

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



South Tyneside Council

**South Tyneside Council
Final Report**

November 2010

Contents

Preamble.....	i
1. Introduction.....	1
1.1 Study Area.....	1
1.2 Methodology.....	1
2. Analysis of Survey Data.....	5
2.1 Littlehaven Beach.....	5
2.2 Herd Sands.....	7
2.3 Trow Quarry.....	9
2.4 Marsden Bay.....	10
3. Problems Encountered and Uncertainty in Analysis.....	11
4. Recommendations for 'Fine-tuning' the Monitoring Programme.....	13
5. Conclusions and Areas of Concern.....	13

Appendices

Appendix A	Beach Profiles
Appendix B	Topographic Survey

List of Figures

Figure 1	Sediment Cells in England and Wales
Figure 2	Survey Locations

List of Tables

Table 1	Analytical, Update and Overview Reports Produced to Date
Table 2	Sub-division of the Cell 1 Coastline

Authors	
Nick Cooper	Royal Haskoning
Tanja Cooper	Royal Haskoning

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 inter-tidal zone.
Geomorphology	The branch of physical geography/geology which deals with the form of the Earth, the general configuration of its surface, the distribution of the land, water, etc.
Groyne	Shore protection structure built perpendicular to the shore; designed to trap sediment.
Mean High Water (MHW)	The average of all high waters observed over a sufficiently long period.
Mean Low Water (MLW)	The average of all low waters observed over a sufficiently long period.
Mean Sea Level (MSL)	Average height of the sea surface over a 19-year period.
Offshore zone	Extends from the low water mark to a water depth of about 15 m and is permanently covered with water.
Storm surge	A rise in the sea surface on an open coast, resulting from a storm.
Swell	Waves that have travelled out of the area in which they were generated.
Tidal prism	The volume of water within the estuary between the level of high and low tide, typically taken for mean spring tides.
Tide	Periodic rising and falling of large bodies of water resulting from the gravitational attraction of the moon and sun acting on the rotating earth.
Topography	Configuration of a surface including its relief and the position of its natural and man-made features.
Transgression	The landward movement of the shoreline in response to a rise in relative sea level.
Updrift	Direction opposite to the predominant movement of longshore transport.
Wave direction	Direction from which a wave approaches.
Wave refraction	Process by which the direction of approach of a wave changes as it moves into shallow water.

Preamble

The Cell 1 Regional Coastal Monitoring Programme covers approximately 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.

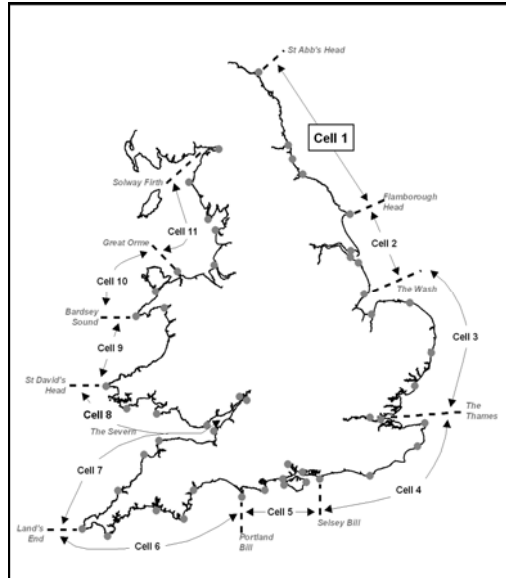


Figure 1 - Sediment Cells in England and Wales

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	Nov 08	May 09	Mar 09	June 09	-
2	2009/10	Sep 09	Mar 10	Mar 10	May 10	-
3	2010/11	Sep 10	Nov 10 ^(*)			

(*) The present report is **Analytical Report 3** and provides an analysis of the 2010 Full Measures survey for South Tyneside 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
	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
	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

South Tyneside Council's frontage extends from the mouth of the River Tyne estuary in the north, to the outfall south of Whitburn. For the purposes of this report, it has been sub-divided into four areas, namely:

- Littlehaven Beach
- Herd Sands
- Trow Quarry
- Marsden Bay

1.2 Methodology

Along South Tyneside Council's frontage, the following surveying is undertaken:

- Full Measures survey annually each autumn/early winter comprising:
 - Beach profile surveys along 17 no. transect lines
 - Topographic survey along Littlehaven Beach (commenced 2010)
 - Topographic survey along Herd Sands
 - Topographic survey along Trow Quarry
- Partial Measures survey annually each spring comprising:
 - Beach profile surveys along 11 no. transect lines
 - Topographic survey along Littlehaven Beach (commenced 2010)
- Cliff top survey (in Full Measures but only once every 2 years) at:
 - Trow Point (reported separately in *Trow Quarry Coastal Defence Scheme - Monitoring Plan Year 2* – available from South Tyneside Council)

The location of these surveys is shown in Figure 2.

The current Full Measures survey was undertaken along this frontage in September 2010, when weather conditions were generally fine with a slight breeze. The sea state was calm but with a strong swell.

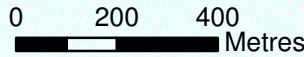
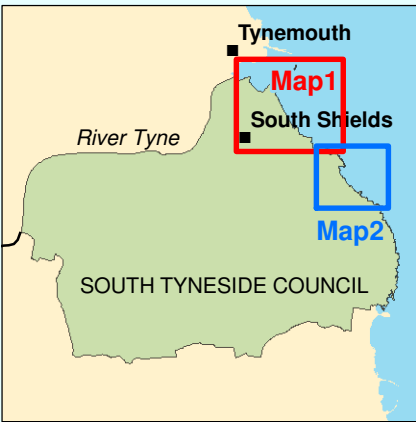
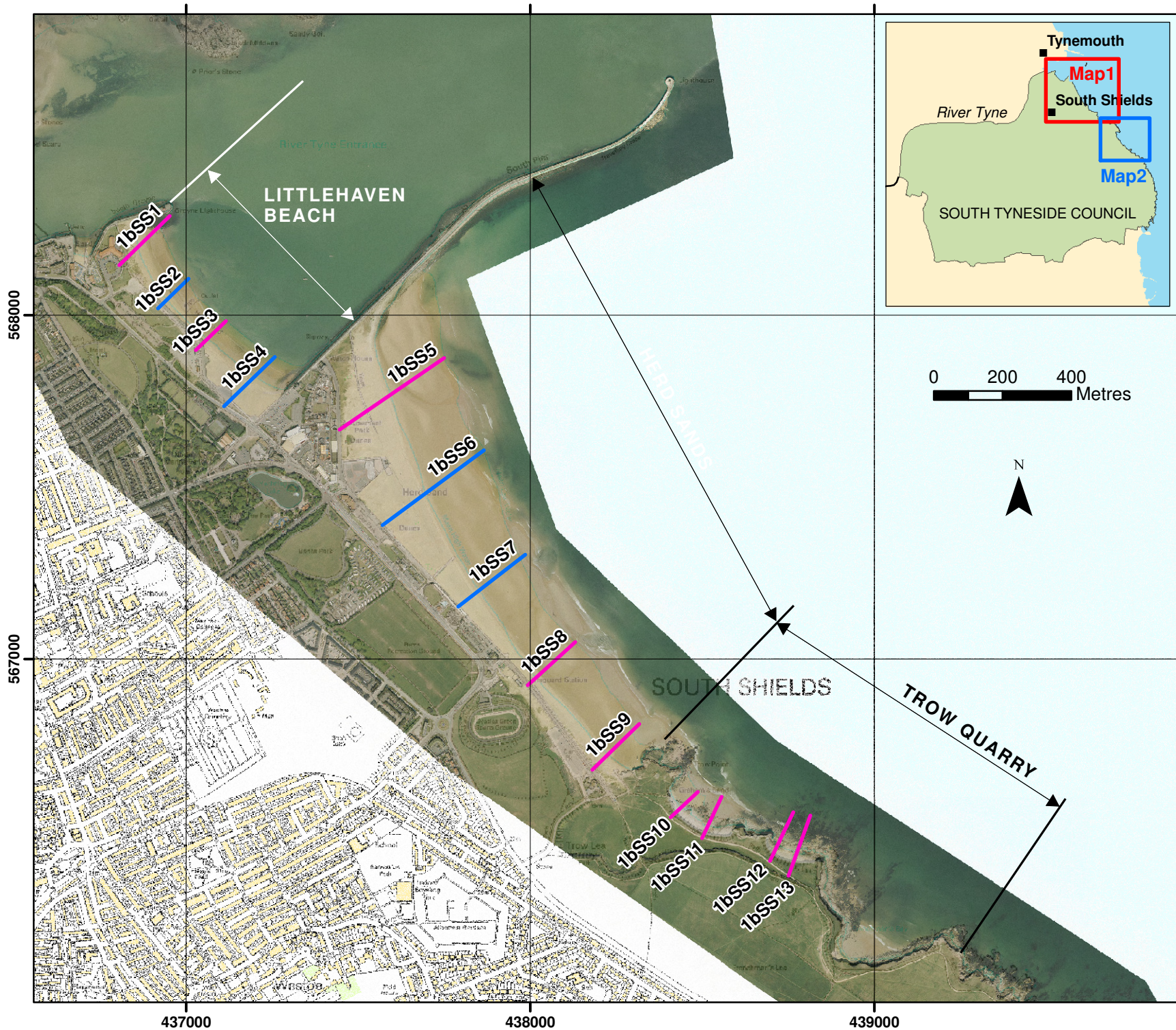
All data have been captured in a manner commensurate with the principles of the Environment Agency's *National Standard Contract and Specification for Surveying Services* and stored in a file format compatible with the software systems being used for the data analysis, namely SANDS and Arc-GIS. This 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 North East Coastal Observatory website (www.northeastcoastalobservatory.org.uk) 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:

- 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
 South Tyneside Council Frontage**

Analytical Report 3
 'Full Measures' Survey 2010

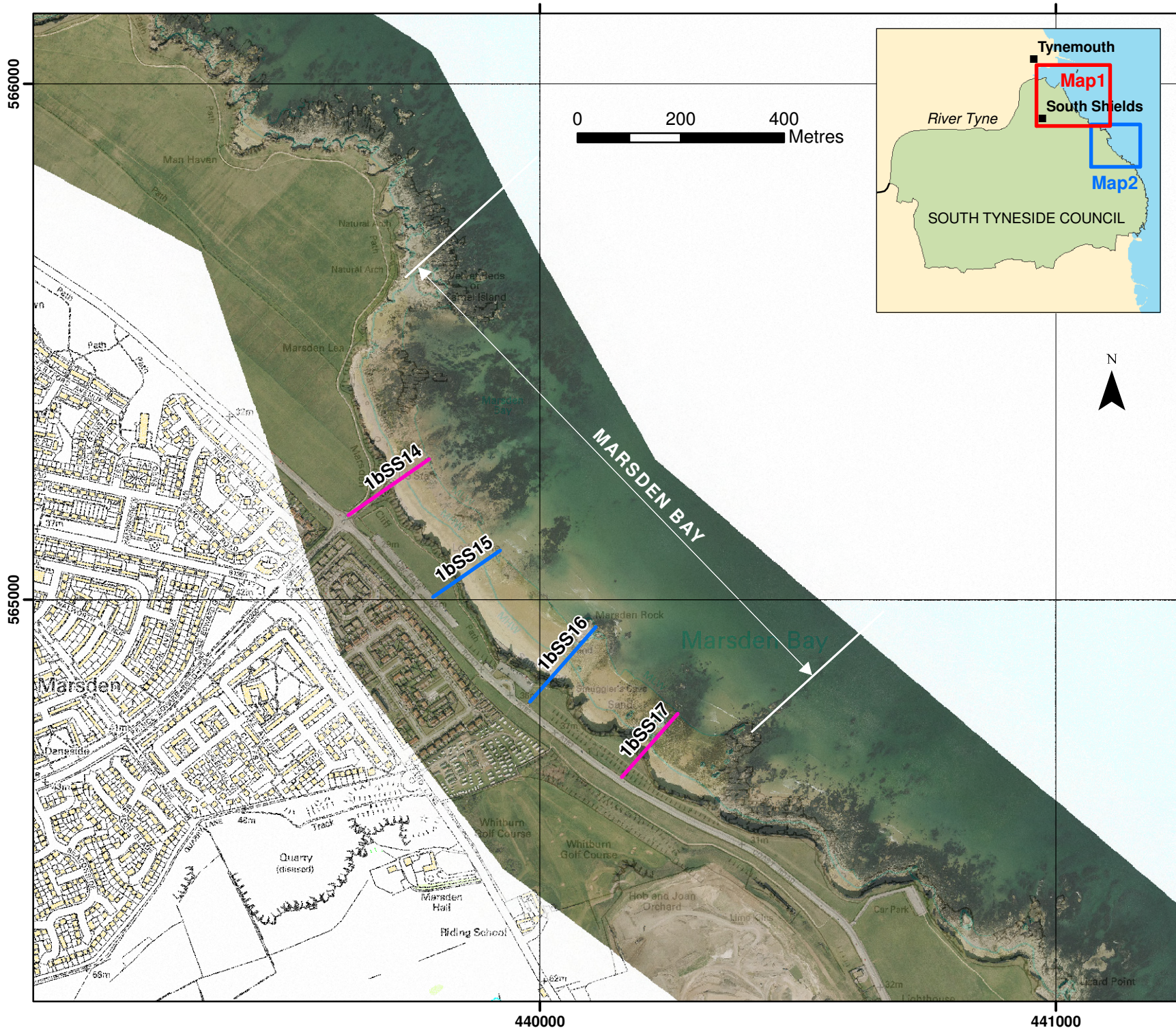
Drawing Scale 1:15,000 at A4

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

 ROYAL HASKONING	 Halcrow
Royal Haskoning Marlborough House Marlborough Crescent Newcastle upon Tyne NE1 4EE	Halcrow Group Ltd Lyndon House 62 Hagley Road Edgbaston Birmingham B16 8PE
Tel: +44 (0)191 211 1300 Fax: +44 (0)191 211 1313 www.royalhaskoning.com	Tel: +44 (0)121 456 2345 Fax: +44(0)121 456 1569 www.halcrow.com

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

I:\916403\Technical_Data\gis\figure7_FULL_measures_report_2010\3_South_Tyneside\Figure2_South_Tyneside_Map1.mxd



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

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

Figure 2 - Map 2
South Tyneside Council Frontage
 Analytical Report 3
 'Full Measures' Survey 2010

Drawing Scale 1:10,000 at A4

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

 ROYAL HASKONING	 Halcrow
Royal Haskoning Marlborough House Marlborough Crescent Newcastle upon Tyne NE1 4EE	Halcrow Group Ltd Lyndon House 62 Hagley Road Edgbaston Birmingham B16 8PE
Tel: +44 (0)191 211 1300 Fax: +44 (0)191 211 1313 www.royalhaskoning.com	Tel: +44 (0)121 456 2345 Fax: +44(0)121 456 1569 www.halcrow.com

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

2. Analysis of Survey Data

2.1 Littlehaven Beach

Survey Date	Description of Changes Since Last Survey	Interpretation
09-2010	<p>Beach Profiles:</p> <p>Littlehaven Beach is covered by four beach profile lines, spaced between South Groyne and South Pier (Appendix A).</p> <p>Whilst profile SS1 remained relatively healthy landward of HAT, including an increase in dune crest level to 6mODN, the mid profile recovered only slightly since the March 2010 survey and the lower profile, seaward of 100m chainage, reduced to new record low levels.</p> <p>Profile SS2 experienced notable redistribution of sediment, with the berm previously recorded around MHWS in September 2009 being flattened resulting in recovery of levels at the toe of the sea wall. Similar to SS1, the lower profile recorded the lowest levels since surveys began in November 2008.</p> <p>Profile SS3 experienced the lowest beach levels recorded to date at the toe of the sea wall in March 2010, leading to significant overtopping and flooding of the backing car park, which was reported in the previous Update Report 2010. Since that time, beach levels at the toe have recovered by some 0.25m to September 2010, with the general beach profile to a chainage of around 62m experiencing notable accretion.</p> <p>Along profile SS4, the previously recorded berm around HAT had slightly flattened but was still pronounced, just above MHWS. Elsewhere along the profile, both landward and seaward of the berm re-adjustment, the profile experienced accretion, in many places to new record high levels.</p>	<p>Despite the lowest levels recorded to date along the seaward end of profile SS1, the dune face remained healthy and the crest increased in height due to wind-blown sand.</p> <p>Beach levels at the toe of the sea wall remain highly variable, as exemplified by SS2 and SS3. Both profiles experienced accretion at the toe of the sea wall. Along SS3, where the sea wall protrudes out across the upper foreshore, beach levels have varied by up to 0.85m since monitoring began in November 2008.</p> <p>The southern section of the frontage remains healthy and experienced general accretion.</p> <p>Overall, Littlehaven Beach experienced a general net increase in sediment, causing beach levels, especially in the centre and south of the bay, to increase. The lower sections of the profile along SS1 and SS2, however, reduced to new record low levels, suggesting a partial re-distribution of sediment from the lower beach to the mid and upper beach.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
09-2010	<p>Topographic Survey:</p> <p>Littlehaven Beach is covered by 6-monthly topographic survey between the South Groyne and the South Pier, which commenced in March 2010. Data from the September 2010 survey have been used to create a DGM (Appendix B – Map 1a).</p> <p>These topographic survey data have been used to create Digital Ground Models (DGMs) of the site using a Geographic Information System (GIS) computer software package (Appendix B – Maps 1a and 1b). These DGMs show how the beach contours between 2.5 and 3.0mODN are interrupted by the protruding sea wall in the centre of the bay. It can also be seen from the August 2009 DGM, which covered topographic survey of the land backing the sea wall, that the older Littlehaven Car Park, immediately behind the sea wall, is notably lower in level (at around 4mODN) than both the land to its rear (at around 5mODN) and the amenity land to its north (at around 6mODN). This is the main reason why sea water tends to pond in the car park when it (frequently) overtops the sea wall.</p> <p>The GIS has also been used to calculate the differences between these two earlier surveys, as shown in Appendix B – Map 1c, to identify areas of erosion and accretion.</p>	<p>Comparison of the March 2010 survey with earlier surveys from August 2009, undertaken as part of a specific project, revealed extensive erosion of beach material along most of the length of Littlehaven Beach, with the worst affected areas concentrated around the toe of the protruding section of sea wall. These low beach levels occurred at a time of spring equinox tides and severe storm action and led to violent overtopping of the sea wall and flooding of the backing land.</p> <p>Since March 2010, the topographic survey from September 2010 reveals that beach levels recovered at the toe of the wall and along the upper and mid sections of beach. However, some of this recovery was caused by lowering of the lower beach and movement landward of the liberated sediment.</p>

2.2 Herd Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
09-2010	<p>Beach Profiles:</p> <p>Herd Sands is covered by five beach profile lines, spaced between South Pier and the rock headland of Trow Point (Appendix A).</p> <p>SS5 shows signs of accretion in the hollows between successive dune crests and apparent deposition of sand across the donkey track at the seaward edge of the dunes. The berm identified on the lower profile in March 2010 has migrated slightly landwards.</p> <p>SS6 experienced accretion of sand in the hollow between the primary and secondary dune fields. The primary dunes decreased slightly in crest level, but remain at a substantial height of 7.35mODN. The berm previously recorded in September 2009 around HAT had become flattened, whilst the foreshore seaward of MHWS level remained very stable.</p> <p>The very large berm and trough feature recorded in the September 2009 survey along SS7 had been flattened by September 2010, with the profile form resembling that recorded during the first survey in November 2008 although with a slight berm and trough recorded along the lower profile.</p> <p>SS8, near Gypsies' Green, recovered somewhat from the notable cut back suffered along the mid to upper profile between September 2009 and March 2010, but beach levels directly at the toe of the sea wall and promenade were some 1m lower than in March 2010. Along the lower beach, beach levels dropped marginally since March 2010, but remain relatively high compared with earlier surveys.</p> <p>At the southern end of the beach, profile SS9 has generally shown marginal recovery in level seaward to a chainage of around 130m, and modest beach lowering further seaward.</p>	<p>The dunes in Herd Sands appeared to have accreted in the hollows between successive dune crest, due to wind-blown sand. Previous (March 2010) low beach levels along some sections of the bay had recovered somewhat by September 2010.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
09-2010	<p>Topographic Survey:</p> <p>Herd Sands is covered by an annual topographic survey between the South Pier and Trow Point. Data have been used to create a DGM (Appendix B – Map 2a).</p> <p>The DGM shows some of the key features of this section of beach, including the hollow in the dunes just south of the children’s play area, and the cutting back of the general embayment contours in the vicinity of Gypsies’ Green.</p> <p>The DGM from the present survey has been compared against that created from the previous survey in September 2009 using a GIS to identify areas of erosion and accretion between the surveys (Appendix B – Map 2b).</p>	<p>In general, the trend between September 2009 and September 2010 has been for material along the mid to upper foreshore to be eroded and become drawn-down the beach where it has tended to become deposited on the lower foreshore. This is most likely associated with the formation of a berm in the September 2009 survey and its flattening by the September 2010 survey.</p>

2.3 Trow Quarry

Survey Date	Description of Changes Since Last Survey	Interpretation
09-2010	<p>Beach Profiles:</p> <p>Trow Quarry is covered by four profile lines (Appendix A).</p> <p>SS10 – SS13 all demonstrate no change in the position or gradient of the coastal slope and rock revetment.</p> <p>Along SS10 and SS11, upper foreshore levels dropped to new record low values seaward to a chainage of around 40m as the superficial sediment was stripped away and the underlying bedrock became exposed.</p> <p>Along SS12 and SS13, there were minor variations in foreshore level largely within the previously recorded bounds of natural change.</p>	<p>The re-graded coastal slope and rock revetment constructed along Trow Quarry within the Graham's Sand and Southern Bay frontages in November 2008 have shown excellent stability over the scheme's operation to September 2010.</p> <p>The changes along the foreshore are consistent with observed trends of a mobile veneer of beach sand covering the underlying rocky foreshore to varying thickness and in various locations depending on the prevailing wave and tide conditions.</p>
	<p>Topographic Survey:</p> <p>Trow Quarry is covered by an annual topographic survey within Graham's Sand, Southern Bay and Frenchman's Bay. Data have been used to create a DGM (Appendix B – Map 2a).</p> <p>The DGM from the present survey has been compared against that created from the previous survey in September 2009 using a GIS to identify areas of erosion and accretion between the surveys (Appendix B – Map 2b). This identifies notable stripping of sediment in Graham's Sand from particularly the mid and lower foreshore but also, in places, the upper foreshore. Southern bay generally experienced modest deposition of sediment over the bed rock.</p>	

2.4 Marsden Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
09-2010	<p>Beach Profiles:</p> <p>Marsden Bay is covered by four profile lines (Appendix A).</p> <p>SS14 covers the cliffs and former lifeguard station adjacent to the Redwell Steps. The concrete platform at the toe of the cliffs is accurately surveyed and shows no signs of change. Beach levels have decreased along the whole profile length since the March 2010 survey, particularly at the toe of the wall where levels are now about 2.6mODN. Further seaward along the profile, record low levels were set. There are apparent changes recorded in the cliff outcrop and its backing bevelled slope to the cliff top.</p> <p>Along SS15 the upper beach has moderately accreted since the previous survey.</p> <p>Along SS16 the cliff line appears further seaward but this is due to two missing points from the lower cliff face that have been surveyed on previous surveys. The foreshore has experienced modest accretion of sand, and the upper foreshore has a small accumulation of boulders.</p> <p>There have been no significant changes in foreshore level along SS17.</p>	<p>Changes in the bevelled slope to the cliff top along SS14 are due to difficulties in surveying this section of the profile (see Section 3 for further discussion).</p> <p>The apparent 'apparent' growth in cliff face position along SS16 is due to the surveyors not capturing two points from the lower cliff face during September 2010.</p> <p>There appears to have been some foreshore lowering from the northern end of Marsden Bay and deposition towards the central and southern end, but these processes are operating on a modest scale.</p>

3. Problems Encountered and Uncertainty in Analysis

Construction Activities along Herd Sands

The promenade and land backing Herd Sands is undergoing construction work throughout 2010, with notable improvement works to the promenade and car park. This meant that the topographic survey was not always taken landward to its usual boundaries in September 2010 and in some places a strip of up to 10m is missing from the survey. This is not considered a major deficit and the areas most susceptible to variation in level have been well captured.

Beach Re-profiling and Beach Combing

Herd Sands is subject to occasional re-profiling and regular 'summer season' beach combing activities by the Council's Foreshore Team, which results in changes in the measured profiles on occasions.

Rock Foreshores

Surveys of foreshore areas that are covered by inter-tidal rock outcrops present some problems to our surveyors (Plate 1). It is logistically difficult for staff to access across the foreshore but more importantly it is very difficult to ensure that identical rock features are re-surveyed on each occasion. Due to the fragmented, creviced and 'rocky' nature of the foreshore it is extremely likely that different features will be recorded on successive surveys due to this. We would expect that the rock foreshore would not experience significant down-weathering over short timescales and therefore any apparent changes between successive surveys are likely to be due to surveying different features rather than erosion. Notwithstanding this, the rock foreshore areas are periodically covered with a thin veneer of beach sand, which due to its mobility, can be absent on subsequent surveys. Such changes are identified through inspection of the photographs that are taken by the surveyors along each transect line and analysis of the sediment coding that is included in the raw data file, depicting areas of 'sand' or 'rock'.

Plate 1 Survey of Rock Foreshore



Marsden Bay

Beach Profile SS14 is located at the northern end of Marsden Bay, close to the Redwell Steps. Surveys of the beach and the concrete platform and steps at the base of the cliffs are accurately undertaken on each survey. Due to this, it has become clear that the changes in the cliff form above the structure are 'apparent' changes caused by survey difficulties on this steeply bevelled cliff face (Plate 2). In particular, the rock that outcrops at the seaward face of the cliff is showing apparent signs of change (see Appendix A - Beach Profile 1bSS14). A slight change in alignment of the profile across the cliff section can result in an apparently large change in form simply due to different rock features being picked up on each survey.

Plate 2 – Survey of Cliff along Beach Profile SS14



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

Following implementation of previous recommendations, no further changes are required at the present time.

5. Conclusions and Areas of Concern

- Following the March 2010 survey which depicted lowering of beach levels at a number of key locations, the September 2010 survey shows general modest recovery.
- The dunes at the northern end of Littlehaven Beach continue to show signs of accretion in crest levels, although the lower foreshore experienced lowering.
- There appear to be onshore-offshore exchanges of sediment along Littlehaven Beach which are linked to prevailing wave conditions. For example, lowering occurred along parts of the lower foreshore between March 2010 and September 2010, but the liberated material was deposited on the mid and upper foreshore to restore beach levels at these locations.
- The dunes in Herd Sands have accreted wind-blown sand in the hollows between successive dune crests.
- Along Herd Sands, a berm recorded in the September 2009 survey has become flattened by the September 2010 survey, resulting in lowering of mid and upper beach levels and increases in lower beach levels.
- There has been excellent stability in the position and form of the re-graded coastal slope and rock revetment constructed in November 2008 as part of the Trow Quarry Coastal Defence Scheme.
- There appears to have been some material erosion through foreshore lowering in the northern end of Marsden Bay and deposition of liberated sediment towards the central and southern end, but these processes are operating on a modest scale.
- The remainder of profiles within Marsden Bay exhibit signs of consistency in cliff form and foreshore levels, supporting the view that erosion generally occurs as occasional localised rock falls along this frontage.

Appendices

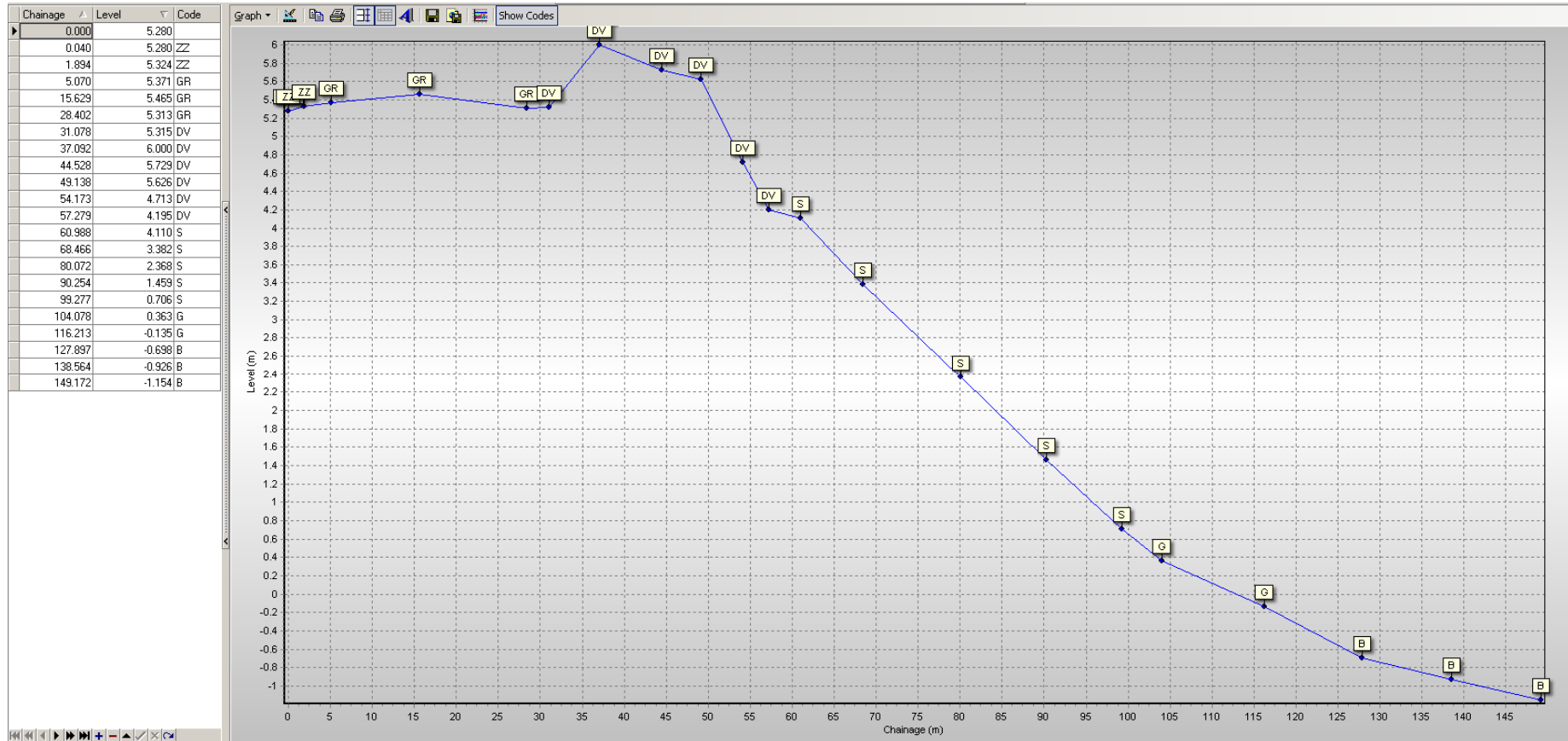
Appendix A
Beach Profiles

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

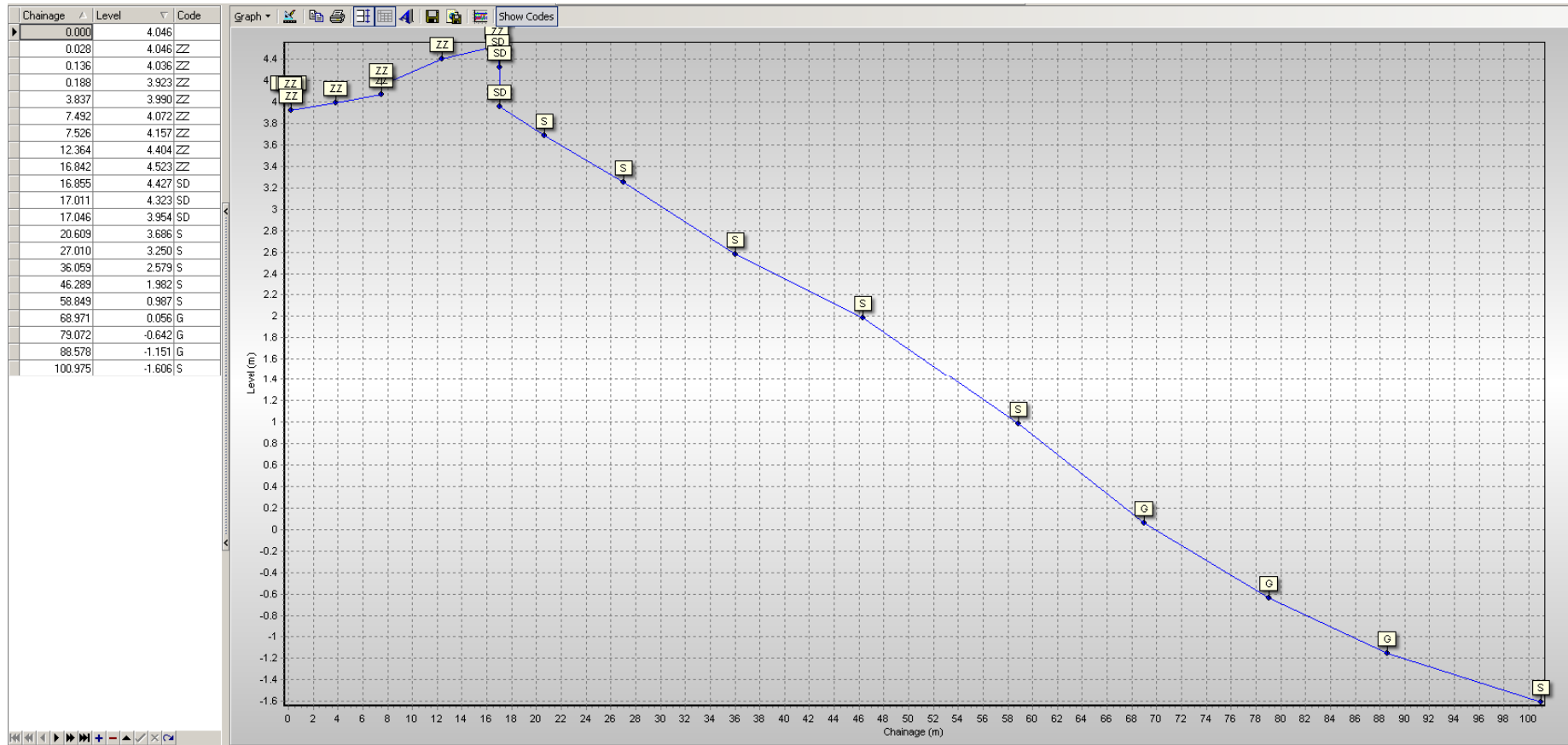
Code	Description
M	Mud
S	Sand
G	Gravel
GS	Gravel & Sand
GM	Gravel & Mud
MS	Mud & Sand
B	Boulders
R	Rock
SD	Sea Defence
SM	Salt Marsh
GR	Grass
D	Dune (non-vegetated)
DV	Dune (vegetated)
F	Forested
X	Mixture
FB	Obstruction
CT	Cliff Top
CE	Cliff Edge
CF	Cliff Face
SH	Shell
W	Water Body
ZZ	Unknown

South Shields

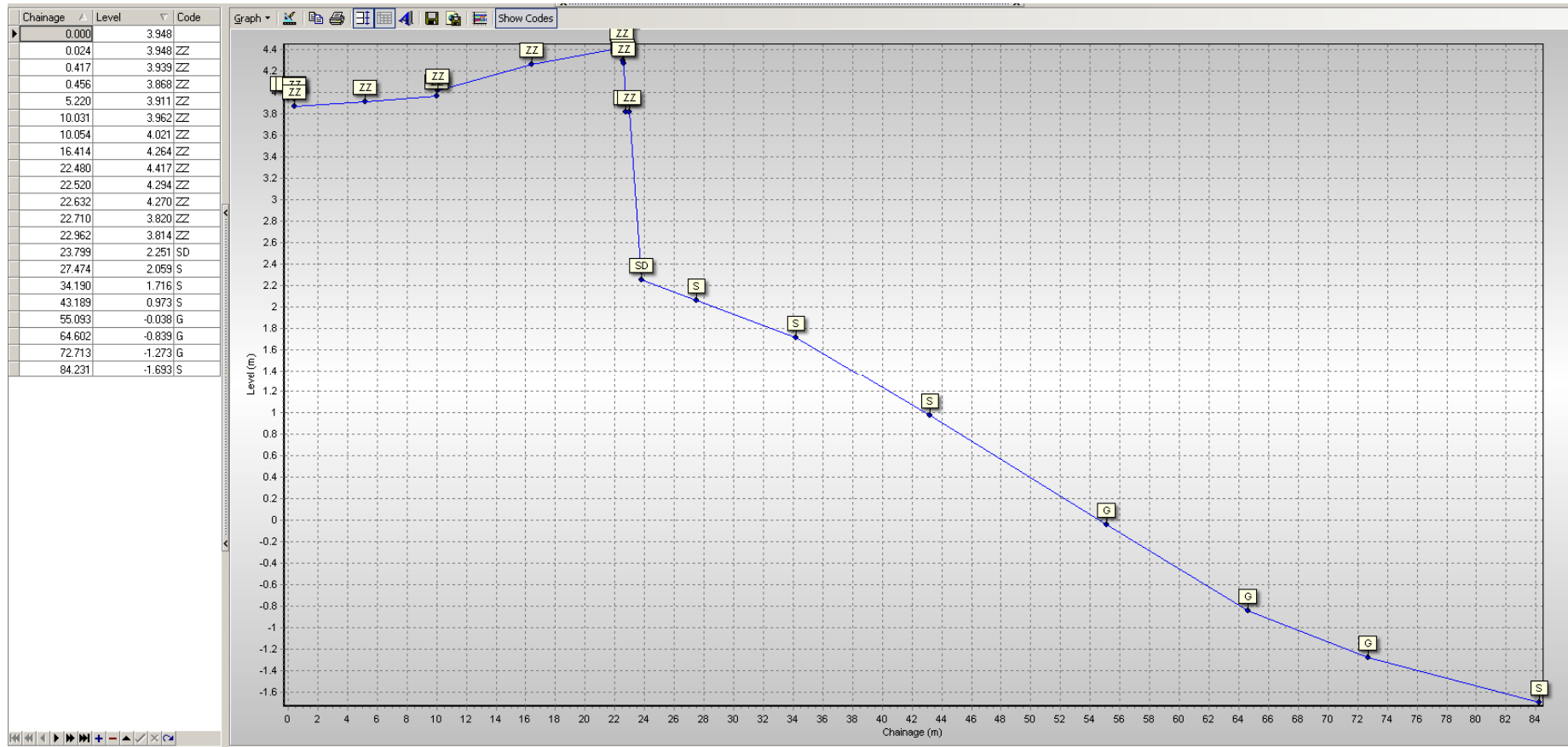
1bSS1 - 14/09/2010



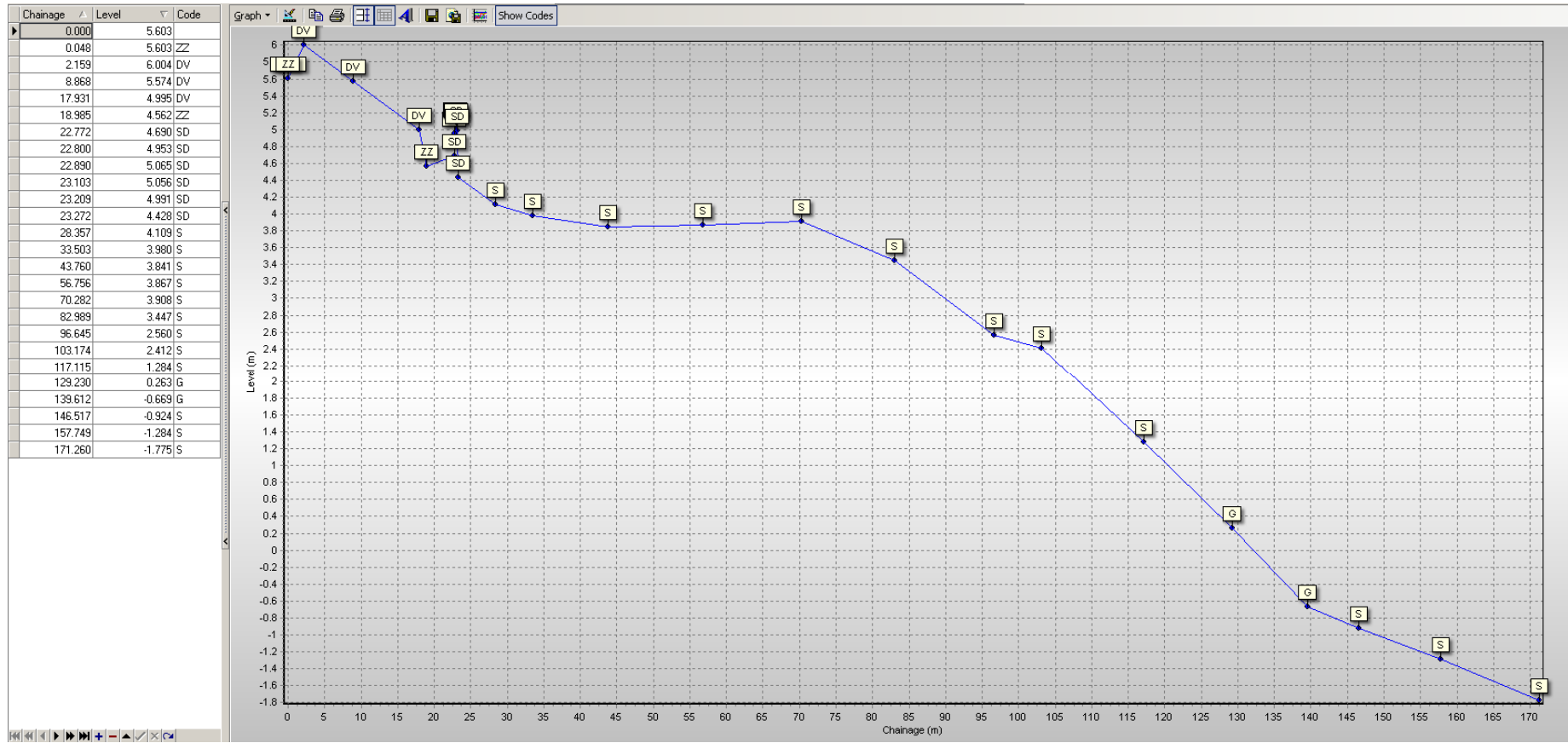
1bSS2 - 14/09/2010



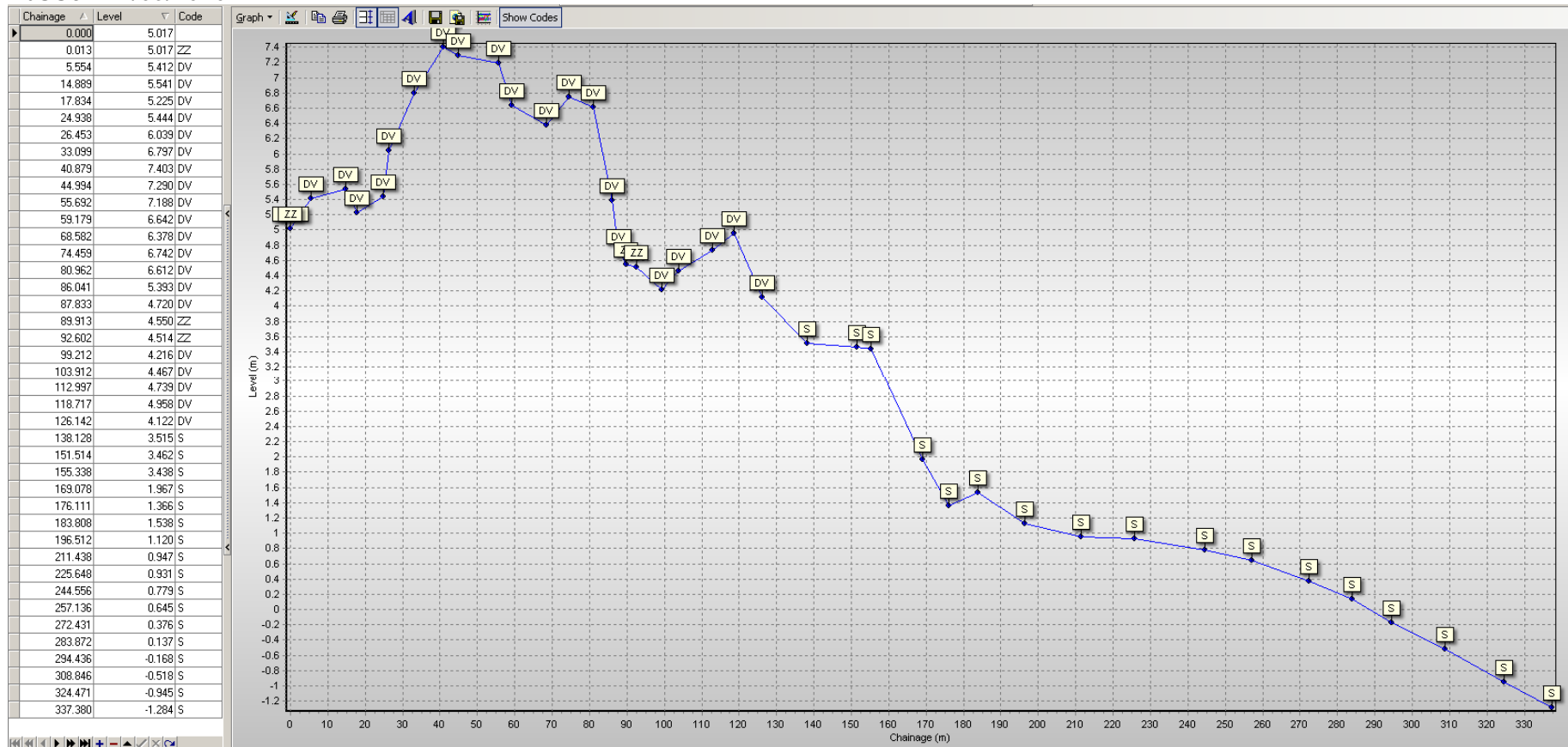
1bSS3 - 14/09/2010



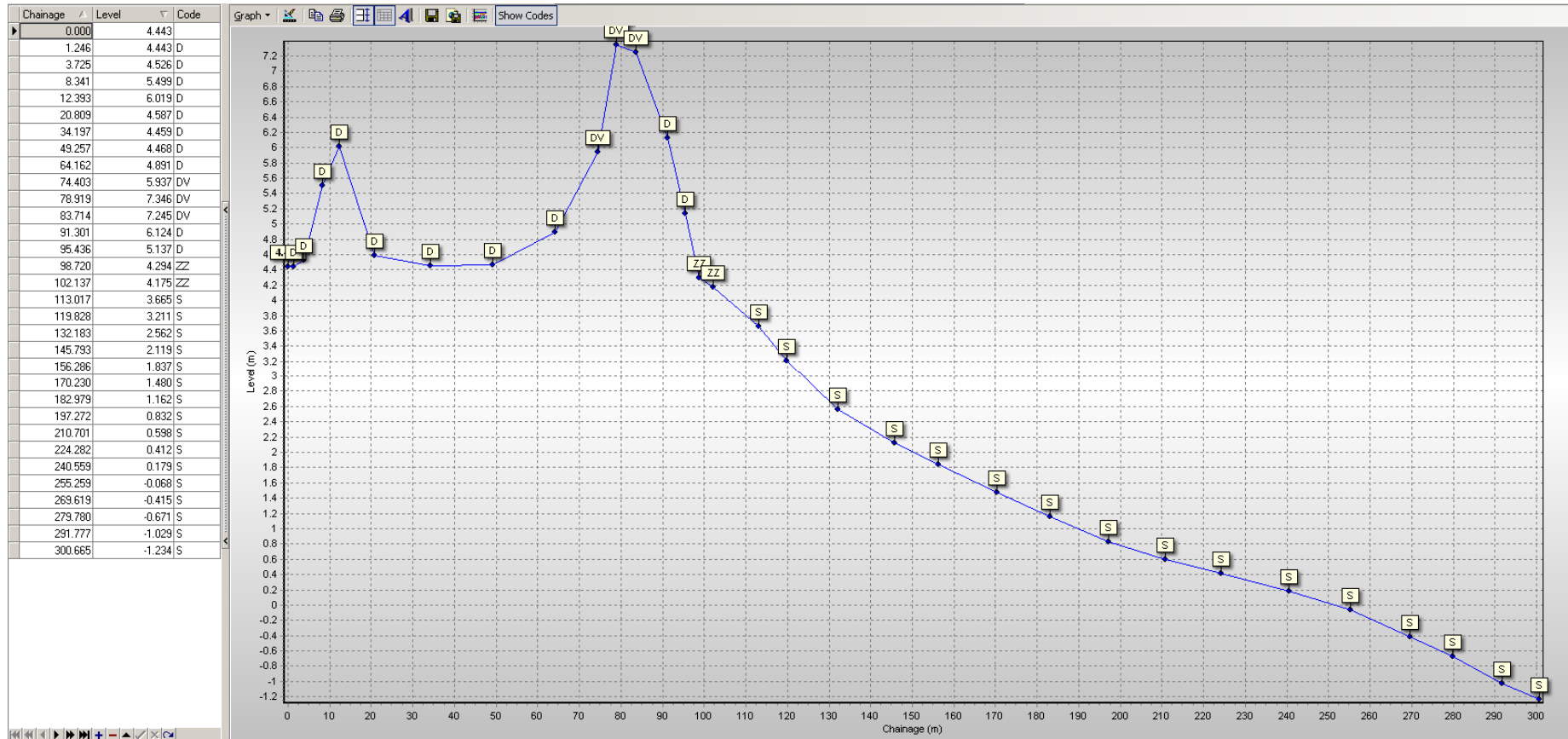
1bSS4 - 14/09/2010



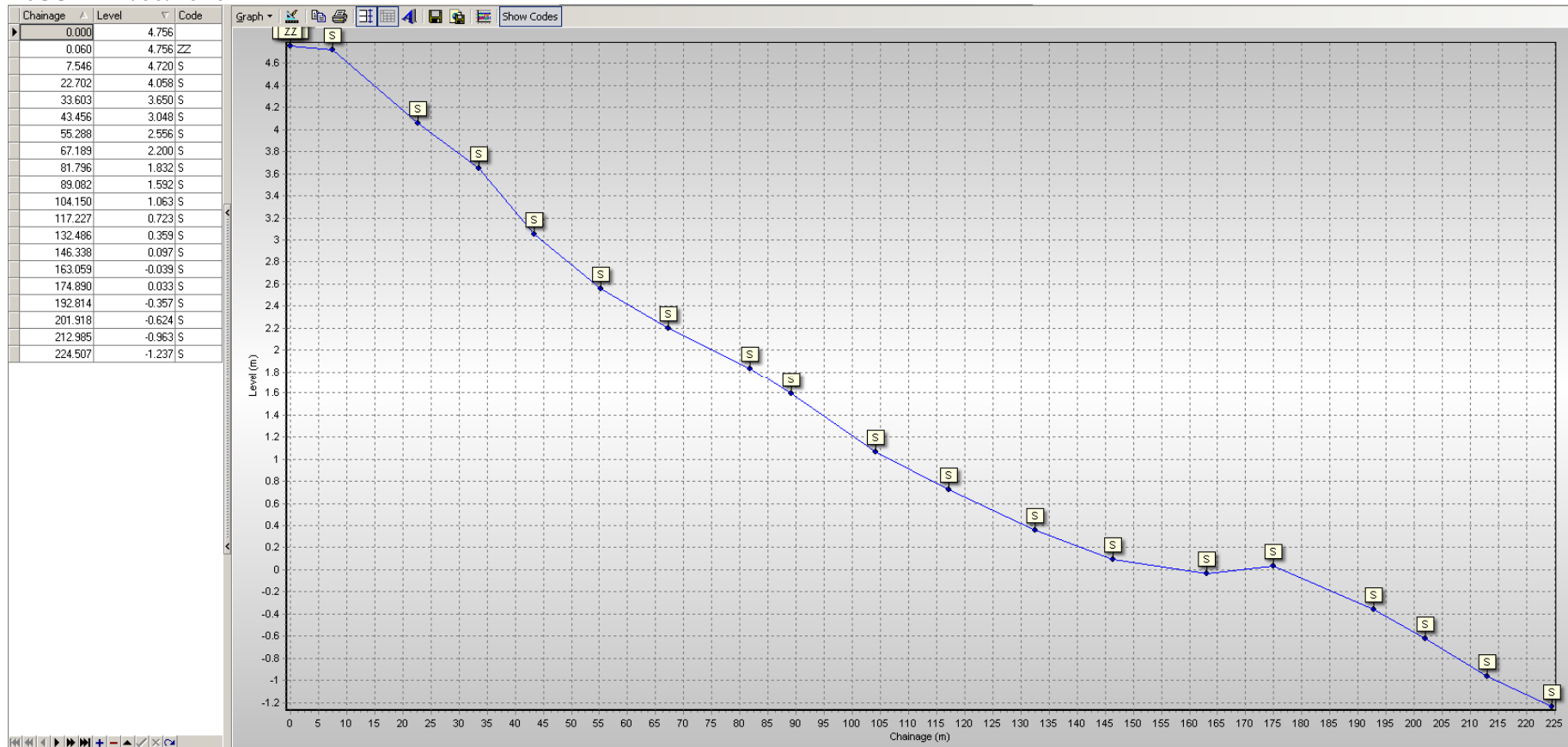
1bSS5 - 14/09/2010



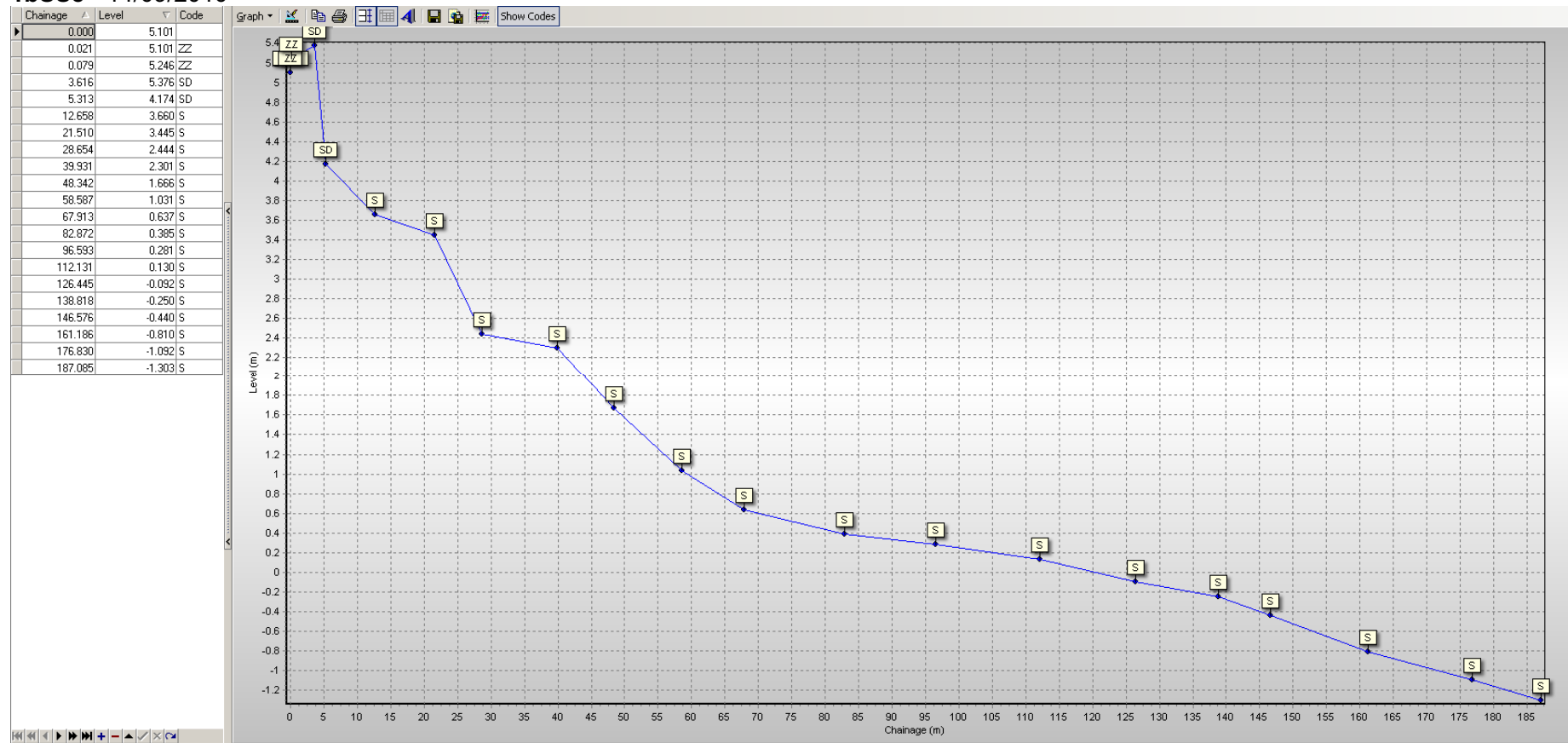
1bSS6 - 14/09/2010



1bSS7 - 14/09/2010

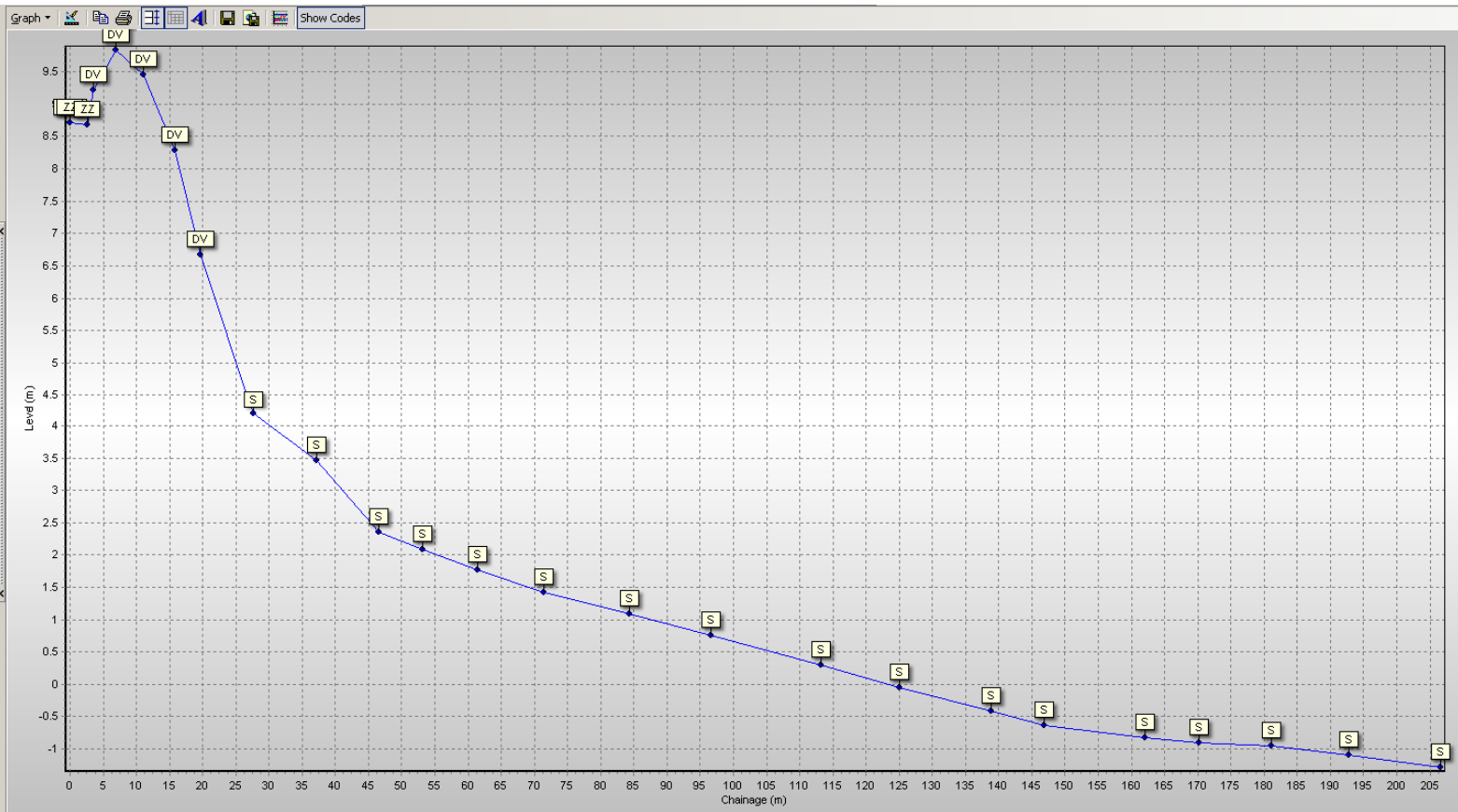


1bSS8 - 14/09/2010

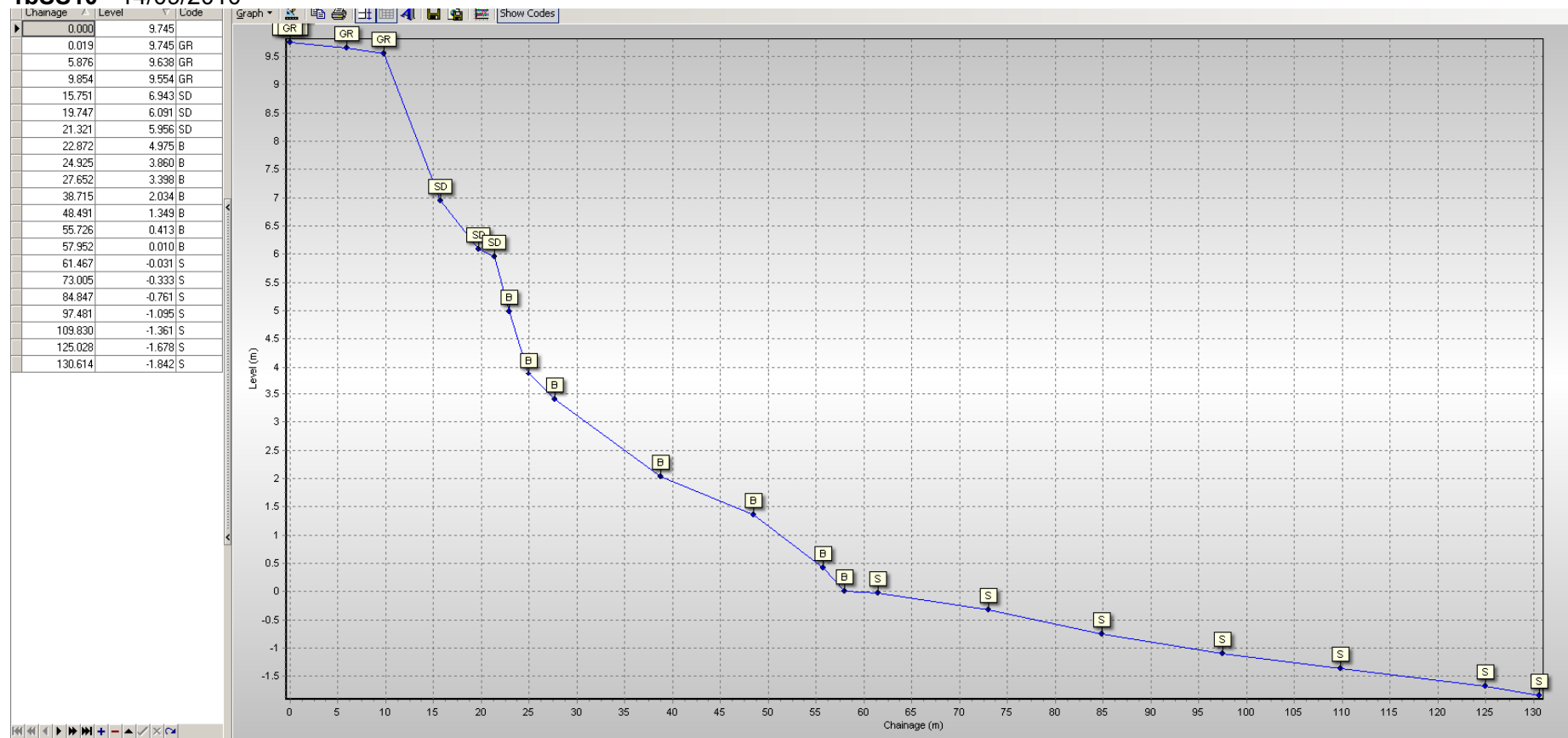


1bSS9 - 14/09/2010

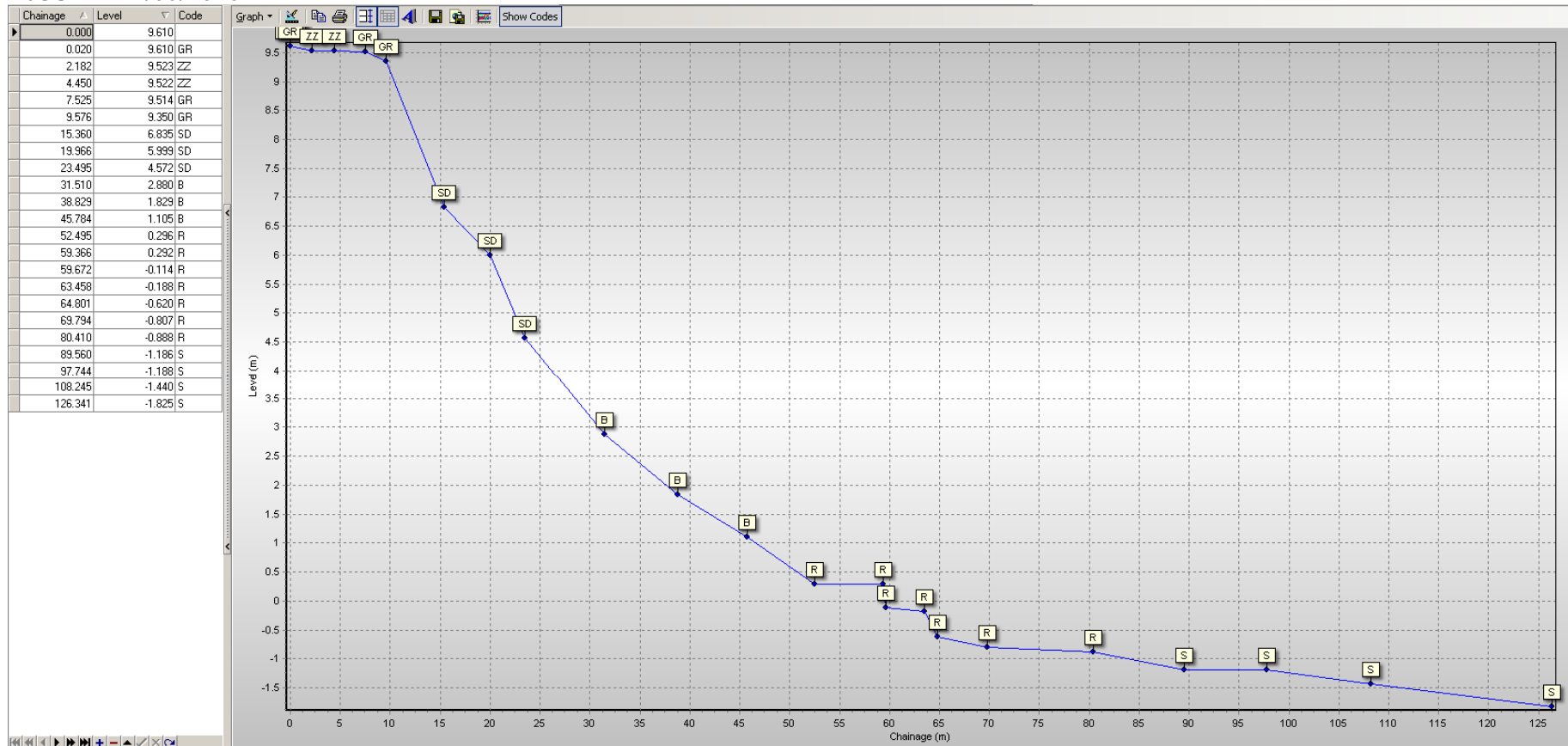
Chainage	Level	Code
0.000	8.720	
0.015	8.720	ZZ
2.686	8.688	ZZ
3.477	9.215	DV
6.989	9.836	DV
11.113	9.454	DV
15.898	8.282	DV
19.626	6.668	DV
27.610	4.193	S
37.139	3.455	S
46.533	2.355	S
53.221	2.086	S
61.512	1.774	S
71.502	1.427	S
84.263	1.088	S
96.593	0.761	S
113.216	0.298	S
125.007	-0.047	S
138.838	-0.421	S
146.882	-0.629	S
162.052	-0.829	S
170.148	-0.902	S
181.182	-0.948	S
192.790	-1.093	S
206.608	-1.284	S



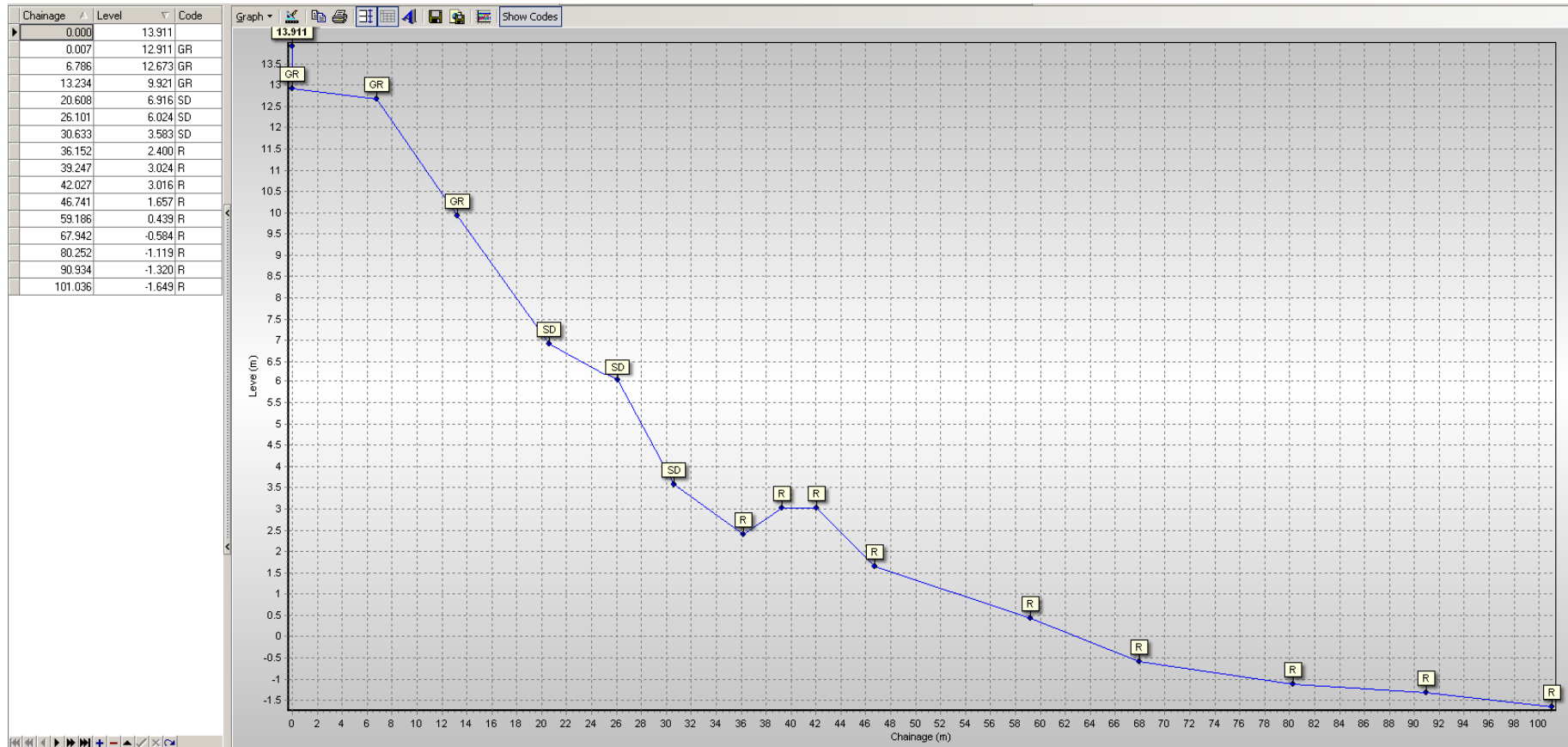
1bSS10 - 14/09/2010



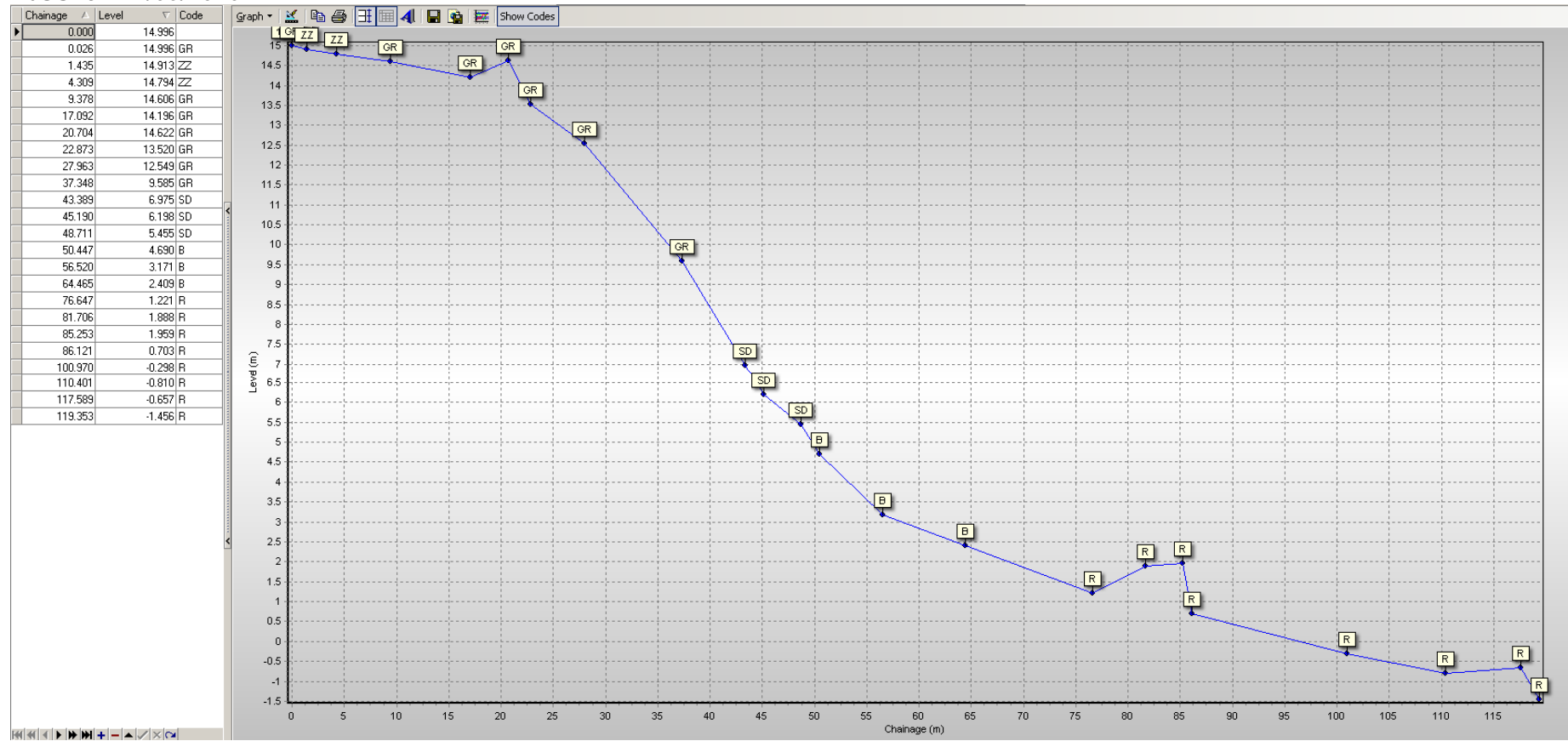
1bSS11 - 14/09/2010



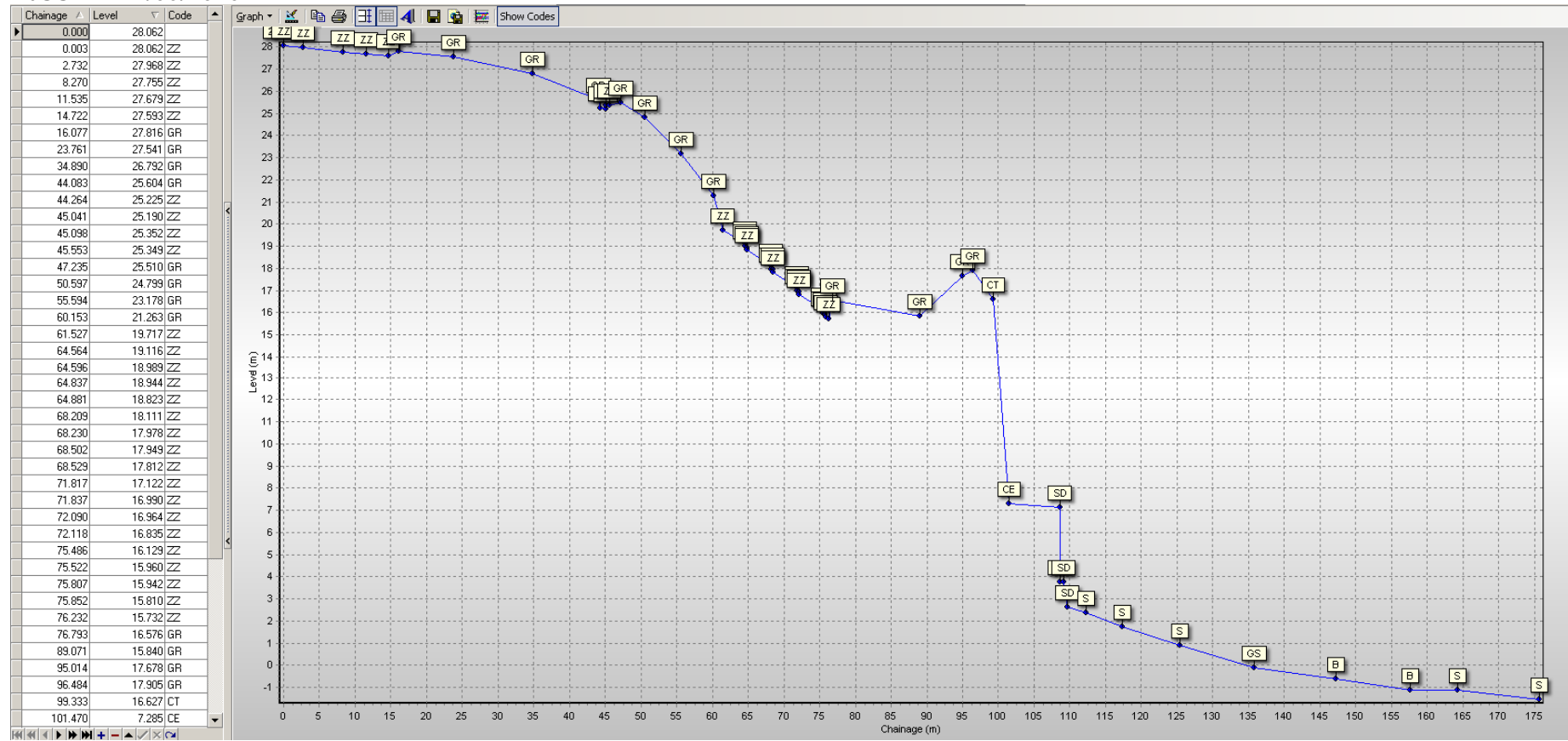
1bSS12 - 14/09/2010



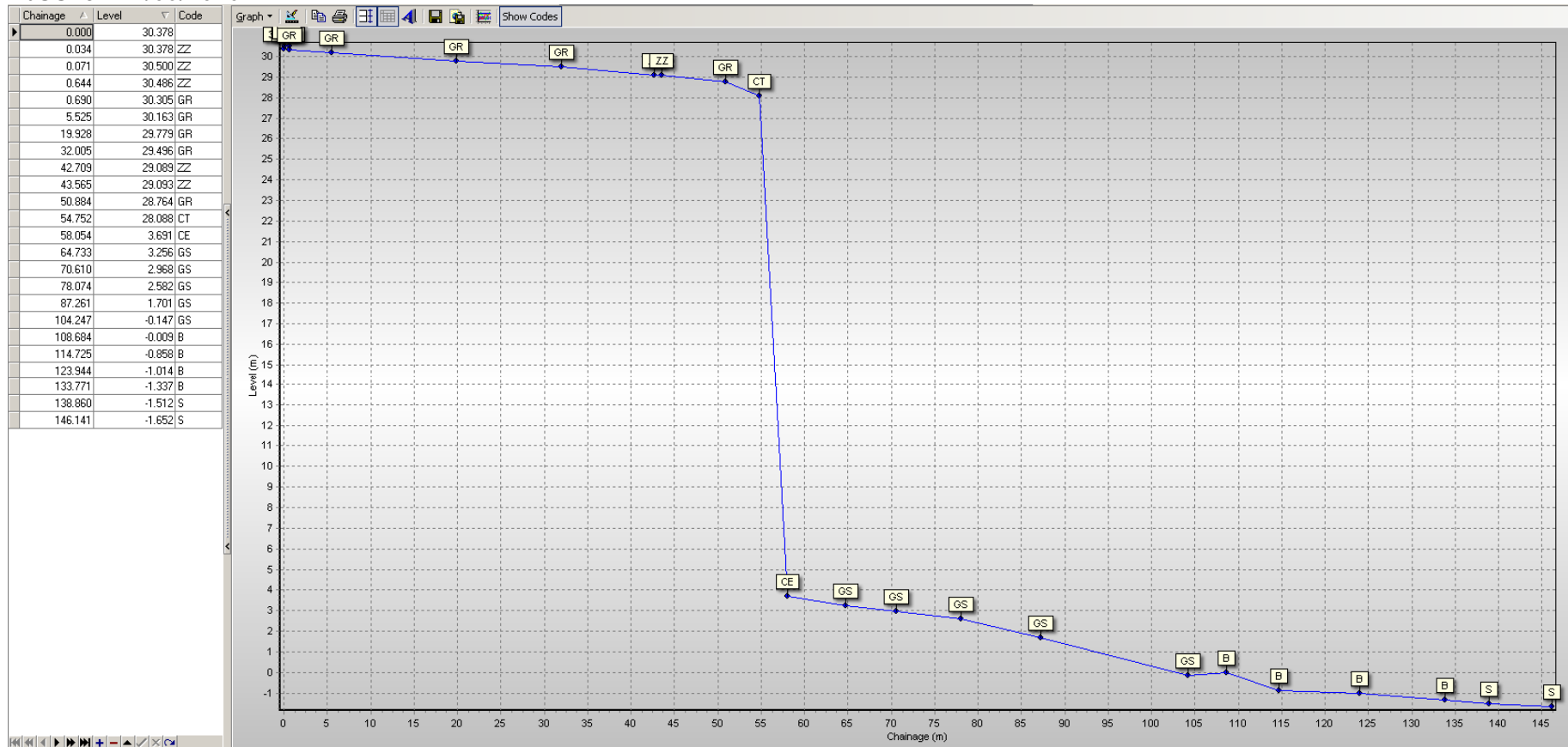
1bSS13 - 14/09/2010



1bSS14 - 14/09/2010

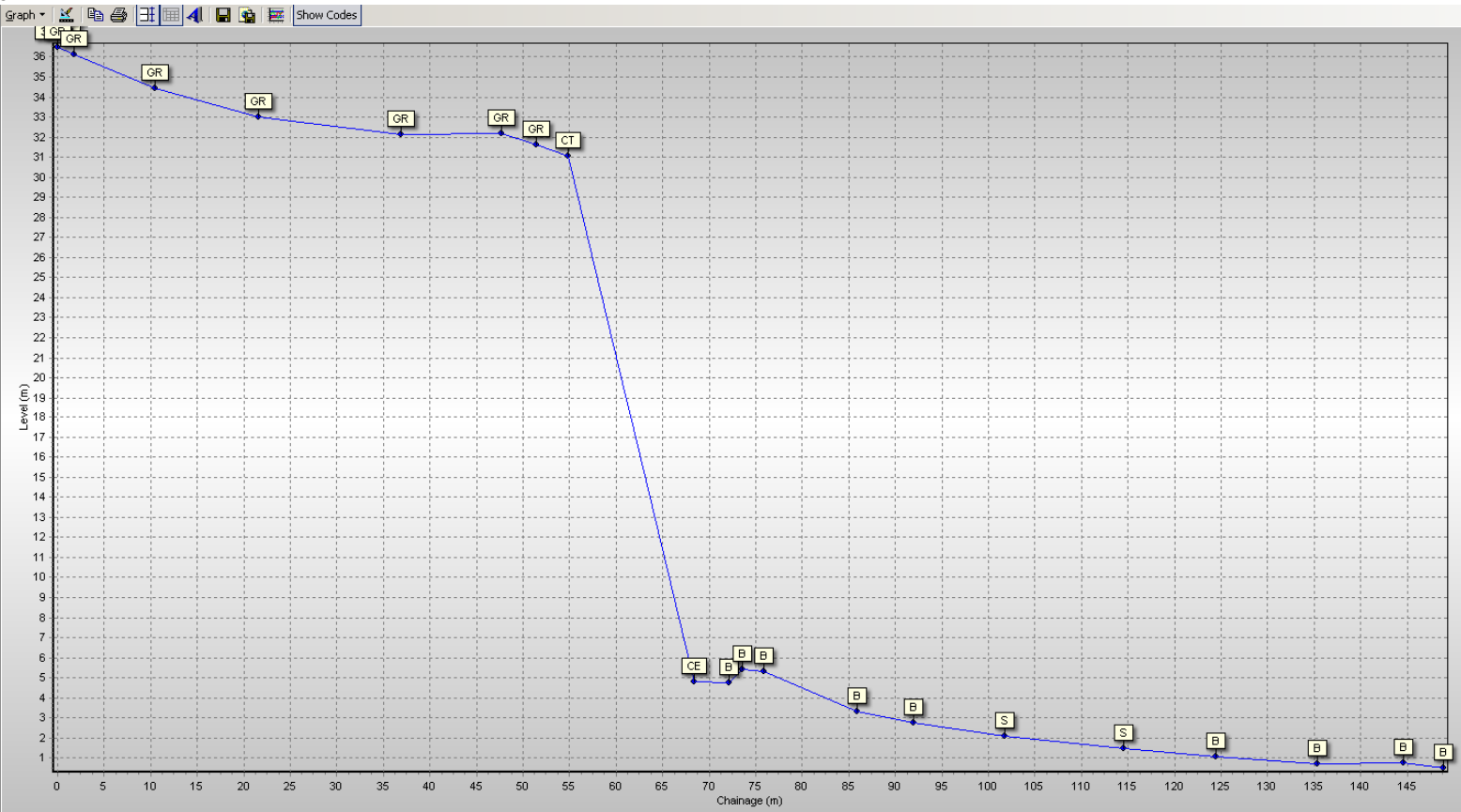


1bSS15 - 14/09/2010

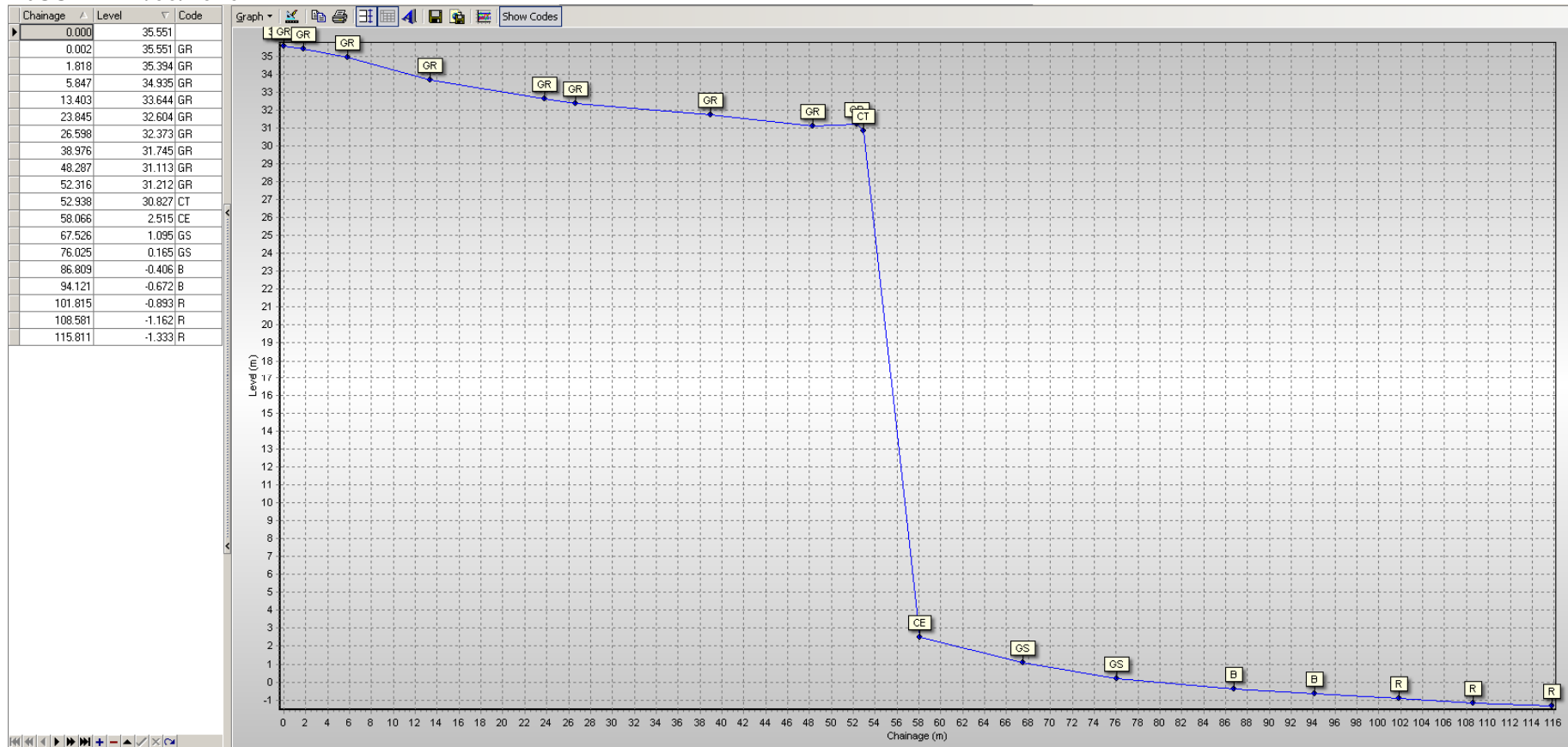


1bSS16 - 14/09/2010

Chainage	Level	Code
0.000	36.483	
0.006	36.483	GR
1.753	36.105	GR
10.469	34.432	GR
21.630	32.993	GR
36.928	32.152	GR
47.719	32.182	GR
51.451	31.642	GR
54.869	31.070	CT
68.355	4.800	CE
72.123	4.747	B
73.593	5.426	B
75.851	5.312	B
85.952	3.344	B
91.962	2.776	B
101.791	2.103	S
114.516	1.470	S
124.433	1.059	B
135.389	0.722	B
144.545	0.778	B
148.893	0.506	B



1bSS17 - 14/09/2010

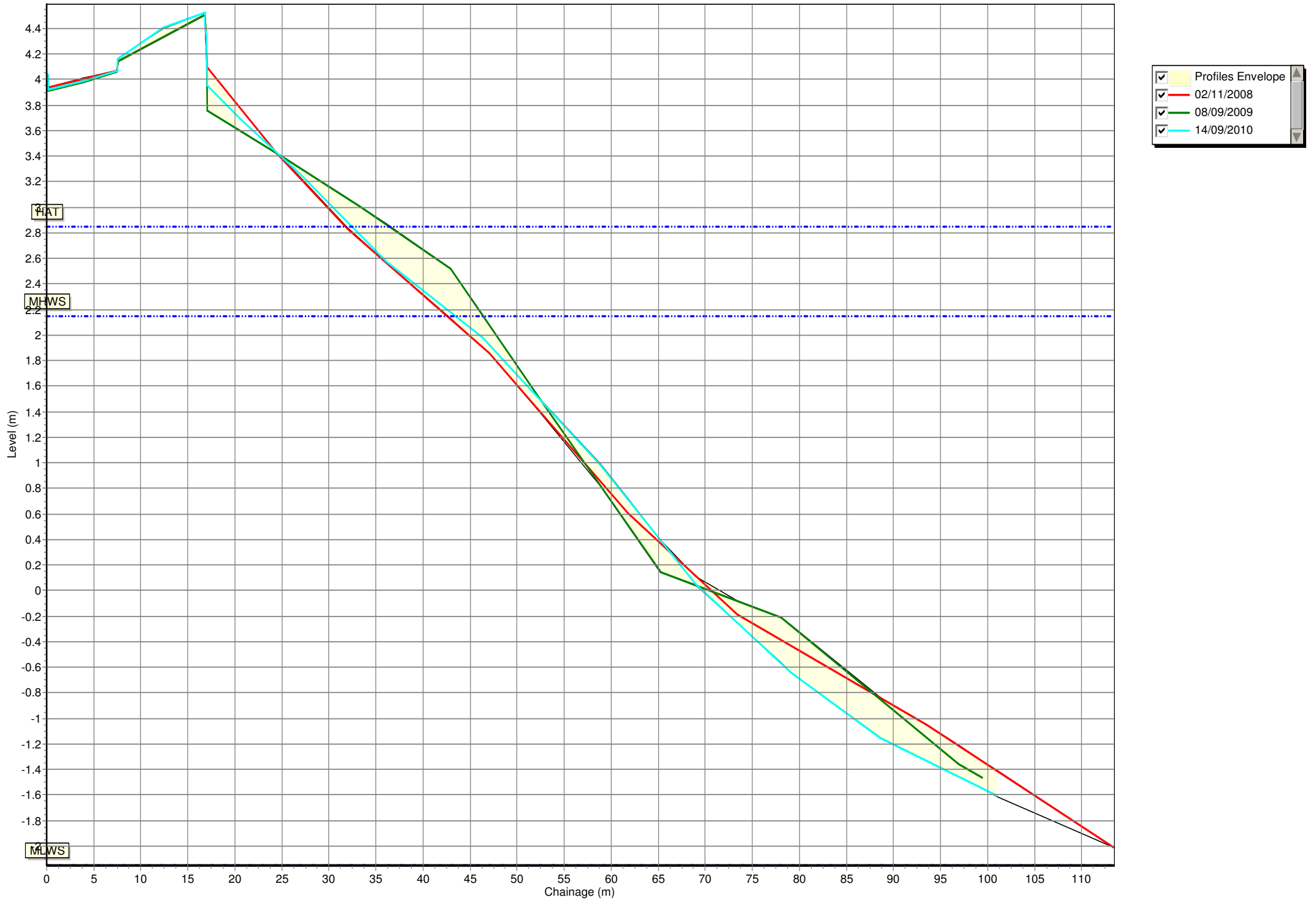


Beach Profiles: 1bSS1

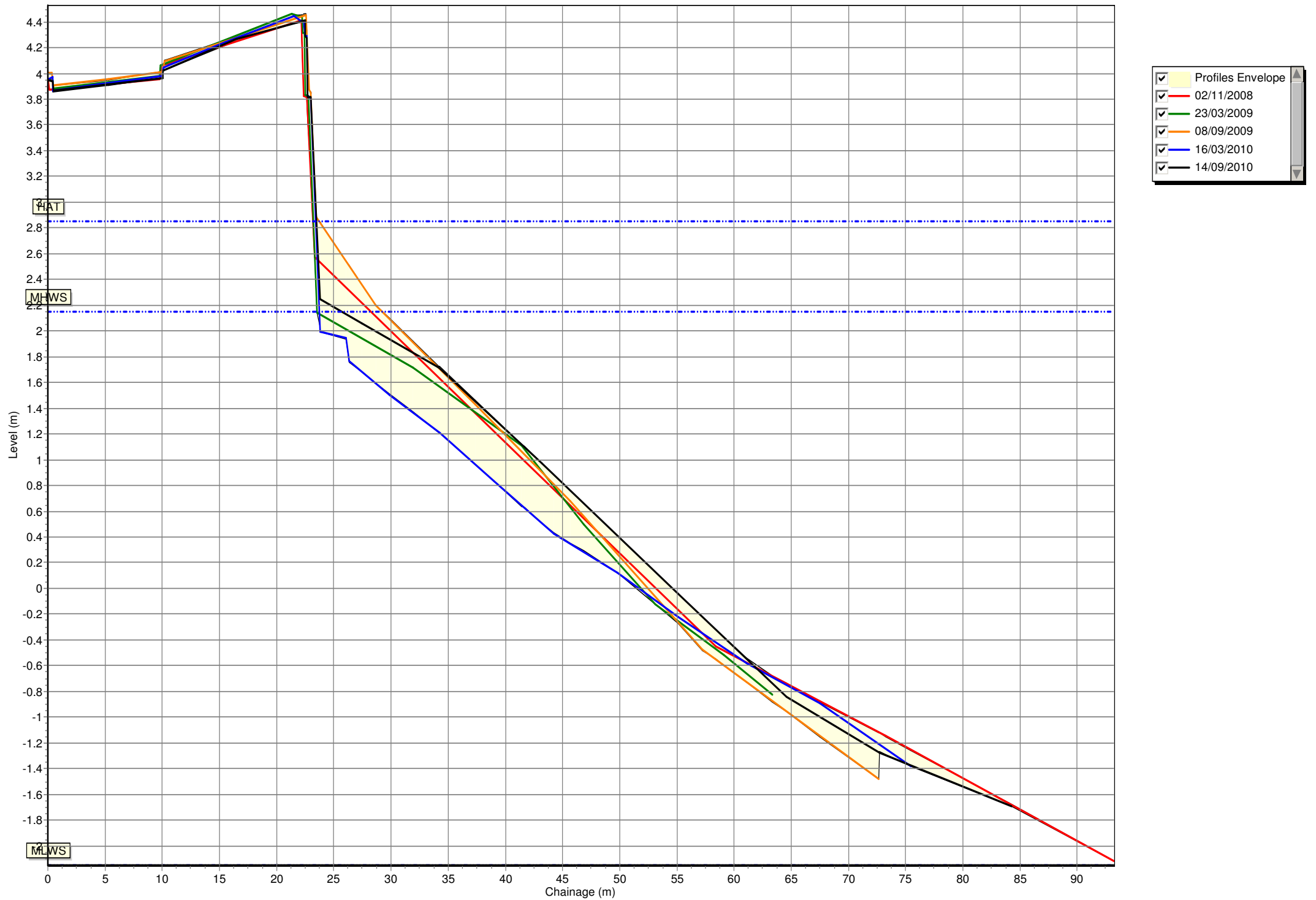


- Profiles Envelope
- 02/11/2008
- 23/03/2009
- 08/09/2009
- 16/03/2010
- 14/09/2010

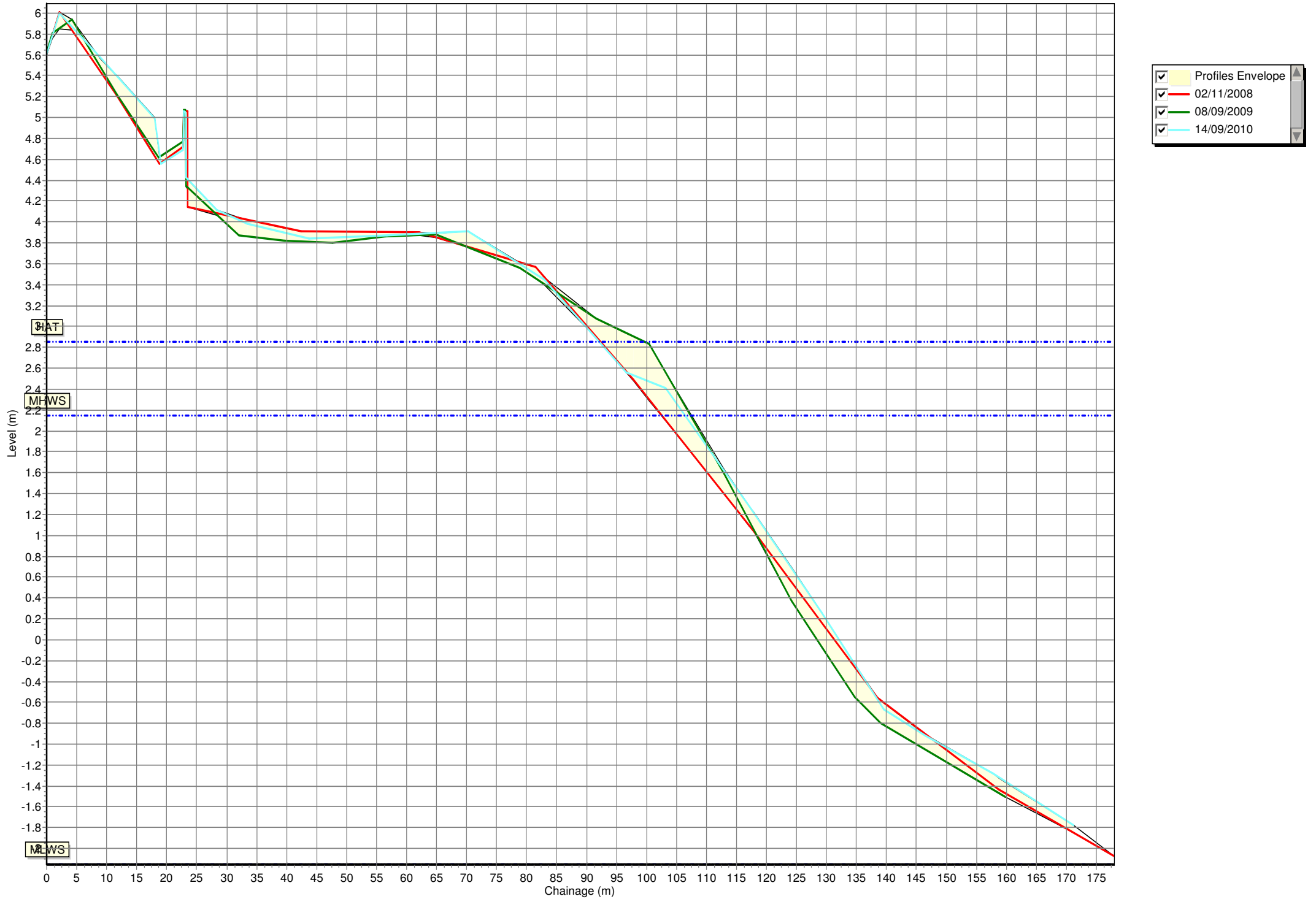
Beach Profiles: 1bSS2



Beach Profiles: 1bSS3



Beach Profiles: 1bSS4



Beach Profiles: 1bSS5



Beach Profiles: 1bSS6



- Profiles Envelope
- 02/11/2008
- 08/09/2009
- 14/09/2010

MHW

MLW

MLWS

Beach Profiles: 1bSS7



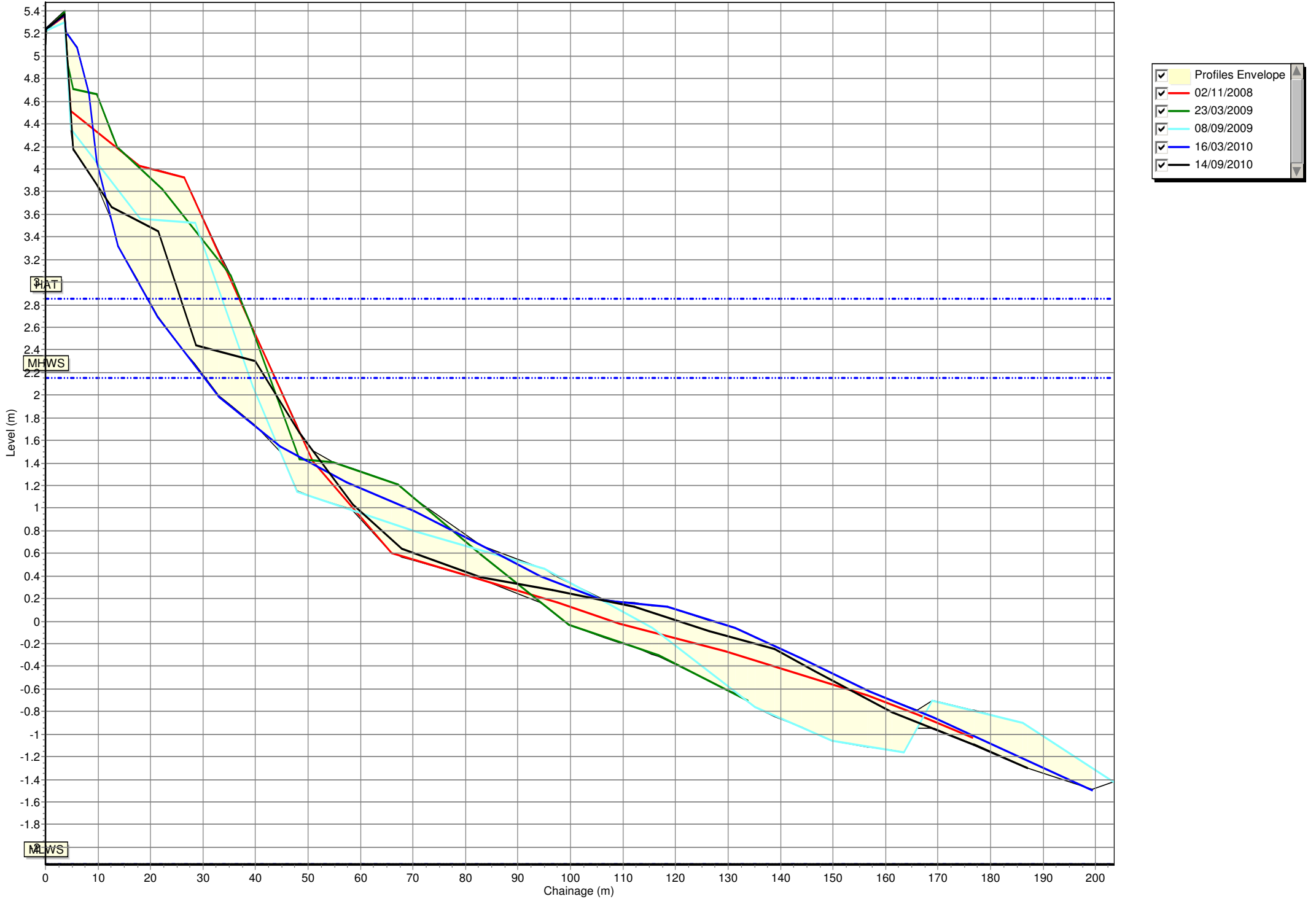
- Profiles Envelope
- 02/11/2008
- 08/09/2009
- 14/09/2010

HAT

MHWS

MLWS

Beach Profiles: 1bSS8



Beach Profiles: 1bSS9



- Profiles Envelope
- 02/11/2008
- 23/03/2009
- 08/09/2009
- 16/03/2010
- 14/09/2010

HAT

MHW

MLW

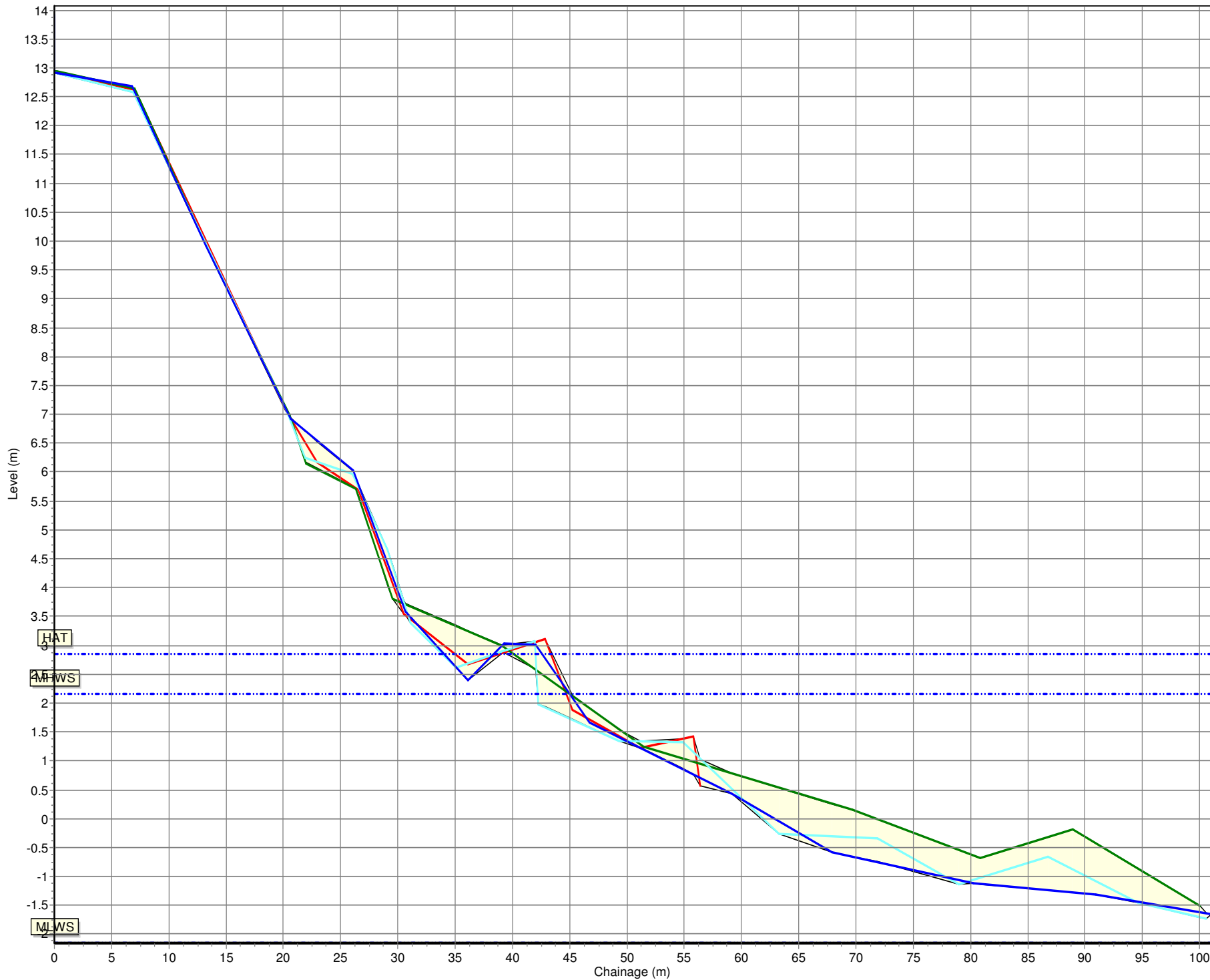
Beach Profiles: 1bSS10



Beach Profiles: 1bSS11



Beach Profiles: 1bSS12



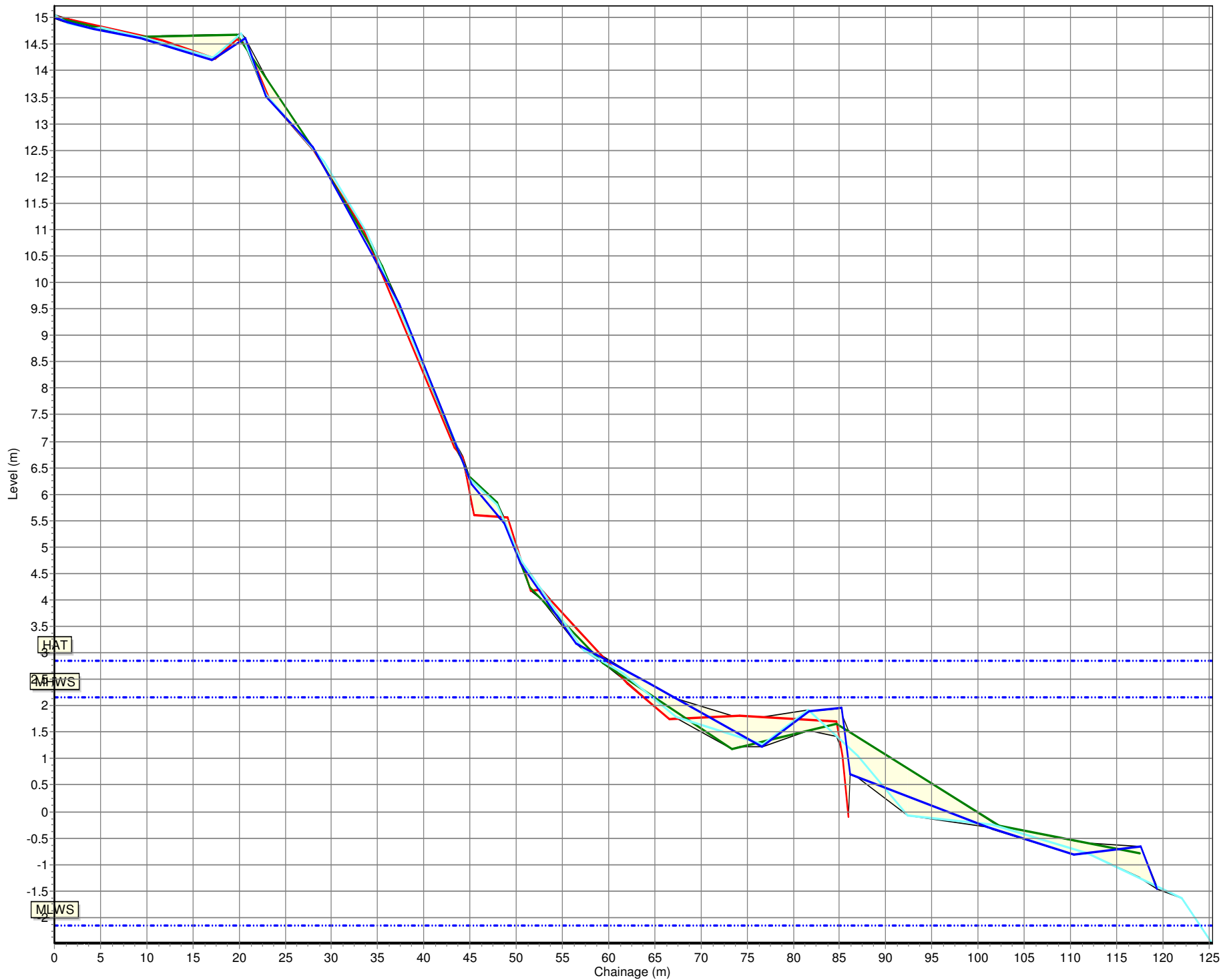
- Profiles Envelope
- 23/03/2009
- 08/09/2009
- 16/03/2010
- 14/09/2010

HAT

MWS

MWS

Beach Profiles: 1bSS13



- Profiles Envelope
- 23/03/2009
- 08/09/2009
- 16/03/2010
- 14/09/2010

Beach Profiles: 1bSS14



Beach Profiles: 1bSS15



Beach Profiles: 1bSS16



- Profiles Envelope
- 01/11/2008
- 08/09/2009
- 14/09/2010

HAT

M+WS

MLWS

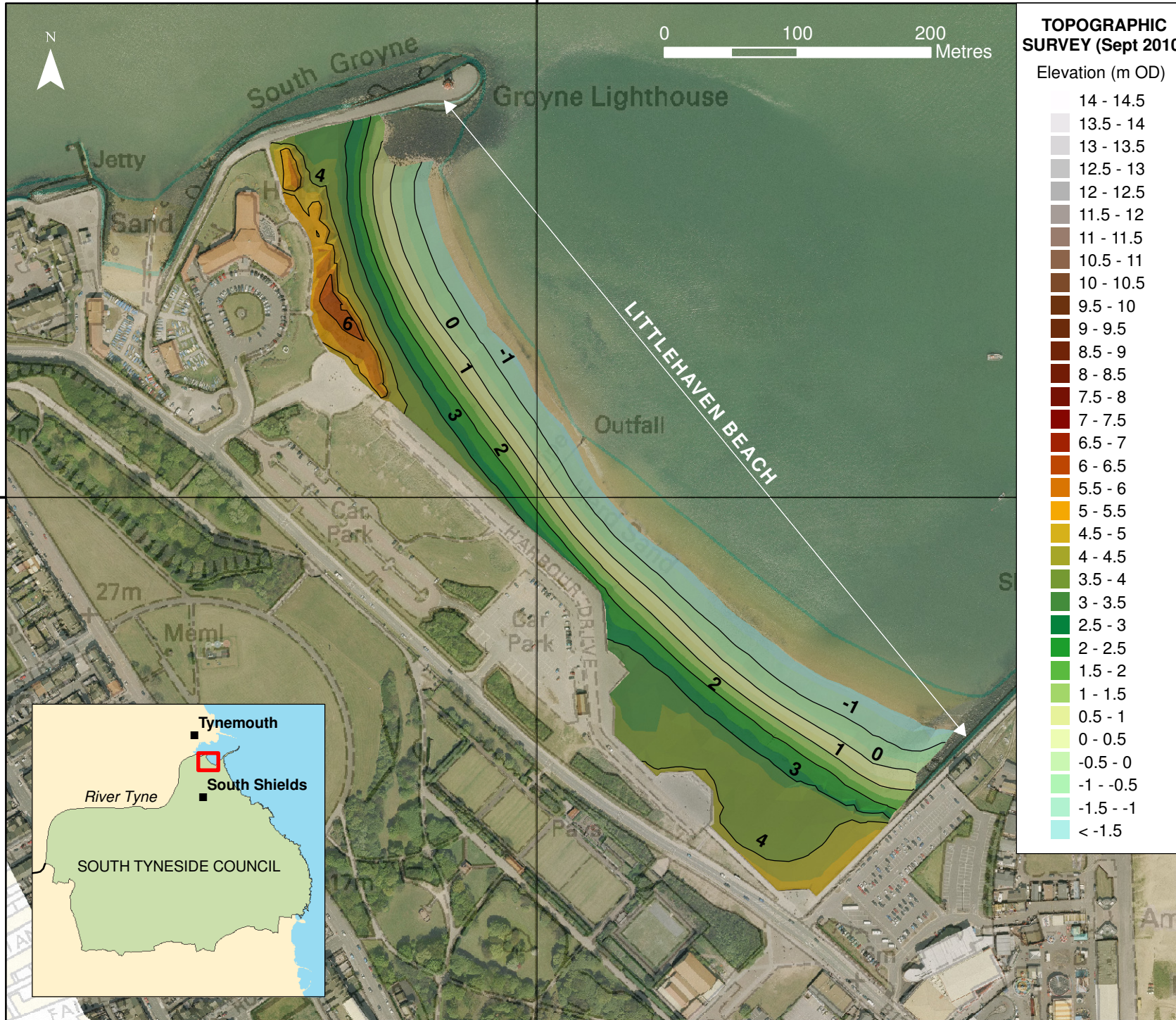
Beach Profiles: 1bSS17



- Profiles Envelope
- 01/11/2008
- 23/03/2009
- 08/09/2009
- 16/03/2010
- 14/09/2010

HAT
M+WS
MLWS

Appendix B
Topographic Survey



TOPOGRAPHIC SURVEY (Sept 2010)

Elevation (m OD)

- 14 - 14.5
- 13.5 - 14
- 13 - 13.5
- 12.5 - 13
- 12 - 12.5
- 11.5 - 12
- 11 - 11.5
- 10.5 - 11
- 10 - 10.5
- 9.5 - 10
- 9 - 9.5
- 8.5 - 9
- 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
- < -1.5

— Topographic Contours at 1 metre interval

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

**Appendix B - Map 1a
 South Tyneside Council Frontage**

Analytical Report 3
 'Full Measures' Survey 2010

Drawing Scale 1:4,000 at A4

Drawn by: TC Date: 27/10/2010
 Checked by: NC Date: 05/11/2010
 Approved by: NC Date: 05/11/2010



ROYAL HASKONING

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



Halcrow

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

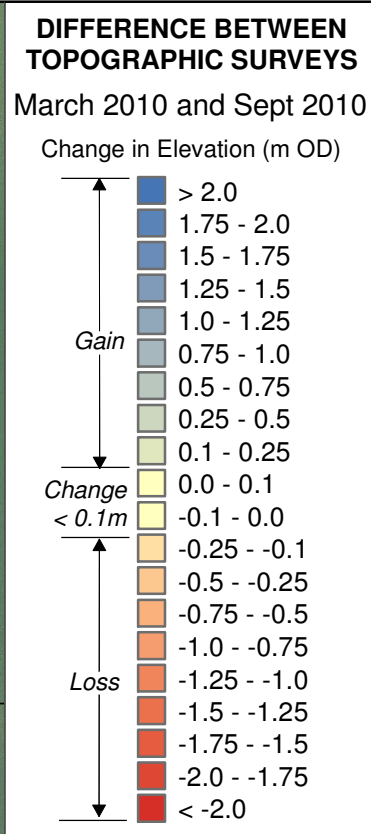
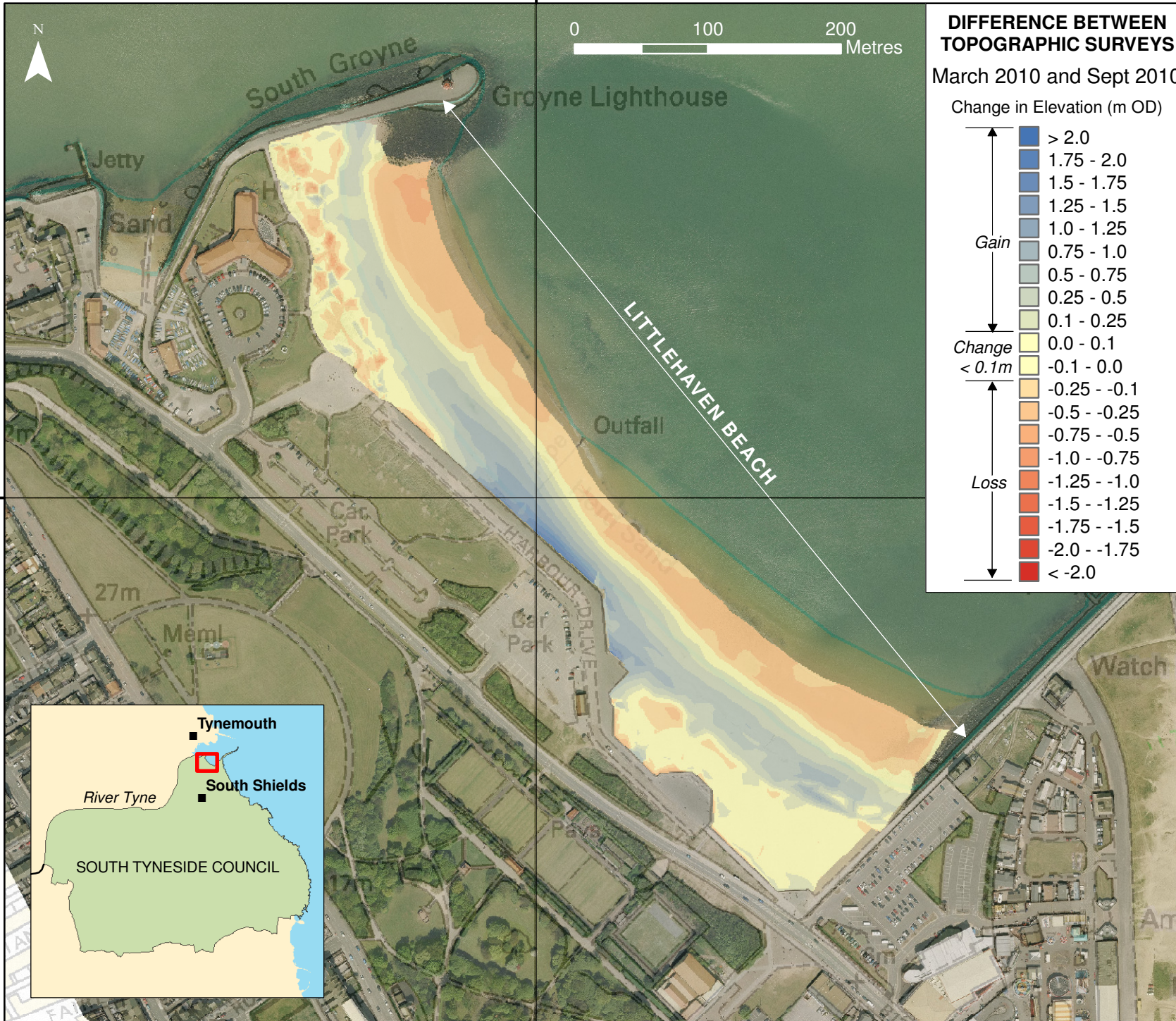
Tel: +44 (0)191 211 1300 Tel: +44 (0)121 456 2345
 Fax: +44 (0)191 211 1313 Fax: +44(0)121 456 1569
 www.royalhaskoning.com www.halcrow.com

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

568000

437000

I:\916403\Technical_Data\gis\figure7_FULL_measures_report_2010\3_South_Tyneside\Appendix_B_South_Tyneside_1a.mxd



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

Appendix B - Map 1b
South Tyneside Council Frontage

Analytical Report 3
 'Full Measures' Survey 2010

Drawing Scale 1:4,000 at A4

Drawn by: TC Date: 27/10/2010
 Checked by: NC Date: 05/11/2010
 Approved by: NC Date: 05/11/2010

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

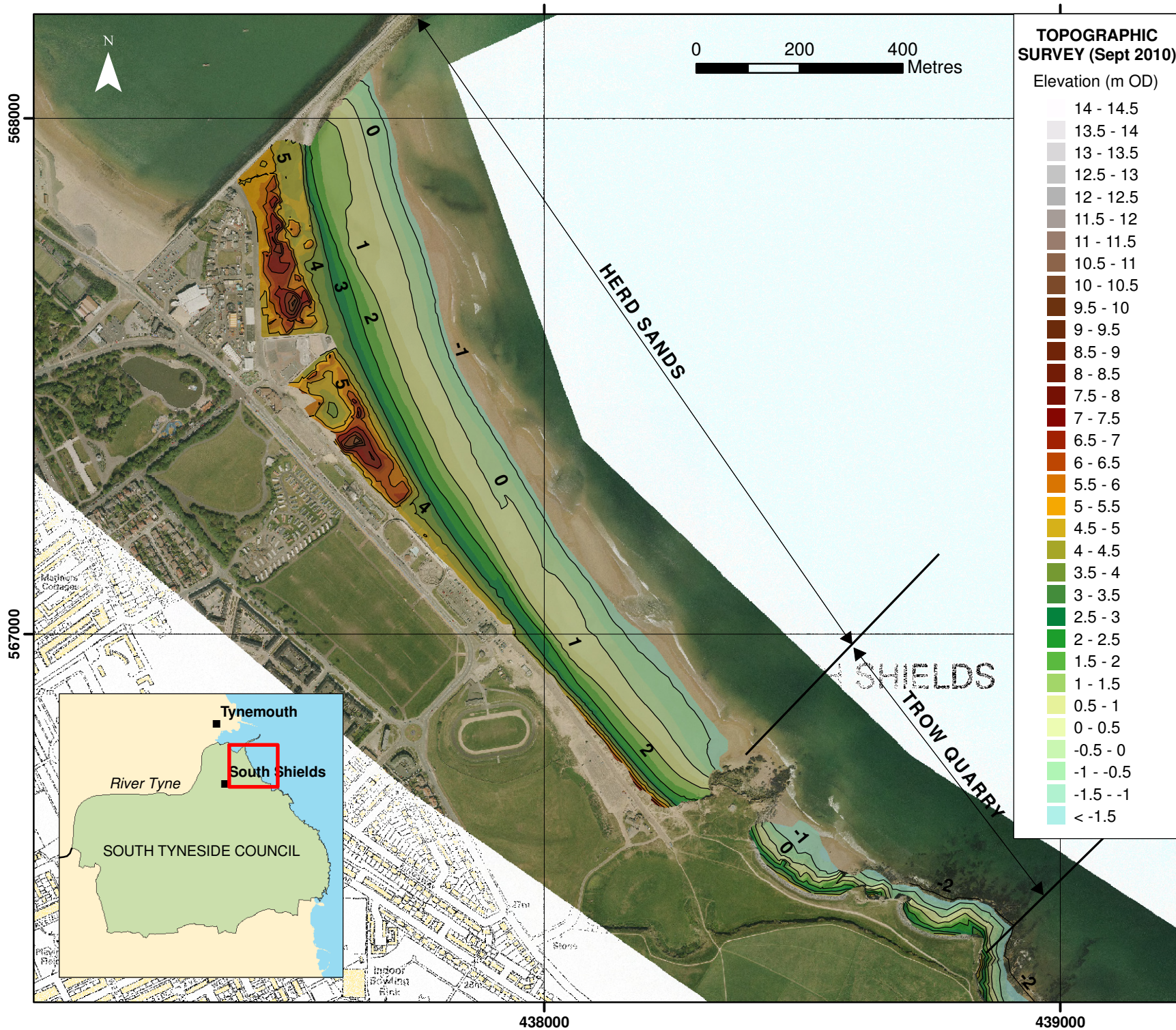
Tel: +44 (0)121 456 2345
 Fax: +44(0)121 456 1569
 www.halcrow.com

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

568000

437000

I:\916403\Technical_Data\gis\figure7_FULL_measures_report_2010\3_South_Tyneside\Appendix_B_South_Tyneside_1b.mxd



TOPOGRAPHIC SURVEY (Sept 2010)

Elevation (m OD)

- 14 - 14.5
- 13.5 - 14
- 13 - 13.5
- 12.5 - 13
- 12 - 12.5
- 11.5 - 12
- 11 - 11.5
- 10.5 - 11
- 10 - 10.5
- 9.5 - 10
- 9 - 9.5
- 8.5 - 9
- 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
- < -1.5

— Topographic Contours at 1 metre interval

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

**Appendix B - Map 2a
 South Tyneside Council Frontage**

Analytical Report 3
 'Full Measures' Survey 2010

Drawing Scale 1:10,000 at A4

Drawn by: TC Date: 27/10/2010
 Checked by: NC Date: 05/11/2010
 Approved by: NC Date: 05/11/2010



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

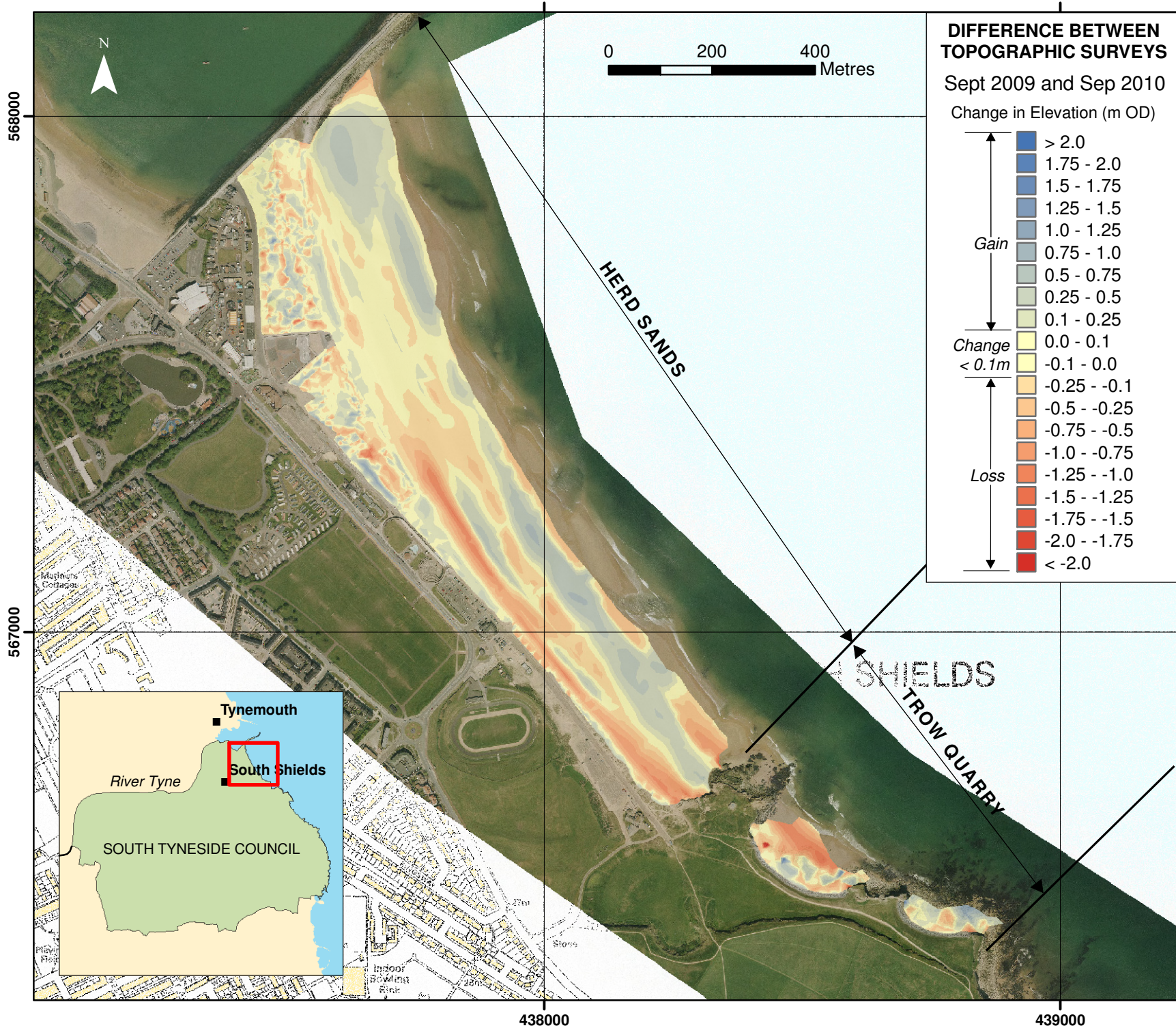


Halcrow Group Ltd
 Lyndon House
 62 Hagley Road
 Edgbaston
 Birmingham
 B16 8PE

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

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

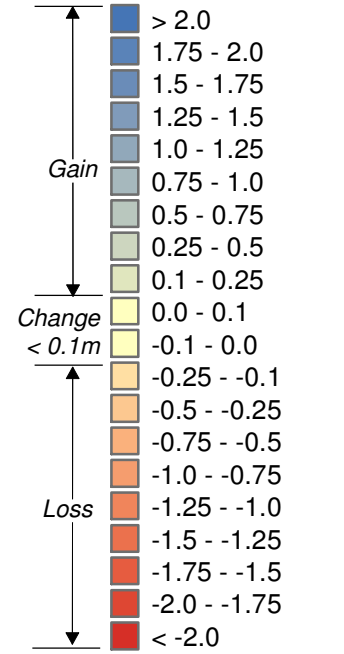
I:\916403\Technical_Data\gis\figure7_FULL_measures_report_2010\3_South_Tyneside\Appendix_B_South_Tyneside_2a.mxd



DIFFERENCE BETWEEN TOPOGRAPHIC SURVEYS

Sept 2009 and Sep 2010

Change in Elevation (m OD)



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

Appendix B - Map 2b
South Tyneside Council Frontage
 Analytical Report 3
 'Full Measures' Survey 2010

Drawing Scale 1:10,000 at A4
 Drawn by: TC Date: 27/10/2010
 Checked by: NC Date: 05/11/2010
 Approved by: NC Date: 05/11/2010

 ROYAL HASKONING	 Halcrow
Royal Haskoning Marlborough House Marlborough Crescent Newcastle upon Tyne NE1 4EE	Halcrow Group Ltd Lyndon House 62 Hagley Road Edgbaston Birmingham B16 8PE
Tel: +44 (0)191 211 1300 Fax: +44 (0)191 211 1313 www.royalhaskoning.com	Tel: +44 (0)121 456 2345 Fax: +44(0)121 456 1569 www.halcrow.com

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

I:\916403\Technical_Data\gis\figure7_FULL_measures_report_2010\3_South_Tyneside\Appendix_B_South_Tyneside_2b.mxd