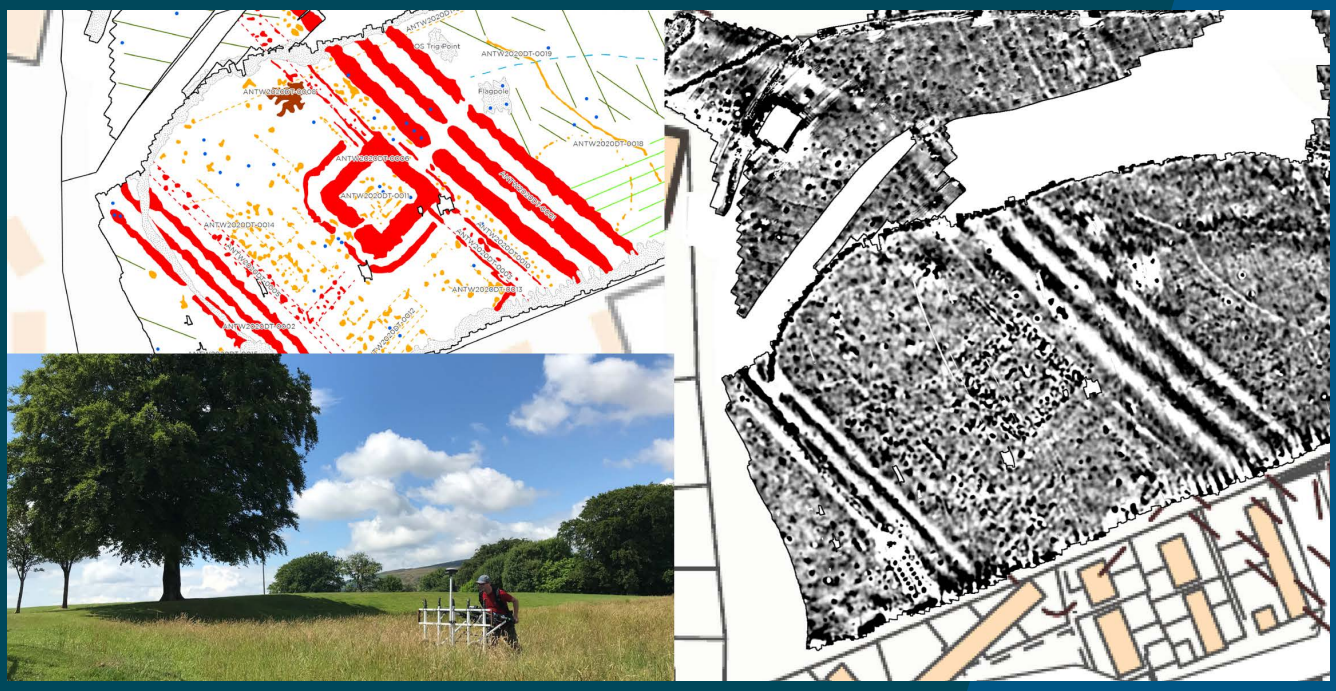
HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

ANTONINE WALL DUNTOCHER

GEOPHYSICAL SURVEY REPORT



HES PROJECT NUMBER: ANTW2020DT
NGR: NS 49513 72699
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EXECUTIVE SUMMARY

Historic Environment Scotland (HES) undertook geophysical (gradiometer and electro-magnetic) survey at Golden Hill Park, Duntocher, West Dunbartonshire, Scotland, G81 6BT. The survey forms part of the Antonine Wall Geophysical Survey project, which aims to address management and research questions relating to the Antonine frontier, by investigating the extent and significance of sub-surface archaeological remains at various locations within the World Heritage Site.

The fieldwork was conducted between 12th and 16th July 2021. In total 3.9 hectares were surveyed with a Sensys MXPDA gradiometer, and 0.21 hectares were surveyed using a CMD Mini Explorer electro-magnetic device. The geophysical surveys produced good quality results which give a high level of confidence that the methodology and survey strategy were appropriate to assess the archaeological potential of the area.

The survey identified an undated possible enclosure which has the potential to pre-date the Roman occupation of the site.

Survey within the fortlet, fort and annexe has identified areas likely to contain internal structures. The detail, layout and function of these structures is, however, is not clear.

The most significant outcome of the survey relates to the triple-ditch system to the northeast of the fort. The survey has confirmed the existence of this ditch system, which at present is a unique feature along the line of the Antonine Wall. The ditch system appears to correspond to the location of the fort and annexe, and does not extend beyond them. The construction of the fort and annexe are currently understood to be contemporary events, and this evidence indicates that the construction of the ditch system was also part of this phase of activity. If this is the case, this indicates that the fortlet was superseded by an overlying fort and that the triple ditch system was constructed at or around the same time, with the fort sub-divided into fort and annexe at a later date. This would support Swan's reinterpretation of the sequence of this site.

The fact that the causeways across the ditch system relate to the northeastern gateway of the fortlet shows that the ditches were dug when the fortlet's gateway was still in use. As no additional causeways have been identified, the fort does not appear to have been provided with any further gateways. If the fortlet gate remained the main entrance for the fort, direct access to the smaller fort envisaged in the sequence proposed by Robertson would not be possible, providing further support for the construction of a larger fort and sub-division to create the annexe at a later date.

No extra-mural activity of Roman date has been identified in the survey area, though this cannot be fully assessed as many of the areas likely to contain this type of feature were not surveyable.

Traces of post-medieval activity in the form of rig and furrow cultivation and field boundaries have also been identified during the survey.

This document has been prepared in accordance with HES' Terrestrial Geophysical Survey Standard Operating Procedures v1.0			
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Author:	Dr Nick Hannon	Date:	09/05/2022
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1.0 - INTRODUCTION

Historic Environment Scotland (HES) undertook geophysical (gradiometer and electro-magnetic) survey at Golden Hill Park, Duntocher, West Dunbartonshire, Scotland, G81 6BT to investigate the extent and significance of potential sub-surface archaeological features within the survey area. The survey was conducted between 12th and 16th July 2021, and forms part of the Antonine Wall Geophysical Survey project, which aims to answer a range of management and research questions relating to the Antonine Wall.

2.0 – PROJECT BACKGROUND & AIMS

Survey at Golden Hill Park, Duntocher, was undertaken to address research questions highlighted in the Scottish Archaeological Research Framework (ScARF 2021) and the Antonine Wall Management plans (HES 2007 & 2014), within the framework of HES' geophysical survey programme (HES 2020a). Golden Hill Park is an area of parkland straddling the recorded line of the Antonine Wall. It also contains the remains of Duntocher fortlet and fort, a bathhouse and a stretch of the Antonine Wall. The survey forms part of a larger programme of geophysical survey within the World Heritage Site. This survey report is intended to be read alongside the survey campaign's project proposal document (HES 2020a).

Geophysical survey of Golden Hill Park, Duntocher, had two aims. Firstly, to identify any previously unknown archaeological, or potentially archaeological, anomalies, and secondly to gain further information about previously identified archaeological features. Beyond these general aims, the survey intended to address the following specific questions:

- Can the relationship between the fortlet, fort and Antonine Wall at Golden Hill Park be better understood by conducting a survey at a higher resolution than previous work at the site? (As per the forthcoming Antonine Wall Management Plan).
- Can the internal layout of the fort and fortlet be established?
- Can the fort's southern gateway be located?
- Can the arrangement of ditches to the northeast of the fort be confirmed? (ScARF research question b).
- Can any traces of extra-mural settlement between the fort and bathhouse be identified? (As per the forthcoming Management Plan).
- Can any further details about the bathhouse be established? (As per the forthcoming Management Plan).

The survey results could lead to the creation of new entries, or the amendment of existing entries in the National Record of the Historic Environment, and/or could inform future review of the designated area under the 1979 Ancient Monuments and Archaeological Areas Act.

3.0 – SITE LOCATION & DESCRIPTION

Duntocher fortlet and fort are located in an area of municipal parkland, 400m east of the centre of Duntocher, West Dunbartonshire, Scotland (Figure 1).

The survey area (centred upon NS 49513 72699) covers a total of 5.4 hectares. It occupies the top of a roughly circular hill which reaches a height of 84m AOD at its centre, dropping to around 65m AOD at its northern, southern and western edges (Figure 2).

The solid geology (Figure 3) is recorded as Lawmuir Formation, with a band of Holybush Limestone. This is overlain with superficial deposits of Devensian Till – Diamicton (BGS 2021). The site's soil type is recorded as Built-up land (Scotland's Soils 2021).

The survey area is comprised of a three land parcels (Figure 2), they are:

- DT01 – An irregularly shaped 2.99 hectare land parcel containing an area of open grassed land covering the south side of Golden Hill Park. Isolated areas of tree cover and a child's play area prevented survey in these areas (Images 1, 2, 3 & 4). It is bounded to the north by a line of trees and a path, to the south by the rear property boundaries of Stewart Drive, to the west by the rear property boundaries of Roman Road and to the east by Golden Hill Park Bowling Club. The land parcel is in the ownership of West Dunbartonshire Council and contains part of scheduled monument SM7070 and the Antonine Wall World Heritage Site.
- DT02 – An irregularly shaped 1.3 hectare land parcel containing an area of open grassed land covering the northwest corner of Golden Hill Park. Isolated areas of tree cover, a fenced section of Antonine Wall base and an area containing a War Memorial prevented survey in these areas (Images 5 & 6). The land parcel is bounded to the north by Duntocher Burn, to the west by the rear property boundary of Trinity Parish Church and to the south and east by a line of trees. This land parcel is in the ownership of West Dunbartonshire Council and contains part of scheduled monument SM7070 and the Antonine Wall World Heritage Site.
- DT03 – An irregularly shaped 1.12 hectare land parcel containing an area of open grassed land covering the northeast corner of Golden Hill Park. The land parcel is bounded to the north by the rear property boundaries of Dumbarton Road, to the south by a path, to the east by a child's play area and the west by a line of trees. This land parcel is in the ownership of West Dunbartonshire Council.

Prior to conducting the survey, permissions to access the land were obtained from West Dunbartonshire Council.

As the survey area contains part of a Scheduled Monument, as per The Scheduled Monument Consent Procedure (Scotland) Regulations 2015, Metal and Mineral Detecting Applications were obtained from Historic Environment Scotland's Planning, Consents and Advice Team prior to survey being conducted.

The survey area does not include any land designated as either a Site of Special Scientific Interest or a Special Area of Conservation. It is not protected under the Ramsar Convention, does not lie within a National or Regional Park and it is not a nature reserve (NatureScot 2021). Reference to the National Biodiversity Network's Atlas (NBN 2021) for the survey area, and a 200m buffer surrounding it, showed no sightings of flora or fauna which required the granting of a licence for the survey to be conducted, therefore NatureScot were not consulted.

During the survey the weather conditions were warm and dry and followed a prolonged period of dry weather.

A photographic record showing the survey areas and ground conditions can be found in Section 11.

4.0 – ARCHAEOLOGICAL BACKGROUND

The presence of a Roman installation on Golden Hill is attested as early as the 18th century by Alexander Gordon, John Horsley, and William Roy (Gordon 1726: 51; Horsley 1732: 164; Roy 1793: plate xxxv). However, as the name Duntocher means '*the fort on the causeway*' (Macdonald 1934: 328), local knowledge of the site's existence may never have been lost. Both Roy and Gordon produced plans of the site and an interesting difference exists

between the two plans. Roy's plan is similar to that we have today, depicting a rectangular installation attached to the south side of the Antonine Wall Rampart (Roy 1793: plate xxxv). Gordon, however, shows a square fort straddling the Antonine Wall Rampart (Gordon 1726: plate 16). Both plans depict a single rectangular building within the fort. In 1775 a bathhouse (NRHE ID: 43317) was discovered northwest of the fort, close to the point the Wall crosses Duntocher Burn (Knox 1785: 611; Camden 1722: 102).

The first excavations on the site were carried out by John Clarke in 1933, confirming that the fort (NRHE ID: 43265) was constructed of turf ramparts (Macdonald 1934: 328). This work remains unpublished. Extensive excavations by Anne Robertson between 1948 and 1951 confirmed the plan of the fort and provided an interpretation of the sequence of construction at the site. Robertson argued that the site initially comprised a free-standing fortlet (NRHE ID: 43265), to which a small fort was later added at the east side. After the construction of the Antonine Wall Rampart, an annexe was then built onto the west side of the fort and fortlet (Robertson 1957: 14 & 15 figure 4). Robertson's excavations demonstrated that the fortlet measured 18m across within turf ramparts set on a stone base 3.6m wide. The later fort was the smallest on the frontier at only 0.2 hectares and was constructed of turf ramparts on a stone base measuring 3.9m wide. Three ditches protected the eastern side of the fort and the annexe was protected by a single ditch to its west. The northern side of the fort was uniquely protected by not just the Antonine Ditch but also by a second smaller ditch. This arrangement presumably led to Gordon's belief that a square fort straddled the Rampart. The fort has no known southern gate, although Robertson searched for this towards the centre of the southern rampart of the fort and not opposite the fortlet's gates.

The sequence of construction proposed by Robertson is based on an awkward relationship between the northeast corner of the fort and the rampart. An alternative interpretation has, however, been forwarded suggesting that a fort was constructed around the earlier fortlet and this was later subdivided into a fort and annexe (Swan 1999: 432). This would mirror the arrangement proposed at Bearsden (Breeze 2016: 320). It may also explain why Robertson could not locate a southern gate for the fort as it would be positioned west of the location in which she looked. Roy's plan adds further support to this as it shows the southern gate in the centre of the installation, opposite the position of the fortlet's gates (Roy 1793: plat xxxv). Further excavation in 1977-8 revealed a pottery kiln 80m southwest of the fort (Robertson 1979: 88).

Geophysical survey carried out in the area around the bathhouse yielded imperfect results (Keppie 2004: 204). Further geophysical survey in August 2016 over the north of the fort identified some internal structures and indicated that there may be a triple ditch arrangement to the northeast of the fort (Jones et al. 2016).

5.0 – SURVEY METHODOLOGY

The survey was conducted between 12th and 16th July 2021.

All survey was carried out in accordance with the Chartered Institute for Archaeologists, *Standard and Guidance for archaeological geophysical survey* (CIfA 2020), the *EAC Guideline for the Use of Geophysics in Archaeology* (Schmidt et al. 2016), and the Historic Environment Scotland, *Geophysical Survey, Standard Operating Procedures* (HES 2020b).

Survey methods were selected to best deliver the aims detailed in Section 2, in accordance with the recommendations outlined in the EAC guidelines, and in accordance with the manufacturer's guidelines (GF Instruments 2019; Sensys 2019). All sensors had valid in-date calibration certificates which are included in Appendix 2.

5.1 – GRADIOMETER SURVEY

The gradiometer survey was conducted using a hand propelled Sensys MXPDA system mounted on a Sensys F-type non-magnetic cart, with standard profile wheels. This system utilised five Sensys FGM650/3 sensors operating at 100hz, mounted at a 0.25m sensor separation with bases positioned 0.10m from the surface. The system was balanced prior to the commencement of the survey, with the calibration position shown in Figure 7.

The survey was conducted by walking parallel traverses in a zig-zag pattern, with traverses aligned northeast-southwest and positioned 1.25m apart. Navigation was provided by MONMX, the system's on-board software which displays position and the areas of previously collected data, ensuring that each traverse was evenly spaced. The position of the traverses is shown as a "breadcrumb" trail in Figure 7. Data points were recorded every 0.125m along each traverse, with positional accuracy provided by a Leica GS16 GNSS antenna mounted directly on the frame of the cart at a height of 1.5m. This provided a constant stream of data in NMEA format allowing each reading to be accurately georeferenced without the need for a pre-determined grid system.

Data was logged using the system's MONMX v.5.01-03/00 software package on a Panasonic FZ-G1 tablet computer in .prm format. Following the completion of the survey the data was then exported from the system in both .asc and .uxo formats. The .uxo file was processed and visualised using DW Consulting's Terrasurveyor v3.0.37.0 and the .asc file retained for archiving purposes. Interpretations of this data were then generated using ESRI ArcGIS Pro v2.5.1.

Data quality was maintained by avoiding ferrous objects within the survey such as fences, gates and inspection covers where possible.

Gradiometer survey can be affected by the site's underlying geology. High levels of background magnetism are often experienced in locations with igneous or metamorphic geologies. This can mask the subtle changes in the magnetic field associated with archaeological remains, making them difficult to detect. The sedimentary bedrock formations recorded at the site (Figure 3) were expected to exhibit low levels of background magnetism and therefore provide a good response to this methodology (EH 2008: 15).

A total of 3.9 hectares of data were collected employing this method.

5.2 – ELECTRO-MAGNETIC SURVEY

The electro-magnetic survey was conducted using a hand-held GF Instruments CMD Mini Explorer. This system employed a single transmitter coil and three receiver coils spaced at 0.32m, 0.71m and 1.18m from the transmitter. The system was initially set in Low (Vertical Coplanar) configuration and then the survey was repeated with the system set in High (Horizontal Coplanar) configuration. This provided estimated effective depth penetrations of 0.25m, 0.50m, and 0.90m and of 0.50m, 1.00m, and 1.80m respectively. The system was carried at approximately 0.1m from the surface to the left-hand side of the operator.

The survey was conducted by walking a series of parallel traverses in a uni-directional pattern, with traverses aligned northeast-southwest and positioned 0.5m apart. Navigation was provided by the system's on-board software which displays position and the areas of previously collected data, ensuring that each traverse was evenly spaced. Data points were recorded every 0.1 seconds along each traverse, with positional accuracy provided by a Leica GS16 mounted on a survey backpack at an antenna height of 1.8m. This provided a constant stream of data in NMEA format allowing each reading to be accurately georeferenced without the need for a pre-determined grid system.

Both quadrature (conductivity) and in-phase (magnetic susceptibility) readings were measured and recorded on the system's integral datalogger, resulting in six readings being recorded at each position in each configuration. This data was later transferred from the system in .bin format. The files were processed and visualised following the process described in Appendices 4, 5 and 6. Interpretations of this data were generated using ESRI ArcGIS Pro v2.5.1.

A total of 0.2 hectares of data were collected employing this method.

6.0 – SURVEY RESULTS & INTERPRETATION

The following section presents the results obtained using the data collection method detailed in Section 5 and the data processing methods in Appendices 5, 6, and 7. The results are presented by anomaly type and method.

The figures relating to these results and interpretations can be found in Appendix 10.

A total of 3.9 hectares of a planned 5.4 hectares for survey were surveyable (Figure 7). The 1.5 hectares discrepancy is accounted for by areas of tarmac path (which were avoided due to their highly magnetic nature), the newly installed children's play park (a physical obstacle), trees within the survey area (physical obstacles) and the tree canopy around the perimeter of the northern part of the survey area which blocked the GNSS signal and prevented survey in this area.

In general, only anomalies of archaeological or possible archaeological origins have been assigned an anomaly number.

6.1 – AREA DT01 GRADIOMETER SURVEY

The gradiometer results for DT01 have been visualised as greyscale plots with minimally processed data plotted at -50/50nT (Figure 8) and fully processed data displayed at -20/20nT (Figure 9 & 12). An XY trace plot has been produced (Figure 10) along with graphical interpretations of the data (Figures 11 & 13). Numbered anomalies are shown in Figure 13, listed in Appendix 3 and described in Appendix 4.

The electro-magnetic (conductivity) results for DT01 have been visualised as greyscale plots with fully processed data for the vertical co-planar set-up displayed at 0/8mS/m, along with a graphical interpretation of the data (Figure 14). Fully processed data for the horizontal co-planar set-up are displayed at 0/12mS/m, along with a graphical interpretation of the data (Figure 15).

The electro-magnetic (magnetic susceptibility) results for DT01 have been visualised as greyscale plots with fully processed data for the vertical co-planar set-up displayed at 0/8ppt, along with a graphical interpretation of the data (Figure 16). Fully processed data for the horizontal co-planar set-up are displayed at 0/10ppt, along with a graphical interpretation of the data (Figure 17).

6.1.1 – AREA DT01 GRADIOMETER SURVEY – ARCHAEOLOGICAL FEATURES

In area DT01 several anomalies of probable archaeological origin have been identified in the gradiometer data.

The largest and most obvious of these features is the line of the Antonine Wall ditches (ANTW2020DT-0001). These are orientated northwest to southeast and are characterised as three broad negative responses. The inner/southwestern of the three

ditches is 4.1m wide and separated from the central ditch by a 4.1m wide berm. The central ditch is 3 m wide and separated from the outer/northeastern ditch by a 4.1m wide berm, while the outer ditch is 3m wide. No responses representing the position of a possible outer mound are visible in the data. At the northwestern perimeter of area DT01 the three ditches begin to converge into a single ditch and this convergence continues into area DT02. While part of this convergence occurs in an area covered by trees that was unsurveyable, the convergence appears to correspond with the expected position of the northwest rampart of the fort's annexe. At the southeastern end of the survey area all three ditches continue beneath the housing of Stewart Drive, and so the point at which they converge back into a single ditch cannot be established.

Opposite the fortlet's northeastern gate, causeways across all three ditches of the Antonine Wall can be seen. These are about 2.4m wide. No other causeways crossing the triple-ditch system are visible in the survey data.

A second group of ditches (ANTW2020DT-0002), characterised as three negative linear responses, are visible in the southwest corner of area DT01. They are orientated northwest to southeast, parallel to ANTW2020DT-0001, and represent the position of the southwestern ditches of the fort and annexe. The inner/northeastern ditch measures 2.7m wide and is separated from the central ditch by a 2m wide berm. The central ditch is 2.1m wide and separated from the outer/southwestern ditch by a 2.4m wide berm, while the outer ditch is 3m wide. A modern path crosses the inner two ditches at the northwest of the survey area and then continues along the line of the outer ditch. At the northwestern perimeter of DT01 the outer two ditches appear to start to turn to the northeast. However, as this area suffers magnetic disturbance from the path and is partially unsurveyable due to tree cover, this cannot be confirmed. At the southeastern end of the survey area all three ditches continue beneath the housing of Stewart Drive and so the eastern extent of the fort and annexe cannot be established. No causeways across this group of ditches can be identified in the survey data.

Located to the southwest of and running parallel with ANTW2020DT-0001 is the line of the Antonine Wall's rampart (ANTW2020DT-0003). This is characterised as a pair of parallel, narrow, negative linear trends running almost continuously through DT01. These trends are 5.5m apart and conform well with the expected width of the wall base. They are located 6.3m from the inner element of the triple-ditch system creating a berm width of 6.3m. The visibility of this feature decreases towards the northwest of the survey area and almost completely fades out before it reaches DT02. Between these linear trends are a number of small discrete positive anomalies which probably represent the locations of sections of surviving wall base. No obvious break in this feature representing the location of a gateway can be observed along its length.

At the southeast end of ANTW2020DT-0003 and partially obscured by the magnetic disturbance from the fence along the edge of the survey area, an 8.6m long negative linear anomaly can be seen projecting in a southwesterly direction perpendicular to the line of the inner face of the Antonine Rampart base (ANTW2020DT-0004). This coincides with the expected location of the fort's southeastern rampart.

The position of the fort and annexe's southwestern rampart (ANTW2020DT-005) runs parallel with ANTW2020DT-0002 and is only partially visible as two very weak parallel negative linear trends set 4.1m apart. They are separated from the inner ditch by a 3.6m berm. Numerous discrete positive anomalies occur between these linear trends indicating areas where stone rampart base survives.

The expected location of the northwestern rampart and ditches of the annexe was unsurveyable because of the row of trees and the path separating areas DT01 and DT02. Therefore, the exact location of the northwestern side of the annexe could not be established.

The location of the fortlet is visible as a square feature (ANTW2020DT-0006) abutting the position of the Antonine Rampart (ANTW2020DT-0003). This is characterised by a 5.5m wide square feature formed of dipolar anomalies, enclosing an area measuring 15.9m internally. This response is caused by the intact rampart base buried beneath the surface and observed during the 1950s excavations (Robertson 1957; SC 354130). No obvious gateways can be seen at the northeastern or southwestern ramparts

The fortlet is surrounded by feature ANTW2020DT-0006, a weak negative linear trend that marks the position of the fortlet's defensive ditch from its free-standing phase. This is separated from the fortlet's rampart by a 3.7m wide berm. A trace of this feature can also be seen in the berm between the Antonine Wall rampart (ANTW2020DT-0003) and the inner ditch of the triple-ditch system (ANTW2020DT-0001).

A pair of parallel weak negative linear trends (ANTW2020DT-0007), oriented northeast to southwest, project perpendicularly from the line of the southwestern rampart of the fort (ANTW2020DT-0005) and extend towards the southern corner of the fortlet (ANTW2020DT-0006). These represent the location of the rampart dividing the fort area from the annexe. A small number of discrete positive anomalies are visible between the linear trends, probably representing stones which once formed the base of the rampart.

Towards the northern corner of the annexe is a high magnitude dipolar response (ANTW2020DT-0008), located immediately behind the line of the annexe's northeastern rampart. The nature of the response and its location suggest that this may represent an oven or kiln of Roman date.

To the east of the fort and west of the newly installed children's play area is a former field boundary oriented north-northwest to south-southeast (ANTW2020DT-0009). It is visible on the ground as a low bank and is characterised in the gradiometer data as a 5m wide line of ferrous spikes, probably representing stones forming the low bank beneath the turf. This boundary is depicted on the 1st edition of the OS map (Ordnance Survey 1865) and is on the same alignment as a section of rig and furrow recorded within the survey data to the east. It is therefore likely post-medieval in date.

6.1.2 – AREA DT01 GRADIOMETER SURVEY – POSSIBLE ARCHAEOLOGICAL FEATURES

In area DT01 several anomalies of possible archaeological origin have been identified in the gradiometer data.

The first group of features ANTW2020DT-0010 is located on the berm of the Antonine Wall, between the fort's northeastern rampart (ANTW2020DT-0003) and the inner ditch of the triple ditch system (ANTW2020DT-0001). These are characterised as a series of discrete positive anomalies, which appear to run in two rows parallel with the line of the frontier. The two rows are spaced approximately 2.4m apart and each anomaly is spaced approximately 2m apart. The location of these anomalies suggest that they may represent small defensive pits dug into the berm, or *cippi*.

Within the interior of the fortlet (ANTW2020DT-0006) a series of positive anomalies (ANTW2020DT-0011) appear to align with ramparts of the fortlet and may relate to the internal buildings.

Within the southwestern section of the fort a series of negative and positive linear trends interspersed with discrete positive anomalies form a broadly rectangular pattern measuring 24m northeast to southwest by 7m (ANTW2020DT-0012). This corresponds with the location of a building identified during the excavations in the 1950's (Robertson 1957: 14 & 15 figure 4). These anomalies may, therefore, relate to the remains of this

building, although they could equally be caused by the disturbance created during the excavation and back filling processes.

A series of discrete positive anomalies ANTW2020DT-0013 are located in the eastern corner of the fort, west of rampart feature ANTW2020DT-0004. Their position suggests they may be of archaeological origin and they may represent pits associated with the Roman occupation of the fort.

A further group of anomalies ANTW2020DT-0014 is located adjacent to the southwestern rampart of the annexe. The anomalies are similar in character to those at the southwestern end of the fort (ANTW2020DT-0012) and share a similar alignment. They may therefore be of similar origin and represent the remains of buildings. Further isolated anomalies of a generally positive and discrete character within the annexe area may also be archaeological in origin, though it is difficult to discern a coherent pattern that might inform an interpretation of them.

Outside the fort's southwestern defences four discrete positive anomalies may represent a series of pits of unknown function. However, the size and position of one (ANTW2020DT-0015) could suggest it represents the position of a *titulus*. If this were the case, it would imply that the fort's southwestern gateway was positioned opposite the southwestern gate of the fortlet. In the same area on a northeast to southwest orientation is a negative linear trend (ANTW2020DT-0016), which may be of archaeological origin and possibly associated with drainage.

A further negative linear trend (ANTW2020DT-0017) is positioned towards the north of DT01 and south of the pathway. It is orientated east-northeast to west-southwest and cuts through the fort's triple-ditch system, suggesting it is of post-Roman origins.

A positive curvilinear trend (ANTW2020DT-0018) is located immediately northeast of the fort's triple ditch system. It appears to be semi-circular on plan, although it may be truncated by the triple ditch system and therefore originally circular or oval in form. If this were the case, it would have had a diameter of about 31m. Possible truncation by the ditches implies it may pre-date their construction and so may be prehistoric in origin. It may represent the location of an enclosure.

A further negative linear trend ANTW2020DT-0019 is located to the northeast of the triple ditch system (ANTW2020DT-0001). It extends from northwest to southeast for 71m and is on a similar alignment to the ditch system. It is sinuous in nature with a broadly symmetrical plan. The function of this feature is unknown, though its symmetrical pattern suggests it is anthropogenic in origin.

6.1.3 – AREA DT01 GRADIOMETER SURVEY – HISTORICAL AGRICULTURAL FEATURES

In area DT01 two groups of anomalies have been identified which are of historical agricultural origins.

The first is located in the centre of DT01. A series of parallel positive linear trends oriented north-northwest to south-southeast and set around 8.7m apart represent an area of rig and furrow cultivation. Similarly aligned anomalies continue through to area DT02.

Similarly spaced series of linear trends orientated west-northwest to east-southeast are visible in the west of the survey area. They also represent rig and furrow and continue into area DT02.

6.1.4 – AREA DT01 GRADIOMETER SURVEY – MODERN AGRICULTURAL FEATURES

A group of anomalies associated with modern agriculture have been identified in the gradiometer data. These weak positive linear trends oriented southwest to northeast and set 4.5m apart are located towards the south of the centre of the survey area. These likely represent modern mowing of grass.

6.1.5 – AREA DT01 GRADIOMETER SURVEY – GEOLOGICAL & FLUVIAL FEATURES

In area DT01 a single feature of fluvial origins can be seen in the gradiometer data. This runs between the location of the OS triangulation point and the newly constructed children's play area. It is characterised as a negative linear trend initially extending to the northeast before curving gently to the southeast. This probably represents the line of a relic stream.

6.1.6 – AREA DT01 GRADIOMETER SURVEY – MODERN FEATURES

Numerous anomalies of modern origin have been identified in the gradiometer data.

The eastern end of the survey area is dominated by areas of modern magnetic disturbance. A modern drain, characterised as a line of strong dipolar responses oriented north to south, extends from the southern boundary of the survey area towards the path at the north. It then turns sharply to the east to follow the path down the hill. East of this is a series of ferrous spikes which form a 'herringbone' pattern, indicating a network of drains extending down towards the path at the north of DT01.

At the summit of Golden Hill, in the north of the survey area, is a large dipolar anomaly representing the location of an OS triangulation point.

Southeast of the summit of Golden Hill and immediately northeast of the fort an area of enhanced magnetism is associated with the position of the flagpole (Image 4). This is characterised by four ferrous spikes arranged in a square pattern measuring 5m with a surrounding area of magnetic disturbance. The four spikes coincide with the location of four concrete settings observed on the ground and represent the position of anchor points.

In the southwest of DT01 are a group of fourteen ferrous spikes, arranged in two rows of seven equally spaced anomalies. Reference to an aerial photograph taken in 1978 (SC 1724702) shows this was once the location of a group of swings. A concrete base for a roundabout was located immediately to the northwest and a corresponding dipolar anomaly is visible in the data.

The southern edge of DT01 is fringed with an area of magnetic disturbance caused by the fencing and the northern edge of the survey area contains magnetic disturbance caused by the tarmac path. At its western end this path turns to the south and towards the location of the swings and roundabout.

6.1.7 – AREA DT01 GRADIOMETER SURVEY – FEATURES OF UNCERTAIN ORIGINS

No anomalies of unknown or uncertain origins have been identified in the gradiometer data.

6.1.8 – AREA DT01 ELECTRO-MAGNETIC SURVEY – CONDUCTIVITY

Electro-magnetic survey was carried out in the south of the survey area, targeting the area where causeways were observed crossing the Antonine Ditch and the area where the presence of internal structures is indicated in the gradiometer data.

Two bands of high conductivity orientated northwest to southeast have been identified in the north of the electro-magnetic survey data (ANTW2020DT-0026), corresponding with the location of the two inner ditches of the fort's northeastern defences.

A band of very low conductivity (ANTW2020DT-0027), also oriented northwest to southeast, occurs to the southwest of ANTW2020DT-0026. This corresponds with the location of the fort's northeastern rampart.

Finally, at the southwest of the electro-magnetic survey area is an irregularly shaped area of low conductivity (ANTW2020DT-0028). This corresponds with the location of the building identified during the 1950s excavations.

6.1.9 – AREA DT01 ELECTRO-MAGNETIC SURVEY – MAGNETIC SUSCEPTIBILITY

In the northern section of the electro-magnetic survey, data banding with low magnetic readings have been identified (ANTW2020DT-0029). These are orientated northwest to southeast and correspond with the location of the inner two ditches of the fort's northeastern defences.

A band with highly magnetic readings (ANTW2020DT-0030) orientated from northwest to southeast occurs to the southwest of ANTW2020DT-0029. This corresponds with the location of the fort's northeastern rampart.

A further band with high magnetic readings (ANTW2020DT-0031) occurs parallel to the line of the rampart and may correspond with the line of a road within the fort.

Finally, at the southwest of the area surveyed a further band of high magnetism occurs (ANTW2020DT-0032). This corresponds with the location of the fort's southwestern rampart.

6.2 – AREA DT02 GRADIOMETER SURVEY

The gradiometer results for DT02 have been visualised as greyscale plots with minimally processed data plotted at -50/50nT (Figure 8) and fully processed data displayed at -20/20nT (Figure 9 & 12). An XY trace plot has been produced (Figure 10), along with graphical interpretations of the data (Figures 11 & 13). Numbered anomalies are shown in Figure 13 are listed in Appendix 3 and described in Appendix 4.

6.2.1 – AREA DT02 GRADIOMETER SURVEY – ARCHAEOLOGICAL FEATURES

In area DT02 two distinct areas containing features of probable archaeological origin have been identified in the gradiometer data.

The first (ANTW2020DT-0001) is located in the west of DT02 and is a band of negative readings orientated northwest to southeast. This represents the course of the Antonine Wall Ditch and continues through from DT01. It measures about 5.9m wide for most of its length through DT02 but broadens out into two arms at the southeastern end, mirroring the pattern seen in DT01. Running to the southwest of, and parallel with, the Antonine

Wall Ditch is a weak negative linear trend. This runs through the area of exposed Antonine Wall Base and so likely represents the course of the base. Small isolated positive anomalies along this line probably represent isolated areas of surviving Antonine Wall Base stonework.

The second feature is located at the north of DT02 and is represented by a narrow ring of strong positive readings in a sub-circular pattern (ANTW2020DT-0020). Within this ring is a single ferrous spike and area of magnetic disturbance. Reference to 1865 OS mapping (Ordnance Survey 1949) shows this is the former location of a bandstand. It is still visible as an earthwork in the LiDAR data (Figure 5).

6.2.2 – AREA DT02 GRADIOMETER SURVEY – POSSIBLE ARCHAEOLOGICAL FEATURES

In area DT02 several features of possible archaeological origin have been identified in the gradiometer data.

The first feature (ANTW2020DT-0021) is located towards the north of the survey area and is a rectangular shaped positive anomaly measuring 6.2m by 4m. This may represent the location of a pit, however, as it is bisected by the course of a modern drain, a modern drainage related function cannot be ruled out.

The second feature (ANTW2020DT-0022) is located in the northeast corner of DT02 and is a 22m long strongly negative linear trend oriented northwest to southeast. This feature is of unknown date as it does not display a similar alignment to either the Roman or medieval features in the area. Therefore, this feature is interpreted as a boundary ditch of unknown date.

The final group of features (ANTW2020DT-0023) comprise twelve distinct positive, broadly circular, anomalies in the area between the Antonine Wall Base and Antonine Wall Ditch. They are like the features observed in DT01 (ANTW2020DT-0010) and may represent the positions of defensive pits located on the frontier's berm.

6.2.3 – AREA DT02 GRADIOMETER SURVEY – HISTORICAL AGRICULTURAL FEATURES

In area DT02 two groups of anomalies have been identified which are of historical agricultural origins.

A series of parallel positive linear trends, oriented north-northwest to south-southeast and set around 5.3m apart, can be seen in the central and eastern sections of the survey area covering an area of about 0.5ha. These represent rig and furrow cultivation and correspond with similarly aligned anomalies in area DT01.

There are also a series of similarly spaced linear trends in the southwest corner of the survey area. These are orientated west-northwest to east-southeast and correspond with similar anomalies in area DT01.

6.2.4 – AREA DT02 GRADIOMETER SURVEY – MODERN AGRICULTURAL FEATURES

No anomalies of modern agricultural origins have been identified in the gradiometer data.

6.2.5 – AREA DT02 GRADIOMETER SURVEY – GEOLOGICAL & FLUVIAL FEATURES

No anomalies of geological or fluvial origins have been identified in the gradiometer data.

6.2.6 – AREA DT02 GRADIOMETER SURVEY – MODERN FEATURES

Numerous anomalies of modern origin have been identified in the gradiometer data.

A slightly sinuous negative linear anomaly extends from east to west through the centre of the survey area for a distance of about 175m. This represents the location of a tarmac path with park benches positioned along its length. It continues eastwards into area DT03. Immediately north of, and parallel with, the path is a dipolar feature which represents the course of a modern service. In the northwest corner of DT02 is a further continuation of the pathway, which follows a Z-shape route as it runs down the slope towards the war memorial.

To the southwest of DT02 is an unsurveyable rectangular area measuring 11m by 8.5m formed by the area of Antonine Wall base on public display. This is surrounded by a steel fence that causes a significant area of magnetic disturbance in the area surrounding it. At the northern edge of DT02 and to the north of the bandstand ANTW2020DT-0020 is an additional area of magnetic disturbance caused by the presence of a path.

In the eastern area of DT02 three modern drains, orientated northeast to southwest and evident as positive linear trends, extend from the central path to the eastern edge of the survey area.

A final significant area of magnetic disturbance can be observed at the west end of the survey adjacent to the boundary with Trinity Parish Church. Reference to aerial photographs taken in 1978 (SC 1724702) shows this was once the location of a flight of concrete steps leading up from the area of the war memorial. While these steps have been removed and replaced with the Z-shaped path discussed above, their magnetic signature is still present.

6.2.7 – AREA DT02 GRADIOMETER SURVEY – FEATURES OF UNCERTAIN ORIGINS

No anomalies of unknown or uncertain origins have been identified in the gradiometer data.

6.3 – AREA DT03 GRADIOMETER SURVEY

The gradiometer results for DT03 have been visualised as greyscale plots with minimally processed data plotted at -50/50nT (Figure 8) and fully processed data displayed at -20/20nT (Figure 9). XY trace plots have been produced (Figure 10), along with a graphical interpretation of the data (Figure 11). Numbered anomalies are listed in Appendix 3 and described in Appendix 4.

6.3.1 – AREA DT03 GRADIOMETER SURVEY – ARCHAEOLOGICAL FEATURES

In area DT03 a single feature of archaeological origin has been identified in the gradiometer data. This is a continuation of feature ANTW2020DT-0009 discussed in section 6.1.1 and probably represents the location of a field boundary.

6.3.2 – AREA DT03 GRADIOMETER SURVEY – POSSIBLE ARCHAEOLOGICAL FEATURES

In area DT03 two features of possible archaeological origin have been identified in the gradiometer data.

The first anomaly (ANTW2020D-0024) is located towards the north of the survey area on a north facing slope. It is orientated roughly east-west, following the contour of the slope, and is visible for 52m before being lost in areas of magnetic disturbance at both ends. It is characterised as a positive linear trend and may represent the location of a pathway or field boundary.

The second feature (ANTW2020DT-0025) lies in the south of the survey area, north of the tarmac path. It is characterised as a weak negative linear trend, extending from west-southwest to east-northeast for 131m. This may represent the location of a pathway.

6.3.3 – AREA DT03 GRADIOMETER SURVEY – HISTORICAL AGRICULTURAL FEATURES

In area DT03 a group of anomalies have been identified which are of historical agricultural origins.

Oriented north-northeast to south-southwest are a series of parallel positive linear trends, spaced around 6.7m apart and covering an area of about 0.5ha. This represents an area of rig and furrow cultivation.

6.3.4 – AREA DT03 GRADIOMETER SURVEY – MODERN AGRICULTURAL FEATURES

No anomalies of modern agricultural origins have been identified in the gradiometer data.

6.3.5 – AREA DT03 GRADIOMETER SURVEY – GEOLOGICAL & FLUVIAL FEATURES

No anomalies of geological or fluvial origins have been identified in the gradiometer data.

6.3.6 – AREA DT03 GRADIOMETER SURVEY – MODERN FEATURES

Numerous anomalies of modern origin have been identified in the gradiometer data.

Areas of magnetic disturbance occur at the edges of the surveyed area. These are caused by the park's perimeter fencing along the north of the survey area, a tarmac path along the south and metal fencing surrounding the child's play area at the east. Additionally, a second tarmac path runs through the centre of DT03 on a roughly east-west orientation.

A large irregular area of magnetic disturbance measuring 28m east-west by 14m north to south is located towards the centre of DT03. The high magnitude nature of this response indicates this is either the location of a large, high intensity burning event such as a bonfire, or the location of a lightning strike.

6.3.7 – AREA DT03 GRADIOMETER SURVEY – FEATURES OF UNCERTAIN ORIGINS

No anomalies of unknown or uncertain origins have been identified in the gradiometer data.

7.0 – CONCLUSIONS

The geophysical survey has produced good quality gradiometer results which have successfully contributed to the aims detailed in Section 2, while the electro-magnetic data supports the findings in the gradiometer data. There is a high level of confidence that the chosen methodology and survey strategy was appropriate to assess the archaeological potential of the survey area.

The survey has identified a single feature which may pre-date the Roman occupation of the site in the form of a possible enclosure. However, the dating of this feature is not certain.

Survey within the fortlet, fort and annexe has identified areas likely to contain internal structures. The detail, layout and function of these structures is not clear.

The most significant outcome of the survey relates to the triple-ditch system to the northeast of the fort. The survey has confirmed the existence of this ditch system, which at present is a unique feature along the line of the Antonine Wall. The ditch system appears to correspond to the location of the fort and annexe and does not extend beyond the location of them. This suggests that the construction of the site currently understood as fort and annexe combined and the construction of the ditch system were related. If this is the case, this indicates that the fortlet was superseded by a fort built around its location and the triple ditch system constructed at or around the same time, with the fort sub-divided into fort and annexe at a later date. This would support Swan's (1999) reinterpretation of the sequence of this site.

The fact that the causeways across this ditch system relate to the northeastern gateway of the fortlet shows that the ditches were dug when the fortlet's gateway was still in use. As no additional causeways have been identified, the fort does not appear to have been provided with any further gateways. If the fortlet gate remained the main entrance for the fort, direct access to the smaller fort envisaged in the sequence proposed by Robertson (1957) would not be possible, providing further support for the construction of a larger fort and sub-division to create the annexe at a later date.

No extra-mural activity of Roman date has been identified in the survey area, though this cannot be fully assessed as many of the areas likely to contain this type of feature were not surveyable.

Traces of post-medieval activity in the form of rig and furrow cultivation and field boundaries have also been identified during the survey.

In assessing these results against the specific aims listed in Section 2.

- *Can the relationship between the fortlet, fort and Antonine Wall at Golden Hill Park be better understood by conducting a survey at a higher resolution than previous work at the site?* Yes, the survey has provided an enhanced understanding of the relationship between the fortlet, fort, and the Antonine Wall.
- *Can the internal layout of the fort and fortlet be established*? Some additional detail of the fort and annexe's layout has been established in the form of a series of anomalies parallel with and perpendicular to the fort's ramparts, although no clear internal plan can be established for the fort.

- *Can the fort's southern gateway be located?* The fort's southern gateway has not been definitively identified. However, the feature interpreted as a possible titulus may hint at the location of the gate.
- *Can the arrangement of ditches to the northeast of the fort be confirmed?* Yes, a triple ditch system has been confirmed and gateways across this identified.
- *Can any traces of extra-mural settlement between the fort and bathhouse be identified?* No Roman period extra-mural activity has been identified.
- *Can any further details about the bathhouse be established?* No, the area containing the bathhouse was unsurveyable.

In summary the survey has confirmed the location and layout of the fortlet and fort and added significant detail to the understanding of the site.

8.0 – CAVEATS

Geophysical survey relies upon the detection of anomalous values and patterns in the physical properties of the ground and uses these as a proxy for anthropogenic activity; it does not directly detect archaeological features. Therefore, the results from this method of survey will not be a direct indicator of the absence or presence of archaeological features.

The ability of geophysical survey to identify the potential for archaeological remains is impacted by several interconnecting factors, including geological and fluvial processes, weather conditions, ground conditions, and the taphonomic processes involved in the archaeological site's formation. Therefore, the survey results may not provide a complete plan of the site's archaeology.

Nonetheless Historic Environment Scotland have endeavoured to produce interpretations of the data as accurately as possible. However, it should be noted that these interpretations and the conclusions contained within this report are a subjective assessment of the data.

9.0 – ARCHIVE DEPOSITION

A digital copy of this report has been supplied to both Historic Environment Scotland and the local Historic Environment Record for archive purposes. An event record has been generated for the National Record of the Historic Environment (NRHE) summarising the methodology and results of the project. As the interpretation of the results has led to the identification of new sites, new NRHE site records have been created. A list of these can be found in Appendix 9. No existing site records have been amended.

In accordance with standard industry practice an Online Access to the Index of Archaeological Investigations (OASIS) record has been generated and submitted to the Historic Environment Record (HER) and the Archaeological Data Service (ADS).

As the survey was conducted in Scotland an entry has been generated for inclusion in "Discovery and Excavation in Scotland". This text can be found in Appendix 8.

The digital elements of the project have been supplied to the NRHE for archive in the following formats.

- Unprocessed survey data supplied as .txt files.
- Processed survey data supplied as .tif files.
- A .zip containing the following .shp files.

- Polygons showing the survey area extents and containing the survey's metadata.
- Interpretation polygons.
- Interpretation polylines.
- Interpretation points.

10.0 – BIBLIOGRAPHY

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11.0 – IMAGES

Image 1 – DT01 looking west (DP378634)

Image 2 – DT01 looking northwest (DP378635)

Image 3 – DT01 looking northwest (DP378636)

Image 4 – DT01 looking northeast (DP378637)

Image 5 – DT02 looking west (DP378638)

Image 6 – DT02 looking northeast (DP378639)

APPENDIX 1 – SURVEY METADATA

The following table details the survey's metadata.

Field	Description
Data Collection Organisation	Historic Environment Scotland
Site Name	Antonine Wall, Duntocher
Project ID	ANTW2020DT
OASIS ID	historic14-412624
Report Title	Antonine Wall, Duntocher, Archaeological Geophysical Survey Report
Report Author	Dr Nick Hannon
Report QC	Dr Kirsty Millican/Dr Dave Cowley
National Grid Reference (centre)	NS 49513 72699
Coordinate System	OSGB1936
Transformation	OSTN15
Geoid	OSGM15
County	West Dunbartonshire
Scheduled Ancient Monument/s	SM7070
Known Archaeology on site	43265, 43284, 43317, & 98876
Survey Personnel	Dr Nick Hannon, Alison McCaig, Dr George Geddes, Dr Łukasz Banaszek
Survey Dates	12/07/2021 to 16/07/2021
Weather Conditions	Hot and Sunny
Land Use	Grassed Parkland
Ground Conditions	Dry
Solid Geology	Lawmuir Formation, with a band of Holybush Limestone (BGS 2021)
Drift Geology	Till, Devensian – Diamicton (BGS 2021)
Soil	Built-up Land (Scotland's Soils 2021)
Survey Type	Gradiometer
Gradiometer Equipment	Sensys MXPDA
Sensors Type	FGM650/3
Sample Rate (hz)	100
Number of Sensors	5
Sensor Serial Numbers	1519/1520/1521/1522/1523
Sensor Separation (m)	0.25
Reading Interval (m)	0.125
Data Collection Software	MONMX v5.01-03/00
Data Processing Software	TerraSurveyor v3.0.37.0
Data Visualisation Software	ArcGIS Pro v2.5.1
Area Covered (ha)	3.9ha
Positional Accuracy	Leica GS16 GNSS +/- 0.02m
Survey Type	Electro-magnetic
EMI Equipment	CMD Mini Explorer
Sensor Separation/s (m)	0.2/0.5/0.7
Sensor Configuration	Low (Vertical Coplanar) & High (Horizontal Coplanar)
Traverse Separation (m)	0.5
Reading Interval (sec)	0.1
Data Collection Software	On-board hardware
Data Processing Software	TerraSurveyor v3.0.37.0
Data Visualisation Software	ArcGIS Pro v2.5.1
Area Covered (ha)	0.21ha
Positional Accuracy	Leica GS16 GNSS +/- 0.02m

APPENDIX 2 – CALIBRATION CERTIFICATES

SENSYS®
Magnetometers & Survey Solutions

SENSYS Sensorik & Systemtechnologie GmbH · Rabenfelde 5 · 15526 Bad Saarow

Technologiezentrum Rabenfelde

Inspection and Calibration Certificate

We hereby confirm that the device below:

MAGNETO® MXPDA 5channel system

(S/N: 000144)

with sensor probes FGM650/3

(S/N: 1519, 1520, 1521, 1522, 1523)

has been inspected and calibrated on **17.09.2020** by SENSYS - Sensorik und Systemtechnologie GmbH according to manufacturer's instructions and according to in-house inspection requirements. All inspections and maintenance procedures are carried out according to the quality management systems ISO 9001:2015 of SENSYS GmbH. No technical defects have been detected on the device. Thus the device can be used without any restrictions.

The next inspection is due in **September 2021** if no other damages or malfunction occurs in the meantime.

Bad Saarow, 17.09.2020

Gerd Rückschloss
Head of Customer Service

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IBAN: DE 24 1705 5050 3000 0030 60

APPENDIX 3 – IDENTIFIED ANOMALIES

The following table lists each named anomaly identified in the survey.

Anomaly ID	Location	Classification	Interpretation
ANTW2020DT-0001	DT01 & DT02	Enhanced Magnetism (Archaeology)	Antonine Wall Ditches / Fort NE Defensive Ditches
ANTW2020DT-0002	DT01	Enhanced Magnetism (Archaeology)	Fort SW Defensive Ditches
ANTW2020DT-0003	DT01	Linear Trend (Archaeology)	Antonine Wall Rampart / Fort NE Rampart
ANTW2020DT-0004	DT01	Enhanced Magnetism (Archaeology)	Fort SE Rampart
ANTW2020DT-0005	DT01	Linear Trend (Archaeology)	Fort SW Rampart
ANTW2020DT-0006	DT01	Enhanced Magnetism (Archaeology)	Fortlet
ANTW2020DT-0007	DT01	Linear Trend (Archaeology)	Rampart separating Fort & Annexe
ANTW2020DT-0008	DT01	Enhanced Magnetism (Area of Burning)	Oven or Kiln
ANTW2020DT-0009	DT01	Enhanced Magnetism (Archaeology)	Field Boundary
ANTW2020DT-0010	DT01	Enhanced Magnetism (Possible Archaeology)	Defensive Pits / Cippi
ANTW2020DT-0011	DT01	Enhanced Magnetism (Possible Archaeology)	Building / Structure
ANTW2020DT-0012	DT01	Enhanced Magnetism (Possible Archaeology)	Building / Structure
ANTW2020DT-0013	DT01	Enhanced Magnetism (Possible Archaeology)	Pits
ANTW2020DT-0014	DT01	Enhanced Magnetism (Possible Archaeology)	Building / Structure
ANTW2020DT-0015	DT01	Enhanced Magnetism (Possible Archaeology)	Pits / Titulus
ANTW2020DT-0016	DT01	Linear Trend (Possible Archaeology)	Drainage
ANTW2020DT-0017	DT01	Linear Trend (Possible Archaeology)	Unknown
ANTW2020DT-0018	DT01	Linear Trend (Possible Archaeology)	Enclosure
ANTW2020DT-0019	DT01	Linear Trend (Possible Archaeology)	Unknown
ANTW2020DT-0020	DT02	Linear Trend (Archaeology)	Bandstand
ANTW2020DT-0021	DT02	Enhanced Magnetism (Possible Archaeology)	Pit
ANTW2020DT-0022	DT02	Linear Trend (Possible Archaeology)	Unknown
ANTW2020DT-0023	DT02	Enhanced Magnetism (Possible Archaeology)	Defensive Pits / Cippi
ANTW2020DT-0024	DT03	Linear Trend (Possible Archaeology)	Path or Field Boundary
ANTW2020DT-0025	DT03	Linear Trend (Possible Archaeology)	Path or Field Boundary
ANTW2020DT-0026	DT01	High Conductivity	Antonine Wall Ditches / Fort NE Defensive Ditches
ANTW2020DT-0027	DT01	Very Low Conductivity	Antonine Wall Rampart / Fort NE Rampart
ANTW2020DT-0028	DT01	Low Conductivity	Building / Structure
ANTW2020DT-0029	DT01	Low Magnetism	Antonine Wall Ditches / Fort NE Defensive Ditches
ANTW2020DT-0030	DT01	High Magnetism	Antonine Wall Rampart / Fort NE Rampart
ANTW2020DT-0031	DT01	High Magnetism	Road
ANTW2020DT-0032	DT01	High Magnetism	Fort SW Rampart

APPENDIX 4 – GLOSSARY OF ANOMALY TYPES

The following table contains a glossary of the technical terminology used for gradiometer survey anomalies within this report.

	Anomaly Type	Description
Area	Area of Disturbance (Modern)	An area of magnetic disturbance caused by modern activity such as metallic fences, gates, inspection covers, green waste, or modern refuse.
	Enhanced Magnetism (Area of Burning)	An anomaly with a distinct pattern in the XY trace plot which indicates burning has taken place, suggesting the location of a hearth or kiln.
	Enhanced Magnetism (Historic Agriculture)	An anomaly caused by historic agricultural activity such as rig & furrow, or a headland.
	Enhanced Magnetism (Archaeology)	An anomaly of probable archaeological origin; this interpretation will either be based on other supporting evidence or on the form of the anomaly.
	Enhanced Magnetism (Historic Feature)	An anomaly caused by an historic feature. This will appear on a documentary record such as an old map but the feature is no longer extant on the surface, such as a demolished building, or a former field boundary.
	Enhanced Magnetism (Possible Archaeology)	An anomaly of possible archaeological origin; this interpretation will have no other supporting evidence.
	Enhanced Magnetism (Unclear Origin)	An anomaly for which it is not possible to assign an interpretation.
	Enhanced Magnetism (Utility)	An area of magnetic disturbance caused by the magnetic field of a utility, such as the halo around a gas pipe.
	Geology/Natural	An anomaly interpreted as caused by geological or fluvial processes, such as variations in underlying bedrock, or palaeo-channels.
Trend	Linear Trend (Archaeology)	A linear anomaly of probable archaeological origin; this interpretation will either be based on other supporting evidence or on the form of the anomaly.
	Linear Trend (Drainage)	A linear anomaly caused by modern drainage such as a field drain.
	Linear Trend (Historic Agriculture)	A linear anomaly caused by historic agricultural activity such as rig & furrow, or a headland.
	Linear Trend (Historic Feature)	A linear anomaly caused by a historic feature. This will appear on a documentary record such as an old map but the feature is no longer visible on the ground, such as an old pathway.
	Linear Trend (Modern Agriculture)	A linear anomaly caused by modern agricultural activity such as ploughing.
	Linear Trend (Possible Archaeology)	A linear anomaly of possible archaeological origin; this interpretation will have no other supporting evidence.
	Linear Trend (Unclear Origin)	A linear anomaly for which it is not possible to assign an interpretation.
	Linear Trend (Utility)	A linear anomaly caused by the presence of a modern utility, such as a gas pipe.
	Geology/Natural	A linear anomaly interpreted as caused by geological or fluvial processes, such as variations in underlying bedrock, or palaeo-channels.
Point	Ferrous Spike	An anomaly caused by a ferrous object in the topsoil which causes a spike in the XY trace plot of the data.

The following table contains a glossary of the technical terminology used for anomalies for electro-magnetic (Magnetic Susceptibility) survey within this report.

	Anomaly Type	Description
Area	High Magnetism	An area displaying particularly high magnetic properties, possibly of anthropogenic origins.
	Low Magnetism	An area displaying particularly low magnetic properties, possibly of anthropogenic origins.

The following table contains a glossary of the technical terminology used for anomalies for electro-magnetic (Conductivity) survey within this report.

	Anomaly Type	Description
Area	Very Low Conductivity	An area displaying very low conductivity, possibly of anthropogenic origins.
	Low Conductivity	An area displaying low conductivity, possibly of anthropogenic origins.
	High Conductivity	An area displaying low high conductivity, possibly of anthropogenic origins.

APPENDIX 5 – DATA PROCESSING METHODOLOGY

The following section details the data processing methodology used for this survey; the specific process parameters used for each datafile are detailed in Appendix 6.

GRADIOMETER DATA PROCESSING

Following the collection of data using the methodology detailed in section 5.1, all datafiles were exported from the Sensys system's MONMX in .asc, and .uxo formats. These files were then transferred to the processing computer.

Data processing was conducted using TerraSurveyor v3.0.36.10 (DW Consulting: 2019). The GPS Geoid was set to "WGS-84" and the coordinate system set to "UTM Zone 30" prior to data import, to match the GNSS used during data collection. The .uxo files were imported using the pre-defined TerraSurveyor import template appropriate for the Sensys system and converted into .xcp format composites. The .asc format file was retained for archiving.

The .xcp file was opened and a .grd exported to allow visualisation of the minimally processed data. The data was destriped and clipped. The data was interpolated to values appropriate to the display requirements for the processed results. These processed results were exported in .grd format. An image boarder was generated and exported as a .dxf. The minimally processed data was clipped to -10/100 nT and an XY trace plot generated and exported as a .dxf.

The .grd and .dxf files were imported to the project's ArcGIS Pro geodatabase and converted into the British National Grid coordinate system using the "Project" and "Project Raster" tools, with the input coordinate system set as "ETRS_1989_UTM_Zone_30N", the output coordinate system as "British National Grid", using the "OSGB_1936_To_ETRS_1989_1" geographic transformation, resampled as "Nearest neighbour".

Once the reprojection was complete the data was manually interpreted.

ELECTRO-MAGNETIC DATA PROCESSING

Following the collection of data following the methodology detailed in section 5.2, all datafiles were exported from the CMD Mini Explorer's datalogger via a USB memory stick in .bin format. These files were then transferred to the processing computer and opened with the CMD Data Transfer application; each file was then exported as an interpolated .dat file. Each data file was opened in Microsoft Excel and the trailing "W" and "N" removed from the data in columns A and B; column B also had the leading "-" removed. The data was saved in .csv format.

Data processing was conducted using Terrasurveyor (DW Consulting: 2019). The GPS Geoid was set to "WGS-84" and the coordinate system set to "UTM Zone 30" prior to data import, to match the GNSS used during data collection. The .csv files were imported using the pre-defined TerraSurveyor import template appropriate for the CMD Mini Explorer system, and converted into .xcp format composite. This process was repeated six times, each time changing the "Val posn" value on the "Source Settings" screen to produce a composite for each of the six sets of readings taken during survey.

The .xcp files were opened and a .grd exported to allow visualisation of the minimally processed data. The data was despiked, destriped and had a high-pass filter applied. The data was interpolated to values appropriate for the display requirements for the

processed results; these processed results were exported in .grd format. An image boarder was generated and exported as a .dxf. The data was clipped and an XY trace plot generated and exported as a .dxf.

The .grd's were imported to the project's ArcGIS Pro geodatabase and converted into the British National Grid coordinate system using the "Project Raster" tool, with the input coordinate system set as "ETRS_1989_UTM_Zone_30N", the output coordinate system as "British National Grid", using the "OSGB_1936_To_ETRS_1989_1" geographic transformation, resampled as "Nearest neighbour".

Once the reprojection was complete the data was manually interpreted.

APPENDIX 6 – DATA PROCESSING STEPS

The following table details the processing steps each data file has undergone and the order these processes were applied before the data was transferred to the data visualisation software.

Filename	Process	Values
ANTW2020DT01-MAG.xcp	Base Settings	Interval 0.121m, Track Radius 0.30m
	Remove Turns	Threshold Angle 45, Cut Length 5m
	Destripe	Median / SD 1.5
	Clip	-100/100 nT
ANTW2020DT02-MAG.xcp	Base Settings	Interval 0.121m, Track Radius 0.30m
	Remove Turns	Threshold Angle 45, Cut Length 5m
	Destripe	Median / SD 1.5
	Clip	-100/100 nT
ANTW2020DT03-MAG.xcp	Base Settings	Interval 0.121m, Track Radius 0.30m
	Remove Turns	Threshold Angle 45, Cut Length 5m
	Destripe	Median / SD 1.5
	Clip	-100/100 nT
ANTW202DT01a-EM-LO-COND1.xcp	Base Settings	Interval 0.201m, Track Radius 0.81m
	Remove Turns	Manually removed
	Low Pass Filter	Uniform (median) Diameter 7
ANTW202DT01a-EM-LO-COND2.xcp	Base Settings	Interval 0.21m, Track Radius 0.81m
	Remove Turns	Manually removed
	Low Pass Filter	Uniform (median) Diameter 9
ANTW202DT01a-EM-LO-COND3.xcp	Base Settings	Interval 0.20m, Track Radius 0.81m
	Remove Turns	Manually removed
ANTW202DT01a-EM-LO-MSUS1.xcp	Base Settings	Interval 0.20m, Track Radius 0.81m
	Remove Turns	Manually removed
ANTW202DT01a-EM-LO-MSUS2.xcp	Base Settings	Interval 0.20m, Track Radius 0.81m
	Remove Turns	Manually removed
ANTW202DT01a-EM-LO-MSUS3.xcp	Base Settings	Interval 0.201m, Track Radius 0.81m
	Remove Turns	Manually removed
ANTW202DT01a-EM-HI-COND1.xcp	Base Settings	Interval 0.20m, Track Radius 0.61m
	Remove Turns	Manually removed
	Low Pass Filter	Uniform (median) Diameter 5
ANTW202DT01a-EM-HI-COND2.xcp	Base Settings	Interval 0.20m, Track Radius 0.61m
	Remove Turns	Manually removed
	Low Pass Filter	Uniform (median) Diameter 5
ANTW202DT01a-EM-HI-COND3.xcp	Base Settings	Interval 0.20m, Track Radius 0.61m
	Remove Turns	Manually removed
	Low Pass Filter	Uniform (median) Diameter 5
ANTW202DT01a-EM-HI-MSUS1.xcp	Base Settings	Interval 0.201m, Track Radius 0.61m
	Remove Turns	Manually removed
	Low Pass Filter	Uniform (median) Diameter 7
ANTW202DT01a-EM-HI-MSUS2.xcp	Base Settings	Interval 0.20m, Track Radius 0.61m
	Remove Turns	Manually removed

	Low Pass Filter	Uniform (median) Diameter 9
ANTW202DT01a-EM-HI-MSUS3.xcp	Base Settings	Interval 0.20m, Track Radius 0.61m
	Remove Turns	Manually removed
ANTW202DT01b-EM-LO-COND1.xcp	Base Settings	Interval 0.20m, Track Radius 0.81m
	Remove Turns	Manually removed
ANTW202DT01b-EM-LO-COND2.xcp	Base Settings	Interval 0.20m, Track Radius 0.81m
	Remove Turns	Manually removed
ANTW202DT01b-EM-LO-COND3.xcp	Base Settings	Interval 0.201m, Track Radius 0.81m
	Remove Turns	Manually removed
ANTW202DT01b-EM-LO-MSUS1.xcp	Base Settings	Interval 0.211m, Track Radius 0.80m
	Remove Turns	Manually removed
ANTW202DT01b-EM-LO-MSUS2.xcp	Base Settings	Interval 0.20m, Track Radius 0.80m
	Remove Turns	Manually removed
ANTW202DT01b-EM-LO-MSUS3.xcp	Base Settings	Interval 0.20m, Track Radius 0.81m
	Remove Turns	Manually removed
ANTW202DT01b-EM-HI-COND1.xcp	Base Settings	Interval 0.20m, Track Radius 0.71m
	Remove Turns	Manually removed
ANTW202DT01b-EM-HI-COND2.xcp	Base Settings	Interval 0.20m, Track Radius 0.71m
	Remove Turns	Manually removed
ANTW202DT01b-EM-HI-COND3.xcp	Base Settings	Interval 0.20m, Track Radius 0.71m
	Remove Turns	Manually removed
ANTW202DT01b-EM-HI-MSUS1.xcp	Base Settings	Interval 0.20m, Track Radius 0.71m
	Remove Turns	Manually removed
ANTW202DT01b-EM-HI-MSUS2.xcp	Base Settings	Interval 0.20m, Track Radius 0.71m
	Remove Turns	Manually removed
ANTW202DT01b-EM-HI-MSUS3.xcp	Base Settings	Interval 0.20m, Track Radius 0.71m
	Remove Turns	Manually removed

APPENDIX 7 – GLOSSARY OF DATA PROCESSING TERMS

The following table contains a glossary of the technical terminology used during sections 4 and 5 of this report.

Process	Definition
Break on Jump	This process calculates the distance between each data point along a traverse and if this distance exceeds the set threshold the traverse will be split into individual traverses. This process is used when there is a large gap in the collected data points caused by GNSS signal drop-out.
Clip	This process removes values outside of the defined upper and lower limits and replaces them with the upper and lower limits. It can be applied as absolute values, or as a standard deviation. The process is used to remove the skewing effect of areas of unusually high or low values in the data.
De-spike	This process identifies data points which are unusually high or low compared with those around it and replaces the values with an average value based on the surrounding points. This process is used to remove the skewing effect of spikes in the data due to ferrous objects in the topsoil.
De-stagger	This process corrects mechanical errors which occur during data collection when a traverse is started too early or too late. It shifts the traverse backwards or forwards to compensate for the error. This process is used when data is collected on steep terrain when it is difficult to keep the cart parallel with the surface.
De-stripe	This process calculates the average (Mean, Mode or Median) of each individual traverse and then deducts this value from the readings along that traverse. This transforms the values into the difference from the average instead of an absolute value. This process is used to remove the striping effect caused by neighbouring traverses being surveyed in opposite directions (heading errors). This process is sometimes referred to as a 'Zero Mean Traverse'.
Discard Overlap	This process is used to remove data points when they have been collected too close to other data points. This process is used to remove the distorting effect caused by traverses overlapping due to operator error.
High Pass Filter	This process uses either a Gaussian or uniformly weighted window to remove low-frequency noise from the data to highlight the high-frequency trends.
Interval	This process sets the size of the cells in the greyscale image of the data and thus the level of interpolation applied to the data
Low Pass Filter	This process uses either a Gaussian or uniformly weighted window to remove high-frequency trends from the data resulting in a smoothing effect.
Reduce Points	This process uses an algorithm to reduce the number of data points passed to subsequent processing step. This process is used to reduce processing time for large data sets.
Remove Turns	This process is used to separate a track of data into individual traverses when data collection was not manually stopped by the surveyor at the end of each traverse. A turn is detected by a change in direction of travel and set in degrees. This is commonly used when data is collected using a mechanical towing device.
Straighten	This process corrects sudden changes in direction along a traverse. This process is used to correct errors caused by the GNSS changing between satellite constellations which cause a slight jump in position.
Track Radius	This process sets the size of area around each data point which is included in the interpolated calculation.

APPENDIX 8 – DISCOVERY AND EXCAVATION IN SCOTLAND TEXT

The text below has been submitted for inclusion in the 2020 volume of *Discovery and Excavation in Scotland*.

The HES Archaeological Survey Team undertook geophysical (gradiometer & electro-magnetic) survey at Golden Hill Park, West Dunbartonshire, G81 6AG. This forms part of a wider Antonine Wall Geophysical Survey project which aims to address management and research questions relating to the Antonine Frontier by investigating the extent and significance of sub-surface archaeological remains at various locations within the World Heritage Site.

The fieldwork was conducted between 12 July 2021 and 16 July 2021. In total 3.96 hectares were surveyed using a Sensys MXPDA gradiometer, with 0.21 hectares of that area also surveyed using a CMD Mini Explorer electro-magnetic device. The survey area contained the Duntocher Roman fort, fortlet, and bathhouse. The geophysical survey has produced good quality gradiometer results which have successfully contributed to the aims of the survey. The electro-magnetic survey has provided moderate quality results which have, in part, supported the gradiometer results and therefore provided a moderate contribution to the aims of the survey. There is a high level of confidence that the chosen mixed methodology and survey strategy was appropriate to assess the archaeological potential of the survey area.

The survey has successfully confirmed the course of the Antonine Wall ditch through Golden Hill Park and the presence of a triple ditch system to the north of the wall which extends to the full width of the fort and incorporates a causeway that crosses all three ditches immediately north of the entrance to the fortlet. The survey also confirmed the location of the southern defensive ditches of the fort and identified traces of structures within both the fort and its annexe.

(Project ID: ANTW2020DT)

APPENDIX 9 – NATIONAL RECORD OF THE HISTORIC ENVIRONMENT SITE RECORD CREATION OR AMENDMENT

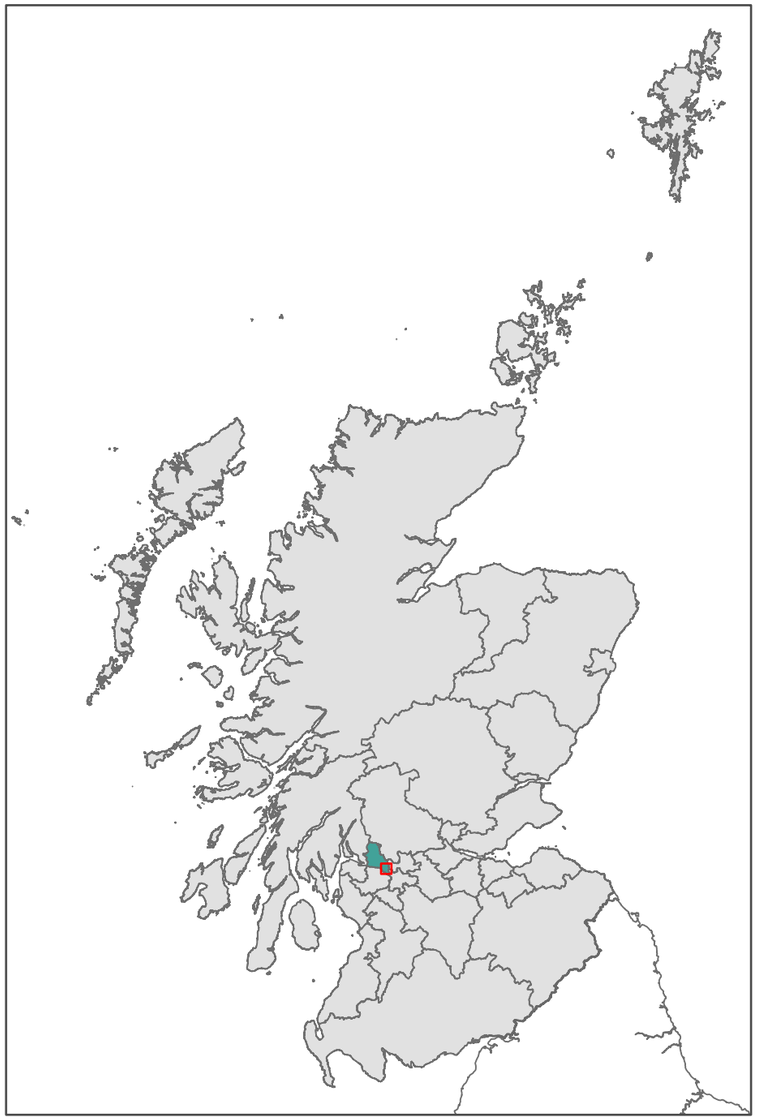
The following table details the National Record of the Historic Environment entries which have been amended or created as a result of this survey.

NRHE ID	Anomaly ID	Change	Notes
43265	ANTW2020DT-0001 ANTW2020DT-0002 ANTW2020DT-0003 ANTW2020DT-0004 ANTW2020DT-0005 ANTW2020DT-0006 ANTW2020DT-0007 ANTW2020DT-0008 ANTW2020DT-0009 ANTW2020DT-0010 ANTW2020DT-0011 ANTW2020DT-0012 ANTW2020DT-0013 ANTW2020DT-0014 ANTW2020DT-0015 ANTW2020DT-0023 ANTW2020DT-0026 ANTW2020DT-0027 ANTW2020DT-0028 ANTW2020DT-0029 ANTW2020DT-0030 ANTW2020DT-0032	Amendment	Record for Duntocher Fortlet & Fort to be updated with new information relating to the fortlet, fort, & Antonine Wall
373299	ANTW2020DT-0018	Addition	Possible circular enclosure predating the construction of the Antonine Wall
373300	ANTW2020DT-0020	Addition	Bandstand to be added to NRHE as site

APPENDIX 10 – FIGURES

Project Name	Duntocher Fort & Fortlet
Project Code	ANTW2020DT
Prepared By	Nick Hannon
Prepared On	02/12/2021
Figure 01	Survey Location

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

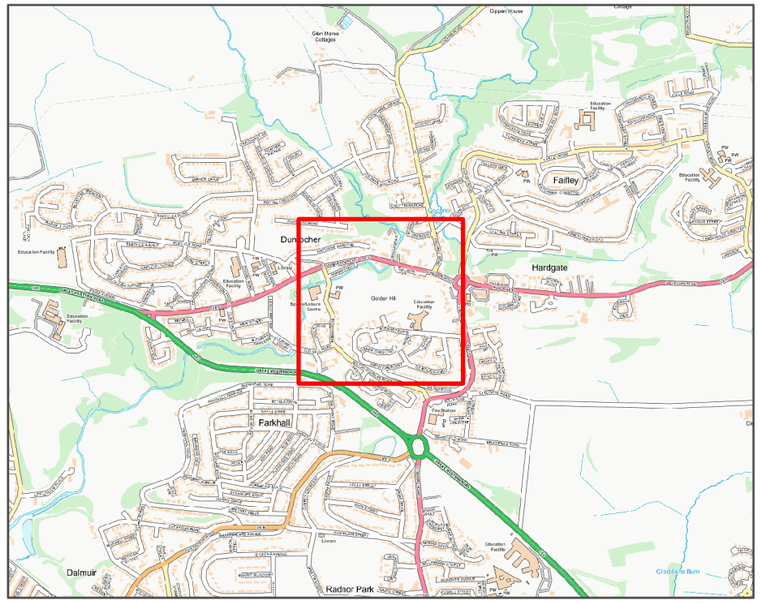


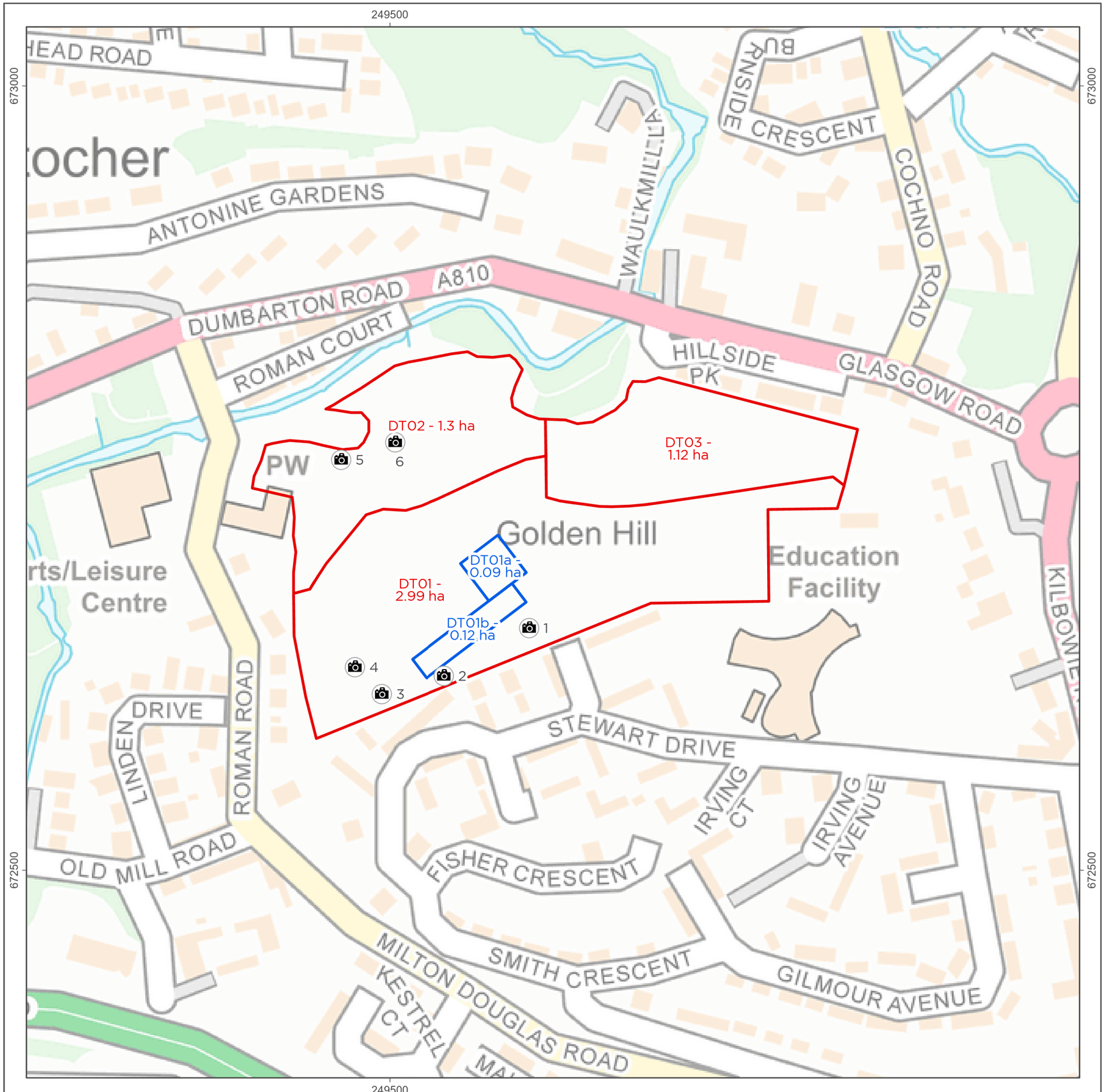
Survey Location
West Dunbartonshire

North	Scale: 1:25,000 @ A3	Datum: OSGB 1936
	Meters 0 500 1,000 1,500 2,000	

Project Name	Duntocher Fort & Fortlet
Project Code	ANTW2020DT
Prepared By	Nick Hannon
Prepared On	04/03/2022
Figure02	Survey Area Showing Photograph Positions

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA





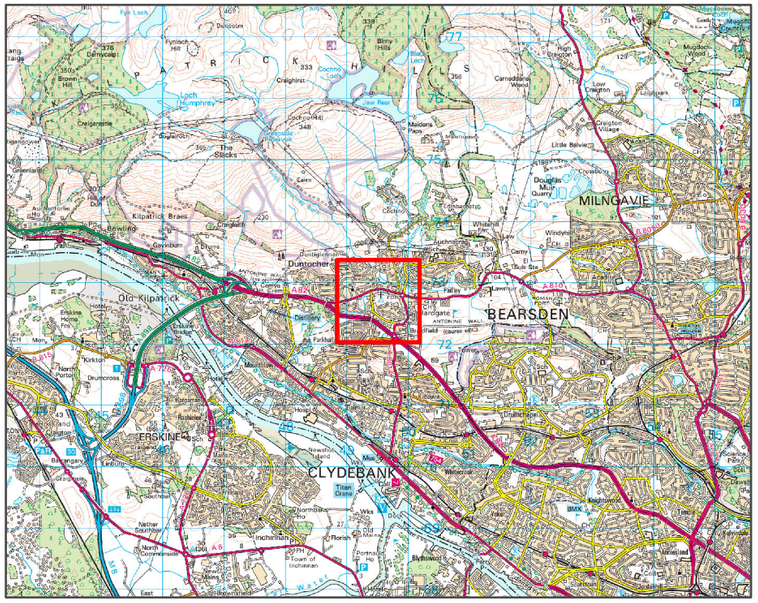
- Survey Area - Electro-magnetic
- Survey-Area - Magnetometer
- Photograph Position

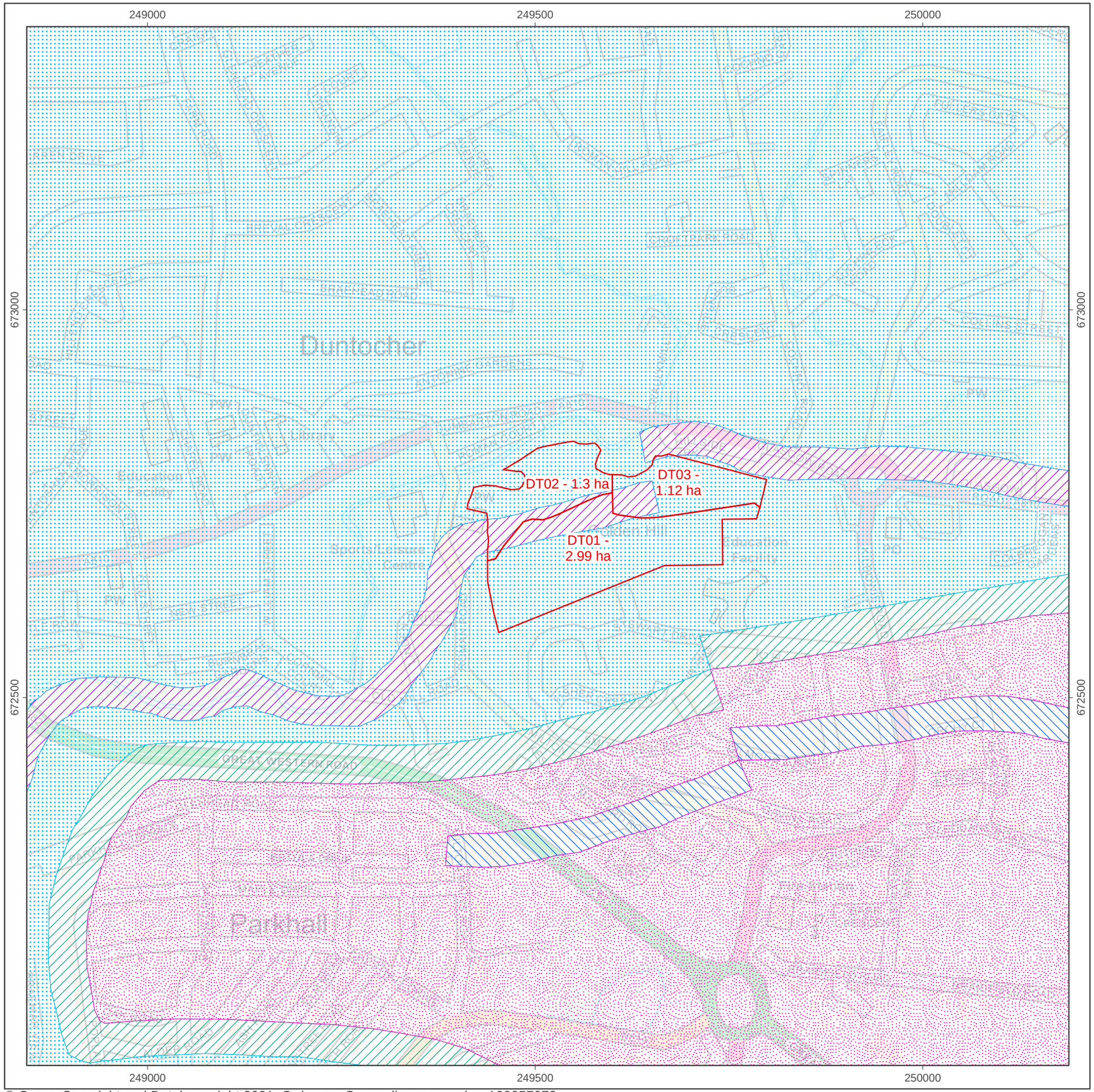
North	Scale: 1:2,500 @ A3	Datum: OSGB 1936

Metres 0 50 100 150 200

Project Name	Duntocher Fort & Fortlet
Project Code	ANTW2020DT
Prepared By	Nick Hannon
Prepared On	02/12/2021
Figure 03	Geology Solid (BGS 2021)

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA





GEOPHYSICAL SURVEY
- Survey Area

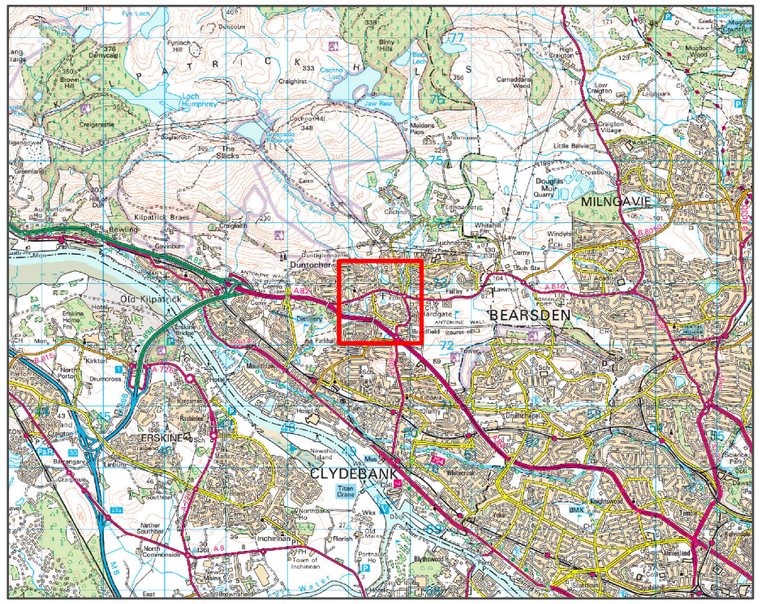
GEOLOGY - SOLID
- Blackhall Limestone
- Holybush Limestone
- Hurlet Limestone
- Lawmuir Formation - Sedimentary
- Lower Limestone Formation

North	Scale: 1:5,000 @ A3	Datum: OSGB 1936

Metres
0 100 200 300 400

Project Name	Duntocher Fort & Fortlet
Project Code	ANTW2020DT
Prepared By	Nick Hannon
Prepared On	02/12/2021
Figure 04	Historic Environment

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

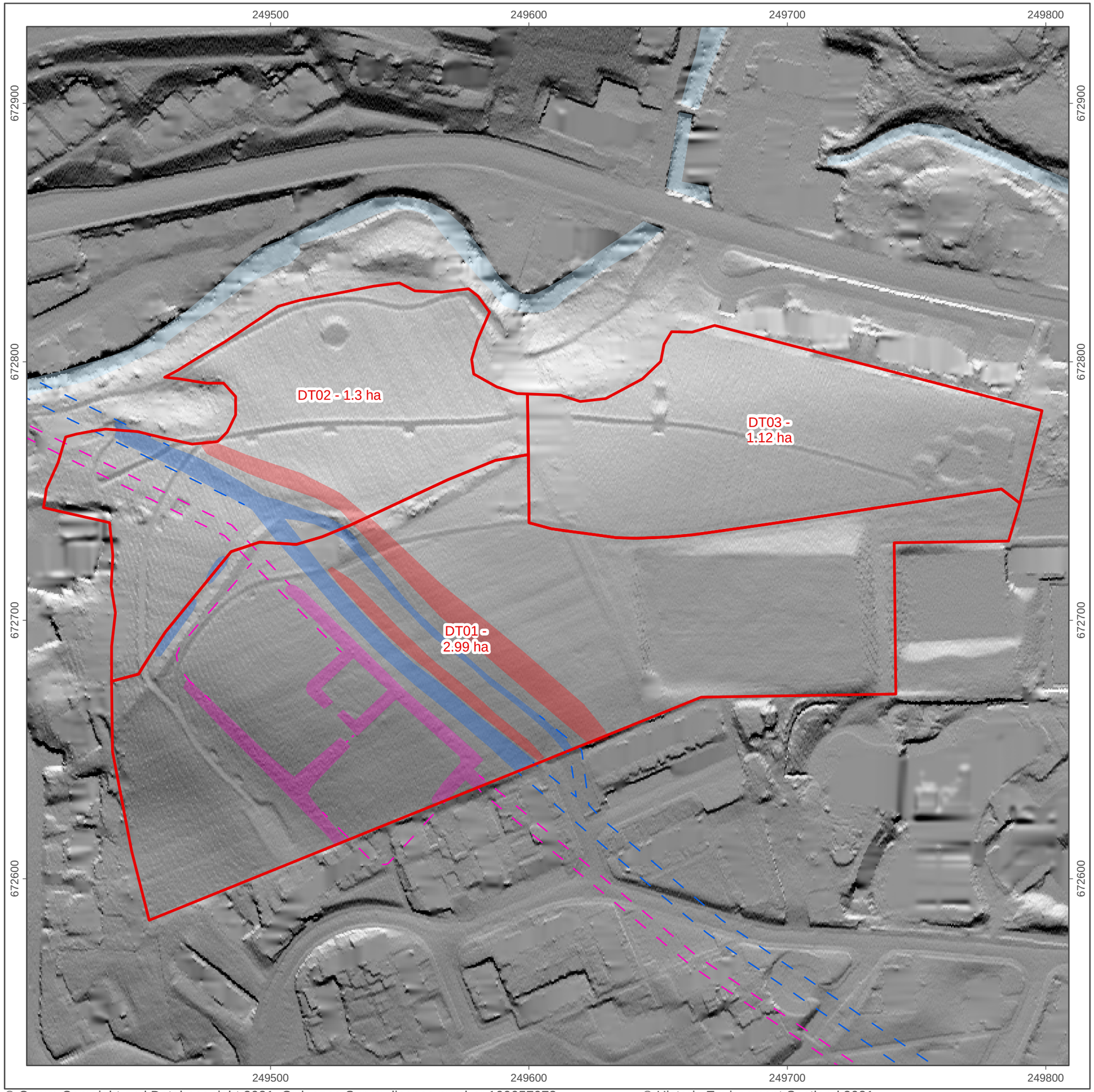


HISTORIC ENVIRONMENT

- Scheduled Monument
- Antonine Wall World Heritage Site

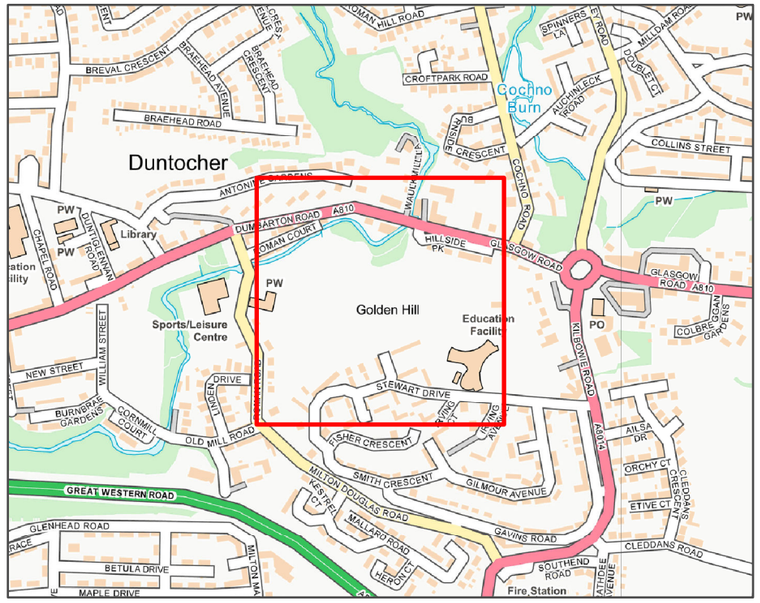
North	Scale: 1:5,000 @ A3	Datum: OSGB 1936

Metres: 0 100 200 300 400



Project Name	Duntocher Fort & Fortlet
Project Code	ANTW2020DT
Prepared By	Nick Hannon
Prepared On	02/12/2021
Figure 05	Historic Environment Scotland Commissioned LiDAR Data

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA



GEOPHYSICAL SURVEY
- Survey Area

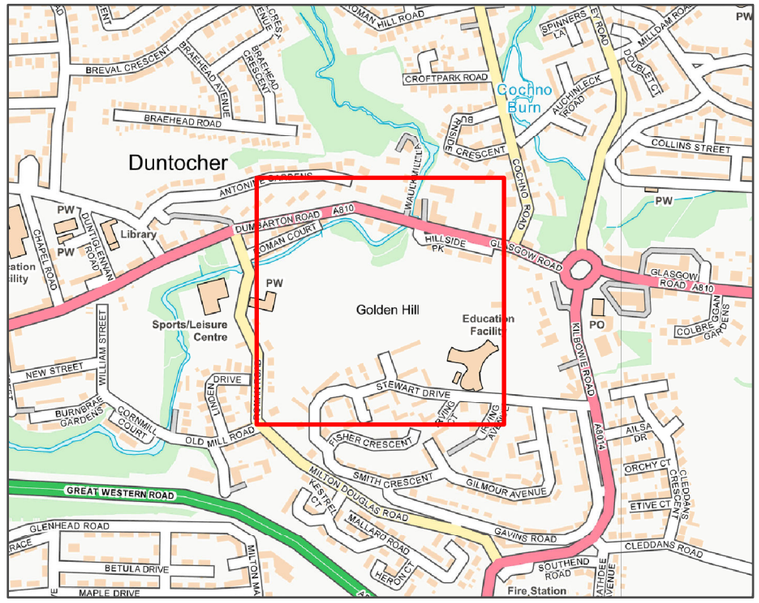
THE ANTONINE WALL
- Rampart
- Outer Mound
- Ditch
- Rampart - projected
- Ditch - projected

Resolution (metres)	0.50
Visualisation	Multi Direction Hillshade
Directions	64
Altitude (degrees)	35
Azimuth (degrees)	N/A
Stretch	Standard Deviation
Standard Deviations	2
Gamma	1
Z-Factor	1

North	Scale: 1:1,500 @ A3	Datum: OSGB 1936
	Metres 0 25 50 75 100	

Project Name	Duntocher Fort & Fortlet
Project Code	ANTW2020DT
Prepared By	Nick Hannon
Prepared On	02/12/2021
Figure 06	Historic Environment Scotland Commissioned Orthographic Photograph

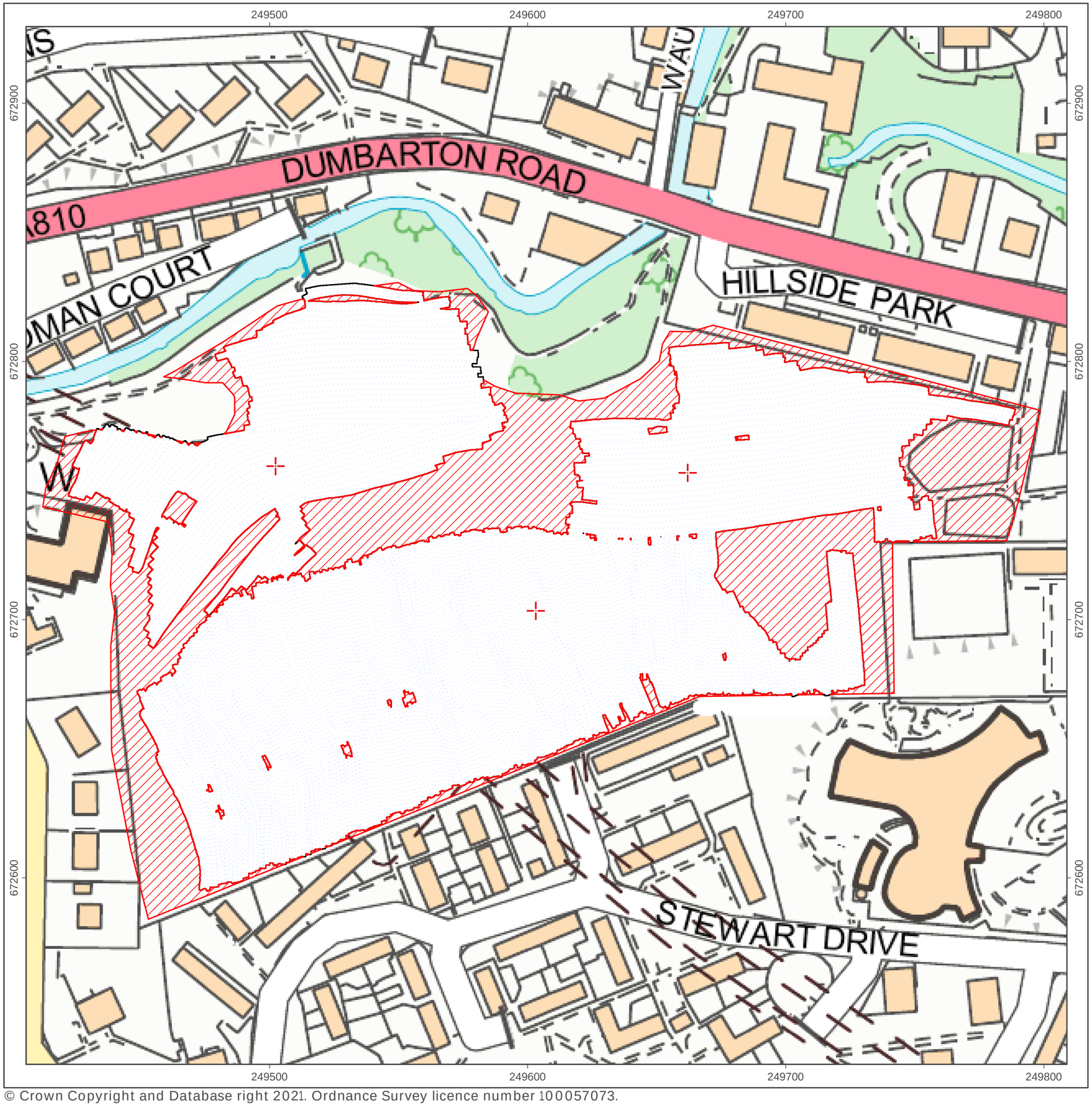
HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA



GEOPHYSICAL SURVEY

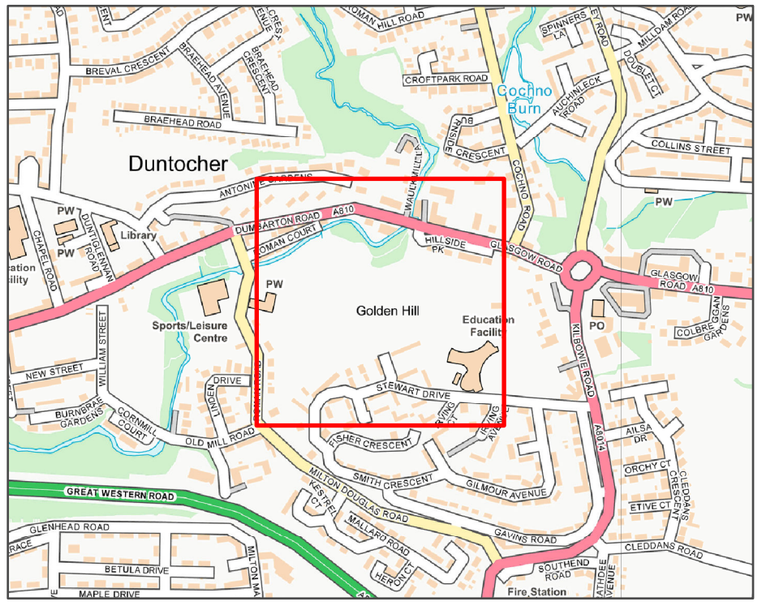
Survey Area

North	Scale: 1:1,500 @ A3	Datum: OSGB 1936
	Metres 0 25 50 75 100	



Project Name	Duntocher Fort & Fortlet
Project Code	ANTW2020DT
Prepared By	Nick Hannon
Prepared On	17/12/2021
Figure07	Gradiometer Survey GNSS Swaths & Calibration Position

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA



GEOPHYSICAL SURVEY

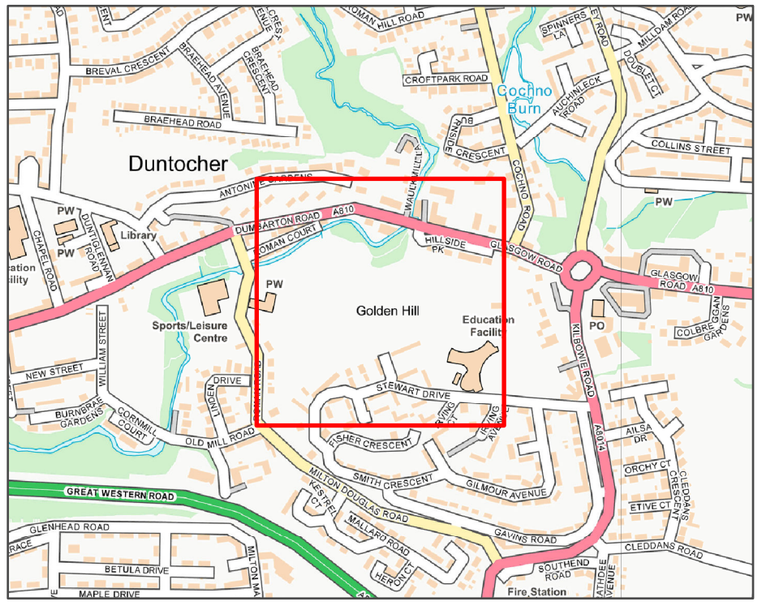
- Unsurveyable
- Calibration Position
- GNSS Breadcrumb

North	Scale: 1:1,500 @ A3	Datum: OSGB 1936

Metres: 0 25 50 75 100

Project Name	Duntocher Fort & Fortlet
Project Code	ANTW2020DT
Prepared By	Nick Hannon
Prepared On	03/12/2021
Figure 08	Minimally Processed Gradiometer Data - Greyscale Plot

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA



GREYSCALE PLOT

Value

50

-50

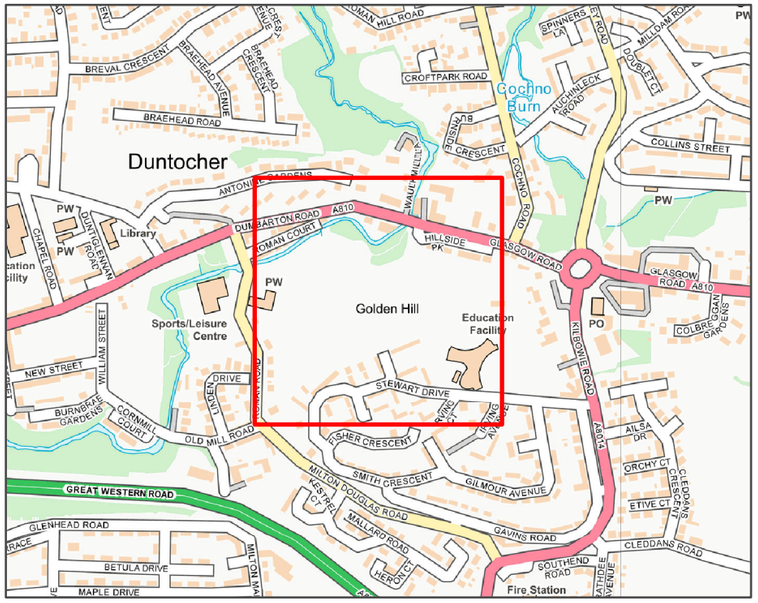
Cell size (m)	0.20
Stretch	Standard Deviation
Standard Deviations	1
Gamma	1

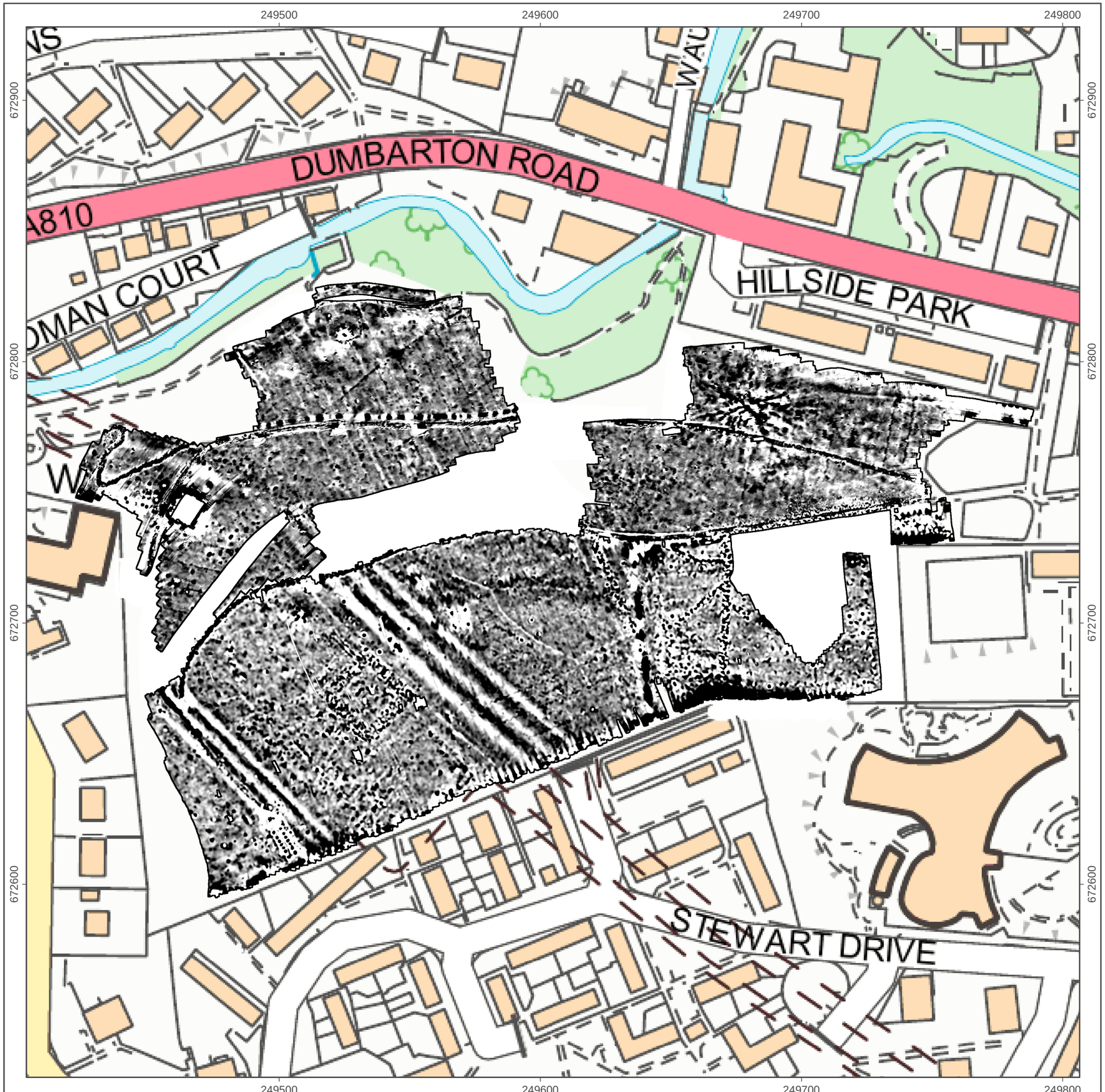
North	Scale: 1:1,500 @ A3	Datum: OSGB 1936

Metres 0 25 50 75 100

Project Name	Duntocher Fort & Fortlet
Project Code	ANTW2020DT
Prepared By	Nick Hannon
Prepared On	03/12/2021
Figure 09	Processed Gradiometer Data - Greyscale Plot

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA





GREYSCALE PLOT

Value

20

-20

Cell size (m)	0.12
Stretch	Standard Deviation
Standard Deviations	1
Gamma	1

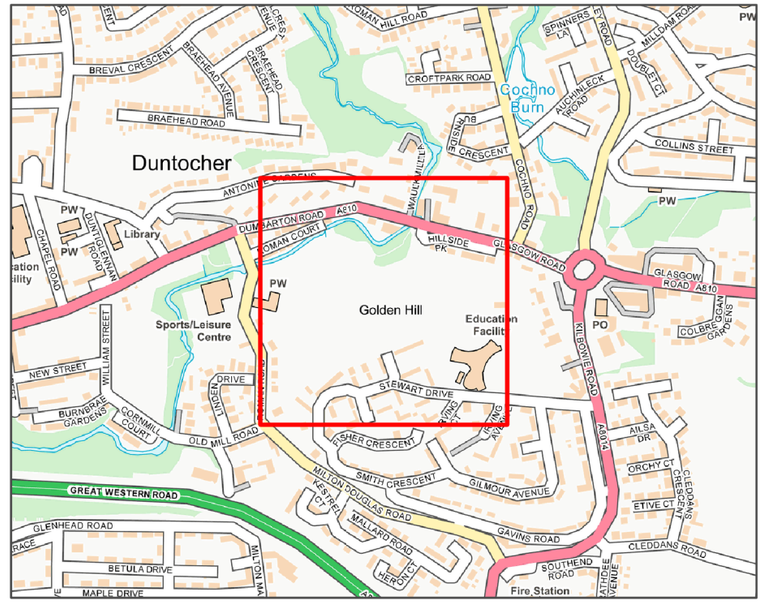
North	Scale: 1:1,500 @ A3	Datum: OSGB 1936

Metres

0 25 50 75 100

Project Name	Duntocher Fort & Fortlet
Project Code	ANTW2020DT
Prepared By	Nick Hannon
Prepared On	01/02/2022
Figure10	XY Trace Plot of Gradiometer Data

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA



GEOPHYSICAL SURVEY

Line_Type

XY Trace Plot

80 nT

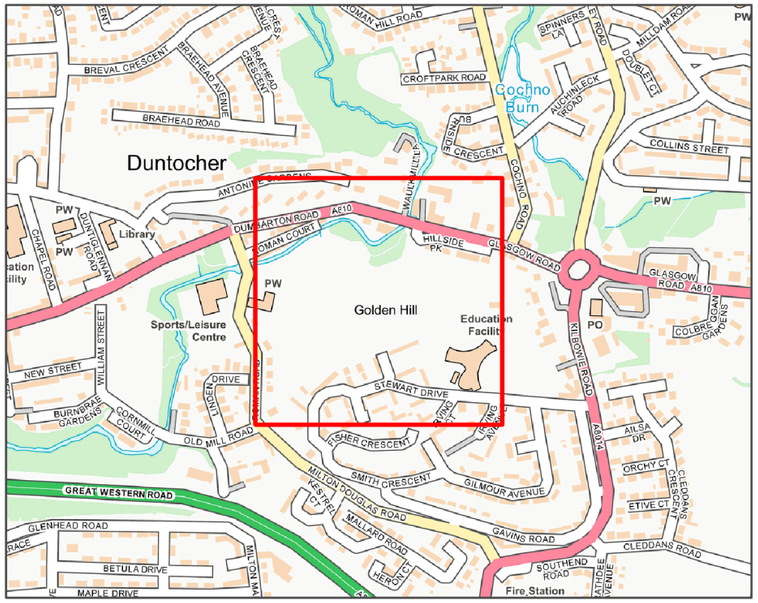
40 nT

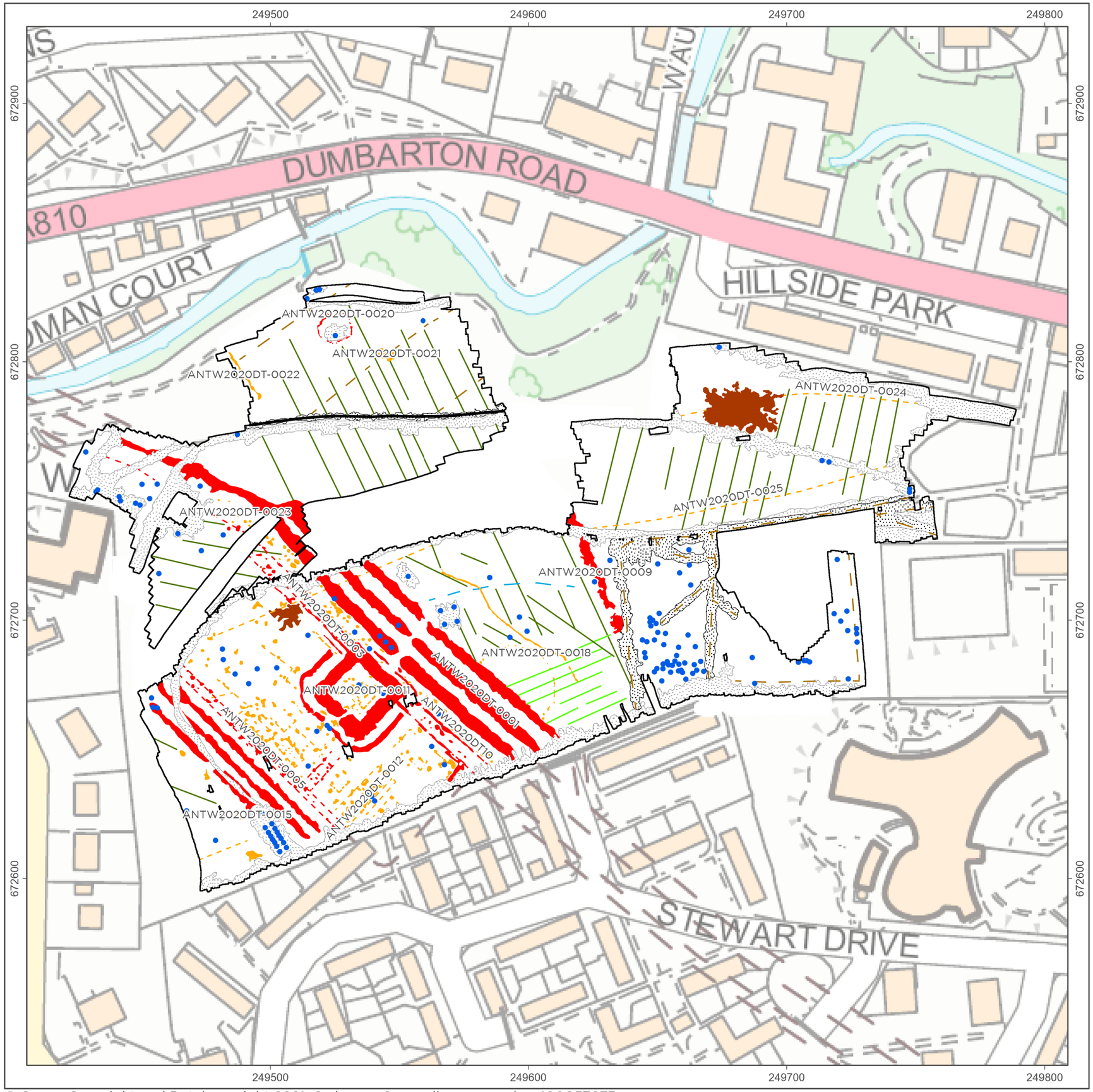
0 nT

North	Scale: 1:1,500 @ A3	Datum: OSGB 1936
	Metres 0 25 50 75 100	

Project Name	Duntocher Fort & Fortlet
Project Code	ANTW2020DT
Prepared By	Nick Hannon
Prepared On	14/02/2022
Figure 11	Interpretation of Gradiometer Data

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA





ARCHAEOLOGICAL INTERPRETATION

- Ferrous Spike
- Geology/Fluvial
- Linear Trend (Archaeology
- Linear Trend (Possible Archaeology)
- Linear Trend (Historic Agriculture)
- Linear Trend (Modern Agriculture)
- Linear Trend (Drainage)
- Linear Trend (Utility)
- Area of Disturbance (Modern)
- Enhanced Magnetism (Archaeology)
- Enhanced Magnetism (Possible Archaeology)
- Enhanced Magnetism (Area of Burning)
- Enhanced Magnetism (Utility)

North

Scale: 1:1,500 @ A3

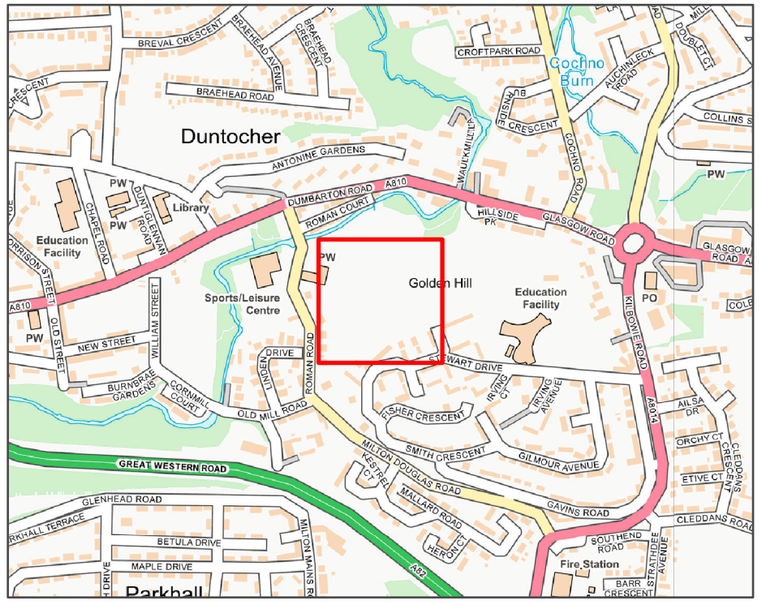
Datum: OSGB 1936

Metres 0 25 50 75 100

Project Name	Duntocher Fort & Fortlet
Project Code	ANTW2020DT
Prepared By	Nick Hannon
Prepared On	03/12/2021

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

Figure 12 — Processed Gradiometer Data - Greyscale Plot



GREYSCALE PLOT

Value

20

-20

Cell size (m)	0.12
Stretch	Standard Deviation
Standard Deviations	1
Gamma	1

North

Scale: 1:750 @ A3

Datum: OSGB 1936

Metres 0 10 20 30 40 50

Project Name	Duntocher Fort & Fortlet
Project Code	ANTW2020DT
Prepared By	Nick Hannon
Prepared On	06/05/2022
Figure 13	Interpretation of Gradiometer Data

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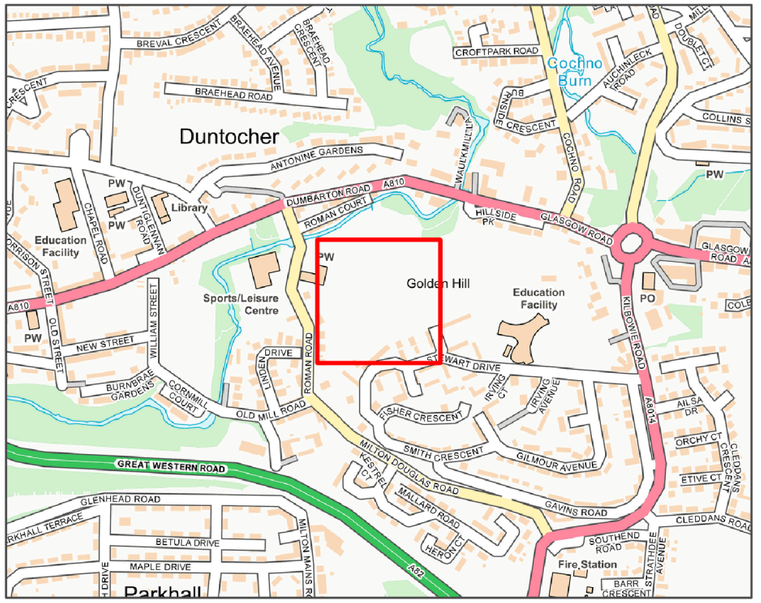
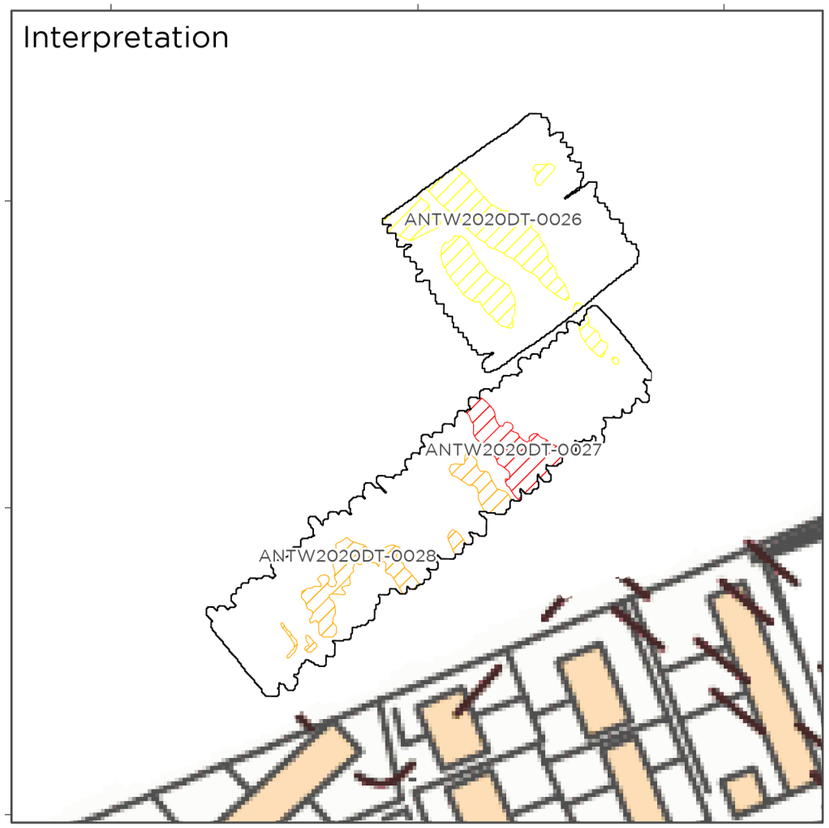


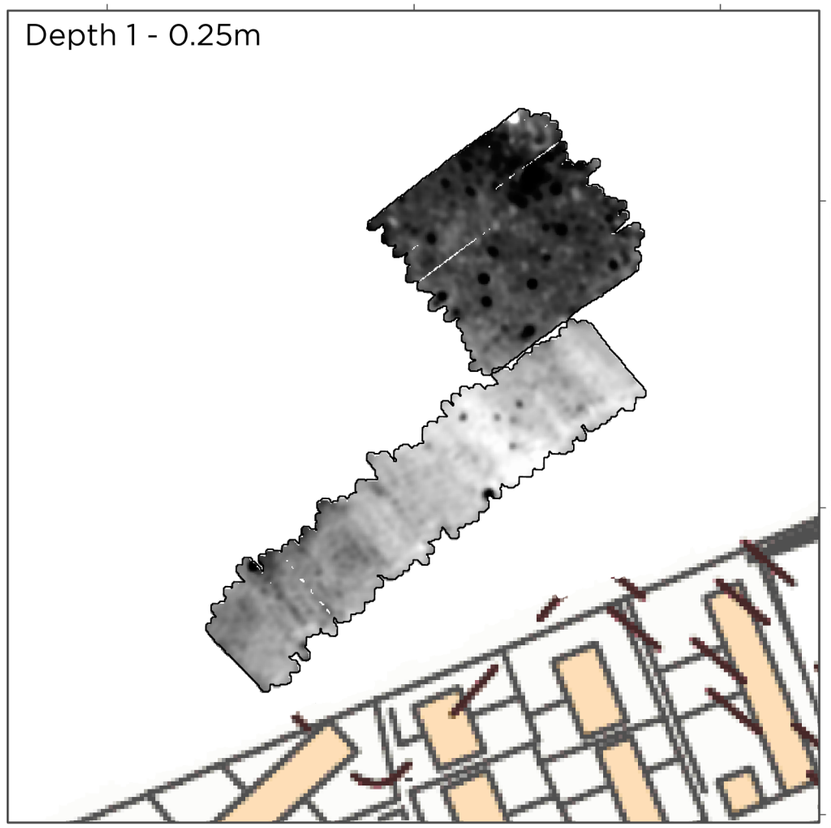
ARCHAEOLOGICAL INTERPRETATION

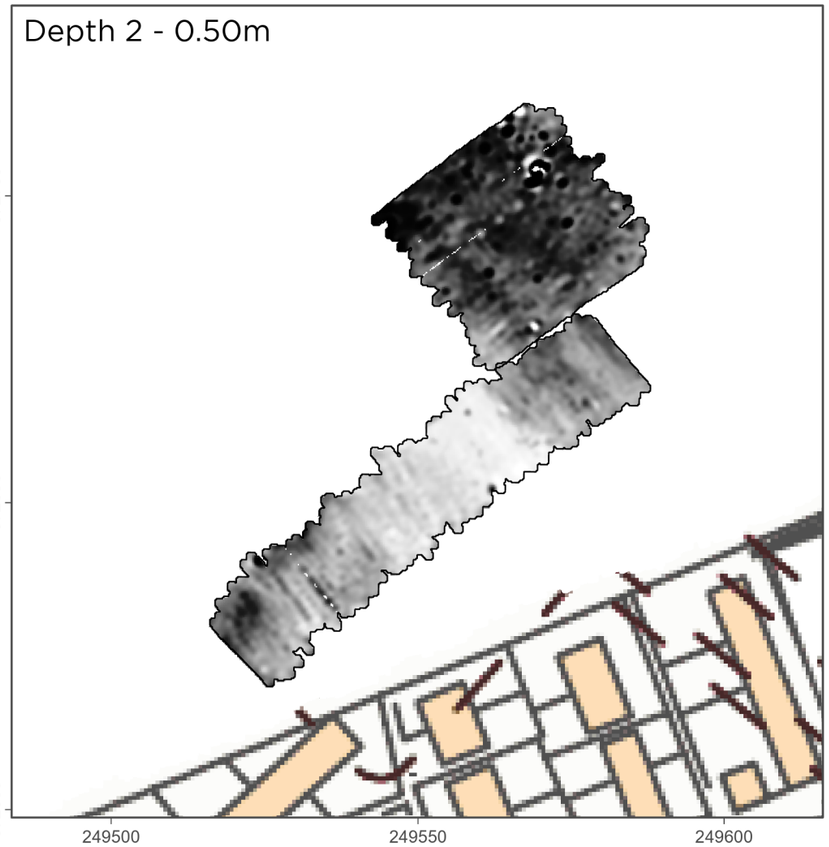
- Ferrous Spike
- Geology/Fluvial
- Linear Trend (Archaeology)
- Linear Trend (Possible Archaeology)
- Linear Trend (Historic Agriculture)
- Linear Trend (Modern Agriculture)
- Linear Trend (Drainage)
- Linear Trend (Utility)
- Area of Disturbance (Modern)
- Enhanced Magnetism (Archaeology)
- Enhanced Magnetism (Possible Archaeology)
- Enhanced Magnetism (Area of Burning)
- Enhanced Magnetism (Utility)

North	Scale: 1:750 @ A3	Datum: OSGB 1936

Metres 0 10 20 30 40







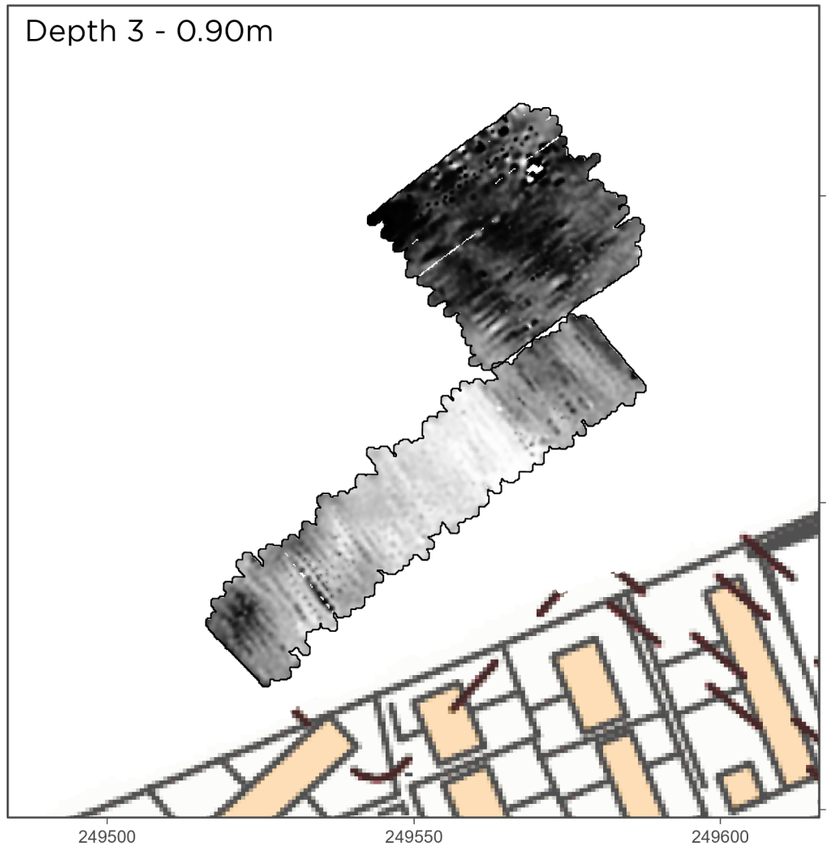


Figure 14	Processed Electro-magnetic Data & Interpretation Vertical Co-planar Conductivity
Project Name	Duntocher Fort & Fortlet
Project Code	ANTW2020DT
Prepared By	Nick Hannon
Prepared On	14/02/2022

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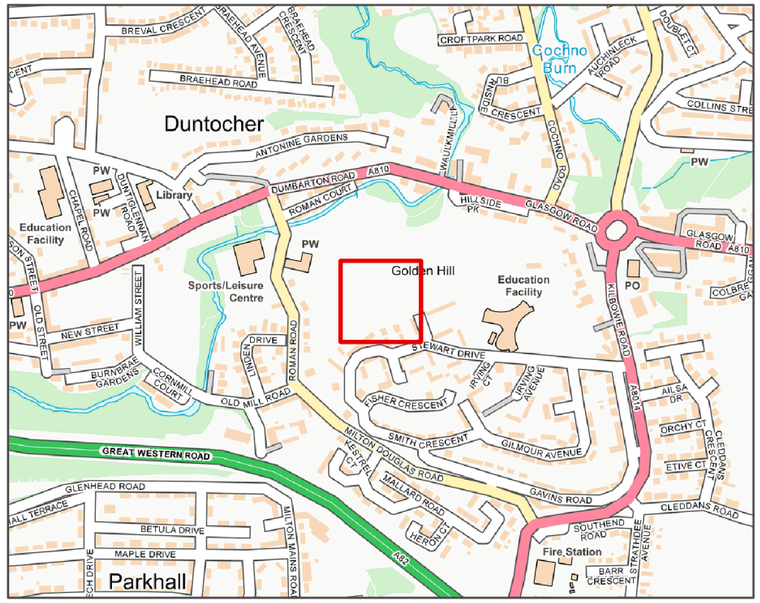


CONDUCTIVITY GREYSCALE

Value

8

0

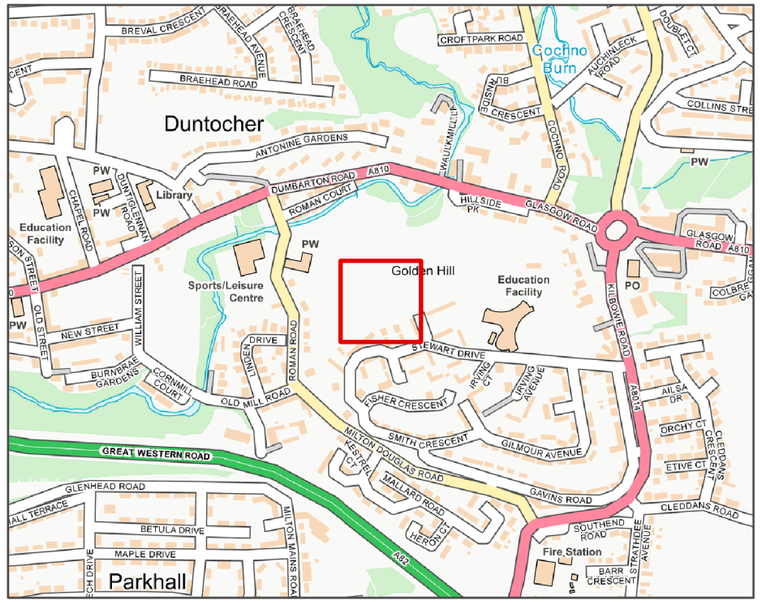
- High Conductivity
- Low Conductivity
- Very Low Conductivity

North	Scale: 1:1,000 @ A3	Datum: OSGB 1936

Metres 0 20 40 60 80

Figure 15	Processed Electro-magnetic Data & Interpretation Horizontal Co-planar Conductivity
Project Name	Duntocher Fort & Fortlet
Project Code	ANTW2020DT
Prepared By	Nick Hannon
Prepared On	14/02/2022

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA



CONDUCTIVITY GREYSCALE

Value

12

0

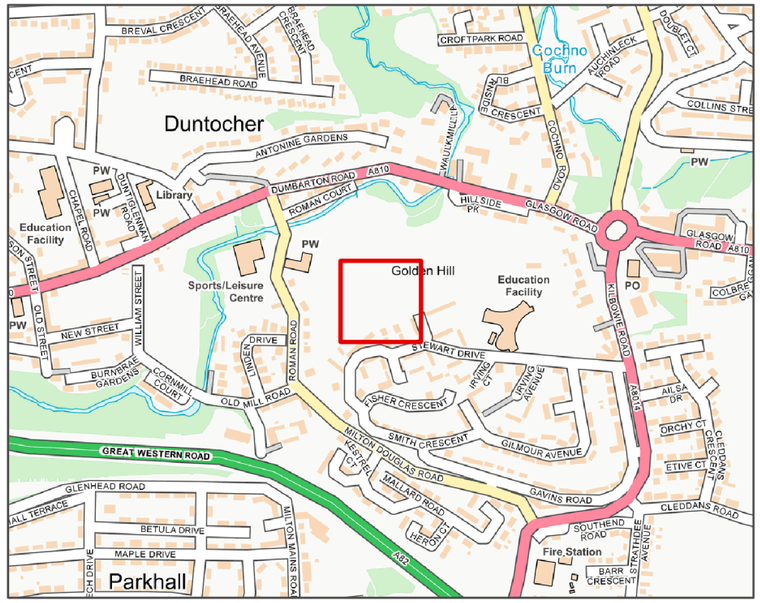
- High Conductivity
- Low Conductivity
- Very Low Conductivity

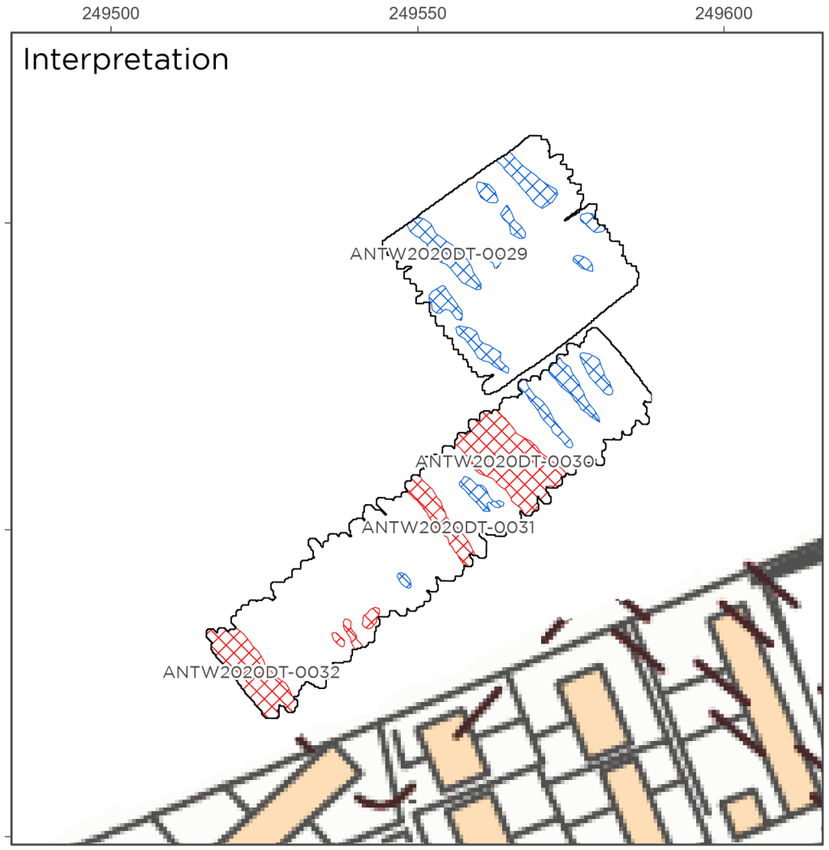
North	Scale: 1:1,000 @ A3	Datum: OSGB 1936

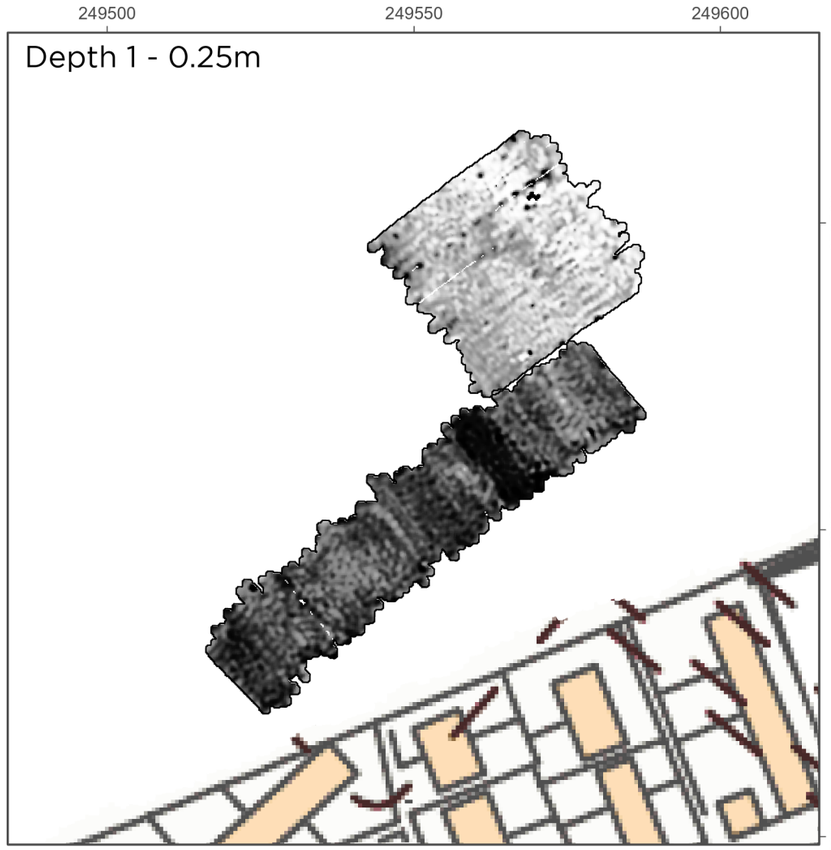
Metres 0 20 40 60 80

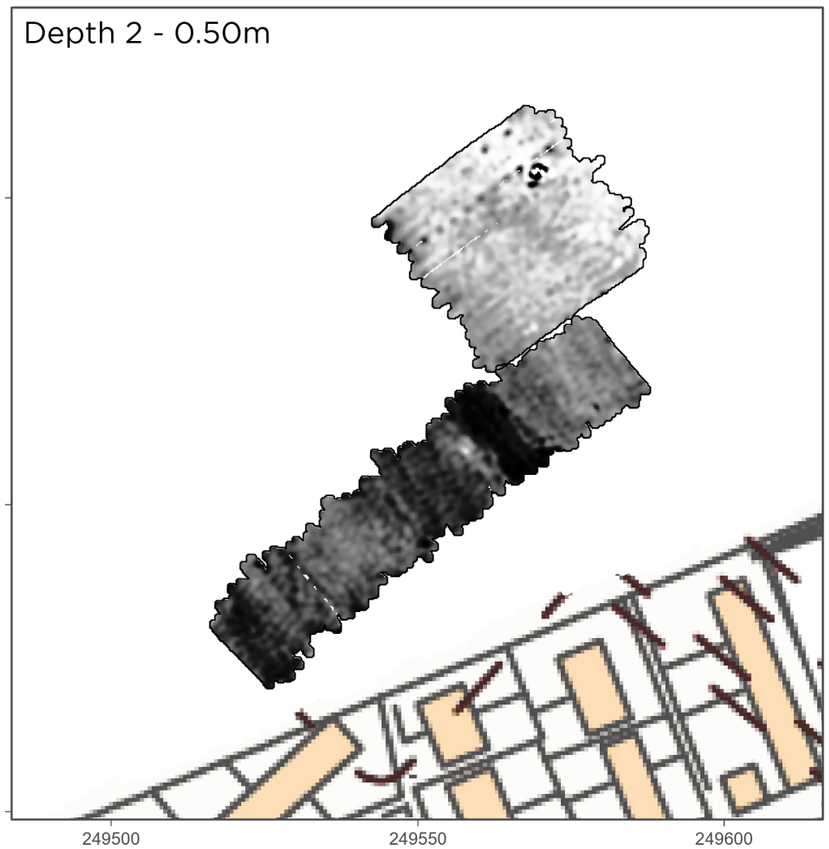
Figure 16	Processed Electro-magnetic Data & Interpretation Vertical Co-planner Magnetic Susceptibility
Project Name	Duntocher Fort & Fortlet
Project Code	ANTW2020DT
Prepared By	Nick Hannon
Prepared On	14/02/2022

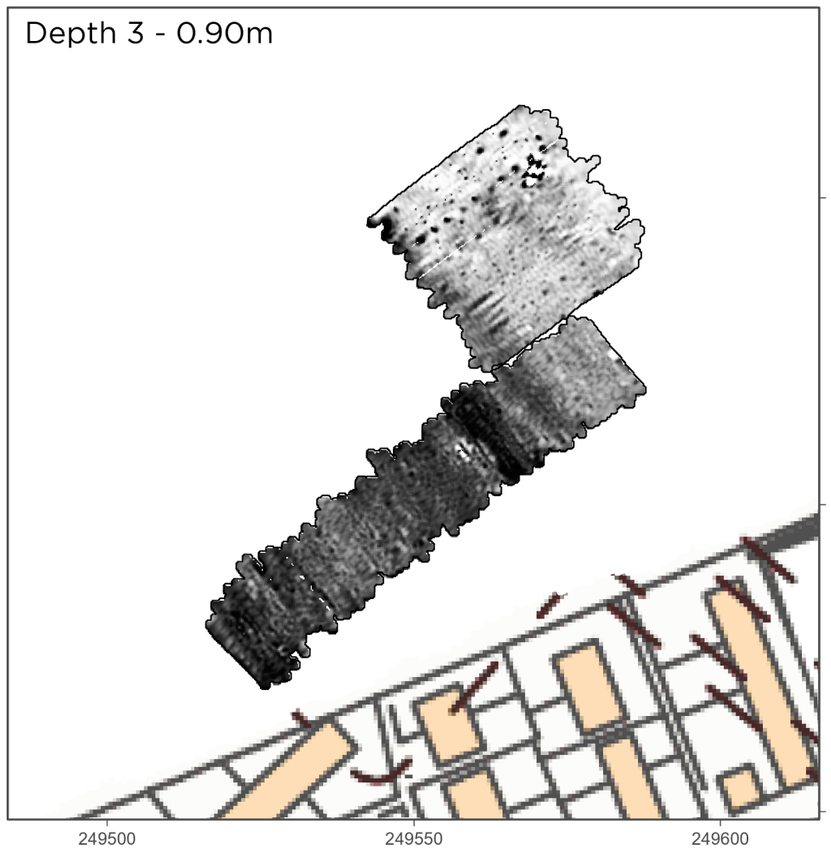
HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA











249500 249550 249600
672700 672650 672600

MAGNETIC SUSCEPTIBILITY GREYSCALE

Value

8

0

High Magnetism

Low Magnetism

North

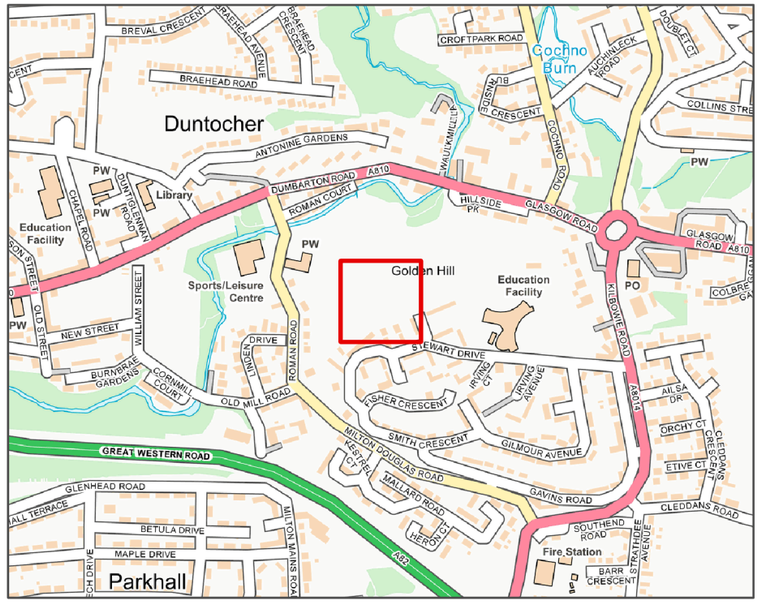
Scale: 1:1,000 @ A3

Datum: OSGB 1936

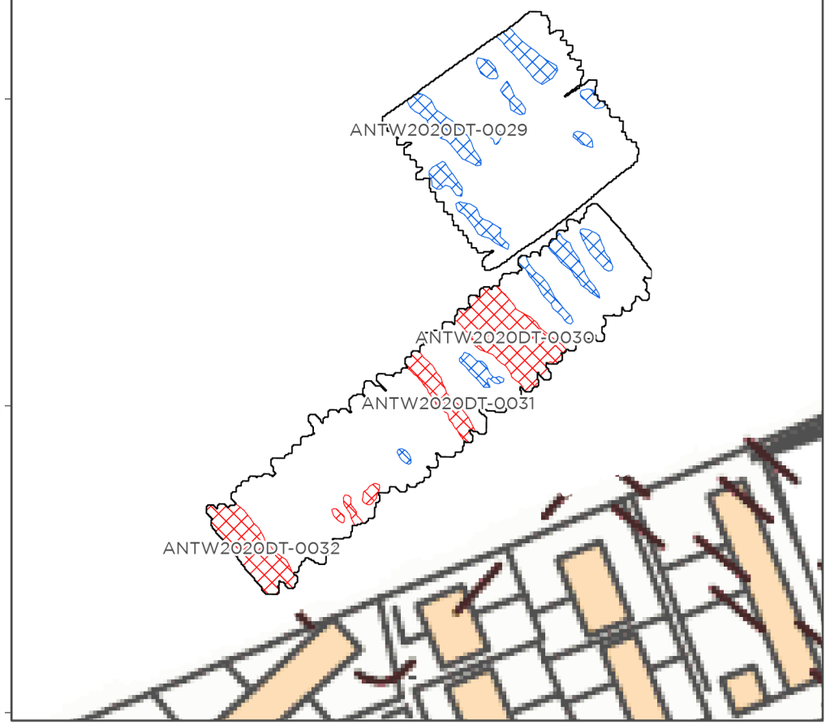
Metres 0 20 40 60 80

Figure 17	Processed Electro-magnetic Data & Interpretation Horizontal Vertical Co-planar Magnetic Susceptibility
Project Name	Duntocher Fort & Fortlet
Project Code	ANTW2020DT
Prepared By	Nick Hannon
Prepared On	14/02/2022

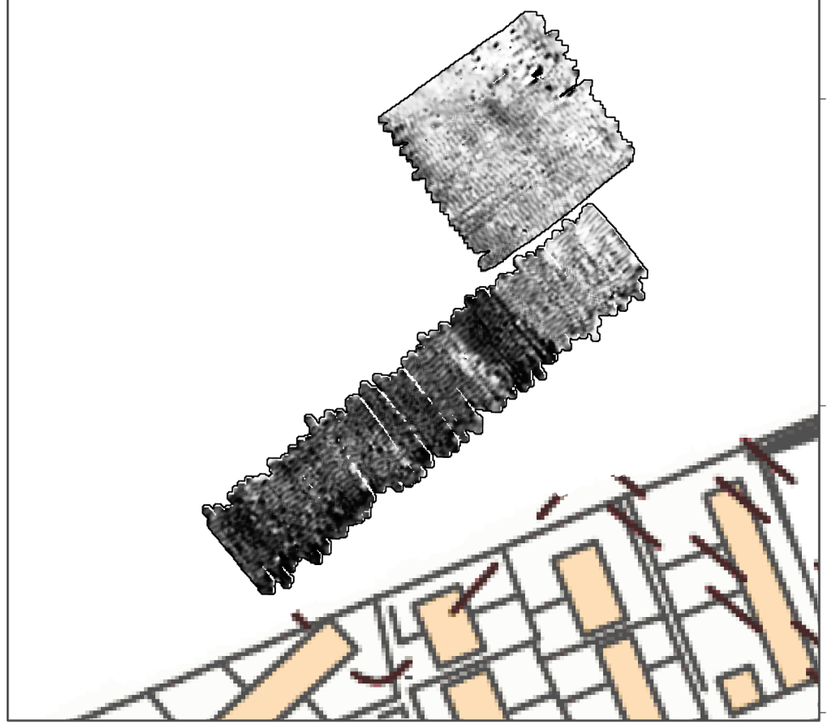
HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA



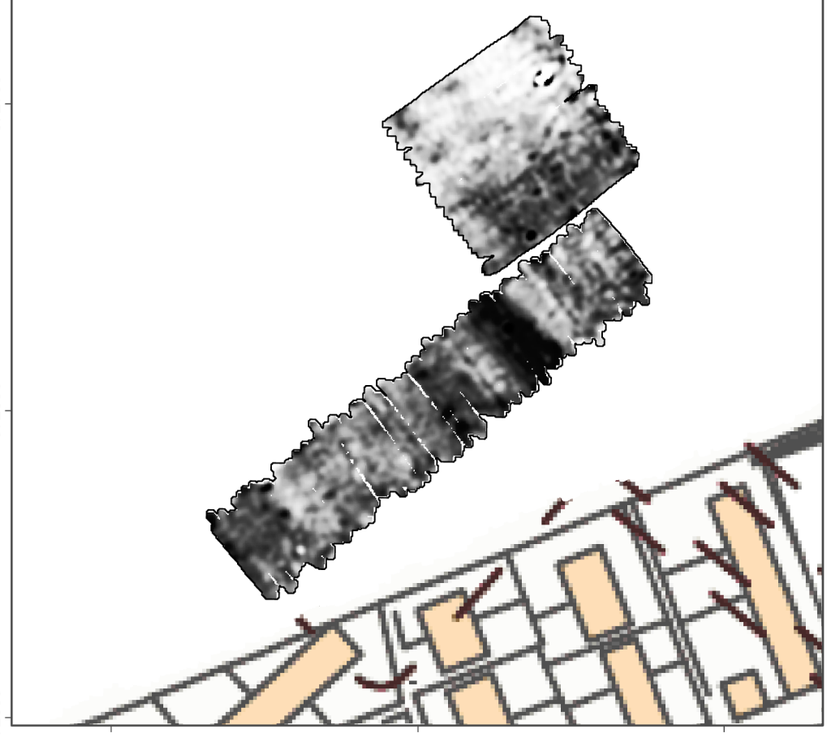
Interpretation



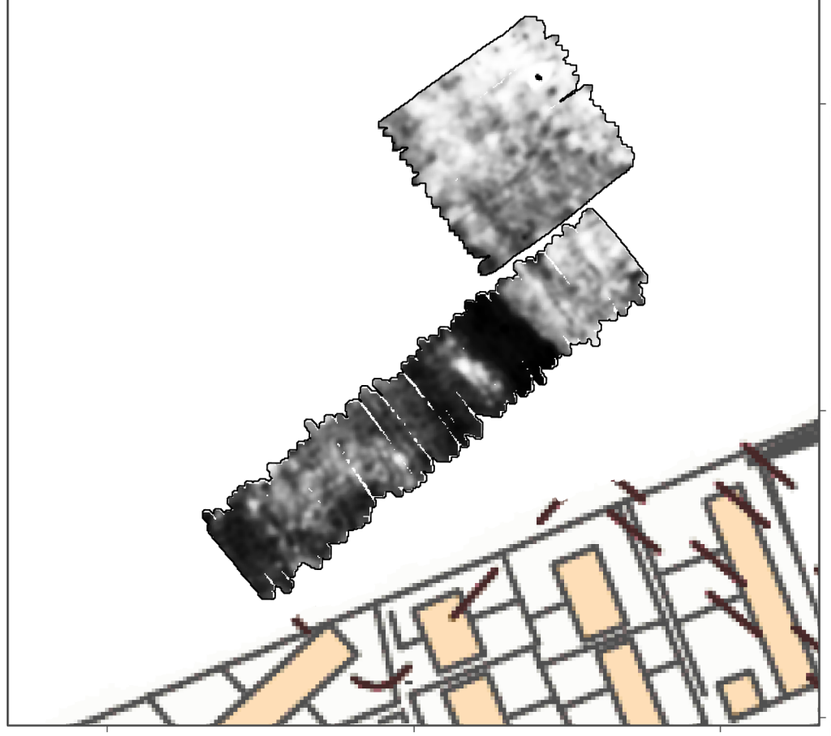
Depth 1 - 0.50m



Depth 2 - 1.00m



Depth 3 - 1.80m



249500 249550 249600

672700 672650 672600

MAGNETIC SUSCEPTIBILITY GREYSCALE

Value

10

0

High Magnetism

Low Magnetism

North

Scale: 1:1,000 @ A3

Datum: OSGB 1936

Metres 0 20 40 60 80

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HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

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