Cefnwerthyd Road, Bontnewydd, Gwynedd

Geophysical Survey

Ymddiriedolaeth Archaeolegol Gwynedd
Gwynedd Archaeological Trust

Cefnwerthyd Road, Bontnewydd, Gwynedd

Geophysical Survey

Prosiect Rhif / Project No. G2603

Adroddiad Rhif / Report No.1473

Prepared for: Watkin Jones Homes

February 2019

Written by: Neil McGuinness

Gwynedd HER Event PRN 45400

Cyhoeddwyd gan Ymddiriedolaeth Achaeolegol Gwynedd
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Rev No.	**Summary of Changes**	**Ref Section**	**Purpose of Issue**
1.1	Changes to summary and recommendations	p.3 (para4) p.13 (para3)	Health and safety considerations

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CRYNODEB ANHECHNEGOL

Roedd Ymddiriedolaeth Archeolegol Gwynedd yn ddirprwyedig gan Gartrefi Watkin Jones i ymgymryd arolwg archeolegol geoffisegol mewn cae pori 0.88ha yn gyfagos I Lon Cefnwerthyd ym Montnewydd, Gwynedd mewn cefnogaeth o gais cynllunio i gynllun awgrymedig tai preswyl.

Ddaru'r arolwg geoffisegol dynodi'r presenoldeb o wasanaethau cyfoes ond ddim adnabod unrhyw gweddillion archeolegol. Mae yn argymhellir fod briff gwylio archeolegol yn cael ei wneud ar y safle i gadarnhau'r canlyniadau'r arolwg i benderfynu'r presenoldeb/absenoldeb o gweddillion archeolegol.

NON-TECHNICAL SUMMARY

Gwynedd Archaeological Trust (GAT) was commissioned by Watkin Jones Homes to undertake an archaeological geophysical survey in a 0.88ha pasture field adjacent to Cefnwerthyd Road in Bontnewydd, Gwynedd in support of a planning application for a proposed residential housing scheme.

The geophysical survey identified the presence of modern services but did not identify any archaeological remains. It is recommended that an archaeological watching brief is carried out at the site during the construction phase of the project to verify the survey results and determine the presence/absence of archaeological remains.

1 INTRODUCTION

Gwynedd Archaeological Trust (GAT) was commissioned by Watkin Jones Homes to undertake a programme of non-invasive archaeological evaluation using geophysical survey in support of a planning application for a proposed scheme of 29 residential units on a site adjacent to Cefnwerthyd Road in Bontnewydd, Gwynedd (NGR SH48056012; Figure 01). The development area measures 0.88ha and consists of a large trapezoidal field of improved open pasture, alongside Afon Beuno.

The geophysical survey was conducted on Friday 22nd February 2019. It was undertaken as specified in the Gwynedd Archaeological Planning Service (GAPS) approved Written Scheme of Investigation (Appendix I) and is in accordance with the following guidance:

- *Guidance for the Submission of Data to the Welsh Historic Environment Records (HERs)* Version 1.1 (The Welsh Archaeological Trusts, 2018);
- *Guidelines for Digital Archives* (Royal Commission on Ancient and Historic Monuments of Wales, 2015);
- *Management of Archaeological Projects* (English Heritage, 1991);
- *Management of Research Projects in the Historic Environment: The MoRPHE Project Managers' Guide* (Historic England, 2015); and
- *Standard and Guidance for Archaeological Geophysical Survey* (Chartered Institute for Archaeologists, 2014).

The project has been monitored by GAPS and the content of this report by GAT has been approved by GAPS prior to final issue.

Gwynedd Archaeological Trust is certified to ISO 9001:2015 and ISO 14001:2015 (Cert. No. 74180/B/0001/UK/En) and is a Registered Organisation with the Chartered Institute for Archaeologists and a member of the Federation of Archaeological Managers and Employers (FAME).

1.1 Site Details

NGR / Postcode	SH 4805 6012 / LL55 2UD
Location	The site is located on the western side of the village of Bontnewydd, Gwynedd on the northern bank of the Afon Beuno. It is bounded by the minor roads Cefnwerthyd Road to the east and Dol Beuno to the south. To the west it is bounded by a mature hedgerow which separates it from a pasture field, and to the north by modern housing.
HER	Gwynedd Archaeological Trust HER
District	Gwynedd
Parish	Llanbeblig
Topography	Sloping from north to south
Current Land Use	Pasture
Geology	Solid: Nant Ffrancon Subgroup - Siltstone. Superficial: Till, Devensian - Diamicton (BGS 2019)
Soils	Freely draining slightly acid loamy soils (Soilscapes 2019)
Survey Methods	Magnetometer survey (fluxgate gradiometer)
Study Area	c. 0.88 ha

1.2 Geophysical Survey Aims and Objectives

The key aim and objective of the geophysical survey is to:

- establish the extent to which potential archaeological remains survive at the location of the proposed development.

If previously unknown potential archaeological features are identified through geophysical survey, they may need to be evaluated with trial trenches to confirm their existence and to establish their date and function, and following on from this, to assess the implications of the findings on the current understanding of the historical development of the area. Any archaeological features encountered may require preservation by record, i.e. further investigation, or preservation in-situ that may require amending the layout of the proposed development.

2 ARCHAEOLOGICAL AND HISTORICAL BACKGROUND

An examination of the regional Historic Environment Record demonstrates that the evaluation area contains no known archaeological activity, although Roman, medieval and post-medieval assets are present within the wider area, including the following:

- Primary Reference Number (PRN) 17554 (NGR SH47645813): Segontium – Pen Llystyn – Tomen y Mur Road, located 181m east of the development along the route of what is now the A487 (Figure 01);
- PRN 3104 (NGR SH48306010): a medieval cross-incised stone, now removed, located 184m east of the development plot (Figure 01);
- PRN 63287 (NGR SH47896000): a former railway bridge crossing the Afon Gwyrfau, part of the Caernarfon to Afonwen Railway and opened in 1867. The bridge is located 137m southwest of the development plot (Figure 01);
- PRN 63284 (NGR SH48065993): Nantlle Tramway River Bridge crossing the Afon Gwyrfau, connecting Talysarn in the slate-quarrying area of Dyffryn Nantlle with Caernarfon. The bridge is located 124m southwest of the development plot (Figure 01).

Bontnewydd is also listed as Area 2 of the Caernarfon/Nantlle Historic Landscape Characterisation area (PRN 15701) and is qualified as a ribbon settlement, with the following description:

> The nucleus of the village is the early nineteenth-century stone bridge over the Afon Gwyrfai and the Newborough Arms public house nearby (SH48315989), established pre-1815, a building which retains some polite architectural features. Later buildings include a late nineteenth century brick-built terrace alongside the road, an interesting mill complex, Capel Siloam, a ‘German-church' Calvinistic Methodist chapel dating from 1866 (SH48315993), and a local design of mid-twentieth century prefabricated house, apparently built on a timber frame with a slate roof, as well as more recent social housing and suburban estates as Caernarfon overspill (Gwyn, D. & Thompson, D., 2001).

An examination of the Ordnance Survey first to third edition ordnance survey 1-inch to 25-mile county series map sheet of the area (sheets xv.08 and xv.12; 1889, 1900 and 1918 respectively; cf. Figures 02 to 04) shows the development area within an enclosed field that

matches the current boundaries. On all three editions a spring is in plot to the west, whilst a large house Glan Beuno with a formal garden arrangement at the front is located to the immediate east. The overall development is little altered between the three editions, with the main development along Afon Gwyrfai to the south and what is now the A487 road to the east. The modern layout of Bontnewydd reflects localised expansion into the areas between Afon Gwyrfai and Afon Beuno and along the A487 road. This includes the development of Glan Beuno grounds from the formalised gardens into what is now a housing estate.

3 METHODOLOGY

3.1 Geophysical Survey

3.1.1 Technical Detail

The survey was carried out in a series of traverses within 8x20m grids covering the footprint of the proposed development. The grids were tied into the Ordnance Survey grid using a Trimble high precision GPS system. The survey was conducted using a Bartington Grad 601-2 dual fluxgate gradiometer. The surveys were carried out at standard resolution with a 1.0m traverse interval and 0.25m sample interval.

3.1.2 Instrumentation

The Bartington Grad 601-2 dual fluxgate gradiometer uses a pair of Grad-01-100 sensors. These are high stability fluxgate gradient sensors with a 1.0m separation between the sensing elements, giving a strong response to deeper anomalies. The instrument detects variations in the earth's magnetic field caused by the presence of iron in the soil. This is usually in the form of weakly magnetized iron oxides which tend to be concentrated in the topsoil. Features cut into the subsoil and backfilled or silted with topsoil, therefore contain greater amounts of iron and can therefore be detected with the gradiometer. This is a simplified description as there are other processes and materials which can produce detectable anomalies. The most obvious is the presence of pieces of iron in the soil or immediate environs which usually produce very high readings and can mask the relatively weak readings produced by variations in the soil. Strong readings are also produced by archaeological features such as hearths or kilns as fired clay acquires a permanent thermo-remnant magnetic field upon cooling. This material can also get spread into the soil leading to a more generalized magnetic enhancement around settlement sites. Not all surveys can produce good results as results can be masked by large magnetic variations in the bedrock or soil or high levels of natural background "noise" (interference consisting of random signals produced by material with in the soil). In some cases, there may be little variation between the topsoil and subsoil resulting in undetectable features. The Bartington Grad 601 is a hand held instrument and readings can be taken automatically as the operator walks at a constant speed along a series of fixed length traverses. The sensor consists of two vertically aligned fluxgates set 500mm apart. Their mu-metal cores are driven in and out of magnetic saturation by a 1,000Hz alternating current passing through two opposing driver coils. As the cores come out of saturation, the external magnetic field can enter them producing an electrical pulse proportional to the field strength in a sensor coil. The high frequency of the

detection cycle produces what is in effect a continuous output. The gradiometer can detect anomalies down to a depth of approximately one meter. The magnetic variations are measured in nanoTeslas (nT). The earth's magnetic field strength is about 48,000 nT; typical archaeological features produce readings of below 15nT although burnt features and iron objects can result in changes of several hundred nT. The machine is capable of detecting changes as low as 0.1nT.

3.1.3 Data Collection

The gradiometer includes an on-board data-logger. Readings are taken along parallel traverses of one axis of a 20m x 20m grid. The traverse interval is 1.0 m. Readings are logged at intervals of 0.25m along each traverse. Marked guide ropes are used to ensure high positional accuracy during the survey. The data is transferred from the data-logger to a computer where it is compiled and processed using TerraSurveyor V3.0 software. The data is presented as a grey-scale plot where data values are represented by modulation of the intensity of a grey scale within a rectangular area corresponding to the data collection point within the grid. This produces a plan view of the survey and allows subtle changes in the data to be displayed. This is supplemented by an interpretation diagram showing the main feature of the survey with reference numbers linking the anomalies to descriptions in the written report. It should be noted that the interpretation is based on the examination of the shape, scale and intensity of the anomaly and comparison to features found in previous surveys and excavations etc. In some cases the shape of an anomaly is sufficient to allow a definite interpretation e.g. a Roman fort. In other cases all that can be provided is the most likely interpretation. The survey will often detect several overlying phases of archaeological remains and it is not usually possible to distinguish between them. Weak and poorly defined anomalies are most 4 susceptible to misinterpretation due to the propensity of the human brain to define shapes and patterns in random background "noise". An assessment of the confidence of the interpretation is given in the text.

3.1.4 Data Processing

The data is presented with a minimum of processing although corrections may be made to compensate for instrument drift and other data collection inconsistencies. High readings caused by stray pieces of iron, fences, etc. are usually modified on the grey scale plot as they have a tendency to compress the rest of the data. The data is however carefully examined before this procedure is carried out as kilns and other burnt features can produce similar readings. The data on some 'noisy' or very complex sites can benefit from 'smoothing'. Grey-scale plots are always somewhat pixellated due to the resolution of the

survey. This at times makes it difficult to see less obvious anomalies (Figure 02). The readings in the plots can therefore be interpolated thus producing more but smaller pixels and a small amount of smoothing based on a low pass filter can be applied. This reduces the perceived effects of background noise thus making anomalies easier to see. Any further processing is noted in relation to the individual plot.

4 RESULTS

4.1 Geophysical Survey Results

The results of the geophysical survey are shown as a minimally processed plot (Figure 05, raw data clipped to +/- 15 nT and de-striped) and an interpretative plot Figure 06.

No likely archaeological anomalies were identified within the survey area.

A north-northwest-south-southeast aligned linear bipolar anomaly with a strong response (1) most likely represents a substantial service. The points where the anomoly exits the field correspond with the location of gas pipeline markers inserted into the field boundaries.

A second, less substantial, linear bipolar anomaly with a lower response (2) runs west-southwest–east-northeast inside the southern field boundary. Gas pipeline markers also mark its exit point from the field. This southern boundary of the field is also defined by a post and metal wire fence which may enhance the magnitude of responses along its length.

A third, less substantial, linear bipolar anomaly with a lower magnitude response (3) runs west-northwest-southeast across the southern part of the development area. Again this is likely to be a modern service.

A number of dipolar responses (a single positive anomoly with an associated negative response) (not individually marked on Figure 06) are distributed across the survey area and are a result of ferrous metal debris in the topsoil.

The eastern edge of the survey area showed high amplitude bipolar disturbance from modern ferrous metal objects in the form of the post and wire fencing along the eastern edge of the field, a gate at the centre of the eastern field boundary, and steel wire stays from a wooden electricity pole in the south east corner.

5 CONCLUSIONS AND RECOMMENDATIONS

The magnetometer survey of the proposed development area did not identify any likely archaeological anomalies. The identified anomalies are most likely the magnetic signatures of modern services.

The high amplitude responses from the modern services may however be masking archaeological features in proximity to them. In addition, the lack of definite identifiable archaeological features in areas away from the modern services do not preclude the possibility of archaeological activity being present at the site.

The results of the geophysical survey are inconclusive. Given the nearby evidence for archaeological sites dating from the Romano-British period onwards, it would ordinarily be recommended that the proposed development area is tested by machine cut trial trenches to conclusively establish the presence or absence of archaeological features. However, the health and safety risks associated with any such undertaking in close proximity to a live gas main may make this unfeasible. Instead it is proposed that a an archaeological watching brief is undertaken during ground disturbance activity associated with the construction phase of the project once the gas main has been made safe.

6 SOURCES CONSULTED

British Geological Survey, 2019, *Geology of Britain viewer* [Accessed 22/02/2019] website http://www.bgs.ac.uk/opengeoscience/home.html?Accordion1=1#maps

Chartered Institute for Field Archaeologists, 2014, *Standard and Guidance for Archaeological Geophysical Survey*

English Heritage, 1991, *Management of Archaeological Projects*

English Heritage, 2015, *Management of Research Projects in the Historic Environment (MoRPHE)*

The Welsh Archaeological Trusts, 2018, *Guidance for the Submission of Data to the Welsh Historic Environment Records* (HERs) (Version 1.1)

Gwyn, D. & Thompson, D., 2001, *Historic Landscape Characterisation - Caernarfon-Nantlle*. Gwynedd Archaeological Trust Report 402.

Ordnance Survey First, Edition Ordnance Survey 1-inch to 25-mile County Series Map Sheets XV.08 and XV.12; 1889.

Ordnance Survey, Second Edition Ordnance Survey 1-inch to 25-mile County Series Map Sheets XV.08 and XV.12; 1900.

Ordnance Survey, Third Edition Ordnance Survey 1-inch to 25-mile County Series Map Sheets XV.08 and XV.12; 1918.

Royal Commission on Ancient and Historic Monuments of Wales, 2015, *Guidelines for Digital archives*

Soilscapes, 2019, *Cranfield Soil and Agrifood Institute Soilscapes viewer*, [Accessed 22/02/2019] website http://www.landis.org.uk/soilscapes/

FIGURES

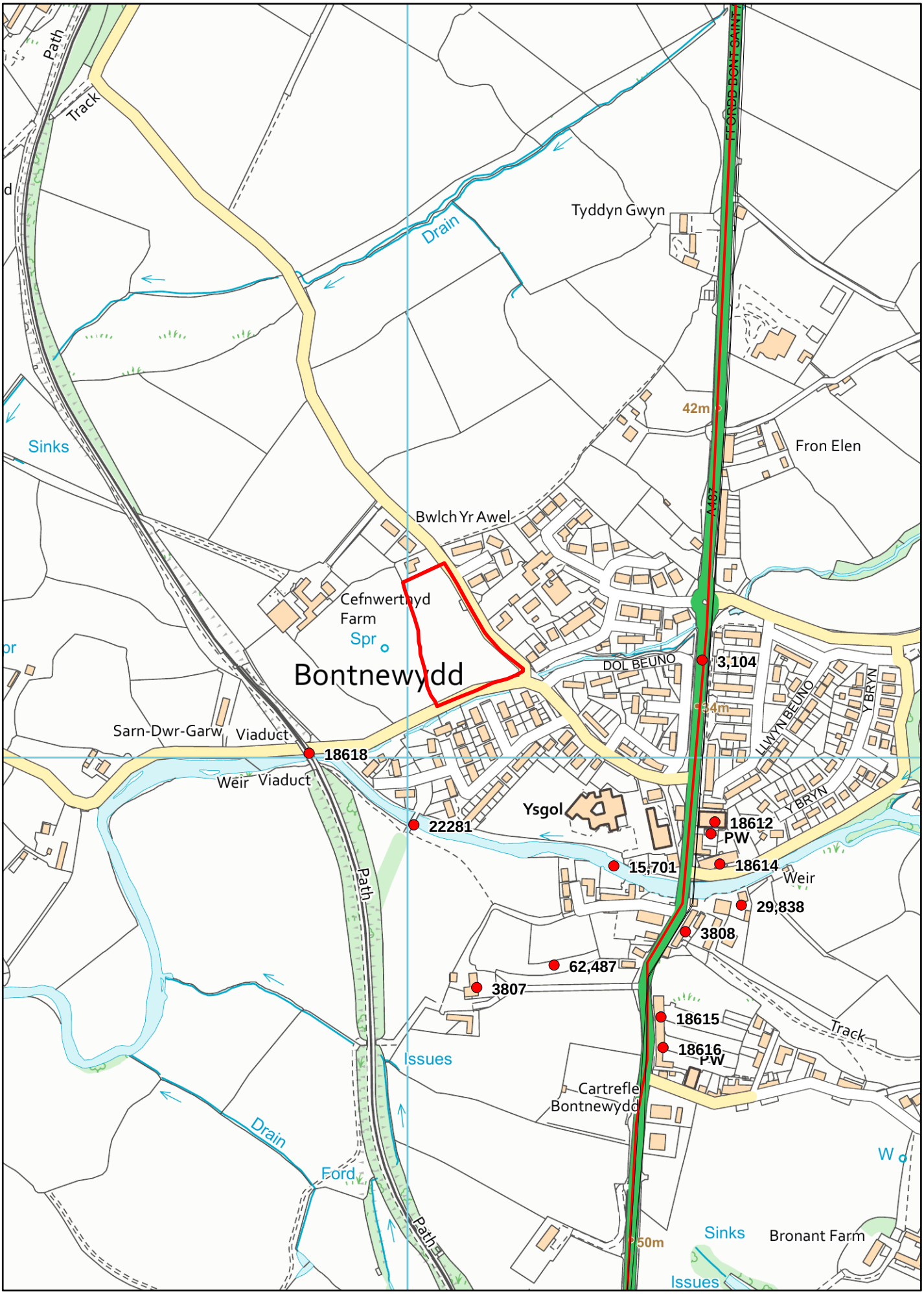


FIGURE 01: Location of assessment area (outlined red) and local archaeological features. Based on Ordnance Survey 1:10000 County Series Map Sheets SH46SE. Scale 1:5000 @A4. © Crown Copyright. All Rights Reserved. License Number Al100020895.

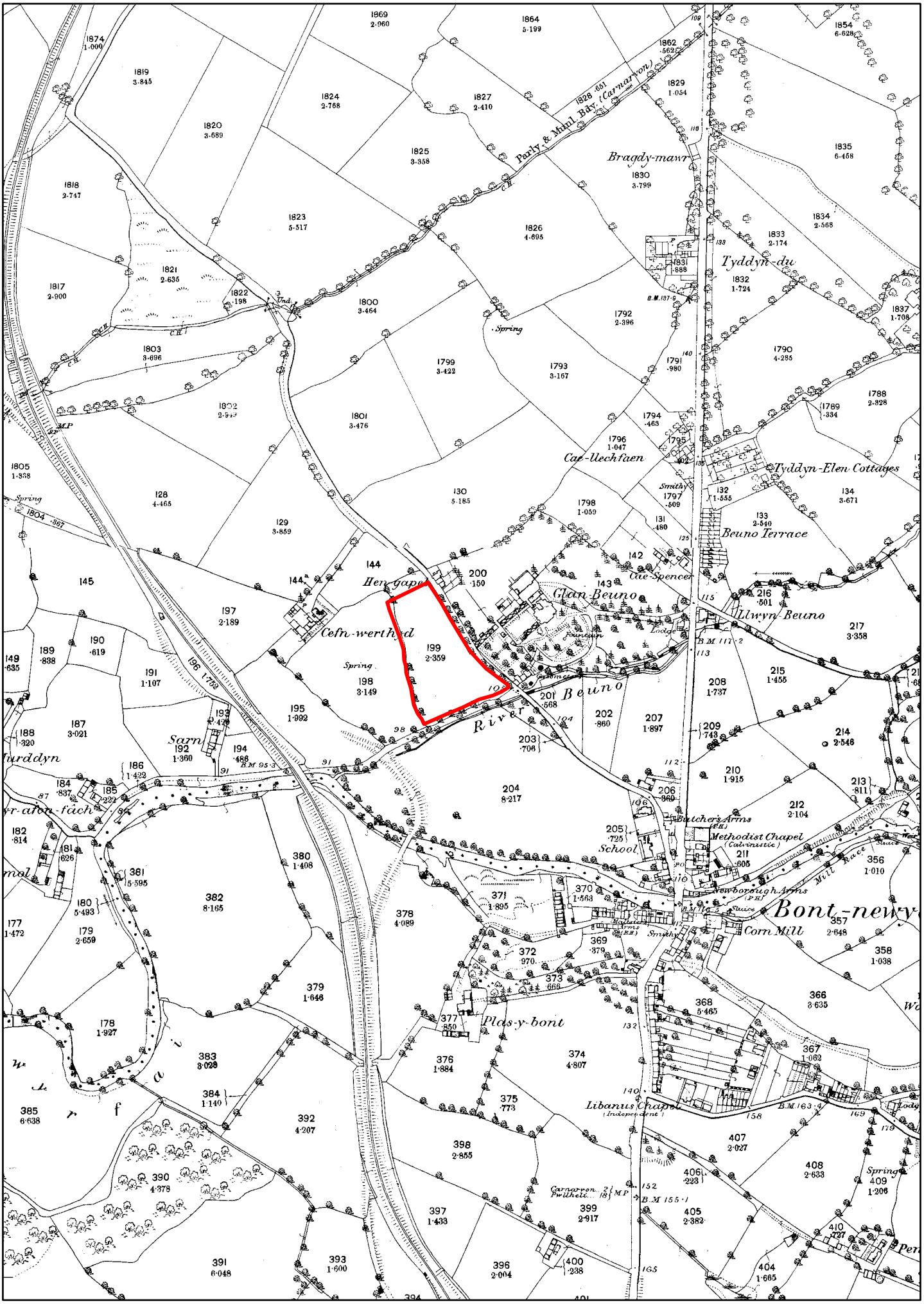


FIGURE 02: Reproduction of Ordnance Survey First Edition Ordnance Survey 1-inch to 25-mile County Series Map Sheets XV.08 and XV.12; 1889. Scale 1:5000 @A4.

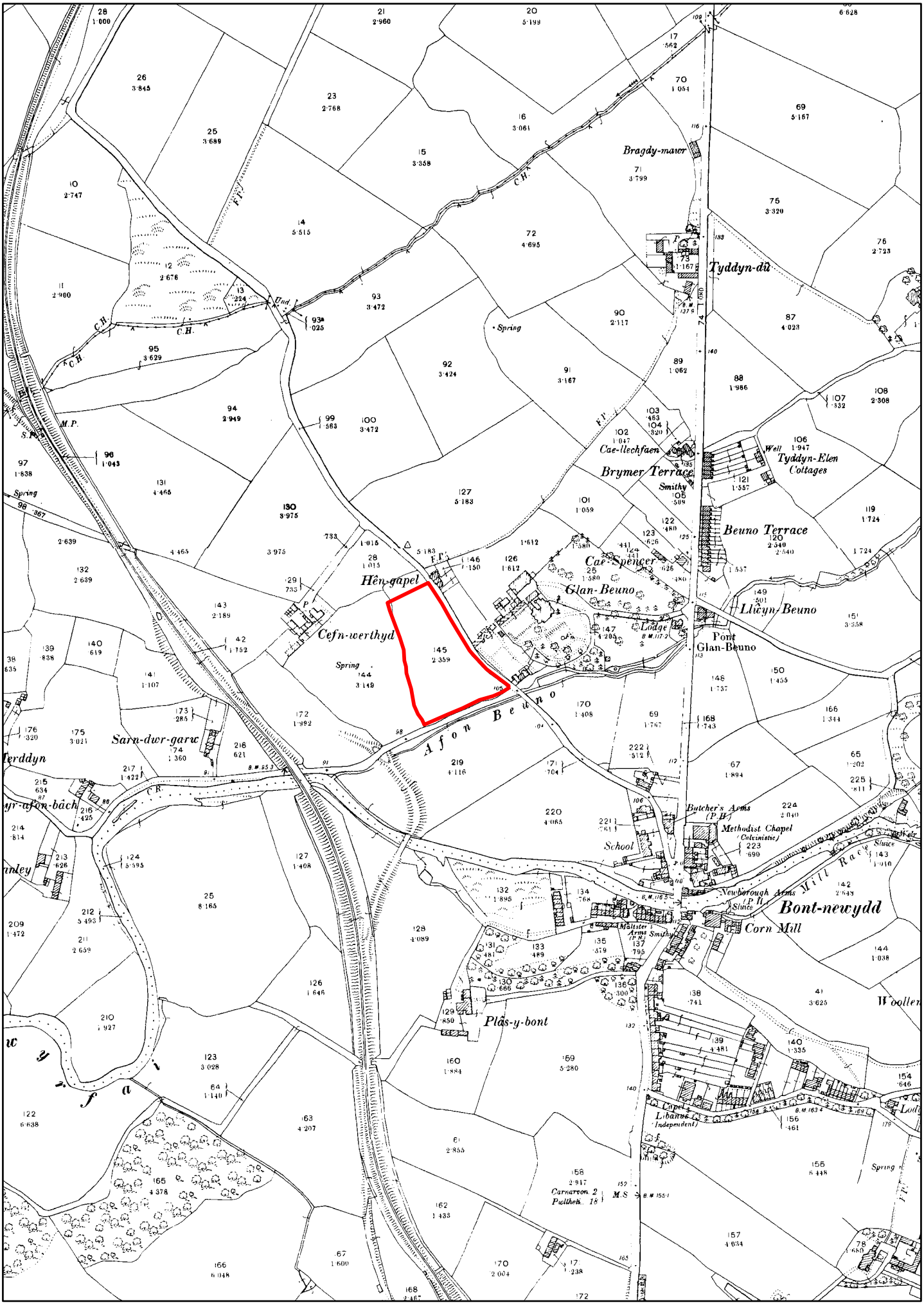


FIGURE 03: Reproduction of Ordnance Survey Second Edition Ordnance Survey 1-inch to 25-mile County Series Map Sheets XV.08 and XV.12; 1900. Scale 1:5000 @A4.

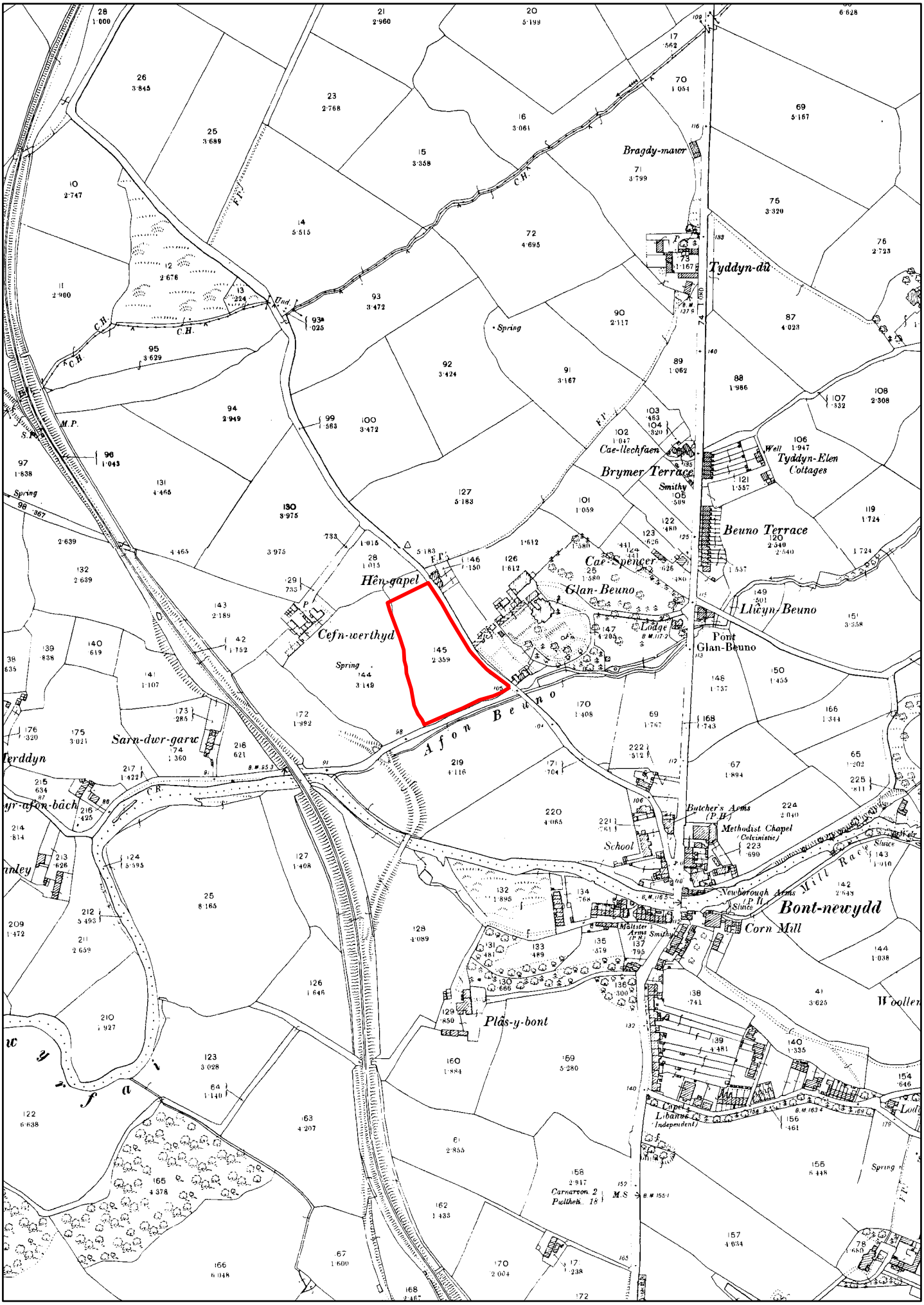
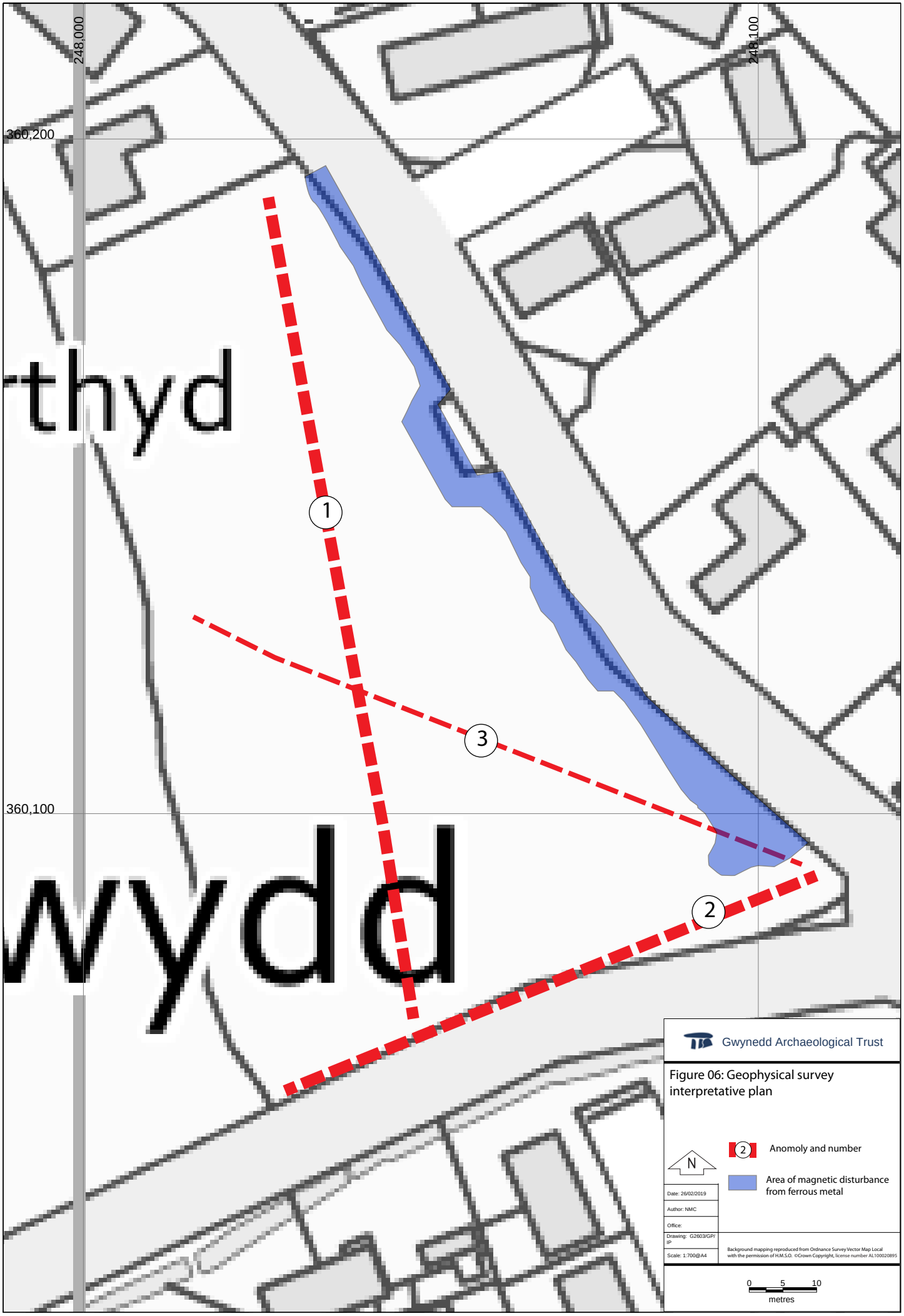


FIGURE 04: Reproduction of Ordnance Survey Third Edition Ordnance Survey 1-inch to 25-mile County Series Map Sheets XV.08 and XV.12; 1918. Scale 1:5000 @A4.


248,000
248,100
360,200
360,100
Gwynedd Archaeological Trust
Figure 05: Geophysical survey greyscale plot
(raw data clipped to +/- 15 nT and de-striped)
15 nT
0 nT
-15 nT
N
Date: 26/02/2019
Author: NMC
Office:
Drawing: G2603/GP/GS
Scale: 1:700@A4
Background mapping reproduced from Ordnance Survey Vector Map Local with the permission of H.M.S.O. ©Crown Copyright, license number AL100020895
0 5 10
metres


248,000
248,100
360,200
360,100
rthyd
wydd
1
2
3
Gwynedd Archaeological Trust
Figure 06: Geophysical survey interpretative plan
N
2
Anomoly and number
Area of magnetic disturbance from ferrous metal
Date: 26/02/2019
Author: NMC
Office:
Drawing: G2603/GP/IP
Scale: 1:700@A4
Background mapping reproduced from Ordnance Survey Vector Map Local with the permission of H.M.S.O. ©Crown Copyright, license number AL100020895
0
5
10
metres

APPENDIX I - Cefnwerthyd Road, Bontnewydd (G2603) WSI

CEFNWERTHYD ROAD, BONTNEWYDD (G2603)

WRITTEN SCHEME OF INVESTIGATION FOR EVALUATION (GEOPHYSICAL SURVEY)

Prepared for Watkin Jones Homes

February 2019

Ymddiriedolaeth Archaeolegol Gwynedd
Gwynedd Archaeological Trust

Approvals Table				
	Role	**Printed Name**	**Signature**	**Date**
Originated by	Document Author	JOHN ROBERTS		14/02/19
Reviewed by	Document Reviewer	CAROL RANYOUNG		14/2/19
Approved by	Principal Archaeologist	JOHN ROBERTS		14/02/19

Revision History			
Rev No.	**Summary of Changes**	**Ref Section**	**Purpose of Issue**

All GAT staff should sign their copy to confirm the project specification is read and understood and retain a copy of the specification for the duration of their involvement with the project. On completion, the specification should be retained with the project archive:

Name Signature Date

CEFNWERTHYD ROAD, BONTNEWYDD (G2603)

WRITTEN SCHEME OF INVESTIGATION FOR ARCHAEOLOGICAL EVALUATION (GEOPHYSICAL SURVEY)

Prepared for *Watkin Jones Homes*, February 2019

CONTENTS

1 INTRODUCTION

Gwynedd Archaeological Trust (GAT) has been asked by Watkin Jones Homes to prepare a written scheme of investigation for an archaeological evaluation (geophysical survey) in support a planning application for a residential scheme of 29 residential units on a site adjacent to Cefnwerthyd Road in Bontnewydd, Gwynedd (NGR SH48056012; Figure 01). The development area measures 0.88ha and is a large trapezoidal field of improved open pasture, alongside Afon Beuno.

The evaluation will be undertaken from February and will conform to the following guidelines:

- *Guidance for the Submission of Data to the Welsh Historic Environment Records (HERs)* Version 1.1 (The Welsh Archaeological Trusts, 2018);
- *Guidelines for digital archives* (Royal Commission on Ancient and Historic Monuments of Wales, 2015);
- *Management of Archaeological Projects* (English Heritage, 1991);
- *Management of Research Projects in the Historic Environment: The MoRPHE Project Managers' Guide* (Historic England, 2015); and
- *Standard and Guidance for Archaeological Geophysical Survey* (Chartered Institute for Archaeologists, 2014).

GAT is certified to ISO 9001:2015 and ISO 14001:2015 (Cert. No. 74180/B/0001/UK/En) and is a Registered Organisation with the Chartered Institute for Archaeologists and a member of the Federation of Archaeological Managers and Employers (FAME).

1.1 Monitoring Arrangements

The archaeological mitigation will be monitored by the Gwynedd archaeological Planning Service (GAPS). GAPS have stated that the evaluation must include some limited research to place the survey results in context and inform their interpretation. The content of this WSI and all subsequent reporting by GAT must be approved by GAPS prior to final issue.

The contact details are:

- Jenny Emmett jenny.emmett@heneb.co.uk | 01248 370926

1.2 Historic Environment Record

In line with the Gwynedd Historic Environment Record (HER) requirements, the HER will be contacted at the onset of the project to ensure that any data arising is formatted in a manner suitable for accession to the HER and follows the guidance set out in *Guidance for the Submission of Data to the Welsh Historic Environment Records (HERs)* (The Welsh Archaeological Trusts, 2018). The HER will be informed of the project start date, location including grid reference, estimated timescale for the work, and further relevant information associated with the project.

The GAT HER Enquiry Number for this project is GATHER1070 and the Event PRN is 45400. The GAT HER will also be responsible for supplying Primary Reference Numbers (PRN) for any new assets identified and recorded.

2 ARCHAEOLOGICAL AND HISTORICAL BACKGROUND

A brief examination of the regional Historic Environment Record demonstrates that the evaluation area is not within an area of known archaeological activity, although Roman, medieval and post-medieval assets are present within the wider area, including the following:

- Primary Reference Number (PRN) 17554 (NGR SH47645813): Segontium – Pen Llystyn – Tomen y Mur Road, located 181m east of the development along the route of what is now the A487 (Figure 01);
- PRN 3104 (NGR SH48306010): a medieval cross-incised stone, now removed, located 184m east of the development plot (Figure 01);
- PRN 63287 (NGR SH47896000): a former railway bridge crossing the Afon Gwyrfau, part of the Caernarfon to Afonwen Railway and opened in 1867. The bridge is located 137m southwest of the development plot (Figure 01);
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Bontnewydd is also listed as Area 2 of the Caernarfon/Nantlle Historic Landscape Characterisation area (PRN 15701) and is qualified as a ribbon settlement, with the following description:

> The nucleus of the village is the early nineteenth-century stone bridge over the Afon Gwyrfai and the Newborough Arms public house nearby (SH48315989), established pre-1815, a building which retains some polite architectural features. Later buildings include a late nineteenth century brick-built terrace alongside the road, an interesting mill complex, Capel Siloam, a ‘German-church' Calvinistic Methodist chapel dating from 1866 (SH48315993), and a local design of mid-twentieth century prefabricated house, apparently built on a timber frame with a slate roof, as well as more recent social housing and suburban estates as Caernarfon overspill (Gwyn, D. & Thompson, D., 2001).

An examination of the Ordnance Survey First to Third Edition Ordnance Survey 1-inch to 25-mile County Series Map Sheet of the area (Sheets XV.08 and XV.12; 1889, 1900 and 1918 respectively; cf. Figures 02 to 04) shows the development area within an enclosed field that

matches the current boundaries. On all three editions a spring is in plot to the west, whilst a large house *Glan Beuno* with a formal garden arrangement at the front is located to the immediate east. The overall development is little altered between the three editions, with the main development along Afon Gwyrfai to the south and what is now the A487 road to the east. The modern layout of Bontnewydd reflects localised expansion into the areas between Afon Gwyrfai and Afon Beuno and along the A487 road. This includes the development of *Glan Beuno* grounds from the formalised gardens into what is now a housing estate.

3 METHODOLOGY

3.1 Geophysical Survey

3.1.1 Summary

The geophysical survey will be undertaken by GAT staff and will incorporate the assessment area, defined as the highlighted plot in Figure 01and will be carried out in a series of 20m grids, which will be tied into the Ordnance Survey grid using a Trimble R8 high precision GPS system. The survey will be conducted using a Bartington Grad 601-2 dual fluxgate gradiometer with a 1.0m traverse interval and a 0.25m sample interval. GAPS have stated that the evaluation must include some limited research to place the survey results in context and inform their interpretation. This will include an examination of the regional Historic Environment Register ((HER) Gwynedd Archaeological Trust, Craig Beuno, Ffordd y Garth, Bangor, Gwynedd LL57 2RT), utilising the core HER data, the 1:2500 County Series Ordnance Survey maps and any secondary information held within the HER.

3.1.2 Instrumentation

The Bartington Grad 601-2 dual fluxgate gradiometer uses a pair of Grad-01-100 sensors. These are high stability fluxgate gradient sensors with a 1.0m separation between the sensing elements, giving a strong response to deeper anomalies. The instrument detects variations in the earth's magnetic field caused by the presence of iron in the soil. This is usually in the form of weakly magnetized iron oxides which tend to be concentrated in the topsoil. Features cut into the subsoil and backfilled or silted with topsoil, therefore contain greater amounts of iron and can therefore be detected with the gradiometer. This is a simplified description as there are other processes and materials which can produce detectable anomalies. The most obvious is the presence of pieces of iron in the soil or immediate environs which usually produce very high readings and can mask the relatively weak readings produced by variations in the soil. Strong readings are also produced by archaeological features such as hearths or kilns as fired clay acquires a permanent thermo-remnant magnetic field upon cooling. This material can also get spread into the soil leading to a more generalized magnetic enhancement around settlement sites. Not all surveys can produce good results as results can be masked by large magnetic variations in the bedrock or soil or high levels of natural background "noise" (interference consisting of random signals produced by material with in the soil). In some cases, there may be little variation between the topsoil and subsoil resulting in undetectable features. The Bartington Grad 601 is a hand

held instrument and readings can be taken automatically as the operator walks at a constant speed along a series of fixed length traverses. The sensor consists of two vertically aligned fluxgates set 500mm apart. Their cores are driven in and out of magnetic saturation by a 1,000Hz alternating current passing through two opposing driver coils. As the cores come out of saturation, the external magnetic field can enter them producing an electrical pulse proportional to the field strength in a sensor coil. The high frequency of the detection cycle produces what is in effect a continuous output. The gradiometer can detect anomalies down to a depth of approximately one meter. The magnetic variations are measured in nanoTeslas (nT). The earth's magnetic field strength is about 48,000 nT; typical archaeological features produce readings of below 15nT although burnt features and iron objects can result in changes of several hundred nT. The machine is capable of detecting changes as low as 0.1nT.

3.1.3 Data Collection

The gradiometer includes an on-board data-logger. Readings are taken along parallel traverses of one axis of a 20m x 20m grid. The traverse interval is 1.0m and readings are logged at intervals of 0.25m along each traverse. Marked guide ropes are used to ensure high positional accuracy during the high resolution survey. The data is transferred from the data-logger to a computer where it is compiled and processed using ArchaeoSurveyor2 software. The data is presented as a grey scale plot where data values are represented by modulation of the intensity of a grey scale within a rectangular area corresponding to the data collection point within the grid. This produces a plan view of the survey and allows subtle changes in the data to be displayed. This is supplemented by an interpretation diagram showing the main feature of the survey with reference numbers linking the anomalies to descriptions in the written report. It should be noted that the interpretation is based on the examination of the shape, scale and intensity of the anomaly and comparison to features found in previous surveys and excavations etc. In some cases the shape of an anomaly is sufficient to allow a definite interpretation e.g. a Roman fort. In other cases all that can be provided is the most likely interpretation. The survey will often detect several overlying phases of archaeological remains and it is not usually possible to distinguish between them. Weak and poorly defined anomalies are most 4 susceptible to misinterpretation due to the propensity of the human brain to define shapes and patterns in random background "noise". An assessment of the confidence of the interpretation is given in the text.

3.1.4 Data Processing

The data is presented with a minimum of processing although corrections are made to compensate for instrument drift and other data collection inconsistencies. High readings caused by stray pieces of iron, fences, etc. are usually modified on the grey scale plot as they have a tendency to compress the rest of the data. The data is however carefully examined before this procedure is carried out as kilns and other burnt features can produce similar readings. The data on some 'noisy' or very complex sites can benefit from 'smoothing'. Grey-scale plots are always somewhat pixellated due to the resolution of the survey. This at times makes it difficult to see less obvious anomalies. The readings in the plots can therefore be interpolated thus producing more but smaller pixels and a small amount of smoothing based on a low pass filter can be applied. This reduces the perceived effects of background noise thus making anomalies easier to see. Any further processing is noted in relation to the individual plot.

3.1.5 Aims

The report will include a discussion of the grey scale plot and an interpretation of the any anomalies identified; these anomalies will be presented as either positive or negative, suggesting whether they could be cut features (ditches, pits etc.), or built sub-surface features (e.g., banks). Figures will be included for the grey scale plot and for the anomaly interpretation. The results of the geophysical survey will be used to inform further recommendations for archaeological evaluation and/or mitigation (if relevant)

3.2 Report compilation

Following completion of the stages outlined above, a report will be produced incorporating the following:

1. Front cover;
2. Inner cover;
3. Figures and Plates List;
4. Non-technical summary (Welsh/English);
5. Introduction;
6. Methodology;
    i. Geophysical survey;
7. Results;
8. Conclusions and recommendations;
    a. Conclusion and recommendations;
9. Acknowledgements;
10. Bibliography;
    a. Primary sources;
    b. Secondary sources;
11. Figures; inc.:
    - location plan;
    - grey scale plot;
    - anomaly identification and interpretation;
12. Appendix I (approved written scheme of investigation);
13. Appendix II (Sites listed on GAT Historic Environment Record);
14. Appendix III (Definition of mitigation terms);
15. Back cover.

Illustrations will include plans of the location of the study area; historical maps, when appropriate and if copyright permissions allow, will be included.

A full archive including plans, photographs, written material and any other material resulting from the project will be prepared. The archaeological evaluation outlined in this written scheme of investigation will be submitted in draft format in March 2019; a final report will be submitted to the Historic Environment within six months of submitting the draft report (September 2019).

The following dissemination will apply:

- A digital report(s) will be provided to the client/consultant and GAPS (draft report then final report);
- A paper report plus a digital report will be provided to the regional Historic Environment Record, Gwynedd Archaeological Trust; this will be submitted within six

months of project completion (final report only), along with any relevant, digital information such as the project database and photographs. All digital datasets submitted will conform to the required standards set out in *Guidance for the Submission of Data to the Welsh Historic Environment Records (HERs)* (Version 1.1); and

- A digital report and archive (including photographic and drawn) data will be provided to Royal Commission on Ancient and Historic Monuments, Wales (final report only), in accordance with the *RCAHMW Guidelines for Digital Archives Version 1*. Digital information will include the photographic archive and associated metadata.

4 PERSONNEL

The project will be managed by John Roberts, Principal Archaeologist GAT Contracts Section. The evaluation will be completed by a team of Project Archaeologists who will have responsibility for completing and compiling the survey data, interpreting the results, preparing the subsequent report and archive. The project manager will be responsible for reviewing and approving the report prior to submission.

5 INSURANCE

5.1 Public/Products Liability

Limit of Indemnity- £5,000,000 any one event in respect of Public Liability
INSURER Aviva Insurance Limited
POLICY TYPE Public Liability
POLICY NUMBER 24765101CHC/UN/000375
EXPIRY DATE 21/06/2019

5.2 Employers Liability

Limit of Indemnity- £10,000,000 any one occurrence.
The cover has been issued on the insurers standard policy form and is subject to their usual terms and conditions. A copy of the policy wording is available on request.
INSURER Aviva Insurance Limited
POLICY TYPE Employers Liability
POLICY NUMBER 24765101 CHC / UN/000375
EXPIRY DATE 21/06/2019

5.3 Professional Indemnity

Limit of Indemnity- £5,000,000 in respect of each and every claim
INSURER Hiscox Insurance Company Limited
POLICY TYPE Professional Indemnity
POLICY NUMBER 9446015
EXPIRY DATE 22/07/2019

6 SOURCES CONSULTED

1. English Heritage, 1991, Management of Archaeological Projects
2. English Heritage, 2015, Management of Research Projects in the Historic Environment (MoRPHE).
3. *Guidance for the Submission of Data to the Welsh Historic Environment Records (HERs)* (Version 1.1)
4. Gwyn, D. & Thompson, D., 2001 , Historic Landscape Characterisation - Caernarfon-Nantlle. Gwynedd Archaeological Trust Report 402.
5. Ordnance Survey First Edition Ordnance Survey 1-inch to 25-mile County Series Map Sheets XV.08 and XV.12; 1889.
6. Ordnance Survey Second Edition Ordnance Survey 1-inch to 25-mile County Series Map Sheets XV.08 and XV.12; 1900.
7. Ordnance Survey Third Edition Ordnance Survey 1-inch to 25-mile County Series Map Sheets XV.08 and XV.12; 1918.
8. Royal Commission on Ancient and Historic Monuments of Wales 2015 *Guidelines for digital archives*
9. Standard and Guidance for Archaeological Geophysical Survey (Chartered Institute for Archaeologists, 2014).

FIGURE 01

Location of assessment area (outlined red) and local archaeological features. Based on Ordnance Survey 1:10000 County Series Map Sheets SH46SE. Scale 1:5000 @A4. © Crown Copyright. All Rights Reserved. License Number Al100020895.

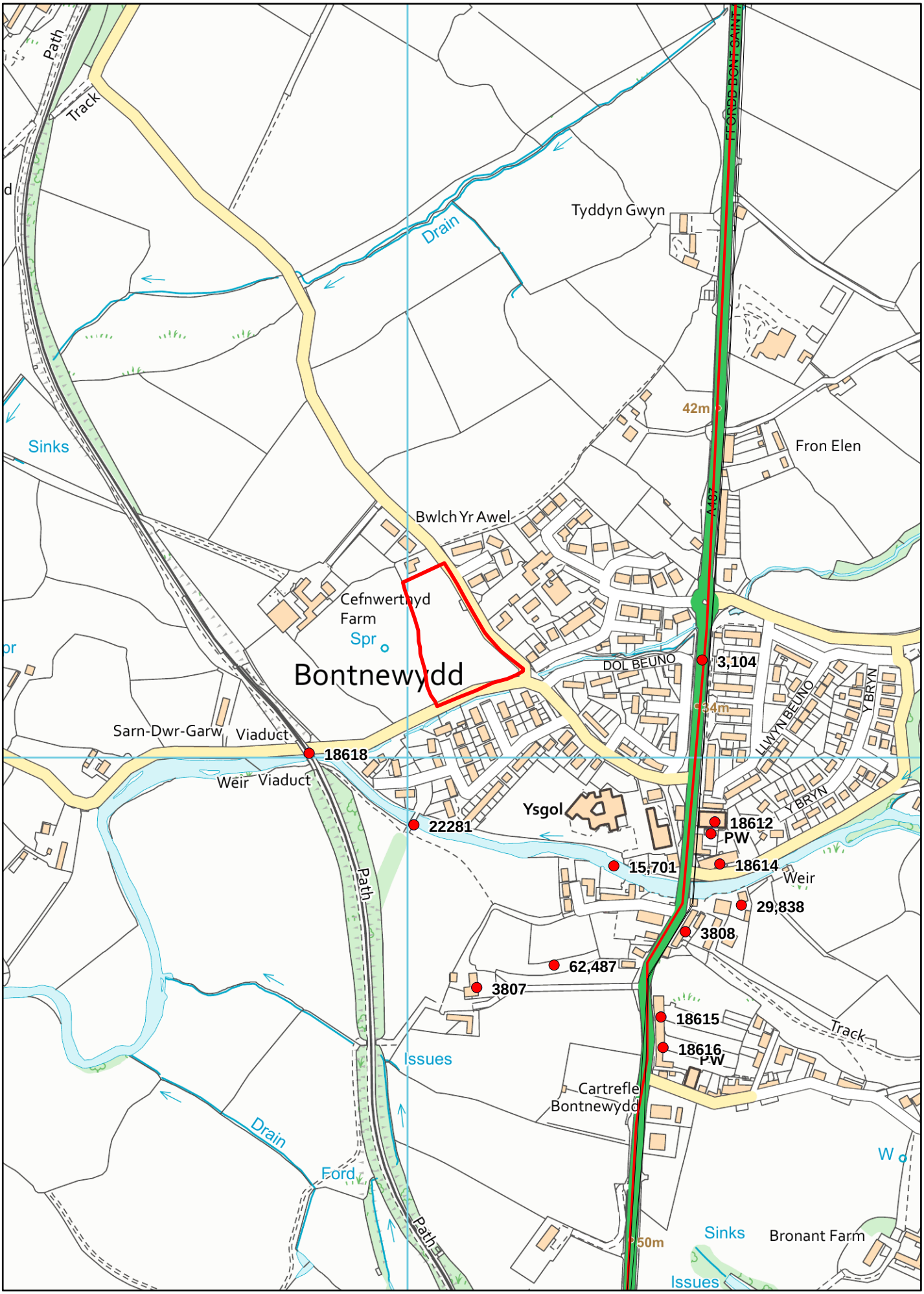

FIGURE 01: Location of assessment area (outlined red) and local archaeological features. Based on Ordnance Survey 1:10000 County Series Map Sheets SH46SE. Scale 1:5000 @A4. © Crown Copyright. All Rights Reserved. License Number Al100020895.

FIGURE 02

Reproduction of Ordnance Survey First Edition Ordnance Survey 1-inch to 25-mile County Series Map Sheets XV.08 and XV.12; 1889. Scale 1:5000 @A4.

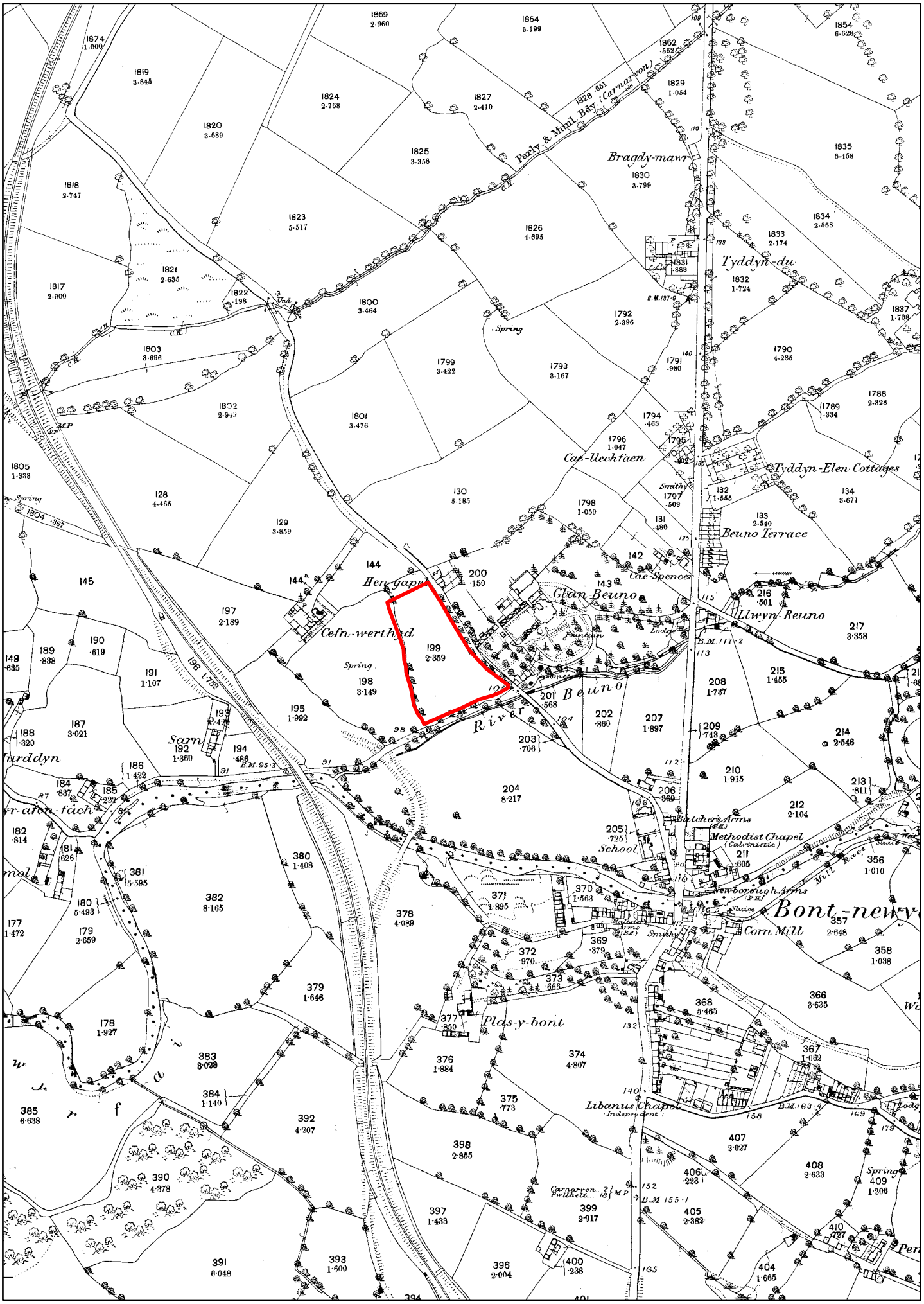

FIGURE 02: Reproduction of Ordnance Survey First Edition Ordnance Survey 1-inch to 25-mile County Series Map Sheets XV.08 and XV.12; 1889. Scale 1:5000 @A4.

FIGURE 03

Reproduction of Ordnance Survey Second Edition Ordnance Survey 1-inch to 25-mile County Series Map Sheets XV.08 and XV.12; 1900. Scale 1:5000 @A4.

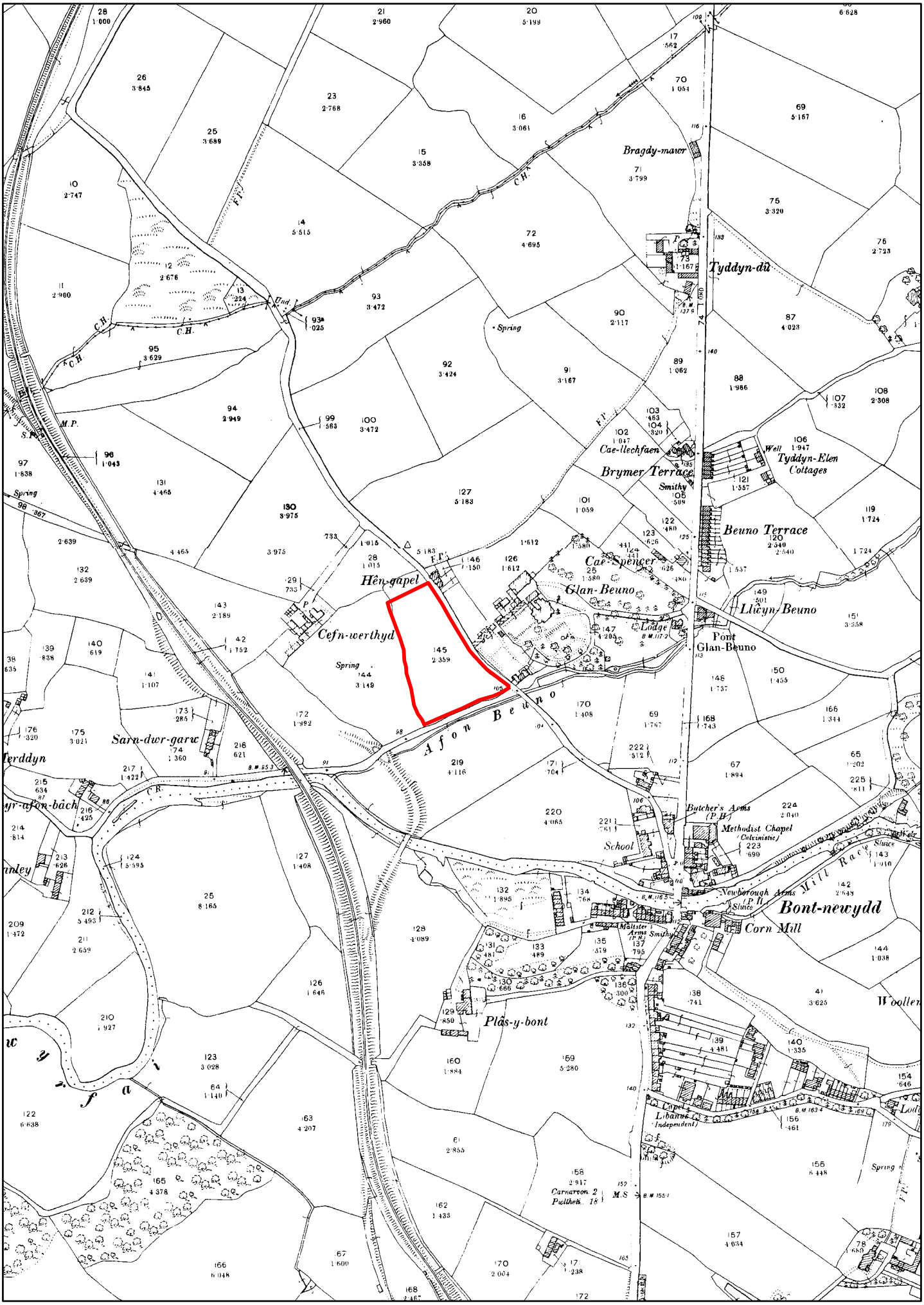

FIGURE 03: Reproduction of Ordnance Survey Second Edition Ordnance Survey 1-inch to 25-mile County Series Map Sheets XV.08 and XV.12; 1900. Scale 1:5000 @A4.

FIGURE 04

Reproduction of Ordnance Survey Third Edition Ordnance Survey 1-inch to 25-mile County Series Map Sheets XV.08 and XV.12; 1918. Scale 1:5000 @A4.

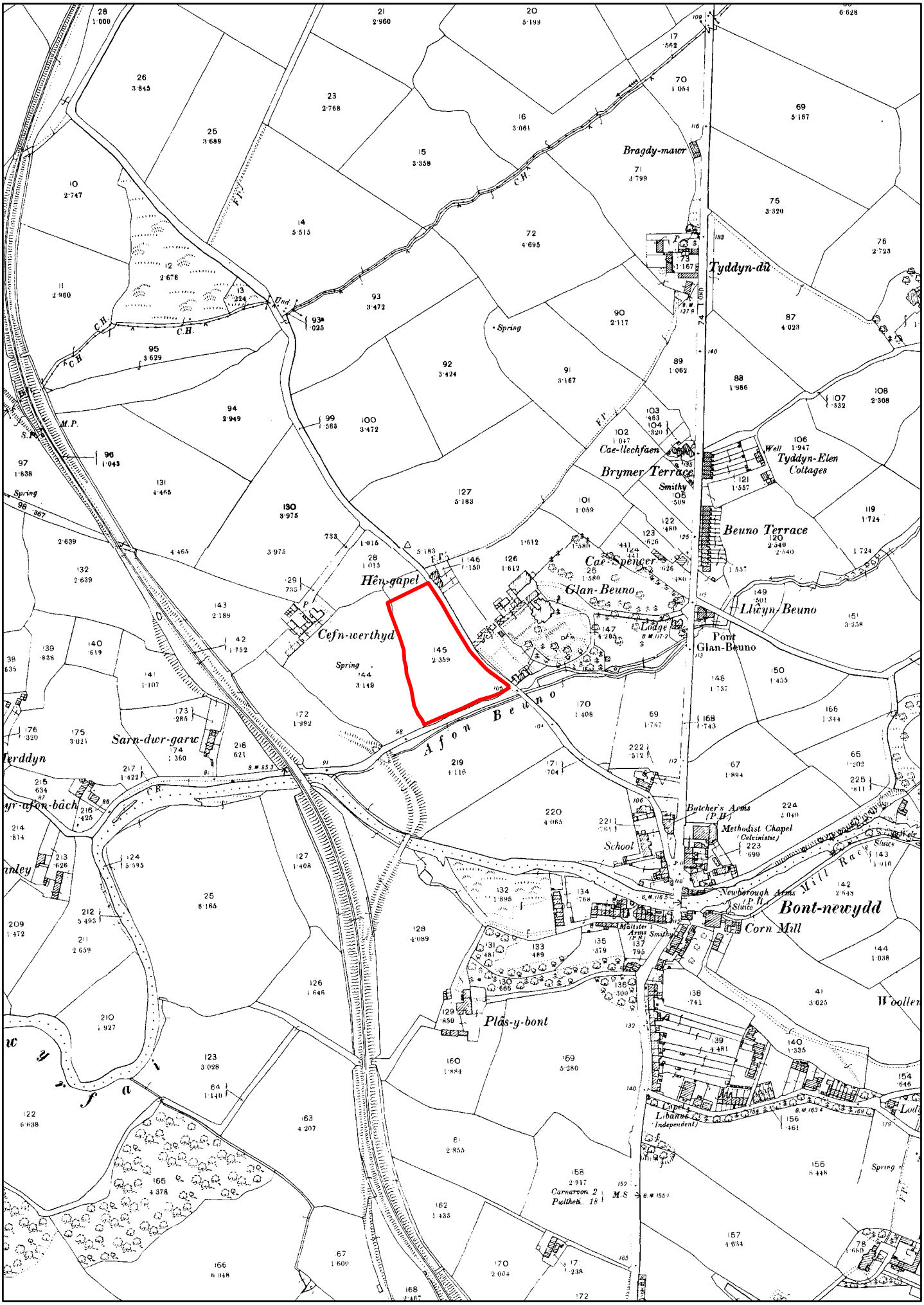

FIGURE 04: Reproduction of Ordnance Survey Third Edition Ordnance Survey 1-inch to 25-mile County Series Map Sheets XV.08 and XV.12; 1918. Scale 1:5000 @A4.

Gwynedd Archaeological Trust
Ymddiriedolaeth Archaeolegol Gwynedd

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