Cell 1 Regional Coastal Monitoring Programme
Update Report 7: 'Partial Measures' Survey 2015

A great place to live, work & play

Scarborough Council
Final Report

July 2015

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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 (m AOD)			
Water Level Parameter	**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).

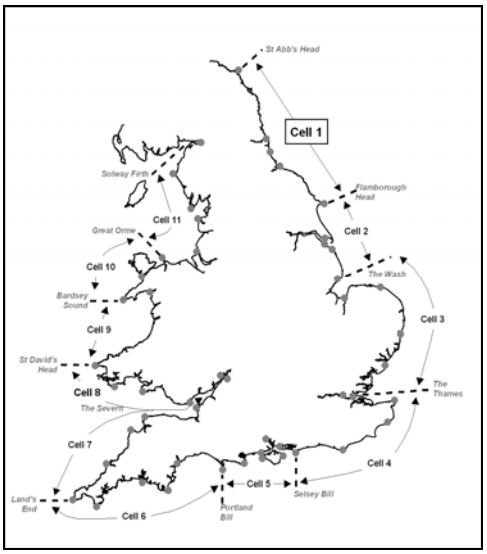


Figure 1 Sediment Cells in England and Wales

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 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	Sept-Dec 08	May 09	Mar-May 09	June 2009	-
2	2009/10	Sept-Dec 09	Mar 10	Feb-Mar 10	Jul 10	-
3	2010/11	Aug-Nov 10	Feb 11	Feb-Apr 11	Aug 11	Sept 11
4	2011/12	Oct-Nov 11	Feb 12	Mar-May 12	July 13	
5	2012/13	Sept 12	Mar 13	Apr-May 13	May 13	
6	2013/14	Oct-Nov 13	Feb 14	Mar-April 14	July 14	
7	2014/15	Sept 14	Feb 15	March 15	July 15(*)	

(*) The present report is **Update Report 7** and provides an analysis of the 2015 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:

- Staithes[1]
- 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 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

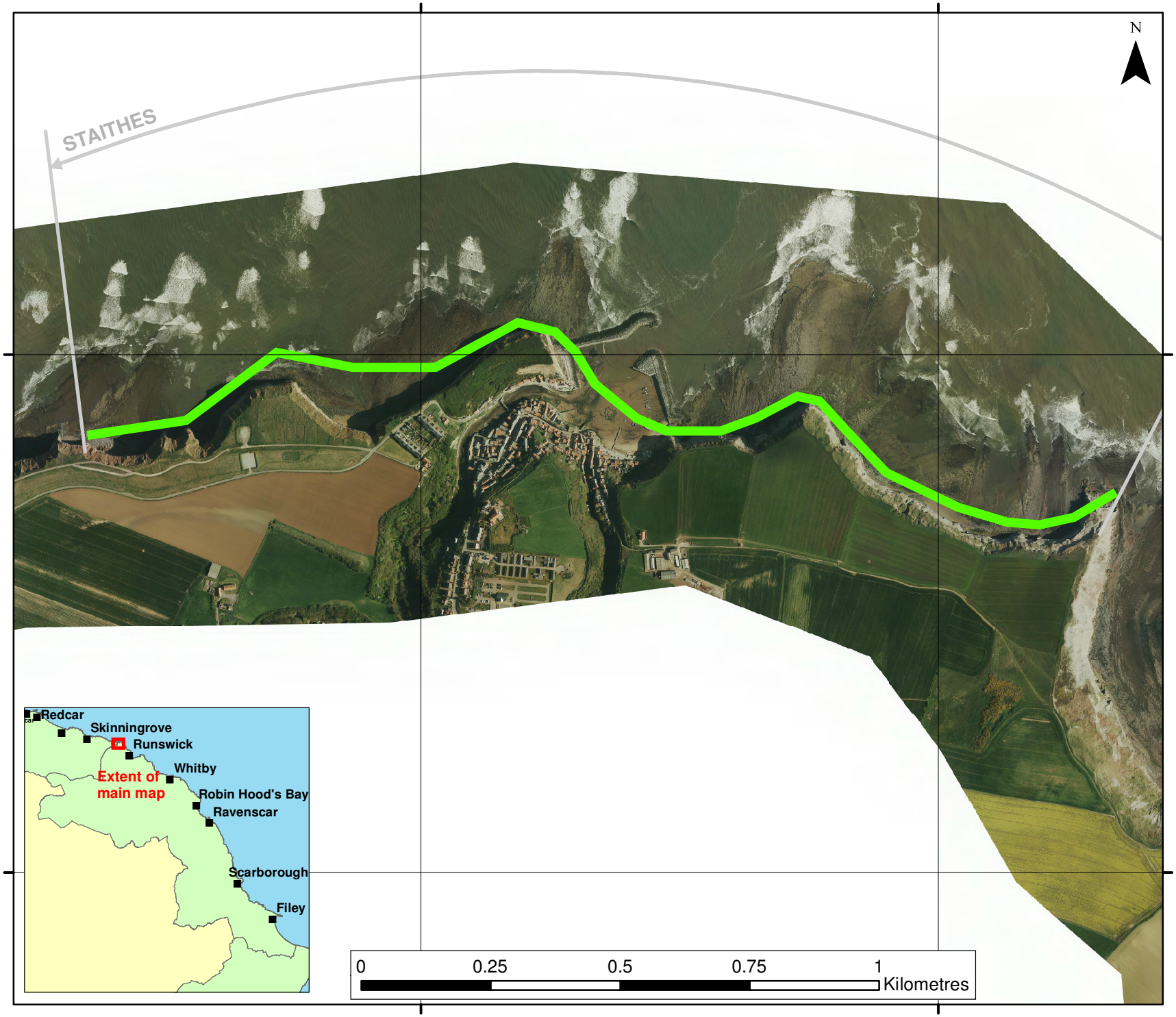
The location of these surveys is shown in Figure 2. The Partial Measures survey was undertaken along this frontage between 5th and 27th March 2015. During this time weather conditions varied considerably; refer to the survey reports for details of the weather conditions over this survey period.

The Update Report presents the following:

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

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

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



KEY

Topographic Profiles

- Annual
- 6 monthly

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs

- 50m centres
- 100m centres
- 300m centres

(Indicative survey extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Figure 2 - Map 1
Survey Locations
Staithes
Scarborough
Borough Council

Update Report 7
Partial Measures Survey
Spring 2015

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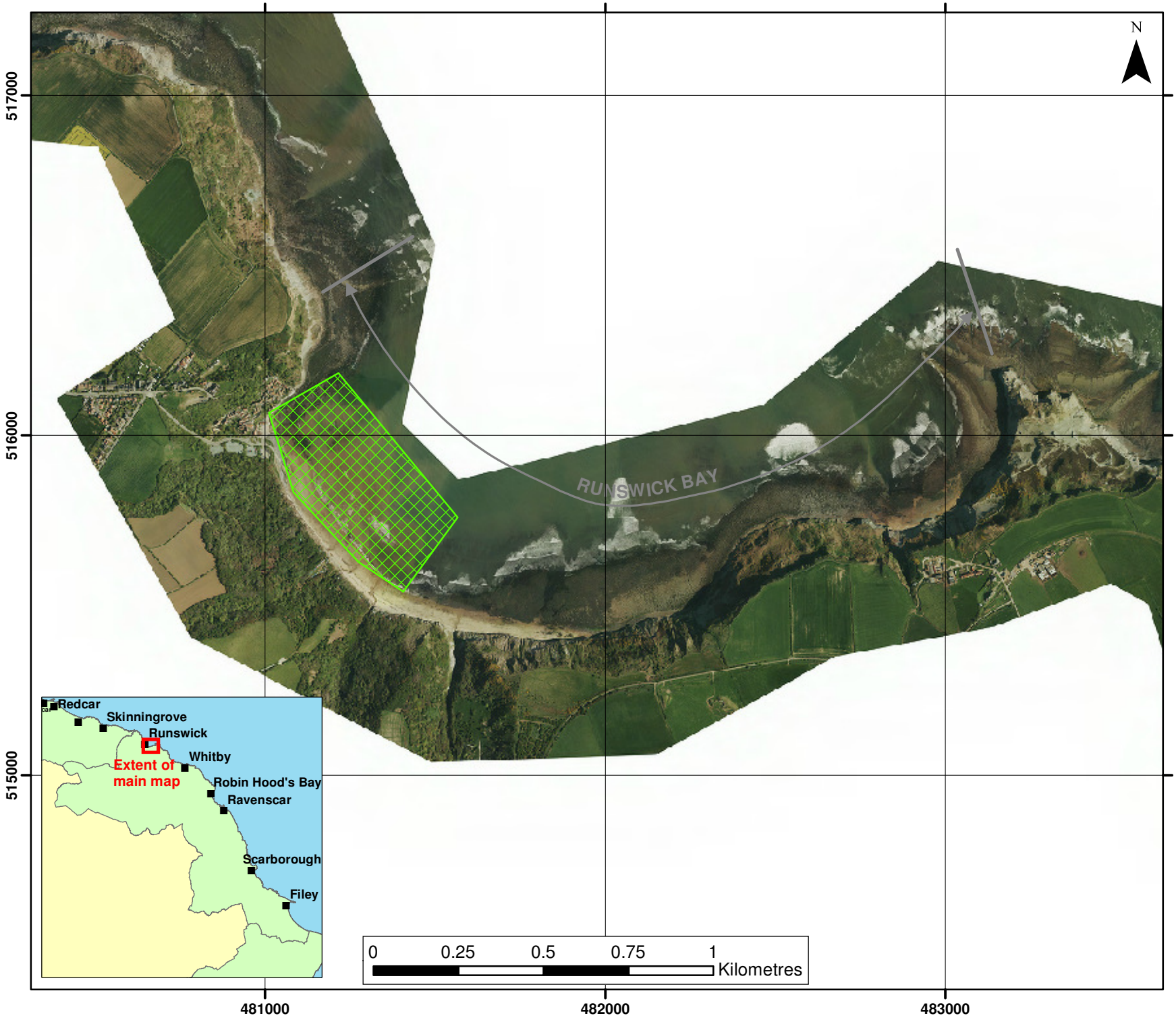

KEY

Topographic Profiles

- Annual
- 6 monthly

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs

- 50m centres
- 100m centres
- 300m centres

(Indicative survey extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Figure 2 - Map 2
Survey Locations
Runswick Bay
Scarborough
Borough Council

Update Report 7
Partial Measures Survey
Spring 2015

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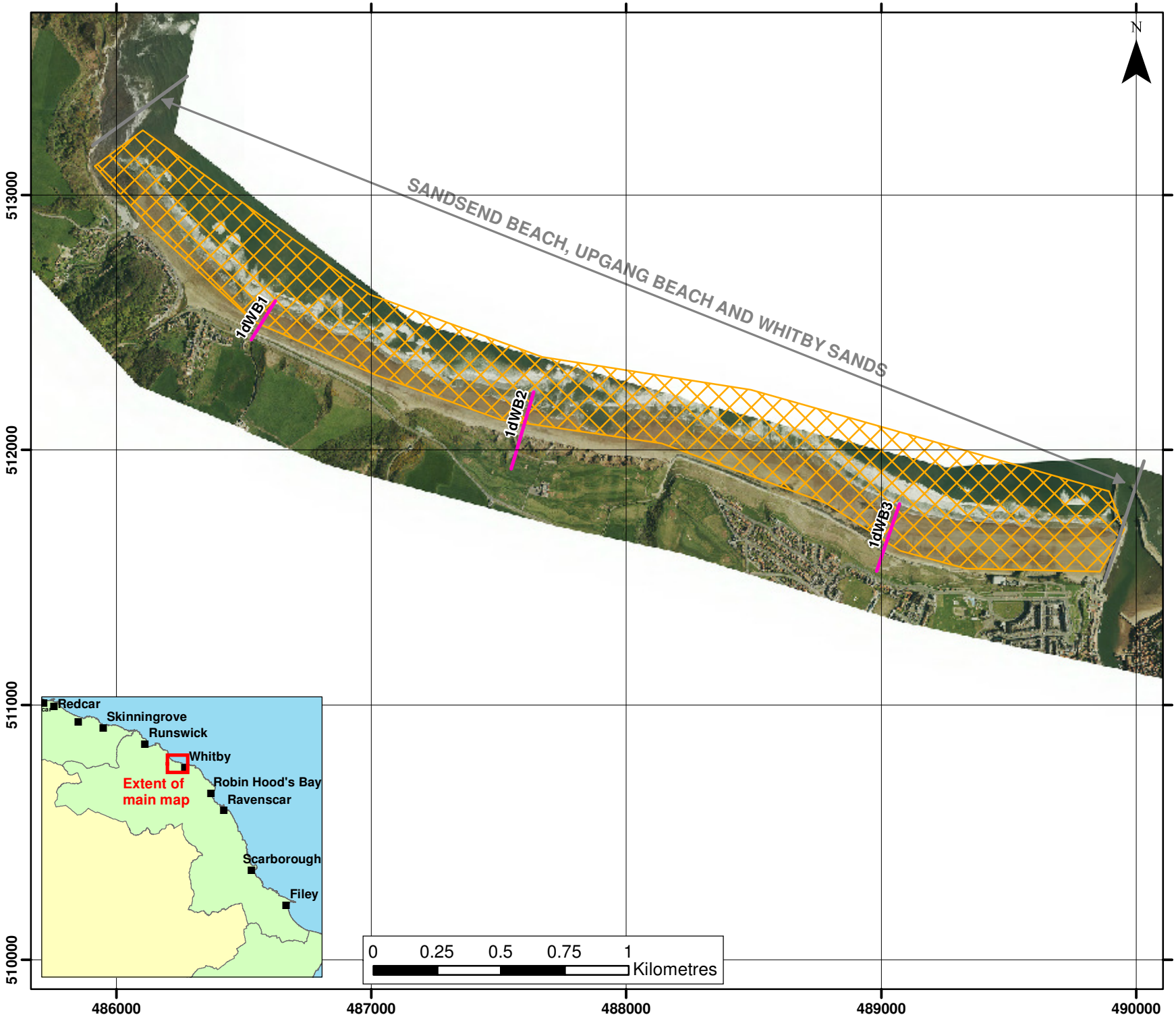

KEY

Topographic Profiles
- Annual
- 6 monthly

Topographic Surveys
- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs
- 50m centres
- 100m centres
- 300m centres

(Indicative survey extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Figure 2 - Map 3
Survey Locations
Sandsend to Whitby
Scarborough Borough Council

Update Report 7
Partial Measures Survey
Spring 2015

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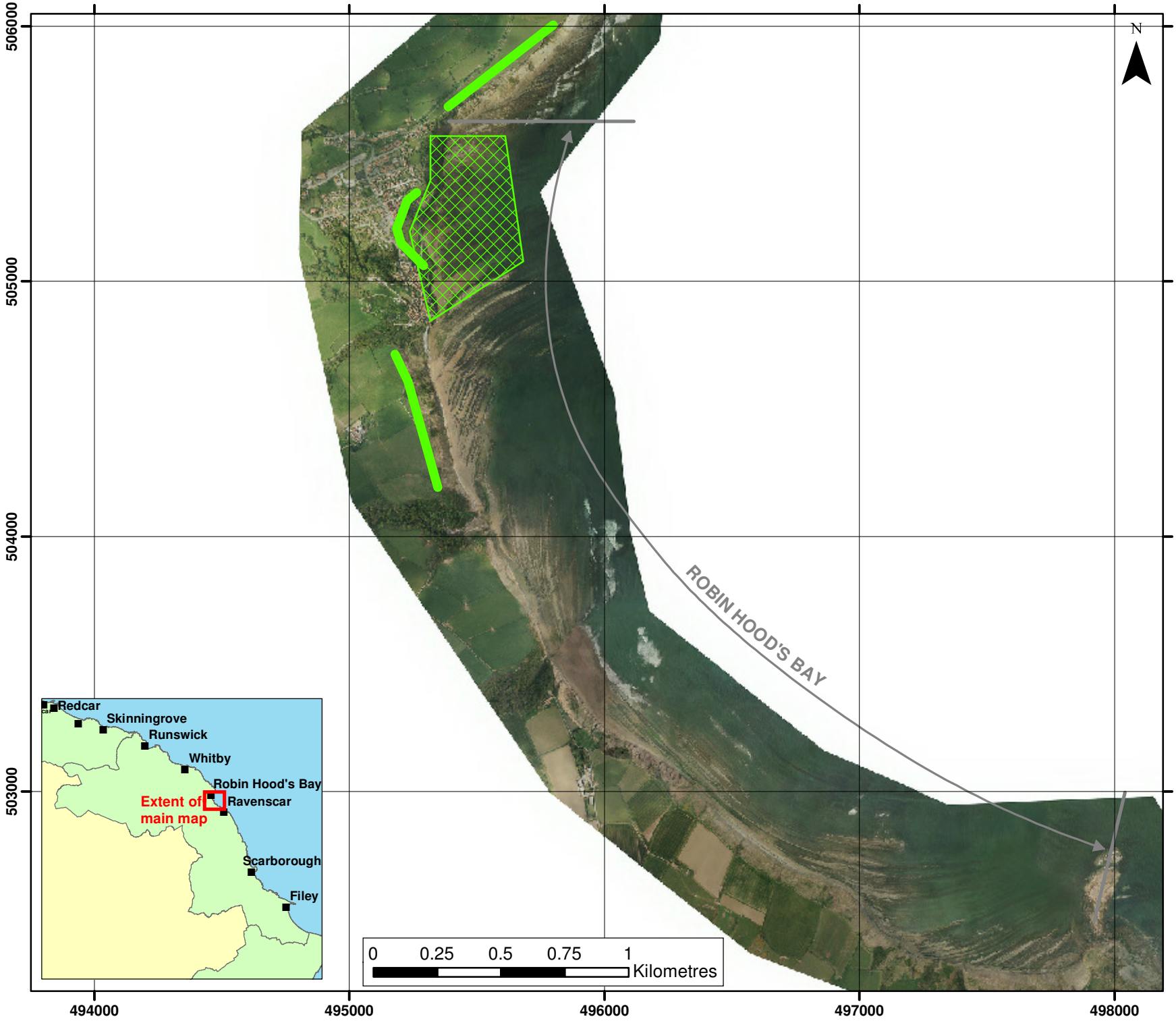

KEY

Topographic Profiles
- Annual
- 6 monthly

Topographic Surveys
- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs
- 50m centres
- 100m centres
- 300m centres

(Indicative survey extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Figure 2 - Map 4
Survey Locations
Robin Hood's Bay
Scarborough
Borough Council

Update Report 7
Partial Measures Survey
Spring 2015

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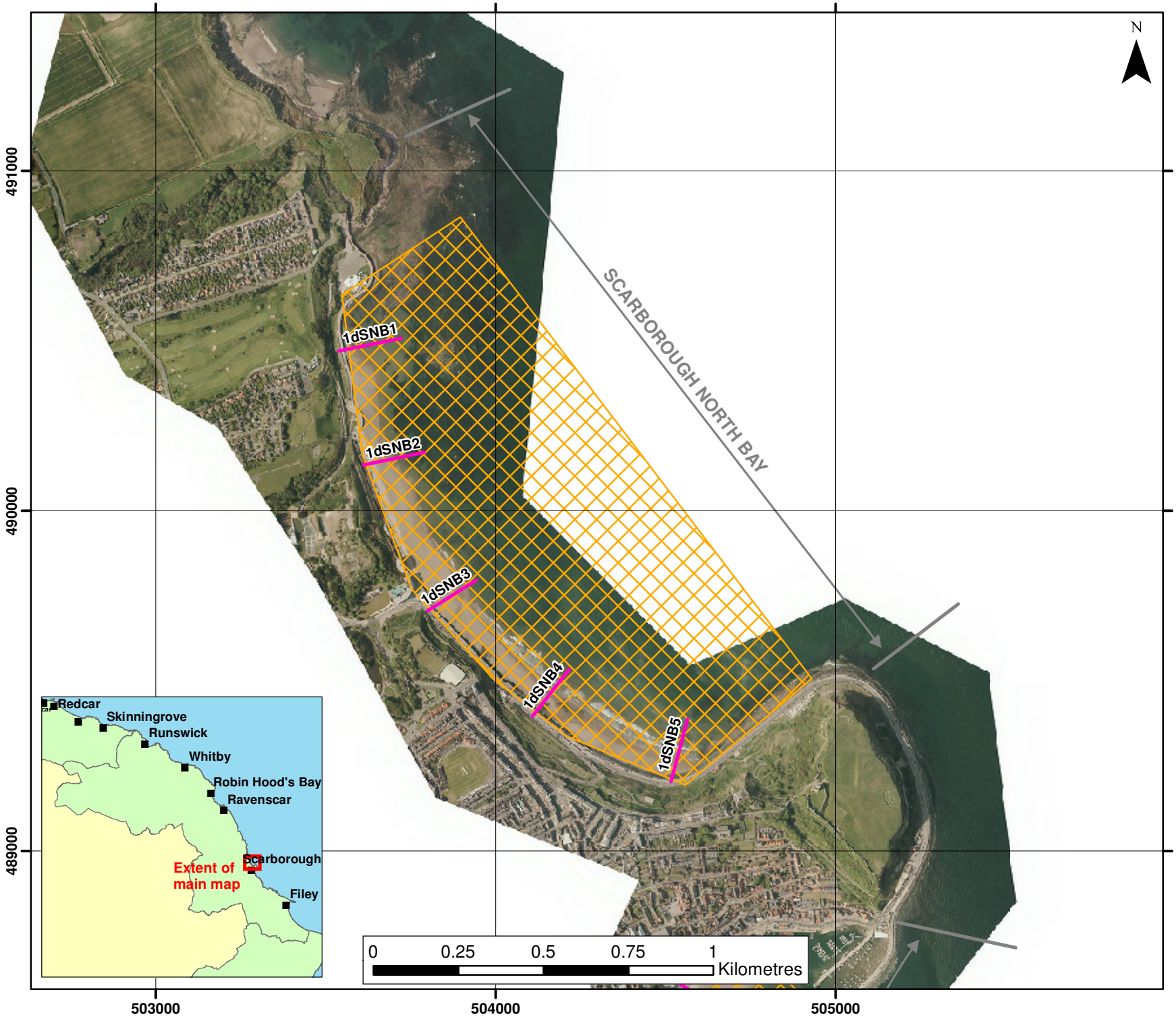

KEY

Topographic Profiles

- Annual
- 6 monthly

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs

- 50m centres
- 100m centres
- 300m centres

(Indicative survey extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Figure 2 - Map 5
Survey Locations
Scarborough North Bay
Scarborough Borough Council

Update Report 7
Partial Measures Survey
Spring 2015

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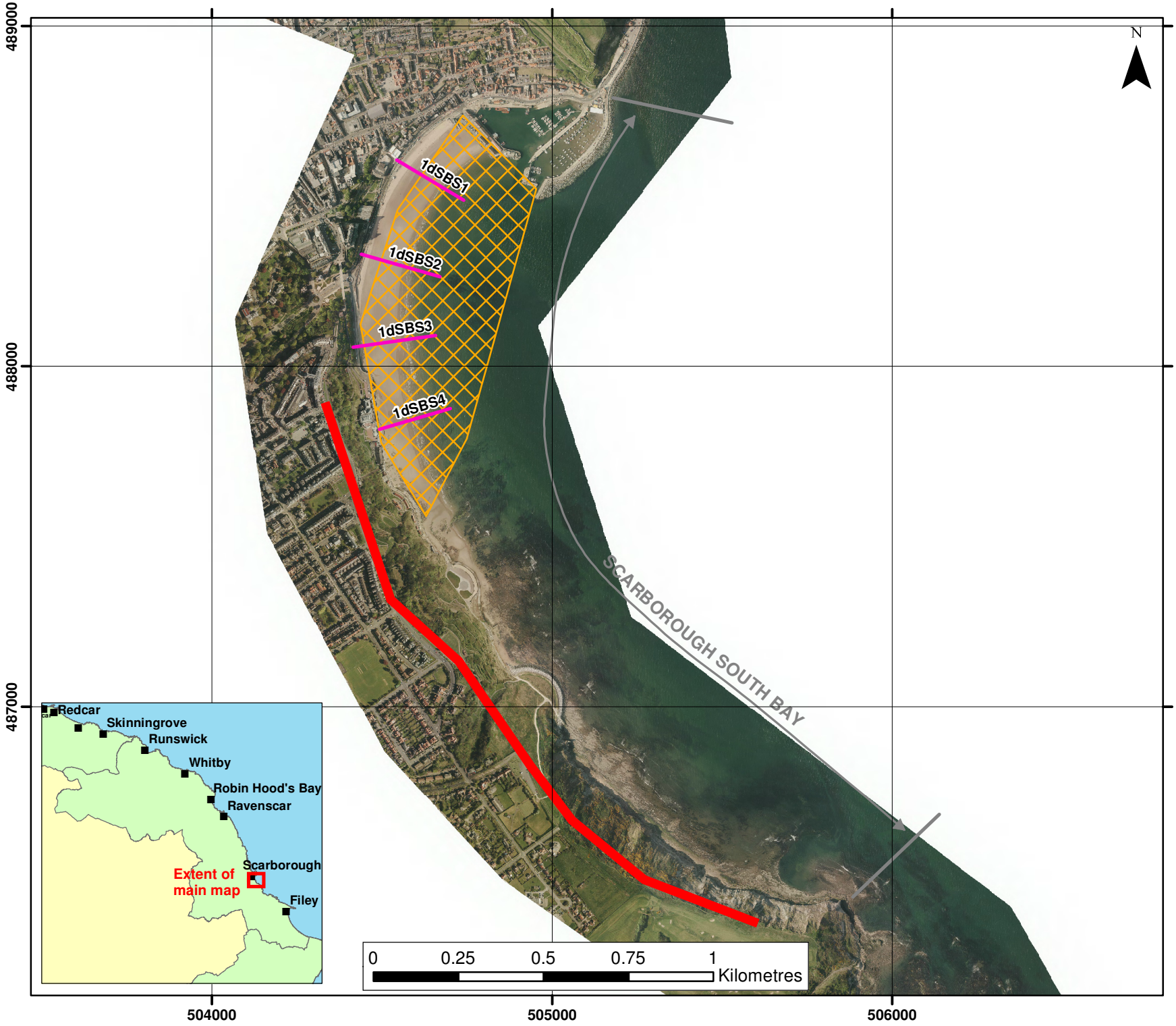

KEY

Topographic Profiles
- Annual
- 6 monthly

Topographic Surveys
- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs
- 50m centres
- 100m centres
- 300m centres

(Indicative survey extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Figure 2 - Map 6
Survey Locations
Scarborough South Bay
Scarborough
Borough Council

Update Report 7
Partial Measures Survey
Spring 2015

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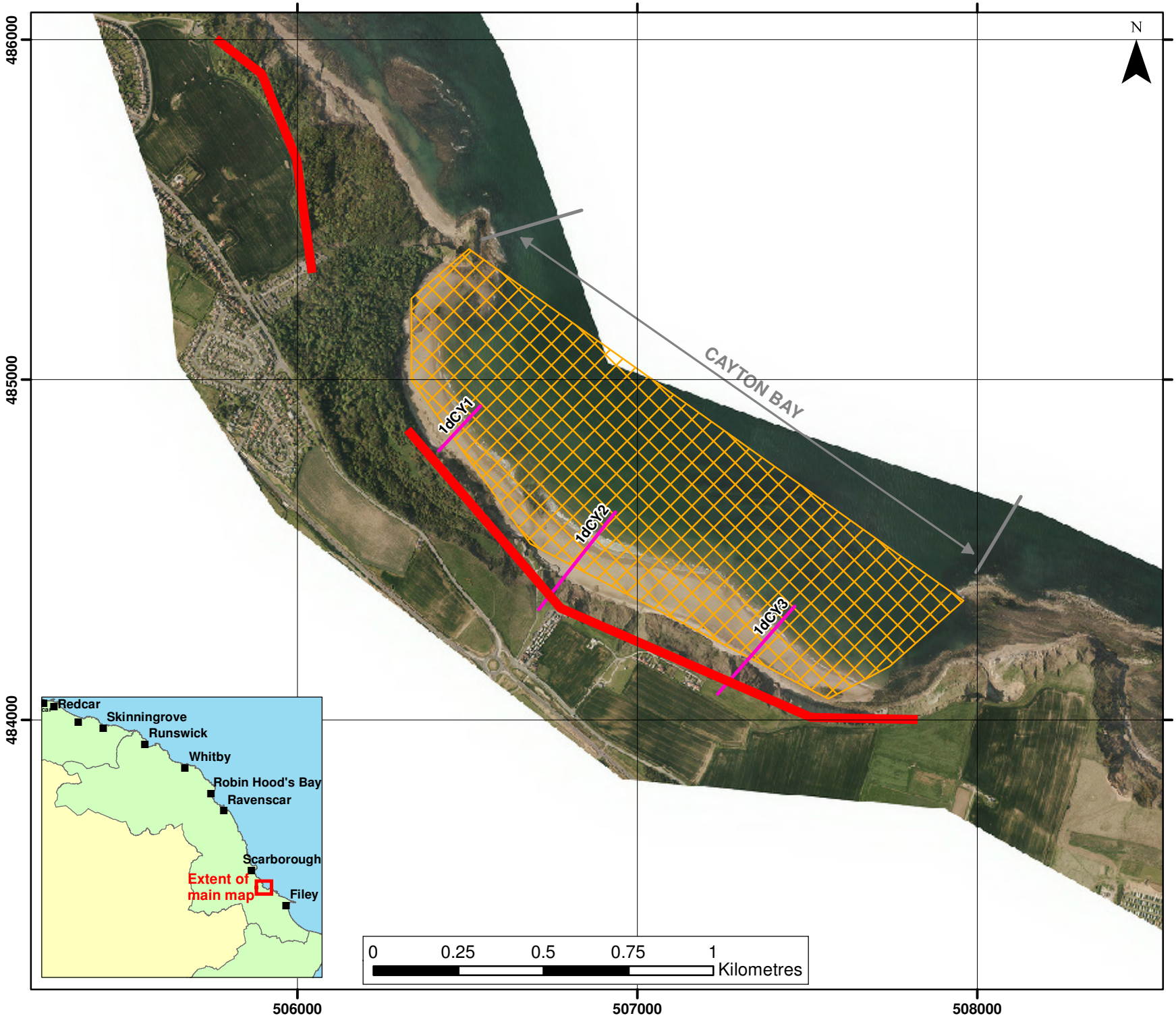

KEY

Topographic Profiles

- Annual
- 6 monthly

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs

- 50m centres
- 100m centres
- 300m centres

(Indicative survey extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Figure 2 - Map 7
Survey Locations
Cayton Bay
Scarborough Borough Council

Update Report 7
Partial Measures Survey
Spring 2015

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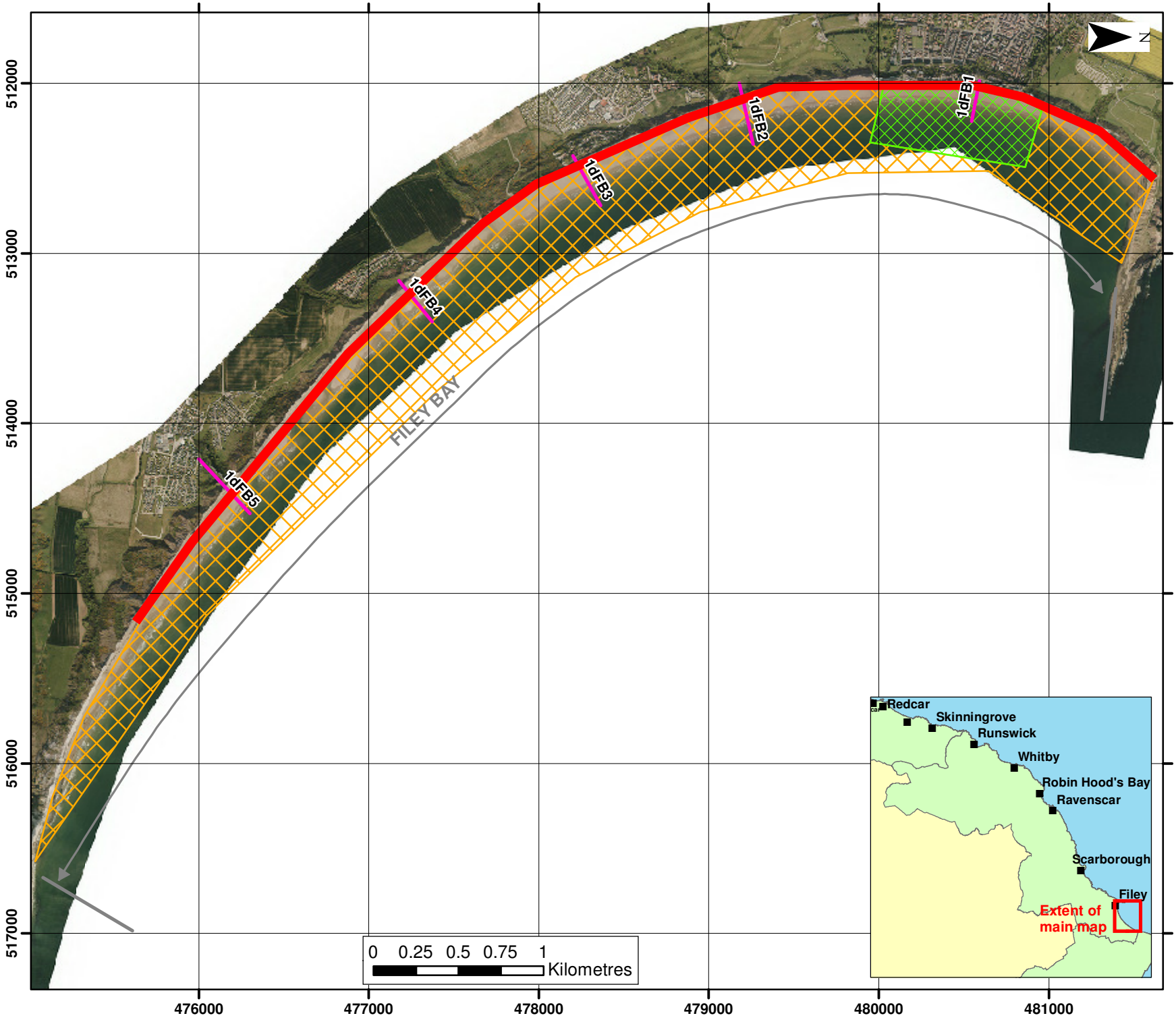

KEY

Topographic Profiles
- Annual
- 6 monthly

Topographic Surveys
- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs
- 50m centres
- 100m centres
- 300m centres

(Indicative survey extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Figure 2 - Map 8
Survey Locations
Filey
Scarborough
Borough Council

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2. Analysis of Survey Data

2.1 Staithes

Survey Date	Description of Changes Since Last Survey	Interpretation
27th March 2015	**Cliff-top Survey:** Twenty ground control points have been established at Staithes for the purposes of cliff top monitoring. The separation between any two points is a nominal 100m. The cliff top surveys at Staithes are undertaken bi-annually. Data collection involves a distance offset measurement from the ground control point to the cliff edge along a fixed bearing. Appendix C provides results from the March 2015 survey, showing the distance from the ground control point to the edge of the cliff top along the defined bearing and changes in position since the November 2008 baseline survey and the previous October 2014 survey. The results provided in Appendix C show that six of the profiles have experienced erosion greater than the assumed error of ±0.1m between October 2014 and March 2015. Four profiles show erosion of 0.1m over the winter (Points 13, 15, 16 and 18), while nearby, point 17 had eroded by 0.2. The area of the largest erosion was Point 5 where 0.6m was lost.	The recorded changes to the cliff top between October 2014 and March 2015 are small. There have been no large failures which have affected the cliff top. **Longer term trends:** Table C1 in Appendix C presents the erosion rates calculated from the data collected since 2008. Points 1, 4, 7 and 17 have a recession rate of 0.1m/yr. The highest rate of erosion is 0.4m/yr at Point 13.

2.2 Runswick Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
24th March 2015	**Topographic Survey:** 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 1a) and to calculate the differences between the current topographic survey (Spring 2015) and the previous survey (Autumn 2014) 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 1b). Appendix B - Map 1b shows changes that are primarily shore-parallel, with erosion at the top and bottom of the shore and accretion in the middle. The erosion in the landward band has resulted in a drop in beach level of up to 1m over the winter period. At the seaward extent of the survey in the middle of the bay up to 0.5m lowering has occurred. The accretion in the middle of the beach was moderate, with only local parts of the beach showing accretion of 1m.	Material appears to have been moved from the top and bottom of the beach to the centre of the beach. The pattern is indicates seasonal draw down, with material moving down the beach towards temporary stored below MLW. **Longer term trends:** The data collected since 2008 indicate a general pattern of winter drawdown and spring recovery with no net change. The trends and plots from this survey are comparable with 2013 and 2014.

2.3 Sandsend Beach, Upgang Beach and Whitby Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
23rd March 2015	**Beach Profiles:** 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 September 2014 (2014 Full Measures) and in March 2015. **Profile 1dWB1** is located around 400m south of Sandsend village. The profile above HAT (to around 45m chainage) has not changed except for some minor erosion of the vegetated cliff. From 45m to 80m chainage the beach level has dropped by 0.2m. Between 80 and 170m chainage the beach level has risen by 0.4m. **Profile 1dWB2** is located in the centre of Upgang beach. The upper beach is at a historical low and between 145m and 190m chainage levels have dropped by 1.2m over the winter of 2014/15 bringing levels to the same low levels experienced after the December 2013 storm surge. From 190m to 280m chainage the beach level has increased by around 0.4m since September 2015. The profile is flat and featureless compared to adjacent profiles. **Profile 1dWB3** is located on Whitby Sands and showed no change from 0 to 90m chainage which covers a cliff and seawall. At 90m chainage the beach level at the toe of the sea wall had dropped by 0.5m since September 2014. From 90m to 150m the beach level has dropped by 0.3m. Between 150m and 170m chainage there was no change in beach level. From 170 to 230m chainage the beach level has dropped by up to 0.2m. For the rest of the profile levels are unchanged. Overall, the profile is in the middle of the past range levels.	All the profiles show relatively smooth beach profiles that are free of berms and troughs. All of the profiles have low upper beaches. The beach at WB2 is as low as the profile recorded after the December 2013 storm surge. **Longer term trends:** The drop in beach level over the winter is to be expected and follows past patterns. However the upper beach has lowered more considerably than in the past. This exposure of the cliff toe may lead to accelerated erosion in coming months. The mid and lower beach levels were close to the mid-range of profiles for the majority of the frontage.

2.4 Robin Hoods Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
5th March 2015	**Topographic Survey:** Data from the most recent topographic survey (Partial Measures, Spring 2015) have been used to create a digital ground model (DGM) (Appendix B – Map 2a) using a Geographical Information System (GIS). A difference plot has also been produced using the DGM (Appendix B – Map 2b) from the last topographic survey (Full Measures, Autumn 2014) and the present survey. The difference plot shows changes in level between Autumn 2014 and Spring 2015 and highlights a patchy distribution of erosion and accretion. The majority of the bay has seen little change (±0.25m) over the winter of 2014/15 which is associated with rocky outcrops that run perpendicular to the shore. The most severe losses are in the north of the bay where there is a large area of up to 0.75m erosion. Along the landward extent of the survey there is a consistent band of erosion, showing the upper beach levels have dropped. There was also erosion of up to 0.5m in the centre and south of the bay. There are three main patches of accretion over the rocks in the bay, where the increase in level was around 0.5m.	The distribution of accretion and erosion is patchy but lowering is consistent at the back of the beach. There has been little change over the rock promontories in the bay, although some parts have accreted sediment. **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 persistent lowering of the foreshore in front of the sea wall observed in the previous three winters continued. The long term difference plot for Autumn 2008 to Autumn 2014 shows a more stable patter over the bay with some accretion close to the defended part of the frontage.
5th March 2015	**Cliff-top Survey:** 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 March 2015 survey showing change since the last survey in September 2014 and the baseline survey in March 2010 (Appendix C- Map 2). The accuracy of the survey technique means change of less than 0.1m is assumed to be error. Three of the monitoring points show erosion since the last survey: Points 2, 4 and 7 show losses of between 0.1 and 0.2m. 2.8m erosion was also seen at Point 5 however reference to survey photographs show that this is error and relates a large mound of garden debris obscuring the cliff top ad making precise identification of the cliff edge impossible. Issues in surveying are less important for the longer term trends where the real recession can be seen. Comparison of the latest survey to March 2010 baseline indicates erosion is taking place at two locations. 0.9m/yr is recorded at point 1 and 0.3m/yr at point 5.	Overall the cliff top has been stable since the previous survey in September 2014. Points 2, 4 and 7 have eroded by between 0.1 and 0.2m since September 2015. **Longer term trends:** The erosion rates calculated from the observed changes since March 2010 show no erosion at most of the monitoring reports, but localised areas where rates as high as 0.7m/yr have been recorded. This reflects localised and episodic rockfalls.

2.5 Scarborough North Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
21st March 2015	**Beach Profiles:** Scarborough North Bay is covered by five beach profile lines for the Partial Measures survey (Appendix A) that are monitored biannually. The previous survey was undertaken in September 2014. **Profile 1dSBN1** is located around 200m south of the Sea Life Centre. At 10m chainage much of the seawall is exposed because the beach is low. Between 10m and 30m chainage the level at the top of the beach has dropped by up to 0.5m since September 2014. Between 30 and 55m chainage there has been little change in beach level. From 55m to 150m chainage the beach level has dropped by between 0.1 and 0.2m and level is the lowest on record. **Profile 1dSBN2** is located close to the former chair lift. In September 2014 the beach level was high and there was a mound of material on the upper beach. By March 2015 between 10m and 80m chainage the beach level had dropped by 0.8m and the beach surface was smoothed. Between 80m and 100m there has been little change. Beyond 100m chainage the rocky foreshore is exposed. The beach level is near the middle of the range of previous profiles, but is flatter than many other profiles. **Profile 1dSBN3** is located near Royal Albert Drive. Overall the beach has accreted since September 2014. The largest increase of 0.5m was at the sea wall at 15m chainage. The amount of accretion on the beach reduces towards MLW with little change recorded by 140 to 160m chainage. The beach level is high compared to previous profiles but the beach gradient is similar to previous profiles. **Profile 1dSBN4** is located at the northern end of Clarence Gardens. At the base of the seawall, between 20m and 60m chainage, rocks are exposed following a 0.7m drop in beach level. The rocky shore platform is regularly exposed at this location. Their previous exposure was December 2013. From 60 to 75m chainage the beach level has dropped by 0.2m due to the loss of the mound which was present in September 2014. Between 75 and 100m chainage the beach has remained the same. From 100m to 170m chainage the beach level has dropped, and smoothed, resulting in lowering of around 0.1m. **Profile 1dSBN5** is located southern of Clarence Gardens. There has been little change on the defended part of the profile to 25m chainage. From 25m to 100m chainage the beach level has dropped by 0.2m over the winter of 2014/15. Between 100 and 120m chainage there is little difference in the profiles.	The beach levels are high or mid-range and the gradients are close to the average for most of the profiles. At profile SBN1 much of the seawall has been exposed by 0.5m of erosion. The bottom of the profile is low as well, the centre is similar to previous surveys. The erosion described on profiles SBN2, and SBN4 has often been a result of the loss of mounds of beach material which had built up over the summer of 2014. Profile SBN3 has accreted on the upper beach. **Longer term trends:** The beach is within the mid-range of profiles so the beach has recovered from the severe storms during December 2013. The amount erosion described for this part of the coast is typical for the winter months.

Survey Date	Description of Changes Since Last Survey	Interpretation
	From 120m to 150m chainage the beach level has dropped by 0.4m since September 2015. The profile has a similar gradient to the previous profiles and the beach level was close to the middle of the previous profiles.	
24th January 2015	**Atypical Beach Profiles** In January 2015 the client noted unusual beach morphology in North Bay and requested an additional survey to determine whether or not these were historical extremes or simply an unusual pattern of berms and troughs. The additional surveys were undertaken on 24 January 2015 and showed similar elevations to previous surveys. **Profile 1dSBN1** shows that the upper beach berm between 10m and 20m chainage was dropping between the September 2014 and March 2015 profiles. Between 25-65m chainage the beach level was 0.1m above the September level, and comparable with the March 2014 level. From 65m to 120m chainage there was little change in beach level since September 2014. The lower beach from 120 to 155m had dropped by 0.1m over the winter and was one of the lowest recorded profiles for the lower beach, but not as low as the March 2015 profile which had dropped by a further 0.1m. **Profile 1dSBN2** has a high upper beach due to a berm of material between 5m and 25m chainage. In September 2014 almost a metre of seawall was visible but by January much of the face of the seawall has been buried. From 25m to 95m chainage the January profiles are around 0.2m below the September profiles. The March 2015 profiles are 0.1 to 0.6m below the January 2015 profiles showing that the mid beach level continued to drop in the early part of 2015. **Profile 1dSBN3** the majority of this profile is 0.2-0.4m higher than the September 2014 beach level and looks similar to the previous records. The March 2015 profile is 0.2m higher than the January 2015 profile on the upper and lower parts of the beach. The mid beach appears to have remained stable between January and March 2015. **Profile 1dSBN4** the rocks at the top of the profile were covered in September 2014 but were exposed in January and March 2015. Between 70m and110m change the January 2015 beach was 0.1m lower than in September 2014 and March 2014. The level of the rest of the beach is similar to the September 2014 profile, but 0.2m higher than the March 2015 profile. **Profile 1dSBN5** the majority of the January 2015 profile is the highest recorded for much of its length,	The **January 2015 profiles** are usually between the September 2014 and March 2015 beach levels. The Scarborough North January 2015 profiles in many cases and are not significantly different from those recorded previously. It is likely that the high beach level at SBN2 looked out of the ordinary because the sea wall is not usually buried to that extent.

Survey Date	Description of Changes Since Last Survey	Interpretation
	the each level is 0.1-0.2m higher than in September 2014 and 0.4-0.8m higher than the March 2015 profiles.	
	Cliff-top Survey: Survey of the clifftops adjacent to properties at Scalby Ness is undertaken by dGPS walkover. The data indicates very little change since Autumn 2011. Almost all of the cliff shows no change, however a 3m long section at the western-most extent of the survey area shows minor recession of ≤0.8m between Autumn 2011 and Spring 2015. This is equivalent to a long-term recession rate of 0.2m/yr and relates to collapse of a small 'headland' feature.	

2.6 Scarborough South Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
21st March 2015	**Beach Profiles:** Scarborough South Bay is covered by four beach profile lines for the Partial Measures survey (Appendix A). The profiles were surveyed during the Full Measures survey of September 2014. **Profile 1dSBS1** is located around 250m south of the West Pier. The profile is unchanged to the upper edge of the sea defences at 15m chainage. From 15m to 50m chainage the beach has accreted by up to 0.6m. Between 50 and 120m chainage there has been very little change in beach level since September 2014. From 120m to 220m chainage the beach level has dropped by 0.2m. Overall, the beach has steepened. The upper and middle beach is near historical high levels while the lower beach is in the mid-range of previous profiles. **Profile 1dSBS2** is located on the shore fronting St Nicolas Cliff. Overall the beach has remained stable since September 2014. The largest change is between 40m and 100m chainage where there was 0.2m of erosion. **Profile 1dSBS3** is located 250m north of the Scarborough Spa complex. Overall the beach has flattened with loss berms seen in the last survey. At the base of the seawall (15m chainage) the beach has eroded by 0.3m. From 20m chainage to 100m chainage the beach has eroded by up to 0.2m. From 100m to 140m chainage the beach has accreted by 0.2m. Between 140 and 180m chainage the beach has changed very little. The profile is in the middle of the range of historical profiles. **Profile 1dSBS4** is located on the beach in front of the Scarborough Spa Complex. There has been very little change in the beach profile since September 2014. The largest recoded change is 0.1m of accretion between 80m and 140m chainage. The profile is in the mid-range of previous profiles dating back to November 2008.	Between September 2014 and March 2015 there was little change on the Scarborough South Profiles. Profiles remained generally stable with limited erosion to a maximum of 0.2m, generally associated with smoothing of the profile and removal of berms. The upper part of profile SBS1 accreted by 0.6m, this was the largest accretion in the bay. The rest of the profile shows little change. **Longer term trends:** The observed changes in the profiles in South Bay are consistent with the seasonal fluctuations of sediment with a bay system. However, beach levels did not fall by as much during the winter of 2014/15 as they did in part winters.

Survey Date	Description of Changes Since Last Survey	Interpretation
17th April and 5th May 2015	**Pre and Post Beach Recycling Analysis** To tackle the net northerly transport of sediment towards the harbour, which causes sand blow across the frontage, beach recycling works are periodically undertaken where material is excavated from the northern part of South Bay and moved to the beach fronting the Spa. The pre-recycling works survey was carried out on 17th April 2015 and a post-recycling works survey was carried out on 5th May 2015. The beach profiles show losses of around 0.4m on the upper beach at SBS1 and 2 in the north of the bay. There is gain of 0.4m beach material at the top of profile SBS3 in the south of the bay. The GIS analysis and difference plots show an area of loss north of the bay close to the seawall which is calculated to be 6,358m^3. The area in the centre of the bay, close to the sea wall, where the recycled material was placed shows an increase in volume of 14,739m^3. The fact this gain in volume is over twice the volume lost in the north indicates that volumes of sediment naturally deposited are more significant than the volumes moved by recycling. Analysis of the volume change for the whole beach between the two surveys shows a gain of 2,874m^3 of sediment in this 2 week period.	The difference plot showing the change in the beach over the period of reprofiling shows loses in the north and gains in the middle of the bay. The 6,358m^3 of material lost from the north of the beach was moved into the south and centre of the bay. This is supported by the beach profile surveys, which show a loss of 0.4m in the north of the bay and a gain of 0.4m in the south of the bay. There is some uncertainty about the exact quantity of sand moved because of the two week gap between pre- and post-recycling surveys. However, because the gain in volume in the south was over twice the volume of sediment lost from the north natural process are clearly capable of moving significant volumes of sediment in a short time.
	Sediment Tracer Study: A sediment tracer study was carried out in Scarborough South Bay for 54 days from December 2014 to January 2015. The Partrac report entitled 'South Bay, Scarborough Beach Sand Tracking Study April 2015 (P1486.03.05.D01v02)' discusses the study and presents the results. The sediment tracking study confirms the divergent sediment transport trend within the Bay. The tracer was placed on the foreshore in the centre of the bay and was moved both north and south by coastal processes. The observed sediment movement is due to the naturally occurring conditions over the 54 days of the study. The study does not provide a long term assessment of the sediment transport within the bay, however, it is useful to confirm the bi-directional movement of sediment.	The tracer study supports the hypothesis that there is a sediment drift divide in the bay, although over the monitoring period the signal is slightly stronger for sediment moving northwards. The strength of the north and southward movement of sand will change in response to the hydrodynamic climate in the bay. The zone of sediment transport is divergence is likely to move around on the beach in response to forcing by the prevailing coastal processes, and as a result there would be no clear evidence of the divergence on Scarborough South beach.

Survey Date	Description of Changes Since Last Survey	Interpretation
21st March 2015	**Cliff-top Survey:** 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 2015, 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 0.1m 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. The recorded changes between September 2014 and March 2015 show that only Points 5 and 13 have eroded, by 0.2m and 0.1m respectively. Over the longer term, three survey points (No 9, 11 and 12) show erosion of up to 0.6m/yr since March 2010.	Overall the cliff survey locations have remained stable. Points 5 and 13 show recession between September 2014 and March 2015. **Longer term trends:** The recession rates for the longer term only show erosion at Points 9, 11 and 12 of between 0.1-0.6m/yr. The rest of the study area has remained stable.

2.7 Cayton Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
20th March 2015	**Beach Profiles:** Cayton Bay is covered by three beach profile lines for the Partial Measures survey (Appendix A). The previous survey was undertaken in September 2014. **Profile 1dCY1** is located on the beach in front of Tenants' Cliff in the north of the Bay. The surveyors report states that 'the top of section 1 could not be measured due to dense vegetation'. The profile to 20m chainage is similar to the September 2014 record. From 20m to 45m chainage the beach level is 0.4m higher than in September 2014. Between 45m and 65m chainage there has been little change in beach level. From 65m to 115m chainage the beach level has increased by 0.6m over the winter of 2014/15. Between 115m and 160m chainage the rocks on the foreshore have been exposed because the beach level is low. From 160m to 180m chainage the beach level has dropped by 0.6m and is the lowest recorded level since 2008. **Profile 1dCY2** is close to the former pumping station in the middle of Cayton Bay. The beach survey is very similar to the March and September 2014 profiles. The profile shows little difference to 130m chainage. From 130m to 230m chainage the beach has eroded by up to 0.3m since September 2014. From 230m to 360m chainage the beach level has altered very little, up to 0.1m over the winter of 2014/15. **Profile 1dCY3** is located around 600m southeast of the pumping station. The continuing erosion of the cliffs and means that there is some debris at the base of the cliffs at 125m chainage. The upper beach level is high because of a mound of material, between 130m and 150m chainage has grown by 0.5m since September 2014. From 150m to 190m chainage the beach level has dropped by 0.3m over the winter. A second mound has formed in the lower beach between 190m and 240m chainage where there has been accretion of up to 0.5m. From 240m chainage to the end of the survey at 290m there has been little change in the beach level.	At CY1 the upper beach is comparatively high but the lower beach is very low. Both CY2 and CY3 are high compared to previous profiles, which at the end of winter may be due to the redistribution of material from cliff erosion. **Longer term trends:** The beach levels are comparatively high, which is likely to be due to the erosion at the toe of the cliffs apparent in the photographs. The pattern of healthy beaches is likely to continue as the cliffs of Cayton Bay are undefended and freely eroding.
20th March 2015	**Cliff-top Survey:** 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	Only point 6 has shown erosion, the rest of the locations have been stable since September 2014. However, the erosion of the cliff toe and instability visible in the survey photographs is likely to eventually

Survey Date	Description of Changes Since Last Survey	Interpretation
	Cayton Bay are undertaken bi-annually. Appendix C provides results from the March 2015 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 September 2014 survey. The accuracy of the technique means results of less than 0.1m are not considered reliable. Furthermore, indications of an advancing cliff are error related to problems in precise identification of the cliff edge, particularly where vegetation is present. Only Point 6 shows cliff recession since September 2014, where there has been 0.2m of erosion over the winter. No change was recorded at other locations.	result in cliff top erosion in future surveys. **Longer term trends:** The long-term average recession rates show recession in four out of the eight survey locations. Points 1, 2, 4 and 6 have all eroded by up to 0.8m/yr on average.

2.8 Filey Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
22nd March 2015	**Beach Profiles:** Filey Bay is covered by five beach profile lines for the Partial Measures survey (Appendix A). The previous programmed survey (Full Measures 2014) was undertaken on 10th September 2014. **Profile 1dFB1** is located in front of Filey town in the north of the bay. There has been little change to 20m chainage, at the base of the sea wall. At 20m chainage the beach is low and there is a scour hollow running at the toe of the sea wall, around 0.6m of sediment has been lost here since September 2014. From 30m to 80m chainage the beach has increased by 0.2m over the winter of 2014/15. Between 80m and 170m chainage there has been little change in beach level. From 170m to the end of the survey at 270m chainage the beach level has dropped by 0.2m since September 2014. Overall the beach has become smoother and steeper. **Profile 1dFB2** is located north of Primrose Valley Holiday Village. The surveyor noted is was not possible to measure the beginning of the profile due to vegetation and that the face of dune was becoming very difficult to measure due to deep fissures in soil/mud. There is little change on the upper beach, between 70 and 160m chainage. From 160m to 300m chainage the beach level has risen, with the amount of increase getting larger (to a maximum of 0.5m) towards MLW. The beach has flattened and the level is high compared with historical surveys from 2008. **Profile 1dFB3** is located in front of Flat Cliffs hamlet. The beach profile has not changed since September 2014. The largest changes are between 60m and 180m chainage where there has been 0.2m erosion and from 200m to 250m chainage the beach has accreted by 0.3m where a runnel has infilled. Overall the beach has flattened, the level is high compared to previous profiles. **Profile 1dFB4** is located near Humanby Gap. There is little difference between profiles to 30m chainage. From 30m to 100m chainage the beach level has dropped by up to 0.5m since September 2014. Between 100m and 140m chainage there has been very little change. From 140m to 200m chainage the beach level has increased by around 0.2m since September 2014. The beach appears to have remained stable over the winter, the beach level is comparatively high. **Profile 1dFB5** is located close to Reighton Gap. The surveyor noted that the middle of profile 1dFB5 was unable to be measured from 63m to approx 206m chainage due to vegetation. The upper half of the	All the profiles in Filey Bay appear to have remained stable since September 2014. Many of the profiles are high compared to historical levels. There are some large changes on the upper beach at FB1 where there was erosion at the toe of the sea wall. FB2, FB4 and FB5 had accretion on the lower beach. **Longer term trends:** Beach levels are comparatively high and may reflect a pulse of sediment from cliff erosion during the winter of 2014/15 which is indicated by survey photographs.

Survey Date	Description of Changes Since Last Survey	Interpretation
	beach appears to have remained stable over the winter of 2014/15. On the lower beach between 310 and 330m chainage a dip in the profile has deepened, due to a loss of 0.3m. From 330m to the end of the profile at 450m chainage the mound of material on the lower beach has accreted by up to 0.5m. Compared to previous profiles the level of the March 2015 profile is low in the upper and mid beach and high in the lower beach.	
Spring 2015	**Topographic Survey:** Data from the most recent topographic survey (Partial Measures, spring 2015) have been used to create a digital ground model (DGM) (Appendix B – Map 5a) 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 5b) comparing the last topographic survey (Full Measures, Autumn 2014) to the present survey. The difference plot shows bands of change running parallel to the shore. In front of the sea wall there is a narrow band of erosion of up to 1m. On the upper beach there is a band of accretion of up to 0.75m. In the middle beach there has been little change (up to ±0.5m), although there are patches of erosion in the north and accretion in the south of the difference plot. Most of the lower beach has eroded by up to 0.5m, but the centre of the lower beach has not changed.	The erosion at the top of the beach next to the sea wall was observed in the previous partial measures report. The erosion of this part of the beach is probably due to the refection of wave energy on the hard defences through the winter. The rest of the beach appears to be continuing the seasonal variation in levels seen at Filey. **Longer term trends:** The erosion of the upper beach, close to the sea wall is observed over the winter of 2014/15 is unlikely to reflect the long term trend. Difference plots for Autumn 2008 to Autumn 2014 show less change over the longer term with slight accretion against the seawall.
22nd March 2015	**Cliff-top Survey:** 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 March 2015. The accuracy of the technique means results of less than 0.1m 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. Between the September 2014 and the current survey four out of the 28 markers showed up to 0.3m of erosion. The other locations showed no change.	Over the winter of 2014/15 marker points suggest cliff stability, with only four locations showing erosion of up to 0.3m. Highest long term recession rates are seen at Point 5, south of the Filey town defences, where 1m/yr is recorded; Point 7 at Muston Sands shows recession of 0.3m/yr. Points 14, 15 and 16 near Hunmanby Gap have all eroded by 0.1-0.2m/yr. On the north side of Filey Brigg Points 25 and 27 have eroded by 0.1m/yr since they were set up in March 2011. **Longer term trends:** Filey Brigg continues to be a focus of erosion.

3. Problems Encountered and Uncertainty in Analysis

Individual Profiles

At Upgang Beach, the cliff top and seaward face of the cliff at profile 1dWB2 were not measured due the presence of thick vegetation on the landward side preventing access to the cliff top and deep fissures and soft ground on the active cliff face.

At Cayton Bay the top of section 1 could not be measured due to dense vegetation.

At Filey Bay the cliff section of 1dFB2 was described in the surveyor's report as 'becoming very difficult to measure due to deep fissures in soil/mud' and the middle of profile 1dFB5 was not measured from 65m to approx. 206m chainage due to vegetation.

Cliff Top Surveys

At Robin Hoods Bay, the dumping of waste vegetation at monitoring point 5 is a known source of error.

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 records from cliff top monitoring show little erosion over the winter of 2014/15. The longer term data show that five locations have recession rates of 0.1 to 0.4m/yr since November 2008.
- Runswick Bay shows shore-parallel changes, with erosion at the top and bottom of the shore and accretion in the middle. This may be due to beach draw-down over the winter.
- At Sandsend, Upgang and Whitby, beach profiles indicate smoothing and flattening since September 2014. All of the profiles have low upper beaches. The beach at WB2 is as low as the profile recorded after the December 2013 storm surge.
- At Robin Hoods Bay, there was a patchy distribution of accretion and erosion but with a band of erosion at the top of the beach. The cliff was stable overall although Points 2, 4 and 7 had eroded by 0.1 to 0.2m since September 2015. There was an error on Point 5 of the survey due to a resident dumpling vegetation on the cliff edge.
- At Scarborough North Bay, the beach shows a pattern of recovery since the December 2013 storm surge. The beach levels are high or mid-range and the gradients are close to the average for most of the profiles. Additional profiles were taken in January 2015 because the beach looked odd to the client, but analysis has shown that the profiles are comparable to the previous profiles.
- The profiles at Scarborough South Bay shows stability of the beach over the winter 2014/15. The largest accretion in the bay was at the top of SBS1 where 0.6m of material was gained. The pre- and post-recycling works show that around 6,000m^3 of material was recycled from the north of the bay although there was a net gain over 14,000m^3 in the south of the bay over the same period. This suggests significant volumes of sediment were deposited by natural beach processes. The cliffs have remained stable, with only two locations showing recession between September 2014 and March 2015.
- Beach profiles in Cayton Bay are high, with the exception of the low beach levels at the bottom of CY1. The high beaches may be due to the erosion of the cliffs providing sediment.
- At Filey the beach profiles were high and had changed little since September 2014. The high beaches are likely to be due to the erosion of the cliffs. The Filey difference plot shows patchy accretion and erosion in front of the town. The most significant area of erosion is in front of the seawall. The cliff survey shows that over the winter of 2014/15

the marker points show stability overall only four points show erosion of 0.1-0.3m between September 2014 and March 2015. The recession rated for the majority of the bay are not significant at less than 0.1m/yr. However seven points have erosion of up to 0.3m/yr.

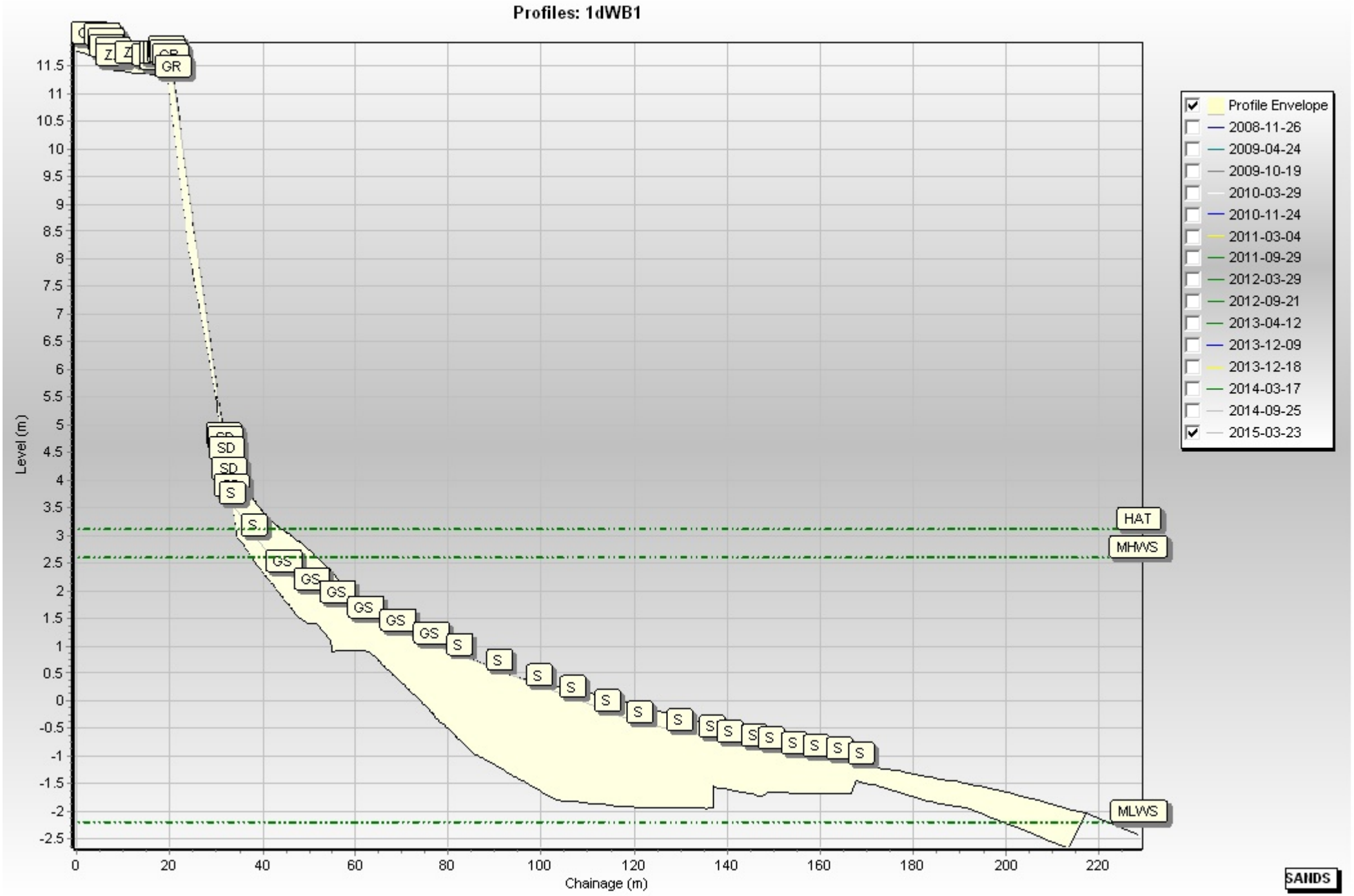
Appendices

Appendix A

Beach Profiles

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

Code	Description
S	Sand
M	Mud
G	Gravel
GS	Gravel & Sand
MS	Mud & Sand
B	Boulders
R	Rock
SD	Sea Defence
SM	Saltmarsh
W	Water Body
GM	Gravel & Mud
GR	Grass
D	Dune (non-vegetated)
DV	Dune (vegetated)
F	Forested
X	Mixture
FB	Obstruction
CT	Cliff Top
CE	Cliff Edge
CF	Cliff Face
SH	Shell
ZZ	Unknown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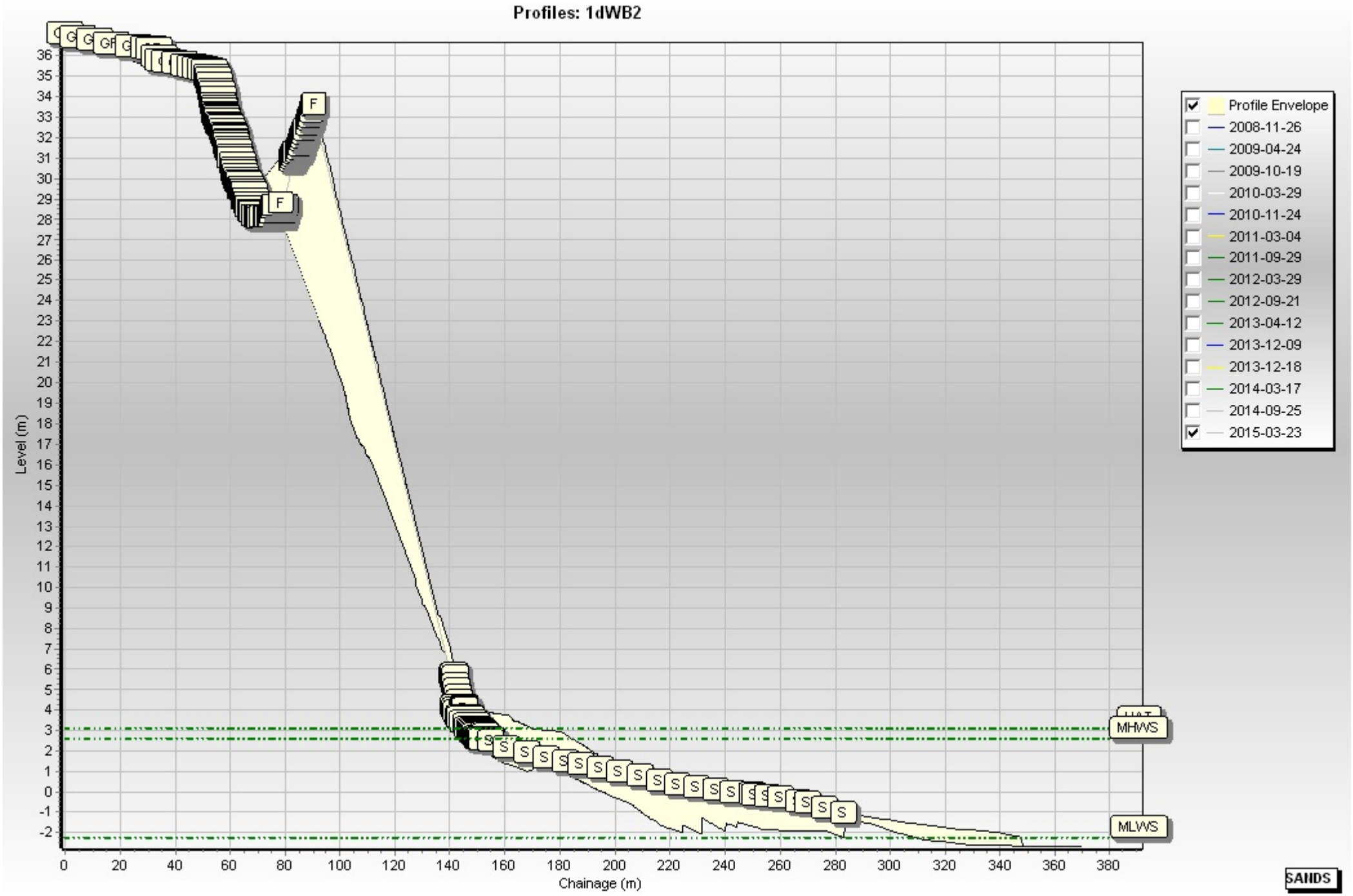
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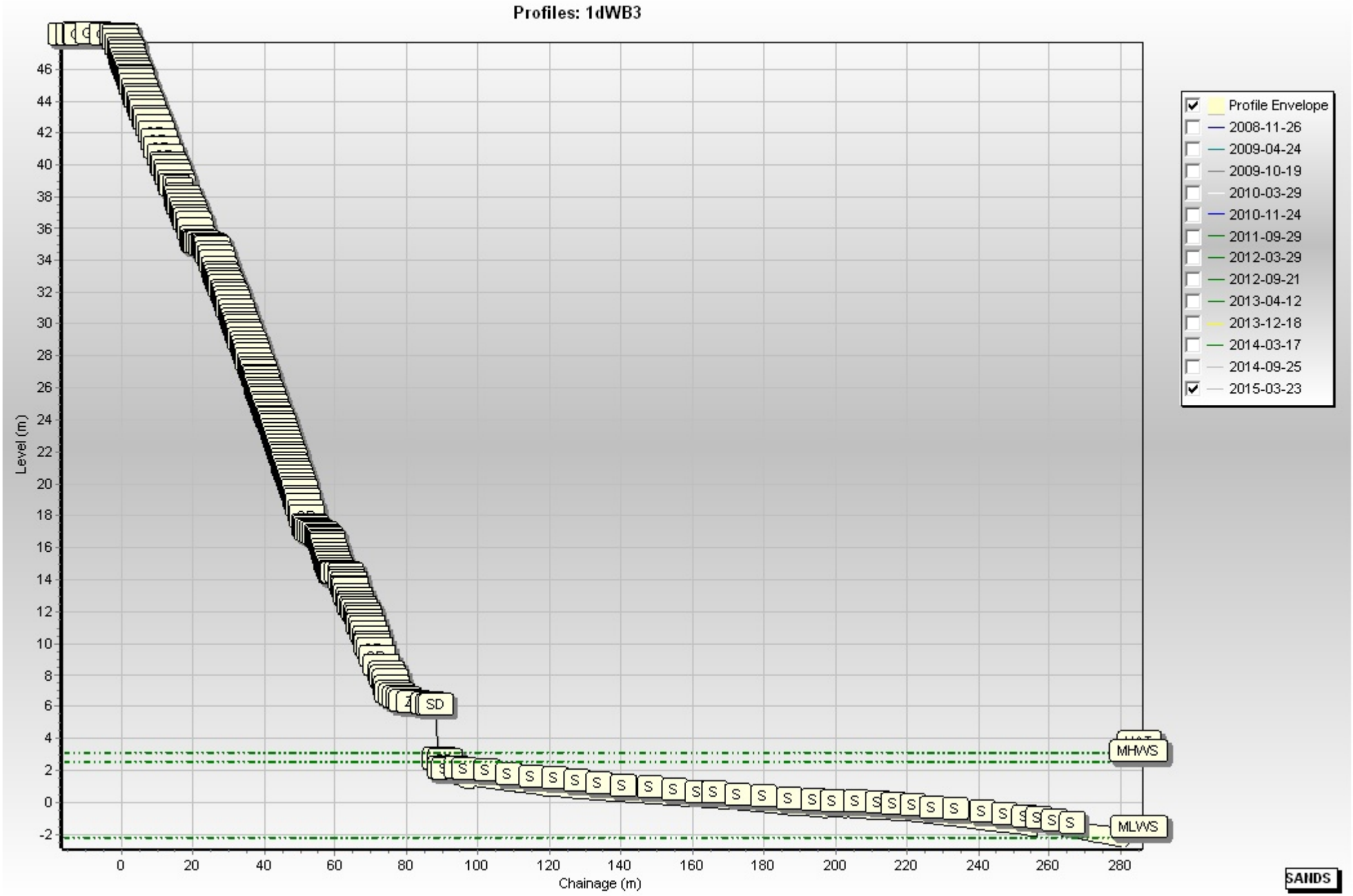
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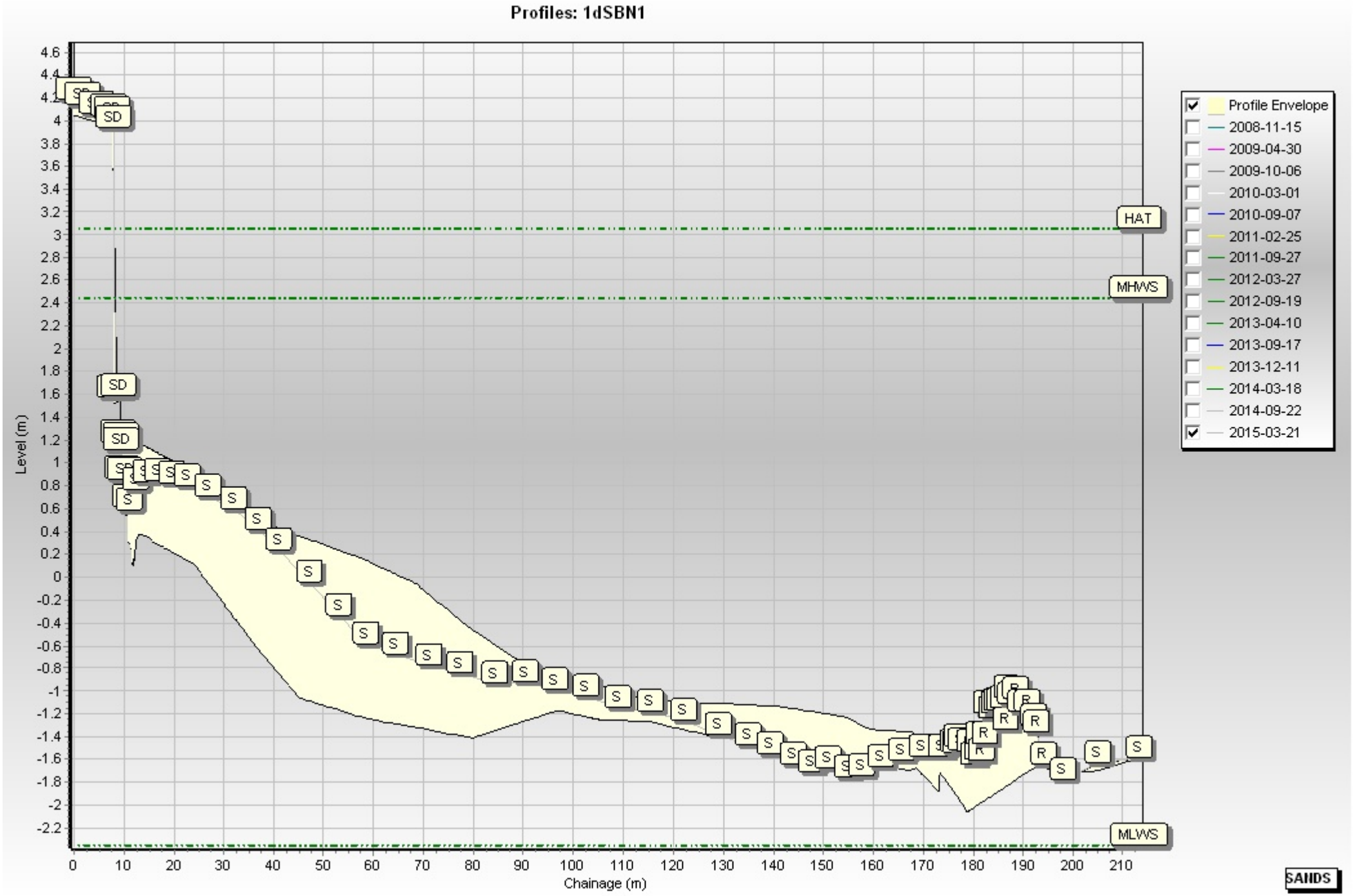
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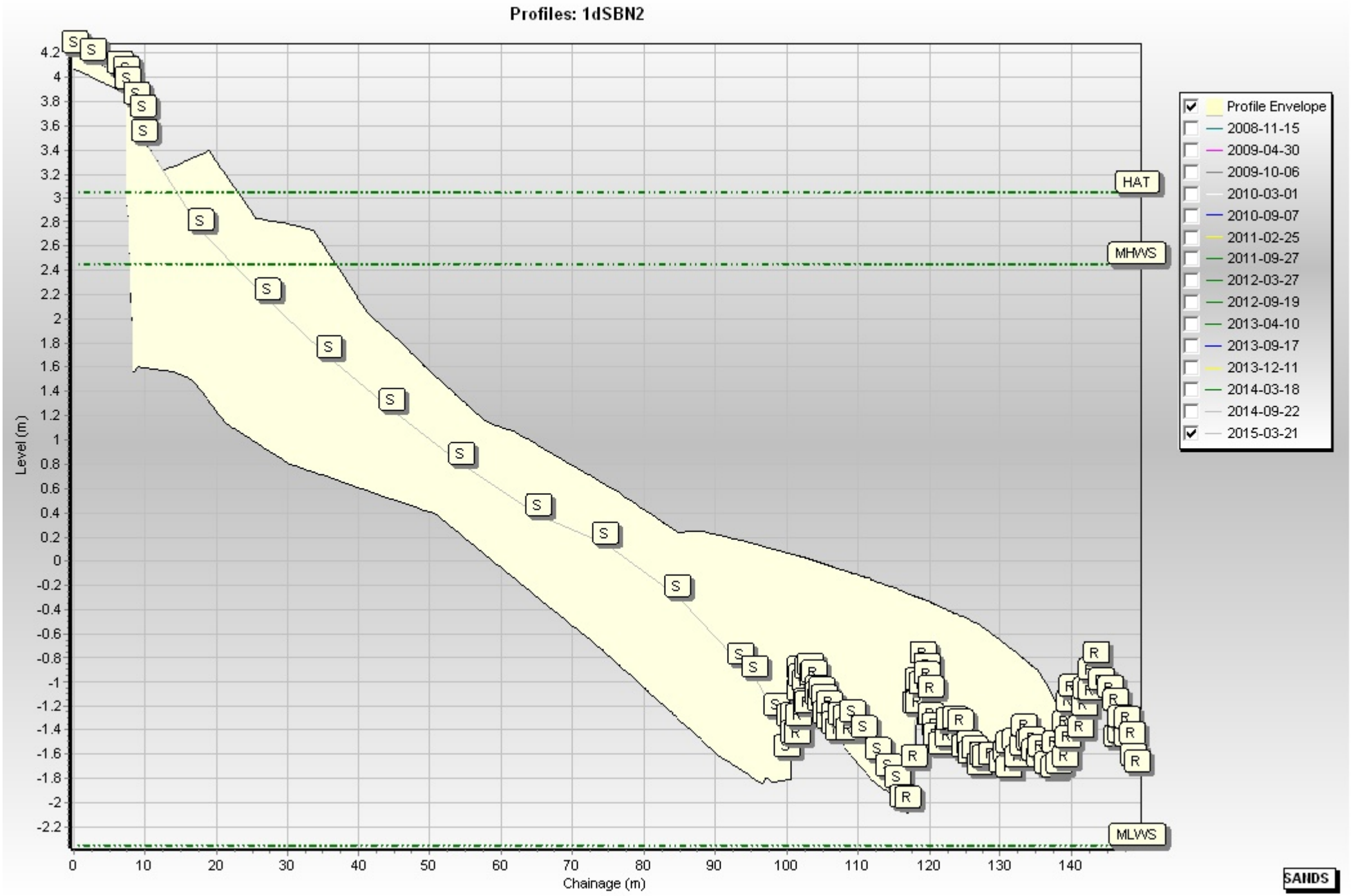
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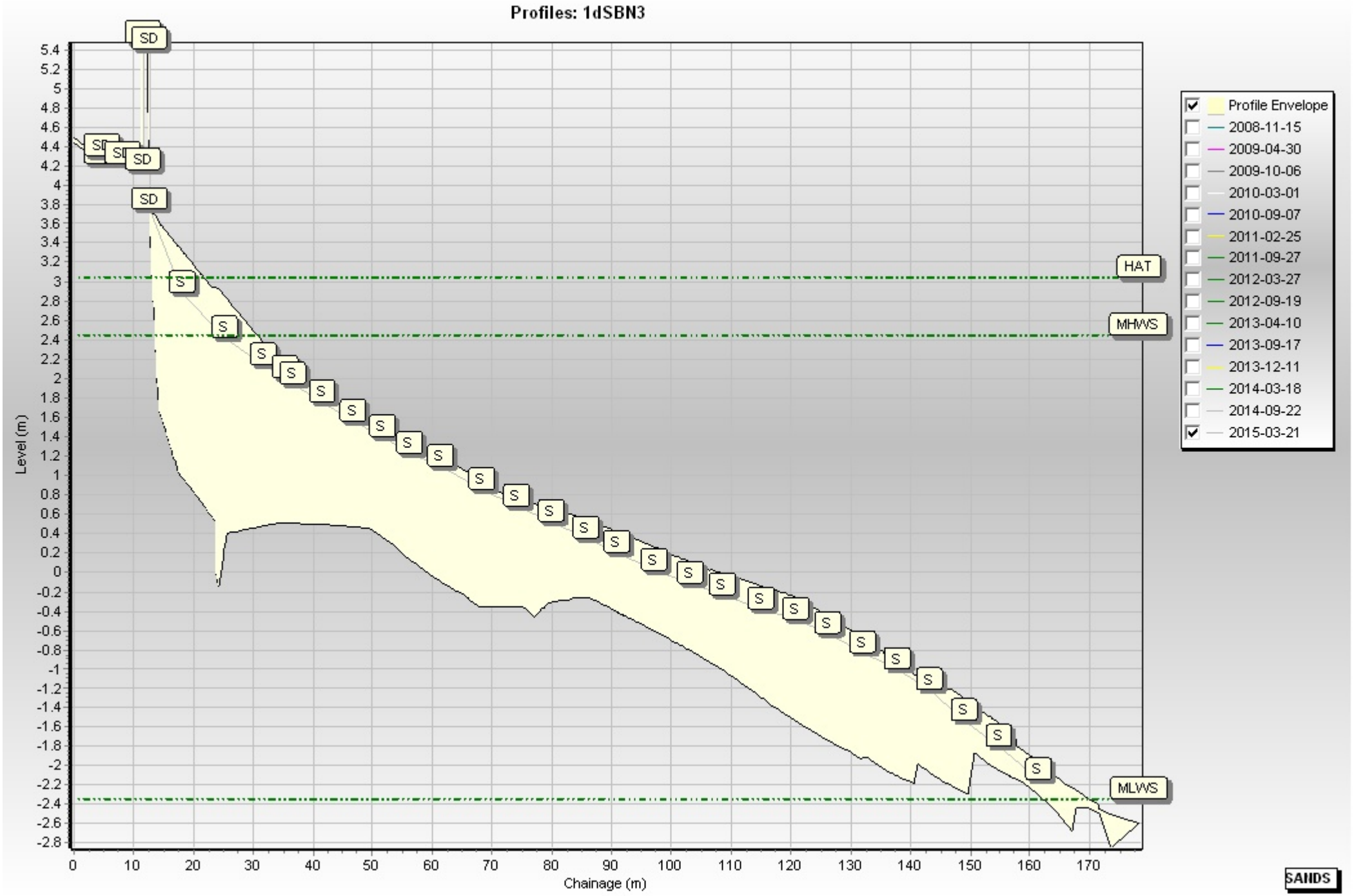
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MHWS
MLWS
Profile Envelope
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2009-10-06
2010-03-01
2010-09-07
2011-02-25
2011-09-27
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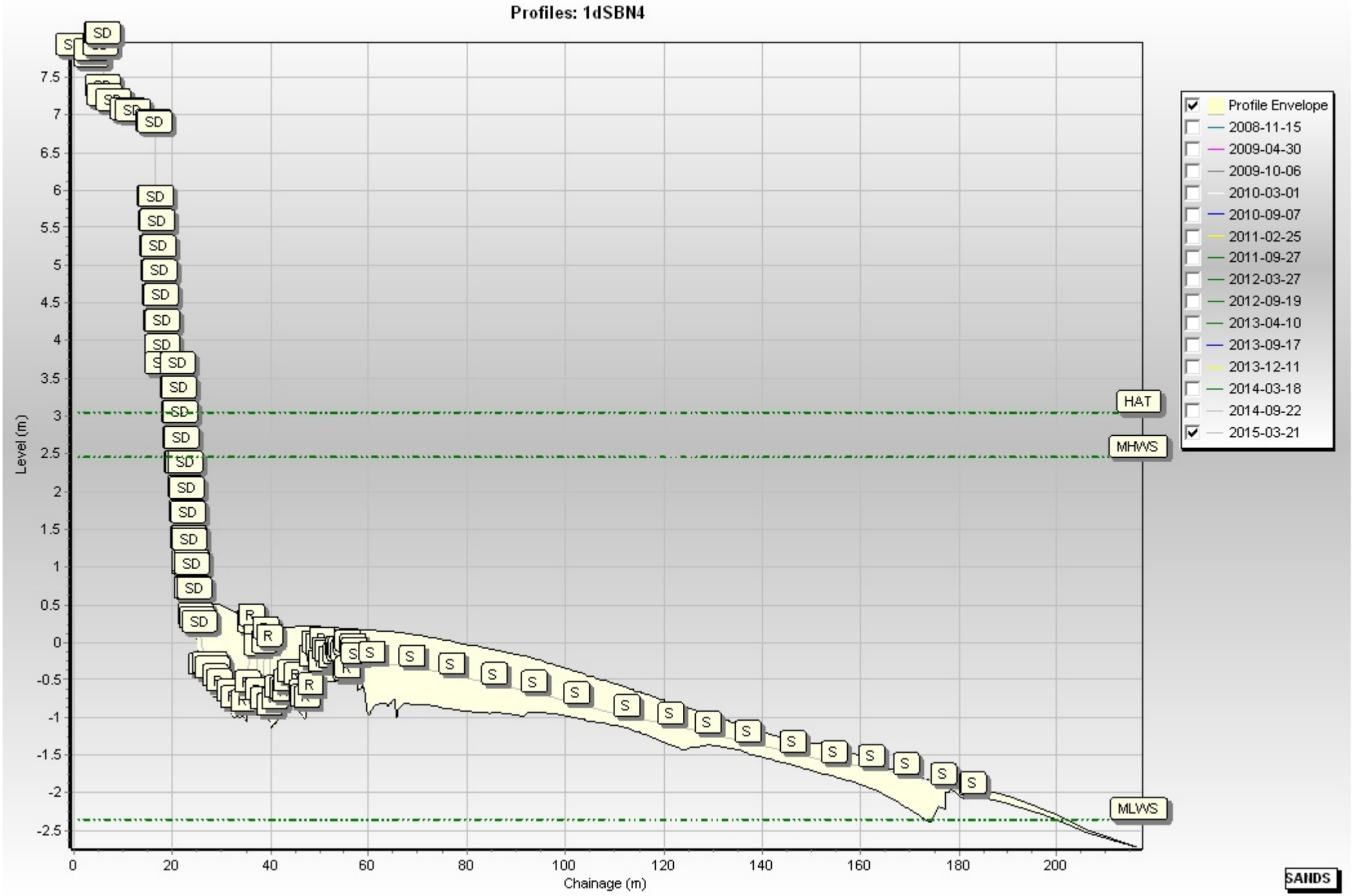
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2012-03-27
2012-09-19
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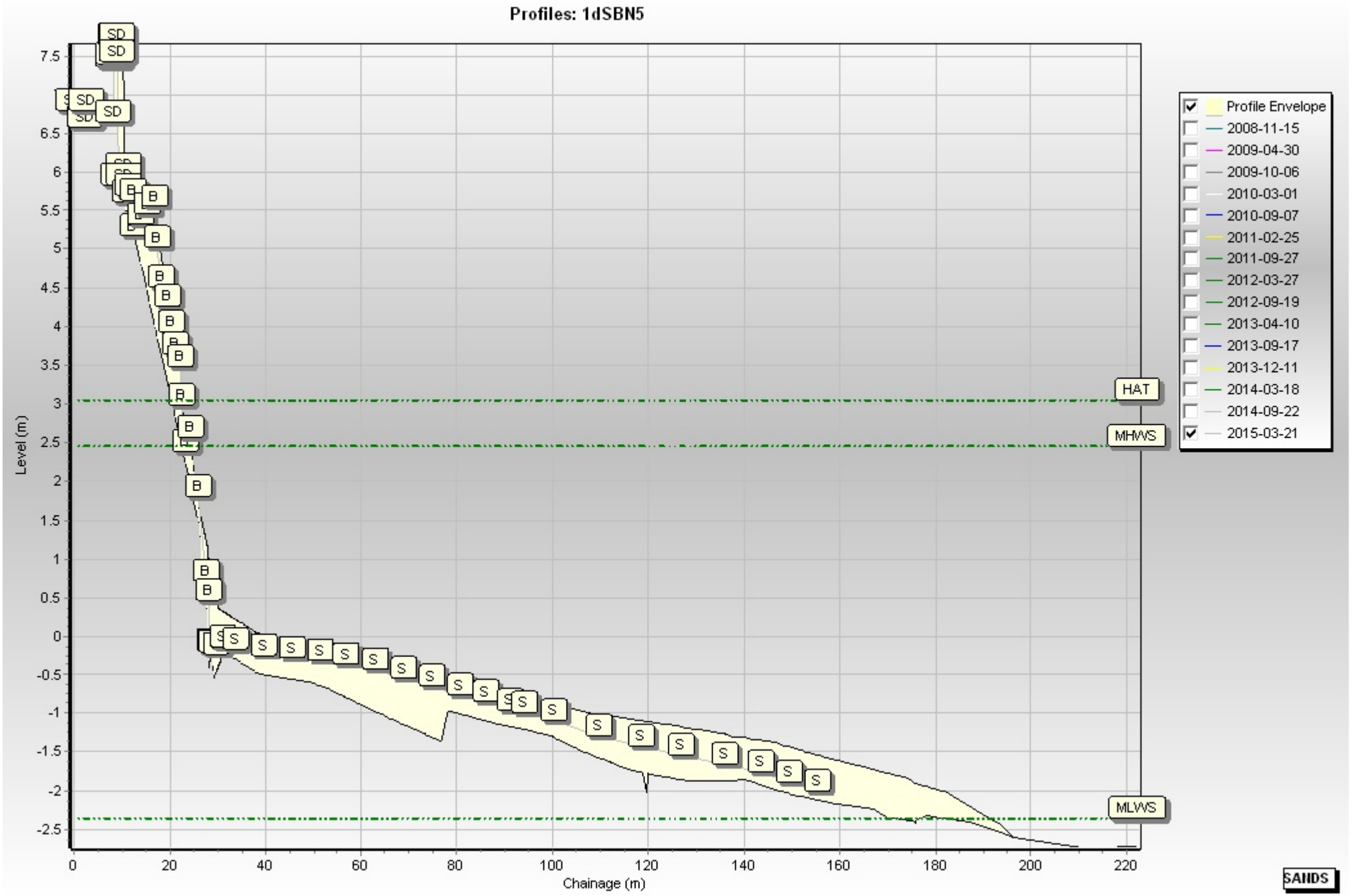
2013-09-17
2013-12-11
2014-03-18
2014-09-22
2015-03-21
SD
R
S
SANDS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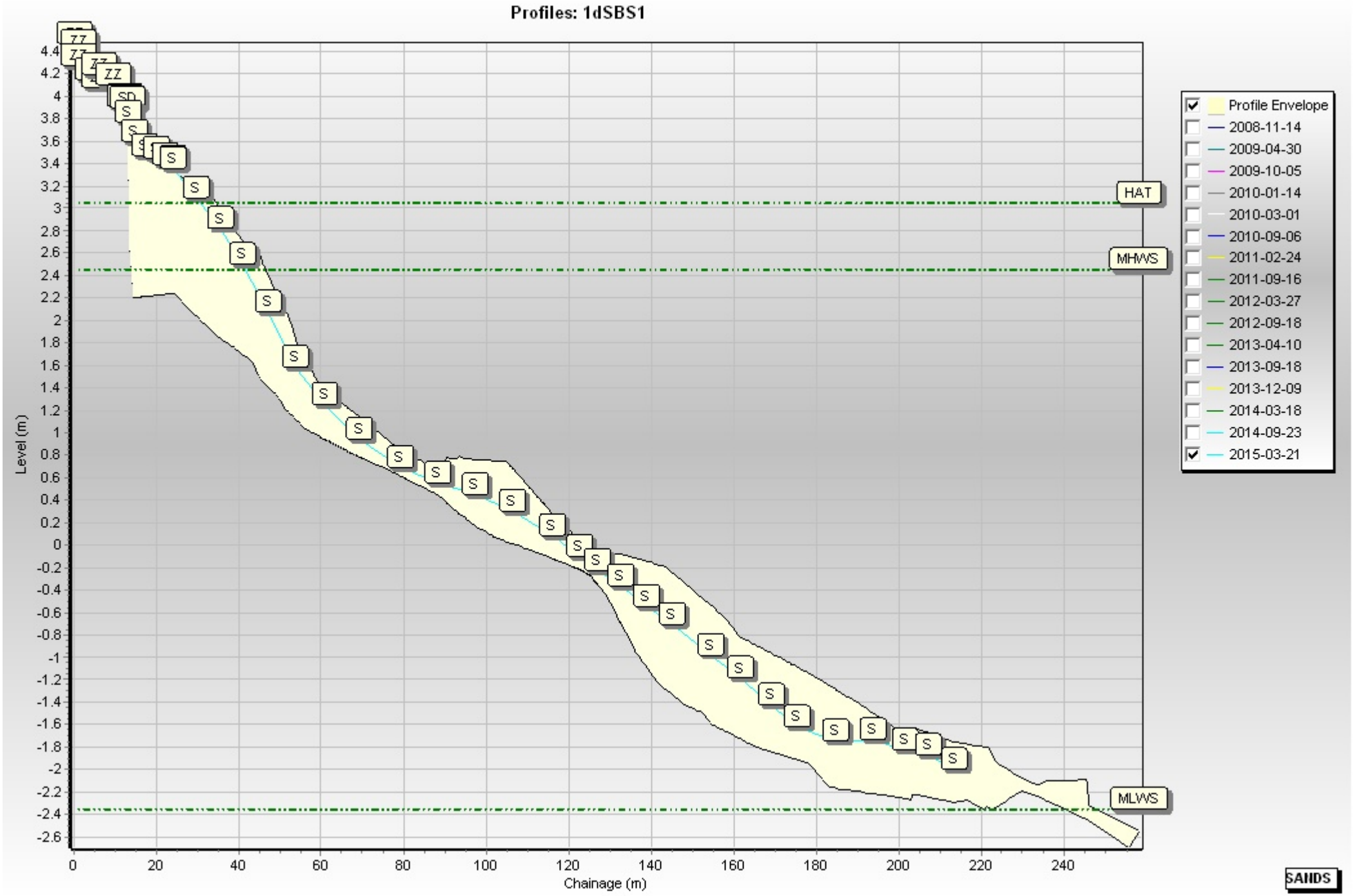
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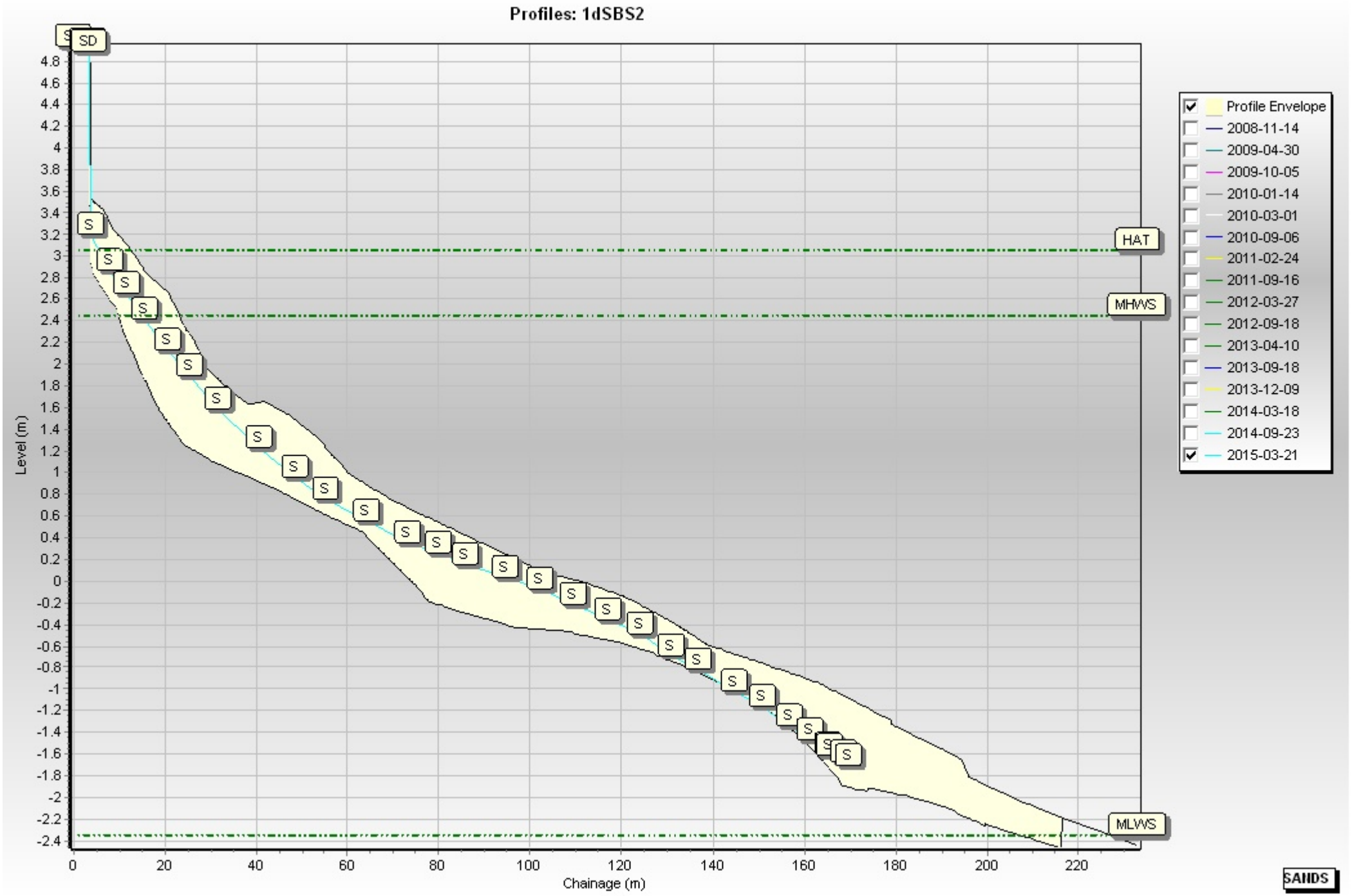
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HAT
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3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
-1.6
-1.8
-2
-2.2
-2.4
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60
80
100
120
140
160
180
200
220
Profile Envelope
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2010-03-01
2010-09-06
2011-02-24
2011-09-16
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2014-03-18
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2015-03-21
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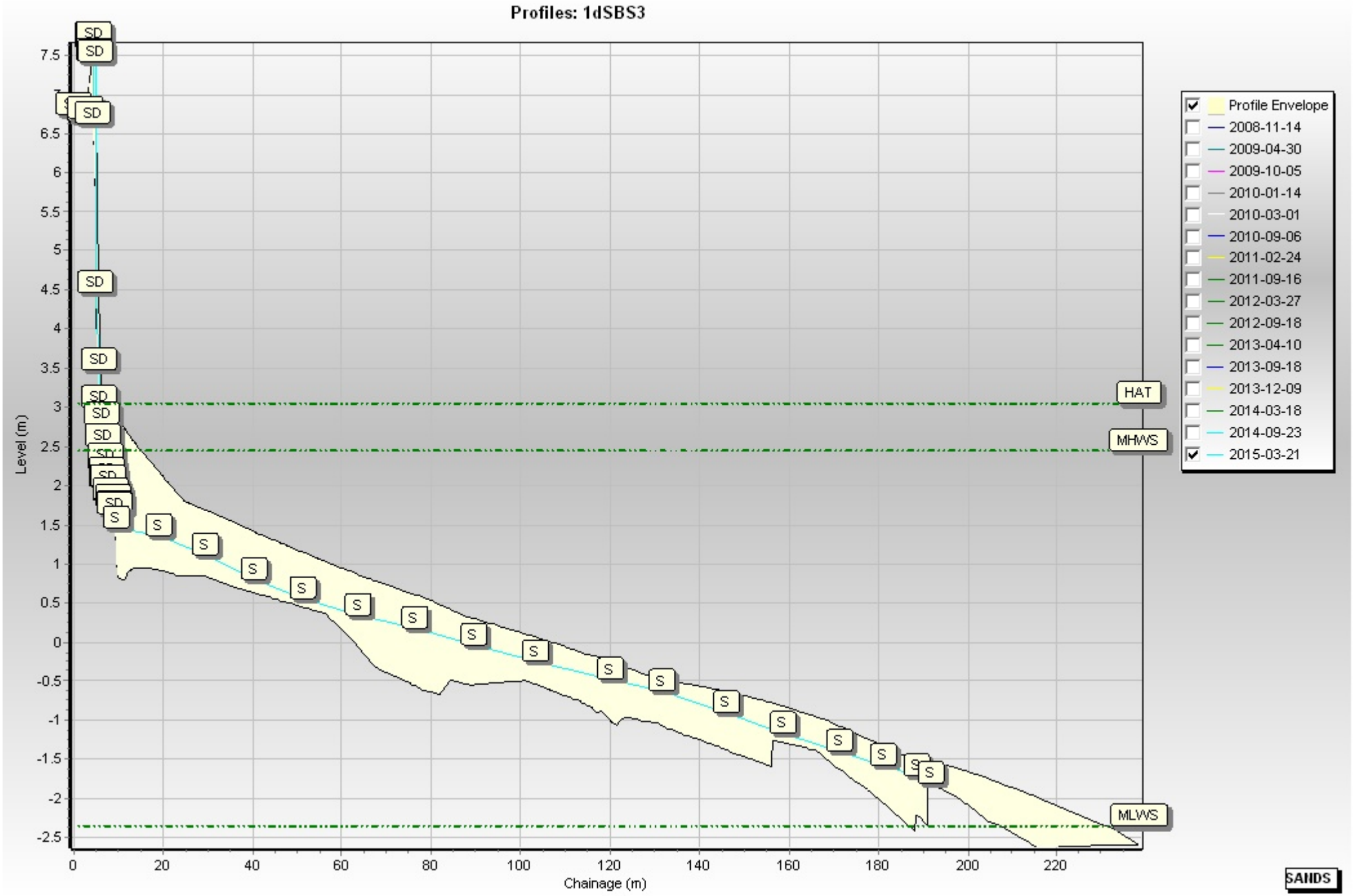
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MLWS
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2011-02-24
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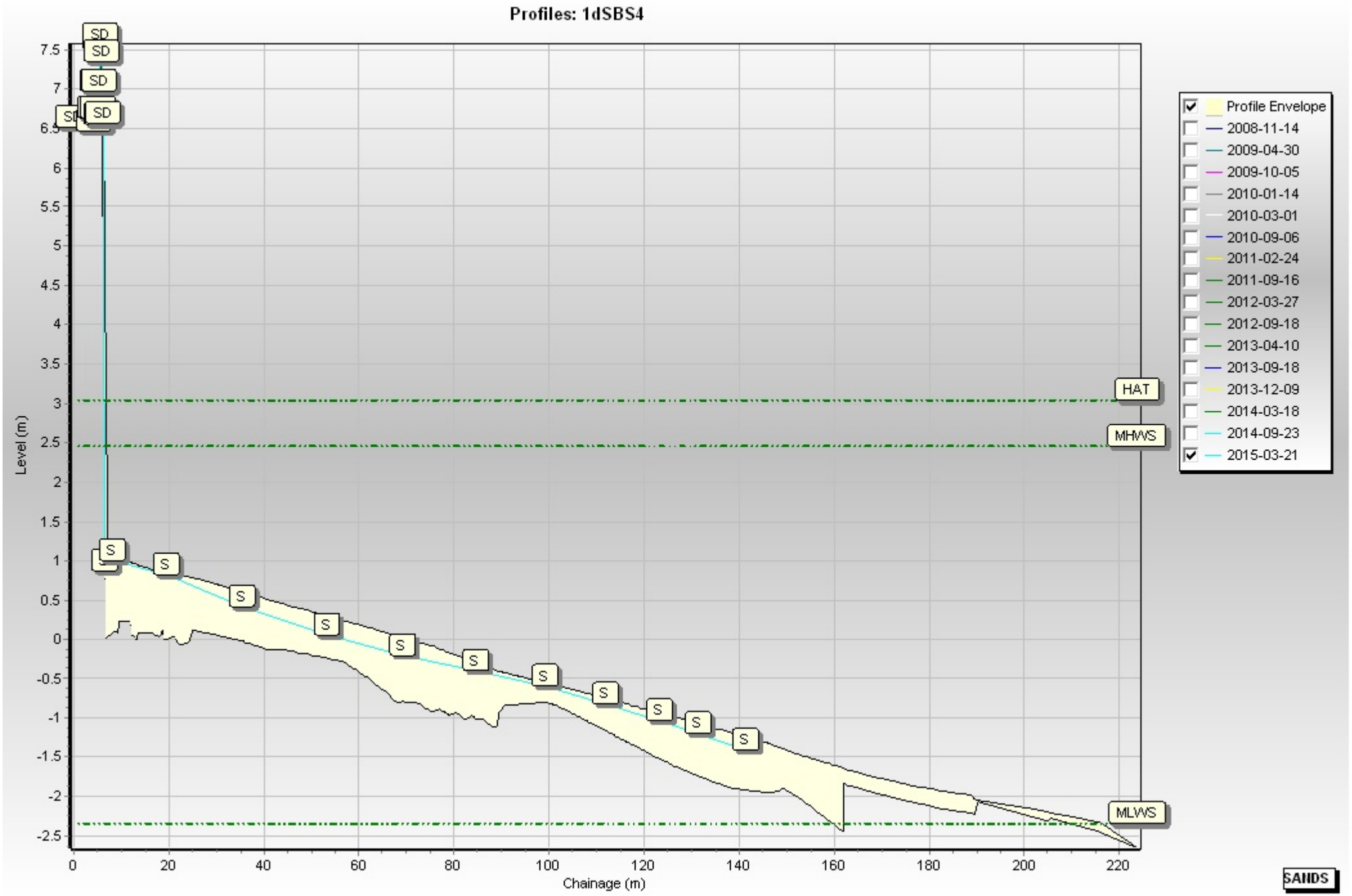
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2009-10-05
2010-01-14
2010-03-01
2010-09-06
2011-02-24
2011-09-16
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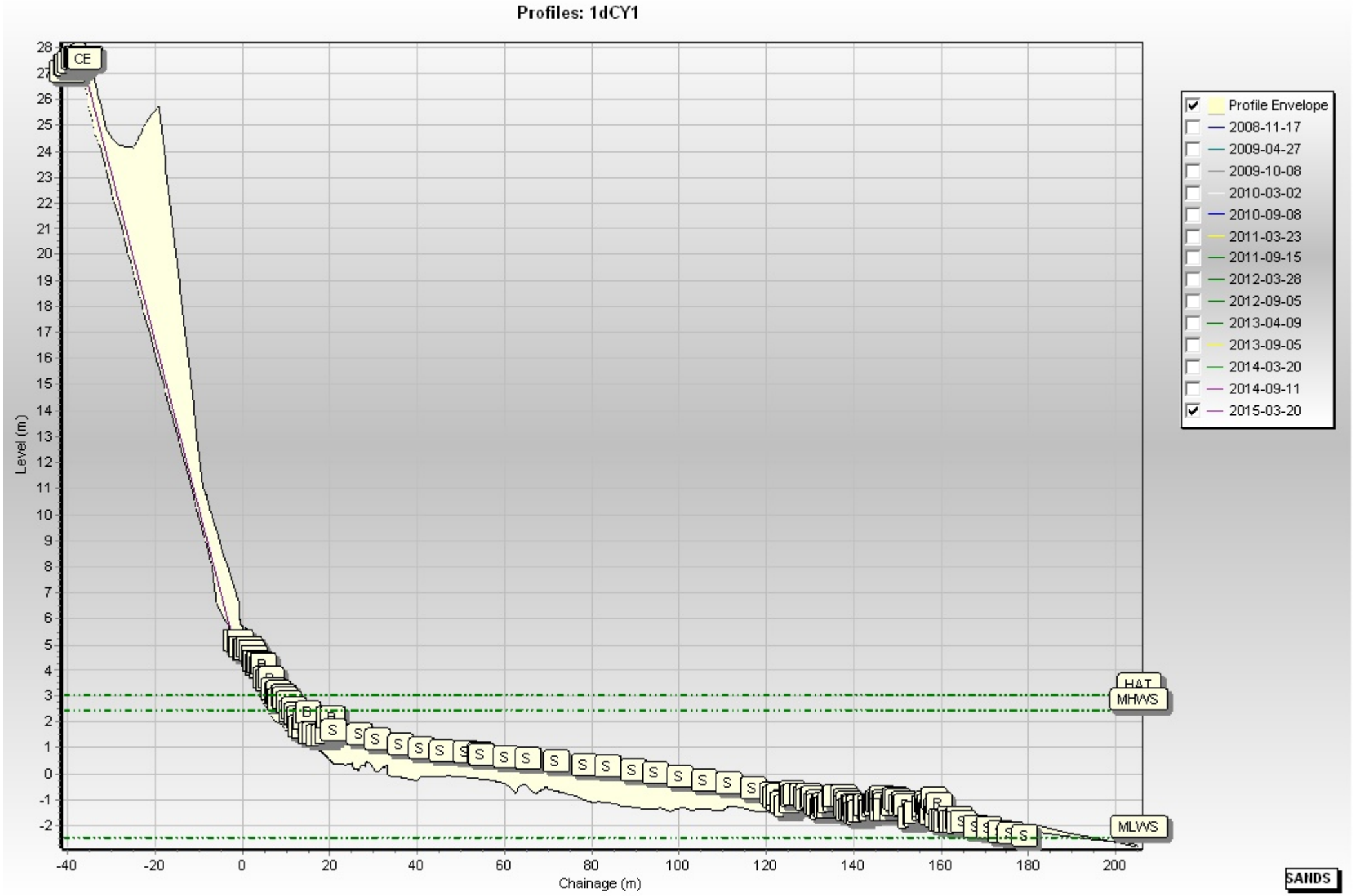
SAIDS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HAT
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MLWS
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Chainage (m)
Profile Envelope
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2011-03-23
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2013-09-05
2014-03-20
2014-09-11
2015-03-20
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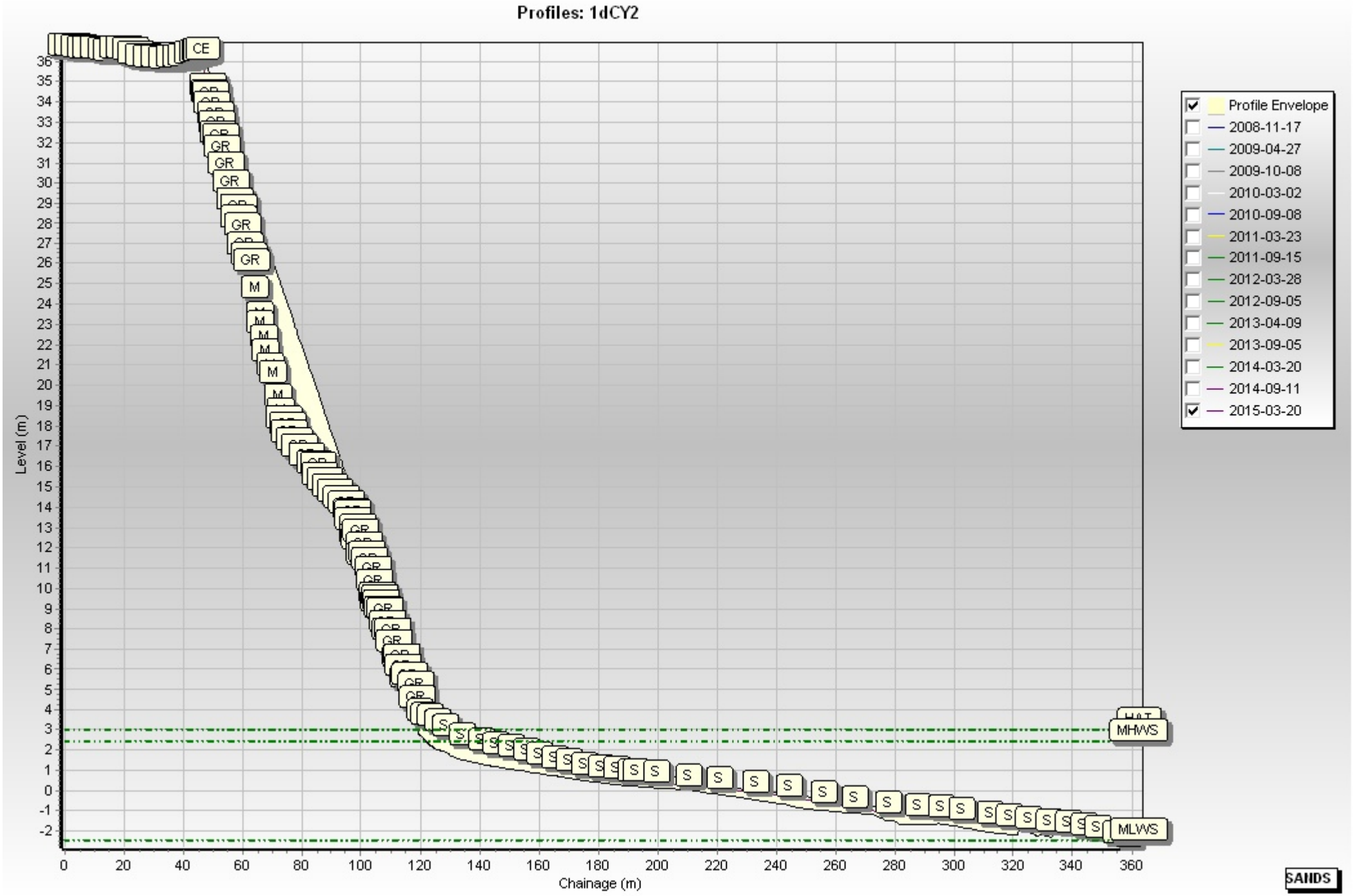
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Chainage (m)
CE
GR
M
S
MHWS
MLWS
Profile Envelope
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2009-10-08
2010-03-02
2010-09-08
2011-03-23
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2015-03-20
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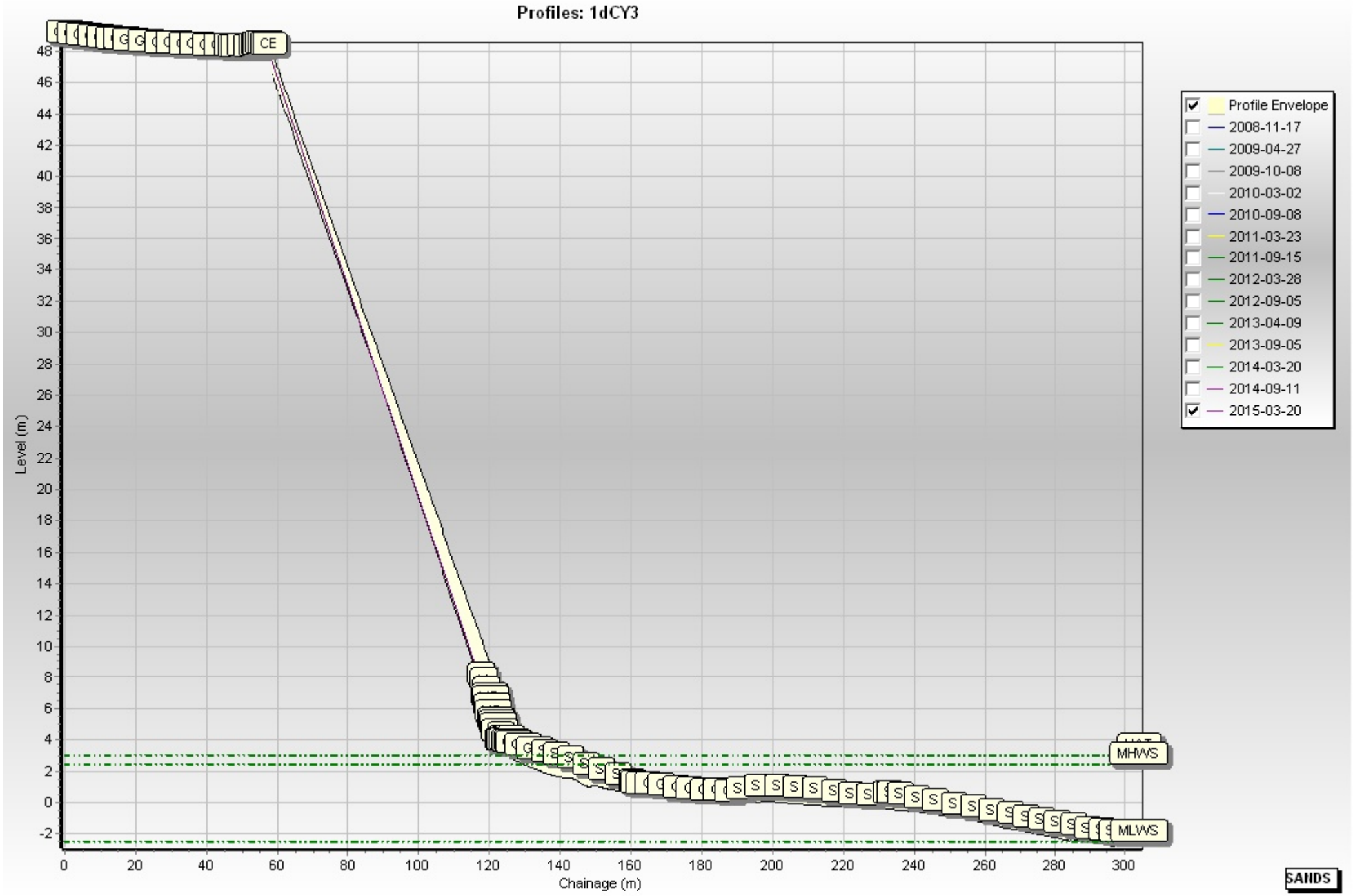
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Level (m)
Chainage (m)
Profile Envelope
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2015-03-20
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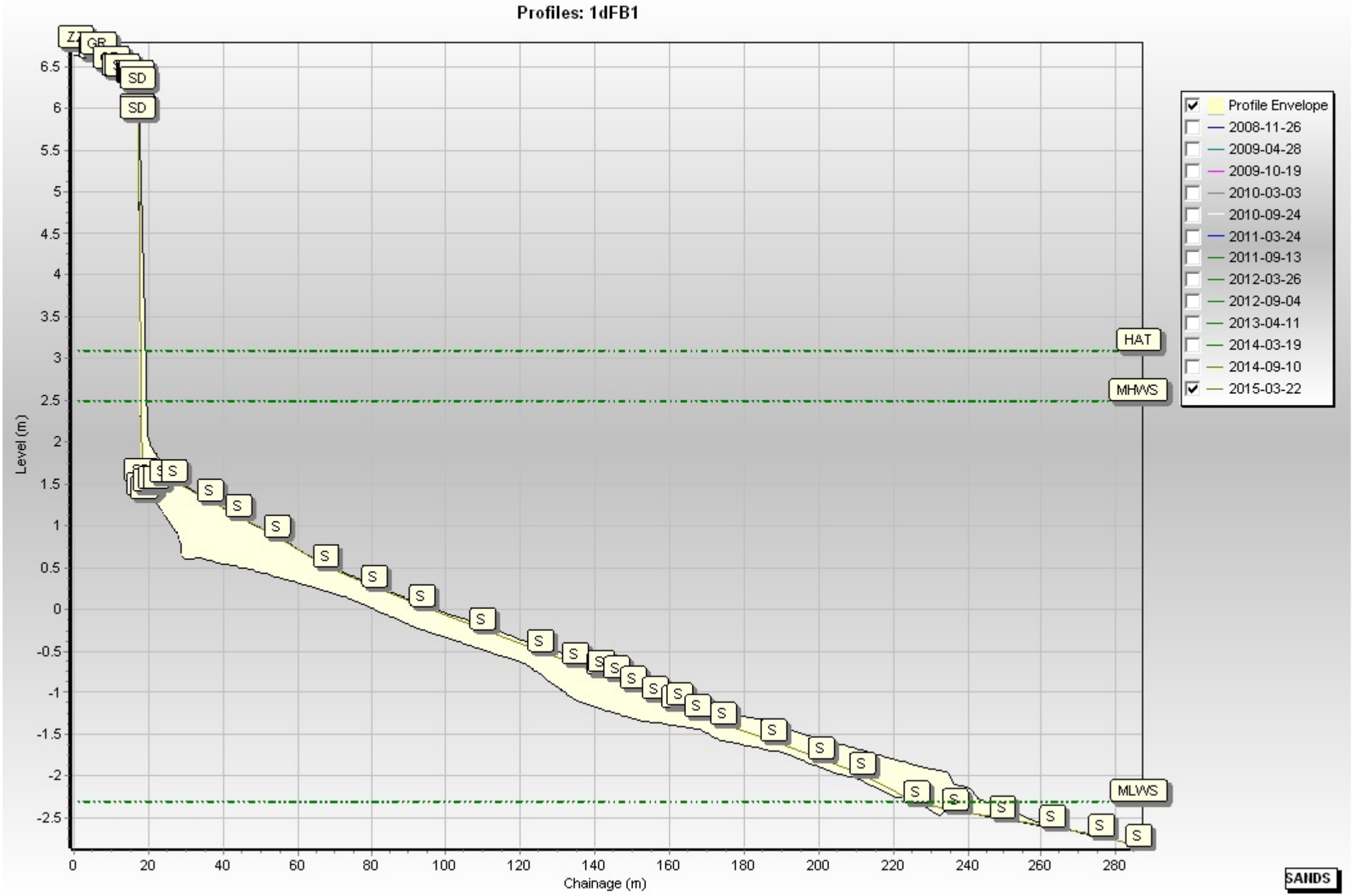
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Chainage (m)
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MHWS
MLWS
SD
S
Profile Envelope
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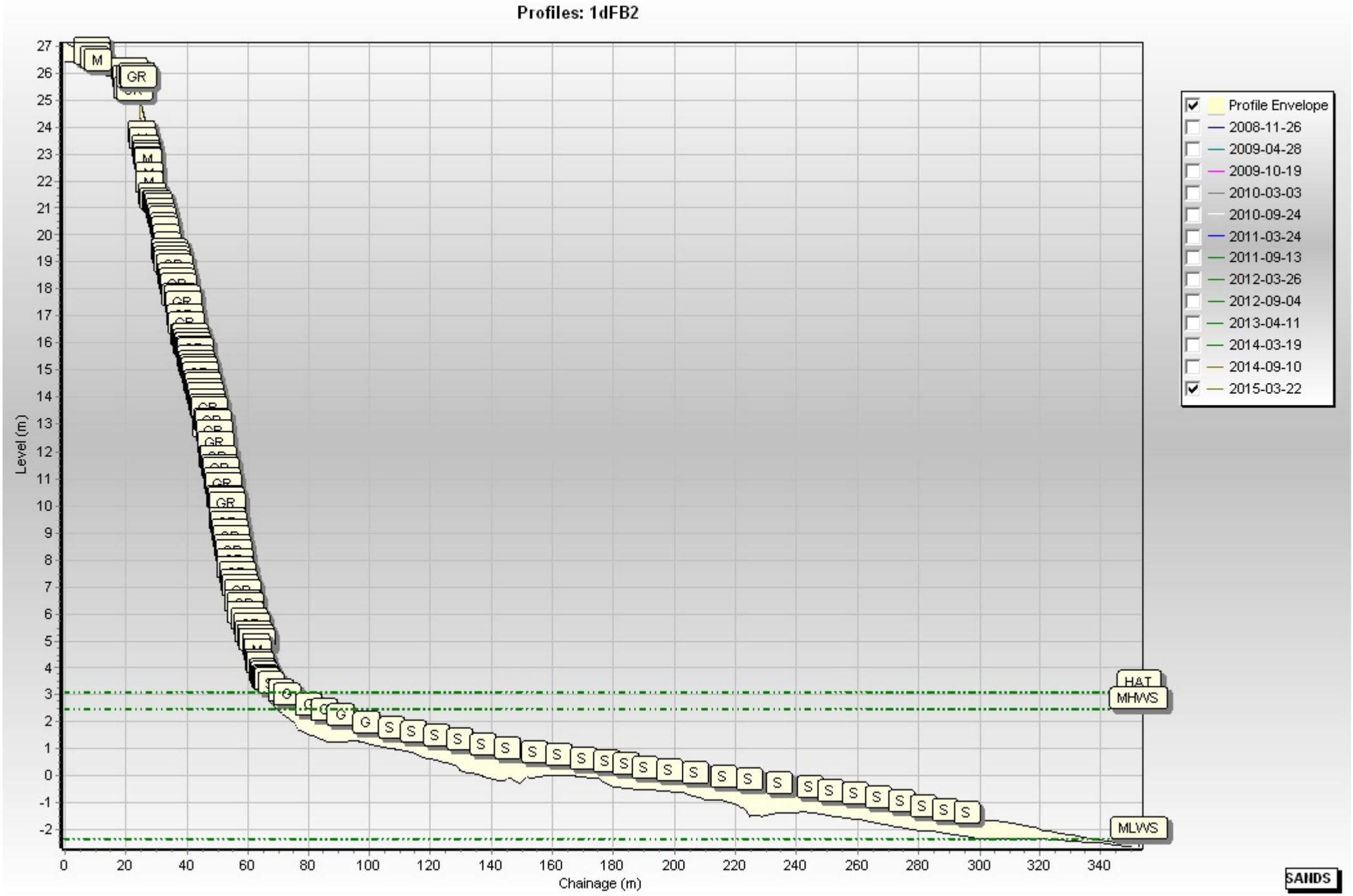
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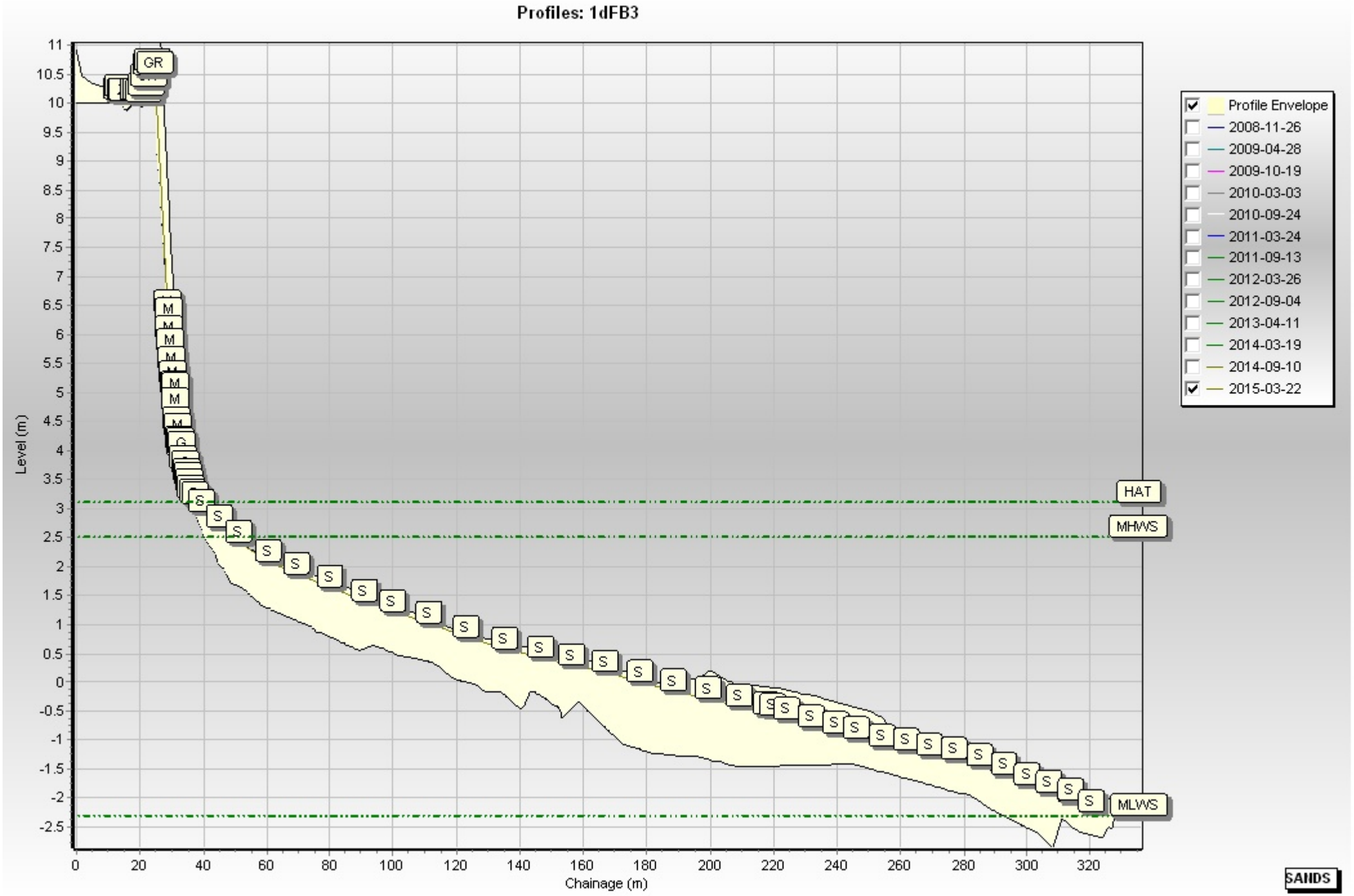
HAT
MHWS
MLWS
SAIDS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2010-03-03
2010-09-24
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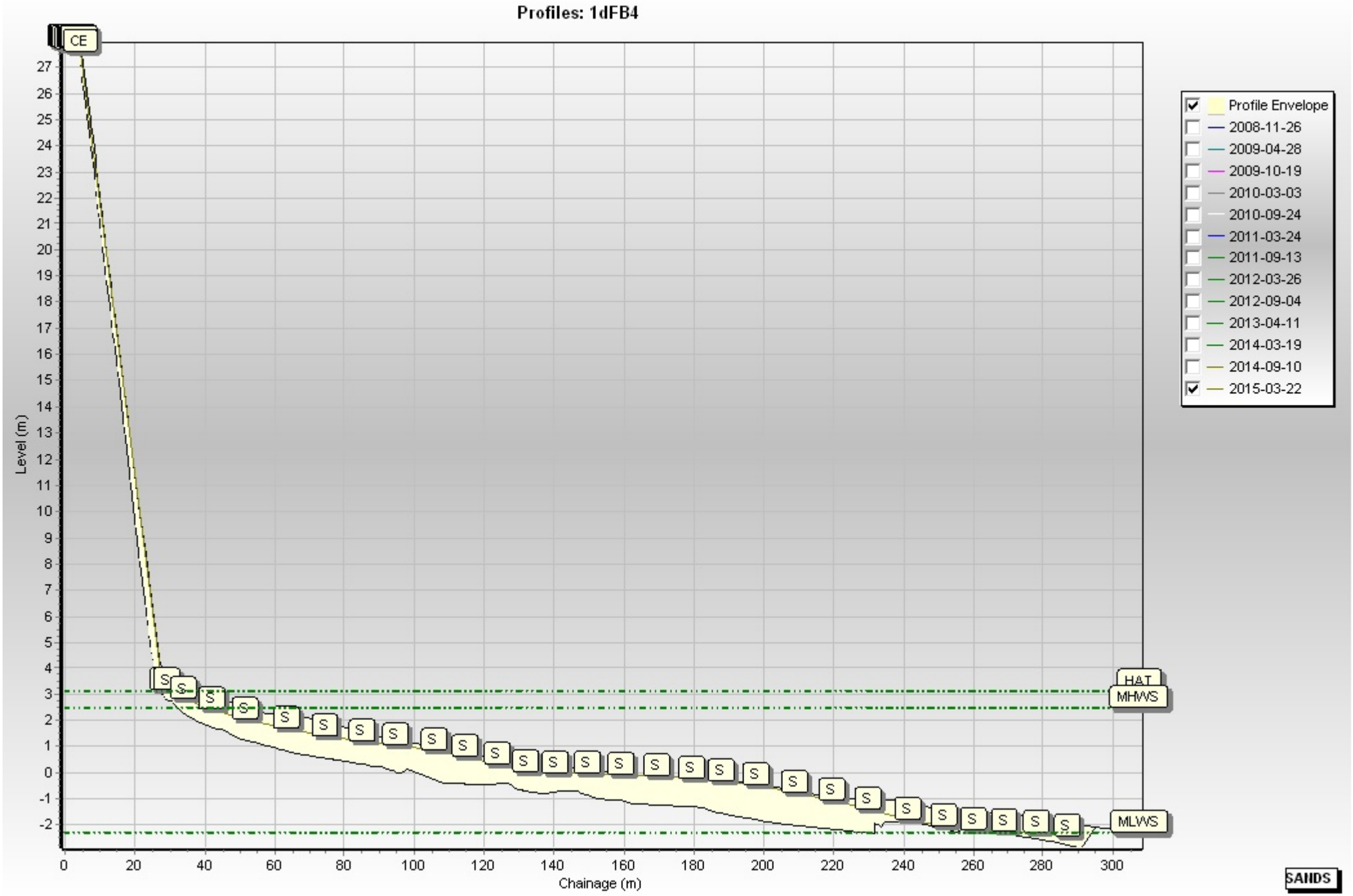
2014-09-10
2015-03-22
SANDS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HAT
MHWS
MLWS
Level (m)
Chainage (m)
Profile Envelope
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2010-03-03
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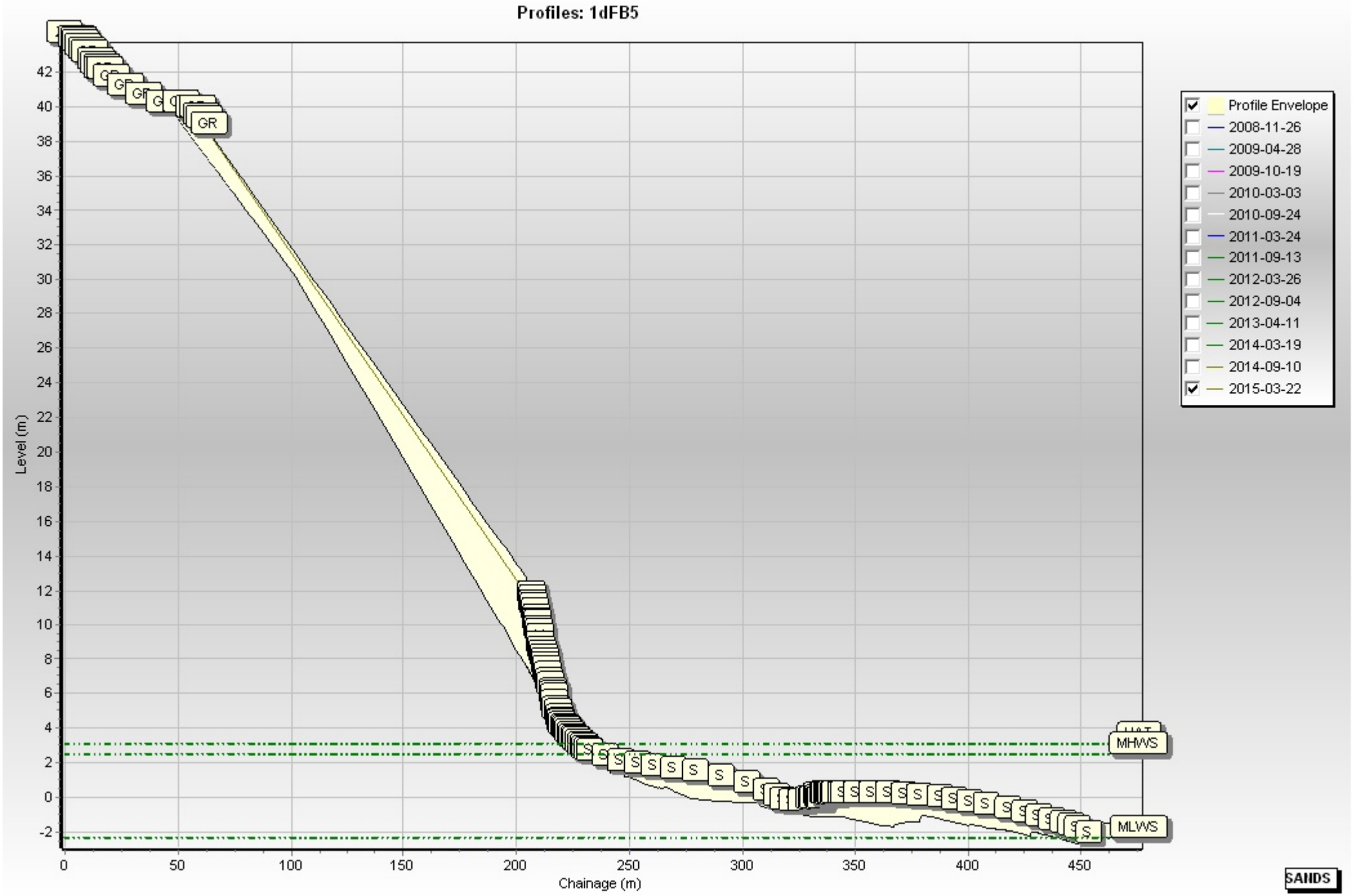
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Chainage (m)
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MLWS
Profile Envelope
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2010-03-03
2010-09-24
2011-03-24
2011-09-13
2012-03-26
2012-09-04
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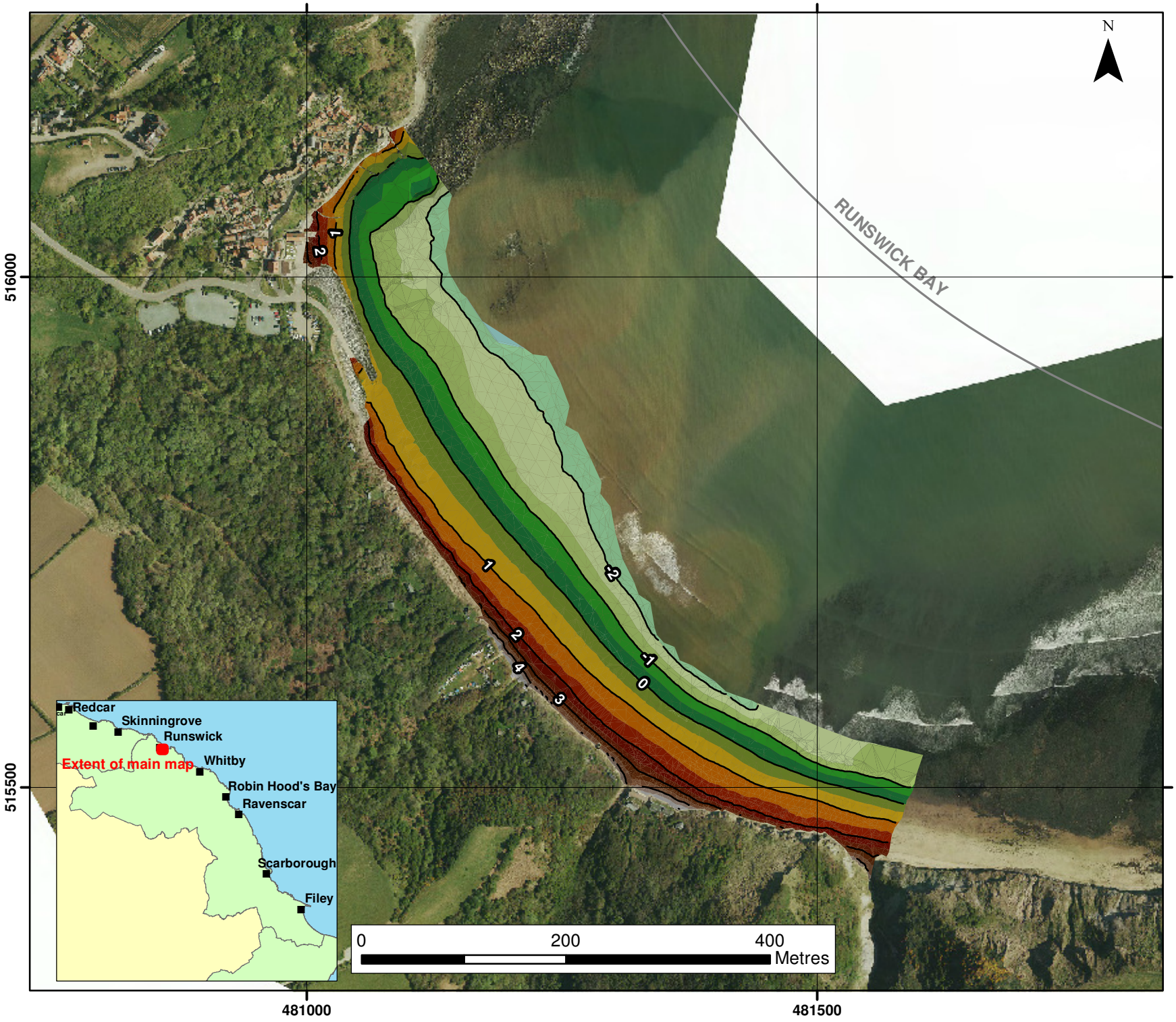
2014-03-19
2014-09-10
2015-03-22
SANDS

Appendix B

Topographic Survey



KEY

Elevation (m OD)

- 5.5 - 6
- 5 - 5.5
- 4.5 - 5
- 4 - 4.5
- 3.5 - 4
- 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
- -3 - -2.5
- Contour 1m

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B - Map 1a
Topographic Survey
Runswick
Scarborough
Borough Council

Update Report 7
Partial Measures Survey
Spring 2015

ch2m

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www.ch2m.com

Photography courtesy of North East Coastal Observatory
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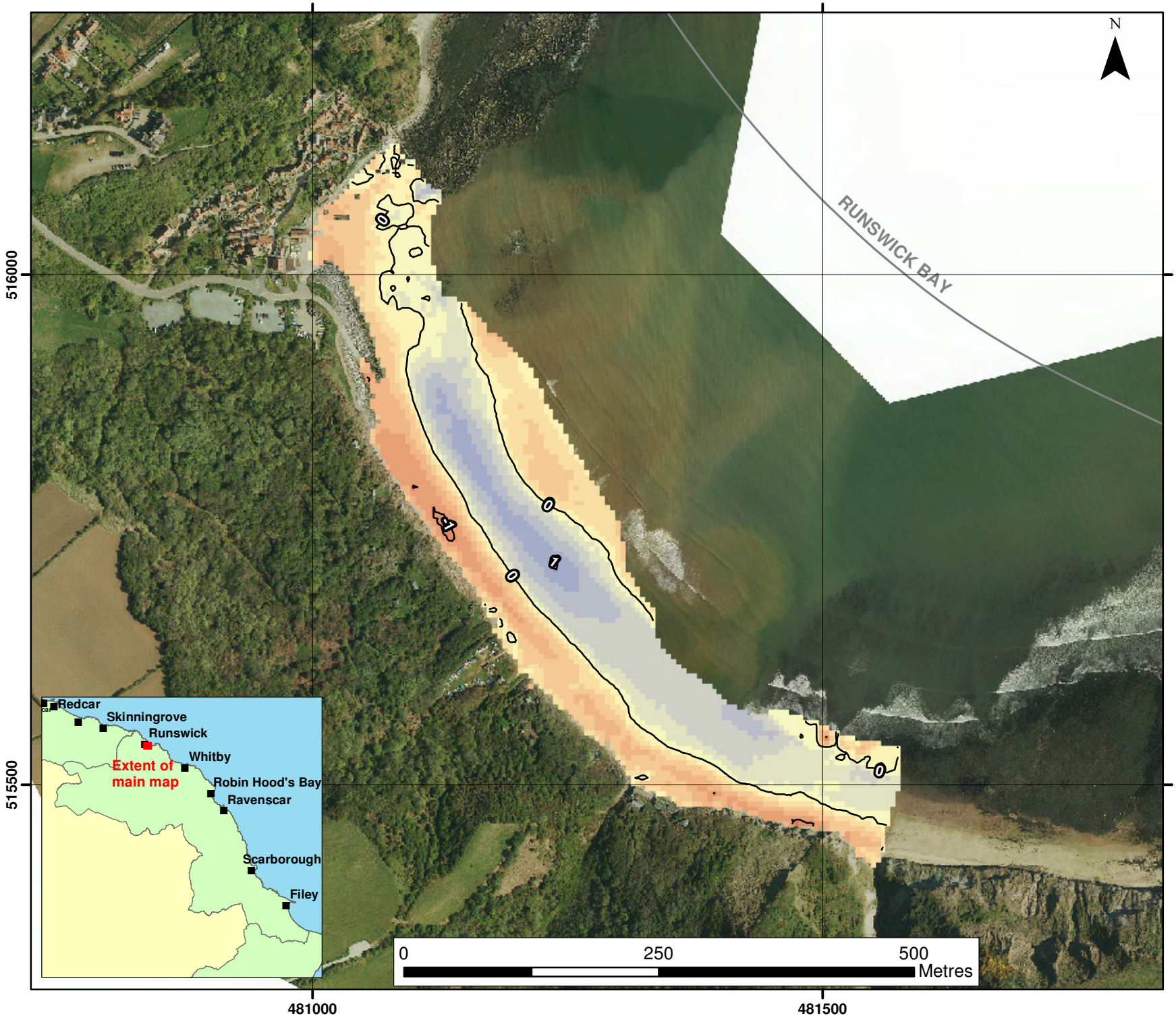

KEY Autumn 2014 and Spring 2015
Change in elevation (m)

<-2	Loss
-2 - -1.75	
-1.75 - -1.5	
-1.5- -1.25	
-1.25 - -1	
-1 - -0.75	
-0.75 - -0.5	
-0.5 - -0.25	
-0.25 - -0.1	
-0.1 - 0	Change < 0.1 m
0 - 0.1	
0.1 - 0.25	Gain
0.25 - 0.5	
0.5 - 0.75	
0.75 - 1	
1 - 1.25	
1.25 - 1.5	
1.5 - 1.75	
1.75 - 2	
>2	

Contours of change

Client: North East Coastal Group
Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B - Map 1b
Short-term Elevation Change
Runswick
Scarborough Borough Council

Update Report 7
Partial Measures Survey
Spring 2015

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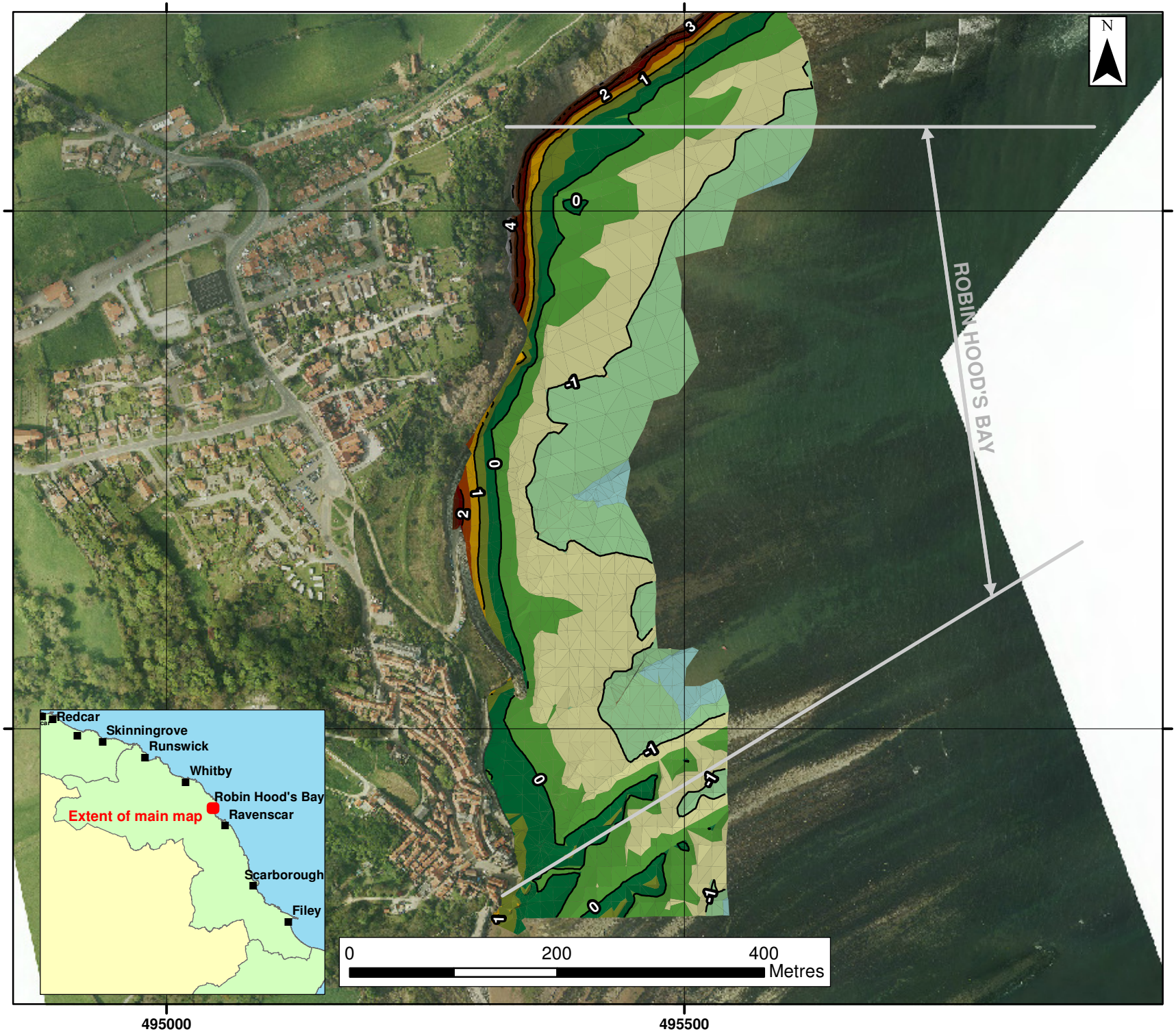

KEY

Elevation (m OD)

- 5 - 5.5
- 4.5 - 5
- 4 - 4.5
- 3.5 - 4
- 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
- Contour 1m

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B- Map 2a
Topographic Survey
Robin Hood's Bay
Scarborough
Borough Council

Update Report 7
Partial Measures Survey
Spring 2015

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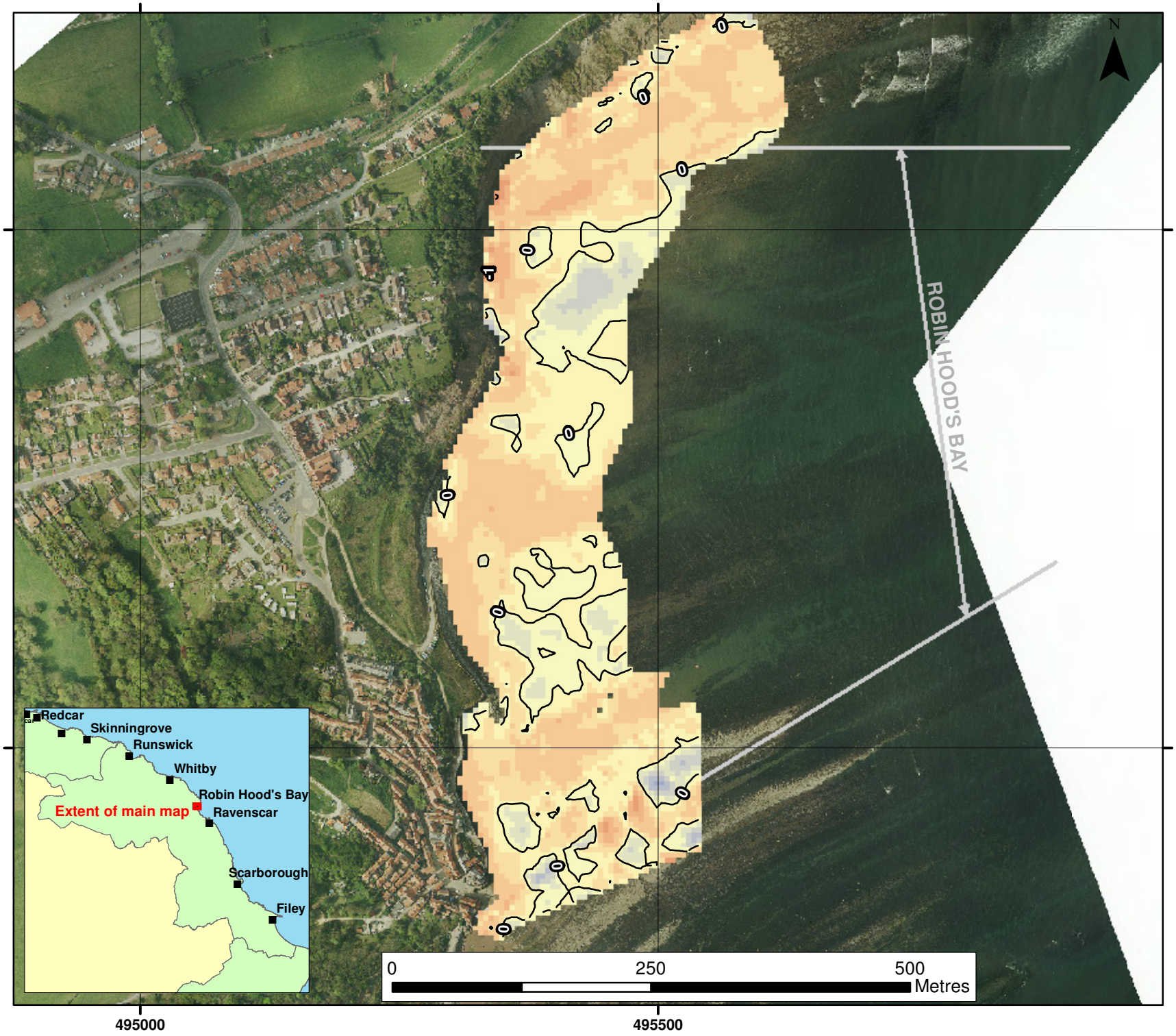

KEY Autumn 2014 and Spring 2015 Change in elevation (m)

<-2	Loss
-2 - -1.75	
-1.75 - -1.5	
-1.5- -1.25	
-1.25 - -1	
-1 - -0.75	
-0.75 - -0.5	
-0.5 - -0.25	
-0.25 - -0.1	
-0.1 - 0	Change < 0.1 m
0 - 0.1	
0.1 - 0.25	
0.25 - 0.5	
0.5 - 0.75	
0.75 - 1	
1 - 1.25	Gain
1.25 - 1.5	
1.5 - 1.75	
1.75 - 2	
>2	

Contour 1m

Client: North East Coastal Group
Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B- Map 2b
Short-term Elevation Change
Robin Hood's Bay
Scarborough Borough Council

Update Report 7
Partial Measures Survey
Spring 2015

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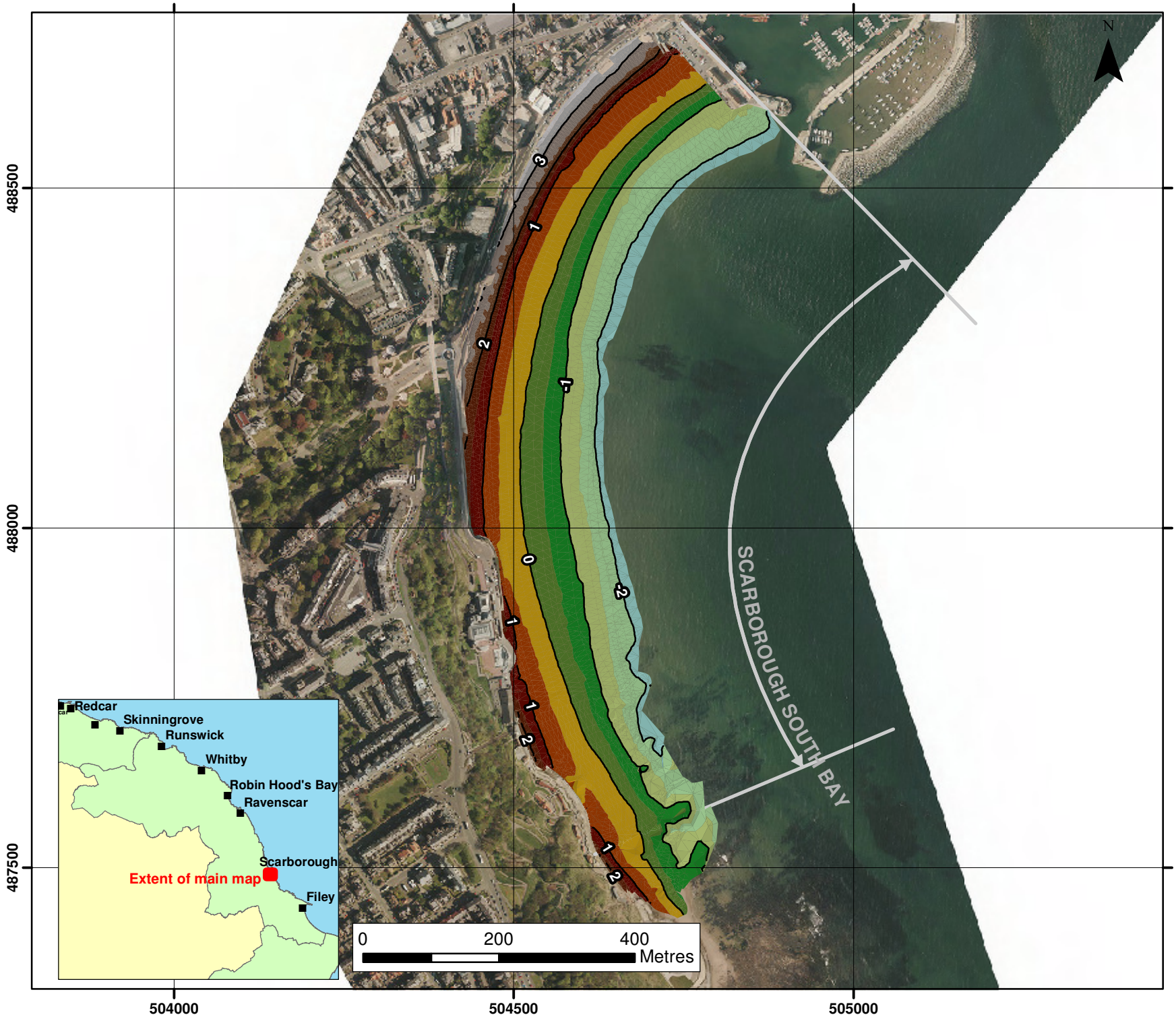

KEY

Elevation (m OD)

- 3.5 - 4
- 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
- Contour 1m

Elevations are before beach recycling (17/04/2015)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B- Map 3a
Topographic Survey
Scarborough South
Scarborough
Borough Council

Update Report 7
Partial Measures Survey
Spring 2015

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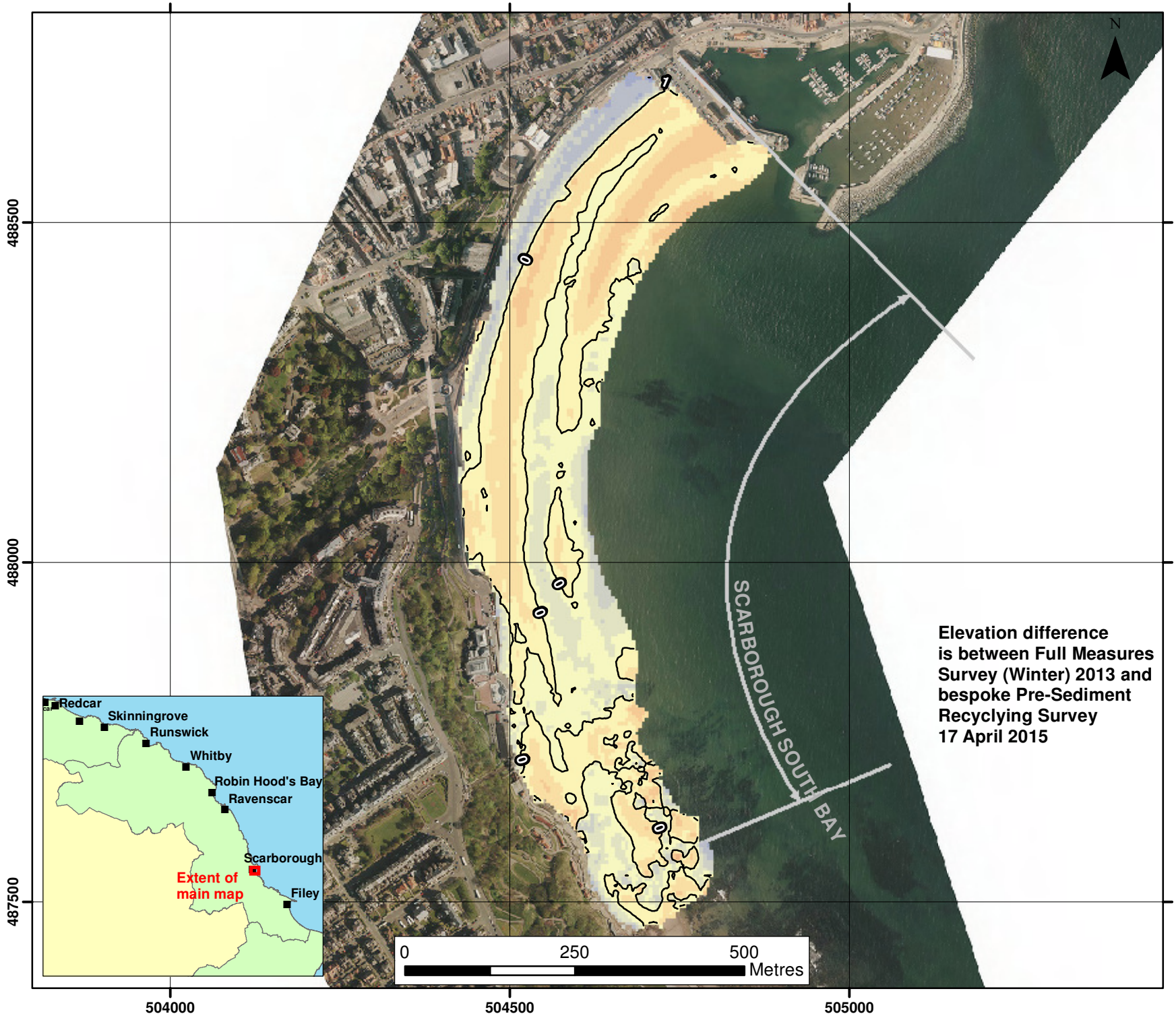

Elevation difference is between Full Measures Survey (Winter) 2013 and bespoke Pre-Sediment Recyclying Survey 17 April 2015

KEY Autumn 2014 and Spring 2015 Change in elevation (m)

<-2	Loss
-2 - -1.75	
-1.75 - -1.5	
-1.5- -1.25	
-1.25 - -1	
-1 - -0.75	
-0.75 - -0.5	
-0.5 - -0.25	
-0.25 - -0.1	
-0.1 - 0	Change < 0.1 m
0 - 0.1	
0.1 - 0.25	Gain
0.25 - 0.5	
0.5 - 0.75	
0.75 - 1	
1 - 1.25	
1.25 - 1.5	
1.5 - 1.75	
1.75 - 2	
>2	

Contours of change

Client: North East Coastal Group
Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B- Map 3b
Short-term Elevation Change
Scarborough South Scarborough Borough Council

Update Report 7
Partial Measures Survey
Spring 2015

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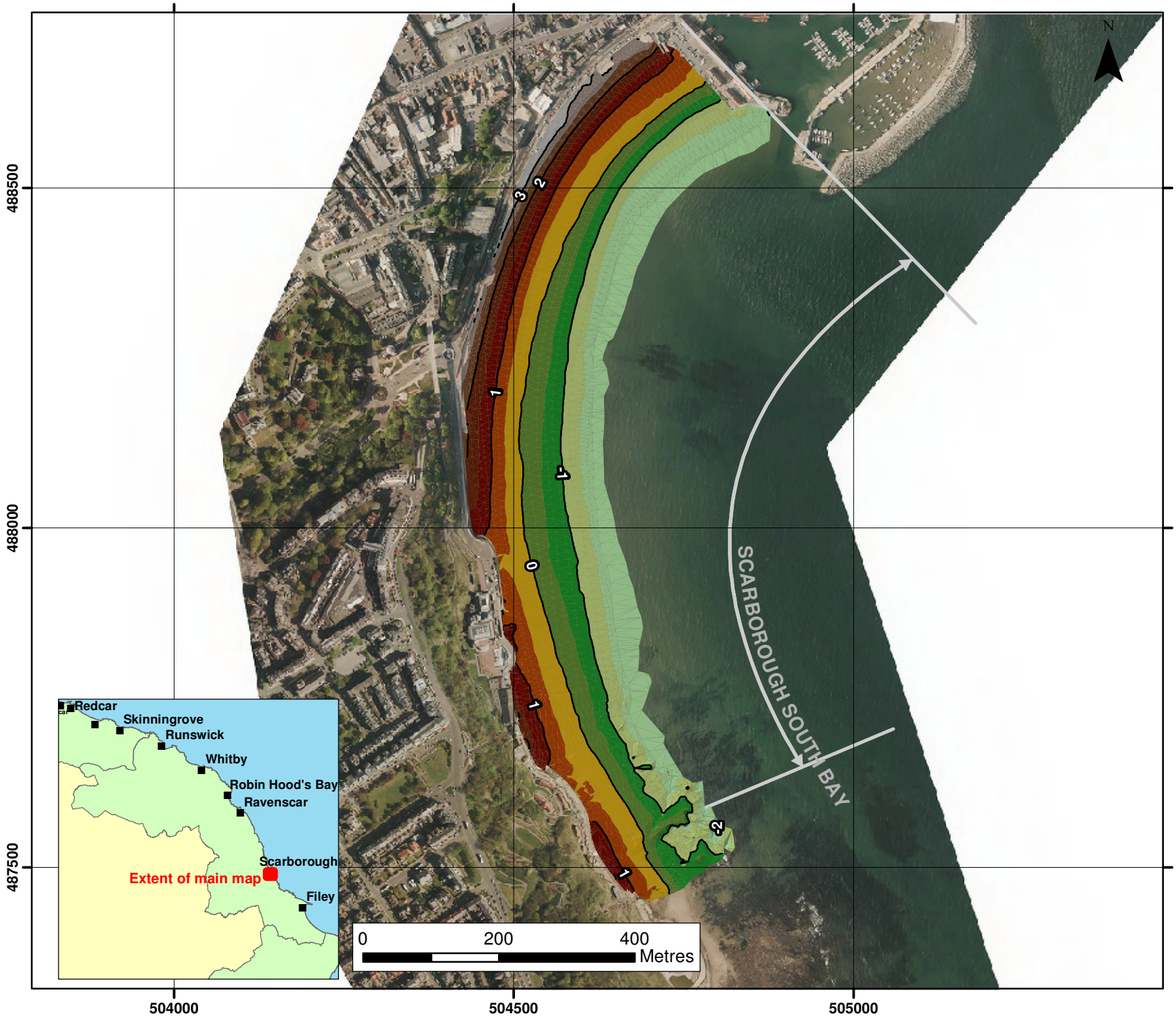

KEY

Elevation (m OD)

- 3.5 - 4
- 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
- Contour 1m

Elevations are after beach recycling (05/05/2014)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B- Map 4a
Topographic Survey
Scarborough South
Scarborough
Borough Council

Update Report 7
Partial Measures Survey
Spring 2015

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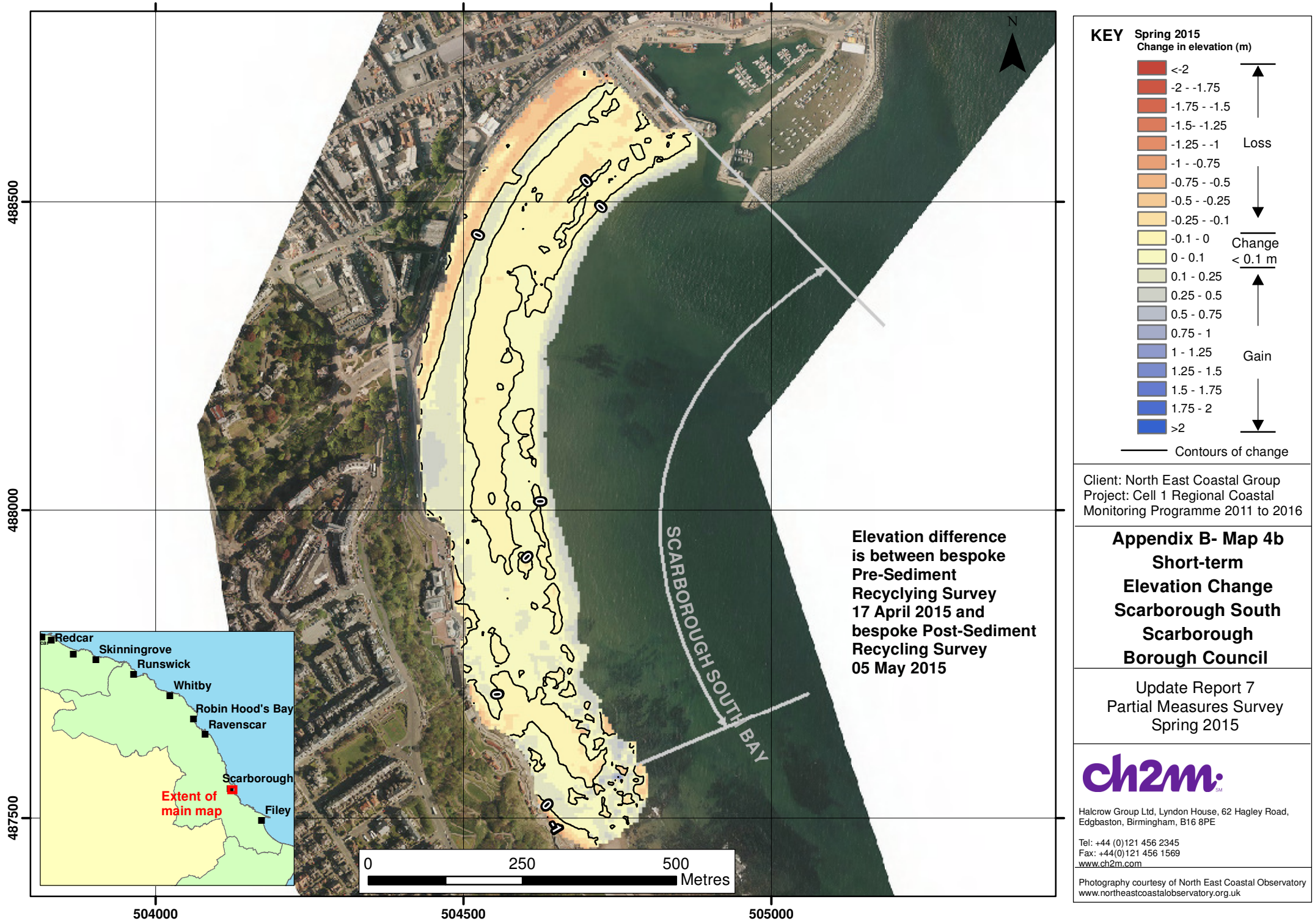

Elevation difference is between bespoke Pre-Sediment Recyclying Survey 17 April 2015 and bespoke Post-Sediment Recycling Survey 05 May 2015

KEY Spring 2015
Change in elevation (m)

- <-2
- -2 - -1.75
- -1.75 - -1.5
- -1.5- -1.25
- -1.25 - -1
- -1 - -0.75
- -0.75 - -0.5
- -0.5 - -0.25
- -0.25 - -0.1
- -0.1 - 0
- 0 - 0.1
- 0.1 - 0.25
- 0.25 - 0.5
- 0.5 - 0.75
- 0.75 - 1
- 1 - 1.25
- 1.25 - 1.5
- 1.5 - 1.75
- 1.75 - 2
- >2

Loss
Change < 0.1 m
Gain
Contours of change

Client: North East Coastal Group
Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B- Map 4b Short-term Elevation Change Scarborough South Scarborough Borough Council

Update Report 7
Partial Measures Survey
Spring 2015

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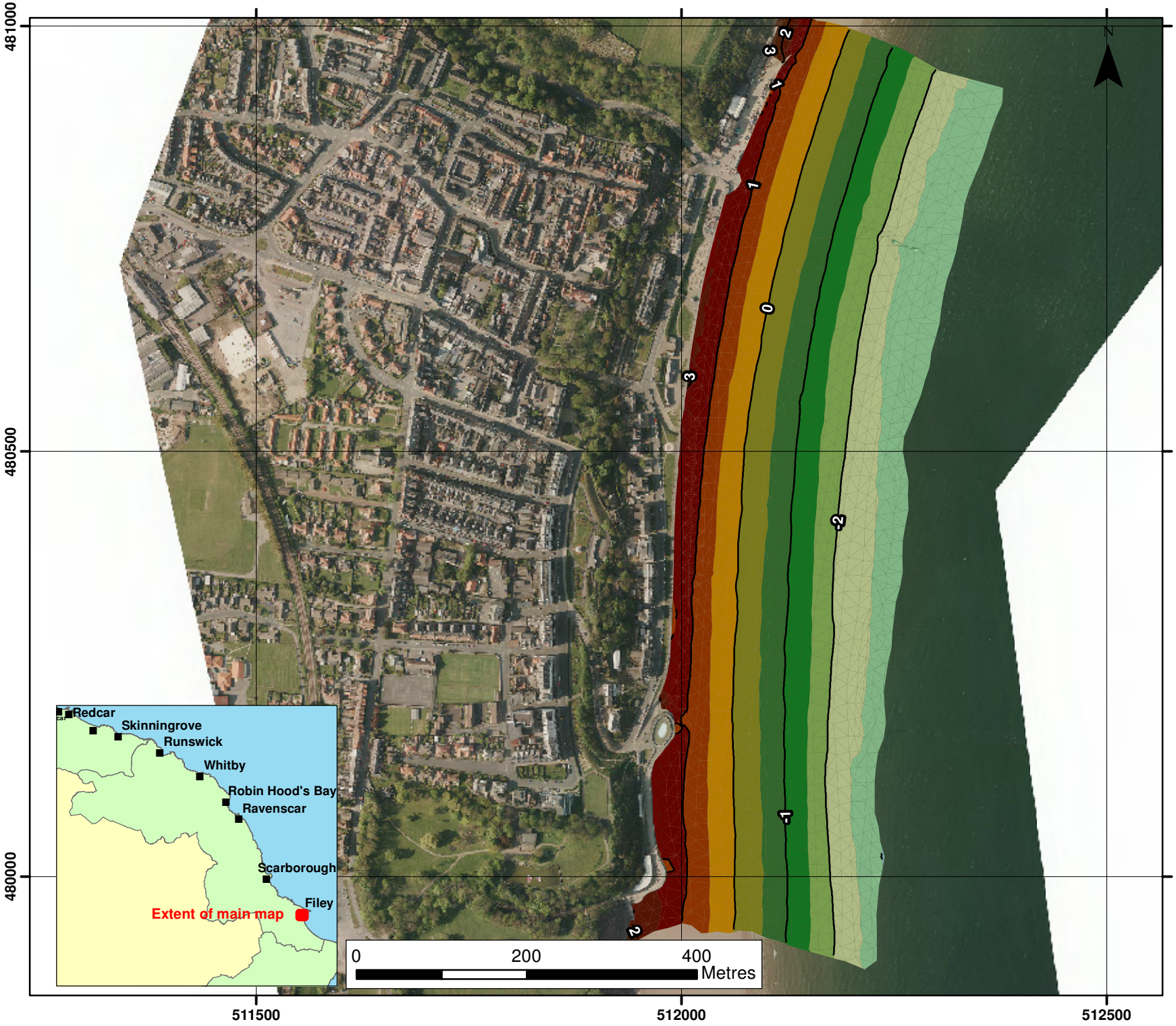

KEY

Elevation (m OD)

- 4.5 - 5
- 4 - 4.5
- 3.5 - 4
- 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
- -3 - -2.5
- -3.5 - -3
- Contour 1m

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B- Map 5a
Topographic Survey
Filey Bay
Scarborough Borough Council

Update Report 7
Partial Measures Survey
Spring 2015

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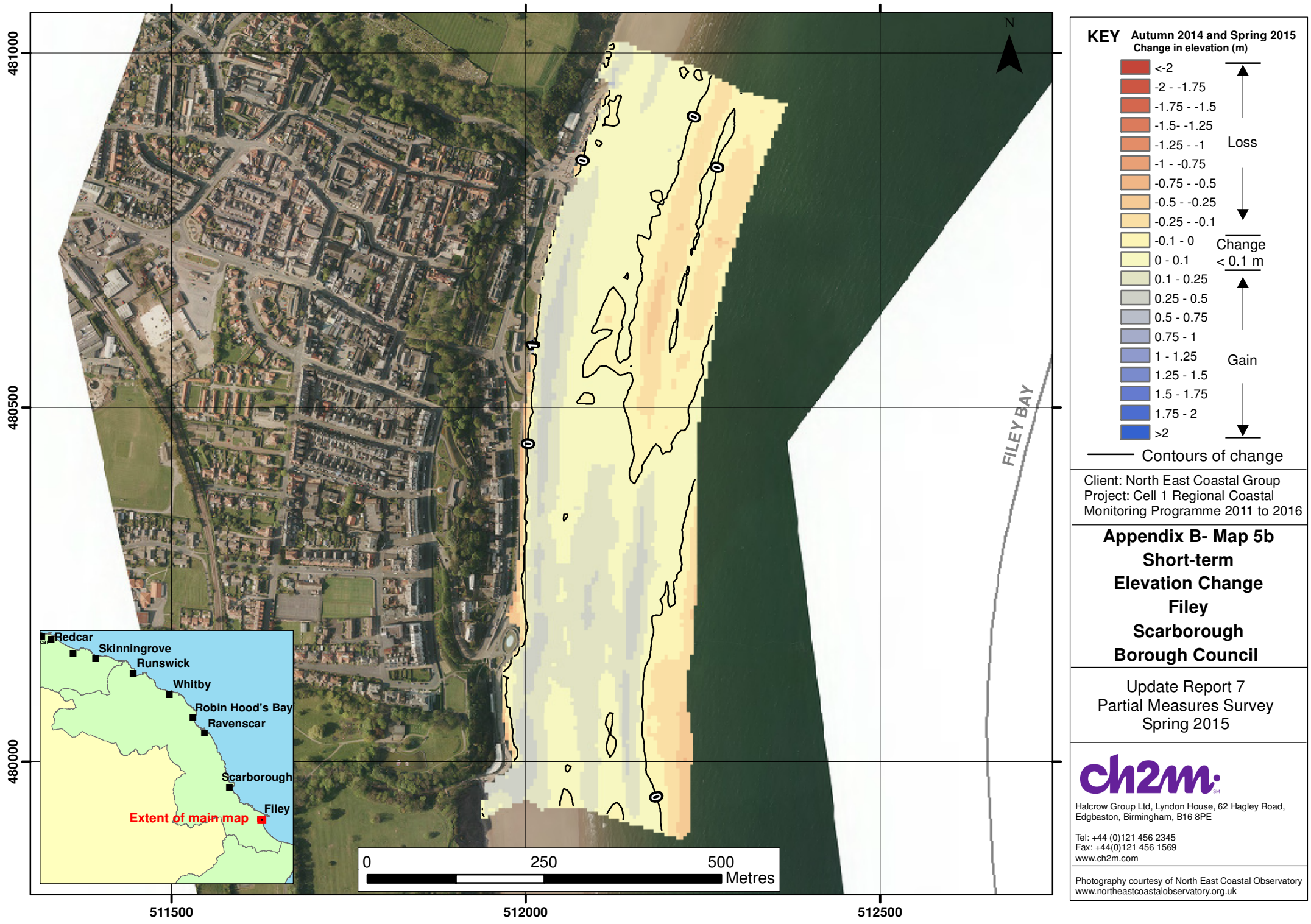

KEY Autumn 2014 and Spring 2015
Change in elevation (m)

<-2	Loss
-2 - -1.75	
-1.75 - -1.5	
-1.5- -1.25	
-1.25 - -1	
-1 - -0.75	
-0.75 - -0.5	
-0.5 - -0.25	
-0.25 - -0.1	
-0.1 - 0	Change < 0.1 m
0 - 0.1	
0.1 - 0.25	Gain
0.25 - 0.5	
0.5 - 0.75	
0.75 - 1	
1 - 1.25	
1.25 - 1.5	
1.5 - 1.75	
1.75 - 2	
>2	

Contours of change

Client: North East Coastal Group
Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix B- Map 5b
Short-term Elevation Change
Filey
Scarborough Borough Council

Update Report 7
Partial Measures Survey
Spring 2015

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Appendix C

Cliff Top Survey

Cliff Top Survey

Staithes

Twenty ground control points have been established at Staithes (Figure C1). 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 Point Details				Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Bearing (º)	Baseline Survey (Nov 2008)	Previous Survey (Oct 2014)	Present Survey (Mar 2015)	Baseline (Nov 2008) to Present (Mar 2015)	Previous (Oct 2014) to Present (Mar 2015)	Baseline (Nov 2008) to Present (Mar 2015)
1	477228	518769	320	1.9	1.6	1.6	-0.3	0.0	-0.1
2	477334	518798	0	10.9	10.8	10.8	-0.1	0.0	0.0
3	477487	518789	350	7.1	8.3	8.3	1.2	0.0	0.2
4	477594	518801	340	5.9	5.1	5.1	-0.8	0.0	-0.1
5	477683	518911	350	8.4	9.1	8.5	0.1	-0.6	0.0
6	477792	518867	30	8.6	8.5	8.5	-0.1	0.0	0.0
7	477891	518828	60	7.7	7.3	7.3	-0.4	0.0	-0.1
8	477959	518873	350	8.7	9.8	9.8	1.1	0.0	0.2
9	478088	518950	350	7.6	8.2	8.3	0.7	0.1	0.1
10	478191	519023	340	8.4	8.8	8.8	0.4	0.0	0.1
11	478237	519007	60	6.9	6.8	6.7	-0.2	0.0	0.0
12	478213	518988	150	6.1	6.5	6.5	0.4	0.0	0.1
13	478501	518809	15	11.4	9.2	9.1	-2.3	-0.1	-0.4
14	478624	518807	20	7.5	7.5	7.5	0.0	0.1	0.0
15	478737	518858	60	6.1	6.5	6.4	0.3	-0.1	0.0
16	478823	518757	60	8	8.9	8.8	0.8	-0.1	0.1
17	478944	518671	30	9.3	9.2	9.0	-0.3	-0.2	-0.1
18	479052	518630	20	9.2	9.5	9.4	0.2	-0.1	0.0
19	479147	518610	0	14.2	14.4	14.4	0.2	0.0	0.0
20	479274	518618	20	11.4	11.1	11.4	0.0	0.3	0.0

Cliff Top Survey

Robin Hoods Bay

Thirteen ground control points have been established at Robin Hoods Bay (Figure C2). 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 Point Details				Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Bearing (º)	Baseline Survey (March 2010)	Previous Survey (Sept 2014)	Present Survey (March 2015)	Baseline (March 2010) to Present (March 2015)	Previous (Sept 2014) to Present (March 2015)	Baseline (March 2010) to Present (March 2015)
1	495799.5	506002.2	130	11.6	8.0	7.9	-3.7	0.0	-0.7
2	495549.2	505807.3	135	9.3	9.2	9.0	-0.3	-0.2	-0.1
3	495456.3	505740	130	5	5.2	5.3	0.3	0.1	0.1
4	495389.9	505683.7	140	6.3	6.2	6.1	-0.2	-0.1	0.0
5	495259.4	505342.5	130	11.3	12.7	10.0	-1.3	-2.8	-0.3
6	495231.2	505315.7	95	5.9	5.8	5.8	-0.1	0.0	0.0
7	495184.8	505210.7	85	6.4	6.4	6.3	-0.1	-0.1	0.0
8	495206.5	505153	75	5	5.2	5.2	0.2	0.0	0.0
9	495287.8	505060.5	80	4.3	4.5	4.6	0.3	0.0	0.0
10	495187.8	504708.8	70	3.1	2.5	2.6	-0.5	0.1	-0.1
11	495226.2	504615.7	120	3.8	3.9	4.0	0.2	0.0	0.0
12	495297.5	504380.2	80	11	11.1	11.1	0.1	0.0	0.0
13	495350.4	504193	55	3.7	3.7	3.8	0.0	0.0	0.0

Cliff Top Survey

Scarborough South Bay

Thirteen ground control points have been established at Scarborough South Bay (Figure C3). 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 Point Details				Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Bearing (º)	Baseline Survey (March 2010)	Previous Survey (Sept 2014)	Present Survey (March 2015)	Baseline (March 2010) to Present (March 2015)	Previous (Sept 2014) to Present (March 2015)	Baseline (March 2010) to Present (March 2015)
1	504339.5	487887.3	70	7.0	7.0	7.0	0.0	0.0	0.0
2	504422.3	487603.7	80	4.8	4.8	4.8	0.0	0.0	0.0
3	504534.8	487318.3	40	15.1	15.1	15.1	0.0	0.1	0.0
4	504730.2	487137.9	55	9.6	9.6	9.6	0.0	0.0	0.0
5	504922.9	486837.8	60	8.8	8.8	8.6	-0.2	-0.2	0.0
6	505071.1	486652.1	75	3.8	3.5	3.8	0.0	0.4	0.0
7	505284.3	486480	35	7.0	6.9	6.9	-0.1	0.1	0.0
8	505597.9	486363.4	30	8.6	8.5	8.6	0.0	0.1	0.0
9	505758.6	486005.1	45	9.1	8.8	8.8	-0.3	0.0	-0.1
10	505896	485889.6	15	14.8	14.8	14.8	0.0	0.1	0.0
11	505990	485657.1	80	4.7	1.6	1.6	-3.1	0.0	-0.6
12	506024.9	485421.8	55	6.1	4.1	4.1	-2.0	0.0	-0.4
13	506036	485315.3	90	7.0	7.1	7.0	0.0	-0.1	0.0

Cliff Top Survey

Cayton Bay

Eight ground control points have been established at Cayton Bay (Figure C4). 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 Point Details				Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Bearing (º)	Baseline Survey (Nov 2008)	Previous Survey (Sept 2014)	Present Survey (March 2015)	Baseline (Nov 2008) to Present (March 2015)	Previous (Sept 2014) to Present (March 2015)	Baseline (Nov 2008) to Present (March 2015)
1	506325.5	484849.7	50	4	3.4	3.5	-0.6	0.0	-0.1
2	506459.4	484715.9	65	5	-0.1	0.0	-5.0	0.1	-0.8
3	506597.4	484538.6	65	5	6.3	6.3	1.3	0.0	0.2
4	506778.1	484345.5	21	9	6.1	6.0	-3.0	0.0	-0.5
5	507018.6	484221.6	342	7.7	8.1	8.1	0.4	0.0	0.1
6	507242.3	484121.7	2	7.4	6.5	6.3	-1.1	-0.2	-0.2
7	507518.2	484008.2	25	7.5	7.8	7.8	0.3	0.0	0.0
8	507818.7	484006	1	5.5	6.2	6.3	0.8	0.1	0.1

Cliff Top Survey

Filey Bay

Twenty-eight ground control points have been established in Filey Bay (Figure C5 and C6). 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) 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.

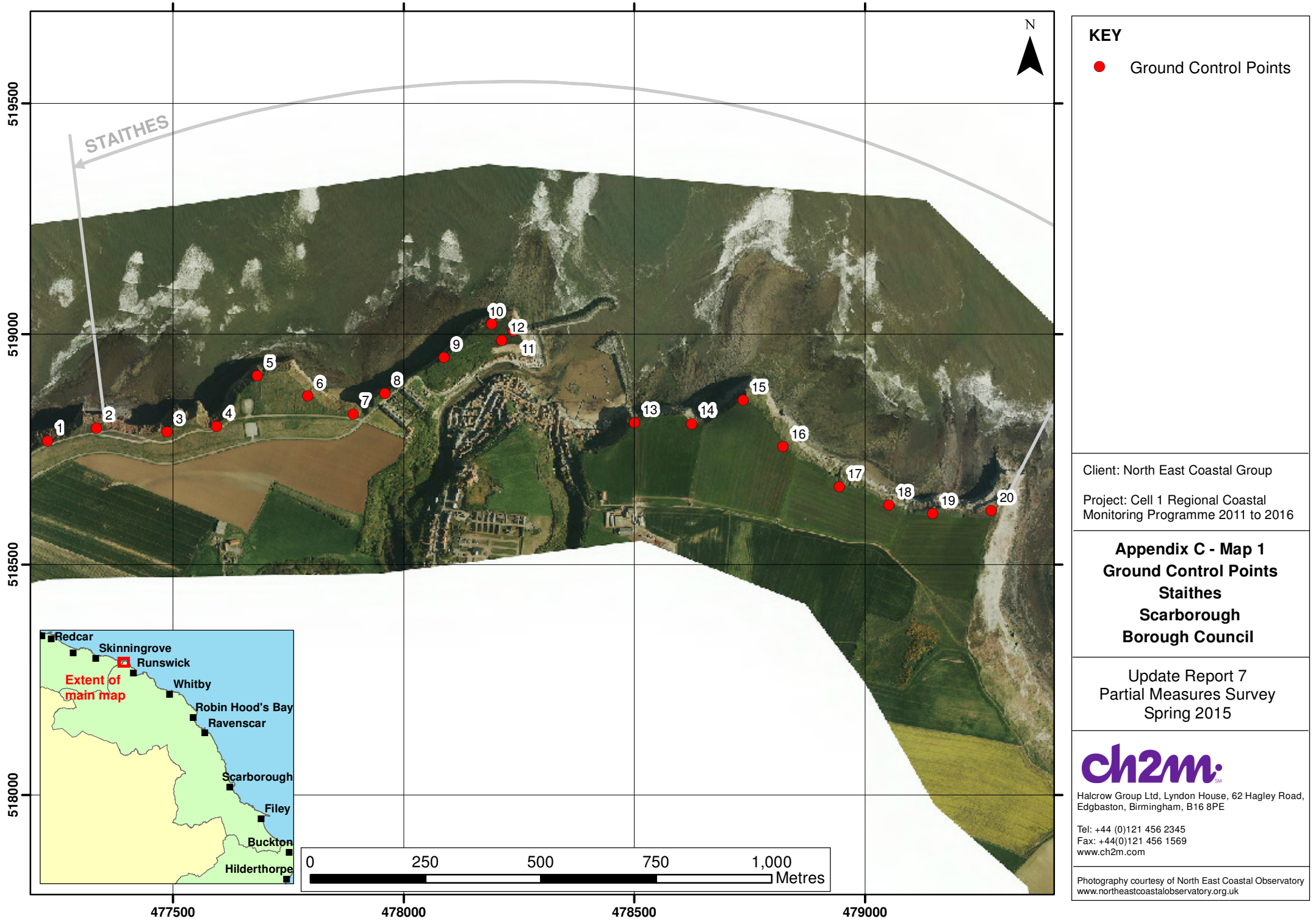
Table C5 – Cliff Top Surveys in Filey Bay

Ground Control Point Details				Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Bearing (º)	Baseline Survey (Nov 2008)	Previous Survey (Sept 2014)	Present Survey (Mar 2014)	Baseline (Nov 2008) to Present (Mar 2015)	Previous (Sept 2014) to Present (Mar 2015)	Baseline (Nov 2008) to Present (Mar 2015)
1	512444.9	481630.9	130	8.7	8.8	8.8	0.1	0.0	0.0
2	512306.7	481490.3	144	7.6	7.9	7.8	0.2	0.0	0.0
3	512153.6	481234.6	122	8.3	8.5	8.4	0.1	0.0	0.0
4	512029.2	480959.9	115	7.4	7.6	7.6	0.1	0.0	0.0
5	511895.4	479888	89	7.1	0.7	0.8	-6.3	0.0	-1.0
6	511908.5	479597.1	48	6.7	7.1	7.2	0.5	0.1	0.1
7	511991.4	479310.4	69	6.7	4.7	4.7	-2.0	0.0	-0.3
8	512083.4	478981.5	66	10.2	10.2	10.4	0.2	0.1	0.0
9	512121.3	478786.3	76	8.3	8.4	8.3	0.0	0.0	0.0
10	512226.2	478547.9	74	7.5	7.2	7.2	-0.3	0.0	0.0
11	512471.4	478153.5	53	6.6	7.8	7.8	1.2	0.0	0.2

12	512558.9	477901.9	66	7.7	7.7	7.7	0.0	0.0	0.0
12A*	512655.8	477822.4	67	13.9	13.8	13.7	-0.2	-0.1	0.0
13**	512697.6	477719	34	4.2	No Data	No Data	No Data	No Data	No Data
13A*	512805.5	477572.1	32	13.42	13.4	13.5	0.0	0.0	0.0
14	512939.4	477400.9	66	8	7.0	7.0	-1.0	0.0	-0.2
15	513157	477192.7	51	5.2	4.6	4.6	-0.6	0.0	-0.1
16	513299.5	477024.6	30	7.7	7.1	7.2	-0.5	0.0	-0.1
17	513507.7	476821.1	34	10.7	10.6	10.7	0.0	0.1	0.0
18	513721	476602.3	31	7.2	7.0	7.0	-0.2	0.0	0.0
19	513916.6	476354.1	51	6.6	6.4	6.5	-0.1	0.1	0.0
20	514174.8	476179.4	32	7	6.9	6.9	-0.1	0.1	0.0
21	514471.5	475965.7	66	7.6	7.6	7.5	-0.1	-0.1	0.0
22	514656.2	475728.8	101	8.1	8.2	8.2	0.1	0.0	0.0
23	514889.5	475537.6	60	9.1	9.1	9.1	0.0	0.0	0.0
24*	512603.7	481665.9	14	19.9	19.8	19.8	-0.1	0.0	0.0
25*	512607.1	481648.9	184	17.2	17.0	17.0	-0.2	-0.1	-0.1
26*	512301.9	481825.5	18	11	10.9	10.9	-0.1	0.0	0.0
27*	512475.8	481712.1	20	11.6	11.64	11.36	-0.2	-0.3	-0.1

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

**Surveyor's report has previously stated that 'VMP 13 was unable to be measured due to vegetation growth and land shape change'



KEY

- Ground Control Points

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix C - Map 1
Ground Control Points
Staithes
Scarborough
Borough Council

Update Report 7
Partial Measures Survey
Spring 2015

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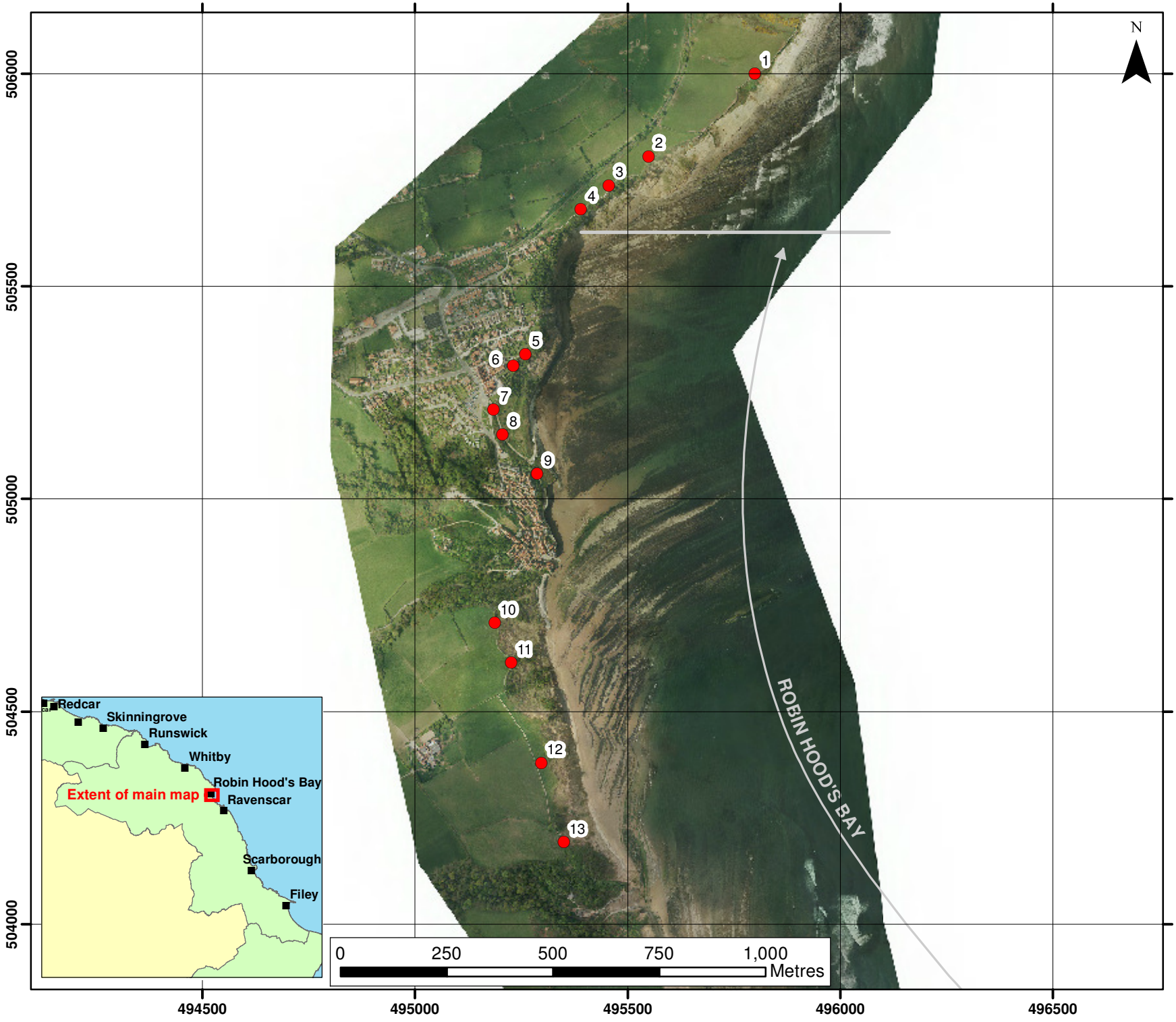

KEY

- Ground Control Points

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix C- Map 2
Ground Control Points
Robin Hood's Bay
Scarborough
Borough Council

Update Report 7
Partial Measures Survey
Spring 2015

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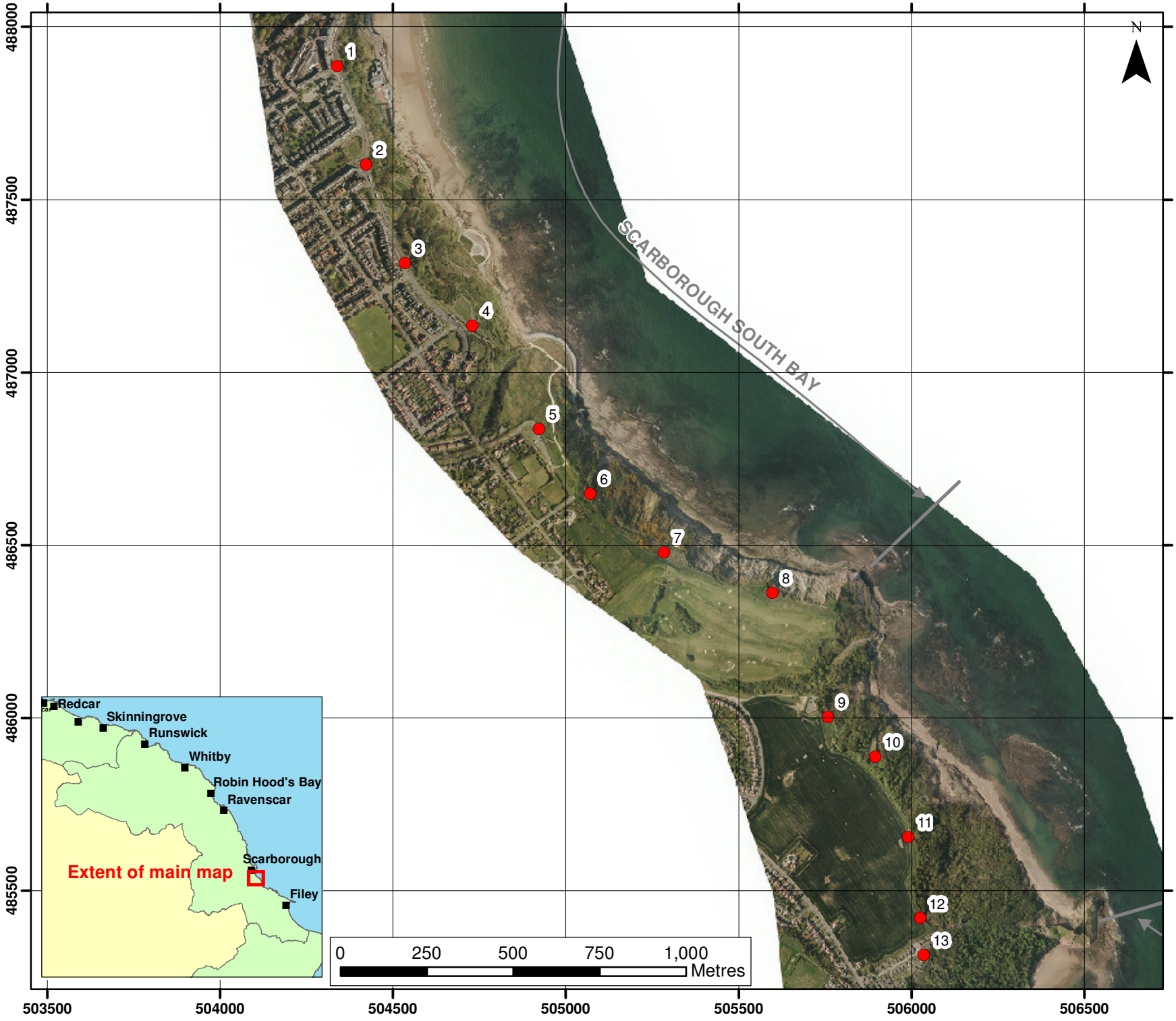

KEY

- Ground Control Points

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix C - Map 3
Ground Control Points
Scarborough South Bay
Scarborough
Borough Council

Updatel Report 7
Partial Measures Survey
Spring 2015

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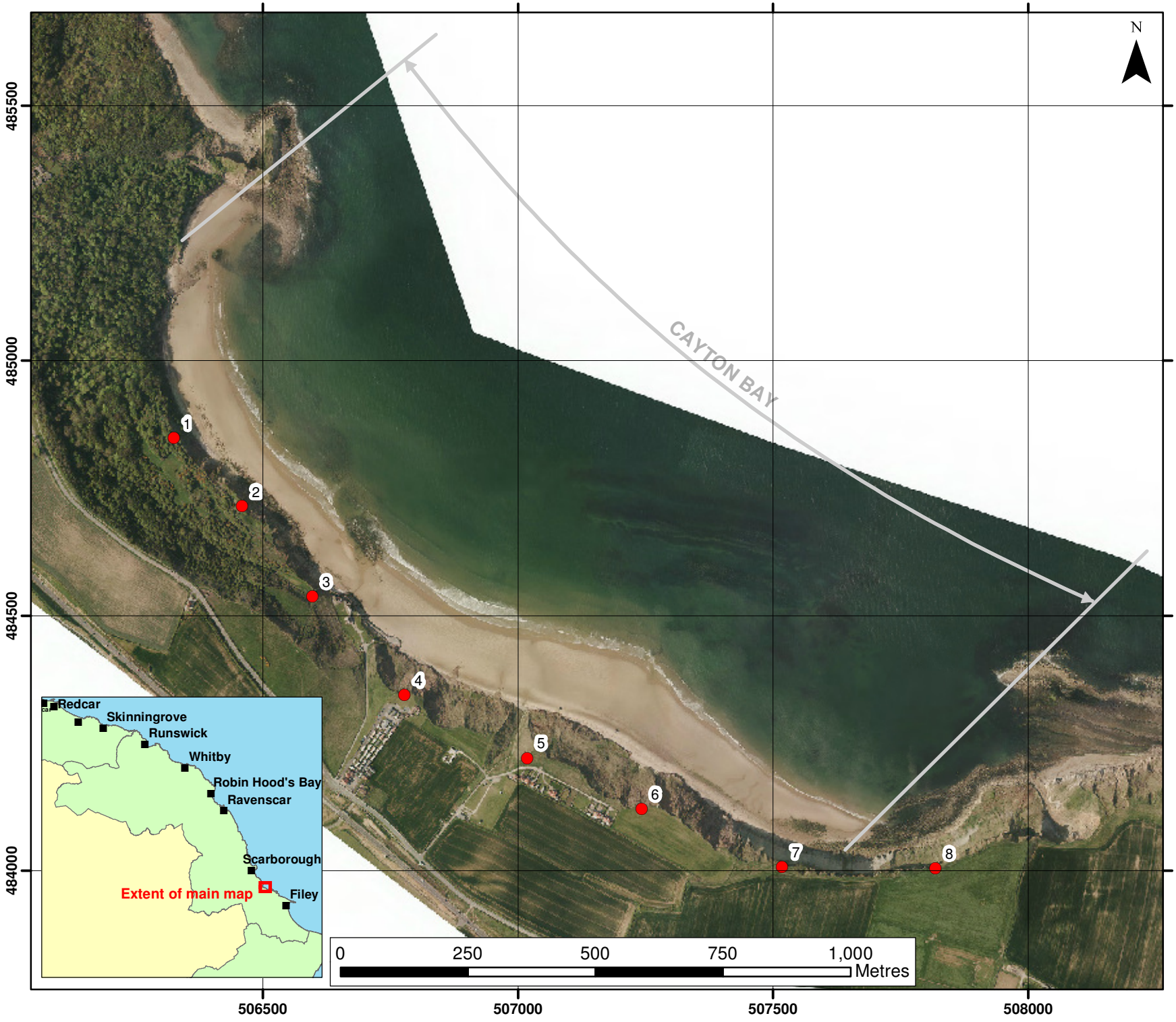

KEY

- Ground Control Points

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix C - Map 4
Ground Control Points
Cayton Bay
Scarborough
Borough Council

Update Report 7
Partial Measures Survey
Spring 2015

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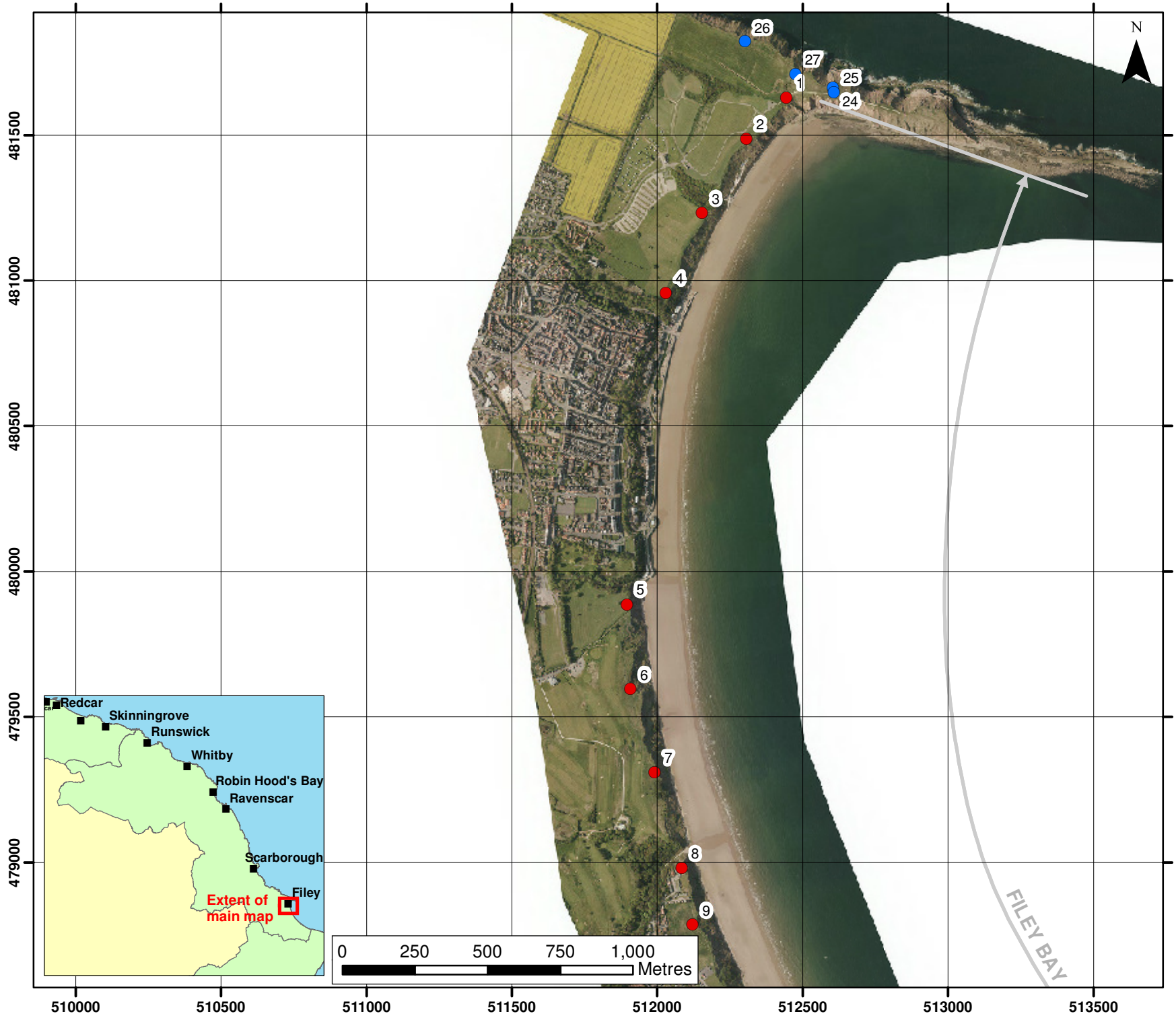

KEY

Ground Control Points

- Established March 2011
- Established Nov 2008

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix C - Map 5
Ground Control Points
Filey Bay North
Scarborough
Borough Council

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Partial Measures Survey
Spring 2015

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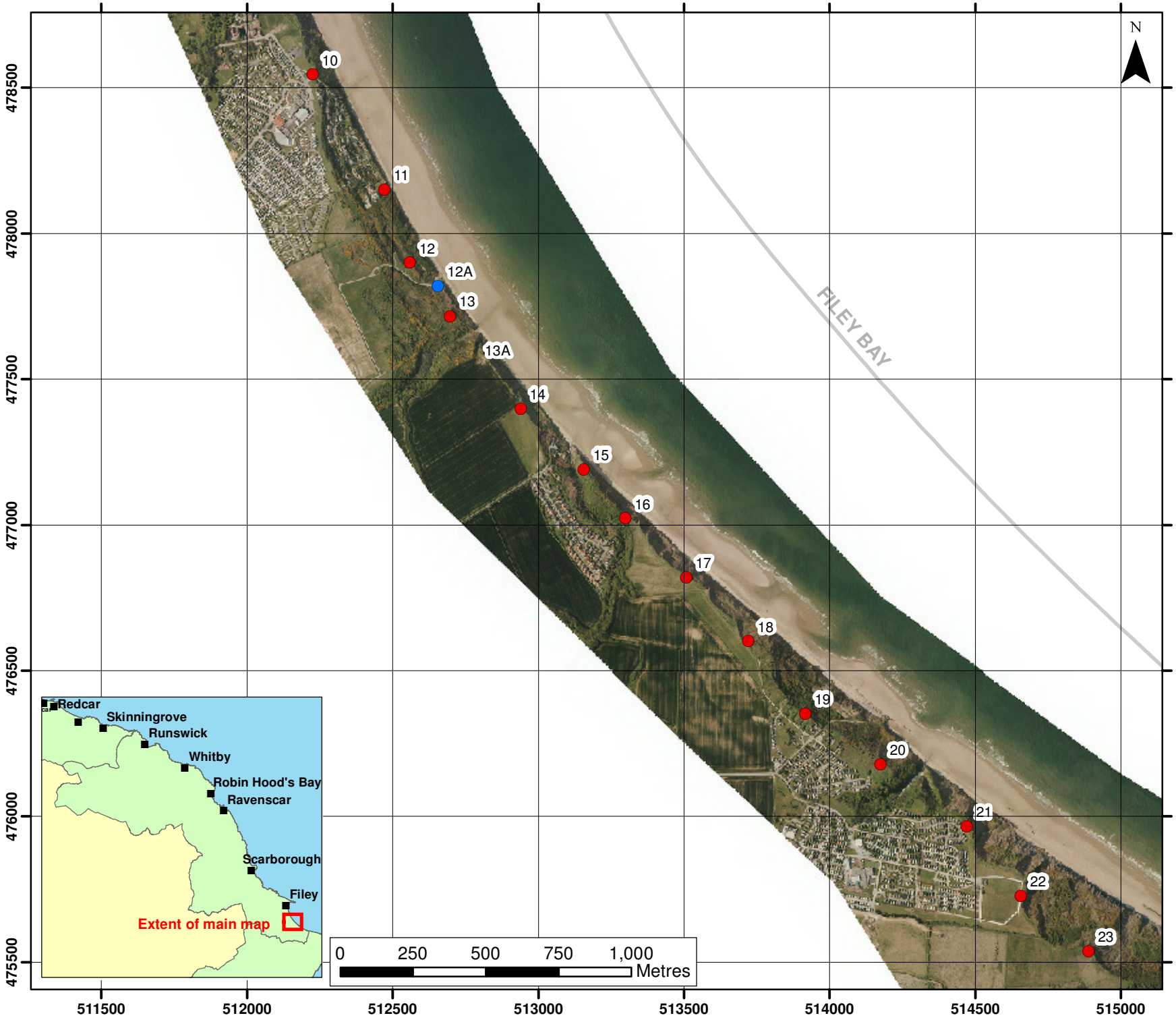

KEY

Ground Control Points

- Established March 2011
- Established Nov 2008

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme 2011 to 2016

Appendix C - Map 6
Ground Control Points
Filey Bay South
Scarborough
Borough Council

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Partial Measures Survey
Spring 2015

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