**GWYNEDD COUNTY COUNCIL**

# LAND ON A497 AT BRON EIFION, CRICCIETH, GWYNEDD, LL52 0RR

# GEOTECHNICAL, GROUND PERMEABILITY AND CONTAMINATION INVESTIGATION REPORT

**REPORT No. E1125.GGCI.R1**

**JUNE 2020**

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| **Client :** | **GWYNEDD COUNTY COUNCIL** |
| **Project Title :** | **LAND ON A497 AT BRON EIFION, CRICCIETH, GWYNEDD, LL52 0RR** |
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| **Project No.** | **E1125** |
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| **Date.** | **JUNE 2020** |

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**Distribution:** **GWYNEDD COUNTY COUNCIL**

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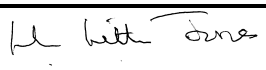
| **Signed:** |  | | |

# 1. INTRODUCTION.

## 1.1 Background and Terms of Reference

1.1.1 In June 2020 e-geo Solutions Ltd were commissioned by Gwynedd County Council to undertake a combined geotechnical, ground permeability and ground contamination investigation at a proposed school site on land on the A497 at Bron Eifion, Criccieth. The objective of the investigation was to determine the ground conditions at the site, the ground permeability and the geotechnical properties of the ground strata, and to assess the site with respect to potential contamination.

1.1.2 This report presents the findings of intrusive investigations with in-situ geotechnical tests, permeability tests and the chemical analysis of soil samples.

1.1.3 The site is presently is grassed agricultural land. It is proposed to redevelop the site with a new school and the findings of the intrusive investigation have been assessed against this proposed end use.

1.1.4 The report has been prepared by e-geo Solutions Ltd for the sole use of the Client, for the purposes described and no extended duty of care applies to other parties. Any other party using this report for any purpose whatsoever do so at their own risk and any duty care to that party is specifically excluded.

1.1.5 The comments given, and opinions expressed, in this report are based on the information available at the time the report was compiled, however there may be additional information and data which becomes available at a later date which has an impact on the report content. Where data supplied by others has been used it has been assumed that the information is correct. No responsibility can be accepted by e-geo Solutions Ltd for inaccuracies within the data supplied by others.



## 1.2 Report Contents

1.2.1 The report includes sections on:-

- Present site description, profile and setting
- The scope of the investigation, testing and analysis and its justification
- The geological and hydro-geological conditions encountered in shallow boreholes and trial pits
- The results of in-situ geotechnical tests in the boreholes
- The results of ground permeability tests
- Chemical analysis results and an assessment of contamination
- Comments on foundation design and development considerations

## 2. SITE LOCATION, DESCRIPTION AND PROFILE.

### 2.1 Site Location

2.1.1 The site is located on the western outskirts of Criccieth, Gwynedd immediately south of the A497 Criccieth to Pwllheli main road. The site location is shown on Figure 1 and is centred at Grid Reference 249220, 338047.

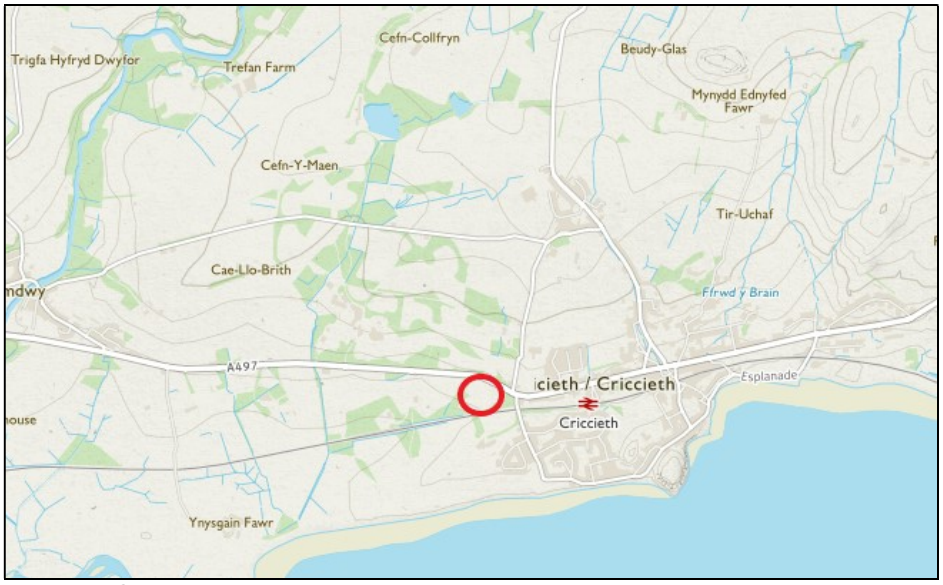


Figure 1 – Site Location

2.1.2 The extent of the site and the study area boundaries is shown on Figure 2.

Figure 2 – Site Extent

## 2.2 Site Description and Topography

2.2.1 The area for investigation (site) presently comprises grassed agricultural land used for grazing, to the south of the A497 and between the main road and Criccieth to Pwllheli railway line. The site is slopes gently towards the south and the railway line which forms the southern boundary. There are no structures on the site. An aerial photograph of the site area is shown as Figure 3.

Figure 3 -Aerial Photograph

## 2.3 Site Profile

2.3.1 A desk-based study of the site has been undertaken. Full details of the site history with historical Ordnance Survey maps are presented in Appendix 1. Details of the geological and environmental setting are presented in Appendix 2. A summary of the findings and site profile are presented below:

| Profile Item | LAND ON A497 AT BRON EIFION, CRICCIETH, GWYNEDD, LL52 0RR |
|---|---|
| ***Site Status:*** | The site presently comprises grassed agricultural land used for grazing. . There are no structures or activities on site and no evidence of wastes or contamination. The ground in the site slopes from north to south gently and flattens towards the southern boundary |
| ***Site History: (Historical OS Maps presented in Appendix 1)*** | **1889**: The site is agricultural land divided by a track running north to south with a small wooded area in the northwest corner. A railway line forms the southern boundary.<br>**1900**: The site is unchanged but with woodland surrounding the agricultural land on all sides.<br>**1916**: There site and surrounding land is as in 1900.<br>**1977**: There site and surrounding land is as in 1916<br>**1995**: There site and surrounding land is as in 1977. |
| ***Services:*** | There are no known main services within the site. |
| ***Geology: (Geological maps and data*** | Information from the British Geological Survey Map indicates that drift (soil) deposits at the site comprise Glacial Till. The Glacial Till will consist of silt and clay with varying proportions of sand and gravel and locally derived cobbles |

| | |
|---|---|
| ***are presented in Appendix 2)*** | and boulders. The Glacial Till extends for at least 500m in all directions. The bedrock comprises Felsic Tuff of the Pitts Head Tuff Formation.<br><br>There is no record of any made ground within the site.<br><br>There is a fault at the eastern boundary running north to south.<br><br>The site is classed as Grade 3B moderate quality agricultural land.<br><br>Other than the railway cutting to the south there are no surface working features within 500m of the site.<br><br>There is no historical mining, coal mining or non-coal mining features within 1000m of the site.<br><br>There is a negligible risk of shrinkage and swelling clay at the site.<br>There is a negligible risk of ground dissolution of soluble rocks below the site.<br>There is a negligible risk of compressible deposits below the site.<br>There is a very low risk of collapsible deposits below the site.<br>There is a very low risk of running sand at the site.<br>There is a very low risk of landslides. |
| ***Radon :*** | The site is not in a radon affected area with less than 1% of properties above the action level.<br><br>No radon protection measures are required. |
| ***Ground Permeability :*** | The bedrock will be of low to medium permeability with permeability governed predominantly by fractures and fissures. |
| ***Hydrogeology: (Environmental data is presented in Appendix 3)*** | The superficial deposits are not classed as an aquifer.<br><br>The bedrock at depth is classed as a secondary B aquifer. This is defined as geology of low permeability layers, which store and yield limited amounts of groundwater for local supplies and were formerly the water bearing parts of minor aquifers.<br><br>There are no Groundwater Abstraction Licence or Surface Water Abstraction Licence points within 1000m of the site. |
| ***Hydrology:*** | According to the Aquifer and Abstractions Map there are no surface water feature near the site, however there are ditches which contain water all year round at the southern and western boundary. |
| ***Sensitive Land Uses:*** | The nearest designated Sites of Special Scientific Interest is Glanllynnau A Glannau Pen-Ychain I Gricieth 348m south. |
| ***Landfills:*** | There are no Environment Agency registered landfill sites and Local Authority landfill sites or historic landfill within 500m. |
| ***Historical Industrial Sites:*** | The nearest land use with a potentially contaminative use is the railway at the southern boundary of the site. |
| ***Pollution Incidents:*** | There are no Environment Agency pollution incidents which originate at the site. |
| ***Potential Contamination:*** | The site only previous use was as agricultural land. No contamination is anticipated. |

## 3. GROUND INVESTIGATION WORKS.

### 3.1 Previous Investigations

3.1.1 There are no known previous investigations of the ground at the site.

### 3.2 Scope of Work – Exploratory Holes

3.2.1 A geotechnical, permeability and ground contamination investigation were undertaken to provide information on the ground conditions at the site. The works were carried out by e-geo Solutions Ltd with the field work element undertaken on 3rd June 2020. The investigation was designed, supervised and administered by e-geo Solutions Ltd and undertaken in accordance with BS5930 (1999) – code of Practice for Site Investigations (Amendment 1).

3.2.2 The main scope of work involved:

- The excavation of 4 Nr trial pits to allow strata description, soil sampling and permeability tests. Trial pit records are presented in Appendix 3.
- The construction of 5 Nr window sample boreholes with dynamic cone penetrometer tests with continuous SPTs to determine soil density and strength. The results of DCP tests giving SPT N values are presented in Appendix 4.
- The examination of ground strata by a geo-environmental engineer and the careful description of soil types. Detailed descriptions of the ground strata are presented on the trial pit records in Appendix 3.
- Undertaking permeability tests in four trial pits (TP1, TP2, TP3, TP4). The results are presented in Appendix 5.
- Collection of 3 Nr. ground samples from near the ground surface for chemical analysis

### 3.3 Scope of Work – Testing and Analysis

3.3.1 A total of 3 Nr. ground samples were collected from the trial pits and submitted for chemical analysis at an accredited analytical laboratory. The analytical results are presented in Appendix 5. Samples were tested for:

| Suite | Chemical Determinants | No. of Samples |
|---|---|---|
| Suite 1 | pH, arsenic, cadmium, chromium (total and hexavalent), lead, mercury, selenium, copper, nickel, zinc, cyanide (total), sulphide, sulphur, sulphate. PAH (speciated) | TP1-0.4, TP2-0.4, TP3-0.2 |
| Suite 2 | Soluble SO4 | TP1-0.4, TP2-0.4, TP3-0.2 |
| Suite 3 | Asbestos screen | TP1-0.4, TP3-0.2 |

### 3.4 Trial Hole Locations

3.4.1 Window sample boreholes and trial pit locations are indicated on Figure 4 below.

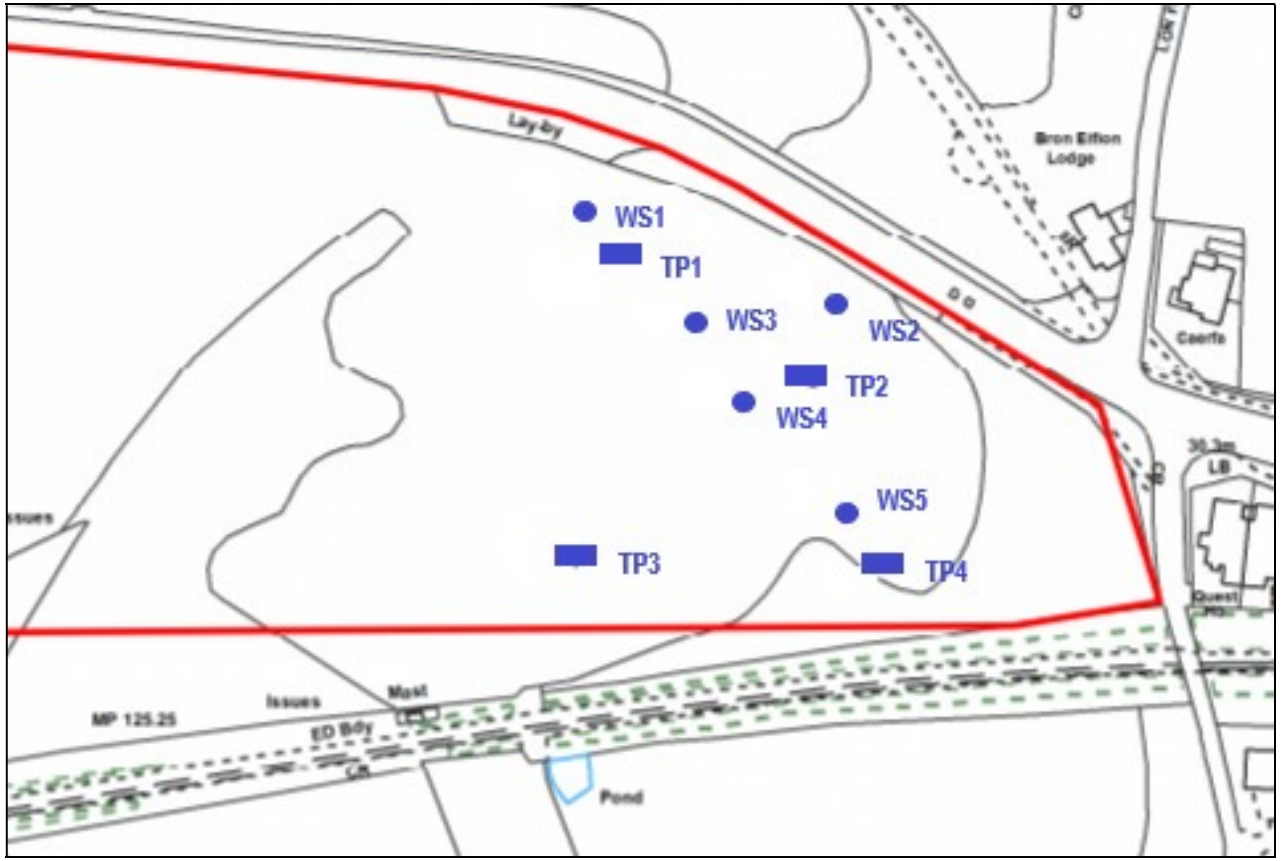



Figure 4 – Window Sample Boreholes (WS1 to WS5) and Trial Pit Locations (TP1 to TP5)

## 4. GROUND CONDITIONS AND GEOLOGY.

### 4.1 General

4.1.1 Details of the ground strata and depths are presented on the trial pit records in Appendix 3. A summary of the findings is presented below.

4.1.2 The results of in-situ standard penetration tests (SPTs) undertaken with a dynamic cone are presented in Appendix 4.

### 4.2 Stratigraphy

4.2.1 The strata and depths encountered during the investigation was:

| Stratum | Description | Depth to base m range (average) |
|---|---|---|
| Topsoil | Light brown slightly gravely silty TOPSOIL | 0.25 |
| GLACIAL TILL 1 | Firm to stiff to stiff light brown very gravely sandy silty CLAY. Gravel is fine to coarse subrounded to subangular of various lithologies. Low cobble content. | 0.60 – 1.50 |
| GLACIAL TILL 2 | Stiff light grey and greyish brown gravely sandy silty CLAY. Gravel is fine to coarse subangular of various lithologies. Low cobble content | |

### 4.3 Groundwater

4.3.1 Groundwater was only encountered in WS1 as a seepage at 0.70m and 1.80m. No groundwater was encountered in the trial pits to 1.90m.

### 4.4 Contamination Observations

4.4.1 During the examination of the ground strata no obvious indications of contamination were noted. There was no indication of hydrocarbons, vapours or unusual odours.

### 4.5 Geotechnical Properties

4.5.1 The results of Dynamic probe tests are presented in Appendix 2. The following SPT N values were obtained in the various strata.

| Stratum | Description | Depth (m) | SPT 'N' value |
|---|---|---|---|
| GLACIAL TILL 1 | Firm to stiff to stiff light brown very gravely sandy silty CLAY. Gravel is fine to coarse subrounded to subangular of various lithologies. Low cobble content. | 0.50<br>0.80<br>1.10<br>1.40 | 11,9,26,12,11<br>14,4,24,13,23<br>24,4,26,28<br>18,6,28, |
| GLACIAL TILL 2 | Stiff light grey and greyish brown gravely sandy silty CLAY. Gravel is fine to coarse subangular of various lithologies. Low cobble content | 1.40<br>1.70<br>2.00<br>2.30<br>2.60<br>2.90<br>3.20<br>3.50<br>3.80<br>4.20<br>4.50<br>4.80<br>5.00 | 15,11,26,9,28<br>10,17,43,8,28<br>12,20,33,21,29<br>15,23,29,25,23<br>13,28,20,39,18<br>15,32,15,21,26<br>R,17,14,48,21<br>28,25,R,34<br>27,15,66<br>30,17,34<br>51,27,22<br>R,24,26<br>36,29 |

| | | | |
|---|---|---|---|
| | | 5.30<br>5.60<br>5.90<br>6.20<br>6.50<br>6.80 | 34,38<br>28,39<br>27,50<br>26,R<br>20,<br>24, |

4.5.2 The results of the insitu SPTs indicate N values in the Glacial Till 1 clay to a depth of typically 1.20m in the range 4 to 28 with an average of 19 at 1.20m bgl. This gives approximate shear strength of 114 kN/m2. The results of hand held shear vane tests confirm that the clay to have a shear strength of at least 100 kN/m2.

4.5.3 The results of the insitu SPTs in the Glacial Till 2 clay from a depth of 1.20m indicate N values in the range 8 to 66 with an average of 23 between 2.0 to 3.0m bgl, an average of 29 between 3.0 and 4.0m bgl and an average of 31 between 4.0 and 5.0m bgl. This gives approximate shear strengths of 138kN/m2 at 3.0m bgl, 174kN at 4.0m bgl and 186kN/m2 at 5.0m bgl.

### 4.6 Permeability Test Results

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4.6.1 The results of the permeability tests are presented on the Field Test Results sheets in Appendix 5.

### 4.7 Soil Infiltration Rate Calculations

4.7.1 The Soil Infiltration Rate (f) is based on the method described in the BRE Digest and is calculated from the time taken for the water level to fall from 75% to 25% of the actual water depth in the trial hole.

4.7.2 The Soil Infiltration Rate (f) is calculated by the equation:

f = Vp75 – 25/ ap50 x tp75 -25
Where - Vp75 -25 is the storage volume in the hole from 75% to 25% effective depth,
ap50 is the internal surface area of the hole to 50% effective depth plus the base area,
tp75 – 25 the time taken for water to fall from 75% to 25% effective depth

4.7.3 In TP1 the following results were obtained:

Test TP1
The permeability test failed with very slow drainage. The water level dropped only 6cm in 2.5 hours and was static and 20cm above the 75% full mark when the test was terminated.

4.7.4 In TP2 the following results were obtained:

Test TP2
Vp75 – 25 = 1.40x 0.60 x (1.23 - 0.41) = 0.6888 cu.m
Ap50 = Base + (Int surface area to 50% eff depth)
Ap50 = (1.40 x 0.60) + (2 x 1.40 x 1.65/2 + 2 x 0.60 x 1.65/2) = 4.14 sq.m
tp75 – 25 = 1500 (estimated) -93= 1407min
Soil Infiltration Rate TP2(f) = Vp75–25/ap50xtp75 -25 = 0.6888/4.14x1407 x60 = 1.97 x $10^{-6}$m/sec (extrapolated)

4.7.5 In TP3 the following results were obtained:

Test TP3
The permeability test failed with very slow drainage. The water level initially dropped 19cm in 2.5 hours but then dropped only 2cm in the following 1.25 hours and was 49cm above the 25% full mark when the test was terminated.

4.7.6 In TP4 the following results were obtained:

Test TP4
The permeability test failed with very slow drainage. The water level dropped only 15cm in 3.5 hours and was 18cm above the 75% full mark when the test was terminated.

# 5. CONTAMINATION ASSESSMENT

## 5.1 General

5.1.1 The results of the chemical analysis of soils samples are presented in Appendix 6. An assessment of the results of the analysis of samples has been undertaken to determine the presence and extent of any ground contamination. The assessment of contamination undertaken is a 'Tier 1 Generic Risk Assessment' which requires the comparison of contaminant concentrations to a set of generic Tier 1 Screening Values (TSV) risk based screening concentrations.

5.1.2 Contaminant concentrations below the TSVs are considered not to warrant further risk assessment. It should be noted that exceeding the TSVs does not necessarily mean there is a risk and the site should be remediated.

## 5.2 Soils Reference Values

5.2.1 TSVs for soil derived to be protective of human health are defined for standard end use situations in accordance with UK CLR framework. The values chosen are dependant on the site use or proposed development. The site is to be developed with a school but for comparison purposes the guideline values for residential housing (with no plant uptake) have been used for assessment purposes. The TSVs selected to assess soils in relation to human health over the whole site are therefore 'residential with no plant uptake'.

5.2.2 The applicable TSVs for assessment of the analytical results are based on the following guideline criteria: CLEA 2009) Soil Guideline Values (SGVs) for 'residential and no plant uptake' end-use. (where available), LQM CIEH Generic Assessment Criteria – 2nd Edition 2009, Welsh Assembly Government C4SL.

## 5.3 Soils Analysis Assessment

5.3.1 Comparison of the analytical results for metals and non-metals using maximum concentrations as a means of assessment with the Tier 1 TSVs for 'residential use with no plant uptake' indicates that the shallow ground strata do not contain any significant concentrations of contaminants above available respective trigger concentrations.

5.3.2 Concentrations of cadmium and chromium were significantly below the guideline concentrations or below detection limits.

5.3.3 Concentrations of arsenic were below the guideline concentration.

5.3.4 Concentrations of selenium, mercury were below the detection limits.

5.3.5 Concentrations of copper, nickel, zinc and lead were significantly below the guideline concentrations.

5.3.6 No elevated concentrations of sulphate or sulphur were found in the ground. Phenol and cyanide concentrations were generally below the detection limits.

5.3.7 Concentrations of polyaromatic hydrocarbons were below the detection limit.

5.3.8 No elevated concentrations of soluble sulphate were detected.

# 6 DEVELOPMENT CONSIDERATIONS.

## 6.1 Foundations

6.1.1 The ground conditions encountered across the site are relatively uniform with firm to stiff to stiff light brown cobbly very gravely sandy silty CLAY (GLACIAL TILL 1) found below the topsoil from a depth of 0.25m to typically 1.20m. This was underlain by a stiff light grey and greyish brown cobbly gravely sandy silty CLAY (GLACIAL TILL 2) to a depth of at least 4.00m (window sample boreholes) to 8.00m (DCP probe hole). Occasional boulders were encountered in all the Glacial Till.

6.1.2 Standard strip foundations placed within firm to stiff to stiff light brown cobbly very gravely sandy silty CLAY (GLACIAL TILL 1) at standard depth should be designed for an Allowable Bearing Capacity of 200kN/m2.

6.1.3 The clay will be low plasticity clay with a low potential for shrinkage and swelling.

## 6.2 Floor Slabs

6.2.1 Floor slabs can be ground bearing on the firm to stiff to stiff light brown cobbly very gravely sandy silty CLAY (GLACIAL TILL 1).

## 6.3 Earthworks

6.3.2 The natural ground strata of Glacial Till can be easily excavated with normal groundworks excavation plant. However excavations may experience some slight overbreak where boulders are present.

6.3.3 No groundwater inflows were recorded in the trial pits at shallow depth. However a slight groundwater seepage was encountered in the northwest corner of the site at a depth of 0.70m.

## 6.4 Concrete

6.4.1 The results of laboratory pH and sulphate content indicate that ACEC Class AC1 and sulphate class DS-1 conditions prevail at the site, in accordance with BRE Special Digest 1 ‘Concrete in Aggressive Ground 2005’.

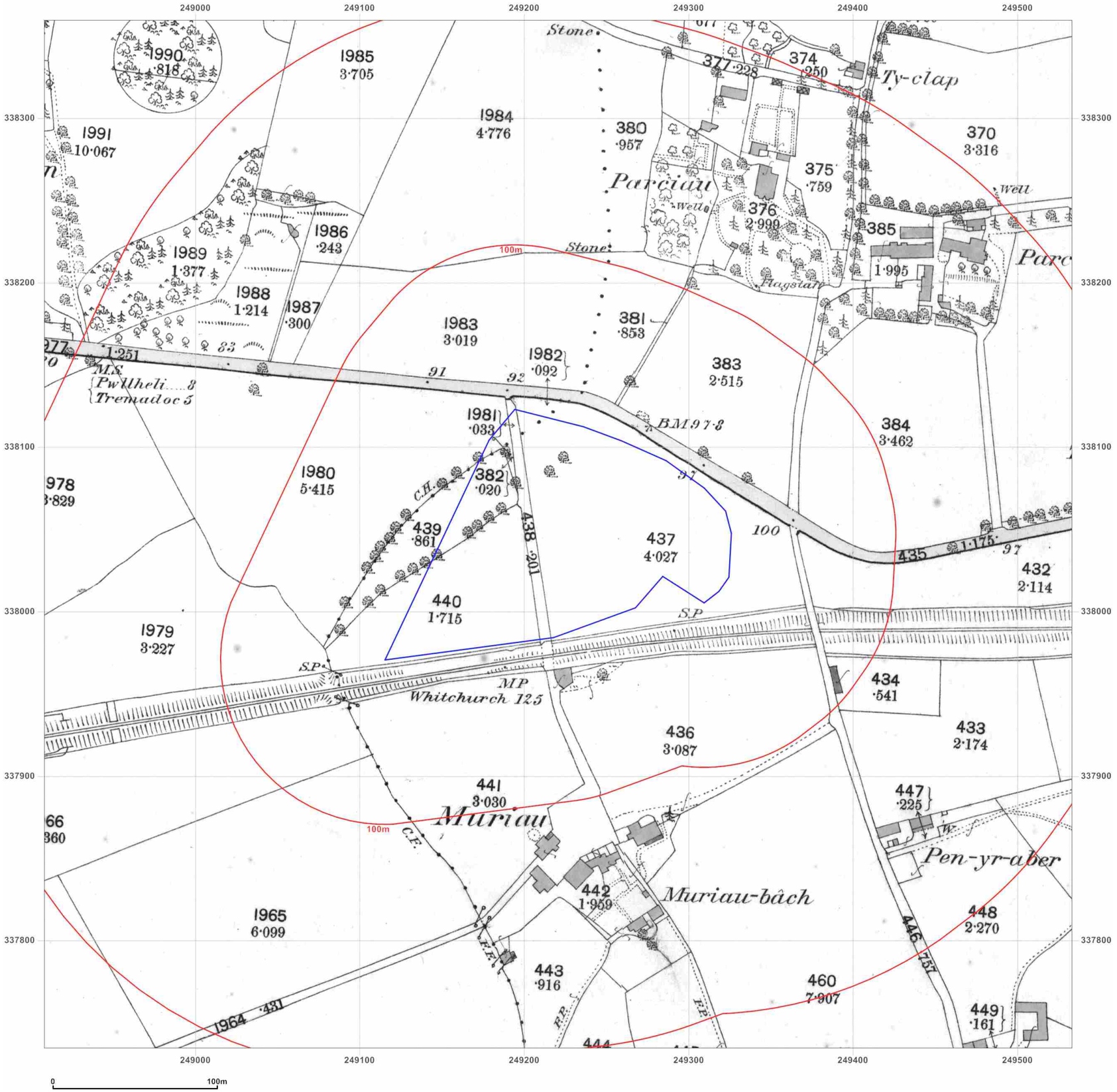
## 6.5 Surface-Water Soakaways

6.5.1 Soil infiltration rates could not be calculated in three of the trial pits with the permeability tests failing. However, soil infiltration will be dependent on the degree of consolidation and percentage of granular material. From site observations in TP2 some drainage can be achieved in the Glacial Till where a soil infiltration rate of 1.97 x 10 - 6m/sec (extrapolated) was obtained.

## 6.6 Ground Contamination

6.6.1 The shallow ground strata do not contain any significant concentrations of contaminants above available respective trigger concentrations and there are no contamination risks.

Appendix 1 - Historical OS Maps




Groundsure INSIGHTS

**Site Details:**

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CRICCIETH, LL52 0SA

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**Report Ref:** HMD-165-6825692
**Grid Ref:** 249220, 338047

**Map Name:** County Series

**Map date:** **1889**

**Scale:** 1:2,500

**Printed at:** 1:2,500

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Surveyed 1889
Revised 1889
Edition N/A
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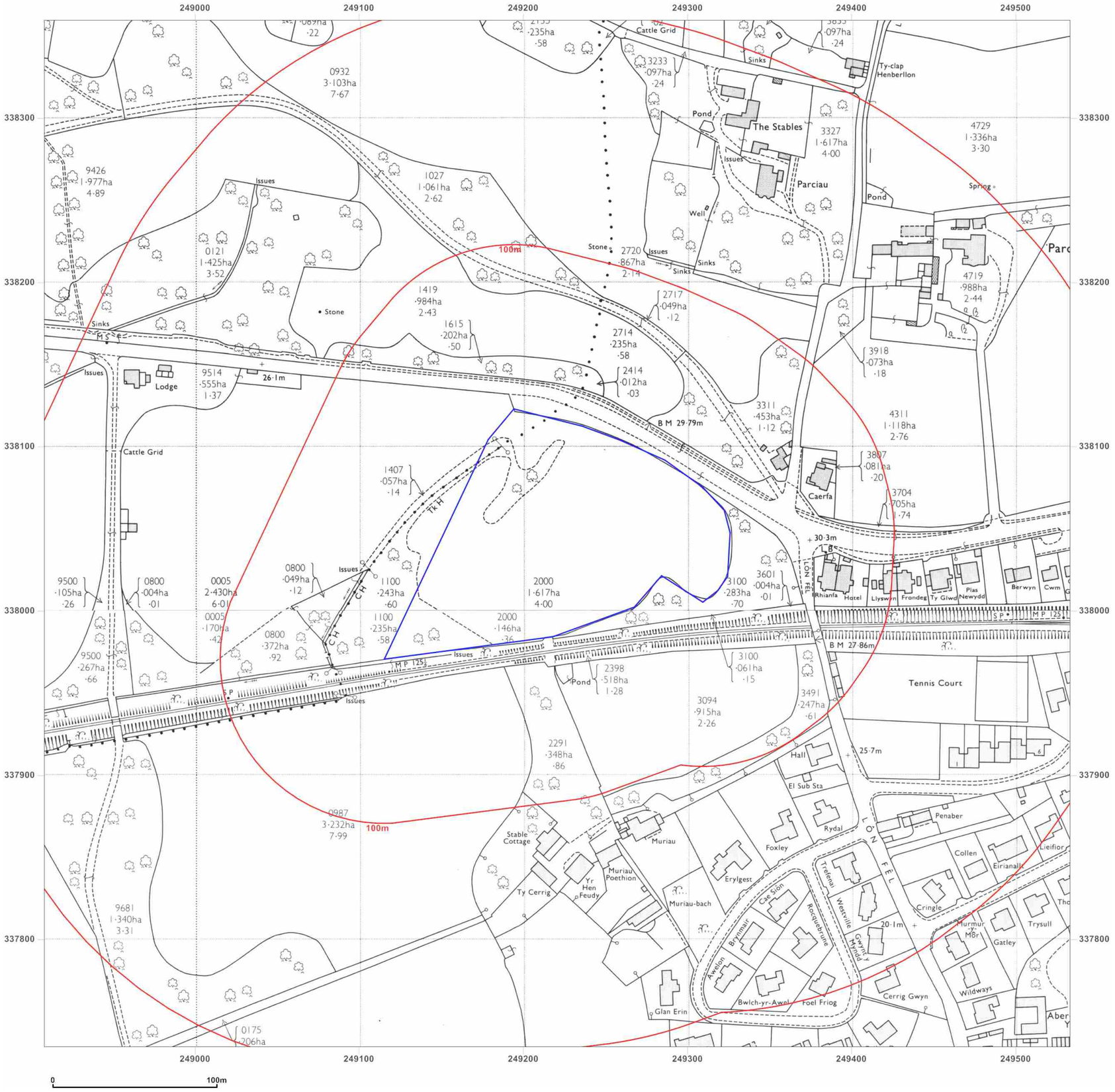


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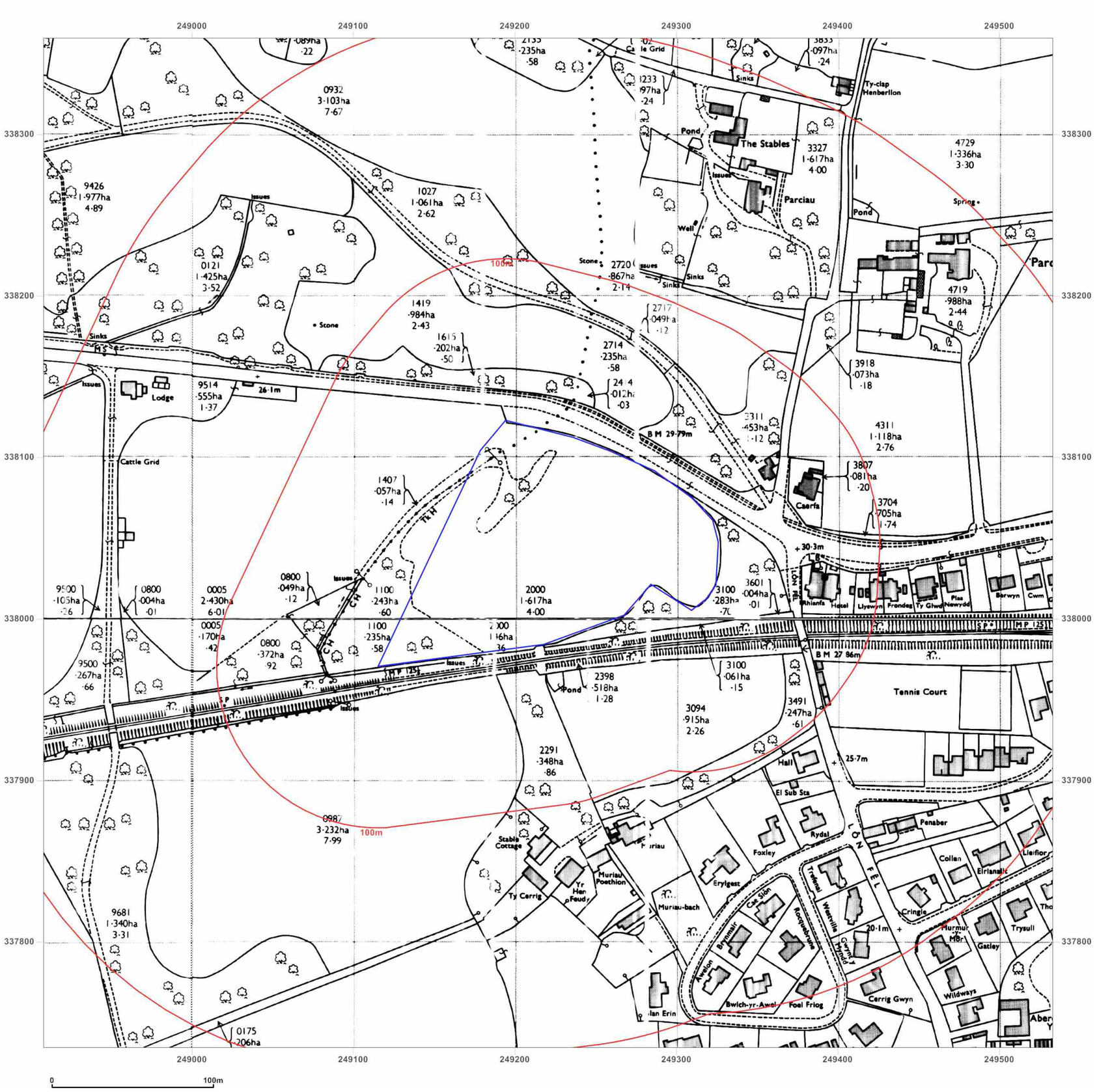


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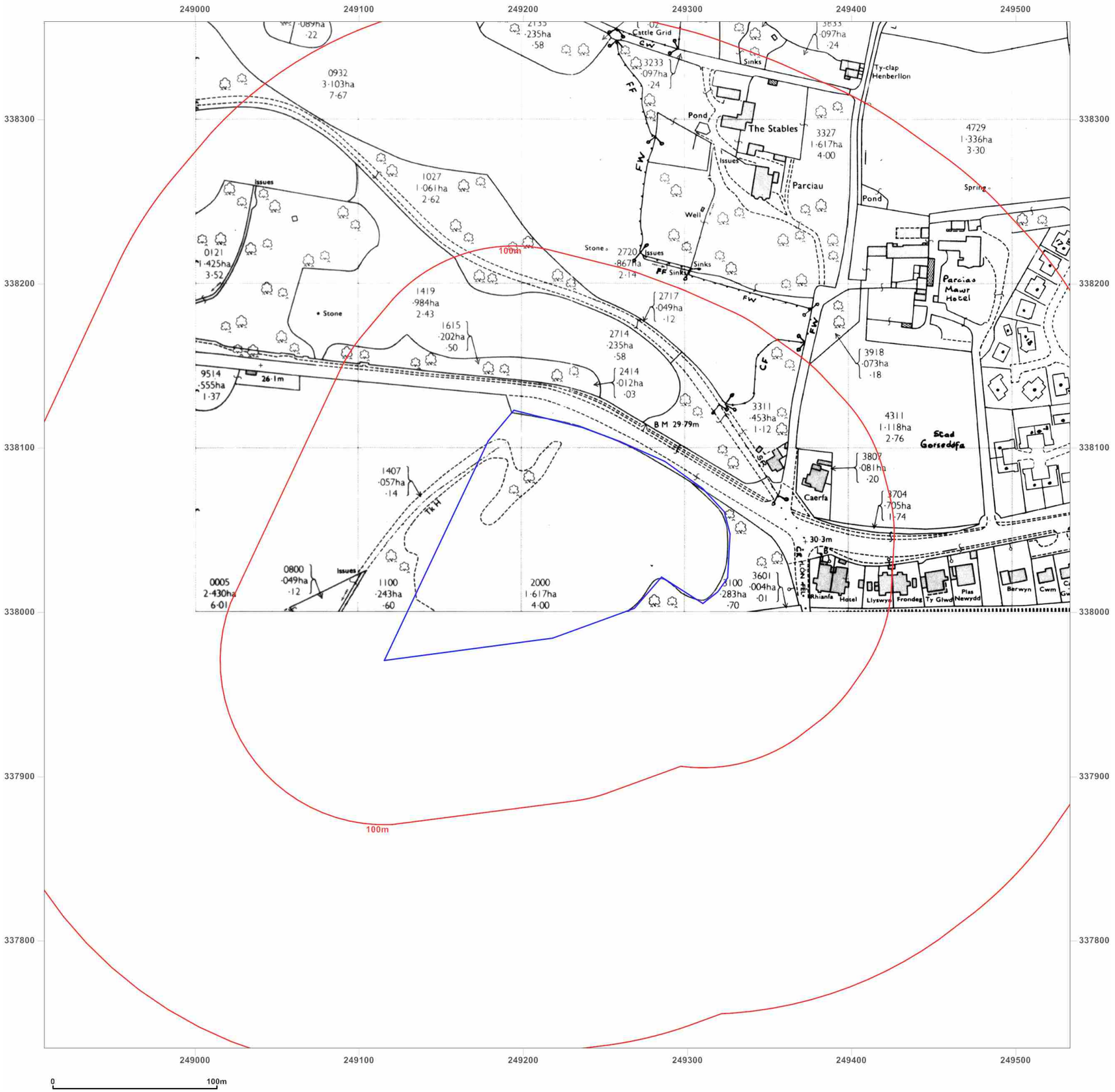


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**Report Ref:** HMD-165-6825692
**Grid Ref:** 249220, 338047

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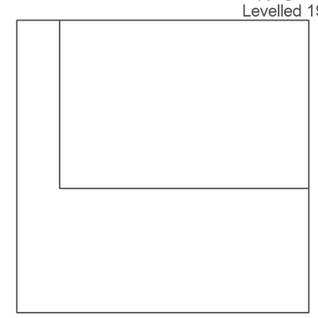

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Production date: 01 July 2020

Map legend available at:
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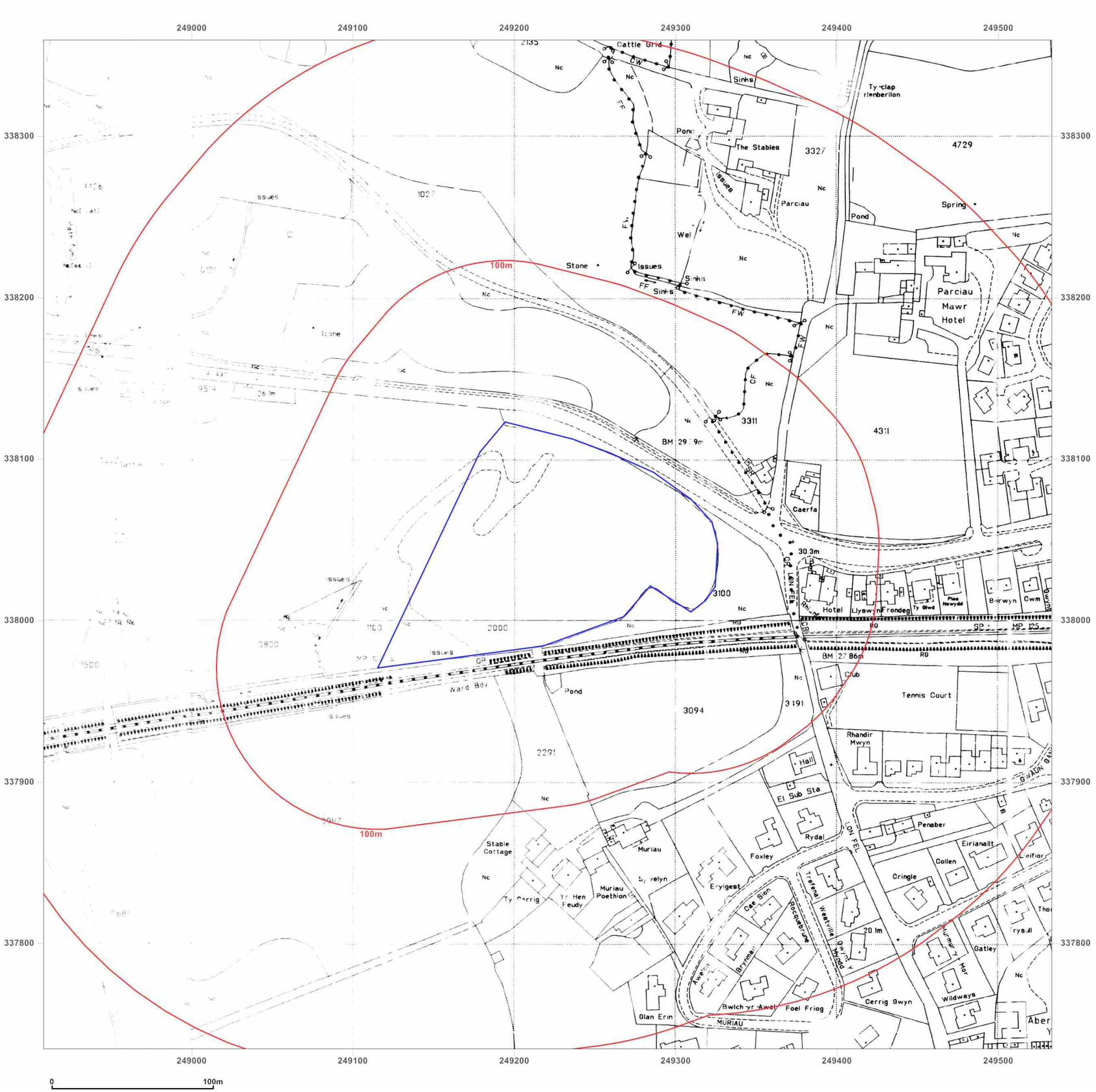


Groundsure INSIGHTS

**Site Details:**

LAND AT BRON EIFION, A497,
CRICCIETH, LL52 0SA

**Client Ref:** E1125
**Report Ref:** HMD-165-6825692
**Grid Ref:** 249220, 338047

**Map Name:** National Grid

**Map date:** **1995**

**Scale:** 1:2,500

**Printed at:** 1:2,500

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Revised N/A
Edition N/A
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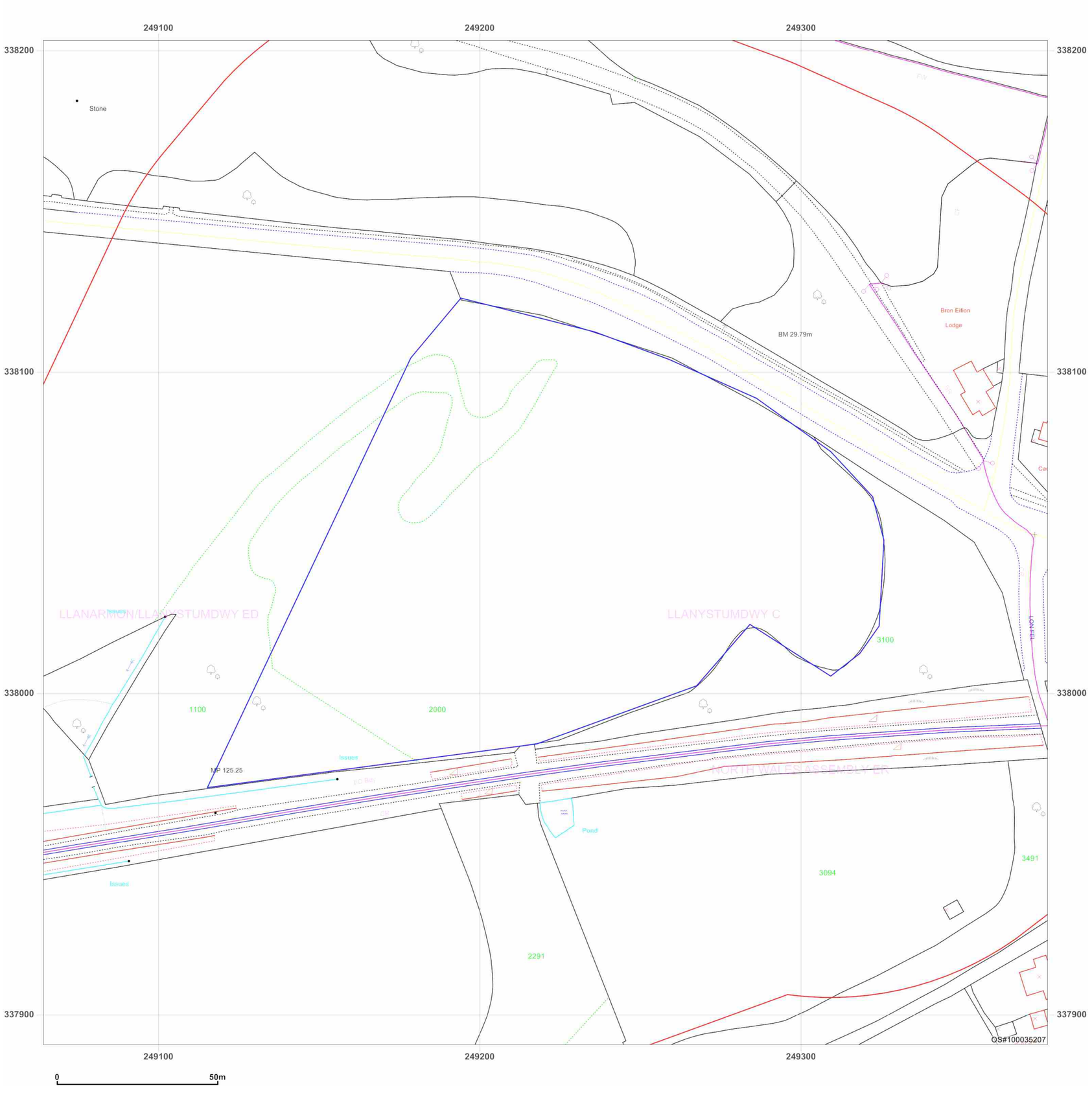


Groundsure INSIGHTS

**Site Details:**

LAND AT BRON EIFION, A497,
CRICCIETH, LL52 0SA

**Client Ref:** E1125
**Report Ref:** HMD-165-6825692
**Grid Ref:** 249220, 338047

**Map Name:** LandLine
**Map date:** **2003**
**Scale:** 1:1,250
**Printed at:** 1:1,250

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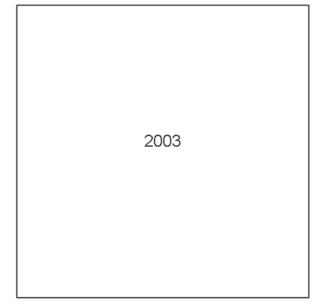


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