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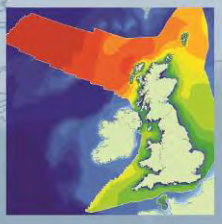
Lymington to Yarmouth Ferries: Third Annual Mitigation Review

Progress Report 3 and 8th Report for the Environment Management Panel

Report R.2313

December 2014

Creating sustainable solutions for the marine environment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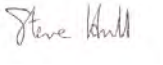
Project Director:	S C Hull		8 December 2014

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Summary

This report presents results from latest surveys of the mitigation work undertaken as part of the operation of the Wightlink Ltd. ferry service between Lymington and Yarmouth. This mitigation is designed to offset any effects that might arise from the ferry operations. Such ferry service effects are uncertain but, if they did occur, would contribute to an ongoing process of naturally-dominated mudflat erosion along the low-shore edges of the Lymington Estuary.

The mitigation works involved carrying out sediment recharge campaigns on an area of decaying saltmarsh (referred to as Boiler Marsh) located at the mouth of the Lymington Estuary. Initially a series of fences were placed within a deteriorating central section of this marsh and then maintenance dredge arisings from Lymington Estuary and marinas were pumped into this area. These mitigation works are designed to reverse the process of ongoing erosion within the marsh and, thus, offset any accelerated mudflat erosion that may occur from the ferries within the estuary.

The mitigation measures are deliberately designed to be adaptable so that they can be altered in scale and frequency in response to the results of separate ferry impact monitoring. The mitigation work is overseen by an Environmental Management Panel (EMP) who advises on the requirements for monitoring and management in light of survey evidence. On the basis of the work done, and the opinions of the EMP, two recharge campaigns were undertaken between January and March in both 2012 and 2013. At the most recent EMP meeting, in November 2013, it was agreed that no campaign was required in 2014 but that monitoring should continue for another year.

This report now presents the results from surveys of the mitigation area that have been undertaken in 2014. In particular it details the findings from the main annual survey that was undertaken by ABP Marine Environmental Research Ltd (ABPmer) in September 2014. This report also includes the results of separate survey work undertaken by the Environment Agency and the Channel Coastal Observatory (CCO).

The surveys undertaken up to September 2014 (18 months after the second recharge work was completed) have shown that the sediment which was placed in the recharge area over two campaigns has remained *in situ*. There has also been some accretion of sediment within the recharge area of the overall. Some of this accreting material will be sediment that has eroded within the site from the channels in the northern part of the site or off the surfaces of the exposed clay mounds. However, much of the accreting sediment is likely to have been imported and then settled into the area (possibly influenced by higher levels of suspended sediment in the water column following the sequence of winter storms in 2013/14).

On present evidence, though, it is not possible to conclude whether the area will be a net importer of sediments in more typical years. However, it is clear that the habitat is very stable and the project has achieved the objective of reversing an ongoing process of physical erosion across this decaying area of the marsh. The site is ecologically functional with marsh plants growing effectively in the areas of highest elevation as well as evidence of occasional bird roosting and feeding activity in keeping with the baseline levels.

The results of this work were discussed at a meeting of the EMP which was held on 20 November 2014 (following circulation of a draft copy of this report). At that meeting, it was agreed that the results from the recharge surveys and from the separate ferry monitoring work were positive and that there was no need for further recharge campaigns in 2015.

It was also concluded that there should be a substantial reduction in the monitoring and reporting work. In 2015 an annual survey of the recharge area will again be undertaken in September and only a brief technical note produced of the results from this and any separate Environment Agency or CCO data. There will only be a meeting of the EMP in 2015 if these results highlight any issues, otherwise the next meeting will be in November 2016.

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1. Introduction

1.1 Project Background

In 2012 and 2013 Wightlink Ltd carried out two annual programmes of dredge sediment recharge work on an area of eroding saltmarsh (Boiler Marsh) near Lymington, Hampshire. The location of the site is shown in Figure 1. This site and the recharge work itself have been surveyed regularly since July 2010 and this report now presents results from survey work undertaken in 2014. In particular the findings from the main annual survey, carried out in September 2014, are presented and reviewed in the context of past results. This September 2014 survey was undertaken 18 months after the second of the two recharge campaigns was completed (in March 2013).

This sediment recharge project (see Image 1) was undertaken to slow the rate at which the north east corner of Boiler Marsh was eroding and, in so doing, to mitigate for any potential impacts arising from the operation of W Class ferries between Lymington and Yarmouth. These ferry impacts may involve a contributory erosive effect to low shore mudflat habitat which lies along the navigable reaches of Lymington Channel and which are part of the designated Solent European Marine Site. The extent to which such ferry effects occur is being monitored and reported separately (ABPmer 2012a, 2012b, 2013a, 2013b, 2014).

The recharge work was designed as part of the overall adaptive mitigation and monitoring package which was undertaken to avoid any effects arising from the ferry service on the integrity of the designated Solent European Sites (by reference to the site's Conservation Objectives). The requirements for, and scope of, the recharge and the monitoring are set out in a Section 106 Agreement and this process is being overseen by an Environmental Management Panel (EMP).

The formal 'Objective' of the recharge work (called 'Habitat Works') is also set out in Paragraph 1, Schedule 4 of the Section 106 Agreement for this project as follows:

> *The Objective of the Habitat Works is to offset the potential loss of intertidal habitat extent and the reduction in quality of intertidal habitat of the European Sites that may occur as a result of the Ferries by achieving Increased Habitat Persistence within the boundary of the European Sites by delaying the loss of intertidal habitat to ensure that there is no adverse effect on the integrity of the European Sites by reference to the Conservation Objectives.*

For the recharge work a series of fences were initially placed within the deteriorating central section of Boiler Marsh and then maintenance dredge arisings from the Lymington Estuary and marinas were pumped into this area (see Figure 2 and Image 1). The first phase of the recharge was carried out between February to March 2012 and the second was undertaken from January to March 2013.

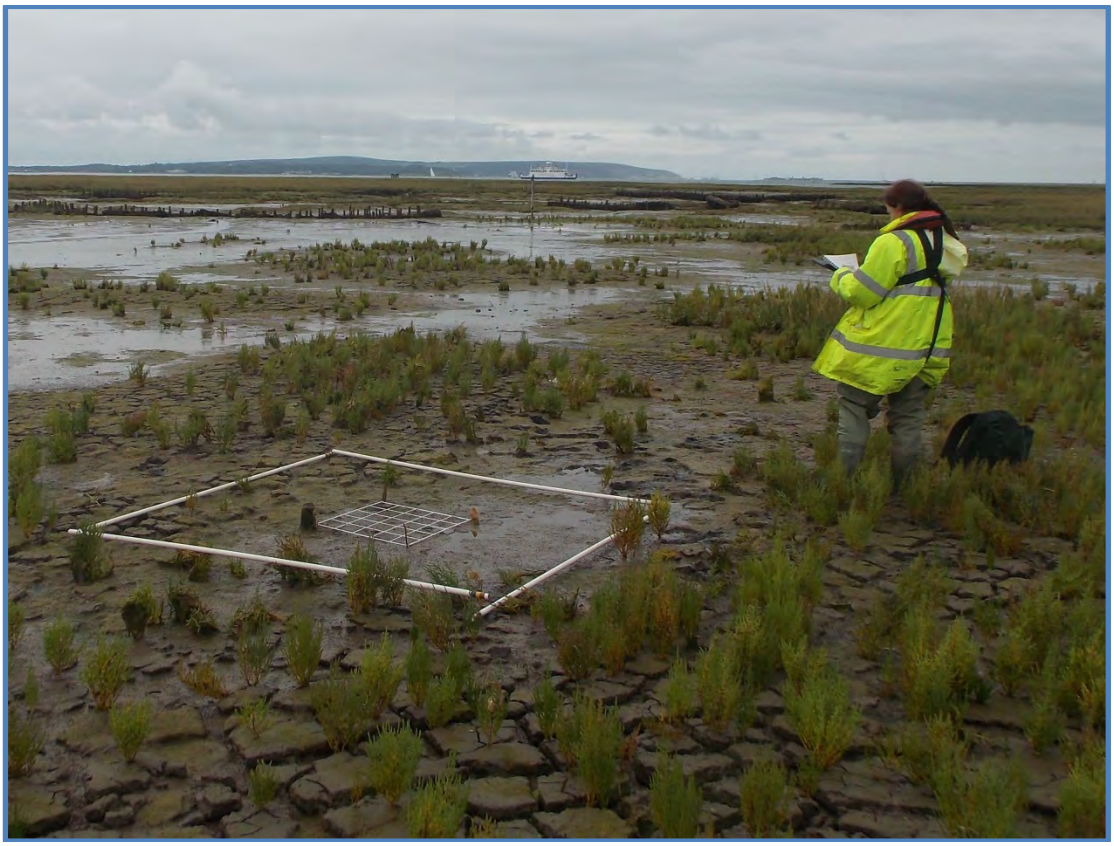

Image 1. View of the recharge area September 2014

During these recharge campaigns a total of 4,450m^3 of dredged sediment were placed on the decaying marsh. The greater proportion of this (3,120m^3) was placed in 2013 while in 2012 a lower volume (1,330m^3) was deposited due to time constraints and technical challenges during this first campaign[1]. From these two campaigns, a total of over 2,000m^3 of sediment was retained (as required) within the recharge area while the remainder dissipated into the environment and often settling quite close to the site. On the basis of the work done it was agreed, at the November 2013 EMP meeting, that no further recharge was required in 2014 but that monitoring should continue for another year. Summary details about the scope of this 2014 monitoring work are presented in Section 2.

In keeping with the 'adaptive management' principles of this mitigation and monitoring work, the results of this monitoring survey are to be viewed alongside the results of separate monitoring work that has been undertaken to monitor the effect of the ferries. These results, for the period from June 2009 to July 2014, have been presented in a separate report to the EMP (ABPmer 2014).

[1] The methods are described in greater detail within the preceding annual reports (ABPmer 2012c and 2013c).

2. Methods

2.1 Summary of Key Monitoring Tasks

The monitoring requirements for assessing the success of the Habitat Works (in meeting the 'Objective') are set out in Schedule 5 of the Section 106 Agreement (S106), 2011 and within a supporting Recharge Method Statement (ABPmer 2010). The survey work undertaken in 2014 adheres to the requirements of this 'monitoring protocol' although not all of the listed survey elements are now required for the 2014 review period (as presented in this report). This is because some of the necessary work has now been completed and has been presented within previous reports (ABPmer 2012c and 2013c). This includes aspects such as: the documentation of recharge campaigns and water quality monitoring during the recharge work itself. In addition the EMP has agreed that some work is no longer required such as measurements of shear stress in the recharge sediment or sampling of the marine invertebrate colonisation of the habitat.

The main focus of the 2014 monitoring work was to describe the functioning of the recharge area and the surrounding saltmarsh. The key components of the 2014 survey work were as follows:

- Regular sites visits and an annual survey of the recharge site which includes the following:
  - Fixed point photographs of stakes to record the change in level of the marsh/mudflat (during both surveys);
  - *In situ* samples/notes of saltmarsh plant growth during the autumn survey; and
  - *In situ* quadrat-based analysis of plant abundance (during the autumn survey) at 10 fixed-point locations to describe the quality of the marsh habitat immediately surrounding the Recharge Site.

- Use of aerial imaging data (e.g. aerial photographs and Light Detection And Ranging (LiDAR) data) made available from the separate monitoring programmes conducted in the Solent (by Environment Agency (EA) and/or the Channel Coastal Observatory) to understand how the marsh surrounding the Recharge Site and the other intertidal habitats beyond are evolving.

- Surveys of bird numbers (to be undertaken in the winter following each recharge) to understand the value of the recharge site as a feeding habitat for birds[2].

Outline details about these three survey components are presented in the following sections.

[2] Following consultation with the EMP, it was decided that monitoring work would be best undertaken by introducing a fixed-point camera taking continuous pictures that could be reviewed later. This was because it is difficult for an ornithologist to access this site without also disturbing any birds using the area.

2.2 Site Visits and Annual September Survey

During the process of developing and implementing the mitigation measures, surveys, inspections and site visits have been undertaken regularly since July 2010. These have been carried out to initially describe the baseline conditions and then to describe the results of the recharge work. This work has included regular annual surveys of the marsh in September each year from 2010 to 2014. A full list of the 17 previous site visits and surveys undertaken was presented in the preceding monitoring report (ABPmer 2013c).

In 2014, three further visits and an annual September survey were conducted as follows:

- 6 February 2014: Site visit/inspection one year after the second recharge to check on performance of the site after the winter storms and download data from the static camera;
- 6 March 2014: Site visit/inspection undertaken with the Marine Management Organisation (MMO) to confirm adherence to marine licence conditions;
- 29 July 2014: Site visit/inspection to check on performance of the site and download data from the *in situ* camera; and
- 1 September 2014: Third post-recharge ecological survey (including fixed-point photography and saltmarsh quadrat monitoring).

The monitoring positions for these visits and especially for the annual surveys were established during the first baseline survey (in July 2010). This included:

- Nine boundary posts around the internal edge of the recharge area which mark fixed-point photograph locations;
- Ten saltmarsh quadrat sampling sites on the surrounding marsh,
- Four benthic core and sediment analysis sites; and
- Several graduated stake locations (to monitor sediment elevation).

In subsequent years, additional sites have been added to obtain extra information or repositioned where required. A full list of these monitoring positions is presented in the preceding reports and their positions are illustrated in Figure 3.

In September 2014, following methods adopted in past years, fixed-point photographs were taken from each of the boundary post markers and recordings were made of sediment elevations at each of the graduated stake locations across the recharge area. At each of the ten saltmarsh sampling location a 0.5x0.5m (0.25m^2) quadrat was used to objectively record species abundance and coverage. Also, following a recommendation made by the EMP, an additional 2mx2m (4m^2) quadrat was used to describe the percentage coverage of plant

species at each saltmarsh sampling locations in both 2013 and 2014. This larger quadrat was added to describe the broader changes in species abundance and coverage at these locations.

2.3 Aerial Imaging and CCO Topographic Surveys

To complement the site visit and annual survey work, extra data has been made available for this study by the Environment Agency and CCO. As part of their national monitoring commitments the Environment Agency collect LiDAR data across this part of the shoreline on an annual basis. This describes the intertidal habitat elevations. For this report, the Environment Agency provided the latest LiDAR data (as collected in March 2014) and this has been reviewed alongside previous data as also provided for each year since 2007.

In addition, the CCO has also begun collecting survey data at this location. They carried out a laser elevation survey of the recharge area just before and just after the 2013 recharge (in October 2012 and April 2013 and April 2014). This data can be used to define with a relatively high level of accuracy the changes in bed elevations and the amount of sediment that was retained within the recharge area (Image 2 provides an example output of this work). CCO has provided the results of these surveys and these have been reviewed for this study.

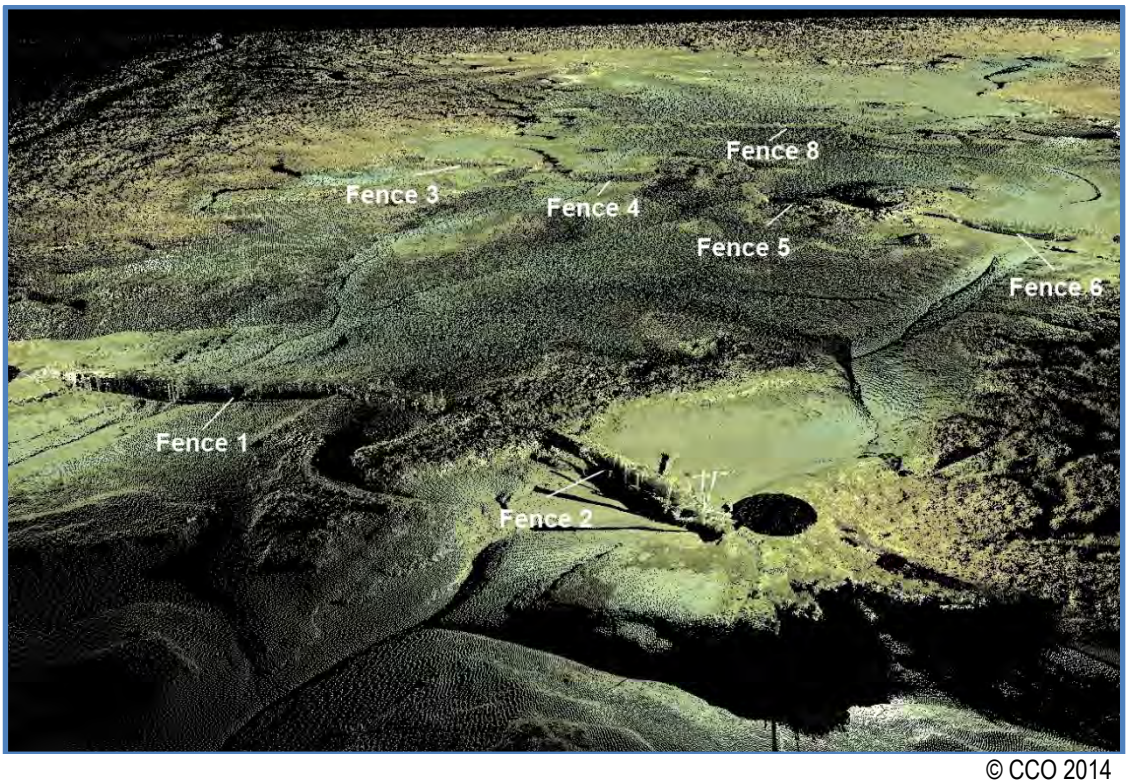

Image 2. 'Aerial' view of recharge from CCO laser elevation survey April 2014

2.4 Surveys of Bird Numbers

To qualitatively describe the bird use of the recharge area, a static camera was deployed on the site. A camera was used (as noted in footnote above) because the visibility of the site from a boat is poor and accessing the site for surveys itself causes disturbance and influences any results obtained.

The camera was set up on 29 January 2013 viewing (to the north and away from the sun) the upper recharge area where the main sediment placement work took place. Photographs were taken at least every minute for the majority of its deployment and it was then removed on 1 September 2014. Photographs from this camera were obtained and reviewed for February to June 2013 and 2014 in order to describe the bird activities on site in the late winter and early spring/summer breeding periods.

3. Results and Discussion

3.1 Introduction

In this section the data obtained from the 2014 surveys are presented and then reviewed in the context of the findings from past survey work. This has been done in order to describe how the recharge area has performed and then evolved over the 18 months following completion of the second recharge campaign. The key surveys that are considered include the following undertaken by ABPmer, EA and CCO:

Baseline Surveys:

- Remote sensing EA LiDAR surveys annually 2007 to 2011 (before recharge)
- On-site ABPmer surveys in July 2010, September 2010 and September 2011; and
- Remote sensing EA LiDAR survey January 2012 (<1 month before first recharge);

After First Recharge (February to March 2012):

- On-site ABPmer annual survey in September 2012 (6 months after first recharge);
- On-site CCO laser-scan survey October 2012 (7 months after first recharge); and
- Remote sensing EA LiDAR survey January 2013 (<1 month before second recharge).

After Second Recharge (February to March 2013):

- On-site CCO Laser Scan survey April 2013 (1 month after the second recharge);
- On-site ABPmer annual survey in September 2013 (6 months after first recharge);
- Remote sensing EA LiDAR survey March 2014 (1 year after second recharge);
- On-site CCO laser-scan survey April 2014 (13 months after the second recharge); and
- On-site ABPmer annual survey in September 2014 (18 months after second recharge).

3.2 Performance of the Recharge Area

To describe the latest conditions on the recharge site, a selection of the fixed-point panoramic photographs (taken on site over the last three years) is shown in Appendix A. The results of the sediment elevation changes at each of the graduated stake locations are also shown in Table 1 and in Images 3 and 4.

In addition, the results of the Environment Agency LiDAR surveys are shown in Figures 4 to 5 (expressed as differences in elevation between 2008 and 2014 and between 2013 and 2014) and in Figure 6 (showing cross-section elevation changes based on annual surveys from 2007 to 2014). A visual summary of the bed elevation changes from the April 2013 and 2014 CCO survey work is also presented in Appendix B.

The results from all these surveys show how much of the sediment was retained on site after the two recharge campaigns and, then, how it has remained stable subsequently. They also provide information about more subtle changes in bed elevations that have occurred over the 18 months following the recharge. Based on all the surveys listed above[3], a summary of how the site has evolved since the second recharge campaign is detailed below.

As described in the previous annual report (ABPmer 2013c), more than half of the sediment which was pumped to the site stayed within the defined recharge area (the zone defined by the surrounding marshes and the fences as shown in Figure 3). The bulk of this sediment settled across the top (northern) half of the recharge area nearest to the discharge locations. However, sediment also settled throughout much the southern half of the site. This was mostly deposited within the main drainage channels but also across the adjacent banks between the more elevated clay mounds (see Figures 4 and 6). Furthermore, much of the sediment which did not remain within the recharge area settled along the channels and creek margins just outside the recharge area to the south of the last fence alignment.

After deposition, the deposited sediment then settled and consolidated and its elevation was reduced by around 20%. Most of this sediment consolidation happened in the first few weeks and months. For example, at Stake I in the northern part of the site where the sediment was deepest, the sediment was at 38.5cm depth in March 2012 and it then consolidated down by 6cm to June 2013 and then by a further 2cm to September 2013. After this first summer, the now consolidated sediment in this northern half of the site was lying at depths of around 80cm (where it had settled over the deeper drainage channels) and around 10-30cm on average across the adjacent banks.

In the southern part of the site after the first summer it was also at depths of around 80cm in the channels (see Figures 4 and 6) but at shallower depths across the adjacent banks. The sediment depths over the banks reflected the pattern of sediment dispersion and therefore generally reduced in a southerly direction away from where the sediment discharge pipe was positioned. Thus, the depths over the adjacent banks were around 10cm in the middle of the site (e.g. at Graduated Stake E) and around 1-5cm (at Graduated Stakes J, L, M, N and O) in the southernmost section (see Figure 3 for Stake locations). Also, outside the recharge area similar levels of sediment deposition and retention (around 4.5cm depth at Stake K) were recorded in September 2013.

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3 Please note that care needs to be taken when comparing the results from the three sources as they were taken at different times, describing different periods of change and with varying levels of accuracy (see Section 3.1). Also the Environment Agency surveys are not necessarily labelled by the calendar year in which they were taken so that their '2013' winter survey was undertaken in March 2014.

Table 1. Sediment elevation (cm) changes from baseline at the graduated stakes

Graduate Stake Ref	Stake Colour Codes	July 2010	September 2010 (cm change)	September 2012 (cm change)	September 2013 (cm change)	September 2014 (cm change)
Stake A		Installed	+2.0 *	Not Taken	+13.5	+13.5 (0.0#)
Stake C		Installed	+1.5 *	+1.0 *	+1.5 *	-1.5 (-3.0#)
Stake D		Installed	Not Visible**	+7.4	+8.7 *	+11.9 (+3.2#)
Stake E				Installed	+10.5 *	+10.5 (0.0#)
Stake F				Installed	+17.9 *	+18.4 (+0.5#)
Stake G				Installed	+8.2	+10.7 (+2.5#)
Stake H				Installed	+30.5 *	+ 30.5 (0.0#)
Stake I				Installed	+29.5	+29.0 (-0.5#)
Stake J				Installed	+2.5 *	+3.0 (+0.5#)
Stake K				Installed	+4.5 *	+4.5 (0.0#)
Stake L				Installed	+1.0 *	no reading
Stake M				Installed	+4.0	+4.0 (0.0#)
Stake N				Installed	+5.2 *	+11.2 (+6.0#)
Stake O				Installed	+3.5 *	+8.0 (+4.5#)

* There was a layer of green algal growth over substratum influencing readings by up to maximum of 2cm.

** This stake was in water at the time of the survey so unable to get a definable accretion level.

These values in brackets describe the sediment elevation change between the 2013 and 2014 survey. All other values in the table express change from the time that the stake was put in place.

By September 2014, after a further year, it is clear that the area has been very stable. There was very little further reduction in elevation through consolidation and there was net sediment accretion overall. Between September 2013 and 2014, the northern area, where the majority of the sediment settled out, showed either no elevation change (Graduated Stakes A, E, F, and H) or exhibited a marginal reduction in elevation (0.5cm at Graduated Stake I). This stability of the sediment is shown by the results in Table 1 and illustrated by the photographs of the Graduated Stakes in Images 3 and 4 as well as by the photographs of the general area in Image 5. Also it is notable that there has been accretion (by 2.5cm) in the most sheltered area at the very top of the site (Graduated Stake G).

Across the southern part of the site between September 2013 and 2014, there was typically net accretion of between 1 and 6cm (at Graduated Stakes D, J, N and O) or there was no change (Graduated Stake M). At Graduated Stake C there was erosion of 2.7cm however this stake is positioned at the surface of an exposed clay mound and, therefore, this change is likely to signify a process of continued erosion of that exposed surface rather than a change to the deposited sediment. Outside the site near to Fence 1, Stake K has also shown no change after the 4.5cm of deposition observed following the recharge.

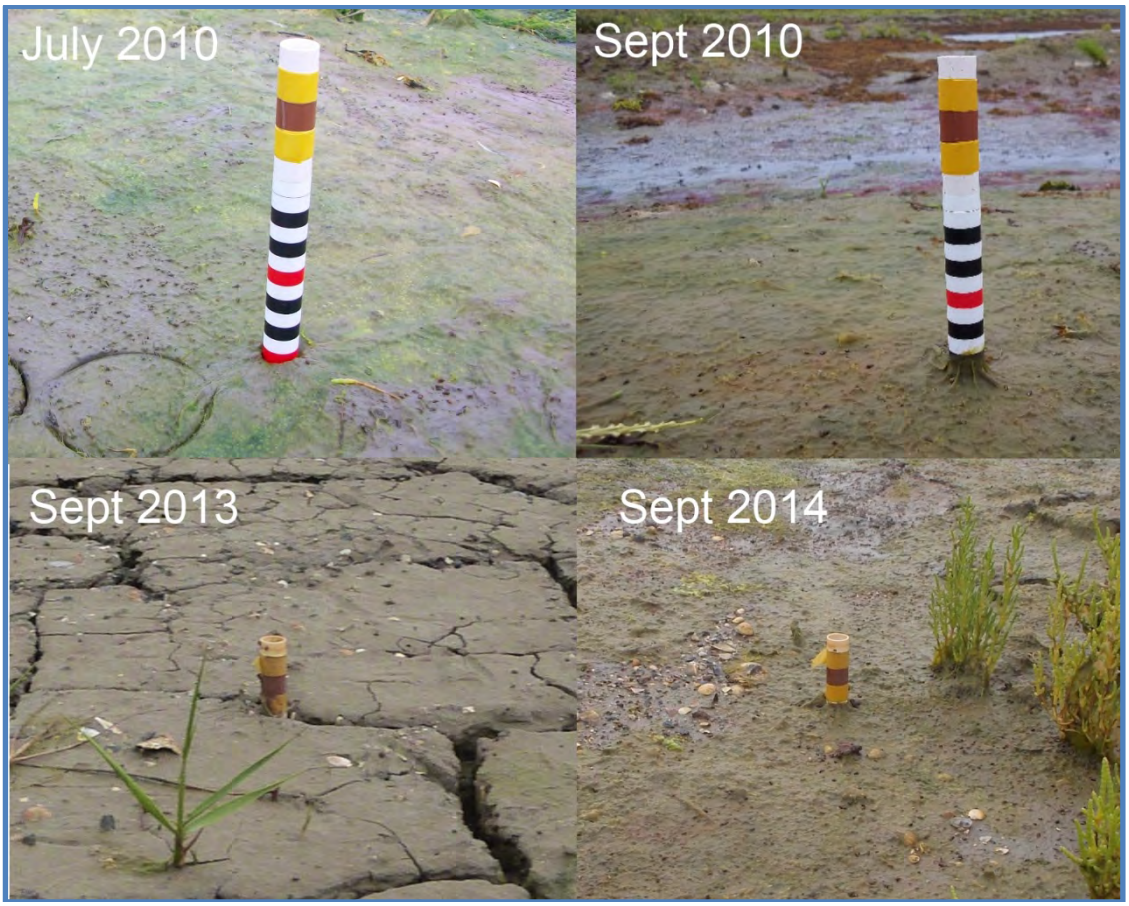

Image 3. Graduated Stake A before and after the 2012 ad 2013 recharge work

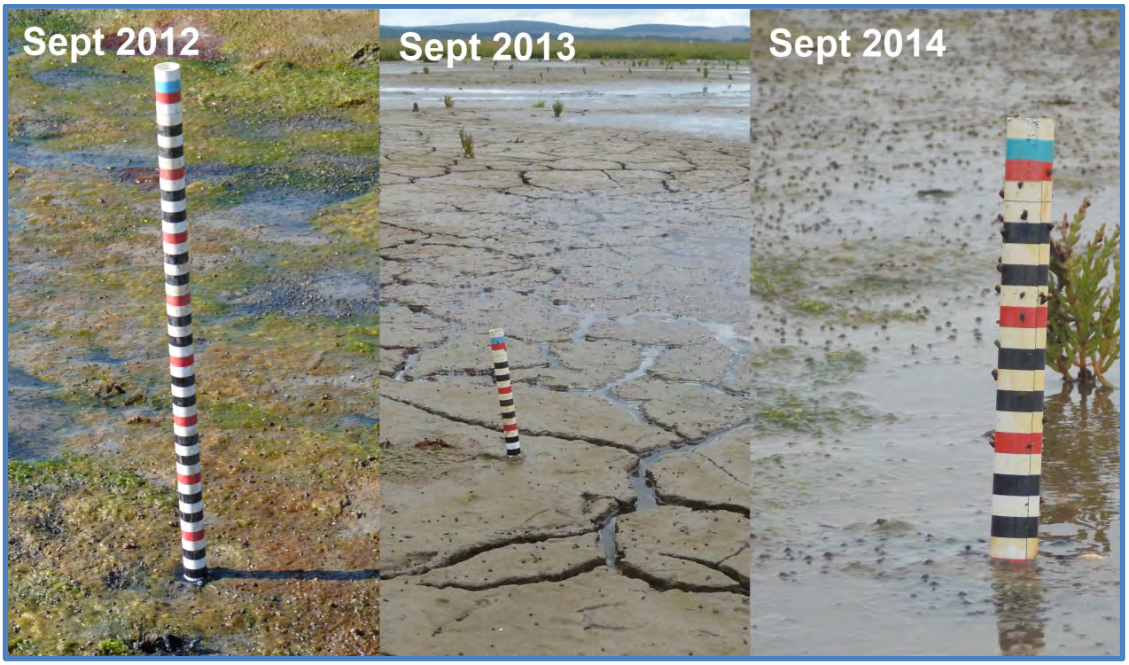

Image 4. Graduated Stake I after the 2012 and then 2013 recharge work

These results are supported by the findings from the latest EA LiDAR surveys taken in January 2013 and March 2014. These were taken before and a year after the 2013 recharge and indicate how the sediment has stayed *in situ*. The results are described in Figures 4 to 6. Figures 4 and 5 show the habitat elevation changes in a plan-view format. Figure 6 presents a cross-section of the bed elevations and describes how, by March 2014, the recharge sediment was still present at depths of 60-70cm at the top end of the site (a combination of recharge sediment place in both 2013 and 2014) with the recharge sediment then become becoming shallower (up to 15 to 20cm deep) at the southern end of the site. It also confirms that there was net sediment deposition immediately outside of the site to the south by March 2014.

These findings are also mirrored by the latest CCO survey results. The most recent two surveys were taken immediately after the second recharge in April 2013 and then again a year later in April 2014. Therefore, they describe how the site has developed since the final campaign. Over this post-recharge period these results show that there was a reduction in elevation of the northern half of the site by around 6cm, a relatively stable condition in the central section and accretion of up to 10cm in the southern section and in the small creek at the top of the site (beyond Fence 10). Across the whole site the CCO analysis also indicates a slight net accretion of 100m^3 between April 2013 and 2014, and the general changes in elevation from this work are most clearly described by the plot shown in Appendix B.

The CCO results also indicate that there has been net accretion outside the recharge area extending around 60m to the south. The degree of sediment deposition/accretion reduced with distance away from the final outer fences and was approximately 10cm at a location close to Fence 1 and then around 3cm to 4cm at a location 30m away.

Together the graduated stake and CCO survey results confirm that after the recharge in the northern half of the site there was a period of initial sediment consolidation and this area subsequently stabilised from September 2013 onwards. As the CCO data describes the change between April 2013 and April 2014, the reduction in elevation it describes in the northern half of the site is likely to represent this period of early summer consolidation.

Both surveys then indicate that there was accretion in the central and southern sections of the area much of which happened after September 2013 and before April 2014. Some of this accreting material will be sediment that has eroded within the site from the channels in the northern part of the site or from the surfaces of the exposed clay mounds. However, a good proportion of the accreting sediment is likely to have been imported and then settled into the area.

It is likely that the fences, which will be marginally slowing the rate of tidal flow though the site, are helping to create 'stilling' conditions in the area and are helping to trap suspended material. It is also notable that the amount of sediment that was present naturally in suspension was quite high following the 2013/14 winter storms and therefore the propensity for accretion in the area may well have been greater than usual in the 2014 spring/summer period. From the separate ferry monitoring work, there were also comparable indications of relatively high sediment accretion alongside the Lymington Channel (ABPmer 2014) during early 2014. These were also attributed to the storm effects and the greater amount of resuspended sediment in the water column as a result.

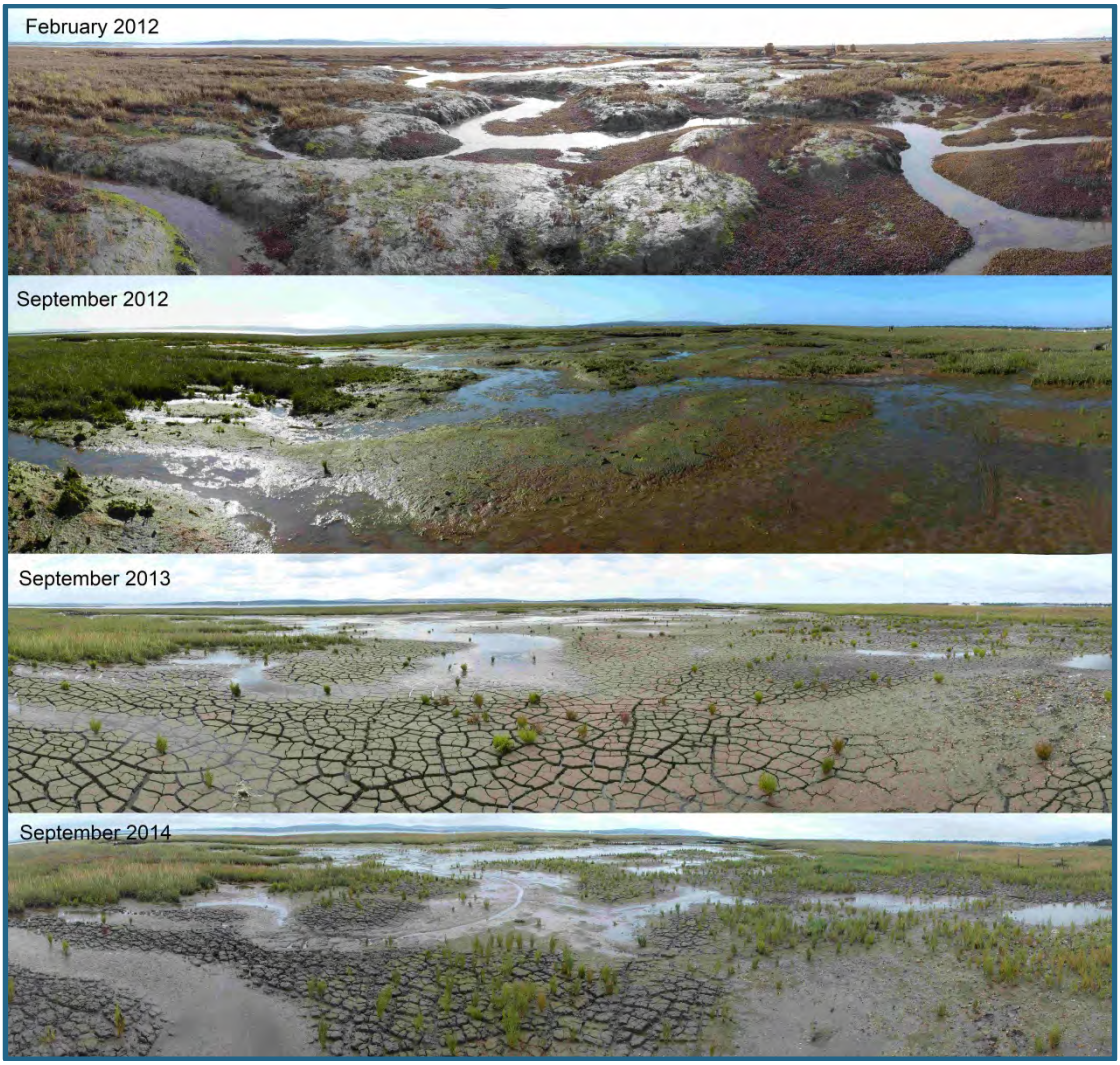

Image 5. View from BP3 before and after the recharge campaigns in February March 2012 and 2013

On present evidence, though, it is not possible to conclude whether the area will be a net importer of sediments in more typical years. However, it is clear that the habitat is stable and has achieved the objective of reversing an ongoing process of physical erosion across this decaying area of the marsh.

From survey observations made in 2014 (see also Section 3.3 and 3.4) it is evident that the recharge area also retains a comparable ecological functionality to that recorded in 2013. The higher elevation areas at the top of the site are increasingly being colonised by pioneer saltmarsh plant species (see Section 3.3). The other areas of mudflat habitat across the sites are often visibly dominated by mud snails and, based on results from the 2013 survey, have a relatively low biodiversity and richness. This was in keeping with the conditions experienced under baseline conditions with the relatively impoverished mudflat habitat having recovered rapidly following the recharge work. It is clear, though, that bird prey species are present and there are signs of regular but low-level bird feeding within this habitat (see Section 3.4).

For the most part the sediment retaining fences are also stable. In large part this is because most of them are buried under the sediment. However damage occurred during the winter storms to exposed parts of some fences with bales and polders having been removed. This is particularly evident at the side of most exposed Fence 2. However, the damage is minor, entirely to be expected and is not compromising the functioning of the site and its overall stability.

3.3 Saltmarsh Around and Within the Recharge Area

The results of the saltmarsh monitoring including photographs of the quadrat sites are shown in Appendix A. The data from the quadrat analysis are presented in Tables 2 and 3 which respectively describe the results from the 0.25m^2 and the 4m^2 sampling. The results from the 4m^2 quadrats are also shown in Figure 7.

The sampling locations are labelled Quadrats 1 to 11 (see Figure 3). Quadrats 1 to 10 are located outside and surrounding the recharge area and have been analysed regularly to understand how this surrounding marsh is naturally developing over time (i.e. in a manner unrelated to the recharge work). These sites have been sampled annually since 2010 although Quadrat 2 is no longer sampled as it was lost between the 2012 and 2013 surveys when the margins of the adjacent channel moved.

In 2013 Quadrat 11 was added to the survey regime. This site is positioned on the northernmost part of the recharge area where the sediment was sufficiently elevated and firm to be accessed. This quadrat provides information about how marsh plants are colonising this section of the recharge area. However, given the patchy nature of that colonisation, the best indication of this plant coverage is provided by the photographs of the general area as shown Images 1, 5 and 6.

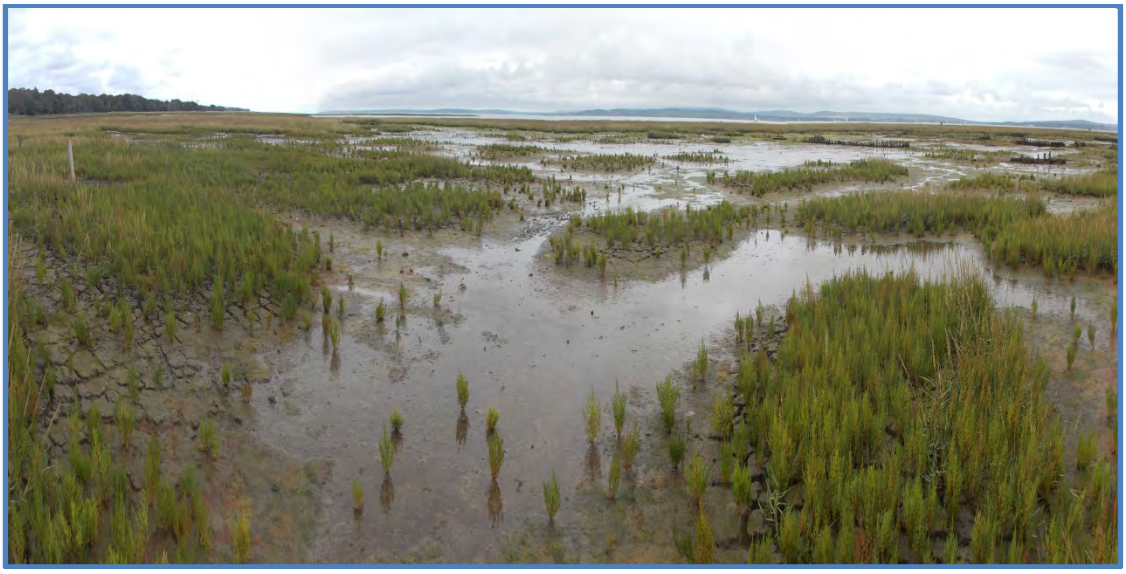

Image 6. View from BP2.5 September 2014 showing plant colonisation in the northern part of recharge area

Table 2. Saltmarsh species frequency at 0.25m^2 quadrat sample site (2014)

Common Name	Latin Name/Quadrat	1	3	4	5	6	7	8	9	10	11*
Sea Aster	*Aster tripolium*				2	2					
Sea Purslane	*Atriplex portulacoides*	9		17		25	1	25	9	25	
Sea Lavender	*Limonium vulgare*	25	10	12	11	3	21	1	14		
Saltmarsh-grass	*Puccinelia maritima*		8	13	19	4	24	2	12		
Glasswort	*Salicornia spp*	24	8	24	18	12	25	5	21	16	
Cord-grass	*Spartina anglica*	19	21	18	18	17	16	15	24	18	
Annual Sea-blite	*Suaeda maritima*	1			5	4	4	4		4	
Vegetation % Cover (remainder mud or water)		80	45	95	50	98	95	98	80	98	0

Values for plant species indicate number of 'cells' in which species were present within 25 10x10cm cells within a 0.25m^2 quadrat
* Site 11 is located on the recharge area while all other sites are located on the established surrounding marsh (see Figure 3)

Table 3. Saltmarsh species frequency at 4m^2 quadrat sample site (2014)

Common Name	Latin Name/Quadrat	1	3	4	5	6	7	8	9	10	11
Sea Aster	*Aster tripolium*			15	2	1	1	1		1	
Sea Purslane	*Atriplex portulacoides*	4		20		45	1	50	20	82	
Sea Lavender	*Limonium vulgare*	20	25	25	15	4	25	10	10	4	
Saltmarsh-grass	*Puccinelia maritima*		2	4	10	2	2	1	5		
Glasswort	*Salicornia spp*	35	20	5	26	5	30	5	5	5	3
Cord-grass	*Spartina anglica*	10	23	26	10	33	25	25	35	5	
Annual Sea-blite	*Suaeda maritima*	1			2	5	1	3			
Vegetation % Cover (remainder mud or water)		70	70	95	65	95	85	95	75	97	3

All values shown indicate the percentage cover of species present within a 4m^2 quadrat

As described during previous surveys, the marsh surrounding the recharge area is characterised by a typical range of pioneer and middle-low shore marsh species. The species composition of the plant communities at any given location varies in response to differences in tidal elevation, exposure levels and the degree to which there is good drainage of tidal waters. At Quadrats 4, 6, 8 and 10, which are the more elevated and/or well drained sites, there is a robust plant assemblage with a dense coverage (95-98%) of species such as Sea purslane, Common Sea lavender and Cord grass. In 2014, as in past years, these sites continued to have this dense cover indicating a relatively high stability compared to other areas.

By contrast, at Quadrats 1, 3, 5 and 9 to the north and east of the recharge area the plant communities are under greater stress due to lower elevations and/or more poorly draining conditions. In 2014, there is continued evidence of decay at these sites and a continuing decline in the percentage plant coverage (i.e. an increased proportion of visible mud or poorly draining water). Site 5 was worst affected because of the poorly draining conditions at this location and, as a result, plant cover declined by an estimated 20% over the last year alone (see Image 7).

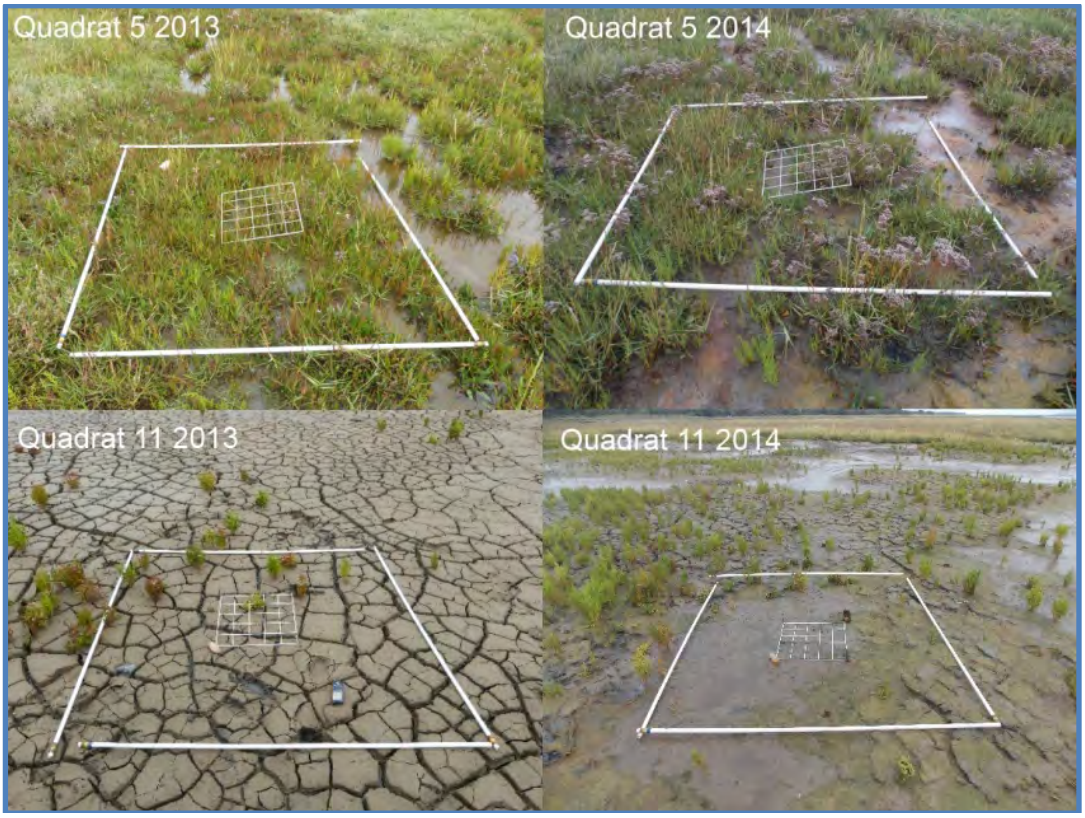

Image 7. Saltmarsh deteriorating at Quadrat 5 and developing at Quadrat 11

These results continue to show that the quality of the marsh surrounding the recharge area is in decline in many areas. Thus there is a continued process of both external physical erosion and internal qualitative deterioration (referred to as 'pan die back'). The outer exposed face of the marsh is continuing to retreat by around 2 to 3m per year on the exposed eastern face (see Figures 4, 5 and 6).

Within the recharge area the marsh has been expanding with plant colonisation (mainly *Salicornia* and *Spartina* spp.) occurring across approximately 10% of the area (see Images 1, 5, 6 and 7). As noted previously this 10% in the northernmost half of the site occurs in areas where the sediment is highest and, hence, the frequency of tidal inundation is lowest. Plant density/coverage within this area is still relatively low, but the observed pattern of colonisation is in keeping with other previous recharge projects. It usually takes 4 to 5 years to achieve 100% plant coverage over initially barren sediment in areas that have an appropriate elevation and good drainage.

The saltmarsh survey results confirm previous expectations that the main path of likely future 'pan die back' will be in the direction of Sites 5 and 9 to the north of the recharge area. This is still considered to be the case and certainly the area where the marsh is narrowest and most likely to break up. However, the changes at Sites 1 and 3 as well as the historic patterns of marsh die-back on the margins of the recharge increasingly indicate that the rate of die-back is likely to be just as great to the east.

3.4 Bird Usage

Under baseline conditions the recharge area was not a major feeding ground for waterbirds. This is because it had a relatively low abundance of key prey species and the sediment was soft, anoxic and often covered with a surface layer of macroalgae. As a result, the pre-recharge baseline surveys indicated that there were low numbers (around 18 birds per survey) of species feeding in the area (although access and site visibility for these surveys was poor). The species recorded were: Shelduck, Oystercatcher, Redshank, Dunlin, Grey Plover, Curlew, Turnstone and Brent Goose.

After the 2013 recharge work there have been subtle changes to the benthic invertebrate species on the site and a greater range of habitat niches than were available under the baseline conditions. However these are not expected to result in substantial positive or negative changes to the value of the site in terms of the bird prey resource. This was indicated by the results of the invertebrate sampling in 2013 and by the bird survey results obtained in the period from February to June 2013. During this period, birds were observed intermittently roosting and feeding in the northern part of the site (i.e. the zone covered by the static camera) at abundances similar to baseline levels.

In February 2013 before sediment pumping work started, the most common species observed were Brent Geese, Shelduck and occasional waders such as Redshank, Bar-tailed Godwit and Curlew. Shelduck and waders were often observed feeding while Brent Geese were recorded loafing on the water in larger numbers (10-30 birds) towards high tide. In the weeks after the recharge, and as the mud became firmer, birds began to forage on the mud again. Black Headed Gulls became the most common species when they began to breed on the surrounding marshes (which are an important nesting and roosting site). The adults fed on the mud when the tide was out and many were seen loafing on the water when the tide was in. The number of gulls present increased throughout the survey period and on 24 May 2013 an estimated 100 gulls were observed at dusk feeding and preening at low tide.

Similar results were obtained for the equivalent February to June period in 2014. The dominant species throughout was Brent Geese which were recorded in moderate numbers (up to around 30 individuals) loafing at high water or feeding on the ebbing or flooding tide (see Image 8). Low numbers of wader species (1-6 individuals) such as Curlew, Shelduck and Oystercatcher were occasionally recorded feeding across the northern part of the site.

From April onwards Black Headed Gulls again became the most common species as they began to breed on the surrounding marshes. The adults foraged on the mud when the tide was out and were seen loafing on the water when the tide was in. The number of gulls present increased throughout the survey period.

The results show that the site continues to have a low value for feeding and roosting wader species. It provides a well-used roosting location, and occasionally a feeding site for gull during the breeding season. It is functioning as expected for a high level mudflat at and near the mean high water mark.

Image 8. Waterbirds feeding and roosting in the northern part of the recharge area

3.5 Further Work

The results of this work were discussed at a meeting of the EMP which was held on 20 November 2014 (following circulation of a draft copy of this report). At that meeting, it was agreed that the results from the recharge surveys and from the separate ferry monitoring work were positive and that there was no need for further recharge campaigns in 2015.

It was also concluded that there should be a substantial reduction in the monitoring and reporting work. In 2015 an annual survey of the recharge area will again be undertaken in September and only a brief technical note produced of the results from this and any separate Environment Agency or CCO data. There will only be a meeting of the EMP in 2015 if these results highlight any issues, otherwise the next meeting will be in November 2016.

4. References

ABPmer (2010). Wightlink - Replacement Lymington to Yarmouth Ferries: Method Statement for the Recharge/Habitat Creation Work. ABP Marine Environmental Research Ltd, Report No. R.1687. October 2010.

ABPmer (2012a) Wightlink - Replacement Lymington to Yarmouth Ferries: Monitoring Possible Short-term Effects of the W-Class Ferries - Progress Report 19, February 2012. ABP Marine Environmental Research Ltd, Report No. R.1556s.

ABPmer (2012b) Wightlink - Replacement Lymington to Yarmouth Ferries: Monitoring Possible Short-term Effects of the W-Class Ferries - Progress Report 20, December 2012. ABP Marine Environmental Research Ltd, Report No. R.1556t.

ABPmer (2012c) Wightlink – Replacement Lymington to Yarmouth Ferries: First Annual Mitigation and Monitoring Report (October 2012) Progress Report 1 and 3rd Report for the Environment Management Panel December 2012. ABP Marine Environmental Research Ltd, Report No. R.2007.

ABPmer (2013a) Wightlink - Replacement Lymington to Yarmouth Ferries: Monitoring Possible Short-term Effects of the W-Class Ferries - Progress Report 21 and 4th Report for the Environment Management Panel June 2013. ABP Marine Environmental Research Ltd, Report No. R.1556u.

ABPmer (2013b) Wightlink - Replacement Lymington to Yarmouth Ferries: Monitoring Possible Short-term Effects of the W-Class Ferries - Progress Report 22 and 5th Report for the Environment Management Panel November 2013. ABP Marine Environmental Research Ltd, Report No. R.1556v.

ABPmer (2013c) Replacement Lymington to Yarmouth Ferries: Second Annual Mitigation and Monitoring Report Progress Report 2 and 6th Report for the Environment Management Panel December 2013

ABPmer (2014) Evaluating Possible Effects of the Lymington to Yarmouth Ferries. Monitoring Report 23 and 7th Report for the Environmental Management Panel. ABP Marine Environmental Research Ltd, Report No. R.1556w.

S106 Agreement (2011): Agreement Under Section 106 Town And Country Planning Act 1990 relating to the application for planning permission to carry out Habitat Works for the protection, restoration and regeneration of an area of saltmarsh at Pylewell Bank and shore works at Lymington Pier within and adjacent to the Solent Maritime Special Area of Conservation (1) Solent and Southampton Water Special Protection Area (2) Solent and Southampton Water Ramsar Site (3) and The Hurst Castle and Lymington River Estuary Site of Special Scientific Interest (4) 21 October 2011.

Figures

LiDAR Survey Data (Mar 2014)
Elevation (mODN)

- -1.0 to -0.75
- -0.74 to -0.5
- -0.49 to -0.25
- -0.24 to 0
- 0.01 to 0.25
- 0.26 to 0.5
- 0.51 to 0.75
- 0.76 to 1.0
- 1.01 to 1.5

LiDAR data for the 2013 winter season were recorded on 5th March 2014. Dataset is gridded at 1m resolution and is unfiltered.

Date	By	Size	Version
Nov 14	NKD	A4	1
Coordinate System		British National Grid	
Projection		Transverse Mercator	
Scale		1:20,000	
QA		TAP	
3772-005_R2313_Fig1_Location of Boiler Marsh			
Produced by ABPmer			

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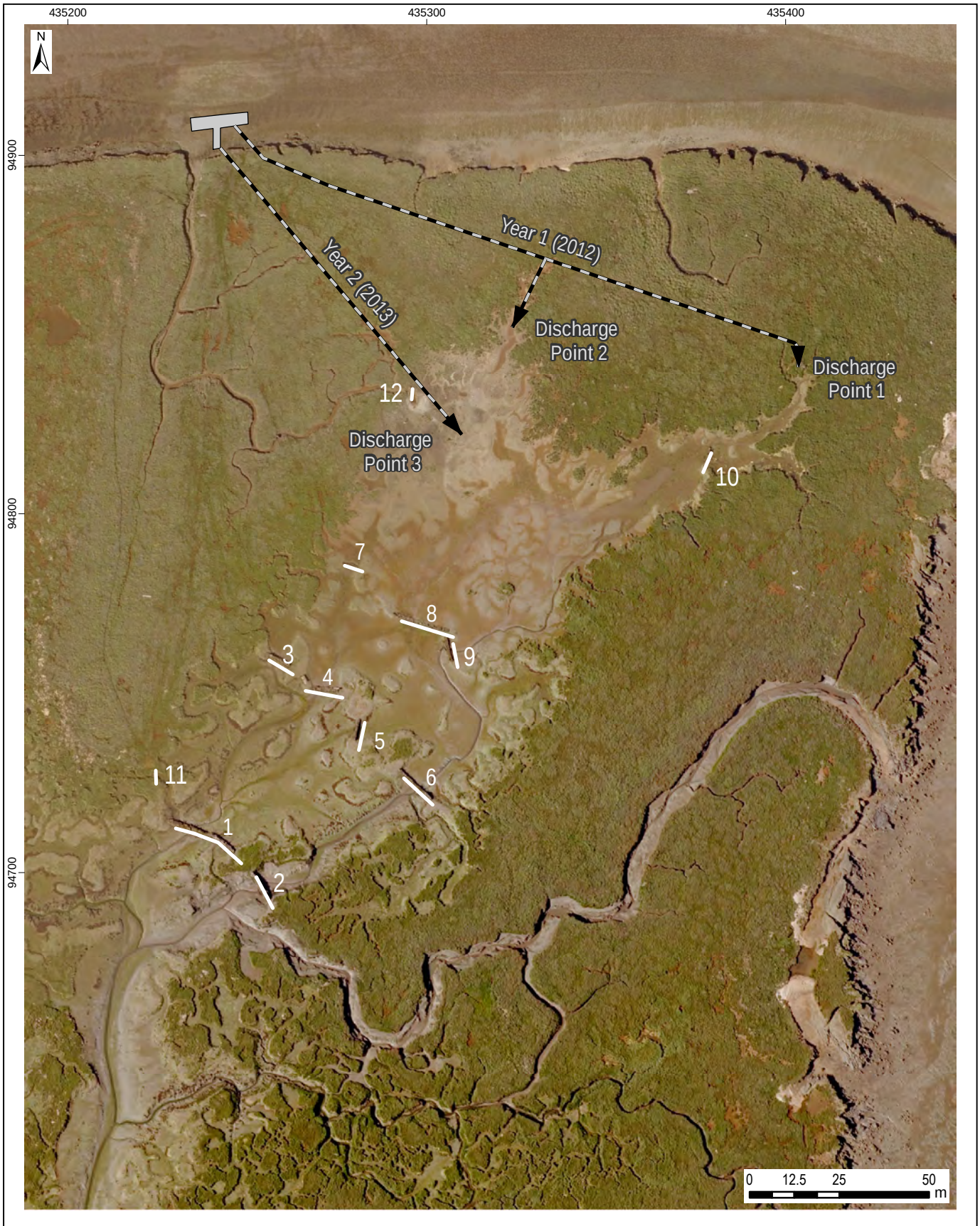
Location of the Boiler Marsh recharge area

Figure 1



Date	By	Size	Version
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Coordinate System	British National Grid		
Projection	Transverse Mercator		
Scale	1:1,500		
QA	TAP		
3772-005_R2313_Fig2_Recharge_work			
Produced by ABPmer			

Pontoon location

Pipeline routes and discharge points for recharge

Recharge fence locations

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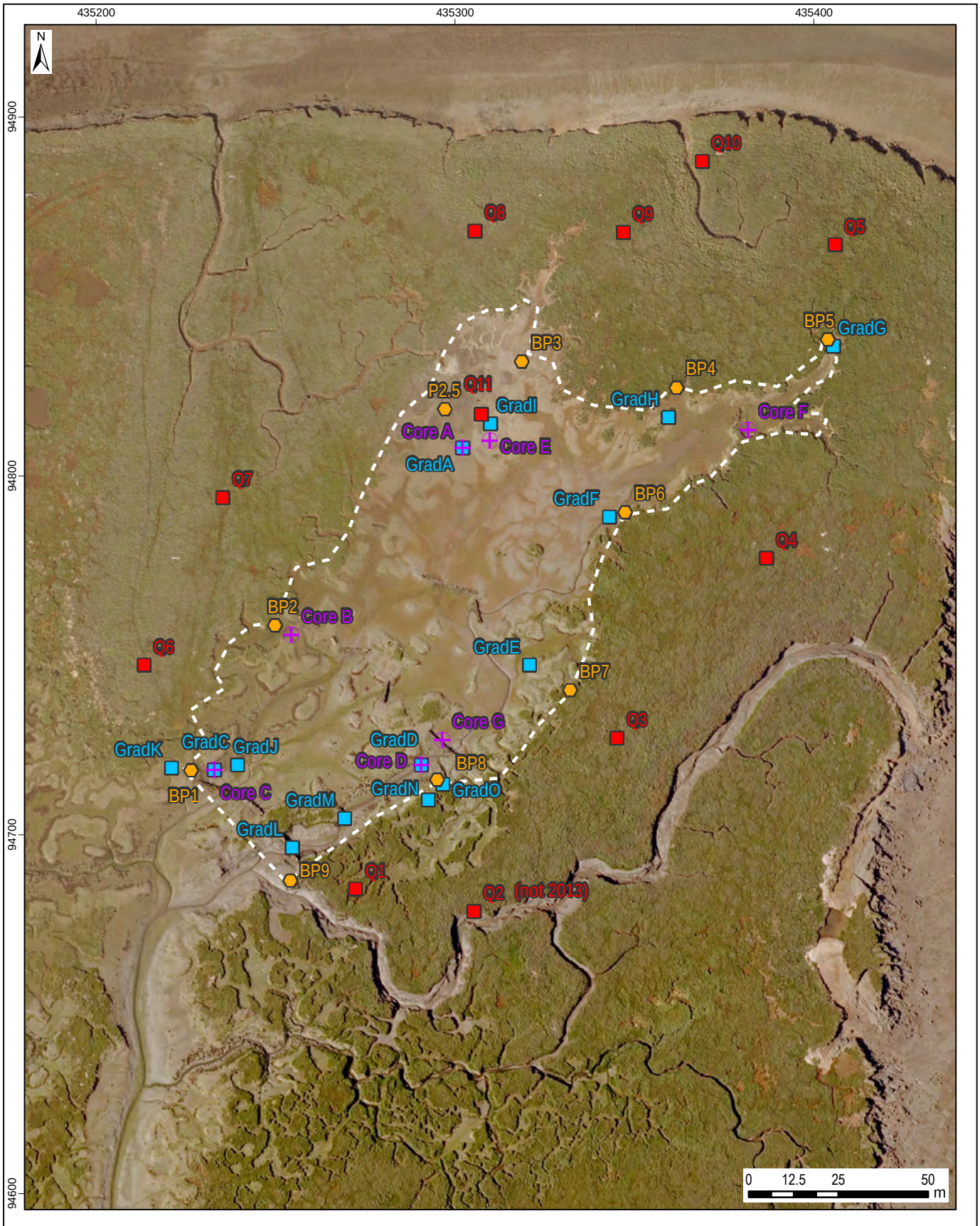
Location of pontoon, fences and pipelines for the Boiler Marsh recharge work

Figure 2



Date	By	Size	Version
Nov 14	NKD	A4	1
Coordinate System	British National Grid		
Projection	Transverse Mercator		
Scale	1:1,500		
QA	TAP		
3772-005_R2313_Fig3_Monitoring_Sites			
Produced by ABPmer			

- Recharge area
- Saltmarsh quadrat positions
- Benthic core sample sites
- Boundary post and fixed-point photography sites
- Graduated stake locations

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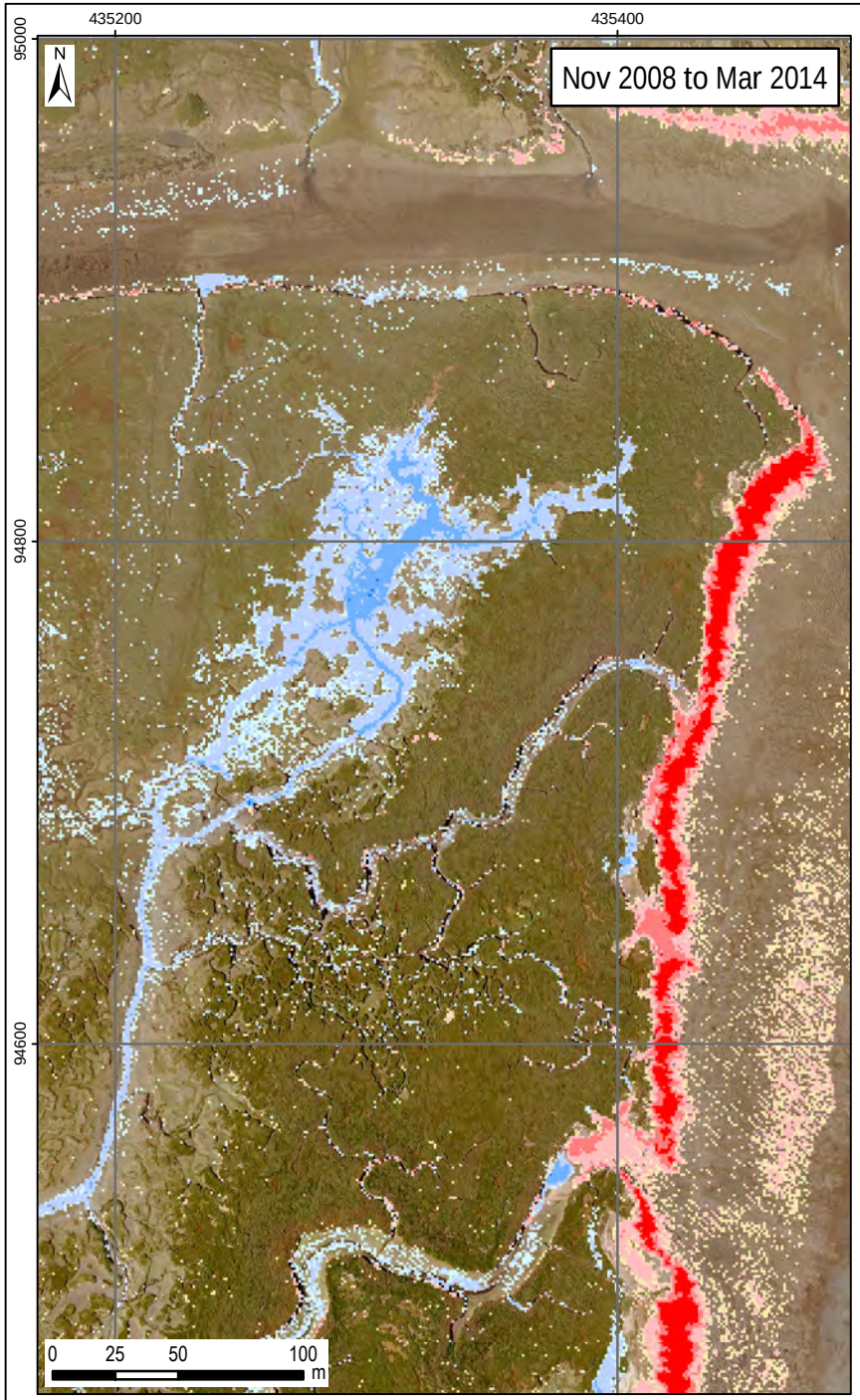
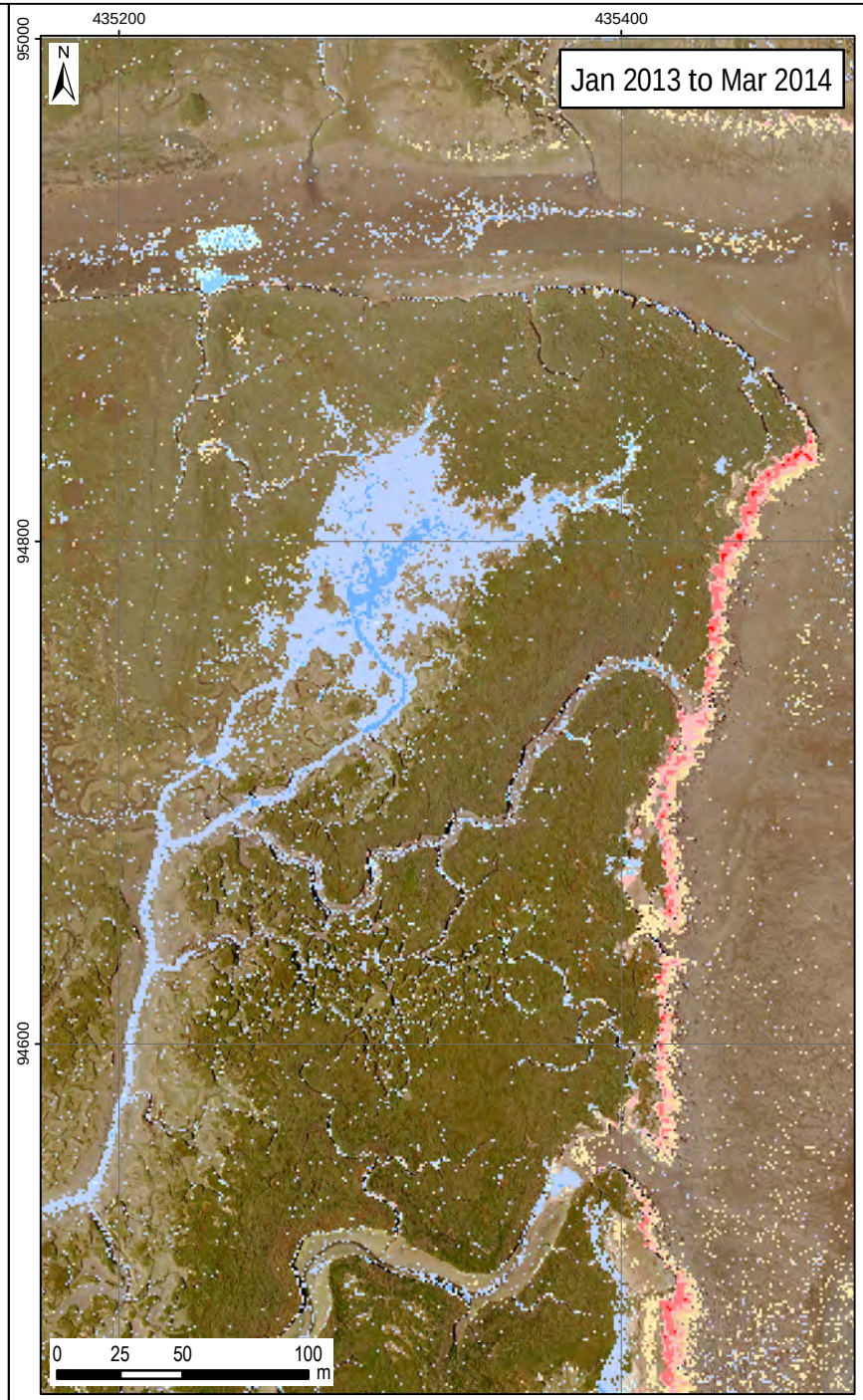
Location of monitoring sites for the Boiler Marsh recharge work

Figure 3



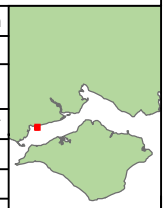


Change in Elevation (m)

Erosion	Accretion
< -5.00	0.21 to 0.50
-4.99 to -4.00	0.51 to 1.00
-3.99 to -3.00	1.01 to 2.00
-2.99 to -2.00	2.01 to 3.00
-1.99 to -1.00	3.01 to 4.00
-0.99 to -0.50	4.01 to 5.00
-0.49 to -0.20	> 5.00
-0.19 to 0.20	

LiDAR data for the 2008 winter season were recorded on 26th November 2008. LiDAR data for the 2012 winter season were recorded on 15th January 2013. LiDAR data for the 2013 winter season were recorded on 5th March 2014. Datasets are gridded at 1m resolution and are unfiltered.

Date	By	Size	Version
Nov 14	NKD	A4	1
Coordinate System		British National Grid	
Projection		Transverse Mercator	
Scale		1:3,000	
QA		TAP	
3772-005_R2313_Fig4_Lidar_Elev_Change			
Produced by ABPmer			



Data Source: Environment Agency 2008, 2013, 2014; aerial photographs courtesy of Channel Coastal Observatory, 2013

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Changes in habitat elevation around the recharge area using EA LiDAR data

Figure 4

Change in elevation November 2008 to March 2014 (metres)

< -3.0	Erosion
-2.99 to -2.5	
-2.49 to -2.0	
-1.99 to -1.5	
-1.49 to -1.0	
-0.99 to -0.5	
-0.49 to -0.4	
-0.39 to -0.3	
-0.29 to -0.2	
null -0.19 to 0.0	
null 0.01 to 0.2	
0.21 to 0.3	Accretion
0.31 to 0.4	
0.41 to 0.5	
0.51 to 1.0	
1.01 to 1.5	
1.51 to 2.0	
2.01 to 2.5	
2.51 to 3.0	

Date	By	Size	Version
Nov 14	NKD	A4	1
Coordinate System	British National Grid		
Projection	Transverse Mercator		
Scale	1:13,000		
QA	TAP		
3772-005_R2313_Fig5_Lidar_Diff_Frontage			
Produced by ABPmer			

LiDAR data: EA, 2008, 2014. Aerial photographs courtesy of Channel Coastal Observatory, 2013.

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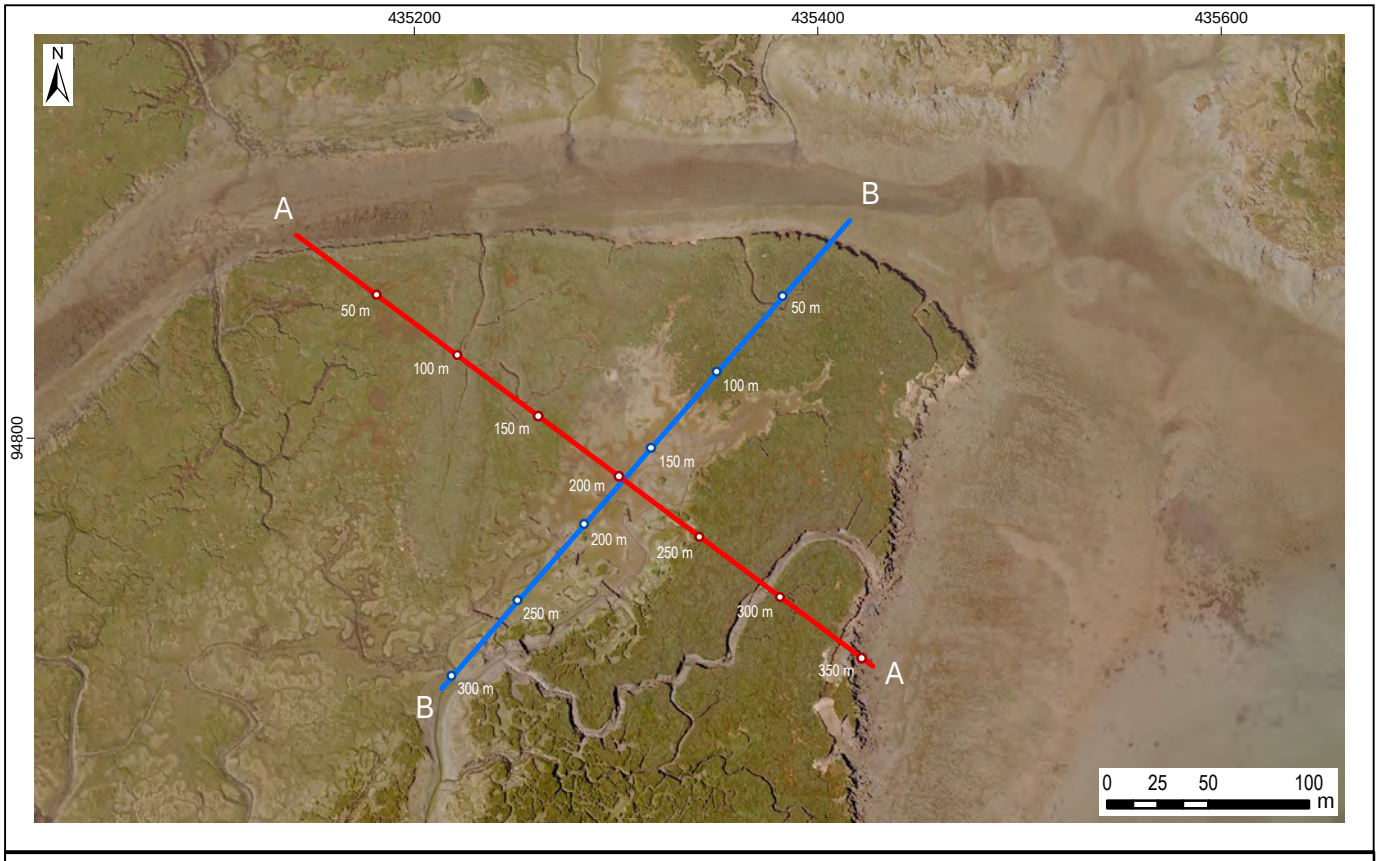
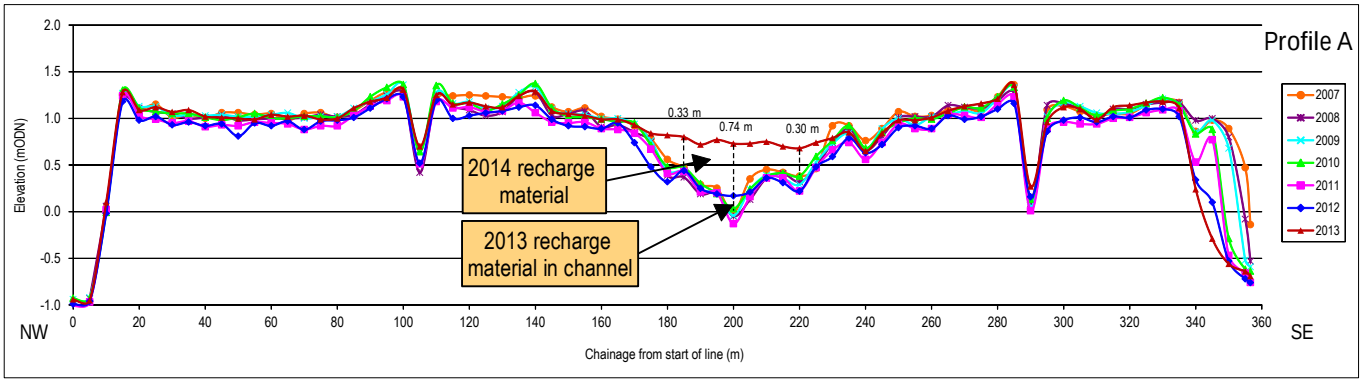
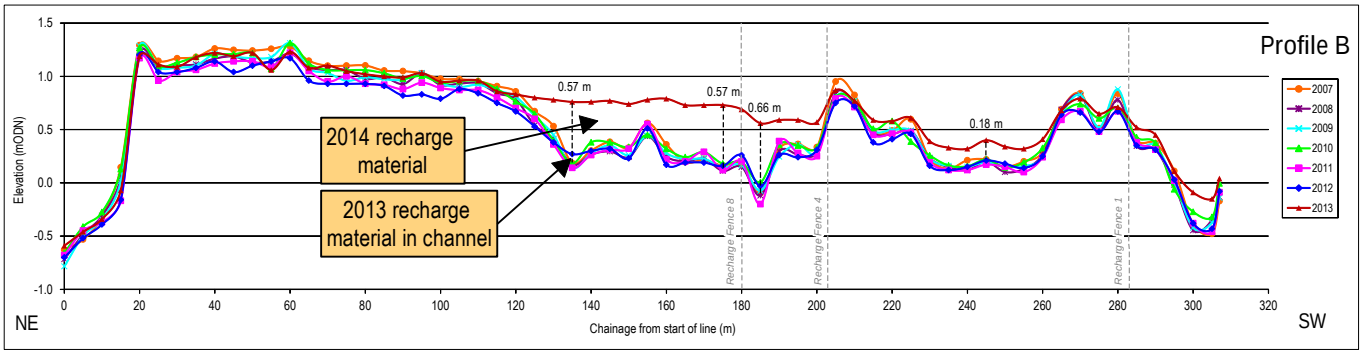
Changes in habitat elevation along the Lymington frontage using EA LiDAR data

Figure 5







Date	By	Size	Version
Nov 14	NKD	A4	1
Coordinate System		British National Grid	
Projection		Transverse Mercator	
Scale		1:3,750	
QA		TAP	
3772-005_R2313_Fig6_Profiles_A-B			
Produced by ABPmer			

Data Sources: LiDAR data supplied by the Environment Agency, 2007, 2008, 2009, 2010, 2012, 2013 and 2014.

Profile A
Profile B

NOTES:
- LiDAR data for the 2007 winter season were recorded in December 2007 and are filtered.
- LiDAR data for the 2008 winter season were recorded in November 2008 and are unfiltered.
- LiDAR data for the 2009 winter season were recorded in October 2009 and are unfiltered.
- LiDAR data for the 2010 winter season were recorded in November 2010 and are unfiltered.
- LiDAR data for the 2011 winter season were recorded in January/February 2012 and are unfiltered.
- LiDAR data for the 2012 winter season were recorded in January 2013 and are unfiltered.
- LiDAR data for the 2013 winter season were recorded in March 2014 and are unfiltered.

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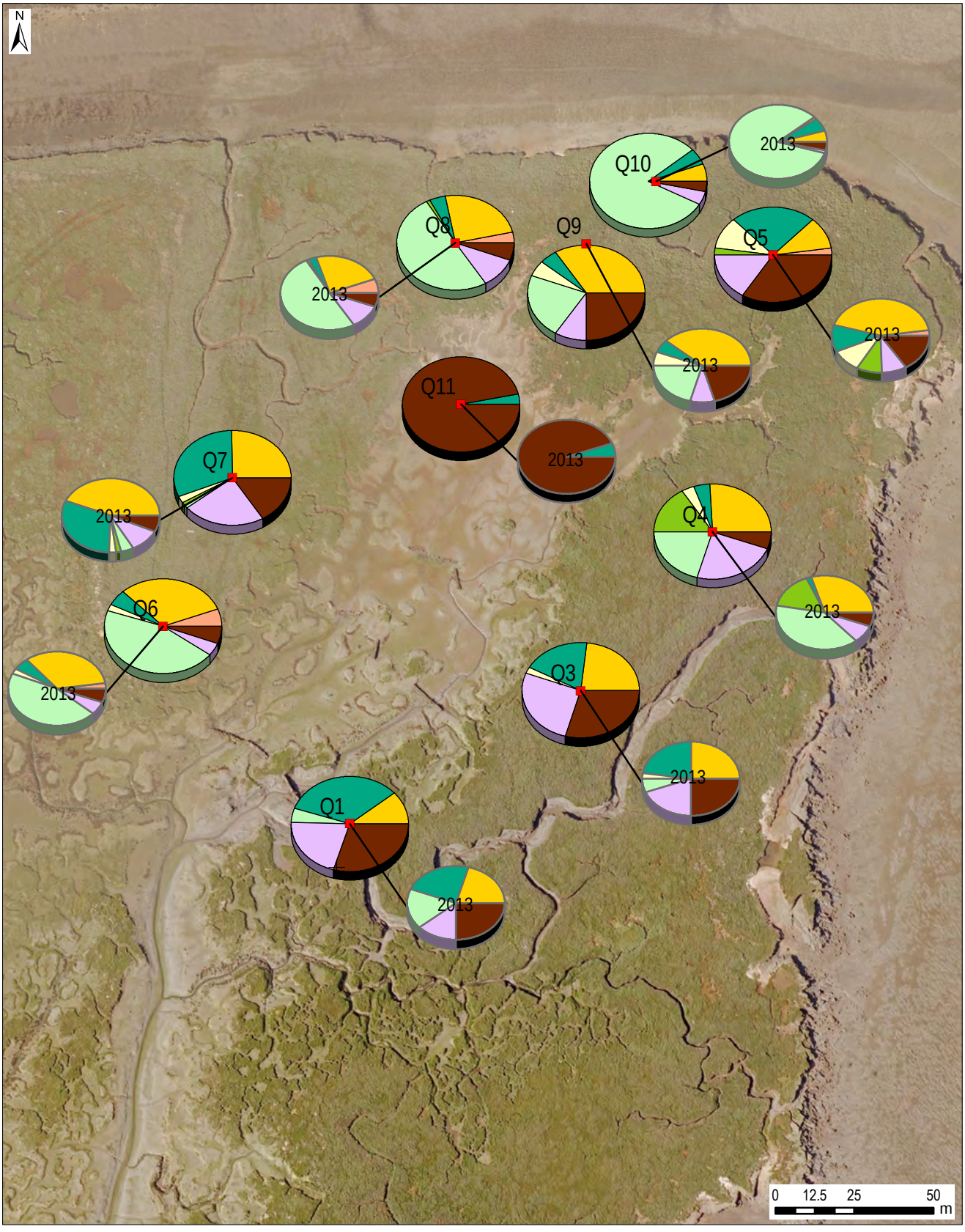
Cross-section elevations of Boiler Marsh using EA LiDAR data

Figure 6



Date	By	Size	Version
Nov 14	NKD	A4	1
Coordinate System	British National Grid		
Projection	Transverse Mercator		
Scale	1:1,750		
QA	TAP		
3772-005_R2313_Fig7_Pie_Charts			
Produced by ABPmer			

Saltmarsh quadrat positions

Pie charts show % vegetation or mud cover at each quadrat site

- Annual Sea-blite
- Cord-grass
- Glasswort
- Saltmarsh grass
- Sea Aster
- Sea Purslane
- Sea Lavender
- Mud

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Saltmarsh plant coverage at the 4m² quadrat sites in 2013 and 2014

Figure 7

Appendices

Appendix A

Photographs of the Monitoring Positions Within and Around the Recharge Area

A. Photographs of the Monitoring Positions Within and Around the Recharge Area

Table A1. Fixed-Point Panoramic Views from Boundary Posts (September 2012)

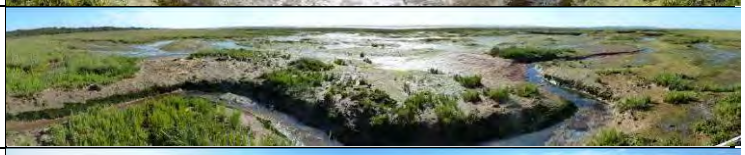
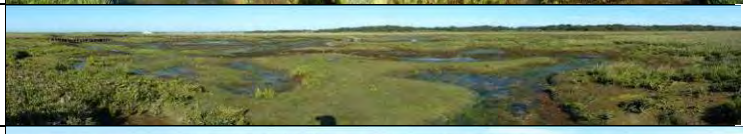
Position	Code	Date	Panoramic View
Boundary Post 1	BP1	5 September 2012	
Boundary Post 2	BP2	5 September 2012	
Photo Position 2.5	P2.5	5 September 2012	
Boundary Post 3	BP3	5 September 2012	
Boundary Post 4	BP4	5 September 2012	
Boundary Post 5	BP5	5 September 2012	
Boundary Post 6	BP6	5 September 2012	
Boundary Post 7	BP7	5 September 2012	
Boundary Post 8	BP8	5 September 2012	
Boundary Post 9	BP9	5 September 2012	

Table A2. Fixed-Point Panoramic Views from Boundary Posts (September 2013)

Position	Code	Date	Panoramic View
Boundary Post 1	BP1	11 September 2013	
Boundary Post 2	BP2	11 September 2013	
Photo Position 2.5	P2.5	11 September 2013	
Boundary Post 3	BP3	11 September 2013	
Boundary Post 4	BP4	11 September 2013	
Boundary Post 5	BP5	11 September 2013	
Boundary Post 6	BP6	11 September 2013	
Boundary Post 7	BP7	11 September 2013	
Boundary Post 8	BP8	11 September 2013	
Boundary Post 9	BP9	11 September 2013	

Table A3. Fixed Point Panoramic Views from Boundary Posts (September 2014)

Position	Code	Date	Panoramic View
Boundary Post 1	BP1	1 September 2014	
Boundary Post 2	BP2	1 September 2014	
Photo Position 2.5	P2.5	1 September 2014	
Boundary Post 3	BP3	1 September 2014	
Boundary Post 4	BP4	1 September 2014	
Boundary Post 5	BP5	1 September 2014	
Boundary Post 6	BP6	1 September 2014	
Boundary Post 7	BP7	1 September 2014	
Boundary Post 8	BP8	1 September 2014	
Boundary Post 9	BP9	1 September 2014	

Table A4. Graduated Stake Photographs 2010 to 2014 (Stakes A, C, D)

Graduated Stake Number	Graduated Stake A (Near Core Sample Site A)	Graduated Stake C (Near Core Sample Site C and Post 1)	Graduated Stake D (Near Core Sample Site D and Post 8)
Graduated Stake Colour Code			
Position X	435201.45	435153.70	435189.85
Position Y	94871.39	94819.15	94783.02
Deployment Photo 15 July 2010 (date when installed)			
Baseline Survey 14 September 2010			
After Recharge Survey 5 September 2012	Not Taken		
11th September 2013			
Year 1 post Recharge 1st September 2014			

Table A5. Graduated Stake Photographs 2010 to 2014 (Stakes E, F, G)

Graduated Stake Number	Graduated Stake E (Near Boundary Post 7);	Graduated Stake F (Near Boundary Post 6)	Graduated Stake G (Near Boundary Post 5)
Graduated Stake Colour Code			
Position X	435220.01	435242.22	435304.71
Position Y	94810.80	94852.09	94899.64
After Recharge Survey 5 September 2012 (date when installed)			
11th September 2013			
Year 1 post Recharge 1st September 2014			

Table A6. Graduated Stake Photographs 2010 to 2014 (Stakes H, I J)

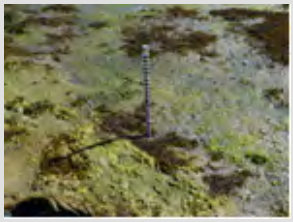
Graduated Stake Number	Graduated Stake H (Near Boundary Post 4)	Graduated Stake I (Near Boundary Photo Position 2.5)	Graduated Stake J (Near Boundary Post 1 and Graduated Stake C, Inside Site)
Graduated Stake Colour Code			
Actual Position X	435258.83	435209.18	435138.70
Actual Position Y	94879.79	94878.05	94782.91
After Recharge Survey 5 September 2012 (date when installed)			
11th September 2013			
Year 1 post Recharge 1st September 2014			

Table A7. Graduated Stake Photographs 2010 to 2014 (Stakes K, L, M)

Graduated Stake Number	Graduated Stake K (Near Boundary Post 1 But Outside Site Near Fence 1)	Graduated Stake L (Near Boundary Post 9 But Outside Site Near Fence 1)	Graduated Stake M (Near Boundary Post 9 But Inside Site Near Fence 1)
Graduated Stake Colour Code			
Position X	435120.26	435153.88	435168.54
Position Y	94782.04	94759.85	94767.98
After Recharge Survey 5 September 2012 (date when installed)			
11th September 2013			
Year 1 post Recharge 1st September 2014			

Table A8. Graduated Stake Photographs 2010 to 2014 (Stakes N &O)

Graduated Stake Colour Code	Graduated Stake N (Near Boundary Post 9 But Outside Site Near Fence 1)	Graduated Stake O (Near Boundary Post 9 But Inside Site Near Fence 1)
Graduated Stake Colour Code		
Position X	435191.84	435195.93
Position Y	94773.24	94777.45
After Recharge Survey 5 September 2012 (date when installed)		
11th September 2013		
Year 1 post Recharge 1st September 2014		

Table A9. Saltmarsh Quadrat Photographs 2010 to 2014 (Quadrats 1 to 3)

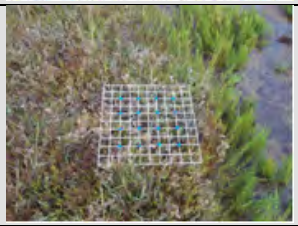
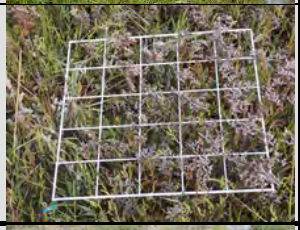
Saltmarsh Quadrat No	Quadrat No. 1	Quadrat No. 2	Quadrat No. 3
Marker Colour Code (used from 2012)			
Position X	435172.25	435205.16	435245.11
Position Y	94747.23	94741.10	94789.42
Baseline Survey 14 September 2010			
Baseline Survey 8 September 2011			
After Recharge Survey 5 September 2012			
11th September 2013 ($0.5m^2$ Quadrat)			
11th September 2013 ($4m^2$ Quadrat)		n/a	
1st September 2014 ($0.5m^2$ Quadrat)			
1st September 2014 ($4m^2$ Quadrat)		n/a	

Table A10. Saltmarsh Quadrat Photographs 2010 to 2014 (Quadrats 4 to 6)

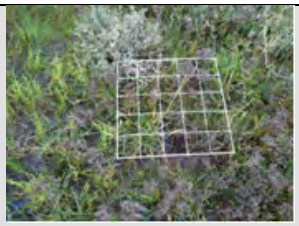
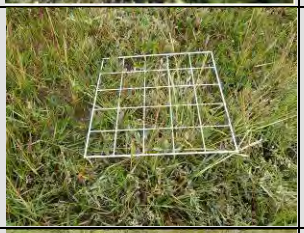
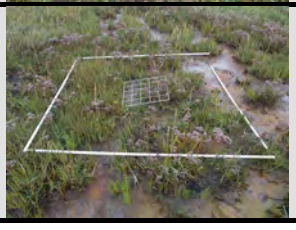
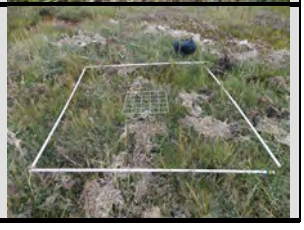
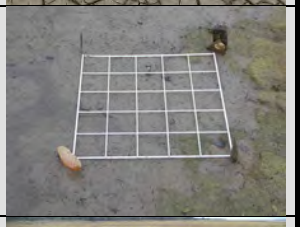
Saltmarsh Quadrat No	Quadrat No. 4	Quadrat No. 5	Quadrat No. 6
Marker Colour Code (used from 2012)			
Position X	435286.74	435305.84	435113.28
Position Y	94839.49	94926.81	94809.65
Baseline Survey 14 September 2010			
Baseline Survey 8 September 2011			
After Recharge Survey 5 September 2012			
11th September 2013 (0.5m² Quadrat)			
11th September 2013 (4m² Quadrat)			
1st September 2014 (0.5m² Quadrat)			
1st September 2014 (4m² Quadrat)			

Table A11. Saltmarsh Quadrat Photographs 2010 to 2014 (Quadrats 7 to 9)

Saltmarsh Quadrat No	Quadrat No. 7	Quadrat No. 8	Quadrat No. 9
Marker Colour Code (used from 2012)			
Actual Position X	435135.18	435205.51	435246.84
Actual Position Y	94856.50	94930.69	94930.29
Baseline Survey 2 14 September 2010			
Baseline Survey 3 8 September 2011			
Post-Recharge Survey 4 5 September 2012			
11th September 2013 (0.5m² Quadrat)			
11th September 2013 (4m² Quadrat)			
1st September 2014 (0.5m² Quadrat)			
1st September 2014 (4m² Quadrat)			

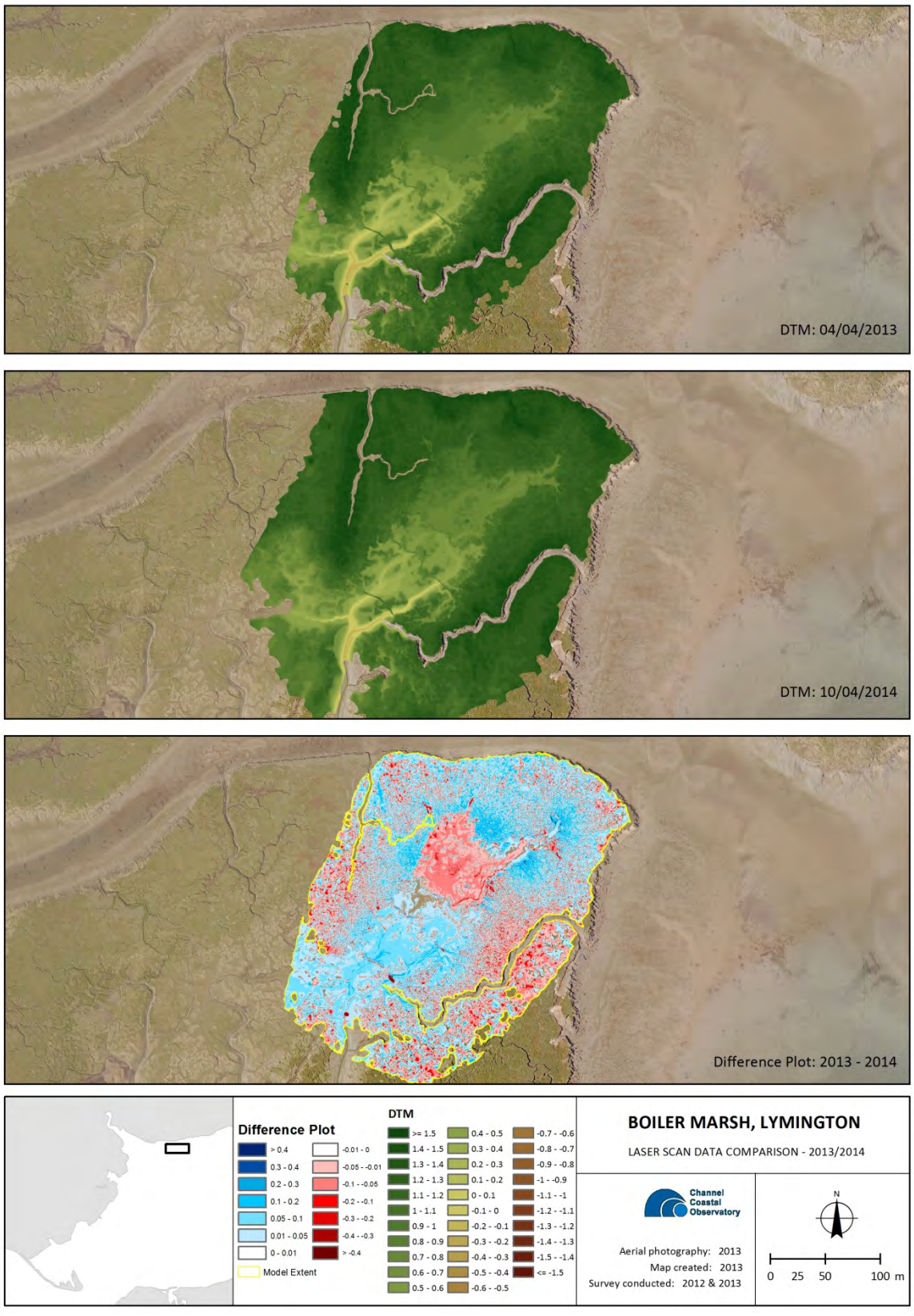
Table A12. Saltmarsh Quadrat Photographs 2010 to 2014 (Quadrats 10-11)

Saltmarsh Quadrat No	Quadrat No. 10	Quadrat No. 11
Marker Colour Code (used from 2012)		
Actual Position X	435268.85	
Actual Position Y	94950.13	
Baseline Survey 2 14 September 2010		n/a
Baseline Survey 3** September 2011		n/a
Post-Recharge Survey 4 5 September 2012		n/a
11th September 2013 (0.5m² Quadrat)		
11th September 2013 (4m² Quadrat)		
1st September 2014 (0.5m² Quadrat)		
1st September 2014 (4m² Quadrat)		

Appendix B

CCO Laser Scan Survey Comparison (2013 and 2014)

B. CCO Laser Scan Survey Comparison (2013 and 2014)



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