

Appendix E

Archaeological Assessment of Aerial Photographs, Satellite Imagery and LiDAR data



AIR PHOTO SERVICES

Archaeology • Research • Law • Environment • Planning

Little Oakley Realignment Site Essex

Archaeological Assessment of
Aerial Photographs, Satellite Imagery and
LiDAR data

APS 221 10 03
November 2021



Little Oakley Realignment Site, Essex

Archaeological Assessment of Aerial Photographs, Satellite Imagery and LiDAR data

Client	Royal Haskoning DHV
Planning Authority	Essex Council
Air Photo Services Document	221 10 03_01
Air Photo Services Project Number	221 10 03
National Grid Reference (NGR)	TM 231283
Co-ordinates	623195,228360
Report Status	FINAL
Issue date	24 11 2021
Report prepared by	Chris Cox MA MCIFA FSA
Interpretation, mapping and GIS	Adam Jarvis ACIFA
QA checked by	David lang BA PCIFA

Disclaimer

©Air Photo Services Ltd

No part of this report is to be copied in any way without prior written consent.

This report has been prepared by Air Photo Services Ltd with all reasonable skill, care and diligence within the terms of the contract with the client, incorporation of our General Terms and Conditions of Business and taking account of the resources devoted to us by agreement with the client. We disclaim any responsibility to the client and others in respect of matters outside the scope of the above. This report is confidential to the client and we accept no responsibility for the actions and opinions of third parties, to whom this report, or any part thereof, is made known. Any such party relies on the report at its own risk.



Table of Contents

Summary

1. Introduction	1
2. Sources of data	4
3. Interpretation and mapping	6
4. Environment and previously recorded heritage assets.....	7
5. Results.....	12
6. Conclusion.....	19
Bibliography	21
Acknowledgements.....	22

Figures

Figure 1 Location of the site

Figure 2 Aerial photographs consulted at the Historic England Archive

Figure 3 Geology within the site and buffer area

Figure 4 Soils within the site and buffer area

Figure 5 Detailed mapping, sites APS_01 – APS_13

Summary

- S1. This assessment of aerial imagery considers land at the Little Oakley Realignment Site in Essex. The site is centred at UK National Grid Reference TM 231283, coordinates 623195,228350.
- S2. This report considers all available aerial and satellite imagery alongside visualised LiDAR data from a range of sources, as part of an assessment of archaeological features within the site for evaluation purposes.
- S3. This low lying site is situated in the immediate landward hinterland of the North Sea coast, between Pewitt Island to its south and Little Oakley to its northwest, and is shown on **Figure 1**.
- S4. This report represents the work undertaken by APS in November 2021.
- S5. The object of this assessment was to provide information on the location and nature of buried and upstanding archaeological features which are visible on historic aerial photographs, modern aerial and satellite imagery and visualised Airborne Laser Scan (ALS) which is also known as Light Detection And Ranging (LiDAR) data to assess the buried, topographic and micro topographic features within the Site.
- S6. Aerial photographs, satellite imagery and LiDAR survey data gathered between the 1940s and the present time record salterns, modern military defences, Post-Medieval boundaries and drainage features, and sea defences. An 'enclosure' identified as a possible site by the Essex National Mapping Programme (ENMP) was re-interpreted as an hydrological feature.
- S7. Some of the features have been previously identified by the Essex Historic Environment Record (EHER) and the ENMP survey.
- S8. Whilst all available aerial images have been consulted, it is always possible that further non-intrusive survey or intrusive investigations will discover additional buried features to those recorded from airborne sources.

1. Introduction

- 1.1. This assessment of aerial imagery considers land at the Little Oakley Realignment Site in Essex (**Figure 1**).
- 1.2. The site is centred at UK National Grid Reference TM 231283, coordinates 623195,228350.
- 1.3. This report considers all available aerial and satellite imagery alongside visualised LIDAR data from a range of sources (**Appendix**), as part of an assessment of archaeological features within the site for evaluation purposes.

Figure 1 Location of the site

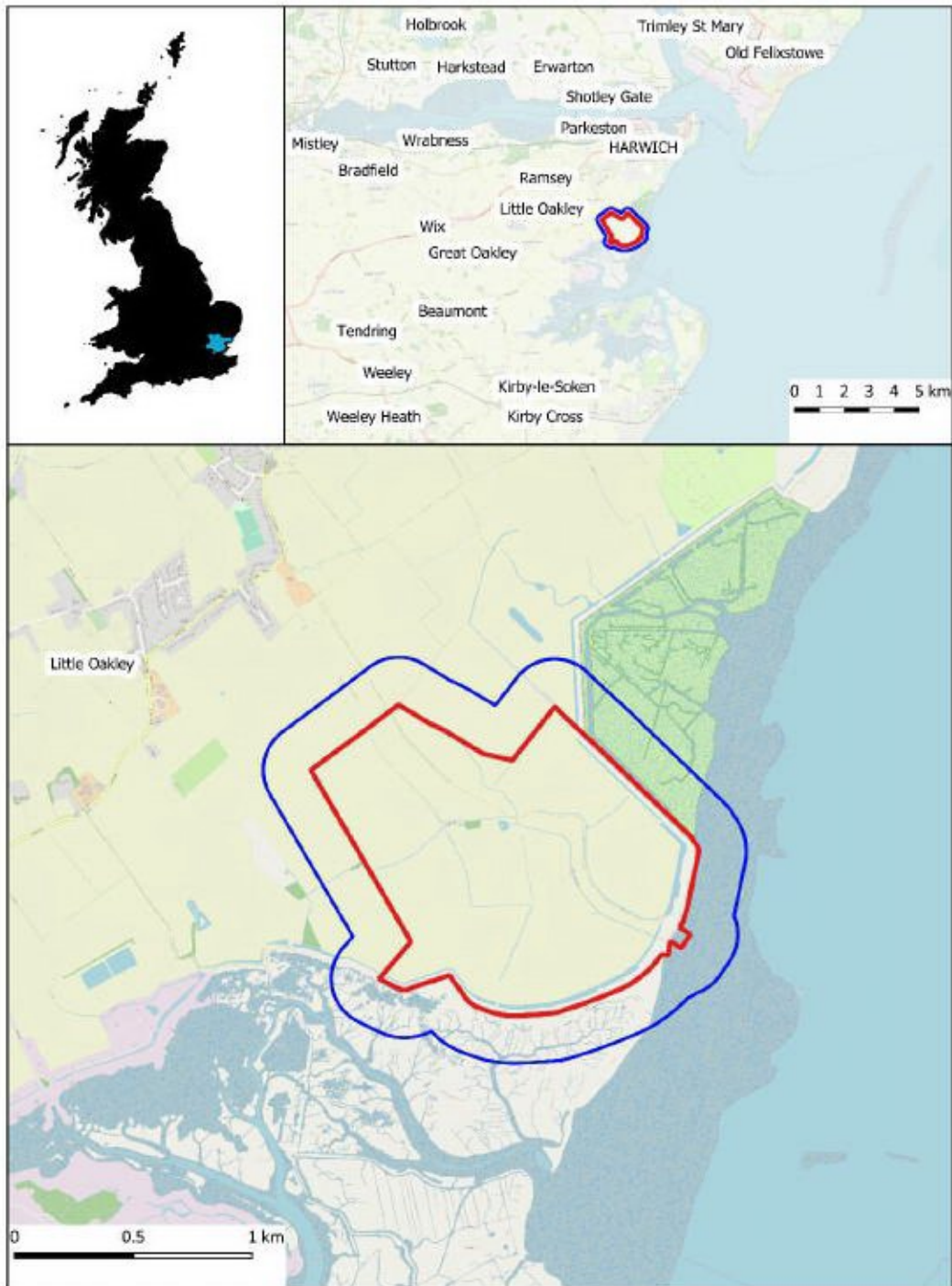


Figure 1: Site Location



Little Oakley, Essex
 Client: RHDHV
 Date: November 2021
 Project: APS 221 10 03
 By: Adam Jarvis ACIFA

- Site Outline
- 200m Buffer

 **AIRPHOTO SERVICES**
www.airphotoservices.co.uk
 © Crown Copyright and Database Right 2021
 Ordnance Survey Licence 100059897

Aims and objectives

1.5. This assessment aimed to:

- provide information on the location and nature of buried and upstanding archaeological features visible on historic aerial photographs, modern aerial and satellite imagery and visualised LiDAR data to assess the buried, topographic and micro topographic features within the Site; and
- integrate and build upon the data collected previously by the Essex National Mapping Programme, to update and expand on these data from more modern sources.

1.6. The objective of this report is to identify the potential for heritage asset presence and preservation through the assessment of aerial imagery, LiDAR data and satellite imagery.

2. Sources of data

2.1. This assessment systematically examined the following sources of data:

- Historic and modern aerial photographs *via* online sources at Google Earth;
- Specialist oblique, military oblique and vertical aerial photographs held at the Historic England Archive in Swindon, under enquiry number 131001, the locations of which are shown on **Figure 2**. These photographs date from the 1940s and provide a comprehensive view over the history of the site;
- Search data as Shape (SHP) and Portable Document Format (PDF) files from the Essex Historic Environment Record (EHER);
- Department for Environment, Food and Rural Affairs (DEFRA) georeferenced digital aerial imagery data which covered the majority of the site to 2016, and the whole of the site from surveys conducted in 2018 and 2020;
- The Essex National Mapping Programme (NMP) quarter sheet TM22NW, which was used as baseline data (Ingle and Saunders 2003), and covers the whole of the Site. This project was an early NMP, begun in 1993, and interpretation continued to 2017 with the Tendring Enhancement add-on to the original data¹; and
- Environment Agency (EA) and National LiDAR Programme (NLP) LiDAR data were available over the whole site and were captured in 1999 (2m resolution), 25cm resolution in 2008, and then at 1m resolution in 2009, 2017, 2018 (NLP) and 2020.

¹ <https://www.historicengland.org.uk/research/research-results/recent-research-results/east-of-england/essex-nmp/>

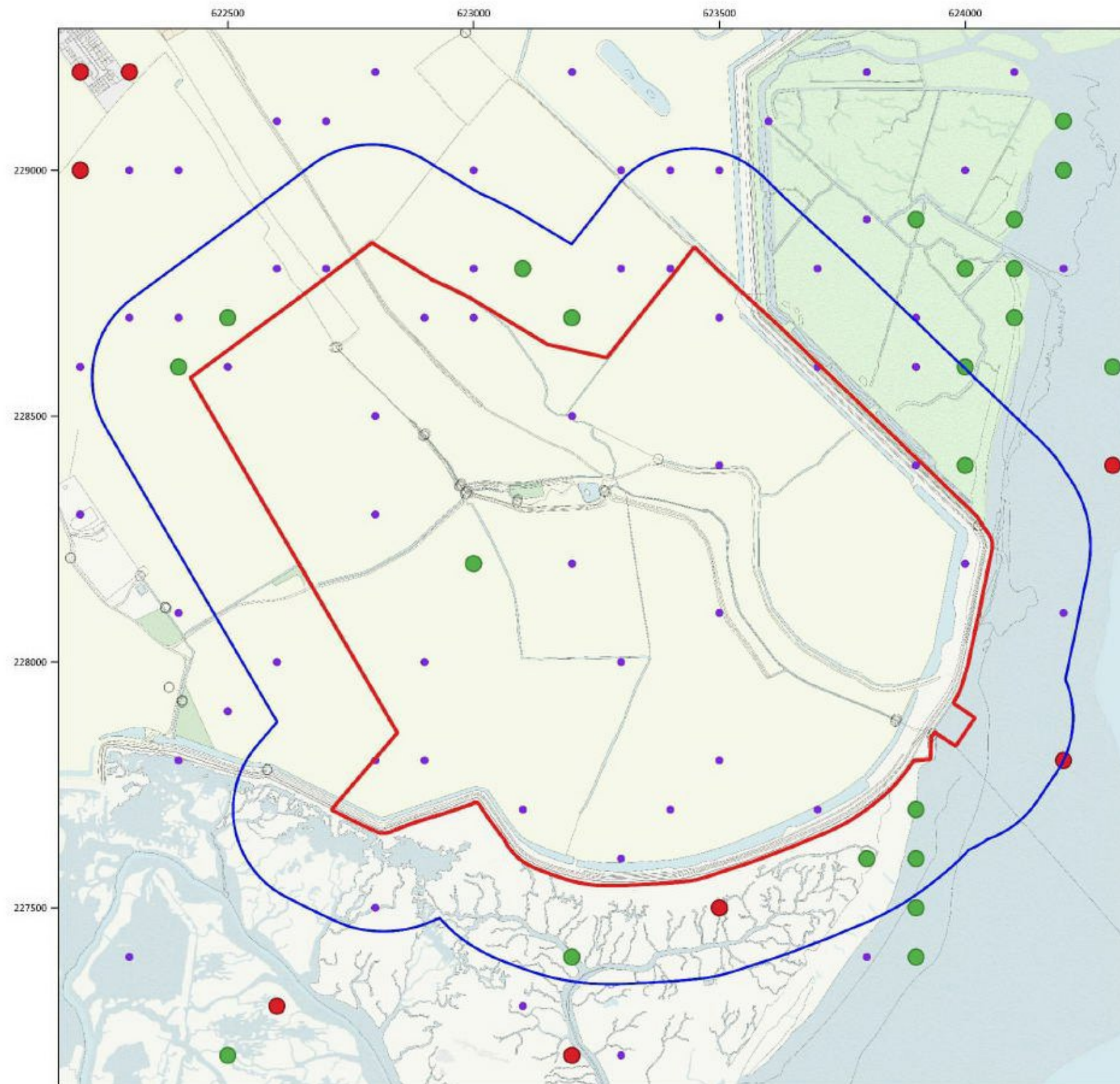
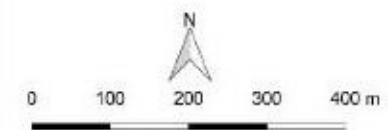


Figure 2 Aerial photographs consulted at the Historic England Archive

- ▭ Site Outline
- ▭ 200m Buffer
- Military Obliques
- Specialist Obliques
- Verticals
 - Vertical aerial photos held as prints for consultation



Little Oakley
Assessment of Aerial Imagery

Client Royal Haskoning DHV
 Date November 2021
 Project APS 221 10 03
 By Chris Cox MCifA FSA
 Source Historic England Enquiry number 131001



© Air Photo Services 2021
 www.airphotoservices.co.uk
 © Crown copyright and database right Ordnance Survey Licence 100059897

3. Interpretation and mapping

- 3.1. All photos, satellite images and LIDAR data visualisations were interpreted and mapped at a level compatible with a 1:2500 scale base map.
- 3.2. Aerial photographs were closely examined by eye and under 1.5x and 3x magnification and interpreted with the aid of a mirror stereoscope where appropriate, or in detail on screen when consulted as digital files.
- 3.3. Aerial photographs were digitally rectified to an OS base map using the QGIS rectification tool. This was done to remove perspective distortion and ensure correct rectification of aerial photographs to the OS map (Scollar 2002 and 2014). Images from Google Earth were also interpreted and rectified to OS map bases and used in accordance with observations made by Scollar and Palmer, 2008.
- 3.4. In all transformations prepared for this assessment, the mean mismatches were less than $\pm 2.5\text{m}$ where possible. The rectified files were set as background layers in QGIS where features were interpreted and drawn over the rectified photographs.
- 3.5. The Essex NMP data were taken into careful consideration, used as baseline data and updated where appropriate from newer data sources.
- 3.6. Layers from the final drawing have been used to prepare the illustration for this report and are provided digitally for import to a Geographic Information System, in ESRI Shapefile format.
- 3.7. LIDAR data were downloaded, visualised and imported to QGIS and ArcGIS for interpretation and mapping. These data were downloaded and visualised in accordance with standards and techniques set out by Bennett *et al* (2010), Hesse (2010), Historic England (2018) and Stular *et al* (2012).
- 3.8. Methods of acquisition, processing, transcription and interpretation are detailed in the Appendix to this report, alongside a discussion of the limitation of each survey technique for archaeological discovery and mapping.

4. Environment and previously recorded heritage assets

- 4.1. The nature of the environment has a complex effect on both the preservation and visibility of both buried and upstanding features from the air. Many factors combine to influence very marked seasonal and temporal limitations to visibility of cropmarks² soil marks³ and earthworks⁴. Land use, agricultural regimes, weather, geology and soil types are all major contributing factors to the visibility of heritage assets from airborne and satellite-derived sources.

Topography and Land Use

- 4.2. The site lies within the landward hinterland of the North Sea coast at Crabknowe Spit. It comprises reclaimed marshland and open arable land north of Pewitt island and southeast of Little Oakley. The site is low-lying within the redline boundary and the buffer area then rises to 10m Above Ordnance Datum (AOD) to the northeast of the site at Little Oakley.
- 4.3. The site has been progressively drained, reclaimed and defended from the sea since the 18th century CE. The coast was and is subject to erosion, and at times flooding from the sea, and was heavily defended during WWII against potential maritime and airborne invasion forces. To the west of the coastal defences, the land is laid to arable use.

Topography and Land Use Conclusion

- 4.4. The low-lying site carries some potential for preservation of pre-modern horizons beneath the marine alluvium, and does indicate crop and soil marks over features which are now removed or eroded within the top strata of the alluvial deposits.
- 4.5. Remains of recently silted channels and smaller streams are readily visible as marks in crops and soil.

² Where crops grow differentially over buried features such as ditches banks and walls and reveal the pattern of past sites and landscape in the colour and density of their growth.

³ Differently coloured and toned soil which is part of buried features which are being directly brought to the surface by ploughing or erosion and are visible in contrast to the surrounding soil.

⁴ Upstanding ditched and embanked features which show from the air *via* their shadows or *via* the differential topography revealed by visualised LiDAR data.

Geology

- 4.6. The drift deposits (Cranfield University 2021, British Geological Survey (BGS) 2021) comprise Marine Alluvium over the majority of the site, which interfaces with Tertiary clay in the northwest part of the site. The extent, type and location of these deposits are shown on **Figure 3**.

Soils

- 4.7. Saltmarsh environments are present adjacent to the coast, where soils of soft variable texture are flooded by high tides⁵, seasonally wet deep clay over tertiary clays⁶, seasonally wet deep clays⁷. The soils are shown on **Figure 4**.

Geology and soils conclusion

- 4.8. The environment is a typical low lying coastal hinterland zone which succeeds from saltmarsh to drained reclaimed land over deep layered marine alluvial deposits. The major features expected, and indeed recorded, from airborne and satellite remote sensing sources comprise modern military defences and former Post-Medieval field systems. The alluvial deposits may conceal earlier buried features.

⁵ SALINE 1 soil type which supports coastal saltmarsh vegetation

⁶ WALLASEA 1 soil type

⁷ WINDSOR soil type

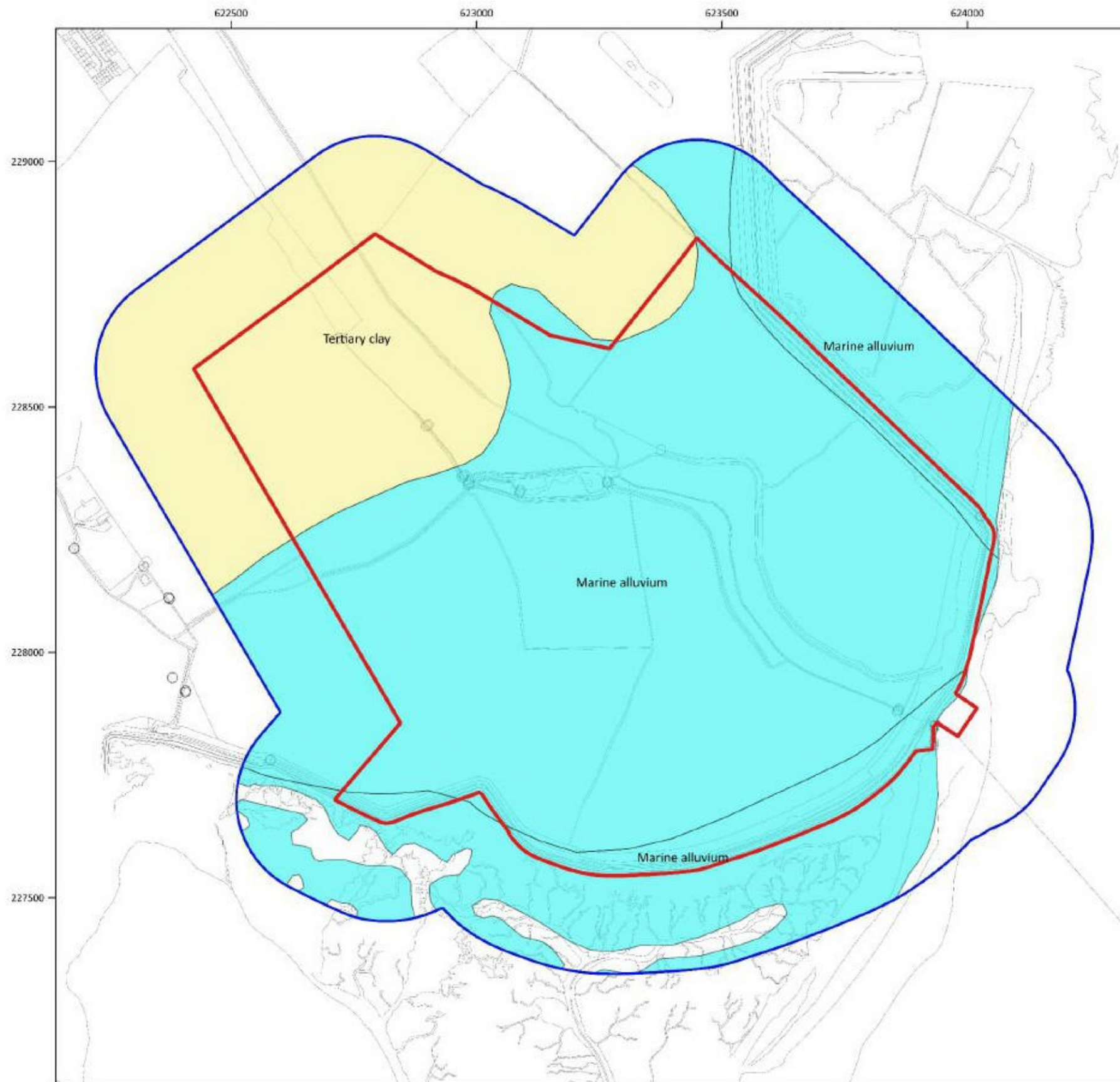
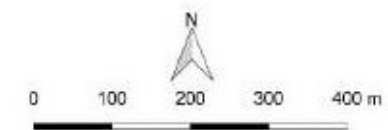


Figure 3 Geology within the site and buffer area

- ▭ Site Outline
- ▭ 200m Buffer
- 152217-1_NationalSoilMap GEOLOGY
- ▭ Marine alluvium
- ▭ Tertiary clay



Little Oakley
Assessment of Aerial Imagery

Client Royal Haskoning DHV
Date November 2021
Project APS 221 10 03
By Chris Cox MCifA FSA
Source <http://www.landis.org.uk/soilscapes/>



© Air Photo Services 2021
www.airphotoservices.co.uk
© Crown copyright and database right Ordnance Survey Licence 100059897

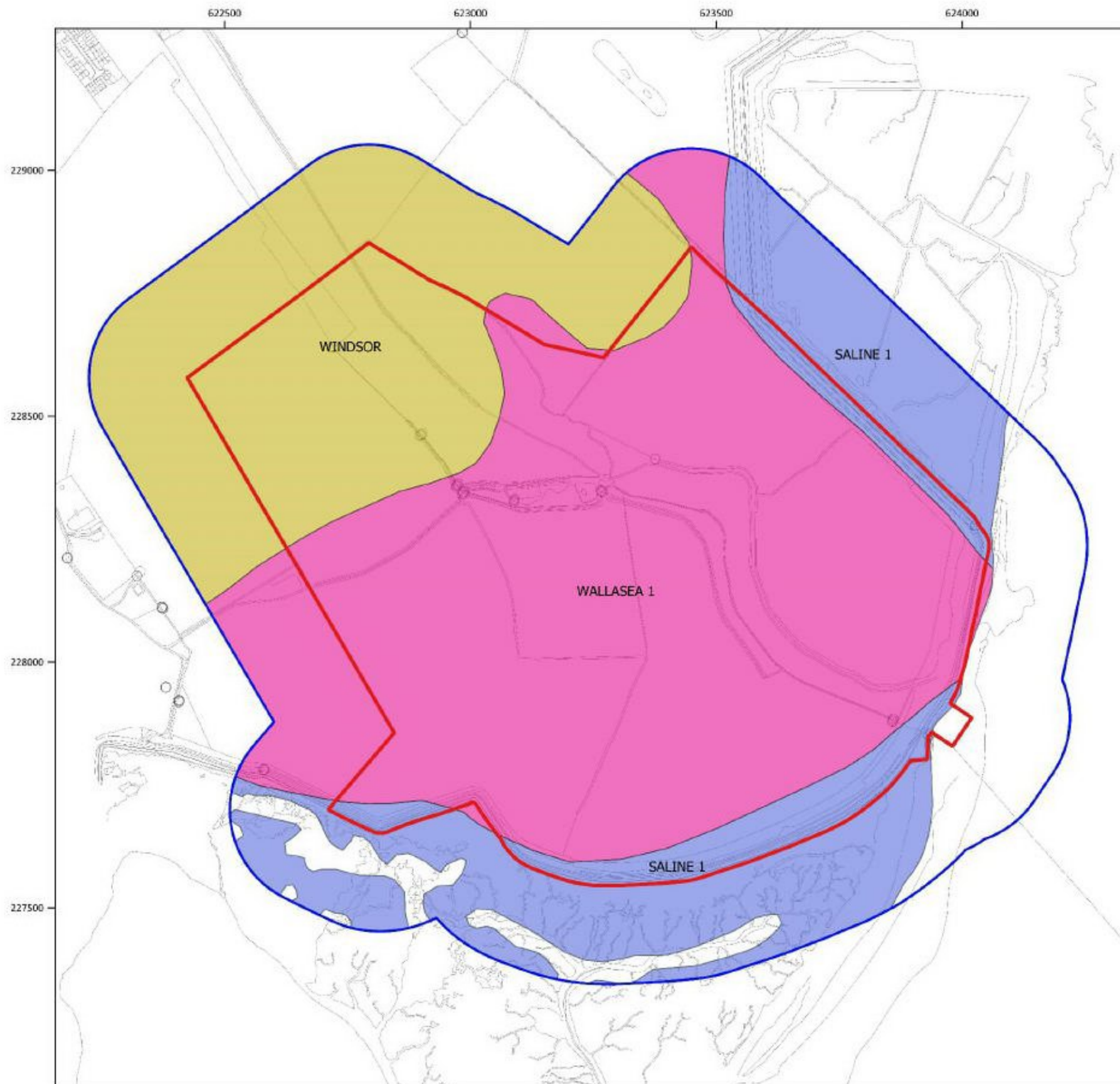
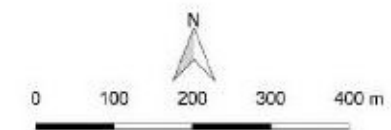


Figure 4 Soils within the site and buffer area

- ▭ Site Outline
- ▭ 200m Buffer
- 152217-1_NationalSoilMap SOILS
- ▭ SALINE 1
- ▭ WALLASEA 1
- ▭ WINDSOR



Little Oakley
Assessment of Aerial Imagery

Client Royal Haskoning DHV
Date November 2021
Project APS 221 10 03
By Chris Cox MCifA FSA
Source <http://www.landis.org.uk/soilscapes/>



© Air Photo Services 2021
www.airphotoservices.co.uk
© Crown copyright and database right Ordnance Survey Licence 100059897

Previously recorded heritage assets

- 4.9. The EHER demonstrates that the Site contains known evidence for prehistoric findspots within and beneath the alluvium, salterns of unknown date, which may have been associated with a Roman settlement landscape on the higher ground to the west and northwest of the site.
- 4.10. In later periods the expansion of more mechanised and widespread agriculture has led to the removal of post-enclosure field boundaries, particularly in the latter part of the 20th century in the areas which have been reclaimed for arable agricultural use since the 18th century CE.
- 4.11. The coast area and hinterland was robustly defended during the 20th century. It contains relict or previously observed and destroyed sites which include a tight line of coastal WWII defensive pillboxes, a minefield (MEX41584, 41585 and 41589) within the site, and MEX41582 and 41588 within the 200m buffer area to the east of the site.
- 4.12. A former 'Diver' anti-aircraft battery (MEX1031556) lay within the site. A minefield, now characterised by craters from exploded mines, extended into and around the site (MEX1031522).
- 4.13. Anti-glider obstruction ditches extended across a large area within the site and buffer zone and were visible as extant or recently infilled features on aerial photographs taken in the 1940s and 1950s and are now visible as marks in crops and soils.
- 4.14. A crop-marked 'enclosure' (MEX1037442) was identified within the site. This feature was identified as a possible enclosure or field system by the Essex NMP interpretation team, from a vertical aerial photograph taken in 1980 (MAL 32/80/76 frame 78). However, the appearance of the dark toned soil mark on this photograph indicates that it is part of a wider system of natural hydrological features.

Baseline heritage assets conclusion

- 4.15. Overall the HER demonstrates the range of visible archaeological resources in the area and has informed this assessment, which has confirmed and expanded on it's data in some areas.

5. Results

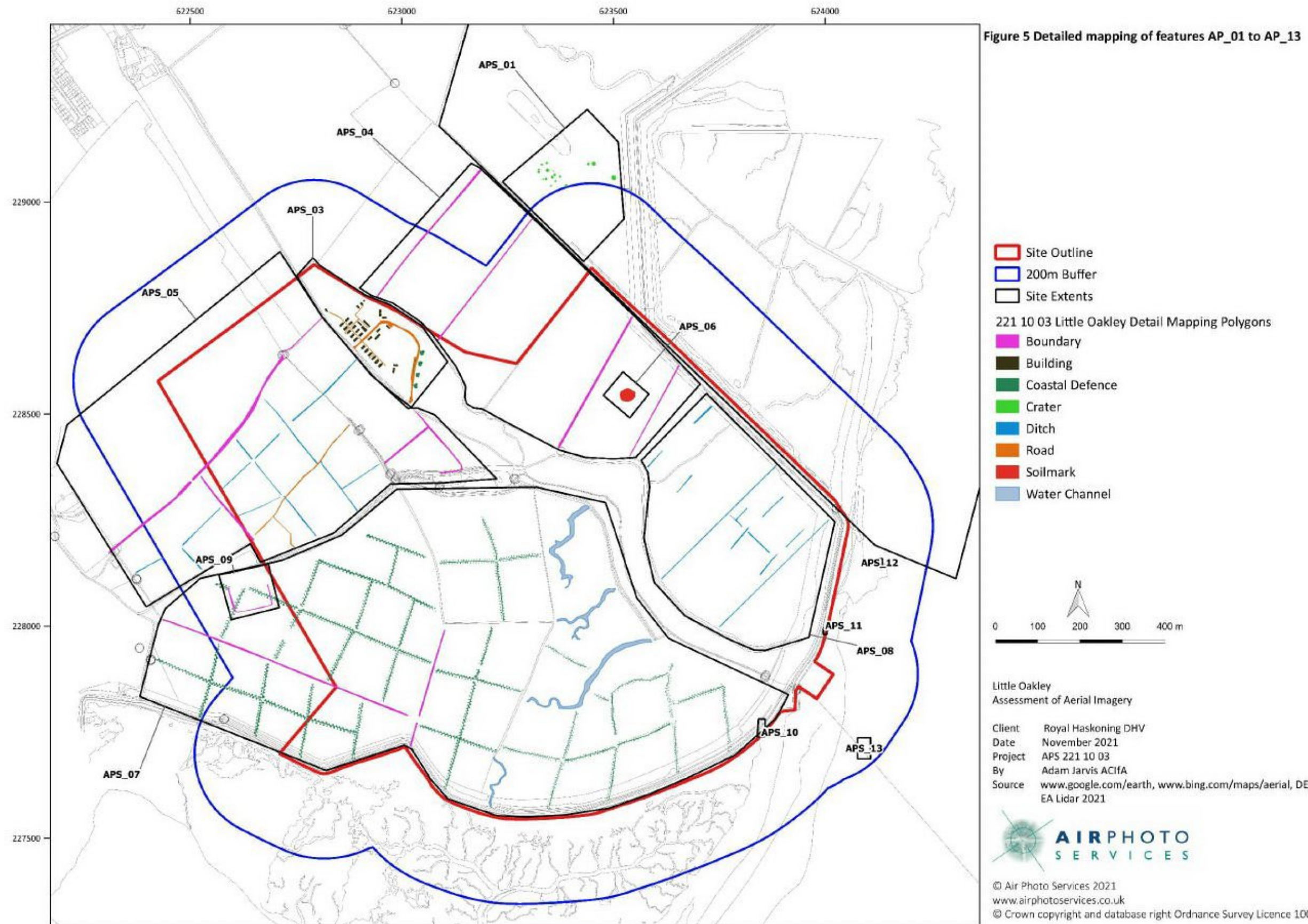
- 5.1. The results from the interpretation and mapping are presented in Tables 1 and 2 are illustrated by Figure 5.
- 5.2. The detailed sources and condition notes are recorded in the Shapefiles which accompany and inform this report.
- 5.3. The fields in **Tables 1 and 2** comprise:
 - APS Site Id;
 - RHDHV Id (to be added);
 - Asset Type;
 - Condition on last recorded data source;
 - Period;
 - EHER MonUID;
 - Interpretation notes;
 - Easting coordinates;
 - Northing coordinates; and
 - Six figure National Grid Reference (NGR).

Table 1 Features within, or partially within, the redline boundary

APS_Site	RHDHV_id	Asset_Type	Broad_Type	Condition on latest recorded data	Period	EHER MonUID	Comment	Easting	Northing	NGR
APS_02		Sea Walls	Sea Defence	Earthwork	Undated	MEX1031542	Remains of sea walls and possible oyster or borrow pits for maintenance are visible across all imagery and LiDAR data for this area. These features bound the eastern edge of the site and extend beyond into the buffer area.	623904	229112	TM 239 291
APS_03		Diver battery	Battery	Cropmark	WWII	MEX1031556	HER records a WWII anti-aircraft Battery, Diver Site K10, at this location. Visible on 1940's vertical photographs. Cropmark visible on satellite imagery and an area of disturbance visible on LiDAR data.	622941	228688	TM 229 286
APS_04		Field Boundary	Boundary	Cropmark	Undated	NA	Area of former field boundaries visible on 1940's vertical photographs. Now visible as faint cropmarks on satellite imagery.	623306	228708	TM 233 287
APS_05		Field Boundary	Boundary	Cropmark/slight earthwork	Post-Medieval	MEX1035960	Formerly extant field boundaries once visible on Military vertical photographs, now visible on satellite imagery vertical photographs as cropmarks. LiDAR data shows residual microtopographic earthworks.	622633	228439	TM 226 284
APS_06		Saltern	Structure	Cropmark	Undated	MEX12827	EHER records evidence of a Saltern here, which appears to be visible as a reddish soilmark referred to as a 'red hill' by the EHER.	623530	228545	TM 235 285
APS_07		Anti-Glider Defences	Defensive feature	Cropmark	Modern (WWII)	MEX1031561	Former WWII anti glider ditches are visible across satellite and vertical photography, extant in the 1940s, and presently as cropmarks under suitable conditions. Area also includes former channels and field boundaries which have been mapped for context. These features extend across the southern part of the site and into the buffer area and beyond.	623140	227929	TM 231 279
APS_08		Field Boundary	Boundary	Cropmark/slight earthwork	Undated	HEX42383, HEX42384, HEX42385	Ditches associated with drainage are visible as extant ditches on vertical aerial photographs and later as cropmarks in satellite imagery.	623783	228220	TM 237 282
APS_10		Pillbox	Defensive feature	Extant structure	Modern WWII	MEX41584	An extant Type FW3/22 defensive pillbox.	623849	227746	TM238277
APS_11		Pillbox	Defensive feature	Destroyed	Modern WWII	MEX41585	A former type FW3/22 defensive pillbox which was visible on 1940s aerial photos and is now destroyed.	623999	227987	TM 239279

Table 2 Features outside the redline boundary but within, or partially within, 200m of the boundary

APS_Site	RHDHV_id	Asset_Type	Broad_Type	Condition on latest recorded data	Period	EHER MonUID	Comment	Easting	Northing	NGR
APS_01		Minefield	Minefield	Cropmark/ slight topographic feature	Modern (WWII)	MEX1031522	Site of a minefield is visible on satellite imagery, vertical photographs and LiDAR data. HER reports land is now cultivated however craters remain. Smaller craters outside of this extent may be related to further mines. Area previously extended further west than at present and may present an unexploded ordnance (UXO) risk which has not been assessed during this project as it is outside of our expertise to do so.	623409	229040	TM 234 290
APS_09		Field Boundary	Boundary	Soilmark/cropmark	Post-Medieval/Modern	NA	Buried ditched boundary which has been recently removed from a small enclosed field.	622648	228045	TM 226280
APS_12		Pillbox	Defensive feature	Inconclusive, likely eroded by tides	Modern WWII	MEX41588	Type FW3/22 defensive pillbox which was sited on the beach during the 1940s and 1950s. The sea has encroached since then and the area is now intertidal mudflats. The pillbox was extant in 2000 in shallow water on the mudflat, but not seen conclusively since. It has been accurately located for this assessment from a georeferenced 25cm photo provided by Bluesky/Infoterra Ltd, and the position is/was 22.5m to the southeast of the position recorded by the EHER monument point for this record.	624130	228149	TM 241281
APS_13		Pillbox	Defensive feature	Very residual	Modern WWII	MEX41582	A ruined type FW3/22 pillbox which showed clearly as part of a line of extant pillbox structures on the foreshore in the 1940s and 1950s, seen as a ruined structure in sea in 1960, now only visible as wave disturbance over the eroded ruins in the sea, in the intertidal zone which is visible on the 2017 timeline of images displayed at Google Earth	624090	227709	TM240277



- 5.4. This assessment has recorded thirteen individual sites or areas of archaeological potential or interest within the site and buffer area. Some of these sites have been recorded previously by the NMP and the EHER. These previous interpretations have been noted, some sites have been remapped and re-positioned and the NMP interpretations updated during this assessment.

Prehistoric and Roman periods

- 5.5. No sites or features within the site and buffer area have been identified from airborne remote sensing and satellite imagery sources which are dated to the prehistoric and Roman periods.
- 5.6. There are findspots which record artefactual evidence which reflect a human presence in prehistory, but no crop marked or topographic evidence for areas of settlement or funerary sites has been recorded. The dynamic coastal nature of the site, the coverage of marine alluvium and saltmarsh environments would indicate that permanent settlement and land use may be more evident on the more firm, higher ground to the west and northwest of the site.

Medieval and Post-Medieval/Undated periods

- 5.7. No sites or features within the site and buffer area have been dated directly to the Medieval period.
- 5.8. Undated and Post-Medieval field systems and field boundaries have been identified where crop marks, soil marks and slight earthworks persist over their former locations, at **APS_04, APS_05, APS_08** within the site and at **APS_09** adjacent to the west boundary of the site and within the buffer area.
- 5.9. These former boundaries reflect changes to the landscape on drainage, reclamation, and enclosure in and after the 18th century CE, and indeed into the modern period at **APS_09** in the buffer area, where a small field was extant until very recently and has now been integrated to a wider arable area with removal of its boundary.
- 5.10. Undated salterns, where salt was extracted from saline water, are recorded as 'red hills' by the EHER within and around the site. These features are not all visible from airborne remote sensing sources, but one has been identified as a distinctly coloured area at **APS_06**.

Modern sites

- 5.11. The area was heavily and swiftly defended from the outset of World War Two (WWII) between 1939 and 1945 CE.
- 5.12. Aerial photographs taken in the 1940s and 1950s show extensive areas of anti-glider ditches which were designed to prevent any potential landing grounds for invasion forces. These extensive former trenches are all now infilled and buried. They are recorded as **APS_07**, where they are visible as crop and soil marks over large parts of the southern sector of the site and the buffer area.
- 5.13. The site of a former K10 type 'Diver' battery, a defensive feature which was setup to intercept and destroy German V1 and V2 rockets in the latter part of World War II, was situated at **APS_03**. The gun emplacement and associated structures and an access way were recorded as extant features from contemporary 1940s aerial photographs. The installation was removed following the end of the war and is now only residually visible as marks in crops and soil and as slight irregularities in the ground surface via visualised LiDAR data.
- 5.14. The coast at the immediate east of the redline boundary was defended by a row of concrete type FW3/22 pillboxes, which are compact defended structures to house gunners and gun posts for direct defensive purposes.
- 5.15. Within and on the edge of the site boundary the pillbox at **APS_10** is still extant and visible at the latest timeline of imagery displayed at Google Earth in 2020. **APS_11** was aligned to the northwest of APS_10, again on the edge of the seawall defences, was recorded from aerial photos taken in the 1940s and 1950s and is no longer extant above ground.
- 5.16. Outside of the site but within the buffer area to the east of the sea defences, **APS_12** and **APS_13** completed this defensive alignment of FW3/22 pillboxes. **APS_12** was sited on the beach during the 1940s and 1950s. The sea has encroached since then and the area is now intertidal mudflats. **APS_12** was extant in 2000 CE in shallow water on the mudflat protruding from under shallow seawater but has not been seen conclusively from airborne sources since. It may survive as residual foundations on the seabed. It has been accurately located for this assessment from a georeferenced 25cm resolution aerial photograph which was taken in 2000, by Bluesky/Infoterra Ltd. The

position of this feature is/was 22.5m to the southeast of the position recorded by the EHER monument point for this record.

- 5.17. **APS_13** was a further type FW3/22 pillbox, which showed clearly as part of the line of extant pillbox structures on the foreshore in the 1940s and 1950s in an alignment with **APS_10 - 12**. It was recorded by the EHER as a ruined structure in the sea from a Hunting Surveys Ltd (HSL) vertical aerial photograph, which was taken in 1960. The very residual base of the feature is now only visible as wave disturbance over the eroded ruins in the sea, in the intertidal zone. The position of the residual remains of this structure is visible on the 2017 timeline of images displayed at Google Earth.
- 5.18. Outside and to the immediate north of the site, **APS_01** is the site of a former defensive minefield which was laid in WWI. The area is characterised by residual craters where the mines have been deactivated and exploded. These are recorded via vertical aerial photographs and as slight irregularities seen via visualised LiDAR data. The area may present an unexploded ordnance (UXO) risk, but assessment of this risk is beyond the remit or capability of this assessment.

6. Conclusion

- 6.1. Aerial photographs, satellite imagery and LiDAR survey data gathered between the 1940s and the present time record a low lying reclaimed and drained landscape over marine alluvial and Tertiary clay deposits. The area was drained and laid to agriculture in the Post-Medieval period and is protected from the heavy tides of the North Sea by a series of sea defence embankments. The remains of some of the former drains and field boundaries are evident as marks in crops and soils where boundaries have been removed in the 20th century to facilitate modern agriculture.
- 6.2. Some of the features identified during this assessment have been previously identified by the EHER and the Essex NMP survey. In some cases this assessment has augmented and added to these data from modern airborne and satellite imagery sources.
- 6.3. As expected in such an environment, crop and soil marked remains of prehistoric and Roman settlement and funerary features are now expected to be present or visible within the deeply stratified marine alluvium. Prehistoric and Roman occupation and land use was likely confined to the higher ground above the 10m contour to the west and northwest of the site. Findspots near to the site indicate prehistoric activity, and the area was likely to have been used to hunt and gather natural food resources in the earlier periods rather than as a stable settlement area.
- 6.4. A crop-marked possible 'enclosure' (MEX1037442) was identified within the site by the EHER. This feature was identified as a possible enclosure or field system by the Essex NMP interpretation team, from a vertical aerial photograph taken in 1980 (MAL 32/80/76 frame 78). However, the appearance of the dark toned soil mark on this photograph which was re-examined at the HE Archive for this assessment indicates that it is indeed part of a wider system of natural hydrological features.
- 6.5. WWII defensive features have also been mapped from aerial photos on the eastern edge of the site and into what is now the intertidal zone. These features comprise a 'Diver' anti-V1/V2 rocket site and a series of defensive pillboxes and a former minefield on the coastal edge of the site and buffer area. Extensive former anti-glider trenches extended across the southern part of the site in the 1940s and are now completely infilled and levelled.
- 6.6. From an aerial perspective, this landscape may be analysed in a 'living' manner as one which developed and was specifically defended from the sea and drained over time

and contains multi-period elements. These will be more deeply stratified and extensive below the ground than is apparent in the results of the survey, and some elements of the WWII defensive features may be preserved below ground and in some cases on the inter-tidal zone seabed.

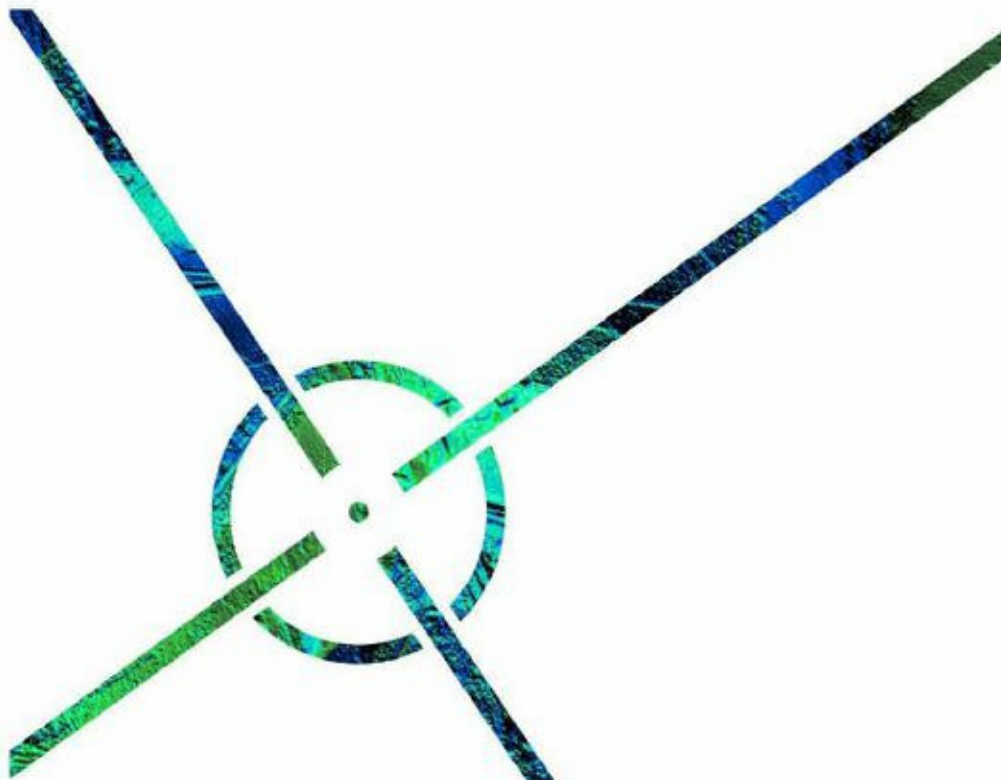
Bibliography

- Bennett, R. Welham, K. Hill, R.A. & Ford, A. 2012. 'A Comparison of visualisation techniques for models created from airborne laser scanned data' in *Archaeological Prospection* 19. PP. 41-48.
- British Geological Survey (BGS). 2021. <http://mapapps.bgs.ac.uk/geologyofbritain/home.html> Accessed November 2021.
- Cranfield University. 2021. <http://www.landis.org.uk/soilscapes/index.cfm> Accessed November 2021
- Historic England 2018 *Using Airborne LiDAR in Archaeological Survey: The Light Fantastic*. Swindon. Historic England. [HistoricEngland.org.uk/research/methods/airborne-remote-sensing/LiDAR/](https://www.historicengland.org.uk/research/methods/airborne-remote-sensing/LiDAR/)
- Hesse, R. 2010. 'LiDAR-derived Local Relief Models - a new tool for archaeological prospection' in *Archaeological Prospection* 2.
- Ingle, C. and Saunders, H. 2003 *Essex NMP Project Management Report*. Historic England and Essex Council. <https://www.historicengland.org.uk/research/research-results/recent-research-results/east-of-england/essex-nmp/>
- Scollar, I. & Palmer, R. 2008. 'Using Google Earth Imagery' in *AARG News* 37. PP. 15-21.
- Scollar, I. 2002. 'Making Things Look Vertical'. In Bewley RH and Raczkowski W (Eds) *Aerial Archaeology: Developing Future Practice*. NATO Science Series, 337. PP. 166 – 172.
- Štular, B. Kokalj, Ž. Oštir, K. Nuninger, L. 2012. 'Visualisation of LiDAR – derived relief models for detection of archaeological features' in *Journal of Archaeological Science* 39. PP. 3354-3360.

Acknowledgements

Many thanks to those who have supported this assessment through the provision of research materials and advice on sourcing documents during a time of restricted access:

- Royal HaskoningDHV;
- Essex HER ; and
- Historic England Archive, Swindon.



AIR PHOTO SERVICES

Archaeology • Research • Law • Environment • Planning

Air Photo Services Ltd
The Shaftesbury Centre
Percy Street Swindon SN2 2AZ



Directors

Chris Cox MA MCIFA FSA

David Lang BA PCIFA

Company No. 5248188 Registered Office The Shaftesbury Centre SN2 2AZ UK