

# Holme Fen Spitfire - X4593



## Excavation Report



March 2016

**Client: Bedfordshire, Cambridgeshire  
and Northamptonshire  
Wildlife Trust**

OA East Report No: 1872  
OASIS No: oxfordar3-230464  
NGR: TL 2087 8960

## **Holme Fen Spitfire - X4593**

*Archaeological Excavation*

*By Anthony Haskins MSc BSc ACIfA, James Fairbairn and David Brown BA*

*With contributions by Stephen Macaulay (BA MPhil MCIfA), Dr Louise Loe BA, Carole Fletcher (BA, ACIfA) Sgt. Paul Turner, Sgt. Richard Percival*

*Illustrator: David Brown BA & Gareth Rees BA*

*Report Date: March 2016*

**Report Number:** 1872  
**Site Name:** Holme Fen Spitfire X4593, Holme, Cambridgeshire  
**HER Event No:** ECB 4366  
**Date of Works:** August & October 2015  
**Client Name:** Bedfordshire, Cambridgeshire and Northamptonshire Wildlife Trust  
**Client Ref:** 156823  
**Planning Ref:** N1200729FUL  
**Grid Ref:** TL 2087 8960  
**Site Code:** HOMSPI15  
**Finance Code:** HOMSPI15  
**Receiving Body:** RAF Wyton

**Accession No:**

Prepared by: Anthony Haskins  
Position: Fieldwork Project Officer  
Date: 1/3/16

Checked by: Stephen Macaulay  
Position: Senior Project Manager  
Date: 2/3/16  
Signed:



**Disclaimer**

*This document has been prepared for the titled project or named part thereof and should not be relied upon or used for any other project without an independent check being carried out as to its suitability and prior written authority of Oxford Archaeology being obtained. Oxford Archaeology accepts no responsibility or liability for the consequences of this document being used for a purpose other than the purposes for which it was commissioned. Any person/party using or relying on the document for such other purposes agrees and will by such use or reliance be taken to confirm their agreement to indemnify Oxford Archaeology for all loss or damage resulting therefrom. Oxford Archaeology accepts no responsibility or liability for this document to any party other than the person/party by whom it was commissioned.*

**Oxford Archaeology East,**  
15 Trafalgar Way,  
Bar Hill,  
Cambridge,  
CB23 8SQ

t: 01223 850500  
f: 01223 850599  
e: oaeast@thehumanjourney.net  
w: <http://thehumanjourney.net/oaeast>

© Oxford Archaeology East 2011  
Oxford Archaeology Limited is a Registered Charity No: 285627

## Table of Contents

<b>Summary.....</b>	<b>8</b>
<b>1 Introduction.....</b>	<b>10</b>
1.1 Location and scope of work.....	10
1.2 Circumstances of the Project.....	10
1.3 Legislation.....	11
1.4 Geology and topography.....	11
1.5 Archaeological and historical background (App. G).....	11
1.6 Acknowledgements (Plates 40 - 43).....	12
<b>2 Aims and Methodology.....</b>	<b>14</b>
2.1 Aims.....	14
2.2 Site Specific Research Objectives.....	14
2.3 Methodology.....	14
<b>3 Results.....</b>	<b>17</b>
3.1 Introduction.....	17
3.2 Spitfire impact crater (Figs. 3 -7; Plate 4 & 5).....	17
3.3 1940's recovery excavation (Figs. 3 - 7; Plates 1-3 & 6-10).....	18
3.4 Finds Summary.....	18
3.5 Environmental Summary.....	21
<b>4 Discussion and Conclusions.....</b>	<b>22</b>
4.1 Crash and recovery.....	22
4.2 Significance.....	23
4.3 Critique.....	24
4.4 Recommendations.....	27
4.5 Conclusions.....	28
<b>Appendix A. Trench Descriptions and Context Inventory.....</b>	<b>29</b>
<b>Appendix B. Finds Reports.....</b>	<b>30</b>
B.1 Finds Catalogue.....	30
B.2 0.303 Ammunition.....	30
B.3 Cu alloy objects (Plate**).....	33

---

B.4 Iron (Fe) Objects.....	34
B.5 Lead (Pb) Objects.....	35
B.6 Pottery.....	38
<b>Appendix C. Environmental Reports.....</b>	<b>40</b>
<b>Appendix D. Archaeological Specification (Macaulay 2015).....</b>	<b>44</b>
<b>Appendix E. Geophysical Survey Report.....</b>	<b>45</b>
<b>Appendix F. JCCC License for the Excavation of X4593.....</b>	<b>46</b>
<b>Appendix G. P/O Harold Penketh.....</b>	<b>47</b>
<b>Appendix H. Bibliography.....</b>	<b>48</b>
<b>Appendix I. OASIS Report Form.....</b>	<b>50</b>

## List of Figures

- Fig. 1 Site location showing archaeological trench (red)
- Fig. 2 Geophysics and metal-detecting finds
- Fig. 3 The excavation sequence (Spits C-G), showing all finds recorded in-situ by photogrammetry and/or 3D locating
- Fig. 4 The excavation sequence (Spits H-K), showing all finds recorded in-situ by photogrammetry and/or 3D locating
- Fig. 5 Detailed plan of in-situ. aircraft parts encountered during the excavation of Spit K, with the locations of human remains marked. Location and depth within overall trench inset top
- Fig. 6 Views of extraction/impact crater, showing 3D located finds
- Fig. 7 Representation of results of photogrammetry

## List of Plates

- Plate 1 Top of recovery excavation after degraded peat had been removed
- Plate 2 1940's recovery excavation
- Plate 3 1940's recovery excavation at top of Oxford clay
- Plate 4 Top of original impact crater
- Plate 5 Impact crater under going excavation
- Plate 6 Hand excavation of plank and pilots flying helmet
- Plate 7 Hand excavation of pilots flying helmet, during BBC Countryfile filming
- Plate 8 Part of the site team recording the excavation
- Plate 9 Part of the site team during excavation
- Plate 10 Machine excavation of the crater
- Plate 11 Recording of the top of the propeller
- Plate 12 Long arm 360 machine used during the excavation
- Plate 13 DGPS locating of the impact crater and use of magnetometer to locate the engine block
- Plate 14 Metal detecting the spoil heaps
- Plate 15 The propeller
- Plate 16 Engine showing the surviving Rolls Royce
- Plate 17 Engine during cleaning at RAF Wytton
- Plate 18 Propeller and engine on site prior to transport to RAF Wytton
- Plate 19 Propeller and engine on site prior to transport to RAF Wytton
- Plate 20 Foam interior of Pilots headrest
- Plate 21 Oxygen cylinder

---

Plate 22	Pitot tube
Plate 23	Supermarine spitfire rudder pedal
Plate 24	Brake fluid pressure gauge
Plate 25	Ammunition showing manufacturing and date stamps
Plate 26	Gordons highlanders shoulder flash
Plate 27	RAF plate
Plate 28	Brass uniform button
Plate 29	Planks undergoing excavation
Plate 30	Rubber glove used by the recovery team
Plate 31	Pilots flying helmet
Plate 32	Communicator from flying helmet
Plate 33	P/O Penkeths Cuff Link
Plate 34	P/O Penkeths Cigarette case
Plate 35	P/O Penkeths watch, the time of the crash can just be made out as c.14.23
Plate 36	P/O Penkeths nail file
Plate 37	Cleaning the finds on site
Plate 38	Finds waiting to be cleaned
Plate 39	Finds waiting to be cleaned
Plate 40	The Oxford Archaeology East site team
Plate 41	Jigsaw Volunteers
Plate 42	Jigsaw Volunteers with Jemima and Jo
Plate 43	Oxford Archaeology Project team, the wildlife trust team, Pete masters, Flt Sgt P. 'Yoda' Atkinson and Peter Stanley

#### List of Tables

Table 1	Elements of Spitfire X4593 recovered
Table 2	0.303 ammunition photographic catalogue
Table 3	Iron (Fe) objects Catalogue
Table 4	Lead (Pb) objects catalogue
Table 5	Inventory of human remains
Table 6	Dental inventory



***This report is dedicated  
to the memories of all aircrews  
killed in conflict.  
In particular Harold E Penketh,  
who one was of the few***





---

## Summary

*During October 5th to 11th 2015 Oxford Archaeology East, local community volunteers, and members of Operation Nightingale excavated the remains of Spitfire Mk Ia X4593 'Kerala' near Holme Fen, Cambridgeshire.*

*Spitfire X4593 crashed on the 22nd November 1940, on a routine training flight and Pilot Officer Harold E Penketh was killed. The official MoD records note that a recovery team excavated down to the aircraft in the week following the crash and recovered the remains of Pilot Officer Penketh. Evidence for this subsequent excavation and recovery of Pilot Officer Penketh was found, along with an RAF mess plate believed to have been left on the site by the recovery team as a marker.*

*Remains of the Spitfire, including the engine block and parts of the cockpit were found in-situ at a depth of -6.27m OD, along with other parts of the airframe (including .303 ammunition) that were within the area excavated during the recovery operation.*

*Mark 1a Spitfire, including the engine block and parts of the cockpit were found in-situ at a depth of -6.27m OD, along with other parts of the airframe (including ammunition) that were within the area excavated during the recovery operation.*

*Sadly some remains of Pilot Officer Harold Penketh, that were not recovered in 1940 were discovered, along with some of his personal effects including a cigarette case (engraved with his initials) and his watch.*

*The remains of the aircraft were transferred to the Pathfinder Museum at RAF Wyton for conservation and display.*



## 1 INTRODUCTION

### 1.1 Location and scope of work

- 1.1.1 An archaeological excavation was conducted at Holme Fen, Holme, near Peterborough, Cambridgeshire (TL 2087 8960).
- 1.1.2 This archaeological excavation was undertaken in accordance with a License issued by the Joint Casualty and Compassionate Centre (JCCC; see section 1.2; App. F), and a Brief issued by Kasia Gdaniec of Cambridgeshire County Council (CCC; 2012), supplemented by a Specification prepared by OA East (Macaulay 2014; App. D).
- 1.1.3 The project was designed to recover the remains of Spitfire Mk Ia X4593. The work was part of the Great Fen Wetland Recreation project and specifically the Rymes Reedbed Project. The Wildlife trust plan to increase the water table, and this will alter the soil chemistry potentially affecting the preservation of the aircraft and making it impossible for a future excavation.
- 1.1.4 The site archive is currently held by OA East and will be deposited with the appropriate county stores in due course. The physical (artefactual) remains of the Spitfire will be taken to the Pathfinder Museum at RAF Wyton, although ultimately the remains may be exhibited at a planned Great Fen Visitor Centre, that is being considered as part of the Great Fen Vision.

### 1.2 Circumstances of the Project

- 1.2.1 The Great Fen Project is a 50 year+ scheme, which aims to create a huge wetland area, and transform the land between Huntingdon and Peterborough, into one of Europe's largest wetland habitat for both wildlife and people. Although the Great Fen Project is primarily aimed at developing new wetland habitats, it is also designed around local community involvement and engagement in conservation work and also in understanding the history, heritage, and archaeology of the areas within the project.
- 1.2.2 The Rymes Reedbed Project, is part of the overall Great Fen vision and involves the creation of a reedbed to the west of Whittlesey Mere. This will involve the excavation of new drainage ditches and the re-wetting/flooding of land which is currently dry and under arable cultivation. The location of Spitfire X4593 meant that the aircraft was to be recovered in advance of this landscape alteration.
- 1.2.3 The project to recovery Spitfire X4593 was undertaken within the wider purpose to engage and involve the local community, in this important part of their local heritage and to ensure that the remains were treated respectfully and correctly.
- 1.2.4 Due to the military nature of the excavation, members of Operation Nightingale were invited to participate. Operation Nightingale is a project who's aims are to aid current and ex-military personal develop new transferable skills (though archaeology) and to assist them with dealing with physiological and psychological injuries received in service.
- 1.2.5 Oxford Archaeology, in consultation with Historic England and the Ministry of Defence Archaeologist, devised a scheme to recover Spitfire X4593 and design a working methodology for the controlled recovery of crash site remains. The methods and lessons learned from this project will contribute to the current updating on the Historic England advice outlined in the [guidance note on military aircraft crash sites](#).

### 1.3 Legislation

- 1.3.1 Military crash sites within territory belonging to the United Kingdom or British Military Aircraft crash sites in international waters are controlled under the Protection of Military Remains Act 1986. As such it is an offence to damage, move or unearth any items at such sites. Therefore to carry out the excavation of Spitfire X4593 a License was required and issued by the JCCC (License 1804; See App. F).
- 1.3.2 The license required that on the discovery of human remains or unexploded ordnance all works must cease until the Ministry of Defence allows it to continue. If human remains are found the Ministry of Defence should be notified by telephone as soon as possible. If ordnance is found the excavator is required to contact the police.

### 1.4 Geology and topography

- 1.4.1 The geology and topography of the site is well understood through previous archaeological work, in particular at Rymes Reedbed by Boreham (See Boreham 2013). The following simplified text draws largely on this work and also the Rymes Reed Bed project (Haskins 2013).
- 1.4.2 The site lies on a bedrock of Jurassic Oxford Clay with overlying Late Glacial minerogenic sediments sealed by the Holocene organic deposits ('peat'). The peat formation starts around 6794±120 BP (Waller 1994, 195). Trundel Mere, located immediately to the north of the excavation area was an open body of water. At this time, floating mats of vegetation had formed in the mere. As the vegetation sank water levels rose and acidic peat bog started to form (Begg *et al.* 2008, 28 for example).
- 1.4.3 During the Iron Age, the Whittlesey Mere, a very large freshwater lake located to the north and east of the excavation began to form calcium rich marls (Boreham 2008). These marls are derived from calcium carbonate rich water travelling along the River Nene. Whittlesey Mere was a major fishing resource in the medieval period, so much so it was fought over by several local religious houses. Outside of the Meres peat formation continues until land drainage started in 1849. By 1853 Whittlesey Mere was drained (Page *et al.* 1974). Degradation of the peat started at this time and has continued to this day in particular around the Holme Fen Post (Hutchinson 1980). The Holme Fen Post was put in place to measure peat loss.
- 1.4.4 The location on the crash site on the edge of Whittlesey Mere was within one of the deeper areas of preserved peat. Had this occurred in areas of shallower peat the recovery during 1940 would have been easier and the preservation of the remains recovered during the excavation may not have been as good.
- 1.4.5 The weather during November 1940 was described at the time by the MET office as Unsettled and wet with '*excessive rainfall notably in England and Wales, where more than twice the average occurred*' (Johnson 1941). As such the area of the crash was heavily saturated with a much higher water table than during the Oxford Archaeology excavation. Drainage and degradation of the peat deposits has meant that potentially over 1m of deposit has been lost since 1940 (Boreham pers. comm.).
- 1.4.6 The current site lies in flat open grassland at c.-2m OD.

### 1.5 Archaeological and historical background (App. G)

- 1.5.1 On November 22<sup>nd</sup> 1940 a flight of three spitfires from 266 squadron left RAF Wittering on a routine training exercise. During a battle climb to 28,000 feet Pilot Officer (P/O) Harold E Penketh fell out of formation and entered a spiralling dive. The operation

reports at the time suggest some attempt was made to recover from the dive at around 2000 feet, although this may have just been an uplift effect caused by different air pressures. The Spitfire according to eye witnesses crashed almost vertically into the fen at 14.20hrs and P/O Harold Penketh was killed in the impact.

- 1.5.2 Operation reports state that P/O Penketh was recovered after seven days search from a c. 25 foot deep hole(8-9m). The remains of P/O Penketh were cremated at Woodvale Crematorium, Brighton and his ashes scattered (see Appendix G).

### ***Service History***

- 1.5.3 P/O Penketh had enlisted in the RAF volunteer reserve on the 6<sup>th</sup> October 1940, with seniority dated to the 29th September (London Gazette, 5th November 1940). After his initial training he was transferred to 266 Rhodesia Squadron (8th November 1940) as he had connections with South Africa. He had 13 hours flying time in a Spitfire and his commanding officer stated he was quite capable of flying the single seater aircraft. It is unclear what happened during the incident and the crash was attributed to either a failure of the oxygen system, or pilot failure.

### ***Spitfire X4593***

- 1.5.4 The Spitfire X4593 – Kerala – was a Mark 1a, built 1st October 1940 as part of a trio of sponsored by the Madras Mail. Initially issued to 603 City of Glasgow squadron on October 8th 1940. The plane saw action in several intercepts in 603 squadron and was attributed a successful kill. On the 17th October X4593 was then transferred to 266 Squadron. This was part of an operational move from sector 11 as 266 Squadron had suffered heavy losses during the Battle of Britain. The squadron was withdrawn from the front line to RAF Wittering for patrols and training to rebuild the squadron. The Spitfire Mk IIa's that 266 squadron had been flying were transferred to 603 squadron and 266 squadron received the Spitfire Mk Ia's that 603 squadron had been flying including X4593. X4593 was then involved in several operations and training flights until the crash. A second air victory of a BF109 E-1, which crashed in Elham, Kent, was assigned to the plane during this period.
- 1.5.5 The wider historical and archaeological background of the landscape within the Great Fen project has been covered in several pieces of work, including a detailed archaeological desk based assessment (Hatton 2002).
- 1.5.6 The area of the plane crash is within the Rymes Reed bed wetland creation scheme. Previous archaeological work for this aspect of the project was carried out by Oxford Archaeology East (Clover and Clarke 2013, Haskins 2013). This found little of archaeological interest but added to the understanding of the development of the peat and Meres within this area of Holme fen. A small scale metal detector survey carried out during these earlier works identified several fragments of aluminium airframe confirming the crash location (Haskins 2013).

## **1.6 Acknowledgements (Plates 40 - 43)**

- 1.6.1 All the project staff would like to thank Valetta Cranmer and her sister-in-law Jill Knight for their understanding and support for this excavation.
- 1.6.2 The author would like to thank everyone involved with the project from the Wildlife trust in particular Kate Carver for commissioning the work but also, Helen Bailey, Josh Hellon, Mark Uilyet, Louise Rackham, John Keaveny, Greg Ambarchian, Mandy Corney, Lauren Stonebridge and Caroline Fitton.

- 
- 1.6.3 Thanks should also go to Jonathon Papworth for supplying the plant and excavator and Stuart Greenwood for driving the machine with immaculate skill.
  - 1.6.4 The volunteers from the Great Fen and other Jigsaw groups involved with the project should also receive thanks -
  - 1.6.5 Great Fen Archaeology Group: Sue Wallis, Alan Malt, David Peters, Lin Mack, Glenis Carroll, Paul Springford,
  - 1.6.6 Covington: Simon Parsons,
  - 1.6.7 St Ives Archaeology Group: Philip Stimson, Alan Roberts, Alan Davis,
  - 1.6.8 Warboys Archaeology Project: Roger Mould, Alex Edwards, John Edwards.
  - 1.6.9 As well as Claire Haskins for her assistance on Saturday 11th October.
  - 1.6.10 Operation Nightingale volunteers – Sgt. Richard Percival, Sgt. Paul Turner, FS Peter Atkinson, SAC Thomas Sigworth, AC Richard Howes, Anouska Osborne, Hillery Harrison, Chris Headon, and Gary Phillips – who provided much in the way of help with the excavation inside the finds tent and with dealing with 0.303 ammunition.
  - 1.6.11 Thanks also go to members of 5131 BD Squadron who provided EOD cover. Thanks also go to 5131 for allowing Oxford Archaeology East to use their portable X-Ray machine when it was required.
  - 1.6.12 LGC Forensics are thanked for assisting us with the storage of the remains of Harold Penketh prior to his re-internment by the JCCC.
  - 1.6.13 Finally thanks go to the site staff of Stephen Macaulay – who also managed the project, Anthony Haskins, James Fairbairn, Dave Brown, Nick Cox, Paddy Lambert, Jo Richards, Jemima Woolverton and Carole Fletcher. Special thanks also go to Louise Loe, of Oxford Archaeology, as well as Peter Masters, and Nicholas Marquez-Grant of Cranfield University. Finally thanks go to Cambridgeshire Historic Environment Team in particular Kasia Gdaniec, who monitored the project, and the Aviation Archaeologists Peter Stanley, Jeff Carless, Steve Visard, and Bas Coolen and finally Historic England Archaeologist Vince Holyoak.

## 2 AIMS AND METHODOLOGY

### 2.1 Aims

- 2.1.1 The original aims of the project were set out in the Brief and Written Scheme of Investigation (Gdaniec 2012, Macaulay 2014).
- 2.1.2 The main aims of this excavation were
- To mitigate the impact of the development on the surviving archaeological remains. The increase in the water table had potential to have a negative impact upon the preservation of the aircraft remains.
  - To preserve the archaeological evidence contained within the excavation area by record and to attempt a reconstruction of the history of the site.
  - To provide data and information to Historic England to assist with the update of the current Air crash guidance (Holyoak and Schofield 2002).

### 2.2 Site Specific Research Objectives

- 2.2.1 Several more site specific research aims were identified.
- Could the excavation identify the cause of the training accident?
  - Could the story of the crash and recovery of the pilot be understood by the excavation?
  - What additional data could be gleaned from using up to date recording techniques such as photogrammetry? Do these techniques add to the understanding of what happened during the crash and rescue?
  - The fuel and oil ratio within early Spitfires is not known. Therefore if preservation is good could a sample of the fuel oil be analysed?
  - How much hydro-carbon contamination was present and did it have an impact on the landscape?

### 2.3 Methodology

- 2.3.1 The methodology used followed that outlined in the Brief (Gdaniec 2012) and detailed in the Written Scheme of Investigation (Macaulay 2015; App.D).

#### ***Geophysical Survey (Fig. 2)***

- 2.3.2 Prior to the excavation work a geophysical survey was undertaken by Peter Masters of Cranfield University. The geophysical survey was the only practical methodology to confirm the location of the crash site and therefore determine the position of the trench. The geophysical survey was initially located over the recorded location of the crash. A combination of poor readings (the geophysical survey would attempt to locate the engine, which is the only part of the aircraft which would produce a strong enough signal to confirm the impact crater location) and the results of the simultaneous metal detector survey resulted in the movement of the geophysical survey more than 60m to the south-west of the presumed location of the crash. (See below section 2.3.3). The geophysical survey applied a combination of techniques; initially a magnetometer was used to attempt to locate the engine block and then Electrical Resistance Tomography (ERT) and Ground Penetrating Radar (GPR) were used to attempt to pinpoint the depth at which the engine lay. Although the soil types/conditions were not very responsive to

the other geophysical survey techniques used, the crash site was clearly identified in the magnetometer survey (See Masters 2015 App. E). The magnetometer accurately located the Merlin Rolls Royce engine to within a few centimetres on the XY axis although the depth of the engine was predicted to be shallower (c.3m below ground surface) than the actual depth it was finally encountered (5m+).

***Metal Detector Survey (Fig. 2 & Plate 14)***

- 2.3.3 A metal detector survey of the field was carried out by volunteers from The Great Fen Archaeology Group supported by members of several other Jigsaw Archaeology Action Groups (Covington, Warboys, STAG). This was to assist the geophysical survey by locating the debris scatter around the crash site. The metal detector finds were located using a hand-held GPS and then plotted with the geophysical results (see fig. 2). Ultimately the metal detector survey allowed the geophysical survey to pinpoint the crash site quicker. Due to time constraints it was not possible to cover the entire area and further metal detecting was carried out (to the south and west of the position of the impact crater) prior to the start of machining to complete the survey.

***Excavation methodology (App. D; Plates 1 - 11)***

- 2.3.4 Due to the probable depth of excavation (4m+) a strong and robust methodology was implemented. This was of particular importance as reports from 1940 put the Spitfire at depths of c. 25ft (See App. G). Initially an area of 20m x 20m (i.e. the wingspan of the Mk 1 Spitfire) was to be opened, centred on the location of the impact crater determined by Geophysical Survey. This was to be excavated in 1m steps until the physical outline of the impact crater was revealed. The area of trenching was then to be reduced to cover only the impact crater and stepped every 1m until the engine/cockpit was located.
- 2.3.5 Stepping, rather than shoring was selected as the method to open a large and potentially deep trench, and this would provide increased safety both from section collapse (in what was also a potentially waterlogged environment) and also from possible contamination and fuel fumes. Finally, the timing of the excavation was deliberate to coincide with the time of year when the water levels in the Holme Fen were at their lowest, i.e. October, when the Internal Drainage Board reduce the groundwater levels. This proved to be a very good decision as water ingress was minimal. An outline of the excavation methodology is presented here and a critique is presented in section 4.3.
- 2.3.6 Machine excavation was carried out by a 13.5 ton 360° excavator and a 14 ton long arm 360° excavator. Both used flat bladed ditching buckets under constant supervision of a suitably qualified and experienced archaeologist (Plates 10 & 11).
- 2.3.7 The initial excavation area of 20m by 20m was stripped of turf and then metal detected. Finds were three dimensionally located using a Lecia GS08 DGPS with base station (Plates 8 & 13). The area was then reduced to the base of the degraded peat (c. 500mm). The excavation area was then targeted on the visible 1940 recovery excavation and impact crater. It was planned that as the excavation area got deeper it would be made safe by stepping in the sides (with a 1m step every 1m down) and subsequently by battering the sides back to a 45° angle. A long arm 360° excavator would be used to do most of the excavation work. Concern about water ingress and section stability during the project restricted hand excavation and potentially excavation would only be carried out by machine. A decision about when this would occur would be made by Anthony Haskins (OA East H&S advisor). Any water within the excavated area



was to be pumped into a small drainage ditch controlled by the Wildlife Trust. The area of excavation was fenced off with several layers of Netlon fencing to control all access.

- 2.3.8 The engine block was to be lifted according to a lift plan using the long arm excavator. Once out of the excavated area the engine was lifted using suitably rated straps and transferred onto a pallet. The pallet was then loaded onto a flatbed by a suitably rated telehandler and taken from site. The telehandler also unloaded the engine once it had been delivered to RAF Wyton.
- 2.3.9 Spoil, exposed surfaces and features were scanned with a metal detector. All metal-detected and hand-collected finds were retained for inspection.
- 2.3.10 All archaeological features and deposits were recorded using OA East's *pro-forma* sheets. The trench location and digital plans of the excavation were recorded using Leica 1200 DGPS and base station. 3-Dimensional (3D) recording of significant elements within the impact crater was undertaken using photogrammetric techniques.
- 2.3.11 Geomatics played an integral role in the excavation and post-excavation methodology of this site enabling detailed recording of in-situ finds as well as the post-excavation reconstruction of the impact crater and crash site. The site survey was carried out using Leica GS08 and Leica 1200 DGPS systems using correctional data from Leica SMARTNET and an on-site base station. The trench was located over what had been interpreted as the location of the engine by a magnetometry survey. After the excavation of each spit the trench edge and the outline of the crater were planned using the DGPS and levels were recorded across the spit. In-situ finds were recorded by placing markers on the artefacts, the 3D locations of which were then recorded. The artefacts were then photographed from multiple angles in their original location using a Nikon FD90 and a Canon EOS 450D. In the case of the engine and the propeller it was not possible to take adequate photographs in the trench due to the site conditions and so these artefacts were photographed in detail post-excavation with reference points relate-able to their original positions.
- 2.3.12 In post-excavation the survey data was used to make a digital 3D reconstruction of the impact crater using AutoCAD. Photographs of many of the artefacts, including the engine, were used to create 3D models using Structure from Motion (SfM) processing software AgiSoft Photoscan Pro. This has enabled the reconstruction of many elements of the crash site and the subsequent recovery efforts.
- 2.3.13 On site cleaning, processing and recording of all finds was carried out by volunteers from Operation Nightingale and Jigsaw Volunteer groups (including the Great Fen Jigsaw Group) with assistance from Oxford Archaeology East staff (Plates 37 - 39).
- 2.3.14 Due to health and safety concerns specific methodologies were undertaken to minimise the risks involved in such a deep excavation. The main concern was the size and depth of the excavation area (See above – Section 2.3.4). Further health and safety concerns are listed below (Sections 2.3.15 – 2.3.17).

#### **Live ammunition (Plate 25)**

- 2.3.15 As the aircraft crashed during war time it was expected to be carrying a load out of live .303 ammunition. EOD cover was therefore organised for the excavation through 5131 Bpmb Disposal (BD) Squadron based at RAF Wittering. Following a meeting on site with personnel from 5131 BD Squadron it was agreed that volunteers from Operation Nightingale, who are currently serving in Her Majesty's Armed forces and are trained Ammunition Trained Officer's (ATO), would control the live ammunition in the day to day running of the site. 5131 BD Squadron then removed the ammunition at the

end of the excavation works. All ammunition once recorded was stored in a designated 'safe area' within an ammunition crate surrounded by sandbags within an isolated cage made out of HERAS fence panels and located on the site away from visitors, access routes and casual observation. Only those individuals identified by 5131 BD Squadron to be competent with live ammunition were allowed within this area.

#### **Control of Substances Hazardous to Health (COSHH)**

- 2.3.16 A number of potentially hazardous substances such as fuel oil, hydraulic fluid and engine coolant were present on/in the aircraft at the time of the crash. Therefore a detailed set of COSHH risk assessments were produced. These were based on the principles of elimination and put in place controls that would allow the excavation to continue should dangerous levels of contamination occur.

#### **Human Remains**

- 2.3.17 The official MoD records record that the remains of P/O Harold Penketh were recovered and these were buried in Brighton shortly after the crash in November 1940. The 2015 archaeological excavation always knew there remained a strong possibility for the recovery of further human remains, as recovery during the war was not always 100%. The law stipulated that 7 lb (3 kg) was needed to establish a body (Holyoak 2004). Due to the burial conditions in anaerobic peat deposits material other than just skeletal remains was also potentially going to be present. Oxford Archaeology had arranged a contingency that if any remains were found Dr. Louise Loe, head of burials at Oxford Archaeology would be immediately available to assist. During Thursday 8th October, a single fragment of human skeleton was recovered. Dr. Louise Loe of Oxford Archaeology and Dr. Nicholas Marquez-Grant from Cranfield University attended the site on Friday 9th October to record all the remains recovered.

### **3 RESULTS**

#### **3.1 Introduction**

- 3.1.1 The site stratigraphy was relatively straightforward with effectively four contexts. These contexts can be broken down into two groups, the cut and fill of the impact crater formed on the 22nd November 1940 as a result of the crash and then the modification to the impact crater during subsequent recovery effort in the following weeks in November 1940, and then the backfilling. As such the results will be presented in these two groups.

#### **3.2 Spitfire impact crater (Figs. 3 -7; Plate 4 & 5)**

- 3.2.1 The unmodified impact crater (1) was 2.75m wide and c. 3m deep. The crater had steep sides and a relatively flat base. The engine block was located in the north-east corner of the crater. Wreckage of the airframe, in particular that of the fuselage, and the parts that hadn't been removed during the 1940 recovery operation filled the crater. The fragments of human remains were largely located within the area of the engine block. The majority of P/O Penketh's personal effects were also recovered from the unmodified crater other than parts of the flying helmet, which were recovered higher in the trench from the base of the recovery excavation (See 3.3.2).
- 3.2.2 The impact crater (1) contained a single mixed fill (2) composed of a mixture of degraded sphagnum moss peat, Oxford clay, and fragments of aluminium airframe. The fill formed at the time of the impact and was truncated by the recovery excavation (3).

- 3.2.3 Found at a significantly shallower depth than the surviving unmodified crater was the Pitot tube. The pitot tube located on the underside of the port wing tip is a pressure measurement system used to determine the indicated airspeed of the aircraft. The shape of the tube had allowed it to penetrate into the peat with minimal disturbance (shot through like a bullet) and therefore gave the impression that the it was recovered from undisturbed peat (Plate 22).

### 3.3 1940's recovery excavation (Figs. 3 - 7; Plates 1-3 & 6-10)

- 3.3.1 The original impact crater was truncated by the 1940's recovery excavation (3). This had moderately sloping sides and was 9m long and 8m wide and excavated to a depth of c. 2m. The sides of the impact crater had been straightened during the recovery making the crater into a polygon shape.
- 3.3.2 Sets of two and three horizontal planks and parts of an old door were found at various stages within the excavation. These formed a series of steps and solid work points, with a final plank lying across the base of the recovery excavation. Part of P/O Penketh's flying Helmet was found on the northern end of this plank where it had presumably been discarded during the recovery operation. Several of the sets of planks had airframe fragments placed on them, presumably as they had been pulled out of the way to allow access for the recovery team.

### 3.4 Finds Summary

#### *Spitfire*

- 3.4.1 Below is a list of the reported finds from the excavation related to X4593 (See App. B.1; Plates 15 - 25).

Aircraft Remains:	Quantity	Description
Merlin Engine (394)	1	Damaged Remains of Merlin III engine c60% (Fig 9 & 10; Plate 16 – 19)
Propeller (374)	1	2 Blades of De Havilland propeller assembly (Fig. 9 & 10; Plate 15, 18 – 19)
Cockpit materials		Various metal cable, electrical wire, metal pipe with connector. Bracket join, blue and red electrical cable.
Cockpit Instrument Panel (1142)	2	Incomplete – remains of instrument panel
Cockpit Dial (1158)	1	3 Instruments attached – Brake fluid pressure gauge (Plate 24)
Radio Frame (1134)	1	
Cockpit panel with Wedge plate attached(1131)	1	Ref 14A/540
Gunsight lense and housing (1119)	1	
Engine Plate (1087)	1	Merlin engine limitations plate
Engine Fragments	Var (lots)	Fuel Pump, cogs, gearing, frame and struts etc.
.303 Ammunition (inc standard, Tracer, HE & Phosphorus)	Var	All removed by 5131 BD Squadron to RAF Wittering to be made safe
Cockpit canopy	Var	ragments of canopy perspex various sizes and with various form and curvature
Rudder Pedal (1117)	1	Complete (Plate 23)

Metal Plate (368)	1	Bulkhead Armour
Pitot Tube (341)	1	Intact 7.5" Brass colour (Plate 22)
Leather Headrest cover (348) and form interior (347)	3	Pilots head rest contaminated with aviation fuel (Plate 20)
Starter Motor (355)	1	Fragment of Starter motor
Under carriage selector (1094)	1	under carriage selector
Oxygen bottle (367)	1	Complete oxygen bottle missing regulator etc. (Plate 21)
Cloth (382)	1	Fragments of first aid bag
Bulk material	4 x 1 tonne aggregate bags	Mix of aluminium airframe fragments, radiator piping, and unidentifiable parts to be cleaned and sorted

Table 1: Elements of Spitfire X4593 recovered

- 3.4.2 A number of the finds were recovered from within the recovery excavation and from higher up in the Impact Crater than would have been expected, indicating that these had been moved by the Recovery Crew during their attempt to recovery the remains of Pilot Officer Harold Penketh. Hence remains such as the cockpit canopy, headrest, pilots helmet, radio communications etc. were all subsequently moved from their original location following the crash and then discarded back into the crater once Harold Penketh's remains had been removed.

### **0.303 Ammunition**

- 3.4.3 A detailed catalogue and report of the identified 0.303 rounds is presented in App. B.2. The ammunition recovered from X4593 is a mix of ball, tracer and incendiary or High explosive. The majority of the ammunition is dated between 1937 and 1938 and was produced at Kynoch & Co, Witton, Birmingham, and the Royal Laboratory, Woolwich Arsenal, Kent. A single round is dated to 1940 (App B.2; Plate 25). All rounds were removed from site by 5131 BD Squadron to be made safe for display.

### **Recovery excavation finds**

- 3.4.4 Several items recovered can be attributed to the 1940 recovery excavation (App. B.1, B.3 & B.6).
- 3.4.5 A single shoulder flash of the word 'Gordons' was recovered from the area of the excavation. The shoulder flash would have been wore on both sides of the uniform of the Gordons Highlanders. Originally the Highlanders flash was 'Gordon' and the 'S' was added in 1922. The Shoulder flash was either lost during manoeuvres/training or that it belonged to the military personnel at the crash site (Plate 26).
- 3.4.6 A single brass plated button, with the legend 'Buttons Ltd. B'HAM' on the reverse, was recovered from the area (plate 28). This type of button was issued on British Army Battledress between 1937 to the early 1940s, when the metal buttons were replaced with plastic. It is likely that the button comes from the same uniform element as the shoulder flash.
- 3.4.7 Fragments of an RAF mess plate were recovered near the top of the recovery excavation (Plate 27). Although there is no clear evidence the plate may have been intentionally placed to mark the site. A fragment of a decorated saucer was also recovered. The saucer is likely to have come from a local house possibly providing a cup of tea for the recovery team.

- 3.4.8 A series of wooden planks were found placed around the edge of the rescue excavation (Fig. 3; Plate 29). Similar planks have been seen at other excavations but have never been recorded 'in-situ'.
- 3.4.9 A single red rubber glove, worn by a member of the recovery team, had been discarded within the impact crater. The glove is likely to have been imported from the USA (Plate 30).

#### **Other finds**

- 3.4.10 A series of items recovered were not related to the events in November 1940. These provide further insight into the use of the area prior to the drainage of Whittlesey mere.
- 3.4.11 A total of fifteen lead alloy (Pb) objects were recovered from or near the crash site of Spitfire X4593 (App. B.5). Eleven were found within the excavation area and four were found on the spoil heaps. All are either cast fishing weights made especially for nets or furred pieces of flat lead used as fishing tools. No attempt has been made to decorate any of these utilitarian objects. Only a broad medieval date can be given to this type of object. Fishing weights manufactured from lead have been in production from the Iron Age and were still being used well in to the post medieval period. Other weights of a similar design were found at Ramsey 8km to the south-east, these were also thought to be of a medieval date. (Cooper, S. 2005)
- 3.4.12 The excavation lies at the edge of Whittlesey Mere, which was extensively associated with fishing in the medieval period. Whittlesey Mere was drained in 1853 so the objects would date from prior to this time (Page *et al.* 1974).
- 3.4.13 A total of seventeen heavily corroded ferrous objects Iron (Fe) objects were recovered from the excavation. Fifteen were found using metal detectors in the crash site and excavation area and two were found on the spoil heaps. None of the objects found relate to the crashed aircraft. All are casual agricultural losses. Small Find 9999 (TL20950 89711) was part of a pair of pliers.
- 3.4.14 Two 0.303 rounds were recovered dated to 1895 – 1911 (App. B.2). These either relate to pre-WW1 training or are ammunition that had been acquired by a local farmer.

#### **Personal Items**

- 3.4.15 Due to the sensitive nature of the project it was not appropriate to fully report on all the personal items belonging to P/O Harold Penketh. A brief description of these finds is presented here (Plates 31 – 36).
- 3.4.16 Several fragments of clothing were recovered during the excavation. These included fragments of an RAF uniform shirt, Woollen uniform, woollen jumper, and sheep skin flying jacket. Other items of personal clothing recovered include two woollen gloves, a boot, and a pair of woollen socks.
- 3.4.17 The pilots flying helmet and communicator was also recovered from the excavation in good condition (Plates 31 & 32). Part of it was found on the end of one of the planks used by the recovery team (Plate 6 & 7). The second fragment was found in the area of the engine with the flying goggles. Some of the lens glass was still attached to the goggles.
- 3.4.18 A single shirt cuff link was recovered from the uniform fragment (Plate 33). The cuff link was alloy plated and had a stylised zig-zag pattern on the outer surface. The Cuff link had five strands of rubberised thread coming out of the back to attach it to the other side (Plate 33).

- 
- 3.4.19 A silver cigarette case engraved with the initials HEP was recovered from the excavation area (Plate 34). The case was bent and therefore could not be opened.
- 3.4.20 A single rectangular faced Swiss made watch was recovered from the excavation near to the engine. No makers mark was present. The watch face has marks suggesting the watch stopped at around 2.23 or 2.24, which corresponds with the operational reports that state the plane crashed at 14.20hrs (Plate 35).
- 3.4.21 A single nail file was also recovered from the excavation (Plate 36). Although a makers mark is present it was not legible.

### **3.5 Environmental Summary**

No environmental samples were taken due to the nature of the excavation and the concerns about hydro-carbon contamination.

## 4 DISCUSSION AND CONCLUSIONS

### 4.1 Crash and recovery

- 4.1.1 The archaeological excavation of the crash site of Spitfire X4593 has allowed a partial reconstruction of the tragic events on and immediately after the 22nd November 1940. From the known operation reports, at c. 14.20hrs P/O Penketh broke formation in a battle climb to 28,000 feet (App. G). His aircraft entered a spiralling dive and plummeted towards the ground. During this dive it is suggested that he attempted to regain control, although it is unclear if he did. It may be that the reported response was caused by an uplift effect. As the plane approached the ground lift is created by different air pressures which can change the angle of descent. The plane, which would have been travelling at least 400mph impacted into the soft peat deposits just outside Holme village, Cambridgeshire.
- 4.1.2 The archaeological evidence at the crash site suggests that the plane hit the ground starboard (right) wing down from the south-west of the impact crater. The plane is likely to have impacted at a slight angle rather than in a completely vertical dive, as demonstrated by the position and angle of the Pitot tube, just outside the impact crater. During the impact one of the propeller blades seems to have broken off and may have flown quite a distance, and was not recovered during the archaeological excavation. The plane drove through the overlying peat deposits and into the harder Oxford clay. The wings would have broken up behind the fuselage as it crashed into the ground. The propeller was lodged into the Oxford clay (at a depth of -6.14m OD; Fig. 7 & 8). This would have impeded the rotation of the propeller and must have caused the plane to counter rotate as the throttle is believed to have been fully open, although this could not be proven. The engine and fuselage would have rotated at speed in a clockwise direction ripping it away from the propeller and driving it into its final resting place (at -6.27m OD). The stresses applied to the engine can be seen by the damage to the crank case, cylinder head and cylinders which had partially exploded. As the engine was moving within the impact crater, the rest of the fuselage crumpled in, pushing parts of the cockpit into/onto the spinning engine and wrapping them around it.
- 4.1.3 A notable discovery was that the watch face of Harold Penketh's wrist watch, recovered from the site, suggests that the operational report that the plane had crashed at around 14.20hrs is correct. As it seems to be displaying a time of 14.23 or 14.24hrs.
- 4.1.4 After the crash an attempt to recover the remains of P/O Penketh from the wreckage of the aircraft was carried out. It is unclear who would have been involved with the recovery in 1940 and the individuals involved may not have been military personnel. It is thought that a team from RAF Wittering would be the most probable source of the recovery crew. The recovery operation, which lasted a week, altered the impact crater to allow the recovery crew access down to the aircraft, at a reported depth of c.25 foot (App. G). The recovery team had hand dug down to a depth of -5.00m OD in poor weather, in the impact crater filled with aviation fuel, hydraulic fluid, oils, other contaminants, and ground water. The remains of the wings, 0.303 guns, and most of the 0.303 ammunition seem to have been removed during this time to facilitate access to the cockpit area of the fuselage. During the 2015 archaeological investigation around 250 rounds of ammunition, out of the 1200 round load carried by a Spitfire Mk Ia was recovered and none of machine guns were found (they were presumably removed along with the wings).

- 4.1.5 The archaeological excavation also found a series of sets of wooden planks that were used to create work platforms at various locations and depths within the impact crater placed there by the recovery team. This is the first time the use of planks has been recorded, previous archaeological aviation excavations have revealed similar structures but these were not recorded (Peter Stanley pers. comm.). Anecdotal and documented evidence states that late November 1940 was very wet, and as a result of this the ground conditions were very poor, with the trench filling with water (Johnson 1941). Fragments of the airframe were found along with part of the pilots helmet (Plate 22) discarded on the planks, where they had been left by the recovery team in November 1940. As the recovery team got near to the cockpit area, and the remains of P/O Penketh, a single plank was braced across the impact crater to provide a stable working platform to recover his body. Half of his flying helmet was found discarded at the end of this plank.
- 4.1.6 Members of the Gordons Highlander regiment may have been involved with the recovery as the shoulder flash and dished button, produced by 'Buttons Ltd.', come from a post 1937 uniform. Although these items may come from manoeuvres or training of the Gordons Highlanders prior to them shipping out as part of the 1939 Expeditionary Force.
- 4.1.7 Once the body of P/O Penketh had been recovered from the deep waterlogged impact crater it was backfilled with the surrounding spoil and discarded fragments of the aircraft that were not worth recovering. Along side these fragments of aircraft and wooden planks a fragment of a broken RAF mess plate (Plate 27) was placed at the centre of the crater. Whether this was an intentional marker, or a causally discarded plate broken during the recovery is unclear. However, the plates location would suggest it had been placed as an intentional marker and this is the interpretation of the excavators. The recovery of a similar plate from a different investigation, seen at The Wisbech Aviation Museum, would add support to its use as an intentional marker by the recovery team (David Brown pers. comm.).
- 4.1.8 Due to the damage and limited recovery of the oxygen system there is no evidence to indicate that failure of the oxygen system was the cause of the accident, although as per the operational reports of the time the crash is still thought to have been caused by either oxygen failure or pilot failure.

## 4.2 Significance

- 4.2.1 The project involved the archaeology of a historic catastrophe which occurred during World War 2. The excavation was carried out just under 75 years after the event. However, the use of modern archaeological techniques has helped to demonstrate their potential to improve the understanding, and discover the story of a WWII military aircraft crash site. The crash site itself has little significance to the archaeological record, it did not have a huge impact on the landscape, only a few were influenced and involved with the crash and its aftermath. At the time pilots were regularly killed in training and combat operations. However, the work carried out to improve aviation excavation methodology, the recovery of the remains of P/O Penketh and the untold story of the herculean efforts to recover P/O Penketh in 1940, have dramatically increased the archaeological significance of the crash and subsequent recovery.
- 4.2.2 The understanding of the events of the 22nd November has allowed closure for the family and several of the witnesses. It provided an opportunity to finally recover all the remains of P/O Penketh and has allowed for these remains to be treated with the



respect they deserve re-uniting them with the previously recovered remains, concluding the story of a young man was prepared to fight and die for his country.

- 4.2.3 The excavation has significant implications for the recovery of historic air-crash sites. Archaeological techniques have been used to understand and tell the story of the events of November 22nd 1940 and the recovery. Most previous aviation excavations of this type have not been recorded in a modern archaeological framework. The focus from the aviation crash site investigators has often largely been targeted on the recovery of the aircraft, rather than understanding the story of the crash and the site itself.

### 4.3 Critique

- 4.3.1 The following section will critique the archaeological excavation. What was successful and what was not, to develop ideas about how an integrated modern archaeological framework can be used to excavate aviation crash sites, such as that of Spitfire X4593, to improve the recording and understanding of historic air-crash sites and provide data and information for a subsequent air-crash investigation If possible. Helping to develop an improved narrative within a gradually diminishing resource and assist in concluding the stories of the young air-crews killed in military conflict.

#### ***Geophysical and metal detector survey.***

- 4.3.2 Had it not been for the pre-excavation non-intrusive surveys, carried out by Cranfield University (Peter Masters) and volunteers from the Great Fen Jigsaw group, it would not of been possible to accurately pinpoint the location of the crash site. Eye witness accounts at the time placed it further to the north-west and the recorded location was c.60m north-east of the actual impact crater. Without the metal detector survey, which identified the scatter of debris from the impact, the geophysical survey would of taken significantly longer to locate the engine block. This multi-disciplinary approach to identify the crash site enabled Oxford Archaeology East, and its partners, to produce good accurate data in a short period of time, maximising the information recovered in the time period available.

#### ***Machine excavation***

- 4.3.3 During the archaeological investigations there was a reliance on using a mechanical excavator to do the majority of the work. Generally archaeological practice would consider hand digging the most favourable methodology to recover as much information as possible. 'Aviation archaeology' is reliant on using a mechanical excavator to rapidly reduce the site to recover the engine. With an impact crater in the region of 9m by 8m in plan and -7.29m OD deep, hand excavation was impractical in terms of the numbers of individuals and the time impact it would have. It would not have been possible to hand excavate the base of the crater at 5m+ deep as it would not have been safe at lower depths. Balancing the use of a mechanical excavator with hand excavation techniques and metal detecting the spoil allowed the project to carry on without losing significant amounts of information. The location of material in the modified and unmodified crater was recorded during the works as best as possible. The successful hybrid excavation methodology that was developed for the project involving controlled stripping by machine assisted with hand digging to recover fragments of the crash was a compromise aimed at balancing the need for speed against the recovery of information and artefacts.

- 4.3.4 Although not originally planned for, as with previous aviation excavations, the original plan was to place the spoil near to the crater, the removal of the spoil by tractor and trailer was a good method brought through from standard modern archaeological practice. It kept the excavation area clear of loose spoil and allowed it to be safely metal detected. However, the hap hazard spoil management led to problems in backfilling the excavation. Spoil management strategies should be carefully considered during this sort of excavation (where the size of the trench resulted in large amounts of spoil) with designated routes and clearly designated zones for dumping material in a systematic way.
- 4.3.5 Consideration of the health and safety of the excavation, based on the principle that it could be a deep and potentially very wet trench, led to stepping the sides to avoid creating dangerous deep sections and mitigate against potential section collapse. Although, during the work this was largely well handled, due to a lack of space near the base of the excavation, it was not possible to safely hand excavate in the area of P/O Penketh's remains. In hindsight the original excavation area, which was determined after the initial stripping of the topsoil closely targeted the impact crater, could have been made at least 2-3 metres wider, as this would have provided sufficient space to be able to safely excavate the remains by hand lower down the trench.
- 4.3.6 The large width of the trench (20m x 20m) at the top led to a well ventilated area and this mitigated against the potential impact from fuel fumes when the engine was discovered.

#### ***Data recovery***

- 4.3.7 The excavation was aimed at recovering as much data as possible to assist with understanding the story of P/O Penketh and Spitfire Mk1a X4593. The methodology chosen to record the excavation was primarily through electronic means; digital photographs, photogrammetry, and the use of DGPS. This was supported by sketch plans and contexts sheets, along with a detailed finds register. The cleaning and recording of the recovered elements on site allowed a fast turn around on the finds and enabled the aviation specialists Peter Stanley, Jeff Carless, Steve Visard, and Bas Coolen to qualitatively sort the recovered material and provide on the spot identification of the finds. In normal archaeological practice all the 'finds' would have been taken for archive storage. This was impractical with large fragments of airframe. Due to the lack of archaeological/historical value, as many Spitfires survive in considerably better condition, the majority of the material will be scrapped, with permission of the Ministry of Defence. Without assistance from the aviation enthusiasts (experienced crash-site investigators) the segregation of material worth keeping and that to be scrapped would not have been possible.
- 4.3.8 It became apparent that the levels of recording used on this project have allowed for a better picture to be built up about the crash and recovery. Although, planks have previously been found at crash sites they had not been recorded 'in-situ'. The excavation of X4593 has demonstrated that significant amounts of information beyond the aircraft itself can be recovered. The investigation of the crash-site of X4593 has clearly shown us details about the angle of impact and subsequent disintegration of the plane. The archaeological investigation has revealed much effort the 1940 recovery team were willing to go through to reclaim the lost pilot. It is unlikely that this information would have been recorded, or as well understood, had the excavation been solely aimed at the recovery of the aircraft alone.

#### ***Photogrammetry***

- 4.3.9 As this was a new technique that had not been carried out in this situation several points have come to light that need to be addressed if used in other similar excavations.
- 4.3.10 A lack of image quality due to poor light levels within the crater meant that further images should have been taken, although this was partially mitigated as elements could be photographed later. Finally the processing time was considerably longer than expected and had to be carried out using a dedicated graphics PC.

***Human remains (with Dr. Louise Loe)***

- 4.3.11 Several issues arose from the recovery of P/O Penketh. These are listed below:-
- Due to the state of preservation and recent date of the remains, different legislation, than would normally be encountered during archaeological works, was required and relevant to this project. Although this particular issue is directly related to the burial conditions.
  - Due to the impact trauma, and the need to machine excavate due to the unsafe conditions, the remains were fleshed and highly fragmented.
  - Guidance from JCCC was sufficient in terms of instruction to approach the police and follow through official channels to Coroner. Advice was at the time considered slightly less helpful than what was required but as this was surprisingly only second time human remains have been uncovered in an air crash recovery excavation of this type (Raftree pers. Comm.), it was understandable. The Coroner was also in an equally difficult position and had little reference to deal with situation (this is worth noting for future projects, the local Coroner would not necessarily be aware of how they should react). A clear benefit that a large professional archaeological organisation such as Oxford Archaeology (who has its own Burials Section) were excavating the remains, meant it was possible to deal with them correctly. This was in part due to OA's professional reputation and links with other Institutions who could fulfil the legal requirements such as storage of the remains. Allowing us to safely and sensitively deal with the remains in a way the Coroner felt suitable. Amateur/Volunteer groups would not be able to provide this level of coverage and professionalism. The fact that Oxford Archaeology was under taking the excavation assisted the Coroners decision (See also Sections 4.3.14 – 4.3.15).
  - Finally two questions arise from the experience of excavating the remains of P/O Penketh. Are Human Remains found more often during these sorts of excavations by the amateur aviation enthusiasts? Should licenses to sites that the aircrew were killed in be restricted to professional organisations who would be in a position to deal with the recovery of Human Remains?

***Impact of media***

- 4.3.12 As expected the excavation of a Spitfire that fought in the Battle of Britain at the time of the 75th anniversary was heavily covered in the media. Both due to the use of social media such as Facebook and Twitter, more conventional forms of news such as ITN and BBC news programmes and BBC local and national radio stations. The impact this had on the excavation was well handled, even with the discovery of remains belonging P/O Penketh. The careful management of the news outlets was well controlled by all parties, although lessons can always be learned. It was felt that potentially better controls might be put in place should a project of this scale and public interest were to be repeated. This should include controls placed on where and what routes the media

are allowed to use. Several potential near misses occurred as media parties used unsuitable routes to access the excavation area.

- 4.3.13 The use of social media during this excavation was a great success as was of benefit for all of the parties involved.

#### ***JCCC Guidance and support***

- 4.3.14 Although the discovery of human remains was not entirely unexpected, this possibility had been included in the terms of the license issued by the JCCC and in the devised excavation methodologies (Macaulay 2015). The issued license stated that on the discovery of human remains to contact the JCCC and they would give procedural guidance. On finding the remains of P/O Penketh the JCCC were informed by telephone and asked Oxford Archaeology East to contact the Police and local Coroner.
- 4.3.15 The Police arrived on site and proceeded to inform the Coroner who made a decision that the work could continue. Due to the professional reputation and contacts of Oxford Archaeology it was a simple and straightforward decision for the Coroner to make and was done so within a few hours of the discovery of the human remains. Had it been an amateur group carrying out the work, or indeed a smaller sized professional archaeological organisation, without its own dedicated Burials Team, it is unclear how the Coroner would of responded to the situation.
- 4.3.16 Due to the nature of the remains they were covered by both the 2004 Human Tissue Act and the 1998 Protection of Military Remains act, both are not normally applicable during standard archaeological investigations. The presence of Dr. Louise Loe and Dr. Nicholas Marquez-Grant on site allowed the site staff to deal with the remains within the law. It is suggested that clearer guidance is provided by the JCCC of the legalities of recovering human remains from crash sites, potentially included as part of the license. Although this excavation was abnormal as the JCCC stated that they know of only two instances of reported human remains recovered from a crash site (Raftree pers. comm.). With hindsight clearer guidance would assist in dealing with similar situations. Furthermore it is suggested that careful consideration of licensing of air-crash sites with reported fatalities should be restricted to groups with professional archaeological support.
- 4.3.17 As part of the recovery, Oxford Archaeology was required to inform the JCCC of all remains found within the crash site. It was unclear how much detail should be included and perhaps a section on recording these elements should be incorporated into the Historic England guidance on military crash site excavations.
- 4.3.18 Standards for the excavation, recording, storage and archiving of air-crash sites and material recovered should be developed by archaeologists and Historic England for the Ministry of Defence and the JCCC.

## **4.4 Recommendations**

### ***Excavation strategy and Guidance***

- 4.4.1 This projects represents one of the first times a professional archaeological organisation (in this instance Oxford Archaeology) has undertaken the excavation of a crashed aircraft. The methods and techniques used and reviewed allow for the first time a critical analysis of how to excavate, record and understand an air crash site. It is clear that much information would have been lost, had more conventional aircrash recovery techniques been employed.

- 4.4.2 Identifying and mapping the impact crater, through a multidisciplinary approach using both metal detector survey and geophysical survey allowed the identification of the exact location of the crash site. The combined approach allowed identification of the site within the first day of survey. The use of archaeological magnetometry, which records the data and presents it in a visual form, as opposed to the more commonly used bomb disposal magnetometer, also had a positive impact on the information gained about the size and shape of the impact crater and provided a solid area to target the excavation on.
- 4.4.3 Oxford Archaeology would normally use hand digging techniques to gain the maximum amount of information. However, these techniques, would not have been practicable, both in terms of the excavation conditions and significantly due to health and safety concerns. A hybrid methodology was specifically developed for the Spitfire excavation combining the best elements of traditional archaeology and 'aviation archaeology' allowing rapid excavation but significantly improving on the data recovery should be considered as best practice within this specialised field.
- 4.4.4 It is also recommended that guidance on the reporting of recovered material be produced either as part of the JCCC license or through an updated Historic England Military Air Crash guidance.

#### ***Human remains***

- 4.4.5 Due to the difficult circumstances of finding human remains within the crash site. It is recommended that guidance and support are issued on how to deal with the situation should human remains be found in a similar excavations. Oxford Archaeology took the lead in dealing with the remains, both archaeologically but also in assisting the Coroner to the decision he made.
- 4.4.6 Archaeological excavation methods allow for a more focused approach to the site investigation to ensure the necessary recording and a better/fuller understanding of the sequence of events being considered. This also allows for procedures to be in place to tackle unexpected consequences. Had the excavation been carried out by an amateur aviation group it may have been difficult for them to progress the excavation.

#### ***Contamination***

- 4.4.7 The crash site was contaminated by hydro-carbons although not so significantly that it affected the excavation strategy. However, some of the finds taken back to be cleaned were heavily contaminated. In some cases these were stored in enclosed spaces and therefore increased the risk. It is therefore recommended that contaminated finds are initially cleaned in either a well ventilated space or under portable extraction units.

### **4.5 Conclusions**

- 4.5.1 The methodologies used by Oxford Archaeology to excavate the crash site provide a good example to develop a more involved and detailed guidance for the ideal recovery methodology of air-crash sites. The combined use of archaeological hand excavation and machine excavation under constant supervision provided a good balance between speed and the precision required for good recording and data recovery. The use of a modern archaeological approach to recording using GPS and photogrammetry has allowed Oxford Archaeology to re-create the crash site within a 3d computer generated model and provides an accurate model of the site that has now been lost to the archaeological record.

## APPENDIX A. TRENCH DESCRIPTIONS AND CONTEXT INVENTORY

Excavation Area							
General description					Orientation		N/A
Trench devoid of archaeology. Consists of soil and subsoil overlying a natural of silty sand.					Avg. depth (m)		0.44
					Width (m)		20m
					Length (m)		20m
Contexts							
context no	type	width (m)	depth (m)	comment	finds	date	
1	Cut			Impact crater		November 22nd 1940	
2	Fill			Fill of impact crater 1	Spitfire Mk1a parts, HR, personal effects and clothing, 0.303 ammunition	November 22nd 1940	
3	Cut			Rescue excavation		November 22nd onwards 1940	
4	Fill			Fill of rescue excavation 3	Spitfire Mk1a parts, RAF plate, Gordons Shoulder flash, 0.303 ammunition	November 22nd onwards 1940	

## APPENDIX B. FINDS REPORTS

### B.1 Finds Catalogue

**Ministry of Defence**  
**Report of Items Removed under Licence from Aircraft Crash Site**  
**In accordance with**  
**The Protection of Military Remains Act 1986**

**Licensee's Name: STEPHEN MACAULAY**

Address: Oxford Archaeology East Representing Group (if any):  
 15 Trafalgar Way, Bar Hill, Cambridge, CB23 8SQ

.....  
 Email: stephen.macaulay@oxfordarch.co.uk

Telephone: (01223) 850554 (direct) or 07766780532 (mobile)

Licence No	Aircraft Type	Aircraft Serial No	Date of Crash	Location (Grid Ref)
1804	Mark 1A Spitfire	X4593	22/11/1940	TL (5)20967 (2)89614

Did the Recovery take Place?

**Yes**

If YES, the date

**5/10/15-10/5/15**

Was anything removed from the crash site?

**Yes**

**If YES, please list below:**

ITEMS	Qty	REMARKS
Post Medieval Pottery	1	Stray find not relevant to Crash
Medieval Lead (Pb) Fishing Weights	4	Stray find not relevant to Crash
White Ceramic China Plate	1	RAF logo on plate (broken) placed in crash crater by recovery crew in November 1940
Metal Clothing fragment	1	Gordon's Highlander Shoulder Flash possibly left by recovery crew in November 1940
Brass Button	1	Marked B'Ham
Red Rubber Glove	1	Workers glove poss. left by recovery crew
<b>Personal Effects</b>		<b>Harold Penkeths personal items</b>
Watch & Strap	2	Damaged case and watch face
Cigarette Case (silver or silver plate)	1	Engraved with Pilot Officers Initials HEP
Nail File	1	Personal Effect of Harold Penketh
Cuff-link	1	Single cuff-link from Uniform shirt sleeve
Leather Flying Helmet	20	Broken but fairly complete Pilots Flying helmet includes communicators and most of goggles

(Carry details forward to Continuation Sheet if required)

**PLEASE TURN TO NEXT PAGE FOR SIGNATURE**



**Ministry of Defence**  
**Report of Items Removed under Licence from Aircraft Crash Site**  
**In accordance with**  
**The Protection of Military Remains Act 1986**  
*(Continuation Sheet)*

ITEMS	Qty	REMARKS
<b>Aircraft Remains:</b>		<b>Remains of Spitfire X4593</b>
Merlin Engine (394)	1	Damaged Remains of Merlin III engine c60%
Propeller (374)	1	2 Blades of De Havilland propeller assembly
Cockpit materials	Var	Metal cable, electrical wire, metal pipe with connector. Bracket join, blue and red electrical cable.
Cockpit Instrument Panel (1142)	2	Incomplete – remains of instrument panel
Cockpit Dial (1158)	1	3 Instruments attached
Radio Frame (1134)	1	
Cockpit panel with Wedge plate attached(1131)	1	Ref 14A/540
Gunsight lense and housing (1119)	1	
Engine Plate (1087)	1	Merlin engine limitations plate
Engine Fragments	Var (lots)	Fuel Pump, cogs, gearing, frame and struts etc.
.303 Ammunition (inc standard, Tracer, HE & Phosphorus)	Var	All removed by 5131 BD Squadron to RAF Wittering to be made safe
Cockpit canopy	Var	fragments of canopy perspex various sizes and with various form and curvature
Rudder Pedal (1117)	1	complete
Metal Plate (368)	1	Bulkhead Armour
Pitot Tube (341)	1	Intact 7.5” Brass colour
Leather Headrest cover (348) and form interior (347)	3	Pilots head rest contaminated with aviation fuel
Under carriage selector (1094)1under carriage selector		
Oxygen bottle (367)	1	Complete oxygen bottle missing regulator etc.
Cloth (382)	1	Fragments of first aid bag
Bulk material	4 x 1 tonne aggregat e bags	Mix of aluminium airframe fragments, radiator piping, and unidentifiable parts to be cleaned and sorted

*Stefan Macaulay*

**Signed:**..... **Dated: 26/10/15**

**Please also write name in Block Capitals: STEPHEN MACAULAY**

**To be returned to:**

Defence Business Services, Joint Casualty & Compassionate Centre  
(Commemorations & Licensing), Innsworth House, Imjin Barracks, Gloucester GL3 1HW.

## B.2 0.303 Ammunition

*By Sgt. Paul Turner and Sgt. Richard Percival*

- B.2.1 None of the 8 Browning 303 machine guns were found intact. Although region of c.250 rounds of 0.303 ammunition were recovered. These had been manufactured by 2 companies, Kynoch & Co., Witton, Birmingham and Royal Laboratory, Woolwich Arsenal, Kent.
- B.2.2 They were split into three types:-
- Ball
  - Tracer
  - Incendiary/ High explosive (Hi-Ex)
- B.2.3 Ball were identified by the copper heads, tracer by the silver head and the Hi-Ex were identified by the fact that the heads had a screw base (at least eight of this type of head were found).
- B.2.4 The years of manufacture were mainly 1937-38 with the exception of one round being dated 1940
- B.2.5 Two other cases were found dated pre WW1 (1895-1911). It is suspected that the area may have been used a training area either pre WW1 or during WW1. Although the rounds could potentially come from another source such as a local farmer.
- B.2.6 The rounds were in various states of preservation from burnt corroded to intact and in nearly mint condition. Many of the rounds were damaged due to cook off i.e exploding when the ammunition in the plane was caught up in the fire/explosion that followed the crash. Most of the rounds found were in singles, although, in the crater several rounds were clustered together and in one case a belt of 20+ rounds was found all in excellent condition.
- B.2.7 The majority of the rounds were found in the spoil by the detectorists. The rounds found in the crater were found with the remains of the ammo box lining showing signs of where the cooking off rounds pierced the metal.

Photo No.	Type	Date	Photographer	Manufacture Mark
PA080002	Ball	08/10/2015	Sgt Turner Op/N	RL 1938 MK7
PA080003	Ball	08/10/2015	Sgt Turner Op/N	RL 1938 MK7
PA080004	Tracer	08/10/2015	Sgt Turner Op/N	K 1937 MK7
PA080005	Tracer	08/10/2015	Sgt Turner Op/N	K 1937 MK7
PA080006	Tracer	08/10/2015	Sgt Turner Op/N	K 1937 MK7
PA080007	Ball	08/10/2015	Sgt Turner Op/N	RL 1937 MK7
PA080008	Ball	08/10/2015	Sgt Turner Op/N	RL 1937 MK7
PA080009	Ball	08/10/2015	Sgt Turner Op/N	K 1939 MK 7
PA080010	Ball	08/10/2015	Sgt Turner Op/N	K 1939 MK 7
PA080011	Ball	08/10/2015	Sgt Turner Op/N	RL 1937 MK7 X 3 / K MK 7 x 1
PA080012	Ball	08/10/2015	Sgt Turner Op/N	RL 1937 MK7 X 3 / K MK 7 x 1
PA080013	Ball	08/10/2015	Sgt Turner Op/N	RL 1938 MK7
PA080014	Ball	08/10/2015	Sgt Turner Op/N	RL 1938 MK7
PA080015	Cupro-Nickel	08/10/2015	Sgt Turner Op/N	.303 Head
PA080016	Tracer	08/10/2015	Sgt Turner Op/N	RL 1937 MK7
PA080017	Tracer	08/10/2015	Sgt Turner Op/N	RL 1937 MK7
PA080018	Ball	08/10/2015	Sgt Turner Op/N	RL 1937 MK7
PA080019	Ball	08/10/2015	Sgt Turner Op/N	RL 1937 MK7
PA080020	Ball	08/10/2015	Sgt Turner Op/N	.303 Shell exposing Cordite
PA080021	Ball	08/10/2015	Sgt Turner Op/N	.303 Shell exposing Cordite
PA080022	Ball	08/10/2015	Sgt Turner Op/N	.303 Shell exposing Cordite
PA080023	Ball	08/10/2015	Sgt Turner Op/N	RL 1937 MK7 Shell exposing Cordite
PA080024	Ball	08/10/2015	Sgt Turner Op/N	RL 1937 MK7 Shell exposing Cordite
PA080025	Ball	08/10/2015	Sgt Turner Op/N	RL 1937 MK7 Shell exposing Cordite
PA080026	Ball	08/10/2015	Sgt Turner Op/N	Clip / 1 x RL 1937 MK 7 / 2 Unknown
PA080027	Ball	08/10/2015	Sgt Turner Op/N	Clip / 1 x RL 1937 MK 7 / 2 Unknown
PA080028	Ball	08/10/2015	Sgt Turner Op/N	Clip / 1 x RL 1937 MK 7 / 2 Unknown
PA080029	Tracer	08/10/2015	Sgt Turner Op/N	Clip / 1 x RL 1937 MK 7 / 1 Unknown
PA080030	Tracer	08/10/2015	Sgt Turner Op/N	Clip / 1 x RL 1937 MK 7 / 1 Unknown
PA080031	Tracer	08/10/2015	Sgt Turner Op/N	Clip / 1 x RL 1937 MK 7 / 1 Unknown
PA080032	Incendiary / Smoke	08/10/2015	Sgt Turner Op/N	Clip / 2 Unknown exposing nitrocellulose powder
PA080033	Incendiary / Smoke	08/10/2015	Sgt Turner Op/N	Clip / 2 Unknown exposing nitrocellulose powder
PA080034	Incendiary / Smoke	08/10/2015	Sgt Turner Op/N	Clip / 2 Unknown exposing nitrocellulose powder
PA080035	Ball	08/10/2015	Sgt Turner Op/N	Unknown MK7 Shell exposing Cordite
PA080036	Ball	08/10/2015	Sgt Turner Op/N	Unknown MK7 Shell exposing Cordite
PA080037	Unknown	08/10/2015	Sgt Turner Op/N	Clip / 2 Unknown
PA080038	Unknown	08/10/2015	Sgt Turner Op/N	Clip / 2 Unknown
PA080039	Unknown	08/10/2015	Sgt Turner Op/N	Clip / 2 Unknown
PA080040	Ball	08/10/2015	Sgt Turner Op/N	Damaged K 1938 MK 7

Photo No.	Type	Date	Photographer	Manufacture Mark
PA080041	Ball	08/10/2015	Sgt Turner Op/N	Damaged K 1938 MK 7
PA080042	Ball	08/10/2015	Sgt Turner Op/N	RL 1937 MK7
PA080043	Ball	08/10/2015	Sgt Turner Op/N	RL 1937 MK7
PA080044	Ball	08/10/2015	Sgt Turner Op/N	RL 1937 MK7 exposing Cordite
PA080045	Ball	08/10/2015	Sgt Turner Op/N	RL 1937 MK7 exposing Cordite
PA080046	Ball	08/10/2015	Sgt Turner Op/N	RL 1937 MK7 exposing Cordite
PA080047	Ball	08/10/2015	Sgt Turner Op/N	RL 1937 MK7 exposing Cordite
PA080048	Ball	08/10/2015	Sgt Turner Op/N	RL 1937 MK7 exposing Cordite
PA080049	Ball	08/10/2015	Sgt Turner Op/N	RL 1937 MK7 exposing Cordite
PA080050	Incendiary / Smoke	08/10/2015	Sgt Turner Op/N	RL 1940 MK 6 B Z
PA080051	Incendiary / Smoke	08/10/2015	Sgt Turner Op/N	RL 1940 MK 6 B Z
PA080052	Ball	08/10/2015	Sgt Turner Op/N	RL 1937 MK7
PA080053	Ball	08/10/2015	Sgt Turner Op/N	RL 1937 MK7
PA080054	Ball	08/10/2015	Sgt Turner Op/N	K 1938 MK7
PA080055	Ball	08/10/2015	Sgt Turner Op/N	K 1938 MK7
PA080056	Ball	08/10/2015	Sgt Turner Op/N	RL 1937 MK7 / Damaged
PA080057	Ball	08/10/2015	Sgt Turner Op/N	RL 1937 MK7 / Damaged
PA080058	Ball	08/10/2015	Sgt Turner Op/N	RL 1937 MK7 / Damaged
PA080059	Ball	08/10/2015	Sgt Turner Op/N	.303 Shell exposing Cordite
PA080060	Ball	08/10/2015	Sgt Turner Op/N	.303 Shell exposing Cordite
PA080061	Ball	08/10/2015	Sgt Turner Op/N	K 1938 MK7
PA080062	Ball	08/10/2015	Sgt Turner Op/N	K 1938 MK7
PA080065	Mixed	08/10/2015	Sgt Turner Op/N	40 x .303 Mixed / Damaged
PA080066	Mixed	08/10/2015	Sgt Turner Op/N	20 x .303 Damaged exposing Cordite
PA090001	Mixed	08/10/2015	Sgt Turner Op/N	Link .303 Mixed / Damaged
PA090002	Mixed	08/10/2015	Sgt Turner Op/N	Link .303 Mixed / Damaged
PA090003	Mixed	08/10/2015	Sgt Turner Op/N	Link .303 Mixed / Damaged
PA090004	Mixed	08/10/2015	Sgt Turner Op/N	Link .303 Mixed / Damaged
PA090005	Mixed	08/10/2015	Sgt Turner Op/N	Link .303 Mixed / Damaged
PA090006	Mixed	08/10/2015	Sgt Turner Op/N	Link .303 Mixed / Damaged RL 1937 MK 7 x 1
PA090007	Mixed	08/10/2015	Sgt Turner Op/N	Link .303 Mixed / Damaged K 1937 MK 7 x 1
PA090008	Mixed	08/10/2015	Sgt Turner Op/N	Link .303 Mixed / Damaged

Table 2: 0.303 ammunition photographic catalogue

### B.3 Cu alloy objects (Plate 26 and 28)

*By James Fairbairn and Anthony Haskins*

- B.3.1 A Copper alloy shoulder title of the Gordon Highlander regiment was found by metal detector within the spoil removed during the excavation to the recover the remains of Spitfire X4593. The regiment was formed in 1881 by the amalgamation of the 75th (Stirlingshire) Regiment of foot with the 92nd (Gordon Highlanders) Regiment of Foot. The object measures 45mm x 11m and is made from curved cast copper alloy with a pierced legend. Two fixing loops that would have been attached to the rear are missing. The shoulder title would have been present on both sides of the uniform jacket.
- B.3.2 The example found at the site dates from post 1920 as earlier pieces dating to the first world war were manufactured without the "S" on the end of Gordon. It has been suggested that during preparations for WWII the area close to the crash site was used for military exercises involving the Gordon Highlanders. This makes it a possibility that the example found during the excavation could have either been a casual loss from a member of the regiment on exercise or a member of the soldiers guarding the crash site.
- B.3.3 A single small dished brass button with four holes and 'Buttons Ltd. B'HAM' stamped on reverse was also found. The button is part of British Army Battle dress and is dated to 1937 – early 1940. It is likely the button relates to the same item of clothing as the shoulder flash.

#### **Small find 293**

- B.3.4 Shoulder title. Cast copper alloy, Uniform attachment. Patinated overall. Date: Modern. Length 45mm: Width: 11m. Thickness 2.5mm, Weight: 3.2gms.

#### **Small find 1057**

- B.3.5 Button. Cast Copper alloy, British Battle dress, some patination. Date: Modern (1937 - 1940) Diameter 17.27mm: Thickness 2.79mm: Weight: 2g

## B.4 Iron (Fe) Objects

*By James Fairbairn*

- B.4.1 A total of seventeen heavily corroded ferrous objects Iron (Fe) objects were recovered from or near the crash site of spitfire X4593. Fifteen were found using metal detectors during a scan of the crash site and excavation area and two were found on the spoil heaps. None of the objects found are thought to relate to the crashed aircraft. All are either casual agricultural losses or in the case of SF 9999 (TL20950 89711) a constitution part of a pair of pliers.

Small find No	Material	Height/Length mm	Width mm	Diamm m	Weight ms	Date	Metal Detected	Comments	Co-ordinates
3	Fe	44	4		20	Post medieval	yes	Fragment	TL20971 89580
7	Fe		1	8	0.2	Post medieval	yes	Nail head	TL20947 89568
23	Fe		7	16.5	4	Post medieval	yes	Fragment	TL20946 89570
27	Fe	103	9		48	Post medieval	yes	Harrow spike	TL20958 89650
28	Fe	29	8.5		14	Post medieval	yes	Fragment	TL20948 89618
29	Fe	40.5	4		9	Post medieval	yes	Staple	TL20957 89628
31	Fe	92	11		45	Post medieval	yes	Harrow spike	TL20954 89611
39	Fe	46	22		36	Post medieval	yes	Fragment	TL20975 89606
45	Fe	85.5	9		37	Post medieval	yes	Nail/ Agricultural pin	TL20947 89602
65	Fe	51	4.1		6	Post medieval	yes	Nail	TL20983 89577
69	Fe	33	5		7	Post medieval	yes	Large nail head	TL20967 89591
72	Fe	34	6		6	Post medieval	yes	Nail	TL20961 89588
75	Fe	30	1		2	Post medieval	yes	Nail	TL20971 89582
78	Fe		11	20		Post medieval	yes	Nut	TL20986 89579
121	Fe	21	21		18	Post medieval	yes	Staple	TL20958 89626
9999	Fe	83	10		44	Post medieval	no	Fragment of loop	TL20948 89716
9999	Fe	151	10		85	Post medieval	no	Broken pliers	TL20950 89711

Table 3: Iron (Fe) objects Catalogue

## B.5 Lead (Pb) Objects

*By James Fairbairn*

- B.5.1 A total of fifteen lead alloy (Pb) objects were recovered from or near the crash site of spitfire X4593. four were found using metal detectors. Eleven were found during a scan of the excavation area and four were found on the spoil heaps. All seem to be associated with fishing and are either cast weights made especially for nets or furred pieces of flat led that have a secondary use as a fishing tool. No attempt has been made to decorate any of these utilitarian objects. Only a broad medieval date can be given to this type of object. Fishing weights manufactured from lead have been in production from the Iron Age and were still being used well in to the post medieval period. Others of a similar design were found at Ramsey 8km to the southeast, these were also thought to be of a medieval date. (Cooper,S. 2005)

- B.5.2 The site of the excavation at Whitlesey Mere was extensively associated with fishing in the medieval period and had associations with the religious houses at Peterborough, Thorney, Ramsey and Ely. Whitlesey Mere was drained in 1853 so the objects would date from prior to this time.

### ***Small find 30***

- B.5.3 Rolled Lead weight. rolled weight, probably for use with a fishing line. Patinated overall. Suggested date: Medieval to post medieval, 1100-1700. Diameter: 20.5mm, Thickness: 5mm, Height: 18.0mm, Weight: 3gms.

### ***Small find 36***

- B.5.4 Lead Strip. Cast tubular strip, unrolled weight probably for use with a fishing line. Patinated overall. Suggested date: Medieval to post medieval, 1100-1700. Width: 22.0mm, Height: 31.0mm, Weight: 11.1gms.

### ***Small find 50***

- B.5.5 Lead weight. Cast tubular weight, probably for use with a fishing line. Patinated overall. Suggested date: Medieval to post medieval, 1100-1700. Diameter: 18.0mm, Thickness (wall): 3.6mm, Height: 18.0mm, Weight: 41.0gms.

### ***Small find 51***

- B.5.6 Lead strip. Cast strip, probably part of an-unfurled fishing weight . Patinated overall. Suggested date: Medieval to post medieval, 1100-1700. Width: 4.6mm, Length: 20.0mm, Weight: 3.8gms.

### ***Small find 81***

- B.5.7 Lead strip. Cast strip, broken, uncertain use. Patinated overall. Suggested date: Medieval to post medieval, 1100-1700. Length 31.0: 18.0mm, Width 22mm, Weight:15.2gms.

### ***Small find 95***

- B.5.8 Lead strip.Cast un-furled cast strip, probably for use with a fishing line. Patinated overall. Suggested date: Medieval to post medieval, 1200-1700. Length 14.0mm, Width: 15mm, Weight: 15.2gms.

### ***Small find 120***



- B.5.9 Lead weight. Rolled lead strip, probably for use with a fishing line. Patinated overall. Suggested date: Medieval to post medieval, 1100-1700. Height: 18.0mm, Width: 6.0mm, Weight: 19.0gms.

***Small find 122***

- B.5.10 Lead strip. Cast lead strip, un-furled and once used with a fishing line. Patinated overall. Suggested date: Medieval to post medieval, 1100-1700. Diameter: 20.5mm, Thickness (wall): 4.6mm, Height: 18.0mm, Weight: 32.64gms.

***Small find 285***

- B.5.11 Lead weight. Cast tubular weight with a central hole, probably for use with a fishing line. Patinated overall. Suggested date: Medieval to post medieval, 1100-1700. Diameter: 19.0mm, Thickness (wall): 3.1mm, Height: 15.0mm, Weight: 49.2gms.

***Small find 286***

- B.5.12 Lead weight. Cast squat tubular weight with a central hole, probably for use with a fishing line. Patinated overall. Suggested date: Medieval to post medieval, 1100-1700. Diameter: 18.00mm, Thickness (wall): 4.2mm, Height: 20.0mm, Weight: 65.5gms.

***Small find 291***

- B.5.13 Lead weight. Cast tubular weight with a central hole, probably for use with a fishing line. Patinated overall. Suggested date: Medieval to post medieval, 1100-1700. Diameter: 21.0mm, Thickness (wall): 5.1mm, Height: 9.0mm, Weight: 29gms.

***Small find 293***

- B.5.14 Lead weight. Cast tubular weight, probably for use with a fishing line. Patinated overall. Suggested date: Medieval to post medieval, 1100-1700. Diameter: 18.0mm, Thickness (wall): 5.0mm, Height: 18.0mm, Weight: 46.4gms.

***Unstratified small find TL20953 89684***

- B.5.15 Lead Strip. Cast tubular strip, unrolled and probably for use with a fishing line. Patinated overall. Suggested date: Medieval to post medieval, 1100-1700. , Width: 22.0mm, Length: 31.0mm, Width: 44.0mm, Weight: 15.6gms.

***Unstratified small find TL20951 89703***

- B.5.16 Lead Strip. Cast tubular strip, unrolled and probably for use with a fishing line. Patinated overall. Suggested date: Medieval to post medieval, 1100-1700. Width: 22.0mm, Length: 28.0mm, Width: 22.0mm, Weight: 14.2gms.

***Unstratified small find TL 20939 89669***

- B.5.17 Lead strip. Cast tubular strip, rolled and used as a weight most probably for use with a fishing line. Patinated overall. Suggested date: Medieval to post medieval, 1100-1700. Height: 110.0mm, Width: 91, Weight: 32.64gms.

Small find No	Material	Height/L ength mm	Width mm	Diam mm	Weightg ms	Date	Metal Detected	Co-ordinates
30	Pb	18	5		3	med-post med	yes	TL20960 89616
36	Pb	31	22		11.1	med-post med	yes	TL20917 89587
50	Pb	18		18	41	med-post med	yes	TL20926 89579
51	Pb	20	18		3.8	med-post med	yes	TL20944 89568

Small find No	Material	Height/L length mm	Width mm	Diam mm	Weightg ms	Date	Metal Detected	Co-ordinates
81	Pb	31	22		15.2	med-post med	yes	TL20962 89576
95	Pb	14	15		15.2	med-post med	yes	TL20980 89576
120	Pb	18	6		19	med-post med	yes	TL20976 89613
122	Pb	32	12		7.5	med-post med	yes	TL20934 89646
285	Pb	15		19	49.2	med-post med	yes	
286	Pb	20		18	65.5	med-post med	yes	
291	Pb	9		21	29	med-post med	yes	
293	Pb	18		18	46.4	med-post med	yes	
9999	Pb	44	15		15.6	med-post med	yes	TL20953 89684
9999	Pb	28	22		14.2	med-post med	yes	TL20951 89703
9999	Pb	110	91		27	med-post med	yes	TL 20939 89669

Table 4: Lead (Pb) objects catalogue

## B.6 Pottery

*by Carole Fletcher*

### **Introduction**

- B.6.1 In November 1940, a Royal Air Force recovery team were sent to retrieve the remains of P/O Penketh (and any ordinance on the site). The team left behind traces of their activity, including fragments of a plate from an RAF mess or canteen. A base sherd from a bone china saucer was also found.

### **Assemblage**

- B.6.2 The assemblage consists of six sherds weighing 0.330kg, from a refined white earthenware plate 25cm/10 inches in diameter, and having an estimated vessel equivalent of 0.51. The plate has a small area of blue transfer-printed decoration on the inner surface of the rim. This is a circle approximately 1 inch in diameter (approx. 2.5cm), within which is a King's crown above the letters RAF (Plate 27); the plate appears otherwise undecorated. The numbers 12 and 39 are impressed into the reverse of the plate, these numbers may relate to the manufacturer or be a production number. A further sherd of refined white earthenware, weighing 0.002kg, most likely from the same vessel, was also recovered, although there is no join with the other broken pieces. This sherd is transfer-printed (in blue) on its reverse and bears part of the original maker's mark. Unfortunately very little of this survives and it has not been possible to identify the mark with any degree of certainty.
- B.6.3 Each part of the maker's mark is slightly curved, the upper row and the lower row of words forming a slight oval. The surviving letters on the upper row are MS & SON and on the lower row [E]NGLA[ND]. The letters MS are at the end of a family name and although SON is clear, the original legend may have read SONS. An examination of references to potter's marks in Godden (1991) and consultation with colleagues, suggests the firm of William Adams & Son (Potters) Ltd. of Tunstall and Stoke in the Staffordshire potteries; there are earlier variations to the name (Godden 1991 pp.21-23 mark nos 17-42a).
- B.6.4 The exact mark is not present in Godden, although there are illustrated marks used from 1914-40 and 1950+ with nothing in between. However, a similar arrangement of the name W ADAMS & SONS ENGLAND, with the & directly above the A of England was observed on a willow pattern jug on eBay (eBay.co.uk 2015). A similar transfer-printed mark (although this time with the & above the N) is viewable online at Pottery Marks@Retro Vintique (pottersmarks.blogspot.co.uk 2012) This mark is described as having been used into the early 1900's. A later mark introduced in the 1920's (which also gives the pattern name) has this same & and N arrangement. It has been suggested that during the Second World War the transfer-printed mark used to identify a pottery manufacturer was not always the most recent mark and that older marks might have been used (J Fairbairn pers. comm.).
- B.6.5 A single sherd from a bone china saucer was also recovered, decorated internally, in a pale brown transfer print. No evidence of a maker's mark is present and the transfer print pattern has not been identified.

### **Discussion**

- B.6.6 The plain nature of the plate, with its RAF mark being a sign of ownership rather than decoration, is common during the war and continued into the post-war period, when the sale of decorated ware in the home market was banned and output limited to a restricted

"Utility" range of undecorated ware. These restrictions, combined with strict price controls, continued for several years after the war to ensure that any decorated ware that could be produced was exported to alleviate the national shortage of foreign currency (thepotteries.org n.d.).

- B.6.7 The presence of a single sherd from a bone china saucer is somewhat more problematic, not fitting with the plain utilitarian wares discussed previously. This sherd is decorated, which may indicate that sherd is pre-war in date, and its presence on the site may indicate supplies brought to the recovery team by local people.
- B.6.8 The saucer may have broken by accident and been left at the site, however the RAF plate seems a more personal link with the RAF, and was perhaps left as a placed deposit after the recovery of P/O Penketh's body.

## APPENDIX D. ARCHAEOLOGICAL SPECIFICATION (MACAULAY 2015)

## **Specification for Archaeological Excavation**

---

**Site Name: Holme Fen Spitfire X4593**

**Site Code: HOM SPI 15**

**County (Grid Ref): Cambridgeshire**

**TL (5)20967 (2)89614**

**Project No: 15683**

**Planning App. No. n/a**

**Client: Beds, Cambs & Northants**

**Wildlife Trust**

**Date: 10/2/15**

**Author: Stephen Macaulay**



*Pilot Officer Harold Penketh*



*Spitfire X4593 in 266 Sqn markings*

## Specification for Archaeological Excavation

*Oxford Archaeology Ltd is an Institute of Field Archaeologists Registered Organisation and follows IFA By-Laws, Standards and Policy.*

**Site Name:** Holme Fen Spitfire X4593  
**Site Code:** HOM SPI 15  
**County (Grid Ref):** Cambridgeshire TL 520967 289614

Project No.: 15683  
Project Type: Excavation  
Cher Event No.: tbc  
Planning App. No.: N1200729FUL  
Client: Beds, Cambs & Northants Wildlife Trust  
Date: 24/02/15  
Author: Stephen Macaulay

### 1 General Background

This Project Proposal conforms to the outline in *MoRPHE Project Planning Note 3: Archaeological Excavation*.

#### 1.1 Circumstances of the Project

The Site is located in the northwest corner of the Great Fen area designation, west of Whittlesey Mere and east of Holme Fen.

The site lies in an area of known historical significance.

The Brief (K. Gdaneic (25/9/12) was written by Cambridgeshire County Council Historic Environment Team, in response to a request by the client (The Beds, Cambs & Northants Wildlife Trust). Due to the potential for archaeological deposits on the site Cambridgeshire County Council Historic Environment Team have recommended that an archaeological investigation takes place in advance of the groundworks associated with the Rymes Reedbed wetland creation.

A Licence under the Protection of Military Remains Act (PMRA) 1986 must be issued by the Joint Casualty & Compassionate Centre (JCCC) prior to any works taking place. The Licence is issued for 1 year only.



This specification conforms to the principles identified in English Heritage's guidance documents Management of Research Projects in the Historic Environment, specifically the *Morphe Project Manager's Guide* (2006) and PPN3 (*Project Planning Note 3: Archaeological Excavation*).

## 1.2 Legislation, Policy and Plans

### **Legislation**

All military aircraft crash sites in the United Kingdom (UK), its territorial waters, or British aircraft in international waters, are controlled sites under the Protection of Military Remains Act 1986. It is an offence under this act to tamper with, damage, move or unearth any items at such sites, unless the Ministry of Defence has issued a licence authorizing such activity. As such, anyone wishing to recover a military aircraft, or excavate a military aircraft crash site in the UK is required to obtain a licence from the Joint Casualty and Compassionate Centre (JCCC), part of the Service Personnel and Veterans Agency (SPVA).

Further to this, The Ministry of Defence reserves the right to deploy its representatives to witness any excavations approved under the Protection of Military Remains Act (Richard Osgood, Senior Archaeologist, Defence Infrastructure Organisation). This project design has been produced in consultation with Richard Osgood.

### **Policy**

English Heritage (2002) has set out guidelines for those wishing to excavate such crash-sites under license. The guidance also considers the case for curation, and even in some instances for protection by means of cultural heritage statute above that of the PMRA. The guidance goes on to suggest that 'In the majority of cases, even for nationally important sites, excavation and recording will be the appropriate response, and close attention should be paid to the methodology adopted. In part this will be determined by the circumstances of the crash and the nature and extent of deposits but, in conjunction with contemporary documentary sources, excavation should aim to recover as much information as possible about the circumstances of the loss. Sampling should take into account the distribution of surface debris in relation to subsurface remains; together these are strong indicators of the point or points of impact. Records of all excavations and field surveying should routinely be made available to the local Sites and Monuments Record (now known as Historic Environment Records), and to the National Monuments Record. Excavation of any aircraft crash site should be undertaken in

accordance with the Institute of Field Archaeologists' (IFA) *Code of Conduct*, and should comply with its *Standard and guidance for archaeological excavation*. (English Heritage, 2002, 7).

Further to the legislative background, and policy backing, there has been an increasing focus on the material remains of events of the 20<sup>th</sup> Century within documents which examine areas of priority in terms of archaeological research. The National Heritage Protection Plan of English Heritage includes much by way of military ethos. Aviation, is a part of this:

### **Plans**

#### **'4E2 TWENTIETH-CENTURY MILITARY HERITAGE**

The evidence base for 20th-century military heritage is extensive; a small number of priorities remain to be addressed to develop understanding of significance and permit informed protection of the most important. All are affected by piecemeal losses and lack of knowledge. Action should focus on Ministry of Defence disposals, First World War heritage, and specific themes such as communications, temporary airfields, aircraft crash sites and Cold War installations'.

It goes on to state that:

#### **Aircraft Crash Sites**

It has been estimated that around 10,000 military aircraft were lost during the 20th century over the United Kingdom. Of these only about a fifth are recorded on heritage databases. Although various wartime records of these losses do survive, their precise location was often poorly recorded or in the 21st century is no longer immediately obvious.

This project will use local Historic Environment Records and volunteers to improve the record of the positions of crash sites. This improved information will allow greater respect to be shown to crash sites threatened by development proposals.

The English Heritage [guidance note on military aircraft crash sites](#) will also be revised and reissued.

Following on from the initial consideration of the importance of crash sites, an action plan was proposed:

Protection Result 4E2.2: Enhanced protection for surviving significant 20th-century military sites

Methodology	Outcome	Output
<p>3. National assessments significance of poorly represented installations, sites and complexes, to include: First World War, Cold War, Civil Defence, Military Communications, Temporary Airfields and Aircraft Crash Sites</p> <p>4. Selection of relevant sites for designation, and feed-through of information to appropriate authorities</p> <p>5. Publication of key thematic reports to assist in future evaluation and assessments</p>	<p>Higher profile and better national protection of more ephemeral but significant military heritage assets</p>	<p>Reports, appropriate designations and enhancements of HERs</p>

The project highlighted in this document aims both to provide higher profile to military remains (both to a military audience and also to wider civilian stakeholders). The site will result in a report, inclusion with the HER of Cambridgeshire, contributing to best-practice models for future investigative groups, and assistance to Statutory Bodies nationwide with regards improved guidance notes and project design templates.

This document thus sets out the component elements for the proposed recovery of a Battle of Britain airframe within the above context: Spitfire X4593 of 266 Rhodesian Squadron Royal Air Force which was based at RAF Wittering in 1940.

### 1.3 The Geology of the Site

The geology of the Holme Fen/Whittlesey Mere area exhibits a somewhat complex series of Holocene sediments overlying late-Glacial sediments and Jurassic bedrock. To the south-west near Holme village, Jurassic bedrock Oxford Clay forms higher ground at the fen-edge. Associated with the bedrock surface (rockhead) are thin sandy and gravelly deposits of presumed late-Glacial age. Near Holme Farm and Top Farm, although not mapped by the BGS, these sediments occur capping ridges and 'islands', but to the north and east they are buried beneath the Holocene fen sediments.

The earliest Holocene deposit from this area is usually thought to be the basal or 'Lower' peat, associated with frequent 'bog oaks', which is generally taken to represent deposition in a damp woodland environment during Mesolithic and Neolithic times. Overlying the 'Lower' peat in the north and east of the area is a unit of intertidal saltmarsh, mudflat and tidal creek deposits assigned to the 'Barroway

Drove Beds' representing the mid-Bronze Age marine incursion into this part of fenland that is thought to have persisted until at least 3400 calendar years BP.

Overlying much of the 'Barroway Drove Beds' is an overgrowth of organic deposits usually referred to as the 'Nordelph' peat. These sediments are a mixture of freshwater reed-swamp (*Phragmites*) peats and acid raised-bog (*Sphagnum*) peats dating from the late Bronze Age and Iron Age. In several locations, including the former sites of Whittlesey Mere, Trundle Mere and Ugg Mere, lake sediments of various types (including 'shell marl') are present overlying the 'Nordelph' peat indicating large areas of standing water from the late Iron Age onwards. In other locations there was no such inundation by extensive open water, and raised bog peat accumulation continued unabated until the mid-19<sup>th</sup> Century.

The drainage of Whittlesey Mere and surrounding areas in 1850 led to a rapid desiccation and shrinkage of the organic sediments, including their internal breakdown through microbial processes. Hutchinson's (1980) study of the peat 'wastage' around Holme Fen post shows the initially rapid and then ongoing lowering of the local ground surface amounting to almost 4m in 130 years.

#### **1.4 The Proposed Development**

The scheme is for wetland creation (Rymes Reedbed) covering c145 hectare of land lying to the north and west of Holme Fen Nature Reserve. The work will include the excavation of new pools, the re-profiling & backfilling of existing dykes (Caldecote and Yaxley) and the excavation of new channels. These works will also include (and result in) the creation of wet woodland, wet grassland and reedbeds in designated areas.

## **2 Archaeological & Historical Background**

A desk-based assessment was undertaken in 2002 which outlined the known archaeological and historical background for the Great Fen project area (Rebecca Casa Hatton 2002 *The Great Fen Project: An Archaeological Desk-based Assessment* Cambridgeshire County Council Report No. 208) and thus will not be repeated in this document.

## 2.1 Spitfire X4593

On 22<sup>nd</sup> November 1940 Spitfire X4593 of 266 Sqn crashed near Holme Lode Farm, Holme. At the controls for what was intended to be a routine training flight was Pilot Officer Harold Penketh. During a battle climb to altitude with two other Spitfires he was seen to break formation entering a dive from which he failed to fully recover. Witnesses stated that his aircraft partially recovered at around 2000ft but immediately re-entered a dive and struck the ground vertically.

P/O Penketh made no attempt to use his parachute and was killed in the resulting crash. Although he was a new pilot with 266 Sqn, based nearby at Wittering, with only some 13 hours experience on Spitfires, his Station Commanding Officer stated that he could fly it quite well and was fully conversant with the oxygen system.

It was assumed that his oxygen system was working as he had reached 28,000ft without any apparent problem. Investigation concluded that either a failure of the oxygen system or a physical failure by P/O Penketh had occurred.

Harold Edwin Penketh's body was recovered from the wreck of his Spitfire and was returned to his home town of Brighton where he had previously worked for the Ocean Accident and Guarantee Corporation. His obituary in the staff magazine ended thus "He was of a charming disposition and his loss was keenly felt by those who knew him."

## 2.2 266 Squadron

No 266 Squadron was formed on 27 September 1918 from Nos 437 and 438 Flights at the seaplane station at Mudros, for anti-submarine patrols over the Aegean. On 1 September 1919, the squadron disbanded.

On 30 October 1939, No 266 Squadron reformed at Sutton Bridge and was intended to be a Blenheim squadron. None were received and after training with Battles, it began to receive Spitfires in January 1940. These it took into action for the first time on 2 June over Dunkirk and during August was based in south-east England, then returned to Wittering.

### **3 Aims and Objectives**

The main aim of the project will be to recover and preserve the archaeological evidence of Spitfire X4953 contained within the excavation area by record.

#### **3.1 Spitfire X4593 Crash Site**

3.1.1 Following the survey components and location of the crash site, the project aspires to recover the air frame. Critical to this is to have a robust set of questions to answer, and project aspirations to fulfil. For SpitfireX4593 these questions are as follows:

- At what depth are the remains?
- In what condition are the remains?
- Can we determine the cause of the crash?
- With what mixture of ammunition was the Spitfire armed
- Does the ground-truthing of excavation refine geophysical survey techniques
- What were the final moments of the airframe
- What does the archaeological recovery of the airframe add to our knowledge
- How can these techniques inform revised crash guidance?
- Is there any other (non air-crash) archaeology in the immediate vicinity and how was this affected by the events of 1940

### **4 Timetable**

4.1 It is estimated that the fieldwork will take approximately 5 working days to complete and the work is scheduled to take place in the week October 5<sup>th</sup>-10<sup>th</sup> 2015.. These figures do not allow for delays caused by bad weather or any additional works beyond the current agreed limits of the excavation area. Working days are based on a 5-day working week, Monday to Friday.

4.2 Post-excavation tasks and report writing will take approximately 12 months following the end of fieldwork, unless there are exceptional discoveries requiring more lengthy analysis. A summary statement of results, however, can be produced more quickly if required.

### **5 Staffing and Support**

5.1 The following named staff will form the project team:  
1 x Project Manager (full time)



1-2 x Project Officer/Supervisor (full time)  
 2 x Site Assistant (full time, as required)  
 1 x Finds Assistant (full time, as required)  
 1 x Illustrator for post-excavation work (part time)  
 TBC x Volunteers inc Great Fen Archaeology Group (& Jigsaw)  
 TBC x Operation Nightingale Team

5.2 The Project Manager and Project Officer/Supervisor will be core staff of OA East. Names, qualifications and experience of key project personnel will be communicated to the relevant County Archaeological Planning Advice team before the commencement of fieldwork. All Site Assistants will be drawn from a pool of qualified and experienced staff. The Contractor will not employ volunteer amateur or student staff, whether paid or unpaid, to fulfil any of the above tasks except as an addition to the stated team

5.3 Specialists will be employed for consultation and analysis as necessary. The following individuals will be consulted based on the evaluation results. Site consultation will be carried out with Richard Osgood (Senior Archaeologist, Defence Infrastructure Organisation), Vince Holyoak (English Heritage). Geophysical Survey will be undertaken by Peter Masters (Cranfield University). Spitfire material will be examined by Jeff Carless, Steve Vizard and Peter Stanley. Faunal remains will be examined by Chris Faine. Environmental analysis will be carried out by OA East staff and the results will be conveyed to the English Heritage Regional Scientific Advisor. Conservation will be undertaken by Peter Stanley and RAF Wyton Museum. Should unexpected remains be encountered, a list of other specialists who may be consulted is given in Appendix 1.

## 6 Methods

### 6.1 Desktop Strategy

6.1.1 The project aspires to undertake the following elements as part of desktop research.

- Operational Diary research & National Archives investigation
- Literature review
- Archive research with the Air Historic Branch, RAF
- Air photographic checks within the National Monuments Record (NMR) of English Heritage in Swindon
- Historic Environment Record (HER) Consultation

- Walkover survey
- Walkover survey with metal-detectors to look for aluminium (each reading will be flagged and recorded but not dug)
- Geophysical survey to encompass magnetometry and ground-penetrating radar

#### 6.1.2 *Operational Diary Research*

May be undertaken by the Richard Osgood and Operation Nightingale Members (6 Rifles) and may be used to inform any revision of the Project Design. Although there are elements that are pertinent to the crash and its cause, the location is rather vague.

#### 6.1.3 *Literature Review*

Information on 266 sqn will be sourced.

#### 6.1.4 *Air Historic Branch*

The Air Historic Branch (AHB) will be contacted.

#### 6.1.5 *Air Photograph Search*

A search of both oblique and vertical air photographs held by the National Monuments Record (NMR) in Swindon and CUCAP in Cambridge will be undertaken. The crash took place in 1940 and normally the earliest subsequent photographic coverage was not until in 1945.

#### 6.1.6 *Historic Environment Record (HER) Consultation*

Discussions with the Cambridgeshire HER confirmed that there were no details on this crash site.

### 6.2 **Site Survey's**

#### 6.2.1 *Walkover survey*

The author and other OAE staff have visited the site on several occasions. No air frame or crater is visible in this area. The site is now rough grassland (having until 2010 been arable farmland). A few fragments of aluminium scraps were recovered in 2013 as part of wider archaeological survey work.

#### 6.2.2 *Metal Detector Survey (non-intrusive)*

The area was surveyed with a metal detector in 2013 and a few pieces of aluminium fragments were recovered. This initial survey will be backed up by a further, measured metal detection survey in advance of the fieldwork, to coincide with the Geophysical Survey (6.2.3 below). During the first day of any fieldwork project, as part of the site gridding



exercise, a non-intrusive metal detecting survey will take place to examine the presence of aluminium. Each reading will be flagged and the location plotted.

#### 6.2.3 *Geophysical Survey (non-instrsive)*

A magnetometer (fluxgate gradiometer) and ground-penetrating radar survey will be carried out by Mr Peter Masters of Defence Academy/Cranfield University in advance of the fieldwork.

### 6.3 **Excavation**

6.3.1 Following the non-intrusive Site Surveys (see 6.2 above) the team will grid out an area for excavation. The extent of land to be stripped will be determined following survey results but is unlikely to exceed 20m x 20m (closer to 10m x 10m). Previous examples of Spitfire crashes have demonstrated that the impact area may be relatively confined (a circular area of c2.5m diameter once elements left on the surface such as wings are discounted). An example of this is illustrated in the existing English Heritage Military Aircraft Crash sites guidance ([guidance note on military aircraft crash sites](#) page 6 – this also notes that the particular crash compacted the airframe from 9m to less than 1.5m and a similar experience on the chalk is expected).

6.3.2 Excavation open areas will be opened using a 360 excavator with a 2m wide toothless ditching bucket. All mechanical excavation will take place under constant supervision of a suitably qualified and experienced archaeologist. All subsequent work will be done by hand, unless being deemed suitable for machining by the Project Officer.

6.3.3 The nature of the local site geology (fen peat above clay) means that the depth at which the Spitfire (engine) is likely to reside may be over 3ms below the current ground level. The excavation area/sides will be stepped to allow access, hand excavation/recovery, and to ensure safety (avoiding trench collapse), however if the working depth is not considered safe, then no staff will enter the trench and the recovery of the Spitfire will be undertaken by the Mechanical Excavator and bucket. It is likely that significant water will enter the trench and this will compromise trench integrity and safety. Water will be pumped out but ultimately this will result in access to the trench becoming impossible.

6.3.4 Major airframe components will need mechanical removal from the excavation and transportation to the point of curation and conservation. The RAF Wyton Pathfinder Museum will be asked to receive this material for conservation.

- 6.3.5 All excavation areas will be cleaned as necessary to facilitate the identification of archaeological features and buried soils. All features will be mapped onto a base plan either by hand (1:50 or 1:100) or using a Total Station Theodolite, as appropriate. The survey data will be made available in digital format for transfer to the Heritage Environment Record (HER) GIS system. A plan showing all significant features will be located on the Ordnance Survey National Grid.
- 6.3.6 Established excavation and recording methodology will be used as has been generally employed on rural sites in Eastern England, a system closely based upon the DUA manuals of London Museum, and utilising single-context recording where appropriate. A Project Manager will monitor the work of the site director (Project Officer/Supervisor). A Supervisor and experienced excavators will be used to ensure accuracy of excavation and recording. Regular communication between PM/PO will ensure that the work programme and research direction is kept to, and that the recording strategy develops in the light of excavation results and input from finds, environmental and other specialists. On-site records checking and matrix creation will be kept up to date and will be carried out by key site personnel. Photographic records and hand-drawn sections will be completed to recognised standards.
- 6.3.4 Spoil will be scanned visually and with a metal detector to aid recovery of artefacts.
- 6.3.5 An inventory of all artefacts is to be created as one of the conditions of the PMRA license. As these will be recovered from an archaeological excavation, the finds will all be context-recorded and 3-D spot located too. They will be assigned a unique small find number, and will all be recorded onto Excel sheets to be included as part of the site archive. All artefacts remain property of the Ministry Of Defence until such time as signed over to RAF Museum Hendon, or to the other collecting Museum or repository (in this case we propose Ratcliffe College as above). Bulk corrosion will simply be recorded by area and not retained.
- 6.3.6 Site Conservation
- Only immediate stabilisation will be carried out on site and then only if it is judged to be necessary.
  - With the permission of JCCC, recovered items of engine and airframe will initially be taken to a suitable location by the applicants and then steam-cleaned to remove the worst of the

soil contamination and then coated with WD-40 to aid preservation. Subsequent cleaning will be carried out by hand prior to preservation and eventual display.

- Individual small items will be bagged according to standard archaeological practice for the materials concerned as set out in publications such as “First Aid for Finds” [Watkinson and Neal, 2001].
- Where appropriate bags will be perforated to allow circulation of air.
- The white “Write On” strips will carry identification labels written in Permanent Black Ink Pen with a 0.5 nib and will include Site Code, Unique Finds Number and Date.

6.3.7 Monochrome and colour photographs supplemented by colour slides will form the photographic archive.

6.3.8 Bulk samples will be taken by the excavator and in consultation with the English Heritage Regional Scientific Advisor and the projects environmental specialists (Rachel Fosberry, Steve Boreham) where practicable, to test for the presence and potential of micro- and macro-botanical environmental indicators. If buried soils are encountered a soil micromorphology specialist will be consulted. The results of any analysis will be included in the excavation report.

6.3.9 If **Human remains** are encountered then all excavations will be suspended (the JCCC Licence will be suspended as per the Guidance Note Item 15) and the Ministry of Defence will be contacted immediately (advice will also be sought on site from Richard Osgood). In addition the relevant Cambridgeshire County Council Historic Environment Teams and the local Coroner will also be informed. Removal of these remains will be carried out under instruction from the Ministry of Defence in accordance with their procedures and will only occur after a Ministry of Justice licence has been obtained.

6.3.10 **Public Presentation:** The nature of the excavation makes it unsuitable for direct presentation through the provision of a public open day, however the interest is such that there will be managed tours, radio and television involvement and press briefings. The results of this work will be also disseminated to talks to local schools, lectures and presentations to the public and societies upon request. Ultimately the results of the excavation and the physical remains of Spitfire X4593 will be displayed at the Pathfinder Museum at RAF Wyton and the planned

Interpretation Centre at the Great Fen. This assumes that the MOD gift the remains.

## **7 Post-excavation, Publication and Archive**

- 7.1 A full archive report will be produced within 12 months of the completion of fieldwork and submitted to the Service Personnel & Veterans Agency (JCCC) Ministry of Defence, the Beds, Cambs and Northants Wildlife Trust and Cambridgeshire Historic Environment Record.
- 7.3 An Oasis report will be submitted on completion of report.
- 7.4 A hard copy of the approved report will be produced for the Cambridgeshire HER and the County Archaeological Advisor. In addition a digital copy of the report will also be made available.
- 7.5 If appropriate a report will be published in an appropriate journal as approved by the County Archaeological Advisor.
- 7.6 A security copy of the archive will be made.
- 7.7 All artefactual material recovered will be held in storage by OA East and ownership of all such archaeological finds will be given over to the relevant authority to facilitate future study and ensure proper preservation of all artefacts. In the unlikely event that artefacts of significant monetary value are discovered, and if they are not subject to Treasure Act legislation separate ownership arrangements may be negotiated.
- 7.8 It is Oxford Archaeology Ltd's policy, in line with accepted practice, to keep site archives (paper and artefactual) together wherever possible. All archives will comply in format with PPN3 recommendations.
- 7.9 The project archive will follow the guidelines contained in *Guidelines for the Preparation of Excavation Archives for Long Term Storage* (United Kingdom Institute for Conservation, 1990), *Standards in the Museum care of Archaeological Collections* (Museums and Galleries Commission 1992), and *Archaeological Archives: A guide to best practice in creation, compilation, transfer and curation* (Brown 2007). The archive will be deposited within an approved county store. Costs associated with the deposition of the archive will be met by the client.

## 8 Further Considerations

### 8.1 Backfilling/Reinstatement

Backfilling of the excavation area will be undertaken.

### 8.2 Monitoring

Cambridgeshire County Council Historic Environment Team will be informed appropriately of dates and arrangements to allow for adequate monitoring of the works.

### 8.3 Health and Safety

- 7.3.1 A risk assessment covering all activities carried out during the lifetime of the project will be prepared prior to project commencement and updated throughout the life of the project. This draws on OA East's activity-specific risk assessment literature and conforms with CDM requirements.
- 7.3.2 All aspects of the project, both in the field and in the office will be conducted according to OA East's Health and Safety Policy, Oxford Archaeology Ltd's Health and Safety Policy, and *Health and Safety in Field Archaeology* (J.L. Allen and A. St John-Holt, 1997). A copy of OA East's Health and Safety Policy can be supplied on request.
- 7.3.3 Specific Hazards on the Crash Site

The Spitfire Mk1a was armed with eight Browning .303 machine guns. There is a strong likelihood that .303 bullets may be extant at the site in the form of complete rounds and heat-ruptured rounds. It is only the complete rounds that are likely to present any hazard, and this is an exceptionally low-level hazard. Such finds will be dealt with appropriately by an experienced team and in accordance with MOD guidance which forms a condition of the PMR Licence. Site work will include an Ammunition Technical Officer (ATO) from the Royal Logistics Corps (RLC) as part of the excavation team. He will be able to deal with any elements of ordnance (after they have been recorded for headstamps and any other data), along with residual elements consistent with lying on a military training area.

Some instruments fitted to aircraft of this type contained radium in their dials. However, the hazard likely to be presented by any such material

at this site is considered remote. This is because the nature of the impact and subsequent fire will have destroyed all instrumentation which were Bakelite plastic but with metal (aluminium or brass) dial faces on which numbers and graduations were picked out in luminous paint. Experience has shown that where instrument faces have survived such an impact the luminous paint is disrupted from the instrument face and is no longer present although it remains possible that some low-level residual radiation might still exist.

It is considered that all fuels and oils and Glycol coolants will have burnt off during the subsequent impact fire. That which remains will have most likely dispersed or dissipated in the soil but the team will remain alert for possible remnants of such fluids being present.

Compressed air cylinders or oxygen bottles, if extant, are likely to have ruptured or rusted and be no longer charged. However, all will be treated with caution and set aside for safety examination if discovered.

#### **8.4 Contingency Resourcing**

The client is advised that consideration should be given to the possible need for additional contingency payments to ensure adequate project resourcing. Additional costs may be incurred in certain circumstances including: unexpected discoveries, prolonged periods of poor weather, or major changes in excavation strategy.

#### **8.5 Insurance**

OA East is covered by Public and Employer's Liability Insurance. The underwriting company is Allianz Cornhill Insurance plc, policy number SZ/14939479/06. Details of the policy can be seen at the OA East office.

#### **8.6 Services, Public Rights of Way, Tree Preservation Orders etc.**

The client will inform the project manager of any live or disused cables, gas pipes, water pipes or other services that may be affected by the proposed excavations before the commencement of fieldwork. Hidden cables/services should be clearly identified and marked where necessary. The client will likewise inform the project manager of any public rights of way or permissive paths on or near the land which might affect or be affected by the work. The client will also inform the



project manager of any trees subject to Tree Preservation Orders within the subject site or on its boundaries

## **8.7 Site Security**

Unless previously agreed with the Project Manager in writing, this specification and any associated statement of costs is based on the assumption that the site will be sufficiently secure for archaeological work to commence. All security requirements, including fencing, padlocks for gates etc. are the responsibility of the client.

## **8.8 Access**

The client will secure access to the site for archaeological personnel and plant, and obtain the necessary permissions from owners and tenants to place a mobile office and portable toilet on or near to the site. Any costs incurred to secure access, or incurred as a result of withholding of access will not be OA East's responsibility. The costs of any delays as a result of withheld access will be passed on to the client in addition to the project costs already specified.

## **8.9 Site Preparation**

The client is responsible for clearing the site and preparing it so as to allow archaeological work to take place without further preparatory works, and any cost statement accompanying or associated with this specification is offered on this basis. Unless previously agreed in writing, the costs of any preparatory work required, including tree felling and removal, scrub or undergrowth clearance, removal of concrete or hard standing, demolition of buildings or sheds, or removal of excessive overburden, refuse or dumped material, will be charged to the client, in addition to any costs for archaeological evaluation already agreed.

## APPENDIX 1: CONSULTANT SPECIALISTS

NAME	SPECIALISM	ORGANISATION
Bishop, Barry	Lithics	Freelance
Booth, Paul	Roman pottery and coins	Oxford Archaeology
Boreham, Steve	Pollen and soils/ geology	University of Cambridge
Brown, Lisa	Prehistoric Pottery	Oxford Archaeology
Brundell, Matt	Bronze Age& Iron Age pottery	Freelance
Cane, Jon	illustration & reconstruction	Freelance
Crummy, Nina	Small Find Assemblages	Freelance
Carless, Jeff	WW2 Aircraft Cash Sites	Freelance
Dodwell, Natasha	Human Bone	Freelance
Evans, Jerry	Roman pottery	Freelance
Faine, Chris	Animal bone	Oxford Archaeology
Fletcher, Carole	Medieval pot	Oxford Archaeology
French, Charlie	Soil micromorphology	University of Cambridge
Fryer, Val	Molluscs/environmental	Freelance
Lyons, Alice	Late Iron Age/Roman pottery	Oxford Archaeology
Knight, Mark	Neolithic pottery	Freelance
Macaulay, Stephen	Roman pottery	Oxford Archaeology
Masters, Pete	geophysics	Cranfield University
Palmer, Rog	Aerial photographs	Air Photo Services
Percival, Sarah	Prehistoric pottery, querns	Oxford Archaeology
Popescu, Adrian	Roman coins	Fitzwilliam Museum
Powell, Kelly	Prehistoric & Roman small finds	Oxford Archaeology
Robinson, Mark	Insects	University of Oxford
Sealey, Paul	Iron Age pottery	Freelance
Shafrey, Ruth	Worked stone, cbm	Oxford Archaeology
Smith, Wendy	Plant remains	Oxford Archaeology
Spoerry, Paul	Medieval pottery	Oxford Archaeology
Stanley, Peter	WW2 Aircraft Cash Sites	RAF Wyton Museum
Vizard, Steve	WW2 Aircraft Cash Sites	Freelance

Radiocarbon dating is normally undertaken for OA East by SUERC.

**Geophysical prospection is normally undertaken for OA by Cranfield University, Bartlett Clark Consultancy or Britannia Archaeology Ltd.**

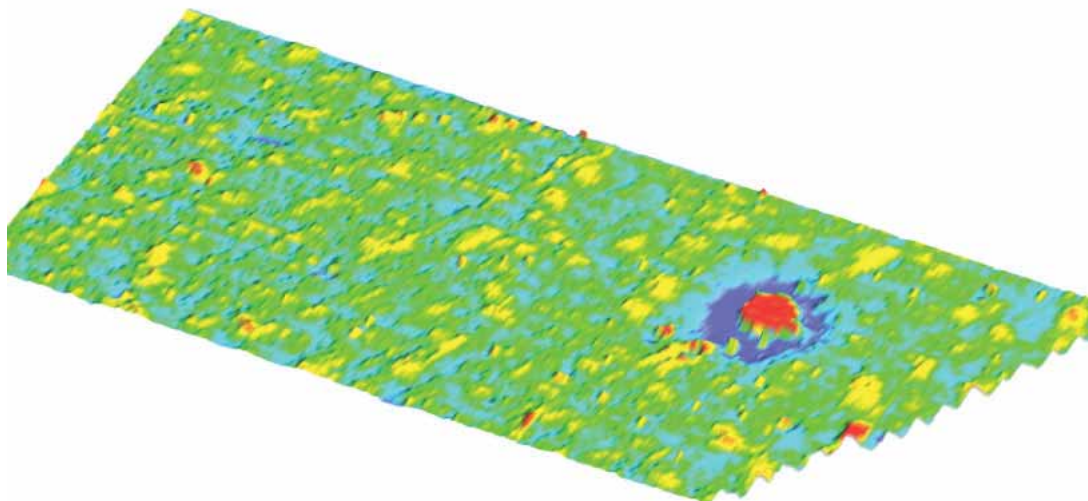


## APPENDIX E. GEOPHYSICAL SURVEY REPORT

**GEOPHYSICAL SURVEY OF  
HOLME FEN SPITFIRE X4593,  
HOLME FEN,  
CAMBRIDGESHIRE**

**SITE CODE: HOM SPI 15**

Cranfield Forensic Institute Report No. 125



**Peter Masters**

**September 2015**

## CONTENTS

<i>ABSTRACT</i>	1
1.0 INTRODUCTION	1
2.0 LOCATION AND DESCRIPTION	1
3.0 BACKGROUND INFORMATION	2
4.0 AIMS AND OBJECTIVES	3
5.0 METHODOLOGY	3
6.0 INTERPRETATION AND ANALYSIS OF RESULTS	4
7.0 CONCLUSIONS	6
8.0 ACKNOWLEDGEMENTS	6
9.0 BIBLIOGRAPHY	6

## ILLUSTRATIONS

FIG. 1: Location plan, scale – 1:5000.

FIG. 2: Location of Gradiometer survey, scale 1:1000.

FIG. 3: Colour scale and trace plots of raw and enhanced data, scale 1:1000.

FIG. 4: Interpretation of gradiometer results, scale - 1:1000.

FIG. 5: Location of ERT profiles in relation to the gradiometer survey, scale – 1:1000.

FIG. 6: ERT pseudosections of GFS1 profile and interpretation.

FIG. 7: ERT pseudosections of GFS2 profile and interpretation.

FIG. 8: Metal detecting finds in relation to the gradiometer survey results, scale – 1:1000.

## **ABSTRACT**

*A geophysical survey was carried out on land at Holme Fen, Cambridgeshire. The work was undertaken in August 2015. The purpose of the survey was to locate the remains of the Spitfire X4593 which crashed near Holme Lode Farm on the 22<sup>nd</sup> November 1940 and nose dived vertically into the ground following a routine training flight.*

*Three techniques were employed: gradiometer, ground penetrating radar and electrical resistance tomography in order to provide a full coverage of the remains from its nature and extent to actual depth of the aircraft remains.*

*The fluxgate gradiometer survey produced good results of the extent of the remains of the aircraft, in particular the probable remains of the Merlin engine and associated parts within the impact crater. GPR results have produced the size and depth of the impact crater. The third technique employed was ERT where two profiles were recorded across the centre of the impact crater. The results show the depth and width of the impact crater containing the remains of the spitfire particularly well.*

*In addition to the geophysical survey, a metal detecting survey was undertaken by the Great Fen Archaeology Group which form part of the Jigsaw Project. Overlaying the metal detecting finds with the gradiometer survey results shows a good correlation.*

*Many of the finds recorded show as anomalies in the magnetic data as well.*

*No other anomalies of archaeological significance were recorded.*

## **1.0 INTRODUCTION**

Oxford Archaeology East commissioned the Centre for Archaeological and Forensic Analysis, Cranfield Forensic Institute, Cranfield University to undertake a gradiometer survey Holme Fen, Cambridgeshire (Fig 1). This work was carried out in September 2015.

The purpose of the survey was to locate the remains of the Holme Fen Spitfire X4593 and its associated impact crater.

The survey methodology described in this report was based upon guidelines set out in the Historic England (formerly English Heritage) document 'Geophysical Survey in Archaeological Field Evaluation' (EH 2008).

## **2.0 LOCATION AND DESCRIPTION**

The information contained within sections 2 and 3 of this report is based on information supplied by Oxford Archaeology East (Macaulay 2015).

The site is located in the northwest corner of the Great Fen area designation, west of Whittlesey Mere and east of Holme fen, Cambridgeshire.

The area of investigation comprises a large polygonal shaped field and is located to the east and south of the Holme Lode Farm and Holme Lode. The site is bounded to the northwest and north by Holme Fen Engine Drain, to the south-west by Holme Fen Nature Reserve and by drains to the east and south-east (Fig 1).

The site is currently under grass cultivation at the time of the survey. The field is relatively flat.

The underlying geology of the site is comprised of a complex series of Holocene sediments (Peat, Organic mud, and calcareous mud) overlying late Glacial sediments and Jurassic bedrock (Geological Map Data ©NERC 2015). The magnetic susceptibility of these types of geologies is generally variable.

### **3.0 BACKGROUND INFORMATION**

The Cambridgeshire Historic Environment Record (HER) shows that the application site lies within an area with a potential for the presence of archaeological remains particularly dating to the Prehistoric and Roman periods (Hatton 2002).

On 22<sup>nd</sup> November 1940, Spitfire X4593 of 266 Sqn crashed near Holme Lode Farm, Holme, Cambridgeshire. This flight was supposed to have been on a routine training exercise and Pilot Officer Harold Penketh was in the cockpit. It was whilst in a battle climb to altitude of 28,000ft with two other spitfires when he broke formation and entered into a dive. During this dive, witnesses stated that his aircraft managed to partially recover at around 2,000ft but then re-entered into a dive and struck the ground vertically.

Pilot Officer Penketh made no attempt to bail out using his parachute and he was killed upon impact with the ground. He was a relatively new pilot with 266Sqn, who were based at nearby RAF Wittering and he had only gained some 13 hours experience flying spitfires. His Station Commanding Officer stated that he reasonably confident at flying these aircraft and was fully conversant with the oxygen system.

There was no apparent problem considering he had reached a height of 28,000ft but it was concluded from the investigation that either his oxygen had failed or some form of physical failure had occurred to P/O Penketh.

Harold Edwin Penketh's body was recovered from the wreckage and he was returned to his home town of Brighton where he originally had previously worked for Ocean Accident and Guarantee Corporation. In the staff magazine, his abituary read 'He was of a charming disposition and his loss was keenly felt by those who knew him.'

Historic maps show the area of investigation as three smaller fields on the 1889 First Edition Ordnance Survey map. By 1926, the field was subdivided into two fields. On the 1979 Ordnance Survey map the field was partially subdivided by a drain. More recently a new drain has been cut which forms a serpentine like shape subdividing the field into two with access to both halves along the northern side of the field.

## **4.0 AIMS AND OBJECTIVES**

The main aim of the geophysical survey was to locate and map the underlying remains in order to allow for the full recovery and preservation of the Spitfire X4953.

## **5.0 METHODOLOGY**

### **Gradiometry**

Gradiometry is a non-intrusive scientific prospecting technique used to determine the presence/absence of some classes of sub-surface archaeological features (eg pits, ditches, kilns, and occasionally stone walls). By scanning the soil surface, geophysicists identify areas of varying magnetic susceptibility and can interpret such variation by presenting data in various graphical formats and identifying images that share morphological affinities with diagnostic archaeological as well as other detectable remains (Clark 1990; Gaffney and Gater 2003).

The use of gradiometry is used to establish the presence/absence of buried magnetic anomalies, which may reflect sub-surface archaeological features.

The area survey was conducted using a Bartington Grad 601 dual fluxgate gradiometer with DL601 data logger set to take 4 readings per metre (a sample interval of 0.25m). The zigzag traverse method of survey was used, with 1m wide traverses across 30m x 30m grids. The sensitivity of the machine was set to detect magnetic variation in the order of 0.1 nanoTesla.

The data was processed using *TerraSurveyor v3*. The results are plotted as greyscale and trace plot images (Figs. 3-5).

The enhanced data was processed by using zero-mean functions to correct the unevenness of the image in order to produce a smoother graphical appearance. It was also processed using an algorithm to remove magnetic spikes, thereby reducing extreme readings caused by stray iron fragments and spurious effects due to the inherent magnetism of soils. The data was also clipped to reduce the distorting effect of extremely high or low readings caused by discrete pieces of ferrous metal.

### **Ground Penetrating Radar**

A Malå Geoscience AB RAMAC/GPR system consisting of shielded monostatic antenna, CUII control unit and XV monitor was used to collect profiles with a 500MHz antenna.

The 500MHz antenna was selected as most suitable centre frequency for obtaining the depth penetration and lateral resolution required for the survey. Individual profiles were collected over the site at 0.5m and at a station spacing of 0.05m. The nominal location of each profile is shown in Figure 3.

Processing was carried out using RAMAC GroundVision 2 and Reflex3D Scan software. DC offset correction and linear time gain was applied to the radar data to correct for low frequency noise and amplitude attenuation with distance respectively.

The following basic processing functions have been applied to the data:

*DC correction* removes a constant offset in each trace, caused by imperfections in the radar electronics

*Time Gain* time varying gain is applied to the trace to compensate for amplitude loss due to spreading and attenuation.

### **Electrical Resistance Tomography (ERT)**

Electrical imaging systems, enabling Electrical Resistance Tomography (ERT) surveys, are similar to GPR systems in that they record vertical sections through the ground enabling a 3D image to be recorded. Imaging is suitable on sites having soils with a high moisture or clay content where GPR is not suitable, and can also retrieve data from a greater depth. ERT, however, can suffer from limited resolution on some site types (Schmidt 2013).

ERT was carried out using a multi-electrode resistivity system with Wenner and dipole-dipole array along a total of 3 profiles.

A Syscal Pro Switch resistivity meter was used in multi-electrode configuration to collect the apparent resistivity data. The ERT method allows for the electrical resistivity of the subsoil to be obtained by injecting an electrical current into the ground and measuring the potential difference at two determined points of the surface. This method is suitable in the fact that buried structures can be detected as contrasts or anomalies in the electrical properties of the medium. If an electrical tomography of the subsoil can be obtained, the probable location of the structure can be delimited.

ERT data processing consists of obtaining a pseudo-section by plotting the apparent resistivity versus the depth for each midpoint of a given electrode configuration. The Res2dinv/Res3dinv resistivity inversion software (Loke 2001) was used to automatically invert the data and to yield a three-dimensional resistivity model.

## **6.0 INTERPRETATION AND ANALYSIS OF RESULTS (Figs. 2-4)**

### **Gradiometer Survey**

A detailed fluxgate gradiometer survey covering an area of c. 0.76ha located to the south and east of Homle Lode, Great Fen, produced significant anomalies relating to the aircraft crash site remains.

Generally, a series of isolated individual anomalies were detected (Fig. 4, examples circled pink) that reflect areas of modern ferrous litter, which lie just below or on the surface of the ground.

A large positive anomaly surrounded by a negative halo (Figs 3 and 4, 1) was recorded towards the southern end of the survey area. This denotes the presence of the spitfire remains, in particular the Merlin engine. Surrounding the large anomaly is a series of discrete bipolar individual anomalies that appear to reflect other parts of the crashed spitfire (Figs 3 and 4, 2).

A linear dipolar anomaly (Figs 3 and 4, light blue line) runs diagonally from north to south denotes the presence of a drain.

### **Ground Penetrating Radar (Not Illustrated)**

Two targeted areas were surveyed using 500 MHz and 250 MHz antennas at 0.5m and 1m spaced parallel lines to map the impact crater and remains of the engine.

In both cases the radar survey was unable to penetrate through the dense peaty/clay soil which attenuated much of the radar energy at about 0.5m limiting the depth penetration within the substrata.

### **Electrical Resistance Tomography**

The ERT data were inverted by using the RES2dinv software to obtain a detailed image of the subsurface. Two profiles were recorded in a cross configuration using the wenner array (Figs 5-7, GFS1 and GFS2) with each profile 36m in length with electrodes set 1m apart.

Two types of inversion models have been produced for both profiles. The least-squares inversion produces a model with a reasonably smooth variation in the resistivity values. In contrast, the robust inversion method is useful in that this method allows for sharp boundaries when these are expected to be present in the dataset. In this particular case this has allowed for sharp boundaries of the impact crater.

GFS1 clearly shows the outline of the impact crater (Fig 6, 1) as a low resistance anomaly (20-24 ohms.m). The high resistance (yellow-red) at the surface denotes the clay soil that appears to retain little moisture at the surface.

GFS2 was surveyed orthogonally to GFS1. The profile surveyed is slightly off centre to the impact crater recorded by magnetometer. Despite that, the results clearly show the impact crater at a depth of (Fig 7).

### **Metal Detecting Survey**

A metal detecting survey was undertaken by the Great Fen Archaeology Group under the guidance of Jo Richardson, Jigsaw Project, Oxford Archaeology East. This was carried out at the time the geophysical survey was carried out.

The non-intrusive metal detecting survey was carried with each reading for aluminium was flagged and plotted to illustrate the debris field from the impact. The result illustrated in figure 8 clearly shows a good correlation with the magnetometer plot.



However, the survey is ongoing and further metal detecting will be carried out during the excavation.

## **7.0 CONCLUSIONS**

The survey has successfully identified the remains of Spitfire X4593. The magnetometer survey located the impact crater containing the remains of the highly magnetic Merlin engine. The magnetic signature from the survey suggests that the engine and associated aircraft components lie at a depth of up to 3m.

Individual magnetic anomalies were also detected in close vicinity of the impact crater halo indicating fragmented pieces of the spitfire.

To the north of the remains, a linear dipolar anomaly was detected denoting the presence of a land drain.

The GPR survey failed to locate the engine and outline of the impact crater due to the nature of the soils in this area.

ERT profiles successfully recorded the width and depth of the impact crater containing the remains of the Spitfire engine.

The metal detecting survey produced a good correlation with the magnetometer survey.

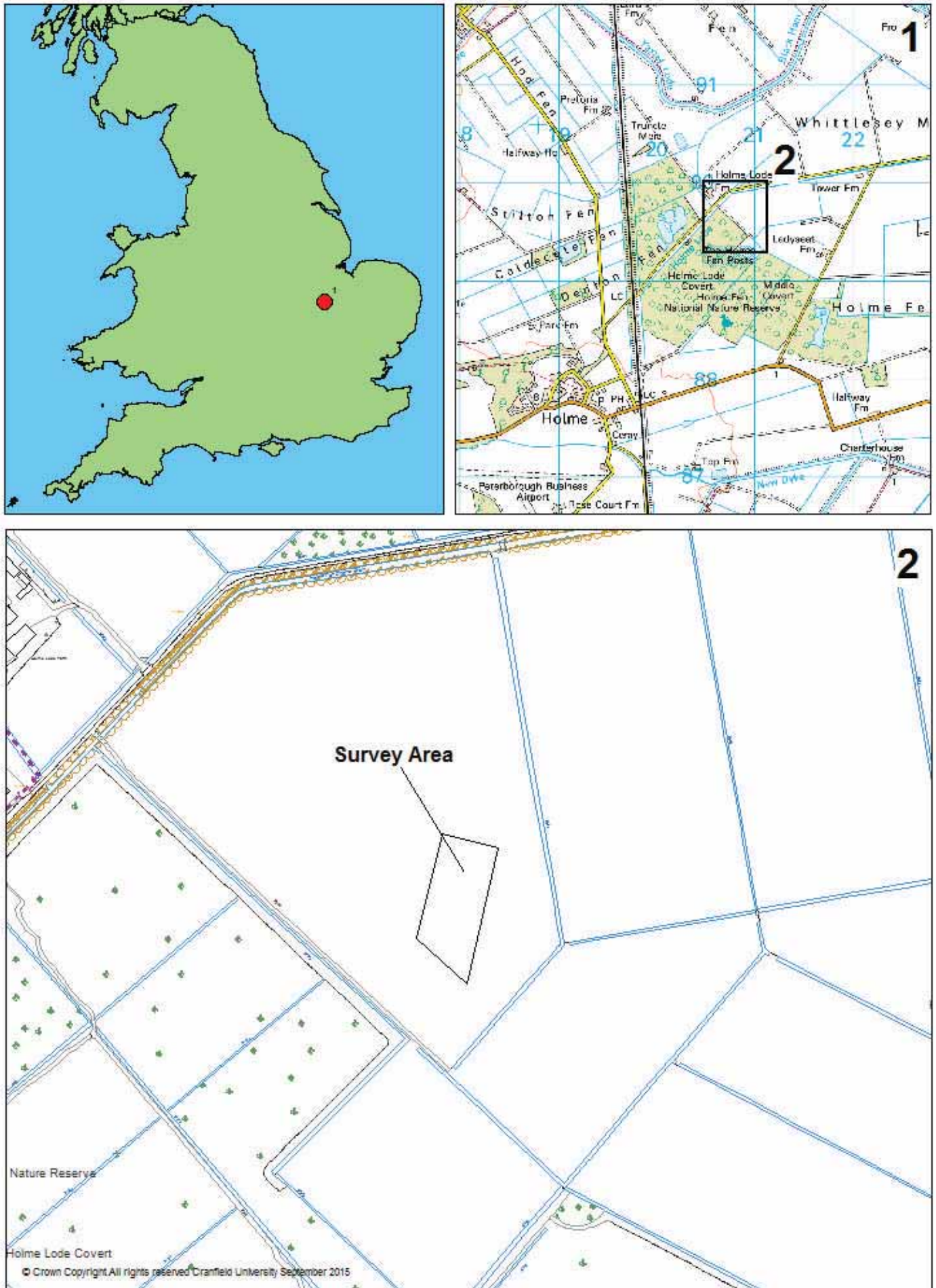
## **8.0 ACKNOWLEDGEMENTS**

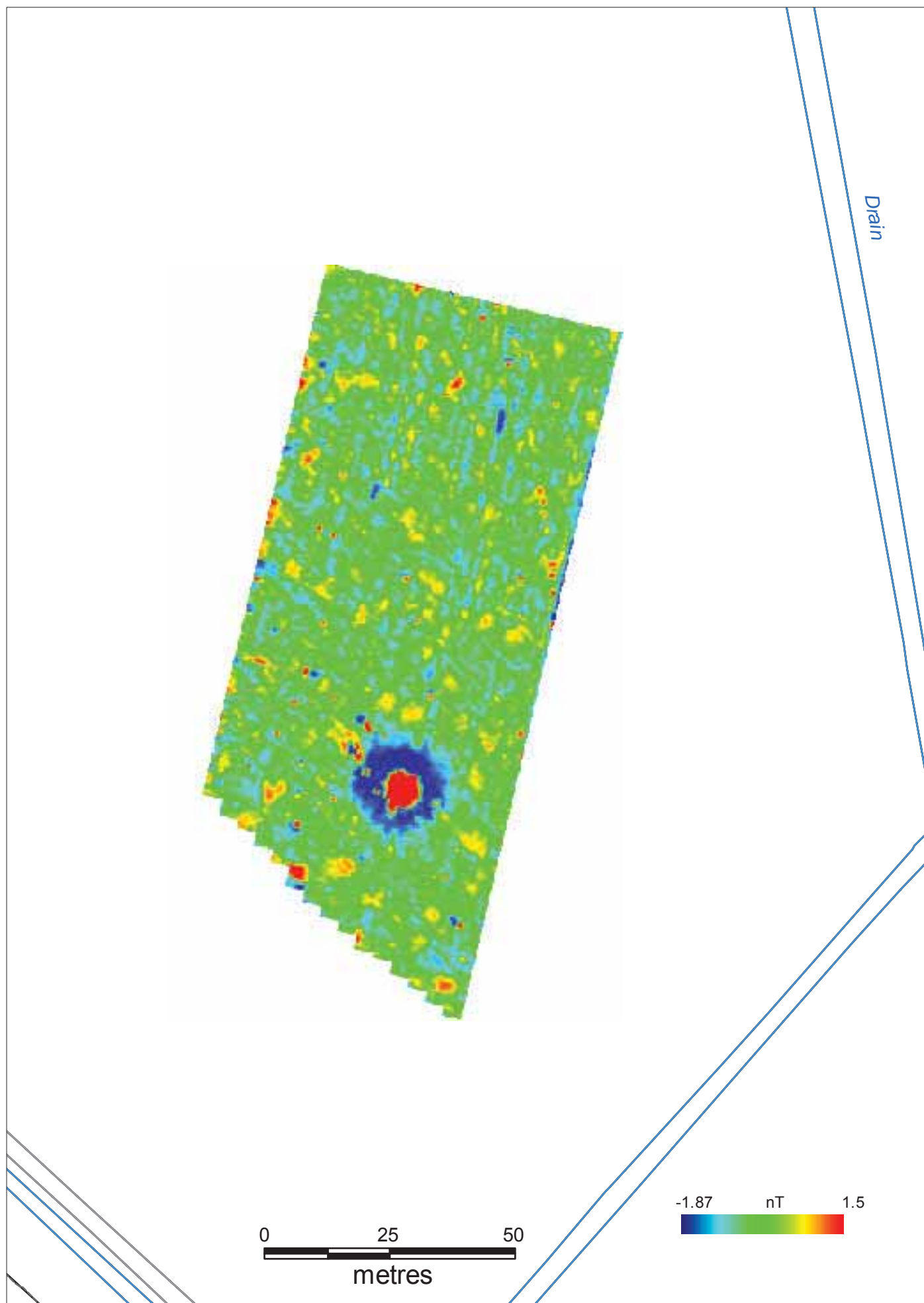
Cranfield University, Centre for Archaeological and Forensic Analysis would like to thank Stephen Macaulay for this commission. I would also like to thank the Great Fen Archaeology Group for undertaking the metal detecting survey which has clearly enhanced the geophysical survey results. Additionally, I would like to thank Matt Guy, Geomatrix Earthscience Ltd for his help and advice in processing the ERT data.

## **9.0 BIBLIOGRAPHY**

- Clark, A. J. 1990 *Seeing Beneath the Soil* London, Batsford
- E.H. 2008 *Geophysical Survey in Archaeological Field Evaluation*. London, English Heritage: Research & Professional Guidelines No.1. 2<sup>nd</sup> Edition
- Gaffney, C. 2003 *Revealing the Buried Past – Geophysics for the Archaeologist*, Tempus publishing.
- Loke, M.H. 2001 Tutorial: 2-D and 3-D electrical imaging surveys. Geotomo Software, Malaysia.

- Macaulay, S. 2015 *Specification for Archaeological Excavation – Holme Fen Spitfire X4593*. Oxford Archaeology East Project No. 15683.
- Schmidt, A. 2013 *Earth Resistance for Archaeologists*, Altamira Press.

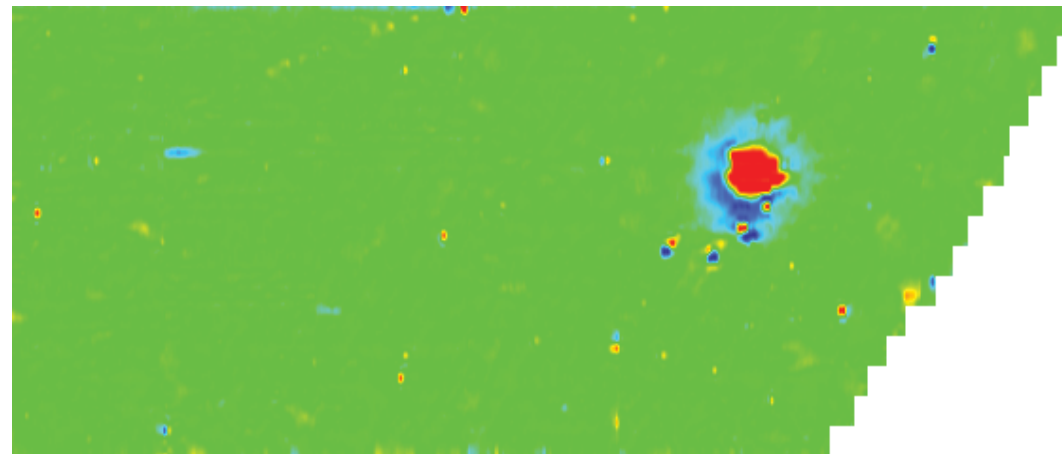




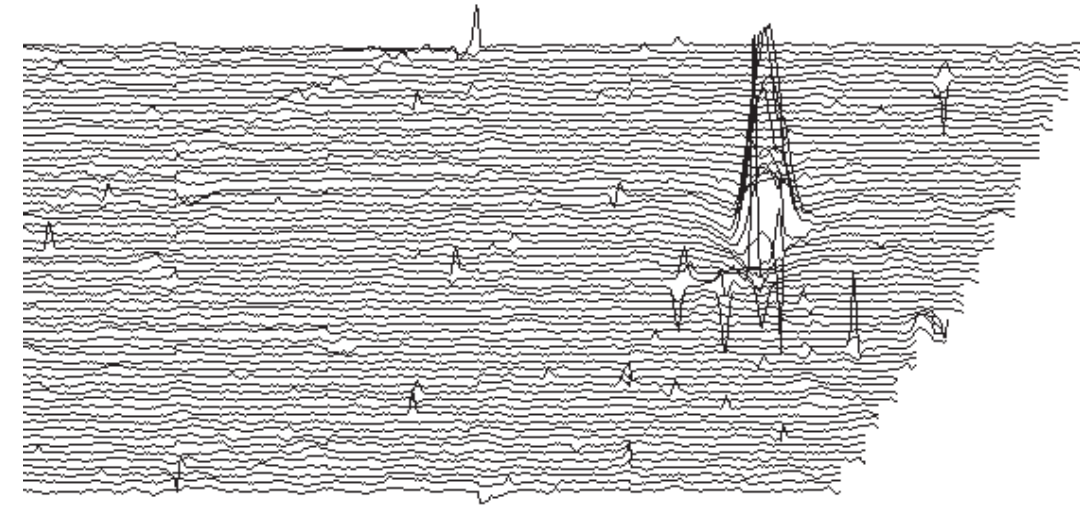
**Fig 2: Location of gradiometer survey, scale - 1:1000**



RAW DATA



TRACE PLOT



ENHANCED DATA

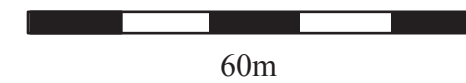
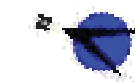
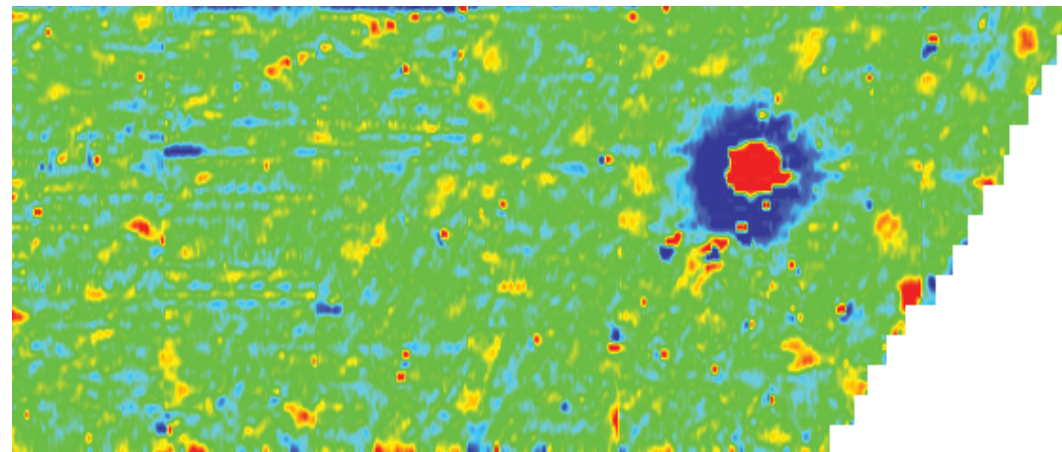
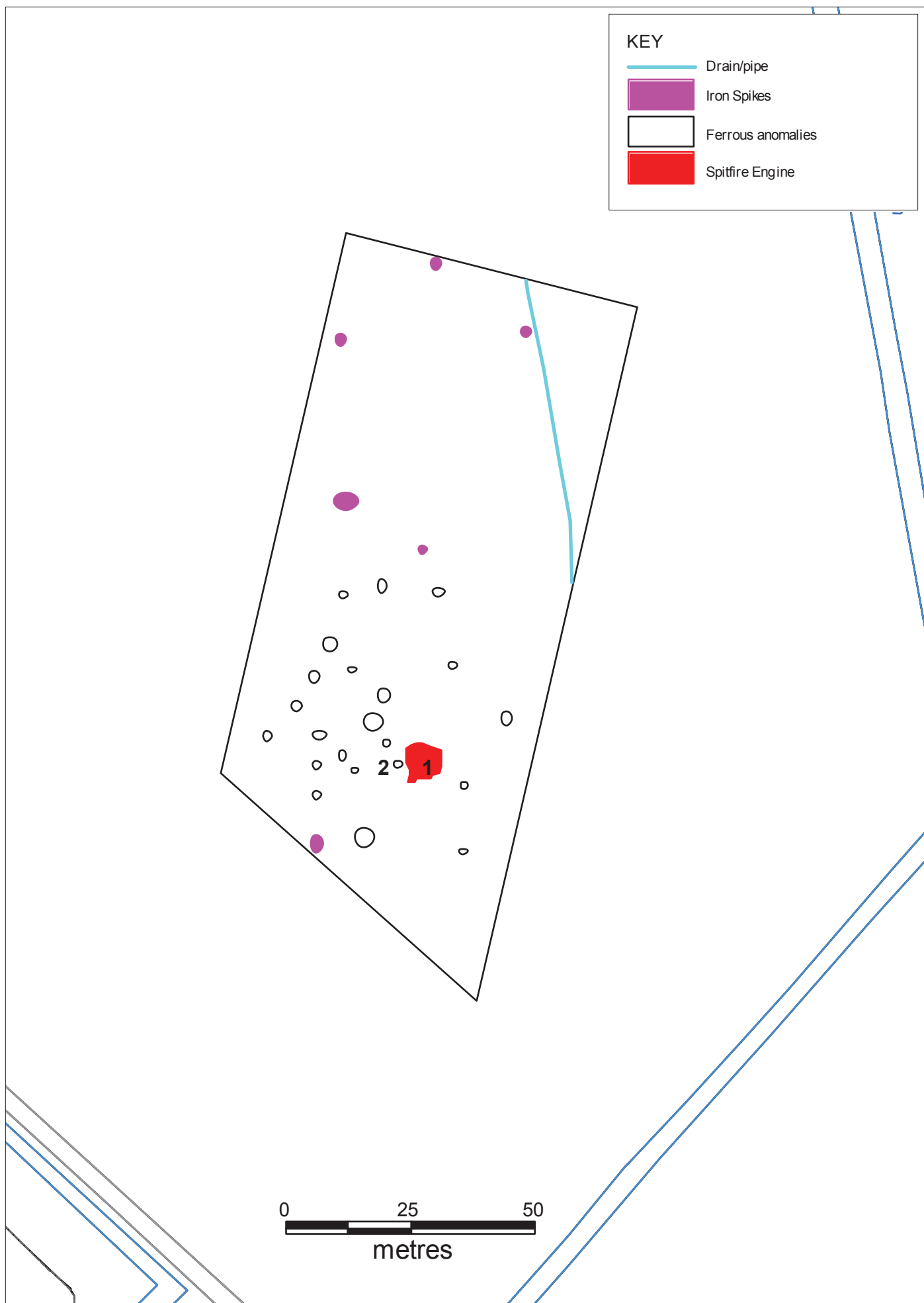
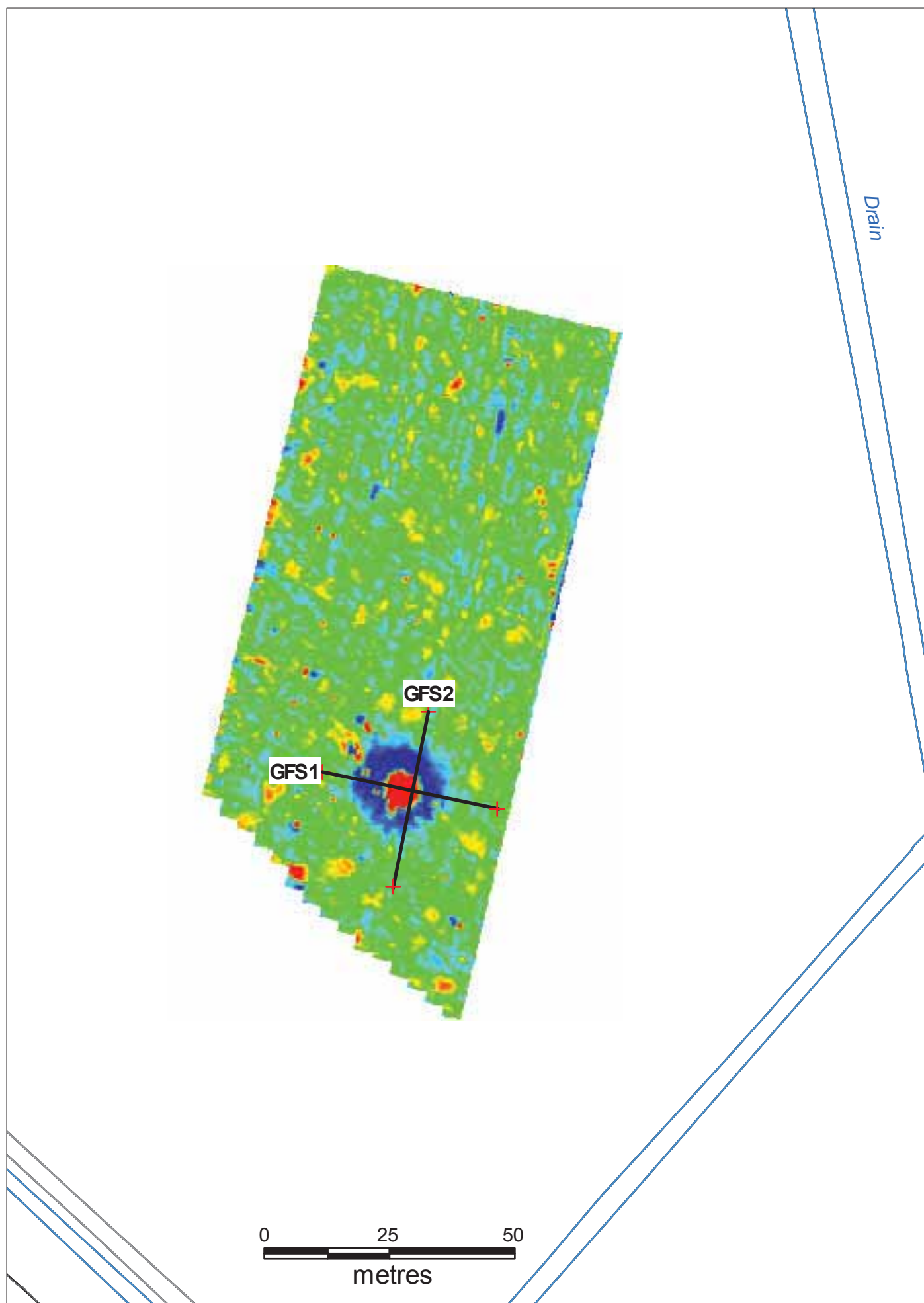


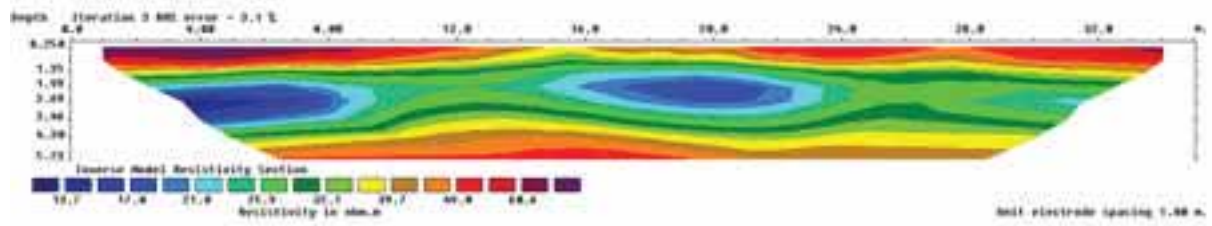
FIG. 3: Gradiometer Survey – Grey scale and trace plots of raw and enhanced data, scale – 1:1000



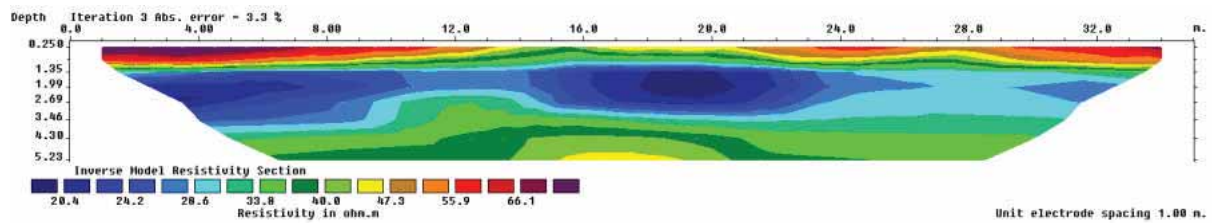
**Fig 4: Interpretation of gradiometer results, scale - 1:1000.**



**Fig 5: Location of ERT profiles in relation to the gradiometer survey, scale - 1:1000**



Standard least-squares smoothness-constrain



Robust Inversion model constrain

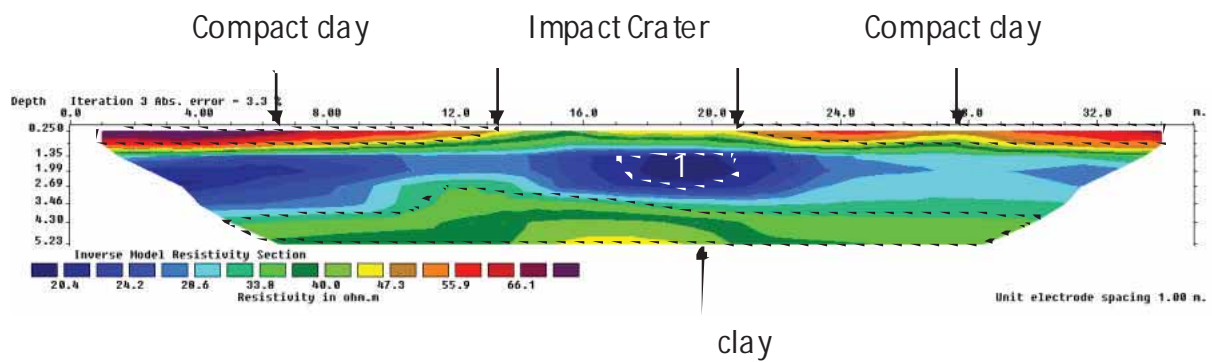
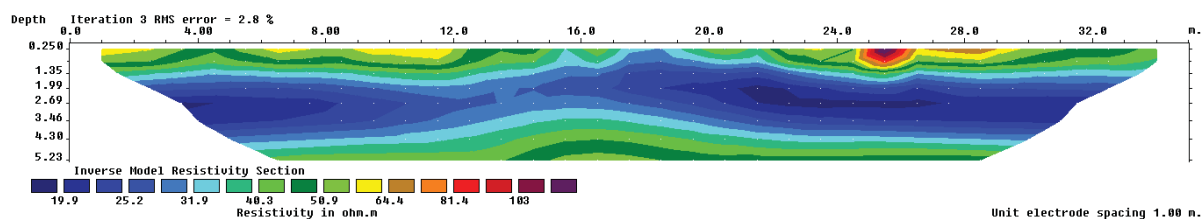
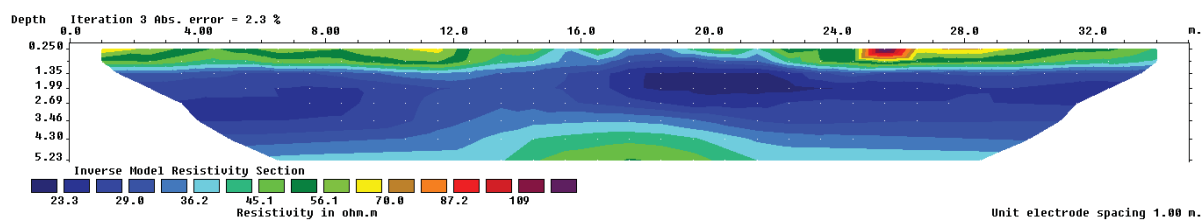


FIG. 6: ERT pseudosection of GFS1 across the centre of the impact crater





Standard least-squares smoothness-constrain



Robust Inversion model constrain

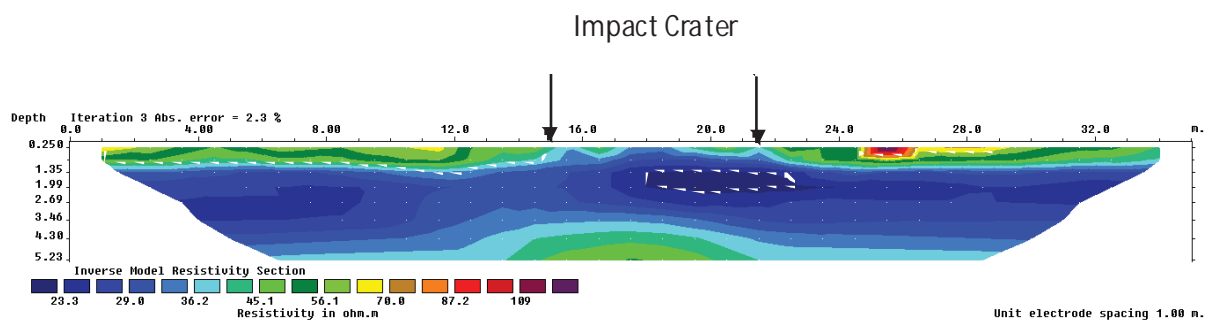
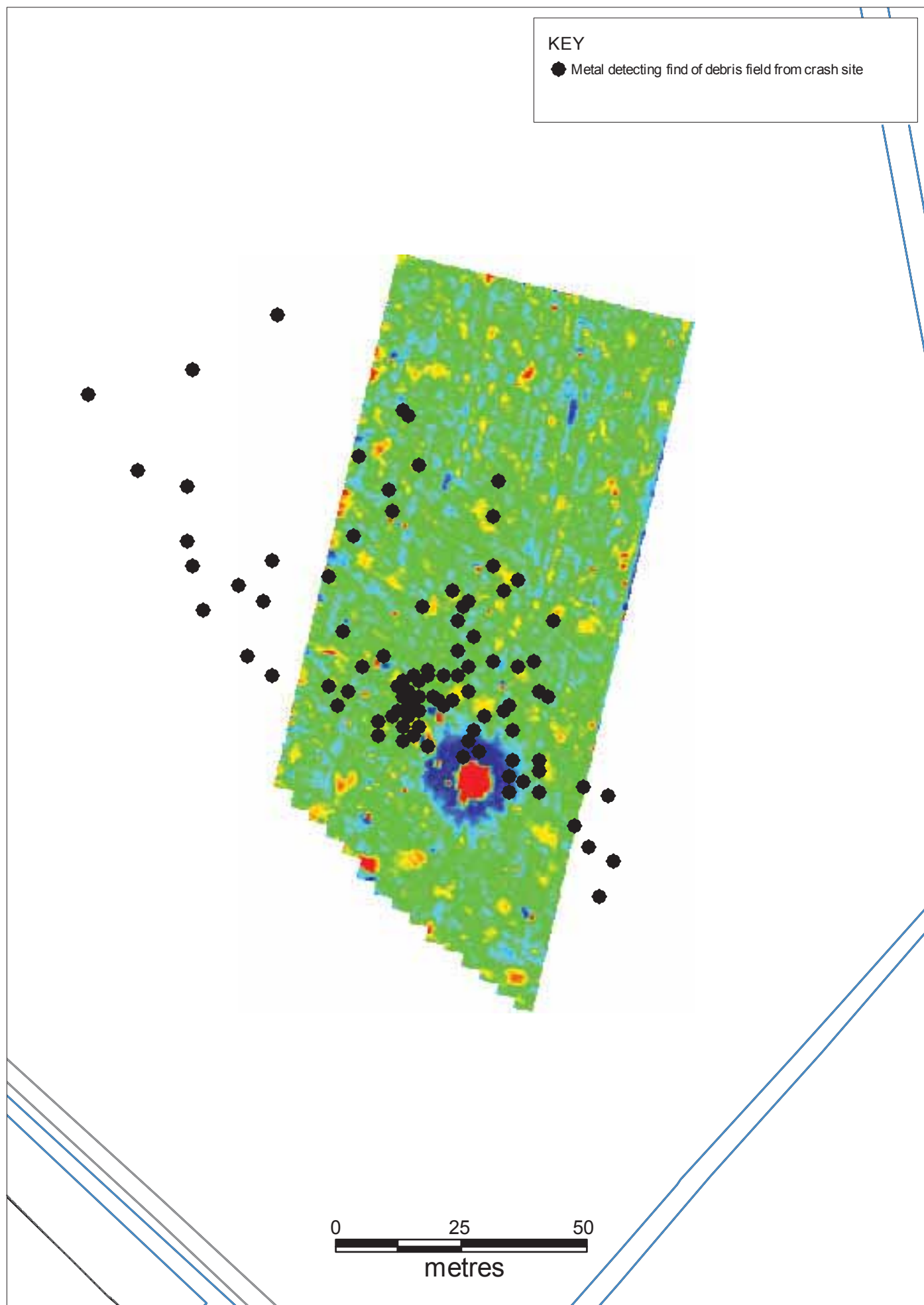


FIG. 7: ERT pseudo section of GFS2 across the impact crater



**Fig 8: Metal detecting finds in relation to the gradiometer survey results, scale - 1:1000**

## APPENDIX F. JCCC LICENSE FOR THE EXCAVATION OF X4593



Ministry  
of Defence

**Defence Business Services**

Joint Casualty and Compassionate Centre  
Imjin Barracks  
Gloucester  
GL3 1HW

Tel: 01452 712612 Ext 7330 or 6303  
Fax: 01452 510813  
95471 Ext 7330 or 6303

Mr S Macaulay  
Oxford Archaeology East  
15 Trafalgar Way  
Bar Hill  
Cambridge  
CB23 8SQ

Date: 5 May 2015

Dear Mr Macaulay

**Protection of Military Remains Act 1986**

We are pleased to tell you that we can issue Licence number 1804 for the excavation of Spitfire serial number X4593.

**The Licence**

The licence allows you to excavate this aircraft under the Protection of Military Remains Act 1986. It is valid for one year.

**Before starting the excavation:**

- **you must contact** Sally Croft, Senior Archaeologist, Cambridgeshire County Council SH1011, Shire Hall, Cambridgeshire (Tel: 01223 728569) or email: [arch.her@cambridgeshire.gov.uk](mailto:arch.her@cambridgeshire.gov.uk)
- They normally require a detailed project design. If you would like help with this you can contact Richard Osgood, Senior Archaeologist, Defence Infrastructure Organisation (DIO), Telephone 01980 674718 or email [DIOODC-IPSConsArch@mod.uk](mailto:DIOODC-IPSConsArch@mod.uk).
- **you must** tell the landowner, Kate Carver, The Wildlife Trust for Bedfordshire, Cambridgeshire and Northamptonshire, and any tenants. This is because it is the landowner's right to set their own conditions, in addition to those set out in the Licence.
- we recommend you have insurance before you excavate. Please refer to paragraph 2 of the application form.

**During the excavation:**

- **the licensee must be present during the entire excavation**
- **if human remains or live ordnance are found, you must follow the strict conditions given on the Licence.**

**Contact us:**

Your reference:

Our reference: DBS/14/2/11

Commemorations & Licensing:

**Contact Name: Deborah Morgan**  
Tel: 01452 712612 Ext 7330

email external:  
[dbs-jccccommem1@mod.uk](mailto:dbs-jccccommem1@mod.uk)

**Contact Name: Sue Raftree**  
Tel: 01452 712612 Ext 6303

email:  
[dbs-jccccommem1SO3@mod.uk](mailto:dbs-jccccommem1SO3@mod.uk)

This letter has been copied to:  
Landowner  
SMR Officer  
DIO  
EOD

Enclosed:  
Licence  
Report of Items Removed form  
Notes for Guidance

**After the excavation:**

- **you must** complete and return the enclosed Report of Items Removed form, even if nothing is found. If you could also let us have photographs of any items. Please note, a copy of the completed form will be sent to the relevant County Council for their information.
- please note that any items found belong to The Crown until it is agreed by us that they will be transferred to you. Paragraph 19 of the Notes for Guidance refers.
- you will need to give Sally Croft, Senior Archaeologist, Cambridgeshire County Council, a post-excavation report within 3 months of the finished excavation.

**More help or explanation**

Please contact us if you have any questions

Yours sincerely

Deborah Morgan (Mrs)  
Licensing

## **LICENCE UNDER THE PROTECTION OF MILITARY REMAINS ACT 1986**

To: Mr S Macaulay

- 1 The Secretary of State, pursuant to Section 4 of the Protection of Military Remains Act ("the Act"), hereby authorises you and anyone assisting you at your request, to do anything within the area described in the Schedule to this licence ("the Area"), which would otherwise be an offence under Section 2 of the Act.
- 2 The authority granted by this Licence is subject to the following limitations and conditions.
- 3 If at any time you, or anyone assisting you, discover human remains or unexploded ordnance within "the Area":
  - (a) the authority granted by this Licence shall have no further effect, and accordingly all work under this Licence must cease until an officer of the Ministry of Defence tells you that it is operative again.
  - (b) in the case of human remains:
    - (i) you must forthwith telephone the Ministry of Defence (01452-712612 6303/7330), or, if you fail to get an answer, you must inform the police as soon as possible thereafter;
    - (ii) the remains must be treated with due respect at all times.
    - (iii) the presumed identity of the remains is not to be divulged to anyone, except the Ministry of Defence or the police;
    - (iv) no steps are to be taken to trace and notify the next of kin;
  - (c) in the case of unexploded ordnance:
    - (i) you must forthwith inform the police;
    - (ii) you must on no account interfere with it.
- 4 A report of items recovered is to be rendered to the Ministry of Defence upon completion of the recovery operation.
- 5 **This licence takes effect from 0001 on 05 May 2015 and expires at 2359 on 04 May 2016 unless revoked.**

**Licence No:1804**

## **LICENCE UNDER THE PROTECTION OF MILITARY REMAINS ACT 1986**

6. This Licence is given solely for the purposes of the Act and does not:
- (a) entitle you to enter any land;
  - (b) affect the rights of any person (including the Crown) as owner of anything found within "the Area", or as owner of the land within "the Area";
  - (c) entitle you to retain anything found within "the Area";
  - (d) constitute a licence or consent to do anything for which licence or consent is required under any other enactment.

### **THE SCHEDULE**

An area of land having a radius of 100 metres around OS map reference: TL209896

Issued on behalf of  
the Secretary of State  
for Defence

**Licence No: 1804**

## APPENDIX G. P/O HAROLD PENKETH



## Harold Edwin Penketh

*From Aviva archive*

Worked for Ocean Accident and Guarantee Corporation Ltd at the Brighton office

### Round the Ocean Branches

#### BRIGHTON

Brighton Branch of the "Ocean" is happy to have this opportunity of contributing to "The Cuaco Link." Out of the small pre-war staff, six were called to the Colours when war broke out, five being members of the Territorial Army and one in the Volunteer Reserve of the Air Force. The latter, Flying Officer H. E. Penketh, completed his training in the minimum of time, and was one of the first of his Unit to obtain his "wings." It is with regret that we record his death, whilst on Active Service, in early November, 1940. He was of a charming disposition and his loss was keenly felt by those who knew him. Our Claims Inspector, Mr. L. Baker, returned



Flying Officer H. E. Penketh (*Brighton*)

to the office early this year, having been invalided out of the Army, after 15 months' service. Of those members still serving, all have at some time or other visited the Branch whilst on leave, and it has been a pleasure to see and talk with them. Our energetic Branch Manager, Mr. Fredk. L. Morey, is contributing his quota as a Company Commander in the 14th Sussex (Hove) Battalion Home Guard, and his many friends will learn with pleasure that he now bears the distinctive rank of "Major." Of the remaining male Staff, two are serving as part-time members of the A.F.S. and one in the Special Constabulary. To all our staff on Active Service we send warmest greetings, with wishes for a safe and speedy return to days of peace and creative civil duties.

From CWGC

Parents – James & Ann Penketh of Hove

Commemorated at Brighton (Woodvale) Borough Crematorium

<http://www.cwgc.org/find-war-dead/casualty/2722953/PENKETH,%20HAROLD%20EDWIN>

From London Gazette

6<sup>th</sup> October 1940

Commissioned as Pilot Officer

THE LONDON GAZETTE, 5 NOVEMBER, 1940		6399
6th Oct. 1940. (Seniority 29th Sept. 1940.)		
745117 Harold Edwin PENKETH (86399).		
745684 Frank Sydney ROBERTS (86400).		
6th Oct. 1940.		
754636 John Harwood MACKINDER (86401).		
748078 Stanley John THOMPSON (86402).		
745636 Philip Davey WHITE (86403).		
745747 Darrell Stewart Frank WINSLAND (86404).		
748477 Raymond Geoffrey WYATT (86405).		
741414 Frederick Peter FERRIS (86406).		
745027 Peter William JEFFREY (86407).		
754088 Denis Campbell TUFNELL (86408).		
9th Oct. 1940. (Seniority 5th Oct. 1940.)		
742779 Anthony DA COSTA (86409).		
745853 Frederick Wilson FAIRWEATHER (86410).		
9th Oct. 1940. (Seniority 6th Oct. 1940.)		
16th Oct. 1940.		
Andrew Charles FAIRTLUGH (86436).		
Acting Pilot Officer on probation Paul Leslie SCOTT (79003) is graded as Pilot Officer on probation. 14th Sept. 1940.		
The undermentioned Flying Officers are promoted to the rank of Flight Lieutenant:—		
3rd Sept. 1940.		
Nigel Dudley Bigland WOOD (70748).		
Roger de Winton Kelsall WINLAW (72178).		
The undermentioned Pilot Officers are promoted to the rank of Flying Officer:—		
3rd Sept. 1940.		
Donald George JOHNSON (72996).		
Douglas Aubrey CRACKNELL (72985).		
Eric John MARTIN (73004).		
Alan Robert Adair FORBES (72989).		
Kenneth Norman Thomson LEE (72998).		
The Hon. David Arthur COKE (73042).		
Ralph Campbell CHOPPING (70126).		
4th Sept. 1940.		
Harold Ridley BJELKE-PETERSEN (73021).		

From Squadron Operation Record Books held at the National Archive at Kew

National Archive ref Air/27/2109 (Crown copyright)

28<sup>th</sup> October

Posted to 611 Sqn at Digby from 7 Operational Training Unit at Hawarden

National Archive ref Air/27/1558 (Crown copyright)

8<sup>th</sup> November

Posted to 266 Sqn at Wittering

22<sup>nd</sup> November

14:20hrs killed in flying accident.

105

11795 W. 3400/1000 400,000 12/35-4000 40-513438

R.A.F. Form 240

**OPERATIONS RECORD BOOK**

Page No. \_\_\_\_\_

No. of pages used for day \_\_\_\_\_

of (Unit or Formation) No. 265 SQUADRON.

*For instructions for use of this form see R.M. and A.C.I., para. 1140, and War Manual, Pt. II., Chapter XX, and also in R.A.F. Form 2000.*

Place	Date	Time	Summary of Events	References to Appendices
WITTERING	1940 NOV 19th.	-	Average temperature. Thick fog all day. Visibility very poor. No flying.	
	20th.	-	Cold. Rain early clearing p.m. Visibility moderate. Practices included Dog Fighting and Camera Gun attacks.	
	21st.	-	Average temperature. Drizzle during afternoon. Visibility moderate except in drizzle. Practices included Sector reconnaissance - dog fighting - aerobatics - interception cloud flying. Three raid investigations during day. Sgt. LEWIS, R.F. posted to 57 O.T.U. for further training.	See Appendix THIRTEEN.
	22nd.	-	Cold, visibility moderate practices included circuits and landings, Battle climb. Interception practice with aircraft of No. 1 Squadron (Hurricane) Two aircraft Air to Air firing at Sutton Bridge. One raid investigation by three aircraft. Spitfire I X.4593, piloted by P/O. H.E. PENKETH dived into the ground with full engine on at Holme, Hunts, near Upwood aerodrome. Both pilot and aircraft were buried in about 30 ft. of earth. Aircraft identified by piece of engine with number, found near scene of crash. P/O. PENKETH arrived at the Squadron on 8th. inst.	See Appendix FOURTEEN.

266 Sqn ORB states

22<sup>nd</sup> – "Cold, visibility moderate practices included circuits and landings, Battle climb. Interception practice with aircraft of No1 Squadron (Hurricane) Two aircraft Air to Air firing at Sutton Bridge. One raid investigation by three aircraft. Spitfire I X4593, piloted by P/O H E Penketh dived into the ground with full engine on at Holme, Hunts, near Upwood aerodrome. Both pilot and aircraft were buried in about 30ft of earth. Aircraft identified by piece of engine with number, found near scene of crash. P/O Penketh arrived at the Squadron on 8<sup>th</sup> inst."

30<sup>th</sup> – "Cold, severe frost early. Visibility poor. One patrol in Wittering Wing during the morning. Only local flying carried out during afternoon owing to deterioration of the weather. P/O Penketh's body recovered from wreckage of Spitfire X4593 at Holme Fen after a weeks search."

On 26<sup>th</sup> November this report was sent by the CO of RAF Wittering with regard to further investigation.

*Royal Air Force Station  
Wittering,  
Peterborough.*

Witt/427/86/P.I

26<sup>th</sup> November 1940.

### Accident to Spitfire X.4593

22.11.40

Sir,

*I have the honour to refer to No. 266 Squadron A.819 dated 22<sup>nd</sup> November, 1940 and attach herewith Form 765 (c) and a report by the Station Engineer Officer.*

2. Pilot Officer Penketh was on a Battle climb with two other Spitfires at 28,000 feet. He was seen to break away from the formation and go into a dive from which he failed to recover.

3. Pilot Officer Penketh had done 13 hours 15 minutes on a Spitfire could fly it quite well and was fully conversant with the oxygen system.

Moreover, it can be assumed that his oxygen was working for part of the flight, because he had attained 28,000 feet without complaining.

4. Close cross-examination of the witnesses elucidated the fact that the pilot appeared to make no effort to abandon his aircraft by parachute, although from the behaviour of the aircraft just before it hit the ground, it is probable that the pilot was making some effort to control it, which rather indicates that he may have recovered at about that height.

It can only be concluded, therefore, that he fainted due to –

(I) Failure of the Oxygen system

(II) Failure of the pilot himself, due to some physical weakness.

5. It is recommended that no further action be taken.

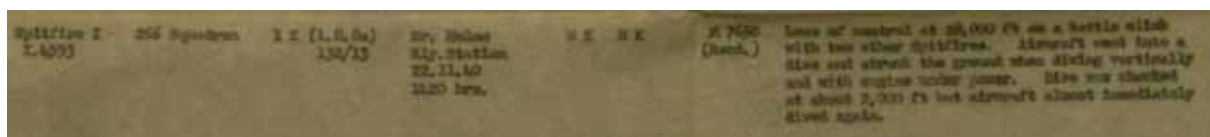
I have the honour to be,

Sir,

Your obedient Servant,

(Signed) RAF Wittering Officer Commanding.

The receipt of the report was recorded



## Spitfire Mk1a X4593

Built by Supermarine at Eastleigh.

Given the name 'Kerala' as a 'presentation' aircraft paid for by readers of the Madras Mail, an English language newspaper of the then Madras Presidency area of India. 2 other Spitfires were provided by the Madras Mail readers.

1st October 1940 First flight, assigned to 8 Maintenance Unit the next day

8<sup>th</sup> October allocated to 603 Sqn at RAF Hornchurch in Essex towards the closing stages of the Battle of Britain. The Spitfire was soon in operational use.

10<sup>th</sup> October flown on a defensive patrol by P/O Soden, during this flight P/O Soden claimed a Messerschmitt Bf109 (German contemporary of the Spitfire) as destroyed.

The Spitfire was used on 2 more operational flights with 603 Sqn

17<sup>th</sup> October it was transferred to 266 Sqn at RAF Wittering

It was used first on the 21<sup>st</sup> of October and then regularly for the next month, with 22 operational flights being recorded.

29<sup>th</sup> October 1940 on the second 'Raid investigation' flight of the day P/O Trousdale was credited with the destruction of a Bf109 whilst flying X4593. The German fighter crashed at Gate Inn Farm, Elham in Kent.

*National Archive ref Air/27/1558 (Crown copyright)*

COPYRIGHT - NOT TO BE REPRODUCED PHOTOGRAPHICALLY WITHOUT PERMISSION						
Aircraft Type and No.	Crew.	Duty.	Time Up.	Time Down.	Details of Battle or Flight.	Reference.
<u>APPENDIX - SPITFIRE SQUADRONS 21.10.40.</u>						
SPITFIRE I.		Raid	1615	1750	Ordered to patrol base from Buxford. Was at 8500 ft.	103
X.4490.	S/Lt. JAMESON.	Investigation.	"	1810	eleven Bf.109's. were spotted at about 3000 ft.	
X.4593.	P/O. TROUSDALE.		"	1755	A short combat ensued but no damage was effected to enemy	
X.7000.	Sgt. COOK.		"	1745	aircraft or ourselves with the exception of a type	
X.4574.	P/Lt. ARMITAGE.		"	1630	badly shot on X.4553 aircraft. The enemy aircraft	
X.6606.	Sgt. ALLEN.		1605	1745	having the advantage of height got away at great	
X.4259.	P/Lt. BAILLY.		"	"	speed. The Squadron was then broken up and later	
X.4594.	P/O. HEDDERLEY.		1615	"	P/O. Trousdale's attention was attracted by a Bf.	
X.3100.	P/O. MITCHELL.				fire. He climbed up into the sun and identified	
					3 aircraft as Bf.109's flying in wide V formation	
					towards S.E. Coast. An engagement followed the result	
					of which one enemy aircraft was brought down burning	
					into flames 10 to 15 miles north of Buxford.	
					<u>APPENDIX - SPITFIRE - 20. 10. 40.</u>	
X.4259.	P/Lt. BAILLY.	-00-	1420	1910	After taking off from Buxford to return to Wittering	
					were detached from rest of Squadron and detailed to	

22<sup>nd</sup> November recorded as crashing 3m NE of Holme. Damage listed as FAC3 (Flying Accident Category3) and finally Struck off Charge on 1<sup>st</sup> December 1940. The total flying time was recorded as 85.05 hrs, of this 29.25 was operational.

X4593 in 266 Sqn markings





## APPENDIX H. BIBLIOGRAPHY

- Begg, C., Boreham, S., and Macaulay, S. 2008 *The Great Fen Project: Archaeological Survey report – Northern Great Fen (Holme Fen and Whittlesey Mere) – Area Above B660*. CAM ARC Report No. 1007 Unpublished
- Boreham, S. 2013 *Borehole Samples* in Haskins (2013)
- Brickley, M and McKinley, J 2004 *Guidelines to the Standards for Recording Human Remains*. IFA Paper No. 7
- Buikstra, J E, and Ubelaker, D H, 1994 *Standards for Data Collection from Human Skeletal Remains*, Arkansas Archaeol Survey Res ser **44**
- Cassa Hatton, R 2002 *The Great Fen Project: An Archaeological Desk-based Assessment*. Cambridgeshire County Council Report No. 208, Unpublished
- Clover, K. and Clarke, G. 2013 *Rymes Reed Bed, Holme, Huntingdonshire Wetland Creation Project (Great Fen Project): Archaeological Preliminary Evaluation report* Oxford Archaeology east Report No. 1438, Unpublished
- Cooper, S, 2005, *Medieval Remains at 96-98 Great Whyte, Ramsey, Cambridgeshire*. AFU report No 824
- Dirkmaat, D. C. 2015 Forensic Anthropology at the Mass Fatality Incident (Commercial Airliner) Crash Scene, in D. C. Dirkmaat (ed) *A Companion to Forensic Anthropology*, pp 136-156, Blackwell Companions to Anthropology, Wiley Blackwell, Chichester
- English Heritage 2008 *Annex to the Protocol Guidance on the use of the Protocol for Reporting Finds of Archaeological Interest in Relation to Aircraft Crash Sites at Sea*.
- Gdaniec, K, 2012, *Rymes Reed Bed, Great fen project, Huntingdonshire: Brief for archaeological investigation*, unpublished
- Godden, G. A. 1964, revised 1991 *Encyclopedia Of British Pottery And Porcelain Marks*, London, Barrie & Jenkins Ltd.
- Haskins, A. 2013 *Monitoring of the excavation of ponds and channels at Rymes Reed Beds, Holme Fen, as part of the Great Fen Project*, Oxford Archaeology East report 1590
- Holyoak, V. and Schofield, J., 2002, *'Military Aircraft Crash Sites: Archaeological guidance on their significance and future management'* English Heritage, Swindon
- Hutchinson, J. N. 1980 *The record of peat wastage in the East Anglian Fenlands at Holme Post, 1848-1978 AD*. Journal of Ecology 68, 229-249.
- Kimmerle E. H. and Baraybar J P 2008 *Skeletal Trauma. Identification of Injuries Resulting from Human Rights Abuse and Armed Conflict*. CRC Press, Boca Raton.
- Macaulay, S. 2015 *Specification for Archaeological Excavation: Holme Fen Spitfire X4593*. Unpublished
- Page, W., Proby, G. and Inskip Ladds, S. (eds) 1974 *Victoria County History of Huntingdonshire, Volume III*. Dawsons of Pall Mall, Folkestone and London
- Waller, M. 1994 *The Fenland Project, Number 9: Flandrian Environmental Change in Fenland*. East Anglian Archaeology Reports No. 70
- Westlake, R. A. 1997, *'Collecting Metal Shoulder Titles'*, no 1373-1375

Electronic sources consulted

<http://pottersmarks.blogspot.co.uk/p/potters-mark-g.html> Consulted on 16/11/2015

<http://www.thepotteries.org/potteries/burgess.htm> Consulted on 16/11/2015

<http://www.ebay.co.uk/itm/Vintage-W-Adams-Sons-Pottery-Blue-Willow-Pattern-Jug-/151881024142?hash=item235cd0828e:g:o~0AAOSwa39U0T4v> Consulted on 16/11/2015

## APPENDIX I. OASIS REPORT FORM

All fields are required unless they are not applicable.

### Project Details

OASIS Number	oxfordar3-230464		
Project Name	Holme Fen Spitfire - X4593		
Project Dates (fieldwork)	Start	05-10-2015	Finish
			10-10-2015
Previous Work (by OA East)	Yes	Future Work	Yes

### Project Reference Codes

Site Code	HOMSPI15	Planning App. No.	N1200729FUL
HER No.	ECB 4366	Related HER/OASIS No.	ECB3893 & ECB4143

### Type of Project/Techniques Used

Prompt	Planning condition
--------	--------------------

### Please select all techniques used:

<input type="checkbox"/> Field Observation (periodic visits)	<input type="checkbox"/> Part Excavation	<input type="checkbox"/> Salvage Record
<input checked="" type="checkbox"/> Full Excavation (100%)	<input type="checkbox"/> Part Survey	<input type="checkbox"/> Systematic Field Walking
<input type="checkbox"/> Full Survey	<input type="checkbox"/> Recorded Observation	<input type="checkbox"/> Systematic Metal Detector Survey
<input type="checkbox"/> Geophysical Survey	<input type="checkbox"/> Remote Operated Vehicle Survey	<input type="checkbox"/> Test Pit Survey
<input type="checkbox"/> Open-Area Excavation	<input type="checkbox"/> Salvage Excavation	<input type="checkbox"/> Watching Brief

### Monument Types/Significant Finds & Their Periods

List feature types using the [NMR Monument Type Thesaurus](#) and significant finds using the [MDA Object type Thesaurus](#) together with their respective periods. If no features/finds were found, please state "none".

Monument	Period	Object	Period
none	None	Aircraft	Modern 1901 to Present
	Select period...	Watch	Modern 1901 to Present
	Select period...	Nail file	Modern 1901 to Present

### Project Location

County	Cambridgeshire	Site Address (including postcode if possible)	
District	Huntingdonshire		
Parish	Holme		
HER	Cambridgeshire		
Study Area	400 sq. M	National Grid Reference	TL2087 8960



## Project Originators

Organisation	OA EAST
Project Brief Originator	Kasia Gdaniec
Project Design Originator	Stephen Macaulay
Project Manager	Stephen Macaulay
Supervisor	Anthony Haskins

## Project Archives

Physical Archive	Digital Archive	Paper Archive
RAF Wyton	OA East	CCC stores
HOMSPI15	HOMSPI15	HOMSPI15

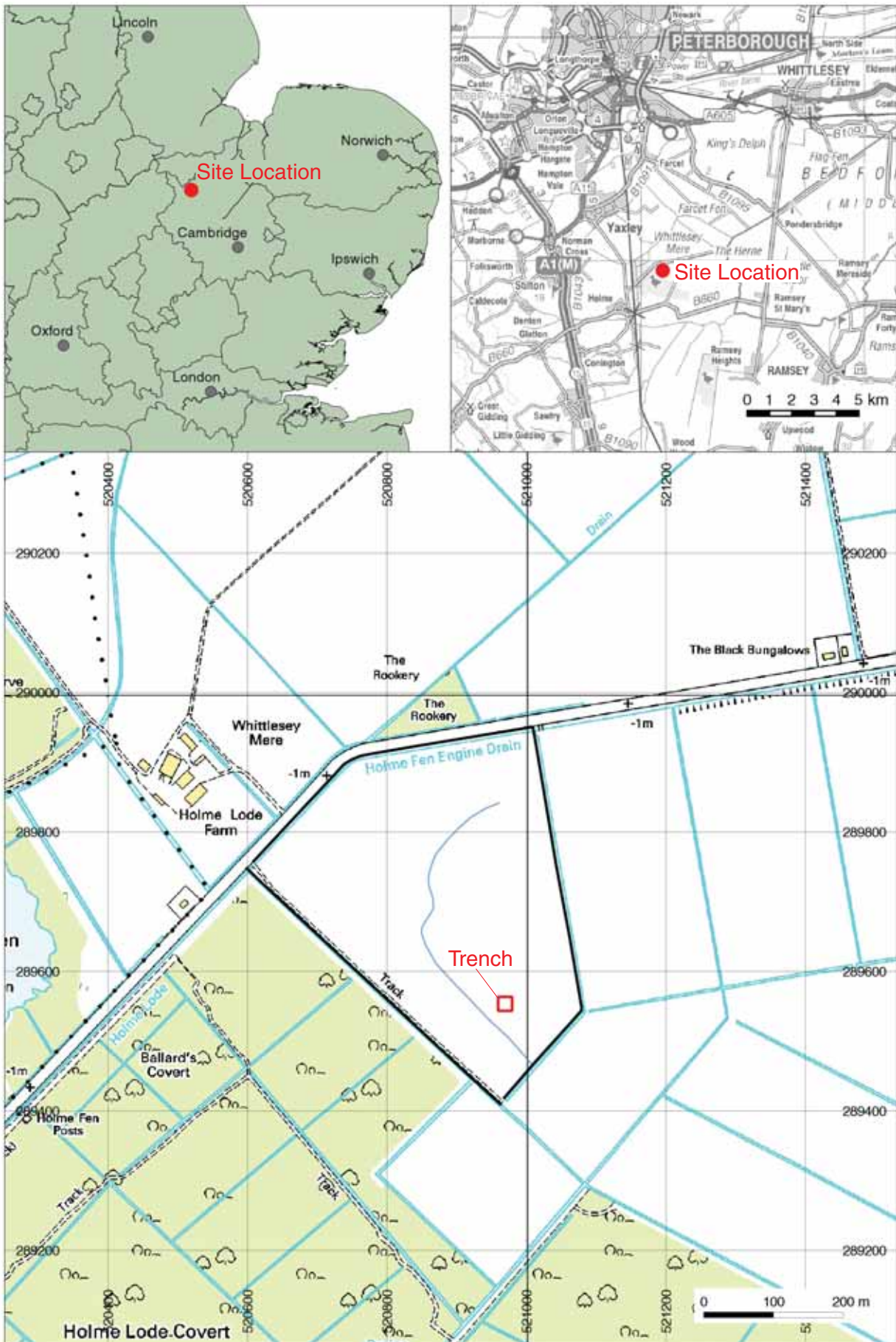
## Archive Contents/Media

	Physical Contents	Digital Contents	Paper Contents
Animal Bones	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Ceramics	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Environmental	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Glass	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Human Bones	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Industrial	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Leather	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Metal	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Stratigraphic		<input type="checkbox"/>	<input type="checkbox"/>
Survey		<input type="checkbox"/>	<input type="checkbox"/>
Textiles	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Wood	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Worked Bone	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Worked Stone/Lithic	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
None	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Digital Media	Paper Media
<input type="checkbox"/> Database	<input type="checkbox"/> Aerial Photos
<input checked="" type="checkbox"/> GIS	<input checked="" type="checkbox"/> Context Sheet
<input checked="" type="checkbox"/> Geophysics	<input type="checkbox"/> Correspondence
<input checked="" type="checkbox"/> Images	<input type="checkbox"/> Diary
<input type="checkbox"/> Illustrations	<input type="checkbox"/> Drawing
<input checked="" type="checkbox"/> Moving Image	<input type="checkbox"/> Manuscript
<input type="checkbox"/> Spreadsheets	<input type="checkbox"/> Map
<input checked="" type="checkbox"/> Survey	<input type="checkbox"/> Matrices
<input type="checkbox"/> Text	<input type="checkbox"/> Microfilm
<input type="checkbox"/> Virtual Reality	<input type="checkbox"/> Misc.
	<input type="checkbox"/> Research/Notes
	<input type="checkbox"/> Photos
	<input type="checkbox"/> Plans
	<input type="checkbox"/> Report
	<input type="checkbox"/> Sections
	<input type="checkbox"/> Survey

### Notes:

Spitfire Mk 1a, Pilots boot, Gloves, 2 x socks, uniform, flying jacket, helmet/flying hat, communicator, RAF refined white ware plate, Small cup/other pottery, Button, Gordons Shoulder flash, 0.303 Ammunition, Wooden planks, First aid bag



Contains Ordnance Survey data © Crown copyright and database right 2016. All rights reserved.

Figure 1: Site location showing archaeological trench (red)

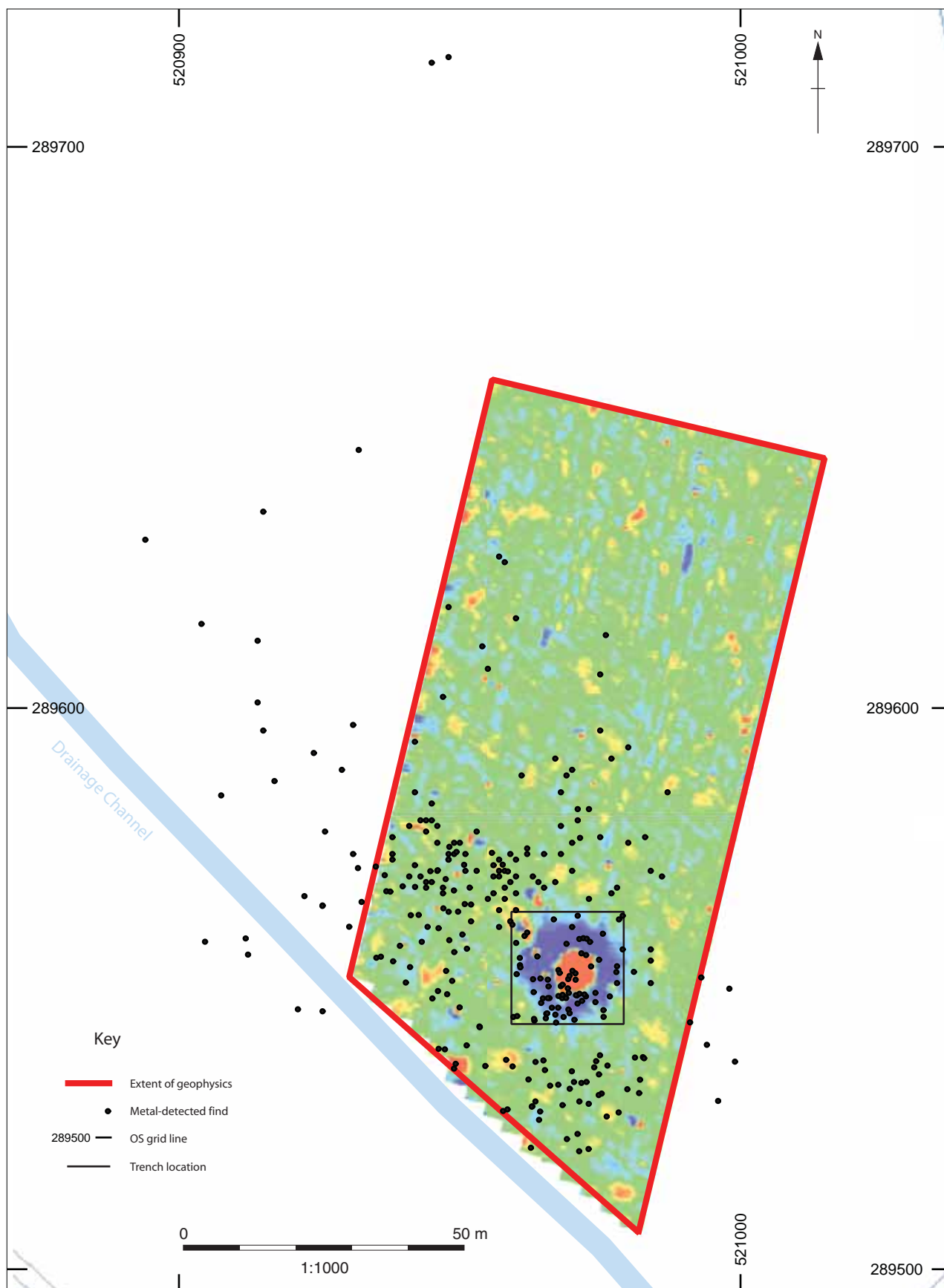


Figure 2: Geophysics & metal-detecting results

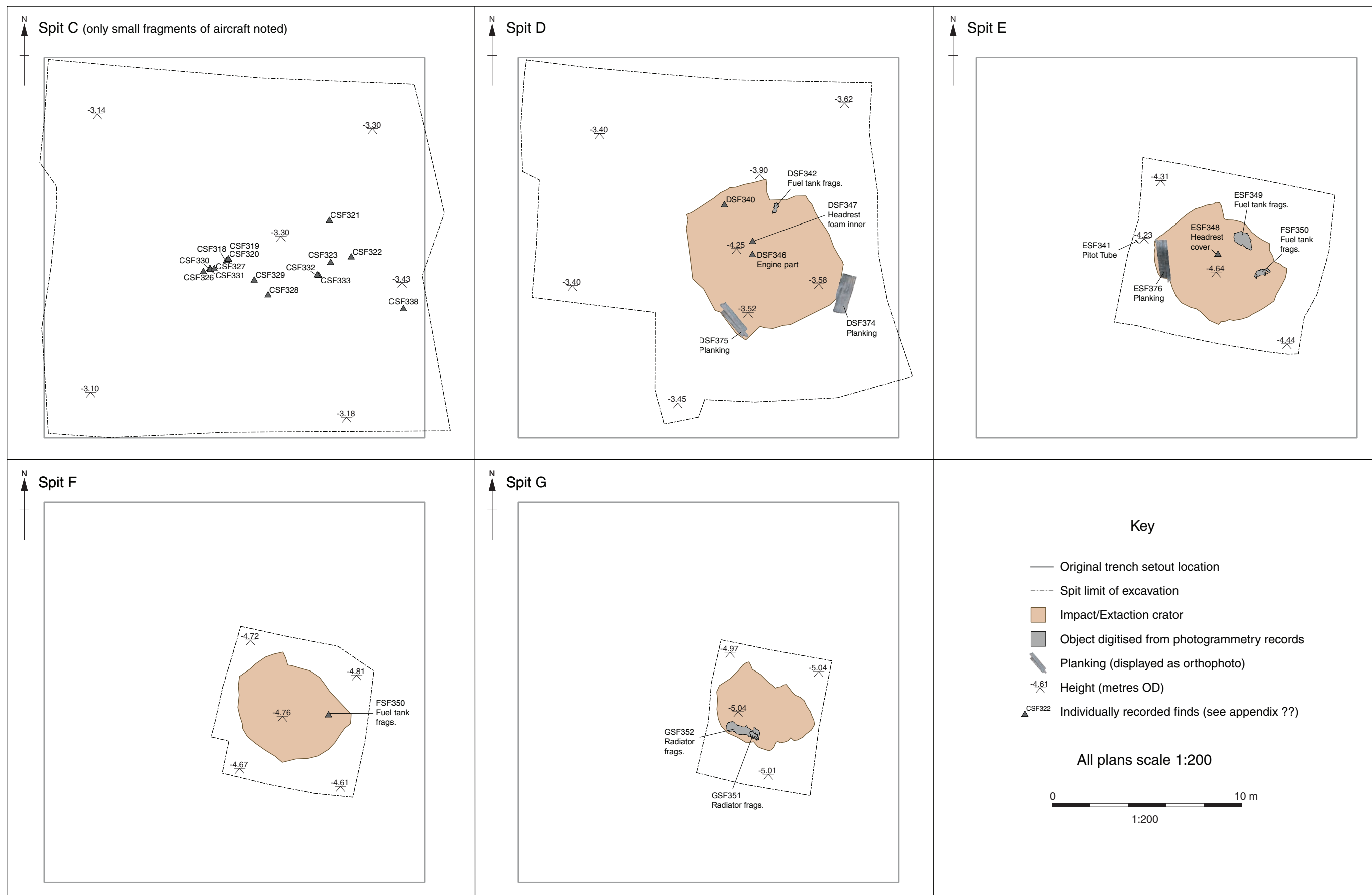


Figure 3: The excavation sequence (Spits C-G), showing all finds recorded in-situ by photogrammetry and/or 3D locating

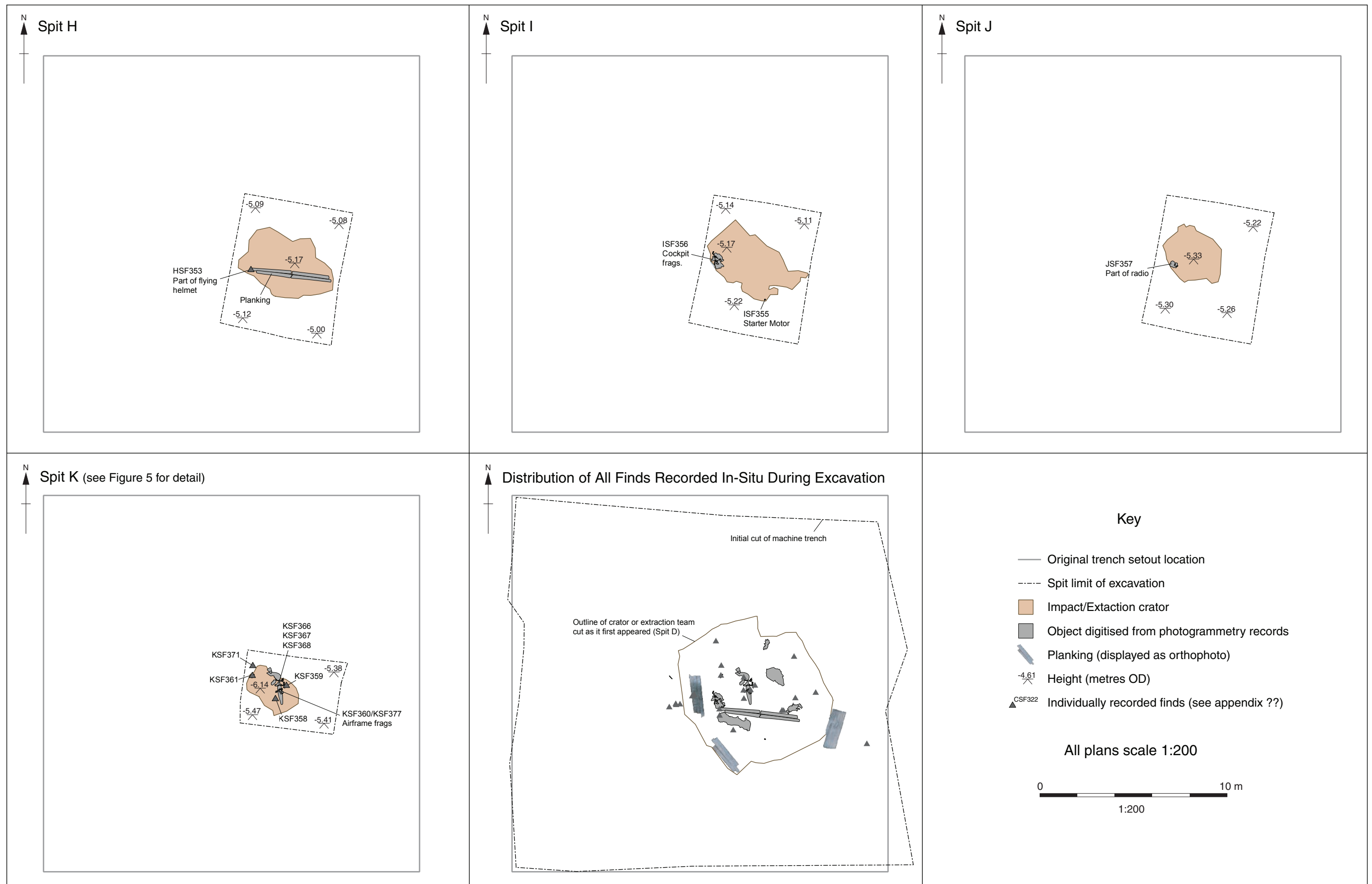


Figure 4: The excavation sequence (Spits H-K), showing all finds recorded in-situ by photogrammetry and/or 3D locating



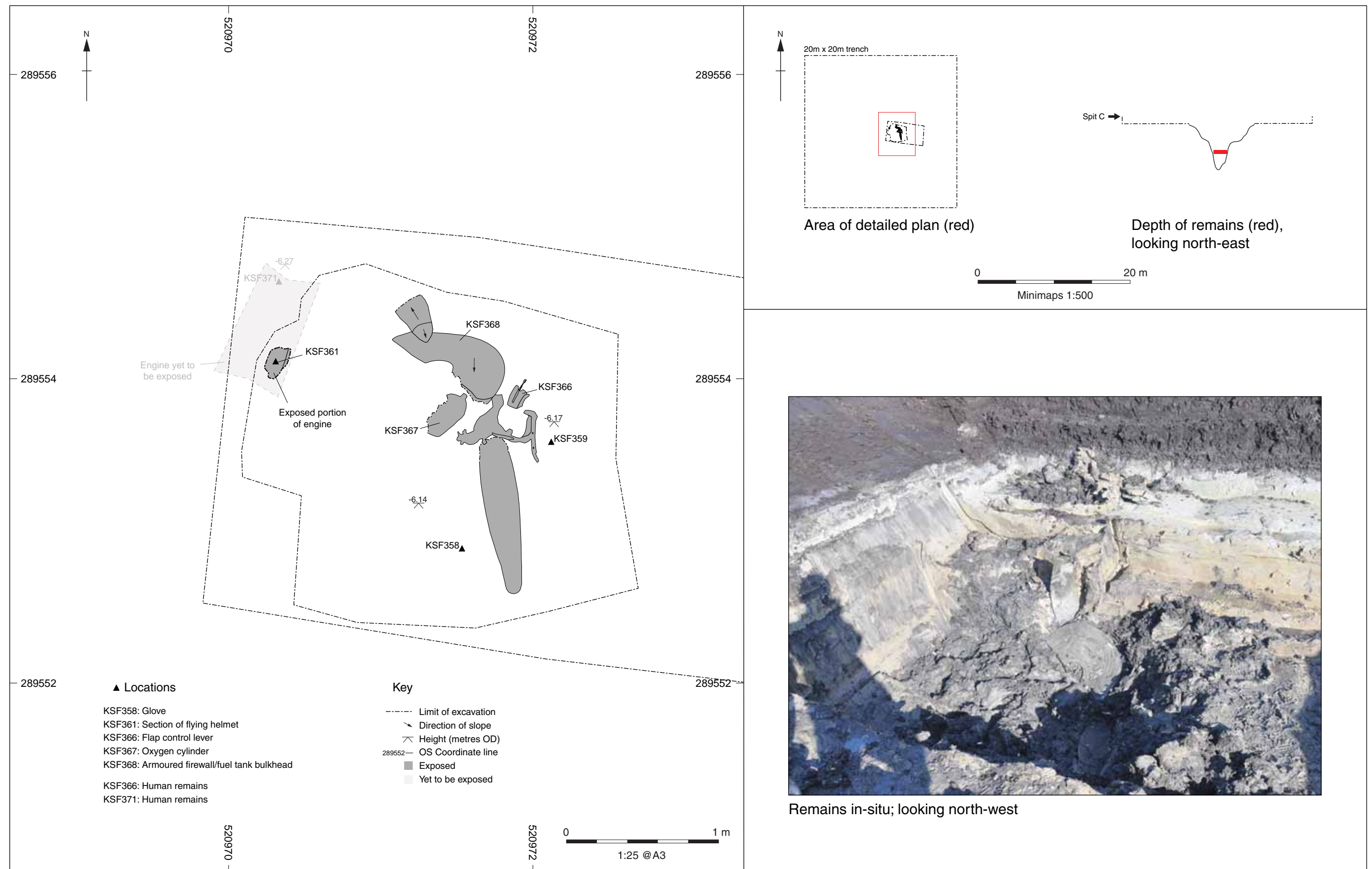


Figure 5: Detailed plan of in-situ aircraft parts encountered during the excavation of Spit K, with the locations of human remains marked. Location and depth within overall trench inset top.

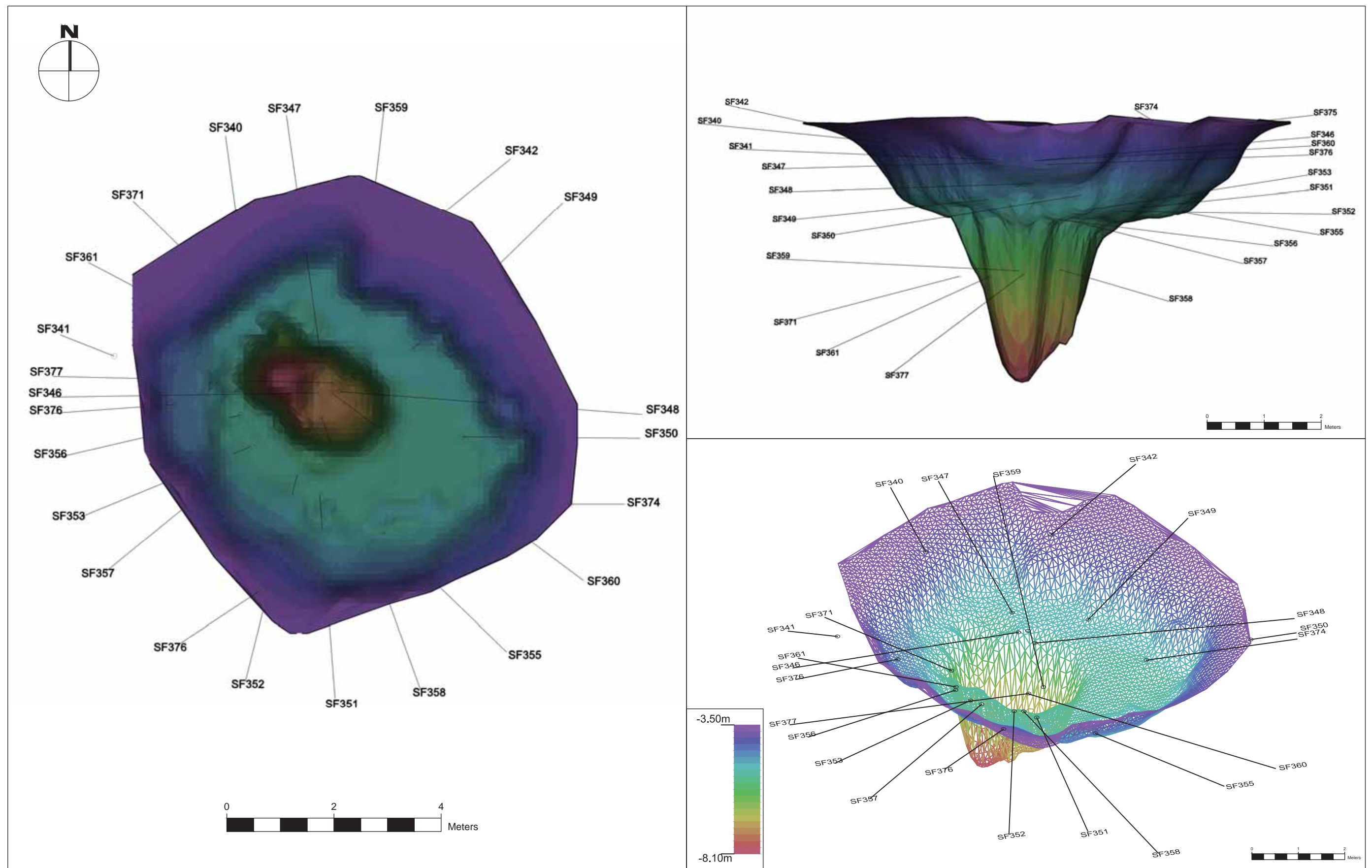


Figure 6: Views of extraction/impact crater, showing 3D located finds

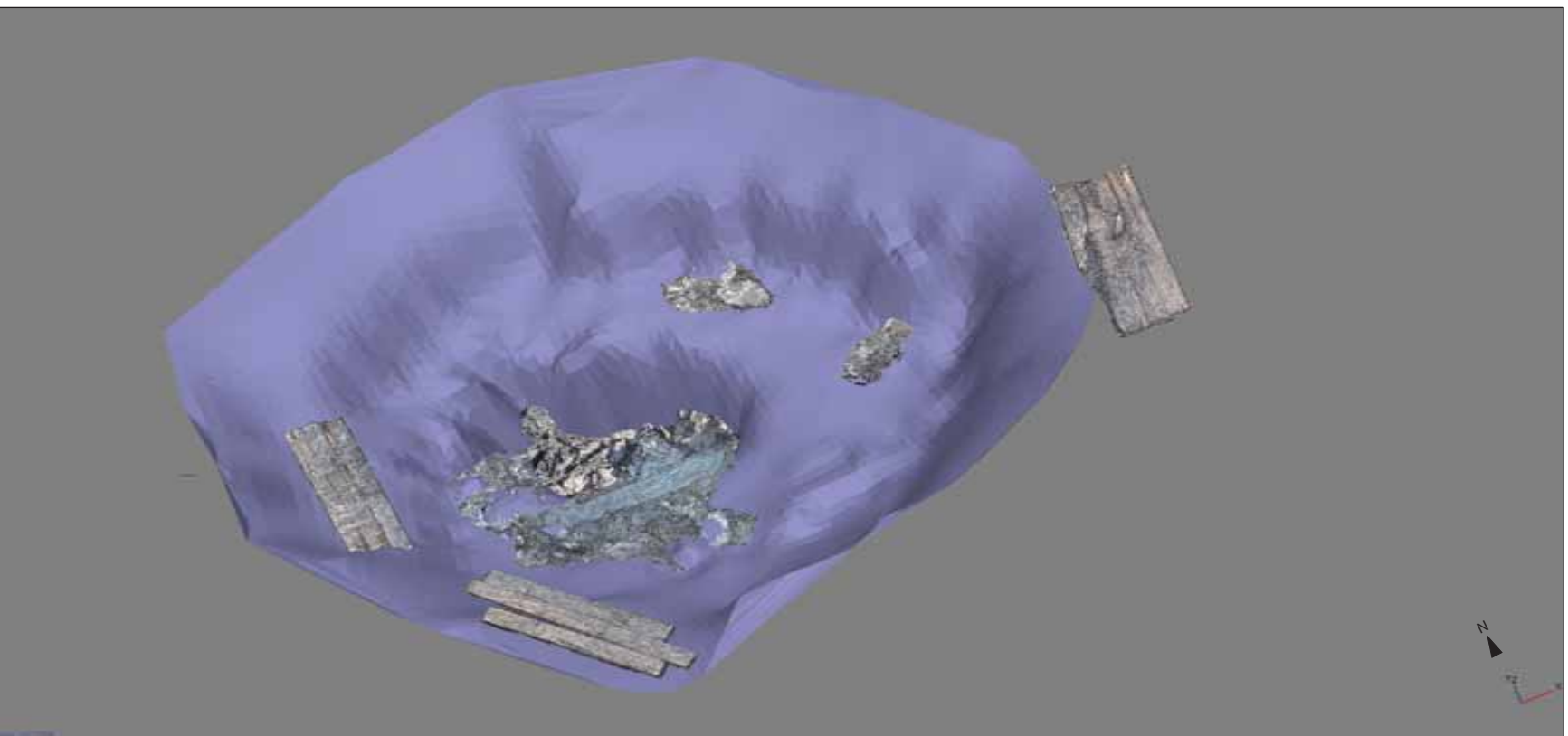


Figure 7: Representation of results of photogrammetry





Plate 1: Top of recovery excavation after degraded peat had been removed



Plate 2: 1940's recovery excavation



Plate 3: 1940's recovery excavation at top of gault clay



Plate 4: Top of original impact crater





Plate 5: Impact crater under going excavation



Plate 6: Hand excavation of plank and pilots flying helmet



Plate 7: Hand excavation of pilots flying helmet, during BBC Countryfile filming



Plate 8: Part of the site team recording the excavation





Plate 9: Part of the site team during excavation



Plate 10: Machine excavation of the crater



Plate 11: Recording of the top of the propeller



Plate 12: Long arm 360 machine used during the excavation





Plate 13: DGPS locating of the impact crater and use of magnetometer to locate the engine block



Plate 15: The propeller



Plate 14: Metal detecting the spoil heaps



Plate 16: Engine showing the surviving Rolls Royce



Plate 17: Engine during cleaning at RAF Wytton



Plate 18: Propeller and engine on site prior to transport to RAF Wytton



Plate 19: Propeller and engine on site prior to transport to RAF Wytton



Plate 20: Foam interior of Pilots headrest





Plate 22: Pitot tube



Plate 24: Brake fluid pressure gauge



Plate 21: Oxygen cylinder



Plate 23: Supermarine spitfire rudder pedal





Plate 25b: Ammunition showing manufacturing and date stamps



Plate 26: Gordons highlanders shoulder flash



Plate 25a: Ammunition showing manufacturing and date stamps



Plate 25c: Ammunition showing manufacturing and date stamps



Plate 27: RAF plate



Plate 28: Brass uniform button



Plate 29: Planks undergoing excavation



Plate 30: Rubber glove used by the recovery team





Plate 32: Communicator from flying helmet



Plate 34: P/O Penkeths Cigarette case



Plate 31: Pilots flying helmet



Plate 33: P/O Penkeths Cuff Link



Plate 36: P/O Penkeths nail file



Plate 38: Finds waiting to be cleaned



Plate 35: P/O Penkeths watch, the time of the crash can just be made out as c.14.23



Plate 37: Cleaning the finds on site





Plate 39: Finds waiting to be cleaned



Plate 40: The Oxford Archaeology East site team



Plate 41: Jigsaw Volunteers



Plate 42: Jigsaw Volunteers with Jemima and Jo



Plate 43: Oxford Archaeology Project team, the wildlife trust team, Pete masters, Flt Sgt P. 'Yoda' Atkinson and Peter Stanley



#### **Head Office/Registered Office/ OA South**

Janus House  
Osney Mead  
Oxford OX2 0ES

t: +44 (0) 1865 263 800  
f: +44 (0) 1865 793 496  
e: [info@oxfordarchaeology.com](mailto:info@oxfordarchaeology.com)  
w: <http://oxfordarchaeology.com>

#### **OA North**

Mill 3  
Moor Lane  
Lancaster LA1 1QD

t: +44 (0) 1524 541 000  
f: +44 (0) 1524 848 606  
e: [oanorth@oxfordarchaeology.com](mailto: oanorth@oxfordarchaeology.com)  
w: <http://oxfordarchaeology.com>

#### **OA East**

15 Trafalgar Way  
Bar Hill  
Cambridgeshire  
CB23 8SQ

t: +44 (0) 1223 850500  
e: [oaeast@oxfordarchaeology.com](mailto: oaeast@oxfordarchaeology.com)  
w: <http://oxfordarchaeology.com>



**Director:** Gill Hey, BA PhD FSA MCIFA  
*Oxford Archaeology Ltd is a  
Private Limited Company, N<sup>o</sup>: 1618597  
and a Registered Charity, N<sup>o</sup>: 285627*