



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

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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.

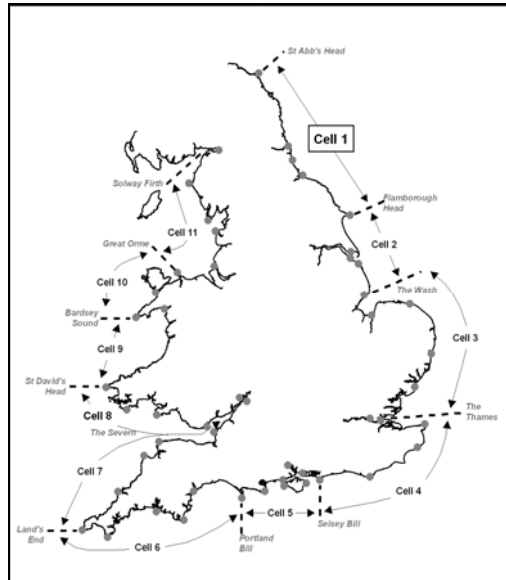


Figure 1 Sediment Cells in England and Wales

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	+	+	Mar-May 09	June 09	-
2	2009/10	Sep-Dec 09	Mar 10 <sup>(*)</sup>			-

<sup>(+)</sup> An Analytical Report was not produced in May 2009 for Sunderland City Council as part of the Cell 1 Regional Monitoring Programme because the survey data collection and reporting was coordinated under an existing agreement with the Council's framework consultants.

<sup>(\*)</sup> The present report is **Analytical Report 2** and provides an analysis of the 2009 Full Measures survey for Sunderland City 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**

<b>Authority</b>	<b>Zone</b>
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
<b>Sunderland City Council</b>	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

Sunderland City Council's frontage extends from The Bents to Ryhope Dene. For the purposes of this report, it has been sub-divided into three areas, namely:

- Whitburn Bay (also referred to as Sunderland North or 'SNN')
- Sunderland Harbour and Docks (also referred to as Sunderland Central or 'SNC')
- Hendon to Ryhope (also referred to as Sunderland South or 'SNS')

### 1.2 Methodology

Along Sunderland City Council's frontage, the following surveying is undertaken:

- Full Measures survey annually each autumn/early winter comprising:
  - 58 no. beach profile lines
  - Topographic survey at Whitburn Bay
  - Topographic survey at Hendon to Ryhope
- Partial Measures survey annually each spring comprising:
  - 14 no. beach profile lines
- Cliff top survey bi-annually at:
  - Hendon to Ryhope

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 was undertaken along Whitburn Bay in September 2009, when weather conditions were fine with calm winds and a flat sea state. The Sunderland Harbour and Docks survey was undertaken in October 2009 under fine and dry conditions with a calm sea state. The Hendon to Ryhope frontage was surveyed in September when weather conditions were dry but breezy and the sea state was moderate.

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.

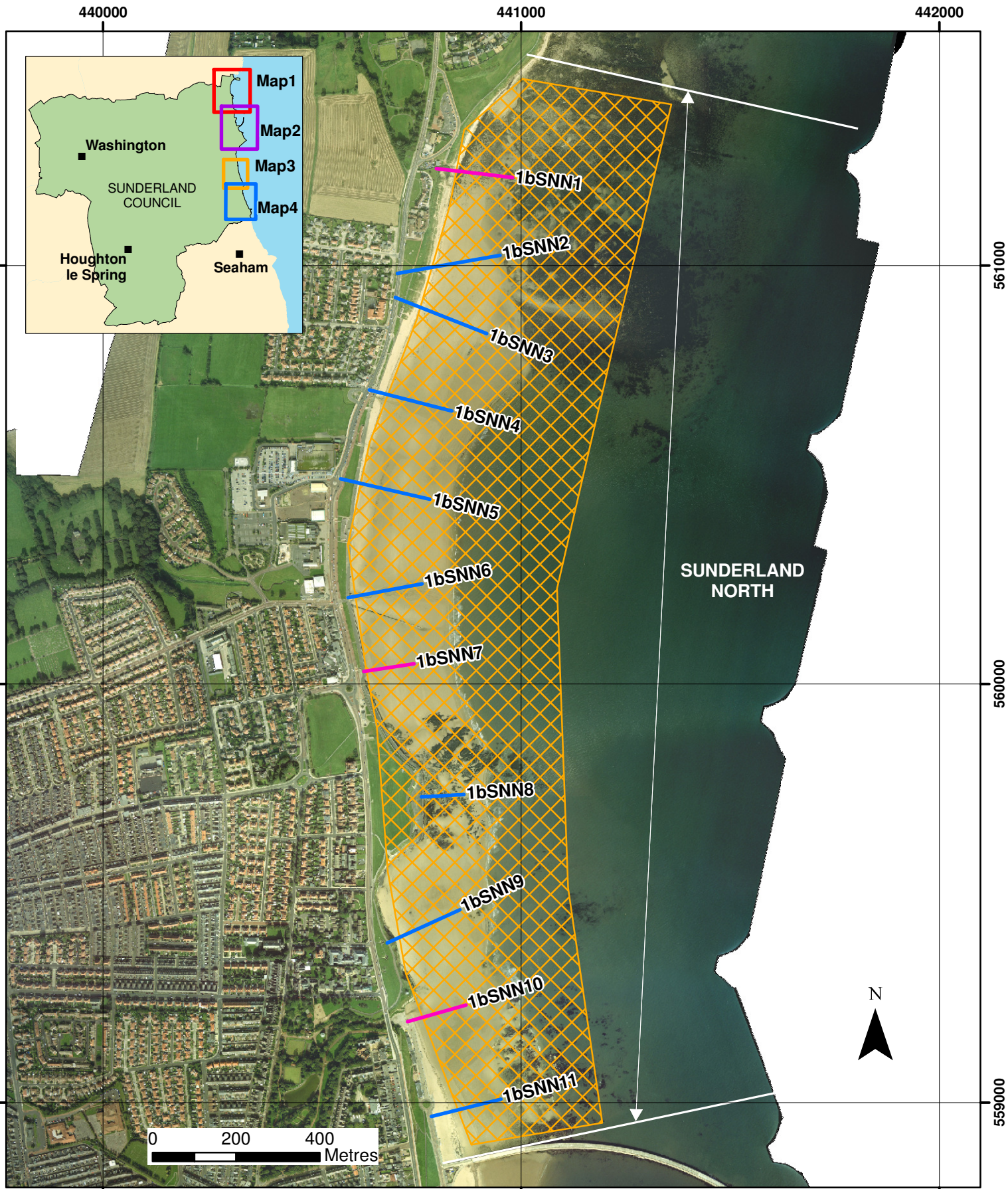
Upon receipt of the data from the survey team, they are quality assured and then uploaded onto the programme's website for storage and availability to others and also input to SANDS and GIS for subsequent analysis.

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.





**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 1  
 Sunderland  
 Council Frontage**

Analytical Report 2  
 'Full Measures' Survey 2009

Drawing Scale 1:12,000 at A4



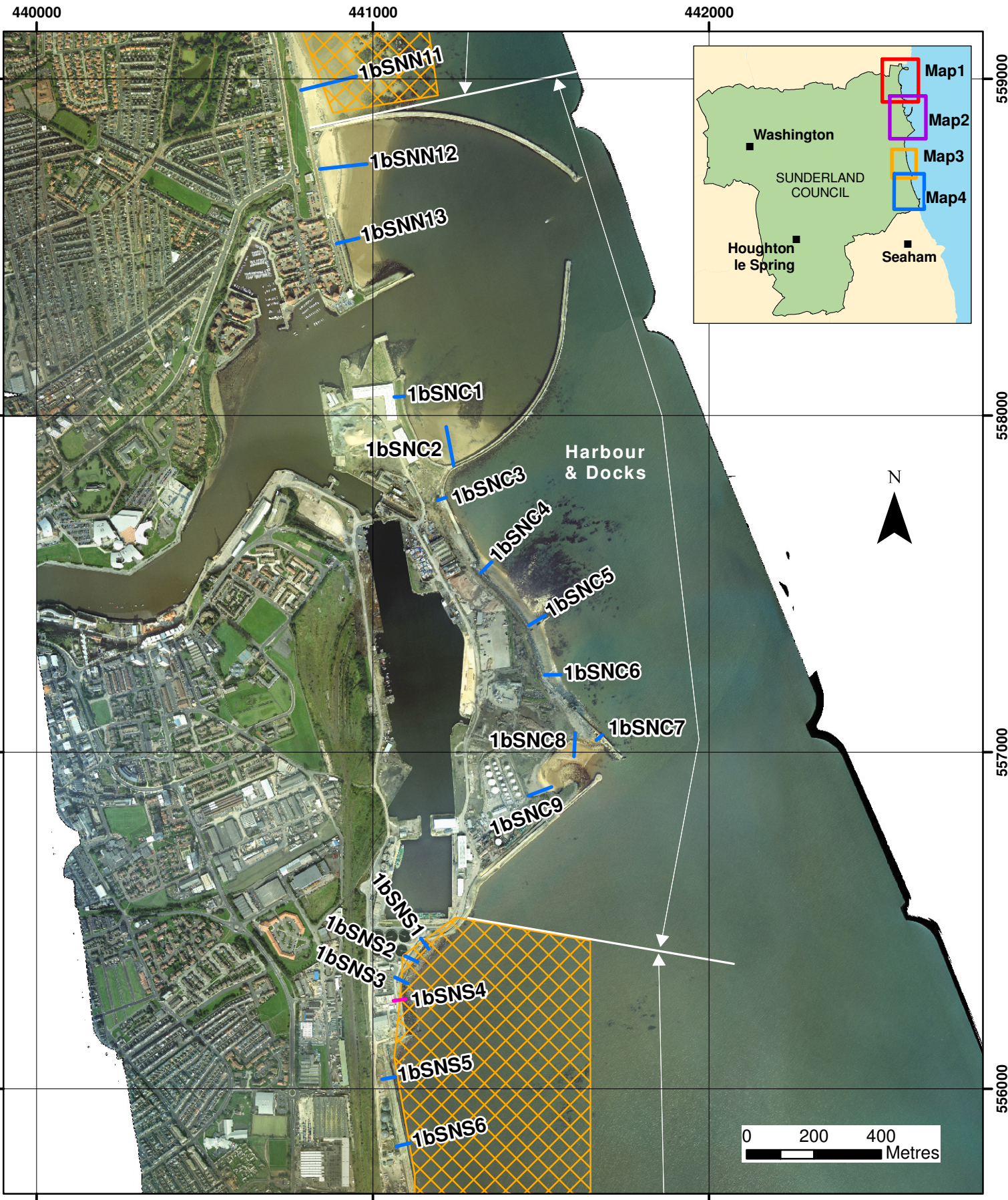
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**TOPOGRAPHIC SURVEY LOCATIONS**

- Annual Profile
- Bi-Annual Profile
- 6 monthly Survey
- Yearly Survey
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- 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 2  
 Sunderland  
 Council Frontage**

Analytical Report 2  
 'Full Measures' Survey 2009

Drawing Scale 1:15,000 at A4

  
**ROYAL HASKONING**

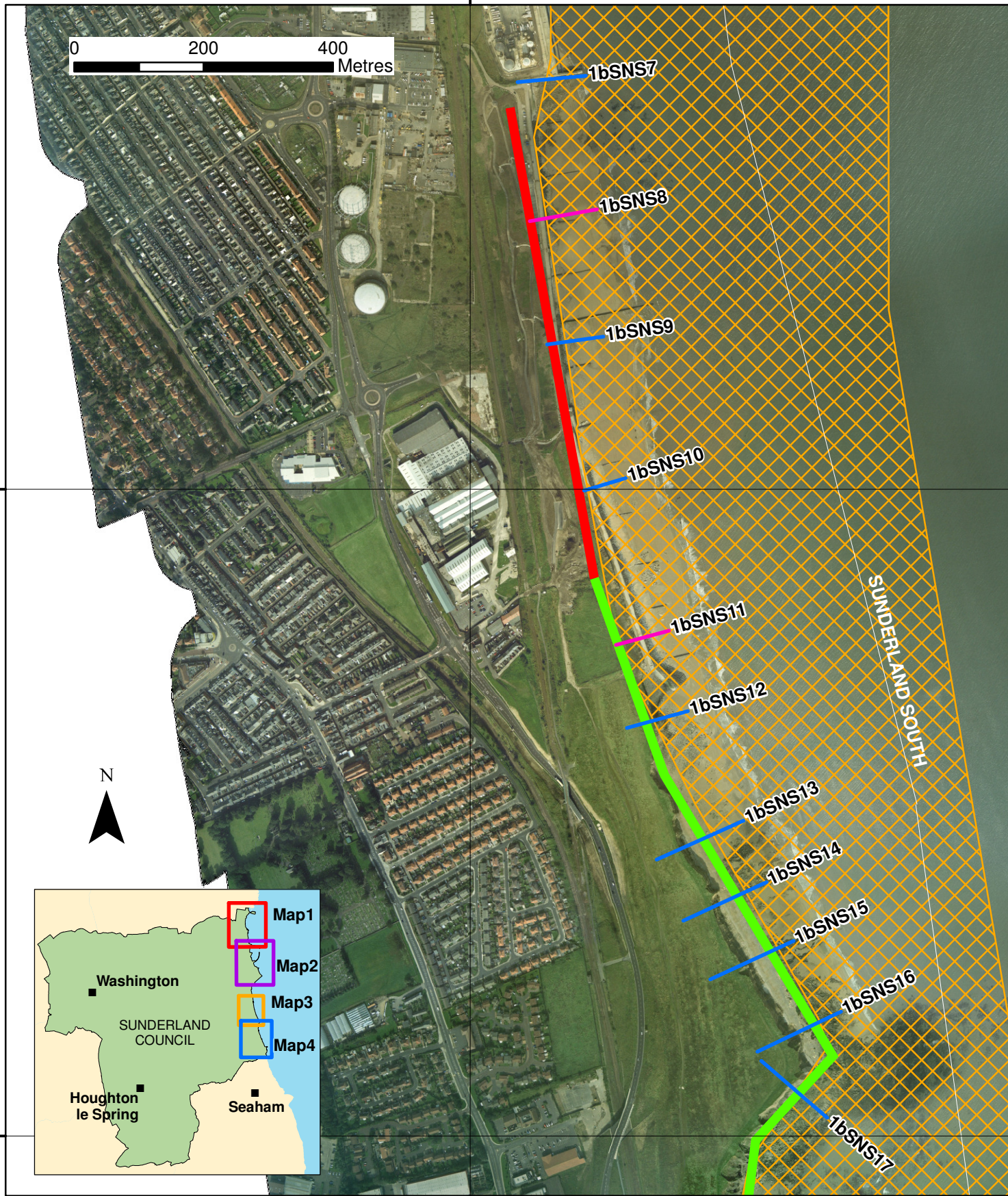
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- Annual Profile
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  - ▨ Yearly Survey
  - ▨ 5 yearly Survey
  - Cliff Top Survey @ 50 centres
  - Cliff Top Survey @ 100 centres
  - Cliff Top Survey @ 300 centres
- (Indicative Survey Extents shown)*

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

**Figure 2 - Map 3  
 Sunderland  
 Council Frontage**

Analytical Report 2  
 'Full Measures' Survey 2009

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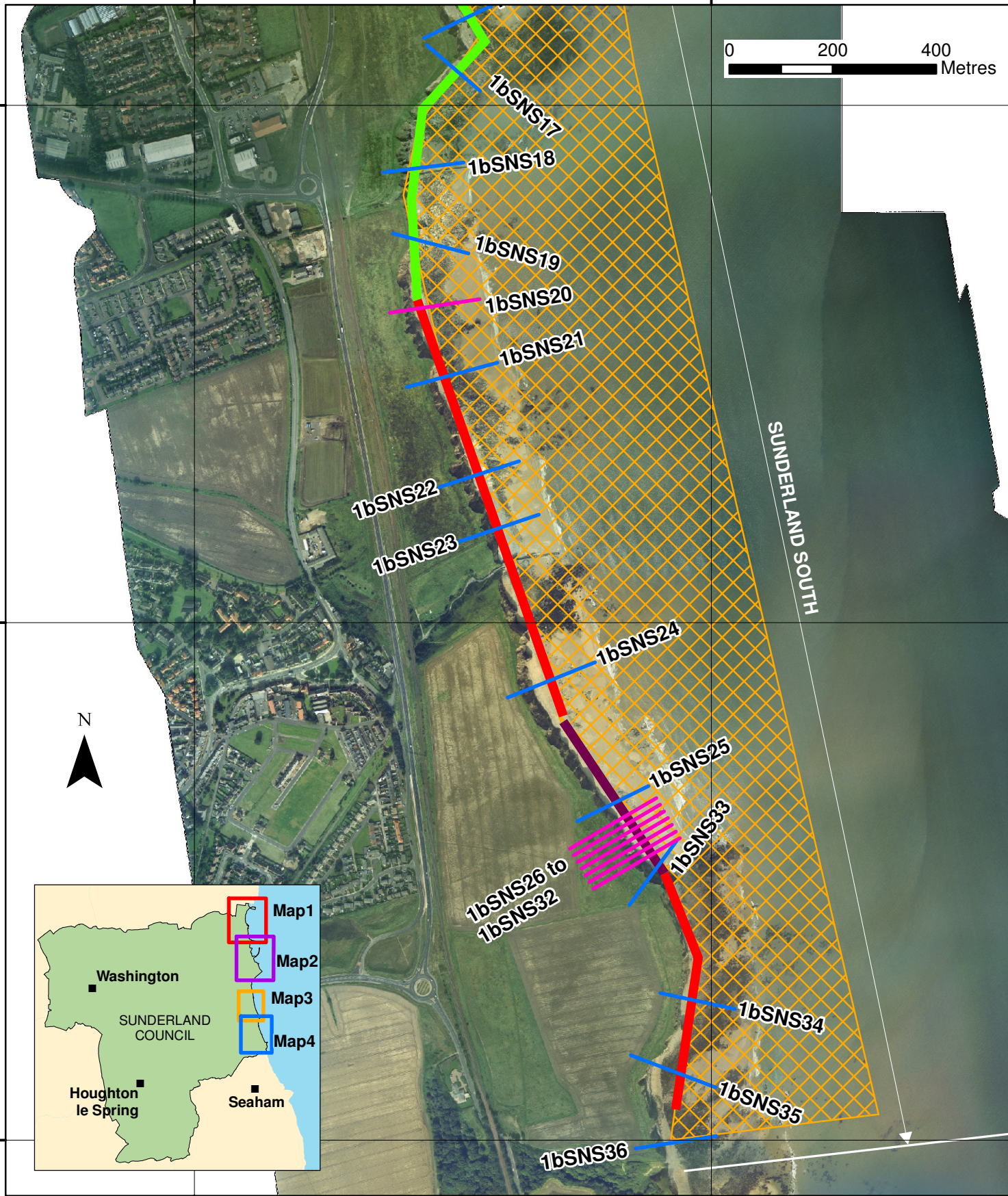
441000

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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 4  
 Sunderland  
 Council Frontage**

Analytical Report 2  
 'Full Measures' Survey 2009

Drawing Scale 1:10,000 at A4



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## 2. Analysis of Survey Data

### 2.1 Whitburn Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
09-2009	<p><b>Beach Profiles:</b></p> <p>Whitburn Bay is covered by eleven beach profile lines (Appendix A).</p> <p>Profiles SNN1, SNN2 and SNN3 are located towards the north of Whitburn Bay and extend across scrubland before reaching the upper gravel foreshore and then dropping across the lower sandy foreshore towards the rocky outcrop of Whitburn Steel.</p> <p>When compared against the previous survey from April 2009, SNN1 shows a consistent profile form in the area of scrub between the low masonry wall by the boat yard and the upper beach gravel. Along the beach, levels are generally higher than those recorded during the previous survey. In places, this difference in beach levels is up to 0.4m.</p> <p>Profiles SNN2 and SNN3 both show similar trends with respect to an earlier survey by the Council in November 2006. The scrubland is stable, but there are signs of slight lowering in beach levels along the upper and mid beach sections.</p> <p>Profiles SNN4 to SNN7 are between the southern edge of South Bents housing estate and just north of Parsons Rock. All profiles show that the position and alignment of the sea wall has not changed since the earlier November 2006 surveys. The surveys then drop from the wall to the generally sandy foreshore and extend down to low water.</p> <p>Along SNN4 and SNN5, however, there also appears to have been an increase in beach levels along the majority of the profile (notwithstanding a slight lowering at the sea wall toe along SNN4). This is typically of the order of 0.2m, but locally up to 0.4m.</p> <p>In contrast, profiles SNN6 and SNN7 show a decrease in upper beach levels compared with the November 2006 survey. Along SNN6 this is up to 0.5m at the toe of the seawall.</p> <p>Profile SNN8 extends across Parsons Rock and generally shows some sand infilling between the rocks and generally consistent foreshore levels when compared against the November 2006 survey.</p>	<p>Beach level fluctuations of anything between 0.2m and 0.4m appear to be very common along the length of Whitburn bay.</p> <p>The low beach levels along upper sections of profiles SNN6 and SNN7 need to be monitored for signs of worsening or recovery.</p> <p>The low levels extending seawards within around 15m of the sea wall along SNN7 may be as a result of wave reflection off the structure.</p>

Survey Date	Description of Changes Since Last Survey	Interpretation
09-09	<p>Profile SNN9 drops from the cliff top to the foreshore at Roker and shows consistency in cliff top and foreshore levels.</p> <p>Profiles SNN10 and SNN11 are between Roker Park and Roker Pier. SNN10 shows a similar profile form to the April 2009 survey, although levels are slightly (typically 0.1m) lower along the upper beach and a slight berm is observed on the lower beach.</p> <p>SNN11 shows a considerably more varied form, with a relatively steep drop-off in beach levels just beyond MHWS.</p>	<p>There is a slight 'apparent' growth in the cliff face along SNN9 due to a slightly different cliff top position being recorded in the most recent survey.</p>
09-09	<p><b>Topographic Survey:</b></p> <p>Whitburn Bay is covered by an annual topographic survey between the Bents and Roker Pier. Data have been used to create a DGM (Appendix B – Map 1).</p> <p>From this DGM it can be seen that north of Parson's Rock, the 2mODN beach level contour intercepts the sea wall around Seaburn. There appears to be a slight increase in general upper beach levels immediately adjacent to Roker Pier.</p> <p>The DGM from the present survey will be compared against that created from the next annual survey in autumn 2010 to identify areas of erosion and accretion between successive surveys.</p>	<p>Low beach levels were identified along upper sections of profiles SNN6 and SNN7 from the above Beach Profile analysis. The availability of the DGM assists in understanding that this is part of the wider-scale issues faced by the natural plan form alignment of the embayment between the Bents and Parson's Rock, which leaves this section of sea wall most exposed.</p>

## 2.2 Sunderland Harbour and Docks

Survey Date	Description of Changes Since Last Survey	Interpretation
10-2009	<p><b>Beach Profiles:</b></p> <p>Sunderland Harbour and Docks is covered by eleven beach profile lines (Appendix A).</p> <p>SNN12 and SNN13 are both located within the shelter of Roker Pier. SNN12 extends across the promenade and sea wall down to the foreshore. There is a beach berm width of around 50m before the profile relatively steeply drops-off down towards low water. SNN13 extends across the car park, promenade and sea wall before extending across the rock revetment to the foreshore. Beach levels at the toe of the wall were at around 1.0mODN.</p> <p>SNC1 and SNC2 are located within the shelter of New South Pier. SNC1 starts at the seaward edge of the dock building and extends across an earth mound before reaching the stepped landward face of the dock wall. The profile then drops from the wall crest into deep water. SNC2 starts at the crest of New South Pier and drops several metres to foreshore level. There is a small pocket of sand trapped adjacent to the structure, which reached a level of 0.9m at the toe of the structure.</p> <p>SNC3 to SNC7 are on the seaward face of the dock. SNC3 extends from the dock yard across a back flood wall, which has a crest level of around 7.2mODN, and promenade to the main seaward dock wall, which has a crest level of 7.55mODN. SNC4 and SNC5 extend from the rock armoured revetment across the short width of foreshore down to low water. SNC6 extends from the concrete wall across the short foreshore width.</p> <p>SNC7 to and SNC9 are within the shelter of North East Pier and South West Breakwater. SNC7 is a section across North East Pier and shows the terraced nature of the landward face of the pier wall, extending across rock to the small sheltered bay between the two structures. SNC8 crosses the boulders and rubble, which reaches a level of around 6.2mODN, and then extends across the sandy but boulder-strewn foreshore. SNC9 starts near the dock facilities and crosses a short length of concrete wall before extending across the sand foreshore to reach and cross a large boulder mound that is towards the seaward end of the South West Breakwater.</p>	<p>The berm width along SNN12 is slightly greater than that recorded during the earlier November 2006 survey, and the beach levels at the toe of the rock armour along SNN13 are around 1m higher. Similarly, the pocket of sand adjacent to New South Pier was some 0.9m higher in the current survey than when compared against the earlier November 2006 survey. These trends suggest that the shelter from Roker Pier and New South Pier is relatively effective, although future surveys will confirm the degree of variation that naturally occurs between surveys.</p> <p>Levels across the short foreshore widths fronting the dock appear to be notably different than those recorded during the earlier November 2006 survey, with higher levels currently observed along SNC4 and lower levels currently observed along SNC5 and SNC6.</p> <p>The previous survey along SNC7 from November 2006 has the same origin as the current survey but extends seawards across the North East Pier rather than landwards. The latter is better suited to understanding foreshore changes within the small sheltered bay.</p>

## 2.3 Hendon to Ryhope

Survey Date	Description of Changes Since Last Survey	Interpretation
09-2009	<p><b>Beach Profiles:</b></p> <p>Hendon to Ryhope is covered by thirty six beach profile lines (Appendix A).</p> <p>SNS1 to SNS6 are located along the sea wall protecting the Hendon Sewage Treatment Works. The profiles typically include a section along the concrete deck, wall crest (which varies in elevation between around 7.0mODN in the north and 7.6mODN in the south after the dog-leg in the wall position), near-vertical seaward face of the wall, and sloping rock armour revetment.</p> <p>SNS7 to SNS10 are located along the defended coastal slopes along south Hendon, which rise in elevation to higher defended cliffs at SNS11. The profile form typically includes a short section of the backing coastal slope (or cliff at SNS11), a rear flood wall (crest levels typically around 7.0mODN), a concrete deck and a vertical sea wall. Rock revetment and natural boulders are present at the toe of the wall along most profiles, with the surveys then extending across the foreshore to low water. Foreshore levels at the toe of the defences are relatively low, ranging from 0.3m to 1.3mODN.</p> <p>SNS12 to SNS36 are located along the undefended cliffs between Grangetown and Ryhope Dene.</p> <p>Profiles SNS12 to SNS16 are between the end of the Hendon sea wall and Salterfen Rocks. Cliff top levels are typically between 20m and 22mODN. They are highest along the profiles further north, dropping in the centre and then increasing again to the south. Beach levels at the toe of the cliffs adopt a similar trend and are around 5.0mODN in the north, 3.8mODN in the centre and 4.6mODN in the south.</p> <p>Profiles SNS17 to SNS36 extend between Salterfen Rock and Pincushion Rocks along Shirley Banks and Halliwell Banks.</p> <p>Profiles between SNS17 and SNS25 typically exhibit a characteristic cliff height of between 23m and 29mODN, with beaches at the toe typically at levels between 3.1m and 4.6mODN.</p>	<p>Future surveys along SNS1 to SNS6 will identify any future changes in the sea wall and rock-armoured revetment. No significant changes (other than slight variation due to different survey details) are observed between the current survey and the earlier November 2006 survey.</p> <p>Profiles SNS8 and SNS11 show an increase in foreshore sand levels of around 0.2m compared with the previous March 2009 survey. This is anticipated to be within the natural bands of variation in beach levels at this location.</p> <p>Comparing the current survey against the earlier November 2006 survey, it is notable that there has been erosion in the cliff top position along profiles SNS13 (by 3m), SNS14 (2m), SNS16 (2.5m), SNS20 (2m), SNS21 (0.5m). There has also been some cut-back since November 2006 at the toe of cliffs along SNS15 (by 1m), SNS20 (1m since the March 2009 survey), and SNS22 (1m). This cut-back at the toe will perhaps create over-steepened cliff face conditions and recession of the cliff top may be an imminent response along these sections.</p>



<p>Profiles SNS26 to SNS32 are all located at close spacings at Halliwell Banks specifically to assess risks from erosion at a former land fill. Cliff height is characteristically around 26m and 27mODN, with beaches at the toe typically at levels between 3.3m and 3.9mODN. Along profiles SNS26 and SNS27, however, beach levels are much lower at 2.1m and 2.9mODN, respectively.</p> <p>Profiles between SNS33 and SNS36 typically exhibit a characteristic cliff height of between 25m and 27mODN, with beaches at the toe typically at levels between 3.3m and 3.9mODN.</p>	<p>The cliffs fronting the landfill area at Halliwell Banks (measured by profiles SNS26 to SNS32) have shown stability along the measured sections since the earlier November 2006 survey.</p>
<p><b>Topographic Survey:</b></p> <p>Hendon to Ryhope is covered by an annual topographic survey between the Hendon Sea Wall and Ryhope Dene. Data have been used to create a DGM (Appendix B – Maps 2 and 3).</p> <p>From this DGM it can be seen that beach levels at the toe of the Hendon Sea Wall are relatively low; there is a general absence of topographic contours above 1mODN. In contrast, the undefended sections of frontage down to Ryhope Dene exhibit higher foreshore levels at the toe of the cliffs.</p> <p>The DGM from the present survey will be compared against that created from the next annual survey in autumn 2010 to identify areas of erosion and accretion between successive surveys.</p>	<p>The Hendon Sea Wall will come under increasing pressure due to the presence of low beach levels at the toe of the defence.</p>
<p><b>Cliff Top Survey:</b></p> <p>Thirty-two ground control points have been established along the cliff top between Hendon and Ryhope (Figure B1). Measurements are taken from each ground control point along a fixed bearing to the edge of the cliff top.</p> <p>These cliff top surveys are undertaken bi-annually and are intended to inform on erosion rates of the sea cliffs extending from the defended industrial areas at Hendon southwards along the undefended cliffs to Ryhope Dene.</p> <p>Appendix C provides results from the September 2009 cliff top survey, showing the position from the ground control point to the edge of the cliff top along a defined bearing. Also shown is the change in measurement since the previous March 2009 cliff top survey.</p>	<p>The results from the cliff top monitoring were anticipated to have an accuracy of <math>\pm 0.2\text{m}</math> due to the techniques being used. However, many results show an apparent increase in the distance to the cliff edge compared against the baseline survey. Clearly this cannot be correct and in part is due to known re-landscaping of the cliff top (points 1 – 3), in part due to the seaward heave prior to a toppling failure, and in part due to different points being defined as the cliff edge on successive surveys. The implications of this are discussed in Section 3.</p>

### 3. Problems Encountered and Uncertainty in Analysis

#### Cliff Top Surveys

Surveying any cliff top is difficult due to the Health and Safety risks posed to surveyors, especially during adverse weather, and the 'apparent' changes that can arise due to surveyors interpreting different points as the cliff edge on successive surveys (Plate 1). This has been identified as affecting one beach profile (SNN9) and most of the cliff top surveys.

#### Plate 1 – Cliff Top Surveying



In addition to surveyor interpretation, the cliffs along this frontage have a characteristic tendency to heave seawards prior to a toppling failure, leading to apparent discrepancies in the data.

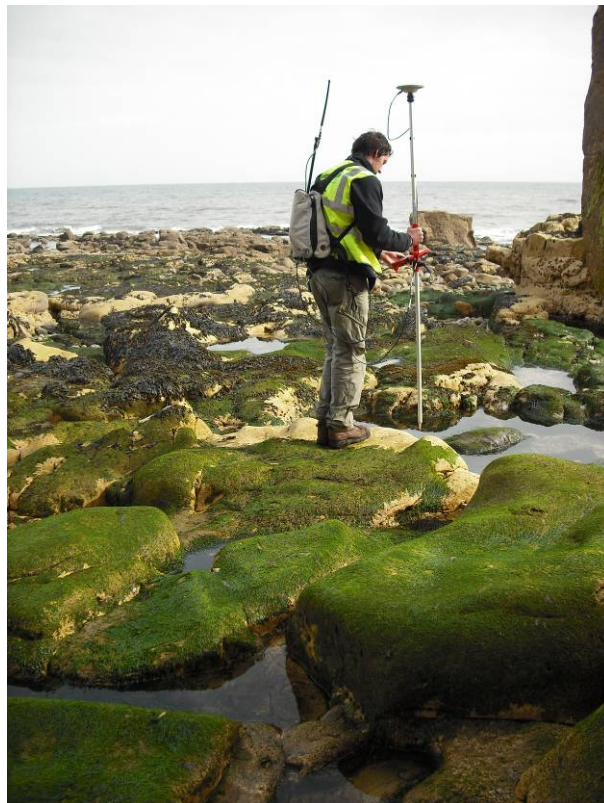
It is also known that along cliff top monitoring points 1 – 3 the cliff top has been re-landscaped behind the coastal defences, giving rise to the apparent massive increase in distance to the cliff edge.

It is recommended that further attempts at the cliff top surveys are made in spring 2010 during the Partial Measures surveys (as already scheduled) and if problems in interpretation persist then the cliff top surveys be removed from the programme, reduced in frequency of occurrence, or undertaken using alternative technology, such as terrestrial laser scanning.

## Rock Foreshores

Surveys of foreshore areas that are covered by inter-tidal rock outcrops present some problems to our surveyors (Plate 2). 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.

**Plate 2 - Survey of Rock Foreshore**



Notwithstanding this, the rock foreshore areas may periodically be 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'.

## Profile SNC7

Profile SNC7 is located along the North East Pier. During the previous available surveys of November 2006, the Council's survey contractor extended the profile from the origin seaward across the structure. During the present survey, our surveyors extended the survey landwards across the structure and in to the small basin formed between the North East Pier and the South West Breakwater. This approach provides useful information on the foreshore levels in this basin. It is recommended that this continues into future surveys, although the seaward face of the wall should also be recorded.

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

The only recommendation for 'fine-tuning' the monitoring programme at the present time is for the survey along profile SNC7 to cover areas both seaward and landward of the profile origin, as discussed in Section 3.

Importantly, analysis of the next set of cliff top surveys will reveal whether or not it is worth continuing with these in their current form.

#### **5. Conclusions and Areas of Concern**

- Along the Whitburn frontage beach level fluctuations of 0.2 to 0.4m are common and these are representative of natural changes between successive surveys.
- Beach levels are particularly low along Seaburn, where the high water contour intercepts the sea wall. This places the structure at high exposure, leaving it vulnerable to damage and toe undermining.
- Despite the shelter provided by the pier and breakwater structures at Sunderland Harbour and Docks, variations in foreshore level can still be quite marked.
- The outer wall of the dock is highly exposed, due to the presence of only a very narrow width of foreshore.
- Localised sections of undefended cliffs between the end of the Hendon Sea Wall and Ryhope Dene have experienced cliff top recession of between 0.5m and 3m between an earlier November 2006 survey and the current survey.
- Other localised sections of undefended cliff along this frontage have also experienced cut-back of around 1m at the cliff toe. This is likely to have led to over-steepened cliff face conditions and a degree of recession in the cliff top position may result imminently along these local areas as a result.
- No significant change has occurred in the cliff top position in the area fronting the landfill at Halliwell Banks since the earlier survey in November 2006.

## **Appendices**

# **Appendix A**

## **Beach Profiles**

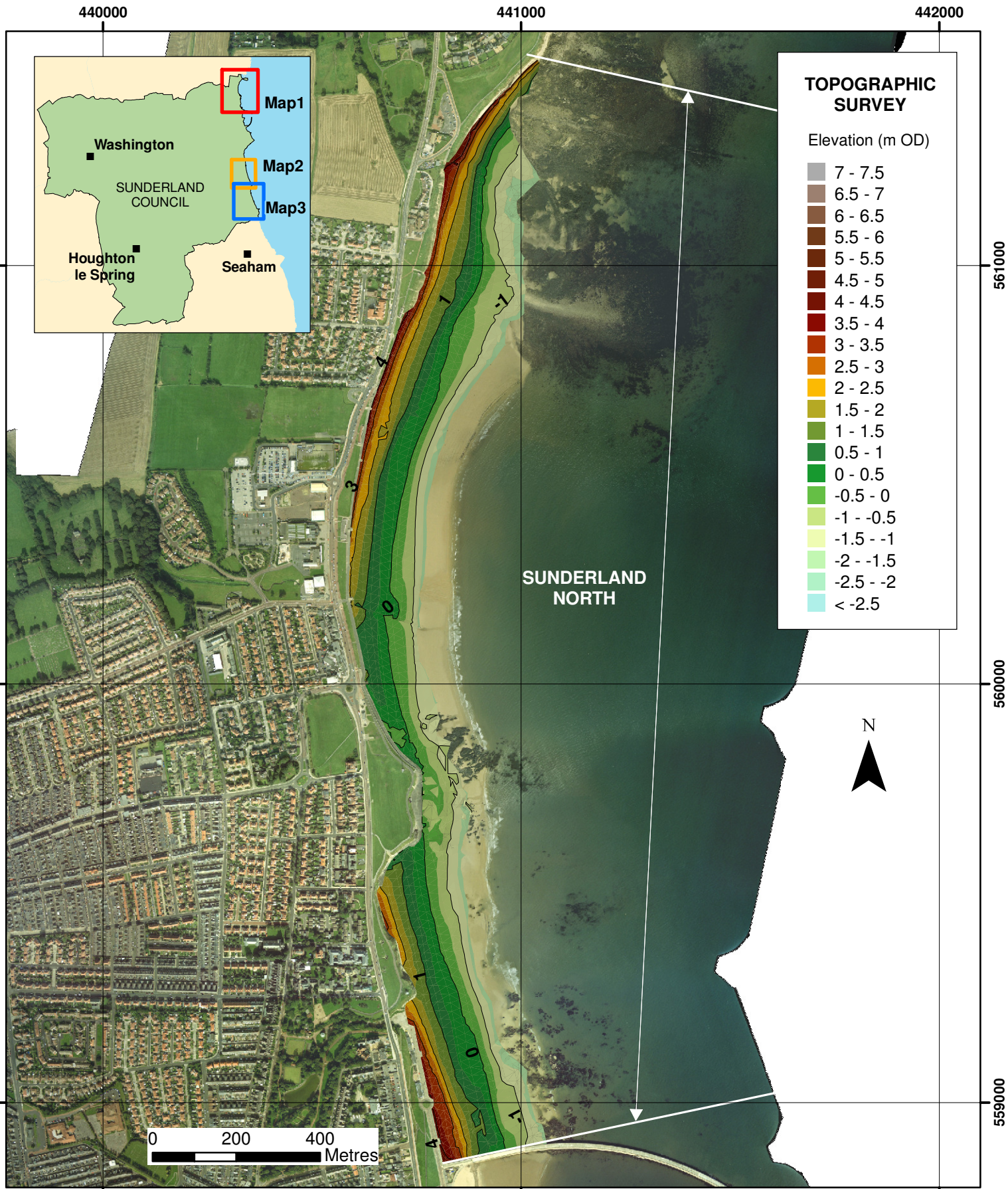
Please see separate files

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

<b>Code</b>	<b>Description</b>
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

**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 1  
Sunderland  
Council Frontage**

Analytical Report 2  
'Full Measures' Survey 2009

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— Topographic Contours at 1 metre interval

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### Appendix B - Map 2 Sunderland Council Frontage

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441000

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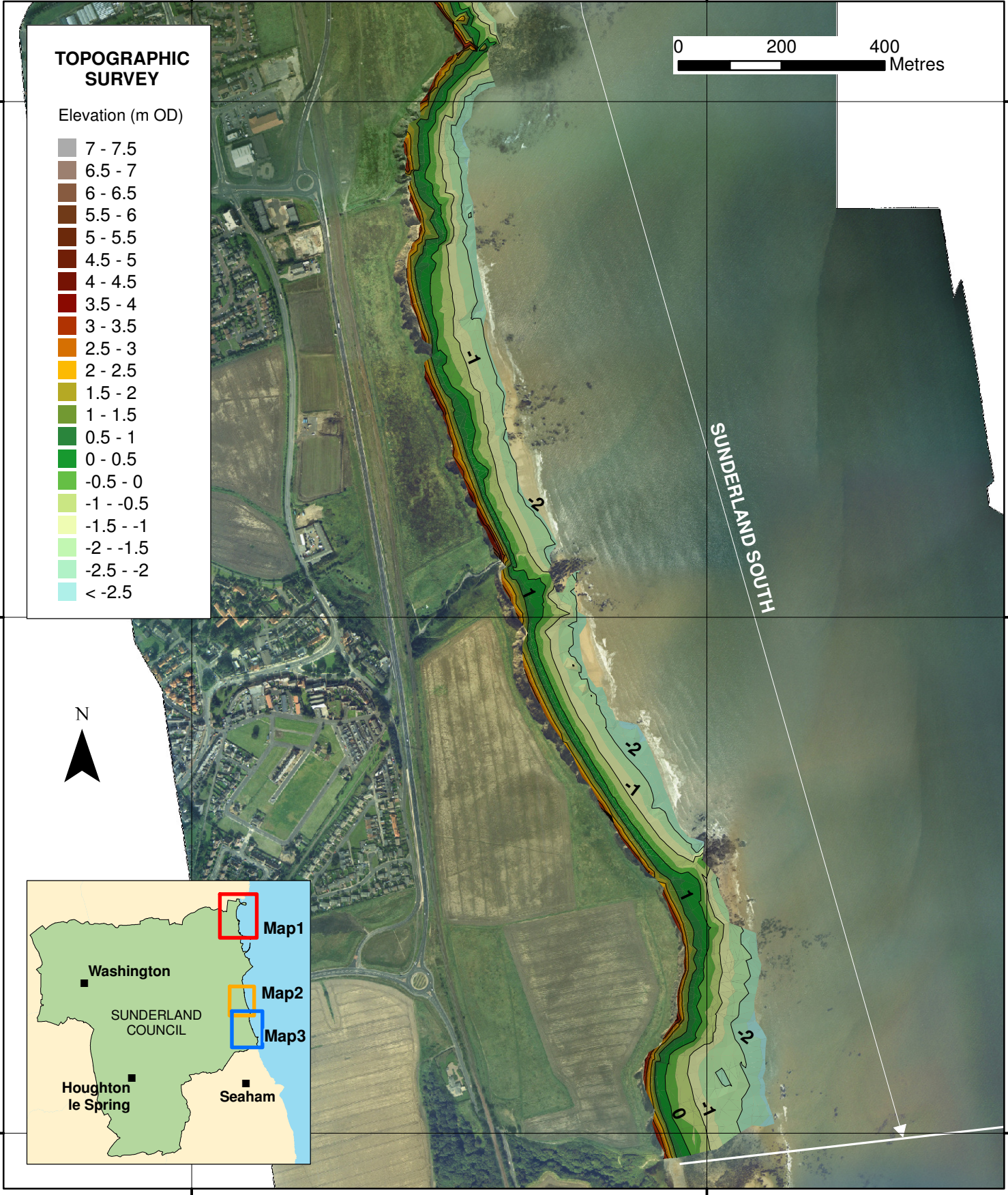
### TOPOGRAPHIC SURVEY

Elevation (m OD)

- 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
- 2.5 - -2
- < -2.5



SUNDERLAND SOUTH



Topographic Contours at 1 metre interval

Client: North East Coastal Group  
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### Appendix B - Map 3 Sunderland Council Frontage

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**Appendix C**  
**Cliff Top Survey**

## Cliff Top Survey

### Hendon to Ryhope

Thirty-two ground control points have been established between Hendon and Ryhope (Figure C1). The maximum separation between any two points varies along the coast, reflecting the degree of risk from the erosion.

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

Table C1 provides baseline information about these ground control points and results from the 2008 (baseline) survey showing the position from the ground control point to the edge of the cliff top along the defined bearing. Future reports will show results from subsequent surveys and provide a means of assessing erosion since the baseline survey.

**Table C1 – Cliff Top Surveys between Hendon and Ryhope**

Ground Control Point Details					Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Level (mODN)	Bearing (°)	Baseline Survey (Mar 2009)	Previous Survey (N/A)	Present Survey (Sep 2009)	Baseline (Mar 2009) to Present (Sep 2009)	Previous (N/A) to Present (Sep 2009)	Baseline (Mar 2009) to Present (Sep 2009)
1	441026	555571	18.9	75	8.2	-	11.0	2.80	-	-
2	441064	555355	17.3	85	7.1	-	8.0	0.91	-	-
3	441098	555124	17.9	82	10.0	-	10.6	0.55	-	-
4	441174	554939	17.0	65	10.3	-	10.2	-0.13	-	-
5	441199	554861	20.0	65	7.7	-	7.7	-0.03	-	-
6	441224	554774	22.4	71	10.8	-	11.0	0.24	-	-
7	441248	554690	22.8	74	10.2	-	10.4	0.21	-	-
8	441259	554597	22.5	101	10.1	-	9.9	-0.19	-	-
9	441276	554513	23.0	66	10.5	-	10.6	0.06	-	-
10	441309	554421	22.0	58	8.8	-	9.1	0.25	-	-
11	441354	554346	19.9	68	8.2	-	8.3	0.08	-	-

Ground Control Point Details					Distance to Cliff Top (m)			Total Erosion (m)		Erosion Rate (m/year)
Ref	Easting	Northing	Level (mODN)	Bearing (°)	Baseline Survey (Mar 2009)	Previous Survey (N/A)	Present Survey (Sep 2009)	Baseline (Mar 2009) to Present (Sep 2009)	Previous (N/A) to Present (Sep 2009)	Baseline (Mar 2009) to Present (Sep 2009)
12	441400	554248	20.5	56	6.2	-	6.3	0.05	-	-
13	441452	554175	22.9	63	11.6	-	11.6	0.03	-	-
14	441472	554081	23.3	127	7.3	-	7.5	0.16	-	-
15	441413	554005	22.9	122	7.8	-	7.9	0.14	-	-
16	441385	553913	23.6	90	9.9	-	9.9	0.04	-	-
17	441404	553815	21.2	93	6.3	-	6.5	0.15	-	-
18	441404	553724	24.6	119	8.1	-	8.1	0.04	-	-
19	441398	553633	25.4	78	8.2	-	8.4	0.16	-	-
20	441438	553453	26.8	71	10.1	-	10.2	0.13	-	-
21	441506	553256	27.7	62	8.6	-	8.7	0.14	-	-
22	441550	553159	26.5	103	6.6	-	6.6	0.01	-	-
23	441585	553076	18.7	64	8.1	-	8.2	0.12	-	-
24	441624	552871	28.1	69	7.5	-	7.9	0.35	-	-
25	441689	552758	28.0	70	14.6	-	10.5	-4.15	-4.15	-8.3
26	441715	552713	28.0	54	12.9	-	12.9	0.01	-	-
27	441749	552674	27.4	62	14.6	-	15.0	0.38	-	-
28	441777	552630	26.9	57	8.6	-	8.7	0.06	-	-
29	441880	552472	26.1	83	15.5	-	15.5	0.03	-	-
30	441921	552269	25.1	97	8.6	-	8.6	-0.04	-	-
31	441853	552094	26.4	75	11.2	-	9.8	-1.41	-1.41	-2.82
32	441883	551988	27.4	96	9.8	-	9.8	-0.05	-	-

**Note:** It is assumed that the accuracy of cliff top monitoring using this technique is  $\pm 0.2\text{m}$ . Therefore any observed changes within this range have been excluded from a calculation of erosion rate. Furthermore, many surveys show an apparent increase in distance to the cliff edge. Such datasets have been removed from the calculation of erosion rate.



440000

441000

442000



0 200 400 Metres



555000

555000

554000

● Cliff Top Monitoring Points

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### Appendix C - Map 1 Sunderland Council Frontage

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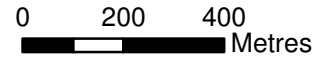
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441000

442000

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554000

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551000

Hendon to Ryhope



 Cliff Top Monitoring Points

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**Appendix C - Map 2  
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