HORIZON
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WYLFA NEWYDD

ENERGY WORKING FOR BRITAIN

Wylfa Newydd Project

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Wylfa Newydd Project

Horizon Nuclear Power

Soils and Geology Baseline Conditions Report

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Contents

Executive summary

This report presents the baseline conditions of soils and geology within the Wylfa Newydd Development Area which may be potentially affected by the Wylfa Newydd Project. It has been prepared to provide a detailed technical appendix on soils and geology to support the Wylfa Newydd Project Environmental Statement.

Two soil types have been identified on-site: East Keswick 1 is the main soil type present, with Brickfield 2 soils present in the southeast of the Wylfa Newydd Development Area. Agricultural Land Classification (ALC) surveys across the Wylfa Newydd Development Area identified predominantly moderate-quality soils with limited areas of very good quality, good quality, poor quality and very poor quality soils. Whilst the majority of the area has remained undeveloped, made ground has been encountered within the Wylfa Newydd Development Area, primarily associated with construction of the Existing Power Station.

The superficial deposits across the Wylfa Newydd Development Area mainly comprise glacial till, deposited during the Devensian glaciation. Glacial till has been encountered to thicknesses of approximately 30m beneath two drumlins in the central part of the Wylfa Newydd Development Area, but is generally thinner or absent elsewhere. The Tre'r Gof Site of Special Scientific Interest (SSSI), located in the north of the Wylfa Newydd Development Area within a buried valley, has a more complex superficial geology, including lacustrine, glacio-lacustrine and alluvial deposits, overlain by organic-rich peat and alluvial sediments.

The majority of the Wylfa Newydd Development Area is underlain by bedrock of the Precambrian New Harbour Group, which is characterised by fissile green mica schist, gritty green mica schist with bedded jasper, jaspery phyllite, psammite and alternating with pelites. The Precambrian to Cambrian Gwna Group, located at the northern extent of the Wylfa Newydd Development Area, comprises rocks of various ages and origins. The main types are pillow lava, green schist and mélange – including large blocks of quartzite, limestone, pillow lava and other rocks set in a matrix of schist. A number of Regionally Important Geodiversity Sites (RIGS) are located within the Gwna Group along the coast within/adjacent to northern parts of the Wylfa Newydd Development Area.

In addition to the sites of geological importance within/in close proximity to the site, Anglesey as a whole has been designated as a United Nations Educational, Scientific and Cultural Organisation (UNESCO) Global GeoPark named 'GeoMôn GeoPark', as a result of its complex and unique geological setting.

This report considers the baseline conditions relating to soils and geological aspects of the Wylfa Newydd Development Area and surrounding area. It does not contain any information related to land contamination; this is reported separately within Appendix D7-2 (Land Contamination Risk Assessment and Remediation Strategy) (Application Reference Number: 6.4.25).

1. Introduction

1.1 Background to Wylfa Newydd Project

Chapter A2 (project overview and introduction to the developments) (Application Reference Number: 6.1.2) provides an overview of the Wylfa Newydd Project (the Project), with more detailed information on the WNDA Development in Chapter D1 (proposed development) (Application Reference Number: 6.4.1).

The following terms are used in this document when describing the geographical areas related to the Project:

- Power Station Site – the indicative areas of land and sea within which the majority of the permanent Power Station buildings, plant and structures would be situated.
- Wylfa Newydd Development Area – the indicative areas of land and sea including the Power Station Site that would be used for the construction and operation of the Power Station. It would also include the Site Campus.

These areas are shown on Figure 1.

1.2 Activities that could affect soils and geology

The principal activities associated with the WNDA Development that could affect soils and geology in and around the Wylfa Newydd Development Area are outlined below.

Site Preparation and Clearance Works would firstly be required to prepare the Wylfa Newydd Development Area for Main Construction. The Site Preparation and Clearance Works would include site establishment, soil remediation, erection of fencing, habitat clearance, demolition and diversion of a watercourse.

Main Construction would include soil stripping and deep excavations for the Wylfa Newydd Power Station foundations and civil construction activities. Temporary fabrication and laydown areas would be required, as well as construction office and welfare facilities, car parking and temporary storage. The WNDA Development would also include the construction of the Site Campus – a temporary facility that would house up to 4,000 construction workers.

In order to provide some visual and noise screening of the Power Station for neighbouring communities, mounds would be formed and landscaped, helping to create an appropriate environmental setting. To achieve this, material excavated during construction activities would be used and, as such, the appearance of the land within the Wylfa Newydd Development Area would change as construction progresses, leading to the completion of the final landscaped Power Station Site.

1.3 Study area

The initial soils and geology study area was defined to include potential environmental receptors within 2km (‘upstream’) of the southern side of the Power Station Site, and within 1km of its eastern and western boundaries, with the northern boundary defined by the Irish Sea coastline. These boundaries were designed to include the adjacent surface water catchments, as identified in Chapter D8 (surface water and groundwater) (Application Reference Number: 6.4.8) in order to cover the maximum possible lateral extents of any potential effects associated with the activities to be undertaken within the Wylfa Newydd Development Area.

This initial soils and geology study area was agreed as being appropriate by the Environment Agency Wales (the predecessor to Natural Resources Wales (NRW)) during a consultation meeting on 11 June 2010. As additional baseline information was obtained, the study area was refined and altered to reflect key features of importance to soils and geology, while at the same time acknowledging the inter-relationship between the geological, hydrogeological and hydrological settings. A revised study area was discussed and agreed with

NRW and the Isle of Anglesey County Council (IACC) during a consultation meeting on 11 March 2015 – refer to Table 2.2 for details.

However, the majority of potential effects on soils and geological receptors are likely to be associated with the direct disturbance of ground conditions, and as the designs have progressed, it has become apparent that the potential effects would be limited to the Wylfa Newydd Development Area and 250m buffer. Therefore, the study area has been refined to this area, shown as a blue dashed line on Figure 1.

1.4 Report purpose

This report has been prepared to provide a detailed technical appendix on soils and geology to support the Environmental Statement for the application for development consent. Although Chapter D7 (soils and geology) (Application Reference Number: 6.4.7) is aimed at a wide audience, this report is primarily aimed at stakeholders requiring a detailed, technical understanding of the baseline conditions for soils and geology.

1.5 Report scope

This report considers the baseline conditions of soils and geology in the study area, and includes a presentation of baseline conditions for the Site Campus. The baseline soils and geology of the Associated Development (including the Power Station Access Road Junction of the A5025 Off-line Highway Improvements) and Off-Site Power Station Facilities are covered by separate baseline conditions reports as follows:

- Off-Site Power Station Facilities – Appendix E7-1 (Soils and Geology Baseline Conditions Report) (Application Reference Number: 6.5.15);
- Park and Ride – Appendix F7-1 (Soils and Geology Baseline Conditions Report) (Application Reference Number: 6.6.15);
- A5025 Off-line Highways Improvements – Appendix G7-1 (Soils and Geology Baseline Conditions Report) (Application Reference Number: 6.7.19); and
- Logistics Centre – Appendix H7-1 (Soils and Geology Baseline Conditions Report) (Application Reference Number: 6.8.15).

The baseline conditions for the Site Campus are detailed in this report. Details regarding land contamination are reported within Appendix D7-2 (Application Reference Number: 6.4.25).

For the purpose of this report, ‘soils’ should be taken to mean Holocene/recent unconsolidated deposits and artificial geology (e.g. made ground, filled ground, worked ground). ‘Geology’ should be taken to mean both superficial deposits and bedrock geology which may be affected by the development, including both listed and notified sites of geological importance and mineral resources/reserves.

2. Information sources

2.1 Previous surveys and investigations

A large number of surveys and investigations have previously been undertaken within the Wylfa Newydd Development Area that are relevant to defining the soils and geology baseline. The most relevant factual and interpretative reports resulting from these surveys have been used to inform the preparation of this report and are presented in Table 2.1 below.

Table 2.1: Summary of baseline surveys (adapted from Atkins, 2017)

Title	Company	Year	Description of work undertaken
Wylfa 'B' Geological and Geomorphological Studies	Allott and Lomax	1987–1988	Geological mapping and fault study
Wylfa 'B' Landscape Studies On Site Feasibility Preliminary Report Volume 3: Appendices 1–9	Travers Morgan Planning	1987	Included soil survey at 1:2,500 scale to enable detailed landscape design
Wylfa 'B' Ground Investigation	Wimpey Laboratories	1987	21 vertical rotary boreholes, 16 inclined rotary boreholes, 17 cable percussive boreholes and eight trial trenches
Combined Cycle Gas Turbine Power Station Ground Investigation (Onshore and Offshore)	Soil Mechanics	1997–1998	Onshore: 24 rotary boreholes, 10 trial pits and 37 probe holes Offshore: four rotary boreholes and hydrographic survey
Wylfa Power Station. Preliminary Investigation (Desk Study) of Land Potentially Affected by Contamination	British Nuclear Fuels Limited	2005	Desk study of the Existing Power Station site and surrounding land
Wylfa, Preliminary Geotechnical Desk Study	Arup	2008	Geotechnical desk study written for the Nuclear Decommissioning Authority
Wylfa 'B' Power Station Stage 2 Geotechnical Desk Study	Enviros Consulting Limited	2008	Geotechnical desk study written for RWE npower
New Wylfa Power Station. Ground Conditions, hydrology and hydrogeology. Environmental Baseline Conditions Report	Halcrow Group Limited	2010	Summary of available information on ground conditions

Title	Company	Year	Description of work undertaken
Report on Preliminary Ground Investigation at Wylfa (Preliminary Site Investigation (PSI))	Structural Soils Limited	2010	11 rotary boreholes, 10 cable percussive boreholes and nine trial pits
Geophysical Survey	Fugro Aperio Limited	2010–2011	52 shallow, hand-dug trial pits and geophysical data collection (using methods such as vertical magnetic gradiometry)
Factual Report on Wylfa New Build Intermediate Onshore Ground Investigation (IOnGI)	Structural Soils Limited	2011	57 rotary cored boreholes, 23 cable percussive boreholes, 10 trial pits, 28 trial trenches and five hand-augered boreholes and surface geophysical testing
Wylfa Newydd Intermediate Offshore Ground Investigation – Phase 3 (IOffGI)	Fugro Seacore Limited	2011	11 cable percussive and rotary cored boreholes
Wylfa New Build: IOnGI Geotechnical Interpretative Report	Halcrow Group Limited	2012	Presentation and interpretation of the results of the IOnGI
Wylfa New Build: IOffGI Geotechnical Interpretative Report	Halcrow Group Limited	2012	Presentation and interpretation of the results of the IOffGI
Wylfa New Build Power Station. Contaminated Land Desk Study and Initial Risk Assessment	Halcrow Group Limited	2012	Desk study concerned with land contamination within the Wylfa Newydd Development Area
Environmental Baseline Conditions Report. Wylfa Newydd Ground Conditions, Hydrology and Hydrogeology	CH2M Hill	2014	Updated summary of available information on ground conditions
Factual Report on Wylfa Newydd Detailed Onshore Ground Investigation: Volume 1 & Volume 2 (DOnGI)	Structural Soils Limited	2015	96 cable percussive boreholes, 282 vertical rotary boreholes, 32 inclined rotary cored boreholes and 85 trial pits
Agricultural Land Classification and Soil Resources	Reading Agricultural Consultants Limited	2015	75 soil auger holes and six observation pits, at a density of one observation per four hectares, to provide profiles for assessment and classification

Title	Company	Year	Description of work undertaken
Factual Report for Task Order 002 – SPC1 (2015 GI)	Structural Soils Limited	2015	Investigation primarily targeted to areas of known/suspected ground contamination. Comprised 53 trial pits, nine hand-dug pits and five boreholes
Wylfa Newydd Nuclear Power Station. DOnGI Final Interpretative Ground Investigation Report	Atkins Limited	2017	Presentation and interpretation of the results of the DOnGI
Agricultural Land Classification and Soil Resources	Reading Agricultural Consultants Limited	2016	28 soil auger points, two observation pits and one exposed trench were examined across approximately 28ha of suspected Best and Most Versatile (BMV) land
Land Contamination Risk Assessment and Remediation Strategy	Jacobs	2017	Collation of all available land contamination information for the Wylfa Newydd Development Area, risk assessment, remediation options appraisal and remediation strategy.
Detailed Offshore Ground Investigation (DOffGI) Factual Report	Fugro Geoservices Limited	2017	Seven rotary cored onshore boreholes, 26 offshore cable percussive and rotary cored boreholes and six cable percussive offshore boreholes[1]

The Ground Investigations of most relevance to the baseline for soils and geology are the PSI (Structural Soils Limited, 2010), IOnGI (Structural Soils Limited, 2011), DOnGI (Structural Soils Limited, 2014; 2015a) and 2015 GI (Structural Soils Limited, 2015b). Factual reports for these Ground Investigations are appended to Appendix D7-2 (Application Reference Number: 6.4.25). Exploratory hole location plans from the PSI, IOnGI, DOnGI and 2015 GI, as well as from the Wylfa 'B' Ground Investigation and Combined Cycle Gas Turbine Power Station Ground Investigation, are presented in Figures 2–5.

2.2 Publically and commercially available literature

The following sources of publicly or commercially available information have been consulted during the preparation of this report:

- British Geological Survey (BGS) *GeoIndex* (BGS, 2015);
- *1:50,000 Scale 'Solid and Drift Geology' Geological Map of Anglesey (Special Sheet 092)* (BGS, 1974);
- *Soils Site Report, Full Site Report 5km x 5km. SH3591792942* (National Soil Resources Institute (NSRI), 2015);
- *MapInsight: All Scales (GS-2084891)* (Groundsure, 2015);
- *Footsteps Through Time: The Rocks and Landscape of Anglesey Explained* (Campbell *et al.*, 2014);
- *Developing a Methodology for Selecting Regionally Important Geodiversity Sites (RIGS) in Wales and A RIGS Survey of Anglesey & Gwynedd. Vol.2* (Wood, 2007);

[1] One of these cable percussive boreholes (BH206) was terminated at 0.95m because it was sited incorrectly; it was re-sited to BH206A.

- *British Regional Geology: North Wales* (Smith and George, 1961);
- *Mineral Resource Map of Wales* (BGS and Welsh Assembly Government, 2010);
- *North West Wales Aggregates Safeguarding Map* (BGS and Welsh Assembly Government, 2012a); and
- *The Geology of Anglesey: Memoirs of the Geological Survey* (Greenly, 1919).

2.3 Technical consultations

Table 2.2 sets out the technical consultations that have been undertaken to inform the preparation of the soils and geology baseline relevant to the study area (see Section 1.3) since the publication of the Pre-Application Consultation Stage One documents.

Table 2.2: Stakeholder consultations relating to soils and geology

Date	Stakeholder	Title and format	Description
November 2014	Animal and Plant Health Agency	Written enquiry	Request for information on the location of any animal burial pits within the study area.
November 2014	GeoMôn	Site walkover (16 December 2014) and subsequent correspondence	Discussions and information-sharing to obtain a clear understanding of the location and sensitivity of the RIGS surrounding the site.
December 2014	NRW	Written enquiry	Request for environmental information in relation to potentially contaminated sites, pollution incidents or permitted activities.
December 2014	The IACC Contamination Team	Written enquiry	Request for environmental information in relation to potentially contaminated sites, pollution incidents or permitted activities.
December 2014	The IACC Minerals Planning Team	Written enquiry	Request for information regarding identified mineral reserves within the study area.
March 2015	NRW and the IACC	Soils and Geology; Materials Management; and Fluvial and Coastal Geomorphology and Water Framework Directive Workshop	Meeting to discuss the topic scope and relationships with other topics; the assessment criteria and methodologies; the likely mitigation measures; and to define the study area.
June 2015	The IACC Contamination Team, IACC Minerals Team, NRW Contamination, Hydrology and Hydrogeology officers	Land Contamination and Minerals Meeting	Meeting to agree assessment methodology and 2015 GI scope.
June 2015	BGS	Telephone and email correspondence	Information on BGS progress updating geological mapping for Anglesey.
July 2015	The IACC and GeoMôn	Porth Wnal Dolerite RIGS meeting	Meeting and site walkover to discuss potential impacts and mitigation on the Porth Wnal Dolerite RIGS.

Date	Stakeholder	Title and format	Description
March 2016	GeoMôn, the IACC and NRW	Written enquiry	Request for opinion on the proposed rock excavation areas.
March 2016	The IACC/North Wales Minerals and Waste Planning Team	Written enquiry	Request for opinion on the potential loss or sterilisation of mineral resources.
September 2016	NRW and GeoMôn	Review of geologically protected sites	Meeting to discuss the proposed Geological Conservation Review of sites around Cemaes Bay and the implications for the Environmental Impact Assessment.
June 2017	NRW, GeoMôn and the IACC	RIGS Mitigation Teleconference	Teleconference to discuss agreed mitigation measures for the Porth Wnal RIGS, updates to design and progress with the Geological Conservation Review.

In addition to the above, a number of consultations have been undertaken with GeoMôn to clarify the location and extent of the RIGS within or close to the Wylfa Newydd Development Area. In particular, consultations included the clarification that the Wylfa Head RIGS, referred to within the Pre-Application Consultation Stage One Preliminary Environmental Information Report (Horizon, 2014), actually forms part of the Cemaes Bay RIGS, rather than forming a RIGS in its own right. As part of these consultations, the descriptions of superficial geology, bedrock geology and sites of geological importance herein have been refined to reflect comments by GeoMôn and NRW geologists. Further details can be found in Section 7.

3. Soil types and quality

Information on soil types and quality within the study area obtained from published sources and baseline surveys is presented below.

3.1 Soil types

The NSRI soils report (NSRI, 2015 – refer to Appendix A) for the study area identifies East Keswick 1 as the main soil association (type) present. However, a narrow band of Brickfield 2 soils with a west to east orientation intersects Tregele in the south of the Wylfa Newydd Development Area. Brickfield 2 soils are also present within southeastern and southwestern extents of the study area. The characteristics of these soil associations are summarised in Table 3.1.

Table 3.1: Characteristics of the soil associations present within the study area

	Soil association	
Characteristic	**East Keswick 1**	**Brickfield 2**
Source	Drift material derived from Palaeozoic sandstone and shale.	Drift from Palaeozoic and Mesozoic sandstone and shale.
Composition	Deep, well-drained fine loamy soils and similar soils with slowly permeable subsoils and slight seasonal waterlogging. Low/negligible storage capacity and low natural soil fertility.	Slowly permeable, seasonally waterlogged, fine loamy soil with low natural soil fertility.
Hydrology of soil type (HOST)	HOST Class 6 – free-draining permeable soils in unconsolidated loams or clays with low permeability and storage capacity. Minor risk of flooding.	HOST Class 24 – Slowly permeable, seasonally waterlogged soils over slowly permeable substrates with negligible storage capacity; minor risk of flooding.
Pollutant leaching potential	Soils of intermediate leaching potential which have a moderate ability to attenuate a wide range of diffuse source pollutants but in which it is possible that some non-absorbed diffuse source pollutants and liquid discharges could penetrate the soil layer.	Soils in which pollutants are unlikely to penetrate the soil layer either because water movement is largely horizontal or because they have a large ability to attenuate diffuse source pollutants.
Land use	Neutral and acid pastures, deciduous woodlands and acid communities, such as bracken and gorse in the uplands, supporting stock-rearing on permanent grassland.	Seasonally wet pastures and woodlands. Dairying and stock-rearing on permanent or short-term grassland; some cereals in drier areas.

In addition to these soil associations, peaty soils are known to be present within the area proposed for the diversion of the watercourse (the Nant Caerdegog Isaf) and within the Tre'r Gof SSSI. The peat within the area proposed for the watercourse diversion was noted in BH2204 (see Figure 5) to a depth of 1.5m below ground level (bgl). The peat in Tre'r Gof SSSI is evidenced by IOnGI logs HA1, HA1D, HA2, HA3, HA4 (see Figure 3). In addition, peat core and probe data presented in Appendix D8-5 (Tre'r Gof Hydroecological Assessment)

(Application Reference Number: 6.4.30) identified peat to depths of up to 3.0mbgl at Tre'r Gof. In some areas the full thickness of peat was not penetrated such that it may extend beyond 3mbgl, particularly in the centre of the basin. Refer to Section 2.3.4 in Appendix D8-5 (Application Reference Number: 6.4.30) for further details.

3.2 Soil quality

The economic resource value of soil is primarily measured by its ability to support agricultural uses. This is quantified by its ALC, which is determined through climatic, topographical and interactive soil limitations. BMV agricultural land equates to Grades 1 and 2 and Subgrade 3a of the ALC system and is the most flexible land in terms of the range of crops that can be grown, the level and consistency of yield and the cost of obtaining yield. *Planning Policy Wales* (Edition 9) states that BMV land should be conserved as a finite resource for future use wherever possible, and considerable weight should be given to protecting it because of its special importance (Welsh Government, 2016).

3.2.1 Semi-detailed ALC survey – 2015

A semi-detailed ALC survey was undertaken in June 2015 across the majority of the Wylfa Newydd Development Area (Reading Agricultural Consultants Limited, 2015 – Appendix B). The ALC surveys were limited in extent to the Wylfa Newydd Development Area, as the only effects which could occur on soils within the 250m buffer would be related to the migration of contamination, for which it was not deemed necessary to obtain site-specific ALC data to assess against. The survey is considered semi-detailed because a survey density of one observation per four hectares was adopted, rather than one observation per hectare which is typically used for detailed surveys (Natural England, 2012). This approach was adopted as, based on a review of desk-based information, the survey was expected to find land predominantly not classed as BMV, i.e. Subgrade 3b or below. The assessment of ALC was completed in accordance with the guidance presented in the *Revised guidelines and criteria for grading the quality of agricultural land* (Ministry of Agriculture, Fisheries and Food (MAFF), 1988).

The 2015 ALC survey comprised soil augering at 75 locations to obtain soil profiles for assessment and six observation pits to examine the subsoil structure. The primary land uses were identified as coastal grassland and agricultural land (refer to Figure RAC6753-1 in Appendix B). Local agro-climatic conditions were interpreted from two Meteorological Office data points, and the area was found to be wet and warm with moderate crop-moisture deficits and a high number of field capacity days.

At each observation point, soil texture, significant stoniness, colour, consistency, structural condition, free carbonate and depth were assessed. Six soil samples were subjected to laboratory analysis for the determination of particle-size distribution, pH, organic matter content and primary macronutrient contents (phosphorous, potassium and magnesium). Soil wetness class was also inferred from matrix colour, mottling and low-permeability layers, and soil droughtiness was calculated through moisture-balance equations.

The survey identified that most of the soils within the Wylfa Newydd Development Area are Subgrade 3b (moderate quality) – land capable of producing moderate yields of a narrow range of crops, principally cereals and grass; lower yields of a wider range of crops; or high yields of grass which can be grazed or harvested over most of the year. Large areas of Grade 5 (very poor quality) land were also encountered, as well as five smaller areas of Subgrade 3a (good quality) and Grade 2 (very good quality) land.

3.2.2 Detailed ALC survey – 2016

In the five areas identified as potential BMV land during the 2015 semi-detailed survey, a detailed survey was undertaken in February 2016 (Reading Agricultural Limited, 2016 – Appendix C) to determine the extent of BMV land with greater confidence and further characterise the soil resources within the Wylfa Newydd Development Area. Auger observations were made at 28 locations, and two excavated observation pits and one exposed trench were examined for subsoil structures across an area of approximately 28ha, conforming to the standard for detailed assessment of one observation per hectare (Natural England, 2012).

3.2.3 Combined results of the two ALC surveys

A number of limitations to ALC grade were identified across the two surveys. Topography and exposure were the limiting factor in areas of Grade 5 within the north, northwest, west and southwest of the Wylfa Newydd Development Area, with exposed outcrops and uneven microtopography. A very small area of Grade 4 was identified to the northeast of Tregele, south of the A5025, due to microrelief and a steep slope. The surveyed area was predominantly characterised by Subgrade 3b land, primarily due to wetness and workability limitations but also due to high stone contents resulting in droughtiness in the northeast and southwest. A small area in the southwest around the Afon Cafnan was restricted to Subgrade 3b due to flood risk. The areas classified as Grade 2 and Subgrade 3a were mainly restricted by wetness and workability but to a lesser extent than those classified as Subgrade 3b.

Non-agricultural land was identified across woodland and the Wylfa Sports and Social Club to the south and east of the Existing Power Station, as well as in a small area characterised by overgrown scrub and Japanese Knotweed east of Tregele.

Table 3.2 presents a summary of ALC grade, area and relative percentage of the encountered grades across the Wylfa Newydd Development Area from the two surveys combined, with the 2016 survey superseding the 2015 survey in areas of potential BMV land. The total area surveyed does not add up to the total area of the Wylfa Newydd Development Area (approximately 380ha) for two reasons:

- the Wylfa Newydd Development Area has extended since the survey was conducted; and
- the Wylfa Newydd Development Area includes several areas which were not assigned ALC grades, including the sea, shoreline and Tre'r Gof SSSI.

However, it is considered that if the areas of additional land were mapped, they would likely be assigned Grade 3b or non-agricultural based on the classifications adjacent to them or their current/past land use.

Table 3.2 also presents a summary of the provisional ALC grades across the entire Isle of Anglesey, where the total area of Anglesey has been taken as 71,361 hectares. The ALC data for Wales (MAFF, 1977) provide no differentiation between Subgrade 3a and 3b, as they are provisional data intended for strategic planning purposes.

Table 3.2: ALC Grades – spatial coverage (adapted from Reading Agricultural Consultants Ltd, 2016)

Grade	Description	Wylfa Newydd Development Area		Anglesey	
		Area (ha)	Percentage (%)	Area (ha)	Percentage (%)
1	Excellent quality (BMV)	0.0	0.0	0.0	0.0
2	Very good quality (BMV)	6.5	2.0	1,116.9	1.6
3a	Good quality (BMV)	18.0	5.6	27,559.3	38.6
3b	Moderate quality	224.3	69.5		
4	Poor quality	0.1	<0.1	27,213.8	38.1
5	Very poor quality	38.0	11.8	10,398.4	14.6
-	Non-agricultural*	35.8	11.1	5,072.6	7.1

* Non-agricultural land includes areas such as woodland and urban land.

Full details of the surveys and assessments can be found in Appendix B and Appendix C. The location and extent of ALC grades are shown in Figure 6.

3.2.4 ALC grades within the 250m buffer of the Wylfa Newydd Development Area

According to provisional ALC data for Wales (MAFF, 1977), the 250m buffer of the Wylfa Newydd Development Area comprises mainly Grade 3 and Grade 4 soils, although an area of Grade 5 soils is also mapped to the east of Tregele. See Figure 6 for the locations of these provisional ALC Grades.

4. Made ground

The BGS geological mapping (BGS, 1974; 2015) does not identify any made ground (artificial geology) within the study area. This is supported by desk-based research which indicates that the majority of the study area has remained undeveloped, and therefore made ground is anticipated to be largely absent. However, made ground has been encountered during Ground Investigations, principally in the area surrounding the Existing Power Station (see Section 4.2).

As a result of these findings, and potential risks from land contamination identified during desk-based research, a number of 'Areas of Potential Concern' (APCs) have been identified. These are areas where the likelihood of made ground contamination is anticipated to be highest, or where contamination is known to be present. The APCs have been added to and amended over time (British Nuclear Fuels Limited, 2005; Halcrow, 2012a; Jacobs, 2017) as more information has become available. Refer to Appendix D7-2 (Application Reference Number: 6.4.25) for full details on the evolution of the APCs over time.

The APCs which are located within the Wylfa Newydd Development Area are shown on Figure 7 and summarised in Table 4.1.

Table 4.1: Summary of relevant APCs

Ref.	Description
APC6	Non-radiological contaminants may be present within fill material (which may have included railway ballast) used to landscape area to the north of the gas turbine fuel oil tanks, in the north of the Existing Power Station site. Ballast may contain some hydrocarbon contamination relating to leaks of fuel and hydraulic liquid from rolling stock.
APC7	Located to the south of the Existing Power Station and included a contractor's laydown area, car park and workshop during construction of the Existing Power Station. Redundant site vehicles and abandoned cars were present in the area in the early 1970s. Chlorinated solvents (primarily trichloroethene) were observed within water samples obtained from a sump and surface water course during historical investigations. Asbestos and hydrocarbon contamination was identified in made ground in the area to the southwest of the Existing Power Station.
APC7a	Located adjacent to the north of APC7 and currently populated by a car park associated with the Existing Power Station. Aerial photography dated to 1968, 1971 and 1972 shows the construction compound and storage area identified within APC7 to have extended across into the area, thus similar ground conditions may persist.
APC9	Located to the north of the 400kV switch house at the Existing Power Station and included offices, parking, site plant, stores, workshops and a cement mixing plant during the construction of the Existing Power Station. APC9 also includes part of a former contractor's site disposal area.
APC10	Former topsoil storage area.
APC11	Existing Power Station construction works spoil heap (later removed to an area north of 400kV switch house, APC9). Former contractor's site disposal area.
APC12	Spoil heap area (including Dame Sylvia Crowe's Mound). Anecdotal evidence that the heap contains buried heavy machinery and site vehicles. The mound covers the areas of two old quarries identified during the review of historical mapping.
APC15	Area identified from historical map review (Halcrow, 2012a) as potentially containing made ground relating to the Existing Power Station construction works.
APC16	Tregele petrol station located within the Wylfa Newydd Development Area, on the southeastern boundary.

Ref.	Description
APC17	A localised area of made ground including a spoil heap containing general waste (plastic, rubber, etc.) but also recorded as containing asbestos located to the east of the Tai Hirion farmstead.
APC18	Made ground associated with former properties along Cemlyn Road (identified following the DOnGI).
APC19	Made ground associated with Wylfa Sports and Social Club area (identified following 2015 GI).
APC20	Area of the Existing Power Station within the Wylfa Newydd Development Area, including a 132kV switch house, car parks and offices. Historical mapping/aerial photography shows the land use to have remained relatively consistent since the Existing Power Station was first shown in 1968, with the occasional addition and removal of buildings/structures.

Characterisation of the APCs in terms of land contamination testing and assessment is provided in Appendix D7-2 (Application Reference Number: 6.4.25).

4.1 Classification of made ground

Within the DOnGI Interpretative Report (Atkins, 2017), made ground was separated into four distinct categories: type 1 to type 4. Table 4.2 presents the classification of these made ground types.

Table 4.2: Made ground units (as identified by Atkins, 2017)

Type	Unit	Typical description
1	Waste material	Dark brown mottled dark grey sandy gravel with cobbles, containing a mixture of metal, wire, plastic sheeting, fibreglass, whole bricks, asphalt, slag, ash, plastic pipe, plastic tape, glass, wood, masonry, corrugated board/metal and possible asbestos board/cement.
2	Re-worked natural ground intermixed with made ground/waste	Brown, clayey, sandy gravel with medium cobble and boulder content, containing inclusions of anthropogenic waste material.
3	Re-worked natural ground/possible made ground	Brown to dark brown or grey, slightly clayey, sandy gravel with rare quantities of brick or ceramics.
4	Topsoil	Brown, firm, friable, gravelly, sandy clay with abundant rootlets and occasional anthropogenic material.

4.2 Encountered made ground

The four types of made ground identified in Table 4.2 have been applied to Ground Investigation data from the PSI, IOnGI, DOnGI and 2015 GI to provide an indication of the nature of made ground across the APCs and Wylfa Newydd Development Area which are described below. As Ground Investigation information is only available for land within the Wylfa Newydd Development Area, consideration of encountered artificial geology is restricted to this area only (this also applies to the encountered superficial and bedrock geology).

The following figures support the discussion of made ground presented below:

- Figures 2 to 5 present the exploratory hole location plans from the various phases of onshore Ground Investigation;
- Figures 8 to 11 present the location of the different types of made ground encountered on-site by exploratory holes (note that in some holes several different types of made ground were recorded, and therefore some holes appear on several figures); and

- Figures 12 to 14 present interpolation plots showing the 'worst case' made ground type found in each hole (e.g. type 1 is shown if type 2 occurs in the same location), the worst case made ground encountered within the upper 0.3m of the soil and made ground encountered at ground level, respectively.

No Ground Investigation data are available for APC7a, APC16 or APC20. APC7a and APC20 are located on the Existing Power Station site where no recent Ground Investigations have taken place; historical investigation data obtained pre-construction of the Existing Power Station will not be representative of current ground conditions.

APC16 is located at Tregele petrol station and was therefore outside of the scope of previous Ground Investigations targeted to the development platform.

Although environmental sampling has been completed at APC6, this did not include formal logging of ground conditions.

Thus, no made ground types have been classified in these locations and they are not discussed further within this section.

Table 4.3 provides a summary of the made ground types encountered in each APC. This is followed by more detailed descriptions of the encountered made ground within each APC.

Table 4.3: Summary of made ground types encountered in each APC

		Location									
Made ground type	**Parameter**	**APC7**	**APC9**	**APC10**	**APC11**	**APC12**	**APC15**	**APC17**	**APC18**	**APC19**	**Other areas**
1	No. of holes in which made ground type encountered	9	0	0	0	0	0	1	3	1	0
	Minimum upper depth (m)	0.15	N/A	N/A	N/A	N/A	N/A	0	0	0.2	N/A
	Maximum lower depth (m)	2.4	N/A	N/A	N/A	N/A	N/A	1.2	0.95	1.8	N/A
	Average thickness (m)	1.1	N/A	N/A	N/A	N/A	N/A	1.2	0.8	1.6	N/A
2	No. of holes in which made ground type encountered	31	9	4	5	11	0	2	39	10	11
	Minimum upper depth (m)	0	0	0	0	0	N/A	0	0	0	0
	Maximum lower depth (m)	4.4	3	0.4	2.8	4	N/A	2.11	5	1.2	1.6
	Average thickness (m)	0.9	1.0	0.3	0.6	1.4	N/A	0.8	0.4	0.5	0.6
3	No. of holes in which made ground type encountered	33	15	8	9	13	2	0	21	19	20
	Minimum upper depth (m)	0	0	0	0	0	0	N/A	0	0	0
	Maximum lower depth (m)	3.8	3	4	2.7	6.4	2.9	N/A	2	3.4	4.5
	Average thickness (m)	0.9	0.9	0.9	0.5	1.3	2.4	N/A	0.5	0.9	0.6
4	No. of holes in which made ground type encountered	33	17	4	5	12	1	0	9	27	19
	Minimum upper depth (m)	0	0	0	0	0	0	N/A	0	0	0
	Maximum lower depth (m)	0.4	0.95	0.15	1.2	0.5	0.25	N/A	0.4	3.9	1.55
	Average thickness (m)	0.2	0.3	0.2	0.3	0.2	0.3	N/A	0.3	0.3	0.4

4.2.1 APC7

Made ground types 1 to 4 have been encountered across APC7, with made ground type 1 largely comprising waste material and confined mainly to the area immediately southwest of the Existing Power Station. Made ground types 2, 3 and 4 were found more generally across the remainder of the APC. The presence of these types of made ground across the APC is likely a result of the former use of the area as a contractor's laydown area, car park and workshop during the construction of the Existing Power Station.

The PSI identified two locations with type 2 made ground, BH301R and BH312, with the anthropogenic materials including concrete and clinker. The maximum depth recorded was 0.75mbgl and the thickness ranged from 0.1m to 0.25m. Type 3 made ground was found at four locations, namely BH301R, BH312, BH313 and BH314, at depths of up to 3mbgl, with the thickness between 0.15m and 2.85m. Type 4 made ground was only encountered at BH301R to 0.2mbgl.

Type 1 made ground was found to be present during the IOnGI at BH617R between 0.15m and 1.2mbgl. Brick, metal, wood and general waste were noted. Type 2 was recorded to a maximum of 4.4mbgl with the thickness ranging from 0.05m to 4.1m. Concrete, metal, tarmac, slag and a brick wall from 0.15m to 1.4m over a concrete base were identified within this material. Type 3 was also recorded at depths of up to 3.7m with thicknesses of 0.05m–2.5m, whilst type 4 was encountered at up to 0.3mbgl.

Five locations with type 1 made ground were encountered during the DOnGI to a maximum of 2mbgl, with the thickness ranging between 0.2m and 1.65m. TP700/1 was noted to contain possible landfill material with inclusions of metal, plastic, bricks, slag, ash, asphalt and an old oil filter. Other fill material including brick, metal, plastic and wire were identified in the other type 1 locations (TP700/2, TP800/25, TP800/26 and TP800/27) to the southwest of the Existing Power Station. Type 2 made ground was found at a number of locations, with the maximum depth recorded as 2mbgl and the thickness ranging between 0.15m and 1.4m. Made ground type 3 was recorded to 3.5mbgl, with a thickness range of 0.1m to 2m, whilst type 4 was encountered to 0.5mbgl.

During the 2015 GI, type 1 made ground was recorded at three locations, namely BH7BH01, PC7TP01 and PC7TP04, with thicknesses ranging between 0.45m and 2.2m. These locations are within broadly the same area that waste type materials were encountered during the previous investigations. Type 3 made ground was also locally recorded, although to a lesser degree, and was frequently found to overlie the type 1 and/or type 2 materials.

4.2.2 APC9

Two trial pits were excavated in APC9 during the PSI, TP315 and TP316, with type 3 and 4 made ground present within both. Type 3 made ground was encountered at depths up to 2.3mbgl, with thicknesses ranging from 0.7m to 2.18m. In TP315, black staining was noted on gravel within the made ground and wire was recorded at 1.2mbgl, indicating the presence of anthropogenic material in or near the hole. Type 4 made ground was recorded up to 0.12mbgl.

During the IOnGI, five trial pits were excavated within the western part of the APC. Type 2 made ground was recorded in two of these holes, TP576 and TP579, to a maximum depth of 2.3mbgl at thicknesses of 0.1m to 2.1m. This included re-worked natural material with brick fragments, corrugated metal, a brick wall (in TP576), rebar and concrete. Reinforced concrete was encountered in TP579 at 2.3mbgl. Type 3 made ground was encountered in TP580 with gravel and cobbles between 0.1m and 2.2mbgl.

During the DOnGI, a number of boreholes were excavated along the alignment of the proposed cooling water outfall tunnels for geotechnical purposes, and two trial pits (TP800/02 and TP800/16) were excavated for geo-environmental purposes. These trial pits encountered made ground type 2 and 3 overlain by made ground type 4. The type 2 made ground was found in TP800/16 at up to 3mbgl and included plastic; type 3 was found in TP800/02 at depths of up to 0.9mbgl. Type 4 made ground (topsoil) was found to overlie the type 2/type 3 made ground in both trial pits at depths of up to 0.2mbgl.

Type 2, 3 and 4 made ground was also found in the boreholes excavated during the DOnGI. Type 2 made ground was encountered in BH854R, BH8554M, BH856, BH858 and BH860 at up to 1.3mbgl, with a maximum thickness of 1.3m. Ceramic, brick, plastic, plastic bags, charcoal fragments, wood, wire and metal bar were all found in this material. Type 3 made ground was recorded at a maximum depth of 3m with a thickness range of 0.1m to 2.2m and type 4 made ground was recorded at thicknesses of 0.07m to 0.95m.

Five trial pits were excavated in APC9 during the 2015 GI; however, made ground was only encountered at a single location (PC9TP05) to a depth of 2.6mbgl. The material was found to comprise type 2 and 3 made ground overlain by type 4. Type 2 was found between 0.2m and 0.8mbgl and included corroded iron/steel and tarmac, whilst type 3 was found below this to a depth of 1.8mbgl and included a concrete slab at a depth of 1.50mbgl. Suspected asbestos-containing materials were also encountered in BH745R, between 0.25m and 1.5mbgl, and TP800/23, between 1m and 1.2mbgl.

4.2.3 APC10

Two trial pits were excavated in APC10 during the PSI, neither of which recorded made ground. However, boreholes BH305AR and BH305R excavated during the PSI both recorded type 3 made ground between 0.15m and 0.45m overlain by type 4 made ground to 0.15mbgl.

A further three trial pits were excavated during the IOnGI, with type 3 made ground recorded in TP571 and TP573 between 0.1m and 4.0mbgl. Three boreholes encountered made ground, BH512, BH512R and BH607R, between 0m and 0.3m and all recorded ballast (type 2 made ground).

During the DOnGI, one trial pit (TP700/27), recorded made ground type 2 between 0m and 0.4mbgl due to the presence of a geotextile membrane at 0.4mbgl. Two boreholes contained both type 3 and 4 made ground (BH925 and BH925R), while BH829 contained type 3 made ground only. The encountered made ground was recorded to a maximum depth of 1.3mbgl with thickness ranging between 0.1m and 1.2m. Asbestos was observed in TP700/27 at 0.3mbgl, where a geotextile membrane and loose fibres were recorded.

The 2015 GI recorded type 3 made ground at XTP076, to a depth of 1.1mbgl and at a thickness range of 0.25m to 0.6m. However, a water pipe was encountered at 1.1m, preventing further advancement of the trial pit.

4.2.4 APC11

Two trial pits were excavated in this area during the PSI, TP317 and TP318, both of which recorded type 3 made ground to a maximum depth of 2.7mbgl, with type 4 made ground overlying the type 3 material in both holes to a maximum thickness of 0.35m.

During the IOnGI, two further trial pits, TP574 and TP575, were excavated within the area, which recorded type 3 made ground to a maximum depth of 1.0mbgl at thicknesses of between 0.3m and 0.6m. One borehole, BH529R, recorded type 4 made ground to 0.3mbgl, although this was not underlain by any made ground and no anthropogenic inclusions were noted on the log.

A number of geotechnical boreholes and three geo-environmental trial pits were excavated in this area during the DOnGI. Made ground type 2 was encountered in two locations: TP800/19 adjacent to the Existing Power Station's Visitor Centre and BH877R southwest of the Existing Power Station. Slag, brick, porcelain and wood were encountered to a depth of 2.8m and thickness range of between 0.4m and 2.1m. Type 3 made ground was found in three locations, BH874RA, BH878R and TP800/19, to a maximum depth of 0.7mbgl and with a thickness range of 0.3m to 0.55m. Type 4 was found in BH874RA and BH875R down to 1.2mbgl.

Three hand-dug pits were excavated within the mounded area of the APC during the 2015 GI. Made ground type 2 was encountered at PC11HP03, PC11HP03A and PC11HP04 with brick, concrete, plastic, porcelain and glass found at up to 0.45mbgl and at a thickness range of 0.2m to 0.25m. Type 3, found at PC11HP03 and PC11HP04, was recorded to depths of 0.0m and 0.3mbgl. However, it is noted that the base of the made ground was not proven within all the hand excavations due to the presence of cobble and/or boulder obstructions.

4.2.5 APC12

Two trial pits were excavated during the DOnGI (TP800/17 and TP800/18) located at the northern extent of the APC and both identified the presence of made ground type 2. Brick, plastic, concrete, pipe, metal and wire were recorded to the full depth of both trial pits, 3.0m in TP800/17 and 2.5m in TP800/18, with the thickness ranging from 0.9m to 2.9m. Potential made ground type 3 was also recorded in TP800/18 between 1.2m and 2.5mbgl and type 4 was present in both TP800/17 and TP800/18. Possible asbestos-containing material was observed in TP800/17 at 2.0mbgl.

Several boreholes excavated across the area during the DOnGI identified the presence of made ground type 2 with brick, concrete and an old shoe noted up to 4mbgl with thicknesses ranging between 0.29m and 4m. Type 3 made ground was recorded at up to 6.4mbgl with the thickness varying from 0.1m to 4m. Type 4 made ground was recorded overlying other made ground to a maximum depth of 0.5mbgl.

Two hand-dug pits (incorrectly labelled PC11) were excavated in the nature trail part of the APC during the 2015 GI, which encountered made ground type 2 (with brick and steel wire) to 0.3m in PC11HP01 and to 0.65mbgl in PC11HP02 with thicknesses between 0.1m and 0.45m. Made ground type 3 was also found in both pits between 0m and 0.2mbgl.

4.2.6 APC15

Three rotary boreholes were drilled in APC15 during the DOnGI with only BH970R recording the presence of made ground type 3 from ground level to 2.9mbgl.

Two trial pits were excavated within this area during the 2015 GI, with PC15TP01 encountering type 3 and 4 made ground. The type 3 made ground was recorded to 2.2mbgl with a thickness of 1.95m, whilst the type 4 was encountered above other made ground to depths of 0.25mbgl.

4.2.7 APC17

The IOnGI Interpretative Report (Halcrow, 2012b) noted an area of buried general waste present near the ground surface to the east of the former Tai Hirion farm buildings, which contained waste material including plastic and rubber.

No holes were excavated in this area during the PSI or IOnGI; however, this area was specifically targeted during the DOnGI. TP700/23 recorded made ground type 2 from 0.0m to 0.4mbgl with glass, metal and plastic recorded. TP700/23A, on the eastern border of the APC, was excavated within a mound of ‘waste’ materials and recorded made ground type 1 from ground level (top of mound) to 1.2m (base of the hole/mound). Concrete, plastic, corrugated iron, wood, plastic and suspected asbestos-containing cement (at 0.3mbgl) were observed in TP700/23A.

One trial pit (PC17TP01) was located in this area upon a mound of material. Made ground type 2 was recorded through the thickness of the mound, extending to a depth of 2.11mbgl (from top of mound) and comprising wood, plastic, mortar and brick.

4.2.8 APC18

One borehole (BH304R) excavated during the PSI encountered type 4 made ground up to a depth of 0.3mbgl with rare brick and ceramic fragments, although made ground was not recorded beneath this layer.

Two boreholes excavated during the IOnGI encountered made ground. In BH501, made ground type 3 was found to be present between 0.45m and 0.6mbgl, whilst in BH501R, made ground types 2, 3 and 4 were recorded. Type 2 was 0.15m thick, was recorded to 0.3mbgl and included brick; type 3 was noted as possible made ground between 0.3m and 0.6mbgl; and type 4 was found to a depth of 0.15mbgl overlying other made ground types.

During the DOnGI, a number of boreholes excavated for geotechnical purposes encountered areas of made ground associated with former farm buildings within this area. Made ground was typically type 2 and 3, but type 1 made ground was recorded in three locations, namely BH741, BH759 and BH763. The type 1 made ground consisted of concrete, bricks, plastic bags, wood, metal, slag, breeze-blocks and rubber tubing, and was recorded to a maximum depth of 0.95mbgl and to a maximum thickness of 0.95m.

Type 2 made ground was recorded at a number of locations to a maximum depth of 5.0mbgl with thickness ranging from 0.05m to 4.25m. Concrete and brick were frequently encountered but other materials such as asphalt and glass were also recorded. Type 3 made ground was recorded up to 2.0mbgl with the thickness ranging from 0.05m to 1.6m, whilst type 4 was comparatively less frequently occurring and was recorded to a depth of 0.4mbgl. A slight chemical odour was noted in made ground between 0.3m and 1.2 mbgl at TP700/48, which is located within the former depot on Cemlyn Road.

A number of additional trial pits carried out in the areas of the former farm buildings to the north and south of Cemlyn Road (XTP087, XTP087A, XTP091 and XTP098) also indicated the presence of made ground, albeit to a relatively shallow depth (maximum of 0.6mbgl at XTP098). The trial pits indicated the presence of type 2 and type 4 made ground. The thickness of the type 2 made ground ranged from 0.05m to 0.5m and the type 4 was found to a depth of 0.1mbgl. Gravel-sized materials such as brick, porcelain, plastic, polystyrene and roof tile were found in the type 2 made ground. Potential asbestos-containing materials were encountered at a depth of 0.2mbgl within XTP087A.

4.2.9 APC19

Although only limited investigation has been possible in this area, due to the presence of the Wylfa Sports and Social Club fields, this area has been found to be underlain by made ground ranging from type 1 to type 4.

PSI borehole BH306R recorded made ground consisting of type 3 to 1.3mbgl, overlain by made ground type 4 to 0.1mbgl. The boreholes and observation trenches excavated during the IOnGI recorded made ground type 2 at one location, BH516R, from 0.3m to 0.8mbgl, with the presence of brick noted. Five locations identified made ground/possible made ground type 3 (BH514, BH514R, BH516, BH516A and BH516R) up to 3mbgl with a thickness range of 0.4m to 2.7m. Type 4 made ground was found to a depth of 0.5mbgl.

Type 2 made ground was found at six locations during the DOnGI (BH881R, BH884R, BH886R, BH887R, TP700/16 and TP700/22) up to a depth of 1.2mbgl, with thickness ranging from 0.2m to 0.9m. A variety of anthropogenic materials were encountered, including metal, concrete, brick, glass, coal, mortar and plastic. Type 3 made ground was also recorded in a number of locations to a maximum depth of 3mbgl and a thickness range of 0.1m to 2.5m. Made ground type 4 was commonly encountered and was present to a depth of 3.9mbgl, although with a thickness range from 0.1m to 0.9m. Asbestos was encountered in TP700/16 (loose fibres and tile) and TP700/22 (loose insulation and board) at 0.3m and 0.4mbgl respectively.

During the 2015 GI, made ground was encountered at locations XTP069, XTP069A, XTP069B, XTP071 and XTP105. Type 1 made ground was encountered at XTP105 (between 0.2m and 1.8mbgl) with corroded lead piping, cables, plastic, wood, glass and bottle fragments recorded at this location. Type 2 made ground, comprising materials such as clay tiles, plastic, brick, rusted iron/steel and corroded lead, was recorded at XTP069A, XTP069B and XTP071 up to a 1.1m depth, with the thickness between 0.15m and 0.8m. Made ground type 3 was encountered at XTP069 and XTP069A to 3.4mbgl with thicknesses of 3.1m and 0.1m respectively.

4.2.10 Areas outside APCs

Due to the rural nature of the Wylfa Newydd Development Area, geo-environmental investigation has been primarily targeted at APCs, with only limited investigation targeted elsewhere. However, the significant number of geotechnical holes excavated during the DOnGI has provided information on ground conditions in the Wylfa Newydd Development Area outside of APCs. The available information indicates that a significant proportion of the made ground encountered outside of the APCs comprises reworked natural material with no anthropogenically derived materials.

However, as Table 4.3 highlights, type 2 made ground was encountered in 11 exploratory holes and type 3 in 20. The former made ground type included anthropogenic materials such as ballast, brick, wood, plastic, mortar, concrete, glass, clinker, slag, asphalt and tarmac. The type 3 made ground included rare brick fragments, clinker, coal and possible slag.

5. Superficial geology

5.1 Onshore

5.1.1 Published superficial geology

According to BGS (1974; 2015) mapping (see Figure 15), the superficial geology underlying the study area predominantly comprises glacial till deposited during the last major glaciation phase, approximately 14,000 to 24,000 years ago (the Late Devensian glaciation). The Tre'r Gof SSSI, which is located in a buried valley feature in the north of the Wylfa Newydd Development Area, comprises primarily layers of alluvium and peat overlying glacial till. Coastal zone deposits of sand, silt and clay are mapped along some stretches of the coast, particularly to the west of the Existing Power Station. Superficial deposits are absent in several small and isolated areas of the study area, including Wylfa Head.

The *Environmental Baseline Conditions Report – Wylfa Newydd Ground Conditions, Hydrology and Hydrogeology* (CH2M Hill, 2014) provides a review of the processes which formed the geological conditions for the study area. A summary of this review is presented below.

During the Late Devensian glaciation, an ice sheet advanced across Anglesey in a broadly northeast to southwest direction, with the lower part of the sheet attenuated, or slowed down, by the northern coastline of the island. This lower part deposited material (mainly glacial till) from areas to the north of Anglesey that had been picked up by, and entrained within, the ice sheet. The upper part of the ice sheet, which contained little entrained material, became separated from the lower part and advanced further inland collecting local material that was then deposited and later formed drumlins, which are small egg-shaped hills moulded by the formation and recession of the ice sheet. The predominantly northeast to southwest orientation of the drumlins reflects the direction of the ice flow. The upper part of the ice sheet eventually started to entrain material from the drumlins deposited on the northern coast, thereby moving both local and non-local geological material further to the south.

After the ice sheet retreated at the end of the glaciation period, wind-blown sediments were deposited and subsequently re-worked by permafrost weathering and erosion during periods of periglacial (freeze/thaw) condition. Valleys and topographical depressions were locally infilled with glacio-lacustrine sediments (mainly laminated silts and clays). The alluvium and peat deposits encountered within the Tre'r Gof SSSI are thought to largely be underlain by a deep sequence of such glacio-lacustrine and lacustrine sediments.

5.1.2 Encountered superficial geology

Ground Investigations have confirmed that the superficial deposits mainly comprise glacial till deposits, which are predominantly composed of sandy gravelly clay. A number of different types of till have been identified which relate to different glacial processes that took place across the area.

During investigations related to the proposed 'Wylfa B' development in the late 1980s and early 1990s, superficial deposits were categorised into six main units (A–F) based on grain size, internal structure, provenance and colour (Allott and Lomax, 1988; Harris, 1991). This classification was later modified within the IOnGI Interpretative Report (Halcrow, 2012b) to reflect the information obtained from the IOnGI investigation, and a seventh unit (Unit G) was added – 'Possible Solifluction Clay'. To maintain continuity, the DOnGI Interpretative Report (Atkins, 2017) retained the previous classification adopted by Halcrow. These units are all presented in Table 5.1. Unit A is presented at the bottom of the table, as the unit is the oldest in the succession, while Unit G is at the top of the table, as it is the youngest unit in the succession.

Table 5.1: Summary of superficial deposits (as interpreted by Atkins, 2017)

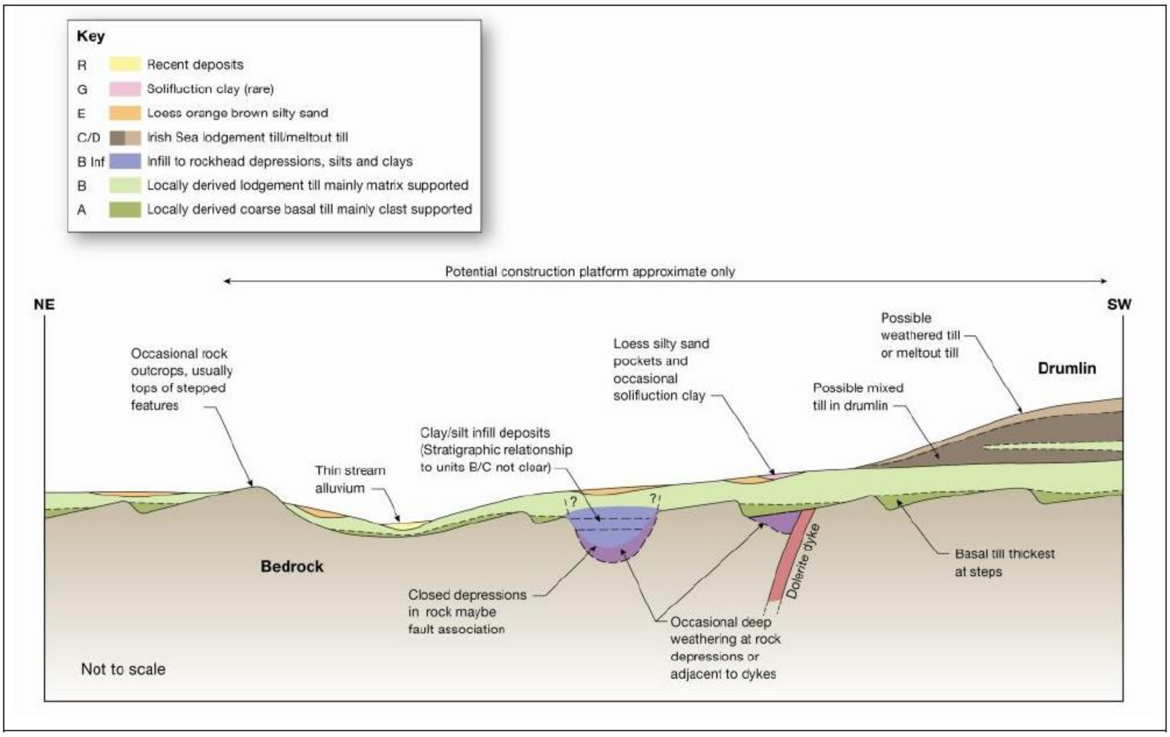
Unit	Lithology	Colour	Matrix	Clasts
Unit G	Solifluction deposits	Light cream brown	Sandy clay	Psammite
Unit F F1 F2 F3	Lacustrine and alluvial deposits (Tre'r Gof SSSI)	Grey/brown Brown/grey Wide range of colours	Sandy clay Clay/silt Sandy gravel	Phyllite and psammite Wide range of lithologies Wide range of lithologies
Unit E	Loess	Orange/brown	Sand/sandy silt	Wide range of lithologies
Unit D	Irish Sea melt-out till	Brown	Clayey/silty sand	Wide range of lithologies
Unit C	Irish Sea lodgement till (matrix supported)	Orange/brown	Sandy clay	Wide range of lithologies
Unit B_{inf}	Local infill deposits (matrix supported)	Grey/brown/yellow	Sandy clay	Psammite, phyllite, dolerite
Unit B1	Locally derived lodgement till (matrix supported)	Brown or mottled orange/red brown	Sandy clay	Psammite, phyllite, dolerite
Unit B	Locally derived lodgement till (clast supported)	Brown or mottled orange/red brown	Sandy clay	Psammite, phyllite, dolerite
Unit A	Locally derived, coarse basal till (clast supported)	Brown/grey	Sand, silt and clay	Psammite, phyllite, dolerite

Units B and C were the most-commonly encountered superficial deposits, and they have similar geotechnical properties. The presence of erratics or shells is the common differing characteristic for Unit C.

The IOnGI Interpretative Report (Halcrow, 2012b) stated that, due to the gradational boundary, it is difficult to differentiate Unit A from Unit B, both of which were derived from the main Anglesey glacial advance. It was also noted that it was difficult to differentiate between the Irish Sea glacial deposits (Units C and D) on-site.

Diagram 1 is a schematic cross section of the superficial deposit succession across the Power Station Site. This cross section and description is based on the IOnGI Interpretative Report (Halcrow, 2012b).

Diagram 1: Schematic cross section of superficial deposits beneath the Power Station Site (Halcrow, 2012b, adapted from Harris, 1991)



It was found that the Power Station Site typically has a stepped bedrock profile which dips to the northeast and is partially infilled by locally derived basal till (Unit A). This grades into lodgement till (Unit B) as the cobble and boulder content decreases. Unit B is typically 0.5m–2.5m thick and consists of rare sand pockets and possible melt-out strata. Deeper depressions within the bedrock (as can be seen in Diagram 1) are typically infilled by a thick succession of matrix-supported silty clay material (Unit B_{inf}). Occasional pockets of aeolian silty sand/loess deposits (Unit E) typically infill surface depressions in the lodgement till.

Thick successions of Irish Sea lodgement till (Unit C) and melt-out till (Unit D) compose drumlin features, which are located to the south and east of the Power Station Site. Evidence of solifluction (creep associated with permafrost conditions) deposits (Unit G) are rare.

In comparison to the Power Station Site, the Tre’r Gof SSSI typically has a more complex model of superficial deposits (Halcrow, 2012b); refer to Appendix D8-5 (Application Reference Number: 6.4.30) for details of the superficial deposits encountered at Tre’r Gof.

Where drumlins are absent within the Wylfa Newydd Development Area, superficial deposits were generally found to be less than 5m thick. Where the depth to rockhead is greater, the thickness of superficial deposits increases to 10m–15m. Where drumlins are present, the thickness of superficial deposits increases to approximately 35m (Atkins 2017; Halcrow 2012b). However, it should be noted that only a small number of drumlins have been detected, which are relatively limited (<100m) in extent (Halcrow, 2012b). The thickness of made ground and superficial geology is illustrated in the form of isopachs in Drawings 0005A and 0005B in Appendix D.

5.2 Offshore

5.2.1 Encountered superficial geology

Ten boreholes were located within the offshore part of the study area during the IOffGI – see Figure 16; BH406 was located outwith the study area and thus is not discussed herein. The scope of the IOffGI was limited to the northwest of the Existing Power Station and to the north of Wylfa Head. Thin surface deposits, comprising sand and occasional gravel, were encountered in three of these boreholes to a maximum depth of 1.00mbgl. Additional thin surface deposits were found in one location between 0.90m and 2.50mbgl, described as soft, sandy, slightly gravelly clay and laminated silt. Granular deposits were noted in all ten boreholes at a range of depths from 0.00m to 8.50mbgl. Strata descriptions for these deposits varied but included gravelly sand, gravel (of various sizes) and cobbles and boulders.

The granular deposits were found to overlie glacial till and glacio-lacustrine laminated silts with granular pockets in three locations. These deposits were encountered from a minimum of 1.10mbgl to a maximum of 32.97mbgl and generally comprised clay or silt, although gravelly sand was noted in one borehole. Basal granular material, comprising dense or very dense, sometimes sandy, fine to coarse gravel was also encountered beneath the glacial till in two boreholes with the depths ranging from 2.15mbgl to 6.50mbgl. All 32 offshore boreholes drilled during the DOffGI were located within the study area, within Porth-y-pistyll and to the west/northwest of the Existing Power Station. Superficial deposits were encountered in most locations but were absent from four boreholes, three of which (BH1207, BH1208 and BH1228) were located to the northwest of Porth-y-pistyll (see Figure 16). The deposits were found to mainly comprise a mixture of gravels of psammite and phyllite and sands with occasional shell fragments,

5.2.2 Correlation between onshore and offshore superficial geology

Detailed correlation of the onshore and offshore geology was beyond the scope of the interpretative report for the IOffGI (Halcrow, 2012c). However, Halcrow (2012c) did provide some preliminary comments of relevance, as per the below.

- The buried valley identified within the Tre’r Gof SSSI (see Section 5.1.2) may correlate with an offshore buried valley encountered at BH410.
- The glacial till encountered by the IOffGI is assumed to be Irish Sea lodgement till (Unit C – refer to Table 5.1).
- The sequence of granular deposits found during the IOffGI has not been encountered by onshore Ground Investigations within the Wylfa Newydd Development Area and may relate to later marine transgression.
- Locally derived, coarse basal till (Unit A – Table 5.1) has not been identified offshore, but its presence cannot be discounted due to the difficulty of identifying it onshore.

6. Bedrock geology

6.1 Onshore

6.1.1 Published stratigraphy

This section is based upon BGS (1974; 2015), Campbell *et al.* (2014) and information received through consultation with GeoMôn (see Section 2.3), unless otherwise stated.

Figure 17 illustrates that the bedrock geology underlying the majority of the study area comprises Precambrian period metamorphic rocks of the New Harbour Group (refer to Section 6.1.2 for discussion on the age of the New Harbour Group). However, the bedrock geology underlying the area northeast of the Existing Power Station comprises the Gwna Group which spans from the late Precambrian supereon to mid-Cambrian period (refer to Section 6.1.2 for further discussion). Southern and southwestern extents of the study area are underlain by the Skerries Group. The age of the Skerries Group is under debate but it has recently been classified as part of the New Harbour Group. A number of igneous intrusions of various compositions are also mapped within the study area.

The Central Anglesey Shear Zone and Berw Shear (undifferentiated) is mapped in two small areas of the study area. The nomenclature of this latter rock type has been questioned (Leslie *et al.*, 2012) because where this group occurs in northern Anglesey, it appears to contain a very different range of lithologies to that described in the southeast of the island. Furthermore, the Gwna mélange (a chaotic deposit comprising rock fragments of widely varying size) is known to be present where the Central Anglesey Shear Zone and Berw Shear (undifferentiated) is mapped in Cemaes Bay (Wood, 2007; 2012); thus, it is more likely that the Gwna Group occurs there. Therefore, Figure 17 should only be taken as a broad indication of the bedrock underlying the study area.

The New Harbour Group was derived from sand and mud turbidites, eroded from a volcanic arc. As a result of plate tectonic activity and subduction, these deposits were thrust under the older Gwna Group as an accretionary prism and weakly metamorphosed. This resulted in the older rocks being inverted at the top, therefore giving the misleading impression that the New Harbour Group is older than the Gwna Group. Sands and muds underwent low-grade metamorphism to pelites and psammites. The New Harbour Group is characterised by fissile green mica schist, gritty green mica schist with bedded jasper, jaspery phyllite, psammite and alternating with pelites. The strata often show evidence of intense multi-generational folding deformation, which may have occurred during plate margin collisions, underplating accretionary processes, and later the Caledonian Orogeny.

The Gwna Group is the main unit of the Monian Supergroup and is considered to comprise the oldest exposed Precambrian strata in Wales (see Section 6.1.2). The Gwna Group comprises rocks of various ages and origins. The main types are pillow lava (originally formed at a volcanic mid-ocean ridge), green schist (once muddy seafloor sediment, now metamorphosed) and mélange – including large blocks of quartzite, limestone, pillow lava and other rocks set in a matrix of schist. The mélange was formed at a destructive tectonic plate margin, where descending ocean crust was broken up and plastered onto the underside of the opposing tectonic plate.

The Skerries Group (Church Bay Tuffs and Skerries Grits) was derived from a sub-volcanic granite/felsic source which was potentially an island arc. The Skerries Group is characterised by widely deformed and metamorphosed bedded successions of pebbly sandstones, conglomerates and basalts.

6.1.2 Chronological discrepancy between New Harbour Group and Gwna Group

The age span of the Gwna Group is reported as 635–508 million years ago (Mya) (Atkins, 2017), although some evidence suggests that the oldest rocks may date to 860 Mya and that the youngest may be older than 508 Mya (Horák and Evans, 2011).

The New Harbour Group has been reported by the BGS to have formed during the Ediacaran Period (approximately 635–542 Mya); however, Campbell *et al.* (2014) discuss recent work which states that the New Harbour Group has a younger depositional age from the Cambrian (approximately 530 Mya–520 Mya).

6.1.3 Published structural geology

This section is based upon Campbell *et al.* (2014), Atkins (2017) and Halcrow (2012b).

Both the Precambrian and Cambrian rocks have been subjected to multiple phases of deformation and metamorphism during the Caledonian Orogeny (during the Ordovician and Silurian periods). Subduction of the oceanic plate and formation of island arcs occurred during the closure of the Iapetus Ocean, and Anglesey began to take form by the progressive accretion of material in a subduction zone trench. As a result, the bedrock geology of Anglesey has been extensively deformed such that original bedding horizons and structures are now largely absent. The pressure and shear forces subjected to the rocks have formed planes of foliation which typically dip at 10° to 45° towards the north or northeast.

Given their age and associated degree of deformation, the structural relationships between rocks of the Gwna Group and New Harbour Group are extremely complex. This structural complexity is further compounded by igneous activity during the Palaeozoic era and later Tertiary period. This led to the intrusion of dolerite rocks in a series of east to west and northwest to southeast trending dykes which cross-cut the rocks of the Gwna Group and New Harbour Group (including the Skerries Group).

Tectonic activity has also resulted in the formation of a series of faults within the bedrock which may affect ground stability and provide preferential pathways for groundwater flow. An understanding of the presence, orientation, persistence and connectivity of faults is important in assessing environmental effects. A total of 28 major (persistent) faults have been mapped across the Wylfa Newydd Development Area, with generally either an east to west or northwest to southeast trend. These faults generally have an inclination between 30° and 80° and have typical thicknesses of 0.1m–5.0m. Numerous smaller faults are also known to be present.

In addition to faults, the bedrock geology is also cut by joints of various orientations, although these joints are predominantly oriented in similar directions to the foliation within the bedrock. The joints are predominantly clean, although joints infilled with clay, silt, sand or gravel are present near the bedrock surface. Mineralised joints (predominantly quartz and calcite) are also common throughout the bedrock mass.

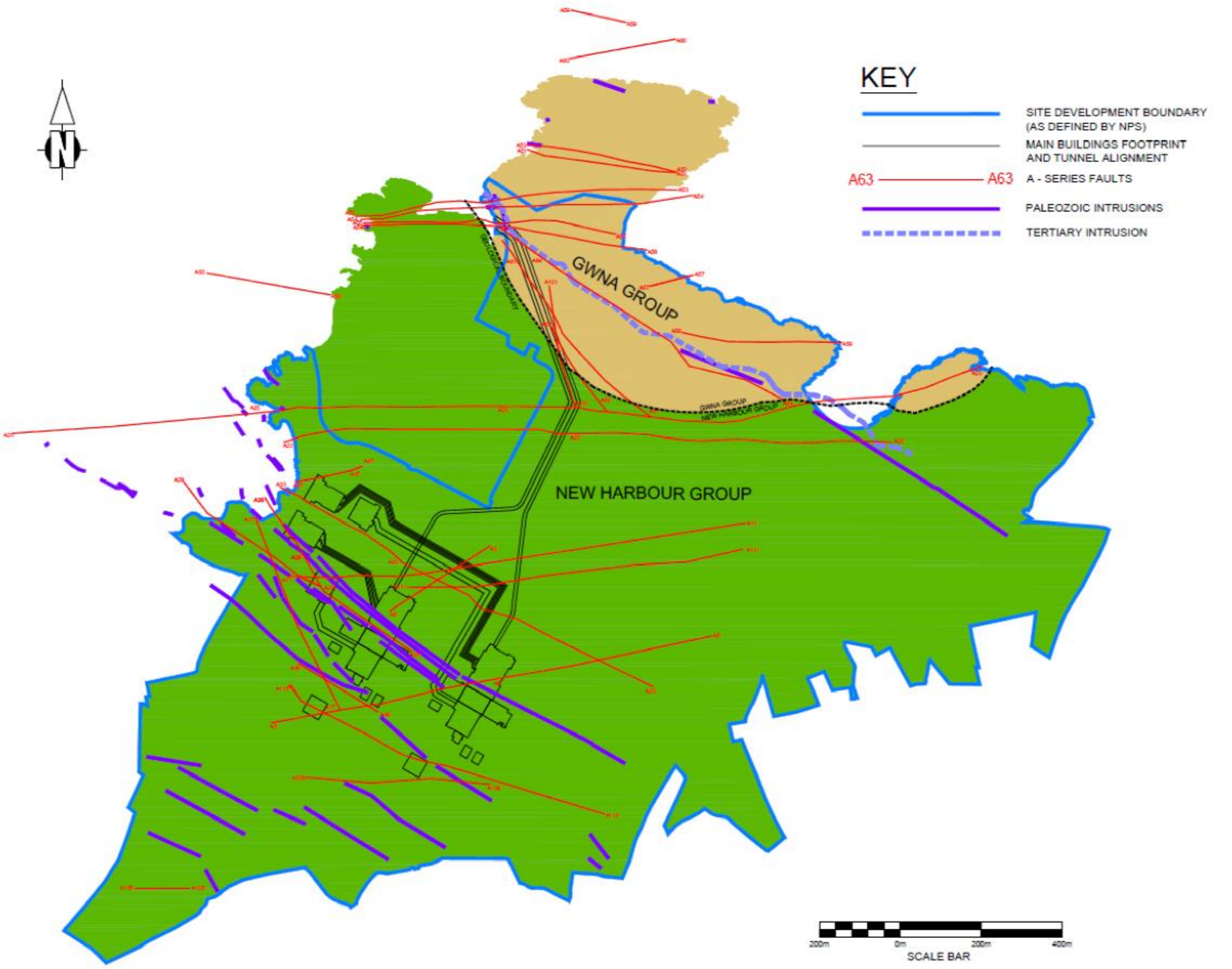
6.1.4 Encountered bedrock geology

The majority of the Wylfa Newydd Development Area was found to be underlain by rocks of the New Harbour Group. The New Harbour Group was found to comprise phyllite, psammite and metaconglomerates. An intense deformation history has led to complex folding and faulting within the New Harbour Group. Considerable variability in lateral and vertical composition of the bedrock was encountered during the DOnGI across the study area, which therefore made lithological interpretation difficult (refer to Diagram 2 for location of known faults and intrusions). During this phase of investigation, the foliation within the New Harbour Group was found to dip between 15° and 45° to the northeast. Complex mineral veining with multiple orientations was found to comprise chlorite, calcite and quartz, and was found to be associated with intrusions and faults. Veins of phyllite were found to follow the foliation orientation within the bedrock (Atkins, 2017).

During the DOnGI, the Gwna Group was encountered towards the northeast of the Wylfa Newydd Development Area. The Gwna Group was found to comprise chaotic, randomly orientated clasts of breccias, quartzite, phyllite, psammite, granites, basalt, limestone and schist in a fine-grained, locally schistose, matrix. Clast size was found to vary from a scale of millimetres to large rafts more than 100m across (Atkins, 2017).

It was originally determined that the boundary between the New Harbour and Gwna Groups occurred as a weathered fault (Allott and Lomax, 1988). Whilst the IOnGI and DOnGI investigations agree with the original boundary orientation, these investigations showed that the boundary is more complex and variable than previously thought. The black dotted line shown in Diagram 2 shows the general position of the boundary, and generally dips at approximately 20° to the northeast. The boundary varied from either an indistinct gradual change to a distinct change in rock type, and was occasionally marked by a zone of discrete faults, a large fracture zone or void. Drawing 0007 in Appendix D illustrates the boundary between the New Harbour Group and Gwna Group, and clearly shows the similar orientation of faults which intersect the boundary. However, it is considered that the boundary is not entirely accurate. The boundary is shown to intersect with the coast at Porth y Wylfa, but the Gwna Group is known to occur further east towards Cemaes, through exposures such as at Trwyn y Penrhyn, where the Gwna mélange is clearly visible (see Section 8.3.5). Therefore, the boundary in this area may more closely follow that shown in Figure 17.

Diagram 2: Simplified site geology plan (Atkins, 2017)[2]



Rockhead elevation across the Wylfa Newydd Development Area varies from 0m Above Ordnance Datum (AOD) to 20m AOD, with the majority of rockhead elevation between 5m AOD and 15m AOD. Rockhead, typically, is deeper towards the coast and increases in elevation inland, with localised depressions associated with glacial erosion. Furthermore, there is not a typical bedrock weathering profile where weathering decreases with depth below the rockhead. Instead, there are isolated locations where weathered rock occurs at different depths, the locations of which typically surround faults (Atkins, 2017).

[2] Diagram 2 is taken from the *Wylfa Newydd Nuclear Power Station – Detailed Onshore Ground Investigation. Final Interpretative Ground Investigation Report* (Atkins, 2017) and therefore the building footprints and site development boundary are no longer accurate.

A 3D rockhead elevation model was generated by triangulation from rockhead elevations during the PSI, IOnGI and DOnGI (Atkins, 2017). Rockhead elevation contours were generated at one-metre intervals from the 3D model. This rockhead elevation plan across the site can be seen in Drawings 0006A and 0006B of Appendix D.

A preliminary study was undertaken during the DOnGI (Atkins, 2017) to correlate the igneous intrusions identified from the IOnGI with the intrusions identified by the DOnGI. Intrusions from the DOnGI generally dip to the northeast, which is consistent with previous investigations. However, a detailed intrusion model of the Wylfa Newydd Development Area was not possible due to the large number of intersections, variable thickness, dip and orientation of the intrusions from the DOnGI.

Faults occur across the Wylfa Newydd Development Area as either open or infilled. Those faults that do not exhibit planes of mechanical weakness may not be geotechnically significant; however, they may still affect groundwater flow. Those which are open form failure surfaces, which may also affect groundwater flow, are of engineering significance (Atkins, 2017).

A fault classification scheme was originally developed within *Wylfa ‘B’ Power Station Pre-Application Studies – Report on Civil Engineering Aspects* (Allott and Lomax, 1988) and adopted for subsequent investigations to maintain consistency. More than 3,500 fault intersections were originally identified, which were then simplified to 29 correlations, including one principal fault set striking northwest to southeast (Allott and Lomax, 1988). The IOnGI encountered fewer faults within the Wylfa Newydd Development Area and along coastal regions in comparison to the earlier investigations. Additional west-southwest to east-northeast trending faults were encountered across the Wylfa Newydd Development Area, which were previously unidentified. The main faults identified by Atkins (2017) during interpretation of the DOnGI are presented in Diagram 2 and Drawing 0007 of Appendix D, which show three major fault sets orientated northwest to southeast, north-northwest to south-southeast, and west-southwest to east-northeast (Atkins, 2017).

A 3D Geological Fault Model was originally produced after the IOnGI by Arup and the BGS (Arup, 2012) and developed further following the DOnGI. This model was incorporated into Atkins’ DOnGI Fault Model, which identified faults of engineering significance and was intended to enable a preliminary engineering assessment of faults in relation to rock slopes, excavations, building foundations and tunnels.

Drawing 0007 of Appendix D compiles fault and intrusion data from all previous Ground Investigation phases and models.

6.2 Offshore

6.2.1 Encountered bedrock geology

The IOffGI boreholes located to the northwest of the Existing Power Station encountered the following lithological assemblages:

- phyllites – very fine-grained laminated and/or foliated metasediment;
- psammite – fine to coarse-grained metasediment, occasionally showing bedded features;
- phyllites and psammites – interlaminated to interbedded sequences of the two rock types above; and
- metabreccia – fine to coarse gravel-sized clasts, randomly orientated in a phyllitic or psammitic matrix.

The boreholes located to the north of Wylfa Head all encountered rocks of the Gwna Group, which generally comprised either a light grey to dark grey, black or green phyllitic matrix, or a black fine-grained pelite matrix. Clasts of psammite and quartzite were found within these matrices, as well as metabreccia in some cases. Intrusions of microgabbro/dolerite were also encountered in both the New Harbour Group and Gwna Group areas. The Gwna Group encountered offshore was found to be similar to that mapped onshore.

An intrusion of microgabbro/dolerite (petrographic analysis would be required to confirm the rock type) was encountered in BH403 to the northwest of the Existing Power Station (see Figure 16). A number of possible faults were also identified during the IOffGI.

Every borehole which was drilled to a sufficient depth to encounter bedrock during the DOffGI encountered phyllite and psammite of the New Harbour Group. Metaconglommerates and metabreccia of the New Harbour Group were also noted in several boreholes and dolerite was encountered in a number of exploratory holes. Faults were identified in many of the DOffGI boreholes.

7. Seismology

7.1 Degree of seismic activity in the region

The UK is considered to be an area of low seismicity. The largest known earthquake within the UK had a magnitude of 5.9M_W (moment magnitude) and occurred near the Dogger Bank, in the North Sea about 100km off the east coast of England on 7 June 1931. The 1984 Lleyn Peninsula, north Wales event, at 5.4M_L (local magnitude), is the largest onshore UK earthquake for which a magnitude can be reasonably determined from measured data. This is considered extremely low in comparison to highly seismically active areas such as California and Japan.

7.2 Probable maximum seismic activity

A Seismic Hazard Assessment (Arup, 2015) has been undertaken to characterise the seismic hazards at Wylfa Newydd. The principal aim of the Seismic Hazard Assessment is to assess the impact of potential seismic events with appropriate conservatism. The Seismic Hazard Assessment also includes an assessment of the potential for ground rupture and an assessment of the maximum probable height of a tsunami wave which could credibly reach the Power Station Site.

The methodology used to assess the ground motion is probabilistic seismic hazard assessment. This combines seismic source zoning, earthquake recurrence and the ground motion attenuation to produce hazard curves in terms of level of ground motion at specific annual probabilities of exceedance.

The assessment has been carried out conservatively, starting with the compilation of an earthquake catalogue for the region within a radius of 300km from Wylfa Newydd, based primarily on BGS data. This was followed by the development of five source model zonations with particular consideration of observed seismicity and geology respectively. Numerous ground motion prediction equations were assessed and those most appropriate to modelling ground motion in the UK were selected.

The intensity of ground shaking (or ground motion) at specific annual probabilities of exceedance was calculated using established methods. The 1 in 10,000-year event was calculated to have a peak ground acceleration of less than 2.5m/s^2. This level of ground motion is broadly consistent with other studies undertaken previously for Wylfa Newydd and commensurate with the results of other site-specific hazard assessments for nuclear facilities in the UK.

The assessment of potential for ground rupture is investigated to determine whether there are any capable faults at the site. A 'capable fault' is defined by the International Atomic Energy Agency (IAEA) as "*a fault that has a significant potential for displacement at or near the ground surface*" (IAEA, 2010). The IAEA states that a geological fault should be considered capable if any of the following conditions apply:

- if it shows evidence of past movement or movements (such as significant deformations and/or dislocations) of a recurring nature within such a period that it is reasonable to conclude that further movements at or near the surface may occur;
- if a structural relationship with a known capable fault has been demonstrated such that movement of the one fault may cause movement of the other at or near the surface; or
- if the maximum potential magnitude associated with a seismogenic structure is sufficiently large and at such a depth that it is reasonable to conclude that, in the current tectonic setting, displacement at or near the surface may occur.

In the context of the UK, current relevant good practice is to investigate for evidence of fault capability within the 'current tectonic regime', which is interpreted to extend from approximately eight Mya to present.

The results of Ground Investigations were considered as part of the ground rupture investigation study. Geological and fault data were assembled to illustrate the geological faulting-related features at the Wylfa

Newydd Development Area. Faults were dated via a programme of laboratory investigations undertaken from samples selected from Ground Investigations at the Wylfa Newydd Development Area. The main conclusion from the capable faulting study is that the geological faults across the development platform are 'not capable' and therefore there is no requirement that these geological faults are avoided or exclusion zones defined. Therefore, there should be no implications for the layout of the proposed facilities at the Power Station with regard to capable geological faulting (Arup, 2015).

The study also indicated that the potential impact of tsunami waves at the Wylfa Newydd Development Area is negligible, both in terms of likelihood and amplitude (Arup, 2015). The only plausible significant tsunami source is an earthquake off the coast of Portugal, similar to the 1755 Lisbon earthquake for which historical records indicate a run-up height of about 3m in some parts of Cornwall.

An assessment of the geology and tectonics offshore from Portugal and consideration of a number of earlier studies regarding different possible tsunami source locations has shown the Gorringe Bank is a possible candidate and is also the most conservative source for tsunami waves propagating into UK waters.

Consideration was made of the 2011 Tohoku Japanese earthquake, and its tsunami that severely impacted on the Fukushima Daiichi nuclear plant. Modelling of an event similar to the one that occurred at Lisbon was performed for $8.7M_W$ and $9.0M_W$ earthquakes using two different analysis tools. The source dimensions were selected to exceed the dimensions of known tectonic structures. The first analysis shows that the shape of the Irish Sea reduces the tsunami wave height as it propagates north. The run-up is estimated as less than 1m at the Wylfa Newydd Development Area. Modelling results offshore from the Wylfa Newydd Development Area provide maximum wave heights of 0.3m (zero to peak). Even allowing for amplification of wave heights during run-up, the sum of the two (less than 2m total) is well within the normal tidal range at the Wylfa Newydd Development Area (Arup, 2015).

7.3 Designed seismic resistance of the Power Station

Structures, systems and components for the Power Station will be seismically classified according to potential consequence and performance criteria defined within safety functions. Furthermore, sensitivity analyses of the plant would be undertaken for events larger than the design basis to ensure that the design is not susceptible to any 'cliff edge' effects, whereby severely abnormal plant behaviour is caused by an abrupt transition from one plant status to another following a small deviation in a plant parameter.

The Design Basis Earthquake has a conservatively assessed probability of exceedance of either 10^{-4} per annum or 10^{-3} per annum. The minimum value of Design Basis Earthquake shall be 0.1g peak ground acceleration, as noted by the IAEA Site Specific Guide (IAEA, 2010). The return period will be dependent on radiological consequence.

8. Sites of geological importance

8.1 The GeoMôn Geopark

The Isle of Anglesey was included in the European Geopark Network in 2009 as a result of its outstanding geodiversity and geological heritage. The Anglesey Geopark (called the 'GeoMôn Geopark') covers the 720km^2 of the Isle of Anglesey and has approximately 200km of coastline.

The European Geopark Network aims to protect geodiversity, promote geological heritage to the general public and support sustainable economic development of Geopark territories through the development of geological tourism. As a member of the European Geopark Network, it is also included in the Global Geopark Network.

In November 2015, the GeoMôn Geopark was designated as a UNESCO Global Geopark at UNESCO's 38th General Conference (UNESCO, 2016). The new designation is intended to raise awareness and promote respect for the environment and integrity of the landscape. The status also expresses governmental recognition of the importance of holistic management of the Geoparks. The designation is not legislative, but the key heritage sites within the Geoparks should be protected under local, regional or national legislation as appropriate. The UNESCO Global Geopark designation is not permanent. A revalidation process exists whereby a thorough re-examination of the Geopark is undertaken every four years, after which the status is either renewed for a further four years, or the management body will be allowed two years to fulfil certain criteria. Should these still not be met after the prescribed period, the park would lose the UNESCO Global Geopark status (UNESCO, 2016).

Both NRW and GeoMôn have responsibilities for protecting geosites. NRW has a statutory responsibility to protect areas notified as geological SSSIs and GeoMôn leads on the conservation of RIGS within the GeoMôn Geopark. Both organisations work together to protect and promote the sustainable use of Anglesey's geoheritage.

8.2 Statutory sites of geological importance

The Geological Conservation Review (GCR) initiative aims to identify sites of national and international importance that demonstrate the key elements of Great Britain's earth heritage. GCR sites are either already notified or being considered for notification as SSSIs and, as such, form the basis of statutory geological and geomorphological site conservation in Great Britain. The Joint Nature Conservation Committee is responsible for the administration of GCR data and, in Wales, NRW are responsible for advising the Joint Nature Conservation Committee of the links between GCR sites and SSSIs (Joint Nature Conservation Committee, 2016).

There are currently no listed or notified GCR or SSSI sites within the study area, although five sites are present within the wider area and are visible on Figure 18:

- Hen Borth SSSI;
- Llanbadrig – Dinas Gynfor SSSI;
- Llanbadrig Area GCR;
- Ogof Gynfor, Hell's Mouth GCR; and
- Ogof Gynfor GCR.

Further information on these sites is presented within Appendix E.

8.2.1 Proposed GCR review of Precambrian geology, Wylfa Head to Dinas Gynfor

NRW is planning to review the Precambrian geology exposed mainly in coastal sections located between the cooling water outfall of the Existing Power Station in the west to Dinas Gynfor in the east. The review will examine currently protected sites along this stretch of coastline, as follows:

- Porth Wnal Dolerite RIGS;
- Porth Wnal Granite RIGS;
- Cemaes Bay RIGS;
- Trwyn y Penrhyn RIGS;
- Trwyn y Parc RIGS;
- Gadlys Quarry RIGS;
- Llanbadrig Area GCR;
- Porth Padrig RIGS;
- Llanbadrig Point Coast RIGS;
- Llanbadrig Point RIGS;
- St Patrick's Dykes RIGS;
- Ffynnon Badrig RIGS;
- Ogof Gynfor GCR;
- Ogof Gynfor – Hell's Mouth GCR; and
- Llanbadrig – Dinas Gynfor SSSI.

The review will determine if a larger GCR site should be created to represent the internationally recognised Precambrian Gwna mélange of northern Anglesey. The review will also consider if the Miocene geology exposed at Trwyn y Parc, near Llanbadrig, merits designation as a separate GCR feature. Parts of the coastline (most notably Wylfa Head) which are not currently included within RIGS or GCR sites will be included within the review.

The GCR review is currently at a very early stage. 'Statements of Interest', which explain the scientific importance and context of any new GCR sites, will be prepared by NRW, with accompanying maps to delimit their extent. The site proposals must then undergo a rigorous review process which includes scrutiny by geologists from Natural England and Scottish Natural Heritage and by key independent geological experts at institutions such as the BGS and National Museum Wales to ensure that the sites are of an appropriate standard to warrant GCR status. Only those sites considered to be of national (Great Britain) or international importance merit GCR status.

When a locality has been approved and registered as a GCR site, it will then be considered for notification as a SSSI. NRW decide when identified geological features (GCR sites) will be notified as SSSIs. The SSSI notification takes up to nine months and includes the requirement for a formal consultation period with affected landowners and interested parties.

8.3 Non-statutory sites of geological importance

8.3.1 Introduction

RIGS are non-statutory listed sites of local, regional or national importance for their geodiversity. RIGS are conserved and protected from development by local authorities, and are designated for their scientific/research, educational, historical and/or aesthetic importance.

There are four RIGS located within the study area, which are discussed below. A further 11 RIGS are present within the wider area (including the eastern portion of the Cemaes Bay RIGS) and are shown on Figure 18; further information on these sites is presented within Appendix E.

The information presented below has been obtained from *Developing a Methodology for Selecting RIGS in Wales and A RIGS Survey of Anglesey & Gwynedd. Vol.2.* (Wood, 2007) and the *Gwynedd & Môn RIGS Group Site Records* (Gwynedd and Môn RIGS, 2012a–c).

8.3.2 Porth Wnal Dolerite RIGS

The Porth Wnal Dolerite RIGS is listed for its scientific and educational importance. The Tertiary mafic dyke is important for enhancing knowledge of plate tectonics and modern day earthquakes, and the site is the only part of the UK outside Scotland that shows multiple, young, Tertiary dyke intrusions in close proximity to older Palaeozoic dykes.

The Tertiary mafic dolerite dyke exposed within the Porth Wnal Dolerite RIGS appears to have intruded the quartzite of the mélange and displays well-defined cooling columns, multiple splays and clear contact relations with the Precambrian Gwna Group (see Photograph 1).

Photograph 1: Porth Wnal Dolerite RIGS

This outcrop and geophysically mapped relationships of the dyke provide evidence that none of the local faults in this part of the Carmel Head Thrust complex have moved since the dyke was intruded in the Tertiary Period. The dyke has been radiometrically dated and mapped by following the strong iron-rich magnetic signature.

8.3.3 Porth Wnal Granite RIGS

The Porth Wnal Granite RIGS is listed for its scientific and educational importance. The Porth Wnal Granite RIGS partially overlaps with the Porth Wnal Dolerite RIGS. The Porth Wnal Granite RIGS is important for demonstrating the relationships between granite inclusions within the Gwna mélange, the formation and deformation of the mélange, and fault movements within the Carmel Head Thrust complex.

The outcrop consists of muscovite granite with quartzite and carbonate blocks. The granite was subjected to strong shearing before being incorporated into the mélange. The granite was also cut by several small felsic intrusions, which were also subjected to shearing associated with the Carmel Head Thrust Complex. Refer to Photograph 2 for an image of the RIGS.

Photograph 2: Porth Wnal Granite RIGS

Ongoing research aims to further understand the stratigraphical correlation of Precambrian units, such as those present at the site. The Precambrian basement rocks were juxtaposed along a series of steep, brittle and/or ductile faults and shear zones.

8.3.4 Cemaes Bay RIGS

The Cemaes Bay RIGS is recognised for its international significance, as the coastal exposure of the mélange of the Gwna Group is considered the type section (best example in the world) of a mélange deposit (see Photograph 3). The age of the mélange and its relationship to the adjacent deformed Ordovician rocks remain uncertain. Recent research has demonstrated that the limestone clasts within the mélange are the oldest rocks in Wales, dating to approximately 800–660 Mya (Horák and Evans, 2011).

Photograph 3: Cemaes Bay RIGS – deformed Gwna Group mélange in Porth yr Ogof

8.3.5 Trwyn y Penrhyn RIGS

The Trwyn y Penrhyn RIGS lies within the Cemaes Bay RIGS and has been separately listed as a RIGS of scientific and educational importance due to its easily accessible group of felsic igneous dykes within the mélange of the Gwna Group and Precambrian stromatolitic fossils within limestone.

The dyke swarm within Trwyn y Penrhyn and its relationship with the carbonate country rock (within the mélange) is clearly exposed in both plan and section. Post-intrusion carbonate veins and tectonic slickensides provide further scientific value. See Photograph 4 for an image of the RIGS.

Photograph 4: Trwyn y Penrhyn RIGS

Rare Precambrian stromatolitic limestones form part of the mélange, and examples are located to the southeast of Trwyn y Penrhyn. A narrow band of black limestone occurs within the limestone and is currently a topic of significant scientific research. The condensed limestone/stromatolitic sequence has provided new chronological, palaeogeographic, palaeontological and palaeoclimatic data important for understanding Precambrian ocean-floor environments.

9. Geological resources

Following consultation with the North West Wales Minerals and Waste Planning Service, the following sources of information have been used to assess the potential impacts of the activities to be undertaken within the Wylfa Newydd Development Area on identified mineral resources:

- *Mineral Resource Map of Wales* (BGS and Welsh Assembly Government, 2010);
- *North West Wales Aggregates Safeguarding Map* (BGS and Welsh Assembly Government, 2012a);
- *Hard Rock and Sand & Gravel Safeguarding Areas in Ynys Môn* (Capita Symonds, 2010); and
- extract from *BritPits* (BGS, 2017)*,* provided by the North Wales Minerals and Waste Planning Service.

A copy of the response is included in Appendix F.

None of the Mineral Safeguarding Areas identified within the *Hard Rock and Sand & Gravel Safeguarding Areas in Ynys Môn* report or the quarries identified within the BritPits extract are located within the study area. BritPits is a database of surface and underground mineral workings produced by the BGS – BritPits is an abbreviation of British Pits.

There are a number of Aggregates Safeguarding Areas which have been identified on the *North West Wales Aggregates Safeguarding Map* (BGS and Welsh Assembly Government, 2012a) within the study area.

The Aggregates Safeguarding Area categories are as follows:

- Category 1 Aggregates Safeguarding Areas, which contain resources considered to be of national importance; and
- Category 2 Aggregates Safeguarding Areas, which contain resources considered to be of local or regional importance.

There are three types of Category 2 Safeguarding Area resources present within the study area, as set out below:

- Igneous – at Porth-y-pistyll, Wylfa Head and in a large area extending across the south/southwest of the Wylfa Newydd Development Area and beyond to the east, south and west of the study area;
- Sand and gravel – present at Tre'r Gof SSSI and in Cemlyn Bay; and
- Quartzitic sandstone (with potential for silica sand and silica rock) – present at Wylfa Head.

The Aggregates Safeguarding Areas are shown on Figure 19.

The Aggregates Safeguarding Areas are based on the aggregate resources identified on the *Mineral Resources Map of Wales* (BGS and Welsh Assembly Government, 2010), with 'safeguarding margins' or buffers created around these resources (BGS and Welsh Assembly Government, 2012b). The buffers were defined to minimise the risk of mineral sterilisation due to amenity considerations in line with *Minerals Technical Advice Note (Wales) 1: Aggregates* (Welsh Assembly Government, 2004), as well as to allow for geological mapping inaccuracies. Buffers of 100m were applied to superficial aggregates and 200m to bedrock resources in order to create the Aggregates Safeguarding Areas. Therefore, the spatial extents of the geological resources identified above are likely to be more limited than the Category 2 Aggregates Safeguarding Areas identified in Figure 19 suggest.

With regards to the igneous resources, these correspond primarily to dolerite intrusions, illustrated approximately in Figure 17. The locations, orientations and thicknesses of these intrusions were more accurately defined during interpretation of the IOnGI (Halcrow, 2012b) based on surface exposures, boreholes and magnetometer data from a number of Ground Investigations. The intrusions mapped by Halcrow (2012b) are presented on Figure 19, and this figure shows more accurately the extents of the igneous resources within the study area and highlights potential inaccuracies with the Aggregates Safeguarding Areas. Moreover, Atkins (2016) noted that the dolerite intrusions only comprised 3% of the total core meterage (encountered bedrock) during the DOnGI (Atkins, 2017), and therefore the mapped aggregate areas relating to these deposits are considered likely to be a significant overestimate of their actual extent.

The quartzitic sandstone resources likely correspond to quartzite of the Gwna Group, which is only mapped as several small occurrences at Wylfa Head in Figure 17 and is thought to correspond to boulders of sandstone and quartzite (which form part of the mélange). The sand and gravel resources are considered to relate to alluvium, which is shown in Figure 15. The alluvium at Tre'r Gof has been described as "*variable clay, silt* [and] *sand with fine gravel*" (Halcrow, 2012b). The geographical extents of both of these geological units are shown to be limited in published superficial/bedrock geology mapping and the *Mineral Resource Map of Wales* (BGS and Welsh Assembly Government, 2010), compared to Figure 19.

A consultation response received from North Wales Minerals and Waste Planning Service (refer to Appendix F for full response) acknowledged that none of the identified Aggregates Safeguarding Areas on-site have been safeguarded as part of the current Unitary Development Plan or proposed Local Development Plan (which are informed by Capita Symonds (2010)).

It should be noted that the sand and gravel resources identified at Tre'r Gof and Cemlyn Bay lie beneath areas designated for their ecological sensitivity. Tre'r Gof and Cemlyn Bay are both designated as SSSIs, whilst a Cemlyn Bay also has a number of international statutory designations. Therefore, it is considered highly unlikely that mineral resources would be extracted in these areas.

10. Glossary

Acronym	Definition
ALC	Agricultural Land Classification
AOD	Above Ordnance Datum
APC	Area of Potential Concern
mbgl	Metres Below Ground Level
BGS	British Geological Survey
BMV	Best and Most Versatile (Agricultural Land Classification)
BritPits	British Pits
DOnGI	Detailed Onshore Ground Investigation
GCR	Geological Conservation Review
GI	Ground Investigation
HOST	Hydrology of soil type
IACC	Isle of Anglesey County Council
IAEA	International Atomic Energy Agency
IOnGI	Intermediate Onshore Ground Investigation
MAFF	Ministry of Agriculture, Fisheries and Food
Mw	Movement magnitude
Mya	Million years ago
NRW	Natural Resources Wales
NSRI	National Soil Resources Institute
PSI	Preliminary Site Investigation
RIGS	Regionally Important Geodiversity Site
SSSI	Site of Special Scientific Interest
UNESCO	United Nations Educational, Scientific and Cultural Organisation

11. References

Allott and Lomax. 1988. *Wylfa 'B' Power Station Pre-Application Studies – Report on Civil Engineering Aspects*. Three Volumes (Introduction; Geotechnical Report; Civil Engineering Appraisal). Allot and Lomax. Report Reference: VGRA/AEJ/DSK/286.

Arup. 2012. *Ground Rupture Interpretative Report*. Horizon Nuclear Power Ltd. Report Reference: 214898/003, Draft 1.

Arup. 2015. *WYB0004 Wylfa Newydd Seismic Hazard Assessment*. Report Reference: REP/214898/5/010, Rev 1.0

Atkins. 2017. *Wylfa Newydd Nuclear Power Station – Detailed Onshore Ground Investigation. Final Interpretative Ground Investigation Report*. Horizon Nuclear Power Ltd. Report Reference: WN02.03.01-ATK-SDT-REP-00001.

British Geological Survey (BGS). 1974. *1:50,000 Scale 'Solid and Drift Geology' Geological Map of Anglesey (Special Sheet 092).*

British Geological Survey (BGS). 2015. *GeoIndex*. [Online] [Accessed: April 2015] Available from: http://mapapps2.bgs.ac.uk/geoindex/home.html

British Geological Survey (BGS). 2017. *BritPits*. [Online] [Accessed: April 2017] Available from: http://www.bgs.ac.uk/products/minerals/BRITPITS.html

British Geological Survey (BGS) and Welsh Assembly Government. 2010. *Mineral Resource Map of Wales*. Nottingham: British Geological Survey.

British Geological Survey (BGS) and Welsh Assembly Government. 2012a. *North West Wales Aggregates Safeguarding Map*. Nottingham: British Geological Survey.

British Geological Survey (BGS) and Welsh Assembly Government. 2012b. *Aggregates Safeguarding Maps of Wales*. [Online] [Accessed: November 2016] Available from: http://nora.nerc.ac.uk/20138/1/Aggregates_Safeguarding_Map_Of_Wales_Final.pdf

British Nuclear Fuels Limited. 2005. *Wylfa Power Station, Preliminary Investigation (Desk Study) of Land Potentially Affected by Contamination*. *E&T/REP/WYA/1605/05 Issue A1*.

Campbell, S. Wood, M. and Windley, B. 2014. *Footsteps Through Time: The Rocks and Landscape of Anglesey Explained*. Anglesey: GeoMôn and Isle of Anglesey County Council.

Capita Symonds. 2010. *Hard Rock and Sand & Gravel Safeguarding Areas in Ynys Môn*. Unpublished report on behalf of Isle of Anglesey County Council.

CH2M Hill. 2014. *Environmental Baseline Conditions Report - Wylfa Newydd Ground Conditions, Hydrology and Hydrogeology*. CH2M Hill. Report Reference: 479175.015.

Fugro Geoservices Limited. 2017. *Factual Report on Wylfa Newydd Detailed Offshore Ground Investigation (DOffGI) without Geotechnical Evaluation*.

Greenly, E. 1919. *The Geology of Anglesey: Memoirs of the Geological Survey of Great Britain*. (2 vols). London: Her Majesty's Stationery Office.

Groundsure. 2015. *MapInsight: All Scales (GS-2084891)*.

Gwynedd and Môn RIGS. 2012a. *Group Site Record. Porth Wnal Dolerite – RIGS 391*.

Gwynedd and Môn RIGS. 2012b. *Group Site Record. Porth Wnal Granite – RIGS 392*.

Gwynedd and Môn RIGS. 2012c. *Group Site Record. Trwyn y Penrhyn – RIGS 393*.

Halcrow. 2012a. *Wylfa New Build Power Station - Contaminated Land Desk Study and Initial Risk Assessment*. Version 1.2 (July 2012). Report Reference: D002 Version 1.1.

Halcrow. 2012b. *Wylfa New Build Power Station - Intermediate Onshore Ground Investigation - Geotechnical Interpretative Report*. Report Reference: WYL-HAL-STD-REP-00013.

Halcrow. 2012c. *Wylfa New Build – Intermediate Offshore Ground Investigation Geotechnical Interpretative Report*. WYL-HAL-SDT-REP-00012.

Harris, C. 1991. Glacially deformed bedrock at Wylfa Head, Anglesey, North Wales. *Engineering Geology Special Publications*, 7: 135–142.

Horák, J.M. and Evans, J.A. 2011. Early Neoproterozoic limestones from the Gwna Group, Anglesey. *Geological Magazine,* 148 (1): 78–88.

Horizon Nuclear Power. 2014. *Pre-Application Consultation Stage One Preliminary Environmental Information Report.*

International Atomic Energy Agency. 2010. Seismic hazards in site evaluation for nuclear installations: safety guide. Vienna. International Atomic Energy Agency.

Joint Nature Conservation Committee. 2016. *Background to the GCR Database*. [Online] [Accessed: November 2016] Available from: http://jncc.defra.gov.uk/page-2949.

Leslie, A.G., Krabbendam, M. and Gillespie, M.R. 2012. *BGS Classification of Lithodemic Units: Proposals for Classifying Tectonometamorphic Units and Mixed-class Units.* British Geological Survey Research Report, RR/12/02.

Ministry of Agriculture, Fisheries and Food (MAFF). 1977. *1:250,000 Series Agricultural Land Classification: Wales*.

Ministry of Agriculture, Fisheries and Food (MAFF). 1988. *Agricultural Land Classification of England and Wales. Revised guidelines and criteria for grading the quality of agricultural land*. London: MAFF.

Natural England. 2012. *Agricultural Land Classification: Protecting the Best and most Versatile Agricultural Land* (Natural England Technical Information Note TIN049). [Online]. [Accessed: October 2016] Available from: http://publications.naturalengland.org.uk/publication/35012

National Soil Resources Institute. 2015. *Soils Site Report, Full Site Report 5km x 5km*. *SH3591792942*. [Online] [Accessed: March 2015] Available from: https://www.landis.org.uk/sitereporter/

Reading Agricultural Consultants Ltd. 2015. *Wylfa Nuclear Power Station Anglesey – Agricultural Land Classification and Soil Resources*. Report Reference: RAC6753 June 2015.

Reading Agricultural Consultants Ltd. 2016. *Wylfa Nuclear Power Station Anglesey – Agricultural Land Classification and Soil Resources*. Report Reference: RAC6753 March 2016.

Smith, B. and George, T. N. 1961. *British Regional Geology: North Wales*. (3rd ed.). London: Natural Environment Research Council, Institute of Geological Sciences and Geological Survey and Museum.

Structural Soils Limited. 2010. *Report on Preliminary Ground Investigation at Wylfa*.

JACOBS

Structural Soils Limited. 2011. *Factual Report on Wylfa New Build Intermediate Onshore Ground Investigation.*

Structural Soils Limited. 2014. *Factual Report on Wylfa Newydd Detailed Onshore Ground Investigation: Volume 1.*

Structural Soils Limited. 2015a. *Factual Report on Wylfa Newydd Detailed Onshore Ground Investigation: Volume 2.*

Structural Soils Limited. 2015b. *Factual Report for Task Order 002 – SPC1.*

UNESCO. 2016. *New UNESCO programme recognises the UK's seven 'Global Geoparks'*. [Online] [Accessed: January 2016] Available from: www.unesco.org.uk/news/new-unesco-programme-recognises-the-uks-seven-global-geoparks/.

Welsh Assembly Government. 2004. *Minerals Technical Advice Note (Wales) 1: Aggregates*. Cardiff: Welsh Assembly Government.

Welsh Government. 2016. *Planning Policy Wales*. Edition 9. Cardiff: Welsh Government.

Wood, M. 2007. *Developing a Methodology for Selecting Regionally Important Geodiversity Sites (RIGS) in Wales and A RIGS Survey of Anglesey & Gwynedd*. *Vol.2.*

Wood. M. 2012. The Historical Development of the Term 'Mélange' and Its Relevance to the Precambrian Geology of Anglesey and the Lleyn Peninsula in Wales, UK. *Journal of Geography,* 121(1): 168–180.

12. Limitations

The potential remains for the presence of unknown, unidentified, or unforeseen surface and sub-surface contamination. Any additional evidence of such potential site contamination would require appropriate surface and sub-surface exploration and testing. The findings of this report were developed in a manner consistent with a level of care and skill normally exercised by members of the environmental science and engineering profession currently practising under similar conditions.

A number of the findings and conclusions presented in this report are based on information provided by third parties and/or historical records, which Horizon Nuclear Power Wylfa Limited has relied on in good faith. Jacobs accepts no responsibility for any deficiency, misstatements, or inaccuracy contained in this report as a result of errors, omissions or misstatements of said third parties or from information obtained from these.

If new information is obtained or developed during future work (which may include excavations, borings or other studies), Jacobs should be requested to re-evaluate the conclusions of this report, and to provide amendments as required.

13. Figures

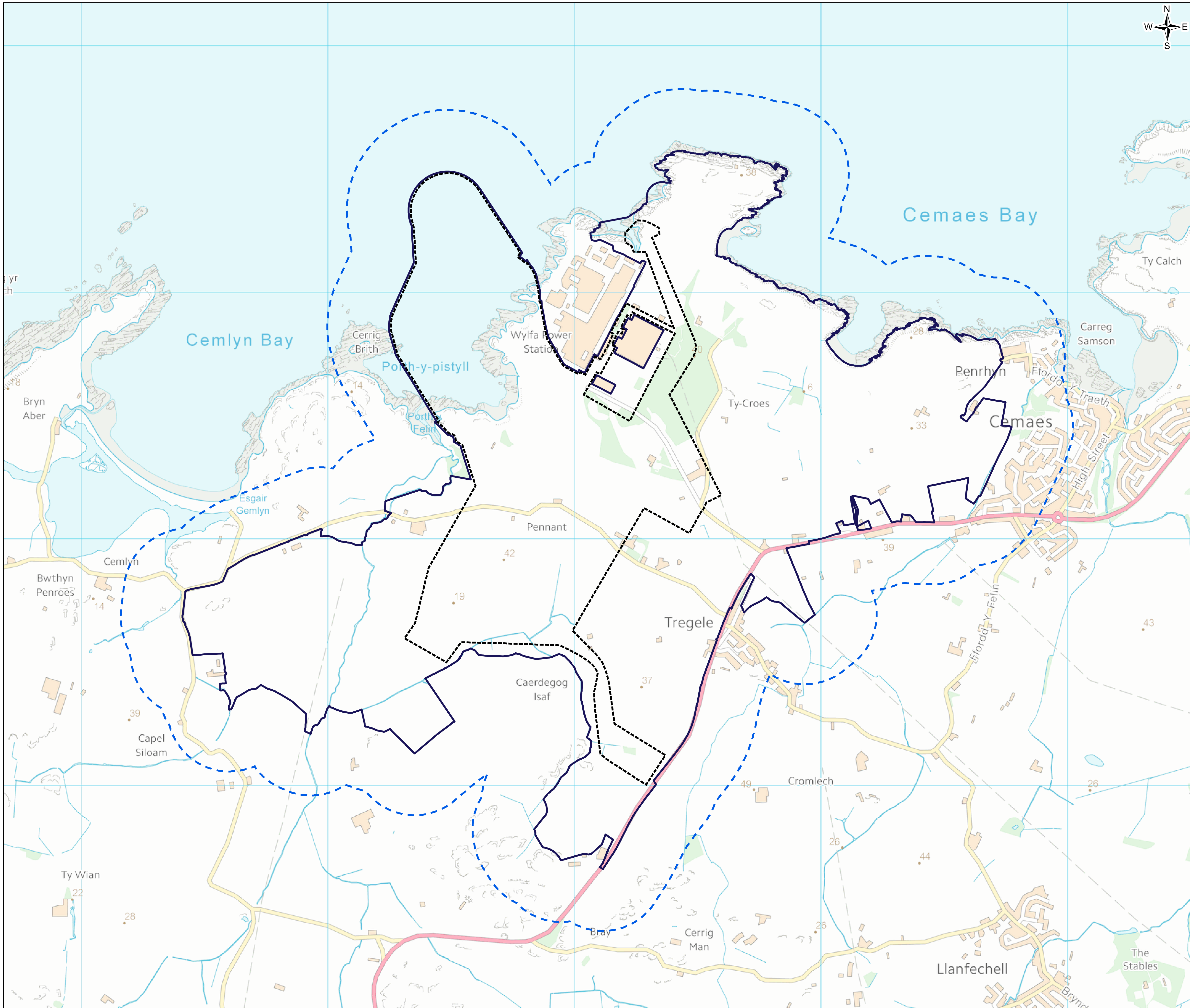


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FIGURE 1

Legend

- Wylfa Newydd Development Area
- Power Station Site boundary
- Study area

0	AUG 17	Initial Issue	AD	CC	KY	RB
Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd

Client

HORIZON NUCLEAR POWER

Project

WYLFA NEWYDD PROPOSED NUCLEAR POWER STATION
BASELINE CONDITIONS REPORT

Drawing Title

SOILS AND GEOLOGY STUDY AREA

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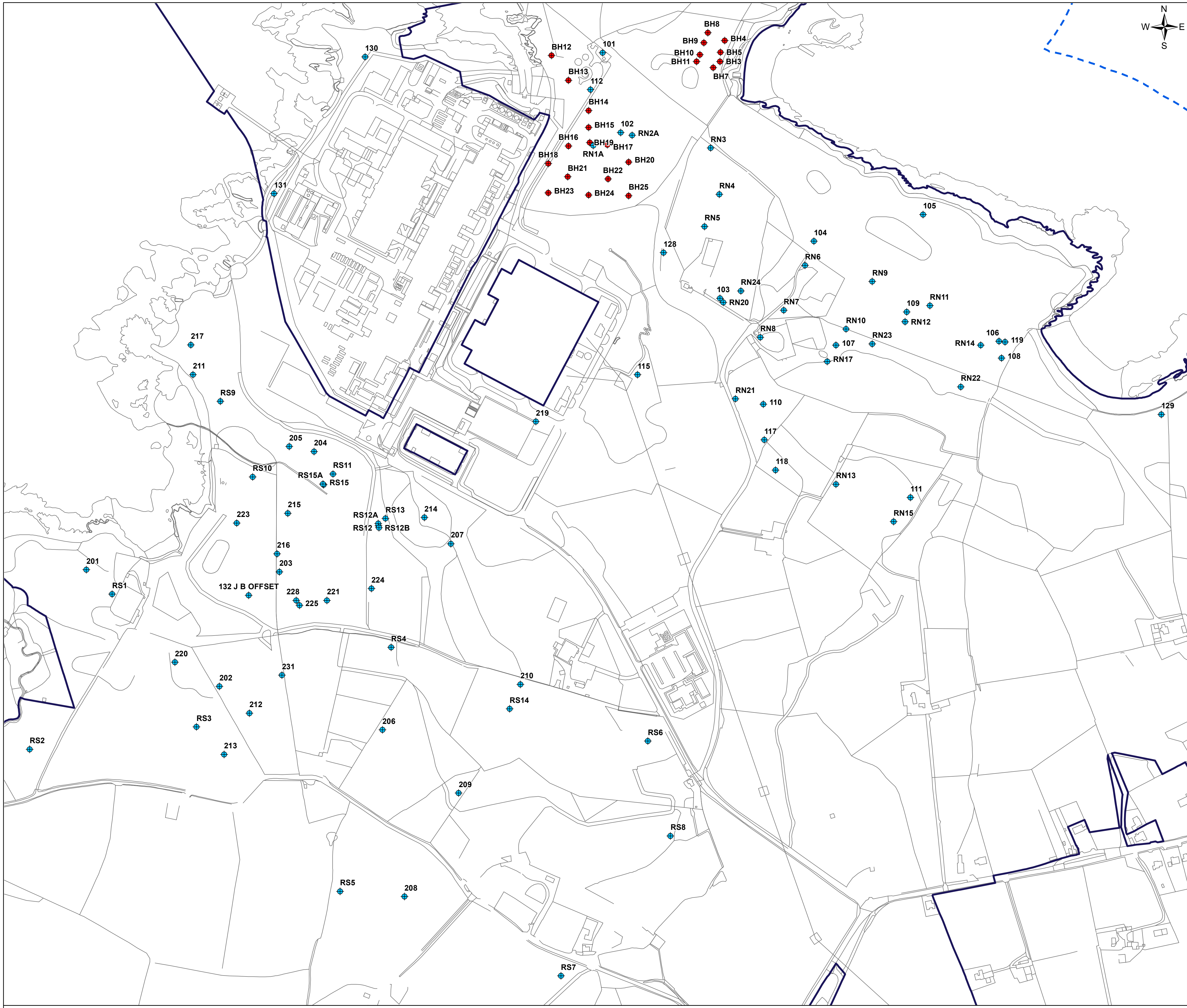
FIGURE 2

Legend

- Wylfa Newydd Development Area
- Study area
- Wimpey Laboratories' (1987) exploratory hole
- Soil Mechanics' (1998) onshore exploratory hole



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Project

WYLFA NEWYDD PROPOSED NUCLEAR POWER STATION
BASELINE CONDITIONS REPORT

Drawing Title

EXPLORATORY HOLE LOCATION PLAN:
WIMPEY AND SOIL MECHANICS

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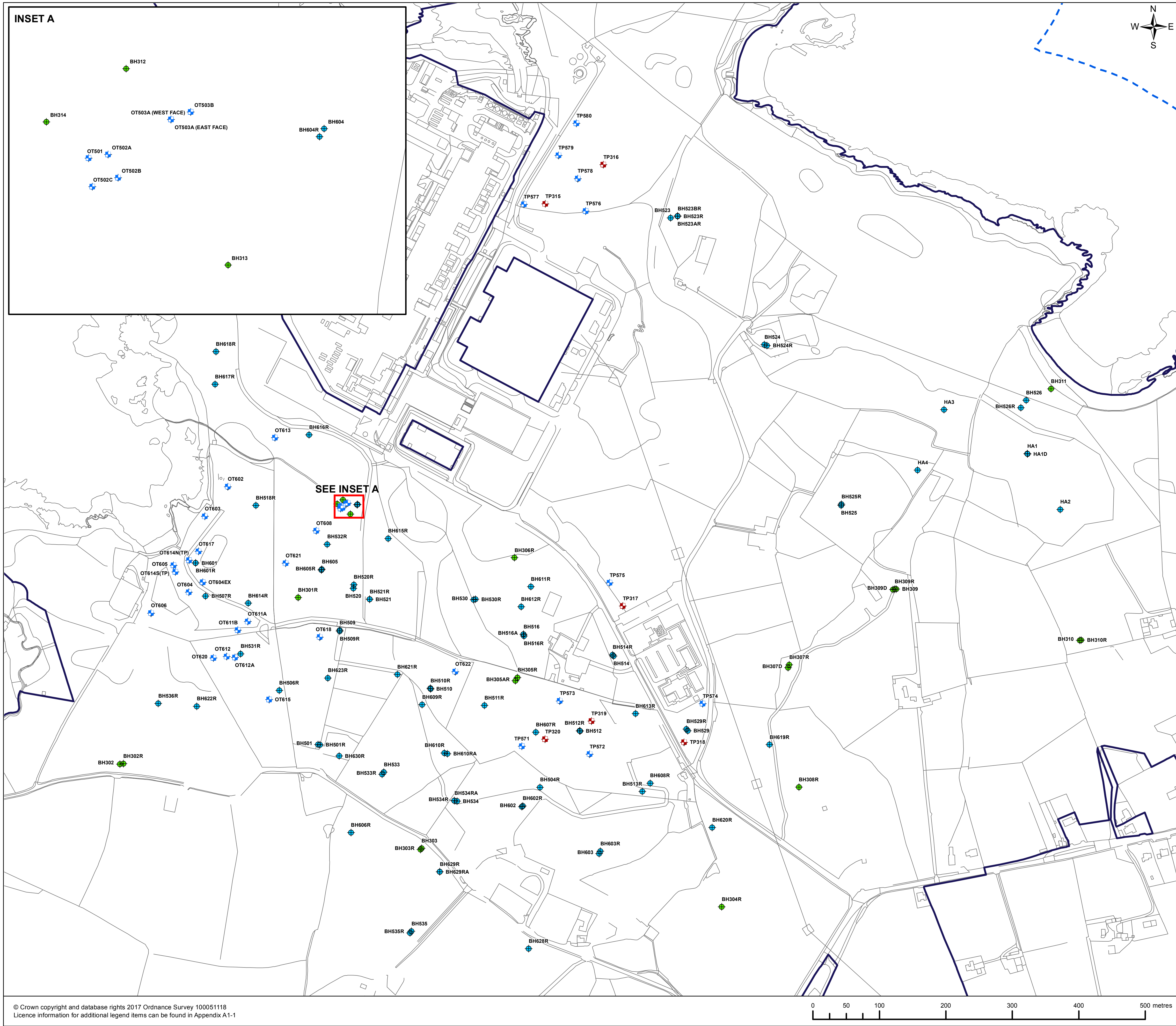

FIGURE 3

Legend

- Wylfa Newydd Development Area
- Study area
- Preliminary Site Investigation (PSI), 2010 - trial pit
- Preliminary Site Investigation (PSI), 2010 - borehole
- Intermediate Onshore Ground Investigation (IOnGI), 2011 - trial pit
- Intermediate Onshore Ground Investigation (IOnGI), 2011 - borehole

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Project

WYLFA NEWYDD PROPOSED NUCLEAR POWER STATION
BASELINE CONDITIONS REPORT

Drawing Title

EXPLORATORY HOLE LOCATION PLAN:
PSI AND IOnGI

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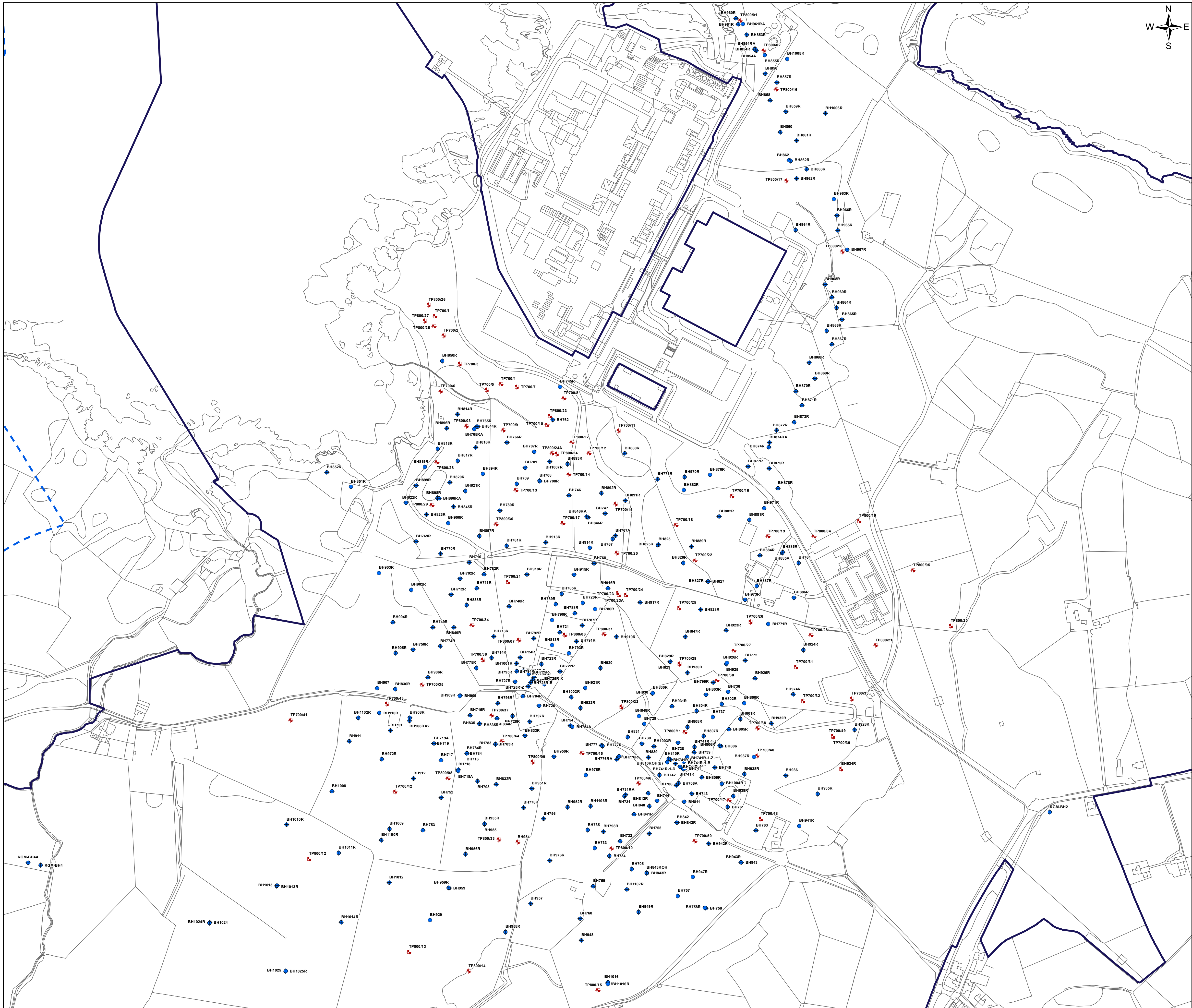

FIGURE 4

Legend

- Wylfa Newydd Development Area
- Study area
- Detailed Onshore Ground Investigation (DOnGI), 2014 - borehole
- Detailed Onshore Ground Investigation (DOnGI), 2014 - trial pit

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Drawing Title

EXPLORATORY HOLE LOCATION PLAN: DOnGI

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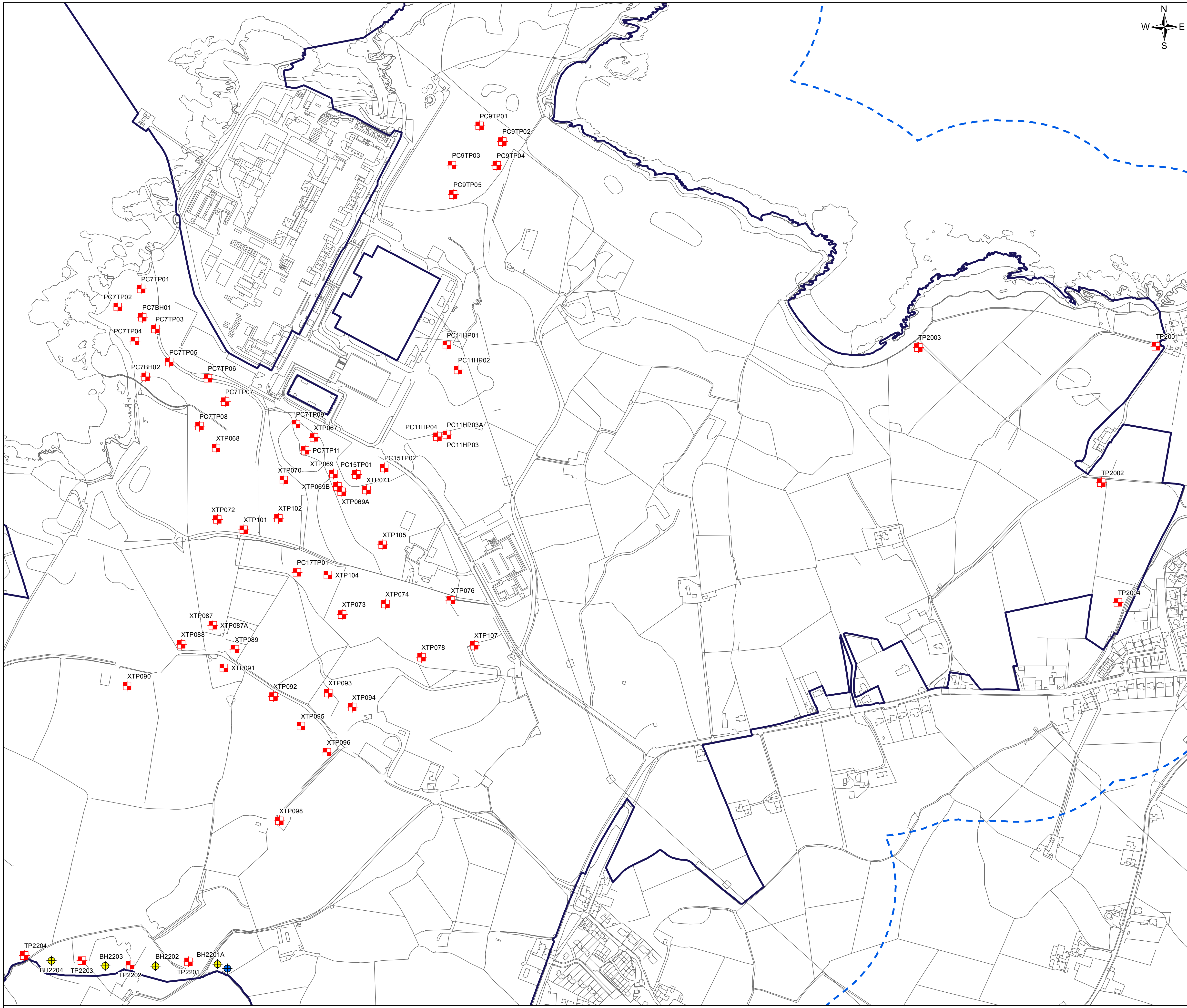
FIGURE 5



Legend

- Wylfa Newydd Development Area
- Study area
- 2015 Ground Investigation (GI) - borehole (cable percussive)
- 2015 GI - borehole (rotary core)
- 2015 GI - trial pit

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WYLFA NEWYDD PROPOSED NUCLEAR POWER STATION
BASELINE CONDITIONS REPORT

Drawing Title

EXPLORATORY HOLE LOCATION PLAN:
2015 GI

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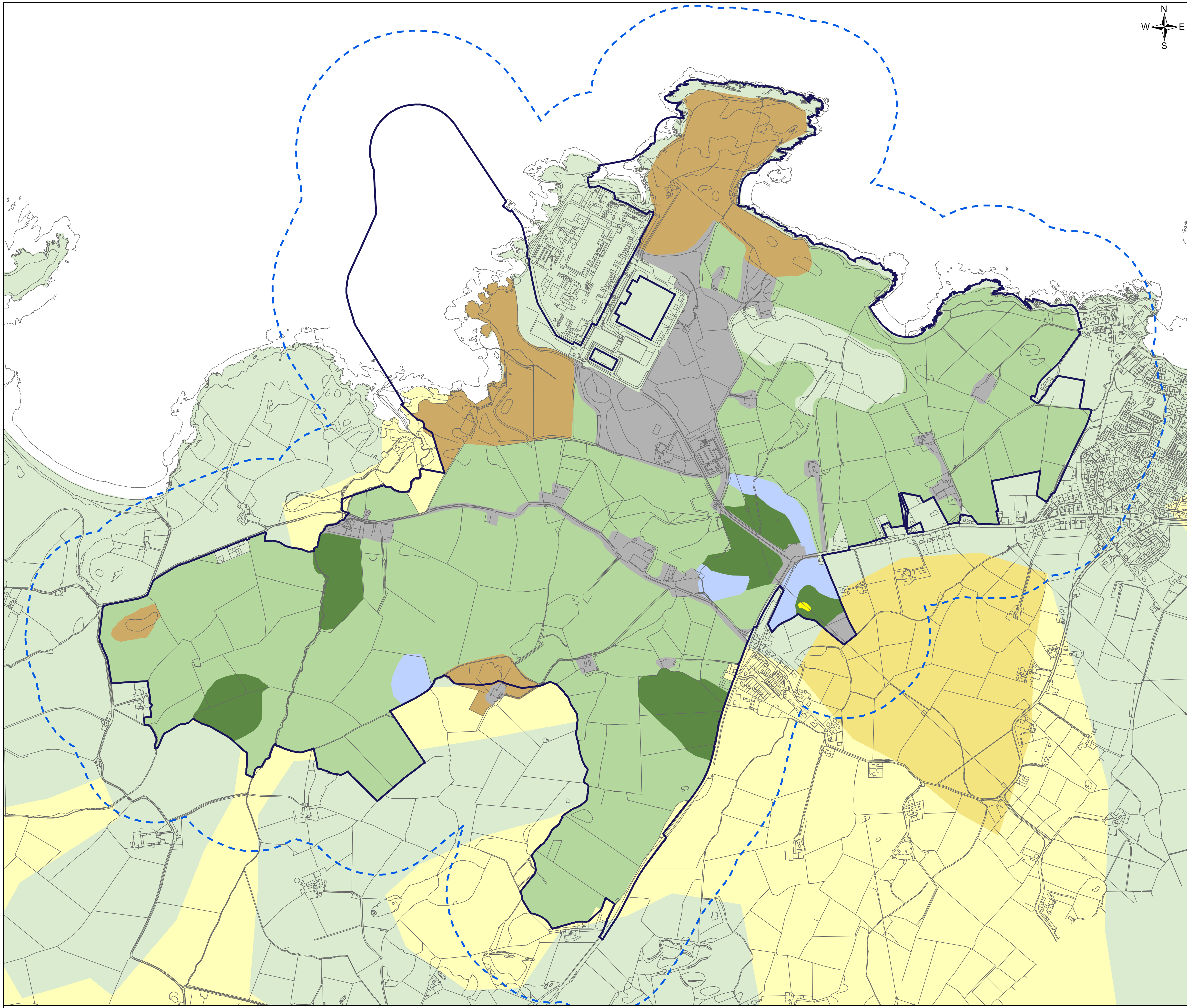

FIGURE 6

Legend

- Wylfa Newydd Development Area
- Study area

Site-specific Agricultural Land Classification (ALC) data

- Grade 2 - very good quality
- Subgrade 3a - good quality
- Subgrade 3b - moderate quality
- Grade 4 - poor quality
- Grade 5 - very poor quality
- Non-agricultural

Source: Reading Agricultural Consultants Ltd. 2016. *Wylfa Nuclear Power Station Anglesey – Agricultural Land Classification and Soil Resources*

Provisional ALC

- Grade 3
- Grade 4
- Grade 5

Source: Ministry of Agriculture, Fisheries and Food.1977. *A review of the Provisional Agricultural Land Classification (ALC) data for Wales.* London: MAFF.

Note: Provisional ALC data shown for areas in which site-specific survey data are not available. It should be noted that these only provide a generalised indication of the potential ALC grades present and are known to be inaccurate in locations such as the Existing Power Station (where hardstanding is present).

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WYLFA NEWYDD PROPOSED NUCLEAR POWER STATION
BASELINE CONDITIONS REPORT

Drawing Title

AGRICULTURAL LAND CLASSIFICATION

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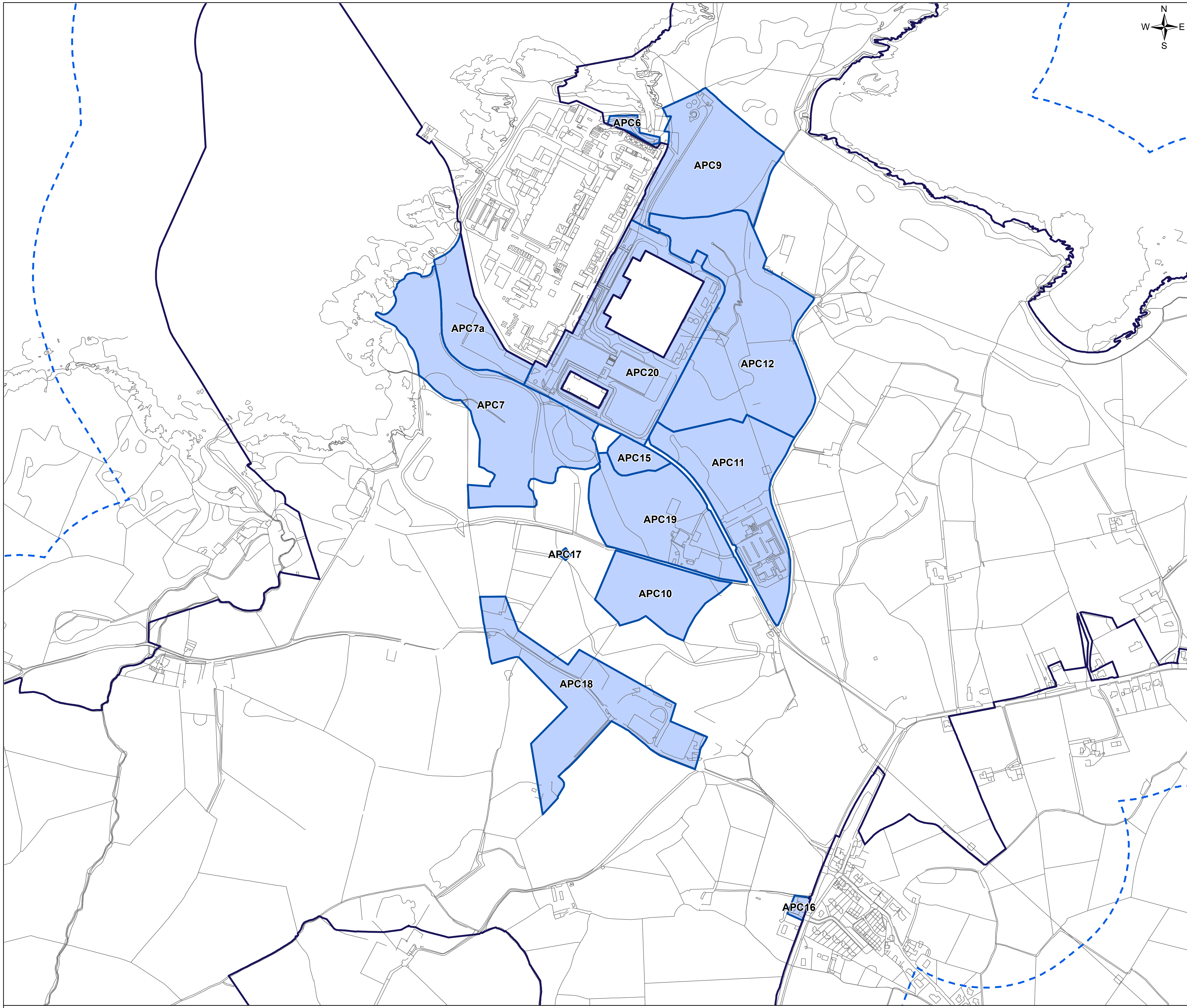
0 125 250 500 750 1,000 1,250 metres

FIGURE 7



Legend

- Wylfa Newydd Development Area
- Study area
- Area of Potential Concern

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Project

WYLFA NEWYDD PROPOSED NUCLEAR POWER STATION
BASELINE CONDITIONS REPORT

Drawing Title

AREAS OF POTENTIAL CONCERN

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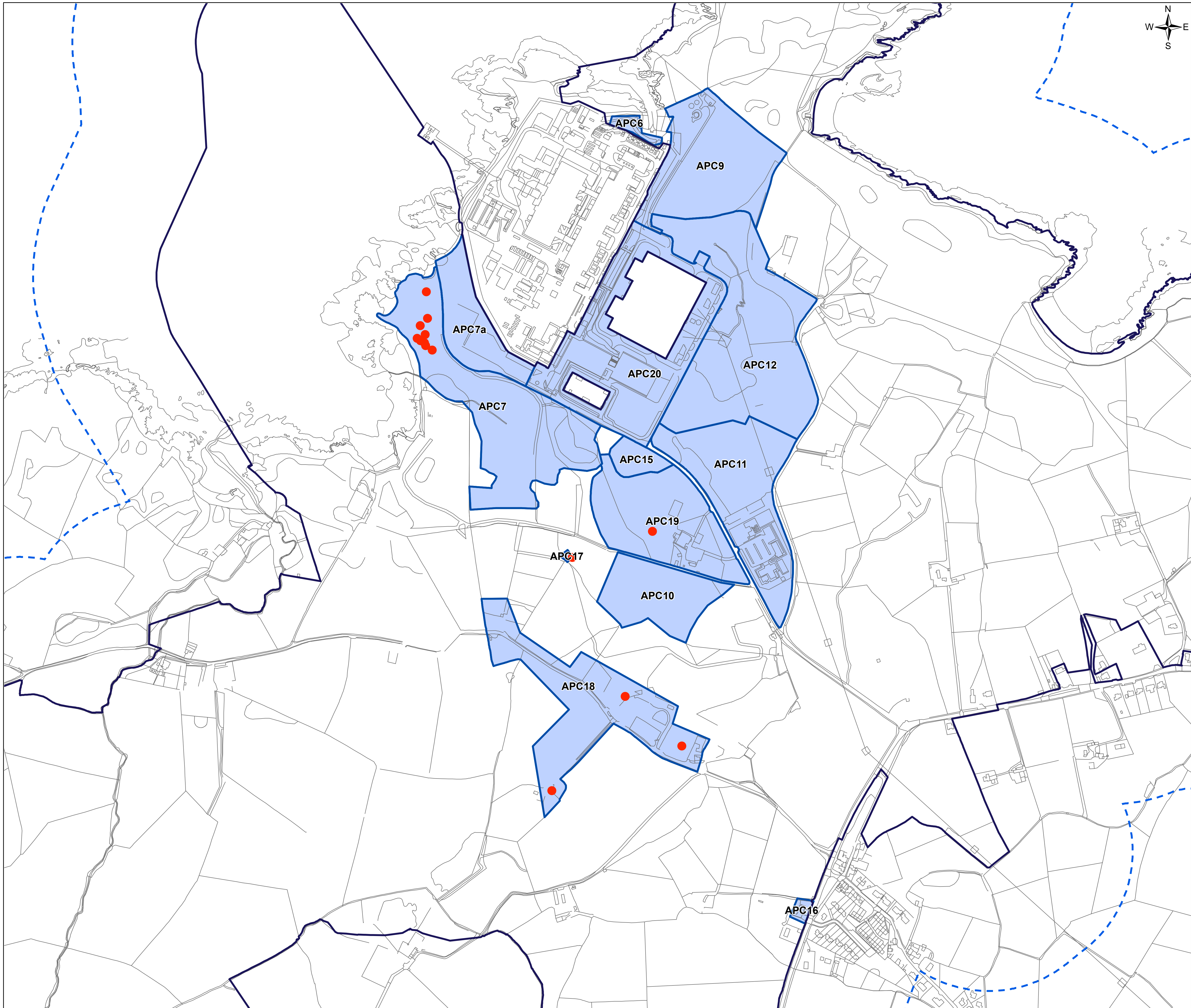

FIGURE 8

Legend

- Wylfa Newydd Development Area
- Study area
- Area of Potential Concern
- Type 1 made ground

Notes:
Made ground identified as interpreted by DOnGI (Atkins, 2015). Ground investigation data from Combined Cycle Gas Turbine Power Station Ground Investigation (1997-1998), PSI (2010), IOnGI (2011), DOnGI (2014) and 2015 GI.

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WYLFA NEWYDD PROPOSED NUCLEAR POWER STATION
BASELINE CONDITIONS REPORT

Drawing Title

MADE GROUND LOCATIONS: TYPE 1

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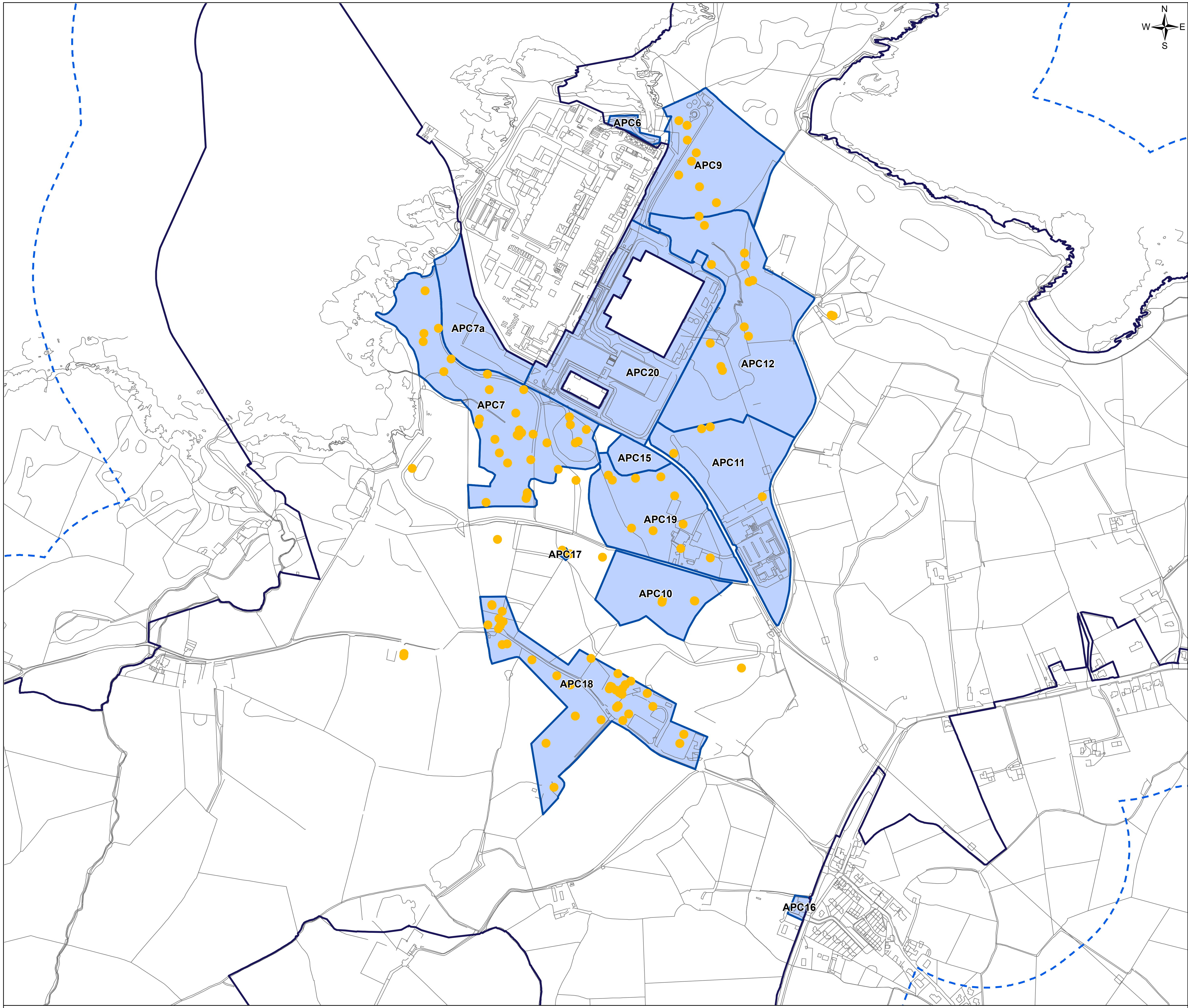
FIGURE 9



Legend

- Wylfa Newydd Development Area
- Study area
- Area of Potential Concern
- Type 2 made ground

Notes:
Made ground identified as interpreted by DOnGI (Atkins, 2015). Ground investigation data from Combined Cycle Gas Turbine Power Station Ground Investigation (1997-1998), PSI (2010), IOnGI (2011), DOnGI (2014) and 2015 GI.

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BASELINE CONDITIONS REPORT

Drawing Title
MADE GROUND LOCATIONS: TYPE 2

Scale @ A3	1:7,500	DO NOT SCALE
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Client No.		
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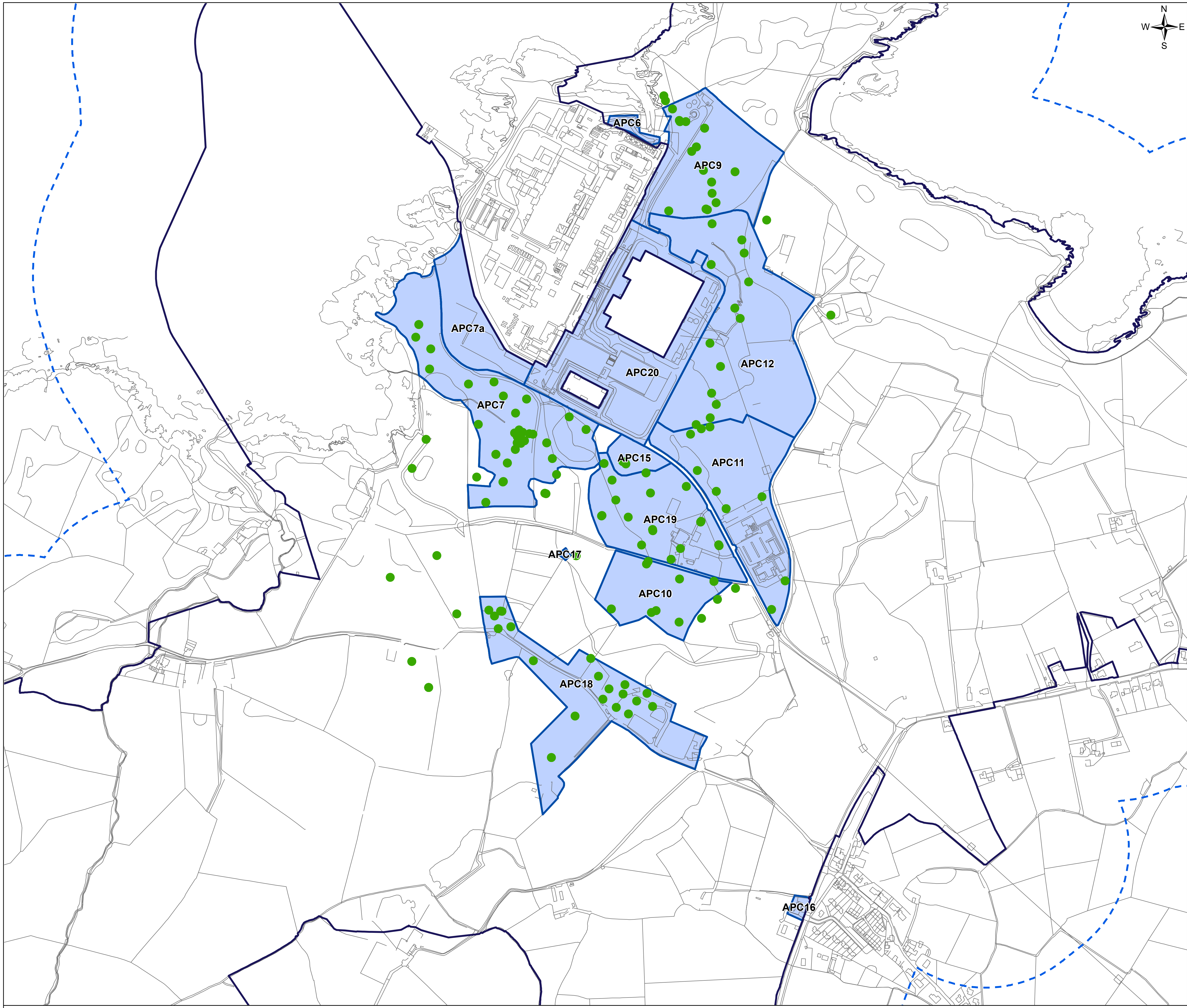
FIGURE 10



Legend

- Wylfa Newydd Development Area
- Study area
- Area of Potential Concern
- Type 3 made ground

Notes:
Made ground identified as interpreted by DOnGI (Atkins, 2015). Ground investigation data from Combined Cycle Gas Turbine Power Station Ground Investigation (1997-1998), PSI (2010), IOnGI (2011), DOnGI (2014) and 2015 GI.

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Project

WYLFA NEWYDD PROPOSED NUCLEAR POWER STATION
BASELINE CONDITIONS REPORT

Drawing Title

MADE GROUND LOCATIONS: TYPE 3

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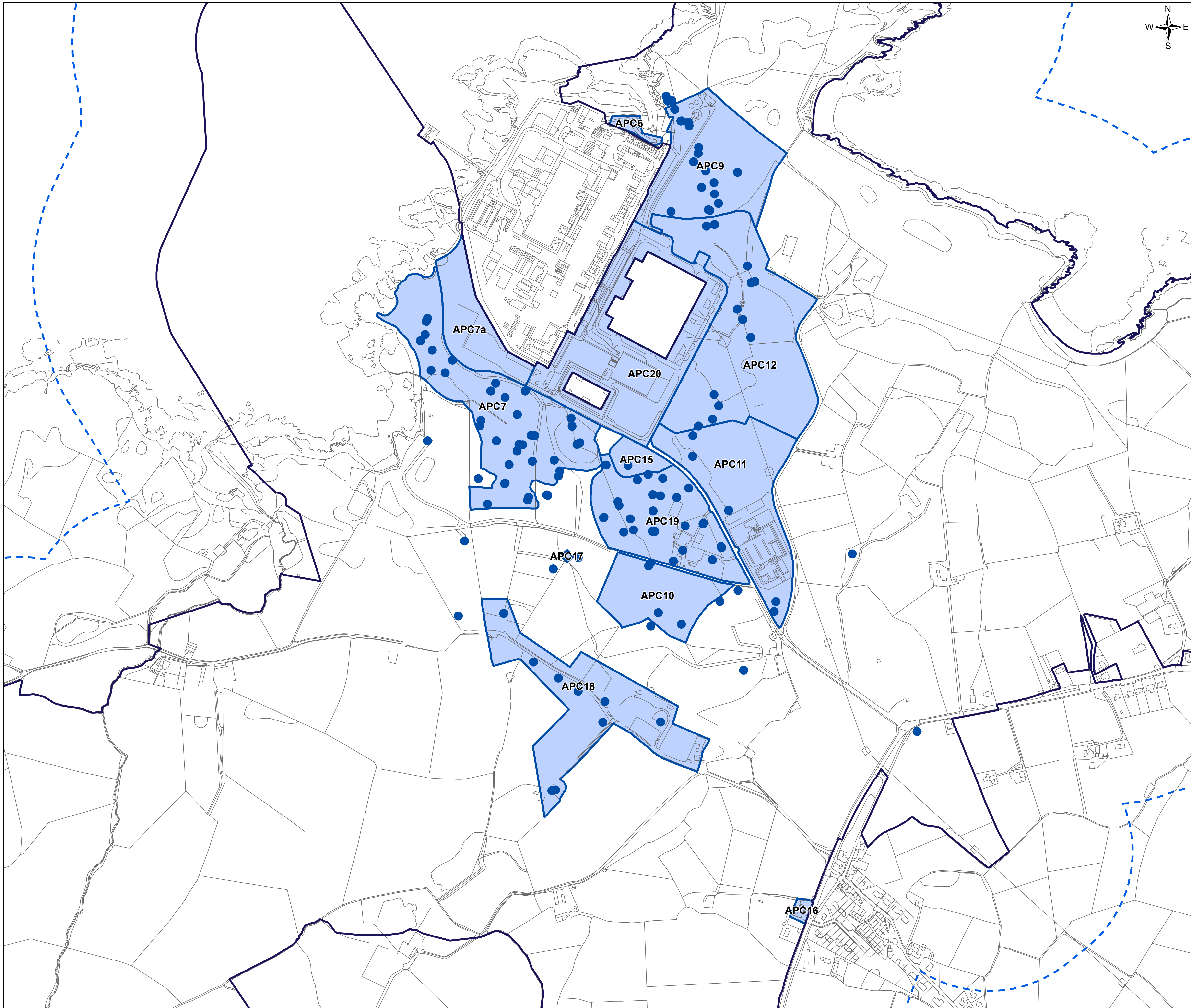
FIGURE 11



Legend

- Wylfa Newydd Development Area
- Study area
- Area of Potential Concern
- Type 4 made ground

Notes:
Made ground identified as interpreted by DOnGI (Atkins, 2015). Ground investigation data from Combined Cycle Gas Turbine Power Station Ground Investigation (1997-1998), PSI (2010), IOnGI (2011), DOnGI (2014) and 2015 GI.

Rev.	Date	Purpose of revision	Drawn	Check'd	Rev'd	Appr'd
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Client

HORIZON NUCLEAR POWER

Project

WYLFA NEWYDD PROPOSED NUCLEAR POWER STATION
BASELINE CONDITIONS REPORT

Drawing Title

MADE GROUND LOCATIONS: TYPE 4

Scale @ A3	1:7,500	DO NOT SCALE
Jacobs No.	60PO8077	
Client No.		
Drawing No.	60PO8077_DCO_BCR_11	

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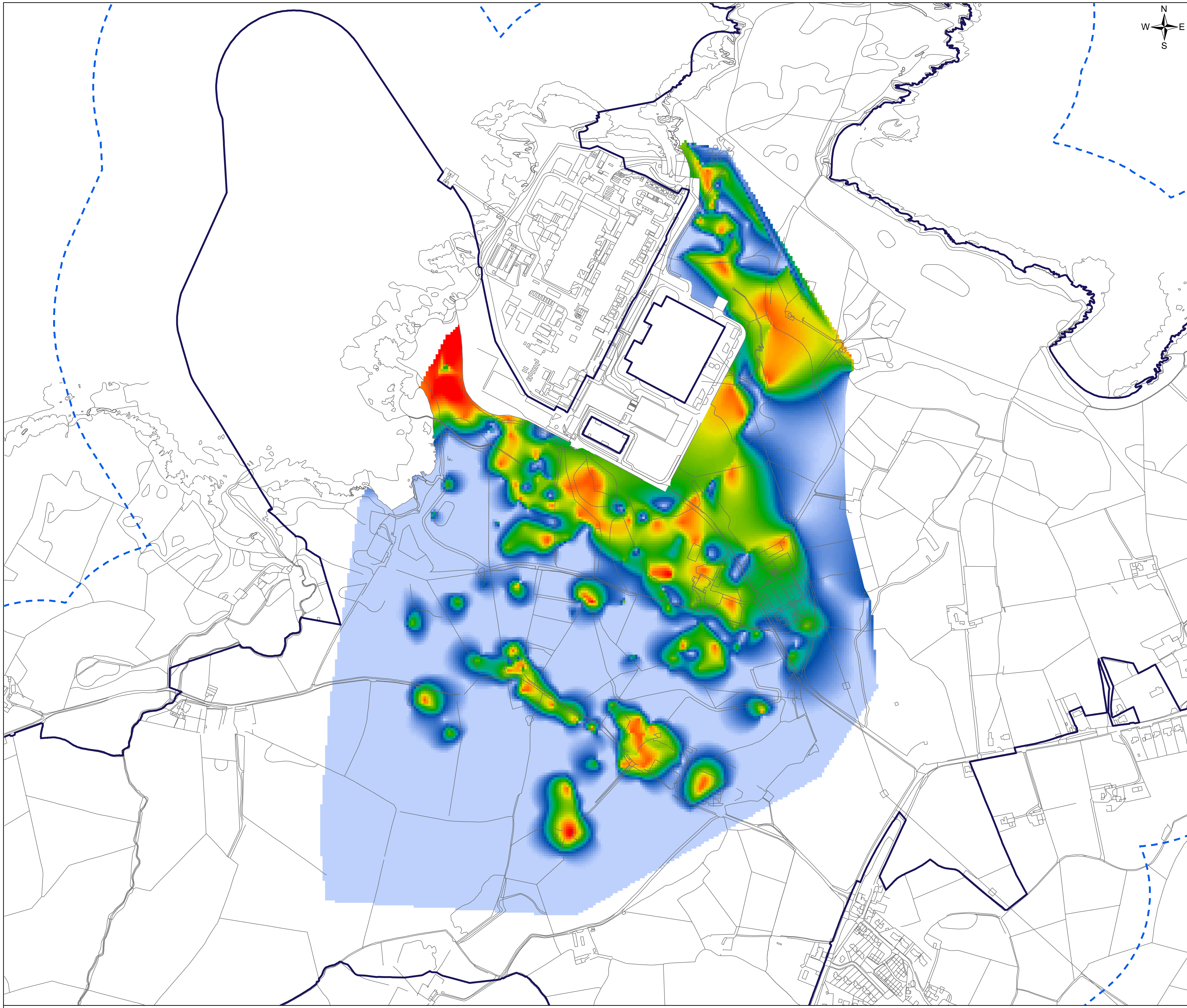

FIGURE 12

Legend

- Wylfa Newydd Development Area
- Study area

Made ground interpolation
- Made ground not anticipated
- Type 4 made ground
- Type 3 made ground
- Type 2 made ground
- Type 1 made ground

Notes:
Made ground types identified as interpreted by DOnGI (Atkins, 2015). Ground investigation data from PSI (2010), IOnGI (2011), DOnGI (2014) and 2015 GI. Display shows all made ground types (1-4) encountered at all depths. Where multiple types occur at the same location, the lowest type has been displayed, to provide a worst case assumption of made ground present.

Type 1 made ground represents waste materials.

Type 2 made ground represents re-worked natural ground intermixed with made ground/waste.

Type 3 made ground represents re-worked natural/possible made ground.

Type 4 made ground represents topsoil.

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0	AUG 17	Initial Issue	AD	CC	KY	RB

Client
HORIZON NUCLEAR POWER

Project
WYLFA NEWYDD PROPOSED NUCLEAR POWER STATION
BASELINE CONDITIONS REPORT

Drawing Title
MADE GROUND COMPOSITE PLAN: WORST CASE

Scale @ A3	1:7,500	DO NOT SCALE
Jacobs No.	60PO8077	
Client No.		
Drawing No.	60PO8077_DCO_BCR_12	

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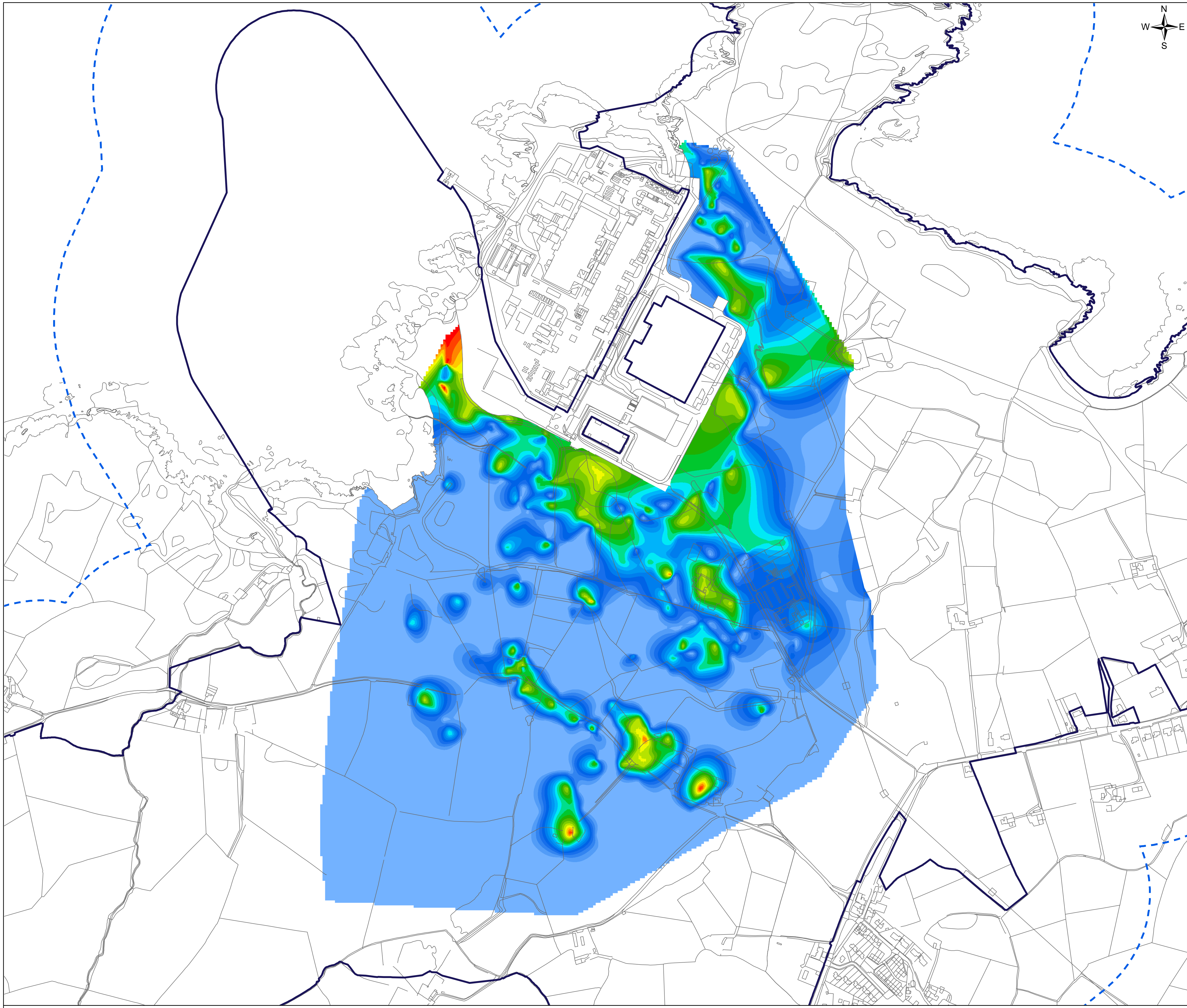

FIGURE 13

Legend

- Wylfa Newydd Development Area
- Study area

Made ground composite for upper 300mm
- Made ground not anticipated
- Type 4 made ground
- Type 3 made ground
- Type 2 made ground
- Type 1 made ground

Notes:
Made ground types identified as interpreted by DOnGI (Atkins, 2015). Ground investigation data from PSI (2010), IOnGI (2011), DOnGI (2014) and 2015 GI. Display shows all made ground types (1-4) encountered at all depths. Where multiple types occur at the same location, the lowest type has been displayed, to provide a worst case assumption of made ground present.

Type 1 made ground represents waste materials.

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Type 3 made ground represents re-worked natural/possible made ground.

Type 4 made ground represents topsoil.

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HORIZON NUCLEAR POWER

Project

WYLFA NEWYDD PROPOSED NUCLEAR POWER STATION
BASELINE CONDITIONS REPORT

Drawing Title

MADE GROUND COMPOSITE PLAN: TOP 0.3M

Scale @ A3	1:7,500	DO NOT SCALE
Jacobs No.	60PO8077	
Client No.		
Drawing No.	60PO8077_DCO_BCR_13	

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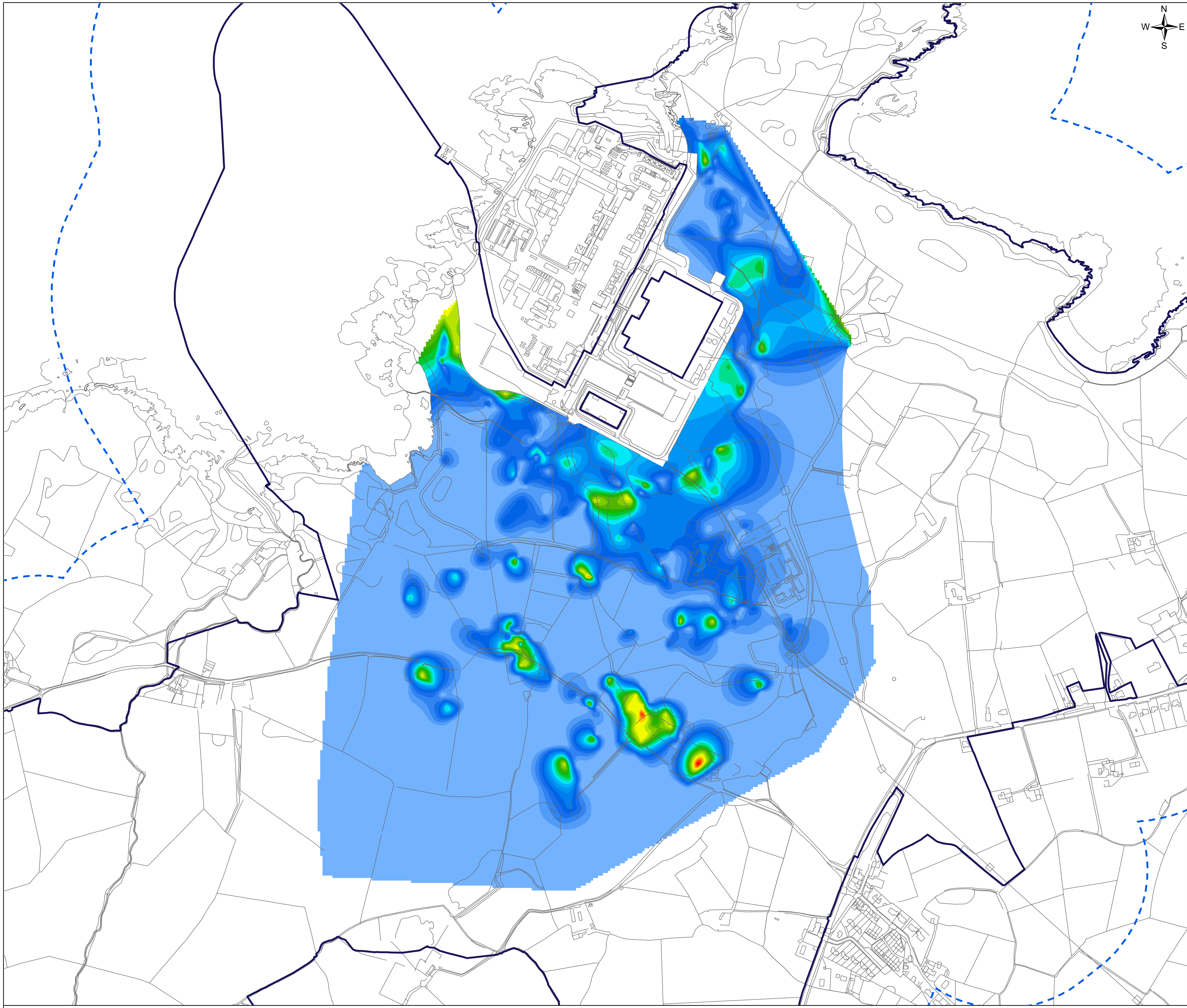

FIGURE 14

Legend

- Wylfa Newydd Development Area
- Study area

Made ground composite at surface (0mm below ground level)

- Made ground not anticipated
- Type 4 made ground
- Type 3 made ground
- Type 2 made ground
- Type 1 made ground

Notes:
Made ground types identified as interpreted by DOnGI (Atkins, 2015). Ground investigation data from PSI (2010), IOnGI (2011), DOnGI (2014) and 2015 GI. Display shows all made ground types (1-4) encountered at all depths. Where multiple types occur at the same location, the lowest type has been displayed, to provide a worst case assumption of made ground present.

Type 1 made ground represents waste materials.

Type 2 made ground represents re-worked natural ground intermixed with made ground/waste.

Type 3 made ground represents re-worked natural/possible made ground.

Type 4 made ground represents topsoil.

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HORIZON NUCLEAR POWER

Project

WYLFA NEWYDD PROPOSED NUCLEAR POWER STATION
BASELINE CONDITIONS REPORT

Drawing Title

MADE GROUND COMPOSITE PLAN: SURFACE

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Client No.		
Drawing No.	60PO8077_DCO_BCR_14	

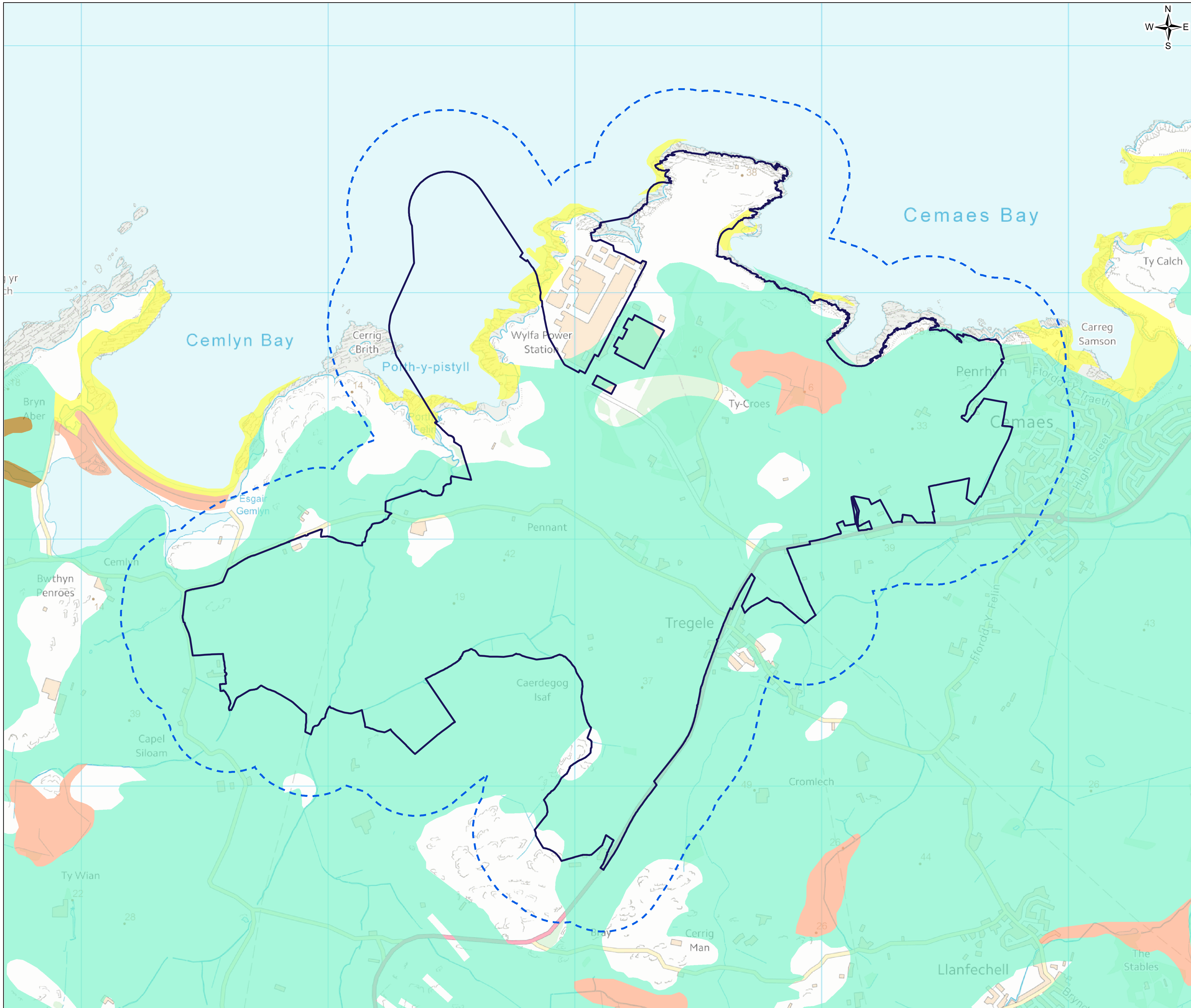

FIGURE 15

Legend

- Wylfa Newydd Development Area
- Study area

Published superficial geology

- Alluvium - clay, silt, sand and gravel
- Coastal zone deposits (undifferentiated) - sand, silt and clay
- Tidal flat deposits - clay and silt
- Glacial till, Devensian - diamicton

Source:
Data obtained from the British Geological Survey.

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HORIZON NUCLEAR POWER

Project

WYLFA NEWYDD PROPOSED NUCLEAR POWER STATION
BASELINE CONDITIONS REPORT

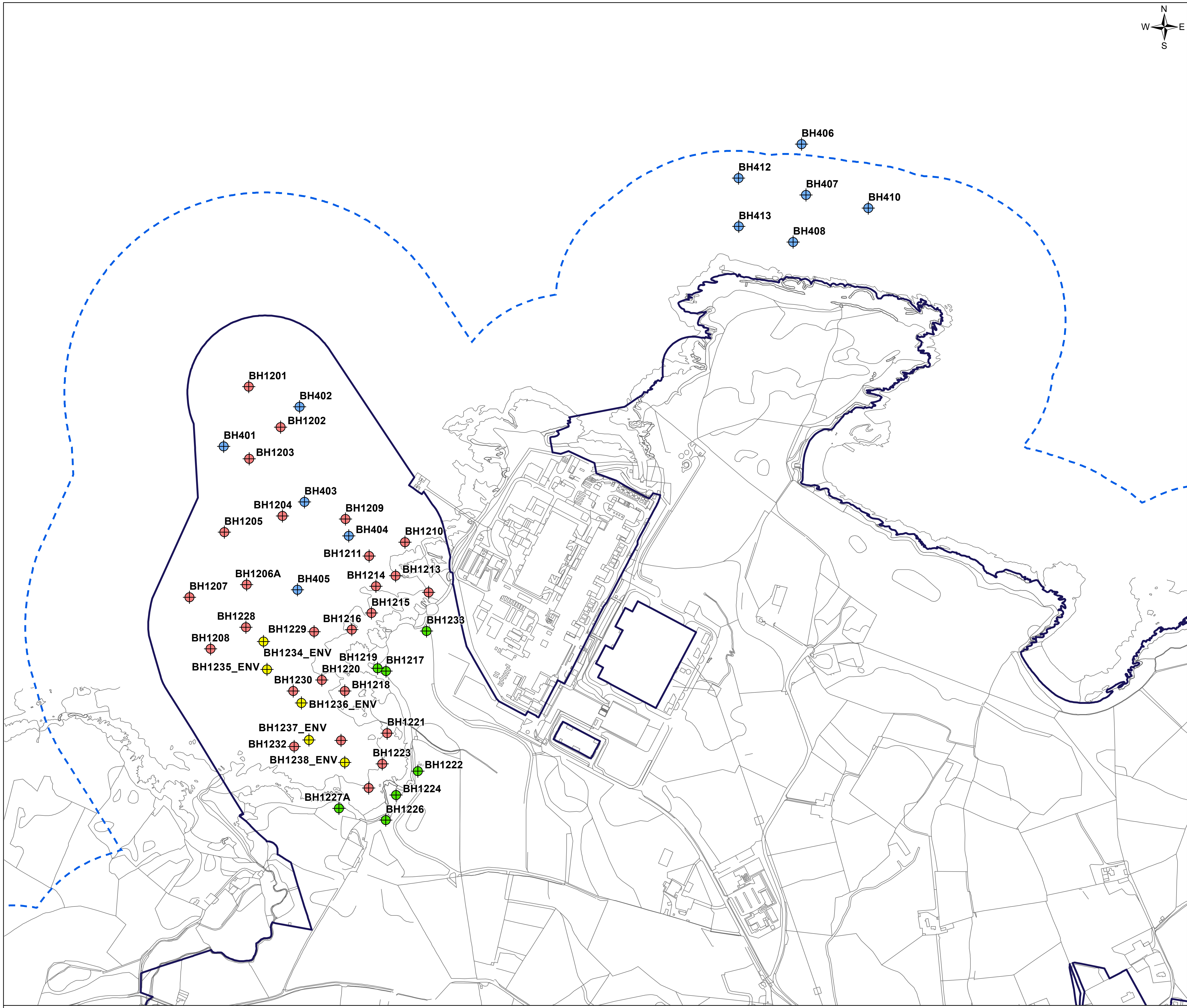
Drawing Title

PUBLISHED SUPERFICIAL GEOLOGY

Scale @ A3	1:15,000	DO NOT SCALE
Jacobs No.	60PO8077	
Client No.		
Drawing No.	60PO8077_DCO_BCR_15	

0 125 250 500 750 1,000 1,250 metres

FIGURE 16



Legend

- Wylfa Newydd Development Area
- Study area
- Intermediate Offshore Ground Investigation (IOffGI), 2011 - borehole
- Detailed Offshore Ground Investigation (DOffGI), 2017 – borehole (cable percussive and rotary cored)
- Detailed Offshore Ground Investigation (DOffGI), 2017 – borehole (cable percussive)
- Detailed Offshore Ground Investigation (DOffGI), 2017 – borehole (rotary cored)

Note:
The location of BH206 was not surveyed and thus it is not included on this figure. However, it is located approximately 25m to the northwest of BH1206A (Fugro, 2017).

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HORIZON NUCLEAR POWER

Project
WYLFA NEWYDD PROPOSED NUCLEAR POWER STATION
BASELINE CONDITIONS REPORT

Drawing Title
EXPLORATORY HOLE LOCATION PLAN: IOffGI AND DOffGI

Scale @ A3	1:7,500	DO NOT SCALE
Jacobs No.	60PO8077	
Client No.		
Drawing No.	60PO8077_DCO_BCR_16	

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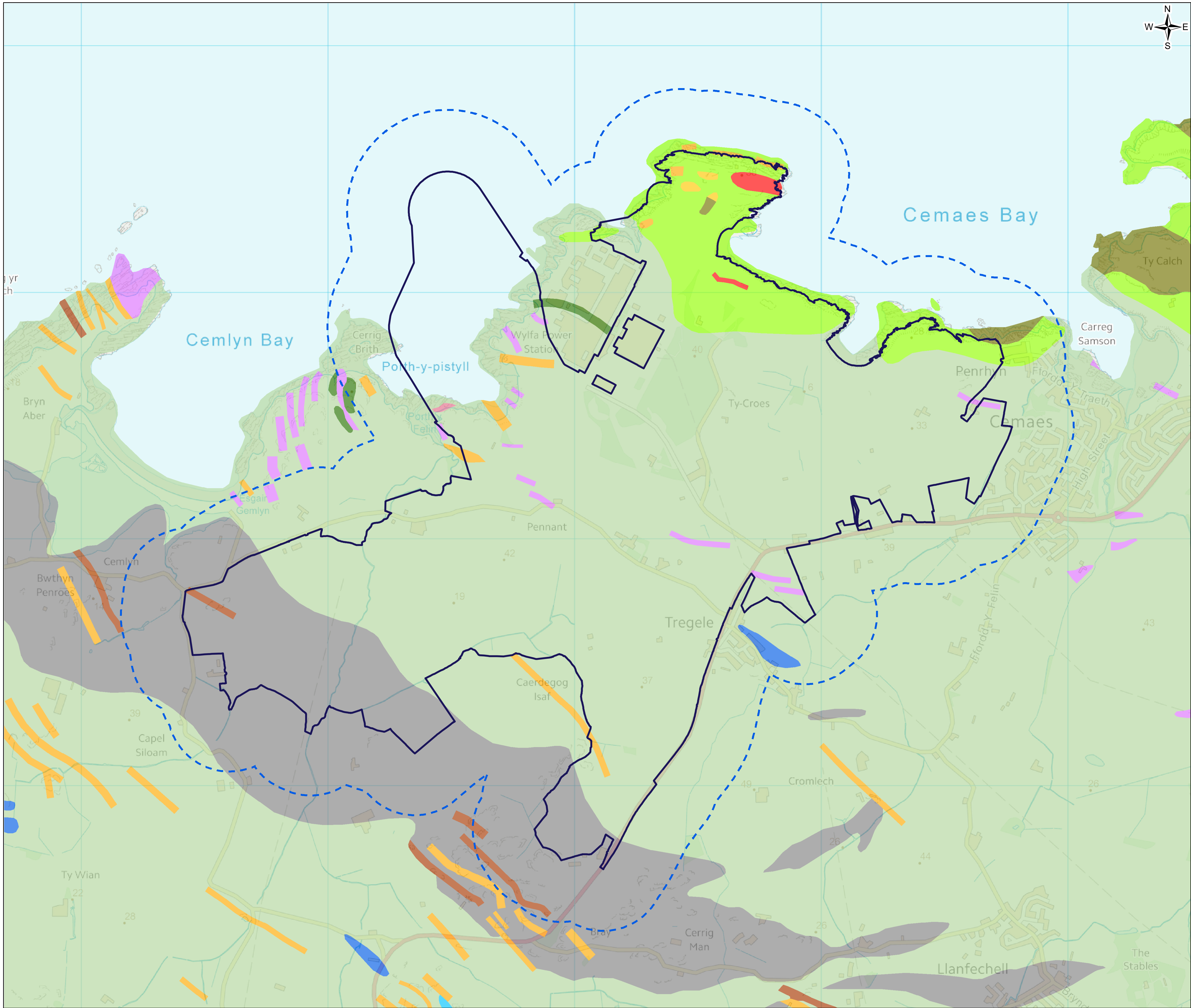
FIGURE 17



Legend

- Wylfa Newydd Development Area
- Study area

Published bedrock geology

- Old Red Sandstone Supergroup - sandstone
- Central Anglesey Shear Zone and Berw Shear Zone (undifferentiated) - schist, glaucophane
- Church Bay Tuffs and Skerries Grits (undifferentiated) - tuff and sandstone
- Gwna Group - metabasaltic-rock
- Gwna Group - quartzite
- Gwna Group - schist
- New Harbour Group - calc-silicate rock
- New Harbour Group - jasper
- New Harbour Group - lava
- New Harbour Group - mica schist and psammite
- Unnamed igneous intrusion of unknown age - felsite
- Unnamed igneous intrusion of unknown age - gabbro, microgabbro and diorite
- Unnamed igneous intrusion of unknown age - serpentinite

Source:
Data obtained from the British Geological Survey.

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HORIZON NUCLEAR POWER

Project

WYLFA NEWYDD PROPOSED NUCLEAR POWER STATION
BASELINE CONDITIONS REPORT

Drawing Title

PUBLISHED BEDROCK GEOLOGY

Scale @ A3	1:15,000	DO NOT SCALE
Jacobs No.	60PO8077	
Client No.		
Drawing No.	60PO8077_DCO_BCR_17	

0 125 250 500 750 1,000 1,250 metres

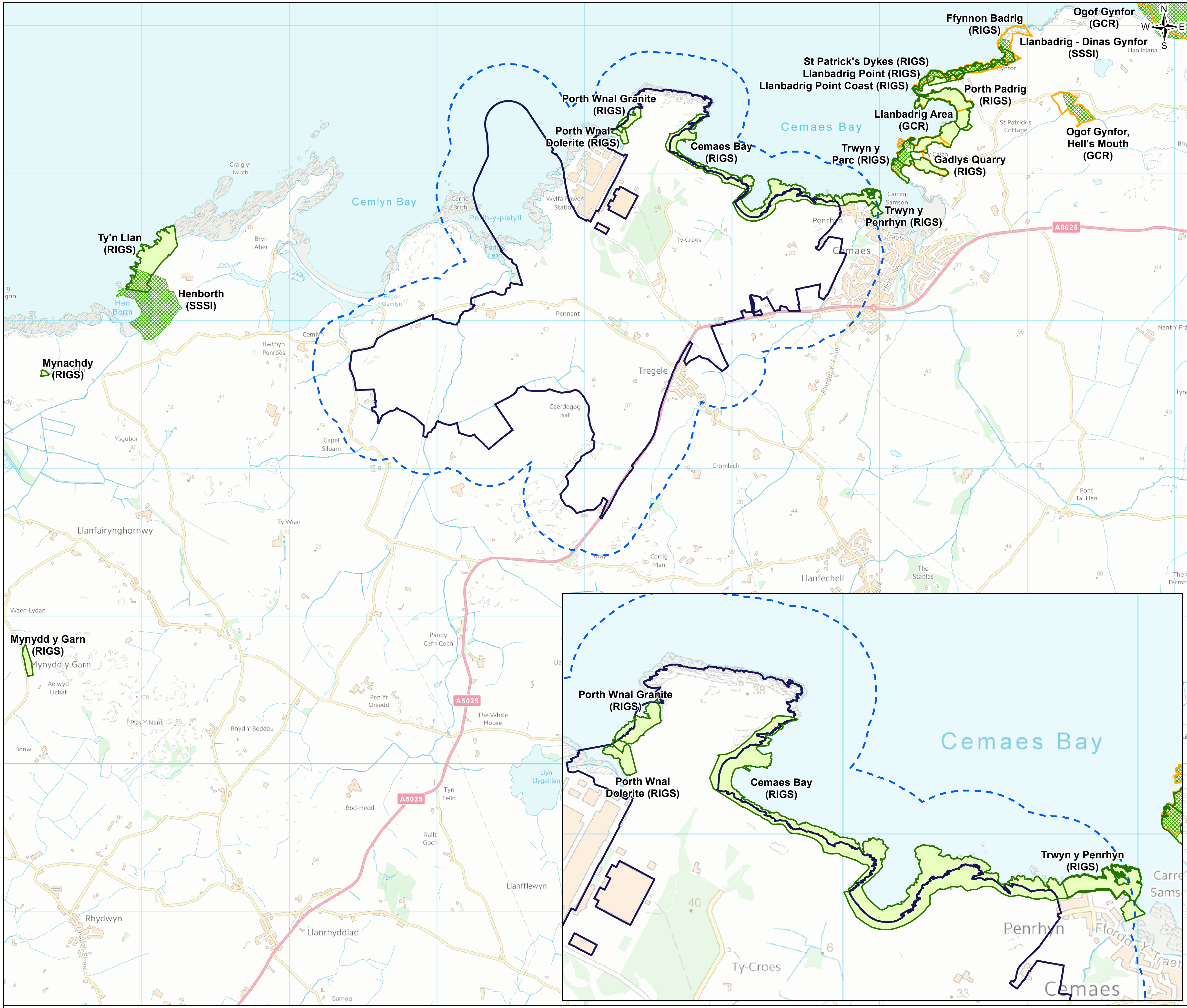
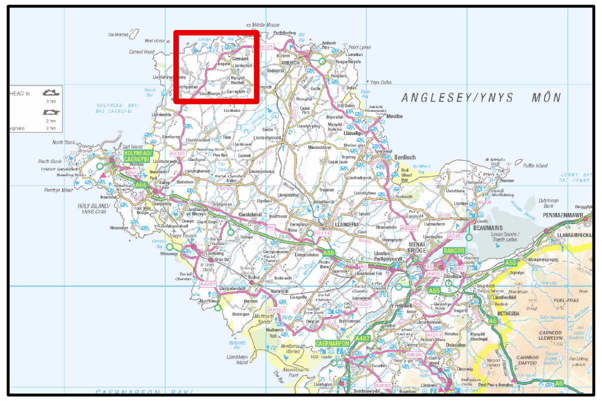


FIGURE 18

Legend

- Wylfa Newydd Development Area
- Study area
- Geological Site of Special Scientific Interest (SSSI)
- Regionally Important Geodiversity Site (RIGS)
- Geological Conservation Review (GCR) site



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HORIZON NUCLEAR POWER

Project

WYLFA NEWYDD PROPOSED NUCLEAR POWER STATION
BASELINE CONDITIONS REPORT

Drawing Title

DESIGNATED SITES OF GEOLOGICAL IMPORTANCE

Scale @ A3	1:25,000	DO NOT SCALE
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Client No.		
Drawing No.	60PO8077_DCO_BCR_18	

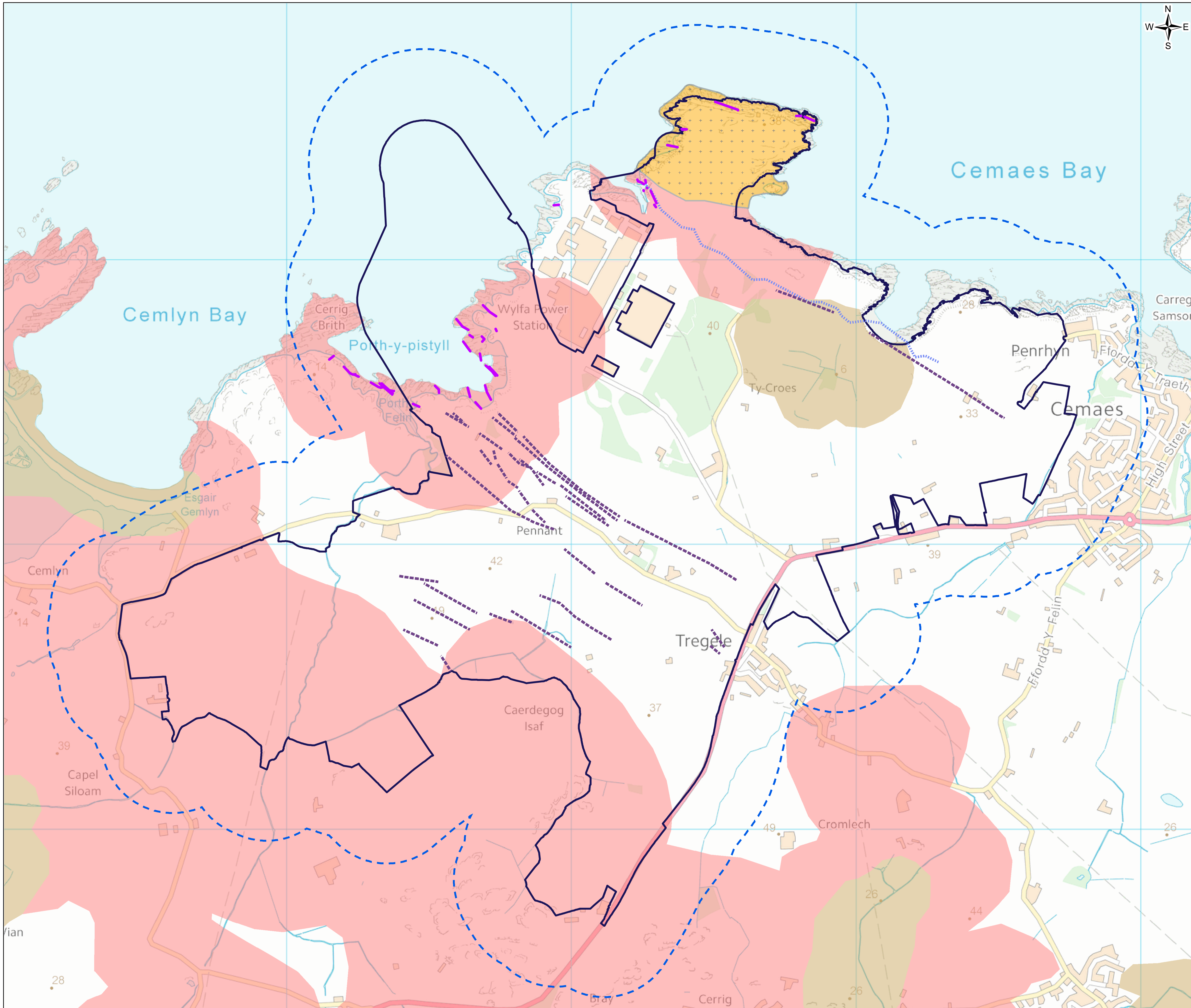

FIGURE 19

Legend

- Wylfa Newydd Development Area
- Study area
- Palaeozoic intrusions
- Coastal exposures of palaeozoic intrusions
- Tertiary intrusions

Category 2 Aggregates Safeguarding Areas

- Sand and gravel
- Sandstone (stipple denotes quartzitic sandstone with potential for silica sand and silica rock)
- Igneous rocks

Source of Aggregates Safeguarding Areas:
BGS and Welsh Government (2012) *North West Wales Aggregate Safeguarding Map*

Notes:
The locations of the intrusions have been sourced and reproduced from Halcrow (2012b) and Atkins (2015); refer to the soils and geology Baseline Conditions Report (Appendix D7-1) for more details.

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HORIZON NUCLEAR POWER

Project

WYLFA NEWYDD PROPOSED NUCLEAR POWER STATION
BASELINE CONDITIONS REPORT

Drawing Title

AGGREGATES SAFEGUARDING AREAS
WITH IGNEOUS INTRUSIONS

Scale @ A3	1:13,000	DO NOT SCALE
Jacobs No.	60PO8077	
Client No.		
Drawing No.	60PO8077_DCO_BCR_19	

0 125 250 500 750 1,000 1,250 metres

Appendix A. National Soil Resources Institute Report

National Soil Resources Institute

Soils Site Report

Full Soil Report

National Grid Reference: SH3591792942

Easting: 235917

Northing: 392942

Site Area: 5km x 5km

Prepared by
authorised user:

Joanne Jeffreys

Jacobs

2 March 2015

Citations

Citations to this report should be made as follows:

National Soil Resources Institute (2015) Full Soils Site Report for location 235917E, 392942N, 5km x 5km, National Soil Resources Institute, Cranfield University. Accessed via https://www.landis.org.uk/sitereporter/.

Disclaimer

About this report

This Soils Site Report identifies and describes the properties and capacities of the soil at your specified location as recorded in the 1:250,000 scale National Soil Map for England and Wales. It has been produced by Cranfield University's National Soil Resources Institute.

The National Soil Map represents the most accurate comprehensive source of information about the soil at the national coverage in England and Wales. It maps the distribution of soil mapping units (termed soil associations) which are defined in terms of the main soil types (or soil series) that were recorded for each soil association during field soil survey. Each soil association is named after its principal soil series and these bear the location name from where they were first described (e.g. Windsor). Each of these soil associations have differing environmental characteristics (physical, chemical and biological) and it is by mapping these properties that the range of thematic maps in this report have been produced.

Soil types and properties vary locally, as well as at the landscape scale. It is not possible to identify precisely the soil conditions at a specific location without first making a site visit. We have therefore provided you with information about the range of soil types we have identified at and around your selected location. Schematic diagrams are also provided to aid accurate identification of the soil series at your site.

Whilst an eight-figure national grid reference should be accurate to within 100m, a single rural Postcode can cover a relatively large geographical area. Postcodes can therefore be a less precise basis for specifying a location. The maps indicate the bounded area the reports relate to.

Your Soils Site Report will enable you to:

- identify the soils most likely to be present at and immediately around your specified location;
- understand the patterns of soil variation around your location and how these correlate with changes in landscape;
- identify the nature and properties of each soil type present within the area;
- understand the relevant capacities and limitations of each of the soils and how these might impact on a range of factors such as surface water quality.

For more information visit www.landis.org.uk/reports

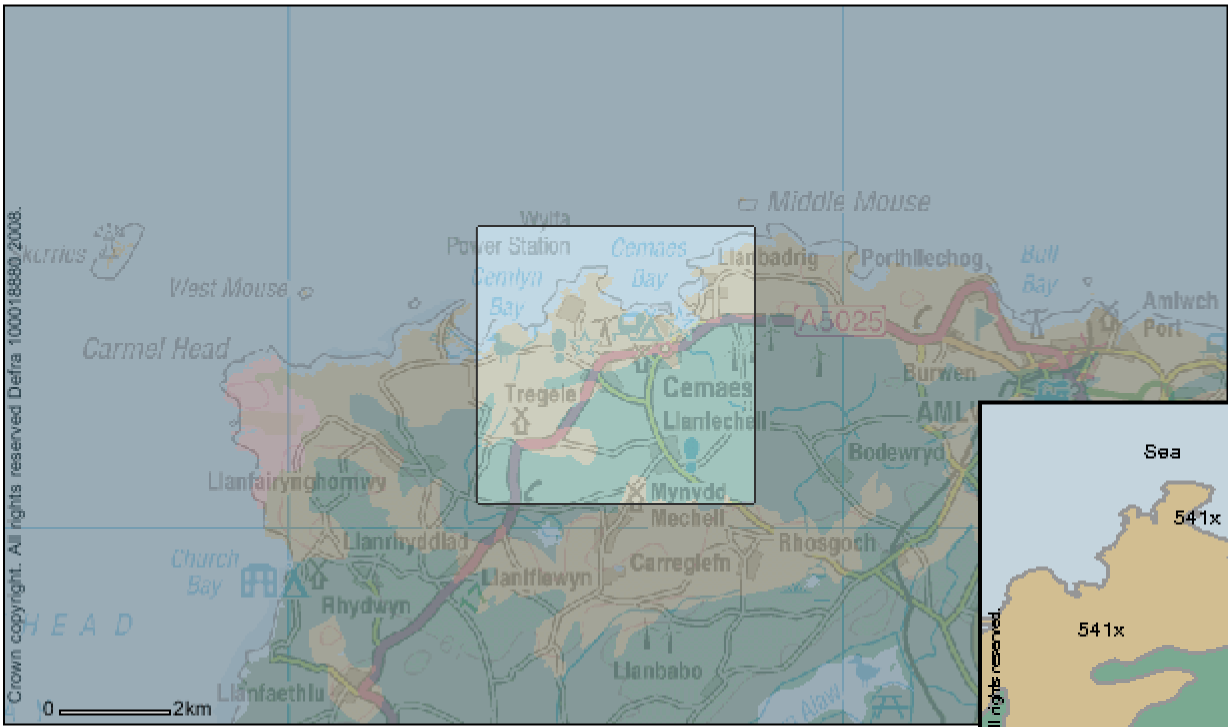
Table of Contents

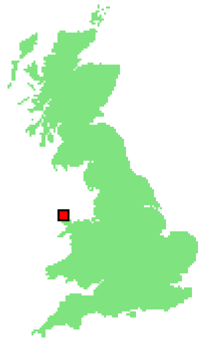
1. SOIL THEMATIC MAPS

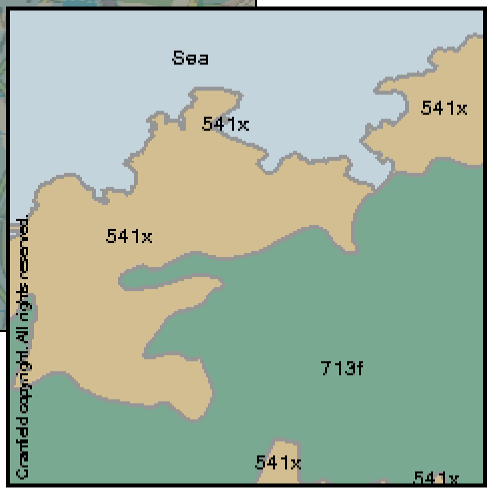
This section contains a series of maps of the area surrounding your selected location, based on the 1:250,000 scale National Soil Map, presenting a number of thematic maps relating to the characteristics of the soils. These provide an overview of the nature and condition of the local soil conditions. It is these conditions that may be used to infer the response of an area to certain events (with the soil as a receptor), such as pollution contamination from a chemical spill, or an inappropriate pesticide application and the likelihood of these materials passing though the soil to groundwater. Other assessments provide an insight into the way a location may impact, by corrosive attack or ground movement, upon structures or assets within the ground, for example building or engineering foundations or pipes and street furniture.

Soil is a dynamic environment with many intersecting processes, chemical, physical and biological at play. Even soils 'sealed' over by concrete and bitumen are not completely dormant. The way soils respond to events and actions can vary considerably according to the properties of the soil as well as other related factors such as land-use, vegetation, topography and climate. There are many threats facing our national soil resource today and forthcoming legislation such as the proposed Soil Framework Directive (SFD) (COM(2006) 232) will seek to identify measures aimed towards soil protection and ensuring the usage of soils in the most sustainable way. This report is therefore a useful snapshot of the soil properties for your given area, providing a summary of a broad range of ground conditions.

1a. SOILS - SPATIAL DISTRIBUTION







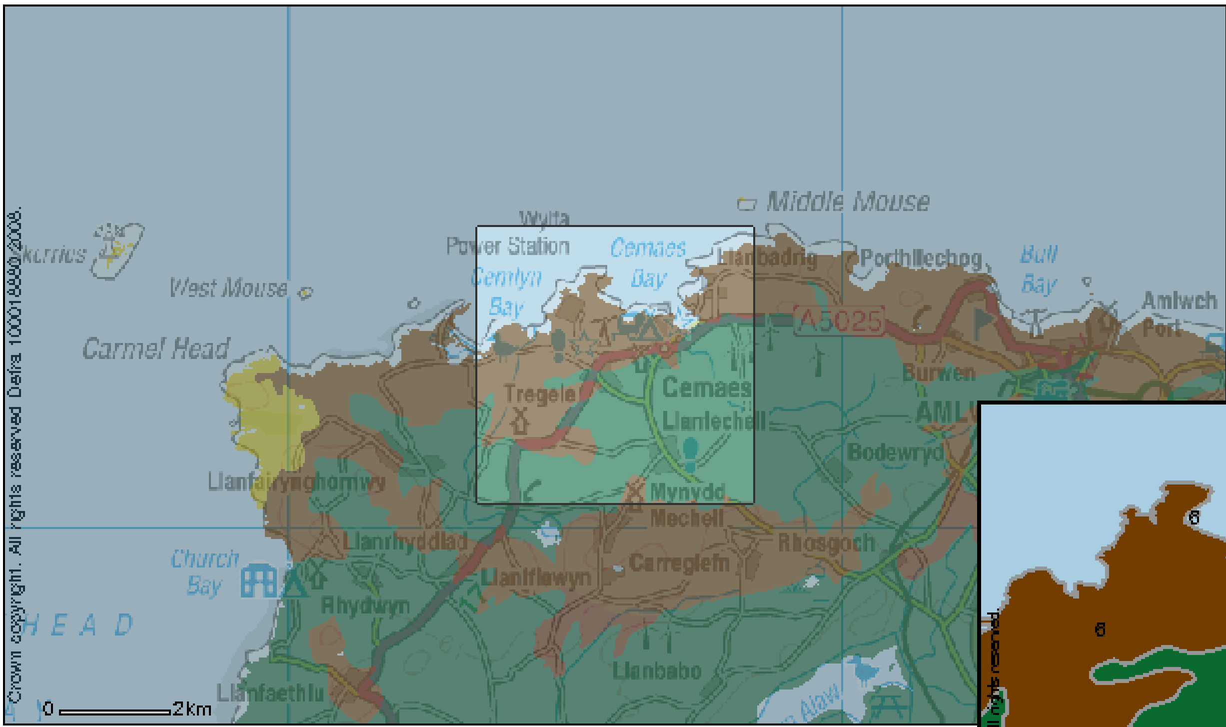
SOIL ASSOCIATION MAP UNIT KEY

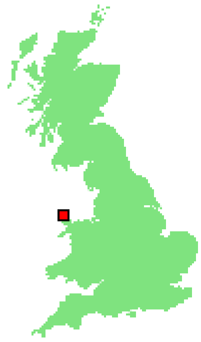
EAST KESWICK 1 541x
Deep well drained fine loamy soils and similar soils with slowly permeable subsoils and slight seasonal waterlogging.

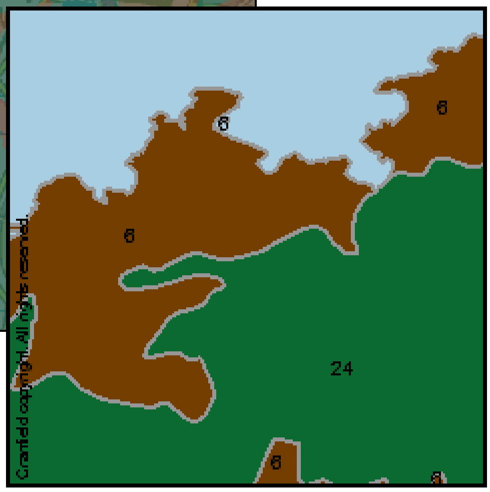
BRICKFIELD 2 713f
Slowly permeable seasonally waterlogged fine loamy soils.

Soil associations represent a group of soil series (soil types) which are typically found occurring together, associated in the landscape (Avery, 1973; 1980; Clayden and Hollis, 1984). Soil associations may occur in many geographical locations around the country where the environmental conditions are comparable. For each of these soil associations, a collection of soil types (or soil series) are recorded together with their approximate proportions within the association. Soil associations have codes as well as textual names, thus code ‘554a’ refers to the ‘Frilford’ association. Where a code is prefixed with ‘U’, the area is predominantly urbanised (e.g. ‘U571v’). The soil associations for your location, as mapped above, are described in more detail in Section 2: Soil Association Descriptions.

1b. HYDROLOGY OF SOIL TYPE (HOST)







HYDROLOGY OF SOIL TYPE KEY

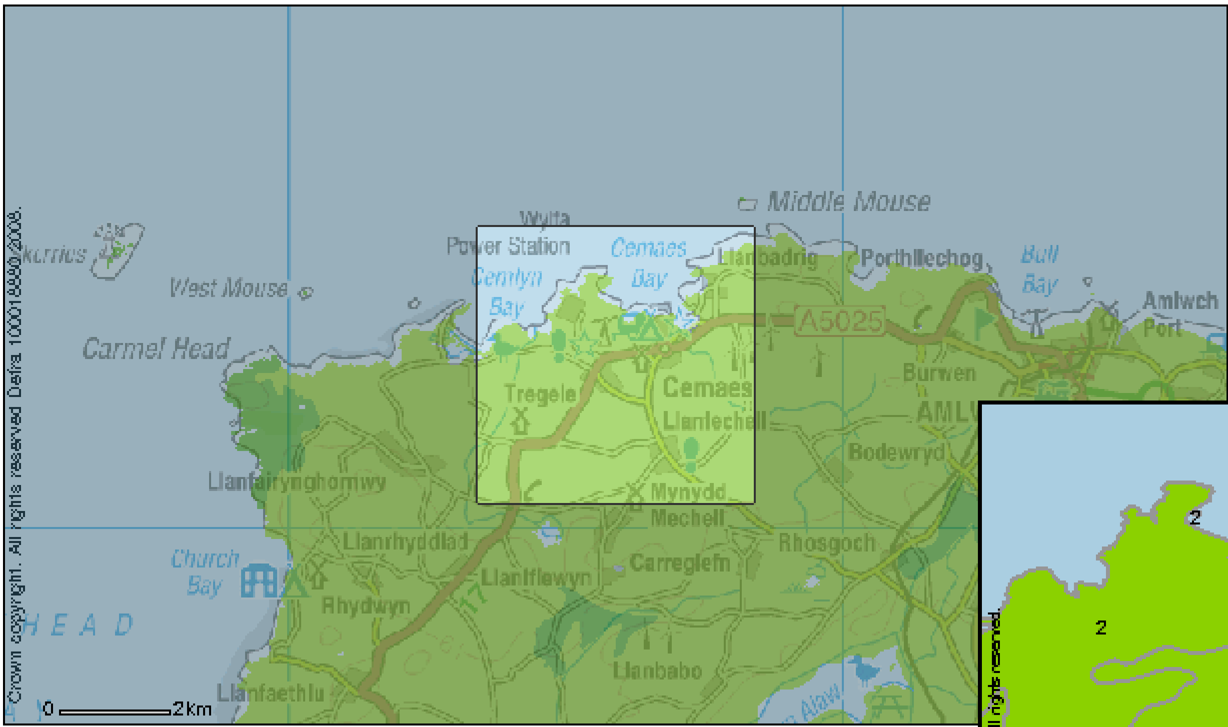
24 - *Slowly permeable, seasonally waterlogged soils over slowly permeable substrates with negligible storage capacity*

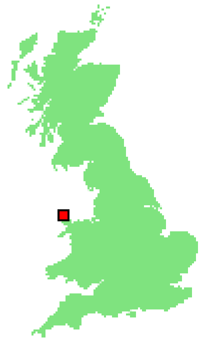
6 - *Free draining permeable soils in unconsolidated loams or clays with low permeability and storage capacity*

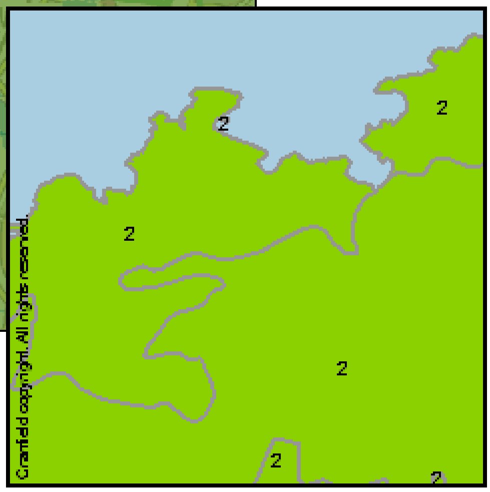
HOST CLASS DESCRIPTION

The Hydrology of Soil Types (HOST) classification describes the dominant pathways of water movement through the soil and, where appropriate, the underlying substrate. Eleven drainage models are defined according to the permeability of the soil and its substrate and the depth to a groundwater table, where one is present (Boorman et al,1995). These are further subdivided into 29 HOST classes to which all soil series have been assigned. These classes identify the way soil water flows are partitioned, with water passing over, laterally through, or vertically down the soil column. Analysis of the river hydrograph and the extent of soil series for several hundred gauged catchments allowed mean values for catchment hydrological variables to be identified for each HOST class, The HOST classification is widely used to predict river flows and the frequency and severity of flood events and also to model the behaviour of diffuse pollutants (Hollis et al, 1995).

1c. GROUND MOVEMENT POTENTIAL







GROUND MOVEMENT POTENTIAL KEY

- 1 - *Very low*
- 2 - *Low*
- 3 - *Moderate*
- 4 - *High*
- 5 - *Very high*

* If a High class is starred, a 'Very High' ground movement potential is likely to be achieved if these soils are drained to an effective depth of at least two metres.

GROUND MOVEMENT POTENTIAL DESCRIPTION

Clay-related ground movement is the most widespread cause of foundation failure in the UK and is linked to seasonal swelling and shrinkage of the clay. The content of clay within the soils of your selected area has therefore a direct bearing upon the likelihood of ground movement.

Among the inorganic particles that constitute the solid component of any soil, clay particles are the smallest and defined as being <0.002 mm - equivalent spherical diameter (esd) in size. Clay particles occur in most kinds of soil but they only begin to exert a predominant influence on the behaviour of the whole soil where there is more than 35 per cent (by weight) of clay-sized material present.

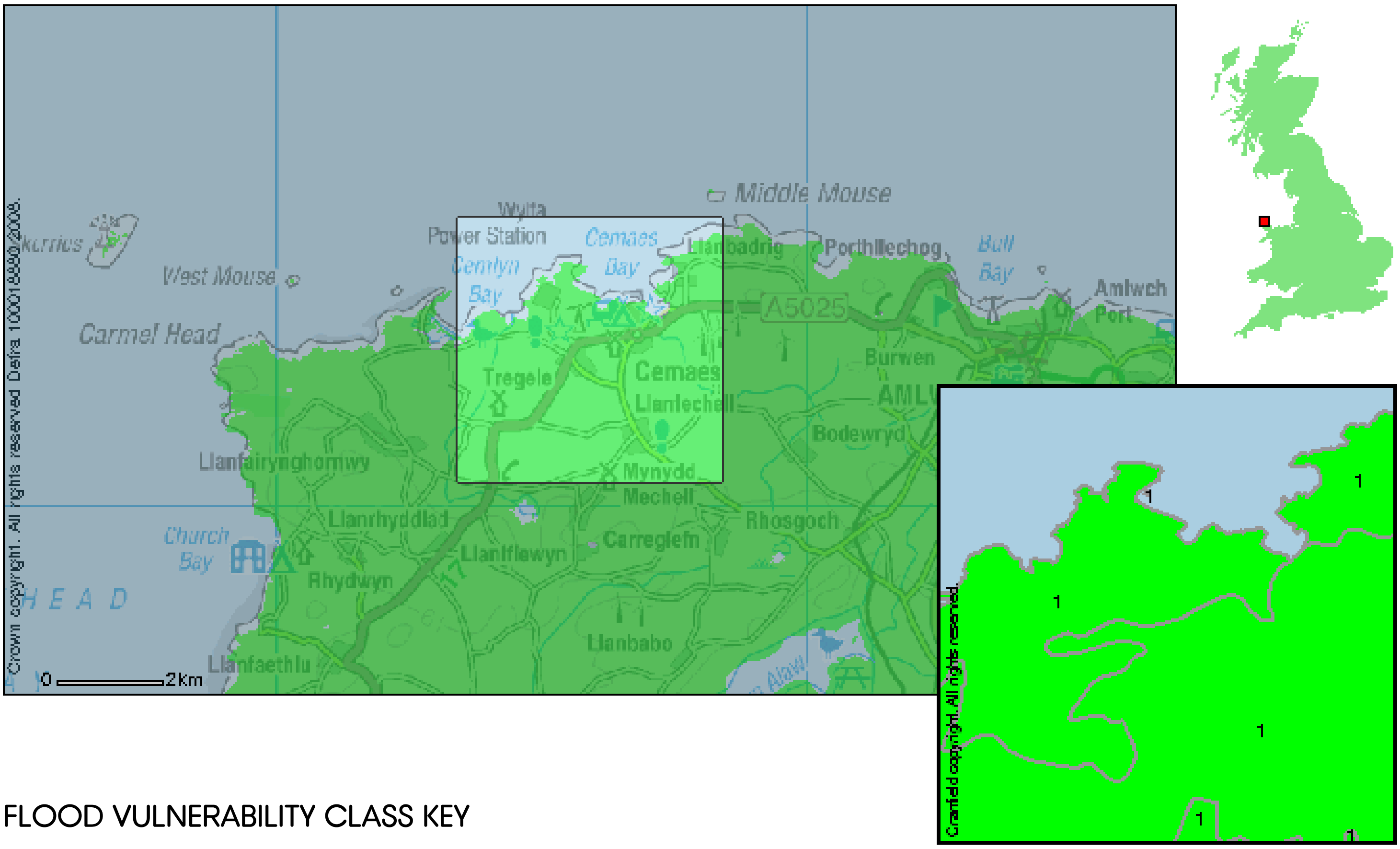
Because clay particles are very small and commonly platy in shape they have an immense surface area onto which water can be attracted, relative to the total volume of the soil material. In addition to surface attraction or inter-crystalline absorption of water, some clay minerals, those with three layers of atoms (most other kinds of clay have only two layers of atoms) are able to absorb and hold additional water between these layers. It is these types of clay mineral, which are widespread in British soils and commonly known as *smectites* that have the greatest capacity to shrink and swell.

In a natural undisturbed condition, the moisture content of deep subsoil clay does not change greatly through the year and consequently there are no changes in volume leading to shrinkage and swelling. However, when clays are exposed at or near the ground surface and especially when vegetation is rooting in them seasonal moisture and volume changes can be dramatic. Plants and trees transpire moisture from the soil to support their growth and transfer necessary nutrients into their structures. Surface evaporation also takes place from soil and plant structures, and the combination of evaporation from surfaces and transpiration by plants and trees is termed *evapotranspiration*. Thus, the layer of soil material down to 2m depth into which plants will root is critical when assessing the vulnerability of land to subsidence.

Whenever soil moisture is continuously being replenished by rainfall, the soil moisture reserves will be unaffected by the removal of moisture by plants as there is no net loss. However, in many parts of Britain, particularly in the south and east, summer rainfall is small and is exceeded by evapotranspiration. Water reserves are then not sufficiently replenished by rainfall and so a soil moisture deficit develops. The water removed from a clayey soil by evapotranspiration leads to a reduction in soil volume and the consequent shrinkage causes stress in the soil materials leading in turn to stress on building foundations that are resting in the soil (Hallett, et al, 1994).

The foundations themselves may then move and thus cause damage to building structures. This problem can be exacerbated by the fact that the soil beneath the structure may not dry out uniformly, so that any lateral pressure exerted on the building foundation is made effectively greater. This assessment identifies the likelihood of soil conditions being prone to ground movement given these other factors.

1d. FLOOD VULNERABILITY



FLOOD VULNERABILITY CLASS KEY

0 - *Major risk*

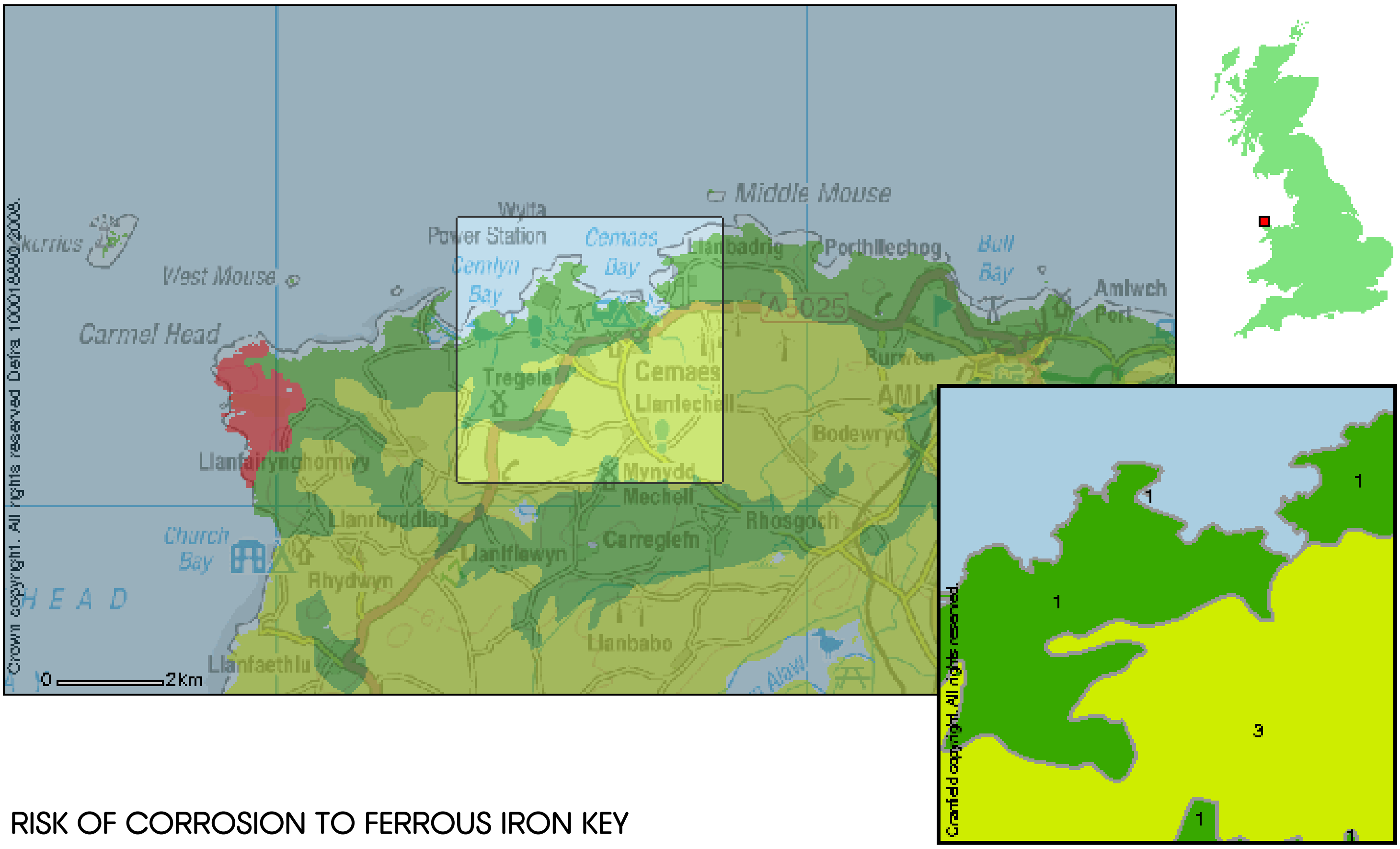
1 - *Minor risk*

FLOOD VULNERABILITY DESCRIPTION

The inundation of properties by flood water can occur in a number of circumstances. Surface run-off can collect on low-lying land from upslope following heavy rainfall. More commonly rivers, lakes and/or the sea extend beyond their normal limits as a result of prolonged or intense rainfall, unusually high tides and/or extreme wind events. Water damage to properties and their contents is compounded by the deposition of sediment suspended in the flood waters. The spatial distribution of such waterborne sediment (or alluvium as defined in soil science) is one basis upon which land that has been subject to historical flooding can be mapped, and this forms a basis for present-day flooding risk assessment.

Both riverine and marine alluvium are identified as distinct soil parent materials within the British soil classifications. Combining soil map units that are dominated by soil series developed in alluvium across Great Britain identifies most of the land that is vulnerable to flooding. This assessment does not account for man-made flood defence measures, showing instead the areas where once water has stood.

1e. RISK OF CORROSION TO FERROUS IRON



RISK OF CORROSION TO FERROUS IRON KEY

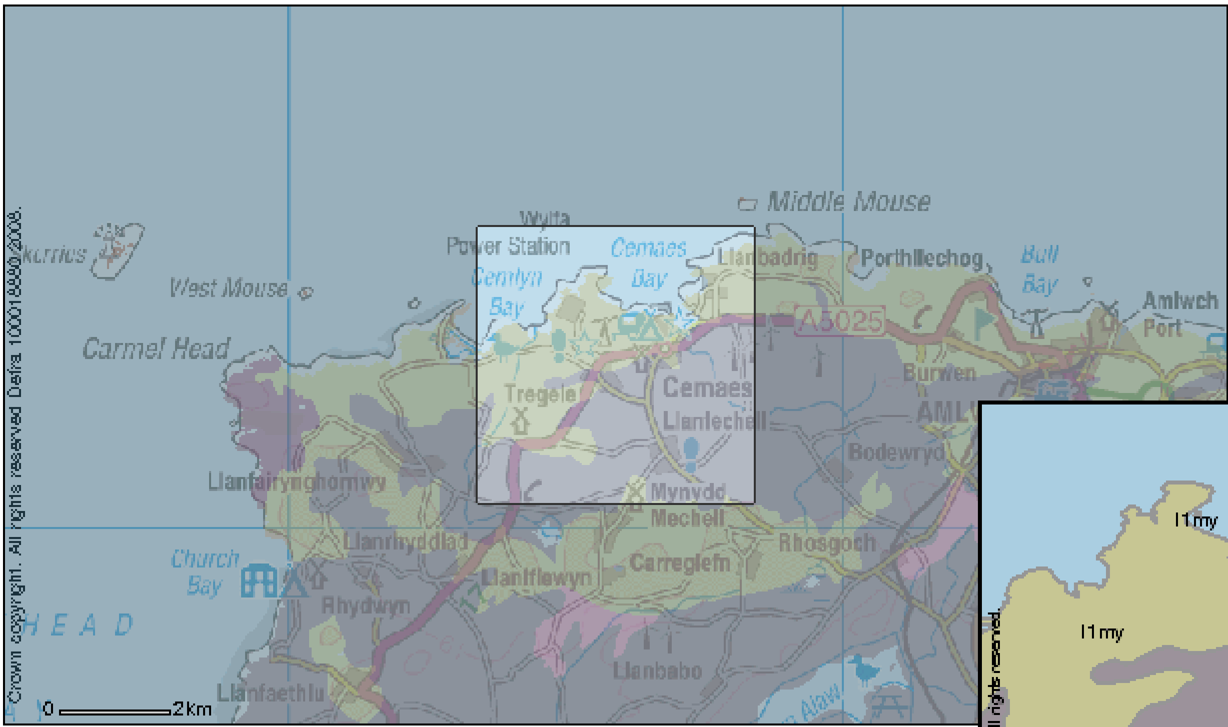
- 1 - *Non-aggressive*
- 2 - *Slightly Aggressive*
- 3 - *Moderately Aggressive*
- 4 - *Highly Aggressive*
- 5 - *Very highly Aggressive*
- 6 - *Impermeable Rock*

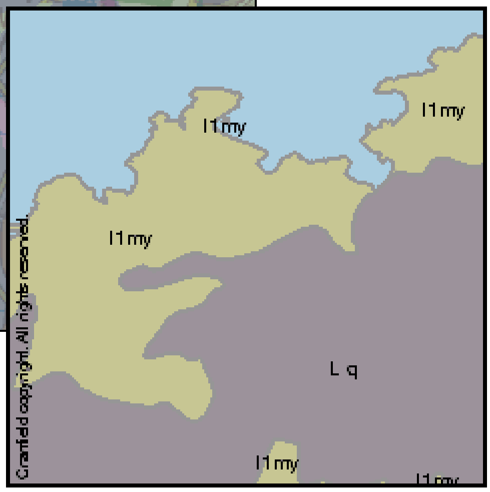
* If a class is starred, it is assumed that there are moderate amounts of sulphate in the soil. If there is abundant sulphate present, the soil may be one class more aggressive. Conversely, if there is very little sulphate, the soil may be one class less aggressive to buried ferrous iron.

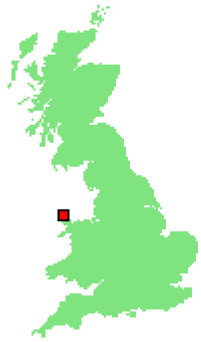
RISK OF CORROSION TO FERROUS IRON DESCRIPTION

Buried iron pipes and other infrastructure corrode at rates that are influenced by soil conditions (Jarvis and Hedges, 1994). Soil acidity, sulphide content, aeration and wetness all influence the corrosivity of the soil. These factors are used to map 5 major classes of relative corrosivity.

1f. PESTICIDE LEACHING RISK







PESTICIDE LEACHING CLASS KEY

I1my - *Deep loamy soil; groundwater at moderate depth*

L q - *Impermeable soils over soft substrates of low or negligible storage capacity that sometimes conceal groundwater bearing rocks at depth*

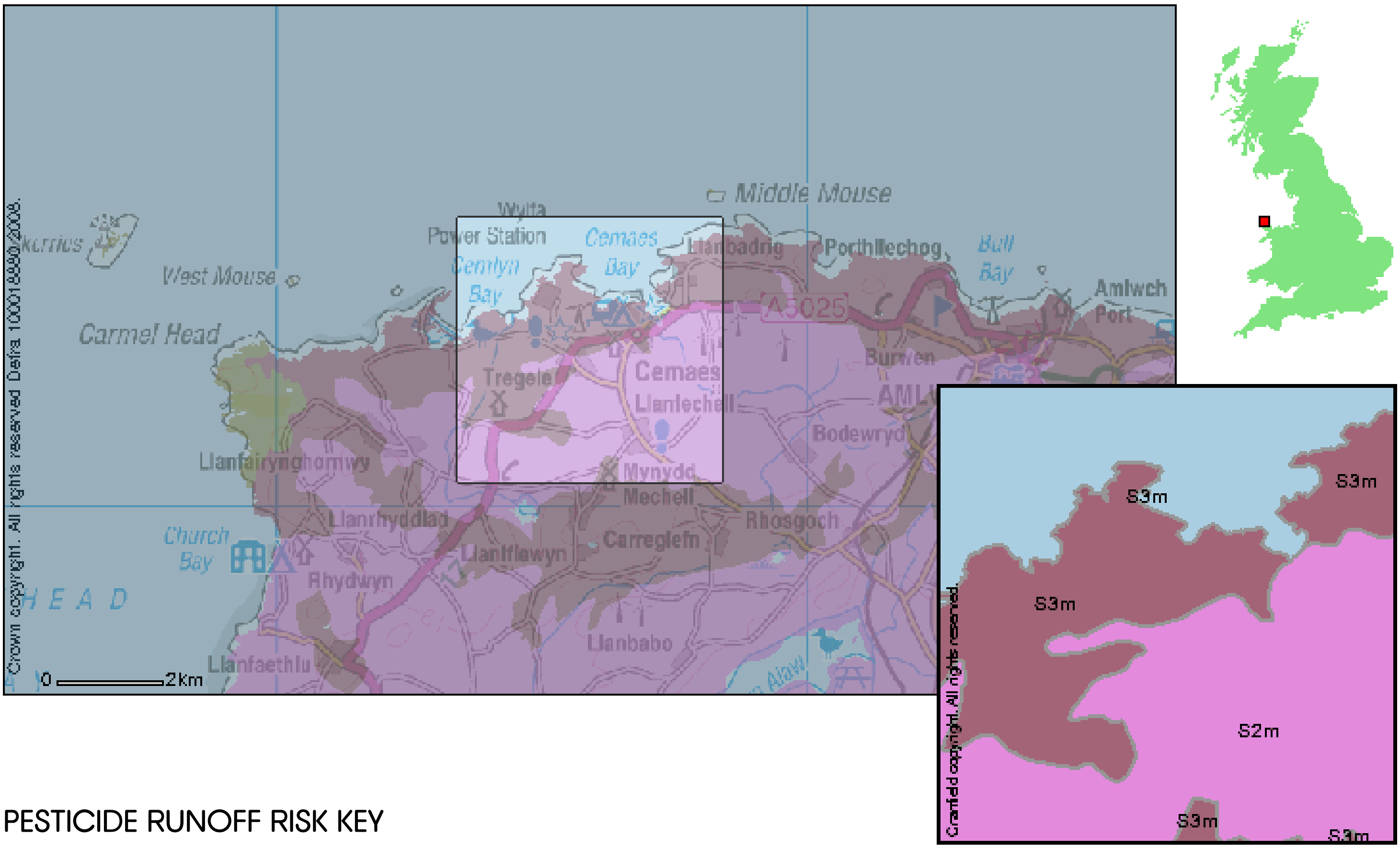
PESTICIDE LEACHING CLASS DESCRIPTION

The natural permeability and water regime of soils are influential in determining the fate and behaviour of pesticides applied to the crop and soil surface (Hollis et al, 1995). A system of vulnerability assessment was devised as part of the national system for Policy and Practice for the Protection of Groundwater. This divided soils into three primary vulnerability classes.

H - Soils of high leaching capacity with little ability to attenuate non-adsorbed pesticide leaching which leave underlying groundwater vulnerable to pesticide contamination.
I – Soils of intermediate leaching capacity with a moderate ability to attenuate pesticide leaching.
L - Soils of low leaching capacity through which pesticides are unlikely to leach.

The primary classes have been further subdivided into nearly forty subclasses. These subclasses, with their descriptions, are mapped above. These classes do not account for differences in land cultivation, which can also have a significant impact on pesticide behaviour.

1g. PESTICIDE RUNOFF RISK



PESTICIDE RUNOFF RISK KEY

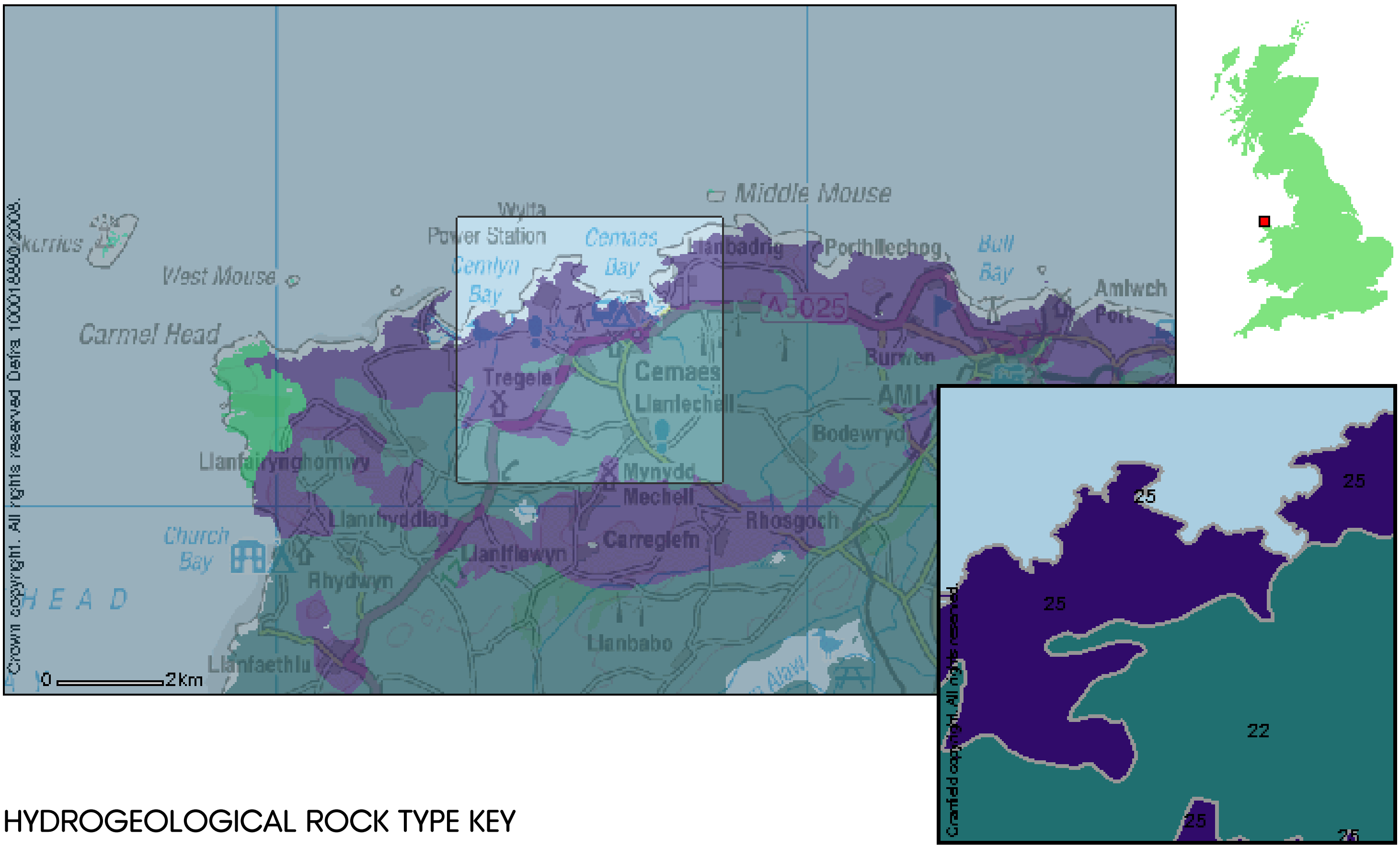
S2m - *Soils with high run-off potential but moderate adsorption potential*

S3m - *Soils with moderate run-off potential and moderate adsorption potential*

PESTICIDE RUNOFF RISK DESCRIPTION

The physical properties and natural water regime of soils influence the speed and extent of lateral water movement over and through the soil at different depths (Hollis et al, 1995). At as result, soils can be classed according to the potential for pesticide run-off. Five runoff potential classes are identified for mineral soils and a further two for peat soils. The mineral soil classes are further subdivided according to the potential for pesticide adsorption.

1h. HYDROGEOLOGICAL ROCK TYPE



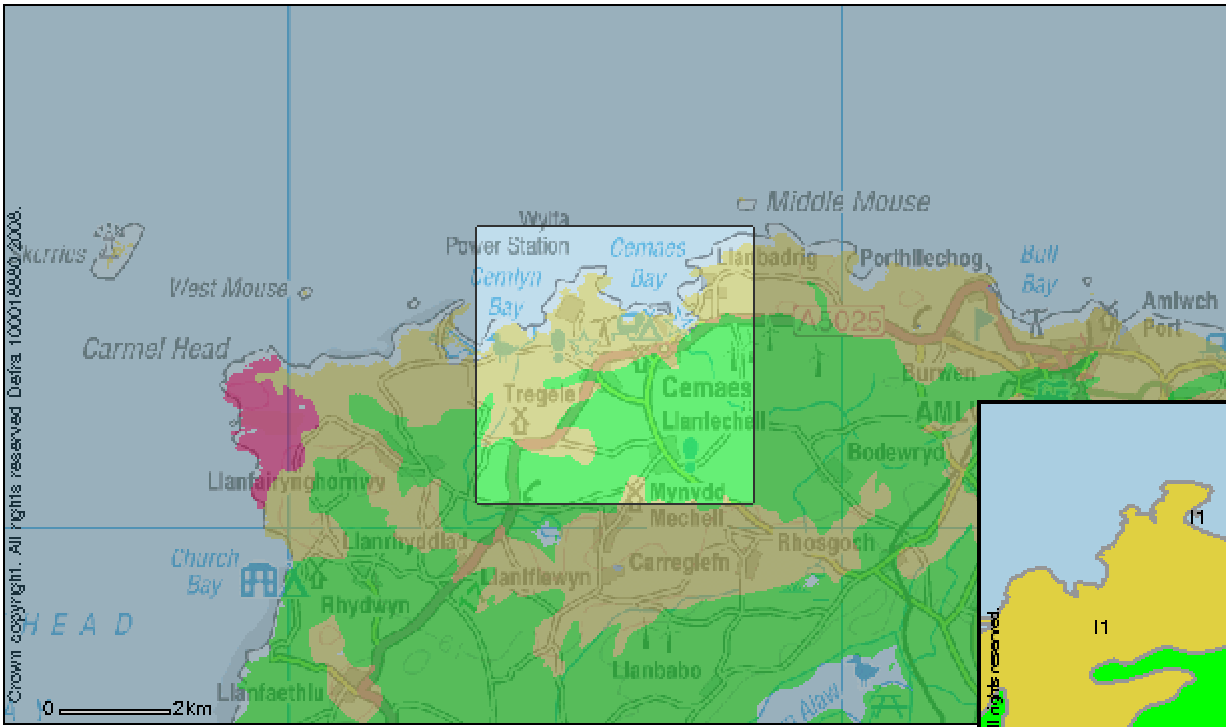
HYDROGEOLOGICAL ROCK TYPE KEY

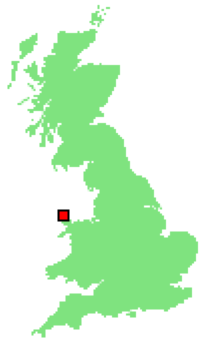
- 22 - *till and compact Head*
- 25 - *loamy drift*

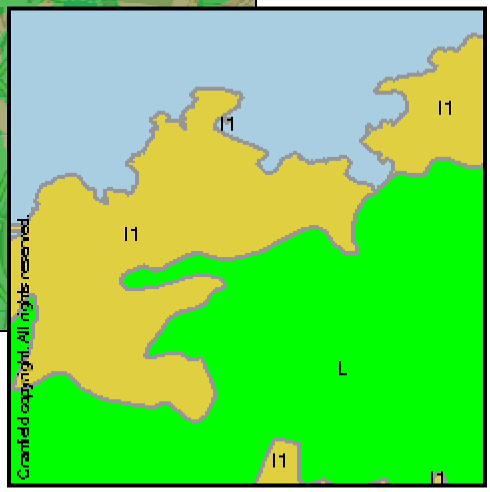
HYDROGEOLOGICAL ROCK TYPE DESCRIPTION

The hydrogeological classification of the soil parent materials provides a framework for distinguishing between soil substrates according to their general permeability and whether they are likely to overlie an aquifer. Every soil series has been assigned one of the 32 substrate classes and each of these is characterised according to its permeability (being characterised as permeable, slowly permeable or impermeable). For further information, see Boorman et al (1995).

1i. GROUND WATER PROTECTION POLICY (GWPP) LEACHING







GWPP LEACHING CLASS KEY

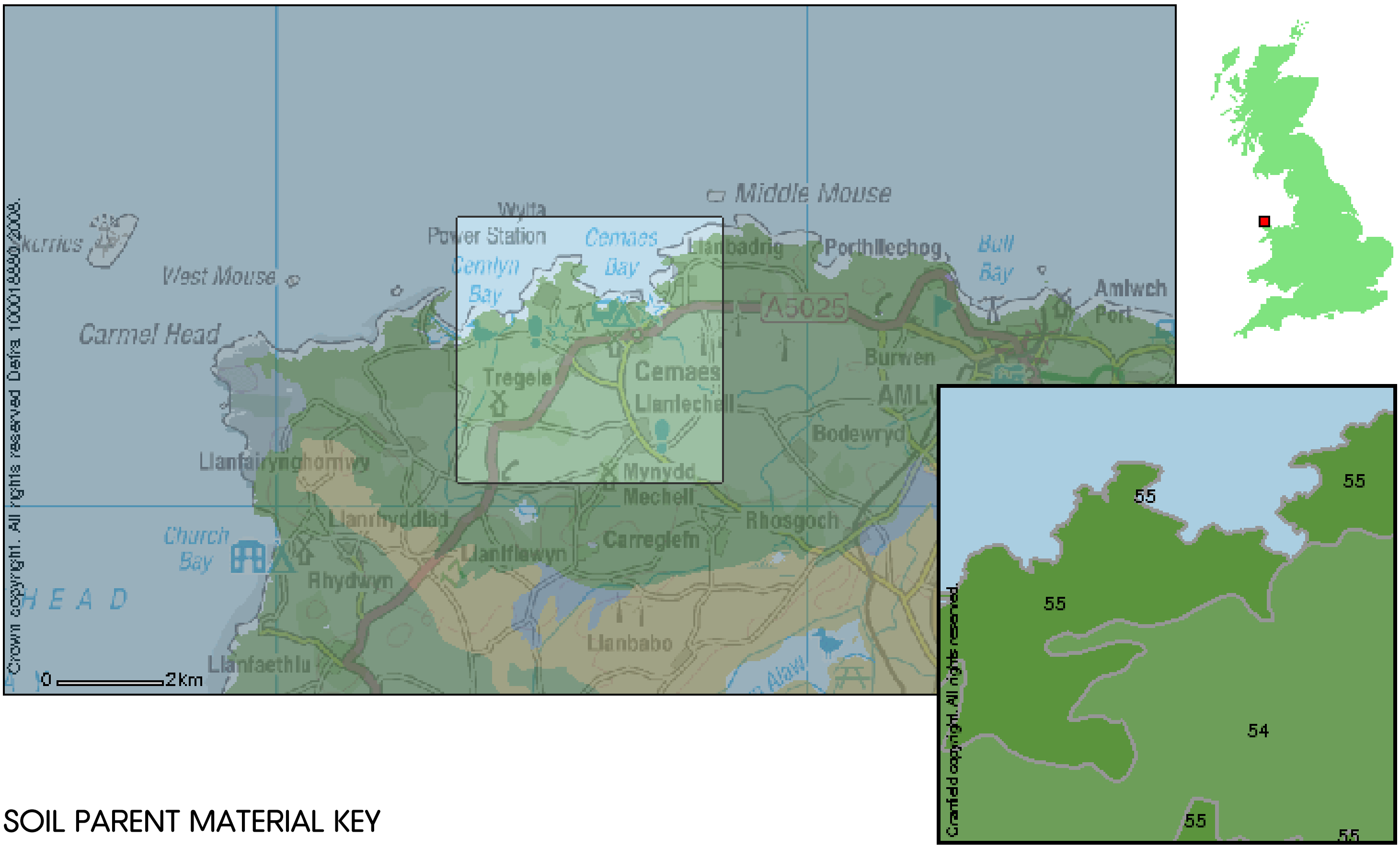
I1 - *Soils of intermediate leaching potential which have a moderate ability to attenuate a wide range of diffuse source pollutants but in which it is possible that some non-adsorbed diffuse source pollutants and liquid discharges could penetrate the soil layer*

L - *Soils in which pollutants are unlikely to penetrate the soil layer either because water movement is largely horizontal or because they have a large ability to attenuate diffuse source pollutants*

GWPP LEACHING CLASS DESCRIPTION

The Ground Water Protection Policy classes describe the leaching potential of pollutants through the soil (Hollis, 1991; Palmer et al, 1995). The likelihood of pollutants reaching ground water is described. Different classes of pollutants are described, including liquid discharges adsorbed and non-adsorbed pollutants.

1j. SOIL PARENT MATERIAL



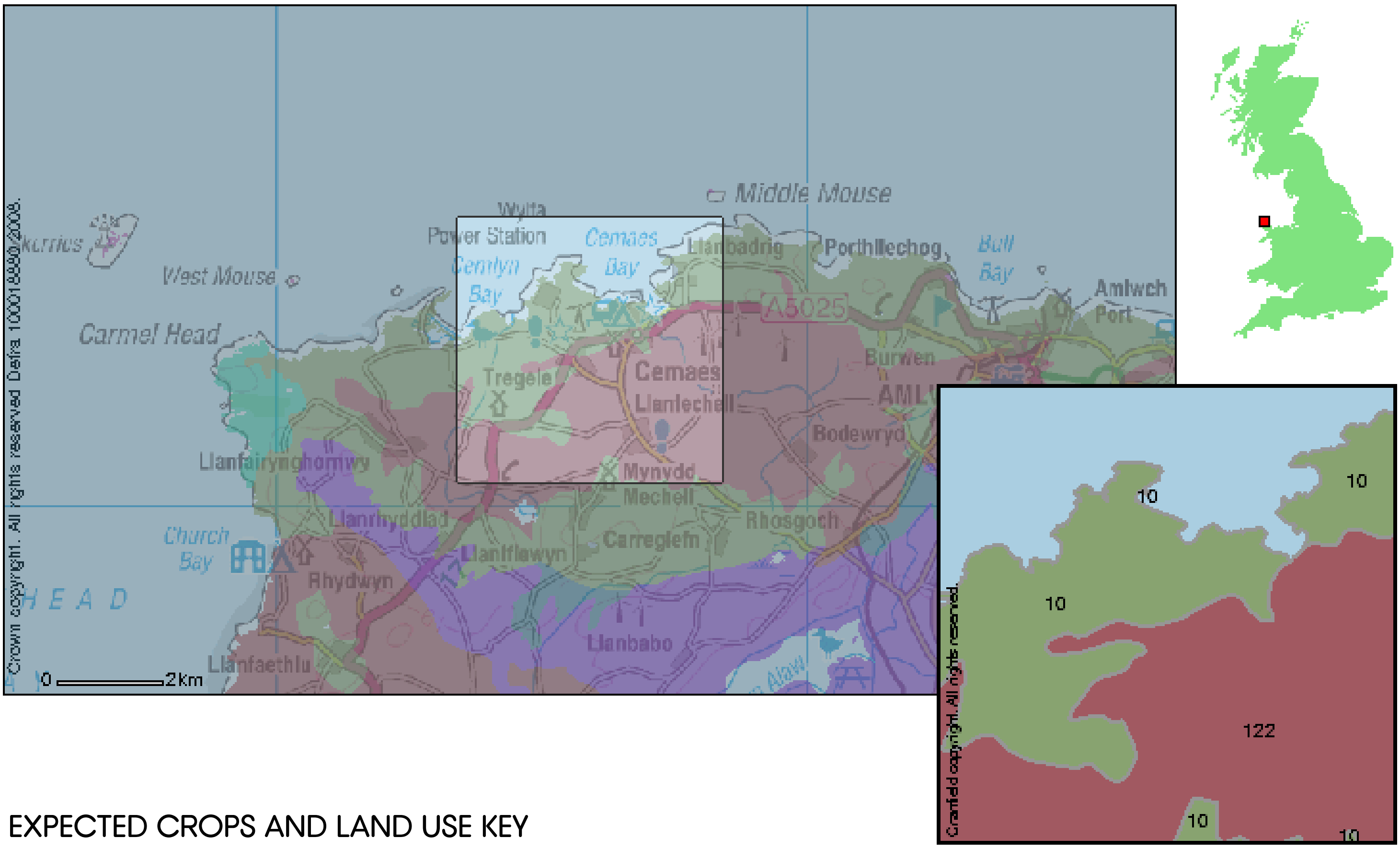
SOIL PARENT MATERIAL KEY

- 54 - *Drift from Palaeozoic and Mesozoic sandstone and shale*
- 55 - *Drift from Palaeozoic sandstone and shale*

SOIL PARENT MATERIAL DESCRIPTION

Along with the effects of climate, relief, organisms and time, the underlying geology or 'parent material' has a very strong influence on the development of the soils of England and Wales. Through weathering, rocks contribute inorganic mineral grains to the soils and thus exhibit control on the soil texture. During the course of the creation of the national soil map, soil surveyors noted the parent material underlying each soil in England and Wales. It is these general descriptions of the regional geology which is provided in this map.

1k. EXPECTED CROPS AND LAND USE



EXPECTED CROPS AND LAND USE KEY

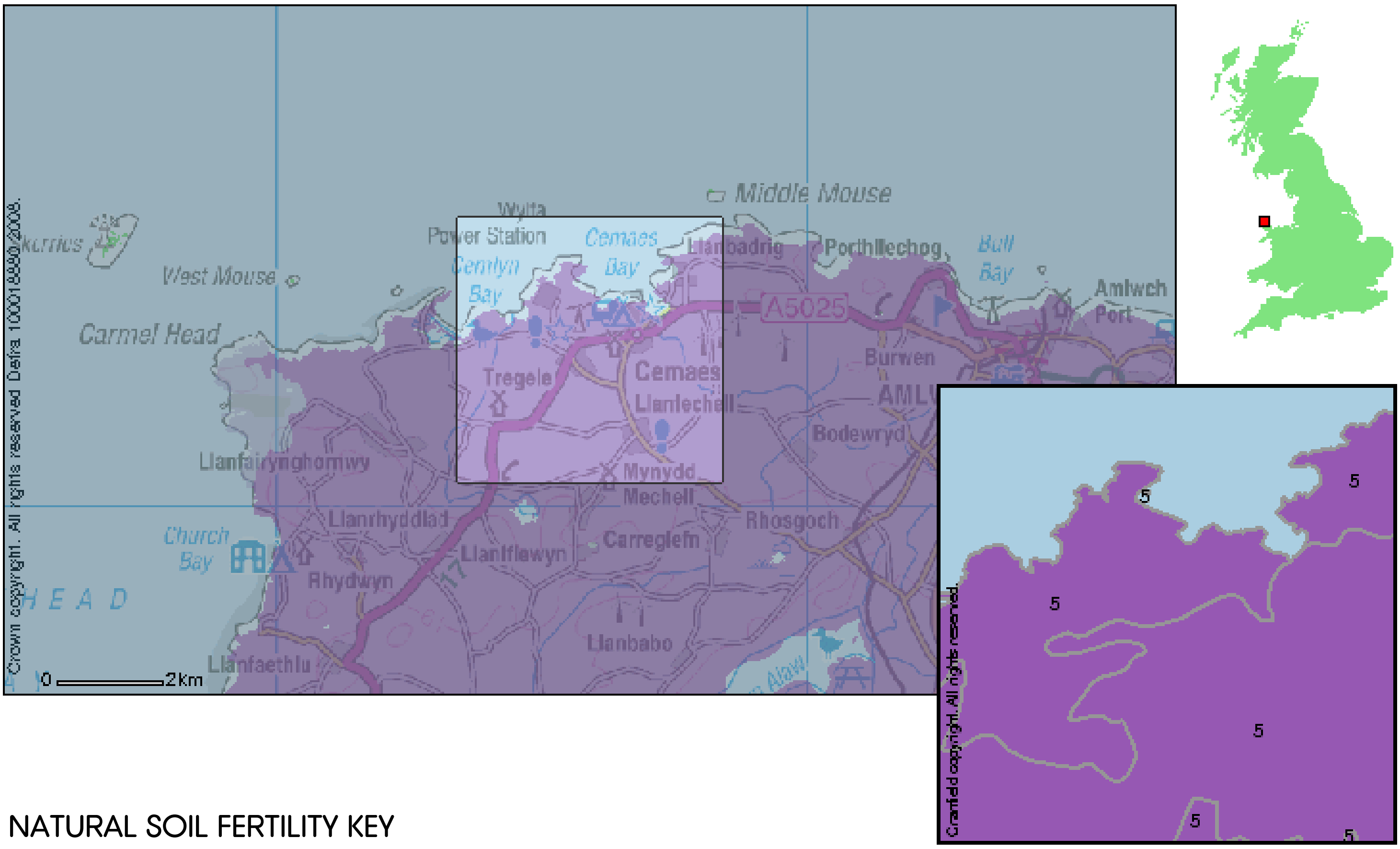
10 - *Cereals and grassland in the Northern Region; stock rearing on permanent grassland in Wales.*

122 - *Dairying and stock rearing on permanent or short term grassland; some cereals in drier areas.*

EXPECTED CROPS AND LAND USE DESCRIPTION

Individual soils are commonly associated with particular forms of land cover and land use. Whilst the soil surveyors were mapping the whole of England and Wales, they took careful note of the range of use to which the land was being put. This map shows the most common forms of land use found on each soil unit.

11. NATURAL SOIL FERTILITY



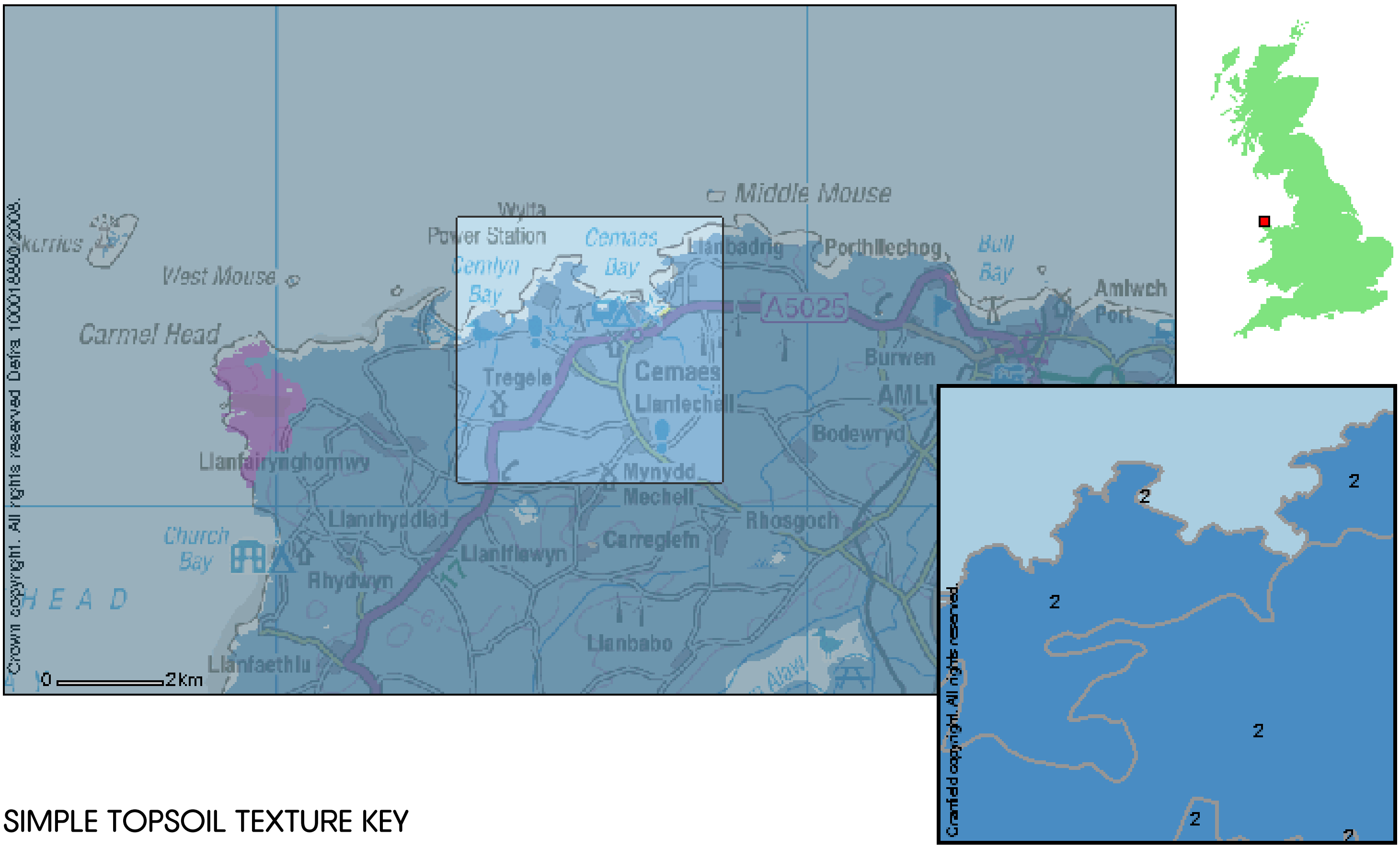
NATURAL SOIL FERTILITY KEY

5 - *Low*

NATURAL SOIL FERTILITY DESCRIPTION

Soil fertility can be greatly altered by land management especially through the application of manures, lime and mineral fertilisers. What is shown in this map, however, is the likely natural fertility of each soil type. Soils that are very acid have low numbers of soil-living organisms and support heathland and acid woodland habitats. These are shown as of very low natural fertility. Soils identified as of low natural fertility are usually acid in reaction and are associated with a wide range of habitat types. The moderate class contains neutral to slightly acid soils, again with a wide range of potential habitats. Soil of high natural fertility are both naturally productive and able to support the base-rich pastures and woodlands that are now rarely encountered. Lime-rich soils contain chalk and limestone in excess, and are associated with downland, herb-rich pastures and chalk and limestone woodlands.

1m. SIMPLE TOPSOIL TEXTURE



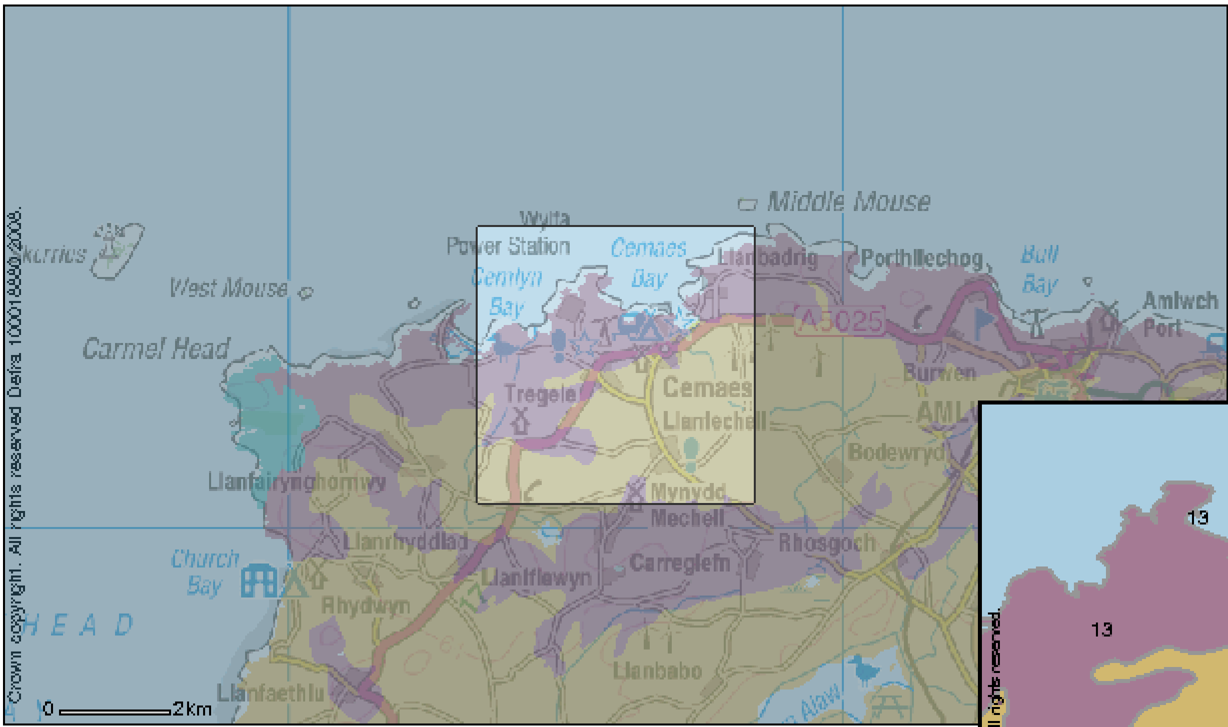
SIMPLE TOPSOIL TEXTURE KEY

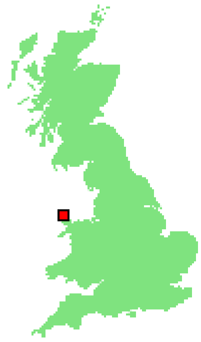
- 1 - *Clayey*
- 2 - *Loamy*
- 3 - *Peaty*
- 4 - *Sandy*

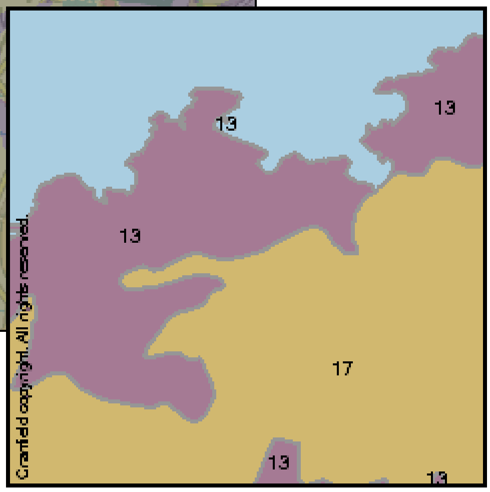
SIMPLE TOPSOIL TEXTURE DESCRIPTION

Soil texture is a term used in soil science to describe the physical composition of the soil in terms of the size of mineral particles in the soil. Specifically, we are concerned with the relative proportions of sand, silt and clay. Soil texture can vary between each soil layer or horizon as one moves down the profile. This map indicates the soil texture group of the upper 30 cm of the soil. 'Light' soils have more sand grains and are described as sandy, while 'heavy' soils have few sand grains but a lot of extremely small particles and are described as clayey. Loamy soils have a mix of sand, silt and clay-sized particles and are intermediate in character. Soils with a surface layer that is dominantly organic are described as Peaty. A good understanding of soil texture can enable better land management.

1n. TYPICAL HABITATS







TYPICAL HABITATS KEY

13 - *Neutral and acid pastures and deciduous woodlands; acid communities such as bracken and gorse in the uplands*

17 - *Seasonally wet pastures and woodlands*

TYPICAL HABITATS DESCRIPTION

There is a close relationship between vegetation and the underlying soil. Information about the types of broad habitat associated with each soil type is provided in this map. Soil fertility, pH, drainage and texture are important factors in determining the types of habitats which can be established. Elevation above sea level and sometimes even the aspect - the orientation of a hillslope - can affect the species present. This map does not take into account the recent land management or any urban development, but provides the likely natural habitats assuming good management has been carried out.

2. SOIL ASSOCIATION DESCRIPTIONS

The following pages describe the following soil map units, (soil associations), in more detail.

EAST KESWICK 1 541x

Deep well drained fine loamy soils and similar soils with slowly permeable subsoils and slight seasonal waterlogging.

BRICKFIELD 2 713f

Slowly permeable seasonally waterlogged fine loamy soils.

The soil associations are described in terms of their texture and drainage properties and potential risks may be identified. The distribution of the soils across England and Wales are provided. Further to this, properties of each association's component soil series are described in relation to each other. Lastly, schematic diagrams of each component series are provided for greater understanding and in-field verification purposes.

EAST KESWICK 1 (541x)

Deep well drained fine loamy soils and similar soils with slowly permeable subsoils and slight seasonal waterlogging.

a. General Description

Deep well drained fine loamy soils and similar soils with slowly permeable subsoils and slight seasonal waterlogging. Some coarse loamy soils affected by groundwater.
The major landuse on this association is defined as cereals and grassland in the northern region; stock rearing on permanent grassland in wales.

b. Distribution (England & Wales)

The EAST KESWICK 1 association covers 804km² of England and Wales which accounts for 0.53% of the landmass. The distribution of this association is shown in Figure 1. Note that the yellow shading represents a buffer to highlight the location of very small areas of the association.

c. Comprising Soil Series

Multiple soil series comprise a soil association. The soil series of the EAST KESWICK 1 association are outlined in Table 1 below. In some cases other minor soil series are present at a particular site, and these have been grouped together under the heading 'OTHER'. We have endevoured to present the likelihood of a minor, unnamed soil series occuring in your site in Table 1.

Schematic diagrams of the vertical soil profile of the major constituent soil series are provided in Section D to allow easier identification of the particular soil series at your site.

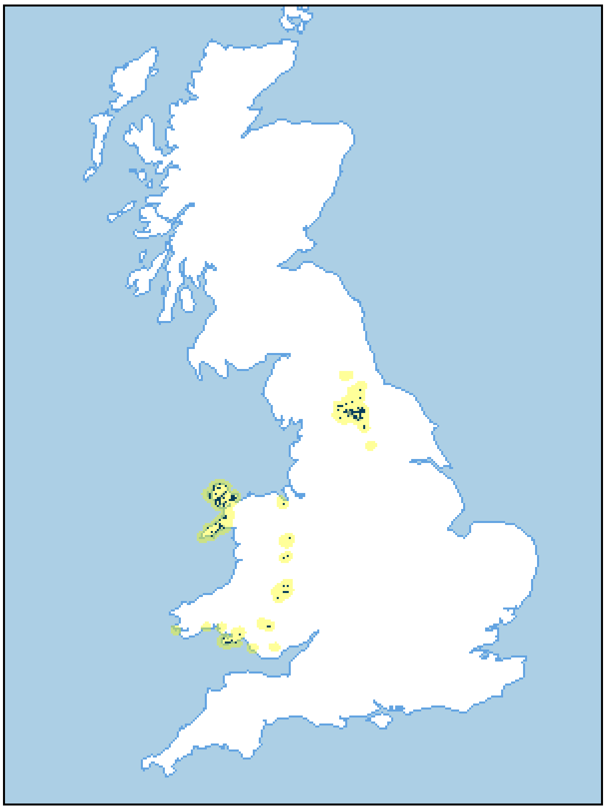


Figure 1. Association Distribution

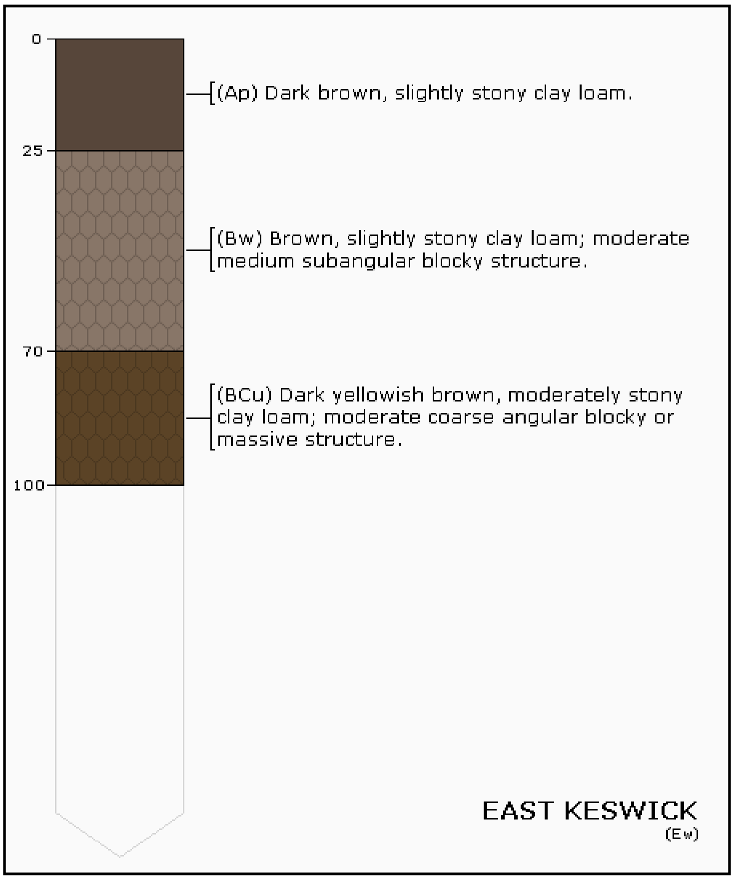
Soil Series	Description	Area %
EAST KESWICK (Ew)	medium loamy drift with siliceous stones	45%
NERCWYS (Nc)	medium loamy drift with siliceous stones	30%
ARROW (aO)	light loamy drift with siliceous stones	10%
OTHER	other minor soils	15%

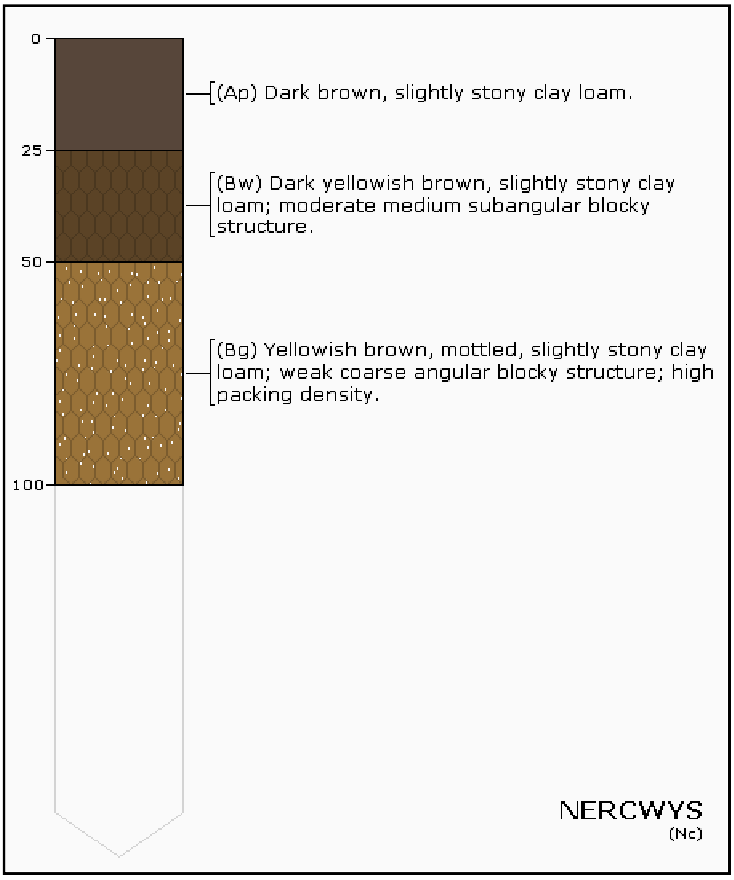
Table 1. The component soil series of the EAST KESWICK 1 soil association. Because absolute proportions of the comprising series in this association vary from location to location, the national proportions are provided.

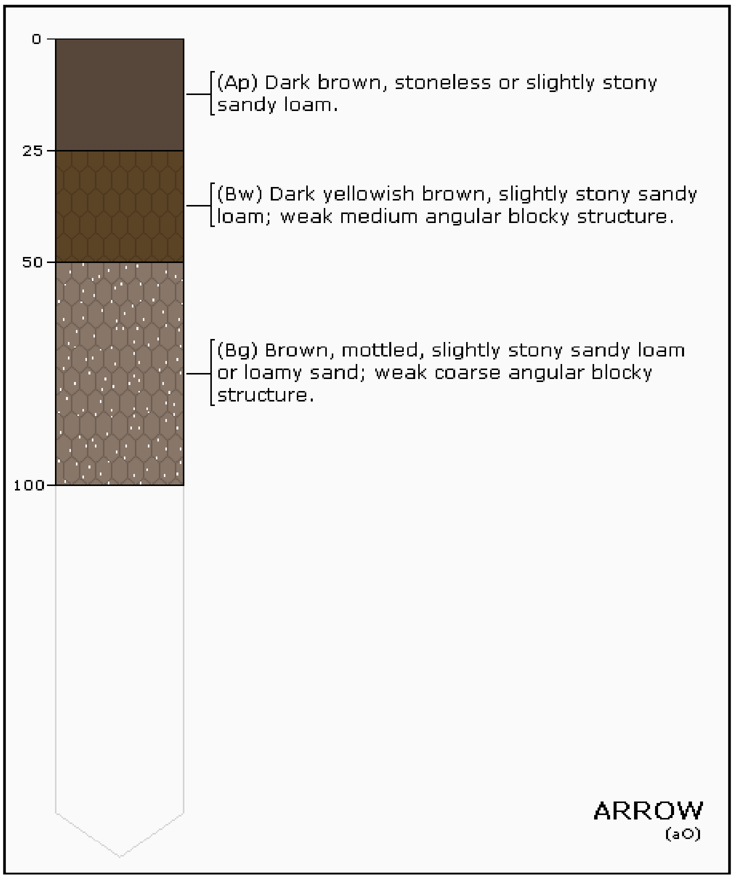
EAST KESWICK 1 (541x)

Deep well drained fine loamy soils and similar soils with slowly permeable subsoils and slight seasonal waterlogging.

d. EAST KESWICK 1 Component Series Profiles







EAST KESWICK 1 (541x)

Deep well drained fine loamy soils and similar soils with slowly permeable subsoils and slight seasonal waterlogging.

e. Soil Properties

This section provides graphical summaries of selected attribute data available for the component series in this association. The blue bars of the graphs presented in this section describe the range of property values for all soils across England and Wales. Superimposed on these graphs are the values for the component soil series in this association. This has been done to provide the reader with an understanding of where each property for each series sits within the national context.

Soil Series	Description	Area %
EAST KESWICK (Ew)	medium loamy drift with siliceous stones	45%
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ARROW (aO)	light loamy drift with siliceous stones	10%
OTHER	other minor soils	15%

Table 1. The component soil series of the EAST KESWICK 1 soil association. Because absolute proportions of the comprising series in this association vary from location to location, the national proportions are provided.

e(i). Soil Depth Information and Depths to Important Layers

Depth to rock A mean depth to bedrock or very stony rubble which has been assigned to each soil series based on observed and recorded soil profiles.

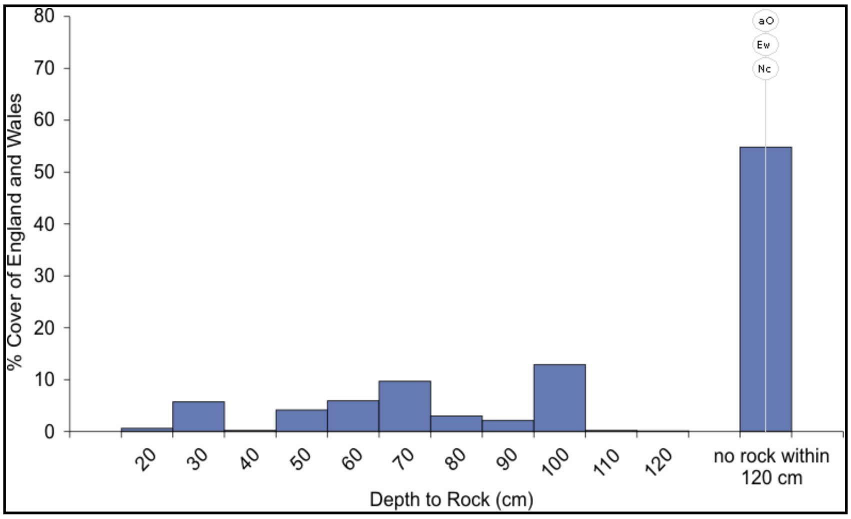


Figure 2. Depth of soil to Rock

Depth to gleying, the presence of grey and ochreous mottles within the soil, is caused by intermittent waterlogging. A mean depth to gleying has been assigned to each soil series based on observed and recorded soil profiles. The definition of a gleyed layer is designed to equate with saturation for at least 30 days in each year or the presence of artificial drainage.

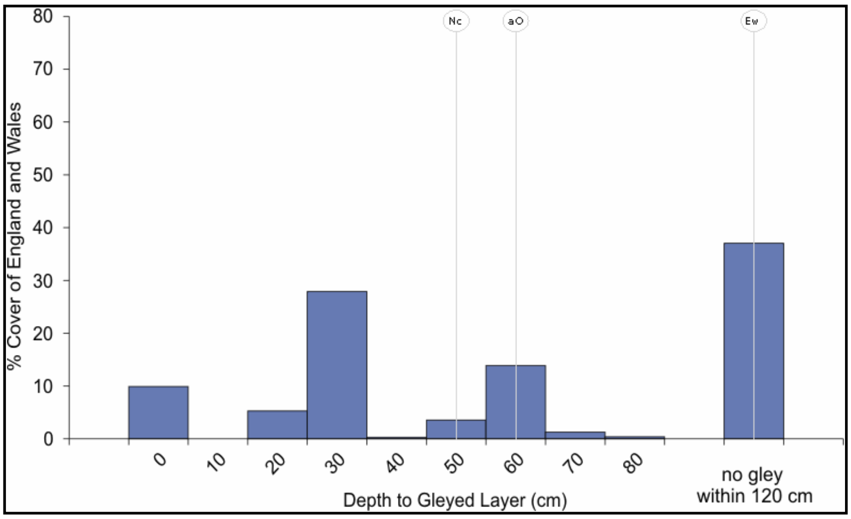


Figure 3. Depth of Soil to Gleying

EAST KESWICK 1 (541x)

Deep well drained fine loamy soils and similar soils with slowly permeable subsoils and slight seasonal waterlogging.

e(i). Soil Depth Information and Depths to Important Layers continued

Depth to slowly permeable layer (downward percolation) A mean depth to a layer with lateral hydraulic conductivity of <10 cm per day has been assigned to each soil series based on observed and recorded soil profiles. Such layers can be defined in terms of their particular soil textural and structural conditions and impede downward percolation of excess soil water. This causes periodic saturation in the overlying soil, reduced storage capacity and therefore increased hydrological response to rainfall events.

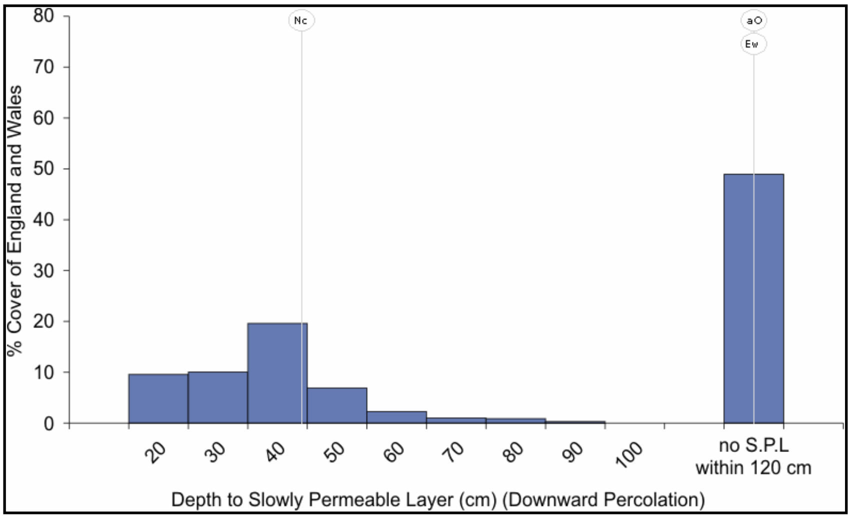


Figure 4. Depth to slowly permeable layer (downward percolation)

Depth to Slowly Permeable Layer (upward diffusion) A mean depth to the bottom of a layer with lateral hydraulic conductivity of <10 cm per day has been assigned to each soil series based on observed and recorded soil profiles. Such layers can be defined in terms of their particular soil textural and structural conditions and impede upward diffusion of water and gasses.

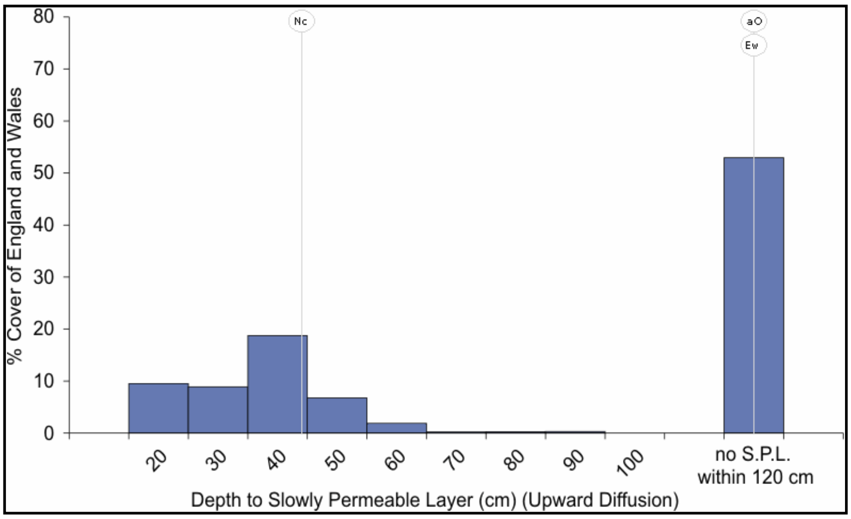


Figure 5. Depth to Slowly Permeable Layer (upward diffusion)

EAST KESWICK 1 (541x)

Deep well drained fine loamy soils and similar soils with slowly permeable subsoils and slight seasonal waterlogging.

e(ii). Soil Hydrological Information

Integrated air capacity (IAC) is the total coarse pore space (>60 μm diameter) to 1 m depth. This size of pore would normally be air-filled when the soil is fully moist but not waterlogged. A large IAC means that the soil is well aerated. This will encourage root development and, provided near surface soil structure is well developed, will allow rainfall to percolate into the ground thus mitigating against localised flooding.

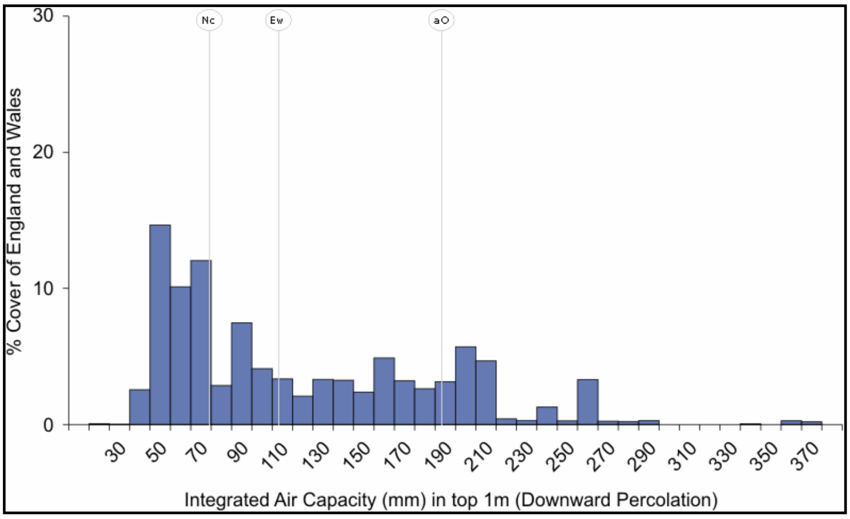


Figure 6. Integrated Air Capacity

Standard Percentage Runoff (SPR) is the percentage of rainfall that causes the short-term increase in flow seen at a catchment outlet following a storm event. The values associated with individual soil series have been calculated from an analysis of the relationships between flow data and the soils present within the catchment for several hundred gauged catchments.

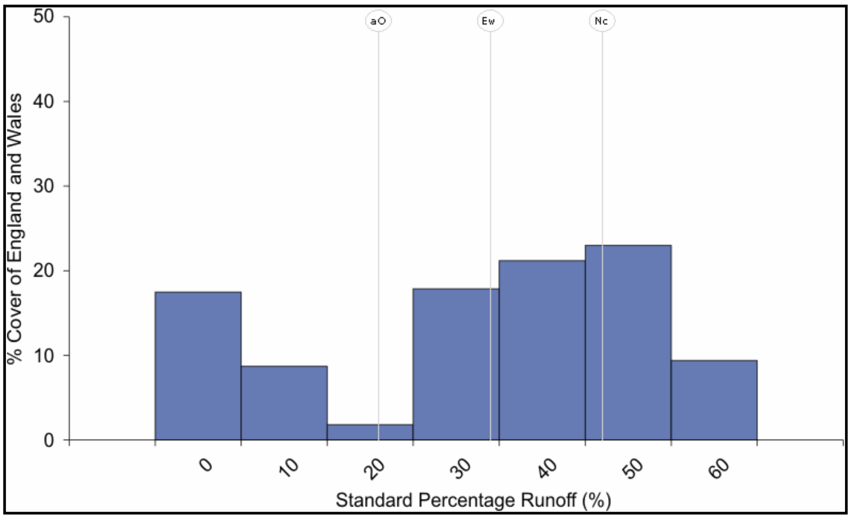


Figure 7. Standard Percentage Runoff

Base flow index is calculated from daily river flow data and expresses the volume of base flow of a river as a fraction of the total flow volume. The values associated with individual soil series have been calculated from an analysis of the relationships between flow data and the soils present within the catchment for several hundred gauged catchments.

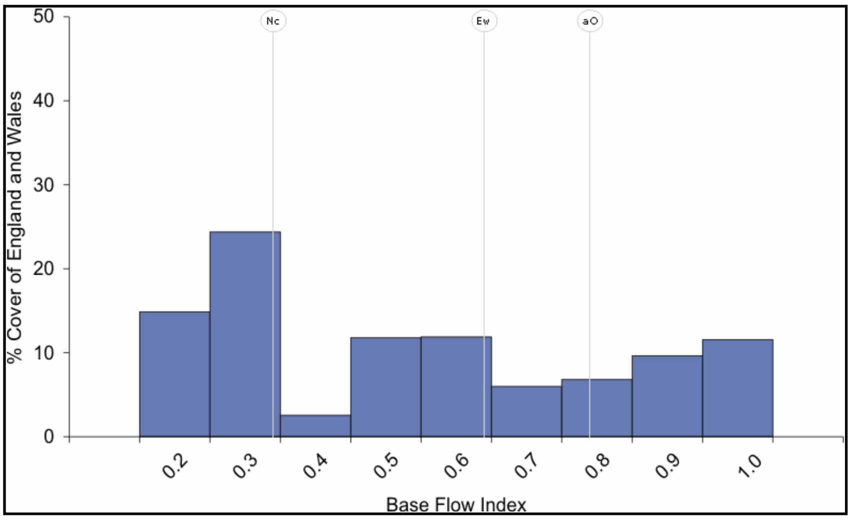


Figure 8. Base Flow Index

EAST KESWICK 1 (541x)

Deep well drained fine loamy soils and similar soils with slowly permeable subsoils and slight seasonal waterlogging.

e(iii). Available Water Content

Available water content for plants varies depending on a number of factors, including the rooting depth of the plants. Described below are differing available water contents for cereals, sugar beet, grass and potato crops, as well as a generic available water value to 1 m depth.

Available water (by crop) Available water content to 1 m for the specified soil series between suctions of 5 and 1500kPa.

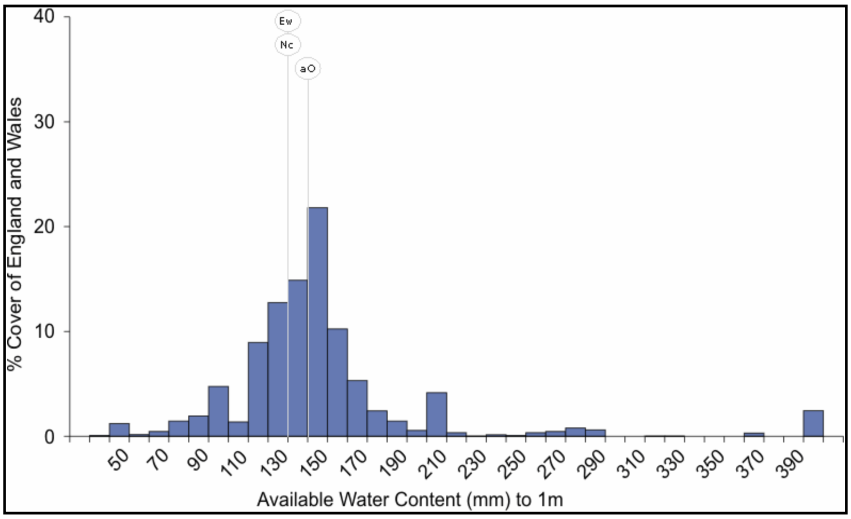


Figure 9. Available Water (by crop)

Available water for grass represents the water that is available to a permanent grass sward that is able to root to 100cm depth.

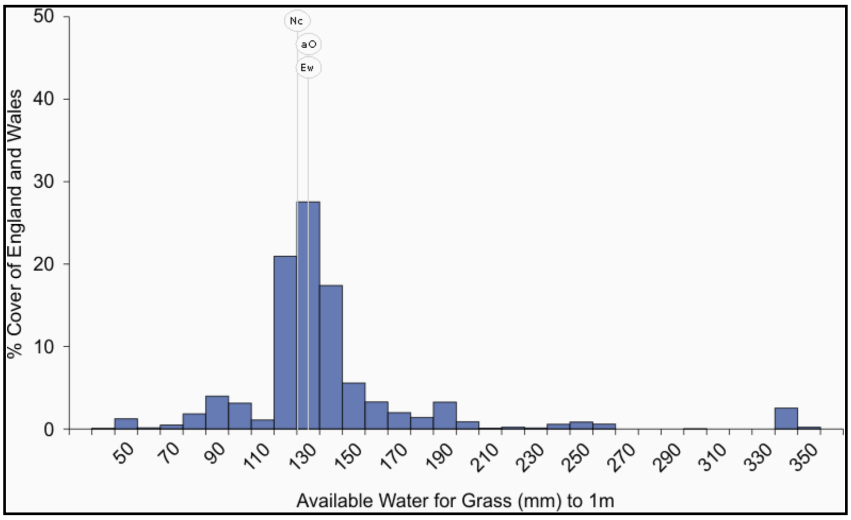


Figure 10. Available Water for Grass

EAST KESWICK 1 (541x)

Deep well drained fine loamy soils and similar soils with slowly permeable subsoils and slight seasonal waterlogging.

e(iii). Available Water Content continued

Available water for cereal represents the water that is available to a cereal crop that is able to root to 120cm depth.

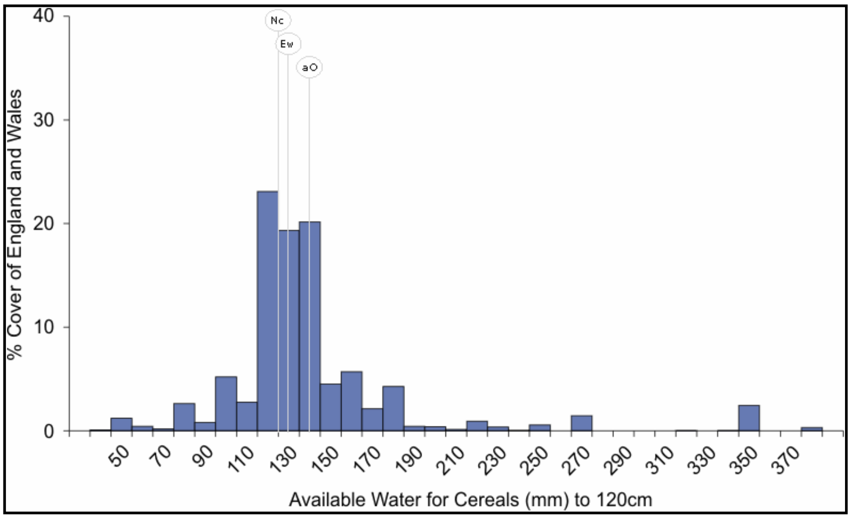


Figure 11. Available Water for Cereal

Available water for Sugar Beet represents the water that is available to a sugar beet crop that is able to root to 140cm depth.

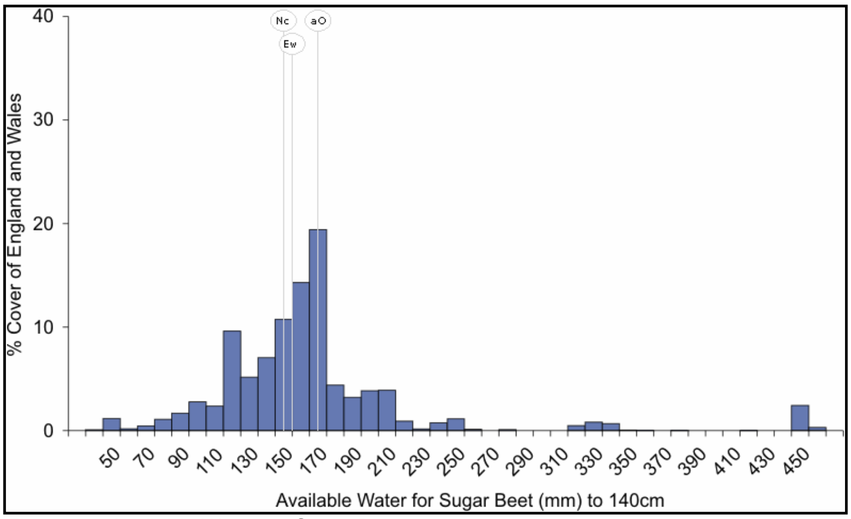


Figure 12. Available Water for Sugar Beet

Available water for Potatoes represents the water that is available to a potato crop that is able to root to 70cm depth.

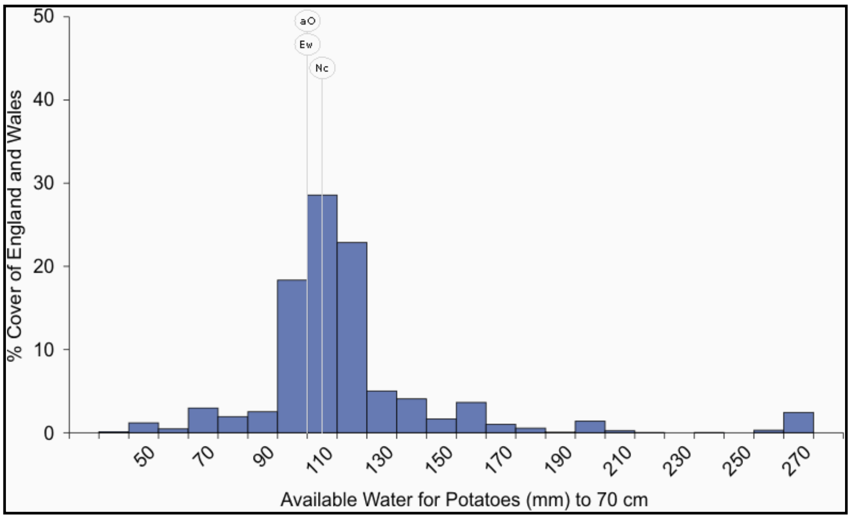


Figure 13. Available Water for Potatoes

BRICKFIELD 2 (713f)

Slowly permeable seasonally waterlogged fine loamy soils.

a. General Description
Slowly permeable seasonally waterlogged fine loamy soils. Associated with fine loamy soils with only slight waterlogging and some deep well drained fine loamy soils.
The major landuse on this association is defined as dairying and stock rearing on permanent or short term grassland; some cereals in drier areas.

b. Distribution (England & Wales)
The BRICKFIELD 2 association covers 1596km² of England and Wales which accounts for 1.06% of the landmass. The distribution of this association is shown in Figure 14. Note that the yellow shading represents a buffer to highlight the location of very small areas of the association.

c. Comprising Soil Series
Multiple soil series comprise a soil association. The soil series of the BRICKFIELD 2 association are outlined in Table 2 below. In some cases other minor soil series are present at a particular site, and these have been grouped together under the heading 'OTHER'. We have endevoured to present the likelihood of a minor, unnamed soil series occuring in your site in Table 2.

Schematic diagrams of the vertical soil profile of the major constituent soil series are provided in Section D to allow easier identification of the particular soil series at your site.

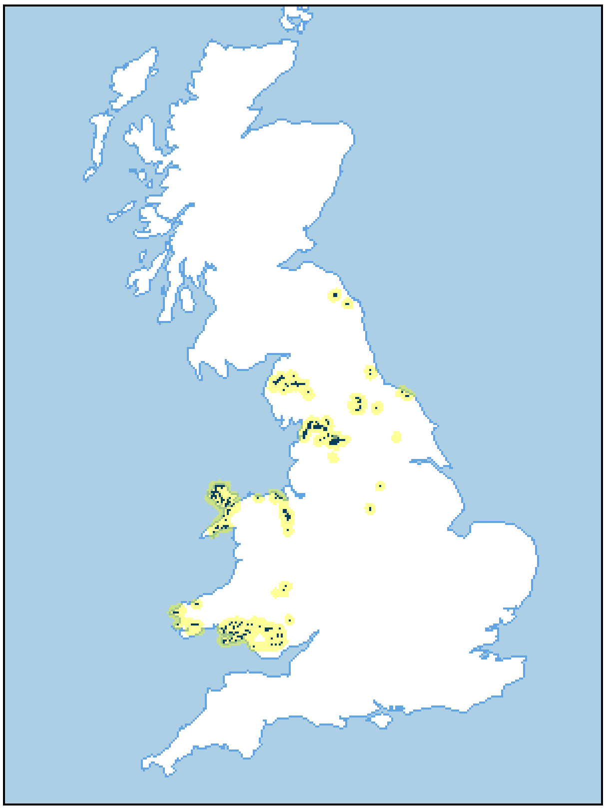


Figure 14. Association Distribution

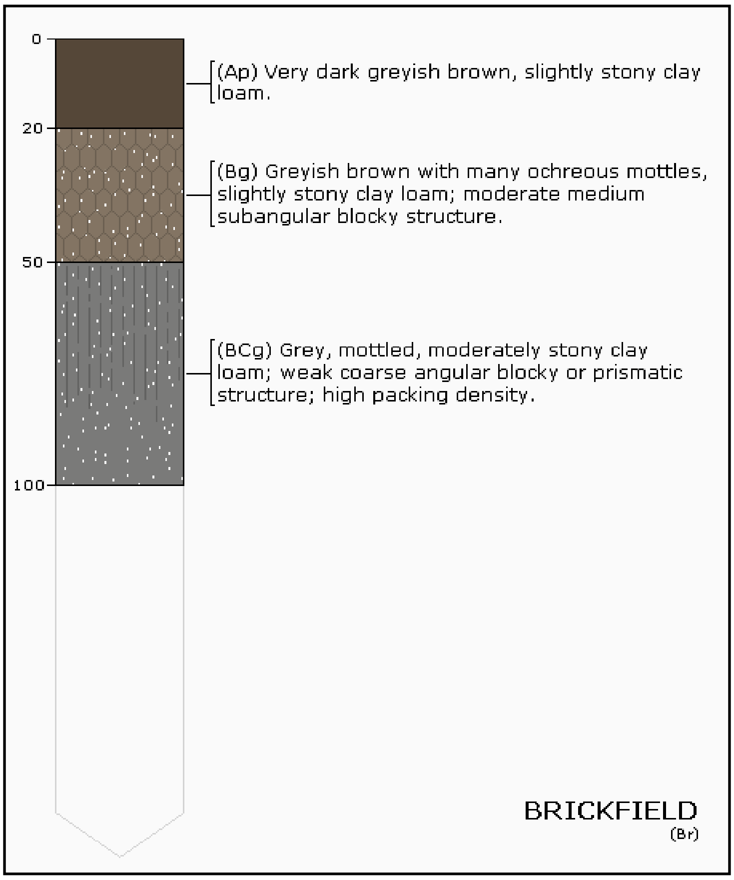
Soil Series	Description	Area %
BRICKFIELD (Br)	medium loamy drift with siliceous stones	40%
NERCWYS (Nc)	medium loamy drift with siliceous stones	20%
EAST KESWICK (Ew)	medium loamy drift with siliceous stones	15%
OTHER	other minor soils	25%

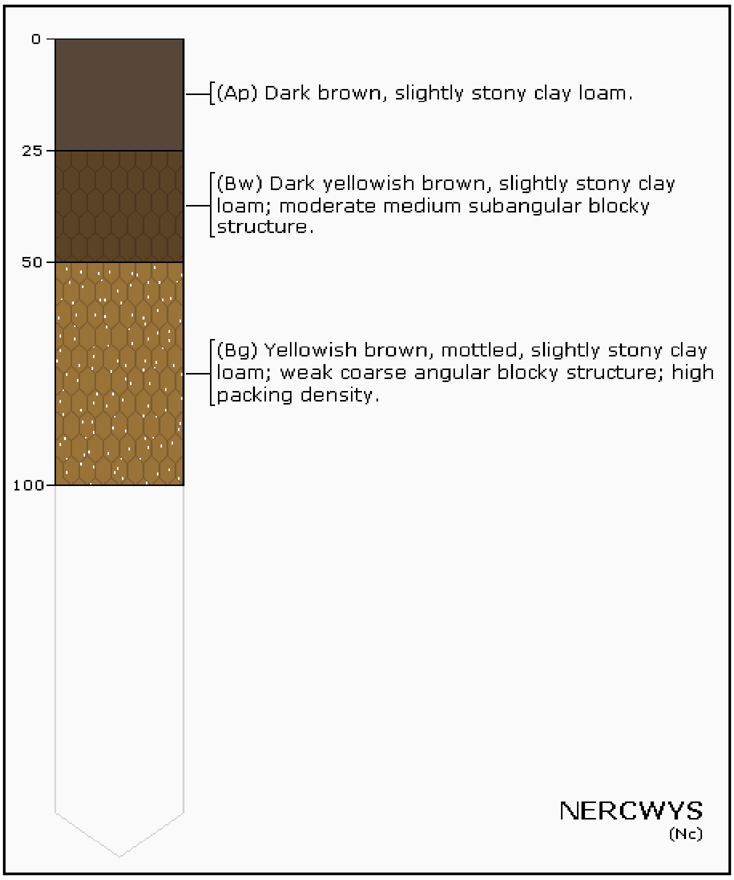
Table 2. The component soil series of the BRICKFIELD 2 soil association. Because absolute proportions of the comprising series in this association vary from location to location, the national proportions are provided.

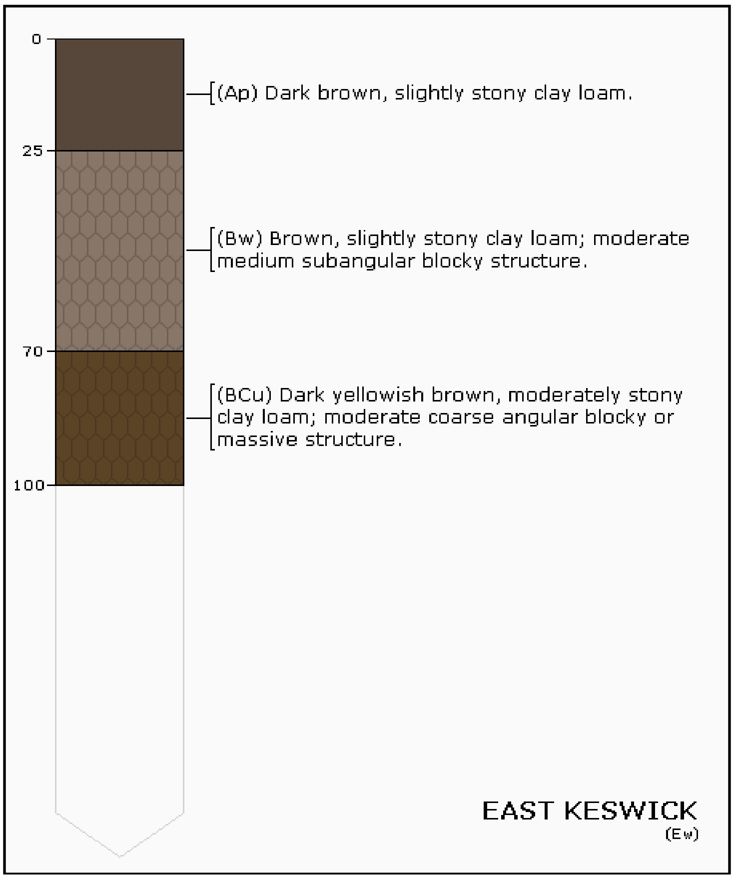
BRICKFIELD 2 (713f)

Slowly permeable seasonally waterlogged fine loamy soils.

d. BRICKFIELD 2 Component Series Profiles







BRICKFIELD 2 (713f)

Slowly permeable seasonally waterlogged fine loamy soils.

e. Soil Properties

This section provides graphical summaries of selected attribute data available for the component series in this association. The blue bars of the graphs presented in this section describe the range of property values for all soils across England and Wales. Superimposed on these graphs are the values for the component soil series in this association. This has been done to provide the reader with an understanding of where each property for each series sits within the national context.

Soil Series	Description	Area %
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EAST KESWICK (Ew)	medium loamy drift with siliceous stones	15%
OTHER	other minor soils	25%

Table 2. The component soil series of the BRICKFIELD 2 soil association. Because absolute proportions of the comprising series in this association vary from location to location, the national proportions are provided.

e(i). Soil Depth Information and Depths to Important Layers

Depth to rock A mean depth to bedrock or very stony rubble which has been assigned to each soil series based on observed and recorded soil profiles.

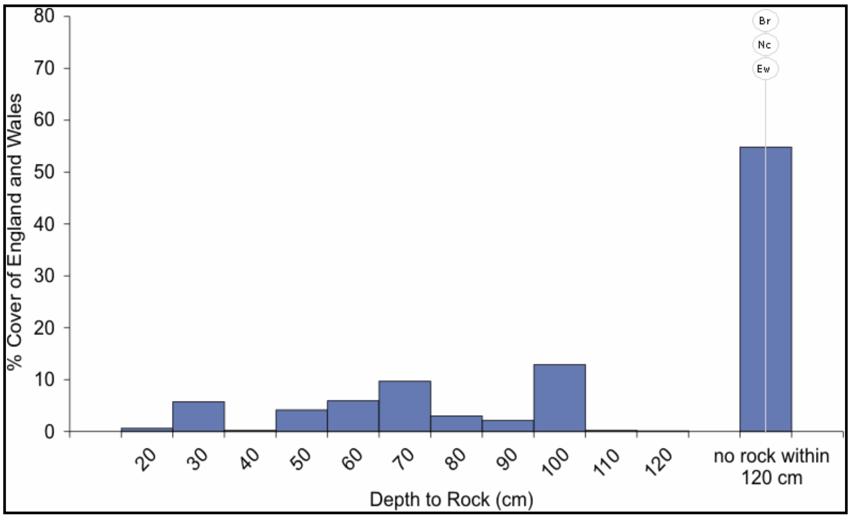


Figure 15. Depth of soil to Rock

Depth to gleying, the presence of grey and ochreous mottles within the soil, is caused by intermittent waterlogging. A mean depth to gleying has been assigned to each soil series based on observed and recorded soil profiles. The definition of a gleyed layer is designed to equate with saturation for at least 30 days in each year or the presence of artificial drainage.

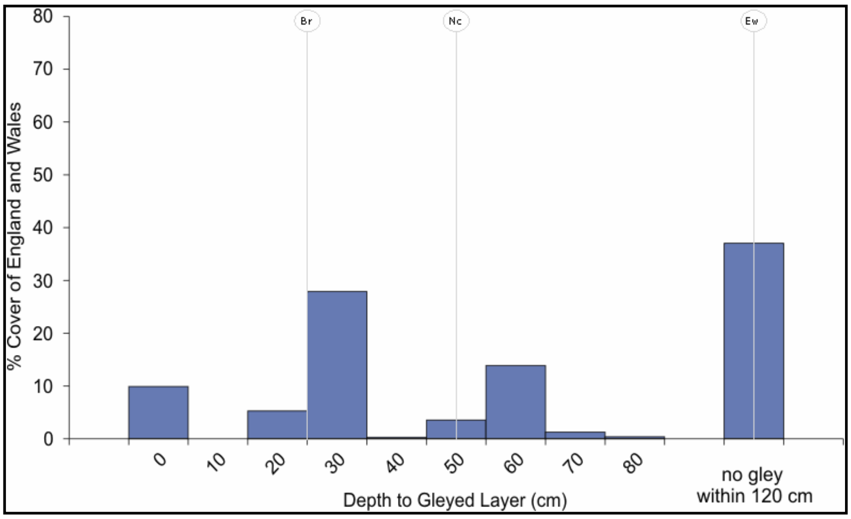


Figure 16. Depth of Soil to Gleying

BRICKFIELD 2 (713f)

Slowly permeable seasonally waterlogged fine loamy soils.

e(i). Soil Depth Information and Depths to Important Layers continued

Depth to slowly permeable layer (downward percolation) A mean depth to a layer with lateral hydraulic conductivity of <10 cm per day has been assigned to each soil series based on observed and recorded soil profiles. Such layers can be defined in terms of their particular soil textural and structural conditions and impede downward percolation of excess soil water. This causes periodic saturation in the overlying soil, reduced storage capacity and therefore increased hydrological response to rainfall events.

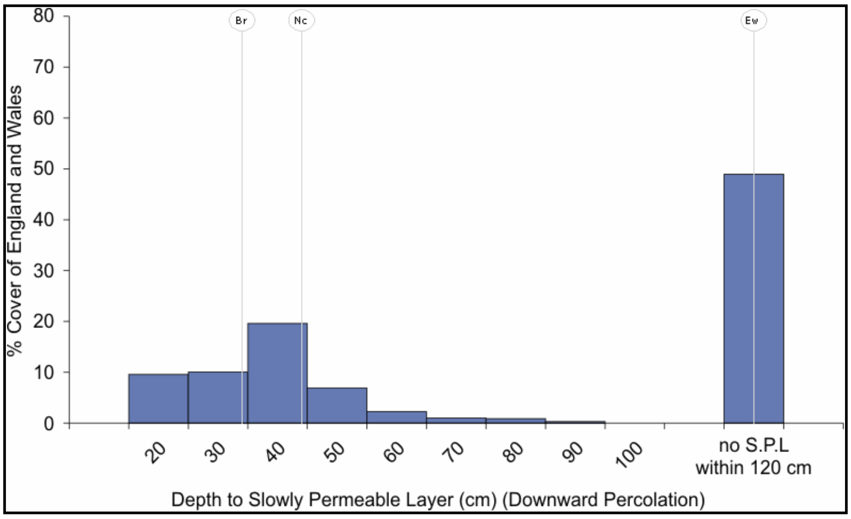


Figure 17. Depth to slowly permeable layer (downward percolation)

Depth to Slowly Permeable Layer (upward diffusion) A mean depth to the bottom of a layer with lateral hydraulic conductivity of <10 cm per day has been assigned to each soil series based on observed and recorded soil profiles. Such layers can be defined in terms of their particular soil textural and structural conditions and impede upward diffusion of water and gasses.

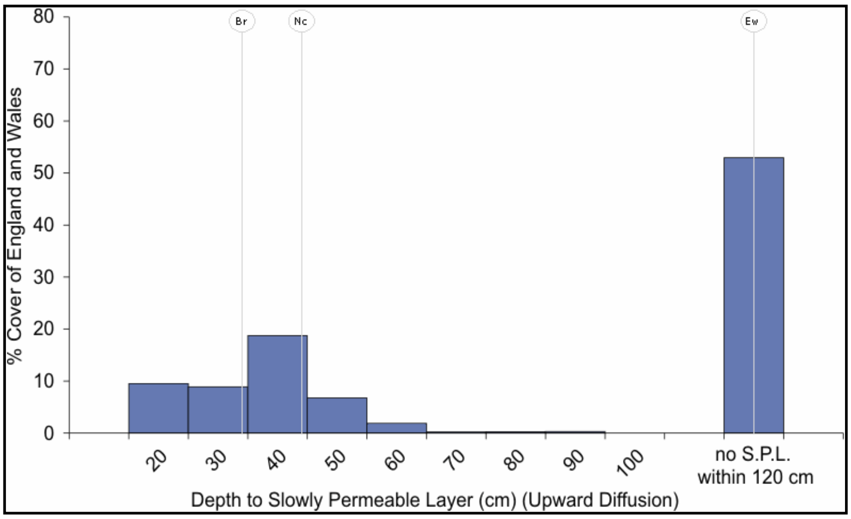


Figure 18. Depth to Slowly Permeable Layer (upward diffusion)

BRICKFIELD 2 (713f)

Slowly permeable seasonally waterlogged fine loamy soils.

e(ii). Soil Hydrological Information

Integrated air capacity (IAC) is the total coarse pore space (>60 μm diameter) to 1 m depth. This size of pore would normally be air-filled when the soil is fully moist but not waterlogged. A large IAC means that the soil is well aerated. This will encourage root development and, provided near surface soil structure is well developed, will allow rainfall to percolate into the ground thus mitigating against localised flooding.

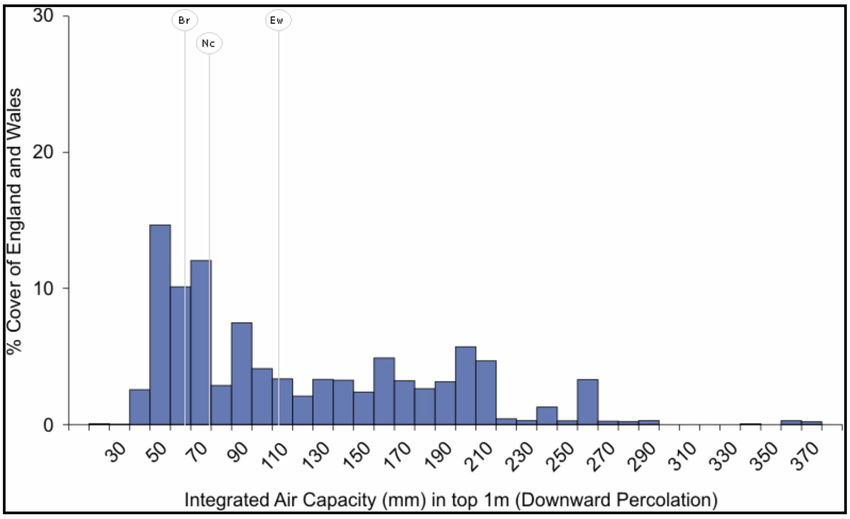


Figure 19. Integrated Air Capacity

Standard Percentage Runoff (SPR) is the percentage of rainfall that causes the short-term increase in flow seen at a catchment outlet following a storm event. The values associated with individual soil series have been calculated from an analysis of the relationships between flow data and the soils present within the catchment for several hundred gauged catchments.

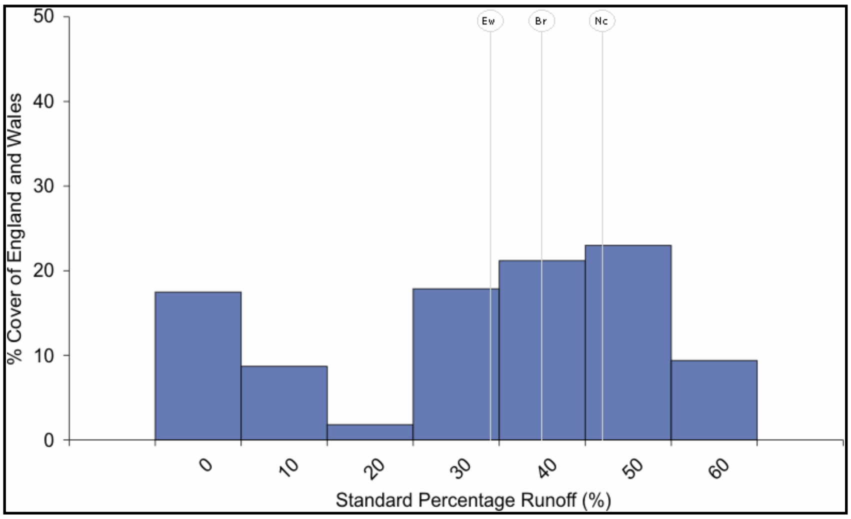


Figure 20. Standard Percentage Runoff

Base flow index is calculated from daily river flow data and expresses the volume of base flow of a river as a fraction of the total flow volume. The values associated with individual soil series have been calculated from an analysis of the relationships between flow data and the soils present within the catchment for several hundred gauged catchments.

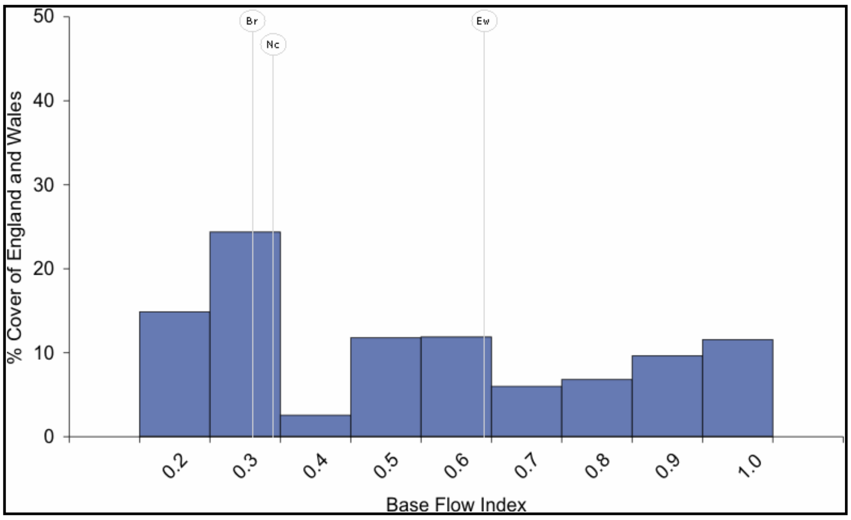


Figure 21. Base Flow Index

BRICKFIELD 2 (713f)

Slowly permeable seasonally waterlogged fine loamy soils.

e(iii). Available Water Content

Available water content for plants varies depending on a number of factors, including the rooting depth of the plants. Described below are differing available water contents for cereals, sugar beet, grass and potato crops, as well as a generic available water value to 1 m depth.

Available water (by crop) Available water content to 1 m for the specified soil series between suctions of 5 and 1500kPa.

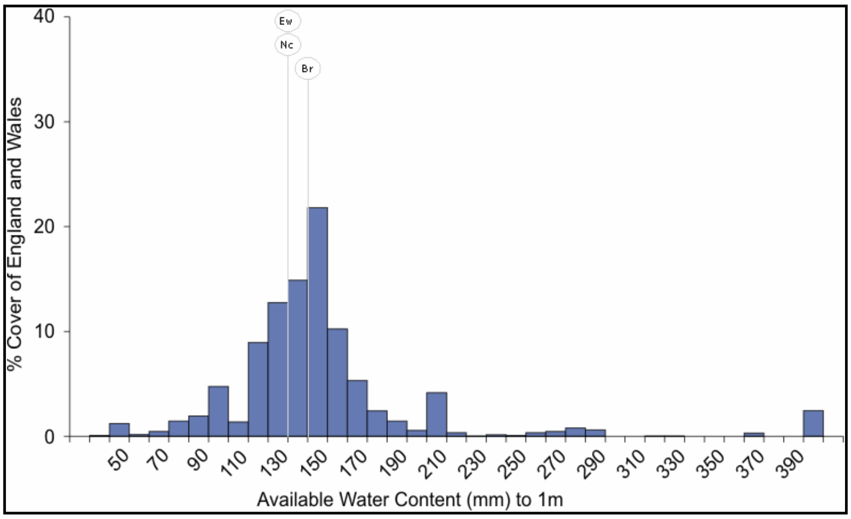


Figure 22. Available Water (by crop)

Available water for grass represents the water that is available to a permanent grass sward that is able to root to 100cm depth.

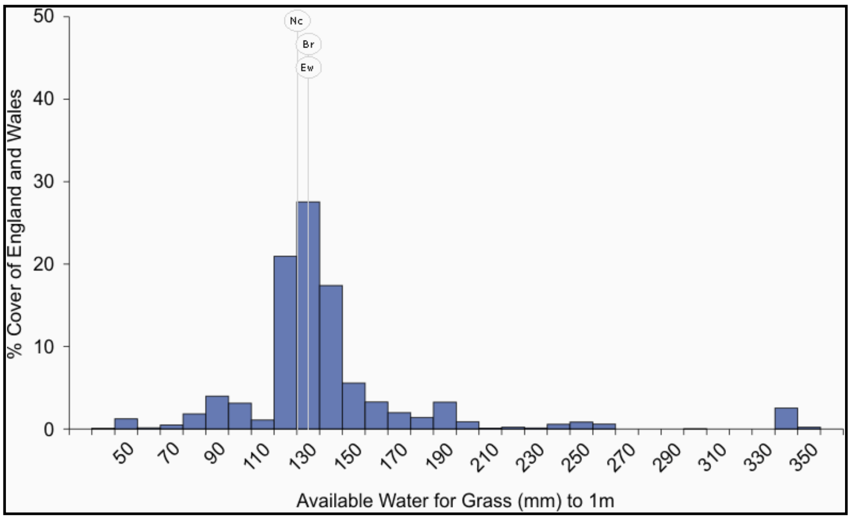


Figure 23. Available Water for Grass

BRICKFIELD 2 (713f)

Slowly permeable seasonally waterlogged fine loamy soils.

e(iii). Available Water Content continued

Available water for cereal represents the water that is available to a cereal crop that is able to root to 120cm depth.

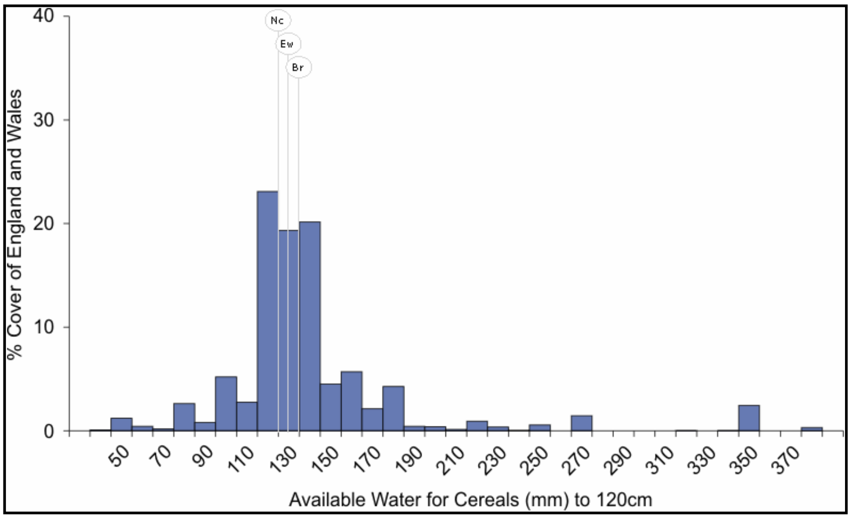


Figure 24. Available Water for Cereal

Available water for Sugar Beet represents the water that is available to a sugar beet crop that is able to root to 140cm depth.

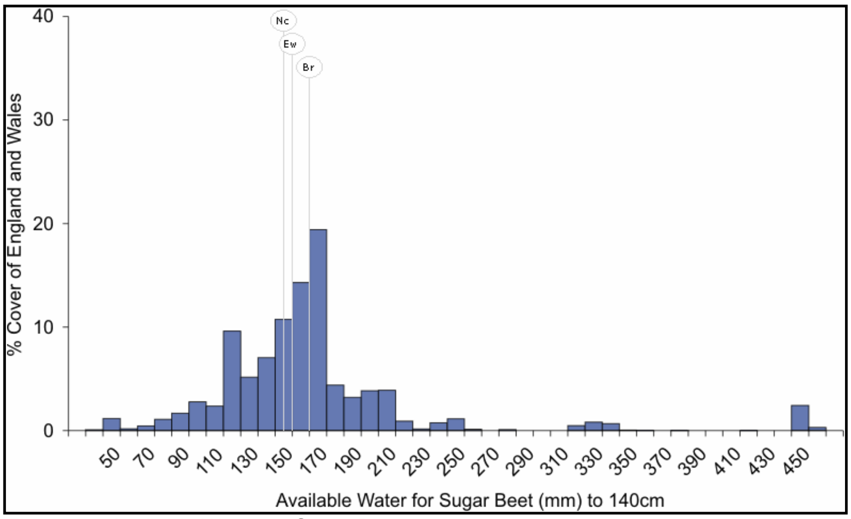


Figure 25. Available Water for Sugar Beet

Available water for Potatoes represents the water that is available to a potato crop that is able to root to 70cm depth.

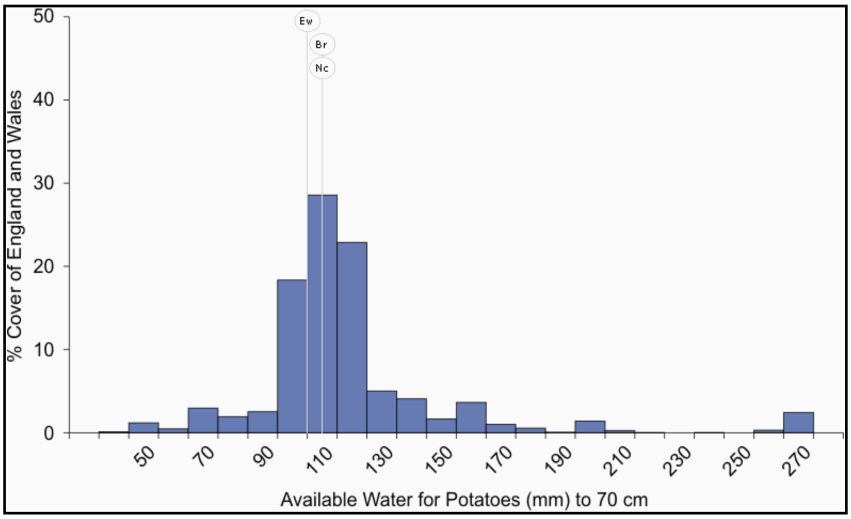
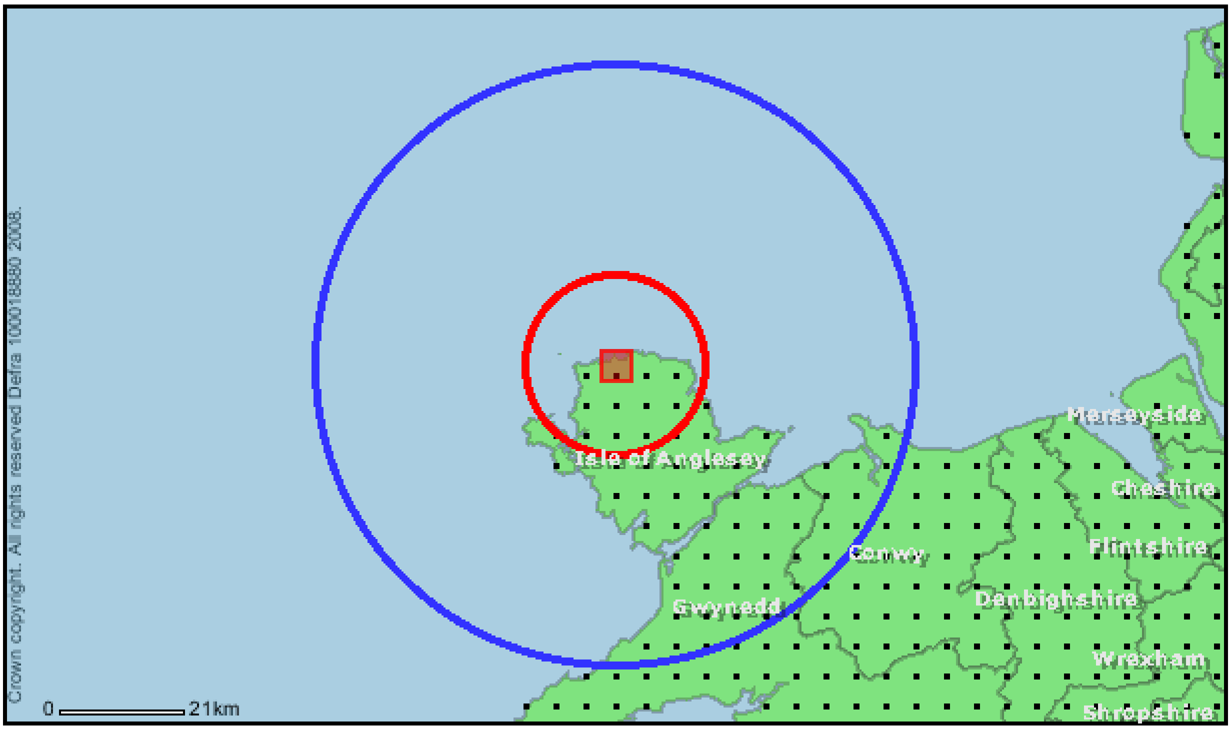
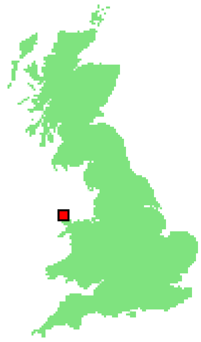


Figure 26. Available Water for Potatoes

3. TOPSOIL ELEMENT BACKGROUND LEVELS





TOPSOIL ELEMENT BACKGROUND LEVELS KEY

- ■ - NSI sample points
- Report area
- 15 km radius - local area
- 50 km radius - regional area

TOPSOIL ELEMENT BACKGROUND LEVELS DESCRIPTION

The National Soil Inventory (NSI) covers England and Wales on a 5 km grid and provides detailed information for each intersect of the grid. Collectively NSI data are statistically representative of England and Wales soils. The original sampling was undertaken around 1980 and there were partial resamplings in the mid-1990s. The most up-to-date data is presented here.

Analysis of the NSI samples provides detailed measurements of over 20 elements from the soils, in addition to pH. This data is summarised over three areas to provide you with an understanding of how your site, and your data for it, sits within the local, regional and national context.

Where available, the soil element levels are compared with the Soil Guideline Values and where a soil sample we have analysed has been found in excess of the SGV guidelines for "residential with plant uptake" land, this is displayed in red in the tables which follow.

SGV levels are provided for the following elements: lead, selenium, nickel, mercury, chromium, cadmium and arsenic.

In the following pages, a number of analyses of the topsoil are provided. The majority of analyses have been performed on the full compliment of sample points, however, in some areas, for some elements, only a few samples were analysed as part of subsequent programmes. In order to present the full suite of possible datasets, and accurately convey the validity of the data, the number of actual measured samples is stated for each analysis. Care should be taken where the number of samples is disproportionately low.

3a. Analyses Within a 15 km Radius (11 Sample Points)

ANALYSES	SAMPLES	MEAN	MIN	MAX	ST. DEV
pH (PH)	11	5.1	4.6	5.6	0.3
Carbon (CARBON)	11	5.0	3.1	13.5	3.2
Aluminium (AL_ACID)	11	36,216.3	26,063.0	53,950.0	8,191.9
Arsenic (AS_ACID)	9	4.2	2.4	9.6	2.2
Barium (BA_ACID)	11	208.3	120.0	372.0	91.3
Calcium (CA_ACID)	11	2,836.8	353.0	4,631.0	1,438.6
Cadmium (CD_ACID)	11	0.6	0.1	1.3	0.4
Cadmium (Extractable) (CD_EDTA)	11	0.2	0.1	0.4	0.1
Cobalt (CO_ACID)	11	13.1	6.4	26.1	7.3
Cobalt (Extractable) (CO_EDTA)	11	0.8	0.1	2.1	0.7
Chromium (CR_ACID)	11	48.8	34.8	83.6	13.6
Copper (CU_ACID)	11	31.6	8.0	103.7	26.0
Copper (Extractable) (CU_EDTA)	11	8.9	4.2	39.2	10.2
Flouride (F_ACID)	10	52.5	0.0	137.0	41.2
Iron (FE_ACID)	11	35,948.2	24,232.0	53,860.0	10,080.5
Mercury (HG_ACID)	9	0.0	0.0	0.1	0.0
Potassium (K_ACID)	11	5,516.5	2,280.0	8,269.0	1,838.8
Potassium (Extractable) (K_NITRATE)	11	114.5	45.0	247.0	58.8
Magnesium (MG_ACID)	11	3,876.0	2,138.0	4,811.0	893.9
Magnesium (Extractable) (MG_NITRATE)	11	123.5	55.0	185.0	44.4
Manganese (MN_ACID)	11	1,211.7	231.0	2,707.0	933.9
Manganese (Extractable) (MN_EDTA)	11	175.8	9.0	589.0	174.0
Molybdenum (MO_ACID)	10	1.0	0.0	2.9	0.8
Sodium (NA_ACID)	11	676.0	193.0	1,176.0	384.4
Nickel (NI_ACID)	11	22.2	10.0	33.0	8.2
Nickel (Extractable) (NI_EDTA)	11	0.9	0.3	2.9	0.7
Phosphorus (P_ACID)	11	928.2	175.0	2,016.0	525.1
Phosphorus (Extractable) (P_OLSEN)	11	24.4	6.0	58.0	15.1
Lead (PB_ACID)	11	49.7	24.0	151.0	36.3
Lead (Extractable) (PB_EDTA)	11	13.3	3.8	56.7	14.8
Selenium (SE_ACID)	9	0.6	0.4	1.0	0.2
Strontium (SR_ACID)	11	30.2	2.0	54.0	13.1
Vanadium (V_ACID)	10	38.0	6.7	52.3	13.7
Zinc (ZN_ACID)	11	98.6	50.0	237.0	54.9
Zinc (Extractable) (ZN_EDTA)	11	3.8	1.1	10.2	2.6

for units, see Analyses Definitions (p41)

3b. Analyses Within a 50 km Radius (61 Sample Points)

ANALYSES	SAMPLES	MEAN	MIN	MAX	ST. DEV
pH (PH)	61	4.8	3.5	6.2	0.6
Carbon (CARBON)	61	10.1	0.2	44.1	11.3
Aluminium (AL_ACID)	61	24,829.1	3,269.0	53,950.0	11,502.9
Arsenic (AS_ACID)	39	5.1	0.4	25.2	4.3
Barium (BA_ACID)	61	152.3	11.0	393.0	88.7
Calcium (CA_ACID)	61	2,025.8	100.0	5,800.0	1,540.3
Cadmium (CD_ACID)	61	0.6	0.0	4.5	0.6
Cadmium (Extractable) (CD_EDTA)	60	0.2	0.0	0.8	0.1
Cobalt (CO_ACID)	61	17.2	0.7	321.8	44.7
Cobalt (Extractable) (CO_EDTA)	60	0.9	0.0	10.8	1.9
Chromium (CR_ACID)	61	36.9	4.3	95.4	21.6
Copper (CU_ACID)	61	22.9	2.4	103.7	18.0
Copper (Extractable) (CU_EDTA)	60	5.7	1.2	39.2	5.2
Flouride (F_ACID)	50	46.3	0.0	340.7	68.0
Iron (FE_ACID)	61	28,477.3	4,223.0	83,515.0	14,672.6
Mercury (HG_ACID)	39	0.0	0.0	0.3	0.1
Potassium (K_ACID)	61	3,963.6	581.0	8,269.0	1,969.9
Potassium (Extractable) (K_NITRATE)	61	105.6	13.0	256.0	51.4
Magnesium (MG_ACID)	61	3,282.2	322.0	11,264.0	2,177.8
Magnesium (Extractable) (MG_NITRATE)	61	109.3	24.0	307.0	52.6
Manganese (MN_ACID)	61	1,320.2	32.0	13,613.0	1,863.0
Manganese (Extractable) (MN_EDTA)	60	181.7	1.0	2,347.0	311.6
Molybdenum (MO_ACID)	50	1.3	0.0	5.9	1.4
Sodium (NA_ACID)	61	459.4	137.0	2,209.0	363.1
Nickel (NI_ACID)	61	18.2	2.9	61.0	11.5
Nickel (Extractable) (NI_EDTA)	60	0.7	0.1	2.9	0.5
Phosphorus (P_ACID)	61	929.3	175.0	2,214.0	395.5
Phosphorus (Extractable) (P_OLSEN)	61	21.0	3.0	88.0	14.6
Lead (PB_ACID)	61	77.8	6.0	795.0	102.6
Lead (Extractable) (PB_EDTA)	60	19.0	3.6	108.0	18.4
Selenium (SE_ACID)	39	0.9	0.0	6.4	1.1
Strontium (SR_ACID)	61	19.7	0.0	54.0	12.0
Vanadium (V_ACID)	51	34.5	0.0	91.5	25.6
Zinc (ZN_ACID)	61	72.1	21.0	237.0	42.0
Zinc (Extractable) (ZN_EDTA)	60	5.1	1.1	21.1	3.7

for units, see Analyses Definitions (p41)

3c. National Analyses (5686 Sample Points)

ANALYSES	SAMPLES	MEAN	MIN	MAX	ST. DEV
pH (PH)	5,630	6.0	3.1	9.2	1.3
Carbon (CARBON)	5,672	6.1	0.1	61.5	8.9
Aluminium (AL_ACID)	5,677	26,775.3	491.0	79,355.0	12,772.2
Arsenic (AS_ACID)	2,729	4.6	0.0	110.0	5.7
Barium (BA_ACID)	5,677	150.0	7.0	3,840.0	159.5
Calcium (CA_ACID)	5,677	13,768.7	0.0	339,630.0	37,785.0
Cadmium (CD_ACID)	5,677	0.7	0.0	40.9	1.0
Cadmium (Extractable) (CD_EDTA)	5,655	0.5	0.0	85.0	3.0
Cobalt (CO_ACID)	5,677	10.6	0.0	567.0	13.7
Cobalt (Extractable) (CO_EDTA)	5,655	1.1	0.0	26.5	1.2
Chromium (CR_ACID)	5,677	38.9	0.0	2,339.8	43.7
Copper (CU_ACID)	5,677	22.6	0.0	1,507.7	36.8
Copper (Extractable) (CU_EDTA)	5,655	6.4	0.3	431.4	11.1
Flouride (F_ACID)	3,320	58.5	0.0	6,307.9	186.2
Iron (FE_ACID)	5,677	28,147.8	395.0	264,405.0	16,510.5
Mercury (HG_ACID)	2,159	0.1	0.0	2.4	0.2
Potassium (K_ACID)	5,677	4,727.7	60.0	23,905.0	2,700.2
Potassium (Extractable) (K_NITRATE)	5,609	182.0	6.0	2,776.0	151.6
Magnesium (MG_ACID)	5,677	3,648.1	0.0	62,690.0	3,284.1
Magnesium (Extractable) (MG_NITRATE)	5,609	146.0	1.0	1,601.0	147.5
Manganese (MN_ACID)	5,677	777.0	3.0	42,603.0	1,068.8
Manganese (Extractable) (MN_EDTA)	5,654	159.4	0.0	3,108.0	188.6
Molybdenum (MO_ACID)	4,417	0.9	0.0	56.3	2.0
Sodium (NA_ACID)	5,677	323.3	17.0	25,152.0	572.3
Nickel (NI_ACID)	5,677	25.4	0.0	1,350.2	29.2
Nickel (Extractable) (NI_EDTA)	5,655	1.6	0.1	73.2	2.0
Phosphorus (P_ACID)	5,677	792.1	41.0	6,273.0	433.9
Phosphorus (Extractable) (P_OLSEN)	5,604	27.4	0.0	534.0	25.5
Lead (PB_ACID)	5,677	73.3	0.0	17,365.0	280.6
Lead (Extractable) (PB_EDTA)	5,655	27.8	1.2	6,056.5	119.7
Selenium (SE_ACID)	2,729	0.6	0.0	22.8	0.8
Strontium (SR_ACID)	5,677	42.3	0.0	1,445.0	67.8
Vanadium (V_ACID)	4,428	41.0	0.0	854.4	33.9
Zinc (ZN_ACID)	5,677	90.2	0.0	3,648.0	104.4
Zinc (Extractable) (ZN_EDTA)	5,655	9.6	0.5	712.0	24.6

for units, see Analyses Definitions (p41)

SOIL GUIDELINE VALUES (SGV)

Defra and the Environment Agency have produced soil guideline values (SGVs) as an aid to preliminary assessment of potential risk to human health from land that may be contaminated. SGVs represent ‘intervention values’, which, if exceeded, act as indicators of potential unacceptable risk to humans, so that more detailed risk assessment is needed.

The SGVs were derived using the Contaminated Land Exposure Assessment (CLEA) model for four land uses:

1. residential (with plant uptake / vegetable growing)
2. residential (without vegetable growing)
3. allotments
4. commercial / industrial

SGVs are only designed to indicate whether further site-specific investigation is needed. Where a soil guideline value is exceeded, it does not mean that there is necessarily a chronic or acute risk to human health.

The values presented in this report represent those from a number of sample points (given in the "Samples" column in each table) providing local, regional and national background levels. Figures which appear in red indicate that a bulked sample from 20m surrounding a sample point, has at a past date, exceeded the SGV for the ‘residential with plant uptake’ land use.

It is always advisable to perform site specific investigations.

More details on all the SGVs can be found on the Environment Agency Website.

All units are mg/kg which is equivalent to parts per million (ppm)

SUBSTANCE	RESIDENTIAL WITH PLANT UPTAKE	RESIDENTIAL WITHOUT PLANT UPTAKE	ALLOTMENTS	COMMERCIAL / INDUSTRIAL
LEAD	450	450	450	750
SELENIUM	35	260	35	8000
NICKEL	50	75	50	5000
MERCURY	8	15	8	480
CHROMIUM	130	200	130	5000
CADMIUM (pH 6)	1	30	1	1400
CADMIUM (pH 7)	2	30	2	1400
CADMIUM (pH 8)	8	30	8	1400
ARSENIC	20	20	20	500

ANALYSES DEFINITIONS

PH (pH)
pH of soil measure after shaking 10ml of soil for 15 minutes with 25ml of water

CARBON (Carbon)
Organic Carbon (% by wt) measured either by loss-on-ignition for soils estimated to contain more than about 20% organic carbon or by dichromate digestion.

AL_ACID (Aluminium)
Total Aluminium concentration (mg/kg) determined by Inductively Coupled Plasma Emission Spectrometry (ICP) in an aqua regia digest

AS_ACID (Arsenic)
Total Arsenic concentration (mg/kg) determined by Hydride Atomic Absorption Spectrometry (AAS), extracted into hydrochloric acid after digestion with nitric acid and ashing with magnesium nitrate

BA_ACID (Barium)
Total Barium concentration (mg/kg) determined by Inductively Coupled Plasma Emission Spectrometry (ICP) in an aqua regia digest

CA_ACID (Calcium)
Total Calcium concentration (mg/kg) determined by Inductively Coupled Plasma Emission Spectrometry (ICP) in an aqua regia digest

CD_ACID (Cadmium)
Total Cadmium concentration (mg/kg) determined by Inductively Coupled Plasma Emission Spectrometry (ICP) in an aqua regia digest

CD_EDTA (Cadmium Extractable)
Extractable Cadmium concentration (mg/l) determined by Inductively Coupled Plasma Emission Spectrometry (ICP) after shaking 10ml of soil with 50ml of 0.05M EDTA at pH 7.0 for 1h at 20 deg. C and then filtering

CO_ACID (Cobalt)
Total Cobalt concentration (mg/kg) determined by Inductively Coupled Plasma Emission Spectrometry (ICP) in an aqua regia digest

CO_EDTA (Cobalt Extractable)
Extractable Cobalt concentration (mg/l) determined by Inductively Coupled Plasma Emission Spectrometry (ICP) after shaking 10ml of soil with 50ml of 0.05M EDTA at pH 7.0 for 1h at 20 deg. C and then filtering

CR_ACID (Chromium)
Total Chromium concentration (mg/kg) determined by Inductively Coupled Plasma Emission Spectrometry (ICP) in an aqua regia digest

CU_ACID (Copper)
Total Copper concentration (mg/kg) determined by Inductively Coupled Plasma Emission Spectrometry (ICP) in an aqua regia digest

CU_EDTA (Copper Extractable)
Extractable Copper concentration (mg/l) determined by Inductively Coupled Plasma Emission Spectrometry (ICP) after shaking 10ml of soil with 50ml of 0.05M EDTA at pH 7.0 for 1h at 20 deg. C and then filtering

F_ACID (Flouride)
Flouride extracted with 1mol / l sulphuric acid and determined by Ion Selective Electrode (ISE)

FE_ACID (Iron)
Total Iron concentration (mg/kg) determined by Inductively Coupled Plasma Emission Spectrometry (ICP) in an aqua regia digest

HG_ACID (Mercury)
Total Mercury concentration (mg/kg) determined by Hydride Atomic Absorption Spectrometry (AAS), digested in a nitric/sulphuric acid mixture

K_ACID (Potassium)
Total Potassium concentration (mg/kg) determined by Inductively Coupled Plasma Emission Spectrometry (ICP) in an aqua regia digest

K_NITRATE (Potassium Extractable)
Extractable Potassium concentration (mg/l) determined by shaking 10ml of air dry soil with 50ml of 1.0M ammonium nitrate for 30mins, filtering and then measuring the concentration by flame photometry

ANALYSES DEFINITIONS continued

MG_ACID (Magnesium)
Total Magnesium concentration (mg/kg) determined by Inductively Coupled Plasma Emission Spectrometry (ICP) in an aqua regia digest

MG_NITRATE (Magnesium Extractable)
Extractable Magnesium concentration (mg/l) determined by shaking 10ml of air dry soil with 50ml of 1.0M ammonium nitrate for 30mins, filtering and then measuring the concentration by flame photometry

MN_ACID (Manganese)
Total Manganese concentration (mg/kg) determined by Inductively Coupled Plasma Emission Spectrometry (ICP) in an aqua regia digest

MN_EDTA (Manganese Extractable)
Extractable Manganese concentration (mg/l) determined by Inductively Coupled Plasma Emission Spectrometry (ICP) after shaking 10ml of soil with 50ml of 0.05M EDTA at pH 7.0 for 1h at 20 deg. C and then filtering

MO_ACID (Molybdenum)
Total Molybdenum concentration (mg/kg) determined by Atomic Adsorption Spectrometyr (AAS) in an aqua regia digest

MO_EDTA (Molybdenum Extractable)
Extractable Molybdenum concentration (mg/l) determined by Inductively Coupled Plasma Emission Spectrometry (ICP) after shaking 10ml of soil with 50ml of 0.05M EDTA at pH 7.0 for 1h at 20 deg. C and then filtering

NA_ACID (Sodium)
Total Sodium concentration (mg/kg) determined by Inductively Coupled Plasma Emission Spectrometry (ICP) in an aqua regia digest

NI_ACID (Nickel)
Total Nickel concentration (mg/kg) determined by Inductively Coupled Plasma Emission Spectrometry (ICP) in an aqua regia digest

NI_EDTA (Nickel Extractable)
Extractable Nickel concentration (mg/l) determined by Inductively Coupled Plasma Emission Spectrometry (ICP) after shaking 10ml of soil with 50ml of 0.05M EDTA at pH 7.0 for 1h at 20 deg. C and then filtering

P_ACID (Phosphorus)
Total Phosphorus concentration (mg/kg) determined by Inductively Coupled Plasma Emission Spectrometry (ICP) in an aqua regia digest

P_OLSON (Phosphorous Extractable)
Extractable Phosphorus concentration (mg/l) determined by shaking 5ml of air dry soil with 100ml of 0.5M sodium bicarbonate for 30mins at 20 deg.C, filtering and then measuring the absorbance at 880 nm colorimetrically with acid ammonium molybdate solution

PB_ACID (Lead)
Total Lead concentration (mg/kg) determined by Inductively Coupled Plasma Emission Spectrometry (ICP) in an aqua regia digest

PB_EDTA (Lead Extractable)
Extractable Lead concentration (mg/l) determined by Inductively Coupled Plasma Emission Spectrometry (ICP) after shaking 10ml of soil with 50ml of 0.05M EDTA at pH 7.0 for 1h at 20 deg. C and then filtering

SE_ACID (Selenium)
Total Selenium concentration (mg/kg) determined by Hydride Atomic Absorption Spectrometry (AAS), extracted into hydrochloric acid after digestion with nitric acid and ashing with magnesium nitrate

SR_ACID (Strontium)
Total Strontium concentration (mg/kg) determined by Inductively Coupled Plasma Emission Spectrometry (ICP) in an aqua regia digest

V_ACID (Vanadium)
Total Vanadium concentration (mg/kg) determined by Atomic Adsorption Spectrometyr (AAS) in an aqua regia digest

ZN_ACID (Zinc)
Total Zinc concentration (mg/kg) determined by Inductively Coupled Plasma Emission Spectrometry (ICP) in an aqua regia digest

ZN_EDTA (Zinc Extractable)
Extractable Zinc concentration (mg/l) determined by Inductively Coupled Plasma Emission Spectrometry (ICP) after shaking 10ml of soil with 50ml of 0.05M EDTA at pH 7.0 for 1h at 20 deg. C and then filtering

REFERENCES

AVERY, B.W. (1973). Soil classification in the Soil Survey of England and Wales. Journal of Soil Science, 24, 324-338.

AVERY, B.W., (1980). Soil classification for England and Wales. Soil Survey Technical Monograph No.14, Harpenden, UK.

BOORMAN, D.B, HOLLIS, J.M. and LILLEY, A. (1995). Hydrology of Soil Types: a hydrologically-based classification of the soils of the UK. Institute of Hydrology Report No.126, Wallingford, UK.

CLAYDEN, B and HOLLIS, J.M. (1984). Critieria for Differentiating Soil Series. Soil Survey Technical Monograph No.17, pp159. Harpenden, UK.

HALLETT, S.H., KEAY, C.A., JARVIS, M.G. and JONES, R.J.A. (1994). INSURE: Subsidence risk assessment from soil and climate data. Proceedings of the Association for Geographic Information (AGI). National Conference Markets for Geographic Information. Birmingham. 16.2.1 - 16.2.7.

HOLLIS, J.M. (1991). Mapping the vulnerability of aquifers and surface waters to pesticide contamination at the national and regional scale. In: Pesticides in Soils and Water, BCPC Monograph No.47, 165-174.

HOLLIS, J.M., KEAY, C.A., HALLETT, S. H., GIBBONS, J.W. and COURT, A.C. (1995). Using CatchIS to assess the risk to water resources from diffusely applied pesticides. In: British Crop Protection Council monograph No. 62: Pesticide movement to water, 345-350

JARVIS, M.G and HEDGES, M.R. (1994). Use of soil maps to predict the incidence of corrosion and the need for iron mains renewal. Journal of the Institution of Water and Environmental Management 8, (1) 68-75.

PALMER, R.C., HOLMAN, I.P., ROBINS, N.S. and LEWIS, M.A. (1995). Guide to groundwater vulnerability mapping in England and Wales. National Rivers Authority R and D Note 578/1/ST.

To view the glossary visit: www.landis.org.uk/sitereporter/GLOSSARY.pdf

For a list of further reading visit: www.landis.org.uk/sitereporter/FURTHER_READING.pdf

For more information visit: www.landis.org.uk/reports

GIS DATASETS:

The GIS data used in the creation of this report is available to lease for use in projects.

To learn more about, or acquire the GIS datasets used in the creation of this report, please contact the National Soil Resources Institute:

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Appendix B. Agricultural Land Classification and Soils Resources (2015 Survey)

Jacobs UK Limited

Wylfa Nuclear Power Station

Anglesey

Agricultural Land Classification

and

Soil Resources

June 2015

Reading Agricultural Consultants Ltd

www.readingagricultural.co.uk

1. Introduction

1.1. Instruction

1.1.1. Reading Agricultural Consultants Ltd (RAC) is instructed by Jacobs UK Limited to investigate the Agricultural Land Classification (ALC) and soil resources of land around Wylfa Nuclear Power Station, located on the north coast of Anglesey between the bays of Cemlyn and Cemaes, by means of a semi-detailed survey of soil and site characteristics.

2. Site and Climatic Conditions

2.1. General Features, Land Form and Drainage

2.1.1. The total survey area extends to approximately 323ha mostly comprising coastal grassland and agricultural land, as outlined in Figure RAC6753-1. Other than the coastline, the survey area is largely bounded by other agricultural land, with the settlements of Tregele to the south and Cemaes to the east. The A5025 runs along the south-eastern boundary of the survey area.

2.1.2. The present operational power station is in the north of the survey area and is surrounded by made ground. Site offices and infrastructure are located to the south-east of the power station. To the north-east is the Tre'r Gof Site of Special Scientific Interest (SSSI) which extends to around 11ha and which is excluded from the present survey area.

2.1.3. The rocky headland in the north is microtopographically complex with slopes of variable steepness and direction. Much of the survey area is undulating and hilly up to around 40m above Ordnance Datum (AOD) with the low-lying SSSI marking one of the lowest altitudes at around 10m AOD. Some of the slopes exceed the 7° threshold representing a limitation to agricultural land quality.

2.2. Agro-climatic Conditions

2.2.1. Agro-climatic data for two points in the survey area have been interpolated from the Meteorological Office’s standard 5km grid point data set at representative altitudes of 10m and 30m AOD, and are given in Table 1. The survey area is wet and warm and has moderate crop moisture deficits. The number of Field Capacity Days (FCDs) is high and is unfavourable for providing opportunities for agricultural field work.

Table 1: Local agro-climatic conditions

	North - 10m AOD	South - 30m AOD
Grid Reference	SH 2356 3936	SH 2345 3928
Average Annual Rainfall	889mm	900mm
Accumulated Temperatures >0°C	1,469 day°	1,447 day°
Field Capacity Days	191 days	192 days
Average Moisture Deficit, wheat	91mm	90mm
Average Moisture Deficit, potatoes	79mm	77mm

2.3. Soil Parent Material and Soil Type

2.3.1. The principal underlying geology of the survey area as mapped by the British Geological Survey[1] comprises mica schist of the Harbour Group and, to the north, of the Gwna Group. Most of the survey area is overlain by superficial deposits of glacial till, the content of which may include clay, sand, gravel and boulders.

2.3.2. The Soil Survey of England and Wales soil association mapping[2] (1:250,000 scale) shows the East Keswick 1 association present across the survey area, with Brickfield 2 soils to the south.

2.3.3. East Keswick soils are characterised by deep, fine loamy brown earths. Drift thickness is variable and rocky exposures may be observed. The soils are mostly permeable, of Wetness Class (WC) I although locally lower horizons may be seasonally waterlogged[3].

2.3.4. Brickfield 2 soils are also characterised by fine loamy soils in till, although are surface water gleys and commonly of WC IV.

[1] **British Geological Survey (2015).** *Geology of Britain viewer, http://mapapps.bgs.ac.uk/geologyofbritain/home.html*

[2] **Soil Survey of England and Wales (1984).** *1:250,000 scale soil association mapping, Sheet 2 – Soils of Wales.*

[3] **Rudeforth *et al.* (1984).** *Soils and Their Use in Wales.* Soil Survey of England and Wales Bulletin 11, Harpenden.

3. Agricultural Land Quality

3.1. Soil Survey Methods

3.1.1. In total, 75 soil profiles were examined using an Edelman (Dutch) auger at an observation density of approximately one per four hectares. A number of fields could not be surveyed due to access being denied where cattle were present or in one field, due to baling operations taking place.

3.1.2. Six observation pits were also excavated to examine subsoil structures. No pits were excavated in the area of made ground in order to avoid any potential risks associated with disturbing asbestos. The locations of observations are indicated on Figure RAC6753-1. At each observation point the following characteristics were assessed for each soil horizon up to a maximum of 120cm or any impenetrable layer:

- soil texture;
- significant stoniness;
- colour (including local gley and mottle colours);
- consistency;
- structural condition;
- free carbonate; and
- depth.

3.1.3. Six soil samples were submitted for laboratory determination of particle size distribution, pH, organic matter content and nutrient contents (P, K, Mg). Results are given in Appendix 1.

3.1.4. Soil Wetness Class (WC) was inferred from the matrix colour, presence or absence of, and depth to, greyish and ochreous gley mottling and/or poorly permeable subsoil layers at least 15cm thick**.**

3.1.5. Soil droughtiness was investigated by the calculation of moisture balance equations (examples are given in Appendix 2). Crop-adjusted Available Profile Water (AP) is estimated from texture, stoniness and depth, and then compared to a calculated moisture deficit (MD) for the standard crops wheat and potatoes. The MD is a function of potential evapotranspiration and rainfall. Grading of the land can be affected if the AP is insufficient to balance the MD and droughtiness occurs. When a profile is found with significant stoniness, sufficient to prevent penetration of a hand auger, then it is assumed, for the purposes of calculating droughtiness, that similar levels of stoniness continues to the full 1.2m depth considered.

3.2. Agricultural Land Classification and Site Limitations

3.2.1. Assessment of agricultural land quality has been carried out according to the MAFF revised guidelines (1988[4]). Soil profiles have been described according to Hodgson (1997 [5]) which is the recognised source for describing soil profiles and characteristics according to the revised ALC guidelines.

3.2.2. There are numerous limitations to agricultural land quality in the survey area including topography, exposure, soil wetness and soil droughtiness. Most of the survey area is limited to Subgrade 3b, with a large area of Grade 5 and small areas of Subgrade 3a and Grade 2.

<u>Grade 5</u>

3.2.3. Topography and exposure are limiting in the north and north-west of the survey area where land is exposed to the influence of the Irish Sea. The area is typified by coastal grassland with exposed rock commonplace. Microtopography is very uneven and it is not considered possible for agricultural machinery to access these areas easily, which are thus suited to rough grazing only. Small patches of similar land are found in the south and south-west of the survey area. These areas are limited to Grade 5.

<u>Subgrade 3b</u>

3.2.4. Soil profiles comprise medium clay loam, sandy clay loam or occasionally sandy loam topsoil which is predominantly dark greyish brown or brown (10YR4/2 or 4/3 in the Munsell soil colour charts[6]).

3.2.5. In the north-east of the survey area, the topsoil is weakly developed with fine subangular blocky peds. Stone content is fairly high at around 15% and comprises gravel sized sediment. The topsoil is well drained with no evidence of prolonged waterlogging.

3.2.6. Observation of soil profiles in the north-east was greatly restricted by stones. The average depth reached was just 22cm, with a range of 19 to 27cm, before the ground became impenetrable to auger. A pit excavated in the area showed the volume of stones to increase significantly from around 40cm depth, so much as to prevent any further excavation with either auger or spade.

3.2.7. It has therefore been assumed that all of the profiles in which stones prevented observation reached at least 40cm depth and that the soil continues to be well drained. Based on these assumptions, the land is limited to Subgrade 3b by droughtiness.

[4] **MAFF (1988).** *Agricultural Land Classification of England and Wales. Revised guidelines and criteria for grading the quality of agricultural land.* MAFF Publications.
[5] **Hodgson, J. M. (Ed.) (1997).** *Soil survey field handbook*. Soil Survey Technical Monograph No. 5, Silsoe.
[6] **Munsell Color (2009).** *Munsell Soil Color Book,* Grand Rapids, MI, USA

3.2.8. There were similar findings in the south-west where auger observation was hindered at depths between 16cm and 40cm. Topsoil structure is moderately to weakly developed with fine subangular blocky peds. Stone content is up to around 10%. A pit excavated in this location revealed fragmented bedrock at around 40cm. As with profiles in the north-east, it is assumed that all restricted profiles in the vicinity reach similar depth and as such are also limited to Subgrade 3b by droughtiness.

3.2.9. Across much of the rest of the survey area, subsoil was observed by use of an auger and the limitation becomes due to soil wetness and workability. Topsoil continues to be of medium clay loam, sandy clay loam or sandy loam which is weakly developed. Peds are mostly medium to fine and subangular blocky, although coarser peds are found in the south of the survey area. Topsoil is commonly mottled and is often considered to be gleyed.

3.2.10. Subsoil textures are clay loam, sandy clay loam or clay which typically have weakly developed medium angular blocky structures. The colour ranges from dark grey to brown (including 10YR4/1, 4/2, 4/3, 5/1 and 5/3). Stone content in the subsoil is mostly around 10%. Fine roots are rarely seen growing through the subsoil which also has few to rare visible pores. The subsoils display ochreous and grey mottles indicating prolonged intermittent wetness, and the soil is poorly permeable.

3.2.11. Most of these profiles are of WC IV which, with medium clay loam, sandy clay loam or sandy loam topsoil textures subject to 191 FCDs results in a wetness and workability limitation to Subgrade 3b (Table 6 of the ALC Guidelines[7]).

Subgrade 3a and Grade 2

3.2.12. In these areas, the topsoil is typically as described above for the Subgrade 3b land. However, the subsoil is coarser in texture and freely draining, comprising sandy loam or very occasionally loamy sand or fine sand. Stone content is lower than in the area of Subgrade 3b at around 5% and the auger observations were able to extend to greater depths.

3.2.13. As the profiles are not restricted in depth or excessively stony, available water reserves are good and the limitation posed by droughtiness is reduced to Subgrade 3a where profiles extended to a depth of around 60cm, and to Grade 2 where profiles were deeper than 60cm.

3.2.14. The areas of each ALC grade are given in Table 2 and are shown in Figure RAC6753-2.

[7] Ibid. **MAFF (1988).**

Table 2: Agricultural Land Classification

Grade	Description	Area (ha)	% of agricultural land
2	Very good quality	4.5	1.6
3a	Good quality	23.4	8.2
3b	Moderate quality	221.0	77.0
5	Very poor quality	38.0	13.2
	Total Agricultural	286.9	100
	Non-Agricultural	35.8	-

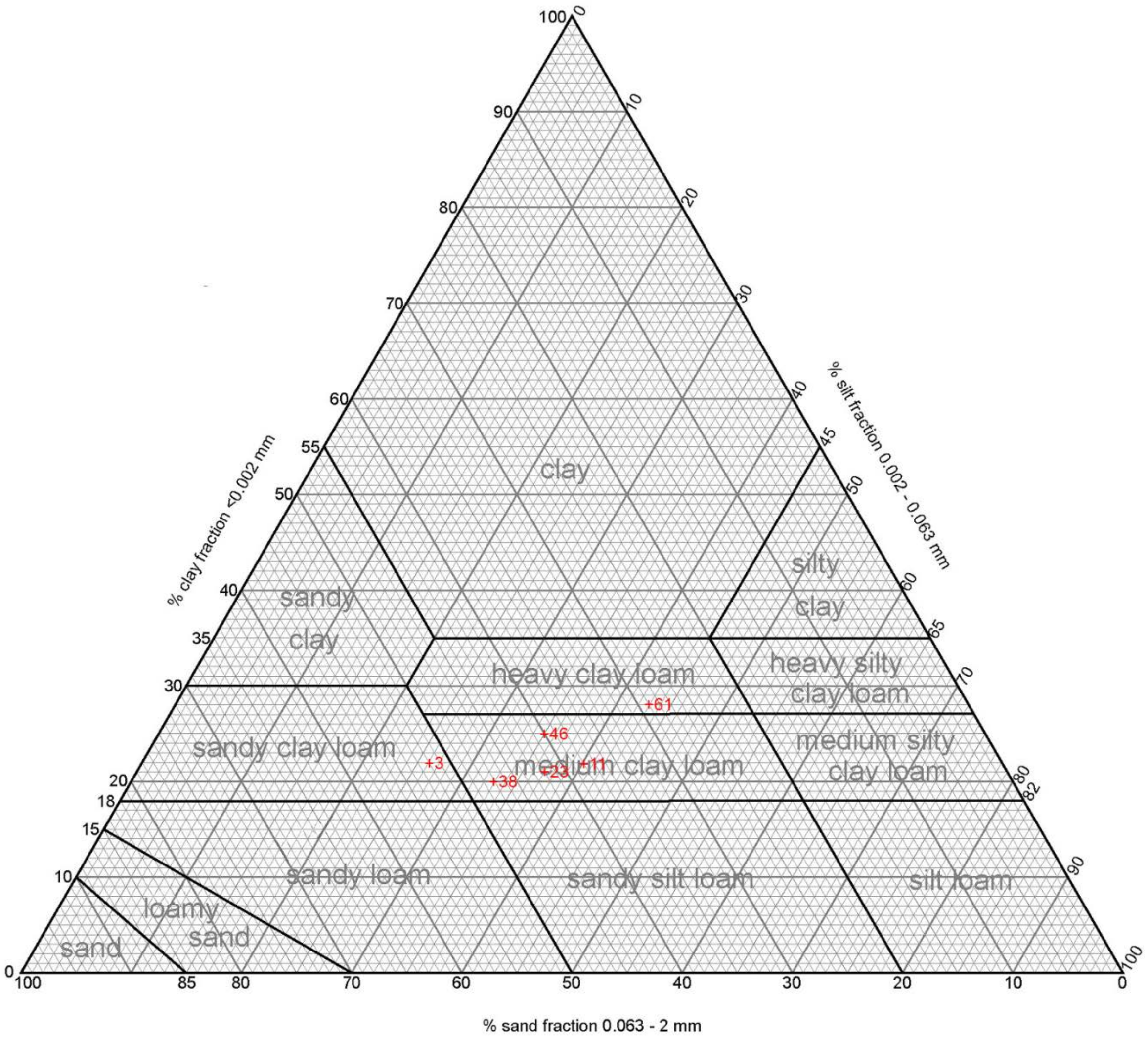
Appendix 1: Laboratory Data

Determinand	Site 3	Site 11	Site 23	Site 38	Site46	Site 61	Units
Sand 2.00-0.063 mm	52	38	42	47	40	29	% w/w
Silt 0.063-0.002 mm	26	40	37	33	35	43	%w/w
Clay <0.002 mm	22	22	21	20	25	28	% w/w
Organic Matter WB	7.0	3.2	5.1	4.7	5.9	5.9	% w/w
Texture	Sandy Clay Loam	Medium Clay Loam	Medium Clay Loam	Medium Clay Loam	Medium Clay Loam	Heavy Clay Loam	% w/w

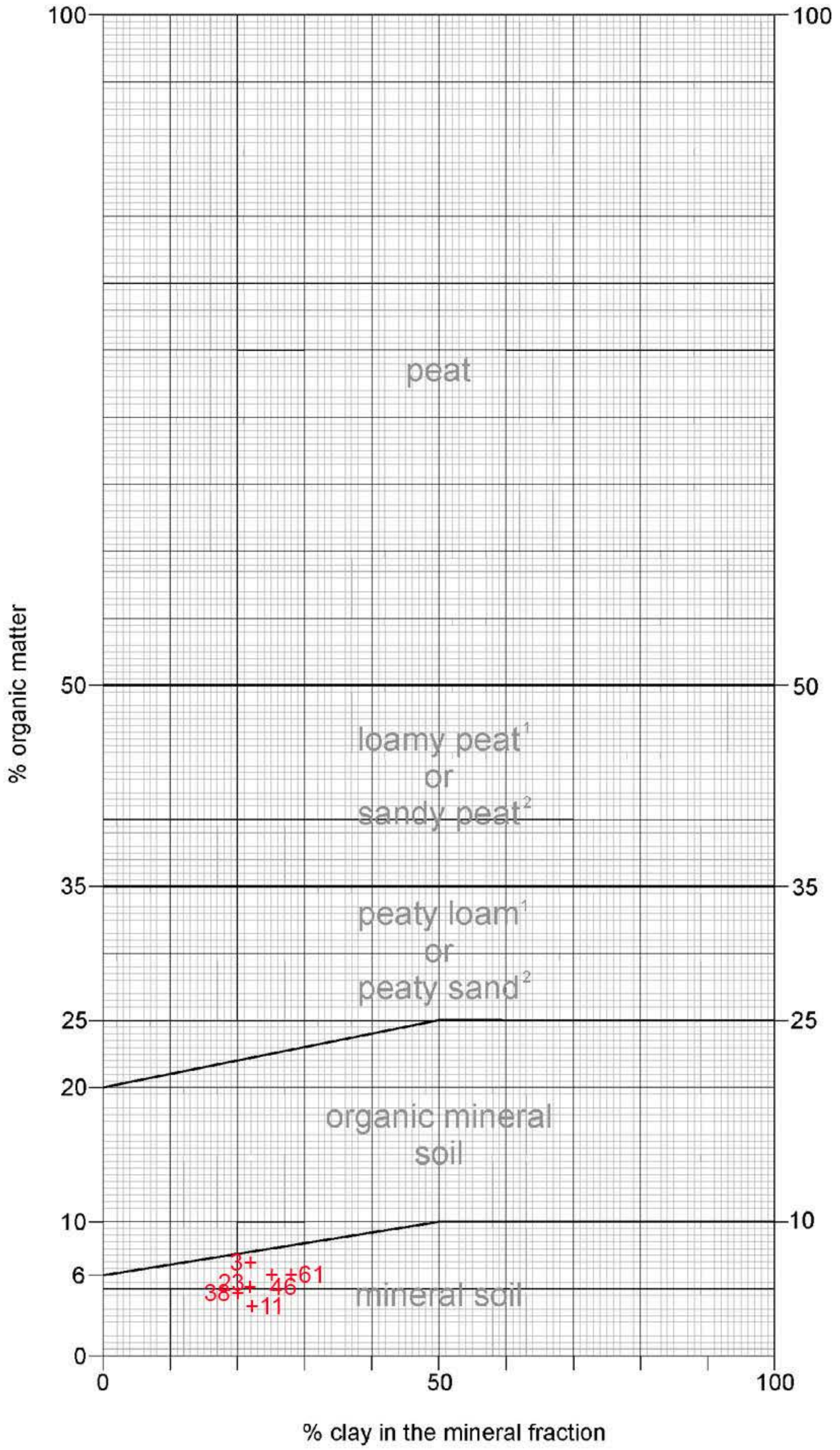
Determinand	Site 3	Site 11	Site 23	Site 38	Site 46	Site 61	Units
Soil pH	5.8	6.4	5.8	5.7	5.7	5.6	
Phosphorus (P)	9.6	9.6	4.2	7.4	16.8	10.0	mg/l (av)
Potassium (K)	84.6	68.5	64.8	50.8	344	84.6	mg/l (av)
Magnesium (Mg)	130	70.1	78.7	77.8	145	75.1	mg/l (av)

Determinand	Site 3	Site 11	Site 23	Site 38	Site 46	Site 61	Units
Phosphorus (P)	1	1	0	0	2	1	ADAS Index
Potassium (K)	1	1	1	0	3	1	ADAS Index
Magnesium (Mg)	3	2	2	2	3	2	ADAS Index

Soil Texture by Particle Size Analysis



Organic Matter Class



[1] Less than 50% sand in the mineral fraction

[2] 50% sand or more in the mineral fraction

Appendix 2: Example Soil Profile Summaries and Droughtiness Calculations

Droughtiness calculations are made according to the methodology given in Appendix 4 of the ALC guidelines, MAFF 1988.
The following grades represent the extent of the limitation posed by droughtiness only. Other factors will also influence the final grading.

MDw= 91 MDp= 79

								Wheat Calculation			Potato Calculation	
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
1	0	20	mSL	10YR4/2		1	1	17	33.7	1	17	33.7
	28	40	mSL			10	1	15	16.3	1	15	16.3
								Total (mm) =	50.0		Total (mm) =	50.0
								MBw=	-41.0		MBp=	-29.0
								Grade =	3b		Grade =	3a

								Wheat Calculation			Potato Calculation	
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
2	0	27	mSL	10YR4/2		1	1	17	45.5	1	17	45.5
	27	50	LmS	10YR4/3	femns	10	1	9	18.9	1	9	18.9
	50	61	LmS	10YR4/3	femns	10	1	6	6.1	1	9	9.0
								Total (mm) =	70.4		Total (mm) =	73.3
								MBw=	-20.6		MBp=	-5.7
								Grade =	3b		Grade =	2

								Wheat Calculation			Potato Calculation	
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
7	0	19	SCL	10YR4/2		1	1	17	32.0	1	17	32.0
	19	40	SCL	10YR4/4		5	1	15	30.0	1	15	30.0
								Total (mm) =	62.0		Total (mm) =	62.0
								MBw=	-29.0		MBp=	-17.0
								Grade =	3b		Grade =	3a

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
8	0	23	MCL	10YR4/2		1	1	18	41.0	1	18	41.0
	23	40	MCL	10YR4/4		5	1	16	25.9	1	16	25.9
								Total (mm) =	66.9		Total (mm) =	66.9
								MBw=	-24.1		MBp=	-12.1
								Grade =	3b		Grade =	3a

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
10	0	48	mSL	10YR4/2		1	1	17	80.8	1	17	80.8
	48	50	mSL	7.5YR4/3		5	1	15	2.9	1	15	2.9
	50	57	mSL	7.5YR4/3		5	0.5	11	7.3	1	15	10.0
	57	60	SCL	7.5YR4/3		5	0.5	10	2.9	1	15	4.3
								Total (mm) =	93.9		Total (mm) =	98.0
								MBw=	2.9		MBp=	19.0
								Grade =	3a		Grade =	1

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
11/P2	0	49	MCL	10YR4/2		5	1	18	84.0	1	18	84.0
	49	50	mSL	7.5YR4/4		0	1	15	1.5	1	15	1.5
	50	70	mSL	7.5YR4/4		0	1	11	22.0	1	15	30.0
								Total (mm) =	107.5		Total (mm) =	115.5
								MBw=	16.5		MBp=	36.5
								Grade =	2		Grade =	1

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm

17	0	48	MCL	10YR4/3		0	1	18	86.4	1	18	86.4
	48	50	C	10YR5/3	fff och	0	1	13	2.6	1	13	2.6
	50	55	C	10YR5/3	fff och	0	1	7	3.5	1	13	6.5
								Total (mm) =	89.0		Total (mm) =	89.0
								MBw=	-2.0		MBp=	10.0
								Grade =	3a		Grade =	1

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
18/P3	0	22	MCL	10YR4/3	cfd och	5	1	18	37.7	1	18	37.7
	22	50	C	10YR4/1	cmf och	15	1	13	31.4	1	13	31.4
	50	70	C	10YR4/1	cmf och	15	1	7	12.2	1	13	22.4
								Total (mm) =	81.3		Total (mm) =	91.5
								MBw=	-9.7		MBp=	12.5
								Grade =	3a		Grade =	1

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
23/P4	0	31	mSL	10YR4/2		10	1	17	47.7	1	17	47.7
	31	50	mSL	10YR4/2		15	1	15	24.5	1	15	24.5
	50	57	mSL	10YR4/2		15	1	11	6.7	1	15	9.0
								Total (mm) =	78.9		Total (mm) =	81.3
								MBw=	-12.1		MBp=	2.3
								Grade =	3a		Grade =	2

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
24	0	48	SCL	10YR4/2		5	1	17	77.8	1	17	77.8
	48	50	SCL	10YR5/3	fff och + grey	10	1	13	2.4	1	13	2.4
	50	55	SCL	10YR5/3	fff och + grey	10	0.5	8	3.6	1	13	5.9

								Total (mm) =	83.7		Total (mm) =	86.0
								MBw=	-7.3		MBp=	7.0
								Grade =	3a		Grade =	2

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
32	0	27	MCL	10YR4/3		0	1	18	48.6	1	18	48.6
	27	40	HCL	10YR5/3	fff och + grey	10	1	12	14.2	1	12	14.2
	40	50	HCL	10YR5/3	fff och + grey	10	1	7	6.4	1	12	10.9
	50	68	HCL	10YR5/3	fff och + grey	10	0.5	7	11.4	1	12	19.6
								Total (mm) =	80.6		Total (mm) =	93.3
								MBw=	-10.4		MBp=	14.3
								Grade =	3a		Grade =	1

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
37	0	27	MCL	10YR4/3		0	1	18	48.6	1	18	48.6
	27	50	SCL	7.5YR4/4		0	1	15	34.5	1	15	34.5
	50	51	SCL	7.5YR4/4		0	0.5	10	1.0	1	15	1.5
								Total (mm) =	84.1		Total (mm) =	84.6
								MBw=	-6.9		MBp=	5.6
								Grade =	3a		Grade =	2

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
38/P5	0	39	MCL	10YR4/3		10	1	18	63.6	1	18	63.6
								Total (mm) =	63.6		Total (mm) =	63.6
								MBw=	-27.4		MBp=	-15.4
								Grade =	3b		Grade =	3a

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
40	0	38	MCL	10YR4/3		0	1	18	68.4	1	18	68.4
	38	50	C	10YR4/3	cmf-d och + grey	0	1	13	15.6	1	13	15.6
	50	59	C	10YR4/3	cmf-d och + grey	0	1	7	6.3	1	13	11.7
								Total (mm) =	90.3		Total (mm) =	95.7
								MBw=	-0.7		MBp=	16.7
								Grade =	3a		Grade =	1
								Wheat Calculation			Potato Calculation	

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
43	0	43	MCL	10YR4/3		0	1	18	77.4	1	18	77.4
	43	50	MCL	7.5YR4/3	fvff och	0	1	16	11.2	1	16	11.2
	50	66	MCL	7.5YR4/3	fvff och	0	0.5	10	16.0	1	16	25.6
								Total (mm) =	104.6		Total (mm) =	114.2
								MBw=	13.6		MBp=	35.2
								Grade =	2		Grade =	1
								Wheat Calculation			Potato Calculation	

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
44	0	20	MCL	10YR4/3		5	1	18	34.3	5	18	34.7
	20	50	MCL	10YR4/3	fmd och	5	1	16	45.8	5	16	46.4
	50	70	MCL	10YR5/3	mmd och	5	0.5	7	13.4	5	12	23.3
	70	80	MCL	10YR5/3	mmd och	5	0.5	7	6.7			0.0
								Total (mm) =	100.1		Total (mm) =	104.4
								MBw=	9.1		MBp=	25.4
								Grade =	2		Grade =	1
								Wheat Calculation			Potato Calculation	

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
57	0	34	HCL	10YR4/2		5	1	18	58.3	5	18	59.0
	34	50	C	10YR4/1	fmd och	5	1	13	19.8	5	13	20.2
	50	63	C	10YR4/1	mmd och	5	0.5	7	8.7	5	13	16.4
								Total (mm) =	86.8		Total (mm) =	95.5
								MBw=	-4.2		MBp=	16.5
								Grade =	3a		Grade =	1
								Wheat Calculation			Potato Calculation	

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
58	0	30	HCL	10YR4/2	fff och	5	1	18	51.5	5	18	52.1
								Total (mm) =	51.5		Total (mm) =	52.1
								MBw=	-39.6		MBp=	-27.0
								Grade =	3b		Grade =	3a
								Wheat Calculation			Potato Calculation	

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
59	0	20	MCL	10YR4/3		5	1	18	34.3	5	18	34.7
	20	45	MCL	10YR4/3	fff och	5	1	16	38.1	5	16	38.6
	45	50	HCL	10YR5/3	mmd och	5	1	12	5.7	5	12	5.8
	50	55	HCL	10YR5/3	mmd och	5	0.5	7	3.3	5	12	5.8
								Total (mm) =	81.5		Total (mm) =	85.0
								MBw=	-9.5		MBp=	6.0
								Grade =	3a		Grade =	2
								Wheat Calculation			Potato Calculation	

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
60	0	30	MCL	10YR4/3	fff och	5	1	18	51.5	5	18	52.1
	30	50	HCL	10YR5/3	mmd och	5	1	12	22.9	5	12	23.3

	50	58	HCL	10YR5/3	mmd och	5	0.5	7	5.3	5	12	9.3
								Total (mm) =	79.7		Total (mm) =	84.7
								MBw=	-11.3		MBp=	5.7
								Grade =	3a		Grade =	2

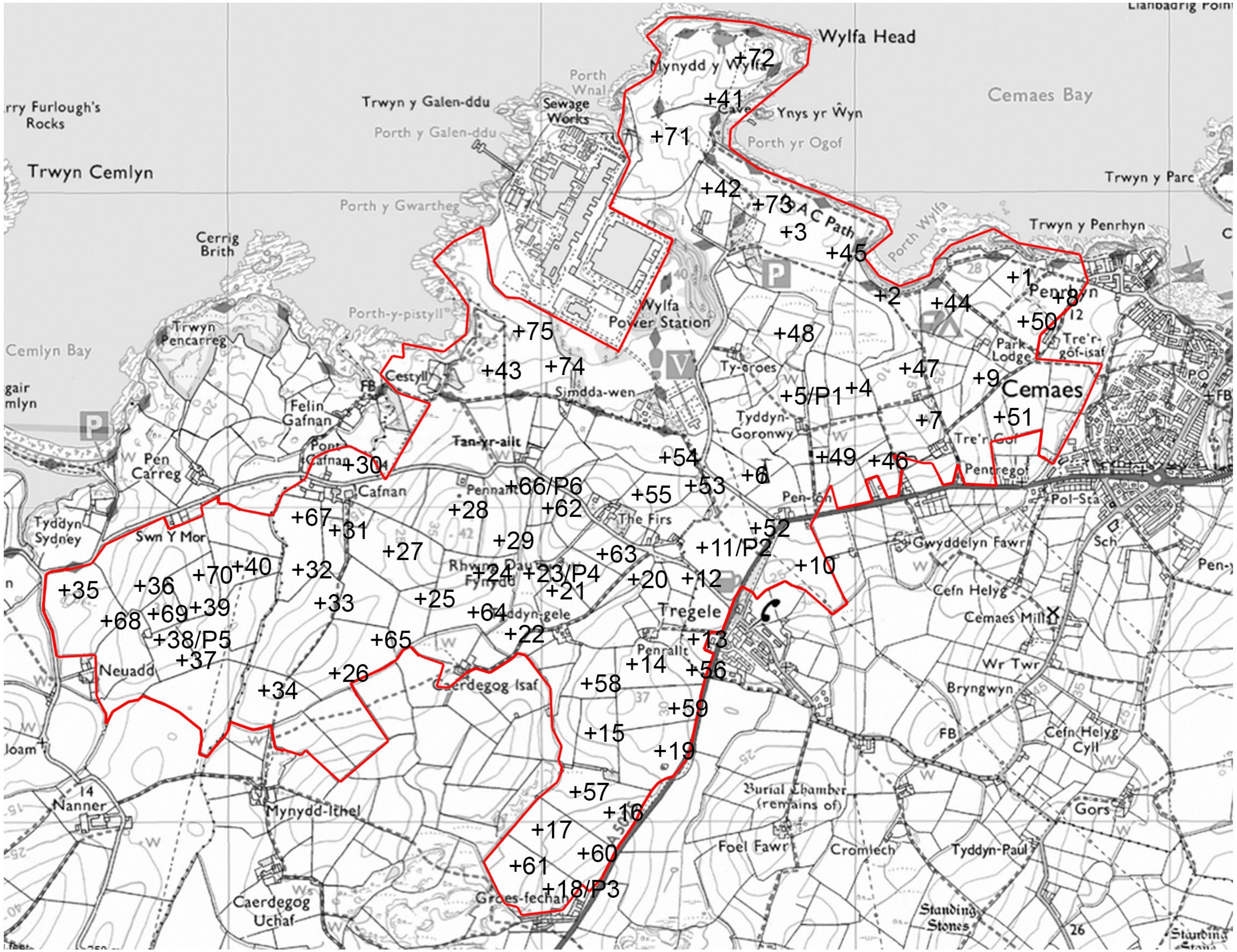
							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
61	0	30	HCL	10YR4/3	fff och	5	1	18	51.5	5	18	52.1
	30	50	HCL	10YR4/3	mmd och	5	1	12	22.9	5	12	23.3
	50	60	HCL	10YR4/3	mmd och	5	0.5	7	6.7	5	12	11.7
								Total (mm) =	81.0		Total (mm) =	87.0
								MBw=	-10.0		MBp=	8.0
								Grade =	3a		Grade =	2

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
62	0	20	HCL	10YR4/3	fff och	5	1	18	34.3	5	18	34.7
								Total (mm) =	34.3		Total (mm) =	34.7
								MBw=	-56.7		MBp=	-44.3
								Grade =	4		Grade =	3b

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
66	0	30	MCL	10YR4/3	fff och	5	1	18	51.5	5	18	52.1
	30	40	SL	10YR4/3	fff och	5	1	15	14.3	5	15	14.5
	40	50	SL	10YR4/3	fff och	5	1	15	14.3	5	15	14.5
	50	70	SL	10YR4/3	fff och	5	0.5	11	21.0			0.0
								Total (mm) =	101.0		Total (mm) =	81.1
								MBw=	10.0		MBp=	2.1
								Grade =	2		Grade =	2

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
73	0	40	SCL	10YR3/3		5	1	17	64.8	5	17	65.6
	40	50	mSL	10YR4/4	mmd och	5	1	15	14.3	5	15	14.5
	50	70	mSL	10YR4/4	mmd och	5	1	11	21.0	5	15	29.0
	70	120	mSL	10YR4/4	mmd och	5	1	11	52.5			
								Total (mm) =	152.6		Total (mm) =	109.1
								MBw=	61.6		MBp=	30.1
								Grade =	1		Grade =	1

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
74	0	<u>16</u>	SCL	10YR3/3		5	1	17	25.9	5	17	26.2
								Total (mm) =	25.9		Total (mm) =	26.2
								MBw=	-65.1		MBp=	-52.8
								Grade =	4		Grade =	3b



Survey Area

.1 Auger Observation

.P1 Pit Observation

DRAWING TITLE

RAC6753-1: Observations

CONTRACT

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Reading Agricultural Consultants Ltd
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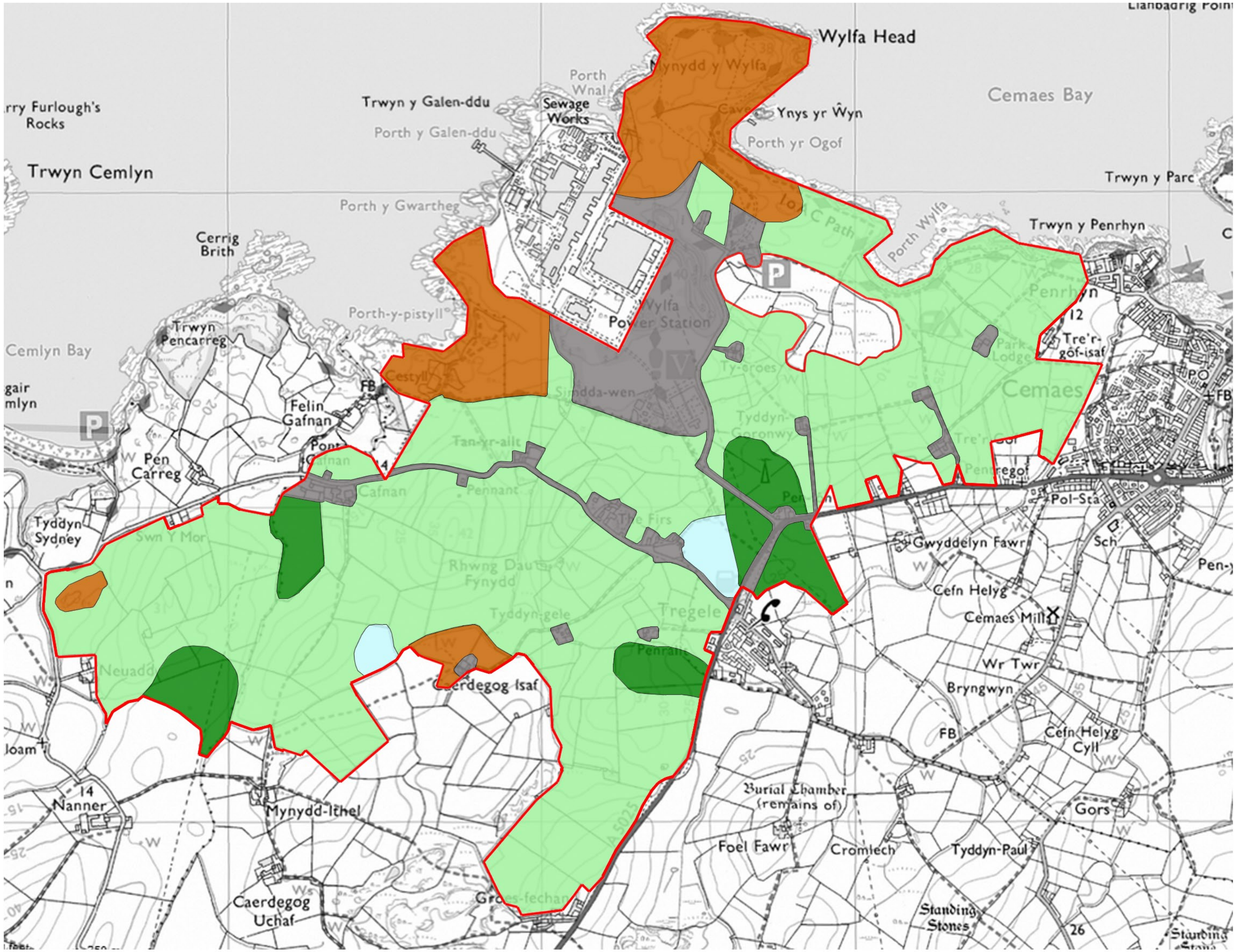
June/2015



N

- * Grade 1 - excellent quality
- Grade 2 - very good quality
- Subgrade 3a - good quality

} Best and most versatile land

- Subgrade 3b - moderate quality
- * Grade 4 - poor quality
- Grade 5 - very poor quality
- * Not Present

DRAWING TITLE

RAC6753-2: Agricultural Land Classification

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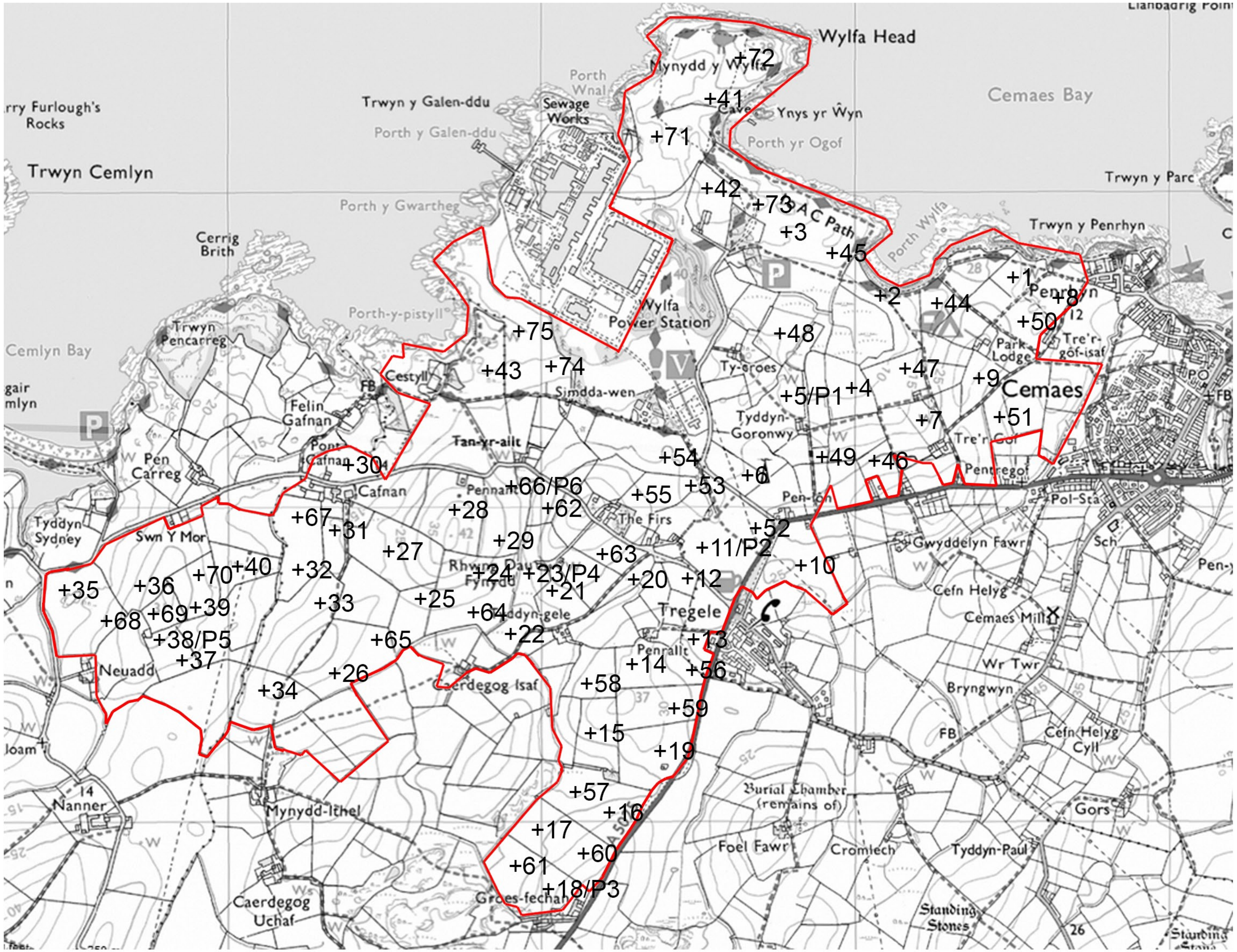
June/2015



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Survey Area
.1 Auger Observation
.P1 Pit Observation

DRAWING TITLE

RAC6753-1: Observations

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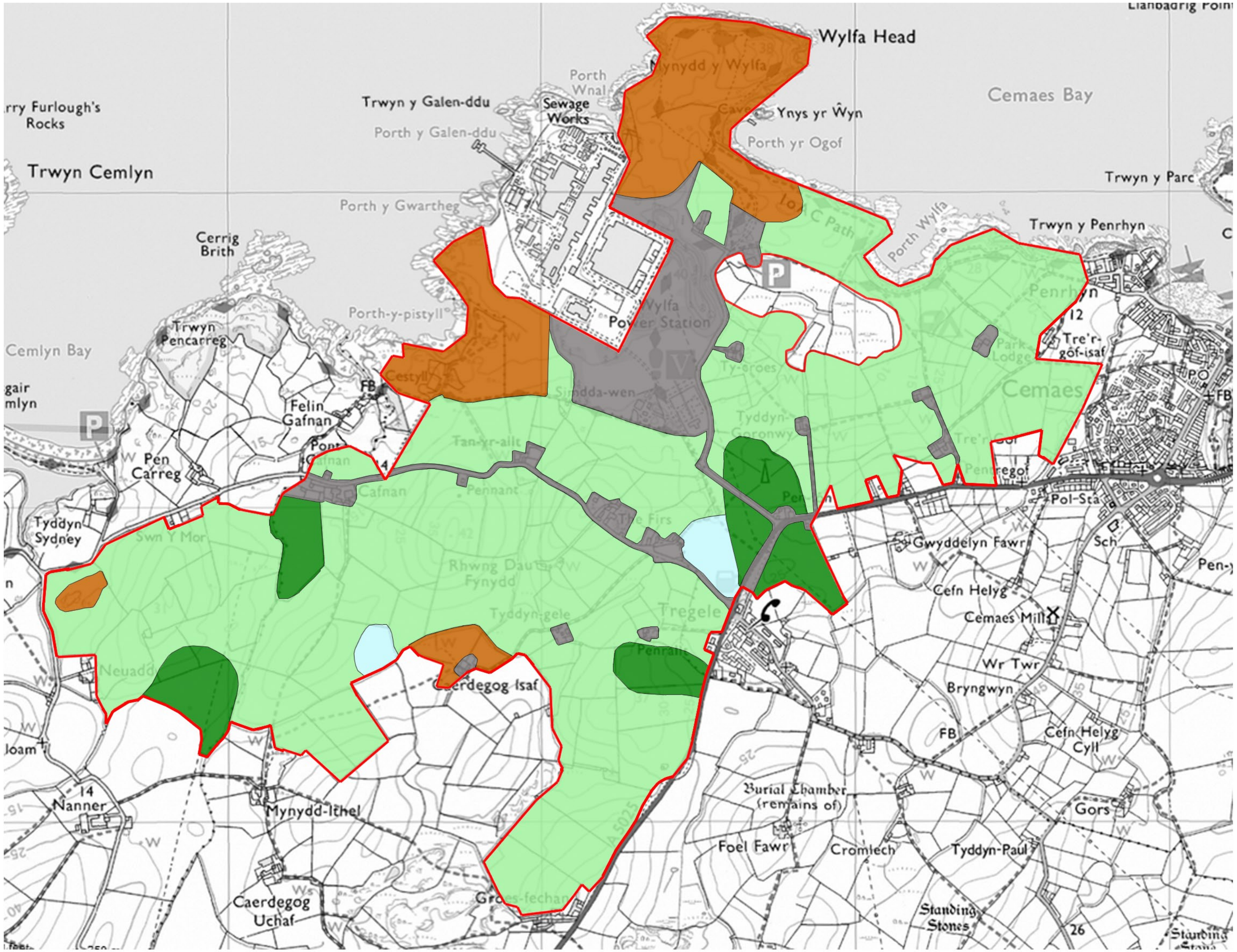

N

Legend	
Grade 1 - excellent quality *	Best and most versatile land
Grade 2 - very good quality	
Subgrade 3a - good quality	
Subgrade 3b - moderate quality	
Grade 4 - poor quality *	
Grade 5 - very poor quality	
* Not Present	

DRAWING TITLE

RAC6753-2: Agricultural Land Classification

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Droughtiness calculations are made according to the methodology given in Appendix 4 of the ALC guidelines, MAFF 1988.

The following grades represent the extent of the limitation posed by droughtiness only. Other factors will also influence the final grading.

MDw= 91 MDp= 79

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
1	0	20	mSL	10YR4/2		1	1	17	33.7	1	17	33.7
	28	40	mSL			10	1	15	16.3	1	15	16.3
								Total (mm) =	50.0		Total (mm) =	50.0
								MBw=	-41.0		MBp=	-29.0
								Grade =	3b		Grade =	3a

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
2	0	27	mSL	10YR4/2		1	1	17	45.5	1	17	45.5
	27	50	LmS	10YR4/3	femns	10	1	9	18.9	1	9	18.9
	50	61	LmS	10YR4/3	femns	10	1	6	6.1	1	9	9.0
								Total (mm) =	70.4		Total (mm) =	73.3
								MBw=	-20.6		MBp=	-5.7
								Grade =	3b		Grade =	2

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
3	0	22	SCL	10YR4/2		1	1	17	37.0	1	17	37.0
	22	40	mSL	10YR4/3		10	1	15	24.5	1	15	24.5
								Total (mm) =	61.5		Total (mm) =	61.5
								MBw=	-29.5		MBp=	-17.5
								Grade =	3b		Grade =	3a

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	Wheat Calculation			Potato Calculation		
							TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
4	0	26	MCL	10YR4/2		0	1	18	46.8	1	18	46.8
	26	40	mSL	10YR4/3		10	1	15	19.0	1	15	19.0
								Total (mm) =	65.8		Total (mm) =	65.8
								MBw=	-25.2		MBp=	-13.2
								Grade =	3b		Grade =	3a

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	Wheat Calculation			Potato Calculation		
							TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
5/P1	0	40	mSL	10YR4/2		15	1	17	58.4	1	17	58.4
								Total (mm) =	58.4		Total (mm) =	58.4
								MBw=	-32.6		MBp=	-20.6
								Grade =	3b		Grade =	3a

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	Wheat Calculation			Potato Calculation		
							TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
6	0	47	mSL	10YR4/2		1	1	17	79.1	1	17	79.1
	47	50	mSL	10YR4/4	femns	5	1	15	4.3	1	15	4.3
	50	55	mSL	10YR4/4	femns	5	1	11	5.3	1	15	7.2
								Total (mm) =	88.7		Total (mm) =	90.6
								MBw=	-2.3		MBp=	11.6
								Grade =	3a		Grade =	1

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	Wheat Calculation			Potato Calculation		
							TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
7	0	19	SCL	10YR4/2		1	1	17	32.0	1	17	32.0

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
	19	40	SCL	10YR4/4		5	1	15	30.0	1	15	30.0
								Total (mm) =	62.0		Total (mm) =	62.0
								MBw=	-29.0		MBp=	-17.0
								Grade =	3b		Grade =	3a

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
8	0	23	MCL	10YR4/2		1	1	18	41.0	1	18	41.0
	23	40	MCL	10YR4/4		5	1	16	25.9	1	16	25.9
								Total (mm) =	66.9		Total (mm) =	66.9
								MBw=	-24.1		MBp=	-12.1
								Grade =	3b		Grade =	3a

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
9	0	20	mSL	10YR4/2		1	1	17	33.7	1	17	33.7
	20	40	mSL	10YR4/4		5	1	15	28.6	1	15	28.6
								Total (mm) =	62.3		Total (mm) =	62.3
								MBw=	-28.7		MBp=	-16.7
								Grade =	3b		Grade =	3a

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
10	0	48	mSL	10YR4/2		1	1	17	80.8	1	17	80.8
	48	50	mSL	7.5YR4/3		5	1	15	2.9	1	15	2.9
	50	57	mSL	7.5YR4/3		5	0.5	11	7.3	1	15	10.0
	57	60	SCL	7.5YR4/3		5	0.5	10	2.9	1	15	4.3

Total (mm) =	93.9	Total (mm) =	98.0
MBw=	2.9	MBp=	19.0
Grade =	3a	Grade =	1

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	Wheat Calculation: TAv or EAv (stones) %	Wheat Calculation: TAv or EAv (soil) %	Wheat Calculation: AP (wheat) mm	Potato Calculation: TAv (stones) %	Potato Calculation: TAv (soil) %	Potato Calculation: AP (potatoes) mm
11/P2	0	49	MCL	10YR4/2		5	1	18	84.0	1	18	84.0
	49	50	mSL	7.5YR4/4		0	1	15	1.5	1	15	1.5
	50	70	mSL	7.5YR4/4		0	1	11	22.0	1	15	30.0

Total (mm) =	107.5	Total (mm) =	115.5
MBw=	16.5	MBp=	36.5
Grade =	2	Grade =	1

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	Wheat Calculation: TAv or EAv (stones) %	Wheat Calculation: TAv or EAv (soil) %	Wheat Calculation: AP (wheat) mm	Potato Calculation: TAv (stones) %	Potato Calculation: TAv (soil) %	Potato Calculation: AP (potatoes) mm
12	0	36	SCL	10YR4/2		5	1	17	58.3	1	17	58.3
	36	42	SCL	10YR5/4	vffd och	2	1	15	8.8	1	15	8.8

Total (mm) =	67.2	Total (mm) =	67.2
MBw=	-23.8	MBp=	-11.8
Grade =	3b	Grade =	3a

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	Wheat Calculation: TAv or EAv (stones) %	Wheat Calculation: TAv or EAv (soil) %	Wheat Calculation: AP (wheat) mm	Potato Calculation: TAv (stones) %	Potato Calculation: TAv (soil) %	Potato Calculation: AP (potatoes) mm
13	0	23	SCL	10YR4/2	fff och	2	1	17	38.4	1	17	38.4
	23	40	SCL	10YR4/2	fff och	2	1	15	25.0	1	15	25.0

Total (mm) =	63.4	Total (mm) =	63.4
MBw=	-27.6	MBp=	-15.6
Grade =	3b	Grade =	3a

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
14	0	39	MCL	10YR4/2		5	1	18	66.9	1	18	66.9
	39	50	SCL	10YR5/3	cmd och	2	1	15	16.2	1	15	16.2
	50	54	SCL	10YR5/3	cmd och	2	1	11	4.3	1	15	5.9
								Total (mm) =	87.4		Total (mm) =	89.0
								MBw=	-3.6		MBp=	10.0
								Grade =	3a		Grade =	2

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
15	0	36	mSL	10YR4/2		5	1	17	58.3	1	17	58.3
	36	40	mSL	10YR4/2		2	1	15	5.9	1	15	5.9
								Total (mm) =	64.2		Total (mm) =	64.2
								MBw=	-26.8		MBp=	-14.8
								Grade =	3b		Grade =	3a

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
16	0	29	SCL	10YR4/3	fff och	5	1	17	47.0	1	17	47.0
	29	40	SCL	10YR4/3	fff och	2	1	15	16.2	1	15	16.2
								Total (mm) =	63.2		Total (mm) =	63.2
								MBw=	-27.8		MBp=	-15.8
								Grade =	3b		Grade =	3a

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm

17	0	48	MCL	10YR4/3		0	1	18	86.4	1	18	86.4
	48	50	C	10YR5/3	fff och	0	1	13	2.6	1	13	2.6
	50	55	C	10YR5/3	fff och	0	1	7	3.5	1	13	6.5
								Total (mm) =	89.0		Total (mm) =	89.0
								MBw=	-2.0		MBp=	10.0
								Grade =	3a		Grade =	1

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
18/P3	0	22	MCL	10YR4/3	cfd och	5	1	18	37.7	1	18	37.7
	22	50	C	10YR4/1	cmf och	15	1	13	31.4	1	13	31.4
	50	70	C	10YR4/1	cmf och	15	1	7	12.2	1	13	22.4
								Total (mm) =	81.3		Total (mm) =	91.5
								MBw=	-9.7		MBp=	12.5
								Grade =	3a		Grade =	1

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
19	0	38	mSL	10YR4/2		0	1	17	64.6	1	17	64.6
	38	40	mSL	10YR4/2		0	1	15	3.0	1	15	3.0
								Total (mm) =	67.6		Total (mm) =	67.6
								MBw=	-23.4		MBp=	-11.4
								Grade =	3b		Grade =	3a

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
20	0	40	MCL	10YR4/2	cfd och	5	1	18	68.6	1	18	68.6
	40	50	MCL	10YR5/1	cmf och	10	1	13	11.8	1	13	11.8

	50	70	MCL	10YR5/1	cmf och	10	0.5	7	12.7	1	13	23.6
	70	120	MCL	10YR5/1	cmf och	10	0.5	7	31.8			
								Total (mm) =	124.9		Total (mm) =	104.0
								MBw=	33.9		MBp=	25.0
								Grade =	1		Grade =	1

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
21	0	28	MCL	10YR4/2	ffd och	0	1	18	50.4	1	18	50.4
	28	40	MCL	10YR4/2	ffd och	0	1	16	19.2	1	16	19.2
								Total (mm) =	69.6		Total (mm) =	69.6
								MBw=	-21.4		MBp=	-9.4
								Grade =	3b		Grade =	2

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
22	0	27	MCL	10YR4/2	fff och	0	1	18	48.6	1	18	48.6
	27	42	C	10YR5/1	fff och	0	1	13	19.5	1	13	19.5
								Total (mm) =	68.1		Total (mm) =	68.1
								MBw=	-22.9		MBp=	-10.9
								Grade =	3b		Grade =	3a

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
23/P4	0	31	mSL	10YR4/2		10	1	17	47.7	1	17	47.7
	31	50	mSL	10YR4/2		15	1	15	24.5	1	15	24.5
	50	57	mSL	10YR4/2		15	1	11	6.7	1	15	9.0

								Total (mm) =	78.9		Total (mm) =	81.3
								MBw=	-12.1		MBp=	2.3
								Grade =	3a		Grade =	2

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
24	0	48	SCL	10YR4/2		5	1	17	77.8	1	17	77.8
	48	50	SCL	10YR5/3	fff och + grey	10	1	13	2.4	1	13	2.4
	50	55	SCL	10YR5/3	fff och + grey	10	0.5	8	3.6	1	13	5.9
								Total (mm) =	83.7		Total (mm) =	86.0
								MBw=	-7.3		MBp=	7.0
								Grade =	3a		Grade =	2

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
25	0	41	MCL	10YR4/3		5	1	18	70.3	1	18	70.3
	41	50	MCL	10YR4/3	fff och + femns	5	1	12	10.3	1	12	10.3
	50	59	MCL	10YR4/3	fff och + femns	5	0.5	7	6.0	1	12	10.3
								Total (mm) =	86.6		Total (mm) =	90.9
								MBw=	-4.4		MBp=	11.9
								Grade =	3a		Grade =	1

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
26	0	14	SCL	10YR3/2		0	1	17	23.8	1	17	23.8
	14	40	SCL	10YR3/2		10	1	15	35.4	1	15	35.4
								Total (mm) =	59.2		Total (mm) =	59.2
								MBw=	-31.8		MBp=	-19.8

								Grade =	3b		Grade =	3a

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
27	0	22	SCL	10YR3/2		0	1	17	37.4	1	17	37.4
	22	40	SCL	10YR3/2		10	1	15	24.5	1	15	24.5
								Total (mm) =	61.9		Total (mm) =	61.9
								MBw=	-29.1		MBp=	-17.1
								Grade =	3b		Grade =	3a

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
28	0	14	MCL	10YR3/2		0	1	18	25.2	1	18	25.2
	14	40	MCL	10YR3/2		10	1	16	37.7	1	16	37.7
								Total (mm) =	62.9		Total (mm) =	62.9
								MBw=	-28.1		MBp=	-16.1
								Grade =	3b		Grade =	3a

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
29	0	20	MCL	10YR4/2		0	1	18	36.0	1	18	36.0
	20	40	MCL	10YR4/2		10	1	16	29.0	1	16	29.0
								Total (mm) =	65.0		Total (mm) =	65.0
								MBw=	-26.0		MBp=	-14.0
								Grade =	3b		Grade =	3a

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm

30	0	28	MCL	10YR4/2		0	1	18	50.4	1	18	50.4
	28	38	MCL	10YR4/3	fff-d och	10	1	12	10.9	1	12	10.9
								Total (mm) =	61.3		Total (mm) =	61.3
								MBw=	-29.7		MBp=	-17.7
								Grade =	3b		Grade =	3a

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
31	0	28	MCL	10YR4/2	cff och	0	1	18	50.4	1	18	50.4
	28	40	MCL	10YR4/2	cff och	10	1	16	17.4	1	16	17.4
								Total (mm) =	67.8		Total (mm) =	67.8
								MBw=	-23.2		MBp=	-11.2
								Grade =	3b		Grade =	3a

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
32	0	27	MCL	10YR4/3		0	1	18	48.6	1	18	48.6
	27	40	HCL	10YR5/3	fff och + grey	10	1	12	14.2	1	12	14.2
	40	50	HCL	10YR5/3	fff och + grey	10	1	7	6.4	1	12	10.9
	50	68	HCL	10YR5/3	fff och + grey	10	0.5	7	11.4	1	12	19.6
								Total (mm) =	80.6		Total (mm) =	93.3
								MBw=	-10.4		MBp=	14.3
								Grade =	3a		Grade =	1

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
33	0	33	MCL	10YR4/3		0	1	18	59.4	1	18	59.4
	33	40	MCL	10YR4/3		0	1	16	11.2	1	16	11.2

Total (mm) =	70.6	
MBw=	-20.4	
Grade =	3b	

Total (mm) =	70.6	
MBp=	-8.4	
Grade =	2	

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	Wheat Calculation: TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	Potato Calculation: TAv (stones) %	TAv (soil) %	AP (potatoes) mm
34	0	20	SCL	10YR4/2		0	1	17	34.0	1	17	34.0
	20	40	SCL	10YR4/2		0	1	15	30.0	1	15	30.0
								Total (mm) =	64.0		Total (mm) =	64.0
								MBw=	-27.0		MBp=	-15.0
								Grade =	3b		Grade =	3a

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	Wheat Calculation: TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	Potato Calculation: TAv (stones) %	TAv (soil) %	AP (potatoes) mm
35	0	16	MCL	10YR3/3		0	1	18	28.8	1	18	28.8
	16	40	MCL	10YR3/3		0	1	16	38.4	1	16	38.4
								Total (mm) =	67.2		Total (mm) =	67.2
								MBw=	-23.8		MBp=	-11.8
								Grade =	3b		Grade =	3a

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	Wheat Calculation: TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	Potato Calculation: TAv (stones) %	TAv (soil) %	AP (potatoes) mm
36	0	24	MCL	10YR4/3		0	1	18	43.2	1	18	43.2
	24	40	MCL	10YR4/3		0	1	16	25.6	1	16	25.6
								Total (mm) =	68.8		Total (mm) =	68.8
								MBw=	-22.2		MBp=	-10.2
								Grade =	3b		Grade =	3a

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
37	0	27	MCL	10YR4/3		0	1	18	48.6	1	18	48.6
	27	50	SCL	7.5YR4/4		0	1	15	34.5	1	15	34.5
	50	51	SCL	7.5YR4/4		0	0.5	10	1.0	1	15	1.5
								Total (mm) =	84.1		Total (mm) =	84.6
								MBw=	-6.9		MBp=	5.6
								Grade =	3a		Grade =	2

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
38/P5	0	39	MCL	10YR4/3		10	1	18	63.6	1	18	63.6
								Total (mm) =	63.6		Total (mm) =	63.6
								MBw=	-27.4		MBp=	-15.4
								Grade =	3b		Grade =	3a

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
39	0	37	SCL	10YR4/3		10	1	17	57.0	1	17	57.0
	37	40	SCL	10YR4/3		10	1	15	4.1	1	15	4.1
								Total (mm) =	61.1		Total (mm) =	61.1
								MBw=	-29.9		MBp=	-17.9
								Grade =	3b		Grade =	3a

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
40	0	38	MCL	10YR4/3		0	1	18	68.4	1	18	68.4

	38	50	C	10YR4/3	cmf-d och + grey	0	1	13	15.6	1	13	15.6
	50	59	C	10YR4/3	cmf-d och + grey	0	1	7	6.3	1	13	11.7
								Total (mm) =	90.3		Total (mm) =	95.7
								MBw=	-0.7		MBp=	16.7
								Grade =	3a		Grade =	1

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
41	0	26	SCL	10YR4/3		0	1	17	44.2	1	17	44.2
	26	40	SCL	10YR4/3		0	1	15	21.0	1	15	21.0
								Total (mm) =	65.2		Total (mm) =	65.2
								MBw=	-25.8		MBp=	-13.8
								Grade =	3b		Grade =	3a

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
42	0	30	SCL	10YR4/3		0	1	17	51.0	1	17	51.0
	30	40	SCL	10YR4/3		0	1	15	15.0	1	15	15.0
								Total (mm) =	66.0		Total (mm) =	66.0
								MBw=	-25.0		MBp=	-13.0
								Grade =	3b		Grade =	3a

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
43	0	43	MCL	10YR4/3		0	1	18	77.4	1	18	77.4
	43	50	MCL	7.5YR4/3	fvff och	0	1	16	11.2	1	16	11.2
	50	66	MCL	7.5YR4/3	fvff och	0	0.5	10	16.0	1	16	25.6

Total (mm) =	104.6
MBw=	13.6
Grade =	2

Total (mm) =	114.2
MBp=	35.2
Grade =	1

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
44	0	20	MCL	10YR4/3		5	1	18	34.3	5	18	34.7
	20	50	MCL	10YR4/3	fmd och	5	1	16	45.8	5	16	46.4
	50	70	MCL	10YR5/3	mmd och	5	0.5	7	13.4	5	12	23.3
	70	80	MCL	10YR5/3	mmd och	5	0.5	7	6.7			0.0

Total (mm) =	100.1
MBw=	9.1
Grade =	2

Total (mm) =	104.4
MBp=	25.4
Grade =	1

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
45	0	30	MCL	10YR4/3		5	1	18	51.5	5	18	52.1

Total (mm) =	51.5
MBw=	-39.6
Grade =	3b

Total (mm) =	52.1
MBp=	-27.0
Grade =	3a

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
46	0	24	MCL	10YR4/3		5	1	18	41.2	5	18	41.6

Total (mm) =	41.2
MBw=	-49.8
Grade =	3b

Total (mm) =	41.6
MBp=	-37.4
Grade =	3b

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
47	0	24	MCL	10YR4/2		5	1	18	41.2	5	18	41.6

Total (mm) =	41.2	Total (mm) =	41.6
MBw=	-49.8	MBp=	-37.4
Grade =	3b	Grade =	3b

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	Wheat Calculation: TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	Potato Calculation: TAv (stones) %	TAv (soil) %	AP (potatoes) mm
48	0	30	MCL	10YR4/2	mmd och	5	1	18	51.5	5	18	52.1
	30	50	C	2.5YR5/1	fmd och	5	1	13	24.8	5	13	25.2

Total (mm) =	76.3	Total (mm) =	77.3
MBw=	-14.8	MBp=	-1.8
Grade =	3a	Grade =	2

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	Wheat Calculation: TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	Potato Calculation: TAv (stones) %	TAv (soil) %	AP (potatoes) mm
49	0	30	MCL	10YR4/3	mmd och	5	1	18	51.5	5	18	52.1

Total (mm) =	51.5	Total (mm) =	52.1
MBw=	-39.6	MBp=	-27.0
Grade =	3b	Grade =	3a

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	Wheat Calculation: TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	Potato Calculation: TAv (stones) %	TAv (soil) %	AP (potatoes) mm
50	0	30	MCL	10YR4/3	mmd och	5	1	18	51.5	5	18	52.1

Total (mm) =	51.5	Total (mm) =	52.1
MBw=	-39.6	MBp=	-27.0
Grade =	3b	Grade =	3a

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	Wheat Calculation: TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	Potato Calculation: TAv (stones) %	TAv (soil) %	AP (potatoes) mm
51	0	30	MCL	10YR4/3	mmd och	5	1	18	51.5	5	18	52.1

Total (mm) =	51.5	Total (mm) =	52.1

								MBw=	-39.6		MBp=	-27.0
								Grade =	3b		Grade =	3a
							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
52	0	20	MCL	10YR4/3		5	1	18	34.3	5	18	34.7
	20	50	MCL	10YR4/3	fmd och	5	1	16	45.8	5	16	46.4
								Total (mm) =	80.1		Total (mm) =	81.1
								MBw=	-11.0		MBp=	2.1
								Grade =	3a		Grade =	2

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
53	0	27	MCL	10YR4/3		5	1	18	46.3	5	18	46.8
								Total (mm) =	46.3		Total (mm) =	46.8
								MBw=	-44.7		MBp=	-32.2
								Grade =	3b		Grade =	3b

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
54	0	23	MCL	10YR4/3		5	1	18	39.4	5	18	39.9
								Total (mm) =	39.4		Total (mm) =	39.9
								MBw=	-51.6		MBp=	-39.1
								Grade =	4		Grade =	3b

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
55	0	12	MCL	10YR4/3		5	1	18	20.6	5	18	20.8
								Total (mm) =	20.6		Total (mm) =	20.8

MBw=	-70.4	MBp=	-58.2
Grade =	4	Grade =	4

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
56	0	40	MCL	10YR4/2		5	1	18	68.6	5	18	69.4
	40	50	HCL	10YR4/1	mmd och	5	1	16	15.3	5	16	15.5

Total (mm) =	83.9	Total (mm) =	84.9
MBw=	-7.2	MBp=	5.9
Grade =	3a	Grade =	2

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
57	0	34	HCL	10YR4/2		5	1	18	58.3	5	18	59.0
	34	50	C	10YR4/1	fmd och	5	1	13	19.8	5	13	20.2
	50	63	C	10YR4/1	mmd och	5	0.5	7	8.7	5	13	16.4

Total (mm) =	86.8	Total (mm) =	95.5
MBw=	-4.2	MBp=	16.5
Grade =	3a	Grade =	1

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
58	0	30	HCL	10YR4/2	fff och	5	1	18	51.5	5	18	52.1

Total (mm) =	51.5	Total (mm) =	52.1
MBw=	-39.6	MBp=	-27.0
Grade =	3b	Grade =	3a

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
59	0	20	MCL	10YR4/3		5	1	18	34.3	5	18	34.7
	20	45	MCL	10YR4/3	fff och	5	1	16	38.1	5	16	38.6

	45	50	HCL	10YR5/3	mmd och	5	1	12	5.7	5	12	5.8
	50	55	HCL	10YR5/3	mmd och	5	0.5	7	3.3	5	12	5.8
								Total (mm) =	81.5		Total (mm) =	85.0
								MBw=	-9.5		MBp=	6.0
								Grade =	3a		Grade =	2

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
60	0	30	MCL	10YR4/3	fff och	5	1	18	51.5	5	18	52.1
	30	50	HCL	10YR5/3	mmd och	5	1	12	22.9	5	12	23.3
	50	58	HCL	10YR5/3	mmd och	5	0.5	7	5.3	5	12	9.3
								Total (mm) =	79.7		Total (mm) =	84.7
								MBw=	-11.3		MBp=	5.7
								Grade =	3a		Grade =	2

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
61	0	30	HCL	10YR4/3	fff och	5	1	18	51.5	5	18	52.1
	30	50	HCL	10YR4/3	mmd och	5	1	12	22.9	5	12	23.3
	50	60	HCL	10YR4/3	mmd och	5	0.5	7	6.7	5	12	11.7
								Total (mm) =	81.0		Total (mm) =	87.0
								MBw=	-10.0		MBp=	8.0
								Grade =	3a		Grade =	2

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
62	0	20	HCL	10YR4/3	fff och	5	1	18	34.3	5	18	34.7
								Total (mm) =	34.3		Total (mm) =	34.7
								MBw=	-56.7		MBp=	-44.3
								Grade =	4		Grade =	3b

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	Wheat Calculation: TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	Potato Calculation: TAv (stones) %	TAv (soil) %	AP (potatoes) mm
63	0	24	MCL	10YR4/3	ffd och	5	1	18	41.2	5	18	41.6

	Wheat		Potato
Total (mm) =	41.2	Total (mm) =	41.6
MBw=	-49.8	MBp=	-37.4
Grade =	3b	Grade =	3b

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	Wheat Calculation: TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	Potato Calculation: TAv (stones) %	TAv (soil) %	AP (potatoes) mm
64	0	24	MCL	10YR4/3	ffd och	5	1	18	41.2	5	18	41.6

	Wheat		Potato
Total (mm) =	41.2	Total (mm) =	41.6
MBw=	-49.8	MBp=	-37.4
Grade =	3b	Grade =	3b

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	Wheat Calculation: TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	Potato Calculation: TAv (stones) %	TAv (soil) %	AP (potatoes) mm
65	0	28	MCL	10YR4/3	fff och	5	1	18	48.0	5	18	48.6
	28	50	fS	10YR4/1	mmd och	5	1	14	29.4	5	14	29.8
	50	70	fS	10YR4/1	mmd och	5	0.5	12	22.9	5	14	27.1
	70	89	fS	10YR4/1	mmd och	5	0.5	12	21.7			0.0

	Wheat		Potato
Total (mm) =	121.9	Total (mm) =	105.5
MBw=	30.9	MBp=	26.5
Grade =	1	Grade =	1

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	Wheat Calculation: TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	Potato Calculation: TAv (stones) %	TAv (soil) %	AP (potatoes) mm
66	0	30	MCL	10YR4/3	fff och	5	1	18	51.5	5	18	52.1
	30	40	SL	10YR4/3	fff och	5	1	15	14.3	5	15	14.5
	40	50	SL	10YR4/3	fff och	5	1	15	14.3	5	15	14.5
	50	70	SL	10YR4/3	fff och	5	0.5	11	21.0			0.0

								Total (mm) =	101.0		Total (mm) =	81.1
								MBw=	10.0		MBp=	2.1
								Grade =	2		Grade =	2

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	Wheat Calculation TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	Potato Calculation TAv (stones) %	TAv (soil) %	AP (potatoes) mm
67	0	30	MCL	10YR4/2	fff och	5	1	18	51.5	5	18	52.1
	30	50	C	10YR4/4	fff och	5	1	16	30.5	5	16	30.9
								Total (mm) =	82.0		Total (mm) =	83.0
								MBw=	-9.1		MBp=	3.9
								Grade =	3a		Grade =	2

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	Wheat Calculation TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	Potato Calculation TAv (stones) %	TAv (soil) %	AP (potatoes) mm
68	0	30	MCL	10YR4/2	fff yellow	5	1	18	51.5	5	18	52.1
	30	40	MCL	10YR4/2	fff yellow	5	1	16	15.3	5	16	15.5
								Total (mm) =	66.7		Total (mm) =	67.5
								MBw=	-24.3		MBp=	-11.5
								Grade =	3b		Grade =	3a

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	Wheat Calculation TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	Potato Calculation TAv (stones) %	TAv (soil) %	AP (potatoes) mm
69	0	32	MCL	10YR4/2	fff yellow	5	1	18	54.9	5	18	55.5
								Total (mm) =	54.9		Total (mm) =	55.5
								MBw=	-36.1		MBp=	-23.5
								Grade =	3b		Grade =	3a

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	Wheat Calculation TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	Potato Calculation TAv (stones) %	TAv (soil) %	AP (potatoes) mm
70	0	40	MCL	10YR4/3	fff yellow	5	1	18	68.6	5	18	69.4
								Total (mm) =	68.6		Total (mm) =	69.4

							MBw=	-22.4		MBp=	-9.6
							Grade =	3b		Grade =	2

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	Wheat Calculation TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	Potato Calculation TAv (stones) %	TAv (soil) %	AP (potatoes) mm
71	0	24	SCL	10YR3/3		5	1	17	38.9	5	17	39.4
								Total (mm) =	38.9		Total (mm) =	39.4
								MBw=	-52.1		MBp=	-39.6
								Grade =	4		Grade =	3b

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	Wheat Calculation TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	Potato Calculation TAv (stones) %	TAv (soil) %	AP (potatoes) mm
72	0	20	SCL	10YR3/3		5	1	17	32.4	5	17	32.8
								Total (mm) =	32.4		Total (mm) =	32.8
								MBw=	-58.6		MBp=	-46.2
								Grade =	4		Grade =	3b

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	Wheat Calculation TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	Potato Calculation TAv (stones) %	TAv (soil) %	AP (potatoes) mm
73	0	40	SCL	10YR3/3		5	1	17	64.8	5	17	65.6
	40	50	mSL	10YR4/4	mmd och	5	1	15	14.3	5	15	14.5
	50	70	mSL	10YR4/4	mmd och	5	1	11	21.0	5	15	29.0
	70	120	mSL	10YR4/4	mmd och	5	1	11	52.5			
								Total (mm) =	152.6		Total (mm) =	109.1
								MBw=	61.6		MBp=	30.1
								Grade =	1		Grade =	1

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
74	0	16	SCL	10YR3/3		5	1	17	25.9	5	17	26.2
								Total (mm) =	25.9		Total (mm) =	26.2
								MBw=	-65.1		MBp=	-52.8
								Grade =	4		Grade =	3b

							Wheat Calculation			Potato Calculation		
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm
75	0	40	MCL	10YR4/2		5	1	18	68.6	5	18	69.4
								Total (mm) =	68.6		Total (mm) =	69.4
								MBw=	-22.4		MBp=	-9.6
								Grade =	3b		Grade =	2

Appendix C. Agricultural Land Classification and Soils Resources (2016 Survey)

Jacobs UK Limited

Wylfa Nuclear Power Station

Anglesey

Agricultural Land Classification

and

Soil Resources

March 2016

Reading Agricultural Consultants Ltd

www.readingagricultural.co.uk

1. Introduction

1.1.1. Reading Agricultural Consultants Ltd (RAC) is instructed by Jacobs UK Limited to investigate the Agricultural Land Classification (ALC) and soil resources of land in the vicinity of Wylfa Nuclear Power Station, located on the north coast of Anglesey between the bays of Cemlyn and Cemaes.

1.1.2. A total of 323ha of agricultural land surrounding the power station was surveyed at a semi-detailed level in June 2015. This reconnaissance survey indicated the presence of best and most versatile (BMV) quality agricultural land at five locations, identified in ten observation points. A second survey was undertaken in February 2016 during which these areas were revisited and surveyed in detail to confirm the extent of BMV land.

1.1.3. Guidance for assessing the quality of agricultural land in England and Wales is set out in the Ministry of Agriculture, Fisheries and Food (MAFF) revised guidelines and criteria for grading the quality of agricultural land (1988[1]).

1.1.4. Agricultural land in England and Wales is graded between 1 and 5, depending on the extent to which physical or chemical characteristics impose long-term limitations on agricultural use. The principal physical factors influencing grading are climate, site and soil which, together with interactions between them, form the basis for classifying land into one of the five grades.

1.1.5. Grade 1 land is excellent quality agricultural land with very minor or no limitations to agricultural use, and Grade 5 is very poor quality land, with severe limitations due to adverse soil, relief, climate or a combination of these. Grade 3 land is subdivided into Subgrade 3a (good quality land) and Subgrade 3b (moderate quality land). Land which is classified as Grades 1, 2 and 3a in the ALC system is defined as best and most versatile agricultural land.

2. Site and Climatic Conditions

2.1. General Features, Land Form and Drainage

2.1.1. The area surveyed at the detailed level extends to approximately 28ha which comprises mostly agricultural grassland. The five areas of survey include land to the north and south-west of Tregele (Areas 1 and 2 respectively), and land to the east and south-east of Cemlyn (Areas 3; and 4 and 5 respectively). Each Area is highlighted in Figure RAC6753-1.

2.1.2. The 2016 survey identified a small portion of Area 1 as non-agricultural land which is characterised by overgrown scrub vegetation with a small area of Japanese knotweed.

[1] **MAFF (1988).** *Agricultural Land Classification of England and Wales. Revised guidelines and criteria for grading the quality of agricultural land.* MAFF Publications.

2.1.3. Much of Area 1 is largely level at around 25m above Ordnance Datum (AOD) except for the field to the east of the A5025 where topography is more complex. There is a general downward slope from west to east to around 20m AOD, and also a ridge with an approximate 14° convex slope down to the south.

2.1.4. The topography in Area 2 is gently sloping from west to east, falling from marginally over 30m AOD to 25m AOD adjacent to the A5025.

2.1.5. Area 3 sits within a shallow valley and is level at around 15m AOD.

2.1.6. Areas 4 and 5 are gently sloping from west to east, falling from around 20m AOD to 15m AOD. Both areas occupy lower hill slopes which fall to valleys.

2.2. Agro-climatic Conditions

2.2.1. Agro-climatic data for two points have been interpolated from the Meteorological Office's standard 5km grid point data set at representative altitudes of 15m and 25m AOD, and are given in Table 1. Climate at the survey area is wet and warm. Crop moisture deficits are moderate and the number of Field Capacity Days (FCDs) is relatively high.

Table 1: Local agro-climatic conditions

	East - 25m AOD	**West - 15m AOD**
Grid Reference	SH 2356 3927	SH 2342 3925
Average Annual Rainfall	903mm	895mm
Accumulated Temperatures >0°C	1,452 day°	1,464 day°
Field Capacity Days	193 days	191 days
Average Moisture Deficit, wheat	89mm	92mm
Average Moisture Deficit, potatoes	77mm	80mm

2.3. Soil Parent Material and Soil Type

2.3.1. The principal underlying geology of the survey area as mapped by the British Geological Survey[2] comprises mica schist of the Harbour Group. Most of the survey area is overlain by superficial deposits of glacial till, the content of which may include clay, sand, gravel and boulders.

[2] **British Geological Survey (2016).** *Geology of Britain viewer, http://mapapps.bgs.ac.uk/geologyofbritain/home.html*

2.3.2. The Soil Survey of England and Wales soil association mapping[3] (1:250,000 scale) shows the East Keswick 1 association present across Areas 3, 4 and 5, with Brickfield 2 soils also across Areas 1 and 2.

2.3.3. East Keswick soils are characterised by deep, fine loamy brown earths. Drift thickness is variable and rocky exposures may be observed. The soils are mostly permeable, of Wetness Class (WC) I although locally lower horizons may be seasonally waterlogged[4].

2.3.4. Brickfield 2 soils are also characterised by fine loamy soils in till, although are surface water gleys and commonly of WC IV.

3. Agricultural Land Quality

3.1. Soil Survey Methods

3.1.1. During the February 2016 survey, 28 soil profiles were examined using an Edelman (Dutch) auger at an observation density of one per hectare.

3.1.2. Two observation pits were also excavated with a spade and one exposed trench was used to examine and record subsoil structures. The locations of observations are indicated on Figure RAC6753-1 (and those combined with the reconnaissance survey are shown at RAC6753-3). At each observation point the following characteristics were assessed for each soil horizon up to a maximum of 120cm or any impenetrable layer:

- soil texture;
- significant stoniness;
- colour (including local gley and mottle colours);
- consistency;
- structural condition;
- free carbonate; and
- depth.

3.1.3. Soil Wetness Class (WC) was inferred from the matrix colour, presence or absence of, and depth to, greyish and ochreous gley mottling and/or poorly permeable

[3] **Soil Survey of England and Wales (1984).** *1:250,000 scale soil association mapping, Sheet 2 – Soils of Wales.*

[4] **Rudeforth *et al.* (1984).** *Soils and Their Use in Wales.* Soil Survey of England and Wales Bulletin 11, Harpenden.

subsoil layers at least 15cm thick, in relation to the number of Field Capacity Days at the location.

3.1.4. Soil droughtiness was investigated by the calculation of moisture balance equations (given in Appendix 1). Crop-adjusted Available Profile Water (AP) is estimated from texture, stoniness and depth, and then compared to a calculated moisture deficit (MD) for the standard crops wheat and potatoes. The MD is a function of potential evapotranspiration and rainfall. Grading of the land can be affected if the AP is insufficient to balance the MD and droughtiness occurs. When a profile is found with significant stoniness, sufficient to prevent penetration of a hand auger, then it is assumed, for the purposes of calculating droughtiness, that similar levels of stoniness continue to the full 1.2m depth considered, unless an observation pit excavated in the vicinity shows otherwise.

3.1.5. Representative topsoil samples were taken from within the BMV survey area and sent to a laboratory for analysis of particle size distribution, organic matter content and major nutrients. The analysis was not able to be completed as the samples were damaged in transit to the laboratory. However, two out of six of the original samples taking during the reconnaissance survey were located within 100-150m of observations made during the detailed survey, one of which was sampled from within a BMV area. The existing analysis is therefore considered representative of topsoils in the detailed survey area.

3.2. Agricultural Land Classification and Site Limitations

3.2.1. Assessment of agricultural land quality has been carried out according to the MAFF revised guidelines (1988[1]). Soil profiles have been described according to Hodgson (1997 [5]) which is the recognised source for describing soil profiles and characteristics according to the revised ALC guidelines.

3.2.2. The collective site area, extending to 323ha in total, is subject to numerous limitations to agricultural land quality, including topography, exposure, soil wetness and droughtiness. Land not of best and most versatile quality is predominantly of Subgrade 3b, with a large portion of Grade 5.

3.2.3. Across the land surveyed in detail, the main limitation to agricultural land quality is soil wetness and workability which limits most of these sites to Grades 2 and 3a. A very small portion of Area 1 is limited more severely by microtopography.

3.2.4. Within the areas surveyed in detail, topsoil is predominantly of medium clay loam, with occasional sandy clay loam and rare instances of heavy clay loam. The average thickness of the topsoil is 36cm and the colour is mostly brown or dark

[5] **Hodgson, J. M. (Ed.) (1997).** *Soil survey field handbook*. Soil Survey Technical Monograph No. 5, Silsoe.

greyish brown (7.5YR4/2 or 4/3, 10YR4/2 or 4/3 in the Munsell soil colour charts[6]), but reddish grey (5YR4/1 and 4/2) and greyish brown (10YR5/2) are also present.

3.2.5. The structure of the topsoil is moderately developed with fine or medium subangular blocky peds. Worms were commonly observed and the distribution of fine roots is extensive, indicating adequate aeration and drainage of the topsoil. Stone content is typically around 5-10% by volume, comprising small hard stones.

3.2.6. Subsoil texture is often also of medium clay loam or sandy clay loam, although heavy clay loam and clay are common. Colour is most often greyish brown or brown (7.5YR5/3, 10YR5/2 or 5/3) although does range from dark grey (5YR4/1) to pale brown (10YR6/3). Most of the subsoil observed is mottled and gleyed, although a weak, moderate to fine subangular blocky structure ensures the profiles remain sufficiently drained. These profiles are of WC II, which when combined with medium clay loam or sandy clay loam topsoil textures results in a slight wetness limitation to Subgrade 3a.

3.2.7. In some profiles, there is no mottling or gleying, or otherwise the gleyed layer occurs at greater depth. As there is no evidence that these profiles are wet within 70cm of the soil surface for prolonged periods, they are of WC I and limited to Grade 2 by slight wetness and workability due to the number of FCDs combined with topsoil texture.

3.2.8. Stone content in the subsoil is higher than in the topsoil, estimated at up to around 35% by volume (Pit 2). At many profiles across the site, subsoil stones obstructed the augers such that full profiles could not be observed. In these cases, restricted profiles are assessed according to similar neighbouring pits or profiles in which profiles could be observed to greater depth.

3.2.9. A pit excavated in Area 1 showed the presence of slate bedrock at 40cm (shown in Appendix 2). Any water available for uptake by crop roots below this slate layer will be negligible at most and therefore the slate has been assessed as the termination of the profile, resulting in a droughtiness limitation to Subgrade 3b. The closest auger observation made was also consistently obstructed by stones at shallow depth. It has therefore been assumed that the applicable point reaches a depth similar to the pit observation before terminating.

3.2.10. The second small area of Subgrade 3b identified in Area 1 is limited due to wetness and workability with distinctly mottled, poorly permeable heavy clay loam. The field corner in which this observation was made is lower lying than the surrounding land and forms a distinct area characterised by small rushes and wetland grasses (as can be seen in aerial photography). Although an isolated point, as there is a clear distinction between this area and the surrounding land which is not affected to the same degree, it has been mapped as a discrete unit.

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[6] **Munsell Color (2009).** *Munsell Soil Color Book,* Grand Rapids, MI, USA

3.2.11. Although the soils are permeable, the area of Subgrade 3b mapped at Area 5 is downgraded due to the high risk of flooding from a river, as mapped by Natural Resources Wales (shown in Appendix 3). High risk relates to a greater than 1 in 30 (3.3%) chance of flooding each year.

3.2.12. The small area of Grade 4 mapped in Area 1 is due to microrelief and the presence of a short but steep (around 14°) slope.

3.2.13. The areas of each ALC grade for the areas surveyed in detail are given in Table 2 and are shown in Figure RAC6753-2.

Table 2: Detailed Agricultural Land Classification of the areas identified as BMV land in the reconnaissance survey

Grade	Description	Area (ha)	% of agricultural land
2	Very good quality	6.5	23
3a	Good quality	18.0	64
3b	Moderate quality	3.4	12
4	Poor quality	0.1	1
	Total Agricultural	28.0	100
	Non-Agricultural	1.9	-

3.2.14. When combined with the results of the reconnaissance survey, the above gives an overall classification for the site as shown in Table 3 and on Figure RAC6753-4.

Table 3: Agricultural Land Classification of the overall site (combining detailed and reconnaissance survey results)

Grade	Description	Area (ha)	% of agricultural land
2	Very good quality	6.5	2.3
3a	Good quality	18.0	6.3
3b	Moderate quality	224.3	78.2
4	Poor quality	0.1	<1
5	Very poor quality	38.0	13.2
	Total Agricultural	286.9	100
	Non-Agricultural	35.8	-

Appendix 1: Soil Profile Summaries

Droughtiness calculations are made according to the methodology given in Appendix 4 of the ALC guidelines, MAFF 1988. The end row demonstrates the limitation from droughtiness; the end column from soil wetness

Values which are underlined represent the maximum depth to which profiles were able to be observed. Subsequent analysis is based upon reasonable assumption.

MDw= 89 MDp= 77

							Wheat Calculation			Potato Calculation						
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm	Gley	SP	WC	Grade
1	0	28	MCL	10YR4/2		5	1	18	48.0	1	18	48.0	n	n	II	3a
	28	50	C	10YR5/3	mmd och	5	1	16	33.6	1	16	33.6	y	n		
	50	70	C	10YR5/3	mmd och	20	0.5	8	13.0	1	16	26.0	y	n		
	70	120	C	10YR5/3	mmd och	20	0.5	8	32.5				y	n		
								Total (mm) =	127.1		Total (mm) =	107.6				
								MBw=	38.1		MBp=	30.6				
								Grade =	1		Grade =	1				

							Wheat Calculation			Potato Calculation						
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm	Gley	SP	WC	Grade
2	0	25	MCL	10YR4/2		5	1	18	42.9	1	18	42.9	n	n	II	3a
	25	<u>45</u>	SCL	10YR4/3+5/3	cmf och	15	1	15	25.8	1	15	25.8	y	n		
	45	50	SCL	10YR4/3+5/3	cmf och	15	1	15	6.5	1	15	6.5	y	n		
	50	70	SCL	10YR4/3+5/3	cmf och	15	0.5	10	17.2	1	15	25.8	y	n		
	70	120	SCL	10YR4/3+5/3	cmf och	15	0.5	10	42.9				y	n		
								Total (mm) =	135.2		Total (mm) =	100.9				
								MBw=	46.2		MBp=	23.9				
								Grade =	1		Grade =	1				

							Wheat Calculation			Potato Calculation						
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm	Gley	SP	WC	Grade
3	0	34	MCL	10YR4/2		5	1	18	58.3	1	18	58.3	n	n	II	3a
	34	50	C	10YR5/3	mmd och	5	1	16	24.4	1	16	24.4	y	n		
	50	70	C	10YR5/3	mmd och	20	0.5	8	13.0	1	16	26.0	y	n		

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm	Gley	SP	WC	Grade
	70	75	C	10YR5/3	mmd och	20	0.5	8	3.3				y	n		
	75	120	C	10YR5/3	mmd och	20	0.5	8	29.3				y	n		
								Total (mm) =	128.2		Total (mm) =	108.7				
								MBw=	39.2		MBp=	31.7				
								Grade =	1		Grade =	1				

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	Wheat Calculation			Potato Calculation			Gley	SP	WC	Grade
							TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm				
4	0	32	MCL	10YR4/3		5	1	18	54.9	1	18	54.9	n	n	II	3a
	32	50	HCL	10YR5/3	cfd och	15	1	16	24.8	1	16	24.8	y	n		
	50	70	HCL	10YR5/3	cfd och	15	0.5	10	17.2	1	16	27.5	y	n		
	70	120	HCL	10YR5/3	cfd och	15	0.5	10	42.9				y	n		
								Total (mm) =	139.7		Total (mm) =	107.1				
								MBw=	50.7		MBp=	30.1				
								Grade =	1		Grade =	1				

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	Wheat Calculation			Potato Calculation			Gley	SP	WC	Grade
							TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm				
5	0	35	MCL	7.5YR4/2		5	1	18	60.0	1	18	60.0	n	n	I	2
	35	50	SCL	7.5YR4/3	cmf och	15	1	15	19.4	1	15	19.4	n	n		
	50	65	SCL	7.5YR4/3	cmf och	15	0.5	10	12.9	1	15	19.4	n	n		
	65	70	SCL	7.5YR4/3	cmf och	15	0.5	10	4.3	1	15	6.5	n	n		
	70	120	SCL	7.5YR4/3	cmf och	15	0.5	10	42.9				n	n		
								Total (mm) =	139.4		Total (mm) =	98.7				
								MBw=	50.4		MBp=	21.7				
								Grade =	1		Grade =	1				

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	Wheat Calculation			Potato Calculation			Gley	SP	WC	Grade
							TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm				
6	0	30	MCL	10YR4/2		5	1	18	51.5	1	18	51.5	n	n	I	2
	30	50	MCL	10YR4/2		5	1	16	30.5	1	16	30.5	n	n		
	50	70	MCL	10YR4/2	mmd och	20	0.5	10	16.2	1	16	26.0	y	n		

	70	120	C	10YR5/3	mmd och	20	0.5	8	32.5				y	n		
								Total (mm) =	130.7		Total (mm) =	108.0				
								MBw=	41.7		MBp=	31.0				
								Grade =	1		Grade =	1				

							Wheat Calculation			Potato Calculation						
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm	Gley	SP	WC	Grade
7	0	30	SCL	5YR4/2		5	1	18	51.5	1	18	51.5	n	n	II	3a
	30	50	MCL	10YR4/2	mmd och	20	1	15	24.4	1	15	24.4	y	n		
	50	70	MCL	10YR4/2	mmd och	20	0.5	10	16.2	1	15	24.4	y	n		
	70	120	C	10YR5/3	mmd och	20	0.5	10	40.5				y	n		
								Total (mm) =	132.6		Total (mm) =	75.9				
								MBw=	43.6		MBp=	-1.2				
								Grade =	1		Grade =	2				

							Wheat Calculation			Potato Calculation						
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm	Gley	SP	WC	Grade
8	0	34	MCL	7.5YR4/3		5	1	18	58.3	1	18	58.3	n	n	I	2
	34	50	MCL	7.5YR4/3	fcd och	5	1	16	24.4	1	16	24.4	n	n		
	50	60	MCL	7.5YR4/3	mmd och	20	0.5	10	8.1	1	16	13.0	n	n		
	60	70	SCL	7.5YR5/3	mmd och	20	0.5	10	8.1	1	15	12.2	y	n		
	70	120	SCL	7.5YR5/3	mmd och	20	0.5	10	40.5				y	n		
								Total (mm) =	139.4		Total (mm) =	107.9				
								MBw=	50.4		MBp=	30.9				
								Grade =	1		Grade =	1				

							Wheat Calculation			Potato Calculation						
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm	Gley	SP	WC	Grade
9	0	45	MCL	7.5YR4/2		0	1	18	81.0	1	18	81.0	n	n	I	2
	45	50	MCL	7.5YR4/3		5	1	16	7.6	1	16	7.6	n	n		
	50	70	MCL	7.5YR4/3		5	0.5	10	19.1	1	16	30.5	n	n		
	70	80	SCL	7.5YR4/4	cff och	10	0.5	10	9.1	1	15	13.6	n	n		

	80	120	SCL	7.5YR4/4	cff och	10	0.5	10	36.2				n	n		
								Total (mm) =	152.9		Total (mm) =	119.1				
								MBw=	63.9		MBp=	42.1				
								Grade =	1		Grade =	1				

							Wheat Calculation			Potato Calculation						
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm	Gley	SP	WC	Grade
10	0	25	SCL	5YR4/2		10	1	17	38.5	1	17	38.5	n	n	II	3a
	25	50	SCL	10YR5/3+5/3	cff och	10	1	15	34.0	1	15	34.0	y	n		
	50	70	SCL	10YR5/3+5/4	cff och	10	0.5	10	18.1	1	15	27.2	y	n		
	70	120	SCL	10YR5/3+5/4	cff och	10	0.5	10	45.3				y	n		
								Total (mm) =	135.9		Total (mm) =	99.7				
								MBw=	46.9		MBp=	22.7				
								Grade =	1		Grade =	1				

							Wheat Calculation			Potato Calculation						
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm	Gley	SP	WC	Grade
11	0	30	MCL	7.5YR4/3		5	1	18	51.5	1	18	51.5	n	n	I	2
	30	50	MCL	7.5YR4/3	fcd och	5	1	16	30.5	1	16	30.5	n	n		
	50	60	MCL	7.5YR4/3	mmd och	20	0.5	10	8.1	1	16	13.0	n	n		
	60	70	SCL	7.5YR5/3	mmd och	20	0.5	10	8.1	1	15	12.2	y	n		
	70	120	SCL	7.5YR5/3	mmd och	20	0.5	10	40.5				y	n		
								Total (mm) =	138.7		Total (mm) =	107.2				
								MBw=	49.7		MBp=	30.2				
								Grade =	1		Grade =	1				

							Wheat Calculation			Potato Calculation						
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm	Gley	SP	WC	Grade
12	0	50	MCL	5YR4/2		5	1	18	85.8	1	18	85.8	n	n	I	2
	50	60	MCL	5YR4/2		5	0.5	16	15.2	1	16	15.3	n	n		
	60	70	SCL	10YR5/3+5/4	cff och	10	0.5	10	9.1	1	15	13.6	y	n		
	70	85	SCL	10YR5/3+5/4	cff och	10	0.5	10	13.6				y	n		

	85	120	SCL	10YR5/3+5/4	cff och	10	0.5	10	31.7				y	n		
								Total (mm) =	155.3		Total (mm) =	114.6				
								MBw=	66.3		MBp=	37.6				
								Grade =	1		Grade =	1				

							Wheat Calculation			Potato Calculation						
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm	Gley	SP	WC	Grade
13	0	46	MCL	10YR4/3		5	1	18	78.9	1	18	78.9	n	n	I	2
	46	50	MCL	10YR5/3	fcd och	5	1	16	6.1	1	16	6.1	n	n		
	50	59	MCL	10YR5/3	mmd och	20	0.5	10	7.3	1	16	11.7	y	n		
	59	70	MCL	10YR5/3	mmd och	20	0.5	10	8.9	1	16	14.3	y	n		
	70	120	MCL	10YR5/3	mmd och	20	0.5	10	40.5				y	n		
								Total (mm) =	141.7		Total (mm) =	111.0				
								MBw=	52.7		MBp=	34.0				
								Grade =	1		Grade =	1				

							Wheat Calculation			Potato Calculation						
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm	Gley	SP	WC	Grade
14	0	45	HCL	10YR4/2		2	1	18	79.5	1	18	79.5	n	n	III	3b
	45	50	HCL	10YR6/3	mfp och	2	1	12	5.9	1	12	5.9	y	y		
	50	70	HCL	10YR6/3	mfp och	2	0.5	7	13.7	1	12	23.6	y	y		
	70	80	HCL	10YR6/3	mfp och	2	0.5	7	6.9				y	y		
	80	120	HCL	10YR6/3	mfp och	2	0.5	7	27.5				y	y		
								Total (mm) =	133.5		Total (mm) =	108.9				
								MBw=	44.5		MBp=	31.9				
								Grade =	1		Grade =	1				

							Wheat Calculation			Potato Calculation						
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm	Gley	SP	WC	Grade
15	0	25	SCL	7.5YR3/2		8	1	17	39.3	1	17	39.3	n	n	I	3a
	25	50	SCL	7.5YR4/2		20	0.5	15	30.3	1	15	30.5	n	n		
	50	70	SCL	7.5YR4/2		20	0.5	10	16.2	1	15	24.4	n	n		

	70	120	SCL	7.5YR4/2		20	0.5	10	40.5				n	n		
								Total (mm) =	69.6		Total (mm) =	69.8				
								MBw=	-19.5		MBp=	-7.2				
								Grade =	3a		Grade =	2				

							Wheat Calculation			Potato Calculation						
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm	Gley	SP	WC	Grade
16	0	30	HCL	10YR4/2		5	1	18	51.5	1	18	51.5	n	n	I	3a
	30	50	SCL	10YR4/2		20	1	15	24.4	1	15	24.4	n	n		
	50	70	SCL	10YR4/2		20	0.5	10	16.2	1	15	24.4	n	n		
	70	120	SCL	10YR4/2		20	0.5	10	40.5			0.0	n	n		
								Total (mm) =	75.9		Total (mm) =	75.9				
								MBw=	-13.2		MBp=	-1.2				
								Grade =	3a		Grade =	2				

							Wheat Calculation			Potato Calculation						
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm	Gley	SP	WC	Grade
17	0	50	SCL	7.5YR4/2		5	1	17	81.0	1	17	81.0	n	n	I	2
	50	70	SCL	10YR5/3+5/4	fff och	10	0.5	10	18.1	1	15	27.2	n	n		
	70	120	SCL	10YR5/3+5/4	fff och	10	0.5	10	45.3				n	n		
								Total (mm) =	99.1		Total (mm) =	108.2				
								MBw=	10.1		MBp=	31.2				
								Grade =	2		Grade =	1				

							Wheat Calculation			Potato Calculation						
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm	Gley	SP	WC	Grade
18	0	30	MCL	10YR4/2	fmd grey	5	1	18	51.5	1	18	51.5	n	n	I	3a
As Pit	30	50	SCL	7.5YR4/2		40	1	15	18.8	1	15	18.8	n	n		
	50	70	SCL	7.5YR4/2		20	0.5	10	16.2	1	15	24.4	n	n		
	70	120	SCL	7.5YR4/2		20	0.5	10	40.5				n	n		
								Total (mm) =	70.3		Total (mm) =	70.3				
								MBw=	-18.8		MBp=	-6.8				

								Grade =	3a		Grade =	2				
							Wheat Calculation			Potato Calculation						
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm	Gley	SP	WC	Grade
19	0	15	SCL	7.5YR4/2		15	1	17	21.9	1	17	21.9	n	n	I	3b
Pit	15	40	SCL	7.5YR4/2		40	1	15	23.5	1	15	23.5	n	n		
	40	50	Slate													
	50	70	Slate													
	70	120	Slate													
								Total (mm) =	45.4		Total (mm) =	45.4				
								MBw=	-43.6		MBp=	-31.6				
								Grade =	3b		Grade =	3b				

West

		MDw=	92			MDp=	80									
							Wheat Calculation			Potato Calculation						
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm	Gley	SP	WC	Grade
20	0	35	HCL	10YR5/2	cmf och	1	1	18	62.4	1	18	62.4	y	n	II/III	3a/3b
	35	50	C	10YR5/2 + 5/3	cmf och	1	1	16	23.8	1	16	23.8	y	n		
	50	70	C	10YR5/2 + 5/3	cmf och	1	1	8	15.9	1	16	31.7	y	n		
	70	80	C	10YR5/2 + 5/3	cmf och	1	1	8	7.9				y	n		
	80	120	C	10YR5/2 + 5/3	cfd/p och	10	1	7	25.6				y	y		
								Total (mm) =	135.6		Total (mm) =	117.9				
								MBw=	43.6		MBp=	37.9				
								Grade =	1		Grade =	1				

							Wheat Calculation			Potato Calculation						
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm	Gley	SP	WC	Grade
21	0	30	MCL	10YR5/2	fmd grey	5	1	18	51.5	1	18	51.5	n	n	II	3a

Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	Wheat Calculation: TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	Potato Calculation: TAv (stones) %	TAv (soil) %	AP (potatoes) mm	Gley	SP	WC	Grade
	30	50	C	10YR5/3	mmd och	10	1	16	29.0	1	16	29.0	y	n		
	50	70	C	10YR5/3	mmd och	10	0.5	8	14.5	1	16	29.0	y	n		
	70	120	C	10YR5/3	mmd och	10	0.5	8	36.3				y	n		
								Total (mm) =	131.2		Total (mm) =	109.5				
								MBw=	39.2		MBp=	29.5				
								Grade =	1		Grade =	1				
							Wheat Calculation			Potato Calculation						
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm	Gley	SP	WC	Grade
22	0	50	M/SCL	7.5YR4/2		15	1	18	77.3	1	18	77.3	n	n	I	2
	50	55	M/SCL	7.5YR4/2		15	0.5	16	6.8	1	16	6.9	n	n		
	55	70	SCL	10YR5/2	cfd + cmf och	35	0.5	10	10.0	1	15	15.2	y	n		
	70	75	SCL	10YR5/2	cfd + cmf och	35	0.5	10	3.3				y	n		
	75	120	SCL	10YR5/2	cfd + cmf och	35	0.5	10	30.0				y	n		
								Total (mm) =	127.5		Total (mm) =	99.3				
								MBw=	35.5		MBp=	19.3				
								Grade =	1		Grade =	1				
							Wheat Calculation			Potato Calculation						
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm	Gley	SP	WC	Grade
23	0	30	SCL	10YR4/2	fmd grey	5	1	17	48.6	1	17	48.6	n	n	II	3a
	30	50	C	10YR5/3	mcd och	10	1	16	29.0	1	16	29.0	y	n		
	50	70	C	10YR5/3	mcd och	35	0.5	8	10.8	1	16	21.5	y	n		
	70	120	C	10YR5/3	mcd och	35	0.5	8	26.9				y	n		
								Total (mm) =	115.2		Total (mm) =	99.1				
								MBw=	23.2		MBp=	19.1				
								Grade =	2		Grade =	1				
							Wheat Calculation			Potato Calculation						
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm	Gley	SP	WC	Grade
24	0	20	SCL	5YR4/2		10	1	17	30.8	1	17	30.8	n	n	II	3a
	20	50	SCL	5YR4/1	femns	15	1	15	38.7	1	15	38.7	y	n		

	50	70	SCL	5YR4/1	femns	15	0.5	10	17.2	1	15	25.8	y	n		
	70	120	SCL	5YR4/1	femns	15	0.5	10	42.9				y	n		
								Total (mm) =	129.5		Total (mm) =	95.3				
								MBw=	37.5		MBp=	15.3				
								Grade =	1		Grade =	1				

							Wheat Calculation			Potato Calculation						
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm	Gley	SP	WC	Grade
25	0	30	SCL	5YR4/2		10	1	17	46.2	1	17	46.2	n	n	II	3a
	30	40	SCL	5YR4/1	femns	15	1	15	12.9	1	15	12.9	y	n		
	40	50	SCL	5YR4/1	femns	15	1	15	12.9	1	15	12.9	y	n		
	50	70	SCL	5YR4/1	femns	15	0.5	10	17.2	1	15	25.8	y	n		
	70	120	SCL	5YR4/1	femns	15	0.5	10	42.9				y	n		
								Total (mm) =	59.1		Total (mm) =	97.8				
								MBw=	-32.9		MBp=	17.8				
								Grade =	3b		Grade =	1				

							Wheat Calculation			Potato Calculation						
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm	Gley	SP	WC	Grade
26	0	40	MCL	5YR4/1	f-cff och	1	1	18	71.3	1	18	71.3	y	n	IV	3b
	40	50	HCL	10YR5/2 + 6/3	cfd och	5	1	12	11.5	1	12	11.5	y	y		
	50	70	HCL	10YR5/2 + 6/3	cfd och	5	0.5	7	13.4	1	12	22.9	y	y		
	70	80	HCL	10YR5/2 + 6/3	cfd och	5	0.5	7	6.7				y	y		
	80	120	HCL	10YR5/2 + 6/3	cfd och	5	0.5	7	26.7				y	y		
								Total (mm) =	129.5		Total (mm) =	105.7				
								MBw=	37.5		MBp=	25.7				
								Grade =	1		Grade =	1				

							Wheat Calculation			Potato Calculation						
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm	Gley	SP	WC	Grade
27	0	30	MCL	10YR4/2		5	1	18	51.5	1	18	51.5	n	n	III	3a
	30	50	SCL	10YR5/3	mmp och	10	1	15	27.2	1	15	27.2	y	n		

	50	70	SCL	10YR5/3	mmp och	10	0.5	10	18.1	1	15	27.2	y	n		
	70	120	C	10YR5/3	mmp och	10	0.5	7	31.8				y	y		
								Total (mm) =	128.5		Total (mm) =	105.9				
								MBw=	36.5		MBp=	25.9				
								Grade =	1		Grade =	1				

							Wheat Calculation			Potato Calculation						
Site No.	Depth (cm)		Texture	Colour	Mottle	stones %	TAv or EAv (stones) %	TAv or EAv (soil) %	AP (wheat) mm	TAv (stones) %	TAv (soil) %	AP (potatoes) mm	Gley	SP	WC	Grade
28	0	40	MCL	10YR4/3		5	1	18	68.6	1	18	68.6	n	n	II	3a
	40	50	HCL	10YR5/3	mmp och	10	1	16	14.5	1	16	14.5	y	n		
	50	70	HCL	10YR5/3	mmp och	10	0.5	10	18.1	1	16	29.0	y	n		
	70	120	HCL	10YR5/3	mmp och	10	0.5	10	45.3				y	n		
								Total (mm) =	146.5		Total (mm) =	112.1				
								MBw=	54.5		MBp=	32.1				
								Grade =	1		Grade =	1				

Appendix 2: Pit Photographs

Pit 1 Slate Bedrock

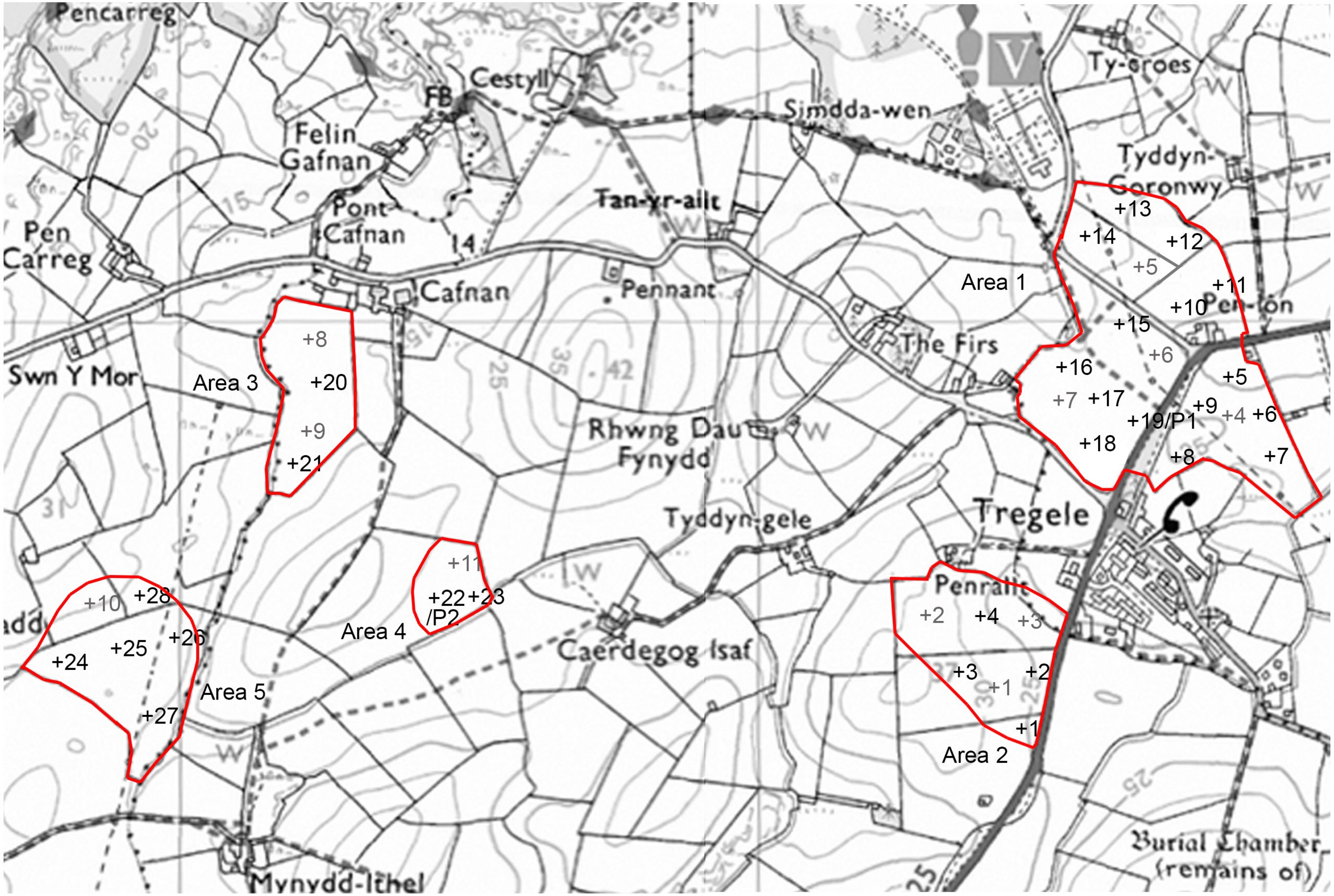
Pit 1 Topsoil

Pit 1 Subsoil Stone

Pit 2

Pit 2 Subsoil Stone

Appendix 3: Flood Risk in Area 5



N

DRAWING TITLE

RAC6753-1: Observations

CONTRACT

Wylfa Nuclear Power Station, Isle of Anglesey

Horizon Nuclear Power

Reading Agricultural Consultants Ltd
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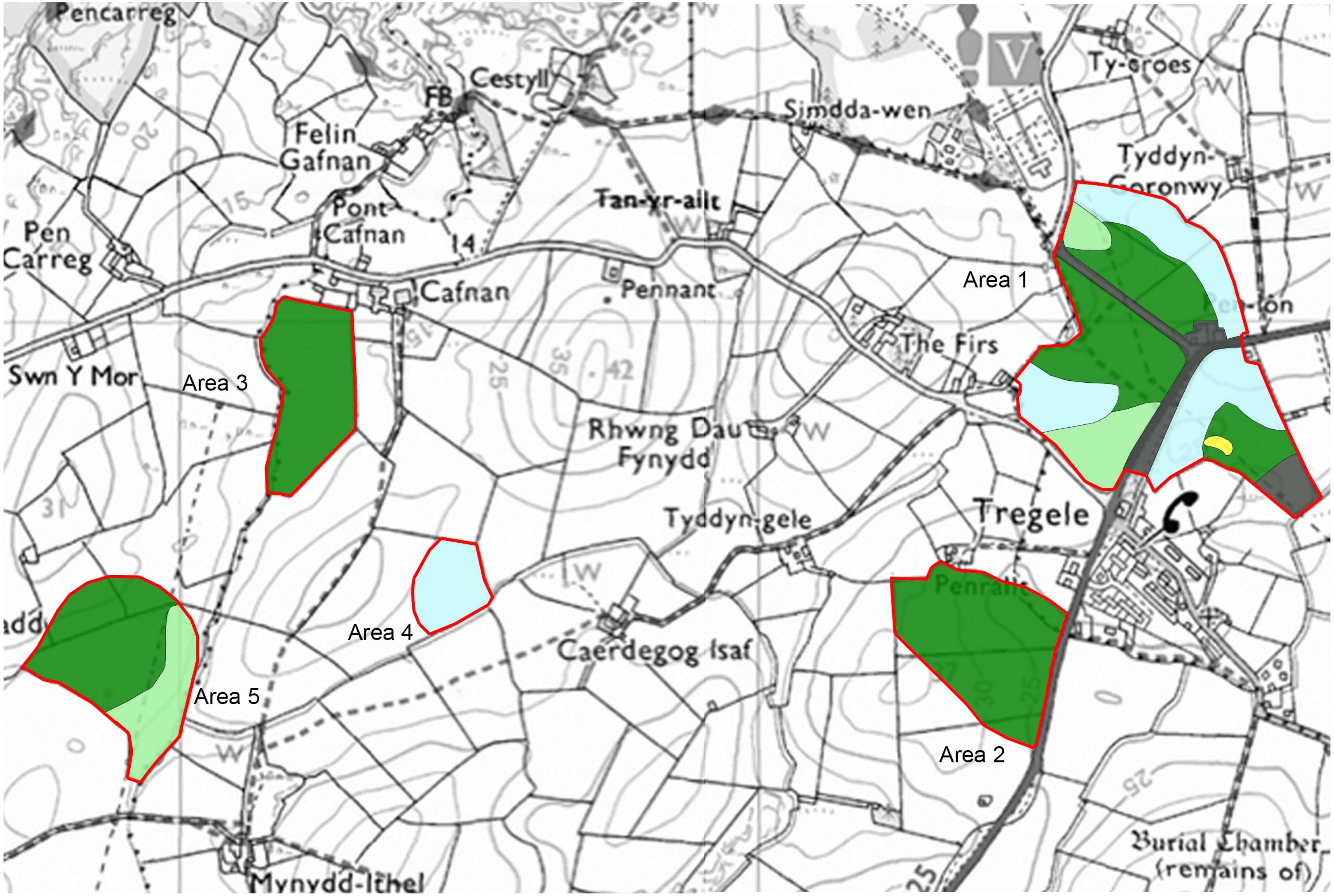
Beechwood Court
Long Toll
Woodcote
RG8 0RR
Tel: 01491684233 Fax: 01491 680800
www.readingagricultural.co.uk

Scale 1:10,000@A4 March/2016



N

- * Grade 1 - excellent quality
- Grade 2 - very good quality
- Subgrade 3a - good quality
- Subgrade 4b - moderate quality
- Grade 4 - poor quality
- * Grade 5 - very poor quality
- Non-Agricultural
- * Not Present

Grades 1, 2 and 3a: Best and most versatile land

DRAWING TITLE

RAC6753-2: Agricultural Land Classification

CONTRACT

Wylfa Nuclear Power Station, Isle of Anglesey

Horizon Nuclear Power

Reading Agricultural Consultants Ltd
Gate House
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Long Toll
Woodcote
RG8 0RR
Tel: 01491684233 Fax: 01491 680800
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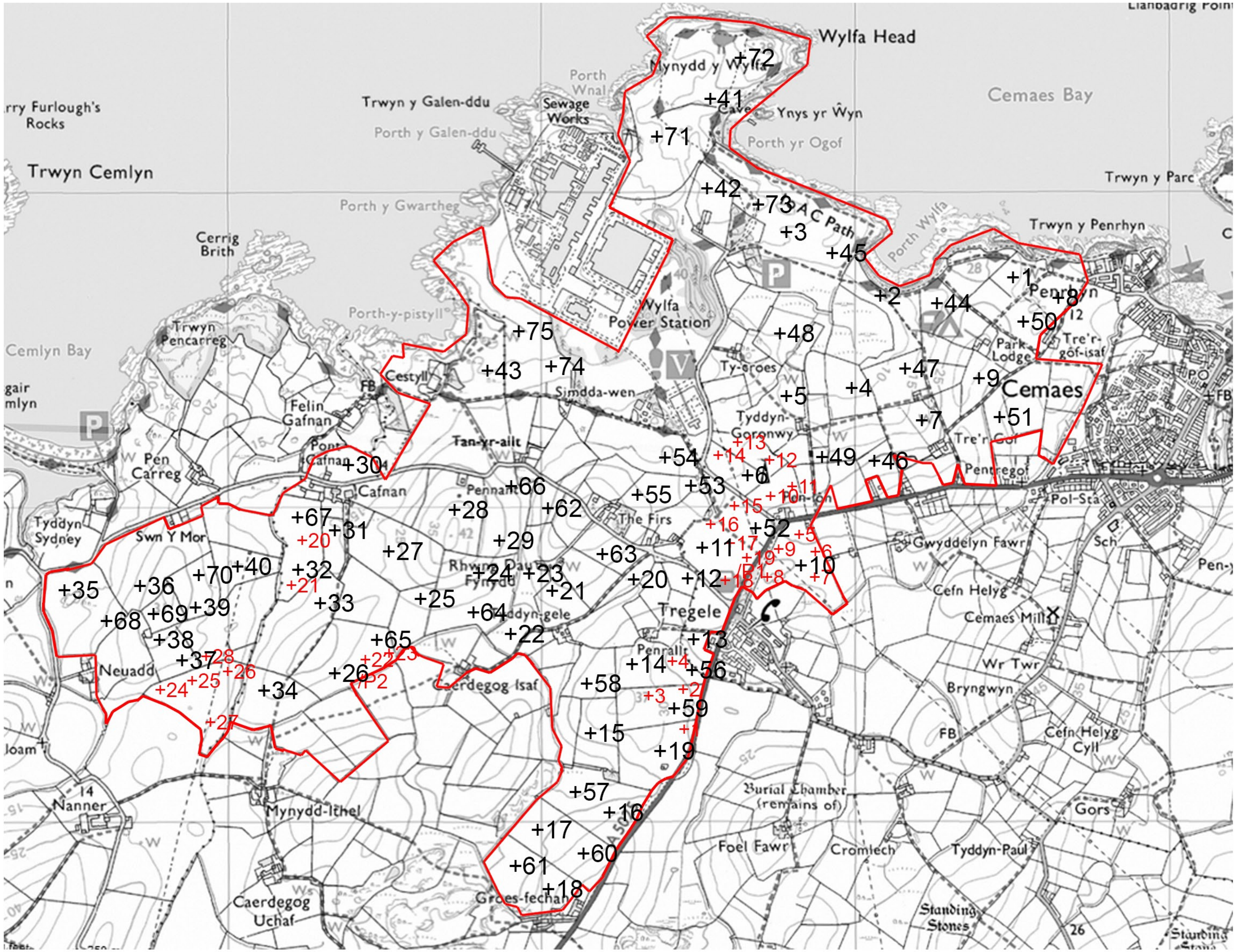
Scale 1:10,000@A4 March/2016



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N

☐	Survey Area
.1	Semi-detailed Auger Observation
.1	Detailed Auger Observation
.P1	Pit Observation

DRAWING TITLE

RAC6753-3: Observations

CONTRACT

Wylfa Nuclear Power Station, Isle of Anglesey

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RG8 0RR
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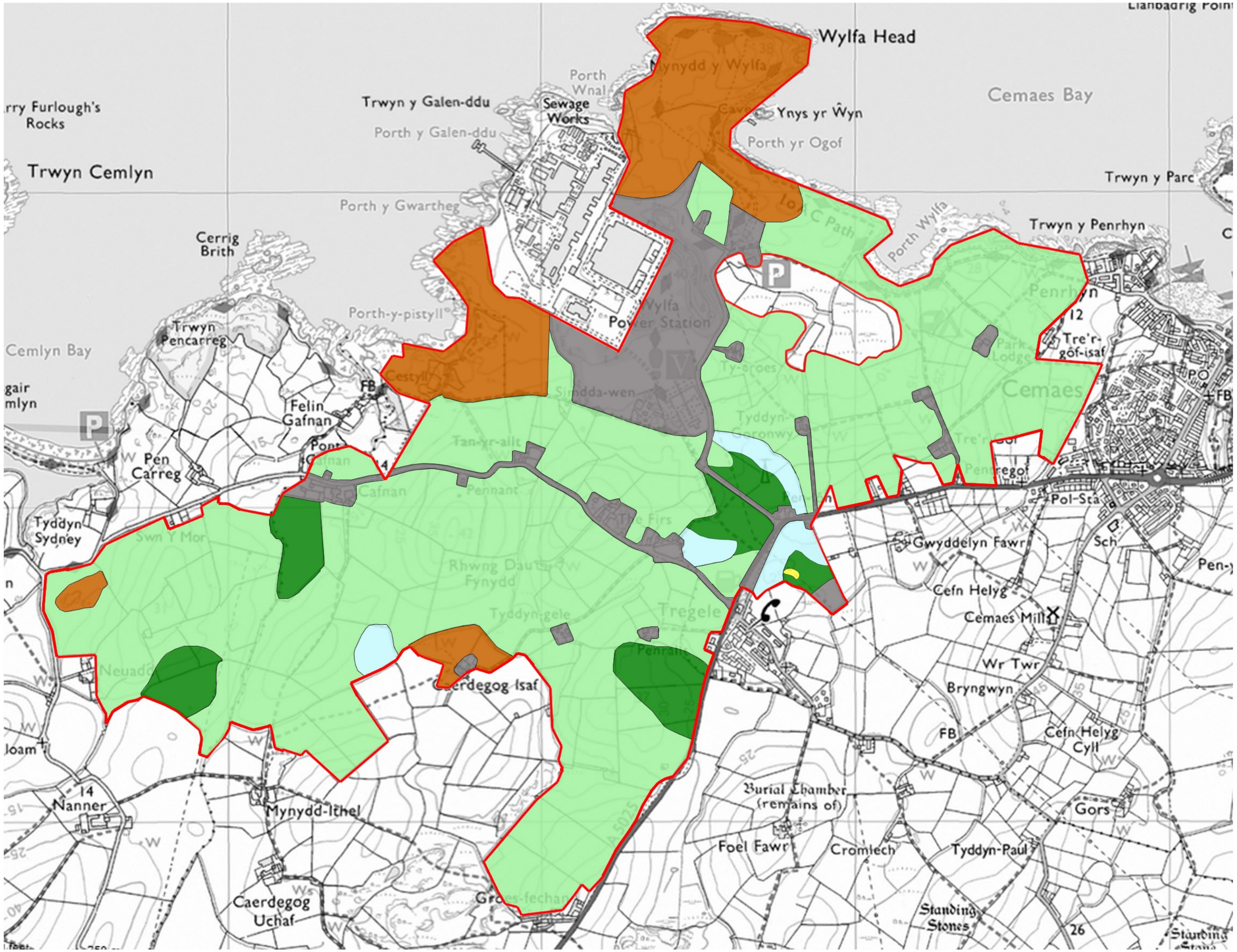
Scale 1:20,000@A4
March/2016



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N

- * Grade 1 - excellent quality
- Grade 2 - very good quality
- Subgrade 3a - good quality

(Grades 1, 2 and 3a: Best and most versatile land)

- Subgrade 3b - moderate quality
- Grade 4 - poor quality
- Grade 5 - very poor quality
- Non-Agricultural

* Not Present

DRAWING TITLE

RAC6753-4: Agricultural Land Classification

CONTRACT

Wylfa Nuclear Power Station, Isle of Anglesey

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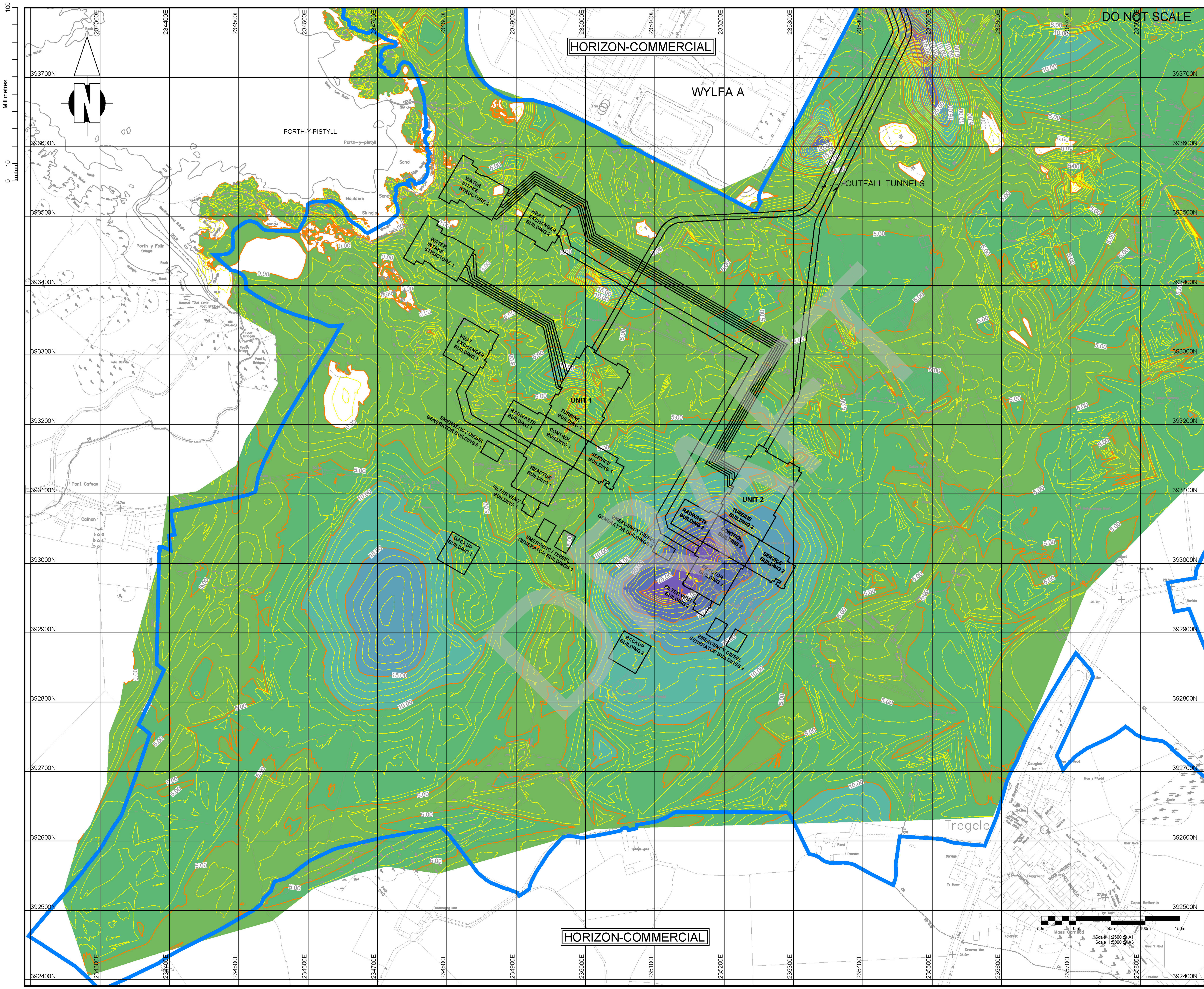
Scale 1:20,000@A4
March/2016

Appendix D. Detailed Onshore Ground Investigation Interpretative Report Drawings (Atkins, 2017)

Drawing 0005A and 0005B	Thickness of Made Ground and Superficial Deposits Isopaches
Drawing 0006A and 0006B	Rockhead Elevation Contour Plan
Drawing 0007	Faults and Intrusions Plan



NOTES

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2. Thickness of superficial deposits has been calculated by subtraction of the interpreted rockhead surface (drawing 5130177-ATK-XX-ZZ-DR-C-0006A and 5130177-ATK-XX-ZZ-DR-C-0006B) from the topographic ground surface. Both surfaces are generated by interpolation between points, and as such contain inherent inaccuracies resulting from the averaged surface profile. The thickness of the superficial deposits is therefore subject to the same inaccuracies, true thicknesses may therefore differ from the indicative thicknesses shown on this plan.
3. For clarity, only the proposed positions of main buildings (100 series) and associated tunnels are shown. Proposed building positions have been taken from HGNE drawing 310QC85-330 Rev.1. A more detailed building layout is shown on drawing 5130177-ATK-XX-ZZ-DR-C-0002A and 5130177-ATK-XX-ZZ-DR-C-0002B.
4. This drawing should be read in conjunction with Atkins' Final Interpretative GIR 5130177/301/011/02.

KEY

SITE DEVELOPMENT BOUNDARY (AS DEFINED BY NPS)

MAIN BUILDINGS FOOTPRINT AND TUNNEL ALIGNMENT (SEE NOTE 3)

THICKNESS OF MADE GROUND AND SUPERFICIAL DEPOSITS

MINIMUM THICKNESS (m)	MAXIMUM THICKNESS (m)	COLOUR
0.00	5.00	
5.00	10.00	
10.00	15.00	
15.00	20.00	
20.00	25.00	
25.00	30.00	
30.00	35.00	

Rev.	Date	Description	By	Chk'd	App'd
P4	29 MAY 2015	FOR FINAL INTERPRETATIVE GIR ISSUE 2.0	DH	RH	MW
P3	8 MAY 2015	FOR FINAL INTERPRETATIVE GIR ISSUE 1.0	DH	RH	MW
P2	28 NOV 2014	FOR INTERIM GIR	DH	RH	MW
P1	14 NOV 2014	FOR DRAFT INTERIM GIR	DH	RH	MW

Drawing Status: FOR ISSUE

Suitability: S2

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Client: HORIZON NUCLEAR POWER WYLFA LTD

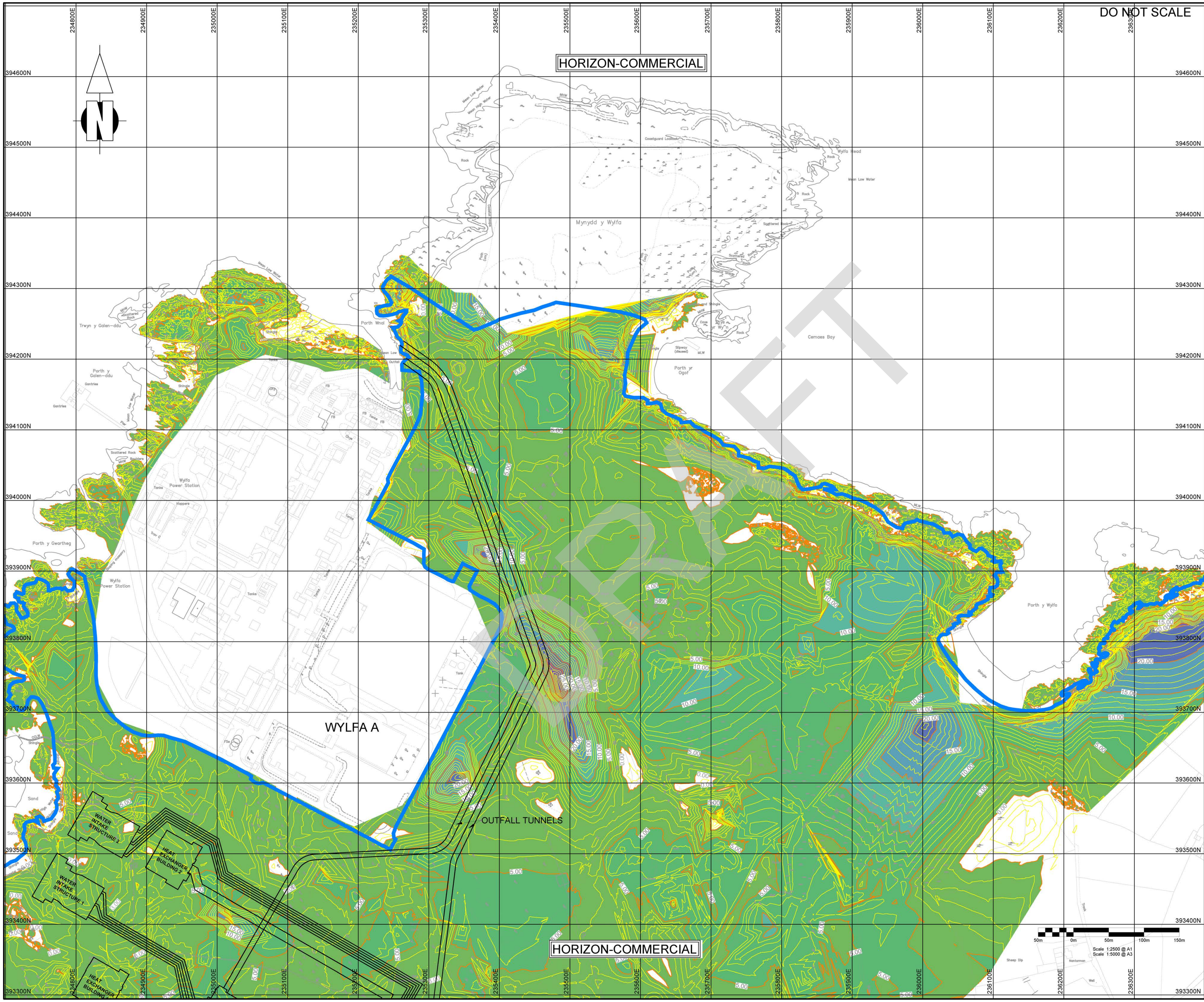
Project Title: WYLFA NEWYDD DETAILED ONSHORE GROUND INVESTIGATION

Drawing Title: THICKNESS OF MADE GROUND & SUPERFICIAL DEPOSITS ISOPACHES

Scale	Designed	Drawn	Checked	Authorised
1:2500	CB	DH	RH	MW
Original Size: A1	Date: 07 NOV 14	Date: 07 NOV 14	Date: 07 NOV 14	Date: 07 NOV 14

Drawing Number: 5130177-ATK-XX-ZZ-DR-C-0005A

Revision: P 4



NOTES

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2. Thickness of superficial deposits has been calculated by subtraction of the interpreted rockhead surface (drawing 5130177-ATK-XX-ZZ-DR-C-0006A and 5130177-ATK-XX-ZZ-DR-C-0006B) from the topographic ground surface. Both surfaces are generated by interpolation between points, and as such contain inherent inaccuracies resulting from the averaged surface profile. The thickness of the superficial deposits is therefore subject to the same inaccuracies, true thicknesses may therefore differ from the indicative thicknesses shown on this plan.
3. For clarity, only the proposed positions of main buildings (100 series) and associated tunnels are shown. Proposed building positions have been taken from HGNE drawing 310QC85-330 Rev.1. A more detailed building layout is shown on drawing 5130177-ATK-XX-ZZ-DR-C-0002A and 5130177-ATK-XX-ZZ-DR-C-0002B.
4. This drawing should be read in conjunction with Atkins' Final Interpretative GIR 5130177/301/011/02.

KEY

SITE DEVELOPMENT BOUNDARY (AS DEFINED BY NPS)

MAIN BUILDINGS FOOTPRINT AND TUNNEL ALIGNMENT (SEE NOTE 3)

THICKNESS OF MADE GROUND AND SUPERFICIAL DEPOSITS

MINIMUM THICKNESS (m)	MAXIMUM THICKNESS (m)	COLOUR
0.00	5.00	
5.00	10.00	
10.00	15.00	
15.00	20.00	
20.00	25.00	
25.00	30.00	
30.00	35.00	

Rev.	Date	Description	By	Chk'd	App'd
P2	29 MAY 2015	FOR FINAL INTERPRETATIVE GIR ISSUE 2.0	DH	RH	MW
P1	8 MAY 2015	FOR FINAL INTERPRETATIVE GIR ISSUE 1.0	DH	RH	MW

Drawing Status: FOR ISSUE
Suitability: S2

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Client: HORIZON NUCLEAR POWER WYLFA LTD

Project Title: WYLFA NEWYDD DETAILED ONSHORE GROUND INVESTIGATION

Drawing Title: THICKNESS OF MADE GROUND & SUPERFICIAL DEPOSITS ISOPACHES

Scale	Designed	Drawn	Checked	Authorised
1:2500	RF	DH	RH	MW
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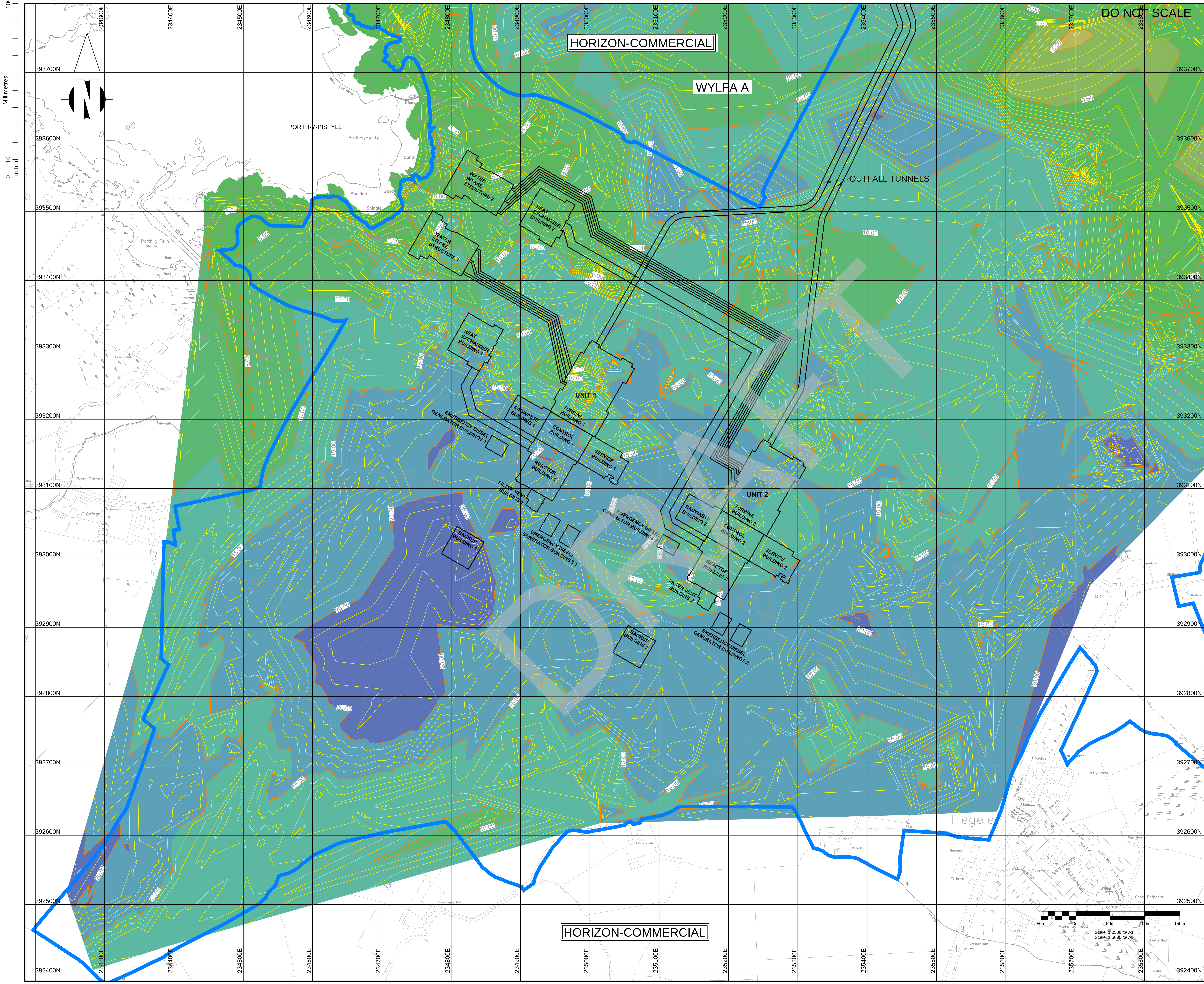
Drawing Number: 5130177-ATK-XX-ZZ-DR-C-0005B
Revision: P 2



NOTES

1. OS tiles provided by Horizon Nuclear Power Wylfa Ltd. Reproduced from Ordnance Survey map data by permission of Ordnance Survey, © Crown Copyright OS License 100051118.
2. Rockhead elevation has been contoured from a 3D surface generated from point data sourced from DOnGI boreholes, DOnGI geophysics, and previous GI phases (IOnGI and historical sources, as detailed in Section 4.6 of the Interim Interpretative GIR).
3. For clarity, only the proposed positions of main buildings (100 series) and associated tunnels are shown. Proposed building positions have been taken from HGNE drawing 310QC85-330 Rev.1. A more detailed building layout is shown on drawing 5130177-ATK-XX-ZZ-DR-C-0002A and 5130177-ATK-XX-ZZ-DR-C-0002B.
4. Several contour anomalies have been identified to the north of the Tre'r Gof SSSI. These anomalies may be due to conflict between borehole data and geophysics data, or may be related to the boundary with the Gwna Group. These anomalies are outside the main construction area, and have therefore not been addressed at this stage.
5. This drawing should be read in conjunction with Atkins' Final Interpretative GIR 5130177/301/011/02

KEY

SITE DEVELOPMENT BOUNDARY (AS DEFINED BY NPS)

MAIN BUILDINGS FOOTPRINT AND TUNNEL ALIGNMENT (SEE NOTE 3)

ROCKHEAD ELEVATION

MINIMUM ELEVATION (mOD)	MAXIMUM ELEVATION (mOD)	COLOUR
-15.00	-10.00	
-10.00	-5.00	
-5.00	0.00	
0.00	5.00	
5.00	10.00	
10.00	15.00	
15.00	20.00	
20.00	25.00	
25.00	30.00	
30.00	35.00	

Rev.	Date	Description	By	Chk'd	App'd
P4	29 MAY 2015	FOR FINAL INTERPRETATIVE GIR ISSUE 2.0	DH	RH	MW
P3	8 MAY 2015	FOR FINAL INTERPRETATIVE GIR ISSUE 1.0	DH	RH	MW
P2	28 NOV 2014	FOR INTERIM GIR	DH	RH	MW
P1	14 NOV 2014	FOR DRAFT INTERIM GIR	DH	RH	MW

Drawing Status: FOR ISSUE

Suitability: S2

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Client: HORIZON NUCLEAR POWER WYLFA LTD

Project Title: WYLFA NEWYDD DETAILED ONSHORE GROUND INVESTIGATION

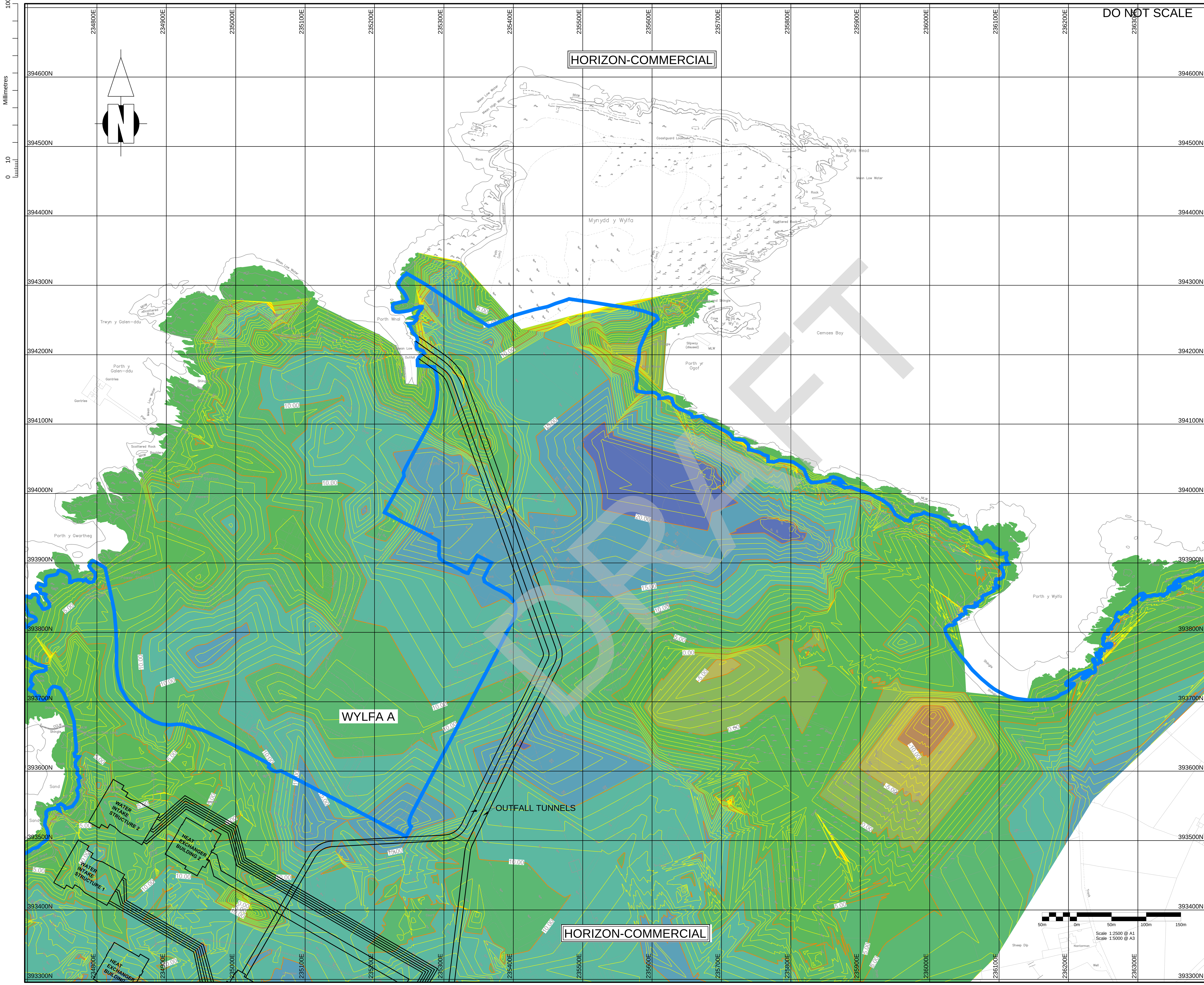
Drawing Title: ROCKHEAD ELEVATION CONTOUR PLAN

Scale	Designed	Drawn	Checked	Authorised
1:2500	CB	DH	RH	MW
Original Size	Date	Date	Date	Date
A1	07 NOV 14	07 NOV 14	07 NOV 14	07 NOV 14

Drawing Number: 5130177-ATK-XX-ZZ-DR-C-0006A

Revision: P 4

DO NOT SCALE



NOTES

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2. Rockhead elevation has been contoured from a 3D surface generated from point data sourced from DOnGI boreholes, DOnGI geophysics, and previous GI phases (IOnGI and historical sources, as detailed in Section 4.6 of the Interim Interpretative GIR).
3. For clarity, only the proposed positions of main buildings (100 series) and associated tunnels are shown. Proposed building positions have been taken from HGNE drawing 310QC85-330 Rev.1. A more detailed building layout is shown on drawing 5130177-ATK-XX-ZZ-DR-C-0002A and 5130177-ATK-XX-ZZ-DR-C-0002B.
4. Several contour anomalies have been identified to the north of the Tre'r Gof SSSI. These anomalies may be due to conflict between borehole data and geophysics data, or may be related to the boundary with the Gwna Group. These anomalies are outside the main construction area, and have therefore not been addressed at this stage.
5. This drawing should be read in conjunction with Atkins' Final Interpretative GIR 5130177/301/011/02.

KEY

SITE DEVELOPMENT BOUNDARY (AS DEFINED BY NPS)

MAIN BUILDINGS FOOTPRINT AND TUNNEL ALIGNMENT (SEE NOTE 3)

ROCKHEAD ELEVATION

MINIMUM ELEVATION (mOD)	MAXIMUM ELEVATION (mOD)	COLOUR
-15.00	-10.00	
-10.00	-5.00	
-5.00	0.00	
0.00	5.00	
5.00	10.00	
10.00	15.00	
15.00	20.00	
20.00	25.00	
25.00	30.00	
30.00	35.00	

Rev.	Date	Description	By	Chk'd	App'd
P2	29 MAY 2015	FOR FINAL INTERPRETATIVE GIR ISSUE 2.0	DH	RH	MW
P1	8 MAY 2015	FOR FINAL INTERPRETATIVE GIR ISSUE 1.0	DH	RH	MW

Drawing Status: FOR ISSUE

Suitability: S2

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Client: HORIZON NUCLEAR POWER WYLFA LTD

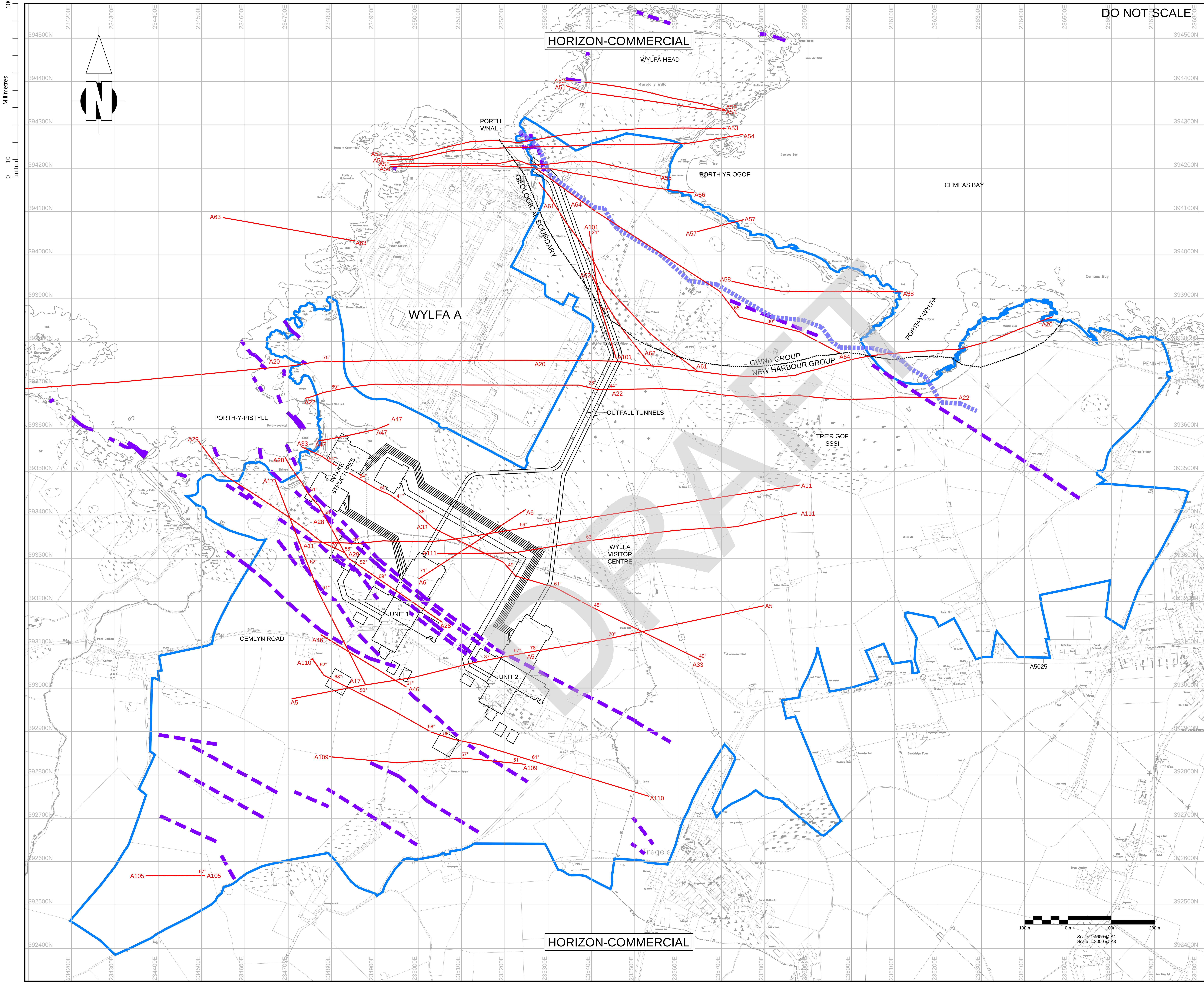
Project Title: WYLFA NEWYDD DETAILED ONSHORE GROUND INVESTIGATION

Drawing Title: ROCKHEAD ELEVATION CONTOUR PLAN

Scale	Designed	Drawn	Checked	Authorised
1:2500	RF	DH	RH	MW
Original Size	Date	Date	Date	Date
A1	8 MAY 15	8 MAY 15	8 MAY 15	8 MAY 15

Drawing Number: 5130177-ATK-XX-ZZ-DR-C-0006B

Revision: P 2



NOTES

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2. For clarity, only the proposed positions of main buildings (100 series) and associated tunnels are shown. Proposed building positions have been taken from HGNE drawing 310QC85-330 Rev.1. A more detailed building layout is shown on drawing 5130177-ATK-XX-ZZ-DR-C-0002A and 5130177-ATK-XX-ZZ-DR-C-0002B.
3. This drawing should be read in conjunction with Atkins' Final Interpretative GIR 5130177/301/011/02.
4. The alignment of intrusions has been taken from the Halcrow drawing TQHOWA/409 and their model produced at IOnGI stage (WYB0002, Feb 2012). Multiple intrusion intersections have been observed at DOnGI stage; the intrusion model has not been updated at Final DOnGI GIR stage.
5. Interpreted plan locations of faults and intrusions are shown at 0mOD. Faults and intrusions have been extrapolated linearly to 0mOD from intersections in boreholes. Estimated fault dip angles are shown on the down dip side of the fault. In reality, such geological features may be curved, or include splays/branches.
6. A-series faults were identified by Arup & BGS, these were agreed upon in a collaborative meeting with Atkins held on 23rd April 2015.
7. Estimated dip angles for faults have been taken from Appendix C of Arup Report Ref: REP/214898/61001/Rev 0.1 (18 May 2015).
8. Faults A59 and A60 are located to the north of Wylfa Head, these faults lie beyond the northern extent of this plan.

KEY

- SITE DEVELOPMENT BOUNDARY (AS DEFINED BY NPS)
- MAIN BUILDINGS FOOTPRINT AND TUNNEL ALIGNMENT (SEE NOTE 2)
- A63 — 54° — A63: A - SERIES FAULTS (SEE NOTES 5 & 6)
- 54°: ESTIMATED DIP SHOWN ON DOWN DIP SIDE
- PALEOZOIC INTRUSIONS (SEE NOTE 4)
- TERTIARY INTRUSION
- INFERRED GWNA GROUP - NEW HARBOUR GROUP GEOLOGICAL BOUNDARY

Rev.	Date	Description	By	Chk'd	App'd
P4	29 MAY 2015	FOR FINAL INTERPRETATIVE GIR ISSUE 2.0	DH	RH	MW
P3	8 MAY 2015	FOR FINAL INTERPRETATIVE GIR ISSUE 1.0	DH	RH	MW
P2	28 NOV 2014	FOR INTERIM GIR	DH	RH	MW
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Project Title: WYLFA NEWYDD DETAILED ONSHORE GROUND INVESTIGATION

Drawing Title: FAULTS AND INTRUSIONS PLAN

Scale	Designed	Drawn	Checked	Authorised
1:4000	CB	DH	RH	MW
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Appendix E. Geologically Protected Sites Information

1. Statutory sites of geological importance

1.1 Introduction

The Geological Conservation Review (GCR) initiative aims to identify sites of national and international importance that demonstrate the key elements of Great Britain's earth heritage.

GCR sites are either already notified or being considered for notification as 'Sites of Special Scientific Interest' (SSSIs) and, as such, form the basis of statutory geological and geomorphological site conservation in Great Britain. All geological SSSIs are GCR sites before they are notified and protected as SSSIs.

There are no designated GCR sites within the study area although five sites are present in the wider area – as shown on Figure 18. For completeness, further information on these sites is presented below, although it is noted that there would be no predicted effects from the WNDA Development.

1.2 Sites within wider area

1.2.1 Hen Borth SSSI

The Hen Borth GCR site was notified as a SSSI in 1989. It is designated for its geomorphological interest as a site of national importance due to the quality of exposed Pleistocene/Quaternary sediments along its coastal cliff sections.

Greenly (1919) mapped over 200 drumlins in the north and west of Anglesey. Hen Borth provides a rare and excellent coastal cliff exposure showing a five metre thick section of the internal structure and sedimentary detail of one glacial mound (drumlin) formed during the last Ice Age (the Late Devensian, approximately 14,000 to 24,000 years ago) (Greenly, 1919). This drumlin is one of a large swarm, has a 300m long axis and is aligned from northeast to southwest, which correlates with the striae found on nearby bedrock surfaces (Cambell and Bowen, 1989). In addition, the drumlin's external shape and landform can be viewed within the inland parts of the GCR site.

Drumlin formation is still not fully understood (Menzies, 1978). The Hen Borth SSSI is therefore important in the ongoing scientific study of drumlins, glacier dynamics and reconstructing regional patterns of ice movement.

1.2.2 Llanbadrig Area GCR

The Llanbadrig Area GCR (referred to as Ogof Gynfor Coast in Gibbons (2000) citation) is designated due to its international geological and historical importance as it preserves one of the best examples of the Gwna Group mélange on Anglesey, has the only direct view of an important well-exposed unconformity with the overlying Ordovician sequence, and includes the only place where macrofossils are found in pre-Arenig basement rock within north west Wales (Gibbons, 2000).

Llanbadrig Area has been described as including 'one of the finest exposures of Gwna mélange' (Barber *et al*., 1981). The Gwna mélange; fragments of limestone, dolomite, quartzite and basalt within a sandy mud matrix; was formed by a catastrophic submarine slump at a destructive plate margin setting, approximately 600 million years ago. The Gwna mélange was the first mélange to be described in the world. The Gwna mélange along the north coast has undergone the mildest degree of tectonism and metamorphic recrystallization in the entire Gwna Group outcrop of northwest Wales (Gibbons, 2000).

Llanbadrig Area also includes an important well-exposed unconformable contact between the Gwna mélange and the overlying Arenig strata of the Torllwyn Formation - at the base of the cliff at Ogof Gynfor. The unconformity is critical in proving the age of the Gwna Group, however studies are still ongoing regarding the time represented by the unconformity. The unconformity also demonstrates 'a classic example of the interrelationships that can obtain between folding and faulting' (Bates, 1974).

The south western section of Llanbadrig Area is of special interest as the Gwna mélange contains an abundance of large limestone clasts which contain the only known late Precambrian stromatolites in the Monian Supergroup within North Wales. These are the oldest known stromatolites to be found in Great Britain.

1.2.3 Ogof Gynfor – Hell's Mouth GCR

The Ogof Gynfor – Hell's Mouth GCR (referred to as The Gynfor Outliers in Owens *et al.* (1999) citation) is designated due to its regional geological importance in interpreting Precambrian Monian and Ordovician stratigraphy, structural relationships and palaeogeography.

Ogof Gynfor – Hell's Mouth comprises three separate areas: Ogof Gynfor, Isallt, and the area from Llanlleiana Head and Porth Cynfor. Ogof Gynfor – Hell's Mouth partially falls within the Llanbadrig Area GCR and includes the unconformity between the Gwna mélange and the overlying Ordovician sedimentary rocks at Ogof Gynfor as discussed above. The same fault complex can be seen inland at Isallt, where the base of the irregular unconformity can be seen dipping at a low angle.

The Porth Cynfor Conglomerate Formation rests unconformably upon the irregular surface of Gwna Quartzite and beneath the Torllwyn Formation in the outlier GCR parcel at Llanlleiana Head to Porth Cynfor. The outcrops either side of Porth Cynfor represent the type locality for the Porth Cynfor Formation (Owens *et al.*, 1999).

1.2.4 Ogof Gynfor GCR

The Ogof Gynfor GCR is designated due to its regional geological importance in interpreting Precambrian Monian and Ordovician stratigraphy, structural and metamorphic relationships. Ogof Gynfor falls within the Ogof Gynfor – Hell's Mouth GCR, and by definition, within the Llanbadrig Area GCR.

The section was first described by Matley (1899). It consists of a fault-bounded succession of Gwna mélange (Precambrian), Arenig Torwllwyn Formation (Ordovician) and Caradoc Gynfor Shales (Ordovician). Ogof Gynfor also provides important exposures of the unconformable contact between the Precambrian and Ordovician rocks.

The structural interest of this site lies in the relationships between the folding and faulting, particularly the way in which the faults are associated with folds and cleavage in the Ordovician sequence, and the way in which these folds pass down into faults in the basement (Bates, 1992). The strongly folded Ordovician rocks include a steeply dipping series of four synclines and three anticlines, which have also been affected by reverse and normal faulting.

1.2.5 Llanbadrig – Dinas Gynfor SSSI

Llanbadrig – Dinas Gynfor is a designated SSSI site, notified in May 1986, due to its geological interest. The Llanbadrig – Dinas Gynfor SSSI includes the Ogof-Gynfor – Hell's Mouth GCR and the Ogof Gynfor GCR, as well as parts of the Llanbadrig Area GCR.

The diversity of geological interest provided by exposures in the Llanbadrig – Dinas Gynfor SSSI makes the site one of the most important geological localities in North Wales; the exposures are critical to Ordovician palaeogeographic studies.

The coastal section is famous for the well exposed unconformity between the Mona Complex and Lower Ordovician fossiliferous rocks. This unconformity is evidence that the Mona Complex is the oldest rock group in Anglesey.

Beneath the unconformity is the Gwna mélange; fragments of limestone, dolomite, quartzite and basalt within a sandy mud matrix, formed by a catastrophic submarine slump at a destructive plate margin setting, approximately 600 million years ago. The only fossils ever found in the Mona Complex are found within the mélange.

The Lower Ordovician rocks above the unconformity represent the thickest conglomeratic development in the Welsh Basin.

2. Non-statutory sites of geological importance

2.1 Introduction

Regionally Important Geodiversity Sites (RIGS) are locally designated sites of local, regional, and national importance for their geodiversity. Although RIGS are not statutorily protected, RIGS are conserved and protected from development by local authorities.

There are four RIGS located within the study area and a further 10 within the wider area (excluding the eastern extent of the Cemaes Bay RIGS). For completeness, further information on sites within the wider area is presented, although it is noted that there would be no predicted impacts from the Wylfa Newydd Development on the RIGS which are outside the study area. Information on RIGS within the study area is presented in the main body of this report. The information below is summarised from Gwynedd and Môn RIGS Group Site Records.

The locations of all RIGS present within the study area and wider area are presented on Figure 18.

2.2 Sites within wider area

2.2.1 Ty'n Llan

The intrusion of several Palaeozoic dykes into the mica schists of the Monian Supergroup as well as a separate geological unit mapped as Church Bay Tuffs makes the Ty'n Llan RIGS an important site for advancing scientific understanding of the Carmel Head Thrust complex.

2.2.2 Mynachdy

The Mynachdy RIGS on Carmel Head is designated largely due to its historical importance, as unusual and rare minerals including asbestos and serpentine were quarried here but are no longer visible. The site and minerals therein were important in early writings, with Pliny describing the use of asbestos cloth in ancient rituals. Furthermore, the site is of geological importance due to the unusual occurrence of deep-sea-derived rocks found in the New Harbour Group schists, which is controversial due to their incongruous depositional environments.

2.2.3 Mynydd y Garn

The Mynydd y Garn RIGS found 3km south of Carmel head is an accessible mafic sill of Palaeozoic age, intruded into Ordovician sediments and exposed in an old quarry. The sill displays evidence of late strike-slip movements in the main Carmel head thrust in the form of well-developed quartz mineral lineations.

2.2.4 Gadlys Quarry

The Gadlys Quarry RIGS partially overlaps with the Cemaes Bay RIGS (portion of Cemaes Bay which is outside the study area) and is designated for national scientific importance due to the fossiliferous Precambrian deposits exposed at this locality.

The Gwna mélange exposed within Gadlys Quarry contains large inclusions of fossiliferous limestone with a microfossils assemblage of layered stromatolites, filaments, and spheroidal vesicularites (algal floating or rolling bodies).

2.2.5 Trwyn y Parc

The Trwyn y Parc RIGS lies within the Gadlys Quarry RIGS and, by definition, the Cemaes Bay RIGS (portion of Cemaes Bay which is outside the study area).

The Trwyn y Parc RIGS is of national importance for its fossiliferous deposits of Miocene age which have major implications for understanding how the British landscape evolved prior to the Pleistocene ice ages. The geomorphological features and strata exposed at this RIGS provide critical evidence supporting the conclusion that Anglesey's broad shape and form, and that of the adjacent Snowdonian mountain block, were well-established landscapes by the end of the Miocene (~5.3 million years ago).

2.2.6 Llanbadrig Point Coast

The Llanbadrig Point Coast RIGS partially overlies with the northern part of the Cemaes Bay RIGS (portion of Cemaes Bay which is outside the study area), and is designated for its scientific and educational importance.

The Llanbadrig Point Coast RIGS provides one of the best views of the Gwna mélange in Anglesey, including a view of the Ogof Gynfor unconformity between the Precambrian schists and quartzites of the Gwna Group, and the overlying Ordovician conglomerates of the Porth Cynfor Formation. The unconformity is crucially important towards understanding the regional palaeogeography in late Precambrian to early Ordovician times.

2.2.7 Llanbadrig Point

The Llanbadrig Point RIGS lies within the Llanbadrig Point Coast RIGS, and by definition, the Cemaes Bay RIGS (portion of Cemaes Bay which is outside the study area). The Llanbadrig Point RIGS is important in understanding Precambrian fossils and minerals within the Gwna mélange.

Iron rich deposits such as siderite and jasper present within the mélange are crucial towards understanding Precambrian rocks worldwide, and particularly as indicators of oxygen levels and sea water composition.

2.2.8 Porth Padrig

The Porth Padrig RIGS partially overlies with the northern part of the Cemaes Bay RIGS (portion of Cemaes Bay which is outside the study area) and is important in demonstrating key evidence and concepts concerning the geomorphological evolution of Anglesey.

The Gwna mélange strata in the north-eastern part of the RIGS exhibit a high degree of in-situ weathering, are extremely friable, and are juxtaposed with solid bedrock masses akin to the corestones found in sections of weathered and altered granite on Dartmoor and sporadically elsewhere in Britain.

2.2.9 St Patrick’s Dykes

The St Patrick’s Dykes RIGS lies within the Cemaes Bay RIGS (portion of Cemaes Bay which is outside the study area) and the Llanbadrig Point Coast RIGS, completely encompasses the Llanbadrig Point RIGS, and partially encompasses the Ffynnon Badrig RIGS. The St Patrick’s Dykes RIGS is designated for its scientific and educational importance in demonstrating the Palaeozoic intrusive doleritic igneous rocks of Anglesey.

The St Patrick’s Dykes RIGS provides an excellent example of an échelon (closely spaced and parallel) dykes trending northwest to southeast, which intrude into matrix weaknesses within the Gwna mélange.

2.2.10 Ffynnon Badrig

The Ffynnon Badrig RIGS lies within the Llanbadrig Point Coast RIGS and, by definition, the Cemaes Bay RIGS (outside the study area). The Ffynnon Badrig RIGS is of international importance for its fossiliferous deposits of Precambrian age.

The quarry also has significant geological historic importance as the limestones present here were the first Gwna mélange deposit recognised to be fossil bearing.

3. References

Barber, A.J., Max, M.D. & Brück, P.M. (1981). Geologists' Association-Irish Geological Association Field Meeting in Anglesey and southeastern Ireland, 4-11 June, 1977. *Proceedings of the Geologists' Association, 92*, 269–291.

Bates, D.E.B. (1974). The structure of the Lower Palaeozoic rocks of Anglesey, with special reference to faulting. *Geological Journal, 9*, 39–60.

Bates, D.E. (1992) In: Treagus, J.E. (Ed.) *Caledonian Structures in Britain South of the Midland Valley. Geological Conservation Review Series No. 3*. Chapman & Hall, 120–122.

Campbell, S. & Bowen, D.Q. (1989) *Quaternary of Wales.* Geological Conservation Review Series No. 2, Nature Conservancy Council. Peterborough, 138–139.

Gibbons, W. (2000) In: Carney, J.N., Horák, J.M., Pharaoh, T.C., Gibbons, W., Wilson, D., Barclay, W.J. & Bevins, R.E. *Precambrian Rocks of England and Wales.* Geological Conservation Review Series No. 20, Joint Nature Conservation Committee. Peterborough, 165–167.

Greenly, E. (1919). *The geology of Anglesey. Memoirs of the Geological Survey of Great Britain*. HMSO, London, 980pp. (2 vols).

Matley, C.H. (1899). On the geology of Northern Anglesey (with an appendix by W.W. Watts). *Quarterly Journal of the Geological Society of London, 55*, 635–680.

Menzies, J. (1978). A review of the literature on the formation and location of drumlins. *Earth Science Reviews, 14*, 315–350.

Owens, R.M., Owen, A.W. & Rushton, A.W.A. (1999) In: Rushton, A.W.A., Owen, A.W., Owens, R.M. & Prigmore, J.K. *British Cambrian to Ordovician Stratigraphy. Geological Conservation Review Series No. 18, Joint Nature Conservation Committee.* Peterborough, 203–205.

Appendix F. North West Wales Mineral and Waste Planning Service Response

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Dear Ms Gralewski,

Wylfa Newydd – Mineral Resources

I agree in part with the findings of your letter of the 4th March re the above.

It is acknowledged that the site lies within a geological area identified as Category 2 Aggregate Safeguarding Area within the 2012 BGS & Welsh Government map. It is noted that the Cat 2 geology within the area is that of quarzitic sandstone, sand & gravel and igneous rock. None of these are identified within a Minerals Safeguarding area within the Capita Symonds report of 2010 and none have been safeguarded as part of the current UDP or proposed LDP. Notwithstanding; the EIA that is to be prepared in support of the proposal must acknowledge and identify the geology and if the reserve on site is to be sterilised, its sterilisation is to be justified within the greater proposal.

From discussions and meetings it is gathered that the Wylfa Newydd project is an exceptionally large scale development project. Having attended the Level 4 Landscape and Environmental Masterplan (LEMP) Meeting of the 13th July, 2015 it was acknowledged by Horizon representatives that the proposed development bar the building stage depicted that of a very large quarrying development; i.e. the stripping of topsoil and overburden, expose and level bedrock, the quarrying of foundations at a depth of circa 25metres for the two reactor buildings on site, the quarrying of foundations for other buildings on site. As such, the development is to generate an exceptionally large amount of material that will include what is classed as category 2 aggregates.

Although the mineral resource has not been identified to be commercially viable within the Capita Symonds report, as you are well aware - there are various benefits in utilising material generated on site and it is envisaged that such a project will utilise as much material as possible; as a result, your report on sterilisation will also acknowledge that a large degree of pre extraction and utilisation of category 2 aggregates will occur as part of the Wylfa Newydd project.

I trust that the North Wales Minerals and Waste Planning Service's position is explained above. However, should you require further advice or additional information regarding the contents of this letter, please do not hesitate in contacting.

Yours faithfully,

Robin Wynne Williams
Senior Planning Officer (Minerals and Waste)

Ar ran Gwasanaeth Cynllunio Mwynau a Gwastraff Gogledd Cymru
On behalf of the North Wales Minerals and Waste Planning Service