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Dartmoor and Upper Plym Valley

Aerial monitoring of scheduled monuments on the English Heritage Estate

Katy Whitaker and Olaf Bayer

Volume 1 of 1

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Front cover image: Bronze Age settlements and post-medieval features in Trowlesworthy Warren, Upper Plym Valley. [Damian Grady © Historic England Archive, detail of HEA_S3360_V_1545 30-MAR-2021]

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Summary

The Dartmoor and Upper Plym Valley: aerial monitoring of scheduled monuments on the English Heritage Estate project was designed to develop methods and provide baseline data to the English Heritage Trust (EHT) to enable assessment of change over time using aerial sources. This work was carried out on scheduled monuments and other archaeological features within four guardianship sites on Dartmoor, Devon. These were: Grimspound, Merrivale Prehistoric Settlement, Hound Tor Deserted Medieval Village and the Upper Plym Valley. The methods devised will be used alongside other approaches to ensure that these nationally important monuments continue to be managed, conserved and presented for the benefit of the public. A summary of the technical specification and methods used to capture and process new aerial imagery for monitoring purposes is given in the report. Historic England aerial investigation methods were applied to new imagery, archive aerial photographs and airborne laser scanning datasets (lidar) to create baseline archaeological mapping. This is the first record of the form and extent of archaeological monuments within the guardianship sites to benefit from the spatial accuracy afforded by precisely geo-located aerial sources. The report provides an overview of the management and research histories of the four guardianship sites; a summary of key aerial investigation and mapping findings; and aerial imagery documenting aspects of vegetation history and erosion at the guardianship sites during the 20th and 21st centuries.

Contributors

Katy Whitaker completed aerial investigation and mapping, undertook field visits to all sites and wrote the report. Olaf Bayer wrote research histories of the four guardianship sites and took Remote-controlled aircraft (drone) aerial photography, which was processed by Matthew Bristow. Olaf Bayer also undertook field visits to all sites and contributed to report illustrations. Damian Grady took light aircraft-derived aerial photography which was processed by David Knight. Elaine Jamieson made site visits to Merrivale and Upper Plym Valley to establish ground control points for aerial orthophotography. Rebecca Pullen undertook field visits and feature-checking at Merrivale and Grimspound. Sally Evans project-managed and provided an editorial role (Historic England).

Acknowledgements

Images © Historic England Archive unless otherwise credited. Permission was granted for drone flights at Merrivale, Grimspound and Hound Tor by the landowners, EHT and Dartmoor National Park Authority. The authors thank staff at the EHT and Dartmoor National Park Authority for providing support and advice throughout the project. Thanks to Helen Winton who developed the original project design with EHT partners. Thanks also to Historic England Archive staff and Devon Historic Environment Record for supply of aerial photographs and Dartmoor National Park Authority Historic Environment Record for archaeological datasets.

Archive location

Historic England Archive, The Engine House, Fire Fly Avenue, Swindon, SN2 2EH.

Date of survey/research/investigation

Research and mapping were carried out between October 2022 and May 2023. The report was written in June 2023.

Contact details

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Table 1: Mapping layer content and drawing conventions.

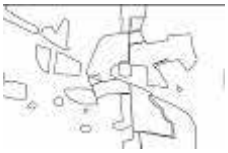
Layer name	Layer content	Layer colour	Feature type	
MONUMENT_ POLYGON	Polygon encompassing features within a single record	Black	Polygon	
BANK	Polygon for features such as banks, platforms, mounds and spoil heaps	Red	Polygon	
DITCH	Polygon for features such as ditches, hollows, pits or hollow ways	Green	Polygon	
EXTENT_OF_FEATURE	Polygon outlining a feature or group of features such as industrial complexes	Dark grey	Polygon	
RIDGE_AND_ FURROW RIDGE_ AND_FURROW_ ALIGNMENT	Polygon depicting the outline of a ridge and furrow plot Polyline depicting the direction of a plot of ridge and furrow	Blue	Polygon Polyline	
STRUCTURE	Polygon for built features including stone, concrete, metal and wood	Dark grey	Polygon	
SCARP_ SLOPE_EDGE	Polylines in form of a schematic t-hachure depicting break of slope	Dark blue	Polyline	

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Figure 1: Location map. Topography derived from 90m SRTM data courtesy of CGIAR http://srtm.csi.cgiar.org. Other mapping derived from Ordnance Survey open data © Crown copyright and database right 2023.

Introduction

The **Dartmoor and Upper Plym Valley: aerial monitoring of scheduled monuments on the English Heritage Estate** project was carried out by Historic England to provide baseline data to the English Heritage Trust to inform condition monitoring and management of scheduled monuments and other archaeological features within four guardianship sites on Dartmoor, Devon: Grimspound, Merrivale Prehistoric Settlement, Hound Tor Deserted Medieval Village and the Upper Plym Valley (Fig. 1).

The English Heritage Trust (EHT) is a charity that cares for more than 400 historic buildings, monuments and sites in England that range in date from prehistory to the Cold War. This is an internationally-important collection of historic sites, with associated artefact and archive collections, presented to the visiting public and managed by the charity for the benefit of future generations. The properties are guardianship sites. In this instance, 'guardianship sites' means areas taken into guardianship by the Secretary of State under the terms of the Ancient Monuments and Archaeological Areas Act, 1979. The English Heritage Trust carries out the Secretary of State's responsibilities to maintain archaeological monuments in guardianship. Guardianship sites often include scheduled monuments, which are individual archaeological sites also protected under terms of the 1979 Act with the presumption that they will be passed on to future generations in much the same state that we have found them. The Dartmoor National Park Authority is contracted to manage the Grimspound, Merrivale and Hound Tor guardianship sites, whilst the English Heritage Trust manages the Upper Plym Valley site.

The EHT requested that Historic England provide information on methods and data that will enable assessment of change over time for each of the four guardianship sites on Dartmoor. This is necessary to ensure that the nationally important monuments in guardianship continue to be managed, conserved and presented for the benefit of the public. The Historic England Heritage At Risk Register aims to find solutions to stabilise the condition of scheduled monuments and the project results will inform this as the scheduled monument at Hound Tor and scheduled monuments in the Upper Plym Valley are on the Register. At Hound Tor, the principal vulnerability is extensive visitor erosion; in the Upper Plym Valley the principal vulnerability is noted as 'plant growth'.

The project thus aims to develop methods to provide a repeatable benchmark to assess changes over time at all four sites, including vegetation encroachment and impacts of visitor pressure. This should be assessed by repeated aerial photography in future seasons.

The project involved the following components:

- aerial photography from a light aircraft to record sites and larger areas as part of Historic England's routine aerial monitoring of scheduled sites;
- Where required, aerial photography using a drone for more detailed survey and sites on steep hill sides;

- Use of the aerial photographs to create an ortho-photograph, a compilation of photographs rectified to a plan view, to provide a point-in-time visual record of erosion and vegetation at the sites;
- Use of ortho-photographs and visualisations of Digital Surface Models derived from the ortho-photography, archive aerial photographs and airborne laser scanning data to create baseline archaeological GIS data on the form and extent of sites;
- Use the analysis of aerial photographs and lidar to target site visits as required.

The project aimed to demonstrate the efficacy of capturing high resolution vertical aerial imagery, with ground control, in different growing seasons at regular, fixed intervals from platforms including a light aircraft and drones. These will provide a visual record of change on the ground through provision of repeated datasets, processed using Structure from Motion to create accurately geo-located ortho-photographs and Digital Surface Models (see Technical Specifications). They may also be suitable for the application of, for example, Automated Change Detection.

In addition, baseline archaeological data in Geographic Information System (GIS) format was created using the first tranche of new imagery, archive aerial photographs and airborne laser scanning datasets (see Methodology). This baseline is the first record of the archaeological sites' form and extent to benefit from the spatial accuracy afforded by precisely geo-located aerial sources. At Grimspound and Hound Tor Deserted Medieval Village, the scheduled areas extend beyond the guardianship boundaries. In those instances, mapping was continued just beyond the scheduling boundaries and takes into account archaeological features in the environs of the sites' access tracks. At Merrivale Prehistoric Settlement, the area in guardianship encompasses a number of separate scheduled monuments, at least two of which also extend beyond the guardianship boundary. There, mapping was carried just beyond the guardianship boundary. The Upper Plym Valley guardianship area includes 108 scheduled areas and many unscheduled archaeological features. All visible archaeological features within the guardianship boundary were mapped and, for linear archaeological features such as reaves and large area features such as tin streaming and peat cutting, slightly beyond in order to make better sense of the monuments.

This report provides an overview of the management and research histories of the four guardianship sites; a summary of key aerial investigation and mapping findings; and aerial imagery documenting aspects of erosion and vegetation history at the guardianship sites during the 20th century. Methods and the sources used are described in the Technical Specification and Methodology (appendix). The project has resulted in a detailed and accurate depiction of all archaeological features visible on aerial sources within the guardianship sites: the detailed mapping is available through Historic England's Aerial Archaeology Mapping Explorer.

Grimspound

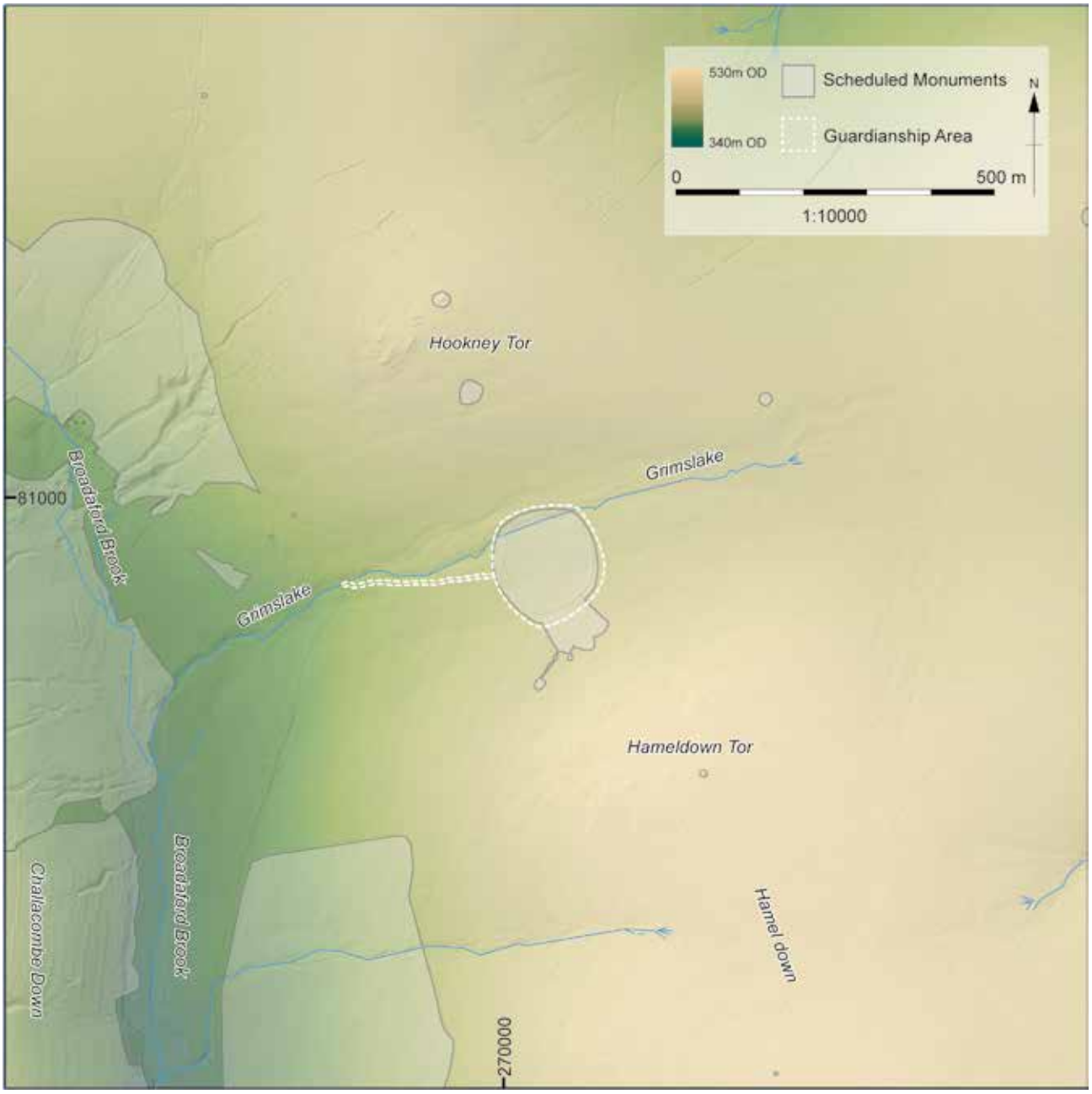


Figure 2: Grimspound location. Height data (above Ordnance Datum (OD)) supplied to Historic England through the APGB agreement by Next Perspectives © Bluesky International/Getmapping PLC. Lidar DSM 11-APR-2021 © Historic England, source Environment Agency. Other mapping derived from Ordnance Survey open data © Crown copyright and database right 2023.

Introduction

Grimspound is located in Manaton parish in north-east Dartmoor (Fig. 2). The site comprises a stone-built enclosure of presumed mid- to late Bronze Age date containing 24 hut circles. The guardianship area is 2.2ha in extent and lies at approximately 450m OD on the western flank of the saddle between Hookney Tor to the north and Hameldown Tor to the south. A small stream called Grimslake rises about 300m to the east and flows through the northern edge of the site. The site is owned by the Duchy of Cornwall and was placed into state guardianship in 1977.

Grimspound was first added to the Schedule of Ancient Monuments in 1928 (NHLE 1014667). The scheduling was amended in 1996. In addition to the substantial stone-built enclosure with its hut circles and other features, the National Heritage List for England schedule entry encompasses an area of unenclosed settlement to the south/south-east. The guardianship site includes only the enclosed hut circle settlement and a pathway to the west.

History of research

A detailed history of research on Grimspound is set out in the Royal Commission on the Historic Monuments of England (RCHME) survey report (RCHME 1991) and is summarised below:

- Grimspound is first mentioned in antiquarian literature of the late 18th century. The first accurate survey of Grimspound was undertaken by Shillibeer in 1829 (reproduced by Pattison and Fletcher 1996, 22-4);
- Substantial excavation and restoration were undertaken at Grimspound in the late 19th century by the Dartmoor Exploration Committee of the Devonshire Association (Baring-Gould et al 1894 & 1895);
- Further restoration work was carried out by the then Devon Archaeological Exploration Society in the 1960s (DAES 1963 & 1964).

The most recent detailed recording of the site was carried out by the Royal Commission on the Historical Monuments of England (RCHME 1991). This work consists of an analytical survey of the site at a scale of 1:500, more detailed plans of 22 (of the 24), internal hut circles at a scale of 1:50, and profiles of the enclosure wall at a scale of 1:50. This work is summarised and contextualised in Pattison and Fletcher (1996). The archive for this work is deposited in the Historic England (HE) Archive under references AF0621339 and PF/GRM.

Grimspound is also covered by Butler's Dartmoor Atlas of Antiquaries (1991, 104-5, 143-145).

Aerial investigation and mapping results

Bronze Age settlement

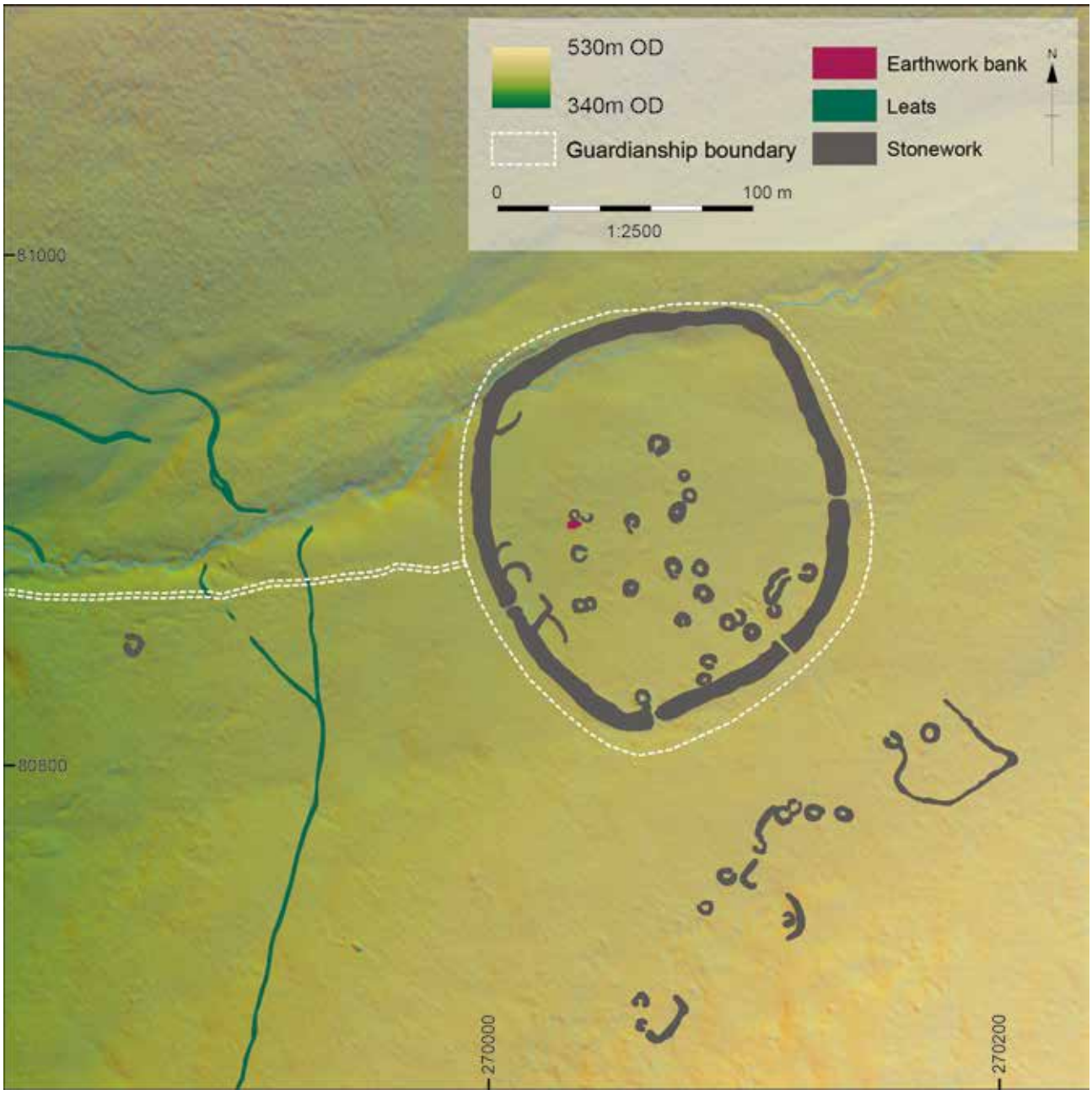


Figure 3: Archaeological features mapped at Grimspound. Archaeological mapping © Historic England. Height data Next Perspectives © Bluesky International/Getmapping PLC. Lidar DSM 11-APR-2021 © Historic England, source Environment Agency.

The enclosed hut circle settlement (Historic England Research Record 445637) is as described in the RCHME survey published in 1991. The substantial rubblestone enclosure wall with its original south-east entrance and later breaks and five walled pens attached to the inside of the enclosure wall were mapped, along with 24 hut circles and a spoil heap at SX 70033 80894 left by the 19th-century Dartmoor Exploration Committee excavations (Fig. 3). These features are largely well-defined in the available imagery, partly because of reconstruction work following the Victorian excavations and partly because weathering and erosion has tended to emphasise the structures by inhibiting vegetation growth.

A possible twenty-fifth hut circle in the enclosure is visible in visualisations of 2021 Environment Agency 1m lidar data. It stands at SX 70125 80875. The feature is a penannular arc approximately 7.4m in diameter from north to south with a west-facing opening. Given the intensity of previous research at Grimspound that has not noted a structure in this location, this identification is tentative but warrants further investigation.

Extra-mural settlement includes an area of hut circles and field boundaries or enclosure walls to the south/south-east (Historic England Research Record 916046) (Fig. 3). At least 12 hut circles, including a conjoined pair, are visible in the available aerial sources. The most substantial enclosure is centred on SX 70179 80801. It contains one hut circle and has a second attached to the enclosure wall. Other walling fragments in the environs are more ephemeral, but investigation during a field visit on 4 February 2023 shows that Bronze Age settlement extends further across the north-west facing hillside (outside this project's scope). Hut circles centred on SX 70133 80781 are impacted by the spread and braiding of the footpath between Hameldown Tor and Grimspound that leads through them.

An unscheduled hut circle standing at SX 69860 80847 (Historic England Research Record 917959), approximately 15m to the south of the main track to Grimspound, was also mapped although a section of prehistoric walling in the environs recorded by RCHME in 1990 was not observed on the available aerial sources (Fig. 3). These features are not included in the guardianship site but are close enough to the trackway to have the potential to be impacted by visitors to the site.

Post-medieval water management

To the west of Grimspound a group of post-medieval leats pass into and out of Grimslake, the stream that runs from east to west through the enclosure. Short sections of these features were mapped for this project, where they are potentially impacted by the track leading between Grimspound and the roadway to the west and by other desire lines leading to the enclosure (Fig. 3). At least three leats (Historic England Research Record 1345326, Historic England Research Record 1345332) follow contours between 415m and 435m OD from the north bank of Grimslake, heading downslope towards the north-west. To the south of Grimslake, one leat (Historic England Research Record 917870) falls from the 445m contour to a fork at SX 69933 80823 from whence two arms curve into the stream. The leats appear to be tied to tinworking to the west, on Headland Warren and in the valley below where the hillsides are scarred by large opencuts.

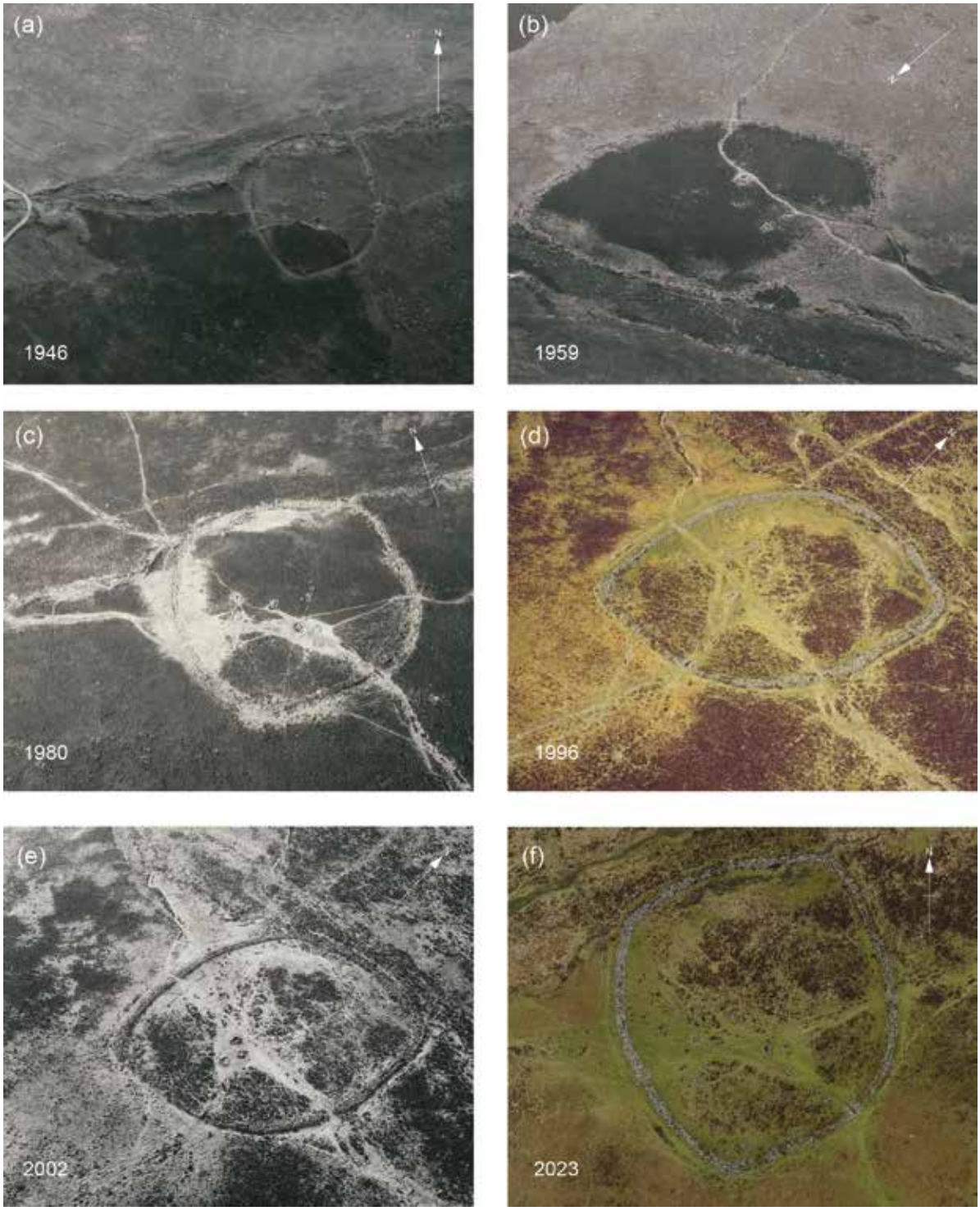


Figure 4: Vegetation change and footpath development at Grimspound, 1946 – 2023 (unscaled photograph extracts, approximate map North indicated). (a) RAF/CPE/UK/1824 3041 04-NOV-1946, Historic England Archive (RAF Photography). (b) HAW9393/07 22-JUL-1959 © Historic England Archive. Harold Wingham Collection. (c) NMR1748/243 23-APR-1980 © Crown copyright. Historic England Archive. (d) NMR15433/08 15-MAY-1996 © Crown copyright. Historic England Archive. (e) NMR21589/14 26-MAR-2002 © Historic England Archive. (f) Structure from Motion ortho-photograph 04-APR-2023 © Historic England.

Vegetation history and erosion

Changing vegetation and some of the impacts of visitors and animals on Grimspound since the Second World War are evident from archive aerial photographs. In the earliest available imagery, Royal Air Force vertical aerial photographs taken on 4 November 1946, the only trackways passing through the enclosure are the south-eastern approach to the monument from Hameldown Tor leading into the original entrance and the roughly east-west oriented former Manaton-Headland Warren footpath passing through breaks in the enclosure wall. In 1946, the south-west quarter of the enclosure and the ground to the south and west is most heavily vegetated with lower growth covering the rest of the enclosure interior (Fig. 4a). In 1959, the situation is largely similar at the time of Harold Wingham's specialist oblique photograph taken on 22 July; two footpaths provide access and the whole of the interior is vegetated in full Summer growth (Fig. 4b).

Evidence for changes in how the site was being accessed over the next 20 years is shown in later photography. In 1980, RCHME specialist oblique aerial photographs taken on 23 April, show a network of tracks criss-crosses the enclosure. In addition to the two established paths, new 'desire lines' (favoured and well-used routes) lead into the enclosure from the north-west using new breaks in the enclosure wall. Paths inside the enclosure between hut circles are more complex and exaggerated. The erosion around the hut circles and features inside the west enclosure wall has inhibited vegetation growth. There is another area of bare ground within the enclosure's northern arc, presumably where tourists but also animal visitors frequent Grimslake, the stream that passes through Grimspound. Outside the enclosure, footpaths are wider and braided. This had an impact on the Bronze Age hut circles and field boundaries outside the enclosure to the south-east (Fig. 4c).

In 1996, this network of trackways is fully established by the date of the RCHME specialist oblique aerial photographs taken on 15 May. In the south-east quarter of the enclosure, the heavy use of paths has reduced previously more vegetated areas down to grass and bare ground. By 1996, the eroded areas within the western and northern enclosure arcs were coterminous and vegetation in the northern half of the enclosure had thinned out (Fig. 4d). The picture is similar in English Heritage specialist oblique aerial photographs taken on 26 March 2002 (Fig. 4e). In 2023, a greater number of the circles inside the enclosure are most clearly visible on the most recent Historic England ortho-photography, dated 4 February (Fig. 4f). Whilst in part due to the high resolution of this imagery, it is also a result of the continued thinning of vegetation especially in the southern part of the enclosure.

Merrivale Prehistoric Settlement

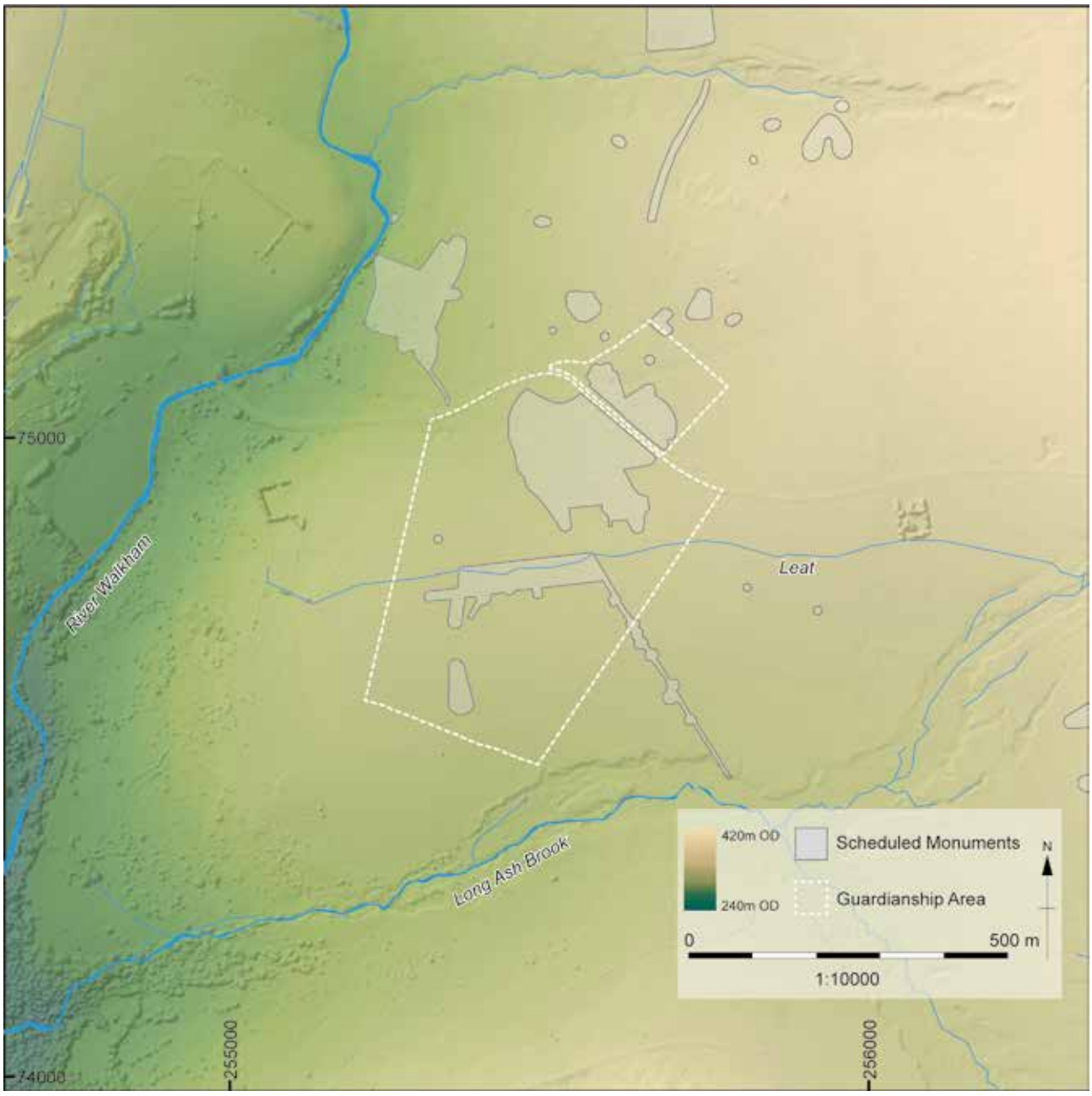


Figure 5: Merrivale Prehistoric Settlement Location. Height data © Bluesky International/ Getmapping PLC. Lidar DSM 11-APR-2021 and 25-FEB-2019 © Historic England, source Environment Agency. Other mapping derived from Ordnance Survey open data © Crown copyright and database right 2023.

Introduction

Merrivale Prehistoric Settlement is located in Walkham parish on the western edge of Dartmoor (Fig. 5). The site comprises a series of ceremonial and funerary monuments of presumed Neolithic, Beaker and Early Bronze Age date; a land division, hut circles and enclosures of presumed mid- to late Bronze Age date; and evidence of post-medieval rabbit farming in the form of a warren, stone cutting, quarrying, Second World War practice trenches, trackways and a leat of post-medieval to 20th-century date. The guardianship area is 23.11ha in extent and straddles the B3357 Tavistock to Princetown road. It lies at between 330m and 370m above Ordnance Datum on the crest of Long Ash Hill, above the Walkham valley. It is ringed by higher ground to the north (Cox Tor, Great Staple Tor, Great Mis Tor), east (Great Hessary Tor), and south (King's Tor) with longer distance views opening to the south-west and west. The site is owned by the Maristow Estate and was placed into state guardianship in 1973.

Archaeological monuments at Merrivale were added to the Schedule of Ancient Monuments at different times during the 20th century. Those within, or partly within, the guardianship site include:

- A partially enclosed stone hut circle settlement, round cairn, post-medieval farmstead, millstone and stone cutting pits 580m ESE of Merrivale Bridge (NHLE 1013427);
- A stone hut circle 650m east of Merrivale Bridge forming part of a partially enclosed stone hut circle settlement (NHLE 1013428);
- Two pillow mounds (artificial rabbit burrows) 660m ENE of Merrivale Bridge, forming part of Merrivale Warren (NHLE 1014672);
- A ring cairn on Longash Common lying 400m south east of Merrivale Bridge (NHLE 1013431);
- Three stone alignments, ten cairns, three stone hut circles and a length of the Great Western Reave on Longash Common (NHLE 1013429);
- A stone circle, standing stone, cairn, recumbent stone and stone alignment on Longash Common (NHLE 1013430).

History of research

Given the site's proximity to historic and current routeways across Dartmoor, Merrivale's prehistoric monuments have long attracted attention. As a result, many of the guardianship site's monuments have been dug into with little or no record. Baring-Gould (1895) provides a summary of 19th-century excavation, damage and reconstruction at the site. His publication includes a plan and a 'birds eye view' of the site.

A series of surveys of the Merrivale Prehistoric Settlement guardianship site were carried

out by EH/RCHME during the 1990s.

- A photogrammetric aerial survey, resulting in a 1:200 scale ‘stone-for-stone’ record of the site with contour lines at 0.25m intervals, was undertaken in 1991 by Photoarc Surveys (commissioned by EH). Survey results are deposited in the Historic England Archive under the reference PF/MPS/001;
- A 1:200 scale survey of the double stone rows, leat and cairns was carried out by RCHME in 1993. The results of this survey are deposited in the Historic England Archive under references 902841 and 902842;
- A further 1:200 scale survey of the leat between the double stone rows was undertaken by RCHME in 1997;
- EH combined these surveys, added further features and interpreted the results during new fieldwork in 1999/2000. This work is published as Probert (2000) and the additional data including survey drawings a 1:500 are deposited with the Historic England Archive under the reference AF1247983;
- The Merrivale guardianship area is also included in Butler’s Dartmoor Atlas of Antiquaries (1994, 23-32, 83).
- Most recently the Merrivale stone rows form a case study in Carnes’ (2014, 32-7) comparison of stone rows in northern Scotland and Dartmoor.

Aerial investigation and mapping results

Ritual and funerary monuments

The presumed Neolithic stone settings and Bronze Age funerary monuments on Longash Common to the south-east of Merrivale village play a significant part in drawing visitors to the locality. See the EH/RCHME surveys published in 2000 for a full description (see above) (Fig. 6).

Two almost parallel double stone rows (northern alignment Historic England Research Record 44005, and southern alignment Historic England Research Record 440056) oriented approximately east-west, occupy Long Ash Hill, constructed perpendicular to the hillside contours. Some 148 stones out of 178 of the shorter, northern alignment were discernible on available aerial sources and 234 out of 245 of the longer, southern alignment. Many of the stones are small, and therefore difficult to detect from the air, but more detail was provided by the newly acquired Historic England 8cm Ground Sampling Distance (GSD) ortho-photography modelled from images captured from a light aircraft on 30 March 2021 (Fig. 7). Only eight stones out of 17 of the third, shorter, ‘branch’ single stone row (Historic England Research Record 440357) were visible on aerial sources, partly because more of the stones in this alignment are flush to the ground surface and because they are obscured by tussocky grass that grows more strongly in areas with less visitor footfall and poaching by livestock.

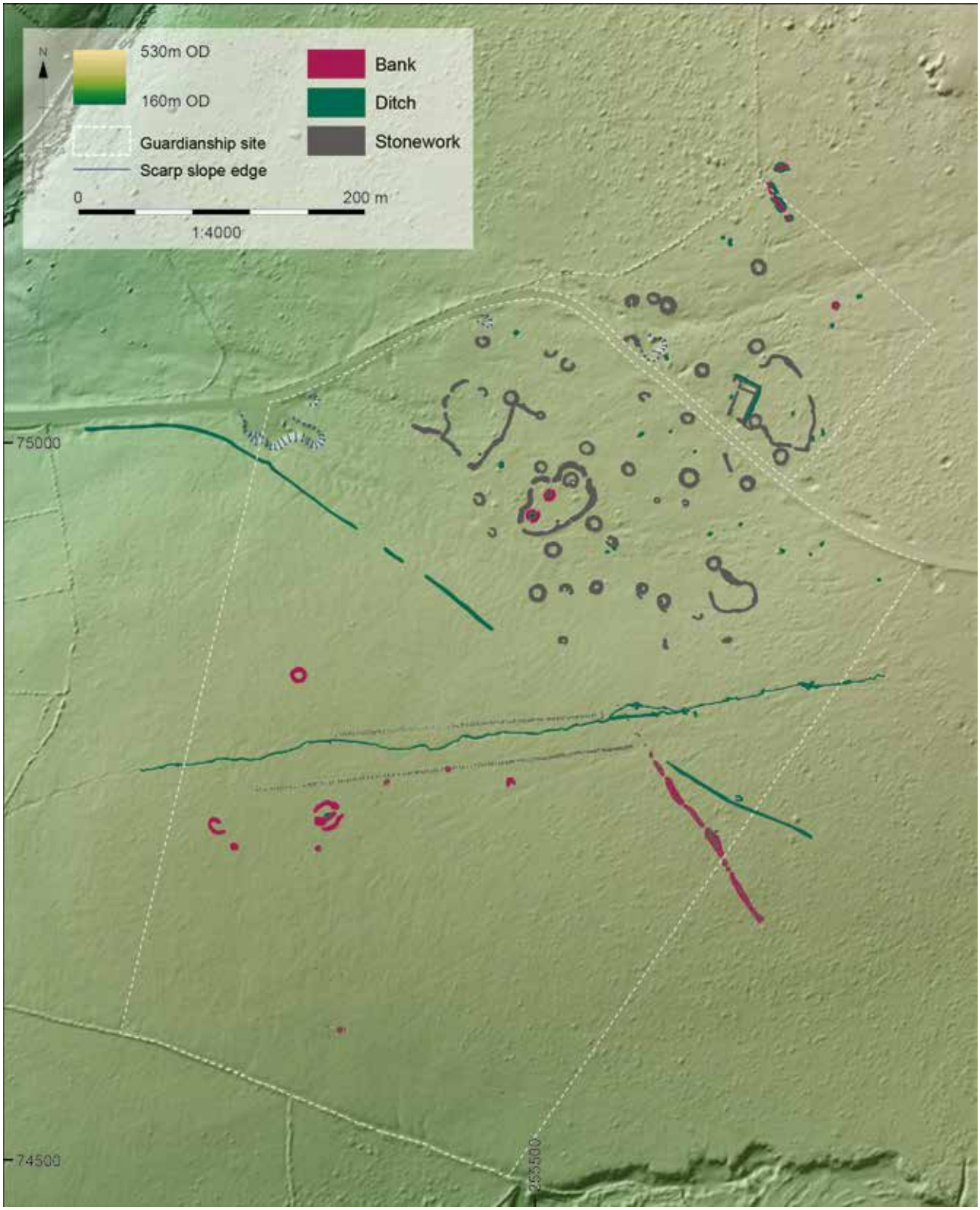


Figure 6: Archaeological features mapped at Merrivale. Archaeological mapping © Historic England. Height data © Bluesky International/Getmapping PLC. Lidar DSM 11-APR-2021 and 25-FEB-2019 © Historic England, source Environment Agency.

The following stones were visible on the new 8cm ortho-photography and mapped - all 11 stones of the stone circle standing at SX 55357 74634, the single standing stone just to the east of the circle (Historic England Research Record 440044), the standing stone at SX 55355 74592 and five of the stones that possibly form alignments in its environs, along with a recumbent stone (Historic England Research Record 440047).

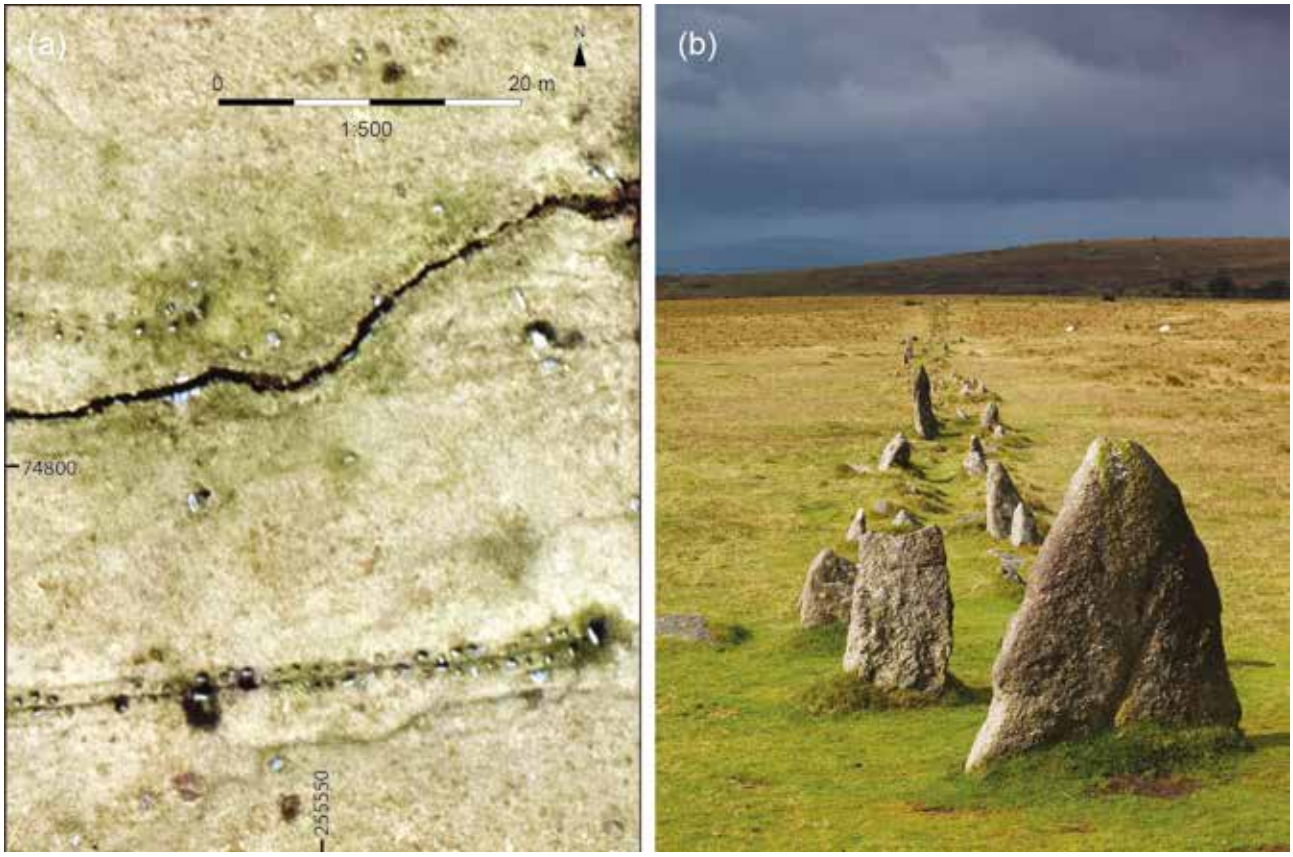


Figure 7: Neolithic stone alignments at Merrivale. (a) extract from Historic England 8cm ortho-photograph 30-MAR-2021 © Historic England. (b) The southern stone row looking west [James O. Davies © Historic England Archive, DP055106].

The guardianship site to the south of the B3357 road was covered by the new aircraft-derived 8cm imagery, and also by a 15mm GSD ortho-photograph modelled from images taken by drone on 4 February 2023. This allowed comparisons between both the new 15mm and 8cm datasets and earlier digital aerial datasets. This demonstrated that different information appears on each data set and that higher resolution is not the only factor. For example, in comparison to 12.5cm GSD Next Perspectives APGB ortho-photography (12 April 2019), the 15mm ortho-photography provides the greatest precision for mapping ‘hard’ features such as the large Early Bronze Age cist (Historic England Research Record 440050) standing at SX 55485 74762. Visualisations of a Digital Surface Model derived from the 8cm ortho-photography facilitate mapping the cist’s remnant cairn material on its west side (Fig. 8).

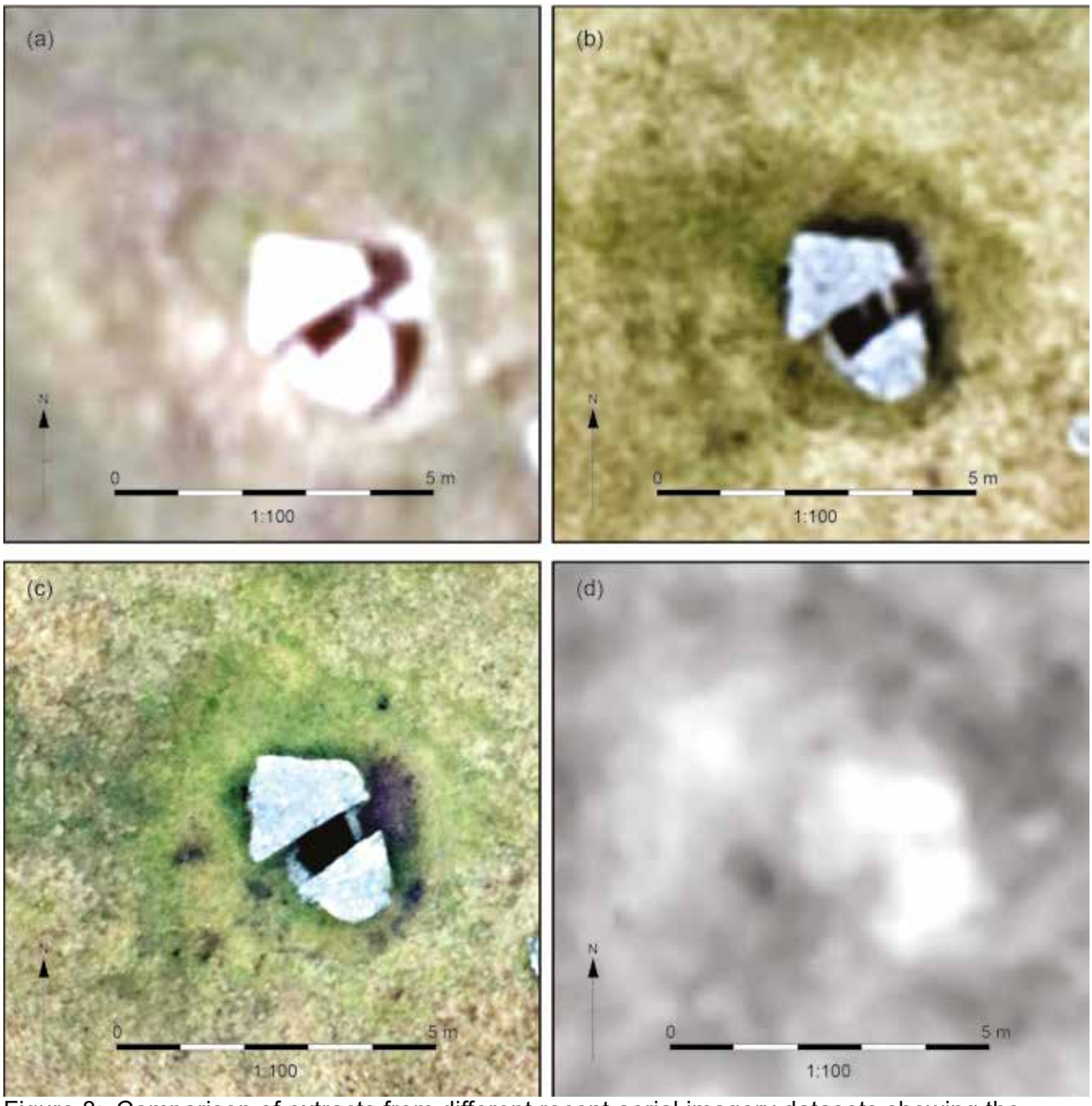


Figure 8: Comparison of extracts from different recent aerial imagery datasets showing the Merrivale cist Historic England Research Record 440050 at SX 55485 74762. (a) SX5574 04-JUL-RGB Aerial Photography (12.5cm GSD) © Bluesky International/Getmapping PLC. (b) Structure from Motion ortho-photograph (8cm GSD) 30-MAR-2021 © Historic England. (c) Structure from Motion ortho-photograph (15mm GSD) 02-FEB-2023 © Historic England. (d) Structure from Motion Digital Surface Model (Simple Local Relief Model) 30-MAR-2021 © Historic England.

Visualisations of the Digital Surface Model derived from the 8cm ortho-photography were especially useful to map Bronze Age cairns in the guardianship site, particularly when combined with the ortho-photograph itself or visualisations of 2019 and 2021 Environment Agency 1m lidar data. This helped identification of the small hollows in the tops of some of the mounds that were the result of antiquarian or earlier digging. Most of the cairns are

clustered around the earlier stone alignments (*see* Fig. 6). They include:

- a ring cairn at SX 55335 74838 (Historic England Research Record 440038);
- a cairn or circle of stones at the east end of the northern stone row (Historic England Research Record 1631073) that incorporates the row's 'blocking' stone;
- the round cairn with cairn circle (Historic England Research Record 440056) added to the southern stone row;
- a round cairn at SX 55396 74763 (Historic England Research Record 440357) on which the third stone alignment Historic England Research Record 440357 is oriented;
- a round cairn at SX 55348 74717 (Historic England Research Record 440312);
- a round cairn at SX 55363 74590 (H Historic England Research Record 440047);
- a possible ring cairn centred on SX 55277 74732 (Historic England Research Record 1303356, unscheduled);
- a round cairn at SX 55290 74718 (Historic England Research Record 1309348, unscheduled);
- the remaining earthwork components of a large scheduled ring cairn centred on SX 55354 74740 (Historic England Research Record 440041), including a hollow formerly containing a cist and a spoil heap (probably the result of an excavation in 1851), were mapped using a combination of the Historic England 8cm ortho products and lidar visualisations.

Most of these funerary monuments appear to cluster around the presumed Neolithic stone alignments to the south-west of the later Bronze Age settlement. However, there is an outlier – a round cairn at SX 55709 75096, some distance to the north-east on the opposite side of the settlement area (Historic England Research Record 1309318).

Bronze Age settlement and land division

Merrivale Bronze Age settlement site includes at least 38 hut circles and four enclosures, now divided by the B3357 road (Fig. 9). To the north-east side of the road, most of the hut circles are not situated within an enclosure. Only one appears to be within the sub-oval enclosure centred on SX 55673 75029 (Historic England Research Record 440079). The road truncates at least one hut circle (at SX 55567 75071) and it is possible that others may have been destroyed during construction of the road. The majority of the hut circles to the south-west side of the road are also not situated within an enclosure. One is inside the central enclosure centred on SX 55514 74958 and three others are attached to walls of the nearby enclosures to north-west and south-east. The hut circles range in size from about 4m to 14.5m in diameter. Two standing at SX 55574 74898 and SX 55589 74890 have porch entrances whilst the large hut circle inside the central enclosure has an internal division. The new 8cm ortho products have made it possible to distinguish some additional

walling to the south-west corner of the north-western enclosure where it passes over an area of intense granite ‘clitter’ (a dense spread of boulders on the surface).

Figure 9: Merrivale Bronze Age settlement site, post-medieval warrener’s house and pillow mounds. Detail of NMR1510/172 26-APR-1979 © Crown copyright. Historic England Archive.

The guardianship site includes part of the Bronze Age Great Western Reave (Historic England Research Record 440360), a 10km-long ‘contour reave’ running from Sharpitor to Whittor perhaps marking a division between higher moor and lower grazing land (Fleming 2008, 54-7). Only 128m of the reave is inside the guardianship boundary. It comprises a discontinuous stony bank containing many protruding boulders, oriented south-south-east to north-north-west as though it might meet or just pass the south-west edge of the Bronze Age settlement. The north-west end of this section of the reave is marked by stones, reaching just beyond the eastern ends of Merrivale’s double stone rows as far as a stone at SX 55557 74817. There is no evidence for the reave across or around the Bronze Age settlement. It reappears to the north of the settlement site outside the guardianship boundary; this northern section of the reave, eventually reaching Roos Tor, was not mapped.

An observation made whilst processing the drone-acquired imagery, and confirmed during mapping and subsequent field visits, is that the line of the Great Western Reave appears to divide the Merrivale landscape into two distinct zones. The funerary and ritual monuments appear to exist almost exclusively to the south and west of the line of the reave, and reciprocally (and almost without exception), the domestic landscape of hut circles and enclosure occur only to its north and east.

Post-medieval themes

Warrening

Although the bulk of Merrivale Warren (Historic England Research Record 439654) is outside the guardianship site, two pillow mounds and a building that is possibly the warrener's house lie outside the warren wall and inside the guardianship boundary (*see* Fig. 9). The pillow mounds are centred on SX 55664 75186, built at right angles to one another. The longer mound is in three segments. The ruined warrener's longhouse (Historic England Research Record 1355487) is located at SX 55648 75039, oriented roughly east to west with a rectangular enclosure of approximately 58m^2 attached to the house's south wall. A ditch drains the north and east walls and the enclosure is attached to a Bronze Age enclosure on the east side. According to Dartmoor National Park Authority Historic Environment Record (MDV20665) the property dates to the early 19th century.

Stone quarrying and clearance

There is considerable evidence for post-medieval surface extraction and splitting of granite moorstone within the guardianship site. Twenty-six extractive pits were mapped, although more evidence including individual blocks of split granite was recorded during field survey in 1999/2000 (Probert 2000). The majority are small, sub-rectangular pits ranging from about 2.5m to 6.6m long and 1.0m to 5.4m wide. The two largest pits, with adjacent spoil heaps, are inside a Bronze Age enclosure. Also within that enclosure is a partially shaped and dressed edge-runner millstone (Historic England Research Record 440035), perhaps intended for a cider press. The majority of these small features were mapped from a combination of the Historic England 8cm ortho products and lidar visualisations.

Of numerous roadside quarries along the route of the B3357 road, three are within the guardianship boundary. The largest, Historic England Research Record 1631070, was mapped by the Ordnance Survey on County Series Devonshire 1:2500 map CVI.7 published in 1885. It is now used as a carpark. Two smaller quarries are located at SX 55464 75086 and SX 55579 75067, the latter described by the Ordnance Survey on the same 19th-century map as a 'sand pit'. Three clearance cairns, two built onto the Great Western Reave, are also likely to be post-medieval features. Single standing stones of uncertain date at SX 55405 74838 (Historic England Research Record 1303362) and SX 55477 74546 (Historic England Research Record 1303362) were also recorded. Both are thought by Probert (2000, 11) to be late in date, related to stone working or set up as livestock rubbing posts.

Transportation

A packhorse route across Dartmoor between Tavistock in the west and Ashburton in the east crosses Walkhampton Common and passes through the Merrivale guardianship site. Guide stones marking the route were erected in 1699/1700 (Dartmoor National Park Authority Historic Environment Record MDV54463), one of which stands at SX 55667 74738 (Historic England Research Record 1303444). The route is visible as lengths of slight earthwork to the east of the Great Western Reave and to the west of the Bronze Age settlement to the point at SX 55186 75009 where it meets the B3357 road. These sections were mapped from the 8cm ortho products although it should be noted that it is possible to trace the route in earlier specialist oblique aerial photographs.

Second World War

Of the dozen or so Second World War practice trenches observed by Probert (2000), four were mapped using a combination of visualisations of 2019 Environment Agency lidar data and the Digital Surface Model derived from the new 8cm Historic England ortho-photography, and Historic England Archive specialist oblique aerial photograph NMR 18029/08 (8 May 1998). All four practice trenches make use of earlier archaeological features, three being cut into the floors of Bronze Age hut circles and one lying parallel to the west wall of the warrener's house enclosure. There is no evidence on 1947 Royal Air Force vertical aerial photographs for a mortar range in the area, a claim of local residents reported by Probert (2000, 11), apart from three or four slight sub-circular disturbances in the ground surface within Merrivale warren to the north that may be weapons pits (outside the guardianship site, unmapped).

Water management

The domestic leat (Historic England Research Record 1303468) crossing the guardianship site from east to west, passing between the two double stone rows, was described as 'recently made' in 1889 (Dartmoor National Park Authority Historic Environment Record MDV80530). Approximately 535m of the leat was mapped using the 2021 Historic England 8cm ortho-photography, including the filled-in section centred on SX 55576 74811 that was recorded with reference to visualisations of the Digital Surface Model derived from the ortho-photograph.

Vegetation history and erosion

The increasing impacts of visitors and, to an extent, livestock on Merrivale since the Second World War are evident from archive aerial photographs. The earliest available imagery dates to 1947, when the only trackways of any significance in use across Longash Common (such that their eroded surface is visible in aerial photographs) are east-west orientated tracks leading to and from openings in farm enclosures (Fig. 10a). The domestic leat has at times in the recent past leaked in consequence of erosion caused by 'animal and vehicular traffic' (Dartmoor National Park Authority Historic Environment Record MDV80530). At times, its overflow has caused surface flooding/run-off downslope, passing along and through the Great Western Reave and the double stone rows (Fig. 10b). Most

recently this has occasioned repairs to the leat, its slight realignment and the insertion of a bridge (with Scheduled Monument Consent).

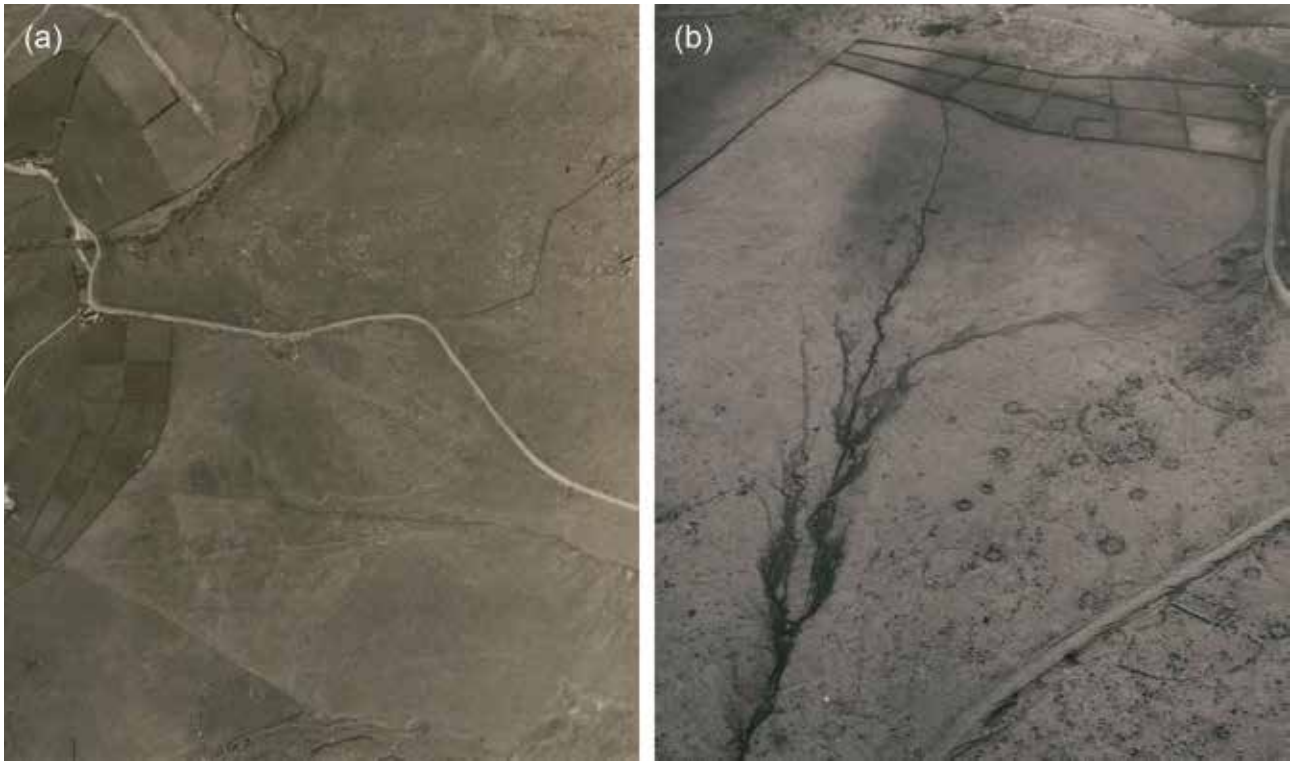


Figure 10: Merrivale guardianship site in 1946 and 1979. (a) extract from RAF/CPE/UK/2149 3175 11-JUN-1947, Historic England Archive (RAF Photography). (b) extract from NMR1510/174 26-APR-1979 © Crown copyright. Historic England Archive.

Strong desire lines between and around monuments are first well-documented in aerial photographs dating to the 1990s, although they probably have slightly earlier origins. The pattern of pathways today had become established by the 2000s, most noticeably in the southern part of the guardianship site crossing the leat and linking the Neolithic stone settings (Fig. 11). The impact appears less amongst the Bronze Age settlement and the part of the guardianship site to the north of the B3357 road, although the areas are cut by tracks enabling people to cross the road and walk towards Over Tor. The impact on both the monuments and surface vegetation of combined vehicle and pedestrian access during the first quarter of the 21st century is clear in English Heritage specialist oblique aerial photographs taken on 25 January 2007 (Fig. 12).

Overall, desire lines running across the southern part of the guardianship site and between its monuments and nearby carparks have become more pronounced. This wear-and-tear is especially noticeable on Next Perspectives APGB false colour infrared ortho-photography (4 July 2019). Contrast between better growing, leafier summer vegetation and the worn pathways (that are reflecting light in a similar way to surface granite boulders that show as pale areas of ‘clitter’ and archaeological structures) is emphasised in this part of the light spectrum (Fig. 13).

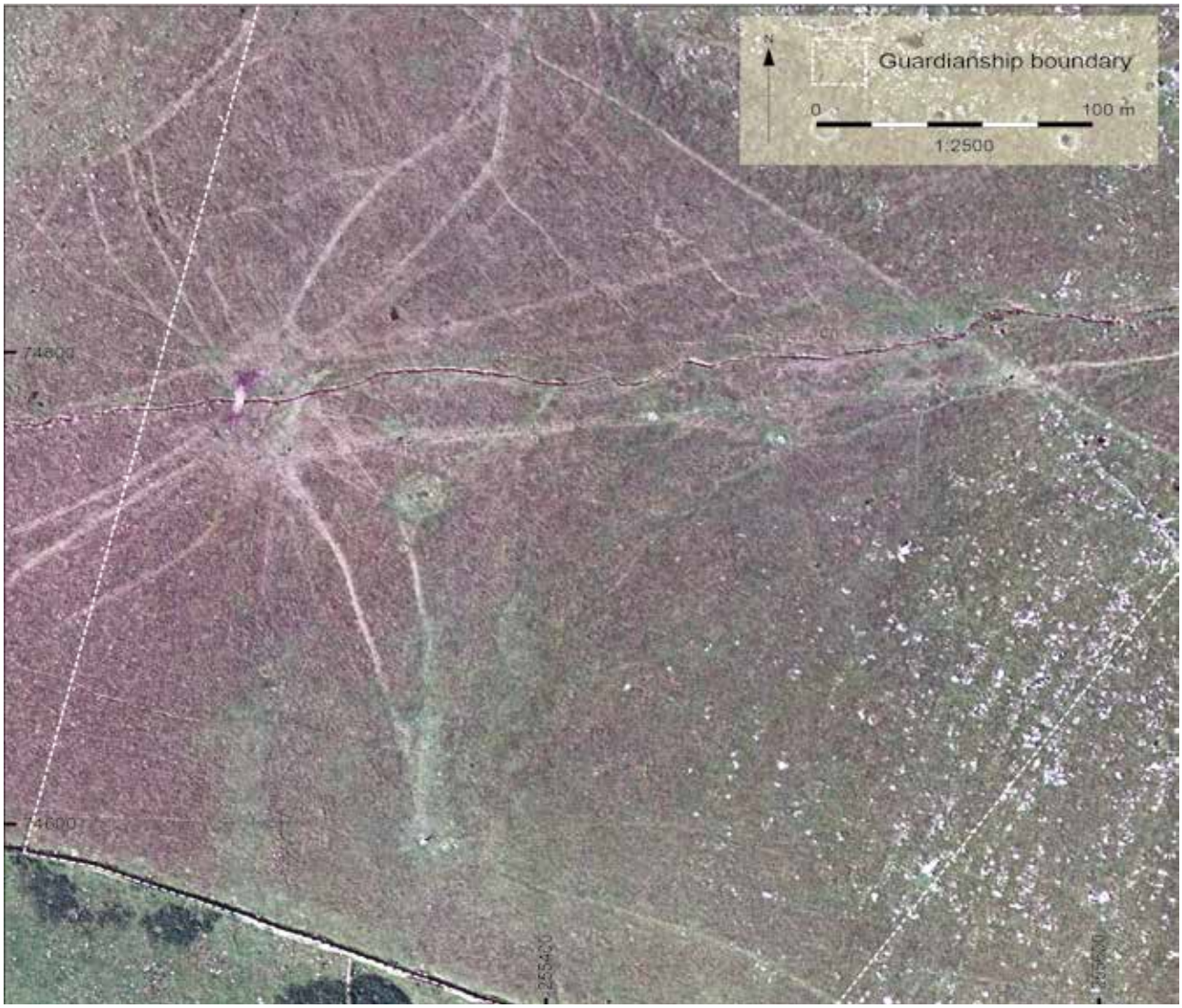


Figure 11: Desire lines established at Merrivale by 2002. Extract from SX 5574 01-JUN-2002 RGB Aerial Photography © Bluesky International/Getmapping PLC.

Figure 12: Footpaths and vehicle tracks at the west end of the Merrivale stone alignments. Detail of NMR24530/35 25-JAN-2007 © Historic England Archive

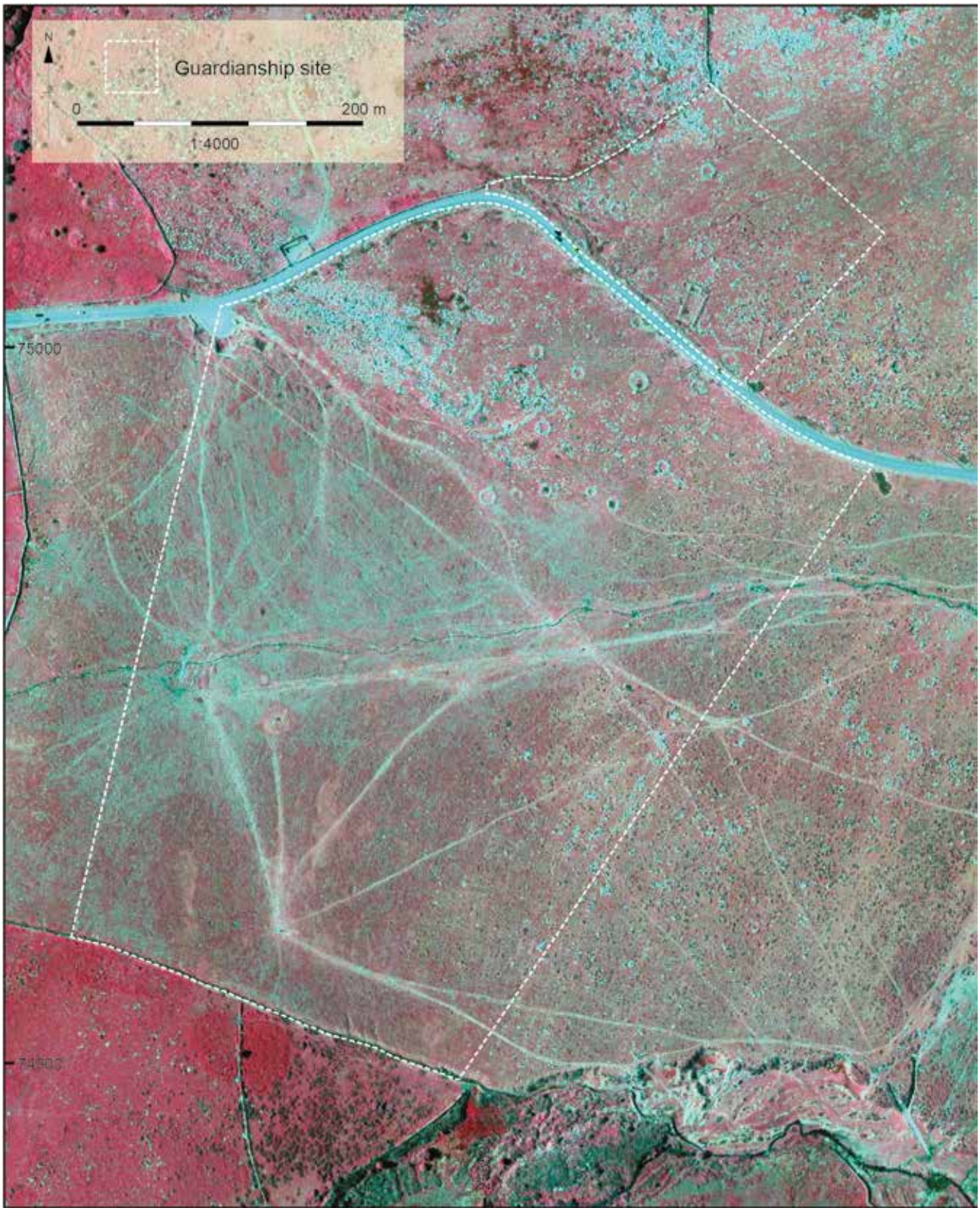


Figure 13: Desire lines established at Merrivale by 2019. Extract from SX 5574 04-JUL-2019 FCIR Aerial Photography © Bluesky International/Getmapping PLC.

Hound Tor Deserted Medieval Village

Introduction

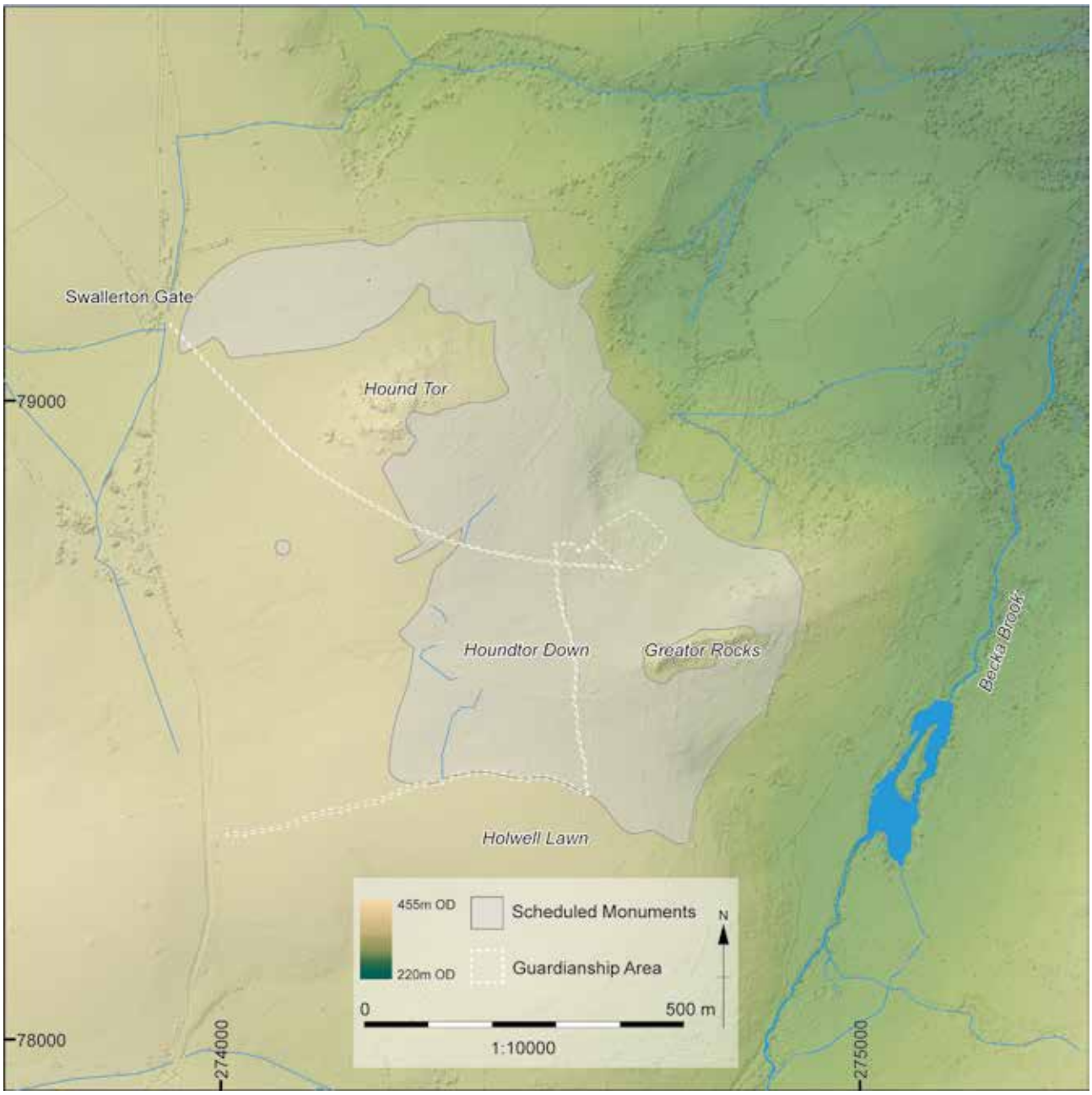


Figure 14: Hound Tor Deserted Medieval Village location. Height data supplied to Historic England through the APGB agreement by Next Perspectives © Bluesky International/ Getmapping PLC. Lidar DSM 11-APR-2021 © Historic England, source Environment Agency. Other mapping derived from Ordnance Survey open data © Crown copyright and database right 2023.

Hound Tor deserted medieval village is located in Manaton parish in north-east Dartmoor (Fig. 14). The site comprises a medieval village abandoned in the mid-14th century, and elements of its associated field system. The guardianship area is 0.64 ha in extent and occupies a north-east facing slope, between Hound Tor to the north-west and Greator Rocks to the south-east, overlooking the head of the Becka Brook valley. The site is owned as a moiety between several local landowners and was placed into state guardianship in 1972.

Prehistoric and medieval settlements and their field systems at Hound Tor were added to the Schedule of Ancient Monuments in 1966 (NHLE 1016255). The schedule entry was amended in 1998. In total, 40.46ha are protected by scheduling. The guardianship site includes only the medieval hamlet of Hound Tor and two footpaths providing access from the nearby road that divides Hound Tor Down from Hedge Down.

History of research

The site was first recognised by Norman Quinnell (Ordnance Survey Archaeology Division) in 1953 (Newman et al. 1995). The site was excavated by Mrs E.M. Minter between 1961 and 1975, whose results were published by Beresford (1979).

The most recent detailed recording of the site was carried out by the RCHME (Newman et al. 1995). This work comprised an analytical earthwork survey at a scale of 1:500. The archive for this work is deposited in the Historic England Archive in file AF1037545.

Hound Tor is included in Butler's Dartmoor Atlas of Antiquaries (1991, 54-6, 80-1).

Aerial investigation and mapping results

Ritual and funerary monuments

Evidence for Neolithic to Bronze Age ritual and funerary practices on Hound Tor Down include a fragment of low, stony bank or walling that may comprise a tor enclosure on Hound Tor itself (Historic England Research Record 1045281) and a ring cairn south-west of Hound Tor 215m east of East Lodge (Historic England Research Record 445101) (Fig. 15).

Tor enclosures are unique to the uplands of Devon and Cornwall. They usually occupy high ground, often enclosing rock outcrops to create a significant place that hybridises the natural and artificial (Historic England 2018). The fragment of stony bank that hints at a Neolithic tor enclosure on Hound Tor is centred on SX 74296 78973 (Fig. 15, point A). It measures approximately 13.8m long, linking two granite outcrops on the east side of Hound Tor and possibly blocking, albeit symbolically rather than physically given its slight height, the space between the northern and southern outcrops.

The Bronze Age ring cairn is scheduled separately (NHLE 1016254) to the prehistoric and medieval settlements of which the guardianship site is part. It was mapped partly

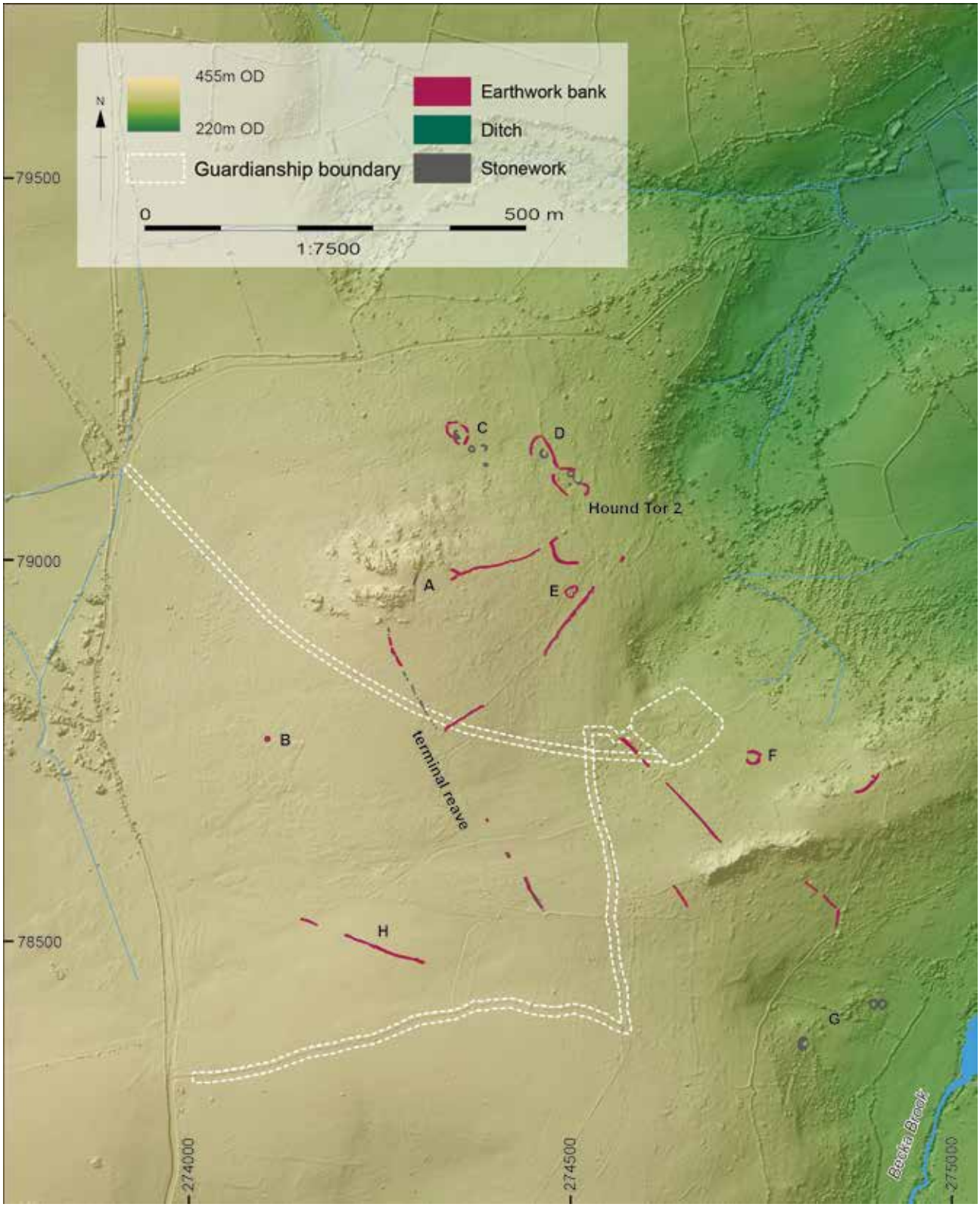


Figure 15: Neolithic and Bronze Age monuments on Hound Tor Down. Archaeological mapping © Historic England. Height data © Bluesky International/Getmapping PLC. Lidar DSM 11-APR-2021 and 25-FEB-2019 © Historic England, source Environment Agency. Other mapping derived from Ordnance Survey open data © Crown copyright and database right 2023.

for archaeological context and partly because desire lines crosscutting the Down and leading to the cairn can be seen clearly in the available aerial sources (Fig. 15, point B). This emphasises the broader spatial context of visits to Hound Tor Down, with not only the guardianship site but other archaeological features and the tor itself all highly accessible from a carpark positioned to the north-west at Swallerton Gate.

Bronze Age settlement

A group of Bronze Age enclosures and hut circles within the scheduled area are incorporated into, or slighted by, the medieval and post-medieval field systems on Hound Tor Down (Fig. 15). In consequence, the enclosures are quite fragmentary. They include:

- a sub-oval enclosure centred on SX 74353 79166 (Historic England Research Record 1044916), formed of five sections of enclosure bank enclosing two hut circles, one attached to the internal side of the enclosure's south wall. Three hut circles stand outside the enclosure to its south-east, one of which has been incorporated onto the medieval 'corn ditch' type of field boundary that cuts through the enclosure (Fig. 15, point C);

- two sections of enclosure bank enclosing a hut circle at SX 74462 79141 (Historic England Research Record 1044916) (Fig. 15, point D). The enclosure's southern boundary may have been utilised in the medieval field boundary that passes from the first enclosure mentioned above. The enclosure and hut circle are cut by a medieval wall running north to south;

- an enclosure centred at SX 74499 79099 (Historic England Research Record 1044916), adapted to form the medieval farmstead known as Hound Tor 2 (Historic England Research Record 445183) (Fig. 15, Hound Tor 2). It is formed of four short lengths of curving enclosure bank with a scarp to the north side. It may have been joined to the previously mentioned enclosure, but a medieval wall passes across this area, obscuring the relationship between the Bronze Age features. The hut circles within the enclosure were adapted to form some of the medieval farmstead's buildings (Beresford 1979, 110);

- a previously unrecorded two-lobed enclosure (Historic England Research Record 1631081) measuring approximately 18.7m by 11.0m on plan, centred on SX 74500 78958 (Fig. 15, point E). Its north-western side has been incorporated into a medieval 'corn-ditch' type of field boundary;

- a sub-circular enclosure centred on SX 74738 78740 (Historic England Research Record 1044930) incorporated into a later field wall to the south-east of Hound Tor deserted medieval settlement (Fig. 15, point F).

Just outside the south-east boundary of the scheduled area, three hut circles stand on the south-east facing slope overlooking the Becka Brook. They were mapped because of their association with likely fragments of prehistoric field system to the north-west that are within the scheduled monument. Short, irregular fragments of earthwork bank centred on

SX 74670 78556 at the south-west base of Greator Rocks may be prehistoric in origin, incorporated into a complex area of medieval/post-medieval field parcels (Fig. 15, point G).

Bronze Age land division

The south and south-east flanks of Hound Tor Down are traversed by fragments of Bronze Age reave (Historic England Research Record 899113), attributed by Fleming (2008, Fig. 27) to the Rippon Tor parallel reave system (Fig. 15). Considerably more archaeological evidence is now recorded than was available to Fleming and it appears that the reaves at Hound Tor comprise fragments of a co-axial system of stony banks oriented largely north-west to south-east and south-west to north-east.

Two sections of reave approach Hound Tor, at SX 74261 78909 and SX 74344 78987. The former heads to the south-east with fragments visible over approximately 426m. This may be a terminal reave from which other roughly perpendicular banks are projected. The latter is one such perpendicular bank, heading roughly north-east in sections for approximately 152m, its south-west end at the tor being forked with a post-medieval shelter (Historic England Research Record 1045175) built in the lee of the bank.

Fragments of field boundary roughly parallel to the possible terminal reave and others perpendicular to it occupy the ground between Hound Tor and Greator Rocks. Centred on SX 74849 78542, to the south-east of Greator, two short sections of north-west to south-east oriented reave have a short southern section on a slightly different orientation.

Two sections of earthwork bank, overall about 133m long, are oriented west-north-west to east-south-east between SX 74153 78529 and SX 74308 78472 (Fig. 15, point H). They may be a section of reave sketched by Fleming (2008, Fig. 27) but discounted by Newman et al. (1995, Fig. 7). These earthwork banks are morphologically similar to the other reave banks on Hound Tor Down. The longer section is perpendicular to a post-medieval field boundary, but it was not possible from the available aerial imagery to determine precisely the relationship between these features where they intersect at SX 74279 78480. The possible reave may cut the field boundary and thus in fact be a later earthwork bank, or the post-medieval field boundary may be built up to the possible reave. On morphological grounds, and because the possible reave section is oriented against the prevailing post-medieval field pattern, these two sections of bank are tentatively interpreted as part of the Bronze Age system of land division, subject to further investigation.

Medieval settlement and field systems

Medieval settlement on Hound Tor Down includes the deserted village known as Hound Tor 1 and a farmstead known as Hound Tor 2 (Fig. 16). As mentioned above, medieval occupation here made use of existing Bronze Age structures in some instances and slighted them in others. This is especially clear at Hound Tor 2 (Historic England Research Record 445183), the farmstead to the north-east of the tor that is built into a Bronze Age enclosure. A combination of 12.5cm GSD Next Perspectives APGB ortho-photography flown on 20 April 2015 and visualisations of Environment Agency 1m lidar data dated 11 April 2021, both captured when the vegetation was low, support detailed mapping in this

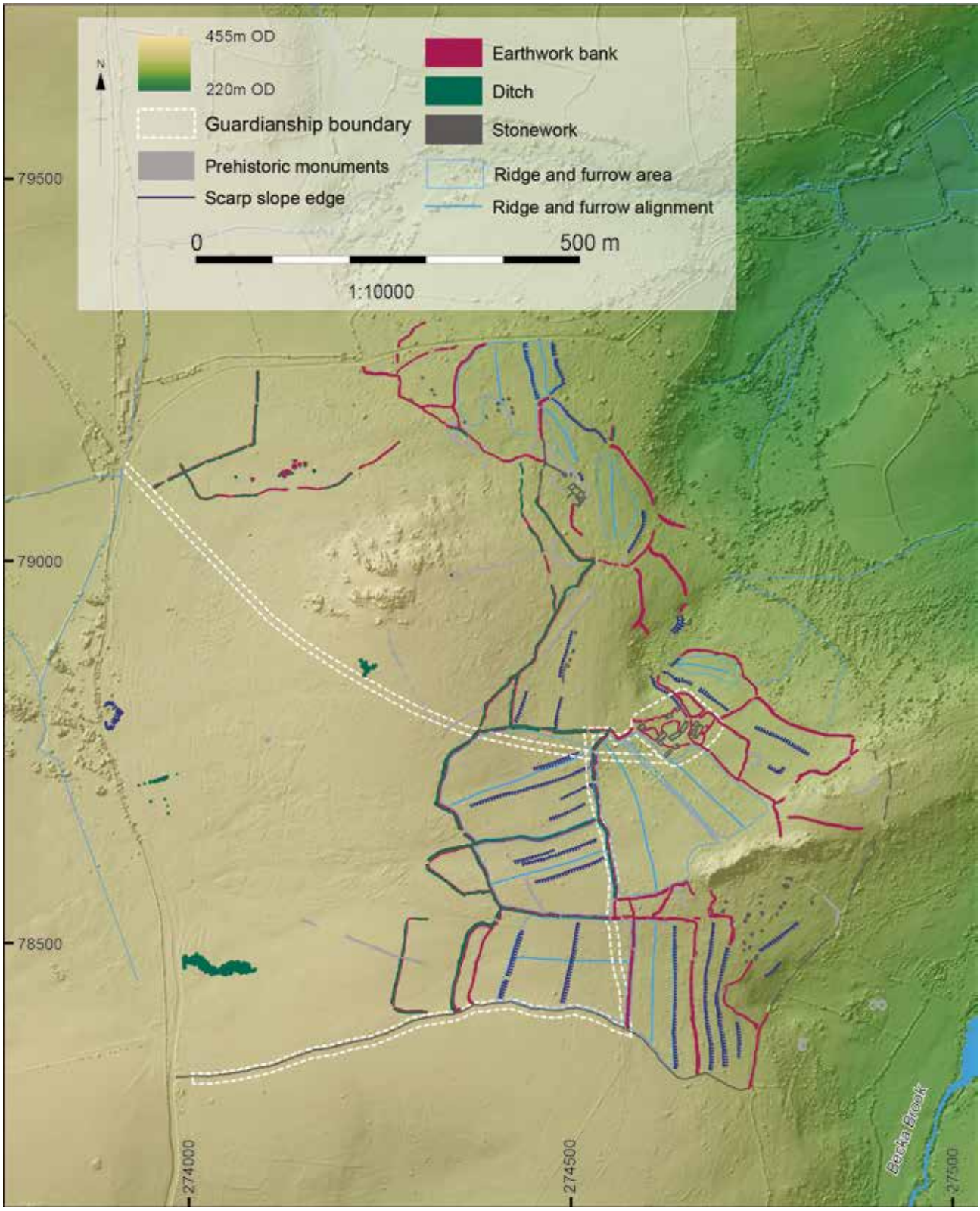


Figure 16: Medieval and post-medieval monuments on Hound Tor Down. Archaeological mapping © Historic England. Height data © Bluesky International/Getmapping PLC. Lidar DSM 11-APR-2021 © Historic England, source Environment Agency. Other mapping derived from Ordnance Survey open data © Crown copyright and database right 2023.

area. For example, the north-west arc of a hut circle underneath the wall of a medieval barn centred on SX 74501 79096 is visible on these aerial sources. A combination of medieval ‘corn-ditch’ type field boundaries and field banks without drainage ditches enclose a series of irregular, agglomerated fields extending downslope from the farmstead: the farmstead stands within a large field, to which a sequence of fields are added. In the north and east, these field boundaries continue outside the scheduled area.

The deserted medieval settlement known as Hound Tor 1 (Historic England Research Record 445104) is within the guardianship site. It is as described by Newman et al. (1995), with small yards and fields to its east and, as at Hound Tor 2, a combination of medieval ‘corn-ditch’ type field boundaries, some field banks without drainage ditches and also Bronze Age field boundaries including reave fragments enclosing a series of irregular, agglomerated fields extending to the south and west. The presence of some butting junctions of the medieval corn-ditches implies that at least three large fields were laid out to the south-west side of Hound Tor 1, to which were added a fourth large field to the west and smaller fields to the south-west.

The relationship, and thus phasing, between fields around Hound Tor 1 and 2 is less clear. This is largely due to the difficulty presented by the wooded, steep-sided coombe that lies between the two sites, where visualisations of the 2021 Environment Agency 1m lidar Digital Terrain Model do not provide enough clarity to distinguish archaeological features. It is possible that enclosures to the north-east of Hound Tor 1 are linked to those to the south-east of Hound Tor 2 but that cannot be confirmed from the currently available imagery. More clearly, it can be seen that a long medieval corn-ditch extends to the south-west from the large field in which the farmstead stands, eventually forming the boundary of the fourth large field to Hound Tor 1 mentioned above, indicating that this is therefore a later development, respecting Hound Tor 2’s fields and augmenting the Hound Tor 1 field system.

Post-medieval farming

Although medieval settlement on Hound Tor Down was abandoned during the 14th century (Beresford 1979, 146), elements of the field systems continued in use, predominantly in the south-east quarter of the scheduled monument. It is difficult to make a hard and fast distinction between ‘medieval’ and ‘post-medieval’ phases from the available aerial sources, given what were likely to have been gradual maintenance processes and reuse of the earlier field parcels. Nevertheless, an angular field boundary enclosing a field in the far north-west corner of Hound Tor Down clearly cuts a medieval corn-ditch, whilst post-medieval clearance cairns overlie remains of ridge and furrow in fields to the north-west of the farmstead Hound Tor 2. Further clearance cairns to the south-east of Greator Rocks probably date to a similar period of agricultural improvement. Areas of narrow ridge and furrow are also associated with post-medieval cultivation (Newman et al. 1995, 9)). The south-east and southern boundary of the overall field system is defined by an upstanding post-medieval wall.

Medieval/Post-medieval surface quarrying

Bulk mineral extraction on Hound Tor Down includes some small-scale tin prospection, a cluster of extractive pits where moorstone was worked and two areas of surface quarrying.

Medieval/post-medieval tin prospecting pits are limited to the far western edge of Hound Tor Down, outside the area of scheduled monument NHLE 1016255 but mapped because of their possible association with the medieval settlement. There are at least ten pits, centred on SX 73964 78698, six of which are in a closely spaced line that is oriented west-south-west to north-east-north, the dominant ore orientation on Dartmoor (Newman 2011, 150). Of those six, one is formed of at least three conjoined pits. Four small pits lie to the south.

There are at least 11 post-medieval extractive pits, some with adjacent spoil heaps, on the gentle, north-facing slope of the Down to the north-west of Hound Tor, described as stone cutting pits during Monuments Protection Programme surveying (Dartmoor National Park Authority Historic Environment Record MDV58427). It is less clear what might have been dug from two areas of surface quarrying, one just to the south-west of Hound Tor centred on SX 74232 78860 (0.02ha), the other at SX 74037 78462 (0.13ha). They are unlikely to be peat cutting ties, given their highly irregular form on plan, and presumably represent locations where some other desirable resource was available from the Down's freely draining, acid loamy soil (Cranfield University 2023).

Vegetation history and erosion

Aspects of recent vegetation history at Hound Tor are illustrated in Next Perspectives False Colour Infrared imagery dating between 2015 and 2018. In April 2015, in the early stages of the growing season, early plant growth is evident from the pink and red shades in cultivation fields around Hound Tor Down, contrasted with the brown to green shades of low grasses, heather and bracken on the Down itself. The dominance of bracken over the northern part of the scheduled monument to the north-east of Hound Tor is clear is the darker green that represents plant matter from the previous season's growth. The way that this bracken grows and comes to obscure archaeological features throughout the year is clear from the equivalent aerial coverage in June 2018, in which the Summer foliage of the larger area of bracken that has colonised the hillside shows in pink to red tones. At this time of year, worn, braided trackways across Hound Tor Down are also more clearly apparent.

Historic aerial photographs document some of the changes in and around Hound Tor 1 at the core of the guardianship site. Upstanding archaeological remains are visible in Royal Air Force vertical photographs of 23 June 1949 (Fig. 17a), indicating that even in the Summer, the vegetation was at that time relatively low. A few trackways passing by the settlement site can be seen as pale lines. Similar Royal Air Force vertical photographs taken on 2 July 1964 show the effect of archaeological excavation that has cleared the ground in and around some of the medieval buildings and opened up the north-west corner of the settlement (Fig. 17b). Slight shadows to the edges of the trackways that

pass by Hound Tor 1 also indicate that vegetation is now growing up more substantially in the environs. By the time of RCHME specialist oblique aerial photographs taken on 14 April 1977, the mid-20th century excavation seasons have largely established the modern appearance of Hound Tor 1 (Fig. 17c). As a visitor attraction, paths through the site are clear in similar photographs taken on 15 May 1996 (Fig. 17d). Encroaching scrub has developed around the settlement by the time of Next Perspectives photography dated 2 April 2021; shortly after that imagery was captured, English Heritage Trust cleared some of this growth (Winn Scutt pers. comm.).

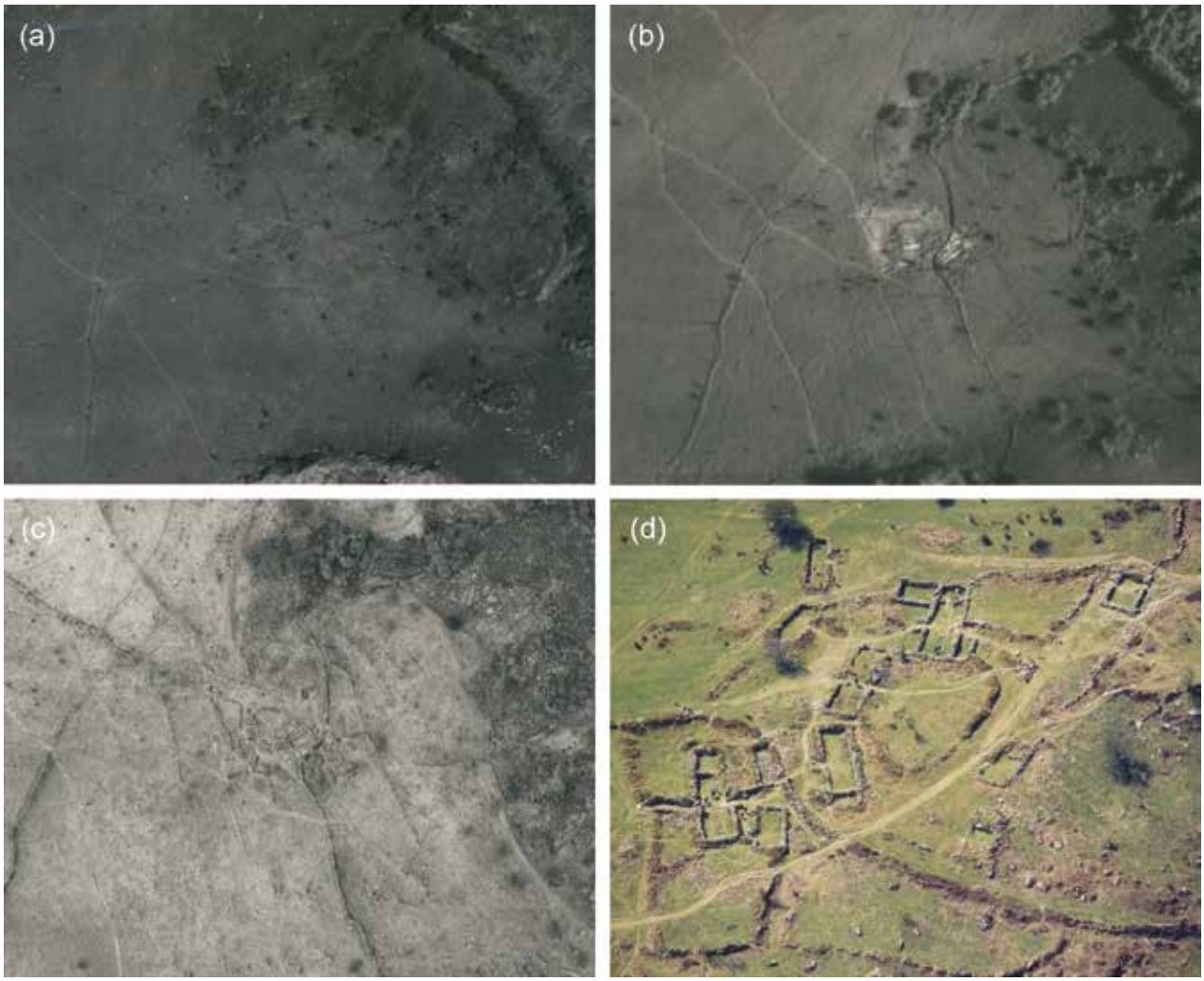


Figure 17: Vegetation change and footpaths at Hound Tor Deserted Medieval Village (unscaled aerial photograph extracts). (a) RAF/540/226 5110 23-JUN-1949, Historic England Archive (RAF Photography). (b) RAF/58/6399 F61 0014 02-JUL-1964, Historic England Archive (RAF Photography). (c) NMR1125/416 14-APR-1977 © Crown copyright. Historic England Archive. (d) NMR15423/28 15-MAY-1996 © Crown copyright. Historic England Archive.

Upper Plym Valley

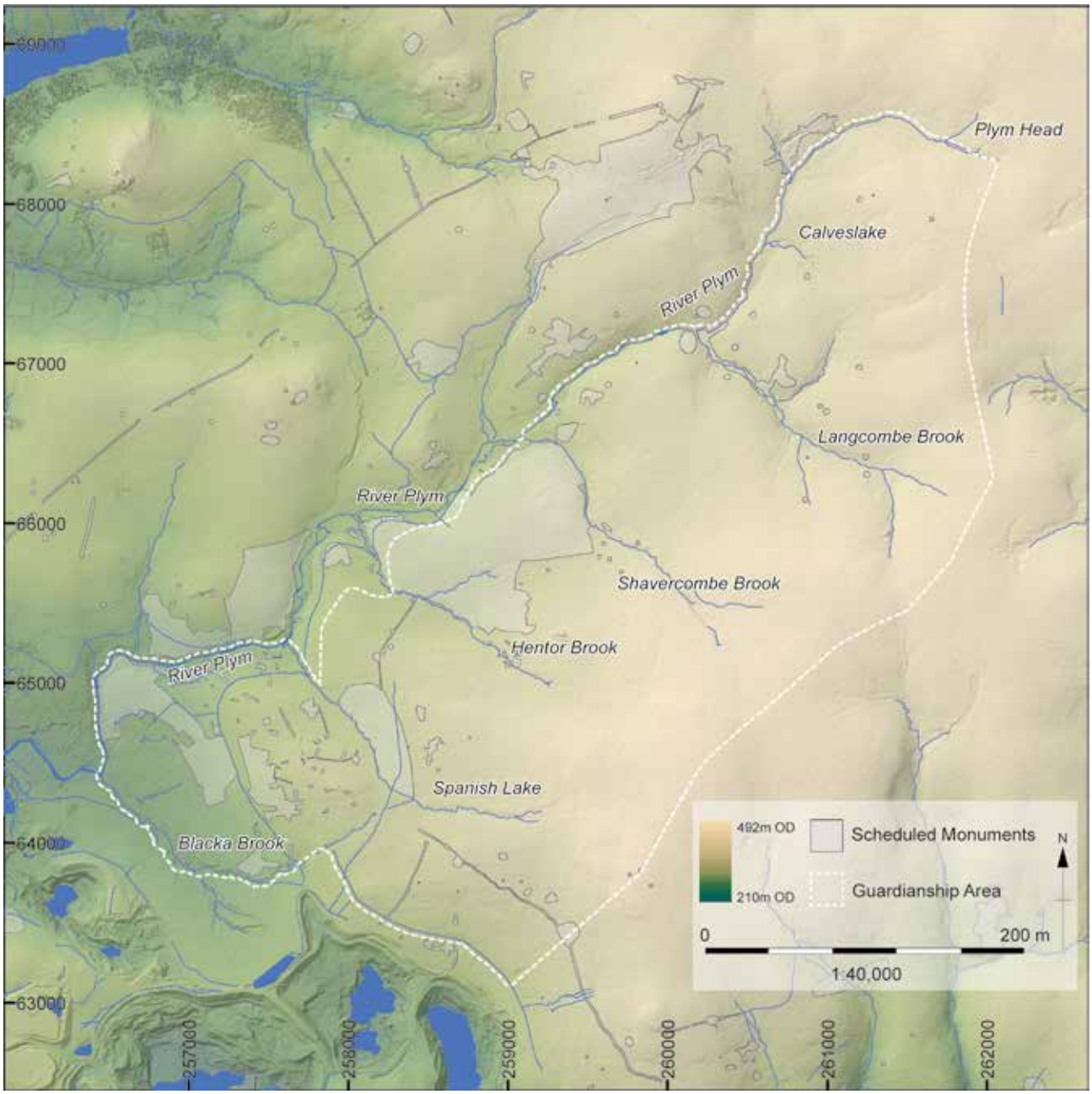


Figure 18: Upper Plym Valley location. Height data © Bluesky International/Getmapping PLC. Lidar DSM 25-FEB-2019 © Historic England, source Environment Agency. Other mapping derived from Ordnance Survey open data © Crown copyright and database right 2023.

Introduction

At 13.22 km^2 in extent the Upper Plym Valley is the largest of the guardianship sites on Dartmoor (Fig. 19). Located on the southern edge of the moor, the site equates to

approximately the north-eastern half of Shaugh Prior parish. The area comprises an extensive multi-period archaeological landscape including ceremonial and funerary monuments of presumed Neolithic and early Bronze Age date; land divisions, hut circles and enclosures of presumed mid- to late Bronze Age date; evidence of tin and peat extraction, rabbit warrening and farming of medieval and post-medieval date; as well as infrastructure associated with 20th-century china clay extraction.

Rising from 220m OD in its south-west corner to between 450 and 490m OD on its northern and eastern edges, the Upper Plym Valley guardianship site comprises the eastern catchment of the River Plym from its source at Plym Head to its confluence with the Blacka Brook. The area is framed by the course of Plym to the north-west; by the high ground of Langcombe Hill, Shavercombe Head, Shell Top and Great Trowlesworthy Tor to the east; and the line of the Blacka Brook to the south. Formerly part of the estates of Lord Morley (Hentor Warren) and Humphrey Woolcombe (Trowlesworthy Warren), the area was acquired by the National Trust during the 1960s (National Trust 2023; The Times 1961) and placed into state guardianship in 1978 (Thackray 1994, 13), presumably following the relinquishing of mineral rights held separately by china clay interests (Land Registry 2023).

Given its large size, the Upper Plym Valley guardianship site understandably includes many scheduled monuments as well as other non-designated archaeological features. In total there are 108 scheduled areas on the National Heritage List for England wholly or partly within the guardianship boundary. Whilst many are prehistoric monuments including, for example, stone rows to the south of Great Trowlesworthy Tor (NHLE 1012114, NHLE 1016147), later protected features include evidence for medieval farming and post-medieval rabbit warrening such as the multi-period remains at Hentor Warren (NHLE 1019082) and medieval/post-medieval tin working on Langcombe Brook (NHLE 1016145). The dates of original addition to the Schedule of Ancient Monuments range from 1952 to 2001 and none of the NHLE entries are in the Old County Number Series, having been surveyed by the Monuments Protection Programme.

History of previous research

The archaeology of the Upper Plym Valley has attracted the attention of antiquaries since at least the late 19th century. Butler (1994, 111-174), Robertson (1991, 1-2) and Grinsell (1978) provide comprehensive summaries of this work. The incidence of numerous unrecorded excavations of monuments in the vicinity (Bayer et al. 2017, 91; Newman 2011, 42; Worth 1900, 47) points to a much longer history of informal investigation. The first overarching illustrated synthesis of the archaeology of the area was published by Worth (1900, updated in 1927).

The Bronze Age origin of the Dartmoor Reaves was first recognised in the south-east corner of the guardianship area in 1972 (Fleming 1988, 1-11). Here Fleming et al. (1973) conclusively demonstrated the extensive nature of the reaves and their prehistoric date.

A series of archaeological surveys conducted between the late 1970s and early 1990s now form the backbone of our understanding of the guardianship site:

- Price undertook a series of studies of extant archaeological features in the catchment of the 'Moorland Plym' with a particular focus on Trowlesworthy Warren (1977, 1979, 1980);
- The Shaugh Moor Project undertook a contextual survey of the prehistoric archaeology of the Upper Plym Valley between 1979 and 1980 (Smith 1982);
- RCHME undertook an aerial photographic survey of Dartmoor including the Upper Plym Valley (Soffe 1985). This produced mapping at a scale of 1:10,560 which is now incorporated into the Historic England Aerial Archaeology Mapping Explorer.
- A more detailed survey was undertaken by the University of Edinburgh between 1982 and 1986 (Mercer 1987). This multi-period (Neolithic to 20th century) landscape survey was conducted at a scale of 1:1,000 with structure/site specific detail recorded at scales between 1:200 and 1:50 (Roberston 1991,4-5). The archive for this project is in the process of being deposited with the Historic England Archive. A doctoral thesis based on this survey was undertaken by Jennifer Robertson at the University of Edinburgh (1991). The thesis includes a series of 1:2,500 reductions of the original survey. A management plan for the Upper Plym Valley guardianship site undertaken by the National Trust and EH also reproduces this mapping at a scale of 1:2500 (Thackray 1994).
- The area is also covered by Butler's *Dartmoor Atlas of Antiquities* (1994 92-92, 111-174).

More recently two further surveys have been carried out within the guardianship area. Survey work was carried out by EH between 2001 and 2002. Referred to as Probert and Fletcher (2002), data derived from this survey appears to only exist in digital form in the Dartmoor National Park Authority Historic Environment Record. The southern edge of the guardianship area is covered by the Avon Valley to Plymouth component of the South Devon coast to Dartmoor aerial investigation and mapping project (Hegarty et al. forthcoming).

Aerial investigation and mapping results

Given the size and archaeological complexity of the Upper Plym Valley guardianship site, the following thematic discussion provides an overview only of key aerial investigation and mapping results, illustrated largely by extracts from the mapping and aerial imagery. Though an intensely studied landscape, new light has been thrown on certain aspects of the area's land-use history, including medieval/post-medieval peat cutting and processing and Second World War military training. The focus of the sections below is on new discoveries and the ways that specific imagery supports the identification and recording of certain monument types using Aerial Survey methodologies.

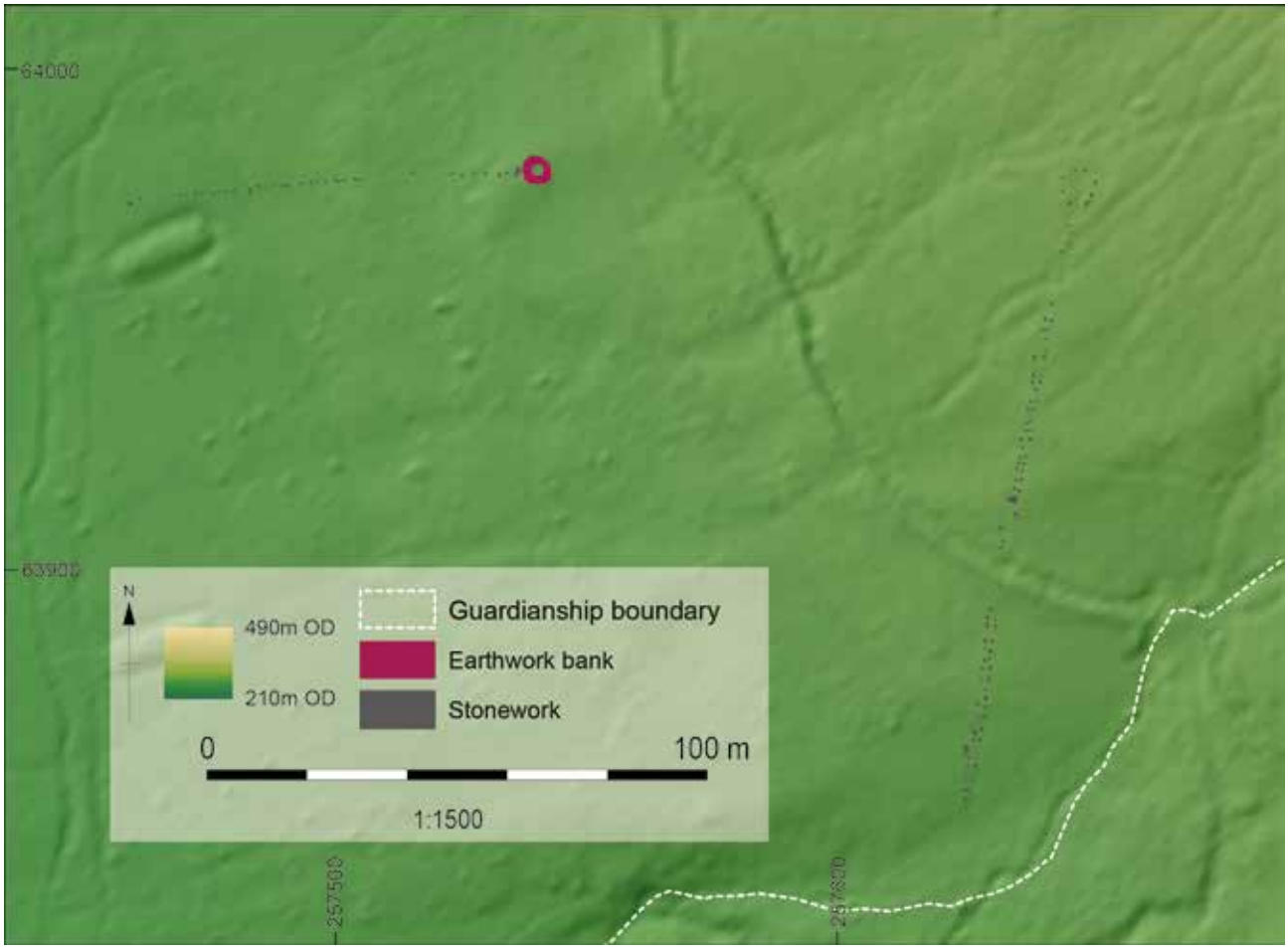


Figure 19: Stone alignments, stone circle and ring cairn, Great Trowlesworthy. Archaeological mapping © Historic England. Height data © Bluesky International/Getmapping PLC. Lidar DSM 25-FEB-2019 © Historic England, source Environment Agency.

Ritual and funerary monuments

Evidence in the guardianship site for the presence of people during the Neolithic is limited to two stone alignments built on the south-west facing slopes below Great Trowlesworthy Tor (Historic England Research Record 439148, Historic England Research Record 439217) (Fig. 19) and two stone circles, one standing at the head of the eastern stone row and the other in Willings Walls Warren centred on SX 58394 64595 (Historic England Research Record 439384). Thirty-eight of the 48 stones in the western stone row and 86 of the 103 stones in the eastern double stone row could be mapped, using the 2021 Historic England 8cm GSD ortho-photography and visualisations of a Digital Surface Model derived from the ortho-photograph. The eight stones of the circle at the head of this latter stone row were similarly mapped, whilst 24 stones of the Willings Walls Warren stone setting were recorded. This latter feature has previously been interpreted as a ring cairn (Dartmoor National Park Authority Historic Environment Record MDV28533) but, in agreement with observations made by Probert and Fletcher (2002), no earthwork bank is discernible in visualisations of 2019 Environment Agency 1m lidar data.

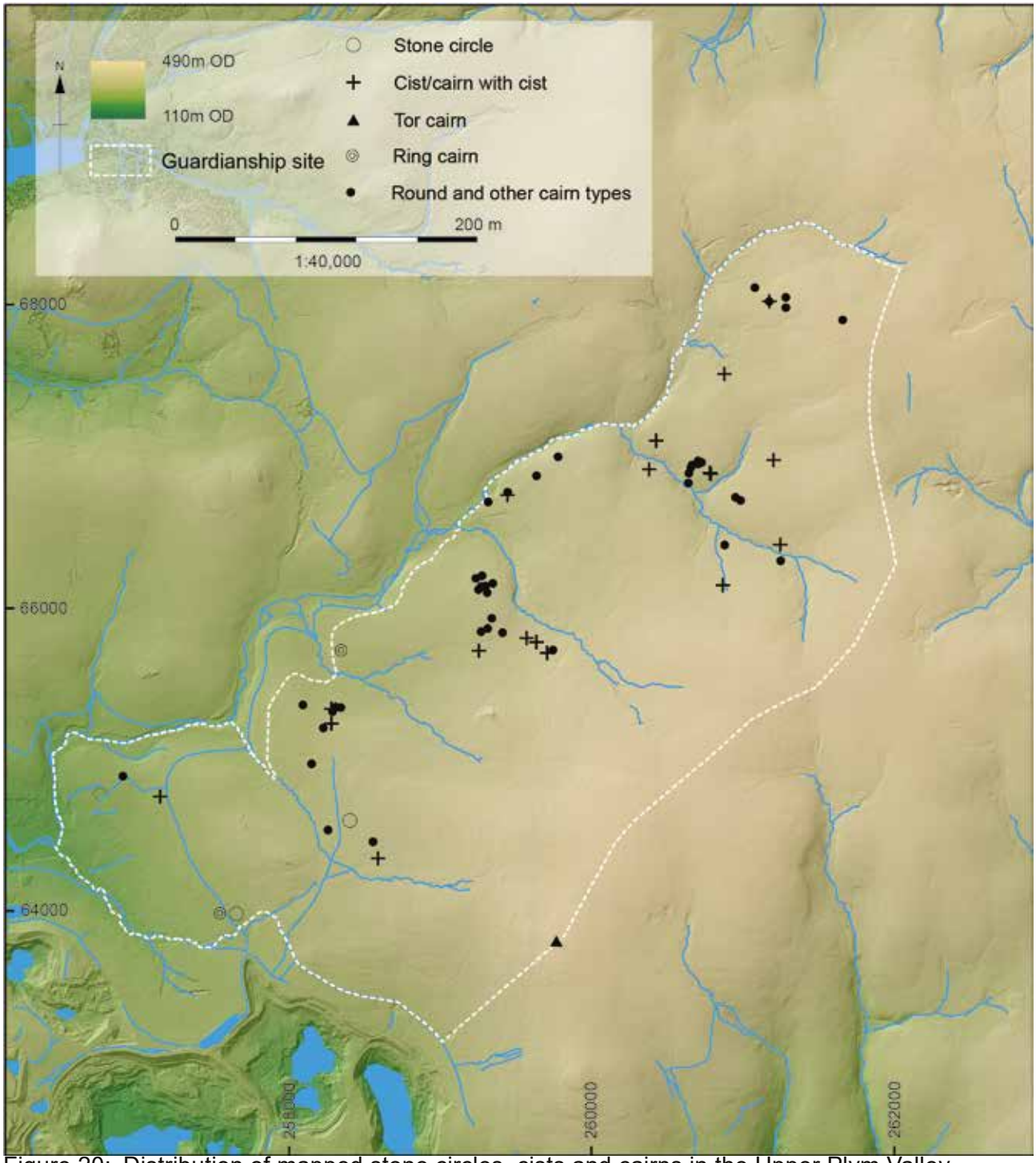


Figure 20: Distribution of mapped stone circles, cists and cairns in the Upper Plym Valley guardianship site. Archaeological mapping © Historic England. Height data © Bluesky International/Getmapping PLC. Lidar DSM 25-FEB-2019 © Historic England, source Environment Agency. Other mapping derived from Ordnance Survey open data © Crown copyright and database right 2023.

A number of presumed early Bronze Age cists, some of which do not appear to have been covered by cairn material (or perhaps cairn material has been completely removed by un-recorded excavation), and a range of different types of Bronze Age cairn including some known to contain cists, are distributed across the guardianship site (Fig. 20). The majority are below the 450m OD contour, the exceptions being the Shell Top tor cairn (Historic England Research Record 439300) and one of the cairns on Great Gnat's Head (Historic England Research Record 441568). This project's new 8cm ortho products have made it possible to map individual stones of cists and, for example, ring cairns built of standing stones and the kerb stones of kerb cairns. Some previously unrecorded small mounds that are probably prehistoric round cairns have been identified, largely from a combination of visualisations of 2019 Environment Agency 1m data and the 8cm Historic England ortho-photography.

Various of the cairns have been affected by recent interventions and have slight hollows in their tops where they have been dug into. As well as unrecorded antiquarian or more recent archaeological investigations, other reasons for such disturbance may include adapation as part of groups of Second World War practice trenches for example within the Hen Tor medieval/post-medieval field system where weapons pits are placed amongst a cairnfield. The large cairn (Historic England Research Record 439130) on which the Cholwich Town reave is oriented has been dug into, revealing rubble cairn material. The disturbance in the top of the mound is very clear in the Historic England 8cm ortho-photography. However, an arrangement of stones on the top of the mound in a x-shape on plan is very reminiscent of the post-medieval vermin traps used in the rabbit warrens in the Upper Plym Valley and could be part of Willings Walls Warren (Historic England Research Record 1631210, Historic England Research Record 438879). A large round cairn (Historic England Research Record 439208) approximately 468m south-east-south of the Cholwich Town reave cairn is also dug into, the hollows and depressions in its surface made clear on the Historic England 8cm ortho-photography and visualisations of a Digital Surface Model derived from the ortho-photograph. Previously interpreted as internal chambers, they are more likely to be a combination of antiquarian excavation and the modern creation of shelters (and see Field Investigator's Comments made in 1977, Historic England Research Record 439208).

Bronze Age settlement

The guardianship site includes considerable evidence for Bronze Age settlement in the form of hut circles, enclosures and some fragments of field boundaries (Fig. 21), occupying ground below the 400m OD contour. Many of these features have been reused and adapted in later periods.

More than 250 hut circles were mapped. They stand in a range of contexts, including enclosed and unenclosed hut circle settlement and examples that are attached to fragments of enclosure wall. In part their appearance today is a result of land use history with significant anthropogenic impacts on prehistoric features (such as adaptation for post-medieval rabbit warrening, see below). Furthermore, some archaeological features are likely to have become obscured by peat growth or vegetation. Many of the accompanying

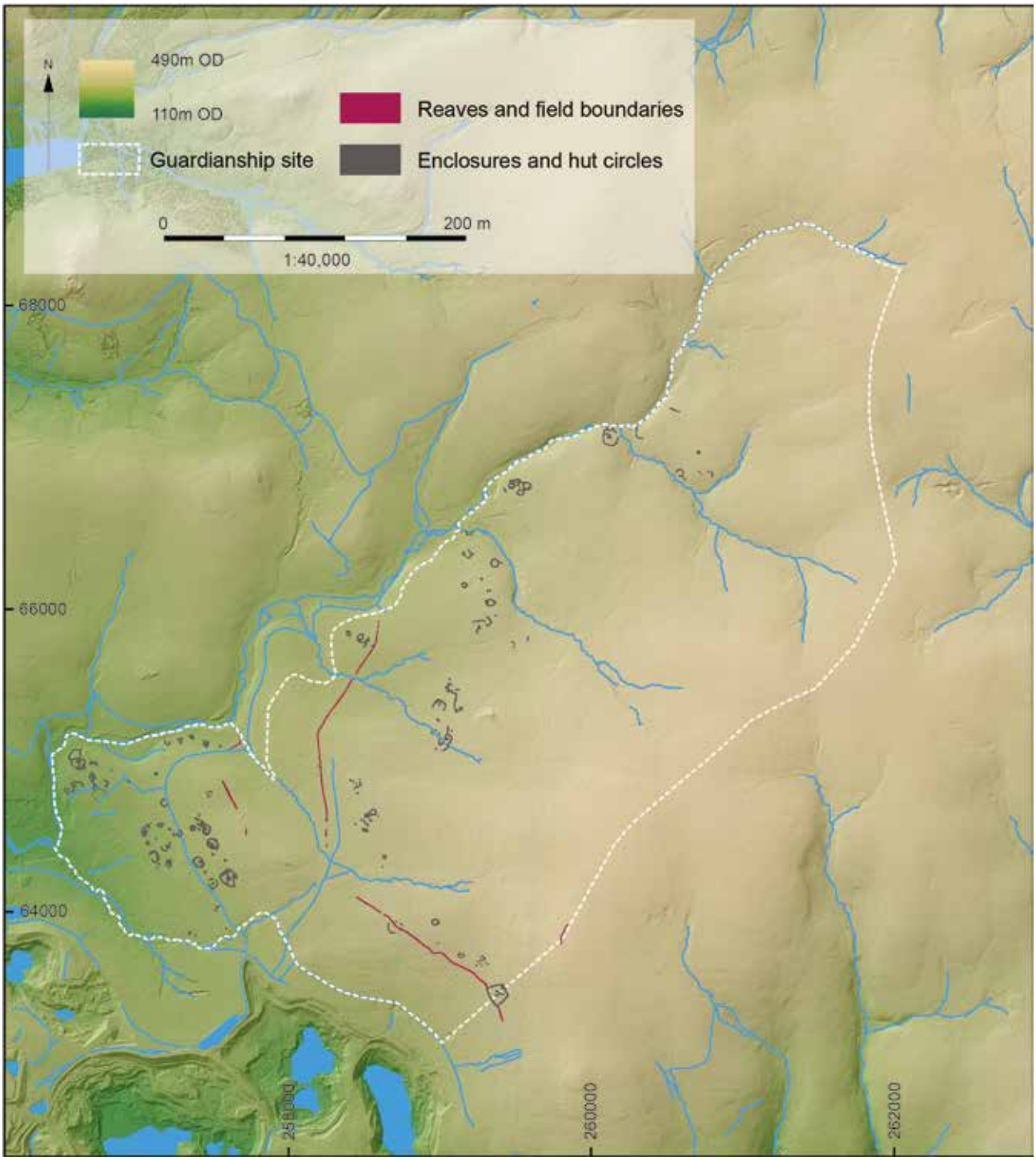


Figure 21: Distribution of hut circles, enclosures, reaves and other Bronze Age field boundaries in the Upper Plym Valley guardianship site. Archaeological mapping © Historic England. Height data © Bluesky International/Getmapping PLC. Lidar DSM 25-FEB-2019 © Historic England, source Environment Agency. Other mapping derived from Ordnance Survey open data © Crown copyright and database right 2023.

enclosures, some perhaps contemporary with the hut circles and others of which may be later constructions, are on the whole well-preserved although some are fragmentary. In addition to adaptation for rabbit warrening and incorporation into medieval farm boundaries, some enclosures on the lower slopes near to the River Plym and its tributaries have been partially removed by later tin streaming and the excavation of tin opencuts. It should also be born in mind that the mapping for this project does not extend beyond the guardianship boundary, but that evidence for considerable Bronze Age settlement continues to the north-east around Legis Tor, Ditsworthy and Eylesbarrow. Nevertheless, the extent of Bronze Age settlement in the area of the guardianship site is clear.

An illustrative selection of settlement sites is described below. In addition to demonstrating different forms of Bronze Age settlement, they show that phase relationships can be discerned between components of the sites and with the reave systems of land division.

Historic England Research Record 439441

An earthwork bank approximately 87.3m long (scheduled monument NHLE 1017399), forming the curved western and southern arc of an enclosure wall, stands approximately 49m to the south-west of the Cholwich Town reave. A hut circle with a south-facing entrance stands at the wall's northern end at SX 58659 63905, although is not attached to the wall. Previous authorities suggest that, if there had been more walling completing the enclosure, it was robbed for the creation of the reave or that it was never complete (see Field Investigator's Comments dating to 1979 and 2002 in Historic England Research Record 439441). Visualisations of 2019 Environment Agency 1m lidar data show that the stony bank parallels the scarp of a slight rise approximately 20m to the north-east. Furthermore, four sections of slight, curving ditches are visible in the visualisations on the up-slope, north-east side of the reave. The ditches possibly represent the other side of the enclosure, in which case it would have been roughly 87m in diameter. One ditch section, centred on SX 58740 63868, appears to underly the reave and thus pre-date it, similar to the large, enclosed hut circle settlement (Historic England Research Record 439273) some 800m to the south-east.

Historic England Research Record 438723

This monument comprises a group of enclosure walls and at least 20 hut circles, some free-standing with others attached to the stony walls and earthwork banks (NHLE 1019082). They are situated on the gently sloping north-west flank of Hen Tor. Part of the northern enclosure has been incorporated into the medieval/post-medieval Hen Tor field system (Historic England Research Record 438864). There is no evidence on the available aerial sources to suggest that the enclosures are attached to one another. This settlement site appears to be an example of those characterised by Newman (2011) as 'partitioned settlements' where some hut circles are linked by connecting walls but are not fully enclosed (2011, 71). For example, sections of arcing wall centred on SX 58993 65345 form three sides of a sub-circular enclosure that is open to the south side. Three free-standing hut circles inside the space are accompanied by three against which the enclosure walls butt. Just to the north-east, another part of the settlement includes fragments of a sub-oval enclosure centred on SX 59084 65460. There, the south-west arc

of enclosure wall cuts the earthwork bank forming the eastern side of the enclosed space. These features were mapped largely from visualisations of 2019 Environment Agency 1m lidar data.

Historic England Research Record 438767

A settlement site on the western flank of Giant's Hill, overlooking the River Plym, is an example of one of the many agglomerated or aggregated settlements in the guardianship site, so called because of the way that new enclosures were built on to earlier ones. It has at least four distinct enclosed areas forming eastern and western groups and was mapped largely from visualisations of 2019 Environment Agency 1m lidar data, augmented by 2021 Historic England 8cm GSD ortho-photography and visualisations of a Digital Surface Model derived from that ortho-photograph.

The northern enclosure of the western group is the earliest, with four conjoined hut circles comprising its north-eastern arc, two hut circles incorporated into its west wall and an internal wall dividing the northern and southern halves of the sub-oval space. A second enclosure was added to the west, also sub-divided and incorporating two hut circles in its walls.

To the east, a D-shaped enclosure with an opening in its west wall surrounds two free-standing hut circles. A short length of stony bank approximately 14m long passes between two hut circles, forming a northern barrier between this latter enclosure and the earliest enclosure of the west agglomeration. Another D-shaped enclosure stands immediately to the south-west, with two wide openings that may be original entrances or simply the result of damage to the stony banks. These two latter enclosures appear not to be attached to one another. Two hut circles stand in the open ground between the western and eastern groups of enclosures, where a medieval or post-medieval tin prospecting tin has also been dug. To the south-west, curved sections of earthwork bank may be fragments of a further enclosure of this settlement. It stands close to three small cairns, one with part of a cist visible in its mound (Historic England Research Record 438767, Historic England Research Record 1358033).

Historic England Research Record 438726

Some of the variety of sizes and forms of hut circles is illustrated by an area of Bronze Age settlement on Hen Tor Meadow (NHLE 1019082). The 11 hut circles range from 4m to 12.3m in overall diameter, perhaps suggesting that these structures were put to different uses (Newman 2011, 61). Four have visible entrances of which two are oriented north-east, one south and one south-east. The largest hut circle has an annex attached to its south side.

The western-most hut circle is incorporated into a sub-oval enclosure. Three hut circles towards the centre of the group are linked by stony enclosure banks. The rest are free-standing, with three to the north and two to the south of a 46m-long section of enclosure wall. A second section of enclosure wall, on the same orientation, stands about 39.3m away to the south-east, attached to the Willings Walls reave (Historic England Research

Record 438849). Unlike the first enclosure described above (Historic England Research Record 439441), this relationship suggests that at least parts of the enclosure banks here were constructed after the reave.

Bronze Age land division

The guardianship site is intersected by at least four reaves that form part of the larger system of Bronze Age land division in the catchments of the Rivers Plym and Erme. The small section of the Shell Top reave (Historic England Research Record 439343) just within the guardianship boundary was mapped, but the principal evidence in the guardianship site for these field systems comprises Little Trowlesworthy Tor, the northern section of the Cholwich Town reave and the Willings Walls reave (Fig. 21).

Cholwich Town reave (Historic England Research Record 439340, NHLE 1017399)

Exploration of the Cholwich Town reave was instrumental in the recognition of a Bronze Age date for these extensive field systems (Fleming 1973; 1988). The northern section of the reave is within the guardianship site. Measuring just over 1km in length, this stony earthwork bank is oriented north-west to south-east. From a hut circle settlement on the guardianship boundary, the bank heads to the north-west following a sinuous course between the 370m OD and 375m OD contours. It makes a slight change in direction at SX 58660 63950, heading towards the large cairn (Historic England Research Record 439130). Damage to the cairn makes it difficult to interpret the relationship between it and the reave, but as mentioned above the reave appears to be oriented on the cairn and butts its north-west side. From the cairn, the reave continues for approximately 191m, cutting across the contours of the north-west facing hillside. Evidence for it is not visible in the available aerial sources much below the 350m OD contour. The bank is broken in numerous places, largely by recent tracks.

Fleming et al. (2008, 5-6) note that the reave butts the southern corner of enclosed hut circle settlement Historic England Research Record 439273 but could not clearly discern the relationship between the enclosure and reave at the north-west corner. Visualisations of 2019 Environment Agency 1m lidar data demonstrate that the reave bank slightly surmounts the enclosure bank in both places, reinforcing the later date of the reave.

Little Trowlesworthy Tor (Historic England Research Record 439136, NHLE 1014471, Historic England Research Record 1015748)

Two sections of reave are oriented on Little Trowlesworthy Tor. The shorter section to the south of the tor, measuring 36.2m long, is oriented north to south. The longer part to the north side of the tor measures 203.8m in a series of sections, oriented north-north-west to south-east-east. The breaks are caused by vehicle tracks that traverse the north-facing slope of the moor and cut the reave. At SX 57643 64694, the reave appears to overlie part of a hut circle. Later use of the reave within Trowlesworthy Warren, including the construction of vermin traps on the northern part, has been the source of debate about its date and purpose (see Monuments Protection Programme and English Heritage

survey details recorded in Dartmoor National Park Authority Historic Environment Record MDV2545). Nevertheless, in visualisations of 2019 Environment Agency 1m lidar data its morphology bears greater similarity to the banks of other reaves within the guardianship site, being slighter and straighter than the usually more substantial and curvilinear medieval field boundaries of Trowlesworthy Farm.

Willings Walls Reave (Historic England Research Record 438849, NHLE 1019083, NHLE 1019082)

The Willings Walls reave is approximately 1.6km long. It stands wholly within the guardianship area, running from a point within Willings Walls Warren northwards towards an earlier embanked stone circle (Historic England Research Record 438720) before turning to the north-east where it passes through a group of Bronze Age cairns and has at least two cairns built onto its bank. The reave continues beyond Hentor Brook before turning slightly more to the north. Evidence for it on the available aerial sources peters out in the environs of SX 58595 65910. The reave is largely as described by previous authorities, with a gap of about 53.6m in Willings Walls Warren, in which stands a medieval farmstead (Historic England Research Record 439325). At SX 58209 64949 a further, shorter gap is occupied by two hut circles and the post-medieval ditch and bank of the warren boundary (Historic England Research Record 439346). Here also a small sub-rectangular medieval/post-medieval structure is built onto the west side of the reave. Other smaller breaks in the reave bank are likely the result of recent activity and post-medieval vermin traps are built onto it in at least two places.

The northern end of the reave and parts of the Hentor medieval/post-medieval field system that refer to it were mapped from a combination of visualisations of 2019 Environment Agency 1m lidar data, 2021 Historic England 8cm GSD ortho-photography and visualisations of a Digital Surface Model derived from that ortho-photograph. This has clarified the archaeological relationships of earthworks in this area. At SX 58580 65799, lengths of medieval/post-medieval field boundary come very close to or butt the reave; this ‘junction’ thus brings the reave into the later field system by creating large intakes formed either side of it. Contrary to previous authorities including Robertson (1991, 19-21), the reave does not continue into and form the foundation of the northern part of the Hentor medieval/post-medieval field system (Historic England Research Record 438855). The reave heads towards the River Plym, whilst the later earthwork bank to the east side of the reave at the aforementioned ‘junction’ forms the first group of enclosures in the field system (described below).

Medieval/post-medieval settlement and field systems

Evidence for medieval settlement is spread across the guardianship site, including Trowlesworthy Farm (Historic England Research Record 439294), a deserted farmstead in Willings Walls Warren (Historic England Research Record 439325), two deserted farmsteads with associated buildings in Hentor Warren (Historic England Research Record 438864, Historic England Research Record 438867) and a deserted farmstead at Little Hentor (Historic England Research Record 438873). Although most if not all of these complexes were in use in the post-medieval period (and Trowlesworthy Farm is still in

occupation), their longhouses likely have medieval origins. Some enclosures and fields in the Trowlesworthy and Hentor systems make use of Bronze Age features; for example the north-eastern Hentor farmstead centred on SX 59179 66344 (Historic England Research Record 438867), where a prehistoric enclosure and two if not three hut circles were adapted to provide an enclosure and yards for a longhouse.

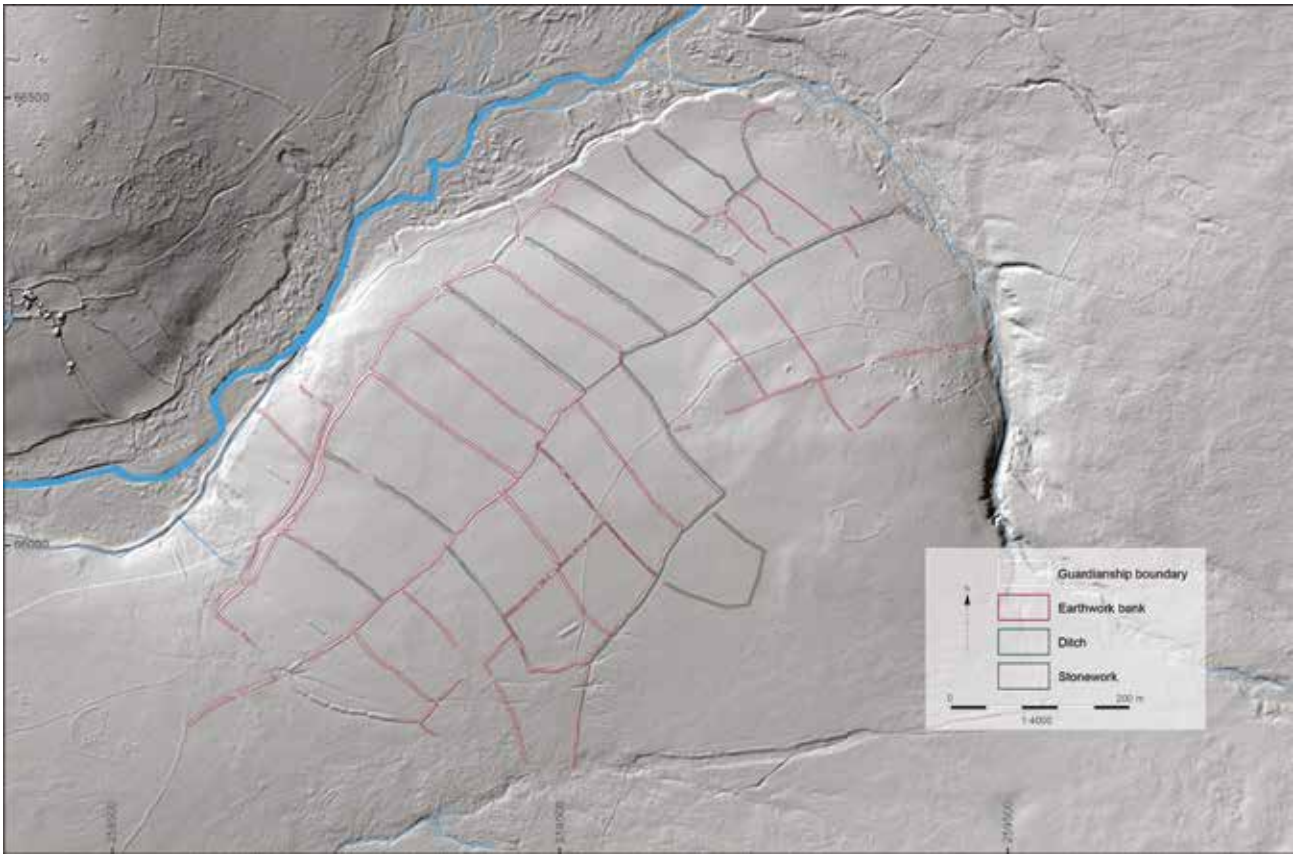


Figure 22: Simplified mapping of the northern Hentor Field system without ridge and furrow and pillow mounds, depicting butting field boundary junctions. Archaeological mapping © Historic England. Lidar DSM 25-FEB-2019 © Historic England, source Environment Agency. Other mapping derived from Ordnance Survey open data © Crown copyright and database right 2023.

The scheduled multi-period Trowlesworthy (NHLE 1020323) and Hentor (NHLE 1019082) field systems are particularly complex, with evidence for medieval enclosures, many defined by 'cornditch' type boundaries, and post-medieval development and adaptation. A number of prehistoric enclosures are incorporated into the north-west quarter of the medieval Trowlesworthy field pattern (Historic England Research Record 1360637), which also stretched to the south-east of the farm buildings initially defined by fields laid out to the south-west of a substantial cornditch, and then extended with the addition of less regularly formed fields with cornditches and simple earthwork boundary banks. Smaller, more geometrically shaped fields with rubblestone walls built closer to the farmstead are later developments of the field system.

The Hentor field system comprises four main areas:

- A cluster of stone-walled fields are assembled around a farmstead (Historic England Research Record 438864) centred on SX 59008 65598 with additional yard and longhouse to the south at SX 58989 65536. These fields are about 5.8ha overall and likely post-medieval in date in this iteration. The group is cut by the early 19th-century Phillips Leat (Historic England Research Record 1360628). A fragmentary stone wall extends from these fields along much of the north bank of Hentor Brook;
- Intakes of around 22.6ha to the north-west of that first group of fields are defined by the fragmentary wall following Hentor Brook, by part of the Willings Walls reave (Historic England Research Record 438849) and an arrangement of probably medieval field boundaries (Historic England Research Record 438864) that cut off the spur of land to the east of the confluence of the River Plym and Hentor Brook;
- The northern Hentor field system (Historic England Research Record 438855) comprises just over 34ha of predominantly arable fields, the majority of which are parallel sub-rectangular fields containing ridge and furrow. This part of the complex is discussed in more detail below;
- A further intake of approximately 14ha to the south-east of the northern Hentor field system, defined by the edge of that field system and an arrangement of earthwork banks with ditches that form a roughly right-angled boundary above Shavercombe Brook.

As mentioned above in the discussion of the Willings Walls reave, mapping from visualisations of 2019 Environment Agency 1m lidar data, 2021 Historic England 8cm GSD ortho-photography and visualisations of a Digital Surface Model derived from that ortho-photograph has clarified the relationship between the Bronze Age reave and the northern Hentor field system. As well as concluding that the field system is not based on an extension of the reave, the mapping makes it clear that the system is developed from a section of medieval field boundary bank that is oriented south-west to north-east away from the east side of the reave. After approximately 212m, this field boundary turns through a right angle to head towards the south-east. At least five subsequent sections of the field system are developed in a similar way, progressing from west to east with roughly right-angled corners turning to north or south to create fields as indicated by butting joins at field corners (Fig. 22).

Earthwork banks to the west side of the field system indicate that, on the riverbank opposite Ditsworthy, some small fields continued towards the River Plym. A possible trackway was formed by parallel field boundaries from SX 58609 65928 to SX 58748 66150. Almost all the field parcels contain north-west to south-east oriented ridge and furrow. In two fields at the very north-east of the field system the ridge and furrow is perpendicular to this dominant orientation. These two fields abut the north-west side of the farmstead Historic England Research Record 438867. The latest part of the field system includes fields in the north-east quarter, defined by slighter earthworks without evidence for ridge and furrow, laid out amongst Bronze Age settlement features and a cairn-field

Figure 23: Peat cutting ties at Shavercombe Head (view approximately south-east, unscaled). Detail of NMR2600/226 10-APR-1985 © Crown copyright. Historic England Archive.

(Historic England Research Record 438947, Historic England Research Record 438779, Historic England Research Record 438776, Historic England Research Record 1356297). Some field banks in the southern part of the system include later rubblestone walls, evidencing maintenance and adaptation of the field system. The later development of Hentor Warren within this and the other components of the overall field system, including the re-working of field boundaries into pillow mounds, is discussed below.

Peat extraction and processing

Within the guardianship site there are a combination of both small and very large areas where peat has been cut in the past. The date of this activity is likely to range from the medieval period into the 20th century (Newman 2010). For reasons discussed below, a significant proportion of the peat cutting on the interfluves of the Rivers Plym, Erme and Yealm, associated with numerous examples of a type of charcoal burning platform that was used to carbonise peat, is interpreted as serving metalliferous industry, in particular tin smelting.

Peat is formed of partially decomposed plant matter that has become compressed by continuous accumulation. It has developed on the elevated, wet ground of Dartmoor over thousands of years. Cut and dried blocks of peat provide a fuel of high calorific value, both for tenants and commoners with turbary rights and for industries using pyrotechnic processes such as firing and smelting. Products such as naptha can be produced from

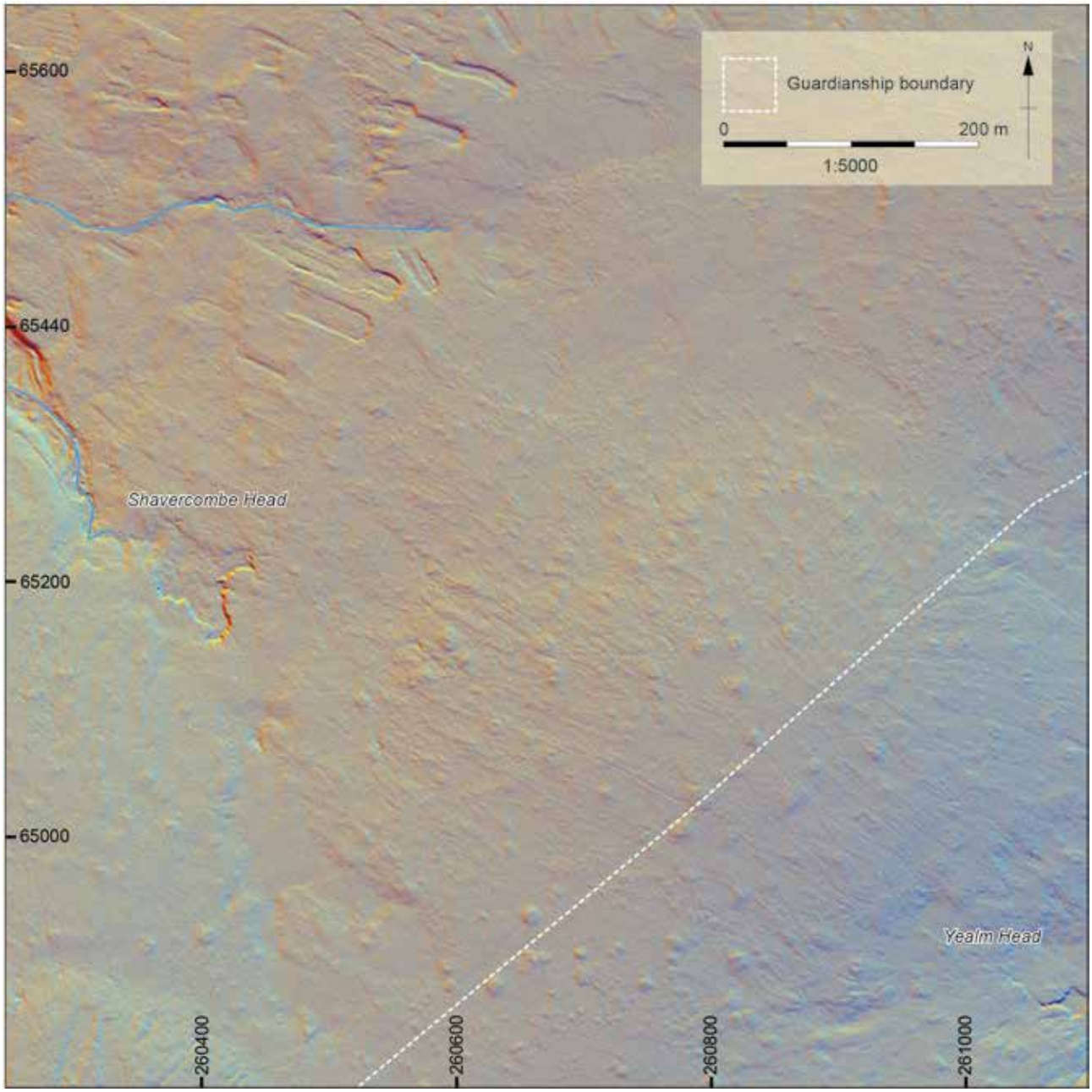


Figure 24: Peat cutting ties (top left) and probable charcoal burning platforms ('meilers') on the south-east boundary of the Upper Plym Valley guardianship site. Lidar DSM 25-FEB-2019 © Historic England, source Environment Agency.

peat through distillation. Domestic use of peat fuel likely has pre-medieval origins, while industrial use in tin smelting was active by the 13th century. Capitalised enterprises engaged in distillation processes were established on Dartmoor by the mid-19th century (Newman 2010, 1; 2018, 17-18).

Peat cutting areas in the Upper Plym Valley catchment were observed during the University of Edinburgh survey carried out in the 1980s (see above) and simplified extents of some of the areas were recorded (Robertson 1991). The geometrically shaped areas, known as ties, are visible as low negative earthworks that reveal the outline of the cuttings,

sometimes with associated drainage ditches. Ties are commonly roughly rectangular on plan, aligned downhill to encourage drainage (Fig. 23).

Within the guardianship site there are some examples of small groups of ties closer to settlement areas, such as a group of seven to the north-west of Little Trowlesworthy Tor (Historic England Research Record 1631148) ranging in size from 16.3m by 7.7m on plan to 90.1m by 20.4m on plan. They may represent domestic peat cutting; turbary rights limited householders to cut only as much as they could use (Newman 2010, 17). However, on the higher ground in and around the north-eastern part of the guardianship area there are some very large concentrations of ties on the hillsides of Lee Moor, Penn Moor, at Shavercombe Head, on Langcombe Hill, Little Gnats Head and Great Gnats Head. In total, the extent of just over 360 hectares of closely grouped ties was mapped (Historic England Research Record 1631190, Historic England Research Record 1631203, Historic England Research Record 1631205, Historic England Research Record 1631206, Historic England Research Record 1631209) (*see* Fig. 28), but the peat cutting areas continue to the south and east towards the Erme and Yealm rivers beyond the project area. More recent peat growth and natural changes to the surface including re-vegetation have obscured what was probably even more extensive peat-cutting across the moor, including areas where the ground appears disturbed but not clearly enough to map from the available aerial sources.

Amongst the peat cutting areas, assembled on the highest ground, are concentrations of sub-circular or sometimes penannular mounds ranging from 5m to 16.6m in diameter (Fig. 24). Although a small number of these features had previously been interpreted as prehistoric burial mounds, that identification was questioned by English Heritage during scheduling assessments carried out in the 1990s and Newman (2010; 2014) subsequently drew attention to previous research by Woolner (1967) suggesting that similar examples on Wild Tor Ridge (Dartmoor Forest) are a form of charcoal burning platform known as a ‘meiler’. Although ‘out-ricking’ did occur on Dartmoor, where stacks of cut peat were left to dry on the moor, the drying turves were arranged alongside the ties rather than at a distance like the mounds observed here (Newman 2010, 37). In consequence, it is more likely that they are charcoal burning platforms. Four groups were mapped in the Upper Plym guardianship site:

- At least 49 located on a saddle of open moor between Shell Top and Langcombe Hill, on flattish and gently sloping north-west facing ground above Shavercombe Head. They stand above the 465m OD contour (Historic England Research Record 1568654). At least this number again occupy the south-east side of the saddle, outside the guardianship boundary (but were not mapped);
- At least 43 located on a flattish spur of ground between Langcombe Head and Hortonsford Bottom, on the gentle north-west facing slopes above Langcombe Head and on the west-facing slopes above Erme Head (Historic England Research Record 1631205). Some of these mounds stand amongst ties. A few are placed as low as the 450m OD contour but the majority are on the highest ground and, similar to the group above, further examples occupy the top of the ridge and the south-east

facing slopes outside the guardianship boundary (but were not mapped);

- At least 12 located on the summit of Great Gnats Head, all positioned at or above 465m OD (Historic England Research Record 1631206). More stand on the ground to the east beyond the guardianship boundary, extending as far as Plym Head and Ducks Pool (but were not mapped);
- At least four located above the 410m OD contour on a gentle east facing plateau of Little Gnats Head, standing amongst ties (Historic England Research Record 1631209).

The mounds are most clearly visible on visualisations of 2019 Environment Agency 1m lidar data. They are largely sub-circular, sometimes with slight depressions in the top, or penannular. These characteristics, combined with their location above and amongst peat ties, suggests most strongly that they are charcoal burning platforms. The central depression or opening in some mounds is likely the former location of an upright post, known as a 'quandel', around which a stack of brushwood and dried peat was formed in a domed pile. The pile was mounded over with turf and soil, the quandel removed to leave a flue, and a controlled burn was performed to carbonise the peat (Newman 2014, 23). Examples still standing on the moor represent perhaps abandoned working areas or, given their relatively low height, the bases and lowest remaining layers of the platforms.

It is unclear from the available aerial sources what routes were used around the ties and between the high ground, where the mounds stand, to the places where peat charcoal would have been used. It is noticeable that the mounds are placed on very high ground and would have entailed transporting the product some distance even to the nearest known tin blowing houses; for example, around 2km as the crow flies from Langcombe Hill to blowing house Historic England Research Record 441611 on the River Plym. Perhaps the flattish ground and prevailing winds are contributory factors to the mounds' locations, but too little is currently known about the overall peat charcoal manufacturing process to infer much more about the spatial distribution of the mounds, ties and possible consumers of peat charcoal.

This peat carbonisation method was in use into the 19th century but may have its origins with the *carbonarii,* specialists who were producing peat charcoal from the thirteenth century onwards as a fuel for tin-smelting; some for the Devon tin industry but many for Cornish tinning. It was, in all likelihood, much more prevalent in the earlier centuries, before coke and coal could be supplied by railway from the mid-19th century (Newman 2014, 22). In an analysis of medieval Account Rolls, Fox (1994, 162) noted up to 100 *carbonarii* working on Dartmoor by 1400, requiring a commensurately significant supply of cut and dried peat. Substantial areas of peat cutting in the Upper Plym guardianship area, with their associated meilers, may date to that period, possibly supplying the extensive tin-streaming works on the River Plym and its tributaries. In the Erme Valley to the east, however, a large holding was let by the Duchy of Cornwall to Messrs Davy and Wilkin to cut peat for a charcoal and naptha works (Newman 2018, 19). Without an obvious way to date peat cutting, but with the potential for radiocarbon determinations from possible meilers, caution is required in dating features that at present can only be assigned as

'medieval/post-medieval'.

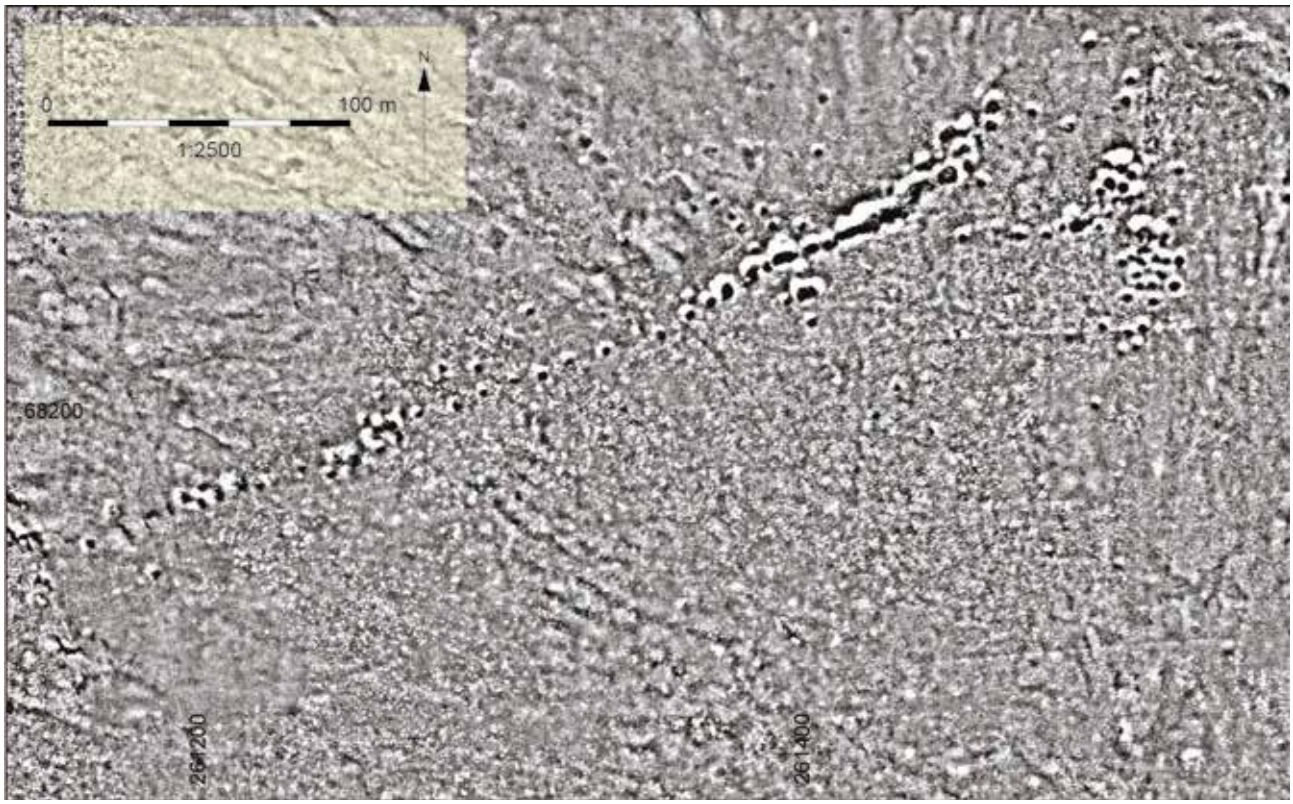


Figure 25: Tin prospecting pits at Plym Head in a Simple Local Relief Model visualisation. Structure from Motion Digital Surface Model 30-MAR-2021 © Historic England Archive.

Tin working

Extensive evidence for medieval and post-medieval tin working in the Upper Plym catchment, documented by previous surveys, reflects the importance of this industry in Devon as a whole. The industry's peak occurred in the early 16th century and following a period of around 150 years when tin production was negligible, revived in a smaller way in the late 18th century (Newman 2011, 142-4). The most noticeable aspects of tin works in the Upper Plym guardianship site comprise streamworks and opencuts in the watercourses (Historic England Research Record 1063602) and a concentration of prospecting pits in the north-east quarter of the site around Plym Head, Great and Little Gnats Head (Historic England Research Record 1355765). The guardianship site also includes examples of tinners' huts and caches, a stamping mill and blowing house, other extractive pits accompanied by spoil heaps and a possible reservoir. The main types of extractive features are discussed below, given the power of their visual impact on the landscape.

Streamworks and opencuts

Probably medieval alluvial tin streamworks in the valleys of the River Plym and its tributaries were mapped from visualisations of 2019 Environment Agency 1m lidar data.

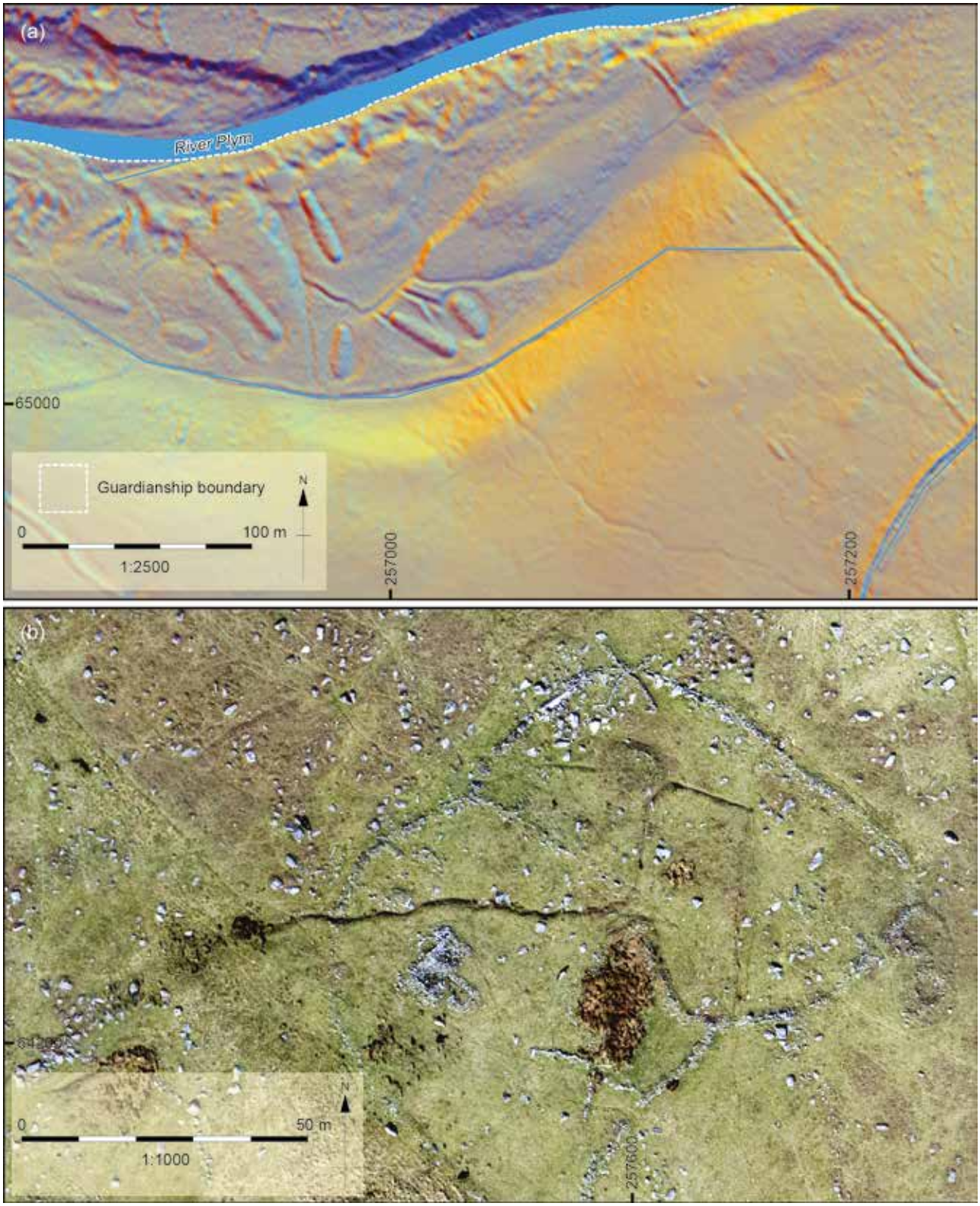


Figure 26: Trowlesworthy Warren, (a) clustered and linear pillow mounds, Lidar DSM 25-FEB-2019 © Historic England, source Environment Agency. (b) filled-in hut circles and vermin traps built onto prehistoric enclosure walls, detail from Structure from Motion ortho-photograph 30-MAR-2021 © Historic England.

Some 181ha of earthworks from Cadover Bridge in the south-west to Plym Head in the north-east, including the tributaries, were recorded; the extent of the streamworks was mapped but not the detail within of tyes and spoil heaps. The steep, cliff-like sides of probably post-medieval opencuts (also known as 'openworks' or 'beamworks') were also recorded from lidar visualisations. The multi-lit hillshade was particularly useful for these major earthworks but at some opencuts, for example Historic England Research Record 1631086 to the south side of Langcombe Brook, pits sunk into the bottom of the excavated channel were more clearly visible in the Positive Openness visualisation.

Tin prospecting pits

Veins or 'lodes' of tin in the granite of Dartmoor generally follow an east-north-east trend (Newman 2011, 150). Although a few isolated tin-prospecting pits are located to the north-east of Little Hentor and on the west side of Erme Head, the majority in the guardianship site are grouped close to Plym Head in linear arrangements that conform to the general trend (Fig. 25). They lie above 400m OD, as do other more extensive examples on the opposite side of the River Plym at Wheal Katherine and Eylesbarrow to which they may be related. The Simple Local Relief Model visualisation of a Digital Surface Model derived from the 2021 Historic England 8cm GSD ortho-photography was particularly important to map these features.

Post-medieval warrening

There is archaeological evidence for 20 rabbit warrens on Dartmoor (Linehan 1966; Newman 2011, 168). The warrens produced rabbit meat, pelts and fur for hatting, with thousands of animals harvested each year by an industry that developed as a commercial activity from the 15th century onwards. The key archaeological elements of each warren comprise the warrener's accommodation and related facilities, pillow mounds, vermin traps, boundaries and drainage features (Newman 2011, 172-175). The Upper Plym Valley guardianship site includes three of the five Upper Plym rabbit warrens: Trowlesworthy Warren, Willings Walls Warren and Hentor Warren. It should be borne in mind that the three warrens are related to the Legis Tor and Ditsworthy Warrens outside the guardianship site to the north side of the River Plym. For example, the Willings Walls and Hentor Warrens were worked together (Robertson 1991, 264) and it seems that the Hentor Warren was worked with Ditsworthy in the 19th century. The following discussion thus focuses on selected aspects of the guardianship site's warrens rather than a broader discussion of this industry in the Upper Plym catchment overall.

Trowlesworthy Warren (Historic England Research Record 439294)

Although previously claimed to be the oldest rabbit warren on Dartmoor, rabbits were probably first introduced to the farm to form Trowlesworthy Warren in the 17th century (Robertson 1991, 192, 254-5). The buildings and yards of Trowlesworthy Farm that served the warren, including warrener's house, kennels, stables and eventually a small hat factory, are documented by Hemery (1983, 221-4), whose account includes oral history and photographs from the last warreners themselves.

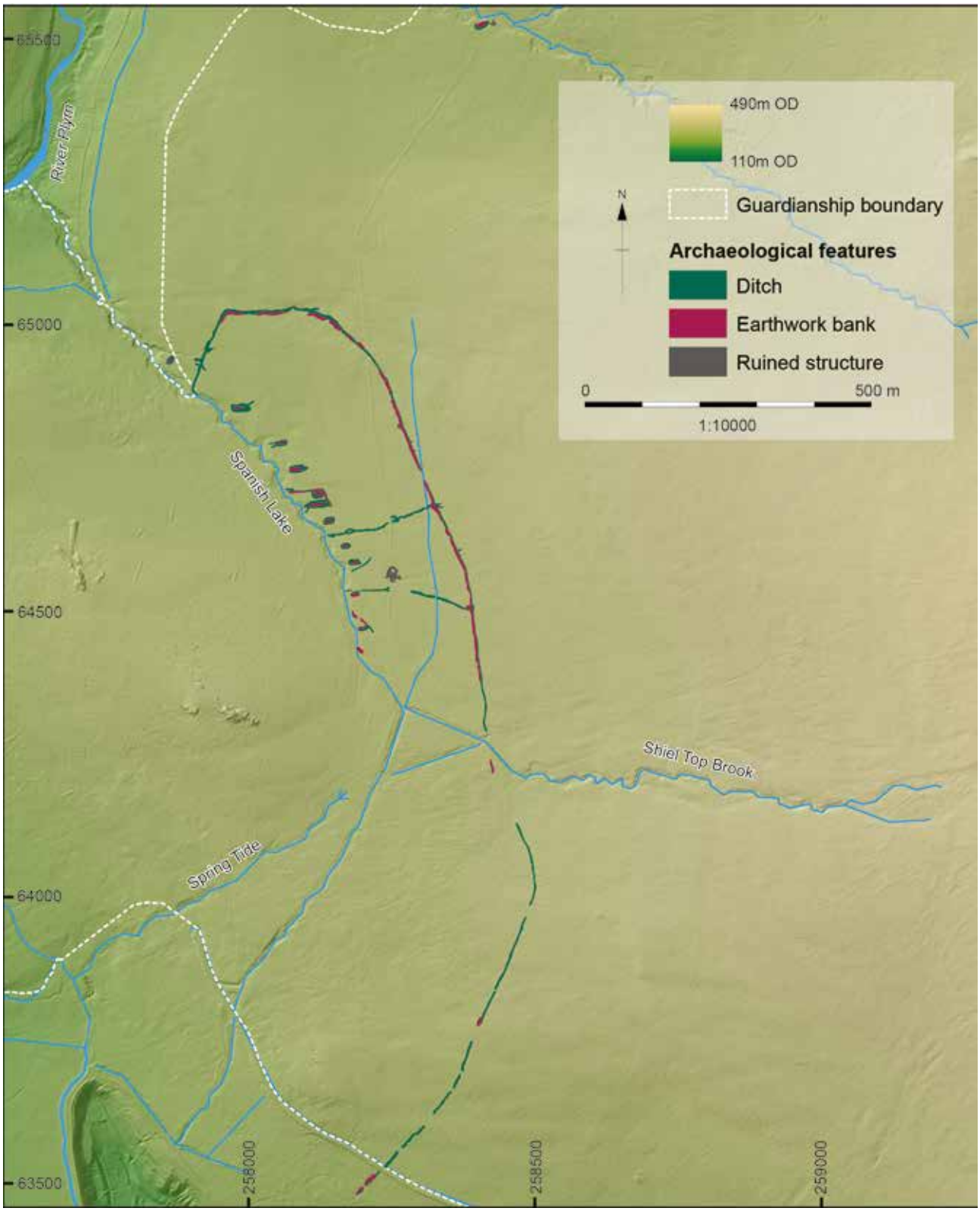


Figure 27: Mapped Willings Walls Warren features. Archaeological mapping © Historic England. Height data © Bluesky International/Getmapping PLC. Lidar DSM 25-FEB-2019 © Historic England, source Environment Agency. Other mapping derived from Ordnance Survey open data © Crown copyright and database right 2023.

A range of features attesting to the extent of the warren between the River Plym, Blacka Brook and Spanish Lake were mapped from visualisations of 2019 Environment Agency 1m lidar data, 2021 Historic England ortho-photograph aerial photography and visualisations of a Digital Surface Model derived from the ortho-photograph. At least 86 pillow mounds and 57 vermin traps were mapped from the available aerial sources.

The majority of the pillow mounds are typical, bolster-shaped earthworks surrounded by drainage ditches. Most stand singly or in groups, but three stand in a linear arrangement between the River Plym and the Lee Moor China Clay leat. An essential component of the pillow mounds are their surrounding drainage ditches, many of which extend downslope beyond each mound, intended to protect the vulnerable rabbits and their young from waterlogging. Although many pillow mounds stand on high ground, even quite isolated on the moor at a distance from the warren buildings, some were, somewhat counter-intuitively, built on low ground close to the watercourses. This has led to the proposal that many of the gullies amongst the mounds were animal runs where vermin traps could be placed, rather than drainage ditches, because if drainage were a priority the pillow mounds would not have been built so close to the river in the first place (see for example Dartmoor National Park Authority Historic Environment Record MDV5689). The aerial mapping demonstrates, however, how pillow mounds, gullies and ditches placed on the lowest slopes and by watercourses are integrated to promote drainage. For example, a group of eight pillow mounds on the south bank of the Plym have ditches draining into the river, whilst the group overall is protected from water-runoff by a long, curving ditch with a bank to the downslope side that drains on the west side into the former tin streamworks (Fig. 26a). It may have been advantageous to the warreners to make use of rubble debris in the streamworks when constructing pillow mounds, in what had perhaps become relatively free-draining ground of waste dumps above the river channel.

In addition to the typically shaped pillow mounds, Trowlesworthy Warren is notable for the adaptation of prehistoric structures for warren infrastructure. For example, a group of Bronze Age enclosures on the gentle west-facing slopes below the tors are all protected from runoff by drainage ditches having banks upcast on the downslope side. These features are V-shaped on plan, forcing water around and away from the enclosures. The enclosure walls and hut circles protected in this way have themselves often been adapted. For example, vermin traps are frequently built onto the enclosure walls and some hut circles have been filled in with rubble and earth to form pillow mounds (Fig. 26b). It is possible that stone dumping noted in numerous prehistoric features across all three Upper Plym warrens (for example, amongst unenclosed hut circle settlement Historic England Research Record 439435 in Willings Walls Warren, Dartmoor National Park Authority Historic Environment Record MDV29984) is not solely representative of field clearance, but dates to the periods of warrening to provide additional cover for rabbits. Further research is required to ascertain if, for example, there is a chronological difference between the adaptation of extant prehistoric features for warrening and the construction of typically bolster-shaped post-medieval pillow mounds across the moor.

Willings Wall Warren (Historic England Research Record 438879)

Willings Walls Warren is enclosed by Hentor Brook, the River Plym and Spanish Lake. It is open to the higher ground of Lee Moor, where its extent was marked by boundary stones. Only the area within the Upper Plym Valley guardianship site was mapped, thus excluding part of the warren nearest the River Plym and the northern reaches of Hentor Brook. In consequence, only 13 pillow mounds were recorded (more pillow mounds survive close to the warren's northern and eastern limits). The majority of these are positioned on the lowest slopes of Lee Moor, overlooking Spanish Lake. They are accompanied by drainage ditches that crosscut the contour, directing water away from the pillow mounds to protect the rabbits and their breeding areas.

The aerial mapping reveals a warren boundary within the wider extent of Lee Moor, delimited by an earthwork bank and ditch enclosing approximately 42 hectares of the eastern banks of Spanish Lake and Spring Tide (Fig. 27). The southern half of this boundary, which survives predominantly as a ditch with a few short sections of bank to its west side, was previously thought to be a prehistoric cross dyke but was first proposed as a Willings Walls Warren boundary by Probert and Fletcher (2002) (see Dartmoor National Park Authority Historic Environment Record MDV15062). The southern limit of the boundary is unclear, lost in the china clay pits. The northern half continues to the north side of Shiel Top Brook, curving to the north-north-west and west to enclose a long, narrow stretch of ground. This northern section comprises both bank and ditch, the bank to the downslope, west side of the ditch. It cuts the Willings Walls reave (Historic England Research Record 438849) and is cut by the Phillips leat (Historic England Research Record 1360628). Two long east-west oriented ditches contribute to drain the boundary ditch into Spanish Lake. Although it is possible that the boundary and associated drainage ditches are medieval in date, enclosing ground around the Willings Walls farmstead (Historic England Research Record 439325), the large area enclosed without additional internal field boundaries and the emphasis on water management suggest that they are post-medieval in date, associated with the rabbit warren.

Hentor Warren (Historic England Research Record 438876)

Hentor Warren occupies the southern bank of the River Plym between Hentor Brook and Shavercombe Brook (although there is at least one pillow mound to the east of Shavercombe Brook). The warren was established by 1807 and Robertson (1991, 264-5) argues that arable farming had come to an end at Hentor by that time. Hentor House and other buildings of the Hentor farmsteads are likely also to have been out of use by this time.

Only the area within the Upper Plym Valley guardianship site was mapped, thus excluding part of the warren nearest the northern reaches of Hentor Brook. The narrow strip of land between the river and the northern Hentor field system was mapped, however, despite being outside the guardianship boundary, given the extension of the field system to the edge of the tin streamworks and the presence of pillow mounds on the boundary itself. In consequence, 36 pillow mounds were recorded (more pillow mounds survive close to the warren's western limit). Although some of these pillow mounds are free-standing

Figure 28: Weapons pits and an observation tower at Hentor (west) with open moor to the east (unscaled, map north to top). Extract from RAF/3G/TUD/UK/223 5238 12-JUL-1946, Historic England Archive (RAF Photography).

earthworks placed amongst the Hentor fields or in the redundant streamworks, many are constructed on field boundaries. In places the earlier earthwork banks are augmented to make the mounds, with new protective drainage ditches added or existing field ditches adapted to encourage water runoff. Most of the boundary of the intake to the south-east of the northern Hentor field system is adapted in this way, including a pillow mound that is just over 100m long. This signals the redundancy of the northern Hentor field system (Historic England Research Record 438855, see above) and other elements of the earlier fields, supporting Robertson's suggestion that farming had been given up in favour of warrening.

Post-medieval water management

A number of post-medieval leats traverse the Upper Plym guardianship site, providing water for industrial and domestic purposes. They were mapped from a combination of visualisations of 2019 Environment Agency 1m lidar data, the 2021 Historic England 8cm GSD ortho-photography and visualisations of a Digital Surface Model derived from that ortho-photograph. Openness visualisations of lidar data and the Simple Local Relief Model of the Digital Surface Model (Kokalj and Somrak 2019) were particularly useful to identify and map these long but narrow linear features. They include:

- Historic England Research Record 1355763, formerly carrying water from the River Plym to Shavercombe Brook;

- Historic England Research Record 1360628, the Philips Leat (constructed about 1835) formerly carrying water from the River Plym to Big Pond;
- Historic England Research Record 1360626, the Trowlesworthy Pot-water Leat formerly carrying water from Spanish Lake to Spring Tide;
- Historic England Research Record 438770, a short leat carrying water from the River Plym to a stamping mill above Little Hentor;
- Historic England Research Record 1400195, the Lee Moor China Clay leat still carrying water from the River Plym to Big Pond, traversed by a number of small footbridges built for Trowlesworthy Warren to assist rabbits crossing the water (Dartmoor National Park Authority Historic Environment Record MDV24933).

Only those sections of the leats within the guardianship boundary were mapped.

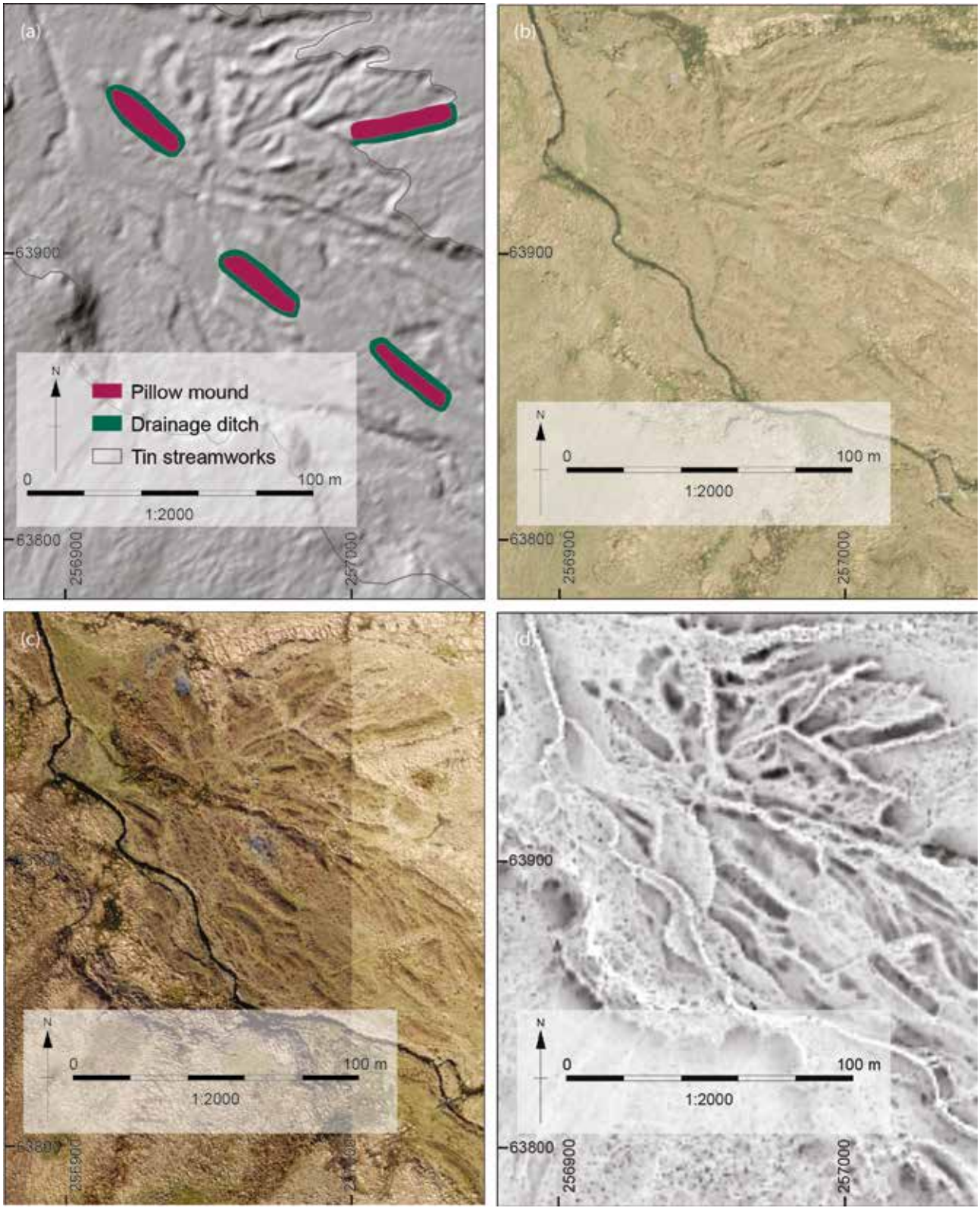
Granite quarrying

In addition to warrening, granite quarrying was a significant post-medieval industry around Trowlesworthy. A small quarry was developed in Little Trowlesworthy Tor, producing a red granite until the late 19th century (Thackray 1994, 10). Other structures probably associated with the quarry include a ruined building standing to the west of the tor, described as a 'Smithy' on Ordnance Survey Devon County Series 1:2,500 map published in 1887. The Dartmoor National Park Authority Historic Environment Record notes more than 50 'granite loading bays' on the ground between and around Little and Great Trowlesworthy tors. These small and subtle features, comprising shallow cart or sledge tracks and slight raised banks to assist loading split moorstone blocks, were recorded during field survey carried out by the National Trust (see for example Dartmoor National Park Authority Historic Environment Record MDV124838). About half could be mapped from the available aerial sources, largely from a combination of visualisations of 2019 Environment Agency 1m lidar data and the 2021 Historic England 8cm GSD ortho-photography.

Military training during the Second World War

The extent of Second World War military training has been slightly expanded by the aerial investigation and mapping. In addition to a previously identified focus of weapons pits around the northern Hentor field system and Little Hentor (Historic England Research Record 1355962, Historic England Research Record 1405454), there is a small group of weapons pits in the tin streamworks to the south-west of Trowlesworthy Farm (Historic

(Facing page) Figure 29 : Appearance of four Trowlesworthy Warren pillow mounds in different aerial datasets including extracts from RGB orthophotography (2007 and 2021) and lidar Openness Negative visualisation (2019). (a) Archaeological mapping © Historic England, lidar DSM 25-FEB-2019 © Historic England, source Environment Agency. (b) SX 5663 03-MAY-2007 RGB Aerial Photography © Bluesky International/Getmapping PLC. (c) Structure from Motion ortho-photograph 30-MAR-2021 © Historic England. (d) Lidar DSM 25-FEB-2019 © Historic England.


(a)
63900
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Pillow mound
Drainage ditch
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257000
(c)
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(d)
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England Research Record 1631107) and two more adjacent to the Lee Moor China Clay leat (Historic England Research Record 1631109). Five possible bomb craters straddle the north-east quarter of the guardianship site in a line from roughly Little Gnats Head to Langcombe Head (Historic England Research Record 1631114). Mapped from visualisations of 2019 Environment Agency 1m lidar data, on Royal Air Force vertical aerial photographs dated 12 July 1946 they appear to be relatively freshly made (Historic England Archive RAF/3G/TUD/UK/223 5226-5227). Each sub-circular crater is completely surrounded by an earthwork bank of spoil. They are between 15m and 23m in diameter. Although visible on 1946 Royal Air Force vertical aerial photographs, those images were not used for mapping due to poor control.

The features on Hentor include groups of weapons pits to either side of Shavercombe Brook, located within the Hentor field systems and the large tin opencut to the north-east of Little Hentor farmstead. An observation tower standing on the edge of the north-west facing steep scarp left by tin-streaming in the River Plym valley is visible as a structure on 1946 Royal Air Force aerial photographs, from which it was mapped. It had been demolished by 1948 (Historic England Archive RAF/3G/TUD/UK/223 4129-4130). The tower appears to have been built out over the edge of the scarp, giving the impression that it looked out over the River Plym towards Ditsworthy Warren and Drizzlecombe. Whilst it may have been associated with the groups of weapons pits on the south-east side of the River Plym, it might have related to the regular arrangement of possibly military boulder-filled pits of uncertain purpose on the opposite riverbank (Historic England Research Record 438989) (Fig. 28).

Vegetation history

A number of scheduled monuments within the Upper Plym guardianship site are on the Heritage at Risk Register (Historic England 2022) on account of vegetation growth. They include a vermin trap and pillow mounds in the southern part of Trowlesworthy Warren, described here to demonstrate late 20th and early 21st-century ground cover that is impacting these archaeological features.

One of Trowlesworthy Warren's vermin traps (NHLE 1014465) is attached to the south-west side of the Lee Moor China Clay leat at SX 57526 64065 . The trap's V-shaped walls are approximately 8m long. The trap is therefore too small to distinguish in 1940s Royal Air Force vertical aerial photographs that were taken at a scale of approximately 1:10,000. In consequence, the first large scale vertical imagery in which it is visible is Next Perspectives APGB ortho-photography dated 1 June 2002. The trap is masked by vegetation but raking sunlight from the south-east casts just enough shadow to pick out the earthwork. Ground cover obscures the vermin trap in all later Next Perspectives imagery. It is, however, visible on visualisations of 2019 Environment Agency 1m lidar data (in particular the Multi-lit Hillshade) and a Digital Surface Model derived from 2021 Historic England 8cm GSD ortho-photography (in particular the Simple Local Relief Model). It is impossible to distinguish in the 2021 orthomosiac itself. Accordingly, it was mapped from the lidar dataset. The lidar visualisation and Digital Surface Model make it clear that the

mapped scheduled area is approximately 15m to the south-east of the monument.

Some of the warren's pillow mounds to the north-east and south-west of this vermin trap are being affected by vegetation in a similar way. Four pillow mounds built on the floor of the Blacka Brook tin streamworks are scheduled under records NHLE 1014616, NHLE 1014664 and NHLE 1014664 (Fig. 29). They are already hard to distinguish from the surrounding mounds of tin streaming waste by the time of the 1 June 2002 Next Perspectives APGB ortho-photography mentioned above, because of the heavy vegetation cover. Even on the following Next Perspectives ortho-photography captured on 3 May 2007, when the vegetation growth is not quite as advanced, the pillow mounds are difficult to pick out. On the equivalent imagery dated 31 May 2016 and 4 April 2019, and on the 2021 Historic England 8cm GSD ortho-photography, slight differences in the plants growing on the mounds and differential growth in the pillow mounds' drainage ditches help to pick out the more straight-sided mounds from the surrounding, less regular, earthworks. Nevertheless, the pillow mounds are most clearly expressed on visualisations of 2019 Environment Agency 1m lidar data, in particular the Negative Openness visualisation, from which they were mapped.

Conclusion

This project was designed to provide baseline archaeological data in a GIS format to the English Heritage Trust to inform condition monitoring of scheduled monuments and other archaeological features at the four Dartmoor guardianship sites of Grimspound, Merrivale Prehistoric Settlement, Hound Tor Deserted Medieval Village and the Upper Plym Valley. Historic England aerial investigation and mapping methods were applied to not only archive aerial photographs and other digital datasets, including lidar, but also to new ortho-photography and Digital Surface Models captured as part of Historic England's regular scheduled monument monitoring programme.

The four guardianship sites have been the subject of research since at least the 19th century. Nevertheless, the baseline archaeological data created using this approach now records the form, extent and position of monuments with the spatial accuracy afforded by precisely geo-located aerial sources. This is particularly important to the ongoing management and conservation of the nationally-important monuments. Impacts of vegetation change and erosion on monuments at the guardianship sites can be monitored and addressed because of the greater confidence that may be placed on the mapped positions of recorded features. Some new discoveries have been made, largely as a result of access to Environment Agency lidar data and the new Historic England datasets. These include, for example, just how extensive was peat charcoal production in the Upper Plym Valley, contributing to forthcoming work on this under-researched topic (Phil Newman pers. comm.).

Despite the importance of digital aerial datasets created post-2000 to both accurate mapping and also the recognition of some monument types, archive aerial photography plays an essential role in the identification and interpretation of features. This includes, for example, Second World War structures that are visible only on 1940s Royal Air Force vertical photographs. They enable a variety of stories to be told about people's past relationships with Dartmoor, presenting a rich narrative of the history of these places to the visiting public. Historical imagery is also essential to reviewing and understanding change that has already occurred in the guardianship sites during the 20th and 21st centuries.

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Technical Specifications

Aircraft acquired photography

A vertical aerial survey of the Merrivale and Upper Plym Valley project areas was carried out on 30 March 2021. The flying altitude for each area was 3,000 feet, which equates to roughly 1,500 feet above ground level (agl). The camera used was a Nikon D850 with a 35mm lens, installed in a camera pod attached to a Cessna 172. The camera sensor size is 8,256 x 5,504 and the ground sampling distance (GSD) of individual photographs ranged from about 5cm to 9cm, depending on the changes in topography. Ground sampling distance is the distance on the ground between adjacent pixel centres in an image (Historic England 2017). There was a 70% overlap between photographs and a 40% overlap between each run. The survey of the Plym Valley took place between 12:05 and 13:35 (UTC) and Merrivale between 13:40 and 13:55, both timed to take advantage of limited vegetation cover and flat light for use in Structure from Motion (SfM). The photographs were shot in RAW format and converted to Tiff for use in SfM. The original Tiff photographs (a total of 1,982 for Plym Valley and 79 for Merrivale) are accessible via the Historic England Archive and lower resolution versions of the photographs can be viewed on the HE Aerial Photograph Explorer (APEX).

SfM is a digital photogrammetric process for producing 3D models from 2D images. These were processed using the SfM software Agisoft Metashape Professional 1.7.5. Ground control was established using a Trimble R8 Global Navigation Satellite System (GNSS) by recording Ordnance Survey National Grid coordinates for readily identifiable topographical detail on the ground that were also visible on the air photographs and could be tied to the processed model. The resulting point cloud data had a true ground position accuracy of between approximately 1-2cm.

The two main outputs from this process were an orthophotograph – a composite of the aerial imagery stitched together to form a single vertical geo-rectified photograph; and a digital surface model (DSM). The orthophotographs for both areas have a ground sampling distance (GSD) or resolution of approximately 8cm. The geo-rectification allowed the imagery to be assessed and used for mapping as a single image covering the whole project area, without any additional rectification.

The DSM has a ground resolution of approximately 15cm per pixel and was primarily used to map subtle earthwork features not obviously visible on aerial photographs or lidar. The DSM was visualised using Relief Visualization Toolbox version 2.2.1 (Kokalj and Somrak 2019; Zakšek et al. 2011) to produce 2D GeoTIFF images using analytical hillshading, 16-direction hillshade, Simple Local Relief Model, Slope, Positive and Negative Openness images for import to ArcMap. In addition, the surface model was also viewed and manipulated live through Quick Terrain Reader.

Remote-controlled aircraft (drone) acquired photography

Drone surveys were undertaken of the Merrivale, Grimspound and Hound Tor guardianship areas between February and March 2023 to take advantage of minimal vegetation cover and flat lighting conditions (Table 2). All survey flights were carried out with a DJI Phantom 4 Pro version 2 drone equipped with a standard 1-inch 20-megapixel CMOS sensor. All flights were planned and controlled with DroneDeploy app and were flown at approximately 60m above ground level, with a 75% forwards overlap and 65-70% side overlap between photographs. All photographs were shot in .jpg format.

Photography was processed in Agisoft Metashape Professional 1.7.5 software. Ground control was established using a Trimble R12i Global Navigation Satellite System (GNSS) by recording Ordnance Survey National Grid coordinates for a series of targets placed within the survey area. The resulting point cloud data had a true ground position accuracy of between 1-2cm. This data was further processed to produce orthophotographs and DSMs for each site with approximate GSDs of 15-20mm and 30-37mm respectively. DSM data was then down-sampled to 110mm GSD for further visualisation in Relief Visualization Toolbox version 2.2.1 as described above (Kokalj and Somrak 2019; Zakšek et al 2011). All drone-acquired photography for this project is held by Historic England.

Table 2: Drone flight details.

	Date	Time (UTC)	Height (ft)	Extent	Photos
Merrivale	04/02/2023	09:58 - 10:20	196.85	24ha	701
Grimspound	04/02/2023	12:51 – 13:01	196.85	5ha	187
Hound Tor	22/03/2023	15:36 - 15:46	196.85	2ha	114

Methodology

Sources

All available vertical and oblique aerial photographs of the project study areas held in the Historic England Archive were assessed for this project. These collections include both prints and born-digital files (Table 3).

Table 3: Summary of available Historic England Archive aerial photographs

Guardianship site	Specialist oblique images	Military oblique images	Vertical images	Date range
Grimspound	55	0	27	1946-2004
Merrivale	122	0	30	1946-2008
Hound Tor	121	0	51	1946-2004
Upper Plym Valley	608	21	242	1942-2008

These were supplemented by a small collection of specialist oblique images curated and kindly supplied by the Devon Historic Environment Record.

Ortho-rectified and georeferenced digital aerial photographs taken between 2002 and 2021 were supplied by Next Perspectives via the Aerial Photography for Great Britain (APGB) agreement. Environment Agency lidar at 1m resolution captured in 2019 and 2021 was downloaded from the DEFRA Survey Data Download website. Nineteenth- and 20th-century Ordnance Survey historic maps were also consulted.

The first set of Historic England aerial imagery newly acquired for the **Dartmoor and Upper Plym Valley: scheduled monuments on the English Heritage Estate** project, photographed on 30 March 2021, was used for mapping in the Merrivale and Upper Plym Valley guardianship sites (see Technical Specifications).

Methodology

Archive photographs were viewed in 3D using a handheld stereoscope. Digital imagery was viewed on-screen in a GIS environment and using the QT Reader. Photographic prints showing archaeological features were scanned and then rectified using the specialist Aerial 5.36 programme. The rectification process involves matching features on a 1:2,500 Ordnance Survey digital map (the control) with the same features on the scanned aerial photograph to remove all height and tilt distortion. This gives an overall accuracy of plotted features of 2m or less to the true ground position. An APGB digital terrain model (DTM) was incorporated into the calculation to improve accuracy by compensating for undulating terrain.

The lidar, digital vertical photographs and Surface models derived from ortho-photography

were already georeferenced so could be imported directly into the mapping software. Environment Agency lidar datasets were processed using the RVT 2.2.1 programme (Relief Visualisation Software Toolbox software) to generate a number of different visualisations (Kokalj and Somrak 2019; Zakšek, Oštir and Kokalj 2011). The RVT was also used to visualise Digital Surface Models derived from new Historic England ortho-photography.

All archaeological features visible as cropmarks and earthworks were mapped. This includes features with a potential date range from the Neolithic to 20th-century military remains. Features were recorded according to morphology using Historic England mapping conventions, using ArcMap 10.3 GIS software. These features were mapped on different layers based on the original form of the feature (bank, ditch etc) irrespective of whether these were seen as earthworks or cropmarks.

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