ROYAL HASKONING

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Cell 1 Regional Coastal Monitoring Programme
Analytical Report 3: 'Full Measures' Survey 2010

HARTLEPOOL BOROUGH COUNCIL

Hartlepool Borough Council
Final Report

January 2011

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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
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. This coastline is often referred to as 'Coastal Sediment Cell 1' in England and Wales (Figure 1). Within this frontage the coastal landforms vary considerably, comprising low-lying tidal flats with fringing salt marshes, hard rock cliffs that are mantled with glacial till to varying thicknesses, softer rock cliffs, and extensive landslide complexes.

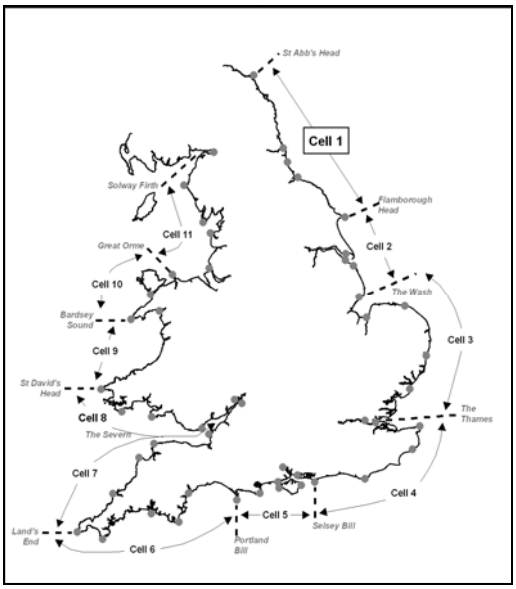


Figure 1 Sediment Cells in England and Wales

The programme commenced in its present guise in September 2008 and is managed by Scarborough Borough Council on behalf of the North East Coastal Group. It is funded by the Environment Agency, working in partnership with the following organisations.

The data collection, analysis and reporting is being undertaken as a partnership between the following organisations:

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.

Each year, an Analytical Report is produced for each individual authority, providing a detailed analysis and interpretation of the 'Full Measures' surveys.

This is followed by a brief Update Report for each individual authority, providing ongoing findings from the 'Partial Measures' surveys.

A Cell 1 Overview Report will also be produced periodically. This will provide a region-wide summary of the main findings relating to trends and interactions along the entire Cell 1 frontage within distinct time phases of the programme, defined by specific funding allocations. The first such report is expected to be produced in spring 2011 (covering 2008 – 2011) when the initial three year funding allocation comes towards an end.

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	Mar-Apr 10	May 10	-
3	2010/11	Sep-Oct 10	Jan 11 (*)			

(*) The present report is **Analytical Report 3** and provides an analysis of the 2010 Full Measures survey for Hartlepool Borough Council's frontage.

In addition, separate reports are produced for other elements of the programme as and when specific components are undertaken, such as wave data collection, bathymetric and sea bed sediment data collection, aerial photography, and walk-over visual inspections.

For purposes of analysis, the Cell 1 frontage has been split into the sub-sections listed in the Table 2.

Table 2 Sub-divisions of the Cell 1 Coastline

Authority	Zone
Northumberland County Council	Spittal A
	Spittal B
	Goswick Sands
	Holy Island
	Bamburgh
	Beadnell Village
	Beadnell Bay
	Embelton Bay
	Boulmer
	Alnmouth Bay
	High Hauxley and Druridge Bay
	Lynemouth Bay
	Newbiggin Bay
	Cambois Bay
	Blyth South Beach
North Tyneside Council	Whitley Sands
	Cullercoats Bay
	Tynemouth Long Sands
	King Edward's Bay
South Tyneside Council	Littehaven Beach
	Herd Sands
	Trow Quarry (incl. Frenchman's Bay)
	Marsden Bay
Sunderland Council	Whitburn Bay
	Harbour and Docks
	Hendon to Ryhope (incl. Halliwell Banks)
Durham County Council	Featherbed Rocks
	Seaham
	Blast Beach
	Hawthorn Hive
	Blackhall Colliery
Hartlepool Borough Council	North Sands
	Hartlepool Headland
	Middleton
	Hartlepool Bay
Redcar & Cleveland Borough Council	Coatham Sands
	Redcar Sands
	Marske Sands
	Saltburn Sands
	Cattersty Sands (Skinningrove)
Scarborough Borough Council	Staithes
	Runswick Bay
	Sandsend Beach, Upgang Beach and Whitby Sands
	Robin Hood's Bay
	Scarborough North Bay
	Scarborough South Bay
	Cayton Bay
	Filey Bay

1. Introduction

1.1 Study Area

Hartlepool Borough Council's frontage extends from Crimdon Beck in the north to the North Gare Breakwater in the south. For the purposes of this report, it has been sub-divided into four areas, namely:

- North Sands
- Hartlepool Headland
- Middleton
- Hartlepool Bay

1.2 Methodology

Along Hartlepool 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 part of North Sands (referred to as Hartlepool North or 'HN')
    - Topographic survey along Middleton (referred to as Hartlepool Central or 'HC')
    - Topographic survey along Hartlepool Bay (referred to as Hartlepool South or 'HS')

- Partial Measures survey annually each spring comprising:
    - Beach profile surveys along 9 no. transect lines

- Additionally, every five years (starting with 2008 as the baseline year), the Full Measures topographic survey at Hartlepool North is extended to fully cover the whole of North Sands and Hartlepool Headland with a topographic survey. This extends across the boundary of jurisdiction between Hartlepool Borough Council and County Durham Council.

The location of these surveys is shown in Figure 2. They have also previously been provided on a digital file which can be opened in Google Earth showing the locations of the surveys.

The Full Measures survey at Hartlepool North was undertaken in September 2010, when weather conditions were dull and windy. The sea state was moderate. The survey at Hartlepool Central was also undertaken in September 2010, when weather conditions were overcast but dry and the sea state had a medium swell. The survey at Hartlepool South was undertaken in October 2010 when the weather was wet and very windy the sea state was rough with a long sweeping swell.

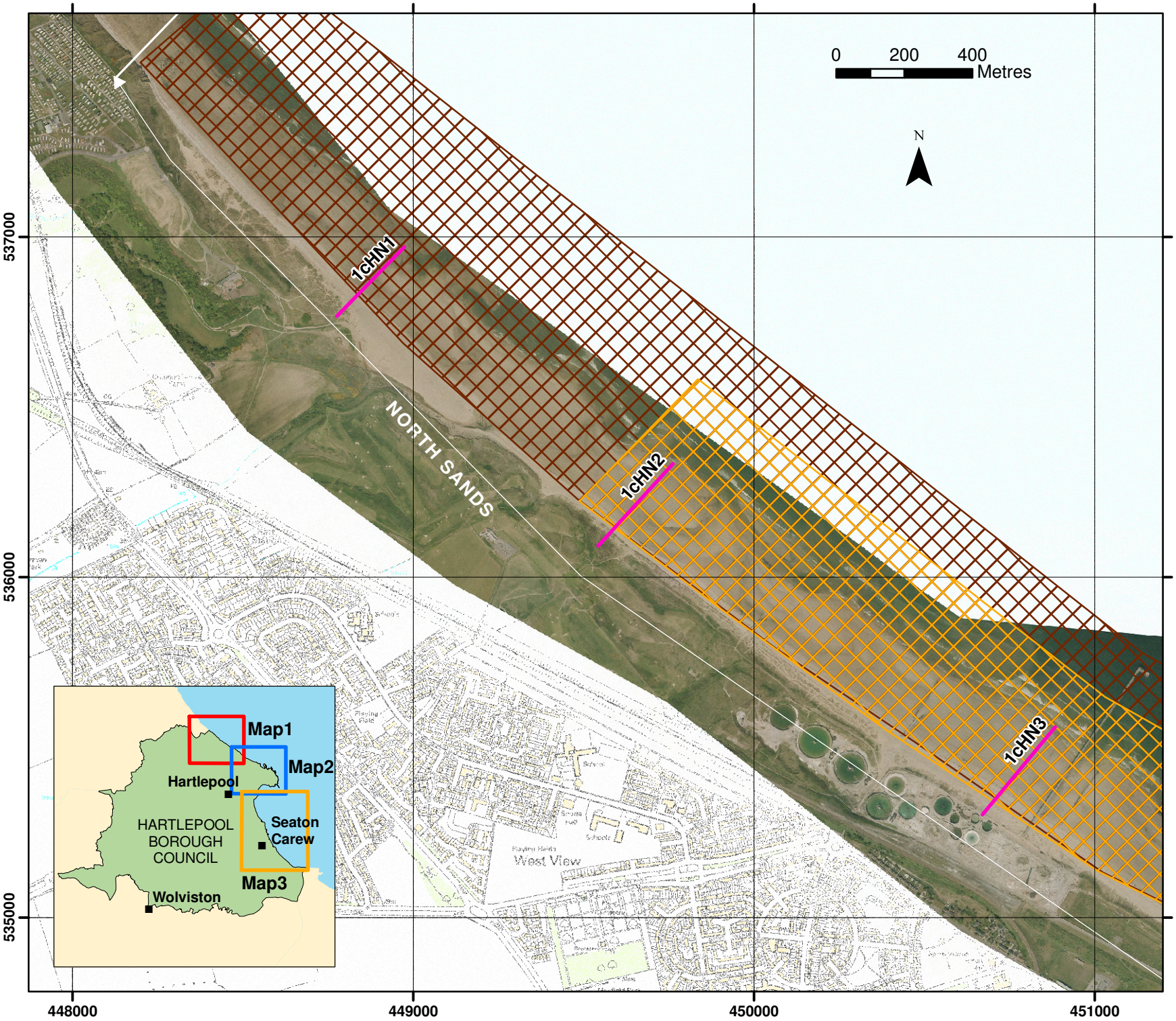
All data have been captured in a manner commensurate with the principles of the Environment Agency's *National Standard Contract and Specification for Surveying Services* and stored in a file format compatible with the software systems being used for the data analysis, namely SANDS and Arc-GIS. This data collection approach and file format is comparable to that being used on other regional coastal monitoring programmes, such as in the South East and South West of England.

Upon receipt of the data from the survey team, they are quality assured and then uploaded onto the programme's website for storage and availability to others and also input to SANDS and GIS for subsequent analysis.

The Analytical Report is then produced following a standard structure for each authority. This involves:

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

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



SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs

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

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Figure 2 - Map 1 Hartlepool Borough Council Frontage

Analytical Report 3
'Full Measures' Survey 2010

Drawing Scale 1:15,000 at A4

Drawn by:	TC	Date:	28/10/2010
Checked by:	NC	Date:	05/11/2010
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North East Coastal Observatory
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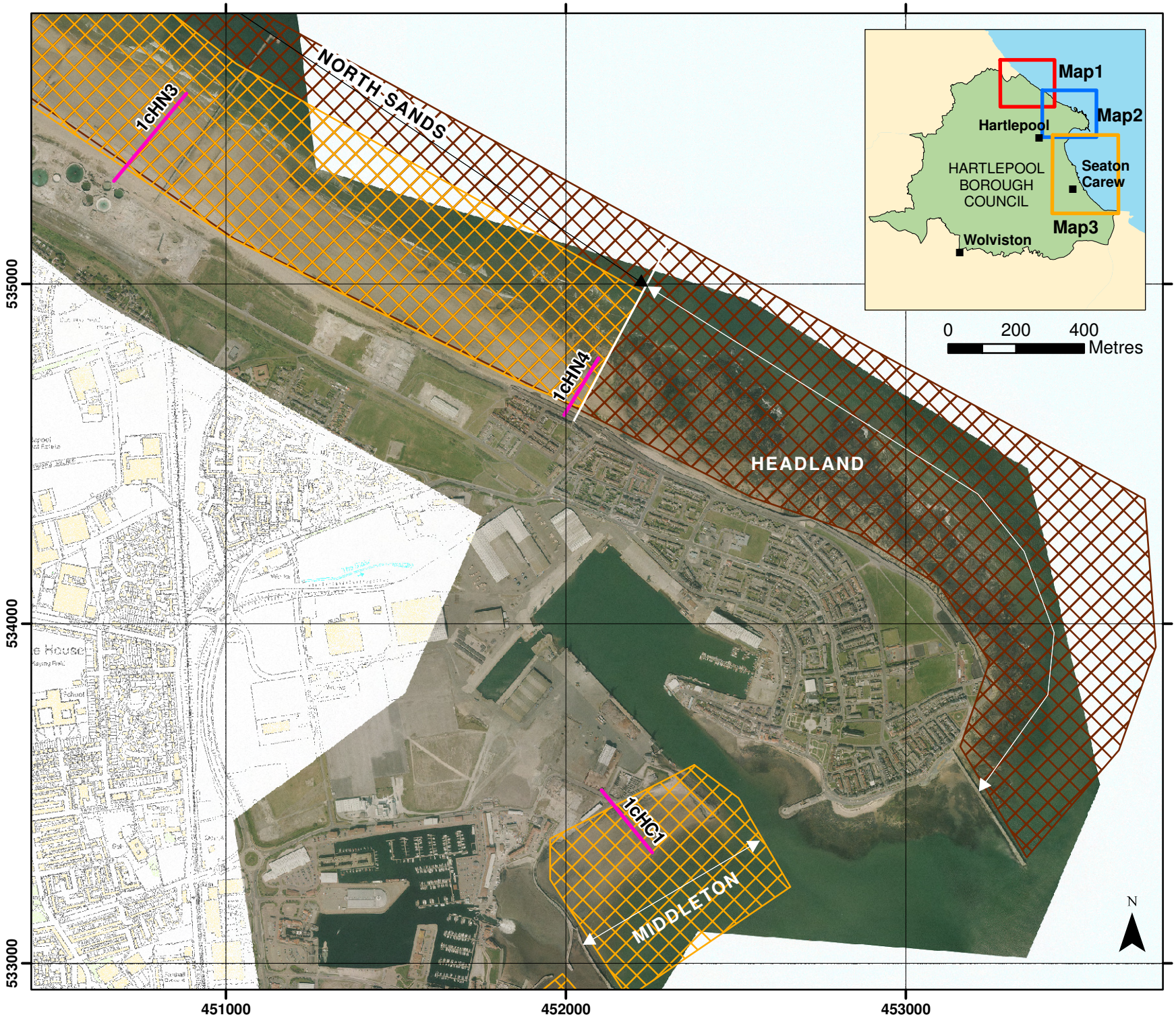

SURVEY LOCATIONS

Topographic Profiles
- Annual
- Bi-Annual

Topographic Surveys
- 6 monthly
- yearly
- 5 yearly

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

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Figure 2 - Map 2 Hartlepool Borough Council Frontage

Analytical Report 3
'Full Measures' Survey 2010

Drawing Scale 1:15,000 at A4

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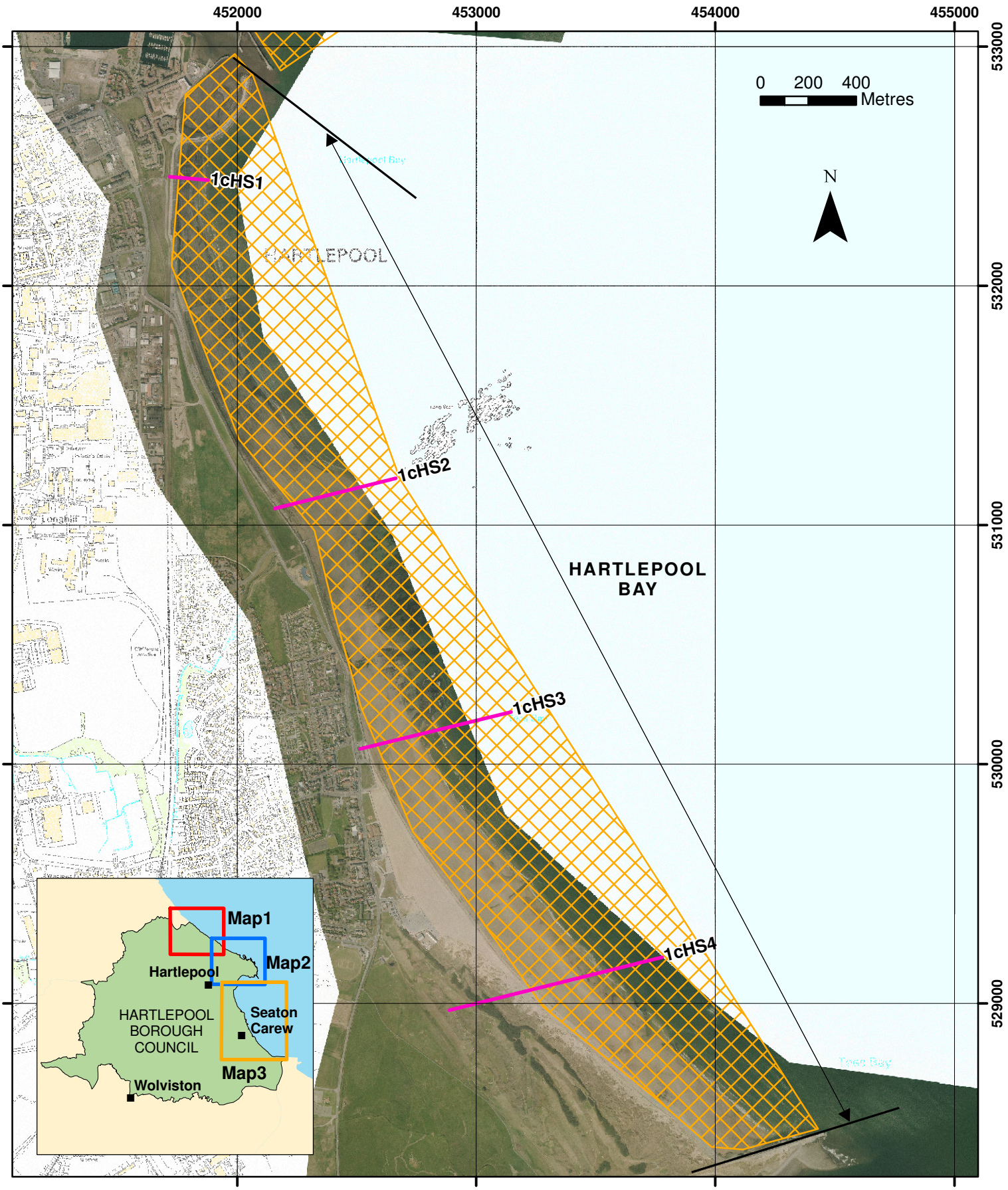

TOPOGRAPHIC SURVEY LOCATIONS

- Annual Profile
- Bi-Annual Profile
- 6 monthly Survey
- Yearly Survey
- 5 yearly Survey
- Cliff Top Survey @ 50 centres
- Cliff Top Survey @ 100 centres
- Cliff Top Survey @ 300 centres

(Indicative Survey Extents shown)

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

Figure 2 - Map 3 Hartlepool Borough Council Frontage

Analytical Report 3
'Full Measures' Survey 2010

Drawing Scale 1:21,000 at A4

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2. Analysis of Survey Data

2.1 North Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
09-2010	**Beach Profiles:** North Sands is covered by four beach profile lines during the Full Measures survey (Appendix A). HN1 is located within Durham County Council's jurisdiction, about 400m north of the outfall of Crimdon Beck, but has been reported here so changes can be interpreted in association with those observed elsewhere along North Sands at HN2, HN3 and HN4. The large berm previously reported in March 2010 at around MSL had been modified, with a general flattening at MSL and movement of most sediment seawards to notably increase levels along the lower profile. A small amount of landward recession, around 4m, occurred at the break of slope between the gravelly sand at the toe of the dunes and the flatter sandy profile, but this was well within the bounds of previously recorded change. There was no measureable change to the main seaward dune crest. The lowering which previously occurred at the toe of the dunes along HN2 between September 2009 and March 2010 showed recovery between March 2010 and September 2010, with upper foreshore levels increasing between the toe of the dunes and a chainage of around 170m, in places by up to 0.8m. Between chainages of around 170m and 250m there was a similar lowering in levels, but seaward of 250m the profile levels again increased, with a berm formed at the seaward extent of the transect. Profile HN3 commences by crossing the slag embankment that protects the former Britmag site. This showed no change in position since the March 2010 survey, but the fronting small dune ridge showed further growth due to sediment deposition since March 2010. Seaward of around MHWS, the entire profile maintained the same form as previously recorded, but suffered a general lowering of around 0.3m.	North Sands has typically been characterised by the redistribution of sediment since monitoring began in November 2008, with typical winter flattening and summer build up of the foreshore. This pattern is apparent in the March 2010 and September 2010 surveys, but complicated by some alongshore changes so that the frontage does not necessarily behave consistently along its length. HN1 has been typically characterised by changes associated with redistribution of sediment previously stored within a large previous berm (March 2010), with berm flattening and movement of sediment seawards to the lower foreshore. HN2 showed an upper foreshore increase in levels, mid beach lowering, and a small berm newly formed at the seaward end. HN3 continues to show stable slag banks, with the small dune at its toe continuing to accrete, with modest lowering of levels along the entire foreshore.

Survey Date	Description of Changes Since Last Survey	Interpretation
09-2010	Along HN4, there was slight further lowering immediately at the toe of the sea wall, but general recovery of previously low foreshore levels seaward of here to a chainage of around 60m. The berm previously recorded in March 2010 at a chainage of around 105m had become flattened and the sediment deposited at the seaward end of the profile, including coverage of the rock outcrops with a sand veneer at the seaward limit of the transect.	HN4 showed an accreting upper foreshore, with redistribution of material from the previously recorded berm to form a sand veneer across the rock outcrops at the seaward end of the transect. Along profiles HN1 and HN2, the dunes remained stable and along HN3 the slag embankment remained stable. For HN2 this is particularly relevant because the Update Report 2 (May 2010) identified an over-steepened 'cliff-edge' to the dunes which could lead to future slumps. These have not, to date, occurred.
09-2010	**Topographic Survey:** North Sands is covered by an annual topographic survey. [Note: Every five years, starting from the 2008 baseline survey, coverage is extended further north along North Sands and further south around Hartlepool Headland, but this was not scheduled for the present survey.] Data from the 2009 Full Measures survey have been used to create a DGM (Appendix B – Map 1a) using a Geographic Information System (GIS) computer software package. This shows that the mid and upper beach contours recorded in September 2010 were relatively consistent across the frontage, with the highest upper beach zones reducing slightly in width to the south where the sea wall begins. The lower beach was, however, much more typified by berms along discrete lengths. The GIS has also been used to calculate the differences between the current topographic survey and the earlier (November 2008) topographic survey, as shown in Appendix B – Map 1b, to identify areas of erosion and accretion. Since the previous topographic survey in September 2009, North Sands has suffered notable lowering of the upper beach along its entire length, with the central zone experiencing erosion across its whole inter-tidal width. The northern zone suffered the greatest lowering of the upper foreshore, but material was deposited further down the profile on the mid and lower beach causing modest accretion, although a mid beach berm previously recorded in September 2009 became flattened.	Whilst the 6-monthly beach profile transects show typical seasonal behaviour of North Sands, the annual topographic survey is intended to identify longer terms trends of net erosion or accretion. At present the surveys are too short to determine any significant longer term trends, but the changes between September 2009 and September 2010 are showing that the changes identified by the beach profiles are generally typical of the entire frontage, with berm formation/flattening and redistribution of sediment from upper to lower foreshore areas in many sections. The lowering across the entire foreshore width in the central section of the frontage does suggest that since September 2009 there may have been a net loss of sediment from the frontage, rather than purely redistribution, but future datasets will aid in this understanding.

2.2 Middleton

Survey Date	Description of Changes Since Last Survey	Interpretation
09-2010	**Beach Profiles:** Middleton is covered by one beach profile line during the Full Measures survey (Appendix A). Profile HC1 experienced significant lowering at the toe of the vertical wall between September 2009 and March 2010 and this process continued (but only directly at the toe of the wall) to September 2010, with levels at the toe now at a low level of 1.04mODN. In September 2009, the beach level at the toe was some 1.9m higher than at present. Seaward of the toe of the wall, however, the profile experienced accretion to a chainage of around 135m, with levels increasing by up to 0.3m in places.	Whilst the changes along most of the transect are within the bounds of previously recorded changed, the levels directly at the toe of the wall are particularly low, being 1.9m lower than those recorded in September 2009. This should be monitored for signs of recovery or further lowering, the latter potentially leading to wall undermining.
	Topographic Survey: Middleton is covered by an annual topographic survey between Middleton Jetty and North Pier. Data from the 2009 Full Measures survey have been used to create a DGM (Appendix B – Map 2a) using a Geographic Information System (GIS) computer software package. This shows that the beach contours recorded in September 2010 were relatively consistent across the frontage, with a slight accumulation of material directly adjacent to the breakwater arm of Hartlepool harbour. The GIS has also been used to calculate the differences between the current topographic survey and the earlier (November 2008) topographic survey, as shown in Appendix B – Map 2b, to identify areas of erosion and accretion. Since the previous topographic survey in September 2009, Middleton has experienced some lowering of the upper beach, especially along the section backed by the vertical wall in central and southern sections of the frontage. This has been confined to a relatively narrow band along the upper beach, with modest accretion typically experienced across the mid and lower foreshores.	Whilst the 6-monthly beach profile survey shows typical seasonal behaviour of Middleton, the annual topographic survey is intended to identify longer terms trends of net erosion or accretion. Whilst there has been some redistribution of sediment between September 2009 and September 2010, this is of a fairly modest scale and does not indicate a net trend. Continued monitoring of this frontage will help build up a longer term understanding of such changes.

2.3 Hartlepool Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
10-2010	**Beach Profiles:** Hartlepool Bay is covered by four beach profile lines during the Full Measures survey (Appendix A). HS1 is located approximately 150m south of the root of the South Pier. The profile starts at the wall to the rear of the promenade and extends across the promenade, over the fronting concrete splash wall and down the sloping face of the rock armour revetment before reaching the beach. It then gently slopes down to low water. The profile experienced lowering by around 0.25m along its entire length, maintaining the same form. Similarly, profile HS2 experienced lowering along most of its length, maintaining the same form. Typically levels were around 0.1m lower than those recorded in March 2010. In contrast, profile HS3 experienced general accretion along its length. This was modest along the upper beach (to a chainage of around 125m) with generally slight depressions being infilled, but further seaward levels increased by up to 0.2m along the remainder of the transect. HS4 is located further south, around 1km north of the North Gare breakwater. It is in the area of undefended dunes at Seaton Sands. The profile covers approximately 350m of dunes before reaching beach level. There has been some very slight accretion on the seaward face of the dunes at around MHWS and above, with some modest foreshore lowering, by up to around 0.2m, around 50m either side of the MWL mark.	The foreshore lowering along the entire lengths of HS1 and HS2, as well as a short section of HS4, is very modest and well within the bounds of previously recorded behaviour. Interestingly, HS3 experienced general accretion, again on a modest scale, but this is the reverse of the trend observed further north (along HS1 and HS2) and further south (HS4).
	Topographic Survey: Hartlepool Bay is covered by an annual topographic survey between the South Pier and the North Gare Breakwater. Data from the 2009 Full Measures survey have been used to create a DGM (Appendix B – Map 3a) using a Geographic Information System (GIS) computer software package.	The survey shows relatively uniform contours along the frontage, with higher beach levels towards the North Gare Breakwater and in the Seaton Carew dunes. The shoreline is ‘pulled’ seawards directly in the lee of Long Scar.

Survey Date	Description of Changes Since Last Survey	Interpretation
	The GIS has also been used to calculate the differences between the current topographic survey and the earlier (September 2009) topographic survey, as shown in Appendix B – Map 3b, to identify areas of erosion and accretion. Generally, the foreshore experienced relatively modest changes, with some degree of upper foreshore lowering and lower foreshore accretion along many sections. The redistribution of sediment became more widespread towards the southern end of the frontage.	Changes observed along Hartlepool Bay are very modest and well within bounds of previously observed behaviour.

3. Problems Encountered and Uncertainty in Analysis

It should be noted that beach profile HN1 is located within Durham County Council's jurisdiction but has been reported here so changes can be interpreted in association with those observed elsewhere along North Sands, along HN2, HN3 and HN4.

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

No changes are needed at the present time.

5. Conclusions and Areas of Concern

- North Sands continues to be characterised by the redistribution of sediment between successive surveys, but not necessarily adopting an entirely consistent trend along its length. This is because the changes tend to be associated with the formation or flattening of berms along the mid or lower beach, superimposed on general accretion or lowering of levels.

- Since September 2009, the upper foreshore along the entire length of North Sands has suffered lowering, and this has extended across the whole foreshore width in the central section of the frontage. Continued monitoring will reveal whether this is part of the cycles of sediment redistribution or whether this is representative of a longer term trend of erosion.

- Whilst profile HN2 still appears to have an over-steepened 'cliff-edge' following the erosion damage during the winter of 2009/10, no slumping was observed between March 2010 and September 2010.

- Foreshore levels directly at the toe of the vertical wall in Middleton are now some 1.9m lower than those recorded in September 2009, although parts of the foreshore did increase in level by up to 0.3m through accretion.

- Changes observed along Hartlepool Bay are very modest and well within bounds of previously observed behaviour.

Appendices

Appendix A

Beach Profiles

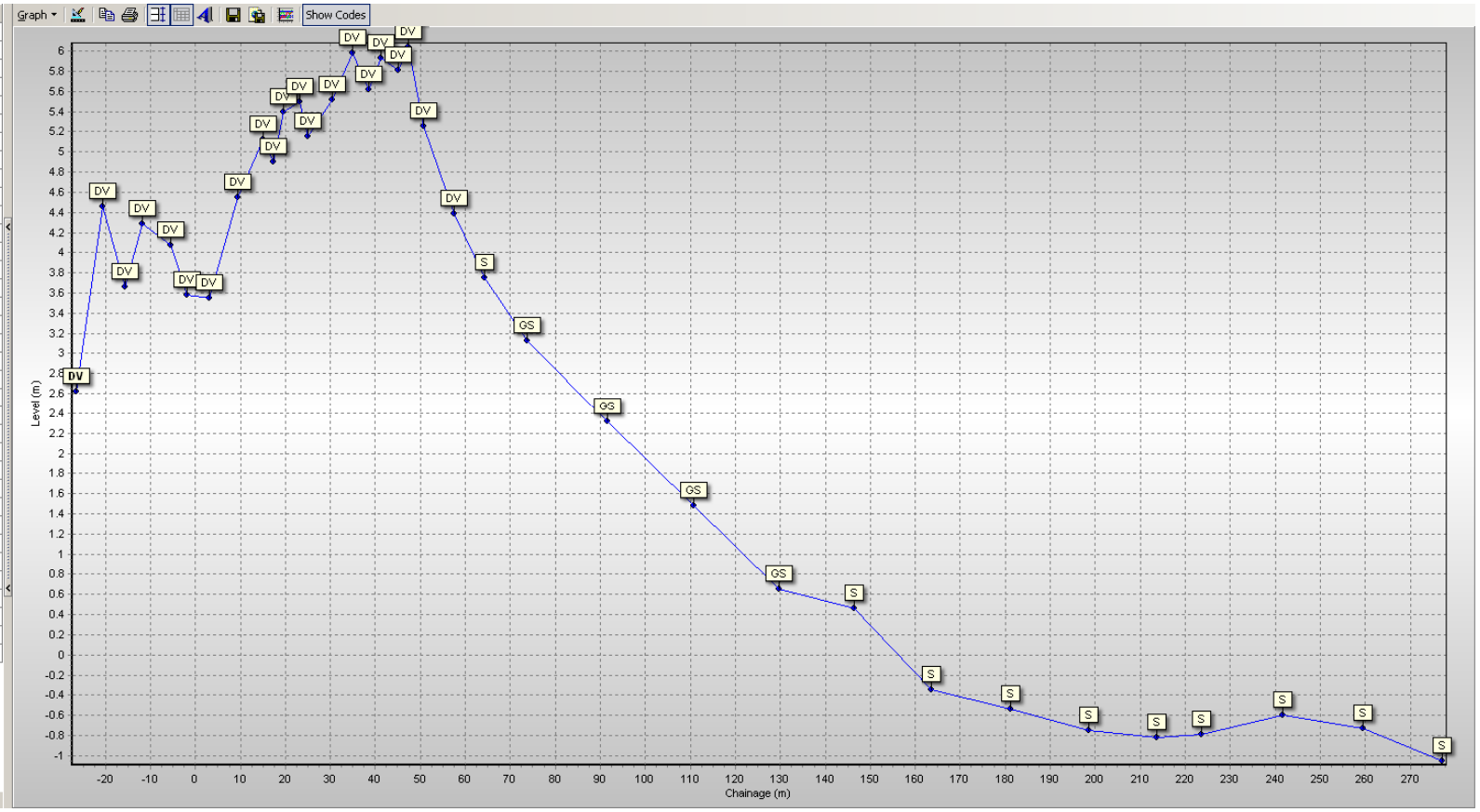
The following sediment feature codes are used on some profile plots:

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

Hartlepool

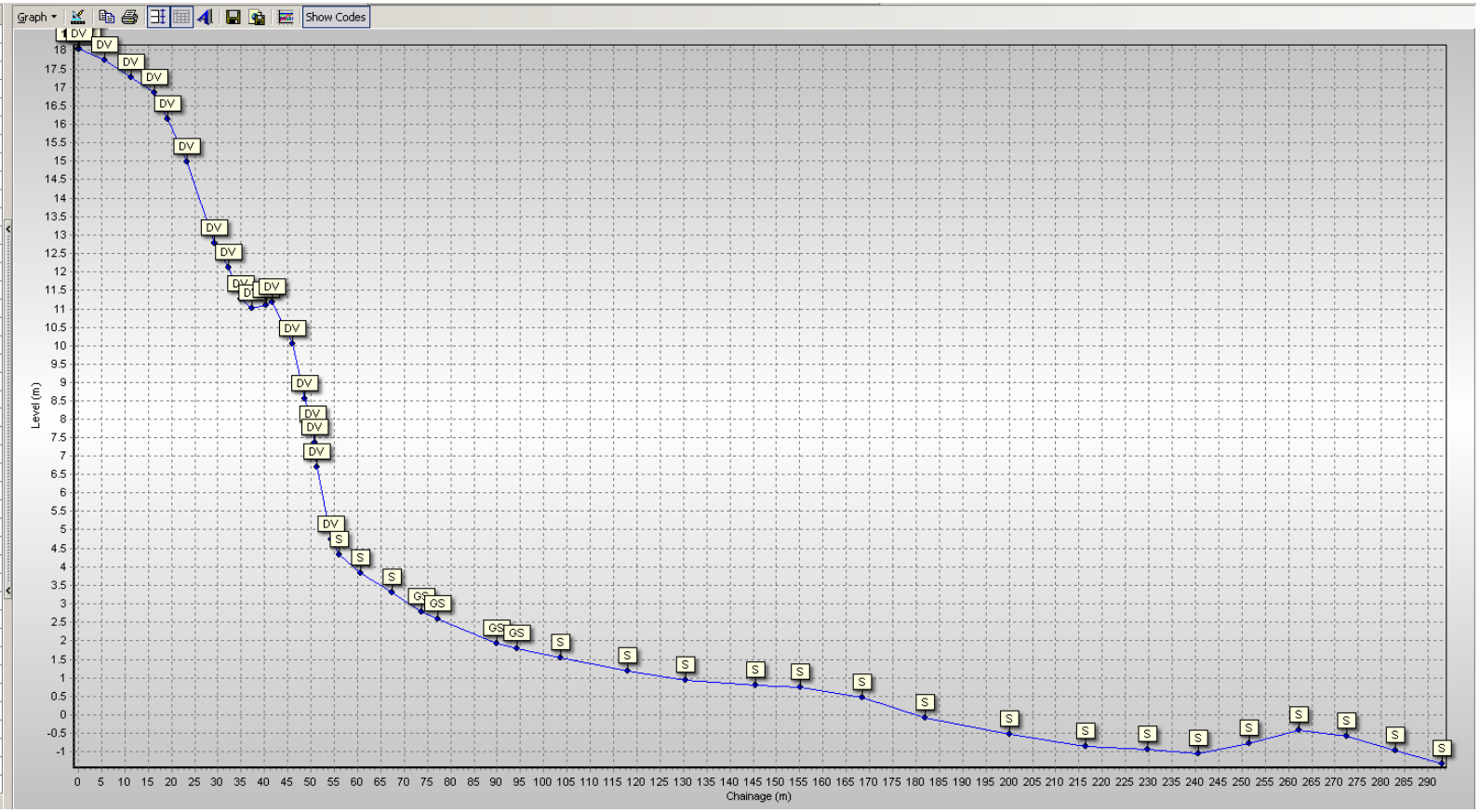
1cHN1 - 29/09/2010

Chainage	Level	Code
-26.449	2.617	DV
-20.610	4.455	DV
-15.651	3.661	DV
-11.717	4.289	DV
-5.498	4.073	DV
-1.887	3.581	DV
3.067	3.554	DV
9.506	4.545	DV
15.086	5.122	DV
17.317	4.897	DV
19.527	5.396	DV
23.190	5.495	DV
24.904	5.149	DV
30.336	5.513	DV
34.938	5.983	DV
38.435	5.619	DV
41.324	5.934	DV
45.078	5.806	DV
47.430	6.042	DV
50.704	5.252	DV
57.533	4.386	DV
64.279	3.755	S
73.773	3.124	GS
91.560	2.319	GS
110.848	1.476	GS
129.668	0.656	GS
146.462	0.463	S
163.624	-0.342	S
181.119	-0.542	S
198.625	-0.745	S
213.660	-0.822	S
223.628	-0.791	S
241.644	-0.595	S
259.582	-0.731	S
277.093	-1.052	S



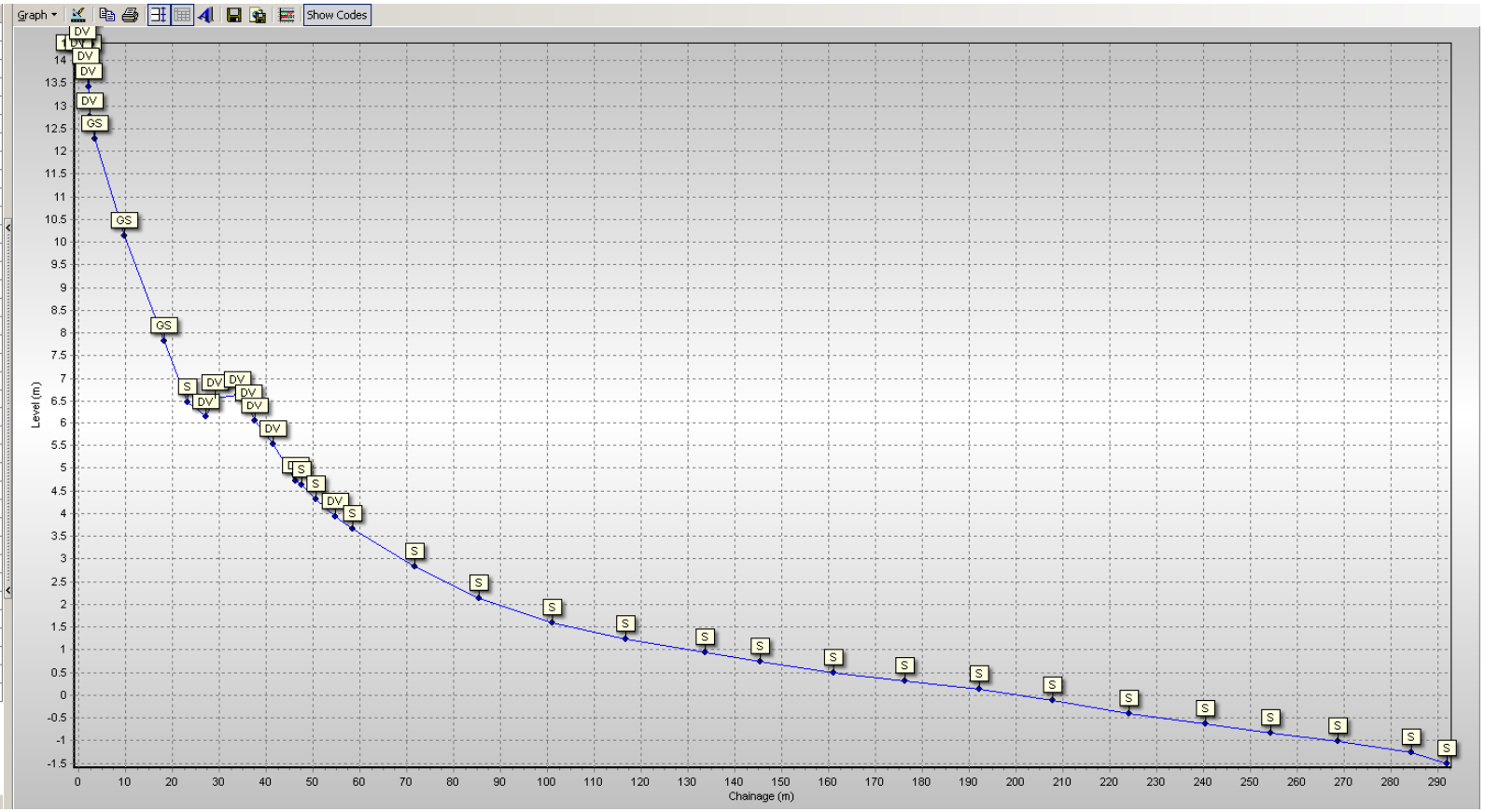
1cHN2 - 29/09/2010

Chainage	Level	Code
0.000	18.037	
0.239	18.037	DV
5.715	17.737	DV
11.384	17.259	DV
16.383	16.856	DV
19.272	16.149	DV
23.446	14.974	DV
29.346	12.777	DV
32.354	12.122	DV
34.851	11.257	DV
37.363	11.017	DV
40.309	11.097	DV
41.747	11.188	DV
46.017	10.052	DV
48.659	8.578	DV
50.318	7.723	DV
50.846	7.351	DV
51.309	6.690	DV
54.257	4.750	DV
56.063	4.330	S
60.585	3.833	S
67.372	3.296	S
73.663	2.794	GS
77.287	2.597	GS
89.896	1.934	GS
94.322	1.790	GS
103.545	1.535	S
117.938	1.192	S
130.469	0.937	S
145.555	0.787	S
155.075	0.747	S
168.523	0.483	S
181.923	-0.075	S
200.061	-0.514	S
216.536	-0.839	S
229.852	-0.931	S
240.733	-1.043	S
251.553	-0.758	S
262.374	-0.423	S
272.552	-0.587	S
283.066	-0.962	S
293.037	-1.320	S



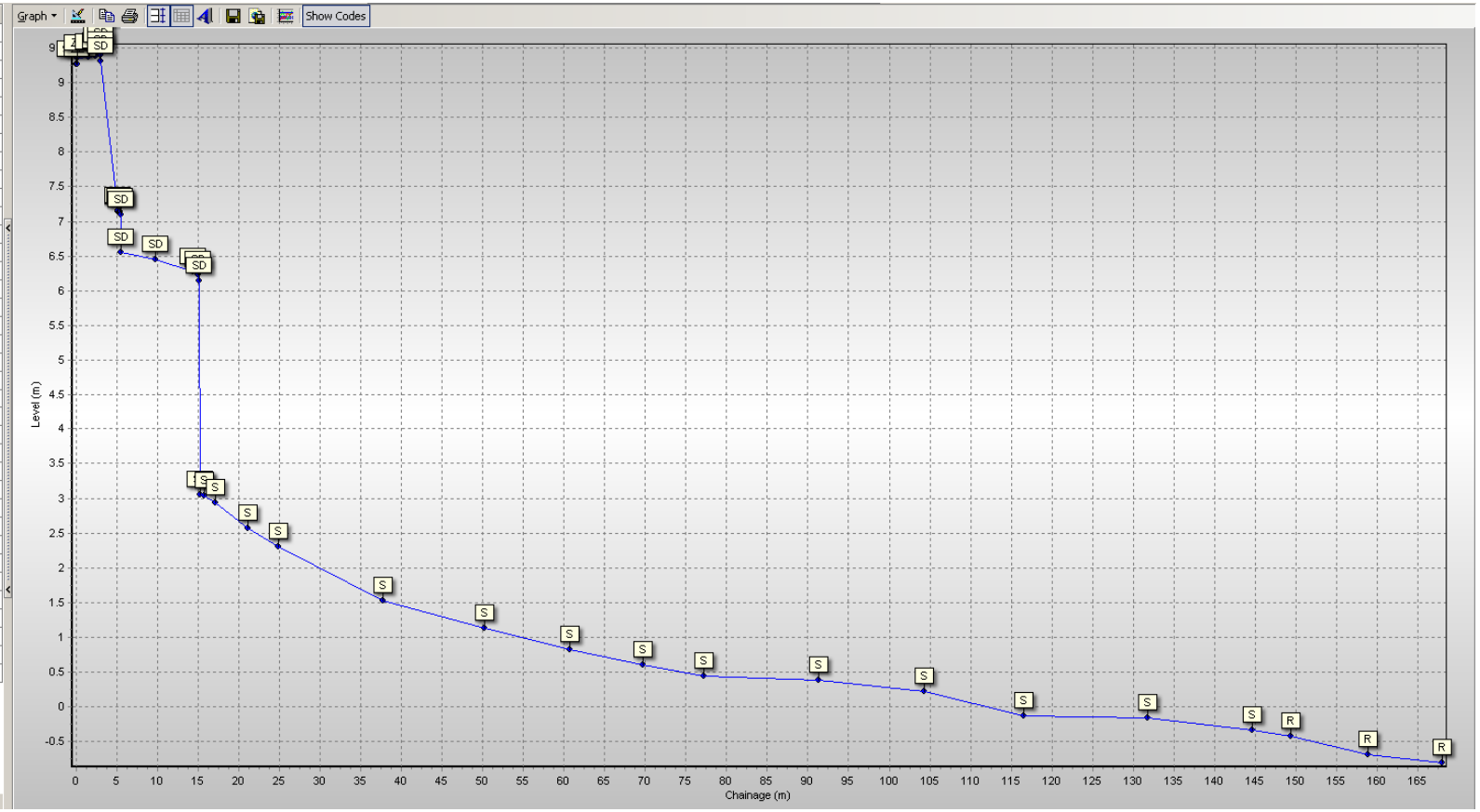
1cHN3 - 29/09/2010

Chainage	Level	Code
0.000	14.056	
0.037	14.056	DV
0.856	14.294	DV
1.536	13.752	DV
2.118	13.409	DV
2.422	12.771	DV
3.578	12.263	GS
9.763	10.126	GS
18.201	7.814	GS
23.287	6.467	S
27.081	6.128	DV
29.198	6.563	DV
33.846	6.640	DV
36.323	6.327	DV
37.664	6.040	DV
41.599	5.539	DV
46.359	4.718	DV
47.512	4.638	S
50.670	4.311	S
54.851	3.942	DV
58.575	3.661	S
71.745	2.823	S
85.369	2.134	S
101.016	1.596	S
116.691	1.239	S
133.766	0.945	S
145.394	0.741	S
161.034	0.488	S
176.362	0.317	S
192.077	0.145	S
207.838	-0.106	S
224.120	-0.400	S
240.385	-0.633	S
254.243	-0.838	S
268.683	-1.010	S
284.400	-1.261	S
291.939	-1.507	S



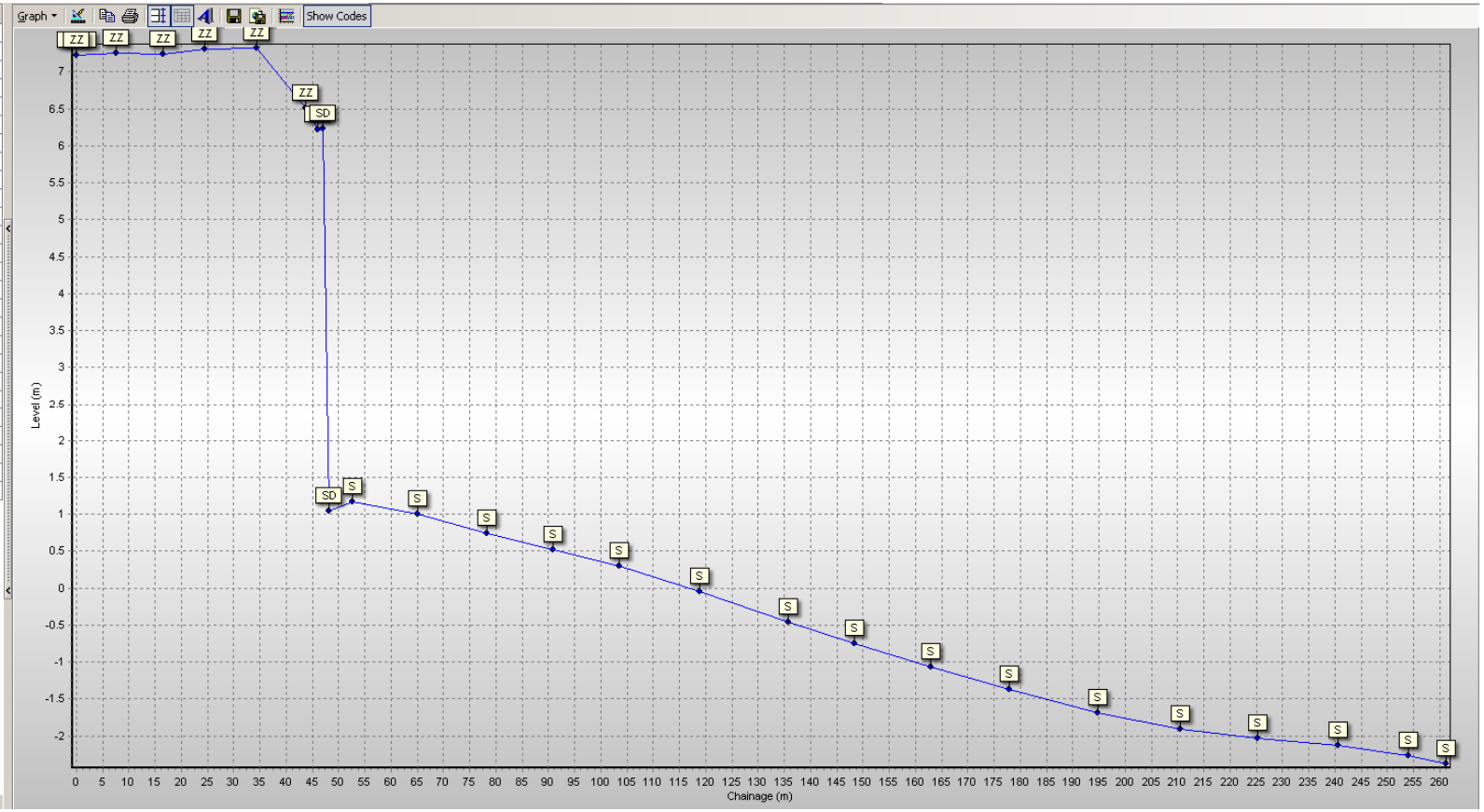
1cHN4 - 29/09/2010

Chainage	Level	Code
0.000	9.267	
0.168	9.267	ZZ
0.187	9.350	ZZ
1.487	9.374	ZZ
2.380	9.386	ZZ
2.491	9.478	SD
2.964	9.500	SD
3.014	9.398	SD
3.046	9.313	SD
5.155	7.141	SD
5.162	7.155	SD
5.433	7.147	SD
5.497	7.098	SD
5.502	6.557	SD
9.779	6.448	SD
14.377	6.281	SD
14.934	6.232	SD
15.142	6.151	SD
15.188	3.055	SD
15.758	3.040	S
17.152	2.934	S
21.111	2.572	S
24.913	2.298	S
37.723	1.522	S
50.223	1.130	S
60.652	0.822	S
69.674	0.598	S
77.218	0.448	S
91.261	0.389	S
104.339	0.231	S
116.506	-0.135	S
131.819	-0.162	S
144.711	-0.331	S
149.458	-0.426	R
158.871	-0.685	R
168.019	-0.802	R



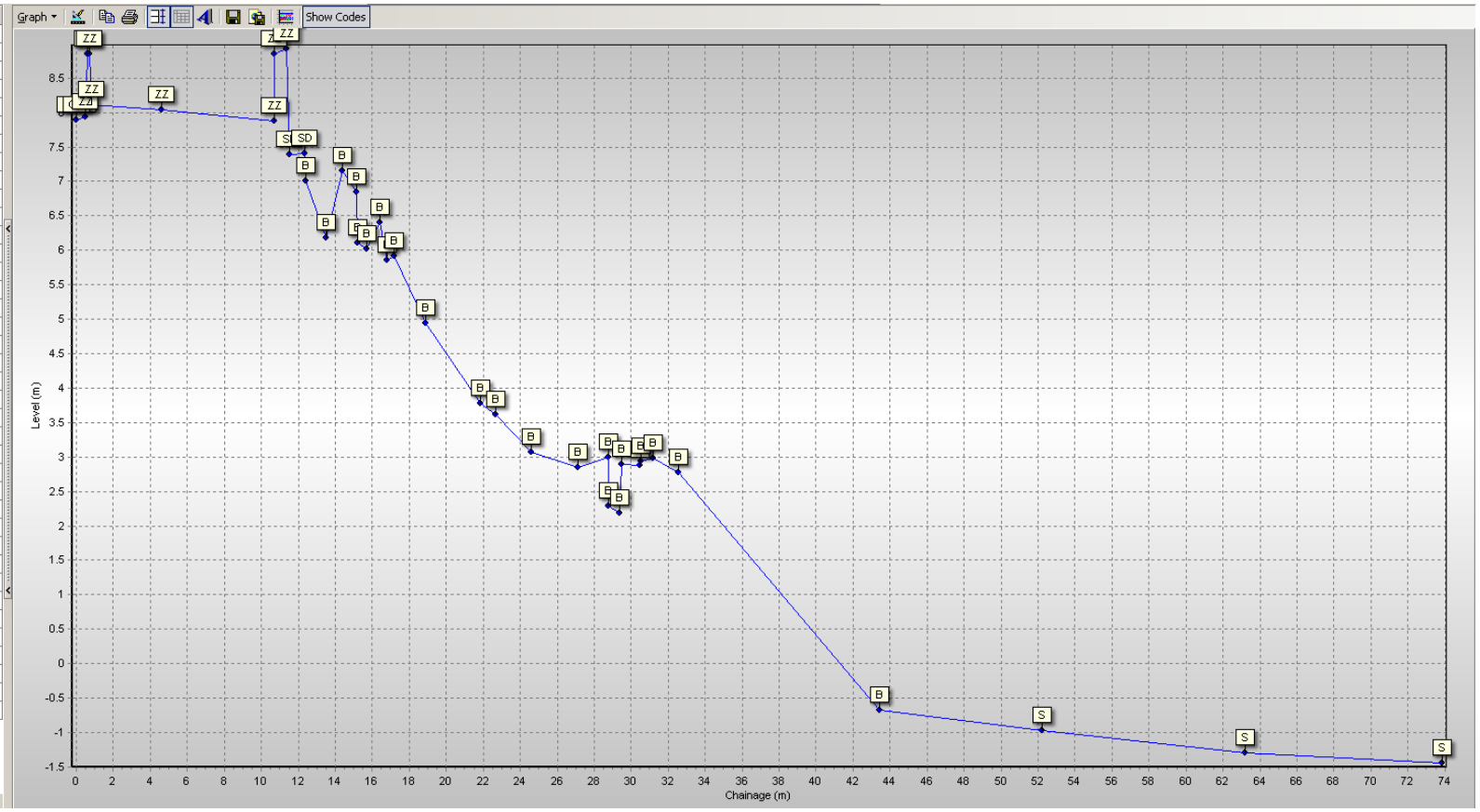
1cHC1 - 08/09/2009

Chainage	Level	Code
0.000	7.222	
0.022	7.222	ZZ
7.560	7.250	ZZ
16.414	7.239	ZZ
24.540	7.311	ZZ
34.380	7.324	ZZ
43.752	6.510	ZZ
45.963	6.225	ZZ
47.019	6.229	SD
48.167	1.038	SD
52.533	1.175	S
65.127	0.997	S
78.348	0.735	S
90.958	0.525	S
103.556	0.299	S
118.887	-0.044	S
135.734	-0.460	S
148.308	-0.747	S
162.839	-1.064	S
177.931	-1.376	S
194.721	-1.693	S
210.408	-1.907	S
225.298	-2.029	S
240.493	-2.133	S
253.998	-2.266	S
261.167	-2.379	S



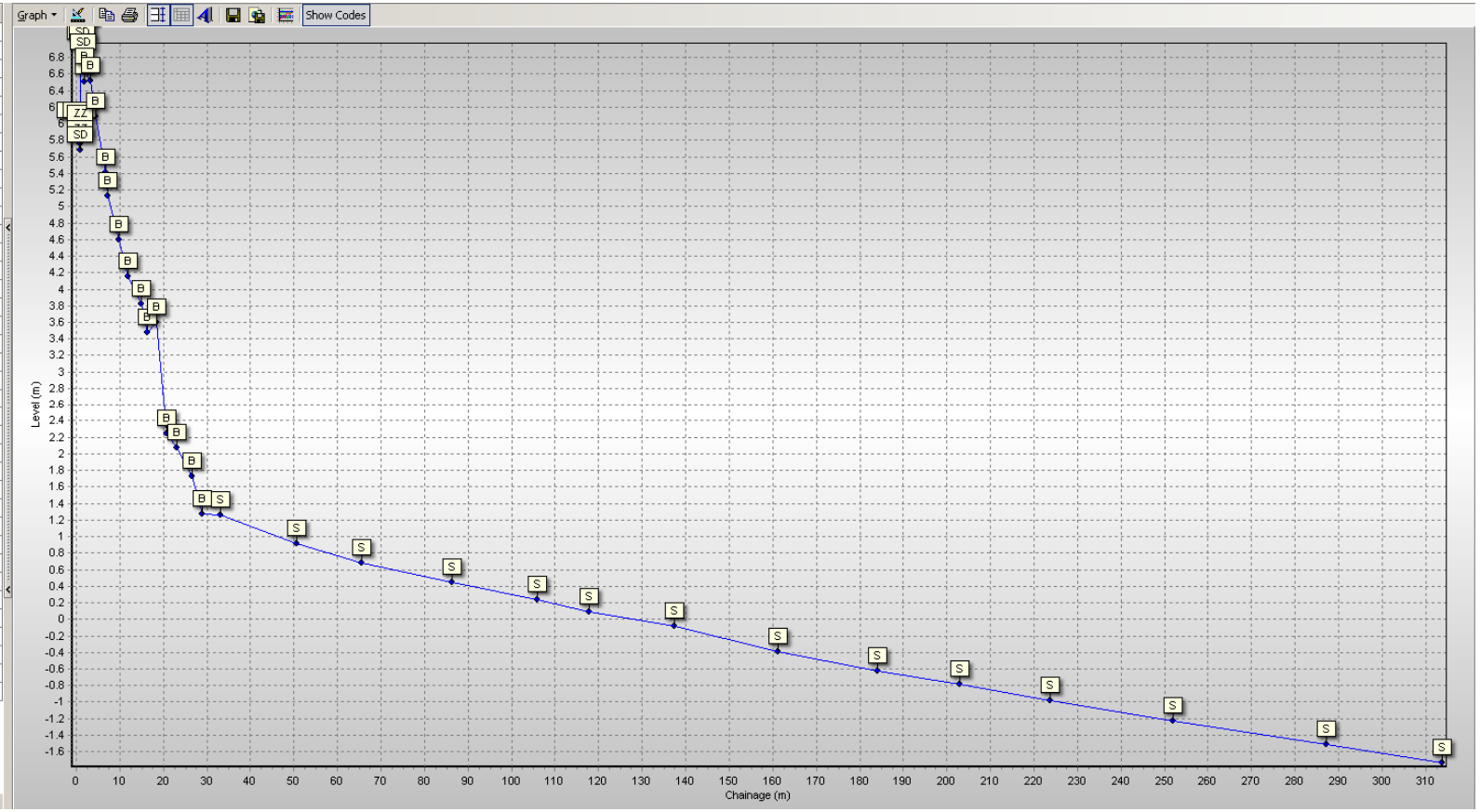
1cHS1 - 23/10/2010

Chainage	Level	Code
0.000	7.893	
0.013	7.893	GR
0.520	7.937	ZZ
0.586	8.856	ZZ
0.729	8.852	ZZ
0.835	8.113	ZZ
4.598	8.043	ZZ
10.687	7.881	ZZ
10.719	8.854	ZZ
11.393	8.924	ZZ
11.525	7.394	SD
12.351	7.408	SD
12.424	7.003	B
13.491	6.177	B
14.392	7.154	B
15.155	6.852	B
15.224	6.102	B
15.731	6.026	B
16.411	6.403	B
16.777	5.853	B
17.203	5.921	B
18.877	4.942	B
21.863	3.783	B
22.652	3.611	B
24.602	3.066	B
27.131	2.846	B
28.752	3.003	B
28.778	2.295	B
29.361	2.180	B
29.490	2.889	B
30.450	2.885	B
30.535	2.938	B
31.197	2.985	B
32.539	2.779	B
43.446	-0.675	B
52.236	-0.967	S
63.213	-1.301	S
73.854	-1.443	S



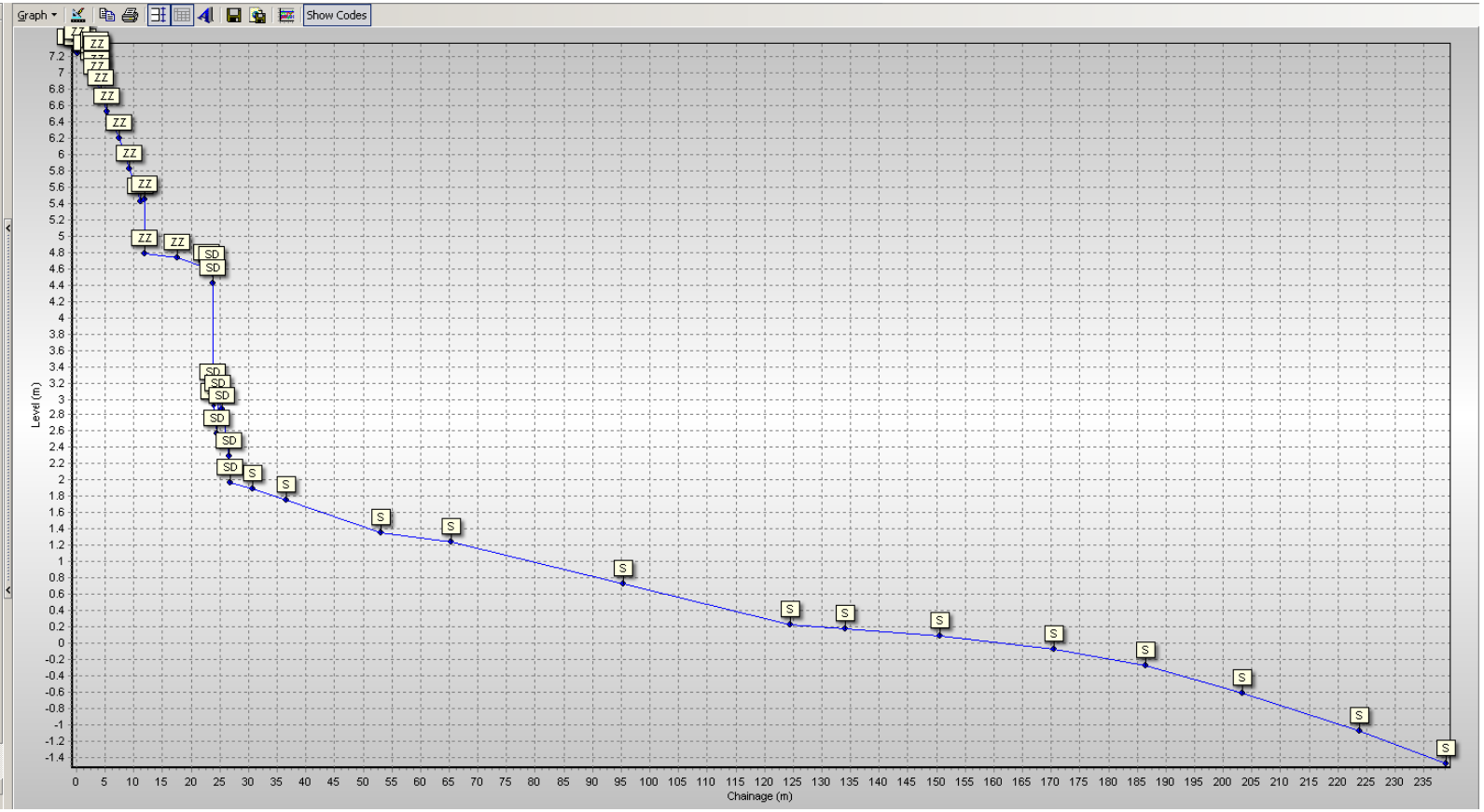
1cHS2 - 23/10/2010

Chainage	Level	Code
0.000	5.972	
0.046	5.972	ZZ
0.847	5.941	ZZ
0.854	5.760	ZZ
1.034	5.683	SD
1.038	6.921	SD
1.514	6.925	SD
1.701	6.802	SD
1.803	6.510	B
1.883	6.625	B
3.278	6.521	B
4.318	6.092	B
6.757	5.410	B
7.251	5.128	B
9.883	4.599	B
11.917	4.160	B
14.869	3.825	B
16.398	3.473	B
18.441	3.605	B
20.691	2.251	B
23.051	2.073	B
26.618	1.723	B
28.951	1.275	B
33.089	1.256	S
50.566	0.917	S
65.594	0.681	S
86.314	0.453	S
105.814	0.238	S
117.802	0.088	S
137.321	-0.078	S
161.140	-0.388	S
184.170	-0.622	S
203.086	-0.786	S
223.682	-0.976	S
252.042	-1.223	S
287.158	-1.507	S
313.802	-1.733	S



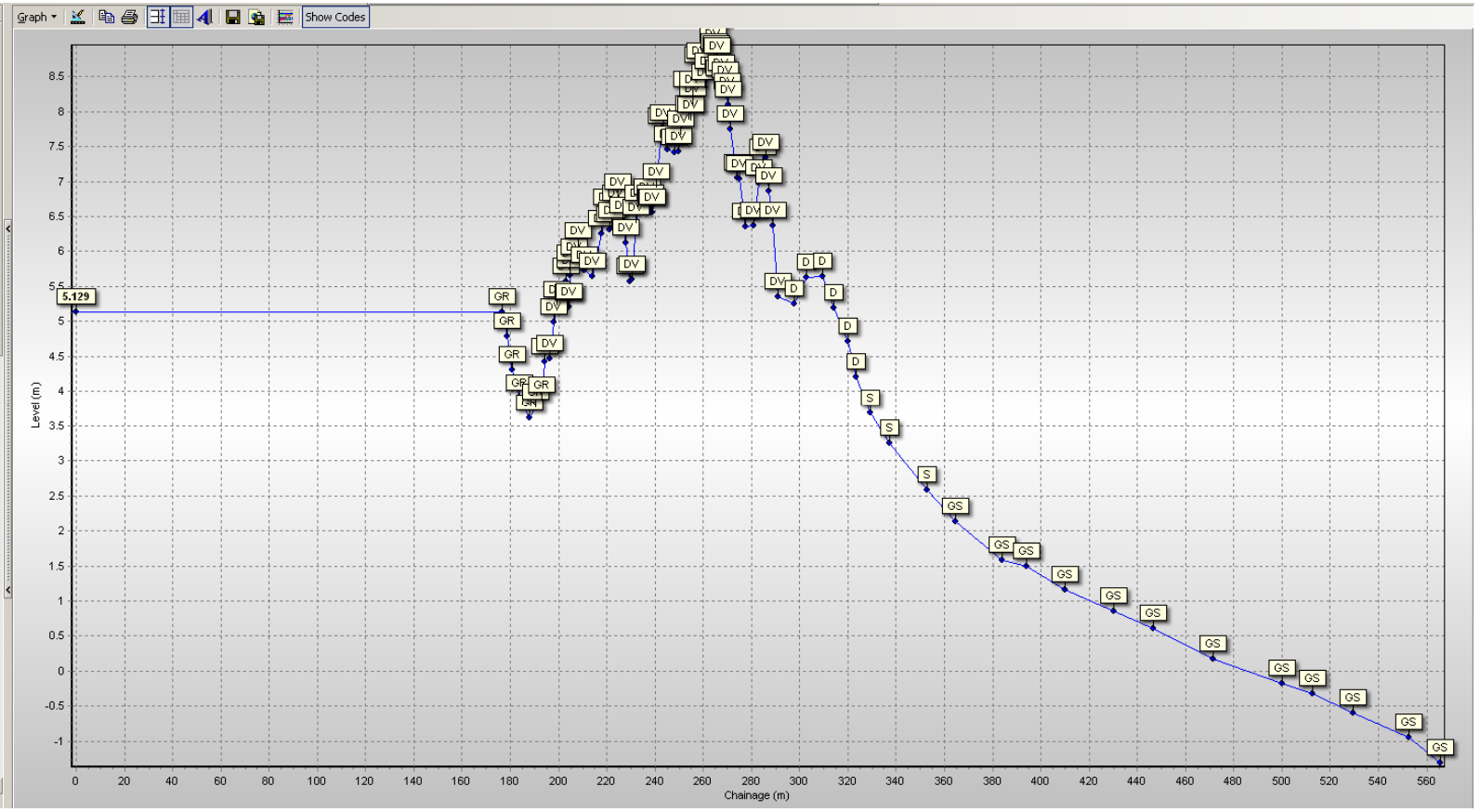
1cHS3 - 23/10/2010

Chainage	Level	Code
0.000	7.254	
0.031	7.254	ZZ
0.220	7.235	ZZ
0.237	7.311	ZZ
1.727	7.179	ZZ
2.949	7.066	ZZ
2.985	7.149	ZZ
3.081	7.206	ZZ
3.427	7.210	ZZ
3.495	7.157	ZZ
3.505	6.981	ZZ
3.523	6.977	ZZ
3.527	6.890	ZZ
4.231	6.748	ZZ
5.398	6.524	ZZ
7.427	6.200	ZZ
9.238	5.820	ZZ
11.153	5.421	ZZ
11.862	5.446	ZZ
11.876	4.784	ZZ
17.615	4.736	ZZ
22.741	4.615	ZZ
23.597	4.589	SD
23.794	4.426	SD
23.814	3.148	SD
23.992	2.914	SD
24.580	2.567	SD
24.708	3.014	SD
25.363	2.867	SD
26.701	2.287	SD
26.904	1.966	SD
30.675	1.890	S
36.614	1.744	S
53.142	1.354	S
65.329	1.234	S
95.349	0.725	S
124.578	0.219	S
134.051	0.169	S
150.557	0.083	S
170.426	-0.070	S
186.492	-0.270	S
203.391	-0.615	S

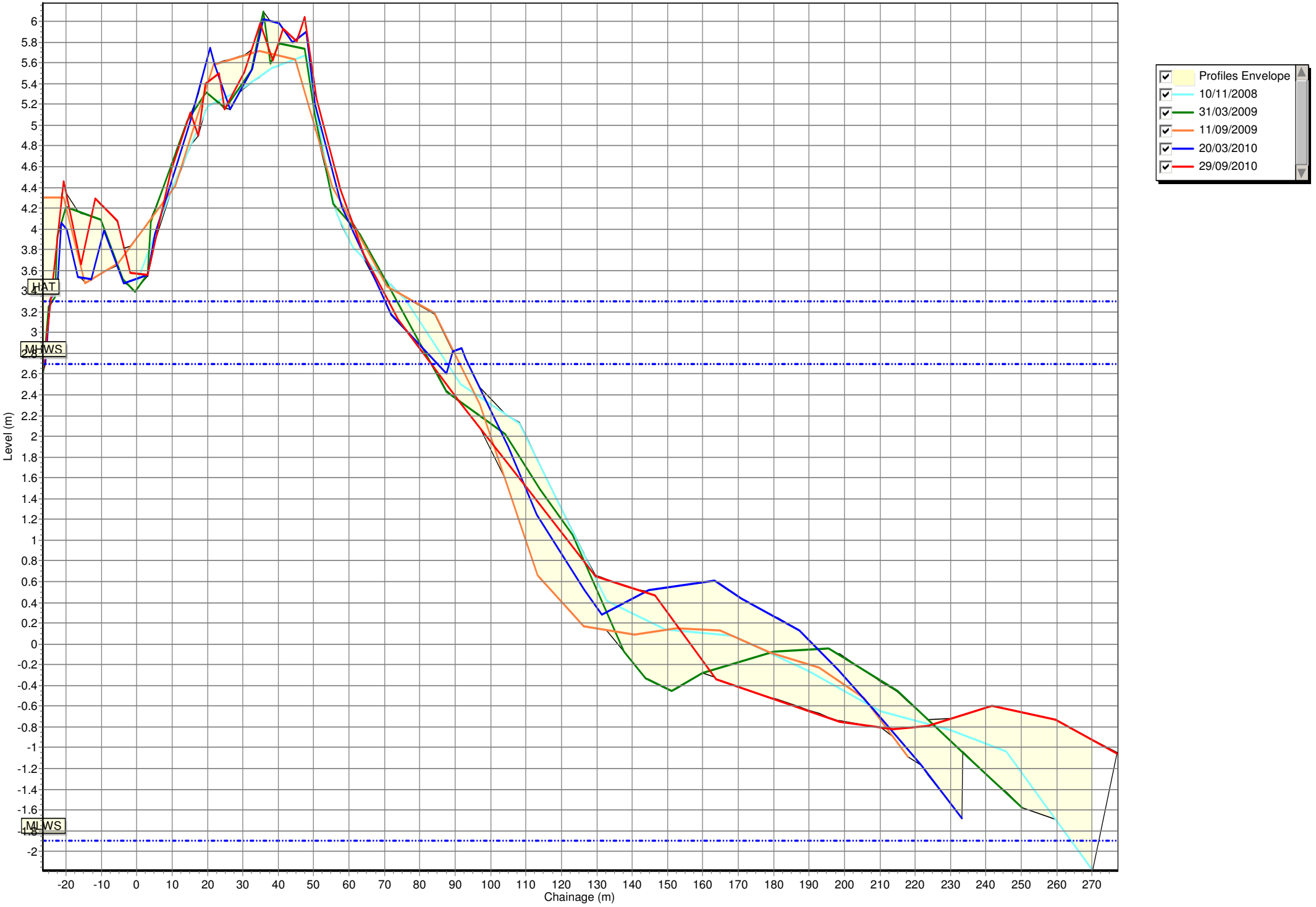


1cHS4 - 23/10/2010

Chainage	Level	Code
0.000	5.129	
176.569	5.129	GR
178.678	4.790	GR
180.679	4.311	GR
183.964	3.904	GR
188.167	3.612	GR
190.570	3.764	GR
192.984	3.871	GR
194.351	4.419	GR
196.385	4.463	DV
198.093	4.995	DV
199.343	5.235	DV
202.988	5.573	DV
203.869	5.198	DV
204.292	5.213	DV
204.797	5.657	DV
204.960	5.754	DV
206.656	5.843	DV
208.237	6.076	DV
210.694	5.735	DV
213.946	5.643	DV
217.807	6.253	DV
220.024	6.563	DV
221.030	6.312	DV
221.907	6.373	DV
223.623	6.612	DV
224.787	6.773	DV
226.502	6.443	DV
227.884	6.123	DV
229.802	5.573	DV
230.516	5.602	DV
232.133	6.412	DV
233.029	6.621	DV
236.659	6.696	DV
238.083	6.612	DV
238.476	6.557	DV
238.974	6.556	DV
240.540	6.923	DV
242.778	7.722	DV
243.455	7.766	DV
245.173	7.463	DV
248.161	7.414	DV



Beach Profiles: 1cHN1



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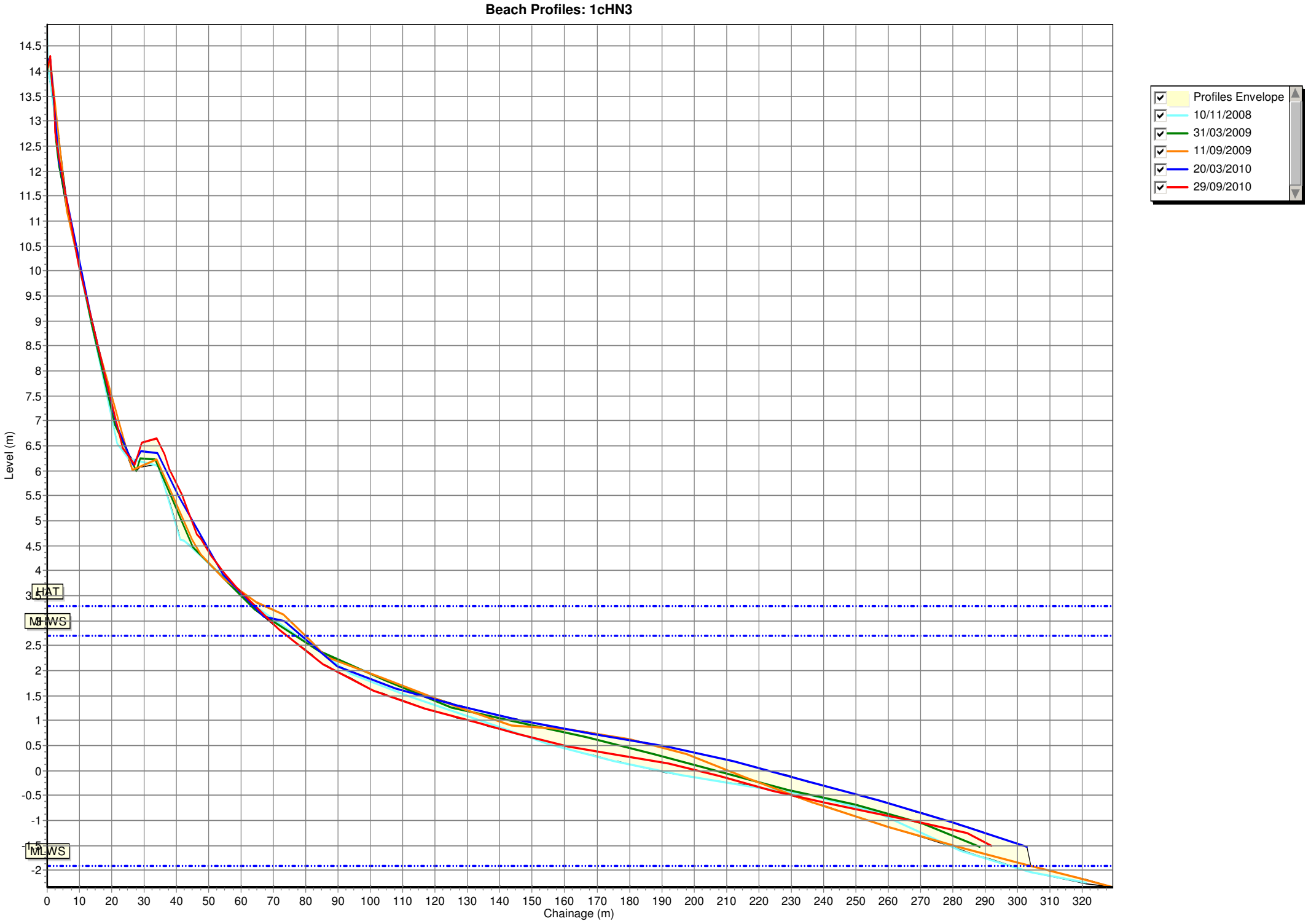
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Profiles Envelope
10/11/2008
31/03/2009
11/09/2009
20/03/2010
29/09/2010
HAT
MHWS
MLWS
Level (m)
Chainage (m)
14.5
14
13.5
13
12.5
12
11.5
11
10.5
10
9.5
9
8.5
8
7.5
7
6.5
6
5.5
5
4.5
4
3.5
3
2.5
2
1.5
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0
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-2
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50
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70
80
90
100
110
120
130
140
150
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170
180
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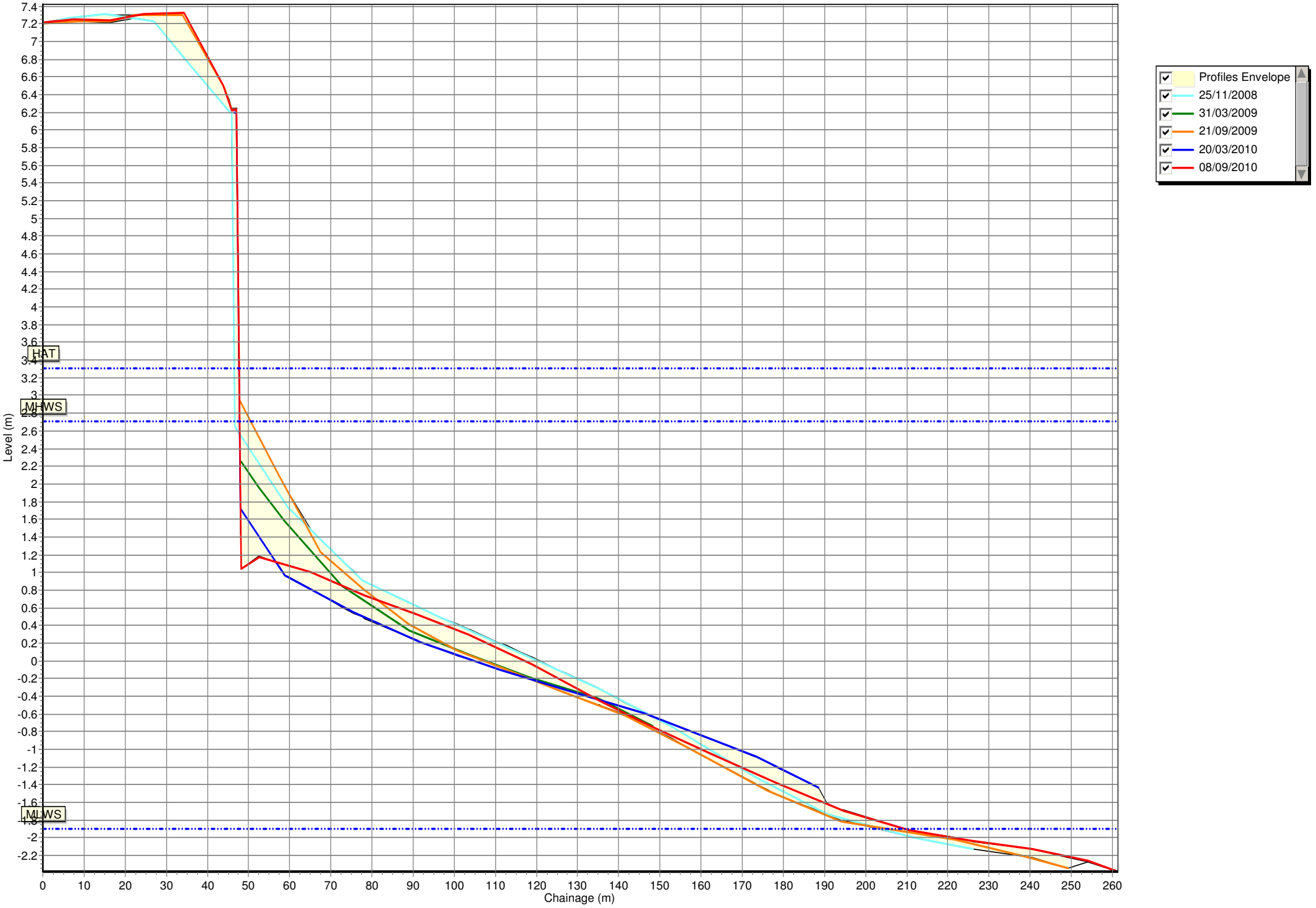
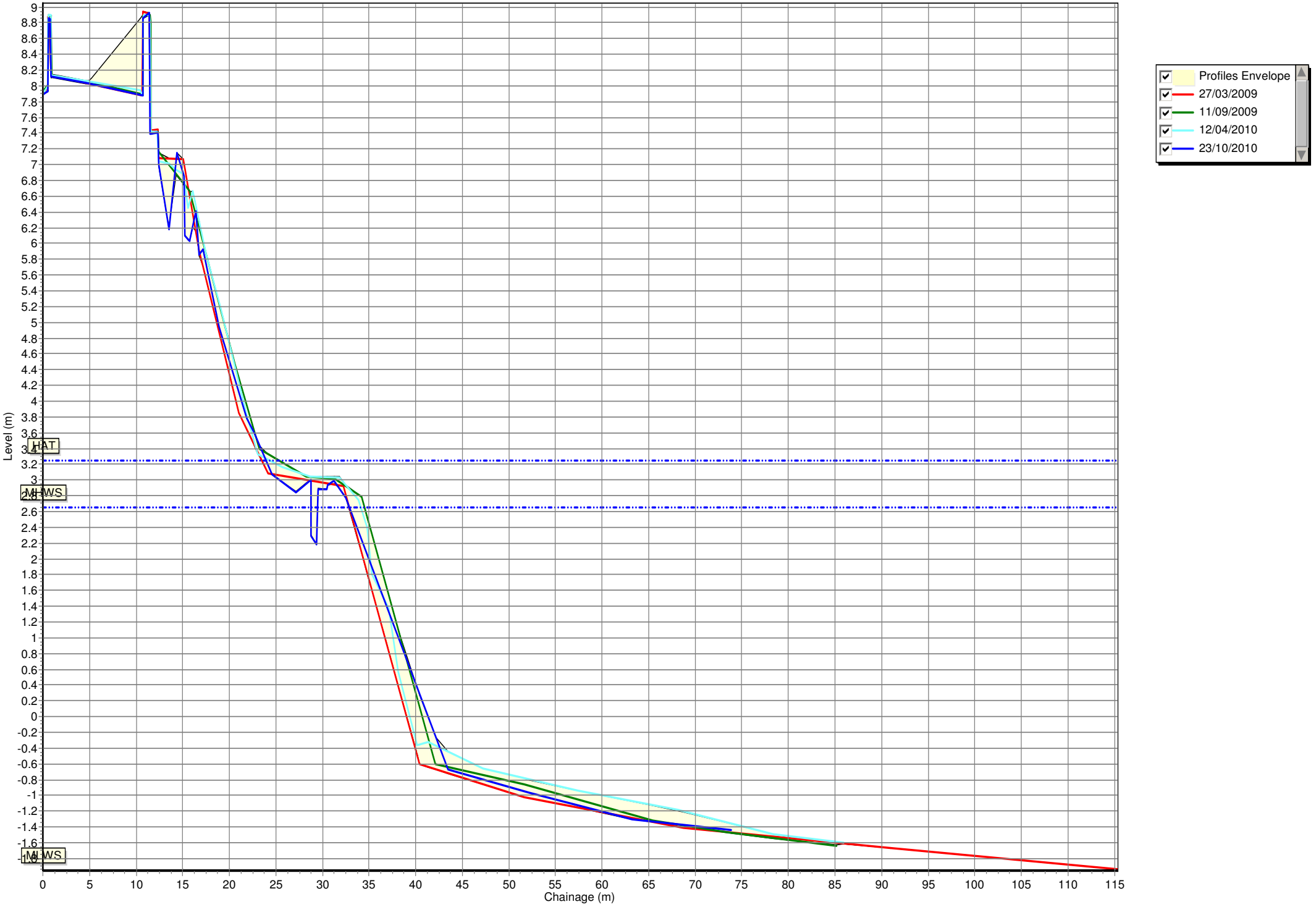
300
310
320

Beach Profiles: 1cHN4

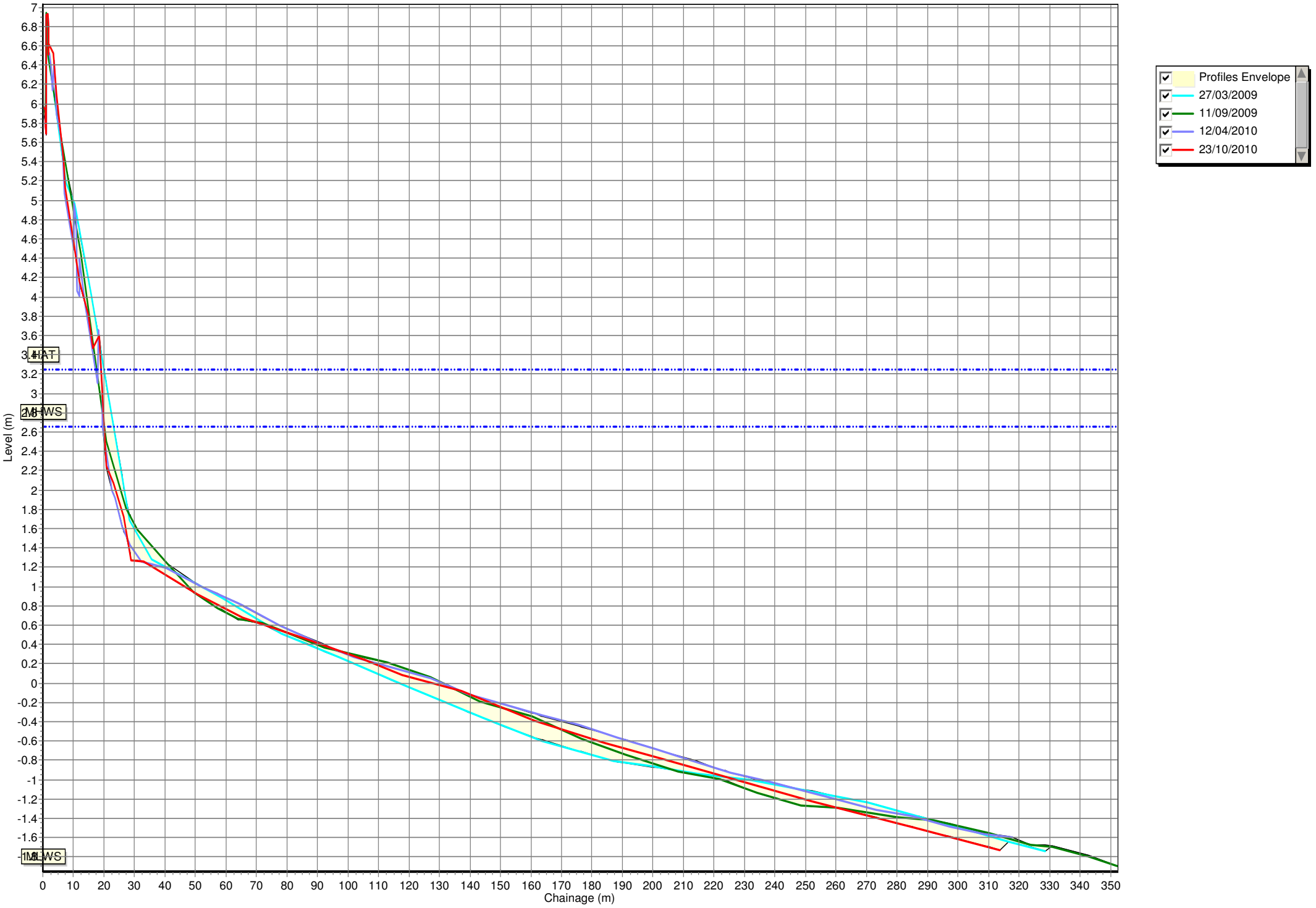
Beach Profiles: 1cHC1



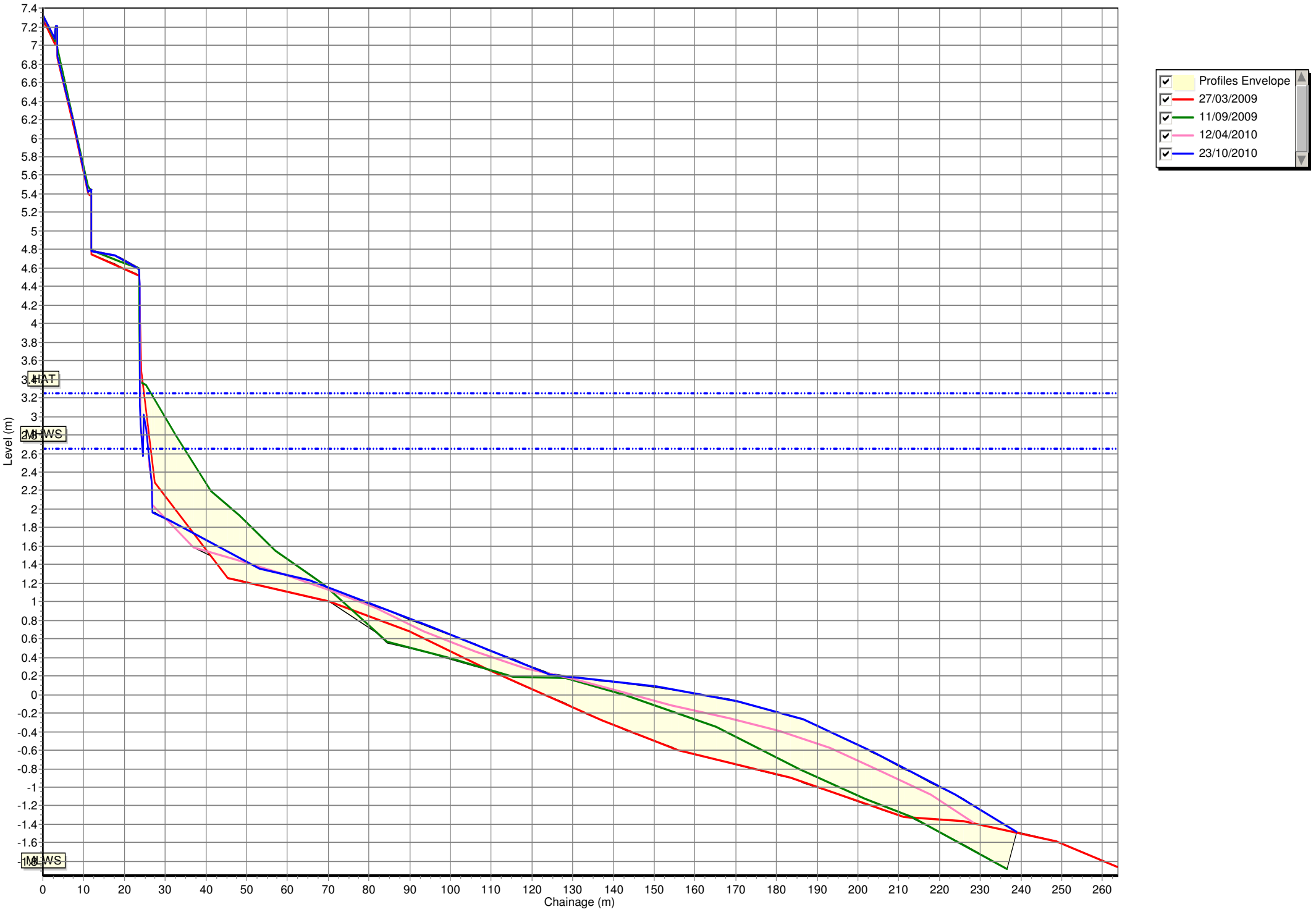
Beach Profiles: 1cHS1



Beach Profiles: 1cHS2



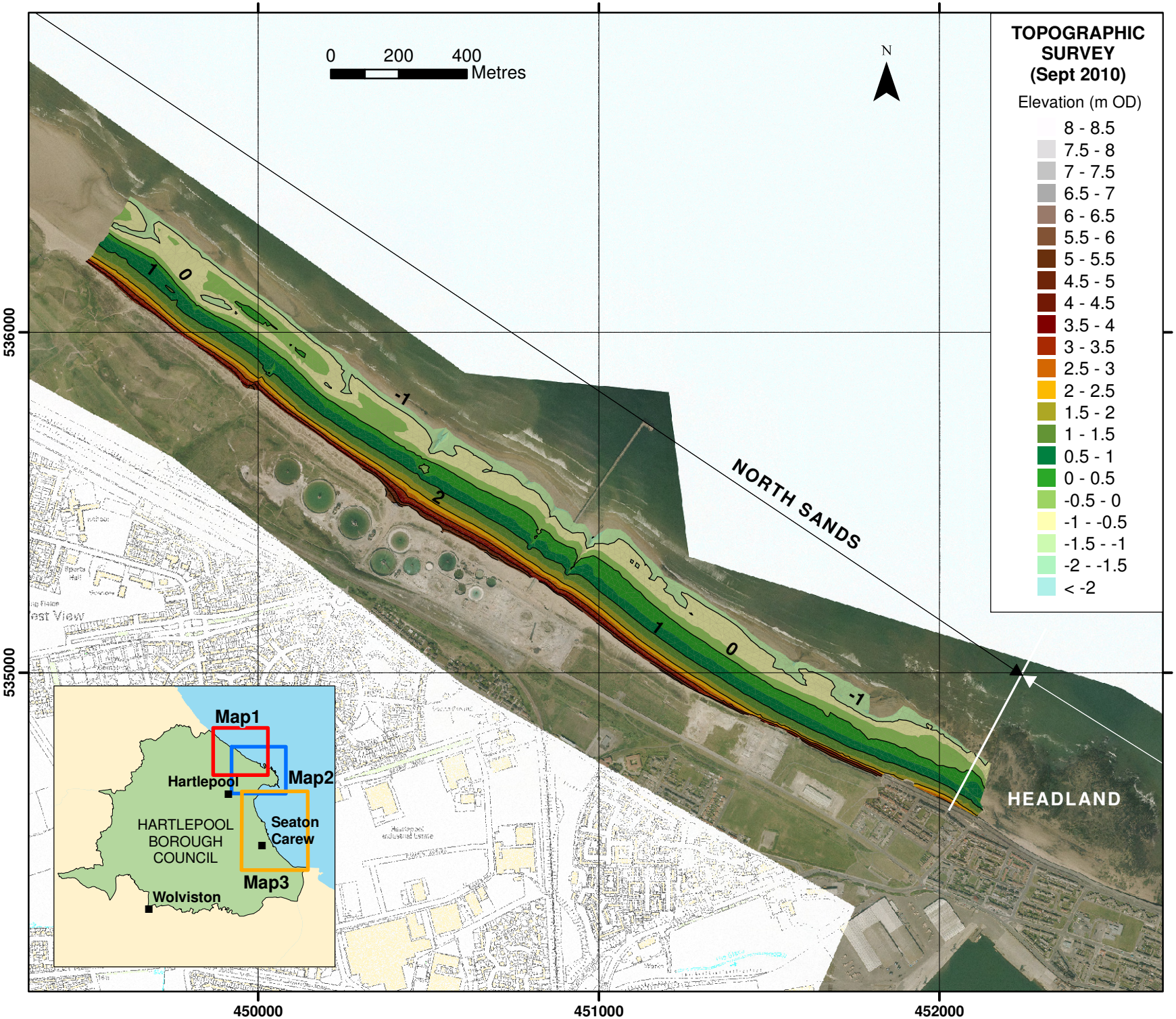
Beach Profiles: 1cHS3



Beach Profiles: 1cHS4

Appendix B

Topographic Survey



Topographic Contours at 1 metre interval

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 1a Hartlepool Borough Council Frontage

Analytical Report 3
'Full Measures' Survey 2010

Drawing Scale 1:15,000 at A4

Drawn by:	TC	Date:	28/10/2010
Checked by:	NC	Date:	05/11/2010
Approved by:	NC	Date:	05/11/2010

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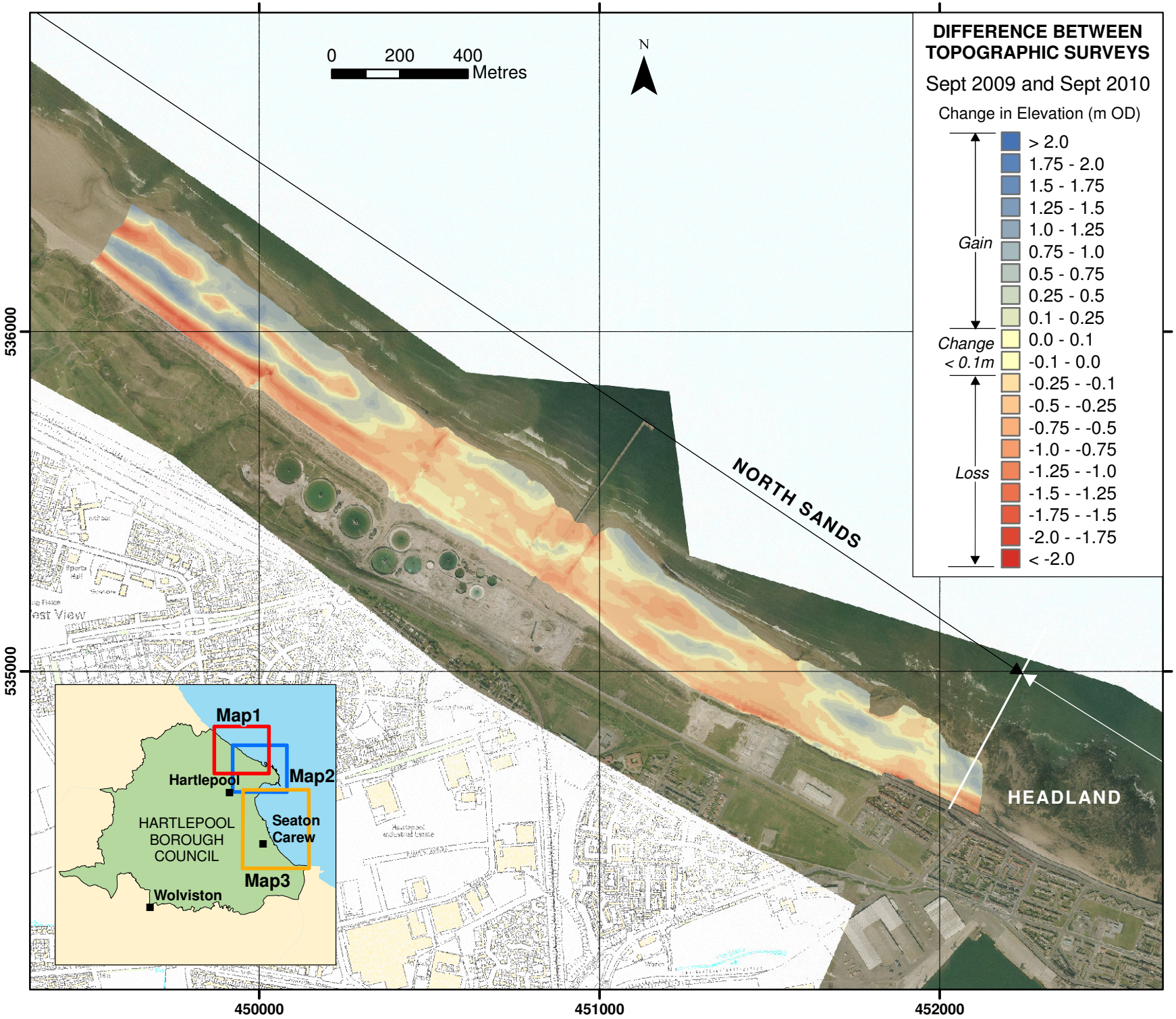
Photography courtesy of
North East Coastal Observatory
www.northeastcoastalobservatory.org.uk

I:\9T6403\Technical_Data\gis\figure\7_FULL_measures_report_201006_Hartlepool\Appendix_B_Hartlepool_Map1a.mxd



Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 1b Hartlepool Borough Council Frontage

Analytical Report 3
'Full Measures' Survey 2010

Drawing Scale 1:15,000 at A4

Drawn by:	TC	Date:	28/10/2010
Checked by:	NC	Date:	05/11/2010
Approved by:	NC	Date:	05/11/2010

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Photography courtesy of
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www.northeastcoastalobservatory.org.uk

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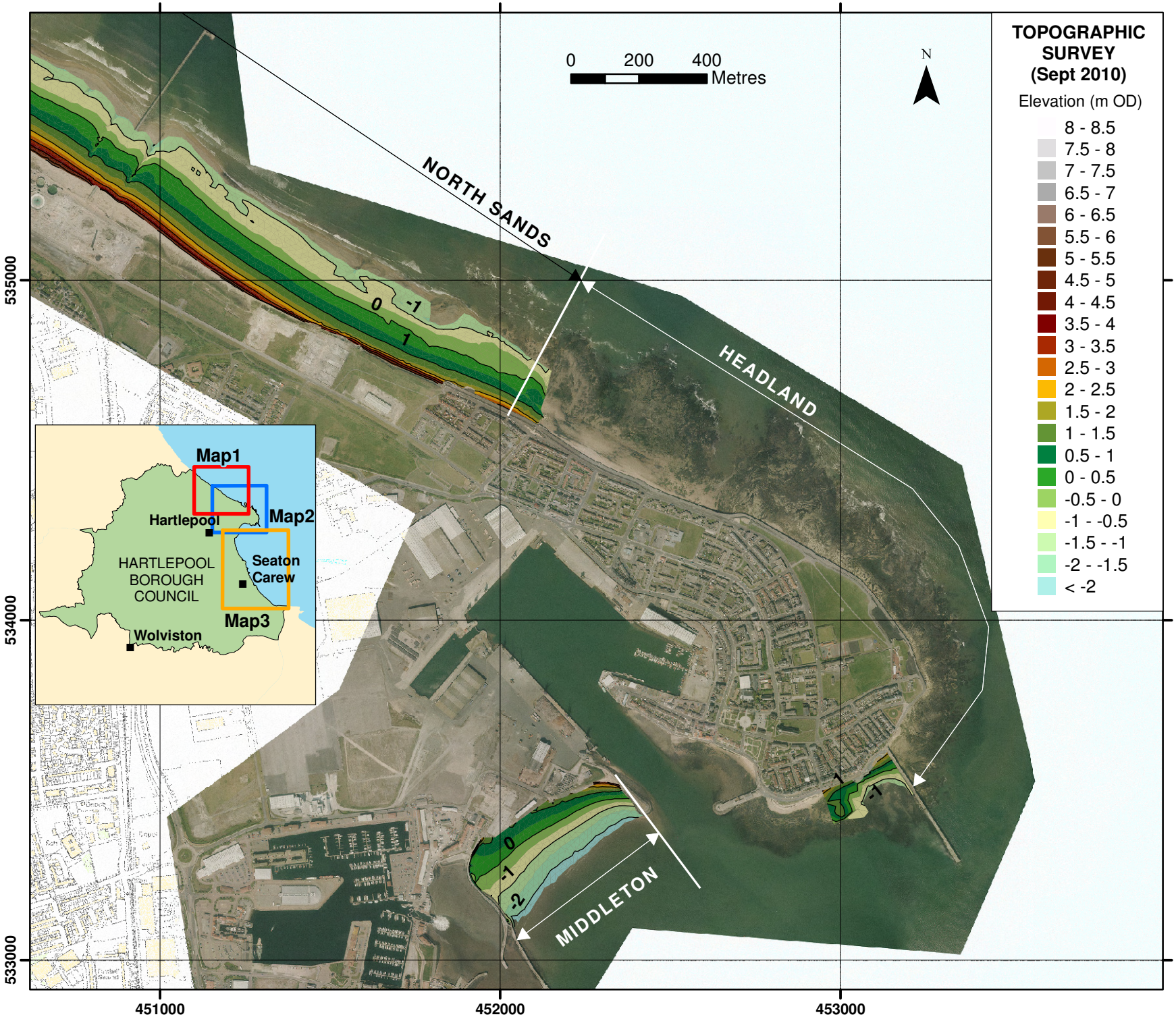

Topographic Contours at 1 metre interval

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 2a Hartlepool Borough Council Frontage

Analytical Report 3
'Full Measures' Survey 2010

Drawing Scale 1:15,000 at A4

Drawn by:	TC	Date:	28/10/2010
Checked by:	NC	Date:	05/11/2010
Approved by:	NC	Date:	05/11/2010

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www.halcrow.com

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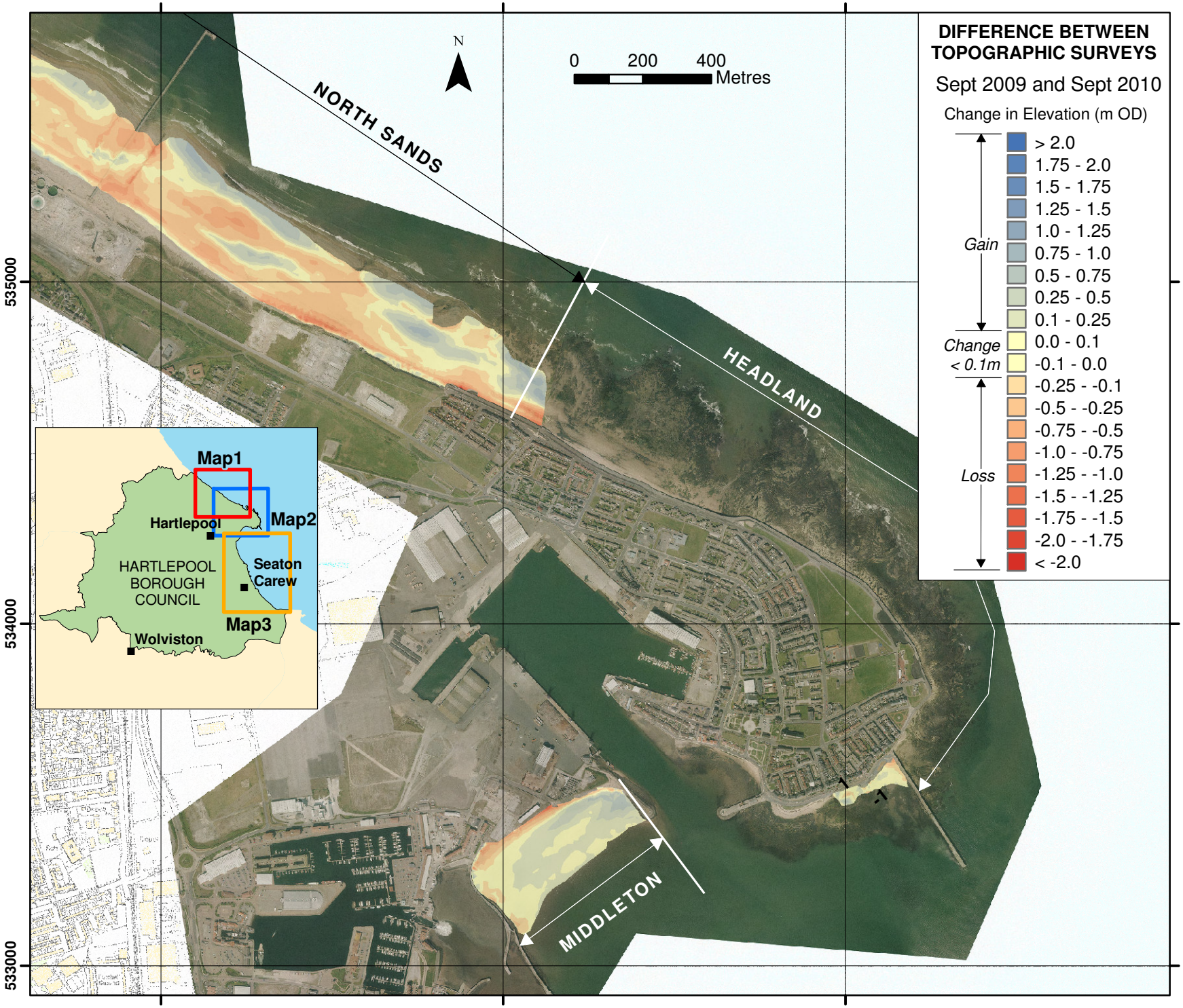

DIFFERENCE BETWEEN TOPOGRAPHIC SURVEYS

Sept 2009 and Sept 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
	-0.1 - 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 Hartlepool Borough Council Frontage

Analytical Report 3
'Full Measures' Survey 2010

Drawing Scale 1:15,000 at A4

Drawn by:	TC	Date:	28/10/2010
Checked by:	NC	Date:	05/11/2010
Approved by:	NC	Date:	05/11/2010

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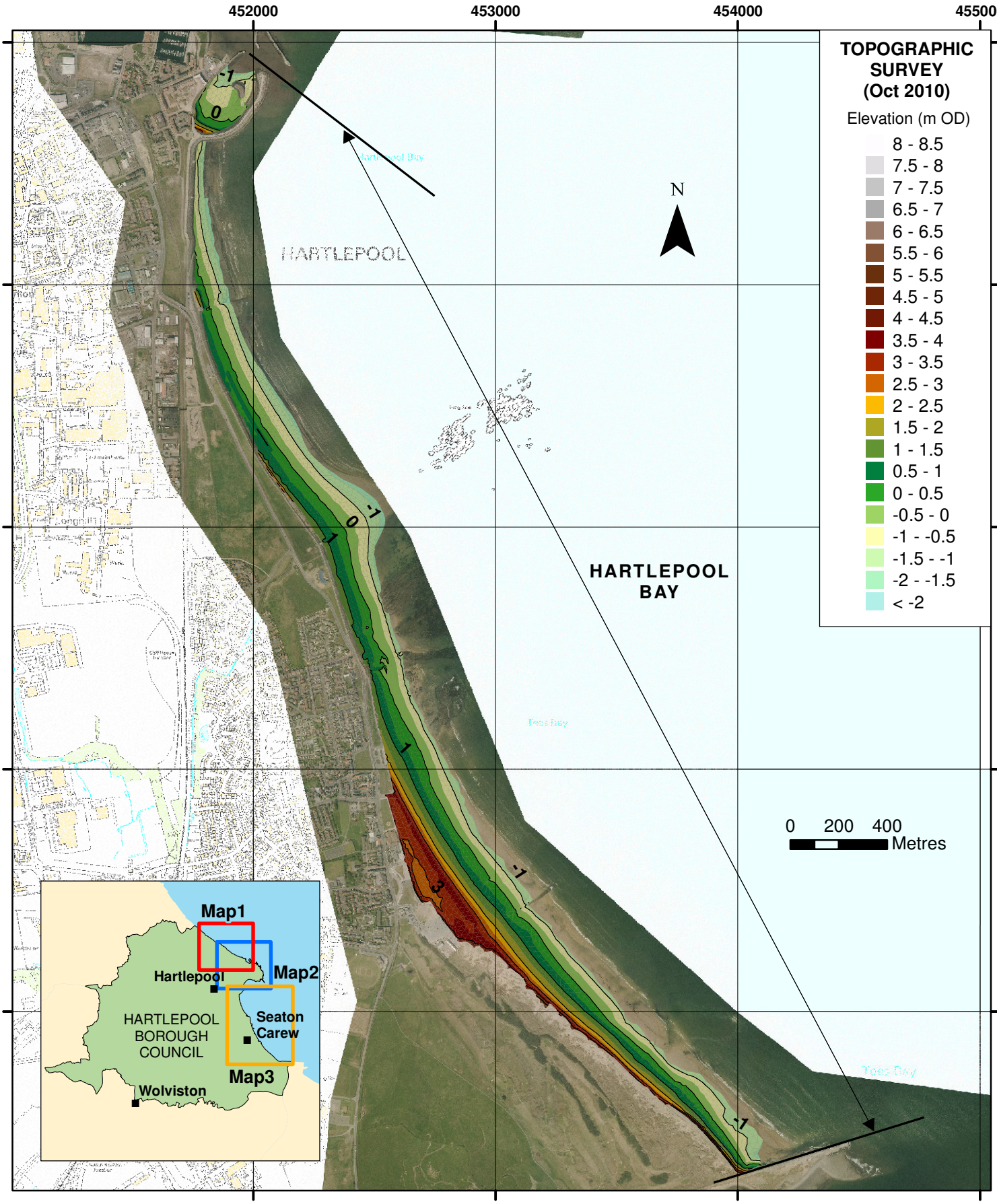

Topographic Contours at 1 metre interval

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

Appendix B - Map 3a Hartlepool Borough Council Frontage

Analytical Report 3
'Full Measures' Survey 2010

Drawing Scale 1:21,000 at A4

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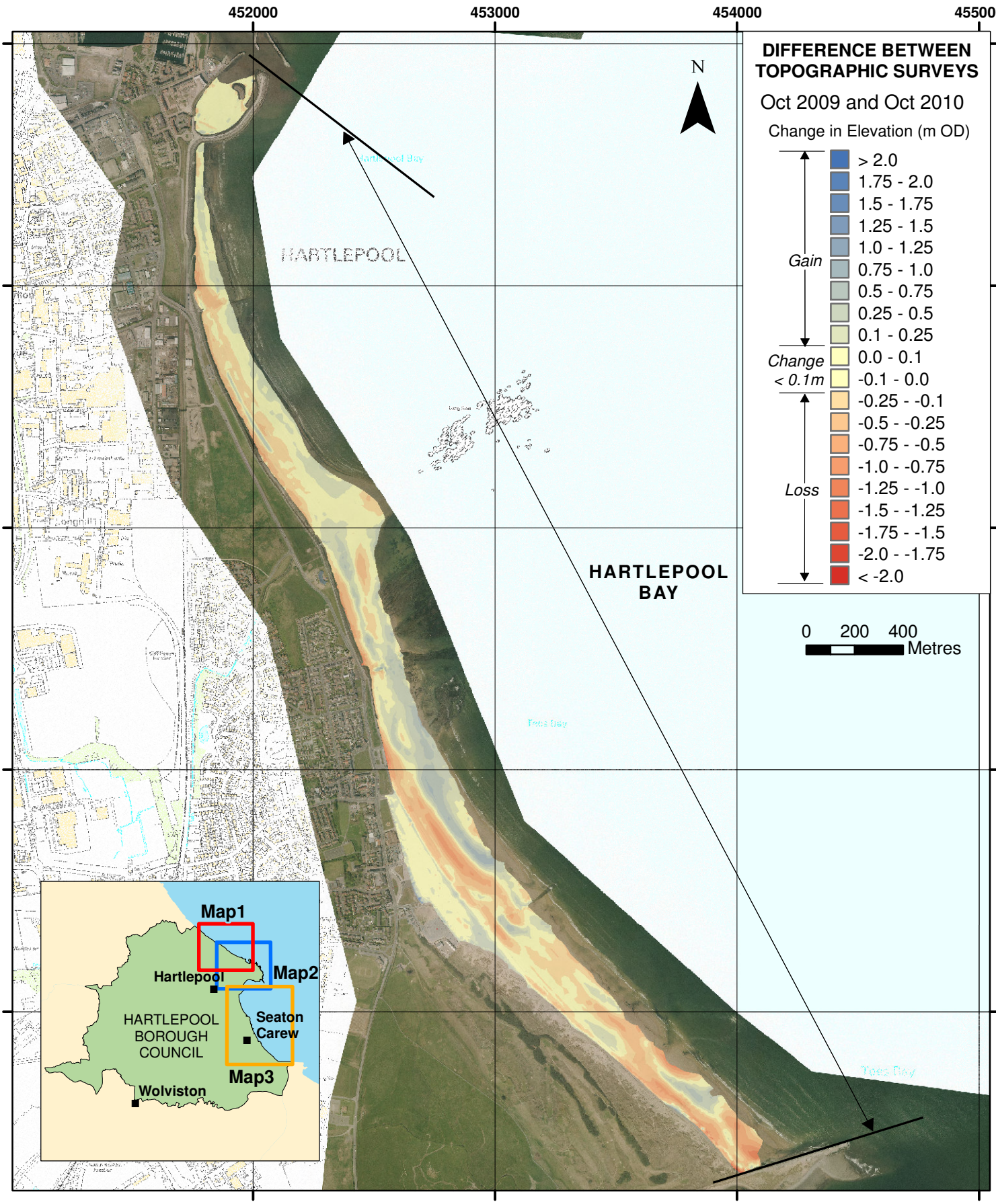

Client: North East Coastal Group
Project: Cell 1 Regional Coastal Monitoring Programme

Appendix B - Map 3b Hartlepool Borough Council Frontage

Analytical Report 3
'Full Measures' Survey 2010

Drawing Scale 1:21,000 at A4

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