ROYAL HASKONING

Halcrow

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

REDCAR & CLEVELAND BOROUGH COUNCIL

Redcar & Cleveland Borough Council
Final Report

July 2010

Contents

Appendices

List of Figures

List of Tables

Authors	
Nick Cooper	Royal Haskoning
Nick Pettitt	Halcrow
Tanja Cooper	Royal Haskoning
Richard Johnson	Halcrow

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 (mODN)			
	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 (mODN)**			
	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 (mODN)**			
	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.

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 Redcar & Cleveland 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

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

- Coatham Sands
- Redcar Sands
- Marske Sands
- Saltburn Sands
- Cattersty Sands (Skinningrove)
- Staithes[1]

1.2 Methodology

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

- Full Measures survey annually each autumn/early winter comprising:
    - Beach profile surveys along 9 no. transect lines
    - Topographic survey along Coatham Sands
    - Topographic survey along Redcar Sands
    - Topographic survey along Marske Sands
    - Topographic survey along Saltburn Sands
    - Topographic survey at Skinningrove along Cattersty Sands

- Partial Measures survey annually each spring comprising:
    - Beach profile surveys along 9 no. transect lines
    - Topographic survey along Redcar Sands
    - Topographic survey along Saltburn Sands
    - Topographic survey at Skinningrove along Cattersty Sands

- Cliff top survey annually at:
    - Staithes

The location of these surveys is shown in Figure 1. They have also previously been provided on a digital file which can be opened in Google Earth showing the locations of the surveys.

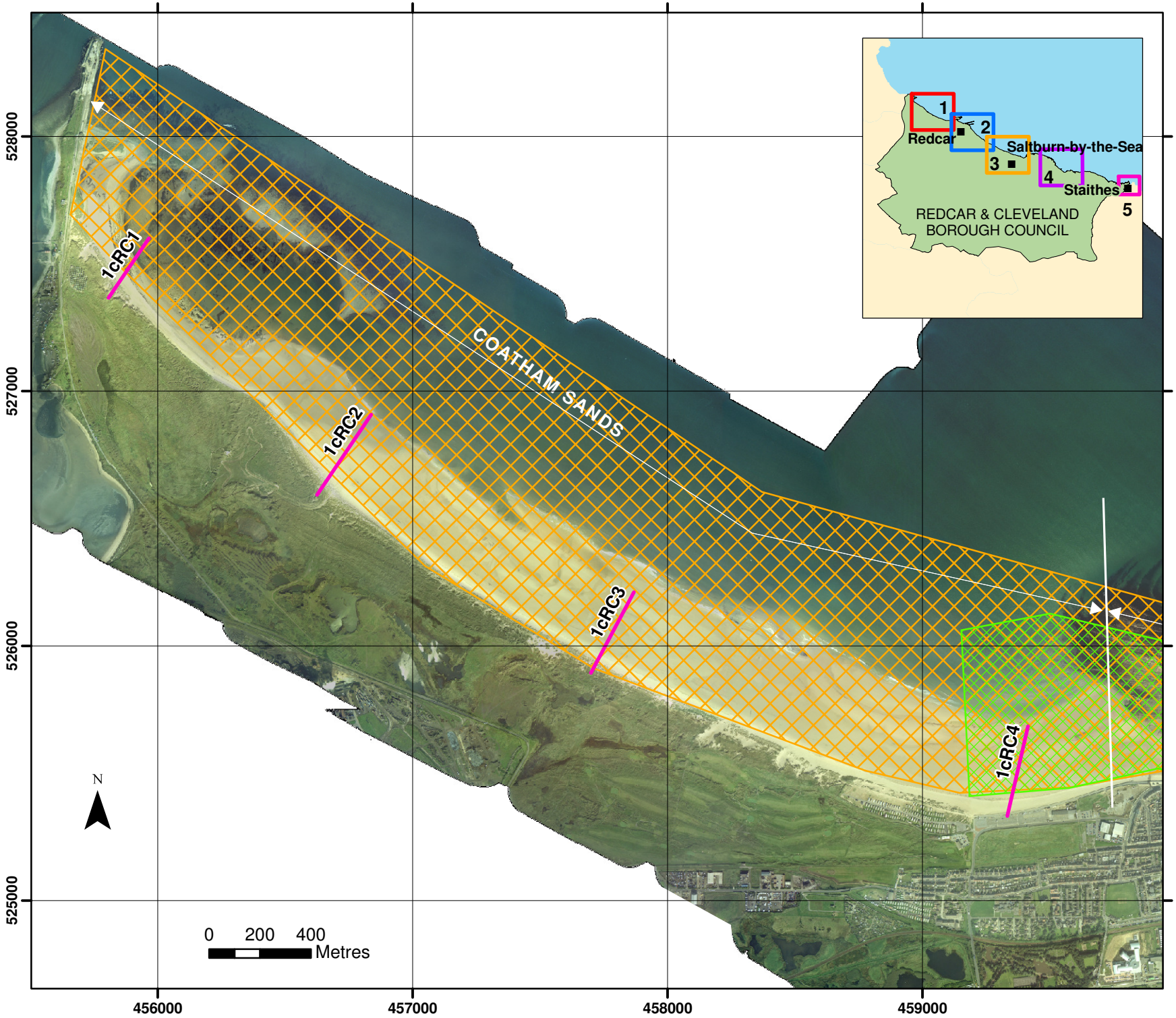
The Partial Measures survey was undertaken along this frontage between late February and April 2010. During the Coatham, Redcar, Marske and Saltburn surveys weather conditions were fine and breezy and the sea state was calm but with a sea fret. During the Skinningrove survey weather conditions were overcast and windy and the sea state was rough with a heavy swell. During the Staithes survey weather conditions were overcast and damp and the sea state was calm.

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);
- 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 Redcar & Cleveland and Scarborough Borough Councils.



SURVEY LOCATIONS

Topographic Profiles
- Annual
- Bi-Annual

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

Figure 1 - Map 1
Redcar & Cleveland Borough Council Frontage

Update Report 2
'Partial Measures' Survey 2010

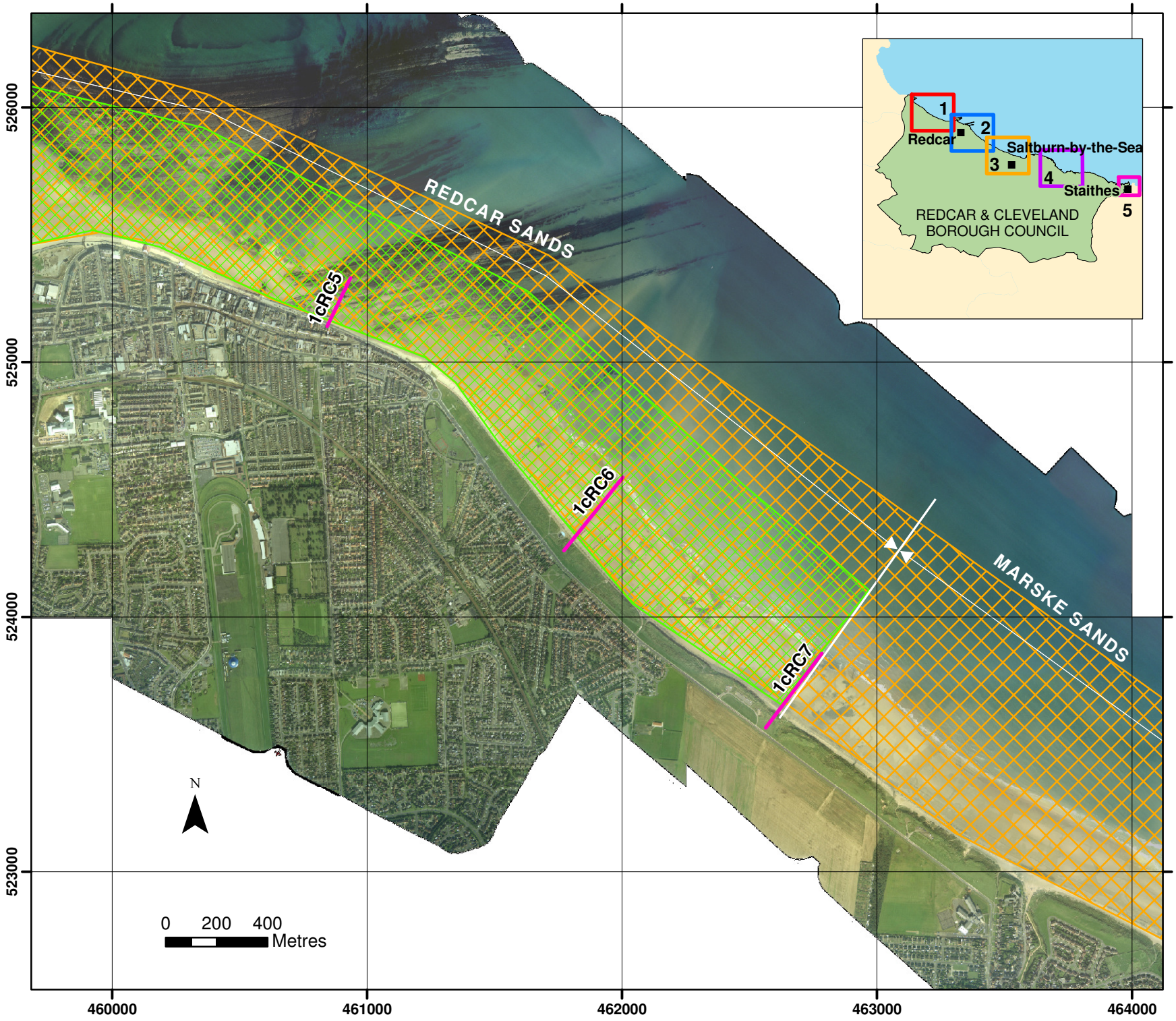
Drawing Scale 1:20,000 at A4

Drawn by:	TC	Date:	17/05/2010
Checked by:	NC	Date:	24/05/2010
Approved by:	NC	Date:	24/05/2010

ROYAL HASKONING
Royal Haskoning
Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE
Tel: +44 (0)191 211 1300
Fax: +44 (0)191 211 1313
www.royalhaskoning.com

Halcrow
Halcrow Group Ltd
Lyndon House
62 Hagley Road
Edgbaston
Birmingham
B16 8PE
Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.halcrow.com

I:\9T6403\Technical_Data\gis\figure\4_PARTIAL_measure_report_2010\7_Recar_Cleveland\Figure1_Redcar_Cleveland_Map1.mxd



SURVEY LOCATIONS

Topographic Profiles
- Annual
- Bi-Annual

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

Figure 1 - Map 2
Redcar & Cleveland Borough Council Frontage

Update Report 2
'Partial Measures' Survey 2010

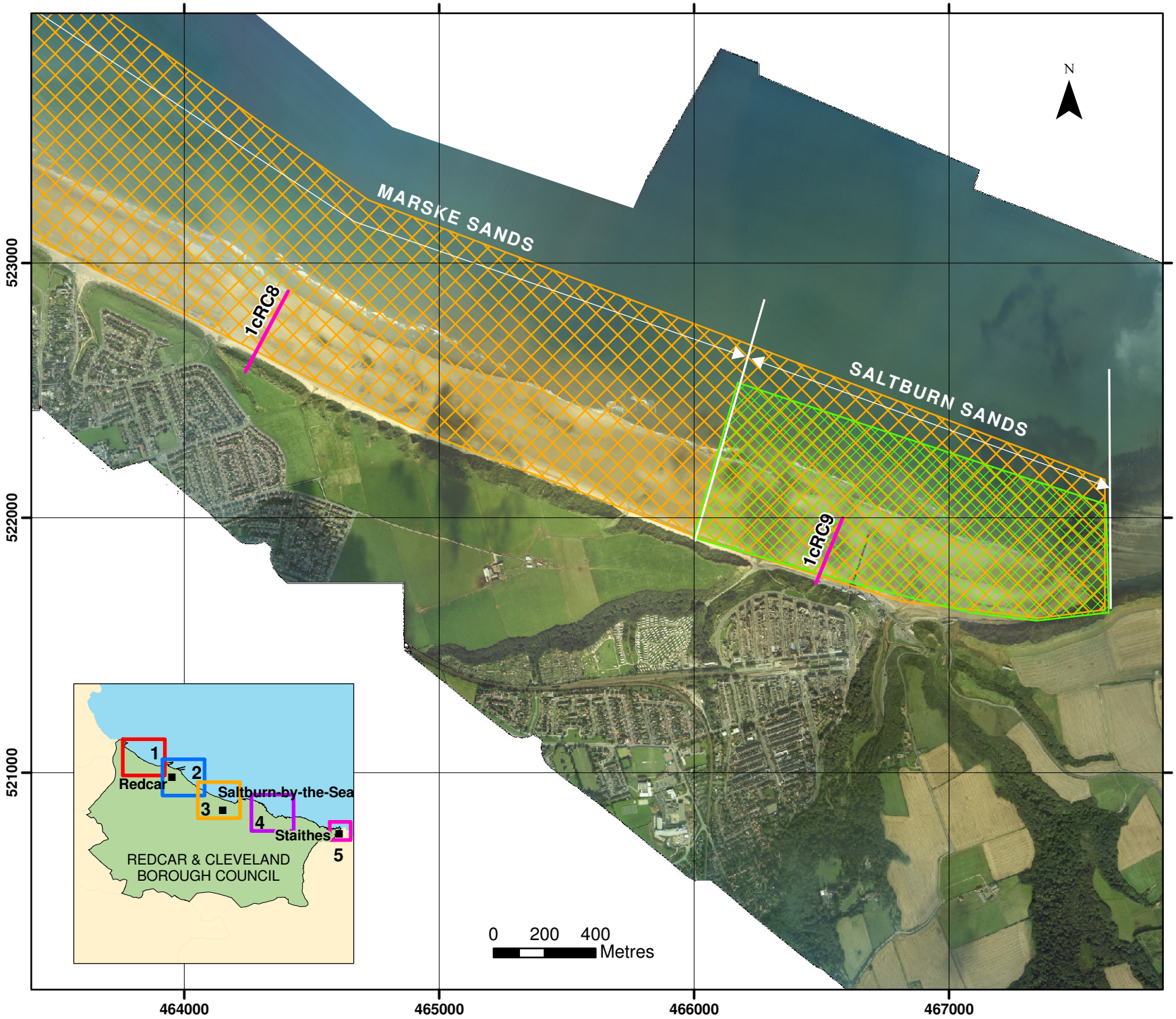
Drawing Scale 1:20,000 at A4

Drawn by:	TC	Date:	17/05/2010
Checked by:	NC	Date:	24/05/2010
Approved by:	NC	Date:	24/05/2010

ROYAL HASKONING
Royal Haskoning
Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE
Tel: +44 (0)191 211 1300
Fax: +44 (0)191 211 1313
www.royalhaskoning.com

Halcrow
Halcrow Group Ltd
Lyndon House
62 Hagley Road
Edgbaston
Birmingham
B16 8PE
Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.halcrow.com

I:\9T6403\Technical_Data\gis\figure\4_PARTIAL_measure_report_20107_Recar_Cleveland\Figure1_Redcar_Cleveland_Map2.mxd



SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

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

Figure 1 - Map 3
Redcar & Cleveland Borough Council Frontage

Update Report 2
'Partial Measures' Survey 2010

Drawing Scale 1:20,000 at A4

Drawn by:	TC	Date:	17/05/2010
Checked by:	NC	Date:	24/05/2010
Approved by:	NC	Date:	24/05/2010

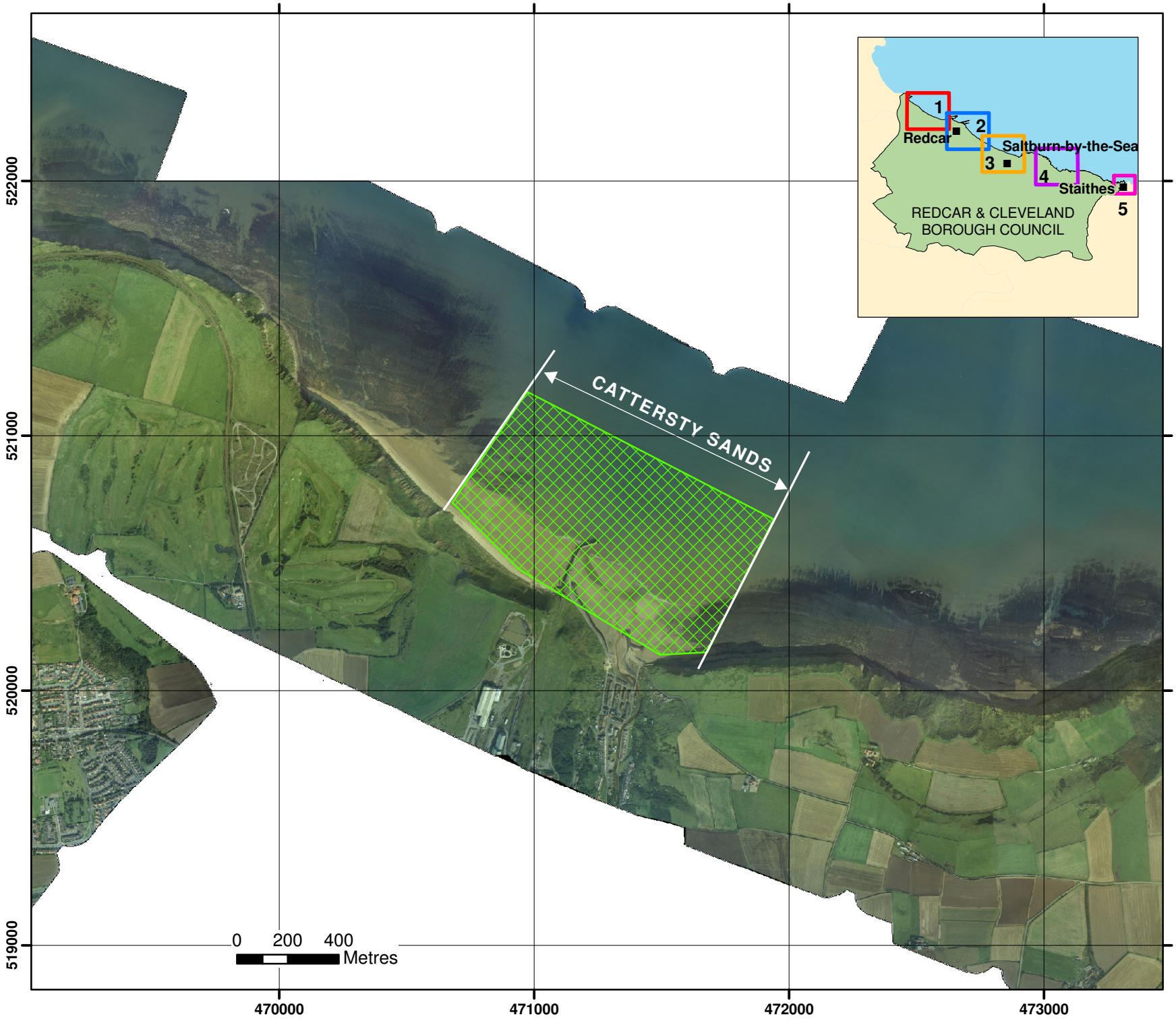
ROYAL HASKONING
Royal Haskoning
Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE

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

Halcrow
Halcrow Group Ltd
Lyndon House
62 Hagley Road
Edgbaston
Birmingham
B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.halcrow.com

I:\9T6403\Technical_Data\gis\figure\4_PARTIAL_measure_report_2010\7_Recar_Cleveland\Figure1_Redcar_Cleveland_Map3.mxd



SURVEY LOCATIONS

Topographic Profiles
- Annual
- Bi-Annual

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

Figure 1 - Map 4
Redcar & Cleveland Borough Council Frontage

Update Report 2
'Partial Measures' Survey 2010

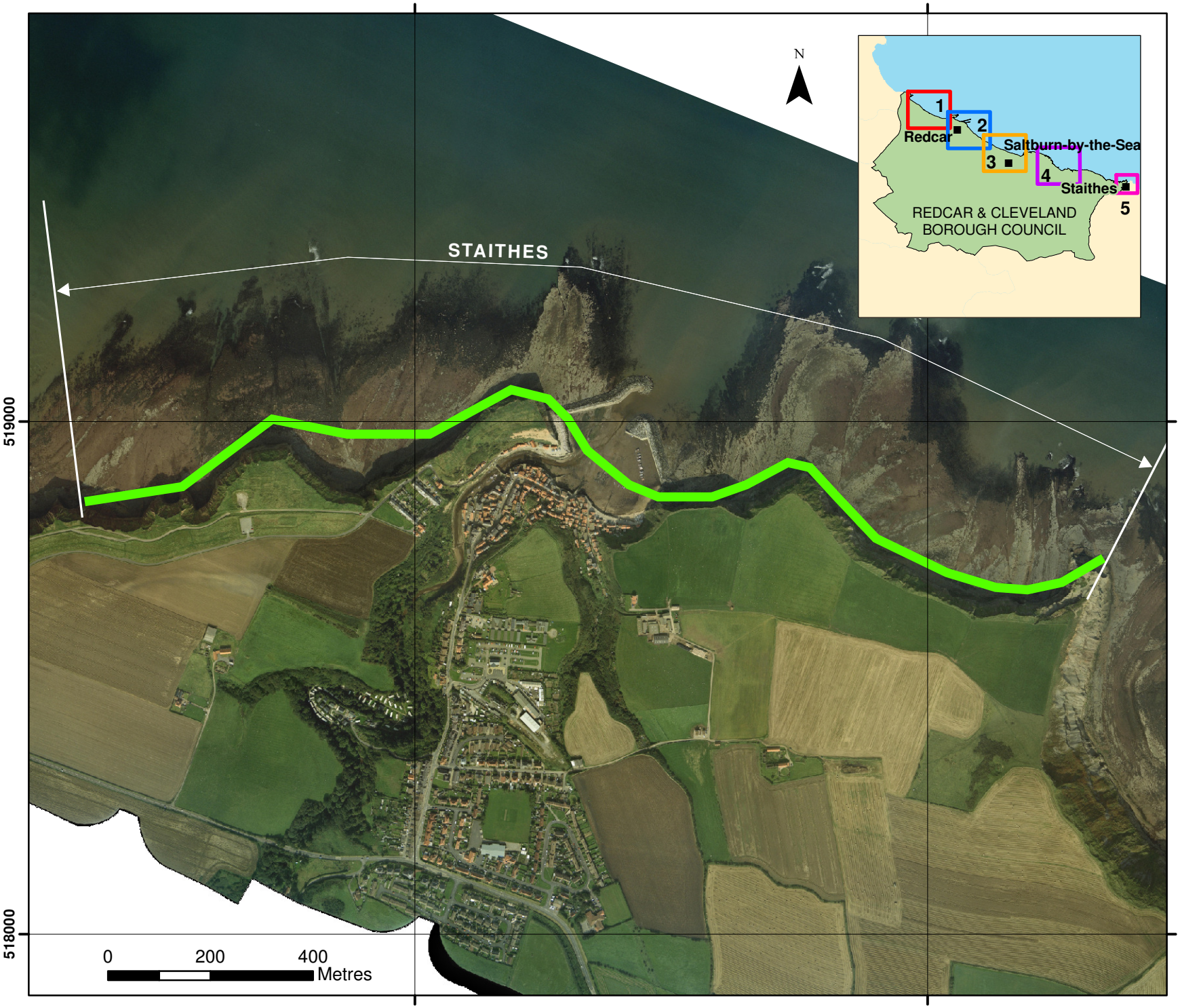
Drawing Scale 1:20,000 at A4

Drawn by:	TC	Date:	17/05/2010
Checked by:	NC	Date:	24/05/2010
Approved by:	NC	Date:	24/05/2010

ROYAL HASKONING
Royal Haskoning
Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE
Tel: +44 (0)191 211 1300
Fax: +44 (0)191 211 1313
www.royalhaskoning.com

Halcrow
Halcrow Group Ltd
Lyndon House
62 Hagley Road
Edgbaston
Birmingham
B16 8PE
Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.halcrow.com

I:\9T6403\Technical_Data\gis\figure\4_PARTIAL_measure_report_2010\7_Recar_Cleveland\Figure1_Redcar_Cleveland_Map4.mxd



SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

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

Figure 1 - Map 5
Redcar & Cleveland Borough Council Frontage

Update Report 2
'Partial Measures' Survey 2010

Drawing Scale 1:10,000 at A4

Drawn by:	TC	Date:	17/05/2010
Checked by:	NC	Date:	24/05/2010
Approved by:	NC	Date:	24/05/2010

ROYAL HASKONING
Royal Haskoning
Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE

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

Halcrow
Halcrow Group Ltd
Lyndon House
62 Hagley Road
Edgbaston
Birmingham
B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.halcrow.com

I:\9T6403\Technical_Data\gis\figure\4_PARTIAL_measure_report_2010\7_Recar_Cleveland\Figure1_Redcar_Cleveland_Map5.mxd

2. Analysis of Survey Data

2.1 Coatham Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
04-2010	**Beach Profiles:** Coatham Sands is covered by four beach profiles during the Partial Measures survey (RC1 to RC4; Appendix A). RC1 is located approximately 300m south of the South Gare Breakwater, immediately in the lee of the German Charlies. The profile showed some minor accretion at the crest of the dunes and stability to landward within the main body of dunes. Along the foreshore, the berm which was notable between MHWS and HAT in the September 2009 survey was flattened by April 2010, causing increases in foreshore levels at the toe of the dunes and along the lower foreshore. Along RC2 beach levels were quite healthy, showing an accretion of sand along much of the profile since the September 2009 survey. In contrast, lowering occurred along almost the entire length of RC3, recording levels similar to those observed in November 2008 during the first survey. The present survey included the lowest recorded levels to date at the toe of the dunes, but no significant erosion of the dune face. Along RC4 accretion of typically 0.15m but locally up to 0.35m occurred.	At the northern end of Coatham Sands, profile RC1 is sheltered to an extent by the presence of the German Charlies slag banks. The April 2010 survey was the first survey along this profile in which a beach berm was absent, suggesting wave-driven flattening of the profile. It is anticipated that the beach will slowly return to its characteristic profile, exhibiting a berm in future surveys. Further south the frontage is outwith the zone of protection of these features and there appears to have been some loss from RC3 and gain along both RC2 and RC4, perhaps indicating a longshore redistribution of sediment within the bay. It is interesting to note that the profile shape along RC2 to RC4 generally remains uniform, but the level increases or decreases relatively consistently across its length depending on the preceding wave and tidal conditions.

2.2 Redcar Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
04-2010	**Beach Profiles:** Redcar Sands is covered by three beach profiles (RC5 to RC7; Appendix A), with RC7 being approximately on the boundary with the Marske Sands area. Beach levels at the toe of the concrete wall and revetment along RC5 lowered by up to 0.45m between September 2009 and April 2010 to reach record low levels since surveys began in November 2008 in places. Further seaward along the profile, subtle increases and decreases in level occurred as a result of local redistribution of sediment. Along RC6 a notable volume of material was 'scalloped' from the beach at around MHWN and deposited at the toe of the dunes in the form of a new foredune. This meant that the profile exhibited a very different shape in April 2010 than has characteristically been observed in previous surveys. The high dune along RC7 exhibited little change between September 2009 and April 2010, although there was modest accretion along the mid foreshore. **Topographic Survey:** Redcar Sands is covered by a 6-monthly topographic survey. Data have been used to create a DGM (Appendix B – Map 1a). This DGM has been compared against the previous (September 2009) survey in Appendix B – Map 1b and the last Partial Measures survey (April 2009) in Appendix B – Map 1c. The DGMs show that considerable redistribution of sediment has occurred across Redcar Sands between September 2009 and April 2010. There appears to have been a general removal of material from the upper and mid beach and its deposition on the lower beach in the lee of Coatham Rocks and Redcar Rocks. Further south the lowering was more consistent across the whole foreshore width, with some material accumulation at the toe of the dunes. Further south still, towards Marske Sands, some accretion on the lower foreshore also occurred. The DGMs also show that the upper beach levels in April 2010 were generally lower than those recorded in April of the previous year.	RC5 is located in the lee of Redcar Rocks and is at the southerly end of a trend shown in the DGM of upper beach lowering (still notably exhibited along RC5) and lower beach accretion (not significantly exhibited along RC5). This suggests that the beach levels at the toe of the defences fronting much of Redcar town lowered notably over the winter of 2009/2010. South of RC5 towards Mackinlay Park, lowering continues to have been exhibited along much of the upper and all of the mid foreshore, but with a strip of material accumulation along the uppermost section of beach, as demonstrated by the new foredune development along RC6. In places the beach lowering continued all the way down the foreshore to low water, but on the north-easterly facing sections accretion along the lower foreshore occurred, suggesting some local redistribution along the Redcar Sands frontage. By comparing the April 2010 survey against the Partial Measures survey from the previous year, it can be concluded that the winter of 2009/2010 had a particularly notable effect on lowering beach levels along the upper foreshore.

2.3 Marske Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
04-2010	**Beach Profiles:** Marske Sands is covered by two beach profiles (RC7 to RC8; Appendix A), with RC7 being approximately on the boundary with the Redcar Sands area. RC7 is located along The Stray and has been discussed in Section 2.2. RC8 experienced some minor redistribution of sediment along the foreshore and general stability in the high backing dunes.	Marske Sands represents a continuation of Redcar Sands and seemed to be relatively stable, with changes confined to minor redistribution of sediments along the foreshore.

2.4 Saltburn Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
02-2010	**Beach Profiles:** Saltburn Sands is covered by one beach profile (RC9; Appendix A). Upper beach levels dropped notably in front of the sea wall, to record new record low levels since surveying began in November 2008. There was a reduction in level of some 0.3m observed at the toe of the defence. This lowering extended from the toe of the wall to a chainage of approximately 80m from the survey origin (i.e. a width of foreshore of approximately 60m. Seaward of this limit, the foreshore became more stable.	Beach changes along Saltburn Sands since September 2009 included relatively consistent lowering to the west of Skelton Beck, changes around the mouth of the beck seemingly caused by changes in its alignment across the foreshore, and modest accretion to the east. This suggests a degree of redistribution of sediment from west to east across Saltburn Sands. Saltburn Sands is in a broadly similar condition in February 2010 to that recorded in April of the preceding year, with differences mostly focused in the vicinity of the outfall channel of Skelton Beck.
	Topographic Survey: Saltburn Sands is covered by a 6-monthly topographic survey. Data have been used to create a DGM (Appendix B – Map 2a). This DGM has been compared against the previous (November 2008) survey in Appendix B – Map 2b and the last Partial Measures survey (April 2009) in Appendix B – Map 2c. The DGMs show that since September 2009 the foreshore to the west of Skelton Beck exhibited general lowering (as observed along profile RC9). There were further differences around the mouth of the beck, while to the east there was general modest accretion. Between April 2009 and February 2010, most differences were observed along the outfall channel of Skelton Beck. East of Skelton Beck the differences in beach levels were very modest increases by April 2010, while west of the beck the changes were relatively modest decreases.	

2.5 Cattersty Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
02-2010	**Topographic Survey:** Cattersty Sands is covered by a 6-monthly topographic survey. Data have been used to create a DGM (Appendix B – Map 3a). This DGM has been compared against the previous (November 2008) survey in Appendix B – Map 3b and the last Partial Measures survey (April 2009) in Appendix B – Map 3c. Appendix B - Map 3b reveals different behaviours either side of the Jetty. Cattersty Sands to the west shows a notable near linear band of erosion at the head of the beach, with two shore-normal erosional zones extending seawards. These are interspersed by areas of stasis/ slight deposition. Collectively this represents a net seaward transfer of beach materials over the winter period. To the east of the Jetty the patterns of change are more irregular, with large areas of slight erosion, mainly centred around the river mouth. There are further areas of erosion away from the river, interspersed with a few areas of beach gain, mainly at the beach head.	This frontage shows beach change influenced by both marine and fluvial processes. The approximate shore-parallel change to the west are indicative of the transition from a swell (summer) to storm (winter) dominated beach profile. In contrast, fluvial impacts are normal to the coastline, resulting in different patterns of beach/ river mouth change.

2.6 Staithes

Survey Date	Description of Changes Since Last Survey	Interpretation
02-2010	**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 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. 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.	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 0.2m to 2.1m (±0.1 m due to survey accuracy). Points 2, 4, and 13 have consistently registered cliff erosion in each cliff top survey to date. Less consistent, but repeated, recession measurements are also determined for points 1 and 5. These survey locations are principally located in the west adjacent to Cowbar Lane. Seven locations (points 3, 9, 10, 12, 16, 17, 19) have shown an increase in distance to the cliff edge. 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.

3. Problems Encountered and Uncertainty in Analysis

The topographic surveys along Redcar Sands and Saltburn Sands revealed that interpreting changes from the profile surveys alone may have led to under-representation of some trends. This is because some profile lines are located just at the boundary of a trend across a wider frontage and only capture the tapered-out effects of that trend.

The cliff top surveys at Staithes are assumed to have a limit of accuracy of ± 0.1 m due to the techniques used. At a sizeable number of locations 'apparent' cliff advance is calculated, which is highly unlikely (except under 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. 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.

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

It is understood that Redcar & Cleveland Borough Council is presently applying to the Environment Agency for funding to commission repeat terrestrial laser scan surveys of cliff faces and cliff tops at Cowbar. The increased accuracy and resolution of data from laser scanning would enable a very detailed appreciation of changing conditions, and thereby further inform management planning.

5. Conclusions and Areas of Concern

- The German Charlies slag banks are providing a degree of shelter to the northern section of Coatham Sands. However, for the first survey, the profile in the lee of the German Charlies did not exhibit a berm, suggesting some storm flattening of the profile.

- Along Redcar Sands the beach morphology continues to be variable, with a combination of cross-shore and longshore redistributions occurring dependent upon the governing tidal and wave conditions. It is envisaged that future surveys will show continued variability, but a longer term series of surveys should reveal any trends of erosion or accretion underlying the seasonal variability.

- Marske Sands showed relately stability along the high dunes covered by the two beach profiles, and only modest changes along the foreshore.

- Saltburn Sands showed a degree of redistribution of sediment from west to east, with most notable changes being lowering at the toe of the sea wall to the west of Skelton Burn, and foreshore changes associated with varying channel alignment of the burn itself.

- Cattersty Sands (Skinningrove) experienced beach change typical of seasonal marine processes, and also showed the influence of the outflowing river. The patterns of beach change are therefore more complicated than would be anticipated by coastal processes alone.

- The Staithes frontage has shown areas of localised cliff top stasis, advance (probably due to the limitations of the survey methodology), and clear and ongoing recession. Hotspots for cliff top retreat at this time are principally to the west, adjacent to Cowbar Lane, and the cliff west of Penny Steel.

Appendices

Appendix A

Beach Profiles

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

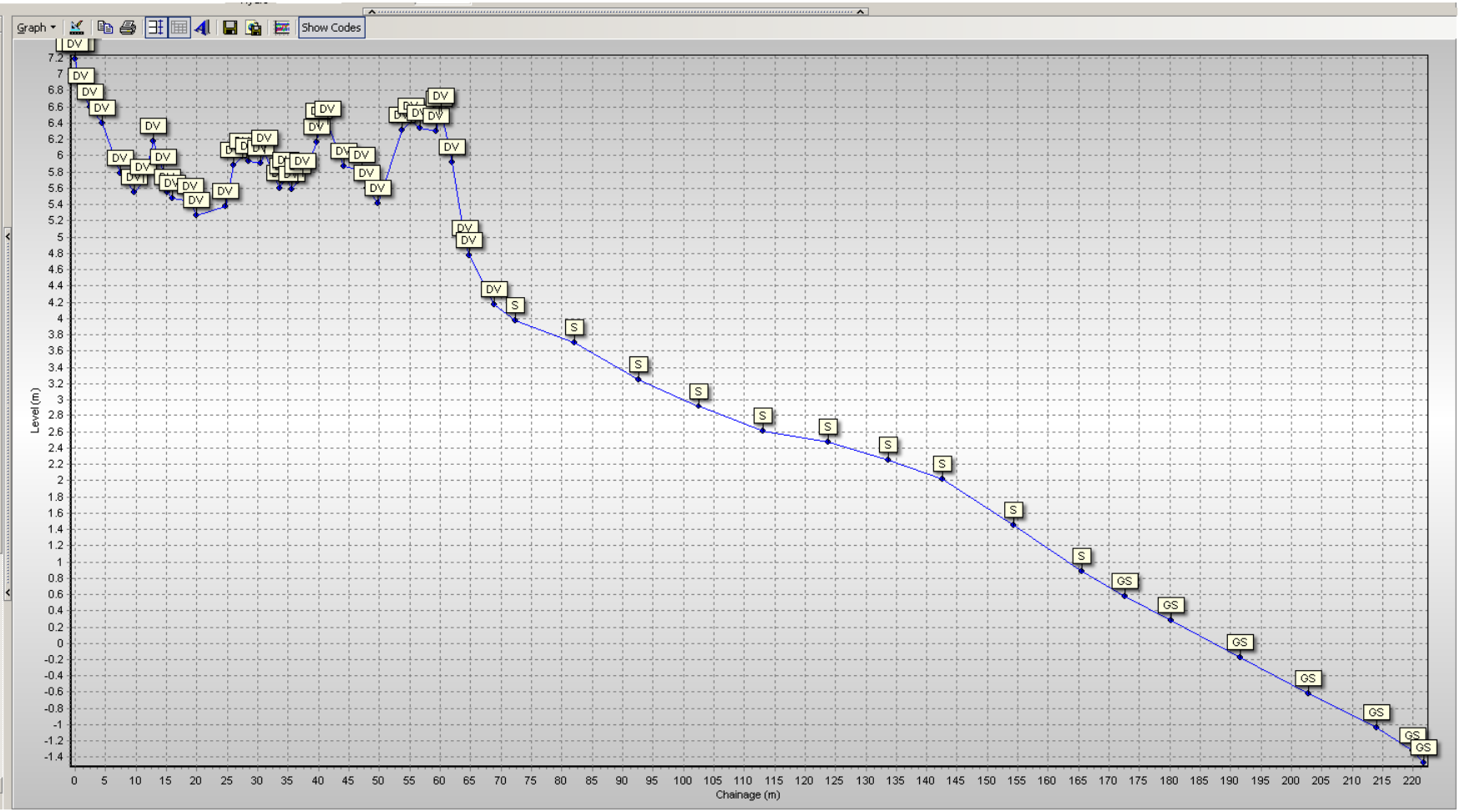
Code	Description
M	Mud
S	Sand
G	Gravel
GS	Gravel & Sand
GM	Gravel & Mud
MS	Mud & Sand
B	Boulders
R	Rock
SD	Sea Defence
SM	Salt Marsh
GR	Grass
D	Dune (non-vegetated)
DV	Dune (vegetated)
F	Forested
X	Mixture
FB	Obstruction
CT	Cliff Top
CE	Cliff Edge
CF	Cliff Face
SH	Shell
W	Water Body
ZZ	Unknown

Appendices

Redcar

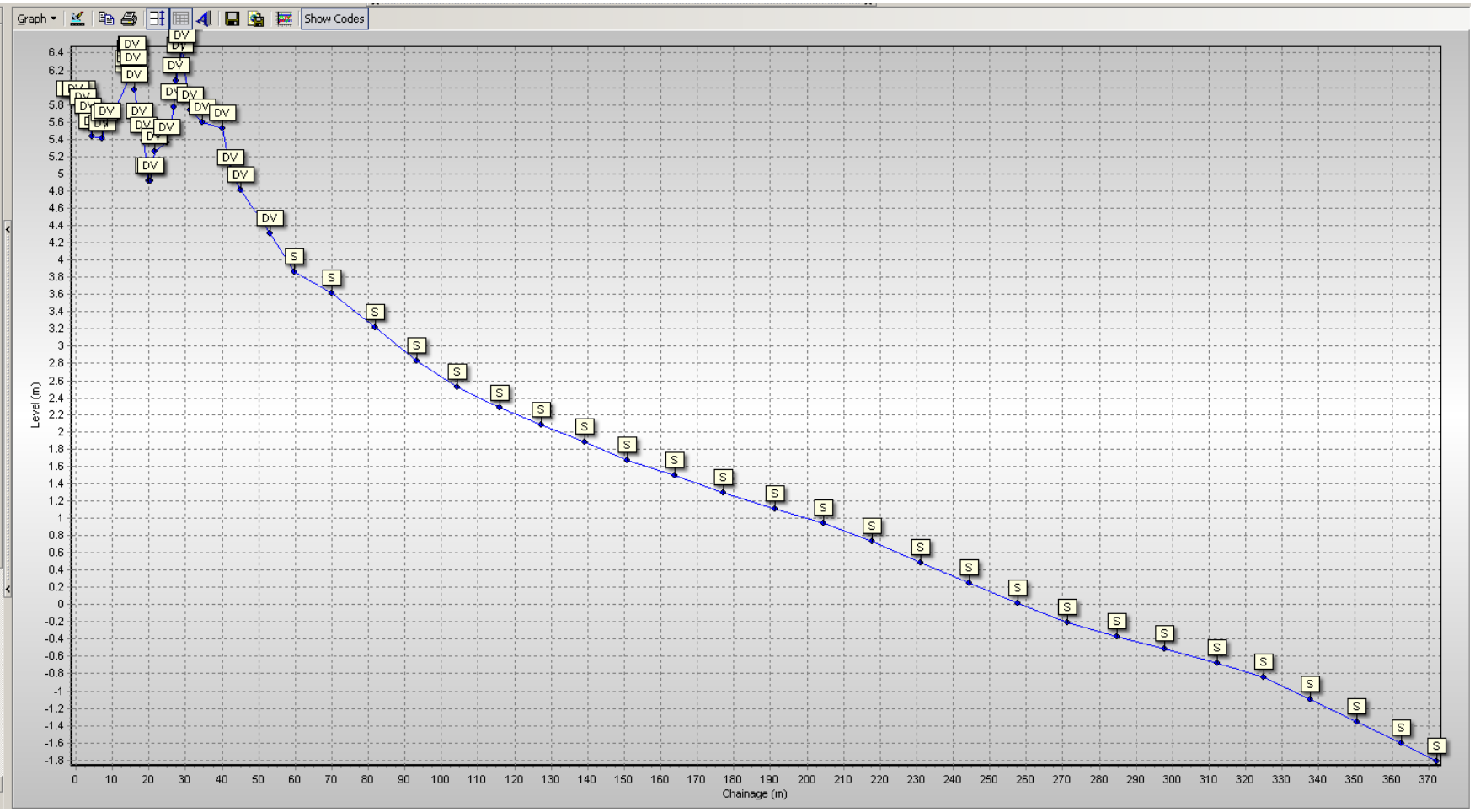
1cRC1 – 14/04/2010

Chainage	Level	Code
0.000	7.187	
0.052	7.187	DV
1.066	6.792	DV
2.552	6.599	DV
4.421	6.401	DV
7.379	5.783	DV
9.771	5.550	DV
11.243	5.668	DV
12.787	6.179	DV
14.440	5.798	DV
15.210	5.547	DV
15.968	5.472	DV
19.010	5.442	DV
19.943	5.268	DV
24.669	5.374	DV
25.977	5.880	DV
27.462	5.998	DV
28.534	5.928	DV
30.504	5.905	DV
31.134	6.033	DV
33.710	5.593	DV
34.144	5.690	DV
34.611	5.762	DV
35.571	5.588	DV
36.671	5.681	DV
37.360	5.742	DV
39.714	6.163	DV
40.021	6.359	DV
41.609	6.383	DV
44.230	5.869	DV
47.169	5.823	DV
47.964	5.601	DV
49.828	5.414	DV
53.725	6.314	DV
55.173	6.424	DV
56.761	6.337	DV
59.291	6.306	DV
59.766	6.510	DV
60.172	6.545	DV
61.918	5.915	DV
64.086	4.922	DV
64.847	4.780	DV



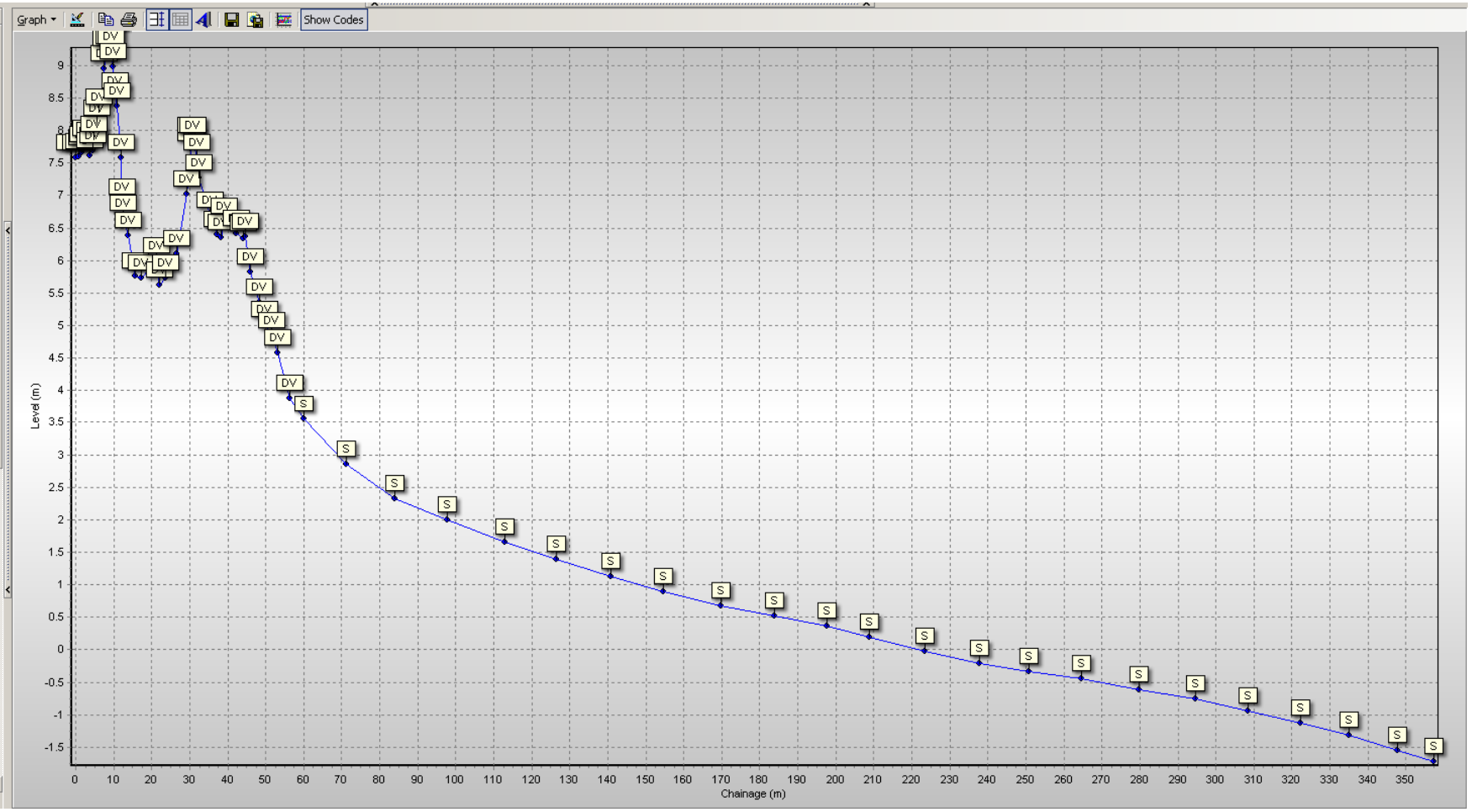
1cRC2 – 14/04/2010

Chainage	Level	Code
0.000	5.813	
0.033	5.813	DV
1.957	5.708	DV
3.276	5.608	DV
4.357	5.428	DV
7.109	5.413	DV
7.694	5.523	DV
8.509	5.552	DV
14.270	6.093	DV
14.466	6.157	DV
14.858	6.202	DV
14.974	6.282	DV
15.213	6.320	DV
15.570	6.321	DV
15.723	6.175	DV
16.154	5.976	DV
17.561	5.550	DV
18.638	5.381	DV
19.940	4.917	DV
20.355	4.914	DV
21.635	5.255	DV
24.870	5.365	DV
26.732	5.775	DV
27.368	6.079	DV
28.613	6.311	DV
29.053	6.429	DV
31.229	5.734	DV
34.490	5.596	DV
40.148	5.523	DV
42.427	5.006	DV
45.140	4.810	DV
53.099	4.307	DV
59.712	3.864	S
70.155	3.615	S
81.919	3.211	S
93.262	2.830	S
104.253	2.526	S
115.939	2.279	S
127.339	2.074	S
139.095	1.880	S
150.886	1.672	S
163.860	1.494	S



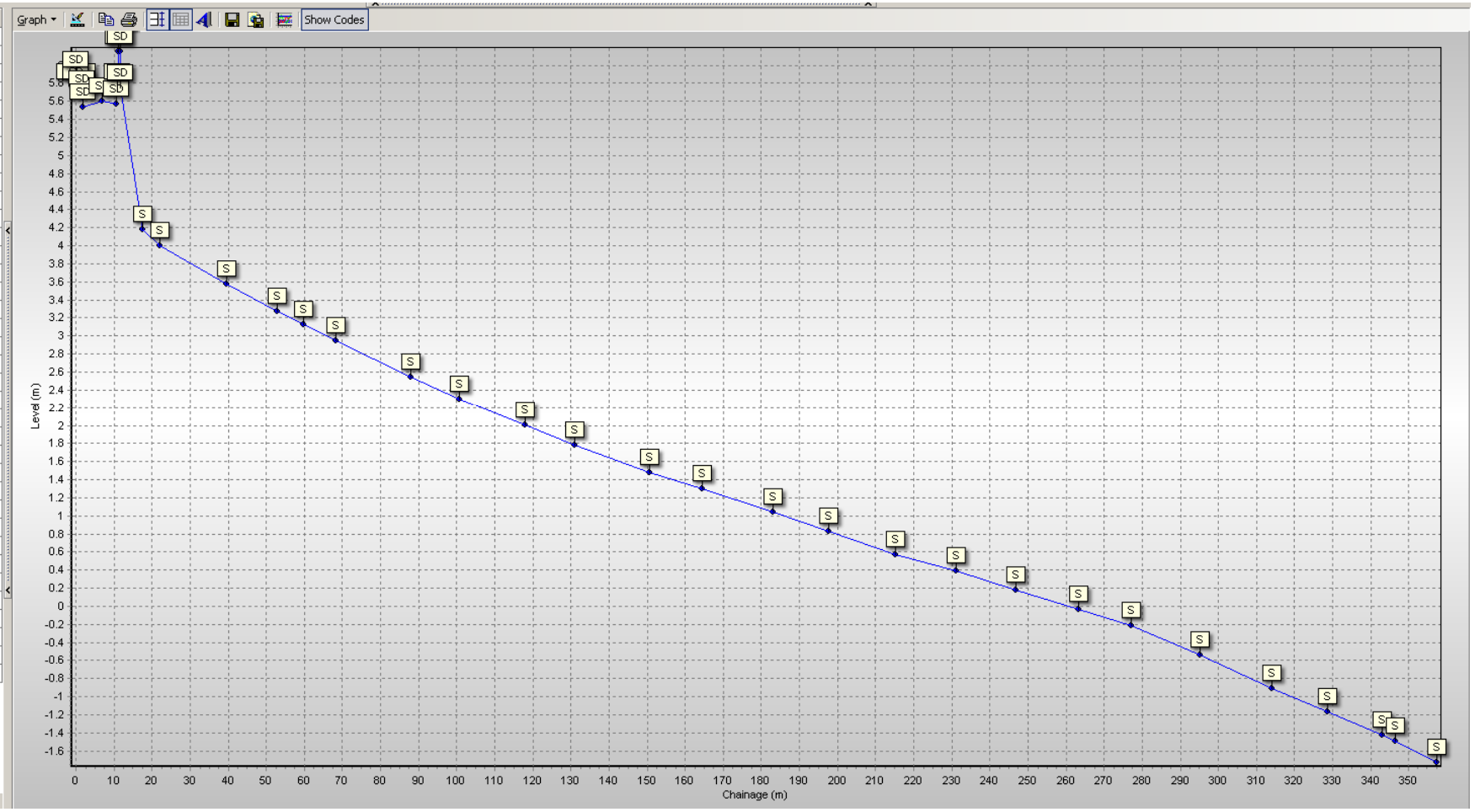
1cRC3 – 14/04/2010

Chainage	Level	Code
0.000	7.586	
0.023	7.586	DV
0.743	7.604	DV
1.628	7.654	DV
1.934	7.707	DV
2.701	7.807	DV
3.659	7.770	DV
3.724	7.615	DV
4.503	7.687	DV
4.688	7.857	DV
5.450	8.115	DV
6.172	8.287	DV
7.398	8.949	DV
7.959	9.192	DV
8.742	9.216	DV
9.378	9.209	DV
9.805	8.983	DV
10.426	8.539	DV
11.006	8.372	DV
11.944	7.589	DV
12.222	6.905	DV
12.476	6.655	DV
13.906	6.386	DV
15.621	5.762	DV
17.169	5.734	DV
21.216	5.993	DV
22.082	5.627	DV
23.729	5.733	DV
26.488	6.111	DV
29.097	7.018	DV
30.207	7.716	DV
30.284	7.848	DV
30.938	7.850	DV
31.919	7.586	DV
32.466	7.266	DV
35.227	6.690	DV
37.259	6.394	DV
38.337	6.351	DV
39.087	6.610	DV
42.358	6.416	DV
44.073	6.336	DV
44.696	6.364	DV



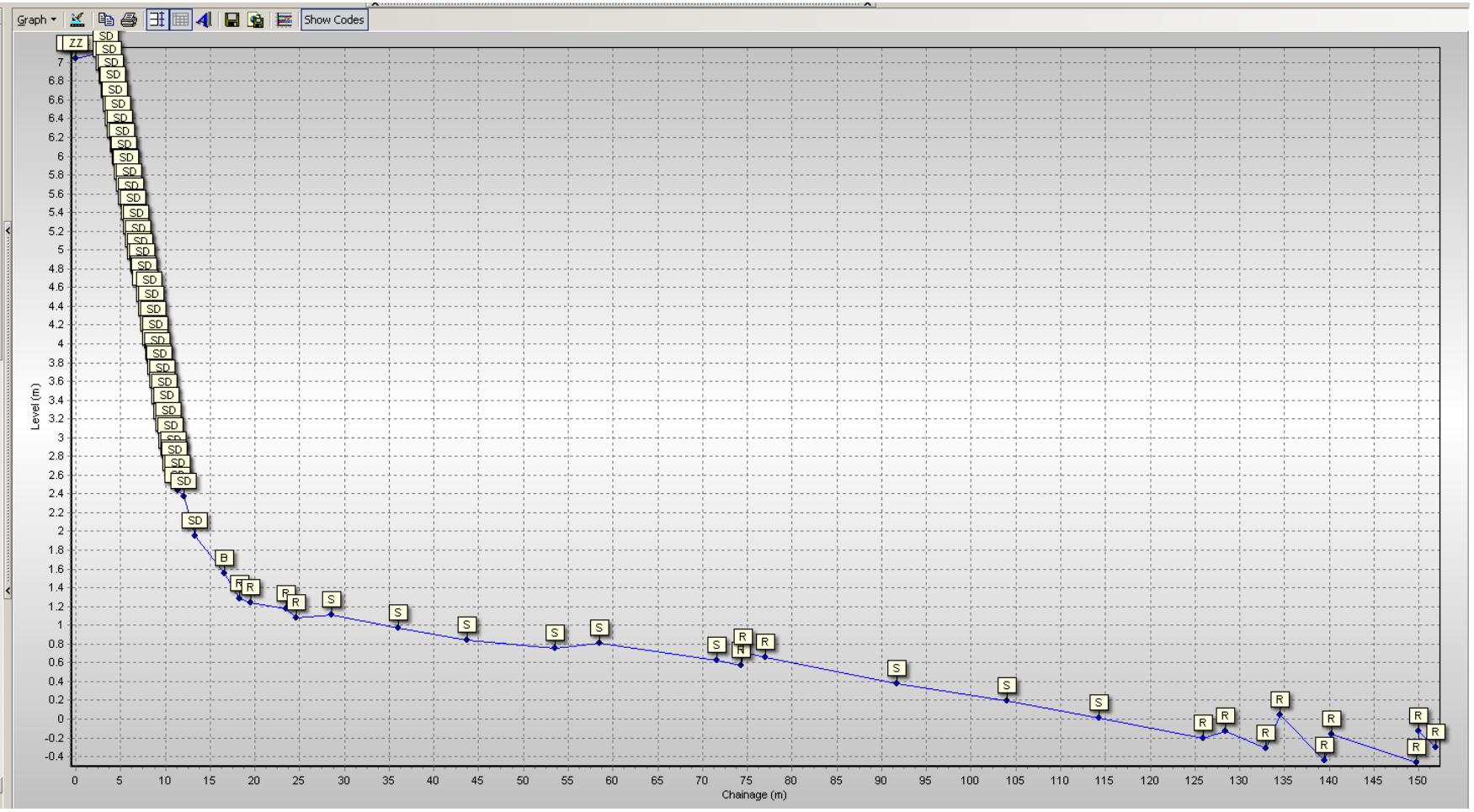
1cRC4 – 14/04/2010

Chainage	Level	Code
0.000	5.764	
0.008	5.764	SD
0.009	5.894	SD
1.651	5.681	SD
1.736	5.531	SD
6.801	5.605	SD
10.737	5.569	SD
10.872	5.758	SD
11.030	6.152	SD
11.564	6.153	SD
11.571	5.744	SD
17.656	4.185	S
22.058	4.004	S
39.667	3.572	S
52.781	3.275	S
59.751	3.124	S
68.240	2.942	S
87.824	2.539	S
100.611	2.302	S
117.903	2.006	S
131.098	1.778	S
150.574	1.475	S
164.578	1.298	S
183.158	1.042	S
197.638	0.829	S
215.278	0.575	S
231.124	0.391	S
246.858	0.174	S
263.263	-0.030	S
277.088	-0.214	S
295.218	-0.541	S
313.968	-0.906	S
328.608	-1.162	S
343.005	-1.429	S
346.354	-1.496	S
357.345	-1.727	S



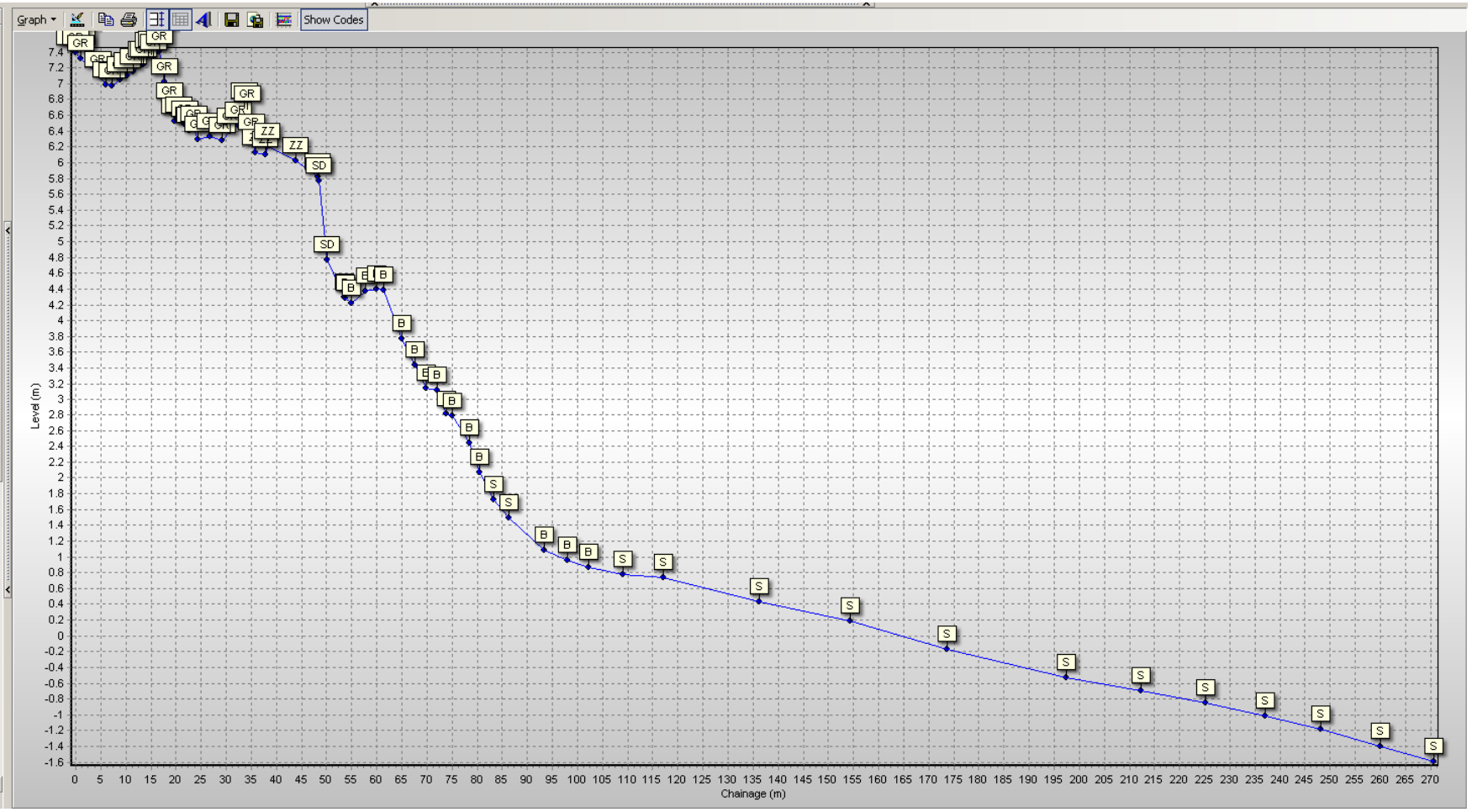
1cRC5 – 14/04/2010

Chainage	Level	Code
0.000	7.044	
0.012	7.044	ZZ
3.425	7.116	SD
3.438	6.978	SD
3.716	6.973	SD
3.726	6.840	SD
3.943	6.840	SD
4.072	6.699	SD
4.187	6.710	SD
4.236	6.549	SD
4.457	6.549	SD
4.478	6.390	SD
4.708	6.398	SD
4.722	6.245	SD
4.966	6.242	SD
4.986	6.111	SD
5.217	6.105	SD
5.296	5.962	SD
5.464	5.961	SD
5.496	5.828	SD
5.702	5.819	SD
5.773	5.675	SD
5.963	5.670	SD
5.982	5.537	SD
6.216	5.523	SD
6.231	5.398	SD
6.444	5.388	SD
6.525	5.245	SD
6.722	5.230	SD
6.749	5.088	SD
6.980	5.072	SD
7.025	4.944	SD
7.213	4.927	SD
7.239	4.819	SD
7.465	4.816	SD
7.514	4.687	SD
7.715	4.666	SD
7.760	4.535	SD
8.231	4.516	SD
8.258	4.365	SD
8.475	4.364	SD
8.508	4.215	SD



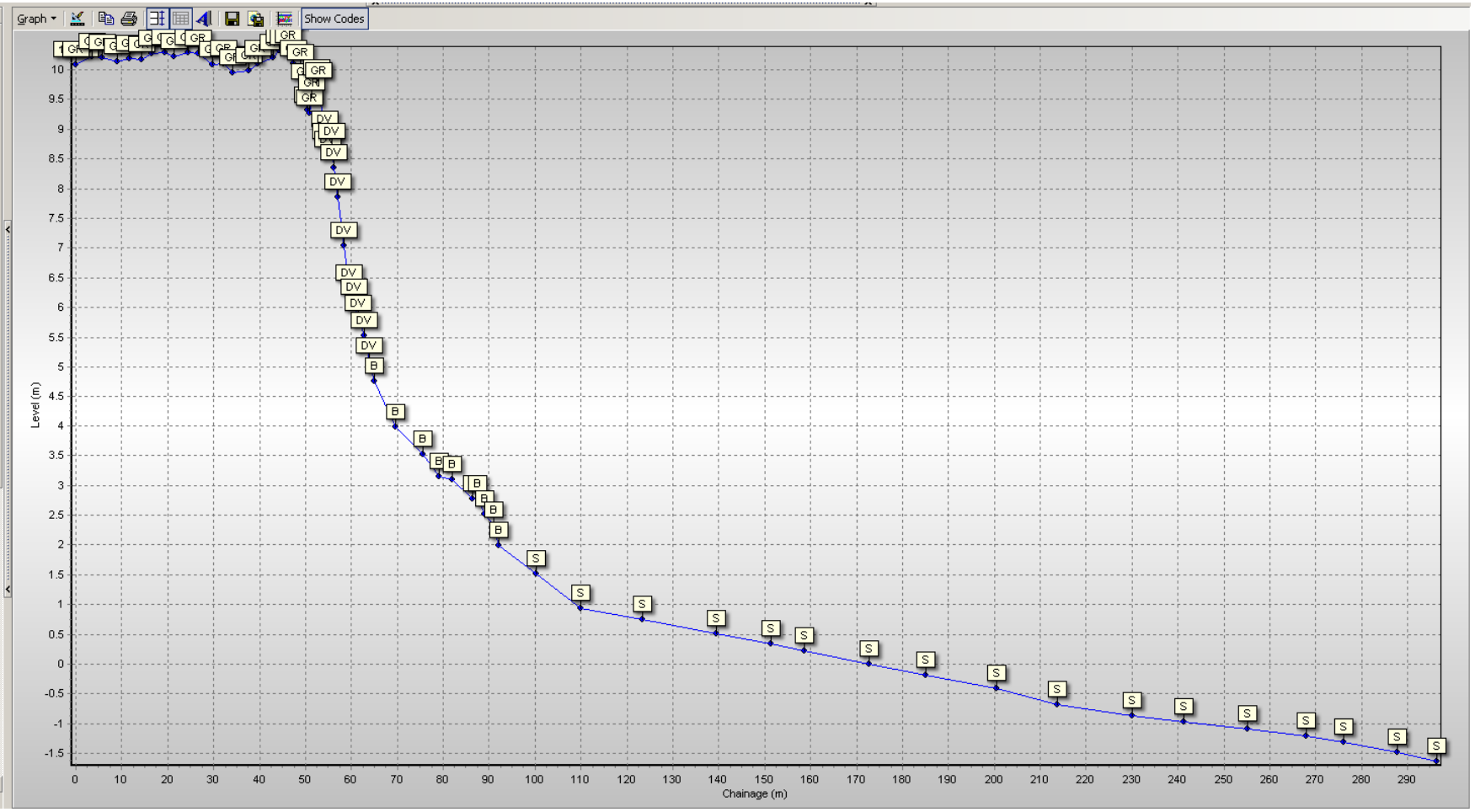
1cRC6 – 14/04/2010

Chainage	Level	Code
0.000	7.395	
0.034	7.395	GR
1.046	7.313	GR
4.347	7.115	GR
5.961	6.990	GR
7.162	6.972	GR
8.850	7.047	GR
10.323	7.098	GR
11.468	7.153	GR
13.162	7.242	GR
13.554	7.246	GR
14.503	7.352	GR
15.162	7.365	GR
15.589	7.329	GR
16.717	7.407	GR
17.654	7.025	GR
18.642	6.722	GR
19.681	6.523	GR
20.611	6.541	GR
21.821	6.491	GR
22.544	6.415	GR
22.649	6.414	GR
23.558	6.422	GR
24.415	6.298	GR
26.671	6.326	GR
29.123	6.281	GR
30.887	6.391	GR
32.387	6.469	GR
33.560	6.721	GR
34.308	6.679	GR
35.035	6.318	GR
35.912	6.131	ZZ
37.760	6.104	ZZ
38.289	6.199	ZZ
43.806	6.019	ZZ
48.214	5.820	SD
48.481	5.768	SD
50.076	4.776	SD
53.532	4.294	B
53.648	4.285	B
54.996	4.225	B
57.757	4.371	B



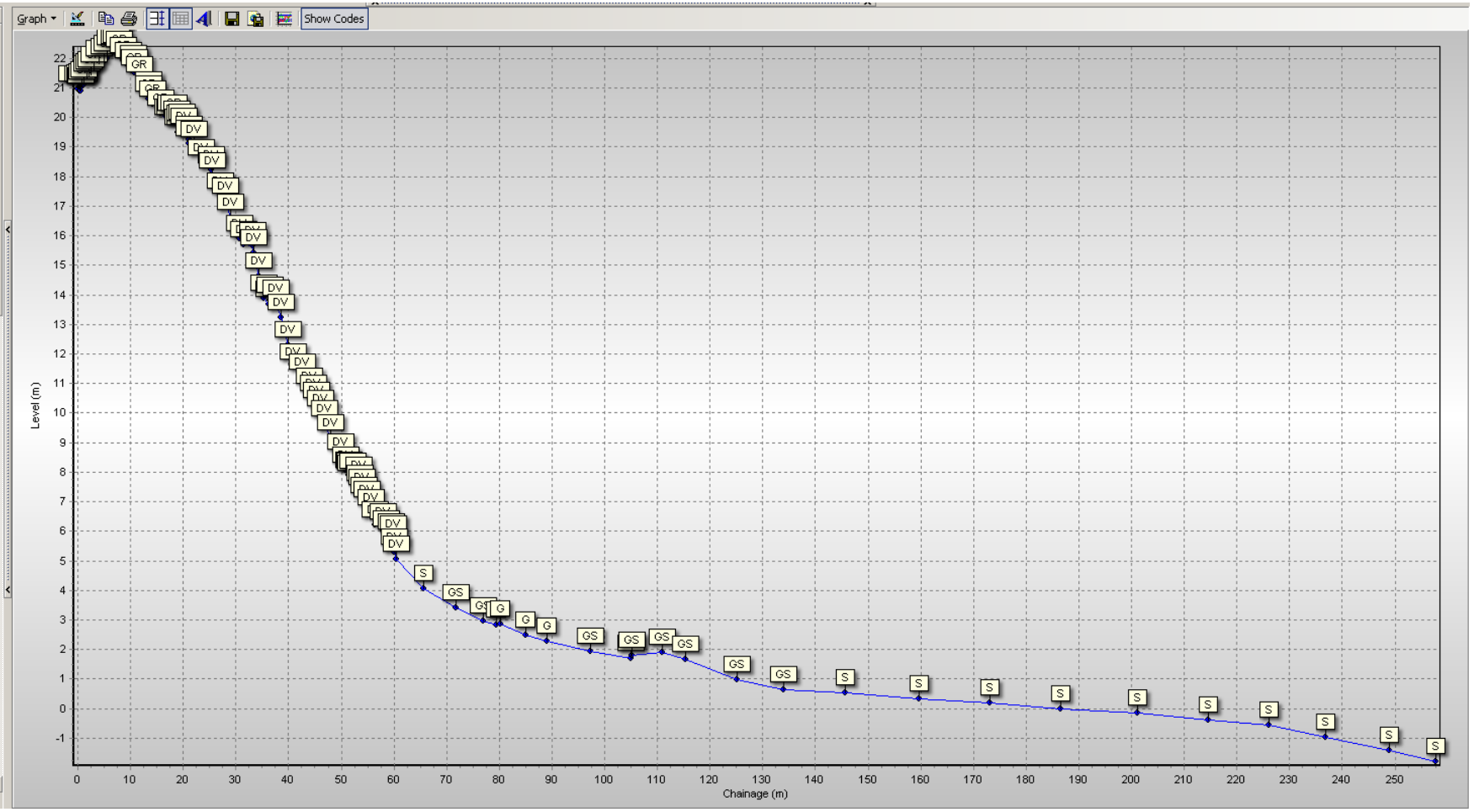
1cRC7 – 14/04/2010

Chainage	Level	Code
0.000	10.083	
0.006	10.083	GR
3.598	10.216	GR
5.742	10.199	GR
8.925	10.127	GR
11.637	10.178	GR
14.397	10.170	GR
16.471	10.272	GR
19.291	10.286	GR
21.271	10.225	GR
24.354	10.296	GR
26.636	10.265	GR
29.735	10.091	GR
32.239	10.093	GR
34.117	9.952	GR
37.668	9.982	GR
39.707	10.105	GR
42.894	10.209	GR
44.228	10.322	GR
45.230	10.280	GR
46.239	10.317	GR
47.339	10.106	GR
48.897	10.038	GR
49.696	9.706	GR
50.460	9.313	GR
50.829	9.263	GR
51.382	9.531	GR
52.374	9.782	GR
52.967	9.723	GR
54.161	8.916	DV
54.451	8.712	DV
54.923	8.578	DV
55.686	8.705	DV
56.144	8.342	DV
57.010	7.850	DV
58.342	7.035	DV
59.572	6.321	DV
60.661	6.081	DV
61.528	5.817	DV
62.806	5.529	DV
63.937	5.107	DV
65.022	4.758	B



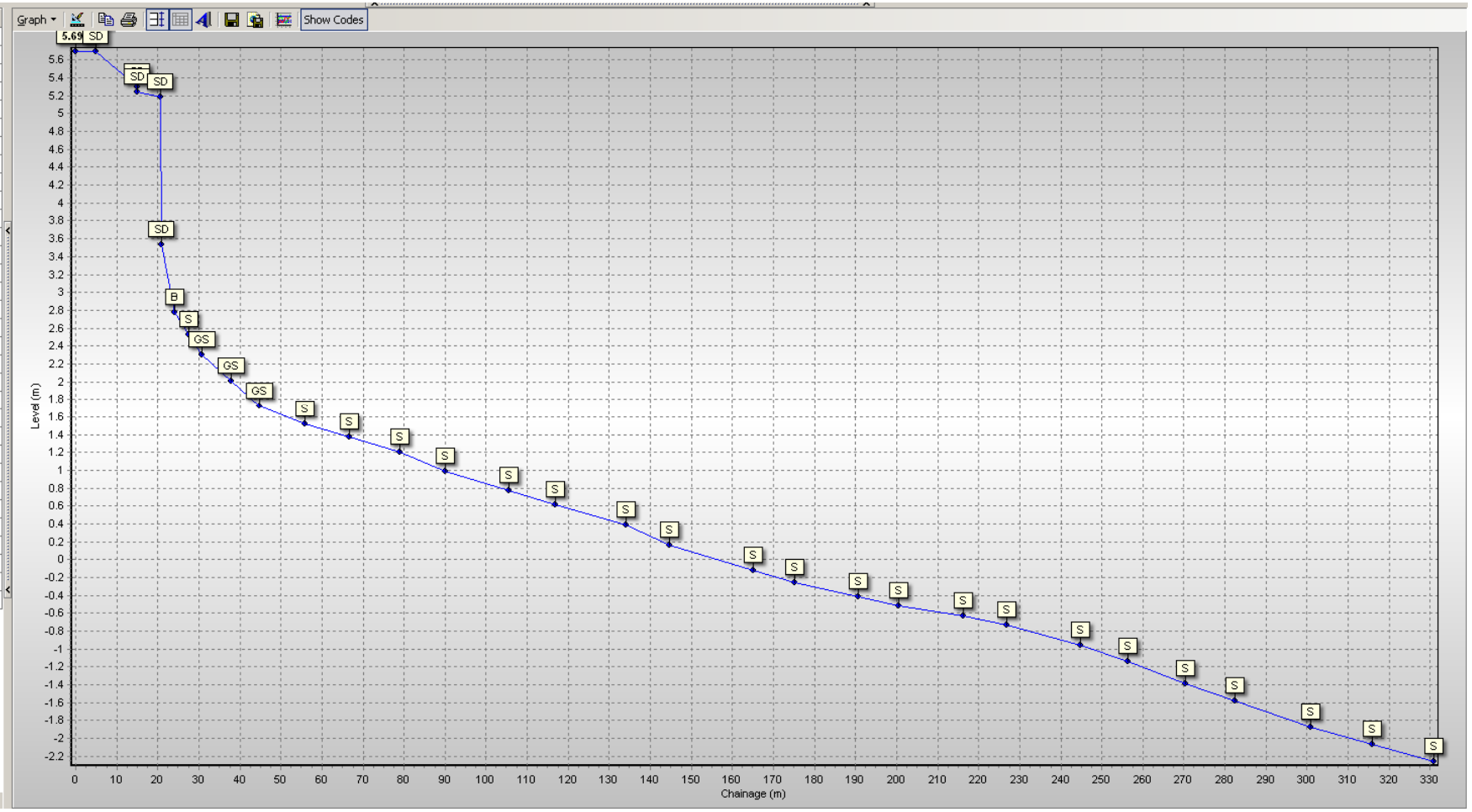
1cRC8 – 14/04/2010

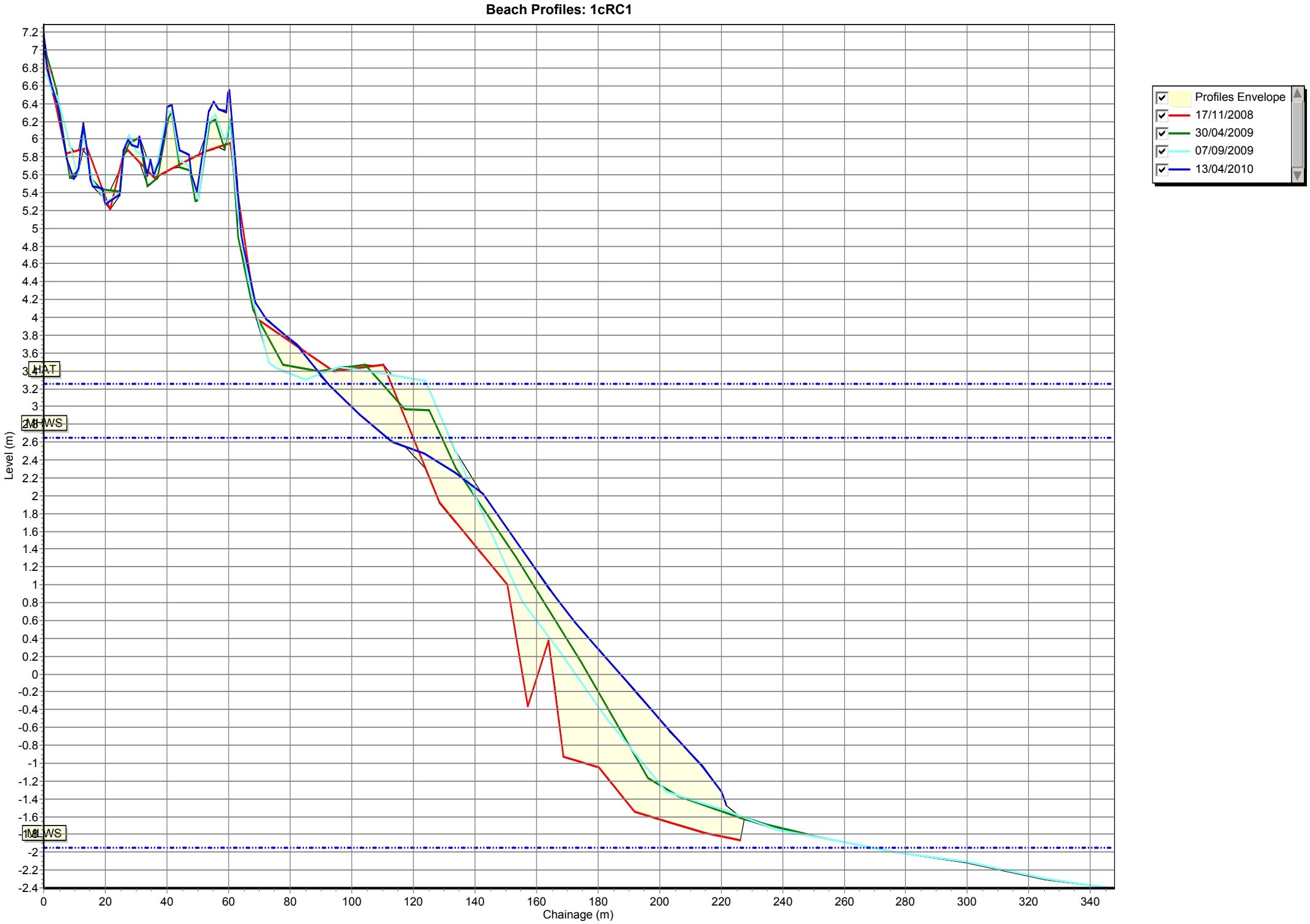
Chainage	Level	Code
0.000	20.960	
0.011	20.960	GR
0.316	20.995	GR
0.366	20.909	GR
0.664	20.902	GR
0.769	21.033	GR
1.193	21.097	GR
1.707	21.292	GR
2.136	21.388	GR
2.582	21.438	GR
3.154	21.629	GR
3.991	21.814	GR
4.994	21.900	GR
5.642	22.001	GR
6.072	22.188	GR
6.929	22.243	GR
7.282	22.267	GR
7.795	22.136	GR
8.553	21.935	GR
9.606	21.751	GR
10.487	21.655	GR
10.800	21.508	GR
11.752	21.273	GR
13.341	20.767	GR
13.444	20.628	GR
14.165	20.439	GR
15.727	20.142	GR
17.054	19.839	GR
17.423	19.828	GR
17.731	19.965	GR
18.202	19.968	GR
18.857	19.776	GR
19.041	19.510	DV
19.397	19.503	DV
19.399	19.639	DV
19.735	19.683	DV
20.168	19.521	DV
21.021	19.251	DV
21.153	19.115	DV
22.047	19.082	DV
23.463	18.473	DV
25.297	18.216	DV

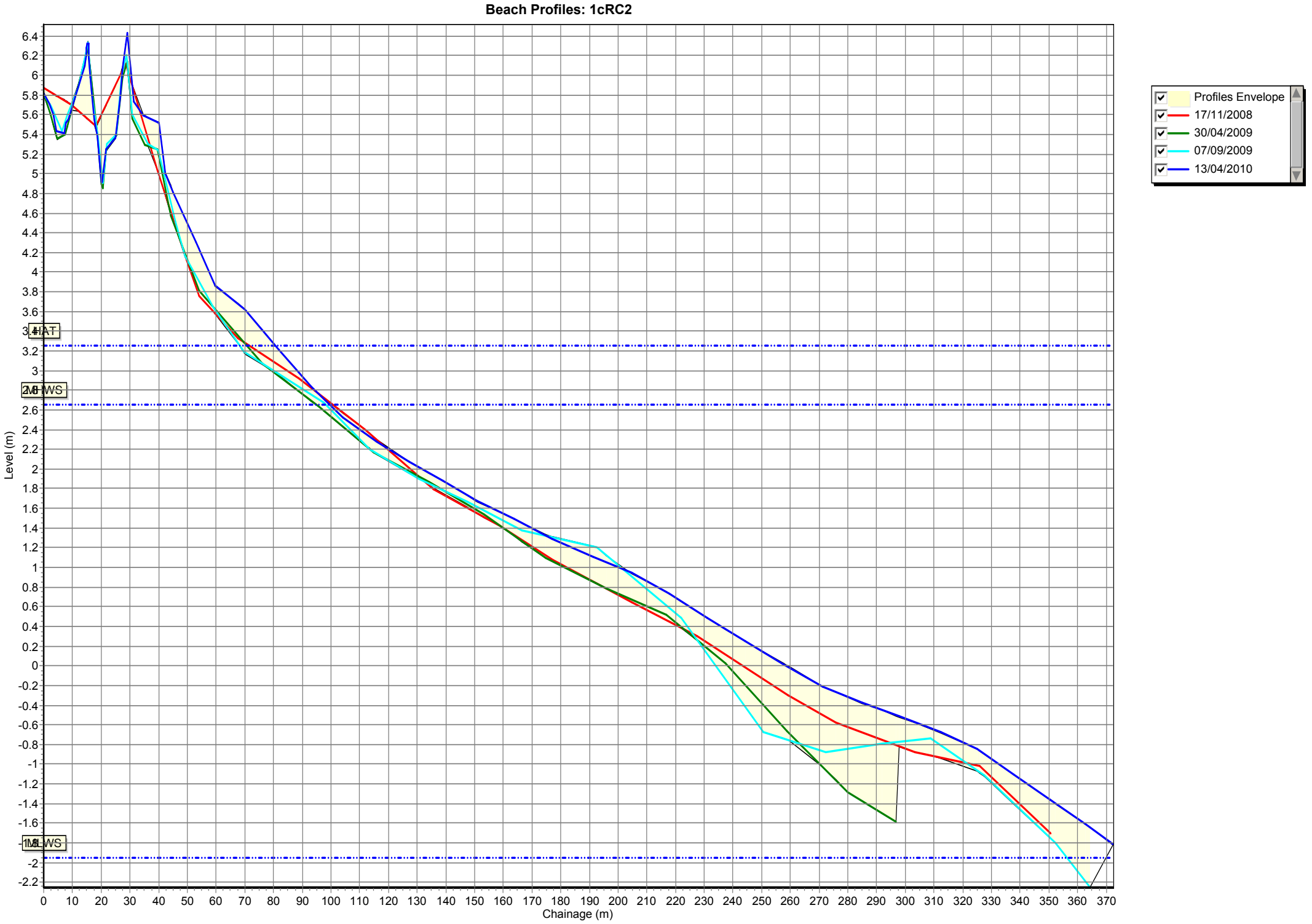


1cRC9 – 14/04/2010

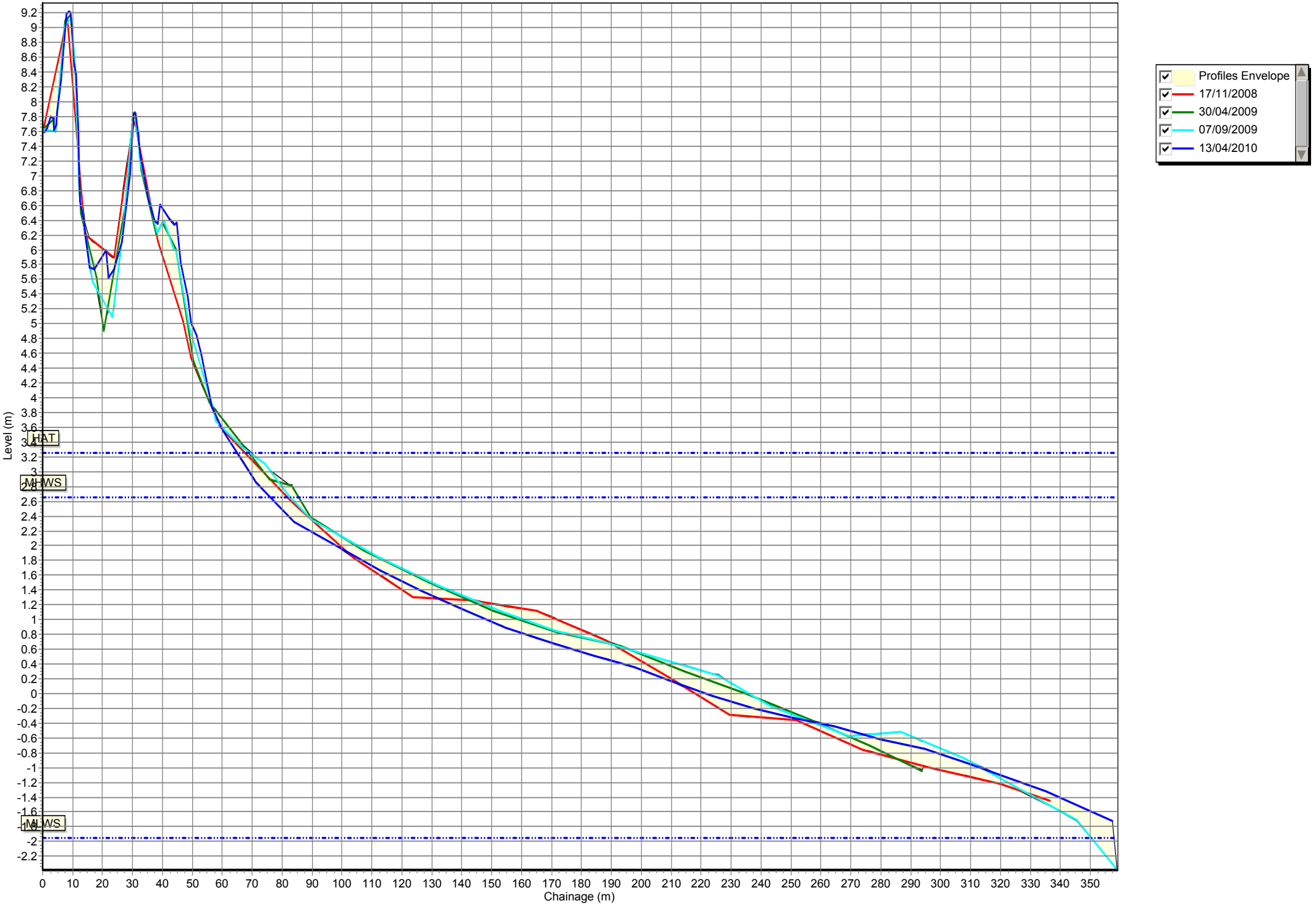
Chainage	Level	Code
0.000	5.695	
4.909	5.695	SD
14.900	5.295	SD
14.971	5.243	SD
20.753	5.186	SD
21.015	3.534	SD
24.064	2.774	B
27.674	2.523	S
30.829	2.302	GS
37.972	2.004	GS
44.719	1.726	GS
55.769	1.524	S
66.755	1.374	S
79.057	1.205	S
90.063	0.986	S
105.530	0.769	S
116.885	0.619	S
134.170	0.393	S
144.740	0.166	S
164.982	-0.121	S
175.186	-0.251	S
190.665	-0.419	S
200.414	-0.520	S
216.305	-0.629	S
226.888	-0.736	S
244.785	-0.960	S
256.374	-1.136	S
270.504	-1.385	S
282.404	-1.578	S
300.795	-1.872	S
315.984	-2.067	S
330.904	-2.259	S

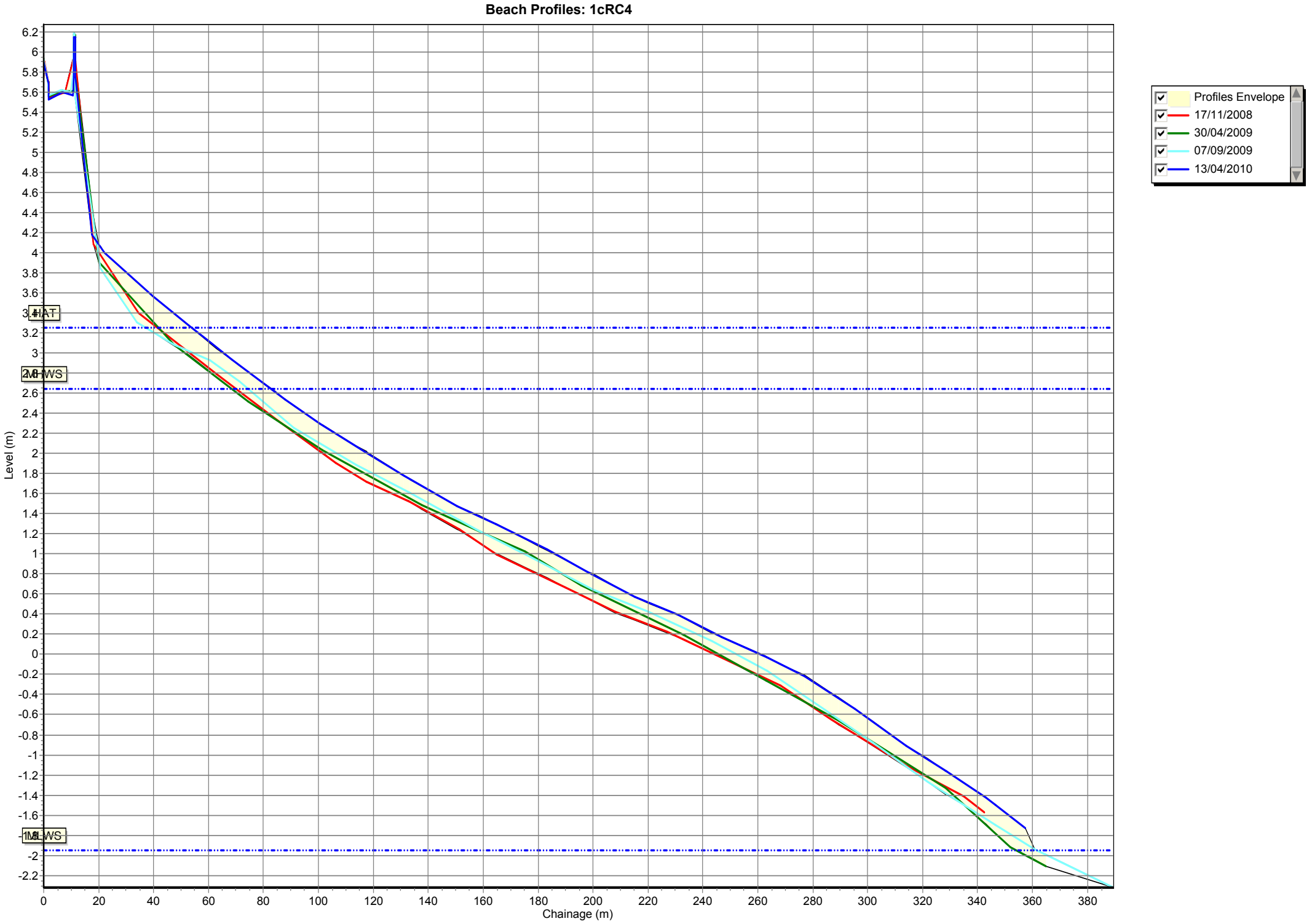



Beach Profiles: 1cRC1
Profiles Envelope
17/11/2008
30/04/2009
07/09/2009
13/04/2010
HAT
MHWS
MLWS
Level (m)
Chainage (m)
7.2
7
6.8
6.6
6.4
6.2
6
5.8
5.6
5.4
5.2
5
4.8
4.6
4.4
4.2
4
3.8
3.6
3.4
3.2
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
-1.6
-1.8
-2
-2.2
-2.4
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340


Beach Profiles: 1cRC2
Profiles Envelope
17/11/2008
30/04/2009
07/09/2009
13/04/2010
HAT
MLWS
Level (m)
Chainage (m)

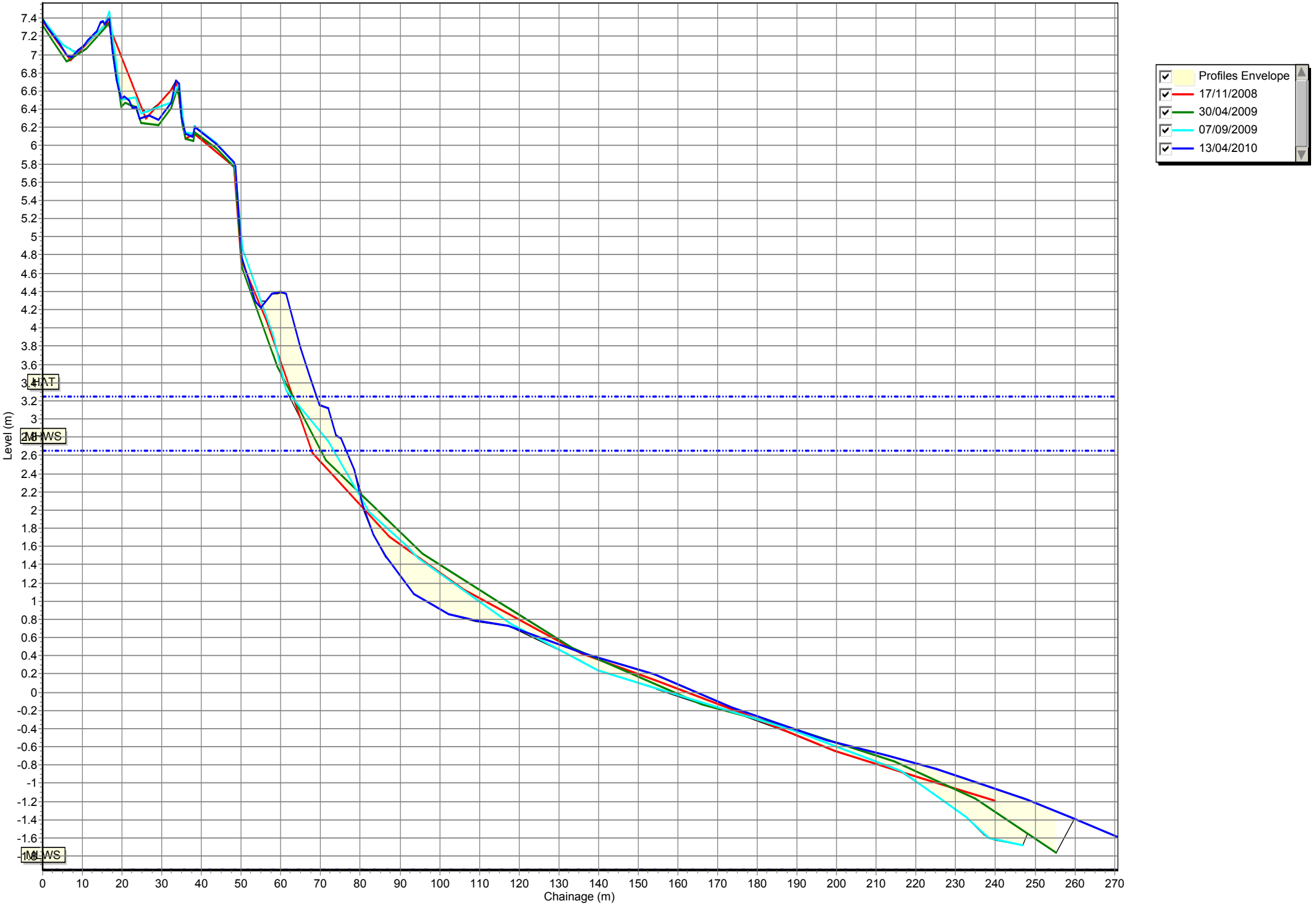
Beach Profiles: 1cRC3




Beach Profiles: 1cRC4
Profiles Envelope
17/11/2008
30/04/2009
07/09/2009
13/04/2010
HAT
MHWS
MLWS
Level (m)
Chainage (m)
6.2
6
5.8
5.6
5.4
5.2
5
4.8
4.6
4.4
4.2
4
3.8
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
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
320
340
360
380

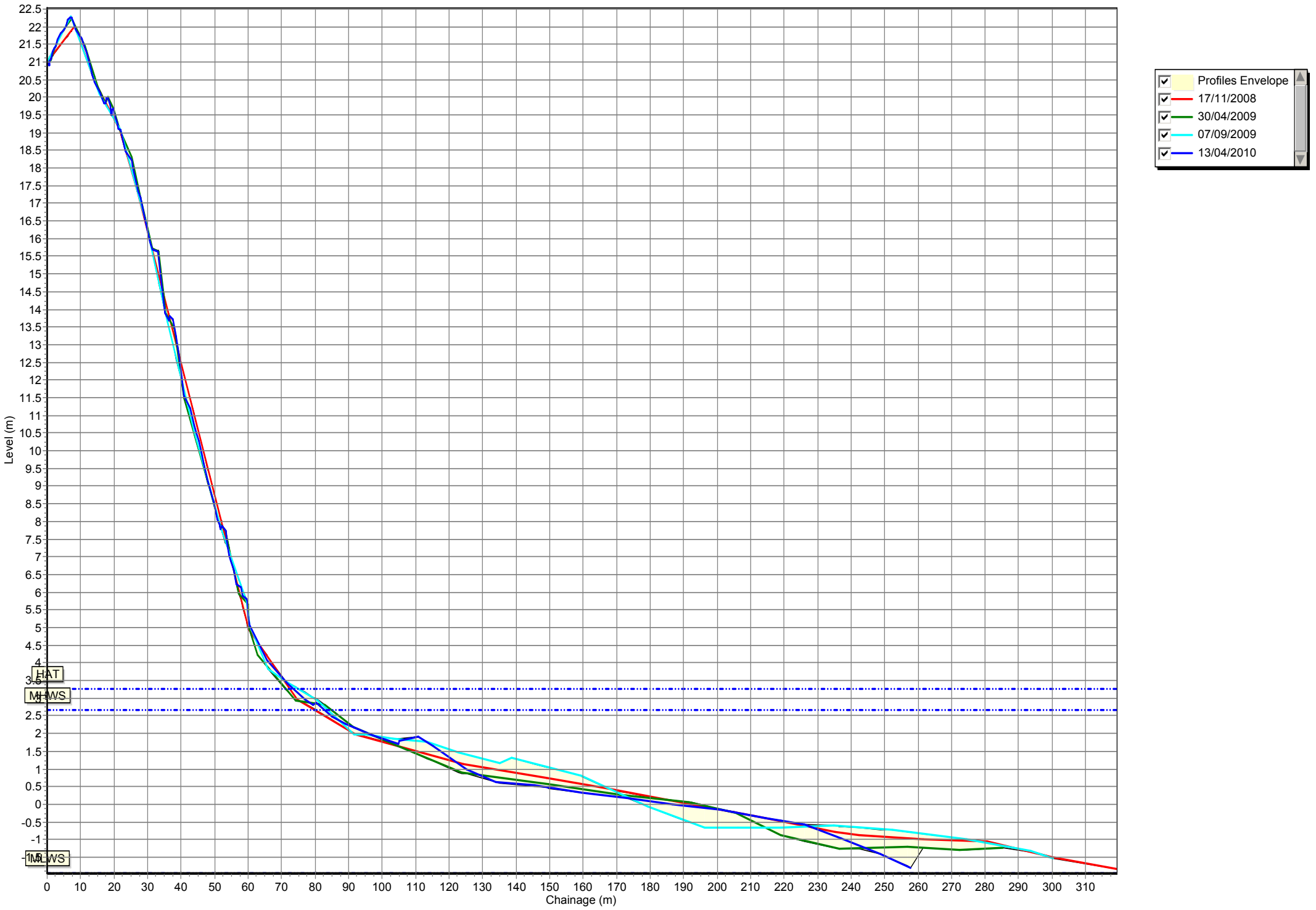
Beach Profiles: 1cRC5

Beach Profiles: 1cRC6

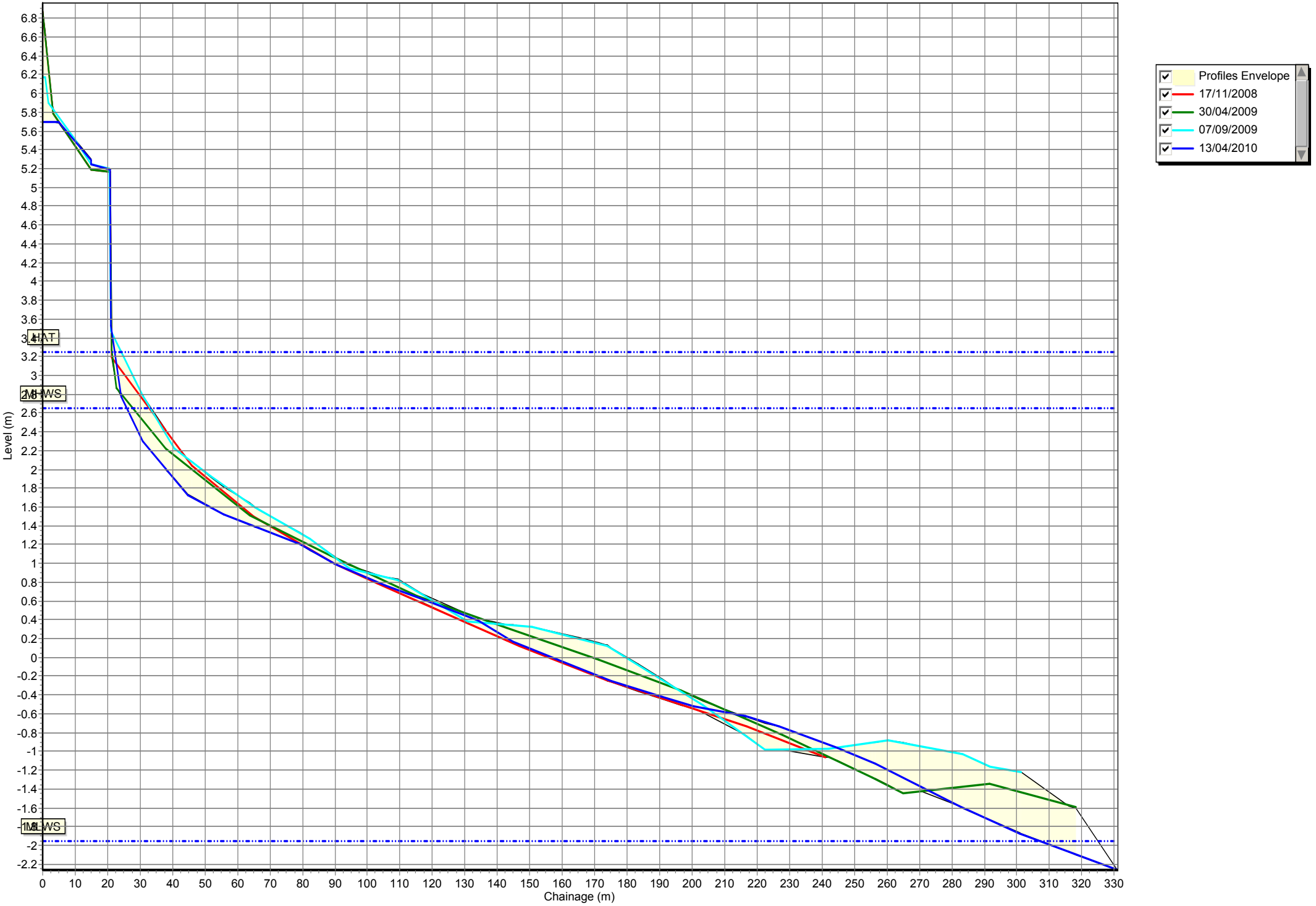


Beach Profiles: 1cRC7

Beach Profiles: 1cRC8

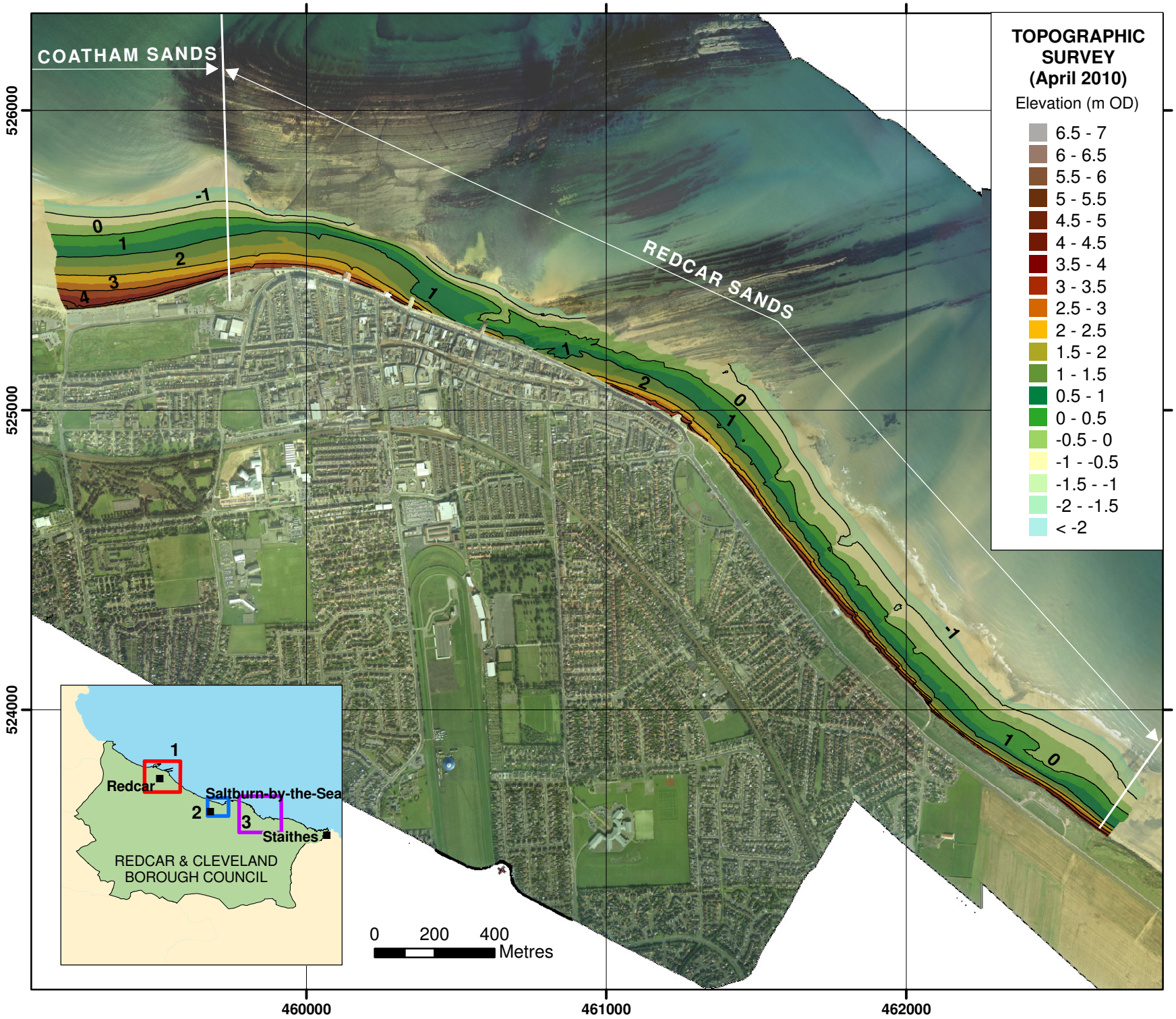


Beach Profiles: 1cRC9



Appendix B

Topographic Survey



TOPOGRAPHIC SURVEY (April 2010)

Elevation (m OD)

- 6.5 - 7
- 6 - 6.5
- 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

— Topographic Contours at 1 metre interval

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 1a Redcar & Cleveland Borough Council Frontage

Update Report 2
'Partial Measures' Survey 2010

Drawing Scale 1:17,000 at A4

Drawn by:	TC	Date:	18/05/2010
Checked by:	NC	Date:	25/05/2010
Approved by:	NC	Date:	25/05/2010

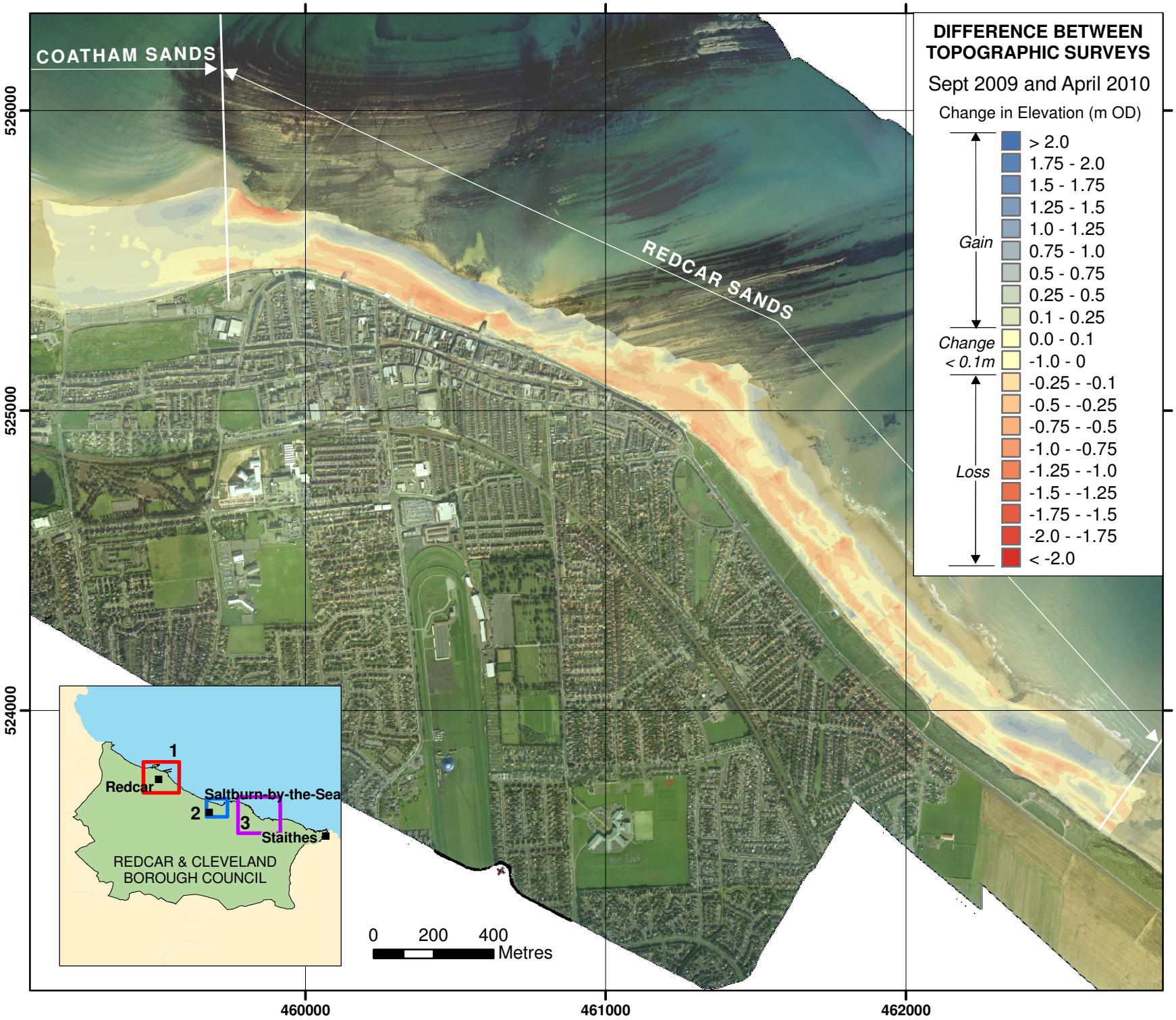
ROYAL HASKONING
Royal Haskoning
Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE

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

Halcrow
Halcrow Group Ltd
Lyndon House
62 Hagley Road
Edgbaston
Birmingham
B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.halcrow.com

I:\9T6403\Technical_Data\gis\figure\4_PARTIAL_measure_report_2010\7_Recar_Cleveland\Appendix_B_Redcar_Cleveland_Map1a.mxd



DIFFERENCE BETWEEN TOPOGRAPHIC SURVEYS

Sept 2009 and April 2010

Change in Elevation (m OD)

Gain	> 2.0
	1.75 - 2.0
	1.5 - 1.75
	1.25 - 1.5
	1.0 - 1.25
	0.75 - 1.0
	0.5 - 0.75
	0.25 - 0.5
	0.1 - 0.25
Change < 0.1m	0.0 - 0.1
	-1.0 - 0
Loss	-0.25 - -0.1
	-0.5 - -0.25
	-0.75 - -0.5
	-1.0 - -0.75
	-1.25 - -1.0
	-1.5 - -1.25
	-1.75 - -1.5
	-2.0 - -1.75
	< -2.0

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 1b Redcar & Cleveland Borough Council Frontage

Update Report 2
'Partial Measures' Survey 2010

Drawing Scale 1:17,000 at A4

Drawn by:	TC	Date:	18/05/2010
Checked by:	NC	Date:	25/05/2010
Approved by:	NC	Date:	25/05/2010

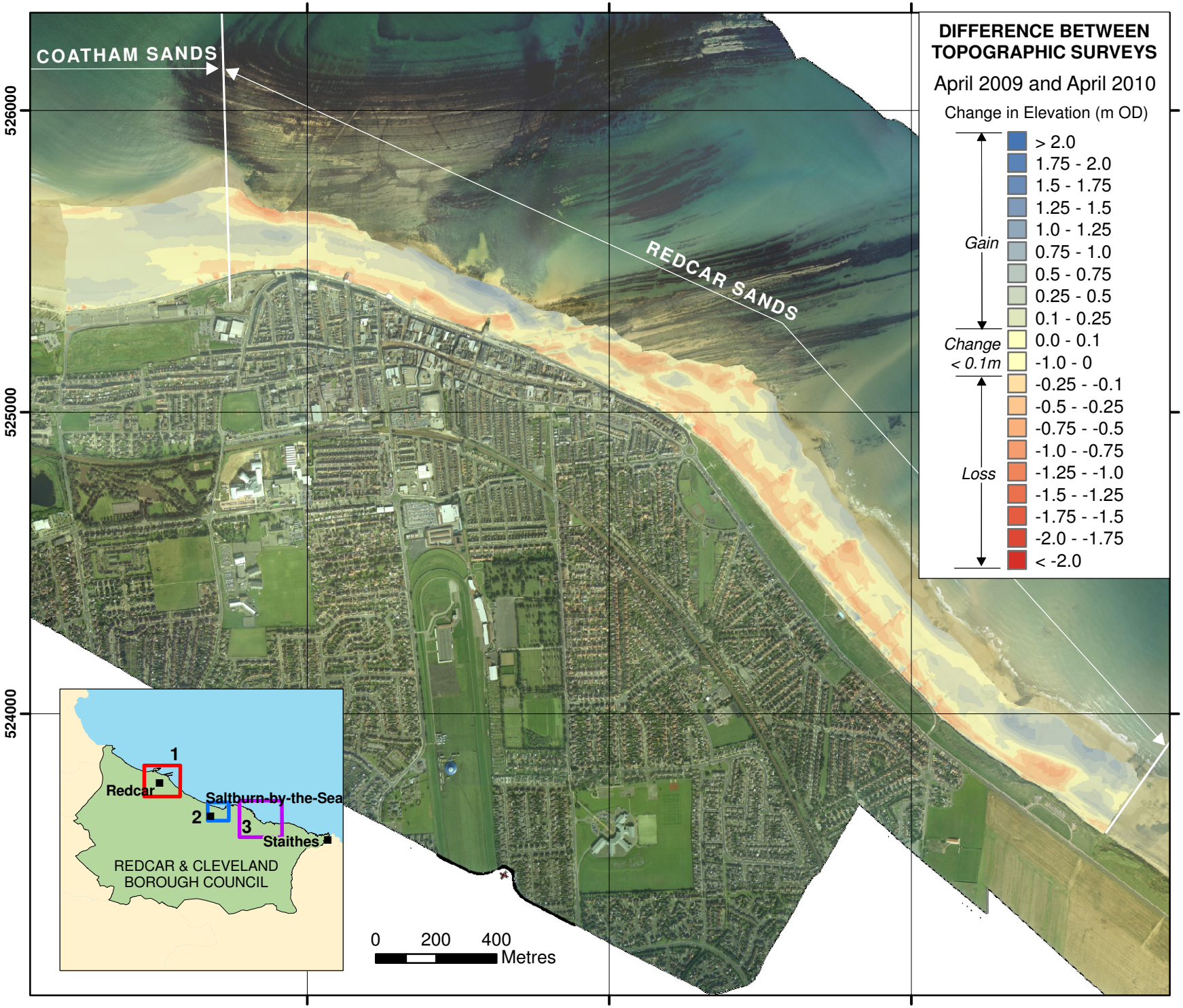
ROYAL HASKONING
Royal Haskoning
Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE

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

Halcrow
Halcrow Group Ltd
Lyndon House
62 Hagley Road
Edgbaston
Birmingham
B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.halcrow.com

I:\9T6403\Technical_Data\gis\figure\4_PARTIAL_measure_report_2010\7_Recar_Cleveland\Appendix_B_Redcar_Cleveland_Map1b.mxd



DIFFERENCE BETWEEN TOPOGRAPHIC SURVEYS

April 2009 and April 2010

Change in Elevation (m OD)

Gain	> 2.0
	1.75 - 2.0
	1.5 - 1.75
	1.25 - 1.5
	1.0 - 1.25
	0.75 - 1.0
	0.5 - 0.75
	0.25 - 0.5
	0.1 - 0.25
Change < 0.1m	0.0 - 0.1
	-1.0 - 0
Loss	-0.25 - -0.1
	-0.5 - -0.25
	-0.75 - -0.5
	-1.0 - -0.75
	-1.25 - -1.0
	-1.5 - -1.25
	-1.75 - -1.5
	-2.0 - -1.75
	< -2.0

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 1c Redcar & Cleveland Borough Council Frontage

Update Report 2
'Partial Measures' Survey 2010

Drawing Scale 1:17,000 at A4

Drawn by:	TC	Date:	18/05/2010
Checked by:	NC	Date:	25/05/2010
Approved by:	NC	Date:	25/05/2010

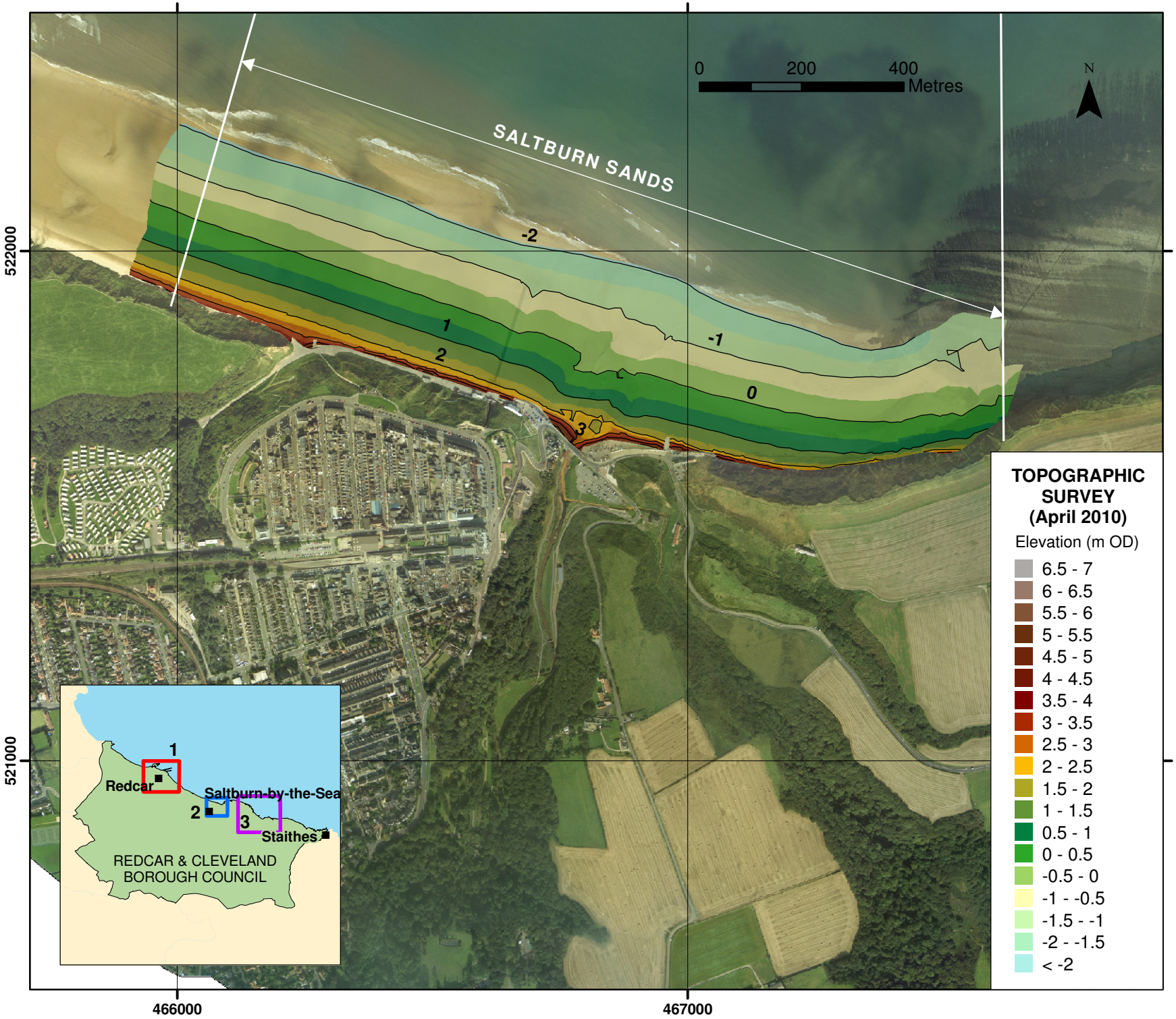
ROYAL HASKONING
Royal Haskoning
Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE

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

Halcrow
Halcrow Group Ltd
Lyndon House
62 Hagley Road
Edgbaston
Birmingham
B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.halcrow.com

I:\9T6403\Technical_Data\gis\figure\4_PARTIAL_measure_report_2010\7_Recar_Cleveland\Appendix_B_Redcar_Cleveland_Map1c.mxd



Topographic Contours at 1 metre interval

TOPOGRAPHIC SURVEY (April 2010)

Elevation (m OD)

- 6.5 - 7
- 6 - 6.5
- 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

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 2a Redcar & Cleveland Borough Council Frontage

Update Report 2
'Partial Measures' Survey 2010

Drawing Scale 1:10,000 at A4

Drawn by:	TC	Date:	18/05/2010
Checked by:	NC	Date:	25/05/2010
Approved by:	NC	Date:	25/05/2010

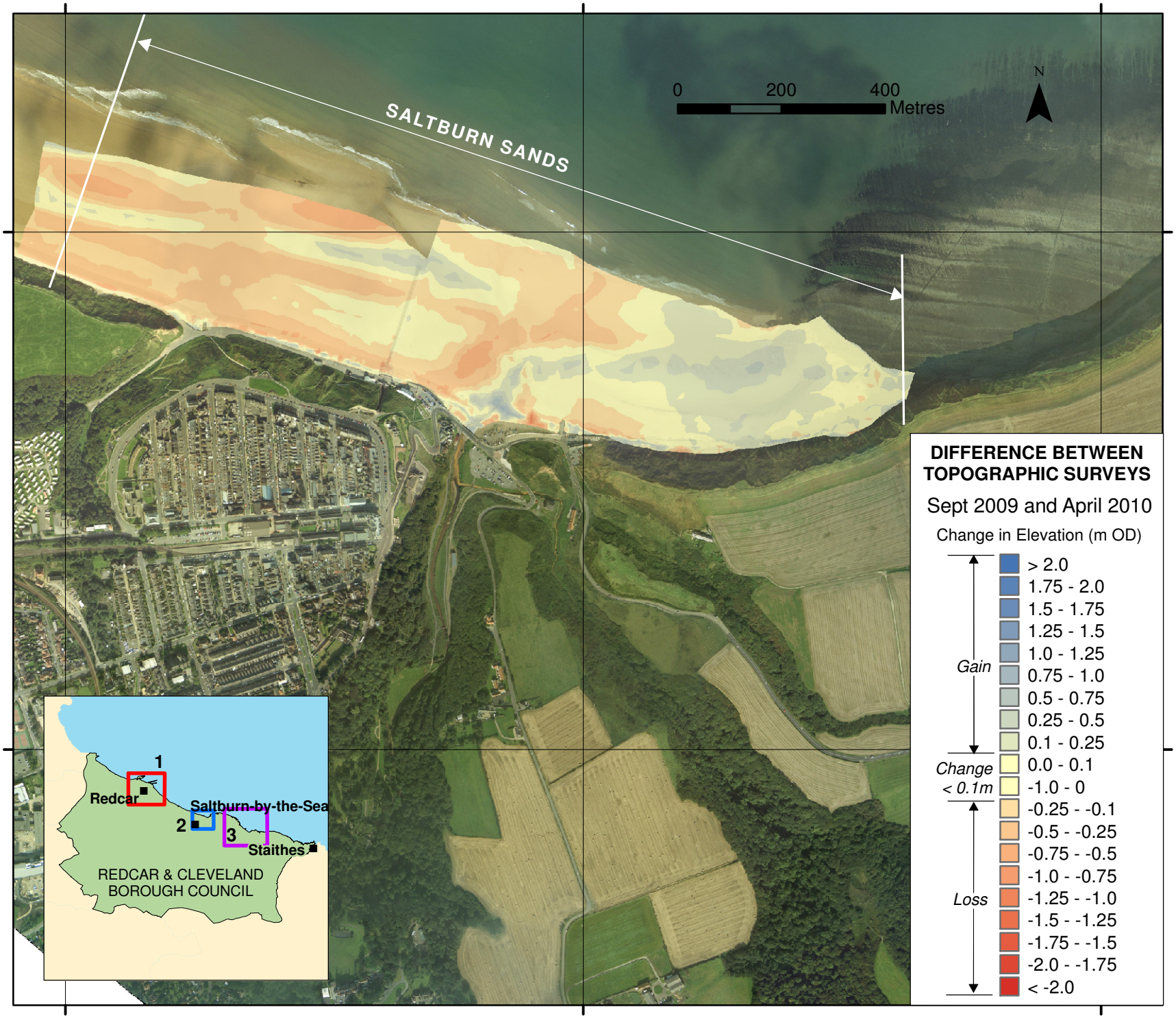
ROYAL HASKONING
Royal Haskoning
Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE

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

Halcrow
Halcrow Group Ltd
Lyndon House
62 Hagley Road
Edgbaston
Birmingham
B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.halcrow.com

I:\9T6403\Technical_Data\gis\figure\4_PARTIAL_measure_report_2010\7_Recar_Cleveland\Appendix_B_Redcar_Cleveland_Map2a.mxd



DIFFERENCE BETWEEN TOPOGRAPHIC SURVEYS

Sept 2009 and April 2010

Change in Elevation (m OD)

Gain	> 2.0
	1.75 - 2.0
	1.5 - 1.75
	1.25 - 1.5
	1.0 - 1.25
	0.75 - 1.0
	0.5 - 0.75
	0.25 - 0.5
	0.1 - 0.25
Change < 0.1m	0.0 - 0.1
	-1.0 - 0
Loss	-0.25 - -0.1
	-0.5 - -0.25
	-0.75 - -0.5
	-1.0 - -0.75
	-1.25 - -1.0
	-1.5 - -1.25
	-1.75 - -1.5
	-2.0 - -1.75
	< -2.0

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 2b Redcar & Cleveland Borough Council Frontage

Update Report 2
'Partial Measures' Survey 2010

Drawing Scale 1:10,000 at A4

Drawn by:	TC	Date:	18/05/2010
Checked by:	NC	Date:	25/05/2010
Approved by:	NC	Date:	25/05/2010

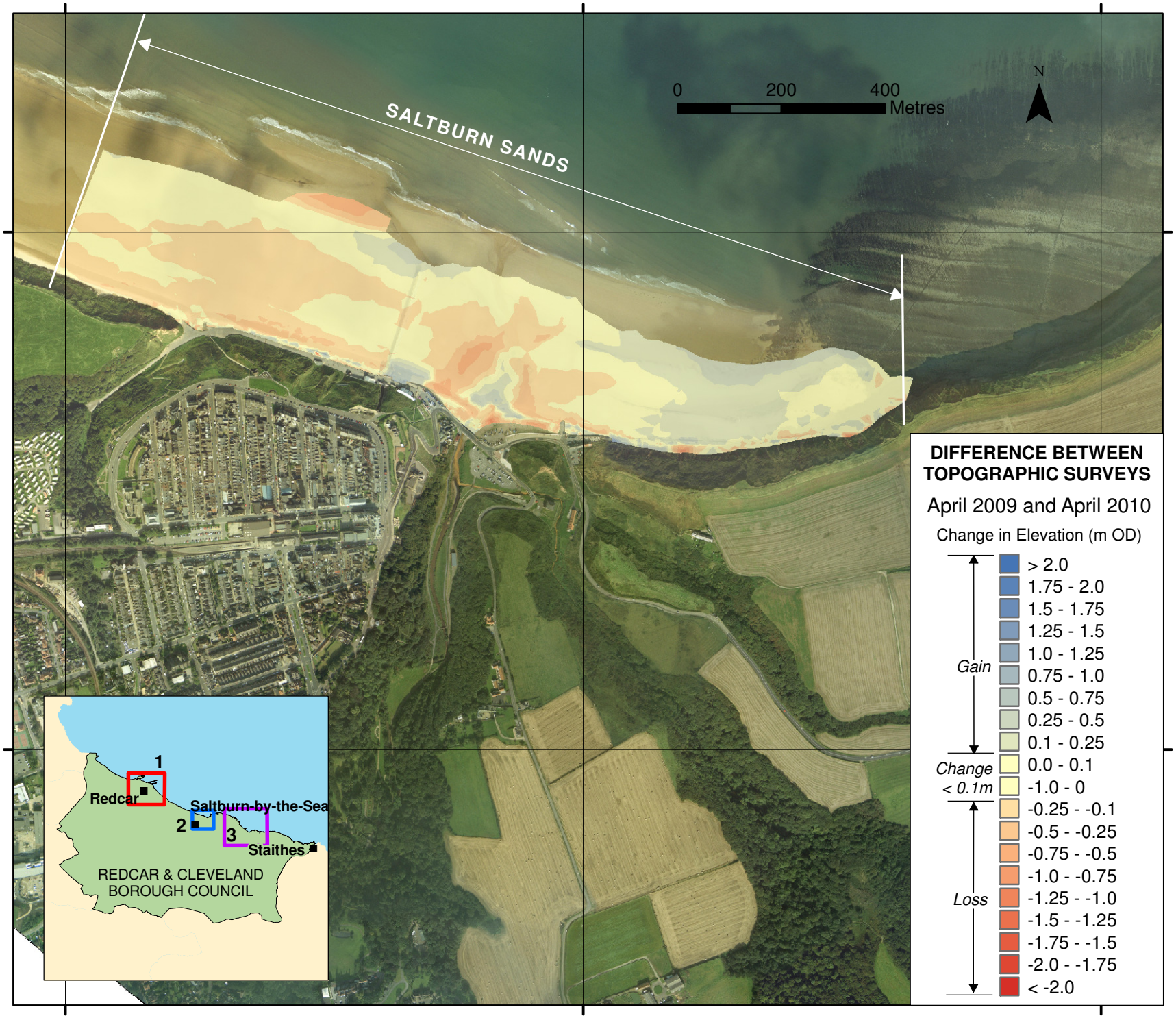
ROYAL HASKONING
Royal Haskoning
Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE

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

Halcrow
Halcrow Group Ltd
Lyndon House
62 Hagley Road
Edgbaston
Birmingham
B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.halcrow.com

I:\9T6403\Technical_Data\gis\figure\4_PARTIAL_measure_report_2010\7_Recar_Cleveland\Appendix_B_Redcar_Cleveland_Map2b.mxd



DIFFERENCE BETWEEN TOPOGRAPHIC SURVEYS

April 2009 and April 2010

Change in Elevation (m OD)

Gain	> 2.0
	1.75 - 2.0
	1.5 - 1.75
	1.25 - 1.5
	1.0 - 1.25
	0.75 - 1.0
	0.5 - 0.75
	0.25 - 0.5
	0.1 - 0.25
Change < 0.1m	0.0 - 0.1
	-1.0 - 0
Loss	-0.25 - -0.1
	-0.5 - -0.25
	-0.75 - -0.5
	-1.0 - -0.75
	-1.25 - -1.0
	-1.5 - -1.25
	-1.75 - -1.5
	-2.0 - -1.75
	< -2.0

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 2c Redcar & Cleveland Borough Council Frontage

Update Report 2
'Partial Measures' Survey 2010

Drawing Scale 1:10,000 at A4

Drawn by:	TC	Date:	18/05/2010
Checked by:	NC	Date:	25/05/2010
Approved by:	NC	Date:	25/05/2010

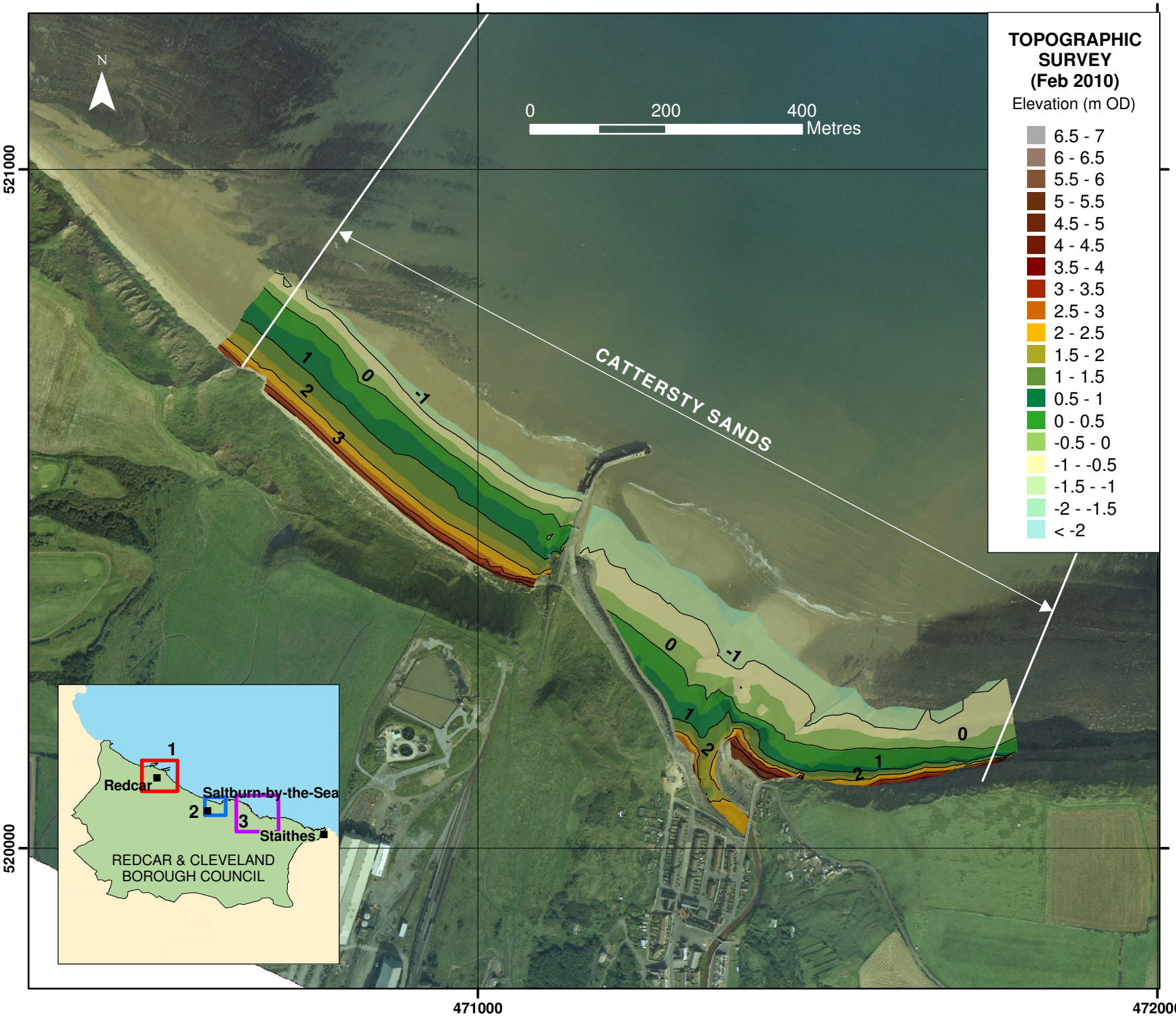
ROYAL HASKONING
Royal Haskoning
Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE

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

Halcrow
Halcrow Group Ltd
Lyndon House
62 Hagley Road
Edgbaston
Birmingham
B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.halcrow.com

I:\9T6403\Technical_Data\gis\figure4_PARTIAL_measure_report_2010\7_Recar_Cleveland\Appendix_B_Redcar_Cleveland_Map2c.mxd



TOPOGRAPHIC SURVEY (Feb 2010)

Elevation (m OD)

- 6.5 - 7
- 6 - 6.5
- 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

— Topographic Contours at 1 metre interval

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 3a Redcar & Cleveland Borough Council Frontage

Update Report 2
'Partial Measures' Survey 2010

Drawing Scale 1:7,500 at A4

Drawn by:	TC	Date:	18/05/2010
Checked by:	NC	Date:	25/05/2010
Approved by:	NC	Date:	25/05/2010

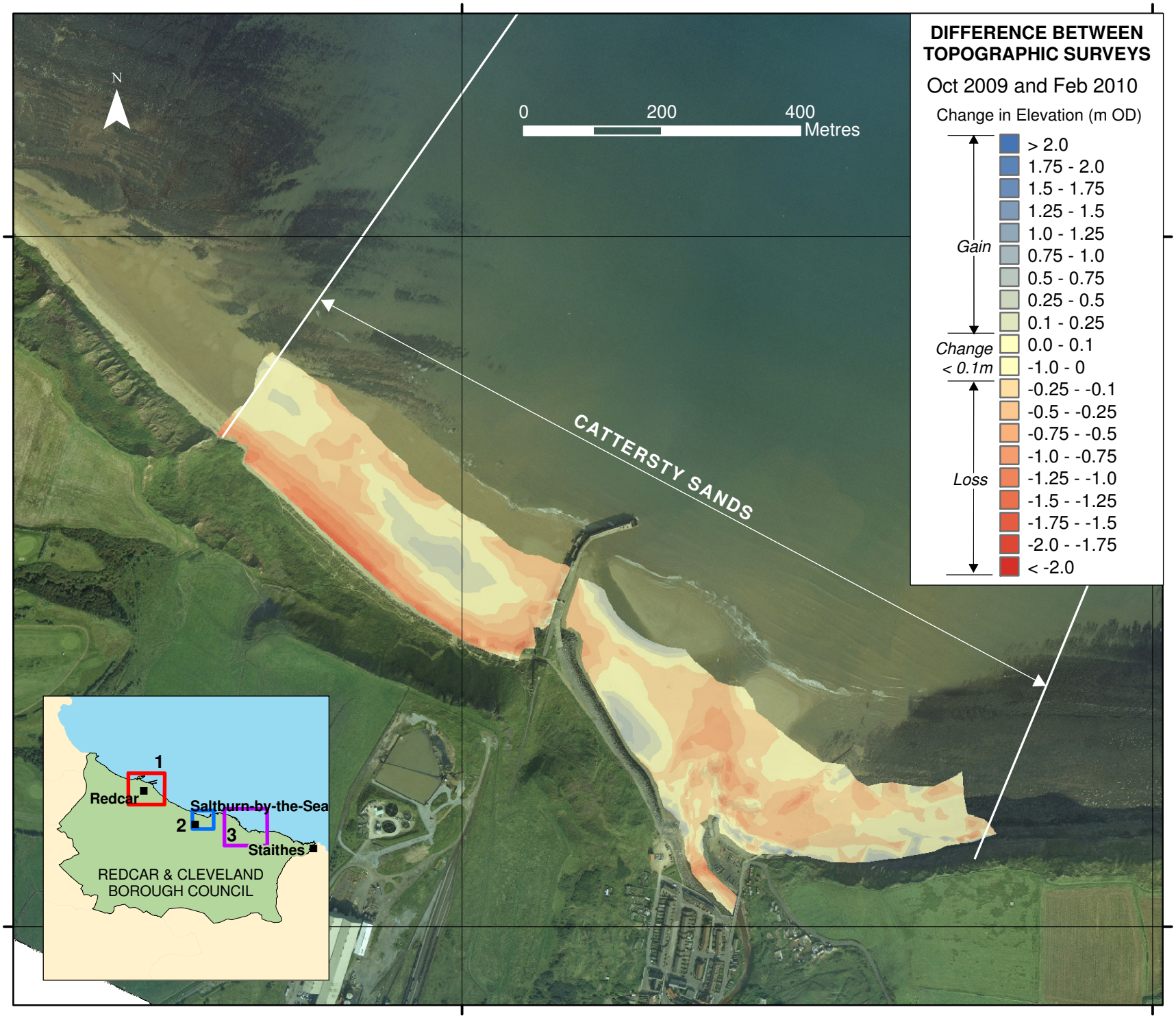
ROYAL HASKONING
Royal Haskoning
Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE

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

Halcrow
Halcrow Group Ltd
Lyndon House
62 Hagley Road
Edgbaston
Birmingham
B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.halcrow.com

I:\9T6403\Technical_Data\gis\figure\4_PARTIAL_measure_report_2010\7_Recar_Cleveland\Appendix_B_Redcar_Cleveland_Map3a.mxd



Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 3b Redcar & Cleveland Borough Council Frontage

Update Report 2
'Partial Measures' Survey 2010

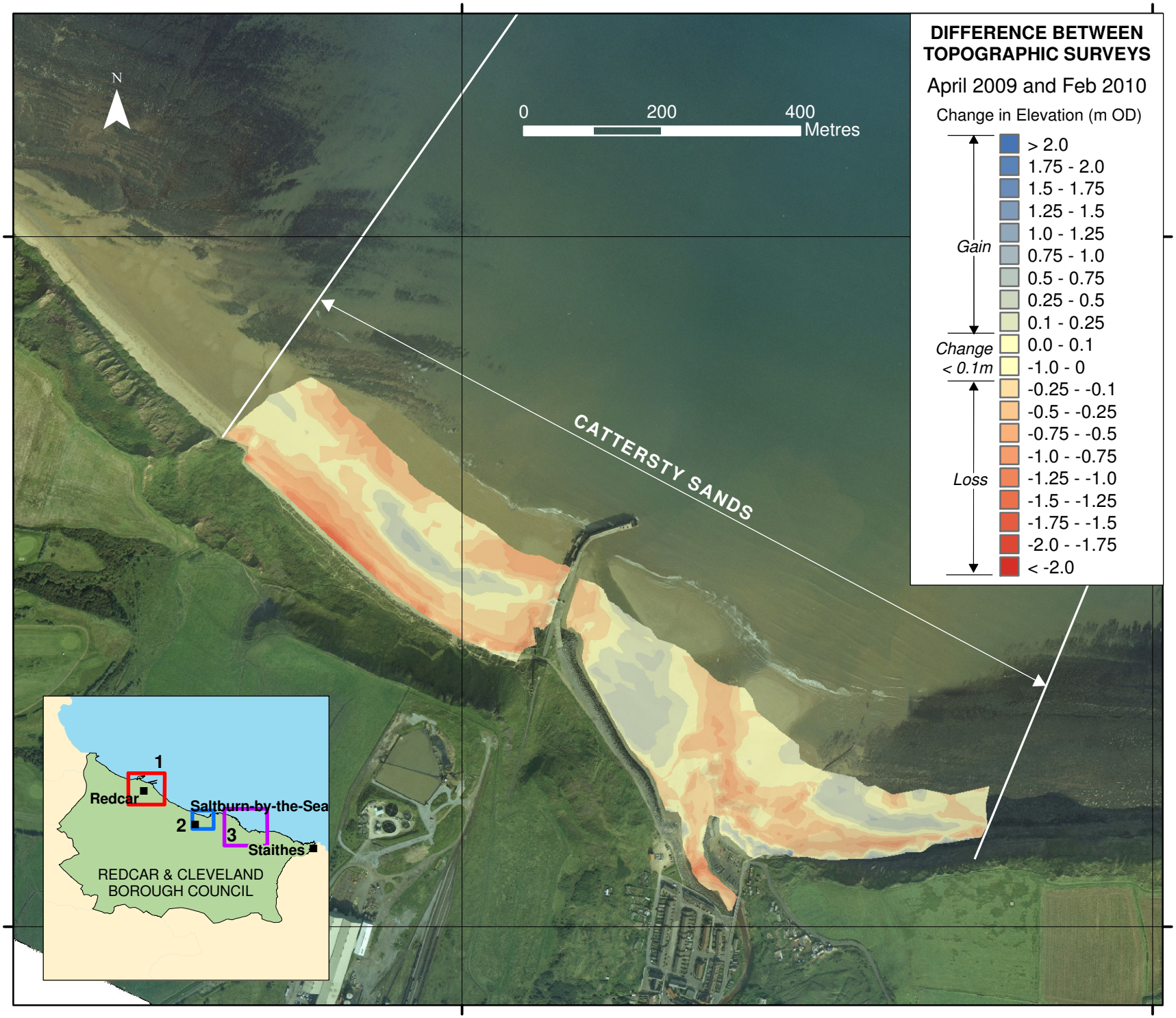
Drawing Scale 1:7,500 at A4

Drawn by:	TC	Date:	18/05/2010
Checked by:	NC	Date:	25/05/2010
Approved by:	NC	Date:	25/05/2010

ROYAL HASKONING
Royal Haskoning
Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE
Tel: +44 (0)191 211 1300
Fax: +44 (0)191 211 1313
www.royalhaskoning.com

Halcrow
Halcrow Group Ltd
Lyndon House
62 Hagley Road
Edgbaston
Birmingham
B16 8PE
Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.halcrow.com

I:\9T6403\Technical_Data\gis\figure\4_PARTIAL_measure_report_2010\7_Recar_Cleveland\Appendix_B_Redcar_Cleveland_Map3b.mxd



DIFFERENCE BETWEEN TOPOGRAPHIC SURVEYS

April 2009 and Feb 2010

Change in Elevation (m OD)

Gain	> 2.0
	1.75 - 2.0
	1.5 - 1.75
	1.25 - 1.5
	1.0 - 1.25
	0.75 - 1.0
	0.5 - 0.75
	0.25 - 0.5
	0.1 - 0.25
Change < 0.1m	0.0 - 0.1
	-1.0 - 0
Loss	-0.25 - -0.1
	-0.5 - -0.25
	-0.75 - -0.5
	-1.0 - -0.75
	-1.25 - -1.0
	-1.5 - -1.25
	-1.75 - -1.5
	-2.0 - -1.75
	< -2.0

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 3c Redcar & Cleveland Borough Council Frontage

Update Report 2
'Partial Measures' Survey 2010

Drawing Scale 1:7,500 at A4

Drawn by:	TC	Date:	18/05/2010
Checked by:	NC	Date:	25/05/2010
Approved by:	NC	Date:	25/05/2010

ROYAL HASKONING
Royal Haskoning
Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE

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

Halcrow
Halcrow Group Ltd
Lyndon House
62 Hagley Road
Edgbaston
Birmingham
B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.halcrow.com

I:\9T6403\Technical_Data\gis\figure4_PARTIAL_measure_report_2010\7_Recar_Cleveland\Appendix_B_Redcar_Cleveland_Map3c.mxd

Appendix C

Cliff Top Survey

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.

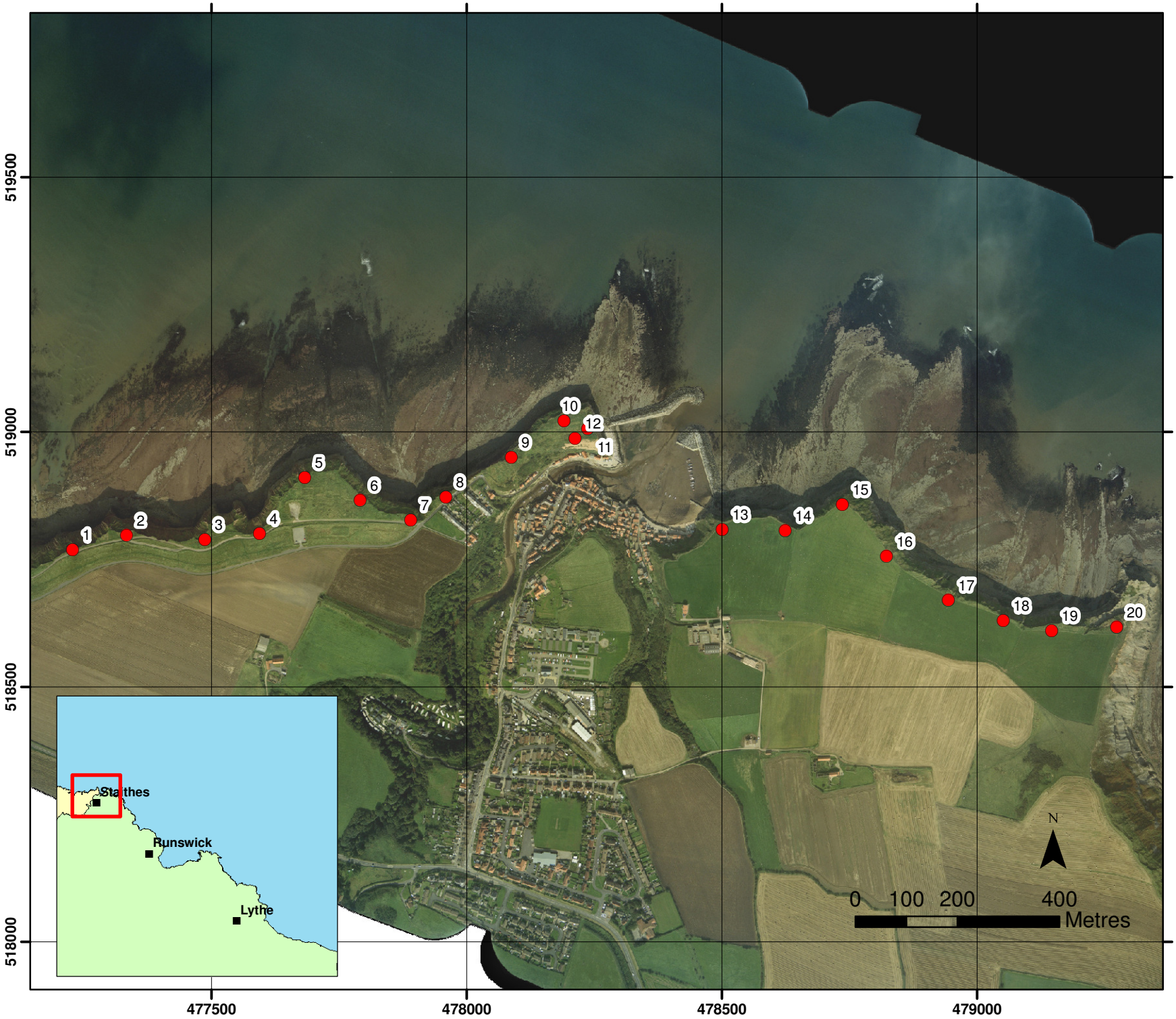
The cliff top surveys at Staithes are undertaken bi-annually. Measurements are taken from a fixed ground control point along a fixed bearing to the edge of the cliff top.

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 (º)	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 ±0.1m. Therefore observed changes have been altered by this amount prior to calculation of an erosion rate. Erosion rates are not calculated where the cliff line shows apparent 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 Redcar & Cleveland 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

ROYAL HASKONING

Royal Haskoning
Marlborough House
Marlborough Crescent
Newcastle upon Tyne
NE1 4EE

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

Halcrow

Halcrow Group Ltd
Lyndon House
62 Hagley Road
Edgbaston
Birmingham
B16 8PE

Tel: +44 (0)121 456 2345
Fax: +44(0)121 456 1569
www.halcrow.com