

Monitoring and Mitigation Scheme

Project:	Swansea Bay University Campus	To:	St Modwens Vinci Prosurv Nick Matthews, Savills Chris Davies, NPT
Subject:	Coastal Monitoring and Mitigation Framework	From:	Atkins
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The following Monitoring and Mitigation Scheme has been developed to resolve planning condition 56 placed on the proposed new Swansea University Bay Campus development.

To support the development of the Monitoring and Mitigation Scheme, various investigations have been carried out by Atkins, including the development of a conceptual model of coastal processes along the frontage and overtopping modelling. Information relating to the background studies and supporting investigations are provided in the Appendices.

Responsibility for meeting the conditions rests with the landowner of the site.

1. Surveying

1.1. Topography

The landowner shall carry out a topographic survey of the area of the foreshore between the landward line shown in Figure 1 and MLWS between Swansea harbour wall to the west and the mouth of the Neath estuary to the east.

Surveys should be undertaken at low tide to ensure the largest possible intertidal area is included in the survey. This will maximise the overlap in the area between the topographic survey and the bathymetric survey to provide complete coverage of the nearshore and intertidal areas.

The landward line has been drawn using aerial photography available via Google, however, due to copyright issues this cannot be shown in Figure 1. Base mapping has used open source MasterMap data meaning that the landward line as shown in Figure 1 may not look correct. Eastings and Northings for 20 points along the line have been provided in Table 1 to enable accurate and reproducible surveys to be carried out. The landward line has been drawn by connecting these points with straight lines.

Surveys shall be undertaken annually at or around the Autumn equinox, unless:

- Threshold trigger points that require additional surveys are met, or
- Changes to the frequency of surveys are agreed in writing with the relevant planning authority

Topographic surveys shall be carried out using survey quality GPS equipment and shall cover the full area shown in Figure 1 from the line defined by the co-ordinates in Table 1 below to MLWS or as near as can be achieved on the survey date.

The report of the survey results shall include the specifications of any equipment used, survey methodologies used and any tender documents used to procure surveys and details of companies / organisations that carried out the surveys.

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Table 1 – Landward survey boundary co-ordinates

Point ID	Easting	Northing
1	268909.25963	192858.55215
2	268925.13466	192864.90217
3	268942.59720	192870.45843
4	268979.10977	192867.28342
5	269182.31018	192813.30831
6	269212.47274	192805.37080
7	269238.66654	192809.33956
8	269258.51033	192816.48332
9	269275.17911	192827.59584
10	269430.75442	192723.61438
11	269645.86110	192722.02688
12	269854.61777	192663.28926
13	270189.58094	192685.51431
14	270442.78770	192720.43938
15	270770.60710	192714.08936
16	271101.60151	192689.48307
17	271513.55859	192712.50186
18	271762.79659	192760.12696
19	271877.09682	192783.93950
20	271980.28452	192850.61464

The results of a baseline topographic survey are included in Appendix 4.

Subsequent surveys should be carried out in accordance with the methodologies used during the first survey and detailed in the first survey report, unless:

- Any review of conditions indicates that the survey methodology should be amended, or
- Changes to the survey methodology are agreed in writing with the relevant planning authority

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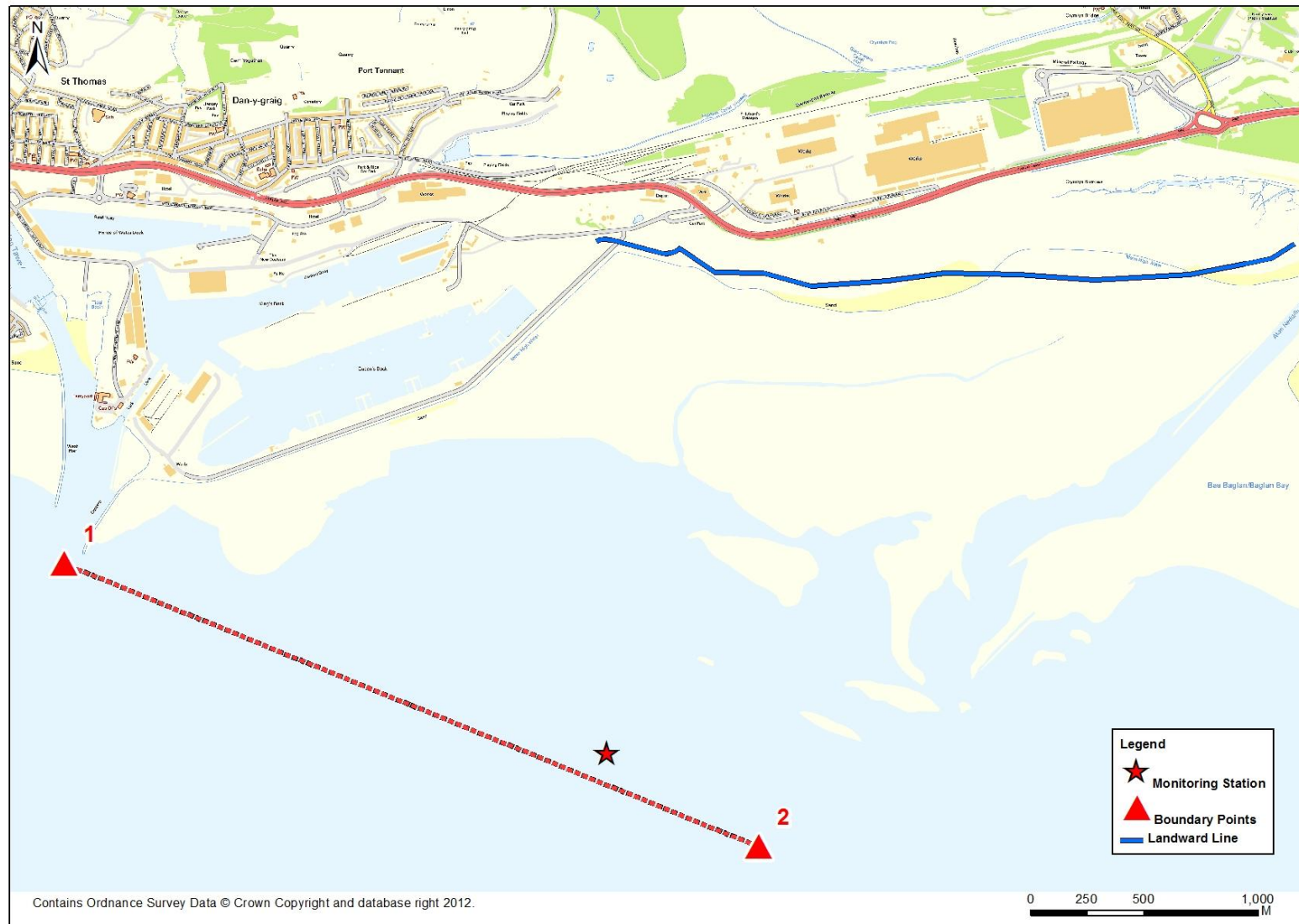


Figure 1 – Monitoring locations

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1.2. Bathymetry

The landowner shall carry out a bathymetric survey of the nearshore area within a line drawn between the end of Swansea dock (Easting 191442, Northing 266575) and a point south west of the end of the western training wall at Neath estuary (Easting 190200, Northing 269625) (see Figure 1).

The survey shall be undertaken during a high tidal state to ensure the largest possible intertidal area is included in the survey as is safe to do so. This will maximise the overlap in the area between the topographic survey and the bathymetric survey to provide complete coverage of the nearshore and intertidal areas.

The survey shall be carried out to IHO Standards for Hydrographic Surveys using single or multibeam sonar with sufficient overlap between vessel passes to provide full coverage of the bathymetry of the nearshore area identified.

The report of the survey results shall include the specifications of any equipment used, survey methodologies used and any tender documents used to procure surveys and details of companies / organisations that carried out the surveys.

The results of the baseline bathymetric survey are included in Appendix 4.

Subsequent surveys should be carried out in accordance with the methodologies used during the first survey and detailed in the first survey report, unless:

- Any review of conditions indicates that the survey methodology should be amended, or
- Changes to the survey methodology are agreed in writing with the relevant planning authority

A second bathymetric survey shall be undertaken 5 years after the first bathymetric survey unless:

- Threshold trigger points that require additional surveys are met, or
- Any review of conditions indicate that the frequency of surveys should be amended, or
- Changes to the frequency of surveys are agreed in writing with the relevant planning authority

1.3. Nearshore wave climate

The landowner shall monitor and record the wave climate in the nearshore area (as defined in relation to bathymetric survey area above) over a 12 month period. As a minimum, data recorded shall include wave direction, height and period.

The wave climate monitoring equipment shall be placed as near as possible to Easting 268958, Northing 190612 (see Figure 1) ensuring the water depth is adequate for the installed product to continuously record data. The exact location of the deployment of the monitoring equipment shall be accurately recorded and included within the report of the results of the wave monitoring. The report shall also include the specifications of the equipment deployed.

Monitoring equipment for subsequent wave climate monitoring should be placed as near as possible to Easting 268958, Northing 190612 (see Figure 1), ensuring the water depth is adequate for the installed product to continuously record data, and be carried out in accordance with the methodologies used during the first wave climate monitoring period and detailed in the first wave climate monitoring report, unless:

- Any review of conditions indicates that the monitoring methodology should be amended, or
- Changes to the monitoring methodology are agreed in writing with the relevant planning authority

The first survey shall commence in early 2013 (subject to necessary licences being in place), be undertaken for a duration of 12 months and reported upon completion. Reporting shall be submitted to the relevant local planning authority within 3 months of completion as per Section 2.

A second 12-month period of wave climate monitoring shall be undertaken 5 years after the completion of the first 12-month period of wave climate monitoring unless:

- Threshold trigger points that require additional surveys are met, or
- Any review of conditions indicate that the frequency of surveys should be amended, or
- Changes to the frequency of surveys are agreed in writing with the relevant planning authority

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1.4. Nearshore tidal currents

The landowner shall monitor and record tidal currents in the nearshore area (as defined in relation to bathymetric survey area above) over a 12 month period. Dependent on the selected monitoring equipment, it is possible that the wave monitoring equipment could record tidal current data.

The tidal current monitoring equipment shall be placed as near as possible to Easting 268958, Northing 190612 (see Figure 1). The exact location of the deployment of the tidal current monitoring equipment shall be accurately recorded and included within the report of the results of the tidal current monitoring. The report shall also include the specifications of the equipment deployed.

Subsequent tidal current monitoring equipment should be placed as near as possible to Easting 268958, Northing 190612 (see Figure 1) and be carried out in accordance with the methodologies used during the first tidal current monitoring period and detailed in the first tidal current monitoring report, unless:

- Any review of conditions indicates that the monitoring methodology should be amended, or
- Changes to the monitoring methodology are agreed in writing with the relevant planning authority

The first survey shall commence in early 2013 (subject to necessary licences being in place), be undertaken for a duration of 12 months and reported upon completion. Reporting shall be submitted to the relevant local planning authority within 3 months of completion as per Section 2.

A second 12-month period of tidal current monitoring shall be undertaken 5 years after the completion of the first 12-month period of tidal current monitoring unless:

- Threshold trigger points that require additional surveys are met, or
- Any review of conditions indicate that the frequency of surveys should be amended, or
- Changes to the frequency of surveys are agreed in writing with the relevant planning authority

1.5. Defence condition

The landowner shall carry out a visual condition inspection of the sea defence along the length of the defence for which they are responsible. The responsibility for inspecting or works relating to other lengths of the defence for which the landowner is not responsible shall remain with the relevant owner(s) of these defences.

This shall be made with reference to relevant good practice guidance for such inspections (e.g. EA Condition Assessment Manual (Doc ref 166_03_SD01)) and include a photographic record of the defence condition.

Visual surveys shall be undertaken annually, at approximately the same time each year (within 2 months) unless:

- Threshold trigger points that require additional surveys are met, or
- Any review of conditions indicate that the frequency of surveys should be amended, or
- Changes to the frequency of surveys are agreed in writing with the relevant planning authority

Visual surveys shall also be undertaken following a storm event, where a storm is defined as a weather event with winds reaching greater than or equal to force 10 on the Beaufort or gusts reaching 61 – 68 knots and persisting for at least 8 hours.

The first survey shall be carried out within 12 months of work starting on site.

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2. Reporting

A report of the results of the baseline topographic survey and of the first bathymetric survey is included in Appendix 4.

Thereafter, an annual report shall be prepared by the landowner and submitted to the relevant local planning authority on the results of any surveys undertaken in the previous 12 months, including both regular and any additional surveys. The report shall include a review of the survey results against the thresholds (see below).

The first annual report shall be submitted within 3 months of the first nearshore wave climate and first nearshore tidal current monitoring being completed. Reports shall be submitted annually thereafter unless:

- Any review of conditions indicate that the reporting frequency should be amended, or
- Changes to the reporting frequency are agreed in writing with the relevant planning authority

In the event that additional surveys are carried out in response to threshold trigger points being met, a report of the results of any additional survey shall be included in the annual report.

Annual reports shall also include in an Appendix the specifications of any equipment used, survey methodologies used and any tender documents used to procure surveys and details of companies / organisations that carried out the surveys. Any changes to the survey or monitoring methodologies used previously should also be detailed in the annual report.

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3. Thresholds

The data reported will be reviewed against the following thresholds. For the purpose of setting thresholds and reporting on surveys, the area of the beach shall be subdivided into 5 areas based on the existing location of beach profiles (see Figure 2):

- Foreshore between seawall and profile 213, with landward limit of rock revetment and seaward limit of MLWS
- Foreshore between profile 213 and 214, with landward limit of rock revetment and seaward limit of MLWS
- Foreshore between profile 214 and 215, with landward limit of rock revetment / dune toe and seaward limit of MLWS
- Foreshore between profile 215 and 216, with landward limit of dune toe and seaward limit of MLWS
- Foreshore between profile 216 and the western training wall of the Neath estuary navigation channel, with landward limit of dune toe and seaward limit of MLWS

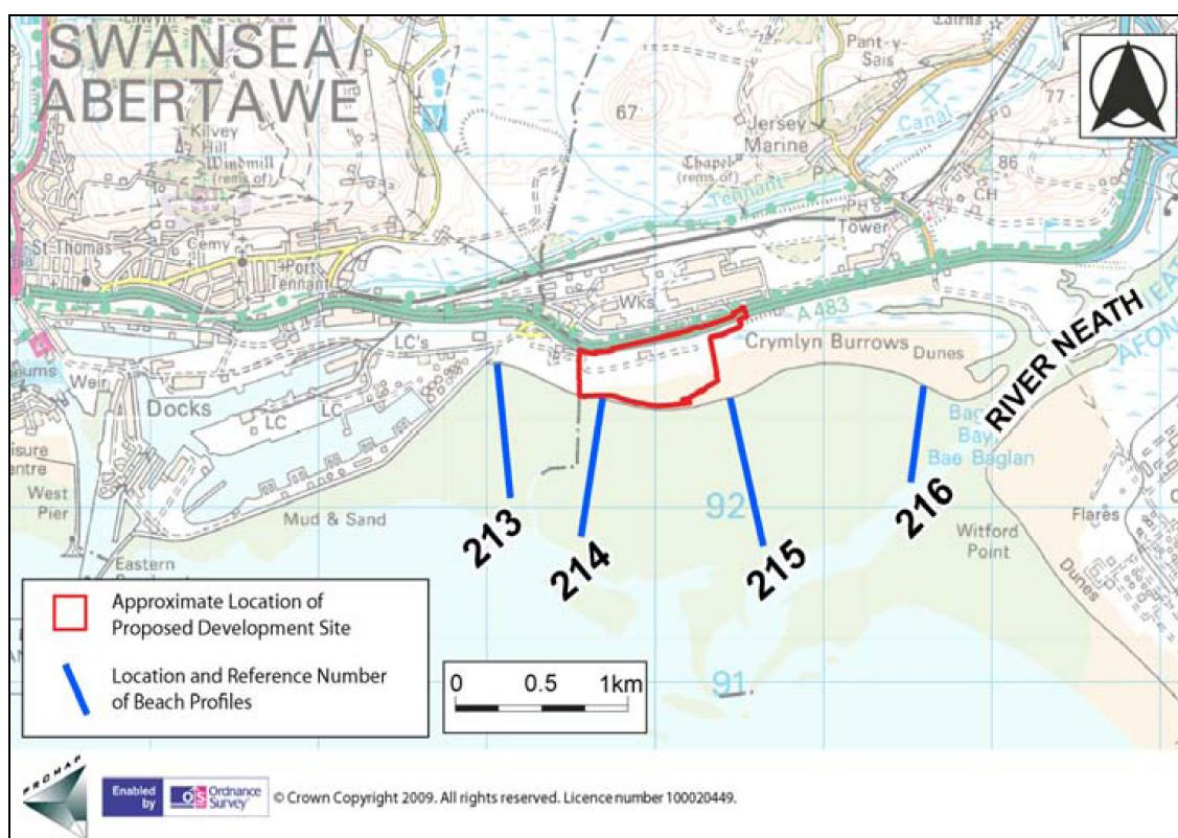


Figure 2 – Profile locations

Any changes to the thresholds shall be agreed with the relevant planning authority in writing in consultation with the Countryside Council for Wales (or other relevant organisation following the creation of the single environment body in Wales or other such change).

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3.1. Beach volume

Table 2 - Beach volume change thresholds

% decrease between surveys				% increase between surveys		
Red	Amber	Green	Profile	Green	Amber	Red
% change < -13	-13 > % change > -12	-12 > % change > 0	213	0 < % change < +11	+11 < % change < +12	% change > +12
% change < -7	-7 > % change > -6	-6 > % change > 0	214	0 < % change < +2	+2 < % change < +3	% change > +3
% change < -6	-6 > % change > -5	-5 > % change > 0	215	0 < % change < +2	+2 < % change < +3	% change > +3
% change < -8	-8 > % change > -7	-7 > % change > 0	216	0 < % change < +3	+3 < % change < +4	% change > +4
% change < -5	-5 > % change > -4	-4 > % change > 0	Total	0 < % change < +1	+1 < % change < +2	% change > +2

Actions as a response to thresholds:

Where an **amber level is recorded for two successive years**, in the annual report, the landowner shall, on receipt of written notice from the Local Planning Authority be required to undertake additional analysis of the data to determine if sediment has been lost from the system or moved to the nearshore area. This may include additional topographic survey, analysis of Lidar data, and / or an additional bathymetric survey if trend data is not available on bathymetric change and shall include requesting data in relation to sediment dredged from Neath Estuary navigation channel.

Analysis of data will include analysis of change in beach width and beach height in addition to the area analysis carried out as routine annual reporting.

No written notice shall be issued by the Local Planning Authority unless a meeting to review the monitoring results and annual report has taken place of representatives from the Local Planning Authority, the landowner and any adjacent landowners and such environmental advisors as the Local Planning Authority considers necessary. All relevant parties must make reasonable endeavours to attend the meeting within six weeks of the publication of the annual report.

Where a **red level** is recorded, in the annual report, the landowner shall, on receipt of written notice from the Local Planning Authority be required to undertake additional topographic survey and bathymetric survey to determine if levels have returned to within the green threshold parameters.

If levels have not returned to within the green threshold parameters, the landowner shall undertake an assessment to determine if the change in survey levels poses a risk to the achievement or maintenance of favourable condition for Crymlyn Burrows SSSI.

If the assessment concludes that there is a risk to the achievement or maintenance of favourable condition for Crymlyn Burrows SSSI, the landowner shall be required to take such actions to ensure that the beach in the area of the profile where the red threshold level was recorded is returned to a level where it no longer poses a risk to the achievement or maintenance of favourable condition for Crymlyn Burrows SSSI. Such actions may include the re-profiling, recycling or replenishment of the beach. In taking such actions, the landowner shall be required to meet the licensing and other regulatory requirements necessary to enable the actions to be carried out.

No written notice shall be issued by the Local Planning Authority unless a meeting to review the monitoring results and annual report has taken place of representatives from the Local Planning Authority, the landowner and any adjacent landowners and such environmental advisors as the Local Planning Authority considers necessary. All relevant parties must make reasonable endeavours to attend the meeting within six weeks of the publication of the annual report.

3.2. Beach width

No thresholds have been set for beach width. Beach width analysis shall be required as part of additional analysis under amber threshold changes (see above).

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The need to set thresholds for beach width will be considered as part of the substantive reviews (see Section 5 - Review of Conditions).

3.3. Beach height

No thresholds have been set for beach height. Beach height analysis shall be required as part of additional analysis under amber threshold changes (see above).

The need to set thresholds for beach height will be considered as part of the substantive reviews (see Section 5 - Review of Conditions).

3.4. Nearshore bathymetry

No thresholds have been set for nearshore bathymetry. Nearshore bathymetric data will be collected as part of the monitoring programme. The purpose of nearshore bathymetric data is to support and help understand any changes in beach width, area, height and volume.

The need to set thresholds for nearshore bathymetry will be considered as part of the substantive reviews (see Section 5 - Review of Conditions).

3.5. Nearshore wave climate

No thresholds have been set for nearshore wave climate. Nearshore wave climate data will be collected as part of the monitoring programme. The purpose of nearshore wave climate data is to support and help understand any changes in beach width, area, height and volume.

The need to set thresholds for nearshore wave climate will be considered as part of the substantive reviews (see Section 5 - Review of Conditions).

3.6. Nearshore tidal currents

No thresholds have been set for nearshore tidal currents. Nearshore tidal current data will be collected as part of the monitoring programme. The purpose of nearshore tidal current data is to support and help understand any changes in beach width, area, height and volume.

The need to set thresholds for nearshore tidal currents will be considered as part of the substantive reviews (see Section 5 - Review of Conditions).

3.7. Defences

No thresholds have been set in relation to the condition of the defences. It is the responsibility of the landowner to determine the need for repairs or amendments to the defences, or other actions, based on the potential risk to the site. Any proposals to amend, upgrade, improve or otherwise alter the revetment defences, including any emergency works, will be subject to relevant planning, licensing and other relevant legislation in place at the time.

4. Defence works

There is no existing work programme related to the revetment defences. There are no planned or anticipated changes to the revetment over the lifetime of the development. It is the responsibility of the landowner to determine the need for repairs or amendments to the defences, or other actions, based on the potential risk to the site.

Any proposals to amend, upgrade, improve or otherwise alter the revetment defences, including any emergency works, will be subject to relevant planning, licensing and other relevant legislation in place at the time.

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5. Review of Conditions

A review of these conditions shall be undertaken by the relevant local planning authority, in consultation with the Countryside Council for Wales (or other relevant organisation following the creation of the single environment body in Wales or other such change) and the landowner after the completion of a review report that includes the following information / analyses:

- The results of the first and second 12-month period of tidal current monitoring and a comparison of the data to determine any changes that have taken place
- The results of the first and second 12-month period of nearshore wave climate monitoring and a comparison of the data to determine any changes that have taken place
- The results of the first and second bathymetric surveys and a comparison of the data to determine any changes that have taken place
- A review of the results of all annual topographic surveys at the four beach profile locations to determine any changes that have taken place. This should also include a review of historic data relating to the beach profiles.
- A review of the results of all annual topographic surveys to determine any volumetric changes to the beach areas set out in Section 3 above
- A review of all previous annual reports prepared in connection with this monitoring and mitigation scheme
- A review of aerial photos of the study area – this should include those photos listed in Appendix 1 of this monitoring and mitigation scheme and any more recent aerial photos that are available
- A review / update of the coastal conceptual model to take account of any improvements in understanding
- Any other information that the landowner deems appropriate to include, to inform the review

The landowner shall prepare and submit to the relevant local planning authority the review report to enable the local planning authority to carry out the review.

The review report shall be completed within 6 months of the completion of the second 12-month period of tidal current and nearshore wave climate monitoring.

The review of conditions shall consider the following matters:

- The frequency of future monitoring of all parameters, including the need to continue any / all monitoring
- The frequency of future reporting of monitoring
- The need to update the area of topographic or bathymetric monitoring
- The need to update / amend the thresholds set out in section 3.1
- The need to update / amend the actions as a response to thresholds set out in section 3.1
- The need to update / amend the thresholds as set out in section 3.1 – 3.7
- The need to carry out monitoring of additional parameters to those included in this monitoring and mitigation scheme
- The appropriateness of the monitoring techniques used up to the time of the review and the need, if any, to amend / update techniques in line with advances in technology, understanding or other issues
- The timing of the next review of conditions

The review shall take account of the review report, climate change and sea level rise predictions, relevant guidance on the use of such predictions and other relevant guidance and policies.

An updated this monitoring and mitigation scheme shall be produced as a result of the review.

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Appendix 1 – Coastal Conceptual Model

Data Sources

Baseline coastal process information is provided and referred to in the South Wales SMP¹. Additional data was obtained from the Neath Estuary Report 2011².

Following review of the published literature and some initial data gathering a draft conceptual model was proposed to show the present understanding of coastal processes along the frontage. This was used to highlight any gaps in knowledge and areas for further work. A further data gathering exercise was undertaken, which included collection of historic aerial photographs and bathymetric charts, to further inform the model.

Aerial Photography

Aerial photos of the study area were obtained from the Aerial Photography Unit at the Welsh Assembly Government (WAG) following a search of their archives. Numerous records were available – those listed in Appendix Table 1 were selected as of most use for this study. It is not possible to include copies of the aerial photographs within this report due to copyright conditions.

Appendix Table 1 – Aerial photographs used to inform conceptual model

Sortie Number	Prints	Date	Comments
S632 H9 140	25	22/10/1941	Sand bar at the outer end of the Baglan side training wall
540 RAF 332	5014, 5015	13/05/1950	Development of old tank farm visible. Nearshore sandbar appears trending east west
OS 63 069	20	24/05/1963	Offshore sand waves visible. Development of Crymlyn Bog.
Meridian 75/70	154	23/09/1970	Development of a low level spit on the beach extending eastward to infill the curvature of Crymlyn Burrows frontage at that time
OS 77 011	3	16/04/1977	Bar formation extends further east and appears increasing in elevation
39 RAF 5697	7	27/08/1981	Area infilled. Outer channel to River Neath sinuous.
1 PRU RAF 2301	40	22/10/1991	Area vegetated. Outer channel to River Neath straight.
OS 94 360	81, 83	15/10/1994	As present day

Bathymetry

The bathymetry of the study area is covered by Chart 1161. Following a search of the archives at the United Kingdom Hydrographic Office (UKHO), copies of the records listed in Appendix Table 2 were obtained. It is not possible to include copies of the aerial photographs within this report due to copyright conditions.

Appendix Table 2 – UKHO charts used to inform conceptual model

Record	Date	Comments
B1	1860	Inner harbour at Swansea prior to large scale development of Swansea Docks. No training walls on the entrance to the River Neath; the channel trends north-south although sinuous and denoted as constantly shifting. Short slag embankment on southern side of river channel at entrance to Britton Ferry Dock.
C1	1885	Development of the outer harbour, Prince of Wales Dock present.
C7	1919	Kings Dock present and reclamation to east. General plan shape of Crymlyn Burrows evident

¹ Halcrow, 2010, Lavernock to St. Ann's Head Shoreline Management Plan SMP2, prepared for Swansea and Carmarthen Bay Engineering Group, available at: <http://www.southwalescoast.org/content.asp?id=55>

² Shoreline Management Wales, 2010, Neath Estuary Report 2011 – 10 Year Data Review & Site Surveys and Design Option Development, prepared for Neath Estuary Group

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Record	Date	Comments
C14	1938	Queens Dock present and plan shape of Crymlyn Burrows as 1919. No change in offshore contours from 1885.
D1	1951	Further dock development with rail infrastructure, some accretion to eastern end of Crymlyn Burrows and slightly change in the offshore contours.
E1	1976	A483 (Fabian Way) present and position of the high water mark is up to the embankment shown alongside the road approximately between and the site and Parc Amazon.
F1	1994	Crymlyn Burrows frontage trending west-east rather than south-west/north-east as previous. 0mCD contour moves inshore very slightly to end of River Neath training walls.
F7	2001	Construction of the M4 road bridge over the River Neath but otherwise as 1994

Main Findings

Bathymetric charts show that following construction of Queens Dock in 1885 the western end of the frontage looks much the same as it does now, with the eastern end gradually showing the development of Crymlyn Burrows. The last phase of dock development was in the 1940's and since then the general layout of the docks has remained unaltered. Since this time there has been accretion along the Crymlyn Burrows frontage, as verified by the historic charts and aerial photography.

No significant change in offshore contours was identified, remaining more or less as present for the last century. Note that this assessment was undertaken qualitatively as the earlier charts are in fathoms and feet. Inshore sand waves are visible on most of the aerial photos and are sinuous in plan but often change location. These sand waves are beyond the limit of resolution of the bathymetric charts.

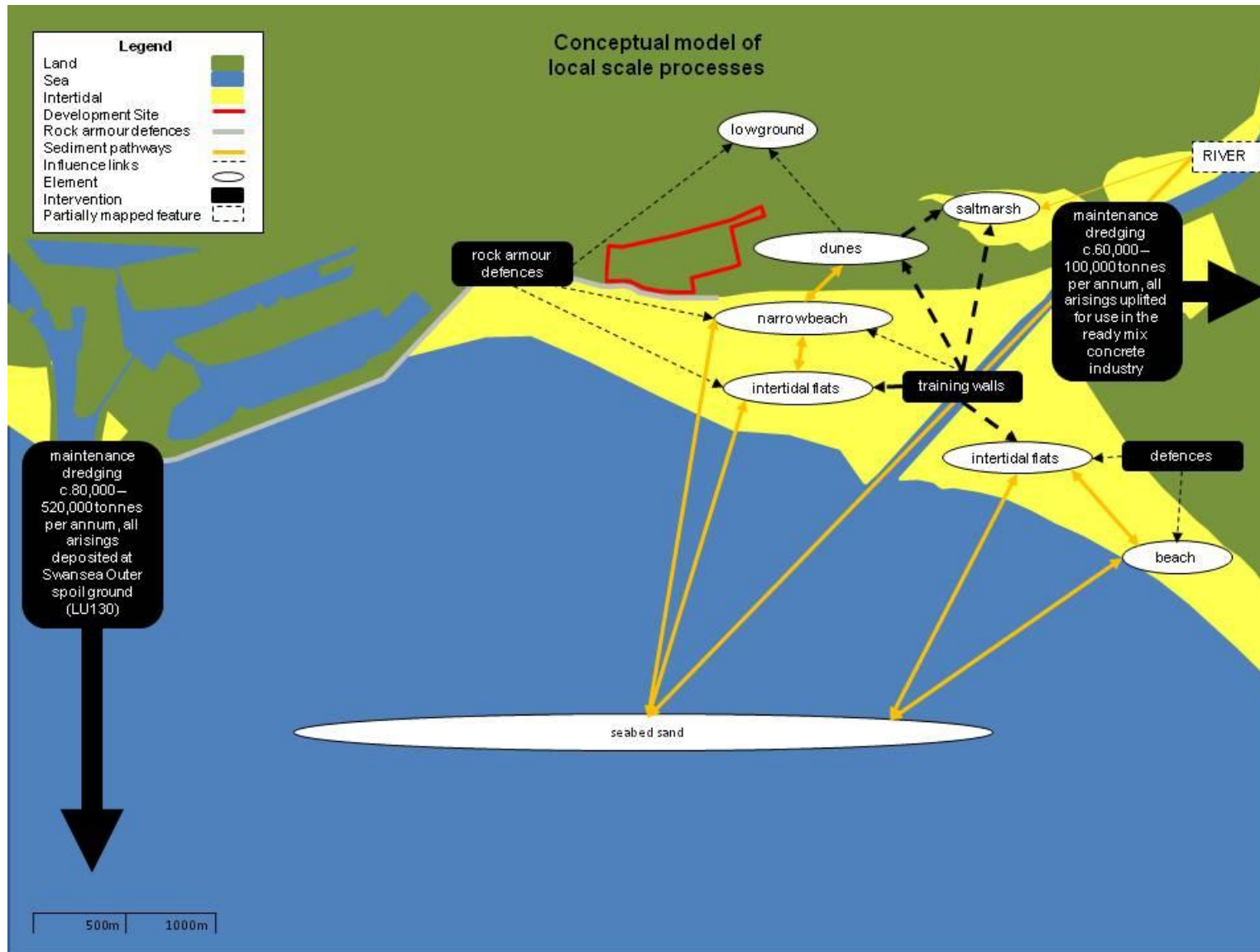
This section of frontage is thought to be a 'closed' system with no natural inputs/removals of sediment. There is no significant on/offshore movement of sediment between this closed system and the wider Swansea Bay. There is thought to be some on/offshore movement of sediment within the system between the beach and the shallow subtidal sand waves present in the nearshore area between Swansea Docks and the Neath estuary. Sediment removed from the Neath estuary is marine only. There is no significant fluvial input of sediment to the system.

The location of the onshore-offshore boundary is perhaps a line from the end of Swansea Docks to the seaward end of the River Neath training walls. Thus, any monitoring should extend to at least here to ensure that any material lost off the beach crest/face is staying nearshore to return in time.

Coastal Processes Conceptual Model

Based on present understanding of coastal processes along the frontage the following conceptual model is proposed.

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Appendix Figure 1 – Conceptual model of Crymlyn Burrows frontage

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Appendix 2 – Beach Analysis and Thresholds for Change

Data Sources

Beach profile data from the Neath Estuary Report 2011³ was used in the analysis.

Beach Analysis

Beach topography data is available at four existing profile locations along the Crymlyn Burrows frontage. Surveys have been carried out approximately biannually and data was obtained for the 10 years between 1998 and 2008. Profiles are shown in Appendix Figures 2 - 5.

For each profile survey the cross section area of the beach at that location has been calculated with respect to a common baseline. The change in beach cross section area over time at each profile location has been calculated as follows to determine if any trends could be identified:

- Inter-survey
- Cumulative
- Spring-Spring
- Autumn-Autumn

The inter-survey change in beach cross section area at Profiles 213, 214, 215 and 216 is shown in Appendix Table 4 and Appendix Figure 6.

The cumulative change in beach cross section area at Profiles 213, 214, 215 and 216 is shown in Appendix Table 4 and Appendix Figure 7.

Typically the inter-survey change was less than 3% (decrease) across all profiles, with a few exceptions. Profile 213 appears to show larger decreases than the others and all four appear to show larger decreases after autumn 2004 although there also appears to be more variation between surveys after this date (see Appendix Table 3).

Appendix Table 3 – Maximum, minimum and average inter-survey change in beach cross section area at Profiles 213, 214, 215 and 216

	213		214		215		216	
	Change (m ²)	% increase	Change (m ²)	% increase	Change (m ²)	% increase	Change (m ²)	% increase
Minimum change	-65.00	-12.38%	-60.00	-5.58%	-78.00	-4.63%	-146.00	-7.13%
Average change	-7.31	-1.10%	-9.31	-0.81%	-15.56	-0.89%	-26.13	-1.19%
Maximum change	49.00	10.54%	23.00	1.99%	32.00	1.96%	63.00	2.88%
1998 - 2008 change	-117	-17.65%	-149	-12.91%	-249	-14.22%	- 418	-19.08%

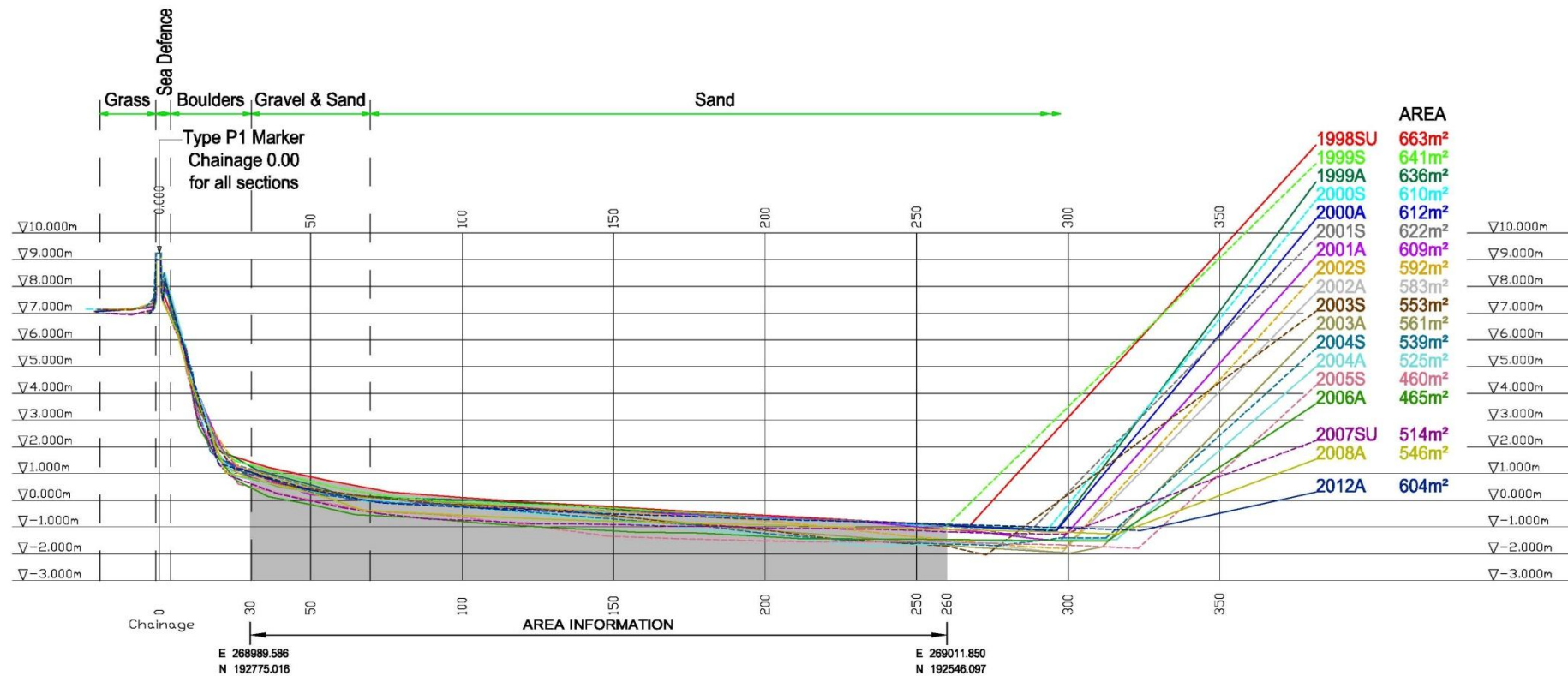
The cumulative analysis shows that beach profile areas have decreased by 12% - 20% over the 10 years with a general trend of reduction in volume evident in all profiles. However, between spring 2005 and summer 2007 a large increase is seen on profile 213 and a smaller increase on profile 215. These increases do not counteract completely the losses in the earlier years (since 1998) but significantly reduce the losses at profile 213. It is not clear what the cause or source of the increase is, however, if there is some on/offshore movement of sediment between the beach and the nearshore sand waves, this could account for the increases seen on the beach. This is, however, supposition as there is insufficient evidence to show how the nearshore bathymetry changes over the same time period.

³ Shoreline Management Wales, 2010, Neath Estuary Report 2011 – 10 Year Data Review & Site Surveys and Design Option Development, prepared for Neath Estuary Group

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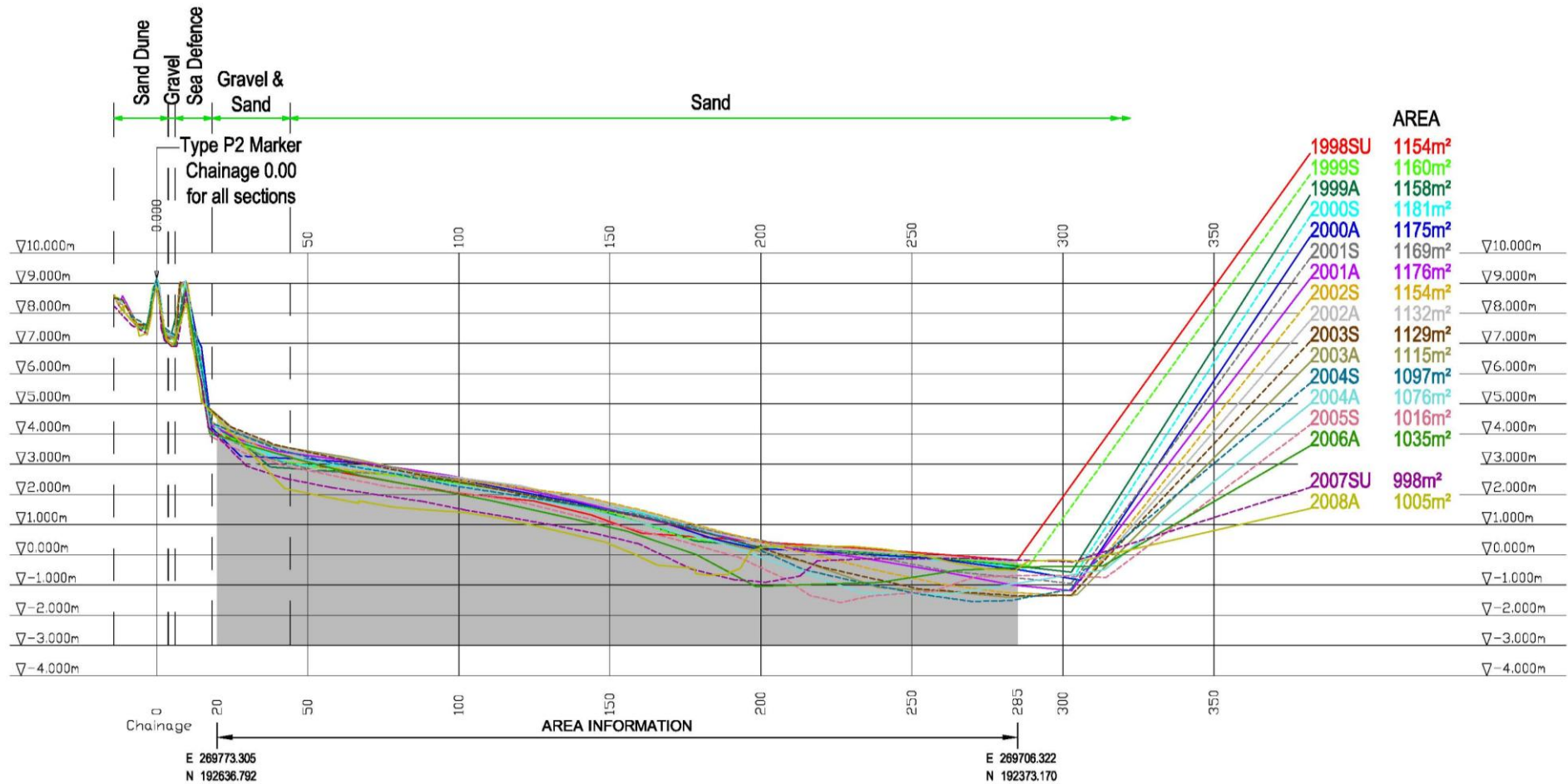
Although other evidence appears to point to a general west to east movement of sediment along the beach and into the Neath estuary navigation channel, including observations and anecdotal evidence from Neath Harbour Commissioners, the beach profile analysis does not show this trend or indeed any other consistent trend, apart from a general decrease over time.

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Appendix Figure 2 – Profile 213

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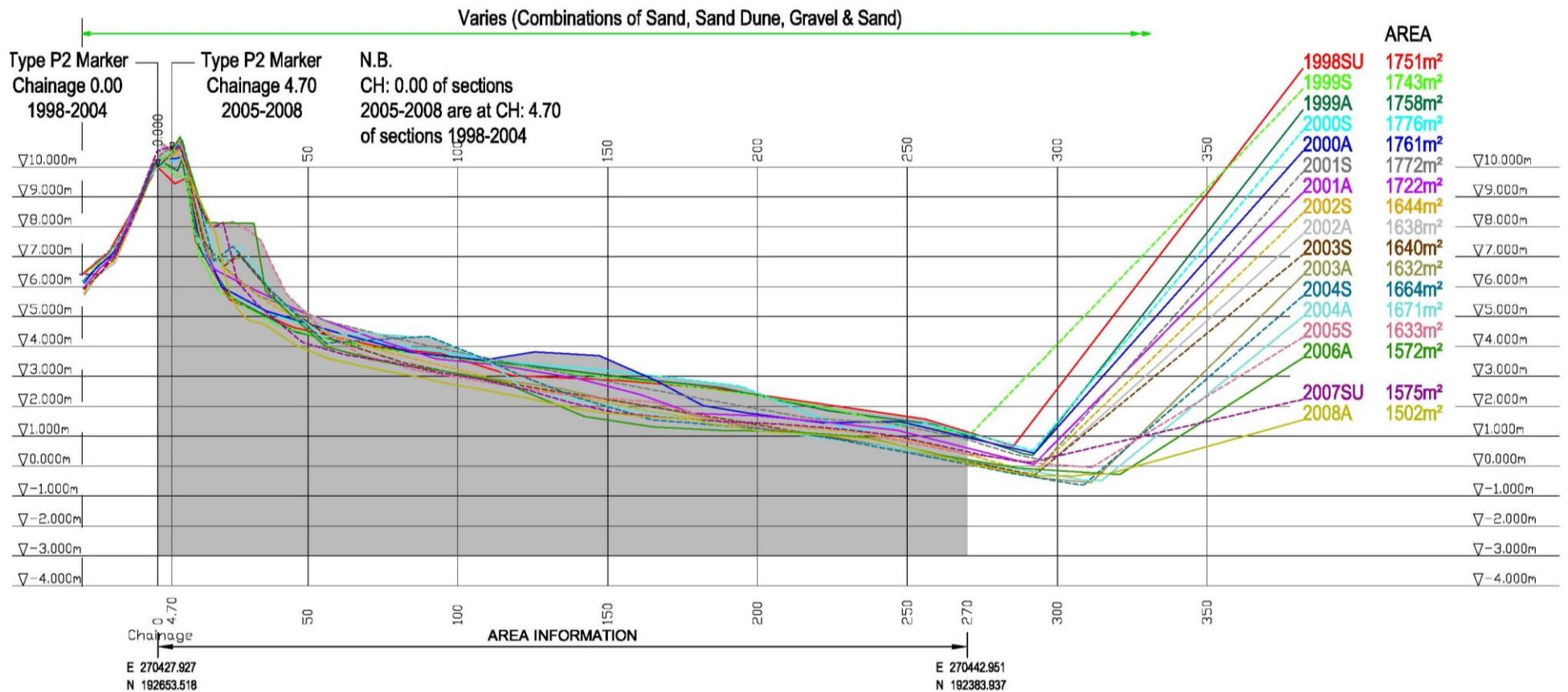


SECTIONS 214 OF DECADE 1998 - 2008

SCALE HZ - 1:1250 V - 1:125 @ A3

Appendix Figure 3 – Profile 213

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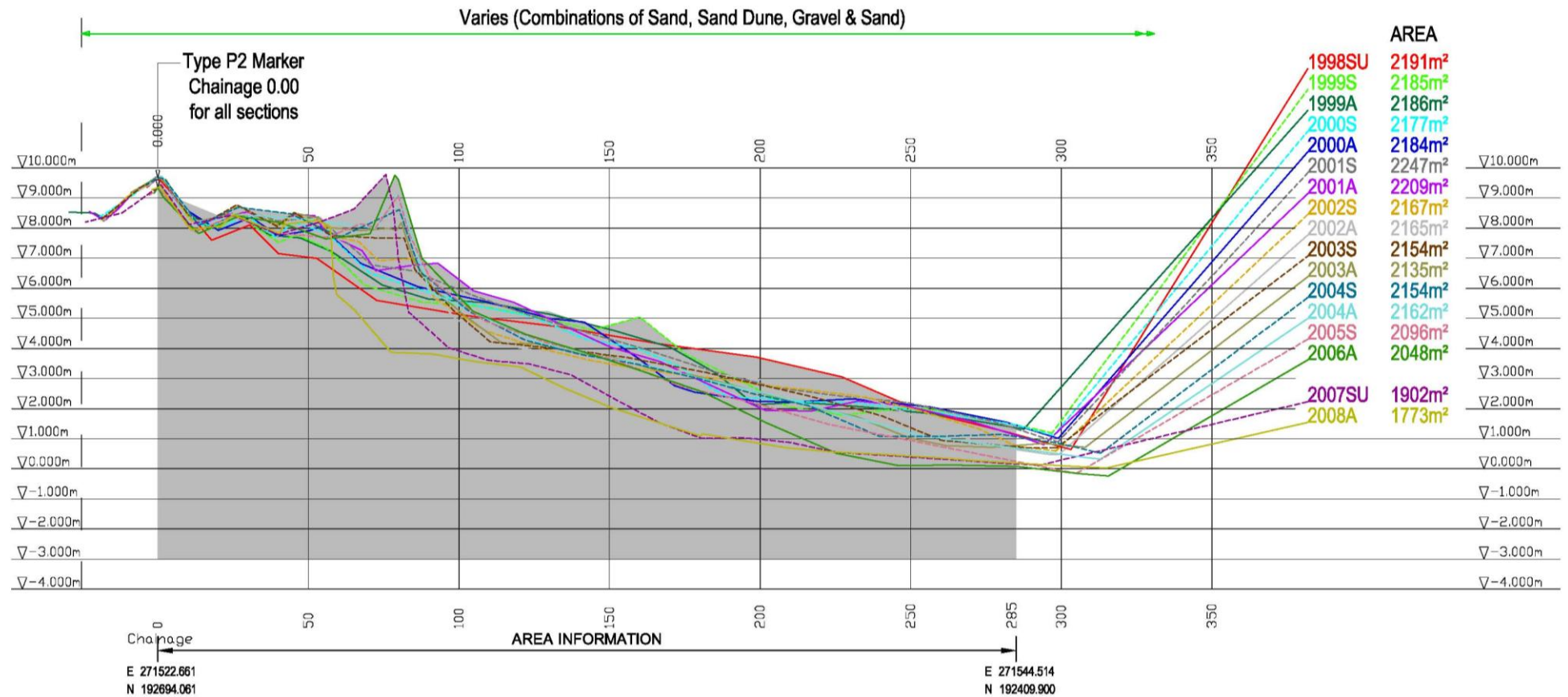


SECTIONS 215 OF DECADE 1998 - 2008

SCALE Hz - 1:1250 V - 1:125 @ A3

Appendix Figure 4- Profile 213

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SECTIONS 216 OF DECADE 1998 - 2008

SCALE Hz - 1:1250 V - 1:125 @ A3

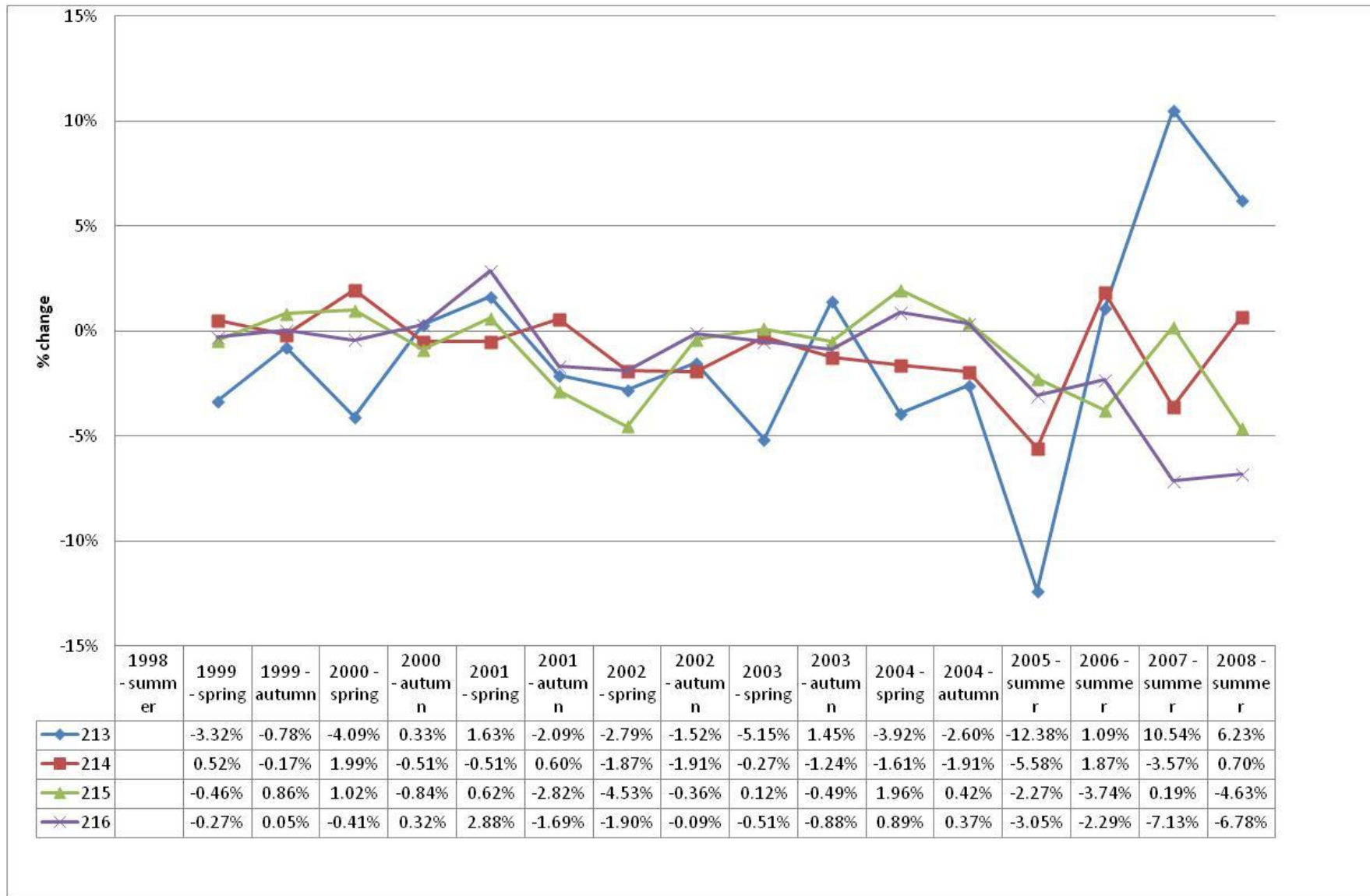
Appendix Figure 5– Profile 213

Monitoring and Mitigation Scheme

Appendix Table 4 – Inter-survey change in beach cross section area at Profiles 213, 214, 215 and 216 (1998 – 2008)

	213			214			215			216		
Date	Area (m ²)	Change (m ²)	% increase	Area (m ²)	Change (m ²)	% increase	Area (m ²)	Change (m ²)	% increase	Area (m ²)	Change (m ²)	% increase
1998 - summer	663	-	-	1,154	-	-	1,751	-	-	2,191	-	-
1999 - spring	641	-22	-3.32%	1,160	6	0.52%	1,743	-8	-0.46%	2,185	-6	-0.27%
1999 - autumn	636	-5	-0.78%	1,158	-2	-0.17%	1,758	15	0.86%	2,186	1	0.05%
2000 - spring	610	-26	-4.09%	1,181	23	1.99%	1,776	18	1.02%	2,177	-9	-0.41%
2000 - autumn	612	2	0.33%	1,175	-6	-0.51%	1,761	-15	-0.84%	2,184	7	0.32%
2001 - spring	622	10	1.63%	1,169	-6	-0.51%	1,772	11	0.62%	2,247	63	2.88%
2001 - autumn	609	-13	-2.09%	1,176	7	0.60%	1,722	-50	-2.82%	2,209	-38	-1.69%
2002 - spring	592	-17	-2.79%	1,154	-22	-1.87%	1,644	-78	-4.53%	2,167	-42	-1.90%
2002 - autumn	583	-9	-1.52%	1,132	-22	-1.91%	1,638	-6	-0.36%	2,165	-2	-0.09%
2003 - spring	553	-30	-5.15%	1,129	-3	-0.27%	1,640	2	0.12%	2,154	-11	-0.51%
2003 - autumn	561	8	1.45%	1,115	-14	-1.24%	1,632	-8	-0.49%	2,135	-19	-0.88%
2004 - spring	539	-22	-3.92%	1,097	-18	-1.61%	1,664	32	1.96%	2,154	19	0.89%
2004 - autumn	525	-14	-2.60%	1,076	-21	-1.91%	1,671	7	0.42%	2,162	8	0.37%
2005 - summer	460	-65	-12.38%	1,016	-60	-5.58%	1,633	-38	-2.27%	2,096	-66	-3.05%
2006 - summer	465	5	1.09%	1,035	19	1.87%	1,572	-61	-3.74%	2,048	-48	-2.29%
2007 - summer	514	49	10.54%	998	-37	-3.57%	1,575	3	0.19%	1,902	-146	-7.13%
2008 - summer	546	32	6.23%	1,005	7	0.70%	1,502	-73	-4.63%	1,773	-129	-6.78%

Monitoring and Mitigation Scheme



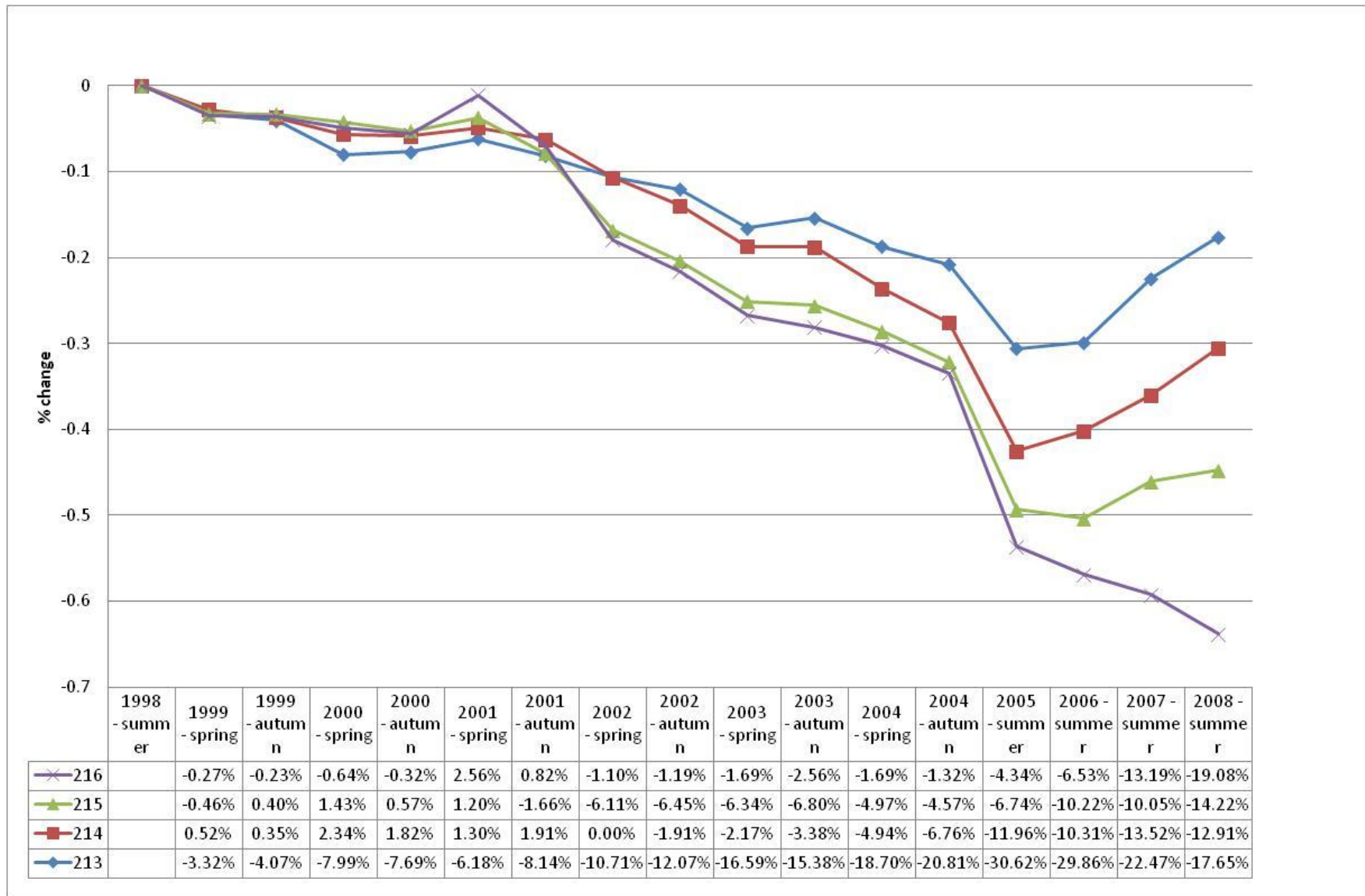
Appendix Figure 6– Inter-survey % change in beach cross section area over time (1998 – 2008)

Monitoring and Mitigation Scheme

Appendix Table 5 – Cumulative change in beach cross section area at Profiles 213, 214, 215 and 216 (1998 – 2008)

	213			214			215			216		
Date	Area (m ²)	Cumulative change (m ²)	% increase	Area (m ²)	Cumulative change (m ²)	% increase	Area (m ²)	Cumulative change (m ²)	% increase	Area (m ²)	Cumulative change (m ²)	% increase
1998 - summer	663	-	-	1,154	-	-	1,751	-	-	2,191	-	-
1999 - spring	641	-22	-3.32%	1,160	6	0.52%	1,743	-8	-0.46%	2,185	-6	-0.27%
1999 - autumn	636	-27	-4.07%	1,158	4	0.35%	1,758	7	0.40%	2,186	-5	-0.23%
2000 - spring	610	-53	-7.99%	1,181	27	2.34%	1,776	25	1.43%	2,177	-14	-0.64%
2000 - autumn	612	-51	-7.69%	1,175	21	1.82%	1,761	10	0.57%	2,184	-7	-0.32%
2001 - spring	622	-41	-6.18%	1,169	15	1.30%	1,772	21	1.20%	2,247	56	2.56%
2001 - autumn	609	-54	-8.14%	1,176	22	1.91%	1,722	-29	-1.66%	2,209	18	0.82%
2002 - spring	592	-71	-10.71%	1,154	-	0.00%	1,644	-107	-6.11%	2,167	-24	-1.10%
2002 - autumn	583	-80	-12.07%	1,132	-22	-1.91%	1,638	-113	-6.45%	2,165	-26	-1.19%
2003 - spring	553	-110	-16.59%	1,129	-25	-2.17%	1,640	-111	-6.34%	2,154	-37	-1.69%
2003 - autumn	561	-102	-15.38%	1,115	-39	-3.38%	1,632	-119	-6.80%	2,135	-56	-2.56%
2004 - spring	539	-124	-18.70%	1,097	-57	-4.94%	1,664	-87	-4.97%	2,154	-37	-1.69%
2004 - autumn	525	-138	-20.81%	1,076	-78	-6.76%	1,671	-80	-4.57%	2,162	-29	-1.32%
2005 - summer	460	-203	-30.62%	1,016	-138	-11.96%	1,633	-118	-6.74%	2,096	-95	-4.34%
2006 - summer	465	-198	-29.86%	1,035	-119	-10.31%	1,572	-179	-10.22%	2,048	-143	-6.53%
2007 - summer	514	-149	-22.47%	998	-156	-13.52%	1,575	-176	-10.05%	1,902	-289	-13.19%
2008 - summer	546	-117	-17.65%	1,005	-149	-12.91%	1,502	-249	-14.22%	1,773	-418	-19.08%

Monitoring and Mitigation Scheme



Appendix Figure 7– Cumulative % change in beach cross section area over time (1998 – 2008)

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Thresholds

Change in beach volume has been used as the primary threshold to trigger action under the proposed conditions. This is seen as the most useful trigger as it could signify a reduction in beach width, height or both. Changes in beach volume and trigger values have been based on an analysis of data collected between 1998 and 2008.

Trigger/threshold values are based on changes to beach volume, using historic changes in the profile areas as a proxy for beach volume. 'Normal' change (green status) is assumed to be that which falls within the observed variation over the previous 10 years' collected profile data. Levels of change which are beyond those observed are considered to flag up potentially concerning levels of change in the beach.

Data relating to volumetric changes within the Neath Estuary 10 year data review report does not give actual volumes. Future topographic data will enable actual beach volumes to be determined. Furthermore, bathymetric data will allow nearshore and intertidal data to be combined for the first time to help determine if on/offshore sediment movement within the closed system is taking place and contributing to some beach replenishment (as seems to have occurred between spring 2005 and summer 2007).

Until such time that sufficient topographic data / beach volumes have been collected for the five beach areas (A – E) (see Appendix Figure 10 - diagrammatic representation of beach), triggers will need to be calculated for the areas below each of the profiles. At the Review of Conditions, it should be determined if sufficient data is available to move from triggers based on profile data to those based on volumes of beach areas.

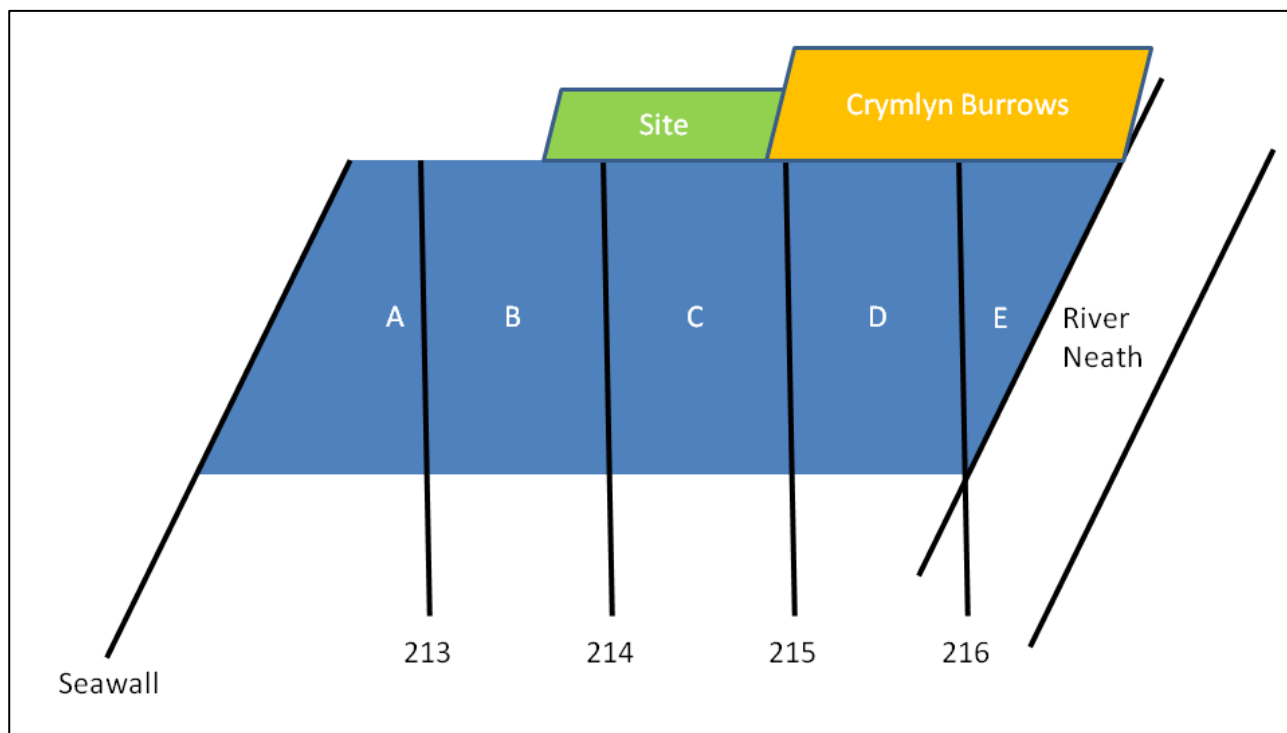
Appendix Table 6 - Beach volume change thresholds - descriptive

	% change between surveys
Red (-ve change)	< - maximum observed change between surveys from collected profile data - average change
Amber (-ve change)	Between: - maximum observed change between surveys from collected profile data and - maximum observed change between surveys from collected profile data - average change
Green	- maximum observed change between surveys from collected profile data + maximum observed change between surveys from collected profile data
Amber (+ve change)	Between: + maximum observed change between surveys from collected profile data and + maximum observed change between surveys from collected profile data + average change
Red (+ve change)	> + maximum observed change between surveys from collected profile data + average change

Appendix Table 7 - Beach volume change thresholds – values

% decrease between surveys				% increase between surveys		
Red	Amber	Green	Profile	Green	Amber	Red
% change < -13	-13 > % change > -12	-12 > % change > 0	213	0 < % change < +11	+11 < % change < +12	% change > +12
% change < -7	-7 > % change > -6	-6 > % change > 0	214	0 < % change < +2	+2 < % change < +3	% change > +3
% change < -6	-6 > % change > -5	-5 > % change > 0	215	0 < % change < +2	+2 < % change < +3	% change > +3
% change < -8	-8 > % change > -7	-7 > % change > 0	216	0 < % change < +3	+3 < % change < +4	% change > +4
% change < -5	-5 > % change > -4	-4 > % change > 0	Total	0 < % change < +1	+1 < % change < +2	% change > +2

Technical note



Appendix Figure 8– Diagrammatic representation of beach

Technical note

Appendix 3 – Overtopping Analysis

Data Sources

The overtopping assessment was carried out using the following datasets:

- Topographic data, sourced from InfoMap Surveys in August 2011.
- Predicted beach lowering information from the Environmental Impact Assessment prepared to support the Swansea Bay Campus development⁴ - this provides for 0.58m of beach lowering by 2060 and 2.67m beach lowering by 2110. These levels of lowering were applied linearly along the frontage (i.e. all areas lowered by the same amount)
- Wave climate information from a peak over threshold analysis of the Scarweather wave buoy data (Atkins, 2008⁵).
- Extreme water levels, sourced from Environment Agency (2010⁶).
- A revetment crest of 8.4m AOD, sourced from the development proposals.

Guidance

The following guidance used to carry out the overtopping assessment:

- EuroTOP manual⁷
- Defra Joint Probability Dependence Mapping and Best Practice⁸ - used to assess the joint probability of wave and tidal events
- Environment Agency Advice for Flood and Coastal Erosion Risk Management Authorities on adapting to climate change⁹ - used to assess the impacts of climate change, under the medium 95th percentile emissions scenario

Overtopping Analysis

Analysis of overtopping performance of the existing situation and the proposed development was carried out for:

- Chainages 20, 40, 60, 80 and 100 from the InfoMap Survey – the Phase 1 frontage runs from chainage 20 – 80.
- The years 2010, 2060 and 2110, applying the medium 95th percentile climate change impacts – this provides results for current and future overtopping amounts, up to 100 years from present.
- 1000, 500, 100, 20, 10, 5, 2, 1, 0.5 and 0.1% AEP wave and tide joint probability events.

The results of the analysis are shown in the following tables. These summarise the total overtopping volume for each % AEP event, occurring during periods of up to 4 hours per linear metre of frontage.

⁴ URS, 2010. The Bay Science and Innovation Campus, Swansea University. Environmental Statement Non-technical Summary

⁵ Atkins, 2008. Swansea Bay Flood Risk Assessment – Strategic Overview

⁶ Environment Agency, 2010. Coastal Flood Boundary Conditions for UK Mainland and Islands. Technical Report 2: Design sea levels

⁷ European Community, 2007. Wave Overtopping of Sea Defences and Related Structures: Assessment Manual

⁸ Defra, 2005. Joint Probability, Dependence Mapping and Best Practice: Technical Report 1: Dependence Mapping

⁹ Environment Agency, 2011. Adapting to Climate Change: Advice for Flood and Coastal Erosion Risk Management Authorities

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Overtopping volumes (m³ per linear m) in 2010

% AEP event	Chainage (m)				
	20	40	60	80	100
1000	0	0	0	0	0
500	0	0	0	0	0
100	0	0	0	0	0
50	0	0	0	0	0
10	0	0	0	0	0
5	0	0	3E-30	3E-30	2E-36
1	0	8E-25	2E-08	2E-08	2E-09
0.5	0	1E-10	9E-05	9E-05	3E-05
0.1	2E-23	2E-02	6E-01	6E-01	4E-01

Overtopping volumes (m³ per linear m) in 2060

% AEP event	Chainage (m)				
	20	40	60	80	100
1000	0	0	1E-28	1E-28	9E-33
500	0	0	2E-19	2E-19	7E-21
100	0	1E-16	5E-08	5E-08	2E-08
50	0	3E-12	3E-06	3E-06	9E-07
10	0	1E-06	1E-03	1E-03	6E-04
5	0	4E-05	8E-03	8E-03	5E-03
1	6E-09	5E-02	6E-01	6E-01	5E-01
0.5	1E-04	7E-01	4E+00	4E+00	3E+00
0.1	1E+00	4E+01	9E+01	9E+01	8E+01

Overtopping volumes (m³ per linear m) in 2110

% AEP event	Chainage (m)				
	20	40	60	80	100
1000	2E-01	2E+00	4E+00	4E+00	4E+00
500	5E-01	3E+00	6E+00	6E+00	6E+00
100	5E+00	2E+01	3E+01	3E+01	3E+01
50	8E+00	3E+01	4E+01	4E+01	4E+01
10	3E+01	7E+01	1E+02	1E+02	1E+02
5	5E+01	1E+02	1E+02	1E+02	1E+02
1	2E+02	3E+02	4E+02	4E+02	4E+02
0.5	4E+02	6E+02	7E+02	7E+02	7E+02
0.1	2E+03	3E+03	3E+03	3E+03	3E+03

The tables above show that at present (year 2010) volumes of overtopping are zero or very small for all overtopping events. Volumes in 2060 remain small for most overtopping events, reaching a maximum of 90m³ during a 4 hour period at chainages 60 and 80 only during 0.1 AEP events.

Conclusion

The proposed drainage system is designed to comply with current standards and has taken account of the volumes of overtopping predicted. The developer considers that there is no need to either increase the height or extend the length of the revetment along the Phase 1 frontage to protect the site from volumes of water that might overtop the defences.

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Appendix 4 – 2012 Topographic and Bathymetric Survey Results

Bathymetric and topographic surveys were carried out in October 2012 based on the survey methodology set out in the monitoring framework. All data has been sent electronically to the client / landowner (St Modwen). Outputs from the survey are:

- Survey data (bathy and topo combined) in xyz format
- A contoured plan in CAD format – pdf version shown in Appendix Figure15
- 63 cross sections in CAD format
- Sections 213 – 216 (surveyed 10 July 2012) in xyz and CAD format
- Survey report - appended to this Appendix

The profile data have been added to that collected and analysed in Appendix 2 and results are presented and discussed below. The data have not been used to update the thresholds for trigger points set out in the Monitoring and Mitigation Scheme.

Appendix Table 8 – Maximum, minimum and average inter-survey change in beach cross section area at Profiles 213, 214, 215 and 216

	213		214		215		216	
	Change (m ²)	% increase	Change (m ²)	% increase	Change (m ²)	% increase	Change (m ²)	% increase
Minimum change	-65.00	-12.38%	-60.00	-5.58%	-78.00	-4.63%	-146.00	-7.13%
Average change	-7.31	-1.10%	-9.31	-0.81%	-15.56	-0.89%	-26.13	-1.19%
Maximum change	49.00	10.54%	23.00	1.99%	32.00	1.96%	63.00	2.88%
1998 - 2008 change	-117	-17.65%	-149	-12.91%	-249	-14.22%	- 418	-19.08%
1998 – 2012 change	- 59	-8.90%	- 84	-7.28%	193	11.02%	- 393	-17.94%
2008 – 2012 change	58	10.62%	65	6.47%	442	29.43%	25	1.41%
Annualised 2008 - 2012 change		2.41%		1.58%		6.67%		0.35%

Between 2008 and 2012 increases at all four sites have taken place, with the largest being at profile 215 (29%). The recent increases have reduced the overall losses since 1998 at three of the profiles and shown an increase of 11% at profile 215. Profiles 213 and 214 also show significant changes, with profile 216 showing least change.

Based on these four profiles, there is approximately 12% more sediment on the beach in 2012 than in 2008. Overall losses between 1998 and 2012 are approximately 6%. Losses between 1998 and 2008 were 16%.

It is not clear what the cause or source of the increase is, however, if there is some on/offshore movement of sediment between the beach and the nearshore sand waves, this could account for the changes. The large offshore sandbar that was seen in the 2008 survey appears to have moved inshore/up the beach. It should however be noted that the weather during summer 2012 has also been anomalous, which may have influenced nearshore / onshore sediment movement.

A bathymetric survey of the nearshore area was carried out in October 2012, but as there are no previous surveys with which to compare the results, it is not possible to determine how the nearshore sediment may have changed or influenced the beach profile results. Analysis of LiDAR could provide an indication of the reasons for the change, however, this would depend on if relevant survey results are available.

The 2012 profiles do not provide any further evidence to support the theory of a west to east movement of sediment along the beach and into the Neath estuary navigation channel, however, if this is the case, the

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significant increases seen in profile 215 could signal future losses from the frontage into the channel. No comparable sized increases in profile 216 are shown in the 2012 survey. This could either be due to sediment not having reached the easternmost end of the beach or sediment moving completely through the eastern area and off the beach into the navigation channel. Removal of sediment that originated from Aberavon beach (east of the River Neath) took place in April 2012, but it is not clear if sediment from the western side of the river has been removed.

The colour coding in the final row of Appendix Table 8 indicates how the changes between 2008 and 2012 relate to the agreed thresholds to trigger actions, as set out in the Monitoring and Mitigation Scheme. As can be seen, only profile 213 is within the 'green' threshold, as based on historic changes in beach profiles. Profiles 214 and 215 are 'red' and have changed so greatly that they are outside of the range of change set out in the Monitoring and Mitigation Scheme. However, as this is the baseline information, this comparison is only for information and not for review or action. The first annual topographic survey is due to be carried out in Autumn 2013.

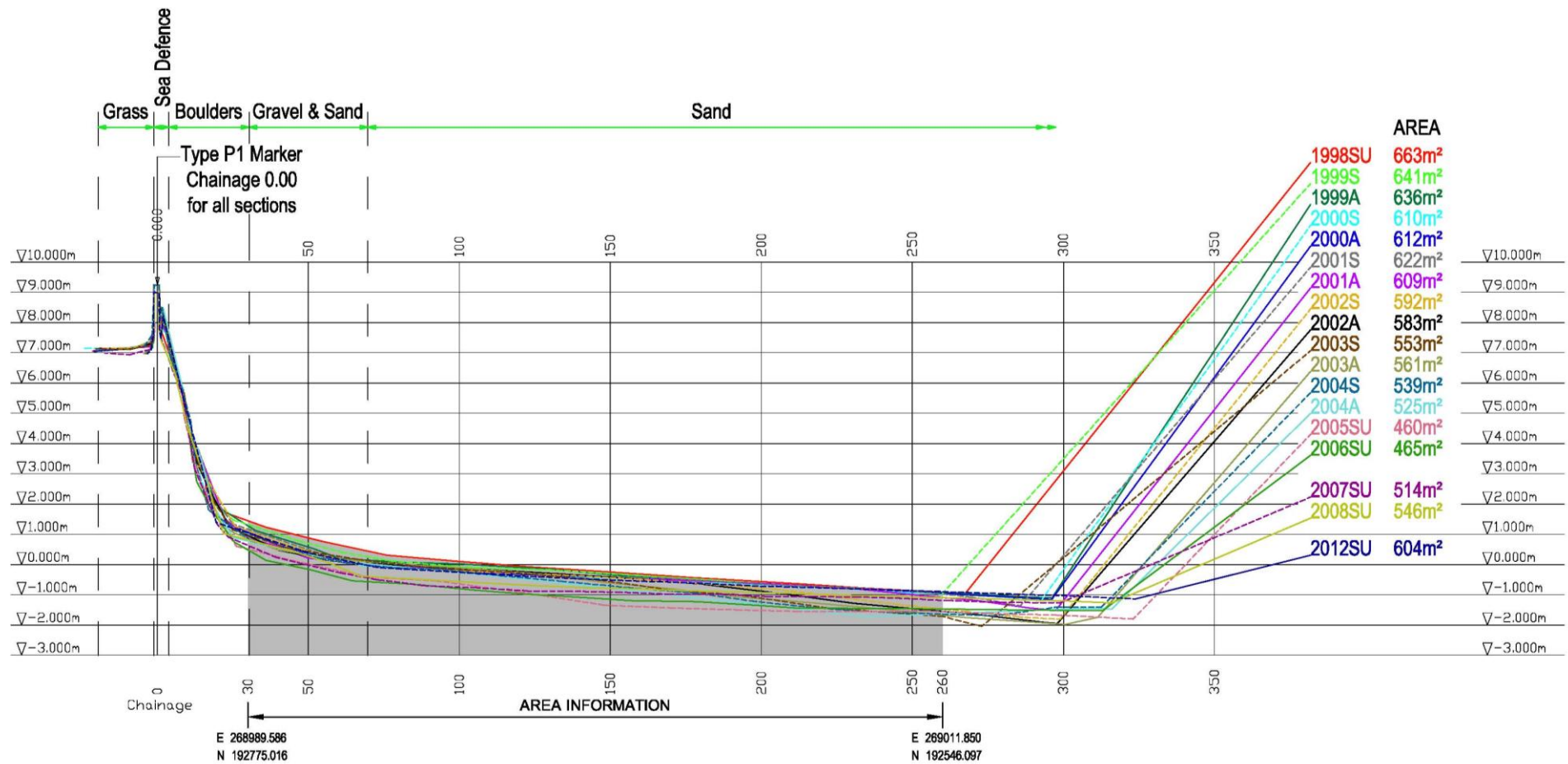
It should be noted that the thresholds are based on annual changes from one year to the next whereas these results show changes that have occurred over a 4 year period. It is not possible to determine when over this 4 year period the changes took place.

It is possible that a 6% increase at profile 214 and a 1.4% increase at profile 216 could occur over a 4 year period without triggering either 'amber' or 'red' levels. However, a 29% increase at profile 215 could not occur over a 4 year period without triggering at least one 'red' result.

The action set out in the Monitoring and Mitigation Scheme on reaching a 'red' trigger is to undertake additional topographic survey and bathymetric survey to determine if levels have returned to within the green threshold parameters, however, the baseline bathymetric survey only took place in October 2012 and there are no previous annual surveys with which to compare the results.

The first annual topographic survey is due to be carried out in Autumn 2013. The next bathymetric survey is due to be carried out, 5 years after the first bathymetric survey (Autumn 2017), unless the results of annual topographic surveys require additional survey work, as set out in the Monitoring and Mitigation Scheme.

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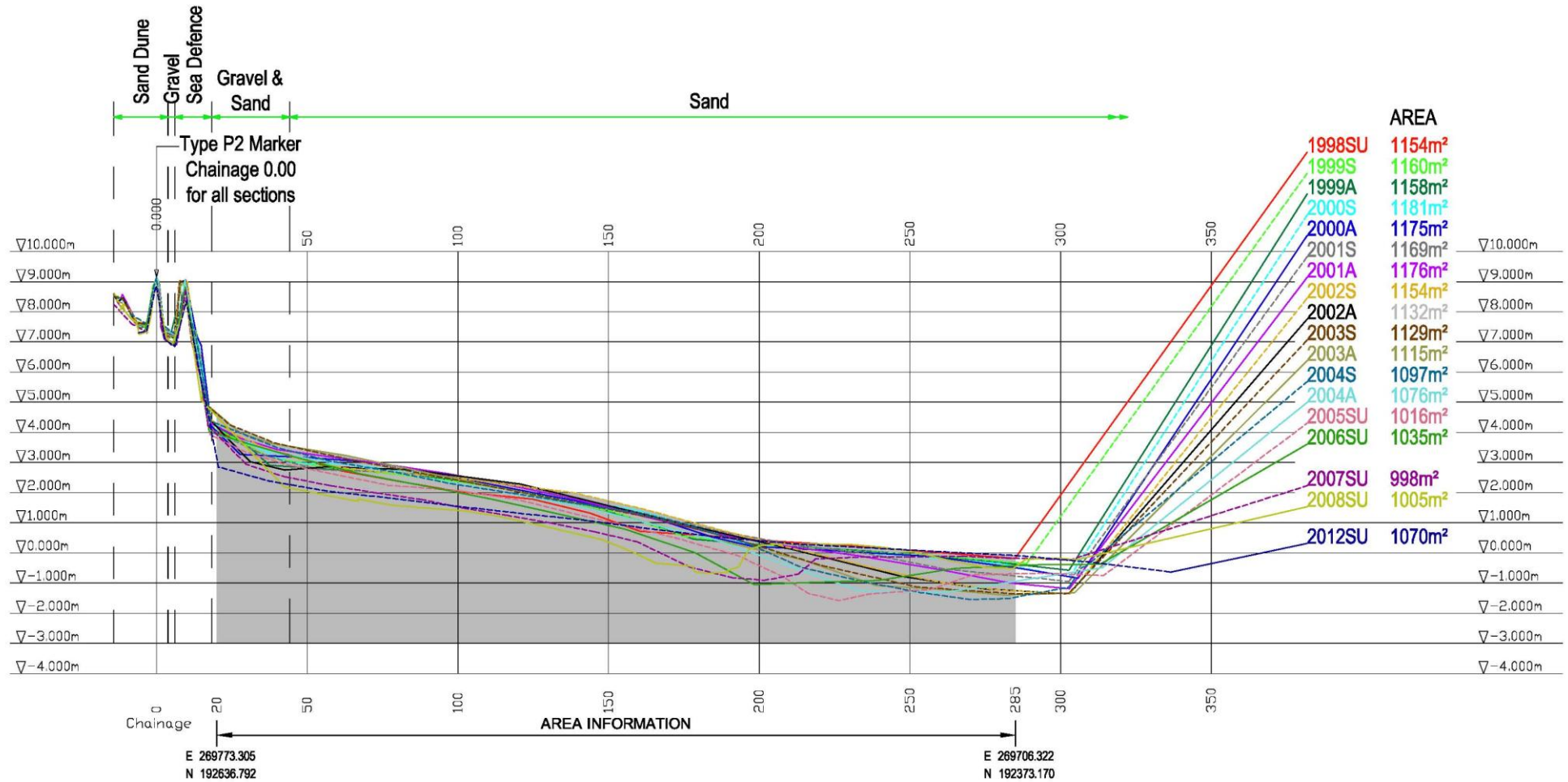


SECTIONS 213 OF 1998 - 2012

SCALE Hz - 1:1250 V - 1:125 @ A3

Appendix Figure 9– Profile 213 (1998 – 2012)

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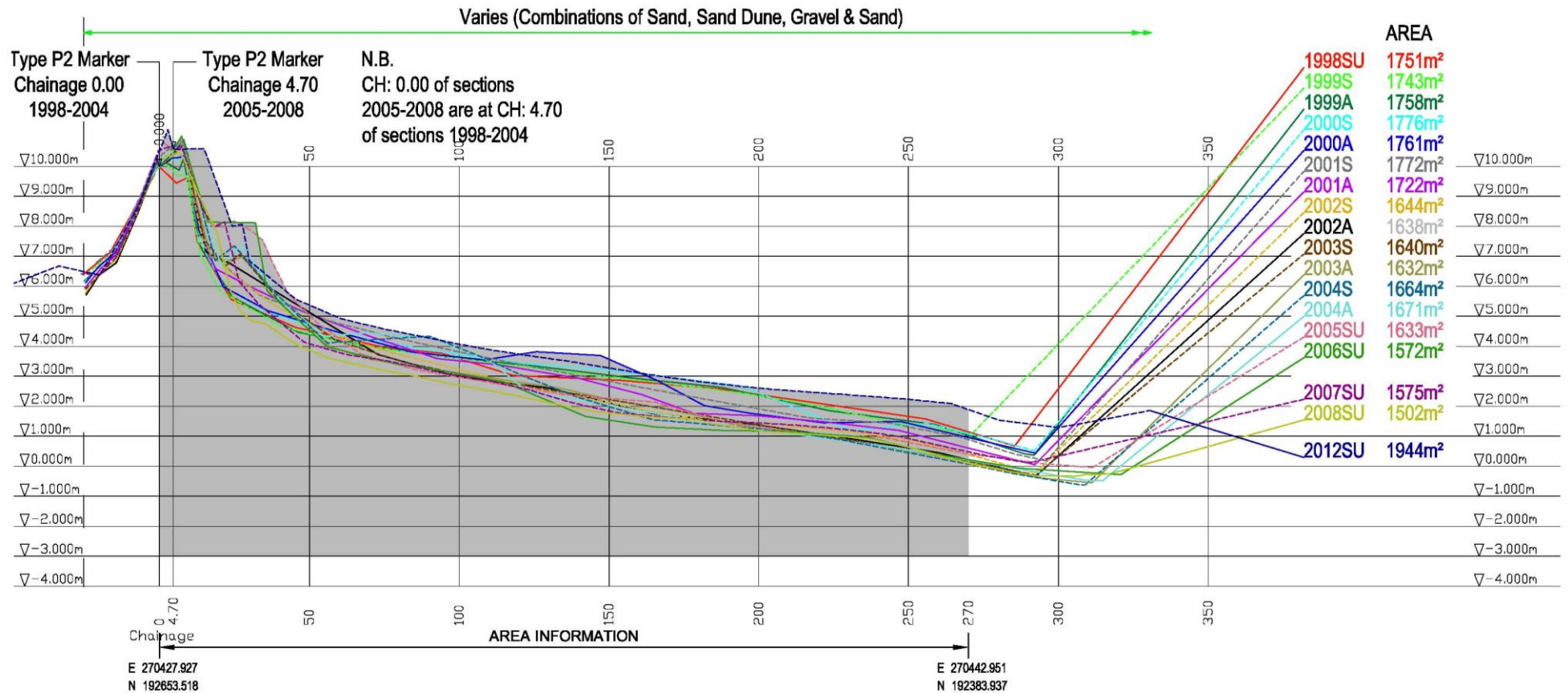


SECTIONS 214 OF 1998 - 2012

SCALE Hz - 1:1250 V - 1:125 @ A3

Appendix Figure 10– Profile 214 (1998 – 2012)

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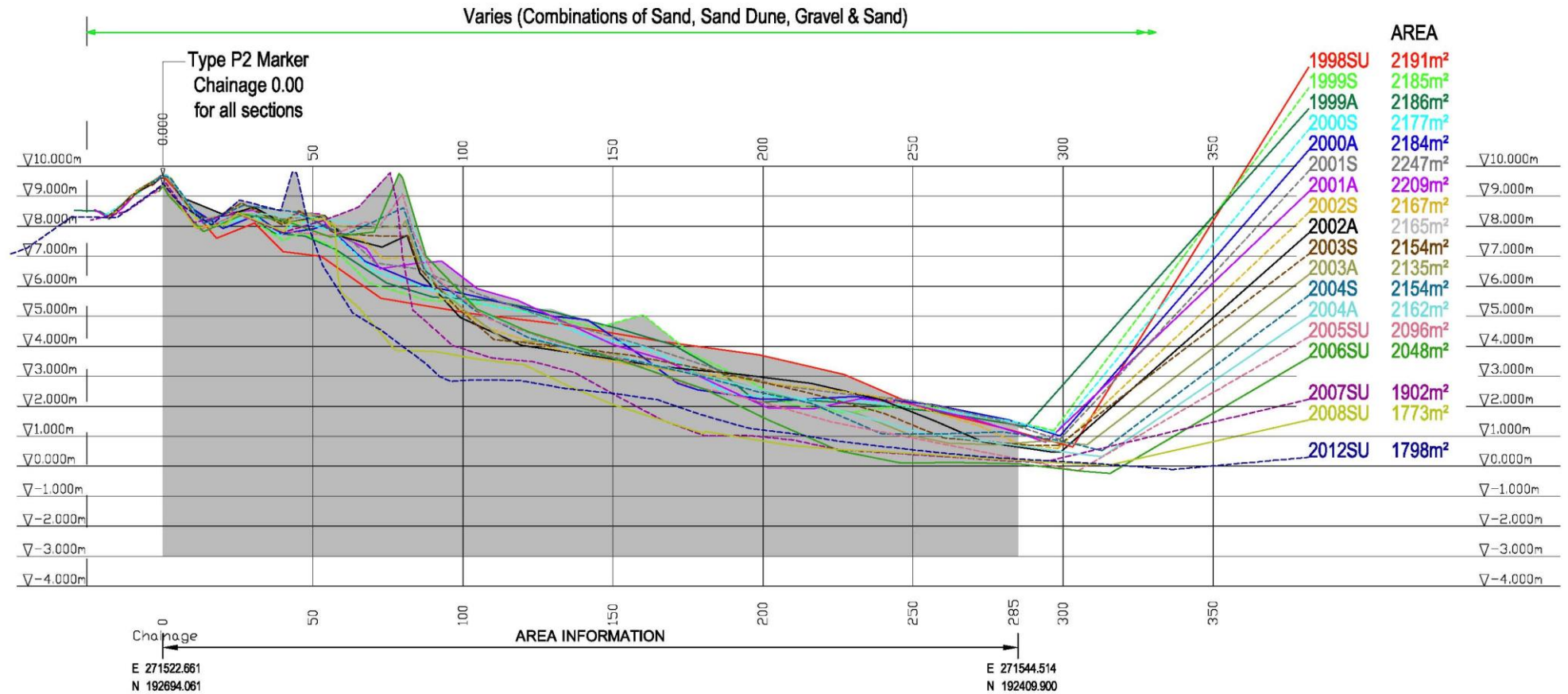


SECTIONS 215 OF 1998 - 2012

SCALE Hz - 1:1250 V - 1:125 @ A3

Appendix Figure 11– Profile 215 (1998 – 2012)

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SECTIONS 216 OF 1998 - 2012

SCALE H: 1:1250 V: 1:125 @ A3

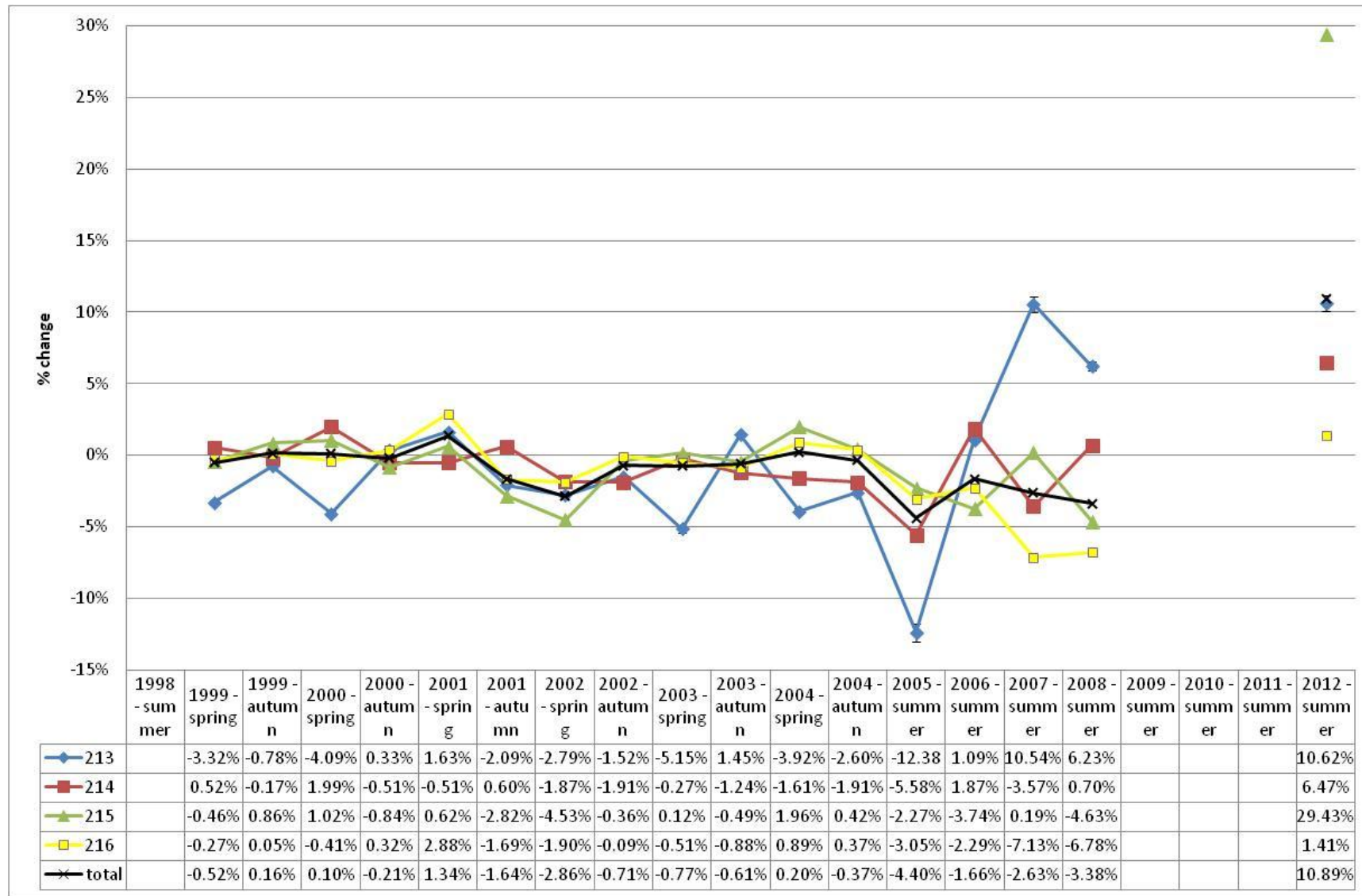
Appendix Figure 12– Profile 216 (1998 – 2012)

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Appendix Table 9 – Inter-survey change in beach cross section area at Profiles 213, 214, 215 and 216

	213			214			215			216		
Date	Area (m ²)	Change (m ²)	% increase	Area (m ²)	Change (m ²)	% increase	Area (m ²)	Change (m ²)	% increase	Area (m ²)	Change (m ²)	% increase
1998 - summer	663	-	-	1,154	-	-	1,751	-	-	2,191	-	-
1999 – spring	641	-22	-3.32%	1,160	6	0.52%	1,743	-8	-0.46%	2,185	-6	-0.27%
1999 – autumn	636	-5	-0.78%	1,158	-2	-0.17%	1,758	15	0.86%	2,186	1	0.05%
2000 – spring	610	-26	-4.09%	1,181	23	1.99%	1,776	18	1.02%	2,177	-9	-0.41%
2000 – autumn	612	2	0.33%	1,175	-6	-0.51%	1,761	-15	-0.84%	2,184	7	0.32%
2001 – spring	622	10	1.63%	1,169	-6	-0.51%	1,772	11	0.62%	2,247	63	2.88%
2001 – autumn	609	-13	-2.09%	1,176	7	0.60%	1,722	-50	-2.82%	2,209	-38	-1.69%
2002 – spring	592	-17	-2.79%	1,154	-22	-1.87%	1,644	-78	-4.53%	2,167	-42	-1.90%
2002 – autumn	583	-9	-1.52%	1,132	-22	-1.91%	1,638	-6	-0.36%	2,165	-2	-0.09%
2003 – spring	553	-30	-5.15%	1,129	-3	-0.27%	1,640	2	0.12%	2,154	-11	-0.51%
2003 – autumn	561	8	1.45%	1,115	-14	-1.24%	1,632	-8	-0.49%	2,135	-19	-0.88%
2004 – spring	539	-22	-3.92%	1,097	-18	-1.61%	1,664	32	1.96%	2,154	19	0.89%
2004 – autumn	525	-14	-2.60%	1,076	-21	-1.91%	1,671	7	0.42%	2,162	8	0.37%
2005 – summer	460	-65	-12.38%	1,016	-60	-5.58%	1,633	-38	-2.27%	2,096	-66	-3.05%
2006 – summer	465	5	1.09%	1,035	19	1.87%	1,572	-61	-3.74%	2,048	-48	-2.29%
2007 - summer	514	49	10.54%	998	-37	-3.57%	1,575	3	0.19%	1,902	-146	-7.13%
2008 – summer	546	32	6.23%	1,005	7	0.70%	1,502	-73	-4.63%	1,773	-129	-6.78%
2009 – summer	-			-			-			-		
2010 – summer	-			-			-			-		
2011 – summer	-			-			-			-		
2012 – summer	604	58	10.62%	1,070	65	6.47%	1,944	442	29.43%	1,798	25	1.41%

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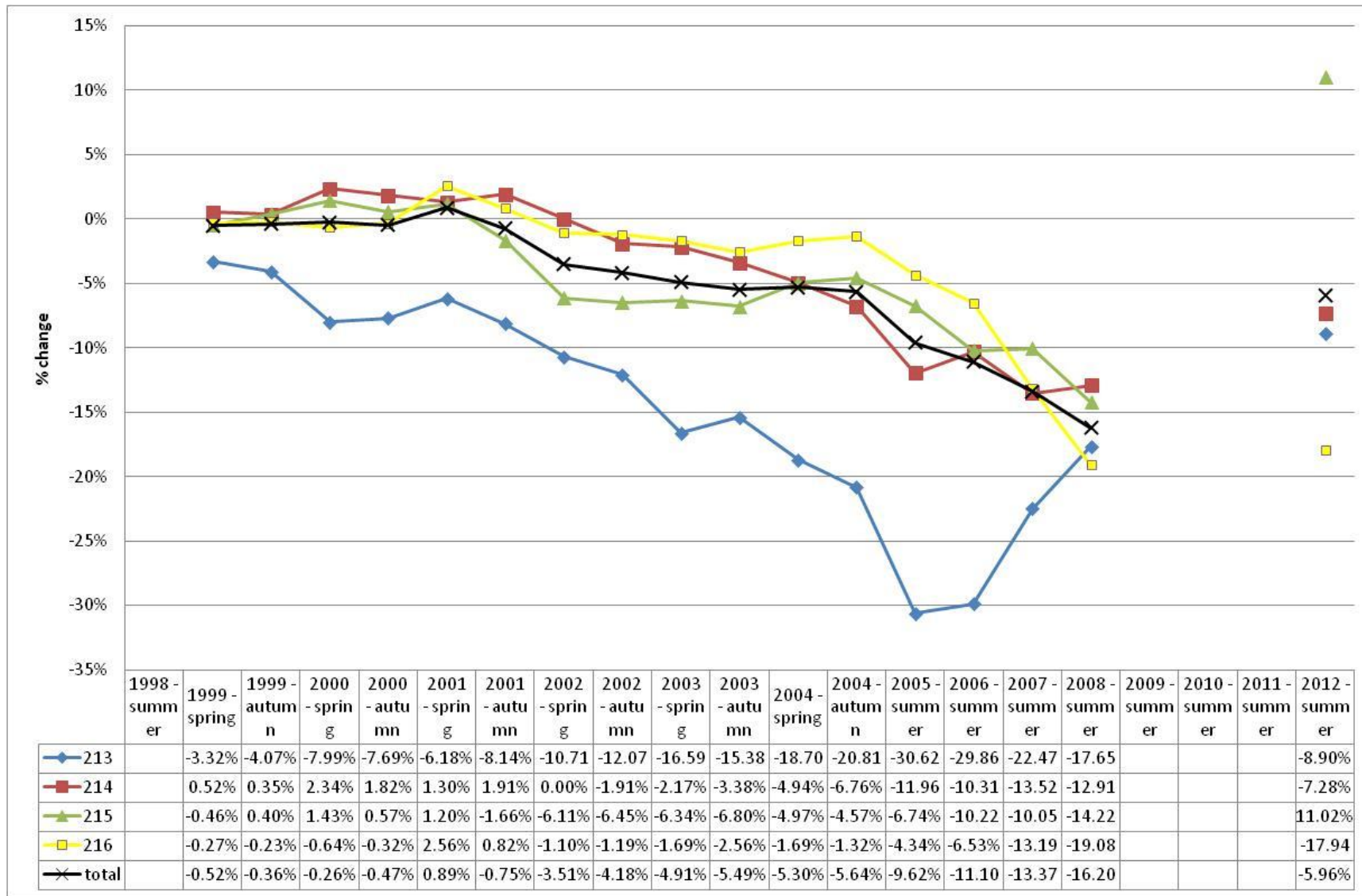
Appendix Figure 13– Inter-survey % change in beach cross section area over time (1998 – 2012)

Technical note

Appendix Table 10 – Cumulative change in beach cross section area at Profiles 213, 214, 215 and 216 (1998 – 2012)

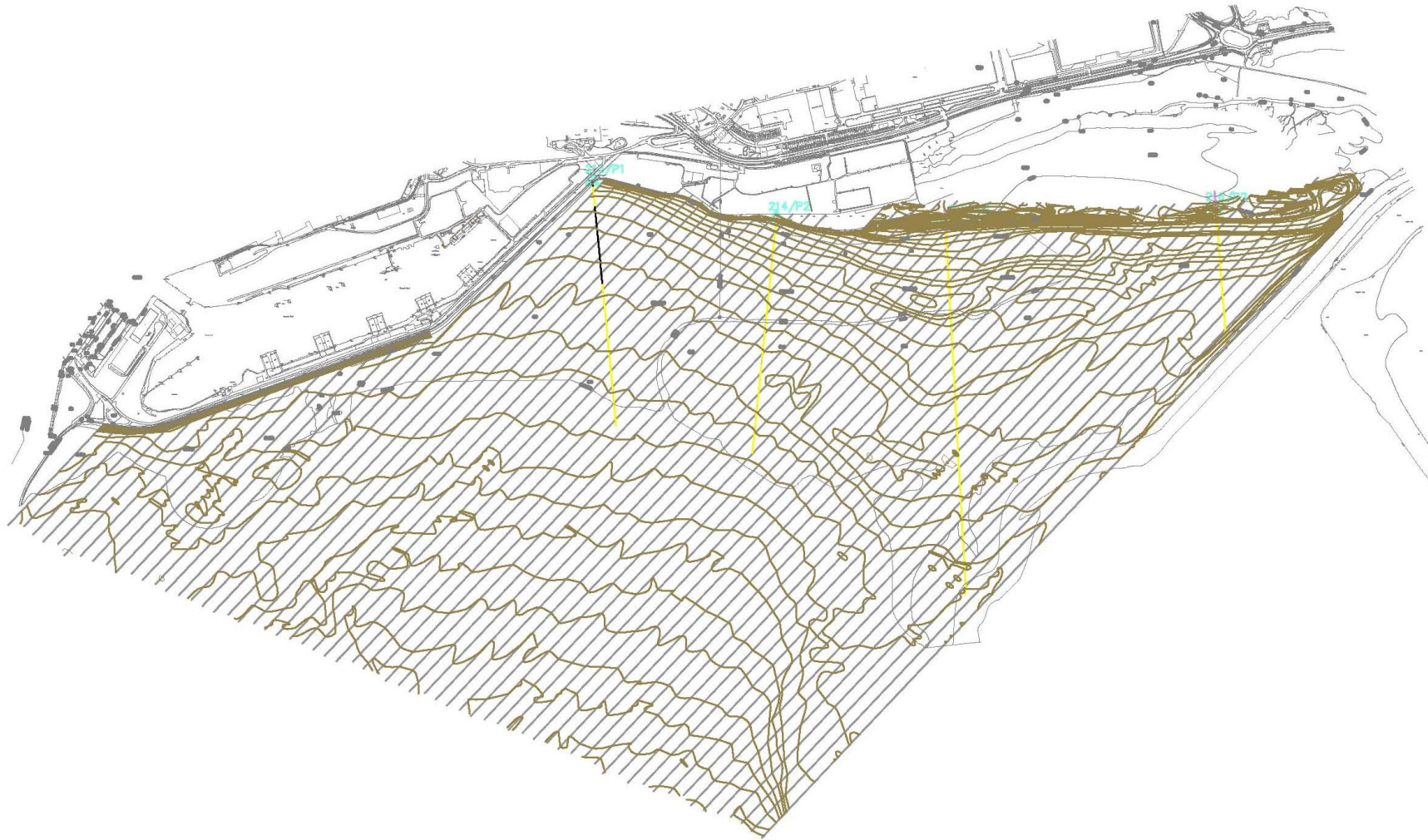
Date	213			214			215			216		
	Area (m ²)	Cumulative change (m ²)	% increase	Area (m ²)	Cumulative change (m ²)	% increase	Area (m ²)	Cumulative change (m ²)	% increase	Area (m ²)	Cumulative change (m ²)	% increase
1998 - summer	663	-	-	1,154	-	-	1,751	-	-	2,191	-	-
1999 - spring	641	-22	-3.32%	1,160	6	0.52%	1,743	-8	-0.46%	2,185	-6	-0.27%
1999 - autumn	636	-27	-4.07%	1,158	4	0.35%	1,758	7	0.40%	2,186	-5	-0.23%
2000 - spring	610	-53	-7.99%	1,181	27	2.34%	1,776	25	1.43%	2,177	-14	-0.64%
2000 - autumn	612	-51	-7.69%	1,175	21	1.82%	1,761	10	0.57%	2,184	-7	-0.32%
2001 - spring	622	-41	-6.18%	1,169	15	1.30%	1,772	21	1.20%	2,247	56	2.56%
2001 - autumn	609	-54	-8.14%	1,176	22	1.91%	1,722	-29	-1.66%	2,209	18	0.82%
2002 - spring	592	-71	-10.71%	1,154	-	0.00%	1,644	-107	-6.11%	2,167	-24	-1.10%
2002 - autumn	583	-80	-12.07%	1,132	-22	-1.91%	1,638	-113	-6.45%	2,165	-26	-1.19%
2003 - spring	553	-110	-16.59%	1,129	-25	-2.17%	1,640	-111	-6.34%	2,154	-37	-1.69%
2003 - autumn	561	-102	-15.38%	1,115	-39	-3.38%	1,632	-119	-6.80%	2,135	-56	-2.56%
2004 - spring	539	-124	-18.70%	1,097	-57	-4.94%	1,664	-87	-4.97%	2,154	-37	-1.69%
2004 - autumn	525	-138	-20.81%	1,076	-78	-6.76%	1,671	-80	-4.57%	2,162	-29	-1.32%
2005 - summer	460	-203	-30.62%	1,016	-138	-11.96%	1,633	-118	-6.74%	2,096	-95	-4.34%
2006 - summer	465	-198	-29.86%	1,035	-119	-10.31%	1,572	-179	-10.22%	2,048	-143	-6.53%
2007 - summer	514	-149	-22.47%	998	-156	-13.52%	1,575	-176	-10.05%	1,902	-289	-13.19%
2008 - summer	546	-117	-17.65%	1,005	-149	-12.91%	1,502	- 249	-14.22%	1,773	-418	-19.08%
2009 - summer	-			-			-			-		
2010 - summer	-			-			-			-		
2011 - summer	-			-			-			-		
2012 - summer	604	-59	-8.90%	1,070	-84	-7.28%	1,944	193	11.02%	1,798	- 393	-17.94%

Technical note



Appendix Figure 14– Cumulative % change in beach cross section area over time (1998 – 2012)

Technical note



Appendix Figure 15– Combined beach and nearshore subtidal contour plan

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1. INTRODUCTION

1.1 Scope of Work

This report covers the survey procedures used, raw data collected and processing following the Bathymetric and Topographic survey of Swansea Bay bounded by the extents of Swansea Docks and River Neath Channel. Seaward and Landward limits were supplied by client.

The work scope, for the purposes of this report, comprised of:

- a) Bathymetric Survey. Line spacing at 50m intervals.
- b) Topographic Survey. Line spacing at 50m intervals.

The Bathymetric Survey was to be carried out over the high water spring tides to maximise coverage up the beach. Topographic Survey was carried out over the low water periods of the same pre-determined survey lines to give a 50m overlap between both land and hydrographic surveys and to cover the upper reaches of the beach.

1.2 Survey Preparation

1.2.1 Pre-Mobilisation

The bathymetric and navigation survey equipment were checked for proper operation in accordance with Longdin & Browning quality and standard procedures before mobilisation to site was made.

1.2.2 Pre-Survey

A local vessel “Blue Thunder” was used for the duration of the Hydrographic Survey working out of Swansea Marina. The vessel was mobilised and equipment checked prior to commencement of survey.

Survey backdrop was taken from OS tiles used from ongoing surveys carried out by ourselves on the Neath River and Swansea Marina Approach Channel.

SURVEY REPORT

1.3 Major Control

1.3.1 Base Station

Existing Survey control was used at Monkstone Marina which is used on a regular basis for the Neath River Channel Surveys.

H15 SLIPWAY

OSGB36	WGS84
273199.832 E	Lat 51° 37' 46.38356" N
193896.117 N	Long 03° 50' 00.18997" W
Ht. 6.893m	Ellip. Ht. 59.5127

1.3.2 Level Control

The tide boards on the Tawe Lock were levelled. The upstream board has a level of 5.470m OD on the 7.00m mark and the downstream board has a level of 5.284m OD on the 10.00m mark.

1.4 Water level Information

Real time water levels were recorded from the Kinematic DGPS on board the vessel and checked against the existing tide boards at Swansea Marina and on the Neath River Outfall.

All soundings have been reduced to Ordnance Datum.

2. DATA COLLECTED

2.1 Bathymetric Operations

2.1.1 Introduction

The seabed levels were obtained using a survey echo sounder mounted on board the survey vessel. Positioning was obtained using RTK DGPS. All data was logged directly to a computer on board the vessel.

2.1.2 Equipment

10m Cygnus Cyfish "BLUE THUNDER" Survey vessel
Leica 1200 RTK GPS
Navisound 415 single beam echo sounder with 210kHz transducer
Datalux portable Computer running Hypack MAX Hydrographic Survey software.

The GPS used has an accuracy of 0.02m and the Navisound echo sounder has an accuracy of 0.02m.

2.1.3 Method

Once details of the site location had been compiled, the information was entered into the Hypack software to generate survey lines at 50m centres parallel to the River Neath Channel.

The survey vessel was equipped with all the necessary instrumentation. The echosounder transducer was side mounted with the DGPS receiver mounted above it, therefore an offset was not needed within the software to account for any position to depth errors.

The computer screen was installed on the vessel in such a way that both the helmsman and operator could view it clearly at all times.

Once the vessel was located in the vicinity of the survey area for a given day, the echo sounder was calibrated using the "disc check" method. A metal plate attached to a calibrated galvanised steel chain was lowered over the side of the vessel directly under the transducer. Calibration marks, at 1.0m intervals from the plate were used to set the disc at precise metre intervals from the water surface. The resultant echoes from the plate, on the echo sounder, were used to set the draft and speed of sound parameters on both the analogue echosounder and the digital output.

SURVEY REPORT

The real time position of the vessel, relative to the OS National Grid, was displayed on the computer screen at all times during survey operations.

The required survey line was displayed on the computer screen. The software indicated to the helmsman track guidance for each pre-determined survey line.

Visual and numerical information displayed included distance offline and chainage along each line. This information enabled the helmsman to navigate the vessel along the required route, hence achieving a regular lattice of soundings.

Once the vessel was on the required line, the software started logging data to the computer. This data comprises of time, computed position, raw GPS, raw depth, corrected depth, tide height, distance to reference line, distance off line and fix numbers. The position information was logged at 0.2 second intervals, in addition, every sounding made by the echo sounder was logged, typically 32 per second. The total sounding density obtained was in the region of a sounding every 0.1m along each survey line.

The computer generated fixes at 10m intervals along each line. The fixes were sent automatically to the echo sounder to generate reference marks on the echo trace. The fixes were annotated automatically with the fix number, time, date and line number.

On the completion of the day's survey the data was viewed on screen to check for completeness, a backup of the data observed was then taken.

The Bathymetric Survey was carried out on the 19th, 20th, 21st and 22nd of October with good sea conditions for the whole period.

The Topographic Survey was carried out using DGPS in a similar process as the Hydrographic, where the same pre-determined lines are uploaded to the GPS Rover and data recorded every 5m along the line until a 50m overlap with the Bathymetric data was achieved.

2.1.4 Data Processing

After completion of the survey work the bathymetric and navigational data were edited. This was conducted on return back in our office. Editing was conducted using the Hypack software. The purpose of the editing was to check the data quality against the analogue records and to remove any spurious data, such as spikes in the raw data sets.

The water level was entered into the program and a profile produced for each day. Each survey line was then viewed on screen. Any erroneous data in the navigation or depth were edited or removed. The edited data was filtered to extract soundings at 1.0m intervals along each line. On completion of the editing of each line the data was saved as a processed file. The same procedure was used on all the observed survey lines. Once all the raw data had been processed it was compiled into one file for use in other steps in the charting procedure.

The final data, at 1m spacing, was imported into a 'TIN' modelling package (Coastal Hypack). Three-dimensional models were generated of the whole survey areas. These were used as a visual check on the validity of the data. Different colour coding and view angles were used to look at the data set. The modelling program was used to generate contours, at 0.5m intervals. The contours produced by Hypack are generally quite spiky so the CAD office smoothed the contours in AutoCAD.

The Topographic data was then added to the drawings and overlapping data was checked and found to be well within tolerance.

Four additional profiles have been added to the final drawing:-

These profiles being STN213, STN214, STN215 and STN216 surveyed by Longdin & Browning in May/June this year for Shoreline Management.