Comments following a site visit to the breach in the American Wall, Lantern Marshes, on 7th October 2015

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1. A visit was made to the American Wall, which separates the Upper and Lower Lantern Marshes (alternatively referred to as Lantern Marshes North and Lantern Marshes South, respectively), at low tide on 7 October 2015. A breach, now approximately 25 m wide, was created in the Wall during the surge tide of 5- 6 December 2013 and has not since been repaired.

2. Prior to the site visit available aerial photographs and LiDAR digital elevation map (DEM) images of the area were examined a and a number of topographic cross-sections extracted. Selected images and cross-sections are reproduced in Annex 1. A number of photographs taken during the site visit are included in Annex 2.

3. The original river walls surrounding Lantern Marshes North and South are of considerable age but have been improved on a number of occasions. The River wall of Lantern Marshes North was in a poor condition when the land ownership passed to the National Trust in 1993, and the sluice in the river wall at the northern end had already partly failed. The remains of the sluice were subsequently removed and a wider artificial breach made in the late 1990s as part of a DEFRA-sponsored scheme to create new saltmarsh habitat. Modifications were also made to create a more efficient tidal creek system linked to the breach.

4. Since 1999 significant vertical accretion of mud has occurred within the area but many of the rejuvenated tidal creeks within the developing marsh have enlarged and there has been some erosion of the eastern side of the river wall, induced both by tidal flows and internally generated waves. The main tidal channel runs almost parallel to the river wall for much of its length, linking a series of former borrow pits, and is unnaturally straight.

5. The walls surrounding Lantern Marshes South were raised and widened prior to construction of the Anglo-American ‘Cobra Mist’ site between 1968 and 1971. A new wall. ‘The American Wall’ was built at the northern end of the facility, effectively separating it from Lantern Marshes North. The eastern half of the wall was largely built of gravel extracted from the north-eastern part of Orford Ness, while the western part appears to have been built mainly of earth.

6. Field inspection on 7 October 2015 suggested that the December 2013 breach occurred at a point where there is a change in the composition of the bank and where

the crest level was lowest (c. 2.7 m OD; Profile P1 in Annex 1 Figure 11 and Annex 2 Photograph 2).

7. Since creation of the breach, scour has caused some further deepening of the breach itself and of the channels immediately adjacent in the adjoining marsh. The Lower Lantern Marshes have a potential spring tidal prism in excess of 5×10^6 $m^{3,}$ sufficient to give rise to flow velocities in excess of the threshold needed for bed erosion within and seaward of the breach.

8. Flood and ebb tides reach the Lower Lantern Marshes mainly via the deep tidal channel which runs behind the Upper Lantern Marshes river wall from the breach near its northern end. As a result of the substantially increased tidal prism following the breach in the American Wall, widening and depending of this channel, and of the Upper Lantern Marshes breach, can be expected. Observations during the site visit suggested that recent bank erosion has occurred on both sides of this feeder channel, and has impacted on parts of the Upper Lantern Marshes river wall. If the breach in the American Wall is not repaired, the higher tidal current velocities associated with the larger volume of water flowing along this channel on the flood and ebb tides will cause further erosion, channel enlargement, and encourage the tendency for the artificially straight channel to develop meanders. This would be potentially damaging to the integrity of the remaining section of the upper Lantern Marshes river wall in the short to medium term. The risk of further breaches will be greatest on the outside of incipient meanders, and where the channel is widest and adjoining tidal flats lowest.

9. The Lower Lantern Marshes ('Cobra Mist site') also contain a number of artificially straight channels (former drainage ditches which are now again tidal). Some of these are likely to experience deepening and widening in the short term, although infilling with sediment is likely in the medium to longer term as sedimentation within the flood compartment brings about a progressive reduction in tidal prism.

10. Areas of higher ground which flank the former drainage ditches, and / or where created to provide access tracks to the former radio masts and pylons within the site, act to pond water after high tides but also provide wave breaks within the flood compartment. Consequently, the potential fetch over which internal waves can be generated by easterly, southeasterly and northeasterly winds is significantly reduced, and the risk of wave erosion of the inside of the Lower Lantern Marshes river wall is relatively low.

11. Saltmarsh communities have already become established around the fringes of the flooded area and on areas of higher ground within the Lower Lantern Marshes compartment. However, plant colonization is unlikely in areas where tidal or rainwater remains ponded, and where the surface soils become anaerobic. The potential for saltmarsh / brackish marsh growth, and the strength of the surface

sediment, could be enhanced by breaching of some of the internal sediment barriers which cause ponding, and possibly by direct pumping.

12. Considerable efforts were made to clear the area of bombs and other debris before the Cobra Mist facility was constructed. However, it will be desirable to minimise sediment erosion (e.g. due to channel widening / deepening) within the area in order to lower the risk of release of contaminants into the wider estuary. It was evident during the site visit, and from examination of the LiDAR DEM, that some erosion has already occurred due to scouring on both sides of the breach in the American Wall. For this, and other, reasons, measures should be taken as soon as possible to repair, or partially repair, the breach.

13. Installation of a sill or sluice at the location of the breach in the American Wall would provide an opportunity for regulated tidal exchange, providing additional flood storage on high spring or surge tides, permitting the raising of levels within the site through sedimentation and saltmarsh development, and providing time intervals when the surface sediments would dry out sufficiently to grain strength and permit other potential land-uses.

14. A summary of hydrodynamic modelling results provided by the Environment Agency suggests that the increase in tidal prism resulting from the failure of the American Wall is likely to have only a minor effect on extreme water levels in the estuary as a whole. Installation of a sill at approximately high water spring tide level would retain increased water storage capacity on extreme tides and potentially reduce water levels in adjoining parts of the estuary by up to a few centimetres.

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ANNEX 1

Figures

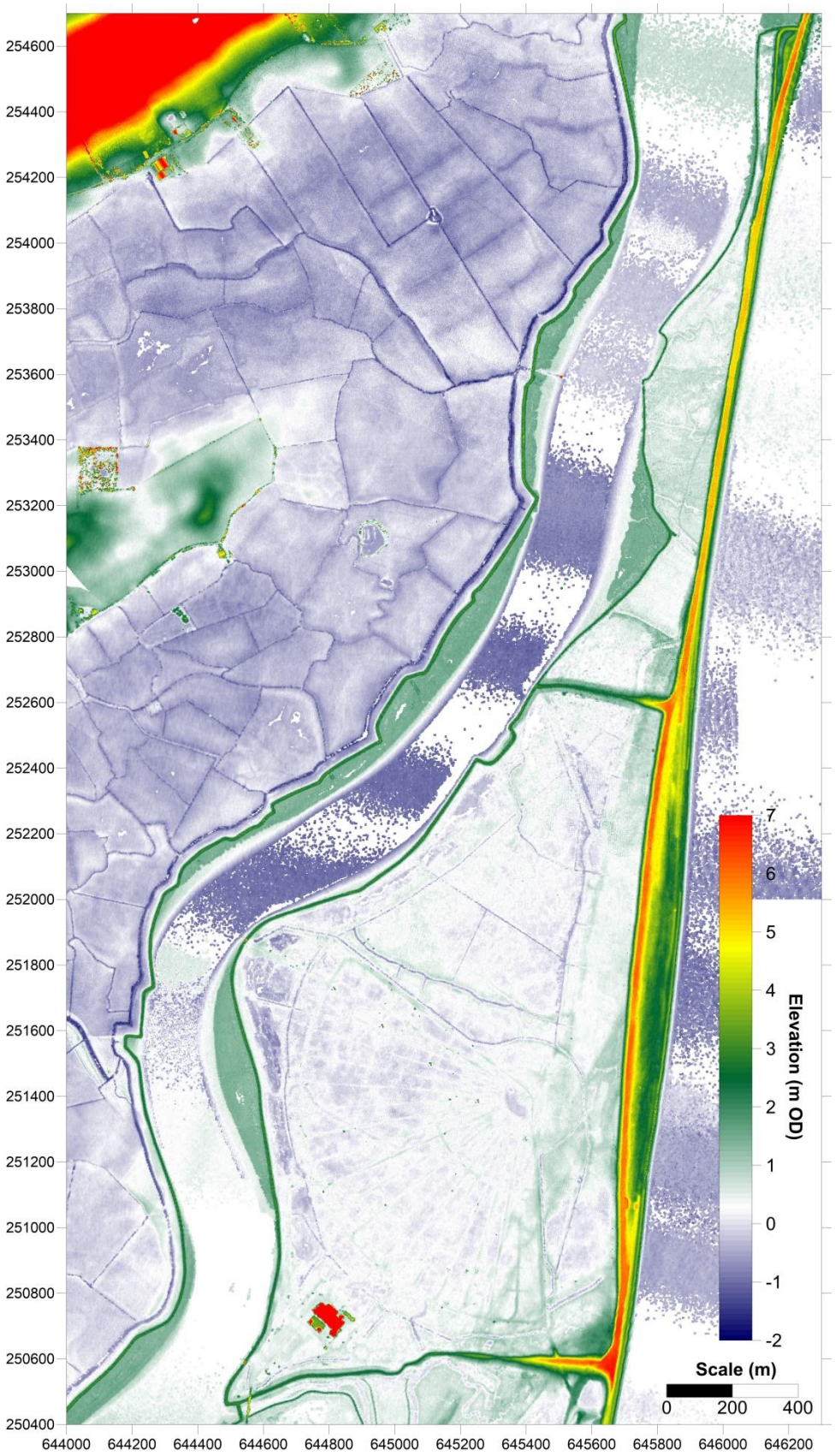


Figure 1. LiDAR digital surface model of Lantern Marshes north and south, including the Cobra Mist site, flown March 1999

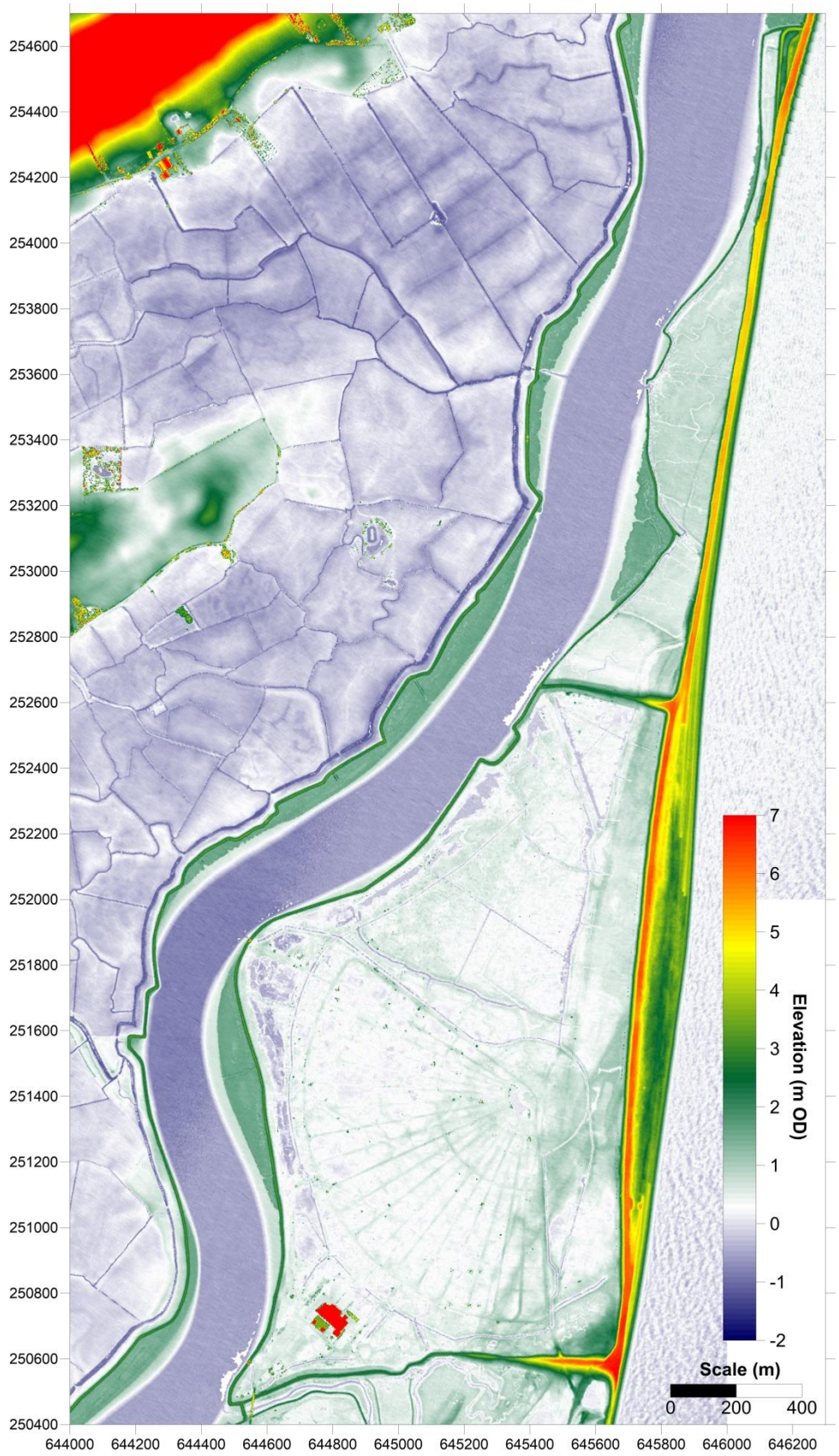


Figure 2. LiDAR digital surface model of Lantern Marshes north and south, including the Cobra Mist site, flown April 2003

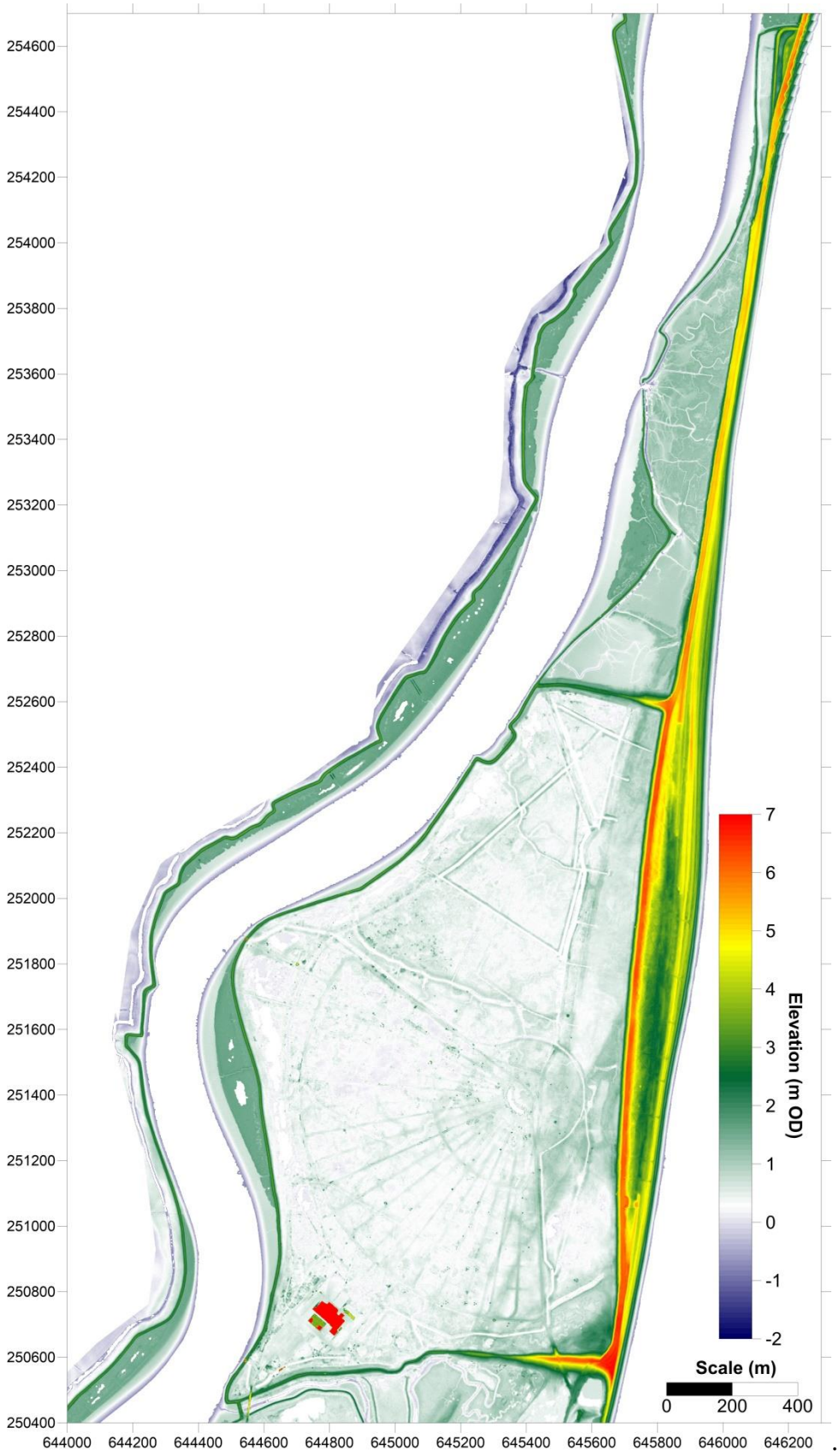


Figure 3. LiDAR digital surface model of Lantern Marshes north and south, including the Cobra Mist site, flown December 2012

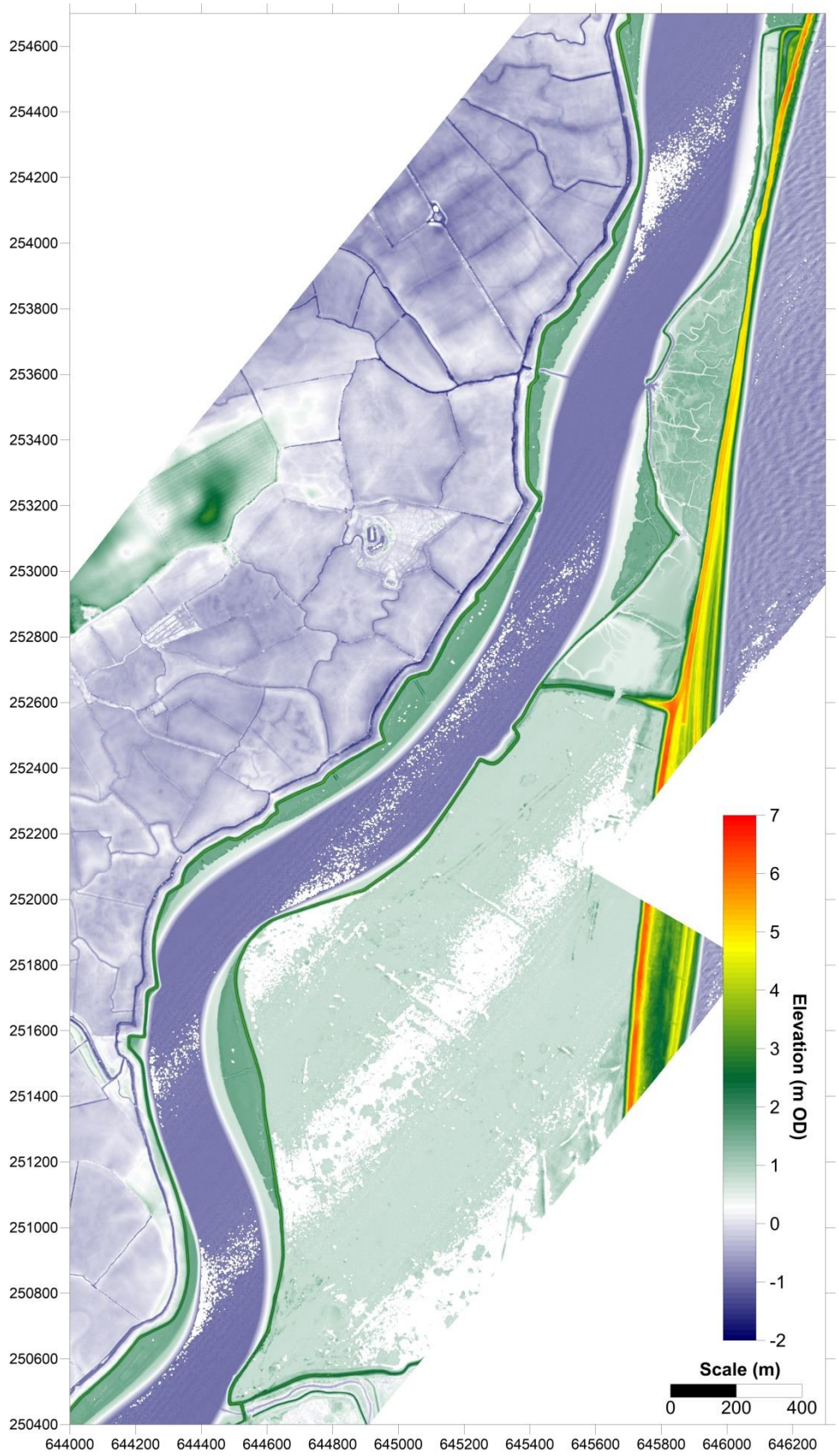


Figure 4. LiDAR digital surface model of Lantern Marshes north and south, including the Cobra Mist site, flown October 2014

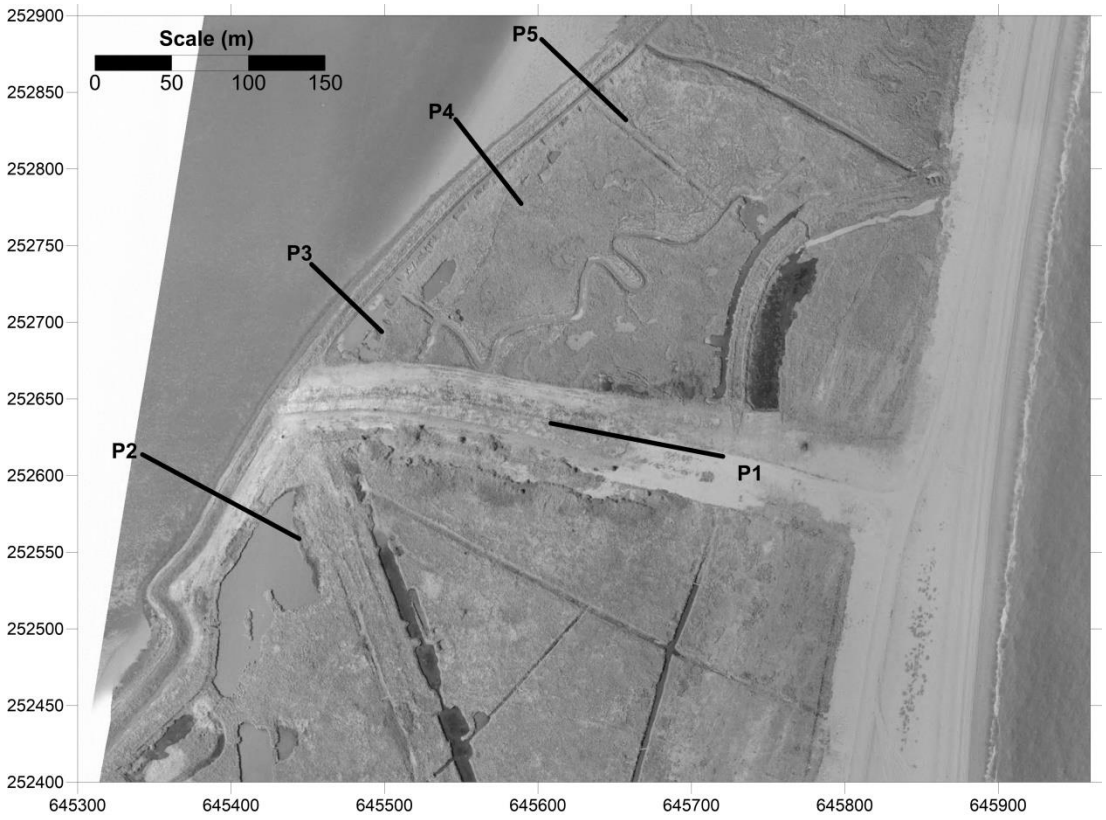


Figure 5. Aerial photograph of the American Wall and Lantern Marshes, flown summer 1992

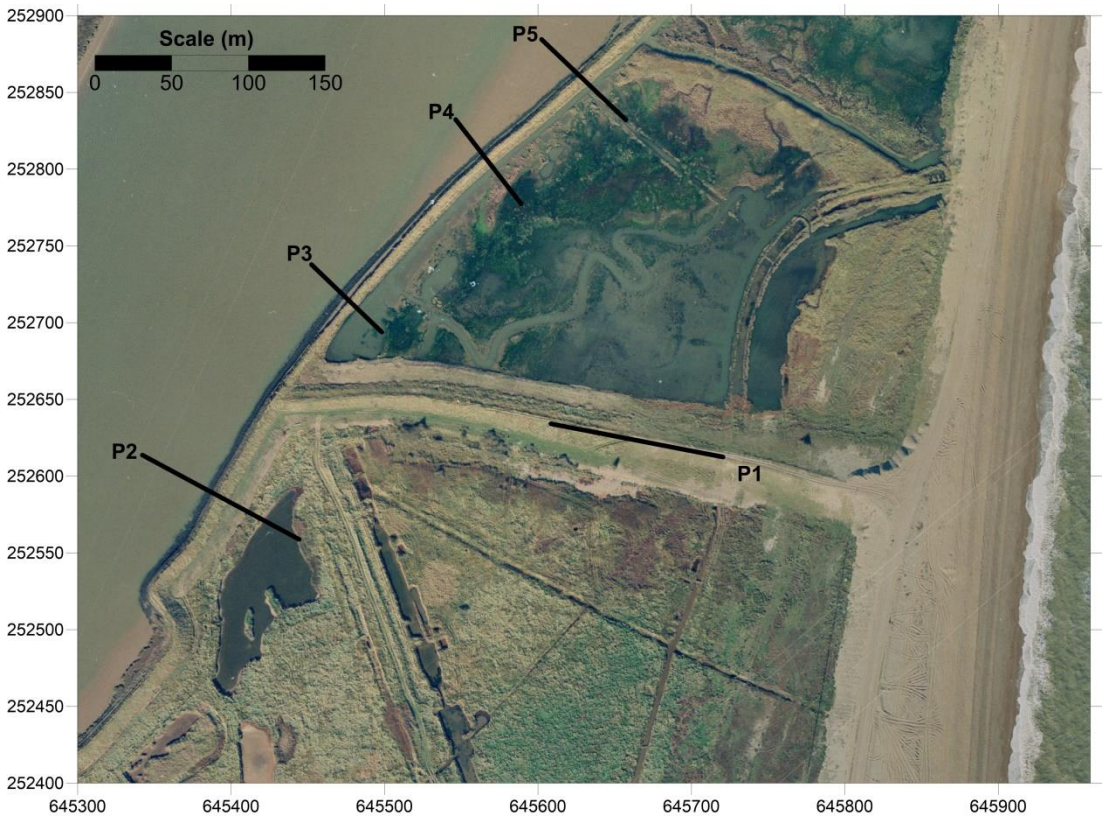


Figure 6. Aerial photograph of the American Wall and Lantern Marshes, flown summer 1997

Figure 7. Aerial photograph of the American Wall and Lantern Marshes, flown summer 2006

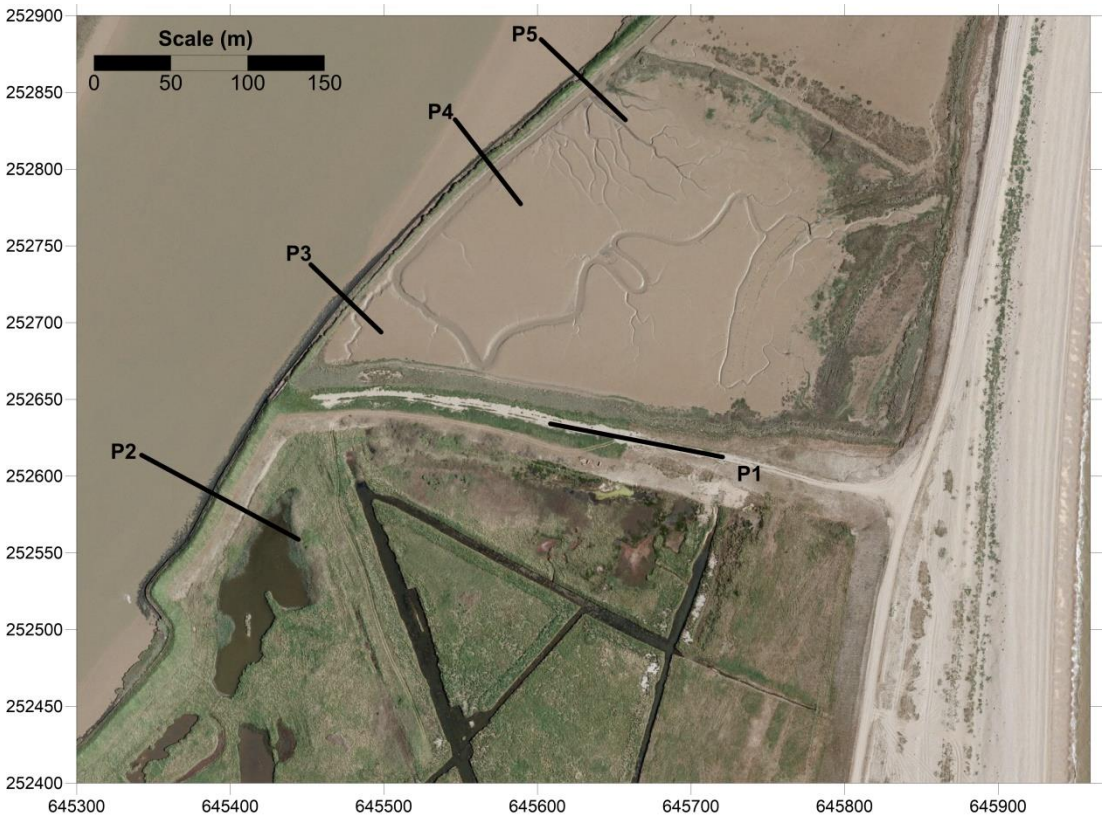


Figure 8. Aerial photograph of the American Wall and Lantern Marshes, flown summer 2010

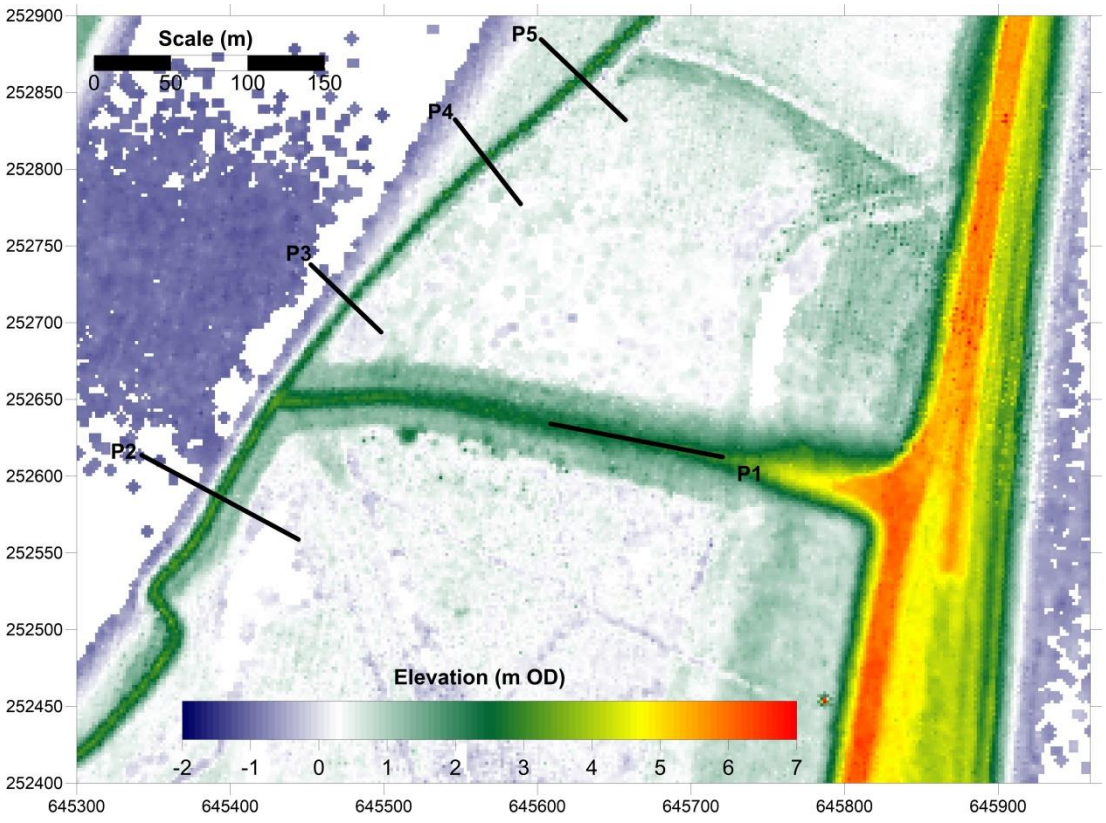


Figure 9. LiDAR DEM of the American Wall and Lantern Marshes, flown March 1999

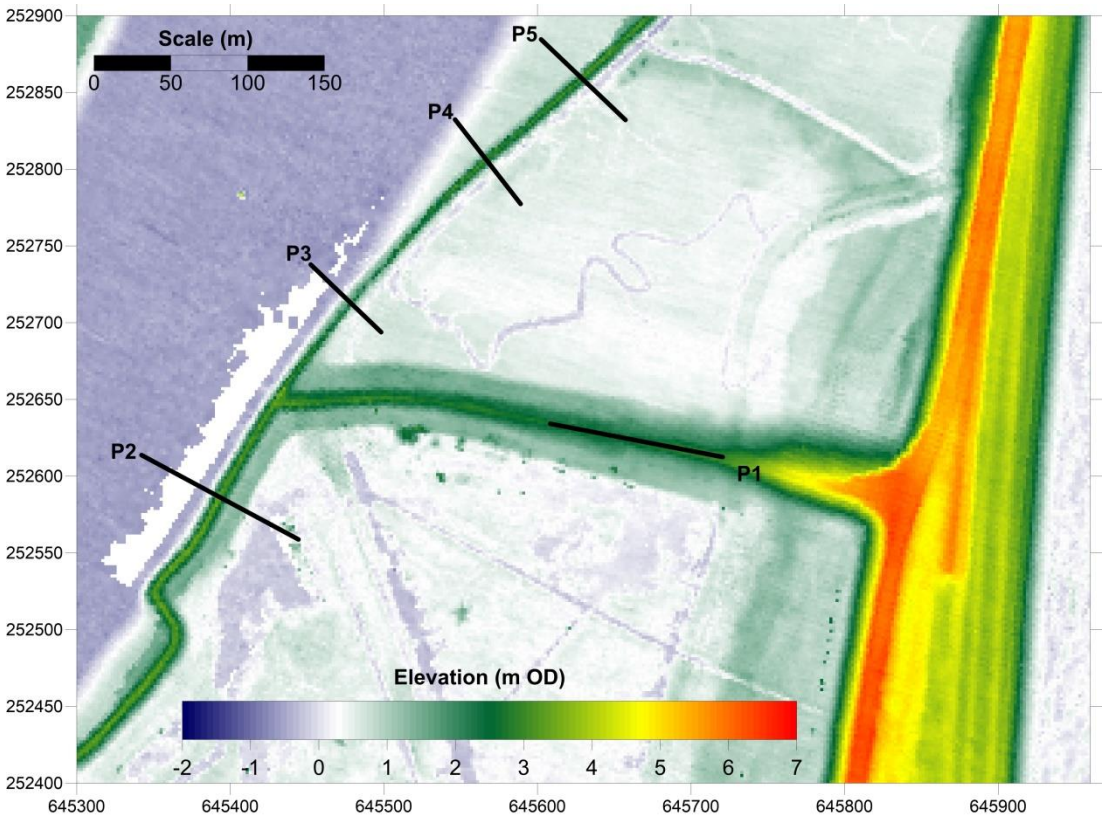


Figure 10. LiDAR DEM of the American Wall and Lantern Marshes, flown April 2003

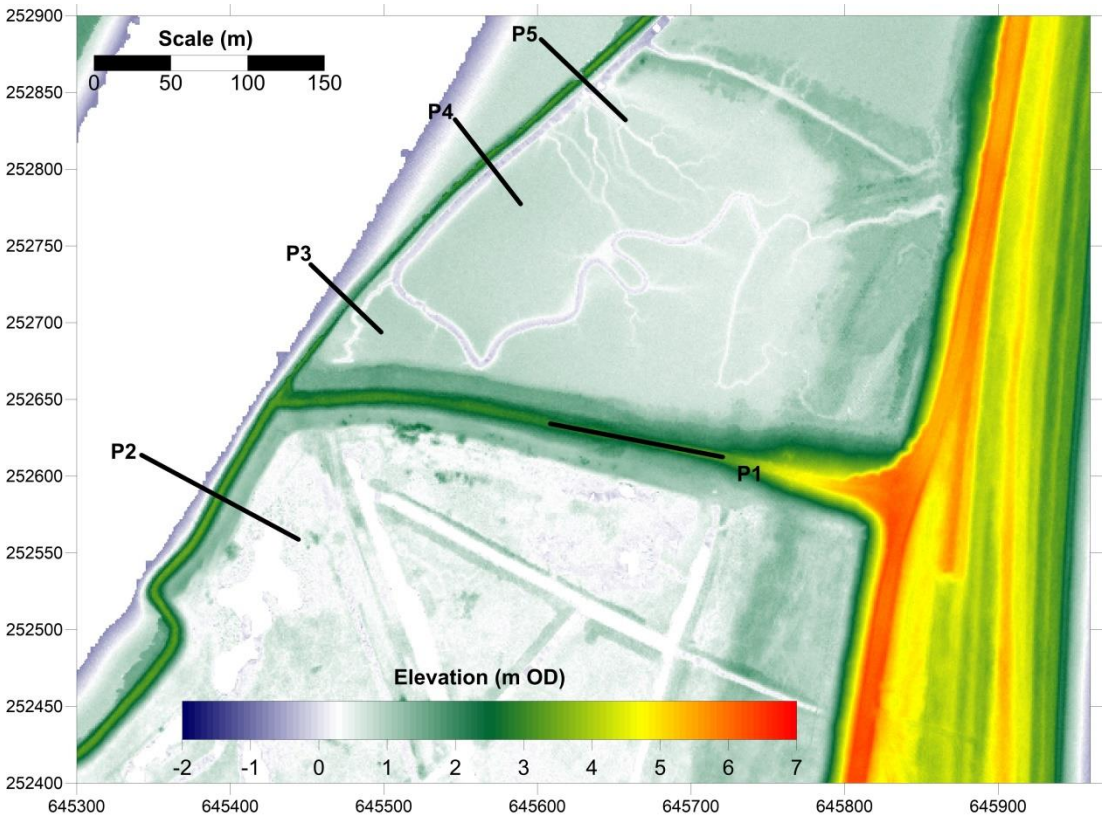


Figure 11. LiDAR DEM of the American Wall and Lantern Marshes, flown December 2012

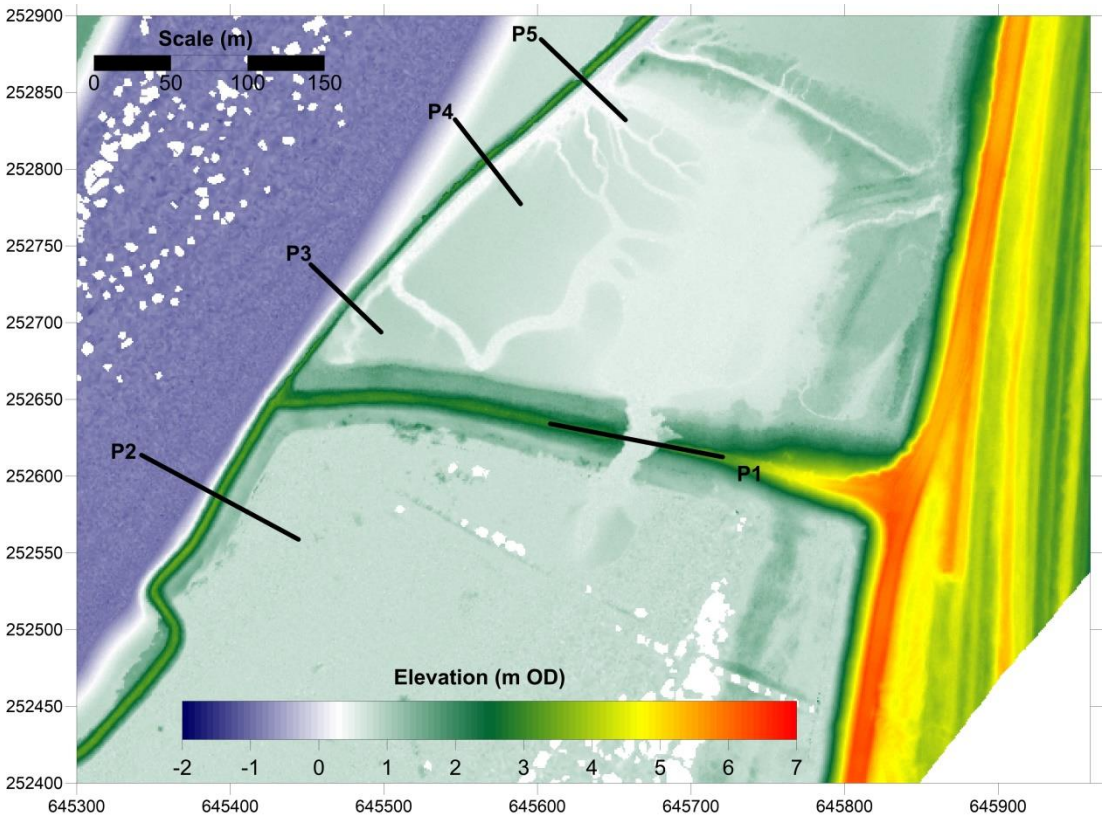
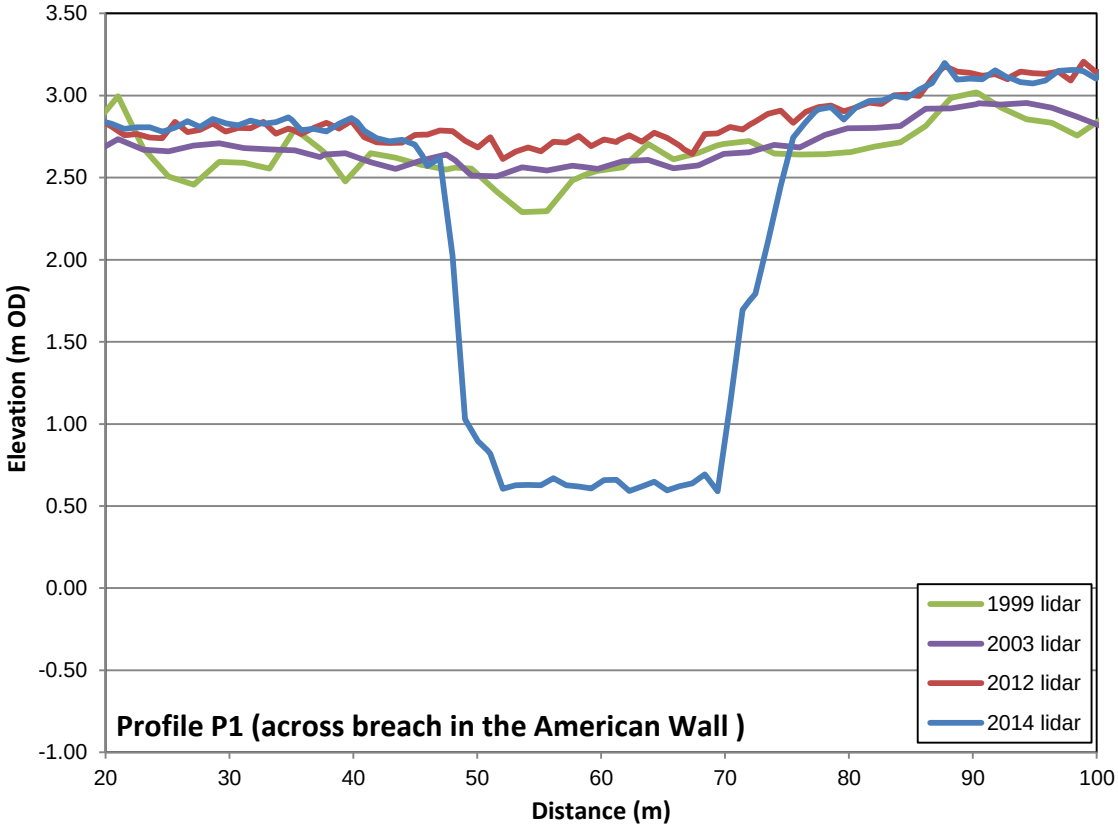


Figure 12. LiDAR DEM of the American Wall and Lantern Marshes, flown October 2014



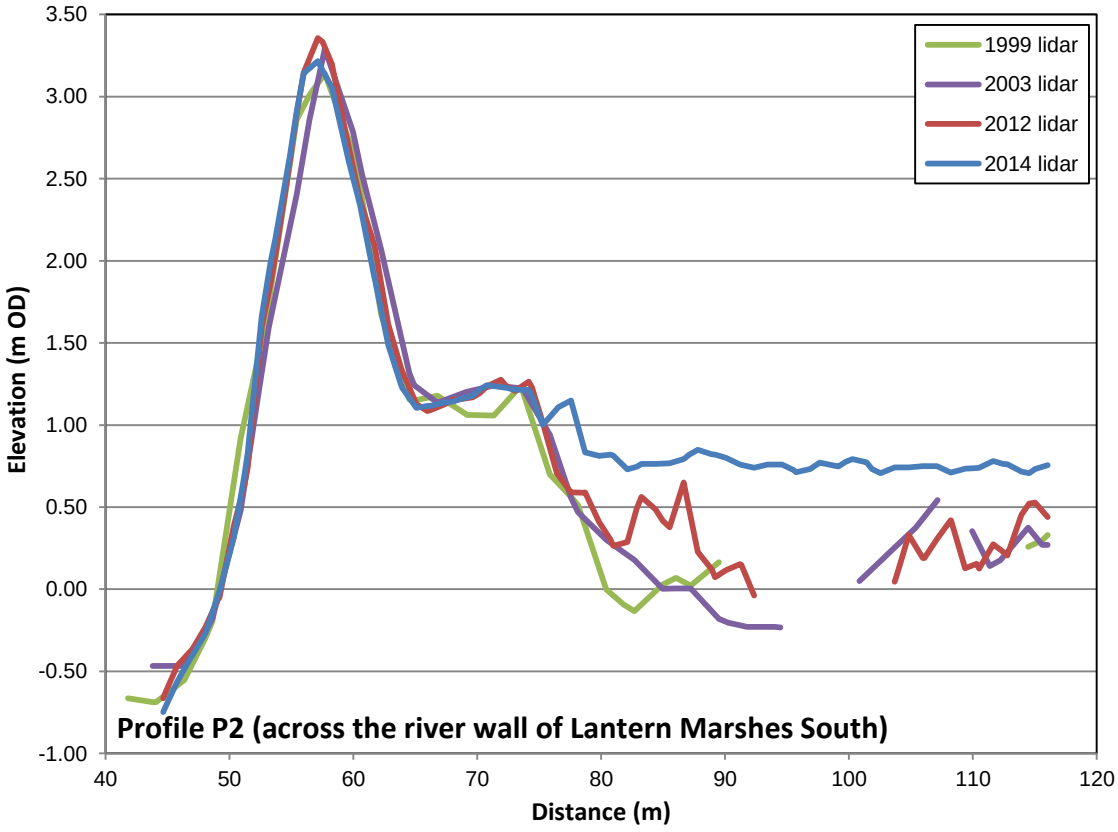
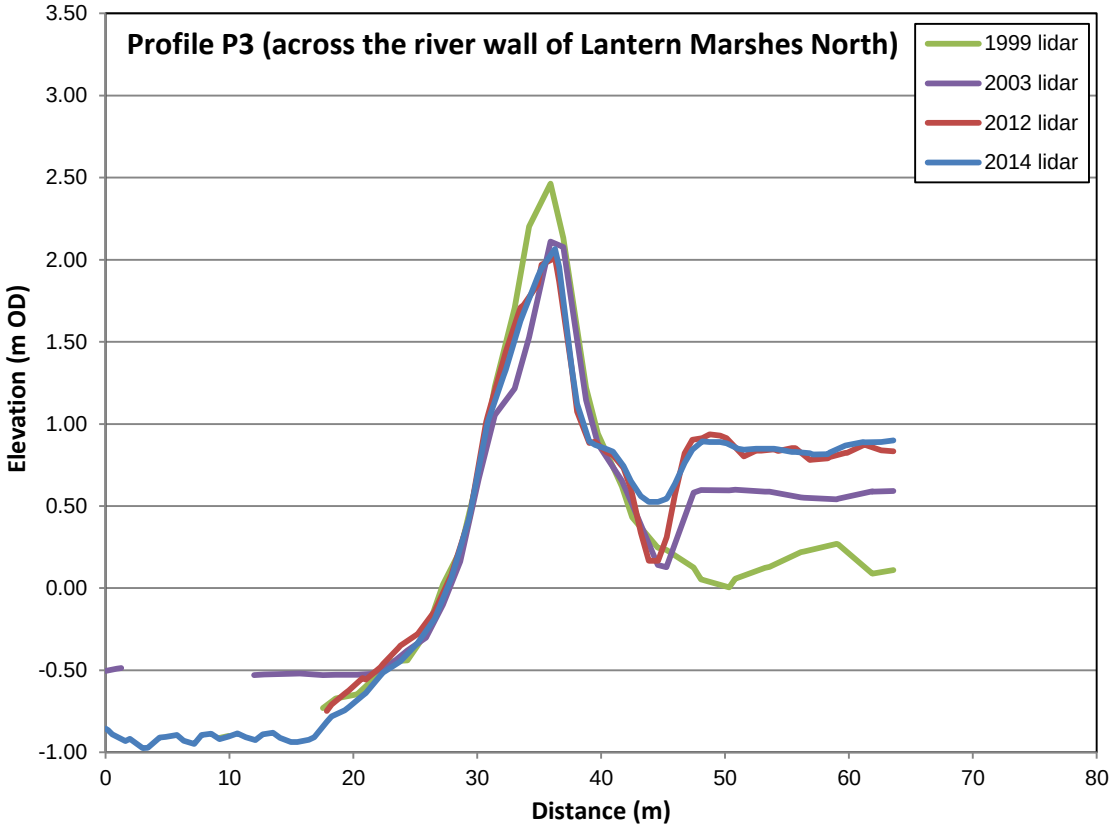


Figure 13. Cross sections of the American Wall and river walls, from LiDAR digital surface models flown 1999-2014



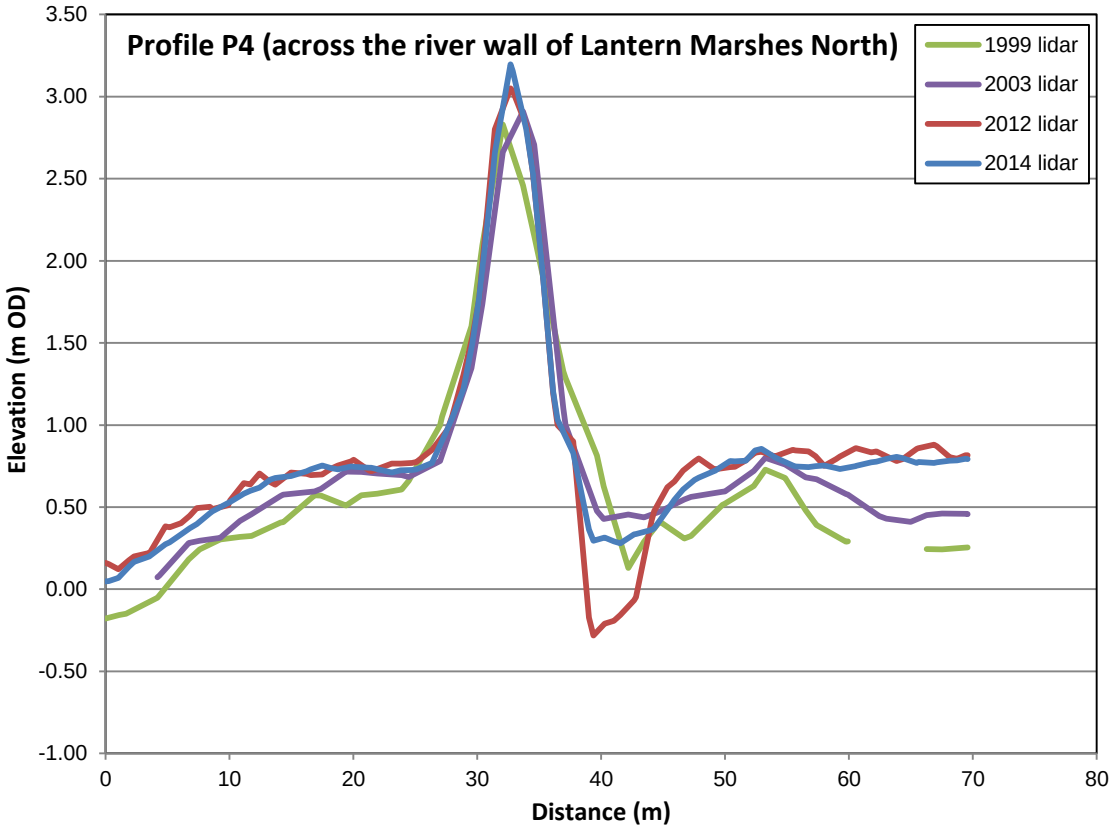


Figure 13 (continued). Cross sections of the American Wall and river walls, from LiDAR digital surface models flown 1999-2014

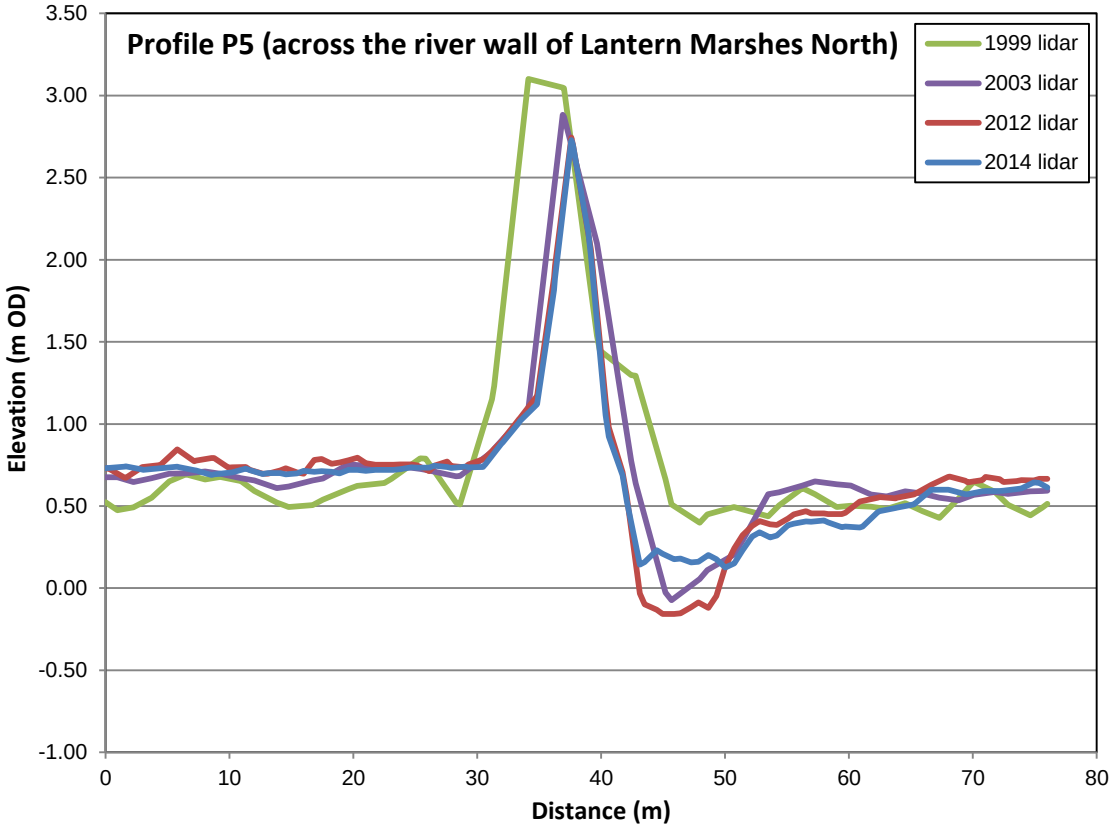


Figure 13 (continued). Cross sections of the American wall and river walls, from LiDAR digital surface models flown 1999-2014

ANNEX 2

Field photographs taken 7th October 2015

Photograph 1. View along the American Wall towards towards the breach, 7 October 2015

Photograph 2. The breach in the American Wall viewed from the east side, 7 October 2015

Photograph 3. The breach in the American Wall, view looking northwest, 7 October 2015

Photograph 4. The eastern side of the breach, showing largely gravel composition of the eastern part of the American Wall, 7 October 2015

Photograph 5. View across Lower Lantern Marshes ('Cobra Mist site'), showing ponded water and marginal saltmarsh development, 7 October 2015

Photograph 6. View across partially flooded Lower Lantern Marshes towards the 'Cobra Mist' control building, 7 October 2015

Photograph 7. View westwards across Upper Lantern Marshes towards the breach in the River wall, 7 October 2015

Photograph 8. View westwards across the mid-part of Upper Lantern Marshes North eastern side of the breach, showing partially eroded landward side of the River Wall, 7 October 2015