended here). The beach profile has been further smoothed, with the main changes since the last survey being: erosion of material c. 40-115 m chainage (maximum 0.45 m); and slight accretion c. 120 m chainage onwards (maximum c. 0.25 m). The overall beach gradient has reduced slightly.</p>	<p>FB 3- The beach morphology has been further smoothed and offers reduced protection to the cliff toe, with a slight transference of materials seawards.</p> <p>FB 4- Shows a similar gradient, with moving profile concavity and convexity resulting in a seawards movement of materials.</p>
	<p>FB 4- The survey of the cliff face remains interpolated, and at this coarse level shows no change; although survey photos (not appended here) indicate an active and unvegetated cliff face. The beach has changed locations of profile concavity and convexity, relative to those witnessed in previous surveys. The most significant changes are intermittent erosion c. 30- 140 m chainage (maximum c. 1.1 m), and accretion 140- 225 m chainage (maximum c. 0.7 m). The beach gradient remains similar to that seen previously.</p> <p>FB 5- The survey photos of the cliff face (not appended here) show active instability, although the extent of this cannot be determined from the interpolated data from these surveys. The beach fronting the cliff toe has lowered by a maximum of 0.85 m (c. 220- 295 m chainage). Seawards of</p>	<p>FB 5- The beach shows undulating change, tending to seawards transfer of materials, with the cliff toe more exposed than seen in the previous survey.</p> <p>Taken together these profiles suggest a seaward transfer of beach materials. No Long-shore changes are readily discernable from these profile data, being better identified by the full measures topographic survey at this location.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
	<p>this there are pockets of erosion and accretion of up to 0.3 m and 0.7 m, respectively, which have had little change on the overall form of the beach.</p> <p>Topographic Survey (Filey Town):</p> <p>Further to the spatially comprehensive annual survey of Filey Bay, a smaller (selected) area within this extent (i.e. fronting Filey Town) is also surveyed in the partial measures programme, enabling bi-annual analysis of beach change for this locality. Data have been used to create a DGM (Appendix B - Map 5) using a Geographic Information System (GIS) computer software package.</p> <p>The GIS has also been used to calculate the differences between the current topographic survey DGM (March 2010, partial measures) and the earlier topographic survey DGM (October 2009, full measures) with 5m raster grids (as shown in Appendix B – Map 6), to identify areas of erosion and accretion. Appendix B - Map 6 reveals a linear band of erosion at the head of the beach, immediately beneath the seawall, and a clear depositional band running parallel and seaward of this.</p> <p>Cliff Top Survey:</p> <p>Twenty-three ground control points have been established within Filey Bay for the purposes of cliff top monitoring. The maximum separation between any two points is nominally 300 m. The cliff top surveys at Filey Bay 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 2010 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.</p>	<p>The upper beach at Filey town has experienced erosion at the head of the beach, with deposition observed further seaward. This pattern of elevation change supports of the findings shown by the beach profiles. This change signal is in part considered to reflect seasonal beach morphodynamics, where beach materials move on (summer- swell dominated) and offshore (winter- storm dominated) according to seasonal wave conditions.</p> <p>When survey accuracy is taken into consideration, twelve of the twenty-three points have shown no change since the November 2008, indicating general stability of the cliff face amongst the surveyed localities. Three locations (points 5, 11, 14) have shown cliff line recession ranging 0.3- 5.6 m (± 0.1 m due to survey accuracy). Point 5 (immediately south of Filey Town) has consistently registered cliff erosion in each full and partial measures report to date. Less consistent, but repeated, recession measurements are also determined for points 11 & 14. The cause of this recession would need to be established by a dedicated field inspection. Eight locations (points 1, 3,</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
		<p>4, 6, 7, 9, 18, 20) have shown an increase in distance to the cliff edge (0.2 to 0.3 m). It is noted that point 3 (to the north of Filey Town) has consistently registered cliff advance. Less consistent, but repeated, advance measurements are also determined for points 4, 7 & 9. Whilst possibly representing a toppling failure the far more likely scenario is different interpretation of the cliff edge between comparative surveys.</p>

3. Problems Encountered and Uncertainty in Analysis

Topographic survey

As outlined in Analytical Report 2 (March 2010).

Survey accuracy of beach/ cliff profiles

Determining the occurrence and indeed magnitude of cliff face change is difficult from the existing combination of interpolated survey profiles and survey photos. Further consideration to improving data capture for steep and unstable cliff locations would assist interpretation and reporting.

Cliff top erosion errors & data capture techniques

The cliff top surveys are in general assumed to have a limit of accuracy of $\pm 0.1\text{m}$ due to the techniques used. At a sizeable number of locations apparent cliff advance is calculated, which is highly unlikely excepting a toppling mechanism of failure. It is more likely that this is due to a different point being identified as the edge of the cliff, especially with different seasonal vegetation covers. This problem is now marked at Staithes, Cayton Bay and Filey Bay, which suggests that this is not just a problem at a single site, but perhaps the product of the adopted technique, and also inherent to the interpretation of data which currently only span a short-period of time. To improve the data quality, enhancing their long-term value, a visit to all measurement locations by a cliff geomorphologist would provide a useful means to evaluate this issue further.

Consideration to commissioning repeat terrestrial laser scan surveys of cliff faces and tops should be undertaken at key locations within the cliff top survey areas. At these cliffs, selected on the grounds of high hazard and risk potential, the increased accuracy and resolution of data would enable a very detailed appreciation of changing conditions, and thereby further inform management planning.

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

The following recommendations are suggested:

- Consider and implement measures to improve the accuracy of cliff top and cliff face survey data capture. This may include a site visit by a cliff geomorphologist, and a programme of targeted laser scanning, as these would increase understanding of cliff change thereby permitting improved management planning. Planned analysis of recently captured orthophotos may well be equally useful in this regard.
- Perform beach profile measurements to a consistent and high-resolution. This may include further attention given to: survey timing coincident with optimum tide and weather conditions, achieving maximum seaward survey extents, and the clear recording of survey dates.

5. Conclusions and Areas of Concern

- The Staithes frontage has shown areas of localised cliff top stasis, advance (erroneous survey), and recession. Hotspots for cliff top retreat at this time are principally to the west adjacent to Cowbar Lane, and more locally the cliff west of Penny Steel.
- The pattern of beach elevation change at Runswick Bay is dominated by two shore parallel bands of change: erosion (at head of the beach) and accretion (further seaward) and is typical of a winter storm type system.
- The Sandsend to Whitby frontage shows dynamic shifts in the beach profile with zones of accretion and erosion. At Sandsend and Uppgang upper beach accretion is notable; whereas at Whitby, erosion of the upper beach has occurred. Localised erosion of undefended cliff faces also occur.
- Robin Hood's Bay shows a largely stable foreshore, especially in areas dominated by rock platforms. Small erosional hotspots underlie the cliffs at Dungeon Hole and West Scar.
- At Scarborough North Bay the overall signal of beach change (excepting profile SB1) is a combination of erosion (at head of the beach) and accretion (further seaward), and is typical of a winter beach adjustment. The seawall is therefore afforded reduced protection to wave impact.
- At Scarborough South Bay the overall signal of beach change is a combination of erosion (at head of the beach) and accretion (further seaward), and is typical of a winter beach adjustment. The seawall is therefore afforded reduced protection to wave impact.
- At Cayton Bay cliff faces show localised evidence of ongoing instability and erosion, as evident from survey photos and monitoring data. Dynamic shifts in the beach surface occur, with zones of accretion and erosion. The overall pattern is that of seawards sediment transfer, comprising erosion at the head of the beach and accretion further seaward.
- At Filey Bay cliff faces show localised evidence of ongoing instability and erosion, as evident from survey photos. The cliff top survey generally shows positional stasis, with a number of locations displaying recession and some showing advance (erroneous survey). A particular recessional hotspot is the undefended cliff immediately south of the Filey seawall (location 5). Dynamic shifts in the beach surface occur, with zones of accretion and erosion. The overall pattern is that of seawards sediment transfer, comprising erosion at the head of the beach and accretion further seaward.

Appendices

Appendix A

Beach Profiles

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

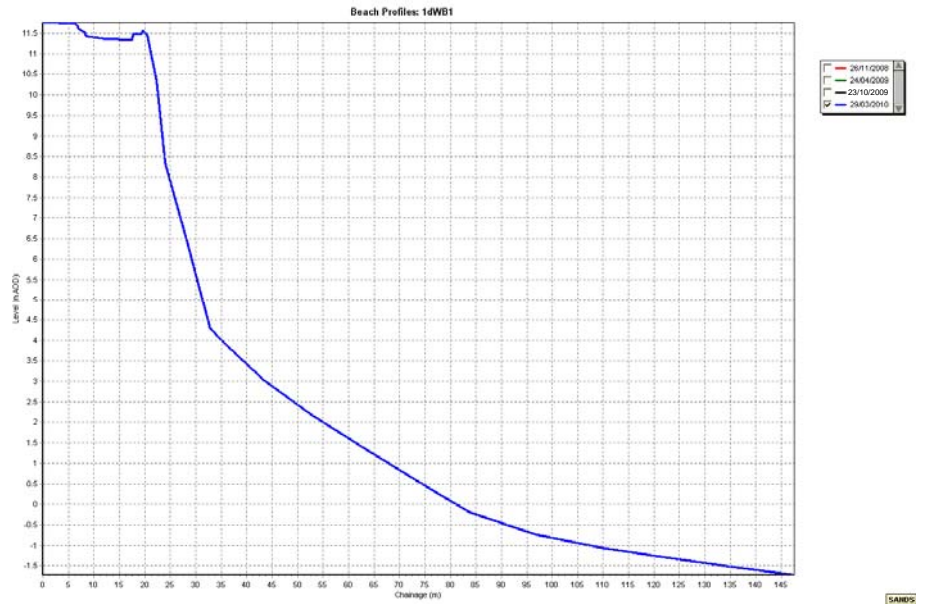
Code	Description
M	Mud
S	Sand
G	Gravel
GS	Gravel & Sand
GM	Gravel & Mud
MS	Mud & Sand
B	Boulders
R	Rock
SD	Sea Defence
SM	Salt Marsh
GR	Grass
D	Dune (non-vegetated)
DV	Dune (vegetated)
F	Forested
X	Mixture
FB	Obstruction
CT	Cliff Top
CE	Cliff Edge
CF	Cliff Face
SH	Shell
W	Water Body
ZZ	Unknown

Beach Profile

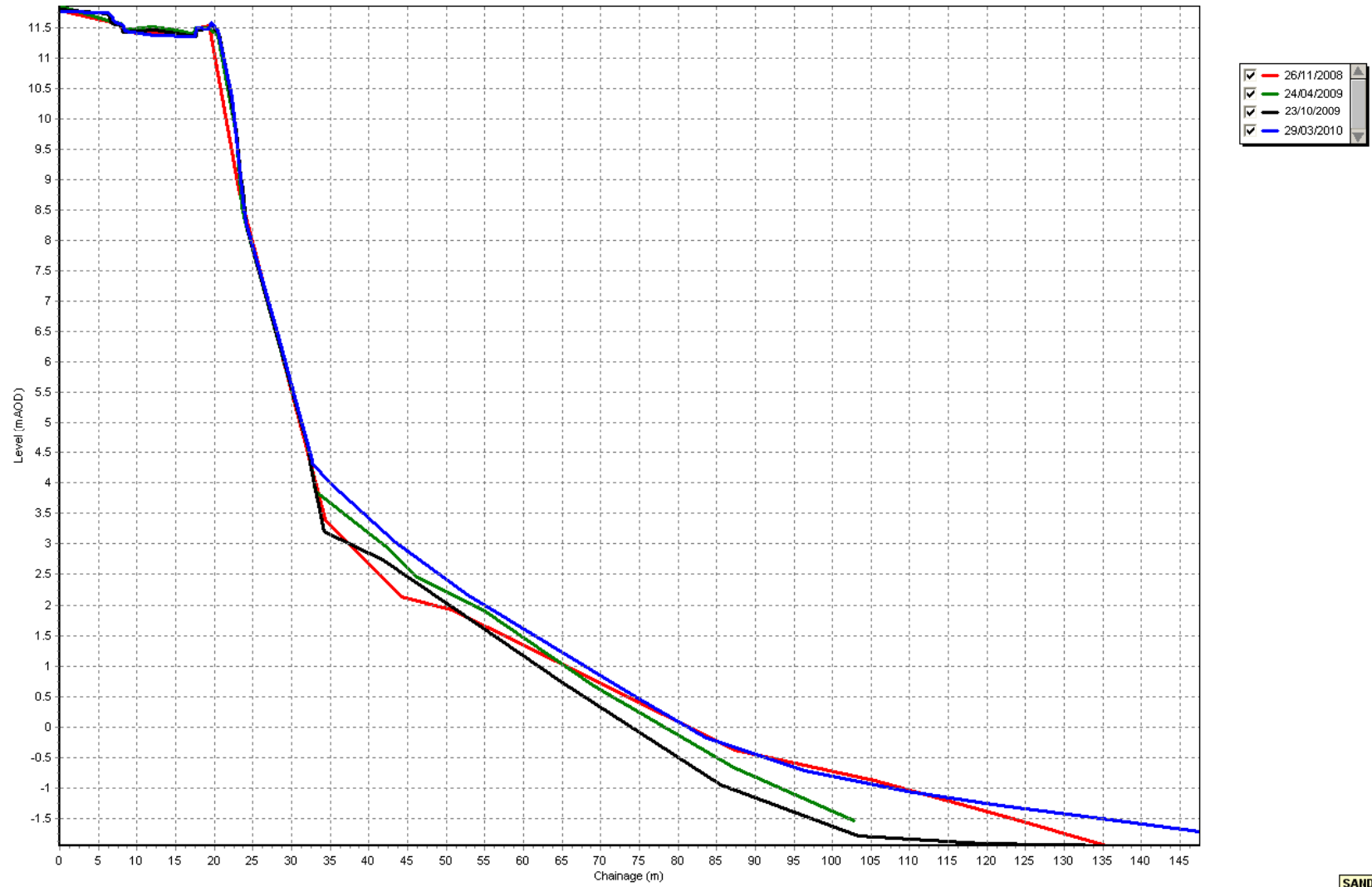
1dWB1

Date 29/03/2010	Inspector	Low Tide (m)	Low Tide Time
Wind	Sea State Rough	Visibility -	10.49
Summary Windy			Rain Yes
Easting 486535.075	Northing 512437.796	Bearing 32	

Chainage (from base station)	Level AOD (m)
0.000	11.762
0.018	11.762
6.337	11.75
6.726	11.688
7.032	11.608
8.237	11.524
8.357	11.438
12.163	11.368
17.521	11.344
17.633	11.49
19.385	11.476
19.599	11.575
20.442	11.445
22.264	10.352
23.816	8.524
24.052	8.276
28.341	6.417
32.637	4.368
32.678	4.318
34.934	4.013
43.454	3.018
52.659	2.175
63.349	1.346
74.798	0.468
83.68	-0.183
96.499	-0.724
109.584	-1.064
121.773	-1.288
134.719	-1.508
147.51	-1.719



Beach Profiles: 1dWB1



SANDS

Beach Profile

1dWB2

Date 29/03/2010	Inspector	Low Tide (m)	Low Tide Time
Wind	Sea State Rough	Visibility -	10.49
Summary Windy			Rain Yes
Easting 487550.221	Northing 511927.902	Bearing 32	

Chainage (from base station)	Level AOD (m)
0.000	36.483
0.175	36.483
11.316	36.16
23.891	35.886
30.688	35.8
34.785	35.328
41.543	35.046
52.51	34.66
54.457	34.2
55.737	33.577
56.91	32.571
60.562	31.43
64.793	29.331
67.126	28.772
68.529	27.993
71.438	27.53
75.364	27.49
77.263	27.585
77.899	28.344
79.058	28.9
81.202	29.957
85.321	31.199
90.049	32.628
91.363	33.275
98.777	21.507
102.783	19.309
104.412	18.521
107.903	17.626
110.939	16.315
114.266	16.806
116.517	17.336

118.429	17.425
120.262	16.451
121.673	15.994
123.448	13.362
126.199	12.444
129.924	10.044
133.089	9.264
134.019	8.727
136.586	8.629
138.581	7.713
140.304	7.026
144.545	3.706
147.675	3.614
155.75	3.517
164.255	3.438
176.733	2.657
188.214	1.733
199.94	0.833
213.298	-0.059
225.271	-0.729
237.636	-1.392
244.299	-1.729



Beach Profiles: 1dWB2



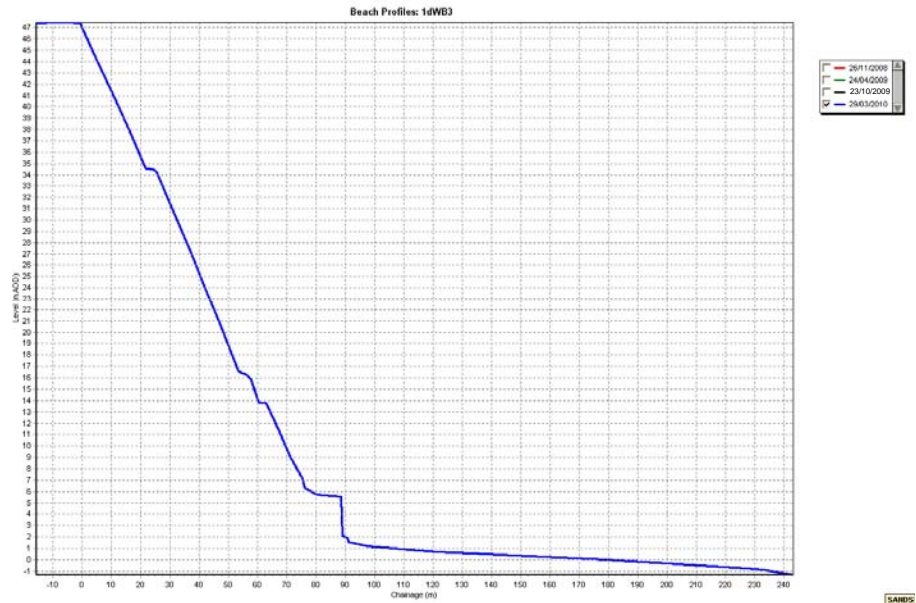
SAHDS

Beach Profile

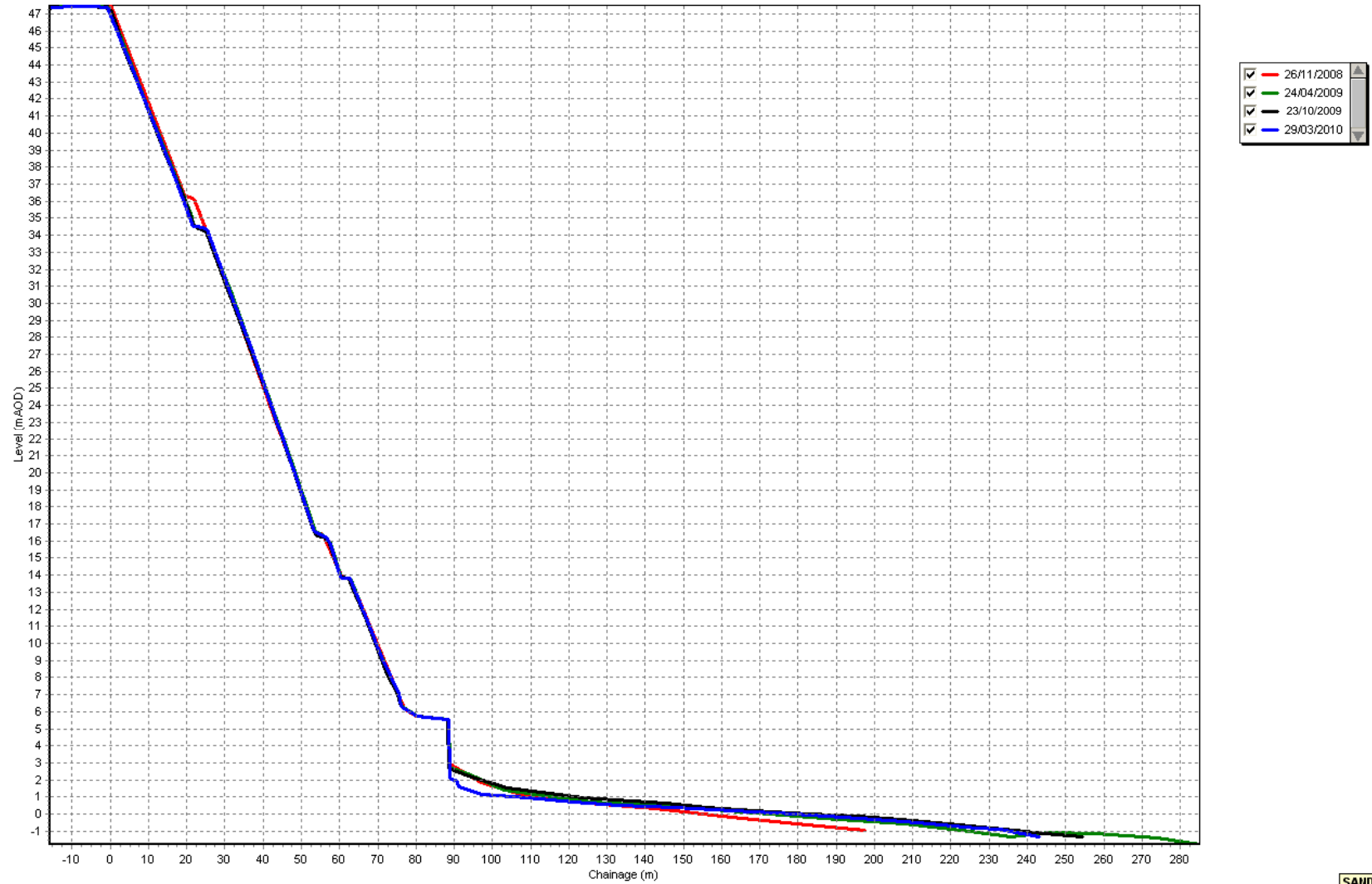
1dWB3

Date 29/03/2010	Inspector	Low Tide (m)	Low Tide Time
Wind	Sea State Rough	Visibility -	10.49
Summary Windy			Rain Yes
Easting 488978.58	Northing 511512.38	Bearing 19	

Chainage (from base station)	Level AOD (m)
-15.63	47.4
-15.373	47.39
-13.287	47.411
-13.18	47.38
-11.274	47.454
-11.098	47.467
-4.802	47.445
-0.75	47.374
5.461	43.957
11.087	40.704
15.989	37.949
21.613	34.525
22.351	34.531
24.057	34.471
24.789	34.39
25.358	34.297
30.801	31.037
36.845	27.344
44.003	22.747
47.86	20.286
53.351	16.569
53.943	16.48
55.683	16.335
56.462	16.21
57.696	15.801
60.237	13.87
60.986	13.8
62.807	13.8
63.12	13.602
66.978	11.495
71.264	9.034
75.454	7.088
76.138	6.288
77.014	6.172
80.29	5.758
85.483	5.603
88.448	5.544
88.951	2.101
90.775	1.915
91.04	1.574
97.445	1.167
109.238	0.941
121.305	0.688
133.205	0.531
147.788	0.375
163.099	0.205
179.125	-0.014
196.07	-0.232
211.441	-0.498
227.095	-0.794
232.69	-0.92
243.178	-1.335



Beach Profiles: 1dWB3



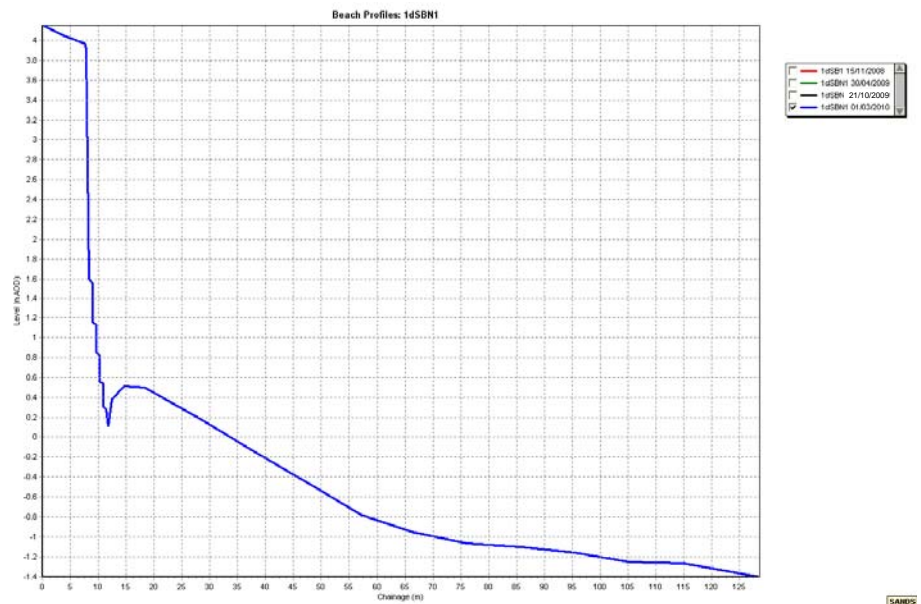
SANDS

Beach Profile

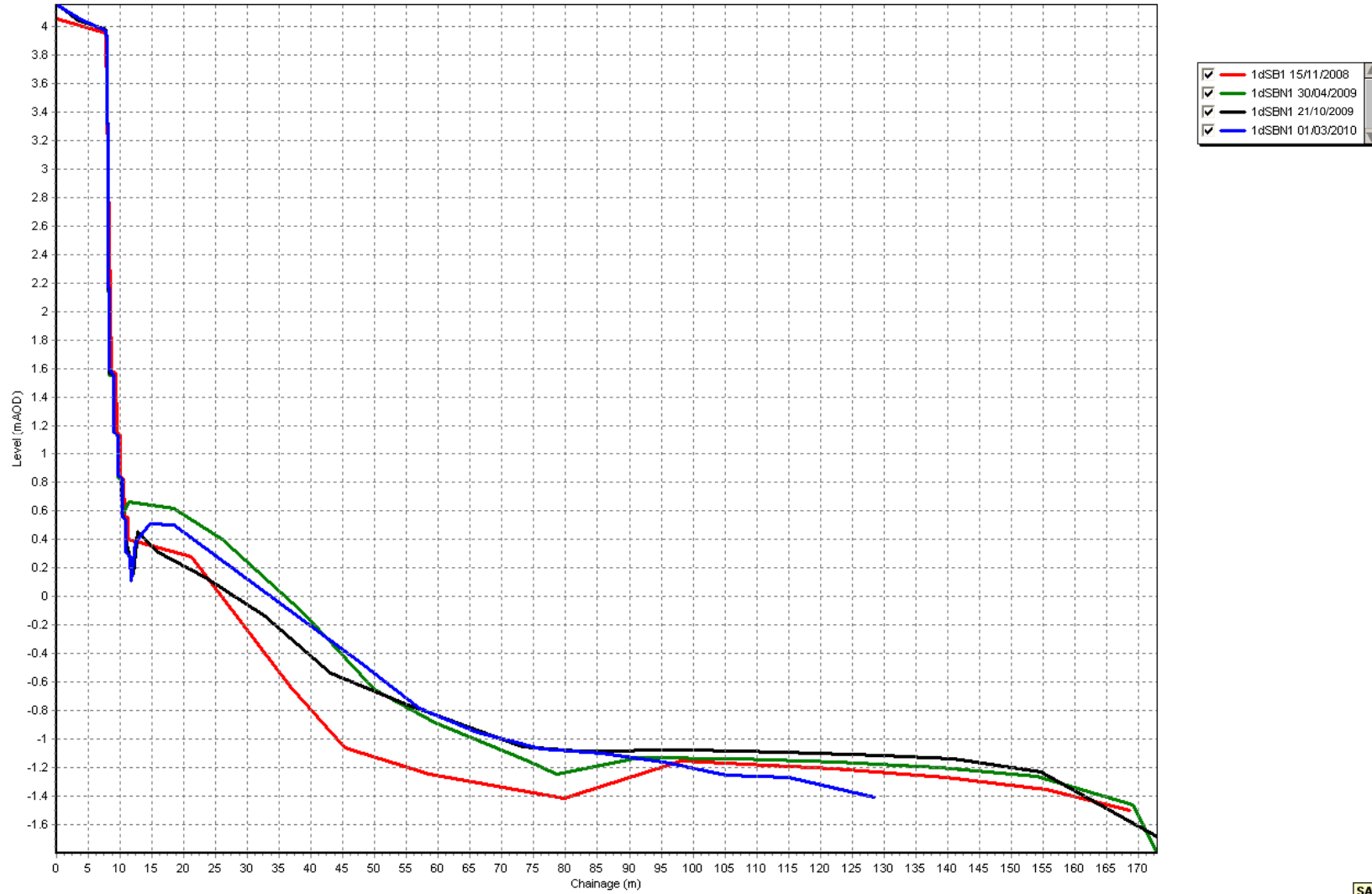
1dSBN1

Date 01/03/2010	Inspector	Low Tide (m)	Low Tide Time
Wind	Sea State Calm	Visibility -	09.54
Summary Fine			Rain No
Easting 503543.363	Northing 490470.74	Bearing 79	

Chainage (from base station)	Level AOD (m)
0.000	4.151
0.082	4.151
3.664	4.05
7.746	3.964
7.863	3.891
8.261	1.602
8.966	1.556
8.973	1.154
9.645	1.133
9.667	0.847
10.252	0.825
10.284	0.559
10.846	0.54
10.906	0.31
11.458	0.284
11.722	0.109
12.45	0.378
14.623	0.51
18.357	0.497
28.264	0.181
38.012	-0.149
47.878	-0.471
57.071	-0.782
66.213	-0.949
76.076	-1.067
85.831	-1.102
95.436	-1.157
105.159	-1.254
115.061	-1.268
128.572	-1.403



Beach Profiles: 1dSBN1



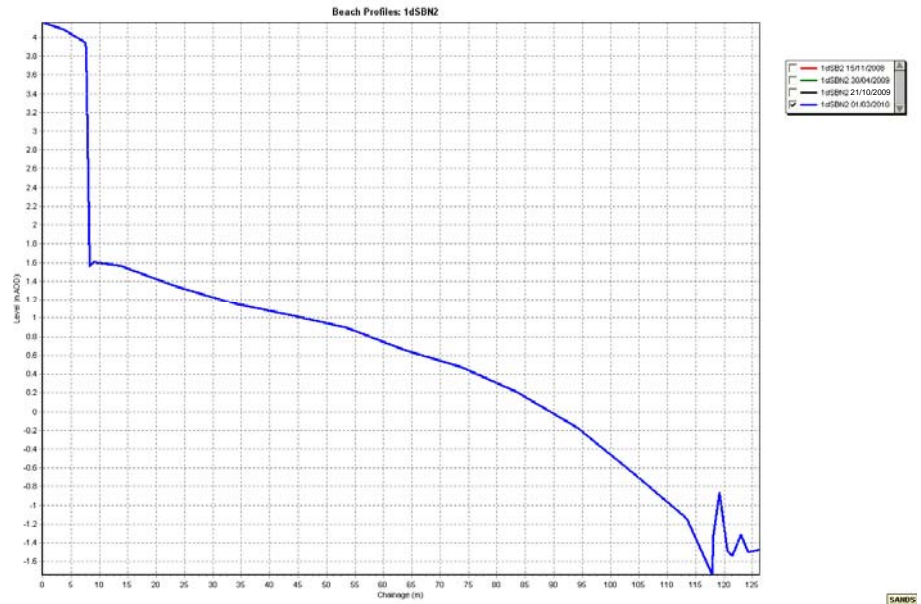
SAHDS

Beach Profile

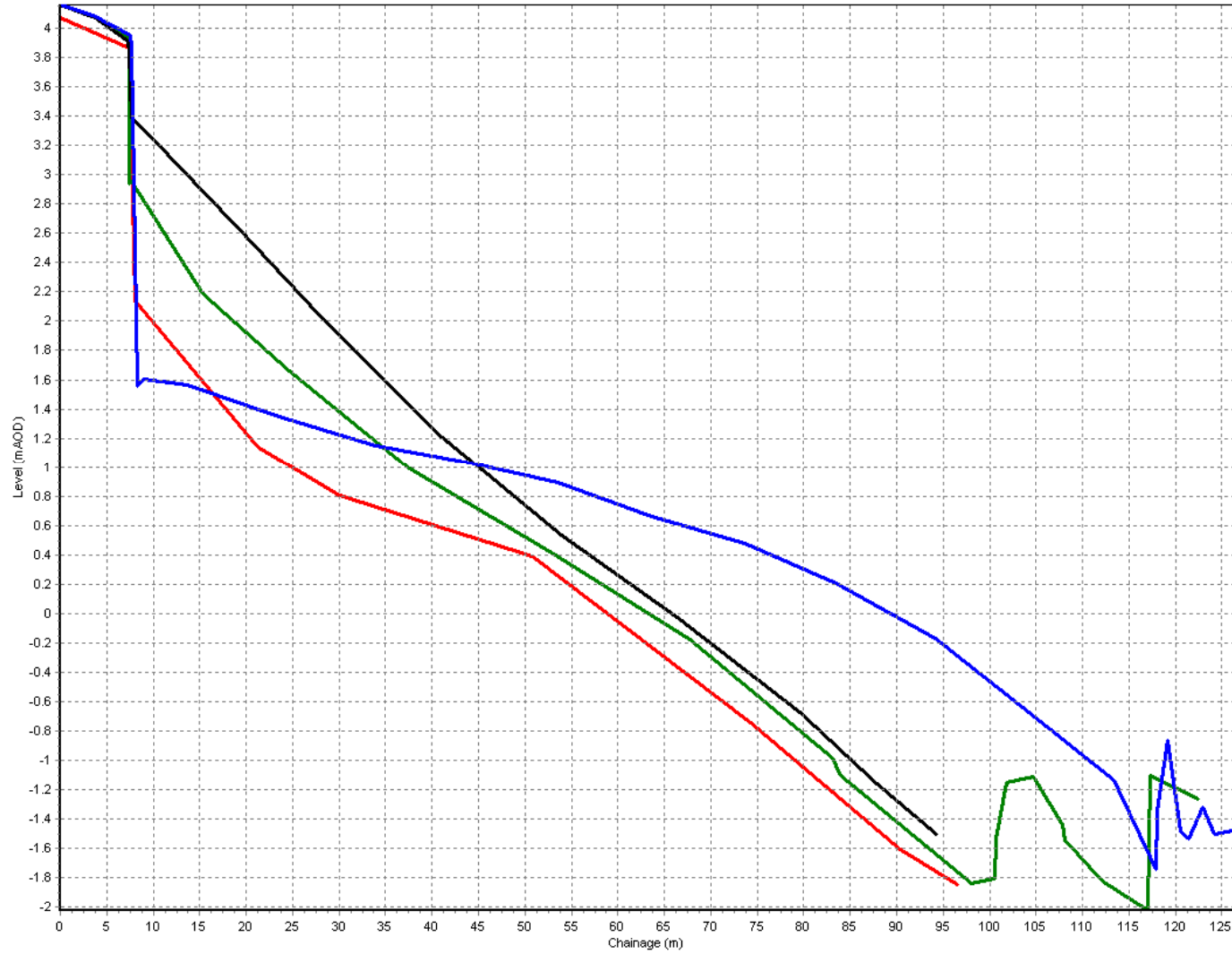
1dSBN2

Date 01/03/2010	Inspector	Low Tide (m)	Low Tide Time
Wind	Sea State Calm	Visibility -	09.54
Summary Fine			Rain No
Easting 503616.346	Northing 490135.674	Bearing 78	

Chainage (from base station)	Level AOD (m)
0.000	4.159
0.023	4.159
3.513	4.09
7.526	3.948
7.617	3.871
8.345	1.558
8.954	1.602
13.728	1.564
23.545	1.347
33.907	1.152
43.462	1.036
53.558	0.896
63.626	0.663
73.68	0.478
83.44	0.208
94.186	-0.171
104.257	-0.67
113.4	-1.136
117.881	-1.742
118.062	-1.341
119.142	-0.865
120.542	-1.479
121.443	-1.535
122.948	-1.317
124.175	-1.501
126.196	-1.478



Beach Profiles: 1dSBN2



- 1dSBN2 15/11/2008
- 1dSBN2 30/04/2009
- 1dSBN2 21/10/2009
- 1dSBN2 01/03/2010

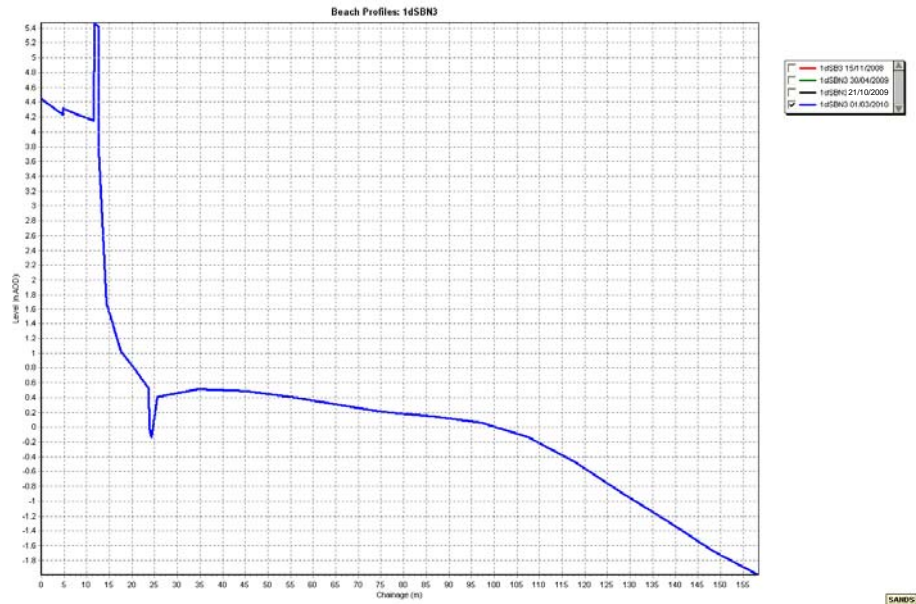
SANDS

Beach Profile

1dSBN3

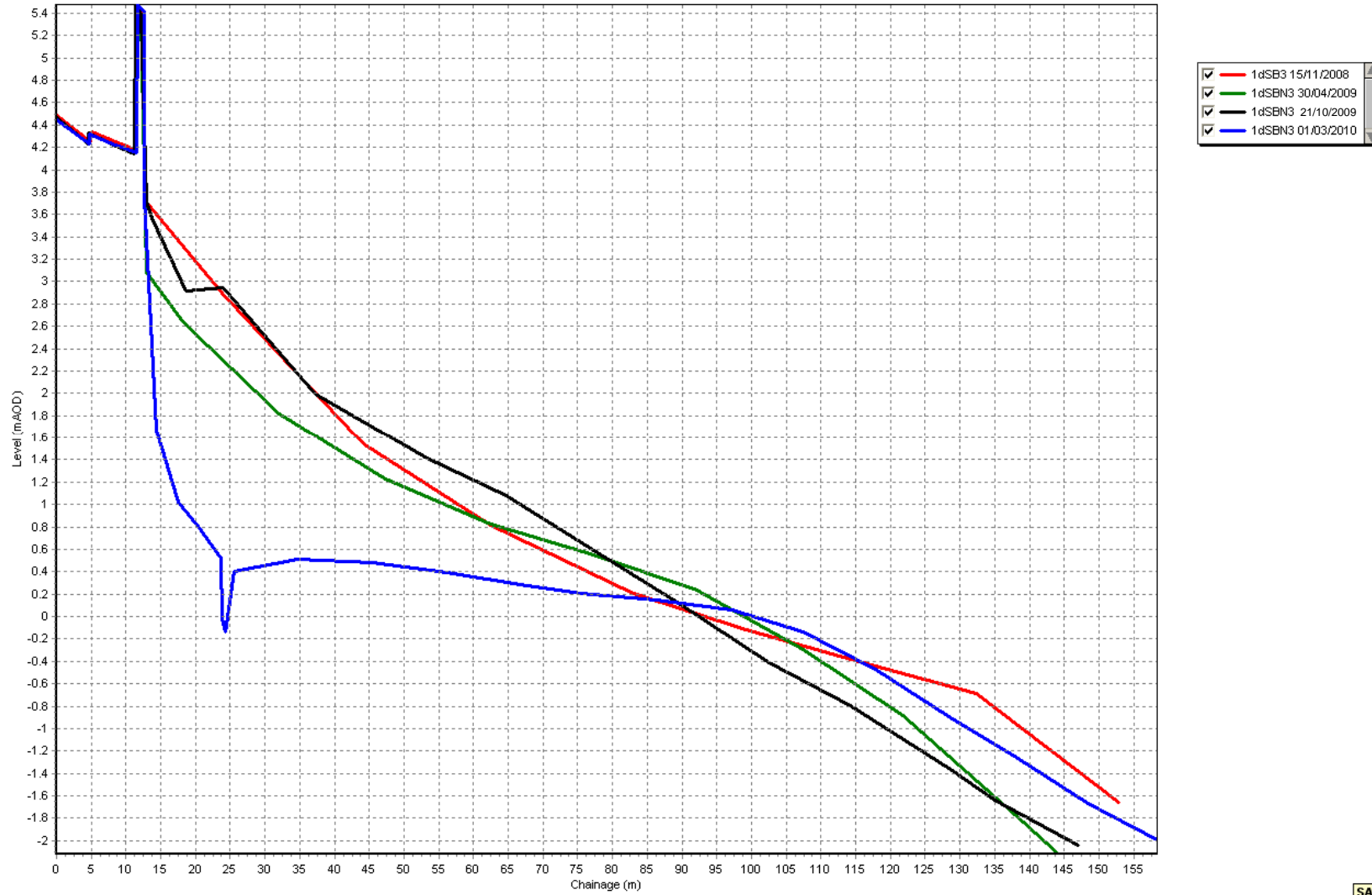
Date 01/03/2010	Inspector	Low Tide (m)	Low Tide Time
Wind	Sea State Calm	Visibility -	09.54
Summary Fine			Rain No
Easting 503803.958	Northing 489708.315	Bearing 58	

Chainage (from base station)	Level AOD (m)
0.000	4.442
4.713	4.228
4.73	4.315
8.118	4.229
11.574	4.156
11.645	5.475
12.621	5.406
12.668	3.753
14.293	1.671
17.476	1.026
20.317	0.807
23.642	0.52
23.759	-0.018
24.225	-0.139
25.574	0.404
34.628	0.513
45.378	0.481
56.222	0.395
66.731	0.29
75.467	0.204
86.258	0.148
97.137	0.062
107.462	-0.132
117.824	-0.471
128.353	-0.896
138.252	-1.267
148.36	-1.672
158.36	-1.995



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Beach Profiles: 1dSBN3



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Beach Profile

1dSBN4

Date 01/03/2010	Inspector	Low Tide (m)	Low Tide Time
Wind	Sea State Calm	Visibility -	09.54
Summary Fine			Rain No
Easting 504111.79	Northing 489397.699	Bearing 38	

Chainage (from base station)	Level AOD (m)
0.000	7.781
0.007	7.781
3.744	7.638
3.785	7.717
5.615	7.784
5.69	7.945
5.915	7.94
6.03	7.239
6.115	7.246
6.22	7.072
11.017	6.929
16.156	6.776
16.474	6.757
16.479	5.781
16.678	5.78
16.678	5.45
16.927	5.45
16.928	5.12
17.178	5.12
17.178	4.79
17.428	4.79
17.428	4.46
17.678	4.46
17.679	4.13
17.928	4.13
17.929	3.8
18.178	3.8
18.178	3.57
21.228	3.57
21.229	3.24
21.476	3.24
21.478	2.91
21.727	2.91
21.729	2.58
21.977	2.58
21.979	2.25
22.227	2.25
22.266	1.924
22.482	1.898
22.54	1.584
22.782	1.54
22.79	1.242
22.945	1.229
23.129	0.906
23.29	0.896
23.301	0.826
23.635	0.726
24.465	0.172
24.754	0.078
25.194	0.046
25.278	-0.074
25.558	-0.092

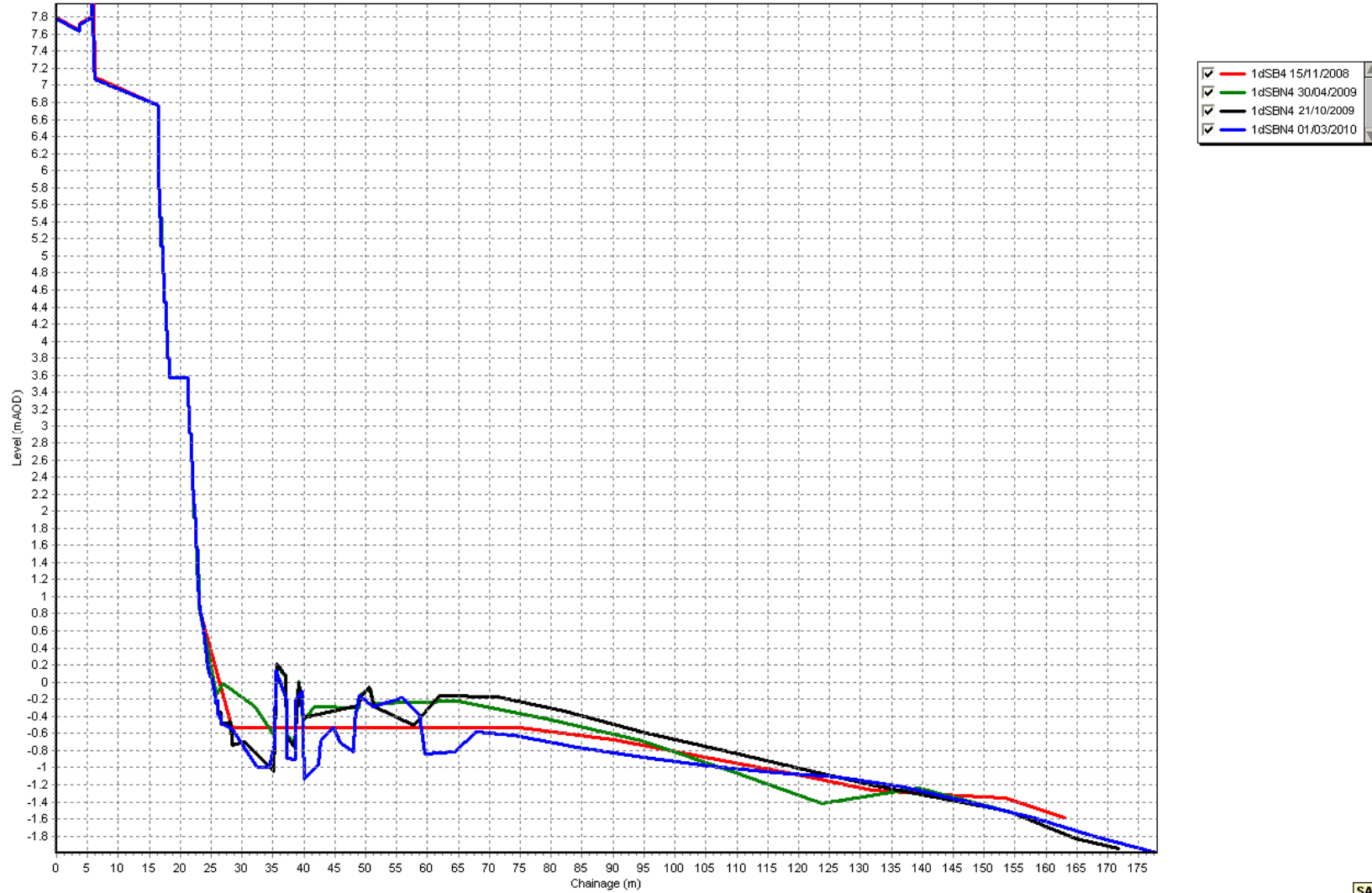
25.649	-0.254
25.649	-0.22
26.032	-0.21
26.064	-0.378
26.437	-0.381
26.526	-0.477
28.331	-0.549
32.479	-0.997
34.46	-0.99
35.286	-0.724
35.519	0.142
37.302	-0.206
37.314	-0.889
38.593	-0.9
38.632	-0.207
39.77	-0.109
39.978	-1.135
42.369	-0.967
42.749	-0.686
44.901	-0.535
45.986	-0.714
48.114	-0.819

48.207	-0.451
48.877	-0.165
51.317	-0.292
55.804	-0.188
58.699	-0.383
59.57	-0.844
64.285	-0.809
67.92	-0.588
73.866	-0.627
84.196	-0.762
94.928	-0.885
105.577	-0.983
116.339	-1.058
126.468	-1.109
136.988	-1.231
147.67	-1.401
157.97	-1.589
167.792	-1.81
177.979	-1.998



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Beach Profiles: 1dSBN4



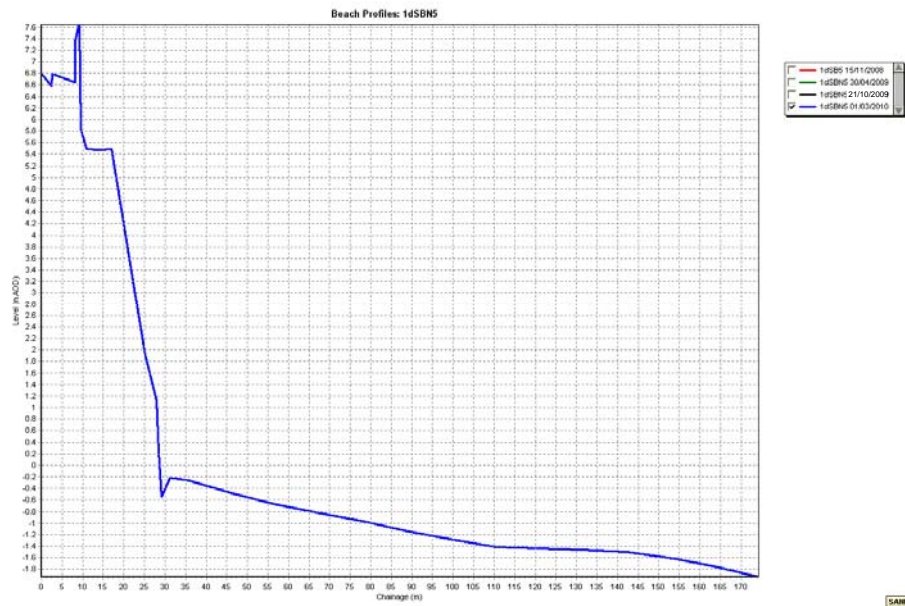
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Beach Profile

1dSBN5

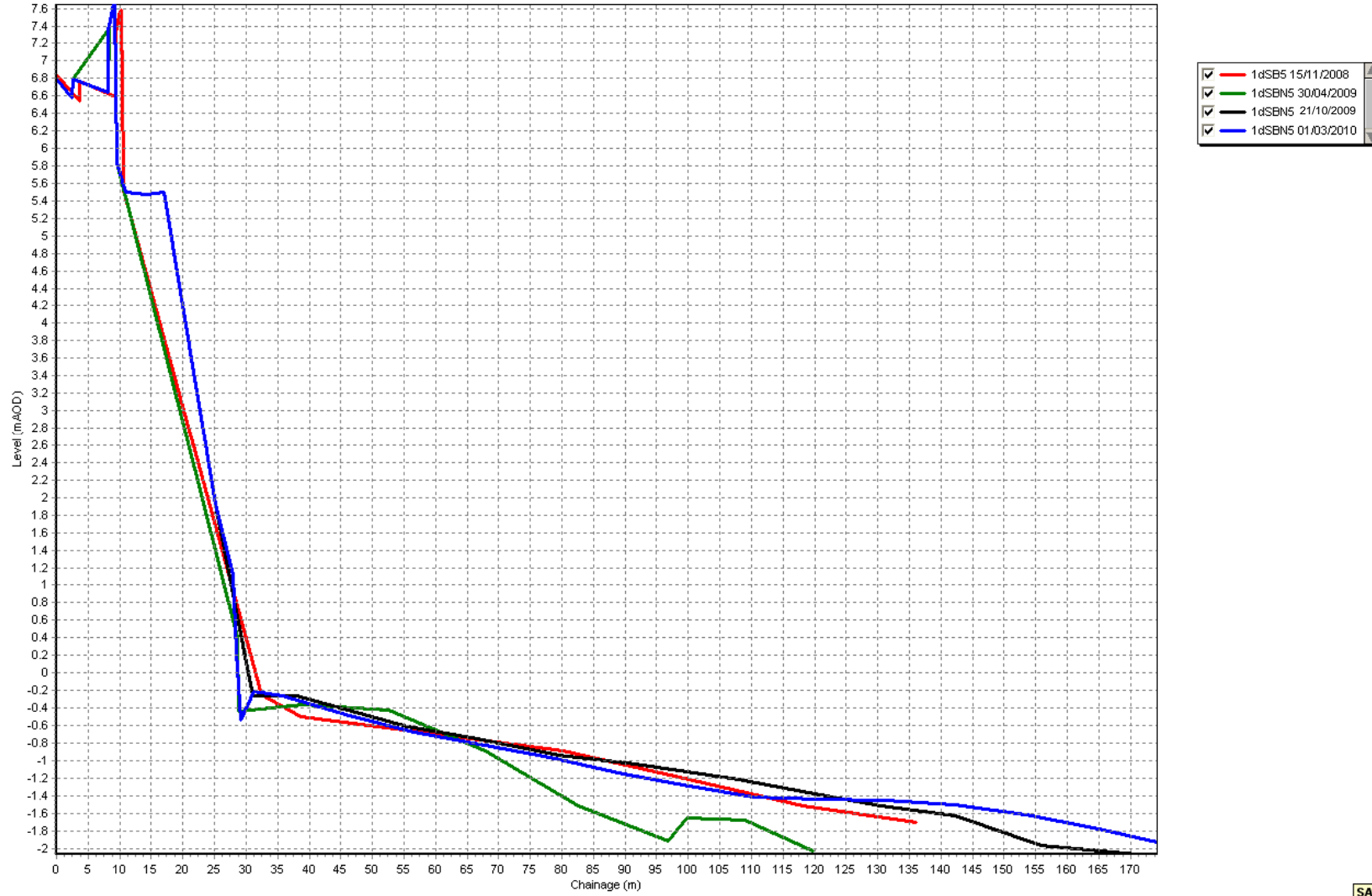
Date 01/03/2010	Inspector	Low Tide (m)	Low Tide Time
Wind	Sea State Calm	Visibility -	09.54
Summary Fine			Rain No
Easting 504515.599	Northing 489205.723	Bearing 14	

Chainage (from base station)	Level AOD (m)
0.000	6.793
0.001	6.793
2.504	6.58
2.576	6.796
8.228	6.646
8.231	6.652
8.235	7.361
8.283	7.397
8.986	7.645
9.164	7.645
9.489	5.833
10.856	5.495
14.148	5.474
16.925	5.496
25.081	1.919
27.977	1.122
28.504	0.238
29.228	-0.542
31.299	-0.208
35.73	-0.256
46.384	-0.483
56.528	-0.671
67.877	-0.831
78.132	-0.965
89.756	-1.156
100.152	-1.285
110.311	-1.411
120.617	-1.441
131.246	-1.458
142.106	-1.498
153.449	-1.614
164.181	-1.763
174.222	-1.931



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Beach Profiles: 1dSBN5



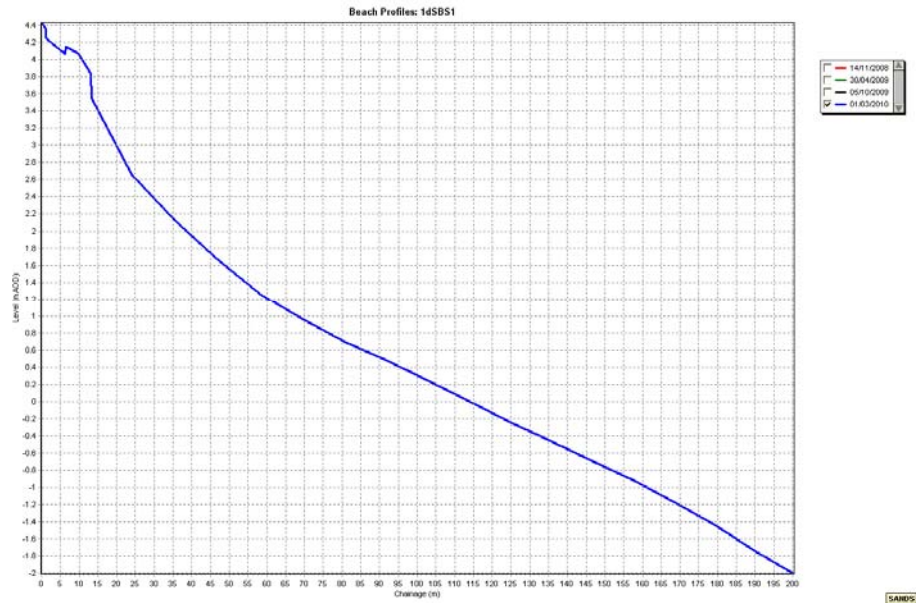
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Beach Profile

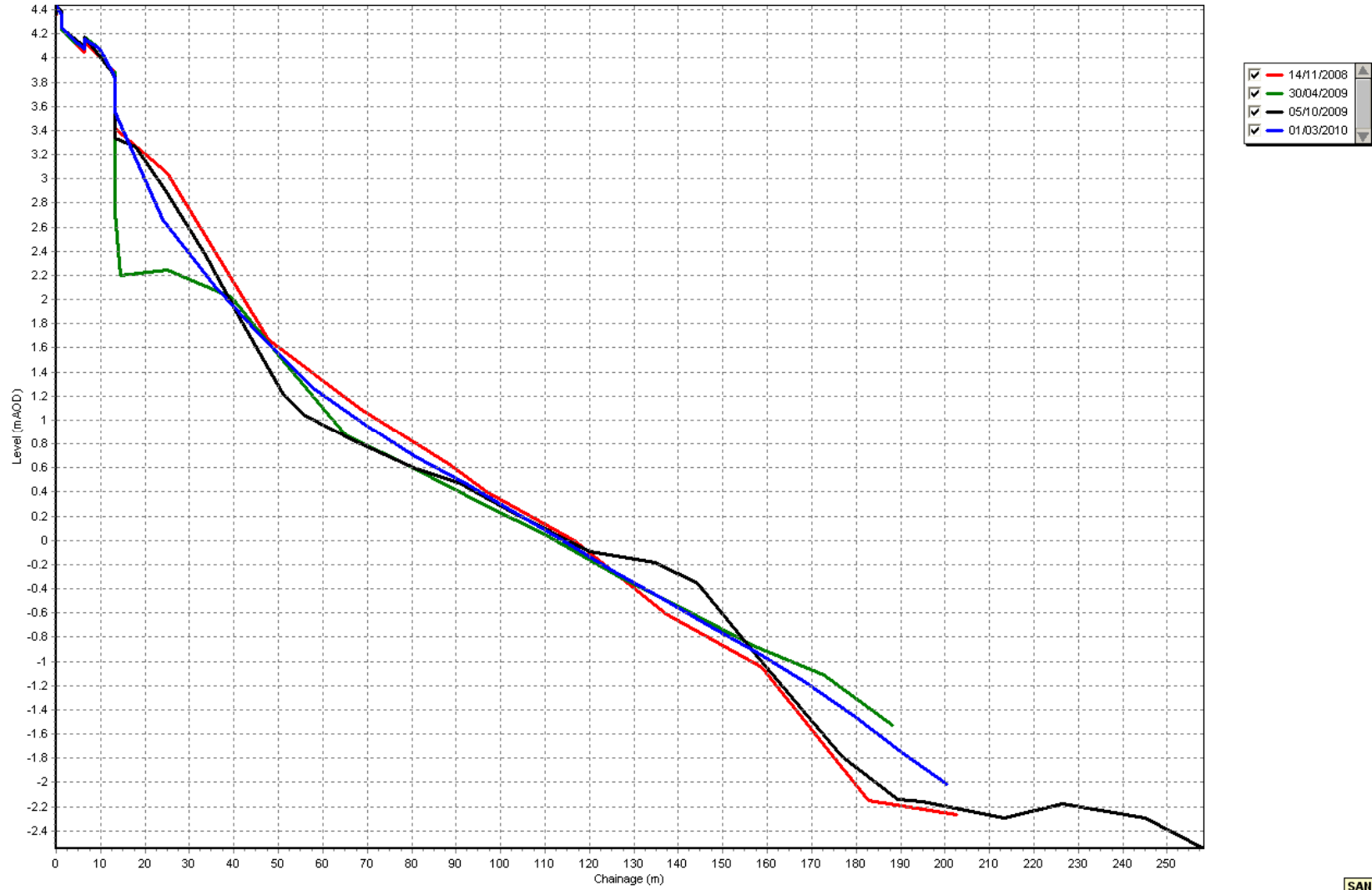
1dSBS1

Date 01/03/2010	Inspector	Low Tide (m)	Low Tide Time
Wind	Sea State Calm	Visibility -	09.54
Summary Fine			Rain No
Easting 504544.727	Northing 488604.814	Bearing 120	

Chainage (from base station)	Level AOD (m)
0.000	4.436
0.024	4.436
1.104	4.358
1.141	4.255
3.495	4.167
6.341	4.072
6.374	4.154
9.757	4.075
12.63	3.88
13.176	3.834
13.292	3.551
24.037	2.661
35.472	2.122
46.847	1.669
58.375	1.254
69.719	0.956
80.907	0.691
91.832	0.476
102.682	0.243
113.622	0.008
124.952	-0.246
135.582	-0.461
146.527	-0.696
157.533	-0.918
168.332	-1.168
179.447	-1.447
190.572	-1.763
200.401	-2.01



Beach Profiles: 1dSBS1



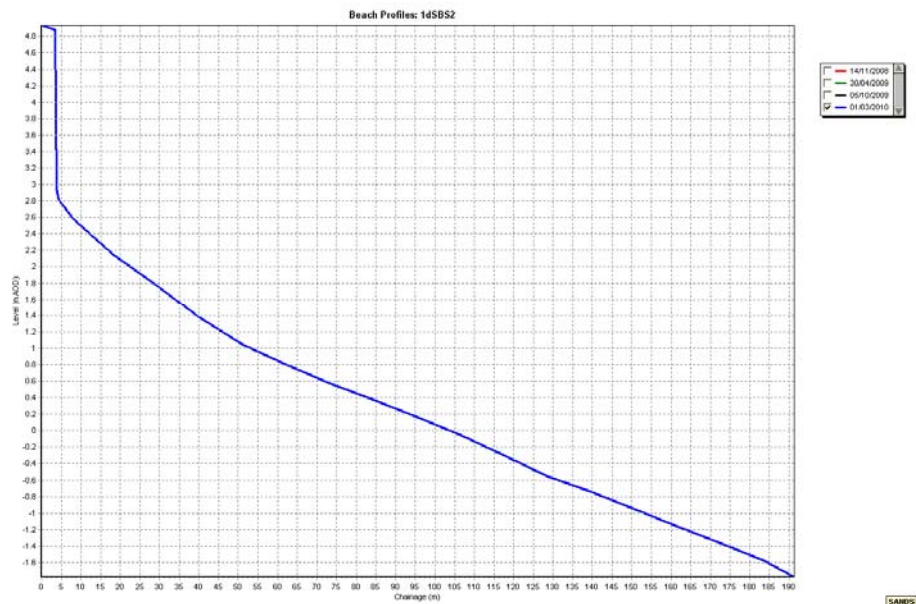
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Beach Profile

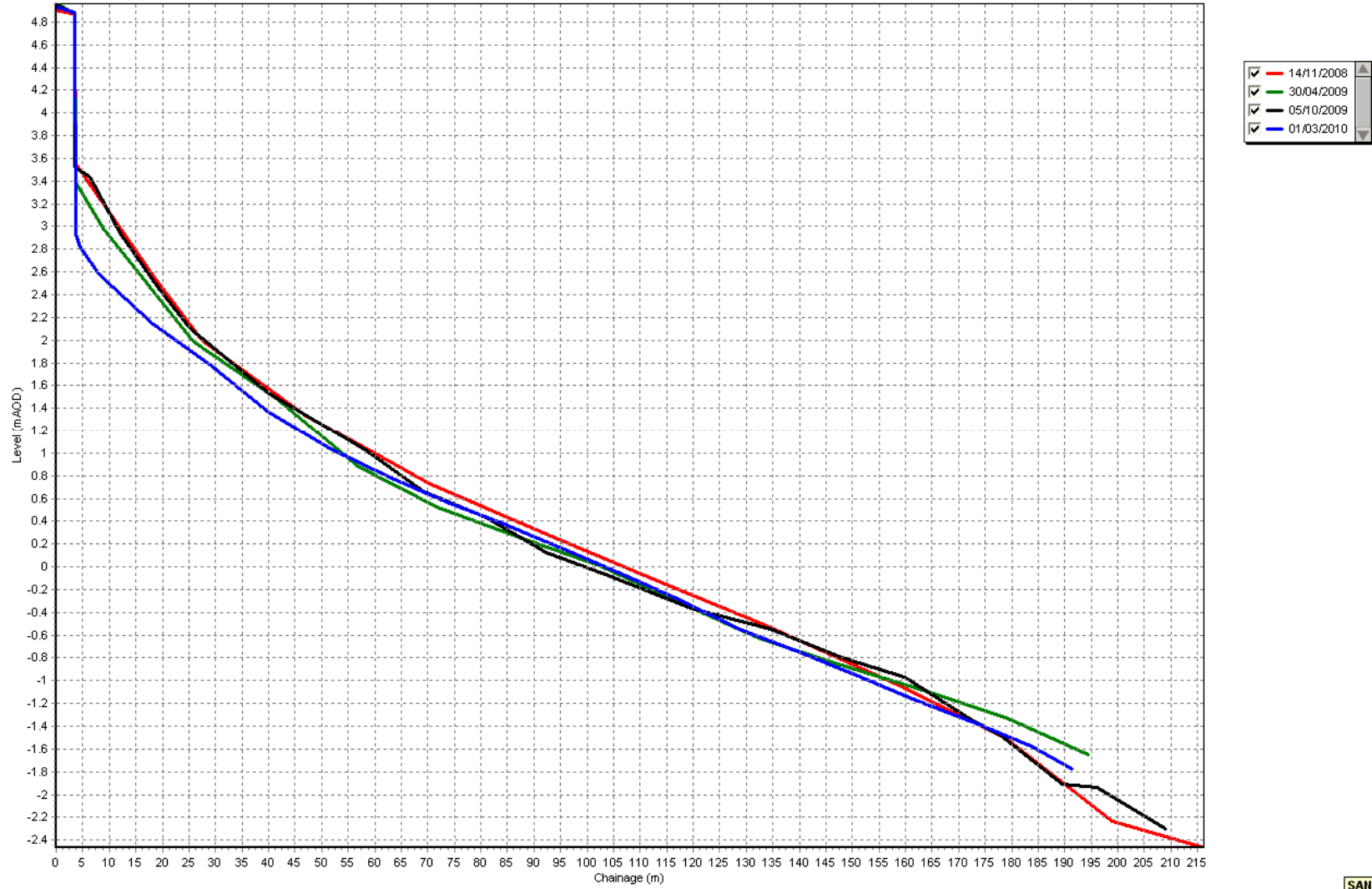
1dSBS2

Date 01/03/2010 Wind Summary Fine	Inspector Sea State Calm	Low Tide (m) Visibility -	Low Tide Time 09.54 Rain No
Easting 504443.218	Northing 488326.371	Bearing 105	

Chainage (from base station)	Level AOD (m)
0.000	4.933
0.007	4.933
3.464	4.882
3.766	2.942
4.426	2.819
7.996	2.583
18.259	2.145
28.871	1.788
39.842	1.378
51.23	1.043
62.667	0.788
73.634	0.568
83.927	0.383
95.229	0.168
106.285	-0.052
117.225	-0.288
128.505	-0.549
139.802	-0.747
150.617	-0.949
161.895	-1.168
173.17	-1.373
183.553	-1.574
191.293	-1.774



Beach Profiles: 1dSBS2



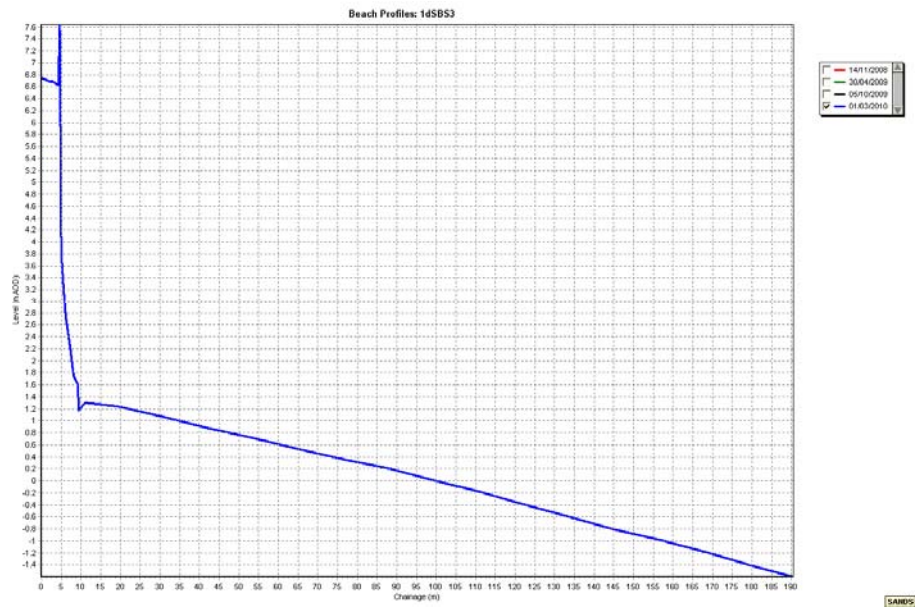
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Beach Profile

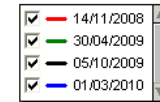
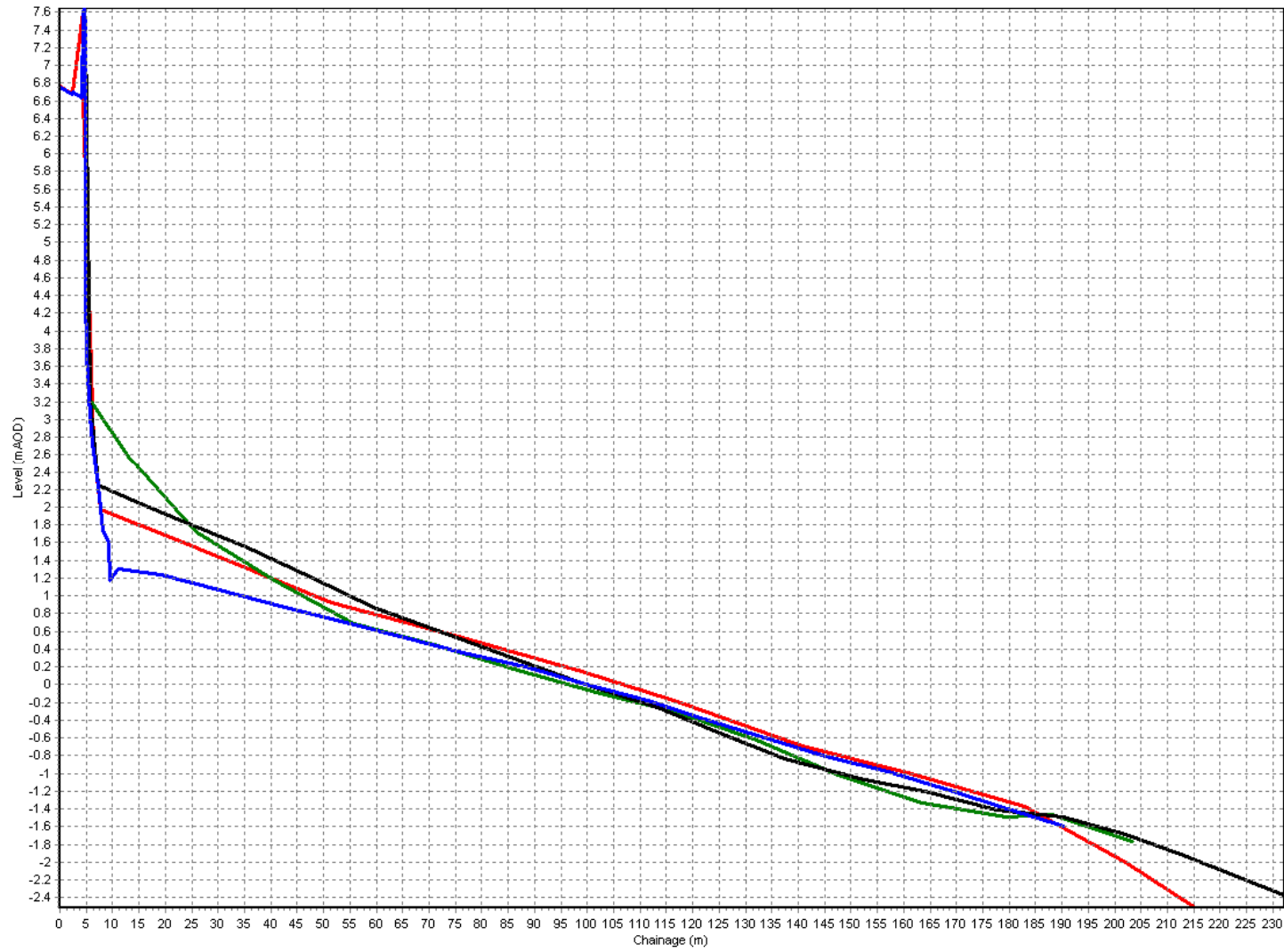
1dSBS3

Date 01/03/2010	Inspector	Low Tide (m)	Low Tide Time
Wind	Sea State Calm	Visibility -	09.54
Summary Fine			Rain No
Easting 504423.086	Northing 488057.66	Bearing 83	

Chainage (from base station)	Level AOD (m)
0.000	6.745
0.012	6.745
2.456	6.673
2.493	6.698
4.287	6.633
4.434	7.579
4.516	7.644
4.773	7.425
4.81	4.46
5.136	3.729
5.758	3.039
6.172	2.739
7.156	2.23
8.207	1.743
9.259	1.606
9.391	1.173
11.003	1.304
19.233	1.243
30.256	1.072
41.812	0.882
53.249	0.715
65.306	0.53
76.461	0.365
88.271	0.2
99.803	0.008
111.459	-0.184
122.113	-0.395
133.549	-0.595
145.21	-0.806
156.977	-0.985
168.6	-1.193
179.604	-1.402
190.487	-1.598



Beach Profiles: 1dSBS3

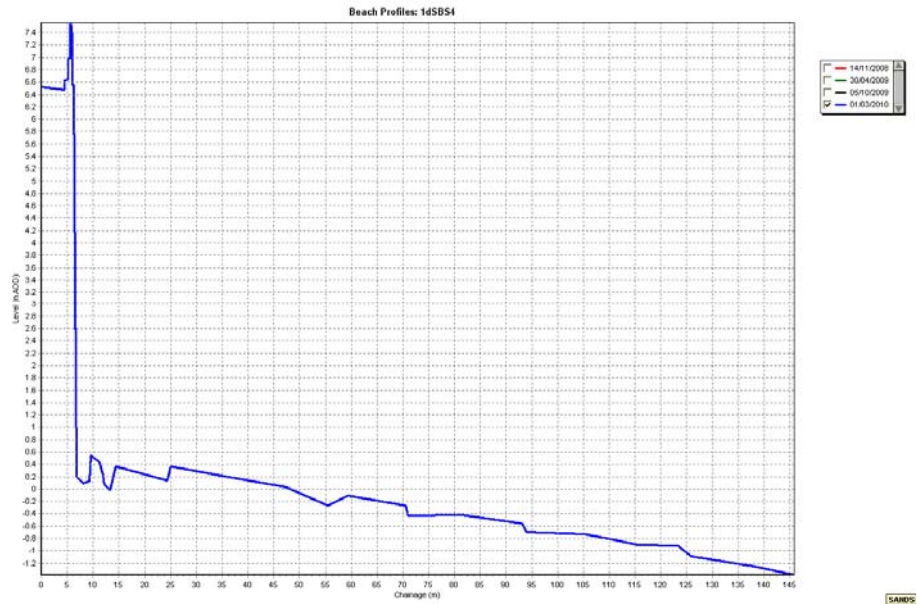


Beach Profile

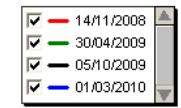
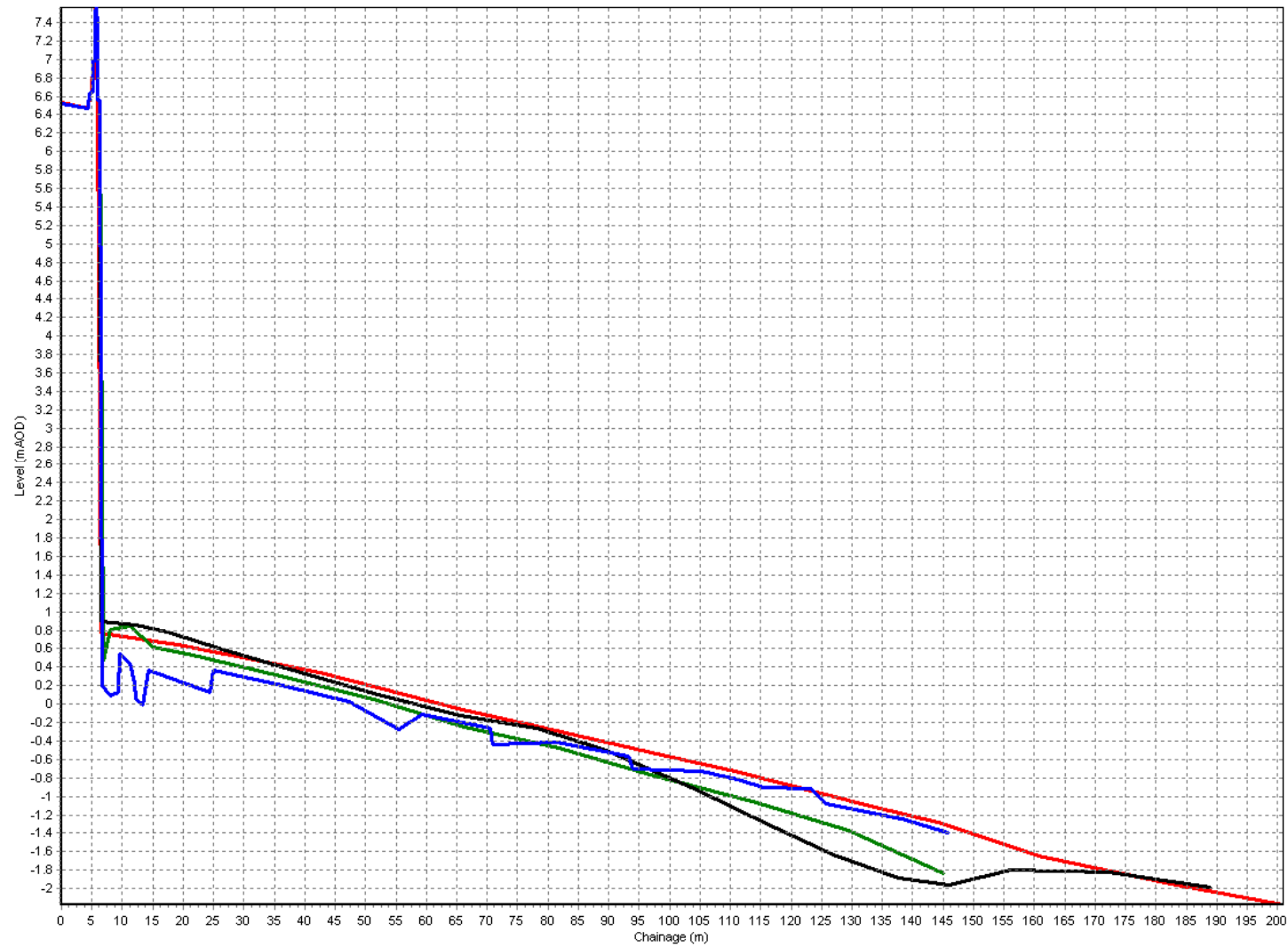
1dSBS4

Date 01/03/2010	Inspector	Low Tide (m)	Low Tide Time
Wind	Sea State Calm	Visibility -	09.54
Summary Fine			Rain No
Easting 504494.785	Northing 487816.983	Bearing 74	

Chainage (from base station)	Level AOD (m)
0.000	6.523
0.017	6.523
4.441	6.474
4.489	6.627
5.084	6.64
5.12	6.979
5.525	6.982
5.556	7.51
5.632	7.563
5.914	7.359
5.975	6.552
6.211	6.56
6.755	0.209
7.997	0.085
9.305	0.128
9.562	0.542
11.207	0.44
12.211	0.063
13.345	-0.015
14.326	0.372
24.985	0.363
36.205	0.2
47.267	0.033
59.336	-0.108
70.545	-0.264
81.444	-0.419
93.123	-0.559
105.158	-0.725
115.476	-0.904
125.894	-1.086
136.272	-1.225
145.83	-1.39
11.932	0.229
24.357	0.132
55.447	-0.273
70.916	-0.433
93.997	-0.699
111.053	-0.82
123.219	-0.917
138.126	-1.247



Beach Profiles: 1dSBS4



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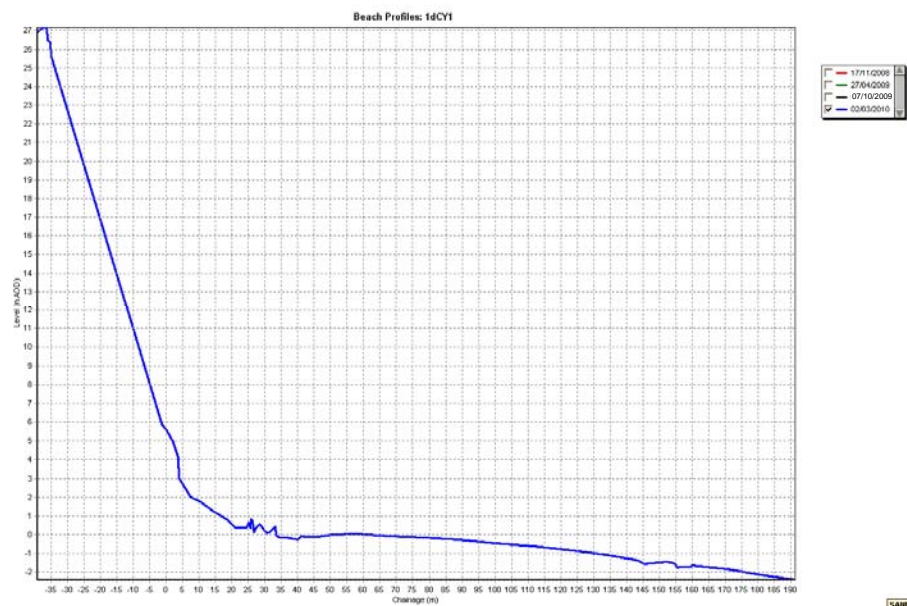
Beach Profile

1dCY1

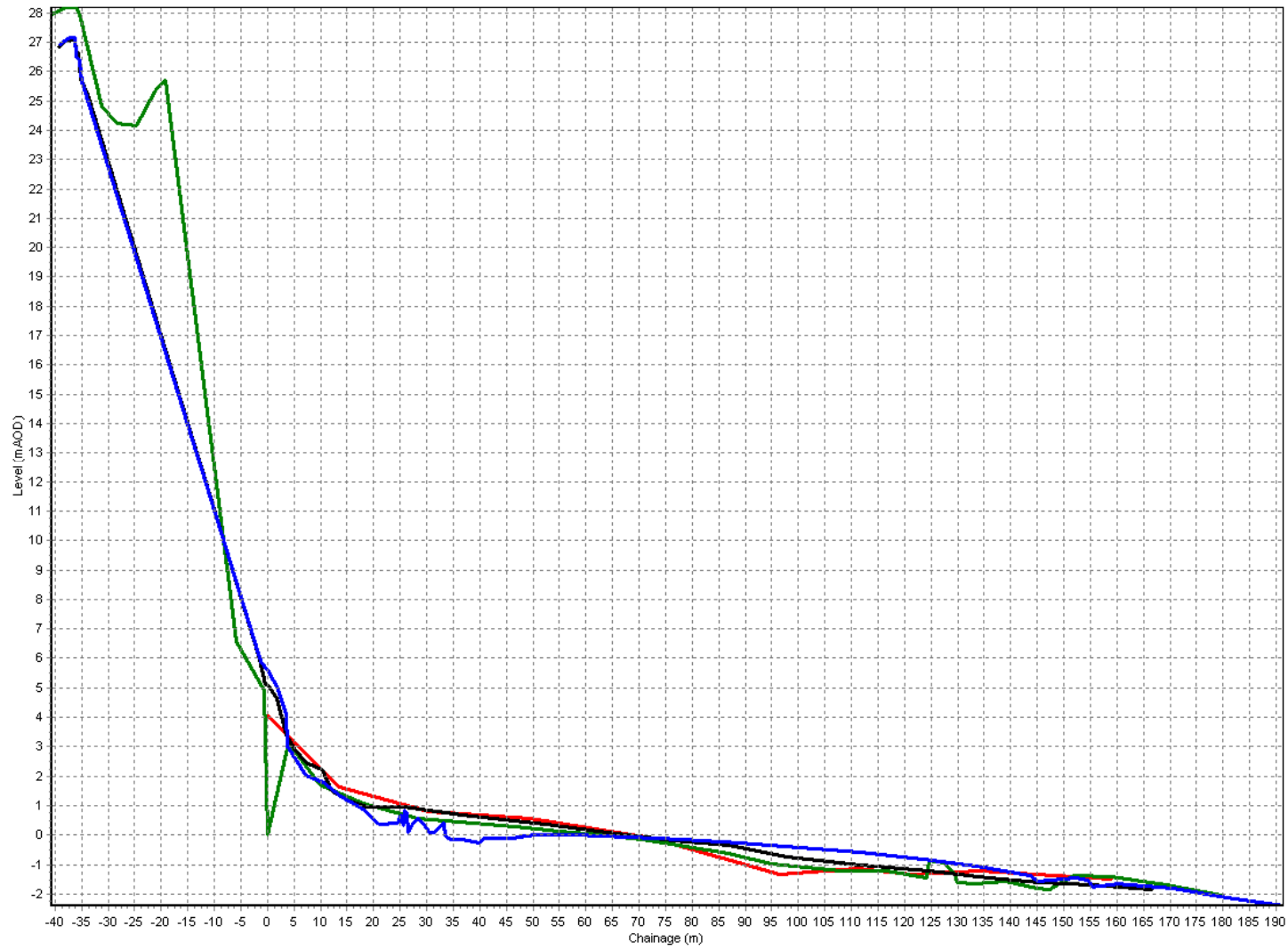
Date 02/03/2010 Wind Summary Fine	Inspector Sea State Calm	Low Tide (m) Visibility -	Low Tide Time 10.35 Rain No
Easting 506393.635	Northing 484765.438	Bearing 43	

Chainage (from base station)	Level AOD (m)
-39.107	26.915
-38.163	27.061
-37.168	27.168
-36.182	27.148
-36.021	26.537
-35.298	26.378
-34.954	25.646
-1.324	5.898
0.247	5.559
2.113	4.938
3.588	4.113
3.817	3.025
7.336	2.028
10.482	1.772
13.897	1.315
18.296	0.850
21.102	0.379
24.565	0.385
25.141	0.664
25.635	0.336
25.864	0.833
26.302	0.727
26.597	0.104
27.154	0.318
28.503	0.582
29.781	0.289
30.587	0.064
31.266	0.104
33.170	0.412
33.406	-0.033
34.581	-0.138
36.516	-0.141
40.091	-0.272
40.935	-0.090
42.465	-0.108
46.199	-0.099
50.325	-0.008
57.908	0.025
67.949	-0.058
78.305	-0.147
88.990	-0.278
100.052	-0.436
111.650	-0.602
123.508	-0.826
133.649	-1.058
143.536	-1.384
145.214	-1.562

147.534	-1.529
152.316	-1.439
154.497	-1.528
155.442	-1.762
156.251	-1.711
159.597	-1.698
159.845	-1.633
170.591	-1.825
180.869	-2.117
191.285	-2.402



Beach Profiles: 1dCY1



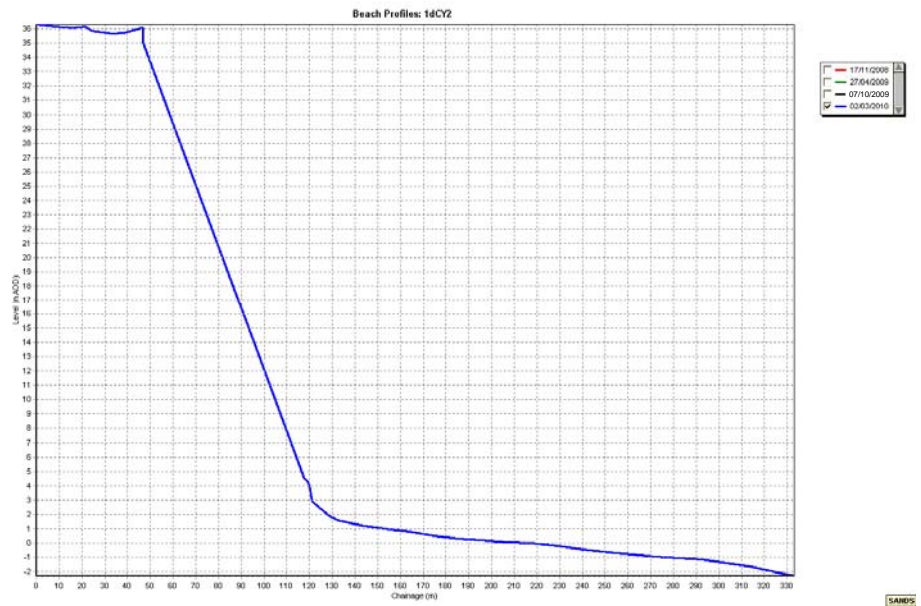
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Beach Profile

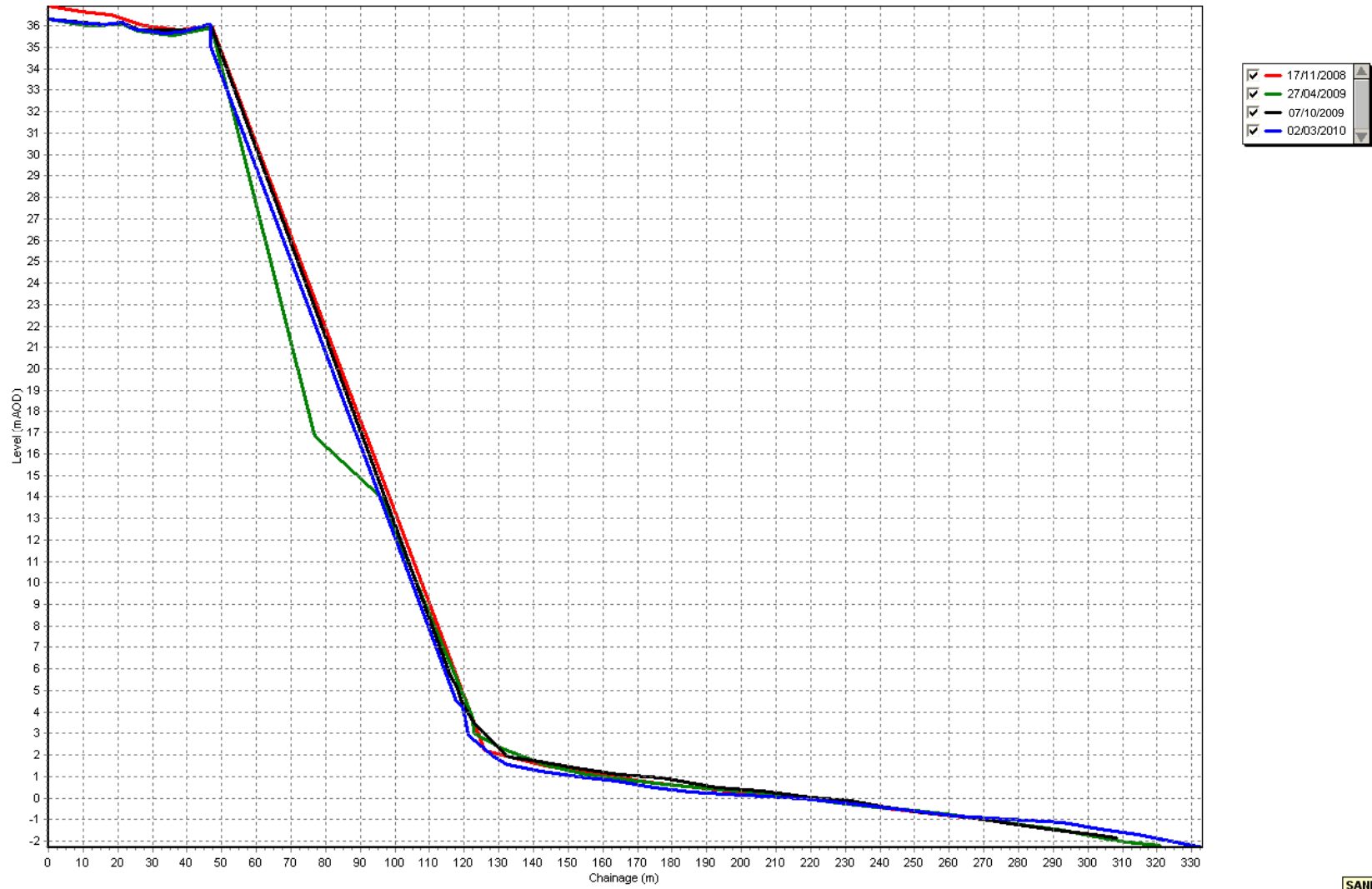
1dCY2

Date 02/03/2010	Inspector	Low Tide (m)	Low Tide Time 10.35
Wind	Sea State Calm	Visibility -	Rain No
Summary Fine			
Easting 506712.583	Northing 484325.966	Bearing 38	

Chainage (from base station)	Level AOD (m)
0.000	36.311
0.035	36.311
8.308	36.162
15.980	36.051
21.244	36.161
24.562	35.847
33.409	35.664
38.370	35.732
45.995	36.080
46.738	36.074
46.915	35.065
117.655	4.482
119.595	4.221
121.319	2.901
128.625	1.888
132.508	1.574
142.260	1.252
152.786	1.005
163.821	0.767
174.767	0.496
185.245	0.303
195.330	0.177
206.748	0.065
217.678	-0.031
229.352	-0.223
240.414	-0.449
251.381	-0.635
261.827	-0.818
271.998	-0.934
282.448	-1.032
292.701	-1.154
303.423	-1.421
314.385	-1.669
323.950	-2.021
333.064	-2.302



Beach Profiles: 1dCY2



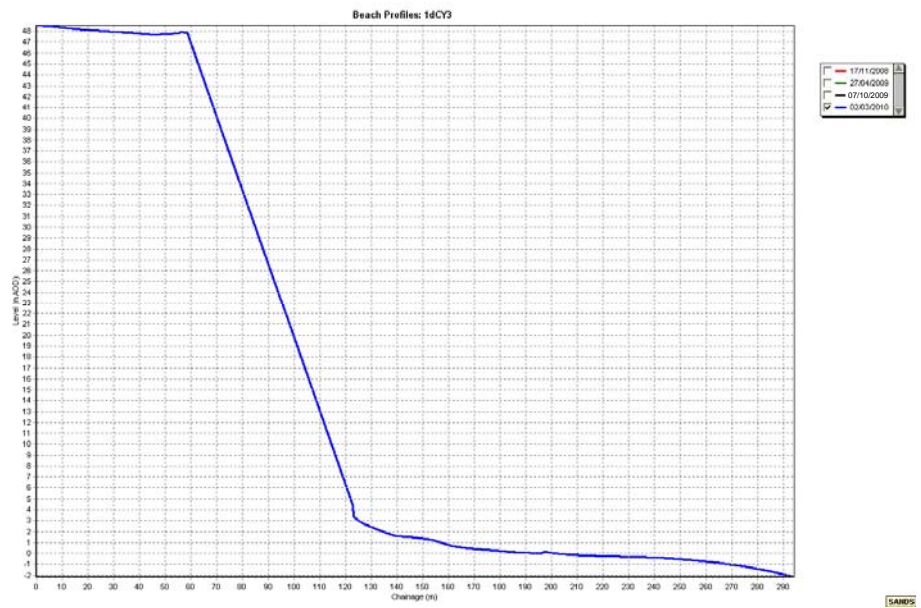
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Beach Profile

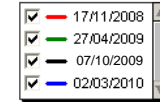
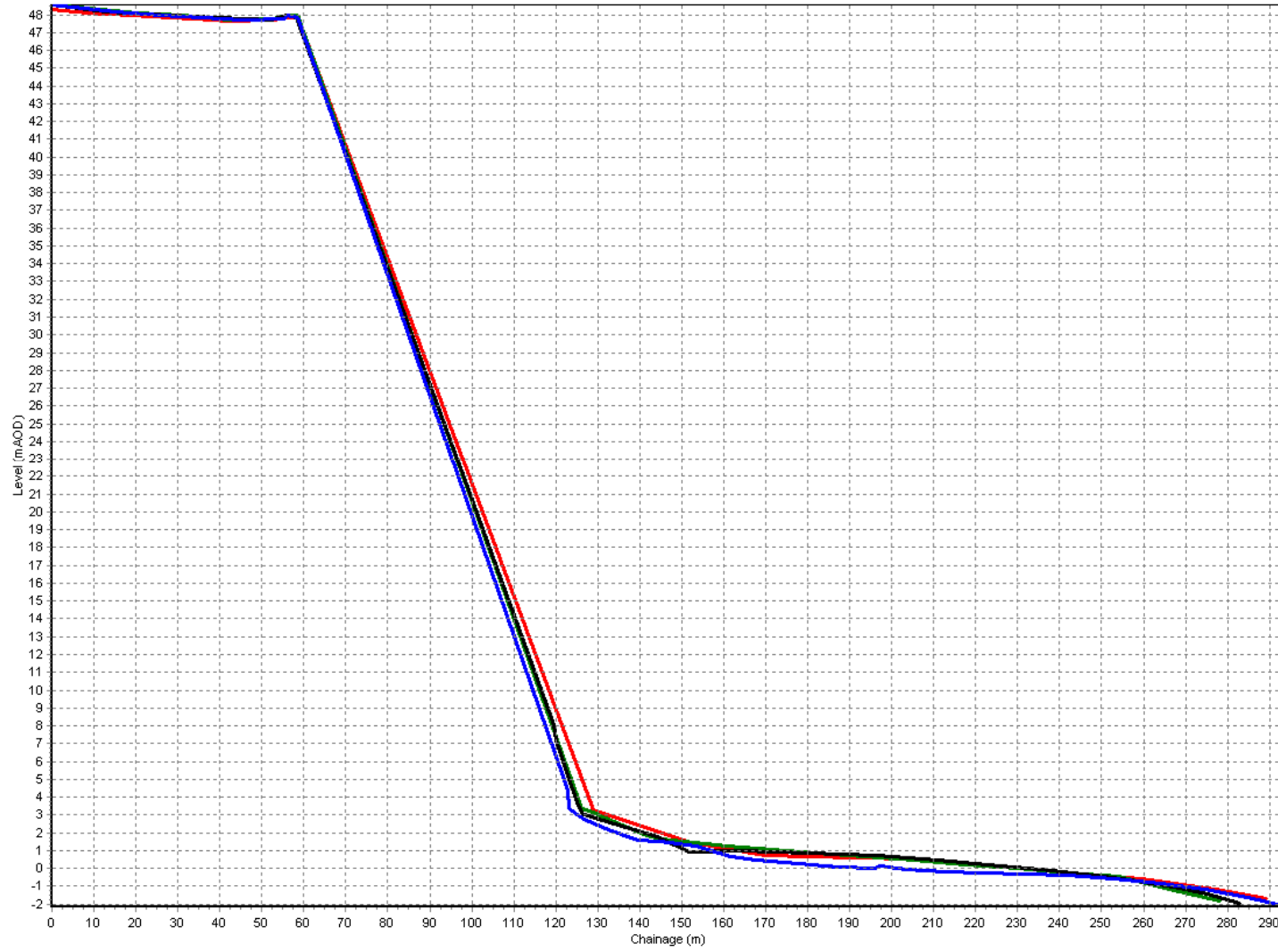
1dCY3

Date 02/03/2010	Inspector	Low Tide (m)	Low Tide Time 10.35
Wind	Sea State Calm	Visibility -	Rain No
Summary Fine			
Easting 507242.203	Northing 484080.896	Bearing 42	

Chainage (from base station)	Level AOD (m)
0.000	48.534
0.020	48.534
4.955	48.461
15.169	48.185
25.882	47.982
35.851	47.860
45.442	47.693
55.403	47.787
56.032	47.956
58.461	47.853
122.725	4.393
123.182	3.363
126.809	2.738
132.465	2.173
139.517	1.605
144.744	1.513
153.266	1.237
161.795	0.636
167.673	0.456
177.743	0.257
187.364	0.096
196.176	-0.003
197.295	0.114
203.649	-0.034
212.578	-0.200
221.574	-0.280
231.503	-0.303
242.097	-0.383
253.030	-0.581
263.949	-0.869
274.656	-1.177
284.950	-1.651
294.246	-2.154



Beach Profiles: 1dCY3



SANDS

Beach Profile

1dFB1

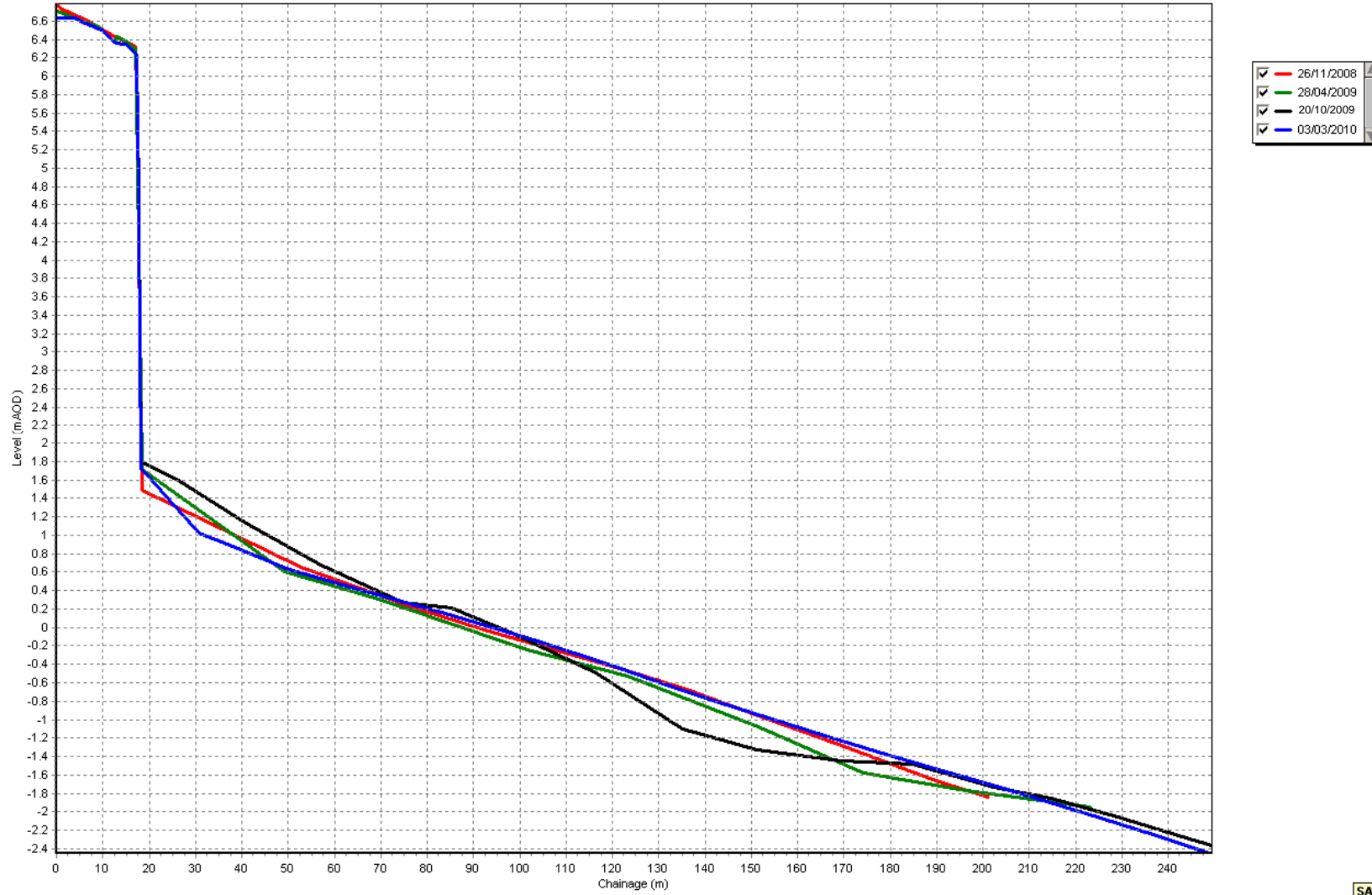
Date 03/03/2010	Inspector	Low Tide (m)	Low Tide Time
Wind	Sea State Calm	Visibility -	11.14 to 11.53
Summary Fine			Rain No
Easting 511989.528	Northing 480590.964	Bearing 100	

Chainage (from base station)	Level AOD (m)
0.000	6.631
4.137	6.631
6.257	6.574
6.373	6.578
9.713	6.501
12.571	6.366
12.667	6.361
14.834	6.343
16.398	6.283
17.252	6.242
17.313	5.88
17.59	5.759
18.165	1.732
30.812	1.021
37.316	0.89
50.086	0.634
65.107	0.418
84.789	0.14
103.016	-0.136
119.73	-0.409
133.694	-0.654
144.659	-0.834
156.048	-1.018
168.118	-1.213
180.552	-1.397
192.781	-1.583
204.396	-1.748
223.804	-2.047
238.94	-2.286
248.864	-2.45



SANPS

Beach Profiles: 1dFB1



SANDS

Beach Profile

1dFB2

Date 03/03/2010	Inspector	Low Tide (m)	Low Tide Time
Wind	Sea State Calm	Visibility -	11.14 to 11.53
Summary Fine			Rain No
Easting 512005.564	Northing 479181.575	Bearing 77	

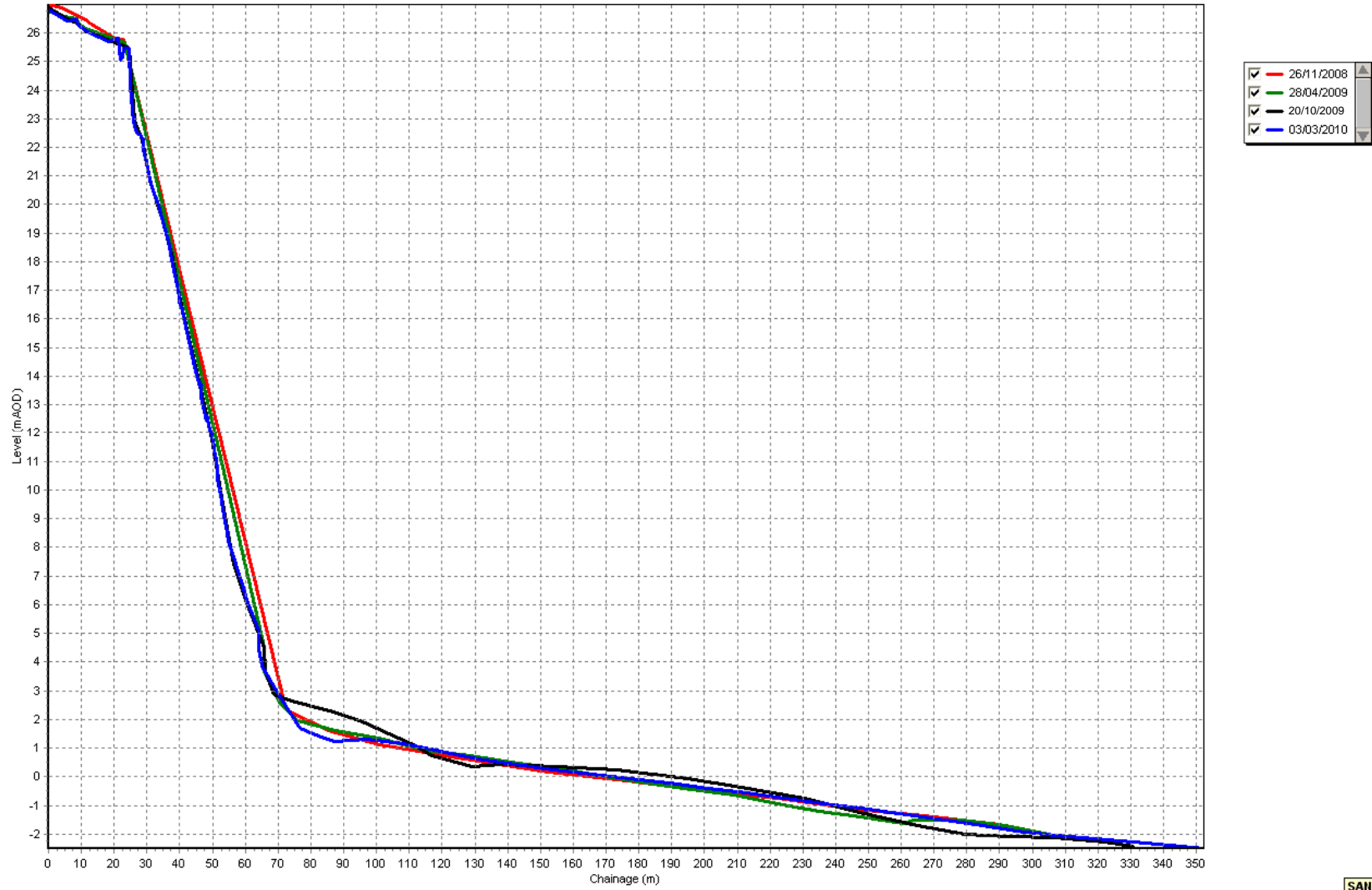
Chainage (from base station)	Level AOD (m)
0.000	26.82
0.069	26.82
5.678	26.434
8.522	26.454
9.031	26.271
11.806	26.051
18.199	25.7
21.145	25.797
21.731	25.448
21.948	25.036
22.604	25.119
22.806	25.458
24.631	25.456
24.938	24.125
26.016	22.902
26.949	22.499
27.922	22.456
28.794	22.248
28.96	21.917
29.824	21.511
30.299	21.184
31.508	20.589
33.073	20.078
36.017	19.002
36.534	18.779
36.766	18.587
37.188	18.253
37.985	17.915
38.078	17.731
38.354	17.516
38.512	17.537
39.671	17.057
40.029	16.38
40.382	16.43
42.214	15.56
44.605	14.349
46.02	13.619
46.086	13.811
46.576	13.648
46.64	13.291
48.092	12.431
48.271	12.616

48.59	12.542	108.109	1.142
48.744	12.275	119.566	0.89
49.908	11.903	130.914	0.632
50.302	11.516	142.362	0.436
50.378	11.283	154.094	0.254
50.667	11.288	165.675	0.1
51.524	10.771	177.433	-0.076
51.525	10.428	189.086	-0.218
52.403	9.834	201.215	-0.389
53.544	9.124	212.898	-0.557
54.201	8.748	224.504	-0.734
54.857	8.225	236.27	-0.925
59.356	6.568	247.622	-1.101
59.823	6.47	259.448	-1.293
60.366	6.166	271.274	-1.474
63.042	5.373	282.926	-1.672
63.917	5.123	295.019	-1.875
64.022	4.456	307.188	-2.047
65.219	3.868	318.979	-2.159
70.77	2.753	330.717	-2.259
76.818	1.691	341.892	-2.403
82.441	1.431	352.258	-2.503
87.337	1.233		
96.847	1.294		



SARIS

Beach Profiles: 1dFB2



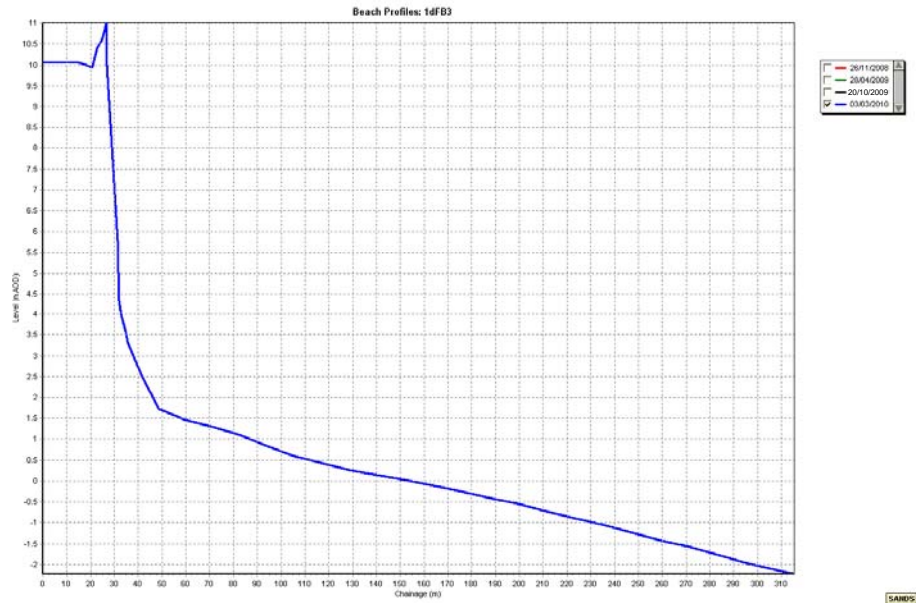
SANDS

Beach Profile

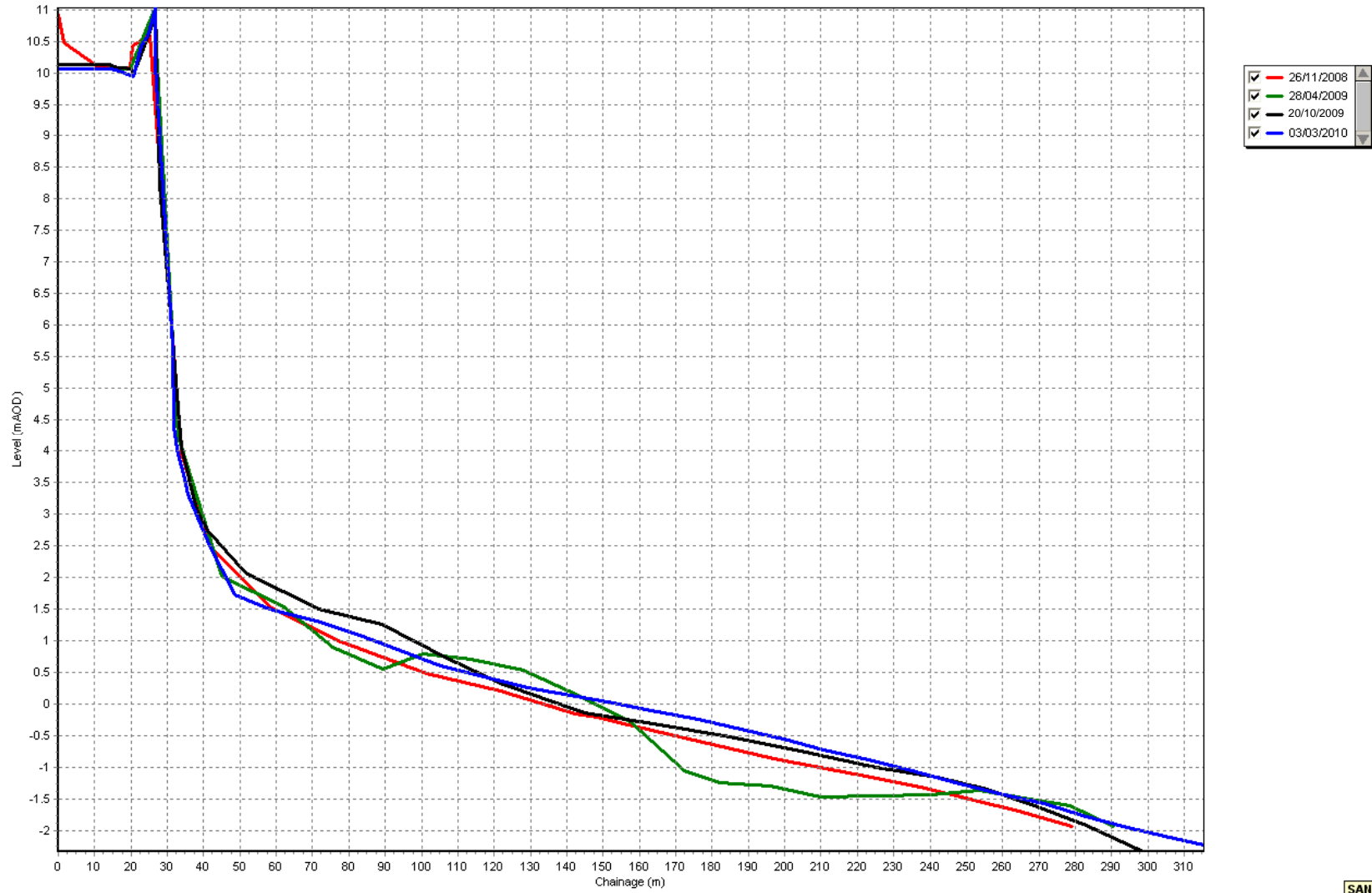
1dFB3

Date 03/03/2010	Inspector	Low Tide (m)	Low Tide Time
Wind	Sea State Calm	Visibility -	11.14 to 11.53
Summary Fine			Rain No
Easting 512429.303	Northing 478202.147	Bearing 61	

Chainage (from base station)	Level AOD (m)
0.000	10.069
14.041	10.069
15.784	10.037
20.639	9.945
22.892	10.429
24.731	10.58
25.755	10.82
26.542	11.02
26.771	10.121
31.607	5.652
31.699	4.402
32.771	4.02
34.761	3.55
35.581	3.309
41.238	2.527
48.622	1.719
56.752	1.54
58.915	1.476
70.996	1.302
82.208	1.107
94.158	0.837
105.349	0.604
117.227	0.424
129.235	0.26
141.007	0.138
153.001	0.022
164.837	-0.123
176.348	-0.252
187.926	-0.405
199.681	-0.558
210.803	-0.724
222.928	-0.885
235.077	-1.054
247.062	-1.236
259.079	-1.422
271.315	-1.574
283.122	-1.772
294.311	-1.947
304.549	-2.096
315.402	-2.227



Beach Profiles: 1dFB3



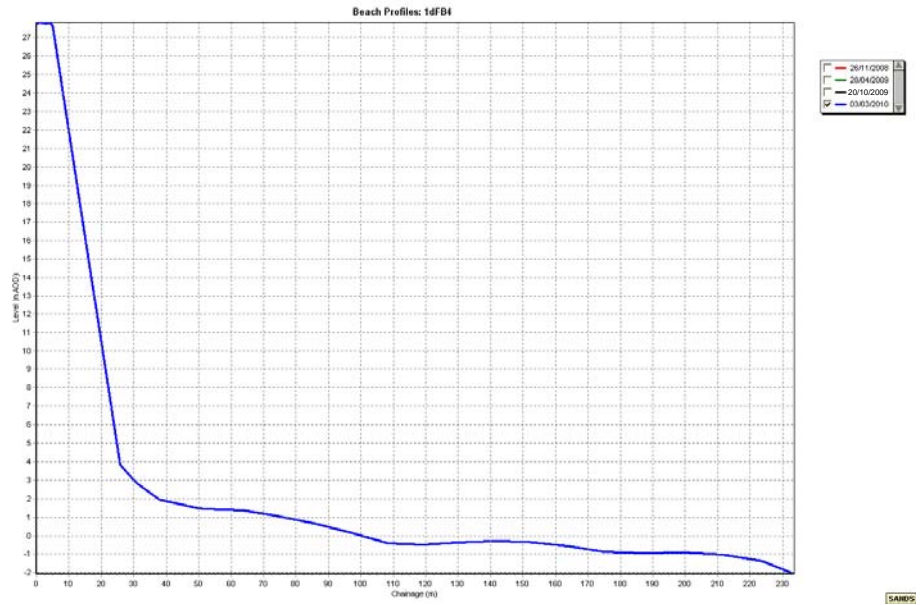
SANDS

Beach Profile

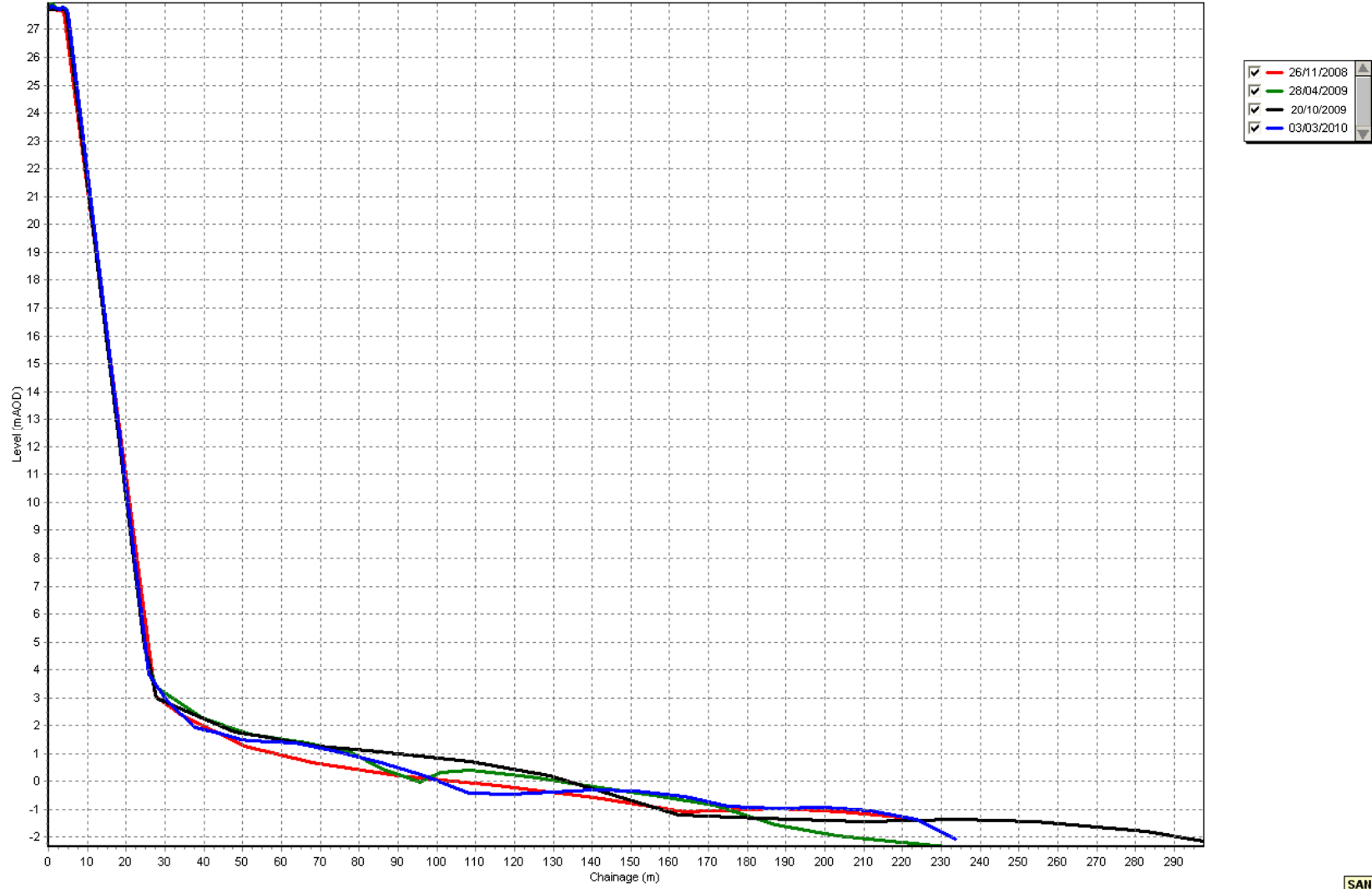
1dFB4

Date 03/03/2010	Inspector	Low Tide (m)	Low Tide Time
Wind	Sea State Calm	Visibility -	11.14 to 11.53
Summary Fine			Rain No
Easting 513165.53	Northing 477182.418	Bearing 5 1	

Chainage (from base station)	Level AOD (m)
0.000	27.748
0.16	27.748
0.905	27.827
1.824	27.777
3.104	27.739
3.653	27.807
4.736	27.697
4.962	27.532
25.673	3.836
30.557	2.865
37.925	1.946
43.857	1.72
49.752	1.503
51.921	1.458
63.695	1.378
74.462	1.072
85.466	0.693
96.762	0.192
108.332	-0.396
119.184	-0.474
129.645	-0.382
140.602	-0.303
151.255	-0.332
163.783	-0.543
174.887	-0.868
187.251	-0.96
199.59	-0.907
211.573	-1.023
223.648	-1.356
233.614	-2.065



Beach Profiles: 1dFB4



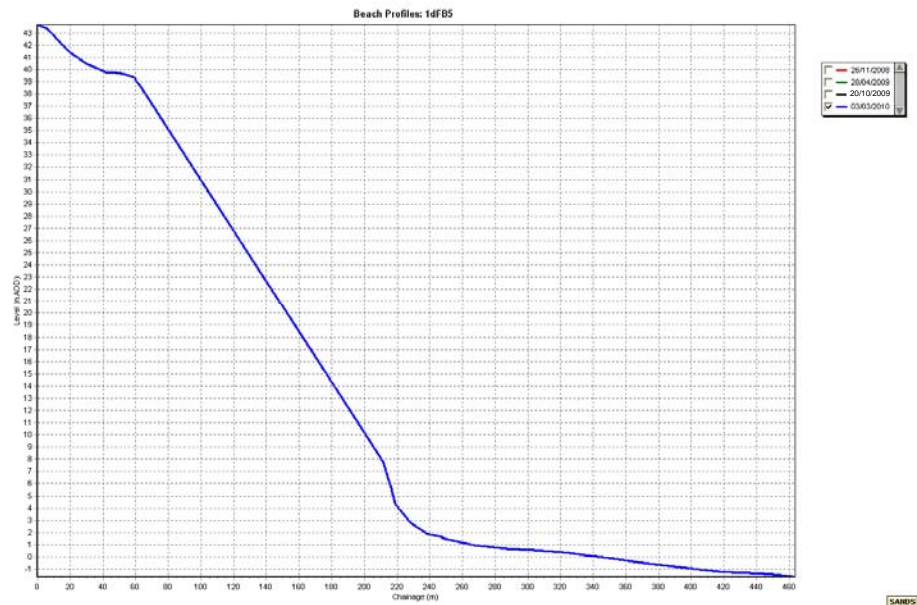
SANDS

Beach Profile

1dFB5

Date 03/03/2010	Inspector	Low Tide (m)	Low Tide Time
Wind	Sea State Calm	Visibility -	11.14 to 11.53
Summary Fine			Rain No
Easting 514207.792	Northing 476001.334	Bearing 47	

Chainage (from base station)	Level AOD (m)
0.000	43.68
0.044	43.68
4.984	43.38
5.526	43.377
10.835	42.644
20.401	41.311
29.999	40.461
37.115	40.043
41.926	39.76
46.789	39.766
52.493	39.657
58.294	39.409
59.844	39.278
60.255	38.988
61.961	38.847
211.608	7.774
214.167	6.59
216.704	5.47
216.936	5.219
217.302	5.211
217.474	4.972
217.959	4.869
218.107	4.696
218.622	4.606
218.889	4.329
228.125	2.798
238.744	1.848
247.782	1.644
247.881	1.517
248.174	1.536
253.771	1.315
265.59	1.014
277.271	0.826
289.197	0.659
300.726	0.582
312.483	0.478
324.19	0.33
336.098	0.132
348.193	-0.081
360.047	-0.312
371.999	-0.518
383.976	-0.715
395.624	-0.911
407.364	-1.08
419.209	-1.231
430.617	-1.309
441.905	-1.353
452.884	-1.466
463.583	-1.645



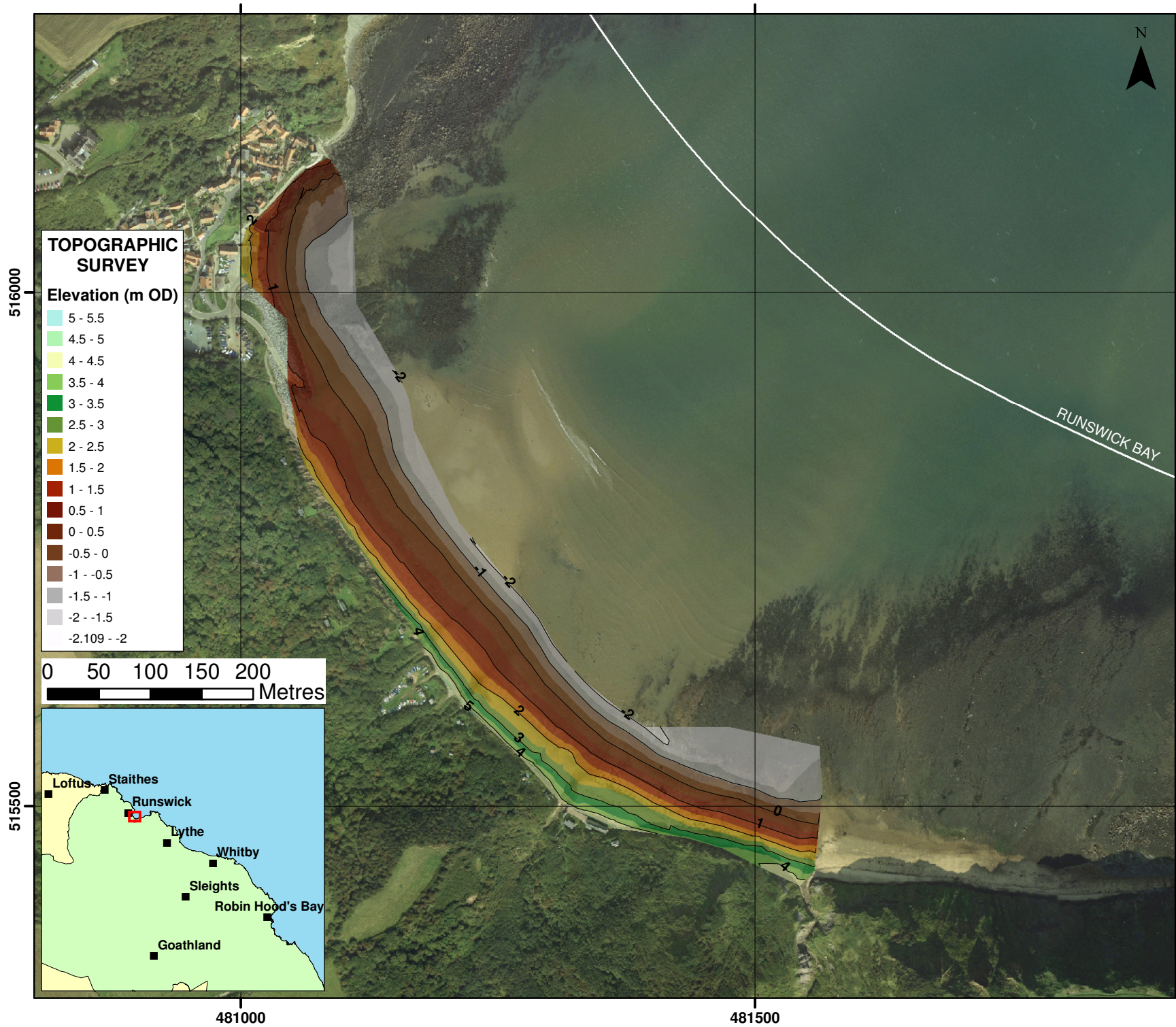
Beach Profiles: 1dFB5



- 26/11/2008
- 28/04/2009
- 20/10/2009
- 03/03/2010

SAHDS

Appendix B
Topographic Survey



— Topographic Contours at 1 metre interval

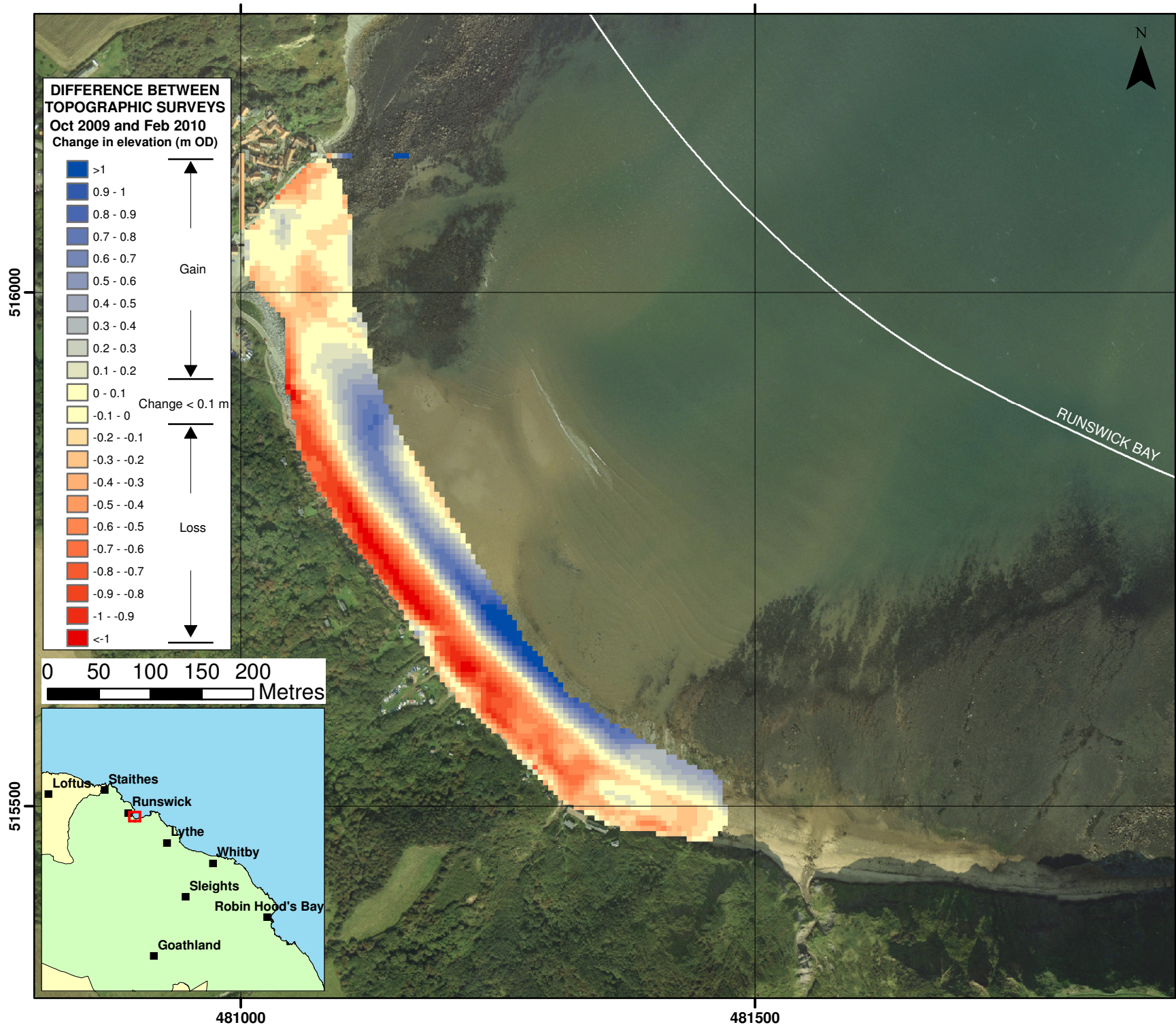
Client: North East Coastal Group
 Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 1
Scarborough
Borough Council Frontage
 Update Report 2
 'Partial Measures' Survey 2010
 Drawing Scale 1:5,000 at A4

Drawn by: ES	Date: 01/06/2010
Checked by: RJ	Date: 04/06/2010
Approved by: RJ	Date: 04/06/2010

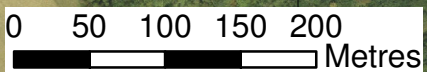
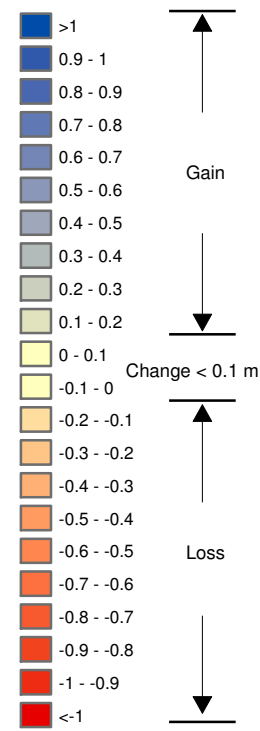
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DIFFERENCE BETWEEN TOPOGRAPHIC SURVEYS

Oct 2009 and Feb 2010
Change in elevation (m OD)



Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 2
Scarborough
Borough Council Frontage

Update Report 2
'Partial Measures' Survey 2010

Drawing Scale 1:5,000 at A4

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Approved by: RJ	Date: 04/06/2010



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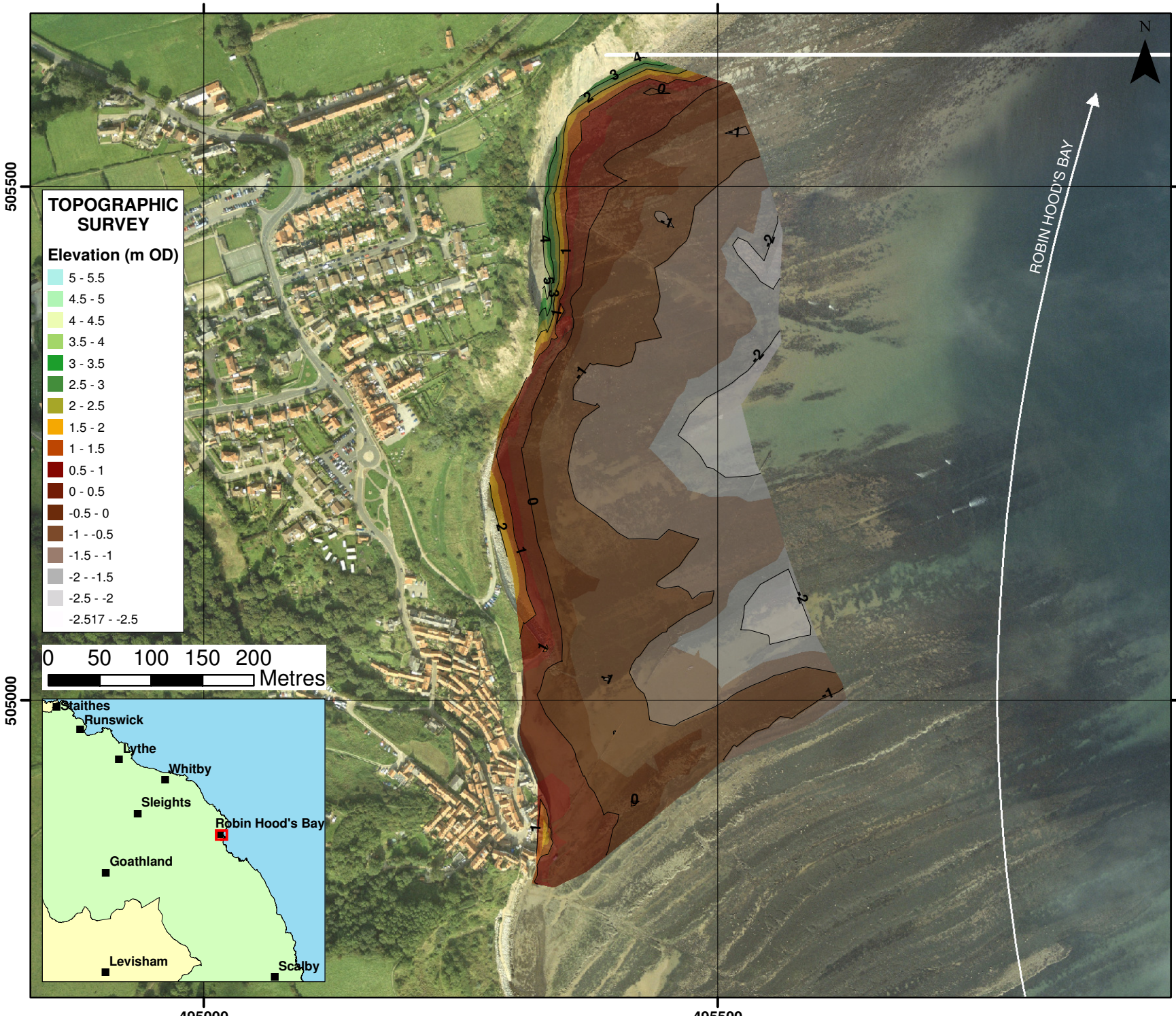
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— Topographic Contours at 1 metre interval

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

**Appendix B - Map 3
 Scarborough
 Borough Council Frontage**

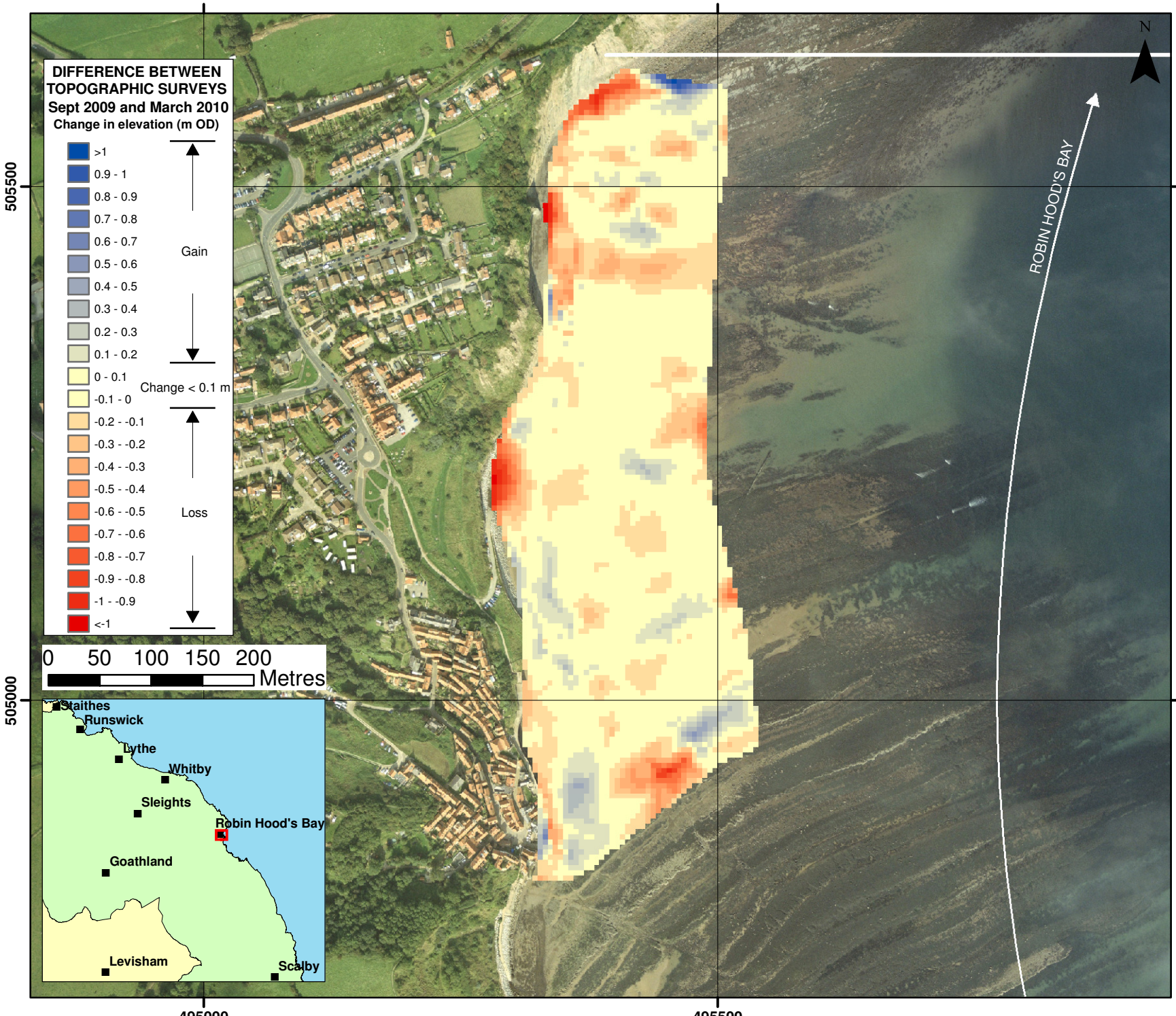
Update Report 2
 'Partial Measures' Survey 2010

Drawing Scale 1:5,000 at A4

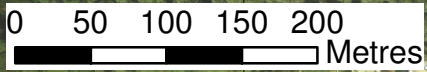
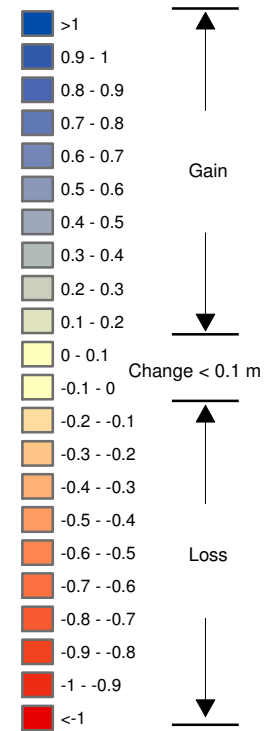
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Checked by: RJ	Date: 04/06/2010
Approved by: RJ	Date: 04/06/2010

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DIFFERENCE BETWEEN TOPOGRAPHIC SURVEYS
Sept 2009 and March 2010
Change in elevation (m OD)



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

Appendix B - Map 4
Scarborough
Borough Council Frontage

Update Report 2
 'Partial Measures' Survey 2010

Drawing Scale 1:5,000 at A4

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Approved by: RJ	Date: 04/06/2010

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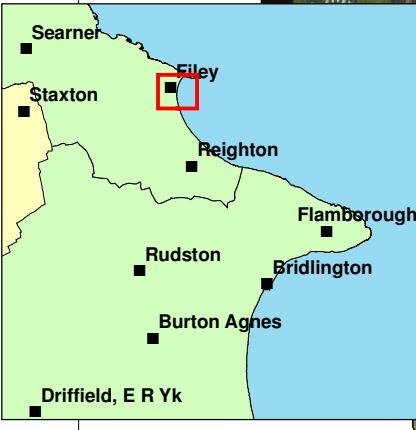
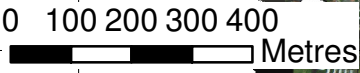
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TOPOGRAPHIC SURVEY

Elevation (m OD)

- 3 - 3.5
- 2.5 - 3
- 2 - 2.5
- 1.5 - 2
- 1 - 1.5
- 0.5 - 1
- 0 - 0.5
- 0.5 - 0
- 1 - -0.5
- 1.5 - -1
- 2 - -1.5
- 2.5 - -2
- 2.532 - -2.5



— Topographic Contours at 1 metre interval

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

**Appendix B - Map 5
 Scarborough
 Borough Council Frontage**

Update Report 2
 'Partial Measures' Survey 2010

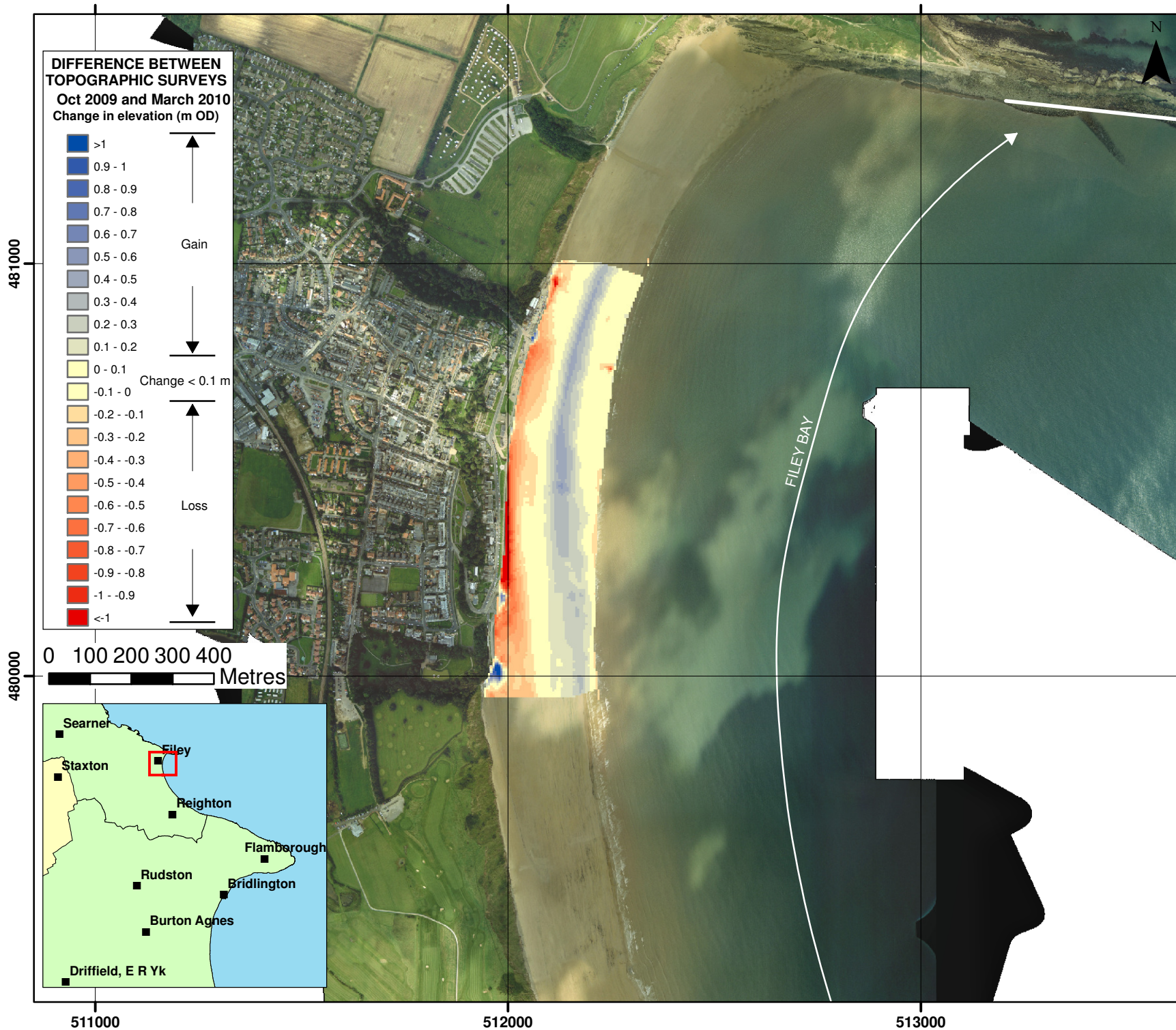
Drawing Scale 1:12,500 at A4

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Checked by: RJ	Date: 04/06/2010
Approved by: RJ	Date: 04/06/2010

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 Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 6
Scarborough
Borough Council Frontage

Update Report 2
 'Partial Measures' Survey 2010


Drawing Scale 1:12,500 at A4

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Approved by: RJ	Date: 04/06/2010



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Appendix C
Cliff Top Survey

Staithes

Twenty ground control points have been established at Staithes (Appendix C- Map 1). The maximum separation between any two points is nominally 100 m.

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 February 2010 survey showing the position 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.

Table C1 – Cliff Top Surveys at Staithes

Ground Control Point Details					Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Level (mODN)	Bearing (°)	Baseline Survey (Nov 2008)	Previous Survey (Sept 2009)	Present Survey (Feb 2010)	Baseline (Nov 2008) to Present (Feb 2010)	Previous (Sept 2009) to Present (Feb 2010)	Baseline (Nov 2008) to Present (Feb 2010)
1	477228	518769	60.587	320	1.9	1.7	1.8	-0.1	0.1	-0.1
2	477334	518798	57.543	0	10.9	10.6	10.7	-0.2	0.1	-0.2
3	477487	518789	54.861	350	7.1	8.4	8.3	1.2	-0.1	-
4	477594	518801	53.636	340	5.9	5.7	5.3	-0.6	-0.4	-0.5
5	477683	518911	48.371	350	8.4	8.5	8.2	-0.2	-0.3	-0.2
6	477792	518867	47.422	30	8.6	8.5	8.4	-0.2	-0.1	-0.2
7	477891	518828	44.602	60	7.7	7.7	7.6	-0.1	-0.1	-0.1
8	477959	518873	39.974	350	8.7	9.0	8.8	0.1	-0.2	-
9	478088	518950	37.281	350	7.6	8.4	8.1	0.5	-0.3	-
10	478191	519023	42.655	340	8.4	12.7	10.7	2.3	-2.0	-
11	478237	519007	39.990	60	6.9	6.8	6.8	-0.1	0.0	-0.1
12	478213	518988	37.169	150	6.1	6.4	6.4	0.3	0.0	-
13	478501	518809	50.260	15	11.4	9.3	9.3	-2.1	0.0	-1.7
14	478624	518807	55.345	20	7.5	7.6	7.6	0.1	0.0	-
15	478737	518858	56.017	60	6.1	6.1	6.1	0.0	0.0	0
16	478823	518757	50.237	60	8.0	7.9	8.8	0.8	0.9	-
17	478944	518671	46.764	30	9.3	9.0	9.6	0.3	0.6	-
18	479052	518630	47.026	20	9.2	9.1	9.1	-0.1	0.0	-0.1
19	479147	518610	47.108	0	14.2	14.0	14.4	0.2	0.4	-
20	479274	518618	44.243	20	11.4	11.5	11.5	0.1	0.0	-

Note: It is assumed that the accuracy of cliff top monitoring using this technique is $\pm 0.1\text{m}$. 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.

Robin Hoods Bay

Thirteen ground control points have been established at Robin Hoods Bay (Appendix C- Map 2). The maximum separation between any two points is nominally 100 m.

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 March 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 Point Details					Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Level (mODN)	Bearing (°)	Baseline Survey (Mar 2010)	Previous Survey (N/A)	Present Survey (N/A)	Baseline (Mar 2010) to Present (N/A)	Previous (N/A) to Present (N/A)	Baseline (Mar 2010) to Present (N/A)
1	495799	506002	65.437	130	11.6	-	-	-	-	-
2	495549	505807	77.314	135	9.3	-	-	-	-	-
3	495456	505739	76.778	130	5.0	-	-	-	-	-
4	495389	505683	73.900	140	6.3	-	-	-	-	-
5	495259	505342	55.041	130	11.3	-	-	-	-	-
6	495231	505315	53.693	95	5.9	-	-	-	-	-
7	495184	505210	44.946	85	6.4	-	-	-	-	-
8	495206	505153	34.093	75	5.0	-	-	-	-	-
9	495287	505060	20.932	80	4.3	-	-	-	-	-
10	495187	504708	43.446	70	3.1	-	-	-	-	-
11	495226	504615	44.665	120	3.8	-	-	-	-	-
12	495297	504380	44.859	80	11.0	-	-	-	-	-
13	495350	504193	45.630	55	3.7	-	-	-	-	-

Note: It is assumed that the accuracy of cliff top monitoring using this technique is $\pm 0.1\text{m}$. 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.

Scarborough South Bay

Thirteen ground control points have been established at Scarborough South Bay (Appendix C- Map 3). The maximum separation between any two points is nominally 300 m.

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 March 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 Point Details					Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Level (mODN)	Bearing (°)	Baseline Survey (Mar 2010)	Previous Survey (N/A)	Present Survey (N/A)	Baseline (Mar 2010) to Present (N/A)	Previous (N/A) to Present (N/A)	Baseline (Mar 2010) to Present (N/A)
1	504339	487887	53.707	70	7.0	-	-	-	-	-
2	504422	487603	52.670	80	4.8	-	-	-	-	-
3	504534	487318	64.346	40	15.1	-	-	-	-	-
4	504730	487137	56.299	55	9.6	-	-	-	-	-
5	504922	486837	61.272	60	8.8	-	-	-	-	-
6	505071	486652	68.935	75	3.8	-	-	-	-	-
7	505284	486479	68.091	35	7.0	-	-	-	-	-
8	505597	486363	56.836	30	8.6	-	-	-	-	-
9	505758	486005	61.483	45	9.1	-	-	-	-	-
10	505895	485889	60.324	15	14.8	-	-	-	-	-
11	505990	485657	60.520	80	4.7	-	-	-	-	-
12	506024	485421	69.863	55	6.1	-	-	-	-	-
13	506035	485315	78.327	90	7.0	-	-	-	-	-

Note: It is assumed that the accuracy of cliff top monitoring using this technique is ± 0.1 m. 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.

Cliff Top Survey

Cayton Bay

Eight ground control points have been established within Cayton Bay (Appendix C- Map 4). The maximum separation between any two points is nominally 300m.

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 March 2010 survey showing the position 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.

Table C4 – Cliff Top Surveys at Cayton Bay

Ground Control Point Details					Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Level (mODN)	Bearing (°)	Baseline Survey (Nov 2008)	Previous Survey (Oct 2009)	Present Survey (Mar 2010)	Baseline (Nov 2008) to Present (Mar 2010)	Previous (Oct 2009) to Present (Mar 2010)	Baseline (Nov 2008) to Present (Mar 2010)
1	506325	484850	32.079	50	4.0	3.5	3.5	-0.5	0.0	-0.4
2	506459	484716	28.227	65	5.0	4.0	-0.1	-5.1	-4.1	-3.8
3	506597	484539	28.204	65	5.0	6.4	6.3	1.3	-0.1	-
4	506778	484345	38.944	21	9.0	8.8	9.0	0.0	0.2	0
5	507019	484222	38.816	342	7.7	7.9	8.1	0.4	0.2	-
6	507242	484122	46.544	2	7.4	7.4	7.5	0.1	0.1	-
7	507518	484008	69.549	25	7.5	7.5	7.8	0.3	0.3	-
8	507819	484006	80.135	1	5.5	5.4	6.0	0.5	0.6	-

Note: It is assumed that the accuracy of cliff top monitoring using this technique is ± 0.1 m. 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.

Cliff Top Survey

Filey Bay

Twenty-three ground control points have been established within Filey Bay (Appendix C- Map 5). The maximum separation between any two points is nominally 300 m.

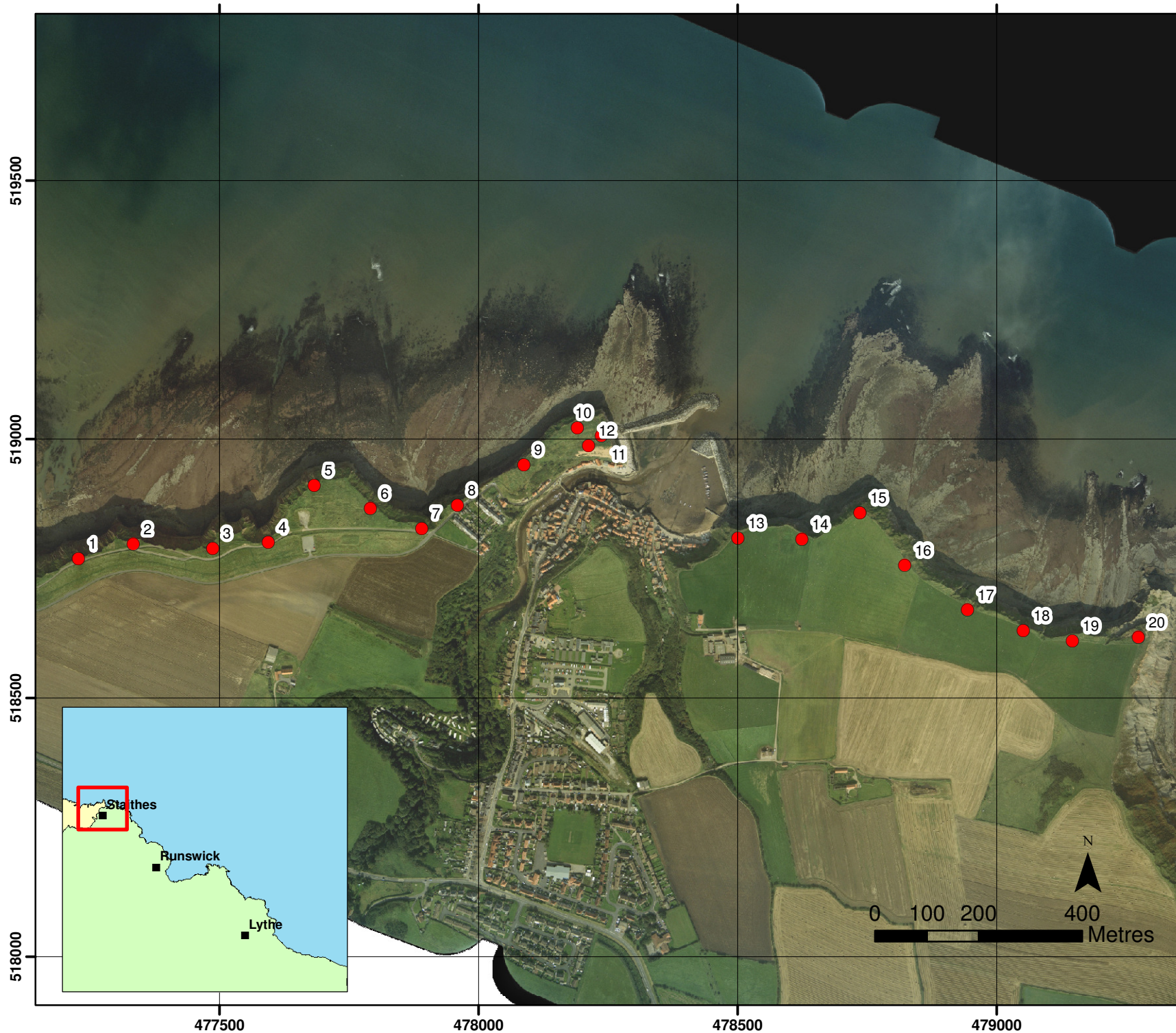
The cliff top surveys at Filey Bay are undertaken bi-annually. Measurements are taken from a fixed ground control point along a fixed bearing to the edge of the cliff top.

Table C5 provides baseline information about these ground control points and results from the March 2010 survey showing the position 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.

Table C5 – Cliff Top Surveys at Filey Bay

Ground Control Point Details					Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Level (mODN)	Bearing (°)	Baseline Survey (Nov 2008)	Previous Survey (Oct 2009)	Present Survey (Mar 2010)	Baseline (Nov 2008) to Present (Mar 2010)	Previous (Oct 2009) to Present (Mar 2010)	Baseline (Nov 2008) to Present (Mar 2010)
1	512445	481631	42.536	130	8.7	8.9	8.9	0.2	0.0	-
2	512307	481490	37.536	144	7.6	7.7	7.7	0.1	0.0	-
3	512154	481235	34.607	122	8.3	8.5	8.5	0.2	0.0	-
4	512029	480960	33.034	112	7.4	7.6	7.6	0.2	0.0	-
5	511895	479888	28.755	89	7.1	3.6	1.5	-5.6	-2.1	-4.2
6	511908	479597	31.804	48	6.7	6.9	6.9	0.2	0.0	-
7	511991	479310	29.201	69	6.7	7.0	7.0	0.3	0.0	-
8	512083	478981	27.177	66	10.2	10.3	10.3	0.1	0.0	-
9	512121	478786	30.903	76	8.3	8.5	8.5	0.2	0.0	-
10	512226	478548	32.958	74	7.5	7.6	7.4	-0.1	-0.2	-0.1
11	512471	478153	11.301	53	6.6	6.2	6.3	-0.3	0.1	-0.2
12	512559	477902	20.254	66	7.7	7.7	7.7	0.0	0.0	0
13	512698	477719	20.216	34	4.2	4.1	4.2	0.0	0.1	0
14	512939	477401	31.736	66	8.0	7.9	7.3	-0.7	-0.6	-0.5
15	513157	477193	27.613	51	5.2	5.3	5.3	0.1	0.0	-
16	513299	477025	27.972	30	7.7	7.8	7.8	0.1	0.0	-
17	513508	476821	36.784	34	10.7	10.8	10.8	0.1	0.0	-
18	513721	476602	39.676	31	7.2	7.3	7.4	0.2	0.1	-
19	513917	476354	48.852	51	6.6	7.1	6.6	0.0	-0.5	0
20	514175	476179	41.826	32	7.0	6.9	7.2	0.2	0.3	-
21	514472	475966	43.232	66	7.6	7.7	7.7	0.1	0.0	-
22	514656	475729	56.553	101	8.1	8.1	8.1	0.0	0.0	0
23	514889	475538	68.497	60	9.1	9.2	9.1	0.0	-0.1	0

Note: It is assumed that the accuracy of cliff top monitoring using this technique is ± 0.1 m. 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



● Ground Control Points

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

**Appendix C - Map 1
Scarborough
Borough Council Frontage**

Update Report 2
'Partial Measures' Survey 2010

Drawing Scale 1:10,000 at A4

Drawn by: ES Date: 02/06/2010

Checked by: RJ Date: 02/06/2010

Approved by: RJ Date: 02/06/2010



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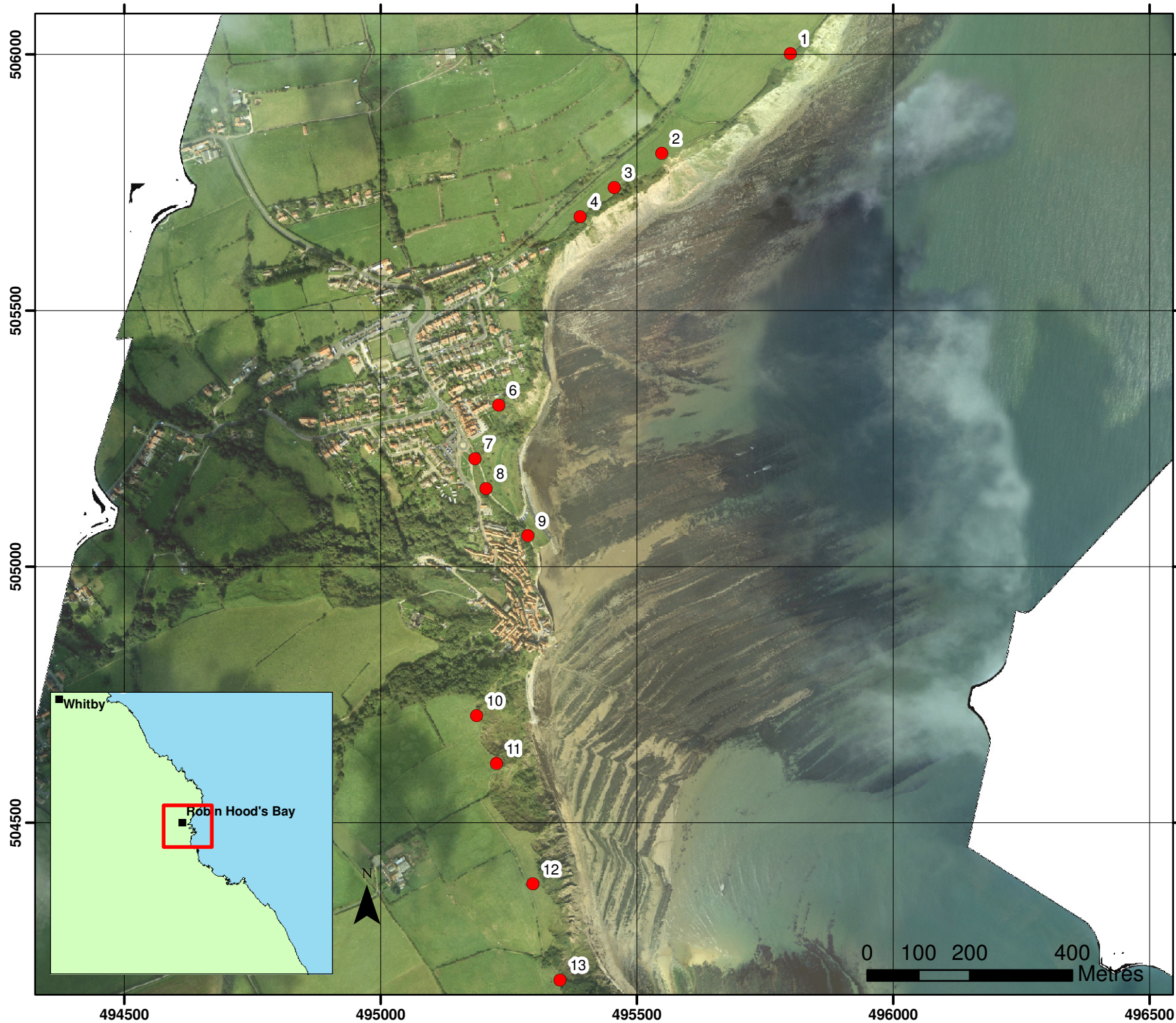


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Appendix C - Map 2
Scarborough
Borough Council Frontage
 Update Report 2
 'Partial Measures' Survey 2010

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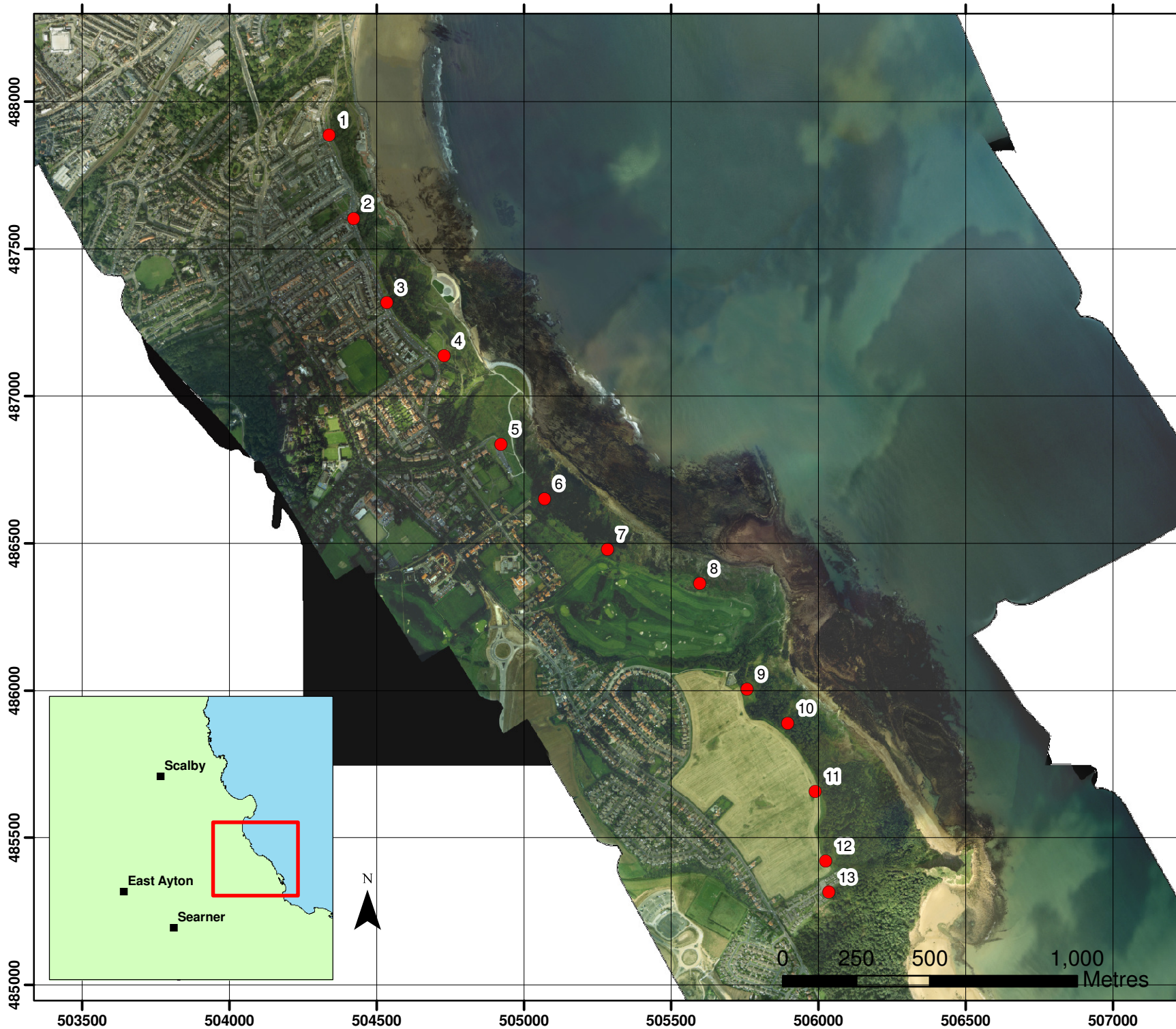


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**Appendix C - Map 3
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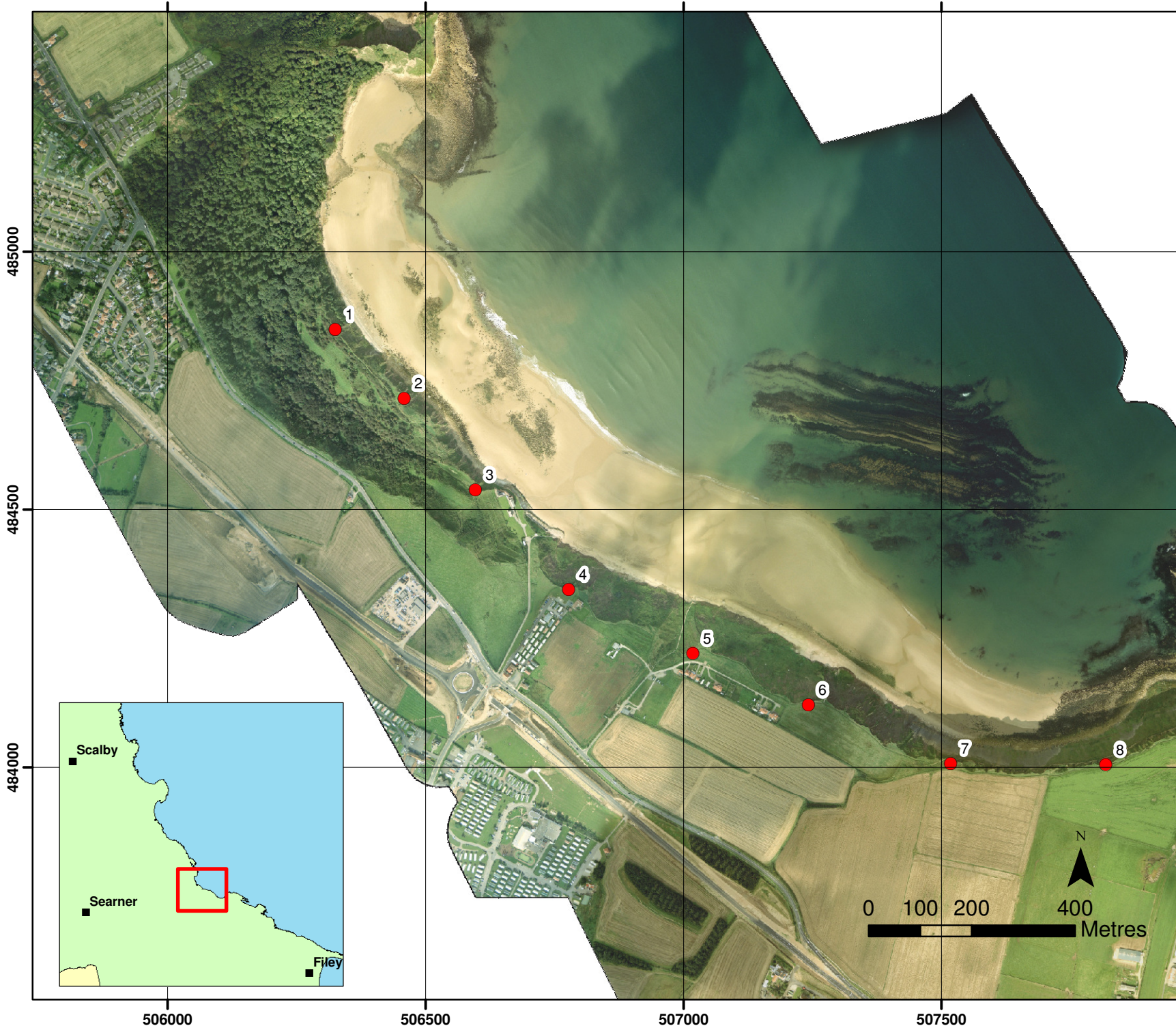


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**Appendix C - Map 4
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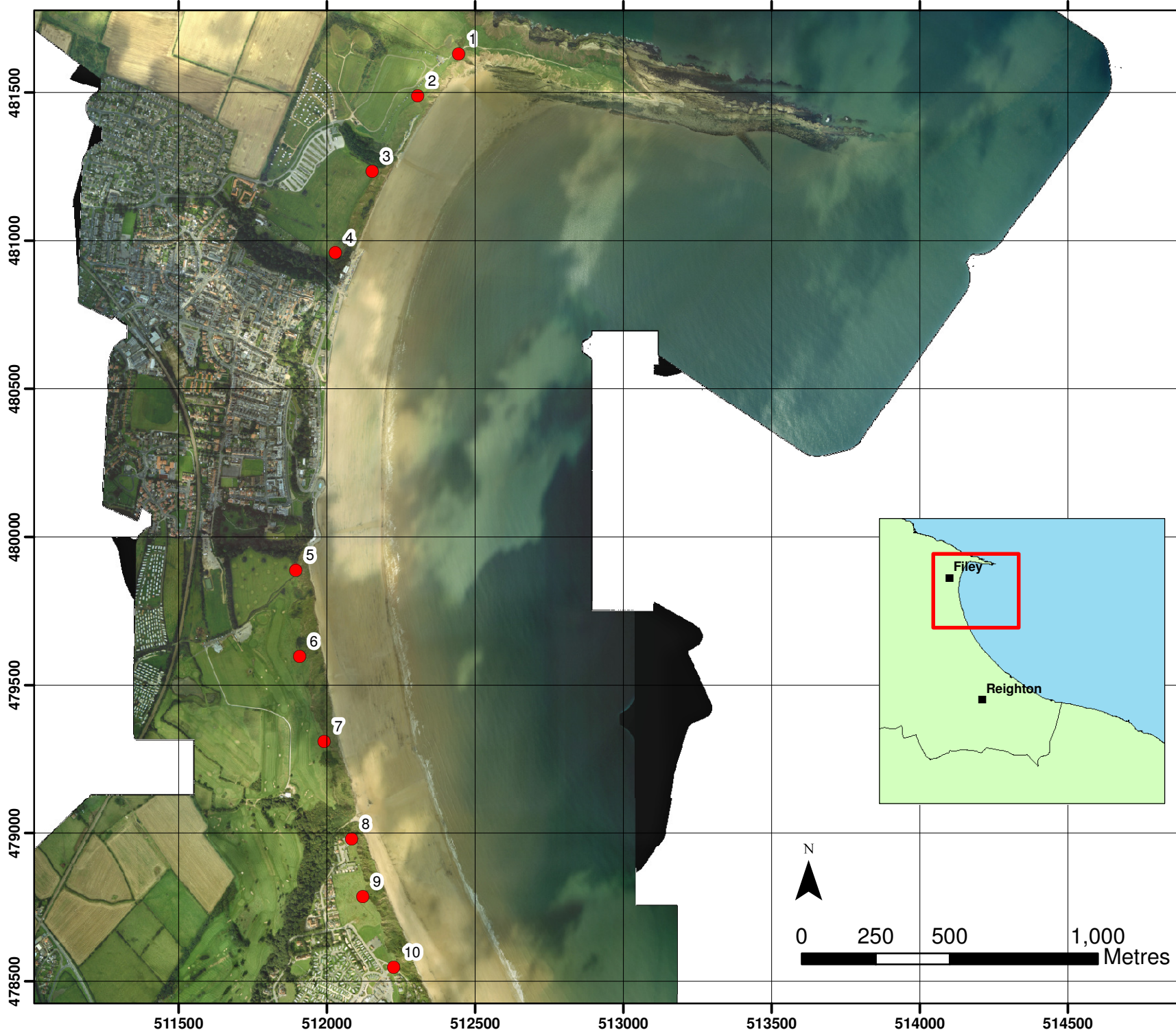
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**Appendix C - Map 5a
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 Borough Council Frontage**
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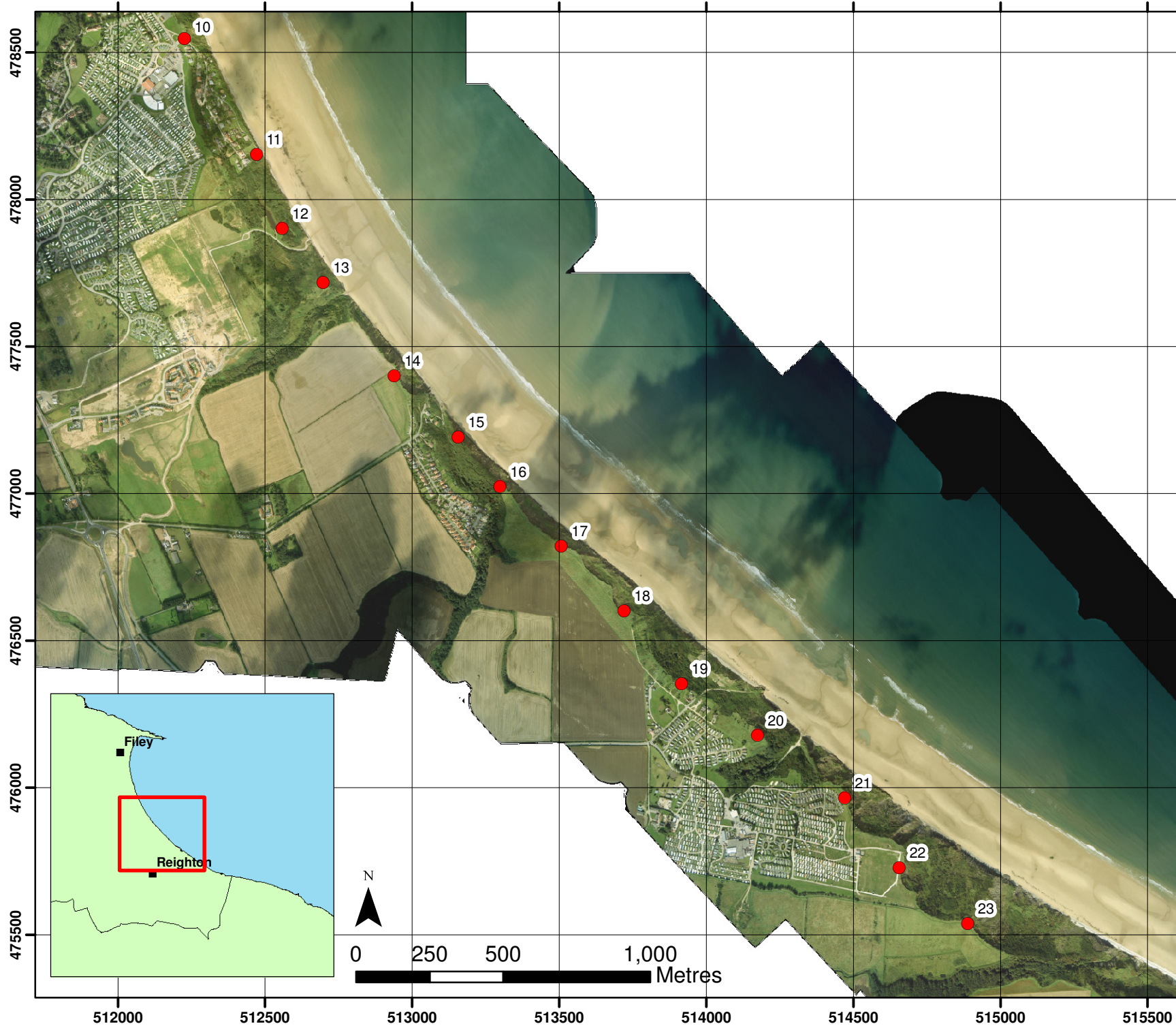


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Appendix C - Map 5b
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