Esgyryn Site
Llandudno Junction

Geophysical Survey
GAT-14-001
April 2014

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Project reference	**GAT-14-001**
On behalf of	**Gwynedd Archaeological Trust**
Report prepared by	**Nigel Barker BA, MA**

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2 Summary

This report presents the results of a geophysical survey undertaken on land west of the A470 road at Llandudno Junction on behalf of Gwynned Archaeological Trust.

The detailed magnetic survey covered approximately 3ha and identified two possible former field boundaries as well as two small curvilinear anomalies that could be soil filled features. A metallic utility runs through the west of the survey and a possible ceramic field drain or in-filled ditch is present across the southern perimeter. Areas of magnetic disturbance were also identified within the data that could be attributed to tipped ferrous material, post and wire fencing or burning.

3 Introduction

A geophysical survey was commissioned by Gwynedd Archaeological Trust on land west of the A470 road, at Llandudno Junction, county borough of Conway (NGR SH 8064 7804). The purpose of the survey was to determine the presence of any archaeological potential present within an area proposed for the development of a new primary school.

The survey area measured approximately 3ha and comprised 3 fields of vacant pasture divided by hedgerows, mature trees and metallic post and wire fencing. The area was defined in drawing *C835.05A Location Plan* and is shown in drawing GAT-14-001.01. The 3 fields have been categorised as A, B and C. The topographical mapping shows the area to be relatively level in the north with an incline in the south. An open field drain bisects fields A and B, with an additional partly culverted field drain running across the northern boundary. The southwest spur of field B was not surveyed as it was heavily overgrown and it was not practicable to establish a data collection grid.

The solid geology of the site is believed to be mudstones and siltstones (Nantglyn Flags formation) overlain by glacial till.

The survey was undertaken using a magnetic gradiometer that could identify the presence and extent of soil filled anomalies and burnt materials in areas not affected by modern ferrous disturbance. The survey was undertaken in accordance with English Heritage (2008) Guideline No 1, *Geophysical survey in archaeological field evaluation*, and the Institute of Field Archaeologists (2002) IFA Paper No 6, *The use of geophysical techniques in archaeological evaluations.*

The survey was undertaken on days between 28th April 2014 and 30th April 2014.

4 Field Methodology

The data was collected over 20m x 20m survey grids that were established in CAD software and overlain onto the topographical survey drawing *877/1,* provided by the client. The grid was uploaded to a Topcon GRS-1 GNSS system to enable the accurate setting out of the co-ordinates in the field. Non-magnetic surface flags were used to define the corner points of the grid and incremented trapeze ropes were used for heading and positional markers.

The survey was undertaken using a Bartington Grad601-02 magnetic gradiometer. The data was collected at 0.25m increments spaced on 1m traverses. The instrument sensitivity was set at 0.1nT. The instrument was balanced in a magnetically stable area located in the low lying area of field A, and was regularly checked and rebalanced if necessary using this point throughout the duration of the survey.

The data collected by the instrument was imported into Archaeosurveyor (v.2.5.10.5) software and was de-striped and de-staggered to compensate for heading errors and minor instrument drift (< 2nT).

The final data sets were exported as raster image files for importation into CAD software, where they were scaled and geo-referenced.

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The greyscale data was clipped between -5nT and 5nT and has been presented as a 1:1000 greyscale plot in drawing GAT-14-001.02 and with overlain topographical contours in drawing GAT-14-001.03.

The X-Y trace plots were clipped between -20nT and 20nT and are presented as a 1:1000 plot in drawing GAT-14-001.04.

5 Results

An interpretation of the magnetic gradiometer survey is presented as a 1:1000 plot in drawing GAT-14-001.05.

5.1 Areas of dipolar magnetic disturbance

Dipolar magnetic anomalies are strong positive-negative responses that indicate the presence of near surface or surface ferrous objects or fired materials.

Field B is dominated by a large linear dipolar anomaly bisecting the field on a north-south axis, and is probably associated with a modern metallic utility. It is possible that additional anomalies may be present within field B that have been masked by the high values and subsequent dipolar 'spill' caused by the probable utility. Another dipolar linear feature is evident in the south of field C. It runs in a northeast-southwest direction and has much weaker values than the anomaly in field B. It is possible that this could be attributed to a fired ceramic field drain or debris filled ditch.

Further pockets of magnetic disturbance can be seen around the west and north perimeter of field B which are likely to be associated with metallic fencing or tipped material from the housing present on this boundary. Similar pockets of magnetic disturbance are also evident around the perimeters of field A and field B and are most likely to be attributed to the post and wire fencing delineating the fields. Field C also has a small area of magnetic disturbance located centrally in the north. This is isolated and could be associated with concentrated metallic items, tipped material or an area of burning.

Numerous isolated dipolar spikes were identified in all three fields using the X-Y trace plots. They are likely to correspond to surface or near-surface metallic debris and have high magnetic values in the data. Only the larger spikes have been shown on the interpretation drawing.

5.2 Positive magnetic anomalies

The positive magnetic anomalies are indicative of an enhanced field gradient, possibly associated with soil filled structures such as ditches or pits.

A series of parallel positive magnetic linear anomalies are evident in field A, running in northeast-southwest orientation, and in field C running in a northeast-southwest direction. The spread and direction of the anomalies are suggestive of an agricultural origin such as ploughing.

Two positive magnetic anomalies are present in field C. Both are linear with a weak magnetic gradient (< 4nT). The first anomaly bisects the field in a northwest-southeast direction. It is possible that the anomaly extends and curves into field B; however the presence of the metallic utility in field B makes this difficult to determine. The second linear anomaly is to the south of field C and has a northeast-southwest orientation. This anomaly does not extend into field A. It is possible that both anomalies are associated with in-filled ditches and could be associated with former field boundaries, field drainage or other delineation feature.

An additional positive magnetic feature is present in the far south of field A. It is weak and associated with isolated magnetic spikes. It is possible that this anomaly is connected with the dipolar linear anomaly evident in the south of field C as it is in the same orientation but yields a much weaker response possibly due to a change in depth or material.

Two minor curvilinear positive magnetic anomalies are also present in field C. They could be associated with an in-filled feature, however their size and incomplete shape does not readily identify them as archaeological features.

Scatters of isolated positive anomalies have been detected in field A and field C. Such anomalies usually have low, broad values and could be indicative archaeological activity when located in concentration and associated with a recognisable archaeological feature. However the anomalies detected in fields A and C are not concentrated and are probably associated with deeply buried ferrous debris or underlying geology.

6 Conclusions

Two possible former field boundaries have been located in field C as well as two small curvilinear features that may represent soil filled features.

Groups of magnetically enhanced linear anomalies have been located in fields A and C. The parallel nature of the linear features in relation to one another is suggestive of agricultural activity such as ploughing.

A metallic utility is evident running through field B, and a smaller possible ceramic field drain was detected across the southern extent of field C, and may extend into field A. Further areas of metallic disturbance are present around the perimeters of the fields and are probably associated with tipped materials or post and wire fencing. An isolated area of magnetic disturbance was detected centrally in field C that could be attributed with concentrated metallic items, tipped material or burning. It is possible that the subsequent ferrous interference within the data could mask any underlying, weaker anomalies that would remain undetected.

Appendix

7 Detailed Magnetic Survey

7.1 Theory

A detailed magnetic survey involves the location of anomalies associated with human agency within the landscape by the detection of small variations in the Earth's magnetic field. Generally, the topsoil will usually have an increased amount of ferrous minerals than the sub-soil and therefore a higher magnetic susceptibility in non-igneous geologies. This is a caused by a complex fermentation effect, proposed by Le Borgne (1955; 1960). The action of digging a ditch or excavating a floor can expose the sub-soil layer which can be filled with debris or topsoil as they are in-filled or silted up, making the features magnetically enhanced in comparison to the sub-soil. The strength of anomaly detected during the survey is largely dependent upon the measurable contrast between the feature and the surrounding material.

The action of heating weakly magnetic compounds will convert them to oxides that are demagnetised as they reach the Curie point (675°C). 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 such 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 magnetic signature within the subsurface. This magnetisation is usually permanent.

The Magnetic susceptibility of the soil is only measurable in the presence of a magnetizing field. This can be applied into the ground by the use of a susceptibility meter (volume specific measurement), or by removing samples for processing and applying a magnetic field in a laboratory sensor (mass specific measurement). Alternatively, the Earth's own magnetic field can be used to passively measure variations in the magnetic susceptibility of the ground using a magnetometer.

7.2 Instrumentation

Fluxgate gradiometer instruments are commonly used in Britain 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 but the bottom sensor will be affected by local variations to 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 bottom sensor. This is the gradient and is measured in nanoteslas (nT). The readings are instant and shown in real-time on a display built into the instrument as well as stored in an internal logger. Eden Mapping will use either a Bartington Grad 601-2 fluxgate gradiometer or a Geoscan FM256 fluxgate gradiometer to undertake magnetic surveys.

7.3 Survey Method

The data collected during a magnetic survey is undertaken using an orthogonal grid system that is established using either a 1-person robotic total station or a GPS instrument. For surveys covering large areas, the grid will be drawn in CAD software and overlain onto

Ordnance Survey digital data used as a backcloth for 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 to 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.

The data from the instrument will be downloaded during a mid-day interval and at the end of the shift to monitor quality and the progression of the survey. The data will be post-processed in bespoke software to produce a greyscale interpretation of the data. An X-Y trace map is also produced if relevant to aid interpretation. The maps are imported into CAD software as raster images for the production of interpretation and data presentation drawings. A report will also be produced to accompany the drawing.

7.4 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 materials and burnt materials can all produce strong responses that can mask the presence of archaeological features.

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 instruments. 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 on 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.

8 References

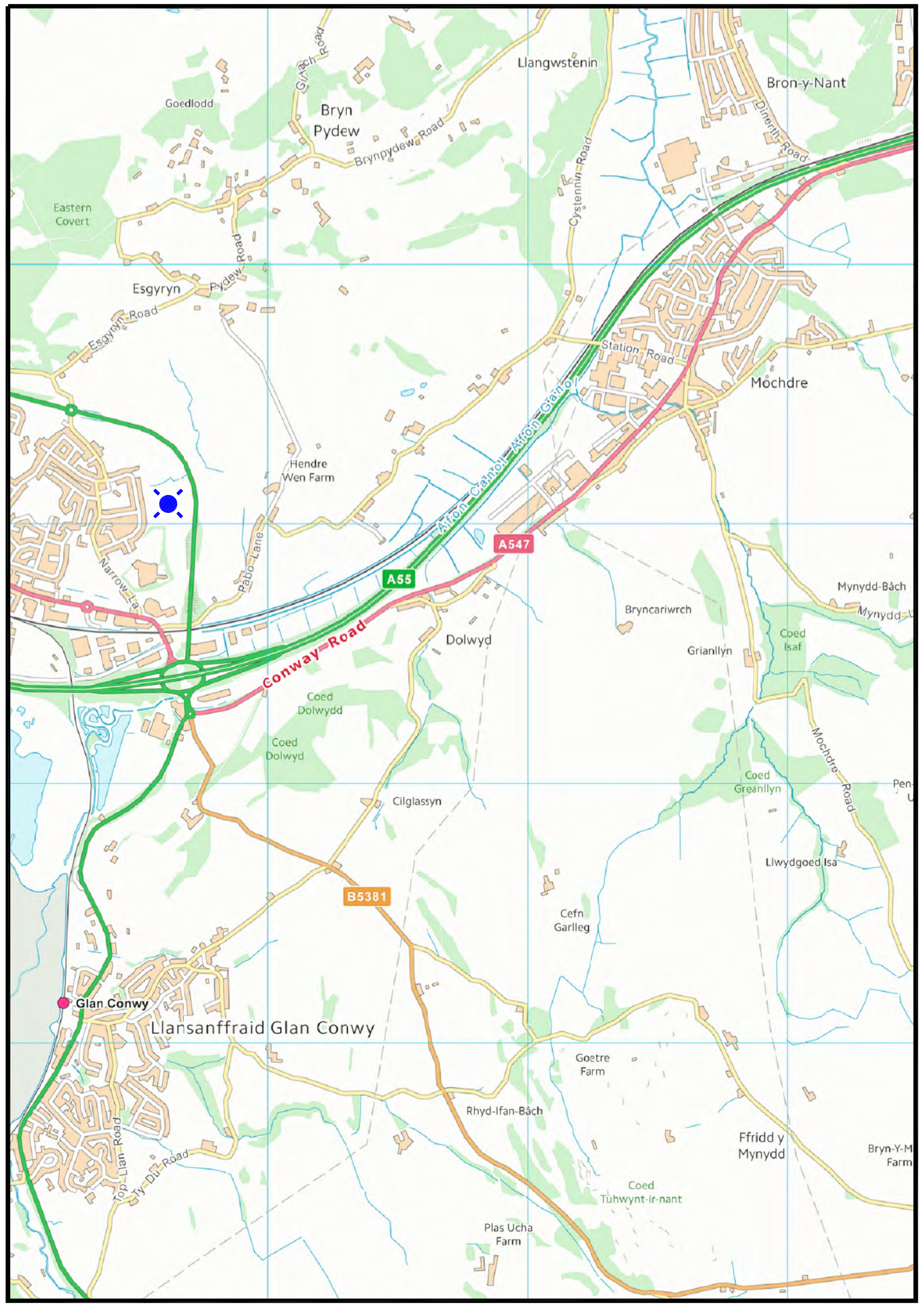
English Heritage (2008) *Geophysical Survey in Archaeological Field Evaluation*. Research and Professional Services Guideline #1.

Institute of Field Archaeologists (2002) IFA Paper No 6, *The use of geophysical techniques in archaeological evaluations*.

Institute of Field Archaeologists (2013*) Standard and Guidance for Archaeological Geophysical Survey*.

Clark, A (2001) *Seeing Beneath the Soil* (2nd edition). Routledge.

Gwynedd Archaeological Trust (2014) *Esgyryn Site, Llandudno Junction, Archaeological Assessment*, Report 1179 (Prelim).



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SH 80 81 82 83

SITE LOCATION

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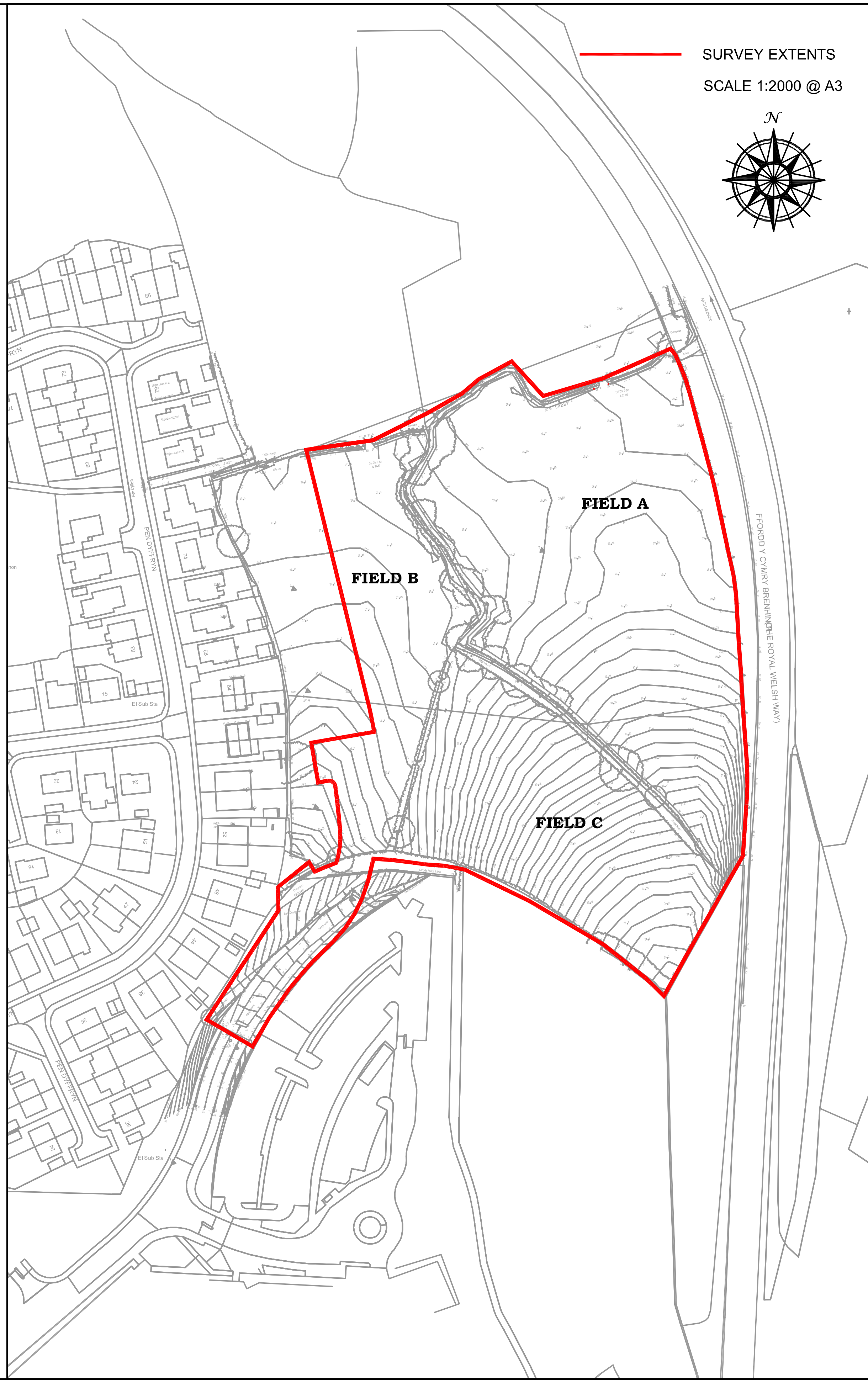

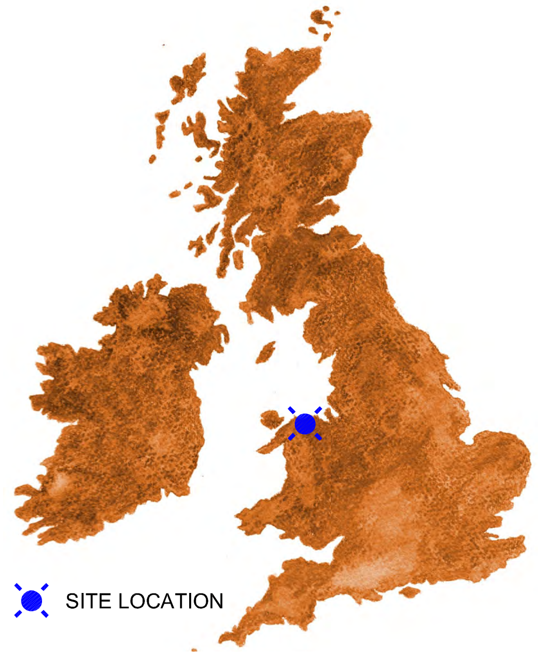

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Gwynedd Archaeological Trust

Job Title

Esgyryn Site
Llandudno Junction

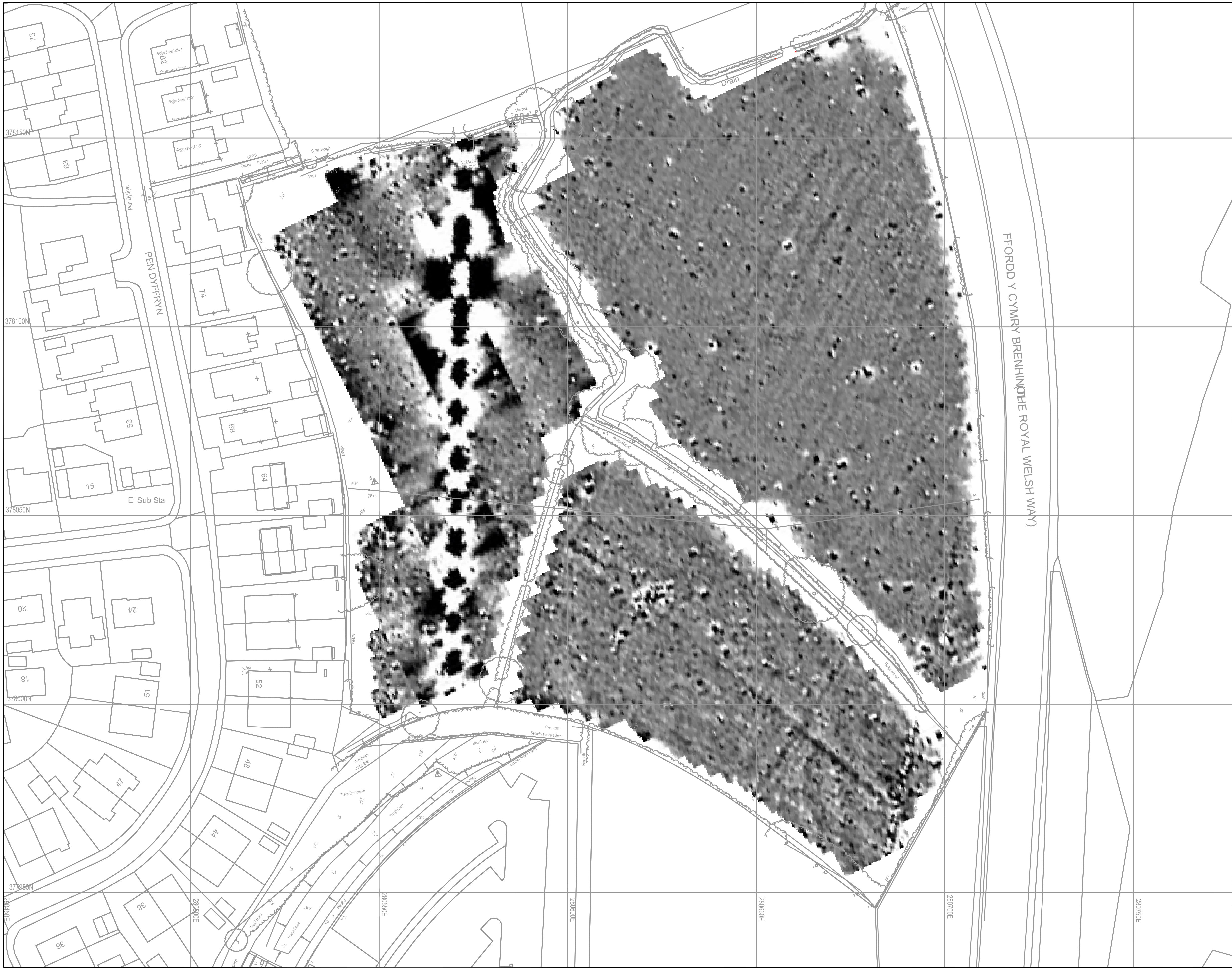
Drawing Title

Site Location & Survey Extents

Scale	1:1000 @ A3	Drawn	NB
Date	30/04/14	Approved	AP

Revision	Amendments	By	Checked

Project Number	Drawing No.	Revision	Status
GAT-14-001	01	-	Final



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Client Name

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Gwynedd Archaeological Trust

Job Title

Esgyryn Site
Llandudno Junction

Drawing Title

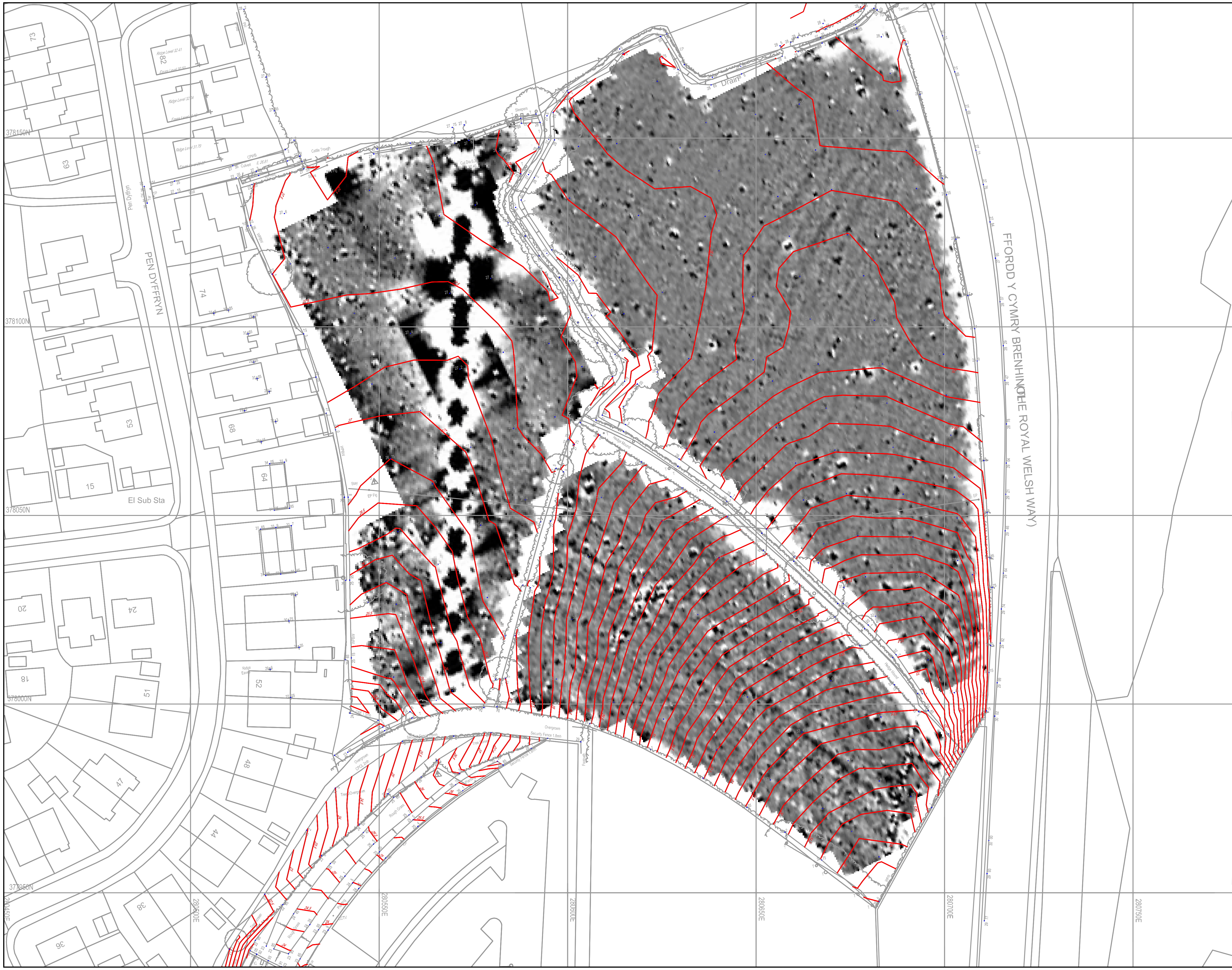
Greyscale Gradiometer Data

Scale	Drawn
1:1000 @ A3	NB

Date	Approved
30/04/14	AP

Revision	Amendments	By	Checked

Project Number	Drawing No.	Revision	Status
GAT-14-001	02	-	Final



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Job Title

Esgyryn Site
Llandudno Junction

Drawing Title

Greyscale Gradiometer Data
& Topographical Contours

Scale	Drawn
1:1000 @ A3	NB
Date	Approved
30/04/14	AP

Revision	Amendments	By	Checked

Project Number	Drawing No.	Revision	Status
GAT-14-001	03	-	Final

Key

- Positive magnetic anomaly. Possibly associated with soil-filled features.
- Positive magnetic anomaly. Probably associated with agricultural activity.
- Area of magnetic disturbance. Probably associated with surface/buried ferrous or fired material.
- Dipolar linear trend. Probably associated with a metallic or ceramic utility pipe.

This drawing must be used in conjunction with the accompanying report GAT-14-001 (Section 5)

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Client Name

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Job Title

Esgyryn Site
Llandudno Junction

Drawing Title

Geophysical Interpretation

Scale	Drawn
1:1000 @ A3	NB

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30/04/14	AP

Revision	Amendments	By	Checked

Project Number	Drawing No.	Revision	Status
GAT-14-001	05	-	Final