
# Tyddyn Mostyn

# Porthaethwy

Geophysical Survey

PN: 3968

January 2023

360 ARCHAEOLOGY

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# Porthaethwy

Geophysical Survey

January 2023

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| **Project reference** | **3968** |
| **GAT project #** | **G2753** |
| **On behalf of** | **Gwynedd Archaeological Trust** |
| **Report prepared by** | **Nigel Barker BA, MA, MCIfA** |
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# 1 Contents

**CAD Drawings: 3968**

| Drawing Number | Paper Size | Scale | Title |
|---|---|---|---|
| 3968-01 | A3 | Various | Site Location & Survey Extents |
| 3968-02 | A2 | 1:500 | Magnetic Greyscale Data |
| 3968-03 | A2 | 1:500 | Magnetic Interpretation |

## 2 Executive Summary

This report presents the results of a geophysical survey undertaken at Tyddyn Mostyn, Porthaethwy, Ynys Môn, LL59 5AX.

The magnetic survey covered approximately 1.7ha of scrub. The ground conditions were poor and contained areas of burning, tipped materials and accumulations of wood and tree stumps from recent clearances.

The survey results were dominated by magnetic disturbance likely to be from localised burning and ferrous tipped materials that would override weaker responses from any possible underlying buried features.

Several undetermined anomalies were identified that are of varying strengths, however there is insufficient form and context to determine if they are of archaeological interest.

Strong, broad anomalies probably derived from natural sub-surface features were also detected that are likely to reflect changes in the underlying geology or superficial deposits.

# 3 Introduction

A geophysical survey was commissioned at Tyddyn Mostyn, Porthaethwy, Ynys Môn by Gwynedd Archaeological Trust, in support of a consultation for a proposed development. The survey area measured approximately 1.7ha in total, encompassing an area of scrub. The extents are shown as the red shaded area in Figure 1 below.


Ordnance Survey Data © Crown copyright and database right 2023

Figure 1

## 3.1 *Location and land use*

The location and scaled survey areas are shown in drawing 3968-01.

| | |
|---|---|
| **NGR Centre** | SH 55500 72395 |
| **Postcode** | LL59 5AX |
| **HER/SMR** | Archwillio Gwynedd |
| **HER Number** | N/A |
| **Period** | N/A |
| **District** | Ynys Môn |
| **Parish** | Llandesilio |

| Area | Hectares | Topography & Notes | Land Use |
|---|---|---|---|
| 1 | 1.7 | Area of partially cleared scrub, sloping from north to south. Rock escarpments were present along the northern perimeter with wooded and overgrown areas present throughout the extents. Evidence of recent burning along with surface metallic debris and accumulations of wood from the tree clearances were evident predominately along the northern half of the area. | Partially cleared scrub |

### 3.2 *Aims and objectives*

The key aim and objective of the geophysical survey was to establish the extent to which potential archaeological remains survive within the survey area.

It was proposed that magnetometry was used as a primary, rapid reconnaissance technique, to locate any buried archaeological features. Any anomalies likely to be anthropomorphic could then be targeted intrusively, if required. A detailed magnetometer survey has the potential to identify targets with enhanced magnetic susceptibility such as ditches, pits, former field systems and palaeochannels. Fired structures such as hearths, kilns and ovens and accumulations of ferrous metal within the sub-surface can be detected using this technique.

The success of the magnetic survey in locating archaeological features is dependent upon a measurable contrast between the anomaly and the surrounding ground. Not all surveys produce good results, as buried features can be masked by large magnetic variations in the geology or soil. In some instances, there may be little variation between the topsoil and subsoil resulting in undetectable buried features. The presence of ferrous metals, made ground and recently burnt remains will all produce strong responses that can obscure the presence of sub-surface archaeological features.

### 3.3 *Site history*

A desk-based assessment (DBA) was not available at the time of the fieldwork.

### 3.4 *Geology and soils*

The predominant underlying geology of the survey area comprises Gwna Group – Schist (green in Figure 2). This is a Metamorphic bedrock formed between 635 to 508 million years ago during the Ediacaran and Cambrian periods. Two intrusions of Gwna Group – Metabasaltic rock occur running in a north-south orientation within the survey area (light brown in Figure 2). This is a Metamorphic bedrock also formed between 635 and 508 million years ago during the Ediacaran and Cambrian periods. The superficial geology is undetermined (British Geological Survey: 2023). Magnetic surveys are considered suitable for such geologies.


Figure 2 (www.bgs.ac.uk)

### 3.5 *Dates and additional information*

The geophysical survey was undertaken on the 9th and 10th January 2023, under mixed weather conditions. Multiple areas containing dense vegetation, accumulations of wood and stumps from the tree clearances could not be surveyed.

## 4 Field Methodology

### 4.1 *Technique*

A detailed magnetic survey was undertaken as the most appropriate means of assessment. Magnetometers detect small variations in the Earth's magnetic field to locate buried anomalies associated with human activity. Usually, the topsoil will contain increased ferrous minerals compared to that of the sub-soil, caused by a complex fermentation effect and therefore has a higher magnetic susceptibility in non-igneous geologies. Under suitable ground conditions, features cut into the sub-soil that are later backfilled or gradually silted up, will be shown to contain a greater amount of iron material, and will be magnetically enhanced in comparison to the sub-soil. Strong magnetic readings can also be produced by archaeological features such as kilns, ovens, hearths, and destructive burning that acquire a thermo-remnant magnetic field upon cooling and a permanent magnetic signature within the subsurface.

The survey was undertaken in accordance with Historic England (2008) Guideline No 1, Geophysical survey in archaeological field evaluation, and the Charted Institute for Archaeologists (2014), Standard and guidance for archaeological geophysical survey.

### 4.2 *Geomatic referencing*

The survey control was predefined in AutoCAD prior to the commencement of the fieldwork using topographic drawing *'Tyddyn Mostyn, Extended 3D.dwg'*. Base lines were plotted within the field to ensure even data coverage. The grid points associated with the base lines were exported from CAD then imported into a Trimble R10 Global Positioning System (GPS). This instrument was used to set out the grid points within the fields using bamboo flags as non-magnetic markers. Survey tapes were used for heading and positional markers.

### 4.3 *Instrumentation*

A SENSYS MAGNETO MX PDA 5 channel survey platform was used for the detailed area gradiometer survey. The platform was GPS enabled using a mounted Trimble R12 antenna and hosted five FGM650/3 sensors spaced 0.5m apart.

### 4.4 *Data Collection*

The data was logged by a field computer mounted on the platform running MonMX Software. The software stored a GPS position every second from the NMEA stream with the gradiometer sensor readings recorded at 100Hz. The platform was pushed by the operator in straight traverses using the baselines for heading references.

To prevent drift within the data from external influences such as diurnal temperature changes, the system was stabilised within a magnetically quiet area prior to data collection.

### 4.5 *Post-processing*

The data collected using the multi-sensor platform was prepared for export using SENSYS DLMGPS software. The system geometry was revised, and the results exported as a suitable .XYZ file for importation into Terrasurveyor 64 v.4.0.5.3 software for further processing, interpretation and presentation.

Processing was kept to a minimum to prevent the creation of artificial artefacts in the data. The processing involved:

- Base Parameters – adjustments made to set the X&Y interval of the interpolated data and the density of points used within the data sets.
- De-stripe – applied to compensate for drift that occurs between the sensors.
- De-stagger – applied to compensate for heading errors caused in GPS cart-based systems by mechanical errors in the recording triggering system.

The data was clipped at a level deemed appropriate to best show any possible archaeology and exported as processed greyscale images.

The final raster images were loaded into CAD software, where they were geo-referenced and used for interpretation.

### 4.6 *Data presentation*

The magnetic data results are presented as a 1:500 grayscale data plot in drawing 3968-02.

### 4.7 *Archive*

360 Archaeology & Heritage LTD hold a full in-house digital archive resulting from the project including all raw and processed data, geomatics, plans, documents, and written material.

## 5 Results

The results of the gradiometer survey are a representation of the measured values of the subsurface, shown in drawing 3968-03. The success of a magnetic survey detecting archaeological features is largely dependent upon a measurable contrast between the buried feature and the surrounding ground. Where anomalies cannot be associated with known features from existing source material, they will be interpreted as either probable or possible archaeology. Probable archaeology will be based on strength of response, typology and the relationship to known archaeology. Possible archaeology will usually be of poor anomaly definition and not supported by other data.

### 5.1 *Categories of Interpretation (Drawing 3968.03 Key)*

| Interpretation Category | Description |
|---|---|
| Probable Archaeology | Anomalies that are likely to be archaeological due to the strength of response, typology or corroboration by other source materials. |
| Possible Archaeology / Weak Responses | Anomalies that could be archaeological, usually with a low magnetic response, fragmented and not corroborated by other source materials. |
| Undetermined Responses | Anomalies that are usually fragmented or lack a defined morphology to be readily identified as anthropogenic. Could also be associated with modern features or changes in the underlying geology or topography. |
| Known Buried Field Boundary | Anomalies that are likely to be from former field boundaries and that are usually documented as historical mapping. |
| Possible Buried Field Boundary | Linear and curvilinear anomalies that are weak, fragmented or not documented as historical mapping. |
| Magnetic Disturbance / Iron Spikes | Usually dipolar and associated with ferrous metal or thermoremanent materials within the sub-surface. Normally derived from tipped materials but also cultural noise from metallic features on the surface. Accumulations of igneous rock can also produce similar responses. Could be of interest when associated with probable or known archaeological features. |
| Natural Buried Features/ Geological Trend | Broad magnetic responses within the subsurface, likely to be from variations in the underlying geology, alluvial deposits, palaeochannels or a change in topography. |
| Cultural Magnetic Spread | Very strong responses possibly from thermoremanent |

| | |
|---|---|
| | magnetization or accumulations of ferrous metal from tipped materials, night soil or ash accumulations from human occupation, agriculture or industry. Spread could be archaeological when associated with known archaeological sites or supported by source material. |
| Ridge & Furrow Cultivation | Broad, parallel linear anomalies, probably associated with ridge and furrow cultivation using non-reversable ploughs. |
| Agricultural (Modern) | Narrow, parallel responses common with modern ploughing techniques. |
| Field Drainage | Parallel, linear responses likely to be surface water drainage. Positive responses are usually from vitrified clay pipes with weaker and negative responses from plastic pipes within cut trenches or gravel filled channels. |
| Buried Utilities | Linear features likely to be associated with buried metallic pipes or cabling, usually having a characteristic repetitive positive/negative bipolar signature. |

### *5.2 Discussion*

#### *5.2.1 Probable and Possible Archaeology*

No probable or possible archaeological anomalies were identified within the magnetic data.

#### *5.2.2 Magnetic Disturbance / Iron Spikes*

Areas of strong magnetic disturbance dominate the data that are likely to correspond to spreads of metallic debris as well as pockets of localised burning evident on the surface. The isolated dipolar iron spikes represented on the drawing have very high magnetic values that probably originate from surface or near-surface ferrous materials.

#### *5.2.3 Natural Buried Features*

Strong, broad anomalies likely to be derived from natural sub-surface features occur within the data. They appear to run in a north to south orientation and could reflect changes in the underlying geology or superficial deposits. It is possible that they correlate to the Metabasaltic rock intrusions shown in the geological mapping.

#### *5.2.4 Undetermined Responses*

Several areas of magnetic enhancement were detected that were not readily identifiable as archaeological, natural, or derived from magnetic disturbance. They have therefore been categorised as undetermined.

## 6 Conclusions

The geophysical survey results are dominated by spreads of magnetic disturbance likely to be the responses from modern burned and tipped magnetic materials. It is possible that additional buried features may have been obscured by the overriding responses from the magnetic disturbance and remain undetected. Two broad magnetic anomalies likely to correspond to changes in the underlying geology were present running in a north to south orientation through the survey area. Several magnetic enhancements were also detected that have an undetermined origin and lack any suitable form or context to be of archaeological interest.

***As with all geophysical investigations, the results presented are not infallible and are derived from data that is representative of the ground conditions at the time of the survey. Where possible, the magnetic data should be used in conjunction with supporting evidence and resources to corroborate or eliminate these findings.***

# 7 References


- Historic England (English Heritage 2008) *Geophysical Survey in Archaeological Field Evaluation. Research and Professional Services #1.*
- Institute of Field Archaeologists (2002) IFA Paper No 6, *The use of geophysical techniques in archaeological evaluations.*
- European Archaeological Council - EAC Guidelines 2 (2015) *Guidelines for the use of Geophysics in Archaeology: Questions to Ask and Points to Consider*
- Charted Institute of Archaeologists (2014) *Standard and Guidance for Archaeological Geophysical Survey.*
- British Geological Survey – Geology of Britain Viewer - www.bgs.ac.uk
- Cover: Ordnance Survey – OS One-Inch Revised New Series - Sheet 106 – Bangor (Hills) – Scale one inch to the mile: 1899.

# 8 Appendix 1

## Detailed Magnetic Survey

### 8.1 *Theory*

A detailed magnetic survey involves the detection of small variations in the Earth's magnetic field to locate buried anomalies associated with human activity. Usually, the topsoil will contain an increased amount of ferrous minerals than that of the sub-soil, caused by a complex fermentation effect and will have a higher magnetic susceptibility in non-igneous geologies. The action of digging a ditch or excavating a floor can expose the sub-soil layer that can be filled with debris or topsoil as they are in-filled or silted up. The features will then be magnetically enhanced in comparison to the sub-soil. The strength of the anomaly detected by the instrumentation is largely dependent upon the measurable contrast between the buried feature and the surrounding material.

In addition, the action of heating weakly magnetic compounds will convert them to oxides that are demagnetised as they reach their relative Curie temperatures. When cooled they become permanently magnetised and aligned with the geomagnetic field present at the time of heating, which is generally greater than the ground that has not been exposed to the high temperatures. This process is referred to as thermoremanence and can be indicative of human activity as kilns, ovens, hearths, and destructive burning will all leave a permanent magnetic signature within the subsurface.

### 8.2 *Instrumentation*

Fluxgate gradiometer instruments are commonly used for magnetic surveys. They have two vertically positioned sensors that have a separation of between 0.5m – 1.0m. Both sensors measure the Earth's magnetic field, however the bottom sensor will be affected by local variations in the field created by weakly magnetised buried features. To determine the strength of the buried anomaly, the value of the top sensor is removed from the value of the bottom sensor. This is the magnetic gradient and is measured in nanoteslas (nT). The readings are instant and shown in real-time on a display built into the instrument and can also be stored in an internal logger. 360 Archaeology & Heritage LTD will use either a Bartington Grad 601-2 fluxgate gradiometer or a SENSYS MAGNETO MX PDA 5 channel survey platform to undertake magnetic surveys.

### 8.3 *Survey Method*

#### 8.3.1 *Gridded Survey*

An orthogonal grid system is used for the gradiometer survey and is established using either a 1-person robotic total station or a Global Positioning System (GPS) instrument. For surveys covering large areas, the grid will be drawn in CAD software and overlain onto Ordnance Survey digital data to be used as a backcloth for the co-ordinates. The co-ordinates can then be transferred to the survey instrument prior to arrival on site. For small areas, a local grid can be established on site to ensure a best fit. If a local grid is used then survey stakes will be established around the perimeter of the survey area. This will ensure that the co-ordinates of any detected anomalies can be easily targeted at a later date.

Each grid square will measure either 20m or 30m. The size used is dependent upon the size and shape of the survey area. Trapeze ropes are used by the operator as a reference for both positioning and heading.

A base point with a stable magnetic background will be established either within the survey area or external to it dependent upon ground conditions. The instrument will be balanced from this point and checked regularly for drift. Readings will be taken using the 0.1nT range every 0.25m over 1m traverses.

### *8.3.2 GPS Enabled Survey Platform*

A multi-channel survey platform will be used for the GPS enabled surveys. The platform will comprise of a mounted GPS antenna along with several gradiometer sensors that are mounted on a non-magnetic cart. The data is collected by a field computer mounted on the platform, the software recording a GPS position every second from the GPS NMEA stream along with the sensor readings. The platform is pushed by the operator in straight traverses using the baselines for heading references.

To prevent drift within the data from external influences such as diurnal temperature changes, the system is stabilised or balanced within a magnetically quiet area prior to data collection, dependent upon the type of system used.

## *8.4 Data Processing*

The data from the instrument will be downloaded during a midday interval and at the end of the shift to monitor quality and the progress of the survey. Data collected by the multi-sensor platform will be prepared for export using bespoke software to revise the system geometry. The composite file will then be exported as a suitable file format. The data will be post-processed in bespoke software to produce a greyscale interpretation of the readings. An X-Y trace map will also be produced to aid interpretation. The maps are imported into CAD software as raster images to produce interpretation and data presentation drawings. A report will also be produced to accompany the drawing.

## *8.5 Limitations*

The success of a magnetic survey detecting archaeological features is dependent upon a measurable contrast between the anomaly and the surrounding ground. The presence of made ground, ferrous debris and burnt materials can all produce strong responses that can mask the presence of buried archaeological features. It is therefore not possible to guarantee that all sub-surface features will be identified by a geophysical survey.

Surface features such as buildings, metallic fencing, vehicles, electricity pylons and wind turbines can also have an impact on the magnetic data due to the sensitivity of the instrumentation. An attempt can be made to remove the magnetic disturbance by post-processing the data in bespoke software, but this cannot reliably be used to detect underlying anomalies and could create false artefacts within the data itself.

Natural sub-surface processes can also produce anomalies that may be mistaken for archaeological features, such as fluvial deposits or the accumulation of sediments in areas prone to flooding. Alternatively, igneous geologies can make it difficult to detect cut features in the sub-surface as there is minimal contrast between the topsoil and sub-soil.

The quality of the data is also reliant upon the operator of the instrument. The data is collected at normal walking pace; therefore, it is advantageous for the ground surface to be even and unobstructed. Overgrown land, roughly ploughed fields and heavily saturated ground can all affect the pace of the operator and movement of the instrument sensors that in turn can produce heading errors and false artefacts in the data. In some instances, it may not be possible to undertake the survey until ground conditions are more favourable. Generally, gradiometer sensors can identify anomalies at a depth of approximately 1.0m dependent upon the strength of the buried feature. Beyond this depth, only large accumulations of thermoremanent materials or ferrous metal will be detected.

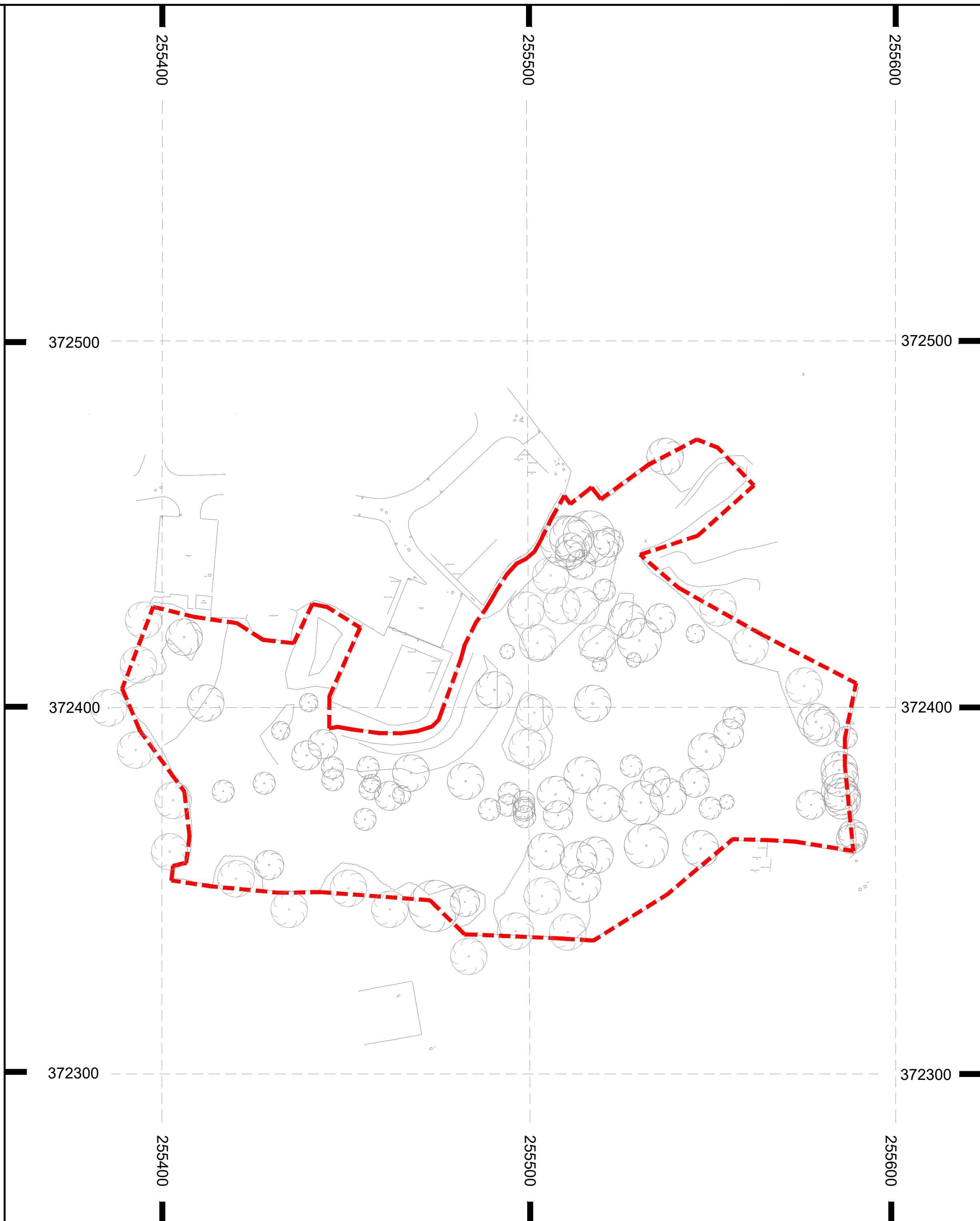



SH 54 55 56 57

SURVEY AREA

SCALE 1:25000

0M 500M 1000M




SURVEY AREA

SCALE 1:1500 @ A3

0 60M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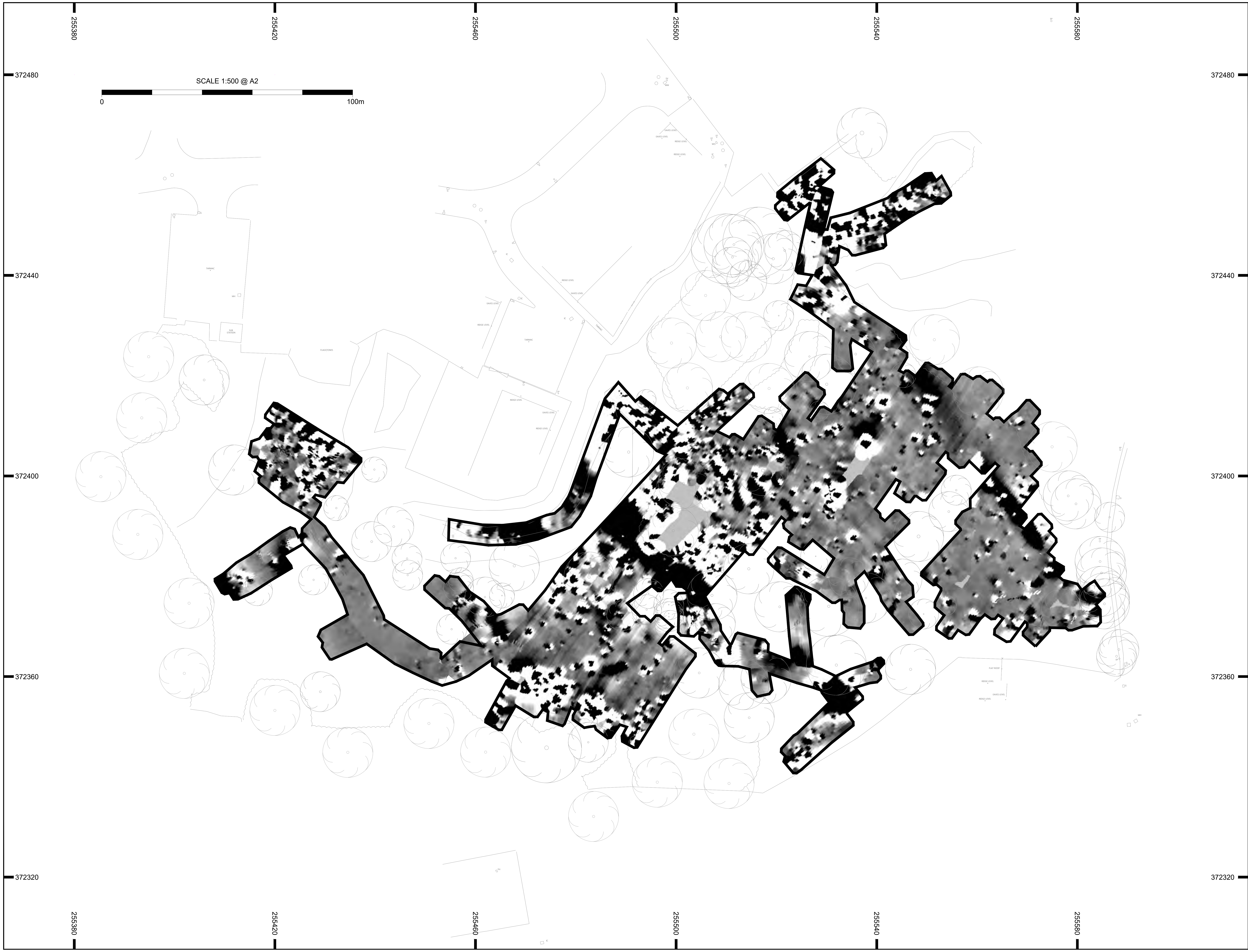
|---|---|
| Client Name | Gwynedd Archaeological Trust |
| Job Title | Tyddyn Mostyn Porthaethwy |
| Drawing Title | Site Location & Survey Extents |
| Scale | As Shown |
| Drawn | NB |
| Date | 10/12/23 |
| Approved | PH |

| Revision | Amendments | By | Checked |
|---|---|---|---|
| | | | |

| Project Number | Drawing No. | Revision | Status |
|---|---|---|---|
| 3968 | 01 | - | Final |




Direction of North based upon Drawing 'Tyddyn Mostyn, Extended 3D.dwg'



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Drawing to be used in conjunction with report 3968

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Gwynedd Archaeological Trust

Job Title
Tyddyn Mostyn
Porthaethwy

Drawing Title
Magnetic Grayscale Data

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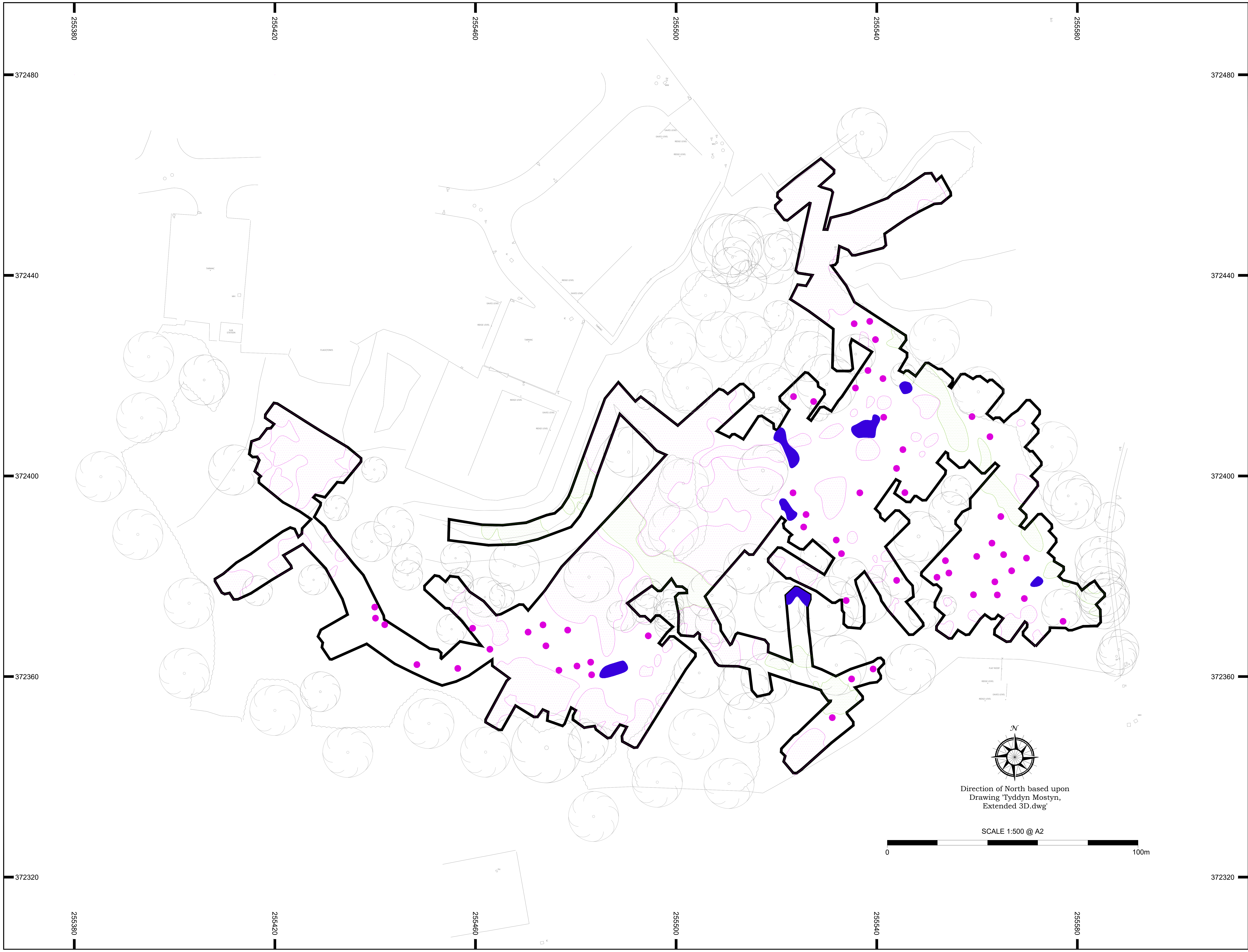
| 3968 | 02 | - | Final |




**Key**

- Probable Archaeology
- Possible Archaeology
- Possible Archaeology - Weak Responses
- Undetermined Responses
- Known Buried Field Boundary
- Possible Buried Field Boundary
- Magnetic Disturbance/ Iron Spikes
- Natural Buried Features / Geological Trend
- Cultural Magnetic Spread
- Ridge and Furrow Cultivation
- Agricultural (Modern)
- Field Drainage
- Possible Metallic Utility
- Extent of Magnetic Data

Drawing to be used in conjunction with report 3968



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Job Title: Tyddyn Mostyn Porthaethwy

Drawing Title: Magnetic Interpretation

| Scale | 1:500 @ A2 | Drawn | NB |
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| Date | 10/01/22 | Approved | PH |

| Revision | Amendments | By | Checked |
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| Project Number | Drawing No. | Revision | Status |
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| 3968 | 03 | - | Final |