Burn of Whilk Windfarm, Caithness LiDAR Survey

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Burn of Whilk Windfarm

Development Boundary LiDAR Assessment

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Abstract

In mitigation for the visual impact on the archaeological landscape surrounding a windfarm development at Burn of Whilk, 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. 79 possible sites, previously unlisted in the Highland Council Historic Environment Record, were recorded.

Introduction and Background

- In accordance with Planning Condition 16 of the Burn of Whilk windfarm development, a LiDAR survey was undertaken of 3200 hectares to the east of the proposed windfarm, comprising the area surrounding the Loch of Yarrows and encompassing the terrain surrounding Thrumster in the north and Blackness and Mid Clyth in the south. The area is exceptionally rich in archaeology, and the Yarrows area constitutes one of the densest concentrations of well-preserved prehistoric archaeology in northern Scotland.
- 2. LiDAR was proposed as the most effective way of recording this sensitive archaeological area in advance of the visual impact caused by the erection of wind turbines. Condition 16 of the development planning consent stipulated that this survey be carried out in advance of construction:
- 3. "Prior to the commencement of development but after tree felling a LiDAR laser scanning survey will be undertaken to ensure that the archaeological landscape that is to be impacted by the development is preserved by record. The area to be surveyed shall include the application area and the archaeological landscapes of Loch of Yarrows and Warehouse Hill. The LiDAR survey shall be professionally interrogated and analysed with the core areas subject to ground-truthing. The results of the survey and findings shall be made fit for public publication and dissemination and shall be lodged with the Highland Historic Environment Record."
- 4. The aim of the survey, therefore, was to produce a detailed record of the impacted area, and derive from the resulting data products suitable for the presentation and interpretation of the archaeology of the area. The survey furthermore aimed to enhance and build upon the archaeological record of the area, providing a detailed and accurate tool for future heritage resource management.
- 5. Condition 16 specifies that the results of the interrogation of the LiDAR data be ground truthed. Aside from the verification of features identified within the development area (see below), no ground truthing work has been carried out. This work will be carried out alongside fulfilment of planning Condition 23. As such, this report comprises the results of the office-based processing and interrogation of the LiDAR data, and the production of data formats suitable for use in online education and outreach products.
- 6. The afforested portions of the development area were excluded from the LiDAR survey with the agreement of the Highland Council archaeologist, since it was agreed that the aerial survey would be of limited use in penetrating such thick plantation, and that the equivalent area would be allocated elsewhere. Deep forestry ploughing is known to be extremely destructive to archaeology and is likely to have destroyed virtually all surviving remains. The density of conifer plantation, furthermore, limits the achievable penetration of airborne LiDAR, so that the chances of detecting archaeological remains within the plantation were negligible, even after removal of the forestry. The plantation was fieldwalked prior to any disturbance, and will be surveyed again following the felling of the trees; as such, this area has received adequate archaeological survey coverage.

Character of the Study Area

7. The area surveyed using LiDAR comprised 32 square kilometres, comprising landscape of varied character. To the north and south of the study area there are substantial areas of improved ground primarily used for pasture. For the most part, however, the study area included upland moorland areas, comprising areas of deep blanket peat. The effect of peat harvesting on the landscape surrounding Yarrows and Whilk is very evident in the LiDAR data, and scars from peat cutting dominate the upland peat areas. The predominance of peat in the surveyed area means that many sites may be buried by peat growth and thick heather coverage, and therefore undetectable by LiDAR. However, extensive remains of prehistoric settlement and agriculture as well as remains relating to the historic centuries have been documented by the survey.



Figure 1: Study area, location map.

Previous Survey

8. The Yarrows area is one of the most completely recorded areas of Caithness, having been the focus of a campaign of field survey by the Royal Commission on Ancient and Historical Monuments of Scotland in 2004 (RCAHMS 2004:142). The RCAHMS carried out a systematic survey of the Yarrows area, so that a large proportion of the visible monuments in the area were already recorded. The RCAHMS survey dataset was acquired for use in the analysis of the LiDAR dataset, and the two surveys cross checked against one another.

Production of the LiDAR datasets

Introduction to LiDAR

9. 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.



Figure 2: General view of the full LiDAR dataset.

10. 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 ±100 to 150mm.

11. 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.

Acquisition

12. The Burn of Whilk 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' digital terrain model (DTM) at 1m resolution.

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

Table 1: Specifications of the scanning system used

Data processing procedure

13. The raw data received from Fugro BKS was processed into two primary datasets. These comprised a 1m DTM based on the 1m ASCII dataset. In addition to the 1m DTM dataset, a higher resolution elevation model was produced using the raw, unfiltered 7 points per square metre DSM (digital surface model) 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.

14. As outlined above, the aim of the 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. It is acknowledged at this stage that LiDAR data allows the possibility for many different types of detailed analysis and re-processing (see e.g. Challis et al 2011; Kokalj et al *forthcoming*), this indepth analysis is considered beyond the core requirement of the current survey and must await further research using the LiDAR data (see *Analysis of the Datasets*, below).

Analytical Hillshading

15. It is accepted that LiDAR datasets require analysis using a range of techniques in order to ensure the extraction of the maximum number of features. Theoretically, each square kilometre of the surveyed area would need to be interrogated using multiple hillshading surfaces, using a combination of lighting angles and altitudes to ensure features masked by being aligned to the lighting direction were detected (see discussion by EH 2010). Production of hillshade surfaces for high-resolution datasets is an intensive process, however, and could not practically be undertaken for all areas of the study zone. Experience gained in the detection of new archaeological features during the Baillie Hill LiDAR survey in northern Caithness (Cavers 2012) showed, however, that use of the Swiss hillshading technique, whereby multiple lighting directions are combined to allow illumination of terrain from several angles simultaneously gives a good compromise of speed and visibility of archaeological features. The Swiss-style composite hillshade dataset was used for the interrogation of each square kilometre of the survey area, with alternative hillshades produced for small areas where archaeological features were detected.



Figure 3: Location of newly identified sites in relation to sites identified by RCAHMS survey.



Figure 4: Location of newly identified sites in relation to Scheduled Ancient Monuments.

Documentation of Known archaeological Sites: the Yarrows landscape

Representation of Known Archaeology

- 16. The LiDAR provides an unparalleled record of the archaeology of the study area in its landscape context. New images of the Scheduled Ancient Monuments (SAMs) of the area have been produced, and the key monuments of Warehouse Hill, Garrywhin, Cairn of Get and the cairns of South Yarrows have been recorded in detail (see figures A1.9, A1.13, A1.19, A1.23 and A1.27 Appendix 1).
- 17. The LiDAR dataset greatly enhances the extents of the known archaeology in the Yarrows area, and many of the enclosures and field systems recorded by the RCAHMS can be seen to be more extensive than originally recorded. The following sections describe the identification of new features in the LiDAR data, and the assessment of the redline boundary of the windfarm prior to development. The RCAHMS will receive copies of the full results of this survey, with which to enhance the existing record.



Figure 5: General view of Yarrows South, showing the broch, chambered cairns and hut circles.

Analysis of the Datasets

Assessment of the Development Area

- 18. For the majority of the development area, no archaeological features are visible, aside from those recorded by the RCAHMS survey (see Maps 1 to 7, Appendix 4).
- 19. There, however, are several archaeological sites located within the boundary of the Burn of Whilk windfarm. These have been recorded previously, however, and were taken into account during the EIA stage of the planning application (Fouracre 2010). The farmstead at Whilk (NMRS: ND24SE 88 and ND24SE 90) will be directly impacted by the access track as designed. However, Condition 15 of the planning permission requires that the access track be microsited to enable preservation *in situ* of these sites. As such the development plans have taken this into account and that the sites will be avoided during construction (see Map 8, Appendix 4).
- 20. A single possible feature was detected in the LiDAR data that was deemed worthy of inspection on the ground, to ensure that the access track would not disturb unrecorded archaeology. A group of small circular features (Map 9, Appendix 4) located at ND 3004 3995 showed possible hut-circles or similar features; cross checks against available aerial photography were inconclusive. These features were visited on 9th May 2012, and were determined to be of recent agricultural origin, most likely stands for cattle feeders (see Plate 1 and 2).

Interrogation of the LiDAR data

- 21. The LiDAR data was systematically searched using a 1km grid, to ensure the full data set was covered.
- 22. A total of 79 newly-identified possible sites were identified in the LiDAR data (see Appendix 2). The majority of these were located outside of the areas surveyed by the RCAHMS, although several possibilities were identified within their study areas. In a few instances, sites recorded by the RCAHMS could be extended on the basis of the LiDAR evidence, and in a few places additional hutcircles were located close to examples recorded by the RCAHMS.
- 23. The character of the evidence in the LiDAR dataset is similar to that of the data collected during the Baillie windfarm survey, and is dominated by evidence from the later prehistoric period (mainly hut-circles, cairns and enclosures) and from the post-medieval period (in the form of long houses, enclosures and field systems). The following discussion refers to the sites listed in the database found in Appendix 2 and illustrated in Appendix 3.

Prehistoric sites

- 24. The following sections refer to the maps of each site reproduced in Appendix 3.
- 25. For the most part, the RCAHMS survey of the Yarrows landscape appears to have recorded the majority of prehistoric monuments visible at ground level. Exceptions include several ring banks,

possible hut circles, such as Site 14 which is located within a square enclosure. Probable examples of hut circles are Sites 29 and 30, circular ring-banks located close to the cliffs at Whaligoe, while one of the clearest hut circles is at Site 25, located close to the possible broch at Ulbster School. At the Warehouse fort, the RCAHMS surveyors had recorded the presence of a hut circle, while the LiDAR data suggests the presence of at least one additional example (Sites 33 and 34). Many examples are fragmentary or too poorly defined to allow confident identification, such as the two circular features close to Warehouse Hill broch (Sites 36 and 37), and a small oval platform located in improved fields to the north of Yarrows (Site 8). Other ring-bank features, such as Sites 57 and 58 are clearly visible, but are somewhat small for hut-circles at around 8-9m in diameter.

- 26. Some 22 'circular features' were catalogued in the dataset. These comprise sites that could not be confidently categorised, but clearly comprised archaeological monuments. Of these 22 sites, 15 are noted as possible hut circles, this being the most likely identification. However, other examples include an intriguing possible ring-ditch feature (Site 28). This feature is unlike other hut-circles in the area and, while it could represent a heavily robbed example, could equally be evidence of a ring-ditch house more closely related to those found further south and hitherto unknown in Caithness. Although ground observation may help to confirm the validity of this feature, it is likely that only excavation will confirm it precise character.
- 27. Other prehistoric features identified within the study area include a probable burnt mound at Site 38, visible as a crescentic mound located close to a burn on Warehouse Hill. In other areas, as at Sites 23 and 24, enclosures and field boundaries seem most probably associated with prehistoric agriculture, although this may only be proven through field investigation.
- 28. Of particular interest is the possible identification of a chambered cairn at Site 53. Although the feature is faintly represented in the data, the presence of a mound with adjoining elongated rectangular mound is similar in form to other cairns documented by the Baillie Hill LiDAR survey.



Figure 6: View of possible cairn, Site 53.

Historic Sites

- 29. Evidence for the historic period is also well represented in the LiDAR dataset. For the most part, and characteristically of the Caithness archaeological record, this is represented by post-medieval farmsteads and related structures, agricultural remains and enclosures. Again, the majority of these were mapped by the RCAHMS survey of Yarrows, although significant extensions to some of the farmsteads, field systems and enclosures have been documented by the LiDAR.
- 30. 12 new unroofed buildings have been documented, as at Sites 65 and 73, where ruinous multicompartment longhouses are visible in association with enclosures and field banks. Such structures are very numerous throughout Caithness and northern Scotland more widely (RCAHMS and Historic Scotland 2002); dating is imprecise since the building form was very long-lived, but most were probably occupied in the 18th and 19th centuries. Other structures associated with the postmedieval centuries include Site 52, a small rectangular building with a circular division at its west end, possibly representing a kiln barn. Site 70, a small rectangular building located close to a possible canalised burn, may be the remains of a mill.
- 31. Evidence for historic agriculture is abundant throughout the dataset, and there are extensive areas of rig and furrow, and many forms of field boundary and enclosures. Some of the best preserved areas of rig and furrow are found along the coastal zones, where broad 'flattened S-shaped' field systems are visible, as at Sites 27 and 74.



Figure 7: View of probable longhouse structure of medieval or later date, Site 65.

Production of archive and presentation datasets

32. The data derived from the Burn of Whilk LiDAR survey has been compiled into data formats suitable for easy accession to the Highland Historic Environment Record. All newly identified features have been created as GIS shapefiles in point, line and polygon format. Terrain models and hillshade images have been produced in high-resolution image formats, suitable for translation to web-friendly formats (e.g. Figure 6). The results of this survey will be used to illustrate educational and interpretation material to be prepared in fulfilment of Condition 23. The full archive is to be deposited with the National Monuments Record for Scotland and offered to the Archaeology Data Service.

Fulfilment of the planning condition

33. This document describes the production of the LiDAR and interpreted GIS datasets that fulfil planning Condition 16 on the Burn of Whilk windfarm. Detailed terrain models of the impacted area that offer the best pre-development record of the area currently possible have been produced. The LiDAR dataset constitutes an unparalleled tool for the inspection and study of the archaeological remains of the Yarrows area, providing the basis for the production of interpretation materials and for the future study of the archaeology of eastern Caithness. As stated in the introduction, ground truthing of the newly-identified features found during the analysis of the data will be carried out during the fulfilment of planning Condition 23.



Figure 8: 3D view of Garrywhin fort.

Glossary of Terms

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

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Burn of Whilk Windfarm LiDAR Survey

Appendix 1: Scheduled Ancient Monuments











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Burn of Whilk Windfarm LiDAR Survey

Appendix 2: Newly-identified sites, catalogue

Site no	x	Y	Class	Description
	220420	045608	Maurad	Circular mound 27m in diameter
1	330430	945698	wound	Circular mound 27m in diameter.
2	331185	945576	Enclosure (possible)	Possible enclosure formed by ditch on north bank of burn.
3	332140	945837	Enclosure, field system	Small enclosure, possible building, 15m by 12m, with associated field system. Probable correct NGR of MHG48275.
4	332184	945623	Field system	Area of rig and furrow, possible associated banks and enclosures to SW.
5	332097	945553	Enclosure	Rectilinear enclosure, associated with field banks AOC 4.
6	333148	945760	Mound	Mound, possible burnt mound or cairn.
7	330987	945471	Enclosure	Square enclosure, 40m square with small compartment in SW corner. Mound, possible clearance in NW corner.
8	331707	944682	Platform, hut circle (possible)	Oval platform, posible hut-circle.
9	331586	944694	Clearance cairns; cairn field (possible)	At least 13 small mounds, probably clearance cairns.
10	331723	944384	Clearance cairns, cairn field (possible)	At least 12 small mounds, probably clearance cairns.
11	333244	943895	Structure (possible)	A rectangular mound, possibly the remains of a structure measuring 23m by 12m.
12	333946	943779	Enclosure (possible)	Remains of a rectilinear enclosure, 63m by 43m.
13	333990	943623	Enclosure (possible)	Possible remains of an enclosure, 65m N/S; extent beyond LiDAR survey.
14	333241	943460	Hut circle (possible)	Small circular depression, within rectilinear enclosure
15	333253	943406	Banks, enclosure	Linear banks forming a right angle; probable remains of SE corner of enclosure possibly associated with MHG 48317.
16	331057	943071	Hut circle (possible)	A circular platform or hollow, c.13m in diameter, similar to nearby hut-circle MHG2223, RCAHMS NUMLINK 9061.

Site no	х		Y	Class	Description
17	3	30648	943098	Banks, enclosure	Possible field banks associated with agricultural remains to S.
18	3	30542	944289	Mound, circular feature	A circular mound, 13m in diameter.
19	3	33424	942396	Bank/wall	Bank or field boundary running NE/SW.
20	3	33092	942522	Bank	Linear field boundary/bank running NE/SW.
21	3	33164	942560	Circular feature (possible)	Circular feature, possible hut circle.
22	3	31711	941500	Circular feature, hut circle (possible)	Small penannular feature in improved ground, possible denuded hut-circle.
23	3	32158	941620	Bank, field boundary	Ruinous banks, probable field boundaries running N/S, E/W.
24	3	32052	941606	Circular feature, mound	Circular mound, 10m in diameter.
25	3	32297	941540	Hut circle	Annular bank 17m in diameter; probable hut circle.
26	3	33099	941557	Bank	Curvilinear field bank, running SW/NE.
27	3	33814	941692	Rig and furrow	Area of rig and furrow.
28	3	32671	941419	Circular feature, ring ditch (possible)	A circular ring-ditch, 17m in diameter, visible in improved fields.
29	3	32735	941031	Circular feature, hut circle (possible)	Annular ring-bank, 12m in diameter, possible hut circle.
30	3	32723	940996	Circular feature, hut- circle (possible)	Annular ring-bank, possible hut-circle.
31	3	32618	941087	Mound	Circular mound, possible cairn.
32	3	31244	941245	Hut circle	Annular ring-bank, 11m in diameter, probable hut circle.
33	3	31257	941261	Circular feature, hut- circle (possible)	Circular feature, similar to hut-circles to SW identified by RCAHMS; possible hut circle.

Site no	х		Y	Class	Description
34		331271	941267	Circular feature, hut circle (possible)	Circular feature, similar to hut circles to SW identified by RCAHMS, possible hut circle.
35		330262	941236	Circular feature; hut circle (possible)	Penannular ring bank within denuded enclosure; possible hut circle.
36		330235	941231	Circular feature; hut circle (possible)	Denuded ring-bank, possible hut circle.
37		330276	941226	Bank; enclosure	Denuded field boundary or enclosure.
38		330402	941437	Burnt mound (possible)	Crescentic mound, 13m across; possible burnt mound.
39		330217	941495	Circular feature, hut circle (possible)	Irregular annular ring-bank, possible hut circle.
40		330744	940737	Circular feature, hut circle (possible)	Circular feature, c.10m in diameter; possible hut circle.
41		330746	940767	Circular feature, hut circle (possible)	Circular feature, c.10m in diameter; possible hut circle.
42		330772	940791	Circular feature, hut circle (possible)	Circular feature, c.10m in diameter; possible hut circle.
43		330792	940767	Clearance cairn; cairn field (possible)	Small mound, possible clearance cairn.
44		330784	940748	Clearance cairn	Small mound, possible clearance cairn.
45		330779	940852	Circular feature, hut circle (possible)	Faint trace of a ring bank, c.10m in diameter; possible hut circle.
46		331218	940855	Circular feature	Circular feature, c.8m in diameter, possible denuded hut circle or pen.
47		331245	940845	Circular feature	Circular feature, c.12m in diameter, possible denuded enclosure.
48		331383	940569	Bank, field boundary	Bank, field boundary.
49		332500	940672	Circular feature, hut circle (possible)	Ring bank, c.12m in diameter. Possible hut circle.

Site no	x	Y	Class	Description
50	331236	940316	Circular feature, platform, enclosure (possible)	A circular feature, possibly an enclosure or platform, c.30m in diameter.
51	331266	940388	Mound, cairn (possible)	A small circular mound, possibly a cairn.
52	329396	939613	Building; kiln barn (possible)	A bipartite structure, oriented NW/SE measuring c.13m in length, close to recorded enclosure. Circular division suggests possible kiln barn.
53	331175	939921	Cairn (possible)	An elongated mound, oriented NW/SE and measuring 24m by 13m. Possible cairn.
54	331044	939972	Bank, field boundary	Low linear earthwork, probable field boundary.
55	331302	939812	Enclosure, field system (possible)	A trapezoidal enclosure, 42m by 34m, with traces of rig and furrow within.
56	331364	939859	Bank, wall	Slight linear earthwork, 63m in length running E/W.
57	330582	939451	Circular feature, hut circle (possible)	Very ephemeral remains of a circular ring-bank, possibly a hut circle, 9m in diameter.
58	330588	939425	Circular feature, hut circle (possible)	Very ephemeral remains of a circular ring-bank, possibly a hut circle, 9m in diameter.
59	329511	939101	Circular feature	Traces of a circular feature, c.10m in diameter.
60	329241	939094	Building	An unroofed bipartite structure, oriented N/S and measuring 14m in length. A D-shaped enclosure adjoins the structure to the E.
61	329142	939041	Building	Ruinous remains of a longhouse, oriented ENE/WSW and 24m in length. Traces of further outbuildings to the S, and an associated enclosure to the N.
62	328724	938773	Bank, field boundary	Curvilinear bank, possibly remnants of an enclosure.
63	328849	938804	Enclosure	Rectilinear enclosure, 18m by 20m; possible traces of structures or subdivisions in NW and SW corners.
64	329134	938677	Building	Ruinous longhouse with three visible compartments, oriented E/W and measuring 21m in length.

Site no Х γ Class Description 65 Ruinous longhouse structure with five visible 329581 938752 Building compartments, oriented E/W and measuring 29m in length. 66 330409 938224 Enclosure (possible) Traces of nearly-square enclosure, 60m by 65m close to a coastal geo (promontory). The banks are low but c.7m in width. Possible traces of structures or rubble within the interior. 67 A ruinous longhouse with at least three visible 328502 938422 Building compartments, 29m in length and oriented E/W. A small enclosure or yard is visible to the S. 68 328432 938334 Building (possible) A small rectangular structure, oriented E/W and c.14m in length. 69 328110 938380 A ruinous bipartite longhouse, oriented E/W and 18m Building in diameter. An associated enclosure or yard is visible to the S. 70 328501 937643 Building, mill (possible) A small rectangular building, 14m in length and oriented E/W. Location close to a stream raises possibility that the structure is a mill. 71 328584 937682 Ruinous longhouse, oriented WSW/ENE and Buildings, enclosure measuring 30m in length; at least three compartments are visible. To the SW, a smaller bipartite structure, 13m in length and oriented N/S. A small yard or enclosure is located 5m to the NW. 72 Ruinous longhouse, oriented NW/SE and 25m in 328767 937681 Building length. At least three compartments are visible. A small yard or enclosure is located to the SW. 73 Ruinous longhouse, oriented NW/SE and 30m in 328994 937544 Building length. Four compartments are visible. 74 Area of rig and furrow, with flattened-S shape 329802 937236 **Rig and furrow** arrangement to the N and perpendicular systems to the S. 75 Two small ruinous rectangular buildings, oriented 329026 937186 **Buildings** roughly E/W. Larger building is 21m in length, with two visible partitions. The smaller, to the S, is 13m in length. 76 Rectangular building, oriented WSW/ENE and 21m in 328331 937418 Building length. Three compartments are visible.

Site no	x		Y	Class	Description
77	3	328197	937347	Building	Small bipartite ruinous building, oriented WSW/ENE and 19m in length.
78	3	330310	939579	Building	A longhouse with three visible compartments, oriented WSW/ENE, and 26m in length.
79	3	330377	939540	Structure/enclosure	A square structure or enclosure, measuring 10m by 10m.

Burn of Whilk Windfarm LiDAR Survey

Appendix 3: Newly-identified sites, LiDAR Images









MHG48275.

945800









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corner.





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OS Coordinates: 333990 , 943623

Possible remains of an enclosure, 65m N/S; extent beyond LiDAR survey.


943500































Site No.:



OS Coordinates: 332297 , 941540 Site Class: Hut circle

Annular bank 17m in diameter; probable hut circle.





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Site Class: Circular feature; hut circle (possible)

OS Coordinates: 330262 , 941236

Penannular ring bank within denuded enclosure; possible hut circle.



















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940800






































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the structure to the E.





Ruinous remains of a longhouse, oriented ENE/WSW and 24m in length. Traces of further outbuildings to the S, and an associated enclosure to the N.

939000















OS Coordinates: 330409 , 938224

Traces of nearly-square enclosure, 60m by 65m close to a coastal geo (promontory). The banks are low but c.7m in width. Possible traces of structures or rubble within the interior.

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Ruinous longhouse, oriented WSW/ENE and measuring 30m in length; at least three compartments are visible. To the SW, a smaller bipartite structure, 13m in length and oriented N/S. A small yard or enclosure is located 5m to the NW.











visible partitions. The smaller, to the S, is 13m in length.













939500

Burn of Whilk Windfarm LiDAR Survey

Appendix 4: Development Boundary, LiDAR Assessment






















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