



**Cell 1 Regional Coastal Monitoring Programme
Analytical Report 2: 'Full Measures' Survey 2009**

**Hartlepool Borough Council
Final Report**

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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.

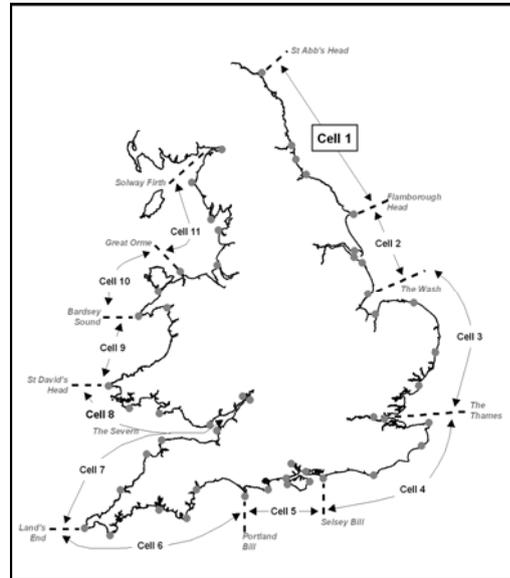


Figure 1 Sediment Cells in England and Wales

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 ^(*) | | | - |

^(*) The present report is **Analytical Report 2** and provides an analysis of the 2009 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, Uppgang 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 2009, when weather conditions were fine and breezy. The sea state was heavy with rough surf. The survey at Hartlepool Central was also undertaken in September 2009, when weather conditions were fine and dry and the sea state was flat and calm. The survey at Hartlepool South was also undertaken in September 2009 when the weather was fine and dry but the sea state was rough due to a heavy 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 2
 'Full Measures' Survey 2009

Drawing Scale 1:15,000 at A4

Drawn by: TC Date: 15/10/2009
 Checked by: NC Date: 23/10/2009
 Approved by: NC Date: 23/10/2009



Royal Haskoning
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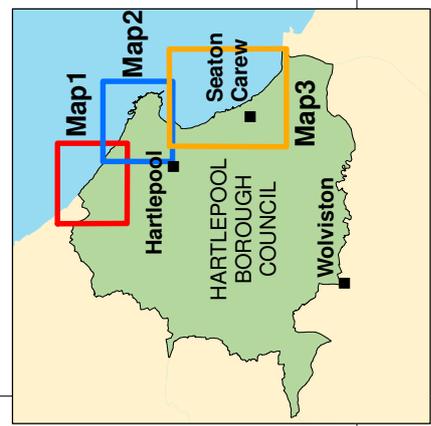
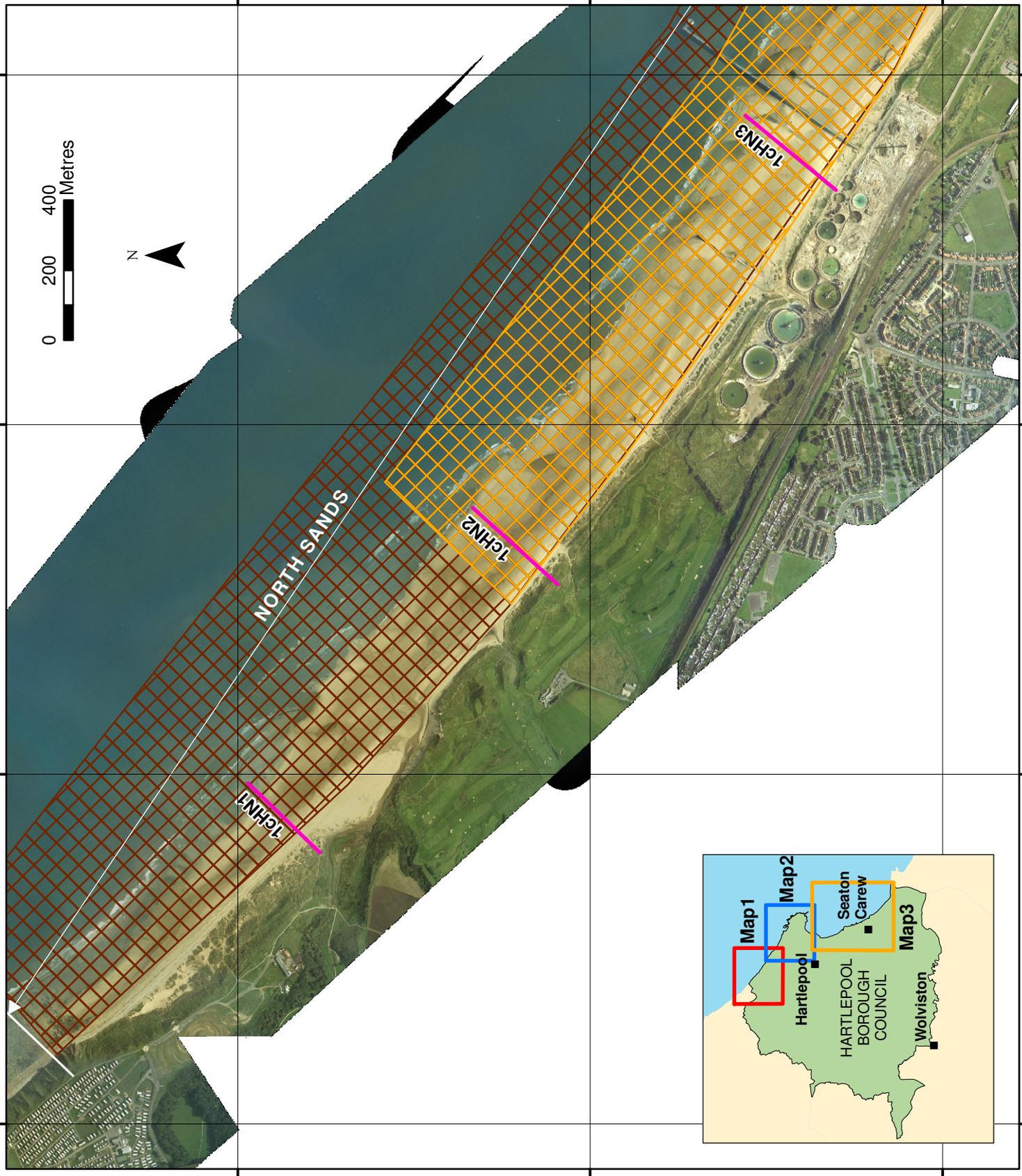


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SURVEY LOCATIONS

Topographic Profiles

- Annual
- Bi-Annual

Topographic Surveys

- 6 monthly
- yearly
- 5 yearly

Cliff Top Monitoring Pegs

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

(Indicative Survey Extents shown)

Client: North East Coastal Group

Project: Cell 1 Regional Coastal Monitoring Programme

**Figure 2 - Map 2
Hartlepool Borough
Council Frontage**

Analytical Report 2
'Full Measures' Survey 2009

Drawing Scale 1:15,000 at A4

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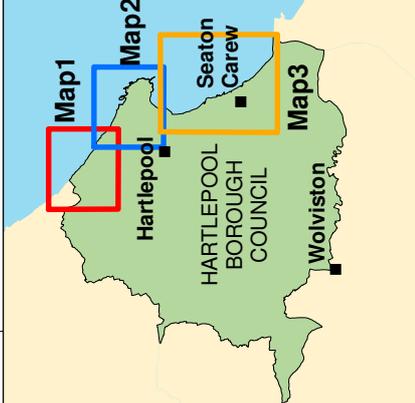


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HEADLAND

NORTH SANDS

MIDDLETON

1CHN4

1CHC1

1CHN3

535000

534000

533000

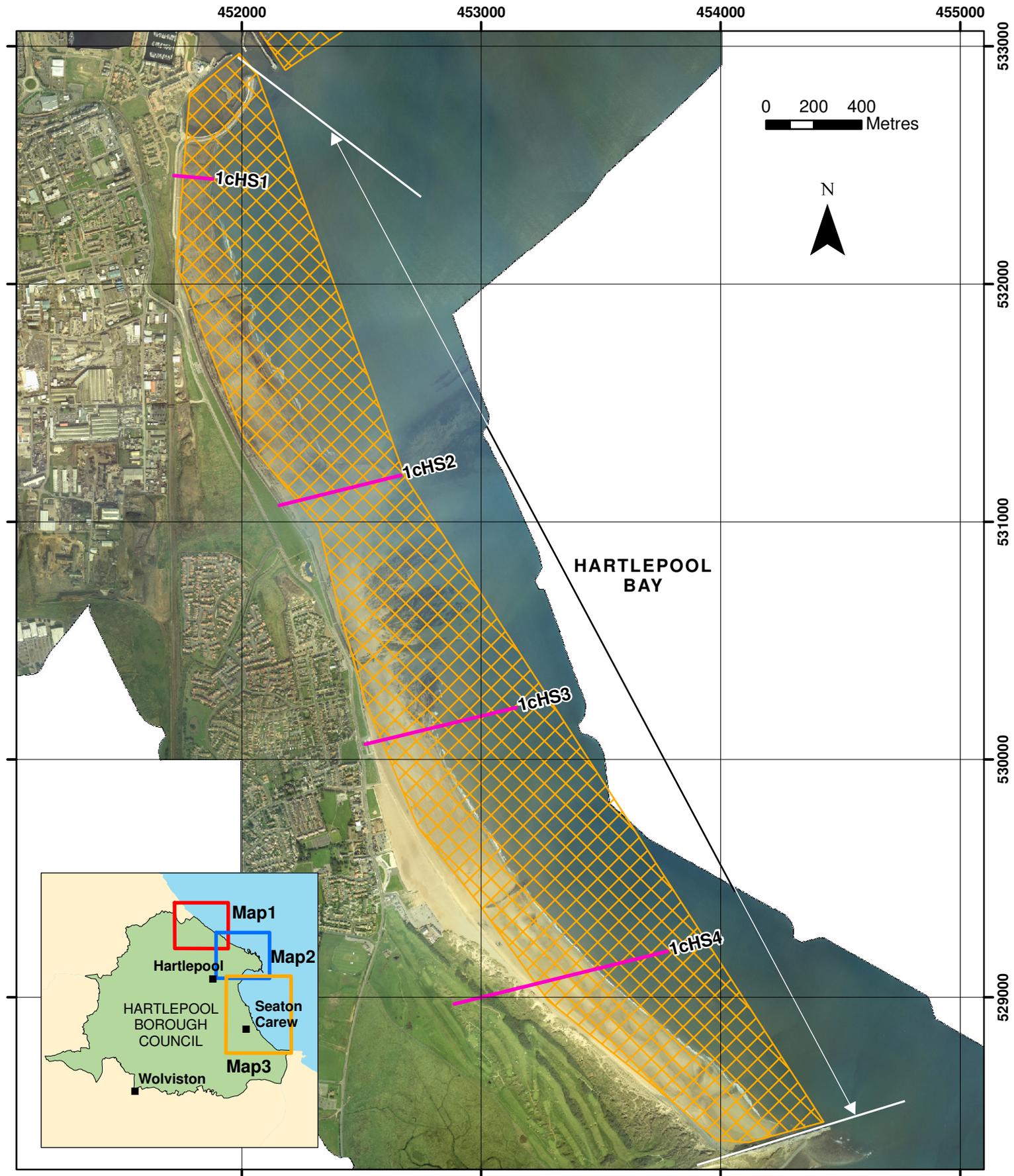
451000

452000

453000

0 200 400 Metres





- 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 2
 'Full Measures' Survey 2009

Drawing Scale 1:21,000 at A4



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| Checked by: MD | Date: 23/10/2009 |
| Approved by: NC | Date: 23/10/2009 |

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2. Analysis of Survey Data

2.1 North Sands

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|-------------|---|--|
| 09-2009 | <p>Beach Profiles:</p> <p>North Sands is covered by four beach profile lines (Appendix A) during the Full Measures survey.</p> <p>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.</p> <p>HN1 starts at the landward side of the dune crest, which has an elevation of approximately 5.7mOD, and then extends across the foreshore to low water level. The dunes show some minor differences to previous surveys, with flattening of small peaks in the crest to form a generally flatter but wider crest. A berm has developed at the toe of the dunes along the upper beach, but the beach between around MHWN and MWL has steepened notably.</p> <p>HN2 exhibits great stability in the dune crest and face, with changes confined to the foreshore where lowering has occurred between chainages of around 110m and 160m.</p> <p>HN3 extends from slag banks across the foreshore down to low water level. Changes compared to previous surveys were confined to minor fluctuations in foreshore level, and the backing slag banks remain stable at present.</p> <p>HN4 extends across the promenade and sea wall before dropping to beach level. In the current survey, foreshore levels were lower than in either of the previous two surveys, especially seaward of a chainage of 60m where notable lowering occurred.</p> | <p>Beach changes along profiles HN1 and HN2, towards the north of North Sands, appear to be linked with the exchange of sediment between the lower-mid and upper beach sections. This represents a redistribution of sand across the profile width. At present the dunes remain in a stable position.</p> <p>Further south along HN3, by the disused industrial areas, the foreshore changes are less pronounced, meaning that the backing slag banks are presently unaffected by erosion.</p> <p>At the southern end of North Sands, along HN4, lowering of the lower foreshore is very pronounced, resulting in rock outcrops being visible along the length seaward of a chainage of 110m. This suggests that during earlier surveys the rock outcrops were covered by a veneer of sand which, in places, was around 0.75m thick, and that this veneer is highly mobile under storm action.</p> |

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|-------------|--|---|
| 09-2009 | <p>Topographic Survey:</p> <p>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.]</p> <p>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. From this it can be seen that beach levels at the toe of the dunes and slag banks along the northern and central sections of North Sands are relatively high, but there is a narrower width of the higher beach contours fronting the Marine Drive sea wall.</p> <p>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.</p> <p>This generally shows a redistribution of sand from the lower to upper beach along most of the frontage between these dates.</p> | <p>The relatively high levels and moderately wide beach at the toe of the dunes and slag banks afford protection to the features against direct wave attack during storms. There generally was some redistribution of sand from the lower and mid beach to the upper.</p> <p>The beach contours along the disused industrial frontage in the centre of North Sands tend to indicate a slight seaward building of mid-beach sections, further protecting the backing slag banks.</p> <p>Further south, the upper beach is narrower, exposing the sea wall to marine conditions more frequently. Lower foreshore levels were also much lower during the most recent survey.</p> |

2.2 Middleton

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|-------------|--|--|
| 09-2009 | <p>Beach Profiles:</p> <p>Middleton is covered by one beach profile line (Appendix A).</p> <p>HC1 showed some upper beach accretion since the previous survey in March 2009 to record the highest beach levels to date at the toe of the vertical wall. Further seaward, the profile form was very similar to the previous survey, but both of these surveys recorded lower levels than were observed in the baseline (November 2008) survey.</p> | <p>Generally, the Middleton beach, pocketed between Middleton Jetty and North Pier, experienced a net lowering over much of the foreshore between the baseline survey (November 2008) and the second survey (March 2009) but has remained relatively constant to date, with some accretion observed at the toe of the vertical wall.</p> |
| | <p>Topographic Survey:</p> <p>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.</p> <p>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.</p> | |

2.3 Hartlepool Bay

| Survey Date | Description of Changes Since Last Survey | Interpretation |
|-------------|---|--|
| 09-2009 | <p>Beach Profiles:</p> <p>Hartlepool Bay is covered by four beach profile lines (named HS1 – HS4).</p> <p>HS1 is located approximately 150m south of the root of the South Pier and experience on minor change in foreshore level.</p> <p>HS2 and HS3 both are located more centrally within Hartlepool Bay and are protected by a smaller revetment than is present along HS1. Both profiles exhibited similar changes, with accretion directly at the toe of the rock armour (very notable accretion along HS3), minor erosion over a short length slightly further seaward, minor accretion over a greater length (around MSL) and finally minor erosion at the seaward end of the profile.</p> <p>HS4 is around 1km north of the North Gare breakwater in an area of undefended dunes. There was no significant change compared with the previous survey.</p> | <p>There is only a narrow foreshore width between the toe of the rock armour and the low water line in the north of Hartlepool Bay, but the rock armour structure provides a substantial defence.</p> <p>In central Hartlepool Bay, there appear to be patterns of sediment redistribution, with minor accretion along the very upper beach and along a notable mid beach section, and minor erosion elsewhere.</p> <p>The dunes at Seaton Sands appear presently very stable.</p> |
| | <p>Topographic Survey:</p> <p>Hartlepool Bay is covered by an annual topographic survey between the South Pier and the North Gare Breakwater.</p> <p>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. This shows how the beach in the north of the bay, near the marina, is much lower and narrow than elsewhere along the frontage. There is a recessed area towards the south of the bay which has infilled with sand.</p> <p>The GIS has also been used to calculate the differences between the current topographic survey and the earlier (March 2009) topographic survey, as shown in Appendix B – Map 3b, to identify areas of erosion and accretion. The beach, generally, has been remarkably stable since the earlier survey, with minor accretion along most of the frontage and only a small number of isolated patches of erosion.</p> | <p>Some notable beach lowering occurred between March 2009 and September 2009 at the very southern end of the bay, adjacent to the North Gare breakwater. This is an apparent reversal of the notable accretion that was recorded in this location between December 2008 (as part of the <i>Seaton Carew Strategy Study</i>), and March 2009.</p> |

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

- Where changes have occurred along the frontage, they appear at present to be linked with seasonal redistribution of sediment across the foreshore. There is presently no evidence of short term significant erosion.
- Some of the potentially more vulnerable areas, such as the dunes and slag banks along North Sands and the dunes along Seaton Sands, appear presently stable and well protected by the foreshore width and level.
- The most notable areas of change were located at the south-eastern end of North Sands (stripping of the sand veneer from the lower foreshore rock outcrops) and the southern end of Hartlepool Bay adjacent to the North Gare breakwater (mid and upper foreshore lowering). Careful attention will need to be paid to these areas in future surveys.
- Elsewhere the changes observed are all very minor in magnitude and are considered to fall within the bounds of natural variability along this frontage.

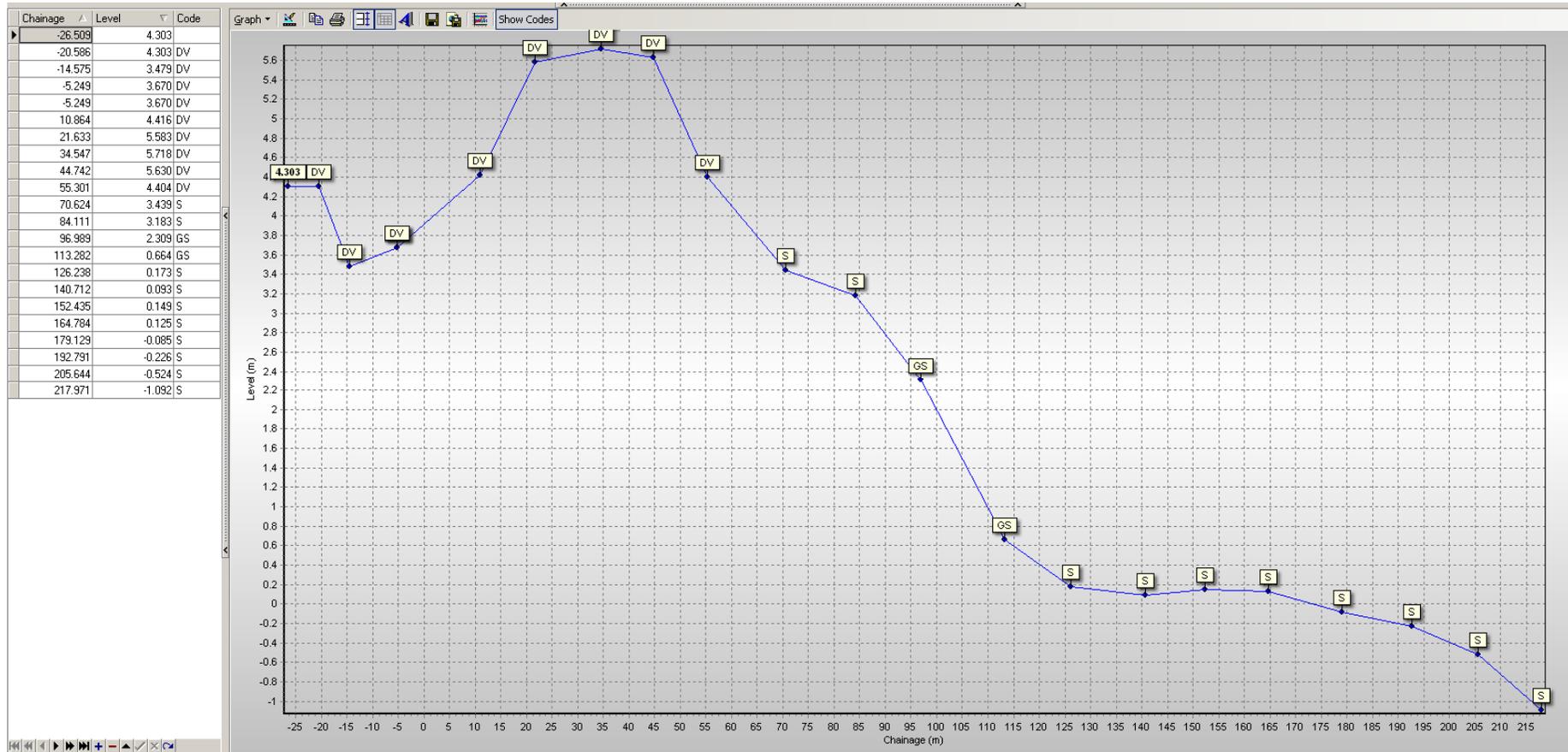
Appendices

Appendix A
Beach Profiles

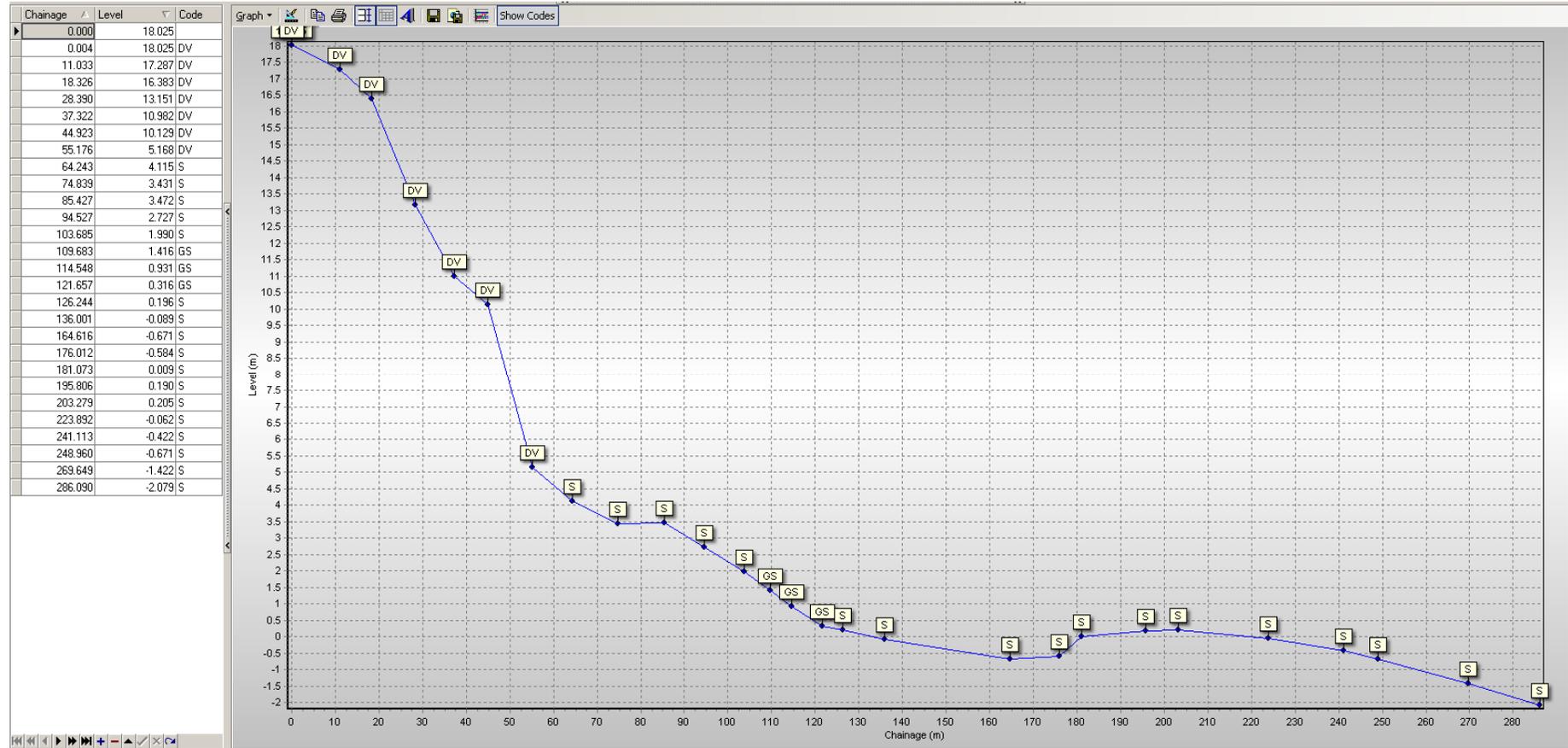
The following sediment feature codes are used on some profile plots:

| 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 |

1cHN1 - 11/09/2009

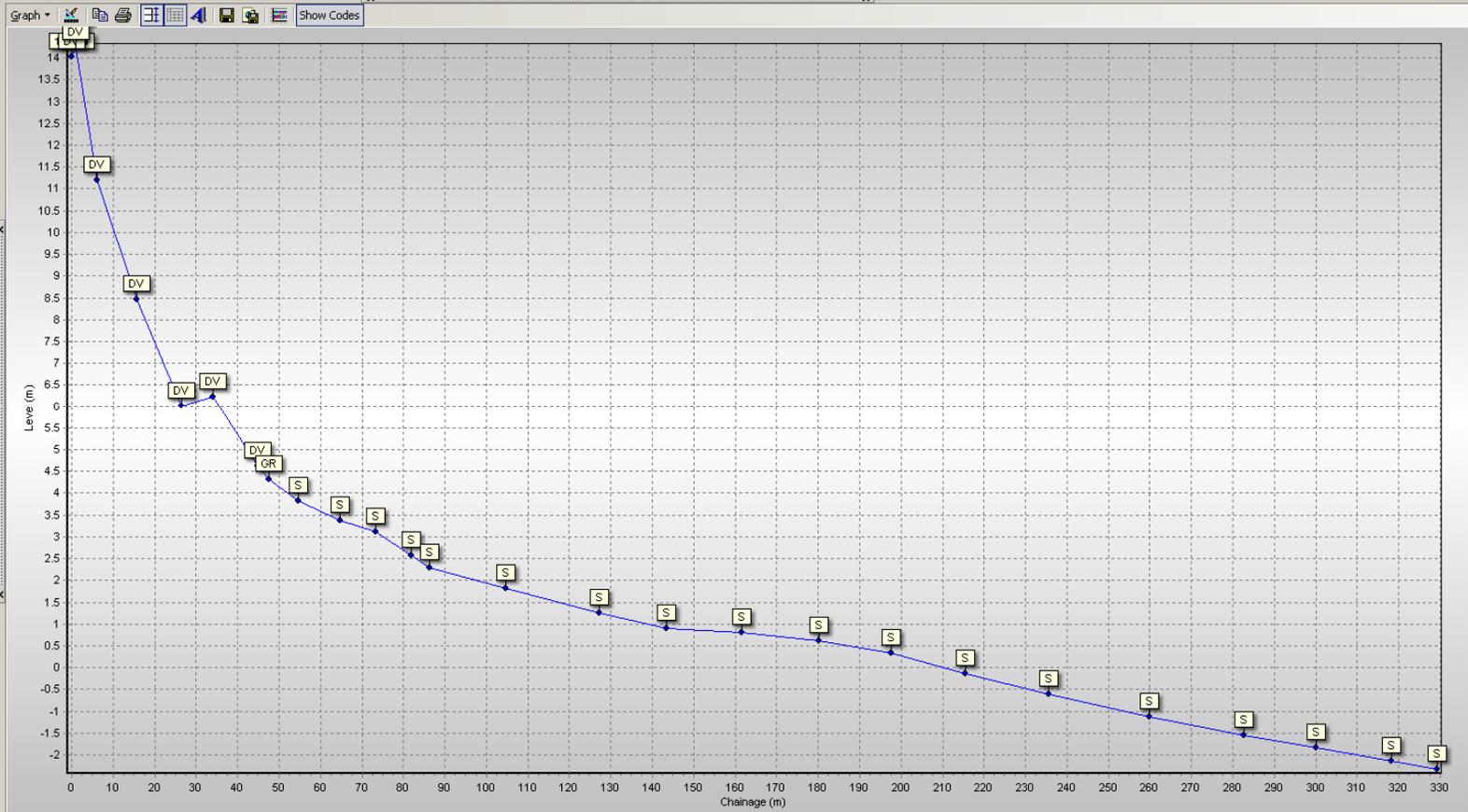


1cHN2 - 11/09/2009



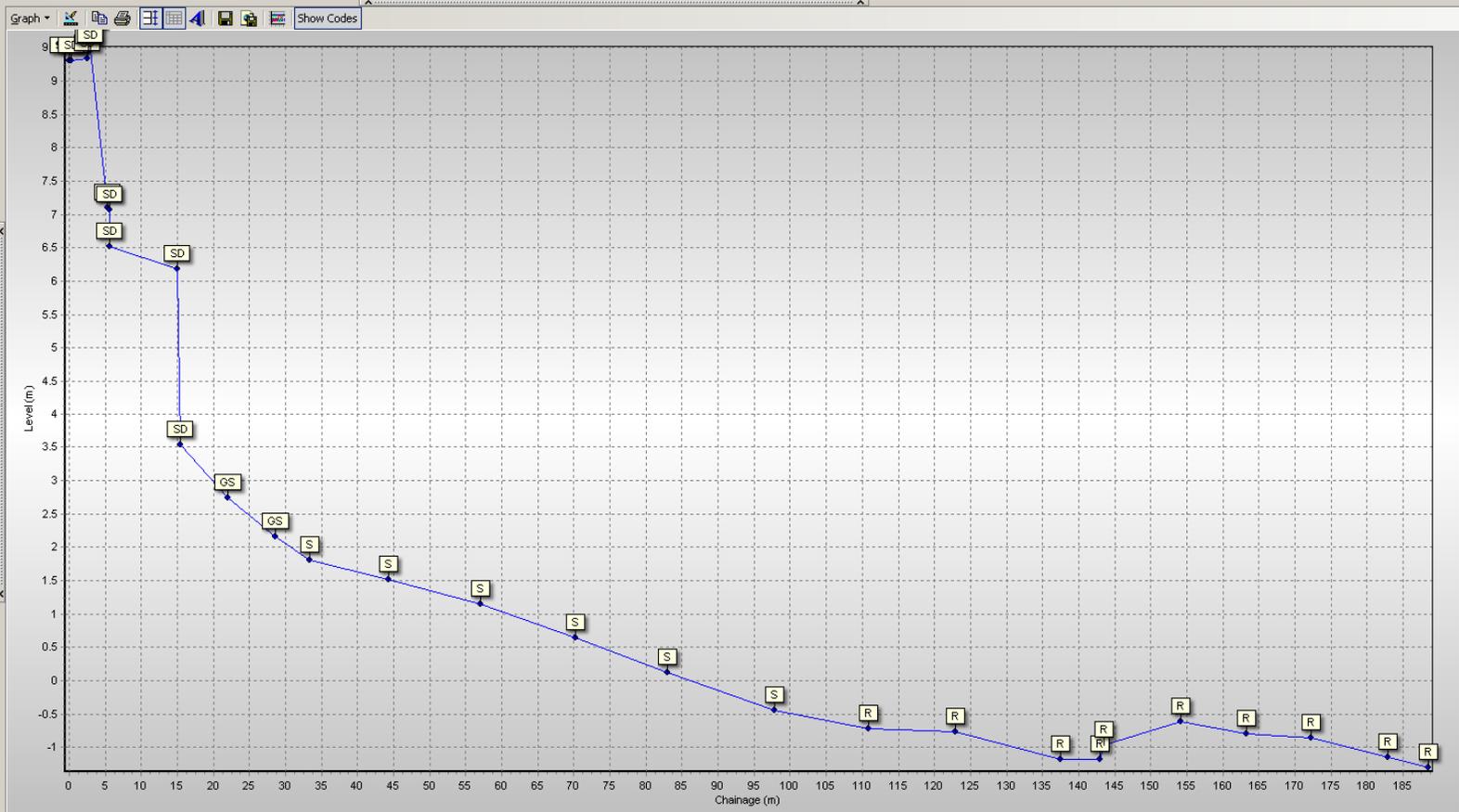
1cHN3 - 11/09/2009

| Chainage | Level | Code |
|----------|--------|------|
| 0.000 | 14.034 | |
| 0.011 | 14.034 | DV |
| 0.859 | 14.239 | DV |
| 6.189 | 11.194 | DV |
| 15.749 | 8.457 | DV |
| 26.374 | 6.011 | DV |
| 33.971 | 6.234 | DV |
| 44.929 | 4.623 | DV |
| 47.643 | 4.320 | GR |
| 54.642 | 3.830 | S |
| 64.659 | 3.369 | S |
| 73.195 | 3.122 | S |
| 81.777 | 2.569 | S |
| 86.351 | 2.285 | S |
| 104.650 | 1.823 | S |
| 127.360 | 1.254 | S |
| 143.503 | 0.896 | S |
| 161.586 | 0.816 | S |
| 180.179 | 0.628 | S |
| 197.555 | 0.342 | S |
| 215.616 | -0.126 | S |
| 235.719 | -0.609 | S |
| 259.855 | -1.122 | S |
| 282.677 | -1.557 | S |
| 300.104 | -1.843 | S |
| 318.229 | -2.145 | S |
| 329.270 | -2.328 | S |



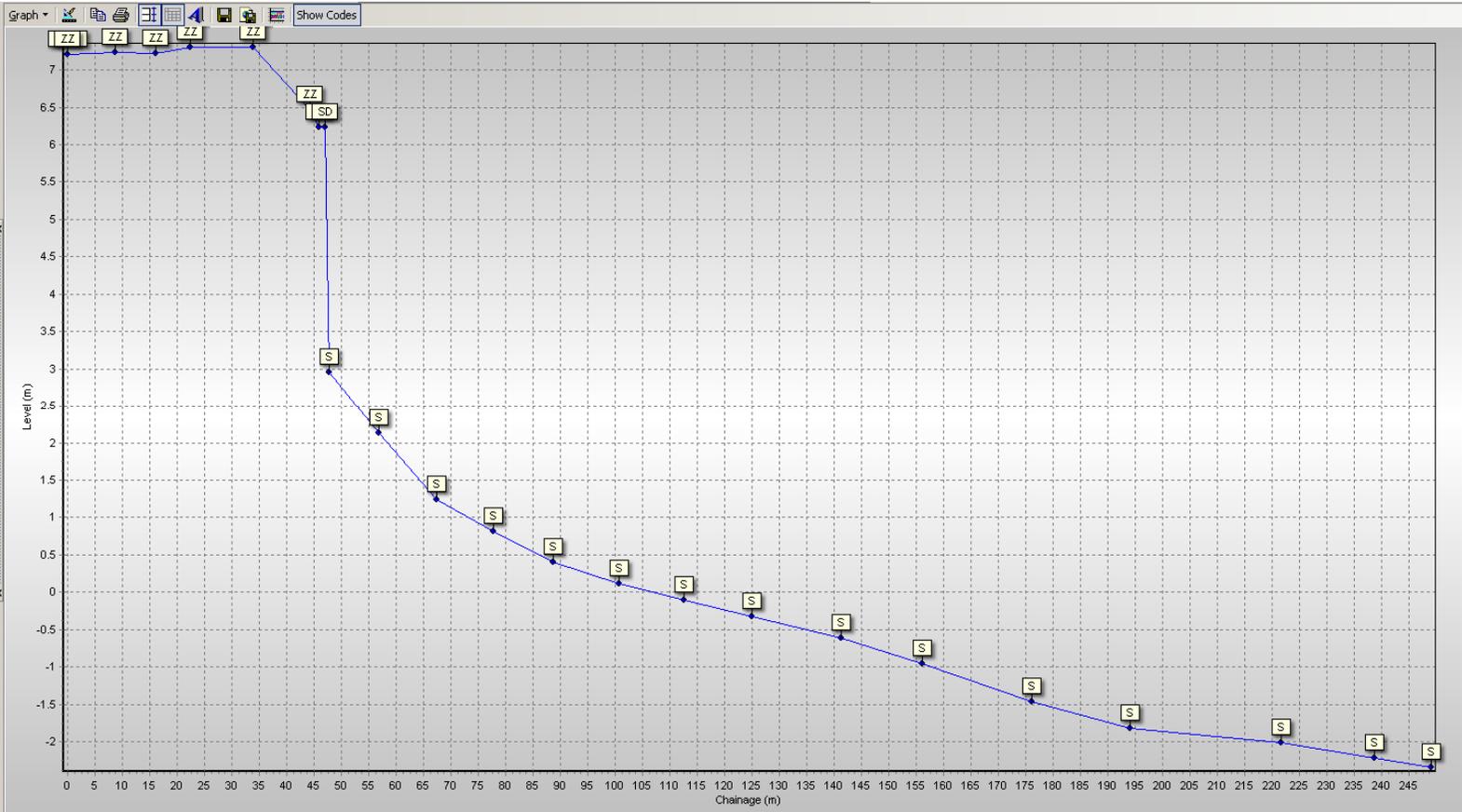
1cHN4 - 11/09/2009

| Chainage | Level | Code |
|----------|--------|------|
| 0.000 | 9.302 | |
| 0.215 | 9.302 | SD |
| 2.544 | 9.339 | SD |
| 2.669 | 9.444 | SD |
| 2.920 | 9.457 | SD |
| 5.338 | 7.101 | SD |
| 5.575 | 7.070 | SD |
| 5.594 | 6.515 | SD |
| 14.964 | 6.181 | SD |
| 15.348 | 3.540 | SD |
| 21.971 | 2.744 | GS |
| 28.627 | 2.152 | GS |
| 33.308 | 1.806 | S |
| 44.232 | 1.507 | S |
| 57.106 | 1.148 | S |
| 70.279 | 0.641 | S |
| 83.040 | 0.118 | S |
| 97.837 | -0.444 | S |
| 110.826 | -0.720 | R |
| 122.951 | -0.770 | R |
| 137.451 | -1.173 | R |
| 142.906 | -1.180 | R |
| 143.524 | -0.959 | R |
| 154.146 | -0.618 | R |
| 163.231 | -0.792 | R |
| 172.208 | -0.858 | R |
| 182.922 | -1.149 | R |
| 188.509 | -1.302 | R |



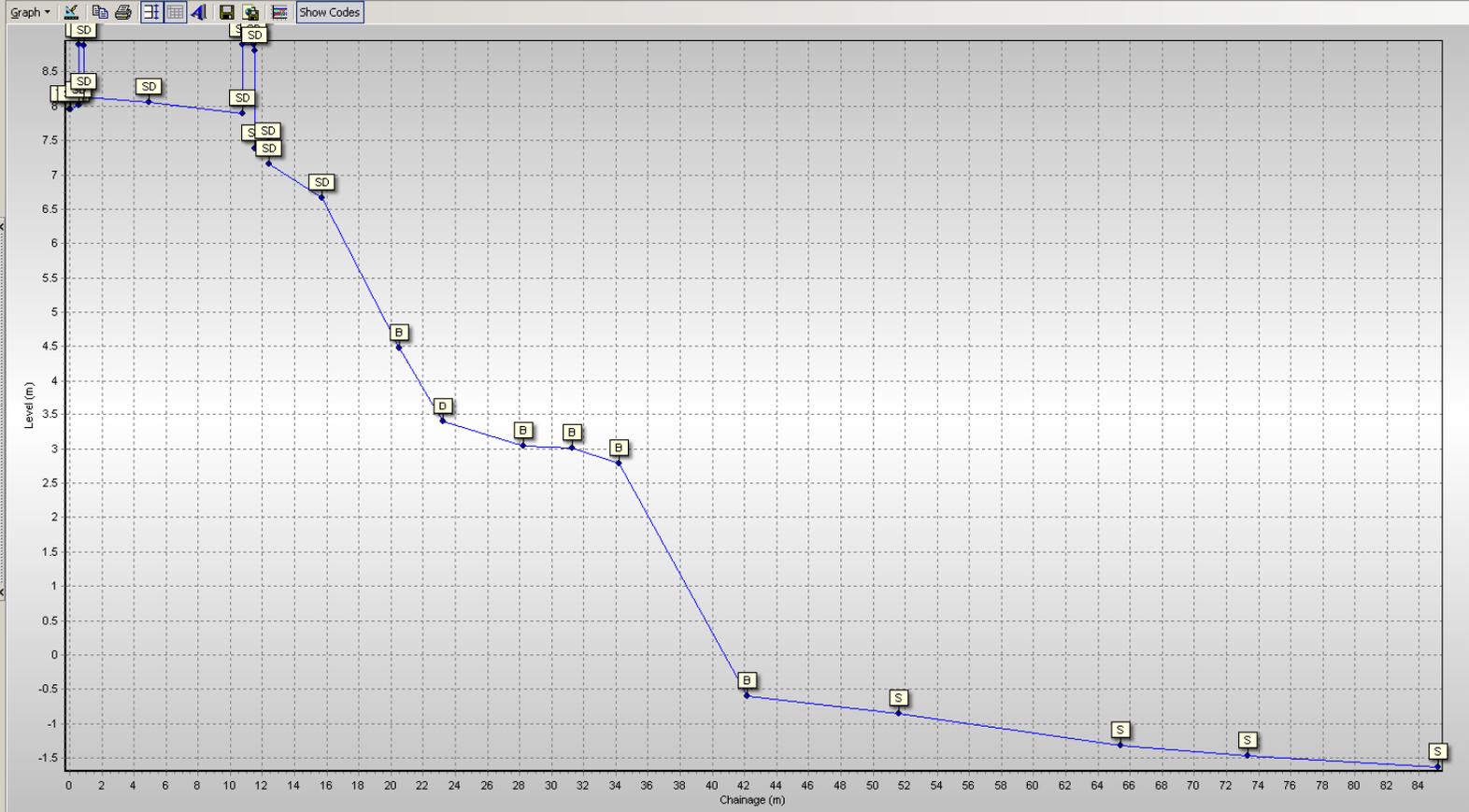
1cHC1 - 21/09/2009

| Chainage | Level | Code |
|----------|--------|------|
| 0.000 | 7.208 | |
| 0.008 | 7.208 | ZZ |
| 8.650 | 7.233 | ZZ |
| 16.165 | 7.224 | ZZ |
| 22.332 | 7.298 | ZZ |
| 33.945 | 7.304 | ZZ |
| 44.224 | 6.467 | ZZ |
| 45.943 | 6.238 | SD |
| 46.999 | 6.238 | SD |
| 47.771 | 2.950 | S |
| 56.828 | 2.137 | S |
| 67.476 | 1.234 | S |
| 77.835 | 0.808 | S |
| 88.783 | 0.409 | S |
| 100.787 | 0.112 | S |
| 112.664 | -0.102 | S |
| 125.128 | -0.330 | S |
| 141.434 | -0.612 | S |
| 156.197 | -0.961 | S |
| 176.124 | -1.465 | S |
| 194.166 | -1.814 | S |
| 221.736 | -2.018 | S |
| 238.720 | -2.212 | S |
| 249.168 | -2.341 | S |



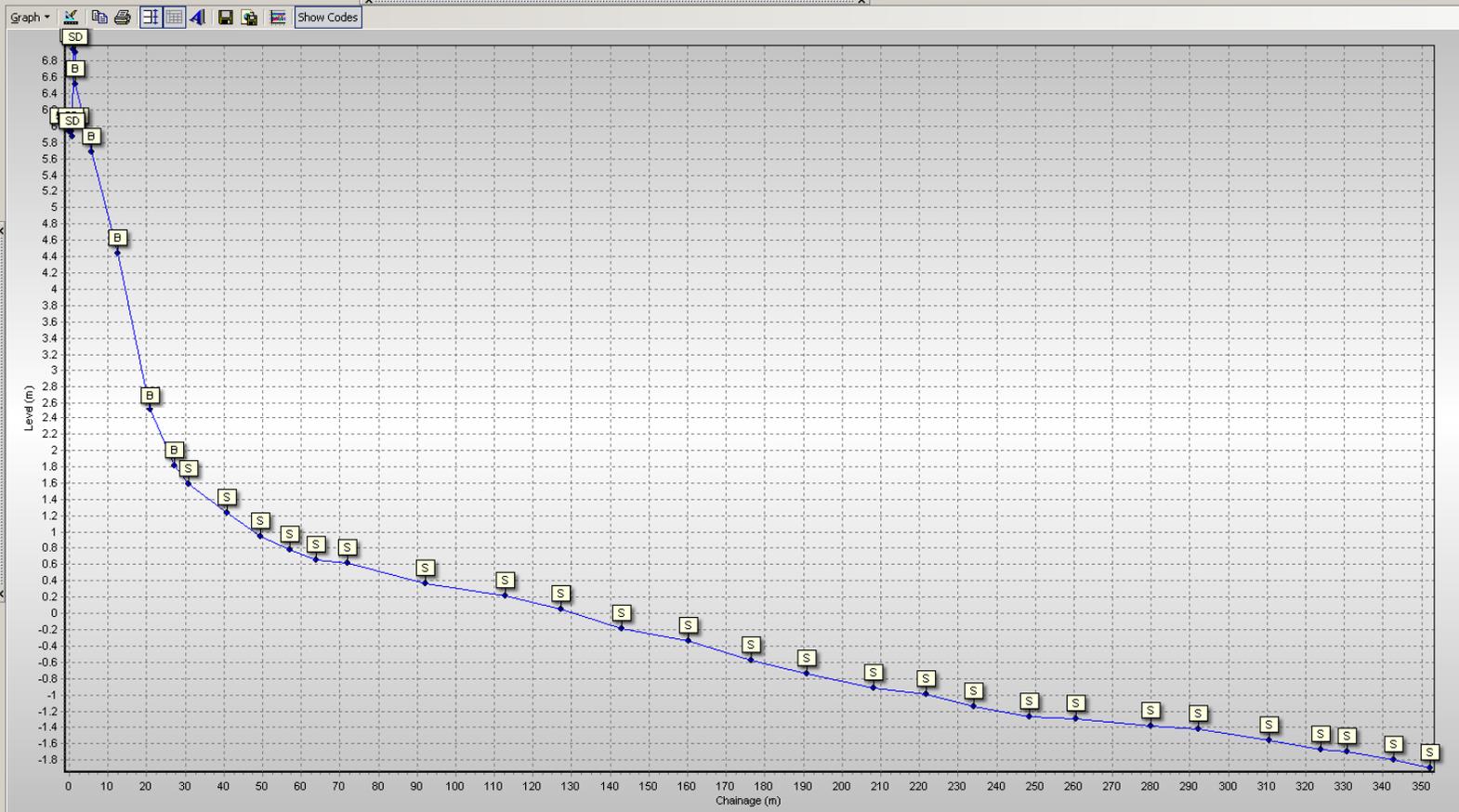
1cHS1 - 11/09/2009

| Chainage | Level | Code |
|----------|--------|------|
| 0.000 | 7.946 | |
| 0.049 | 7.946 | SD |
| 0.546 | 8.005 | SD |
| 0.573 | 8.893 | SD |
| 0.891 | 8.888 | SD |
| 0.899 | 8.129 | SD |
| 4.933 | 8.053 | SD |
| 10.738 | 7.892 | SD |
| 10.744 | 8.890 | SD |
| 11.462 | 8.896 | SD |
| 11.541 | 8.808 | SD |
| 11.549 | 7.388 | SD |
| 12.355 | 7.414 | SD |
| 12.395 | 7.160 | SD |
| 15.713 | 6.659 | SD |
| 20.549 | 4.475 | B |
| 23.254 | 3.394 | B |
| 28.268 | 3.039 | B |
| 31.312 | 3.015 | B |
| 34.209 | 2.786 | B |
| 42.157 | -0.607 | B |
| 51.643 | -0.857 | S |
| 65.394 | -1.320 | S |
| 73.313 | -1.468 | S |
| 85.175 | -1.634 | S |



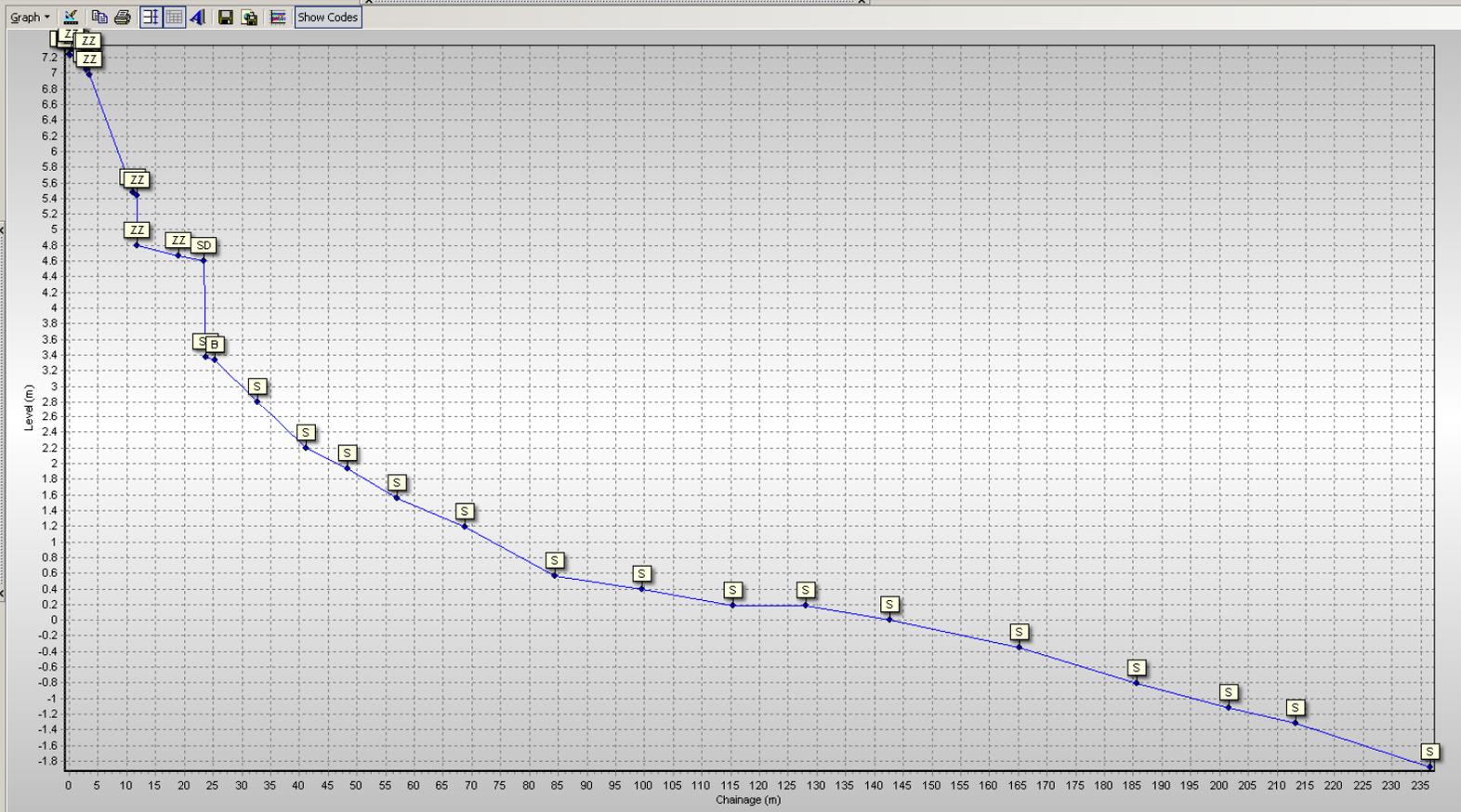
1cHS2 - 11/09/2009

| Chainage | Level | Code |
|----------|--------|------|
| 0.000 | 5.934 | |
| 0.510 | 5.934 | SD |
| 0.852 | 5.868 | SD |
| 1.085 | 6.941 | SD |
| 1.649 | 6.897 | SD |
| 1.678 | 6.517 | B |
| 5.731 | 5.686 | B |
| 12.583 | 4.433 | B |
| 20.910 | 2.500 | B |
| 27.266 | 1.811 | B |
| 30.953 | 1.589 | S |
| 40.757 | 1.239 | S |
| 49.497 | 0.945 | S |
| 57.173 | 0.776 | S |
| 63.995 | 0.661 | S |
| 72.113 | 0.620 | S |
| 92.187 | 0.371 | S |
| 112.733 | 0.210 | S |
| 127.210 | 0.057 | S |
| 143.104 | -0.190 | S |
| 160.374 | -0.340 | S |
| 176.577 | -0.576 | S |
| 191.019 | -0.746 | S |
| 208.213 | -0.914 | S |
| 221.755 | -0.992 | S |
| 234.104 | -1.137 | S |
| 248.468 | -1.273 | S |
| 260.433 | -1.290 | S |
| 279.972 | -1.385 | S |
| 292.231 | -1.419 | S |
| 310.438 | -1.556 | S |
| 323.918 | -1.673 | S |
| 330.820 | -1.692 | S |
| 342.853 | -1.791 | S |
| 352.204 | -1.897 | S |

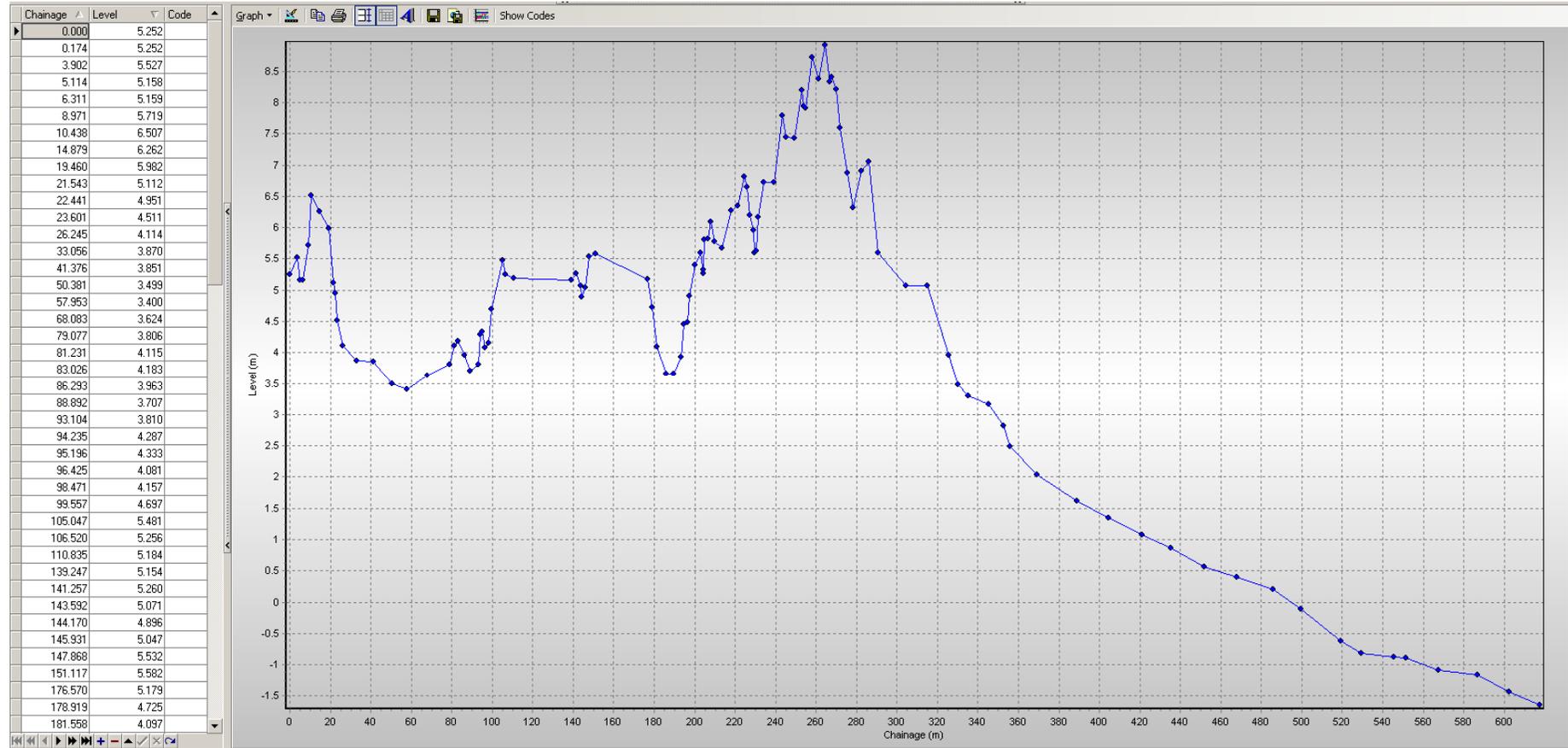


1cHS3 - 11/09/2009

| Chainage | Level | Code |
|----------|--------|------|
| 0.000 | 7.243 | |
| 0.001 | 7.243 | ZZ |
| 0.219 | 7.234 | ZZ |
| 0.285 | 7.306 | ZZ |
| 2.922 | 7.051 | ZZ |
| 3.032 | 7.212 | ZZ |
| 3.358 | 7.211 | ZZ |
| 3.465 | 6.975 | ZZ |
| 11.114 | 5.482 | ZZ |
| 11.804 | 5.431 | ZZ |
| 11.870 | 4.792 | ZZ |
| 19.073 | 4.667 | ZZ |
| 23.485 | 4.597 | SD |
| 23.804 | 3.374 | SD |
| 25.268 | 3.335 | B |
| 32.718 | 2.792 | S |
| 41.153 | 2.193 | S |
| 48.327 | 1.930 | S |
| 57.003 | 1.554 | S |
| 68.876 | 1.188 | S |
| 84.382 | 0.564 | S |
| 99.670 | 0.393 | S |
| 115.391 | 0.189 | S |
| 128.132 | 0.184 | S |
| 142.779 | 0.000 | S |
| 165.225 | -0.351 | S |
| 185.516 | -0.806 | S |
| 201.685 | -1.122 | S |
| 213.214 | -1.320 | S |
| 236.650 | -1.880 | S |



1cHS4 - 11/09/2009

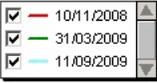
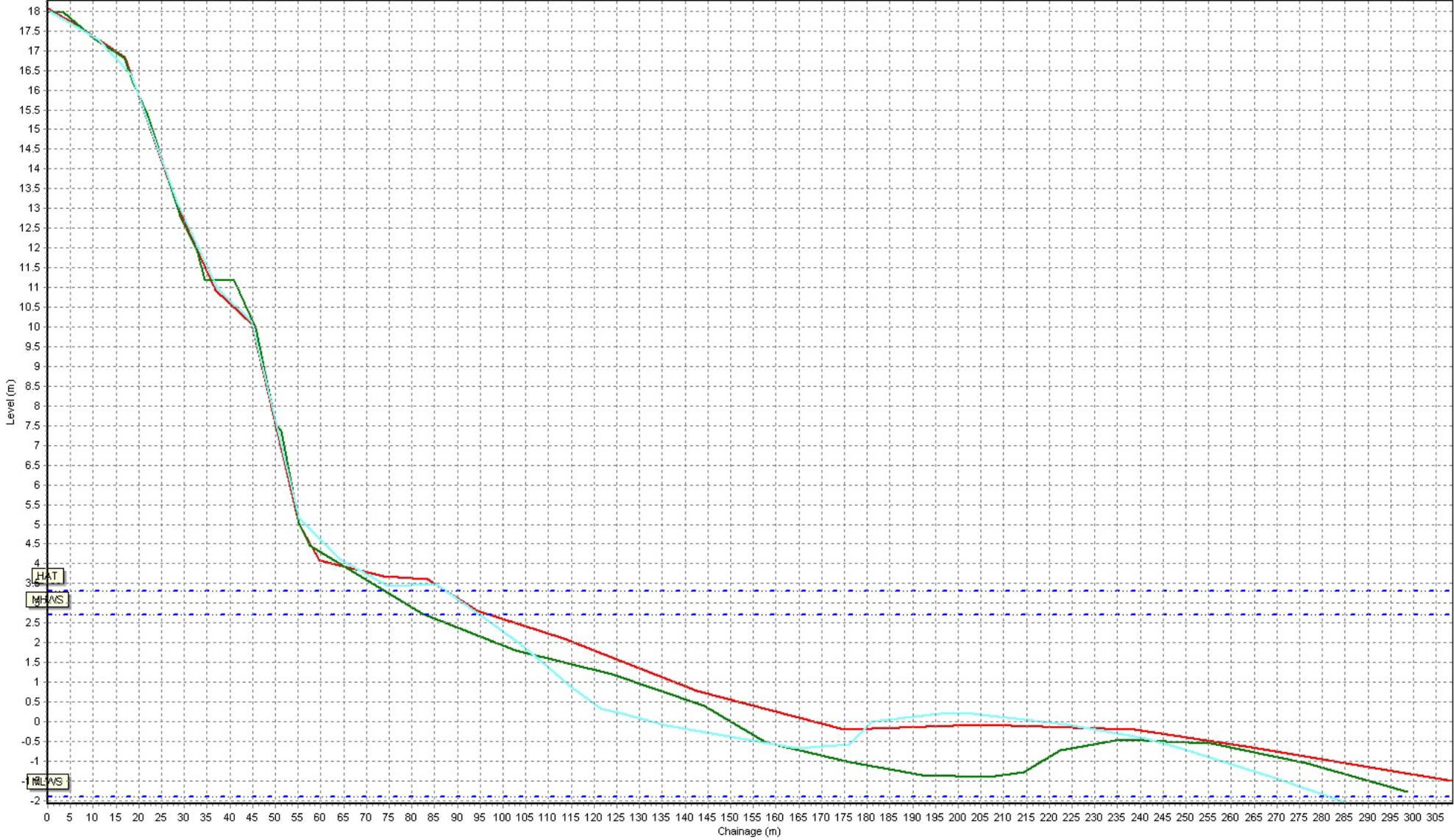


Beach Profiles: 1cHN1



| | | |
|-------------------------------------|------------|---|
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| <input checked="" type="checkbox"/> | 31/03/2009 | ▼ |
| <input checked="" type="checkbox"/> | 11/09/2009 | ▼ |

Beach Profiles: 1cHN2

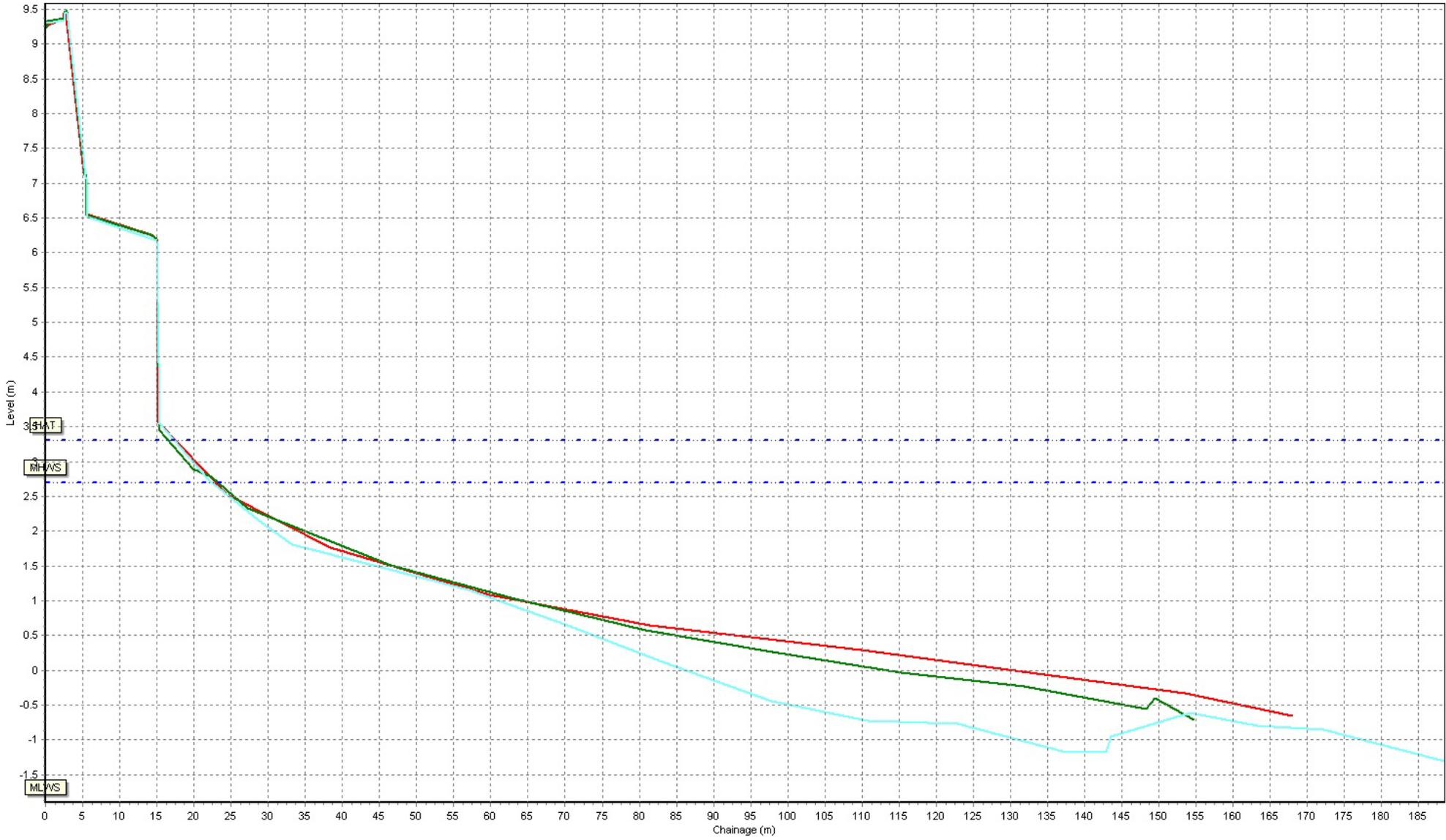


Beach Profiles: 1cHN3



| | |
|-------------------------------------|------------|
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| <input checked="" type="checkbox"/> | 31/03/2009 |
| <input checked="" type="checkbox"/> | 11/09/2009 |

Beach Profiles: 1cHN4



- 10/11/2008
- 31/03/2009
- 11/09/2009

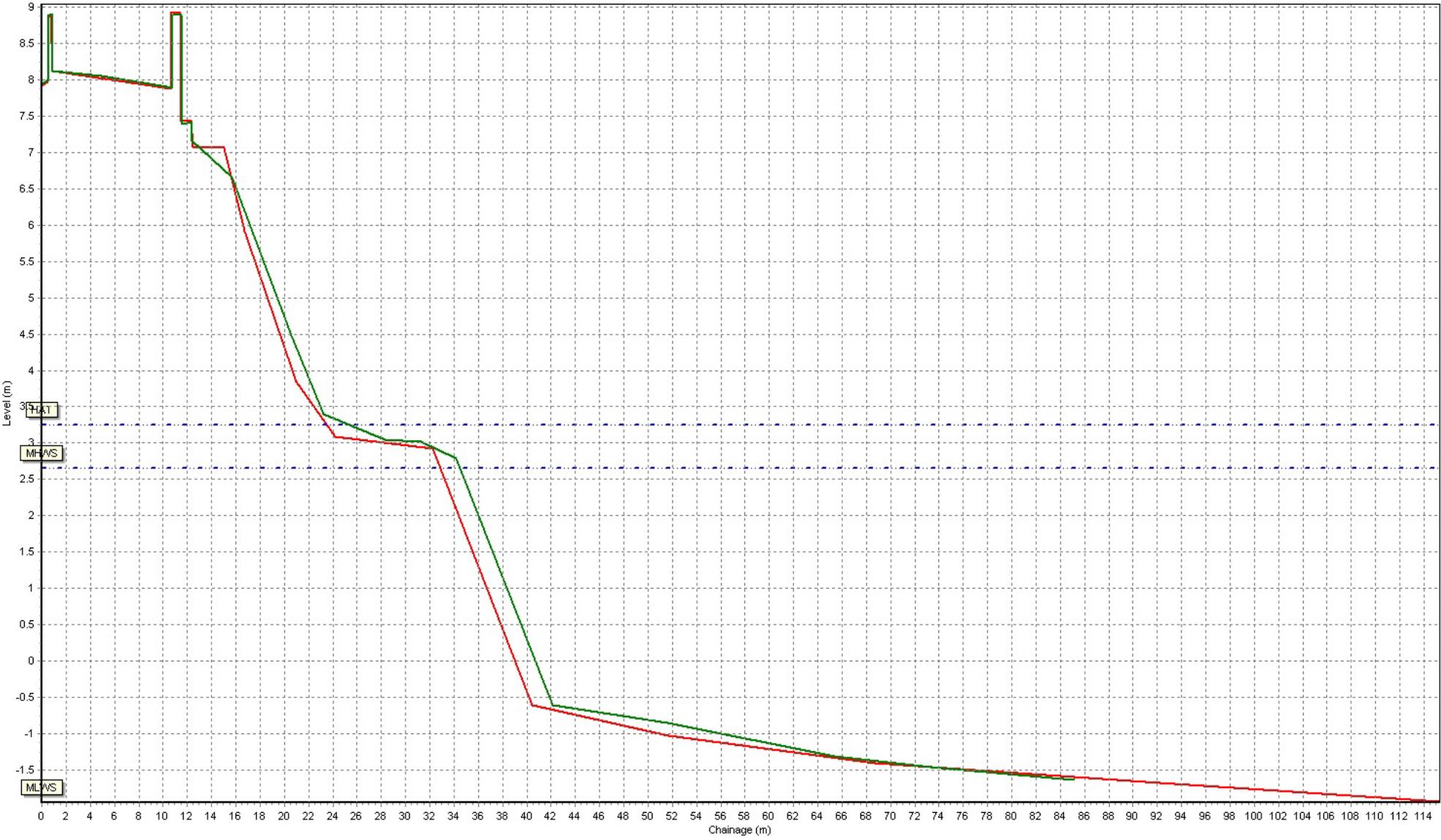
Beach Profiles: 1cHC1



- 25/11/2008
- 31/03/2009
- 21/09/2009

Beach Profiles: 1cHS1

- 27/03/2009
- 11/09/2009



Beach Profiles: 1cHS2



27/03/2009
 11/09/2009

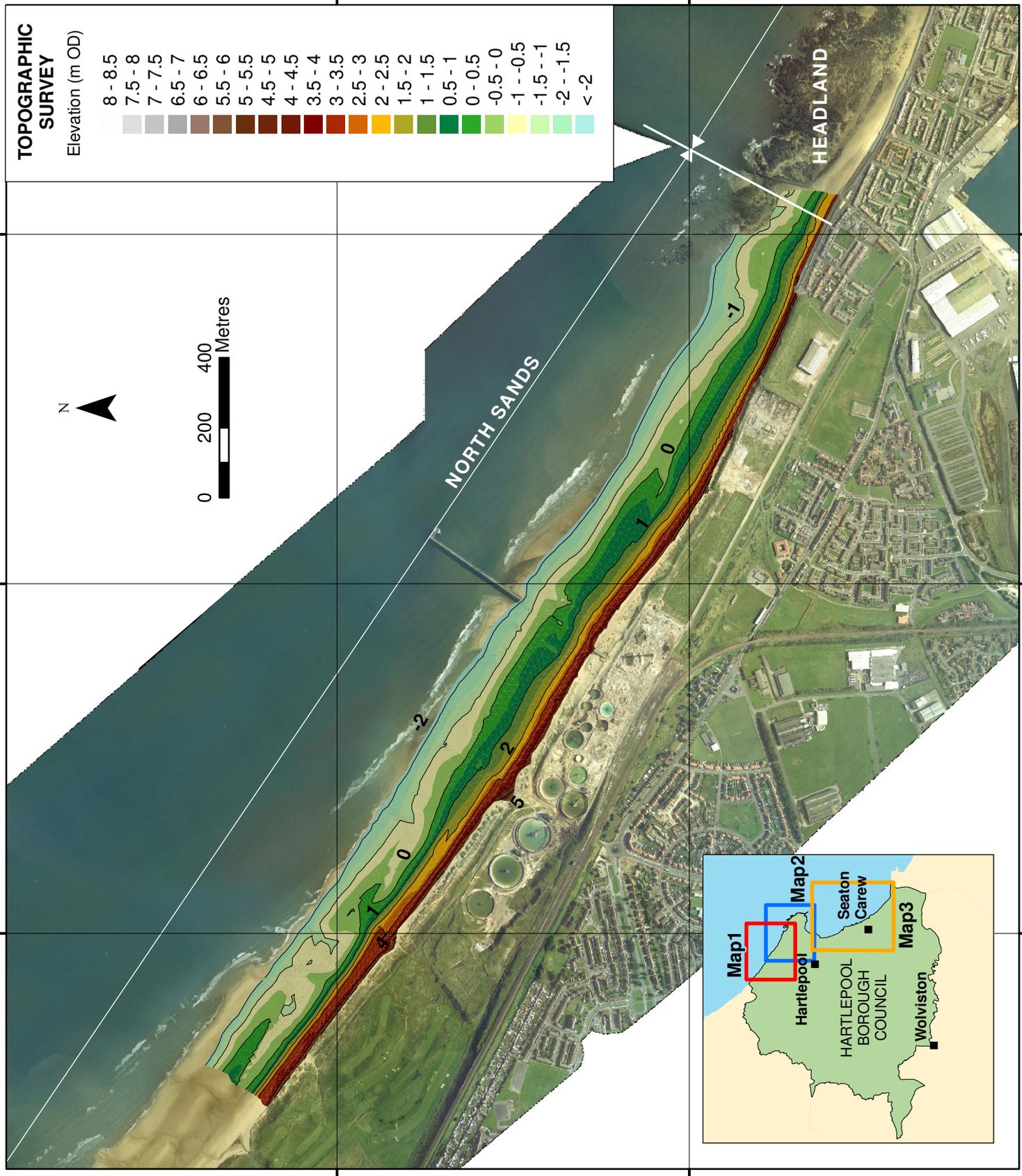
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- 27/03/2009
- 11/09/2009



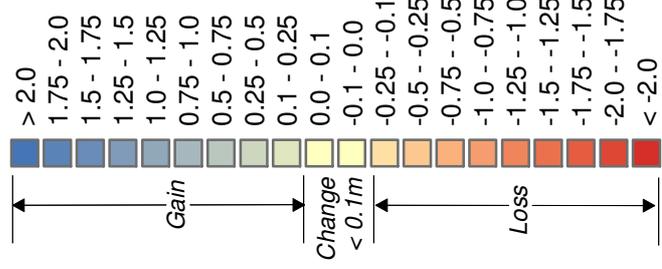
Appendix B
Topographic Survey

| | | |
|--|--|--|
| <p>— Topographic Contours at 1 metre interval</p> | <p>Client: North East Coastal Group</p> <p>Project: Cell 1 Regional Coastal Monitoring Programme</p> | <p>Appendix B - Map 1a Hartlepool Borough Council Frontage</p> <p>Analytical Report 2 'Full Measures' Survey 2009</p> |
| <p>Drawing Scale 1:15,000 at A4</p> <p>Drawn by: TC Date: 27/11/2009</p> <p>Checked by: NC Date: 16/12/2009</p> <p>Approved by: NC Date: 16/12/2009</p> | | |
| <div style="display: flex; justify-content: space-between;"> <div style="width: 30%;">  <p>ROYAL HASKONING Royal Haskoning Marlborough House Marlborough Crescent Newcastle upon Tyne NE1 4EE</p> </div> <div style="width: 30%;">  <p>Halcrow Halcrow Group Ltd Lyndon House 62 Hagley Road Edgbaston Birmingham B16 8PE</p> </div> <div style="width: 30%;"> <p>Tel: +44 (0)191 211 1300 Tel: +44 (0)121 456 2345 Fax: +44 (0)191 211 1313 Fax: +44(0)121 456 1569 www.royalhaskoning.com www.halcrow.com</p> </div> </div> <p style="text-align: right; font-size: small;">© Aerial Photography copyright Scarborough Borough Council</p> | | |



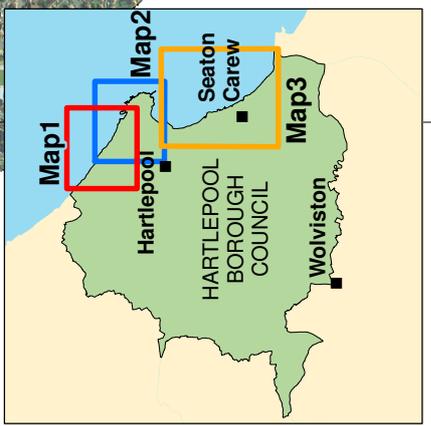
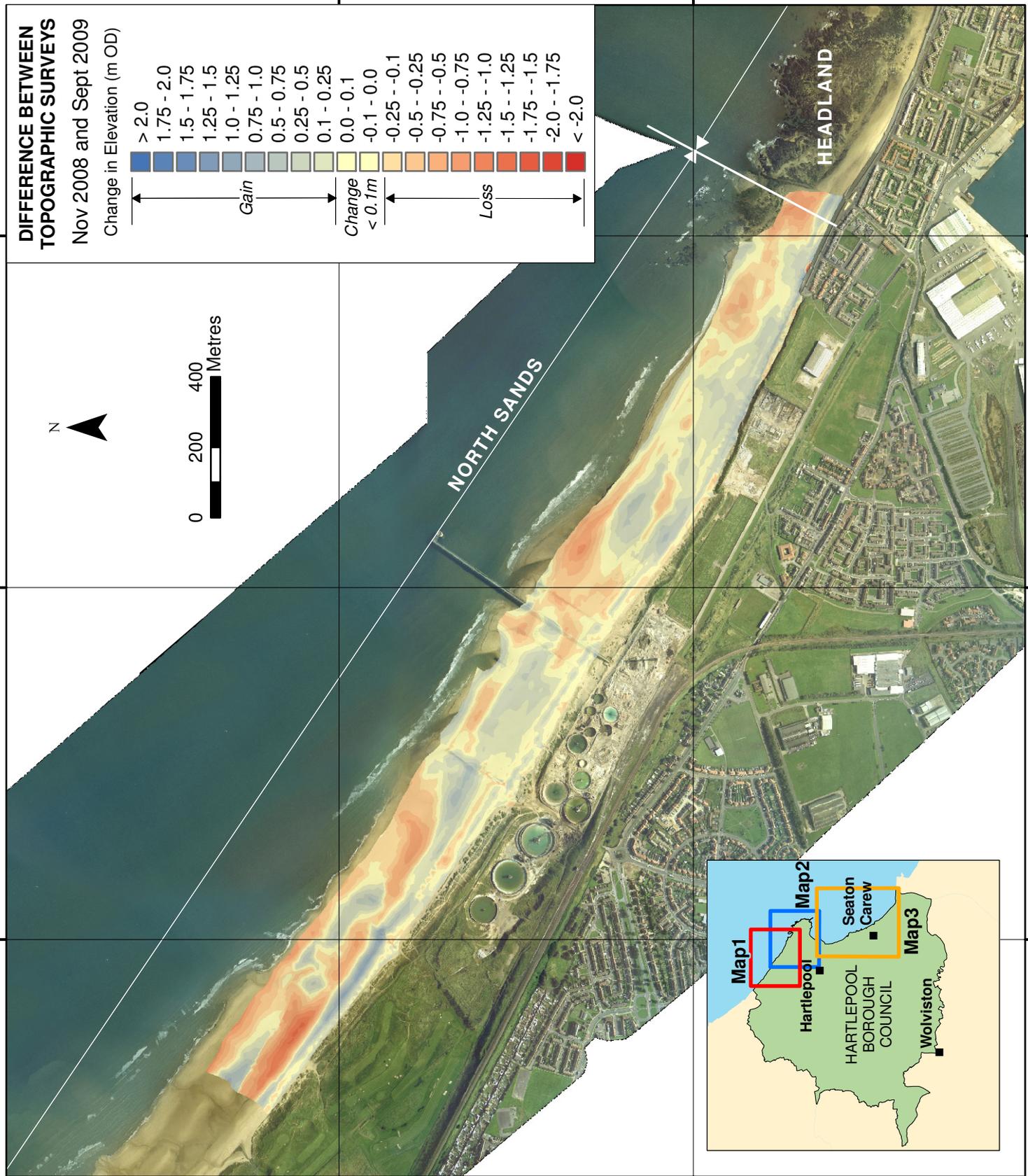
DIFFERENCE BETWEEN TOPOGRAPHIC SURVEYS
 Nov 2008 and Sept 2009

Change in Elevation (m OD)



NORTH SANDS

HEADLAND



000963

539000

450000

451000

452000

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

Appendix B - Map 1b
Hartlepool Borough
Council Frontage

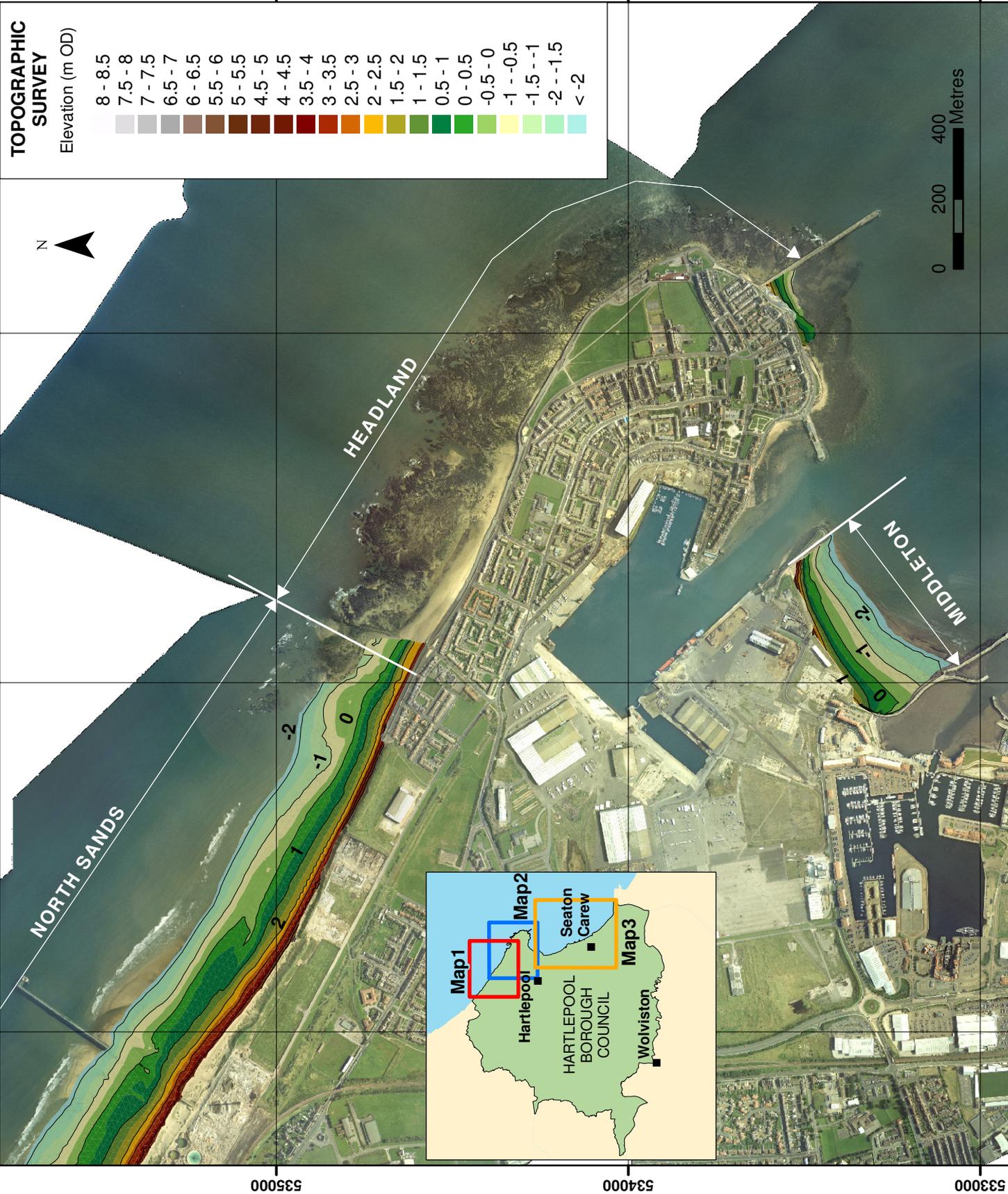
Analytical Report 2
 'Full Measures' Survey 2009

Drawing Scale 1:15,000 at A4
 Drawn by: TC Date: 27/11/2009
 Checked by: NC Date: 16/12/2009
 Approved by: NC Date: 16/12/2009

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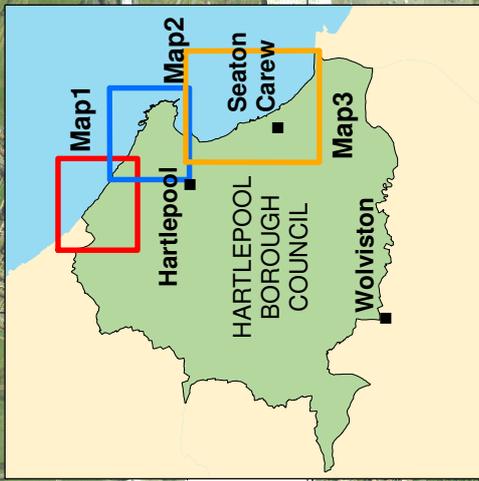
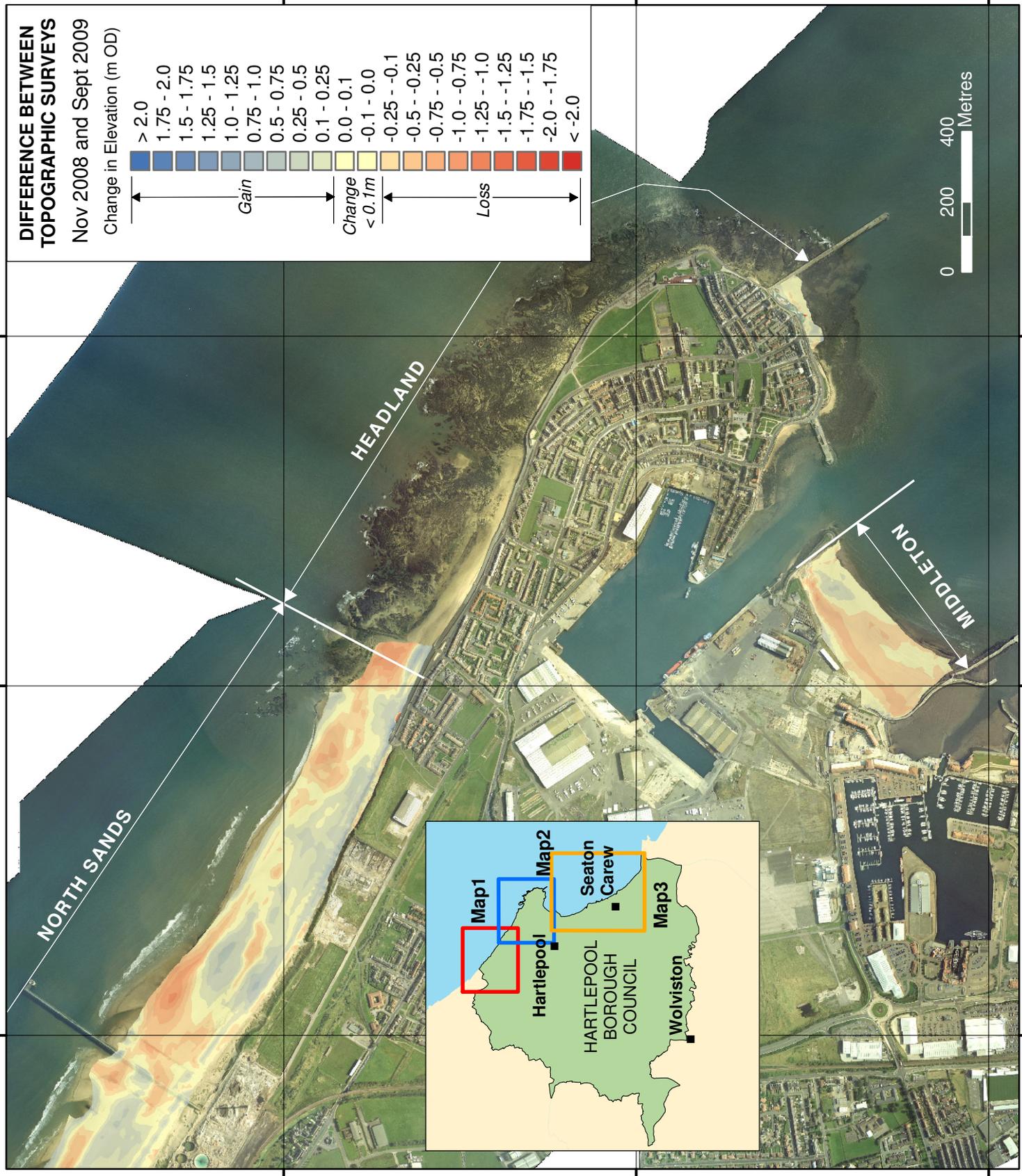
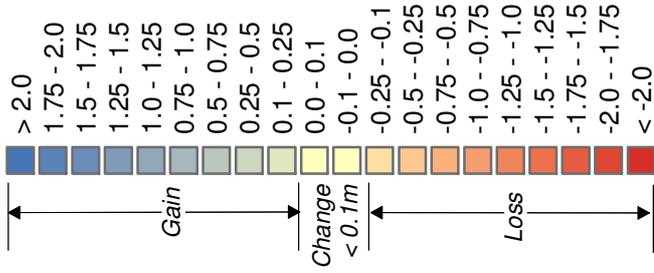
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DIFFERENCE BETWEEN TOPOGRAPHIC SURVEYS
Nov 2008 and Sept 2009

Change in Elevation (m OD)



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

Appendix B - Map 2b
Hartlepool Borough
Council Frontage

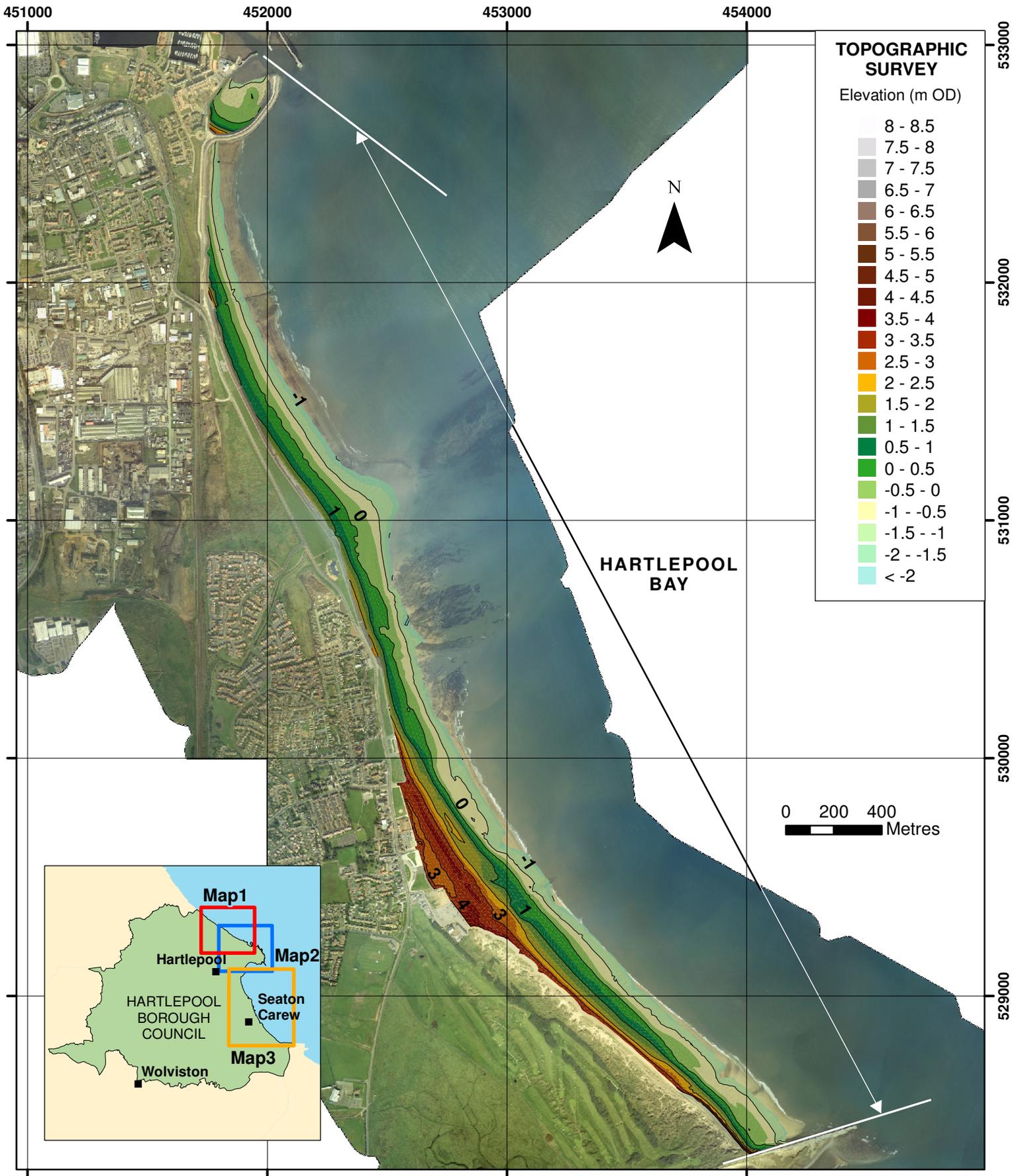
Analytical Report 2
 'Full Measures' Survey 2009

Drawing Scale 1:15,000 at A4
 Drawn by: TC Date: 08/05/2009
 Checked by: NC Date: 08/05/2009
 Approved by: NC Date: 08/05/2009

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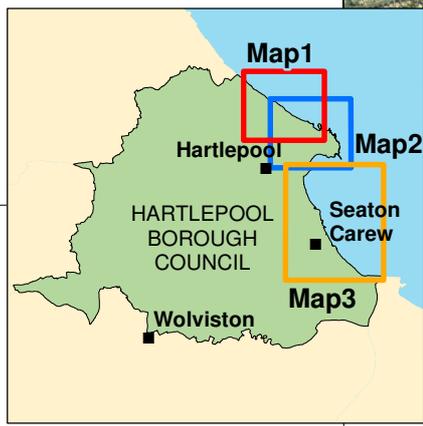
TOPOGRAPHIC SURVEY

Elevation (m OD)

- 8 - 8.5
- 7.5 - 8
- 7 - 7.5
- 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

HARTLEPOOL BAY

0 200 400 Metres



— 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 2
 'Full Measures' Survey 2009

Drawing Scale 1:21,000 at A4



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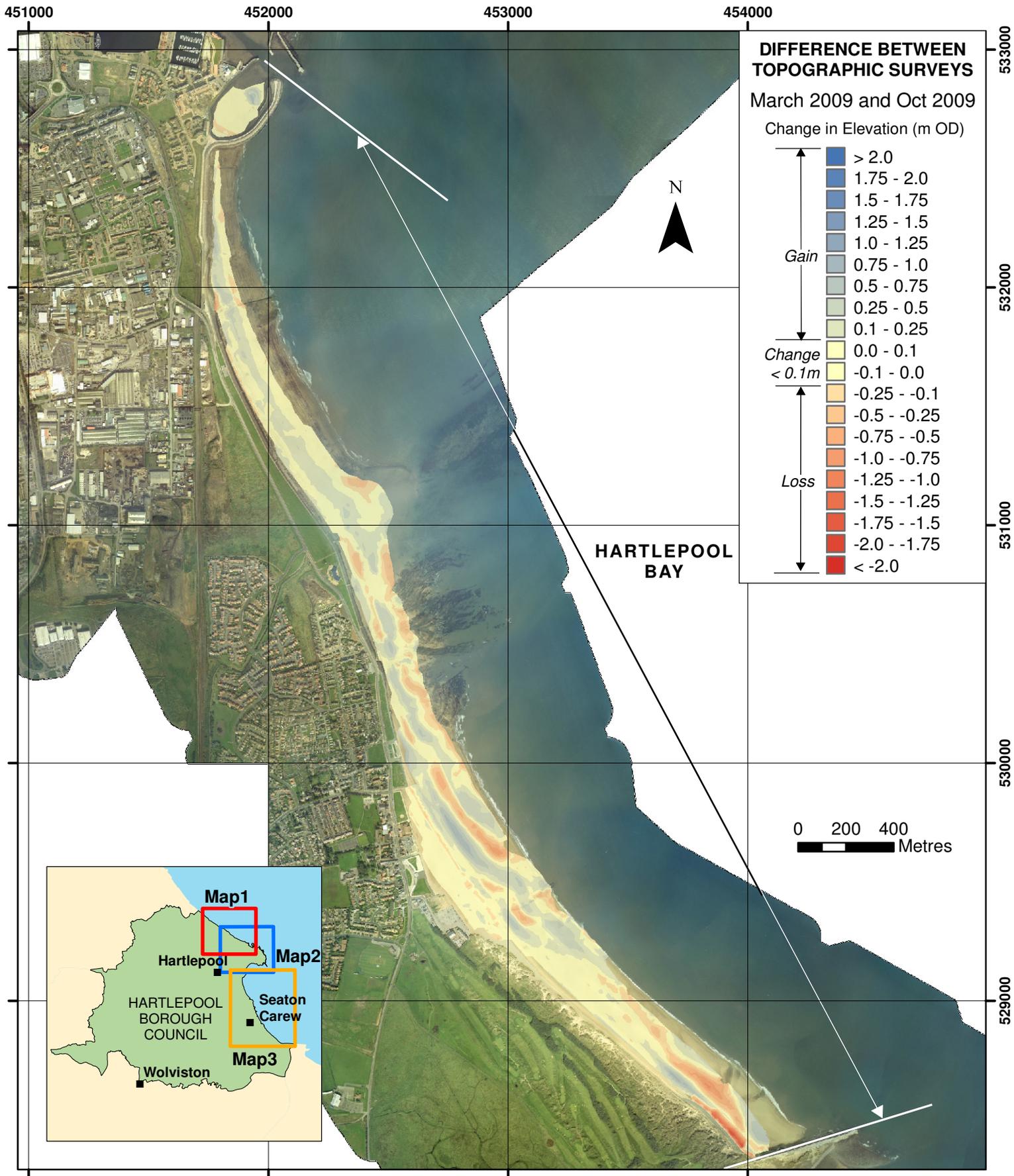


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 Approved by: NC Date: 16/12/2009

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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 2
 'Full Measures' Survey 2009

Drawing Scale 1:21,000 at A4



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