NORTH FALLS

Offshore Wind Farm

ENVIRONMENTAL STATEMENT

Appendix 25.2 Onshore Cable Corridors(s) and Onshore Substation Zone Historic Environment Desk-Based (baseline) Assessment (Part 2 of 2)

Document Reference:	3.3.49
Volume:	3.3
APFP Regulation:	5(2)(a)
Date:	July 2024
Revision:	0

NORTH FALLS
Offshore Wind Farm

Project	North Falls Offshore Wind Farm
Document Title	Environmental Statement Appendix 25.2 Onshore Cable Corridors(s) and Onshore Substation Zone Historic Environment Desk-Based (baseline) Assessment
Document Reference	3.3.49
APFP Regulation	5(2)(a)
Supplier	Royal HaskoningDHV
Supplier Document ID	PB9244-RHD-ZZ-ON-RP-HC-0099

Revision	Date	Status/Reason for Issue	Originator	Checked	Approved
0	July 2024	Submission	RHDHV	NFOW	NFOW

610000 615000 620000 625000

230000 225000 220000 215000

N

Foxash Estate

Ardleigh Cropmark Complex

Ardleigh

Great Bromley

Area to the North of Little Bentley

Bradfield Heath

Wix Area

Tendring

Weeley Area

Holland Brook Floodplain

Little Clacton Area

Hamford Water

The Sokens

Kirby Cross

Great Holland Area

Legend

- Non-Designated Heritage Assets Study Area
- Cable Landfall Search Area

Historic Environment Characterisation Zones (HECZ)

- Ardleigh
- Ardleigh Cropmark Complex
- Area to the North of Little Bentley
- Bradfield Heath
- Foxash Estate
- Great Bromley
- Great Holland Area
- Hamford Water
- Holland Brook Floodplain
- Kirby Cross
- Little Clacton Area
- Tendring
- The Sokens
- Weeley Area
- Wix Area

0 1 2 4 km

Drawing Title

Tendring Historic Environment Characterisation

Rev	Date	Remarks	Drwn	Chkd
02	01/09/2022	Second issue	FC	SM
01	06/04/2022	First issue	FC	SM

Drawing Number	Figure Number
PB9244-RHD-ZZ-ON-DR-GS-0162	6

Scale	Plot Size	Datum	Projection
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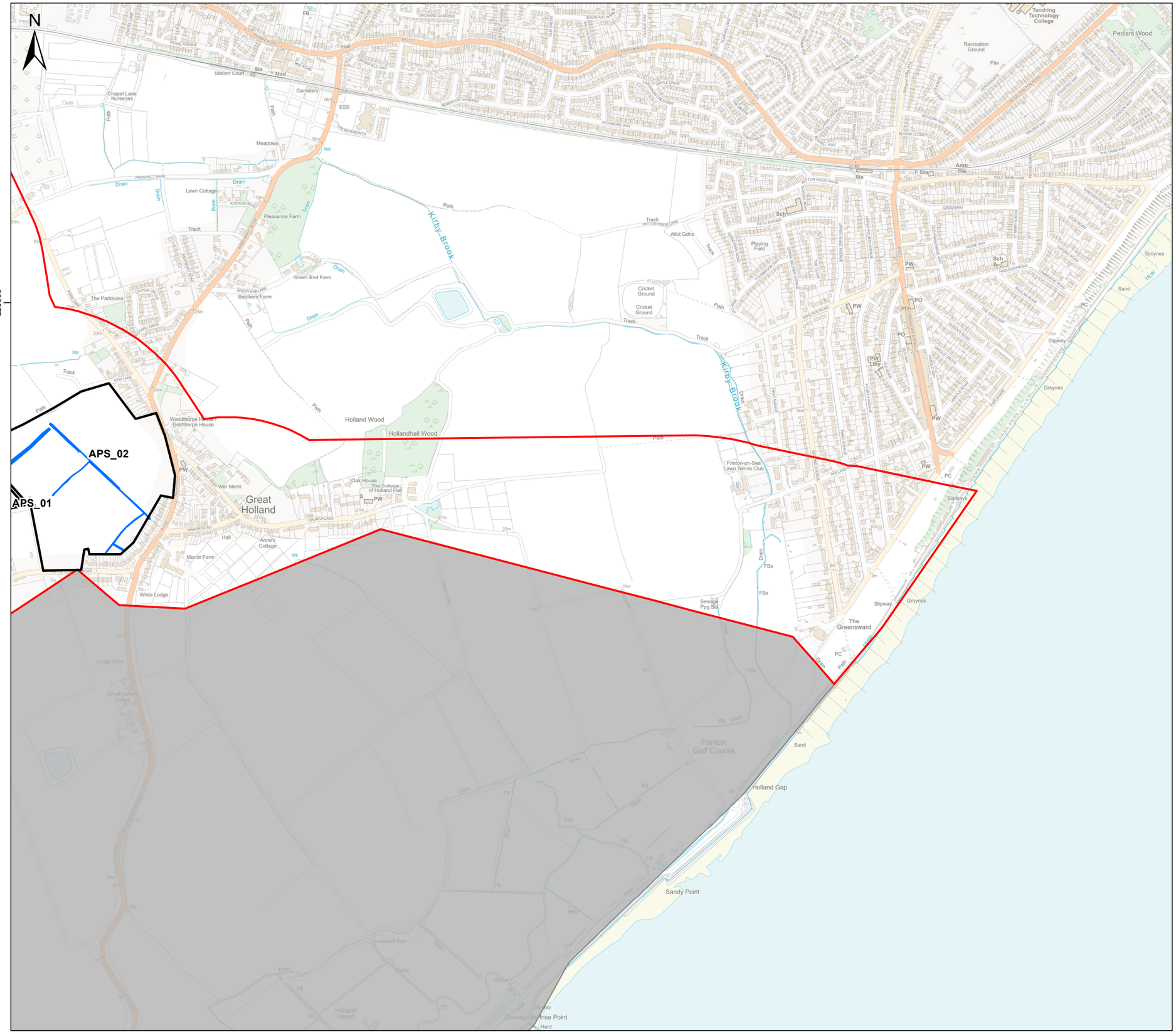
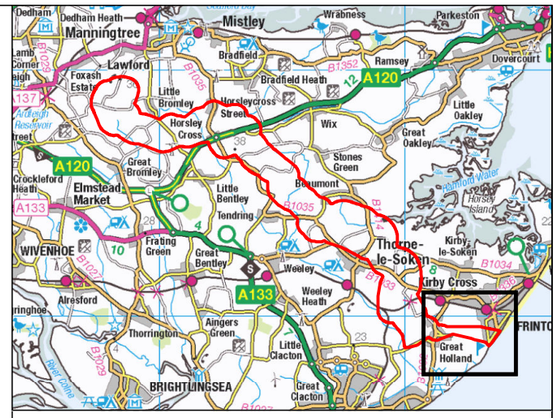
Figure 7 Areas of Heritage Assets derived from Aerial Imagery (APS)





Legend

- Non-Designated Heritage Assets Study Area
- Cable Landfall Search Area
- APS Site

Heritage Assets

- Field Boundary

0 125 250 500 Metres

Drawing Title

Areas of Heritage Assets derived from Aerial Imagery

Rev	Date	Remarks	Drwn	Chkd
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01	06/04/2022	First issue	FC	SM

Drawing Number	Figure Number
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Scale	Plot Size	Datum	Projection
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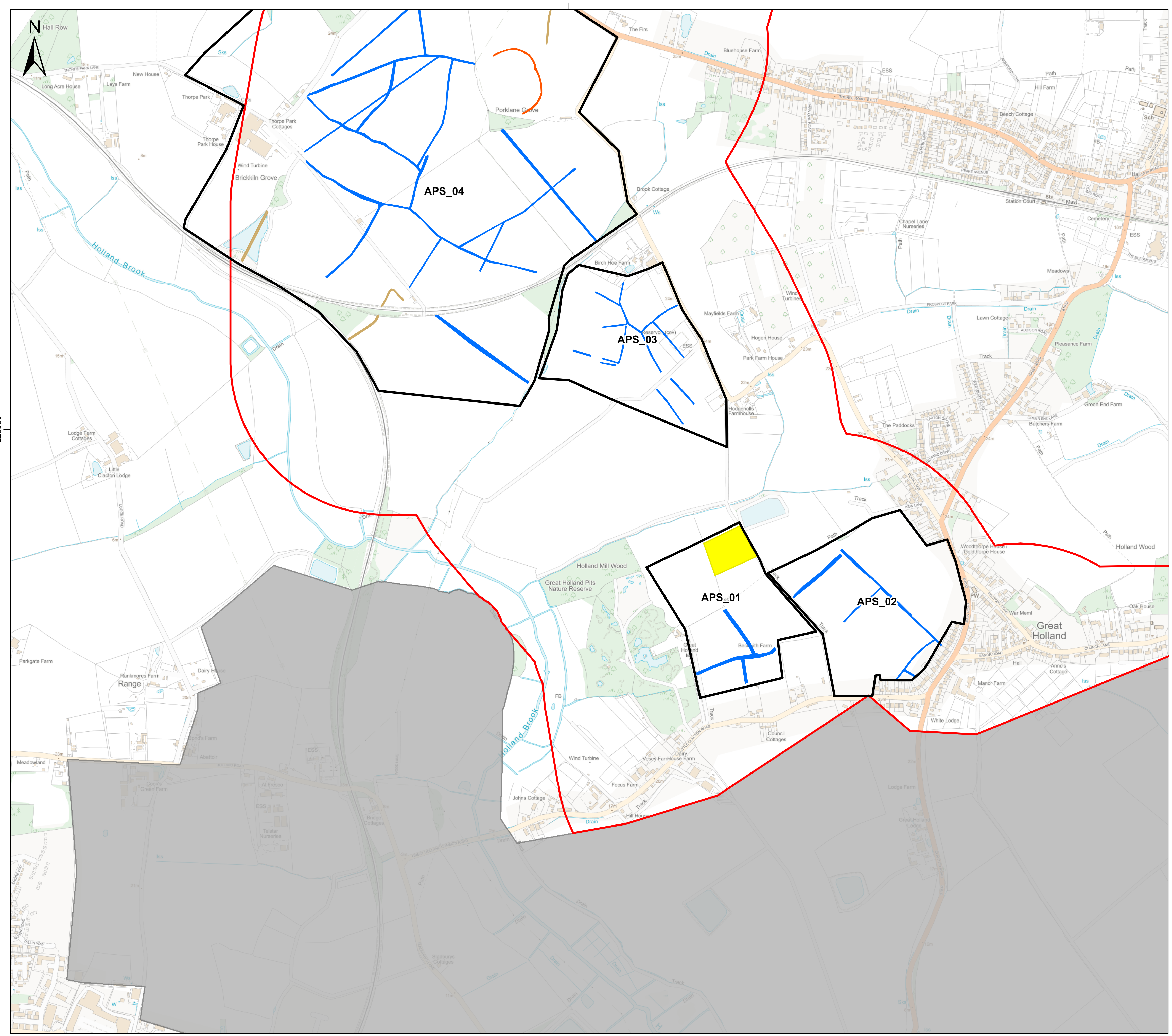

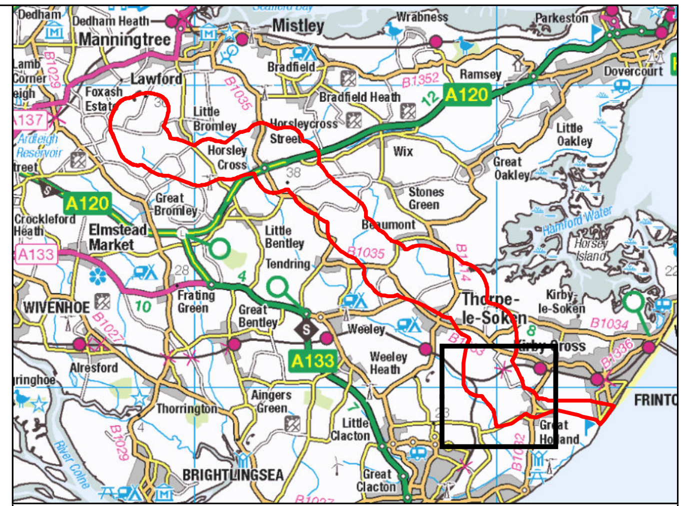

Legend

- Non-Designated Heritage Assets Study Area
- Cable Landfall Search Area
- APS Site

Heritage Assets

- Curvilinear Ditch
- Ditch
- Field Boundary
- Sand and Gravel Pit

0 125 250 500 Metres

Drawing Title

Areas of Heritage Assets derived from Aerial Imagery

Rev	Date	Remarks	Drwn	Chkd
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01	06/04/2022	First issue	FC	SM

Drawing Number	Figure Number
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Scale	Plot Size	Datum	Projection
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APS_06

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APS_04

APS_03

Landermere

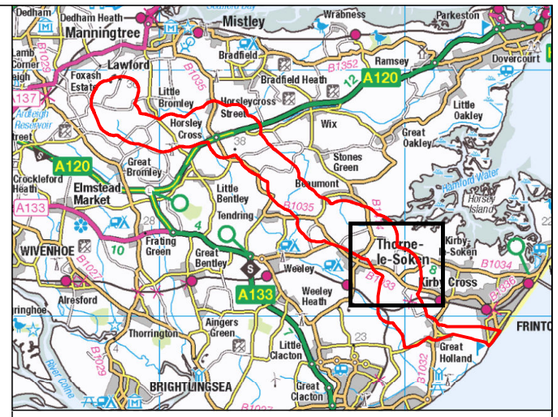
Thorpe-le-Soken

Thorpe Cross

Lane End

Dale Hill

Holland Brook



Legend

- Non-Designated Heritage Assets Study Area
- Cable Landfall Search Area
- APS Site

Heritage Assets

- Curvilinear Ditch
- Ditch
- Field Boundary

0 125 250 500 Metres

Drawing Title

Areas of Heritage Assets derived from Aerial Imagery

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01	06/04/2022	First issue	FC	SM

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APS_09

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Beaumont

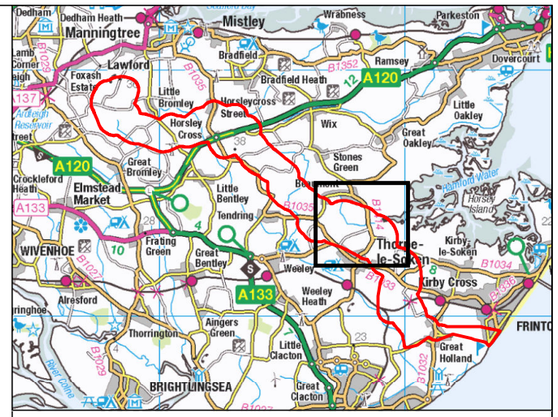
Beaumonthall Wood

Thorpe Green

Thorpe-le-Soken

Landermere

Beaumont Cut



Legend

- Non-Designated Heritage Assets Study Area
- Cable Landfall Search Area
- APS Site

Heritage Assets

- Field Boundary

0 125 250 500 Metres

Drawing Title

Areas of Heritage Assets derived from Aerial Imagery

Rev	Date	Remarks	Drwn	Chkd
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01	06/04/2022	First issue	FC	SM

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Offshore Wind Farm

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APS_10

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Tendring Green

Goose Green

Tendring

Weeley

Far Thorpe Green

Thorpe Green

Tendring Brook

Holland Brook

Stonehall Wood

Gravel Wood

Tendring Grove

Simon's Wood

Hillands Wood

Home Wood

Beaumonthall Wood

Pilcox Wood

Glebe Wood

Hillhouse Farm

Lucas Farm

Oak Farm House

Maple Cottage

Elm Farm

Pond Farm

Wasses Corner

Brambles

Barker's Farm

Barker's Hall

Tendring Lodge

Yewtree Farm

Brookside Cottage

Wayside Cottage

Mill House

Hollywood Farm

New Hall Farm

Hill Farm

Cricket Ground

Lodge House

The Plantation

The Rookery

The Spinney

The Manor House Lodge

Hieland House

Hillhouse Farm

Oakwood House

Ankerdene House

White House

Bradley Hall Farm

Cyprus Cottage

Swallow Tye Cottage

Greyfriars

Comarques Farm House

Comarques Cottage

Whitehall Farm Sewage Works

Whitehall Bungalow

Mill House

James Farm

Barkers Hall Cottages

Brick Layers Cottage

Wind Turbines

Thorpe Green Farm

Green Farm

Hawk Farm

Pestles Hall

Homestead Lake Country Park

Homestead Lake Park

Raptor Rise

Crematorium

Mast

Ppg Sta

Hall

War Mem

Allot Gdns

The Hollies

Ascot House

Sewage Pog Sta

Grange Farm

Kettlethorpe

Pond Farm

Clare House

Romford House

Nearby

Church Farm

Oakley House

Tanzara

Walnut House

Watercress Bed

Old School House

Sch

Oak Farm

Track

Path

Drain

Iss

Sks

FB

Ford

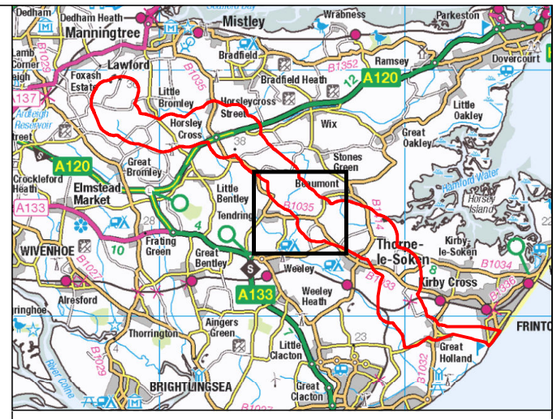
W

PW

PH

Ring Ditch

Trackway



Legend

- Non-Designated Heritage Assets Study Area
- Cable Landfall Search Area
- APS Site

Heritage Assets

- Ditch
- Field Boundary
- Ring Ditch
- Trackway

0 125 250 500 Metres

Drawing Title

Areas of Heritage Assets derived from Aerial Imagery

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Offshore Wind Farm

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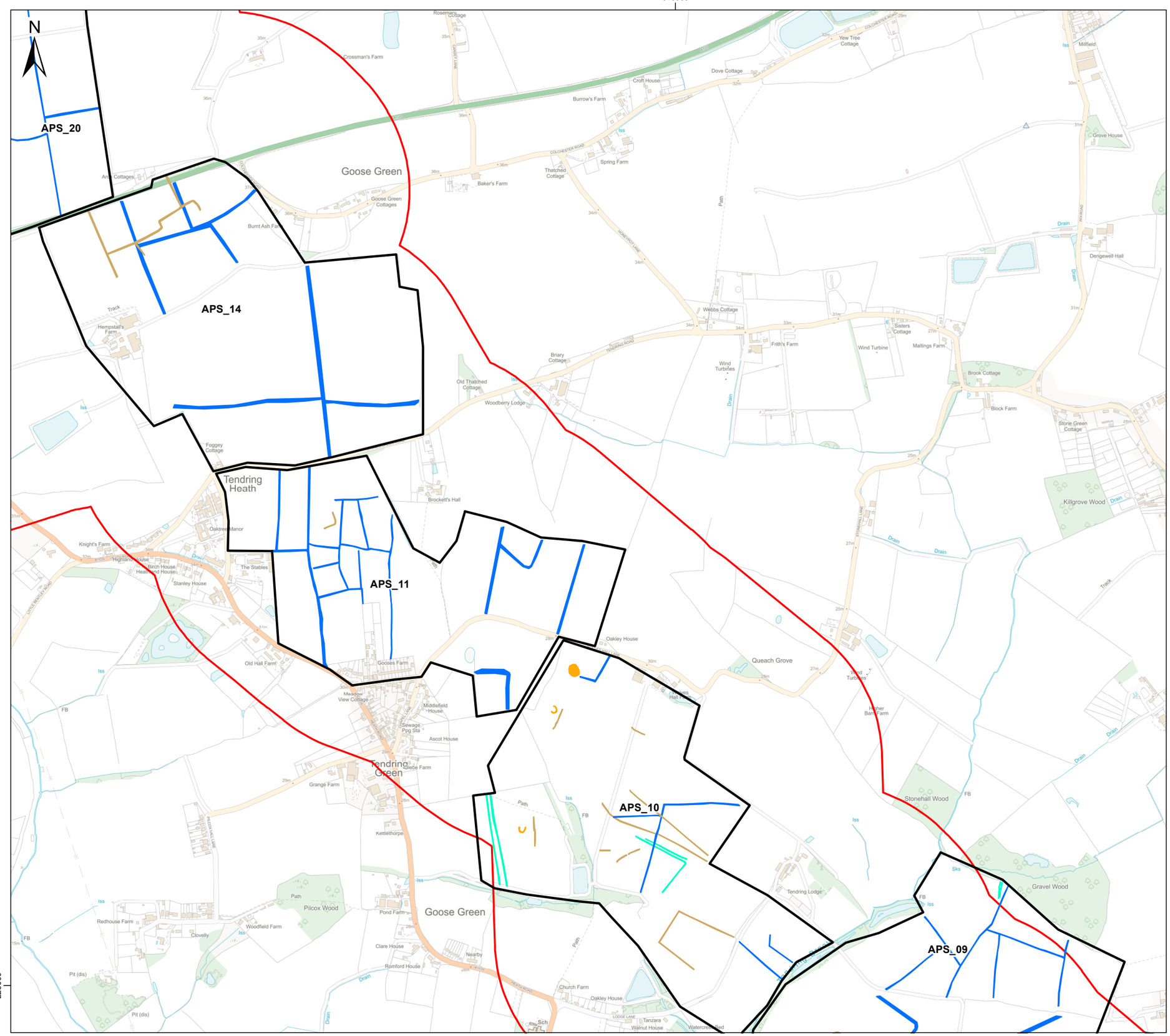

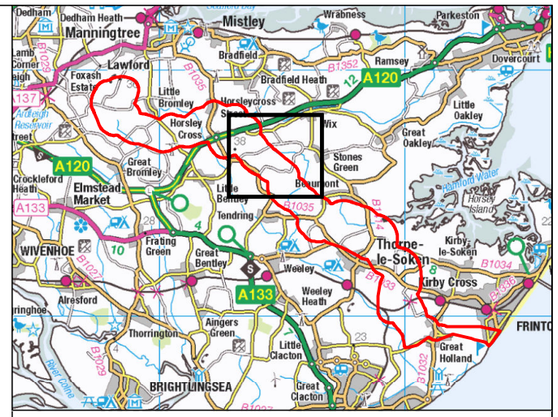

Legend

- Non-Designated Heritage Assets Study Area
- Cable Landfall Search Area
- APS Site

Heritage Assets

- Ditch
- Field Boundary
- Ring Ditch
- Trackway

0 125 250 500 Metres

Drawing Title

Areas of Heritage Assets derived from Aerial Imagery

Rev	Date	Remarks	Drwn	Chkd
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01	06/04/2022	First issue	FC	SM

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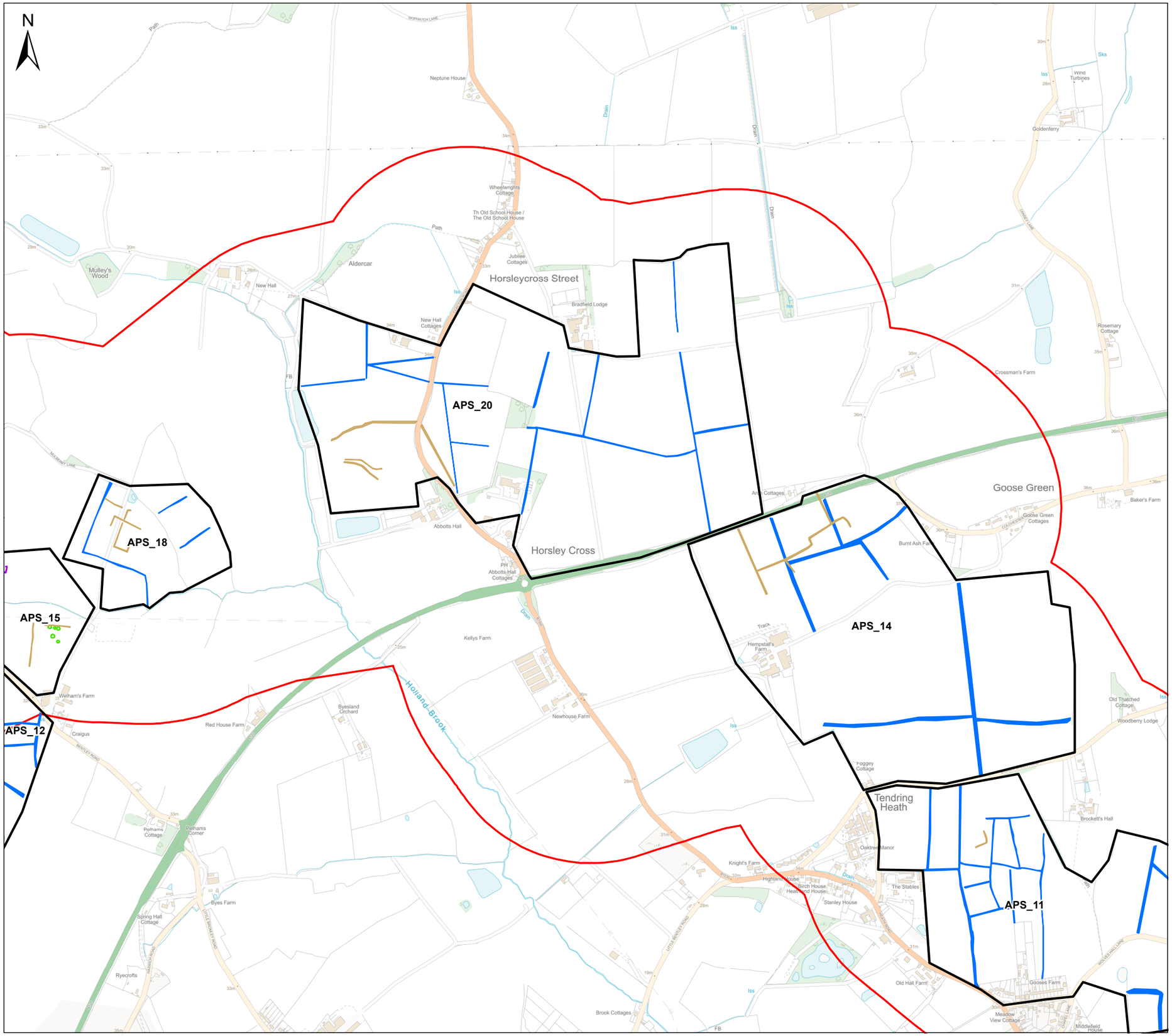

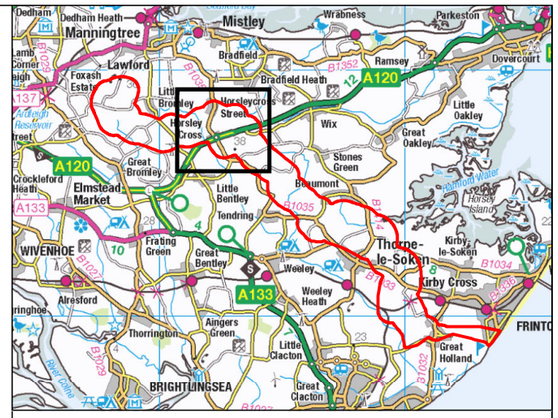

Legend

- Non-Designated Heritage Assets Study Area
- Cable Landfall Search Area
- APS Site

Heritage Assets

- Ditch
- Field Boundary
- Rectilinear Enclosure
- Round Barrow

0 125 250 500 Metres

Drawing Title

Areas of Heritage Assets derived from Aerial Imagery

Rev	Date	Remarks	Drwn	Chkd
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NORTH FALLS
Offshore Wind Farm

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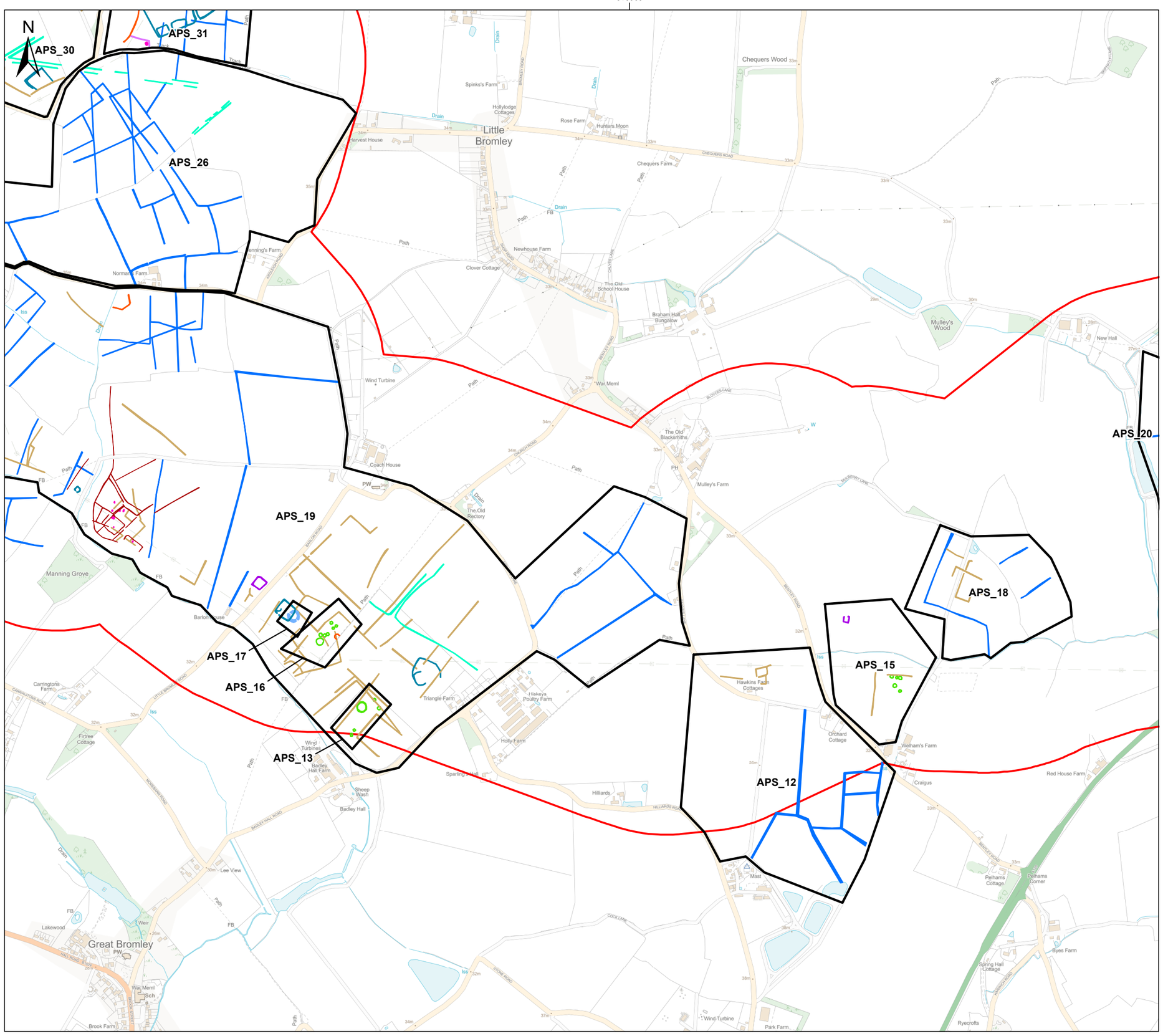

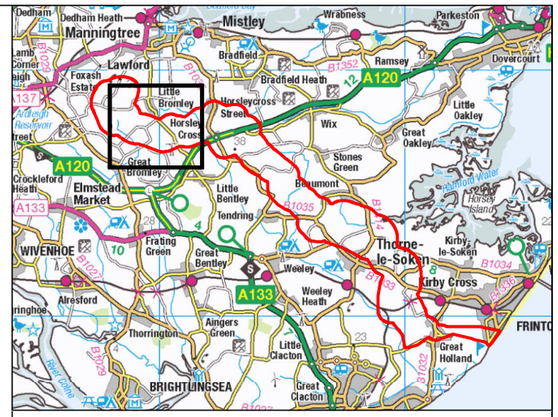

Legend

- Non-Designated Heritage Assets Study Area
- Cable Landfall Search Area
- APS Site

Heritage Assets

- Curvilinear Ditch
- Ditch
- Enclosure
- Field Boundary
- Henge Enclosure
- Pit
- Rectilinear Ditch
- Rectilinear Enclosure
- Round Barrow
- Settlement Site
- Trackway

0 125 250 500 Metres

Drawing Title

Areas of Heritage Assets derived from Aerial Imagery

Rev	Date	Remarks	Drwn	Chkd
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01	06/04/2022	First issue	FC	SM

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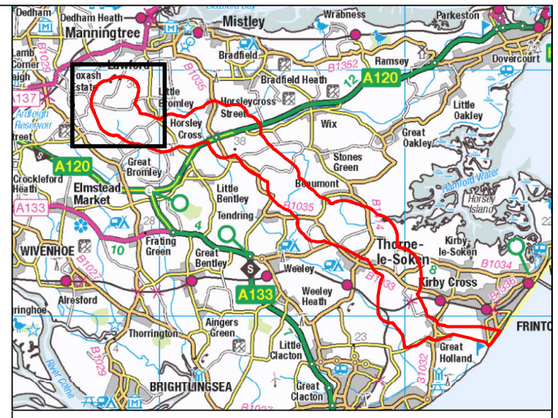

Legend

- Non-Designated Heritage Assets Study Area
- Cable Landfall Search Area
- APS Site

Heritage Assets

- Curvilinear Ditch
- Ditch
- Enclosure
- Field Boundary
- Henge Enclosure
- Maculae
- Oval Enclosure
- Pit
- Rectilinear Ditch
- Rectilinear Enclosure
- Ring Ditch
- Round Barrow
- Settlement Site
- Trackway

0 125 250 500 Metres

Drawing Title

Areas of Heritage Assets derived from Aerial Imagery

Rev	Date	Remarks	Drwn	Chkd
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01	06/04/2022	First issue	FC	SM

Drawing Number	Figure Number
PB9244-RHD-ZZ-ON-DR-GS-0163	7i

Scale	Plot Size	Datum	Projection
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Offshore Wind Farm

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Annex D. Air Photo Services Report

AIR PHOTO SERVICES

Archaeology • Research • Law • Environment • Planning

North Falls Offshore Wind Farm

Onshore Cable Corridors and Substation Options

Assessment Report

Assessment of airborne and satellite remote sensing data and map regression analysis for archaeology

NORTH FALLS OFFSHORE WIND FARM
ONSHORE CABLE CORRIDORS AND SUBSTATION OPTIONS
Assessment of airborne and satellite remote sensing data and map regression analysis for archaeology

Client	Royal HaskoningDHV on behalf of North Falls Offshore Windfarm Limited (NFOW)
Client Project Reference	RHDHV PB9244-107-111
Local Authority	Tendring District Council
Air Photo Services Document	221 05 02_02 FINAL
Air Photo Services Project Number	221 05 02_02
National Grid Reference (NGR)	Northwest: TM 068 289 Southeast: TM213 189
Co-ordinates	Northwest: 606844,228901 Southeast: 621377,218946

Report Status	**FINAL**
Issue date	2022 07 08
Report and map regression analysis	Chris Cox MA MCIfA FSA and Adam Jarvis ACIfA Reference, Cox, C and Jarvis A, 2022 Air Photo Services report 221 05 02_02
Aerial photograph, satellite imagery and LiDAR data interpretation and mapping, GIS data management	Adam Jarvis ACIfA
QA checked by	Chris Cox MA MCIfA FSA (interpretation and mapping), Nereide Gilhead ACCA Affil. CIfA (report) David Lang BA PCIfA (GIS data attribute tables and gazetteer of sites)

Disclaimer

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PB9244-APS-ZZ-ON-DR-YE-0027-Beaumont1839.mxd	Figure 14	Beaumont Tithe map 1839
PB9244-APS-ZZ-ON-DR-YE-0028-Tendring1842.mxd	Figure 15	Tendring Tithe map 1942
PB9244-APS-ZZ-ON-DR-YE-0029-Wix1837.mxd	Figure 16	Wix Tithe map 1837
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PB9244-APS-ZZ-ON-DR-YE-0033-LittleBromley1841.mxd	Figure 20	Little Bromley Tithe map 1841
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PB9244-APS-ZZ-ON-DR-YE-0035-Ardleigh1842.mxd	Figure 22	Ardleigh Tithe map 1842
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Tables

Glossary of abbreviations

APS	Air Photo Services Ltd
ArcGIS	Artificial Intelligence Geographic Information System
ASCII	American Standard Code for Information Interchange
CRS	Coordinate Reference System
CSV	Comma Separated Value file
CUCAP	Cambridge University Collection of Aerial Photography
DEM	Digital Elevation Model
DSM	Digital Surface Model
DTM	Digital Terrain Model
DXF	Drawing Exchange Format
EA	Environment Agency
EPSG	European Petroleum Survey Group
GIS	Geographic Information System
EHER	Essex Historic Environment Record
ERO	Essex Records Office
LiDAR	Light Detection And Ranging
NA	The National Archives
NFOW	North Falls Offshore Windfarm Ltd
NGR	National Grid Reference
NLP	National LiDAR Programme
NMP	(Historic England) National Mapping Programme
OS	Ordnance Survey
MonUID	EHER site reference
QGIS	Quantum Geographic Information System
RVT	Relief Visualisation Toolbox
SLRM	Simple Local Relief Model
WWI	World War One (1914-1918)
WWII	World War Two (1939 – 1945)

Summary

S1. Air Photo Services Ltd (APS) was commissioned to undertake an assessment of airborne remote sensing and satellite imagery data alongside historic map regression analysis, as part of the baseline surveys for the onshore project area components (hereafter referred to as 'the Site') for the onshore cable corridors and substation options for the North Falls Offshore Wind Farm.

S2. The site lies to the west of the Essex coast between Great Holland in its southeast and an area to the south of Lawford and Manningtree in its northwest and is shown on **Figure 1.**

S3. This report represents the work undertaken by APS between January and June 2022.

S4. 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 topographic and micro topographic features within the site.

S5. Aerial photographs and LiDAR survey data gathered between the 1940s and the present time show a former landscape of buried eroded funerary, ritual, settlement, access and agricultural features which are mainly visible on the lighter soils over gravel substrates. Multi-period features dating from prehistoric to likely modern times have been identified and mapped. Some of these features have been previously identified by the Essex Historic Environment Record (EHER) and the Essex National Mapping Programme (ENMP) survey.

S6. The assessment identified thirty five areas of archaeological interest which are detailed below in the report at **Table 1**.

S7. Map regression analysis which considers mapping surveyed between 1777 and 1994 shows that the landscape within the site is one of established smaller rural fields which increase in size as field boundaries are progressively removed since the 1950s.

S8. The small hamlets, farms and settlements have been stably present. One antiquity, a *tumulus* was depicted by the Ordnance Survey (OS) until the 1950s.

S9. After 1967, the landscape began to open-up with the ongoing removal of large areas of Post Medieval field boundaries which changed the rural environment that had been established following land enclosure, making the way for modern mechanised agricultural cultivation methods.

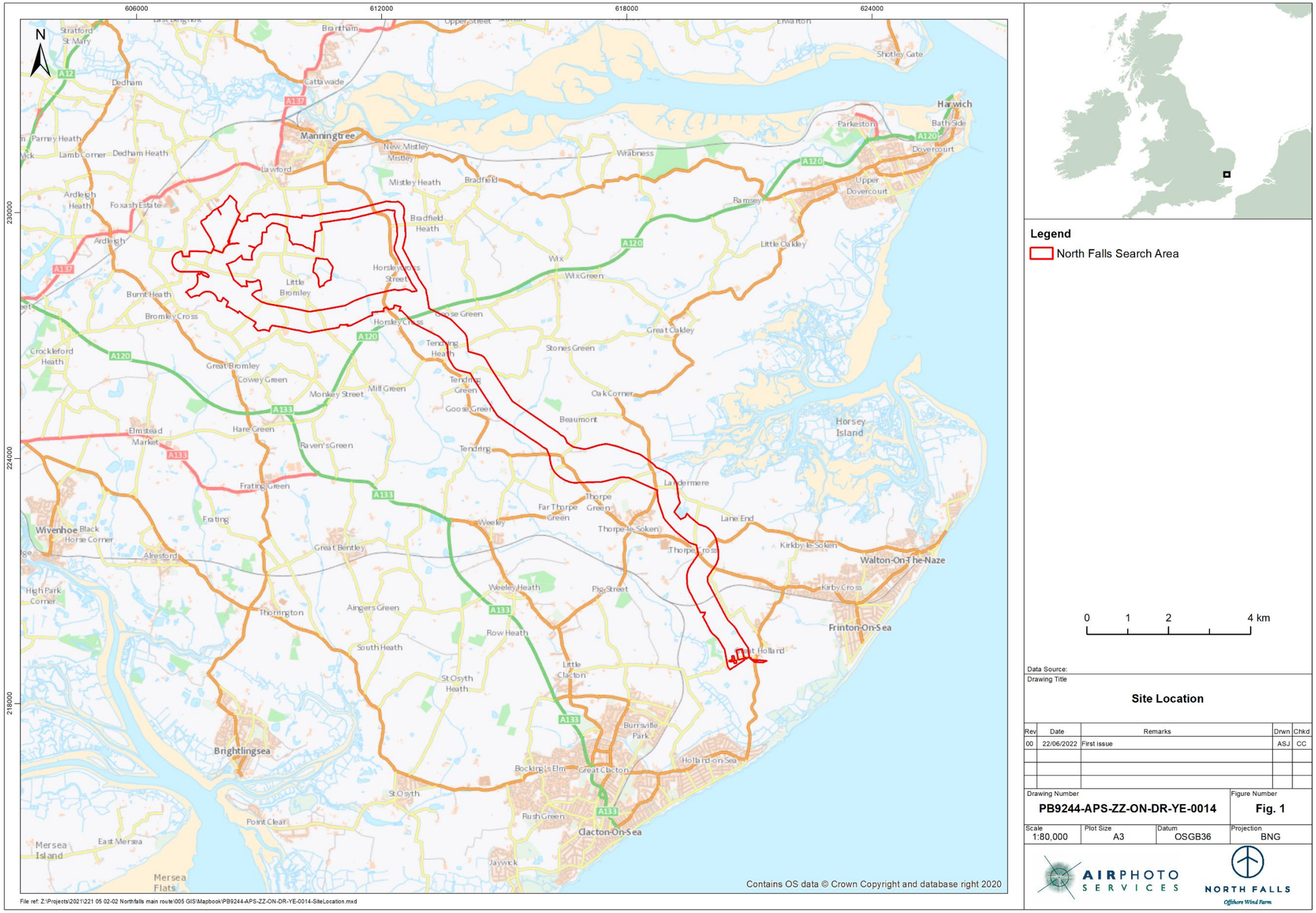
1. Introduction, aims and objectives

1.1. Air Photo Services Ltd (APS) was commissioned to undertake an assessment of airborne remote sensing and satellite imagery data alongside historic map regression analysis, as a baseline survey for the cable corridors and substation options (hereafter referred to as 'the Site') for the North Falls Offshore Wind Farm.

1.2. The Site is a linear onshore cable route corridor and lies to the west of the Essex coast between Great Holland in its southeast extent and an area under consideration for substation options to the south of Lawford and Manningtree in its northwest, as shown on **Figure 1**.

1.3. This report represents the work undertaken by APS between January and June 2022.

Figure 1 Site location



Aims and objectives

1.4. The aim of this assessment report was 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.

1.5. The analysis aimed to assess the present level of preservation of the buried and residual or extant historic landscape features in the Site. This was assessed in respect of the considerable landscape change wrought by intense arable farming over much of the Site to the west of the coast.

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 map regression analysis.

2. Sources of data

2.1. The **Appendix** to this report details:

- The data sources which were consulted, and their metadata as appropriate;
- Methodologies employed; and
- Conclusions drawn from the data acquisition and processing.

2.2. In summary, the assessment systematically examined the following sources of data:

- Historic and modern aerial photographs *via* online sources;
- Satellite imagery *via* online sources;
- Specialist oblique, military oblique and vertical aerial photographs held as accessible prints and digital files at the Historic England Archive in Swindon, the locations of which are shown on **Figure 2**;
- Online search of the Cambridge University Collection of Aerial Photographs (CUCAP) database at https://www.cambridgeairphotos.com/map/ which generates a Comma Separated Value file (CSV) file showing the locations of vertical and oblique aerial photographic surveys and site targets which are shown on **Figure 3**. This collection remains in long term closure during its digitisation in Cambridge and it is not possible to see any of the actual images at the time of writing. However, these images have been examined by the Essex National Mapping Programme (NMP) Tendring Extension project;
- Oblique aerial photographs taken during the course of specialist surveys by Helen Saunders at Essex Council, which were provided digitally as high quality scans. The locations of these obliques are shown on **Figure 4**;
- Search data as Shape (SHP) and Portable Document Format (PDF) files from the Essex Historic Environment Record (EHER);
- The Essex National Mapping Programme (NMP) 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 data;.

- Environment Agency (EA) and National LiDAR Programme (NLP) LiDAR data were available as shown at **Figure 5** and detailed at **Table 5**;
- Tithe maps covering all pre-modern parishes traversed by the Site, derived from the https://www.thegenealogist.co.uk/tithe/. Larger items such as the original paper-based Tithe and the minimal amount of enclosure maps for this area were not available for consultation in the Essex Records Office (ERO) during the timescale of this assessment due to health and safety restrictions on archive activities due to CV19. The online Tithe records present an appropriate data source in this instance and reflect the landscape in the 1830s and 1840s; and
- Georeferenced historical OS mapping provided as a digital package for commercial use by Groundsure (www.groundsure.com).

Figure 2 Historic England aerial photograph coverage

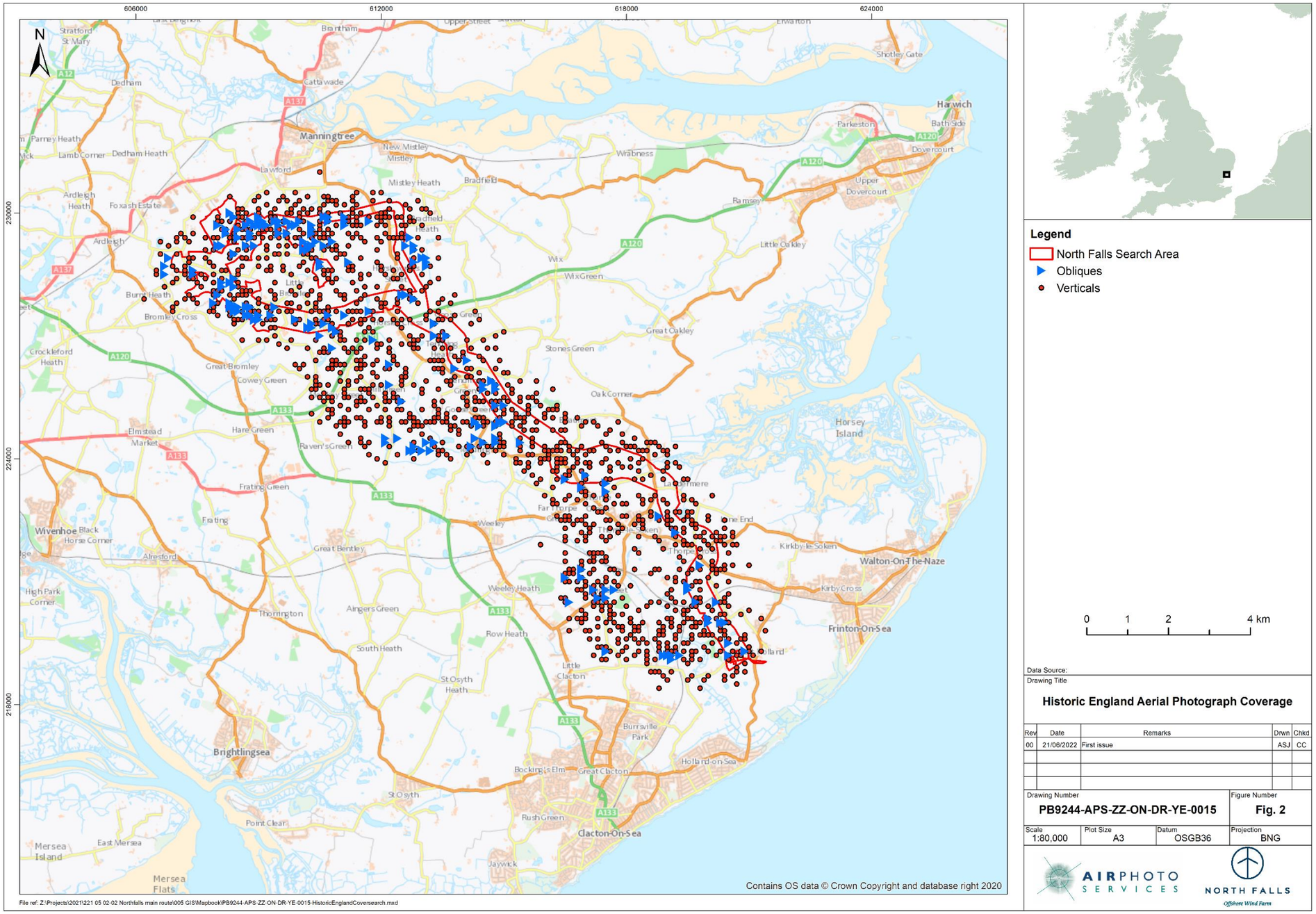


Figure 3 Cambridge University Collection of Aerial Photographs (CUCAP) coverage

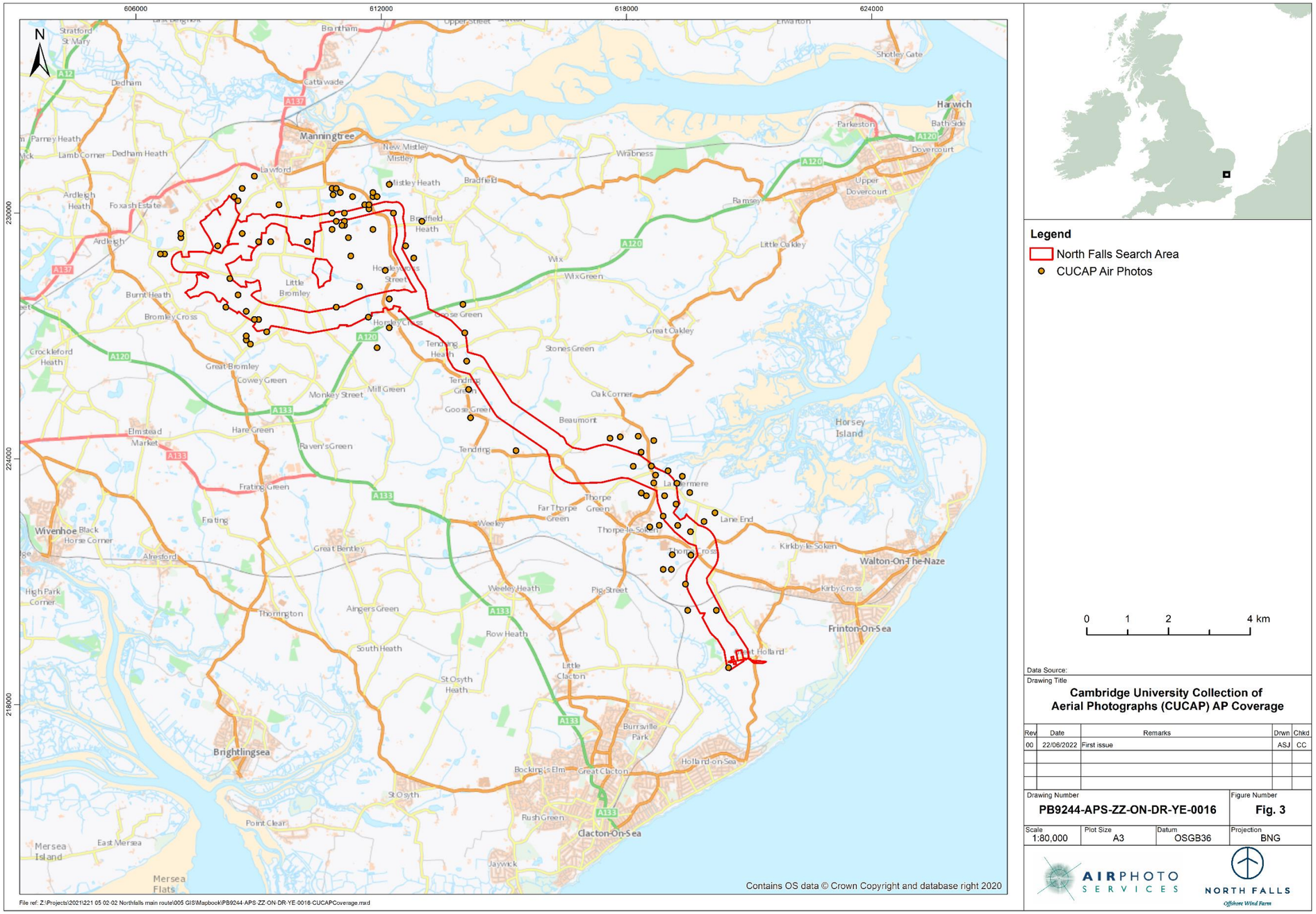


Figure 4 Essex Council aerial photographic coverage

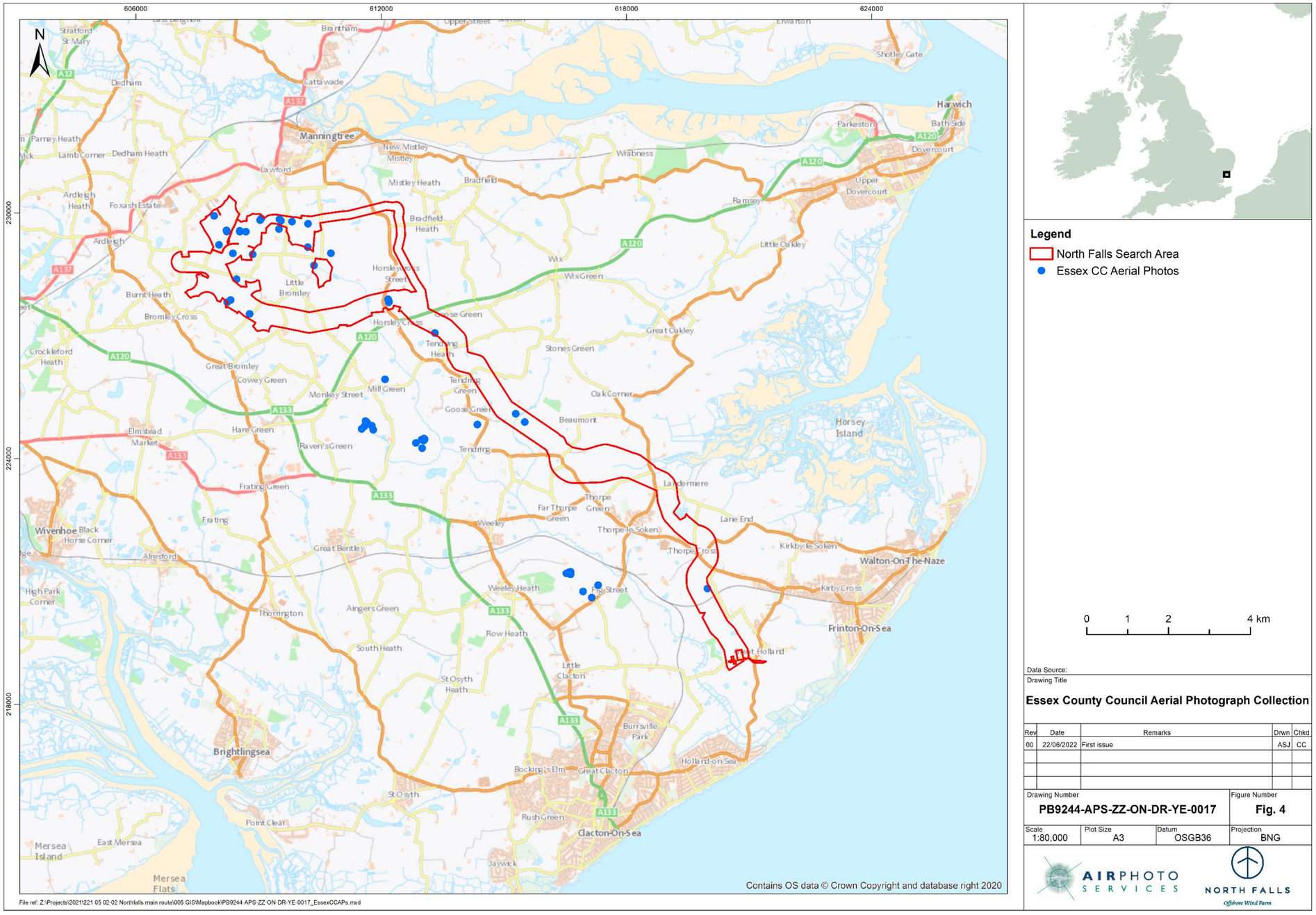
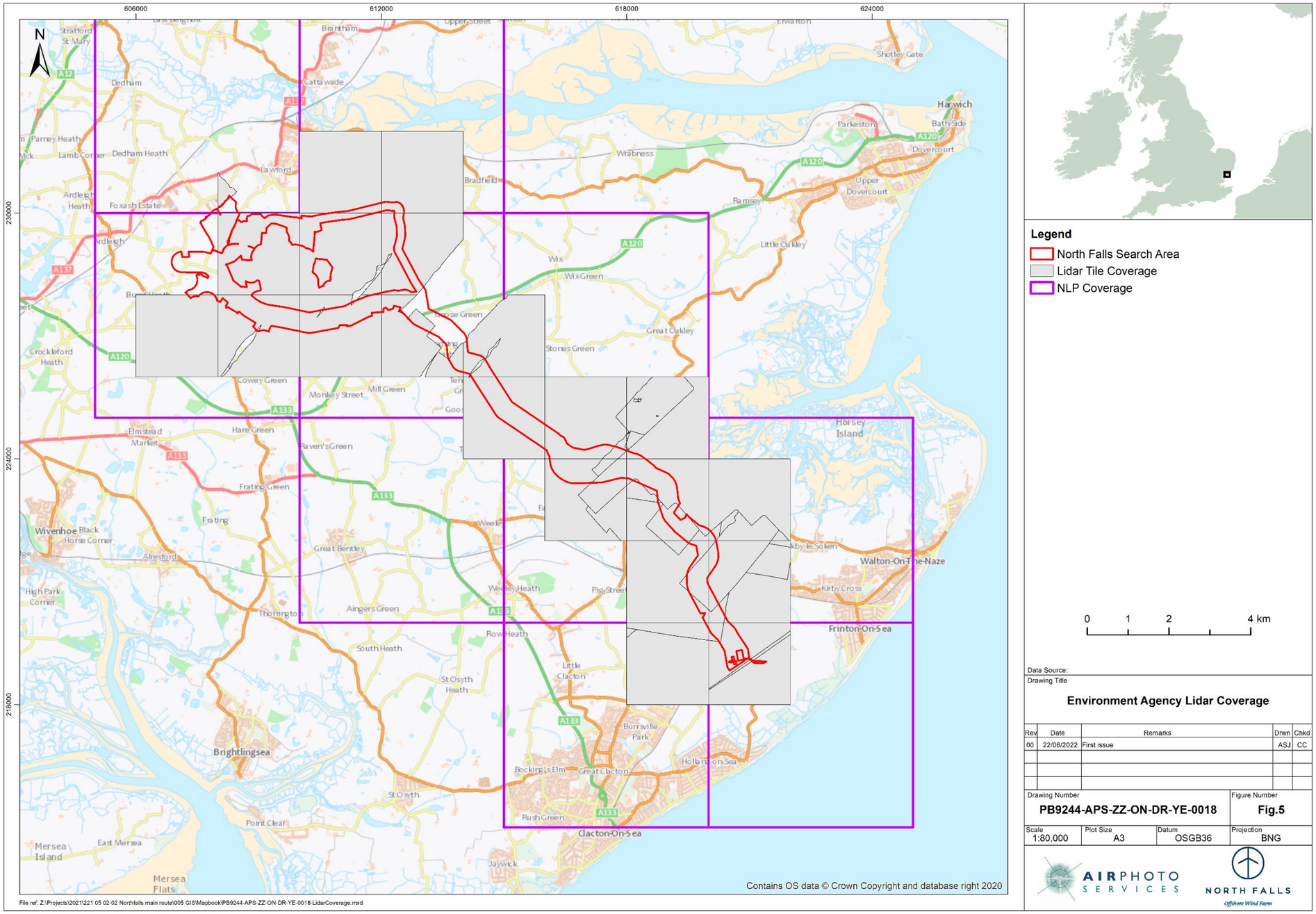


Figure 5 Environment Agency LiDAR data coverage



3. Interpretation and mapping summary

3.1. All photos, satellite images and LiDAR data visualisations were interpreted and mapped at a level compatible with a 1:2500 scale OS digital base map.

3.2. Aerial photographs were closely examined by eye on screen and as paper copies which were photographed at high resolution. Vertical aerial photos were examined with the aid of a mirror stereoscope where appropriate, or in detail on screen when consulted as digital files.

3.3. Selected 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 2008. 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. 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, as discussed with Essex Council. These data are important records, as they include interpretations from CUCAP photos which are not presently available for consultation.

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 (GIS), in ESRI Shapefile format.

3.7. LiDAR data were downloaded, visualised and imported to QGIS and ArcGIS for interpretation and mapping.

3.8. Methods of acquisition, standards and guidance, 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 known 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 cropmarks[1] soil marks[2] and earthworks[3]. 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 a hinterland to the North Sea coast between Great Holland in its southeast and an area to the south of Manningtree and Lawford in its northwest.

4.3. This gently undulating land rises from sea level to between 5 and 30m Above Ordnance Datum (AOD) to the west of the coast.

4.4. The land is now predominately laid to arable use with some small areas of deciduous woodland and some boundaries which act as land drains to ponds and streams, and a watercourse which runs to the sea at Beaumont Cut.

Topography and Land Use Conclusion

4.5. The Site presents some optimal environments for early settlement on the slightly higher ground to the immediate west of the wildlife-rich coastal area.

Within the site and its environs, buried features are recorded from the air as marks in crops following intensive use for cereal and other arable crop production. These cropmarks reveal multi period settlement, agricultural, funerary and possible ritual land use dating from earlier prehistoric through to modern periods.

[1] 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.

[2] 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.

[3] 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 varied drift deposits (Cranfield University 2022, British Geological Survey (BGS) 2022) comprise Glaciofluvial drift (gravel) over Eocene clay, Tertiary clay, aeolian and glaciofluvial drift (gravel), with a very small area of marine alluvium to the immediate west of Beaumont Cut, a marine inlet which lies outside and to the east of the Site. Gravel deposits generally give rise to well drained soils.

4.7. The extent, type and location of the geological deposits is shown on **Figure 6**.

Soils

4.8. The varied substrates throughout the Site give rise to deep loam[4] over well drained glaciofluvial drift, less well drained seasonally wet deep clay[5] over Tertiary clay, better drained deep loam[6], with saltmarsh over marine alluvium[7] in a very small area to the west of Beaumont Cut. The soils are shown on **Figure 7**.

Geology and soils conclusion

4.9. In this area of Essex, the gravel substrate within parts of the Site are well drained, and crops respond readily to differences in the depth and consistency of the top and sub soils, over areas where buried ditched and embanked features are present. This effect also applies to anomalies in the consistency of the substrate. The soils in the Site present a mixed group of substrates with some soils better draining than others.

4.10. The well-drained loamy soils over gravels provide slightly higher and better drained areas among some less well drained and more marshy areas over clays. Marks in crops over eroded buried features and removed field boundaries have been recorded on the areas which lie over gravel and some parts of the areas over clay substrates, throughout the extent of the Site.

[4] WIX soil association, soil map symbol 573b
[5] WINDSOR soil association, soil map symbol 712c
[6] TENDRING soil association, soil map symbol 582e
[7] SALINE 1 soil association, soil map symbol 22

Figure 6 Geology

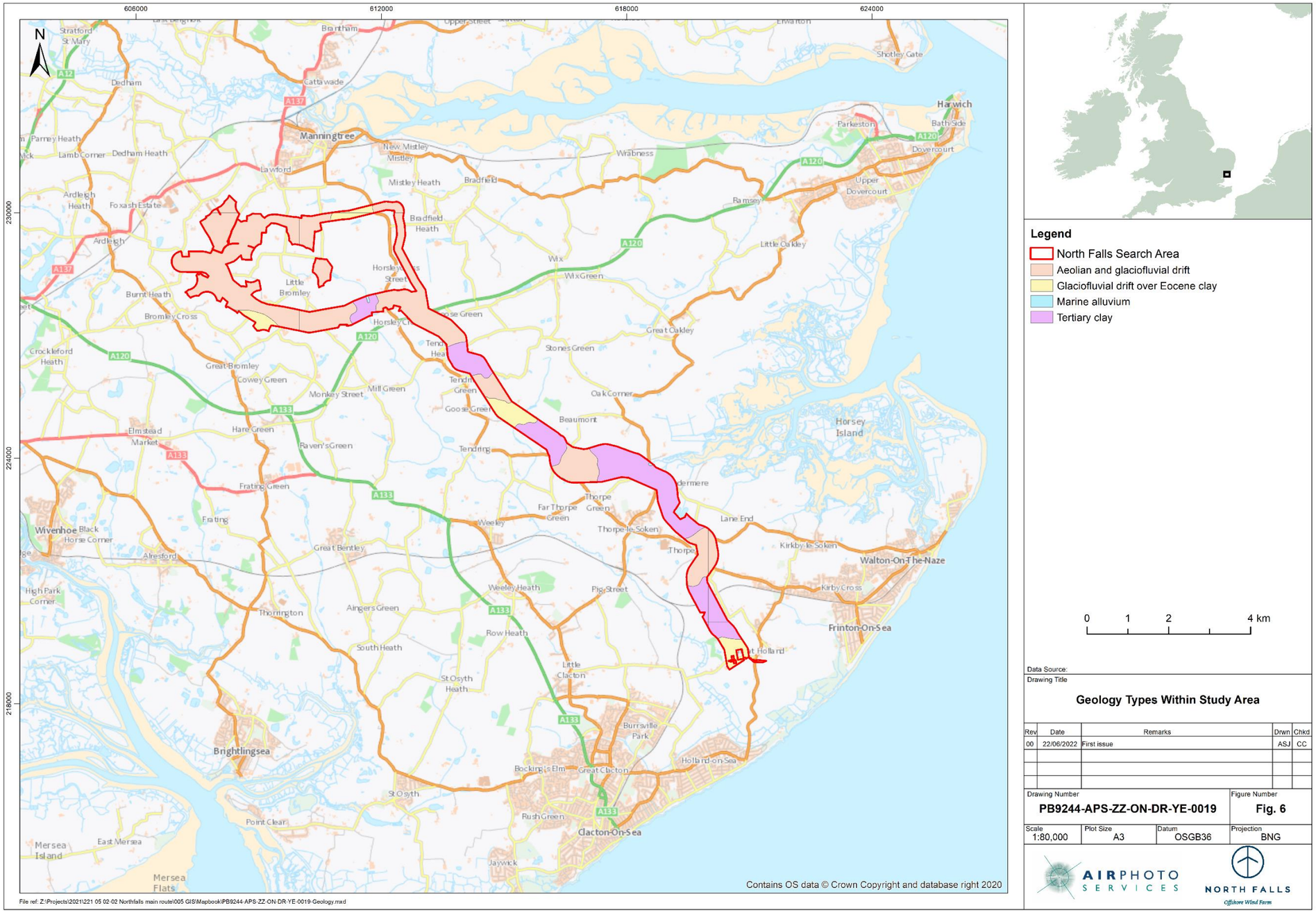
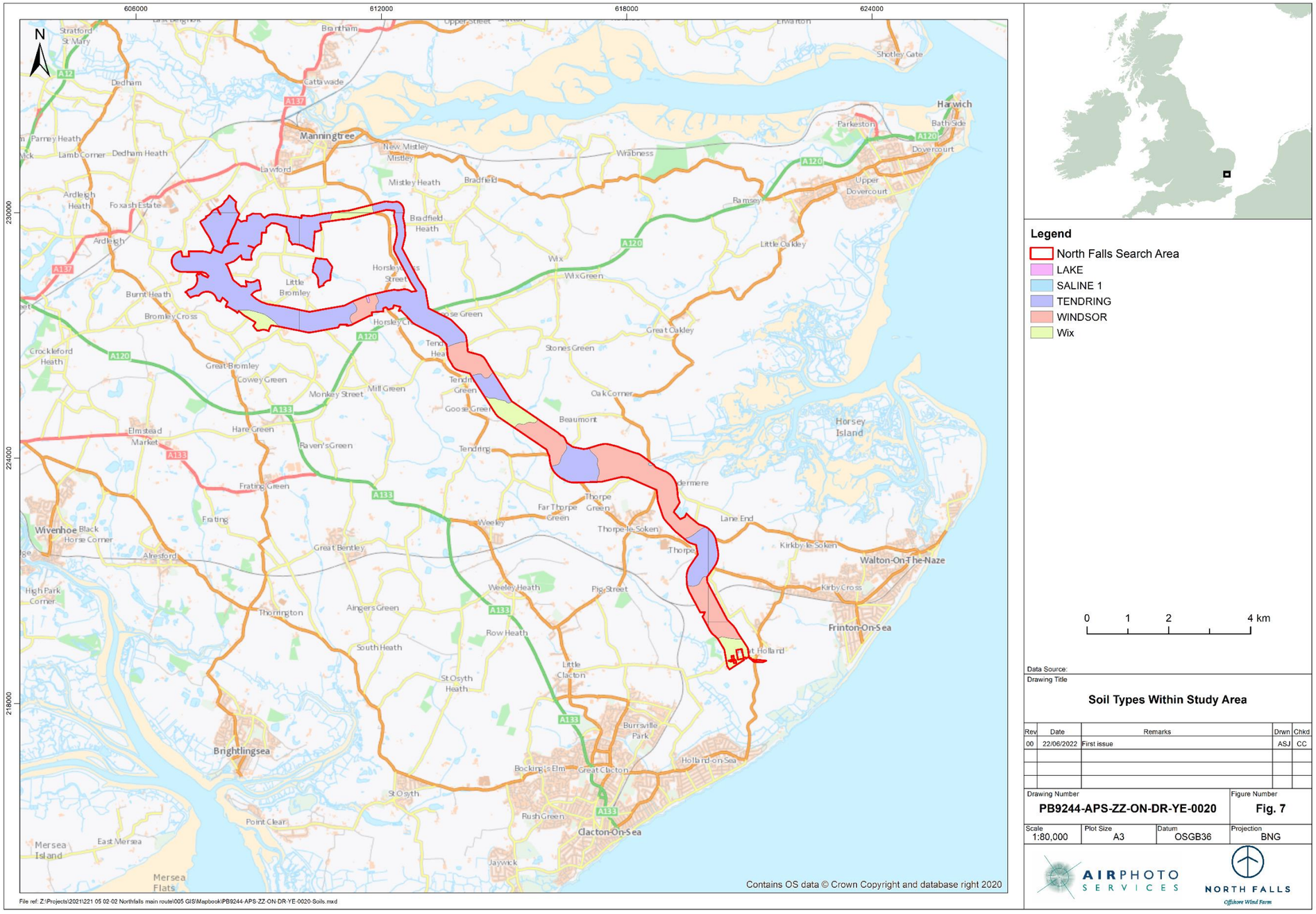


Figure 7 Soils



Previously recorded heritage assets

4.11. The Site contains no statutorily protected Scheduled Monuments, Parks and Gardens or battlefields. The EHER demonstrates that the Site contains known evidence for features and landscapes which date from the earlier prehistoric through to modern periods.

4.12. Arable areas show cropmarked remains of ring ditches which indicate likely Bronze Age funerary sites (round barrows) alongside ditched enclosures and tracks and possible ritual sites. A Roman road traversed the northwest of the site and is now recorded *via* marks in crops over the position of its buried *fossae*[8] .

4.13. These known sites have been recorded previously by the Essex NMP from aerial photographic sources (Ingle and Saunders 2003) and others by the EHER and represent the remains of a buried former landscape which dates from the Neolithic, Bronze and Iron Ages through to the Roman period, although some areas of cropmarks remain undated. Similar landscapes were recorded from airborne remote sensing and satellite imagery sources within the landfall area to the south of and contiguous with the Site (Cox and Jarvis 2021).

4.14. 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. Some areas of drained low lying land and areas with post-1950s boundary loss, with some relict elements, lie among areas of bounded modern arable fields.

4.15. The North Sea coast and its hinterland were robustly defended during the 19th and 20th centuries. This 'inland' area within this linear Site however contains no major traces of World War II (WWII) defensive features. A World War I (WWI) night-time landing strip is recorded in the EHER. According to documentary sources this landing area was used between April and August 1916, but likely does not persist in the below-ground archaeological record nor show on aerial photographs following its return to agricultural use after 1916.

[8] Ditches which flanked and drained the slightly higher embanked or paved surface (the 'agger') of a Roman road.

Baseline heritage assets conclusion

4.16. Overall the EHER and Essex NMP demonstrate the range of previously recorded archaeological resource in the area and have served as an important indication of the type of sites which are visible *via* airborne remote sensing data sources.

5. Results of the archaeological survey

5.1 The results from the interpretation and mapping are presented in **Table 1** and are illustrated by the heritage mapbook presented at **Figures 9.1** – **9.23** which are indexed at **Figure 8.** The detailed sources and condition notes are recorded in the Shapefile which accompanies this report.

5.2 The fields in **Table 1** comprise:

- APS Site Id;
- RHDHV Id (to be added);
- Figure number;
- Asset Type;
- Condition on last recorded data source;
- Period;
- EHER MonUID;
- Essex Sites and Monuments Record (SMR) reference;
- Interpretation notes;
- Easting coordinates;
- Northing coordinates; and
- Six figure National Grid Reference (NGR).

Table 1 Sites identified within the site from aerial photographs, satellite imagery and visualised LiDAR data

APS site ID	RHDHV site ID TBA as needed	Mapbook sheet Figure 9.1 - 9.23	Asset_Type	Condition when last recorded	Period	EHER MonUID	Essex SMR reference	Interpretation notes	Easting coordinate	Northing coordinate	NGR
APS_01		1	Field Boundary	Micro topography	Undated - modern	MEX1031364	N/A	Field boundaries visible as cropmarks on historic aerial photographs with residual earthwork remains visible on LiDAR data. Area also includes a modern sand and gravel pit which was mapped by the OS on the 1976 – 83 map series.	620570	219317	TM 205 193
APS_02		1	Field Boundary	Micro topography	Undated	MEX1031364	16986	Field boundaries visible as cropmarks on historic aerial photographs and satellite imagery with residual earthwork remains visible on LiDAR data. NMP mapping has been added to and partially remapped. Not all NMP features could be confirmed in this study	621004	219441	TM 210 194
APS_03		2	Field Boundary	Cropmarked buried feature	Undated	MEX12997	3570	Field boundaries visible as cropmarks on historic aerial photographs and satellite imagery. NMP mapping has been added to and partially remapped. Not all NMP features could be confirmed in this study	620222	220261	TM 202 202
APS_04		2, 3	Field Boundary	Micro topography	Undated	MEX11450 MEX1031415 MEX11519	3143 3157	Field boundaries visible as cropmarks on historic aerial photographs and satellite imagery with residual earthwork remains visible on LiDAR data. NMP mapping has been added to and partially remapped. Not all NMP features could be confirmed in this study	619508	220881	TM 195 208
APS_05		4, 5	Field Boundary	Micro topography	Medieval/Post Medieval	MEX1040163 MEX1039613	47285 46798	Field boundaries visible as cropmarks on satellite imagery with residual earthwork remains visible on LiDAR data. NMP mapping has been added to and partially remapped. Not all NMP features could be confirmed in this study	619871	222266	TM 198 222
APS_06		5	Field Boundary	Micro topography	Medieval	MEX1039613	46798	Field boundaries visible as cropmarks on satellite imagery with residual earthwork remains visible on LiDAR data	618933	222937	TM 189 229
APS_07		6	Field Boundary	Micro topography	Medieval	MEX1039612	46801	Field boundaries visible as cropmarks on historic aerial photographs with residual earthwork remains visible on LiDAR data. NMP mapping has been added to and partially remapped. Not all NMP features could be confirmed in this study	618150	223442	TM 181 234
APS_08		6, 7	Field Boundary	Micro topography	Undated	MEX1031438	17243	Field system visible as residual earthworks on Lidar data, to add to the ditches previously mapped by NMP	617143	223636	TM 171 236
APS_09		8, 9	Funerary site (round barrow); Field Boundary	Micro topography	Medieval	MEX1031435 MEX10843	3162	A *tumulus* depicted on the earlier edition OS mapping indicates the position of a likely Bronze Age round barrow which was visible later as a cropmark on aerial photographs over its retaining ditch. Field boundaries visible as cropmarks on satellite imagery with residual earthwork remains visible on LiDAR data. Mostly newly identified features, with NMP remapping undertaken where needed	615935	224696	TM 159 246

APS site ID	RHDHV site ID TBA as needed	Mapbook sheet Figure 9.1 - 9.23	Asset_Type	Condition when last recorded	Period	EHER MonUID	Essex SMR reference	Interpretation notes	Easting coordinate	Northing coordinate	NGR
APS_10		8, 9	Field Boundary	Micro topography	Undated	MEX11405 MEX11650 MEX1031514	3136 3189	Cropmarks of ring ditches and linear ditches and possible trackways visible on aerial photographs and satellite imagery. NMP mapping has been added to and partially remapped. Not all NMP features could be confirmed in this study	614811	225552	TM 148 255
APS_11		10	Field Boundary	Micro topography	Undated	MEX11615	3179	Field system and possible drainage visible as earthworks on LiDAR data. NMP mapping has been added to and mostly remapped. Not all NMP features could be confirmed in this study	614145	226311	TM 141 263
APS_12		13	Field Boundary	Micro topography	Undated	MEX11474 MEX1031508	17321 3148	Field and parish boundaries visible as cropmarks on satellite imagery and residual earthworks on LiDAR data. NMP mapping has been added to and mostly remapped. Not all NMP features could be confirmed in this study	610491	226896	TM 104 268
APS_13		14	Barrow Cemetery	Cropmarked buried feature	Undated, likely Bronze Age	MEX8620	2460	Site of barrow cemetery visible as cropmarks on aerial photographs. Barrows have been remapped and repositioned with new rectifications of photographs. Maculae have been left from NMP as are suggestive of environment	609124	227073	TM 091 270
APS_14		11	Field Boundary	Micro topography	Undated	MEX11561	3167	Field system visible while extant in 1950's aerial photographs and cropmarks on satellite imagery. Residual earthworks remain on LiDAR data and add to the previously mapped NMP features. Some have been remapped and repositioned	613584	227159	TM 135 271
APS_15		13	Barrow Cemetery	Cropmarked buried features	Undated, likely Bronze Age	MEX11390	3130 3131	Cropmarks of linear ditches and a series of 5 ring ditches visible on historic aerial photographs and satellite imagery. Locations of the three ring ditches, including two possible ring ditches to the south have been remapped from new rectifications	610803	227242	TM 108 272
APS_16		14, 15	Barrow Cemetery	Cropmarked buried features	Undated, likely Bronze Age	MEX8620	2460	Barrow cemetery visible as cropmarks on historic aerial photographs. Features have been remapped to update positions from NMP mapping	609005	227338	TM 090 273
APS_17		15	Henge	Parchmark in grass	Prehistoric	MEX8620	2460	Possible Class II henge, visible on aerial photographs. Feature has been remapped to update position from NMP mapping	608908	227393	TM 089 273
APS_18		13	Ditch	Micro topography	Undated	MEX11382	3130	Cropmarks of field boundaries and possible trackways visible on aerial photographs and satellite imagery. Residual earthwork remains of field boundaries visible on LiDAR data which add to the existing NMP mapping	611174	227479	TM 111 274
APS_19		14, 15	Field Boundary	Micro topography	Undated	MEX8620	2460	Extensive field system visible as cropmarks on historic aerial photographs and satellite imagery and residual earthworks on LiDAR data. Features have been remapped and repositioned from new rectifications. Some NMP features could not be confirmed	608841	227777	TM 088 277

APS site ID	RHDHV site ID TBA as needed	Mapbook sheet Figure 9.1 - 9.23	Asset_Type	Condition when last recorded	Period	EHER MonUID	Essex SMR reference	Interpretation notes	Easting coordinate	Northing coordinate	NGR
APS_20		12	Field Boundary	Micro topography	Undated	MEX11391 MEX1040370 MEX1031512	3132 17325	Enclosures and field boundaries visible as cropmarks on historic aerial photographs and satellite imagery which expand on previously mapped features from NMP. Not all NMP mapped features could be confirmed and have been left for reference	612466	227876	TM 124 278
APS_21		23	Field Boundary	Cropmarked buried feature	Undated	MEX11382	N/A	Ditch which may relate to further features found east of Mulley's Farm MEX11382. Newly identified feature	610603	228382	TM 106 283
APS_22		16	Ditch	Cropmarked buried feature	Undated	MEX1031611	17472	Series of ditches, possibly former field boundaries visible as cropmarks on satellite imagery. Additional ditches have been mapped, features have been remapped to update positions from NMP mapping	607333	228557	TM 073 285
APS_23		16	Roman road	Cropmarked buried features	Roman	MEX43488	2573	Roman road, linking Mistley with Colchester, mapped across several sites as per HER and NMP grouping. Crosses APS sites 27, 30 and 31. Remapped from new rectifications	606948	228570	TM 069 285
APS_24		23	Ditch	Cropmarked buried feature	Undated	MEX21957	6558	Ditches and pits which correlate with NMP mapping for MEX21957. No remapping undertaken	610790	228719	TM 107 287
APS_25		16	Field Boundary	Cropmarked buried feature	Undated	N/A	N/A	Field boundary visible as a cropmark ditch on aerial photographs. Newly identified feature	607000	228807	TM 070 288
APS_26		17	Trackway	Cropmarked buried feature	Roman	MEX1031552	17110 17486	Site of Roman road and associated linear features including field boundaries. Recorded as grouped by HER MEX1031552. Many boundaries have been repositioned and remapped from new rectifications	608451	228836	TM 084 288
APS_27		16	Trackway	Cropmarked buried feature	Roman	MEX9188	2573	Roman road, linking Mistley with Colchester. Site is connected to APS sites 23, 30 and 31	607494	229120	TM 074 291
APS_28		22	Field Boundary	Micro topography	Undated	N/A	N/A	Former field boundaries visible on historic aerial photographs, satellite imagery and LiDAR data. Newly identified ditches	612415	229130	TM 124 291
APS_29		19, 23	Field Boundary	Micro topography	Undated	MEX8755	2475	Cropmarks of former field system, possible trackways and enclosures visible on historic aerial photographs and satellite imagery. Enclosure ditches have been remapped to update positions from NMP mapping. Additional Features added	609871	229475	TM 098 294
APS_30		17, 18	Enclosure	Cropmarked buried feature	Roman	N/A	17110 17112 2573 2682	Complex area of overlapping enclosures, ditches, a double-ditched ring ditch and a Roman road. Area covers several HER and NMP features due to possible interaction, and is linked to APS Sites 23, 27 and 31 *via* the Roman road	608047	229495	TM 080 294
APS_31		17, 18, 19	Enclosure	Cropmarked buried feature	Undated	MEX8489	2444 17104	Possible Prehistoric enclosures and Roman road are visible as cropmarks on historic aerial photographs and satellite imagery. Partly remapped from new rectifications, and is linked to APS Sites 23, 27 and 30 *via* the Roman road	608843	229653	TM 088 296

APS site ID	RHDHV site ID TBA as needed	Mapbook sheet Figure 9.1 - 9.23	Asset_Type	Condition when last recorded	Period	EHER MonUID	Essex SMR reference	Interpretation notes	Easting coordinate	Northing coordinate	NGR
APS_32		19, 20, 23	Ditch	Cropmarked buried feature	Undated	MEX10930	3055 3522	Complex of ditches, trackways and enclosures visible as cropmarks on historic air photos and satellite imagery. Area mostly consists of previous NMP mapping and there was no need to update it	610576	229667	TM 105 296
APS_33		18	Enclosure	Cropmarked buried feature	Undated	MEX1031543	17476	Cropmarks of a sub-rectangular enclosure are visible on historic aerial photographs. Ditches have been remapped to update position from NMP mapping	608668	229950	TM 086 299
APS_34		20, 21	Ditch	Cropmarked buried feature	Undated	N/A	N/A	Area of trackways, field boundaries and ring ditches, previously mapped by NMP (raster mapping) as visible on Historic England's Aerial Mapping portal	612033	230161	TM 120 301
APS_35		18	Ditch	Cropmarked buried feature	Undated	MEX9864 MEX1031544	17476 2771	Cropmarks of former field boundaries visible as cropmarks on historic aerial photographs and satellite imagery. No remapping undertaken	608371	230186	TM 083 301

5.3 This assessment has recorded thirty five individual sites or areas within the Site. Some of these have been recorded previously by the Essex NMP and the EHER. These previous interpretations have been noted and incorporated fully into the GIS database, where they are acknowledged and separated from the newly interpreted or augmented site interpretations made by APS.

5.4 **Figures 8** to **30** are supplied separately as pdf files, as they are too large to include into a standard word document, for accessibility purposes.

5.5 The following sites, listed at **Table 2** below, are recorded within the EHER, but have not been mapped during this assessment.

Table 2 Sites recorded within the EHER but not mapped for this assessment

EHER Mon_UID	Comment
MEX11536	Cropmarks comprising pits and two ring ditches. While the cited air photo is held within the EHER the ring-ditches are not identifiable on the photograph, although there is some evidence of *possible* pits. This site was not mapped for the NMP or the NMP update (2008), and is not mapped for this present assessment as is not considered to be a conclusive feature
MEX11615	Cropmarks comprising a possible ring ditch, plus linear features which may be geological or field drainage. No ring-ditch was mapped for the NMP, although several linear features were and are mapped for this assessment

5.6 The majority of the site has been heavily ploughed and the majority of the cropmarked remains of pre-modern features do not display any significant microtopography, as evidenced by examination of LiDAR data. There is however obvious potential for the discovery of sub-surface features and deposits in and around the visible foci of cropmarked enclosures, tracks, boundaries and ring ditches.

5.7 Relict post-enclosure field systems are evident where their boundaries have been removed in the 20th century to facilitate modern agriculture. These more recent features show as very slightly upstanding microtopography *via* visualised LiDAR data and as cropmarks on aerial photographs where they have been removed.

Prehistoric features

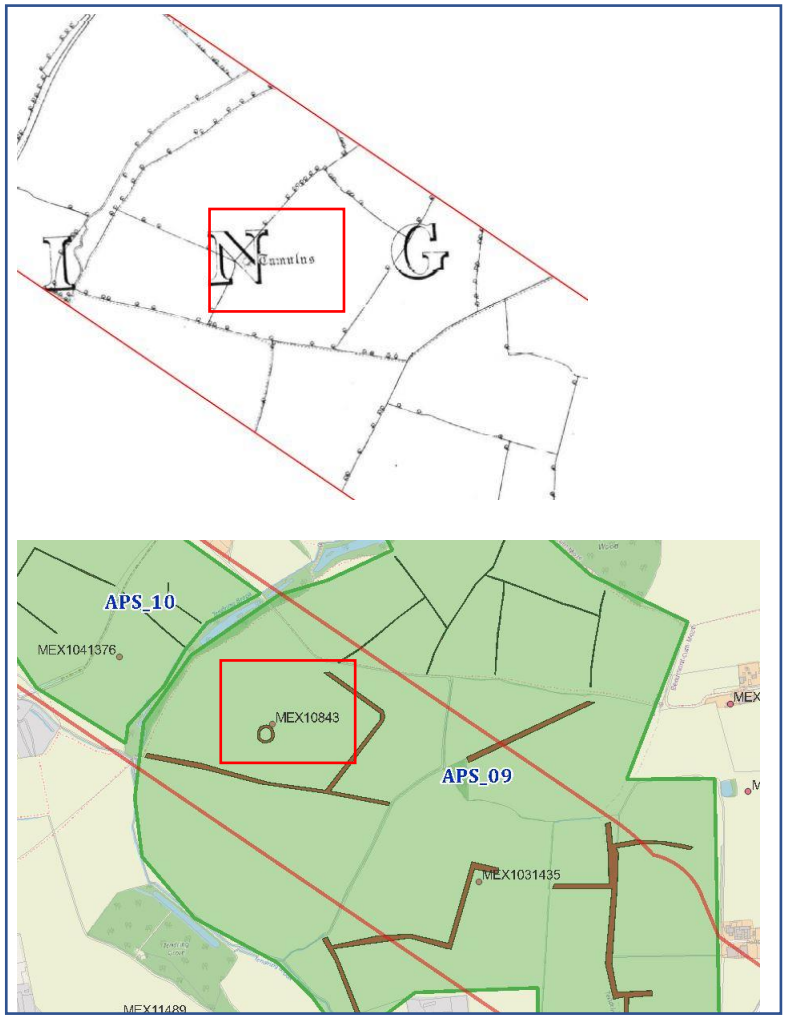
5.8 The search area contains evidence for the buried eroded remains of a possible Class II henge monument, which was mapped by the Essex NMP from aerial photographs as a parchmarked feature, at **APS_17**, EHER MEX8620. This subcircular ditch with internal bank (which in this case shows as a light toned parchmark) may date to the Neolithic period, and possibly reflects ritual rather than settlement use. A Class II henge typically has two rather than one entrances.

5.9 Bronze Age funerary monuments knows as 'round barrows' were circular or sub circular mounds over either inhumation or cremation sites with a retaining ring ditch from which the mound was usually excavated. Ploughing and erosion reduces these mounds and flattens them, leaving evidence in the sub and top soils for residual mounds and more frequently the retaining ring ditch which shows as a cropmark under appropriate environmental conditions.

5.10 Site **APS_09** contains a cropmarked ring ditch indicative of a former likely Bronze Age round barrow (MEX10843, alongside a later post-enclosure (Post Medieval) field system. This likely Bronze Age funerary monument is depicted as a mound (labelled as an antiquity, a *tumulus*) on the 1st edition 1874-75 OS map, **Figure 24, Page 7**.

5.11 The present mapping and the 1874-75 1st edition OS map are shown below at **Plate 1**.

Plate 1 APS-09 1874-5 and present condition, mapped from aerial photos as a cropmarked feature



5.12 Sites **APS_13** (EHER MEX8620), **APS_15** (EHER MEX11390) and **APS_16** (again EHER MEX8620, adjacent to enclosures MEX1044566) record the presence of cropmarked ring ditches which indicate likely Bronze Age barrow cemeteries within this Site.

5.13 **APS_30** records a complex area of overlapping buried ditched enclosures, ditches, a double ring ditch and the side ditches of a Roman road. The double ring ditch at this location may be the remains of a buried Bronze Age funerary monument.

5.14 Possible prehistoric (although presently undated) cropmarked settlement features and enclosures are recorded at **APS_31** (EHER MEX8489), again adjacent to the Roman road. **APS_33** (EHER MEX1031543) is a further cropmarked sub rectangular ditched

enclosure which is as yet undated but is likely to be a prehistoric, possibly Iron Age, settlement feature.

Roman feature

5.15 The side ditches of a Roman road which linked Colchester (*Camulodunum*) and Mistley and associated linear field boundaries are visible as cropmarks at **APS_23, 26** and **27** (EHER MEX9188 and 1031552). **APS_30**, discussed above, may be associated with the former road in this area.

Medieval features

5.16 The EHER records some areas of former field boundaries as Medieval and Post Medieval features at **APS_05, 06, 07** and **09** (MEX1039613, 1040163, 1039612 and 1039613).

Undated features

5.17 **APS_18, 22, 24, 32, 34** and **35** (18 -34 recorded as EHER MEX11382, 1031611, 21957 and 10930) are areas where cropmarked ditches, trackways and enclosures indicate likely prehistoric to Roman settlement and agricultural access features.

5.18 Areas of former field boundaries are visible as cropmarks throughout the Site and are recorded as undated features by the EHER. These boundaries are recorded on the Essex Tithe maps and early editions of the OS mapping in this area, which are presented in the historic map regression analysis below retain slight micro-topography which is recorded as uneven ground *via* visualised LiDAR data[9].

5.19 A modern sand and grave pit is recorded as part of **APS_001** at the southeast part of the Site. This extractive pit removed all deposits down to the natural substrate at this location, and was first recorded by the OS in the 1976-1983 map series, as shown at **Figure 29** in the map regression analysis illustrations.

[9] 2010 1m EA Lidar, 2016 1m EA Lidar, 2018 1m NLP Lidar, 2020 1m EA Lidar

6. Aerial photograph and LiDAR survey conclusion

6.1 Aerial photographs and LiDAR survey data gathered between the 1940s and the present time show a former landscape of buried eroded funerary, settlement, access and agricultural features which are mainly visible on the lighter soils over gravel substrates.

6.2 Features dating to the prehistoric, Roman, Medieval, Post Medieval periods have been identified and mapped. Some of these features have been previously identified by the EHER and Essex NMP survey.

6.3 In some cases this assessment has augmented and added to these data from modern airborne and satellite imagery sources.

6.4 It is likely that the below-ground archaeological deposits which cause the marks in crops and grass in this area are more extensive, both horizontally and vertically, than shown *via* the aerial imagery. Absence of cropmark evidence does not necessarily indicate an absence of archaeological deposits in apparently blank areas.

6.5 The separation of dating into specific periods of prehistory and history can only be confirmed by ground-based or documentary analyses, but some dating evidence for sites within the Site has been proposed by the EHER and NMP and by observation of morphological characteristics of cropmarked sites.

6.6 From an aerial perspective, this landscape may be analysed in a 'living' manner as one which developed over time and contains many multi-period elements. These will be more deeply stratified and extensive below the ground than is apparent in the results of the survey. The remains visible as cropmarks are all likely to have been impacted by agricultural cultivation, to some degree, and retain minimal or no micro-topographic features visible on the ground surface.

6.7 The assessment leads into and has benefited from a concurrent study of historic maps, which detail the development of the landscape over the past two centuries. This map regression study is presented below.

7. Map regression analysis

7.1 An historic map regression study was undertaken concurrent with the aerial imagery and LiDAR analysis to provide understanding of the development of the modern landscape.

Aims and Objectives of the Map Regression Analysis

7.2 The aim of the map regression analysis was to collect appropriate and available historic maps, Tithe maps where present, in areas where Ecclesiastical Parishes levied Tithes, followed by OS 19th century First Edition (1880), subsequent 19th and 20th century revisions and modern cartographic sources.

7.3 The objective was to investigate and demonstrate any landscape changes within the site over the 18th, 19th, 20th and 21st centuries.

Cartographic Sources

18th century mapping, showing the landscape before enclosure

7.4 John Chapman and Peter André's map of Essex was surveyed at a scale of two inches to one mile, and published in 1777. John Chapman was a land surveyor from Suffolk who later came to work in London with Mary Ann Rocque, a cartographer who worked with, and was the widow of, John Rocque. Chapman had previously been involved in producing county maps of Durham, Staffordshire and Nottinghamshire and died the year after his Essex map was published. Peter André was of Huguenot descent, like many others involved in county surveys. Chapman and André were proficient in surveys of large areas of land, and their Essex map is of exceptional accuracy and cartographic excellence.

7.5 It pre-dates the Board of Ordnance (later the Ordnance Survey) by almost 40 years, as one of a series of county maps published by private cartographers in the later 18th century. It was surveyed before Parliamentary Enclosure and the apportionment of land Tithes in this area. The map records landscape features which were to be changed and remodelled over the next five decades, as parts of the open land were better

7.6 drained, enclosed and apportioned to tenants and private owners. It was the first map that accurately portrayed detail in the boundary's roads and villages within the wider landscape, and allows analysis of contemporary landscape patterns such as areas of commons, woodlands and wetlands.

7.7 The map was originally drawn with hachured contours. It was digitally redrawn by Alastair MacNair in 2015 for clarity of interpretation, is referenced at http://www.chapmanandremapofessex.co.uk/. This re-drawing is presented at **Figure 10**.

7.8 The map was originally published in 26 sheets, and further reprints were made in 1785 and 1833. The map show open land and contemporary main roads and settlements, with a different extent of woodlands to that in the modern period. It does not show boundaries or antiquities.

Tithe Maps

7.9 Tithe maps are a detailed survey of the rural landscape within ecclesiastical parish boundaries in force at the time of survey. Tithe apportionment documents show the landholders and tenants of areas subject to tithe. The primary function of the Tithe maps is to provide a graphic index or visual means of reference to the apportionments, for taxation purposes within each ecclesiastical parish. Each piece of land liable to tithes was depicted and given a plot number, unique within that parish, by which it could be identified in the apportionment. The maps are detailed, and present a dated surveyed record of the land (Kain and Oliver 1995) and its boundaries as it was after the Enclosure acts in 1773.

7.10 Tithe maps from the following parishes, listed at **Table 3**, were used for this assessment. The parishes in relation to the Site are shown on **Figure 11**.

Table 3 Tithe maps which were used for this assessment

Parish	Tithe map survey date	Figure
Great Holland	1839	12
Thorpe-le-Soken CP	1841	13
Beaumont	1839	14
Tendring	1842	15
Wix	1837	16
Bradfield	1838	17
Mistley	1843	18
Little Bentley	1841	19
Great Bentley	1841	20
Great Bromley	1839	21
Ardleigh	1842	22
Lawford	1839	23

7.11 The Tithe maps all cover the site, and indicate a well bounded and established rural landscape which is reflected in the later surveys undertaken by the OS from 1880, in contrast to the open land depicted by Chapman and André over 63 years earlier.

Enclosure awards

7.12 In the Post Medieval period, open fields lands and commons were enclosed and bounded in parts following the Enclosure Bills enacted by Parliament between 1604 and 1914.

7.13 Enclosure describes various ways in which land was redistributed into designated units, usually consolidating small landholdings into larger farms. This included the conversion of commons, wasteland and open fields to formally enclosed units of land, the conversion of arable land to pasture and the partition of large areas of communally farmed land into small fields farmed and owned or tenanted by individuals.

7.14 In this area of Essex, only the enclosure one small area to the south of the Site at Holland Green is archived, and this map at this location presents no differing information to the Tithe maps which show the 19th century established boundaries comprehensively and lead into the presentation of the historic OS maps which were surveyed and published from the mid-19th century.

Historic Ordnance Survey Maps

7.15 From the mid-19th century, the OS surveyed, published then revised mapping from their first editions, which in this area were published in 1875, at 1:2,500 (the 'County series') and 1:10560 scale (Oliver, 2013).

7.16 The following map dates which are listed at **Table 4** are shown in mapbooks, **Figures 24 – 30**, which cover the entire length of the Site.

Table 4: OS maps which were used for this assessment

OS map date	Mapbook Figure
1874-75	24
1898	25
1922 - 1925	26
1953 - 1958	27
1966 - 1967	28
1976 - 1983	29
1994	30

1874-1875

7.17 The 1874-75 First Edition 1:10,560 scale OS mapping records the landscape with all the extant field boundaries which were laid down at Enclosure and reflected within the Tithe mapping produced c.40 years earlier.

7.18 This map is shown at **Figure 24** and largely reflects the stable rural landscape of hedged fields and drains which prevails today, and is reflected in the cropmarked and relict remains of the boundaries which had been removed from the second half of the 20th century. An extant *tumulus*, which reflects the presence of a mounded antiquity or round barrow, indicative of a probably Bronze Age funerary monument, is depicted on the map at **Figure 24** page 7. This feature was recorded by this assessment from aerial photographs, as a buried cropmarked ring ditch (**APS_09**, **Figure 9.8**, and **Plate 1**, EHER MEX10843) following the erosion of the original mound. It is the only 'antiquity' marked on the OS maps and is not depicted on the more modern editions.

1898

7.19 The rural landscape is essentially the same in 1898 as it was in 1874-5, as shown at **Figure 25.**

1922-1925

7.20 Again, slight change in the rural environment is reflected in the **1922-25** revisions (**Figure 26)** The *tumulus* at APS-09 is again depicted as a hachured upstanding feature. Some field boundaries have been removed.

1953-1958

7.21 The 1953-58 OS map (**Figure 27**) shows that the post-WWII landscape remains the same, with reducing numbers of small fields and field divisions. The *tumulus* at APS_09 is no longer depicted and is likely to have been plough eroded by this date.

1966-1967

7.22 The landscape is again very similar, but with fewer field divisions and small field than in 1953-58 (**Figure 28**).

1976-1983

7.23 The rural landscape remains essentially the same, with further attrition of field boundaries. At the south of the Site, a sand and gravel pit, which is recorded as part of **APS_001**, is depicted for the first time, (**Figure 29**) and is shown at **Plate 2,** below.

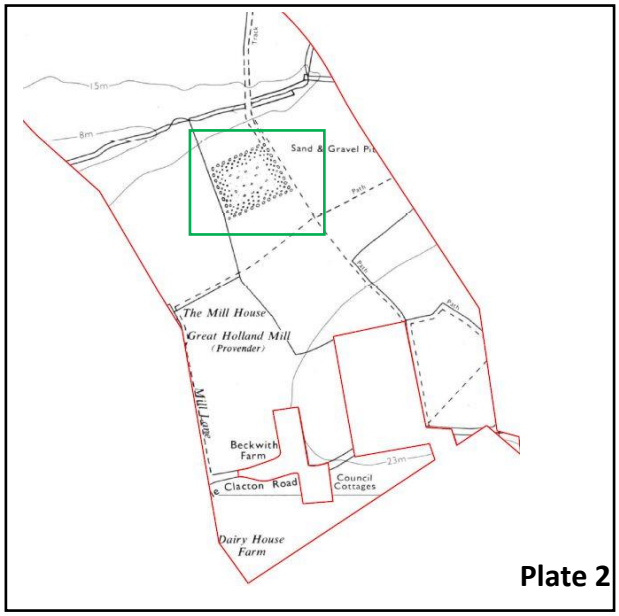


Plate 2

1994

7.24 The 1994 OS map (**Figure 30**) is the first digitally produced 'modern' map edition, and again shows the reduction in the smaller fields in favour of larger units with fewer boundaries.

8. Map Regression Conclusion

8.1 The landscape within this Site is rural, and in the coastal hinterland has been under arable cultivation since first recorded in detail on the Tithe maps flowing Chapman and André's mapping in the late 18th century. The modern landscape boundaries were established during the 19th century following the enclosure acts and are recorded in detail by the ecclesiastical Tithe maps.

8.3 After the 1950s, the landscape began to open up with the removal of large areas of Post Enclosure field boundaries which changed the rural environment since it was established following land enclosure, making the way for modern mechanised agricultural cultivation methods.

8.4 The small hamlets, farms and settlements have been stably present and mapped since at least the 18th century and likely before.

8.5 The only antiquity depicted is a tumulus, likely a Bronze Age round barrow, which was not present by the 1950s, and is now visible only as a completely eroded feature *via* marks in the crops over its former retaining ditch.

9. Appendix Airborne remote sensing data sources, processing, interpretation, mapping methodology and limitations

Data Type and Sources

9.1. This survey has utilised a range of sources and archives in order to identify, interpret and map heritage features from the air and from satellites. This section gives details about the methodology employed to search each archive, the type of data available for study and the interpretation methods applied to each data set.

Online Aerial and Satellite-Derived Images

9.2. Since 1999, digital mosaics of multiple timelines of georeferenced aerial photographs have been uploaded to geoportals such as Google Earth and at Bing.com. The dates attributed to these images are not 100% assured or authenticated, but for heritage survey purposes this has no legal implication in this instance. They are available in real time as open-source imagery online, with some copyright requirements. The imagery may change when new sources are uploaded.

9.3. All available online aerial and satellite derived images which constitute the open-source mosaics of aerial imagery displayed on Google Earth and Bing.com/Maps (aerial and birds-eye if available) were consulted for this survey. All timelines available on these geoportals were systematically consulted, between 1st and 30th June 2021.

9.4. Following magnification, relevant images were captured at the highest resolution using the 'save-image' function in Google Earth Pro or a screen snipping tool. They were saved, labelled and filed for geo-referencing.

9.5. Summer timelines at Google Earth were very helpful in the recording of cropmarked buried sites.

9.6. Aerial images displayed at Bing Maps was used in the same manner but with the limitations that there was a restricted single view timeline and less flexible image capture mechanisms. The Microsoft 'snipping tool' was used to capture the relevant images which generally were not as informative as the comprehensive timeline datasets at Google Earth.

Aerial photographs held at the Historic England Archive

9.7. Paper based copies of all vertical and oblique and specialist oblique aerial photos held at the HE Archive were examined in detail in the Historic England Public Search Room, by Adam Jarvis between January and May 2021. Relevant photographs were recorded using a high resolution digital camera and filed. Selected images georeferenced for the project archive. A map showing the Historic England aerial photograph coverage is presented at **Figure 2**.

Aerial photographs held at The Cambridge University collection of Aerial photographs (CUCAP)

9.8. The CUCAP collection was fully consulted by the Essex NMP. The collection is closed for digitisation, but a coversearch was obtained online at https://www.cambridgeairphotos.com/map/. A map showing the CUCAP aerial photograph coverage is presented at **Figure 3**.

Aerial photographs held at Essex Council

9.9. Digital images were supplied by Essex Council and were processed received from Helen Saunders and georeferenced as needed for interpretation. A map showing the Essex Council aerial photograph coverage is presented at **Figure 4**.

Essex NMP Data

9.10. Essex NMP data were supplied in GIS-ready shapefiles, which were derived from scanning individual drawn OS quarter sheet overlays depicting the NMP data. These data were integrated into this report as separate shapefile layers to maintain the integrity and acknowledgement of the source of these data. They were updated and all features re-digitised to bring them into line with modern recording standards where appropriate. The data covered the site fully and were derived from the Tendring Enhancement NMP project for this area.

Environment Agency LiDAR Data

9.11. The Environment Agency has collected LiDAR data from airborne survey platforms in recent years at varying resolutions, which are available for downloading, processing, visualising and interpreting *via* the EA website https://environment.data.gov.uk/DefraDataDownload/?Mode=Survey

9.12. LiDAR data indicate variation in the height of the ground surface. Data is collected by an active laser beam fired in pulses which scans the ground surface. The reflected pulses are recorded by the sensor on board a geolocated airborne survey platform, fitted with an inertial measurement unit to record the roll, pitch and yaw of the aircraft.

9.13. The point cloud data derived from the survey are processed into a series of Digital Elevation Models (DEM) usually in American Standard Code for Information Interchange (ASCII) format. These include Digital Surface Models (DSM) which contain tree cover and buildings, and Digital Terrain Models (DTM) which remove tree cover and can reveal features beneath the tree canopy (Bennett *et al* 2012; Hesse 2010; Štular *et al* 2012, Historic England, 2018).

9.14. These data are of assistance in recording micro and macro topographic features which may indicate relict or extant archaeological features and historic landscapes alongside more modern features. LiDAR data are best interpreted and used in conjunction with modern and historic aerial photographs and maps to provide ground truth information for features and sites recorded *via* this prospection method.

9.15. The data needed were identified by using the EA timestamp shapefile detailing the LiDAR file names within the area of interest and the OS 10km and 5km grid square to identify the grids and quarter sheets. Digital Terrain Models were selected as the primary data source as the ability to remove the vegetation cover makes it ideal for prospection. All available LiDAR data for this site were downloaded for completeness of evidence. The metadata for the LiDAR downloaded for this assessment can be seen at **Table 5.**

9.16. The whole study area was covered by NLP LiDAR data at 1m resolution with other data available in individual survey areas.

9.17. A map detailing the LiDAR data coverage is presented at **Figure 5.**

9.18. The data were visualised into Hillshade, Multi Directional Hillshade, Sky View Factor, Open Positive and Open Negative using the Relief Visualisation Toolbox (RVT) Version 2.2.1. These visualisations were chosen as they are of most use for archaeological prospection. The multiple ASCII tiles were merged before being

visualised for ease of use in the GIS. The data were analysed alongside the aerial photographs and base mapping to double check the topography and nature of features interpreted from LiDAR data.

9.19. An additional visualisation was created using a simplified process based upon the methodology proposed by Hesse to create a Simple Local Relief Model (SLRM) (Hesse, 2010). A low pass filter was applied to nearest neighbour resampling, and the resampled model was removed from the original DTM, creating a Local Relief Model. This was then processed through the RVT with a smoothing factor of 20m.

Table 5 LiDAR tiles which were downloaded and processed for this assessment

OS Tile Name	Year Flown	Resolution (m)
TM0525	2018	1
TM0530	2018	1
TM0626	1999	2
TM0826	1999	2
TM0828	1999	2
TM0830	2002	2
TM1020	2018	1
TM1025	2018	1
TM1026	1999	2
TM1028	1999	2
TM1030	2018	1
TM1030	1999	2
TM1226	1999	2
TM1228	1999	2
TM1230	1999	2
TM1424	1999	2
TM1426	1999	2
TM1515	2018	1
TM1520	2018	1
TM1525	2018	1
TM1622	2009	1
TM1622	2020	1
TM1622	1999	2
TM1624	2009	1
TM1624	2020	1
TM1624	1999	2
TM1724	2015	0.5

OS Tile Name	Year Flown	Resolution (m)
TM1818	2010	1
TM1818	2016	1
TM1818	1999	2
TM1820	2010	1
TM1820	2016	1
TM1820	2017	1
TM1820	1999	2
TM1822	2009	1
TM1822	2016	1
TM1822	2017	1
TM1822	2020	1
TM1822	1999	2
TM1823	2015	0.5
TM1823ne	2008	0.25
TM1824	2015	0.5
TM1824	2009	1
TM1824	2020	1
TM1824	1999	2
TM1919ne	2009	0.25
TM1920se	2009	0.25
TM1923	2015	0.5
TM1923nw	2008	0.25
TM1923sw	2008	0.25
TM2015	2018	1
TM2018	2010	1
TM2018	2016	1
TM2018	2016	1
TM2018	2020	1
TM2018	1999	2
TM2019nw	2009	0.25
TM2020	2010	1
TM2020	2016	1
TM2020	2017	1
TM2020	2018	1
TM2020	1999	2
TM2022	2016	1
TM2022	2017	1
TM2022	2020	1
TM2022	1999	2

Data Processing

9.20. The collected digitised photographs and images were labelled and archived and selected frames were georectified to the OS digital map base with the QGIS and ArcGIS georectification tools for interpretation and mapping. The project used an OSGB/1936 British National Grid European Petroleum Survey Group (EPSG):27700 Coordinate Reference System (CRS).

9.21. Interpretative or source queries were addressed as appropriate by further reference to the archived photographs in the survey files.

9.22. Following comparison to other airborne sources and all EHER data, extent of area polygons were digitised around the interpreted extent of features identified, and a site database created in QGIS as an attribute table within a shapefile.

9.23. When all data sources had been examined, interpretative polygons were digitised to further shapefiles to indicate the form, extent and type of extant features within areas.

Data Presentation

9.24. The data were presented in shapefile data format within the project GIS. A shapefile contains geographical reference data as individual objects such as a ditch, a bank, a structure or a coordinate area. Features exist as 'objects' and their 'attributes' where the interpretations are recorded within the shapefile.

9.25. In addition to the shapefile, the data derived from the survey are presented in the heritage mapbook which is indexed at **Figure 8.**

9.26. The mapbook presents keyed, labelled and individually numbered illustrations at a consistent scale.

9.27. The data are also presented as a gazetteer of sites at **Table 1.** The gazetteer is derived from selected attributes within the extent of area mapping shapefile. It summarises the location, type, condition and interpretation of each individually identified site or area of features.

Interpretative Mapping

Extent of Area Mapping

9.28. Extent of area mapping was undertaken initially to identify archaeological assets through 'APS Site Polygons.' These polygons indicate the extent of area around a

feature or group of archaeological features. A detailed supporting attribute table was compiled at this stage detailing the following for each feature:

- APS Site Number;
- Asset Type;
- Broad Type;
- NMP coverage;
- APS derived records;
- Evidence Type (1-10);
- Source (1-10);
- Period;
- Monument UID Number;
- Source HER/SMR;
- Comment;
- NMP Additions/Remapping;
- By;
- Supplier;
- Client;
- Project;
- Easting;
- Northing;
- National Grid Reference;
- Map Source; and
- Mapbook Number.

9.29. This process created a database which forms the basis for all detailed mapping and analysis.

9.30. Aerial imagery and LiDAR analysis is a non-intrusive survey method, and not all features which are identified may be accurately dated by this means alone.

Assumptions and Limitations

Historic Aerial Photographs

9.31. The assumption that aerial photographic survey and vertical and oblique aerial photographs show all features and will reveal a complete archaeological record in any given area is erroneous. This is due to many interactive survey, seasonal, environmental, meteorological and perception and interpretation issues which are set out below.

9.32. Interpretation of aerial photographs relies either on visual identification of the effect heritage assets have on crops and other vegetation, marks in soils or visible features or earthworks which are more visible at times of clear low light.

9.33. It is important to note that aerial photographs usually only show part of the horizontal and vertical extent of buried and upstanding features. Their capacity to reveal features as cropmarks, vegetation marks, soil marks or as the shadows cast by banks, ditches and walls, depends upon several environmental and agricultural factors prevalent at the time of the photographic survey. It is possible for many years' photography over one site to show nothing at all, and then during one instance of survey to reveal complex buried cropmark features. The direction of light at the time of photography, with reference to shadows cast and crop or soil marked features highlighted, can also affect the visibility of features on aerial photographs. Unlike digitally processed LiDAR and other data, the azimuth of the sun cannot be changed on a conventional aerial photograph.

9.34. Past and present land use also presents limitations to visibility of features. A cropped arable regime of cereals often allows the formation of cropmarks, whereas grassland, unless seen in times of extreme moisture stress, can mask the appearance of buried features. The time of year is thus important in gaining maximum benefit from aerial photographic sorties. In winter, the low leaf index and lower light angle assists visibility of topographic and earthwork features. In summer, ripening crops, often from April through to harvest in July/August, may show differential marks over buried features. Dry conditions will often cause parching in grass, which will then reveal areas of former foundations as the grass dies over the harder less moisture retentive buried features.

Following harvest, weathering and ploughing, marks in soil often show where buried archaeological deposits are being actively ploughed and brought to the surface.

9.35. In this area of Essex, away from the marine-alluviated coast, the arable areas have been intensively eroded by ploughing. The areas of lighter shallow soils over well drained substrates are conducive to the formation of cropmarks over both buried heritage assets and complex and extensive geological anomalies in the substrates.

9.36. In constructing a comprehensive interpretation of the archaeological landscape, it is essential to examine a range of photographs, taken under a variety of environmental conditions, as has been done in this case.

9.37. The aerial photographs taken in the 1940s often recorded extant landscapes which have been altered or carry evidence for pre-modern fields and extant military features, particularly in coastal areas. These historic photos provide a starting point for the assessment of landscape change, in conjunction with the study of historic maps and modern aerial and satellite-derived imagery.

9.38. The remit of past oblique aerial surveys, the survey areas chosen and the visibility of sites to the aerial archaeologist can often determine the content and coverage of oblique aerial photography. Observer led flights may be heavily biased and may miss features which were present but were not seen or recorded. This area has been surveyed carefully by aerial archaeologists and subject to past mapping by the NMP, but some additions and clarifications to former mapping and interpretations have been made as expected.

9.39. It is also important to note that the perception of the environment and expectation of what is to be found may often limit the air photo analyst's mental 'openness' to features. This perception factor is mitigated by repeated examination of imagery taken in different years and under different conditions, and by teamwork between two or more interpreters checking the data. 'Photo fatigue' is also a factor in drop-off rates of discovery or perception of features. It is mitigated by alternating activities and personnel, checking interpretations with other team members and taking adequate visual breaks.

Online aerial photographs and satellite-derived images

9.40. Google Earth regularly uploads new images and attributes some images with the name of the provider and a date of capture. These dates are not verified, but for archaeological survey this is not a legally essential element of the metadata. The issue with data derived from geoportals such as Google Earth is that it changes and is added to; it is a dynamic collection of varied mosaiced dated images and varied resolutions of data derived from aerial photography and satellite imagery. During 2017-2018, Google began to capture its own data, and these layers are largely 'unattributed' in terms of provider. The main UK providers to Google Earth include Getmapping, Infoterra and Bluesky, The GeoInformation Group, Maxar and CNES/Airbus. The mosaic 'cuts' where images have been blended together and captured in different seasons are readily apparent, often within the same 'timeline' data.

Aerial Imagery Limitations: Conclusion

9.41. Aerial photograph assessments are often based on sequences of historical imagery which provide a series of 'snapshots' of the landscape under different conditions. In contrast, LiDAR and multi-spectral data are typically gathered at a single or series of closely spaced points in time. Levelled features which are now only visible as cropmarks are not usually visible *via* LiDAR data unless they are recorded as substantially differing vegetation heights within a DSM, or the features causing the cropmarks are still extant as micro topographic differences in the ground surface.

9.42. The limitations of these data sources are appreciated and considered during survey and use of multiple data sources. Multiple times of survey increases the discovery rate and certainty of interpretation from all airborne data sources when they are examined concurrently.

LiDAR Data

9.43. LiDAR data are collected for multiple environmental and engineering survey purposes and are therefore sometimes not in compliance with optimum timeframes for heritage survey requirements. An optimum LiDAR survey date for recovery of micro and macro topographic heritage data spans late November to mid-March in the northern hemisphere. This is when leaf canopy and vegetation are at their lowest and

a higher proportion of bare earth is exposed in both woodland and open areas to ensure that the laser pulses reach and return to and from the ground in sufficient density to record topography to create an accurate and detailed DTM.

9.44. Whilst of excellent high resolution, some data are not gathered at an optimal time for specific heritage survey purposes, as they are provided to serve the needs of multi-disciplinary surveys. A lower resolution survey captured during the winter months very often provides more data due to the lack of intervening vegetation which prevents sufficient laser points from reaching the ground surface. A low density of vegetation and leaf canopy is essential to the effectiveness of LiDAR survey in that it ensures maximum penetration of light signals to the ground surface in vegetated areas.

The LiDAR data are, however, of assistance in recording some micro and more macro topographic features which may indicate relict or extant archaeological features and historic landscapes. They were used over the survey area in multiple visualisations alongside the aerial photographs and satellite image data. LiDAR data are best interpreted and used in conjunction with modern and historic aerial photographs and maps to provide ground truth information, and this was achieved in this survey.

9.45. For LiDAR data captured during 'leaf / crop on' conditions, less data is recorded due to foliage and vegetation masking the route of the laser. Similarly, areas of water will absorb the laser giving no returned points.

9.46. The majority of the NLP LiDAR data were collected between October and March, with varied dates for smaller surveys.

9.47. When the point cloud is processed into a DTM, reduced ground coverage results in a simplified geometry surface interpolated from the few available data points which can obstruct features of interest.

9.48. The horizontal cell resolution of LiDAR data can also influence the detection rates of archaeological features. This can occur where the spacing of point measurements is sufficiently wide to conceal or reduce the visibility of small archaeological features. This may have affected this assessment in areas where LiDAR data were gathered at 2m, 1m and 50cm resolutions as opposed to the more detailed 25cm resolution data.

9.49. It is also important to note that LiDAR visualisation techniques are continually developing and advancing. The multiple visualisations now applied to DSM and DTM data *via* the RVT used for this survey are effective in heritage interpretation. Hillshade, and particularly fixed-direction Hillshade, visualisations do not show the correct position of the actual features, only the position of their virtual 'shadows' on the ground. It is thus important to use multiple visualisations of LiDAR data to ensure accurate positioning of recorded features and optimise the results. LiDAR data: conclusion

9.50. The majority of the LiDAR data were captured at times of low leaf index; however, these data did not reveal consistently significant topographic heritage assets over the whole of this area. This is due to the eroded and buried nature of the cropmarked sites which constitute the majority of the aerial evidence which is largely eroded to sub-surface level.

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