Pembrokeshire Coast National Park Authority

Pembrokeshire Coast National Park Local Development Plan 2

Regionally Important Geodiversity Sites

Supplementary Planning Guidance

Date of Consultation: 15th September 2021

Date of Adoption:

This item is also available in Welsh / Mae'r eitem hon ar gael yn Gymraeg hefyd

Abbreviations Used

NRW	Natural Resources Wales
RIGS	Regionally Important Geodiversity Site
GCR site	Geological Conservation Review Site
cm	centimetre
m	metre
km	kilometre
SSSI	Site of Special Scientific Interest

1 Introduction

1.1 This supplementary planning guidance shows the location of Regionally Important Geodiversity Sites (RIGS) within the National Park[1]. It also provides a summary of the Statement of Interest for each RIGS. It will be used to consider planning applications which may have an adverse effect on the main features of interest within a RIGS. It is aimed at helping planning applicants to consider this issue when making a planning application and will help the Authority to assess proposals.

1.2 Supplementary Planning Guidance does not form part of the Local Development Plan, but can provide additional detail about how the policies of the Plan are implemented.

2 Planning Policy Context

National Planning Policy

2.1 Planning Policy Wales (Edition 11, February 2021) identifies the geological value of the countryside (3.38) as well as recognising that geological features are a key part of our natural environment and protecting geodiversity underpins the wider protection and management of our natural resources, including land availability, renewable energy potential, groundwater supply and flood risk (6.3.14). Planning Policy Wales confirms that planning authorities should protect the features for which RIGS have been designated, and are encouraged to promote opportunities for the incorporation of geological features within the design of development (6.3.16).

2.2 Technical Advice Note 5 'Nature Conservation and Planning' provides advice about how the land use planning system should contribute to protecting and enhancing biodiversity and geological conservation. The TAN states that "geodiversity" is the variety of geological environments, phenomena and active processes that make landscapes, rocks, minerals, fossils, soils and their superficial deposits that provide the framework for life on earth. Geodiversity is important because it underpins biodiversity with soils being the link between them (1.4.2).

Local Planning Policy

2.3 This guidance is supplementary to Policy 12 of the Local Development Plan and it will be a material consideration in applications affecting the RIGS.

Geodiversity in Pembrokeshire

2.4 The diverse geology within the Pembrokeshire Coast National Park is identified as a Special Quality[2] of the National Park.

This Special Quality is summarised as follows -

> ***Diverse Geology:*** Pembrokeshire is renowned amongst geologists for its spectacular geology, which has provided the field evidence for understanding the rocks of the Cambrian, Ordovician, Silurian and Carboniferous Periods in geological time. This long geological history is recognisable in the landscape of Pembrokeshire but is most easily read in its complex rocky coastline. This has resulted in the Pembrokeshire Coast becoming one of the UK's most important venues for geological fieldwork, noted by one specialist as being a superlative natural classroom in which large sections of the story of planet Earth can be unravelled as new skills are taught. The rich and varied geological history has given us the powerful volcanic outcrops of Carn Llidi, St. Davids, and the stunning doloritic extrusions which form most of the peaks of the Preseli Hills. The spectacular limestone cliffs and Elegug Stacks provide many fine examples of rock formations to the south of

[1] Regionally Important Geodiversity Sites are funded and supported by Natural Resources Wales. They are designated outside the Local Development Plan process by Geoconservation Cymru – Wales. The Authority supports these designations with supplementary planning guidance which is updated when sites are newly designated.
[2] See Policy 8 Special Qualities of Local Development Plan 2.

the National Park. Inland, the landscape has been shaped by the actions of ice movement, with the Cwm Gwaun valley being a deep gorge eroded by glacial meltwater. Rising sea levels following the melting of the ice at the end of the Devensian glaciation drowned many river valleys, producing spectacular 'rias', of which the Cleddau estuary is the most spectacular, with smaller scale features at Solva and Stackpole.

3 Regionally Important Geodiversity Sites in the National Park

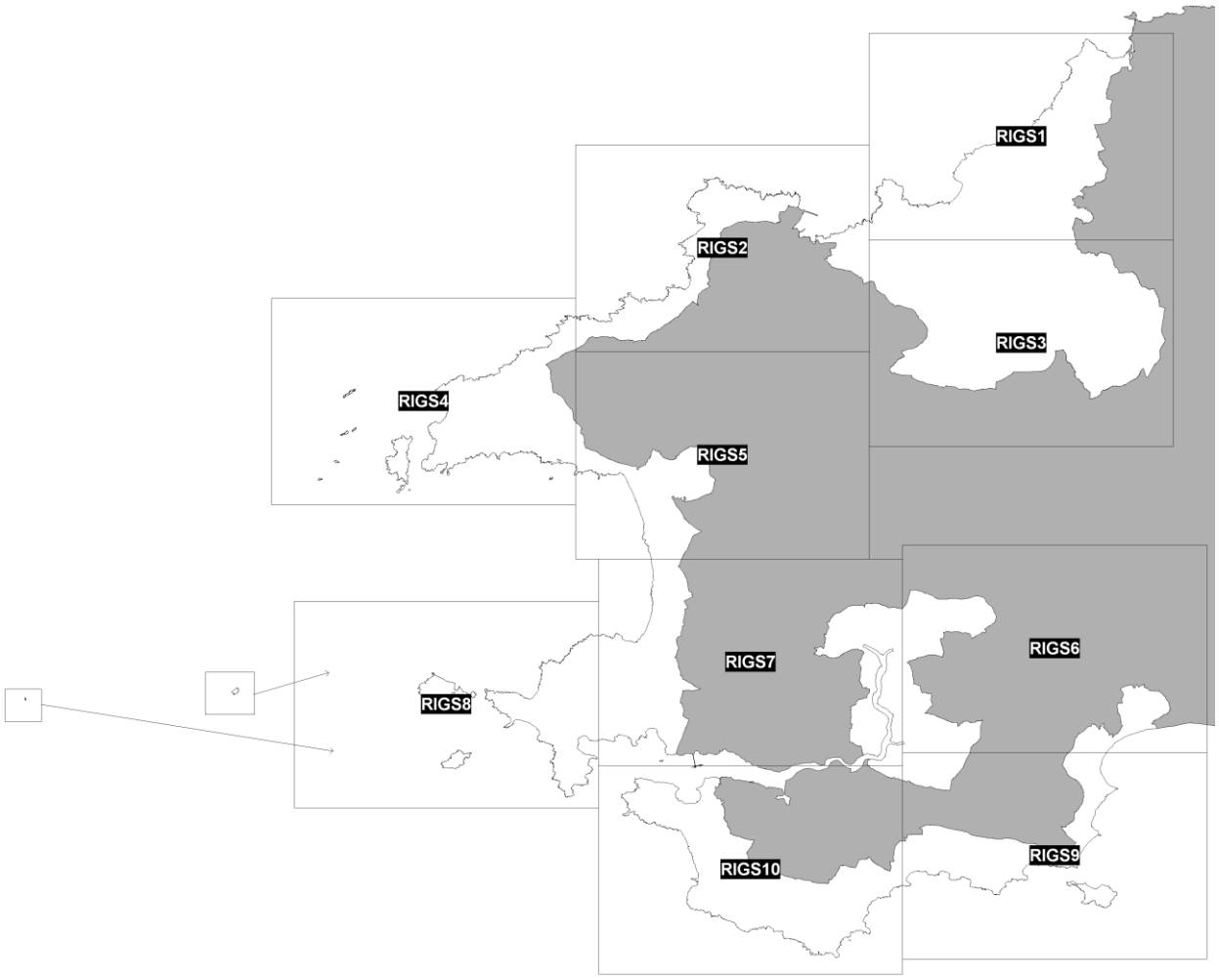
3.1 RIGS are a non-statutory geodiversity designation. They sit under the Geological Conservation Review (GCR) sites designation. [GCR sites are considered to be of national and international importance in relation to British earth science and geological history. GCR sites are localities already notified or being considered for notification as 'Sites of Special Scientific Interest' (SSSI), which provides legal protection.]

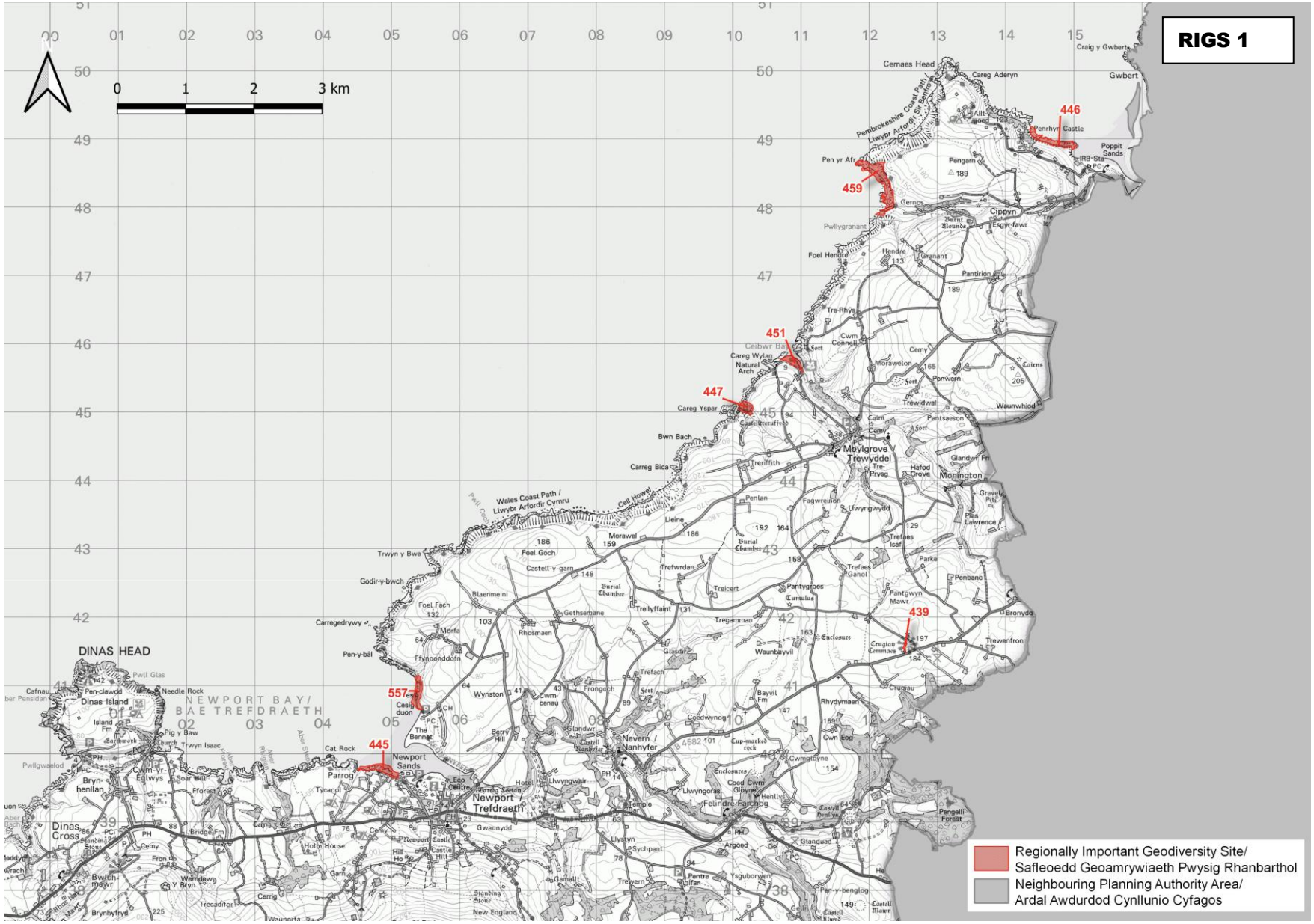
3.2 This Supplementary Planning Guidance provides the location and summary of the Statement of Interest for RIGS within the Pembrokeshire Coast National Park.

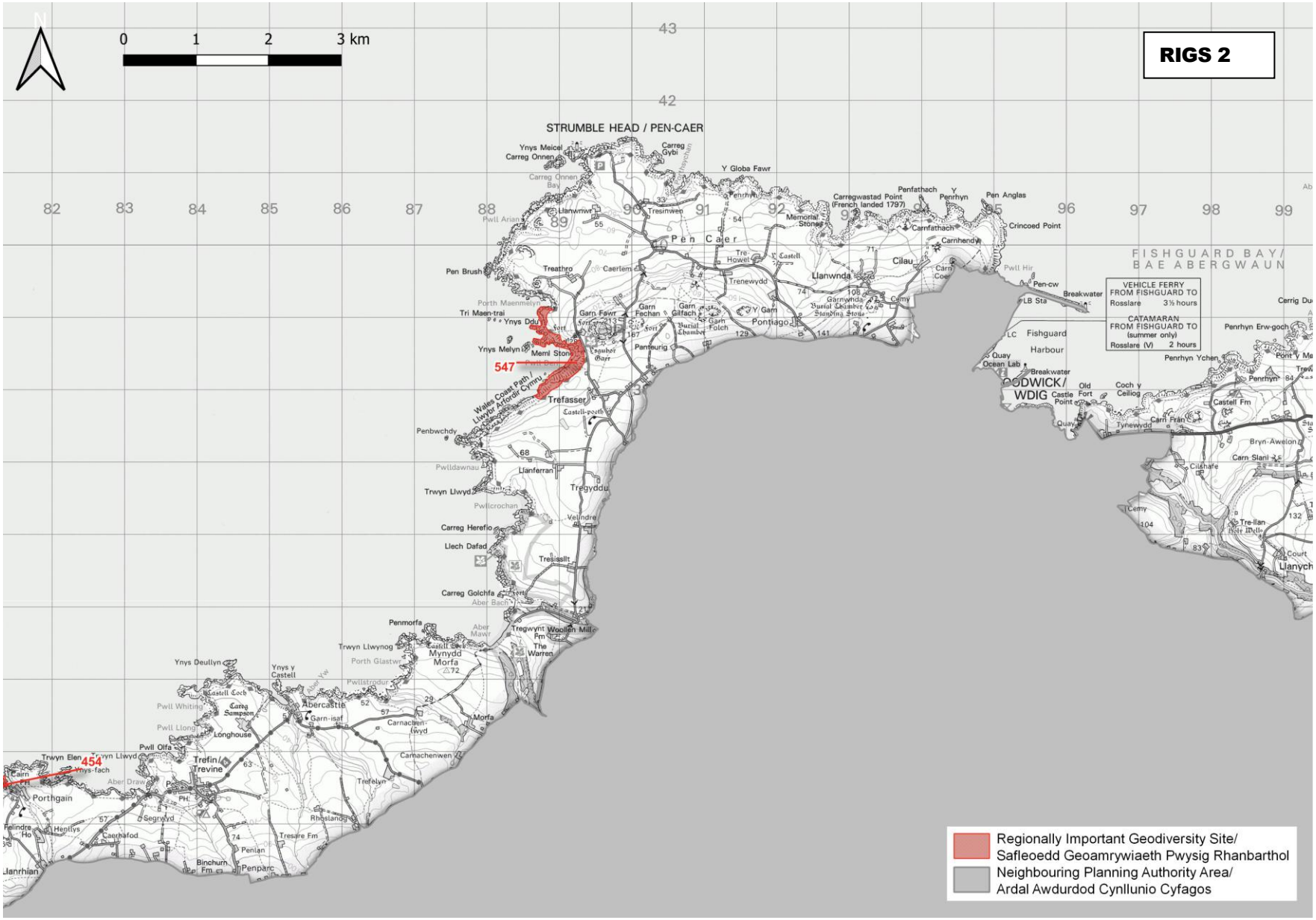
4 How to use this RIGS guidance

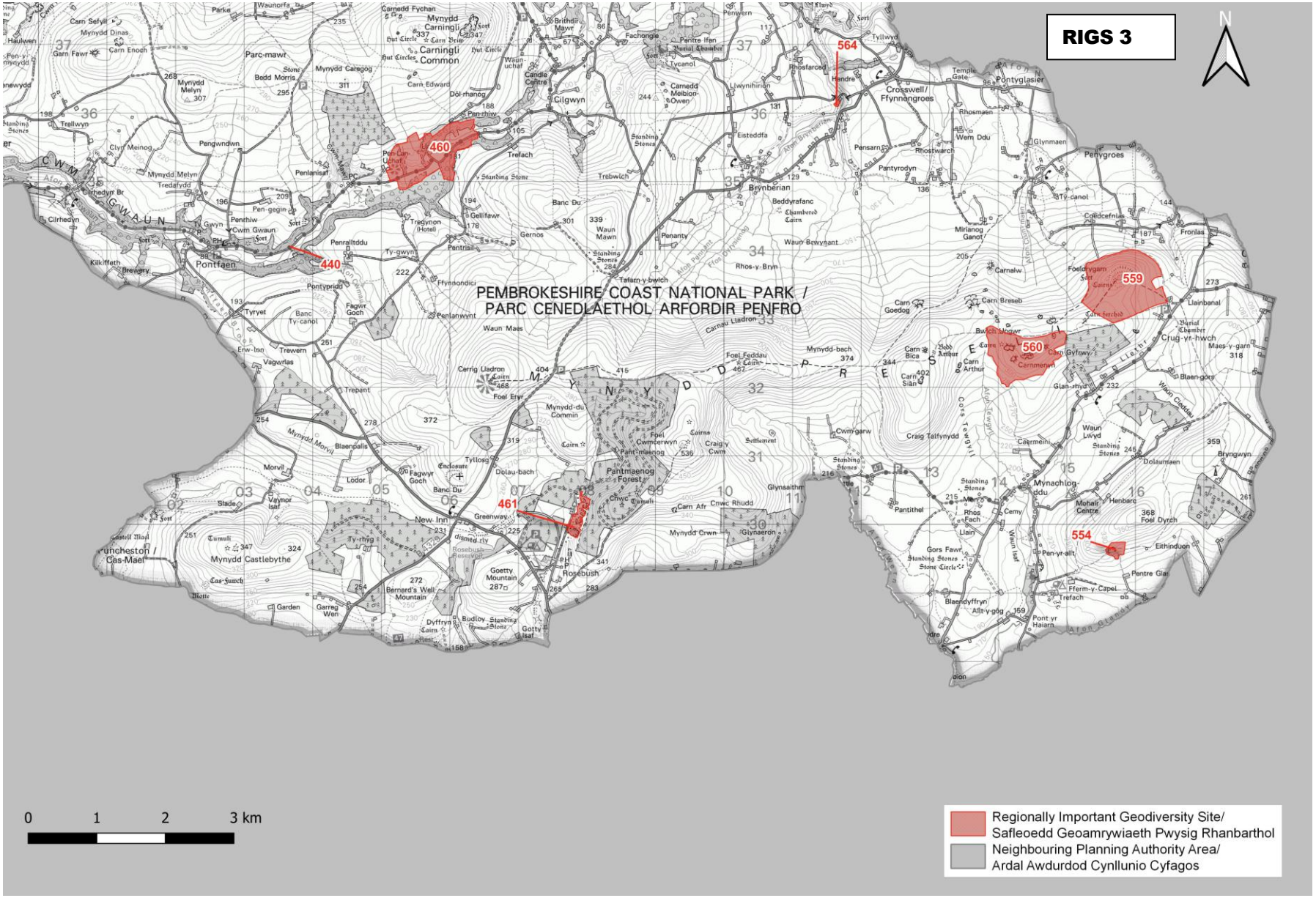
4.1 This guidance provides the location and RIGS number for each RIGS within the National Park. The site specific sheets are in RIGS number order and provide the RIGS name and a summary of the Statement of Interest. RIGS Number 564 was designated by Geoconservation Cymru-Wales in 2016.

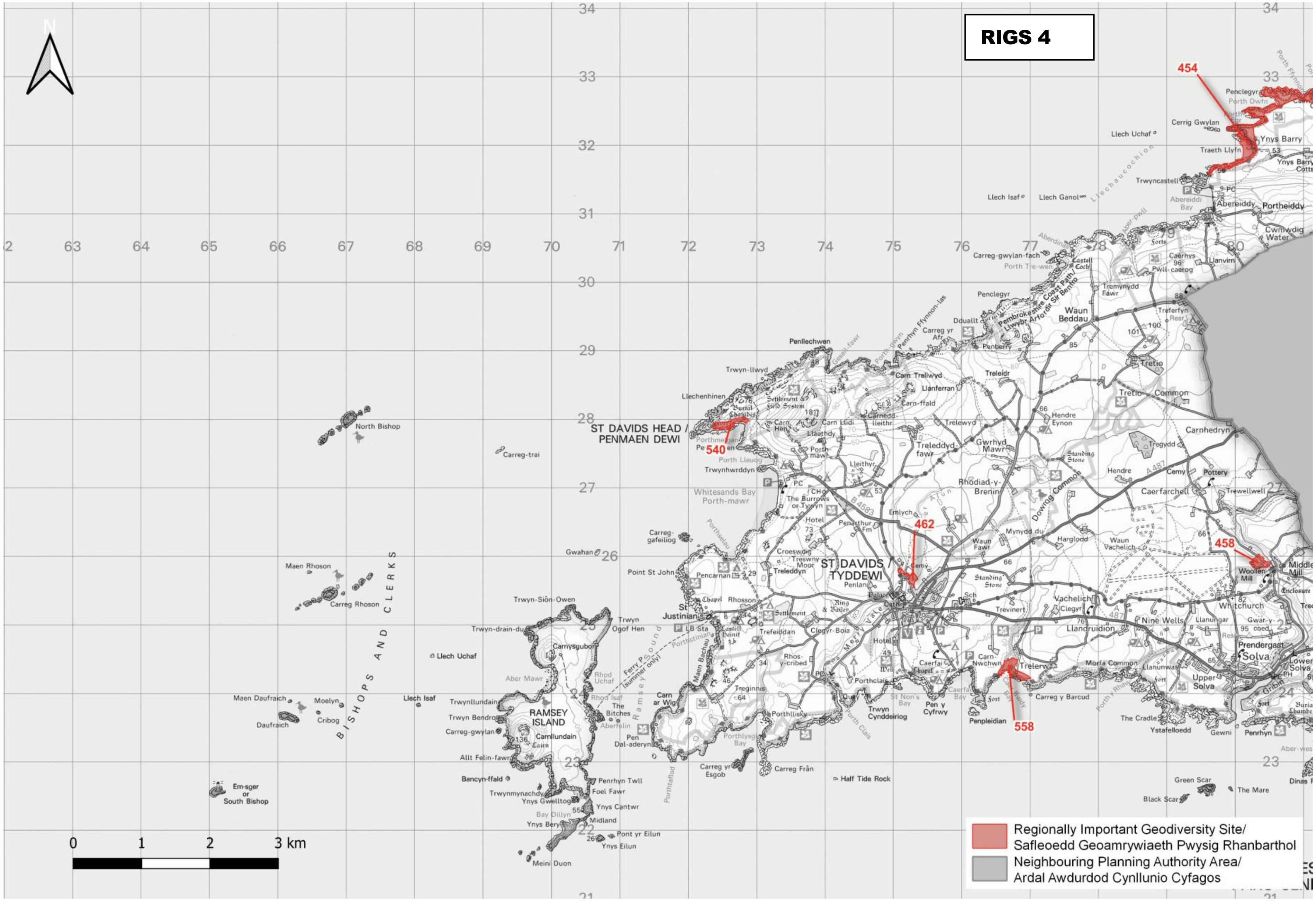
5 Key to overview maps

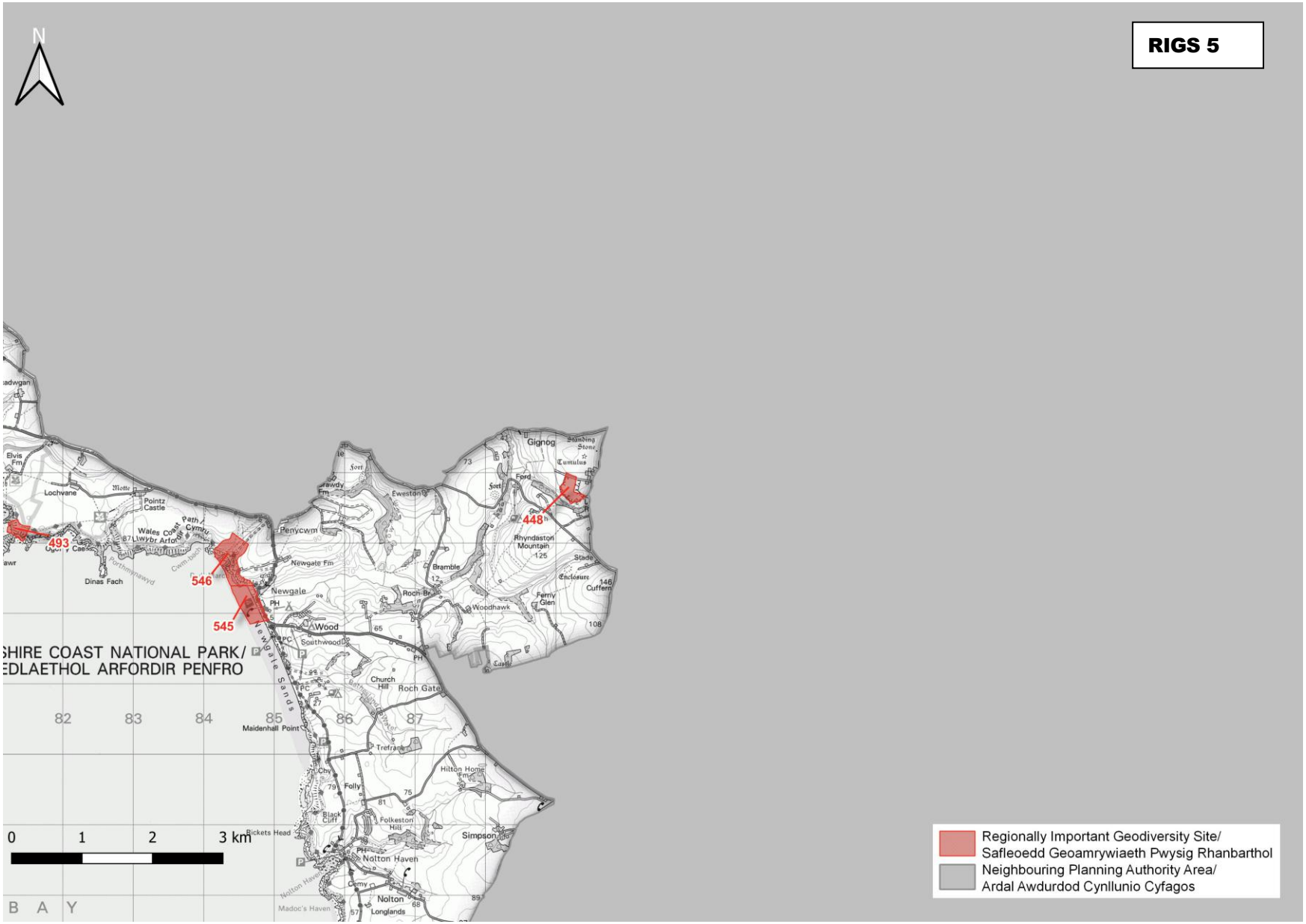


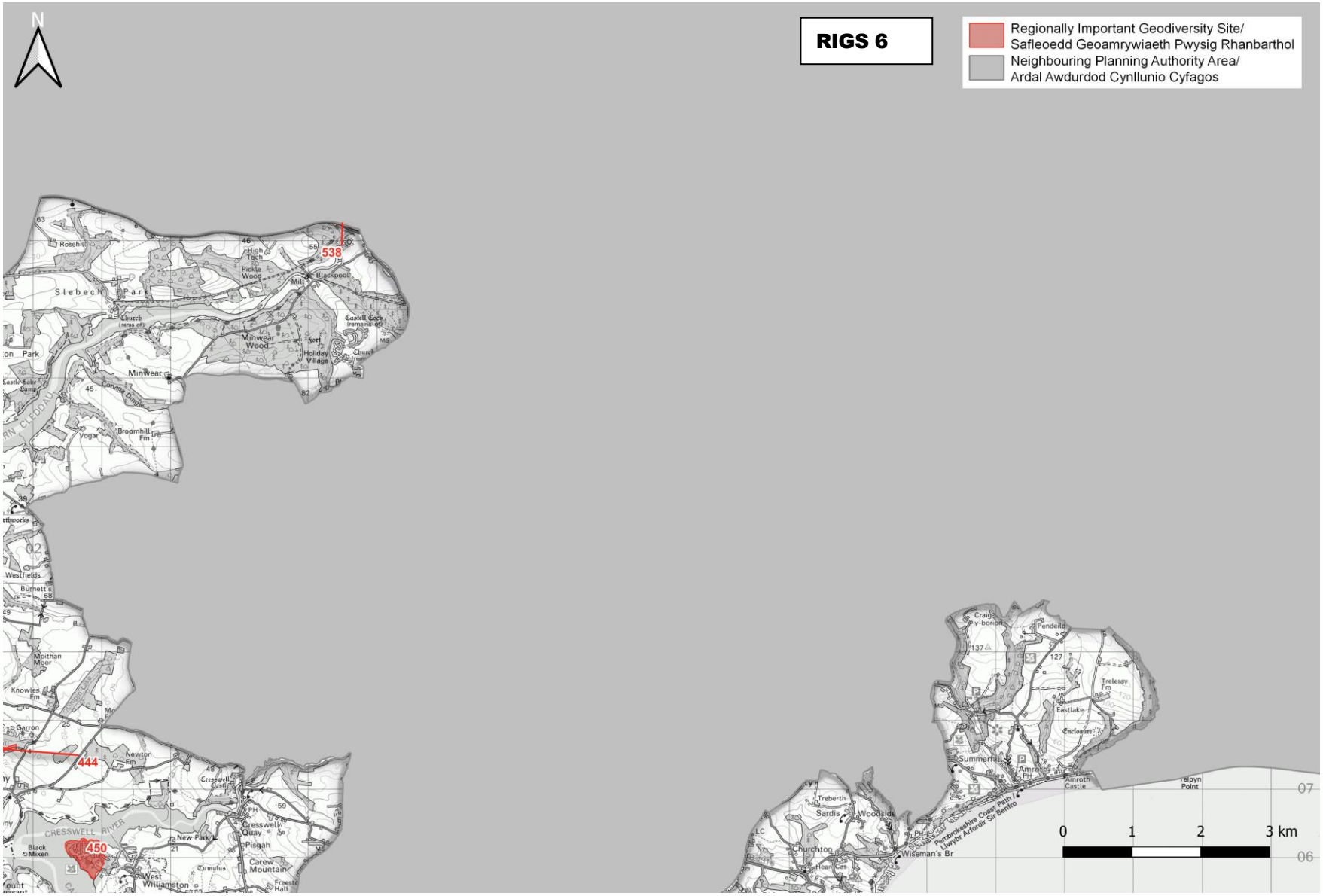

RIGS 1
0 1 2 3 km
446
459
451
447
445
557
439
DINAS HEAD
NEWPORT BAY/
BAE TREFDRAETH
Newport Sands
Newport
Trefdraeth
Moylgrove
Trewyddel
Nevern /
Nanhyfer
Regionally Important Geodiversity Site/
Safleoedd Geoamrywiaeth Pwysig Rhanbarthol
Neighbouring Planning Authority Area/
Ardal Awdurdod Cynllunio Cyfagos

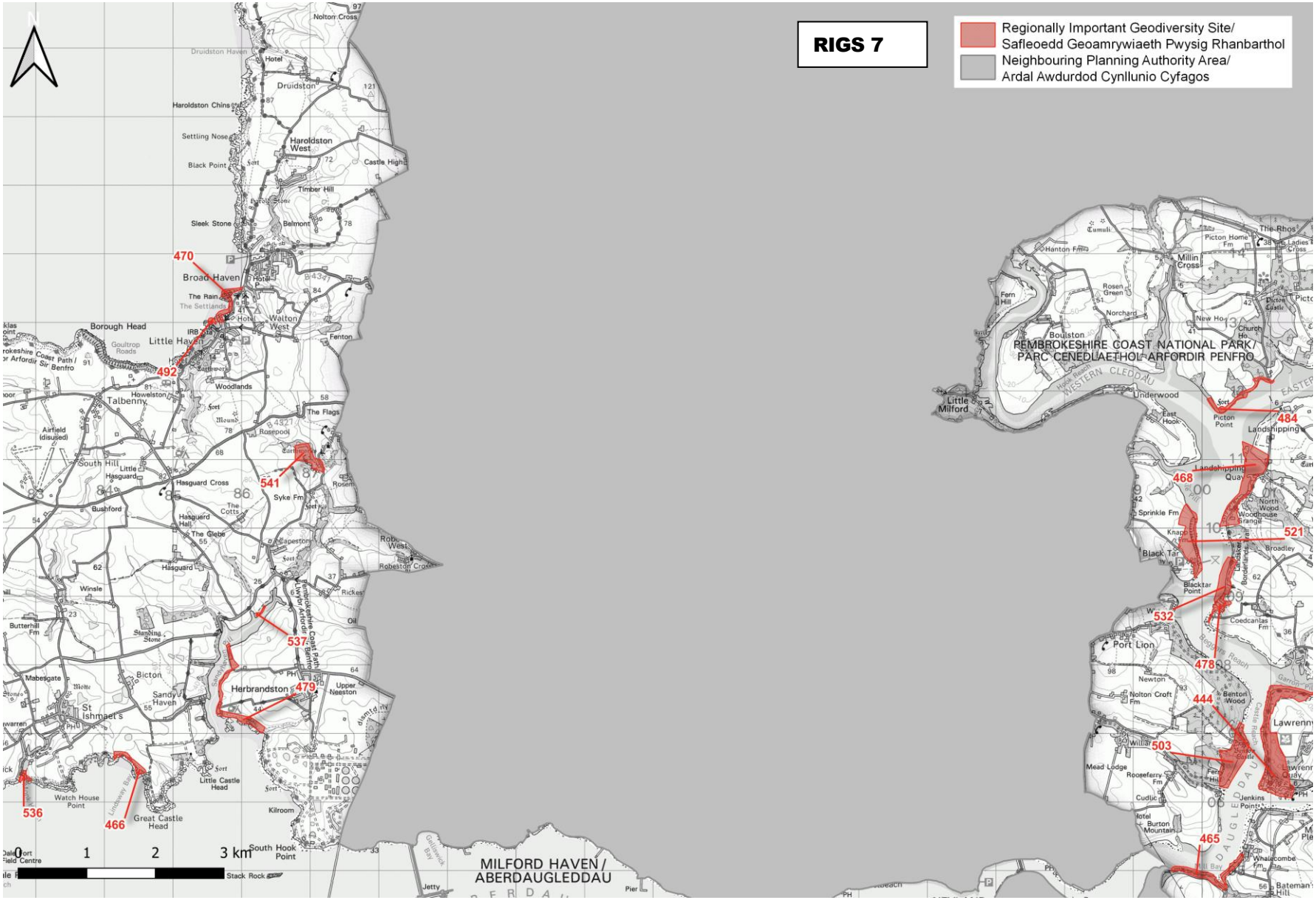

RIGS 2
0 1 2 3 km
STRUMBLE HEAD / PEN-CAER
FISHGUARD BAY/
BAE ABERGWAUN
VEHICLE FERRY
FROM FISHGUARD TO
Rosslare 3½ hours
CATAMARAN
FROM FISHGUARD TO
(summer only)
Rosslare (V) 2 hours
547
454
Regionally Important Geodiversity Site/
Safleoedd Geoamrywiaeth Pwysig Rhanbarthol
Neighbouring Planning Authority Area/
Ardal Awdurdod Cynllunio Cyfagos

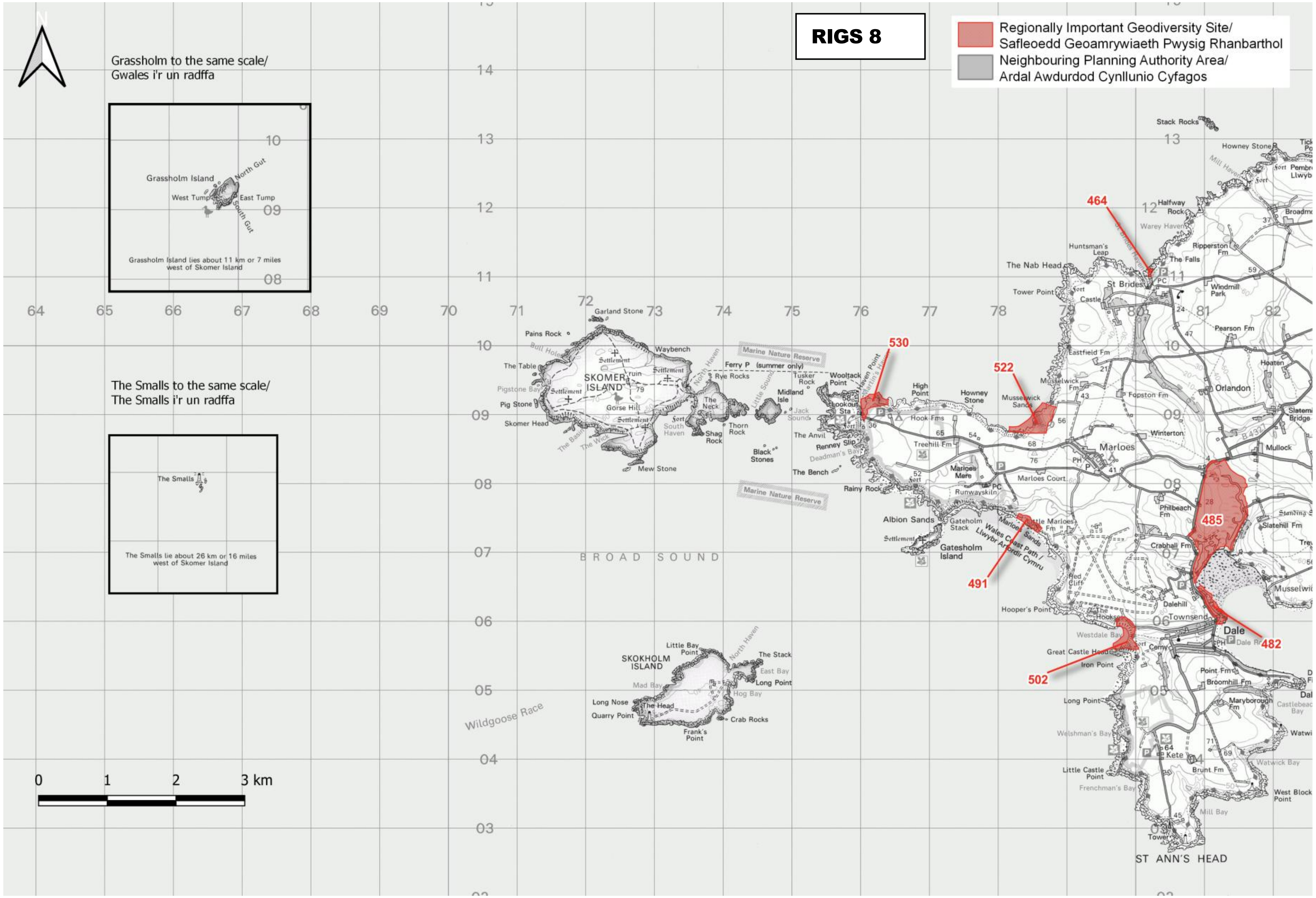

RIGS 3
N
PEMBROKESHIRE COAST NATIONAL PARK /
PARC CENEDLAETHOL ARFORDIR PENFRO
564
460
440
559
560
461
554
0 1 2 3 km
Regionally Important Geodiversity Site/
Safleoedd Geoamrywiaeth Pwysig Rhanbarthol
Neighbouring Planning Authority Area/
Ardal Awdurdod Cynllunio Cyfagos

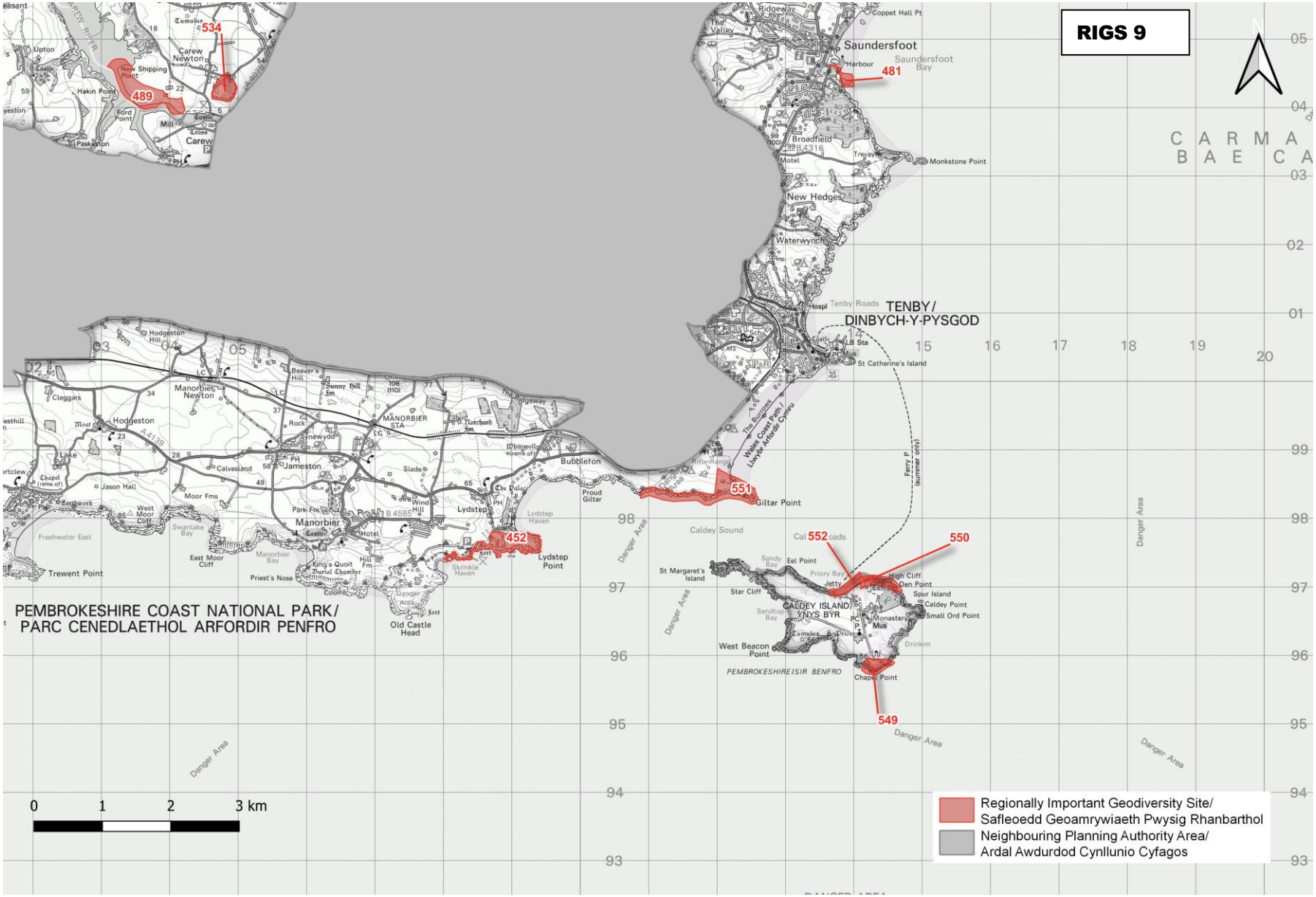

RIGS 4
454
540
462
458
558
ST DAVIDS HEAD / PENMAEN DEWI
ST DAVIDS / TYDDEWI
RAMSEY ISLAND
BISHOPS AND CLERKS
North Bishop
Carreg Rhoson
Maen Rhoson
Daufraich
Em-sger or South Bishop
Whitesands Bay Porth-mawr
Solva
Abereiddy
0
1
2
3 km
Regionally Important Geodiversity Site/
Safleoedd Geoamrywiaeth Pwysig Rhanbarthol
Neighbouring Planning Authority Area/
Ardal Awdurdod Cynllunio Cyfagos

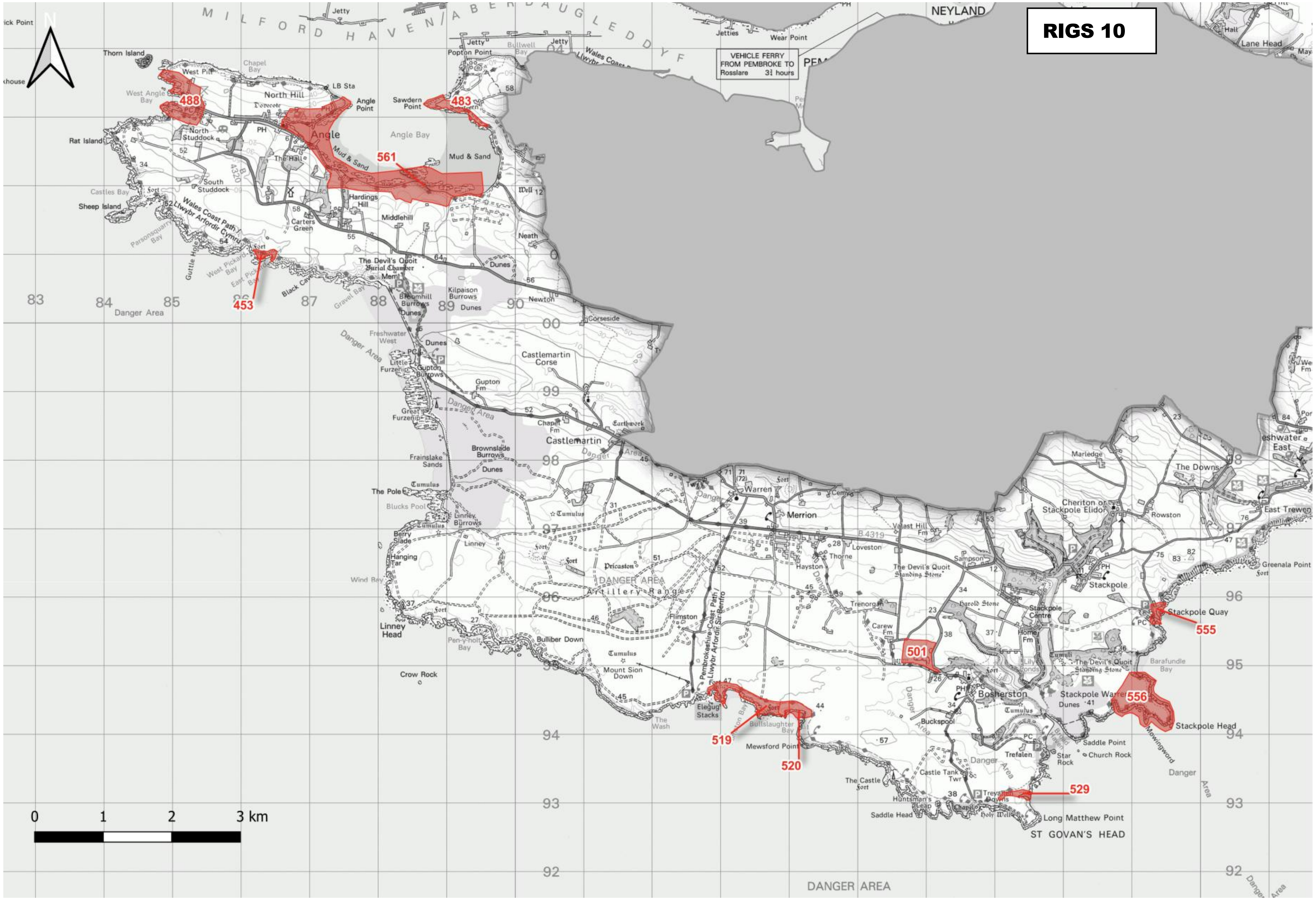

RIGS 5
N
493
546
545
448
SHIRE COAST NATIONAL PARK/
EDLAETHOL ARFORDIR PENFRO
0 1 2 3 km
Regionally Important Geodiversity Site/
Safleoedd Geoamrywiaeth Pwysig Rhanbarthol
Neighbouring Planning Authority Area/
Ardal Awdurdod Cynllunio Cyfagos


N
RIGS 6
Regionally Important Geodiversity Site/
Safleoedd Geoamrywiaeth Pwysig Rhanbarthol
Neighbouring Planning Authority Area/
Ardal Awdurdod Cynllunio Cyfagos
538
444
450
0 1 2 3 km


RIGS 7
Regionally Important Geodiversity Site/
Safleoedd Geoamrywiaeth Pwysig Rhanbarthol
Neighbouring Planning Authority Area/
Ardal Awdurdod Cynllunio Cyfagos
N
470
492
541
537
479
536
466
484
468
521
532
478
444
503
465
PEMBROKESHIRE COAST NATIONAL PARK/
PARC CENEDLAETHOL ARFORDIR PENFRO
MILFORD HAVEN/
ABERDAUGLEDDAU
0 1 2 3 km

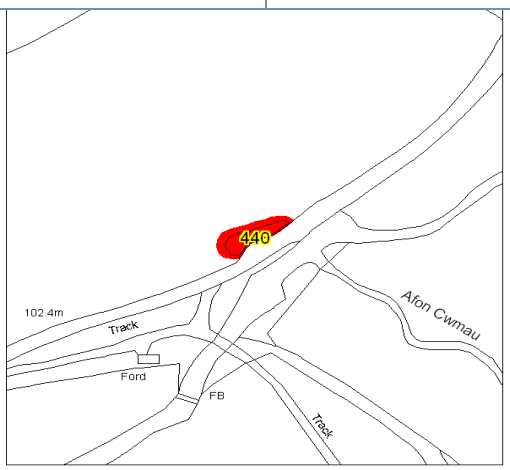

RIGS 8
Regionally Important Geodiversity Site/
Safleoedd Geoamrywiaeth Pwysig Rhanbarthol
Neighbouring Planning Authority Area/
Ardal Awdurdod Cynllunio Cyfagos
Grassholm to the same scale/
Gwales i'r un raddfa
Grassholm Island lies about 11 km or 7 miles west of Skomer Island
The Smalls to the same scale/
The Smalls i'r un raddfa
The Smalls lie about 26 km or 16 miles west of Skomer Island
0
1
2
3 km
SKOMER ISLAND
SKOKHOLM ISLAND
BROAD SOUND
Marloes
Dale
ST ANN'S HEAD
464
530
522
485
491
482
502

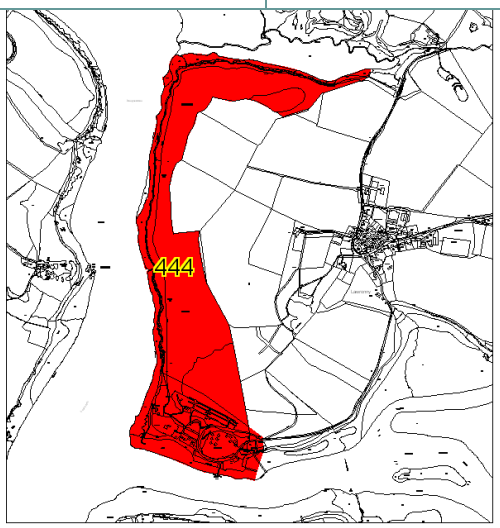

RIGS 9
534
489
481
551
552
550
452
549
Saundersfoot
TENBY/
DINBYCH-Y-PYSGOD
MANORBIER STA
Lydstep Point
Giltar Point
Caldey Sound
CALDEY ISLAND/
YNYS BŸR
PEMBROKESHIRE COAST NATIONAL PARK/
PARC CENEDLAETHOL ARFORDIR PENFRO
PEMBROKESHIRE/SIR BENFRO
Danger Area
0 1 2 3 km
Regionally Important Geodiversity Site/
Safleoedd Geoamrywiaeth Pwysig Rhanbarthol
Neighbouring Planning Authority Area/
Ardal Awdurdod Cynllunio Cyfagos

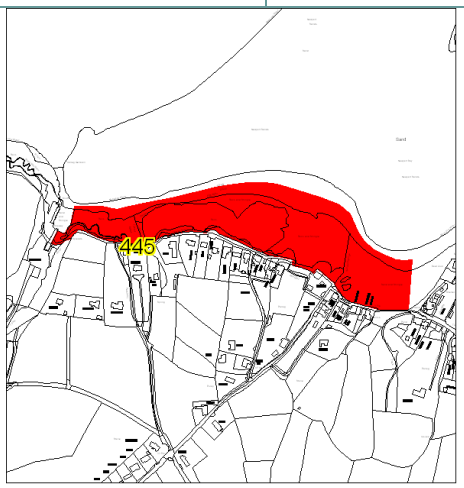

RIGS 10
488
483
561
453
501
519
520
555
556
529
0 1 2 3 km

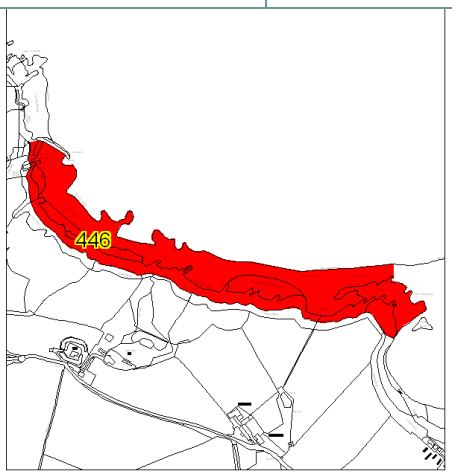
6 RIGS Location Maps and Statement of Interest

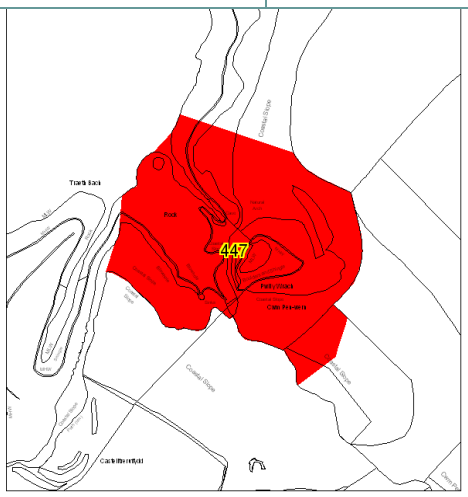
RIGS 439: Grugiau Cemaes Viewpoint	Grid ref	SN 126415
Statement of Interest: This small site is a hummocky mound of pebbly sand deposited as an esker on a sinuous channel cut by a stream flowing beneath a glacier.		

RIGS 440: Dan Coed Quarry	Grid ref	SM 036340
Statement of Interest: This RIGS is a small, disused, roadside quarry that provides a type-section through the early Ordovician marine sedimentary rocks of the Cwm Gwaun Formation. The rocks are sandstones, siltstones and mudstones comprising turbidites that were deposited from submarine density flows in a deep part of the Welsh Basin, the Sealyham Trough. The quarry is of geological research importance but accessibility is seriously impeded, and lower parts of the rock face buried, by thick vegetation and dumped soil, vegetation and some household waste. To be of geological use, the site needs to be cleared of vegetation and waste.		

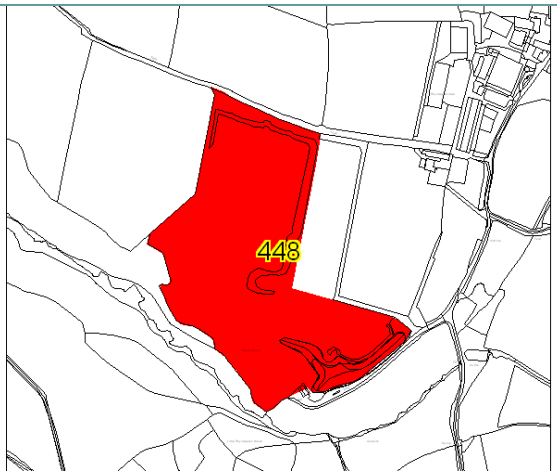
RIGS 444: Lawrenny Cliffs	Grid ref	SN 009070
Statement of Interest: The most significant feature of geological interest here is the sequence of Lower Devonian sandstones and mudstones that are exposed along the banks of the Daugleddau estuary. These rocks form part of the Old Red Sandstone sequence that was deposited by meandering rivers in a semi arid environment north of the Ritec Fault. Both the Milford Haven and Cosheston groups are represented in this RIGS. The strata dip uniformly north-east producing a series of reefs and low cliffs along the east side of the river. There is almost continuous exposure of the rocks in plan and cross section in an area where rock outcrops are scarce.		

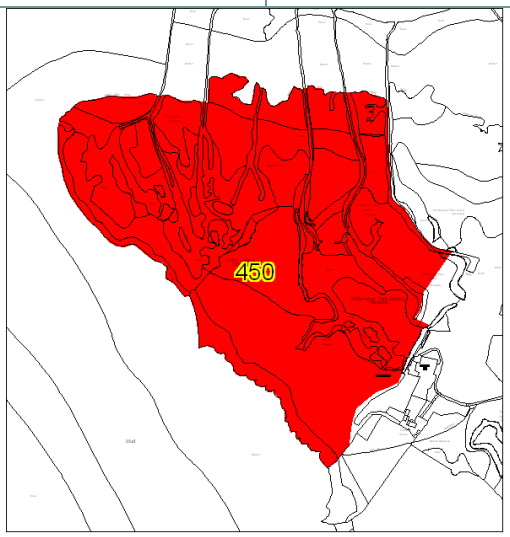
RIGS 445: Newport Sands (South)	Grid ref	SN 050396
Statement of Interest: This RIGS is an easily accessible foreshore section through well-exposed Middle Ordovician sedimentary rocks that were deformed by slaty cleavage. The sedimentary rocks are mainly siltstones and mudstones that comprise excellent examples of turbidites which were deposited from submarine density flows in a deep part of the Welsh Basin. In much of Pembrokeshire, rocks of this age and their tectonic structures are either poorly exposed inland or crop out in inaccessible sea cliffs. This foreshore site is therefore particularly valuable for geological research purposes, providing part of a network of sites that enable the evolution of the Welsh Basin to be determined.		

RIGS 446: Poppit Sands	Grid ref	SN 144490 to SN 150489
Statement of Interest: This easily accessible coastal site has been selected for its well-exposed Middle Ordovician sedimentary rocks and their deformation structures. The sedimentary rocks are mainly sandstones, siltstones and mudstones that comprise excellent examples of turbidites which were deposited from submarine density flows in a deep part of the Welsh Basin. The succession also includes pebbly mudstones that are uncommon elsewhere in the Welsh Basin. The sedimentary rocks were deformed by trains of spectacular folds, cleaved and cut by swarms of quartz veins during the Acadian tectonic events associated with plate collision.		

RIGS 447: Pwll-y-Wrach (The Witches Cauldron)	Grid ref	SN 102451
Statement of Interest: Pwll-y-Wrach ("The Witches' Cauldron") is a spectacular pit-like feature that is linked with the open sea by a natural arch. This collapsed sea cave is a major tourist attraction which is easily visible from the Pembrokeshire Coast Path that crosses the natural arch. In stormy weather, waves pass through the arch into the cauldron which then `boils' and acts as a blowhole. The original cave was excavated by the sea along a linear weakness in the Lower Palaeozoic rocks that underlie this area. The ages of the cave itself and its collapse are not known but are likely to be in the last 2 million years, during the Quaternary Period and are perhaps associated with the Ice Age.		

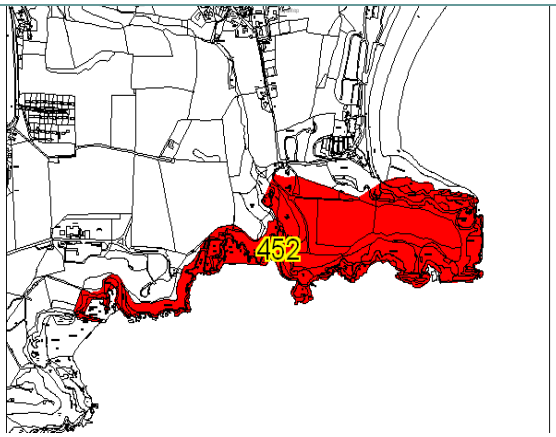
RIGS 448: Rhyndaston Quarry	Grid ref	SM 892237

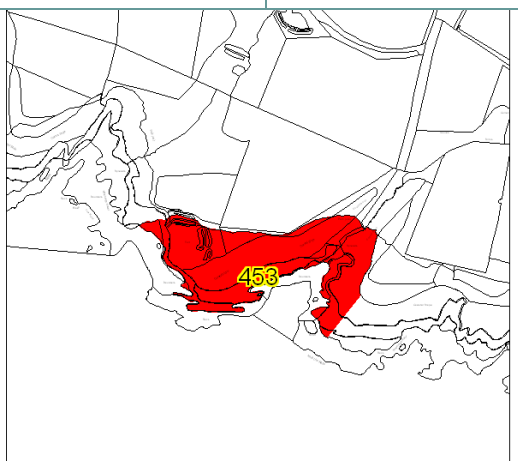
Statement of Interest: This RIGS comprises a complex of active and dormant quarries that provide rare exposures of Late Precambrian (620 to 585 million years ago) rocks that fringe Wales and probably underlie much of the country. The rocks are of volcanic origin, made of rock and mineral debris erupted from volcanoes as clouds of ash that accumulated on the subaerial flanks of volcanoes. They are different from those exposed in the Gignog quarries RIGS, about 1 km away, where the volcanic ash was mostly reworked in the sea before being deposited on submerged parts of volcanoes. The quarries provide fresh rock that could be used for geochemical and isotopic studies of these rarely exposed rocks.	

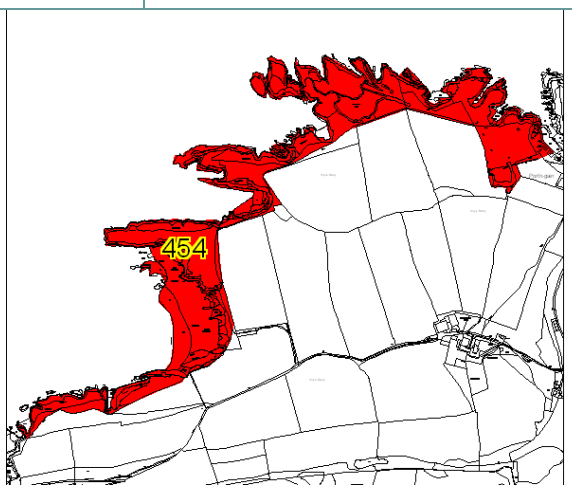
RIGS 450: West Williamston Quarries	**Grid ref**	**SN 025061**
Statement of Interest: The limestone quarries of West Williamston are of historical interest in that they were worked during the 19th century when the stone was transported by sailing barges from the artificial tidal creeks that open out on to the Cresswell River. The limestone was loaded directly on to the barges which entered the quarries on the high tide. Today the quarries are largely overgrown but provide a haven for wildlife and natural vegetation protected as a designated SSSI. Geologically the Lower Carboniferous Limestone exposed here lies on the north-east flank of the Carew Anticline. There are several well exposed palaeokarst features preserved on the limestone ridges between the tidal creeks. These are relatively rare examples in West Wales and they are easily accessible and suitable for geomorphological research.		

RIGS 451: Ceibwr Bay	**Grid ref**	**SN 108168**
Statement of Interest: There are two main interests here: deformed Ordovician sedimentary rocks and Quaternary sediments and landforms. The Ordovician rocks are clearly exposed on a cliff-top platform and in the bank of an estuary in a region where these rocks are generally inaccessible in sea cliffs or hidden by superficial deposits. The Quaternary sediments, considered precede the last glaciation stage of the Ice Age, are well-displayed in profile on the cliff-top platform. The access road and off-road parking sites are situated in a small channel thought to be a distributary of the Moylgrove Channel system that drained water from a melting ice sheet.		

RIGS 452: Church Doors, Lydstep Headland	**Grid ref**	**SS 094975**

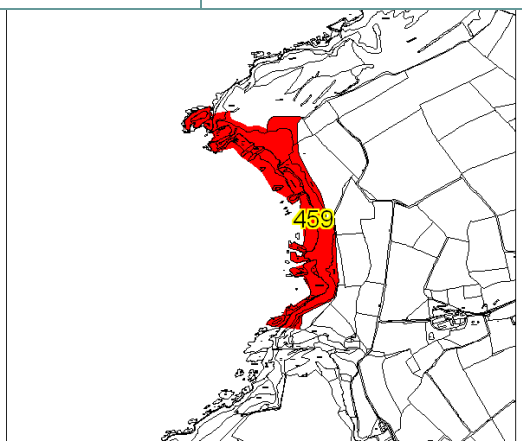
Statement of Interest: This site comprises Lydstep Headland and the coastal extension westwards to Church Doors. The main interest is in the Lower Carboniferous (Dinantian) succession with the Lower Limestone Shales at the base of the sequence continuing through the Main Limestone to the base of the Millstone Grit (Namurian). There are also Variscan structures, Permo-Triassic gash breccias and Quaternary deposits, all of which are of interest to geological researchers.	

RIGS 453: East Pickard Bay	**Grid ref**	**SM 865010**
Statement of Interest: This site comprises East Pickard Bay and the headland separating it from West Pickard Bay. The main geological interest is the section through the Moor Cliffs Formation of the Lower Old Red Sandstone. These beds have been laid down by meandering rivers in a semi-arid environment during Upper Silurian times. This RIGS is particularly important because of the occurrence of some excellent exposures of tuff bands. These are the product of pyroclastic air fall deposits from a nearby volcano. The dust and ash would have been deposited in the sea and so formed a sedimentary layer on the sea bed. The Townsend Tuff and the Pickard Bay Tuff form two regionally important air fall tuffs which act as particularly significant marker horizons within the Upper Silurian.		

RIGS 454: Porthgain	**Grid ref**	**SM 802327 to SM 813326**
Statement of Interest: The well-exposed rocks are a mixture of sedimentary and igneous components. These rocks provide a particularly clear picture of various marine sedimentary processes and interactions between volcanic activity and sedimentation. The Cambrian rocks were uplifted and eroded before renewed submergence in the early Ordovician. This unconformable contact between the two sequences, seen in the cliffs, records important plate-tectonic events. The Cambro-Ordovician rocks were intruded in later Ordovician times along the bedding planes by huge sheets (sills) of basic igneous rocks that crystallized slowly, making easily visible minerals and textures.		

RIGS 458: Middle Mill Quarry	**Grid ref**	**SM 802259**

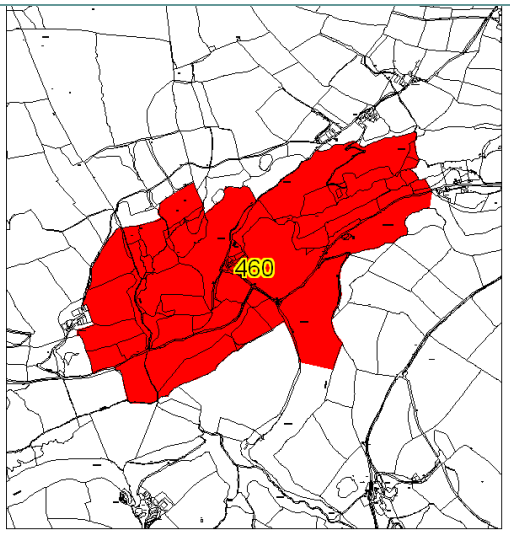
Statement of Interest: This RIGS is a quarry. It provides a rare exposure of the contact between light coloured Middle Cambrian sandstones and a dark igneous intrusion of Middle Ordovician age. The contact, steep in places and gently inclined elsewhere, needs to be viewed from a distance as the quarry faces are unstable. The sandstones were deposited in a shallow sea before Wales became a marine basin. The igneous rock was produced by the subduction of the Iapetus Ocean plate beneath the Avalonia continent. There are abundant blocks of the fresh, unweathered igneous rock on the quarry floor that might be sampled for geochemical analysis to help define its precise plate-tectonic setting and for isotope studies to determine its age and history.	

RIGS 459: Pen yr Afr Cliffs	**Grid ref**	**SN 118487 to SN123480**
Statement of Interest: This site comprises 100 m high sea-cliffs south-west of Cemaes Head and is best viewed from the south-west. The cliffs themselves are inaccessible. The site has been selected for two main reasons. Firstly, its Middle Ordovician sedimentary rocks are particularly well displayed and show some of the larger scale features that are rarely visible elsewhere without painstaking mapping and analysis. Secondly, the rocks have been deformed by a spectacular train of large folds that may be clearly visible from long distances away; they are illustrated on the covers of a recent publication of the British Geological Survey (Davies et al., 2003)[3] and may be regarded as `textbook' examples of folds.		

RIGS 460: Cwm Gwaun	**Grid ref**	**SN 057355**

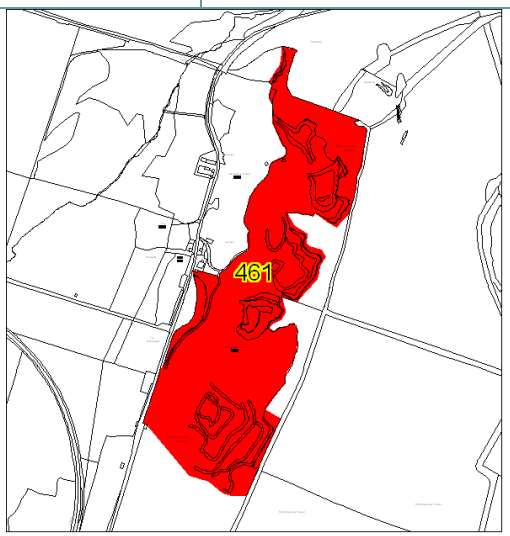
[3] Davies, J.R., Waters, R.A, Wilby, P.R., Williams, M. and Wilson, D. (2003) Geology of the Cardigan and Dinas Island district – a brief explanation of the geological map. British Geological Survey: Keyworth, Nottingham.

Statement of Interest: Topographical features originating during the later stages of the Ice Age, some 15,000 to 10,000 years ago are widespread in north Pembrokeshire. Particularly conspicuous are major, deeply incised valleys, including the Gwaun Valley, that cut up the region north of the Preseli Hills. Current views are that the Irish Sea ice extended well onto the margin of the Preseli Hills, and that the channels flowed beneath the ice and are *sub-glacial* meltwater features. Key evidence for the sub-glacial origin is the presence of humps along the length of the channels. Such features cannot be formed by flowing surface water, which cannot flow uphill. On the other hand, sub-glacial streams can be forced up and over obstacles in the drainage channel when under the hydrostatic high pressure associated with a head of water. This RIGS includes one of the humps in the Gwaun Valley length profile.



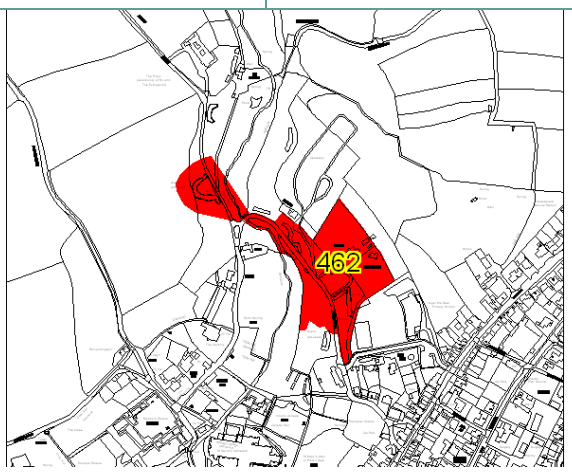
RIGS 461: Rosebush & Bellstone Quarries	**Grid ref**	**SN 078298 to SN 079303**

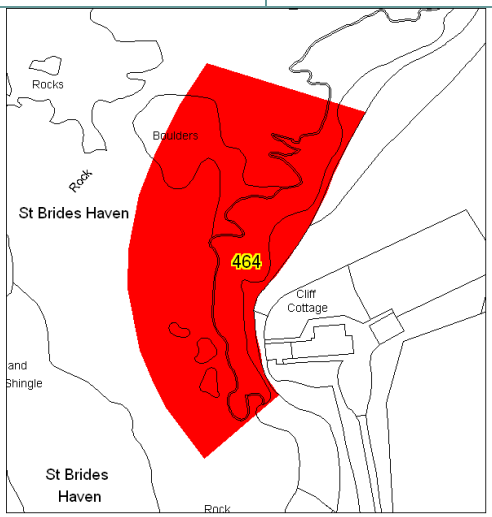
Statement of Interest: This chain of easily accessible quarries and spoil tips has been selected for its well-exposed Early Ordovician sedimentary rocks, their slaty cleavage and historical-industrial heritage importance. The sedimentary rocks are mainly siltstones and mudstones that comprise excellent examples of turbidites which were deposited from submarine density flows in a deep part of the Welsh Basin. In much of Pembrokeshire, rocks of this age and their tectonic structures are either poorly exposed inland or crop out in inaccessible sea cliffs. Slate quarrying is usually associated with North Wales, so this site provides an unusual example from outside that region. Interest in these quarries from a historical-heritage perspective is demonstrated by attention given to them online.

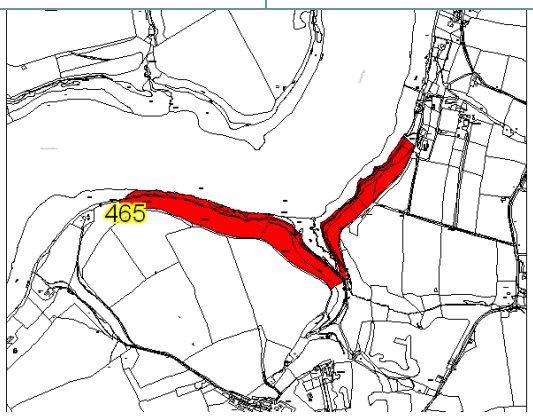


RIGS 462: St Davids Quarries	**Grid ref**	**SM 749255**

Statement of Interest: This RIGS comprises three small disused quarries. Two of them are too heavily overgrown for geological study at present, but Penrhiw Quarry exposes relatively fresh and accessible rocks. Penrhiw Quarry provides rare exposures of Late Precambrian (620 to 585 million years ago) rocks that fringe Wales and probably underlie much of the country; it is the type locality of the Penrhiw Group in the lower part of the Pebidian Supergroup. The rocks are of volcanic origin, made of rock fragments and mineral debris erupted from volcanoes as clouds of ash that accumulated as tuff on the subaerial flanks of volcanoes. The quarries, are of geological research importance, providing information about the Late Precambrian rock types and volcanic processes that is rarely available.



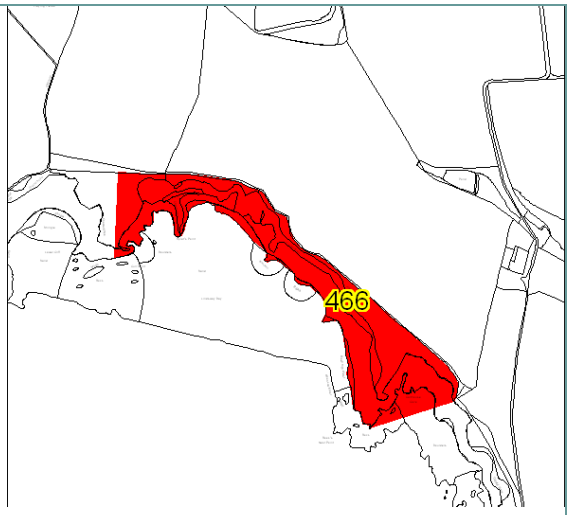
RIGS 464: St Brides Haven	Grid ref	SM 802112
Statement of Interest: This site comprises a c. 150m long cliff and foreshore section on the northern side of St Brides Haven. The Late Silurian rocks here are excellent examples of red mudstones deposited on an alluvial plain with conspicuous intercalations of conglomerates that accumulated in river channels. The mudstones were exposed to fluctuating vertical migration of groundwater in a generally arid environment, producing calcrete fossil soils. The rocks have been deformed by a spectacular set of structures caused by the Variscan plate collision event. The locality provides `textbook' examples and intricacies of small-scale thrust faults, folds and cleavage.		

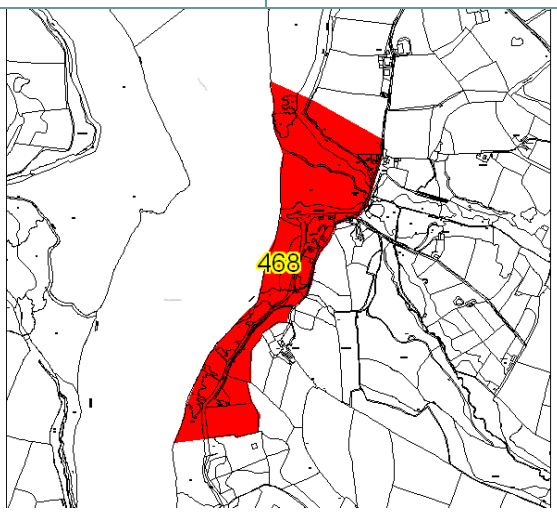
RIGS 465: Mill Bay	Grid ref	SN 002049
Statement of Interest: This RIGS exposes an interesting section of the Mill Bay Formation in the Cosheston Group of the Lower Old Red Sandstone on the south bank of the Daugleddau River. These rocks are particularly interesting geologically because of the abundance and diversity of soft sediment deformation structures including pillow beds, founder folds, ball and pillow structures and convolute bedding. The importance of this locality is highlighted by its inclusion in the Dyfed geological field guide[4] and the research paper by Thomas et al. (2006).[5]		

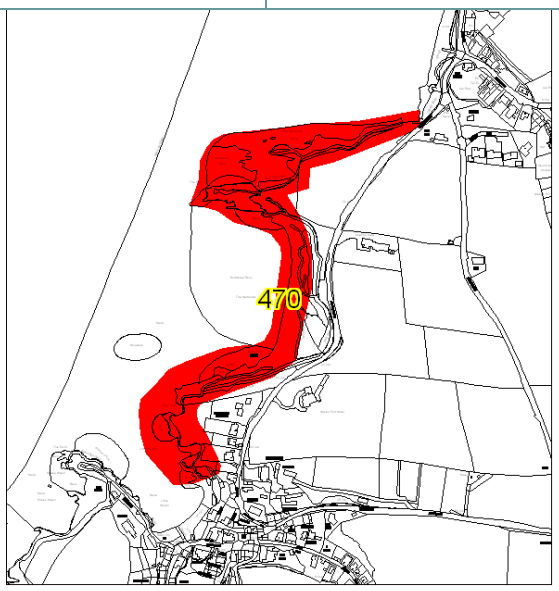
RIGS 466: Lindsway Bay	Grid ref	SM 843067

[4] Basset, M.G (ed). (1982). *Geological Excursions in Dyfed, South West Wales.* National Museum and Galleries of Wales.

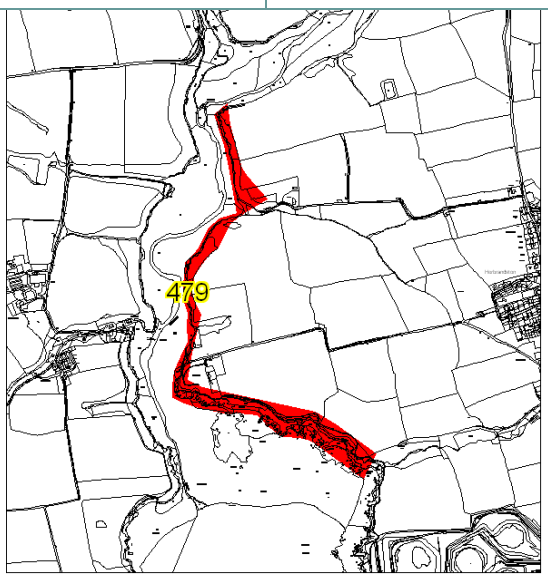
[5] Thomas, R.G., Williams, B.P.J., Morriessey, L.B., Barclay, W.J. and Allen, K.C. (2006). Enigma variations: the stratigraphy, provenance, palaeoseismicity and depositional history of the Lower Old Red Sandstone Cosheston Group, south Pembrokeshire, Wales. *Geological Journal.* 41 (5) pp. 481-536

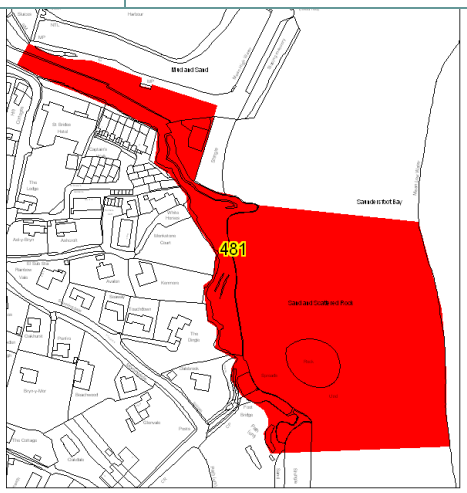
Statement of Interest: The main geological interest in this site is the type section through the Lindsway Bay Formation of the Milford Haven Group in the Lower Old Red Sandstone. Also the conformable junction between the Gray Sandstone Group of the Silurian and the base of the Red Cliff Formation (Old Red Sandstone) is exposed on the north side of the bay on the northern flank of the Marloes Anticline. Recent research on palynomorphs (microfossils including pollen grains and spores) has shown that the Red Cliff Formation at the base of the Old Red Sandstone is of Ludfordian age (Upper Ludlow Stage, Upper Silurian). This is significant in that the major environmental change from the marine Gray Sandstone Group to the terrestrial Red Cliff Formation took place considerably earlier than was formerly thought.	

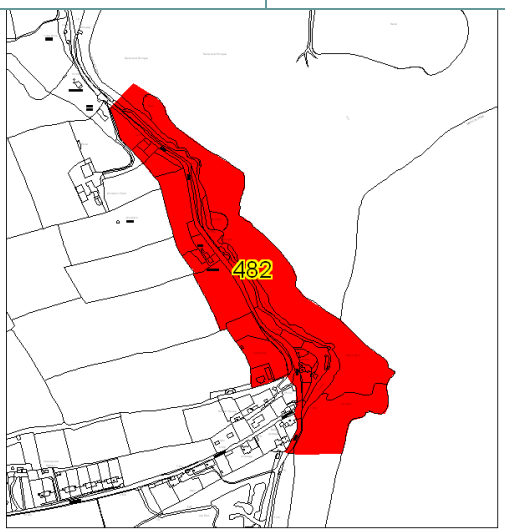
RIGS 468: Landshipping Quay	**Grid ref**	**SN 008108**
Statement of Interest: The main interest in this RIGS is the excellent riverside exposure of Lower Coal Measures, probably the most extensive inland section within the Pembrokeshire coalfield. The section is located in the southern part of the coalfield where intense Variscan folding is much in evidence. The site is also of considerable historical interest since it was a centre of a flourishing coal trade in the early 19th century. Landshipping Quay and the stone bridge across the pill (tributary stream) were constructed in 1800/1 and were linked by a tramway to several local collieries to enable coal and culm (low quality coal) to be shipped out via the Cleddau River.		

RIGS 470: The Settlands	Grid ref	SM 858133
Statement of Interest: This RIGS, a cliff face situated between Little Haven and Broad Haven, provides an excellent geological section through the Lower Coal Measures of the Carboniferous Period on the southern side of the Pembrokeshire Coalfield. Several thin coal seams can be identified within the cyclothems (cycles of sedimentation). Iron stone nodules occur at numerous horizons within the shales. The whole sequence is much folded and thrust faulted as a result of intense Variscan earth movements of the Late Carboniferous. The beds in the headland near to Broad Haven form the overturned limb of a major anticlinal structure. This site is also of considerable historical interest since during the 19th century, both Little Haven and Broad Haven exported coal and culm (low quality coal) mined from small pits located just inland from the Settlands; several adits are seen in the section.		

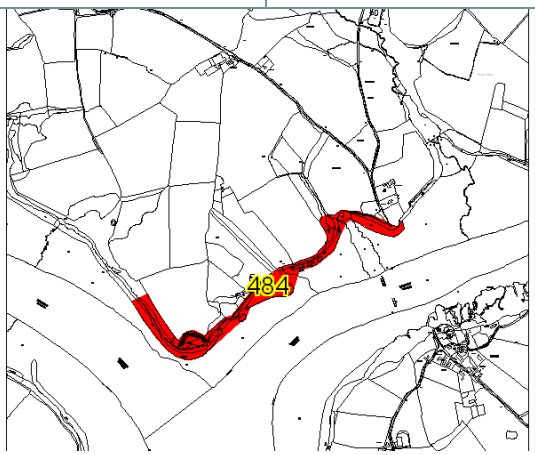
RIGS 478: Coedcanlas (Llangwm Ferry Quarries)	Grid ref	SN002089
Statement of Interest: The Llangwm Ferry limestone quarries at Coedcanlas of are of historical interest in that they were worked during the 19th century when the stone was transported by sailing barges from the artificial tidal creeks that open out on to the Daugleddau Estuary. The limestone was loaded directly on to the barges which entered the quarries on the high tide. Geologically the Lower Carboniferous Limestone exposed here lies on the north-east flank of the Burton Anticline. The limestone occurs in a narrow outcrop about 400m wide that is faulted between the Red Marls at the base of the Lower Old Red Sandstone to the south and the Basal Grit Quartzite of the Marros Group to the north.		

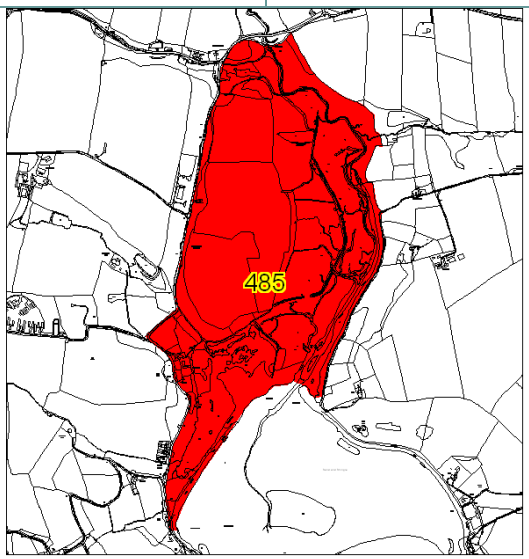
RIGS 479: Sandy Haven	Grid ref	SM 860072
Statement of Interest: The main geological interest in this site is the type section through the Sandy Haven Formation of the Milford Haven Group in the Lower Old Red Sandstone. This formation is equivalent to the Moor Cliffs Formation to the south of the Ritec Fault and both formations contain the 4m thick Townsend Tuff that is an important marker horizon across South West Wales. Several other thin tuff bands were recorded by the British Geological Survey in the early 20th century and referred to as the 'magenta beds'. At that time these Old Red Sandstone rocks were considered to be of Lower Devonian age, but recent research has shown them to be of Upper Silurian age. There is also a representative section through red calcretized mudstones that represent evaporite formation in an arid environment. Seasonal flooding would also have contributed to the reworking of flood plain sediments.		

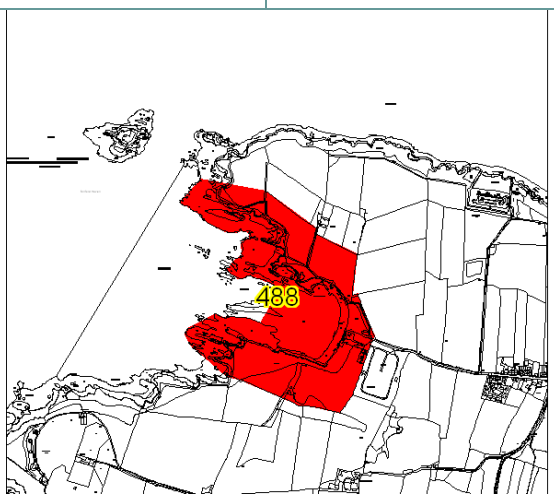
RIGS 481: Glen Beach, Saundersfoot	Grid ref	SN 1381 0458 – SN 1388 0433
Statement of Interest: This site comprises a 400 m long cliff and foreshore section extending south from Saundersfoot Harbour to the Ladies Cave. The Late Carboniferous Westphalian ('Coal Measures') rocks here show excellent examples of folding, brittle fracturing and faulting produced during the Variscan Orogeny. The Ladies Cave Anticline is an iconic feature of the Pembrokeshire coastline and has been illustrated in numerous textbooks. The section is particularly valuable as a geological fieldwork teaching site. Other aspects which are of interest include coastal geomorphology (bays and headlands, rock reef, cave) and coal mining (two adits relating to pre-1900 working of subsurface seams inland of the RIGS).		

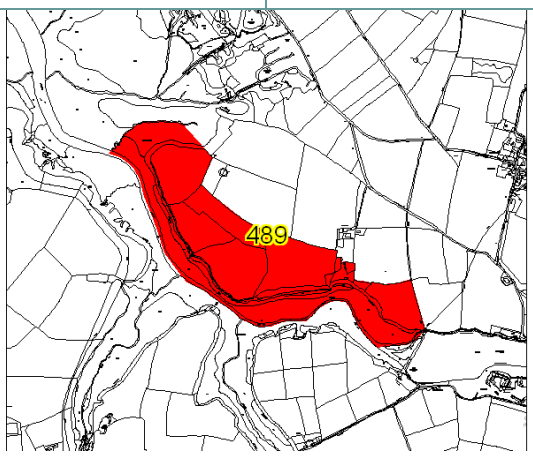
RIGS 482: Townsend	Grid ref	SM 813061
Statement of Interest: This RIGS provides a type section through the Townsend Tuff Bed within the Sandy Haven Formation of the Lower Old Red Sandstone. The tuff is a volcanic air fall deposit that has been laid down on coastal mud flats and now forms a volcanogenic sediment. It is about 4m thick comprising 3 graded air fall units, each fining upwards.The Townsend Tuff forms a distinctive regional marker horizon within the Lower Old Red Sandstone that extends across South West Wales (See East Pickard Bay and Sandy Haven RIGS). The locality is also of interest in that it exhibits a representative section through the lower part of the Sandy Haven Formation comprising a series of rhythmic units of conglomerates, sandstones and red mudstones with calcrete development.		

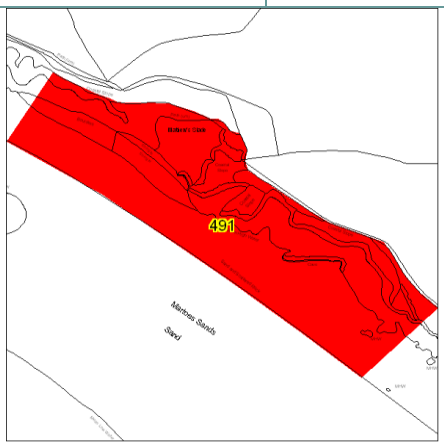
RIGS 483: Sawdern Point	Grid ref	SM 888032
Statement of Interest: This RIGS offers an excellent coastal section through Old Red Sandstone rocks to the south of the Ritec Fault. There is a series of thick conglomerate beds with sharp erosional bases. Sandstones and red mudstones with calcrete soil horizons overlie the conglomerates. The repeated cyclic sequences of the Ridgeway Conglomerate beds were deposited on an alluvial fan that advanced northwards towards the scarp face of the Ritec Fault. The Skrinkle Sandstone Group is exposed in the cliffs to the south of Sawdern Point where it is faulted against the Ridgeway Conglomerate. Here the rocks belong to the West Angle Formation being mainly composed of red and grey interbedded sandstones and mudstones.		

RIGS 484: Picton Point	Grid ref	SN 003117
Statement of Interest: Picton Point is situated at the confluence of the Eastern and Western Cleddau where there are the excellent riverside exposures of Coal Measure cyclothems (cycles of sedimentation). The section is located in the central part of the coalfield where the Middle Coal Measures are preserved within the overall synclinal structure of the coalfield. The strata are highly inclined and often contorted as a result of the Variscan earth movements and the thin seams are often low quality, shaley coal (culm). The Picton Castle estate had several small pits working seams of culm in the 18th and early 19th centuries although production was largely for local use.		

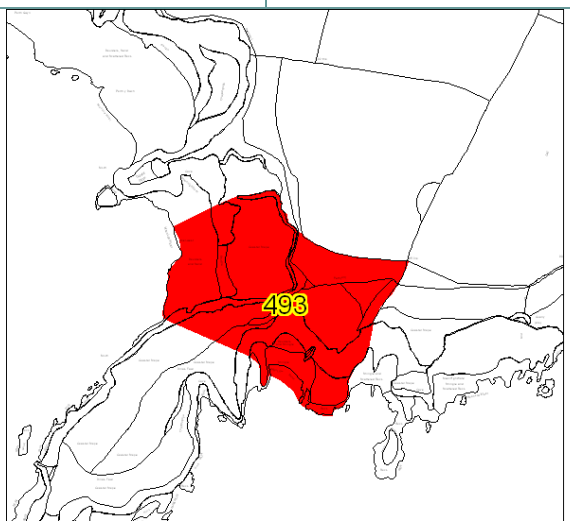
RIGS 485: Mullock Bridge	Grid ref	SM 812079
Statement of Interest: This site is of considerable geomorphological interest since it provides a magnificent example of a kame terrace (landform consisting of stratified sand and gravel deposited by meltwater between an ice mass and a valley side) on the western side of the Gann Estuary. The drift sequence, which was exposed in a large gravel pit about 400m south of Mullock Bridge, has been recorded in detail. Unfortunately the area is now very overgrown and difficult to access. However, the southern face of the kame terrace overlooks several of the flooded workings near Pickleridge where fluvio-glacial sands and gravels can be seen in the low cliffs at the water's edge. Pickleridge is itself an excellent example of a storm beach that impedes the drainage of the River Gann forming tidal lagoons that today form an important wildlife habitat.		

RIGS 488: West Angle Bay	Grid ref	SM 854032
Statement of Interest: This site provides an excellent section through the Lower Carboniferous rocks that are exposed within the Angle Syncline. Variscan tectonic structures are present, including a major thrust plane in which the Avon Group (Lower Limestone Shales) is thrust northwards over the Black Rock Limestone Subgroup. There are also some first rate examples of stylolites (serrated junction resulting from pressure solution), *en echelon* tension gashes, slickensides (striations on the surface of a fault plane) and slump structures. Some beds are highly bioturbated. Corals and brachiopod shells and fragmented crinoids occur in particular horizons within the Black Rock Limestone.		

RIGS 489: New Shipping	Grid ref	SN 039041
Statement of Interest: The geological interest of this RIGS is that it provides the type section of the New Shipping Formation at the top of the Cosheston Group in the Lower Old Red Sandstone to the north of the Ritec Fault. The beds are exposed along the north-east shore of the Carew River between New Shipping Point and a point some 250m west of Carew Mill dam. The New Shipping Formation is composed largely of conglomerates and coarse sandstones with a few siltstone horizons. The strata dip uniformly to the south east producing a series of reefs and low cliffs along the shoreline.		

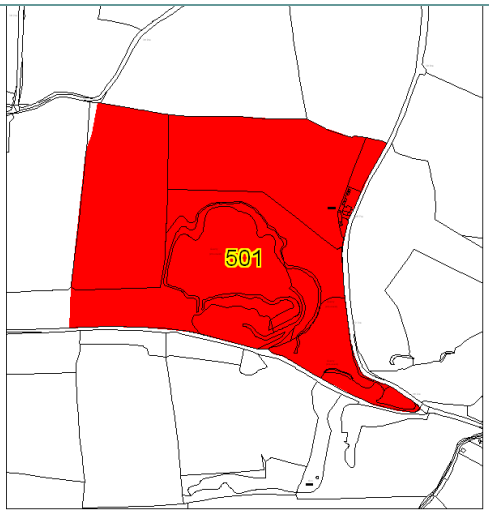
RIGS 491: Marloes Bay / Marloes Sands	Grid ref	SM784073
Statement of Interest: The cliff-backed sands of Marloes Bay are a classic geological locality along which a steeply inclined sequence of Silurian and Devonian strata is exposed. The Silurian sequence includes igneos rocks belonging to the Skomer Volcanic Group of Llandovery age. The basalts contain zones of hydrothermal alteration and are cut by a series of veins carrying quartz and coarsely-crystallised epidote. Some of the finest Welsh examples of epidote have been obtained from this locality. As well as the specimen interest, the timing of the veins' emplacement raises interest.		

RIGS 492: Little Haven Foreshore	Grid ref	SM 856130
Statement of Interest: Numerous conspicuous mineralised joints may be seen, cutting sandstones belonging to the Upper Carboniferous Coal Measures. Mineralisation associated with progressively opened joints in sandstones is observed throughout the South Wales Coalfield and is well known to mineralogists for the excellent crystals of quartz, ankerite and other minerals that have been collected from opencast coal mines. The mineralisation started with fibre-quartz growths along joints as they began to open. The early growths are typically overgrown by much coarser crystals, lining either side of voids several centimetres in width. The assemblages of well-crystallised quartz and other minerals have been smashed to pieces by Variscan deformation.		

RIGS 493: St Elvis Mine	Grid ref	SM 813232
Statement of Interest: This small but historic mine is situated on the Pembrokeshire coast near Solva. The mine explored and worked a quartz vein carrying pods of sulphide minerals, of which galena, chalcopyrite, sphalerite and tetrahedrite were the most important. Sparse tips are to be found at the neck of the Dinas Fawr headland but at the base of the western slopes (right hand side of the headland looking out to sea) there is a limited amount of richly-mineralised material to be found amongst the scree debris. The tetrahedrite contains up to 10% silver, and also contains inclusions of the uncommon lead-copper-antimony sulphide bournonite. Apparently an isolated example of vein mineralisation in the Cambrian strata of this part of Pembrokeshire, the deposit deserves further study.		

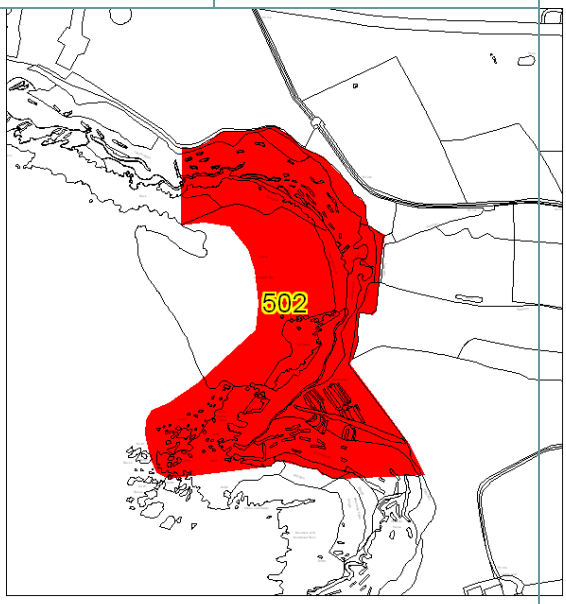
RIGS 501: Caled Quarry	Grid ref	SR 959951

Statement of Interest: Caled Quarry is geologically significant since it provides a unique section through Lower Carboniferous strata of Upper Courceyan age in the crest of the asymmetrical Bosherston Anticline that trends approximately E-W. The beds on the north east face of the quarry display superb Variscan folding with an amplitude of some 20m. The strata in the quarry belong to the Black Rock Limestone Subgroup and consist of well bedded grey bioclastic limestones that contain chert bands and nodules and are dolomitised in places. Small brachiopods and the zonal coral *Zaphrentis* are present in the limestones and there is evidence of bioturbation and burrowing trace fossils at some horizons. The surface of the limestone at the top of the quarry faces is deeply weathered along the joints, some of which have been widened into fissures and filled with sediment.



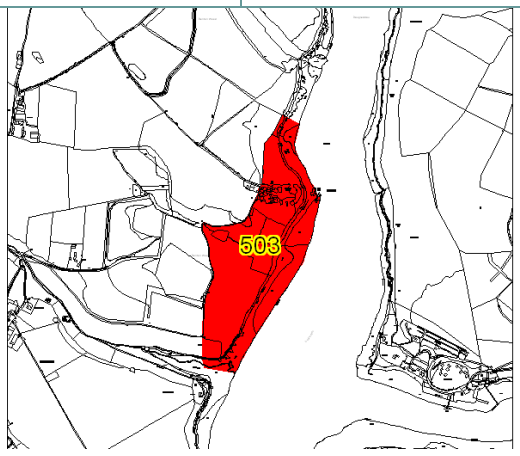
RIGS 502: Westdale Bay	**Grid ref**	**SM 799058**

Statement of Interest: This RIGS is one of the few places where the Ritec Fault is exposed and accessible in a coastal location. On the south side of the bay, the shattered rocks bear witness to the power of the Variscan earth movements as the Lower Old Red Sandstone strata were deformed and dislocated along the fault zone. Westdale Bay also displays a representative section through the upper part of the Sandy Haven Formation comprising a series of rhythmic units of conglomerates, sandstones and red mudstones with calcrete development. Furthermore, the Townsend Tuff is recorded as cropping out near The Hookses on the north side of the bay. The tuff is a volcanic air fall deposit that has been laid down on coastal mud flats and now forms a sediment made of volcanic fragments that is about 1.8m thick at this locality. The tuff, red mudstones and sandstones are all dipping steeply to the south in Westdale Bay as a result of the Late Caledonian (Acadian) earth movements.



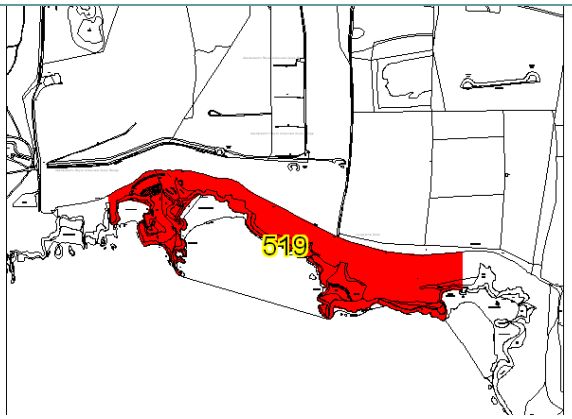
RIGS 503: Castle Reach (West)	**Grid ref**	**SN 006067**

Statement of Interest: This RIGS is of particular geological interest in that it has one of the few exposures of volcanic rocks of late Precambrian age (approximately 600 million years ago) in South Pembrokeshire. These lavas of the Benton Series crop out on the northern side of the Benton Castle Fault and form the feature known as Castle Rocks on the western shore of Castle Reach on the Cleddau River. By contrast, on the southern side of the Benton Castle Fault are low river cliffs formed of the Lawrenny Cliff Formation that is part of the Cosheston Group of the Lower Old Red Sandstone. These sandstones and red mudstones lie in the core of the Lawrenny Syncline and are well exposed on the north side of Williamston Pill.



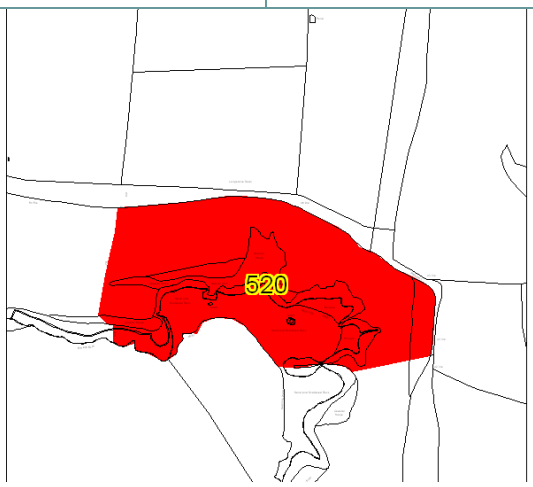
RIGS 519: Longstone Down	**Grid ref**	**SR 937945**

Statement of Interest: This RIGS is also protected as an SSSI but little attention has been given to the karst. The karstic landforms on Longstone Down have developed in the Crickmail Limestone (Asbian Stage) that is inclined southwards at 50º-60º and has been planed by marine erosion during Pliocene times. The limestone surface includes well developed solution features such as solution hollows, clints and grikes. A rich flora of grasses, herbs and wild flowers grows on this cliff top limestone where the rock is covered by *terra rossa* soil. This is a reddish clay soil that represents a residue of insoluble clay minerals derived from the chemical weathering of the limestone.



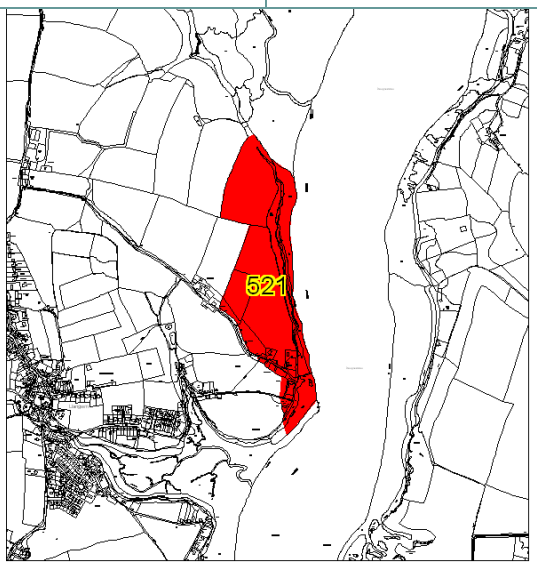
RIGS 520: Bullslaughter Bay	**Grid ref**	**SR 942943**

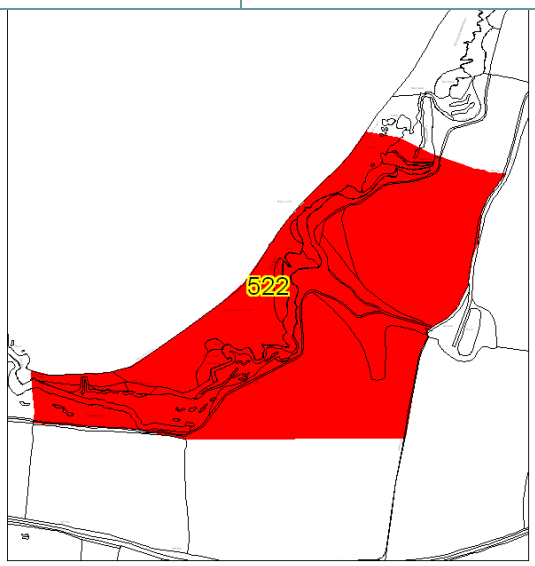
Statement of Interest: Bullslaughter Bay contains a first rate example of a rock unit that is locally known as `gash breccia'. The unit is composed of huge limestone fragments up to 3m across and smaller angular pieces that are cemented together in a matrix of sandy clay. The gash breccia fills fissures, pipes and fault zones in the Carboniferous Limestone in various places along the coast of South Pembrokeshire. Several theories have been postulated to explain these enigmatic deposits notably cavern collapse, accumulation of desert rubble during the Triassic Period, and shattering of limestone along faults. Their origin offers an important research topic particularly in the light of recent studies of what appear to be similar deposits in the faulted limestones of the Pennines.

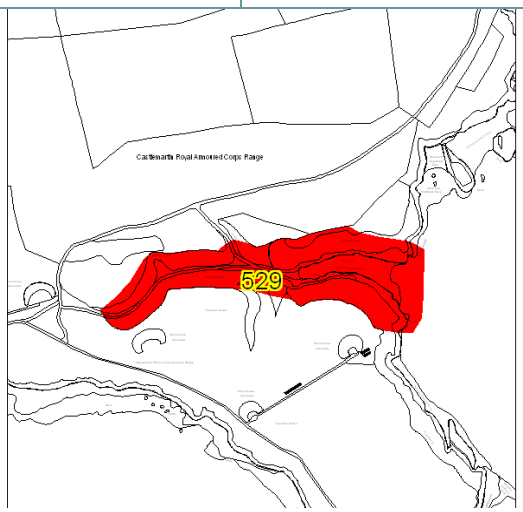


RIGS 521: Black Tar	**Grid ref**	**SM 999094**

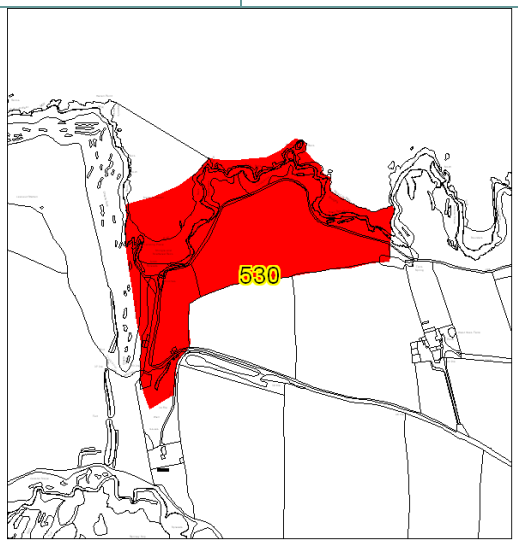
Statement of Interest: Black Tar is the name given to the rocky platform and low cliffs on the north side of Llangwm Pill on the Cleddau River. Here there are particularly clear and representative exposures of the Lower Coal Measures of late Carboniferous age, above the faulted junction with the underlying middle Carboniferous Twrch Sandstone Formation (Marros Group) that forms Black Tar Rocks. The strata in this locality consist largely of cyclothem units (cycles of sedimentation) of cross stratified sandstones, flagstones and siltstones that were deposited in deltaic environments. They are steeply inclined to the south as a result of Variscan earth movements, notably activity on the Johnston Thrust. Llangwm parish had several small pits working seams of culm (low-quality coal) in the 18th century although production was largely for local use.

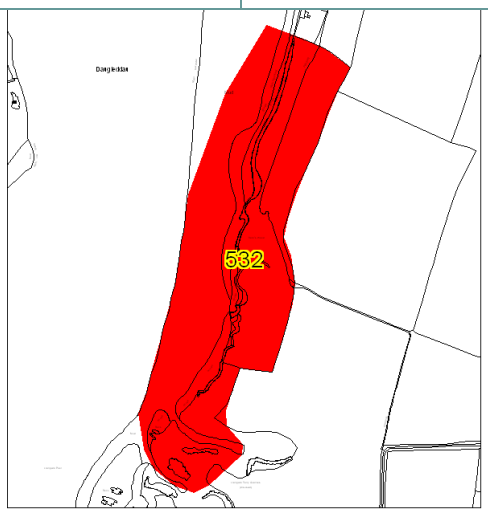


RIGS 522: Musselwick Sands	Grid ref	SM785089
Statement of Interest: This RIGS is designated for its Ordovician stratigraphy, Silurian igneous geology and Acadian structure. The east side of the bay is cut into almost black, cleaved Ordovician mudstones of Llanvirn (Llandeilo) age that were deposited from submarine density flows as distal turbidites in the deep waters of the Welsh Basin. The bedding, gently inclined to the south-east, is picked out by thin layers composed of volcanic ash that was also carried into the basin as turbidites. On the coast path the mudstones have weathered to a rusty orange colour. This is due to the weathering of pyrite, an iron sulphide mineral commonly produced in stagnant, anoxic bottom waters of a deep sea floor. Some of the rocks are conspicuously rich in millimetre-sized pyrite (fools' gold) studs. The strong cleavage, almost perpendicular to the bedding, results from the sediments being subjected to intense pressure during the Caledonian (Acadian) earth movements.		

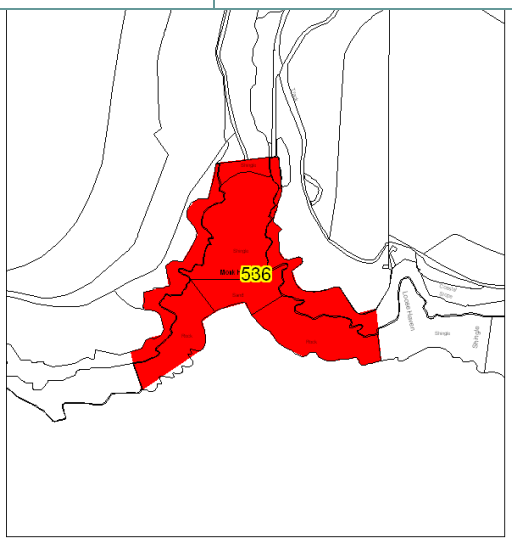
RIGS 529: New Quay (Pembrokeshire)	Grid ref	SR 974932
Statement of Interest: The inlet at New Quay is an excellent example of a steep sided, narrow, fault-guided indentation in the cliffed coastline known as a geo. There are several other geos along the coast to the west of St Govan's Head, including Huntsman's Leap and Stennis Ford (May, 2003)[6]: they are designated GCR sites. This RIGS is designated to complement the GCR examples. The site lies east of the Castlemartin Cliffs SSSI so it does not have SSSI protection. The site is located within the Castlemartin Army Range and access to it is controlled by the Ministry of Defence. Most geos in the region are developed in the well-jointed Stackpole Limestone (Holkerian Stage of the early Carboniferous). At New Quay the geo has been eroded along an east-west fault system.		

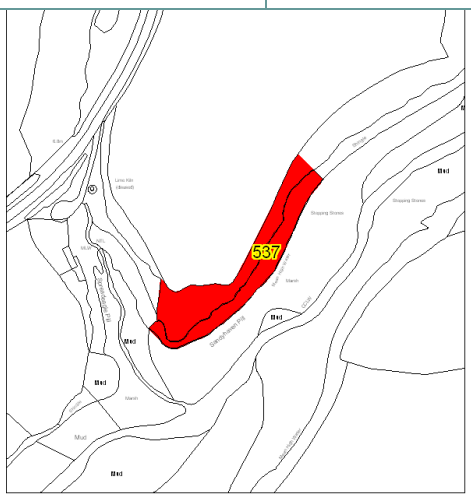
[6] Hansom, J.D. (2003) Bullers of Buchan. In May, V.J. and Hansom, J.D. *Coastal Geomorphology of Great Britain*. Geological Conservation Review Series, Joint Nature Conservation Committee, Peterborough. 28. Site 2325.

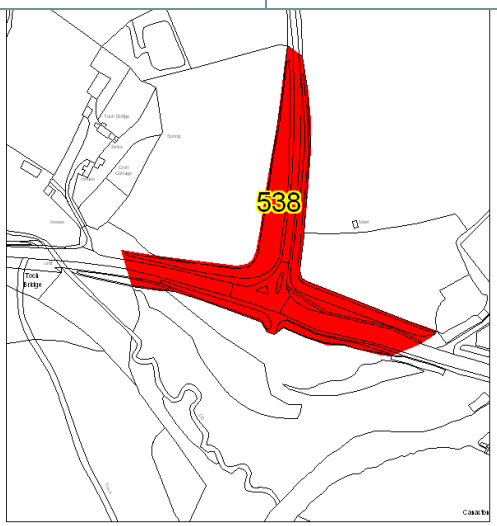
RIGS 530: Martins Haven	Grid ref	SM 761092
Statement of Interest: Martin's Haven offers an excellent coastal section in the Skomer Volcanic Group of Lower Silurian age. The site, comprising easily accessible 5-10m high cliffs, adjoins the Deer Park Peninsula GCR site that is designated, like the RIGS, for the importance of its Silurian igneous geology. The east side of the bay exposes conspicuous basaltic lava flows that were mainly erupted on to land, although some flows appear to have been emplaced underwater as pillow lavas. On the west side of the bay there is a faulted area of rhyolitic tuff and a spectacular water lain conglomerate composed of large rounded cobbles of volcanic rocks. The access road to the haven follows a major North-South fault; the cuttings include several good exposures of quartz-rich sandstone of Lower Silurian age interbedded with the volcanic rocks.		

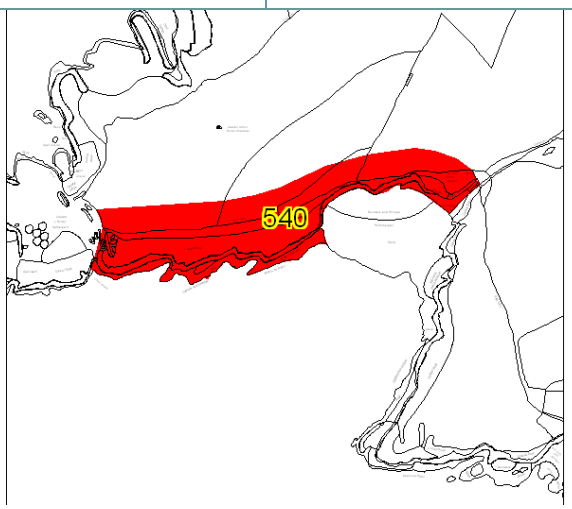
RIGS 532: Sam's Wood	Grid ref	SN 003092
Statement of Interest: The low cliffs along the eastern side of the River Cleddau at Sam's Wood provide a representative section through the Marros Group (formerly known as the Millstone Grit) of mid-Carboniferous (Namurian) age on the southern margin of the Pembrokeshire Coalfield. The section is faulted against the early Carboniferous Limestone in the south and the late Carboniferous Lower Coal Measures in the north. The basal sandstone is known as the Twrch Sandstone Formation and is well exposed on the foreshore between the two tidal creeks that provided shipping access to the Llangwm Ferry limestone quarries. The overlying Bishopston Mudstone Formation forms the cliffs in the northern part of the section where there are some excellent examples of Variscan folds and structures caused by deformation before sediment consolidation.		

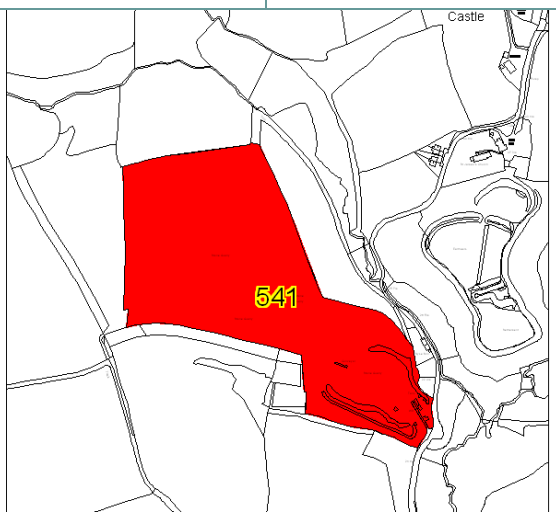
RIGS 534: Carew Quarry	Grid ref	SS048043
Statement of Interest: Carew Quarry is a working quarry producing limestone aggregate. It is geologically significant since it provides one of the few inland exposures and representative sections through Lower Carboniferous strata of Holkerian age.The strata in Carew Quarry belong to the Stackpole Limestone Formation and consist mainly of well bedded grey bioclastic (shell debris) limestones containing the beautifully preserved fossil remains of crinoids, corals, brachiopods and gastropods. The limestone and interbedded shales are inclined at approximately 30º north-east in the quarry, as the beds are on the north-eastern flank of the regional scale Carew Anticline. There are some excellent examples of Variscan folds in the north-west face of the quarry.		

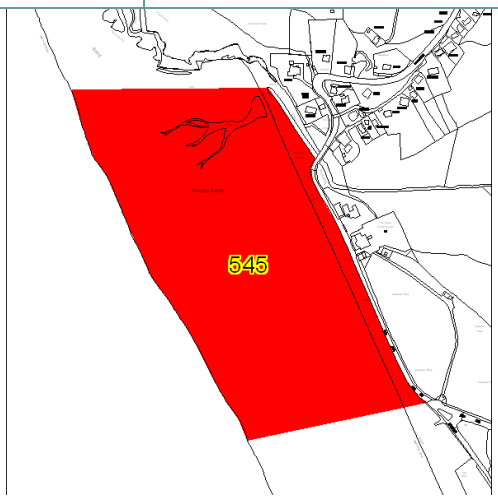
RIGS 536: Monk Haven	Grid ref	SM 828063
Statement of Interest: This RIGS provides a representative section through the Townsend Tuff Bed within the Sandy Haven Formation of the Lower Old Red Sandstone. The tuff is a volcanic ash that was deposited on coastal mud flats and was reworked into sediment composed of ash particles. It crops out on either side of Monk Haven and is about 2.5m thick comprising 3 ash units, each becoming finer grained upwards. The Townsend Tuff forms a distinctive regional marker horizon that extends across South West Wales and parts of the Welsh Borders. This important tuff band within the Lower Old Red Sandstone is named after the small hamlet of Townsend near to the village of Dale. Monk Haven also exposes a section through the lower part of the Sandy Haven Formation of late Silurian age (Pridoli stage) comprising a series of rhythmic units of conglomerates, sandstones and red mudstones with calcrete (fossil soil) development.		

RIGS 537: Sandyhaven Pill	Grid ref	SM 863088
Statement of Interest: The RIGS is an accessible low cliff beside Sandyhaven Pill (tidal river) that lies immediately south of the Pembrokeshire Coast Path. It is situated at the east end of the Winsle Inlier, in which Silurian marine sedimentary rocks are enveloped by Old Red Sandstone desert deposits. It has been selected for RIGS designation as the best exposed and most accessible of several localities in the inlier discussed in key research papers in the 1970s. The site is particularly important for information on the timing and manner of the switch from marine to desert conditions. Abundant fossils in the marine deposits, the demonstration of desert conditions and the evidence of rock deformation during the Variscan mountain building.		

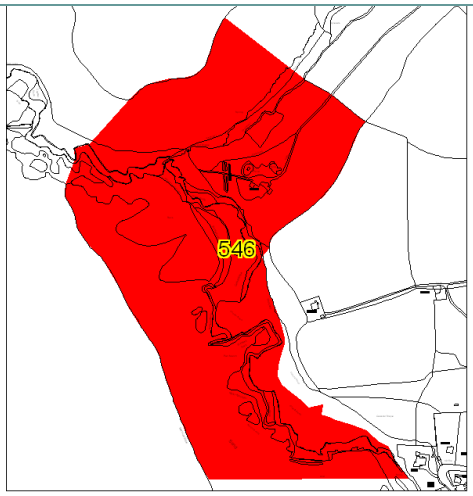
RIGS 538: Canaston Bridge Cuttings	Grid ref	SN 065153
Statement of Interest: The RIGS provides a section through part of the Haverfordwest Mudstone Formation, of Late Ordovician to Early Silurian age, which is generally poorly exposed in this region. The site is supplementary to the GCR site of Gasworks Lane in Haverfordwest. Rocks in the upper part of this formation at the GCR site are rich in fossils; those below are not. The Ordovician-Silurian boundary lies within this formation but its precise position cannot be determined without fossil evidence. This RIGS section provides opportunities for geologists to search for fossils to help define this fundamentally important boundary. Another key issue is tracking the fluctuations of sea-level associated with the Late Ordovician glaciation and de-glaciation: this section may provide fossil and sediment records of that event.		

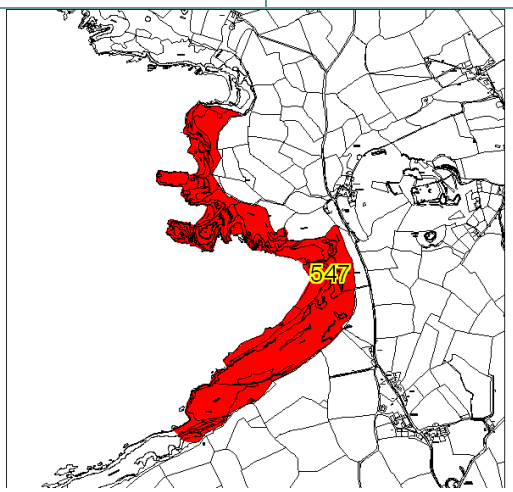
RIGS 540: St Davids Head	Grid ref	SM 724279
Statement of Interest: A particularly well-exposed and, for south-west Wales, a rare example of contact metamorphic rocks. Ordovician sediments were deposited in the Welsh Basin about 485 million years ago, deeply buried, then injected by magma about 10 million years later in the mid-Ordovician. The magma crystallised as the St David's Gabbro. The unusual feature here is the effect of the heat of the gabbro, near 1000ºC, on the sedimentary rocks. The thermal contact produced new, metamorphic minerals in the sedimentary rocks, mainly garnet and cordierite, which are seen as abundant tiny spots up to 1 millimetre across. These igneous, sedimentary and metamorphic rocks were then deformed by the Acadian orogeny about 400 million years ago, when the formerly round metamorphic minerals were compressed into ellipses.		

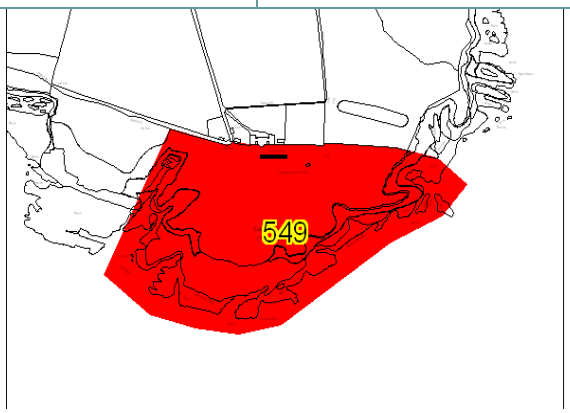
RIGS 541: Syke Quarry	Grid ref	SM 870109
Statement of Interest: Syke Quarry exposes fresh felsites belonging to the Benton Series, and were explosively erupted from a volcano perhaps in the late Precambrian some 650-550 million years ago. They are intercalated with sedimentary rocks which the British Geological Survey assigned to the Silurian; they were deposited in the sea about 435 million years ago. The quarry is situated on a complicated fracture zone. It is important to note that the geological survey maps would probably have been based on information from a quarry, now infilled, a few hundred metres southeast of the present one. The geology exposed in the older and younger quarries is likely to be substantially different in detail, because of lateral changes along the fault zone. The rocks here are extremely difficult to study at outcrop, as they are all fine grained and of similar colour.		

RIGS 545: Newgale Beach	Grid ref	SM 848223 to SM 849218
Statement of Interest: This RIGS is the northern, representative quarter of the 2km long shingle embankment that separates the sands from Newgale. The embankment is a storm beach that was constructed over many centuries, even thousands of years. It comprises c.10cm sized pebbles well-rounded and polished by the sea. They consist of a wide variety of rock types and minerals, probably derived from local and very distant sources, providing museum-quality samples. Newgale Sands are also of interest for the array of erosional and depositional features forming today and as seen in the 540 million year old Cambrian strata in adjacent cliffs. In addition, the sands contain relicts of a fossil forest.		

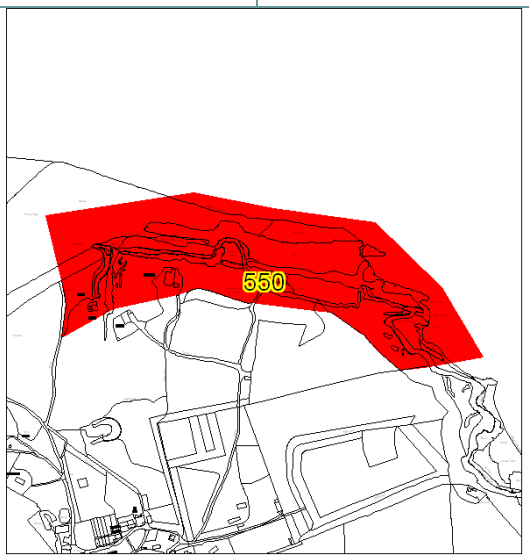
RIGS 546: Pwll March (Newgale)	Grid ref	SM 844226

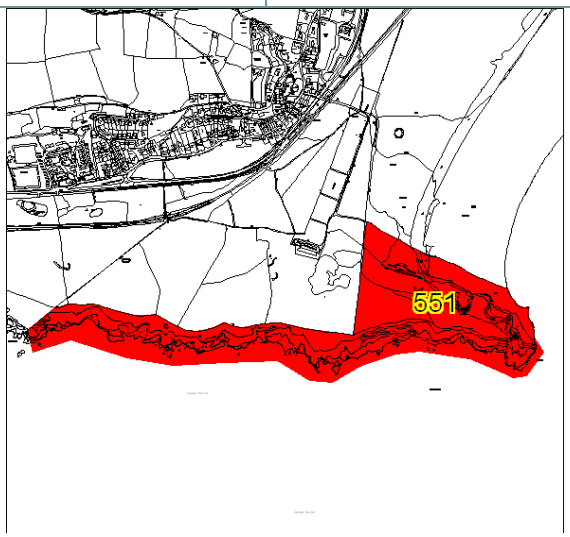
Statement of Interest: The rocks, belonging to the Solva Group of the middle Cambrian, were deposited in the Welsh Basin sea some 530 million years ago. They are mostly sandstones and mudstones with excellent examples of ripples, pebble beds, fossil burrows and other shallow marine features that are clearly displayed in the well-polished outcrops. Thin layers of volcanic ash and a dolerite dyke are added attractions. At the northern end of the RIGS is a narrow valley, Cwm Mawr, that was probably carved by melt waters issuing from the Irish Sea ice during the Devensian glaciation a few tens or hundreds of thousands of years ago. Within the RIGS the valley is partly filled by well exposed superficial deposits.	

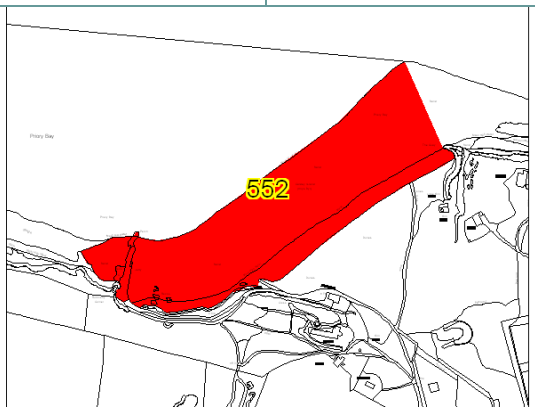
RIGS 547: Pwll Deri	**Grid ref**	**SM 888387**
Statement of Interest: This RIGS is along the Pembrokeshire Coast Path and adjoining sea-cliffs. It contains well exposed early Ordovician marine sediments that were deposited in the Welsh Basin about 480 million years ago, followed shortly after by rocks that were erupted from submerged and emergent volcanoes. Injection of magma then took place about 10 million years later. The RIGS is the southern part of a coastal excursion, described in the Dyfed geological guide (Bevins & Roach, 1982[7]), which is internationally famous for its well-exposed volcanic rocks. The site abuts the southern end of Pen Caer GCR site designated for its volcanic interests. The RIGS recognizes the importance of the slightly older rocks and the igneous intrusions.		

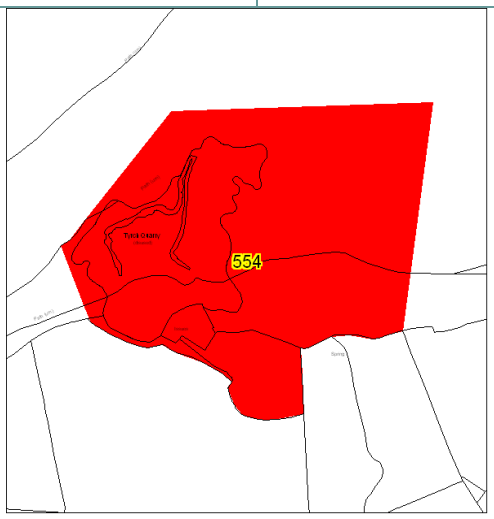
RIGS 549: Caldey Island I: Chapel Point	**Grid ref**	**SS 144957**
Statement of Interest: Here is the Moor Cliffs Formation of the Lower Old Red Sandstone. The top of this formation is marked by a 30m thick sequence of calcretised mudstones and interbedded conglomerates. This is the type section for the Chapel Point Calcretes which form a marker horizon that can be traced across Pembrokeshire. The calcretes occur as nodules, irregular layers and vertical tubes and some enclose pebbles within the conglomeratic beds. Calcretes represent fossil soils produced in a hot savannah climate of alternating dry and rainy seasons.		

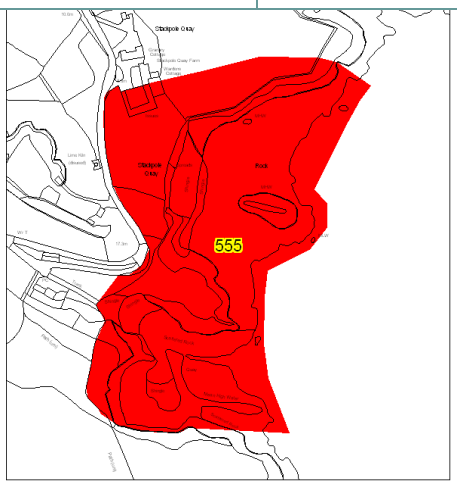
[7] Bevins, R.E. and Roach, R.A. (1982). Ordovician Igneous Activity in South-West Dyfed. In Basset, M.G (ed). *Geological excursions in Dyfed, south-west Wales.* National Museums and Galleries of Wales pp.65-80.

RIGS 550: Caldey Island II: High Cliff	Grid ref	SS 143971
Statement of Interest: High Cliff on the north-east coast of Caldey Island is geologically significant since it provides a representative section through Lower Carboniferous strata of Asbian age. The grey fine grained limestone contains spectacular and abundant fossil remains of shelly animals and corals that lived in shallow tropical seas. Some beds appear broken by a process known as pseudobrecciation; this phenomenon is the subject of modern geological research. The strata are steeply inclined to the north since this outcrop lies on the southern flank of the Pembroke Syncline, the axis of which runs through Caldey Sound. On the east side of the headland there are the remains of old quarry buildings marking the site of an important quarrying operation that supplied building stone to the rapidly expanding holiday town of Tenby in the late 19th century.		

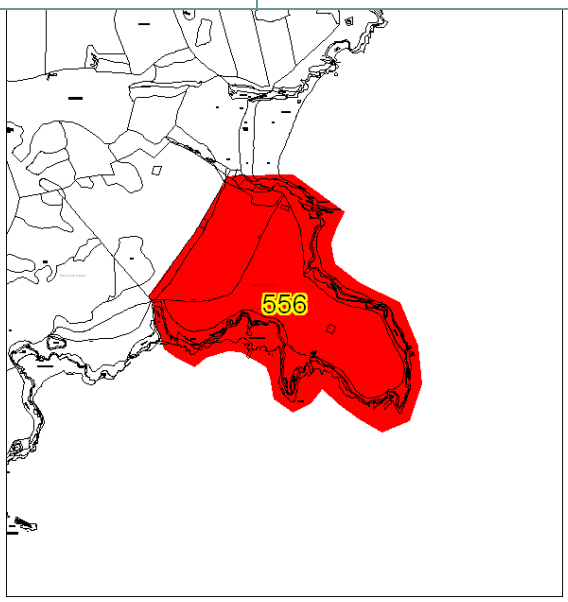
RIGS 551: Giltar Point	Grid ref	SS 125984
Statement of Interest: This RIGS provides an excellent representative section through the Lower Carboniferous strata from Arundian to Asbian age. The strata are steeply inclined to the south since this outcrop lies on the northern flank of the Pembroke Syncline, the axis of which runs through Caldey Sound. At the RIGS, the beds dip in the opposite direction to those of High Cliff (RIGS 550) located on the other side of the syncline. The limestones become younger towards Giltar Point and they contain the well preserved remains of brachiopods, crinoids and corals that are typical of limestones deposited in a shallow marine environment. There are several pockets of gash breccia exposed along the coast. These consist of a jumble of broken limestone clasts set in a matrix of finer fragments and cut by numerous small faults. Varisan earth movements are demonstrated.		

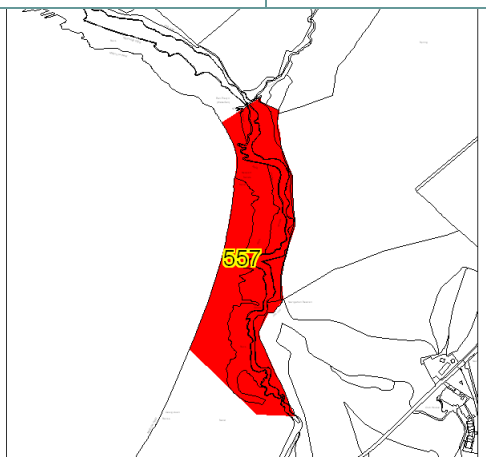
RIGS 552: Caldey Island III: Priory Bay Sands	Grid ref	SS 139970
Statement of Interest: This RIGS is the sandy shore adjacent to the ferry landing site on the north side of Caldey Island. The sands here exhibit excellent examples of sedimentary features forming today, notably braided streams and bars, which are commonly preserved on a much larger scale in ancient sedimentary rocks of shallow marine environments and in various lake, river and alluvial settings. These Caldey Island features are ephemeral, being constantly destroyed then rebuilding during each tide or storm cycle, but are easily observed by researchers and educational groups interested in using modern sedimentary processes to interpret ancient rocks.		

RIGS 554: Tyrch Quarry	Grid ref	SN 156297
Statement of Interest: The highly cleaved mudstones exposed in the disused quarry and in the spoil heaps are if Lower Ordovician age (c.478-466 million years old). These rocks formed a relatively poor quality slate used locally. On the hill slopes immediately to the northeast of the quarry there are several craggy outcrops of dolerite. This dark igneous rock was intruded into the mudstones probably during Middle Ordovician times. Unfortunately the contact between the mudstone and dolerite to the north east is not exposed in the quarry. The mudstones were deposited in the Welsh Basin. The igneous rock was produced as a result of the subduction of the Iapetus Ocean plate beneath the Avalonia continent.		

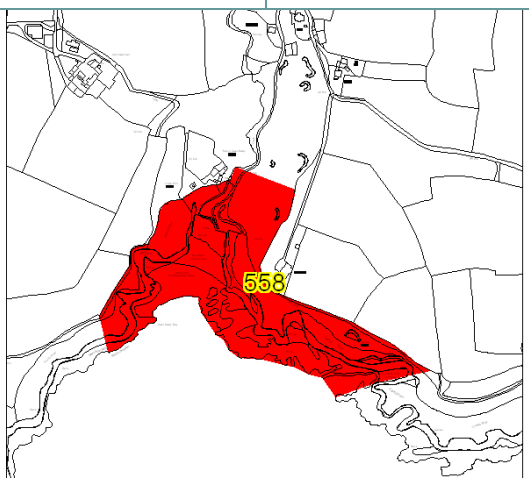
RIGS 555: Middle Cove	Grid ref	SR 994958
Statement of Interest: Geologically this RIGS is particularly interesting in that it contains good exposures of highly fossiliferous Carboniferous limestone. The fossils include large single corals, colonial corals and productid brachiopods. These organisms flourished in the warm shallow waters of the Lower Carboniferous seas. The importance of this locality is highlighted by its inclusion in the field guide 'The Geology of South Wales' (George, 2008).[8] There is a superb example of an asymmetrical syncline in the sea stack in the centre of Middle Cove. This Variscan structure is described separately in the Geological Conservation Review Series, Volume 36.		

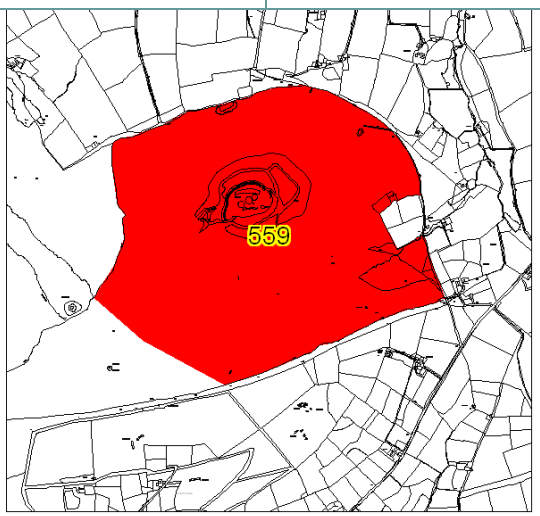
[8] George, T.G. (2008). *The Geology of South Wales: A field guide. gareth@geoserve.co.uk*

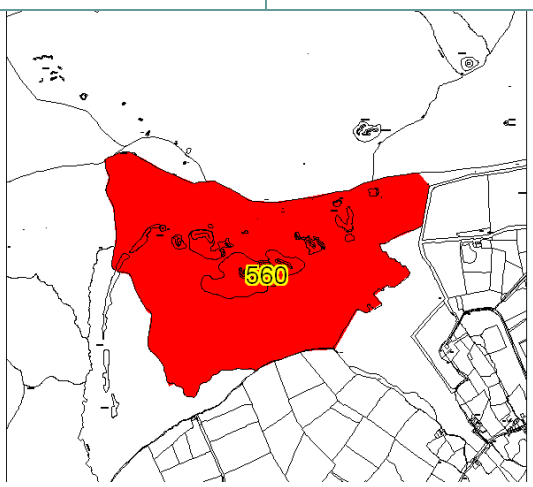
RIGS 556: Stackpole Head	Grid ref	SR 995943
Statement of Interest: Stackpole Head provides one of the best examples of Carboniferous Limestone cliffs in South Pembrokeshire. The strata are almost horizontal on the headland, but the strong vertical joints in the cliffs are much weathered. The surface of the headland shows the characteristic features of karstic solution weathering including fluted and pitted limestone blocks (clints), fissures (grykes) and solution hollows. A rich flora grows on the terra rossa soil that covers much of the limestone plateau. This reddish clay soil represents a residue of insoluble clay minerals derived from the chemical weathering of the limestone. One of the most significant geomorphological features at this RIGS is the pot holed palaeokarst surface that is exposed on a wide ledge (bedding plane) about one third of the way up the cliff face. This surface can be traced around the cliffs to where the coast path dips down on the east side of the Mowingword promontory.		

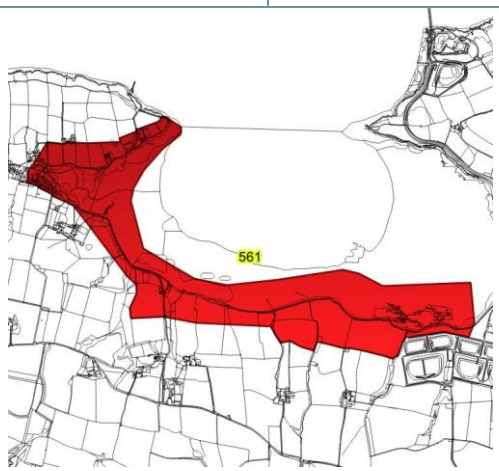
RIGS 557: Newport Sands (North)	Grid ref	SN 054407
Statement of Interest: The cliffs immediately to the north of Newport Sands are composed of strongly cleaved and folded mudstones of Mid Ordovician age. The structural features in these rocks were produced by the late Caledonian earth movements that imposed a north-east / south-west trend on the fold axes in the region. This is one of the few localities along the North Pembrokeshire coastline where the foreshore at the base of the cliffs is accessible at low tide so that it is possible to view the structures close up. Since it is also considered to be a particularly good example of folded Ordovician strata, it has been recorded by George, (2008) in his field guide to South Wales[9].		

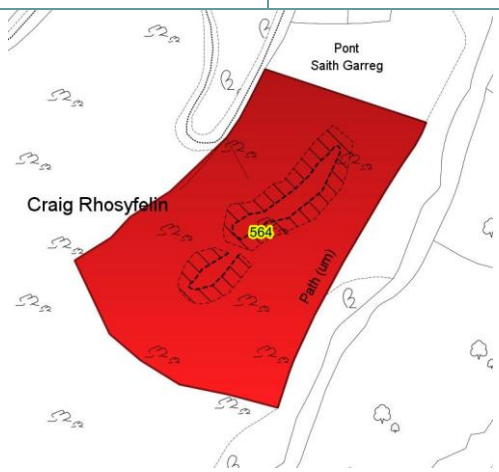
[9] George, T.G. (2008). *The Geology of South Wales: A field guide. gareth@geoserve.co.uk*

RIGS 558: Caerbwdy Bay Quarries	Grid ref	SM 767244
Statement of Interest: Caerbwdy Bay provides and excellent representative section through the Caerbwdy Sandstone of Lower Cambrian age (543-511 million years ago). The purple sandstone is fine to medium grained, generally poorly sorted and often displays bioturbation features (burrowing in the sediment by organisms). The bedding units are up to 3m in thickness and since the sandstone is relatively homogenous, it makes good building stone. There are the remains of several disused stone quarries on the cliff top near the head of the bay. These quarries were used to build the 12th century cathedral of St Davids which is about 2km from Caerbwdy Bay. Restoration work on the cathedral in the 1970s resulted in the temporary reopening of some of the quarries.		

RIGS 559: Foel Drygarn	Grid ref	SN 158336
Statement of Interest: Foel Drygarn is a prominent summit at the eastern end of Mynydd Preseli. At the top there are craggy outcrops (tors) or Ordovician volcanic ash and lava. Foel Drygarn is designated as an SSSI for its wildlife, natural vegetation and geomorphological features. The latter include the development of tors under periglacial conditions. This RIGS has been chosen to illustrate the geological origins of the igneous rock from which the tors have been fashioned. This site provides a geological contrast with the spotted dolerite of Carn Menyn RIGS 555. At least two of the 'bluestone' stumps at Stonehenge consist of volcanic ash but there is no conclusive evidence to suggest that they came from Foel Drygarn. The site has been glaciated during the Pleistocene and it is possible that erratics from this area may have been carried by ice as far as Salisbury Plain.		

RIGS 560: Carn Menyn	Grid ref	SN 144325
Statement of Interest: Carn Menyn is the name given to a group of craggy outcrops (tors) rising above the moorland on the eastern side of Mynydd Preseli. The distinctive 'spotted' dolerite that forms the tors has been matched with some of the 'bluestones' of Stonehenge. The site has been glaciated during the Pleistocene and some geologists think that bluestone erratics may have been carried by ice as far as the Salisbury Plain. Carn Menyn is designated as an SSSI for its wildlife, natural vegetation and geomorphological features. The latter include the development of tors under periglacial conditions. This RIGS has been chosen to illustrate the geological origins of the igneous rock from which the tors have been fashioned.		

RIGS 561: Angle Bay	Grid ref	SM 885022
Statement of Interest: The Avon Group formally known as the Lower Limestone Shales, outcrop on the foreshore on either side of the east-west orientated Angle Bay synclinal axis. On the south side of the axis, the beds dip steeply north and on the north side near Angle village the beds dip to the south. The rocks are only exposed at low tide and are much covered with seaweed, but the site is geologically important since it provides evidence of the eastward extension of the Angle Bay Syncline which is more fully exposed in West Angle Bay (RIGS 488). There are also several small Cariscan fold structures to be seen on the foreshore along the southern part of the bay.		

RIGS 564: Rhosyfelin	Grid ref	SN 117362
Statement of Interest: Craig Rhosyfelin is a craggy outcrop of Ordovician rhyolite in the valley of the Afon Brynberian. The rhyolite belongs to the Fishguard Volcanic Group which outcrops along the northern margin of Mynydd Preseli. This site is of particular interest since the rocks are exposed on a series of fracture planes and rhyolite samples from the rock face have recently been matched to 'bluestone' fragments in the 'debitage' at Stonehenge (see also Carn Menyn RIGS 560). Rhosyfelin is also significant as it offers an opportunity to examine some of the geomorphological processes and landforms typical of the Pleistocene period in the area. There are examples of scoured surfaces, frost shattered crags and scree, glacial till, fluvioglacial gravels and solifluction deposits. With regard to the rock face, from a geomorphological perspective there is ample evidence that glacial, periglacial and biological processes have all contributed to the widening of the joints and the accumulation of rock debris at the foot of the Rhosyfelin crag. **Addendum:** Recent archaeological excavations (Parker-Pearson et al, 2015)[10], however, have led to the assertion that part of the Craig Rhosyfelin outcrop and some of the stone debris at its base (including a large, roughly rectangular block) are the result of prehistoric quarrying. This suggestion has been strongly refuted by the current authors (John, Elis-Gruffydd and Downes, 2015a[11], 2015b[12]) who have argued that the features of the site constitute an association of natural geomorphological landforms and Quaternary sediments. Continued research at the site, both geomorphological and archaeological, including the possible application of Terrestrial Cosmogenic		

[10] Parker-Pearson, M., Bevins, R.E., Ixer, R.A., Pollard, J., Richards, C., Welham, K., Chan, B., Edinborough, K., Hamilton, D., Macphail, R., Schlee, D. Schwenninger, J. Simmons, E. and Smith, M. (2015). Craig Rhos-y-felin: a Welsh bluestone megalith quarry for Stonehenge. *antiquity,* 89(348), pp. 1331-1352.

[11] John, B.S., Elis-Gruffydd, D and Downes, J. (2015). Quaternary Events at Craig Rhosyfelin, Pembrokeshire. *Quaternary Newsletter,* October 2015. No 137 pp. 16-32

[12] John, B.S., Elis-Gruffydd, D and Downes, J. (2015). Observations on the supposed 'Neolithic Bluestone Quarry' at Craig Rhosyfelin, Pembrokeshire. *Archaeology in Wales* 54, pp.139-148

Nuclide (surface exposure) dating, may help resolve the relative contributions of natural and anthropogenic processes at the site.	