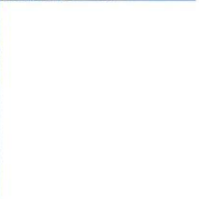
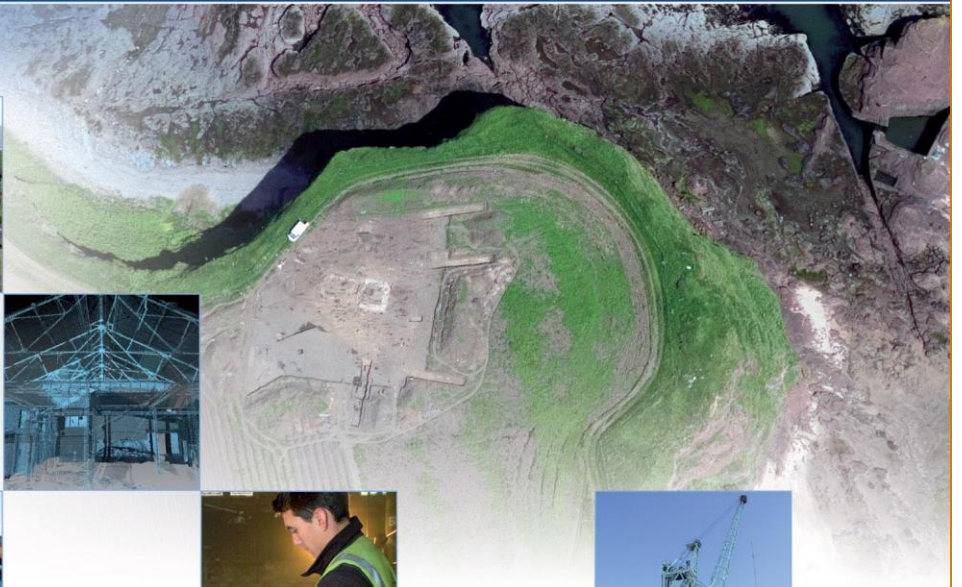
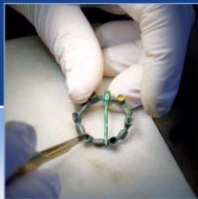


# Baillie Hill and Cnoc Freiceadain, Caithness

## LiDAR Survey

AOC 21585  
10th May 2012



**AOC**  
Archaeology  
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# Baillie Hill and Cnoc Freiceadain, Caithness

## LiDAR Survey

**On Behalf of:** Baillie Hill Windfarm Ltd

**National Grid Reference (NGR):** ND 025 656

**AOC Project No:** 21585

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## Abstract

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In mitigation for the visual impact on the archaeological landscape surrounding a windfarm development at Baillie Hill, Caithness, a high-resolution LiDAR survey was undertaken. The resulting datasets provide a detailed record of the landscape prior to construction of the windfarm, and form an invaluable enhancement of the archaeological record. Over 300 possible sites, previously unlisted in the Highland Council Historic Environment Record, were recorded.

## Baillie Hill and Cnoc Freiceadain

### LiDAR Survey

#### Introduction

- 1 In summer 2011, a LiDAR survey was undertaken in the area surrounding a proposed windfarm development at Baillie Hill, Caithness (ND 025 656). Intended as a means of mitigating against the visual impact of the windfarm construction on the archaeological landscape in the surrounding area, LiDAR was chosen as the most effective means of creating a detailed, accurate and multiperiod record of the physical topography and the archaeological features within visually-sensitive range.
- 2 Condition 20 (ii) of the Baillie Hill planning consent specifies the requirement of a LiDAR survey for the purposes of improved public access and presentation of the archaeological landscape surrounding the development:

*The scheme shall include measures to improve public access to the Hill of Shebster and Cnoc Freiceadain scheduled ancient monuments; and for improved interpretation of the cairns, incorporating the results of a LiDAR laser scanning survey to be undertaken on behalf of the applicant in consultation with Historic Scotland.*

- 3 The survey area is divided into the 'Core Area', incorporating the nationally significant complex of Neolithic monuments on Cnoc Freiceadain, and the wider survey zone, incorporating a large number of individual sites and relict landscapes of various periods.
- 4 The Baillie Hill LiDAR survey thus had the following principal aims:
  - To provide a detailed three-dimensional record of the visually-sensitive archaeological landscape surrounding Baillie Hill
  - To enhance the record of known monuments in the area by providing detailed and accurate mapping, as a tool for heritage management
  - To create a resource for future research into Caithness archaeology
  - To provide a means of presenting the rich archaeological resource of the area surrounding Baillie Hill to the public

#### Background to the LiDAR technique

- 5 LiDAR (Light Detection and Ranging) is now an established technique used for large-scale landscape survey in areas where microtopographic detail is important. Originally developed for topographic survey, particularly in modelling flood susceptibility and other civil engineering, military and cartographic applications, the potential offered by high-resolution elevation modelling was quickly recognised by archaeologists, and over the past ten years, numerous spectacular surveys have been produced using high-resolution LiDAR data (e.g. Corns et al 2008; Hesse 2010). Unlike traditional surveying or aerial photography, LiDAR offers the most complete means by which to record subtle features in the landscape, by recording very small variations in topography and allowing the

identification of earthworks and structures that are otherwise extremely difficult to record. The history and development of LiDAR and its application in heritage research has recently been collated by English Heritage (EH 2010); the reader is referred to that publication for further detail on this background, and for the full definition of terminology used in this report.

- 6 In essence, LiDAR survey involves the use of a laser scanner mounted to a fixed wing aircraft or helicopter, which measures the height of the terrain flown over by emitting a pulse of laser light, and recording the response time. Geographic control is applied to the 3D coordinate produced by the laser scanner using differential GPS, so that the data collected is registered to Ordnance Survey coordinates at the time of collection. By collecting pulse returns at a rate of tens of thousands per second, this technique allows for the collection of many millions of measurements, providing survey resolutions of decimetres, with typical accuracies in the range of  $\pm 100$  to 150mm.
- 7 The data deriving from LiDAR survey can be manipulated in a variety of ways. Raw, or unprocessed data is received as a point cloud, which has the advantage of representing the direct measurements (rather than 'derived' or interpolated elevations) in the highest resolution possible, but the disadvantage of being unwieldy, and difficult to interpret (EH 2010:10-11). More usually, LiDAR data is processed into elevation surfaces suitable for use in GIS, which thereafter allow access to a suite of processing and analysis tools for interrogation and visualisation. The following report presents the results of processing the raw LiDAR data in GIS for the production of realistic elevation models suitable for non-specialist interpretation.
- 8 The Baillie Hill LiDAR data collection was subcontracted to Fugro BKS Ltd. The data was collected using a Riegl LMS-Q680 (LiteMapper 6800) scanner mounted on a fixed-wing aircraft (see table 1), at a resolution of no less than 7 points per square metre. The raw data was subject to four stages of initial quality control processing prior to supply as raw ASCII datasets, in 1x1km tiles, to AOC Archaeology. The pulse data was also classified using TerraScan in order to produce a 'bare earth' DTM at 1m resolution.

| Hardware   | Purpose  |
|--|--|
| <b>Riegl Scanner LMS-Q680 (LiteMapper 6800)</b>        | Airborne Laser Scanner with full waveform signal capture |
| <b>Scanner Type</b>                                    | 4 Faced Polygon Rotating Mirror                          |
| <b>Scan Direction</b>                                  | Parallel Scanning Lines                                  |
| <b>Scan Speed</b>                                      | 10 to 160 lines per second (100 for this project)        |
| <b>Scan Angle</b>                                      | 60°  |
| <b>Sensor Accuracy (flat surface parallel to beam)</b> | 20mm   |
| <b>Pulse Repetition rate</b>                           | 240,000Hz  |
| <b>Maximum number of returns</b>                       | Unlimited  |

**Table 1:** Specifications of the scanning system used

## The Survey Area

- 9 The survey area comprises an area of 85 km<sup>2</sup>, including the Core Area surrounding Baillie Hill and Cnoc Freiceadain and incorporating both upland, unimproved peatland and lowland arable and pasture (see **Figure 1**). As might be expected, the most sensitive upstanding sites are, for the most part, located in the upland areas, although several large broch settlements and chambered cairns are also to be found in lowland improved zones. Several areas within the surveyed zone are afforested with modern conifer plantation; these were also covered by the LiDAR survey and a bare earth model produced.

## Processing Procedure and Dataset Products

- 10 As outlined above, the aim of the Baillie Hill LiDAR survey was to produce a record that could be presented to the public and used for future research initiatives. In order to achieve this, the raw LiDAR data was processed to produce a range of surface elevation models in GIS, which could then be rendered to produce hillshaded relief maps suitable for interpretation by the non-specialist user. Production and interrogation of the full range of LiDAR products necessary for the complete analysis of the dataset was beyond the scope of the current project, and while a wider range of surface visualisations are considered essential for complete analysis of LiDAR datasets (see Challis et al 2011; Kokalj et al *forthcoming*), this in-depth analysis must await further research using the LiDAR data (see *Analysis of the Datasets*, below).
- 11 Three principal datasets were produced from the raw data supplied by Fugro BKS. For Cnoc Freiceadain, a 25cm DTM was produced using gridded high resolution data DTM points, and for the entire dataset, a 1m DTM was produced using the gridded data points supplied by Fugro BKS. These DTMs were produced by rasterising each data tile using the Spatial Analyst extension for ArcGIS, before combining to create a single elevation model (see **figure 2**).
- 12 In addition to the above DTM datasets, a third elevation model was produced using the raw, unfiltered 7 ppsm DSM dataset. This model was produced using the following processing routine in ArcGIS. Firstly, the points were filtered by rasterising and selecting the minimum value within a 0.5m cell size. The resulting raster was then converted back to point data before the DTM was built using a natural neighbour interpolation. This process was repeated for each of the 1 x 1km raw data tiles before being assembled into a single elevation model. The final raster, therefore, is of higher resolution than the 1m DTM derived from gridded data, and has been subjected to some noise filtering using the lowest value conversion process. Dense vegetation and buildings are still present and as such this data set comprises a DSM, but in non-wooded areas this comprises the best dataset for the identification of archaeological features.

## Visualisation and analytical hillshading

- 13 Each of the datasets has its own merits and drawbacks. Obviously, the 25cm DTM provides the greatest clarity of the Cnoc Freiceadain area, while the 1m DTM provides terrain data for areas covered by vegetation, and without distractions created by modern walls, telegraph poles and similar above-ground features. The 0.5m DSM provides good resolution of the entire area, and allows the identification of archaeological features in relation to modern wall and buildings.
- 14 In order to provide a basic visualisation of each dataset for the purposes of presenting the survey, a standard hillshaded view of each elevation model was produced, illuminated from the NW (azimuth 315) at an angle of 45 degrees. These visualisations have the advantage of being easily interpretable to non-specialist users, but the disadvantage that features parallel to the angle of lighting can be masked (see discussion summarised by EH 2010:23-4). Other visualisations of the elevation data, including hillshades lit from various angles, slope and solar insolation surfaces were also produced in order to assist with the analysis of the dataset (see below). The multi-directional oblique-weighted (MDOW) hillshading technique, which calculates a composite hillshade using oblique illumination of a range of surface aspects, is particularly useful for highlighting subtle terrain that may be masked by single illumination direction (see **figure 3**). Experiments with more sophisticated visualisation, using weighted multi-directional hillshades computed using the technique devised by Loisios et al (2007) was also experimented with in small study areas (see **figure 4**).
- 15 The most suitable visualisation of the LiDAR data for general presentation, however, was derived from a 'Swiss' hillshading style, created using ESRI's Hillshading Tools<sup>1</sup>. The Swiss shading style creates a composite visualisation of the elevation data using low-pass filtered and aerial (simulated variation in illumination from a vertical perspective) hillshades, displayed using varying degrees of transparency. This visualisation was selected for use in presenting the data on the project website.
- 16 Several 3D perspectives (**Figure 5**) and 'flythrough' videos were produced for areas of interest within the study area. These were produced using ESRI Arcscene and exported to standard movie formats.

## Scheduled Ancient Monuments in the Core Area

- 17 Detailed imagery of the Scheduled Ancient Monuments in the Core Area, SAMs 90078, 2386, and 476 has been produced (see **figures 6, 7, 8 and 9**). A flythrough movie of the 0.25m DTM of the Core Area has also been produced.

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<sup>1</sup> See <http://mappingcenter.esri.com/index.cfm?fa=arcgisResources.modelsScripts>



## Analysis of the Datasets

18 Following the production of the terrain models, the dataset was analysed for the presence of previously undetected sites. In total, over 310 new features have been identified. Given that the rationale of the survey was not primarily to detect new sites, a basic analysis only was undertaken of the full dataset, using the Swiss hillshaded model and slope surfaces for analysis. It is acknowledged that much further work could be done on the analysis of the full LiDAR dataset, involving processing of varied lighting conditions and other visualisations for all of the new sites identified. However, this lay outside the scope of the current project and must await further research.

## The development area

19 In accordance with planning conditions, the development area was assessed for the presence of new sites within the footprint of the ground to be disturbed by the windfarm. No sites were detected within the footprint of the groundbreaking works, although two possible hut circles, a possible platform or enclosure, several clearance cairns within a field system, a 'mound' and a modern sheepfank were identified outside the groundbreaking footprint (see **table 2 and figures 10, 11, 12, 13 and 14**).

| Study ID | Class1              | X coord | Y coord |
|----------|---------------------|---------|---------|
| 69       | ?Hut circle         | 302164  | 965623  |
| 70       | ?Hut circle         | 302171  | 965611  |
| 74       | ?Platform/enclosure | 303316  | 965872  |
| 75       | ?Cairn/mound        | 302972  | 965463  |
| 76       | Clearance cairn     | 303046  | 965460  |
| 77       | Clearance cairn     | 303047  | 965473  |
| 78       | Clearance cairn     | 303067  | 965485  |
| 79       | Sheep fank          | 302880  | 964966  |
| 80       | Mound               | 303749  | 964790  |

**Table 2:** Possible new features within the development area

## Recording a multi-period landscape

20 Improved imagery has been produced from the LiDAR data for the 568 known monuments in the survey area. This includes several spectacular examples of brochs and chambered cairns- the juxtaposed broch with outworks and probable burial chamber at Green Tullochs (see **figure 15**; MHG1227 and MHG1233) being a good example, where even the extent of erosion caused by footpaths is visible. Similarly, the monuments in the core area, including the Cnoc Freiceadain chambered cairns are particularly suited to recording by LiDAR.

- 21 In some areas, such as on the W shore of Loch Calder, where several chambered cairns and hut-circles are present (see **figure 16**) the survey has increased the number of monuments recorded within a previously known group; in this case adding a further four probable hut-circles to the seven already known there. In other cases, the LiDAR data has considerably added to the known extents of previously-recorded archaeological sites. For example, the full extent of many of the recorded field systems and enclosures in the study areas is now documented, and in the case of some field boundaries and enclosures, multiple phases of activity can be detected (**figure 17**). Indeed, it is as a record of the multiperiod nature of the archaeological landscape of northern Caithness that the dataset is of most value (see below).
- 22 In total, over 300 new features have been identified within the dataset, as a result of the basic analysis undertaken here; this figure should be expected to rise should future projects that incorporate more extensive manipulation of the data be possible. For the most part, these the newly detected monuments relate to site-types that are already known in Caithness, and are typically preserved as upstanding structures. For this reason the identification of target features within the dataset broadly follows the currently accepted classification of monuments in the northern mainland, extending and enhancing rather than radically altering our picture of the documented archaeological landscape. For the most part, the newly identified features relate to the later prehistoric landscape and to the post-medieval and early modern landscape, with a large number of probable hut-circles present within the new dataset and more extensive evidence of prehistoric agriculture than had previously been recognised. Similarly, unroofed buildings, longhouses and farmsteads are well represented, as are extensive enclosures of widely varying dates and associated traces of agriculture. Less easy to identify are features demonstrably relating to the medieval period, though this is, perhaps, to be expected given the general difficulty in detecting medieval activity underlying later settlements and agriculture. Similarly, earlier prehistoric ritual monuments, such as stone rows and standing stones are not well represented by the data, mainly as a result of the small size of these features.

### Afforested areas

- 23 The use of DSM and DTM datasets allows some scope for the identification of archaeological features in afforested areas (see Devereux et al 2005; Crow et al 2007; Gallagher and Josephs 2008). The majority of the current survey area is open ground, being largely open pasture in the north, and upland moor to the south. However, significant areas are covered by conifer plantation, and smaller stances by deciduous woodland and scrub. In some instances, use of the 1m DTM enabled the identification of the full extent of features that were partially obscured by vegetation, such as the enclosure at site 300 (see **figure 18**), the western half of which could only have been mapped using the DTM data. At other sites, such as the possible hut circle at Site 46, removal of the vegetation provides somewhat clearer imagery of the site (**figure 19**), but does not significantly extend the likely boundaries of the surviving archaeology. In only three instances were possible targets detected within conifer plantation (Sites 121 (**figure 20**), 149 and 154), though these are dubious examples. In general, it seems that the survival of upstanding features is rare in coniferous plantation (Ritchie and Wordsworth 2010:6), and that where these do survive, they are either so denuded as to evade detection or the canopy is so thick that the DTM is insufficiently detailed to allow detection. Having

said this, areas of commercial forestry plantation cannot be excluded from surveys of this type, since even where deep ploughing is likely to have destroyed surviving archaeology, significant sites may survive in forest rides and other clearings (e.g. **Figure 31**, **Figure 32**).

## Prehistoric settlement and agriculture

- 24 Chambered cairns are well represented in the dataset although, as noted above, less substantial earlier prehistoric monuments, such as stone rows and standing stones, elude representation in the LiDAR data. For the most part, the substantial chambered cairns such as those on Cnoc Freiceadain in the core area and those at Tulloch of Assery, Loch Calder (**figure 21**) and Knock Glass (**figure 22**) are well represented by the data, while there are also a large number of indeterminate cairns and mounds, at least 20 of which are newly identified.
- 25 One of the most significant contributions to the archaeology of the area made by the Baillie Hill survey is the documentation of cairnfields, scarps and enclosures which probably relate to traces of prehistoric agriculture. In areas such as West Shebster, extensive cairnfields appear to predate the more substantial later post-medieval field systems (**figure 23**), whereas at Broubster, extensive cairnfields associated with fragmentary field boundaries and denuded hut-circles are visible beneath distinctive S-shaped medieval and later rig and furrow systems (**figure 24**).
- 26 Hut-circles are the most ubiquitous features to be newly identified in the data. While the majority of features identified by this survey can be classified as hut-circles with some confidence, being associated with other hut-circles or relict field systems however, many of those identified should perhaps only be described as 'ring-banks', and it should be expected that many of the newly identified targets are in fact cairns, natural peat haggings or overgrown sheep fanks. Ground-truthing is the only means of refining these identifications, but it seems probable that the majority of features identified here as hut-circles are genuine archaeological sites. In some areas, hut-circles cluster in areas that would repay detailed survey work, where more extensive evidence of prehistoric settlement could be expected. This is certainly the case in areas like Hill of Shebster in the core area, where three hut-circles may be associated with contemporary agricultural remains (**figure 25**). Given the proximity of the cairns of Shebster and Cnoc Freiceadain, this area should be considered a high-priority candidate for future campaigns of field survey.
- 27 Few other settlements have been recorded by the LiDAR survey, although a possible broch has been identified at Allt Torigil (see **figure 6 and 26**; Site 181), unrecorded in either the Highland Council HER or the NMRS.

## The post-medieval and modern landscape

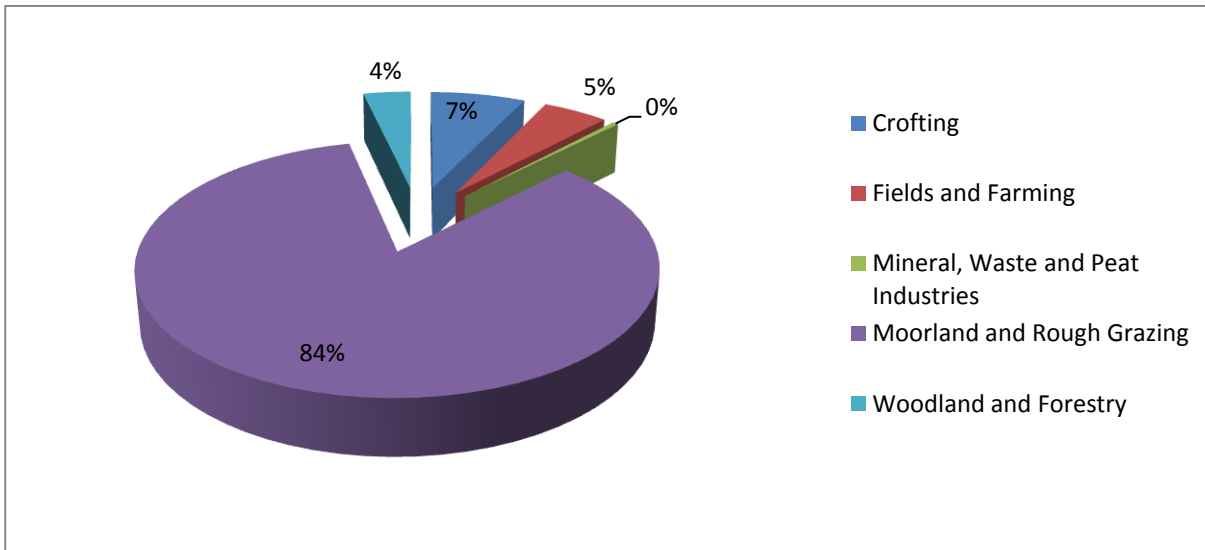
- 28 The survey has also recorded a significant quantity of more recent archaeology, relating to post-medieval farming and settlement. A total of 23 unroofed structures were identified, only three of which seem likely to relate to townships or farmsteads previously listed in the Highland Council HER. As noted above, the extent and complexity of many of the known enclosures and boundary walls has

been extended, and the limits of post-medieval, pre-improvement farming are clearly documented in the data. Particularly good examples of the post-medieval farming landscape are at Achnacly (MHG29219; **figure 27**), where an enclosed farmstead is accompanied by a well preserved corn-drying kiln, and at south Shebster, where multiple phases of enclosure and rig and furrow are clearly visible, providing context for the development of agricultural activity around the farmstead buildings (**figure 28**). At Broubster, the 0.5m resolution dataset shows traces of earlier buildings within post-medieval enclosures and S-shaped rig-and-furrow fields (see **figure 29**); in areas such as these further detailed ground survey may yield evidence of medieval settlement that is otherwise elusive. A recurrent theme in the study area is the construction of modern sheep fanks over stony mounds that seem likely to denote the presence of earlier structures, perhaps hut-circles or MoLRS settlements (see **Figure 33**).

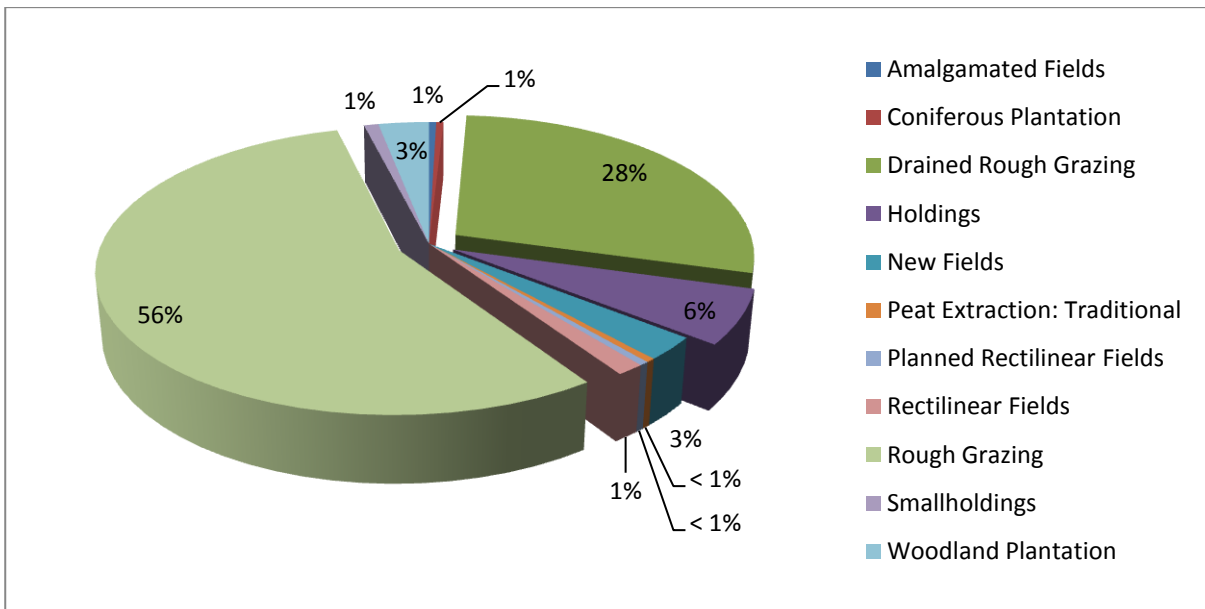
- 29 In several instances, farmsteadings have been recorded in the HER as a result of the First Edition Settlement Project (RCAHMS 2002). Typically, grid references for these entries can be low-accuracy, although in several cases in the present survey, unroofed farm buildings were located nearby, as at Widow's Banks (MHG17699; **figure 30**).
- 30 Aside from several corn drying kilns associated with post-medieval settlements, a range of non-domestic structures have also been recorded, including several mills (see the lade, to the east in **figure 24**) and the chapel at St Mary's Crosskirk (MHG373).

### 'Patterns of Survival and Recovery'

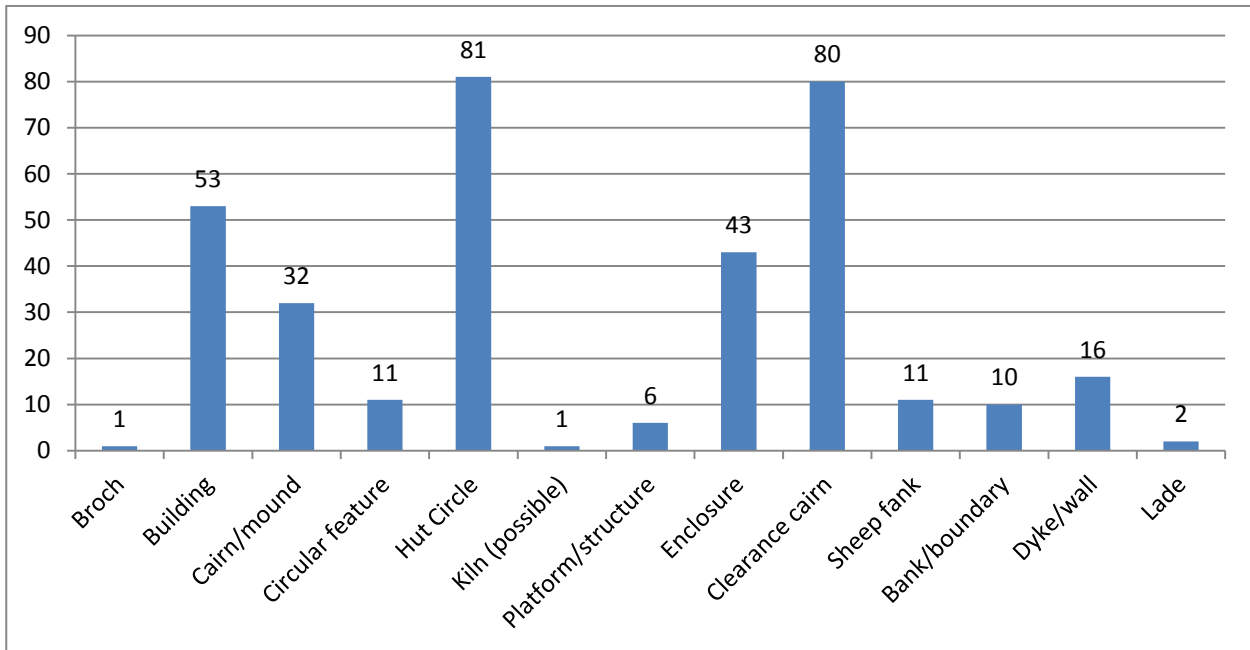
- 31 The survey provides valuable information on the extent of the historic landscape of Caithness that is currently unrecorded. As might be expected, the largest percentage of newly-identified sites were located on ground classed as 'Moorland and Rough Grazing' classes of the *Historic Landuse Assessment* (Dixon et al 1999), though significant numbers were located on areas that would be considered zones of low-survival rate (Stevenson 1976), such as improved pasture and other intensively farmed agricultural land (**figures 31 and 32**). Surveying landscapes using LiDAR allows for a much more accurate assessment of the completeness of the archaeological record than either map sources or aerial photography allow, and as such constitutes an invaluable management tool.



**Figure 31:** Distribution of newly detected sites across *Historic Landuse Assessment* land classifications.



**Figure 32:** Distribution of newly-identified monuments across *Historic Landuse Assessment* land types.



**Figure 33:** Summary of newly-identified site classes.

## Conclusion and Future Prospects

- 32 The Baillie Hill LiDAR survey has provided an unparalleled record of the archaeological landscape of northern Caithness, and as such is successful in providing mitigation for the visual impact of the windfarm construction. The record produced has value beyond a simple record of the area, however, and offers an opportunity for future research that would greatly enhance our understanding of landscape evolution in northern Scotland.
- 33 Two strands of future research are readily presented: further manipulation of the data, and ground truthing of identified features. The first of these avenues, further manipulation of the data, might be expected to produce even more new sites, for the reasons discussed above. Additionally, it may be possible to develop processing routines to automate the detection of archaeological features of the type recorded by the current survey. Such procedures have been developed using LiDAR data to detect burial mounds in the United States (Riley 2009), and using high resolution satellite imagery in Scandinavia (Trier et al 2009). Although there are challenges to developing a model for such an application in areas like Caithness, given sufficient resources this would be possible, and would greatly assist in the detection of new features and reducing the reliance on multiple hillshade surfaces.
- 34 Secondly, the value of the LiDAR results could be greatly enhanced through a concerted campaign of ground-truthing in those areas that have proven most productive in terms of new monuments. Desk-based analysis of the dataset alone cannot verify the authenticity of new features, and only primary fieldwork can provide a handle on the likely success rate of this method of prospection in Caithness.



**35 Fulfilment of the Planning Condition**

- 36 This survey fulfils the requirements of Planning Condition 20 (ii) by creating a detailed record of the Caithness landscape prior to the windfarm development. The record has been made accessible by (a) creating a bespoke website, (b) by incorporating it in the Highland Council's sites and monuments record (SMR) and, (c) in due course, by its lodgement with the National Monuments Record for Scotland (NMRS). All three records are accessible to members of the public. The bespoke website is linked directly to the Highland Council's SMR, and website users are automatically connected to the latter when they click on a site or monument in the website imagery. The SMR is institutionally interconnected with the NMRS. Thus all three foci of access are interconnected and data modifications in the light of ongoing work will flow into all three. The stability and longevity of the data is assured, ultimately, in the continuous updating processes of the NMRS, which is part of the national archive, and also in the parallel processes of the SMR and at a somewhat lower level, in the bespoke website.

## Glossary of Terms

|              |  |
|--------------|--|
| <b>DTM</b>   | Digital Terrain Model (also known as a 'bare earth' model): an elevation raster the cells assigned a height based on the ground surface, after the removal of buildings.         |
| <b>DSM</b>   | Digital Surface Model. An elevation raster with each of the cells assigned a height based on the actual surface recorded by the survey, i.e. including vegetation and buildings. |
| <b>GIS</b>   | Geographic Information System  |
| <b>GPS</b>   | Global Positioning System  |
| <b>LiDAR</b> | Light Detection And Ranging  |

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Figure 1: Location of LiDAR survey area.



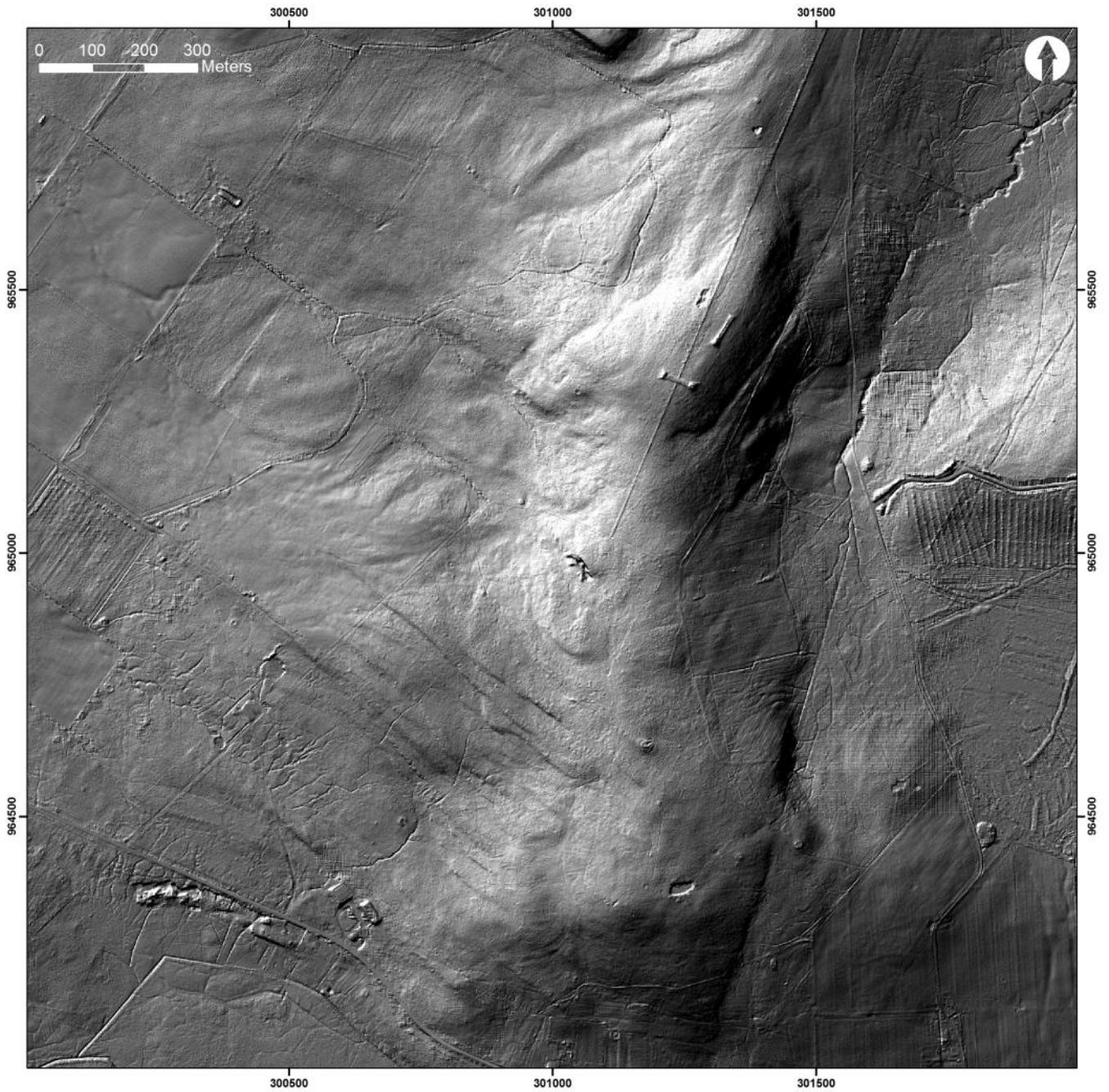


Figure 2: Hillshaded 25cm DTM of the Core Area: Cnoc Freiceadain and Hill of Shebster.



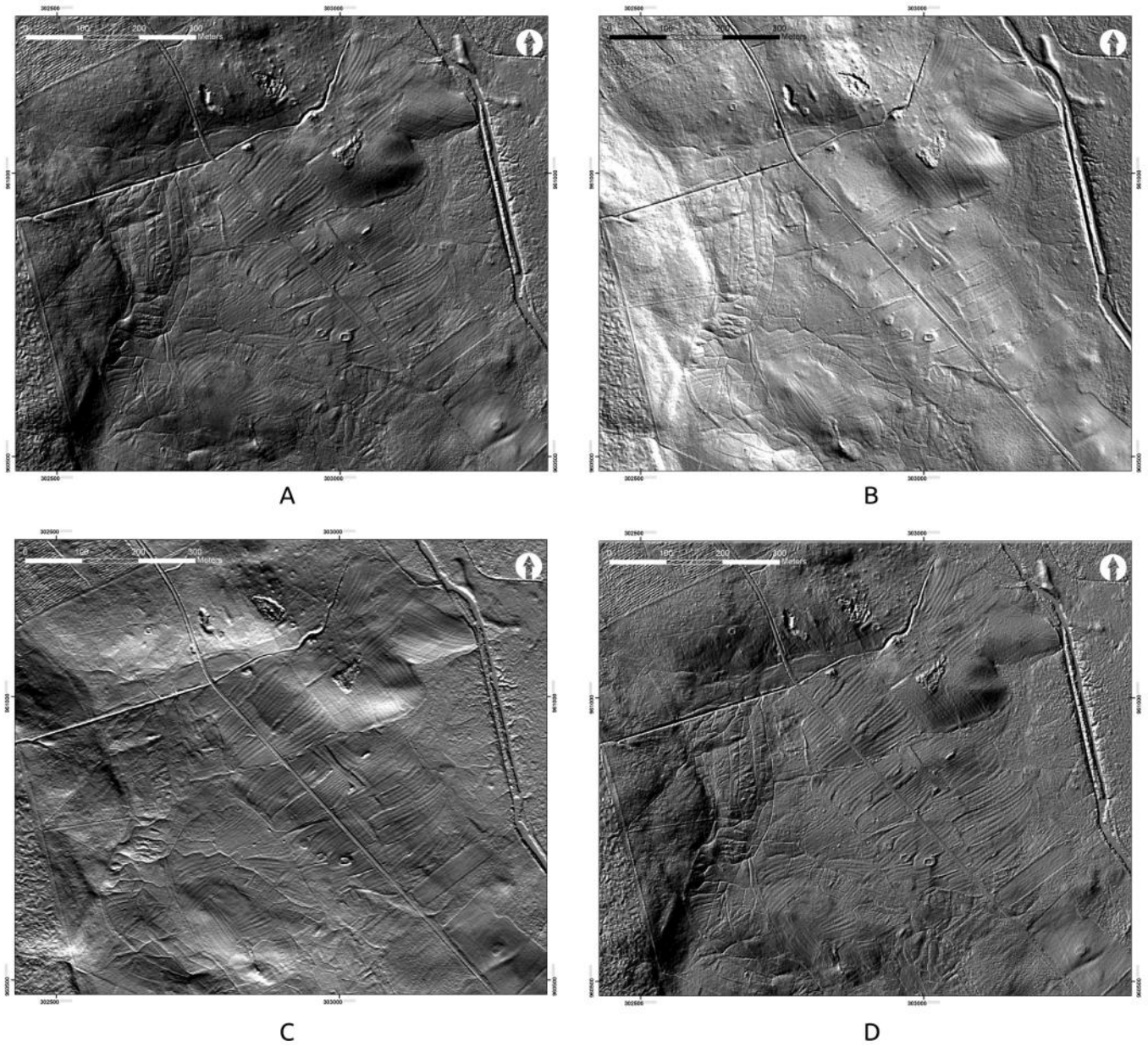


Figure 3: The effect of varied hillshading settings; note how the extent of the rig and furrow is masked in each example, so that only a combination of lighting effects is likely to identify all features. A: Hillshading from the NW; B: Hillshading from the NE; C: Hillshading from the S; D: MDOW Hillshading



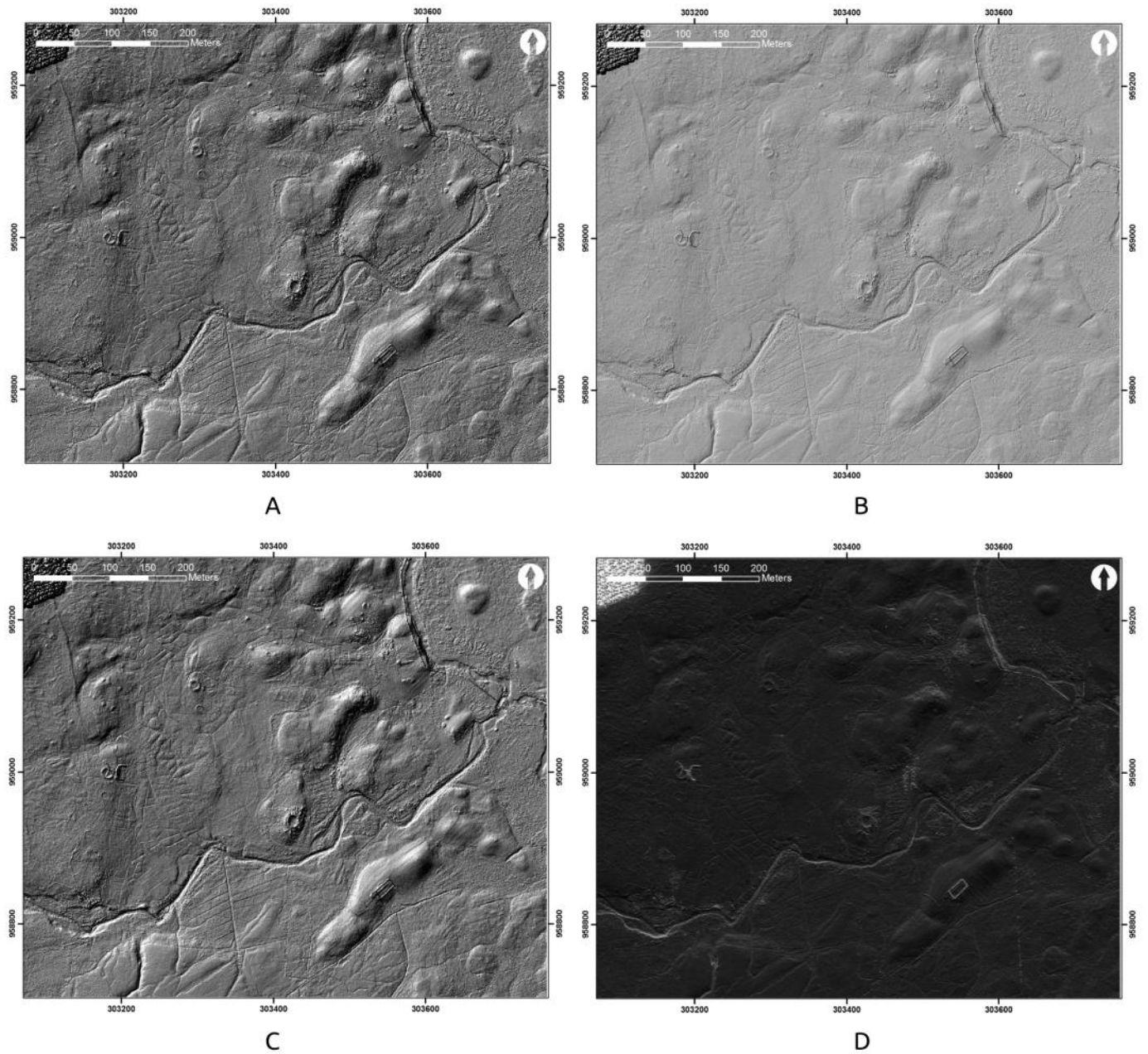


Figure 4: Analytical hillshading techniques. A: Hillshading using the directional weighting technique developed by Loios et al (2007); B: standard hillshading from the NW; C: Hillshading using the Swiss shading style; D: shading based on incident solar radiation.

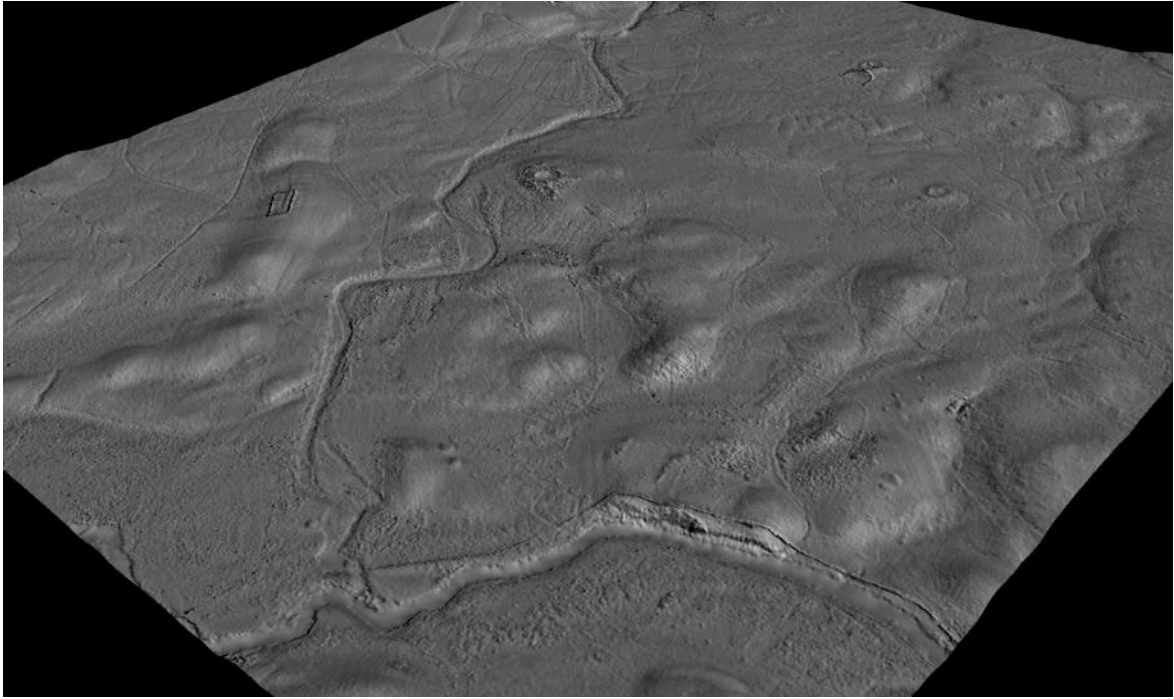


Figure 5: 3D perspective view of the possible newly-identified broch site at Allt Torigil.



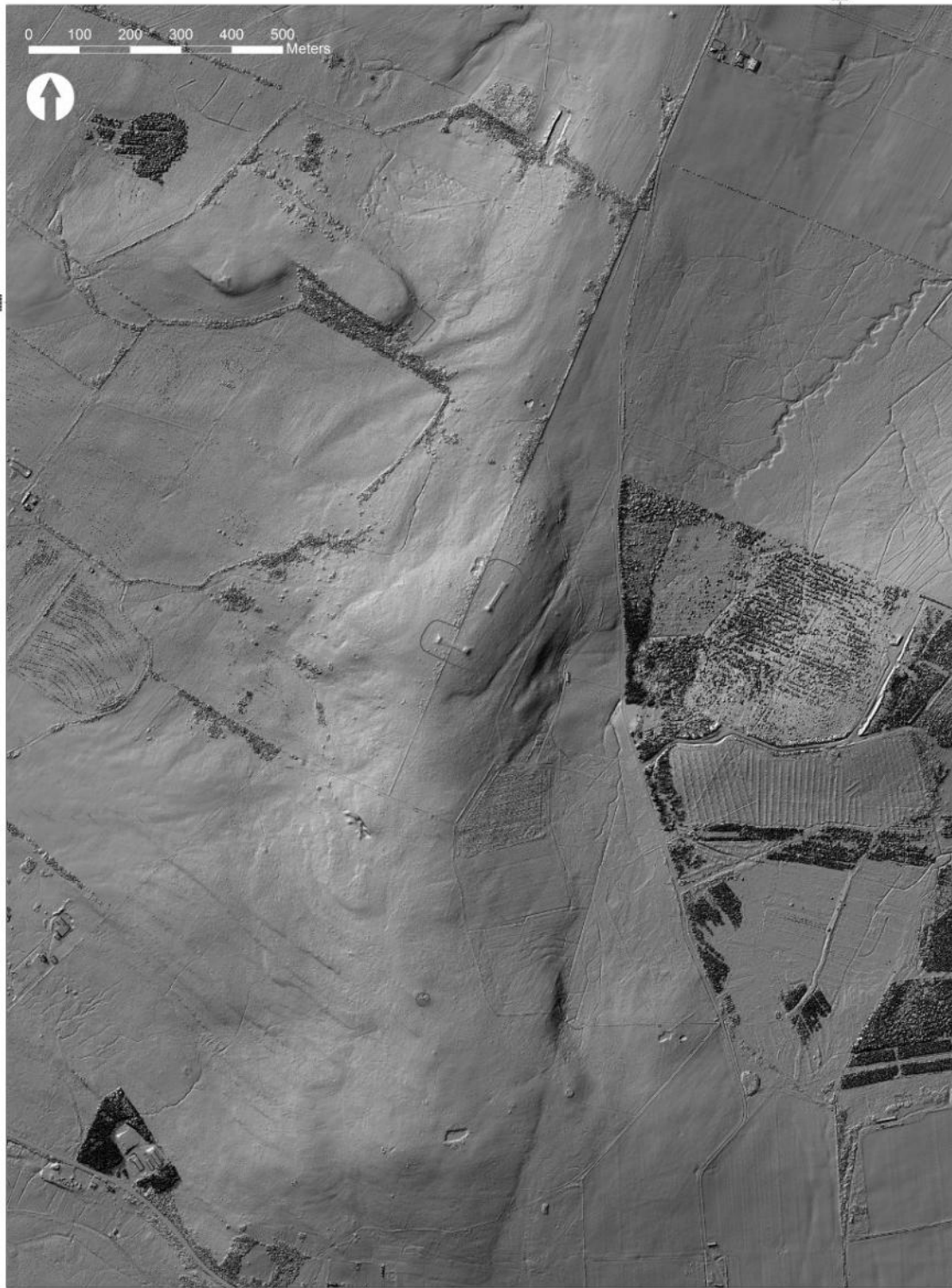


Figure 6: Core Area: scheduled cairns on Cnoc Freiceadain.

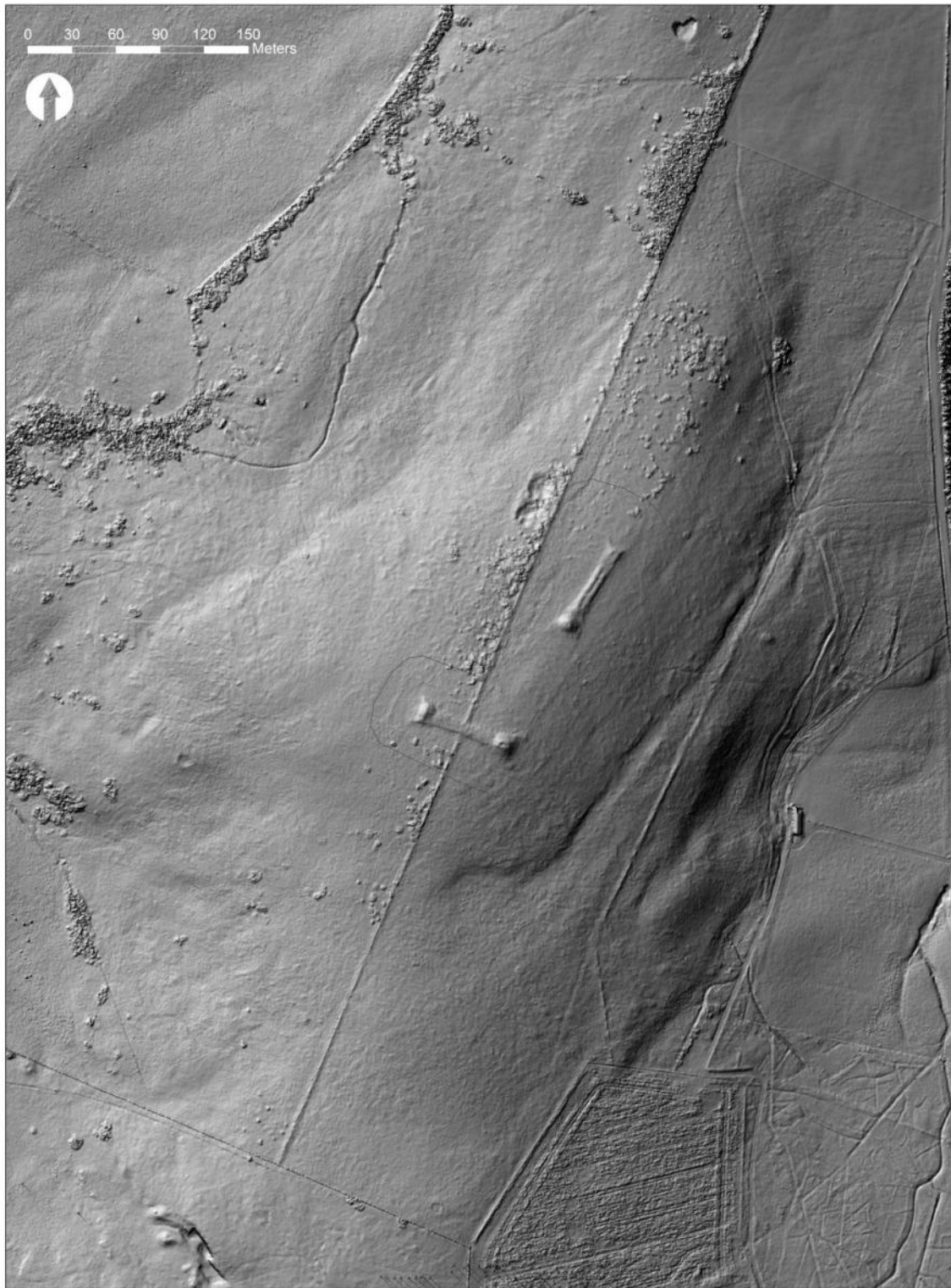


Figure 7: Core Area: scheduled cairns on Cnoc Freiceadain.





Figure 8: Core Area: scheduled cairns on Hill of Shebster.

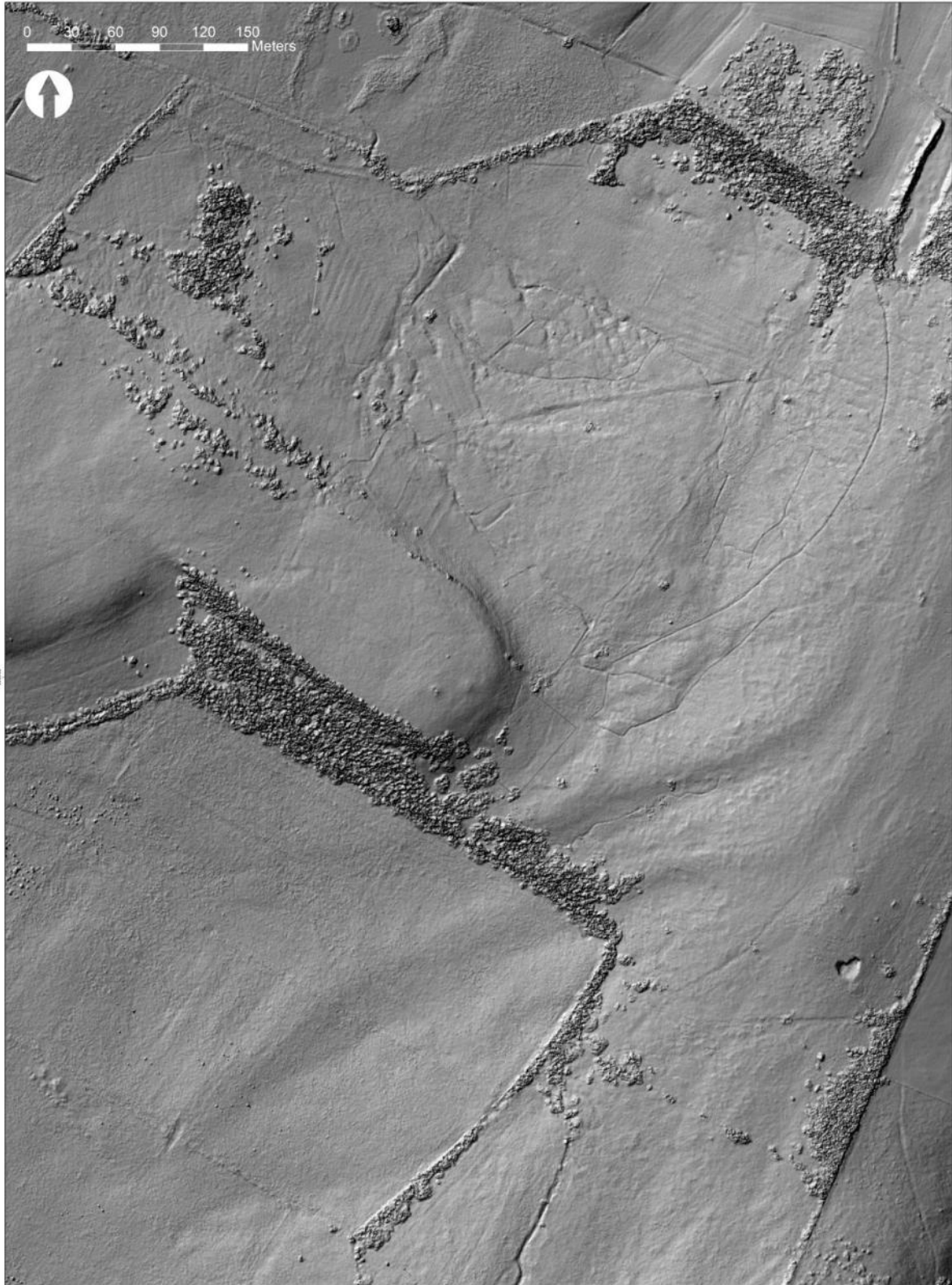


Figure 9: Core Area: scheduled stone rows, Cnoc Freiceadain.



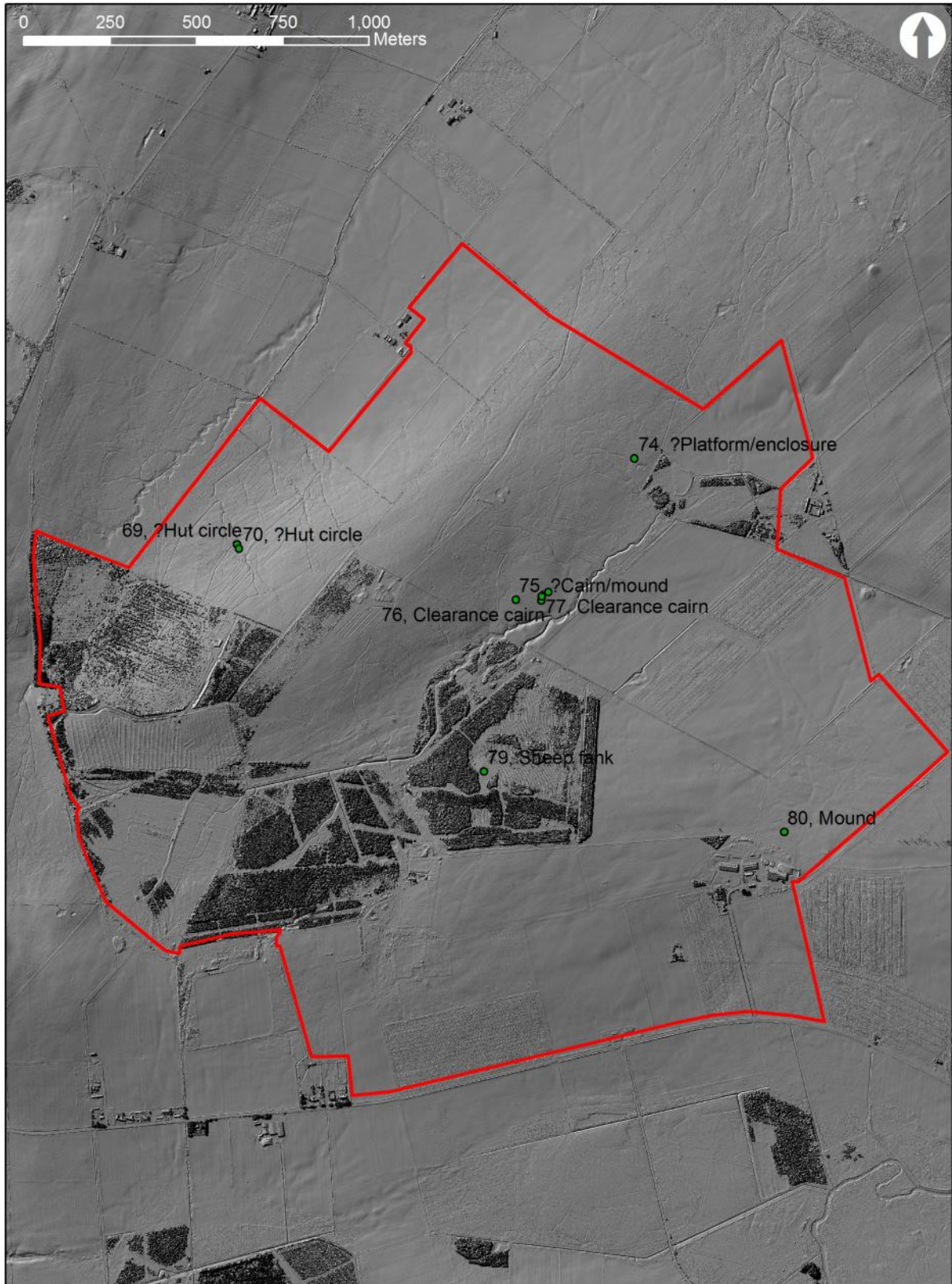


Figure 10: The development area.

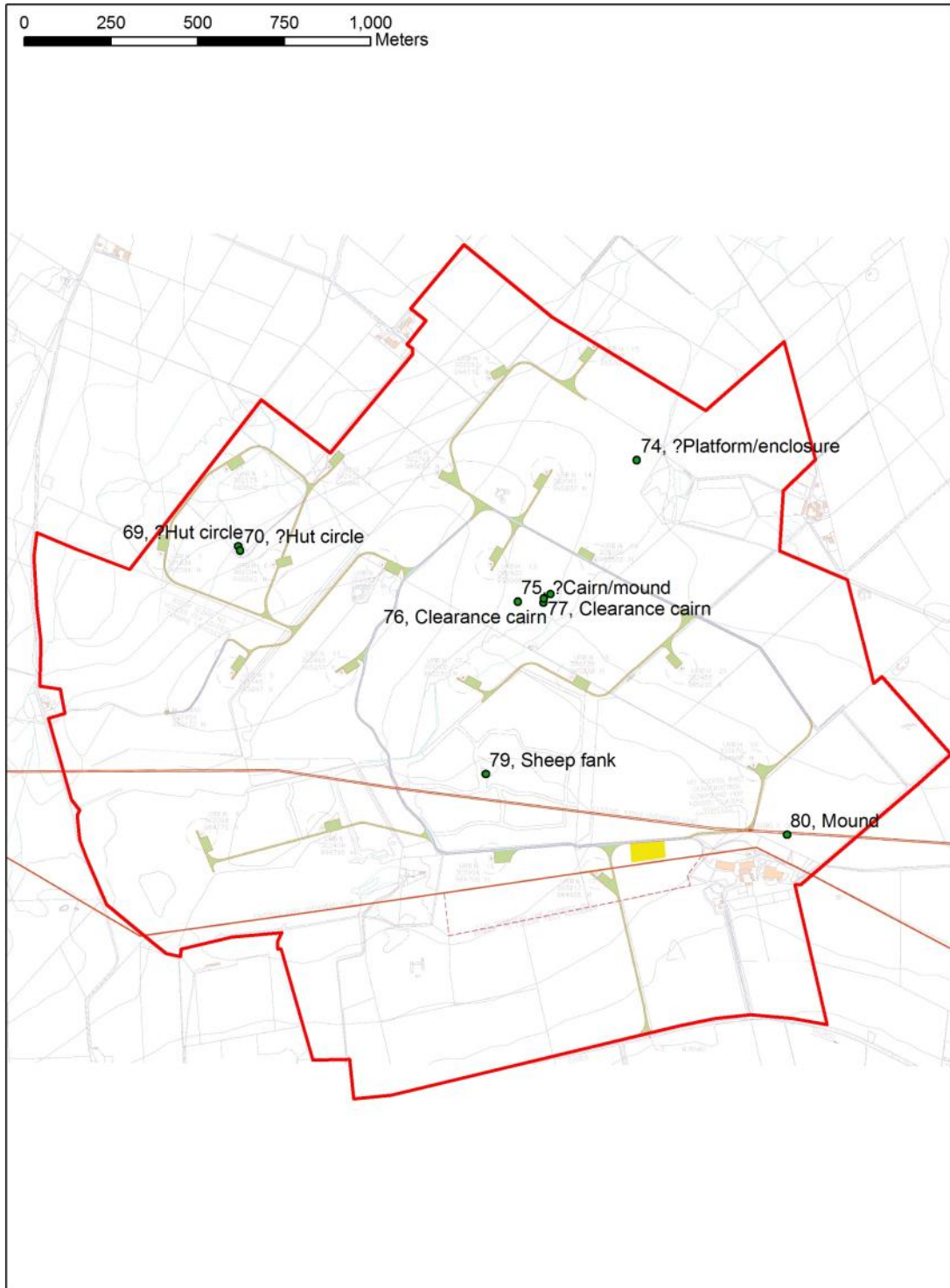


Figure 11: Possible sites within the development boundary.



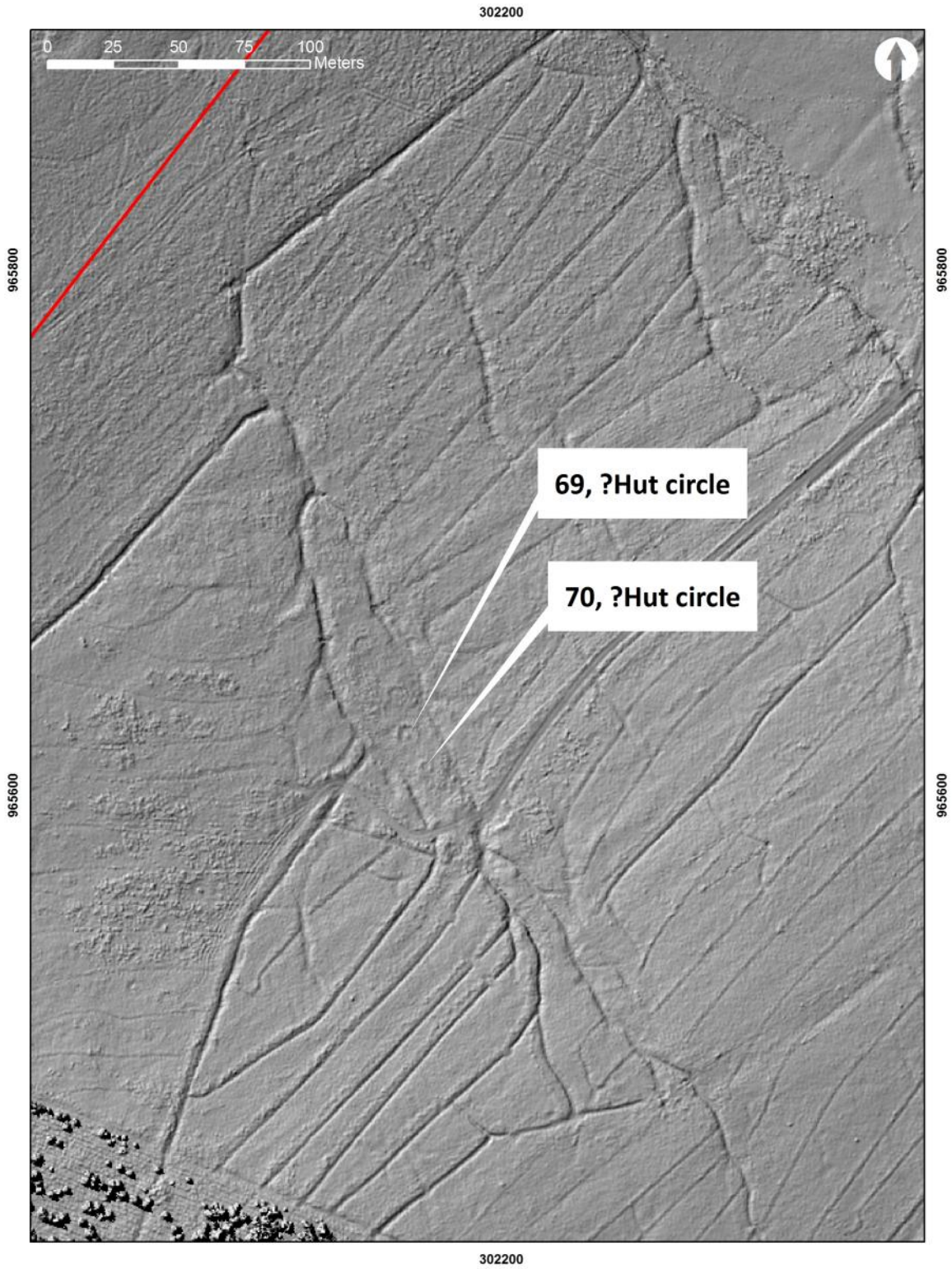


Figure 12: Possible hut circles within the development boundary.

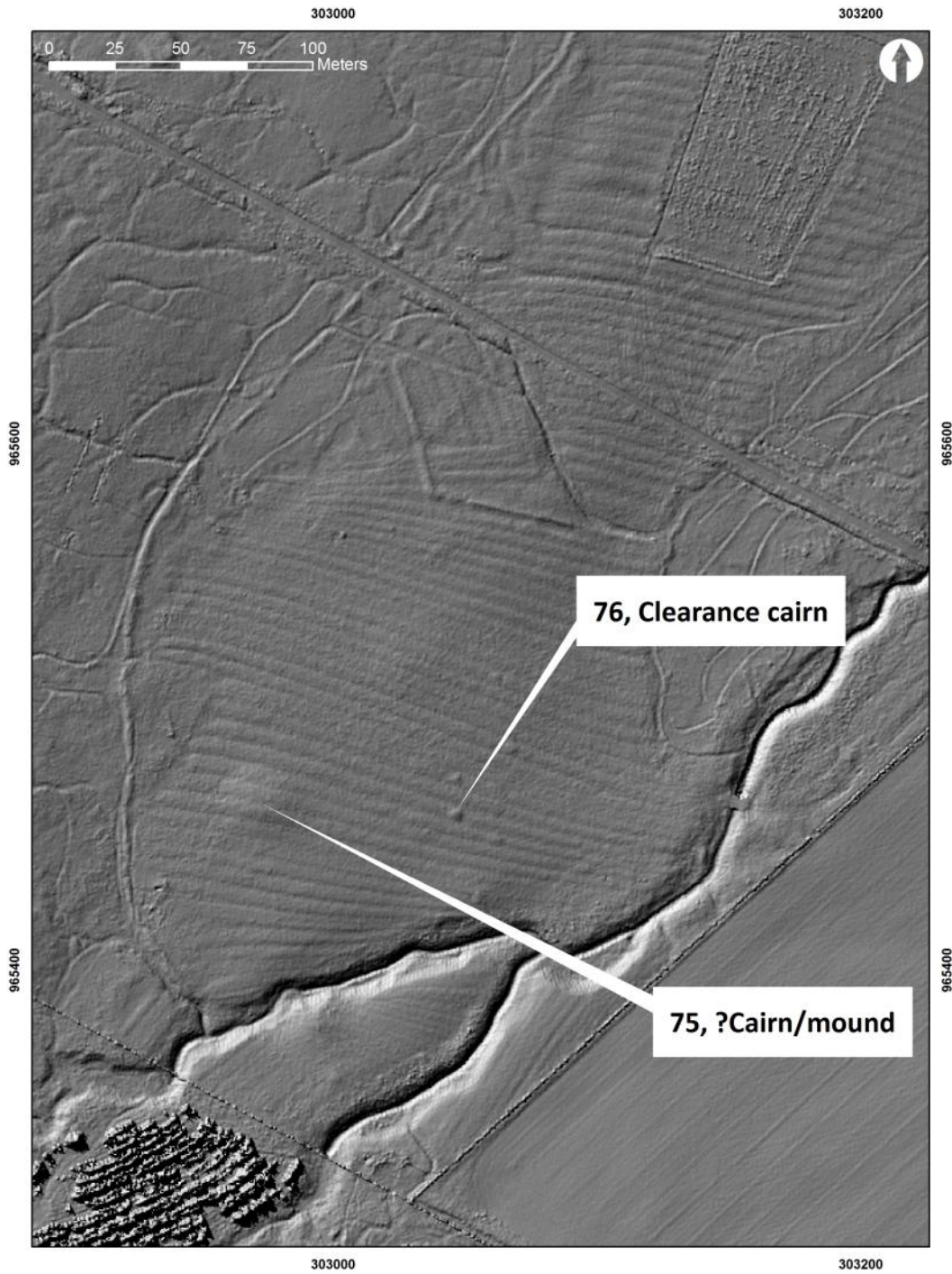


Figure 13: Possible cairn or mound and clearance cairns within the development area.



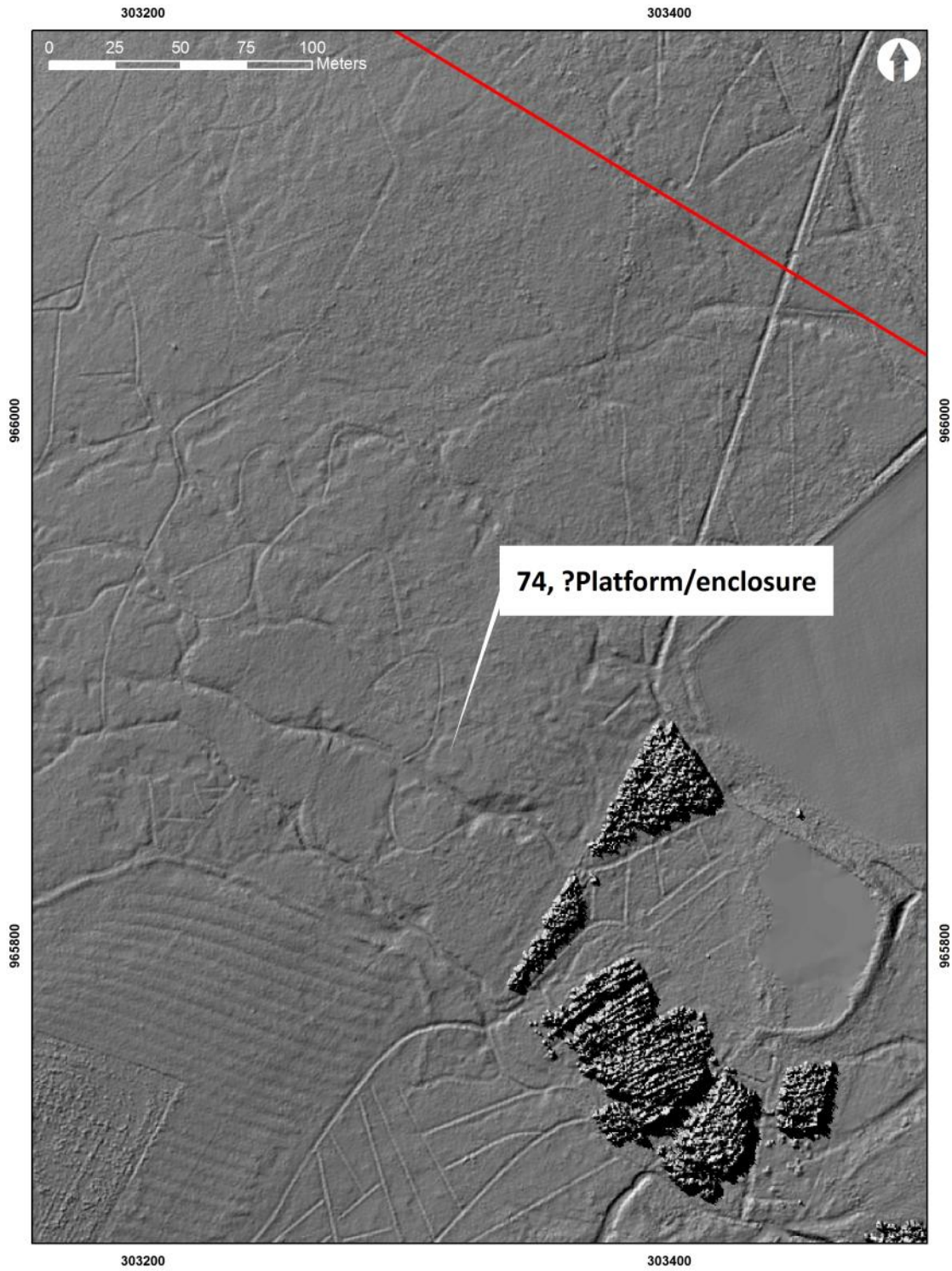


Figure 14: possible platform or enclosure within the development boundary.

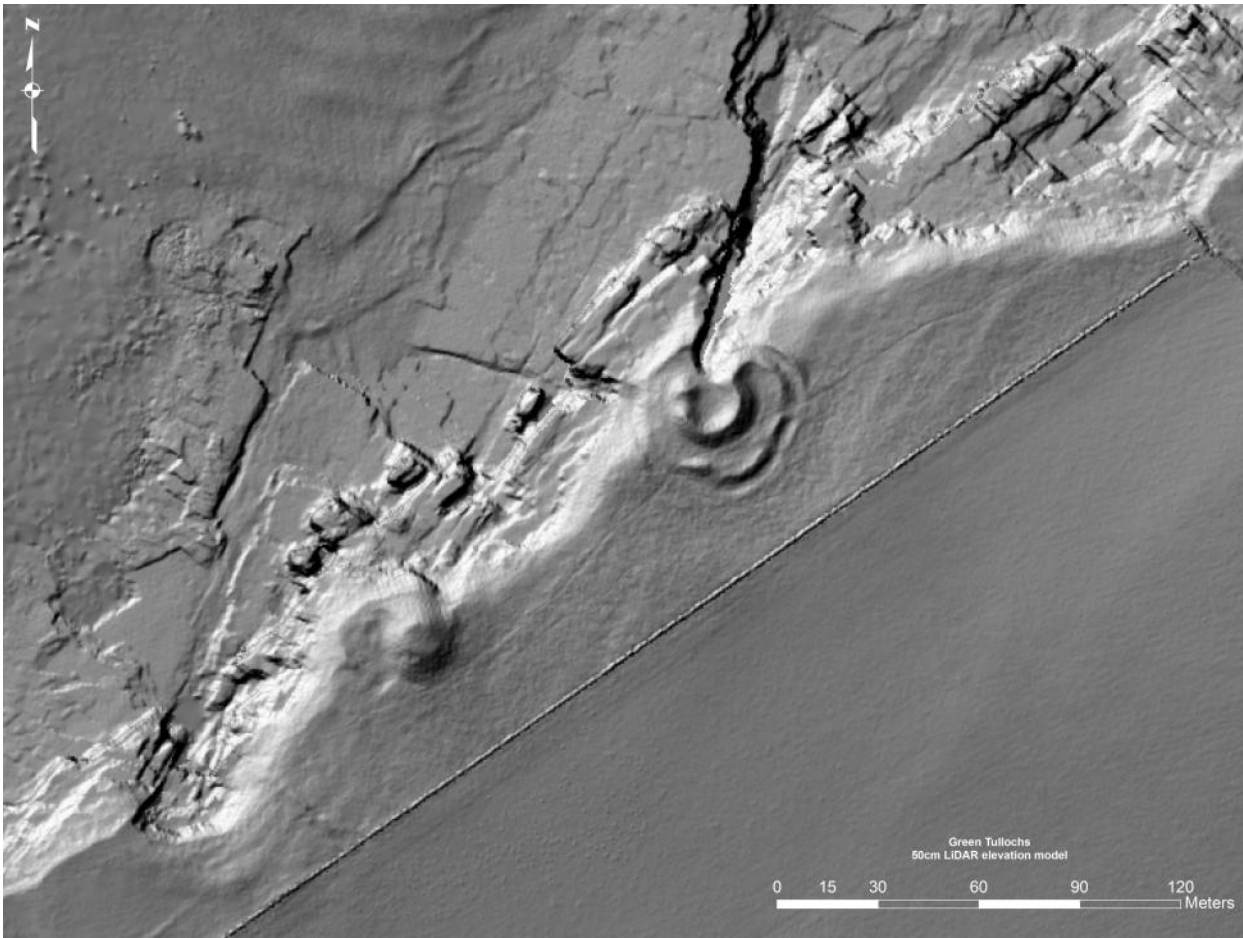


Figure 15: Broch with outworks, and adjacent burial mound, at Green Tullochs (MHG1227).



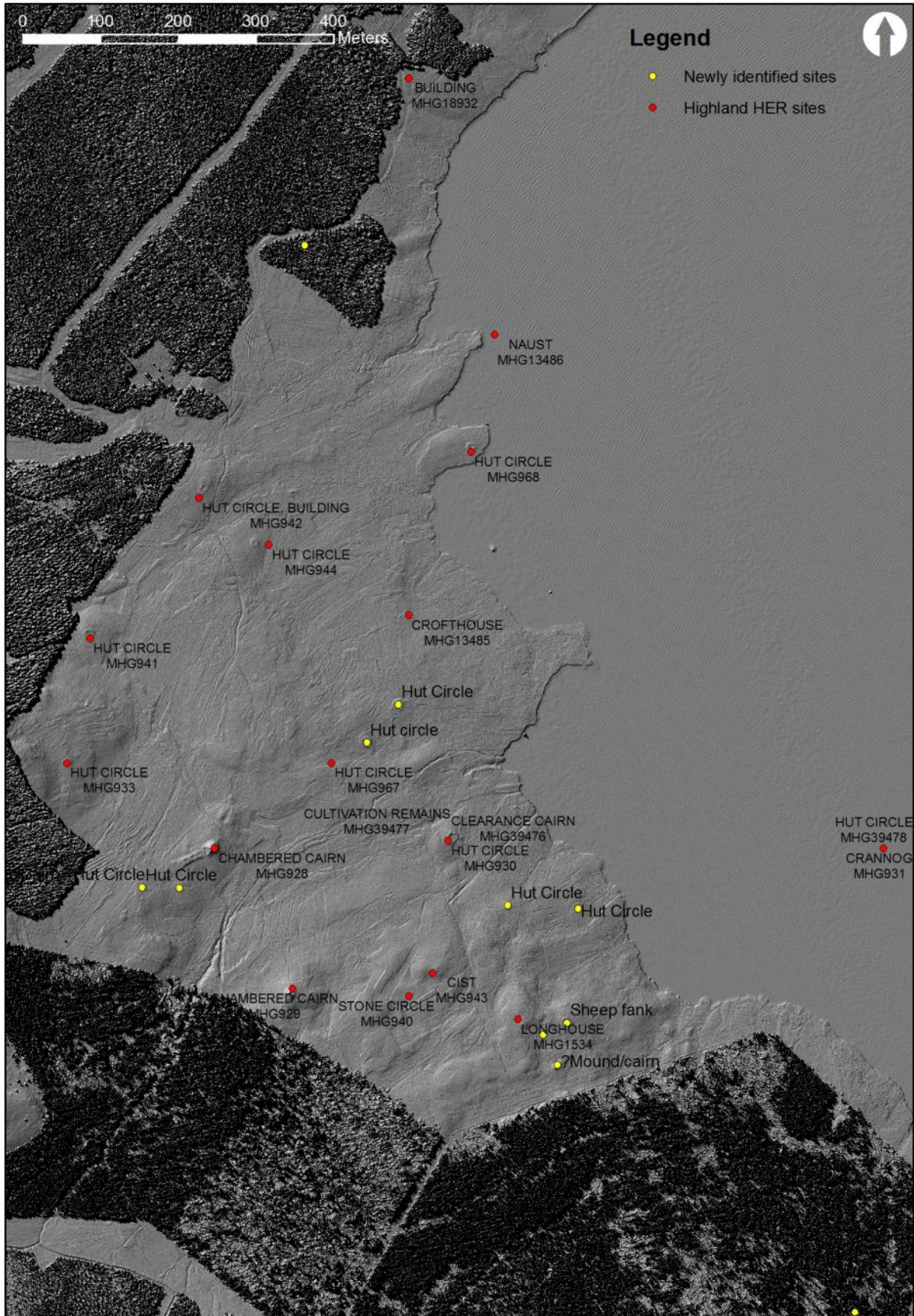


Figure 16: Chambered cairns and hut-circles, Loch Calder West.



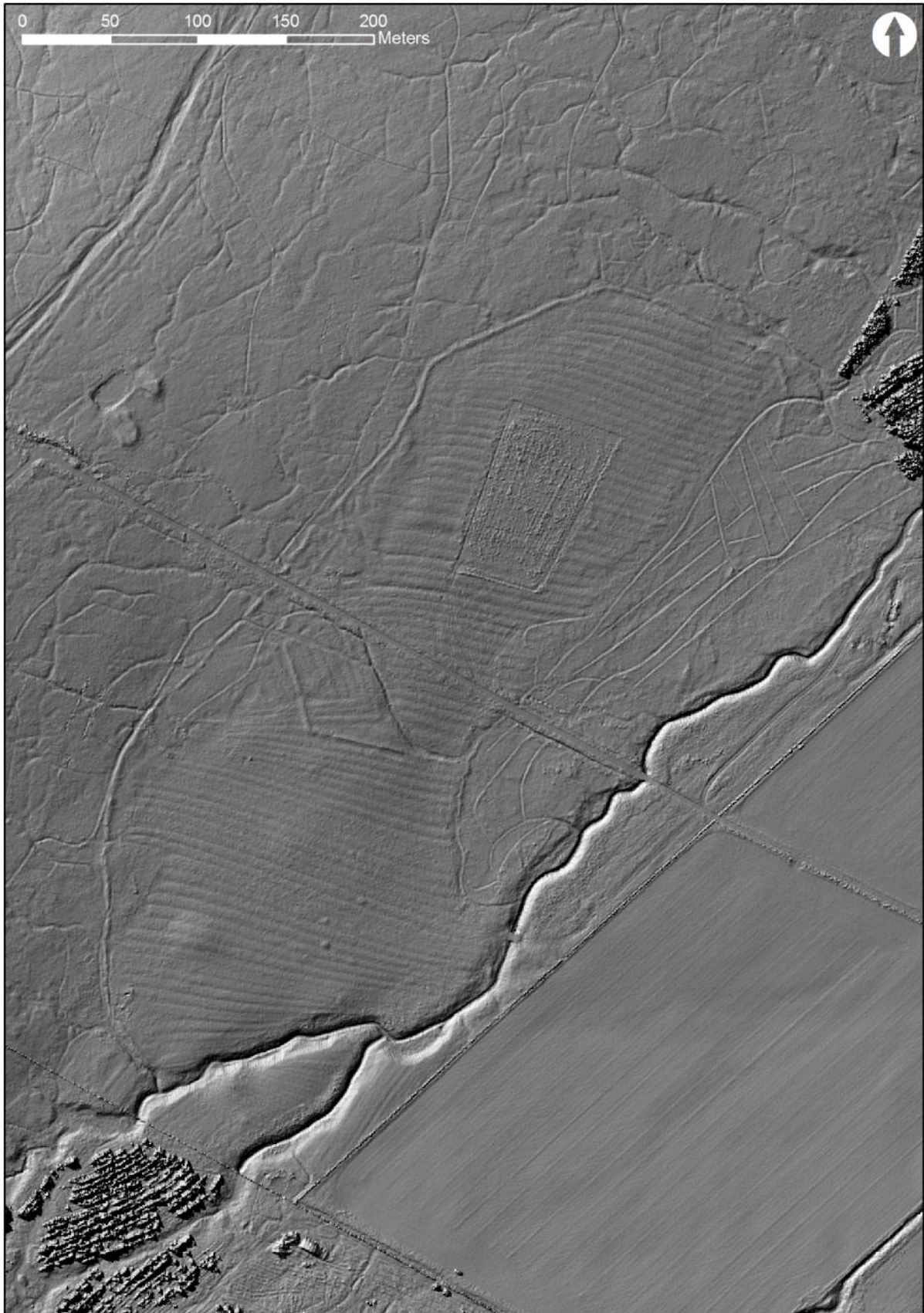


Figure 17: Multiphase enclosures, Baillie Hill.



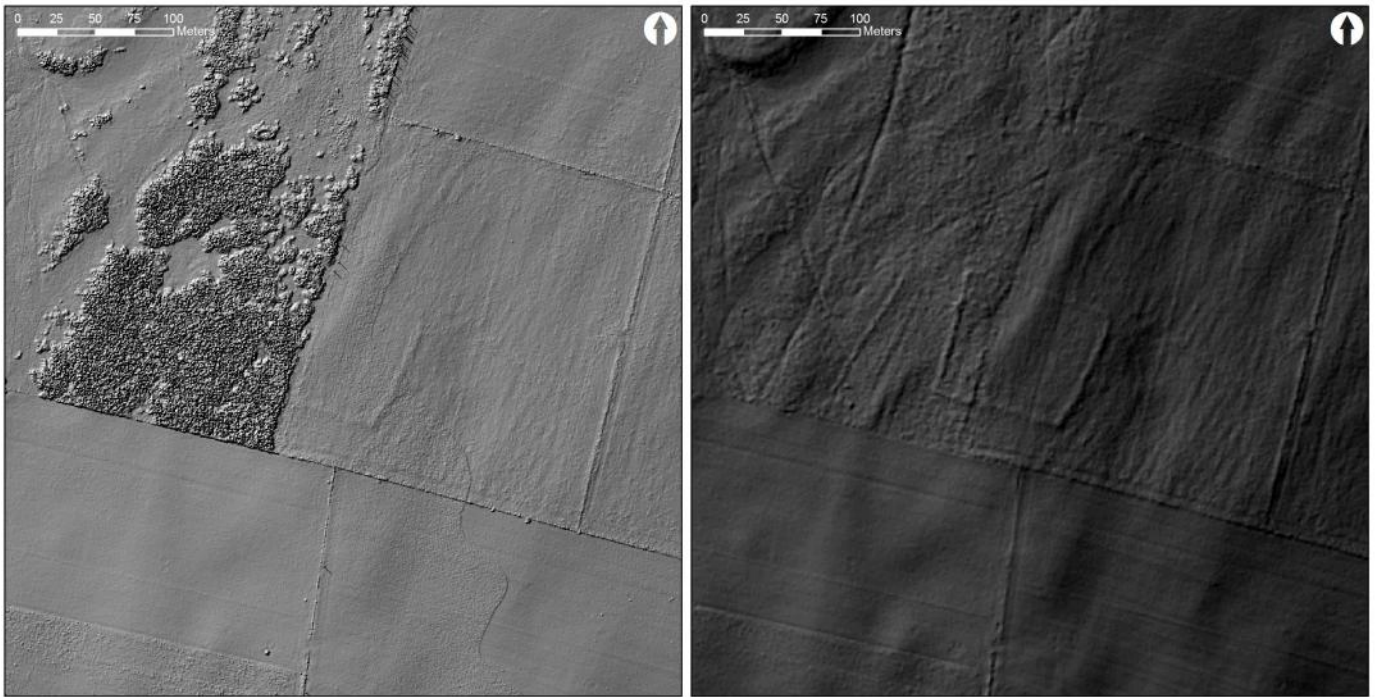


Figure 18: Bare earth versus surface models: Left: rectilinear enclosure, its western half partially obscured by woodland scrub and its eastern half in open ground, shown in the first-return DSM; right: the same enclosure shown in the bare earth DTM with equalised hillshading, with woodland removed.



Figure 19: Possible hut circle, Dounreay, partially obscured by vegetation.



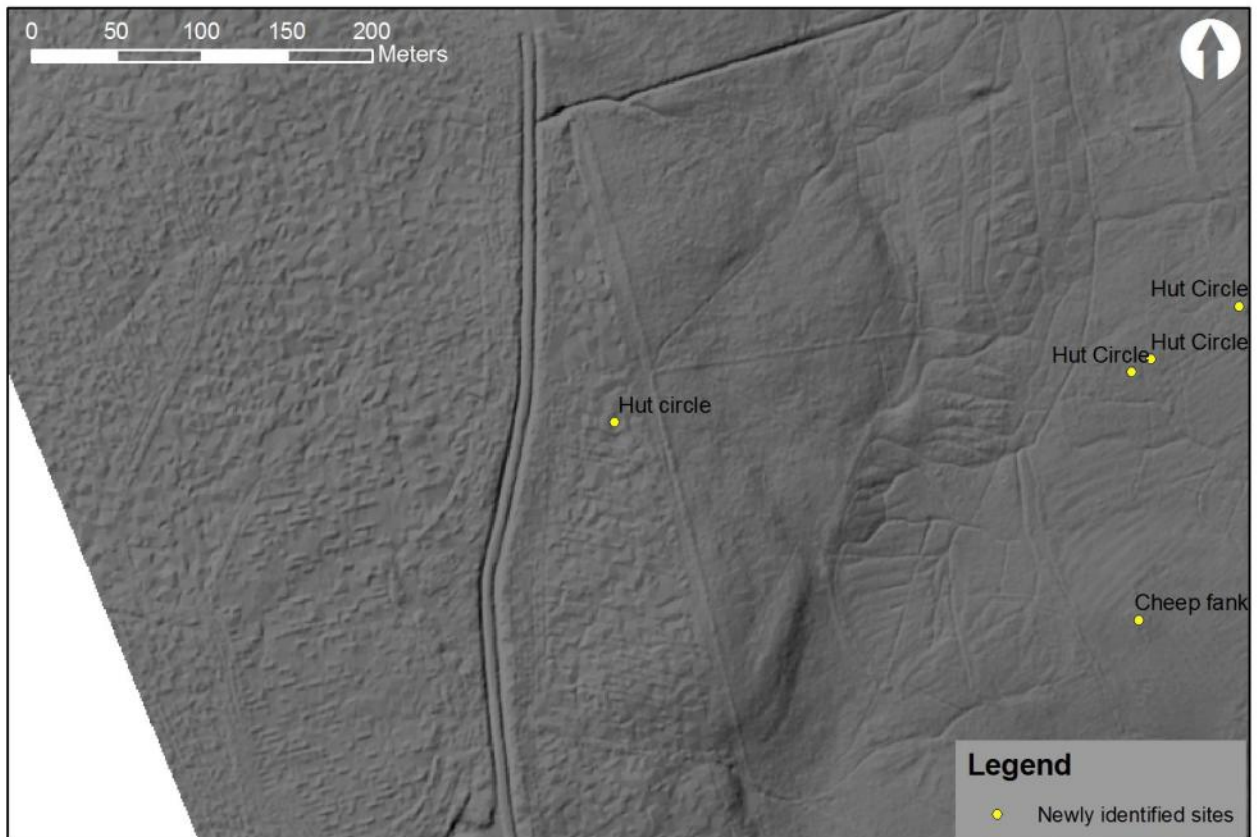


Figure 20: Possible hut-circle identified in the DSM (above) and bare earth data (below), one of three possible sites located beneath coniferous plantation.



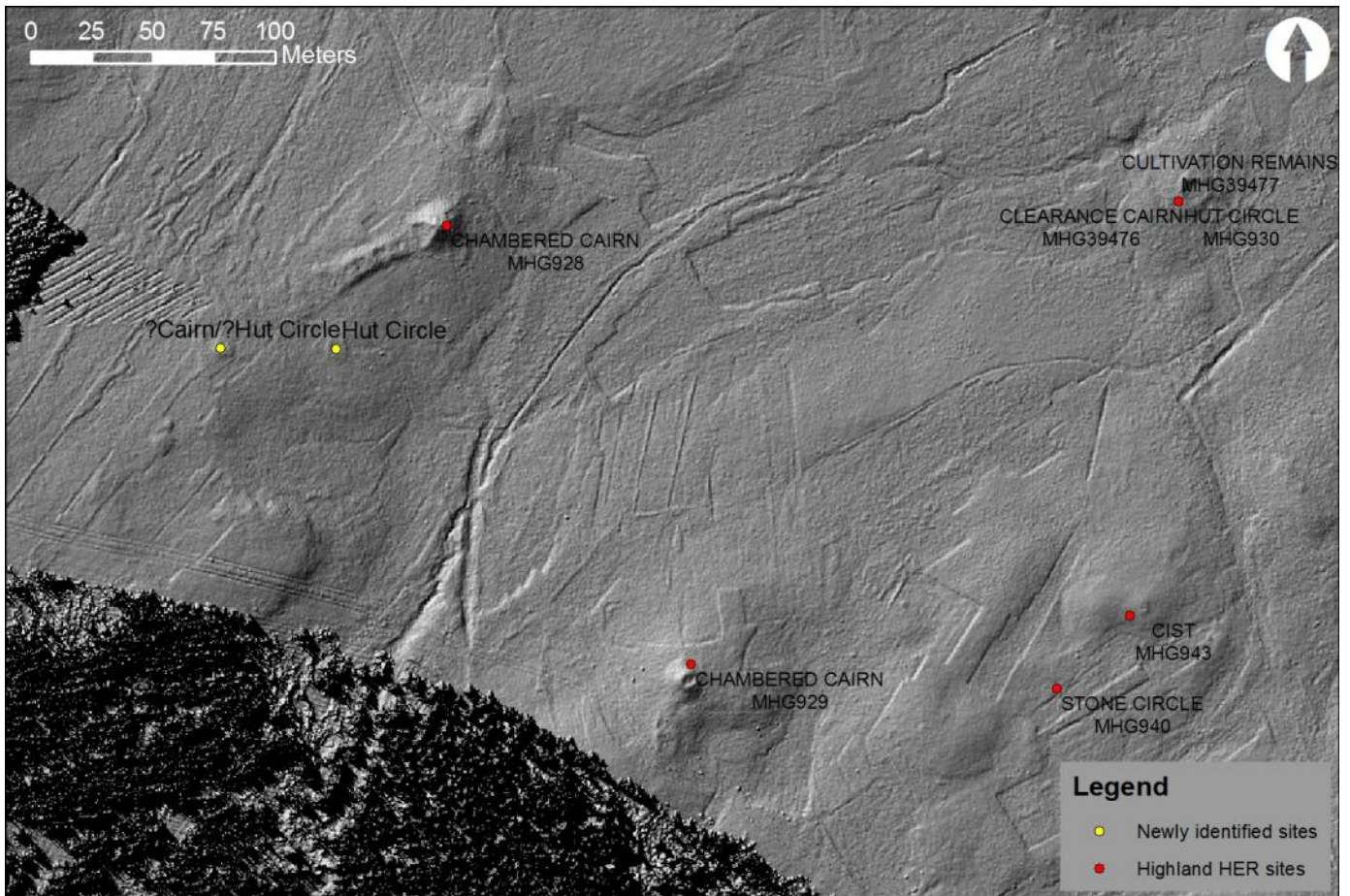


Figure 21: Chambered cairns at Torr Ban Na Gruagaich (MHG929) and Tulach Buaile Assery (MHG928)

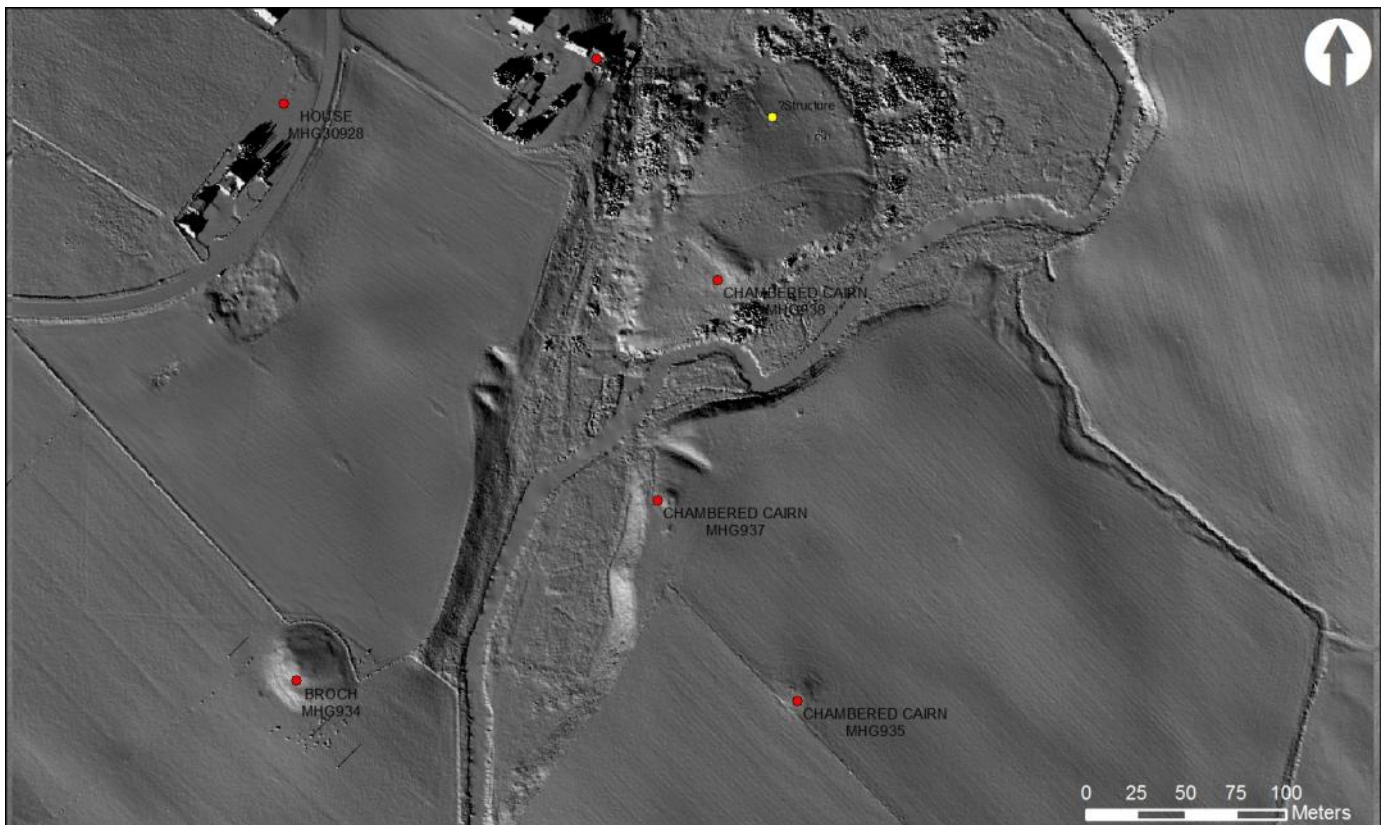


Figure 22: Chambered cairns, broch and possible structure highlighted with low-zenith lighting from the SW, at Knock Glass..







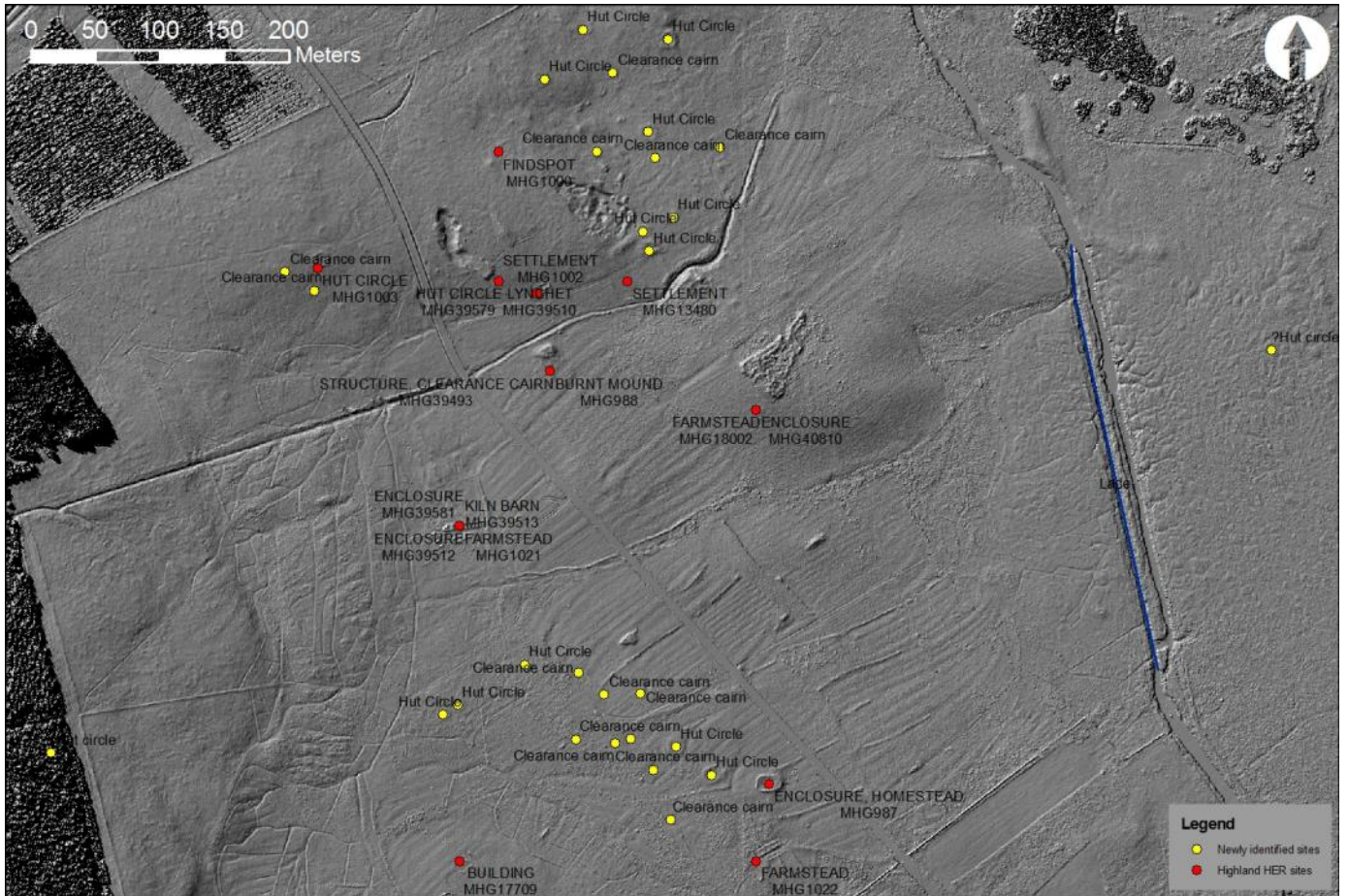


Figure 24: Remains of prehistoric settlement and agriculture underlying medieval or later S-shaped rig systems at Broubster.

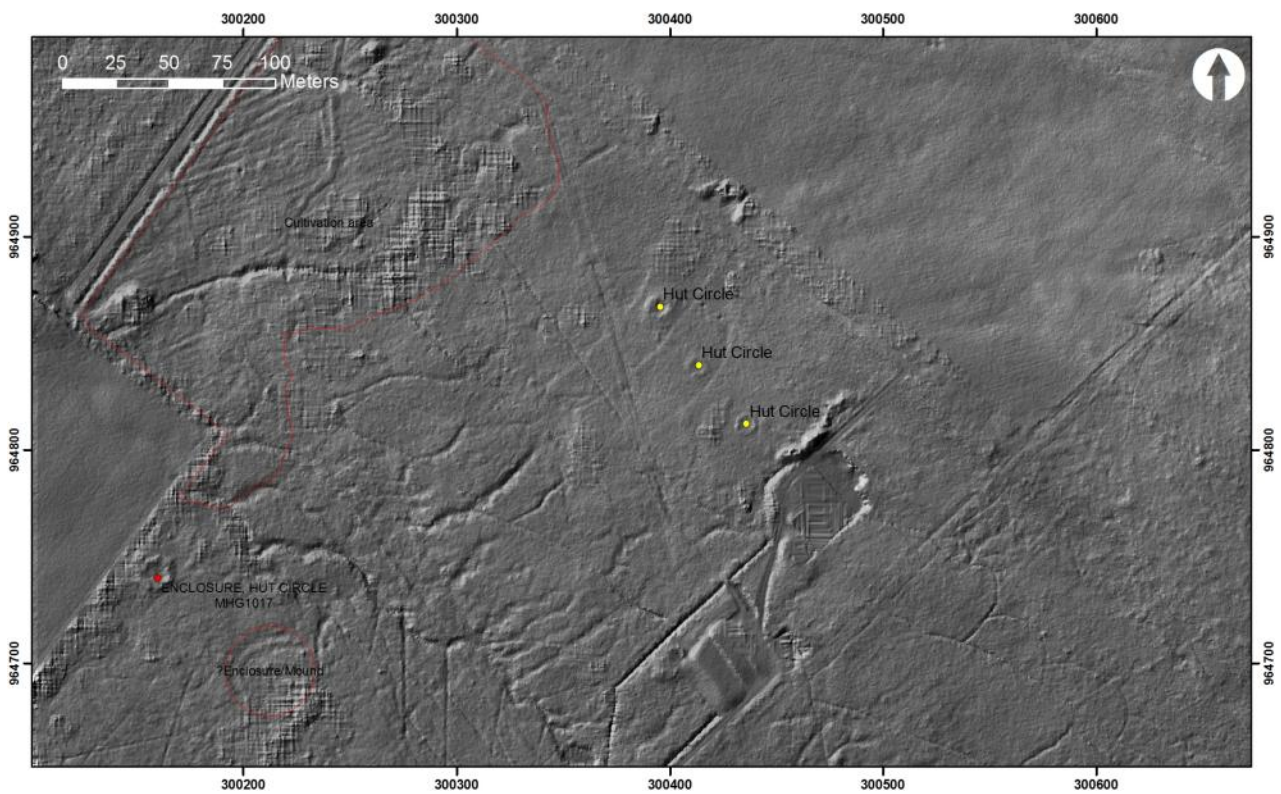


Figure 25: Hut circle group and cultivation area at Hill of Shebster, identified on the 0.25m DTM.



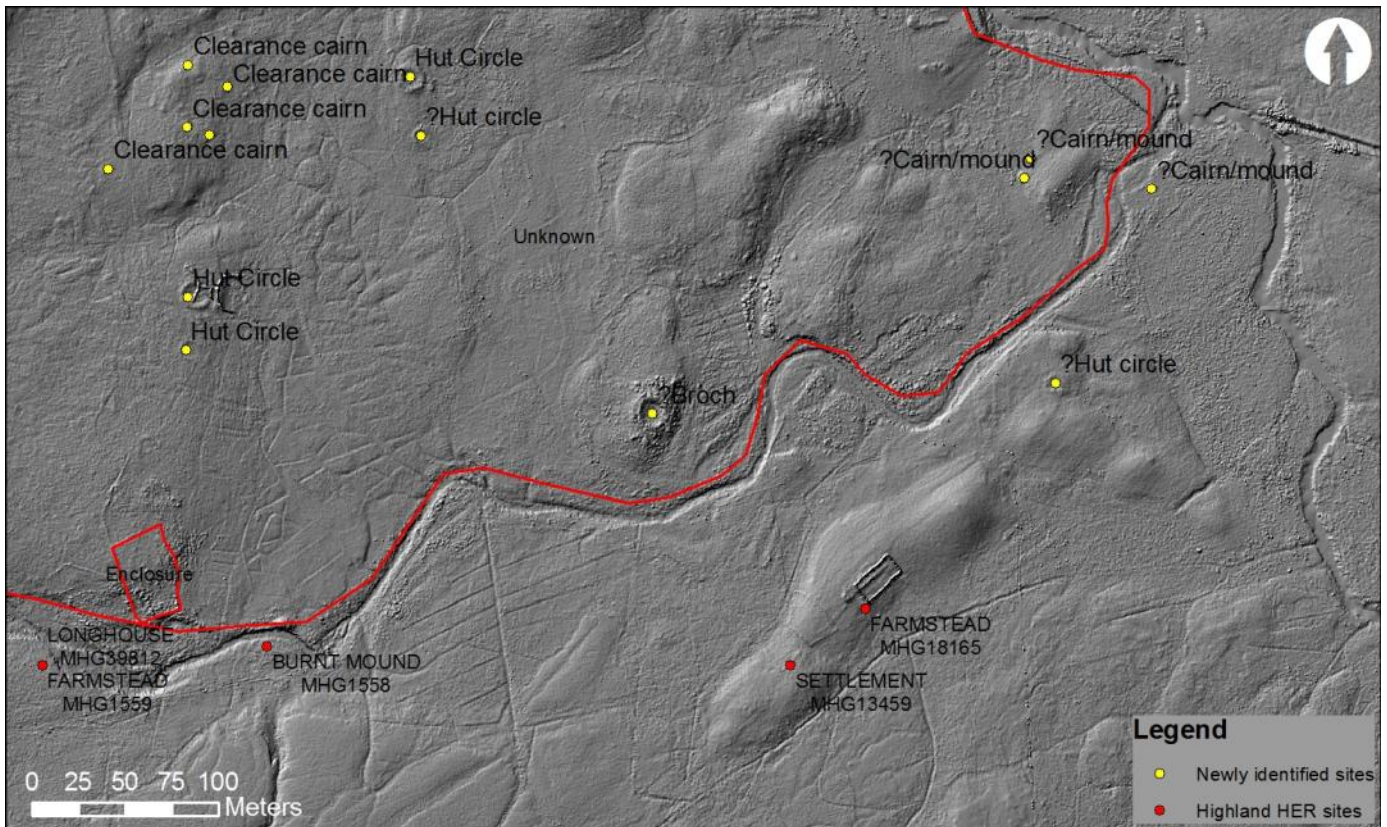


Figure 26: Possible broch (newly identified), hut-circle cluster and later farm enclosures at Allt Torigil.

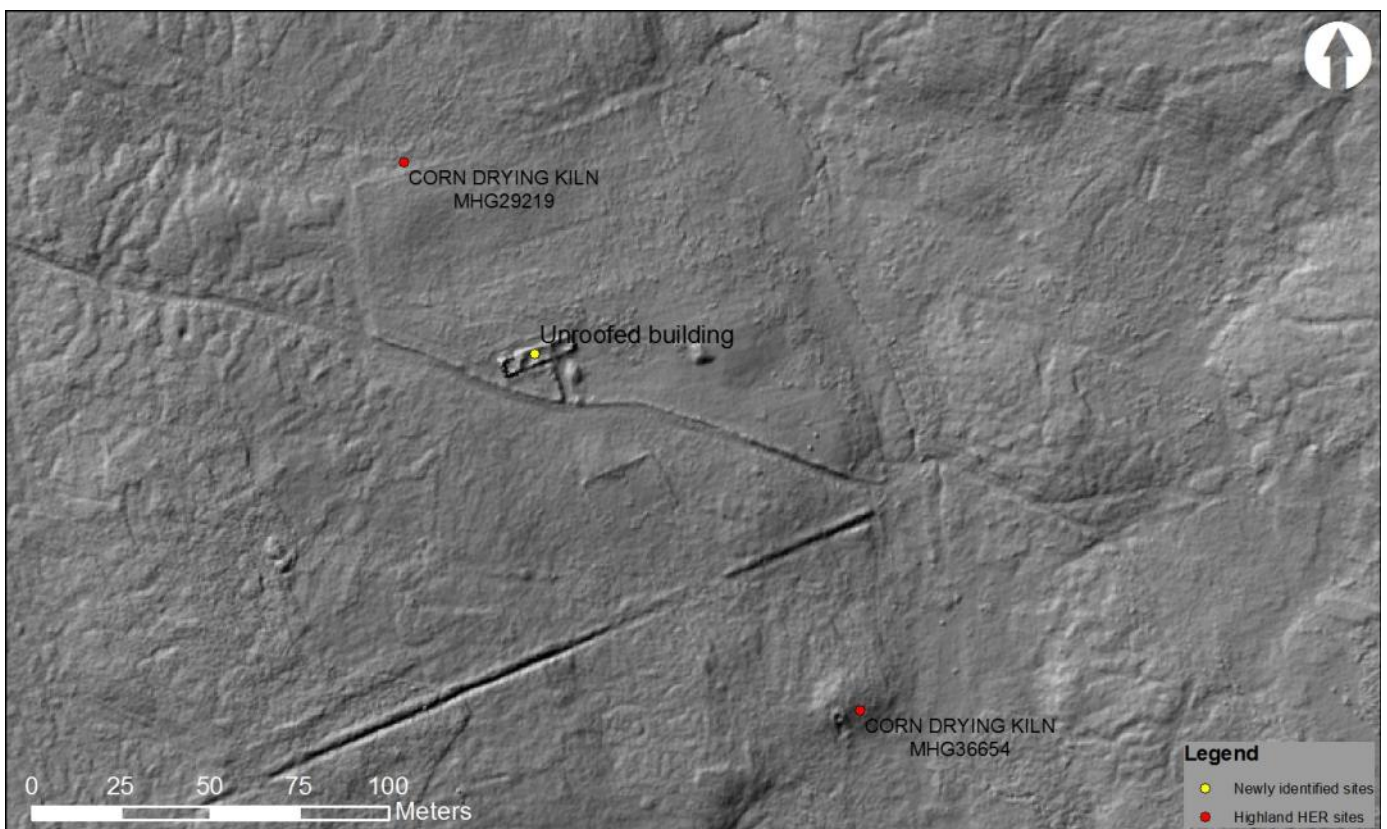


Figure 27: Farmstead and corn-drying kiln at Achnaclay (MHG36654).



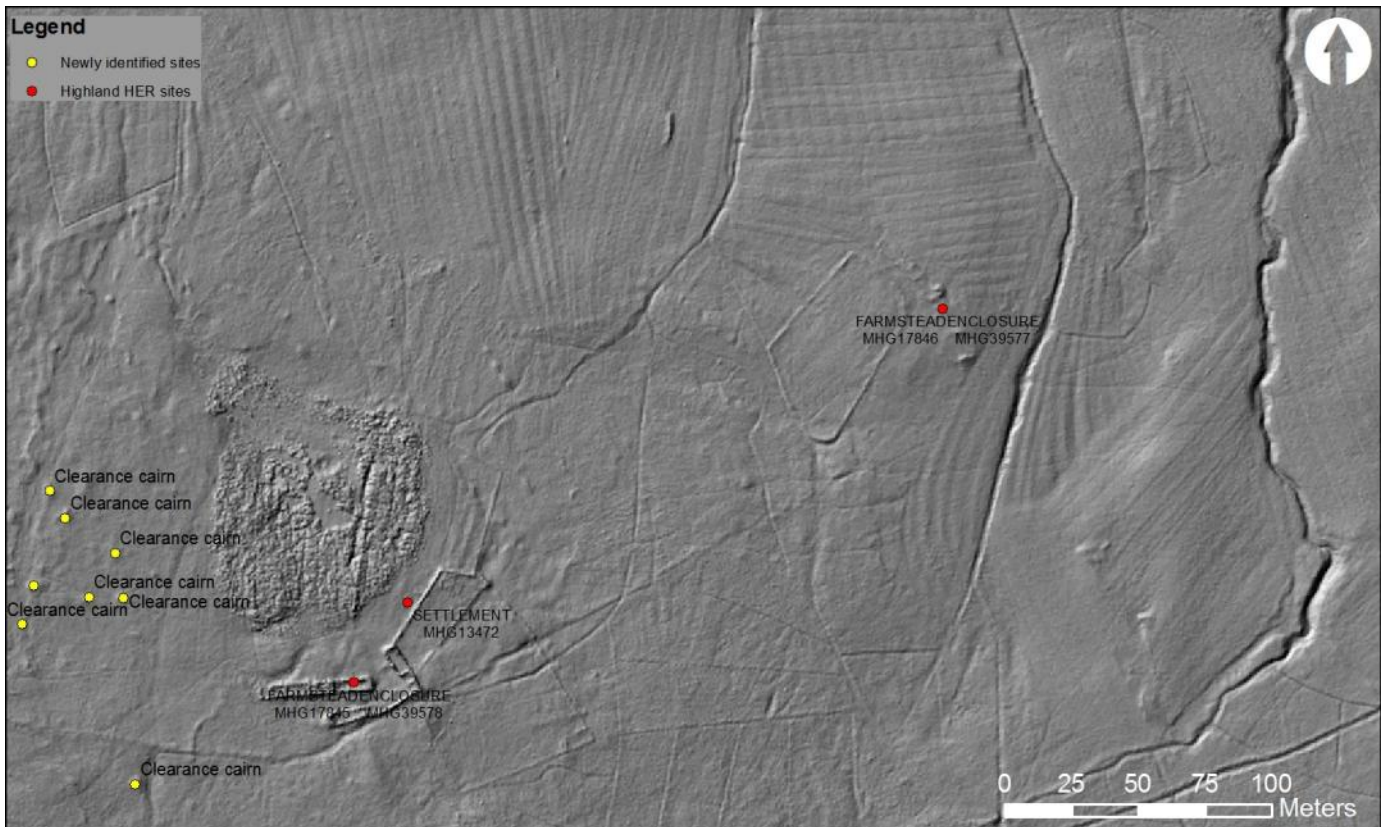


Figure 28: Farmsteads, enclosures and associated field systems at South Shebster.

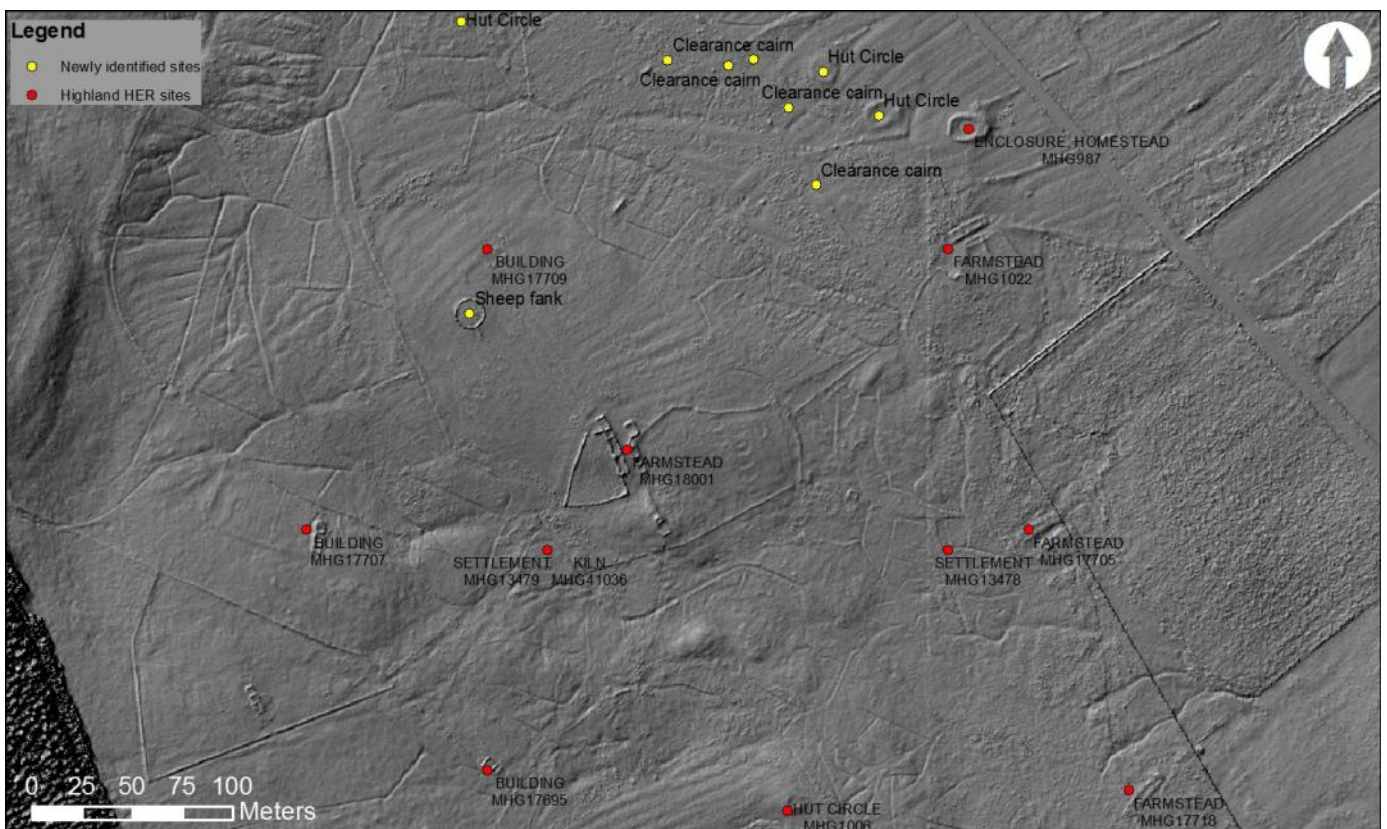


Figure 29: Post-medieval farmsteads and associated field systems at Broubster.

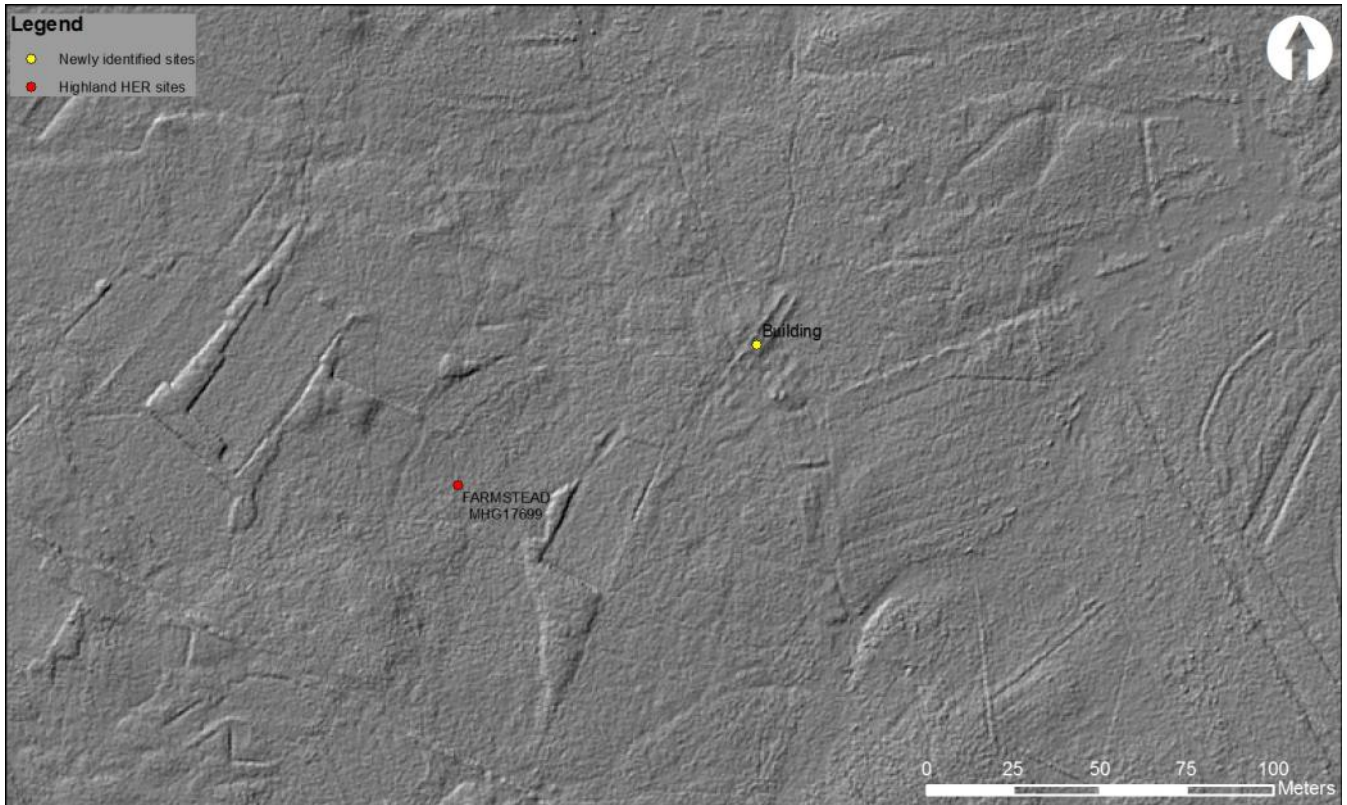


Figure 30: Relationship between farmstead at Widows Banks, identified by the FESP project, and the probable correct location, to the NE.



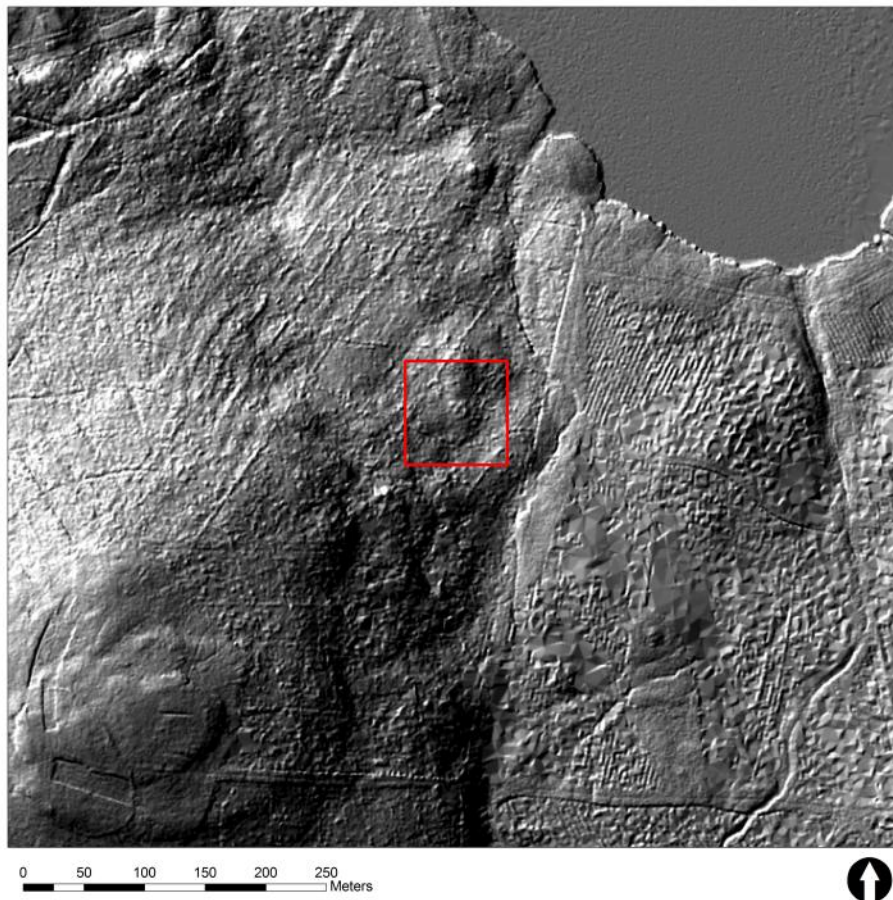
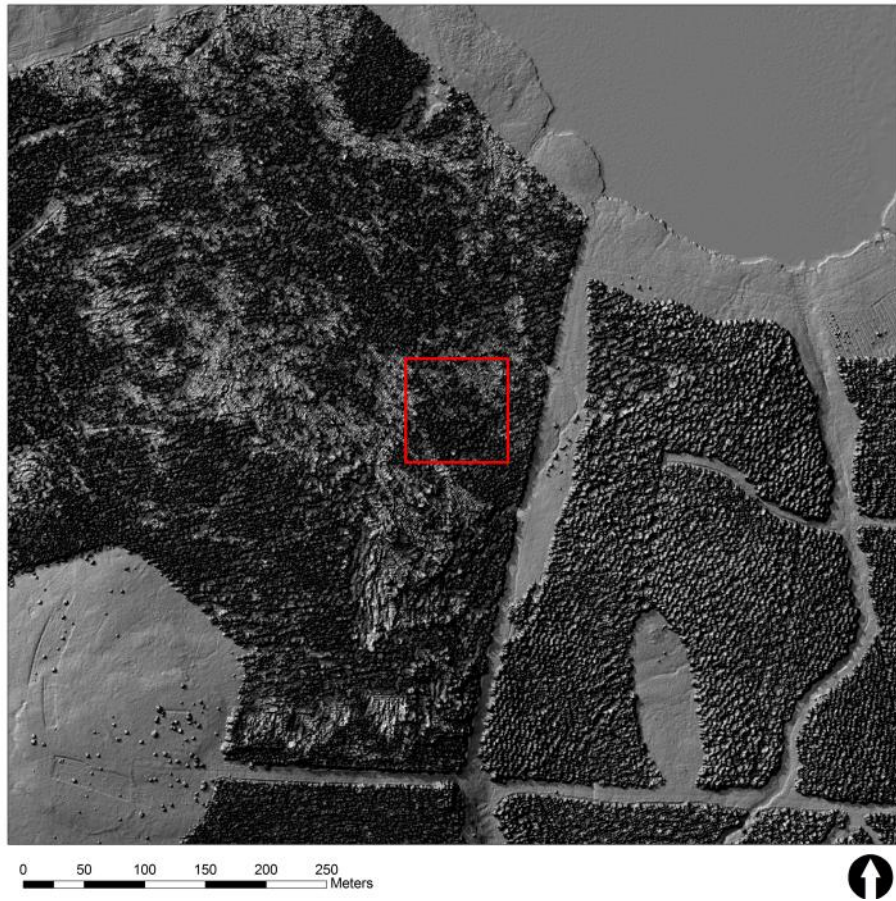


Figure 31: Possible hut-circle located in forestry plantation (above, 'first return' data; below, 'bare earth' data with forestry removed).



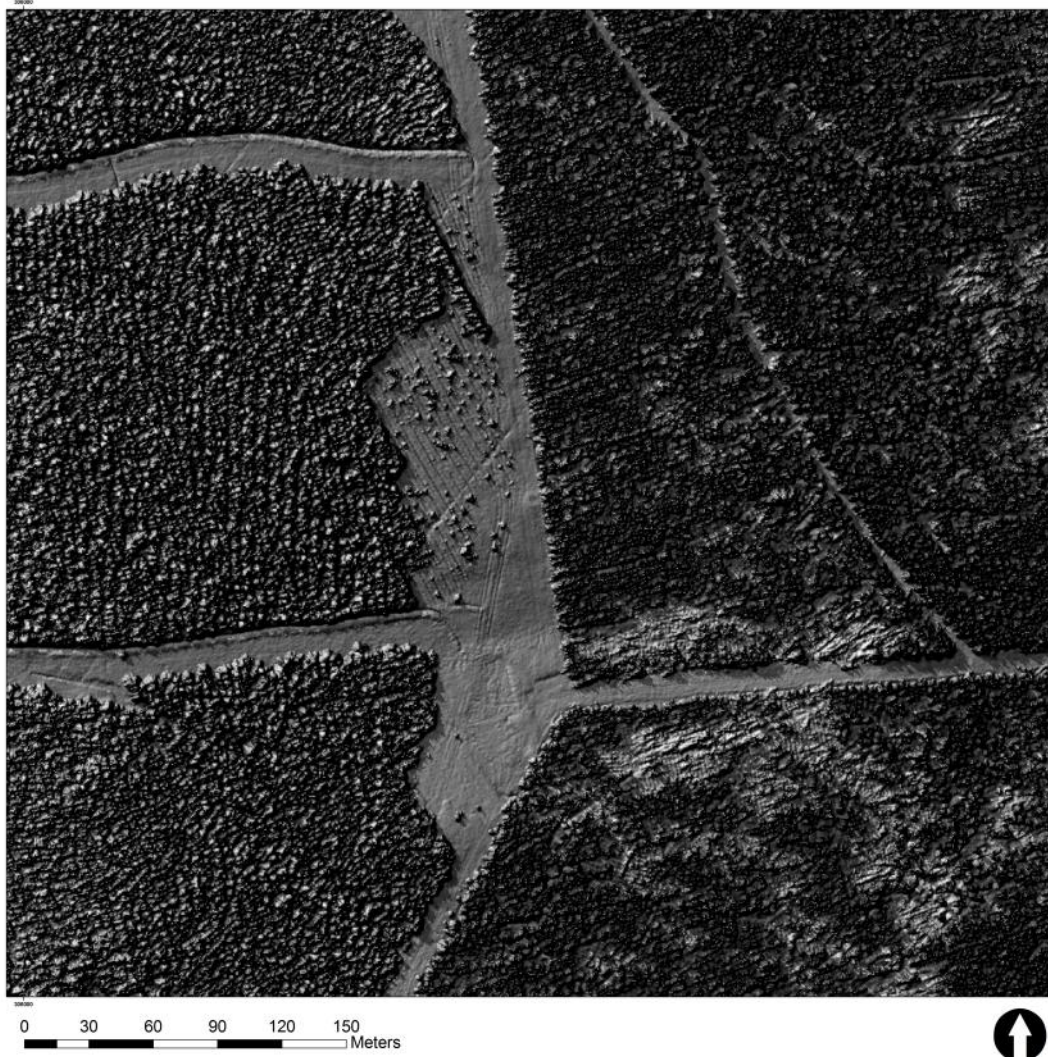


Figure 32: Possible hut circle or small cairn, visible in the centre of this image, surviving in a forest ride.

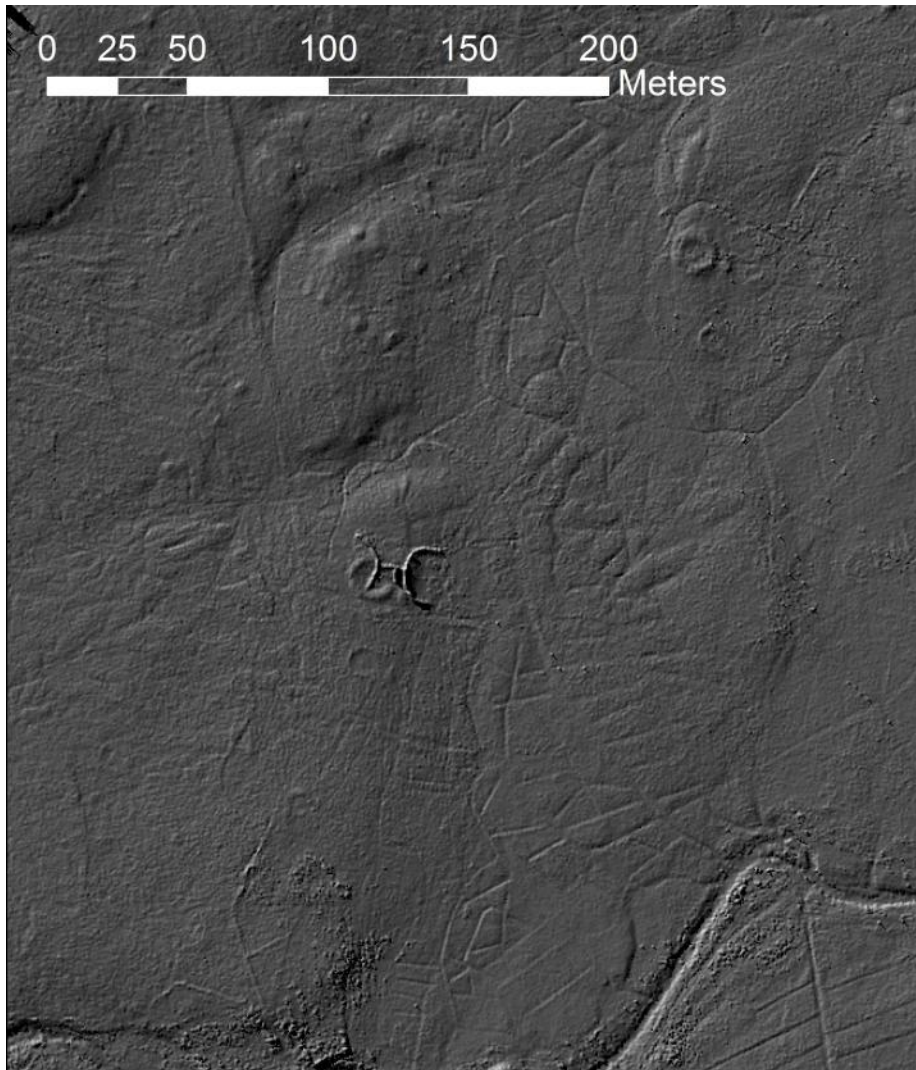


Figure 33: Hut circle overlain by a modern sheep fank, Allt Torigill.



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# Baillie Hill and Cnoc Freiceadain LiDAR Survey

## Section 2: Newly-identified Sites

## Appendix 1: LiDAR Assessment: New Features (Point)

| Site no | X      | Y      | Class      | Description  |
|---------|--------|--------|------------|--|
| 1       | 299251 | 965024 | Hut Circle | Hut circle located 170m north of road, partially obscured by vegetation. Possible enclosure/banks associated to the SW.                                      |
| 2       | 299285 | 964993 | Hut Circle | Hut circle located 155m north of road, 40m SE of site 1. Partially obscured by vegetation. Possible associated enclosure/agricultural traces to the S.       |
| 3       | 300395 | 964867 | Hut Circle | Hut circle. One of four arranged in a line running NW from the farm building at ND 0047 6477, to the NE of a modern farm track.                              |
| 4       | 300413 | 964840 | Hut Circle | Hut circle. One of four arranged in a line running NW from the farm building at ND 0047 6477, to the NE of a modern farm track.                              |
| 5       | 300436 | 964812 | Hut Circle | Hut circle. One of four arranged in a line running NW from the farm building at ND 0047 6477, to the NE of a modern farm track.                              |
| 6       | 300716 | 964490 | Hut Circle | Hut circle, located 190m north of Leans of Shebster, N of a small stream. Associated with at least seven clearance carins and a further possible hut circle. |
| 7       | 301772 | 966022 | Hut Circle | Hut circle. One of three possible hut-circles in close proximity.  |
| 8       | 301788 | 966054 | Hut Circle | Hut circle. One of three possible hut-circles in close proximity.  |
| 9       | 302916 | 961215 | Hut Circle | Hut circle. One of several within a cluster associated with clearance cairns and enclosures.   |
| 10      | 302932 | 961287 | Hut Circle | Hut circle. One of several within a cluster associated with clearance cairns and enclosures.   |
| 11      | 302912 | 961138 | Hut Circle | Possible hut-circle, asociated with field clearance and possible enclosures.   |
| 12      | 302917 | 961123 | Hut Circle | Possible hut-circle, asociated with field clearance and possible enclosures.   |
| 13      | 302936 | 961149 | Hut Circle | Possible hut-circle, asociated with field clearance and possible enclosures.   |
| 14      | 302836 | 961256 | Hut Circle | Possible hut-circle, asociated with field clearance and possible enclosures.   |

## Appendix 1: LiDAR Assessment: New Features (Point)

| Site no | X      | Y      | Class              | Description  |
|---------|--------|--------|--------------------|--|
| 15      | 302865 | 961295 | Hut Circle         | Possible hut-circle, associated with field clearance and possible enclosures.  |
| 16      | 302938 | 960739 | Hut Circle         | Hut-circle, underlying later rig-and-furrow, probably associated with similar structures to SE and evidence of field clearance.                            |
| 17      | 302965 | 960717 | Hut Circle         | Hut-circle, underlying later rig-and-furrow, probably associated with similar structures to N and evidence of field clearance.                             |
| 18      | 302757 | 960764 | Hut Circle         | Possible hut-circles or cellular structures overlain by later agricultural remains.  |
| 19      | 302768 | 960771 | Hut Circle         | Possible hut-circles or cellular structures overlain by later agricultural remains.  |
| 20      | 302820 | 960802 | Hut Circle         | Possible hut-circle fragment, overlain by later agricultural remains.  |
| 21      | 303395 | 960617 | Hut Circle         | Circular feature, possible hut circle located close to Forss Water.  |
| 22      | 303183 | 959316 | Hut Circle         | Hut circle. One of several in this area of Broubster, associated with a complex of enclosures and field clearance; overlain by later agricultural remains. |
| 23      | 303297 | 959115 | Hut Circle         | Hut circle. One of several in this area of Broubster, associated with a complex of enclosures and field clearance; overlain by later agricultural remains. |
| 24      | 303178 | 958997 | Hut Circle         | Probable hut-circle, with modern sheep bucht constructed on top.   |
| 25      | 303177 | 958968 | Hut Circle         | Circular feature, possible hut-circle associated with possible sub-rectangular enclosure.  |
| 26      | 304830 | 958170 | Hut Circle         | Circular feature, possible hut-circle. Possible associated rectilinear enclosure to W.   |
| 27      | 305987 | 960375 | Hut Circle         | Hut circle, located 150m from W shore of Loch Calder. One of several in this area.   |
| 28      | 305657 | 960140 | ?Cairn/?Hut Circle | Small mound, possibly associated with the long cairn at Tulach Buaile Assery.  |
| 29      | 305705 | 960139 | Hut Circle         | Small mound, possible cairn or hut circle associated with the long cairn at Tulach Buaile Assery.  |



## Appendix 1: LiDAR Assessment: New Features (Point)

| Site no | X      | Y      | Class             | Description   |
|---------|--------|--------|-------------------|---|
| 30      | 306217 | 960112 | Hut Circle        | Circular feature, possible hut circle, located 57m from W shore of Loch Calder.   |
| 31      | 306127 | 960117 | Hut Circle        | Circular feature, possible hut circle or cairn, located 135m from W shore of Loch Calder.   |
| 32      | 307188 | 963838 | Hut Circle        | Hut circle, one of three closely set circular features.   |
| 33      | 307200 | 963834 | Hut Circle        | Hut circle, one of three closely set circular features.   |
| 34      | 307212 | 963831 | Hut Circle        | Hut circle, one of three closely set circular features.   |
| 35      | 307121 | 963787 | Hut Circle        | Small circular feature, possible hut-circle.  |
| 36      | 307042 | 963838 | Hut Circle        | Small circular feature, possible hut-circle.  |
| 37      | 307459 | 962250 | Hut Circle        | Prominent hut-circle 300m east of east shore road beside Loch Calder.   |
| 38      | 307646 | 958670 | Hut Circle        | Hut circle located within small enclosure on promontory in Loch Calder.   |
| 39      | 307488 | 959301 | Hut Circle        | Hut circle located 73m W of shore of Loch Calder. Possible associated rectilinear enclosure located to E.                               |
| 40      | 307491 | 959000 | Hut Circle        | Fragmentary circular structure, badly disturbed by later MoLRS building and enclosure. Possible hut-circle.                             |
| 41      | 307498 | 958997 | Hut Circle        | Fragmentary circular structure, badly disturbed by later MoLRS building and enclosure. Possible hut-circle.                             |
| 42      | 307503 | 958992 | Hut Circle        | Fragmentary circular structure, badly disturbed by later MoLRS building and enclosure. Possible hut-circle.                             |
| 43      | 303303 | 962253 | Hut Circle        | Small circular feature located at the edge of forestry plantation. Possible hut circle; likely to be badly disturbed by deep ploughing. |
| 44      | 303795 | 971071 | ?Hut circle       | Cicular feature; possible hut circle or platform.   |
| 45      | 302789 | 968799 | Unroofed building | Bipartite longhouse, with associated square enclosure yard to S.  |

## Appendix 1: LiDAR Assessment: New Features (Point)

| Site no | X      | Y      | Class                 | Description   |
|---------|--------|--------|-----------------------|---|
| 46      | 300555 | 966309 | Hut circle            | Circular feature, possible hut circle partially disturbed by modern forestry plantation; ploughing appears to have avoided the feature. |
| 47      | 301778 | 966004 | Hut circle            | Circular feature, possible hut-circle; one of three possible hut-circles in close proximity.  |
| 48      | 301730 | 965762 | ?Hut circle           | Circular feature, possible hut-circle located within modern peat drainage system.   |
| 49      | 301673 | 965745 | ?Hut circle           | Circular feature, possible fragmentary hut circle.  |
| 50      | 304721 | 967452 | Rectilinear enclosure | Rectilinear enclosure, formed by a bank 33m by 33m, 4m in width.  |
| 51      | 305420 | 967625 | ?Cairn/mound          | Circular feature; possible cairn.   |
| 52      | 304386 | 966811 | ?Building             | Possible square structure, c. 10m by 10m.   |
| 53      | 300743 | 964458 | ?Hut circle           | Possible fragmentary hut circle associated with field clearance.  |
| 54      | 301240 | 964403 | ?Cairn/mound          | Circular feature, possible cairn.   |
| 55      | 300665 | 964485 | Clearance cairn       | Clearance cairn.  |
| 56      | 300615 | 964427 | Clearance cairn       | Clearance cairn.  |
| 57      | 300658 | 964448 | Clearance cairn       | Clearance cairn.  |
| 58      | 300695 | 964516 | Clearance cairn       | Clearance cairn.  |
| 59      | 300708 | 964518 | Clearance cairn       | Clearance cairn.  |
| 60      | 300741 | 964491 | Clearance cairn       | Clearance cairn.  |
| 61      | 300770 | 964492 | Clearance cairn       | Clearance cairn.  |
| 62      | 301032 | 964200 | Clearance cairn       | Clearance cairn.  |
| 63      | 301031 | 964194 | Clearance cairn       | Clearance cairn.  |
| 64      | 301044 | 964192 | Clearance cairn       | Clearance cairn.  |
| 65      | 301062 | 964220 | Clearance cairn       | Clearance cairn.  |

## Appendix 1: LiDAR Assessment: New Features (Point)

| Site no | X      | Y      | Class               | Description   |
|---------|--------|--------|---------------------|---|
| 66      | 301342 | 964629 | ?Building           | Possible building or small enclosure, measuring approx 20m square, within a much larger enclosure containing evidence of MoLRS agriculture. Possible traces of further structures are visible 35m to the N. |
| 67      | 301048 | 965304 | ?Cairn/mound        | Small mound, possible cairn located on W slope of Coc Freiceadain.  |
| 68      | 301444 | 965388 | ?Cairn/mound        | Small mound, possible cairn located on E slope of Conc Freiceadain.   |
| 69      | 302164 | 965623 | ?Hut circle         | Small circular feature, one of four possible hut-circles located within modern peat drainage.   |
| 70      | 302171 | 965611 | ?Hut circle         | Small circular feature, one of four possible hut-circles located within modern peat drainage.   |
| 71      | 301686 | 966288 | ?Hut circle         | Small circular feature within improved field, 35m NE of the W corner of the field.  |
| 72      | 301399 | 966504 | Unroofed building   | Unroofed building approx 13m in length, oriented E/W.   |
| 73      | 301478 | 966510 | Unroofed Building   | Unroofed building approx 17m in length, oriented NW/SE.   |
| 74      | 303316 | 965872 | ?Platform/enclosure | Circular feature, probably a platform or small enclosure, possibly a hut-circle, 18m in diameter.   |
| 75      | 302972 | 965463 | ?Cairn/mound        | Large mound, possibly a cairn, overlain by later rig-and-furrow within a large enclosure; approximately 30m in diameter.  |
| 76      | 303046 | 965460 | Clearance cairn     | Clearance cairn, within a large enclosure containing rig-and-furrow agriculture.  |
| 77      | 303047 | 965473 | Clearance cairn     | Clearance cairn, within a large enclosure containing rig-and-furrow agriculture.  |
| 78      | 303067 | 965485 | Clearance cairn     | Clearance cairn, within a large enclosure containing rig-and-furrow agriculture.  |
| 79      | 302880 | 964966 | Sheep fank          | Modern sheep fank with projecting walls located within forestry plantation.   |
| 80      | 303749 | 964790 | Mound               | Circular mound 25m in diameter, with possible curvilinear bank to the N.  |



## Appendix 1: LiDAR Assessment: New Features (Point)

| Site no | X      | Y      | Class             | Description  |
|---------|--------|--------|-------------------|--|
| 81      | 302284 | 966044 | ?Circular feature | Circular feature, approx 7m in diameter, one of ten similar features within an area of improved agriculture. Character/authenticity uncertain. |
| 82      | 302272 | 966063 | ?Circular feature | Circular feature, approx 7m in diameter, one of ten similar features within an area of improved agriculture. Character/authenticity uncertain. |
| 83      | 302289 | 966072 | ?Circular feature | Circular feature, approx 7m in diameter, one of ten similar features within an area of improved agriculture. Character/authenticity uncertain. |
| 84      | 302296 | 966082 | ?Circular feature | Circular feature, approx 7m in diameter, one of ten similar features within an area of improved agriculture. Character/authenticity uncertain. |
| 85      | 302299 | 966092 | ?Circular feature | Circular feature, approx 7m in diameter, one of ten similar features within an area of improved agriculture. Character/authenticity uncertain. |
| 86      | 302320 | 966065 | ?Circular feature | Circular feature, approx 7m in diameter, one of ten similar features within an area of improved agriculture. Character/authenticity uncertain. |
| 87      | 302330 | 966070 | ?Circular feature | Circular feature, approx 7m in diameter, one of ten similar features within an area of improved agriculture. Character/authenticity uncertain. |
| 88      | 302343 | 966074 | ?Circular feature | Circular feature, approx 7m in diameter, one of ten similar features within an area of improved agriculture. Character/authenticity uncertain. |
| 89      | 302351 | 966068 | ?Circular feature | Circular feature, approx 7m in diameter, one of ten similar features within an area of improved agriculture. Character/authenticity uncertain. |
| 90      | 302350 | 966054 | ?Circular feature | Circular feature, approx 7m in diameter, one of ten similar features within an area of improved agriculture. Character/authenticity uncertain. |
| 91      | 305634 | 965161 | ?Hut circle       | Small circular feature, possible fragmentary hut-circle. Several surrounding linear banks.   |
| 92      | 302028 | 963535 | ?Mound            | Small mound, possible cairn or modern stone clearance.   |
| 93      | 301486 | 963437 | Sheep fank        | Modern circular sheep fank, with associated small enclosure.   |

## Appendix 1: LiDAR Assessment: New Features (Point)

| Site no | X      | Y      | Class                | Description   |
|---------|--------|--------|----------------------|---|
| 94      | 301039 | 963012 | Clearance cairn      | Clearance cairn.  |
| 95      | 301059 | 962963 | Clearance cairn      | Clearance cairn.  |
| 96      | 301070 | 962980 | Clearance cairn      | Clearance cairn.  |
| 97      | 301087 | 962995 | Clearance cairn      | Clearance cairn.  |
| 98      | 301107 | 962989 | Clearance cairn      | Clearance cairn.  |
| 99      | 301097 | 963012 | Clearance cairn      | Clearance cairn.  |
| 100     | 301121 | 963016 | Clearance cairn      | Clearance cairn.  |
| 101     | 301149 | 962993 | Clearance cairn      | Clearance cairn.  |
| 102     | 301155 | 963009 | Clearance cairn      | Clearance cairn.  |
| 103     | 300982 | 962989 | ?Structure/enclosure | Rectilinear enclosure or structure measuring 16m by 21m, associated with traces of enclosures and clearance cairns to the E. Cut by modern peat drainage. |
| 104     | 300586 | 963619 | Hut circle           | Small circular depression c.15m in diameter; possible hut-circle close to modern forestry.  |
| 105     | 300773 | 963565 | Hut circle           | Small circular depression, possible denuded hut-circle.   |
| 106     | 300653 | 963362 | ?Hut circle          | Slight circular depression, possible denuded hut-circle.  |
| 107     | 300866 | 963242 | Clearance cairn      | Clearance cairn   |
| 108     | 300872 | 963231 | Clearance cairn      | Clearance cairn.  |
| 109     | 300860 | 963206 | Clearance cairn      | Clearance cairn.  |
| 110     | 300856 | 963192 | Clearance cairn      | Clearance cairn.  |
| 111     | 300837 | 963183 | Clearance cairn      | Clearance cairn.  |
| 112     | 300829 | 963126 | Clearance cairn      | Clearance cairn.  |
| 113     | 300898 | 963132 | Clearance cairn      | Clearance cairn.  |
| 114     | 300894 | 963202 | Clearance cairn      | Clearance cairn.  |

## Appendix 1: LiDAR Assessment: New Features (Point)

| Site no | X      | Y      | Class                         | Description  |
|---------|--------|--------|-------------------------------|--|
| 115     | 300891 | 963219 | Clearance cairn               | Clearance cairn.   |
| 116     | 300881 | 963202 | Clearance cairn               | Clearance cairn.   |
| 117     | 301303 | 963720 | ?Platform/structure/enclosure | Possible rectilinear enclosure or longhouse structure, measuring approx 30m in length and oriented WNW/ESE. Possibly associated with Duncan's Well, Leans of Shebster (MHG32206) |
| 118     | 301382 | 963479 | ?Cairn/mound                  | Circular mound, possible burnt mound or cairn, 130m ESE of Burn of Shebster cairn (MHG880; ND06SW 9).  |
| 119     | 301175 | 962917 | ?Hut circle                   | Fragmentary circular feature, possible denuded hut-circle overlain by later rig-and-furrow.  |
| 120     | 301144 | 962525 | Sheep fank                    | Modern sheep fank located within forest clearing.  |
| 121     | 302453 | 960734 | Hut circle                    | Possible circular feature detected in bare-earth LiDAR within commercial forestry. Possible fragmentary hut-circle.  |
| 122     | 302761 | 960618 | Sheep fank                    | Modern circular sheep fank.  |
| 123     | 302657 | 961092 | Clearance cairn               | Clearance cairns in area of rig-and-furrow, overlying earlier hut-circles.   |
| 124     | 302634 | 961107 | Clearance cairn               | Clearance cairns in area of rig-and-furrow, overlying earlier hut-circles.   |
| 125     | 302889 | 961261 | Clearance cairn               | Clearance cairns in area of rig-and-furrow, overlying earlier hut-circles.   |
| 126     | 302877 | 961200 | Clearance cairn               | Clearance cairns in area of rig-and-furrow, overlying earlier hut-circles.   |
| 127     | 302922 | 961195 | Clearance cairn               | Clearance cairns in area of rig-and-furrow, overlying earlier hut-circles.   |
| 128     | 302972 | 961203 | Clearance cairn               | Clearance cairns in area of rig-and-furrow, overlying earlier hut-circles.   |
| 129     | 302862 | 960796 | Clearance cairn               | Clearance cairns in area of rig-and-furrow, overlying earlier hut-circles.   |
| 130     | 302910 | 960780 | Clearance cairn               | Clearance cairns in area of rig-and-furrow, overlying earlier hut-circles.   |



## Appendix 1: LiDAR Assessment: New Features (Point)

| Site no    | X      | Y      | Class           | Description  |
|------------|--------|--------|-----------------|--|
| <b>131</b> | 302882 | 960779 | Clearance cairn | Clearance cairns in area of rig-and-furrow, overlying earlier hut-circles.   |
| <b>132</b> | 302903 | 960745 | Clearance cairn | Clearance cairns in area of rig-and-furrow, overlying earlier hut-circles.   |
| <b>133</b> | 302890 | 960742 | Clearance cairn | Clearance cairns in area of rig-and-furrow, overlying earlier hut-circles.   |
| <b>134</b> | 302860 | 960744 | Clearance cairn | Clearance cairns in area of rig-and-furrow, overlying earlier hut-circles.   |
| <b>135</b> | 302920 | 960721 | Clearance cairn | Clearance cairns in area of rig-and-furrow, overlying earlier hut-circles.   |
| <b>136</b> | 302934 | 960682 | Clearance cairn | Clearance cairns in area of rig-and-furrow, overlying earlier hut-circles.   |
| <b>137</b> | 303400 | 961046 | ?Hut circle     | Fragmentary circular feature.  |
| <b>138</b> | 302702 | 961377 | Sheep fank      | Modern circular sheep fank.  |
| <b>139</b> | 304286 | 962040 | Building        | Longhouse structure measuring 32m in length; probable ancillary structures to S and SE, and traces of enclosure walls to NW and W. Probable correct location of Widow's Banks (MHG 17699; ND06SW 148), depicted on OS 1st edition map. |
| <b>140</b> | 305010 | 961464 | Sheep fank      | Modern rectilinear sheep fank, overlying an earlier square enclosure 30m by 27m, located just to the N.  |
| <b>141</b> | 305151 | 962252 | ?Structure/fank | A small square structure located to the N of Forsie Moss settlement (MHG13490).  |
| <b>142</b> | 305316 | 962211 | Sheep fank      | Probable modern sheep fank.  |
| <b>143</b> | 306492 | 962299 | ?Mound/cairn    | Small mound, possible cairn bisected by modern field boundary.   |
| <b>144</b> | 307061 | 961986 | Building        | Bipartite longhouse structure 20m in length oriented NE/SW, with probable ancillary or precursory buildings to the N. Probable correct location of Lieurary farmstead (MHG29216).  |
| <b>145</b> | 307158 | 963724 | ?Mound/cairn    | Small mound or cairn, possibly a hut-circle, located close to other similar features to the N.   |

## Appendix 1: LiDAR Assessment: New Features (Point)

| Site no    | X      | Y      | Class                  | Description  |
|------------|--------|--------|------------------------|--|
| <b>146</b> | 307276 | 963632 | ?Building              | Denuded remains of a building and probable associated enclosures, partially disturbed by a modern farm track and bisected by modern field boundary. Associated traces may be located to the N and S. |
| <b>147</b> | 307114 | 963527 | ?Mound/cairn           | Small mound, possible cairn.   |
| <b>148</b> | 307200 | 962347 | Unroofed building      | Small unroofed building or enclosure, located in improved farmland.  |
| <b>149</b> | 305866 | 960965 | ?Hut circle            | Possible circular feature located within commercial forestry planting, detected on bare-earth LiDAR.   |
| <b>150</b> | 305946 | 960326 | Hut circle             | Probable hut-circle located 175m from the W shore of Loch Calder.  |
| <b>151</b> | 306203 | 959966 | Sheep fank             | Modern circular sheep fank.  |
| <b>152</b> | 306173 | 959951 | ?Mound/cairn           | Small mound, possible cairn.   |
| <b>153</b> | 306191 | 959912 | ?Mound/cairn           | Small mound, possible cairn.   |
| <b>154</b> | 306573 | 959594 | ?Hut circle            | Small circular feature, possible hut-circle, located within forestry and detected in bare-earth LiDAR.   |
| <b>155</b> | 305468 | 959851 | Mound/cairn            | Small mound, possible cairn located within forestry clearing.  |
| <b>156</b> | 307531 | 959074 | Hut circle             | Possible hut circle or cellular building on W shore of Loch Calder.  |
| <b>157</b> | 307545 | 959069 | Hut circle             | Possible hut circle or cellular building on W shore of Loch Calder.  |
| <b>158</b> | 307237 | 959068 | Sheep fank/?Hut circle | Circular feature, probable sheep fank. Appears to overlie enclosure bank, suggesting relatively recent origin.   |
| <b>159</b> | 307260 | 959053 | Unroofed building      | Small, sub-rectangular building 12m in length, oriented NE/SW. Traces of possible enclosure to SW.   |
| <b>160</b> | 307462 | 958985 | Unroofed building      | Unroofed building with three visible compartments. Possible kiln barn at SE end of structure.  |
| <b>161</b> | 308431 | 960404 | ?Mound/cairn           | A circular mound, possibly a cairn, is visible in the SW corner of improved, drained field.  |

## Appendix 1: LiDAR Assessment: New Features (Point)

| Site no | X      | Y      | Class             | Description  |
|---------|--------|--------|-------------------|--|
| 162     | 308205 | 960412 | Mound             | A circular mound, 25m in diameter is visible in improved drained fields.   |
| 163     | 308248 | 960747 | ?Hut circle       | Circular mound, 20m in diameter, with central depression   |
| 164     | 308408 | 960998 | Building          | A ruinous rectangular structure, with associated enclosure   |
| 165     | 308017 | 962546 | Unroofed building | An unroofed structure, with three visible compartments, oriented E-W and 18m in length                                 |
| 166     | 307788 | 962552 | ?Mound/cairn      | A small mound, possibly a cairn, 10m in diameter.  |
| 167     | 307973 | 962767 | ?Hut circle       | Ring bank visible; possibly due to presence of a cattle feeder.  |
| 168     | 307539 | 962354 | ?Cairn            | Small mound, 5m across; possible clearance cairn.  |
| 169     | 304639 | 959680 | Unroofed building | An unroofed building oriented NE/SW, 23m in length with four visible compartments.                                     |
| 170     | 304176 | 958654 | Unroofed building | A small, single compartment structure measuring approx 12m by 5m.  |
| 171     | 304194 | 958507 | Unroofed building | An unroofed bipartite structure, 40m in length and 6m across.  |
| 172     | 304188 | 958297 | Unroofed building | A small, ruinous unroofed structure measuring 11m by 5m.   |
| 173     | 304239 | 958279 | Unroofed building | An unroofed building with two visible compartments, oriented N/S, measuring 19m by 5m.                                 |
| 174     | 304148 | 958153 | Unroofed building | The footings of an ruinous rectangular building with three visible compartments, oriented E/W and measuring 18m by 7m. |
| 175     | 304240 | 958097 | Unroofed building | An unroofed building, oriented E/W and measuring 27m by 5m, with three visible compartments.                           |
| 176     | 303677 | 958043 | Unroofed building | The footings of a ruinous rectangular structure, 21m in length with two visible compartments.                          |
| 177     | 303598 | 958062 | Unroofed building | A rectangular structure with two visible compartments, oriented N/S and 15m in length.                                 |



## Appendix 1: LiDAR Assessment: New Features (Point)

| Site no | X      | Y      | Class           | Description  |
|---------|--------|--------|-----------------|--|
| 178     | 303543 | 958027 | Structure       | Remains of a possible small structure are visible close to an area of rig and furrow.  |
| 179     | 303543 | 958144 | Sheep fank      | Modern sheep fank.   |
| 180     | 303828 | 958276 | ?Structure      | The remains of a possible wall or structure.   |
| 181     | 303426 | 958934 | ?Broch          | A large circular structure, 25m in external diameter, with a wall c.6m thick. Possible broch or monumental roundhouse structure. |
| 182     | 303303 | 959083 | ?Hut circle     | Fragmentary ring bank or hut-circle, 13m in diameter.  |
| 183     | 303642 | 958951 | ?Hut circle     | Circular depression, possible hut-circle.  |
| 184     | 303693 | 959055 | ?Cairn/mound    | Small mound or cairn.  |
| 185     | 303625 | 959061 | ?Cairn/mound    | Small mound or cairn.  |
| 186     | 303628 | 959071 | ?Cairn/mound    | Small mound or cairn.  |
| 187     | 303370 | 959164 | Clearance cairn | Clearance cairn.   |
| 188     | 303366 | 959203 | Clearance cairn | Clearance cairn.   |
| 189     | 303395 | 959190 | Clearance cairn | Clearance cairn.   |
| 190     | 303199 | 959110 | Clearance cairn | Clearance cairn.   |
| 191     | 303189 | 959084 | Clearance cairn | Clearance cairn.   |
| 192     | 303178 | 959121 | Clearance cairn | Clearance cairn.   |
| 193     | 303177 | 959088 | Clearance cairn | Clearance cairn.   |
| 194     | 303135 | 959066 | Clearance cairn | Clearance cairn.   |
| 195     | 303165 | 959235 | Clearance cairn | Clearance cairn.   |
| 196     | 303289 | 959313 | Clearance cairn | Clearance cairn.   |
| 197     | 303302 | 959318 | Clearance cairn | Clearance cairn.   |
| 198     | 303316 | 959304 | Clearance cairn | Clearance cairn.   |

## Appendix 1: LiDAR Assessment: New Features (Point)

| Site no    | X      | Y      | Class               | Description  |
|------------|--------|--------|---------------------|--|
| <b>199</b> | 303336 | 959297 | Clearance cairn     | Clearance cairn.   |
| <b>200</b> | 303362 | 959325 | Clearance cairn     | Clearance cairn.   |
| <b>201</b> | 303319 | 959328 | Clearance cairn     | Clearance cairn.   |
| <b>202</b> | 303334 | 959337 | Clearance cairn     | Clearance cairn.   |
| <b>203</b> | 303364 | 959353 | Clearance cairn     | Clearance cairn.   |
| <b>204</b> | 303235 | 959380 | Clearance cairn     | Clearance cairn.   |
| <b>205</b> | 303301 | 959349 | ?Hut circle         | Circular mound; possible cairn or hut-circle.  |
| <b>206</b> | 303216 | 959310 | Clearance cairn     | Clearance cairn.   |
| <b>207</b> | 303215 | 959340 | Clearance cairn     | Clearance cairn.   |
| <b>208</b> | 303271 | 959441 | Clearance cairn     | Clearance cairn.   |
| <b>209</b> | 303522 | 959219 | ?Cairn/?burnt mound | Fragmentary ring-bank; possible hut-circle or burnt mound.   |
| <b>210</b> | 304724 | 959578 | ?Kiln               | Possible kiln structure, 9m by 5m oriented NNW/SSE.  |
| <b>211</b> | 305395 | 962407 | Building/Structure  | A small, sub-rectangular structure with an annex at the W end, 13m in length.                          |
| <b>212</b> | 305021 | 967592 | Mound/?burnt mound  | Small mound close to a stream, one of a group of possible cairns or burnt mounds.                      |
| <b>213</b> | 306113 | 958291 | Building            | Possible ruinous rectangular structure oriented NW/SE.   |
| <b>214</b> | 303573 | 959868 | Building            | Ruinous rectangular building measuring 20m by 6m, oriented N/S.  |
| <b>215</b> | 302655 | 960423 | Building            | Rectangular longhouse structure with four visible compartments, 25m in length oriented NNW/SSE.        |
| <b>216</b> | 302665 | 961138 | Clearance cairn     | Small clearance cairn, one of several surrounding hut-circle MHG1003.                                  |
| <b>217</b> | 302225 | 961866 | Building            | Ruinous remains of possible rectangular longhouse structure , oriented NE/SW, measuring 24m in length. |

## Appendix 1: LiDAR Assessment: New Features (Point)

| Site no    | X      | Y      | Class                   | Description  |
|------------|--------|--------|-------------------------|--|
| <b>218</b> | 301021 | 963223 | Building                | Possible footings of ruinous longhouse structure, possibly precursor of structures at MHG39578.                        |
| <b>219</b> | 306238 | 958880 | ?Hut circle/mound/cairn | Circular mound, possible remains of a hut circle located in forest ride.   |
| <b>220</b> | 305950 | 961654 | Mound/?cairn            | Square feature, possible cairn or structure.   |
| <b>221</b> | 305983 | 960354 | ?Hut circle             | Fragmentary circular depression; possible hut-circle.  |
| <b>222</b> | 303920 | 963334 | ?Building/bridge        | Possible remains of a building or bridge.  |
| <b>223</b> | 304147 | 962462 | Building                | Small, rectangular structure 16m in length, with two visible compartments.   |
| <b>224</b> | 303188 | 962711 | ?Hut circle             | Small, fragmentary circular depression; possible remains of a hut-circle.  |
| <b>225</b> | 303046 | 962705 | Mound/?cairn            | Large mound; possible cairn.   |
| <b>226</b> | 303116 | 962746 | ?Hut circle             | Small circular depression; possible hut-circle.  |
| <b>227</b> | 303444 | 962344 | Building                | Ruinous remains of a rectangular structure, c.30m in length and oriented NW/SE. Located in modern forestry plantation. |
| <b>228</b> | 305057 | 961071 | Mound/?cairn            | Mound or cairn, located in forestry ride; c.12m in diameter.   |
| <b>229</b> | 305016 | 967563 | Mound/?burnt mound      | Small mound close to a stream, one of a group of possible cairns or burnt mounds.                                      |
| <b>230</b> | 305914 | 961687 | Mound/?cairn            | Small mound close to a stream, one of a group of possible cairns or burnt mounds.                                      |
| <b>231</b> | 303329 | 959576 | Clearance cairn         | Clearance cairn.   |
| <b>232</b> | 303304 | 959459 | Mound/cairn             | Circular mound or cairn, 16m in diameter.  |
| <b>233</b> | 303321 | 959510 | Cairnfield              | Clearance cairn.   |
| <b>234</b> | 303267 | 959608 | Sheep fank              | Modern circular sheep fank.  |
| <b>235</b> | 303193 | 959478 | Clearance cairn         | Clearance cairn.   |
| <b>236</b> | 303219 | 959470 | Clearance cairn         | Clearance cairn.   |



## Appendix 1: LiDAR Assessment: New Features (Point)

| Site no    | X      | Y      | Class                | Description   |
|------------|--------|--------|----------------------|---|
| <b>237</b> | 303212 | 959506 | Clearance cairn      | Clearance cairn.  |
| <b>238</b> | 303315 | 959491 | Clearance cairn      | Clearance cairn.  |
| <b>239</b> | 306079 | 958303 | ?Hut circle          | Fragmentary circular bank; possible remains of a hut-circle.  |
| <b>240</b> | 303297 | 959551 | Clearance cairn      | Clearance cairn.  |
| <b>241</b> | 303345 | 959503 | Clearance cairn      | Clearance cairn.  |
| <b>242</b> | 303404 | 959492 | Clearance cairn      | Clearance cairn.  |
| <b>243</b> | 303342 | 959464 | Clearance cairn      | Clearance cairn.  |
| <b>244</b> | 304576 | 959963 | Unroofed building    | Two-phase, ruinous unroofed building with two visible compartments; 16m in length and oriented NNW/SSE.                                   |
| <b>245</b> | 304464 | 960898 | ?Hut circle          | Ring bank truncated by modern field boundary; probable hut-circle.  |
| <b>246</b> | 305708 | 963861 | ?Structure/Enclosure | Possible structure associated with a rectilinear enclosure at Knock Glass.  |
| <b>247</b> | 300363 | 964887 | ?Hut circle          | Fragmentary remains of a hut-circle, truncated by modern track; possible fourth hut-circle in a row running NW from modern farm building. |
| <b>248</b> | 307021 | 962184 | ?Hut circle          | Circular depression; possible ruinous hut-circle.   |
| <b>249</b> | 307190 | 961794 | Building             | Rectangular structure; possible boat house on Loch Calder.  |
| <b>250</b> | 308159 | 960688 |                      | Circular mound; one of several NW of rectilinear enclosure; possible hut-circle.  |
| <b>251</b> | 307050 | 962122 | Circular features    | A series of circular depressions  possible hut-circles close to MHG973.   |
| <b>252</b> | 308185 | 960735 | ?Hut circle          | Circular feature; possible ruinous hut circle.  |
| <b>253</b> | 308193 | 960696 | ?Hut circle          | Circular bank/depression; possible hut circle.  |
| <b>254</b> | 302160 | 965636 | ?Hut circle          | Circular depression; possible hut-circle.   |

## Appendix 1: LiDAR Assessment: New Features (Point)

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| Site no    | X      | Y      | Class              | Description  |
|------------|--------|--------|--------------------|--|
| <b>255</b> | 305099 | 967591 | Mound/?burnt mound | Small mound close to a stream, one of a group of possible cairns or burnt mounds.  |
| <b>256</b> | 305036 | 967575 | Mound/?burnt mound | Small mound close to a stream, one of a group of possible cairns or burnt mounds.  |
| <b>257</b> | 302148 | 965654 | ?Hut circle        | Circular depression; possible hut-circle.  |
| <b>258</b> | 307497 | 961416 | Building           | Rectangular longhouse stucture with three visible compartments, 38m in length. Remains of a similar stucture 12m to south. |
| <b>259</b> | 303257 | 959522 | Clearance cairn    | Clearance cairn.   |
| <b>260</b> | 303118 | 962714 | ?Hut circle        | Circular depression; possible hut circle.  |

## Appendix 2: LiDAR Assessment: New Features (Polyline)

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| Site no    | X (centre) | Y (centre) | Class          |
|------------|------------|------------|----------------|
| <b>261</b> | 302910     | 962543     | Trackway       |
| <b>262</b> | 303446     | 966061     | Mill Lade      |
| <b>263</b> | 301234     | 964172     | Dyke           |
| <b>264</b> | 301161     | 964237     | ?Enclosure     |
| <b>265</b> | 301331     | 964626     | ?Enclosure     |
| <b>266</b> | 301225     | 964797     | ?Enclosure     |
| <b>267</b> | 301494     | 965536     | ?Enclosure     |
| <b>268</b> | 301654     | 965695     | Enclosure      |
| <b>269</b> | 303149     | 965811     | Enclosure      |
| <b>270</b> | 302933     | 965565     | Enclosure      |
| <b>271</b> | 304854     | 964190     | Dyke           |
| <b>272</b> | 301402     | 963093     | Enclosure/Dyke |
| <b>273</b> | 301064     | 962957     | Enclosure/Dyke |
| <b>274</b> | 300889     | 963083     | Dyke           |
| <b>275</b> | 300823     | 963157     | Dyke           |
| <b>276</b> | 301431     | 962980     | Dyke           |
| <b>277</b> | 301405     | 962928     | Dyke           |
| <b>278</b> | 302712     | 960269     | Dyke           |
| <b>279</b> | 302668     | 960500     | Enclosure      |
| <b>280</b> | 303275     | 960963     | Lade           |
| <b>281</b> | 302916     | 961543     |                |
| <b>282</b> | 302685     | 961713     | Dyke           |



## Appendix 2: LiDAR Assessment: New Features (Polyline)

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| Site no    | X (centre) | Y (centre) | Class              |
|------------|------------|------------|--------------------|
| <b>283</b> | 303811     | 961504     | Dyke               |
| <b>284</b> | 306551     | 961997     | ?Enclosure         |
| <b>285</b> | 306119     | 959669     | Dyke               |
| <b>286</b> | 307542     | 958405     | Dyke               |
| <b>287</b> | 307497     | 958188     | Dyke               |
| <b>288</b> | 303669     | 958218     | Dyke               |
| <b>289</b> | 303608     | 958208     | Dyke               |
| <b>290</b> | 303519     | 958154     | Dyke               |
| <b>291</b> | 303470     | 958376     | Dyke               |
| <b>292</b> | 302989     | 959039     | Bank/boundary wall |
| <b>293</b> | 303140     | 959133     | Bank/boundary wall |
| <b>294</b> | 303134     | 958871     | Wall               |
| <b>295</b> | 303290     | 959357     | Enclosure/wall     |
| <b>296</b> | 303291     | 959504     | Boundary/bank      |
| <b>297</b> | 304437     | 960928     | Bank               |
| <b>298</b> | 304281     | 962058     | Bank               |
| <b>299</b> | 304399     | 962065     | Bank               |
| <b>300</b> | 307059     | 962168     | Bank/enclosure     |
| <b>301</b> | 306026     | 958283     | Bank               |
| <b>302</b> | 306159     | 958294     | Bank               |
| <b>303</b> | 303405     | 959521     | Enclosure          |
| <b>304</b> | 303357     | 959475     | Bank               |

## Appendix 2: LiDAR Assessment: New Features (Polyline)

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| Site no    | X (centre) | Y (centre) | Class     |
|------------|------------|------------|-----------|
| <b>305</b> | 303421     | 959500     | Bank      |
| <b>306</b> | 303674     | 959188     | Enclosure |
| <b>307</b> | 302772     | 960268     | Enclosure |
| <b>308</b> | 302777     | 960187     | Enclosure |
| <b>309</b> | 302674     | 960413     | Enclosure |
| <b>310</b> | 302235     | 961893     | Enclosure |
| <b>311</b> | 304424     | 962075     | Enclosure |
| <b>312</b> | 303212     | 962726     | Enclosure |
| <b>313</b> | 303247     | 962007     | Enclosure |
| <b>314</b> | 305010     | 961500     | Enclosure |

### Appendix 3: LiDAR Assessment: New Features (Polygon)

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| Site no | X (centre) | Y (centre) | Class               |
|---------|------------|------------|---------------------|
| 315     | 299296     | 964891     | Cultivation Area    |
| 316     | 299582     | 966232     | ?Munitions Store    |
| 317     | 300213     | 964696     | ?Enclosure/Mound    |
| 318     | 299702     | 964307     | Sheep Fank          |
| 319     | 299679     | 964314     | Hut Circle          |
| 320     | 301219     | 963092     | Cultivation Area    |
| 321     | 302787     | 968800     | Unroofed Building   |
| 322     | 302664     | 964455     | Cultivation Area    |
| 323     | 302894     | 961261     | Cultivation Area    |
| 324     | 302656     | 960425     | Unroofed Building   |
| 325     | 303685     | 960138     | Unroofed Building   |
| 326     | 303573     | 959865     | Unroofed Building   |
| 327     | 303763     | 959612     | Cultivation Area    |
| 328     | 304148     | 962461     | Unroofed Building   |
| 329     | 304247     | 963203     | Unroofed Building   |
| 330     | 303167     | 963075     | Sheep Fank          |
| 331     | 303623     | 963682     | Rectilinear Feature |
| 332     | 303231     | 964644     | Unroofed Building   |
| 333     | 303558     | 968215     | Unroofed Building   |
| 334     | 303821     | 971148     | Cultivation Area    |
| 335     | 304890     | 970690     | Unroofed Building   |
| 336     | 304244     | 969847     | Munitions Dump      |



### Appendix 3: LiDAR Assessment: New Features (Polygon)

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| Site no | X (centre) | Y (centre) | Class             |
|---------|------------|------------|-------------------|
| 337     | 304176     | 967310     | Cultivation Area  |
| 338     | 305394     | 962408     | Unroofed Building |
| 339     | 306205     | 960092     | Cultivation Area  |
| 340     | 306169     | 961415     | Roofed Building   |
| 341     | 306164     | 961410     | Unroofed Building |
| 342     | 301900     | 969004     | Enclosure         |
| 343     | 300708     | 964479     | Cultivation Area  |
| 344     | 303092     | 965607     | Cultivation Area  |
| 345     | 302456     | 960730     | Enclosure         |
| 346     | 302831     | 960262     | Unroofed building |
| 347     | 302810     | 960266     | Enclosure         |
| 348     | 302782     | 960205     | Enclosure         |
| 349     | 302867     | 960249     | Ridge and furrow  |
| 350     | 302792     | 961491     | Cultivation Area  |
| 351     | 303157     | 958849     | Enclosure         |
| 352     | 303385     | 959506     | Enclosure         |
| 353     | 303281     | 959164     | Cultivation area  |
| 354     | 303665     | 959229     | Enclosure         |
| 355     | 300238     | 964913     | Cultivation area  |
| 356     | 304618     | 959878     | Enclosure         |
| 357     | 304168     | 961300     | Cultivation area  |
| 358     | 304401     | 961913     | Cultivation area  |

### Appendix 3: LiDAR Assessment: New Features (Polygon)

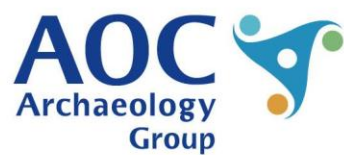
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| Site no | X (centre) | Y (centre) | Class                 |
|---------|------------|------------|-----------------------|
| 359     | 305945     | 961659     | Unroofed Building     |
| 360     | 306907     | 963933     | Unroofed Building     |
| 361     | 305455     | 966423     | Munitions Dump        |
| 362     | 304720     | 967451     | Rectilinear Enclosure |
| 363     | 307200     | 963834     | Cultivation Area      |
| 364     | 307042     | 963838     | Cultivation Area      |
| 365     | 307121     | 963788     | Cultivation Area      |
| 366     | 307716     | 962328     | Cultivation Area      |
| 367     | 307986     | 961147     | Quarry                |
| 368     | 307645     | 958669     | Enclosure             |
| 369     | 307642     | 958673     | Enclosure             |
| 370     | 307528     | 959303     | Rectilinear Enclosure |
| 371     | 300616     | 964331     | Roofed Building       |
| 372     | 300389     | 965672     | ?Munitions Dump       |
| 373     | 302048     | 969912     | Anti Aircraft Battery |
| 374     | 301438     | 966874     | Unroofed Building     |
| 375     | 301442     | 966813     | Unroofed Building     |
| 376     | 301638     | 964752     | Enclosure             |
| 377     | 301480     | 964860     | Enclosure             |
| 378     | 302642     | 960436     | Enclosure             |
| 379     | 302621     | 960637     | Cultivation Area      |
| 380     | 302993     | 960845     | Cultivation Area      |

### Appendix 3: LiDAR Assessment: New Features (Polygon)

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| Site no    | X (centre) | Y (centre) | Class                 |
|------------|------------|------------|-----------------------|
| <b>381</b> | 303094     | 961142     | Cultivation Area      |
| <b>382</b> | 303396     | 961385     | Enclosure             |
| <b>383</b> | 304413     | 962090     | Enclosure             |
| <b>384</b> | 304215     | 962390     | Cultivation Area      |
| <b>385</b> | 303208     | 960280     | Unroofed Building     |
| <b>386</b> | 303572     | 966304     | Mill Pond             |
| <b>387</b> | 303456     | 965806     | Mill Pond             |
| <b>388</b> | 305624     | 966653     | Quarry                |
| <b>389</b> | 302242     | 968029     | Rectilinear Enclosure |
| <b>390</b> | 307275     | 963634     | ?Enclosure            |
| <b>391</b> | 308399     | 961010     | Enclosure             |
| <b>392</b> | 304665     | 959641     | Enclosure             |
| <b>393</b> | 303580     | 958084     | Enclosure             |
| <b>394</b> | 303743     | 958106     | Cultivation Area      |



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