

A12 Chelmsford to A120 widening scheme

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6.3 ENVIRONMENTAL STATEMENT APPENDIX 7.4 AERIAL INVESTIGATION AND MAPPING REPORT

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ENVIRONMENTAL STATEMENT APPENDIX 7.4 AERIAL INVESTIGATION AND MAPPING REPORT

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A12 Road Widening Scheme Between Boreham & Marks Tey

Aerial Investigation and Mapping Report



Client: Jacobs

Date: January 2021

An aerial photograph showing a rural landscape with fields, trees, and a road. A large, semi-transparent red overlay covers a significant portion of the image, indicating the project area. The text 'PLACE SERVICES' is overlaid in white on a red geometric shape in the lower-left quadrant.

PLACE
SERVICES



Essex County Council

| | Name | Signed | Date |
|-------------------------------|--|--------|-----------------|
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1. Introduction and Background

This is the final report to accompany the Aerial Investigation and Mapping (AIM) assessment of targeted areas along the route of the A12 road widening scheme between Boreham and Marks Tey. The existing A12 by-passes the towns of Hatfield Peverel, Witham and Kelvedon cutting through the surrounding rural landscape with the historic environment record identifying both designated and non-designated heritage assets identified from cropmarks in the vicinity.

While the proposed road widening corridor runs between Boreham and Marks Tey the current AIM work has specifically targeted three areas. A GIS shape file of the specific road corridor was supplied by the client and areas were identified within this corridor that would benefit from additional AIM work. The study areas cover approximately 845 hectares including a small buffer of 100m (Figure 1). The majority of historic assets visible were within these areas and were recorded for this project, although several features were noted outside the study areas.

For large infrastructure schemes it is essential to understand the potential for unknown heritage assets (buried or near surface) and the risks involved in the scheme encountering them. AIM is a quick, efficient and cost-effective method of determining the location and quantity of below-ground archaeological features within a landscape that is conducive to the formation of cropmark and can be used in conjunction with other survey methods such as geophysical survey. Once the AIM work has been completed the extent of potential impacts to the buried archaeological resource will be determined during the detailed assessment and evaluation programme.

This project has used AIM techniques to ensure the systematic examination of all the readily available aerial photographs and then to record and map all visible archaeological features accurately. The information gathered through this survey will contribute to a better understanding of the historic environment that will be impacted by the road development and its significance. This includes below-ground archaeological features

and landscapes showing as earthworks, soilmarks and cropmarks dating from the later prehistoric period through to the twentieth century.

Preserved settlements, cemeteries, farming, drainage and industry from late prehistory to the post-Medieval period may lie in the buried environment along the route of the road widening scheme and these below-ground archaeological features will be adversely affected by the development. The predominant bedrock geology along the proposed route is London Clay, with outcrops of sands and gravels, Lowestoft formation and river terrace deposits. Cropmark formation on clay geology can be infrequent, with very specific climatic conditions needed for the cropmarks to form. However, frequent aerial reconnaissance of the clay geologies in the county has shown that there are extensive archaeological remains in areas where it was previously thought that there was little activity. To research such remains, aerial reconnaissance has been employed in Essex since 1974. Annual reconnaissance surveys have been undertaken, which has led to the compilation of a large archive of oblique aerial photographs. More recent photography from 2013 and 2017 have been particularly important for this study.

The assessment has been undertaken in accordance with the guidelines set out in Historic England guidance on *Aerial Investigation and Mapping (Historic England 2019)*. Following the systematic assessment of available aerial photographs held by ECC and the Essex Historic Environment Record (EHER), all visible archaeological features have been transcribed and the results will be used in the Cultural Heritage assessment and to facilitate a programme of targeted trial trenching as part of the overall Environmental assessment of the scheme. A full methodology can be found in Appendix 1 and a full list of aerial photographic sources consulted for the project can be found in the Aerial Photographic Catalogue.

2. Project Aims

The overall aim of this project was to complete aerial investigation and mapping work along the proposed link road corridor and to identify and interpret the archaeological features (both upstanding and below-ground) visible on aerial photographs. No Lidar was assessed for this project.

The principle aims of this project were:

1. To examine all easily accessible aerial photographs within the site boundary, plus a buffer study area, to identify archaeological features, both known and hitherto unknown. This study included those photographs already used in previous National Mapping Programme (NMP) or AIM surveys.
2. To accurately rectify relevant aerial photographs and georeference them;
3. To transcribe archaeological features from rectified and/or georeferenced aerial sources to HE standards, and reproduce them in ArcGIS format;
4. To provide detailed accurate information to facilitate the placement of archaeological trial trenches to maximise the quality of information recovered:



Plate 1 - Aerial Photograph of a possible enclosure (Site 16) (EX19/03/015 © Essex County Council)

3. Aerial Photography

The sources of aerial photographs for this project included the Essex Historic Environment Record (HER), Essex County Council Vertical Collection, Aerial Photography Great Britain (APGB) digital photography from 2016 and 2019 and Google Earth. A full list of all the images viewed within the project area can be found in the Aerial Photographic Catalogue.

AIM work on a scheme of this size would normally include a full assessment of the Historic England Archive (HEA) collections. However, due to the current Covid-19 restrictions the Historic England Archive and other remote archives are currently closed and have not been consulted and only Essex County Council archives and online sources have been used for this work.

All the photographic prints held within the HER were assessed in conjunction with the digital images (both oblique and verticals) held (Plate 1 is an example of a digital oblique image held within the HER and Plate 2 is an extract from the ECC vertical collection). The Essex County Council vertical collection is entirely digital, with scanned prints from 1960 to 1990 and digital ortho-rectified images from 2000, 2010 and 2014. The HER holds a limited number of prints from the Cambridge University Collection of Aerial Photographs (CUCAP) and these were assessed along with the other prints; however, the HER only holds approximately 18% of the prints that are actually within the CUCAP collection.

Images from Google Earth were assessed onscreen and images of visible archaeological features were saved and used for digitising. 8-10 sets of photographs were available, although there was not complete coverage of the project area for each set.

Additional ortho-rectified vertical photography from 2016 and 2019 were supplied by APGB and these were also assessed.



Plate 2 - Extract from a 1960 ECC vertical prior construction of the A12 (ESSEX/60/19/042 © Essex County Council)

4. Previous Work

Historic England's (formerly English Heritage) sponsored National Mapping Programme (NMP) has been completed in Essex, with work carried out between 1993 and 2003 and produced 1:10,000 scale hand-drawn maps. The work included both upstanding archaeological features (visible in the form of earthworks) and those below-ground archaeological features visible only as cropmarks and soil marks but did not make use of any lidar data. The results of the Essex mapping were incorporated into the Essex HER at the time of the project, but little work has been carried out since the completion of the project in 2003.

Essex County Council has undertaken specialist archaeological aerial reconnaissance since the 1970's and has commissioned vertical photography of the county since the 1960's. All these aerial photographs have the potential to contain information of currently unknown above and below-ground archaeological features. While the area covered by the proposed road corridor was part of Essex NMP, the work was completed in 1997 and no overall photographic assessments have been completed on the ever-growing aerial photographic collections since.

In addition, modern aerial investigation and mapping standards have been implemented which ensure increased accuracy and use a wider spectrum of sources. The features recorded during the original NMP were mapped using manual rectification practices at a scale of 1:10,000. The accuracy of the transcription of each site is unknown and there were limited records of the photographs used for mapping. It should also be noted that while the original NMP data can be viewed in a GIS the source data was not created in a digital format, but was hand drawn on 1:10,000 film sheets that have been subsequently scanned and geo-referenced; a process that can exacerbate inaccuracies.

A number of the features mapped for the original NMP could not be located on the aerial photographs assessed for this project and have not been digitally recorded (but are visible on the scans of the original NMP). These features should not be dismissed although they

have not been remapped. These features are likely to be on photographs that could not be accessed for this project, such as the HEA and CUCAP collections that are currently unavailable (other than those images held within the HER).

The original NMP emphasized the extensive number of below-ground archaeological features that could only be seen from the air. However, recent excavations have demonstrated that while archaeological cropmarks are crucial to the identification of sites, they rarely give a true indication of the number of archaeological features on a site. The archaeological cropmarks of a circular enclosure approximately 40m in diameter, some field boundaries and a possible incomplete sub-circular enclosure were identified and recorded during the Essex NMP at Mill House Farm, Chadwell St. Mary (Plate 3). However, Plate 4 shows the excavation plan following work carried out ahead of gravel extraction (Archaeological Solutions 2017). This excavation identified an extensive archaeological landscape comprising in excess of 1000 features.

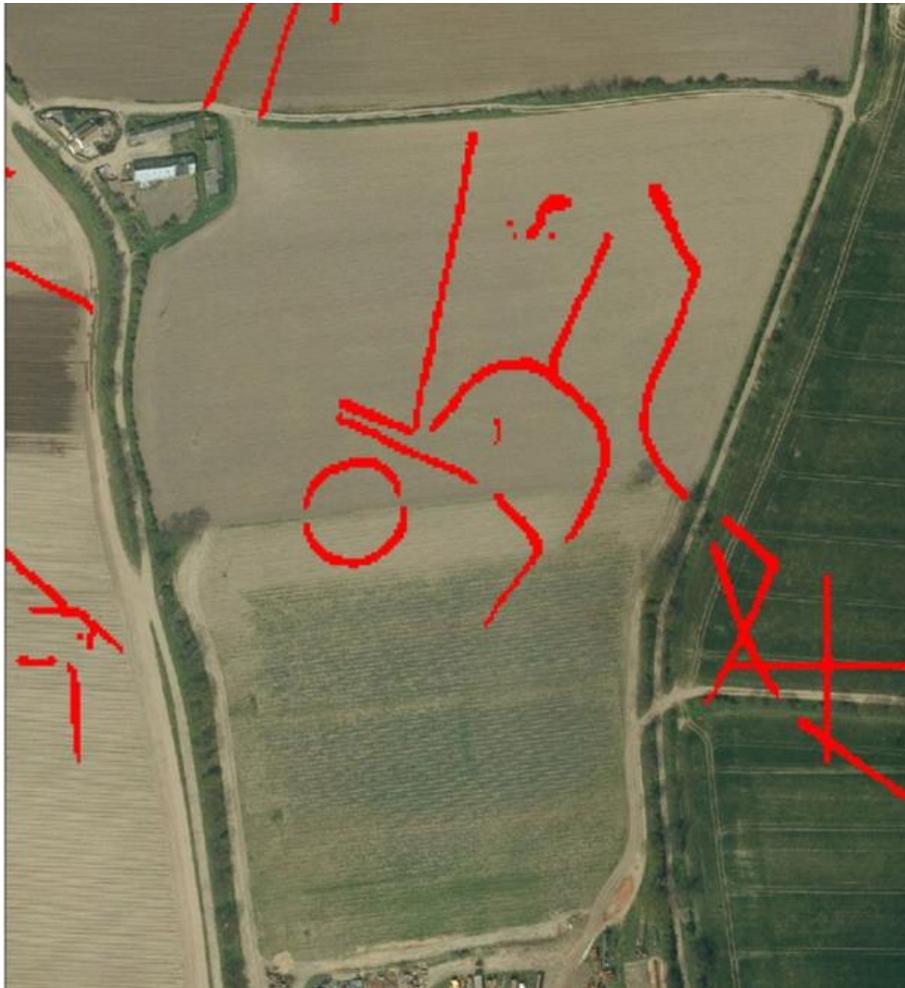


Plate 3 - The archaeological cropmarks identified during the NMP at Mill House Farm, Chadwell St. Mary

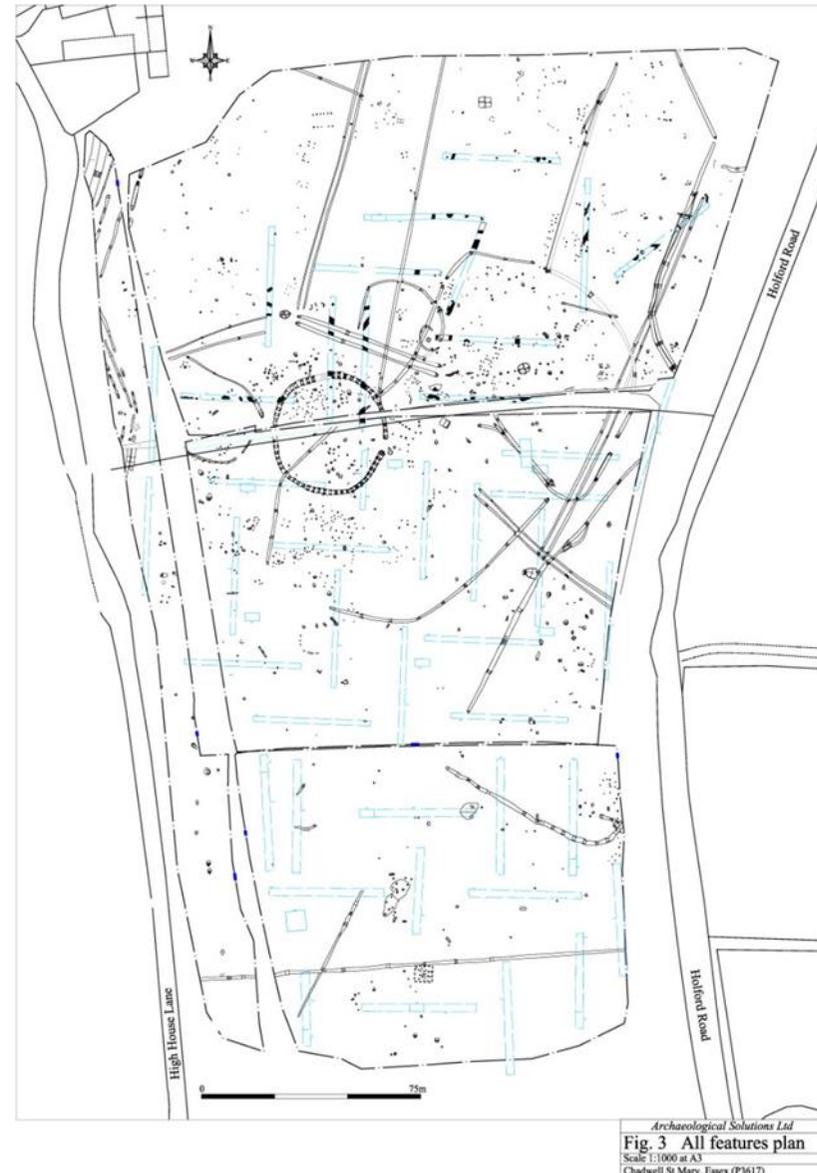


Plate 4 - Excavation plan of all features identified at Mill House Farm, Chadwell St. Mary (© Archaeological Solutions 2017, Figure 3)

5. Challenges

Several challenges were faced during the aerial investigation and mapping carried out throughout this project. The aerial photography assessed for the project ranged in date from 1960 to 2019. While much of the landscape has remained rural, extensive housing development has occurred around Witham and Kelvedon, and the photography from the 1960s is prior to the construction of the A12. This caused some issues with the identification of suitable control points (control points are used to ensure accurate rectification of the aerial photographs) on some of the earlier oblique aerial photographs. However, this should not have caused a significant problem with the accuracy of the rectification of the aerial photographs used for this project.

The aerial photographs that have been assessed for this project have been a combination of hard copy prints held in the Essex HER and digital images. None of the vertical images could be viewed as stereo pairs or under magnification. This means that surviving earthworks could not be detected on the vertical photography, this is particularly significant when using the photography from the 1960s and 1970s where extant earthworks that have since been ploughed out may have survived. As no lidar assessment was carried out, which may have enabled low-level extant earthworks to be detected, there has been no way to compensate for the loss of stereo assessment, and no earthworks have been mapped.

As the HEA collections were not assessed there were some issues with a reduced number of photographs of sites. It is common for archaeological features to be recorded on multiple photographs, often taken over a number of years and this frequently means different features showing on different photographs. However, in a few cases there was

only a single photograph of a feature or site which may mean some of the finer details have not been recorded or mapped.

Several sites had both archaeological and geological cropmarks visible. Where the underlying geology created geological cropmarks, it is possible that further archaeological features have been masked. Plate 5 shows the widespread geological marks on Site 7, with extensive archaeological features present.

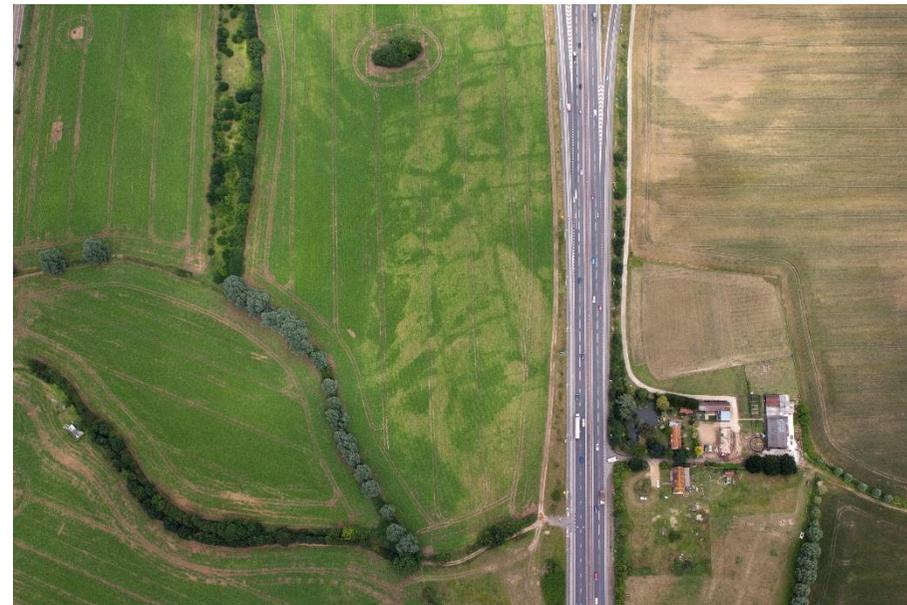


Plate 5 – Geological cropmarks masking archaeological features at Site 7 (EX17/04/107 © Essex County Council)

6. Results

Archaeological features were recorded along the road corridor and an overall project results can be seen in Figure 2 . Below is a table of the results from this AIM work. Each site area has a summary description of the features recorded and where possible a suggested date and function. A guide to the archaeological potential and archaeological significance of each site has been given as Low, Medium, High or Very High. The location of each site can be seen in Figure 3. There were a few features that were recorded on the original NMP that were not recorded during this current project. This could be because access to the photographs was limited and they were not visible on the assessed images or because of the interpretation of the visible features. Where these previously mapped features are located within a digitally mapped site they have been noted below

| Site Number | HER Number | Description of site and features mapped | Potential | Significance |
|-------------|------------|---|-----------|--------------|
| 1 | 6174 | Cropmarks of probable former field boundaries forming part of a field system or smaller paddocks. None of these linear features are visible on the 1st edition OS mapping of the 1880s so may have much earlier origins. Some of these boundaries are located outside the project corridor. | Low | Low |
| 2 | 8959 | Cropmarks of former field boundaries and a former woodland boundary that forms a large enclosure. These features are all marked on the 1st edition OS mapping of the 1880s but may have earlier origins. An additional linear feature, which probably represents a former field boundary (not on the 1st Edition mapping) has also been mapped, along with a possible small incomplete curvilinear enclosure of an unknown date. | Low | Low |
| 3 | 8136 | Cropmarks of a possible trackway and field boundaries of unknown date. A possible round barrow of Bronze Age date has also been mapped within this area, although this cropmark was very faint and only visible on a single photography. | Medium | Low |
| 4 | 8140 | Cropmarks of former field boundaries (only one is marked on the 1st edition OS mapping of the 1880s) and an extraction site | Low | Low |
| 5 | 8401 | Extensive cropmarks of a large, but incomplete enclosure with internal divisions, with widespread pits, field boundaries and other linear features surrounding it. The enclosure could be of prehistoric date. The cropmarks continue to the west side of an area of disturbed land with a series of overlapping field boundaries and linear features. To the north of this further field boundaries (not visible on the first edition OS mapping) and a possible trackway. A small circular enclosure, possibly representing a round barrow was also mapped (Figure 4). There is the potential for additional features within this area, but the geological cropmarks are extensive and could be masking them. | High | High |

| Site Number | HER Number | Description of site and features mapped | Potential | Significance |
|-------------|----------------|---|-----------|--------------|
| 6 | 8407 | Cropmarks of field boundaries, other linear ditches and large extraction pits | Low | Low |
| 7 | 8422, 16445 | <p>Extensive cropmarks of a square enclosure and incomplete annex of possible Roman date. A ring-ditch, with internal pits, that may represent a Bronze Age round barrow and a possible trackway (Figure 5). There are also widespread linear features which may represent a field system associated with the enclosure. Other cropmark features mapped could represent additional enclosures, although none are complete or as substantial as the features on the east side of the site. Additional field boundaries marked on the 1st Edition OS mapping have also been mapped. Geology across this site could be masking further archaeological features.</p> <p>The geophysical survey that was conducted along the boundary adjacent to the current A12 did record some of the archaeological features including the round barrow and some of the other boundaries visible on the aerial photographs.</p> | High | High |
| 8 | 8429 | <p>Cropmarks of a possible trackway, which continues to the south (outside of the project area). This trackway is only faintly visible on the available aerial photographs for a short distance. Other features within this site include field boundaries (some visible on the 1st edition OS mapping).</p> <p>The geophysical survey has detected some of the field boundaries, but the trackway does not appear to be visible.</p> | Medium | Low |
| 9 | 8463 | Cropmarks of former field boundaries, some of which are marked on the 1 st Edition OS mapping and other short sections of ditch | Low | Low |
| 10 | 8468 | <p>Cropmarks of a possible trackway, visible for 281m of an unknown date and field boundaries. Some of the field boundaries are marked on 1st Edition OS mapping, but may have earlier origins, but other field boundaries are not visible on cartographic sources and have a different orientation.</p> <p>This area was not covered by the geophysical survey.</p> | Low | Low |
| 11 | 8471 | <p>Cropmarks of a trackway, enclosure, field boundaries, a possible round barrow and extraction pits. The round barrow is only faintly visible on a single photograph and the northern part of the enclosure is masked by geology. The geological cropmarks across this site are quite extensive. The course of a former road marked on the 1st Edition OS map is also visible (Figure 6).</p> <p>This site was not covered by the geophysical survey</p> | Medium | Medium |

| Site Number | HER Number | Description of site and features mapped | Potential | Significance |
|-------------|--------------------|---|-----------|--------------|
| 12 | 8804 | Cropmarks of a former field boundary, visible on the 1 st edition OS mapping (and was detected on via the geophysical survey) and a small circular enclosure which maybe a former pond (not visible on 1 st edition OS mapping though) | Low | Low |
| 13 | 8806 | Cropmarks of a series of linear features and field boundaries. Further cropmarks of a possible Bronze Age barrow cemetery have been mapped to the north of this field, which is located just outside the project boundary. There are extensive geological cropmarks across this site which may be masking further archaeological marks (Figure 7) | Medium | Medium |
| 14 | 14247, 14245 | Cropmarks of a sinuous trackway of an unknown date and an extensive field system marked on the 1 st Edition OS mapping of the 1880s but may have earlier origins. The location of a former farm/settlement that is marked on the OS mapping is also visible and identified through the boundaries around it. | Medium | Low |
| 15 | NEW | Cropmarks of former field boundaries marked on the 1 st Edition OS mapping of the 1880s. Geological cropmarks appear to be masking some of the field system. There is an incomplete rectangular enclosure and a round barrow that have been mapped, but are outside of the immediate project area | Low | Low |
| 16 | 48301 | Cropmarks of a series of overlapping enclosures and field boundaries. The enclosure is not complete. | Medium | Medium |
| 17 | 45184 New | Cropmarks of an extensive field system marked on 1 st Edition OS mapping of the 1880s and the cropmarks of the route of the former Kelvedon to Tiptree light railway. The route of the railway continues into Site 3 to the north. | Low | Low |
| 18 | 8363, 8362, New | This site covers a large area and the features mapped adjacent to the A12 include a field system that is visible on the 1 st edition OS mapping of the 1880s. However, to the south of the site are a series of cropmarks of short linear features, pits and a possible incomplete curved enclosure these features could be associated with the Iron Age burial and Roman settlement site. While the cropmark features do not appear to go into the field to the north the geology may be masking features. There is also an isolated square enclosure (only visible on a single aerial photograph) located to the north-west of the main cropmark complex (Figure 8). | Medium | Medium |

7. Conclusions

The results of the aerial investigation and mapping provides an accurate location for the known below-ground archaeological features visible as cropmarks and will support the evidence base for the environment statement and facilitate the accurate positioning of trial trenches for the field assessment.

This work allowed several sites and features to be accurately mapped for the first time allowing a better understanding of the landscape to be developed. In addition, this work has complimented the geophysics surveys that have already been completed, by locating features that were within areas that were inaccessible or where the local geology has masked the features on the surveys. This is particularly evident at Site 5 where additional cropmark features have been detected.

Several areas of former field boundaries were identified across the project area and many of these boundaries are likely to be medieval in origin. Along much of the road corridor there is clear evidence that the medieval field patterns are still in use and there is evidence that field boundary loss is quite extensive in some areas, for example to south of Kelvedon.

The pattern of cropmarks within this corridor is typical within the local area, with pockets of archaeological features identified and large gaps in the cropmark record in between. It is likely that many of these gaps in the cropmark record are due to the underlying geology. Clay soils often become waterlogged during periods of wet weather and become dry hard soils in times of draught. This is not conducive to cropmark development so features are not visible as regularly as they are on sands and gravels.

There are numerous places along the current proposed route where there are archaeological cropmark features visible in close proximity to the project boundary. In

most cases these features have not been mapped, but further work would be recommended should any changes be made to the proposed route or the wider scheme.

No earthworks were recorded during the project as available lidar for the area was not assessed and there was no way of examining the vertical photography using a stereoscope. However, as this area has a long history of ploughing it is likely that any extant earthworks that may have been visible on the early photography (pre-1960s) have since been ploughed level.

While every effort has been made to access the widest variety of photographic sources, there are some differences between the original NMP mapping and the digital mapping evidence. The original NMP mapping for Site 7 included some linear features that could not be seen on the available photography; however, this does not mean these features should be dismissed (Figure 9).

There are pockets of cropmarks within this road corridor, but it should be noted that even where cropmarks are known, they may only represent a fraction of the archaeological features actually present. Furthermore, the absence of cropmarks is by no means likely to be an indication of a lack of archaeological features but rather a result of either the soil-types or the agricultural regime not being conducive to cropmark formation (Ingle and Saunders, 2011, 81).

The aerial survey has therefore provided an indication of the extent and complexity of the archaeological landscape traversed by the road widening scheme and with the geophysics will support the trial trenching and environmental statement for the project.

8. Figures

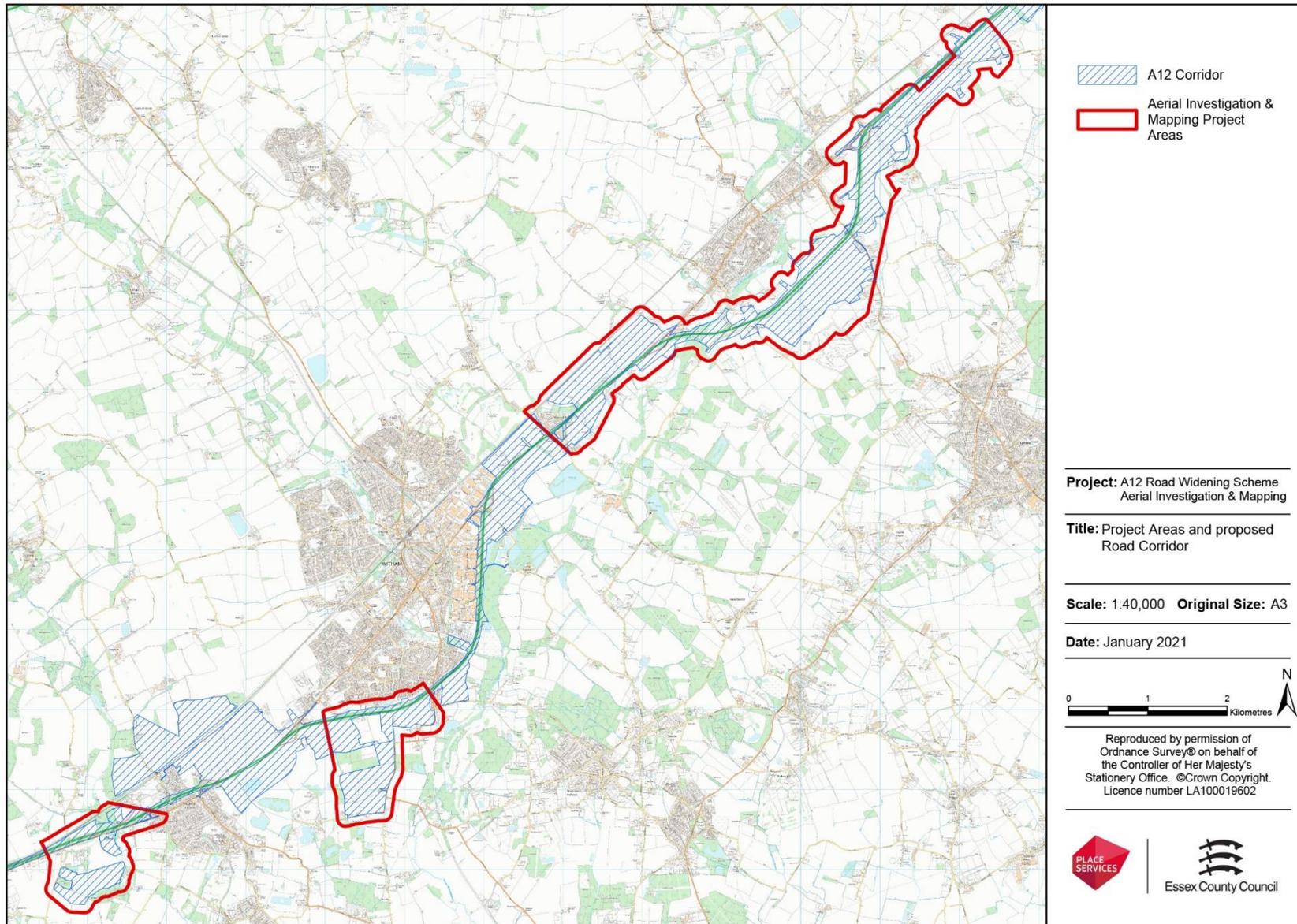


Figure 1 - Project areas and proposed road widening corridor

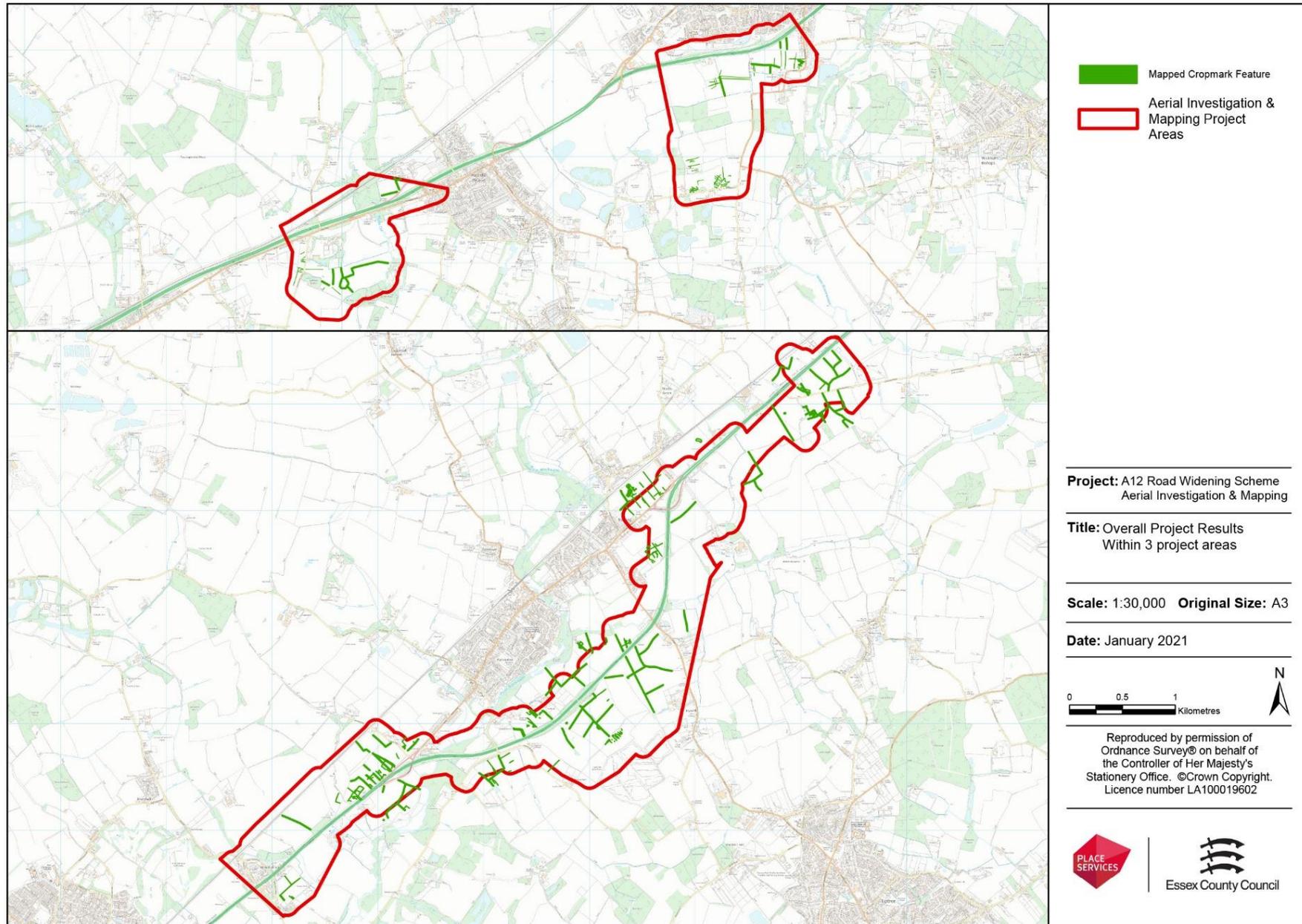


Figure 2 - All archaeological features mapped within the project areas

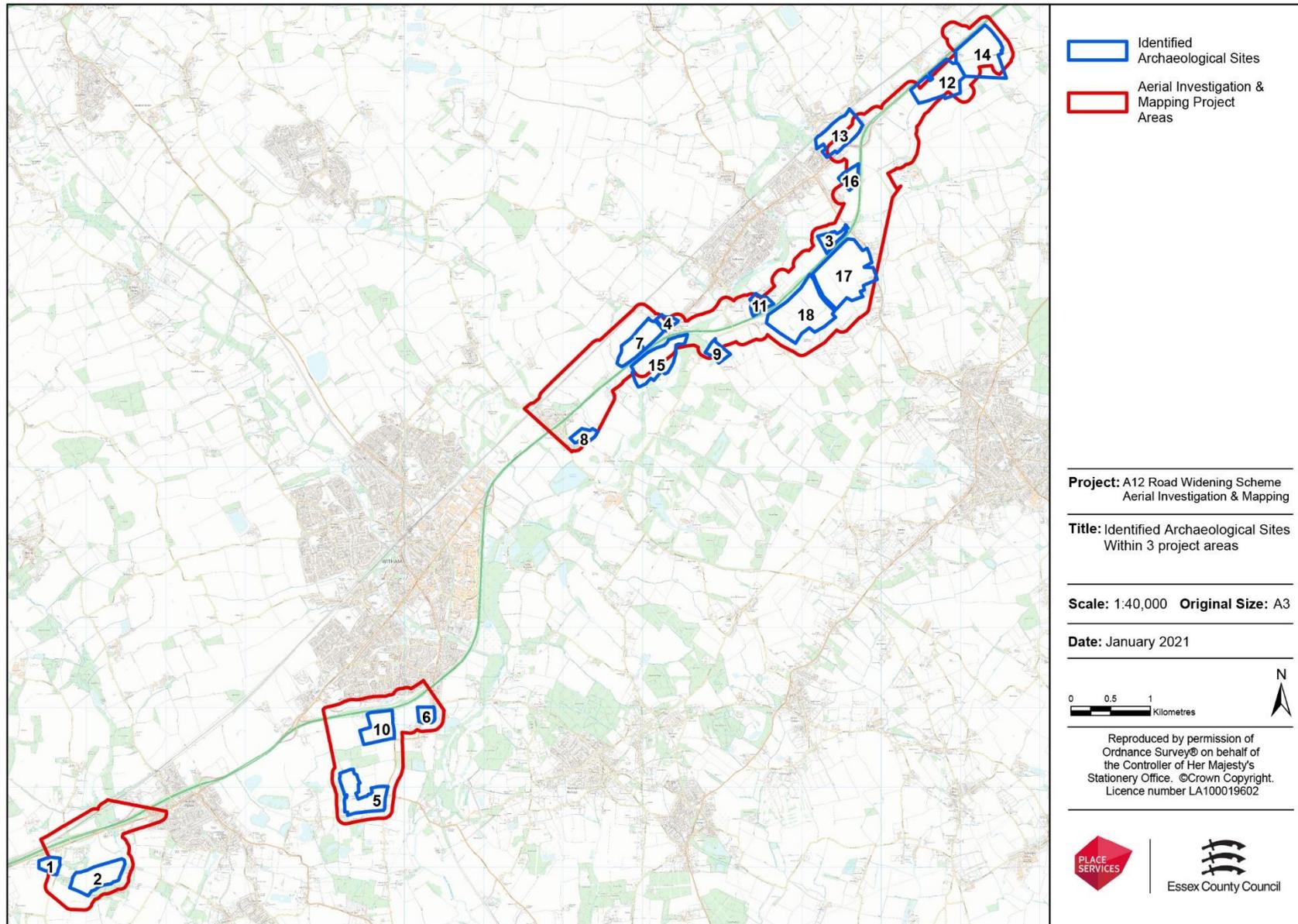


Figure 3 – Areas of identified archaeological features and Site Numbers

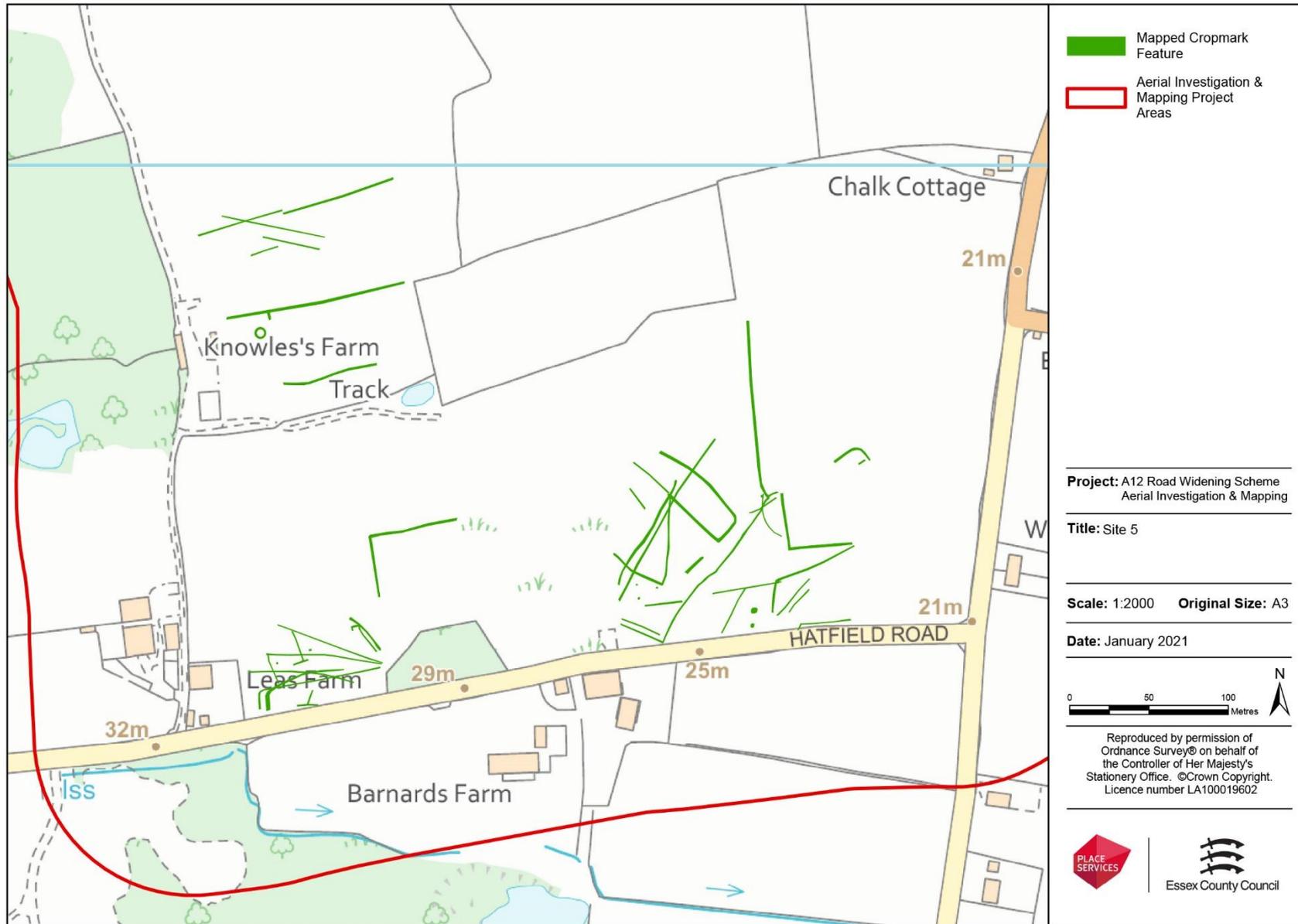


Figure 4 – Cropmarks of enclosure, pits and field boundaries (Site 5)

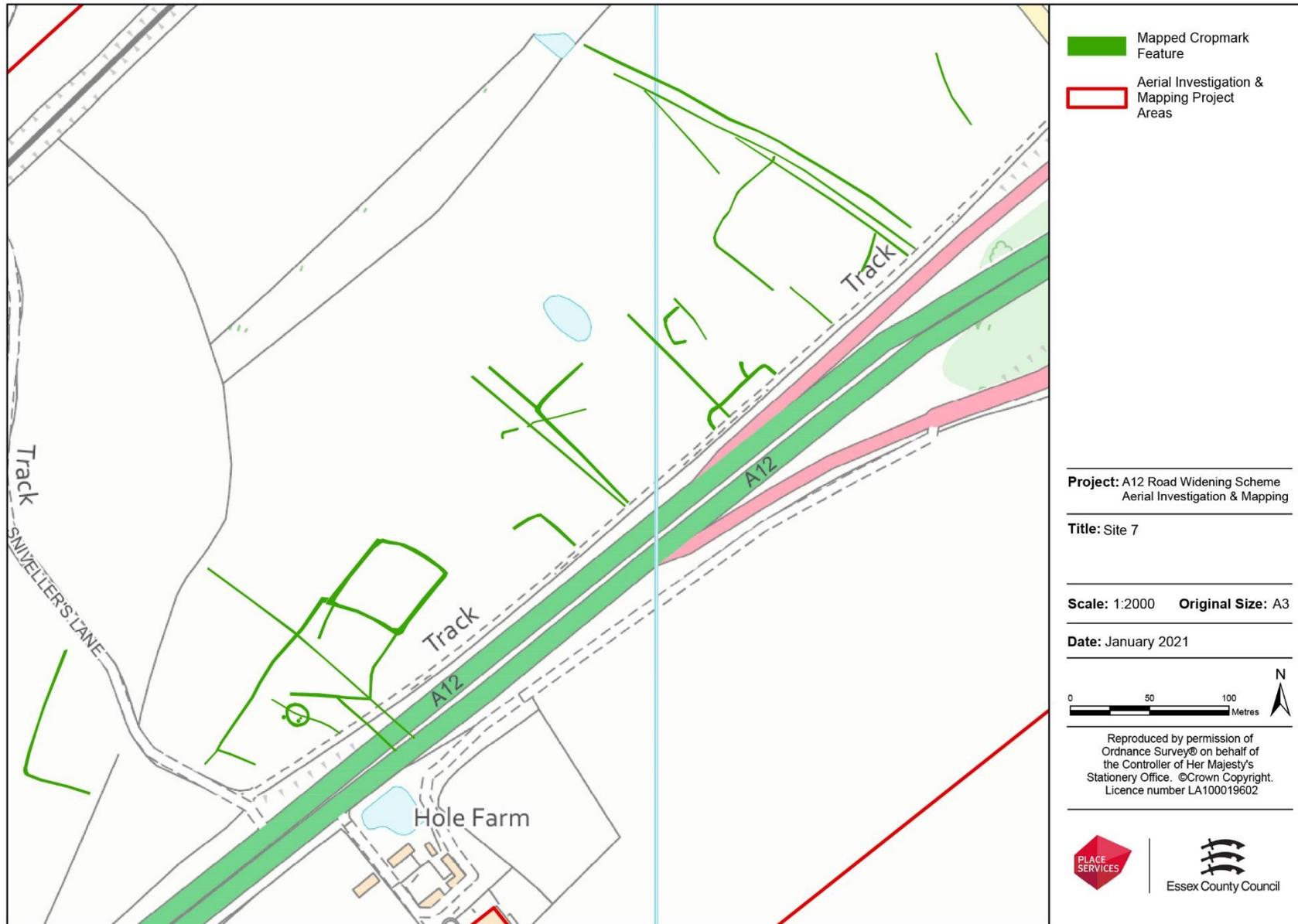


Figure 5 – Cropmarks of enclosure with annex, round barrow and field boundaries (Site 7)

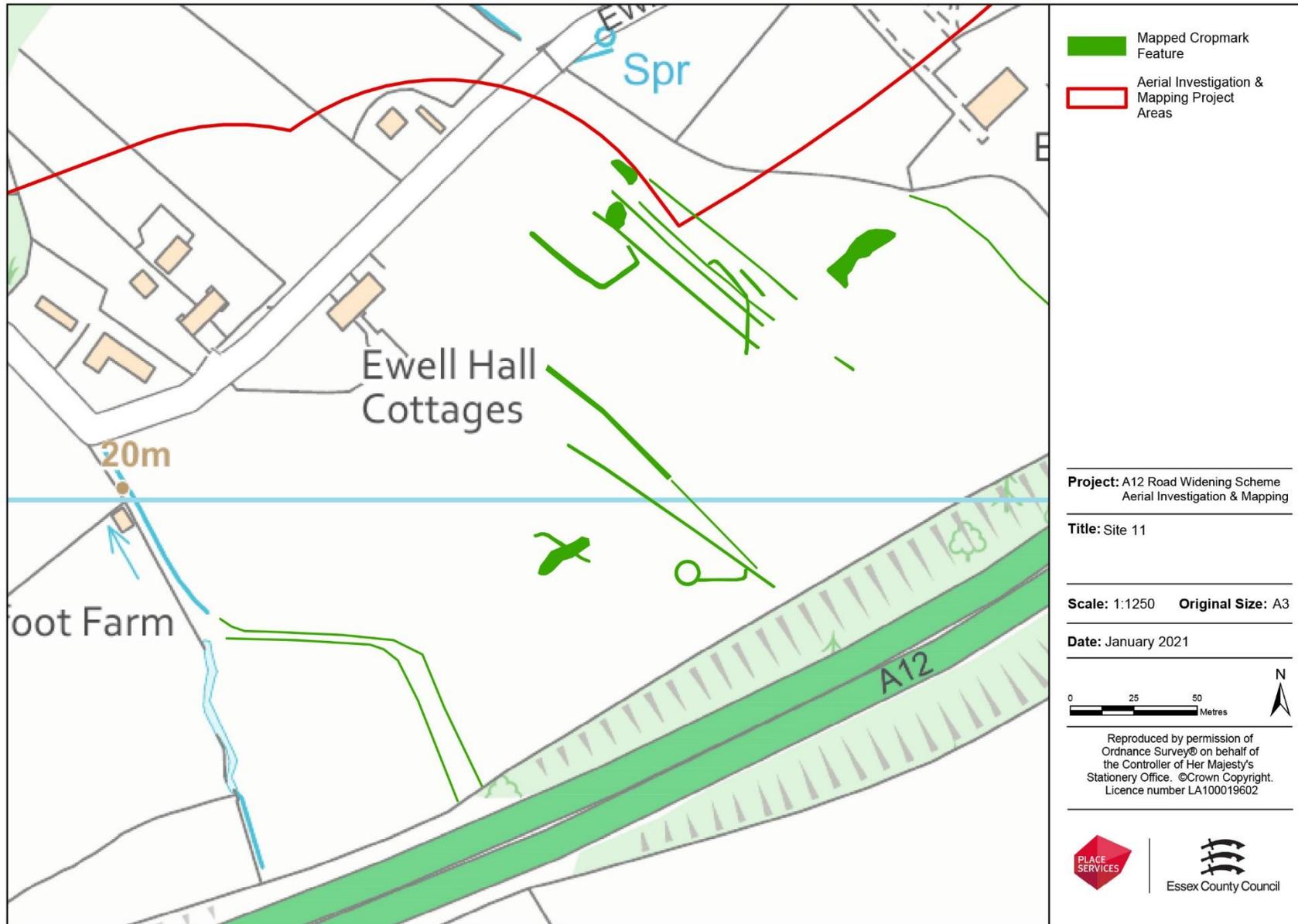


Figure 6 - Cropmarks of trackway, ring ditch, enclosure and field boundaries (Site 11)

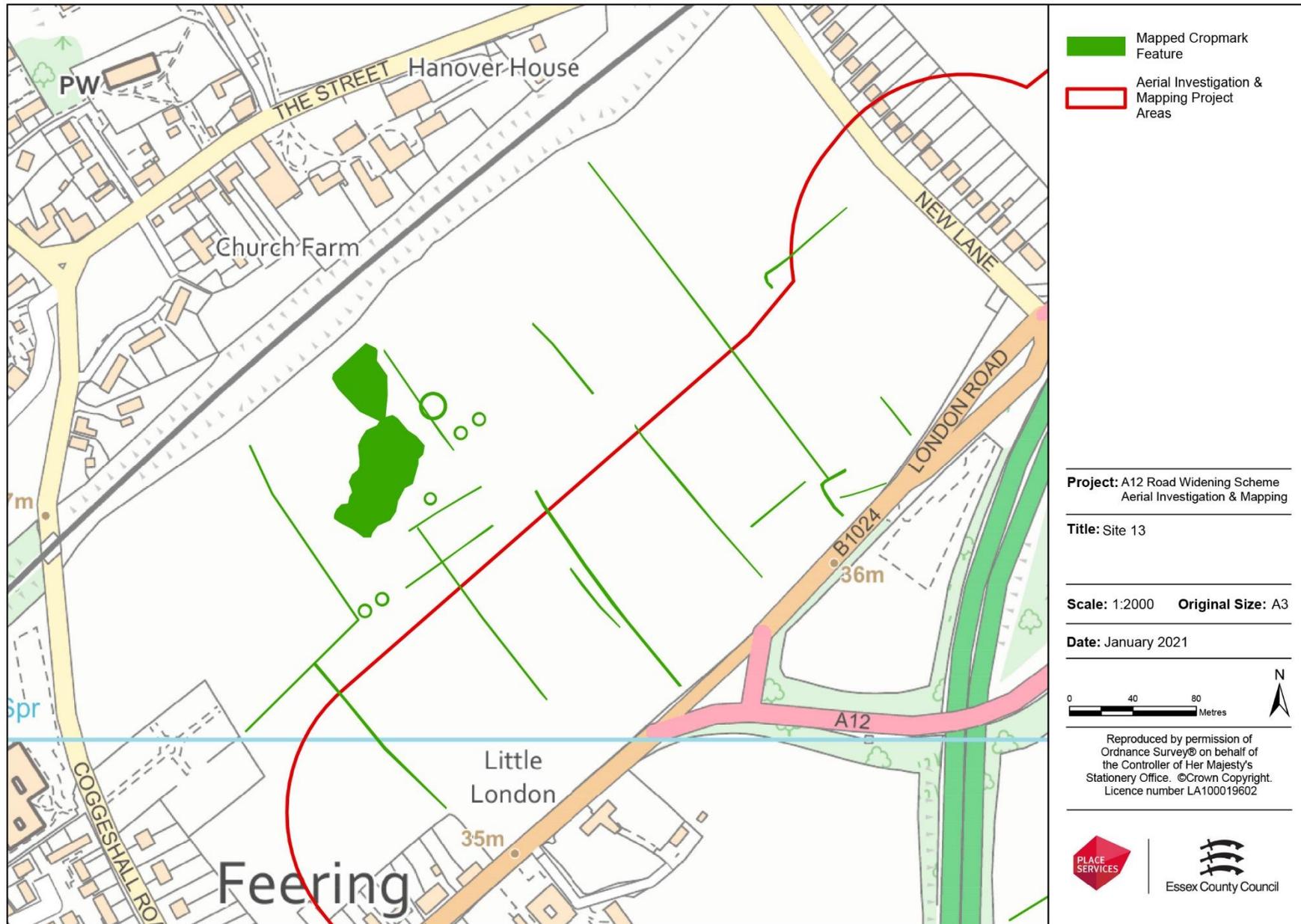


Figure 7 - Cropmarks of field boundaries, possible Bronze Age barrow cemetery and extraction pits (Site 13)

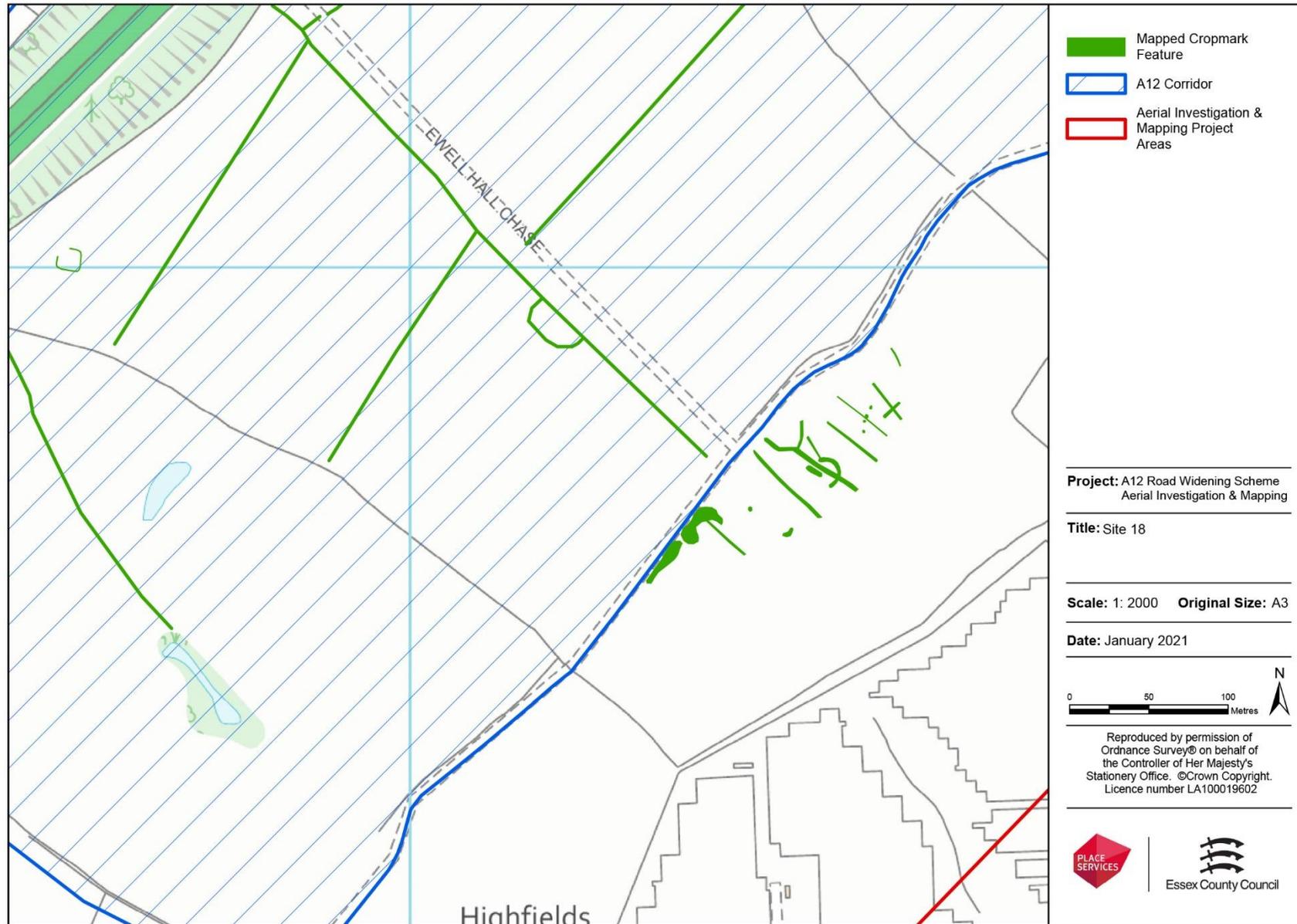


Figure 8 - Cropmarks of possible enclosure, linear features, pits and boundaries possibly associated with nearby Iron Age and Roman sites (Site 18)



Figure 9 - Differences between digital mapping and original NMP mapping at Site 7

References

Archaeological Solutions 2017, *Mill House Farm, Chadwell St Mary, Essex, archaeological assessment and updated project design* unpublished report

Historic England, 2019, *Historic England Aerial Investigation & Mapping (formerly National Mapping Programme) Standards Technical Review*, Research Report Series 46/2019

Ingle, C. and Saunders, H. 2011, *Aerial Archaeology in Essex: the role of the National Mapping Programme in interpreting the landscape* E. Anglian Archaeol. 136

Appendix 1: Methodology for Mapping

The following sections identify the archaeological scope of the project, the aerial photographic sources consulted and the methodology used for transcription. Aerial investigation and mapping typically records all archaeological features visible on aerial photographs and other airborne remotely sensed data such as Lidar dating from the Neolithic up to the 20th Century. The following lists the classes of monuments that were within the scope of this project, though not all feature types were recorded:

Archaeological Scope

Plough-levelled features and earthworks: All cropmarks and soilmarks that represent below-ground features of archaeological origin have been recorded. All earthwork sites visible on aerial photographs and Lidar were recorded. Earthworks that were no longer extant on the most recent photography were mapped and recorded as 'levelled earthworks' in the GIS attributes (see Section A1.3 below for further information regarding GIS attributes).

Post-medieval field boundaries: Former field boundaries and field systems that were marked on the 1st edition OS mapping (c. 1880s) were mapped where they were visible in conjunction with other archaeological features (and these field boundaries were mapped in a different GIS layer) to ensure the former field boundaries were identified correctly and not misinterpreted (e.g. in areas with complex archaeological features). Where former field boundaries that were on the 1st Edition OS mapping were visible in isolation (with no other archaeological features to be mapped) they were not mapped. All other field boundaries and field systems not marked on the OS mapping were recorded.

Twentieth-century Military remains: Military buildings and structures were recorded and mapped according to their form (e.g. military buildings or pillboxes were recorded

as structures; airfields were recorded as extent of feature). Military features and structures mapped included anti-glider ditches and anti-aircraft batteries.

Ridge and Furrow: All remains of medieval and post-medieval ridge and furrow were recorded using a standard convention to indicate the extent of area covered by the ridge and furrow, with arrows to indicate the direction of the furrows.

Buildings and structures: Foundations of buildings and structures which appeared as ruined stonework, earthworks, cropmarks, soilmarks or parchmarks were recorded. Only buildings relating to military or industrial sites were mapped as 'structures' or defined by an 'extent of area' as appropriate, other standing buildings (e.g. with roofs) and structures were not plotted.

Parks and Gardens: Earthworks and levelled landscape features associated with historic parks and gardens were recorded but features associated with 20th-century parks and gardens were not included.

Water meadows and drainage: Areas of water meadow were mapped using bank and ditch mapping conventions. While extensive areas of drainage were not routinely mapped, drainage channels were included where the features were associated with other identified archaeological features (such as moats or water meadows).

Natural Features: Geological and geomorphological features were not mapped, although these natural features were noted in the record and within the attributes of other mapped features where their presence would help to define the limits of archaeological features or if they could be misinterpreted.

Transport: Transport features such as canals or railways were not mapped as these features are adequately recorded elsewhere such as on historic OS mapping. Smaller features such as trackways and pathways were assessed and mapped if appropriate (for example, some historic pathways were visible on the aerial photographs were identified on the 1st edition OS mapping and these features were mapped when they were visible with other archaeological features, in a similar way to the post-medieval field boundaries).

Sources of Aerial photographs

All readily available aerial photographs were consulted during the project. Table A1 shows the main sources for the photographs that were reviewed for the project.

| Source | Type of photography |
|---|--|
| Essex County Council HER | Oblique and vertical |
| Cambridge University Collection of Aerial Photographs (CUCAP) | Oblique and vertical images that are held within the HER or HEA. The CUCAP library is currently not accessible, therefore not all images could be viewed |
| Google Earth | Verticals (from up to 8 different years) |

Table A1 - Sources and types of aerial photography consulted for this project

Vertical Photography

The main vertical collection for this project came from the d ECC vertical collections (Table A1). Essex County Council holds a vertical collection which ranged in date from 1960 to 2014. The ECC verticals from 2000, 2010 and 2014 were available as digital

ortho-photographs with the pre-2000 photographs available as high quality scanned images (not georeferenced).

Vertical photography from Google Earth and Bing Maps was assessed; both these sources of photography are high resolution, with good clarity, are accessible and easy to assess. Up to eight sets of photographs of the project area were available on Google Earth. The available photography on Google Earth ranges in date from 2000 to 2017.

Oblique Photography

The main source of oblique aerial photography was the Essex HER. Oblique photography from the Essex HER consisted of hard copy prints of some of the HEA photography, along with hardcopy ECC photography and digital images taken between 2009 and 2018.

The CUCAP library in Cambridge was not consulted as it is currently closed, however, the Essex HER contained CUCAP images, which were assessed.

Lidar

No Lidar was assessed for this project.

Transcription and GIS

The results of the mapping were produced entirely in a digital format. ESRI's ArcMap 10.4 was used. As all the aerial photographs were assessed and archaeological features were identified a GIS polygon was created to identify the extent of the visible features and each area was given a site number (information such as description of features visible, existing HER number (if applicable) and photograph reference

number were recorded in the attribute table). This system of numbered polygons allowed hardcopy and digital images of the same site to be collated, while mapping was tracked and suitable images of each site were recorded.

The oblique and vertical photographs to be used for transcription were either scanned (if the original was a hard copy held within the HER) or the digital image identified. The images were rectified using Aerial (a programme for the rectification of perspective distortion in aerial photographs, enabling archaeological features to be directly mapped from the rectified image). Control information (points such as the corner of a building or field boundary identifiable on the OS maps and the aerial photograph) was derived from OS MasterMap or the digital ortho-photography available and a digital terrain model (created from digital contour data) was used to compensate for distortion due to slope and terrain. The rectified aerial photographs were imported into the GIS and could be viewed in conjunction with other geographic information such as geology, soil information and historic OS mapping (see Section A1.1.1 for other available layers).

Archaeological features were digitally transcribed in ArcMap using conventions and guidance from the 'Standards for National Mapping Programme projects on transcription (English Heritage, 2012, 22-23) in a compatible format of the existing digital Essex NMP. The transcription was carried out using two GIS layers (polygons and polylines) within an ESRI Personal Geodatabase. The geodatabase made use of 'domains' (the attribute domain is the set of values permitted in the attribute); this allowed rules on the editing of data to be imposed. These rules allowed 'coded values' or set text to be used that ensured consistent categories of attributes could be recorded through a pick-list system throughout the project (for example, for the attribute 'Feature Type' either – DITCH, BANK, EXTENT OF AREA, STRUCTURE, RIDGE AND FURROW and LARGE CUT FEATURE could be chosen from a list to best describe the feature that had been mapped).

The majority of the features identified during the project were digitised as polygons, while former field boundaries marked on the 1st edition OS mapping were digitised in a polyline layer (for further information regarding the mapping of field boundaries please see Archaeological Scope in Section A1). The mapping conventions used for the project (and in the illustrations throughout this report, unless otherwise stated) are shown in Table A1.

| Feature Type | Layer Format | Colour | Description |
|--------------------|----------------------|----------------------------|---|
| DITCH | Polygon and Polyline | Green | Used for all negative features seen as cropmarks and earthworks, e.g. ditches or pits. Only features digitised in the polyline layer were field boundaries marked on the 1 st Edition OS mapping |
| BANK | Polygon | Red | Used for upstanding earthwork, earthworks that were visible on earlier photographs that had since been levelled or compacted surfaces such as roads/trackways |
| EXTENT OF AREA | Polygon | Dashed outer line, no fill | Used to depict the extent of large areas features such as airfields or searchlight emplacements |
| STRUCTURE | Polygon | Grey | Used to outline structures such as pillboxes, Nissen huts or military tents |
| RIDGE AND FURROW | Polygon | Purple with purple arrow | Used to depict the area of ridge and furrow with an arrow showing direction of furrows |
| LARGE CUT FEATURES | Polygon | | Used to depict large areas of quarrying |

Table A2 - Mapping conventions used in the GIS for this project

A1.1.1 Other data

During the assessment and transcription of photographs several other digital sources were also consulted (Table A3).

| Data type | Source | Format |
|--|-----------------------------|---|
| HER monuments | ECC | GIS shape files |
| HER Event | ECC | GIS shape files |
| Essex HER | ECC | HBSMR database |
| Scheduled Monuments | HE | GIS Shape file |
| Previous/surrounding NMP data | ECC | Georeferenced TIFF images |
| Quarry data showing disused, existing and proposed quarry & mineral extraction areas | ECC | GIS Shape files |
| Geology/Soil maps | ECC/BGS/Cranford University | GIS Shape files and data from www.bgs.ac.uk/ www.landis.org.uk/soilscapes |
| Historic Mapping (OS 1 st – 4 th Edition 25 Inch) | ECC | Georeferenced Tiff's |

Table A3 – Sources of other digital data consulted during the project

Place Services

County Hall, Essex CM1 1QH

T: +44 (0)3330 136 844

E: enquiries@placeservices.co.uk

www.placeservices.co.uk

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Essex County Council

A12 Widening Scheme Between Boreham & Marks Tey

Aerial Investigation and Mapping Photographic Catalogue



Client: Jacobs

Date: January 2021

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| | Name | Signed | Date |
|-------------------------------|--|--------|------|
| Title | A12 Widening Scheme between Boreham and Marks Tey: Aerial Investigation and Mapping Photographic Catalogue | | |
| Author | Helen Saunders | | |
| Derivation | | | |
| Origination Date: | January 2021 | | |
| Reviser(s) | N/A | | |
| Date of last revision: | | | |
| Version: | 1.0 | | |
| Status: | Final | | |
| Summary of Changes: | N/A | | |
| Circulation: | | | |
| Required Action: | | | |
| File Name/Location: | | | |
| Approved | N/A | | |

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1. Essex County Council Photography – Oblique Photography

| | |
|-----------------|---------------|
| 1A/19, 23 | 8 July 1987 |
| 17/15 | 26 July 1983 |
| 3/11 | Unknown |
| 41/1 | 1986? |
| 61/3-7 | 1987 |
| 81/3 | 12 July 1988 |
| 140/2 | Unknown |
| 151/35 | Unknown |
| 428/1--8 | 12 June 1992 |
| 428/15 | 12 June 1992 |
| 177/35 | Unknown |
| 177/36-37 | Unknown |
| 179/6-7 | Unknown |
| 427/5-7 | 12 June 1992 |
| CP/95/9/6, 8 | 4 July 1995 |
| CP/96/40/7 | 5 July 1996 |
| CP/96/6/12 | 12 June 1996 |
| CP/06/10/15 | 18 July 2006 |
| CP/06/11/01-03 | 18 July 2006 |
| EX09/02/081-104 | 16 June 2009 |
| EX10/06/031-045 | 5 August 2010 |
| EX13/05/092-098 | 16 July 2013 |
| EX13/05/103-113 | 16 July 2013 |
| EX13/05/133-134 | 16 July 2013 |
| EX13/05/135-141 | 16 July 2013 |
| EX13/08/018-024 | 26 July 2013 |
| EX17/02/009-013 | 30 May 2017 |
| EX17/04/100-107 | 29 June 2017 |
| EX17/04/108-112 | 29 June 2017 |
| EX19/03/015-016 | 27 June 2019 |

Other

| | |
|--------------|---------|
| McMaster 140 | Unknown |
|--------------|---------|

2. Essex County Council Photography - Verticals

1960

| | |
|---------------------|--------------|
| ESSEX/60/6/111 | 31 May 1960 |
| ESSEX/60/11/043 | 18 June 1960 |
| ESSEX/60/11/121 | 18 June 1960 |
| ESSEX/60/16/089 | 20 June 1960 |
| ESSEX/60/19/039 | 20 June 1960 |
| ESSEX/60/19/042-043 | 20 June 1960 |
| ESSEX/60/20/011-012 | 20 June 1960 |

1970

| | |
|---------------------|-------------------|
| HSL/UK/70/1068/1071 | 24 September 1970 |
| HSL/UK/70/1071/2576 | 26 September 1970 |
| HSL/UK/70/1071/2505 | 26 September 1970 |
| HSL/UK/70/1067/0996 | 24 September 1970 |
| HSL/UK/70/1067/0935 | 24 September 1970 |

1980/81

| | |
|-------------------|--------------|
| MAL/81/21/036 | 22 June 1981 |
| MAL/81/22/037-038 | 22 June 1981 |
| MAL/81/22/114 | 22 June 1981 |
| MAL/81//21/235 | 22 June 1981 |
| MAL/81/17/119 | 14 June 1981 |

1990

| | |
|----------------------------|----------------|
| Aerofilms/90/196/5710 | 8 October 1990 |
| Aerofilms/90/196/5713 | 8 October 1990 |
| Aerofilms/90/194/5389-5391 | 8 October 1990 |
| Aerofilms/90/194/5309-5311 | 8 October 1990 |

ECC digital ortho-photographs from 2000, 2010 and 2014, were also assessed along with APGB digital images from 2016 and 2019
Google Earth Images from 2000-2018 were assessed between 21-23 December 2020 for the entire route

3. Photography (Non-ECC) Held within HER

CUCAP

| | |
|------------|---------|
| BWT24 | Unknown |
| BJJ56 | Unknown |
| BXX64-65 | Unknown |
| BWT20, 23 | Unknown |
| BJJ57, 58 | Unknown |
| BXN 26, 34 | 1976 |
| CGE036 | 1978 |
| YG38 | Unknown |
| YG39-40 | Unknown |
| YG45 | Unknown |

Historic England Images

| | |
|-----------------------|--------------|
| TL7810/1/313-314, 316 | 9 July 1975 |
| TL7810/3/123, 126 | 8 June 1976 |
| TL7710/1/421, 428 | 12 July 1979 |
| TL7809/3/321 | 9 July 1975 |
| TL7709/3/312 | 9 July 1975 |
| TL7710/2/60 | 29 June 1977 |
| TL7711/1/432 | 12 July 1979 |
| SF1573 Fr 197 | 3 July 1979 |
| SF1573 Fr 208 | 3 July 1979 |
| SF1573 Fr 194 | 3 July 1979 |
| SF1573 Fr 193 | 3 July 1979 |
| SF1573 Fr 196 | 3 July 1979 |
| SF1573 Fr 187 | 3 July 1979 |
| SF1573 Fr 199 | 3 July 1979 |
| TL8111/3/206, 208 | 5 June 1974 |
| SF1573 Fr 252 | 3 July 1979 |
| TL8111/6/181 | 8 June 1976 |
| SF1573 Fr 256, 259 | 3 July 1979 |
| TL8111/3/209 | 5 June 1974 |
| TL8111/4/219 | 5 June 1974 |
| SF1573 Fr 239 | 3 July 1978 |

| | |
|---------------|--------------|
| SF1573 Fr 250 | 3 July 1979 |
| TL8212/2/214 | 5 June 1974 |
| SF1573 Fr 245 | 3 July 1979 |
| TL8212/1/212 | 5 June 1974 |
| TL8212/3/179 | 8 June 1976 |
| TL8113/1/32 | 24 July 1979 |
| TL8517/1/42 | 24 July 1979 |
| TL8617/1/203 | 3 July 1974 |
| TL8112/2/8 | 18 July 2006 |
| SF1573 Fr 180 | 3 July 1979 |
| SF1573 Fr 172 | 3 July 1979 |
| SF1573 Fr 185 | 3 July 1979 |

Place Services

County Hall, Essex CM1 1QH

T: +44 (0)3330 136 844

E: enquiries@placeservices.co.uk

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