Llywodraeth Cynulliad Cymru
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Balfour Beatty Jones Brothers Joint Venture

A487 Porthmadog, Minffordd and Tremadog Bypass

Report on archaeological mitigation (GAT report 1065)

Photograph by Chris Lane

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Report on archaeological mitigation

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1 SUMMARY

A programme of archaeological excavation work and watching briefs was carried out on the route of the A487 Tremadog, Porthmadog and Minffordd Bypass during its construction. The bypass route runs through a landscape of reclaimed land, the former Glaslyn estuary, known as Traeth Mawr. There were 27 sites of archaeological interest identified in addition to 69 field boundaries and drainage features. All these features were investigated and recorded appropriately and watching briefs were carried out. The low hill of Y Bryn, also known as Bryn-y-Fynwent, which would have been above the level of the now drained Glaslyn estuary, was of particular archaeological importance. Here excavation uncovered the remains of a Roman lime kiln, two pits thought to be associated with smithing, and a collection of Roman roofing slates. These remains are thought to form part of a larger Roman presence in the area, and therefore associated with the Roman bath-house which lies across the road from Y Bryn and a corn drying kiln located under the new hospital site.

An attempt to locate the old road across Traeth Mawr using geophysical survey and trial trenching was unsuccessful, but a medieval shell midden was located and an area of peat was analysed for pollen. This analysis revealed evidence for a Bronze Age clearance episode.

This report describes in full the findings of the archaeological works.

2 INTRODUCTION

Hyder Consulting (UK) Limited commissioned Gwynedd Archaeological Trust to undertake a programme of archaeological works during the construction of the A487 Tremadog, Porthmadog and Minffordd Bypass.

The work was monitored on behalf of the local planning authority by Gwynedd Archaeological Planning Services (GAPS). The bypass starts at Tremadog (SH55470 40294) and runs for 5200m and ends at Minffordd hospital (SH60256 38658) (figure 1).

Previous work related to the project includes an archaeological assessment carried out in April 1995 (Roberts 1995, GAT Report 155), in which recommendations were made for further evaluation and mitigation. This was supplemented in November 1995 by a programme of archaeological evaluation at Bryn y Fynwent, Tremadog (Hopewell 1995 (GAT Report 182)). The results of both reports were incorporated into an environmental statement that was published in May 2008 (A487 Porthmadog/Tremadog Bypass Technical Report 2: Cultural Heritage).

3 AIMS AND OBJECTIVES

The original aim of the works was to mitigate the impact of the development on known or potential archaeological remains. In order to achieve this aim a set of objectives were completed by undertaking a phased programme of works comprising:

- Strip, map and sample of defined areas
- Trial trenching within defined areas or on specific features
- Detailed or Basic recording of upstanding features
- Watching briefs

The current aim is to ensure the long term curation of the recovered data, and its dissemination in a form suitable to its academic value in line with nationally defined guidelines.

4 SPECIFICATION AND PROJECT DESIGN

An archaeological Project Design for the scheme was written by Gwynedd Archaeological Trust and submitted to Hyder Consulting (UK) Limited and Gwynedd Archaeological Planning Service in in February 2010. This formed *Welsh Assembly Government: A487 Porthmadog Minffordd Tremadog Bypass: Archaeological Mitigation Design: February 2010* (here-after called the Mitigation Design), and listed the identified archaeological features along the scheme and the proposed mitigation (reproduced in appendix I). It also formed the basis of a method statement submitted for the work. The archaeological excavation and recording was undertaken in accord with the Mitigation Design. This was achieved by undertaking a phased programme of works between February 2010 and December 2011. The ground-works were undertaken by Balfour Beatty Jones Bros Ltd*.*

On completion of the fieldwork the data collected was assessed for potential and an updated project design for the completion of the post-excavation programme was produced. Post excavation analysis was carried out according to this design leading to the production of the current report, the long term archiving of finds and site records, and the dissemination of the results.

This project and the production of the current report have followed the standards defined in *Management of Archaeological Projects* (Second Edition, English Heritage, 1991), and *Management of Research Projects in the Historic Environment Project Manager's Guide* (English Heritage 2006).

5 METHODS AND TECHNIQUES

5.1 Introduction

A phased programme of works was undertaken. These works included:

- Evaluation trenching within defined areas
- Strip/map/sample of defined areas
- Recording of upstanding features (Basic and Detailed)
- Palaeoenvironmental assessment and analysis
- Geophysical Survey

5.2 Watching brief

A watching brief was conducted during all topsoil stripping and boundary removal associated with the route, including construction compounds and temporary access roads. A watching brief was carried out on test pits dug in January 2010 but the main works started in February 2010 and the last watching brief took place on 2nd December 2011.

In the following report national grid references will be used to locate archaeological features but field numbers were allocated during the fieldwork and are also used to define parts of the route (see figures 2 and 3). The field and boundary numbers are of particular use if the site archive is consulted as they are used to locate areas of stripping and features. These field numbers do not correspond to the OS County Series map field numbers.

The watching brief focused on specific mitigation areas defined by the Mitigation Design and listed in appendix I. These are listed here with their Primary Record Number (PRN) for the Gwynedd Historic Environment Record (HER) to allow easier cross referencing with the text below where the PRN is used to make future reference easier.

Feature 01 (PRN 1380) Roman bath-house, Tremadog (sub-surface survival only)
Feature 03 (PRN 33587) Drystone revetting at Y Bryn
Feature 04 (PRN 21171) Tremadog/Gorseddau Tramway
Feature 05 (PRN 21172) Madocks' Canal
Feature 06 (PRN 33605) The old route across Traeth Mawr and junction with the improved turnpike road
Feature 07 (PRN 33603) Gorsedd Circle
Feature 09 (PRN 33545) Revetted drain
Feature 10 (PRN 21174) Welsh Highland Railway (Porthmadog)
Feature 11 (PRN 33601) Site of shooting butts
Feature 15 (PRN 33598) Embankment with road
Feature 16 (PRN 33600) Pre-turnpike road from Penrhyndeudraeth to Minffordd
Feature 18 (PRN 21177) Ffestiniog Railway embankment

Feature 20 - Field Boundaries and hedgerows
Feature 21 - Areas of Unknown Archaeological Potential
Feature 23 - Environmental Archaeology
Feature 43 – (PRN 33602) Tidal gates to Llyn Bach

The watching brief on feature 01 at the limits of the scheduled area of the Roman bath-house was carried out under Scheduled Monument Consent following the method statement included as appendix II.1. The report on this work as sent to Cadw on 19th January 2012 is included as appendix II.2

5.2.1 Detailed recording

Features of archaeological importance requiring detailed recording were identified in the Mitigation Design.

These were:

Feature 05 (PRN 21172) Madocks' Canal
Feature 09 (PRN 33545) Revetted drain
Feature 10 (PRN 21174) Welsh Highland Railway (Porthmadog)
Feature 15 (PRN 33598) Embankment with road
Feature 21 - Areas of Unknown Archaeological Potential
Feature 23 - Environmental Archaeology
Feature 43 – (PRN 33602) Tidal gates to Llyn Bach

Detailed recording included a photographic record, measured survey and the production of a measured drawing prior to the commencement of the works on site.

5.2.2 Basic Recording

Features of archaeological importance requiring basic recording were identified in the Mitigation Design.

These were:

Feature 03 (PRN 33587) Drystone revetting at Y Bryn
Feature 07 (PRN 33603) Gorsedd Circle
Feature 11 (PRN 33601) Site of shooting butts
Feature 16 (PRN 33600) Pre-turnpike road from Penrhyndeudraeth to Minffordd
Feature 20 - Field Boundaries and hedgerows
Feature 42 (PRN 33599) Area of quarrying

Basic recording included photographs and written descriptions prior to the commencement of the works on site. The fields and boundaries along the whole route were numbered to allow their identification during the project. The numbers ran along the bypass route starting at Tremadog and ending at Minffordd, (see figures 2 and 3). For details on individual field boundaries see appendix III.

5.3 Strip/Map/Sample

The Mitigation Design required that the area at Y Bryn, Tremadog where Neolithic flints had been found (Feature 02, centred on NGR SH55704010)) was investigated by strip/map/sample techniques. The design defined the area to be investigated and the investigation was conducted following all topsoil stripping and boundary removal associated with the route in this area. The investigation was undertaken between February 2010 and March 2010; a total area of approximately 0.1km² was investigated. The turf was stripped from most of the site using a tracked 360˚ excavator. In areas that this was unable to access safely, e.g. the narrow passage between the stone wall and Y Bryn outcrop, a small mechanical excavator was used. This was a controlled strip with an archaeologist observing at all times.

After the topsoil initial strip observed features were surveyed using a total station theodolite and partially excavated to evaluate their archaeological potential. This was followed by complete excavation of the features deemed significant. All subsequent excavation was by hand, undertaken stratigraphically. Detailed plans were produced of all significant archaeological features, as well as section drawings as appropriate. A water pump was used drain water and allow the recording of features discovered by the old estuary edge where flooding occurred. Deposits and features were recorded using context sheets, on which the character of the context and its stratigraphical relationships were described. A photographic record was produced using digital SLR cameras and a register of the photographs was kept. Finds were bagged, recorded and stored as appropriate. Bulk samples were taken where appropriate, particularly from features with prehistoric finds or charcoal, and labelled with their stratigraphical context and sample number. In the post-excavation phase the bulk samples were processed by flotation, and the charred plant remains sent for assessment and if necessary further study. The coarse and fine residues were inspected for finds and non-floating ecological remains. The artefacts from site and from the residues were all cleaned, catalogued and stored in a stable condition.

5.4 Geophysical Survey and Evaluation Trenching

The old route across Traeth Mawr and its junction with the improved turnpike road (Feature 06) were identified in the Mitigation Design. The investigation of feature 06 was completed as a staged process including geophysical survey and targeted trenching.

5.4.1 Stage 01 – Geophysical Survey

A magnetometer geophysical survey was conducted across an area of approximately 2.64ha within the relevant mitigation area and was divided into two areas (see figures 4 and 5):

Western geophysics area (area A): Bodawen Roundabout 1.8ha (300.0m x 60.0m); centred on NGR SH56703950

Eastern geophysics area (area B): Eastern side of the crossing of Traeth Mawr: 0.84ha (140.0m x 60.0m); centred on NGR SH58703900.

The survey was completed by *Stratascan* in February 2010 (Report *J2696*: February 2010). The survey grids were located by a Leica Smart Rover RTK GPS (Real-time Kinematic Global Positioning System) which has an accuracy of around 0.01m; the survey was completed using a dual sensor Grad601-2 Magnetic Gradiometer manufactured by Bartington Instruments Ltd. The instrument consists of two fluxgates very accurately aligned to nullify the effects of the Earth's magnetic field.

Readings relate to the difference in localised magnetic anomalies compared with the general magnetic background. Readings were taken at 0.25m centres along traverses 1m apart. This equates to 3600 sampling points in a full 30m x 30m grid. The Grad 601 has a typical depth of penetration of 0.5m to 1.0m. This would be increased if strongly magnetic objects have been buried in the site. The collection of data at 0.5m centres provides an optimum methodology for the task balancing cost and time with resolution.

Specialist software known as *Geoplot 3* was used to process the data. This can accentuate various aspects contained within the data but which are often not easily seen in the raw data. Basic processing of the magnetic data involves 'flattening' the background levels with respect to adjacent traverses and adjacent grids. 'Despiking' is also performed to remove the anomalies resulting from small iron objects often found on agricultural land. After the basic processing has flattened the background, further processing can be carried out, which may include low pass filtering to reduce 'noise' in the data and hence emphasise the archaeological or man-made irregularities (Report *J2696*: February 2010). For the full report see appendix IV.

5.4.2 Stage 02 - Evaluation trenching

Two evaluation trenching areas were targeted in tandem with the geophysical survey areas. A total of twenty nine trenches were excavated in these two areas and another trench was excavated in field 27 targeting the shooting butts (PRN 33601).

Bodawen Roundabout (centred on NGR SH56703950): 15 trial trenches (figure 4).

Eastern side of the projected crossing of Traeth Mawr: (centred on NGR SH58703900): 14 trial trenches were excavated (figure 5).

The trenches were excavated using tracked 13, 5 or 3 ton 360 excavator provided by the contractor, under constant archaeological control. For the results of individual evaluation trenches see appendix V.

5.5 Environmental sampling

A programme of environmental sampling was undertaken to assess the palaeoenvironmental potential of the Traeth Mawr area within the scheme.

In February 2010 Birmingham Archaeo-Environmental (BAE) carried out an initial hand-bored coring survey of deposits along the line of the Porthmadog bypass. The route had previously been identified as having potential for the preservation of palaeoenvironmental deposits. Further recommendations were made in response to the results of the hand-bored survey. The sampling and analysis were both completed by BAE.

Possible locations for the preservation of deposits of palaeoenvironmental potential were identified by carrying out a walkover survey, however there were areas to the far eastern end of the study area adjacent to Minffordd that were not accessible. A total of sixteen boreholes were subsequently excavated in three main areas along the line of the bypass (see appendix VI figure 1). The coring survey was carried out using an Eikjelcamp gouge corer. The stratigraphy of the deposits was logged in the field using the Troels Smith (1955) method and the locations of the cores were recorded using a GPS.

The results from the Palaeoenvironmental assessment of deposits along the line of the Bypass between Porthmadog and Tremadog (appendix VI.1) suggested that any deposits with palaeoenvironmental potential would probably be deeply buried beneath the fluvial deposits of the Traeth Mawr estuary.

The survey noted that there may be residual pockets of sediment that may be encountered outside of the area selected for coring. During the groundworks of the bypass just such a deposit was encountered at Minffordd, directly to the south of the Ffestiniog railway line (see appendix VI.2, Fig.1 and 2). A core sample was taken using a Russian Auger. Eight additional 10L bulk samples were also recovered. As well as the Russian auger core, 6 smaller cores were taken, using an Eikjelcamp gouge corer, adjacent to the sample site (see appendix VI.2 Fig.3). Stratigraphic Analysis of the deposits was logged in the field using the Troels Smith (1955) method and the locations of the cores were recorded using a GPS. Twelve sub-samples were taken from the Russian core for the pollen assessment. Three of the bulk samples were processed for plant macrofossil and beetle assessments. For the full report see appendix VI.2.

The beetle and plant macrofossil remains were not recommended for further work but the pollen was well-preserved and full analysis of the pollen core was recommended. Twenty two sub-samples from the sediment core were taken for pollen analyses at 0.04m intervals. Pollen preparation followed standard techniques including potassium hydroxide (KOH) digestion, hydrofluoric acid (HF) treatment and acetylation (Moore *et al.,* 1991). At least 300 total land pollen grains (TLP) excluding aquatics and spores were counted for each sample.

A further 3 samples from the peat (0.16m, 0.32m and 0.76m), in addition to the two taken for the assessment, were submitted to Beta Analytic Ltd for AMS dating. The report on the full pollen analysis is included as appendix VI.3.

5.6 Post excavation analysis and reporting

The post-excavation analysis, report and archiving has been carried out according to the post excavation project design submitted in October 2010 and revised in January 2012.

5.6.1 Data collection from site records

Site records were checked, and photographs, plans, finds and samples were cross referenced to the relevant context sheets. Site records, including context sheets and field drawings, were scanned to provide a security copy of the information. These records were used as the basis of descriptions and discussion of individual features and for the creation of illustrations. A database of photographs was created to provide appropriate metadata to allow for the active curation of the digital photographs.

5.6.2 Finds

The finds have been catalogued and grouped by material type. See appendix VII.1 for a list of finds with brief descriptions. All finds, where appropriate, were cleaned, and have been packaged in suitable containers for long term storage. The flint flakes and other stone items have been studied by George Smith, GAT's in-house lithics expert and have been drawn where appropriate by Macsen Flook. Other finds were sent to specialists. Dr Peter Webster from the department of Archaeology and Numismatics at the National Museum of Wales assessed the Roman pottery, brick and tile. Dr Nora Bermingham analysed all the bone and teeth found. Dr Gwynfor Pierce Jones examined the Roman roof slates. Phil Parkes x-rayed the iron objects and Dr Tim Young studied the metalworking residues and clay kiln lining.

5.6.3 Environmental samples

Twenty five bulk soil samples (see appendix VII.2) were collected and these were processed by flotation and wet sieving, using a 500 micron mesh to collect charred plant remains. The residue from the sieving was sorted to check for small artefacts. The charred plant remains were studied by Rosalind McKenna (free-lance environmental specialist). Appropriate pieces were selected for radiocarbon dating. See appendix VIII for the full report.

5.6.4 Radiocarbon dating

The potential for gaining significant archaeological information by radiocarbon dating the sites found along the scheme was assessed and the collection of features on Y Bryn (feature 2) were considered to have the highest potential but a shell midden of otherwise unknown date was also considered worth dating. The significance and stratigraphic relationships of the deposits on y Bryn were considered and the most appropriate deposits selected for dating. This selection took into account the taphonomy of the material to be dated. Rosalind McKenna then selected short-lived, identifiable material from the chosen samples. Two pieces of material from each context were dated to allow these to be compared to detect any mixing or contamination of the deposit.

Six samples of charcoal and 2 samples of marine shell were submitted to the Scottish Universities Environmental Research Centre to be measured by Accelerator Mass Spectrometry (AMS). The charcoal samples were pre-treated following Stenhouse and Baxter (1983), and combusted as described in Vandeputte *et al* (1996) with the graphite targets prepared and measured following Xu *et al* (2004). Shell carbonate was pre-treated by removing any adhering detritus by physical abrasion before sonication in an ultrasonic bath to remove any further debris. 20% by mass of the outer surface was then removed by etching in 1M HCl solution. After rinsing and drying, a 0.1g cross-section of the shell, from umbo to shell margin, was selected for acid hydrolysis to integrate the entire lifespan of the organism. The shell fragments received a further 20% surface removal, *in situ*, immediately before hydrolysis, in order to remove any adsorbed CO_2 that may have accumulated in the storage period between pre-treatment and hydrolysis.

The radiocarbon dates are presented in appendix XVI. In order to statistically compare the 2 dates from each context and to provide a rigorous interpretation of the dates from Y Bryn Derek Hamilton of the Scottish Universities Environmental Research Centre carried out statistical analysis on the dates and also on dates previously obtained from a Roman corn drier found in the vicinity some years ago (Kenney 2006). The aim was to compare dated Roman activity in the area in an attempt to relate the different activities.

5.6.5 Reporting and dissemination

The present document provides a record of the methodology and results of the archaeological works. It will be held in the Gwynedd Historic Environment Record and will be available for public and academic consultation. A copy of the report will be sent to the Gwynedd Archaeological Planning Service Archaeologist. A copy of the report will be sent to the Royal Commission on the Ancient and Historical Monuments of Wales and will be made available on their website. A summary of the work with appropriate illustrations will be published in the journal Archaeology in Wales.

5.6.6 Archiving

The artefacts and ecofacts are to be held by the Gwynedd Museum and Art Gallery, Bangor (accession number 2010/10) and the paper archive will be held by the National Monuments Record (NMR), Aberystwyth. The Museum have agreed to only take a selection of ther Roman roofing slates collected so the rest will be discarded. Large unworked stones will also be discarded. The charred plant remains and charcoal are to be held with the artefacts. The full digital record including photographs with the appropriate metadata will be stored by the Royal Commission for the Ancient and Historical Monuments of Wales in their active digital storage facility.

6 TOPOGRAPHICAL, HISTORICAL AND ARCHAEOLOGICAL BACKGROUND

Dave Hopewell

6.1 Geology and topography

There are three definable landscapes which have been affected by the Bypass, the upland areas to the north and the west, the reclaimed Traeth Mawr, and the Penrhyndeudraeth Peninsula. The former and latter areas are rugged rocky terrain but Traeth Mawr (the Great Sand) is flat reclaimed estuary land.

The geology of the area affected by the bypass has been little altered since the end of The Great Ice age some 11,000 years ago and the main changes have been due to slight subsidence of the land. Between the coastline of Criccieth and Porthmadog and up to five miles inland is a small triangular outcrop of Upper Cambrian rocks with an outcrop of intrusive igneous rock close to Porthmadog itself. This is the site of Minffordd Quarry, which is a granite quarry and was open for setts in the 1870's (Bassett and Davies 1977). The Tremadog Beds occupy the uppermost position in the Cambrian sequence which is the rock type most prominent in the area affected by the scheme. The Tremadog beds consist of thick monotonous succession of grey and blue mudstones and shales many of which have been altered into slates. The area of Tremadog and Y Bryn is in the shadow of the cliff face known as Craig-y-Castell. Transitional deposits from Cambrian rocks to Ordovician rocks occur mainly at the village of Tremadog.

Traeth Mawr was once the estuary of the Afon Glaslyn, with a western bulge where the Nant yr Afon Oer formerly entered the sea. The breadth of the estuary was not related to the size of the rivers but to the fact that these valleys were originally carved out by glaciers. The mouth of the estuary was blocked by the building of an embankment (known as the Great Embankment or the Cob) by William Madocks in the early 19th century and the land was reclaimed as farmland. Until recently the only information about the marshes prior to reclamation was on large-scale maps such as John Evans' 1797 map of Wales. A map, drawn by John Salter in 1775, was recently discovered in the Penmaen Ucha Estate papers at the Dolgellau Record Office. This shows Traeth Mawr in detail and is remarkably accurate for its time. It shows the extent of the marshes and sands and the course of the river along with roads, crossing points and early embankments. The 1775 map has been transcribed onto a modern Ordnance Survey map (see Figure 6). Place names have been updated to modern spelling where appropriate.

6.2 Archaeology and history

6.2.1 Neolithic and Bronze Age (4000 BC to 800 BC)

PRN refers to the Primary Record Number of the Gwynedd Historic Environment Record.

The known distribution of sites of the Neolithic and Bronze Age periods tends to be concentrated on the better agricultural lands south and west of Moel y Gest, the large hill that dominates the west side of Traeth Mawr. These include the three Neolithic chambered cairns of Cist Cerrig (PRN 218), Caerdyni (PRN 1291), and the site of a possible cairn on the coast at Garreg Wen Fach (PRN 1433). Though no Neolithic settlement sites are known, they are most likely to be found in the vicinity of the cairns, that is on the lower lying ground south of Moel y Gest, where a polished stone axe has been found (4065). The megalithic tradition continued into the Bronze Age, and several standing stones survive (PRN 192, 1300, 1381, 2360) and a possible stone circle (PRN 1383). Cremation burials of the Bronze Age have been found on slightly higher ground to the west (PRN 2377, 2378). Cup marks (round depressions cut into a stone, sometimes with a ‘ring’ around them) are usually dated to this period, and can be found at several sites in the area, including Cist Cerrig (PRN 218) and Llannerch (PRN 2294). On the route of the scheme, field evaluation at Y Bryn undertaken as part of the EIA process carried out for the 1993 Preferred Route, recovered a number of flint fragments diagnostic of the late Mesolithic and early Neolithic period. The excavation report (Hopewell 1995) concluded that ‘the topographic situation … a low knoll overlooking a broad flat valley floor, would be very suitable for temporary occupation during Later Mesolithic or Neolithic hunting/gathering’.

Finds of Later Bronze Age metalwork include four axes (PRN 2380, 4061, 4181, and 4347) and a sword (PRN 4180). Three of these, including the sword, were found on lower lying ground on the east side of Traeth Mawr, two close together at Penrhyndeudraeth. On the higher ground, to the west of the bypass route, are three burnt mounds, all probably of later Bronze Age date (PRN 1302, 4055, 5773).

6.2.2 Late Prehistoric and Roman (800 BC to AD 400)

Settlement within the late Prehistoric and Roman-British periods is considerably more extensive. These are found in both lowland and upland contexts, with a particular distribution around Moel y Gest, which is surmounted by a hillfort (PRN 1290) associated with several round houses. Some of these settlements lie close to the sides of the estuary, including that at Ty’n y Berllan (PRN 1192), and a settlement on Ynysfor (PRN 2392).

Immediately north of the proposed roundabout at the Tremadog / Penmorfa end of the scheme at SH55734041, is the site of a Roman bath-house (PRN 1380 and Scheduled Ancient Monument Cn 174). The site was discovered in the 19th century, and excavated in 1908 (Breeze and Anwyl 1909). The site is not visible above ground, although much of it is preserved below ground.

The Roman road between the forts of Segontium (at Caernarfon), via Pen Llystyn (at Bryncir 12km to the north-west of the scheme) and on to Tomen y Mur (near Trawsfynydd 13km to the east) is likely to have passed close to this point, though the exact crossing of Traeth Mawr has not been located. It has been suggested that the bath-house at Tremadog was associated with a *mansio* (an official government maintained stopping place) for official travellers along the road. It is also possible the iron ore at Bryn y Garreg Haiarn was being exploited at this time, and that the bath-house formed part of a settlement associated with the mines.

Excavations in 2006 (Kenney 2006) in advance of the new hospital at Llidiart Yspytty discovered a Romano-British corn-dryer on a natural shelf to the north-west of the Roman bath-house (PRN 19661)

6.2.3 Medieval (400AD - 1485AD)

The area lies within the Commotes of Eifionydd and Ardudwy-is-Artro, which once formed part of the Cantref of Dunoding. The bypass route crosses through land that lay within the townships of Gest and Penrhyndeudraeth, and was formerly divided between the three parishes of Ynyscynhaearn, Llanfrothen and Llanfihangel-y-Traethau. A 6th Century inscribed stone, decorated with a chi-rho symbol, lies in Treflys church.

There are no known Medieval sites located near the bypass route, however, south-west of Minffordd at SH58833715 is the castle of Aber Ia, within the grounds of Portmeirion, a 12th century motte, and possibly the stronghold of Gruffydd ap Cynan mentioned by Giraldus Cambrensis (Avent 1983).

The potential for earlier archaeology on the reclaimed Traeth Mawr is mostly confined to early crossing points, the former coastline on the estuary shores, and former islands, such as Ynysfor to the far north of the estuary. Traeth Mawr is mentioned in The Mabinogion in the tale of Math son of Mathonwy. The story tells of conflict and battles over who would be lord of Gwynedd. Math of Gwynedd and Pryderi of the South were at a truce when they travelled together until they reached the Traeth when at Y Felenrhyd 'the men on foot could not be restrained from shooting at each other' (Jones and Jones, 1963, p59).

The name Llidiart Yspytty, literally translated as the 'Gate of the Hospice', and applied to land at the western end of Tremadog, suggests a possible connection with the Order of St. John. The Order of St. John of Jerusalem or the Knights Hospitallers was established during the first half of the 11th Century to provide hospitality for pilgrims making the journey to the Middle East. Though no contemporary references survive, this would have been an obvious place for pilgrims making their way to Bardsey to rest having negotiated the perils of Traeth Mawr, and a hostel may have been maintained here. The discovery of skeletons by the road in 1820, later reburied in Penmorfa church, may be connected with the site of a hospitium (Alltud Eifion 1975). The earliest known documentary reference is in the late 16th Century, when Sir John Wynn was attacked at Llidiart Yspytty by a gang of eight armed men sent there, he claimed, by his enemy William Maurice, who would have killed him had it not been for ‘passengers traveling that waye’ (Gresham 1973). Though detail of the event is sparse, the episode suggests that Llidiart Yspytty was a recognised route across Traeth Mawr, and possibly the landing point from a ferry boat.

6.2.4 Post-Medieval and Later (1485 AD to the present day)

There were various attempts to reclaim parts of the estuary from as early as 1485, particularly around Penmorfa and Llanfrothen (Lewis 1989). During the early Post-Medieval period the area north of Traeth Mawr was largely in the hands of the Price family of Rhiwlas, who had been actively engaged in a programme of estate expansion since the late 16th century (Gresham 1973). By the 17th Century the land on the south side of Traeth Mawr was in the hands of a cadet branch of the Anwyl family of Parc, based at Plas Newydd. The 18th century naturalist and author Thomas Pennant describes Traeth Mawr as ‘a large extent of sands…of most dangerous passage to strangers, by recon of the tides which flow here with great rapidity’ (Pennant 1991, 193). Pennant also recollected a scheme to reclaim the estuary and Traeth Bychan designed by Sir John Wynne in 1625 (Moore 1997). The 1775 map (figure 6) shows several embankments reclaiming small areas along the edges of the estuary. It also shows a proposed embankment intended to reclaim most of the estuary. However nothing came of these larger schemes, and full reclamation was not achieved until the early 19th century.

Large estates continued to dominate the area well into the 19th century, with the lands of the Anwyls of Plas Newydd passing into the hands of the Mostyn estate, and the purchase of the Penmorfa estate, including the house of Tan-yr-Allt and lands bordering the Glaslyn estuary, from the Rhiwlas estate by William Alexander Madocks in 1798 (Beazley 1985, 55).

The arrival of Madocks proved to be a great watershed in the development of the area. His work has bequeathed one of the most remarkable ‘improved’ landscapes in Wales or indeed Great Britain, and succeeded in laying strong foundations for subsequent prosperity in the 19th and 20th century. His plan contained three related elements: the reclamation and enclosure of Traeth Mawr in order to increase his agricultural holding, the creation of a planned urban settlement, and development of the area’s industrial, mineral and transport potential (Beazley 1985).

The first part of the scheme involved an embankment which reclaimed land in the western part of the Glaslyn estuary, close to Penmorfa, thus adding over 1,000 acres to the estate. Parts of the embankment are still visible, running from the north-eastern side of present-day Porthmadog to Portreuddyn. It was eventually adapted to carry the Croesor Tramway in 1860 (Boyd 1975). In 1805 he started construction on his model village of Tremadog, in part hoping it would become a stopping place on the proposed new Porthdinllaen route to Ireland. Today the village of Tremadog retains its original plan, now a conservation area, it contains several Listed Buildings. Encouraged by the Porthdinllaen Harbour Bill, Madocks started on the construction of the Great Embankment (the Cob) which was completed in 1811, and allowed reclamation of the entire estuary (Beazley 1985). On the west side of the Penrhyndeudraeth peninsula lies the Boston Lodge works, part of the Ffestiniog Railway, and also the site of the construction works of the Cob, with associated quarry and barracks.

In the mid-19th Century, improvements on the south side of the estuary were largely undertaken by David Williams, a lawyer, businessman and Liberal MP for Merionethshire, who lived at nearby Bron Eryri (later Castell Deudraeth). He bought some of the marshlands alongside the estuary in 1853, and set about draining them. He built new roads between Rhos and Ty Obry and between Minffordd and Groeslon Glynen, and built, or sold land for building, to create much of the present village of Penrhyndeudraeth.

6.2.5 Roads, Rail and Industry

The Merioneth Turnpike Trust was formed in 1777 and was responsible for maintaining the roads in the area between Penmorfa, Pont Aberglaslyn and Penrhyndeudraeth during the 18th and 19th centuries. According to map and other evidence (principally the Map of Traeth Mawr, 1775, see figure 6) the original route between Penmorfa and Penrhyndeudraeth crossed the sands of Traeth Mawr and followed a line from near the hill known as Bryn-y-Fynwent, which directly translated means Cemetery Hill (now Y Bryn) on the north-west side of the estuary, running along the south-western side of Ynys-hir (Bodawen) to a point just north of the village of Minffordd on the south-east side of the estuary. A branch at Ynys-hir led to a second and longer crossing leading to a point to the south of Brodanw near present day Llanfrothen. These dangerous tidal crossings were only superseded in 1811 by the construction of the Great Embankment and the associated new connecting road to Penrhyndeudraeth. Madocks mile long embankment across the estuary of the Treath Mawr diverted the flows of the rivers Dwyryd and Glaslyn by means of tidal gates or sluices creating a body of inland water (Hughes and Eames 1975). In 1864 the Porthmadog and Beaver Pool Turnpike Trust was set up to oversee the building and maintenance of the road between the Boston Lodge turnpike and the road junction at the Oakley Arms. The Turnpike Trust was finally abolished in 1886.

In 1807 a new road was constructed connecting Tremadog with Criccieth and Pwllheli, which Madocks hoped would become part of a major road between London and Porth Dinllaen. In 1845 the Caernarfon road was rebuilt on its present alignment to Penmorfa, prompted by the development of mining on Llidiart Yspytty.

There was ship building on the estuary by 1745 and a number of Traeth Bach boats were hired to help build the Cob, however there is less evidence for trade by boat in Traeth Mawr (Lewis 1989). The construction of the Cob across the mouth of the estuary, as well as altering road communications, also had a profound impact upon both rail and maritime links. The new port (Portmadoc or Porthmadog) was created within the new deep-water channel at the mouth of the Glaslyn, displacing the earlier harbour at Ynys Cyngar, and remains a fine example of a 19th century port landscape, despite some modern development. Plans were put forward to build an inner harbour in 1845, an embankment was built around Llyn Bach and new sluice gates were installed but the harbour was never built (Lewis 1989). Porthmadog’s history as a major slate port and shipbuilding centre is a relatively brief, lasting less than 100 years. The first recorded dues on vessels using the harbour date from 1825, when it became the centre for the export of slate from Blaenau Ffestiniog. Over 260 ships were built at Porthmadog and Borth y Gest between 1825 and 1913, including the ‘Western Ocean Yachts’, designed to service the Newfoundland and Labrador salt cod industry. . The outbreak of the First World War in August 1914 led led to the severance of links with Hamburg and the German ports marking the decline of Porthmadog’s slate export trade, and the general decline of the maritime community (Hughes and Eames 1975). The new UK network rail links also had a severe effect on the trade being handled by the port with the railway eventually taking over what trade remained (Jones 2005).

Efforts to connect the new port with the productive Ffestiniog and Moelwyn slate quarries failed several times, but eventually in 1832 the Ffestiniog Railway Bill was passed and by 1836 the Ffestiniog Railway was opened along a route surveyed by James Spooner. The line was initially gravity and horse worked, steam traction being introduced in 1863 by James Spooner’s son Charles to cope with increased traffic. This latter event was the precursor of steam railways throughout the industrial world, making use of the first bogie rolling stock in Britain (Boyd 1972).

The Tremadog tramway was built circa 1843 to transport iron ore from the ironstone mines of Llidiart Yspytty and Pensyflog. In 1855-7 the railway was completely rebuilt and extended to give access to the remote Gorseddau slate quarry some three miles to the north. It was designed by James Brunlees, later to be knighted as one of the foremost engineers of the mid-19th century (Boyd 1972), and designer of Southport and Llandudno piers. The former mine at Llidiart Yspytty was used as a storage area for slates destined for local trade, whilst the remainder were taken to the port for export.

Other important transport developments include the opening of the Croesor Tramway in 1864 to connect the port with the slate quarries beyond Croesor at Parc, Rhosydd and Moelwyn. This line used a 2’ gauge, and was partly designed by Spooner, the engineer of the Ffestiniog Railway. At the Porthmadog end the line used the reclamation embankment built in 1800. The tramway was maintained and extended by two companies, prior to the embodiment of the Porthmadog end of the tramway into the Welsh Highland in the 1920s: the Croesor & Porthmadog Railway Company (July 1865) and the Porthmadog, Croesor & Beddgelert Tram Railway Company (July 1879). Leased to the Ffestiniog Railway in 1934, the Welsh Highland was finally wound up in 1944 (Boyd 1972). The line has recently been undergoing reconstruction.

In 1867 the Cambrian Railways main line, linking Pwllheli and Aberdovey was opened, running along an embankment to the north of the Cob.

An additional mode of transport was the canal that ran from Tremadog to Porthmadog. Though its primary use was almost certainly a drain, Madocks was inspired to widen it and revet the sides to allow boats to travel along it, and moor in a basin in Tremadog (Beazley 1985). The use of the canal was largely superseded by the Tremadog tramway. This is generally referred to as ‘Madocks Canal’.

7 RESULTS OF THE PROGRAMME OF ARCHAEOLOGICAL WORKS

Feature numbers were given to areas of archaeological interest within this scheme; these have now been replaced by Historic Environment Record Primary Record Numbers (PRNs) to aid future reference. Context numbers for excavated features are given in round brackets for fills and layers and square brackets for cuts and structures.

7.1 Roman Bath-house, Tremadog (PRN1380, SH55734014)

The discovery of finds, especially masonry and other material in a drainage trench dug in 1876 led to the investigation in 1908 of the potato patch attached to the house of Glasfryn on the western outskirts of Tremadog (Breese 1908; Breese and Anwyl 1909). This excavation uncovered the full extent of a Roman bath-house (feature 1 in the Mitigation Design) comprising a complex of rectangular rooms constructed from walls of roughly coursed masonry set in mortar. Two of the rooms contained hypocausts, whilst others were flagged with stone slabs, one with a flue beneath it (Breese and Anwyl 1909). Pottery from the bath-house dated to the 2nd to 4th centuries AD (RCAHMW 1960, 260).

The site now lies under the front garden of Arfryn house (figure 7), and nothing is visible on the surface, though it remains scheduled as a monument of national importance. The reason for its location here is not known, though it would usually be expected to form part of a larger conglomeration of buildings, perhaps a *villa* or *mansio*. It has been suggested that Roman exploitation of the iron ores at Tremadog may have led to the construction of an official residence and bath-house, or that a *mansio* was constructed for use by official travellers crossing Traeth Mawr. This would mean the presence of a Roman road, though none has yet been found.

A watching brief was undertaken on 21st June 2011 during all ground disturbances within the vicinity of the scheduled area. This work comprised the removal of an 8m section of the existing footway located at the back of the existing verge, and was carried out under Scheduled Monument Consent following the method statement included as appendix II.1. A 5 tonne tracked excavator with a toothed bucket was used to remove approximately 70mm of tarmac (the top layer), leaving the lower deposits of tarmac in situ. Associated curb stones were also removed, but the concrete surrounding them was left in situ. These works did not impacted in any way on any underlying archaeology. Photographs were taken and notes made. The report on this work as sent to Cadw on 19th January 2012 is included as appendix II.2

7.2 Y Bryn (Bryn y Fynwent)

7.2.1 Introduction

Y Bryn, also known as Bryn y Fynwent, was a low rounded rocky outcrop in close proximity to the site of the Roman bath-house (PRN 1380). Before the reclamation of the surrounding land, this would have been an island in the Glaslyn estuary, and would have been habitable since the end of the last glacial period. The lower land was all reclaimed in the early 19th Century.

The name Bryn y Fynwent (cemetery hill) is connected with the discovery of a possible cemetery. The exact nature, date and location of this cemetery are unclear as the records of its discovery are confused. In 1849 Robert Isaac Jones (Alltud Eifion) described the single tomb found at Llidiart Yspytty as similar to the "chambers composed of stones successively overlapping each other until they meet in the roof" (Breese and Anwyl 1909, 474). This suggests a Neolithic chambered tomb. In 1868 Robert Isaac Jones reported that large quantities of Roman brick and bone were found at Llidiart Yspytty and that in about 1810 "an immense quantity of bones had been removed from the spot to Penmorfa Churchyard" (Breese and Anwyl 1909, 475). An article dated between 1850 and 1860 in a local paper mentioned a burial ground near Llidiart Yspytty "where many tombs were found about forty years ago" (Breese and Anwyl 1909, 476). The Roman brick clearly came from the bath-house and the expectation of burials caused the remains of the bath-house when first exposed in a drainage trench to be interpreted as a sepulchre. The OS County Series maps mark the site of the bath-house as Hen Fynwent (the old cemetery). Although it is also marked "Roman remains found". Further investigation of the site led to the discovery of the bath-house but no human bones were found there, although animal bones were (Breese and Anwyl 1909).

It seems fairly clear that human remains were found somewhere near Llidiart Yspytty in about 1810 while the town of Tremadog was being built but it is not clear whether one communal tomb was found or several graves. It seems unlikely that either was on the site of the bath-house and it is probable that finds in the area had been conflated. The issue is further confused by the local knowledge of a discovery of "the skeletons of numerous horses" found in about 1860 when the road was widened, truncating the foot of the hill (Y Bryn) (information from a letter sent in 1993, in the Gwynedd HER FI file, PRN 1924). The horses might well have been related to the Roman activity in the area, and could indicate stables near the bath-house, but the explicit description of the tomb by Robert Isaac Jones as having a corbelled roof strongly suggests that an otherwise unrecorded Neolithic chambered tomb stood in this area. This was possibly removed for building stone, so exposing the human remains. Reports of numerous bodies could easily have been misinterpreted as meaning numerous graves, so explaining the newspaper article.

It is therefore possible that Bryn y Fynwent was misnamed and that any cemetery or tomb was not particularly close to the hill, although Ellis Owen in a letter of 1855 quoted by Breese and Anwyl (1909, 492-493) mentions Bryn y Fynwent "where I have myself seen some graves opened", so the issue must remain open. As the hill was recently more commonly known just as Y Bryn (the hill) this more neutral name is preferred in this report.

The discovery of the horse skeletons has been recorded on the Gwynedd HER as PRN 1924. Due to this reference an evaluation of the hill was carried out in 1995, including a geophysical survey and evaluation trenches (Hopewell 1995). The ferrous nature of the underlying bedrock masked the presence of the features revealed in the present project but a small number of worked flints were recovered from the trenches. This assemblage was referred to in the Environmental Statement and Mitigation Design as PRN 1924, but this number refers only to the find of horse remains and a new PRN 33595 has been allocated to the flint scatter.

Due to the discovery of the flint scatter (feature 2 in the Mitigation Design) and the proximity of the bath-house a strip/map and sample evaluation was recommended in the Mitigation Design for the area of Y Bryn. It was initially proposed that an area of 3750m² was to be investigated but this was extended to include all of the affected area between SH55688 40106 and SH55741 40010, on the requested of Gwynedd Archaeological Planning Services. During the strip, map and sample phase a total of 15 archaeological features were identified. Many of these features are probably of Roman date and will be discussed together below. Features relating to other periods will be discussed separately (see figure 7 for a plan of Y Bryn and its features).

7.2.2 Roman features

7.2.2.1 Lime kiln and oven (PRN 34844, SH 55701 40082)

7.2.2.1.1 Description

A stone-built circular feature [3054], interpreted as a lime kiln, was located on the upper slope on the east of Y Bryn, dug into the hill (SH 55701 40082) (see figures 7 and 8 and plate 1). The lack of revetment on the east and north east of the hill allowed a substantial amount of hillwash/colluvium to build up above the feature. The first indication of archaeology being present was the exposure of an extensive area of charcoal-rich dark grey-brown clay silt with frequent burnt clay and heat-affected stone (3001). This contained fragments of burnt clay and stones which appeared to have been glazed. Much of this deposit was covered by colluvium up to 0.18m deep, and the removal of this revealed an arc of stones around which there was a large amount of burnt clay. Further investigation showed that the arc of stones was the outer wall of a circular structure.

Excavation showed that the structure had been built in a construction cut [3102], essentially a pit which was roughly circular in plan with steep sides and a flat base. This had been dug into solid bedrock to the south and west, and through a mix of broken shale/schist bedrock and subsoil of mid orange brown clay silt to the north (see plate 2). The pit [3102] measured 6m in length, 4.5m wide and was 2m deep. There was an initial layer of charcoal at the base, on which lay an outer drystone wall [3095] made up of large to medium angular and sub-angular local stone had been constructed against the cut, with an opening in the eastern side. This wall was generally 0.5m thick on the back edge of the structure, but widened to 1.3m at the opening where it would have supported a lintel. A stone that might have been the lintel was found broken by heat collapsed at the entrance of the kiln (plate 3). The wide walls at the opening formed a fairly wide flue, approximately 0.5m, into which a person could quite easily enter the main chamber of the kiln. On the eastern side, outside the wall opening, the construction cut splayed out to form a level area [3077], measuring 2.35m wide and was 0.3m in depth, allowing access to the opening into the structure.

Within the chamber a mortared stone bench or shelf [3065] had been constructed, this was 0.6m wide and stood at a height of 1.15m. The base of the chamber was lined with a very hard concrete like ‘bowl’ which appeared to be part of the main construction, upon removal by machine this was found to be between 0.27m and 0.5m thick. Shells were noted within the mortar of the bench.

The interior of the structure contained a fused friable mass of white calcined blocks with evidence in places of vitrification producing some thin glassy green surfaces. This material appeared to be the remains of limestone blocks that had been burnt to produce lime, suggesting that the structure was a lime kiln. There were some layers of charcoal-rich material inside the kiln but charcoal was mainly concentrated in a layer (3001) within the levelled entrance area [3077] and extending for at least 5m beyond to the east. This deposit also contained burnt clay and heat-affected stone (figures 10 and 11), as well as sherds of Roman pottery. The charcoal-rich layer (3001) is interpreted as material raked out of the kiln, with the levelled area [3077] forming a raking-out pit, designed for easy access to the inside of the kiln. The waste was spread down the slope towards what would have been the waters’ edge. There seemed to have been some erosion of material into the raking-out pit [3077] before layer (3001) was spread over it. The eroded material was a dark orange-brown clayey silt with burnt clay fragments and charcoal flecks (3067) (figure 10 and plate 4).

To the south of the entrance of the kiln was another small structure [3091]. This was also cut into solid bedrock and was of a similar oval shape to the main kiln but was far smaller, measuring 1.5m in diameter and 0.5m deep, with steep sides and a flat base (see plate 5). There was no trace of any constructed wall within the cut; however the opening was stone-lined with either well-chosen or possibly dressed stones to create a neat entrance. The fill (3094) consisted of firm dark orange brown clay silt with small amounts of burnt clay and charcoal flecks (figure 9). Heat-affected bedrock at the base of the feature indicated that there had been burning *in situ*, and the feature is interpreted as an oven.

7.2.2.1.2 Finds and ecofacts

7.2.2.1.2.1 Roman Pottery

Peter Webster

The lime kiln, feature 3054, produced a small quantity of Roman pottery (see appendix IX for a complete list). The following catalogue presents more important pieces (figure :

Context 3001 (kiln raking)

Find 320: flanged and ridged bowl in Black-burnished Ware, burnt to a light buff internally and over the rim (cf. Gillam 1976, 47-9). The external decoration is only partially surviving but appears to have been wide intersecting loops. 4th century. A further fragment (find 327), probably from this vessel, comes from an unstratified context.

Find 321: flanged and ridged bowl in Black-burnished Ware, burnt to a pink buff internally and over the rim and in a patch on the wall (cf. Gillam 1976, 49). 4th century.

Find 322: flanged and ridged bowl in Black-burnished Ware, sooted externally and partly degraded by heat (cf. Gillam 1976, 45-6). Late 3rd to early 4th century.

Find 328: mortarium rim in a very light buff fabric which is somewhat abraded and has an iron accretion over the flange. The most likely source is the Oxford kilns. Two other fragments (finds 308 and 317) are probably part of the same vessel. The form seems to span Young's (1977) forms M12 and M21. Probably 3rd century.

Context 3069 (colluvium)
Find 325: straight sided dish in Black-burnished ware with a faint trace of a bead rim. The decoration is unclear but may have been irregular (cf. Gillam 1976, 82). A fourth century date is possible but not certain.

Brick and Tile
In addition to the above, topsoil levels produced a number of fragments of brick and tile, all probably Roman (finds 335 (brick), 336 and 338 (flat tile) and 337 (box tile)). There was a further fragment of probable Roman brick from context 3060 (a fill of the kiln). Although one would normally associate the box tile with a hypocaust flue, it seems more likely that all were used in the kiln superstructure.

Comment
All datable pottery fragments are third or fourth century. The entire assemblage is likely to date to the period c.A.D.200-350. We may, however, note that all the Black-burnished bowl forms are late third century at the earliest and could well be fourth century, while the Oxford mortarium form is not among the latest to appear in Wales and more probably 3rd century. As a small group, this collection seems more likely to be homogenous and near contemporary rather than the product of casual loss over a long period. If we can assume this, then it is reasonable to suggest a much closer dating for the group of late 3rd to early 4th century.

7.2.2.1.2.2 Other material

The kiln seems to have produced a large amount of dark charcoal-rich material as the spread of (3001) filled part of the raking-out pit [3077] and spread over an extensive area to the east of the kiln. The abundance of charcoal and lack of coal within and around the kiln demonstrates the use of wood as fuel. Oak was by far the most numerous of the charcoal fragments and may have been the preferred fuel wood, but hazel, ash, and willow were also present. Fragments of charred hazelnut shells were found and the nut shells were most probably introduced to the kiln on branches used for fuel. Some of the fills of the lime kiln and the charcoal spread (3001) contained a small number of charred cereal grains, although none were identifiable to species. There were also a small number of seeds of the Brassicaceae (member of the cabbage family), which are arable weeds associated with cereal fields and are rarely found elsewhere. This provides some evidence for cereal growing in the vicinity. The small oven [3091] did not produce much charcoal and the majority of what was identifiable was hazel with some oak, possibly showing a different preference for fuel woods for the oven in comparison to the lime kiln (McKenna, appendix VIII).

The rocks used in the construction of the kiln were probably from the dolerite sill intrusion in the cliffs north of the site. These rocks would have been easily available from the scree below the cliffs, and they have regular planar joint faces suitable for building with.

The calcined material inside the kiln had mostly been transformed into a white structureless mass but enough of the original rock could be seen to demonstrate that it was limestone. Outcrops of Carboniferous limestone occur on the north coast of Wales (*i.e.* Anglesey/Gwynedd/ Clwyd), and it is most probable that the stone was brought in bulk to the site by boat (Jenkins, appendix XII). Traces of what appeared on site to be shells in the lime proved on close inspection to be remnants of secondary lime crusts formed on cracks within rocks and ceramics (Young, appendix XV), and it seems that only limestone was used in this kiln.

Much of the material recovered from the inside of the kiln had a clear or green wood ash glaze and was so intensely altered that the rock type could not be clearly determined. Young (appendix XV) suggests that many of the large blocks were from the structure of the kiln but they are all likely to be limestone and therefore probably represent part of the last charge of the kiln.

Fired clay was also common inside the kiln. The presence of sharp angles on this clay suggests that it was in the form of bricks or tiles, presumably lining the kiln. These tiles contained organic temper in the form of grass stems, and some also contained shells, indicating they were probably made form very local estuarine clay. The 19th century use of the estuary clay for brick-making shows that it was suitable for this purpose. Some of the ceramics were fired to a very high temperature but others were indicative of low temperature firing. Several also had wood ash glaze on their surfaces (Young, appendix XV). It seems probable that the tiles for lining the kiln were made on site and fired to a low temperature but some were refired during the use of the kiln to high temperatures depending where they were situated in the kiln. The presence of a box tile (Webster, above) may indicate that material from the bath-house was being reused in the kiln.

One piece of lead (sf 334) came from the raking-out spread (3001) and one (sf 326) came from the colluvium above this. Both pieces were strips of sheet lead and might be either cut-offs from lead used in building or scrap from lead tags on consignments of good, such as possibly loads of limestone (Young, appendix XIV).

Two stone objects were collected, both elongated pebbles with fractured ends. One is of quartzite (sf313), 112mm long, found in the spread of material from the kiln (3001). The other, very thin pebble (sf 314), 157mm long, is of micaceous schist, and was unstratified. Both have a few old scratch marks but none indicating continuous directional use and no faceting to indicate use as rubbers or whetstones. However, both are almost certainly pebble tools (Smith, appendix XIII).

7.2.2.1.3 Interpretation

The presence of vitrified calcined blocks inside the kiln, as well as its general form, indicates that the feature was a lime kiln and the pottery suggests a Roman date. There are very few Roman lime kilns in the British archaeological record and no other kiln of this size and type in the region of Gwynedd. This makes the Tremadog lime kiln (PRN 34844) a rare discovery. A Roman lime kiln was discovered at a Roman fort settlement at Loughor, Glamorgan but was described as a pit with its sides shored up in areas with large cobbles. The Loughor kiln was not fully excavated as only a narrow segment was exposed (Ling and Ling 1973), nevertheless a parallel can be drawn from this kiln as both this and the Tremadog kiln could not obtain the material required for lime burning locally and would probably have shipped limestone along estuaries and brought to shore very close the to the kiln sites.

The extensive use of lime as mortar and agricultural fertiliser, and the development of well-built kilns in Britain and more generally Western Europe, has been attributed to the Romans (Williams, 2004), and parallels to the Tremadog kiln can be found elsewhere in Britain. A very comparable Roman lime kiln was discovered at Weekley, Northamptonshire in the 1970's (SP 885 818). The shape of this kiln in plan shows it to be a periodic or flare kiln, which would have been loaded with a single charge of limestone at a time. The kiln then had to cool down completely before the lime was removed and another load could be fired (Jackson *et al*, 1973).

This kiln would have consisted of an open-topped combustion chamber with a flue at the base. A vault of mortared stone, resting on an internal ledge, would have been built over the chamber. The rest of the limestone was stacked above this. This meant that the fuel was not in direct contact with the charge of limestone, so good quality lime, unmixed with ash, could be produced. For all the limestone to be calcined the fire needed to be stoked for a number of days (Dix 1979).

Latin author Cato described the construction of a lime kiln and the process of lime-burning in the 2nd century BC as translated in Dix 1982 (see Dix 1982 appendix for the original Latin).

"Make the lime-kiln ten feet wide, twenty feet deep, and reduce it to the width of three feet at the top. If you are burning with a stokehole, make a pit inside large enough to hold the ashes, so that it will not be necessary to clear them out. Build the kiln well, and see that the ledge goes round the entire kiln chamber at the bottom. If you burn with two stokeholes, there will be no need for the pit; when it becomes necessary to clear out the ashes, clear through one stokehole while the fire is in the other. Take care not to neglect the fire, but rather keep it going constantly, and be careful not to neglect it at night or at any other time. Charge the kiln with good stone, as white and little mottled as possible. When you build the kiln, let the opening run straight down, and when you have dug deep enough, make a bed for the kiln so as to give it the greatest possible depth and least exposure to the wind. If you have a spot where you cannot set the kiln deep enough, build up the top with brick or else rough stone and clay and daub the top on the outside. If, when you have lit the fire, flame comes out from anywhere except at the round opening at the top, daub it with clay. Ensure that the wind does not approach the stokehole, and be particularly on your guard against the south wind. This shall be the

sign when the lime is calcined: the stones at the top should be burnt, the calcined stones at the bottom will settle, and a less smoky flame will come out"

The Tremadog kiln varies from those described by Cato in that it had only one stokehole, but it had numerous similarities, particularly the strength and robust construction, and the internal shelf that runs round the inside of the chamber. The burnt clay found in the kiln fills suggests a clay lining. The Tremadog kiln was 4.5m diameter which is much larger than the average kiln Cato describes (average of 3.0m (Jackson et al 1973)). Roman lime kilns were excavated at Iversheim, Germany and one was reused as an experiment. The successful production of calcined limestone in this restored kiln demonstrated how the kiln could be used and it is assumed that the same methodology can be applied to the majority of Roman lime kilns in Britain, including the Tremadog kiln (Jackson et al, 1973 and Dix 1979). In the Iversheim experiment an arched timber frame was rested on the internal shelf of the kiln and limestone blocks were laid on it, with further lumps of lime loaded on top to fill the gaps above. The timber frame burnt away and the limestone charge became self-supporting as it settled. The fuel, in the case of Tremadog kiln, appears to have been a mixture of hazel and oak wood. Hazel is softwood and has good burning properties and oak is a hardwood and if old dry and seasoned it is excellent for heat and burns slow and steadily producing little ash (McKenna, appendix VIII). The charcoal found within the main kiln chamber may have been partially from wooden supports on which the charge of limestone would have been loaded, perhaps explaining the importance of oak to provide larger timber for supports.

There was some evidence for a possible lintel over the stokehole and the amount of stone rubble which had collapsed into the stokehole passage suggests that the stokehole was roofed, ensuring a controllable draught. This walled stokehole is similar to those found at the Iversheim lime kilns. Due to there being no evidence of lime in the stokehole the calcined lime was likely to be removed from the top of the kiln as was the lime at the experiment at Iversheim.

The Iversheim experiment did not undertake building a kiln from its very beginning and so did not indicate the effort involved in the construction of the kiln. It can be assumed that the construction of the Tremadog kiln would have taken a considerable amount of man hours and hard labour; in addition to the time it would have taken to collect the limestone for the charge. The firing and cooling processes each took a week and the lime would have had to be removed as quickly as possible to that moisture did not affect the integrity of the lime dome and avoid collapse (Jackson et al 1973).

At the Weekley lime kiln calculations of approximate volumes of usable calcined lime produced from one charge of this kiln would be enough to at least erect a rectangular building with walls measuring 30m by 10m in length, 3m in height and 0.75m wide (Jackson et al 1973). The Roman bath-house at Tremadog (PRN 1380) measured roughly 15.24m in length and 6.6m in breadth with the majority of the walls measuring 0.6m wide (Breese and Anwyl 1909). The Tremadog kiln was larger than the Weekley kiln and could therefore produce more calcined lime in a single firing. If the Tremadog kiln was constructed to provide mortar for a single building it would appear that the building was much bigger than the bath-house, although bath-houses would have used more lime than standard buildings as it would be required for the *opus signinum* to line the bath and other functions. However the kiln may have supplied several buildings.

There is no definite evidence that the kiln was fired more than once. It may have been fired and cleared out thoroughly and fired again numerous times, however the stratigraphy within the kiln only reveals its last firing, which may also be its only firing. The extent of the dark charcoal-rich material from the raking-out pit, which spread over the whole slope on the east side of Y Bryn, could suggest more than one use of the kiln.

The relationship of the pottery to the firing of the kiln is unclear. Five fragments of bricks and tile came from the topsoil, six sherds of late 3rd to early 4th century roman pottery from the material within the raking out pit, and a sherd of 4th century black burnished ware was found in the deposit that overlaid the raking out deposit. The only fragment that came from a deposit within the kiln chamber itself was a possible piece of Roman brick. The entire assemblage is likely to date to the period c.A.D.200-350 (Webster, appendix IX), but could have been dumped into the kiln after it went out of use. However the radiocarbon dates, discussed below, also suggest the 3rd to early 4th centuries AD for the use of the kiln, so the pottery may be at least approximately contemporary.

The small oven feature [3091] adjacent to the kiln, and built in a similar style, is interpreted as an oven in which food was cooked by those who tended the lime kiln. The *in situ* burning of the inside of the feature indicated a temperature suitable to an oven and it had a small stokehole so that the fire could be tended. The charcoal recovered indicated the use of oak and hazel as fuel.

Cato (quoted above) stated that the kiln fire should never be neglected. As firing the kiln took weeks with someone in constant attendance, a means of cooking food would have been essential. This interpretation is further supported because the oven was sealed under the raking-out deposit (3001). This would suggest use with the kiln but that the oven had no further function once the kiln was raked-out for the last time.

7.2.2.2 Collection of roofing slates with associated smithing pits and dumps of burnt material (PRN 34845, SH 55698 40098)

7.2.2.3.1 Description

About 10m north-west of the kiln on the north-eastern slope of Y Bryn was a large deposit of thick, roughly cut roofing slates and at the lower end of the slope was a rubble deposit and two gullies (see figure 7 and plate 6, SH 55698 40098). The slates appeared to have been stacked in organised rows but had slipped down the slope (plate 7). Most of the slates had a hole punctured through them and some of them even had the remains of an iron nail within the hole.

The slates were not in any cut features but were resting on firm bright brown orange clay silt, interpreted as colluvium, and lying over the slates was a similar colluvium, both deposits thought to be eroded sediments which had collected at the base of the slope. There were two deposits of slates ((3049) and (3063)), which were very similar in that they both consisted of roofing slates in a matrix of colluvium (figure 14). Deposit (3063) may have been in a cut although this is more likely to have been a natural hollow in which the slates were stacked for storage. Deposit (3048), further down the slope, consisted of possible structural stones and building rubble with a few sherds of purple slate.

Below the slate deposit (3063) was a very firm light grey yellow silt clay, which in turn sealed a dark charcoal-rich deposit (3003). It is possible that (3003) was a dump or spread of deposit from the lime kiln (3054). The charcoal present was mostly of oak, with some hazel. There were no other identifiable charred plant remains from deposits associated with the area of the roofing slates (see appendix 7 for full report)

Running between the slate dumps and deposit (3048) were two parallel ditches/gullies ([3055] and [3056]) (figure 14). These had the distinctive shards of broken purple slate within their fills. Both features had steep sides and were cut into the colluvium (3057). The fill of [3056] was firm mid-orange brown clay silt and the base was flattish, however the fill of [3055], likely to be the same as linear [3089], was very firm dark grey brown clay silt and the base was concave. The difference in fills may suggest different usage or different periods of use. The two ditches/gullies ([3056] and [3055]) were possibly for drainage and the slates in their fills suggest that they were present before the dumping of the slate material.

At the bottom of the hill slope to the north-west of the slate deposits was a small shallow feature [3010]. This may have been related to a deeper pit [3050] to the north-east of the slates, which had already been partially excavated during the evaluation (GAT report 182, feature 1) (see figure 7). Both pits contained hammerscale in their fills. The shallower pit [3010] was sub-rectangular in shape, 0.55m in length, 0.50m in width and 0.11m deep. It had two dark charcoal-rich fills separated by a large piece of flat purple worked slate (which appeared to be the same type as those in (3049) and therefore likely to have originated from the same source) (see plate 8). On removal, the slate fractured into small pieces, this could be due to intense or prolonged heat or pressure. The majority of the hammerscale was found within the lower fill underneath the slate. The deeper pit [3050] was sub-circular in shape, 1.10m in diameter and 0.21m deep. A whitish clay lined the pit, which was filled by two charcoal-rich fills and then two silt fills.

Only about 8m north-east of the slate deposits, at the bottom of the hillslope (SH 55710 40107, figure 7) was a dump of burnt clay on what would have been the shore of the estuary. This area was built-up of estuarine grey silts and gravels. A spread of dark deposit with orange burnt clay fragments (3020) spread over an area measuring about c.7m by 6m (plate 9). Two slots were excavated through the deposit, which revealed that it rested on a band of grey estuarine silt over a natural deposit of light grey shale and schist gravel, which had some large flat stones on the surface. The burnt clay fragments were found throughout a layer of grey clay silt over which was an area of intense burning with a concentration of burnt clay fragments. The burnt clay deposits were sealed by a grey silt with charcoal fragments, cut into which was a shallow hollow containing a sherd of modern pottery in its fill. This was probably part of an animal burrow.

Just south of the burnt clay deposit (3020) was a patch of dark charcoal-rich grey silt with fire-cracked stone (3021). Layer (3021) was covered by alluvium from previous flooding of the estuary. A rising main sewage pipe cut through this site and a pit associated with it was most likely a modern cut related to the repair of the pipe.

7.2.2.3.2 Finds and ecofacts

7.2.2.3.2.1 Slates

A total of 425 complete or near complete slates were collected from the site, as a rough visual estimate this probably would have represented 60-70% of the total number of slates present on site, if they were all undamaged. The majority of the slates were a rough long hexagonal shape, having a single nail hole located just off-centre at the upper pointed end (plate 10). They averaged 32 cm vertical tip-to-tip length and 22 cm width (typically a nominal 12-inch length, but a variation in width from 10-inches up to 14-inches, and around 10 inches wide). The slates varied in thickness from around 13mm (roughly ½-inch) down to around 7mm (around ¼-inch). Some slates appeared to be more of a diamond shape, not having the two short edges making up the hexagon. The slates would have been hung in a 'diagonal stripe' pattern (plate 12), typical of Roman roofs. A small number of the slates are pentagonal in shape and would have been used as the base course on the eaves (plate 11). The final (upper) row of slates abutting the roof apex would have been similar but upside-down, and with probably two fixing holes across a straight top. None of this type was identified at Y Bryn. Nor were any ridge tiles found (Jones, appendix XVI.1).

The majority of the slates have a distance from the bottom point of the slate to the nail hole which corresponds to a Roman foot; a *pes* (296mm). However at least two slates are a larger size; a *palmipes* (370mm) (a foot and a palm-width, 1¼ *pedes*). This dimension from the tip of the slate to the nail hole is directly related to the distance between the battens for fixing the slates, so slates of different sizes cannot be mixed on one roof. The fact that there are two different size slates suggests two different roofs. The presence of some slates with two nail holes also suggests larger slates cut down to fit onto a roof with smaller slates (WT Jones appendix XVI.4).

Most of the slates were either purplish-blue with green stripes or more purple in colour. A smaller number were a 'plum' coloured reddish-purple. The use of two colours of roofing slate has been noted on other Roman sites and may suggest the use of a decorative pattern (Jones, appendix XVI.1).

The slates were held in place on the roof by iron nails of about 4mm square section, several of which remain as very rusty fragments in their fixing holes (plate 13). The holes seem to have been formed by a sharp but robust implement, possibly of square section, being repeatedly struck at different angles radially around a point to form both hole and bevel (Shakespeare, appendix XVI.2).

Within the slate deposit (3049) were a collection of nails concreted together with corrosion (sf 401) (see appendix XI for the x-ray). These may had presumably been removed from the slates, possibly in preparation for rehanging them.

The slates are characterised by having a poorly developed cleavage, which is non-parallel, uneven, and created a very wrinkly surface to the individual sheets. In more recent times such poor quality slates would only have been used on low status buildings but the Romans did not have access to the best quality slate from deep underground and would have had to use this poorer material from rock outcrops. Considering the poor quality material the quality of craftsmanship of production is excellent.

The slates came from various different strata of 'Cambrian purple' slate. The sources of this slate are very variable so locating the source of the Y Bryn slates is difficult, especially as later quarrying has removed most of the earlier working. The Cambrian Slate formation extends from Llanllyfni to Bethesda via Cwm Gwyrfai and Llanberis, and theoretically, the Y Bryn slates could have come from a number of sites with surface exposures along the length of the veins. However, the variety of colours suggests that they came from a source where all these colours were available in close proximity, making an extraction site in the Nantlle Valley most likely. The Nantlle district is also the closest source of blue-purple Cambrian slate. However it is possible that a small quarry much closer to the site was the source but that this has either not been identified or has been destroyed by later quarrying (Jones, appendix XVI.1).

If the slates originated from the Nantlle Valley it means that they had been transported at least 15 miles, and must have been chosen specifically for their colour or quality as suitable material could have been found much closer. The stockpile of slates was composed of several individual stacks of slates, laid on edge in a manner that indicated care for the material. Given that they are all holed for use, and many had the remains of iron fixing nails concreted by rust in the fixing hole, it must be that these are slates that have been taken off a roof, and possibly one that needed its timber replacing. The slates are not precisely datable but the Romans were using local Cambrian slate by the 3rd century AD (Jones, appendix XVI.1).

7.2.2.3.2.2 Other finds

Within the rubble deposit (3048) a fragment of a plain shale bracelet (sf 319) was recovered. It is a lathe-turned highly polished bracelet, with an internal diameter of 60mm and external diameter of 78mm (see figure 15) (Smith, appendix XIV). It was made of a fine material that could have been imported from the south of England although a closer source is possible, e.g. from the Anglesey coal deposits. Shale bracelets are most common in the Roman period although they do occur in prehistory; occasionally appearing in the Late Bronze Age and being made increasingly in the Middle and Later Iron Age. Plain bracelets were most common type in the Late Roman Period; four turned shale bracelets were found at Segontium Roman fort, Caernarfon, of which one was a plain example of similar form to that from Y Bryn and was found in an early-mid 4th century context (Casey and Davies 1993, 206, 208). It is therefore likely that this bracelet fragment is Roman and probably from the nearby bath-house or related activity. A similar piece of a shale bracelet was found at the bath-house (Breese and Anwyl 1909, 490).

A small fragment of dense iron slag (sf 371) came from (3037), the fill of gully [3036]. This seems to be the result of iron working. Other ironworking residues were recovered from pits [3010] and [3050]. These were mainly microresidues typical of smithing, including flake hammerscale, spheroidal hammerscale, slag droplets and flats and fuel ash slag. There was also smithing pan and other concreted residues. Some of the hammerscale is rather thick and this indicates prolonged high temperatures, often associated with working large pieces of iron. In layer (3020), where charcoal and burnt clay had been dumped on the edge of the water fragments of coal and clinker may hint at coal being used as a fuel for the smithing, as did sometimes occur in the Roman period (Young, appendix XV).

A flint flake was found in the fill of pit [3050], but this is likely to be from the erosion of the hill and part of the general flint scatter (PRN 33595).

A copper alloy object (sf 330) was recovered from the colluvium (3066) over the lime kiln. This is a bent elongated object with the remains of an iron rod passing through its widest part (figure 16), and is probably post-medieval in date. A light functional copper alloy ring (sf 316) (figure 16) came from the charcoal spread (3021). It has a fairly irregular cross-section, rather than circular, but whether this is its true form, because of wear, or because of corrosion is difficult to tell (Evan Chapman, National Museum of Wales).

The burnt clay deposit (3021) by the water's edge had a charcoal assemblage dominated by oak and no other charred plant remains were identified. There were four charred cereal grains in pit [3010], but they could not be identified to species. Pit [3050] only produced a single indeterminate cereal grain but had 7 fragments of rachis internodes (McKenna, appendix VIII). This indicates a low presence of cereals on the site possibly introduced as chaff used as kindling. The charcoal in the two pits was mostly oak and hazel, but pit [3010] contained some ash and [3050] some willow. The charcoal is probably from fuel wood.

7.2.2.3.3 Interpretation

Iwan Parry

It is likely that the two deposits of slates, (3049) and (3063), and the rubble deposit (3048) were essentially contemporary. The slates were originally neatly stacked in rows. The cluster of iron nails found corroded together within context (3049) could indicate the deliberate removal of the nails from the slates, although some still retained their nails. This suggests that it was intended to reuse the slates. Pits [3010] and [3050] were probably the base of smithing hearths or closely related to smithing. The radiocarbon dates, discussed below, demonstrate that these pits were also probably roughly contemporary with the rest of the Roman activity on the hill. The slate used in pit [3010] also supports this. The smithies could have been used to produce new nails for rehanging the slates, although the suggestion from the hammerscale that larger items were forged there may indicate a different function. The general impression of the features on this site is that slates had been removed from a roof and were being stored before being replaced or reused. Although it is possible that the slates were brought in from another site by water it is more likely that the roof they came from and the one they were to be used on were close by.

Breese and Anwyl (1909, 488) state that "a number of roofing slates, purple in colour, and of hexagonal and diamond shape" were found at the bath-house, and that "some specimens still retain the iron nail in the hole at the upper angle". This makes it likely that the Y Bryn slates originated from the bath-house. It is possible that the slates were removed to allow the repair of the roof and were stored nearby, but it is also possible that the slates might be exactly the same as those discovered during the excavation and that they were stored on Y Bryn. The latter hypothesis is perhaps less likely as there were no 20th century finds amongst the slates or amongst the rubble dumped with them. It also seems unlikely that the slates and particularly rubble was transported across the main road and dumped on the side of the hill rather than immediately adjacent to the excavation. It is therefore considered more likely that the slates were stacked on the hill in the Roman period. The presence of the smithy pits also supports this, as possibly does the shale bracelet.

It is impossible to know whether the bath-house roof was being repaired or whether slates from it were being store for use on another nearby building once the bath-house went out of use. It is also possible that the slates came from the roof of a much larger building and some were used on the bath-house, perhaps explaining why so many were left unused. With no evidence of the main group of buildings that must have formed the core of the Roman complex at Tremadog it is impossible to determine exactly where the slates fit. However, the presence of two different slate sizes suggests that there was more than one slate roof in the complex, and that a group of high status buildings several of which were roofed in slate might be imagined.

In a wider context the slates are a very important discovery, representing the earliest phase of the north Wales slate industry which boomed in the 19th century. The quality of the workmanship suggests that this was not just a one off exploitation of local material. The skilful way in which the material has been shaped displays well-developed techniques using specialised tools, reminiscent of other Roman slate working areas.

It is almost certain that the slates represent a high status building material. Although slates have been found in military contexts at Segontium and Chester, the majority of other examples are from villa sites. It appears that there was a supply of clay suitable for making tiles at Tremadog, as it was used in the lime kiln (Young, appendix XIV), but it was neglected in favour of the slates for roofing.

7.2.2.4 Radiocarbon dating

7.2.2.5.1 The choice of material for dating

The pottery from the lime-kiln provides an indication of the date of the site, and initial advice from Peter Marshall of English Heritage was that radiocarbon dates would not improve on the dating from the pottery. The pottery however was largely within the spread of material from clearing out the kiln and might have been mixed into this layer after the kiln went out of use. Other features in the area produced no artefactual dating evidence. It was of particular importance to test whether the oven adjacent to the kiln and the pits containing smithing debris were contemporary with the lime kiln or evidence of later periods of activity. It was therefore clear that radiocarbon dating could provide important information despite the presence of a small number of Roman pot sherds on the site.

A total of six radiocarbon measurements were obtained. The samples for dating were chosen to be as closely related to the activity to be dated as possible. The material from the lime kiln was selected from the layer of charcoal in the base of the kiln where it was least likely to have been disturbed and most probably originated from fuel used to fire the kiln. Similarly the sample from the smithing pit [3010] was from the base of the pit. Pit

[3050] was not chosen for dating because it had already been partially excavated in 1995 and there was some risk of contamination. The sample from the oven [3091] was chosen as probably being from fuel wood used to fire the oven, two each from selected deposits within the lime kiln, oven and smithing pit. Unfortunately the charcoal present amongst the roofing slates was so poorly preserved it was unidentifiable and not ideal for radiocarbon dating. There was also no clear relationship between the charcoal and the slates so this deposit was not dated.

All the samples dated were single-entities (Ashmore 1999), and consisted of short-lived hazel charcoal. The species of the samples were identified by Roz McKenna (freelance palaeoenvironmental specialist). The samples were submitted to the Scottish Universities Environmental Research Centre (SUERC) to be measured by Accelerator Mass Spectrometry (AMS). Table 1 below gives the results and the radiocarbon certificates are included in appendix XII.2

Table 1: Radiocarbon results from Bryn-y-Fynwent. The charcoal samples were calibrated using the IntCal09 atmospheric curve of Reimer *et al* (2009).

Lab ID	Context	Material	Radiocarbon age (BP)	Calibrated date (95% confidence)
SUERC-37690	3015: fill of smithing pit [3010]	charcoal: *Corylus avellana*	1815 ±30	cal AD 120–320
SUERC-37694	3015: fill of smithing pit [3010]	charcoal: *Corylus avellana*	1730 ±30	cal AD 230–400
SUERC-37695	3090: thin layer of charcoal at the base of kiln [3054]	charcoal: *Corylus avellana*	1785 ±30	cal AD 130–340
SUERC-37696	3090: thin layer of charcoal at the base of kiln [3054]	charcoal: *Corylus avellana*	1750 ±30	cal AD 220–390
SUERC-37697	3094: fill of oven/small furnace [3091]	charcoal: *Corylus avellana*	1735 ±30	cal AD 230–400
SUERC-37698	3094: fill of oven/small furnace [3091]	charcoal: *Corylus avellana*	1765 ±30	cal AD 170–380

7.2.2.5.2 Analysis of the dates and comparison to dates from the Llidiart Yspytty corn drier

Derek Hamilton (SUERC)

The section of the calibration curve for the Roman period tends to produce calibrated dates with large errors and combined with the high precision necessary to fit dates into a historical chronology this makes it difficult to use the dates as produced. However there are techniques for statistically comparing and interpreting dates and a Bayesian approach was used to model the dates from Y Bryn (see appendix XVII for the full report).

Comparisons of the two dates from each context showed that the pair from the small oven (3091) and the pair from the lime kiln (3054) are statistically consistent and could be the same actual age, showing that the dates probably relate directly to the use of the features. The dates from smithy pit (3010) are not statistically consistent and this may indicate that the results are from either a mixed deposit, or one with some longevity.

Although the two results from the smithing pit are not statistically consistent, as a group, the six measurements from these three contexts are statistically consistent and suggests that deposition occurred over a shorter, rather than longer, period of time, i.e. all three features were in use around the same time, if not exactly contemporary.

When these dates are statistically modelled using the assumption that they represent one phase of activity the model estimates that activity began in *cal AD 120–320* (*95% probability*) and probably in either *cal AD 195–255* (*48% probability*) or *cal AD 275–310* (*20% probability*). The activity continued for *1–260 years* (*95% probability*) and probably *1–110 years* (*68% probability*). This activity ended in *cal AD 240–410* (*95% probability*) and probably in either *cal AD 250–270* (*9% probability*) or *cal AD 290–355* (*59% probability*) (see appendix XVI.1 for graphs and full detail of the modelling).

Most activity on Y Bryn has proved to be Roman in date and could possibly be related to the potential *mansio* or villa site assumed to explain the existence of the bath-house. It is therefore worth testing to see how the sites may relate together. The bath-house was excavated before radiocarbon dating and is not well dated by finds, but a T-shaped corn drier was excavated in 2005 on the site of the present hospital (Kenney 2006). This structure was of a design usually associated with Roman villas and was probably also associated with the proposed *mansio*. A comparison has therefore been made between the Y Bryn dates and the dates from the corn drier as below:

Table 2: Radiocarbon results from the Llidiart Yspytty corn drier, Tremadog

Lab ID	Context [Sample ID]	Material	Radiocarbon age (BP)	Calibrated date (95% confidence)
Beta-205125	318: an upper layer of deposit (322) that spread over the south-eastern end	8 charred emmer/spelt wheat grains	1840 ±40	cal AD 70–320

	of the corn-drier flue [2]			
Beta-205126	321: an upper layer of deposit (322) that spread over the south-eastern end of the corn-drier flue [3]	4 charred barley grains	1820 ±40	cal AD 80–330
Beta-205127	324: collapsed lining of oven (330/331) [5]	charcoal: cherry/plum twig	1830 ±40	cal AD 70–320
Beta-205128	332: charcoal-rich deposit inside (363) [7]	charcoal: hazel stem	1770 ±40	cal AD 130–390

The four results from the Llidiart Yspytty corn drier are all statistically consistent, suggesting that the material in these features was deposited over a relatively short span of time. The chronological model estimates that activity at that site began in *40 cal BC–cal AD 245* (*95% probability*) and probably in *cal AD 105–215* (*68% probability*). This activity continued for *1–435 years* (*95% probability*) and probably for *1–150 years* (*68% probability*), and ended in *cal AD 135–445* (*95% probability*) and probably in *cal AD 165–290* (*68% probability*) (see appendix XII.1 for graphs and full detail of the modelling).

The Bayesian approach has enabled a modelling of the start and end dates of activity at the sites and can be used to compare the chronology of Y Bryn and the corn drier, with the aim of determining if the two were likely coeval in use or if one is considerably earlier than the other. However the number of dates available is relatively small and this makes the models less precise than they could be.

Based on the modelled probabilities, there is a 90% probability that the corn drier was built before activity started on Y Bryn. Similarly, there is a 40% probability that the corn drier went out of use before activity started on Y Bryn. Finally, there is an 80% probability that the corn drier went out of use before the end of the activity Y Bryn. These modelled probabilities suggest that while activity at corn drier was initiated prior to Y Bryn, the two sites may have overlapped in their use.

Bearing the potential problems associated with the low number of dates, the results of the Bayesian analysis and modelling can be summarised as follows:

The start of activity at Llidiart Yspytty most probably predates that at Y Bryn, but the two sites most likely overlap in their use;

The activity at Llidiart Yspytty probably began in the 2nd century cal AD, though may have begun as early as the second half of the 1st century cal BC;

The activity at Y Bryn probably began in the 3rd century cal AD, although it may have begun in the 2nd century cal AD;

Activity at Llidiart Yspytty ended in the 2nd or 3rd century cal AD, while that at Y Bryn probably persisted until the second half of the 3rd or first half of the 4th century cal AD.

If all this activity was related to different phases of use of a central building, whether a villa or a *mansio*, it suggests that this may have been built by the 2nd century AD and could have been in use through until the late 3rd century AD. These dates are very general but hint at quite a long period of use.

7.2.2.6 Discussion

Iwan Parry and Jane Kenney

The radiocarbon dates are consistent with the pottery dates giving a 3rd to early 4th century date for the lime kiln. The dates also demonstrate that the oven [3091] adjacent to the kiln and the smithing pit [3010] were roughly contemporary with the kiln. If it can be argued that the smithing pits were related to the production of nails for rehanging the stack of slates then it can be argued that all the main areas of activity on Y Bryn were of Roman date. The modelling of the radiocarbon dates indicated that this activity probably began in the 3rd century cal AD, although it may have begun in the 2nd century cal AD, and probably continued into the second half of the 3rd or first half of the 4th century cal AD.

The dates from the T-shaped corn drier at Llidiart Yspytty, c. 245m north-west of Y Bryn, show that it was in use before the activity on the hill started but may have overlapped with it. The corn drier was probably used in the 2nd century AD but may have begun as early as the second half of the 1st century cal BC and could have continued in use into the early 3rd century. The pottery found supported the 2nd century date (Kenney 2006).

The corn drier is of a type normally associated with villas and no others have been found in north-west Wales where *villas* are so far unknown. The lime kiln was clearly constructed to supply lime, probably for mortar, for a large building project. The slates had been removed from the roof of a high status building and were presumably intended to either be rehung on the same repaired roof or to be reused on another roof. The similarity of the slates found at Y Bryn and those from the bath-house suggest that the source of the Y Bryn slates was the bath-house, although other buildings in the same complex would presumably have the same type of slates.

This all indicates the presence of a substantial residential building or building complex not yet discovered. The combined dates from the corn drier and Y Bryn suggest this building or complex was in use from the 2nd century AD possibly into the early 4th century, with building or rebuilding work undertaken in the later part of that period. The pottery from the bath-house also fell within the 2nd to 4th century range (RCAHMW 1960, 260). Many *villas* excavated in Britain show a history of multi-phase development over decades or even centuries. Unfortunately without the discovery and subsequent excavation of such a building this will remain a conjecture.

It has been suggested that the focus for this activity may have been a *mansio*, an official lodging house for official travellers. The site would have been on the Roman road from Segontium via Pen Llystyn to Tomen y Mûr (PRN 17553). This section of the road (PRN

17560) is assumed to run along the line of the modern A487 (Hopewell 2007, 79). However this route was constructed on its present line in 1845, and the turnpike road from Penmorfa to Llidiart Yspytty ran further uphill under the present site of the hospital (Hopewell and Gwyn 2002 and Davidson and Roberts 2004). The straight route from immediately north of Y Bryn to Penmorfa would almost certainly have been too wet for a Roman road, if not actually under water at high tide. It seems possible that the Roman road followed the base of the steep slopes below Craig-y-Castell and Craig-y-Dref, joining the line of the A487 just west of Penmorfa. Part of the Goreddau tramway (PRN 28503) might indicate a possible route for the Roman road (figure 18). Traces of a “paved road” between Llidiart Yspytty and Penmorfa were noted in the 19th century (Breese and Anwyl 1909, 493-494), although their exact location was not recorded. It is possible that traces of this road might still survive.

It has also been noted that the site is immediately adjacent to an outcrop of ironstone exploited in the 19th century. There is no evidence of Roman working but the ore would have been obvious in the Roman period and its exploitation is not unlikely (Hopewell and Gwyn 2002). A *villa* might have been the residence of the mine manager, or some other local official.

The lime kiln was obviously placed on the small island projecting into the estuary to enable limestone to be delivered by water and the island would have provided a sheltered landing place for other uses. The island is likely to have been accessible at all but high tide. Its accessibility is suggested by the situation of the kiln and slate store here; they would not have been so positioned if inaccessible or if the crossing to Y Bryn was particularly hazardous or difficult.

The bath-house was also located close to the shore, but as discussed above it seems unlikely that the Roman road ran between Y Bryn and the bath-house. These sites should perhaps be considered as being within a single land holding undivided by the road. The main building associated with these sites must have been a little further inland (figure 18). The corn drier indicates that associated activity extended further west but no trace of a substantial building was located here. The most likely position of a *mansio* or *villa* is probably under the school, Ysgol y Gorlan, which was built when the 1889 first edition OS County Series map was surveyed.

7.2.3 Other features at Y Bryn

7.2.3.1 Lithics scatter (PRN 33595, SH55710 40060 and PRN 33604, SH55663 40070)

George Smith (Gwynedd Archaeological Trust)

7.2.3.1.1 Introduction

During the excavations at Y Bryn a number of prehistoric flint and chert artefacts were found. These resulted mainly from surface collection over the top and eastern side of the rocky hillock. Most were unstratified, found in an eroded and disturbed area, although some were found in the red-brown silt (3005) covering the hill and representing the lower horizon of the soil that had built up over the hill.

The area had been disturbed by plant during stripping and had been eroded by rain during the excavation so although the collection was carried out quite intensively the area was not gridded. Therefore no indication of how the material was distributed over the mound was recorded, nor were the locations of areas of activity. The degree of erosion suggested that activity areas were unlikely to have been preserved, and the majority of the worked pieces came from the lower sides of the hillock where they appeared to have accumulated as a result of erosion. Three pieces of worked flint were also recovered close to test pit 103 on the western edge of the site (see figure 7 for locations).

The collection must represent just a proportion of the total present and be biased towards larger pieces. However, it is quite a large and well-preserved assemblage collection for this area. This assemblage is considered as a continuation of the flint scatter (feature 2 in the Mitigation Design) found in the evaluation trenching (Hopewell 1995, 14), when 4 flints were found in trench A and 1 in trench E (figure 7). The new assemblage is therefore recorded under the same PRN as the evaluation finds (PRN 33595), with the exception of the few flints from the western side of the hill near test pit 103 (SH 55663 40070), which are possibly Mesolithic and have been allocated a separate PRN (33604).

A total of 157 individual pieces of flint and chert were collected, mostly of possible Neolithic date. See tables XIII.1 and XIII.2 in appendix XIII for a summary of the assemblage and tool types. See figure 19 for illustrated pieces.

7.2.3.1.2 Raw material

All the material is flint derived entirely from small pebbles. The colour of the flint is masked by a degree of patination, leaving most surfaces dull light grey or cream, where affected by iron-staining. Pieces with fresh breaks show that most of the flint was mid to light grey originally. A few pieces are glossy and fresh, which may mean they are of different period than the rest.

7.2.3.1.3 Technology and waste products

The use of small pebbles from the boulder clay restricts the possible size of products, the largest piece being a flake 45mm long but most complete flakes around 30mm long. There are only two complete cores (sf 1.3 and sf 1.1), both small, 27 and 34mm long and semi-prismatic with 2 opposed platforms (Figure 19, 1-2).

Of 100 waste flakes or fragments 38 are complete, ranging from 8 to 45mm long. The assemblage is unusual in the high proportion of tertiary flakes, there being only 3 primary flakes, 42 secondary and 97 tertiary. The primary flakes are broader and of more mixed colours of flint, suggesting they may not belong to the production of the rest of the waste material.

The large number of tertiary waste pieces are characterised as small broad blades, many broken. The breaks are clean snaps so may be deliberate rather than accidental. Of those identifiable 11 were distal fragments, 16 were proximal and 11 were mid-parts.

7.2.3.1.4 Retouched and utilised pieces

The most notable feature is the unusual absence of scrapers apart from one possible snapped butt fragment. Even this latter piece is of a fresher, unpatinated condition than the rest and so is possibly unrelated to them. As a whole the assemblage is dominated by cutting tools with 3 classified as edge-retouched knives, one serrated blade (sf 301) and 6 casually retouched and 17 utilised sharp-edge pieces. Of the latter any utilisation gloss present is slight. There are only four piercing tools, including spurred pieces. There is also one denticulate (sf 1.74), but just a snapped-off edge fragment.

Apart from these more common tool types there are two diagnostic tools. The first is a microlith and the second is a fragment of a thin invasively shaped piece, probably a fragment of a leaf-shaped arrow-head.

The microlith (sf 329) is of a similar patina to the majority of the waste pieces here and so could belong with them. It is of trapezoidal form, retouched on three edges and of a size and type that fits with those microlithic forms of the earlier Mesolithic described by Jacobi (1980). It compares closely to those from Trwyn Du, Anglesey (White 1978) and from Rhuddlan Site M, Flintshire (Berridge 1994). Trwyn Du has produced a radiocarbon date of 5900+/- 150 (Q-1385) and Rhuddlan Site M a date of 5640+/-73 (BM-882).

The microlith was found with the serrated blade (sf 301) and a retouched blade (sf 302) near test pit 103 on the western side of the site and isolated from the other finds (figure 7). There is nothing within the rest of the rest of the assemblage to suggest the manufacture of microliths or that would typologically fit with an assemblage of that period although the size and shape of the flakes would be suitable and comparable in size to flint flakes from Rhuddlan Site E (Berridge 1994, 103). As judged by the rest of the assemblage cutting was the main function being carried out, and it is possible that there are two separate activity sites of different dates represented.

A possible arrow-head fragment (sf 3001) is probably the butt of a round-based, leaf-shaped form. The breaks are old and it is slightly iron-stained and with an all-over slight gloss suggesting long surface exposure. In this it is different to the bulk of the waste pieces and so may be an isolated and unrelated find, as arrow-heads often are. There is also no hint of fine invasive working amongst the rest of the assemblage, or of preparation of platforms and no retouching tools.

7.2.3.1.5 Discussion

The former coastal or at least estuarine setting of Y Bryn must have had a bearing on its function whatever period it was. The absence of scrapers, usually the most common tool type, and of denticulates, suggests it was not a domestic site or involved with the use of animal products. None of the cutting tools show the strong development of gloss, so the intensive exploitation of plant products, such as reeds seems unlikely. The near absence of points indicates that the site was not a hunting camp, whether for land or marine mammals. This leaves shell-fish collecting or fishing as the possible economic activities, with comparisons with the many coastal sites of western Scotland known as Obanian, associated with shell middens. Dating of the Scottish sites has indicated an overlap between what is normally considered the Late Mesolithic and the Early Neolithic. Research in Scotland suggests that lithic assemblages varied distinctly between sites with different economic bases (Finlayson 1995). Amongst the Scottish coastal sites there are also some with very few microliths and dominated by blade-like flakes with casual retouch (Cormack 1970) and this provides a possible comparison with Y Bryn.

One curious feature at Y Bryn is the high proportion of tertiary flakes and fragments to primary and secondary pieces and the presence of only two cores and two core rejects. Of the total identifiable, including retouched pieces, there are 3 primary flakes, 42 secondary flakes and 97 tertiary flakes. This suggests that most of the primary and secondary waste material is missing because the flakes were mainly made elsewhere, perhaps where raw material was available, and then brought to the site where they were used. This means that there must be locations where flint pebbles were easily available and where primary and secondary working was carried out. Only one such location is known at present. This is the coastal flint working site at Trefor Old Pier, Trefor, 17km to the north–west where several hundred waste pieces of flint have been collected but no diagnostic retouched artefacts (Smith 2001). This site bears no relation to Y Bryn because the colours of the flint there are quite different, predominantly yellow-toned. As a flint source it is more likely to be associated with a Neolithic settlement area (GAT Site G1560) that has recently been located near to Clynnog Fawr, 5km to the north-east of Trefor.

The majority of the Y Bryn assemblage (PRN 33595) must be mainly of one period, and because it lacks any evidence of microlith manufacture, probably of Early Neolithic date, but the microlith and blades from the western part of the site could indicate transitory Mesolithic activity (PRN 33604).

7.2.3.2 Scatter of animal bone (PRN 34846, SH 55702 40061)

7.2.3.2.1 Location of the burnt bone scatter

A small quantity of burnt bone (find 331) was found scattered over an area just off the south-eastern edge of the top of Y Bryn (figure 7). This was on the edge of the area of the flint scatter described above. The burnt bone was scattered on the stripped surface of the natural deposits and was not associated with any features.

7.2.3.2.2 Description of the material

Nora Bermingham

A small collection of mammal bone was submitted for full analysis (see appendix X for table of finds). The material is unstratified. The assemblage size prohibits analysis beyond simple quantification and identification where possible.

The assemblage comprised of approximately 56 burnt bone fragments, ranging in size between 5mm to 50mm in length and with a total weight of c. 6g. The majority of fragments measure between 5-25mm in length. The material is poorly preserved. There are no intact bones but a small number of bone fragments identifiable to species are present.

Most of the assemblage is unidentifiable to species though is clearly animal rather than human in origin. Where fragments are listed as mammal they are most probably non-human (appendix X). Three fragments derive from sheep/goat, two phalanges and an astragalus. Large and medium sized animals are represented within the assemblage. The majority of fragments derive from post-cranial skeletal elements with rib and long bone fragments occurring. Almost all of the fragments are burnt with many white in colour. A single piece, the largest fragment of limb bone, retained a chop mark on one edge.

The assemblage is unstratified and hence of uncertain origins and/or period. Given that no human bones are present the material may best be regarded as general domestic/consumption debris.

7.2.3.2.3 Discussion

It seems possible that this assemblage was related in some way to the flint scatter discussed above. They might be expected to have come from a hearth or dump of hearth waste but no concentrations of charcoal were noted in the area. Without a more direct link to the flint scatter it is not possible to say whether these bones were prehistoric or the result of much more recent dumping of waste on the hill.

7.2.3.3 Roman coin found near Y Bryn (PRN 34847, SH 55684005 (approx.))

During the excavation a member of the public brought a coin to the excavation team and donated it to the project. The coin (figure 17) was found on the field track to the south-west of Y Bryn (figure 7). Edward Besly of the National Museum of Wales considers that the coin resembles a House of Valentinian bronze / SECVRITAS REIPVBLICAE, victory left, type. The emperor is uncertain, but likely to be Valentinian I (AD 364-75). The mint is uncertain. The coin has been corroded in the past and cleaned by the finder. Its corroded state supports the claim that it is a genuine British find.

7.2.3.4 Boundary walls around Y Bryn

The Mitigation Design identified two sections of drystone revetment on the western and southern sides of Y Bryn for basic recording (feature 3). During the excavations the remains of a wall was also found running along the eastern side of the hill and traces of one to the south. Together these formed the boundaries of Y Bryn (figure 7). The remains of a 19th century barn were also found.

7.2.3.4.1 Drystone revetting (PRN 33587, SH 55665 40074)

A length of drystone revetment runs intermittently along the south-western side of Y Bryn. It is made up of large local boulders and stones (plate 14). A section was excavated through this revetment (3012) in order to gain understanding of its construction and to assess if samples could be collected from a buried ground surface (plate 15). No relict soils were discovered therefore no samples were collected. This revetment created a wider flatter area on top of Y Bryn and is probably post medieval in origin. Its function was to stop material washing down on a farm track below which is also on the south side of Y Bryn but was not affected by the works.

Running north-east from the north-western end of revetment (3012) was another similar revetment running along the north-western side of the hill. This structure was built of local schist/slate and was mainly a single stones width in construction, it measured between 0.5-0.7m wide (3014) (plate 16). Upon inspection it became apparent that the revetment was simply retaining material from slipping off the hill. Local folklore suggested that Roman remains had been found behind this feature; however no evidence of such finds were observed. It is likely that the feature was post medieval in origin and was built when the original road was built. The stones of this revetment were retained and rebuilt as a feature by the new roadside.

These boundaries are shown on the 1842 tithe map and could have been built soon after this part of the Traeth was first reclaimed at the very end of the 18th century.

7.2.3.4.2 Boundary walls (PRN 33586, SH55714 40090 to SH55739 40013)

Two post medieval boundary walls were partially excavated and recorded in the strip, map and sample area. These had been detected by the earlier evaluation trenches (Hopewell 1995) but then they had been assumed to be stone filled field drains and were not investigated.

Wall (3000) ran approximately north-south along the lower part of Y Bryn and on the edge of the wetter area of the field. At its southern end this wall abutted another similar wall (3027) running perpendicular to it (figure 7). Both walls survived as foundations only and were composed of a mixture of sub-angular stones with some boulders (plates 17 and 18). They were built directly on estuarine clay. The continuation of wall (3027) could be seen as a revetment along the southern side of Y Bryn, which was in places quite well preserved (plate 19). These walls appear on the 1889 1st edition OS map and probably date to the early 19th century.

7.2.3.4.3 Timber building (PRN 33588 SH 255745 340019)

At the junction between the walls (3000) and (3027) was a group of eight postholes, some of which contained remnants of wooden posts (figure 7, plate 20). Due to the water table these postholes were not excavated but they were described and planned using the total station theodolite. The postholes could have supported a building measuring approximately 9.25m x 6.0m (building 3028). Two sets of postholes on the northern side were doubled up as if to offer additional structural support on this side. The 1889 first edition OS County Series map shows a building in this location, but it had gone by the publication of the 2nd edition in 1900. The building was probably a field barn and its position in the corner of the field showed that it could not have predated the field boundaries.

7.3 19th and 20th century field boundaries, drainage features and agricultural buildings

7.3.1 Field boundaries and culverts

Field boundaries that were affected by the bypass were all recorded before breakthrough. There were 22 culverts and 45 field boundaries recorded. They were all post medieval in date with some very modern walls. The walls recorded were mostly of local stone material of granite, slate and schist and generally of dry stone walling. There were stone and earth banks, some field boundaries had wooden post and wire fencing running along the top or alongside them. Most of the walls were built on reclaimed land and therefore could not predate the early 19th century, however some on higher ground at the eastern end of the scheme have the potential to be earlier. Some of these, especially boundaries 91 and 92 had the rather wandering lines typical of earlier fields. Boundary 92 (plate 21) had been rebuilt relatively recently but boundary 91 (plate 22), a tumbled revetment on a steep scarp could preserve early remains. However the wandering line of this wall was largely determined by it running along the top of a rocky escarpment. Details of all the boundaries are given in appendix III and their locations are shown on figure 2 and 3.

As most of the route of the scheme is along reclaimed land the number of drains and culverts is unsurprising. None date to before the early 19th century and several appeared more recent (see appendix III for details and figures 2 and 3 for locations).

Some of the culverts were recorded in more detail. The Mitigation Design specified detailed recording for feature 9, a revetted culvert. This was recorded as Culvert 8 (PRN 33545, SH 56728 39555, figure 4). A profile was drawn of this culvert showing that it was quite shallow and wide, but no revetment was seen whilst recording. The drain ran under a track through a stone drain (plate 23). The bypass route cut straight through it; however some of the drain still remains.

Culvert C7A (PRN 33541, SH 56517 39730) ran under the current Tremadog-Porthmadog road towards the Nurseries. It runs through a stone built culvert then under the road into C7 and has overflow pipes at both ends. Most of the other culverts were just general drainage ditches some with banks on one or both sides. A post medieval ditch (3006) was recorded in the Y Bryn excavations (figure 7). It ran NNE to SSW, and measured approximately 25m long and 1.2m wide with regular and fairly steep sides and a slightly round to flattish base. It was filled with mottled mid brown grey clay silt with some sub-rounded and sub angular stones measuring 0.1m to 0.3m across (PRN 33590, SH 55719 40105).

Some of the ditches appeared to be modern, such as culvert 13 (PRN 33560, SH 58628 39098). It ran north-south, measured 1.0m wide and 0.23m deep with gradual sides and a rounded base. The primary fill was a dark grey brown sand silt with some iron staining and organic material at 0.13m deep. A possible re-cut measuring 0.5m wide and 0.1m deep could be seen with a mottled yellow orange sand and some iron staining at 0.1m deep

A post medieval well (PRN 33592, SH 57356 39252) was located 5.5m from the edge of the road directly opposite the fence between Porthmadog Football Club and the field gate. This feature consisted of three large slates forming the mouth or working surface of the well (plate 24). They measured 0.77m by 1.85m, 0.54m by 1.5m and 0.4m by 1.35m. The interior was well constructed using local slate and schist material and a dry stone construction method (plate 25). The diameter of the circular opening made up of two of the slates was 0.65m. The interior of the well was somewhat square in shape and measured 1.15m wide. Well had presumably gone out of use and silted up. The depth recorded from the top slate surface stones to the 'silted up level' was 1.0m. The opening was covered with a steel/iron plate secured by hinges and a chain which measured 0.77m by 0.77m. On the 1900 second edition OS County Series map, but not on any others wells are marked in this area. There is one at the farm adjacent to the Beddgelert Siding on the Welsh Highland Railway and another on the edge of a field to the north, isolated from any buildings (figure 20). This particular well is not marked but it was clearly not unusual to have wells in fields as well as close to buildings.

7.3.2 Two drystone walled buildings (PRN33589, SH56384 39785)

In field 15, just south of Tremadog, the upstanding remains of two drystone walled structures were recorded (figure 21). The buildings were constructed of what appeared to be mostly granite stones. The large foundation stones measured over 1.0m in length and the majority of the walls consisted of angular stones measuring 0.2 to 0.6m. The smaller of the two buildings stood to the north-west and was cut by a drain at its north-western end. This building measured 10.6m long, with 6.5m of the wall remaining, and 5.5m wide. Areas of stone had been removed, most likely by the farmer, at the north-western and south-eastern parts of the building. The south western wall survived to 3 courses and measured 1.0m high, however the foundation slabs are only what survives on the opposite wall.

The slightly larger building was approximately 11.8m to the south-east of the smaller building. It measured 12.7m by 12.3m. A modern field drain cut through the north-western wall and then curved towards the south-east. The south-western wall survived generally as well-defined tumble measuring 0.6m high, where the actual wall survived it measured 0.8m wide. The rest of the remains of this building were mostly a spread of tumble with a concentration of stones where the walls used to be. There was no evidence of roofing material, and a fair amount of post medieval pottery sherds were found within the surrounding area of the buildings.

The areas of robbed out stones suggests that stones from the buildings were used by the farmer to repair boundary walls in his fields. There buildings were probably agricultural, and the lack of roofing material could indicate that they were enclosures or shelters rather than roofed buildings. They are not represented on any of the Ordnance survey maps of this area, which might support the suggestion that they were not roofed buildings and perhaps not considered worth mapping. As they stand on reclaimed land they cannot date from before the early 19th century.

7.4 Transport routes

7.4.1 Tramways and railways

7.4.1.1 Tremadog/Gorseddau Tramway PRN 21171; SH56093978 (central point), running from SH55894012 to SH55604024

The tramway (feature 04 in the Mitigation Design) was built on the embankment built by engineer James Creassy for William Madocks in 1800 to reclaim the Penmorfa inlet of Traeth Mawr for farmland. The embankment was built of sea sand covered with turf, but it ran for about 1.5km and was a substantial undertaking. In 1801 the land to the west of the embankment was under oats and in subsequent years different crops were planted until the land was ready for permanent pasture, which was the ultimate object of the exercise (Beazley 1985, 57-60).

The tramway itself was first built in 1841 (Caernarfon and Denbigh Herald, 25 September 1841) as a horse-drawn tramway and ran from the Llidiart Yspytty Iron Mine to the harbour at Porthmadog (figure 22). A lease of 1840 gave the right to lay a tramway from Llidiart Yspytty to the wharf at Porthmadog. The tramway transported ironstone from the mines at Llidiart Yspytty and Pensyflog (Boyd 1972). Boyd (1972, 8) suggests that it had a 3ft gauge track but Gwyn believes that a 2ft gauge was more likely (Hopewell and Gwyn 2002).

The railway was altered several times but in 1855-57 it was completely rebuilt and extended to the Gorseddau Slate Quarry by the Bangor & Porthmadog Slate and Slab Company, this time with a 3ft gauge track (Hopewell and Gwyn 2002). By the 1860s the slate quarry was closed and in 1872 the Gorseddau Junction & Porthmadog Railways Company was incorporated to take over the tramway and convert it to a 2ft gauge. The extended and improved railway was reopened to freight on 2 September 1875, using a locomotive, but was little used. The line was to remain open until the mid-1890s (Boyd 1972).

The section of this tramway within the scheme runs from just west of the former junction of the A487 and A498 roads along the line of the A487 towards Tremadog, turning south, following the western bank of the canal.

During the watching brief a section of the tramway (PRN 33594, SH55742 40129) was exposed in a service trench dug immediately south of the scheduled area for the Roman bath-house (figure 7). The tramway track was identified on 12th April 2010 during an intermittent watching brief of a service trench measuring 13.0m in length and 1.0m in width. The tramway was defined by kerb stones (002) and to the east was a compact surface of stone setts (001) (figure 23, plate 26). Some wooden beams and ironwork which formed part of the construction were also noted in the trench. No evidence for earlier archaeological activity was visible on evaluation of the deposits.

The stone setts (001) in the eastern part of the trench were long and narrow, and set on edge running in a northwest to southeast direction. The average measurement for these was 0.44m in length, 0.1m in breadth and 0.17m in depth. They formed a very solid surface of one course thick and probably represent the old road surface. The tramway was on a slightly different alignment (west-northwest to east-southeast) and was defined by large sub-rounded stone blocks (002) forming a kerbing. Between the kerb stones were the remains of wooden sleepers running in same direction. There was a distinct gap in plan and in section between the setts of the road and the kerb of the tramway, but this was probably the result of later disturbance and the two features must have functioned together with the tramway tracks fixed to the sleepers and set flush with the road surface. The gauge is difficult to reconstruct from the remains. The berm between the sleeper beams was about 0.65m wide (i.e. 2ft 1 ½ inches) which seems to rule out a 2ft track. Either a 3ft or standard gauge (4ft 8 ½ inch) track could be accommodated. This may suggest that the track was part of the slate quarry phase of the tramway, and that the later 2ft railway ran on a slightly different line. The ironwork found during the watching brief were cast-iron rail chairs i.e. the castings that attach the rails to the sleepers (David Gwyn pers. com. 2011).

If the identification of this as a 3ft track is correct it suggests that the features recorded dated from 1855-57, but the line was originally part of the track from the Llidiart Yspytty iron mine shown on the 1848 map; its position is marked on figure 22. This would have been the lower track to the mine and was presumably later incorporated into a loop line which was built from this lower track to the top on the mine. Figure 24 indicates where this section of track appears on an 1871 map after the line had been extended to serve the Goseddau slate quarry. Figures 25 and 26 show the same location in 1889 and 1900.

This discovery demonstrates that some of the industrial archaeology of Tremadog still survives beneath the modern roads.

Where the scheme again crossed the route of the tramway to the south of Tremadog (see figure 21) no remains now survive.

7.4.1.2 Welsh Highland Railway (Porthmadog) (PRN 21174, SH57323950)

The scheme crossed the embankment of the Welsh Highland Railway (feature 10 in the Mitigation Design) (formerly the Croesor Tramway) just to the south-west of Pen-y-mount Station, on the site of the Beddgelert Siding. The 2ft gauge Croesor Tramway was built in 1864 to link the Croesor quarries to Porthmadog. Its principal proprietor was Hugh Beaver Roberts, and the line was partly designed by Spooner, who surveyed the route in 1863. The south end of the tramway crossed the 1800 reclamation embankment used by the Gorseddau tramway. The Beddgelert Siding was used to transfer slates between the narrow gauge tramway and the standard gauge Cambrian Railway (now the Cambrian Coast Mainline Railway). Though no longer visible, earthworks formerly existed here of an abortive attempt in 1865 to build a standard gauge railway from Porthmadog to Nant Gwynant. Though half of the earthworks had been completed, a halt was called when it was realised the proposed line was too expensive. In 1867 these earthworks were used to construct the exchange sidings and link with the Cambrian railway. Closure of the tramway finally occurred in the 1930's, after a complex history of company changes, ending with the creation of the Welsh Highland Railway (Porthmadog) in 1922. The small section of line known as the Beddgelert Sidings (from Porthmadog to Pen y Mount) was restored in 1964 by the Welsh Highland Light Railway Company, and is still used to run trains along the ¾ mile of track (Boyd 1972, 92-139).

This railway line was largely unaffected by the construction of the bypass other than a culvert under a narrow section. Avoidance of the railway was achieved by the use of a bridge which spans the width of all four railway tracks.

7.4.1.3 Ffestiniog Railway embankment (PRN 21177, SH60143865)

The Ffestiniog Railway, built between 1833 and 1835 (Boyd 1972, 28-29), which runs over William Madocks' Great Embankment (the Cob), was crossed by the scheme just east of Minffordd (figure 27). Where the embankment of the Ffestiniog Railway (feature 18 in the Mitigation Design) was excavated for a new bridge constructed to carry it over the scheme the embankment varies between 0.8m and 1.5m in height and is 3m wide at the top. The outer facing is almost vertical, of dry stone walling. The embankment begins to widen at this point in order to accommodate the two lines running into the station to the west along with associated points and signage. The road to Bronturnor crosses just to the north-east. The crossing is guarded by two relatively recent steel gates.

A trial hole showed that the embankment wall extends approximately 0.6m below surface and was sitting on a laid stone layer (slabs) all of local stone (plate 27). Part of the slate wall of the embankment was dismantled. The slate wall was on average 1.0m high, including the concrete capping and 0.8m wide. The remaining embankment was made up of shale and schist which butted up against the embankment wall.

7.4.1.4 Cambrian Coast Mainline Railway PRN 21175, SH59430 38946

Very little recording was undertaken on the Cambrian Coast Mainland Railway due to inaccessibility. The bypass route runs alongside the railway for under just 2km from the east of Ty Bricks caravan park to the east of Minffordd Quarry. The alignment was changed to the south of its original course for a distance of approximately 850m and a containment structure was built where the railway line and bypass were less than 10m apart.

7.4.2 Roads

7.4.2.1 The 'old' route across Traeth Mawr and junction with the turnpike road (PRN 33605, SH56403980 - SH56673956)

The line of the present A487, between Capel Peniel and Bodawen Lodge, south of Tremadog, overlies the probable junction (feature 06 in the Mitigation Design) of the old route across Traeth Mawr with the new turnpike route from Tremadog to Penrhyndeudraeth built following the construction of the Great Embankment of 1811. The new road is shown on the OS map of 1838. The start of the old road across the Traeth is also shown, though it does not continue all the way across. The John Evans map of 1797 shows the old road continuing into Minffordd, by the old house of Rhos, and then north towards Maentwrog. The 1775 Penmaen Ucha map (figure 6) shows the old road running across the marshes from Penmorfa and around the south-west side of Ynys-hir. It then takes a direct route across the sands to Minffordd, crossing the river at low tide just to the south-west of Garth (now Minffordd Quarry). Breese and Anwyl (1909, 493) note evidence of an old road across the Traeth from the area of Llidiart Yspytty through to a place near Penrhyndeudraeth, and it is likely that the line of the crossing will have varied over time due to movements in the river channel. There are suggestions in the historical documents that in the medieval period the route across the Traeth ended/or started at Llidiart Yspytty (Hopewell and Gwyn 2002) but this may have been a crossing by boat at high tide with a different route at low tide.

The compound for the bypass Scheme was situated close to the probable junction of the two routes, near Ynys Hir, and the bypass also crossed the line of the old road across the sands at its eastern end. The presence of a clearly defined road across the sands on the 1775 map implies that there was some type of laid surface.

To investigate the possible survival of a road across the Traeth geophysical surveys were carried out in two areas: Area A, SH 567 395, fields 17 and 18, on the site of the scheme compound, and Area B, SH 587 390, c. 1km north west of Minffordd, fields 17, 18, 29, 30 and 31 (see figures 4 and 5). The surveys were magnetometer surveys carried out by Stratascan (see appendix IV for full report).

Area A contained two positive linear parallel anomalies (A), representing cut features. Although these might be road-side ditches they were parallel to the main drainage ditch to the north and to agricultural marks seen in the survey, suggesting that the parallel anomalies were drainage ditches. Weak positive linear (B) and area anomalies (C) could be geological responses.

Magnetic disturbance, associated with modern services and agricultural marks were present. The east of the area contained some magnetic disturbances associated with nearby metallic objects such as field boundaries, made-ground or rugby posts.

In area B several linear anomalies, representing cut features of possible archaeological origins, were evident in the centre and east of the field (D). These features may alternately be associated with local geology / pedology. Four discrete positive anomalies, representing possible archaeological pits, were apparent in the south and east of the area.

Magnetic disturbance, associated with nearby field boundaries, could be seen within the area. An area of magnetic variations, probably associated with geological / pedological variations, can be seen in the east. A moderately strong discrete bipolar anomaly, of an unknown origin, can be seen in the centre of the area.

Evaluation trenching in fields 17 and 18 showed that there was estuarine sands at a depth of about 0.3m below the ground surface but identified no features except a shallow ditch or gully seen in trenches 17.04 and 17.05, running north-west to south-east, contrary to the agricultural marks detected in the geophysics survey. In trenches 18.01 and 18.02 there was a dump of late 19th century and early 20th waste forming a layer across the trenches. This was also seen in a nearby test pit (TP108) and this area seems to have been subject to the dumping of rubbish.

When field 17 was stripped of topsoil for the site compound a number of wide, shallow drainage ditches were located running northwest to southeast, one of which was the ditch found in the evaluation trenching (PRN 33593, SH 56710 39590(C)). A slot was excavated across one of the ditches, which showed that it measured 3m wide and 0.12m deep with dark brown grey silt fill. The ditch was cut into mottled grey yellow estuarine sand silt (plate 28).

The parallel features seen in the geophysics (anomaly A) were not seen during the stripping of the field.

In area B (fields 29, 30 and 31) the evaluation trenches showed that the estuarine sands were no more than 0.2m below the ground surface. There were no features identified so the anomalies detected in the geophysical survey seem to be geological. One of the strong bipolar anomalies was investigated and proved to be an iron object with four legs in the topsoil.

This work therefore revealed no convincing evidence for a built road across the Traeth and it is probable that this was always a route on the sand, probably with marker posts. A built road would probably have been rapidly eroded away by the daily inundation by the sea.

7.4.2.2 Pre-turnpike road from Penrhyndeudraeth to Minffordd PRN 33600; NGR: SH59923878

The pre-turnpike road from Penrhyndeudraeth to Minffordd (feature 16 in the Mitigation Design) is represented by a minor tarmac road running from Minffordd towards the farms of Plas Newydd and Ty Obry, entering Penrhyndeudraeth after crossing beneath the Ffestiniog Railway (figure 27). The line of the road is clearly shown on the John Evans map of 1797 as the main route between the crossing of Traeth Mawr and Maentwrog and areas to the east. The road probably represents a traditional line of communication dating from at least the medieval period.

There is a good dry stone revetment wall where a minor stream crosses under just to the south of the turning to Plas Newydd. There is a record of a new road being constructed during the 19th century between Rhos and Tyddyn Obry, though it may have been an improvement of the existing road. The road runs through a rock cutting at the point where the scheme crosses. This is likely to be a feature of later improvements. Excavation through the road only showed evidence of the road-make-up deposits. There was 0.5m of grey hardcore/sub-base under the current tarmac surface. Below this was a deposit of a combination orange earth and broken bedrock that appeared to be retained by a stone wall on either side. In section this deposit appeared to form a camber.

7.4.2.3 Embankment with road PRN 33598; NGR SH59593870 - 59453893

Feature 15 in the Mitigation Design was an earthen linear embankment, with a road on top, leading to Minffordd Quarry (figure 27). Originally an embankment protecting an area of low lying land from inundation this feature has been adapted and altered during the 19th century and has been truncated by the embankment of the Cambrian Coast Mainline Railway and its level crossing. The embankment was probably constructed during the 18th century, one of several built in the last quarter of the 18th century along the Merioneth shore of Traeth Mawr to reclaim land for farming (Beazley 1985, 54). It starts from close to Graig Rhos House, a 17th century house (PRN 6498), possibly hinting at an even earlier date. The feature appears on the OS map of 1838 and may be indicated on the John Evans map of 1797. However, much drainage work and construction of new roads was undertaken in the 19th century, following the construction of the Cob, led by David Williams of Castell Deudraeth.

The embankment was partially removed due to the realignment of the Cambrian Coast Mainline and a record was made of structure. The embankment measured approximately 2.5m high with a general width of 15m and was steeper on the north eastern side. The road was 4.5m wide and was surfaced with tarmacadam. The road widened to approximately 20m near Minffordd Quarry entrance. A watching brief ensured that there were no earlier features buried by the road.

7.4.3 Madocks' Canal (PRN 21172, SH55944013 - SH57103896)

The embankment built by engineer James Creassy for William Madocks in 1800 (Beazley 1985, 57-60) had a ditch running down the eastern side. This is marked as Y Cyt (the Cut) on the County Series maps but was commonly known as Madocks' Canal, and was intended for use as both a drain and a canal. The inspiration behind it is reputed to be the Brecon Canal, which Madocks knew from his visits to Talgarth. The canal drained the surrounding land, discharging water through the 1800 embankment via the Great Sluice into the estuary of the Glaslyn. It is reported that in its heyday the canal was capable of accommodating vessels of up to 120 tons. The small ironstone mine at Llidiart Yspytty used the canal to transport material from the 1820s until 1842, when it started to use the Tremadog Tramway. Similarly ore from the Bron-y-Gadair Copper Mine was transported out to sea-going vessels by the same route. Ultimately the canal lost its economic value and reverted to the function of a drain. It has been known as Y Cyt since the end of the 19th century. Current usage of the name Y Cyt refers to Madocks' canal from Llyn Bach to Pensyflog and then a drain running to Nant yr Afon Oer as opposed to the canal running to Tremadog.

The canal (feature 05 in the Mitigation design) is a steep sided water-filled linear drain, with areas of stone revetting remaining in places. A photographic record was made of the short section of the canal disturbed by the works before these started (plates 29 and 30).

7.5 Other sites

7.5.1 Peat Bed (PRN 33596; SH60002 38635 to SH60255 38675)

Prior to the start of work on the road scheme Birmingham Archaeo-Environmental carried out a borehole survey to evaluate the palaeoenvironmental potential of the deposits along the line of the Tremadog to Porthmadog bypass. A total of sixteen boreholes were produced using an Eikjelcamp gouge corer. The survey recorded sand and silt deposits associated with the estuary of Traeth Mawr, and did not identify significant organic deposits.

The deposits consist of a thin sandy top soil onto buff medium coarse sand which trended into a light grey wet silty sand at depth. In places the deeper deposits were a buff medium coarse sand becoming grey and saturated with depth.

The coarse sand and silt/clay in all the cores represent deposits associated with fluvial and marine processes operating in Traeth Mawr estuary prior to its reclamation on the early 19th century. This evaluation led to no recommendations for specific work but did suggest that if peat deposits were found during the groundworks that these should be investigated (see appendix VI.1 for full report).

The groundworks did indeed reveal a peat deposit. This was an extensive deposit identified during the construction of an access track near the Snowdonia Business Park (NGR SH 60153860) (figure 27). GAT observed a quantity of preserved wood varying in size from 0.5m – 4.0m in length. This material was inspected for signs of human activity e.g. tool marks, none could be seen and upon further discussion the material was identified as bog oak. Many of the pieces of bog oak could clearly be identified as tree trunks with roots still attached suggesting that they fell naturally rather than being cut down.

Photographs were taken of the section of the trench where the peat was seen to be approximately 2.0m deep. The maximum depth of peat noted was approximately 3.5m.

Due to concerns about safety Gwynedd Archaeological Trust were unable to collect column samples from the trench edge so a programme of coring and assessment was devised and carried out by Birmingham Archaeo-Environmental. A core was recovered using a Russian auger from which a 1 metre of sediment was collected with accompanying bulk samples.

Sub-fossil pollen, plant and beetle remains were extracted and two samples of wood (near top and base) were radiocarbon dated. The dates showed that the sediment was formed during the Bronze Age. The pollen assessment illustrated an alder carr environment with a birch and oak woodland which later became more open indicating a period of clearing. The plant macrofossil record highlighted intrusive woody root material which offered little interpretable value to the understanding of the formation of the deposit. Coleoptera remains were absent from the bulk samples. The report therefore did not recommend further work on the plant macrofossils and beetle remains but did recommend full analyse of the pollen core with further dates (see appendix VI.2 for report).

The pollen core taken at SH 60162 38625 comprised 1m of well-humified, silty peat. Twenty two sub-samples from the core were taken for pollen analyses at 0.04m intervals and further 3 samples from the peat were submitted from radiocarbon dating in addition to the 2 samples dated in the assessment (see appendix VI.3 for full report).

The sampling site was probably in a shallow depression within the local bedrock in which peat had accumulated due to increased wetness probably related to climatic change or vegetational disturbance by humans. Four of the five radiocarbon dates for this sequence are dated to the second-third millennium cal BC indicating that the pollen record reflects a Bronze Age phase of landscape development. The lower samples where dated as being slightly later than the upper samples but this is probably to be explained by the rapid accumulation of sediment, which is supported by the presence of in-washed material from dryland. The date from 0.32m below the surface is in error as this is dated to the early medieval period; probably due to contamination by intrusive rootlets.

The basal zone indicates a closed canopy fen woodland environment on and around the sampling site. The proportions of different tree species within this woodland fluctuate as the composition of the woodland changes over time, possibly due to changes in the depth of the water table locally. There is clear evidence from 0.33m below the surface for a substantial reduction in the woodland cover, with significant reductions in most tree species, although hazel, which is at first reduced then increases steadily. Grass pollen displays a marked rise at the opening of the zone, and it would seem likely that the spread of grassland was related to the clearance of woodland at this location by human communities during the Bronze Age. However, any such activity did not result in the complete removal of the woodland cover, but targeted the birch, oak and alder trees, whilst hazel seems to have remained largely unaffected. Ribwort plantain and tormentil suggest open pastoral environments, with the latter typical of slightly acid grassland, although percentages remain relatively low. Low quantities of other herbs suggest a pastoral vegetation typical of grazed meadows, but also include taxa found in more open fen environments. There is no record of cereal pollen.

The palynological data therefore indicate a phase of woodland clearance at this site during the Bronze Age, perhaps associated with pastoral agriculture, but it is possible that this was only a local clearance and does not necessarily indicate that the whole area was deforested. The overlapping nature of the calibrated radiocarbon dates and the likely presence of an erroneous determination around the level of the interpreted clearance event prevent a precise estimate of date for the clearance event.

7.5.2 Shell Midden (PRN 33597, SH 60153860)

During topsoil stripping in field 37 a small shell midden was found on an outcrop of bedrock. It appears that prior to the land reclamation of the late 18th century this would have formed a low island in a small bay on the northern side of the Penrhyndeudraeth peninsula, sheltered to the north by the outcrop of Y Garth (see figure 27). The shell midden would have been on the southern shore of this island.

The material appeared to have been dumped directly onto the bedrock and consisted of mostly shells with some fragments of mammal bones. The shells and bone were in a matrix of dark grey brown silt clay with some mid orange brown clay silt overlying the bedrock in places. The midden was on the very edge of the area being stripped therefore it was only partially revealed. The portion of the midden that was uncovered measured 3.1m wide, and 0.3m deep at its deepest point.

Three fragments of bone, one of which was burnt, were recovered and studied by Nora Bermingham who identified them as from large mammals but the species could not be further identified (appendix X). No identifiable charcoal was recovered and only a single fragment of hazelnut shell.

The shells were almost all of the common cockle (*Cerastoderma edule*), both complete and broken, but there were also occasional fragments of oyster shells.

Shell middens are often assumed to be prehistoric so it was important to obtain a date for the midden. Two of the cockle shells were selected for dating to give a direct date on the shell gathering activity. The dates were as shown in the table below (see appendix XVII.2 for the radiocarbon certificates).

Table 3: Radiocarbon results from the shell midden in field 37. The shell measurements were calibrated using the Marine09 marine curve of Reimer *et al* (2009) with a ΔR value of 1 ±49a for the coast of Wales.

Lab ID	Context	Material	$\delta^{13}C$ (‰)	Radiocarbon age (BP)	Calibrated date (95% confidence)
SUERC-37699	37004: shell midden	shell: *Cerastoderma edule*	0.3	1150 ±30	cal AD 1130–1340
SUERC-37700	37004: shell midden	shell: *Cerastoderma edule*	0.5	1115 ±30	cal AD 1170–1400

The two results are statistically consistent and could be the same age. The latest date (SUERC-37700) provides cal AD 1220–1330 (68% confidence) as the best estimate for the date of deposition (Hamilton, appendix XVII.1).

This midden would therefore appear to be medieval in date and demonstrates that the collection of marine shellfish for food or bait cannot be assumed to be restricted to the prehistoric period. People at all times have eaten and used shellfish and the dating of this site provides a useful reminder of this.

7.5.3 Area of quarrying (PRN 33599, SH59963876)

Feature 42 in the Mitigation Design was an outcrop of poor quality slate running roughly NNW to SSE (figure 27). It was entirely covered in mature ash and sycamore trees. There were clear indications of quarrying where the removal of stone has left hollows (Plate 32). A rough stone boundary (FB91) ran along the top of the outcrop. The occupants of the Ffestiniog Union Workhouse (Bron-y-Garth Hospital) were employed to quarry stone for road building and maintenance and small scale quarrying can be seen in most of the larger outcrops around the former Ffestiniog Union Workhouse.

The road works cut through this outcrop and removed much of it. The stripping prior to rock removal was monitored on the 7th April 2010.

7.5.4 Site of Shooting Butts (PRN 33601, SH 58250 39190)

The shooting butts (feature 11 in the Mitigation Design), shown on the OS 25" county series maps of 1889 and 1917, were at the eastern end of a rifle range extending to SH 57364 39234 (figure 28). Targets are marked every 100 yards up to 800 yards on the first and second edition maps but only up to 600 yards on the third edition. The rifle range was probably associated with the County Volunteers.

The site was visible on the ground as a low sub-rectangular mound, and is visible on aerial photographs as a series of parallel lines. Surface finds of bullets and cartridges were picked up before and during the watching brief of the area built no structures or negative features were noted.

An evaluation trench (trench 27.01) was located to investigate the shooting butts. This found no trace of the butts but did reveal closely spaced parallel ploughmarks over part of the trench (plate 33). These ran east-west and are presumably the lines that can be seen on the aerial photographs. Bullets were recovered with a metal detector during the trench excavation. These were of .303 and .45 sizes.

7.5.5 Tidal gates to Llyn Bach (PRN 33602, SH57258 38559)

Madocks' drainage pattern, after the construction of the Cob, entailed the diversion of the Glaslyn through sluice gates between Ynys Tywyn and the mainland (now the Britannia Bridge). The gates prevented the ingress of the tides behind the Cob. The scouring action of the river led to the formation of Porthmadog Harbour. The harbour was overcrowded throughout most of its early history and in 1845 plans were made to build an inner harbour inland of the sluice gates. A substantial rubble embankment was built about 10 years later enclosing Llyn Bach (figure 29). New flap-type sluice gates were constructed between the embankment and Ynys Tywyn consisting of 5 cast iron and wood gates. The cast elements were made by Charles H Williams Ltd in the Glaslyn

Foundry, Porthmadog. A second set of vertically-hung tidal gates were added at the mouth of Y Cyt/Madocks' Canal. The original tidal sluices were removed but the inner harbour was never built. The sluices and gates still prevent the ingress of the tide into the reclaimed land of Traeth Mawr and the lake has continued to perform a useful function as a buffer between the waters of the harbour and the Glaslyn. Llyn Bach remains much as originally planned. The rubble bank still stands to what appears to be its original height although some repairs may have been carried out on the northern side. The western side has been modified in recent years during the construction of a supermarket car park. Both sets of sluice gates have been modified to incorporate modern closing mechanisms and barriers to conform to health and safety legislation. Much of the original stonework and cast iron elements have however been retained (plate 34).

A pile of wooden gate-parts lay on Ynys Tywyn presumably dating from the refurbishment of the sea defences. A cast iron winching mechanism stands on top of the bank to the north of the dock gates. This does not appear to be in its original position and may be part of the original sluice mechanism.

A watching brief was undertaken to record the removal and replacement of the tidal gates at the south-eastern entrance to Llyn Bach on 11th March and 4th April 3011. Some of the old equipment was photographed *in situ* and as it was removed.

An area of land running from the Cob Crwn Embankment around Llyn Bach to the Porthmadog Football grounds was topsoiled to create a flood defence bund. An intermittent watching brief (on 16th September 2011 and 2nd December 2011) was undertaken on this work but no archaeological features were seen, which was to be expected as this would have been open estuary before 1811.

7.5.6 Gorsedd Circle (PRN 33603, SH 56574 39660)

This is a stone circle erected in 1987 for the National Eisteddfod. It measures about 24.9m in diameter with 11 stones in the circle and another stone set just inside. There is an 'altar' made of a large horizontal stone in the centre (plates 35 and 36). The stones are all clearly quarried using modern techniques.

The circle is set in a flat field close to the road and was clearly intended to be seen from the road. The hill of Ynys Hir lies to the north and the housing estates on the edge of Porthmadog to the south (figure 4).

8 CONCLUSION

The bypass route provided a transect for investigation from the large flat expanses of the sandy Traeth Mawr to the small stone outcrop, Y Bryn. It runs through an area of mostly reclaimed land. While some reclamation occurred in the late 18th century, it was the William Madocks' creation of the Great Embankment and the town of Tremadog in the early 19th century, which has shaped and moulded the landscape to what it is today.

The discoveries at Y Bryn contribute significantly to the understanding of the Roman activity at Llidiart Yspytty just west of Tremadog. The new discoveries support the argument for a significant building in this area requiring considerable quantities of mortar and roofed with slate. It was positioned so that the estuary could be used to bring in supplies, especially heavy materials such as lime for the lime kiln, by water.

The Roman activity was preceded by prehistoric settlement on Y Bryn. Although no features were found to elucidate this settlement the assemblage of stone tools has been expanded and there are hints of two phases of activity on different parts of the hill; probably Neolithic on the eastern side and Mesolithic on the western side. Evidence for Bronze Age clearance land to the east of Traeth Mawr also indicates the extent of prehistoric activity.

The medieval period was represented by a shell midden. The dating of this was important to demonstrate that shell middens might be of periods later than the prehistoric and to indicate one of the less frequently identified activities of medieval people in the area.

Most of the features recorded were related to the industrial and transport history of the area or to the reclamation of the estuary without which the other structures could not have functioned.

This project has significantly contributed to our understanding of Traeth Mawr and its development from late Mesolithic times.

9 ACKNOWLEDGEMENTS

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10 REFERENCES

10.1 Published sources

‘Alltud Eifion’ (Robert Isaac Jones), 1975. *Y Gestiana*, reprinted Porthmadog

Ashmore, PJ, 1999. ‘Radiocarbon dating: avoiding errors by avoiding mixed samples’, *Antiquity*, 73 (279), 124–30

Avent, R, 1983. *Castles of the Princes of Gwynedd / Cestyll Tywysogion Gwynedd*. HMSO, London

Bassett, TM and Davies, BL, 1977. *Atlas of Caernarvonshire*, Gwynedd Rural Council, Caernarfon

Beazley, E, 1985. *Madocks and the Wonder of Wales*, Aberystwyth

Berridge, P. 1994. The Lithics. In H. Quinnell and M.R. Blockley (eds) *Excavations at Rhuddlan, Clwyd: 1969-73 Mesolithic to Medieval*, CBA Res. Rep. 95, 95-114.

Boyd, JIC, 1972. *Narrow Gauge Railways in South Caernarvonshire*, Oakwood Press, Surrey

Boyd, JIC, 1975. *The Festiniog Railway*, Oakwood Press, Surrey

Breese, CE, 1908. ‘Roman Buildings at Glasfryn, Tremadoc, Caernarvonshire’, *Archaeologia Cambrensis* 6th Series vol VIII, 287-288

Breese, CE and Anwyl, E, 1909. ‘Roman Building at Glasfryn, Tremadoc, Caernarvonshire’, *Archaeologia Cambrensis* 6th Series vol IX, 473-494

Casey, PJ and Davies, JL, 1993. *Excavations at Segontium (Caernarfon) Roman fort, 1975-1979.* Council for British Archaeology, London.

Cormack, WF, 1970. A Mesolithic site at Barsalloch, Wigtownshire, *Trans. Dumfries and Galloway Nat. Hist*. Soc. 47, 63-80.

Dix, B, 1979. ‘Roman lime-burning’, *Britannia* 10, 261-262

Dix, B, 1982. ‘The manufacture of lime and its uses in the western Roman provinces’, *Oxford Journal of Archaeology* 1(3), 331-345

English Heritage, 1991 *Management of Archaeological Projects* (Second Edition)

English Heritage 2006 *Management of Research Projects in the Historic Environment Project Manager’s Guide*

Finlayson, W. 1995. Complexity in the Mesolithic of the Western Scottish seaboard. In A. Fischer (ed.), *Man and sea in the Mesolithic*, Oxbow, Oxford.

Gillam, J.P. 1976. ‘Coarse fumed ware in north Britain and beyond’, *Glasgow Archaeological Journal,* 4, 57-80

Gresham, C, 1973. *Eifionydd*, Cardiff

Hopewell, D, and Gwyn, D, 2002. *Land to the north-west of Tremadoc (Llidiart Yspytty): archaeological assessment*, unpublished GAT report 455

Hopewell, D, 1995. *A487 Porthmadog Bypass proposed roundabout west of Tremadog: archaeological evaluation*, unpublished GAT report 182

Hopewell D, 2007. *Roman Roads in North-west Wales*, unpublished GAT report 668

Hughes, E. and Eames, A., 1975. *Porthmadog Ships*. Gwynedd Archive Services Publications.

Jackson, D.A., Biek, L, and Dix, B.F., 1973. 'A Roman Lime Kiln at Weekley, Northants', *Britannia* vol 4, 128-140

Jacobi, R. M. 1980. The Early Holocene Settlements of Wales. In J.A. Taylor (ed), 131-206

Jones and Jones 1963. *The Mabinogion*,

Jones, G., P. 2005 in report 577 *Ports and Harbours of Gwynedd*, Andrew Davison and John Roberts 2005.

Kenney, J., 2006. *Land to the northwest of Tremadog (Llidiart Yspytty)*, unpublished GAT Report 626.

Lewis, M. J. T., 1989. *Sails on the Dwyryd*. Snowdonia National Park Study Centre, Tan Y Bwlch

Ling, R, and Ling LA, 1973. 'Excavations at Loughor, Glamorgan: The north-east and south-east angles of the Roman fort', *Archaeologia Cambrensis*, CXXII, 99-144

Moore, D, 1997. 'Thomas Pennant's Vision of the Landscape', *Archaeologia Cambrensis*, CXLVII (2000), 138-177

Pennant, T. 1991. *A Tour in Wales, volume II*, Bridge books

RCAHMW 1960. *An Inventory of the Ancient Monuments in Caernarvonshire*, vol II, HMSO, London

Reimer, PJ, Baillie, MGL, Bard, E, Bayliss, A, Beck, JW, Blackwell, PG, Bronk Ramsey, C, Buck, CE, Burr, GS, Edwards, RL, Friedrich, M, Grootes, PM, Guilderson, TP, Hajdas, I, Heaton, TJ, Hogg, AG, Hughen, KA, Kaiser, KF, Kromer, B, McCormac, FG, Manning, SW, Reimer, RW, Richards, DA, Southon, JR, Talamo, S, Turney, CSM, van der Plicht, J and Weyhenmeyer, CE 2009. 'INTCAL09 and MARINE09 radiocarbon age calibration curves, 0–50,000 years cal BP', *Radiocarbon*, 51(4), 1111–50

Roberts, J, 1995. *A487 Porthmodog to Minffordd: archaeological assessment*, unpublished GAT Report 155

Smith, G.H. 2001 *North-West Wales Lithic Scatters Project: Evaluation of the Early Prehistoric Landscape through Lithic Finds*, GAT Rep. No. 354.

Stenhouse, MJ and Baxter, MS, 1983. '^{14}C reproducibility: evidence from routine dating of archaeological samples', *PACT*, 8, 147–61

Taylor, JA (ed) 1980. *Culture and Environment in Prehistoric Wales*, BAR Brit Ser 76

Troels-Smith, J. 1955. 'Characterization of unconsolidated sediments'. *Danmarks Geologiske Undersøgelse 4 Række* 3/10,1–73.

Vandeputte, K, Moens, L and Dams, R, 1996. 'Improved sealed-tube combustion of organic samples to CO_2 for stable isotope analysis, radiocarbon dating and percent carbon determinations', *Analytical Letters*, 29(15), 2761–73

White, R.B. 1978. Excavations at Trwyn Du, Anglesey 1974, *Arch. Camb.* 127, 16-39

Williams, R, 2004. *Limekilns and Limeburning*, Shire Archaeology, Shire Publications Ltd, Aylesbury

Young, C.J. 1977 *Oxfordshire Roman Pottery,* British Archaeological Reports, British Series, 43, Oxford

Xu, S, Anderson, R, Bryant, C, Cook, GT, Dougans, A, Freeman, S, Naysmith, P, Schnabel, C and Scott, EM, 2004. 'Capabilities of the new SUERC 5MV AMS facility for ^{14}C dating', *Radiocarbon*, 46(1), 59–64

10.2 Maps

10.2.1 Ordnance Survey 25 inch County Series maps

Caernarvonshire first edition sheets XXXIV.09, 11, 12, 16 (1889)

Caernarvonshire second edition sheets XXXIV. 09 (1900), 11 (1900), 12 (1901)

Caernarvonshire third edition sheets XXXIV. 09 (1915), 11 (1915), 12 (1918), 13 (1917), 16 (1917)

Merionethshire first edition sheet XI.13 (1889)

Merionethshire second edition sheets X.16 (1900), XI.13 (1900)

10.2.2 Other maps

Map of Traeth Mawr by John Salter (1775), Penmaen Ucha Estate papers, Dolgellau Record Office (Z/DBQ)

Map of North Wales, John Evans 1797

Tithe maps of Ynyscynhaearn parish and Penmorfa parish (1842), Caernarfon Record Office

11 FIGURES AND PLATES

Figures

Plates

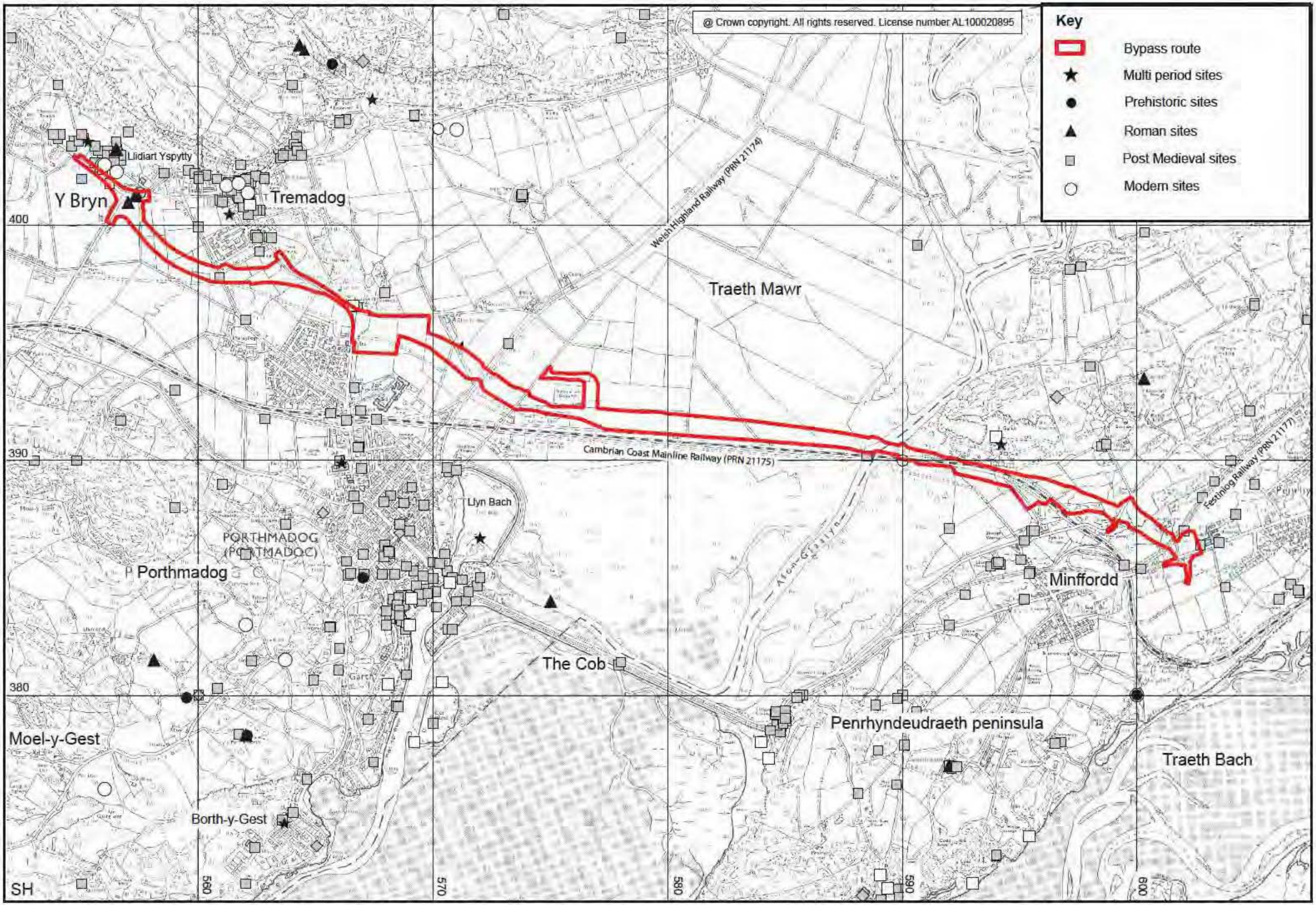


Figure 1. Route of A487 Porthmadog/Minffordd/Tremadog Bypass showing archaeological sites already on the Gwynedd Historical Environment Record

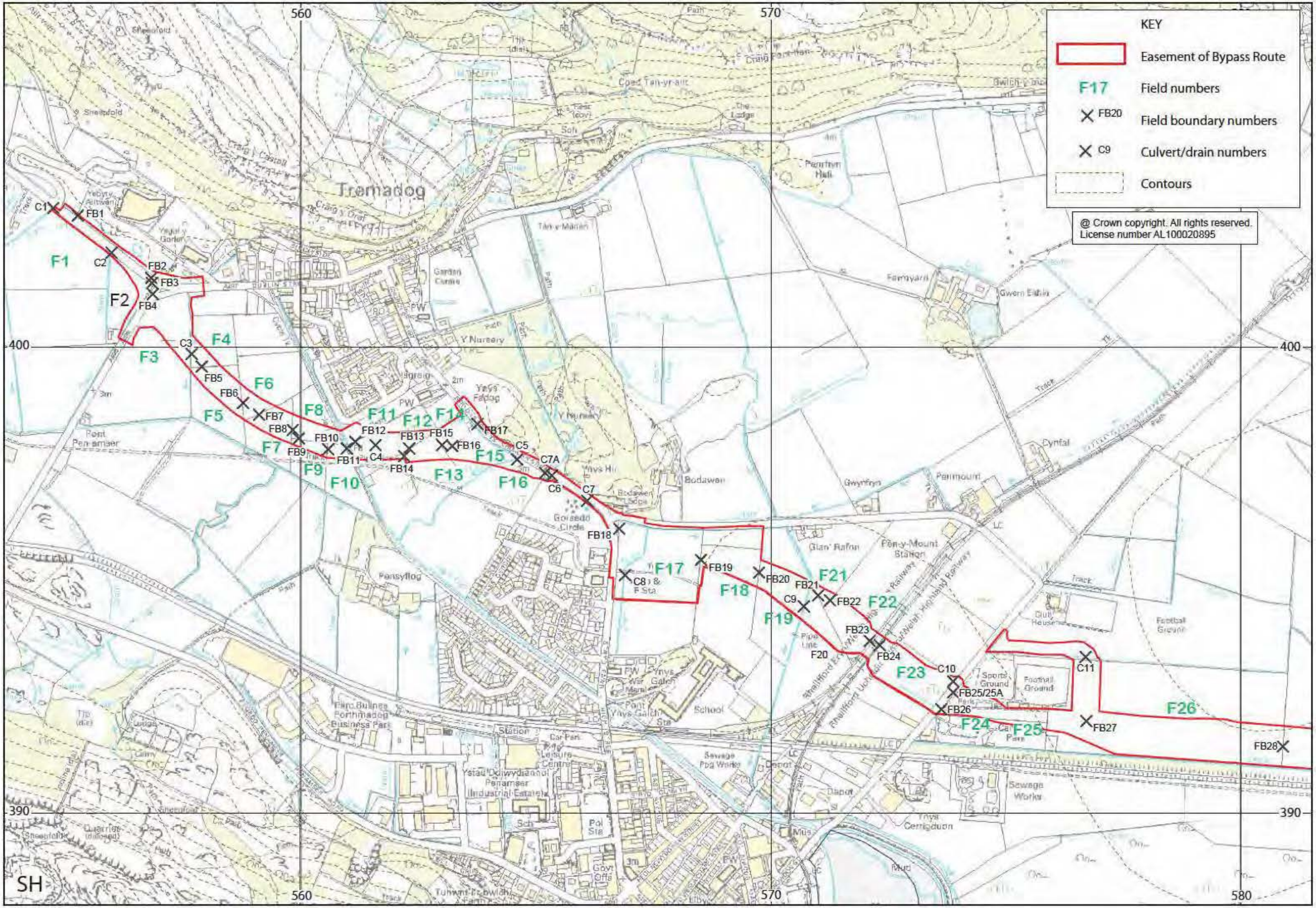


Figure 2. Plan of location of recorded field boundaries and culverts, showing field numbers

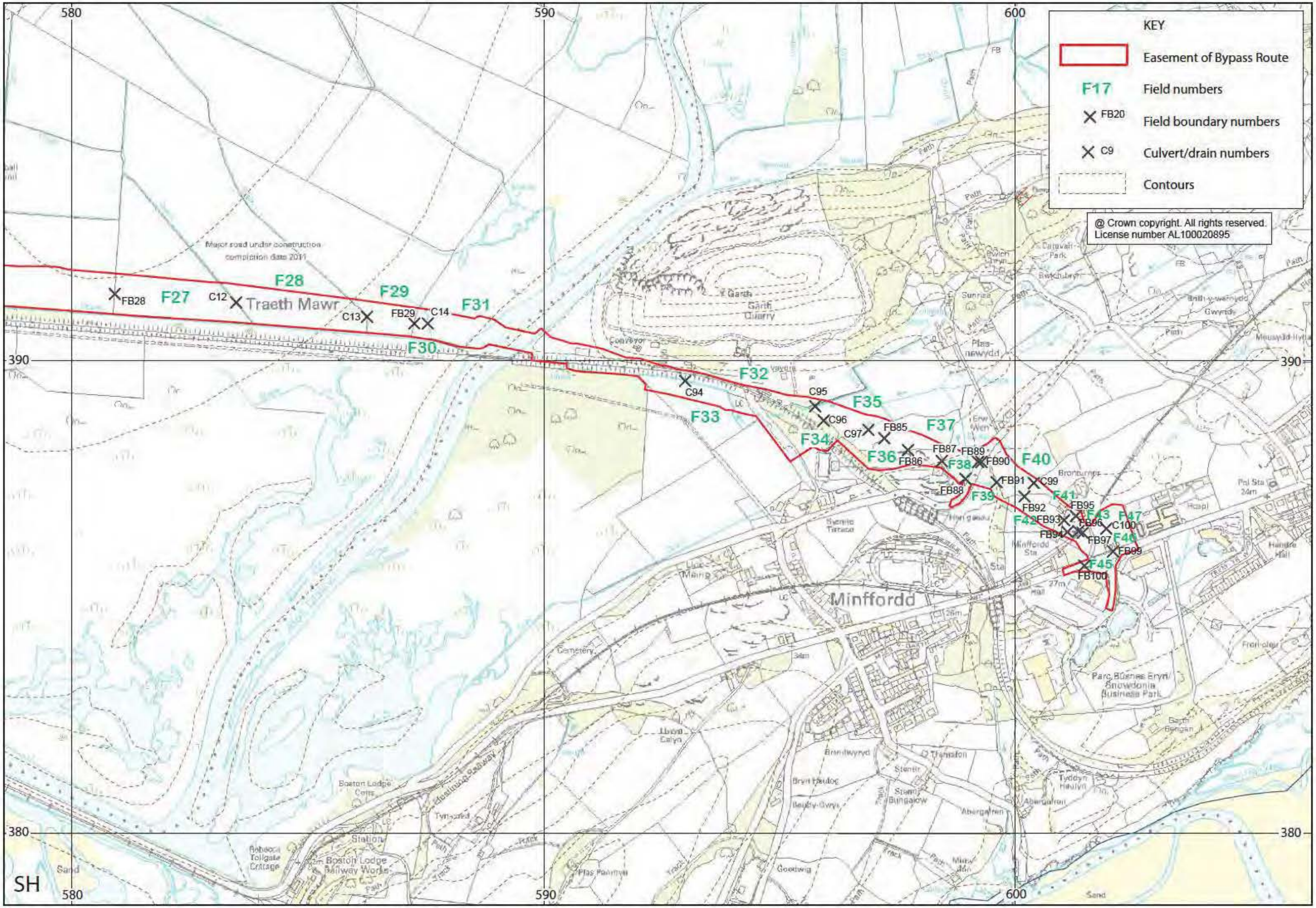


Figure 3. Plan of location of recorded field boundaries and culverts, showing field numbers

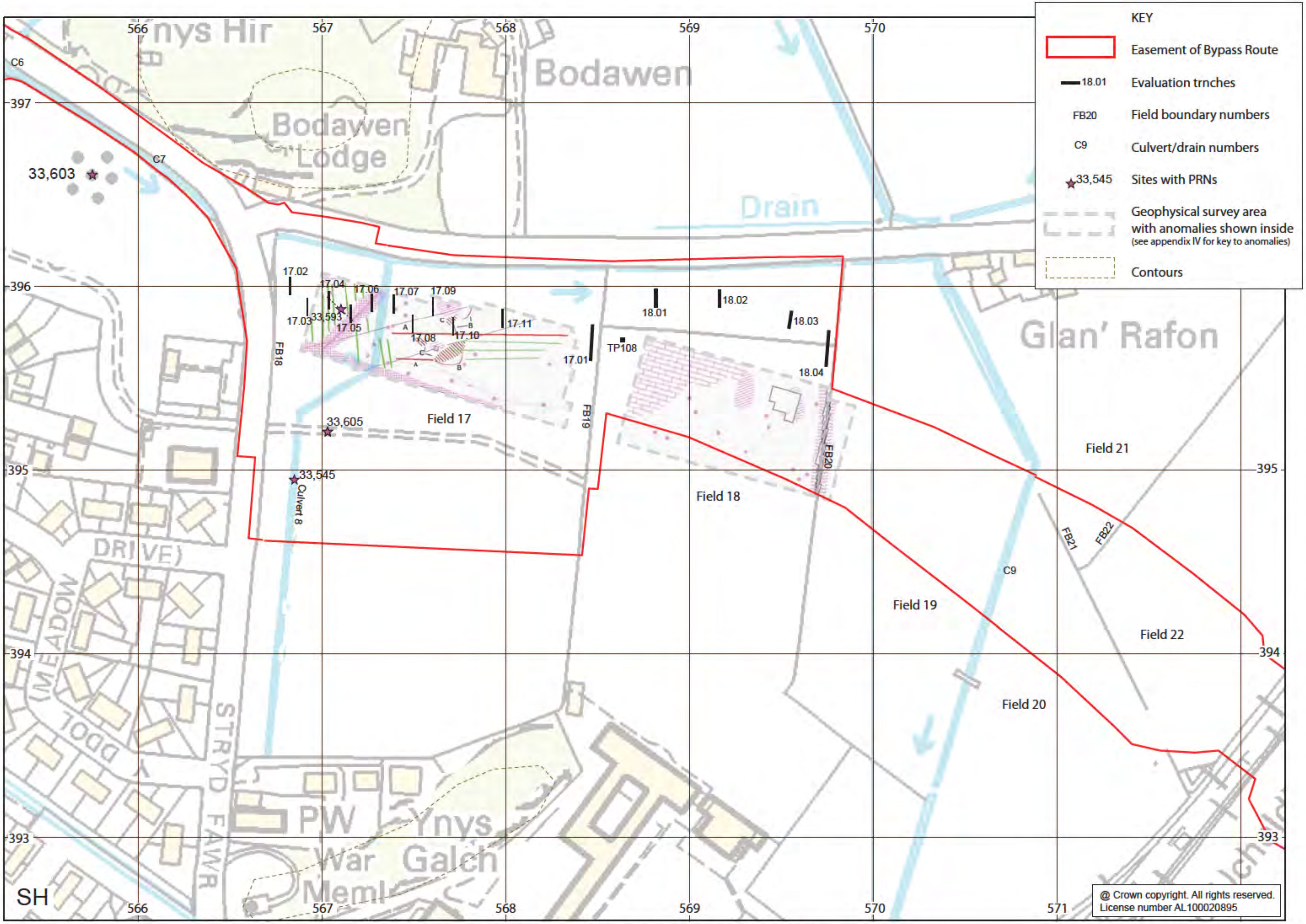


Figure 4. Plan of the western geophysics area (area A) and evaluation trenches

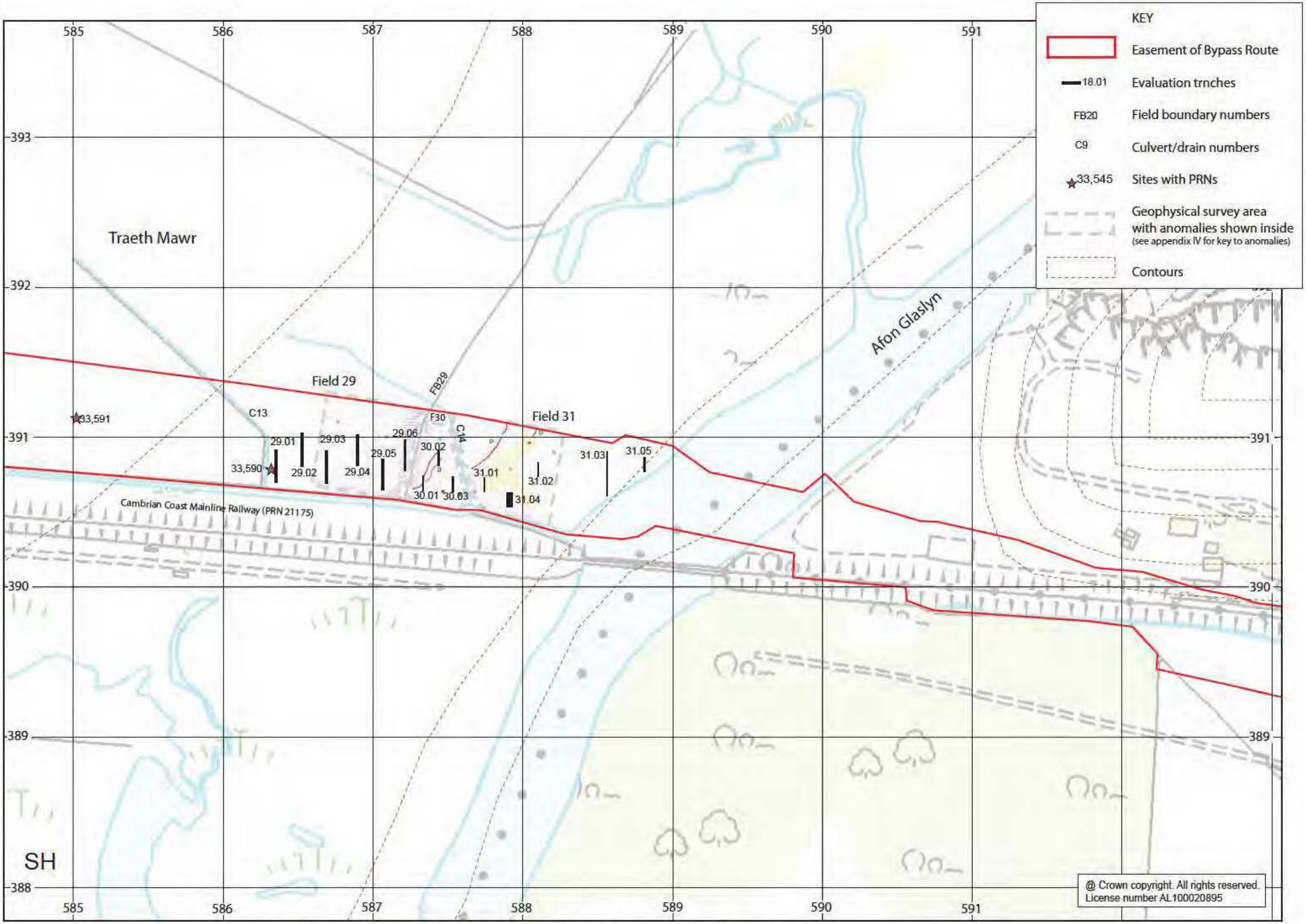


Figure 5. Plan of the eastern geophysics area (area B) and evaluation trenches

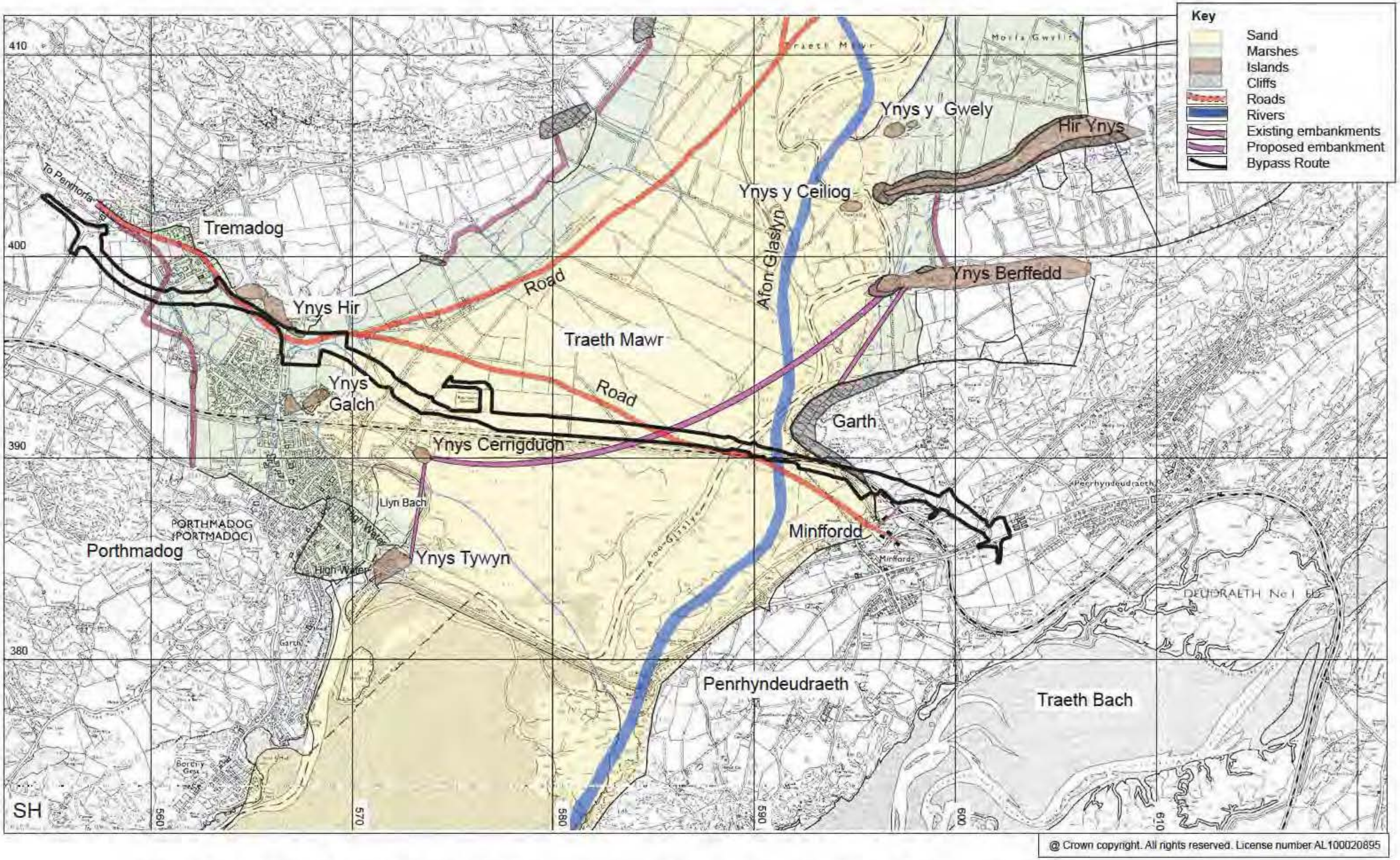


Figure 6. Transcription of a Map of Traeth Mawr dated 1775 (John Salter, Penmaen Ucha Estate Papers) onto the modern 1:10,000 map

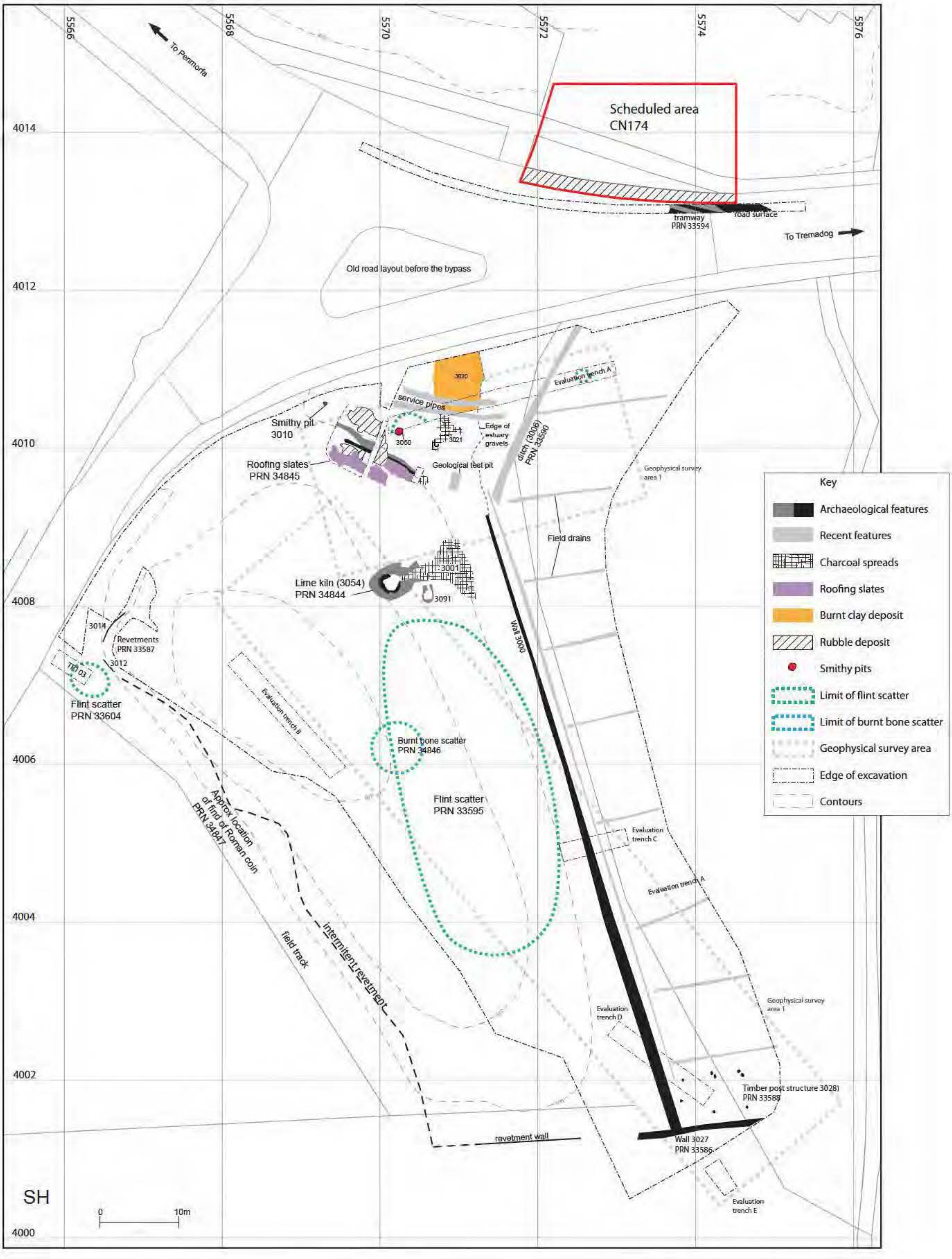


Figure 7. Plan of Y Bryn showing archaeological features discovered in the mitigation programme and the location of the previous geophysical survey and evaluation trenches

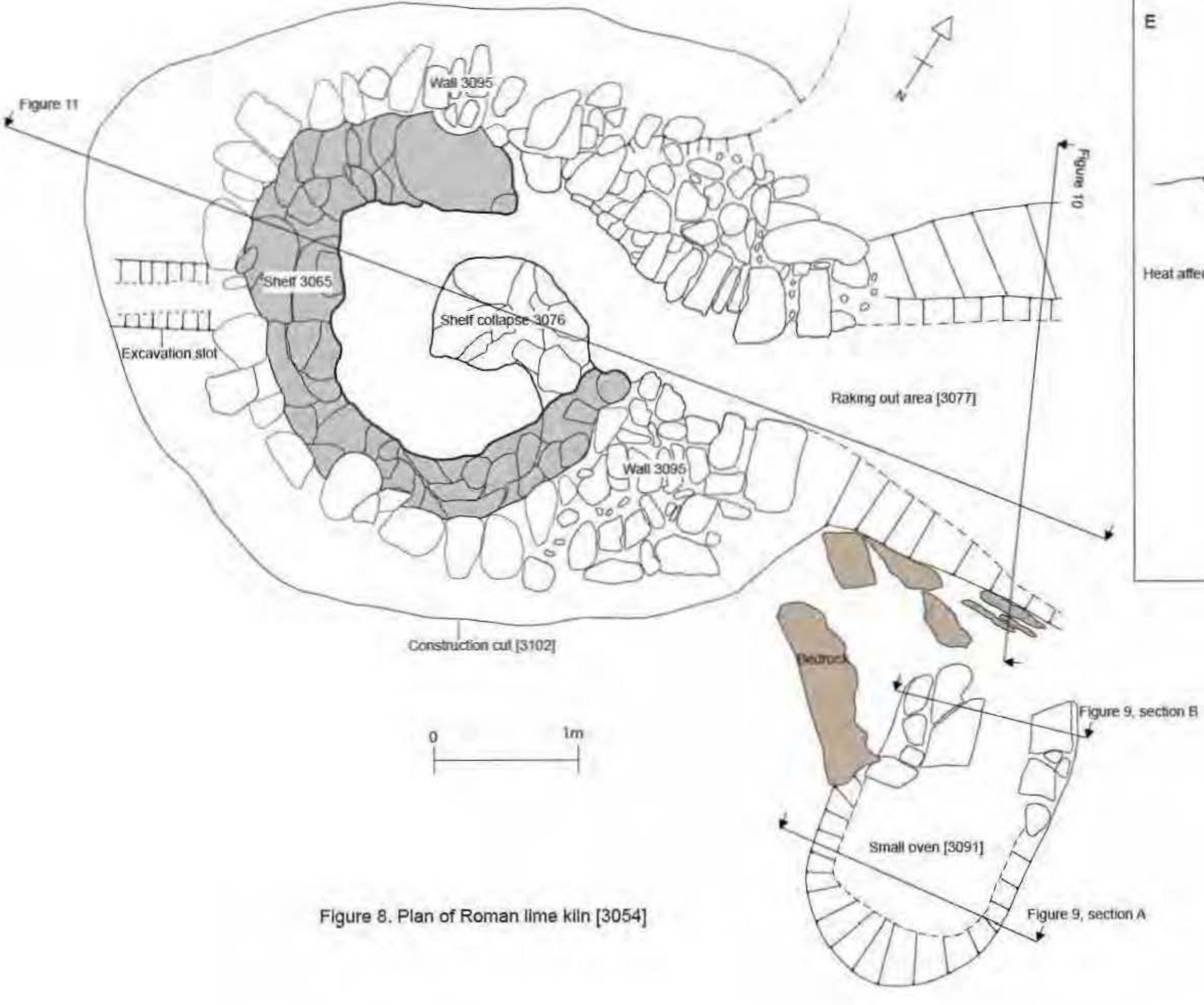


Figure 8. Plan of Roman lime kiln [3054]

Figure 9. Sections through oven [3091]

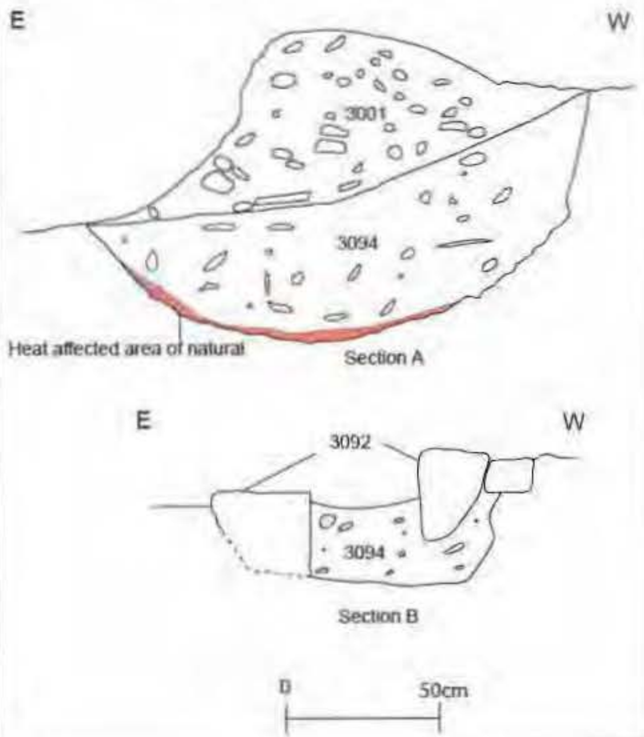


Figure 10. Section through raking-out area of Roman lime kiln [3054]

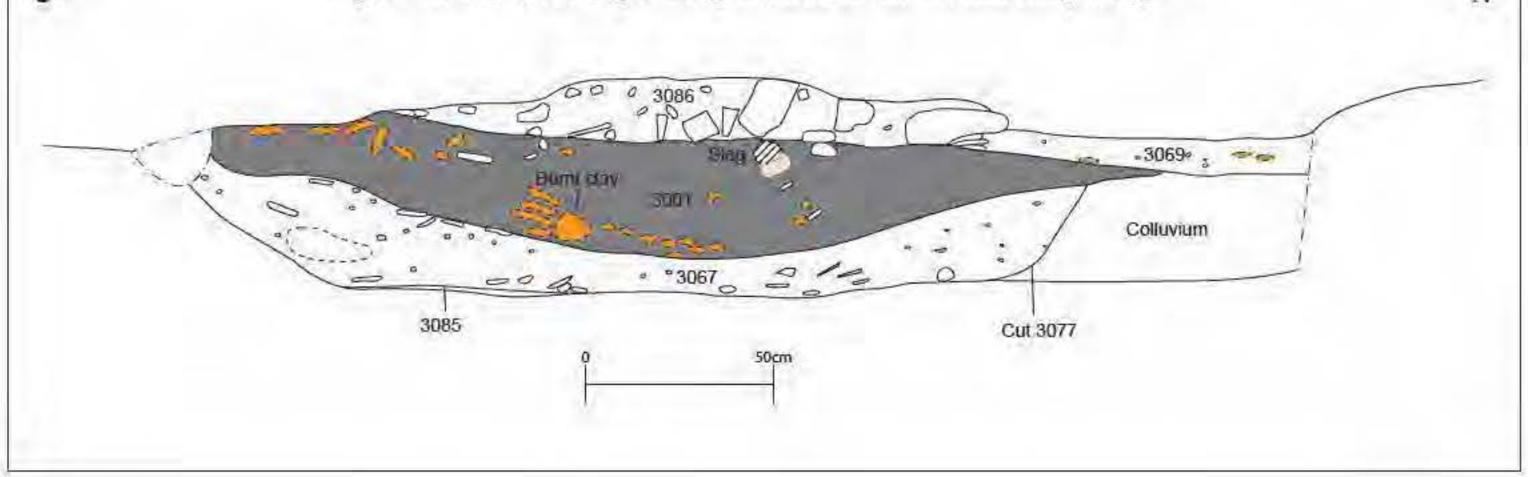


Figure 11. Section through Roman lime kiln [3054]

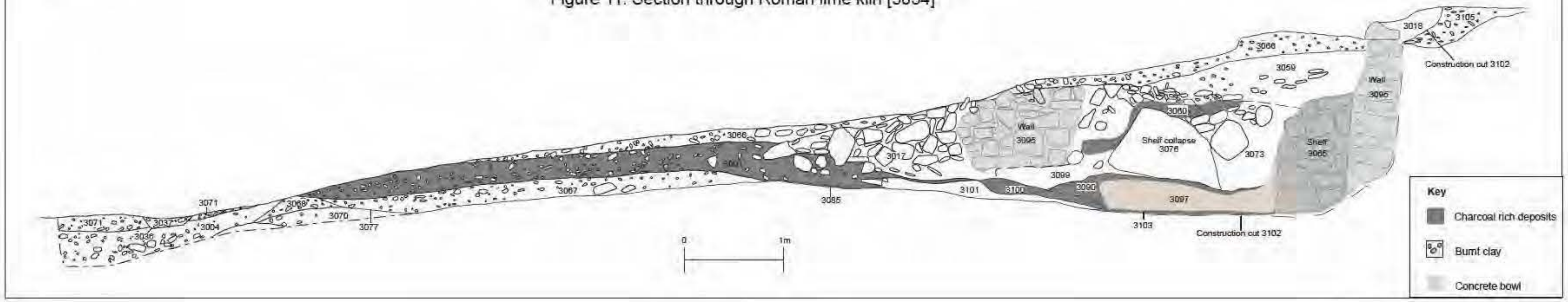


Figure 12. Section through slate deposit (3049), showing dumping deposit (3048)

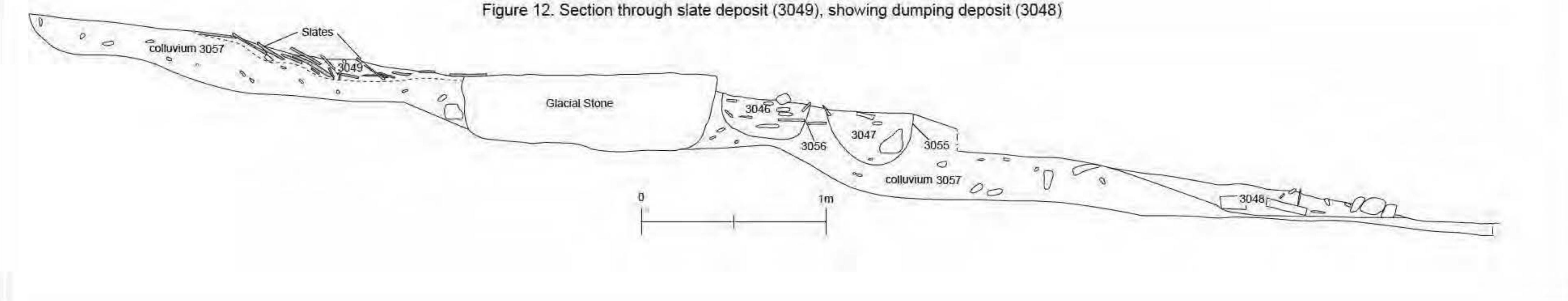


Figure 13. Roman pottery from the lime kiln and its vicinity
(Mortaria sherds: 304, 317, 328; Black Burnished ware: 320, 321, 322, 325, 327; Tile: 338)

Figure 14. Plan of roofing slate area, showing concentrated areas of purple roofing slates with dumping deposits to the north. This area sloped down from south to north.

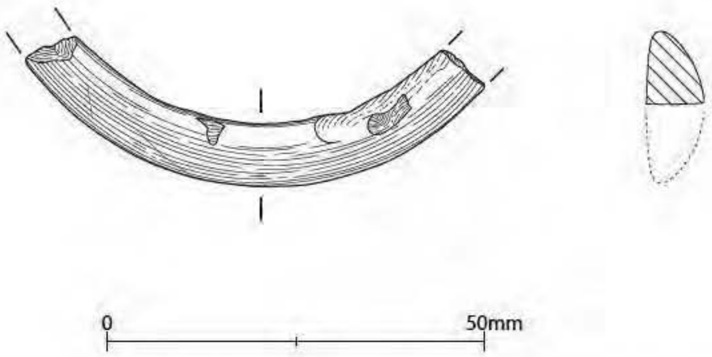


Figure 15. Shale bracelet fragment found in rubble deposit 3048.

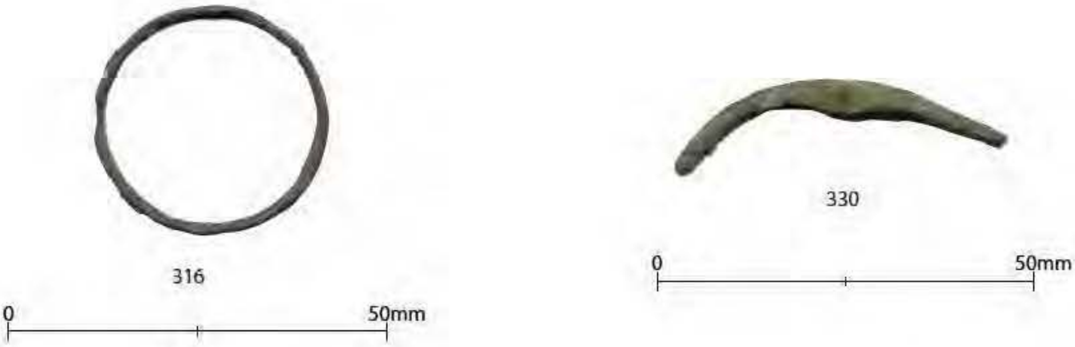


Figure 16. Copper alloy objects

Figure 17. Roman coin handed in by a local resisdent, found near Y Bryn.
A House of Valentinian bronze coin (probably Valentinian I AD 364-375)

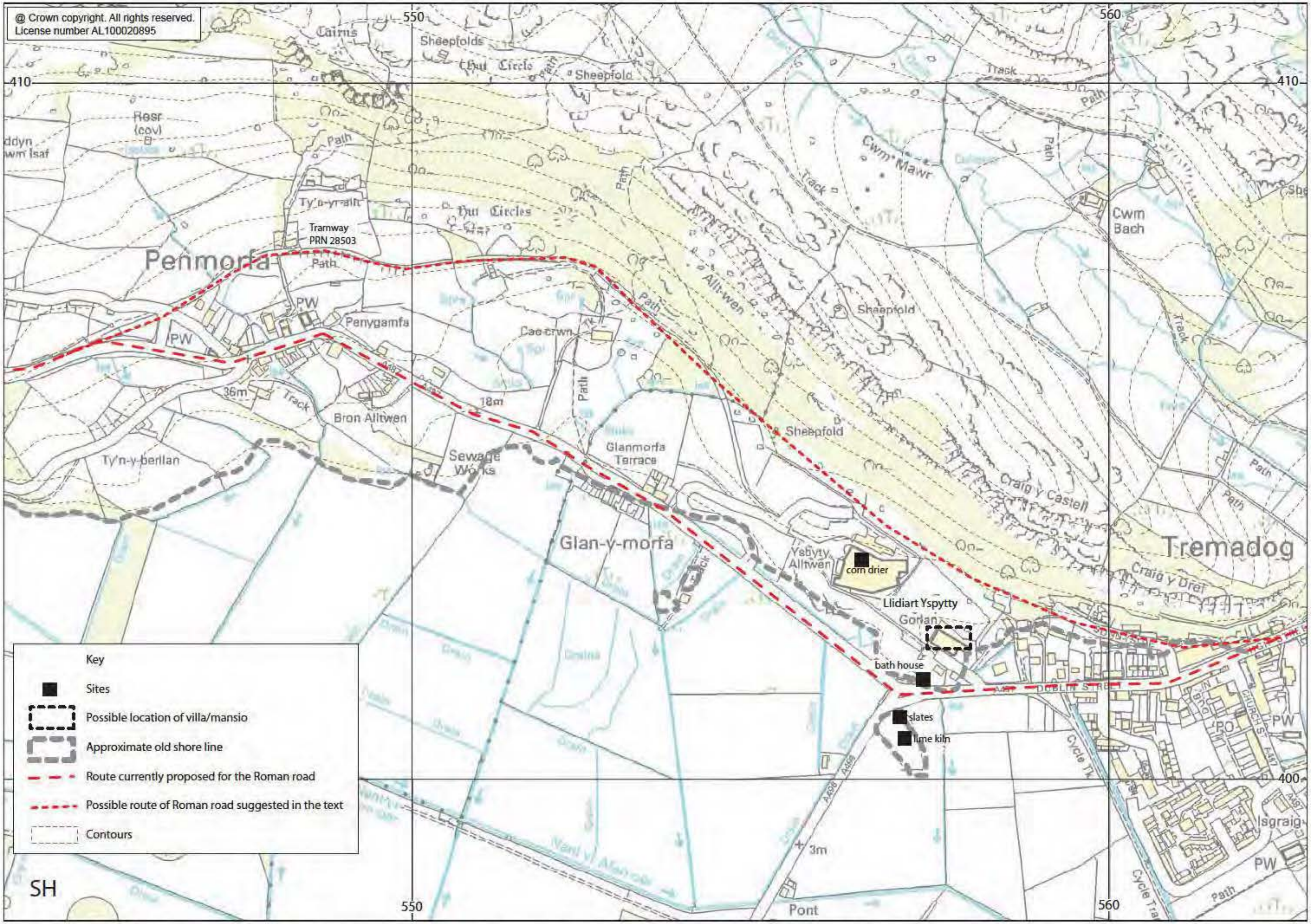


Figure 18. Plan of Roman sites in the Llidiart Yspytty area of Tremadog showing the approximate line of the former shore and a possible route for the Roman road

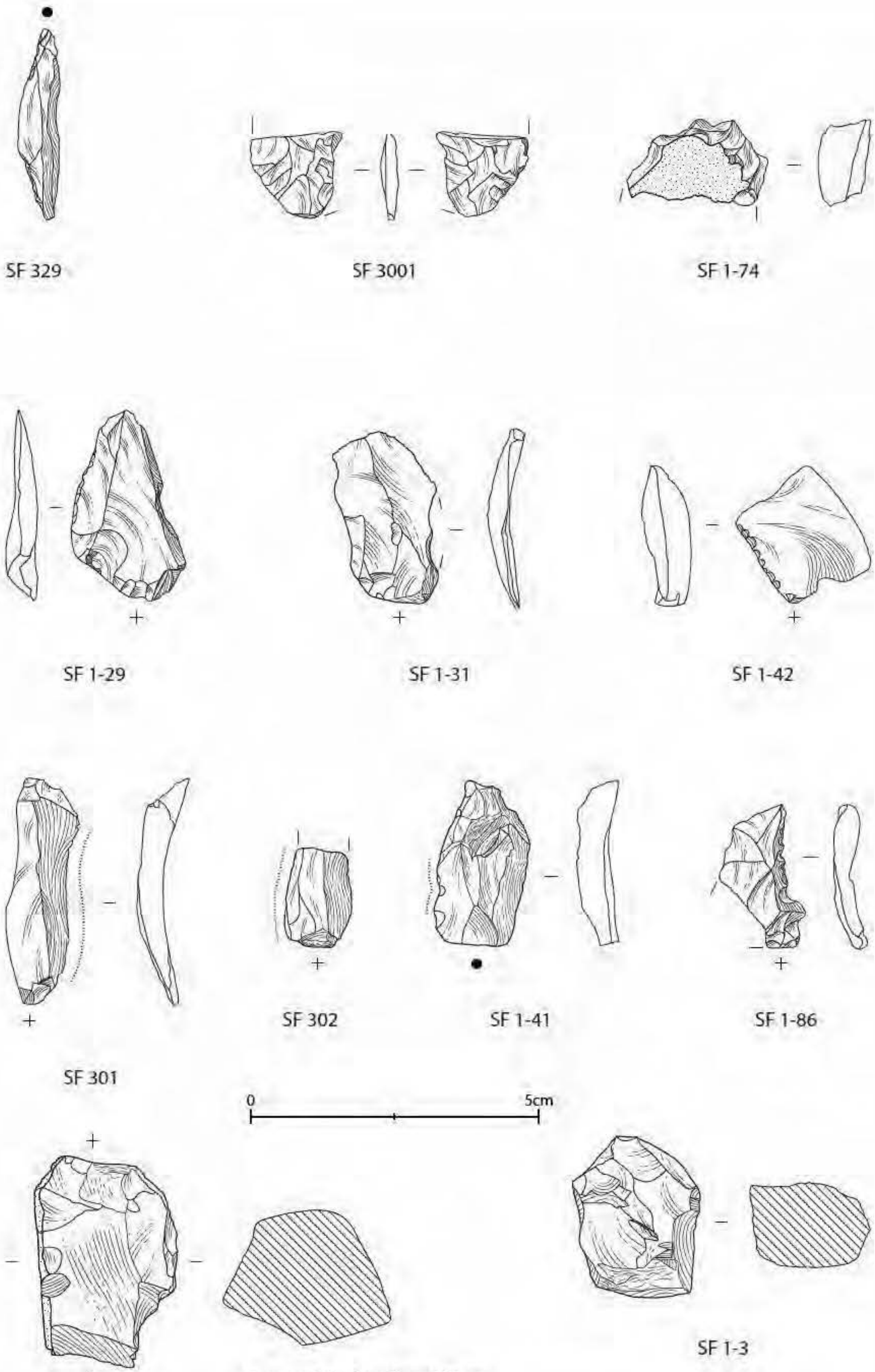


Figure 19. Lithics from Y Bryn
329: microlith; 3001: fragment of leaf-shaped arrowhead;
1.74: denticulate piece; 1.29, 1.31 and 1.42: retouched pieces;
301: serrated blade; 302: retouched blade; 1.41 and 1.86: spurred pieces;
1.3 and 1.3: cores

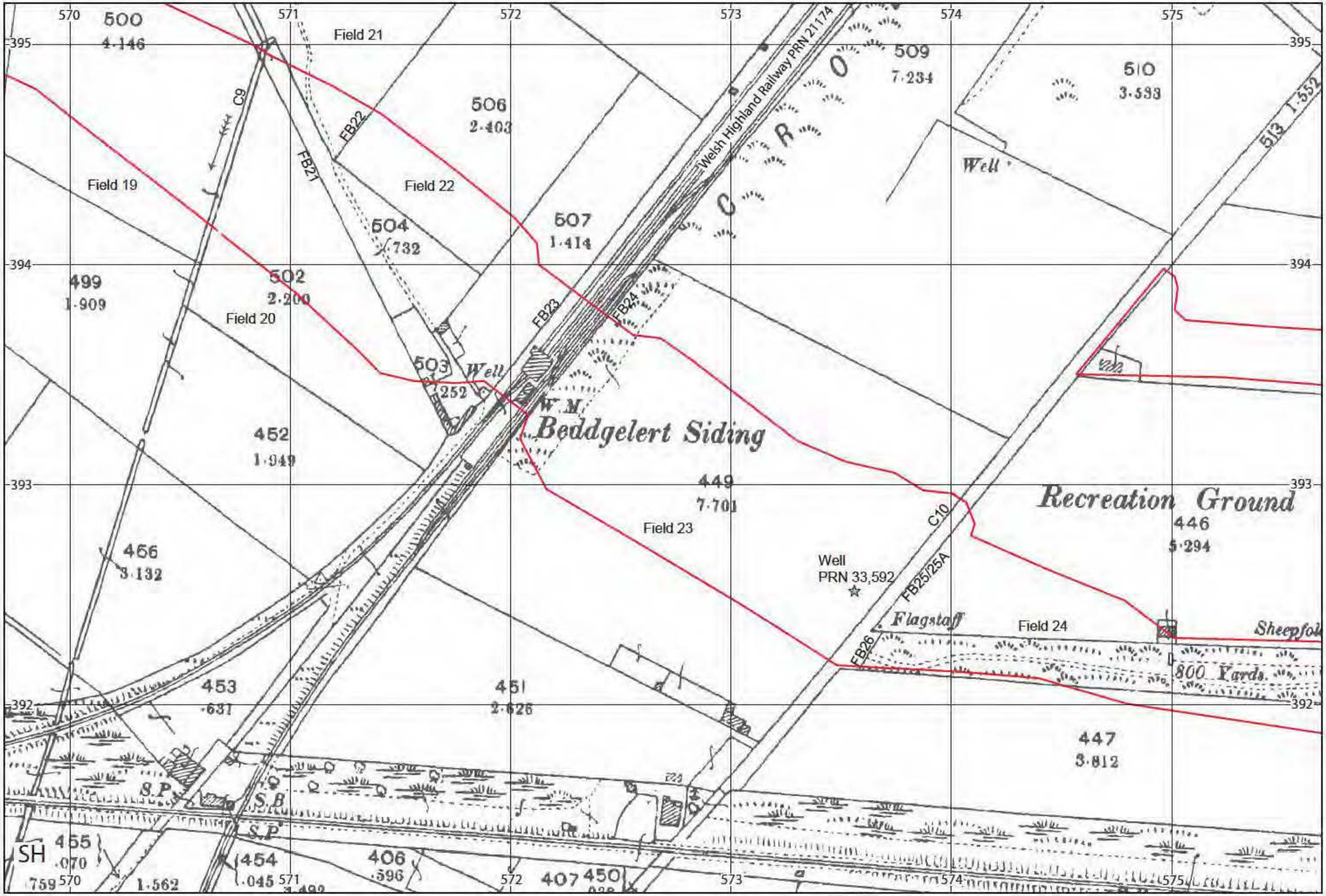


Figure 20. Second edition OS County Series map showing location of well (PRN 33592) and nearby wells

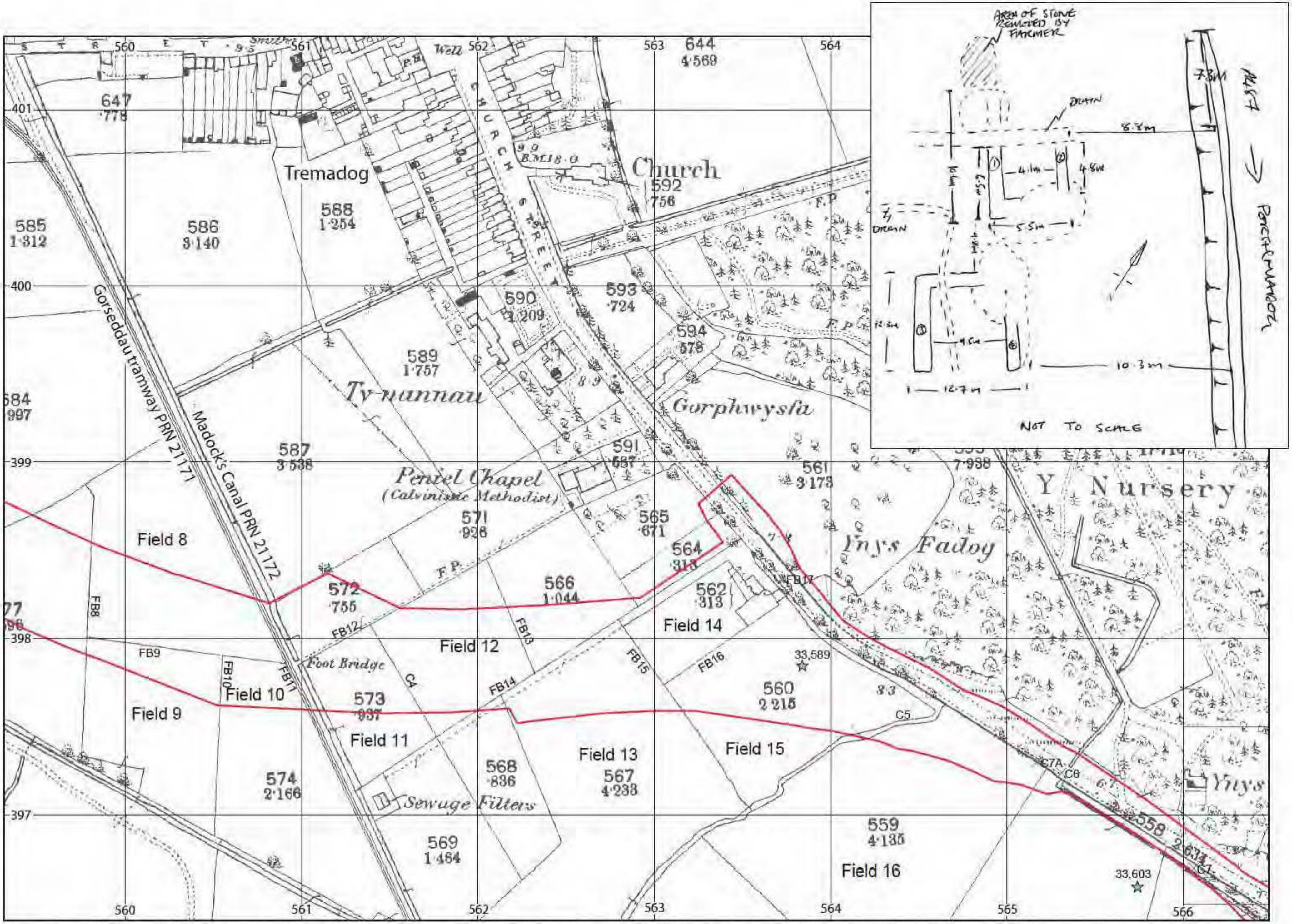


Figure 21. First edition OS County Series map showing location of structures (PRN 33589) and surrounding features (with inset showing sketch of the structures)

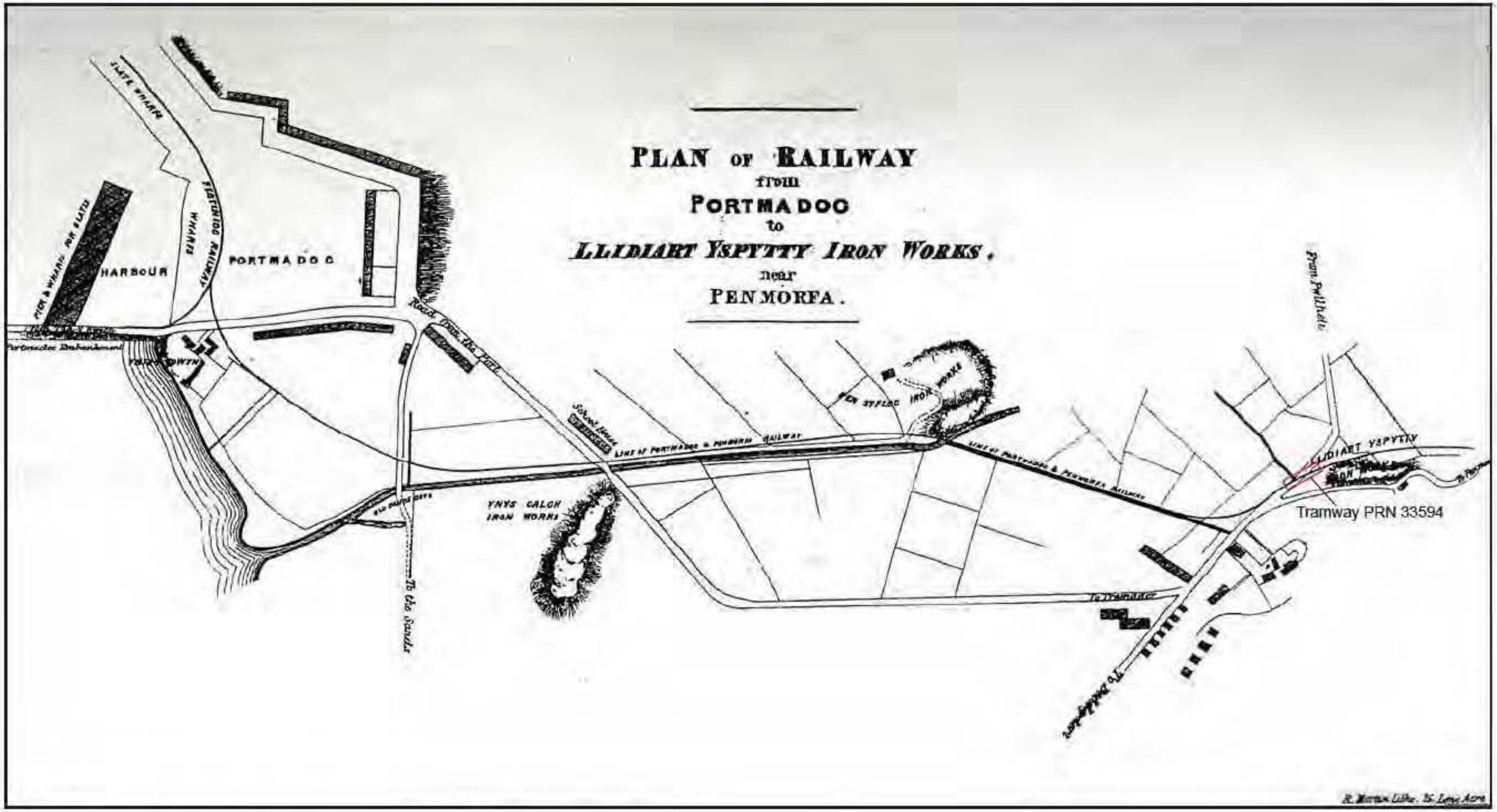


Figure 22. Plan of railway from Porthmadog c. 1848 (NLW, MAP 5753)

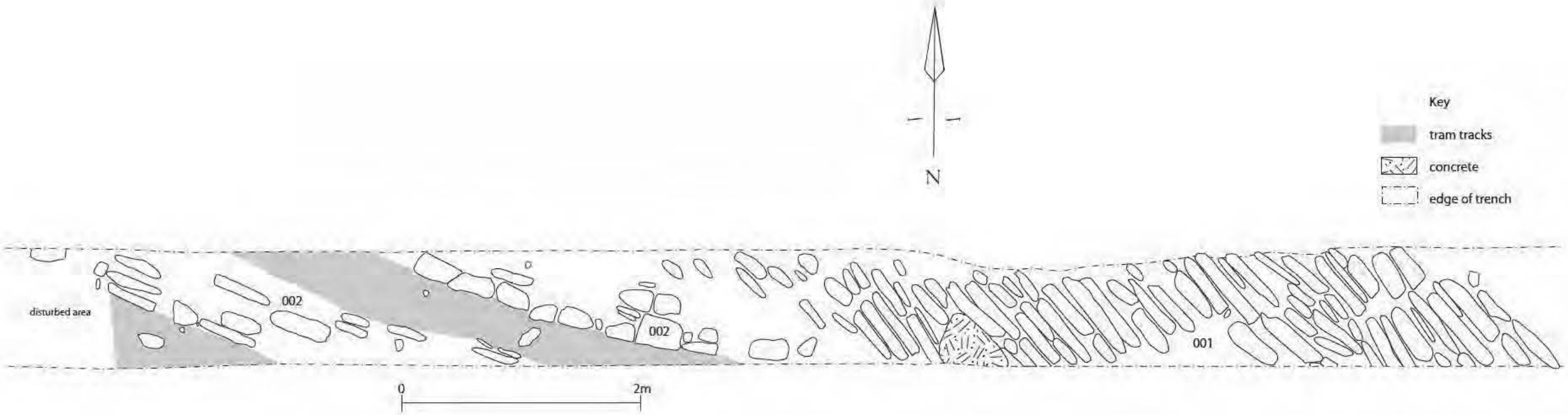
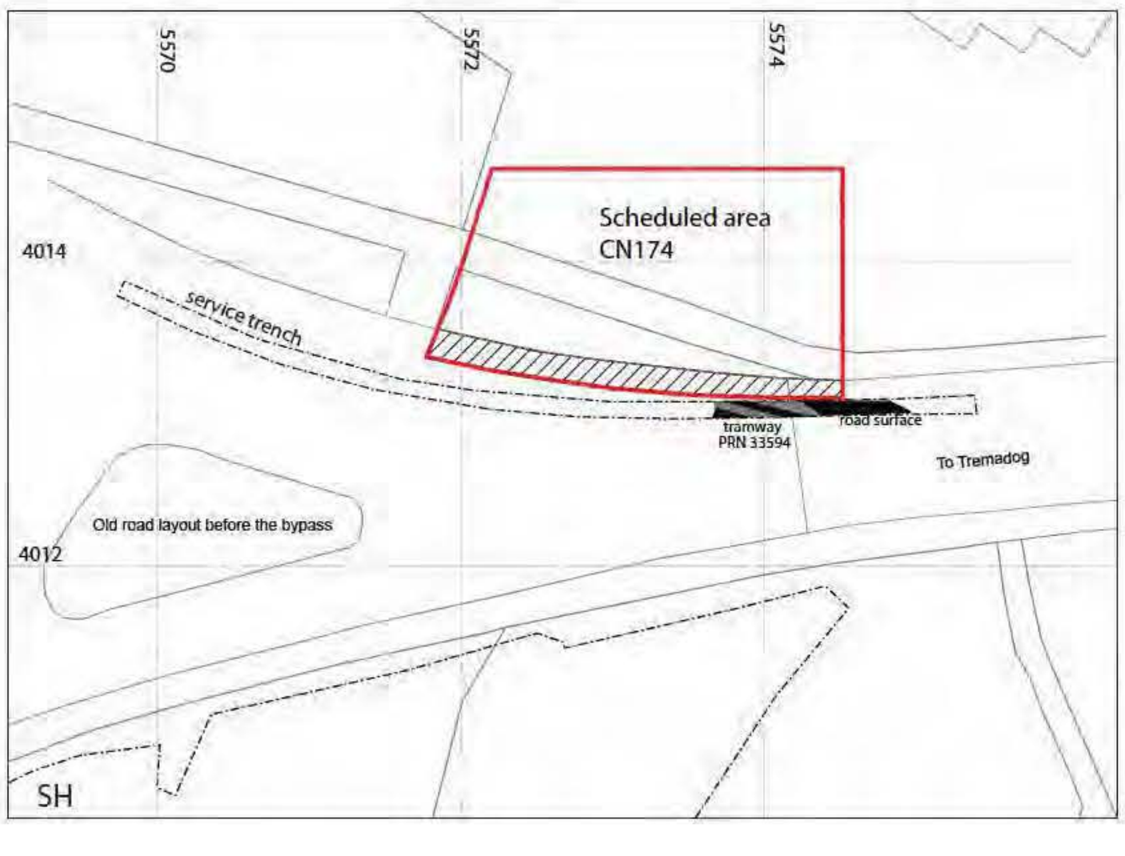


Figure 23. Plan of tramway and road surface with inset showing location and full length of service trench



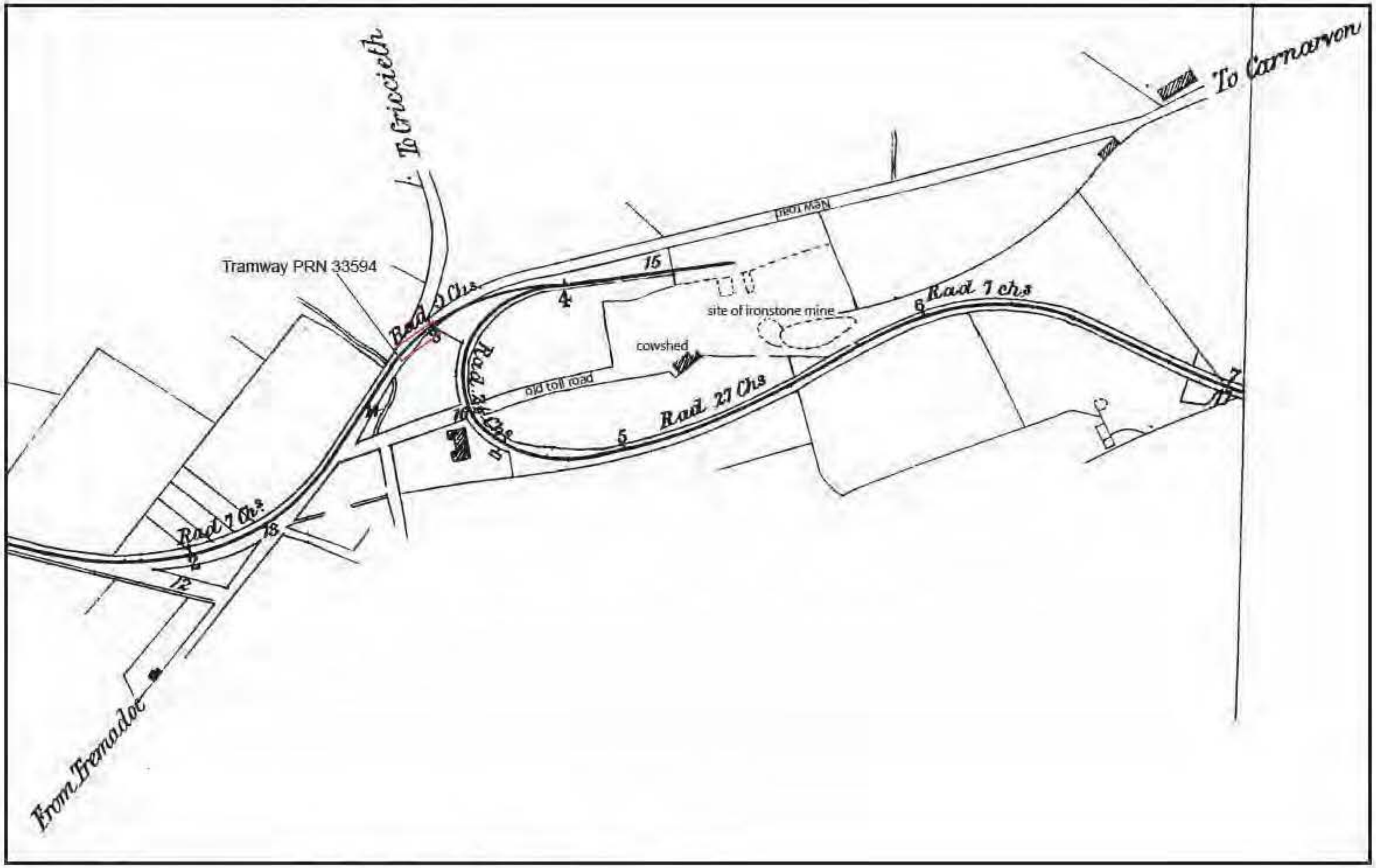


Figure 24. Plan of tramways in 1871 (CRO, X/Plans/R/69)

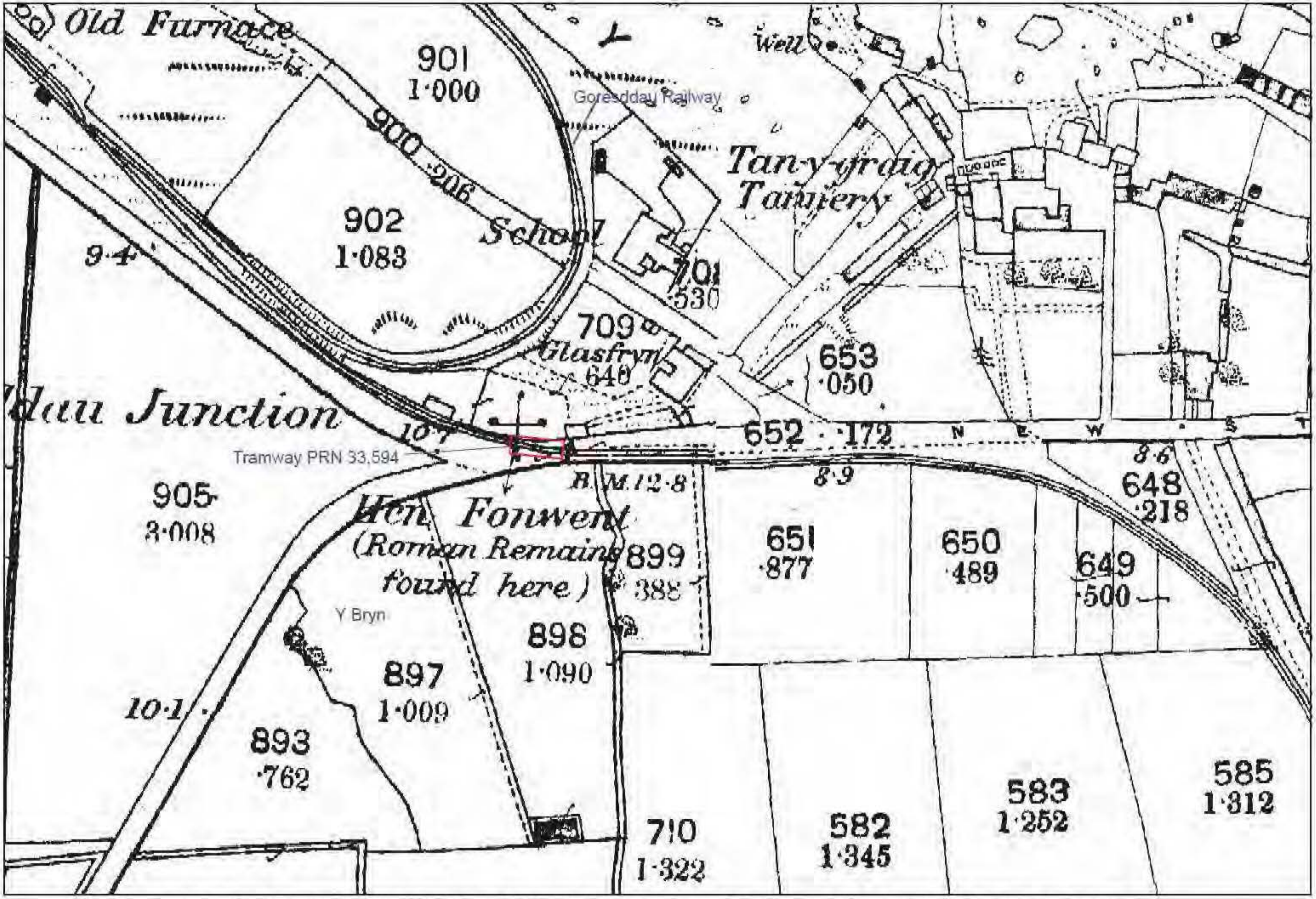


Figure 25, 1889 Caernarfonshire XXXIV.11 and XXXIV.12 Ordnance Survey 25 inch. Showing tramway route towards Porthmadog

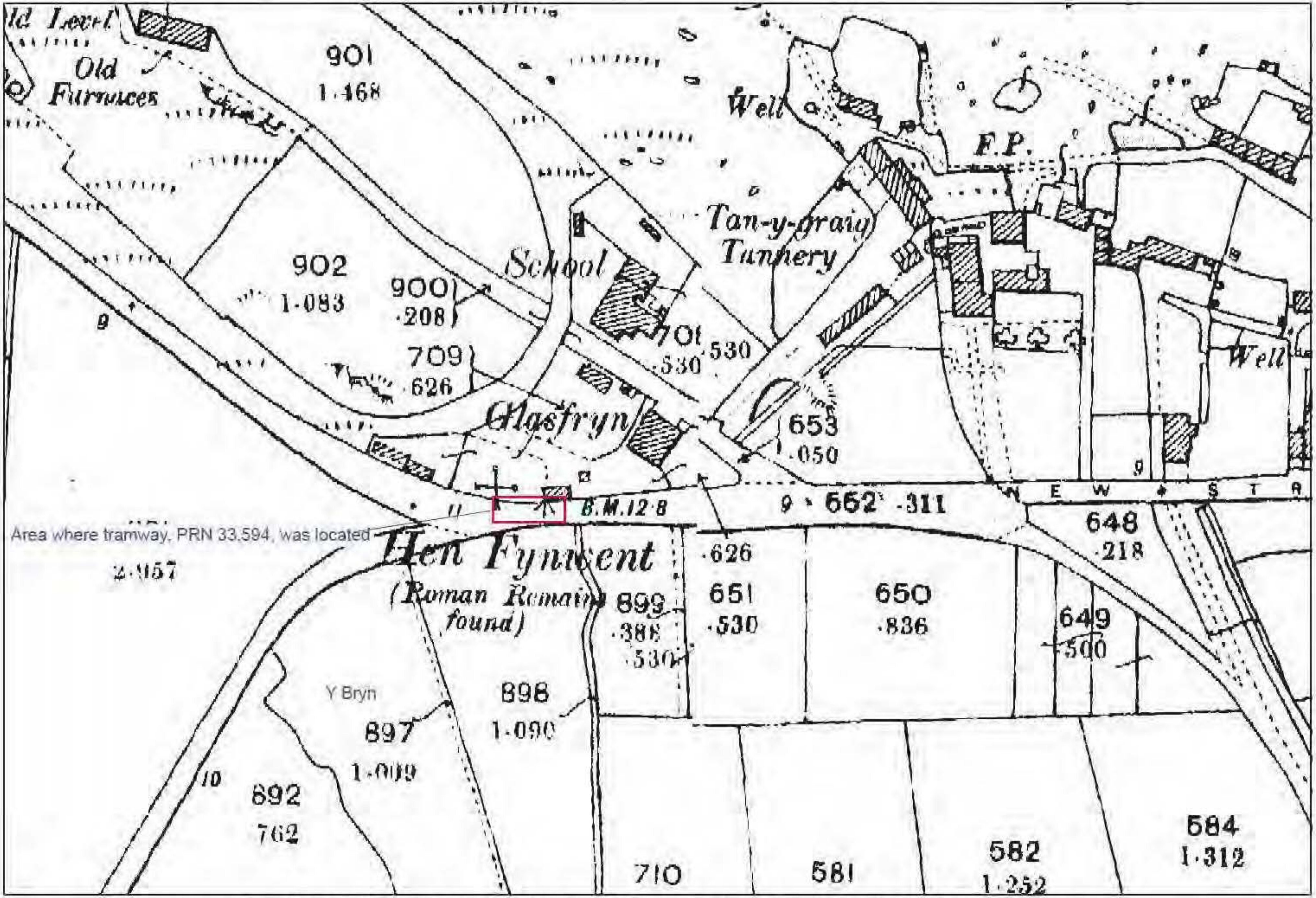


Figure 26. 1900 Caernarfonshire XXXIV.11 and XXXIV.12 Ordnance Survey 25 inch. Showing no tramlines.

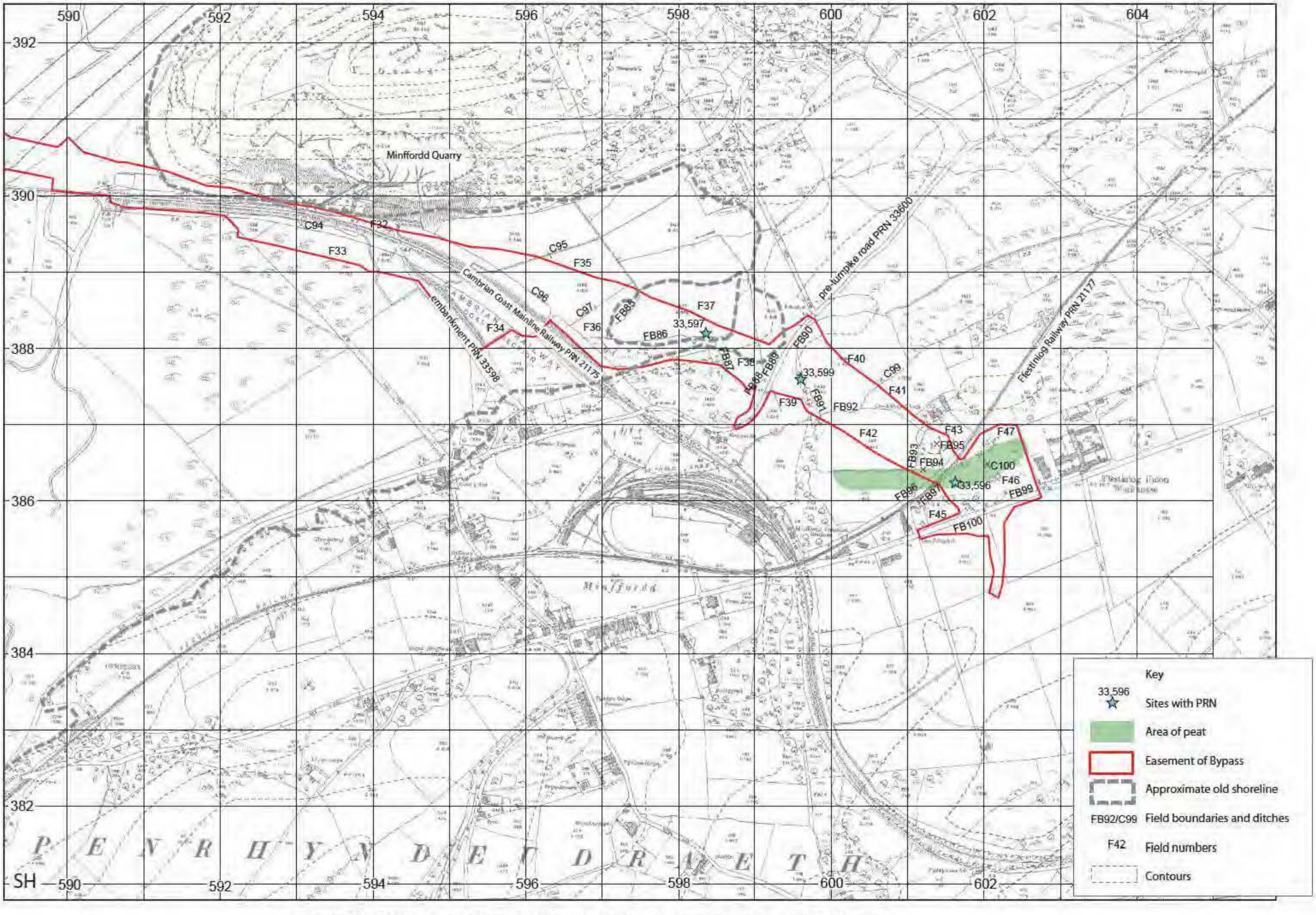


Figure 27. 1917 third edition OS County Series map with sites near Minffordd

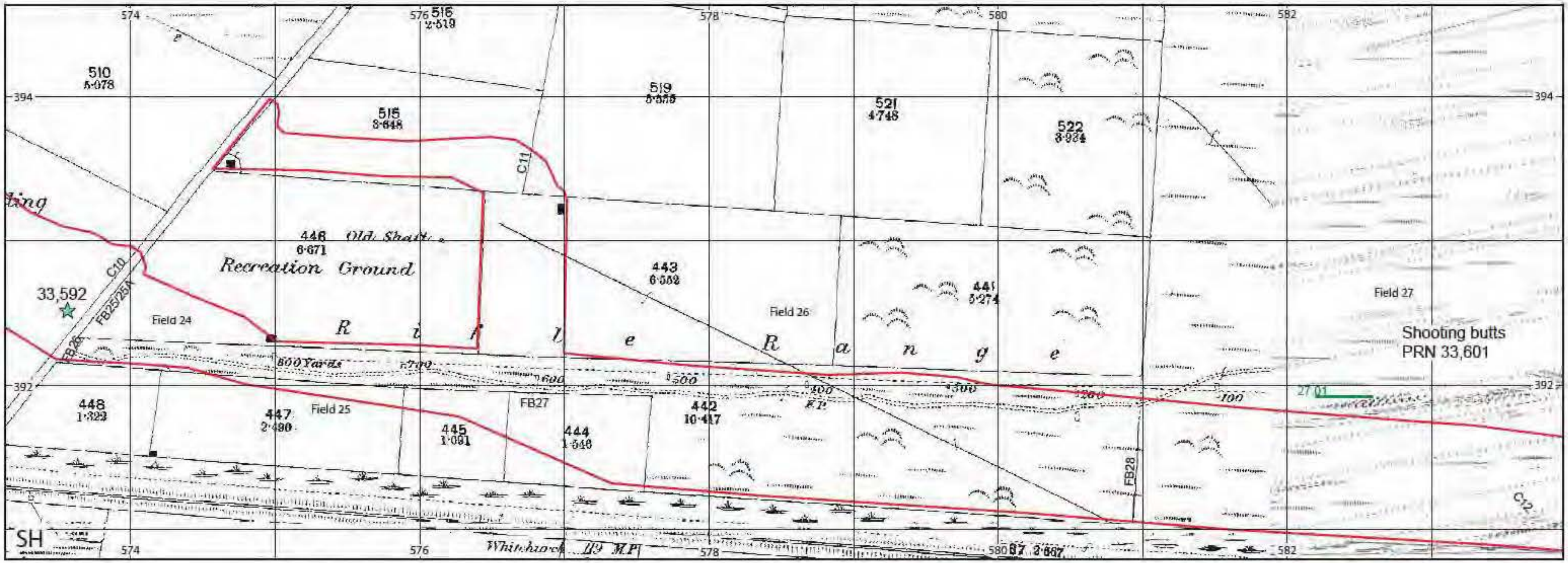


Figure 28. 1889 first edition OS County Series map showing shooting butts and range (evaluation trench in green)

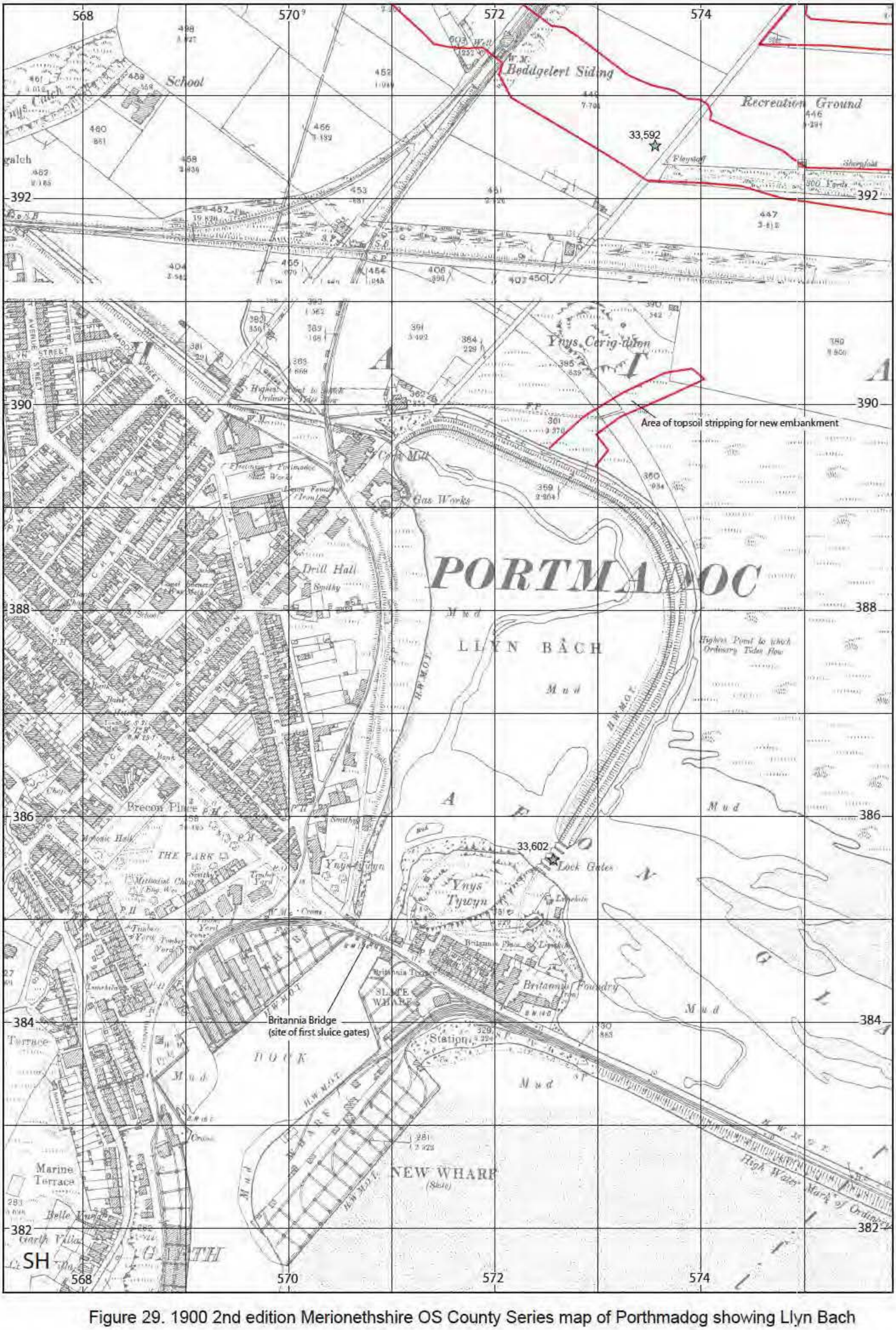


Figure 29. 1900 2nd edition Merionethshire OS County Series map of Porthmadog showing Llyn Bach

Plate 1: Roman lime kiln, showing the internal 'shelf' and 'shelf 'collapse

Plate 2: Section through the Roman lime kiln's main chamber

Plate 3: Showing possible collapse of a stone lintel in the stoking area of the kiln

Plate 4: Section through 'raking-out' area of the lime kiln

Plate 5: Small oven [3091] close to the lime kiln

Plate 6: Looking towards South. Showing the area of slates with the lime kiln just visible to the south east

Plate 7: Showing slates that have slipped from stacking

Plate 8: Showing shaped slate within smithy pit [3010]

Plate 9: Section through burnt clay deposit (3020)

Plate 10: Typical slate (photograph by Bill Jones)

Plate 11: Pentagonal eaves slates (photograph by Bill Jones)

Plate 12: Slates laid out to indicate how they would be hung on the roof (photograph by Bill Jones)

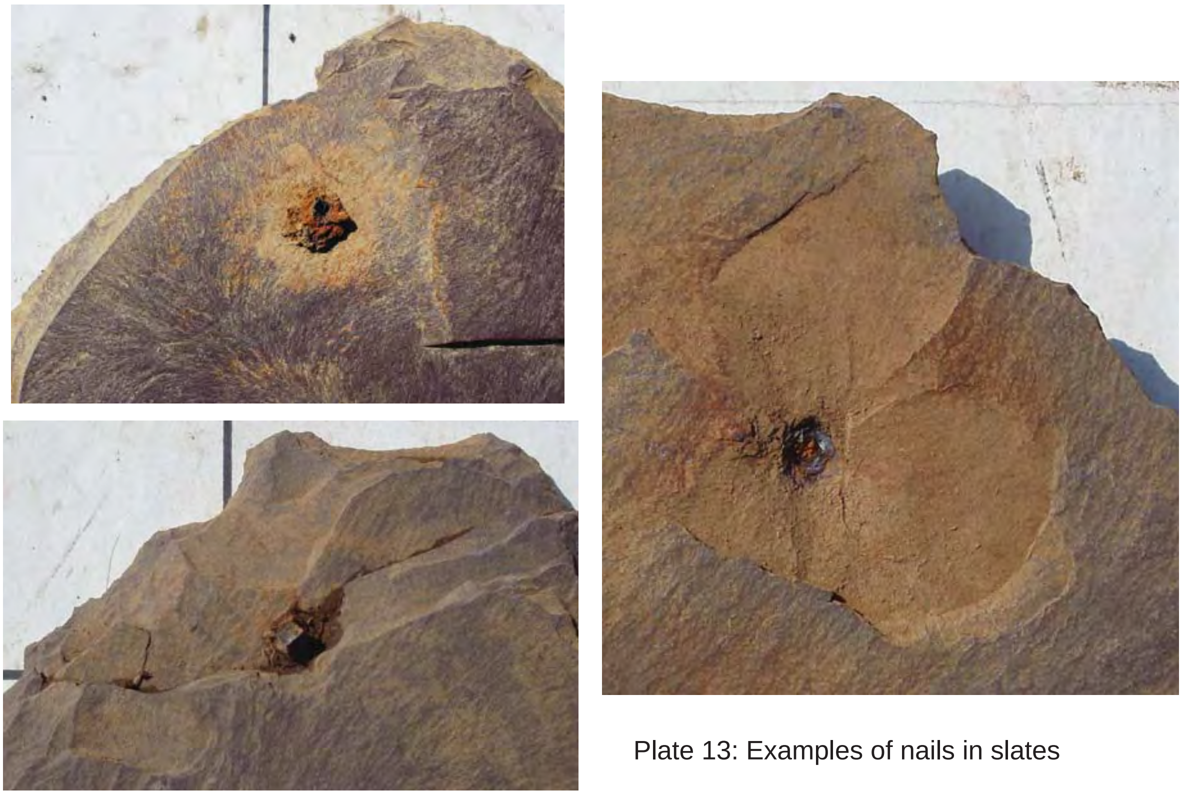


Plate 13: Examples of nails in slates

Plate 14: Revetment along south-western side of Y Bryn

Plate 15: Section through revetment (3012)

Plate 16: Revettment (3014) on the western side of Y Bryn

Plate 17: Wall (3000) on the eastern side of Y Bryn

Plate 18: Junction of walls (3000) and (3027)

Plate 19: Revetment along southern side of Y Bryn

Plate 20: Post forming part of building (3028)

Plate 21: Field boundary 92

Plate 22: Field boundary 91

Plate 23: Culvert 8

Plate 24: Post-medieval well, PRN 33592

Plate 25: Interior of well

Plate 26: Tramway in service trench

Plate 27: Trial hole dug against the embankment wall of the Ffestiniog Railway

Plate 28: Section through shallow linear feature in field 17, part of PRN 33593

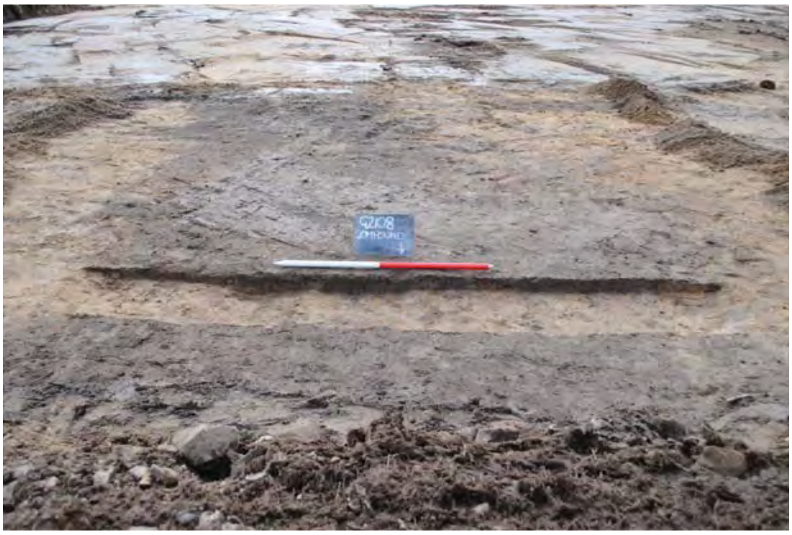


Plate 29: View along Madocks' Canal where the Bypass is to cross it, looking north-west

Plate 30: View along Madocks' Canal where the Bypass is to cross it, looking south-east, showing footbridge

Plate 31: Shell midden in section

Plate 32: Quarried rock outcrop (PRN 33599)

Plate 33: Evaluation trench 27.01 from western end

Plate 34: Tidal gates to Llyn Bach from north-west on the Porthmadog shore

Plate 35: Gorsedd circle from north

Plate 36: Gorsedd circle from south-east

12 APPENDIX I: MITIGATION TABLE

Scheme specific mitigation recommendations (Welsh Assembly Government A487 Porthmadog Minffordd Tremadog Bypass Archaeological Mitigation Design February 2010)

No	Description	Location (NGR)	Archaeological Value	Archaeological Mitigation
01	Roman bath-house, Tremadog (sub-surface survival only)	SH55734014 (CH0300)	High / Scheduled Ancient Monument Cn 174	A watching brief should be carried out where any ground disturbance will occur in the vicinity of the scheduled area. Detailed recording of any features identified should be carried out.
02	Neolithic finds at Bryn	SH55704010 (CH0330)	Medium	A programme of strip map and sample (75.0m x 50.0m; 3750m²/0.375ha) would be carried out in order to identify any further prehistoric activity. This involves machine stripping of the topsoil from the area, plotting observed features and then partially excavating those features. This would be followed by complete excavation of significant discoveries.
03	Drystone revetting at Bryn-y-Fynwent	SH55684002 - SH55724002 and SH55664006C (CH0310)	Negligible	Basic recording. A photographic record and written description would be made of the site in advance of destruction.
04	Tremadog/ Gorseddau Tramway	SH56093978 and SH55894012-SH55604024	Medium	Avoidance/Watching Brief The Proposed Tremadog Bridge would cross the former tramway. Disturbance to the site should be avoided if possible. A watching brief supplemented by excavation and detailed

No	Description	Location (NGR)	Archaeological Value	Archaeological Mitigation
				recording should be carried out if there is to be any disturbance.
05	Madocks’ Canal	SH55944013 - SH57103896	High	The proposed Tremadog Bridge would cross the canal. Disturbance to the site should be avoided. A watching brief supplemented by excavation and detailed recording should be carried out if there is any disturbance to the site or its immediate environs. The original dimensions and form of Madocks’ Canal are not known. There could be significant archaeological deposits to either side of the current watercourse so a watching brief should be carried out during all ground disturbances within 5m of the site. This also applies to ancillary works such as drainage.
06	The old route across Traeth Mawr and junction with the improved turnpike road	SH5640398 to SH56673956	Medium	Geophysical survey (CH1500 to 1800 & CH3580 to CH3725), trial trenching (CH1500 to 1800 & CH3580 to CH3725) and watching brief. The level of survival of the feature is unknown. Staged mitigation in the form of geophysical survey and trial trenching would be carried out in the area around the proposed Bodawen Roundabout and on the eastern side of the crossing of Traeth Mawr. Up to 5% trial trenching area coverage would be required. A staged approach is recommended because a less intensive coverage may be acceptable because trenches cut at right angles across the scheme corridor should intersect the linear routeway. Any features identified would be excavated and fully recorded. It should be noted that this crossing of Traeth Mawr may have been used since Roman times and its line will have varied over time due to changes in the river channel. A watching brief should therefore be kept across the whole of the crossing that is from the proposed Tremadog Roundabout to the other side of the proposed Afon Glaslyn Viaduct including low lying land to the south of Minffordd Quarry.
07	1987 Gorsedd Circle	SH56583966	Low	Basic recording, sympathetic design. A basic record should be made of the site and its setting. Sympathetic design of the road and nearby Proposed Bodawen Roundabout could provide some screening to prevent any impact on the setting.

No	Description	Location (NGR)	Archaeological Value	Archaeological Mitigation
09	Revetted drain	SH57073954	Medium	Detailed recording, minimise disturbance. A detailed record of the feature should be made in advance of and during any direct impact. Disturbance should be kept to a minimum and original features and drainage patterns should be retained where possible.
10	Welsh Highland Railway (Porthmadog)	SH57323950	Medium	Detailed recording, watching brief and sympathetic reinstatement. The trackbed is now used by the Welsh Highland Railway. Disturbance will occur to the trackbed during the insertion of a culvert beneath the railway embankment and the construction of the bridge piers. A detailed record would be made of all areas that will be disturbed in advance of construction. A watching brief would be carried out during all disturbances. The embankment would be reinstated using original materials in order to match the undisturbed embankment to either side. The culvert would be designed to blend in with the embankment to either side.
11	Site of shooting butts	SH58303917	Negligible	Basic recording and watching brief (including excavation if necessary) A substantial part of the site will be destroyed but archaeological information will be retained.
14	Garth/Minffordd quarry	SH59403896C	Negligible	Avoidance of archaeological features by ancillary works
15	Embankment with road	SH59593870 – 59453893	Low	Detailed recording, watching brief A detailed record would be made of the embankment prior to the commencement of works. A watching brief would be carried out during groundworks in order to record any early features buried by the present road.
16	Pre-turnpike road from Penrhyndeudra	SH59923878	Low	Basic Recording A basic record would be made of the affected part of the road and its setting.

No	Description	Location (NGR)	Archaeological Value	Archaeological Mitigation
	eth to Minffordd			
18	Ffestiniog Railway embankment	SH59923878	Low	Basic Recording A basic record would be made of the affected part of the road and its setting.
20	Field Boundaries and hedgerows	N/A	Moderate adverse	Basic Recording A basic record should be made of all hedgerows and field boundaries prior to the commencement of works on site. Planting of new mixed species hedgerows of the same character as the lost lengths of hedgerow alongside the proposed scheme should help to integrate the scheme with the existing field systems.
21	Areas of Unknown Archaeological Potential	N/A	Unknown	Watching brief, detailed recording A watching brief would be kept during the construction of the scheme, including construction compounds and temporary access roads. Any significant sites identified would be fully excavated and recorded. Given the reclaimed nature of much of the landscape the scope for discovering extensive sites of national importance is low but isolated finds of a maritime nature are possible. The archaeology beneath soil storage areas would not be affected providing that the current ground surface is retained beneath storage areas. A watching brief would be required wherever there is any excavation below the current ground surface during all phases of the scheme.
23	Environmental Archaeology	N/A	Medium	Detailed Recording (staged environmental sampling) Extensive organic deposits are probably not present. A staged sampling strategy is recommended. This would entail an initial low intensity hand bored survey. The results from this would be analysed in order to determine the next stage. If microfossil survival levels were poor or non-existent and there was no datable material present no further action would be needed. If there was significant survival further analysis would be undertaken, a second phase of higher intensity, targeted sampling could be used to provide refinement of the ecological

No	Description	Location (NGR)	Archaeological Value	Archaeological Mitigation
				reconstruction of the area.
42	Area of quarrying	SH59963876C	Negligible	Basic recording A basic record should be made of the affected area ensuring that archaeological information is not lost.
43	Llyn Bach	SH59963876C	Negligible	Basic recording A basic record should be made of the affected area ensuring that archaeological information is not lost.

13 APPENDIX II: WORKS UNDER SCHEDULED MONUMENT CONSENT

13.1 Appendix II.1: Method statement for works adjacent to the Roman bath-house

13.1.1 Introduction

This method statement has been prepared to accompany an application for Scheduled Monument Consent associated with works on the A487 Porthmadog bypass improvement which are situated nearby the Roman bath-house Scheduled Ancient Monument (Cn174), positioned adjacent to the footprint of the existing A487 carriageway to the north of the proposed Tremadog Roundabout (NGR SH 5573 4014).

The Scheduled Area in relation to the proposed works has been identified from the scheduling maplet for SAM No. Cn174 (GWY) (Ref:A-CAM-001-01-3177). This footprint will be marked on the ground prior to commencement of works so that the measures described below can be implemented accurately. The works described below will commence under archaeological supervision (see section 5 below).

13.1.2 Description of works

The existing carriageway is replaced by a wide verge at the position of the Scheduled Area (see sections on attached plan 8217-GD31151-02), with the new carriageway sitting approximately 200mm above the existing elevation. Works up to the Scheduled Area which involved removal of the existing pavement, laying of the new kerbline and trenching for a street lighting duct behind the new kerbline were undertaken between November and December 2010.

Works which are subject to the consent application and are situated adjoining/within the Scheduled Area include the removal of the existing kerbline, removal of two information signs and reconstruction of existing footway to tie into a new elevated section.

Care will be taken to remove the existing kerbline by breaking the backing and leaving the concrete base in place using a 5 tonne excavator and breaker.

The two information signs currently located within the existing verge, are situated within the Scheduled Area (see photograph 1) and will be replaced as part of the works. It will be necessary to excavate down approximately 200-300mm to the top of the existing concrete bases using a 5 tonne excavator and cut the post flush at this point with a still saw. The remaining hole will be filled with mortar and over filled with soil, leaving the concrete base in situ.

At the back of the existing verge an 8m section of the existing footway surfacing within the Scheduled Area will be removed with a planner to a depth of approximately 100mm, in order to tie in the overlay surfacing of the new footway which runs behind the new kerbline to the west. New edging kerbs will be hand laid along southern edge of the footway

The landscape design excludes the Scheduled Area from any planting proposals within the wide verge to the north of Tremadog roundabout but some topsoiling and grass seeding may be required to tie into the new verge level to the south (see attached drawings 3042 and 3044-GD31151-WXD-A).

Photograph 1 - Existing information signs within the Scheduled Area

13.1.3 Toolbox Talk

Site staff working in the area will be made aware of the footprint of the Roman bath-house and significance of this buried site. Staff will also be notified of the method of works described above and the requirement for an archaeologist to be present throughout.

13.1.4 Archaeological Supervision

A comprehensive watching brief will be carried out by Gwynedd Archaeological Trust where any ground disturbance will occur in the vicinity of the scheduled area, which will involve the following:

A photographic record will be maintained throughout, using a digital SLR camera set to maximum resolution.

Any subsurface remains will be recorded photographically, with detailed notations and a measured survey.

A Geodometer Pro Electronic Distance Measuring Total Station may also be used if extensive subsurface remains are identified.

The archive will then be held by GAT under an appropriate project number.

The archaeological supervision will also extend to ensuring that works in the vicinity of the Bath-house are undertaken in accordance with this method statement, and a summary report will be provided for approval to GAPS and Cadw within 28 days of completion of the works outlined above.

In the event of discovery of any archaeological remains the GAT team will notify Cadw & GAPS and arrange a site meeting before proceeding with any detailed recording / mitigation.

13.2 Appendix II.2: Report on works carried out under Scheduled Monument Consent adjacent to the Roman bath-house

Scheduled Monument Consent was obtained to carry out minor works within the scheduled area relating to the Roman bath-house Scheduled Ancient Monument (SAM) Cn174 at Tremadog (NGR SH 5573 4014) (Ref:A-CAM-001-01-3177). See figure 1 for location of groundworks.

Works were related to the construction of the Porthmadog bypass and include the removal of the existing kerbline, removal of two information signs and reconstruction of existing footway to tie into a new elevated section. The works were carried out by Jones Brothers as contractors for Balfour Beatty in accordance with a method statement submitted with the application for Scheduled Monument Consent.

Gwynedd Archaeological Trust carried out a watching brief on the groundworks relating to the kerb and the footway, but the removal of the signs was not monitored.

The work took place on 21/06/11 and was monitored by Jess Davidson of Gwynedd Archaeological Trust. A watching brief was carried out during the removal of an 8m section of the existing footway located at the back of the existing verge, within the scheduled ancient monument. A 5 tonne tracked excavator with a toothed bucket was used to remove approximately 70mm of tarmac (the top layer), leaving the lower deposits of tarmac in situ. Associated curb stones were also removed, but the concrete surrounding them was left *in situ*. These works did not impact in any way upon the underlying archaeology.

Mini-digger working within Scheduled Area

Groundworks within Scheduled Area completed

Kerb removed and tarmac reduced showing remaining tarmac and lack of exposure of deposits possibly containing archaeology

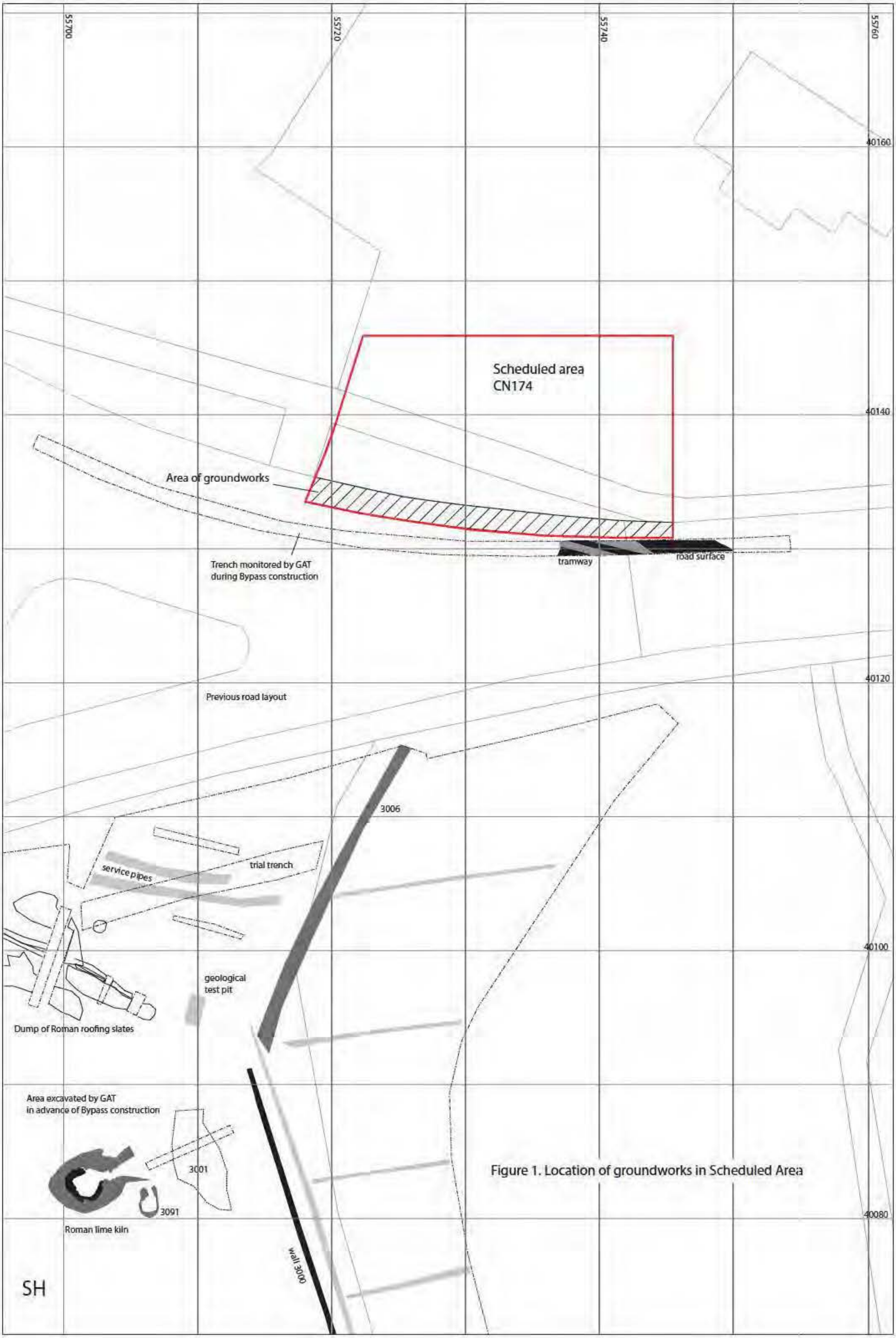


Figure 1. Location of groundworks in Scheduled Area

14 APPENDIX III: FIELD BOUNDARIES AND CULVERTS AFFECTED ALONG THE ROUTE OF THE BYPASS.

Boundary table (see figures 2 and 3)

C = culvert/ditch
FB = field boundary

PRN number	Boundary number	Orientation	Height/ Depth	Width Min	Width Max	Notes	Eastings	Northings
33518	C1	SW-NE			2.70m	This culvert is opposite to Ysbyty Alltwen and will not be affected during the works.	255468	340295
33519	FB1	ESE-WNW	0.47m		0.50m	Very straight modern wall with concrete mortar. Curves round a corner (the entrance of Ysbyty Alltwen). The stones within the wall are mostly angular to sub-angular with a mixture of schist/slate/sandstone and granite stones. Average size of stone = 0.30x0.25x0.10m. Metal (steel) posts have been set into the top with concrete. Wall was probably built during the construction of Ysbyty Alltwen. Runs along the A487 with a ditch/culvert running along the non-roadside.	255521	340279
33520	C2	N-S		3.0m (eastern bank width)	3.20m (width of water holding area)	Full of water and vegetation. Slightly wandering. Various types of tree run along its east bank.	255592	340199

PRN number	Boundary number	Orientation	Height/ Depth	Width Min	Width Max	Notes	Eastings	Northings
33521	FB2	NW-SE	1.70m-0.40m	0.48m	0.50m	Wall turns at a right angle to a NE-SW direction (FB3). The character of the wall changes from a low/straight/modern wall (with a mixture of stone types and wooden posts set into the top with concrete) to a high wall with no posts set into it which also straight and modern. Average size of stones 0.30x0.25x0.10m (in low wall) to 0.30x0.30x0.15m (in high wall). Some of the stones look dressed and shaped (visible machine marks on some stones).	255677	340145
33522	FB3	NE-SW	1.55m-0.66m	0.44m	0.80m	This wall is a continuation of FB2. Unlike FB2 it has wooden fence posts on top (fixed with concrete) and wire fencing. This wall changes character from a high/straight modern wall (mixture of stone types – slate/schist/granite) with the average stone size 0.64x0.36x0.28m. Changes character to a partially collapsed dry stone wall. With wooden posts inserted into the top with wire fencing. Largest stone size = 2.15x0.60x0.20m. This was most likely the first phase of this wall.	255679	340134
33523	FB4	NNE-SSW	1.50m-0.75	0.68m	1.30m	The northern most end of wall is very modern and straight. It is mostly a mixture of granite and slate with a concrete mortar. A lot of the stones have been shaped and 'squared off'. A turret style has been used on top of the wall (possibly for decoration or stock proofing). The average stone size for this modern part of the wall is 0.44x0.16x0.12m. There is a gap (removed gate) then a change in character.	255681	340112

PRN number	Boundary number	Orientation	Height/ Depth	Width Min	Width Max	Notes	Eastings	Northings
						Initially there is a 2.0m long area of schist/slate slabs built up – probably to support the gate post. These slabs are on top of a stretch of this field boundary best described as earth and stone bank. The stones are a mixture of granite and schist. Turf covers most of the bank. A water filled ditch also runs along the inside of this part of the field boundary. Average stone size 0.36x0.16x0.09m (not including slate slabs).		
33524	C3	N-S			1.60m	Ditch with still water and vegetation. Overgrown and rusty iron bed posts within it. Trees and brambles run along its east bank as well as wooden posts with wire fencing (posts are rotten and partially falling down).	255764	339983
33525	FB5	E-W	0.80m		1.50m	Dry stone wall. Almost revetment like. The stones have been pushed against earth bank/trees to form a boundary. The stone type is a mixture of slate/schist/granite which was mostly angular to sub-angular. Stone sizes range from medium (0.18x0.14x0.08m) to large (0.70x0.42x0.20m).	255785	339956
33526	FB6	N-S	1.10m		4.0m	Earth bank which incorporates some stone (≤5% visible). Hedges and trees - as well as the earth bank define this boundary. There are also wooden posts and wire fencing running along the top of it (stock proofing?). The stones that are visible are angular schist and granite. Average size of stones = 0.42x0.38x0.18m (with some smaller stones).	255874	339879

PRN number	Boundary number	Orientation	Height/ Depth	Width Min	Width Max	Notes	Eastings	Northings
33527	FB7	NE-SW	0.45m		2.20m (of bank)	Earth bank with hedges and trees running along top of it. Ditches run either side of the boundary both approximately 2.0m wide.	255908	339855
33528	FB8	N-S	1.0m		3.20m (of bank)	Earth bank and ditches with trees and hedges running along top of it. Ditches are approximately 1.60m in width.	255979	339821
33530	FB9	E-W	3.0m		1.30m	Dry stone revetment-like wall. Stones built against an earth bank with trees and hedges to form a boundary. There is a mixture of slate/schist/sandstone/granite sub-angular to angular stones. Average stone size=0.32x0.18x0.09m.	255992	339803
33531	FB10	N-S	0.80m		3.20m (of bank)	Earth bank with ditches running either side and trees and hedges running along top. Ditches are approximately 1.60m in width	256055	339781
33532	FB11	NW-SE	0.62m		0.75m	Dry stone wall. There are trees/hedges/wooden posts with wire fencing running along the 'field side' of the wall. A tarmac path runs along the other side. This wall is made up of granite/sandstone/'old' concrete - angular and sub-angular stones. Average stone size = 0.38x0.30x0.11m	256094	339782
33533	FB12	NE-SW	0.45m		2.0m	Hedgerow boundary with a shallow ditch running along its south west side. Hedges are on a slightly raised bank of earth. Width of ditch = 1.62m	256112	339796
33534	C4	NW-SE			1.60m	This area looks less like a culvert and more like a spread out wet area at its south east end. At its	256155	339790

PRN number	Boundary number	Orientation	Height/ Depth	Width Min	Width Max	Notes	Eastings	Northings
						north west end it is more like a culvert with banks. It is very overgrown with reeds growing within it and on its banks. Quite wandering in nature.		
33535	FB13	NNE-SSW	0.70m	1.80m (width of ditches)	2.10m (width of bank)	Earth bank with vegetation running along top of it. Ditches run either side of this (water filled with reeds).	256228	339782
33536	FB14	NNW-SSE	0.80m (height of bank)	1.50m (width of culvert)	2.50m (width of bank)	Consists of eastern bank with two narrow culverts either side.	256216	339766
33537	FB15	NNW-SSE	0.80m (height of bank)	2.0m (width of each ditch)	3.10m (width of bank)	Consists of an earth bank and two ditches either side. Some fairly mature trees/shrubs growing along the bank.	256298	339789
33538	FB16	NE-SW	0.80m (bank height)	1.80m (each ditch width)	3.10m (bank width)	Boundary consists of an earth bank with culverts/drainage ditches on either side. Comes off FB15 at a right angle.	256320	339788
33539	FB17		0.80m-1.20m		2.20m (width of ditch)	Consists of a fairly wide culvert/ditch and a low modern mixed stone and mortar wall. There is farmland on west/south side of boundary and current the Tremadog-Porthmadog road to east/north. The bank on the east/north side is approximately 1.0m high but only 0.3 on the west/south side. The low wall is constructed from mixed imported stone ranging in size from 0.10m-0.50m. Stones are set on edge.	256373	339834

PRN number	Boundary number	Orientation	Height/ Depth	Width Min	Width Max	Notes	Eastings	Northings
33540	C5	NW-SE then bends to the NE-SW				Wandering drainage ditch.	256458	339759
33541	C7A	N-S		1.40m-2.0m	3.7m	Stream/culvert which runs under the current Tremadog-Porthmadog road. It runs through a stone built culvert then under the road into C7and has overflow pipes at both ends.	256517	339730
33542	C6	N-NE-SSW				Part of culvert 7 which runs towards the main Porthmadog - Tremadog road and ran underneath the road and comes out at a very well-constructed partially revetted drain. Large drainage ditch.	256531	339724
33543	C7	WNW-ESE		1.40m-2.0m	3.7m	Stream/culvert which runs under the current Tremadog-Porthmadog road. This ran parallel to the road on the south side of the road. It runs through a stone built culvert then under the road into C7A and has overflow pipes at both ends.	256606	339670
33544	FB18	N-S				Dry stone wall running along road towards Porthmadog. Built of local slate schist stone with brambles, trees and some hedges incorporated within it.	256675	339611
33545	C8	N-S				Also feature 9 a revetted drain. No revetment seen, looked to be a general drainage ditch.	256728	339555
33546	FB19	N-S	0.80m-1.0m	2.20m (width of	2.50m	Boundary between farmland (compound field) to the west and school playing field to the east. Comprises of an earth bank with dry-stone revetting on eastern	256849	339545

PRN number	Boundary number	Orientation	Height/ Depth	Width Min	Width Max	Notes	Eastings	Northings
				ditch)		side and stones set on end along the top. A possible ditch runs along the western side of the bank – north of the tramway in the area to be occupied by the carriageway. Modern concrete posts and plastic covered metal fencing runs along the eastern edge of the bank. Mature bushes and trees (gorse/hawthorn/ash) grow along the length of the boundary. Dumping appears to have taken place on the bank - early 20th Century household waste of pots and bottles etc. within the bank and more recently leftover concrete.		
33547	FB20	N-S	1.20m	0.70m	0.90m	Dry stone wall boundary between the school playing fields to the east and general farmland to the west. A fairly well constructed dry stone wall consisting of local slate/schist which has mostly been laid flat. On top of the wall stones have been set on edge. Boundary has been stock proofed with wooden posts and stock fencing along the top of the wall.	256974	339518
33548	C9	N-S	1.0m (height of banks)		5.0m	Culvert which turns at a right angle at the northern end and becomes culvert 7. Banks are fairly steep	257069	339446
33549	FB21	NNE-SSW	1.20m		0.80m	Dry stone wall made up of local angular and sub-angular stones with an average size of 0.28x0.12x0.08m. Possible evidence of stock proofing with some of the stones on top set on edge and slightly over hanging. Wooden posts with barbed wire fencing runs along the wall (some of it	257100	339469

PRN number	Boundary number	Orientation	Height/ Depth	Width Min	Width Max	Notes	Eastings	Northings
						collapsed).		
33550	FB22	NNE-SSW	0.90m-1.40m	0.80m	1.0m	Dry stone wall of mixed local stone and generally well built. However in places the wall has slumped and collapsed. The stones range in size from 0.10x0.04m to 0.40x0.30m. Initially stock proofed with stones set on edge along the top of the wall then there are later additions of posts – barbed wire – stock fencing along both sides of the wall.	257124	339458
33551	FB23	NE-SW	1.0m			Low dry stone revetment with the Welsh Highland Railway (WHR) on its eastern side and farmland on its western side. The stone revetment is needed to contain the higher ground on the WHR side of the boundary. A fence of wooden posts –stock fencing – barbed wire runs along its eastern edge. The average stone size is generally 0.30m to 0.50m.	257210	339372
33552	FB24	NE-SW	1.20m			This boundary consists of posts – stock fencing – barbed wire which runs between the WHR to the west and farmland to the east.	257230	339363
33553	C10	NNE-SSW	1.10m		2.90m (bank to bank)	A culvert which along with post - stock fencing – barbed wire fence forms the boundary between farmland and the road to Porthmadog football club.	257388	339286
33554	FB25/25A	N-S	ditch depth=0.9 m fence height=1.3		2.10m	Boundary runs between the road and the grounds of Porthmadog football club and consists of concrete posts and heavy duty fencing with a ditch on the eastern side. The ditch is generally overgrown and filled with silt and rubbish. It also appears to be	257388	339263

PRN number	Boundary number	Orientation	Height/ Depth	Width Min	Width Max	Notes	Eastings	Northings
			m			revetted with stones on its western side.		
33555	FB26		stock fencing height=1.05m/security fencing height 2.05m			A post - stock fencing – barbed wire fence lined with evergreens which changes to a fairly high metal fence in the immediate area of the football ground. This boundary surrounds the main football ground and car park separating it from farmland to the south and east.	257362	339227
33556	FB27	E-W	1.20m (height of fence)			This boundary is between the caravan park farmland to the north and east. It consists of posts – stock fencing – barbed wire and is lined with trees and shrubs. It initially runs E-W but turns to the south at a right angle.	257672	339202
33557	C11	WNW-ESE	0.80m		2.2m	Culvert runs along the northern edge of the main football ground and is fairly overgrown in places. The bank is higher on the southern side and is stock proofed with posts – stock fencing – barbed wire.	257669	339338
33558	FB28	N-S	height of fence=1.15m/depth of ditch=0.30m		3.20m	Mostly consisting of posts – stock fencing – barbed wire. There are also the remains of a silted up ditch/culvert that can be seen in the area which the road will occupy.	258090	339147
33559	C12	NW-SE	1.0m		3.40m	A fairly wide and well maintained culvert. A collapsed posts – stock fencing – barbed wire fence runs along its western bank.	258349	339129

PRN number	Boundary number	Orientation	Height/ Depth	Width Min	Width Max	Notes	Eastings	Northings
33560	C13	S-N then curves back to the WNW	1.0m		3.0m	A well maintained culvert in the area of the road.	258628	339098
33561	FB29	S-N then turns to the NE	1.15m			A post – stock fencing – barbed wire boundary.	258728	339085
33562	C14	SSE-NNW then turns to the west	1.0m		3.0m	A well maintained culvert.	258758	339084
33563	C94	WNW-ESE	0.9m			Dry stone build wall made up of local slate and schist stone. Wooden post and wire fencing runs along the top of it.	259306	338962
33564	C95	NE-SW				Drainage ditch with a large amount of reeds and a bank on the north side.	259583	338909
33565	C96	NW-SE	1.0m		2.4m	Drainage ditch with collapsed wire fencing and trees lining it. Fairly large and separates Minffordd Quarry from the pasture land.	259601	338878
33566	C97	NE-SW	0.85m		1.8m	Drainage ditch with a large amount of reeds.	259697	338858
33567	FB85	NE-SW generally but turns to a SE direction to the south.	0.7m		0.7m	Fairly low dry stone wall lined with mature oak and hazel trees. Built generally of local schist and slate however two large vertical slate stones have been set on end. Holds back some material from field 37	259730	338840

PRN number	Boundary number	Orientation	Height/ Depth	Width Min	Width Max	Notes	Eastings	Northings
33568	FB86	E-W	0.9m		0.7m	Dry stone wall revetment with higher dry stone construction in places with a wooden post and wire fencing. Built of local slate and schist.	259781	338815
33569	FB87	NW-SE	1.15m		0.7m	Joins with field boundary 88. Dry stone wall mostly consisting of fairly large blocks of mixed stone - local schist/slate and quartz. This boundary acts as a revetment in places holding back material from field 37A	259853	338792
33570	FB88	NE-SW				Partially collapsed stone and earth bank	259903	338754
33571	C98	N-S	0.8m		2.6m	Small field drainage ditch with a large amount of reeds.	259907	338787
33572	FB89	NNE-SSW				Stone built slate wall with wooden post and wire fencing running along the top of it. Partially well-constructed modern wall into a more collapsed stone built wall.	259930	338790
33573	FB90	NNE-SSW				Stone built slate wall. Various size stones.	259937	338789
33574	FB91	N-SE slightly wandering	0.9m		0.6m	Runs along the top edge of a small cliff. Generally built of schist/slate	259970	338746
33575	FB92	E-W	1.0m		0.6m	Partially consists of a well-constructed dry stone wall. The remainder is a post and wire fence on a low bank, a fence also runs along the wall.	260029	338716
33576	C99	NE-SEW	0.5m		3.0m	A curving drainage ditch.	260049	338744

PRN number	Boundary number	Orientation	Height/ Depth	Width Min	Width Max	Notes	Eastings	Northings
33577	FB93	N-S				Stone built slate wall with wooden post and wire fencing running along the top of it.	260114	338666
33578	FB94	E-W				Stone built slate wall with wooden post and wire fencing running along the top of it	260120	338641
33579	FB95	WNW-ESE				Wooden post and wire fencing.	260138	338675
33580	FB96	NE-SW				Wooden post and wire fencing running alongside the railway line.	260144	338643
33581	FB97	NE-SW				Stone built slate wall with metal post and wire fencing running along the top of it. Runs alongside of railway lines.	260153	338639
33582	C100	E-W				Wide drainage ditch.	260204	338648
33583	FB98 (boundary group)	NE-SW				Wire and post fencing along edge of track way.	260177	388618
33584	FB99 (boundary group)	E-WE-W				Various modern stone built walls some with concrete mortar and some with wire and post fencing. Part of a footpath running alongside the main road.	260217	338599
33585	FB100	NE- SW	>1.0m			Large slate stone built wall	260157	338568
33591		SE-NW	0.2m	1m		Modern drainage ditch found during watching brief on topsoil stripping	258,502	339,113

15 APPENDIX IV: GEOPHYSICAL SURVEY REPORT

Simon Haddrell (Stratascan)

15.1 Summary of results

Detailed gradiometer survey was carried out over two areas measuring approximately 300m x 60m (Area A) and 140m x 60m (Area B) near Porthmadog, Gwynedd. Both areas contain possible archaeological cut features, two of which may be associated with a Roman Road, however none of these features are conclusively archaeological so further investigations of some of these may be warranted. Area B contains several possible archaeological pits and an area of possible geological/pedological variations. Made ground is apparent in the eastern section of Area A. Agricultural marks are present in the west of Area A while both areas have a scattering of magnetic spikes.

15.2 Introduction

15.2.1 Background synopsis

Stratascan were commissioned to undertake a geophysical survey to form part of an archaeological investigation for a new road bypass. This survey forms part of an archaeological investigation being undertaken by Gwynedd Archaeological Trust.

15.2.2 Site location

Area A is located at OS ref. SH 567 395 which is to the north east of Porthmadog, south east of Tremadog and east of A487.

Area B is located at OS ref. SH 587 390 which is approximately 2km east of Porthmadog and 1km north west of Minffordd.

15.2.3 Description of site

The survey area is 2.6ha split over two separate areas, consisting of relatively flat land laid down with grass.

15.2.4 Geology and soils

The underlying geology is Caradoc (British Geological Survey South Sheet, Fourth Edition Solid, 2001). The overlying soils are known as Rockcliffe, which are typical Alluvial Gley soils. These consist of deep stoneless silty and fine sandy soils variably affected by ground water (Soil Survey of England and Wales, Sheet 05 Wales). The drift geology is Alluvium (British Geological Survey South Sheet, First Edition (Quaternary), 1977).

15.2.5 Site history and archaeological potential

Archaeological features are known to exist on and in close proximity to the survey area. The most important of these is a Roman bath-house which has been designated a Scheduled Ancient Monument. The survey areas lie on a former Roman Road, however due to changes in the river channel the route may have varied over time.

15.2.6 Survey objectives

The objective of the survey was to locate any features of possible archaeological significance in order that they may be assessed prior to development.

15.2.7 Survey methods

Detailed magnetic survey (gradiometry) was used as an efficient and effective method of locating archaeological anomalies. More information regarding this technique is included in the Methodology section below.

15.3 Methodology

15.3.1 Date of fieldwork

The fieldwork was carried out over three days from 22nd – 24th February 2010. Weather conditions during the survey were dry and sunny.

15.3.2 Grid locations

The location of the survey grids has been plotted in Figure 2 together with the referencing information. Grids were set out using a Leica Smart Rover RTK GPS.

An RTK GPS (Real-time Kinematic Global Positioning System) can locate a point on the ground to a far greater accuracy than a standard GPS unit. A standard GPS suffers from errors created by satellite orbit errors, clock errors and atmospheric interference, resulting in an accuracy of 5m-10m. An RTK system uses a single base station receiver and a number of mobile units. The base station re-broadcasts the phase of the carrier it measured, and the mobile units compare their own phase measurements with those they received from the base station. A SmartNet RTK GPS uses Ordnance Survey's network of over 100 fixed base stations to give an accuracy of around 0.01m.

15.3.3 Survey equipment

Although the changes in the magnetic field resulting from differing features in the soil are usually weak, changes as small as 0.2 nanoTesla (nT) in an overall field strength of 48,000nT, can be accurately detected using an appropriate instrument. The mapping of the anomaly in a systematic manner will allow an estimate of the type of material present beneath the surface. Strong magnetic anomalies will be generated by buried iron-based objects or by kilns or hearths. More subtle anomalies such as pits and ditches can be seen if they contain more humic material which is normally rich in magnetic iron oxides when compared with the subsoil.

To illustrate this point, the cutting and subsequent silting or backfilling of a ditch may result in a larger volume of weakly magnetic material being accumulated in the trench compared to the undisturbed subsoil. A weak magnetic anomaly should therefore appear in plan along the line of the ditch.

The magnetic survey was carried out using a dual sensor Grad601-2 Magnetic Gradiometer manufactured by Bartington Instruments Ltd. The instrument consists of two fluxgates very accurately aligned to nullify the effects of the Earth's magnetic field. Readings relate to the difference in localised magnetic anomalies compared with the general magnetic background. The Grad601-2 consists of two high stability fluxgate gradiometers suspended on a single frame. Each gradiometer has a 1m separation between the sensing elements so enhancing the response to weak anomalies.

15.3.4 Sampling interval, depth of scan, resolution and data capture

15.3.4.1 Sampling interval

Readings were taken at 0.25m centres along traverses 1m apart. This equates to 3600 sampling points in a full 30m x 30m grid.

15.3.4.2 Depth of scan and resolution

The Grad 601 has a typical depth of penetration of 0.5m to 1.0m. This would be increased if strongly magnetic objects have been buried in the site. The collection of data at 0.5m centres provides an optimum methodology for the task balancing cost and time with resolution.

15.3.4.3 Data capture

The readings are logged consecutively into the data logger which in turn is daily down-loaded into a portable computer whilst on site. At the end of each job, data is transferred to the office for processing and presentation.

15.3.5 Processing, presentation of results and interpretation

15.3.5.1 Processing

Processing is performed using specialist software known as *Geoplot 3.* This can emphasise various aspects contained within the data but which are often not easily seen in the raw data. Basic processing of the magnetic data involves 'flattening' the background levels with respect to adjacent traverses and adjacent grids. 'Despiking' is also performed to remove the anomalies resulting from small iron objects often found on agricultural land. Once the basic processing has flattened the background it is then possible to carry out further processing which may include low pass filtering to reduce 'noise' in the data and hence emphasise the archaeological or man-made anomalies.

The following schedule shows the basic processing carried out on all processed gradiometer data used in this report:

Despike (useful for display and allows further processing functions to be carried out more effectively by removing extreme data values)

Geoplot parameters: X radius = 1, y radius = 1, threshold = 3 std. dev. Spike replacement = mean

Zero mean traverse (sets the background mean of each traverse within a grid to zero and is useful for removing striping effects)

Geoplot parameters: Least mean square fit = off

15.3.6 Presentation of results and interpretation

The presentation of the data for each site involves a print-out of the raw data both as greyscale (Figure 03) and colour plots (Figure 04), together with a greyscale plot of the processed data (Figures 05). Magnetic anomalies have been identified and plotted onto the 'Abstraction and Interpretation of Anomalies' drawing for the site (Figures 06).

15.4 Results

The gradiometer survey near Porthmadog, Gwynedd was split over two areas.

15.4.1 Area A

Area A contains two positive linear parallel anomalies, representing cut features possibly associated with the Roman road (**A**), in the west of the area. These features appear in the same direction as agricultural marks and may alternatively be associated with these. Weak positive linear (**B**) and area anomalies (**C**), representing either possible archaeological cut features or geological responses, are evident in the west of the areas.

Magnetic disturbance, associated with modern services and agricultural marks are present. The east of the area contains some magnetic disturbances associated with nearby metallic objects such as field boundaries, made ground or rugby posts.

15.4.2 Area B

Several linear anomalies, representing cut features of possible archaeological origins, are evident in the centre and east of the field (**D**). These features may alternately be associated with local geology / pedology. Four discrete positive anomalies, representing possible archaeological pits, are apparent in the south and east of the area.

Magnetic disturbance, associated with nearby field boundaries, can be seen within the area. An area of magnetic variations, probably associated with geological / pedological variations, can be seen in the east. A moderately strong discrete bipolar anomaly, of an unknown origin, can be seen in the centre of the area.

15.5 Conclusion

The geophysical survey undertaken at Porthmadog, Gwynedd, has identified two parallel cut features which may be associated with a Roman road. These features appear in the same orientation as agricultural and may alternatively be associated with these, further investigations of the features are recommended to determine their true origins. Several cut features are apparent in Area B which may be archaeological in origin; however they may be associated with geological / pedological variations also evident in the data.

15.6 References

British Geological Survey, 2001. Geological Survey Ten Mile Map, South Sheet, Fourth Edition (Solid). British Geological Society.

Soil Survey of England and Wales, 1983. Soils of England and Wales, Sheet 5 Wales.

15.7 Appendix IVa – Basic principles of magnetic survey

Detailed magnetic survey can be used to effectively define areas of past human activity by mapping spatial variation and contrast in the magnetic properties of soil, subsoil and bedrock.

Weakly magnetic iron minerals are always present within the soil and areas of enhancement relate to increases in *magnetic susceptibility* and permanently magnetised *thermoremnant* material.

Magnetic susceptibility relates to the induced magnetism of a material when in the presence of a magnetic field. This magnetism can be considered as effectively permanent as it exists within the Earth’s magnetic field. Magnetic susceptibility can become enhanced due to burning and complex biological or fermentation processes.

Thermoremnance is a permanent magnetism acquired by iron minerals that, after heating to a specific temperature known as the Curie Point, are effectively demagnetised followed by re-magnetisation by the Earth’s magnetic field on cooling. Thermoremnant archaeological features can include hearths and kilns and material such as brick and tile may be magnetised through the same process.

Silting and deliberate infilling of ditches and pits with magnetically enhanced soil creates a relative contrast against the much lower levels of magnetism within the subsoil into which the feature is cut. Systematic mapping of magnetic anomalies will produce linear and discrete areas of enhancement allowing assessment and characterisation of subsurface features. Material such as subsoil and non-magnetic bedrock used to create former earthworks and walls may be mapped as areas of lower enhancement compared to surrounding soils.

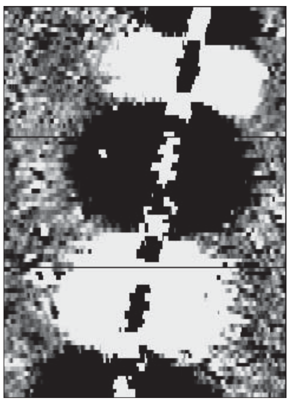
Magnetic survey is carried out using a fluxgate gradiometer which is a passive instrument consisting of two sensors mounted vertically either 0.5 or 1m apart. The instrument is carried about 30cm above the ground surface and the top sensor measures the Earth’s magnetic field whilst the lower sensor measures the same field but is also more affected by any localised buried field. The difference between the two sensors will relate to the strength of a magnetic field created by a buried feature, if no field is present the difference will be close to zero as the magnetic field measured by both sensors will be the same.

Factors affecting the magnetic survey may include soil type, local geology, previous human activity, disturbance from modern services etc.

15.8 Appendix IVb – Glossary of magnetic anomalies

Bipolar

A bipolar anomaly is one that is composed of both a positive response and a negative response. It can be made up of any number of positive responses and negative responses. For example a pipeline consisting of alternating positive and negative anomalies is said to be bipolar. See also dipolar which has only one area of each polarity. The interpretation of the anomaly will depend on the magnitude of the magnetic field strength. A weak response may be caused by a clay field drain while a strong response will probably be caused by a metallic service.



Dipolar

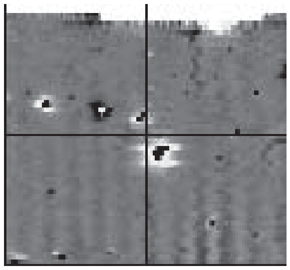
This consists of a single positive anomaly with an associated negative response. There should be no separation between the two polarities of response. These responses will be created by a single feature. The interpretation of the anomaly will depend on the magnitude of the magnetic measurements. A very strong anomaly is likely to be caused by a ferrous object.

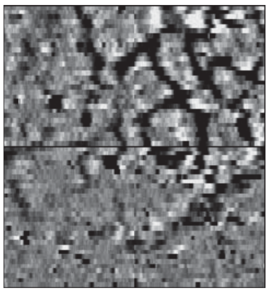
Positive anomaly with associated negative response

See bipolar and dipolar.

Positive linear

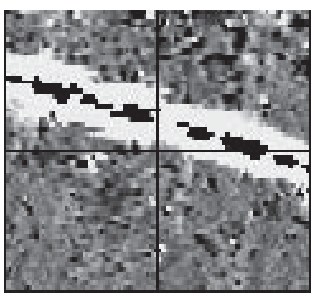
A linear response which is entirely positive in polarity. These are usually related to infilled cut features where the fill material is magnetically enhanced compared to the surrounding matrix. They can be caused by ditches of an archaeological origin, but also former field boundaries, ploughing activity and some may even have a natural origin.



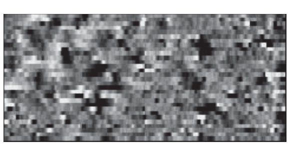


Positive linear anomaly with associated negative response

A positive linear anomaly which has a negative anomaly located adjacently. This will be caused by a single feature. In the example shown this is likely to be a single length of wire/cable probably relating to a modern service. Magnetically weaker responses may relate to earthwork style features and field boundaries.



Positive point/area



These are generally spatially small responses, perhaps covering just 3 or 4 reading nodes. They are entirely positive in polarity. Similar to positive linear anomalies they are generally caused by infilled cut features. These include pits of an archaeological origin, possible tree

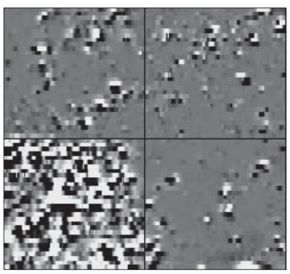
bowls or other naturally occurring depressions in the ground.

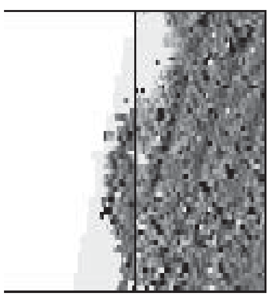
Magnetic debris

Magnetic debris consists of numerous dipolar responses spread over an area. If the amplitude of response is low (+/-3nT) then the origin is likely to represent general ground disturbance with no clear cause, it may be related to something as simple as an area of dug or mixed earth. A stronger anomaly (+/-250nT) is more indicative of a spread of ferrous debris. Moderately strong anomalies may be the result of a spread of thermoremnant material such as bricks or ash.

Magnetic disturbance

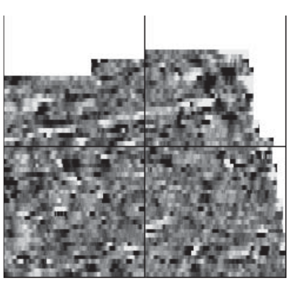
Magnetic disturbance is high amplitude and can be composed of either a bipolar anomaly, or a single polarity response. It is essentially associated with magnetic interference from modern ferrous structures such as fencing, vehicles or buildings, and as a result is commonly found around the perimeter of a site near to boundary fences.

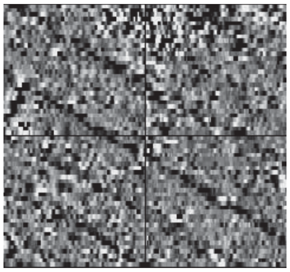




Negative linear

A linear response which is entirely negative in polarity. These are generally caused by earthen banks where material with a lower magnetic magnitude relative the background top soil is built up. See also ploughing activity.





Negative point/area

Opposite to positive point anomalies these responses may be caused by raised areas or earthen banks. These could be of an archaeological origin or may have a natural origin.

Ploughing activity

Ploughing activity can often be visualised by a series of parallel linear anomalies. These can be of either positive polarity or negative polarity depending on site specifics. It can be difficult to distinguish between ancient ploughing and more modern ploughing, clues such as the separation of each linear, straightness, strength of response and cross cutting relationships can be used to aid this, although none of these can be guaranteed to differentiate between different phases of activity.

Polarity

Term used to describe the measurement of the magnetic response. An anomaly can have a positive polarity (values above 0nT) and/or a negative polarity (values below 0nT).

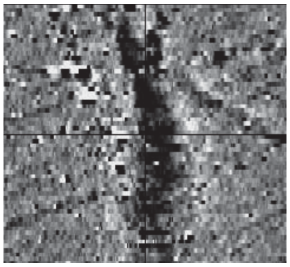
Strength of response

The amplitude of a magnetic response is an important factor in assigning an interpretation to a particular anomaly. For example a positive anomaly covering a $10m^2$ area may have values up to around 3000nT, in which case it is likely to be caused by modern magnetic interference. However, the same size and shaped anomaly but with values up to only 4nT may have a natural origin. Trace plots are used to show the amplitude of response.

Thermoremnant response

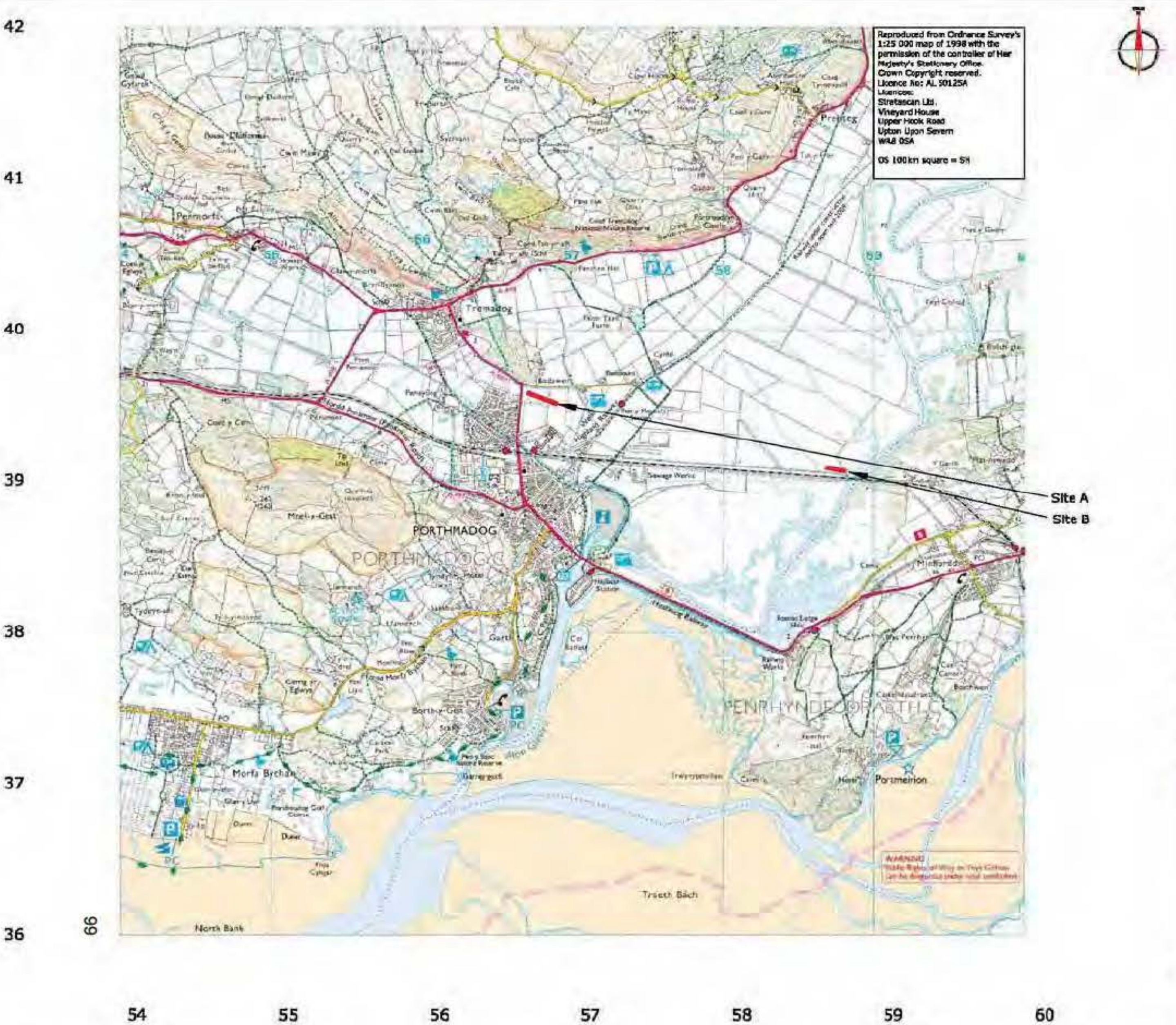
A feature which has been subject to heat may result in it acquiring a magnetic field. This can be anything up to approximately +/-100 nT in value. These features include clay fired drains, brick, bonfires, kilns, hearths and even pottery. If the heat application has occurred in situ (e.g. a kiln) then the response is likely to be bipolar compared to if the heated objects have been disturbed and moved relative to each other, in which case they are more likely to take an irregular form and may display a debris style response (e.g. ash).

Weak background variations



Weakly magnetic wide scale variations within the data can sometimes be seen within sites. These usually have no specific structure but can often appear curvy and sinuous in form. They are likely to be the result of natural features, such as soil creep, dried up (or seasonal) streams. They can also be caused by changes in the underlying geology or soil type which may contain unpredictable distributions of magnetic minerals, and are usually apparent in several locations across a site.

15.9 List of Figures



Amendments

Issue No.	Date	Description
-	-	-
-	-	-

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Site A centred on NGR	SH 567 395
Site B centred on NGR	SH 587 390

Client

GWYNEDD ARCHAEOLOGICAL TRUST

Project Title — Job No. 2696

GEOPHYSICAL SURVEY - PORTHMADOG & TREMADOG, GWYNEDD

Subject

LOCATION PLAN OF SURVEY AREA

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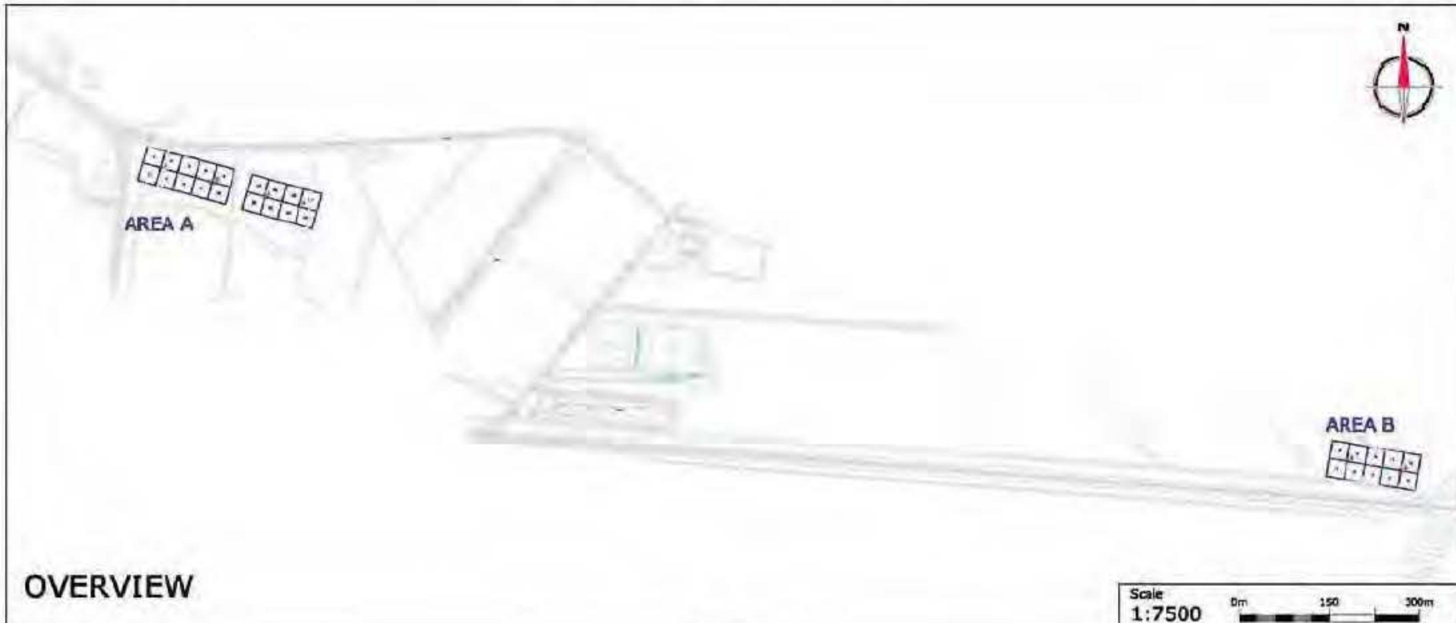
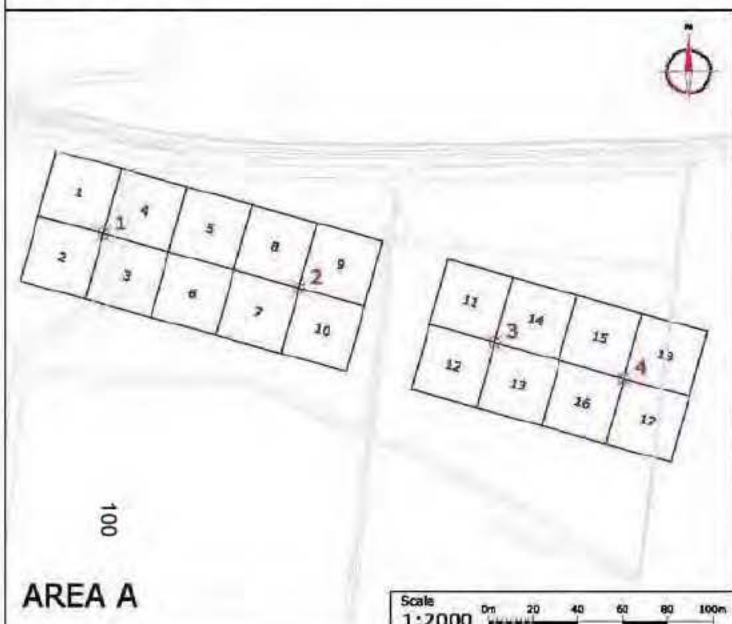
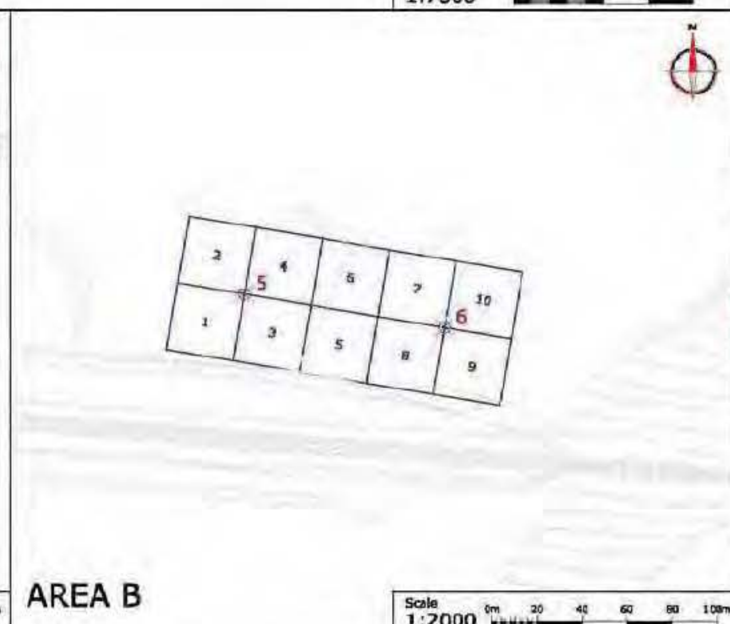
Survey date FEB 10	Drawn by SDH/AD	Figure No. 01







Amendments

Issue No	Date	Description
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OS GRID REFERENCES

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2	256810.60	339559.13
3	256897.32	339535.05
4	256955.13	339519.00
5	258700.49	339092.82
6	258789.24	339077.86

Client
GWYNEDD ARCHAEOLOGICAL TRUST

Project Title — Job No. 2696
GEOPHYSICAL SURVEY - PORTHMADOG & TREMADOG, GWYNEDD

Subject
LOCATION AND REFERENCING OF SURVEY GRIDS

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Scale
AS SHOWN

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Survey date	**Drawn by**	**Figure No.**
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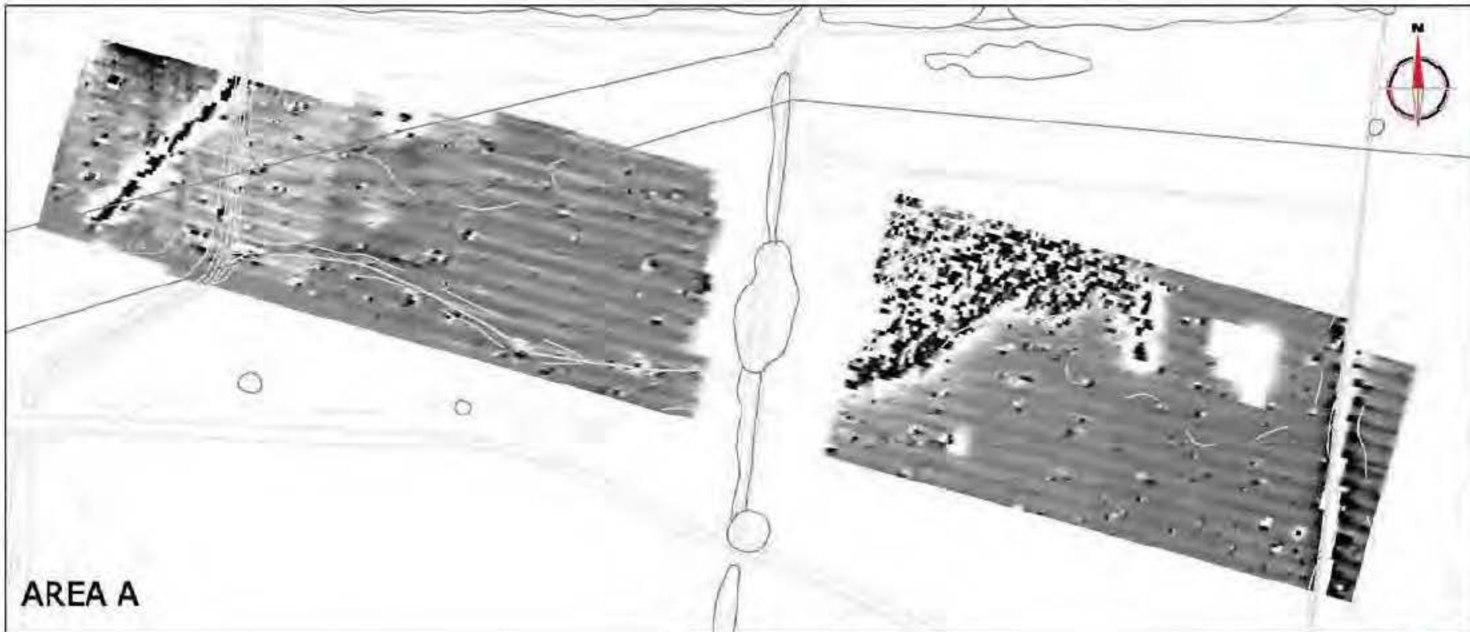

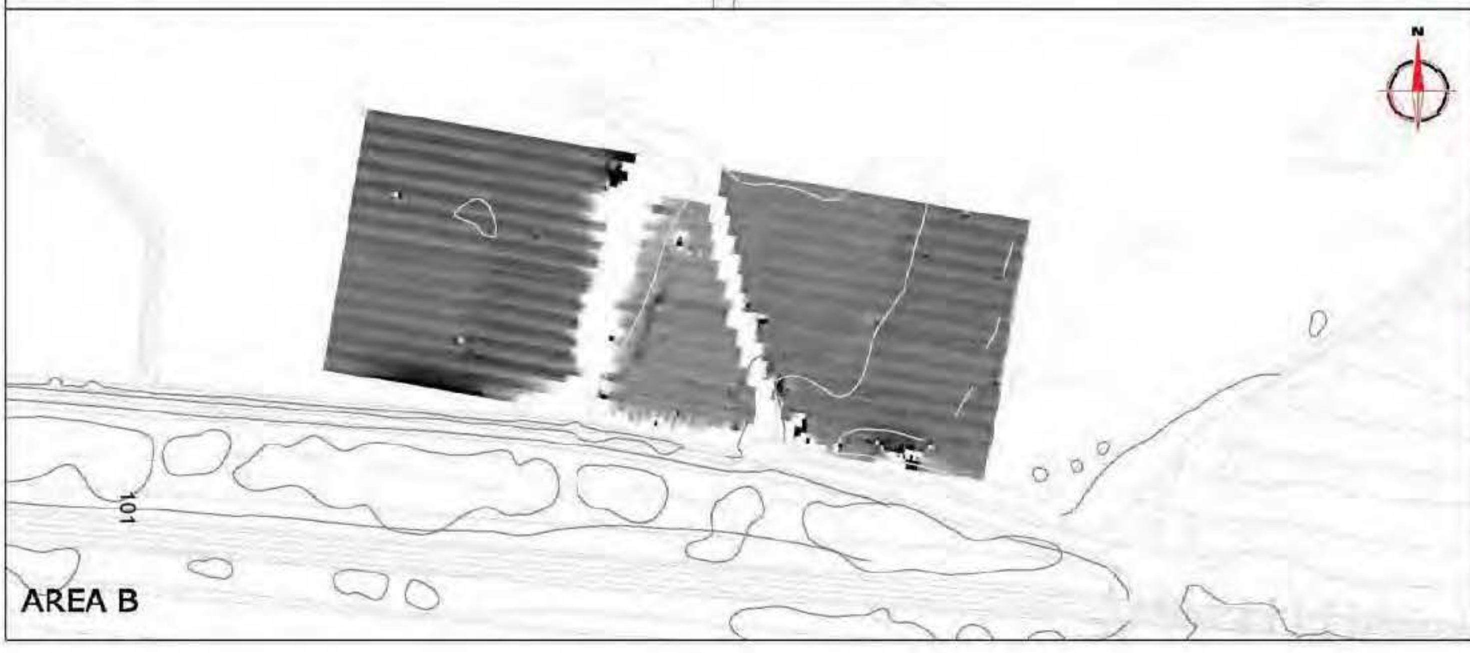

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AREA A

Plotting parameters

Maximum +5nT (black)
Minimum -5nT (white)

Zero Mean

-5nT +5nT

+5nT -5nT

AREA B

Plotting parameters

Maximum +5nT (black)
Minimum -5nT (white)

Zero Mean

-5nT +5nT

+5nT -5nT

Client
GWYNEDD ARCHAEOLOGICAL TRUST

Project Title
Job No. 2696
GEOPHYSICAL SURVEY - PORTHMADOG & TREMADOG, GWYNEDD

Subject
PLOT OF RAW GRADIOMETER DATA

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Survey date	Drawn by	Figure No.
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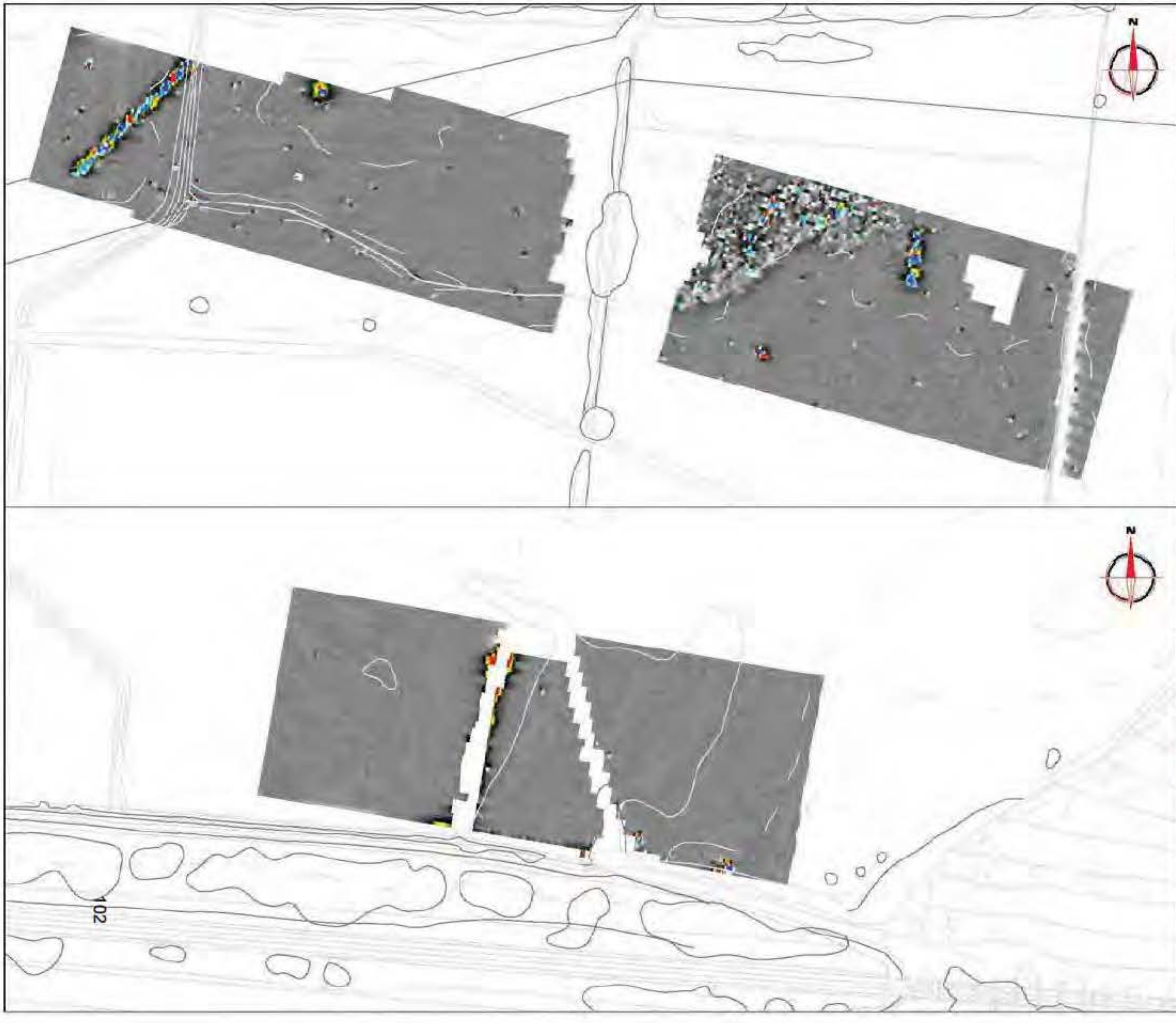

Amendments

Issue No.	Date	Description
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+250nT

-250nT

Client
GWYNEDD ARCHAEOLOGICAL TRUST

Project Title
Job No. 2696
GEOPHYSICAL SURVEY - PORTHMADOG & TREMADOG, GWYNEDD

Subject
TRACE PLOT OF GRADIOMETER DATA SHOWING POSITIVE VALUES

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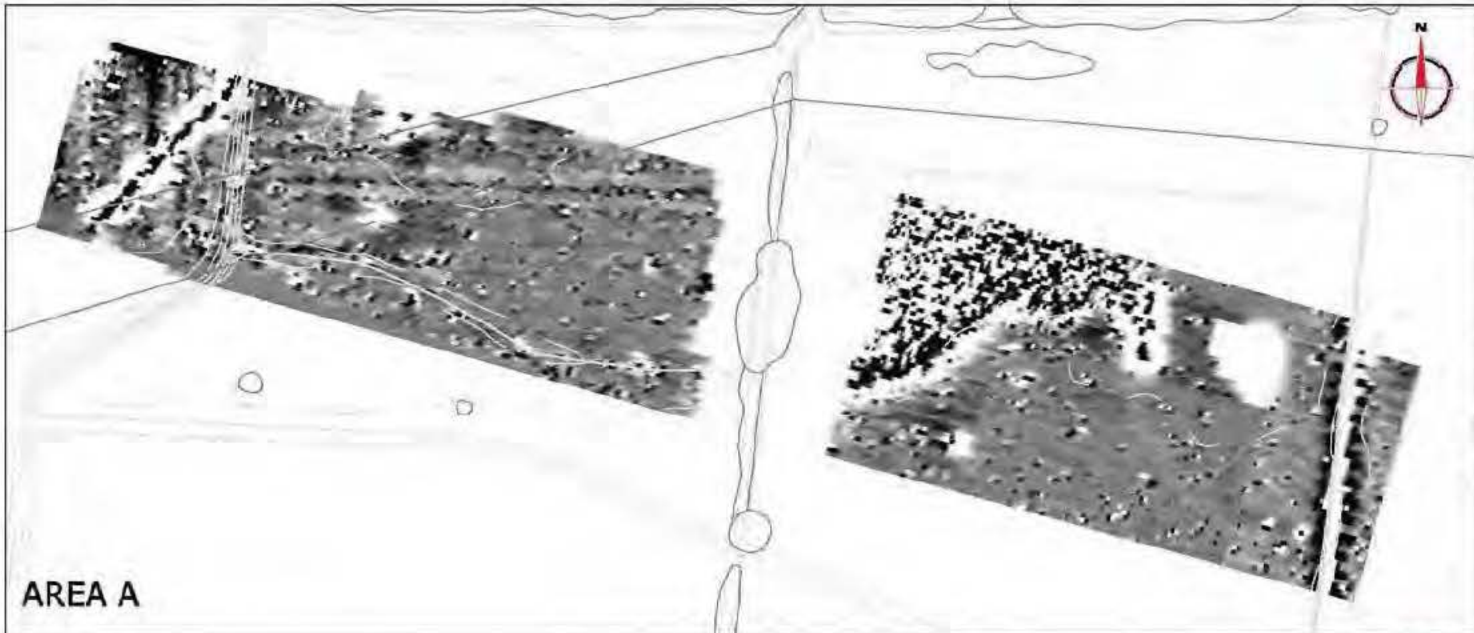

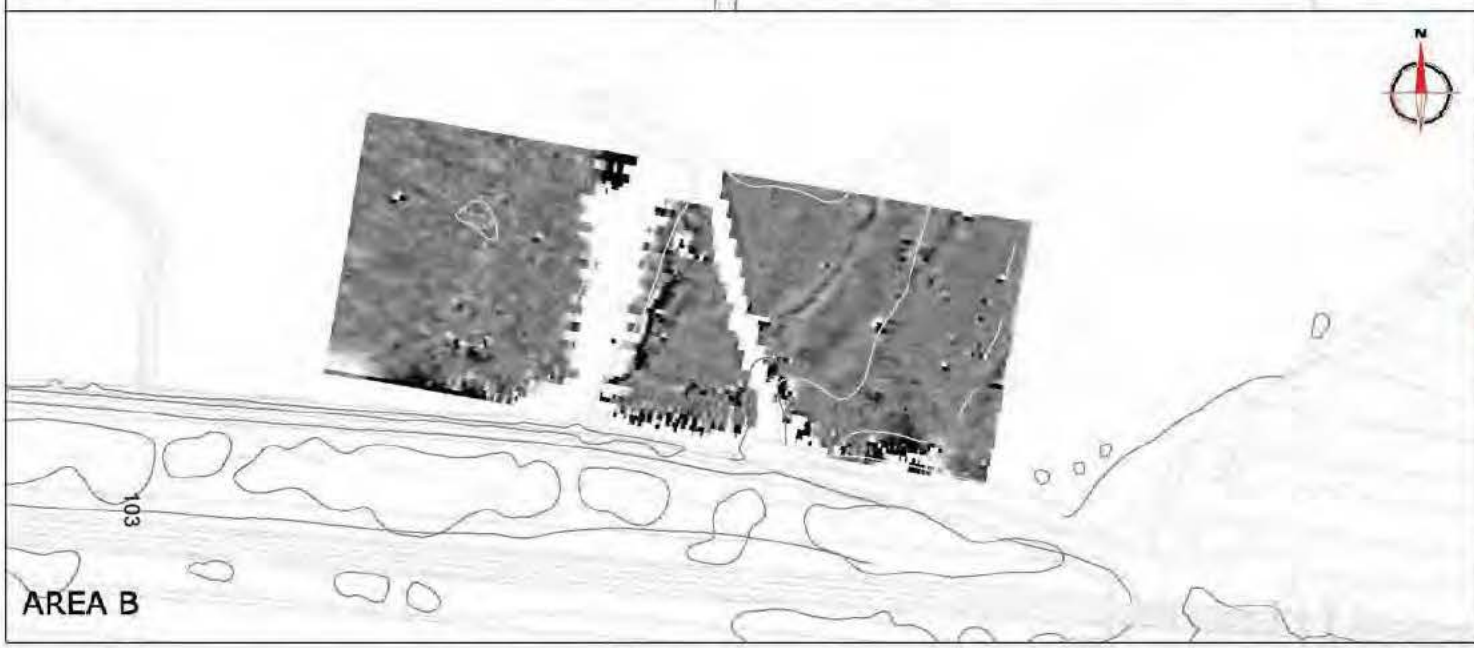

Amendments

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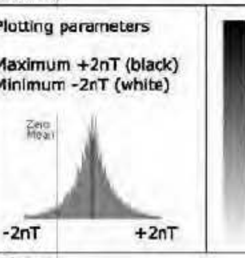
AREA A

Plotting parameters

Maximum +2nT (black)
Minimum -2nT (white)



AREA B

Plotting parameters

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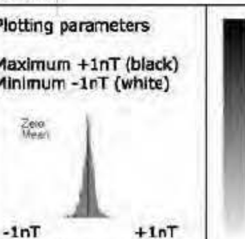

Client
GWYNEDD ARCHAEOLOGICAL TRUST

Project Title — Job No. 2696
GEOPHYSICAL SURVEY - PORTHMADOG & TREMADOG, GWYNEDD

Subject
PLOT OF PROCESSED GRADIOMETER DATA

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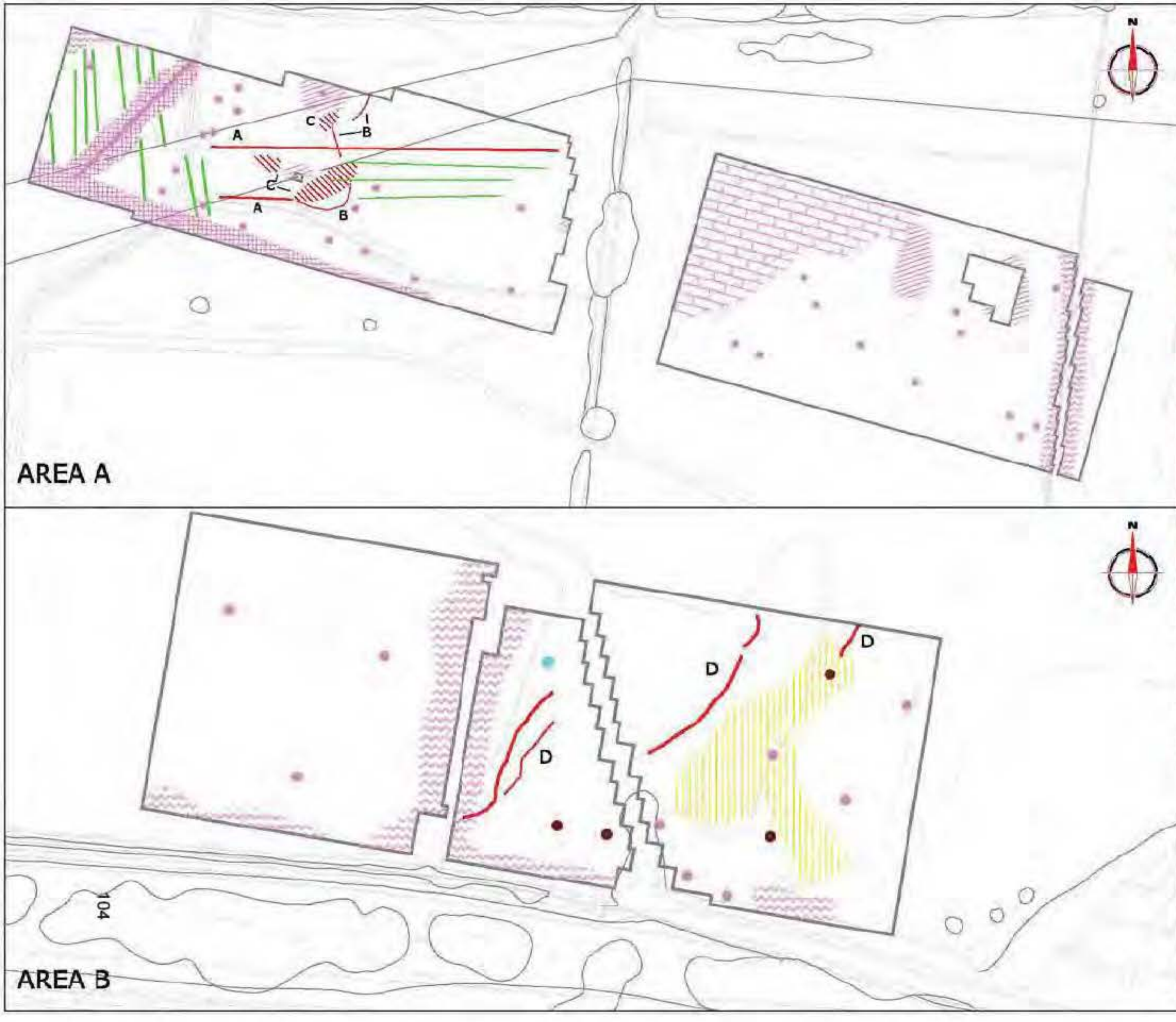

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KEY

- Discrete positive anomaly - possible pit
- Positive anomaly with associated negative response - ferrous object
- Bipolar anomaly of an unknown origin
- Magnetic disturbance - associated with pipe/cable
- Positive linear anomaly - agricultural mark
- Positive linear anomaly - cut feature of possible archaeological origin
- Linear anomaly - possibly related to land drains
- Positive area anomaly - cut feature of possible archaeological origin
- Weak positive area anomaly
- Magnetic disturbance associated with nearby service
- Magnetic disturbance associated with nearby metallic objects
- Magnetic disturbance associated with nearby field boundaries
- Magnetic disturbance associated with an area of made ground
- Area of possible geological / pedological variation

Client
GWYNEDD ARCHAEOLOGICAL TRUST

Project Title — Job No. 2696
GEOPHYSICAL SURVEY - PORTHMADOG & TREMADOG, GWYNEDD

Subject
ABSTRACTION AND INTERPRETATION OF GRADIOMETER ANOMALIES

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Survey date: FEB 10	Drawn by: SDH	Figure No.: 06

16 APPENDIX V: TRENCHING TABLE

Table recording depth and character of deposits in evaluation trenches. For trench locations see figures 4 and 5.

Trench Number	Field	Trench size (metres)	Max. trench depth (metres)	Orientation	Context number	Description	Photos	General Summary/features
17.01	17	20 x 1.8	0.9	North-south	17.01.01	0-0.3m: Topsoil mid grey brown, sand silt.	G2108,Mitigation, 0397 - 0400	Located 3.9m from field boundary 19 and 29.6m from drainage ditch running east-west to the north. Water table reached at 0.9m in southern end. No sign of features mentioned in the Geophysics report
					17.01.02	0.3-0.9: Estuarine sand. Light orange yellow sand.		
17.02	17	10 x 1.0	0.75	North-south	17.02.01	0-0.25m: Topsoil grey brown sand silt.	G2108,Mitigation, 0577 - 0580	Located 7.10m from the western boundary and 20m from the northern stream field boundary. Small piece of modern pot was found
					17.02.02	0.25-0.75m: Estuarine sand.		
17.03	17	10 x 1.0	0.8	North-south	17.03.01	0-0.3m: Topsoil	G2108,Mitigation, 0581-0584	Located 16.17m from the western field boundary and 29m from the northern stream field boundary. Two pieces of modern pot was found
					17.03.02	0.3-0.8m: Estuarine sand.		
17.04	17	10 x 1.0	0.75	North-south	17.04.01	0-0.3m: Topsoil.	G2108,Mitigation, 0505-0592	Located 28.6m from the western field boundary and 23m from the northern stream field boundary. A linear feature, yellow brown 0.56m wide and 0.18 deep ran NW-SE and was dug into the estuarine sands.
					17.04.02	0.3-0.75m: Estuarine sand		
17.05	17	10 x 1.0	0.8	North-south	17.05.01	0-0.3m: Topsoil.	G2108,Mitigation, 0593-0598 G2108,Mitigation, 0665 - 0666	Located 27.9m from the northern field boundary and 11.2m from trench 17.04 to the east. A linear feature was discovered which was similar to the linear found in trench 17.04 and ran in the same direction. The linear was 0.4m wide and 0.2m deep. A metal pipe ran from the SW-NE across the trench close to the
					17.05.02	0.3-0.8m: Estuarine sand.		

Trench Number	Field	Trench size (metres)	Max. trench depth (metres)	Orientation	Context number	Description	Photos	General Summary/features
								centre.
17.06	17	10 x 1.0	0.65	North-south	17.06.01	0-0.25m: Topsoil.	G2108,Mitigation, 0599 - 0602	Located 4.5m west of the ditch.
					17.06.02	0.25-0.65m: Estuarine sand.		
17.07	17	10 x 1.0	0.68	North-south	17.07.01	0-0.3m: Topsoil	G2108,Mitigation, 0607 - 0609	Located 4.0m east of the ditch and 18m from the northern field boundary. At the eastern side of the trench the water table hit at a depth of 0.68m.
					17.07.02	0.3-0.41m: faint mottled band of sandy clay		
					17.07.03	0.41-0.68: Estuarine sand		
17.08	17	10 x 1.0	0.71	North-south	17.08.01	0-0.28m: Topsoil	G2108,Mitigation, 0610 - 0612	Located 10m east of trench 17.07 and 27m south of the northern field boundary.
					17.08.02	0.28-0.71m: Estuarine sand		
17.09	17	10 x 1.0	0.7	North-south	17.09.01	0-0.0.25m: Topsoil	G2108,Mitigation, 0613-0618	Located 16.6m from the northern field boundary and 10m east of trench 17.08.
					17.09.02	0.25-0.7m: Estuarine sand		
17.10	17	10 x 1.0	0.7	North-south	17.10.01	0-0.3m: Topsoil	G2108,Mitigation, 0616 - 0618	Located 27.4m from the northern field boundary and 10m east of trench 17.09.
					17.10.02	0.3-0.7m: Estuarine sand		
17.11	17	10 x 1.0	0.75	North-south	17.11.01	0-0.3m: Topsoil	G2108,Mitigation, 0619 - 0621	Located 22.2m from the northern field boundary and 26m from trench 17.10 to the west. A small fragment of modern pot was found.
					17.11.02	0.3-0.75: Estuarine sand		
18.01	18	10 x 1.8	0.85	North-south	18.01.01	0-0.35m: Topsoil mid grey brown sand silt with some post medieval debris.	G2108,Mitigation, 0401 - 0404	Located 26.6m from field boundary 19 and 3.5m from the edge of the school land.
					18.01.02	0.35-0.85m: Estuarine sand		

Trench Number	Field	Trench size (metres)	Max. trench depth (metres)	Orientation	Context number	Description	Photos	General Summary/features
18.02	18	10 x 1.8	0.9	North-south	18.02.01	0-0.25m: Topsoil dark brown sand silt.	G2108,Mitigation, 0405 – 0408	Located 32.5m east of trench 18.01 and 4.5m from the edge of the school land.
					18.02.02	0.25-0.65m: Dump material. Dark brown cinder rich silt. 19th/20th century rubbish, glass bottles etc.		
					18.02.03	0.65-0.9m: Estuarine sand.		
18.03	18	10 x 1.8	0.85	North-north-east to south-south-west	18.03.01	0-0.3m: Topsoil mid grey brown sand silt.	G2108,Mitigation, 0409 - 0412	Located 36.6m from trench 18.02 (east) and 18.6m from the boundary of the school land to the north. 26.4m from field boundary 20.
					18.03.02	0.3-0.85: Estuarine sand.		
18.04	18	10 x 1.8	0.9	North-north-east to south-south-west	18.04.01	0-0.3m: Topsoil mid grey brown sand silt.	G2108,Mitigation, 0413 - 0416	Located 3.5m from field boundary 20 and 30m from the school boundary to the north. 23.2m from trench 18.03
					18.04.02	0.3-0.9m: Estuarine sand.		
27.01	27	40 x 1.9	0.3	East-west	27.01.01	0-0.15m: Topsoil	G2108,Mitigation, 0329 - 332	No features identified other than regular plough marks running east-west. 0.303 and 0.45 calibre bullets were recovered using a metal detector.
					27.01.02	Estuarine sands.		
					27.01.03	0.1-0.05m: Plough marks.		
29.01	29	22 x 1.9	0.2	North-south	29.01.01	0-0.12m: Topsoil.	G2108,EvalTrenches, 01 - 04	No features identified.
					29.01.02	0.12-0.2m: Pale orange grey estuarine sand.		
29.02	29	22 x 1.9	0.2	North-south	29.02.01	0-0.12m: Topsoil.	G2108,EvalTrenches, 05 - 08	No features identified.
					29.02.02	0.12-0.2m: Pale		

Trench Number	Field	Trench size (metres)	Max. trench depth (metres)	Orientation	Context number	Description	Photos	General Summary/features
						orange grey estuarine sand.		
29.03	29	22 x 1.9	0.21	North-south	29.03.01	0-0.14: Topsoil.	G2108,EvalTrenches, 09 - 16	Two shallow square areas of disturbance were uncovered, likely to be geological test pits.
					29.03.02	0.14-0.21m: Estuarine sand.		
29.04	29	21 x 1.89	0.19	North-south	29.04.01	0-0.14m: Topsoil.	G2108,EvalTrenches, 17 - 20	A shallow (0.04m in depth) feature probably bioturbation.
					29.04.02	0.14-0.19m: Estuarine sand		
29.05	29	21 x 1.9m	0.22	North-south	29.05.01	0-0.14m: Topsoil.	G2108,EvalTrenches, 21 - 24	No features identified.
					29.05.02	0.14-0.22m: Estuarine sand.		
29.06	29	21 x 1.9	0.17	North west-south east	29.06.01	0-0.13m: Topsoil	G2108,EvalTrenches, 25 - 28	No features identified.
					29.06.02	0.13-0.17m: Estuarine sand.		
30.01	30	10 x 1.0	0.70	North-south	30.01.01	0-0.2m: Estuarine sand.	G2108,Mitigation, 0627 - 0629	Located 10m east of field boundary fence and 7.6m north of the canal to the south. Water table appeared at 0.7m.
					30.01.02	0.2m-0.3m: Narrow band of grey, possible old turf line.		
					30.01.03	0.3-0.7m: Grey Estuarine sand.		
30.02	30	10 x 1.0	0.68	North-south	30.02.01	0-0.2m: Estuarine sand	G2108,Mitigation, 0630 - 0633	Located 26.5m north of the canal and 9.3m west of trench 30.03. Water table appeared at 0.68m.
					30.02.02	0.2-0.68m: Grey Estuarine sand.		
30.03	30	10 x 1.0	0.61	North-south	30.03.01	0-0.15m: Estuarine	G2108,Mitigation,	Located 9.3m east of trench 30.02 and 11m north of

Trench Number	Field	Trench size (metres)	Max. trench depth (metres)	Orientation	Context number	Description	Photos	General Summary/features
						sand.	0634 - 0636	the canal. Water table appeared at 0.61m.
					30.03.02	0.15-0.21m: Narrow band of silt clay, possible old turf line.		
					30.03.03	0.21-0.61m: Grey Estuarine sand.		
31.01	31	10 x 1.0	0.74	North-south	31.01.01	0-0.24m: Estuarine sand.	G2108,Mitigation, 0637 - 0639	Located 10.4m from the central ditch to the east and 11.4m from the canal. Water table appeared at 0.74m.
					31.01.02	0.24-0.74m: Grey Estuarine sand.		
31.02	31	10 x 1.0	0.8	North-south	31.02.01	0-0.18m: Estuarine sand.	G2108,Mitigation, 0640 - 0642	Located 27.5m north of the canal. Water table appeared at 0.8m.
					31.02.02	0.18-0.24m: Brown silt clay, possible old turf line.		
					31.02.03	0.24-0.54m: Wide band of estuarine sand.		
					31.02.04	0.54-0.8m: Grey estuarine sand.		
31.03	31	30 x 1.0	0.8	North-south	31.03.01	0-0.18m: estuarine sand.	G2108,Mitigation, 0643 - 0645	Located 5.7m from the northern grass edge and 28.5m from the river to the east.
					31.03.02	0.18-0.24m: Brown silt clay, possible old turf line.		
					31.03.03	0.24-0.6m: Compact light shade of		

Trench Number	Field	Trench size (metres)	Max. trench depth (metres)	Orientation	Context number	Description	Photos	General Summary/features
						estuarine sand.		
					31.03.04	0.6-0.8m: Dark grey band 7m from the north end of the trench and 0.21m wide.		
31.04	31	10 x 1.0	0.85	North-south	31.04.01	0-0.4m: Estuarine sand.	G2108,Mitigation, 0646 - 0648	Located 10m from the canal boundary to the south. An iron object and a modern wooden stake were discovered close to the turf line.
					31.04.02	0.4-0.5m: Brown silt clay, possible old turf line.		
					31.04.03	0.5-0.91m: Light grey estuarine sand.		
31.05	31	10 x 1.0	0.85	North-south	31.05.01	0-0.21m: Estuarine sand.	G2108,Mitigation, 0659 - 0661	Located 11.9m south of the grass area to the north.
					31.05.02	0.21-0.27m: Brown silt clay, possible old turf line.		
					31.05.03	0.27-0.85: Light grey estuarine sand.		

17 APPENDIX VI: PALAEOENVIRONMENTAL STUDY OF TRAETH MAWR WITH SPECIFIC INVESTIGATION OF DEPOSITS AT MINFFORDD

17.1 Appendix VI.1: Palaeoenvironmental assessment of deposits on the line of the Porthmadog Bypass

Benjamin R. Gearey MIfA and Kristina Krawiec (Birmingham Archaeo-Environmental)

17.1.1 Summary

In February 2010 BAE were commissioned to carry out a borehole survey to evaluate the palaeoenvironmental potential of subsurface deposits along the line of the Tremadog to Porthmadog bypass. The survey recorded sand and silt deposits associated with the estuary of Traeth Mawr. It is probable that any organic sediments, which could yield information about past environments are deeply buried beneath these sands. It is unlikely the proposed road scheme will disturb these deposits but upon the removal of overburden during archaeological excavation there may be residual pockets of sediment with higher palaeoenvironmental potential. Any such deposits should be recorded and sampled.

17.1.2 Introduction

In February 2010 Gwynedd Archaeological Trust commissioned BAE to carry out an investigation of deposits along the line of the Porthmadog bypass. The route had previously been identified as having potential for the preservation of palaeoenvironmental deposits.

17.1.3 Methods

A walkover survey was carried out to identify possible locations for the preservation of deposits of palaeoenvironmental potential, although some areas (far eastern end of the study area adjacent to Minffordd) were not accessible. A total of sixteen boreholes were subsequently excavated in three main areas along the line of the bypass (Figure 1). The coring survey was carried out using an Eikjelcamp gouge corer. The stratigraphy of the deposits were logged in the field using the Troels Smith (1955) method and the locations of the cores were recorded using a GPS.

17.1.4 Results

The core logs are provided in Appendix 1. Cores 1-5 were located across the estuary, parallel with the Cambrian Coast mainline railway (Figure 2). The land is currently flat, open pasture with drainage ditches. The deposits consist of a thin sandy top soil onto buff medium coarse sand which trended into a light grey wet silty sand at depth. This unit shows no significant variation between Cores 1 to 5. Coring beyond a depth of c.1.75m was not possible due to the thixotropic nature of the saturated sand at depth.

Cores 9-11 were located to the west of the football ground along open flat pasture (Figure 3). The stratigraphic profiles were similar to that observed in Core 1-5, with buff medium coarse sand becoming grey and saturated with depth. Coring below a maximum depth of 1.0m (Cores 9-11) was not possible due to the saturated nature of the sediments.

Cores 12-16 were located in open pasture along the proposed line of the bypass to the south and west of Tremadog (Figure 4). The deposits are slightly different in this area, consisting of silty clay and silty sand, trending into saturated medium coarse sands with depth. Coring below a maximum depth of 1.75m. (Core 12 and 13) was not possible due to the saturated nature of the sediments.

Cores 6-8 were located at the northern end of the bypass adjacent to a prominent rocky outcrop (west of Tremadog at Bryn) which sits c. 2m above the floodplain. This has previously been the subject of archaeological investigation and has yielded Neolithic flint artefacts (J. Roberts, pers. comm.). The cores were located to assess the local context of this site. The area around the outcrop is currently pasture with some poorly drained boggy areas. All three cores demonstrate similar stratigraphies, with coarse grey silty clay trending into smooth blue grey silty clay. The only organic remains identified were rootlets and humified material associated with the modern topsoil. Coring was not possible below a maximum depth of 1.50m (Core 7).

17.1.5 Discussion

The coarse sand and silt/clay in all the cores represent deposits associated with fluvial and marine processes operating in Traeth Mawr estuary. The estuary was partly reclaimed in the early 19th century by William Madocks with the construction of the ‘cob’ embankment which effectively reduced the tidal influence of the sea on sediment deposition behind this feature. This provides a likely terminus ante quem for the deposition of the sands. However, the precise timing of changes in depositional environments and the interrelationship with fluctuations in relative sea level and other environmental processes remains unknown. For example, recent work has established that the nearby dune complex of Morfa Harlech (south of the Glaslyn and Dwyryd valleys) has formed over the last ~100-500 years, possibly linked to the climate deterioration of the Little Ice Age (Wynne, pers. comm.).

The greater prevalence of silt and clay in the overlying deposits in Cores 6-8 and 12-15 indicates deposition under slightly lower energy conditions. Cores 12-15 in particular demonstrate a sequence of ‘fining up’ with silts and clays capping coarser sands. This suggests a reduction in the relative energy of the past depositional environment. This is perhaps also related to the impact of the emplacement of the cob on estuarine sedimentation processes, although earlier aggradation of areas further inland is also possible. The blue-grey silts in Core 12 (0.50-1.75m) depth are almost certainly alluvial in origin, indicating the location of this part of the site in the lower reaches of a fluvial system draining into the estuary. No organic deposits such as peat were recorded in any of the boreholes.

17.1.6 5. Conclusions and Recommendations

The borehole survey indicates that much of the study area consists of sand and related silt/clay deposits lain down in an estuarine context. Presumably much of this area was reclaimed at or shortly after the construction of the cob embankment, but the precise chronology of sediment accumulation is unknown. Further work including dating using Optically Stimulated Luminescence (OSL) might provide absolute dates for these sediments (see Bailey et al. 2001), but such work is not currently recommended. No organic deposits of palaeoenvironmental potential were identified during the auger survey and no further analyses on the deposits identified to date are recommended. It is probable that any peats/organic sediments associated with lower sea levels are deeply buried. It is recommended that any such thicker and/or organic-rich sediments identified during subsequent ground works are recorded and possibly sampled for possible further assessment.

17.1.7 Acknowledgements

Thanks go to the groundworks team at the site and to John Roberts (GAT) for information and assistance.

17.1.8 References

Bailey, S.D., Wintle, A.G., Duller, G.A.T. and Bristow, C.S. 2001. Sand deposition during the last millennium at Aberffraw, Anglesey, North Wales as determined by OSL dating of quartz. Quaternary Science Reviews 20, 701-704.

Troels-Smith, J. 1955. Characterization of unconsolidated sediments. Danmarks Geologiske Undersøgelse 4 Række 3/10,1–73.

Figures

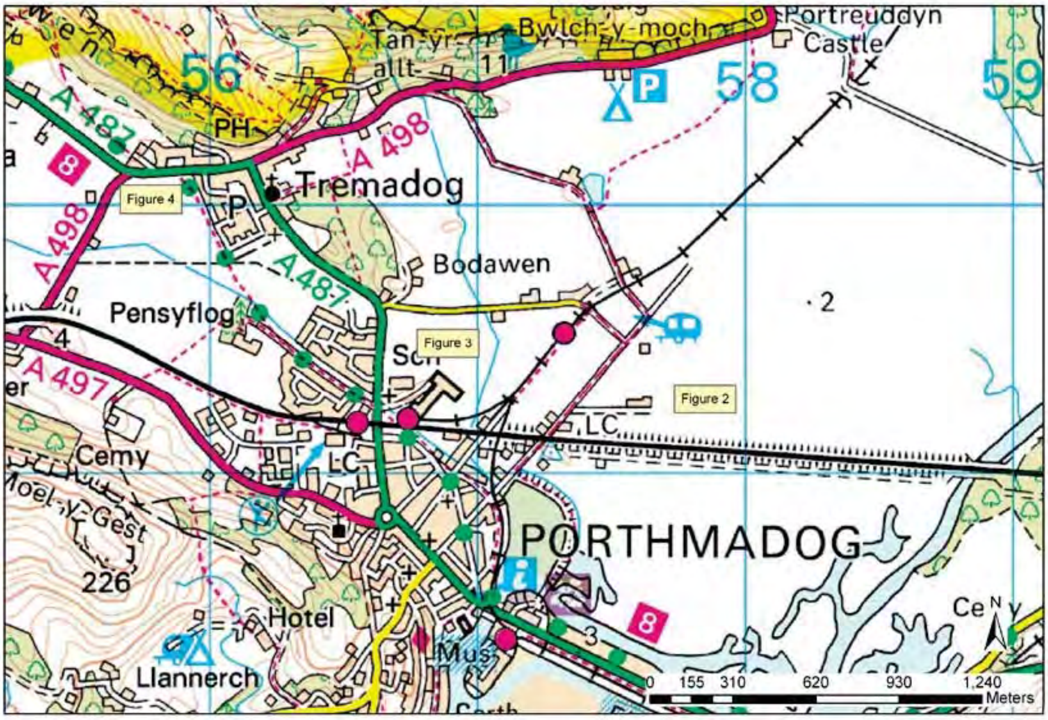

Figure 1: General location of boreholes.

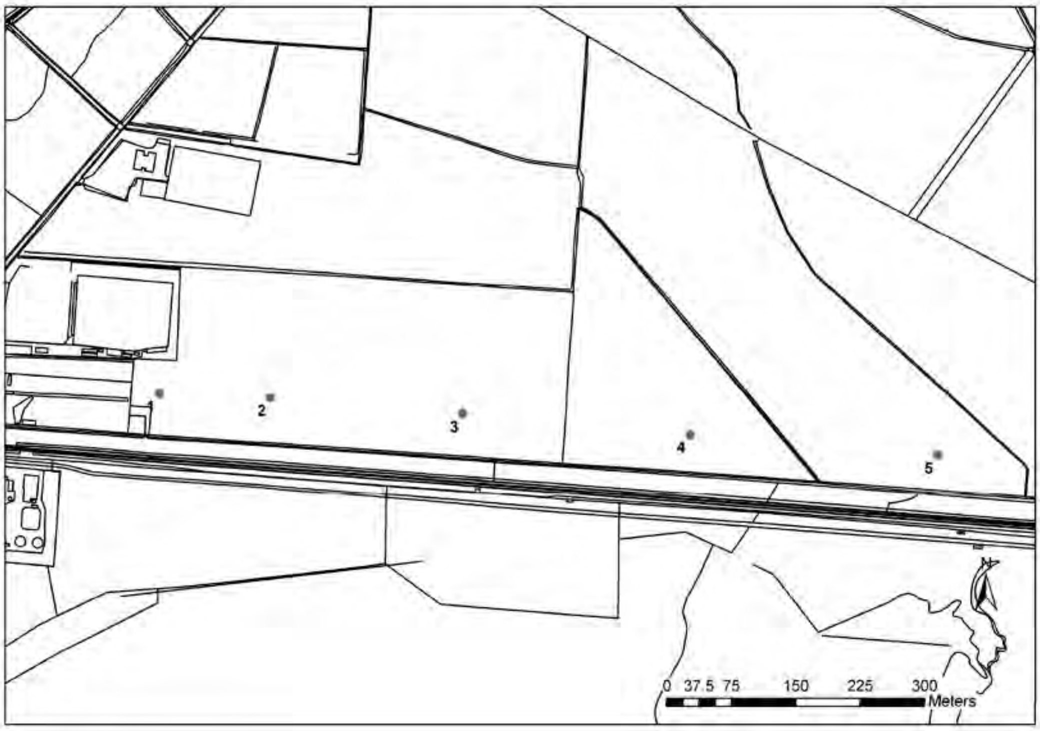

Figure 2: Borehole locations (cores 1-5) at south eastern end of study area.

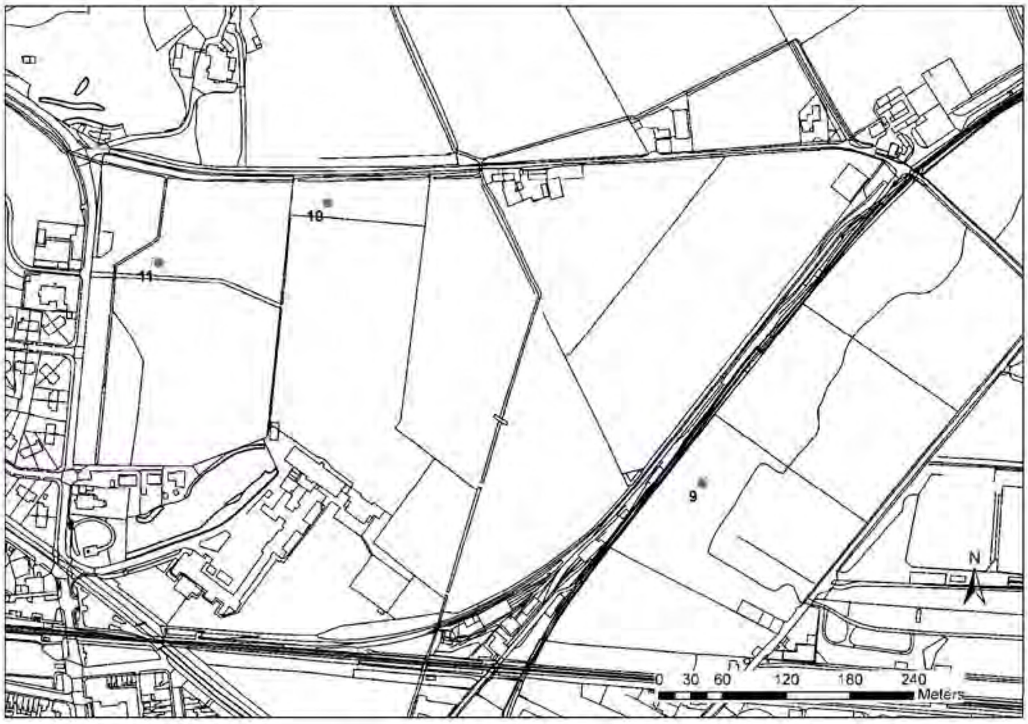

Figure 3: Borehole locations (cores 9-11) in central section of study area.

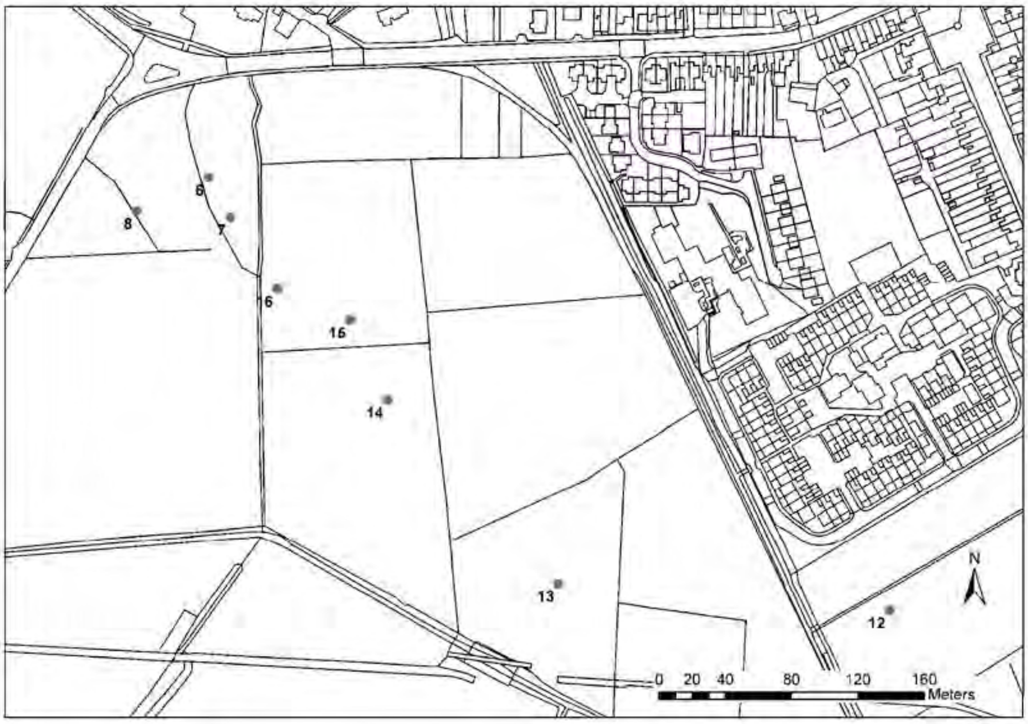

Figure 4: Borehole locations at north western end of study area

Borehole Logs

Core 1
0-1.45m: Buff sand becoming silty and wetter with depth (Gmin 3, Ag 1)
SH 57616 39653

Core 2
0-1.50m: Buff sand some iron mottling, greyer and silty with depth, occasional shelly fragments (Gmin 4, Pt.m.+)
SH 57748 39648

Core 3
0-1.45m: Buff sand becoming grey and silty with depth (Gmin 4, Ag +)
SH 57972 39619

Core 4
0-1.20m: Buff sand becoming silty with depth, wet at base (Gmin 4, Ag +)
SH 58238 39595

Core 5
0-0.60m: Buff sand becoming grey and wet with depth (Gmin 4, Ag +)
SH 58516 39567

Core 6
0-1.00m: Loose grey silty clay, modern rootlets (As 3, Ag 1, Dh +)
1.00-1.25m: Blue-grey smooth silty clay (As 3, Ag 1)
SH 55626 40537

Core 7
0-0.30m: Coarse grey silty clay (As 3, Ag 1)
0.30-1.50m: Blue grey sandy clay (As 3, Gmin 1)
SH 55662 40498

Core 8
0-0.30m: Coarse blue grey sandy clay (As 3, Gmin 1)
0.30-0.60m: Buff medium coarse sand (Gmin 4)
SH 55631 40469

Core 9
0-0.10m: Sandy topsoil
0.10-1.00m: Buff medium coarse sand becoming grey with depth (Gmin 4)
SH 57217 39759

Core 10
0-10m: Sandy topsoil

0.10-1.00m: Buff medium coarse sand becoming grey and saturated with depth (Gmin 4)
SH 56886 40022

Core 11
0-10m: Sandy topsoil
0.10-1.00m: Buff medium coarse sand (Gmin 4)
SH 56719 39980

Core 12
0-0.50m: Fine grey sandy silt becoming clay rich at depth (Ag 3, As 1)
0.50-1.75m: Blue grey silts with sandy lenses (Ag 4, Gmin +)
SH 56124 40290

Core 13
0-50m: Grey mottled silty clay becoming sandy at depth (As 3, Ag 1)
0.50-1.75m: Grey fine sand becoming coarser at depth (Gmin 4)
SH 55919 40264

Core 14
0-60m: Grey mottled silty clay (As 3, Ag 1)
0.60-1.20m: Silty grey sand
SH 55837 40400

Core 15
0-1.00m: Grey silty sand (Gmin 3, Ag 1)
SH 55750 40418

Core 16
0-1.00m: Grey silty sand becoming saturated with depth (Gmin 3, Ag 1) H 55696 40469

17.2 Appendix VI.2: Assessment of pollen, macrofossils and beetle remains in deposits near Minffordd

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(Birmingham Archaeo-Environmental)

17.2.1 Summary

During the removal of overburden from the proposed line of the Porthmadog/Tremadog bypass deposits were encountered that had the potential for the preservation of organic remains suitable for palaeoenvironmental analysis. A core was recovered using a Russian auger from which a 1 metre of sediment was collected with accompanying bulk samples.

Sub-fossil pollen, plant and beetle remains have been extracted whilst two samples of wood (near top and base) have been dated using the radiocarbon method. The dates show that the sediment was formed during the Bronze Age. The pollen assessment illustrates an alder carr environment with a birch and oak woodland which later becomes more open indicating a period of clearing. The plant macrofossil record highlighted intrusive woody root material which offered little interpretable value to the understanding of the formation of the deposit. Coleoptera remains were absent from the bulk samples. The report also makes recommendations for full analyses of the pollen samples.

17.2.2 Introduction

In July 2010 Birmingham Archaeo-Environmental were commissioned on behalf of Gwynedd Archaeological Trust to undertake environmental sampling at Minffordd, Porthmadog (NGR SH 60162 38625). Previous work at the site included a program of coring along the route of the proposed bypass between Porthmadog and Tremadog (Gearey and Krawiec 2010). This survey indicated that any deposits with palaeoenvironmental potential would probably be deeply buried beneath the fluvial deposits of the Traeth Mawr estuary. It also noted that there may be residual pockets of sediment that may be encountered outside of the area selected for coring. During the groundworks of the bypass just such a deposit was encountered at Minffordd, directly to the south of the Ffestiniog railway line (Fig.1 and 2)

17.2.3 Methods

17.2.3.1 Russian Auger Sampling

As the area to be investigated was relatively small, a sampling location was chosen that could be accessed with a mechanical digger. The top 0.14m of sediment was removed using a shovel as the ground had been disturbed up by heavy plant. A core was then taken using a standard pattern Russian Auger. The recovered sediment was placed into a length of tubing and wrapped in cling film. Eight accompanying 10L bulk samples were also recovered. As well as the Russian auger 6 smaller cores were taken, using a Eikjelcamp gouge corer, adjacent to the sample site (Fig.3).

17.2.3.2 Stratigraphic Analysis

The stratigraphy of the deposits was logged in the field using the Troels Smith (1955) method and the locations of the cores were recorded using a dGPS provided by the client.

17.2.3.3 Pollen Assessment

Twelve sub-samples were taken from the Russian core for pollen assessment at 0.08m intervals. Pollen preparation followed standard techniques including potassium hydroxide (KOH) digestion, hydrofluoric acid (HF) treatment and acetylation (Moore *et al.,* 1991). At least 125 total land pollen grains (TLP) excluding aquatics and spores were counted for each sample.

17.2.3.4 Plant Macrofossil Assessment

Three (sample 8, sample 5 and sample 2) of the bulk samples were processed for plant macrofossil and beetle assessments. The bulk samples were processed using the standard method of paraffin flotation outlined in Kenward *et al.* (1980). The insect remains were then sorted from the paraffin flot. The resultant flot remainders together with the paraffin residue were then washed through a sieve with 300μm mesh using a mixture of detergent and water in order to remove the paraffin from the remaining organic material. The samples were then sorted in order to retrieve waterlogged plant-macrofossils.

Plant material was identified under a low power binocular microscope at magnifications of x10 and x40. Identification was aided by use of a modern comparative collection and by using various seed identification manuals (Anderberg, 1994; Beijerinck 1947 and Berggren 1969 & 1981 and Cappers *et al* 2006). Nomenclature and habitat information follows Stace (1997).

17.2.3.5 Beetle Assessment

The insect remains were sorted from the paraffin flot as described above and the sclerites identified under a low power binocular microscope at x10 magnification. The system for “scanning” faunas as outlined by Kenward *et al.* (1985) was followed. This assessment was undertaken to answer the following questions:

Are any insect remains of interpretative value preserved?

Do any of the insects present suggest the nature of the surrounding environment at the time of deposit formation?

Do any of the insects indicate the nature of human activity at and around the site?

17.2.4 Results

The bore holes indicated that the organic deposits were present at consistent depth across this small area (Fig.1 and 2). The deposit was still well saturated at the time of sampling which reflects the poor permeability of the underlying bedrock

This bedrock was overlain by a 1m thick deposit of well humified, silty peat with was weak silty laminations.

This deposit trended into a thin layer of black, well humified silty peat 0.08m thick which in turn was overlain by a degraded rooty well humified silty peat through which the turf was growing.

The sediment became increasingly woody with depth with well-preserved branches and twigs present. Several ‘bog oaks’ had already been removed from the deposit in other this general area, although none was observed *in situ*. The abundance of sub-fossil wood indicates the presence of trees on the sampling site during deposit accumulation (see below). The silt content and associated laminations suggesting periods of in-wash of mineral matter and/or the presence of shallow standing water on the site.

17.2.4.1 Radiocarbon dating

The results of the radiocarbon dating are summarised in Table 1. Radiocarbon dates were calibrated using Intcal04 (Reimer *et al*., 2004). The basal peat sample (0.90m depth) dated to 3460±40 BP (Cal BC 1890 to 1680, Cal BP 3840 to 3630, Beta282592). The sample (0.40m depth) dates to 3690±40 BP Cal BC 2200 to 1960 (Cal BP 4150 to 3910, Beta282591).

17.2.4.2 Pollen Assessment

All of the pollen samples displayed excellent concentration and preservation of palynmorphs for palaeoenvironmental interpretations. The results are presented in the form of a pollen diagram (Fig.4), produced using TILIA and TILIA*GRAPH (Grimm 1991). To facilitate discussion, the diagram has been provisionally divided into three local pollen assemblage zones with the site prefix ‘PM’. All percentage figures are of Total Land Pollen (TLP) unless otherwise specified.

PM-1: 1.00-0.33m, Alnus-Betula-Quercus

The basal zone (PM-1) is dominated by tree and shrub pollen (up to 100%). The majority of this consists of *Alnus glutinosa* (alder) and *Betula* (birch) reaching values between 60-80%. *Alnus* and *Betula* fluctuate throughout; with rises in *Alnus* associated with respective declines in *Betula* and vice versa. It is probable that *Alnus* was growing on the sampling site itself and the sub-fossil wood remains in the peat may reflect the presence of this tree. *Betula* will also grow on poorer, peaty soils and this tree was probably also present on and/or close to the sampling site. *Quercus* (oak) reaches up to 55% at 0.78m, then declines and maintains values between 10-20% throughout the rest of the zone. *Quercus* (*Q. petrea*) may also grow on acidic soils. *Corylus avellana*-type (hazel) maintains low but consistent values <10% and it is probable that this tree/shrub was present in the wider landscape. Other trees and shrubs are rare but include occasional grains of *Ulmus* (elm), *Pinus sylvestris* (pine), Ericaceae (heather family), *Hedera helix* (ivy) and *Ilex* (holly).

Herbaceaous pollen is also recorded in low proportions and is represented mainly by Poaceae (wild grasses) at between 5-15% and Cyperaceae (sedges) which peak at 0.70m at just over 20%. Spores are present in the form of *Polypodium vulgare* (common polypody), *Pteridium aquilinium* (bracken) and Pteropdia (monolete) indet. (ferns).

The local environment on and around the sampling site would have been dominated by alder carr with birch with oak and hazel probably established on the drier soils. At the base of the diagram there is a fairly rapid decline in alder and a rise in oak which would suggest the site becoming somewhat drier as peat accumulation progressed, resulting in more favourable conditions for oak. Alder rises again alongside the peak in sedges which perhaps indicate a shift back to wetter conditions locally. Towards the top of the zone grasses expand at the expense of alder. It is possible that this indicates vegetation changes on the sampling site itself, with more open vegetation including wetland grasses such as *Phragmites* (common reed) replacing the fen vegetation.

PM-2: 0.33-0.14m, Poaceae-Corylus-Betula

Arboreal pollen continues to dominate this zone but at decreased values of between 60-80%. *Corylus* increases to become the dominant woodland species (up to 35%). *Betula* and *Alnus* have declined by the top of the zone to values between 5-10%. *Quercus* maintains consistent values between 10 and 20%. Other trees and shrubs are rare with a slight increase in Ericaceae to values <5% along with a single grain of *Salix. Ulmus, Pinus, Hedera helix* and *Ilex* have declined completely.

Herbaceous pollen increases up to 40% which largely consists of Poaceae up to 35% and Cyperaceae at up to 5%. The range of herbs present has increased from PM-1 and includes Caryophyllaceae (pink family), *Centaurea nigra* (common knapweed), Chenopodiaceae (fat hen), *Cirsuim*type (thistles), *Filipendula* (meadowsweet), Lactuceae (dandelions), *Plantago lanceolata* (ribwort plantain) and Rosaceae (rose family) at low values <5%. *Sphagnum* is also recorded at values up to 10% TLP+spores whilst *Polypodium*, *Pteridium* and Pteropsida are present at trace values (<1%).

The environment has become more open in comparison to the previous zone with grasses (*Phragmites*) colonising the wetter areas of the sampling site along with tall herbs such as meadowsweet and members of the pink family. Grassy meadow communities are also represented by dandelions and thistles. The presence of fat hen and ribwort plantain indicates disturbed possibly ruderal environments, with the latter particularly linked to human activity (Behre, 1981). The variety of habitats represented in the herbaceous flora along with the decline in arboreal species such as alder and birch would suggest some clearance/disturbance to the woodland, quite probably by human agency. The increase in hazel could indicate further human manipulation of the woodland as hazel is often favoured for coppicing. Alternatively, this may reflect an increased representation of extra-local vegetation associated with the reduction in the on-site tree cover.

17.2.4.3 Plant macrofossil and Beetle Assessment

The results are presented in stratigraphic sequence lowermost first. A brief summary of the processing method and an estimate of the remaining volume of unprocessed sediment are recorded (in brackets):

0.84 to 1.00m

Sample 8 (1 kg/1 litres sieved to 300 microns with washover; approximately 4 litres of unprocessed sediment remain): Moist, dark brown, soft and slightly sticky to crumbly (working soft), amorphous organic sediment, with rootlets common, more substantial ‘woody’ root and wood fragments present and a single large fragment of slate (to 200 mm). The wet residue (~250ml) was mostly of fine rootlet and indeterminate plant detritus, with some more substantial ‘woody’ root fragments, a little fine charcoal (to 6 mm; indeterminate) and occasional small fragments of rotted wood and small stones (both to 15 mm). Amongst the wood were some twig fragments (all very rotted and soft) a few of which retained bark and represented only a few years of growth; the wood structure was too decomposed for species identification. Also present were a few ‘granules’ (to 2 mm) of burnt organic matter (charred – possibly burnt peat?) and lumps of un-disaggregated sediment (to 1 mm). No beetle remains were seen.

0.54 to 0.64m

Sample 5 (1 kg/1 litres sieved to 300 microns with washover; approximately

litres of unprocessed sediment remain):

Moist, dark brown, soft and slightly sticky (working more or less soft and very sticky), amorphous organic sediment, with rootlets common and more substantial ‘woody’ root present.

The wet residue (~200 ml) was mostly of quite ‘woody’ root, with some finer rootlet and some other more substantial fragments, occasional small fragments of very rotted wood (to 6 mm, including some very soft, indeterminate roundwood twig fragments of only a few years growth and retaining bark), a trace of very fine charcoal (to 2 mm) and a few lumps of un-disaggregated sediment (to 1 mm). There were also a few small stones and some sclerotia of a soil-dwelling fungus (*Cenococcum geophilum* Fr.). No beetle remains were seen.

0.24 to 0.34 m

Sample 2 (1 kg/1 litres sieved to 300 microns with washover; approximately

1.5 litres of unprocessed sediment remain):

Moist, dark brown to dark grey(ish) brown, brittle to slightly crumbly (working soft), amorphous organic sediment, with rootlets common.

The wet residue (~175 ml) was mostly fine rootlet, with some plant detritus, a few small stones (to 13 mm, most to 5 mm), occasional very rotted wood fragments (to 6 mm; indeterminate) and ?part-charred peat (to 8 mm), a trace of very fine charcoal (to 2 mm) and a few small lumps of disaggregated sediment (to 1 mm). There were also a few heavily degraded leaf fragments (leaf ‘skeleton’ fragments), a few possible rush (cf. *Juncus*) capsules (very poorly preserved being very pale, distorted and ‘filmy’) and occasional indeterminate ?‘seed’ fragments. Sclerotia of a soil-dwelling fungus (*Cenococcum geophilum* Fr.) were quite numerous. A few scraps of indeterminate insect cuticle were present, together with a single mite (cf. *Acarina* sp.; probably modern) and a few earthworm egg capsules (almost certainly intrusive).

17.2.5 Discussion and Conclusions

The sampling location would seem to represent an area of topogeneous peat accumulation, probably within a shallow depression within the local bedrock. The processes leading to peat inception are unclear but may be associated with increased wetness related to external factors such as climatic change. Alternatively, disturbance to the environment, possibly by human activity, might lead to localised waterlogging through the removal of trees/shrubs. However, there is no palynological evidence for such anthropogenic disturbance until towards the top of the sequence (zone PM-2, see above). The sequence (0.90m) is dated to between 3460±40 BP (Cal BC 1890 to 1680, Cal BP 3840 to 3630, Beta282592) and (0.40m depth) 3690±40 BP Cal BC 2200 to 1960 (Cal BP 4150 to 3910, Beta-282591); hence, the basal date is somewhat later than the upper date. This may indicate that the sediment accumulated fairly rapidly, as the two dates bracket only 0.50m of sediment. This interpretation may be supported by the fact that the stratigraphy and macrofossil assessments suggest that the sampled sediment incorporated in-washed material including that from dryland soils (charcoal and *Cenoccocum* sclerotia). Minerogenic sediment such as this can accumulate relatively rapidly. Alternatively, one of the dates may be in error; the basal wood sample may be intrusive from the shallower peat, for example. It is not clear which of the above processes may be involved. However, it can be stated that the two dates do indicate that the deposit dates broadly to the Bronze Age. Most of the macroscopic organic remains recovered from the subsamples from the deposits were of rootlet with more substantial 'woody' root material indicating disturbance to the deposits. Probable ancient remains were restricted to poorly preserved wood and twig fragments (unidentified to species) from the two lower deposits, traces of fine indeterminate charcoal (present in each of the subsamples), possible charred (or part-charred) peat (in the upper and lower deposits) and perhaps the few very poorly preserved plant macrofossils from the uppermost deposit (mostly unidentified but possibly including rush capsules). Invertebrate remains were wholly absent from the two lower deposits and the few noted in the upper deposit were almost certainly representative of modern intrusions (e.g. earthworm egg capsules). The poor preservation of the material is probably related to the fact that local hydrological conditions were marginal for peat formation. In addition, the evidence for the incorporation of remains from dryland contexts may also explain the poor preservation.

The pollen record illustrates alder became established on the sampling site itself following peat inception, with this tree favouring the waterlogged soils. Birch and oak were components of the local woodland throughout most of the sequence, whilst hazel was growing in the wider environment. Conditions subsequently became more open with a decline in arboreal species indicating a period of woodland clearance. The record of herbs indicates the expansion of grassland, typical of pastoral environments in the close vicinity of the site. There is no evidence for arable habitats, but the pollen source area for this sort of deposit can be regarded as heavily biased towards local vegetation (i.e. that growing within tens of metres of the site). The only plant macrofossil remains recovered from the subsamples that might have derived from this human activity were the charcoal (all three deposits) and small lumps of charred/part-charred peat (sample 2 and sample 8) but these small amounts of material could also have resulted from natural fires.

17.2.6 Recommendations for Further Analysis

The pollen samples produced excellent concentrations and preservation of palynmorophs throughout the entire sequence. Few other palaeoenvironmental records exist in this region; hence the pollen record can be regarded of regional importance. This sequence has the potential to shed light on environmental change and human activity during the Bronze Age, in a region which is short of such data. It is therefore recommended that full analysis of the pollen sequence is undertaken with additional radiocarbon dating to establish a more robust chronology. The roundwood twig fragments recovered from the two lower samples could not be identified to species they would probably provide sufficient material for radiocarbon dating (via AMS), if required. Although the sediment matrix of each of the bulk samples analysed was clearly primarily organic; the paucity of interpretatively valuable macroscopic remains recovered from the subsamples provided few insights into the formation of the deposits. No further study of the macrofossil or insect remains from these deposits is therefore warranted.

17.2.7 References

Anderberg, A. L., 1994. *Atlas of seeds, Part 4 Resedaceae-Umbelliferae.* Sweden: Risbergs Tryckeri AB.

Behre, K.E. 1981. The interpretation of anthropogenic indicators in pollen diagrams. *Pollen et Spores* 23, 225-243.

Berggren, G., 1981 *Atlas of seeds and small fruits of Northwest-European plant species with morphological descriptions.* Stockholm: Swedish Museum of Natural History.

Berggren, G., 1969 *Atlas of seeds, Part 2, Cyperaceae:* Stockholm, Swedish Natural Science Research Council.

Cappers, R., Bekker, R., and Jans, J., 2006.

Digitalezadenatlas Van Nederland.

Groningen: Barhuis Publishing & Groningen University Library.

Dainton, M. (1992). A quick, semi-quantitative method for recording nematode gut parasite eggs from archaeological deposits. *Circaea, the Journal of the Association for Environmental Archaeology* **9**, 58-63.

Gearey, B.R and Krawiec, K 2010 A palaeoenvironmental assessment of deposits on the line of the Porthmadog Byass, Gwynedd, North Wales. BAE report 2042a

Kenward, H. K., Engleman, C., Robertson, A. & Large, F., 1985. Rapid Scanning of Urban Archaeological Deposits for Insect Remains. *Circaea* 3, 163-72.

Kenward, H. K., Hall, A. R., & Jones, A. K. G., 1980. A Tested Set of Techniques for the Extraction of Plant and Animal Macrofossils from Waterlogged Archaeological Deposits. *Scientific Archaeology* 22, 3-15.

Moore, P. D., Webb, J. A. & Collinson, M. E. 1991. *Pollen Analysis*, 2nd Edition. Blackwell Scientific Publications, Oxford.

17.3 Appendix VI.3: Full analysis of pollen in deposits near Minffordd

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17.3.1 Summary

This report presents the results of the full pollen analysis and radiocarbon dating of a sediment sequence from Minffordd, Porthmadog, Gwynedd. The radiocarbon dates suggest that the sampled deposit accumulated during the Bronze Age, but the available chronology does not permit greater precision. The pollen data indicate the presence of alder-oak-birch woodland on the sampling site, with hazel dominated woodland in the wider landscape. Fluctuations in the woodland taxa for much of the sequence are interpreted as reflecting natural processes of competition between the local trees. However, a marked reduction in the woodland taxa towards the top of the diagram indicates clearance of the woodland by Bronze Age communities, possibly for pastoral agriculture. This event did not appear to affect the hazel woodland, implying that the landscape remained at least partially wooded.

17.3.2 Introduction

During the groundworks of the Minffordd-Porthmadog bypass 1m of well humified, silty peat was encountered and Birmingham Archaeo-Environmental (BA-E) was subcontracted to undertake a palaeoenvironmental assessment of these deposits by Gwynedd Archaeological Trust (GAT). The assessments demonstrated considerable palaeoenvironmental potential in the form of the pollen record and recommended full analyses with further radiocarbon dating (Krawiec *et al*, 2010). This report describes the results of these further analyses.

17.3.3 Methods

17.3.3.1 Pollen Analysis

Twenty two sub-samples from the sediment core were taken for pollen analyses at 0.04m intervals. Pollen preparation followed standard techniques including potassium hydroxide (KOH) digestion, hydrofluoric acid (HF) treatment and acetylation (Moore *et al.,* 1991). At least 300 total land pollen grains (TLP) excluding aquatics and spores were counted for each sample.

17.3.3.2 Radiocarbon Dating

A further 3 samples (0.16m, 0.32m and 0.76m) from the peat were submitted to Beta Analytic Ltd for AMS dating.

17.3.4 Results

17.3.4.1 Radiocarbon dating

The results of the radiocarbon dating are summarised in Table 1 with all calibrations calculated using Intcal04 (Reimer *et al*., 2004). The basal sample (sub-fossil wood; 0.90m) was dated to 3460±40 BP (Cal BC 1890 to 1680, Cal BP 3840 to 3630, Beta-282592). The sample (peat) from 0.76m was dated to 3100±30 BP (Cal BC 1430 to 1310, Cal BP 3380 to 3260, Beta-321014). The sample (sub-fossil wood) from 0.40m produced a date of 3690±40 BP (Cal BC 2200 to 1960, Cal BP 4150 to 3910, Beta-282591). The sample (peat) from 0.32m was dated to 1390±30 BP (Cal AD 610 to 670, Cal BP 1340 to 1280, Beta-321013). The top sample from 0.16m (peat) was dated to 3660±30 BP (Cal BC 2140 to 1950, Cal BP 4080 to 3900, Beta-321012). Thus all the radiocarbon dates with the exception of that from 0.32m yielded determinations with overlapping calibrated ranges. This probably indicates that the entire sequence accumulated relatively rapidly during the Bronze Age. The determination from 0.32m of 1390±30 BP (Cal AD 610 to 670, Cal BP 1340 to 1280, Beta-321013) is probably erroneous, resulting from the ‘younging’ of the sample through root penetration from the overlying peat deposits.

17.3.4.2 Pollen Analysis

All of the pollen samples produced sufficient concentrations of palynomorphs for palaeoenvironmental interpretation. However, pollen concentrations and preservation varied throughout the sequence with some samples displaying excellent preservation and extremely high concentrations, particularly sample 0.83m. Four of the samples (0.19m, 0.27m, 0.31m and 0.39m) contained split and broken grains and others which exhibited signs of corrosion. The results are presented in the form of a pollen diagram (Figure 1), produced using TILIA and TILIA*GRAPH (Grimm 1991). To facilitate discussion, the diagram has been provisionally divided into three local pollen assemblage zones with the site prefix ‘PM’. All percentage figures are of Total Land Pollen (TLP) unless otherwise specified.

PM-1: 0.95-0.33m, *Alnus-Quercus-Betula*

The basal zone (PM-1) is dominated by tree and shrub pollen (95-100% TLP). The majority of this consists of *Alnus glutinosa* (alder), *Quercus* (oak) and *Betula* (birch). *Betula* and *Quercus* fluctuate throughout; with rises in *Betula* associated with respective declines in *Quercus* and vice versa. It is probable that *Alnus* was growing on the sampling site itself and the sub-fossil wood remains in the peat may reflect the presence of this tree. *Betula* and *Quercus* can also grow on acidic, nutrient poor soils and may have been growing close to the sampling site; although interpretation is hindered slightly by lack of knowledge of the species involved. *Corylus avellana*-type (probably hazel rather than sweet gale) maintains low but consistent values around 10% in the first half of this zone but then increases to c. 30% at 0.55m. *Corylus avellana* scrub/woodland was hence probably prevalent on the better drained soils beyond the wetland edge. Other trees and shrubs are rare but include occasional grains of *Pinus sylvestris* (Scots’ pine), *Fraxinus excelsior* (ash), *Ulmus* (elm), *Tilia* (lime), *Calluna vulgaris* (heather), *Ilex* (holly) and *Salix* (willow). These trees/shrubs were probably not dominant components of the local vegetation although the latter two taxa (*Salix* and *Ilex*) tend to be poorly represented palynologically and as such may have been present in the local woodland.

Herbaceous pollen is recorded in low proportions and represented mainly by Poaceae (wild grasses) and Cyperaceae (sedges) at between 5-10%. The local environment therefore appears to have been dominated by *Alnus* fen with *Betula* and *Quercus* also perhaps growing on the poorer drained soils as well as with *Corylus* in the wider landscape. Aside from Poacaeae and Cyperaceae, very few other herbs are recorded implying largely closed canopy conditions. The ferns Pteropsida and *P. vulgare* form low but consistent curves and are typical of such shady, damp woodland; the latter is often also an epiphyte on oak trees.

PM-2: 0.33-0.15m, Poaceae-*Corylus avellana*-type

Arboreal pollen continues to dominate this zone but at decreased values of around 55%, of which *Corylus* increases to become the dominant woodland species (up to 40%) whilst *Betula* and *Quercus* decrease to values up to 10% and *Alnus* between 5-10%. An isolated peak of 20% *Calluna vulgaris* is apparent at 0.27m. Other trees and shrubs are rare with occasional grains of *Fraxinus* and *Ulmus* and single grains of *Hedera helix* and *Salix*. *Ilex* has disappeared from the record completely.

Herbaceous pollen increases up to 45% which largely consists of Poaceae (up to 40%) along with Cyperaceae, *Plantago lanceolata* (ribwort plantain) and *Potentilla* (tormentil) all at 5%. A range of other herbs appear at trace values including Apiacaeae (the carrot family), *Aster*-type, Brassicaceae (the cabbage family), *Caltha* (marsh marigold), Caryophyllaceae (pink family), *Cirsium*-type (thistles), *Ranunculus acris* (meadow buttercup), Rosaceae (rose family) and *Rumex*-type (docks). Spores are present in the form of *Sphagnum* (bog moss), whilst *Polypodium vulgare* (common polypody) and Pteropsida (monolete) indet. (ferns) have disappeared almost completely from the record. Aquatics are rare but include single grains of *Sparganium* indet. (bur-reed) and *Potamogeton* (pondweed).

The implied environment in PM-2 has become more open in comparison to the previous zone. Taxa such as *Potentilla*, *Valeriana* (valerian) and Chenopodiaceae (goosefoot family) are perhaps indicative of the ground flora of fen environments on the sampling site. The peak in *Calluna vulgaris* is notable as this is a low pollen producer and is insect pollinated and this may indicate an expansion in this shrub on the surface of the sampling site itself. Limited areas of open water are also indicated by the presence of the aquatic plants. Grassy meadow communities on the areas around the wetland are implied by Lactuceae (dandelions), *Cirsium*-type (thistles) and *P. lanceolata* with the latter possibly indicating ruderal environments (Behre, 1981). The variety of habitats represented in the herbaceous flora along with the decline in arboreal species such as *Alnus* and *Betula* would suggest clearance/disturbance to the woodland, quite probably by human agency (see below).

17.3.5 Discussion

The sampling site is located in an area of topogeneous peat accumulation, probably in a shallow depression within the local bedrock. The processes leading to peat inception are unclear but may be associated with increased wetness related to external factors such as climatic change. Alternatively, disturbance to the environment, possibly by human activity, might lead to localised waterlogging through the removal of trees/shrubs. However, there is no unequivocal palynological evidence for such anthropogenic disturbance until towards the top of the sequence (see below).

Four (0.16m, 0.40m, 0.76m and 0.90m) of the five radiocarbon dates for this sequence are dated to the second-third millennium BC indicating that the pollen record reflects a Bronze Age phase of landscape development. The two basal dates (0.76m and 0.90m) are somewhat later than the upper dates. This may indicate that the sediment accumulated fairly rapidly, as these two determinations bracket only 0.50m of sediment. This interpretation may be supported by the fact that the stratigraphy and macrofossils assessments (Krawiec *et al*. 2010) suggested that the sampled sediment incorporated in-washed material from dryland soils in the form of charcoal and *Cenoccocum* sclerotia. Minerogenic deposits can accumulate relatively rapidly due to the deposition of such allochthonous material. It is likely that the fifth date from 0.32m is in error as this is dated to the Anglo-Saxon period; it is possible that intrusive rootlets from the shallower peats may have penetrated the lower deposits introducing younger carbon which has contaminated the radiocarbon sample.

The basal zone indicates a closed canopy fen woodland environment on and around the sampling site. There is evidence for changes in this local vegetation throughout PM-1, generally involving *Betula*, *Quercus* and *Alnus* and thus implying fluctuations in the relative composition of the woodland canopy on and around the sampling site. At the base of the diagram there is a slight decline in *Alnus* and a rise in *Quercus* and *Betula*. A small peak in Cypercaeae at around 0.72 m is followed by a rise in *Alnus*. *Betula* increases between 0.45-0.60m, apparently at the expense of both *Alnus* and *Quercus*, whilst towards the top of the zone Poaceae expands at the expense of *Alnus*. It is probably unwise to read too much into these variations, which almost certainly reflect autogenic processes related to localised vegetation change close to and on the wetland itself. Whilst it is possible that external factors such as climatic change might be implicated in some way with these subtle changes in the composition of the wetland vegetation, the current data are insufficient to reconstruct these with any confidence.

Factors which would have affected the composition of the woodland include relative fluctuations in the depth of the water table, which would in turn be connected to processes and rates of peat accumulation controlled by autogenic as well as allogenic (e.g. climatic) factors. Hence, drier conditions probably favoured *Quercus* and *Betula* over *Alnus,* whilst wetter conditions would lead to increases in *Alnus* and perhaps other fen taxa such as Cyperaceae*.* There appears to be a negative relation between *Quercus* and *Betula* in particular, with an increase in one equating to a reduction in the other. The processes which might have resulted in this pattern are difficult to reconstruct but were probably also related to natural competition amongst the main woodland trees.

The representation of other taxa which may not necessarily have been growing on the sampling site itself (i.e. extra-local as well as regional vegetation) would also be affected by changes in the local vegetation. For example, the expansion in *Corylus* near the top PM-1 is closely associated with a reduction in *Alnus*. Interpretation is hindered slightly by the fact that that the pollen source area of the sampling site would have fluctuated in line with the openness of the vegetation on the site itself. Hence, these increased percentages of *Corylus* may not necessarily reflect an actual areal increase in this tree/shrub, but may be associated with enhanced influx of pollen from extra-local sources following the reduction in *Alnus* after c. 0.55m. Increases in Poaceae are also difficult to interpret, as this taxon may include both dryland grasses as well as wetland species such as *Phragmites* (common reed).

There is clear evidence in PM-2 for a substantial reduction in the woodland cover, with significant reductions in *Betula*, *Alnus* and *Quercus*, whilst *Corylus* also displays an initial reduction but then increases steadily across the zone. Poaceae displays a marked rise at the opening of the zone, but there is little marked response from other herbs aside from *Potentilla* and *P. lanceolata*. It would seem likely that the spread of grassland was related to the clearance of woodland at this location by human communities during the Bronze Age. However, any such activity did not result in the complete removal of the woodland cover, but targeted the birch, oak and alder trees, whilst hazel seems to have remained largely unaffected. Ribwort plantain and tormentil suggest open pastoral environments, with the latter typical of slightly acid grassland, although percentages remain relatively low. Other herbs which are recorded in low and sporadic quantities include Chenopodiaceae, Caryophyllaceae, *Rumex* and *Plantago major*.

Aside from *P. major* (greater plantain), which is strongly suggestive of disturbed soils, this suite of herbs might reflect pastoral vegetation typical of grazed meadows, but also include taxa found in more open fen environments. There is no record of cereal pollen. Taken collectively, the palynological data therefore indicate a phase of woodland clearance at this site during the Bronze Age, perhaps associated with pastoral agriculture. The available evidence indicates that this mainly affected the oak-hazel-birch cover but not the hazel scrub/woodland. The precise degree of openness of the wider landscape cannot be determined on the basis of the current diagram, and it is possible that this clearance event may have been impacted on a relatively limited area around the sampling site.

17.3.6 Conclusions

These data add to the body of palynological study in this area which has previously mainly focussed on the uplands of Snowdonia during the earlier Holocene (Ince 1983). The analyses provide a ‘snapshot’ of vegetation change for this area, probably for a relatively short period of time during the first-third millennium BC. The suite of radiocarbon dates does not permit the construction of a precise chronology for the implied sequence of events. Whilst detailed interpretation has not been possible, the pollen record indicates that this area was dominated by closed canopy woodland until the Bronze Age, with alder-oak-birch fen woodland growing on and around the wetland system represented by the sampled peat deposits. The drier soils beyond the peat accumulating system probably supported hazel scrub/woodland in which oak, birch and other deciduous taxa were also components, with willow, ivy and holly present in smaller quantities.

The fluctuations in the composition of the woodland for much of the sequence has been attributed to competition between the major arboreal taxa and probably associated with changes in edaphic conditions. The nature of the sampling site suggests that the pollen record is likely to reflect a relatively local picture of vegetation and the role of allogenic processes, if any, such as climate change cannot be determined on the basis of the current data. There is good evidence for anthropogenic clearance of the woodland, with reductions in the local alder-oak-birch vegetation, and the expansion of open grassy pastoral vegetation, although the persistence of hazel indicates that the local landscape was not completely deforested. Again, the overlapping nature of the calibrated radiocarbon dates and the likely presence of an erroneous determination around the level of the interpreted clearance event prevent a precise estimate of date.

17.3.7 References

Behre, K.E. 1981. The interpretation of anthropogenic indicators in pollen diagrams. *Pollen et Spores* 23, 225-243.

Gearey, B.R and Krawiec, K 2010 A palaeoenvironmental assessment of deposits on the line of the Porthmadog Byass, Gwynedd, North Wales. BAE report 2042a.

Ince, J. 1983. Two postglacial pollen profiles from the upland of Snowdonia, Gwynedd, North Wales. *New Phytologist*, 95, 159-172.

Krawiec,K., Hopla, E., Carrott, J and Gearey,B.R. 2010. Palaeoenvironmental assessment of deposits at Minffordd, Porthmadog Bypass, Gwynedd,North Wales. BAE Report.2042b.

Moore, P. D., Webb, J. A. & Collinson, M. E. 1991. *Pollen Analysis*, 2nd Edition. Blackwell Scientific Publications, Oxford.

Simmons, I.G. 1996. *Changing the Face of the Earth*. Blackwell, Oxford.

Lab no	Material	13C/12C	Radiocarbon Age	Calibrated Age
321012 0.16m	Peat: Acid/alkali/acid	-28.2 o/oo	3660+/-30 BP	Cal BC 2140 to 1950 (Cal BP 4080 to 3900)
321013 0.32m	Peat: Acid/alkali/acid	-29.0 o/oo	1390+/-30 BP	Cal AD 610 to 670 (Cal BP 1340 to 1280)
282591 0.40m	Wood: acid/alkali/acid	-26.0 o/oo	3690+/-40BP	Cal BC 2200 to 1960 (Cal BP 4150 to 3910)

321014 0.76m	Peat: Acid/alkali/acid	-29.2 o/oo	3100+/-30 BP	Cal BC 1430 to 1310 (Cal BP 3380 to 3260)
282592 0.90m	Wood: acid/alkali/acid	-29.7 o/oo	3460+/-40BP	Cal BC 1890 to 1680 (Cal BP 3840 to 3630)

Table.1. Radiocarbon dates from Porthmadog

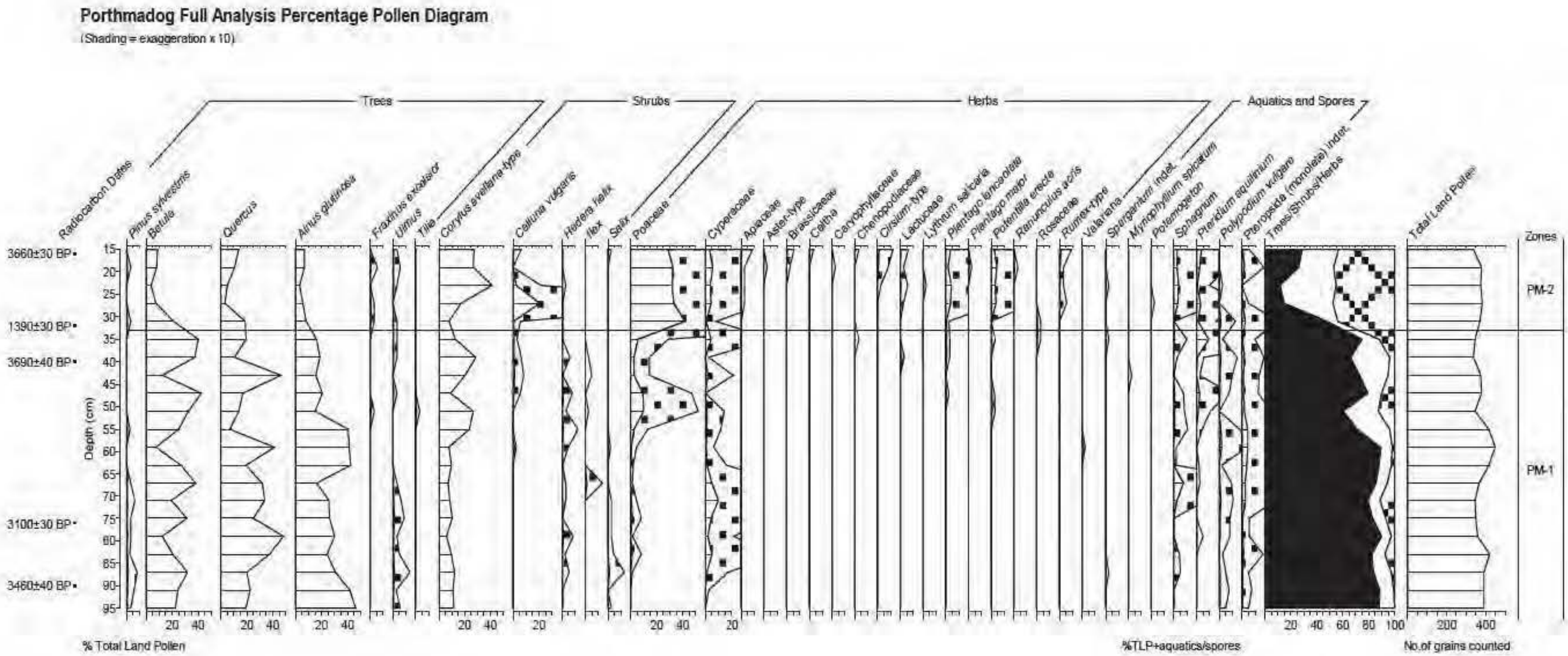

Figure.1. Porthmadog Percentage Pollen Diagram

18 APPENDIX VII: LIST OF FINDS AND SAMPLES

18.1 Appendix VII.1: Table of finds

Material	Find No	Context No	Area	Period	No of items	Weight (g)	Description
Bone							
	331	3200	F3	Unknown	59	20	Burnt bone fragments, unstratified on Y Bryn
	345	3020	F3	Roman	1	0.1	Very small fagment of burnt bone
	373	3048	F3	Roman?	1	1	Fragment of an incisor, cow.
	390	37004	F37	medieval	3	4	Bone fragments, 1 burnt
	391	3100	F3	Roman	6	1	Burnt bone fragments
Burnt clay							
	303.2	3001	F3	Roman	1	78	Burnt clay with finger-tip impression
	306	3001	F3	Roman	8	786	Burnt clay/kiln lining
	363	3001	F3	Roman	3	0.63	burnt clay
	375	3075	F3	Roman	0	818	burnt clay
	376	3075	F3	Roman	0	27.94	burnt clay partially 'glazed'
	377	3059	F3	Roman	0	666	Burnt clay
	378	3001	F3	Roman	17	26.92	Burnt clay
	379	3100	F3	Roman	0	13	Burnt clay
	380	3037	F3	Roman	3	10	Burnt clay
	382	3067	F3	Roman	4	54	Burnt clay
	384	3090	F3	Roman	0	50	Burnt clay
	385	3073	F3	Roman	0	366	Burnt clay
	386	3090	F3	Roman	1	16	Burnt clay with linear markings
	387	3103	F3	Roman	0	62	Burnt clay

Material	Find No	Context No	Area	Period	No of items	Weight (g)	Description
	388	3094	F3	Roman	1	0.56	Burnt clay
	389	3020	F3	Roman	0	392	Burnt clay
	400	3200	F3	Roman	0	0	Burnt clay and possible Roman tiles
Ceramic							
	304	3001	F3	Roman	1	103	Brick
	308	3004	F3	Roman	1	61	Mortarium sherd
	317	3001	F3	Roman	1	55	Mortarium rim
	318	3060	F3	Roman	1	229	Probable brick fragment
	320	3001	F3	Roman	1	47	Rim sherd, black burnished ware
	321	3001	F3	Roman	1	21	Black burnished ware rim
	322	3001	F3	Roman	1	33	Black burnished ware rim
	325	3069	F3	Roman	1	10	Black burnished ware rim
	327	3200	F3	Roman	1	17	Black burnished ware sherd
	328	3001	F3	Roman	1	24	Mortarium rim sherd
	335	3201	F3	Roman?	1	952	Fragment of probable Roman brick
	336	3201	F3	Roman	1	397	Fragment of red roofing tile
	337	3201	F3	Roman	1	96	Fragment of Roman box tile
	338	3201	F3	Roman?	1	88	Fragment of Roman tile
	367	0	F17	Post medieval	3	28	clay pipe bowls
	402	3200	F3	Roman	11	1100	Pieces of tile, unstratified
Charred plant remains							
	347	37004	F37	medieval	1	0.1	Hazelnut shell fragment
Copper alloy							
	310	3200	F3	PostMed	1	1	Coin
	316	3021	F3	Roman?	1	0.5	Small copper ring

Material	Find No	Context No	Area	Period	No of items	Weight (g)	Description
	330	3066	F3	Roman?	1	4	Copper alloy object
	332	3200	F3	Roman	1	1.5	Coin handed in by finder. 4th Century Valentinian I/II
Flint							
	1	3200	F3	Prehistoric	149	0	Unstratified flint flakes and other pieces
	301	3200	TP10 3	Prehistoric	1	0	Chert blade
	302	3200	TP10 3	Prehistoric	1	0	Broken flint blade
	309	3000	F3	Prehistoric	1	0	Broken flake, possibly re-touched
	311	3005	F3	Prehistoric	1	0	flake/waste blade
	312	3005	F3	Prehistoric	1	0	flake/waste blade
	329.1	3200	TP10 3	Prehistoric	1	0	Microlith found near TP103
	355	3053	F3	Prehistoric	1	0	Flint flake
	3001	3200	F3	Prehistoric	1	0	Fragment of leaf-shaped arrowhead
Iron							
	303.1	3002	F3	?	1	35	Ferrous object, possible nail shaft
	401	3049	F3	Roman?	2	191	Corroded lump composed of nails
	404	0		Post medieval	2	0	Cast-iron rail chairs. Found in service trench dug across route of tramway (PRN 33594)
Lead							
	326	3069	F3	Roman	1	18	Lead strip, bent
	334	3001	F3	Roman	1	26	A piece of lead sheet
Lead/Cu alloy							
	372	0	F27	Post medieval	26	260	Cartridge shells
Metalworking							
	341	3052	F3	Roman	3	0.1	Very small amount of possible hammerscale

Material	Find No	Context No	Area	Period	No of items	Weight (g)	Description
	346	3015	F3	Roman	0	138	Smithing microresidues
	352	3011	F3	Roman	0	9	Smithing microresidues
	359	3015	F3	Roman	15	4.36	Smithing pan
	392	3051	F3	Roman	17	0.28	Smithing microresidues
Natural							
	364	3001	F3	Natural	6	1	Natural concretions
	383	3052	F3	Natural	8	4	Natural concretions
Shell							
	348	37004	F37	medieval	11	0.5	Fragments of possible oyster shell?
	368	37004	F37	medieval	0	2302	Cockle shells
	393	3073	F3	Roman	1	0.1	Shell fragment
Slag							
	329.3	3011	F3	Roman	1	0.6	Slag
	339	3011	F3	Roman	1	0	Metal object
	340	3053	F3	Roman	0	0.39	Slag
	342	3090	F3	Roman	0	130	Burnt stone and slag
	343	3020	F3	Roman	14	0	Slag
	344	3073	F3	Roman	0	156	Slag/lime kiln waste product
	351	3059	F3	Roman	0	10.95	Small slag pieces
	354	3075	F3	Roman	20	3.07	Fuel ash slag
	357	3090	F3	Roman	6	2.3	slag
	358	3015	F3	Roman	5	2	slag
	371	3037	F3	Roman	6	37	slag
Stone							
	305	3001	F3	Roman	1	936	Vitrified stone
	307	3003	F3	Roman	1	1205	Vitrified stone
	313	3001	F3	Roman	1	181	Possible rubbing stone?
	314	3200	F3	Unknown	1	66	Possible whet stone
	319	3048	F3	Roman	1	4	Shale bracelet, broken fragment

Material	Find No	Context No	Area	Period	No of items	Weight (g)	Description
	323	3001	F3	Roman	1	274	Purple slates
	324	3001	F3	Roman	3	470	Vitrified stone
	329.2	3001	F3	Roman	1	50	Vitrified stone or ceramic
	333	3004	F3		1	910	Possible worked stone
	353	3075	F3	Roman	60	7.05	Vitrified stone
	356	3073	F3	Roman	2	12.3	Burnt stone/lumps of lime
	365	3075	F3	Roman	3	0.44	Oxidised stone?
	366	3073	F3	Roman	26	2.8	Lime waste from the kiln
	369	3020	F3	Roman	3	36	Vitrified stones
	370	3075	F3	Roman	4	26	Vitrified stone
	374	3200	F3	Roman?	1	9.42	Vitrified stone
	381	3103	F3	Roman	1	4	Vitrified stone
	394	3097	F3	Roman	3	628	Blocks of lime
	395	3073	F3	Roman	1	256	Vitrified stone
	396	3073	F3	Roman	1	396	Vitrified stone
	397	3073	F3	Roman	1	1955	Vitrified stone
	398	3073	F3	Roman	1	1625	Vitrified stone
	399	3001	F3	Roman	1	0	'Glazed' stone
	403	3049	F3	Roman	93	0	Roman roofing slates. 93 retained in total, including 9 with nails and 6 eaves slates, all complete.
Stone (unworked)							
	315	3033	F3	Natural	1	0	Unworked stone slab
	349	3075	F3	Natural	1	0.2	Natural object
	350	3003	F3	Natural	1	0	Natural stone
	360	3059	F3	Natural	1	0.31	Natural stone
	361	3003	F3	Natural	1	0.19	Natural rock
	362	3075	F3	Natural	1	0.5	Natural crystaline deposit

18.2 Appendix VII.2: Table of samples

Sample No	Context No	Field number	Context description	Sample volume (litres)	Flot weight (g)
1	3011	F3	Upper charcoal-rich fill of smithing pit [3010]	8	550
2	3015	F3	Lower charcoal-rich fill of smithing pit [3010]	2	61
3	3020	F3	Spread of burnt clay and charcoal at water's edge	8	3
4	3021	F3	Spread of charcoal	11	25
5	3038	F3	Alluvial deposit over 3021	8	2
6	3051	F3	Lower fill of smithing pit [3050]	2	61
7	3052	F3	Fill of smithing pit [3050]	2	47
8	3003	F3	Lower fill of hollow [3002] containing slates (3063)	7	28
9	3073	F3	Erosion deposit backfilling kiln [3054]	10	19
10	3075	F3	Fill of kiln [3054]	16	13
11	3060	F3	Fill of kiln [3054]	9	19
12	3059	F3	Erosion deposit backfilling kiln [3054]	14	3
13	3090	F3	Layer of charcoal in base of kiln [3054]	20	68
14	3052	F3	Fill of smithing pit [3050]	4	31
15	3053	F3	Upper fill of smithing pit [3050]	4	139
16	3001	F3	Spread of charcoal from kiln	6	28
17	3067	F3	Fill of kiln raking-out pit [3077]	4	9
18	3004	F3	Fill of hollow under gully [3036]	10	66
19	3037	F3	Fill of gully [3036]	9	10
20	3100	F3	Layer of charcoal in base of kiln [3054]	1	72
21	3103	F3	Layer of charcoal in base of kiln [3054]	1	3
22	3094	F3	Fill of oven [3091]	5	18
23	3104	F3	Patch of charcoal	4	410
24	37004	F37	Shell midden	11	17
25	3049	F3	Roofing slate deposit	0.5	3

19 APPENDIX VIII: AN ASSESSMENT OF CHARRED PLANT REMAINS AND CHARCOAL

Rosalind McKenna

19.1 Introduction

A series of twenty five samples were submitted in June 2011 from deposits excavated at the Tremadog to Porthmadog bypass, for an evaluation of their environmental potential. The excavation was carried out by Gwynedd Archaeological Trust 2010. The samples came from kilns, spreads, pits and a shell midden.

A programme of soil sampling from sealed contexts was implemented during the excavation. The aim of the sampling was to:

- assess the type of preservation and the potential of the biological remains
- provide C14 material for assistance in dating features
- identify if any human activities were undertaken on the site
- reconstruct the environment of the surrounding area

19.2 Methods

The material was submitted to the author in a processed state. It was processed by staff at Gwynedd Archaeological Trust using their standard water flotation methods. The flot (the sum of the material from each sample that floats) was sieved to 0.5mm and air dried. The heavy residue (the material which does not float) was not examined, and therefore the results presented here are based entirely on the material from the flot. The flot was examined under a low-power binocular microscope at magnifications between x12 and x40.

A four point semi quantative scale was used, from ‘1’ – one or a few specimens (less than an estimated six per kg of raw sediment) to ‘4’ – abundant remains (many specimens per kg or a major component of the matrix). Data were recorded on paper and subsequently on a personal computer using a Microsoft Access database.

The flot was then sieved into convenient fractions (4, 2, 1 and 0.3mm) for sorting and identification of charcoal fragments. Identifiable material was only present within the 4 and 2mm fractions. A random selection of ideally 100 fragments of charcoal of varying sizes was made, which were then identified. Where samples did not contain 100 identifiable fragments, all fragments were studied and recorded. This information is recorded with the results of the assessment in Table 3 below. Identification was made using the wood identification guides of Schweingruber (1978) and Hather (2000).

Taxa identified only to genus cannot be identified more closely due to a lack of defining characteristics in charcoal material.

19.3 Results

Table One below shows the components recorded from each of the samples.

Of the twenty five samples submitted, charred plant macrofossils were present in eight of the samples but were generally poorly preserved, and were lacking in most identifying morphological characteristics. The results of this analysis can be seen in Table 2 below. The samples produced small assemblages of plant remains both in volume and diversity. The most common and abundant remain was indeterminate cereal, which were present in four of the samples in small numbers. Four of the samples contained very small / individual numbers of charred cereal grains, many of which lacked identifying morphological characteristics, and are therefore recorded as 'indeterminate cereal'. Another, more indirect, indicator of cereals being used on site is the remains of arable weeds that were found in three of the samples. These weeds, some of which are characteristic of cereal fields and rarely found elsewhere, are member of the cabbage family (BRASSICACEAE). Plant remains were only present in the following areas; the small feature at the bottom of the slope close to the roofing slate area, the kiln and its associated raking out area and the shell midden.

Charcoal remains were present in all twenty five of the samples and scored between '1' and '4' on the abundance scale. There were identifiable remains in sixteen of the samples. The preservation of the charcoal fragments was relatively variable even within the samples. Some of the charcoal was firm and crisp and allowed for clean breaks to the material permitting clean surfaces where identifiable characteristics were visible. However, most of the fragments were very brittle, and the material tended to crumble or break in uneven patterns making the identifying characteristics harder to distinguish and interpret. Table 3 below shows the results of the charcoal assessment.

Oak and hazel were the dominant species, although salix/poplar and ash were also present in small numbers in several of the samples. The samples have a similar composition, although ash is only present in samples from the kiln and associated raking out area and the small feature at the bottom of the slope close to the roofing slate area. Salix / Poplar is also only present in the kiln and associated raking out area, the small feature at the bottom of the slope close to the roofing slate area and the interface between the estuarine clay and colluvium. The absences of these taxa from the other areas may indicate a deliberate choice in fuel use or may merely indicate that ash and salix / poplar may not have been as readily available.

The total range of taxa comprises oak (Quercus), ash (Fraxinus), salix/poplar (Salix/Populus), and hazel (Corylus). These taxa belong to the groups of species represented in the native British flora. A local environment with a range of trees and shrub is indicated from the charcoal of the site. As seen in Table 3, oak is by far the most numerous of the identified charcoal fragments, and it is possible that this was the preferred fuel wood obtained from a local environment containing a broader choice of species. Oak is probably the first choice structural timber, and with a local abundance it may have been used instead of ash, thereby providing more by-product fire fuel.

Generally, there are various, largely unquantifiable, factors that effect the representation of species in charcoal samples including bias in contemporary collection, inclusive of social and economic factors, and various factors of taphonomy and conservation (Thery-Parisot 2002). On account of these considerations, the identified taxa are not considered to be proportionately representative of the availability of wood resources in the environment in a definitive sense, and are possibly reflective of particular choice of fire making fuel from these resources. Bark was also present on some of the charcoal fragments, and this indicates that the material is more likely to have been firewood, or the result of a natural fire.

Root / rootlet fragments were also present within all twenty five of the samples. This indicates disturbance of the archaeological features, and this may be due to the nature of some features being relatively close to the surface, as well as deep root action from vegetation that covered the site. The presence of insect fragments in one of the samples and earthworm egg capsules in seven of the samples further confirms this disturbance.

19.4 Conclusion

The samples produced little environmental material, with the exception of the charcoal and the plant macrofossils from the samples. The deposits from which the samples derive, probably represent the domestic waste associated with fires.

These charcoal remains showed the exploitation of several species native to Britain, with the prevalence of oak and hazel being selected and used as fire wood. Oak has good burning properties and would have made a fire suitable for most purposes (Edlin 1949). Oak is a particularly useful fire fuel as well as being a commonly used structural/artefactual wood that may have had subsequent use as a fire fuel (Rossen and Olsen 1985). Small portions of ash and salix / poplar are also present in small numbers and associated with certain areas of the site.

The archaeobotanical evidence found in the samples shows hazelnut shell, and small numbers of indeterminate cereal, possibly indicating an exploitation of cereals. Due to the small numbers of cereal grains and associated weed seeds, there is limited interpretative information. No information can be gained in relation to a reconstruction of the local environment.

The hazelnut shell fragments show no marks typically associated with processed shells. Together with the high portion of hazel charcoal, this may indicate that they are merely representative of hazel wood trees being burnt, which could be either a natural or a man-made process. However, with the remains of several cereal grains throughout the samples it is more likely that the samples represent occupation build-up of domestic waste.

19.5 Recommendations

The samples have been assessed, and any interpretable data has been retrieved. No further work is required on any of the samples.

19.6 References

English Heritage (2002) Environmental Archaeology: A guide to the theory and practise of methods, from sampling and recovery to post-excavation. English Heritage Publications. Swindon.

Edlin, H L, 1949. Woodland crafts in Britain: an account of the traditional uses of trees and timbers in the British countryside, London, Batsford

Hather, J G. 2000 The identification of Northern European woods; a guide for archaeologists and conservators, London. Archetype Press.

Kenward, H.K., Hall, A.R. and Jones A.K.G. (1980) A tested set of techniques for the extraction of plant and animal macrofossils from waterlogged archaeological deposits. Science and Archaeology 22, 315.

Rossen, J, and Olson, J, 1985 The controlled carbonisation and archaeological analysis of SE US wood charcoals, Journal of Field Archaeology **12**, 445-456

Schweingruber, F H, 1978 Microscopic wood anatomy. Birmensdorf. Swiss Federal Institute of Forestry Research

Théry-Parisot, I, 2002, ‘Gathering of firewood during the Palaeolithic’ in S Thiébault (ed), Charcoal Analysis, Methodological Approaches, Palaeoecological Results and Wood Uses, BAR International Series 1063

Table 1a. Components of the subsamples from deposits recovered from the Tremadog to Porthmadog bypass (G2108). Field 3 – Site 01: Large concentration of roofing slates and associated contexts. Semi quantitative score of the components of the samples is based on a four point scale, from ‘1’ – one or a few remains (less than an estimated six per kg of raw sediment) to ‘4’ – abundant remains (many per kg or a major component of the matrix).

Sample No. Context No. Feature Type	08 3003 Roofing slate area	25 3049 Roofing slate area
Charcoal fgts.	4	4
Earthworm egg capsules	1	
Root/rootlet fgts.	2	
Sand	2	
Slag fgts.	1	

Table 1b. Components of the subsamples from deposits recovered from the Tremadog to Porthmadog bypass (G2108). Field 3 – Site 02: Kiln and ‘raking out’ area of kiln. Semi quantitative score of the components of the samples is based on a four point scale, from ‘1’ – one or a few remains (less than an estimated six per kg of raw sediment) to ‘4’ – abundant remains (many per kg or a major component of the matrix).

Sample No. Context No. Feature Type	09 3073 Kiln	10 3075 Kiln	11 3060 Kiln	12 3059 Kiln	13 3090 Kiln	16 3001	17 3067 Kiln	18 3004 Kiln	19 3037 Kiln	20 3100 Kiln	21 3103 Kiln
Charcoal fgts.	1	1	4	1	4	4	4	4	4	4	2
Earthworm egg capsules			1				1				
? Mortar fgts.	3	2		2	2					2	4
Plant macrofossils (ch.)			1		1	1		1			
Root/rootlet fgts.	2	2	2	2	2	2	2	2	3	1	2
Sand	4	4		4	3	4	2	3	3		4

Table 1c. Components of the subsamples from deposits recovered from the Tremadog to Porthmadog bypass (G2108). Field 3 – Site 03: charcoal-rich spread with burnt clay. Semi quantitative score of the components of the samples is based on a four point scale, from ‘1’ – one or a few remains (less than an estimated six per kg of raw sediment) to ‘4’ – abundant remains (many per kg or a major component of the matrix).

Sample No. Context No. Feature Type	03 3020 Spread	04 3021 Spread	05 3038 Spread
Charcoal fgts.	2	4	2
Root/rootlet fgts.	4	2	2
Sand	3		4
Slag fgts.			1

Table 1d. Components of the subsamples from deposits recovered from the Tremadog to Porthmadog bypass (G2108). Field 3 – Smithing pits [3010] and [3050]. Semi quantitative score of the components of the samples is based on a four point scale, from ‘1’ – one or a few remains (less than an estimated six per kg of raw sediment) to ‘4’ – abundant remains (many per kg or a major component of the matrix).

Sample No. Context No. (Fill) Context No. (Cut)	01 3011 3010	02 3015 3010	06 3051 3050	07 3054/2 3050	14 3052 3050	15 3053 3050
Charcoal fgts.	4	4	4	4	4	4
Earthworm egg capsules			1	1		1
Plant macrofossils (ch.)	1		1		1	
Plant macrofossils (m/c)		1				
Root/rootlet fgts.	3	2	2	2	2	2
Sand			1		3	2
Slag fgts.		2				

Table 1e. Components of the subsamples from deposits recovered from the Tremadog to Porthmadog bypass (G2108). Field 3 – Small oven ȋ3091]. Semi quantitative score of the components of the samples is based on a four point scale, from ‘1’ – one or a few remains (less than an estimated six per kg of raw sediment) to ‘4’ – abundant remains (many per kg or a major component of the matrix).

Sample No. Context No. Feature Type	22 3094 ‘Oven’
Charcoal fgts.	3
Charred concretions	4
Root/rootlet fgts.	2
Sand	1
Slag fgts.	2

Table 1f. Components of the subsamples from deposits recovered from the Tremadog to Porthmadog bypass (G2108). Field 3 – Interface between estuarine clay and colluvium. Semi quantitative score of the components of the samples is based on a four point scale, from '1' – one or a few remains (less than an estimated six per kg of raw sediment) to '4' – abundant remains (many per kg or a major component of the matrix).

Sample No. Context No. Feature Type	23 3104 Interface
Charcoal fgts.	4
Root/rootlet fgts.	1

Table 1g. Components of the subsamples from deposits recovered from the Tremadog to Porthmadog bypass (G2108). Field 37 – Shell midden. Semi quantitative score of the components of the samples is based on a four point scale, from '1' – one or a few remains (less than an estimated six per kg of raw sediment) to '4' – abundant remains (many per kg or a major component of the matrix).

Sample No. Context No. Feature Type	24 37004 Shell midden
Charcoal fgts.	1
Earthworm egg capsules	2
Herbaceous detritus	4
Insect fgts.	2
Plant macrofossils (m/c)	1
Root/rootlet fgts.	4
Snails	3

Table 2a: Complete list of taxa recovered from the Tremadog to Porthmadog bypass (G2108). Field 3 - Smithing pits [3010] and [3050]. Taxonomy and Nomenclature follow Stace (1997).

Sample Number Context Number Feature Type Sample volume (ml)	01 3011 Smithing pit [3010] 1800	06 3051 Smithing pit [3050] 200	14 3052 Smithing pit [3050] 80	
LATIN BINOMIAL				COMMON NAME
POACEAE				Grass Family
Indeterminate cereal	4	1		Indeterminate cereal
Indeterminate glume		1		Indeterminate glume

base				base
Indeterminate rachis internodes		7		Indeterminate rachis internodes
Indeterminate culm node			1	Indeterminate culm node
Unidentified			1	Unidentified

Table 2b: Complete list of taxa recovered from the Tremadog to Porthmadog bypass (G2108) - Field 3 – Site 02: Kiln and 'raking out' area of kiln.. Taxonomy and Nomenclature follow Stace (1997).

Sample Number Context Number Feature Type Sample volume (ml)	10 3075 Kiln 60	13 3090 Kiln 200	18 3004 Kiln 170	16 3001 Raking-out material 80	
LATIN BINOMIAL					COMMON NAME
Corylus avellana (fgts.)				4	Hazelnut shell fgts.
BRASSICACEAE	2		1	2	Cabbage Family
Carex spp.		1		1	Sedge
Indeterminate cereal	2	1		4	Indeterminate cereal
Indeterminate culm node				1	Indeterminate culm node
Indeterminate nut shell fgts.	3		1		Indeterminate nut shell fgts.
Indeterminate			1	1	Indeterminate
Unidentified nut shell			1		Unidentified nut shell
Unidentified		1			Unidentified

Table 2c: Complete list of taxa recovered from the Tremadog to Porthmadog bypass (G2108). Field 37 - Shell midden. Taxonomy and Nomenclature follow Stace (1997).

Sample Number Context Number Feature Type Sample volume (ml)	24 37004 Shell midden 175	
LATIN BINOMIAL		COMMON NAME
Corylus avellana (fgts.)	1	Hazelnut shell fgts.

Table 3a. Complete list of taxa recovered from deposits at deposits recovered from the Tremadog to Porthmadog bypass (G2108). Field 3 – Site 01: Large concentration of roofing slates and associated context. Taxonomy and nomenclature follow Schweingruber (1978). Numbers are identified charcoal fragment for each sample.

Name	Vernacular	Sample 08 (3003) 200+ fgts. max. size – 12mm
Corylus avellana	Hazel	21
Quercus	Oak	72
	Indet.	7

Table 3b. Complete list of taxa recovered from deposits at deposits recovered from the Tremadog to Porthmadog bypass (G2108). Field 3 – Site 02: Kiln and 'raking out' area of kiln. Taxonomy and nomenclature follow Schweingruber (1978). Numbers are identified charcoal fragment for each sample.

Name	Vernacular	Sample 11 (3060) 200+ fgts. max. size – 19mm	Sample 13 (3090) 500+ fgts. max. size – 32mm	Sample 17 (3067) 100+ fgts. max. size – 12mm	Sample 18 (3004) 700+ fgts. max. size – 23mm	Sample 19 (3037) 100+ fgts. max. size – 15mm	Sample 20 (3100) 1000+ fgts. max. size – 31mm
Corylus avellana	Hazel	75	47				
Salix / Populus	Salix / Poplar		9		10	21	
Fraxinus excelsior	Ash	25		26	38		
Quercus	Oak		28	35	52	37	100
	Indet.		14	39		42	

Table 3c. Complete list of taxa recovered from deposits at deposits recovered from the Tremadog to Porthmadog bypass (G2108). Field 3 – Site 03: charcoal-rich deposits with burnt clay. Taxonomy and nomenclature follow Schweingruber (1978). Numbers are identified charcoal fragment for each sample.

Name	Vernacular	Sample 04 (3021) 200+ fgts. max. size – 12mm
Quercus	Oak	38
	Indet.	62

Table 3d. Complete list of taxa recovered from deposits at deposits recovered from the Tremadog to Porthmadog bypass (G2108). Field 3 – Smithing pits [3010] and [3050]. Taxonomy and nomenclature follow Schweingruber (1978). Numbers are identified charcoal fragment for each sample.

Name	Vernacular	Sample 01 (3011) 5000+ fgts. max. size – 23mm	Sample 02 (3015) 500+ fgts. max. size – 23mm	Sample 06 (3051) 1000+ fgts. max. size – 21mm	Sample 07 (3054/2) 200+ fgts. max. size – 29mm	Sample 14 (3052) 500+ fgts. max. size – 20mm	Sample 15 (3053) 1000+ fgts. max. size – 28mm
Corylus avellana	Hazel	45	15	59	43	33	
Salix / Populus	Salix / Poplar					16	14
Fraxinus excelsior	Ash	47					
Quercus	Oak		85	26	34	51	79
	Indet.	8		15	23		7

Table 3e. Complete list of taxa recovered from deposits at deposits recovered from the Tremadog to Porthmadog bypass (G2108 Field 3 – Small oven [3091]. Taxonomy and nomenclature follow Schweingruber (1978). Numbers are identified charcoal fragment for each sample.

Name	Vernacular	Sample 22 (3094) 50+ fgts. max. size – 24mm
Corylus avellana	Hazel	33
Quercus	Oak	8
	Indet.	9

Table 3f. Complete list of taxa recovered from deposits at deposits recovered from the Tremadog to Porthmadog bypass (G2108 Field 3 – Interface between estuarine clay and colluvium. Taxonomy and nomenclature follow Schweingruber (1978). Numbers are identified charcoal fragment for each sample.

Name	Vernacular	Sample 23 (3104) 6000+ fgts. max. size – 31mm
Corylus avellana	Hazel	51
Salix / Populus	Salix / Poplar	11
Quercus	Oak	38

20 APPENDIX IX: CATALOGUE OF ROMAN POTTERY

Peter Webster

G2108.308 Very decayed mortarium in light buff fabric with rounded white, grey and red trituration grits. The fabric has tended to laminate and most of the grits have been dislodged. Probably part of the same vessel as 317 and 328. The most likely source is the Oxford kilns. The form seems to span Young's (1977) forms M12 and M21. Probably 3rd century.

G2108.317 (Kiln raking, 3001). Mortarium in light buff fabric with rounded grey-white trituration grits. Probably part of the same Oxfordshire vessel as 308. 3rd century.

G2108.318 (Context 3060). Fragment, probably of a brick. The maximum thickness is 3 cms but the upper surface is missing. The fabric is light red/orange, with lighter patches and with ?sandstone, grit and probably clay inclusions. Of the two surviving surfaces, one is noticeably smoother than the other. Although not certainly Roman, this is most probably a Roman brick.

G2108.320 (Kiln raking, 3001). Flanged and ridged bowl in Black-burnished Ware, burnt to a light buff internally and over the rim; cf. Gillam 1976, 47-9. The external decoration is only partially surviving but appears to have been wide intersecting loops. 4th century.

G2108.321 (Kiln raking, 3001). Flanged and ridged bowl in Black-burnished Ware, burnt to a pink buff internally and over the rim and in a patch on the wall; cf. Gillam 1976, 49. 4th century.

G2108.322 (Kiln raking, 3001). Flanged and ridged bowl in Black-burnished Ware, sooted externally and partly degraded by heat; cf. Gillam 1976, 45-6. Late 3rd to early 4th century.

G2108.325 (Context 3069). Straight sided dish in Black-burnished ware with a faint trace of a bead rim. The decoration is unclear but may have been irregular as Gillam 1976, 82. A fourth century date is possible but not certain.

G2108.327 (Unstratified but from an area associated with kiln raking). A small fragment of flanged and ridged bowl in Black-burnished ware, abraded on the flange. This could well be a further fragment of the vessel represented by 320 above. 4th century.

G2108.328 (Kiln raking, 3001). Mortarium rim in a very light buff fabric which is somewhat abraded and has an iron accretion over the flange. The most likely source is the Oxford kilns, Probably part of the same vessel as 308 and 317. 3rd century).

G2108.335 (From topsoil). A fragment of a probable Roman brick approximately 4 cms thick in a mixed orange and light orange-buff clay.. The piece shows signs of being hand formed; the upper surface is smoothed, the lower rough.

G2108.336 (From Topsoil). A fragment of red tile c.22mm thick. One edge only survives but this appears to be part of a flat Roman tile (as opposed to a roofing tile). The upper surface is smoothed, the lower rough. The one surviving edge suggests that it was formed within a frame.

G2108.337 (From topsoil). A fragment of Roman box tile c.2cms thick in light red fabric.. The internal surface is very rough. The external surface is smoothed with shallow parallel scorings running longitudinally. Sufficient survives to indicate a rounded corner between two walls

G2108.338 (From Topsoil). Tile fragment in light red fabric c.18mm thick. One surface may have been smoothed, the other is rough and has two parallel lines cut deeply into it. Although this could be part of a box tile, a flat tile with scoring to aid adhesion to mortar seems more likely. Probably Roman.

Bibliography

Gillam, J.P. 1976 'Coarse fumed ware in north Britain and beyond', *Glasgow Archaeological Journal,* 4, 57-80.

Young, C.J. 1977 *Oxfordshire Roman Pottery,* British Archaeological Reports, British Series, 43, Oxford.

21 APPENDIX X: TABLE OF FAUNAL REMAINS

Dr Nora Bermingham

Site	**Context**	**Δ**	**Unid.**	**Burnt**	**Frag. Ct.**	**Description**
G2108	F3	331	Y & N	Y	59	Mostly unidentifiable animal bone fragments. 5-50mm L; most between 5-25mm. All burnt and/or calcined - grey to white in colour. Mainly post-cranial fragments with pieces of rib and limb bones present. 3 fragments - Sh/gt. 1 x phal. I; 1 x phal. III; 1 x astragalus. 1 x distal end tibia poss. sh/gt. 1 lge calcined frag - limb bone prob. lge mammal with chopped edge.
	3048	373	Y	N	1	Fragment of an incisor, cow.
	3100	391	Y	Y	6	All burnt; 8-20mm L. Unidentified mammal – medium size.
	3020	345	Y	Y	1	<5mm L. Unidentified mammal.
	37004	390	Y	Y	3	1 burnt fragment. All fragments unidentified mammal – Large.
					TOTAL: 70	

22 APPENDIX XI: X-RAY AND DESCRIPTIONS OF IRON OBJECTS

Phil Parkes (Cardiff Conservation Services)

Objects from excavations at GAT Project G2108 were received for x-raying and assessment. Finds were x-rayed using a Faxitron 43805 cabinet system. X-ray films were digitised using an Array Corporation 2905 Laser Film Digitiser. Below are comments on information provided by the x-rays.

Find number	X-ray number	Notes
303	H430	Nail shaft fragment? Broken at both ends
401 was 339	H430	Nails concreted together with corrosion, broken into 2 pieces.

23 APPENDIX XII: ROMAN LIME KILN, PORTHMADOG BYPASS

Dr David Jenkins (formerly of Bangor University)

The limekiln is built against the E side of a glacially rounded outcrop and comprises a flue and rounded chamber standing some 2m proud. The kiln is well constructed of rocks with clearly defined planar joint surfaces. The interior contains a fused friable mass of white calcined blocks with evidence in places of vitrification producing some thin glassy green surfaces. The purpose of this study is to identify the rock types that had been calcined and that had been used in the construction of the kiln and also, if possible, their provenance.

23.1 Rock description

Rock samples were collected of (a) the local bedrock, (b) the kiln structure, (c) the calcined material (d) other rock types in the excavated spoil for identification.

The local bedrock consists of dark grey cleaved mudstones of the Tremadoc Series at the base of the Ordovician system (Dol-cyn-afon member) grading up into unconformably overlying Arenig Series (Allt Llwyd formation – Howells 2007) which dip to the W. A lower bed on the N flank of the outcrop is a heavily orange/black Fe/Mn-stained dark grey oolitic ironstone.

The rock used for construction of the kiln is dominated by a coarsely crystalline equigranular grey igneous rock in which grey pyroxene and white feldspar are evident: where subjected to high temperatures the pyroxene is red-brown in colour. This is interpreted as the dolerite which is exposed in the cliffs nearby to the north which develop the distinctive regular planar jointing. There are also fragments of a paler grey more uniform dolerite.

The calcined material is mostly transformed to a white structureless mass whose original nature is no longer recognisable but its calcareous nature is evident in its effervescence on addition of acid. In places, however, the original nature of some rock can occasionally be seen: for example some blocks of a very fine grained pale grey/white limestone (micrite) show the distinctive grooved weathered surface of limestone. More common are fragments of additional calcareous rocks including a fine-grained dull brownish rock traversed by white decomposed calcite veins and a distinctive dark grey crystalline limestone streaked with pink/dull red aligned grains.

Scattered amongst the spoil from the excavation are fragments of massive vein quartz, though occasionally with well-formed euhedral crystals, and often obviously fired.

23.2 Interpretation

The rocks utilised in the construction of the kiln (b) are apparently the dolerite sill intrusion available locally from the scree below the cliffs to the north which, as noted, have suitable planar joint faces for such purpose.

The calcined material is obviously limestone and, where recognisable, typical of Carboniferous outcrops the nearest of which would be on the north coast of Wales (*i.e* Anglesey/Gwynedd/ Clwyd). Although some rare cobbles may be found in glacial deposits, such material was presumably brought in bulk to the site by boat. This may have included dolomitised limestone to give the brown calcareous rock also present in the calcined material. Also of interest is the less common but distinctive red-flecked dark grey limestone which cannot at present be provenanced: if it were of “local” Lower Palaeozoic origin this might explain the initiation of a kiln at this site, but no identification has yet been possible.

24 APPENDIX XIII: WORKED FLINT AND OTHER STONE FROM Y BRYN

George Smith

24.1 Appendix XIII.1: Table summarising flint assemblage

Burnt fragment	4
Core/reject/fragment	4
Core trimming piece	3
Pebble unused	1
Casually retouched piece/fragment	9
Scalar piece	1
Flake	38
Flake fragment	52
Irregular fragment	11
Retouched piece	3
Retouched piece fragment	8
Unclassified fragment	1
Utilised piece	22
Total	**157**

24.2 Appendix XIII.2: Table summarising tool types

Retouched pieces	
Arrow-head, leaf	1
Denticulate	1
Edge-retouched knife	3
Microlith trapezoid	1
Serrated piece	1
Spurred piece	1
Unclassified	1

Casually retouched pieces	
Cutter	6
Piercer	1
Spurred piece	1
Utilised pieces	
Cutter	17
Piercer	1
Unclassified	4

24.3 Table XIII.3: Lithics detailed record table

Field codes and definitions

mat: material. c: chert, bac: banded chert, gc: greensand chert, cq: crystal quartz, f: flint, gl: Graig Lwyd, mr: Mynydd Rhiw, la: Langdale, mud: mudstone, o: other, q: quartz, sh: shale, tf: tuff.

gtyp: general lithic type, fl: flake, rp: retouched piece, up: utilised piece, c: core, crp: casually retouched piece, ep: scalar/ecaille piece,if: irregular fragment, b: burnt, np: natural piece, f: fragment, mf:microflake/fragment, pu: pebble unused, sp: split pebble piece.

styp: specific type: c: core, cbif: core bifacial, cp: core prismatic, cs: core single directional, cb: core bidirectional, ce: core scalar/bipolar, ci: core irregular, cr: core reject, cf: core frag, ctf: core trimming flake, aho: arrow-head oblique, ahl: arrow-head leaf, ahb: arrow-head barbed and tanged, ll: laurel leaf, dent: denticulate, np: nosed piece, ndp: notched piece, sce: scraper end, scs: scraper side, sth: scraper thumbnail, scd: scraper double ended, sch: scraper hollow, scup: scraper on a utilised piece, scr: scraper reject, erk: edge-retouched knife bik: bifacial knife, ok: ovate knife, cut: utilised cutting flake, bbl: backed blade, ob: obliquely truncated piece, pcr: piercer, awl: awl, bbmic:broad blade microlith, nbmic:narrow blade microlith, ser: serrated piece, spp: spurred piece, tf: truncated flake, up: utilised piece, bur: burin/graver, sp: split pebble, gf: gunflint, unc: unclassified, m: missing.

col: colour: l: light, d: dark, m: mid, gr: grey, b: blue, br: brown, bf: buff, bl: black, y: yellow, r: red, pnk: pink, mot: mottled

pat: patina/cortication coded 1-3, low, medium, high

bur: burning, 1: slight, 2: medium, 3: high

dam: secondary damage, 1: slight, 2: medium, 3: high

cor: cortex type code, 1: pebble, 2: rolled, 3: nodular, 4: tabular, 5: uncertain

imp: primary impact type, 1: normal, 2: pronounced, 3: flat, scalar, 4: bipolar, 5: punch

cla: reduction class, 1-3

fra: fragmentation class, 1: distal, 2: proximal, 3: mid-part

pla: platform type code, 1: plain, 2: cortical, 3: battered, 4: facetted, 5: dihedral, 6: prepared edge

len: length of complete piece, perpendicular to the striking platform

ilen: length of incomplete piece, perpendicular to the striking platform

bre: breadth of complete piece, parallel to the striking platform

ibre: breadth of incomplete piece, parallel to the striking platform

rettyp: retouch type: ab: abrupt, mar: marginal, st: steep, inv: invasive, sc:scalar

retpos: retouch position: side, distal, proximal

retfac: retouch face: b: bulbar, n-b: non-bulbar

retsha: retouch shape: str: straight, conv: convex, conc: concave, ang: angular

retlen: retouch length, mm

wrtyp: usewear type, 1: polish/gloss, 2: crushing, 3: abrasion, 4: microchipping

Find no.	Sub find no.	Context	gtyp	styp	comment	illus	mat	col	pat	bur	dam	cor	imp	cla	fra	pla	len	ilen	bre	ibre	dep	idep
1	1	Unstrat	c	cb	semi-prismatic	y	f	crm	0	0	0	2	0	0	0	0	34	0	27	0	22	0
1	2	Unstrat	c	cr	battered pebble		f	lgy	0	0	0	2	0	0	0	0		0	0	0	0	0
1	3	Unstrat	c	cb	semi-prismatic	y	f	bf	0	0	0	0	0	0	0	0	27	0	22	0	15	0
1	4	Unstrat	peb		unused		f	blk	0	0	0	0	0	0	0	0		0	0	0	0	0

Find no.	Sub find no.	Context	gtyp	styp	comment	illus	mat	col	pat	bur	dam	cor	imp	cla	fra	pla	len	ilen	bre	ibre	dep	idep
1	5	Unstrat	c	cr			f	lgy	0	0	0	0	0	0	0	0		0	0	0	0	0
1	6	Unstrat	f		large thick flake		f	crm	3	0	0	2	0	2	0	0	35	0	37	0	10	0
1	7	Unstrat	f		iron-stained		f	crm	0	0	0	2	2	1	0	0	30	0	38	0	16	0
1	8	Unstrat	f				f	crm	0	0	0	2	2	2	0	0	26	0	34	0	14	0
1	9	Unstrat	f				f	crm	0	0	0	2	2	2	0	0	33	0	33	0	13	0
1	10	Unstrat	ff				f	crm	0	2	0	2	2	2	0	0		0	0	0	11	0
1	11	Unstrat	ff				f	crm	0	3	0	0	0	0	0	0		0	0	0	0	0
1	12	Unstrat	ctf		large thick irreg flake		f	bf	0	0	0	2	2	2	0	0	53	0	44	0	13	0
1	13	Unstrat	f				f	crm	0	2	0	2	1	2	0	0	45	0	27	0	8	0
1	14	Unstrat	up?		poss util pol around 2 tips		f	motlg y/r	0	0	0	0	0	3	0	0	46	0	24	0	5	0
1	15	Unstrat	up?	cut	microch 1 conv sharp edge		f	lgy	2	0	0	2	0	2	0	0		36	18	0	7	0
1	16	Unstrat	crp		fine invasive ret 1 sl conv sharp edge		f	ybr	0	0	0	1	2	2	0	0	28	0	30	0	11	0
1	17	Unstrat	if				f	lgy	0	1	0	1	0	2	0	0	27	0	19	0	10	0
1	18	Unstrat	f		prob lgy before pat		f	crm	0	0	0	2	2	1	0	0	22	0	28	0	8	0
1	19	Unstrat	ep		small battered pce fresh no pat		f	lgy	0	0	0	0	0	3	0	0	26	0	24	0	11	0
1	20	Unstrat	ff				f	lgy	0	0	0	2	0	2	0	0		18	0	30	10	0
1	21	Unstrat	f				f	lgy	2	0	0	2	2	2	0	0	20	0	27	0	9	0
1	22	Unstrat	f				f	crm	2	0	0	1	2	2	0	0	26	0	21	0	6	0
1	23	Unstrat	if				f	crm	2	0	0	0	2	0	0	0		0	0	0	0	0
1	24	Unstrat	if				f	crm	2	0	0	2	0	2	0	0	20	0	23	0	11	0
1	25	Unstrat	ctf				f	crm	2	0	0	2	1	2	0	0	36	0	28	0	7	0
1	26	Unstrat	ctf				f	crm	2	0	0	1	1	2	0	0	45	0	15	0	11	0
1	27	Unstrat	crp	cut	ret 1 sharp conv edge		f	crm	2	0	0	0	0	3	2	0		35	21	0	11	0
1	28	Unstrat	up	cut	microch 2 sharp edges		f	crm	2	0	0	0	1	3	0	0	36	0	22	0	6	0
1	29	Unstrat	crp	cut	fine ret 1 sharp side edge	y	f	bf	2	0	1	0	2	3	0	0	26	0	25	0	5	0
1	30	Unstrat	f				f	crm	2	0	0	0	1	2	0	0	36	0	18	0	4	0

Find no.	Sub find no.	Context	gtyp	styp	comment	illus	mat	col	pat	bur	dam	cor	imp	cla	fra	pla	len	ilen	bre	ibre	dep	idep
1	31	Unstrat	crp	cut	fine ret 1 sharp side edge	y	f	crm	2	0	0	0	1	3	0	0	29	0	21	0	4	0
1	32	Unstrat	up	cut	microch 1 sharp side edge		f	bf	2	0	0	0	1	3	0	0	37	0	12	0	4	0
1	33	Unstrat	up	cut	microch 1 sharp side edge		f	crm	2	0	0	0	1	3	2	0		34	14	0	4	0
1	34	Unstrat	up	cut	microch 1 sharp side edge		f	crm	2	0	0	0	0	3	1	0	36	0	16	0	5	0
1	35	Unstrat	upf	cut	microch 1 sharp side edge		f	crm	2	0	0	0	2	3	2	0		20	0	29	7	0
1	36	Unstrat	ff				f	crm	2	0	0	0	1	3	3	0		29	16	3	0	0
1	37	Unstrat	ff				f	bf	2	0	1	0	0	3	3	0		26	0	19	9	0
1	38	Unstrat	ff				f	crm	2	0	0	0	0	3	0	0	27	0	0	21	6	0
1	39	Unstrat	f				f	crm	2	0	1	1	0	2	0	0	35	0	18	0	7	0
1	40	Unstrat	up	cut	microch + sl gloss both side edges. Colour burnt		f	pnk	1	0	0	1	1	2	0	0	37	0	14	0	5	0
1	41	Unstrat	crp	spp	end spur made by alt ret	y	f	bf	1	0	0	0	0	3	1	0		29	15	0	6	0
1	42	Unstrat	crp	cut	fine ret 1 sharp edge	y	f	crm	2	0	0	2	1	2	0	0	24	0	24	0	6	0
1	43	Unstrat	ff				f	crm	2	0	0	2	1	2	2	0		34	15	0	5	0
1	44	Unstrat	f				f	crm	2	0	0	1	1	2	0	0	32		12	0	6	0
1	45	Unstrat	crp	cut	fine ret 1 sharp edge		f	crm	2	0	0	0	1	3	0	0	26	0	23	0	5	0
1	46	Unstrat	f				f	crm	0	0	0	1	1	2	0	0	32	0	13	0	6	0
1	47	Unstrat	f		fresh, from neat blade core		f	bf	0	0	0	0	1	3	0	0	39	0	14	0	5	0
1	48	Unstrat	up?		fine inverse ret one conv edge, could be dam		f	crm	2	0	0	0	1	3	0	0	29	0	15	0	7	0
1	49	Unstrat	up?	cut	irreg microch		f	lgy	1	0	0	0	0	3	0	0		23	14	0	6	0

Find no.	Sub find no.	Context	gtyp	styp	comment	illus	mat	col	pat	bur	dam	cor	imp	cla	fra	pla	len	ilen	bre	ibre	dep	idep
					both sharp side edges																	
1	50	Unstrat	ff		sl burnt		f	bf	1	0	0	2	0	2	0	0		20	0	18	5	0
1	51	Unstrat	f				f	crm	2	0	0	1	1	2	0	0	31	0	15	0	8	0
1	52	Unstrat	ff				f	lgy	1	0	0	2	1	2	0	0		22	21	0	5	0
1	53	Unstrat	f				f	lgy	1	0	0	1	2	2	0	0	18	0	25	0	6	0
1	54	Unstrat	ff		unusual flint crm with dark flecks		f	crm	1	0	0	0	0	3	1	0		25	18	0	6	0
1	55	Unstrat	f				f	crm	2	0	0	0	0	3	0	0	20	0	22	0	5	0
1	56	Unstrat	f				f	lgy	2	0	0	2	0	1	0	0	23	0	22	0	6	0
1	57	Unstrat	ff				f	crm	2	1	0	0	2	3	0	0		20	0	23	6	0
1	58	Unstrat	f		iron-stained		f	crm	0	0	0	2	1	2	0	0	24	0	22	0	4	0
1	59	Unstrat	f				f	lgy	1	0	1	0	1	3	0	0	26	0	16	0	3	0
1	60	Unstrat	up	cut	sl microch and edge pol 2 sharp side edges		f	crm	1	0	0	0	1	3	0	0	32	0	12	0	4	0
1	61	Unstrat	crp	pcr	ff with random point microch or ret at point		f	crm	1	0	0	1	0	2	0	0	24	0	18	0	5	0
1	62	Unstrat	f				f	lgy	1	0	0	2	1	2	0	0	27	0	13	0	5	0
1	63	Unstrat	up	cut	microch both sharp side edges		f	crm	2	0	0	0	1	3	0	0	30	0	12	0	3	0
1	64	Unstrat	ff				f	crm	2	0	0	0	1	3	2	0		21	18	0	4	0
1	65	Unstrat	if				f	crm	2	0	0	1	0	2	0	0	25	0	16	0	10	0
1	66	Unstrat	ff				f	crm	2	0	0	2	2	2	0	0		21	18	0	5	0
1	67	Unstrat	up	cut	microch 1 sharp side edge		f	lgy	2	0	0	0	0	3	2	0		23	13	0	3	0
1	68	Unstrat	f		some microch prob dam		f	lgy	2	0	0	1	0	2	0	0	22	0	13	0	4	0
1	69	Unstrat	f				f	lgy	1	0	0	0	1	3	0	0	28	0	11	0	5	0
1	70	Unstrat	f				f	pnk	2	0	0	0	0	3	0	0	20	0	16	0	3	0
1	71	Unstrat	f				f	crm	2	0	0	0	1	3	0	0	24	0	11	0	4	0
1	72	Unstrat	ff				f	crm	2	2	0	0	0	3	0	0		24	0	15	0	3
1	73	Unstrat	ff		fine blade frag		f	crm	2	0	0	0	0	3	0	0		21	10	0	4	0

Find no.	Sub find no.	Context	gtyp	styp	comment	illus	mat	col	pat	bur	dam	cor	imp	cla	fra	pla	len	ilen	bre	ibre	dep	idep
1	74	Unstrat	rpf	dent	prob snapped-off edge of dent scr	y	f	lgy	2	0	0	1	0	2	0	0		15	25	0	5	0
1	75	Unstrat	uncf		blade frag with some steep ret one side		f	crm	2	0	0	0	0	3	0	0		29	12	0	4	0
1	76	Unstrat	ff				f	crm	2	0	0	0	0	3	1	0		17	16	0	4	0
1	77	Unstrat	if				f	lgy	1	2	0	0	0	3	0	0		20	0	18	0	12
1	78	Unstrat	ff		flint same as 54. Fine blade frag		f	crm	1	0	0	0	1	3	2	0		32	13	0	3	0
1	79	Unstrat	ff				f	crm	2	1	0	0	0	3	0	0		20	0	14	0	5
1	80	Unstrat	ff				f	crm	2	0	0	0	0	3	1	0		18	14	0	3	0
1	81	Unstrat	ff				f	crm	2	1	0	1	0	2	0	0		14	0	21	0	5
1	82	Unstrat	ff				f	crm	2	0	0	0	1	3	2	0		18	19	0	4	0
1	83	Unstrat	f				f	lgy	1	0	0	0	0	3	0	0	19	0	16	0	5	0
1	84	Unstrat	f				f	crm	2	0	0	0	1	3	0	0	16	0	20	0	5	0
1	85	Unstrat	ff				f	lgy	1	0	0	0	0	3	1	0		22	11	0	3	0
1	86	Unstrat	rpf	spp	ad hoc point enhanced by steep irregular ret	y	f	lgy	1	0	0	0	0	3	0	0		23	0	20	4	0
1	87	Unstrat	up?	pcr	fine blade with chance point prob util		f	ybr	0	0	0	0	0	3	0	0	27	0	9	0	4	0
1	88	Unstrat	ff				f	lgy	0	2	0	0	0	3	0	0		16	0	16	5	0
1	89	Unstrat	ff				f	crm	2	0	0	0	0	3	0	0		28	12	0	3	0
1	90	Unstrat	upf	cut	fine ret or microch along 1 sharp side edge		f	crm	2	0	10	0	0	3	0	0		17	0	14	5	0
1	91	Unstrat	ff		lgy internally		f	crm	1	0	0	2	0	2	0	0		19	12	0	3	0
1	92	Unstrat	ff				f	crm	2	0	0	1	0	2	0	0		14	17	0	7	0
1	93	Unstrat	bf				f	lgy	0	0	0	0	0	0	0	0		0	0	0	0	0
1	94	Unstrat	ff				f	crm	2	0	0	0	0	3	0	0		18	0	16	2	0
1	95	Unstrat	upf?	cut	microch and gloss 1 sharp side edge		f	crm	0	0	0	0	0	3	0	0		17	0	12	6	0

Find no.	Sub find no.	Context	gtyp	styp	comment	illus	mat	col	pat	bur	dam	cor	imp	cla	fra	pla	len	ilen	bre	ibre	dep	idep
1	96	Unstrat	crpf	cut	fine abrupt ret 1 sharp side edge		f	crm	2	0	0	0	0	3	0	0		19	11	0	5	0
1	97	Unstrat	f		iron stained		f	crm	1	0	0	0	0	3	0	0	14	0	21	0	3	0
1	98	Unstrat	ff				f	crm	0	0	0	0	0	3	0	0		20	11	0	3	0
1	99	Unstrat	ff				f	crm	0	1	0	0	0	3	0	0		16	0	13	0	5
1	100	Unstrat	ff				f	lgy	0	0	0	1	0	2	0	0		21	0	10	5	0
1	101	Unstrat	f				f	ybr	0	0	0	0	0	3	0	0	27	0	7	0	3	0
1	102	Unstrat	up?		irregular nibbling on 1 sharp edge		f	pnk	1	1	0	0	0	3	0	0	19	0	13	0	8	0
1	103	Unstrat	f				f	crm	2	0	0	0	1	3	0	0	19	0	12	0	3	0
1	104	Unstrat	rpf		microl ret 1 straight sharp side edge		f	lgy	0	0	0	0	1	3	2	0		19	12	0	4	0
1	105	Unstrat	ff				f	crm	2	0	0	0	1	3	2	0		17	14	0	3	0
1	106	Unstrat	ff				f	lgy	2	0	0	0	0	3	3	0		17	16	0	4	0
1	107	Unstrat	ff		lgy originally		f	crm	2	0	0	0	0	3	3	0		16	14	0	4	0
1	108	Unstrat	if				f	crm	2	0	0	0	0	3	0	0		24	0	12	0	7
1	109	Unstrat	up?	cut	microch and gloss 1 sharp side edge		f	crm	2	0	0	0	1	3	0	0	19	0	12	0	4	0
1	110	Unstrat	ff				f	lgy	0	2	0	0	0	3	0	0		21	11	0	5	0
1	111	Unstrat	ff				f	crm	2	0	0	0	0	3	3	0		10	16	0	4	0
1	112	Unstrat	rpf		narrow blade + some abr ret to straighten back		f	crm	2	0	0	0	0	3	2	0		19	10	0	4	0
1	113	Unstrat	ff				f	gybr	1	0	0	0	0	3	3	0		18	9	0	2	0
1	114	Unstrat	ff				f	crm	1	0	0	0	0	3	3	0		11	13	0	3	0
1	115	Unstrat	ff				f	crm	2	0	0	0	0	3	1	0		14	12	0	4	0
1	116	Unstrat	up?	cut	some microch both side edges		f	crm	2	0	0	0	0	3	3	0		16	10	0	3	0
1	117	Unstrat	f				f	crm	2	0	0	0	0	3	0	0	15	0	12	0	3	0
1	118	Unstrat	f				f	crm	2	0	0	0	1	3	0	0	16	0	11	0	4	0
1	119	Unstrat	f				f	crm	2	0	0	0	1	3	0	0	17	0	10	0	2	0
1	120	Unstrat	ff				f	pnk	2	0	0	0	1	3	2	0		12	14	0	3	0
1	121	Unstrat	upf	cut	microch & pol		f	crm	2	0	0	0	1	3	2	0		19	8	0	3	0

Find no.	Sub find no.	Context	gtyp	styp	comment	illus	mat	col	pat	bur	dam	cor	imp	cla	fra	pla	len	ilen	bre	ibre	dep	idep
					1 sharp side edge																	
1	122	Unstrat	ff		burnt fracture		f	crm	2	1	0	0	0	3	0	0		14	0	11	4	0
1	123	Unstrat	ff				f	crm	2	0	0	0	0	3	1	0		14	8	0	2	0
1	124	Unstrat	if				f	crm	2	0	0	2	0	2	0	0		15	0	10	4	0
1	125	Unstrat	if				f	lgy	1	0	0	1	0	2	0	0		14	0	11	4	0
1	126	Unstrat	if				f	lgy	1	0	0	0	0	3	0	0		13	0	11	5	0
1	127	Unstrat	ff				f	lbr	1	0	0	0	0	3	3	0		16	0	10	2	0
1	128	Unstrat	ff				f	crm	2	0	0	0	0	3	2	0		12	0	10	3	0
1	129	Unstrat	ff				f	crm	2	0	0	0	0	3	2	0		12	10	0	4	0
1	130	Unstrat	if				f	lgy	2	0	0	1	0	2	0	0		12	0	10	4	0
1	131	Unstrat	ff				f	crm	2	0	0	0	0	3	3	0		10	12	0	3	0
1	132	Unstrat	f				f	crm	2	0	0	0	0	3	0	0	11	0	9	0	3	0
1	133	Unstrat	ff				f	ybr	1	0	0	0	0	3	2	0		11	12	0	3	0
1	134	Unstrat	if				f	lgy	0	2	0	0	0	3	0	0		13	0	9	0	5
1	135	Unstrat	bf		colour heat altered		f	purp	0	0	0	1	0	2	0	0		13	0	10	0	4
1	136	Unstrat	bf				f	lgy	0	0	0	0	0	3	0	0		12	0	7	0	5
1	137	Unstrat	ff				f	crm	2	0	0	0	0	3	1	0		15	7	0	2	0
1	138	Unstrat	f				f	lgy	1	0	0	0	0	3	0	0	14	0	7	0	2	0
1	139	Unstrat	ff		burnt fractured		f	crm	2	2	0	0	0	3	3	0		11	9	0	3	0
1	140	Unstrat	ff				f	crm	2	0	0	0	0	3	1	0		10	8	0	2	0
1	141	Unstrat	f				f	crm	2	0	0	0	0	3	0	0	8	0	11	0	2	0
1	142	Unstrat	rpf	erk?	burnt frag of flake + fine ret 1 sharp edge		f	crm	2	0	0	0	0	3	0	0		15	0	7	0	2
1	143	Unstrat	ff				f	crm	2	0	0	1	0	3	0	0		4	0	6	3	0
1	144	Unstrat	f				f	lgy	1	0	0	1	0	2	0	0	10	0	10	0	2	0
1	145	Unstrat	ff		small heavily burnt frag		f	crm	2	2	0	0	0	3	0	0		10	0	10	0	2
1	146	Unstrat	up?		small narrow blade + some gloss poss utlil		f	crm	2	0	0	0	0	3	1	0		12	4	0	2	0
1	147	Unstrat	bf				f	crm	2	0	0	0	0	0	0	0		12	0	5	0	4
1	148	Unstrat	f		chip only		f	crm	2	0	0	0	0	3	0	0	9	0	6	0	1	0
1	149	Unstrat	rpf	erk	ff with some fine invasive		f	crm	1	0	0	0	0	3	0	0		0	0	0	0	0

Find no.	Sub find no.	Context	gtyp	styp	comment	illus	mat	col	pat	bur	dam	cor	imp	cla	fra	pla	len	ilen	bre	ibre	dep	idep
					ret 1 sharp edge																	
301	0	Unstrat	rp	ser	curving blade 1 side finely serrated, no use wear	y	f	lgy	0	0	0	0	0	0	0	0	40	0	11	0	5	0
302	0	Unstrat	rpf	erk	thin blade frag, fine ret one edge	y	f	lgy	0	1	0	0	0	0	0	0		17	11	0	3	0
309	0	3000	rpf	unc	butt of thick fl with alt sides ret. Poss thumb sc		f	mbr	0	0	0	0	0	0	0	0		12	0	22	5	0
311	0	3005	ff		Cherty fl butt of fine blade fr prepared core		f	lgy	0	0	0	0	0	3	0	0		24	15	0	3	0
312	0	3005	up	cut	thin irreg blade + pol 1 sharp edge		f	crm	0	0	0	0	0	3	0	0	25	0	15	0	3	0
329	0	Unstrat	rp	nbmic	conv backed ret 3 sides	y	f	crm	0	0	0	0	0	0	0	0	33	0	7	0	4	0
355	0	3053	f				f	lgy	1	0	0	2	0	2	0	0	22	0	22	0	11	0
3001	0	Unstrat	rp	ahf	leaf a-head	y	f	crm	3	0	0	0	0	0	0	0		14	0	16	3	0

24.4 Appendix XIII.4: Other worked stone

Two stone objects were collected, both elongated pebbles with fractured ends. One is of quartzite, 112mm long, the other, very thin pebble, 157mm long, is of micaceous schist. Both have a few old scratch marks but none indicating continuous directional use and no faceting to indicate use as rubbers or whetstones. However, both are almost certainly pebble tools.

Another sub-rounded pebble, 120mm long, of heavy vesicular igneous rock has a naturally eroded cavity resembling a ‘cup-mark’, 30mm diameter and 20mm deep. This cavity could have been utilised for grinding, although not evidently so, or the stone could have been collected as a curiosity.

25 APPENDIX XIV: SHALE BRACELET FROM Y BRYN

George Smith

Find no. 319. From Context 3048. This context was a large spread of rubble and stones.

A fragment consisting of about 25% of the circumference of a circular, lathe-turned bracelet, 60mm internal diameter and 78mm external diameter. The bracelet has also split widthways along a natural cleavage plane. The original bracelet appears to have had a flat internal surface and a hemispherical outside surface and about 18mm wide. The outside surface is neatly turned but the inside face had been finished by abrading across the section, leaving a slightly irregular curve. However, both inside and outside surfaces have a high polish. The material is quite fine and so may have been imported from Southern England, although a nearer source is possible, e.g. from the Anglesey coal deposits.

Shale bracelets occur occasionally in Late Bronze Age contexts but began to be made as more of a craft industry in the Middle and Later Iron Age with manufacturing waste indicating the use of lathes, e.g. at Maiden Castle, Dorset (Laws 1991, 233-4). They occur even more frequently through the Roman period, e.g. in London and Winchester. Cool (2011) notes that plain bracelets were used throughout the Roman period but were the most common type in the Late Roman period, e.g. at Caister-on-Sea and at the Lankhills cemetery, Winchester. Four turned shale bracelets were found at Segontium Roman fort, Caernarfon, of which one was a plain example of similar form to that from Y Bryn and was found in an early-mid 4th century context (Casey and Davies 1993, 206, 208).

25.1.1 References

Casey, P.J. and Davies, J.L. 1993. *Excavations at Segontium (Caernarfon) Roman fort, 1975-1979.* Council for British Archaeology, London.

Cool, H.E.M. 2011. *Romano-British. Bracelets and Bangles*. Barbican Archaeological Associates. www.barbicanra.co.uk/shopimages/Documents/**bracelets**.doc

Laws, K. 1991. Later Prehistoric. Bracelets. In N.M. Sharples, *Maiden Castle*, English Heritage Arch. Rep. No. 19, HB

26 APPENDIX XV: EVALUATION OF INDUSTRIAL RESIDUES FROM Y BRYN

Dr T.P. Young (Geo Arch)

26.1 Abstract

The submitted assemblage comprised two main components: materials associated with the construction and operation of a limekiln and materials associated with some apparently small-scale iron working.

Materials associated with the limekiln were apparently mainly structural, with both heat affected rock and artificial ceramics. The rocks were rarely identifiable because of their high degree of alteration, but most did not appear to be waste from the lime burning itself, but to be highly altered stones from the walls. The ceramics ('fired clay') included much that was not closely identifiable, but sufficient pieces with angles and corners survived to suggest that much of the assemblage had been in the form of brick or tile. A significant proportion of this ceramic had either been heated to the point of bloating and partial melting, or had been glazed with a clear-green wood ash glaze – indicating that this material too had probably been part of the kiln structure (although some of the heat damage might alternatively been attributed to some of this material being kiln wasters). Several of the fired clay pieces bore external moulds of tiny gastropods (comparable in form to Hydrobia sp., although not formally identified as such). One piece also bore a small fragment of external mould of a thin, finely concentrically ribbed bivalve similar to Scrobicularia plana. The presence of moulds of these shells indicates that the clay was probably derived from a deposit formed as an intertidal mudflat, or similar environment.

Possible relict material from the lime-burning itself was limited to very small pieces of highly degraded rock with remnants of a rather coarse crystalline texture, but the high degree of alteration meant that these were not closely identifiable. Some lime deposits were present, but these did not contain recognisable relict material.

Iron-working was represented by one piece of smithing slag from deposits associated with the limekiln and by several samples of microresidues associated with a hearth. The amount of material was small, but it was perhaps noteworthy that the flake hammerscale present was particularly thick – although this might be a product of sampling bias.

26.2 Methods

All materials were examined visually with a low-powered binocular microscope where required. As an evaluation, the materials were not subjected to any high-magnification optical inspection, not to any form of instrumental analysis. The identifications of materials in this report are therefore necessarily limited and must be regarded as provisional. The summary catalogue of examined material is given in Table 1.

26.3 Results

26.3.1 Materials associated with the limekiln

The kiln was associated with a variety of strongly altered rocks. The high degree of alteration suggests that at least some of these may have contained a minor component of lime (the local igneous rocks are commonly slightly secondarily calcified). Whatever the nature of the reactive component, it is clear that some rocks have undergone partial melting, with the development of a vesicular texture within the remnant rock and a somewhat mobile external slag phase. Most of the slag does not have the appearance of significant flow, although there are some examples of viscous slag ‘flaps’ (e.g. c3090 #357). The most strongly melted material is in the form of a black vesicular glass.

Even more pervasive than actual slagging, is the development of a clear to slightly green wood ash glaze, particularly on the more refractory (mainly quartz-rich) lithologies and on the fired clay (see below).

These very highly altered rocks are mainly in very large pieces – suggesting that they were originally from the fabric of the kiln.

In some contexts (e.g. c3090, find #342) there are finer grained materials that might include some residues from the burning process itself. These are generally very highly altered, but some retain a cellular structure, perhaps relict from a coarsely crystalline (dolomitic?) precursor.

The fine residues include a few pieces of white shell-like material (find #366), but none of this shows convincing morphological or microstructural evidence for actually being shell. Instead, it is more likely that these are remnants of secondary lime crusts formed on cracks within rocks and ceramics (cf. find #385, from the same context (3073) as find #366). Much of the material shows secondary lime deposits – including examples with very fine microstructure, coarse crystals or botryoidal texture.

26.3.2 Fired clay

The fired clay material forms an assemblage with several uniting characteristics. Firstly, sharp angles and corners are rather common amongst the assemblage, as are planar surfaces, suggesting the fired clay was largely or wholly originally in the form of bricks or tiles.

The fired clay typically shows slightly bleached surfaces, perhaps most commonly around large internal voids. These voids typically show rough, corrugated surfaces. Some are suggestive of external surfaces that have been smooth by wiping with a bunch of grass, but most are probably either irregular cracks formed during the kneading of the clay or possibly moulds of coarse organic temper (leaves?). Finer moulds of organic temper include tubes with longitudinal striations suggestive of grass stems.

Probably the most interesting aspect of the fired clay is that several pieces contain moulds of former shelled organisms. These include tiny gastropods (c3075 #375, c3075 #376, c3090 #384) which have not been studied in detail, but closely resemble the brackish water gastropod *Hydrobia* sp., and one example of a finely concentrically-ribbed bivalve, which closely resembles *Scrobicularia plana*, another creature of brackish and intertidal environments. These two together are the most common shelly organisms on modern intertidal mudflats. Such material is not likely to have been added to the clay deliberately and is almost certainly an indicator of the origin of the original clay.

The heat alteration of the fired clay is instructive; it includes examples where the ceramic grades into highly bloated textures, showing intense heating of the ceramic (almost certainly during use – although some over-firing during manufacture cannot be excluded), but also includes examples where the low-fired ceramic is overlain by a clear-green wood ash (or otherwise lime-rich) glaze, indicating a lower temperature reaction. This suggests use of the fired clay ceramic at different locations within the kiln structure.

26.3.3 Lead

The assemblage included two fragments of lead sheet. These are not immediately interpretable, but may be scrap/offcuts from lead working for building purposes – but might also be scrap from lead ‘baggage tags’.

26.3.4 Ironworking residues

The only significant piece of macro-residue attributable to ironworking is a small fragment of dense iron slag from c3037 (find #371), which appears to contain charcoal clasts. Other ceramic-derived slags and fuel ash slags from the kiln area might be from ironworking – but are just as likely to be derived from the limekiln.

Site 03 produced ironworking microresidues from several contexts (c3011, c3015, c3051, c3052, c3053). These microresidues included flake hammerscale (FHS; the product of the superficial oxidation of hot iron in air), spheroidal hammerscale (SHS; droplets of superficial oxide expelled during forge welding), slag droplets (mainly formed by dripping of the slag within the fuel bed of the hearth), slag flats (thin slag accumulations from the surface of the workpiece or smith’s tools), blebs of fuel ash or lining slag (mainly formed from melted hearth material) together with small angular fragments from broken slag pieces and assorted pieces of fired clay. In addition to these materials several contexts yielded examples of materials cemented by the redistribution of iron following corrosion of iron debris, forming various ferricrete materials, including smithing pan – a deposit of microresidues cemented by secondary iron minerals. These microresidues are typical of materials found around early smithing operations. The only slightly unusual facet of this material is that much of the flake hammerscale is rather thick. The scale grows through oxygen and iron diffusion, so thickens with time at high temperature – so thick scale suggests prolonged high temperatures. This is usually an indication of the extra time required to heat up large pieces of iron. It is possible however, that sampling bias has exaggerated the occurrence of the thick scale if fine scale fragments were less well recovered during sieving.

A small quantity of the material from c3020 provides a slight suggestion that coal might have been employed as well as charcoal in the smithing – with two tiny possible coal fragments and a bleb of slag resembling clinker (partially melted coal residue). Coal was frequently used as a fuel for smithing in the Roman period (Smith 1997; Tylecote 1986, p. 226), but thereafter disappears as fuel (particularly in areas far from the coalfields) until the late- or post-medieval periods.

26.4 Interpretation

The collection of residues from the limekiln area adds disappointingly little to the understanding of the resource exploited, although there are hints that is was a limestone rock, rather than shell material.

The biological evidence of extraction of clay from intertidal deposits is interesting. It parallels the early 19th century extraction of clays for brick-making from reclaimed salt- marsh in the area, during construction of Porthmadog (*http://www.tremadog.org.uk/content/ 29.php*) - a time when the Tremadog area was again used for lime-burning. This later use of the clays of the estuary area would indicate their suitability for brick manufacture and the evidence from this site would suggest that suitability was also exploited at an earlier period.

The small scale evidence for ironworking provides little indication of the purpose of the activity, although, if genuine, the apparent abundance of thick flake hammerscale might suggest that larger objects were being fashioned or repaired.

26.5 Evaluation of potential

Although interesting, the assemblage contains little that might provide additional useful information through further detailed analysis.

The limekiln residues are dominated by altered materials from the kin construction, rather than containing surviving materials that would assist with the sourcing of the raw limestone.

The ironworking residues are very few and the potential of such an assemblage of microresidues to generate useful data is currently very limited.

26.6 References

Smith, A. H. V., 1997. Provenance of Coals from Roman Sites in England and Wales. *Britannia*, **28**, 297–324.

Tylecote, R.F. 1986. *The prehistory of metallurgy in the British Isles*. The Institute of Metals. 257pp.

Table 1: Summary Catalogue

Find no.	Context	Find type	Number	Weight	Notes
303.2	3001	burnt clay (with possible finger mark)	1	78	fired clay: with fingertip-like hole extending in from highly bloated pale surface
305	3001	vitrified stone	1	936	vitrified stone: glazed end of stone slab. Internal granular texture, appears to be quartzose sandstone with quartz veins
306	3001	burnt clay	8 + bits	786	fired clay: large blocks of oxidised fired clay. Some show planar surfaces, but most irregular. Several show abrupt coverage by apparent glaze on an unvitrified surface. All very soft, low fired. Some show small angular grit particles, but seems generally to have rather little temper
307	3003	vitrified stone	1 (4)	1205	vitrified stone: broken glazed rock with mullion- or voussoir-like half-hexagon cross-section, but most likely a natural fracture. Mostly glazed. The rock itself is of uncertain nature - it had large rounded vesicles and a dominantly fine grain size - probably feldspathic, with some larger natural: crystals, some interstitial Fe oxides and some euhedral quartz on some external breaks
324	3001	vitrified stone	-3	470	vitrified stone: appears to be slagged porous rock and a second slag fragment from a similar system. Texture difficult to recognise - possibly calcite replaced basalt?
326	3069	lead strip, bent	1	18	lead: tightly folded small piece of thin lead strip, probably c.80mm x 12-15mm x 1-2mm
329.2	3001	vitrified stone	1	50	glazed (clear to dark green) deep pinkish material, highly vesicular - could be highly altered andesite? - or could be vitrified bloated ceramic
329.3	3011	slag	1	0.6	slag: black glassy lining slag bleb
334	3001	lead	1	26	lead: small piece of oxidised lead sheet 2-4mm thick but irregular
340	3053	slag	assm	0.39	small collection of slag debris, FHS and slag flats with charcoal
341	3052	hammerscale		<	3 small pieces of flake hammerscale plus several dark rock fragments
342	3090	slag	assm	130	burnt stone and slag: large number of small fragments ranging from rare dark vesicular glass, through sandy fuel ash slags to more common possibly degraded limestone fragments - these show a hard cellular structure with voids filled with a brown shrinking material. Also bits of Tremadoc ironstone and other rocks. A wide variety of burnt bits!
343	3020	slag	14	<	2 tiny fragments of possible coal
343	3020	slag			1 large clinkery maroon surfaced complex bleb
343	3020	slag			3 tiny fragments of dense slag?

343	3020	slag			6 pieces of highly vesicular fuel ash slag
343	3020	slag			2 pieces of probable ferricrete
344	3073	slag	assm	156	burnt stone and FAS: dark vesicular fuel ash slags in thin sheets attached to granular lime rich material. All rather difficult to interpret. One small piece has angular brecciated brown ?mudstone chips bound by lime (at least one piece of the granular white material is large enough to section)
346	3015	smithing microresidues	assm	138	smithing microresidues: rich assemblage of rather thick flake hammerscale and slag flats, occasional slag droplets and other broken slag material
349	3075	natural	1	0.2	natural: granular material - possibly oxidised pyrite rod - fossil burrow
350	3003	natural	1	<	natural: single coarse grain of rounded black grains set in pale, almost lilac, matrix - not a slag
351	3059	slag	assm	10.95	full range of material from heat decomposed stone: FAS, dark glassy slags, dull slags and lime-rich particles
352	3011	smithing microresidues	assm	9	smithing microresidues: rich assemblage of coarse FHS, some SHS, slag flats, slag droplets and angular slag debris
353	3075	vitrified stone	c60	7.05	slagged/vitrified stone: mainly dark vesicular glassy slags - but some are paler and greener and some are more crystalline materials - possibly rock remnants rather than slags
354	3075	slag	c20	3.07	FAS and burnt stone: mainly vesicular greenish fuel ash slag, but also fragments of bleached sandstone, some highly fired clay and a piece of burnt bone
356	3073	Burnt stone	2	12.3	burnt stone: one piece is contorted and fissured grey low density bloated rock fragment or ceramic fragment, surface lime-coated in places - with possible fuel impression. Second piece is somewhat rounded low density lump that is undergoing explosion, presumably some expandable heat product inside
357	3090	slag	6	2.3	slag: remains of probably 4 slag blebs - one is oddly folded over - all probably fairly viscous
358	3015	slag	5	2	FAS: highly bloated fuel ash slag blebs with dark opaque iron slag veneer
359	3015	smithing pan	15	4.36	smithing pan: small particles of concretion with scale, fuel ash (some iron stained), slag fragments, slag flats
360	3059	natural	1	0.31	natural: possibly an iron pisoid from the Tremadoc ironstone
361	3003	natural	1	0.19	natural: grain of quartzo-feldspathic rock with biotite on one end
363	3001	burnt clay?	3	0.63	fired clay: 1 scrap of oxidised clay with bleached rough surface at one end, scrap of bloated FAS, 1 scrap of reduced fired clay with abundant organic temper
365	3075	natural	3+	0.44	fragments of strange red pelletal material with iridescent sheen to interstitial material - could this be oxidised Tremadoc ironstone - perhaps a sulphidic variety?

366	3073	burnt stone	c26	2.8	burnt stone: includes 5 fragments of thin lime sheet - superficially like shell, but no hint of morphology or microstructure to support this, so probably a coating; 1 piece appears to be a decomposing burnt limestone, the rest are a wide variety of decomposed stones and fuel ash slags, all very lime encrusted
369	3020	vitrified stone	2	16	glazed stone: 2 pieces of laminated quartz-rich rock. The larger piece shows some highly porous material on one end (decalcified), both show a dominantly clear glaze with some bright green patches
369	3020	vitrified stone	1	20	glazed stone: deep green glazed end of red stone/brick. Glazed face concavely curved. Face meets planar lower face at c 60 degrees.
370	3075	vitrified stone	4	26	vitrified stone: 3 pieces of slaggy grey vesicular material with glazed surface and hints of quartz-rich substrate; 1 small glazed probably sandstone pebble
371	3037	slag	6	37	largest piece is a dense slag with pendent lobes on base and charcoal clasts - possibly an iron slag; 4 pieces of vesicular fuel ash slag grading to black vesicular glass; 1 curious blebby piece - possibly the altered rind off a slagged stone?
374	u/s	vitrified stone	1	9.42	vitrified stone/clinker: clinkery blebs adhering to white foliated burnt stone - could potentially, but not necessarily, be modern
375	3075	burnt clay	ass	818	fired clay: large collection of good orange burnt clay. Several pieces show good right angles, one has tiny gastropods, several show the swirled/corrugated surfaces- in one case this is definitely internal, most are not vitrified, but some go as far as slightly flowed glaze; right angled corners are common
376	3075	burnt clay	assm	27.94	fired clay: one piece shows vitrified surface but below is fracture with external mould of cf. Scrobicularia plana and also gastropods, all pieces oxidised fired; where seen the glaze is milky green
377	3059	burnt clay	assm	666	fired clay: well oxidised, turns white near surfaces. Organic temper. Some of the white surfaces look as if they were smoothed with bunches of grass of some similar artefact. Some of the material is so fired that it has greyed and bloated - but the glassy surface is overlain by white-yellow deposits - is this decomposed glass or lime?
378	3001	burnt clay	17	26.92	fired clay: variably but mainly oxidised clay now in rounded abraded pieces. Largest piece shows two perpendicular faces with surficial bleaching and internal ?grass temper
379	3100	burnt clay	assm	13	fired clay: many tiny fragments of mainly buff coloured silty clay, a couple of grey pieces, a couple of well fired vesicular bits and one fired stone
380	3037	burnt clay	3	10	fired clay: 2 small fragments of oxidised clay and one large piece. Faces at right angles have

					pale surface with local light vitrification and hint of flowage - suggests a crude brick corner
381	3103	vitrified stone	1	4	vitrified stone: small chip from surface of glazed rock - pale fine ?feldspathic body with clumps of dark mineral - microgranite?
382	3067	burnt clay	4	54	fired clay: 3 small rounded abraded nubs of oxidised fired clay, 1 larger piece with planar base (i.e. brick like?) and highly vitrified end burnt off irregularly,
383	3052	natural	8	4	small concretions in dark brown deposit with coarse sand and charcoal
384	3090	burnt clay	assm	50	fired clay: similar to other examples - has pale bleached rough surfaces, some with organic marks. One piece has two probable small gastropods, one piece shows gradation into blebby drips of fuel ash slag. A minority of the material is reduced fired - this is harder denser and often shows odd complex shapes.
385	3073	burnt clay	assm	366	fired clay: similar to other examples. Larger lumps indicate clearly that the material had planar surfaces, often the surfaces, cracks and vesicles are coated in white material - presumably lime. The cracks sometimes show multiple plates of lime - suggesting that they opened (and filled) over several discrete events; some pieces show organic temper - but very difficult to identify
386	3090	burnt clay	1	16	fired clay: with white ?external surface with wiped texture. Internally rich in organic temper (grass?). Larger voids have botryoidal? white material (these are these so-called finger prints)
387	3103	burnt clay	assm	62	fired clay: burnt clay fragments with organic temper and sometimes charcoal internally, has pale planar surfaces or possible wicker impressions, one piece shows a sharp 60 degree angle to surface, This piece has smooth surfaces intersected by round holes, internally it is a brown clay with voids filled/lined by white (presumed lime).
388	3094	burnt clay	1	0.56	fired clay: small rounded piece of buff/orange fired clay with small elongate moulds
389	3020	burnt clay		392	fired clay: many pieces of oxidised fired clay with organic temper. Some rough pale surfaces might be due to larger temper pieces but might be contact with wicker or stone? One piece shows a slightly vitrified front face with a pale, transparent glaze.
392	3051	smithing microresidues	17	0.28	smithing microresidues: small particles including smithing pan, FHS, slag flat, glassy lining slag, stone ?charcoal
394	3097	lime pieces	3	628	lime: large blocks of fairly homogeneous cream coloured lime - with cavities and cracks with both crystalline and tufa-like secondary materials. Some broken surfaces reveal clasts (grey and red) and ghosts of lime clasts - but there is no evidence for surviving primary texture. One face of two of the pieces grades into a tufa-like gritty layer with clasts of small rounded pebbles

395	3073	vitrified stone	1	256	vitrified stone: block with vesicular black glassy clinkery material with maroon-brown surface binding various highly altered stone fragments. One appears to be a siltstone (just possibly a ceramic) and one is a dark rock with dark, almost purple, superficial vesicular melted layer - possibly a manganiferous slate?
396	3073	vitrified stone	1	1100	vitrified stone: pale large rock fragment glazed on all sides with clear glaze with green patches. Rock pale with elongate parallel holes weathering in surface - possibly welded tuff?
397	3073	vitrified stone	1	1955	vitrified stone: appears to be large wedge-shaped stone block, heavily altered and slagged. Slag is dark vesicular and has a very shiny mineral in it (?hematite). Remnant stone is porous brown and has a somewhat clotted texture
398	3073	vitrified stone		1625	vitrified stone: highly slagged material with dished surface and slightly slagged surfaces on at least two perpendicular sides - probably the end of a structural component? Stone remnant is brownish and granular with lots of secondary lime. Lime also fills cracks and forms botryoidal masses in some voids, towards outside the clotted texture locally becomes almost columnar or dendritic; slag is vesicular and rich in secondary lime

27 APPENDIX XVI: ROMAN SLATE HOARD, Y BRYN, TREMADOG

27.1 Appendix XVI.1: A technical appraisal

Dr. Gwynfor Pierce Jones

27.1.1 Introduction

Following the discovery of a stockpile of roofing slates (dating from the Roman Period) during preliminary excavation on the site of the new Porthmadog bypass, Gwynedd Archaeological Trust invited the slate quarrying archaeology expert, Dr. G. P. Jones (of Talysarn) to examine the finds. The assistance of Mrs. Margaret Shakespeare, who has practical experience of slate roofing using 'random' sizes and employing unconventional methods, was a valuable contribution to an understanding of the techniques used by the roofer(s).

27.1.2 The Site Context

The stockpile of roofing slate was discovered on a mound of slightly higher ground adjacent to the site of a Roman bath-house that had been discovered (and excavated by antiquarians) in 1908.[1] The bath-house was presumed to be associated with the working of iron ore on the adjacent major geological exposure of ironstone, of which the site of the stockpile was a continuation. It has been suggested that the bath-house might have been part of the residence of the mine manager, or some other local official, although no trace has been found of any further domestic buildings. It is presumed that any such additional structures of the Roman era were destroyed during the construction of the main road and the building of the modern village of Tremadog.[2]

During the excavation of the then-remaining lower courses of the bath-house (which uncovered a hypocaust and associated furnace), roofing slates with some iron nail were found in the rubble layer. Although these finds have since been lost, the published description is sufficiently detailed to allow a correlation to be made between these and the stockpile hoard from across the road.[3]

The conclusion of the geo-technical analysis (see below) of the present excavated roofing slate used at this site is that it had been transported a minimum of fifteen miles from the nearest matching geological exposure, and that slate deposits adjacent to the site were

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[1] Breese, E., *Arch. Camb*. (1908), pp. 286-288; Breese and Anwyl, *Arch. Camb.* (1909), pp.473-494.

[2] Breese and Anwyl (1909), pp.474-475, refs to 19th century disturbance of the immediate vicinity of this site, which would have been exacerbated by further 1920-30s house building.

[3] Breese & Anwyl (1909) p.488, description the roofing slates found inside the Llidiart Yspytty structure.

ignored (except for the existence of one 'local' slate). This suggests that the roofer was choosing material specifically for colour or quality, and it is thus concluded that the use here of this material was indicative of high status.

The site of the bath-house was once a beach, and the rocky mound (named 'Bryn-y-Fynwent') had been a minor island just off this coast (as witnessed by the sand deposits exposed just under the sub-surface hardcore of the main road during pipe-laying in 2010).

The stockpile of roofing slates was composed of several individual stacks of slates, laid on edge in a manner that indicated care for the material. Given that they are all holed for use, and many had the remains of iron fixing nails concreted by rust in the fixing hole, it must be that these are slates that have been taken off a roof, and possibly one having decayed timbering. It is assumed (with great confidence) that they had all once been on the bath-house roof because of the discovery (mentioned above) of similar slates in the archaeological rubble layer during the 1908 excavation of that building.

Neither the date of the production of these roofing slates nor the date of their removal to the beach stockpile is known. However, the Romans were using slate from locally-sourced 'Cambrian Strata' exposures for floor slabs and roofing 'tiles' on structures within this region by the 3rd century AD (as established by professionally-led excavations at *Segontium*). The bath-house at Llidiart-Yspytty, Tremadog might well be of a similar date.[4]

The date of the un-roofing of the Tremadog bath-house (and thus the creation of the slate stockpile on Bryn-y-Fynwent) might well be not long after the withdrawal of the Romans from the region in the 4th Century AD, or it might have been later. Thus, this could have been a recycling of a standing roof, or it might have been a salvaging of material from a collapsed structure. The existence of rusted iron nail heads in about 20 per cent of the stockpile tends to suggest the latter option, though the hypothesis is very tentative.

Ward's investigations of the Cwmbrwyn fortlet in 1907, and more recent excavations at the Abermegwr villa site, in the former Caermarthenshire and Cardiganshire (respectively), show a similar use of local sources for the slate used in the roof. Moreover, all of these examples are comparable to Roman era local slate roofs in Leicestershire and there are also some parallels in design to the stone roofing material (limestone and others fissile stone) at excavated sites in the south west of England and the Isle of Wight.[5]

Given that the Tremadog slate hoard was stacked next to a beach at a convenient loading point, it is probable that they were awaiting loading into a boat, to be taken away for re-use. It must be significant that the 300 or so (at most) slates found here were only perhaps 20

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[4] Wheeler (1923), pp.101-104. He states that the first fort was roofed with clay tiles, but purple roofing slate became common in debris from the 3rd Century constructions. The Romans apparently used whatever was to hand, because they also used at *Segontium* fort a local rough mudstone, one roughly pentagonal example of which (complete with asymmetrically-place nail hole in the top corner) was discovered in the 1975-79 excavations [Casey and Davies, CBA 90; p.214, part 12, Worked Stone (by J. C. N. Coulson), Artefact 7].

[5] Ward and Cantrill (1907), pp.188-189; 211; McWhirr (1988), p.3; Fig.1; Www. Coflein, Report of RCHM(W) investigations at Abermegwr (2010), *passim*., discusses this issue, though the shape of the slate heads was different in shape at that site (see discussion below).

per-cent of the roof covering of the bath-house, which was a 50ft x 22ft structure.[6] Why this last load was left behind is an unsolvable mystery.

The fate of the other slates that were undoubtedly taken away from this site is also presently unknown, and they have not yet been found in any archaeological site so far excavated. However, the present 'finds' have sufficiently strong physical characteristics, and are easily identifiable.

27.1.3 Physical characteristics of the Tremadog slates

27.1.3.1 Shape

With the exception of special half-size slates for the eaves (described separately), all of the Tremadog slates are (or were prior to damage) a rough long hexagonal shape, having a single nail hole located just off-centre at the upper pointed end (so as too allow nail head to be covered by the next highest course of slates. Some appeared to be more of a diamond shape, not having the two short edges making up the hexagon. However, these examples were of a cruder finish than the vast majority of the specimens, and they might have fitted into the roofing pattern 'as they were'. The diamond shape would have been a penultimate stage in the shaping process of all the specimens, prior to hacking off the tips of the left and right 'points' in the majority of them, creating two short 'straight' edges (as a relative term in this context) that allowed adjoining slates to abut more closely. Just enough was cut off the right and left tips to ensure that abutting slates reduced the gap between the upper tips to a manageable size that would be completely covered by the overlying slate course.[7]

This hexagonal shaping was required so as to allow the slates to be hung in the 'diagonal stripe' pattern so beloved of Roman builders. The Tremadog slates thus firmly belong to a Roman tradition of architecture that is well known to archaeologists, and examples found in the internal debris during the excavation of the nearby bath-house from whence they are thought to have originated.[8] There are correlations in design between the present hoard of Tremadog slates and ones from the Cwmbrwyn fortlet in Carmarthenshire[9] and from Leicestershire,[10] and also to ***some*** discovered by Sir Mortimer Wheeler at the major regional fort of *Segontium* in 1923.[11]

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[6] Breese and Anwyl (1909), pp.479.

[7] *The Pattern of Scottish Roofing* (2000), pp.3-5; 14-15 provides a context to slate roofing methodologies.

[8] Breese & Anwyl (1909) p.488, described the roofing slates found inside the Llidiart Yspytty structure, in the debris at floor level: "A number of roofing slates, purple in colour and of hexagonal and diamond shape …and some of the specimens still retain the iron nail in hole at the upper angle."

[9] Wood & Cantril (1907), pp.188-189; Figs.8-9.

[10] McWhirr (1988), pp.2-3; 7-8.

[11] Wheeler (1923), pp.101-104. Although there were hexagonal 3rd century purplish slates (broken and re-used in a 4th century re-building of the fort), he also found oblong ones that were similar to those used in more recent centuries under the generic title of 'random,' 'moss,' or 'ton' slates. Boon (1960), pp.141-142; 170; Fig 8 and photograph (b.) also found rectangular slates with two nail holes for horizontal laying, in his excavation of the adjacent *Mithraeum*. An intermediate shape of roofing slate was

27.1.3.2 Special shapes

Some pentagonal slates were also found at Tremadog. These have straight-cut bottoms and lower right and left sides of about 110mm (around 4-inches) length cut at 90-degrees. They were thus shaped for use as the base course on the eaves, where they abutted snugly. Similar examples (but more roughly triangular, without the accurately cut lower sides) were referred to by McWhirr from the Narborough group of Roman roofing slates.[12] Their use would have been a requirement for this type of roofing, and examples would have been expected at other excavated sites, though the survival of such material is not good in general on a national scale. This is due to recycling of a valuable commodity and breakage from falling to the ground from height during demolition of natural decay of a building into ruins.

No specially shaped slates suitable for a final (upper) row of slates abutting the roof apex were noticed when looking through the Tremadog salvaged slate batch. These would, if they ever existed, have been the same shape as the eaves slates turned upside-down (described above), and with probably two fixing holes across a straight top. However, the ridge tiles might have been sufficiently deep to cover the gaps between the heads of adjoining tips of the hexagonal ‘standard’ slates in the uppermost course. The depth of the cover needed on the roof apex having slates the same size as those at Tremadog would have between equal to the upper ‘skirt’ of these slates, which was in the 3-inch to 4-inch range.

27.1.4 Ridge tiles

None were discovered at the present finds site at Tremadog, but Breese and Anwyl (1909) found fragments of ridge tiles during the Tremadog bath-house excavation, but unfortunately did not elaborate on the details of these finds. However, the suggestion in the syntax of this quote is that these were ordinary (i.e. fired clay) ridge tiles.[13] An alternative to fired clay ridge tiles was sculptured stone ones. These carved stone versions have been described on modern-era vernacular roofs and there have been suggestions of this in Roman-era roofing elsewhere.[14]

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a pentagonal one (at Abermegwr villa, RCHM-W 2010) having a flat two-nail top that allowed horizontal laying, but retained the illusion of diamond diagonal patterning from its lower pointed tip. This latter design was revived in the nineteenth century (utilising machine-cutting of the tips) to give a decorative shape used on ‘fancy’ slate roofs and also on vertical panels attached to the sides of buildings as weather-proofing.

[12] McWhirr (1988), pp.2-3; Ward & Cantril (1907), fig.9.

[13] Breese & Anwyl (1909), p.488 described the roofing debris found inside the Tremadog bath-house structure: “The slate roof was in all probability surmounted by a row of ridge tiles, portions of such tiles having been secured.” The suggestion in the syntax of this quote is that these were ordinary (i.e. fired clay) ridge tiles.

[14] Historic Scotland Roofing Report (2000), p.18 – ‘4.3 Ridging;’ Ward & Cantril (1907), pp.188-189 reported that “…no fragments of the presumed stone ridge-stones were found” at Cwmbrwyn (Carmarthenshire), the syntax suggesting that this was the type of material that they were expecting to find, rather than fired clay tiles.

27.1.5 Dimensions

The Tremadog slates are remarkably consistent in their individual size, averaging 32 cm vertical tip-to-tip length and 22 cm width (typically a nominal 12-inch length, but varying from 10-inches up to 14-inches, and around 10 inches wide). This is relatively similar to the 11-inch wide size of slates excavated at Cwmbrwyn (in the old Carmarthenshire) and at Nareborough, Leicestershire, but are slightly larger than most of the slates attributed to the Swithland quarry in the latter county.[15]

This consistence in size was noted in discussion of the first-named district and the author quoted the opinion of local expert H. B. Sharp (of Stamford) that this indicated that the roofs were not graded in diminishing-length courses (as commonly found in roofs slated with 'random'-grade material). Furthermore, the length of the 'skirt' (the distance from the lower point to the start of the maximum width) of the Tremadog slates correlated strongly to the 3-inch to 4½-inch quoted by McWhirr (1988) for Leicestershire examples, this being a measurement that dictated the amount of overlap of successive courses of slates (and termed 'lap' in modern roofing parlance).[16] The length of these slates was not too crucial when using a boarded roof timber (not battens), within a certain tolerance, but the width was more crucial for regulating the top gap resulting from the diamond shape, and needed to be more consistent. However, some minor alterations could be made as the roof was being constructed, by re-cutting portions of individual slates to fit.

The thickness of the Tremadog slates varied from around 13mm (roughly ½-inch) down to around 7mm (around ¼-inch), though this figure tended to vary in different parts of any one individual slate. This lack of uniformity of thickness in most of the slates had two characteristics. In some, one end or side was thicker, this having been the original upper surface of the block whilst still *in situ* in the rock body, and the progressive thinning away from that point was due to the character of the so-called 'slatey cleavage' (or 'split') that was ill-formed in comparison with the material exploited for the thin, consistently-even roofing slate of the more modern era.[17] In other examples of the Tremadog specimens, there were 'islands' of thicker material amongst a generally thinner-splitting mass of rock, this also being a geological anomaly found in this particular vein of slate that would have been (in more modern times) only used as a source of small thick slates for roofing low-status cottages and farm buildings.[18]

Only one blue slate approximated to the more modern thickness once known as 2nd Quality of 1/8th-inch thickness (around 3mm), it also having a regular cleavage. The existence of this

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[15] Ward & Cantrill, (1907), pp.188-189; McWhirr (1988), pp.7-8, Tables 1-2.

[16] McWhirr (1988), p.2, 'USES – Roofing Slates' para. 2. See Historic Scotland research report (2000) *passim.* for a full discussion on this (and other) type of roofing.

[17] This 'cleavage' in slates differs from that in other splittable rocks (such as some sandstones and limestones) that were also exploited in the Roman period as roofing material. In true slates it is not related to the bedding of the rock, and it is created by micro-layers of fissile material that break more readily than the surrounding layers. The strength of these cleavage layers, their regularity of structure, and their distance apart were the deciding factors regulating the cleavage characteristic of the slate rock. The illustrations in *Scottish Slate Quarries* (Historic Scotland, TAN 21) provide a good explanation of this micro-geology.

[18] The roofs of the majority of the local late-18th century – early 19th century squatters' subsistence-farming cottages (termed 'tyddynod') are roofed with this quality of slate, though cut to roughly rectangular shapes.

one sheet points to the one-time existence of others derived from the same portion or block of raw material, as this single sheet could not have been produced as a sole example, though it cannot be estimated how many there might have been of this quality. That they were not to be seen in the remaining hoard at Tremadog suggests that they were probably in the hypothesised majority batch no longer at the site.[19]

The length and width of the Tremadog slates are also partly dictated by the geology of the raw material. The critical factor was the distance between the top and bottom ‘foot joints’ (i.e., the ‘bedding planes’ in geological terminology) in the rock whilst in the ground. In the case of rectangular slates, this decided the maximum length of the sheet, but owing to the cutting of the Tremadog slates into a diamond shape (prior to lopping off the edge-tips), these natural joints consequently delineated the diagonal width of many of the samples.[20]

27.1.6 Colour

There are three main shades of blue-purple colouration in the Tremadog slate hoard. These are (1) purplish-blue with green stripes; (2) a more purple version (having a greater amount of iron-ore haematite in it); and (3) a ‘plum’ coloured reddish-purple. Types 1 and 2 are found in approximately equal numbers, but the Type 3 is present in a much smaller number.

The roofing slates found at Cwmbrwyn (Carmarthenshire) were also of two colours, being a pale greenish-grey of granular texture, and a blue-black slate of finer material and somewhat silky lustre.[21] This raises the question of whether there was any decorative pattern on that roof, and the same question arises with the Tremadog roof. Given that there was an approximate equal number of bluish to the more purplish slates in the recovered batch, it is not impossible. Possible patterns at Tremadog could have been diagonal stripes, or perhaps a block colouring, or perhaps a combination of both. Alternatively, the roof might have been ‘speckled’ with a random use of the different colours.

27.1.7 The ‘rogue’ local slate

There was one example in the Tremadog slate hoard of a dark ‘smokey-blue’ slate (having partial iron rust staining from pyrites crystals) that was completely geologically different from all the remainder that were investigated by the present author, though probably of the same hexagonal ‘worked design’ (see discussion below). This slate has been split as thinly as the thinnest of the Cambrian ones, at 3mm average, though there is a slight wedging of the cleavage from its 6mm thick presumed former upper bedding joint. It has a single very enlarged nail hole, possibly demonstrating its relatively softer physical nature than the blue-purple Cambrian ones.

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[19] If there is one slate sheet of this quality, it must have had at least a twin (by virtue of the nature of the production method), and that portion of the rock must have produced at least a small batch of these better-quality examples.

[20] The diamond shape was achieved by cutting the sides of the sheet (as viewed when in the rock body) diagonally in parallel, forming a rough rhomboidal shape. One of those side-points would then become the top point of the finished slate as hung on the roof.

[21] Ward & Cantril (1907), p.211, notes by T. C. Cantrill on ‘The Roofing Slates.’

As found, it was of a rough quadrilateral shape having one pair of roughly parallel sides, but it is almost certain that one of those parallel sides is a damage fracture along a natural plane of weakness, as the slate would not have fitted easily into the roofing pattern in its present shape. It appears that the fracture has occurred from the upper to the lower tip of the slate, of which the complete right half from the vertical mid-line, is now missing.

This ‘rogue’ slate is derived from a younger slate vein that the Cambrian blue ones, and is characteristic of the several Lower Ordovician strata that abound the Tremadog/Cwm Pennant/Beddgelert districts. One of these veins having a very similar type of colouration to this particular specimen can be found in a prominent cliff face a few hundred yards distant (to the north-west) from the Tremadog site, this being the ‘Narrow Vein’ of the nineteenth-century Alltwen (or ‘Penmorfa’) Slate Slab Quarry. Another exposure of this vein was briefly worked in that century at a quarry to the south, on the slopes of Moel-y-Gêst, and there was another parallel vein of it found to the west at Tu-hwnt-i’r-bwlch.

Whilst it cannot be discounted that this single slate represents the remains of a major portion of the removed roof, it is highly likely that it in fact represents a small amount of local material used for ‘running repairs’ to the bath-house whilst it was in use.

27.1.8 Fixing nails

The Tremadog slates were held in place on the roof by iron nails of about 4mm square section, several of which remain as very rusty shards in their fixing holes. It is probably that they were of a design similar to those excavated at the Caernarfon *Mithraeum*.[22]

The method of creating the fixing holes and a further discussion of the fixing nails is provided in an addendum authored by Mrs. Margaret Shakespeare.

27.1.9 Quality and workmanship

Using the criteria of the modern era (eighteenth century and later), the Tremadog slates (by the quirk of their unfavourable geological characteristics) would have been condemned for use only on low status buildings. However, this was an era when slates with better, straighter cleavage, were being obtained from deeper-buried rock. This latter material had not been extractable before the introduction of gunpowder blasting techniques in the eighteenth century, and previous to this, all roofing slates were obtained from material is still to be found in surface exposures of slate rock, where the action of frosts had released the tightness from the cleavage, bedding joints and other natural jointing in the material (termed in Welsh, ‘dyfr-holltau’ = water splitting).[23]

The Romans would have used whatever raw materials they discovered, and Dr. Edward Greenly FGS stated (in Wheeler 1923) that the poorer, coarser slates were the only ones that would have remained within sight as surface exposures of little ridges (as they still do here and there in the ‘slate country’). In contrast, the better quality less coarse slate rock

[22] Boon (1960), fig.8 Inset.

[23] Ambrose (1872), pp.74-75; Sylwebydd (1889), pp.66-67, describing pre-nineteenth century slate quarrying techniques.

(whether extractable or not) would have in general been weathered into smooth slopes (more likely to have been completely grass-covered), and were thus not easily visible.[24]

The Tremadog slates are characterised by having a poorly developed cleavage ('split'), which is non-parallel, uneven, and created a very wrinkly surface to the individual sheets. However, the quality of craftsmanship of production is excellent, considering the difficulty of working with rock of this type.

Although detaching the material from the rock body in a frost-shattered surface exposure would have been relatively easily achieved using chisels, the 'dressing' of the thick split sheets into shape was a different issue. They have been commonly cut by chopping from one side, creating a bevelled edge, and these cuts look similar to those illustrated on other Roman examples. It is therefore hypothesised that the already established techniques of dressing stone and roofing slabs were imported into North Wales by the Roman army, and modified (if required) to suit the new material of blue/purple Cambrian slates.

27.1.10 Source

27.1.10.1 (a). Introduction

Although weathering makes identification of colour shades tricky, the physical characteristics of the Tremadog slates correlate to a particular set of slate 'veins' within the 'Cambrian' strata. They are identifiable from matching of the body colour, green stripe tint, and texture of cleavage as sub-strata within the Striped Blue Slate Group and the Purple Slate Group.[25]

A consultation of professional and 'amateur' descriptions of the Cambrian slate deposits (the latter being by various expert nineteenth century quarrymen) has shown that the Tremadog slate hoard were from various differing strata, these being:

a vein of striped blue slate, probably from the lowest part of the group sub-strata, which has well-banded stripes that are generally fine-grained, and the slate has a purplish tint;

either a more purplish sub-vein of (1), or part of the adjoining Purple Slate Group, where green stripes of coarse grit are found in the highest sub-strata; and

a very distinctive plum-coloured 'red slate' vein which is most likely the one that is generally characteristic of the lower part of the highest (in geological terms) division of the Purple Slate Group, and is known as the 'Upper Stripes.' [26]

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[24] Wheeler (1923), p.102.

[25] As defined by Morris and Fearnsides (1927), p.255, 'III. The Succession.'

[26] Morris and Fearnsides (1927), p.255, 'III. The Succession.' provides a descriptions of sub-strata in the various identified major rock groups in the Nantlle district, with a correlation to similar veins in other Cambrian slate districts. The lower section (*Llygad Brith-goch*) of the 'Upper Stripes' sub-stratum was described (*ibid*., p.259) as being redder and softer than the upper section (*Llygad Brith-Las*), and only produced 2nd or 3rd quality slates due to the profusion of stripes. This appears to match the

A particular problem with identifying the precise location of the source of the Tremadog slate samples is that the material in these formations can vary greatly in different geographical locations. In the Nantlle district, for instance, the complex geological structure underlying the surface causes a significant change in the rock under foot over even a few yards distant. However, such a geological structure comprising of a succession of ‘blocks’ of rock that have been severely affected by slide and shear faulting provides the topographical scenario where a number of very different slate bodies from strata hundreds of feet distant in their original stratigraphy, can be found very close together.[27]

However, centuries of intensive quarrying in the major slate districts of north-west Caernarfonshire has removed a large amount of earlier workings (especially if they were on or near productive rock), and tipping of waste rock (90-per cent plus of the excavated total) has overlaid much of the ground surrounding these workings. This combination of circumstances therefore adds to the complications of identifying a source of the Tremadog slates.

27.1.10.2 (b). Analysis

The Cambrian Slate formation extends from Llanllyfni to Bethesda via Cwm Gwyrfai and Llanberis. Theoretically, the slates could have come from a number of sites along the length of the veins, though the requirement for the existence of surface exposures of the correct types reduces the likely extraction sites to only a few locations.

However, given the variety of colours found in the Tremadog hoard, and a likelihood that the source of all the variants of this material was in close proximity, it may well be that an extraction site in the Nantlle Valley is most likely for reasons of geology alluded to in (a).

Coincidentally, the Nantlle district is also the closest site of blue-purple Cambrian slate exposures to Tremadog, though McWhirr (1988) made the point that the Romans did carry material further if it was deemed necessary, and some examples of purple Cambrian roofing slate have been found at Chester, together with more local dark Silurian Strata slates.[28]

The Geological Map of the Tremadog district did, however, indicate that there was some type of ‘Cambrian’ rock deposits closer at hand. A field trip to investigate this potential source identified a vein of slate (and an associated series of grits) running south-west to north-east from Mynydd Ednyfed, Cricieth (where it had been quarried), to a small working near Dolbenmaen church (and *via* another unsuccessful quarry at Bach-y-Sant). However, the slate in this range was dark in colour, with a pyrite content that leached as rust streaks. Its very poor cleavage (yielding thick sheets) had a lustrous finish, and the bedding planes restricted such sheets to only 8-inches to 10-inches length. This was patently not the same

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Tremadog Group (3) slates; Sylwebydd (1889), pp.12-26, *passim*. and Hughes (1870s?), pp.6-9, describe blue, blue-purple, and red striped slate on the westerly ‘fault block’ that correlate virtually exactly to those found in the Tremadog hoard.

[27] Morris and Fearnsides (1927), pp.264-269, ‘IV. – The Structure.’

[28] McWhirr (1988), p.6; Strickland .9-12; 15; 20. Examination of the Chester slate finds by Dr G. P. Jones confirms their origins.

material as that found at Tremadog, and if indeed it was correctly identified as being from the Cambrian orogony, then it was from the separate Upper Cambrian Series.[29]

However, the rough cleavage of almost all of the Tremadog samples, the wrinkly appearance, the range of colours (particularly the rarer red 'plum' one with very thin green stripes) and the associated types of green stripes can be correlated to the slate exposures of the most western bed, as described by historical geological descriptions. Moreover, relict surface exposures in and around the very old workings on the upper hillside of Talysarn estate (at a point known as *Allt Lechi* – 'the hill of the slate' – Grid Ref. SH 496 536 and in nearby field exposures at SH 498 537) are of a very similar characteristic to the blue slates with wider stripes, and the more purple-blue slates are found nearby.

However, since these latter exposures are hardly disturbed, and the *Allt Lechi* Quarry is supposedly of 18th Century origin, a more likely source containing all of the slate colourations would be upslope (and to the north-east) of this site, in the vicinity of Grid Ref. SH 500 539. There, on high ground formerly known as *Ochr-y-Cilgwyn* (now known as 'Cilgwyn') were (allegedly) medieval slate workings that were claimed by local historians to have been the oldest in Wales.[30] Unfortunately for archaeologists, intensive quarrying in the nineteenth and early-twentieth centuries of the excellent slate found at Cilgwyn have ether dug away or buried all of the earlier remains, and this site in more recent years became a waste disposal landfill site.

It may be significant that there is an antiquarian theory of a Roman road passing close to the Ochr-y-Cilgwyn slate outcrops. This road, it is claimed, ran from a junction with the main coast road coming south from the major fort of *Segontium* to the fords at or about Llidiart Yspytty.[31] The alleged branch road from the Foryd fords at Caernarfon was made (it was said) for the Bronze Age copper mines of Drws-y-coed, Nantlle. In doing so it passed close to the Ochr-y-Cilgwyn slate outcrops when it climbed onto the upland plateau of Rhos-y-Pawl.[32] From Drws-y-coed this route is said to have continued over the pass to join another road in the Gwyrfai valley (leading to the Aberglaslyn Pass) that also reached the fords at Llidiart Yspytty from a different direction.[33]

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[29] Field investigation by Dr G. P. Jones and Mrs. M. Shakespeare, with gratitude to the proprietors of the Cricieth Golf Course for allowing free access to their property.

[30] Ambrose (1872), p.74-75; Sylwebydd, pp. 12-26; 64.

[31] Breese and Anwyl (1909), pp.492-493 quoting the well-respected local antiquarian Ellis Owen FSA (of Cefn-y-Meusydd, Penmorfa, writing in *Arch. Camb*. 1869), describing a stone paved road leading from Llidiart Yspytty towards Penmorfa, which still existed in 1855. This would have subsequently proceeding towards Dolbenmaen and on to Caernarfon – all areas being littered with antiquarian finds. [N.B: *The Roman fortlet at Llystyn, Bryncir, which lay on this presumed road, had not been discovered at the tine of writing the quoted articles*].

[32] Ambrose (1872), p.51. This road was said to have passed through a 'mini-pass' on a dry valley at nearby Bwlch-y-Llyn at SH 505 552 (though named as 'Bwlch-y-Pawl' in this sources) where there are outcrops of very poorly formed blue slate to this day, though not ever having been worked because of its unsuitability

[33] Breese and Anwyl (1909), pp.492-493 quoting antiquarian Ellis Owen (from *Arch. Camb*. 1869) as suggesting that a Roman road ran through the Aberglaslyn Pass to Rhyd ddu and then over to the Nantlle district and Caernarfon.

27.1.11 Conclusion

The roofing slate found in the excavated stockpile at Tremadog is of ‘Cambrian purple’ type, although this general description belies the existence of a wide range of colours in the various strata making up this geological group of metamorphic rocks. Several of these colours are represented by slates in this hoard, of which the majority were blue or blue-purple, having distinctive green stripes.

It is also very likely (though not absolutely proved) that the source of these roofing slates was from hillside outcrops in the Nantlle Valley, which was the closest location of this material, and was also possibly near a Roman road that could have expedited its transport to the Tremadog site. There are certainly great similarities between the Tremadog slates and those that could be made from present-day outcrops on one particular slate ‘vein’ marking the western boundary of the Nantlle slate beds.

The evidence suggests that in the Roman era this particular type and quality of slate roofing must have been considered as **high status** material because (a) it had been transported a fair distance from the nearest possible source of extraction; (b) slate deposits immediately local to the bath-house site seems to have been ignored, other than possibly for a repair (see above); and (c) the standard of workmanship of their production was of the highest order considering the quality of the material that the quarrymen/roofers had to be contended-with.

The presence of one ‘local’ (Tremadog) Lower Ordovician Strata slate has been discussed, and has been judged to have possibly been a later repair to the main roof of Cambrian slates.

27.1.12 BIBLIOGRAPHY

27.1.12.1 Printed Sources

Ambrose, W.R.; *Hynafiaethau, Cofiannau a Hanes Presennol Nant Nantlle*, (Penygroes 1862, 2nd ed. Llanllyfni, Gwynedd 1985). Welsh language antiquarian essay about the Nantlle Valley.

Boon, G. C.; ‘A Temple of Mithras at Caernarvon – Segontium,’ *Arch. Camb.* (1960), 136-172 with photographs and end-plates.

Breese, Charles E.; ‘Roman buildings at Glasfryn, Tremadoc, Carnarvonshire,’ *Arch. Camb*. (1908) pp.286-288. (Interim notes of the discovery).

Breese, Charles E., and Anwyl. E.; ‘Roman buildings at Glasfryn, Tremadoc, Carnarvonshire,’ *Arch Camb.* (1909), pp.473-494. (Full report of the excavation).

Casey, P. J.; and Davies, J. L.; with Evans, J.; *Excavations at Segontium (Caernarfon) Roman Fort 1975-79*, CBA Research Report 90 (1993).

Emerton, G.; Research Report: *A Pattern of Scottish Roofing* (Historic Scotland, Edinburgh, 2000); ISBN 1903570 093. Background information on ‘random’ and other types of roofing styles.

Morris, T. O.; and Fearnsides, W. G.; The Stratigraphy and Structures of the Cambrian Slate-Belt of Nantlle (Carnarvonshire), *Quart. Journal Geological Soc*., Vol. lxxxvii, part 2 (1927), pp.276-303.

McWhirr, A.; 'The Roman Swithland Slate Industry,' *Transactions of the Leicestershire Archaeology and History Society,* No.62 (1988), pp.1-8.

Strickland, T.J.; *Chester: Excavations in the Princess Street / Hunter Street area 1978-1982. A First Report on Discoveries of the Roman Era*.

Sylwebydd (John Griffiths); *Chwarelau Dyffryn Nantlle a Chymdogaeth Moeltryfan* (essay of 1889, pub. Conway n.d, but *c.*1934). (Welsh-language history of slate quarrying in the Nantlle district, with economic geological details).

Ward, J., and Cantrill, T. C.; 'Roman remains at Cwmbrwyn, Carmarthenshire,' *Arch Camb.* (1907) pp.175-211.

Walsh, Joan A.; Scottish Slate Quarries, Historic Scotland Technical Advice Note (TAN) 21 (2000); ISBN 1 9035 70 04 2. (Contains details of the micro-geology of slatey cleavage).

Wheeler, R. E. Mortimer; 'Segontium and the Roman Occupation of Wales,' *Y Cymrodor* Vol. XXXIII (Hon. Society of Cymrodorion, London, 1923), pp. 101-106 (and photo facing).

Report of RCHM(W) investigations at Abermegwr, Ceredigion, (2010), (available on Www. Coflein), Finds Ref. C862 941, and C 862 947, photographs of roofing slates.

Scottish Roofing Slate: Characteristics and Tests; (Research / Study Report: Historic Scotland).

27.1.12.1 Manuscripts

Caernarfon Records Office, XM 4771: O. J. Hughes; 'Traethawd ar Lechfeini Nant Nantllef' (not dated, but 1870s, previous to 1878). A Welsh-language exposition of the commercial geology of the Cambrian slate beds in the Nantlle valley, written by a self-educated experienced quarryman.

27.2 Appendix XVI.2: Tremadog Roman slates – nail-hole analysis

Margaret Shakespeare

The placing and formation of the single hole in the Tremadog slates is of interest. The deliberate positioning, slightly off-centre, would ensure that the holes were fully covered by succeeding courses when hung.

Modern, thinner slates are holed by being struck sharply on the reverse by a single blow either stamped by machine or hit with a spiked, weighted slating hammer, while the rest of the slate is supported to prevent it from fracturing.

Due to the sedimentary structure of the material, such percussion causes layers to flake off the opposite, upper surface forming a natural bevel and countersink around the hole for the fixing nail. The head of the nail thus sits below the face of the hung slate, allowing subsequent covering courses to lie flat.

With slates as thick as these, a blow of considerable strength would be needed to make a hole in this way, and the probability of breakage would be high. In addition, there is no evidence that the necessary specialist slating tools were available at the time. Indeed, in view of the small numbers of slate roofs at Roman sites in Britain, this would seem unlikely.

Drilling is another possible way of holing slates, but again, there is no evidence of this in the Tremadog slates. The holes in these slates appear to have been made in a different manner. Whilst there is a compact bevel around each hole, this appears to have been made from the upper surface, a hypothesis supported by the loss of a single, thin but wide flake from the opposing (under) side.

Careful inspection shows tool-marks on the upper face of a majority of the slates, which indicate that a sharp but robust implement, possibly of square section, was repeatedly struck at different angles radially around a point to form both hole and bevel.

This implies the use of two, separate tools; a spike to form the hole and a hammer with which to apply a succession of blows. As such, this method would entail the use of both hands, the question then arises as to how the slate was supported. When holing a slate a skilful slater balances it upside down on one hand, fingers spread to support and cushion the slate on either side of the hole position to deaden the shock and prevent breakage, while the other hand strikes firmly with the spike of the slating hammer. Similarly, a holing machine is designed with bars that support the slate each side of the hole, leaving both of the operator's hands free to hold it in the right place and deaden the blows while the hole is stamped.

In the absence of specialist tools, an alternative method of support would be needed. A rigid platform with an aperture through which the hole could be pierced is possible, but would require an additional person to hold the slate firm. Most likely, a padded 'cushion' would have been used to support the slate, which would hold it steady, while the same time deadening the impact. This has proved effective (if rather time-consuming) in practice using a sandbag. Sand, of course, would be have been readily available at the then shoreline Tremadog site.

No definitive conclusion can be drawn from the shape of the holes as to how long the slates were in use or, indeed whether all of them had, in fact been hung at all. The presence of half and trimmed slates for the bottom courses, together with the fact that the slates are holed at all (both jobs usually done on site in accordance with the specific requirements of a particular roof) suggests that they had been used.

However, while some of the holes are rather enlarged and rounded, as would be expected from weight and wear in use, many still exhibit the crisp tool marks and edges apparent when newly made as described above. On these, there is no sign of the tool marks being abraded by the heads of nails. If all the slates were hung, this would imply very little movement, and is testimony to the skill and precision of craftsmen and roofers.

A number of nails (described elsewhere) were found beneath the Tremadog slates, which were uncovered, stacked in a pile, rather than as a collapsed roof. Iron nails appear to be the usual Roman method of fixing slates (as opposed to the wooden pegs commonly used to hang single hole slates in later periods). Nails were found alongside similar slates in the debris of the nearby Roman bath-house dug in 1908-09 [34] as well as at the Cwmbrwyn site in Carmarthenshire.[35]

With ironstone occurring naturally in Tremadog and contemporary iron working in the area, it seems likely that the nails would have been produced on site.

Approximately 10% of the slates display the remains of nails in the holes. While half of these show a rusty, broken length of nail as would be expected, the remainder seemed initially more ambiguous. They appeared to have an iron eyelet or collet around the hole, with only a tiny aperture in the middle-far too small to accommodate a nail to take the weight.

This, however, was recognised by a professional metalworker as exactly the pattern of corrosion one would expect in hand-nails. The repeated heating and hammering required to draw out a bar of iron sufficiently thin to make nails would temper and harden the outside surfaces of the bar as it is worked. The soft centre of the broken nail would therefore be the first to rust away, leaving the outer, square section of the worked metal *in situ*.

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[34] Breese, Charles E.; and Anwyl, E.; ‘Roman buildings at Glasfryn, Tremadoc, Carnarvonshire,’ *Arch. Camb.* (1909), pp.473-494.

[35] Ward, J.; and Cantrill, T. C.; ‘Roman remains at Cwmbrwyn, Carmarthenshire,’ *Arch. Camb.* (1907) pp.175-211.

27.3 Appendix XVI.3: Identification of the significance of the annular iron remains in the Tremadog Roofing Slates

Dylan Shakespeare

Manufacturing typically involved casting the metal into small billets and then hammering it out to thin it down to the right diameter wire that would be cut to the desired length. The hammering out of the billet to reduce the diameter is called 'plastic' deformation, often known as cold working, and will make the metal a lot stronger by flattening out the crystalline structure and reducing the flaws/spaces between the crystals. It is a process that is often used on iron and steel.

This deformation will not take effect all the way through the metal and the core of the wire *will remain relatively unchanged*. I would expect the un-hardened centre of the metal to corrode away quicker than the exterior and it looks like this is what has happened.

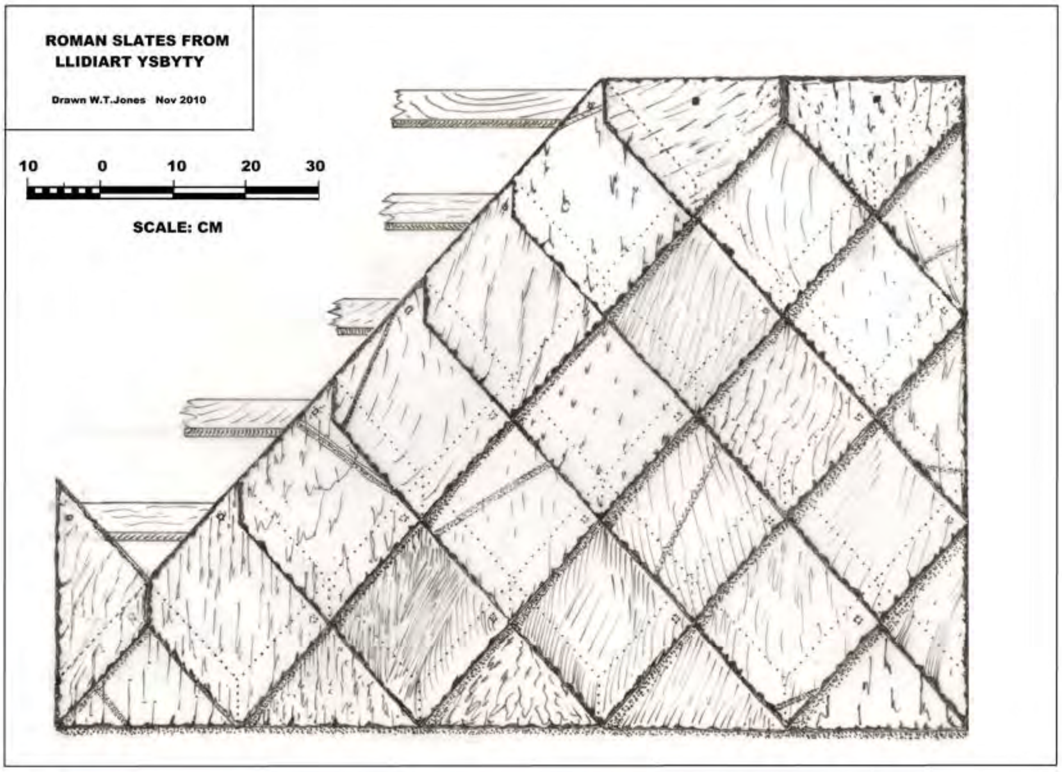
27.4 Appendix XVI.4: Notes on sizes and reconstruction

William T. Jones

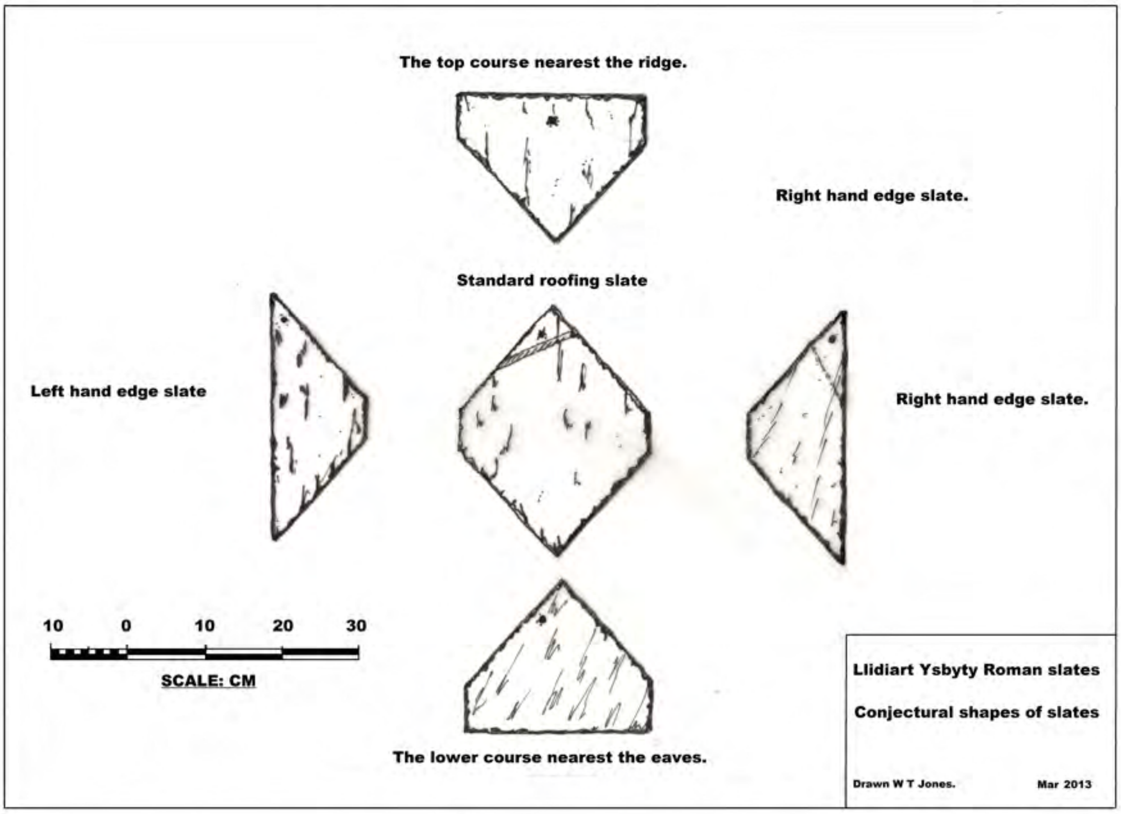
The bulk of slates recovered from Y Bryn have a distance from the bottom point of the slate to the nail hole which corresponds to a Roman foot; a *pes* (296mm). However at least two slates are a larger size; a *palmipes* (370mm) (a foot and a palm-width, 1¼ *pedes*). This dimension from the tip of the slate to the nail hole is directly related to the distance between the battens for fixing the slates, so slates of different sizes cannot be mixed on one roof. The fact that there are two different size slates suggests two different roofs.

The *pes* slates cannot be used on a *palmipes* roof, but a *palmipes* slate can be reduced in size, and a new nail hole punched to be used on a *pes* roof. As most of the slates are *pes* slates, and all the eave slates examined were of a size to fit on a *pes* roof, this suggests that both the roof that the slates were recovered from and the one that they were intended to be used on was a *pes* roof. The small number of *palmipes* slates must have come from a different roof but could have been intended for reworking to fit the *pes* roof.

This interpretation is supported by the presence of three slates each with two nail holes in them. The use of standard size slates means that the nail hole would not normally need to be repositioned if the slate was reused. The only reason why this would have occurred is if they were reduced in size for reuse. This suggests that these slates came from a different roof or maybe a different building. Along with the unaltered *palmipes* slates this suggests that a small number of larger slates were taken from a different roof to be reused on a roof with smaller slates.



Reconstruction by William Jones of how the slates would have been hung



Shapes of slates that would be necessary for roofing (William Jones). Only the standard slate form and the lower course form were found in the excavation.

28 APPENDIX XVII: RADIOCARBON DATES AND ANALYSIS

28.1 Appendix XVII.1: Radiocarbon dating and Bayesian analysis

Derek Hamilton (SUERC)

A total of eight radiocarbon measurements are available on samples recovered from a lime kiln, oven, smithing pit, and shell mound excavated at Bryn-y-Fynwent. All the samples were single-entities (Ashmore 1999), and consisted of either short-lived charcoal or cockle shell. They were submitted to the Scottish Universities Environmental Research Centre to be measured by Accelerator Mass Spectrometry (AMS).

The charcoal samples were pretreated following Stenhouse and Baxter (1983), and combusted as described in Vandeputte *et al* (1996) with the graphite targets prepared and measured following Xu *et al* (2004). Shell carbonate was pretreated by removing any adhering detritus by physical abrasion before sonication in an ultrasonic bath to remove any further debris. 20% by mass of the outer surface was then removed by etching in 1M HCl solution. After rinsing and drying, a 0.1g cross-section of the shell, from umbo to shell margin, was selected for acid hydrolysis to integrate the entire lifespan of the organism. The shell fragments received a further 20% surface removal, *in situ*, immediately before hydrolysis, in order to remove any adsorbed CO_2 that may have accumulated in the storage period between pretreatment and hydrolysis. The radiocarbon results from Bryn-y-Fynwent are given in Table 1, and in Figures 1 and 2.

Four samples of charcoal and carbonized grain from a corn drier located at Llidiart Yspytty near Tremadog had been submitted to Beta Analytic (http://www.radiocarbon.com) for AMS dating as part of a separate project. The samples were processed following procedures outlined on their website, and the results are present here (Table 2 and Figure 3) as comparison to the scientific dating from Bryn-y-Fynwent.

Both laboratories maintain rigorous internal quality assurance procedures, and participation in international inter-comparisons (Scott 2003) indicate no laboratory offsets; thus validating the measurement precision quoted for the radiocarbon ages.

The results in Tables 1 and 2 are conventional radiocarbon ages (Stuiver and Polach 1977), quoted according to the international standard set at the Trondheim Convention (Stuiver and Kra 1986). The terrestrial samples (e.g. charcoal, grain) calibrated with the internationally agreed IntCal09 atmospheric curve of Reimer *et al* (2009), while the marine shell was calibrated with the internationally agreed Marine09 marine curve of Reimer *et al* (2009) with a ΔR value of 1 ±49a for the coast of Wales. All calibrations were done using OxCal v4.1 (Bronk Ramsey 1995; 1998; 2001; 2009). The date ranges in Table 1 have been calculated using the maximum intercept method (Stuiver and Reimer 1986), and quoted in the form recommended by Mook (1986) with the endpoints rounded outward to 10 years. The probability distributions seen in Figures 1–3 were obtained by the probability method (Stuiver and Reimer 1993).

28.1.1 Methodological Approach

A Bayesian approach has been adopted for the interpretation of the chronology (Buck *et al* 1996). Although the simple calibrated dates are accurate estimates of the dates of the samples, this is usually not what archaeologists really wish to know. It is the dates of the archaeological events represented by those samples, which are of interest. In the case of the lime kiln at Bryn-y-Fynwent, it is the overall chronology of the use of the area – when did it begin; when did it end; and for how long did it take place – that is under consideration, not necessarily the dates of any individual samples. The dates of this activity can be estimated not only using the absolute dating information from the radiocarbon measurements on the samples, but also by using the stratigraphic relationships between samples.

Fortunately, methodology is now available which allows the combination of these different types of information explicitly, to produce realistic estimates of the dates of archaeological interest. It should be emphasised that the *posterior density estimates* produced by this modelling are not absolute. They are interpretative *estimates*, which can and will change as further data become available and as other researchers choose to model the existing data from different perspectives.

The technique used is a form of Markov Chain Monte Carlo sampling, and has been applied using the program OxCal v4.1. Details of the algorithms employed by this program are available from the on-line manual or in Bronk Ramsey (1995; 1998; 2001; 2009). The algorithm used in the model described below can be derived directly from the model structure shown in Figures 1 and 3.

28.1.2 The Bryn-y-Fynwent Samples

Three contexts were dated from the lime kiln (3054), and oven (3091), and a pit (3010) associated with nearby smithy features at Site 02 and 03.

There are two results (SUERC-37690 and -37694) on separate fragments of hazel charcoal from (3015), a fill in smithy pit (3010). The two measurements are not statistically consistent (T'=4.0; v=1; T'(5%)=3.8: Ward and Wilson 1978). This can often indicate that the results are from a either a mixed deposit, or one with some longevity. However, the results are consistent at 3-sigma (T'(1%)=6.6) and so might simply be slight statistical outliers.

The two results (SUERC-37695 and -37696) on separate fragments of hazel charcoal from deposit (3090) in the small oven (3091) are statistically consistent (T'=0.7; v=1; T'(5%)=3.8) and could be the same actual age.

Finally, two results (SUERC-37697 and -37698) are available on separate fragments of hazel charcoal from deposit (3094) in the lime kiln (3054). These two measurements are statistically consistent (T'=0.7; v=1; T'(5%)=3.8) and could be the same actual age.

Although the two results from the smithing pit are not statistically consistent, as a group, the six measurements from these three contexts are statistically consistent (T'=5.8; v=5; T'(5%)=11.1) and suggests that deposition occurred over a shorter, rather than longer, period of time.

28.1.3 Shell Midden Field 37

There are two results (SUERC-37699 and -37700) on cockle shells from the midden recovered within field 37. These results are statistically consistent (T'=0.7; v=1; T'(5%)=3.8) and could be the same age. The latest date (SUERC-37700) provides cal AD 1220–1330 (95% confidence) as the best estimate for the date of deposition.

28.1.4 The Llidiart Yspytty Samples

The four results from Tremadog come from four separate contexts. They include a result (Beta-205125) on a bulk sample of eight wheat grains from context (318) and one (Beta-205126) on a bulk sample of barley grains from context (321), which are two deposits that spread over the southeastern end of the corn-drier flue. The two layers are not related through stratigraphy.

A result (Beta-205127) is available on a twig fragment of cherry/plum charcoal from the lining (324) of oven (330/331), with the fourth result (Beta-205128) on a hazel stem charcoal fragment from deposit (332) that may possibly be from the rake-out or else related to another bit of collapsed lining and found in (363).

The four results are all statistically consistent (T'=1.8; v=3; T'(5%)=7.8), suggesting that the material in these features was deposited over a relatively short span of time.

28.1.5 The Models

There is no stratigraphy at either site to suggest an order for the radiocarbon dates, and so they have been modelled as relating to an unordered phase of activity at each site location. The only parameter for each model is the *uninformative prior* that the dated material comes from a sample pool of material that was uniformly distributed in the past. The models show good agreement between the radiocarbon results and this prior (A_{model}=106).

28.1.6 Bryn-y-Fynwent

The model for Bryn-y-Fynwent estimates that activity associated with the dated features began in *cal AD 120–320* (*95% probability*; Figs 1 and 4; *start: Bryn-y-Fynwent*) and probably in either *cal AD 195–255* (*48% probability*) or *cal AD 275–310* (*20% probability*). The activity continued for *1–260 years* (*95% probability*; Fig 5; *span: Bryn-y-Fynwent*) and probably *1–110 years* (*68% probability*). This activity ended in *cal AD 240–410* (*95% probability*; Figs 1 and 4; *end: Bryn-y-Fynwent*) and probably in either *cal AD 250–270* (*9% probability*) or *cal AD 290–355* (*59% probability*).

28.1.7 Llidiart Yspytty

The chronological model for Llidiart Yspytty estimates that activity at that site began in *40 cal BC–cal AD 245* (*95% probability*; Figs 3 and 4; *start: Tremadog*) and probably in *cal AD 105–215* (*68% probability*). This activity continued for *1–435 years* (*95% probability*; Fig 5; *span: Tremadog*) and probably for *1–150 years* (*68% probability*). The activity at Tremadog ended in *cal AD 135–445* (*95% probability*; Figs 3 and 4; *end: Tremadog*) and probably in *cal AD 165–290* (*68% probability*).

28.1.8 Comparison of the chronologies of Bryn-y-Fynwent and Llidiart Yspytty

The Bayesian approach allows us to move beyond simply modelling the start and end dates for a site, and provides a methodology by which we can compare those probabilities and determine the more probable order of modelled events. In this case we are interested in the chronology of Bryn-y-Fynwent and Llidiart Yspytty, with the aim of determining if the two were likely coeval in use or if one is considerably earlier than the other. This is accomplished in OxCal by invoking the Order function.

Based on the modelled probabilities, there is a 90% probability that *start: Tremadog* occurred prior to *start: Bryn-y-Fynwent*. Similarly, there is a 40% probability that *end: Tremadog* occurred before *start: Bryn-y-Fynwent*. Finally, there is an 80% probability that *end: Tremadog* occurred prior to *end: Bryn-y-Fynwent*.

These modelled probabilities suggest that while activity at Llidiart Yspytty was initiated prior to Bryn-y-Fynwent, the two sites likely temporally overlapped in their use.

28.1.9 Discussion

While the uniform distribution prior produces robust models, when there are only a few radiocarbon measurements the models can be less precise then we might hope. This is the result of having an inadequate number of measurements to fully account for the statistical spread on the radiocarbon measurements (Steier and Rom 2000), which can be further exacerbated by the location of the measurements in relation to the wiggles of the calibration curve. When this is the case, there is usually a pronounced tail on the modelled probability distributions for the start and end dates of the site, causing the 95% probability ranges to be rather wide and the probability that the real start or end date is any individual year is very low. In these situations the 68% probability range is often more informative for the interpretation as the probabilities for each individual year are generally much higher.

Bearing the potential problems associated with the low number of dates, the results of the Bayesian analysis and modelling can be summarised as follows:

The start of activity at Llidiart Yspytty most probably predates that at Bryn-y-Fynwent, but the two sites most likely overlap in their use;

The activity at Llidiart Yspytty probably began in the 2nd century cal AD, though may have begun as early as the second half of the 1st century cal BC;

The activity at Bryn-y-Fynwent probably began in the 3rd century cal AD, although it may have begun in the 2nd century cal AD;

Activity at Llidiart Yspytty ended in the 2nd or 3rd century cal AD, while that at Bryn-y-Fynwent probably persisted until the second half of the 3rd or first half of the 4th century cal AD.

Table 1: Radiocarbon results from Bryn-y-Fynwent. The charcoal samples were calibrated using the IntCal09 atmospheric curve of Reimer *et al* (2009a), while the shell measurements

were calibrated using the Marine09 marine curve of Reimer *et al* (2009b) with a ΔR value of 1 ±49a for the coast of Wales.

Lab ID	Context	Material	$\delta^{13}C$ (‰)	Radiocarbon age (BP)	Calibrated date (95% confidence)
SUERC-37690	3015: fill of smithing pit [3010]	charcoal: *Corylus avellana*	-27.7	1815 ±30	cal AD 120–320
SUERC-37694	3015: fill of smithing pit [3010]	charcoal: *Corylus avellana*	-26.0	1730 ±30	cal AD 230–400
SUERC-37695	3090: thin layer of charcoal at the base of kiln [3054]	charcoal: *Corylus avellana*	-27.8	1785 ±30	cal AD 130–340
SUERC-37696	3090: thin layer of charcoal at the base of kiln [3054]	charcoal: *Corylus avellana*	-25.8	1750 ±30	cal AD 220–390
SUERC-37697	3094: fill of oven/small furnace [3091]	charcoal: *Corylus avellana*	-26.2	1735 ±30	cal AD 230–400
SUERC-37698	3094: fill of oven/small furnace [3091]	charcoal: *Corylus avellana*	-26.0	1765 ±30	cal AD 170–380
SUERC-37699	37004: shell midden	shell: *Cerastoderma edule*	0.3	1150 ±30	cal AD 1130–1340
SUERC-37700	37004: shell midden	shell: *Cerastoderma edule*	0.5	1115 ±30	cal AD 1170–1400

Table 2: Radiocarbon results from Llidiart Yspytty

Lab ID	Context [Sample ID]	Material	$\delta^{13}C$ (‰)	Radiocarbon age (BP)	Calibrated date (95% confidence)
Beta-205125	318: an upper layer of deposit (322) that spread over the southeastern end of the corn-drier flue [2]	8 charred emmer/spelt wheat grains	-23.9	1840 ±40	cal AD 70–320

Beta-205126	321: an upper layer of deposit (322) that spread over the southeastern end of the corn-drier flue [3]	4 charred barley grains	-22.2	1820 ±40	cal AD 80–330
Beta-205127	324: collapsed lining of oven (330/331) [5]	charcoal: cherry/plum twig	-26.4	1830 ±40	cal AD 70–320
Beta-205128	332: charcoal-rich deposit inside (363) [7]	charcoal: hazel stem	-24.6	1770 ±40	cal AD 130–390

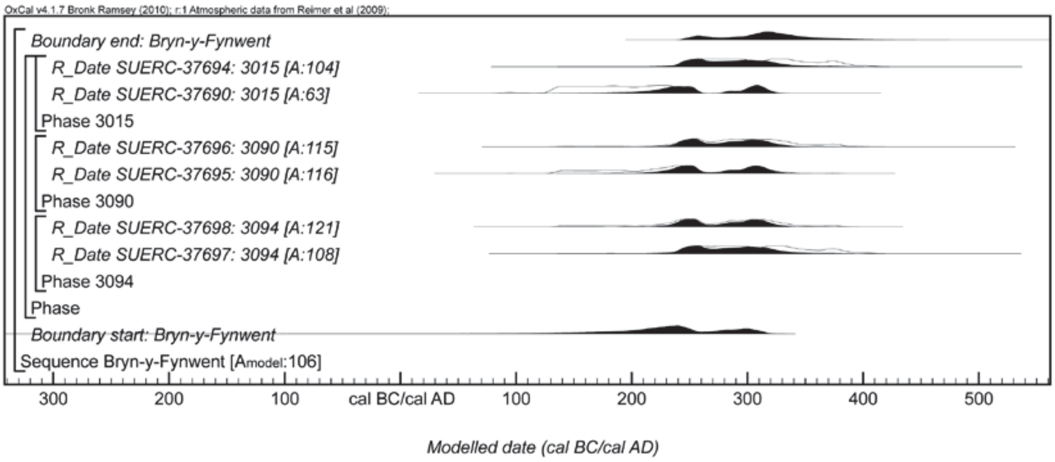


Figure 1: Chronological model for Bryn-y-Fynwent. Each distribution represents the relative probability that an event occurred at some particular time. For each of the radiocarbon measurements two distributions have been plotted, one in outline, which is the result of simple radiocarbon calibration, and a solid one, which is based on the chronological model use. The other distributions correspond to aspects if the model. For example, '*start: Bryn-y-Fynwent Site 02 and 03*' is the estimated date that activity began at this site, based on the radiocarbon dating results. The large square 'brackets' along with the OxCal keywords define the overall model exactly

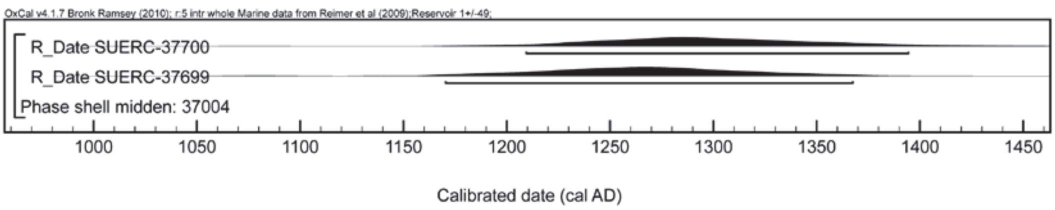


Figure 2: Calibrated dates from the shell midden in Field 37 of the Bryn-y-Fynwent project. The results are calibrated using the Marine09 marine calibration curve of Reimer *et al* (2009) and a ΔR value of 1 ±49a for the Welsh coast

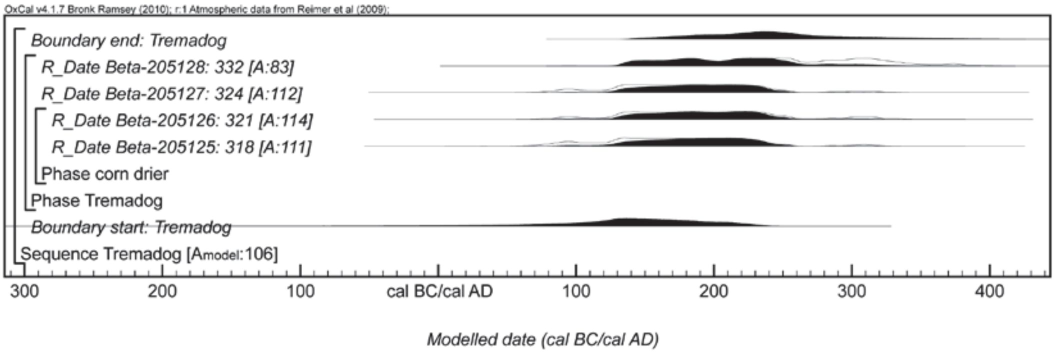


Figure 3: Chronological model for the four results from the corn drier and associated features at Llidiart Yspytty. The model format is as described in Figure 1

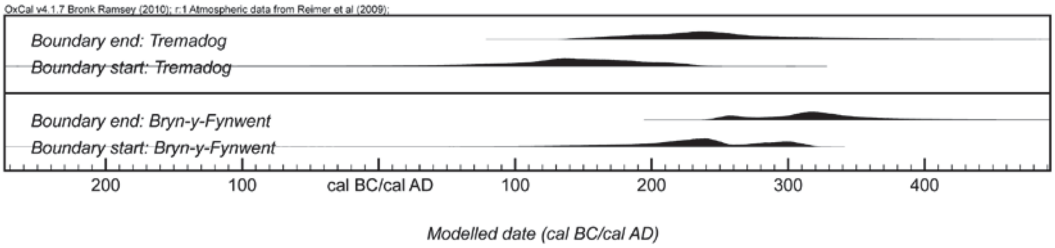


Figure 4: Comparison of the '*start*' and '*end*' dates for Bryn-y-Fynwent and Llidiart Yspytty. The probabilities are derived from the models shown in Figures 1 and 3

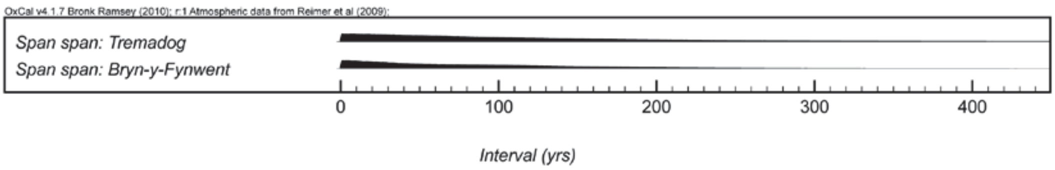


Figure 5: Span of activity associated with the radiocarbon dates from Bryn-y-Fynwent and Llidiart Yspytty

Works Cited

Ashmore, PJ 1999 Radiocarbon dating: avoiding errors by avoiding mixed samples, *Antiquity*, 73(279), 124–30

Bronk Ramsey, C 1995 Radiocarbon calibration and analysis of stratigraphy: the OxCal program, *Radiocarbon*, 37, 425–30

Bronk Ramsey, C 1998 Probability and dating, *Radiocarbon*, 40(1), 461–74

Bronk Ramsey, C 2001 Development of the radiocarbon calibration program, *Radiocarbon*, 43, 355–63

Bronk Ramsey, C 2009 Bayesian analysis of radiocarbon dates, *Radiocarbon*, 51(1), 337–60

Buck, CE, Cavanagh, WG and Litton, CD 1996 *Bayesian approach to interpreting archaeological data*, Chichester: John Wiley & Sons, Ltd.

Mook, WG 1986 Business meeting: Recommendations/Resolutions adopted by the Twelfth International Radiocarbon Conference, *Radiocarbon*, 28, 799

Reimer, PJ, Baillie, MGL, Bard, E, Bayliss, A, Beck, JW, Blackwell, PG, Bronk Ramsey, C, Buck, CE, Burr, GS, Edwards, RL, Friedrich, M, Grootes, PM, Guilderson, TP, Hajdas, I, Heaton, TJ, Hogg, AG, Hughen, KA, Kaiser, KF, Kromer, B, McCormac, FG, Manning, SW, Reimer, RW, Richards, DA, Southon, JR, Talamo, S, Turney, CSM, van der Plicht, J and Weyhenmeyer, CE 2009 INTCAL09 and MARINE09 radiocarbon age calibration curves, 0–50,000 years cal BP, *Radiocarbon*, 51(4), 1111–50

Scott, EM 2003 The Third International Radiocarbon Intercomparison (TIRI) and the Fourth International Radiocarbon Intercomparison (FIRI) 1990–2002: results, analysis, and conclusions, *Radiocarbon*, 45(2), 135–408

Steier, P and Rom, W 2000 The use of Bayesian statistics for ^{14}C dates of chronologically ordered samples: a critical analysis, *Radiocarbon*, 42, 183–98

Stenhouse, MJ and Baxter, MS 1983 ^{14}C reproducibility: evidence from routine dating of archaeological samples, *PACT*, 8, 147–61

Stuiver, M and Kra, RS 1986 Editorial comment, *Radiocarbon*, 28(2B), ii

Stuiver, M and Polach, HA 1977 Reporting of ^{14}C data, *Radiocarbon*, 19(3), 355–63

Stuiver, M and Reimer, PJ 1986 A computer program for radiocarbon age calibration, *Radiocarbon*, 28(2B), 1022–30

Stuiver, M and Reimer, PJ 1993 Extended ^{14}C data base and revised CALIB 3.0 ^{14}C calibration program, *Radiocarbon*, 35(1), 215–30

Vandeputte, K, Moens, L and Dams, R 1996 Improved sealed-tube combustion of organic samples to CO_2 for stable isotope analysis, radiocarbon dating and percent carbon determinations, *Analytical Letters*, 29(15), 2761–73

Ward, GK and Wilson, SR 1978 Procedures for comparing and combining radiocarbon age determinations: a critique, *Archaeometry*, 20, 19–32

Xu, S, Anderson, R, Bryant, C, Cook, GT, Dougans, A, Freeman, S, Naysmith, P, Schnabel, C and Scott, EM 2004 Capabilities of the new SUERC 5MV AMS facility for ^{14}C dating, *Radiocarbon*, 46(1), 59–64

28.2 Appendix XVII.2: The radiocarbon certificates

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RADIOCARBON DATING CERTIFICATE
10 January 2012

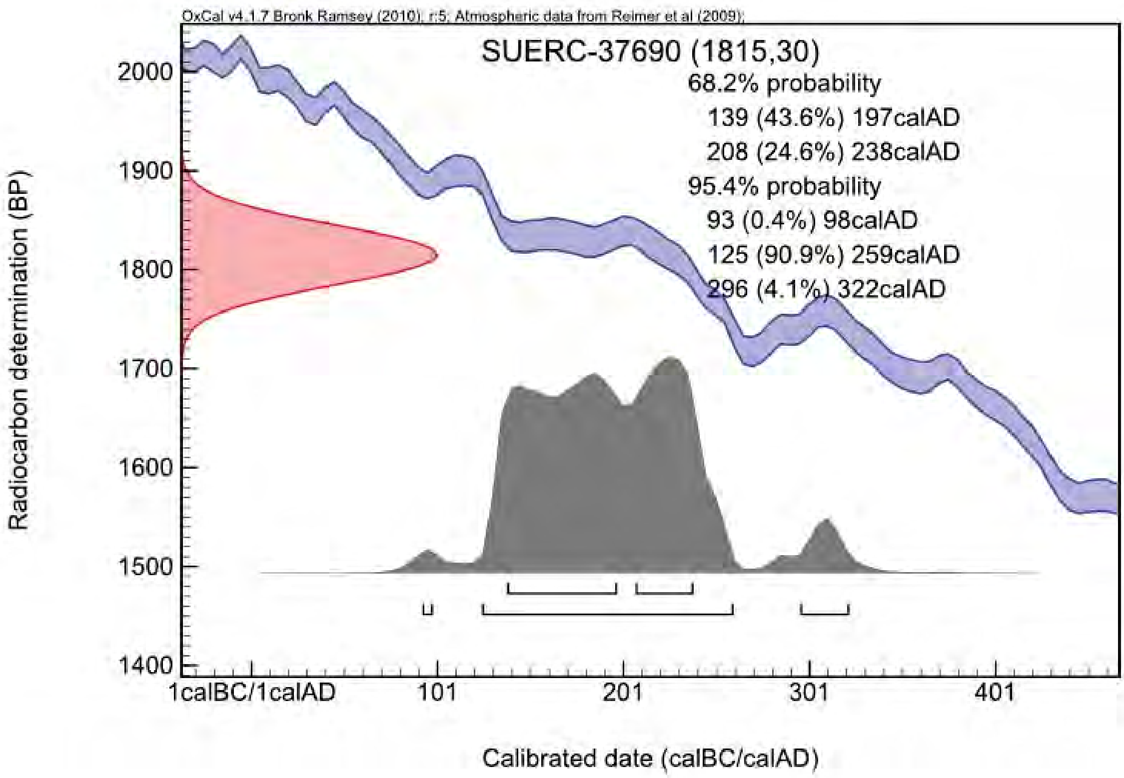
Laboratory Code	SUERC-37690 (GU25880)
Submitter	Laura Parry Gwynedd Archaeological Trust Craig Beuno, Ffordd Y Garth Bangor Gwynedd
Site Reference	G2108 F3
Context Reference	3015
Sample Reference	2
Material	Charcoal : Corylus avallana
δ13C relative to VPDB	-27.7 ‰
Radiocarbon Age BP	1815 ± 30

N.B. The above 14C age is quoted in conventional years BP (before 1950 AD). The error, which is expressed at the one sigma level of confidence, includes components from the counting statistics on the sample, modern reference standard and blank and the random machine error.

The calibrated age ranges are determined from the University of Oxford Radiocarbon Accelerator Unit calibration program (OxCal4).

Samples with a SUERC coding are measured at the Scottish Universities Environmental Research Centre AMS Facility and should be quoted as such in any reports within the scientific literature. Any questions directed to the Radiocarbon Laboratory should also quote the GU coding given in parentheses after the SUERC code. The contact details for the laboratory are email g.cook@suerc.gla.ac.uk or Telephone 01355 270136 direct line.

Calibration Plot



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RADIOCARBON DATING CERTIFICATE
10 January 2012

Laboratory Code	SUERC-37694 (GU25881)
Submitter	Laura Parry Gwynedd Archaeological Trust Craig Beuno, Ffordd Y Garth Bangor Gwynedd
Site Reference	G2108 F3
Context Reference	3015
Sample Reference	2
Material	Charcoal : Corylus avallana
$\delta^{13}C$ relative to VPDB	-26 ‰
Radiocarbon Age BP	1730 ± 30

N.B. The above ^{14}C age is quoted in conventional years BP (before 1950 AD). The error, which is expressed at the one sigma level of confidence, includes components from the counting statistics on the sample, modern reference standard and blank and the random machine error.

The calibrated age ranges are determined from the University of Oxford Radiocarbon Accelerator Unit calibration program (OxCal4).

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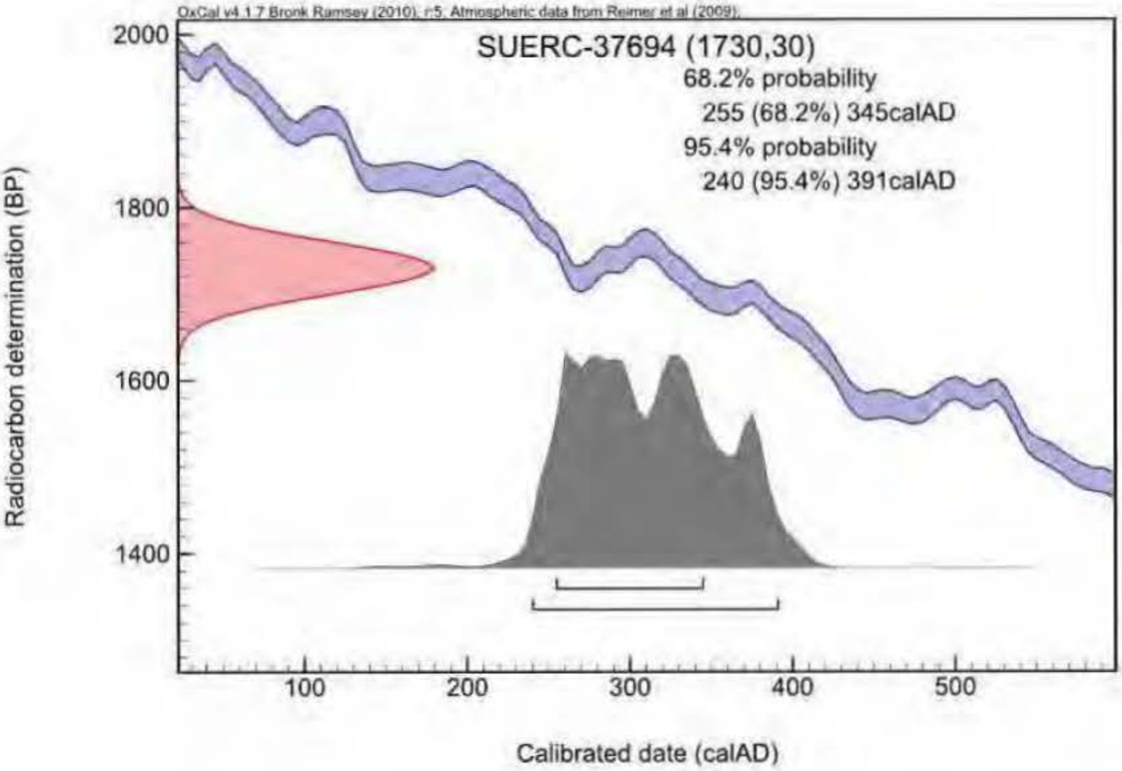
Calibration Plot



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RADIOCARBON DATING CERTIFICATE
10 January 2012

Laboratory Code	SUERC-37695 (GU25882)
Submitter	Laura Parry Gwynedd Archaeological Trust Craig Beuno, Ffordd Y Garth Bangor Gwynedd
Site Reference	G2108 F3
Context Reference	3090
Sample Reference	13
Material	Charcoal : Corylus avallana
$\delta^{13}C$ relative to VPDB	-27.8 ‰
Radiocarbon Age BP	1785 ± 30

N.B. The above ^{14}C age is quoted in conventional years BP (before 1950 AD). The error, which is expressed at the one sigma level of confidence, includes components from the counting statistics on the sample, modern reference standard and blank and the random machine error.

The calibrated age ranges are determined from the University of Oxford Radiocarbon Accelerator Unit calibration program (OxCal4).

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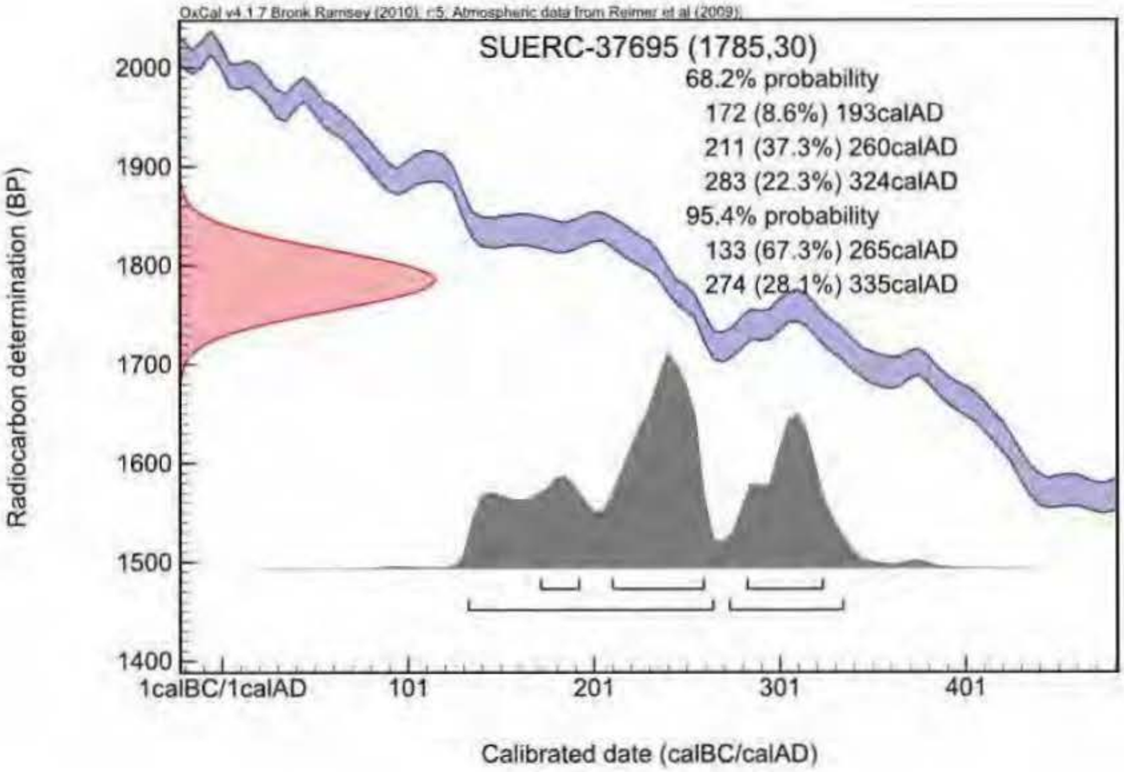
Calibration Plot



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RADIOCARBON DATING CERTIFICATE
10 January 2012

Laboratory Code	SUERC-37696 (GU25883)
Submitter	Laura Parry Gwynedd Archaeological Trust Craig Beuno, Ffordd Y Garth Bangor Gwynedd
Site Reference	G2108 F3
Context Reference	3090
Sample Reference	13
Material	Charcoal : Corylus avallana
$\delta^{13}C$ relative to VPDB	-25.8 ‰
Radiocarbon Age BP	1750 ± 30

N.B. The above ^{14}C age is quoted in conventional years BP (before 1950 AD). The error, which is expressed at the one sigma level of confidence, includes components from the counting statistics on the sample, modern reference standard and blank and the random machine error.

The calibrated age ranges are determined from the University of Oxford Radiocarbon Accelerator Unit calibration program (OxCal4).

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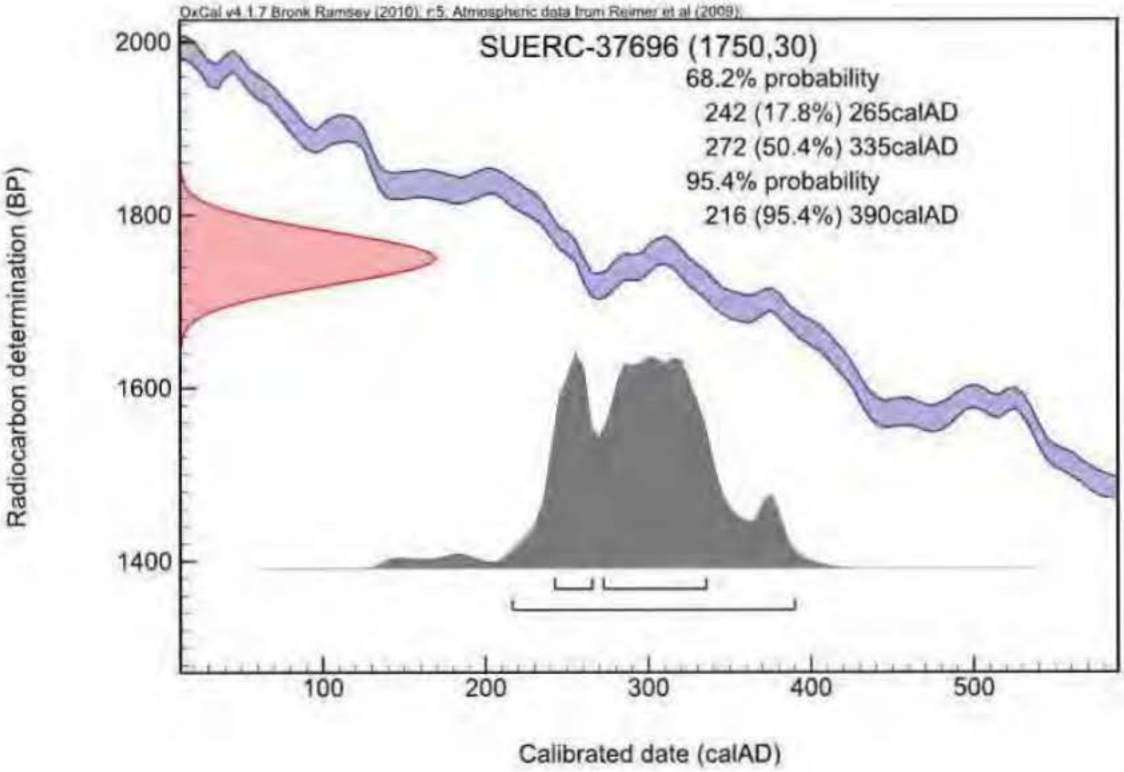
Calibration Plot



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RADIOCARBON DATING CERTIFICATE
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Laboratory Code	SUERC-37697 (GU25884)
Submitter	Laura Parry Gwynedd Archaeological Trust Craig Beuno, Ffordd Y Garth Bangor Gwynedd
Site Reference	G2108 F3
Context Reference	3094
Sample Reference	22
Material	Charcoal : Corylus avallana
$\delta^{13}C$ relative to VPDB	-26.2 ‰
Radiocarbon Age BP	1735 ± 30

N.B. The above ^{14}C age is quoted in conventional years BP (before 1950 AD). The error, which is expressed at the one sigma level of confidence, includes components from the counting statistics on the sample, modern reference standard and blank and the random machine error.

The calibrated age ranges are determined from the University of Oxford Radiocarbon Accelerator Unit calibration program (OxCal4).

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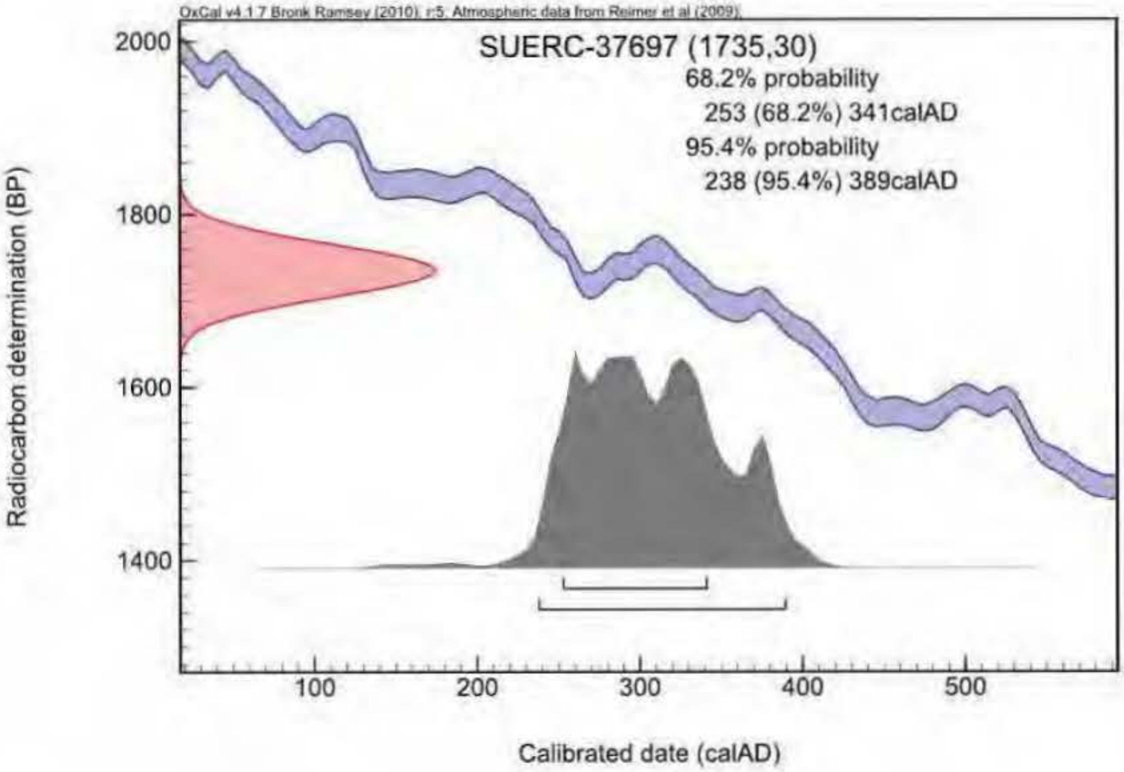
Calibration Plot



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RADIOCARBON DATING CERTIFICATE
10 January 2012

Laboratory Code	SUERC-37698 (GU25885)
Submitter	Laura Parry Gwynedd Archaeological Trust Craig Beuno, Ffordd Y Garth Bangor Gwynedd
Site Reference	G2108 F3
Context Reference	3094
Sample Reference	22
Material	Charcoal : Corylus avallana
$\delta^{13}C$ relative to VPDB	-26 ‰
Radiocarbon Age BP	1765 ± 30

N.B. The above ^{14}C age is quoted in conventional years BP (before 1950 AD). The error, which is expressed at the one sigma level of confidence, includes components from the counting statistics on the sample, modern reference standard and blank and the random machine error.

The calibrated age ranges are determined from the University of Oxford Radiocarbon Accelerator Unit calibration program (OxCal4).

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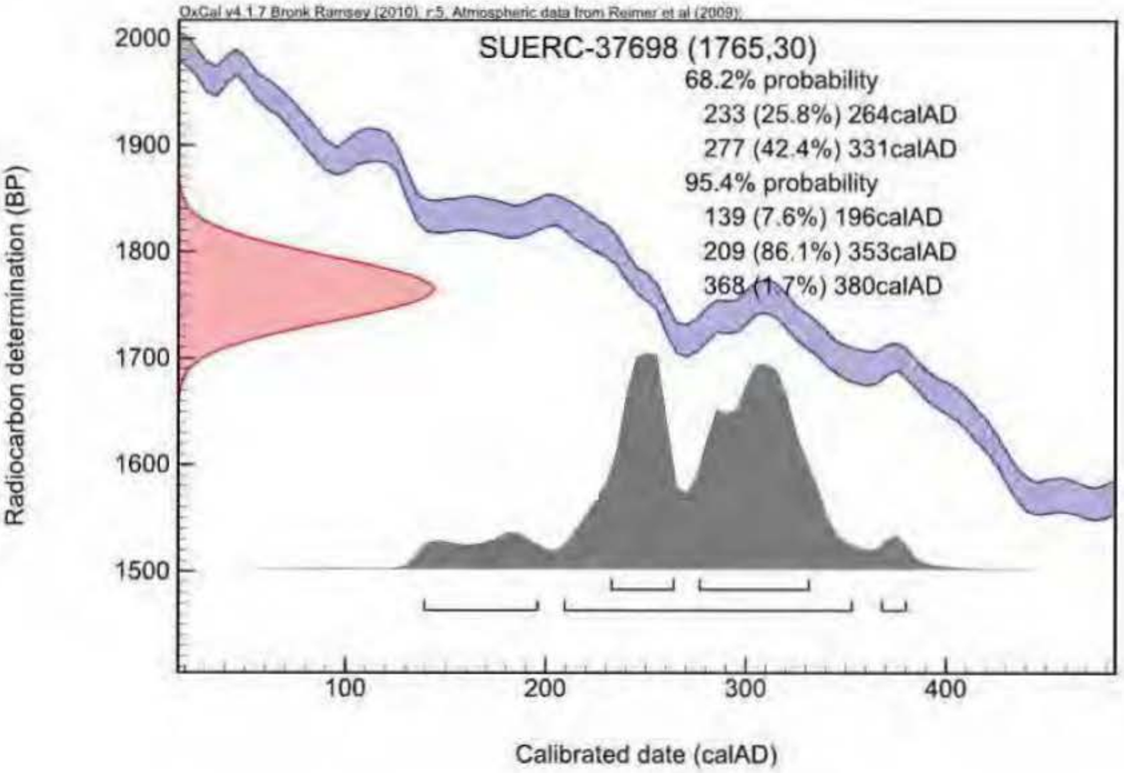
Calibration Plot



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RADIOCARBON DATING CERTIFICATE
10 January 2012

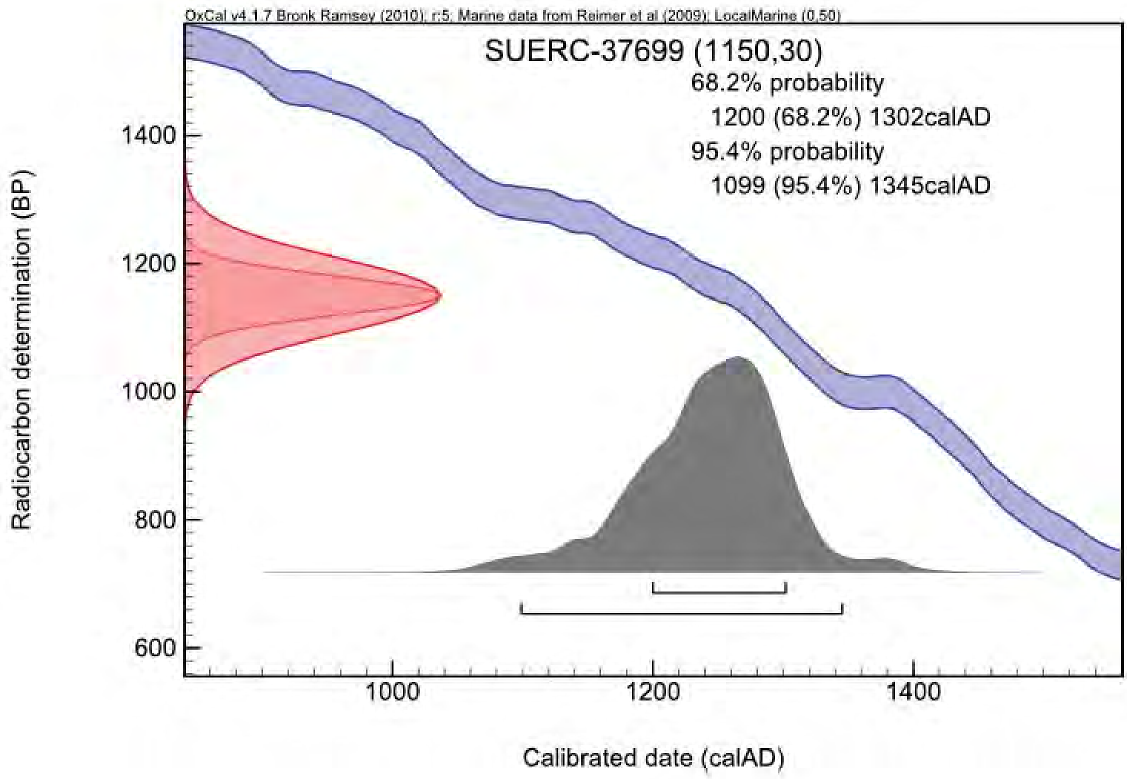
Laboratory Code	SUERC-37699 (GU25886)
Submitter	Laura Parry Gwynedd Archaeological Trust Craig Beuno, Ffordd Y Garth Bangor Gwynedd
Site Reference	G2108 F37
Context Reference	37004
Sample Reference	24
Material	Shell : Cerastoderma edule
δ^{13}C relative to VPDB	0.3 ‰
Radiocarbon Age BP	1150 ± 30

N.B. The above ^{14}C age is quoted in conventional years BP (before 1950 AD). The error, which is expressed at the one sigma level of confidence, includes components from the counting statistics on the sample, modern reference standard and blank and the random machine error.

The calibrated age ranges are determined from the University of Oxford Radiocarbon Accelerator Unit calibration program (OxCal4).

Samples with a SUERC coding are measured at the Scottish Universities Environmental Research Centre AMS Facility and should be quoted as such in any reports within the scientific literature. Any questions directed to the Radiocarbon Laboratory should also quote the GU coding given in parentheses after the SUERC code. The contact details for the laboratory are email g.cook@suerc.gla.ac.uk or Telephone 01355 270136 direct line.

Calibration Plot



Shell sample calibrated using a marine curve and a ΔR of 0±50.

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RADIOCARBON DATING CERTIFICATE
10 January 2012

Laboratory Code	SUERC-37700 (GU25887)
Submitter	Laura Parry Gwynedd Archaeological Trust Craig Beuno, Ffordd Y Garth Bangor Gwynedd
Site Reference	G2108 F37
Context Reference	37004
Sample Reference	24
Material	Shell : Cerastoderma edule
δ^{13}C relative to VPDB	0.5 ‰
Radiocarbon Age BP	1115 ± 30

N.B. The above ^{14}C age is quoted in conventional years BP (before 1950 AD). The error, which is expressed at the one sigma level of confidence, includes components from the counting statistics on the sample, modern reference standard and blank and the random machine error.

The calibrated age ranges are determined from the University of Oxford Radiocarbon Accelerator Unit calibration program (OxCal4).

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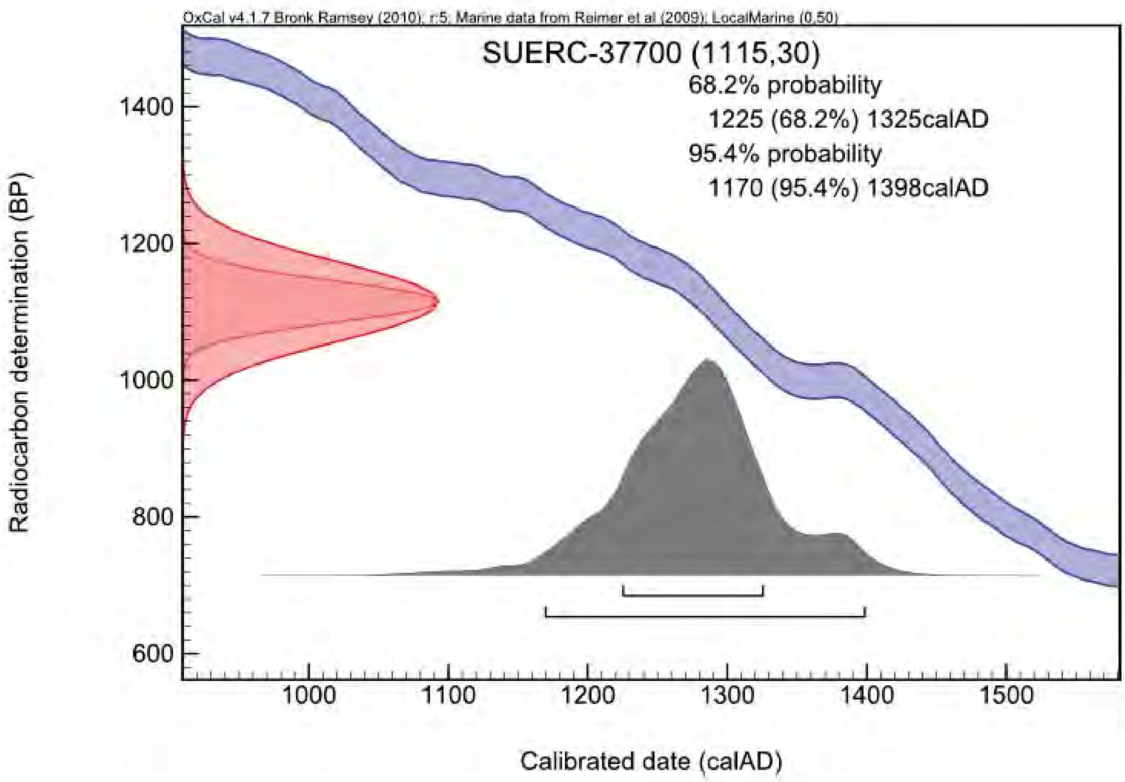
Calibration Plot



Shell sample calibrated using a marine curve and a ΔR of 0±50.

Gwynedd Archaeological Trust
Ymddiriedolaeth Archaeolegol Gwynedd

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