Cell 1 Regional Coastal Monitoring Programme
Analytical Report 7: 'Full Measures' Survey 2014

North Tyneside Council

North Tyneside Council
Final Report

February 2015

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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
MHWN	Mean High Water Neap
MHWS	Mean High Water spring
MLWS	Mean Low Water Neap
MLWS	Mean Low Water spring
m	metres
ODN	Ordnance Datum Newlyn

Water Levels Used in Interpretation of Changes

Water Level Parameter	Water Level (m AOD)
	River Tyne
1 in 200 year	3.7
HAT	3.1
MHWS	2.4
MLWS	-1.9

Source: *Scottish Border to River Tyne Shoreline Management Plan 2.*
Royal Haskoning, May 2009.

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 sediment to varying thicknesses, softer rock cliffs and extensive landslide complexes.

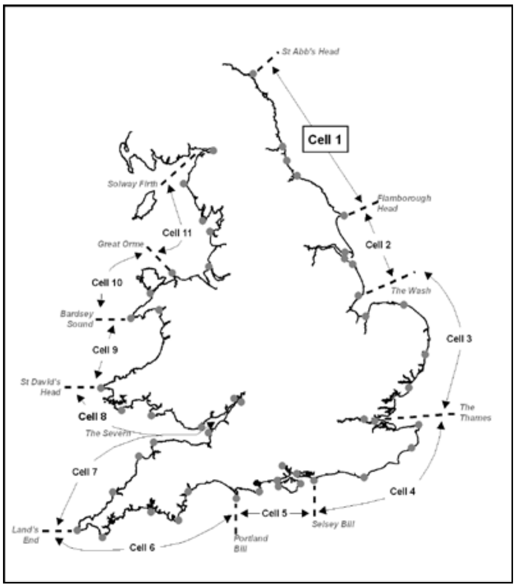

Figure 1 Sediment Cells in England and Wales

The work commenced with a three-year monitoring programme in September 2008 that was managed by Scarborough Borough Council on behalf of the North East Coastal Group. This initial phase has been followed by a five-year programme of work, which started in October 2011. The work is funded by the Environment Agency, working in partnership with the following organisations:

Northumberland County Council	North Tyneside Council	South Tyneside Council
Northumberland Coast Area of Outstanding Natural Beauty		
Sunderland City Council	Durham County Council	Redcar & Cleveland Borough Council
Hartlepool Borough Council	Borough of Scarborough — A great place to live, work & play	East Riding of Yorkshire Council
Environment Agency	Natural England	The National Trust

The original three year programme of work was undertaken as a partnership between Royal Haskoning, Halcrow and Academy Geomatics. For the current five year programme of work the data collection associated with beach profiles, topographic surveys and cliff top surveys is being undertaken by Academy Geomatics. The analysis and reporting for the programme is being undertaken by Halcrow.

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.

Annually, a Cell 1 Overview Report is also produced. This provides a region-wide summary of the main findings relating to trends and interactions along the entire Cell 1 frontage.

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	Sept-Dec 08	May 09	Mar-May 09	June 09	
2	2009/10	Sept-Dec 09	Mar 10	Feb-Mar 10	Jul 10	
3	2010/11	Aug-Nov 10	Feb 11	Feb-Apr 11	Aug 11	Sept 11
4	2011/12	Oct-Nov 11	Oct 12	Mar-May 12	Feb 13	
5	2012/13	Sept-Oct 12	Mar 13	Mar-Apr 13	Jun 13	
6	2013/14	Sept-Oct 13	Feb 14	Mar-Apr 14	Jul 14	
7	2014	Oct-Nov 14	Feb 15 (*)			

(*) The present report is **Analytical Report 7** and provides an analysis of the 2014 Full Measures survey for North 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 (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
	Headland
	Middleton
	Hartlepool Bay
Redcar & Cleveland Borough Council	Coatham Sands
	Redcar Sands
	Marske Sands
	Saltburn Sands
	Cattersty Sands (Skinningrove)
	Staithes
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

North Tyneside Council's frontage extends from Hartley (just south of Blythe) in the north, to the River Tyne in the south. For the purposes of this report and for consistency with previous reporting, it has been sub-divided into four areas, namely:

- Whitley Sands
- Cullercoats Bay
- Tynemouth Long Sands
- King Edward's Bay

1.2 Methodology

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

- Full Measures survey annually each autumn/early winter comprising:
    - Beach profile surveys along eight transect lines (commenced 2002)
    - Beach profile surveys along an additional two transects (commenced 2010)
    - Topographic survey along Whitley Sands (commenced 2010)
    - Topographic survey along Tynemouth Long Sands (commenced 2011)
- Partial Measures survey annually each spring comprising:
    - Beach profile surveys along all ten transect lines (commenced 2010)

The location of these surveys is shown in Figure 1. The Full Measures beach profile survey was undertaken along this frontage for the beach profiles between 6^{th} and 7^{th} October. The topographic survey at Whitley Bay was undertaken on the 6^{th} October 2014 and at Tynemouth Longsands on the 4^{th} November 2014. During this time weather conditions varied considerably; refer to the survey reports for details of the weather conditions over this survey period.

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 ArcGIS. 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.

1.2 Uncertainties in data and analysis

While uncertainty due to survey accuracy or systematic error is likely to be present in all datasets, the work is carefully managed to ensure data are as accurate as possible and results are not misleading. Error may arise from the limits of precision of survey techniques used, from low accuracy measurements being taken or from systematic failings of equipment.

For beach profiles and topographic surveys, all incoming data are checked allowing systematic errors to be identified, and removed from plots and subsequent analysis. The accuracy of these surveys is not known, but it is likely that all measurements are correct to ±0.1m. Therefore, changes less than ±0.1m are ignored and greyed out in the topographic change plots. For cliff top erosion surveys, there are commonly problems in precisely recognising the cliff edge due to vegetation growth and the convex shape of the feature. Errors can manifest themselves as results that suggest the cliff edge has advanced, which is very unlikely unless a toppling failure has been initiated, but the block has not yet fully detached. The accuracy of cliff top surveys are also unknown, but it is assumed that each measurement is accurate to ±0.1m.

These limits of accuracy mean that comparison of annual or biannual data can be of limited value if the measured change is less than or equal to the assumed error. However, all results become more significant over longer time periods when the errors in measurement in years 1 and *x* are averaged over the monitoring period:

$$\text{Error rate of change per year} = \frac{\text{Error in first measurement + Error in last measurement}}{\text{Years between measurements}}$$

The effect of averaging error over different monitoring periods is summarised in Table 3, which assumes that each annual survey is accurate to 0.1m.

Table 3 Error bands for long-term calculations of change.

Years between surveys	**Error bands in inter-survey comparison** (±m/yr)
1	0.200
2	0.100
3	0.067
4	0.050
5	0.040
5	0.033
7	0.029
8	0.025
9	0.022
10	0.020

While considering the uncertainty in comparing and analysing change between monitoring data sets it is also relevant to raise caution about drawing conclusions about short or longer term trends. Clearly the longer the data set the more confidence that can be given to likely ranges of beach changes and trends in change. Potential for seasonal, annual and longer term cycles need to be considered. Studies of long term monitoring data sets for other coastal and estuarial data have established that there are long period cyclical trends related to the 18.6 years lunar nodal cycle which need to be accounted for. Simply put this means that although the Cell 1 monitoring programme now has data in some locations up to 11 years, another 8 to 10 years of consistent data is needed before confidence can be given in trends from the analysis. In the context of this report “Longer Term Trends” are mentioned in each section and it should be noted that this is based on simple visual interpretation of the available data since the current programme began, and is generally based on only 5 to 10 years of data.

2. Wave Data and Interpretation

2.1 Introduction

Wave monitoring data relevant to the Cell 1 Regional Coastal Monitoring Programme is available from one offshore regional wave buoy located at Tyne and Tees and three regional wave buoys, which are further inshore at Newbiggin, Whitby and Scarborough. The Tyne Tees buoy is managed by Cefas as part of the WaveNet system, while the three inshore buoys is managed by Scarborough BC as part of the Cell 1 monitoring programme.

An assessment of baseline wave data is presented in the 2011 Wave Data Analysis Report, which reviewed all readily available data in the region. The present wave data update report provides an update to the baseline with analysis of the wave data collected under the programme for 2012, 2013 and 2014. In order to help put the beach and cliff changes discussed in this report into context, analysed storm data for the wave buoys is presented in this section.

The longest consistent relevant wave data record in the Cell 1 region is from the WaveNet Tyne Tees buoy deployed under the national coastal monitoring programme by Cefas. Data has been downloaded from WaveNet and loaded into SANDS for analysis alongside the beach and cliff monitoring data and is presented in Table 4 below.

To aid interpretation of the results in Table 4 alternate years have been shaded and the storm with the largest peak wave height each year has been highlighted in bold. The annual storm with the highest wave energy at peak has also been highlighted in bold red text as this depends on wave period as well as wave height and so is not always the same as the largest wave height, e.g. in 2007 and 2008.

Table 4: SANDS Storm Analysis at Tyne/Tees WaveNet Buoy

General Storm Information					At Peak			
Start Time	**End Time**	**Duration (Hours)**	**Peak of Storm**	**Mean Direction Vector (Degrees)**	**Hs (m)**	**Tp (s)**	**Direction (Degrees)**	**Energy @ Peak (KJ/m/s)**
19/03/2007 10:30	21/03/2007 05:30	43	20/03/2007 14:30	78.2	6.2	12.4	23	1.7E+04
25/06/2007 20:30	26/06/2007 13:30	17	26/06/2007 10:00	77.3	4.4	8.6	23	4.0E+03
26/09/2007 03:00	27/09/2007 05:00	26	26/09/2007 19:00	79.7	4.6	11.6	6	**7.8E+03**
08/11/2007 20:00	12/11/2007 15:00	91	09/11/2007 08:30	77.7	**6.2**	**13.3**	**6**	1.9E+04
19/11/2007 03:30	25/11/2007 21:30	162	23/11/2007 05:00	76.8	4.9	10.7	17	7.6E+03
08/12/2007 03:00	10/12/2007 14:30	59.5	08/12/2007 03:30	82.9	4.1	10.7	17	5.4E+03
03/01/2008 10:30	04/01/2008 01:30	15	03/01/2008 23:30	14.6	4.2	9.1	62	4.2E+03
01/02/2008 15:00	02/02/2008 09:30	18.5	02/02/2008	80.1	6.0	13.8	17	1.9E+04
10/03/2008 08:30	10/03/2008 12:30	4	10/03/2008 11:00	307.5	4.6	8.1	141	3.8E+03
17/03/2008 15:00	25/03/2008 03:00	180	22/03/2008 05:00	82.1	**7.9**	**12.4**	**6**	2.7E+04
05/04/2008 22:00	07/04/2008 05:00	31	06/04/2008 19:00	83.1	4.6	11.7	6	7.9E+03
20/07/2008 16:00	21/07/2008 09:30	17.5	20/07/2008 23:30	76.0	4.2	9.9	11	4.9E+03
03/10/2008 03:00	03/10/2008 20:30	17.5	03/10/2008 16:30	76.7	4.7	11.4	23	**8.1E+03**
21/11/2008 04:00	25/11/2008 12:30	104.5	22/11/2008 11:30	75.8	6.0	13.1	11	1.7E+04

General Storm Information					At Peak			
Start Time	**End Time**	**Duration (Hours)**	**Peak of Storm**	**Mean Direction Vector (Degrees)**	**Hs (m)**	**Tp (s)**	**Direction (Degrees)**	**Energy @ Peak (KJ/m/s)**
10/12/2008 12:00	13/12/2008 18:00	78	13/12/2008 08:00	332.1	4.9	8.4	129	4.7E+03
31/01/2009 16:30	03/02/2009 09:00	64.5	02/02/2009 22:00	7.2	5.8	9.6	84	8.7E+03
23/03/2009 22:30	28/03/2009 20:30	118	28/03/2009 16:30	89.4	5.3	8.4	6	5.4E+03
10/07/2009 01:30	10/07/2009 02:30	1	10/07/2009 01:30	78.7	4.2	10.0	11	5.0E+03
29/11/2009 20:30	30/11/2009 15:00	18.5	30/11/2009 00:30	72.7	**6.0**	**9.4**	**11**	9.0E+03
17/12/2009 10:30	18/12/2009 05:00	18.5	17/12/2009 19:30	26.3	5.4	10.7	68	**9.4E+03**
30/12/2009 09:00	30/12/2009 23:00	14	30/12/2009 12:30	7.7	5.1	7.6	90	4.1E+03
06/01/2010 05:30	06/01/2010 11:00	5.5	06/01/2010 06:30	63.6	4.2	10.7	11	5.7E+03
29/01/2010 10:30	30/01/2010 00:30	14	29/01/2010 22:30	81.9	5.4	8.6	6	6.0E+03
26/02/2010 22:30	27/02/2010 02:30	4	27/02/2010 01:00	72.4	4.6	8.5	17	4.2E+03
19/06/2010 07:00	20/06/2010 08:30	25.5	19/06/2010 20:00	69.2	5.4	10.7	23	**9.4E+03**
29/08/2010 14:00	30/08/2010 06:30	16.5	30/08/2010 01:00	92.8	4.7	8.6	6	4.7E+03
06/09/2010 22:30	07/09/2010 16:00	17.5	07/09/2010 15:30	353.2	4.6	8.8	90	4.5E+03
17/09/2010 07:00	17/09/2010 18:30	11.5	17/09/2010 08:30	80.7	4.7	11.0	11	7.5E+03
24/09/2010 03:00	26/09/2010	45	24/09/2010 10:00	71.6	5.3	10.2	11	8.0E+03
20/10/2010 02:00	24/10/2010 16:30	110.5	20/10/2010 10:00	78.2	4.2	11.2	17	6.4E+03
08/11/2010 14:00	09/11/2010 20:30	30.5	09/11/2010 10:00	3.0	**5.6**	**8.8**	**73**	6.9E+03
17/11/2010 11:00	17/11/2010 18:30	7.5	17/11/2010 12:00	322.4	4.7	7.7	129	3.7E+03
29/11/2010 19:30	02/12/2010 08:30	61	29/11/2010 21:00	11.8	5.1	9.4	56	6.3E+03
16/12/2010 15:00	17/12/2010 06:30	15.5	17/12/2010 03:30	79.1	4.6	10.5	17	6.4E+03
23/07/2011 14:00	24/07/2011 11:00	21	24/07/2011 03:00	67.1	**4.7**	**10.7**	**17**	**7.2E+03**
24/10/2011 18:30	25/10/2011 09:30	15	25/10/2011 09:30	348.5	4.1	9.5	79	4.2E+03
09/12/2011 08:30	09/12/2011 10:00	1.5	09/12/2011 08:30	84.0	4.1	11.9	6	6.7E+03
05/01/2012 16:00	06/01/2012 05:00	13	06/01/2012 03:00	79.0	4.6	10.5	17	6.4E+03
03/04/2012 13:30	04/04/2012 10:30	21	03/04/2012 17:30	25.1	5.6	8.1	56	5.9E+03
24/09/2012 08:30	25/09/2012 10:30	26	25/09/2012 01:30	16.7	4.7	10.3	62	6.6E+03
26/10/2012 16:30	27/10/2012 14:30	22	26/10/2012 23:00	79.4	4.9	12.8	11	1.1E+04
05/12/2012 16:00	15/12/2012 01:30	225.5	14/12/2012 19:30	18.4	5.4	8.8	96	6.4E+03
20/12/2012 06:00	21/12/2012 14:30	32.5	20/12/2012 23:00	348.4	5.6	9.5	96	8.0E+03
18/01/2013 18:30	22/01/2013 06:00	83.5	21/01/2013 10:00	9.2	6.7	9.4	84	1.1E+04
06/02/2013 08:00	07/02/2013 06:00	22	06/02/2013 12:30	81.6	5.4	10.0	11	8.2E+03
07/03/2013 21:00	10/03/2013 21:30	72.5	08/03/2013 04:00	24.6	4.9	9.0	73	5.4E+03
18/03/2013 09:00	25/03/2013 00:30	159.5	23/03/2013 14:30	5.1	6.0	10.2	90	1.0E+04

General Storm Information					At Peak			
Start Time	**End Time**	**Duration (Hours)**	**Peak of Storm**	**Mean Direction Vector (Degrees)**	**Hs (m)**	**Tp (s)**	**Direction (Degrees)**	**Energy @ Peak (KJ/m/s)**
23/05/2013 18:00	24/05/2013 12:00	18	23/05/2013 22:30	77.5	6.7	10.5	17	1.4E+04
10/09/2013 13:00	10/09/2013 19:30	6.5	10/09/2013 14:00	79.3	4.4	9.2	11	4.6E+03
09/10/2013 22:30	11/10/2013 09:00	34.5	10/10/2013 17:00	79.8	5.4	10.7	22	9.4E+03
29/11/2013 22:30	30/11/2013 06:30	8	30/11/2013 00:30	84.5	5.6	10.7	11	1.0E+04
05/12/2013 14:00	07/12/2013 04:30	38.5	06/12/2013 20:00	80.8	4.7	14.3	6	1.3E+04
27/12/2013 09:30	27/12/2013 12:30	3	27/12/2013 10:00	249.3	4.1	6.1	202	1.8E+03
05/02/2014 04:00	05/02/2014 18:00	14	05/02/2014 05:30	318.4	4.4	7.8	129	3.3E+03
12/02/2014 20:00	14/02/2014 19:00	47	12/02/2014 21:00	275.6	4.6	7.5	141	3.2E+03
21/10/2014 22:00	22/10/2014 01:30	3.5	21/10/2014 23:00	84.4	4.4	9.6	6	5.0E+03

The storms mostly arrive from the north to northeast direction, 0 to 40 degrees, which has the longest fetch, but there are also a significant number of storms from other directions, particularly 80 to 140 degrees.

Comparing the annual storm records it can be seen that 2010 had the most storms (13). In 2010 the largest storm had an incident direction of 73 degrees which is unusual. We might therefore expect that the alongshore drift on the Cell 1 beaches in 2010 may have been atypical with unusual changes from the storm conditions. This was noted in several of the 2010 Full Measures reports.

The years with the fewest storms was 2011 and 2014. This was reflected by a combination of accretion and overall stability recorded within the annual Full Measures reports.

The winter of 2012 to 2013 appears to have suffered with larger storms than usual, with the second largest peak wave height (7.3m) recorded on 23rd March 2013. The longest duration storm in the record was from 5th to 15th December 2012 (226.5 hours).

The storm on the 5th and 6th December 2013, was particularly notable. Although this event did not have such large waves as the 23rd March 2013 storm, it had a high peak energy and exceptionally long wave period at 14.3 seconds. The 6th December storm was also accompanied by a significant storm surge with recorded water levels around 1.75m higher that predicted tides in some locations. The combined high water levels and large waves causing significant damage to many coastal defences and beaches in the north east.

The 2014 storms did appear to have an influence on beach behaviour, as shown by the profile analysis included within this report, with the movement of material across and along the beach. Dune toe erosion was more dominant than in previous years and could be explained by particularly high tides rather than storm erosion alone.

2. Analysis of Survey Data

2.1 Whitely Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
Oct 2014	**Beach Profiles:** Whitley Sands is covered by five beach profile lines for the Full Measures survey (Appendix A). Four of these (1aNTDC01 to 1aNTDC04) were initially surveyed in April 2002 and were surveyed annually to 2009 (Full Measures, autumn 2009) and bi-annually thereafter. From March 2010 (Partial Measures, spring 2010) onwards, an additional beach profile line (NTDC04A) has been surveyed at the southern end of the frontage. All profiles were last surveyed in April 2014 for the Partial Measures survey. **1aNTDC01** is located in the north of Whitley Sands, along the undefended cliffs immediately south of Trinity Road car park. During the present survey, the bottom of the cliff/top of the beach could not be measured as the survey report notes 'fence around the construction site'. The profile starts at a chainage of 40m (height of 3m). A beach berm has formed around the HAT/MHWS mark (2.5m to 3m) / chainage 70m, but seaward of this to a chainage of 140m beach levels have fallen. This suggests that material has been redistributed up the profile over the winter months, or the movement of beach material during the construction process here. Profile **1aNTDC02** is located to the north of Whitley Sands opposite the seawall. Beach levels have increased across the profile, particularly in front of the seawall where they have increased by over 0.5m. As a result the upper beach is slightly steeper than in the previous survey. The lower beach (seaward of a chainage of 110m has remained stable) since the last survey. Profile **1aNTDC03** is located at the centre of Whitley Sands. Beach levels have increased across the profile, by as much as 1m in front of the seawall. The lower beach (seaward of a chainage of 80m) has remained stable since the last survey. Profile **1aNDC04** is located to the south of Whitley Sands. Beach levels have increased across the beach profile by up to 0.5m, burying the exposed rock shore platform to form a more consistent profile. There has been another notable change in sediment type on the beach, which when compared to surveys dating back to 2012 shows a switch from sand to coarse material between the Full Measures	Since the last survey, the most northern and southern profiles have demonstrated cross-shore movement of material, with movement up the beach at profile 1aNTDC01 and down the beach at 1aNTDC04a. In between the beaches have accreted. Given there is no clear trend of erosion to the north and south, this material is likely to be material previously eroded from the beach (between the Full Measures 2013 and Partial Measures 2014) and is now being returned as a natural seasonal recovery process rather than the supply of new material. The material during this time is likely to have been stored temporarily within the nearshore/offshore zone. **Longer term trends:** The trends at profiles 1aNTCD02 to 1aNTDC04 described above are reflected in the long-term record of beach profiles where the profiles are within the bounds of previous surveys and there appears to be cyclical onshore-offshore movement of material over a period of 6 months. This is demonstrated by the seasonal sorting of beach materials, with shingle/cobble material predominant in the winter months and a veneer of sand appearing in the summer months. Beach levels around MHWS at profile 1aNTCD01 are the highest since beach surveys began in May 2002,

Survey Date	Description of Changes Since Last Survey	Interpretation
	and Partial Measures survey i.e. the winter months) and a reversion to sand between the Partial Measures survey and the Full Measures survey (i.e. the summer months) (see Plates 1 to 5). During the present survey, there is still a large proportion of shingle/cobble material on the beach and it has not yet reverted to the same sand content observed during the September 2012 (Full Measures survey). Profile **1aNTDC04a** is located to the south of Whitley Sands. In front of the seawall, beach levels on the upper beach, seaward to a chainage of 20m, have fallen by approximately 0.3m. On the middle beach, beach levels have increased by approximately 0.2m to 0.3m. This suggests that material has been redistributed across the beach during the winter months. The lower beach/rock shore platform has remained stable since the last survey. As at profile 1aNTDC04, there has been a change in the sediment type on the beach from sand to coarse material over the winter months and a veneer of sand present over the summer months (see plates 6 to 10). Although the summer surveys show a sandier beach, it has never fully reverted to the same sand content observed during the September 2012 (Full Measures survey).	which may reflect the landward movement of material by winter storms, or works associated with the construction currently underway. Beach profiles at 1aNTCD04a generally fall within the bounds of previous surveys with the exception of a small section of beach close to the seawall, between a chainage of 10m and 20m, where they are the lowest recorded since surveys began in March 2010.
Oct 2014	**Topographic Survey:** Whitley Sands is covered by an annual topographic survey, which commenced in October 2010. Data from the most recent topographic survey (Full Measures, autumn 2014) have been used to create a digital ground model (DGM) (Appendix B – Map 1a) using a GIS. A difference plot has also been produced using the DGM (Appendix B – Map 1b) produced from the last produced topographic survey (Full Measures, autumn 2013) and the present survey. The difference plot shows maximum elevation gain to the north of Whitely Sands, in the vicinity of 1aNTCD01. This elevation gain (accretion), extends as a narrow band along the upper beach as far as1aNTDC04. A separate band of beach elevation decrease (erosion) extends along the bay from south to north, with greatest erosion at 1aNTCD02. As noted in the Full Measures 2013 report, the SMP notes that sediment movement is generally in a southerly direction and accretion to the north of the bay as indicated by the autumn 2014 survey would suggest northerly movement, which is again the opposite to that described in the SMP. **Longer Term Topographic Trends autumn 2010 to autumn 2014:** The long term difference plot (Appendix B – Map 1c) shows the net change in beach levels between	The topographic survey shows there to be accretion at the northern end of the bay, accretion along the upper beach and erosion along the middle and lower beach. This suggests onshore movement of material since the last survey (possibly seasonal over the summer months). Accretion at the northern end of the bay could reflect a seasonal drift reversal. **Longer term topographic trends autumn 2010 to autumn 2014:** The plot shows a general trend of increasing beach levels to the north of the bay and reducing beach levels to the south. Along the centre of the bay, the upper beach is accreting, whilst the middle and lower beach is eroding. Together these trends suggest an atypical northerly movement of material.

Survey Date	Description of Changes Since Last Survey	Interpretation
	autumn 2010 and autumn 2014. The pattern of change is very similar to that seen in the last 6 months, but with a greater magnitude of change. The plot shows a general trend of increased beach levels at the very north of the bay (over 2m net accretion) and decreased beach levels at the southern end (up to 2m erosion at MLW). Beach levels along the upper beach have increased as far as profile 1aNTDC04. Along the middle and lower beach, there is a band of decreasing beach level. The exception to this is to the very south, at the location of profile 1aNTCD04a, where the whole beach area is eroding.	

Plate 1 – Survey photograph 1aNTDC04_20120928_N4

Plate 2 – Survey photograph 1aNTDC04_20130312_N3

Plate 3 – Survey photograph 1aNTDC04_20131017_N4.jpg

Plate 4 – Survey photograph 1aNTDC04_20140402_N14.JPG

Plate 5 – Survey photograph 1aNTDC04_20141006_N4


Plate 6 – Survey photograph 1aNTDC04A_20120928_N2


Plate 7 – Survey photograph 1aNTDC04a_20130312_N2


Plate 8 – Survey photograph 1aNTDC04A_20131017_N2


Plate 9 – Survey photograph 1aNTDC04A_20140402_N2

Plate 10 – Survey photograph 1aNTDC04A_20141006_N2

2.2 Cullercoats Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
Oct 2014	**Beach Profiles:** Cullercoats Bay is covered by one beach profile line for the Full Measures survey (Appendix A). This was surveyed annually each autumn between 2002 and 2009. From spring 2010 onwards, it has been surveyed bi-annually. The cliff top position along **1aNTDC05** is not reported here. The survey report notes '*cliff not measured at section 5 due to dangerous access*'. The upper (cliff toe to 35m chainage) and lower (100m chainage to seaward) beach have increased by 0.2m, whilst the beach between has decreased by approximately 0.2m.	As in previous surveys access to the cliff has not been possible. The beach profile has shown some change, with an increase of beach levels on the at the cliff toe and on the lower beach, with a fall between. However, the actual change is relatively low. **Longer term trends:** The beach levels observed are within the bounds of previous surveys and there are no discernible trends.

2.3 Tynemouth Long Sands

Survey Date	Description of Changes Since Last Survey	Interpretation
Oct 2014	**Beach Profiles:** Tynemouth Long Sands is covered by three beach profile lines for the Full Measures survey (Appendix A). Profiles 1aNTDC06 and 1aNTDC07 were initially surveyed annually each autumn between 2002 and 2009. A third profile, 1aNTDC06A, was then added in the centre of the frontage. From spring 2010 (Partial Measures) onwards, all profiles have been surveyed bi-annually. **1aNTDC06** is located approximately 150m south of the access ramp towards the north of the bay. The top of the cliff has not changed since the last survey, however, the remainder of the cliff profile cannot be reviewed due to lack of data points in the profile plot as the survey report notes '*no access to middle of section 6 due to seed protection fences*'. The profile, starting from a chainage of 50m (just seaward of the dune fencing), shows an increase in beach levels where a small berm has formed. Seaward of 90m chainage there is a pattern of alternating beach level fluctuation of between 0.2 and 0.4m. At profile **1aNTDC06A**, the dune-cliff face has not significantly changed in form or position. As with section 6, the survey report notes '*no access to middle of section 6a due to seed protection fences*'. Since the last survey, beach levels have increased across the length of the profile by up to 0.5m. Profile **1aNTDC07** is located approximately 50m south of the access route through the dunes towards the southern end of the bay. The dune-cliff has not significantly changed in form or position since the last survey. As with section 6 and 6a, the survey report notes '*no access to middle of section 7 due to seed protection fences*'. Beach levels have fallen across the profile, between 0.2m to 0.4m.	Since the last survey the dunes have retained the same form and position. To the north of Tynemouth Long Sands, the beach has shown some movement with a redistribution of material up the beach. Otherwise, there has only been a small fluctuation in beach levels since the last survey. **Longer term trends:** Overall, the beaches have retained a similar form and are towards the lower bound of previous surveys. The exception is 1aNTD07 which is the lowest levels recorded to date at discrete locations along the profile between a chainage of 140m and 200m and on the lower beach around MLWS.
Nov 2014	**Topographic Survey:** Tynemouth Long Sands is a new survey area. The first survey was undertaken for the Full Measures survey in October 2010. Data from the current topographic survey have been used to create a digital ground model (DGM) (Appendix B – Map 2a) using a Geographical Information System (GIS). A difference plot has also been produced by comparing the current DGM (Appendix B – Map 2b) with that produced from the last topographic survey.	Since the last survey, the beach at Tynemouth Long Sands has been dynamic, with shore parallel sand bars moving in response to storm waves. There is also evidence of a net northerly movement of sediment with material accumulating behind the headland to the north of the bay. **Longer term topographic trends autumn 2011 to autumn 2014:** The plot shows a general reduction in

Survey Date	Description of Changes Since Last Survey	Interpretation
	The difference plot shows an overall of trend of limited change. There is a small amount of erosion north and south of Tynemouth Long Sands with accretion in between. The topographic report notes '*slips evident on face of dunes*', which was not recorded in the beach profile data. **Longer Term Topographic Trends autumn 2011 to autumn 2014:** The long term difference plot (Appendix B – Map 2c) shows the net change in beach levels between autumn 2011 and autumn 2014. Similarly to the Full Measures 2013 survey report, the plot shows a general reduction in beach elevation of up to 1m across most of the beach, and a band of increased beach elevation near MLW in the northern half of the bay. The majority of the back of beach has experienced net erosion.	beach elevation of up to 1m, with a narrow band of increased beach elevation (slightly over 1m) running along the toe of the beach from the north to the centre of the bay. These changes suggest draw-down of material from the beach and/or movement northwards and storage of this material within the middle/lower beach at the northern end of Tynemouth Long Sands.

2.4 King Edward's Bay

Survey Date	Description of Changes Since Last Survey	Interpretation
Oct 2014	**Beach Profiles:** King Edward's Bay is monitored by one beach profile line for the Full Measures survey (Appendix A). This was surveyed annually between 2002 and 2009. From spring 2010 onwards, it has been surveyed bi-annually. At profile **1aNTDC08** between a chainage of 30m and 100m beach levels have increased by 0.5m, but between a chainage of 100m and 160m, beach levels have decreased to form a steeper beach. This is likely to reflect the redistribution of material onshore over the summer months.	Since the last survey, the beach at King Edward's Bay beach has steepened as material has been redistributed towards the upper beach. **Longer term trends:** With the exception of a small section of beach just above MLWS, the changes observed are within the bounds of previous surveys. Between a chainage of 140m and 160m, beach levels are the lowest recorded since surveys began in May 2002.

3. Problems Encountered and Uncertainty in Analysis

Individual Profiles

- At profile 1aNTDC01 the bottom of cliff / top of beach was not measured due to construction works. Future interpretations of beach profile change need to recognise the potential impact of these works.
- At profile 1aNTDC05 the cliff was not measured due to access problems. Access to this profile is noted to have been dangerous in the previous Partial Measures and Full Measures reports, and therefore consideration should be given to changing the location of this survey.
- At Tynemouth Long Sands (profiles 1aNTDC06, 1aNTDC06A and 1aNTDC07) there was no access to the dunes in the middle of the profile due to seed protection fences. This means it has not been possible to monitor the effectiveness of the dune stabilisation scheme

Topographic Survey

At Whitley Bay, the topographic survey report notes:

- Works occurring at southern end of northern sea wall at c. E434892 N574594.
- Working of end of sea wall and cliff line.

At Tynemouth Long Sands, the topographic survey report notes:

- Construction site at northern beach ramp.
- Slips evident on face of dunes.

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

It is recommended that access to the stabilised dunes at Tynemouth Long Sands be attempted in future surveys in order to monitor the effectiveness of the stabilisation fences.

5. Conclusions and Areas of Concern

- At Whitley Sands, at profile 1aNTDC01 the bottom of cliff / top of beach was not measured due a set fence around the construction site. This means that this section of the profile has not been assessed.
- Also at Whitely Sands, an observation has been made, identifying a possible cyclical movement of shingle material onto/off the beach over the various seasons. Whilst is does not cause concern, attention should be given to this change in future reporting to help clarify/confirm the interpretations and conclusions drawn from the beach profile analysis.
- Elsewhere along Whitely Sands, the recorded profiles present no causes for concern.
- At Cullercoats Bay, at profile 1aNTDC05, the cliff was not measured due to dangerous access. Access to this profile is noted to have been dangerous in the previous Partial Measures and Full Measures reports, and therefore consideration should be given to changing the location of this survey.
- At profile 1aNTD07 the beach between chainage of 140m and 200m on the lower beach around MLWS has exhibited the lowest levels recorded to date.
- Elsewhere along Tynemouth Long Sands, the recorded profiles and topographic survey present no causes for concern.
- At King Edward's Bay, a section of the profile between a chainage of 140m and 160m, exhibits the lowest beach levels recorded since surveys began in May 2002.

Appendices

Appendix A

Beach Profiles

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

Code	Description
S	Sand
M	Mud
G	Gravel
GS	Gravel & Sand
MS	Mud & Sand
B	Boulders
R	Rock
SD	Sea Defence
SM	Saltmarsh
W	Water Body
GM	Gravel & Mud
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
ZZ	Unknown

Appendix B

Topographic Survey