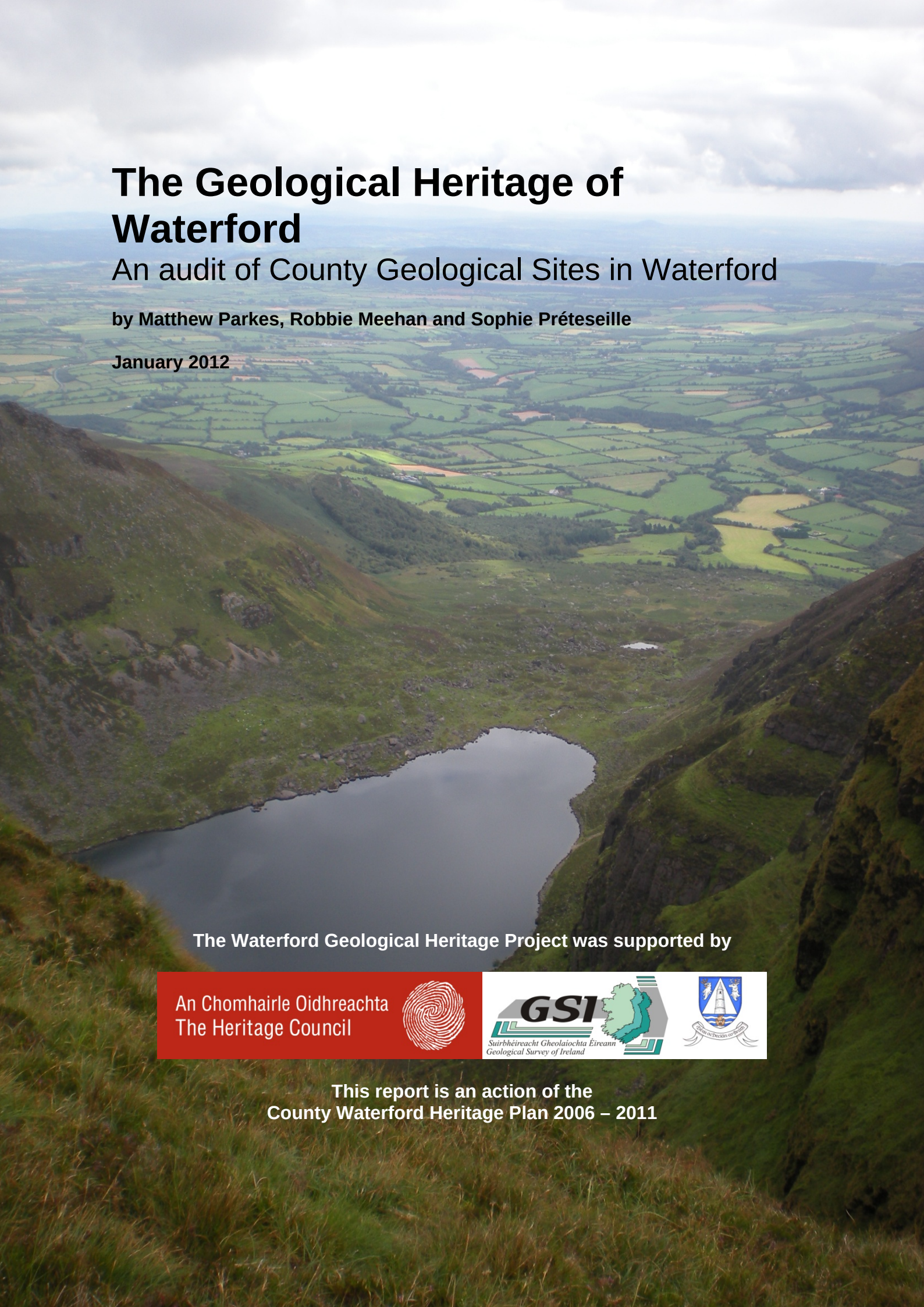

The Geological Heritage of Waterford

An audit of County Geological Sites in Waterford

by Matthew Parkes, Robbie Meehan and Sophie Préteseille

January 2012

The Waterford Geological Heritage Project was supported by

An Chomhairle Oidhreachta
The Heritage Council

GSI
Suirbhéireacht Gheolaíochta Éireann
Geological Survey of Ireland

**This report is an action of the
County Waterford Heritage Plan 2006 – 2011**

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County Waterford Heritage Plan 2006 – 2011

For the:
Irish Geological Heritage Programme
Geological Survey of Ireland
Beggars Bush
Haddington Road
Dublin 4
01-6782837 / 01-6782741

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Report Summary

County Waterford is a geologically diverse place with many landscapes, areas and sites treasured by both natives and visitors. The bedrock foundation, with hundreds of millions of years in its formation and shaping, and the more recent history of geomorphological processes such as coastal erosion, limestone solution and scouring by glaciers, are what has created that underlying geodiversity. Geological understanding and interpretation is best done on the ground at sites where the rocks and landforms are displayed. County Waterford has a wealth of such natural and man-made sites.

This report documents what are currently understood to be the most important geological sites within Waterford by the Irish Geological Heritage Programme (IGH) of the Geological Survey of Ireland (GSI). It proposes them as County Geological Sites (CGS), for inclusion within the Waterford County Development Plan. County Geological Sites do not receive statutory protection like Natural Heritage Areas (NHA) but receive an effective protection from their inclusion in the planning system. However, many of the sites described in this report are considered to be of national importance as best representative examples of particular geological formations or features. They will be formally proposed by the Geological Survey of Ireland, for designation as NHAs by the National Parks and Wildlife Service after due survey and consultation with landowners. However, many of these sites fall within existing pNHAs and SACs where the ecological interest is founded upon the underlying geodiversity. The commission of this audit and adoption of the sites within the County Development Plan ensure that County Waterford follows a now established and effective methodology for ensuring that geological heritage is not overlooked in the general absence of allocated resources for progress at national level. It keeps Waterford at the forefront of geological conservation in Ireland.

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This report is written in non-technical language (with a glossary for unavoidable geological terminology) as a working document for use by the Heritage Officer and the Planning department of Waterford County Council. It will also be made available via the County Council website for the people of Waterford. A chapter of the report includes recommendations on how to best present and promote the geological heritage of Waterford to the people of the county. It will also inform the work of the IGH Programme and be made available through the GSI website.

The preliminary sections, summary geological history and accompanying map, timescale and stratigraphical column particularly may be used as they stand to preface a booklet or as website information in the development of this work, and for information as seen fit by the Heritage Officer. The contents provide the essential ingredients for a public-oriented booklet on the geological heritage of Waterford.

Waterford in the context of Irish Geological Heritage

This report ensures Waterford is active at the forefront of geological heritage within Ireland, as it is only the eighth county to commission such an audit within the scope of the county based Heritage Plan. It will hopefully encourage other local authorities to follow what is now a tried and trusted methodology. In the absence of significant political and economic resources available to the relevant bodies for geological heritage conservation as Natural Heritage Areas (NHA) at a national level, it represents a significant level of progress in defining and safeguarding Ireland's geological heritage.

It also represents a significant commitment on the part of the Local Authority to fulfil its obligations to incorporate geology into the spectrum of responsibilities under the Heritage Act 1995, the Planning and Development Act 2000, Planning and Development Regulations 2001, and the Wildlife (Amendment) Act, 2000 and the National Heritage Plan (2002). The Geological Survey of Ireland (GSI) views partnerships with the local authorities, exemplified by this report, as a very important element of its strategy on geological heritage (see Appendix 8).

The Irish Geological Heritage Programme (IGH) in the Geological Survey of Ireland complements other nature conservation efforts of the last decade, by assessing Ireland's geodiversity, which is the foundation of the biodiversity addressed under European Directives on habitats and species by the designations of Special Areas of Conservation (SAC) and more recently on a national scale by the introduction of Natural Heritage Areas (NHA) as the national nature conservation method. As a targeted conservation measure to protect the very best of Irish geology and geomorphology it fills a void which has been there since the abandonment of the Areas of Scientific Interest scheme, listed by An Foras Forbartha in 1981.

The IGH Programme does this by identifying and selecting the most important geological sites nationally for designation as NHAs. It looks at the whole of Irish geology and geomorphology under 16 different themes. A fundamental approach is that only the minimum number of sites necessary to demonstrate the particular geological theme is selected. This means that our first criterion is to identify the best national representative example of each feature or major sequence, and secondly any unique or exceptional sites. The third criterion, of any sites of International importance, is nearly always covered by the other two.

Designation of geological NHAs is by the GSI's partners in the Programme, the National Parks and Wildlife Service (NPWS) currently operating within the Department of Arts, Heritage and the Gaeltacht. Once designated any geological NHAs will be subject to normal statutory process within the Waterford Planning Department and other relevant divisions. **However, management issues for geological sites are generally less, and somewhat different from many ecological designations. The following section considers these issues**.

IGH THEMES

1. Karst
2. Precambrian to Devonian Palaeontology
3. Carboniferous to Pliocene Palaeontology
4. Cambrian-Silurian
5. Precambrian
6. Mineralogy
7. Quaternary
8. Lower Carboniferous
9. Upper Carboniferous and Permian
10. Devonian
11. Igneous intrusions
12. Mesozoic and Cenozoic
13. Coastal geomorphology
14. Fluvial and lacustrine geomorphology
15. Economic geology
16. Hydrogeology

From a national perspective, as a result of extensive comparison of similar sites to establish which are the best, there is now a good knowledge of many other sites, which are not the chosen best example, but may still be of national importance. Others may be of more local importance or of particular value as educational sites or as a public amenity. It is these various other important sites that are proposed for County Geological Site (CGS) listing in the County Development Plan, along with the clear NHA selections.

In 2011, a Master List of candidate CGS and NHA sites has been established in GSI with the help of Expert Panels for all the 16 IGH themes. For several themes, the entire process has been largely completed and detailed site reports and boundary surveys have been done along with a Theme Report. Because much of the geology of Waterford happens to coincide with sites from these themes, many of the sites documented here are already selected and proposed for NHA designation, but due to various factors, they have not been formally designated yet. Therefore, inclusion of sites as County Geological Sites (CGS) in Waterford's planning system will ensure that they are not inadvertently damaged or destroyed through lack of awareness of them outside of the IGH Programme in GSI.

The sites proposed here as County Geological Sites (CGS) have been visited and assessed specifically for this project, and represent our current state of knowledge. It does not exclude other sites being identified later, or directly promoted by the Council itself, or by local communities wishing to draw attention to important sites for amenity or education with an intrinsic geological interest. New excavations, such as major road cuttings or new quarries for example, can themselves be significant and potential additions to this selection.

Geological conservation issues and site management

Since **geodiversity is the often forgotten foundation for much of the biodiversity** which has been identified for conservation through SAC or NHA designation, it is unsurprising that many of the most important geological sites are actually in the same areas. In these areas, the geological case enhances and cements the value of these sites for nature conservation, but requires no additional designation of actual land areas.

There tend to be two broad types of site identified by the IGH Programme. The first are small and discrete sites, which are the most common. They may be old quarries, natural exposures on hilly ground, coastal cliff sections, or other natural cuttings into the subsurface, such as Raheen shore at Newtown Head, Dunhill Quarry, Newtown, Kilgreany Cave or Clonea Strand. They usually have a specific interest such as fossils, minerals or are a representative section of a particular stratigraphical sequence of rocks. **The other type of site tends to be larger areas that represent a geomorphological interest – landscapes that illustrate processes which formed them**. The Coastal Geomorphology theme, the Quaternary theme and the Karst theme include such sites. In Waterford, the Comeragh Mountains with their superb glacial corries are characteristic of the larger sites encompassed under the IGH 7 Quaternary Theme. Long stretches of the coast of Waterford are likewise characteristic of the Coastal Geomorphology theme sites, aside from their other interesting features making them important under IGH Themes such as Precambrian to Devonian Palaeontology (IGH 2), Cambrian to Silurian (IGH4) or Mineralogy (IGH 6).

It is also important from a geological conservation perspective that planners understand the landscape importance of geomorphological features which may not in themselves warrant any formal site designation, but which are an integral part of the character of Waterford. A lack of awareness in the past, has led to the loss of important geological sites and local character, throughout the country. In Waterford a scenic landscape evaluation has been completed (contained in Appendix A9 Volume 3 of the County Development Plan) but it is intended to prepare a full Landscape Characterisation Assessment when resources allow. This will help provide a tool to help future planning decisions maintain the integrity of the County. However, as things currently operate, consultations with GSI, either by the planning department or by consultants carrying out Environmental Impact Assessment are the norm. This now routine pattern, plus strategic environmental assessment (SEA) have greatly improved the situation.

There are big contrasts in the management requirements for geological sites in contrast to biological sites. Most geology is actually quite robust and generally few restrictions are required in order to protect the scientific interest. In some cases, paradoxically, the geological interest may even be served better by a development exposing more rock. **The important thing is for the sites to be known about in the planning department, and more generally, so that consultation can take place if some development is proposed for a site**. In this way, geologists may get the opportunity to learn more about a

site or area by recording and sample collection of temporary exposures, or influence the design so that access to exposures of rock is maintained for the future, or prevent completely inappropriate developments through a strong scientific case.

In some other counties, working quarries may be designated simply because they are the best representative sections available of entire rock sequences, in areas where exposure is otherwise poor. No restriction would be sought on the legitimate operation of these quarries. However, maintenance of exposure after quarry closure would be sought with the operator and planning authority in such a case. At present, one working quarry, Cappagh Quarry, is included as a site in Waterford. These issues are briefly explored in a set of Geological Heritage Guidelines for the Extractive Industry, issued jointly by the GSI and the Irish Concrete Federation in 2008.

A new quarry may open a new window into the rocks below and reveal significant or particularly interesting features such as pockets of fossils or minerals, or perhaps a karstic depression or cave. Equally a quarry that has finished working may become more relevant as a geological heritage site at that stage in its life. It would possibly need regular maintenance to prevent overgrowth of vegetation obscuring the scientific interest.

Nationally, specific sites may require restrictions and a typical case might be at an important fossil locality or a rare mineral locality, where a permit system may be required for genuine research, but the general opportunity for collecting may need to be controlled. However, Waterford's palaeontological and mineralogical sites are not likely to require such an approach.

Waste dumping

A lesser problem, but one which does still occur, is the **dumping of rubbish in** the countryside, but especially in **closed depressions (dolines), collapsed caves or in active sinkholes in karstic areas**. The karstic areas of Waterford are relatively restricted to the valley floors inland westward from Dungarvan and to a much lesser extent near Ardmore. Long tradition of 'out of sight out of mind', is unacceptable today, and requires attention wherever it occurs.

The Copper Coast also suffers from waste dumping associated with abandoned mine shafts and former mining areas, such as the Tankardstown Mine area near Bunmahon, and along the R675 coast road. The mistaken expectations of people dumping, that the sea will take care of it, can only threaten the marine environment and the bird life such as choughs, for which these cliffs are designated as an SPA.

A dumped mattress opposite Tankardstown Engine House, September 2011.

The dumping of waste is not only unsightly and messy, but when waste materials are dumped in area where rock is exposed, such as quarries or karstic depressions, they may leach into the groundwater table as they degrade. This can cause groundwater pollution and can affect nearby drinking water supplies in wells. Groundwater Protection Schemes (DELG 1999) help to combat pollution risks to groundwater by zoning the entire land surface within counties into different levels of groundwater vulnerability. Such a scheme has been completed for Waterford County Council by the Geological Survey of Ireland, thus ranking the county land surface into vulnerability categories of 'Extreme', 'High', 'Moderate' and 'Low', and helps planners in assessing which developments are suitable in some areas of Waterford, and which are not.

New exposures in development

One less obvious area where the Local Authority can play a key role in the promotion and protection of geology is in the case of new roads. **Wherever major new carriageways are built**, such as around the M9 and its intersection with the N24 and N25 northwest of Waterford City (largely in County Kilkenny), or in other major infrastructural work, it should be a policy within the Planning Department that **where new rock exposures are created, that they be left open and exposed** unless geotechnical safety issues occur (such as bedding dips prone to rock failure). The grading and grassing over of slopes in cuttings is largely a civil engineering convenience and a mindset which is hard to change. However, it leads to sterile and uninteresting roads which look the same throughout the country. By leaving rock exposures along the routeway, where they are intersected, it provides an

improvement in character and interest, reflecting the geology and landscape of the locality. Sympathetic tree or shrub planting can still be done, but leaving bare rocks, especially where they show interesting features, not only assists the geological profession, but creates new local landmarks to replace those removed in the construction of the roadway. This can also potentially save money on the construction. Waterford County Council has been successful in implementing this approach in the construction of new road sections, for example on the N25 between Waterford City and Dungarvan. Three of these new cuttings are treated as a County Geological Site in this report, since they provide valuable new windows into the sedimentary geology of the Waterford volcanic belt.

New cutting in N25 near Kilmeaden

Geoparks

An extremely interesting development in geological heritage, not just in Europe but internationally, has been the rapid recent growth and adoption of the Geopark concept. A **Geopark is a territory** with a well defined management structure in place (such as Local Authority support), **where the geological heritage is used to develop sustainable tourism opportunities**. Initially it was largely a European Geoparks Network (EGN) but has now expanded worldwide as the Global Geoparks Network (GGN) since 2004 and is fully assisted by the United Nations Educational, Scientific and Cultural Organisation (UNESCO) [see www.globalgeopark.org and www.europeangeoparks.org]. A fundamental theoretical basis of the Geopark is that it is driven from the bottom up – the communities in the Geopark, are the drivers of the project and are the main beneficiaries. It therefore provides protection of the geological heritage resource so that the community can benefit from it.

In Ireland there are already two members of the Geopark Network. One is the Copper Coast in Waterford and the other is the cross-border Cuilcagh-Marble Arch Geopark in Fermanagh and Cavan [see www.marblearchcaves.net]. A recent active application for the Burren and Cliffs of Moher in County Clare to become a Geopark, has just been successful (September 2011), strongly supported by Clare County Council. In addition there are aspirant groups

exploring the work and infrastructure required for applications in other areas such as Joyce's Country in Mayo and Galway, and the Mourne Mountains and Carlingford area.

The Copper Coast Geopark has been a member of the network since 2001 and a reappraisal in the summer of 2011 has just confirmed (September 2011) that it still meets the fairly stringent requirements of the Geopark Network membership criteria, and has a valid membership for 4 more years.

This audit project may contribute to ongoing promotion of the geological heritage, and local commitment to the cause as well as firmly demonstrating Waterford County Council's support. In addition, the Copper Coast Geopark is preparing an application to extend the Geopark to include the Comeragh Mountains.
[see www.coppercoastgeopark.com]

Proposals and ideas for promotion of geological heritage in Waterford

The clear and significant inclusion of geological heritage in the Heritage Plan for County Waterford is a most welcome and positive step, for a topic that is often undervalued and poorly known in the wider community. This section examines the existing points in the plan relating to geological heritage and provides specific suggestions of how these may be implemented, supported or enhanced by the audit of geological heritage sites in the county.

AIM 1.0 Collect and disseminate information on the heritage of County Waterford and make it available

Objective 1.1 Establish and publish baseline information on heritage in County Waterford

1.1.17 Compile a database the industrial and engineering heritage of County Waterford.

Audit Action: any mining heritage information not included in the database can potentially be supplied by Matthew Parkes, through the Mining Heritage Trust of Ireland

1.1.20 Protect the geological sites listed in the County Development Plan and review the list where appropriate.

Audit Action: The audit will provide a robust and detailed report and dataset to achieve this objective in the Heritage Plan. However, ongoing review in future years for additional sites will be required. Some vigilance on the ground at sites will be required to ensure they are not damaged. The GSI should be consulted on any planning application that is potentially impacting upon an identified County Geological Site.

Objective 1.2 Add to the body of knowledge on the county's heritage

1.2.2 Continue to assemble images for the online Waterford Image Archive

Audit Action: The audit images can contribute to this objective.

1.2.7 Continue the Dungarvan Caves Project which is researching the archaeology of caves in the Dungarvan Valley.

Audit Action: The audit may contribute to the Dungarvan Caves Project through better integration of geological data with archaeological data.

AIM 2.0 Raise the level of awareness of heritage in County Waterford

Objective 2.1 Production of interpretative material; organisation of public events etc, on heritage in County Waterford

2.1.6 Prepare appropriate exhibitions on County Waterford's heritage for display in various centres throughout County Waterford. Use prepared ENFO exhibitions.

Audit Action: This objective is fulfilled in relation to geological heritage by the inclusion of draft content for a panel based exhibition (provided as supplementary to tender specifications).

2.1.9 Add to the existing stock of County Waterford heritage-related books, journals etc., digitally available on

the County Library website.

Audit Action: Selected geological and speleological titles will be made available digitally to build this collection, from the authors' own connections (as Speleological Union of Ireland Librarian) and resources.

Objective 2.2 Provide access to heritage in County Waterford

2.2.2 Continue to develop an infrastructure on the Copper Coast for sustainable tourism.

Audit Action: The content of the report and ancillary deliverables (i.e. an exhibition) can be used as resources for educational products and in raising awareness of the geological heritage value of the Copper Coast.

2.2.3 Implement and review the Walking Strategy in County Waterford, observing best practice with regard to heritage management and interpretation.

Audit Action: The audit can serve as a basis for developing new walking routes, and associated information leaflets and signage if required.

2.2.4 Prepare and implement a strategy for access to heritage sites and routes, to include the provision of signage.

Audit Action: Strategy should include adding geological information on signage where geological sites have been identified along routes.

2.2.5 Develop a walking route along the old Dungarvan to Waterford railway and consider developing further walking routes.

Audit Action: The audit can serve as a preliminary basis for developing this new walking route, and associated information leaflets and signage if required. However, the survey of the route should be completed by a geologist to further develop this

Objective 2.3 Promote heritage in County Waterford's education sector.

2.3.2 Provide content in the County Heritage webpages aimed at schools.

Audit Action: Exhibition panels included as part of this audit project can be made available as a handy resource. In addition, the Geoschol 4 page leaflet on the geology of Waterford, aimed at primary level, can be made available or through a link to it on the Geoschol website (www.geoschol.ie).

2.3.3 Consider a heritage course for in-service training of teachers in County Waterford.

Audit Action: The Copper Coast Geopark would be in a strong position to assist as they have experience in running geology courses. The authors could also be available to contribute an earth science component to such a course, utilising much of the material in this audit.

2.3.6 Continue the Copper Coast GeoPark education work for schools.

Audit Action: The authors will continue to support Copper Coast Geopark education work in whatever ways are feasible. At present, Matthew Parkes supplies copies of the magazine* Earth Science Ireland *to Copper Coast Geopark and to the Heritage Officer, as well as to individual teachers on request. Other supports will be provided as appropriate opportunities arise.

AIM 4.0 Promote best practice with regard to our heritage

Objective 4.1 Management of Heritage

4.1.11 Pilot biodiversity-enhancing practices in the creation and maintenance of road verges etc.

Audit Action: It is advised that some consideration of geology and soil types is required in such schemes.

4.1.16 Develop a County Waterford policy document on Water as a Heritage, to address the management of rivers, floodplains, lakes, wetlands, and other water bodies; in line with the requirements of the EU Water (framework) Directive.

Audit Action: Material herein may act as a reminder to fully include karstic and other groundwater bodies in such a policy. Authors could potentially assist in developing a water policy document and ensuring that the groundwater component is fully addressed.

4.1.24 Integrate Heritage management with the protection and enhancement of Tramore Dunes and Back Strand.

Audit Action: Tramore dunes and back strand is included here as a site, and the report may provide assistance with this action.

Objective 4.2 Heritage and the Development Process

4.2.3 Carry out Landscape Character Assessment in County Waterford.

Audit Action: Landscape Character Assessment utilises geological characteristics as a fundamental defining factor and the content of this audit and report may provide useful input to the LCA process.

Specific ideas for projects

Guides

There are only a few existing guides to the geology of parts of County Waterford, and even less aimed at a general audience (e.g. *The Copper Coast; Dunabrattin to Benvoy Strand; Stradbally to Ballydwane*. Landscapes from Stone: Geological Survey of Ireland, 1998). There is scope for many others, and for guides at different levels of detail and accessibility to non-specialists. A wide range of leaflets, booklets, books and other media are all feasible, but the research and production of appropriate text and images is a difficult task to do well without appropriate experience, and adequate time and resources. **It is suggested that with only modest editing and reorganisation the content of this report would comprise a good general guide to the geological heritage of County Waterford, in similar style to that produced in Sligo as a follow-on from the audit of sites conducted there in 2004.**

Signboards

Simple explanatory or interpretive signboards may be advisable at key geological heritage locations, but if these are considered, their locations and individual siting should be very selective, since a proliferation of different interest groups may provoke a 'rash' of panels all over the county. The Planning Section should clearly have a controlling input, in conjunction with the Heritage Office. It is most likely that a panel combining various heritage

interests at a place is preferred to single interest panels. It is important to consult with potential partners such as the Copper Coast Geopark in the planning stage so that duplication does not occur.

The subject of panels, and the integration of text and graphics are a fine art to complete successfully, and the IGH Programme can offer input if signs are planned for key visitor localities. The authors of this report are also able to write, review or provide content on geological heritage for any proposed panels.

At present the Copper Coast Geopark, the Mahon Falls and the Comeragh driving route are signed with directional brown tourism signs at several key junctions along the Waterford to Dungarvan route and at many points elsewhere, which is a prominent endorsement and recognition of geological heritage sites by Waterford County Council.

Museum exhibitions

As a result of the work to produce this report, the material for a panel based exhibition has been largely compiled. With some extra research covering human dependence on geology and resources, an interesting exhibition can be put together for display in the Museum, Council offices or County Library branches. The model followed was that produced for Carlow and for Dun Laoghaire-Rathdown. Images of these can be seen on the geological heritage section of the GSI website [www.gsi.ie].

Geoparks

Whilst there exists an active group, based in the local communities, developing Copper Coast Geopark projects and actions, the continued excellent support of the Heritage Office and the local authority is essential to the success and growth of the brand and the tourism potential, both for Irish and foreign visitors.

TV programmes

It is suggested that further short features within existing regular magazine style programmes (e.g. Nationwide on RTE1, EcoEye), or one-off

documentary programmes, may be the best avenues to seek Waterford coverage. With sufficient resources consideration could be given to making a specific programme or even a series on the geological heritage of Waterford. The IGH Programme and the GSI could advise on the development of this idea. Some existing programme concepts developed during International Year of Planet Earth but which did not get funded, are national in scope. The making of a specific programme or series on Waterford would need to be led from the county, and would require considerable drive and initiative to overcome prejudices and disinterest amongst media circles.

New media

There are increasing numbers of examples of new methods of promoting earth sciences, via mobile phones and other electronic media. Self guiding apps on specific sites would be one of these, such as those produced by Ingenious Ireland for Dublin city geology and for other sites. Plans for such products and many other exciting developments have been included in Copper Coast Geopark Interreg funded projects and new project applications, but other parts of Waterford could also benefit from such approaches.

Earth Science Ireland Group and magazine

[http://www.habitas.orguk/es2k/index.html]

The group Earth Science Ireland is an all-Ireland group promoting awareness of earth sciences and supporting educational provision in the subject. A main vehicle for the efforts is the twice a year magazine *Earth Science Ireland* and this is distributed free to thousands of individuals, schools, museums, centres and organisations. The editor would welcome more material from the Republic of Ireland and Waterford's geological heritage is featured in a major article in Issue 9, Autumn 2011. A second article on the Copper Coast is planned for issue 10 in the Spring of 2012.

Geoschol website [www.geoschol.com]

Geoschol is an educational project, now essentially represented by a website, which was largely aimed at producing educational materials on geology for primary schools. A four page pdf summarising the geology and some highlights of Waterford is already part of the available material. If no material is available to add, then at least working links to the Copper Coast Geopark website and to the county council website (when the results of this audit are available) should be established.

A summary of the Geology of Waterford

1) Paragraph summary

The rocks of Waterford include three main types. A complex of volcanic rocks mixed in with sediments, mostly from about 460 million years ago, dominates the eastern part of the county, and is represented by the Copper Coast. Devonian rocks from around 400 million years ago dominate the western half of the county and are normally red sandstones and conglomerates. These are best seen in the Comeragh Mountains. Around 330 million years ago warm tropical seas flooded low areas of Ireland and deposited the generally fossiliferous Carboniferous limestone. Both it and the Devonian rocks were ‘squeezed’ into large scale folds at the end of the Carboniferous Period. Subsequent erosion has left limestone as the bedrock in the downfolds of the Dungarvan and Ardmore synclines while Devonian sandstones form the ridges of high ground. Following erosion over several hundred million years, the last two million years have had a profound impact on the landscape with glaciers eroding the high ground leaving corries in the Comeraghs and blanketing much of the lower ground with till.

AGE (Million Years Ago)	ERA	PERIOD	EVENTS IN WATERFORD	IF THIS TIMESCALE WERE A DAY LONG ...
2	Cenozoic	Quaternary	Several ice ages smothering Waterford, followed in the last 10,000 years by the spread of vegetation, growth of bogs and arrival of humans. Sculpting of corries in Comeraghs.	The ice ages would begin 38 seconds before midnight
65		Tertiary	Erosion, especially of limestone. Caves, cavities and underground streams developing in the Dungarvan and Ardmore synclines.	The Tertiary period begins at 11.40 pm
145	Mesozoic	*Cretaceous*	*Erosion.* *No record of rocks of this age in Waterford.*	11.15 pm
205		*Jurassic*	*Uplift and erosion.* *No record of rocks of this age in Waterford.*	The age of the dinosaurs, starting at 10.55 pm
250		*Triassic*	*Desert conditions on land.*	10.42 pm
290	Palaeozoic	*Permian*	*No record of rocks of this age in Waterford.*	10.30 pm
355		Carboniferous	Land became submerged, limestones with some shales and sandstones deposited in tropical seas across much of Waterford. Limestones remaining today are pure and unbedded in the central portions of the valleys, with muddier limestones at the edges.	Much of Waterford's current rocks (limestone, sandstone and shale) deposited around 10.10 pm
410		Devonian	Caledonian mountain building. Sandstones deposited throughout west Waterford.	'Old Red' Sandstone deposited at 9.52 pm
444		Silurian	Shallow seas, following closure of the Iapetus Ocean. Slates, greywacke and shales deposited between Carrick-on-Suir and the Comeraghs.	Starts at 9.42 pm
488		Ordovician	Slates, siltstones and volcanic rocks form across much of east Waterford.	Begins at 9.28 pm
542		Cambrian	Opening of the Iapetus Ocean. Mudstones and siltstones deposited east of Tramore.	Starts at 9.11 pm
2500	Proterozoic	*Precambrian*	*Some of Irelands oldest rocks deposited in Mayo and Sligo.*	Beginning 11.00 am
4000	Archaean		*Oldest known rocks on Earth.*	Beginning 3.00 am
4600			*Age of the Earth.*	Beginning 1 second after midnight

2) Simple summary

The Precambrian rocks in Waterford are 600 million years old [Ma] and are now metamorphosed or altered sediments that were first deposited into an ocean and later changed during a later mountain-building event. During the Ordovician period (488-444 million years ago) shallow water limestones and some deeper-water muds were laid down in the Iapetus Ocean, that divided Ireland into two at that time. The Tramore Limestone dates from this time and contains bell-shaped fossil bryozoans called *Diplotrypa*. Some brachiopods (shells) and trilobites (arthropods, like Horseshoe Crabs) have also been found. As this ocean slowly closed, the continents on either side were subjected to great stress and volcanoes produced lavas and ash during eruptions. Along the coast at Kilfarrasy and Bunmahon these volcanic rocks can be seen. During the Silurian period, sediments continued to be deposited in the ocean that finally closed. This closure caused another mountain building event to take place causing many of the Silurian rocks to be tilted and then eroded away.

A new continent was created in the Devonian Period, around 400 Ma, when the Iapetus Ocean was finally closed. Large rivers drained from the newly formed mountains and deposited great thicknesses of sand and gravel on the flood plains.These sediments lithified (hardened) and in a few places these Devonian rocks can be seen lying on an ancient erosion surface on steeply tilted older rocks. The boundary between them is called an unconformity. These sandstones and conglomerate (pebble beds) now form all of the higher ground above 200 metres in the county, such as in the Comeragh and Knockmealdown mountains. By about 360 Ma, at the start of the Carboniferous Period, sea level was slowly rising and it drowned the flood plains. The fossiliferous limestones deposited in this warm, shallow equatorial sea now form much of the low ground across the county.

Both it and the Devonian rocks were ‘squeezed’ into large scale folds at the end of the Carboniferous Period. Subsequent erosion has left limestone as the bedrock in the downfolds of the Dungarvan and Ardmore synclines while Devonian sandstones form the ridges of high ground. Following erosion over several hundred million years, the last two million years have had a profound impact on the landscape with glaciers eroding the high ground leaving corries in the Comeraghs and blanketing much of the lower ground with till.

After the Ice Age the rivers in southern Ireland flowed north to south. As they eroded downwards, the upstream parts of rivers were reorientated by the underlying east to west trend of the landscape in south Munster. The River Blackwater flows for most of its length eastwards but at Cappoquin makes a marked right-hand turn and flows south to Youghal.

The coast between Fenor and Kilfarrasy is a European Geopark called 'The Copper Coast', and with good reason. In the nineteenth century, copper was mined at a number of localities by miners, some of whom brought their skills from Cornwall. Along the coast rocks can be seen with the tell-tale staining of copper minerals. Bunmahon was the centre of mining where the Mining Company of Ireland started to extract ore in 1826. A thriving industry needed engine houses with their square outlines and tall chimneys to pump water out of the mine shafts deep underground. Water wheels and dressing floors were used to remove the ore from the surrounding rock, and slipways were needed to transport the ore to ships that carried it to Swansea for smelting into metal ingots. By the late 1800s copper mining had ended in Waterford.

3) Extended summary

The oldest rocks in Waterford are of Precambrian age, dating from 600 million years ago (Ma) and are now metamorphosed or altered sediments that were first deposited into an ocean and later changed during a later mountain-building event. They underlie the low ground inland from Tramore and are not well exposed.

During the Ordovician Period (488-444 Ma) shallow water limestones and some deeper-water muds were laid down in the Iapetus Ocean, that divided Ireland into two at that time. The Tramore Limestone dates from this time and contains bell-shaped fossil bryozoans called *Diplotrypa*. Some brachiopods (shells) and trilobites (arthropods, like Horseshoe Crabs) have also been found in the Tramore Limestone. As this ocean slowly closed, the continents on either side were subjected to great stress and volcanoes produced lavas and ash during eruptions. Along the coast at Kilfarrasy and Bunmahon these volcanic rocks can be seen. Inland the volcanic rocks tend to form the high ground and are better exposed, and give the impression that the volcanic rocks are much more prevalent than is in fact the case.

The long coastal sections of the Copper Coast give an excellent cross section through the geology. There are intrusions of rhyolite and andesite, some like at Knockmahon with columnar shapes like a mini Giant's Causeway. The sediments were often not consolidated so intrusions created complex interactions and different degrees of deformation. The site at Dunhill Quarry provides proof that at times the volcanoes built up above the ocean surface and subaerial eruptions deposited ash and tuffs into the sea.

During the Silurian Period, sediments continued to be deposited in the Iapetus Ocean that finally closed at the end of this time. This closure caused another mountain building event to take place causing many of the Silurian rocks to be tilted and then eroded away. Today these rocks occur in the northeast of the county, to the south of Carrick on Suir, but they are not well exposed.

A new supercontinent was created in the Devonian Period, around 400 Ma, as the Iapetus Ocean closed. Large rivers drained from the newly formed mountains and deposited great thicknesses of sand and gravel on the flood plains. In a few places, like Ballydowane, these Devonian rocks can be seen lying on an ancient erosion surface on steeply tilted older rocks. The boundary between them is called an unconfomity. These sandstones and conglomerate (pebble beds) now form all of the higher ground above 200 metres in the county, such as in the Comeragh and Knockmealdown mountains. By about 360 Ma, at the start of the Carboniferous Period, sea level was slowly rising and it drowned the flood plains. The fossiliferous limestones deposited in this warm, shallow equatorial sea now form much of the low ground across the county.

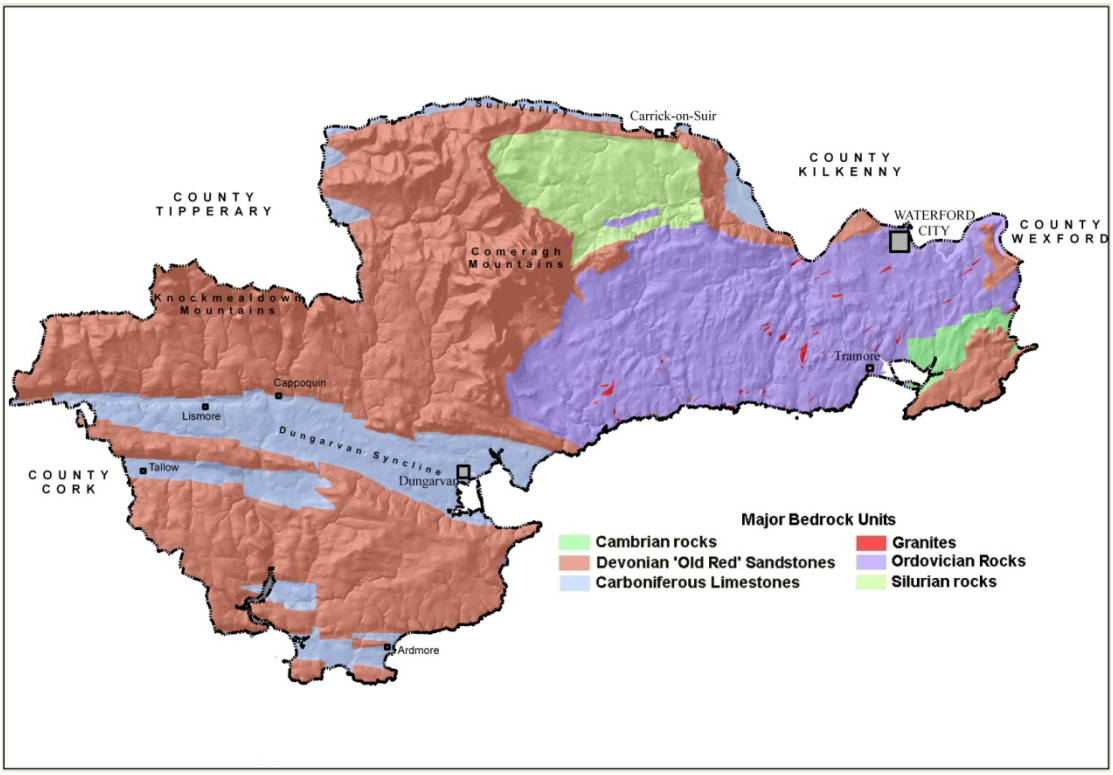
The Carboniferous limestone and the Devonian rocks were all folded into broad east west fold structures across Munster, as part of the Hercynian orogeny or mountain building episode, at the end of the Carboniferous Period. The downfolds, or synclines, now run along valleys from Dungarvan to Fermoy, and also at Ardmore, with a lesser syncline through Tallow. From this time, around 300 Ma, the land surface was subjected to erosion, but was generally stable.

The Pleistocene Period or Ice Age began about 2 Ma and several cold periods interspersed with warm periods saw Waterford smothered with ice. The ice sculpted

the county's landscape and glaciers formed in corries in the Comeragh Mountains and carved out superb features like Coumshingaun. The rock the ice ground down was deposited as an unsorted mixture of debris called till, in thick blankets over much lower ground, and now seen at sites like Ballyquin and Newtown.

The River Blackwater flows for most of its length eastwards, but at Cappoquin makes a marked right-hand turn and flows south to Youghal. This is probably an inheritance of a pre-glacial pattern but still provides an enigma for geologists. Drainage in the Dungarvan Syncline east of Cappoquin is often underground, with a number of caves present. Many of these were formed during the Ice Age as they have bones of extinct animals from warm and cold periods in them.

The coast between Fenor and Kilfarrasy is a European Geopark called 'The Copper Coast' and with good reason. In the nineteenth century, copper was mined at a number of localities by miners, some of whom brought their skills from Cornwall. Along the coast rocks can be seen with the tell-tale staining of copper minerals. Bunmahon was the centre of mining where the Mining Company of Ireland started to extract ore in 1826. A thriving industry needed engine houses with their square outlines and tall chimneys to pump water out of the mine shafts deep underground. Water wheels and dressing floors were used to remove the ore from the surrounding rock, and slipways were needed to transport the ore to ships that carried it to Swansea for smelting into metal ingots. By the late 1800s copper mining had ended in Waterford. Humans continue to remodel the landscape in our time, in what some people are now calling the Anthropocene.



A simplified geology map of Waterford outlining the main geological units.

Geological heritage versus geological hazards

Ireland is generally considered to be a country with very low risk of major geological hazards: there are no active volcanoes, stable tectonic plates mean earthquakes are relatively rare and human history is not peppered with disastrous landslides, mudflows or other geological hazards. Yet there are of course risks of one-off events, and this section briefly looks at the specific record and nature of geological hazards in Waterford and the relationship of the County Geological Sites to those hazards.

The difference between human timescales and geological timescales can be difficult to comprehend but for many geological processes they can be suddenly active with major events, and quiet periods in between. Many of the sites in this audit represent evidence of past environments and geological processes, such as volcanic activity, tropical coral seas, glacier erosion of mountains and so on. However, some sites represent the active geomorphological or land-forming processes of today. These sites, generally coastal, are dynamic environments and are subject to constant or intermittent change.

Landslides and bog flows

The Geological Survey of Ireland has been compiling national data on landslides in the past decade. However, no identified landslips or bog slides are recorded in Waterford. Given the thick blanket bogs, variable slopes and extensive peat coverage of the Comeragh Mountains it seems unlikely that there have been no bog slides there, but the remoteness of the uplands would mean that they could easily go unnoticed and unrecorded.

Minor landslips are often the result of human interference with slopes causing destabilisation. An example of this is the road beneath Dunhill Castle which has been closed due to a minor collapse of the embankment (see below).

Small roadside collapse below Dunhill Castle.

Flooding
There are three types of flooding which need consideration.

Coastal flooding is potentially only a problem in low lying areas when a combination of high tides and weather conditions may cause the sea to overtop barriers or coastal defences, whether man-made or natural. Where natural systems exist different habitats adapt to and absorb occasional inundations, but when people build in vulnerable areas or channelize rivers (remembering that geological time is far greater than human lifespans) problems can occur.

River flooding occurs inland when the rainfall exceeds the capacity of the ground to absorb moisture, and the river channels cannot adequately discharge it to the sea. This has not been a widespread issue in the county except occasionally in Waterford City and south and east of Clonmel. The OPW website www.floods.ie can be consulted for details of individual flood events in Waterford. Floodplains at Bunmahon, Annestown and along the River Blackwater in Lismore are also known flooding locations.

Karstic flooding can occur when underground passages are unable to discharge high rainfall events. The karst in the Dungarvan Syncline has largely relict or inactive caves, yet there are signs in some that the phreatic zone (the water table) does rise significantly. There are no known turloughs in Waterford, which are seasonal lakes where the water table intersects the land surface. The Ordnance Survey of Ireland six inch to the mile mapping does not record any areas 'liable to flooding' in the karstic landscapes. However, the potential exists for karstic flooding to occur along the valley floor.

Coastal erosion
Whilst much of the Waterford coastline is composed of hard rocks such as Ordovician volcanics or Devonian sandstones, erosion is generally slow and not a significant hazard. However, in some areas there are relatively unconsolidated glacial tills and head deposits. These are much more prone to erosion by the sea and can constitute a hazard. The cliffs, at sites such as Ballyquin, retreat by slumping of the cliff faces. The slumped material gets removed by the sea, further undermining the stability of the till, and causing renewed slumps. This only normally becomes a hazard to landowners or property on the cliff-top when assets are threatened.


Slumps at Ballyquin Shore.

Coastal protection techniques include placing of large boulders at the toe of slumping areas, which are a significant modification of local landscapes. This photo of a boulder barrier is at Ballyquin.

Bunmahon beach has been treated the same way.

Karstic collapse

This is a very real, but localised hazard in parts of Waterford. In the flat valley west of Dungarvan, there is limestone a few metres beneath the surface. The number of known caves in the limestone suggest that there are cavities and indicate that there are risks, since some cave entrances such as Carrigmurrish and the two caves called Oonagaloor, are collapses into large chambers. The fluctuations of groundwater in the limestone can remove sand and mud fill in some caves and cause sluggera collapses. These actually

occur quite frequently in some areas such as south east of Cappoquin, but collapses are often filled in quickly by farmers.

The recent example of a collapse in the entrance road at the industrial estate in Cappoquin illustrates this hazard quite spectacularly. In late autumn 2010 a 50m by 10m section of road subsided. Although it has been filled and the road repaired, it is still clearly visible in the photograph below, as a dip in the land surface and from the footprint of the replanted juvenile trees.

Glossary of geological terms

Geological term	Definition
Adit	A horizontal or only gently inclined mine tunnel dug to access ore, or to drain, ventilate or further develop a mine.
Alluvial Deposit	unconsolidated clay, silt, sand and gravel, deposited by a body of running water.
Alluvium	a term for unconsolidated clay, silt, sand and gravel, deposited by a body of running water.
Andesite	a volcanic rock of intermediate composition (between rhyolite and basalt).
Anticline	a structural geological term meaning an upfold of sedimentary strata in a linear arch shape.
Aquifer	a water saturated rock unit.
Arete	A thin, almost knife-like, ridge of rock which is typically formed when glaciers erode two adjacent corries or valleys.
Backwall	the cliffs at the rear section of a corrie.
Bedding Plane	the contact between individual beds of rock.
Bedrock	a general term for the rock, usually solid, that underlies soil or other unconsolidated, superficial material.
Biostratigraphy	using fossils to define the succession of rocks.
Blanket Bogs	bog covering a large, fairly horizontal area, which depends on high rainfall or high humidity, rather than local water sources for its supply of moisture.
Boulder Clay	unconsolidated, unsorted glacial deposits consisting of boulders and cobbles mixed with very finely ground-up rock or silt. Also known as till.
Brachiopods	a marine invertebrate of the phylum Brachiopoda - a type of shellfish. Ranging from Lower Cambrian to present.
Braided River	a river that consists of a network of small channels separated by small and often temporary islands.
Bryozoa	invertebrates belonging to the phylum Bryozoa, ranging from Ordovician to present, often found as frond-like, net-like or stick-like fossils.
Calcareous	containing significant calcium carbonate.
Calcite	a pale mineral composed of calcium carbonate, which reacts with dilute acid.
Carbonate	a rock (or mineral), most commonly limestone (calcite) and dolomite.
Cave	a natural underground space large enough for a human to enter, which is usually formed in either soluble limestone by karstic processes, or in exposed rock along the coastline, where the sea erodes natural rock fractures.
Clast	an individual constituent, grain or fragment of a sediment or rock, usually produced by mechanical weathering (disintegration) of a larger rock mass.
Cleavage	a finely spaced, flat plane of breakage caused by compressive deformation of rocks. e.g. the splitting of slate.
Conglomerate	sedimentary rock comprising of large rounded fragments in a finer matrix.
Corrie	a horseshoe-shaped, steep-walled valley formed by glacial erosion.
Crinoid	a variety of sea-urchin, with a long flexible stem, usually anchored to the sea-floor and a body cup with arms which may be branching (a sea lily).
Cross-bedding	layering in sedimentary rocks at an inclined angle to bedding formed by current-ripples.
Crust	the outermost, solid, layer of the Earth.
Dip/dipping	when sedimentary strata are not horizontal they are dipping in a direction

	and the angle between horizontal and the inclined plane is measured as the dip of the strata or beds.
Doline	circular/oval closed depression found in karst terrain.
Dolomite	calcium and magnesium bearing carbonate mineral; also a rock composed of the mineral.
Dressing floor	in 19th century mines cobbled yards or dressing floors were used to break down lumps of ore by hand to minimise the waste rock included.
Dune slacks	the hollow between dunes, sometime long and linear like a valley, sometimes a round trough.
Epikarst	the shallow layer, near surface, of highly karstified rock, with many voids included.
Erratic	a rock fragment, often large, that has been transported, usually by ice, and deposited some distance from its source. It therefore generally differs from the underlying bedrock, the name "erratic" referring to the errant location of such boulders. Tracing their source can yield important information about glacial movements.
Facies	the character of the rock derived from its original sedimentary environment and process of deposition.
Fault	planar fracture in rocks across which there has been some displacement or movement.
Fault Zone	a tabular volume containing many faults and fault rocks (rocks broken up by fault movement).
Fauna	collective term used to group all animal life.
Floodplain	a flat or nearly flat land area adjacent to a stream or river that experiences occasional or periodic flooding.
Flowstone	calcite or other minerals deposited as a surface crust by water flowing over cave or mine walls and floors.
Fluvial	pertaining to a river or stream.
Fold(ing)	flexure in layered rocks caused by compression.
Formation	a formal term for a sequence of related rock types differing significantly from adjacent sequences.
Fossiliferous	rich in fossils.
Fossils	any remains, trace or imprint of a plant or animal that has been preserved in the Earth's crust since some past geological or prehistorical time.
Geo	a narrow, near vertical sided linear coastal erosion feature, usually exploting some fracture or fault zone. A particularly Scottish term.
Glacial	of or relating to the presence and activities of ice or glaciers.
Gossans	the highly weathered zone, often with brightly coloured oxidised minerals, above a buried mineral deposit.
Grading	a sorting effect with the coarsest material at the base of the bed and finest grained material at the top.
Granite	a coarsely crystalline intrusive igneous rock composed mostly of quartz and feldspar.
Graptolite	extinct organism of the phylum Hemichordata with colonies consisting of one or more fine branches with cups. Ranging from Middle Cambrian to Devonian, but particularly important in dating Ordovician and Silurian rocks.
Greywacke	an impure sandstone, characterised by poorly-sorted, angular grains in a muddy matrix, that was deposited rapidly by turbidity currents (submarine avalanches).
Gully	a deep valley created by running water eroding sharply into bedrock or subsoil.
Haematite	a mineral form of iron oxide, which is the main ore mined as iron.
Head	weathered rock fragments accumulated on lower slopes from periglacial

	freezing and thawing action acting with gravity.
Hummock	a small hill or knoll in the landscape, which may be formed by many different processes.
Ice margin	The edge of an ice sheet or glacier.
Igneous	a rock or mineral that solidified from molten or partially molten material i.e. from a magma.
Interglacial	the time interval between glacial stages, or pertaining to this time.
Irish Sea Till	clay-rich till found along the eastern seaboard of Ireland, and occurring as much as 12km inland, which was deposited by an ice stream which occupied the Irish Sea Basin during the last glaciation.
Joint	a fracture in a rock, which shows no evidence of displacement.
Karst	general term used for landscapes formed by weathering of soluble rocks, usually limestone, by surface water and/or groundwater.
Knoll	a small hill or hillock sticking up from generally flat terrain.
Laminated	the finest example of stratification or bedding, typically exhibited by shales and fine-grained sandstones.
Lapilli	pyroclastic fragments between 2mm and 64mm in size.
Lava	magma extruded onto the Earth's surface, or the rock solidified from it.
Limestone	a sedimentary rock consisting chiefly of calcium carbonate ($CaCO_3$), primarily in the form of the mineral calcite. It is mostly formed by the accumulation of calcareous shells, cemented by calcium carbonate precipitated from solution.
Lithification	the process of rock formation from unconsolidated sediment.
Lithology	the description of rocks on the basis of such characteristics as colour, composition and grain size.
Lodgement	process by which debris is released from the sliding base of a moving glacier/ice sheet and plastered or 'lodged' onto the glacier bed; also describes tills emplaced by this process (i.e. lodgement till).
Maze cave	a cave formed in an extensive grid pattern when slow moving water.
Melt-out	process by which glacial debris is very slowly released from ice that is not sliding or deforming internally; also describes tills emplaced by this process (i.e. melt-out till).
Metamorphic	referring to the process of metamorphism or to the resulting metamorphic rock, transformed by heat and pressure from an originally igneous or sedimentary rock.
Micaceous	rich in mica (shiny, flaky silicate minerals).
Misfit stream	a stream which is too small to have eroded the valley in which it flows, as is often the case with streams now flowing in meltwater channels.
Moraine	any glacially formed accumulation of unconsolidated debris, in glaciated regions, such as during an ice age.
Mudmound	Waulsortian limestone of Carboniferous age is characterised by forming as massive mounds or ridges or sheets of carbonate mud on the seafloor of the time. Mudmound is a general term to describe the varieties of forms.
Mudstone	a very fine grained sedimentary rock, containing quartz and clay minerals. Similar to shale, but not as easily split along the plane of bedding.
Ore	a mineral which is concentrated enough to be exploited by mining.
Orogeny	the creation of a mountain belt as a result of tectonic activity.
Outcrop	part of a geologic formation or structure that appears at the surface of the Earth.
Peperite	Peperites form when hot magma interacts with unconsolidated water-saturated sediment.
Periglacial	very cold but non-glacial climatic conditions.

Phreatic	below the water table.
Phreatic	when a cave passage or void space in limestone rocks is filled with water it is said to be phreatic or in the phreas. When later found without water in them such passages have a characteristic cylindrical shape from solution in all directions and are called phreatic tubes.
Phreatic Zone	the area below the water table, where the rock is completely saturated with water.
Plate Tectonics	a theory that states that the crust is divided up into a number of plates, whose pattern of horizontal movement is controlled by the interaction of these plates at their boundaries with one another.
Pyrite	iron sulphide, pale yellow/gold coloured mineral, commonly occurring as cubes and often called 'fool's gold'.
Pyroclastic	fragmented rock material formed by a volcanic explosion.
Quartzite	a hard, metamorphosed sandstone, composed mostly of recrystallised quartz grains that are tightly interlocking. Quartzite is formed through heat and pressure usually related to tectonic compression.
Rhyolite	an igneous, volcanic (extrusive) rock of acidic composition. The mineral assemblage is usually quartz and alkali and plagioclase feldspars.
Sand spit	a linear coastal sedimentation feature where sand accumulates in a spit across a bay or along a coast.
Sandstone	a fine to coarse sedimentary rock, deposited by water or wind, and composed of fragments of sand (quartz grains), cemented together by quartz or other minerals.
Sedimentary	a rock formed by the deposition of sediment, or pertaining to the process of sedimentation.
Shaft	a vertical hole dug in a mine for access, ventilation, for hauling ore out or for pumping water out.
Shale	a very fine-grained mudstone, containing quartz and clay minerals, that splits easily along the plane of bedding.
Siltstone	is similar to mudstone but with a predominance of silt-sized (slightly coarser) particles.
Sink	another name for a swallow hole, the point where a stream passes underground.
Slate	is a fine-grained metamorphic rock produced from a sedimentary mudstone by pressure, imposing a cleavage along which the slate easily splits.
Sluggera	a tube-like collapse of the Earth's surface into an underground cavity, which has formed by the dissolution of limestone.
Slumping	the movement of a mass of unconsolidated sediment or rock layers down a slope, or pertaining to contorted sedimentary bedding features.
Solution pipe	a karstic feature of solution in a vertical narrow chimney or pipe shape.
Spring	the point where an underground stream reaches the surface.
Stratigraphy	the study of stratified (layered) sedimentary and volcanic rocks, especially their sequence in time and correlation between localities.
Sub-aerial	refers to processes occurring above ground level, such as the weathering of rocks.
Subduction	the sinking of one crustal plate beneath the edge of another through the process of plate tectonics.
Subsidence (zone)	the sudden sinking or gradual downward settling of the Earth's surface with little or no horizontal movement.
Swallow hole	the point where a stream passes underground, sinking below the ground surface.
Syncline	a structural geological term meaning a downfold of sedimentary strata in a linear trough shape.
Terrestrial	pertaining to the Earth's dry land.

Till	unconsolidated, unsorted glacial deposits consisting of boulders and cobbles mixed with very finely ground-up rock as sand, silt or clay also known as boulder clay.
Transgression	an incursion of the sea over land area.
Trilobites	extinct arthropods.
Tuff	rock formed from pyroclastic volcanic ash material usually composed of silt-sized to sand-sized particles.
Tuff(aceous)	consolidated rock formed from the ash ejected from a volcano.
Turbidite	deposit of a turbidity current.
Turbidity Current	underwater density current carrying suspended sediment at high speed down a subaqueous slope. The resulting deposit is called a turbidite.
Unconformable	a sedimentary rock that is not following in sequence from the one below but has a significant time gap present between them.
Unconformity	a buried erosion surface separating two rock masses or strata of different ages, indicating that sediment deposition was not continuous.
Vadose Zone	the area between the surface and the water table.
Vein quartz	white thin veins of quartz injected in rock fractures during episodes of stress. Also found as durable beach pebbles, once it has been eroded.
Volcanic Arc	a linear belt of volcanoes formed on the overlying plate at a subduction zone, resulting from subduction of the underlying plate.
Volcanic Ash	very fine rock and mineral particles ejected from an erupting volcano.
Volcanic Rock	any rock produced from volcanic material, e.g. ash, lava.
Volcanism	the process by which magma and its associated gasses rise into the crust and are extruded onto the Earth's surface and into the atmosphere.
Volcano	a vent in the surface of the Earth through which magma and associated gasses and ash erupt.

Data sources on the geology of County Waterford

This section is a brief summary of relevant GSI datasets, to assist any enquiry concerning geology and to target possible information easily. The GSI has very many datasets, accumulated since it began mapping Ireland's geology in 1845. A Document Management System (DMS) is freely available to any person at the GSI Customer Centre, into which about half a million documents and maps have been scanned. This means that any user can visit the GSI Customer Centre themselves and search on screen for data of relevance to them. High quality colour and black and white print-outs can be made or data supplied on CD, or via USB keys etc. **Data is available free of charge**.

Key datasets include:

1:100,000 Map Report Series

All historical, modern and other mapping has been compiled into very useful maps and reports that describe the geology of the entire country. Parts of Sheets 22 and 23 cover Waterford.

19th century 6 inch to the mile fieldsheets

These provide an important historical and current resource, with very detailed observations of the geology of the entire country.

19th century one inch maps and Memoirs

Information from the detailed 19th century mapping was distilled into one inch to the mile maps, of which parts of Sheets 167,168,178, 179, 188 and 189 cover County Waterford. Each sheet or several sheets were accompanied by a Memoir which described the geology of that area in some detail. These still provide valuable records of observations even though interpretations may have changed with better geological understanding. Memoirs are in the Customer Centre library and scanned on the DMS.

Historical geological mapping is now available via a website: http://www.geologicalmaps.net/irishhistmaps/history.cfm

Open File Data

Each Mineral Prospecting Licence issued by the Exploration and Mining Division of the Department of Communications, Energy and Natural Resources (currently) carries an obligation on the exploration company to lodge records of the work undertaken, for the common good. These records are held by the Geological Survey and are available as Open File Data, once a period of time has expired. They may include geological interpretations, borehole logs, geophysical and geochemical surveys and so on.

MinLocs Data

The MinLocs Database records all known mineral occurrences, however small, from GSI records, such as 19th century fieldsheets and Open File data.

Historic Mine Records

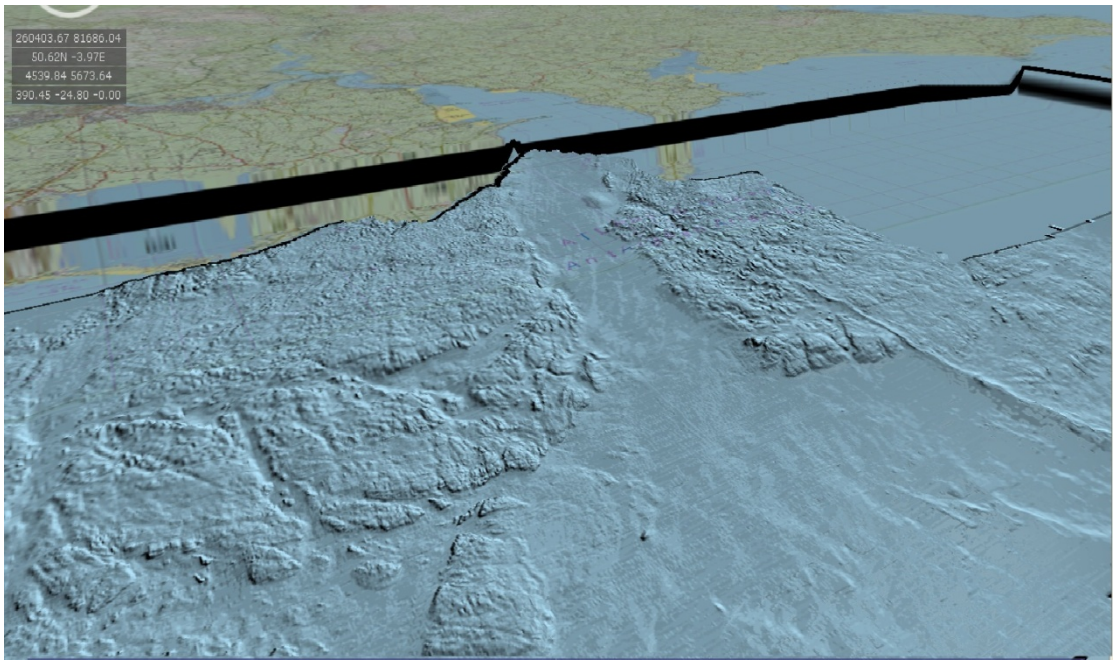
Abandonment plans and varied other material exists for the various mining ventures in the county, at places like Tankardstown Mine, near Bunmahon.

Subsoils Mapping

Since a Groundwater Protection Scheme has been done for County Waterford by GSI, a recently completed map of the subsoils of Waterford exists, as well as the previously completed bedrock mapping. This provides a significant resource in general terms as well as for groundwater protection. Customised output is possible.

Digital mapping of many different datasets is now available via the GSI website: www.gsi.ie

Since 1999 the National Seabed Survey and the INFOMAR project, between the GSI and the Marine Institute, have been mapping Ireland's marine territory. Initial years were focused on the vast extent of deep water offshore. More recent years have seen the emphasis change, with the acquisition of purpose built research vessels, to the shallow inshore waters. During the summer of 2011 an inshore survey of Waterford Harbour took place. This identified many riverbed features including whirlpool scour marks, sand waves, shoals and igneous dykes. It provides a level of continuity between onshore landscape features and the offshore drowned versions of them.



Shortlist of Key Geological References

This reference list includes a few **key** papers, books and articles on the geology and geomorphology of Waterford that are recommended as access points to Waterford's fabulous geological heritage. A full reference list of papers relating to the bedrock geology of County Waterford is included at the back of this report (Appendix 1), plus a list of caving references which are kept separate (Appendix 2). Appendix 3 is specific literature on the mining heritage of County Waterford. Appendix 4 covers the literature on the Quaternary geology of Waterford.

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DALY, D., DREW, D.P., DEAKIN, J., PARKES, M. and WRIGHT, J. 2001. *The Karst of Ireland; Limestone Landscapes, Caves and Groundwater Drainage Systems*. Karst Working Group Dublin, 37pp.

HOLLAND, C.H. (ed.). 2001. *The Geology of Ireland*. Dunedin Academic Press, Edinburgh.

MORRIS, J.H. 1999. *The Copper Coast.* Landscapes from Stone, Geological Survey of Ireland,

SLEEMAN, A.G. and McCONNELL, B.J. 1995. Geology of East Cork - Waterford. A geological description of east Cork, Waterford and adjoining parts of Tipperary and Limerick to accompany the Bedrock Geology 1:100,000 map series, sheet 22, East Cork - Waterford. Geological Survey of Ireland.

STILLMAN, C.J. and SEVASTOPULO, G. 2005. Leinster. Classic geology in Europe 6. Terra Publishing, Harpenden, Herts, England.

TIETZSCH-TYLER, D. and SLEEMAN, A.G. 1994. Geology of south Wexford. A geological description of south Wexford and adjoining parts of Waterford, Kilkenny, and Carlow to accompany the bedrock geology 1:100,000 scale map series, Sheet 23, South Wexford. Geological Survey of Ireland, Dublin.

Full Geological references

See Appendix 1 for the full reference list of all papers, books, articles and some unpublished reports etc relating to the geology and geomorphology of Waterford that could be traced.

Caving References

The references in Appendix 2 relate significantly to caves and caving within the Waterford area. They may only be brief reports or newsletter items. They are generally available within the Speleological Union of Ireland Library which is housed in the Geological Survey of Ireland and is managed by Matthew Parkes.

Mining heritage references

Appendix 3 lists references specifically pertaining to the mining heritage of County Waterford. Assistance with locating these references may be provided by the Mining Heritage Trust of Ireland if required.

Quaternary References

The references in Appendix 4 are all covering the Quaternary, or Ice Age, geology of Waterford. They are split into the specific ones covering Waterford sites or features and a section of national or regional papers with some Waterford data included.

Further sources of information and contacts

Sarah Gatley of the Geological Survey of Ireland, who is the Head of the Geological Heritage and Planning Section, can be contacted in relation to any aspect of this report. Bernadette Guest, the Heritage Officer of Waterford County Council, or Aisling Gleeson, Senior Executive Planner in the County Council are the primary local contacts for further information in relation to this report. Other contacts include the Conservation Rangers of the National Parks and Wildlife Service, currently in the Department of Arts, Heritage and the Gaeltacht. The names and phone numbers of current staff may be found in the phone book, or at www.npws.ie. Tina Keating, Geologist at the Copper Coast Geopark, Bunmahon, County Waterford, is an important local contact, along with Paula McCarthy, the CCG administrator as of 2011 (see www.coppercoastgeopark.com for contact details).

Web sites of interest

www.gsi.ie - for general geological resources

www.geology.ie – the website of the Irish Geological Association who run fieldtrips and lectures for members, including many amateur enthusiasts

http://www.habitas.org.uk/es2k/index.html - for general geological information of wide interest

http://www.tcd.ie/Geography/IQUA/Index.htm - for information, fieldtrips, lectures etc in relation to Ireland's Ice Age history

http://www.cavingireland.org/ - for information on caves and safe caving

http://www.progeo.se/ - for information about ProGEO the European Association for the Conservation of Geological Heritage

Acknowledgements

The authors would like to gratefully acknowledge the assistance of Bernadette Guest, Heritage Officer from Waterford County Council in the development of this project. Funding from the Heritage Council and Waterford County Council is also acknowledged. We also acknowledge the many members of the IGH Programme Expert Panels who helped define the sites which were considered for County Geological Site status. Sarah Gatley in the Geological Heritage and Planning Section of GSI also provided invaluable support throughout the project. Pete Ryder and his caving colleagues in the Moldywarps Speleological Group are thanked for their generosity in making cave surveys and data freely available for this report.

Section 2 - Site Reports

Site reports – general points

The following site reports are brief non-technical summaries of the proposed County Geological Sites for County Waterford. These have been specially prepared for this Report in order to make the information accessible to planners and others without geological training. For most sites more detailed reports and information files are held in the IGH Section in the Geological Survey of Ireland. These are available for consultation if required. Further sites may become relevant as IGH Programme work develops.

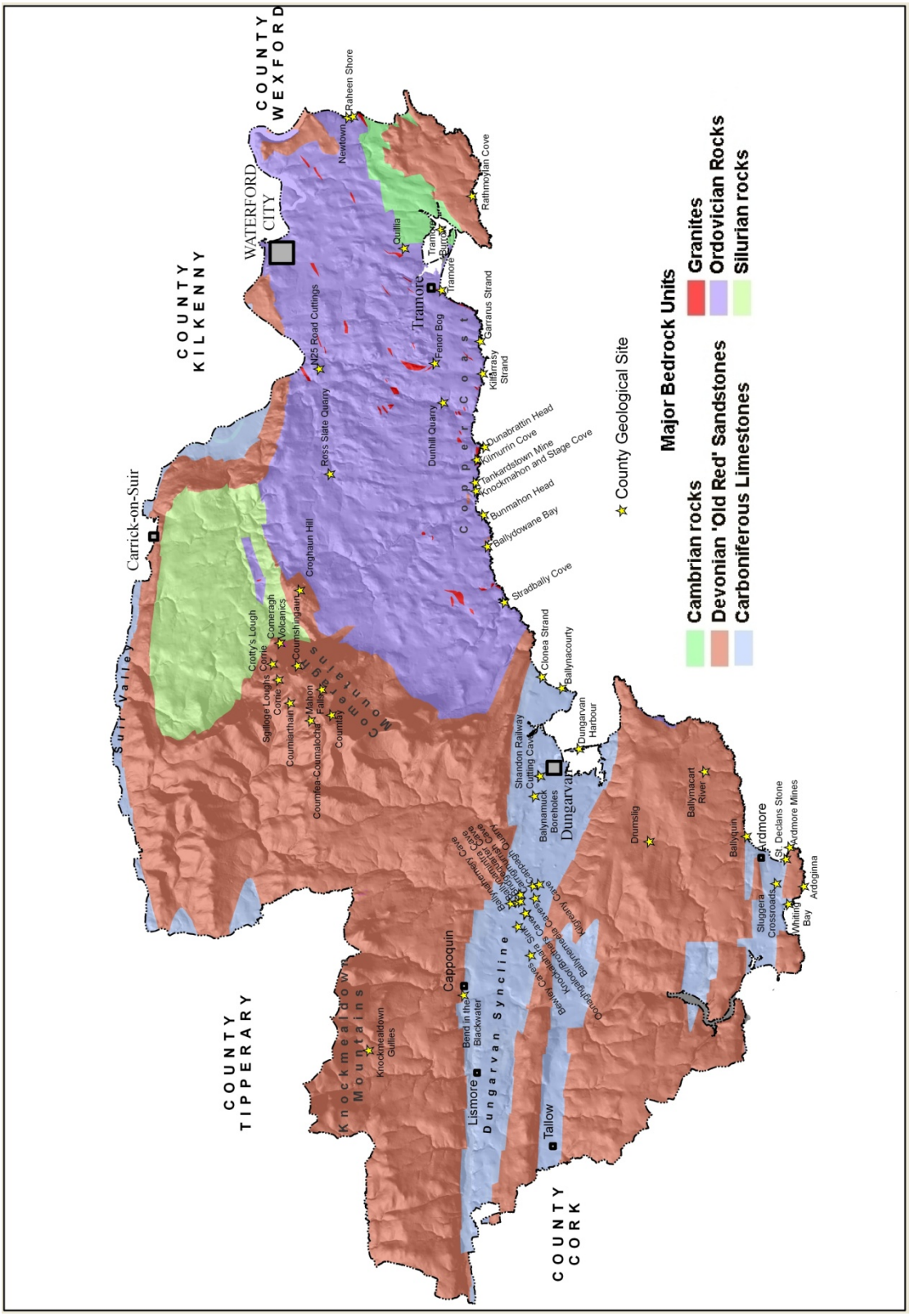
Each site report has primary location information, a mention of the main rock types and their age, and a short description of the key aspects of scientific interest. A section outlining any particular management or other issues specific to the site is included, along with one or two low resolution photographs exemplifying the site. **A CD accompanying this report will include further pictures of most sites at higher resolution, should they be required for a glossy booklet or leaflet for the general public**. Grid references are given normally for a central point in the site if the site is small, or two extreme points at opposite ends of the site if the site is extensive or linear. They are only indicative of the location, but the site extent is best shown on the included maps.

A series of maps are provided with an outline of the site boundary. It is important to note that no legal or definitive basis should be based on these boundaries. They are indicative only of the limits of exposure or of geological interest, and not based on detailed field and boundary surveys, which were outside the scope of this contract.

For sites that have been proposed or will be proposed for NHA designation detailed site boundary maps will become available to the Local Authority, through NPWS as the designation process is undertaken. Some areas may already be available if they are proposed NHAs (pNHA), under the Wildlife (Amendment) Act 2000. Areas which have been designated as Special Areas of Conservation (SAC) under European Habitats Directives will also have statutory boundaries already determined. The geological interest may be included within the wider area of nature conservation.

In terms of any geological heritage site designation as NHA, due process of site reporting, boundary survey and very importantly, consultation with landowners where they can be readily identified, will take place before GSI makes recommendations to NPWS on the most important sites to be designated. Any landowner within areas or sites identified in this report with concerns over any aspect of this project is encouraged to contact Sarah Gatley, Head of the Heritage and Planning Section, in the Geological Survey of Ireland, Beggars Bush, Haddington Road, Dublin 4.
Phone 01-6782837. Email: sarah.gatley@gsi.ie

Simplified Geological Map of Waterford with site locations indicated



WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Ballynahemery Cave**		
Other names used for site			
IGH THEME	**IGH1 Karst**		
TOWNLAND(S)	**Ballynahemery**		
NEAREST TOWN	**Dungarvan**		
SIX INCH MAP NUMBER	**Waterford 30**		
NATIONAL GRID REFERENCE	**216313 96325**		
1:50,000 O.S. SHEET NUMBER	82	**1/2 inch Sheet No.**	22

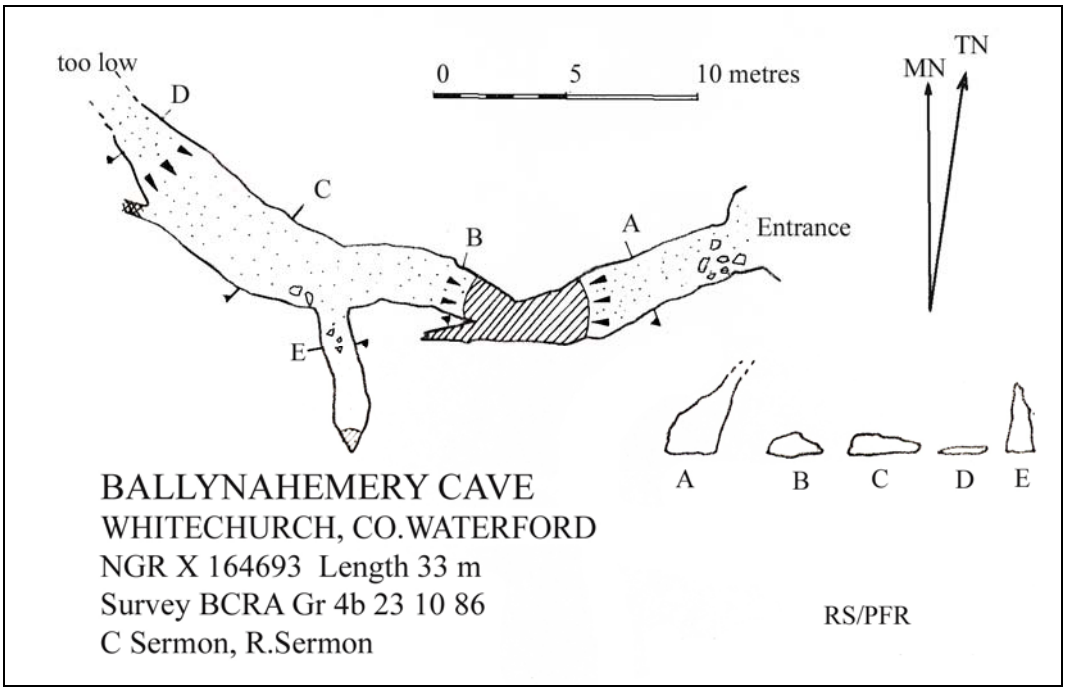
Outline Site Description
A small cave in a limestone escarpment, the entrance being at the back of a wooded, former quarry adjacent to a farm.

Geological System/Age and Primary Rock Type
The cave is probably of Holocene (post-glacial) age, developed within Carboniferous Limestone.

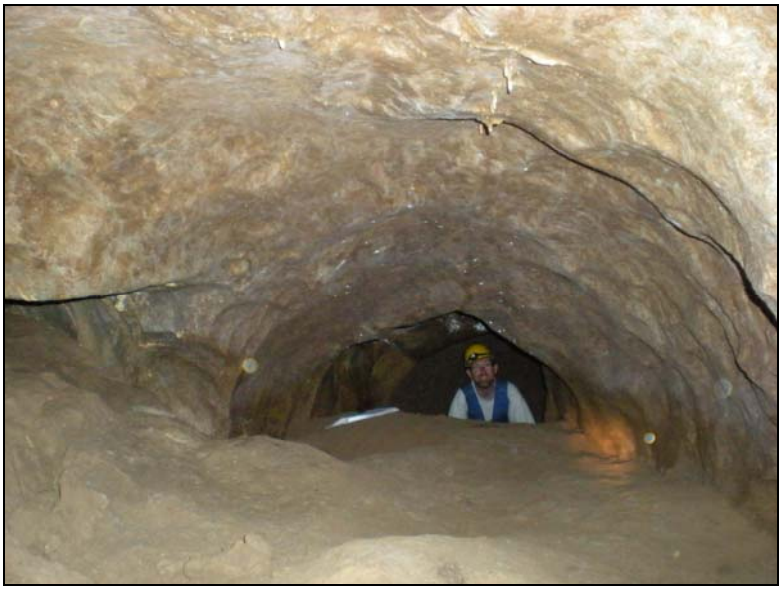
Main Geological or Geomorphological Interest
This small cave is only 33m in length, but is apparently developed on a dipping structure of limestone, in contrast to most Dungarvan Syncline caves which are in flat bedded or unbedded limestone. The caves are in Waulsortian limestone which is usually quite massive. Ballynahemery Cave may be developed on dipping beds on the flank of a Waulsortian limestone mudmounds, or perhaps on a fracture plane. Although a trial archaeological excavation yielded nothing, some potential probably still remains.

Site Importance
This is one of the smallest and least important of Waterford's caves but is still worthy of County Geological Site status.

Management/promotion issues
The cave should be protected from infilling, waste dumping and other disturbance. It is not suitable for general promotion or access.

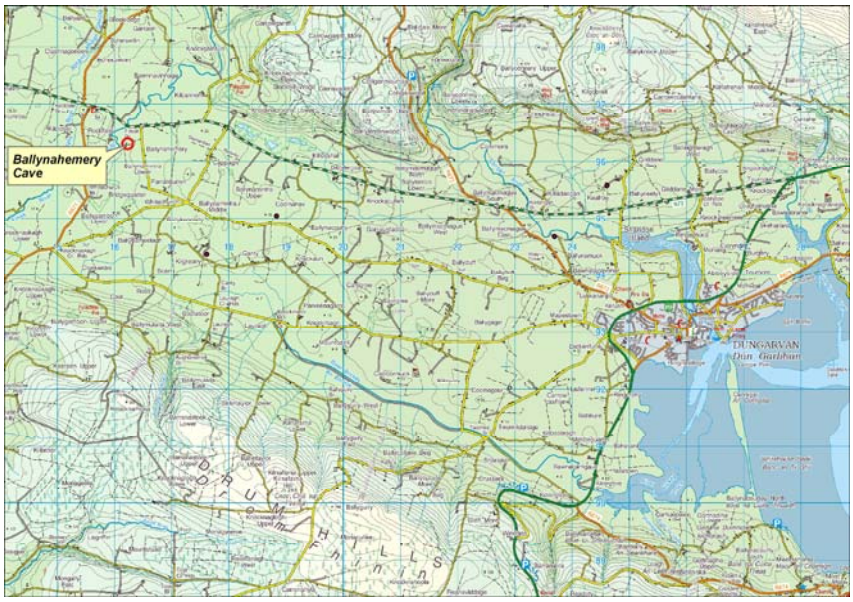


Ballynahemery Cave entrance.

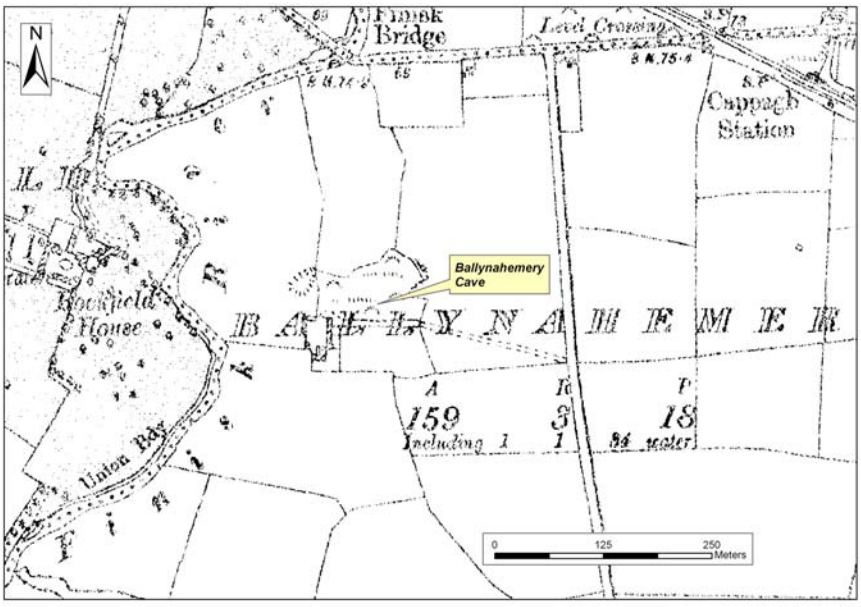


Ballynahemery Cave passage with scalloped roof and mud fill in the passage.

Ballynahemery Cave showing the steep angle of much of the passage presumably following steep bedding in the limestone.


Ballynahemery
Cave
DUNGARVAN
Dun Garbhan
D R U M H I L L S


N
Ballynahemery
Cave
0
125
250
Meters


N
Bridge
Level Crossing
Cappagh
Station
Ballynahemery
Cave
Rockfield
House
BALLYNAHEMERY
159
Including 1
Union Bay
0
125
250
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Ballynameelagh Caves**		
Other names used for site	Well Cave, Through Cave, Tip Cave, Maze Cave		
IGH THEME	**IGH1 Karst**		
TOWNLAND(S)	**Ballynameelagh**		
NEAREST TOWN	**Dungarvan**		
SIX INCH MAP NUMBER	**Waterford 30**		
NATIONAL GRID REFERENCE	**216648 94656**		
1:50,000 O.S. SHEET NUMBER	82	**1/2 inch Sheet No.**	22

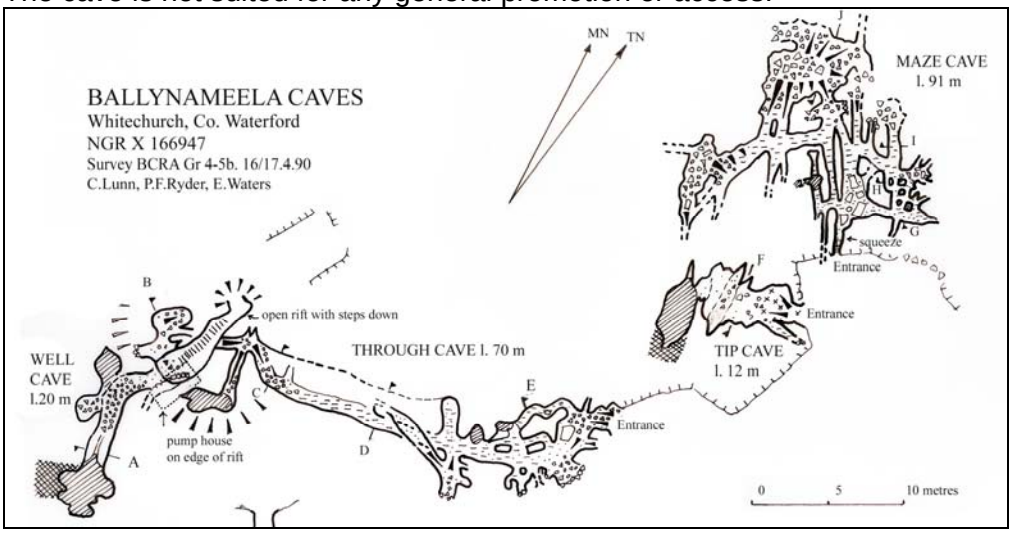
Outline Site Description
At Ballynameelagh, one cave remains of 4 which existed in a limestone knoll, adjacent to a farmyard.

Geological System/Age and Primary Rock Type
The cave is probably Holocene (post-glacial) age but is undated. It is formed within Carboniferous Limestone bedrock.

Main Geological or Geomorphological Interest
The Well Cave is one of very few that are active in Waterford, in that it seems to have a permanent intersection with the water table. A pumphouse above the deep enclosed depression enclosing the cave entrance shows it was once used as a water supply, although it appears to be redundant. Cave surveys done in 1990 by Moldywarps Speleo Group show there were three other caves (Through Cave, Tip Cave, Maze Cave) but these have been buried with earth and rocks by the landowner in farm works on the top of the knoll between 1990 and 1998. However the 2011 visit indicated further recent landscaping, including the entrance slope to Well Cave.

Site Importance
The cave is probably the least important of the Waterford caves included in the audit as County Geological Sites, but still worthy of recognition. The landowner has buried three adjacent caves under earth and rock fill during farm modifications, which has diminished the importance of the site as a whole.

Management/promotion issues
The entrance area to the still accessible Well Cave has also been modified and graded with a digger. Presumably it is not intended to eliminate it, and it may still be the farm water supply. The cave is not suited for any general promotion or access.



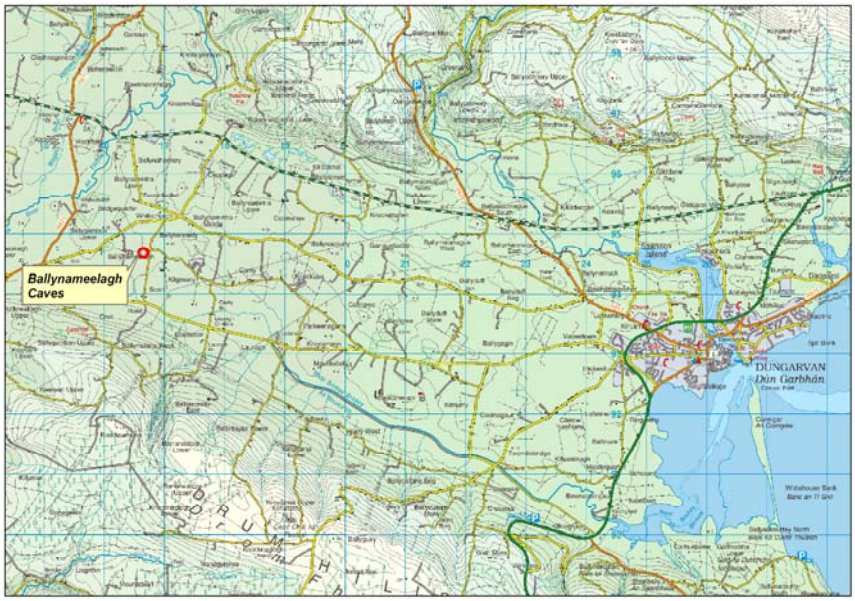
The entrance to Well Cave.

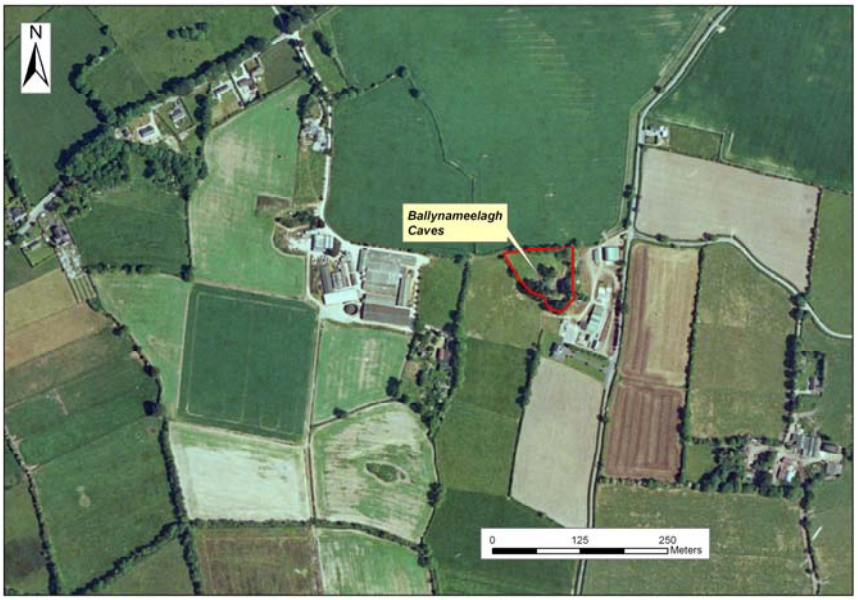
The deep water inside Well Cave.

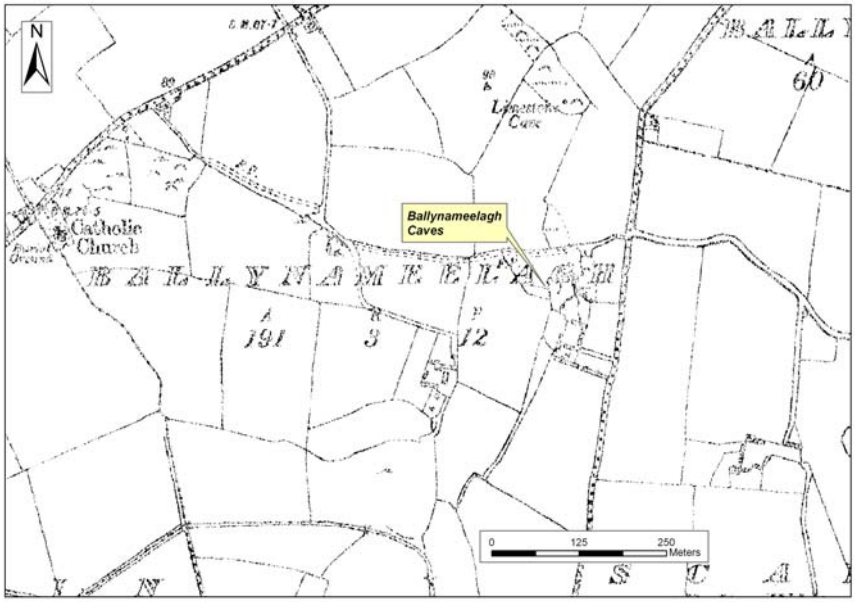
The landscaped entrance to Well Cave.

The earth fill over Tip Cave and Maze Cave.

The earth fill covering Tip Cave and Maze Cave.


Ballynameelagh
Caves
DUNGARVAN
Dún Garbhán


N
Ballynameelagh
Caves
0
125
250
Meters


N
Ballynameelagh
Caves
Catholic
Church
191
3
12
60
0
125
250
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Ballynamintra Cave**		
Other names used for site	Ballynamintra Bone Cave		
IGH THEME	**IGH1 Karst**		
TOWNLAND(S)	**Ballynamintra Lower**		
NEAREST TOWN	**Dungarvan**		
SIX INCH MAP NUMBER	**Waterford 30**		
NATIONAL GRID REFERENCE	**216417 95900**		
1:50,000 O.S. SHEET NUMBER	82	**1/2 inch Sheet No.**	22

Outline Site Description
An inactive cave in a wooded limestone escarpment.

Geological System/Age and Primary Rock Type
The cave probably originated during the Quaternary (Ice Age) with further development in the Holocene (post-glacial) Period. It is developed within Carboniferous Limestone.

Main Geological or Geomorphological Interest
Ballynamintra Cave is a significant cave for geology but also for archaeology. The cave is 95m in length, including small extensions discovered in 1988. The main walking sized passages display a classic phreatic tube shape, created when the void space was fully filled with water which dissolved in all directions into a sub-circular tube. The end of the main entrance passage has an aven in the roof which intersects the surface giving a window into the daylight above.

The cave was excavated in 1879 and as well as human remains of various types, animal bones recovered included bear, Giant Irish Deer and reindeer. In 1928 arctic fox remains were added to the list. Collections from the cave are housed in the National Museum of Ireland (human remains in Antiquities Division, animal bones in Natural History Division) but all could benefit from a modern reassessment.

Site Importance
This is one of the most important of the Waterford Caves and may retain some archaeological potential. It is of County Geological Site importance as a karst site.

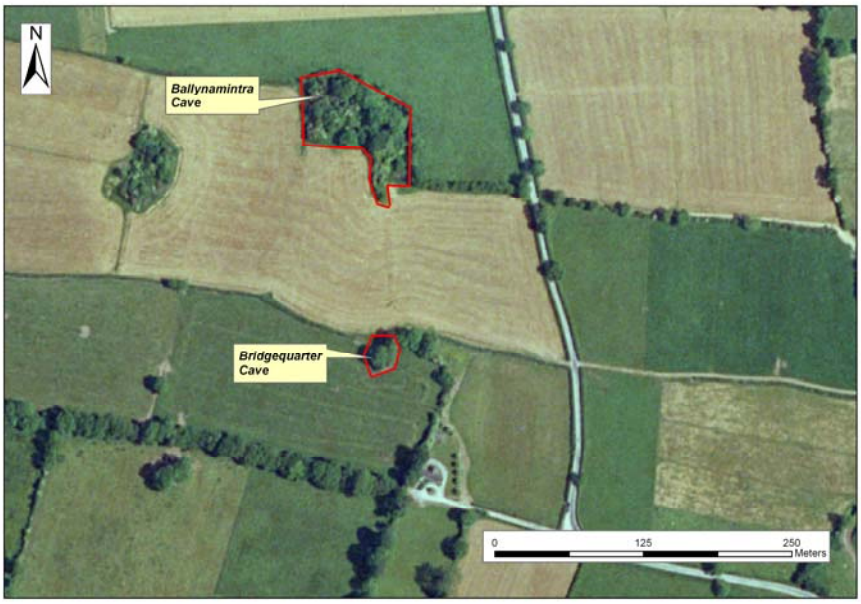
Management/promotion issues
The 1988 extensions included highly decorated stalactite rich areas termed the ‘White Forest Grotto’ by the discoverers, but a 1998 visit showed that many had been damaged by local children visiting the cave. The cave deserves protection from damage and destruction, but is not really suitable for general promotion or access.

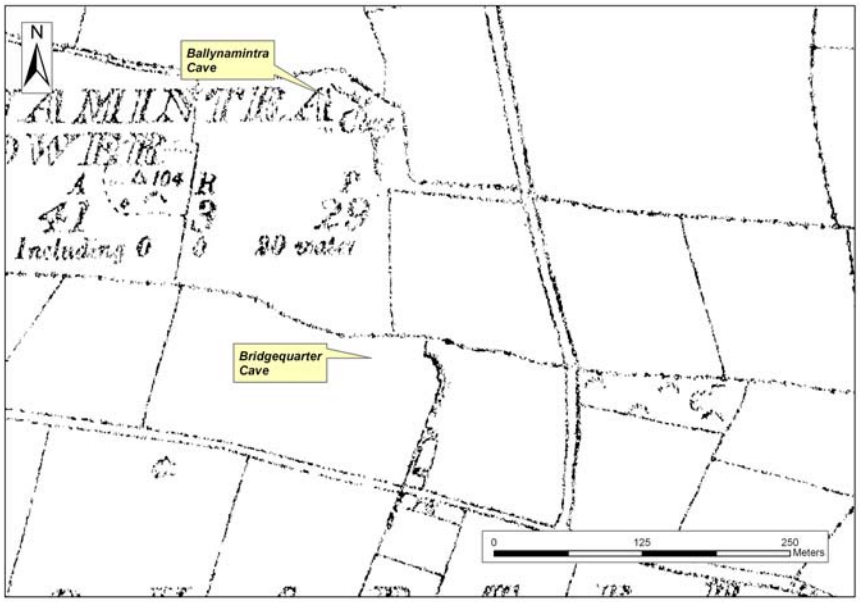
The phreatic tube forming the entrance to Ballynamintra Cave.

Ballynamintra Cave is towards the right hand side within the wooded scarp.

Ballynamintra Cave: open aven inside (left) and entrance (right).


Ballynamintra
Cave
DUNGARVAN
Dún Garbhán


N
Ballynamintra
Cave
Bridgequarter
Cave
0
125
250
Meters


N
Ballynamintra
Cave
Bridgequarter
Cave
0
125
250
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE **Bewley Caves**
Other names used for site
IGH THEME **IGH1 Karst**
TOWNLAND(S) **Bewley**
NEAREST TOWN **Cappoquin**
SIX INCH MAP NUMBER **Waterford 29**
NATIONAL GRID REFERENCE **Main large cave is at 212756 94953**
Bewley Caves West cave entrances at 212574 95029, 212577 95030, 212587 95032 and 212564 94994
1:50,000 O.S. SHEET NUMBER 82 **1/2 inch Sheet No.** 22

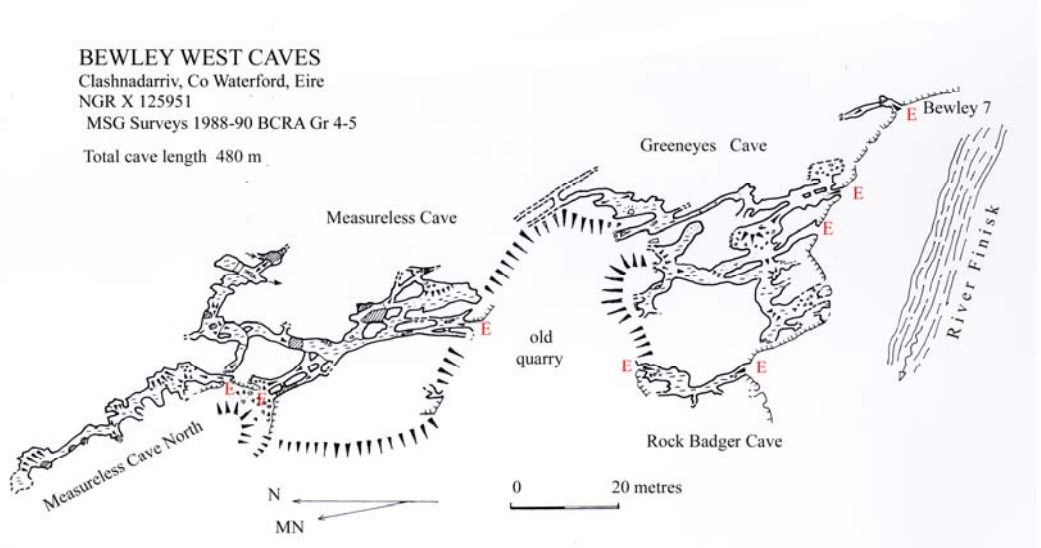
Outline Site Description
Bewley Caves comprise several small caves in low limestone cliffs, alongside the Finisk River.

Geological System/Age and Primary Rock Type
The caves are probably early Holocene (post-glacial) but may have begun forming during the Quaternary: however the caves are undated. The rock in which they have formed is Carboniferous Limestone.

Main Geological or Geomorphological Interest
A series of modest caves with a total passage length of 480m have been surveyed in low limestone cliffs adjacent to the Finisk River. Some have been broken into by quarrying activity, giving a window into the karstic development of caves in the Dungarvan syncline. Most cave development has taken place in the more distant past and only minor fragments of passage intersect present day water table. The caves are essentially inactive remnants of groundwater solution over the last 10,000 years.

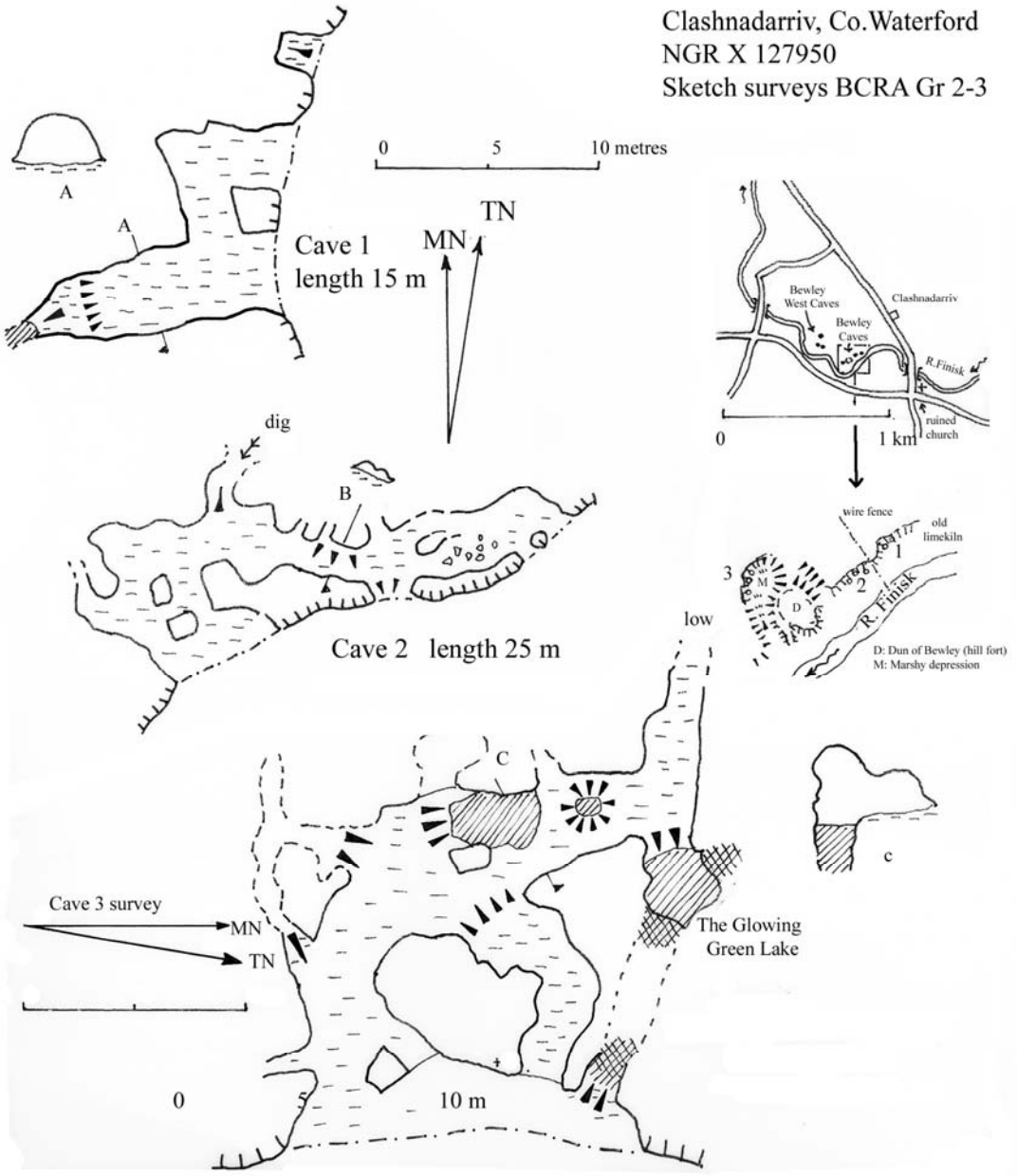
Site Importance
Individually the caves are all small and not of major significance but, as a complex, they are worthy of County Geological Site status. It is also part of Blackwater River (Cork/Waterford) SAC002170.

Management/promotion issues
These caves are seldom visited by sport cavers and are on private farmland, with relatively low risk of disturbance, but should be protected from quarry filling, entrance blockage and ground modification.



BEWLEY CAVES

Clashnadarriv, Co.Waterford
NGR X 127950
Sketch surveys BCRA Gr 2-3



Cave 3 (The Cave of the Glowing Green Lake)
length 60 m

PFR 88

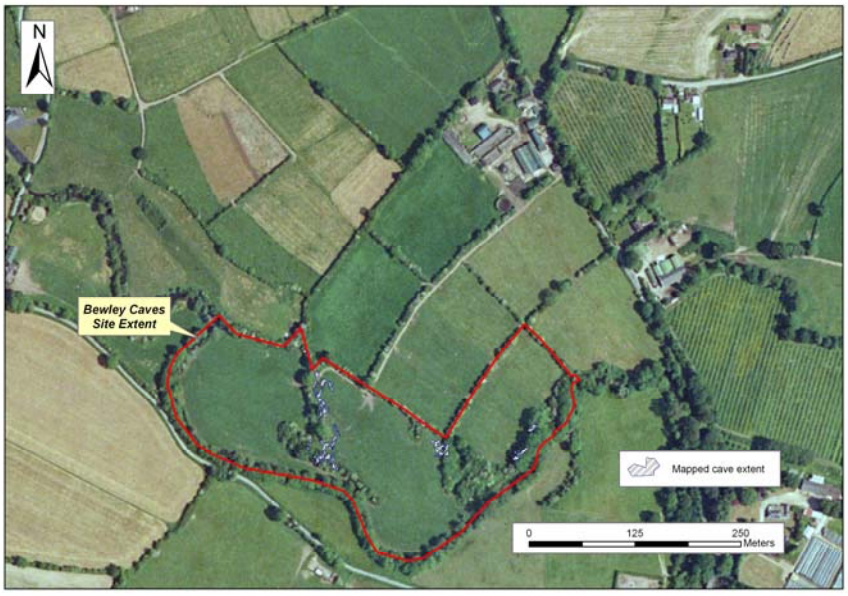
Many Bewley West cave entrances are very small. Bewley East caves are hidden in vegetation.

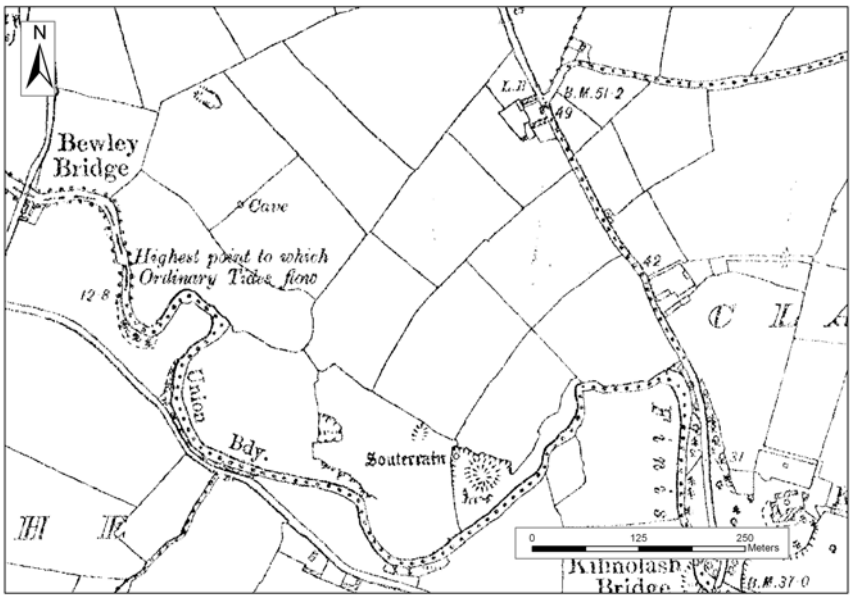
Entrances to Cave 3 (the Cave of the glowing green lake) in a wooded pit.

Bewley West old quarry with many small entrances.

Cave 3 shows phreatic karstification.


CAPPOQUIN
Ceapach Choinn
Bewley Caves


N
Bewley Caves Site Extent
Mapped cave extent
0
125
250
Meters


N
Bewley Bridge
Cave
Highest point to which Ordinary Tides flow
Union Bdy.
Souterrain
0
125
250
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Bridgequarter Cave**		
Other names used for site			
IGH THEME	**IGH1 Karst**		
TOWNLAND(S)	**Bridgequarter**		
NEAREST TOWN	**Cappoquin**		
SIX INCH MAP NUMBER	**Waterford 30**		
NATIONAL GRID REFERENCE	**216446 95666**		
1:50,000 O.S. SHEET NUMBER	82	**1/2 inch Sheet No.**	22

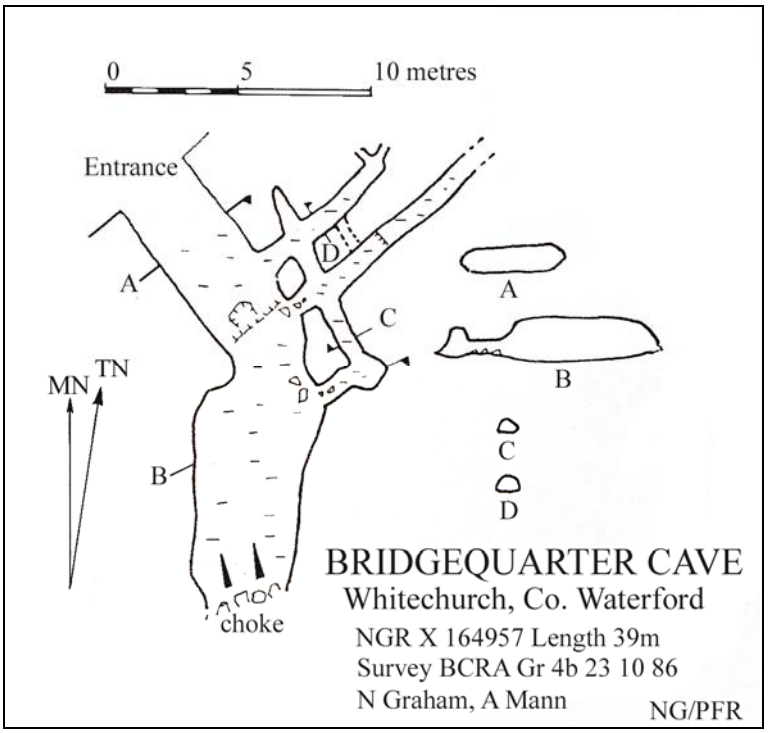
Outline Site Description
Bridgequarter cave is a small cave in a limestone ridge, with the entrance in a small rocky depression in grassland.

Geological System/Age and Primary Rock Type
This small cave is probably of Holocene (post-glacial) age, developed within Carboniferous Limestone.

Main Geological or Geomorphological Interest
This cave is a small remnant cave, developed originally on a bedding plane in a slow moving water environment. It has been developed in the style of maze caves where the flow of water is slow, expanding joints and fractures and bedding planes evenly. A second cave probably exists hidden in an adjacent pit but now blocked by a mass of dead tree cuttings.

Site Importance
This is one of the smallest and least important of Waterford's caves but is still worthy of County Geological Site status.

Management/promotion issues
The cave should be protected from infilling, waste dumping and other disturbance. It is not suitable for general promotion or access.

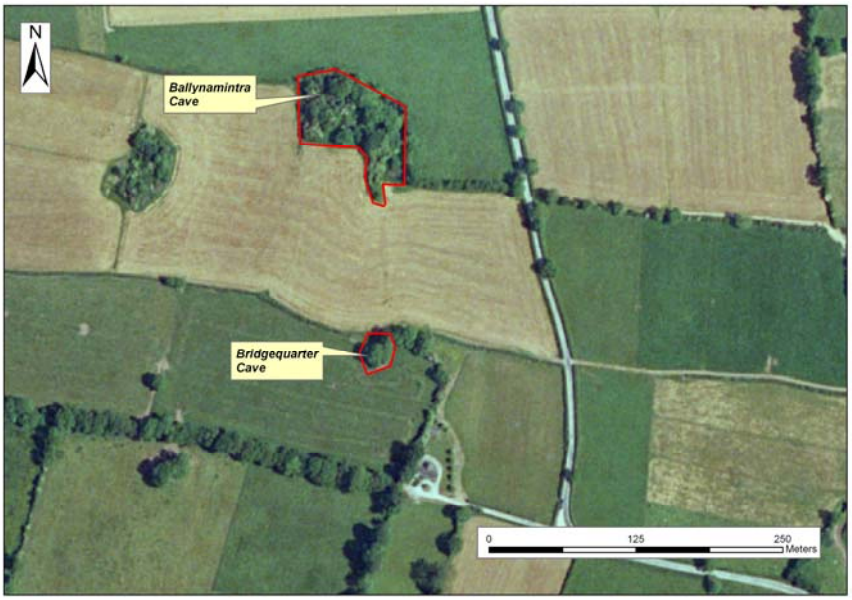


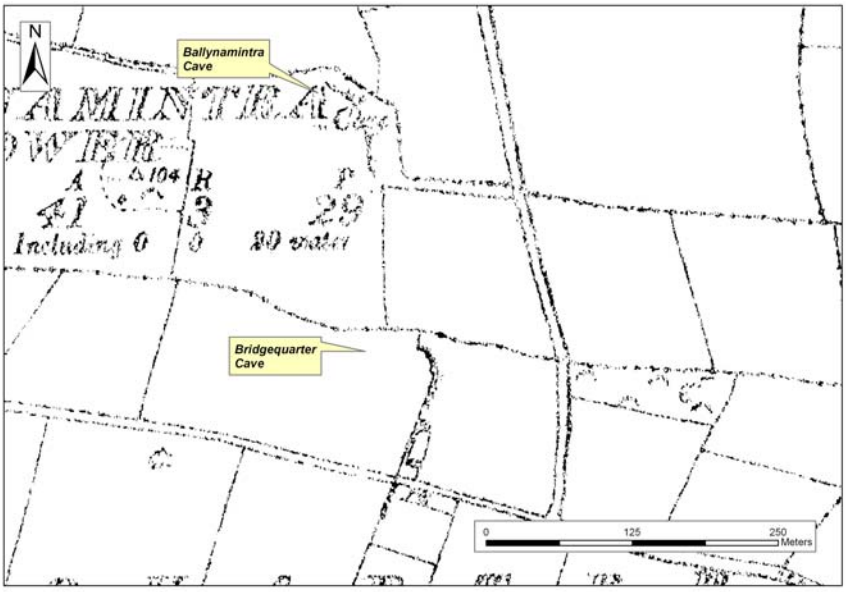
View of low entrance arch of the cave.

Bridgequarter Cave entrance is in the hollow with nettles and tree stump.

Bridgequarter cave entrance, from inside the cave.


Bridgequarter Cave
DUNGARVAN
Dún Garbhán


N
Ballynamintra Cave
Bridgequarter Cave
0
125
250
Meters


N
Ballynamintra Cave
Bridgequarter Cave
0
125
250
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Cappagh Quarry**		
Other names used for site			
IGH THEME	**IGH1 Karst; IGH8 Lower Carboniferous**		
TOWNLAND(S)	**Kilgreany**		
NEAREST TOWN	**Dungarvan**		
SIX INCH MAP NUMBER	**Waterford 30**		
NATIONAL GRID REFERENCE	**217600 94900**		
1:50,000 O.S. SHEET NUMBER	82	**1/2 inch Sheet No.**	22

Outline Site Description
A large working quarry, extracting limestone for aggregate and making concrete blocks.

Geological System/Age and Primary Rock Type
The quarry is excavated in Carboniferous Limestone of the Waulsortian Formation. There are karstic features in the quarry walls which may be of Holocene (post-glacial) age or they may have begun forming during the Quaternary Period (Ice Age).

Main Geological or Geomorphological Interest
The quarry is one of the best places to see Waulsortian rocks in County Waterford, and the rocks here are typical of the entire valley from Dungarvan Harbour eastwards to Lismore and beyond. The rocks are in the core of a geological structure called a syncline which is a downfold of the strata. Hence some of the quarry walls show vertical bedded rocks, although most of the limestone is quite massive, typical of the Waulsortian limestone.

Additional features of interest here are the extensive expressions of karstified limestone. There are solution pipes, sand filled dolines (enclosed depressions), epikarst and expanded joints with brown deposits of the mineral calcite on them. There was a minor cave in the south west corner of the quarry but it is now inaccessible due to the construction of a settling pond adjacent to the face.

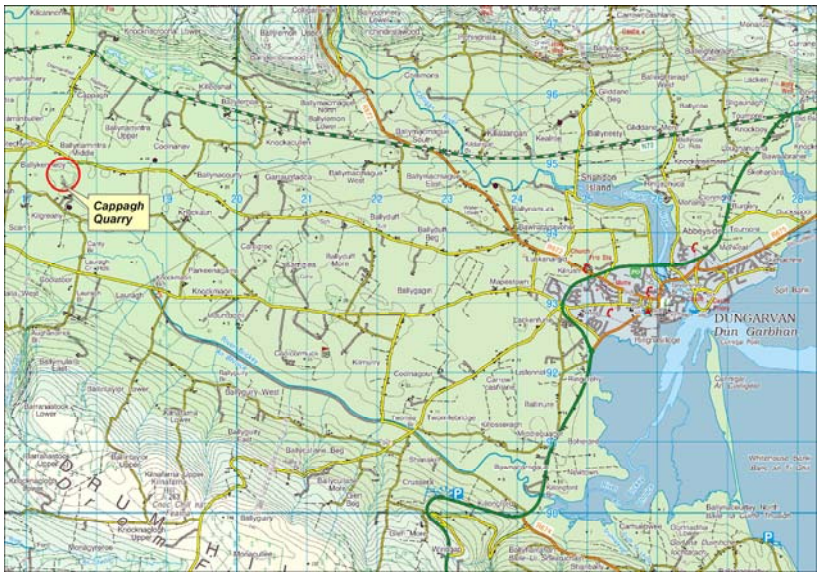
Site Importance
The quarry is worth recording as a County Geological Site since it provides a significant window into the underlying geology of the Dungarvan valley, whose rocks are largely only seen otherwise at the coast and in caves.

Management/promotion issues
As an active quarry, the CGS status has no impact or restriction on the normal permitted operation of the quarry. Unless the operators (John A. Wood) have additional land banks adjoining the existing footprint, it would appear that the quarry is close to the limits of the rock reserve, without working below the water table. There may be opportunities for active engagement with the operators to preserve some interesting quarry faces, such as the heavily karstified eastern side, depending on planned end-use or restoration plans. Further information on possibilities is explored in the GSI and Irish Concrete Federation publication of *Geological Heritage Guidelines for the Extractive Industry* by Sarah Gatley and Matthew Parkes.

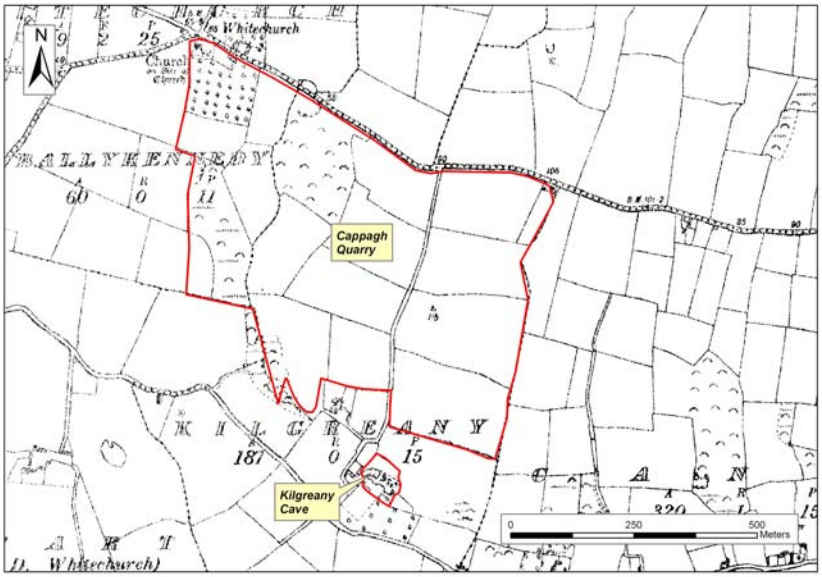
View of sand filled doline (enclosed depression) in eastern wall of Cappagh Quarry.

Near-vertical bedding in the Waulsortian limestone of western face of Cappagh Quarry.

View of karstified limestone at northern face of quarry, showing epikarst – expanded joints and fractures in top few meters of limestone bedrock.


Cappagh
Quarry
DUNGARVAN
Dun Garbhan


N
Cappagh
Quarry
Kilgreany
Cave
0
250
500
Meters


N
Cappagh
Quarry
Kilgreany
Cave
0
250
500
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Carrigmurrish Cave**		
Other names used for site			
IGH THEME	**IGH 1 Karst**		
TOWNLAND(S)	**Farrenbullen**		
NEAREST TOWN	**Dungarvan**		
SIX INCH MAP NUMBER	**Waterford 30**		
NATIONAL GRID REFERENCE	**216900 95666**		
1:50,000 O.S. SHEET NUMBER	82	**1/2 inch Sheet No.**	22

Outline Site Description
Carrigmurrish is a cave system in a densely wooded hill.

Geological System/Age and Primary Rock Type
The cave is undated and probably formed in the Quaternary or early Holocene (post-glacial) period.

Main Geological or Geomorphological Interest
The cave is Waterford's longest, with 460m of surveyed passage. It is a complex system, but is now inactive and largely a dry cave. The entrance is a deep depression on the top of a densely wooded knoll, with a wall around the hole. Large gallery passages 5-10m in width extend in most directions from the entrance depression. No known archaeological interest exists in the cave, although a rath type enclosure is reported around the hilltop. In 1988 the cavers surveying the cave found an extension of higher level passages on the northern side.

Site Importance
It is one of the most important of Waterford's relict cave systems. It is of County Geological Site importance.

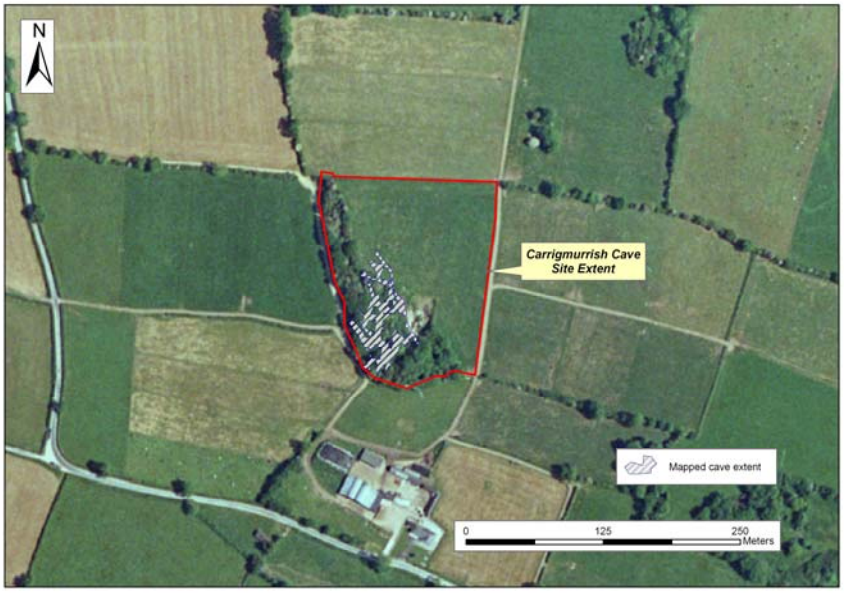
Management/promotion issues
The cave is protected by dense hazel and scrub woodland and is on private farmland. It is unsuitable for general promotion or access and is seldom visited by cavers. It provides a wildlife refuge and should be protected from disturbance or damage by any new activity.

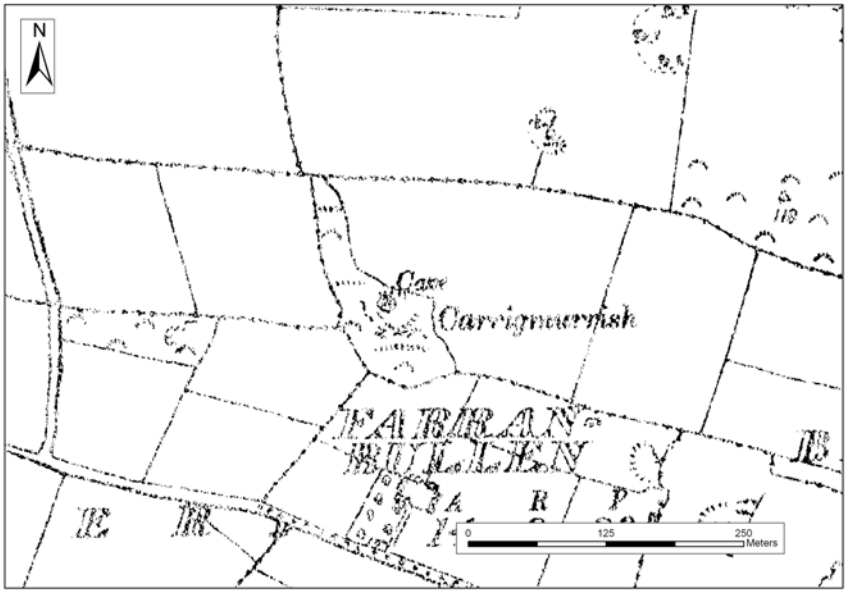
The wooded knoll in which Carrigmurrish Cave is situated.

Robbie Meehan at the top of the entrance collapse.

Matthew Parkes in one of the passages in the bottom of the entrance collapse.


Carrigmurrish Cave
DUNGARVAN
Dún Garbhán


N
Carrigmurrish Cave Site Extent
Mapped cave extent
0
125
250
Meters


N
Cave
Carrigmurrish
0
125
250
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Kilgreany Cave**		
Other names used for site			
IGH THEME	**IGH1 Karst**		
TOWNLAND(S)	**Kilgreany**		
NEAREST TOWN	**Dungarvan**		
SIX INCH MAP NUMBER	**Waterford 30**		
NATIONAL GRID REFERENCE	**217612 94376**		
1:50,000 O.S. SHEET NUMBER	82	**1/2 inch Sheet No.**	22

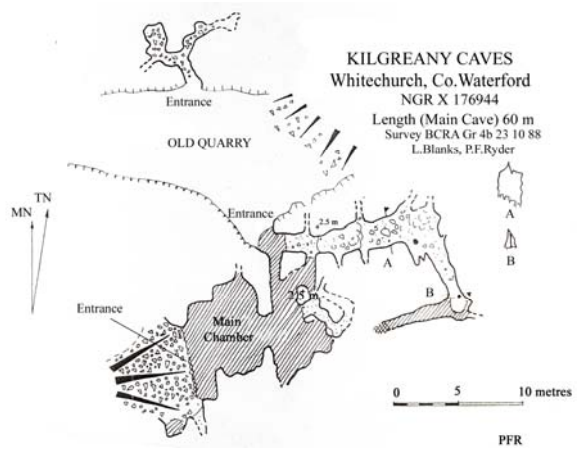
Outline Site Description
A relict (inactive) cave intersected by a disused quarry.

Geological System/Age and Primary Rock Type
The cave is formed within Carboniferous limestone rock. It probably began forming in an interglacial period during the Quaternary (i.e. during the last 1.6 million years) and may have continued forming during the early part of the Holocene (post-glacial) period.

Main Geological or Geomorphological Interest
Kilgreany Cave probably has more archaeological significance than geological but is worth including as a County Geological Site for its geological importance as one of the better known of the Dungarvan karst relict caves. The bottom of the main chamber clearly intersects the water table at wetter periods but this may have been dry before excavations in 1928 and 1934. Human remains were found associated with animal bones from the Ice Age, generating considerable excitement about their co-existence, until it was realized that fluctuations in the cave water table had disturbed the stratification and mixed different age deposits together. A second small cave of 10m length is included in the site. It is found on the opposite side of the old quarry, which has the northern entrances of today to Kilgreany Cave itself.

Site Importance
The site is of County Geological Site importance.

Management/promotion issues
The cave is well hidden away in a wooded old quarry beside a farmyard and is not under any obvious threat. The actively working modern quarry of John A. Wood (Cappagh Quarry) is relatively close although some 20-30m of field separates the quarry berm from Kilgreany Cave. If the present landowners sold land for quarrying it could threaten the site, although obviously subject to planning permission and other constraints. Whilst of some general interest, this cave location on private farmland is not suitable for general promotion by the Heritage Officer, and potential safety issues compound against raising awareness of it.



Kilgreany Cave is in an old quarry within the wood.

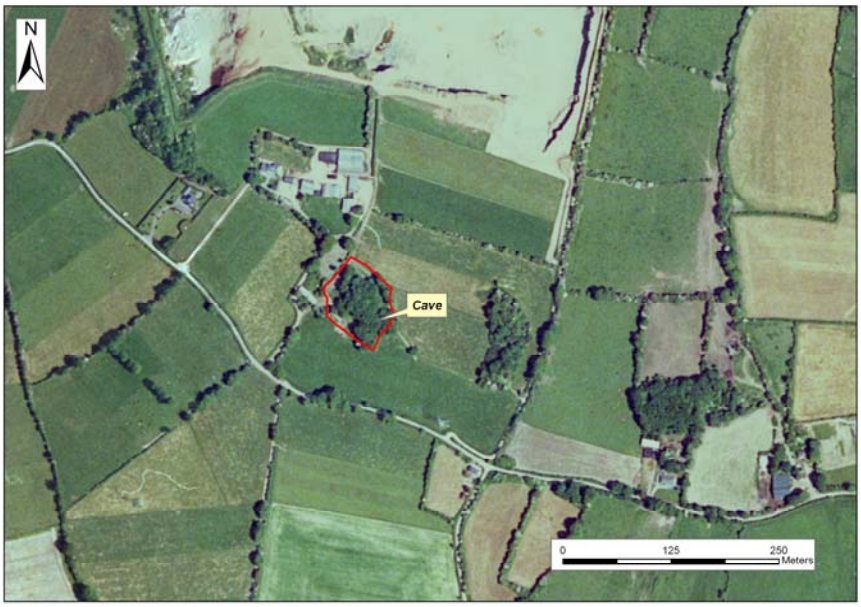
Some calcite deposits called “cave pearls”.

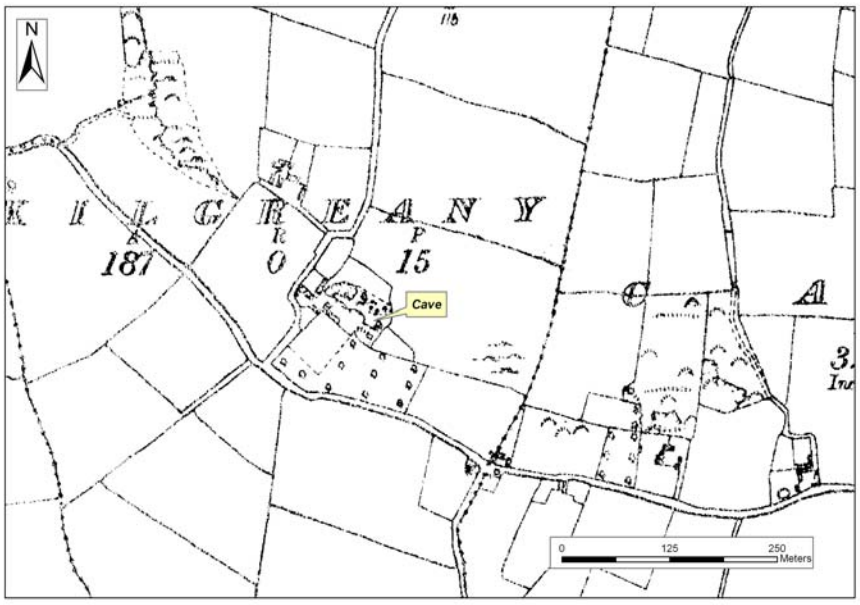
Kilgreany Cave: the old quarry in the wood.

Kilgreany Cave: a calcite column.

Kilgreany Cave: main entrance slope.


Kilgreany Cave
DUNGARVAN
Dún Garbhán


N
Cave
0
125
250
Meters


N
K I L G R E A N Y
181
O
15
Cave
0
125
250
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Knockalahara Sink**		
Other names used for site			
IGH THEME	**IGH1 Karst**		
TOWNLAND(S)	**Knockalahara**		
NEAREST TOWN	**Dungarvan**		
SIX INCH MAP NUMBER	**Waterford 30**		
NATIONAL GRID REFERENCE	**214724 95842**		
1:50,000 O.S. SHEET NUMBER	82	**1/2 inch Sheet No.**	22

Outline Site Description
At Knockalahara, a small stream sinks into a wooded enclosed depression with a sometimes active cave passage continuing underground.

Geological System/Age and Primary Rock Type
The cave is probably of Holocene (post-glacial) age, developed in Carboniferous Limestone.

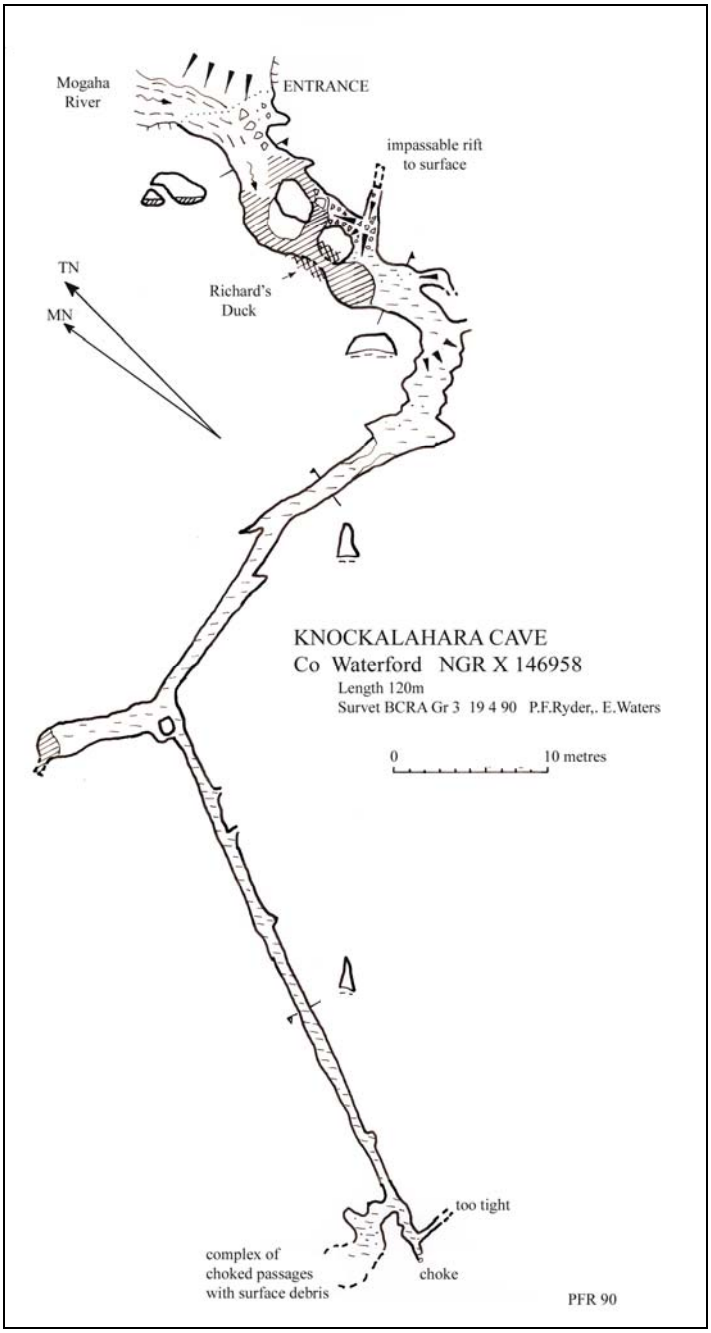
Main Geological or Geomorphological Interest
This is one of very few active caves in Waterford, where flowing water is still developing the feature. It is unclear from the exploration reports and from the site visit how active the cave is, and it may only be active with heavy stream flow in winter or after heavy rainfall episodes.

The feeder stream is unusual in that it appears to be a distributary branch off the Maghaha River. It leaves the river only a few hundred metres before it joins the larger Finisk River, and may only flow in winter or in times of flood flow. It flows only a few hundred metres in length before it sinks at Knockalahara. Local reports suggest the flow is not regular, and during a summer visit in 2011 there was no flow, only damp ground in the channel. However, local reports also suggest sluggera development on the route of the cave flow and occasional flooding in the low lying fields adjacent to the sink at Knockalahara. Unconfirmed suggestions of dye tracing indicate flow from the sink to the Finisk River, which is entirely plausible.

The cave passage entered during low water conditions in 1990 consists of 120m of narrow linear passage ending in a choked area that may have corresponded to a surface collapse or sluggera at the time. Sluggera collapses have occurred in recent memory in the field under which the cave passage lies, but they have apparently been filled in by the farmer/landowner, as no trace is now seen in the arable field.

Site Importance
The site is important as a County Geological Site representing the rare occurrence of active cave development and a stream sinking into a cave, not seen in almost all other Waterford caves. It is also part of the Blackwater River (Cork/Waterford) SAC 002170.

Management/promotion issues
The site is unsuitable for general access or promotion lying in private farmland and difficult to access safely. Any intervention such as drainage works or channelisation for example, in the Finisk River, in the vicinity of the distributary branch, may interfere with the input of water to Knockalahara and should be carefully considered before any works are undertaken.

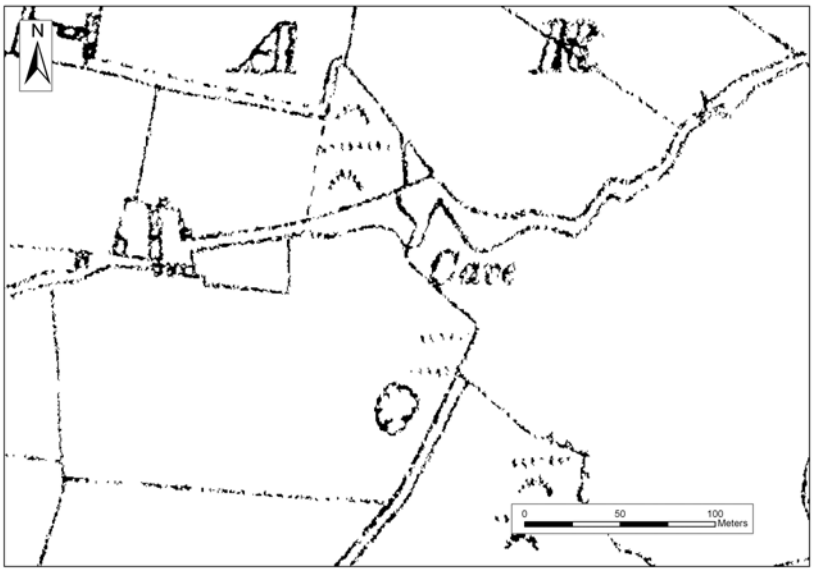


Knockalahara Sink.

The low arch of Knockalahara Sink.


CAPPOQUIN
Ceapach Choinn
Knockalahara Sink


N
Knockalahara Sink
Site Extent
Mapped cave extent
0
50
100
Meters


N
Cave
0
50
100
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Oonagaloor and Brothers Cave**
Other names used for site	
IGH THEME	**IGH1 Karst**
TOWNLAND(S)	**Bridgequarter and Ballygambon Lower**
NEAREST TOWN	**Dungarvan**
SIX INCH MAP NUMBER	**Waterford 30**
NATIONAL GRID REFERENCE	**215636 95321 Oonagaloor**
	215614 95281 Brothers Cave wood entrance
	215576 95258 Brothers Cave quarry entrance
1:50,000 O.S. SHEET NUMBER	82 **1/2 inch Sheet No.** 22

Outline Site Description
Two almost interlinked cave systems in lowland farmland, accessed through old quarries.

Geological System/Age and Primary Rock Type
The caves may have been formed in the Quaternary period or in the early Holocene (post-glacial) period, and are formed in Carboniferous Limestone.

Main Geological or Geomorphological Interest
Cave surveys show these two systems are almost joined with only 5m of separation by passages too small for cavers to access. The length of Oonagaloor is 350m and Brothers is 225m making them amongst the largest of Waterford's caves. Excavations yielding animal and human remains and artefacts from 1906 make these caves important archaeological sites, in addition to their geological interest.

Oonagaloor has been surveyed to a very high standard for fear that the large unstable chamber at the furthest distances from the entrance (named Sheol by the surveyors) could cave in as it was thought to be underneath the roadway into the Whitechurch House, or possibly even under the house itself. To the relief of the new owners of Whitechurch House, who were letting holiday apartments, the cave does not underlie either the road or the house. The cavern is still only 4m below the surface of the adjacent grassland.

Site Importance
These combined are one of the most important cave sites from the known Waterford relict caves. In 2002 the original 1906 detailed excavation records of Brothers Cave were relocated after being lost. These add to the significance of the caves with potential for more finds remaining in unexcavated areas. Chance finds of animal bones, some showing butchery marks, during cave surveying, indicates significant potential in undisturbed parts of Oonagaloor for scientific records of great value. The caves are of County Geological Site importance.

Management/promotion issues
The caves are on private farmland and are unsuited to general access or promotion and should remain the province of scientific cavers and cave archaeologists, but should be protected from disturbance or damage.

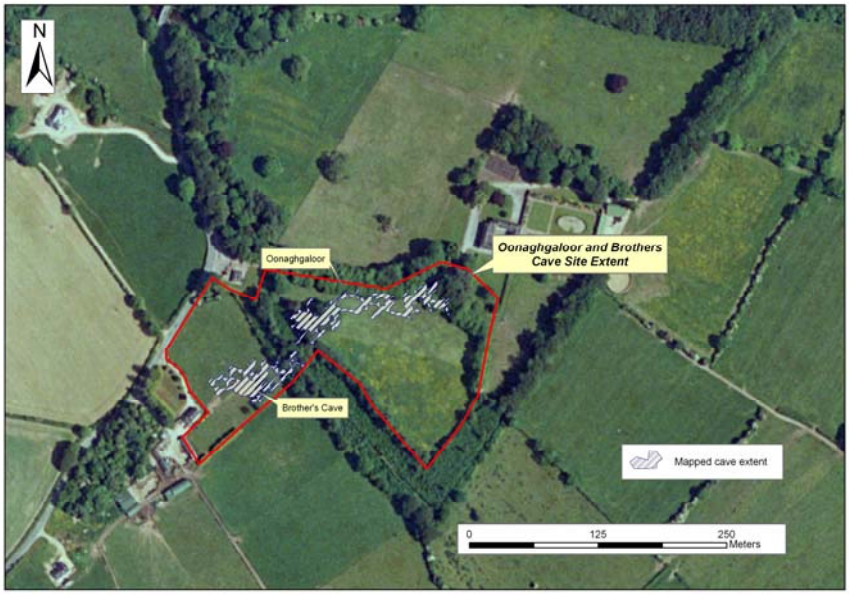
Brothers Cave quarry entrance.

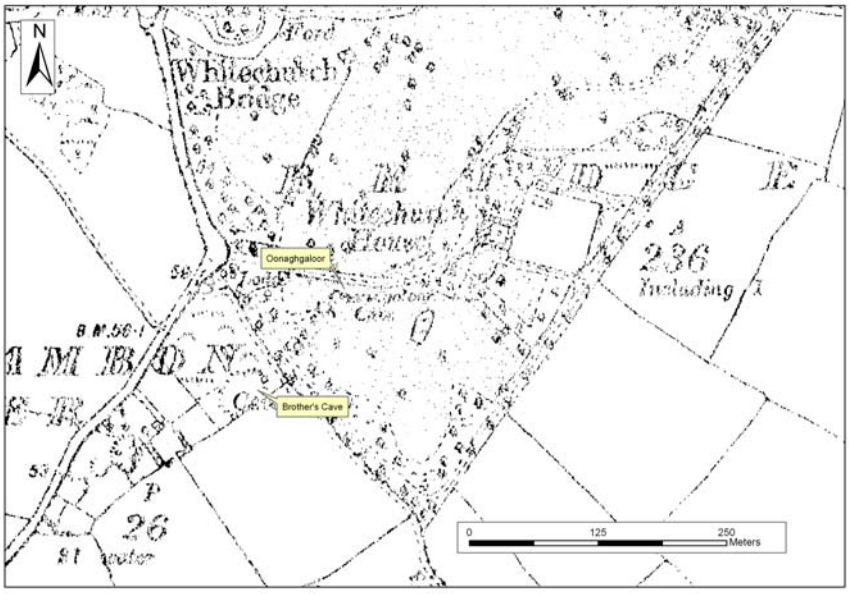
Brothers Cave wood entrance.

Brothers Cave wood entrance.

Pack walls left by archaeologists in Brothers Cave.


Oonaghgaloor and Brothers Cave
DUNGARVAN
Dún Garbhán


N
Oonaghgaloor
Oonaghgaloor and Brothers Cave Site Extent
Brother's Cave
Mapped cave extent
0
125
250
Meters


N
Oonaghgaloor
Brother's Cave
0
125
250
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Shandon Railway Cutting Cave**		
Other names used for site			
IGH THEME	**IGH1 Karst**		
TOWNLAND(S)	**Ballynamuck East**		
NEAREST TOWN	**Dungarvan**		
SIX INCH MAP NUMBER	**Waterford 31**		
NATIONAL GRID REFERENCE	**225017 94328**		
1:50,000 O.S. SHEET NUMBER	82	**1/2 inch Sheet No.**	22

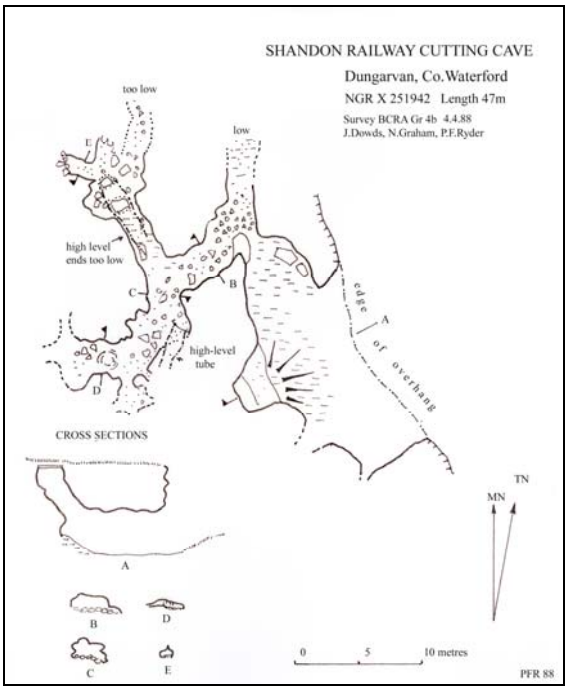
Outline Site Description
A cave system truncated by a railway cutting, cut into a man-made cliff in a pasture field.

Geological System/Age and Primary Rock Type
The cave is probably a Holocene (post-glacial) cave developed in Carboniferous Limestone, but it is undated.

Main Geological or Geomorphological Interest
A modest cave is apparent in a cliff of limestone rock, at Shandon Railway Cutting Cave, which was once the Dungarvan to Lismore railway line. The cave is largely an overhang where the cutting bisected a cave passage of reasonable dimensions. Lower level passages extend from the northwestern end of the overhang cave, with a total length of 47m. An aven at the back of the main overhang originally extended to the surface but has been closed over with timbers by a landowner.

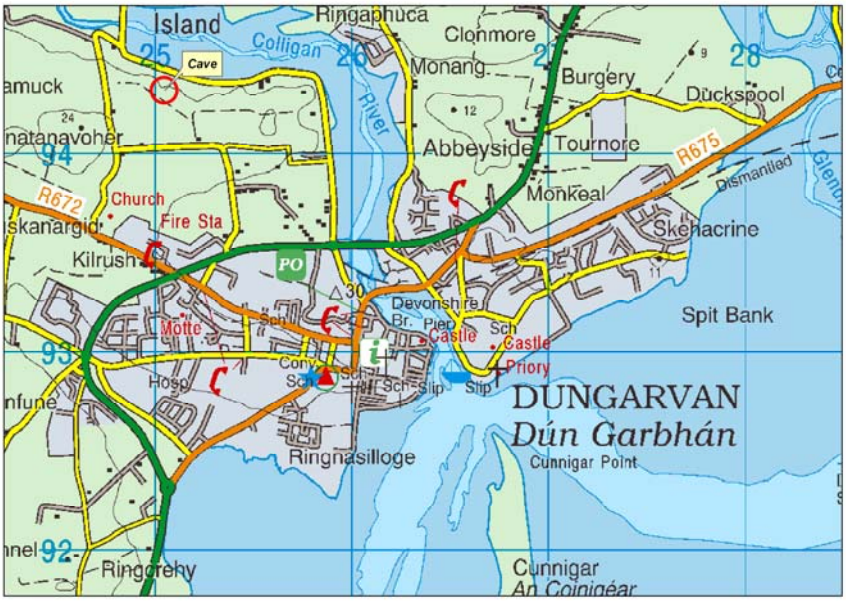
Site Importance
Although interesting, this is one of the lower importance cave sites in Waterford, but is the best remaining of the recorded caves in the important Shandon area and worthy of County Geological Site status for that reason alone.

Management/promotion issues
The cave is on private farmland and of no great extent. It does not suit general promotion or access.

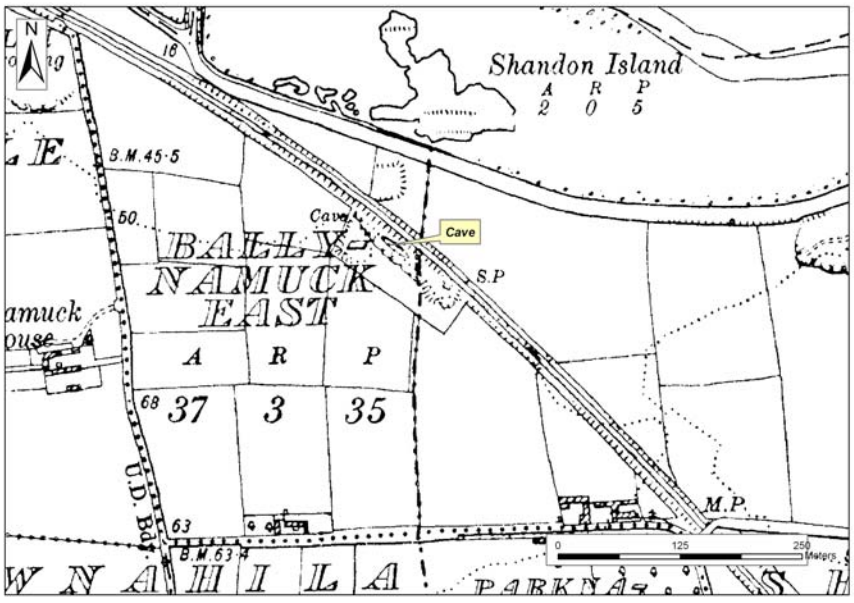


Shandon Railway Cutting Cave, viewed from the southeast.

Calcite flowstone on wall of cave exposed in back of the cave overhang.


Island
Cave
Colligan
River
Ringaphuca
Clonmore
Monang.
Burgery
Ducksspool
Abbeyside
Tournore
R675
Dismantled
Monkeal
Skehacrine
R672
Church
Fire Sta
Kilrush
PO
Devonshire
Br.
Pier
Castle
Sch
Castle
Priory
Spit Bank
Motte
Hosp
Slip
Slip
DUNGARVAN
Dún Garbhán
Cunnigar Point
Ringnasilloge
Ringrohy
Cunnigar
An Coinigéar


N
Cave
0
125
250
500
Meters


N
Shandon Island
A R P
2 0 5
B.M.45·5
Cave
Cave
BALLY-
NAMUCK
EAST
S.P
A R P
37 3 35
M.P
B.M.63
0
125
250
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Sluggera Crossroads**		
Other names used for site	Sluggera sink		
IGH THEME	**IGH1 Karst**		
TOWNLAND(S)	**Monea**		
NEAREST TOWN	**Ardmore**		
SIX INCH MAP NUMBER	**Waterford 38 and 40**		
NATIONAL GRID REFERENCE	**217655 78192**		
1:50,000 O.S. SHEET NUMBER	82	**1/2 inch Sheet No.**	22

Outline Site Description
The Sluggera Crossroads site comprises a small crag of karstified bedrock outcrop and a sinking stream disappearing into the rock face.

Geological System/Age and Primary Rock Type
The feature is a karstic sink formed within Waulsortian limestones. These limestones are often quite massive but do possess well developed enlarged fractures where karstification does occur. The limestone valley between Ardmore and Whiting Bay has few bedrock outcrops. The fact that the sink is present shows that the karst network deep under the valley surface is relatively well developed.

The stream, which sinks into the rock at Sluggera, rises several hundred metres to the south of the feature, and itself emerges from a karstic spring. The area therefore provides a window into an otherwise-underground subsurface drainage network.

Main Geological or Geomorphological Interest
Karstification is an important process in Irish hydrogeology. It involves the enlargement of rock fissures when groundwater dissolves the fissure walls as it flows through them. It usually occurs in 'cleaner', relatively pure limestones.

The sink at Sluggera Crossroads is one of only a handful in Waterford. The Irish word 'Sluggera' means 'sink', and as the crossroads is so named this makes the feature important in a local folklore sense also.

Site Importance
This is a site with good teaching potential on karst and the presence of underground drainage in some of the limestone lowlands in Ireland. It is of County Geological Site importance.

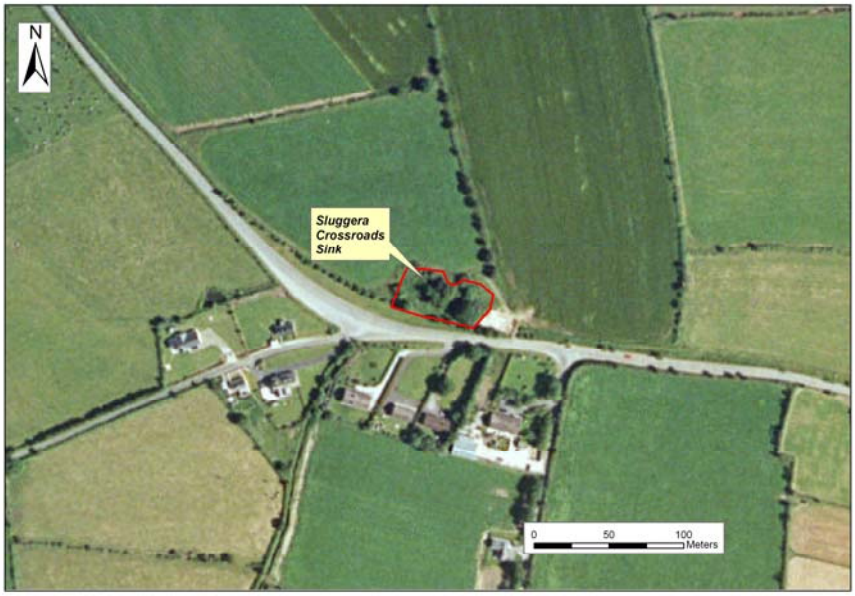
Management/promotion issues
The sink itself lies beside a wide verge at the roadside, making parking and inspection of the feature relatively easy. The crag itself is protected by relatively dense vegetation, however. A signboard at that road verge with the folklore and geological importance of the feature detailed might enhance the site as a local landscape feature that might be visited on a trip to Ardmore.

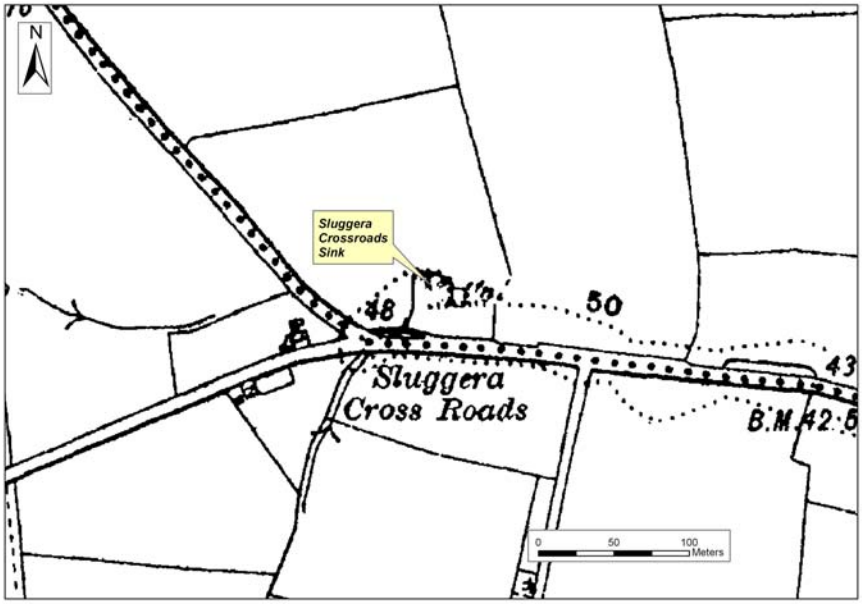
The sluggera at Ardmore Crossroads, from the southwest, behind the roadsigns.

The nettle strewn interior of the sluggera obscures the small sinking stream.

The stream sinking against the rock face at the north side of the sluggera, is only a trickle in summer, but much more substantial in winter.


R673
Monea
Sluggera
Crossroads
Sluggera
Cr. Rds.
Duffcarrick
Ardmore
Aird Mhóre
PO
Fire
Stn.
Pier
Farrangarret
Church
Church and
Round Tower
Monea
Dysert


N
Sluggera
Crossroads
Sink
0
50
100
Meters


N
Sluggera
Crossroads
Sink
48
50
43
Sluggera
Cross Roads
B.M 42.6
0
50
100
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Quillia**		
Other names used for site			
IGH THEME	**IGH2 Precambrian to Devonian Palaeontology**		
TOWNLAND(S)	**Quillia**		
NEAREST TOWN	**Tramore**		
SIX INCH MAP NUMBER	**Waterford 26**		
NATIONAL GRID REFERENCE	**261200 103600**		
1:50,000 O.S. SHEET NUMBER	76	**1/2 inch Sheet No.**	23

Outline Site Description
The site comprises farm fields and tracks, including the main metalled access road.

Geological System/Age and Primary Rock Type
Ordovician calcareous sandstones of the Tramore Limestone Formation.

Main Geological or Geomorphological Interest
A rich and diverse fossil fauna of Ordovician age, from around 460 million years ago, has been found at this locality. The rock is a sandy limestone with many fossils in thin bands, which were originally shell banks, in contrast to the fossiliferous environments represented by the same age rocks at Tramore and southwards along the coast. It is also important as the type locality of a trilobite species, first identified and described from here in 1895. In most cases, the original shell material has dissolved and the fossils are preserved as very finely detailed moulds in a rusty iron coloured fine sandstone or siltstone.

Site Importance
The site is of County Geological Site importance but has already been identified to National Parks and Wildlife Service as one which should be designated as a Natural Heritage Area.

Management/promotion issues
Historical collections of fossils from here are found in museum collections, but there is presently very little exposure of rock at all. However, the bedrock is just below the surface, and the locality of the farm track itself was once a good source of fossils, although there is now a tarmac surface. The landowner is amenable to informing the Natural History Museum if he intends to make any new excavations, and thus provide a new opportunity for collecting material from here.

The Quillia site, viewed from northwestern side.

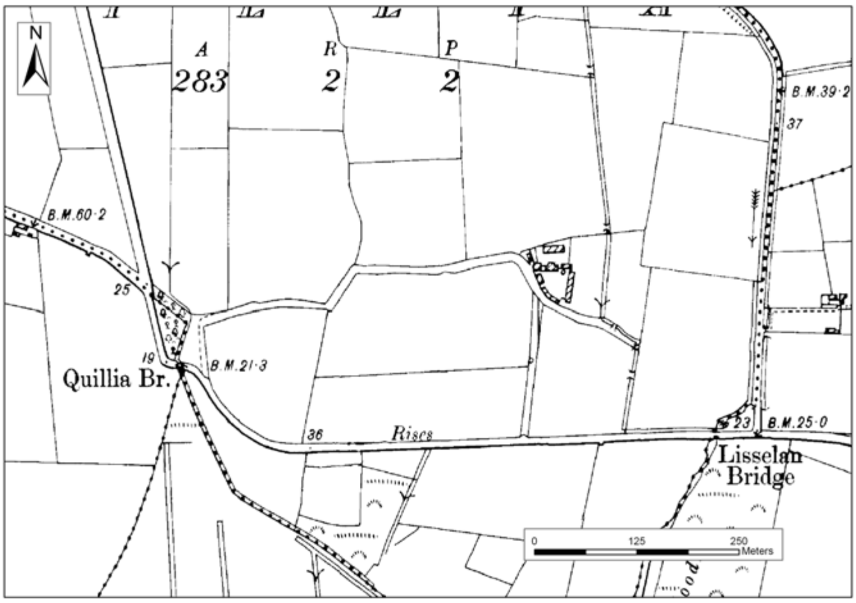
Area with rock just below surface.

The main farm track entrance, which once yielded many fossils.

The grassland at Quillia has no real exposure present, but rock is close to the surface.

Castle
Cullencastle
Ballydrislane
Standing Stone
Pickardstown
Quillia
Kilbride
South
Drumcannon
Glenroad Br.
Quillia Site
Lisselan Br
Morivoy
Glen Road
Ballinattin
Lisselan
Lisselan Intake
Race Course
Monloum
Crobally
Knockanduff
Back Strand
An Chúltrá
Ballycarnane
TRAMORE
Trá Mhór
Coolnagoppoge
Boat Slip
Lifeguard Station
Tramore Strand
Lady Doneraile's Cove
Cuan na Faille
Lifeboat
The Cove
An Cuan
Pier
Lady Elizabeth's Cove
Gleann an Chuain
Tramore Bay
Cuan
Tramore Burrow
An Dumhach
R675
R682
R685

N
Quillia Site Extent
0
125
250
Meters



N
A
283
R
2
P
2
B.M.39·2
37
B.M.60·2
25
19
Quillia Br.
B.M.21·3
36
Rises
23
B.M.25·0
Lisselan Bridge
0
125
250
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Raheen Shore**		
Other names used for site	Newtown Head		
IGH THEME	**IGH 2 Precambrian to Devonian Palaeontology, IGH 4 Cambrian to Silurian**		
TOWNLAND(S)	**Raheen**		
NEAREST TOWN	**Passage East**		
SIX INCH MAP NUMBER	**Waterford 18**		
NATIONAL GRID REFERENCE	**269995, 107310**		
1:50,000 O.S. SHEET NUMBER	76	**1/2 inch Sheet No.**	23

Outline Site Description
Coastal rock exposures, mainly on the foreshore.

Geological System/Age and Primary Rock Type
The site has Upper Ordovician (Caradoc) volcanic rocks about 460 million years old. There are fossils within the sedimentary rocks, with lots of volcanic ash.

Main Geological or Geomorphological Interest
The volcanic ashes include a diverse range of small fossil brachiopod shells, typically centimeter or less, and trilobite fossils and some other species. This characteristic small shell size and the assemblage of fossils indicate they lived in fairly deep water, around the flanks of a volcano. The site is the place that several trilobite species were originally first described from – it is the type locality for those species and also for a cystoid – a type of echinoderm. Despite the fossil collections from here, the precise age of the rocks at Raheen compared with those further west, at Tramore and beyond, is the subject of debate amongst geologists and so the site has much research potential.

Site Importance
The site has already been proposed to National Parks and Wildlife Service for designation as a geological Natural Heritage Area, although it is included within the existing proposed NHA 787. It is also a part of the River Barrow and River Nore SAC 002161. County Geological Site status will help protect it until it is formally put forward for designation as a geological NHA.

Management/promotion issues
The site is accessible through public beach access, but the fossiliferous rocks are largely in the intertidal zone, and covered with barnacles and seaweed or by shifting sands. With the very small size of fossils, collecting fossils is not an easy task and so the site is not particularly suitable for public promotion of the geological interest. The access to the main volcanic rocks of Newtown Head is possible from the beach at the southern end or a path at the northern end, but is controlled by the tides in the River Suir. The site is continuous with the Newtown site, but is reported on separately.

A type fossil trilobite from Raheen Shore

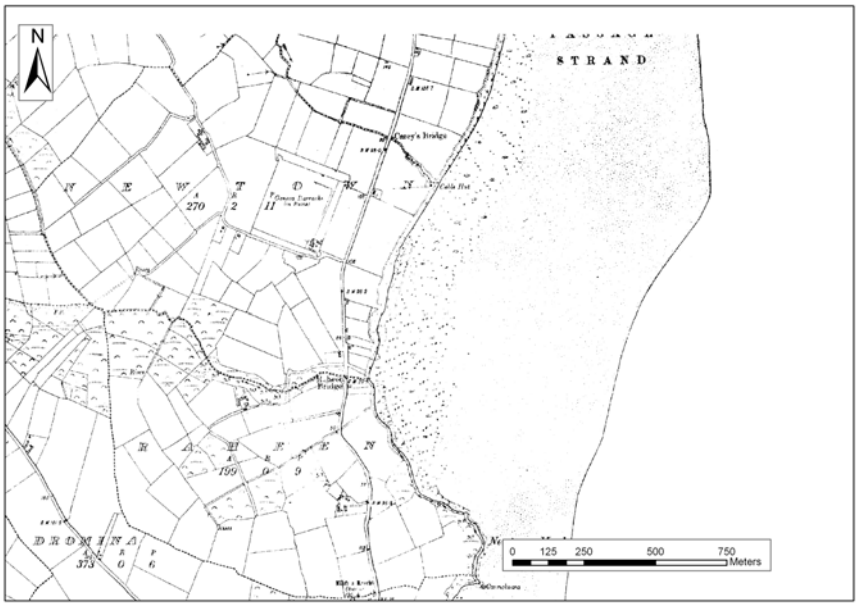
Raheen Shore access path.

A view of site from Newtown cliffs to the north.

The fossiliferous rocks are in the foreshore zone over a lateral distance of several hundred metres.


WATERFORD
Port Láirge
RIVER SUIR
BALLYHACK
Raheen Shore


N
Access point
Raheen Shore
Site Extent
0 125 250 500 750
Meters


N
STRAND
0 125 250 500 750
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Tramore**		
Other names used for site			
IGH THEME	**IGH2 Precambrian to Devonian Palaeontology**		
TOWNLAND(S)	**Westtown, Newtown, Tramore**		
NEAREST TOWN	**Tramore**		
SIX INCH MAP NUMBER	**Waterford 26**		
NATIONAL GRID REFERENCE	**258217 101050**		
1:50,000 O.S. SHEET NUMBER	76	**1/2 inch Sheet No.**	23

Outline Site Description
Rocky sea cliffs and a wooded glen, which is slightly inland from a beach.

Geological System/Age and Primary Rock Type
The rocks in this site are all part of the Tramore Limestone Formation of middle Ordovician age, from around 470 million years ago.

Main Geological or Geomorphological Interest
The rocky coast south of Tramore strand has long been known for highly fossiliferous rocks, classed as part of the Tramore Limestone Formation. It has yielded a rich diversity of marine animals from a mid-Ordovician shelf sea environment. These are mainly trilobites (extinct arthropods) and brachiopod shells, and also a characteristic common dome-shaped bryozoan colony, all of which date from around 470 million years ago. In addition, black slates at Lady Elizabeth's Cove contain numerous graptolites (an extinct planktonic animal).

The mix of useful animal groups makes this an important site for biostratigraphical correlation within the Ordovician Period, both in Ireland and internationally. It is even more important because the animal species present at Tramore were biogeographically differentiated into different faunal provinces in older rocks, and the site will be very important in understanding the breakdown of the faunal provinciality within the Iapetus Ocean that once separated northwest Ireland from southeast Ireland. Tramore appears to have been a key site for the early migration of North American species into the Anglo-Welsh (and Irish) area.

The cliffs at the Tramore beach also have an interesting section of two different Quaternary (Ice Age) tills. A consolidated, lower till was deposited at the base of the ice sheet, while the overlying, less stiff till was "let down" from within and on top of the ice.

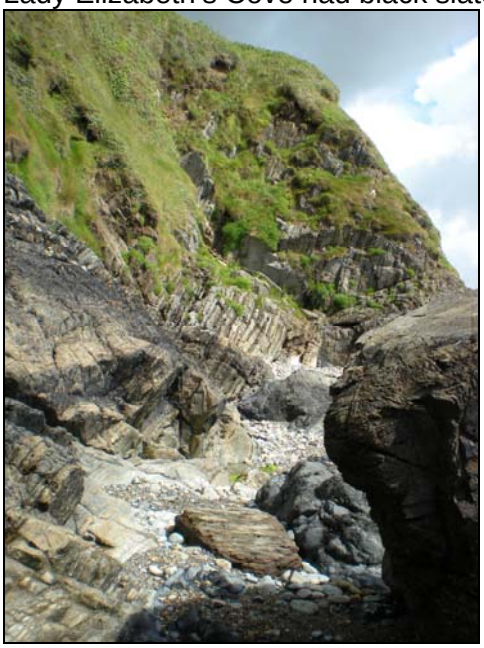
Site Importance
This is a nationally important site which has been proposed for Natural Heritage Area (NHA) designation by the National Parks and Wildlife Service, but which needs immediate protection and recognition as a County Geological Site.

Management/promotion issues
The site is nearly all foreshore and coastal cliffs which are not at great risk, but which can be damaged by developments. For example, construction of a new coastguard station in Lady Elizabeth's Cove has obscured a section which had previously yielded graptolite fossils. Coastal protection works against erosion have the potential to cover key sections, or prevent the sea from removing fallen debris and therefore allow geological sections to degrade for their scientific interest.

Two tills are visible in the cliff at the end of the beach. Rock armour is imported.

The rocks are visible along most of the shoreline south of the beach but low tide is needed.

Lady Elizabeth's Cove had black slates with graptolite fossils, but they are not now seen.

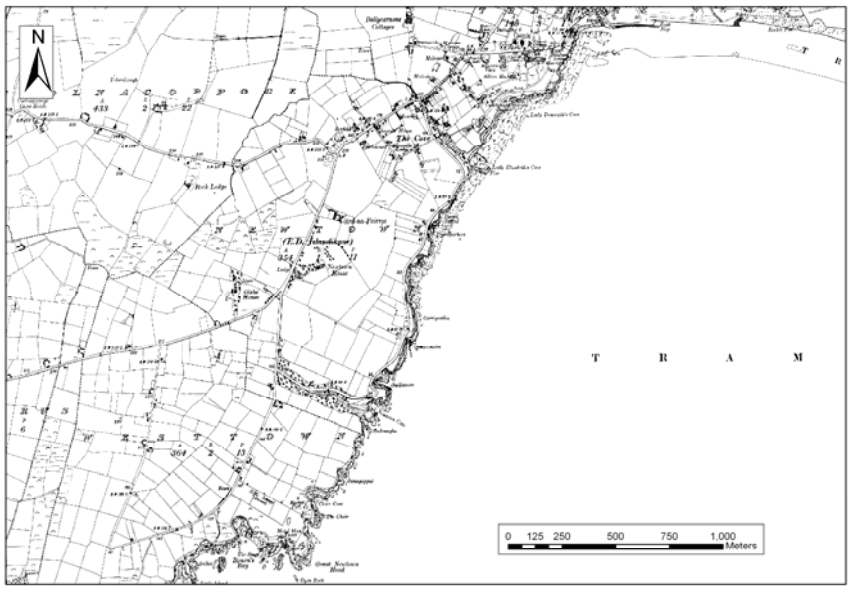


Tramore Limestone Formation.

Calcareous bryozoans fossils dissolve out in bedding planes.


TRAMORE
Trá Mhór
Ballycarnane
Coolnagoppoge
R675
The Cove
An Cuan
Pier
Boat
Slip
Lifeguard
Station
Lady Donerailes Cove
Cuan na Failte
Lady Elizabeth's Cove
Gleann an Chuain
Tramore Bay
Cuan
Thrá Mhór
Tramore
Coastal
Section
Newtown
Newtown Cove
Garrarus
Cross Rds
Crossaire
Gharbhrois
Westtown
Garrarus
Metal Man Tower
An Fear Miotail
Great Newtown Head
Promontory
Fort


N
Tramore Site Extent
Newtown Glen
0 125 250 500 750 1,000
Meters


N
T R A M
0 125 250 500 750 1,000
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Copper Coast (OVERVIEW)**
Other names used for site	
IGH THEME	**IGH4 Cambrian – Silurian, IGH6 Mineralogy, IGH13 Coastal Geomorphology and other themes**
TOWNLAND(S)	**Many**
NEAREST TOWN	**Tramore and Stradbally**
SIX INCH MAP NUMBER	**Waterford 24, 25, 26, 32**
NATIONAL GRID REFERENCE	**East: 258217 101050 West: 236975 96922**
1:50,000 O.S. SHEET NUMBER	76, 82 **1/2 inch Sheet No.** 22, 23

Outline Site Description
A very long section of coastal cliffs from near Tramore in the east to beyond Stradbally Cove in the west.

Geological System/Age and Primary Rock Type
The Copper Coast includes a complete package of Ordovician volcanic rocks and associated sedimentary rocks, which erupted over approximately a 20 million year period, about 475 to 455 million years ago. The rocks include andesites, rhyolites, slates, mudstones, fossiliferous limestones and others. There are also downfaulted blocks of Devonian age sandstones and conglomerates.

Main Geological or Geomorphological Interest
The entire coast is a complex mix of geologically interesting rock sequences, structures and features. There is great geodiversity, including active and dynamic coastal geomorphological features. The rocks were principally the result of two volcanic centres – the slightly older Bunmahon volcano and the slightly younger Kilfarrasy volcano, both of which are informally named. There are also large areas of sedimentary rocks along the Copper Coast, which were deposited in the ocean around the volcanoes, but they are now much less well exposed inland than the volcanic rocks. Hence the coastal sections give a much more detailed picture of the regional geology for geologists to interpret.

The Copper Coast is so named because of the historical mining of copper, mostly in the 19th century, which has left a widespread impression along the coast but especially around Bunmahon, Knockmahon, Stage Cove and Tankardstown. This includes cliff top shafts, cliff face adits, dressing floors, mine buildings, a tramway and the iconic engine house and chimney at Tankardstown. The entire coast provides evidence which can be read by a geologist, but the following site reports are brief focused descriptions of some of the highlights of the area and by default these are the more accessible parts of the coast. Other sites and sections are also important, but not all the coast can be described in full.

Site Importance
The Copper Coast is a superb collection of geology and landscape features, with human interventions for mining. It is at least of national importance, and elements of it are arguably of international importance.The sites highlighted within the Copper Coast in this audit are already part of a proposed NHA (Ballyvoyle Head to Tramore No 1693).

Management/promotion issues
The Copper Coast Geopark, supported by Waterford Council Council has already installed many excellent features, facilities and interpretation in the region. Some of the earliest models of interpretative panels have begun to fade badly with UV light and should be replaced. Supply and distribution of information in as many different formats as can be managed will only further enhance the excellent situation existing in 2011.


Copper Coast
CELTIC SEA
An Mhuir Cheilteach


Knockmahon and Stage Cove
Tankardstown Mine
Garrarus Strand
Kilmurrin Cove
Dunabrattin Head
Bunmahon Head
Ballydowane Bay
Kilfarrasy Strand
Stradbally Cove
Copper Coast
Individual County Geological Sites

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Copper Coast – Garrarus Strand**		
Other names used for site			
IGH THEME	**IGH4 Cambrian – Silurian, IGH7 Quaternary**		
TOWNLAND(S)	**Islandikane East, Caher, Garrarus**		
NEAREST TOWN	**Tramore**		
SIX INCH MAP NUMBER	**Waterford 26**		
NATIONAL GRID REFERENCE	**254732 98400 [entry to beach]**		
1:50,000 O.S. SHEET NUMBER	76	**1/2 inch Sheet No.**	22

Outline Site Description
The site includes the foreshore and coastal cliffs both east and west of Garrarus Strand.

Geological System/Age and Primary Rock Type
The bedrock is all of Ordovician age, from about 460 million years ago. The soft sediments overlying bedrock were deposited by ice during the Quaternary (Ice Age).

Main Geological or Geomorphological Interest
The cliffs in this bay include a wide range of rock types and different formations with faults separating and repeating units. There are baked black shales, pale rhyolite intrusions, limestone of the Tramore Limestone Formation and many intrusions of andesite volcanic rock.

At each end of the beach large channels eroded out of the bedrock are seen in section, and are filled with glacial till.

Site Importance
The site is part of the complex of sites along the Copper Coast, which collectively are of national importance and which are already part of a proposed NHA (Ballyvoyle Head to Tramore No 1693).

Management/promotion issues
The beach has safe access and parking and the rocks are accessible along the beach. If venturing beyond the beach, caution must be taken in relation to the tides, but at low tide it is possible to traverse westwards along to Kilfarrasy.

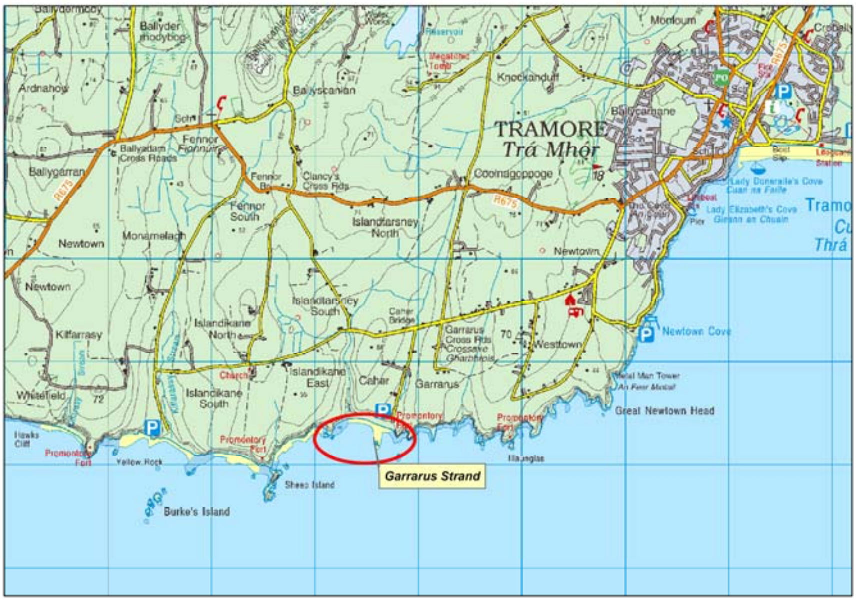
Panorama view of Garrarus Strand from the eastern end, looking westward.

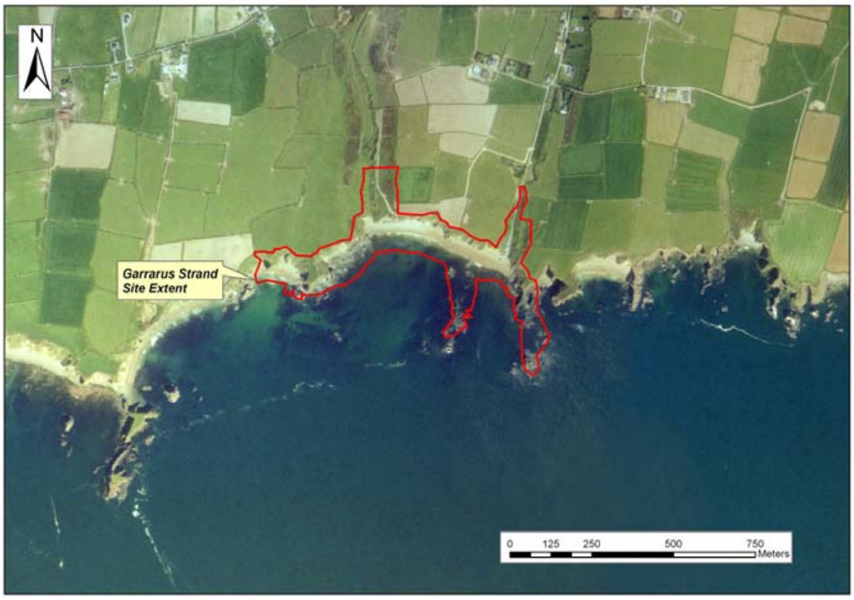
Panorama view of Garrarus Strand from the western end, looking eastward.

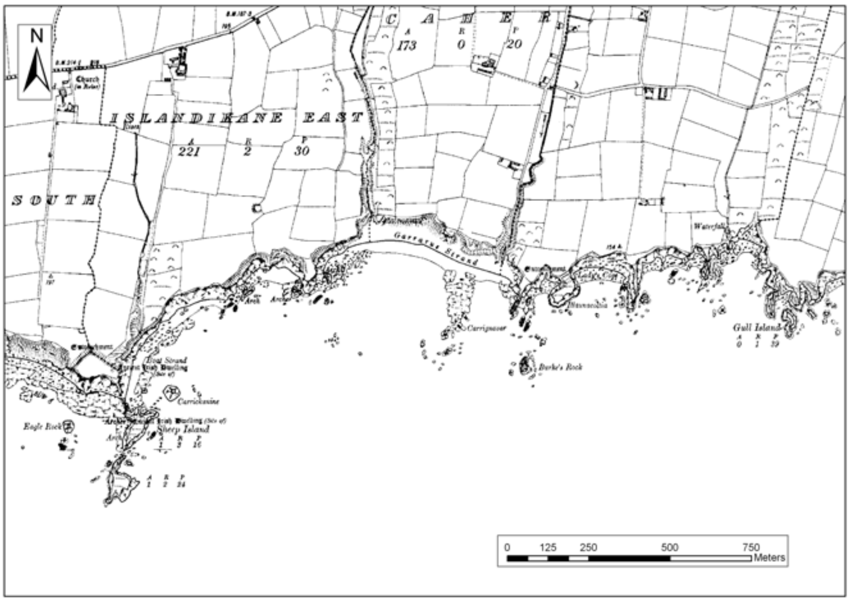
Disrupted dyke of pale volcanic rock intruded into Tramore Limestone.

A cliff section showing the complex relationship of different rock types.

A glacial channel filled with till.


TRAMORE
Trá Mhór
Garrarus Strand
Garrarus
Caher
Islandikane East
Islandikane South
Islandikane North
Islandtarsney South
Islandtarsney North
Fennor South
Fennor
Ballyscanlan
Knockanduff
Coolnagoppoge
Newtown
Westtown
Kilfarrasy
Whitefield
Ballygarran
Ardnahow
Monamelagh
Ballycarnane
Monvoy
Newtown Cove
Great Newtown Head
Metal Man Tower
Hawks Cliff
Yellow Rock
Sheep Island
Burke's Island
Promontory Fort
Church
Lady Elizabeth's Cove
Lady Doneraile's Cove
R675


N
Garrarus Strand
Site Extent
0 125 250 500 750
Meters


N
CAHER
ISLANDIKANE EAST
SOUTH
Garrarus Strand
Sheep Island
Gull Island
Burke's Rock
Eagle Rock
0 125 250 500 750
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Copper Coast – Kilfarrasy Strand**		
Other names used for site			
IGH THEME	**IGH4 Cambrian – Silurian, IGH13 Coastal Geomorphology**		
TOWNLAND(S)	**Kilfarrasy, Islandikane south**		
NEAREST TOWN	**Tramore**		
SIX INCH MAP NUMBER	**Waterford 26**		
NATIONAL GRID REFERENCE	**252600 98280 (entrance to strand)**		
1:50,000 O.S. SHEET NUMBER	76	**1/2 inch Sheet No.**	23

Outline Site Description
A long coastal section of cliffs and bays.

Geological System/Age and Primary Rock Type
The rocks are all of Ordovician age from around 460 million years ago, but are quite variable in type, with rhyolite and andesite volcanic rocks, shales and slaty sedimentary rocks.

Main Geological or Geomorphological Interest
The cliffs display a complex mix of Ordovician volcanic and sedimentary rocks, with many folds and deformation of the sedimentary rocks observed. Where there are no volcanic rocks the sedimentary rocks are strongly cleaved, or slaty, because of the intense pressure they experienced during the Caledonian mountain building event. The volcanic rocks are less deformed. The lithological control on deformation is typical of the region but is displayed well here.

Towards the western end of the section there is a headland with a distinct arch eroded through it. However, on the foreshore eastward of the headland is a freestanding rock arch, with two arches present. Sea stacks and other coastal erosion features abound here.

Site Importance
The site is part of the complex of sites along the Copper Coast, which collectively are of national importance and which are already part of a proposed NHA (Ballyvoyle Head to Tramore No 1693).

Management/promotion issues
The beach is publicly accessible and there is a Copper Coast Geopark interpretative panel mounted near the access point. If exploring further parts of the section westwards to Kilfarrasy Island (a headland) and its sea arch, or eastwards towards Sheep Island the tide needs to be taken into consideration and low tide is needed for access.

Panorama view looking eastwards of the eastern section of the site towards Sheep Island.

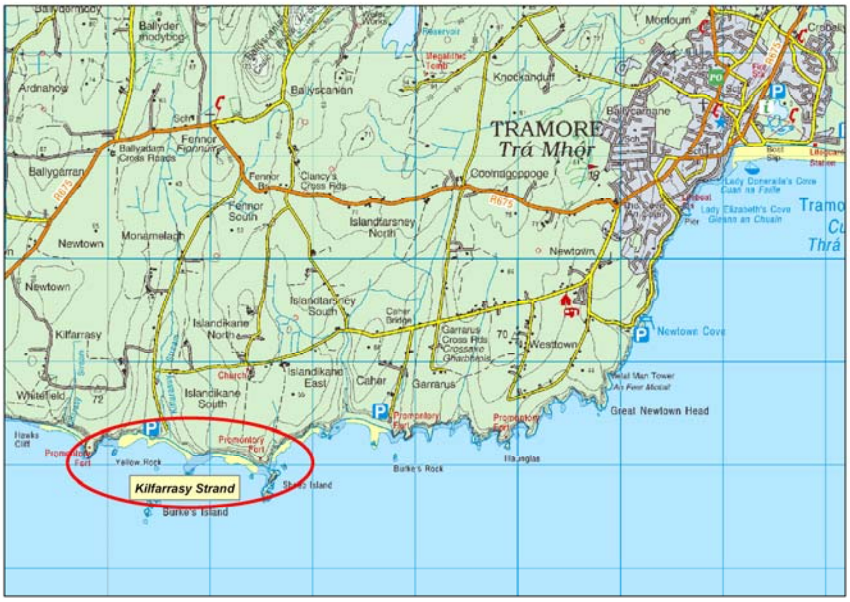
Sea stacks on the east side of Kilfarrasy.

The Geopark display panel at Kilfarrasy.

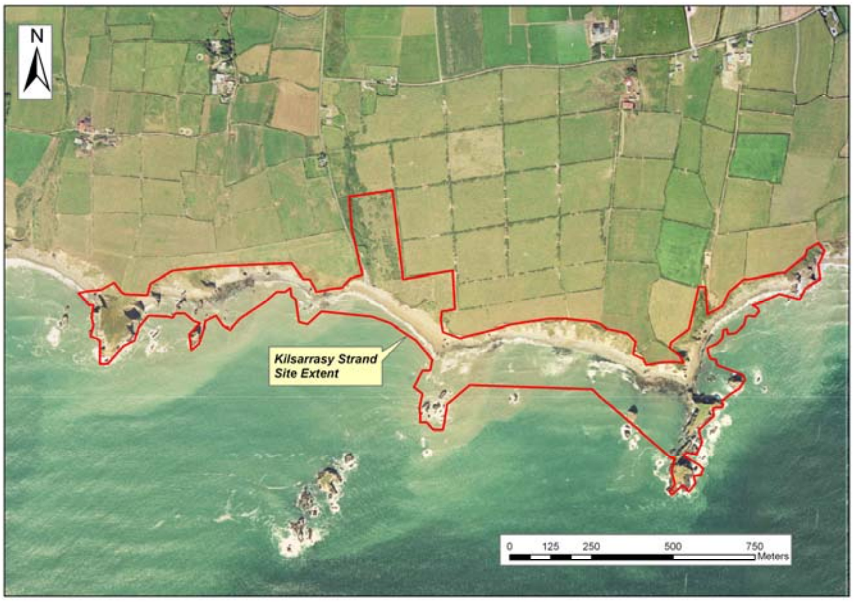
Sea stack with arches at west end of site.

Arch in headland called Kilfarrasy Island.

Panorama view of the west side of Kilfarrasy Strand adjacent to the car park and beach access.



Kilfarrasy Strand
TRAMORE
Trá Mhór
Ballyscanlan
Knockanduff
Monamelagh
Newtown
Kilfarrasy
Islandikane North
Islandikane South
Islandikane East
Islandtarsney North
Islandtarsney South
Caher
Garrarus
Westtown
Coolnagoppoge
Newtown Cove
Great Newtown Head
Metal Man Tower
Lady Doneraile's Cove
Lady Elizabeth's Cove
Promontory Fort
Yellow Rock
Sheep Island
Burke's Island
Burke's Rock
Hawks Cliff
Whitefield
Ballygarran
Ardnahow
Fennor
Church



N
Kilsarrasy Strand
Site Extent
0 125 250 500 750
Meters

N
K I L F A R R A S Y
258 1 18
I S L A N D I K A N E S O U T H
194 3 12
I S L A N D I K A N E
221 2
Yellow Rock
Sheep Island
Eagle Rock
0 125 250 500 750
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Copper Coast – Dunabrattin Head**		
Other names used for site			
IGH THEME	**IGH4 Cambrian – Silurian,** **IGH13 Coastal Geomorphology**		
TOWNLAND(S)	**Dunabrattin**		
NEAREST TOWN	**Bunmahon**		
SIX INCH MAP NUMBER	**Waterford 25**		
NATIONAL GRID REFERENCE	**247415 98139**		
1:50,000 O.S. SHEET NUMBER	82	**1/2 inch Sheet No.**	22

Outline Site Description
The site comprises coastal cliffs and a headland.

Geological System/Age and Primary Rock Type
The rocks at Dunabrattin Head are all Ordovician in age from about 460 million years ago. Rocks of the Tramore Limestone Formation forms the headland itself.

Main Geological or Geomorphological Interest
Most of the headland itself is comprised of rocks of the Tramore Limestone Formation, which is mostly actually composed of calcareous mudstones and siltstones, rather than pure limestone. The rocks here have yielded a collection of fossils, particularly trilobites, for collectors in the 19th century, such as those of the Geological Survey of Ireland. The headland is the type locality for one trilobite species, *Illaenus bowmanni.*

Inland, the rocks pass up into tuffs and mudstones and other sedimentary rocks. They show sedimentary features which indicate that there were earthquakes during the time they were being deposited. There is also a good sea arch eroded in the rocks to the east of the headland.

Site Importance
The site is part of the complex of sites along the Copper Coast, which collectively are of national importance and which are already part of a proposed NHA (Ballyvoyle Head to Tramore No 1693).

Management/promotion issues
Access via the cliff top path is not complete or easy, due to cliff collapses and narrow paths, so general promotion is probably not advisable. Safe access to fossiliferous rocks is very limited and there is very little sea level accessibility, although low tide is essential for some reported access from the Boat Strand Harbour.

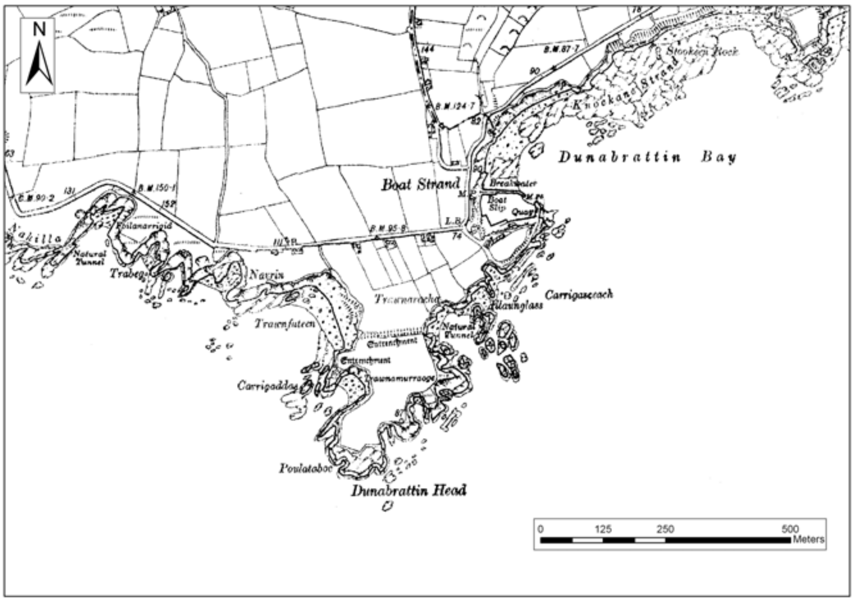
The enrolled trilobite *Illaenus bowmanni*, first described from Dunabrattin Head. The animal is enrolled – a protection measure. Specimen is GSI:F00876, the holotype, and is approximately 7cm long.

Panorama view of Dunabrattin Head.

Sea arch to the east of Dunabrattin Head.

Dipping limestone beds in cliff section on Dunabrattin Head.


Dunabrattin Head
Bunmahon
Bun Machan
Bunmahon Bay
Cuan Bhunmachan
Dunabrattin Bay
Cuan Dhún na mBreatan
Dunabrattin Head
Ceann Dhún mBreatan
Annestown
Bun Abha
Knockmahon
Kilmurrin
Tankardstown
Dunabrattin
Knockane
Ballynagorkagh
Woodstown
Dunhill
Dún Aill
Kilbarrymeaden
Castlecraddock
Lissaviron
Kilsteague
Ballyheadon
Kilcannon
Rathquage
Ballingarry
Ballyristeen
Bog
Kilbeg
Knockmahon
99
98
97

N
Dunabrattin Head
Site Extent
0
125
250
500
Meters

N
Dunabrattin Bay
Boat Strand
Knockane Strand
Breakwater
Boat Slip
Quay
Carrigaseach
Natural Tunnel
Trabeg
Navrin
Trawnfateen
Carrigaddow
Poulatoboe
Dunabrattin Head
Entrenchment
0
125
250
500
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Copper Coast – Tankardstown**		
Other names used for site			
IGH THEME	**IGH6 Mineralogy**		
TOWNLAND(S)	**Knockmahon, Tankardstown**		
NEAREST TOWN	**Tramore**		
SIX INCH MAP NUMBER	**Waterford 25**		
NATIONAL GRID REFERENCE	**245040 98727**		
1:50,000 O.S. SHEET NUMBER	82	**1/2 inch Sheet No.**	22

Outline Site Description
Tankardstown is one of the main complexes on the Copper Coast of mineralised rock that has been mined in the 19th century for copper ores. The site includes the industrial heritage buildings as well as the mineral veins and old mine workings.

Geological System/Age and Primary Rock Type
The great diversity of minerals recorded here are hosted in Ordovician volcanic rocks, but the minerals are a mixture of different ages. The primary ores, probably of Devonian age, occur in veins, which cut across and through the volcanics. There may be some minerals associated with the volcanic eruptions themselves too. However, the most spectacular minerals in Tankardstown mine are secondary minerals derived from oxidation or weathering of the primary ores, and are therefore quite recent, developing since mining ceased.

Main Geological or Geomorphological Interest
Tankardstown is of particular interest for the diversity of minerals it has, some of which are rare. There are at least 36 different minerals recorded from Waterford Copper Coast mines, such as arsenopyrite, azurite, barite, bornite, botallackite, brochantite, chalcopyrite, chrysocolla, cobalt arsenides, connellite, copper, cuprite, dolomite, epidote, erythrite, galena, langite, malachite, pyrite, siderite, sphalerite, tennantite and tetrahedrite, many of which are found at Tankardstown. The finest examples at Tankardstown are of brochantite and the flowstones of langite/brochantite. The minerals are contained in primary veins, secondary weathered zones called gossans and as spectacular flowstone type deposits in the abandoned mine workings.

Of considerable value to the Copper Coast Geopark is the iconic remains of an engine house on the northern side of the road. These have been conserved and interpreted with the aid of the Mining Heritage Trust of Ireland and are safe for visitors to explore and enjoy.

Site Importance
The site is of national importance for its mineralogy. The site is part of the complex of sites along the Copper Coast, which collectively are of national importance and which are already part of a proposed NHA (Ballyvoyle Head to Tramore No 1693).

Management/promotion issues
The disused mine workings are not suitable for general promotion as they presently exist. A major investment costing perhaps millions of euros would be required to make them publicly accessible as a showmine, meeting all safety requirements and regulations. It could be done with adequate funding though, and they are sufficiently interesting to be a tourism attraction that could potentially be quite successful. At present the Tankardstown Mine workings are inaccessible without specialist equipment. Collapsed shafts have blocked access to inner sections for mine heritage specialists. A fenced off open shaft from the clifftop intersects the horizontal adits underground in the mine. Underground mine workings such as these are the responsibility of the Minister for Communications, Energy and Natural Resources and permission must be sought for entry or any intervention.

Tankardstown section and engine house viewed from the east.

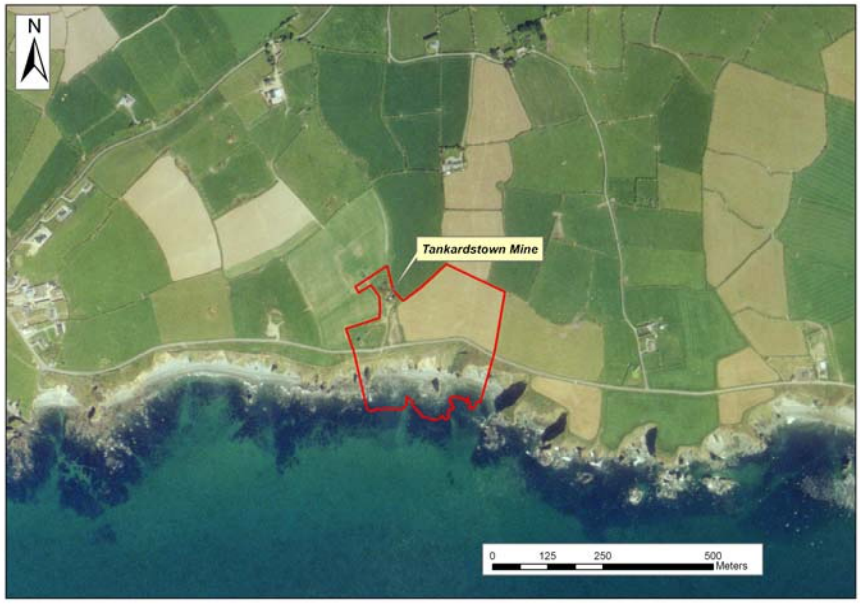
Secondary copper minerals in Tankardstown.

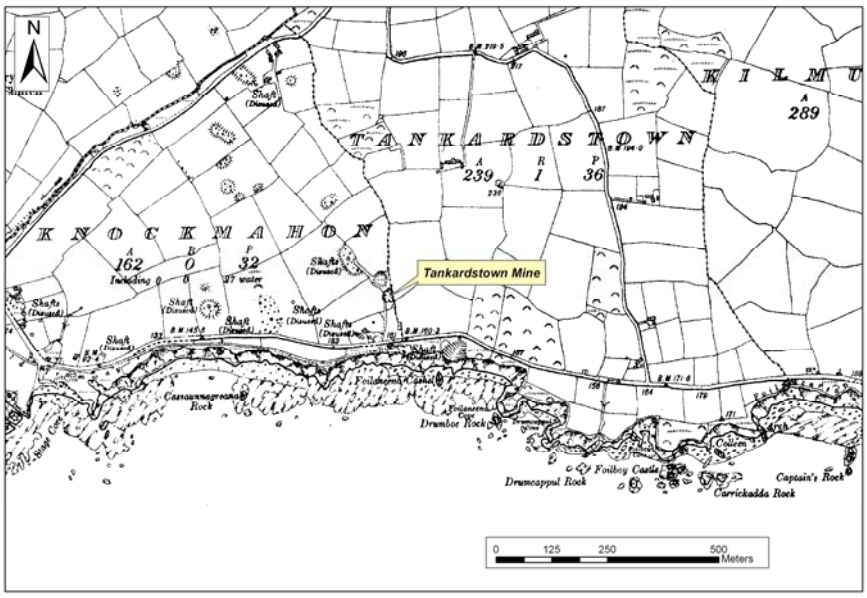
Tankardstown conserved mine buildings.

Clifftop open shaft at Tankardstown.

Dumped mattress in the mineral tramway.


Ballyna-
gigla
Cap's
Cr. Rds.
Bedparka
Cr. Rds.
Glannagair
Cr. Rds.
Knockane
Ballynasissala
R675
Kilduane
Bohernamuck
Cr. Rds.
Kilmurrin
Dunabrattin
Tankardstown
Sch
99
Knockmahon
Tankardstown Mine
PO
Coast and
Cliff Rescue
Slip
Bunmahon
Bun Machan
Promontory
Fort
Cassaunnagreana
Rock
Foilboy
Castle
Coheen
Drumboe
Rock
Drumcappul
Rock
Captain's
Rock
Carrickadda
Rock
Kilmurrin
Cove
Trabeg
R675
Gull Isd
98
Bunmahon Bay
Cuan Bhunmachan


N
Tankardstown Mine
0
125
250
500
Meters


N
KNOCKMAHON
A 162
B 0
P 32
TANKARDSTOWN
A 239
R 1
P 36
KILMU
A 289
Tankardstown Mine
Cassaunnagreana
Rock
Drumboe Rock
Drumcappul Rock
Foilboy Castle
Captain's Rock
Carrickadda Rock
0
125
250
500
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Copper Coast – Knockmahon and Stage Cove**
Other names used for site	
IGH THEME	**IGH4 Cambrian - Silurian**
TOWNLAND(S)	**Knockmahon**
NEAREST TOWN	**Bunmahon**
SIX INCH MAP NUMBER	**Waterford 25**
NATIONAL GRID REFERENCE	**244298 98648 (access at Stage Cove)**
1:50,000 O.S. SHEET NUMBER	82 **1/2 inch Sheet No.** 22, 23

Outline Site Description
The site comprises coastal cliffs and the bay at Stage Cove, and Knockmahon beach to the east of it.

Geological System/Age and Primary Rock Type
Ordovician volcanic rocks such as andesite and rhyolite are injected into sediments such as muddy limestone and slate at the site.

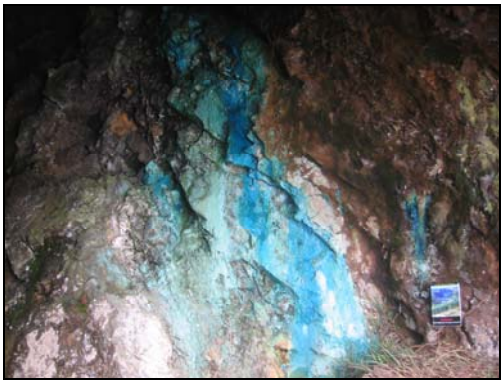
Main Geological or Geomorphological Interest
A main feature of interest here is the Pipes of Baidhb – an intrusion of rhyolite, which has cooled with polygonal columns, perpendicular to the surface of the intrusion. It forms an arch in the cliffs and is reminiscent of the Giant's Causeway, although it is much older. However, weathering is causing the columns to collapse and it is an ever changing feature through the years.

There are also andesite intrusions running through the sedimentary rocks, and andesite tuffs interbedded with the shales.

At Knockmahon, and in Stage Cove especially, there are numerous mine shafts on the cliff top and adits into the cliffs that reflect the mineralised veins, which run northwest-southeast through this site. One mineralised fault in particular is eroded out as a gully. Stage Cove has a slipway, which was used in shipping copper ore out, and also has remains of a Copper Yard with a cobbled floor.

Site Importance
The site is part of the complex of sites along the Copper Coast, which collectively are of national importance and which are already part of a proposed NHA (Ballyvoyle Head to Tramore No 1693).

Management/promotion issues
Access to this site is not easy and descending the gully is not recommended. A grassy path down to beach level is found to the east of the gully. Loose rock fragments do fall down here, certainly on a windy day, and rockfalls, such as at the columnar jointed intrusions, are apparent from the debris at beach level, so caution must be exercised. The mine shafts and adits also require significant care, and should not be entered except in the company of experienced mine explorers (such as the Mining Heritage Trust of Ireland).



Blue copper gels stain the walls of some of the adits but they are wet and easily damaged.

Part of the Pipes of Baidhb.

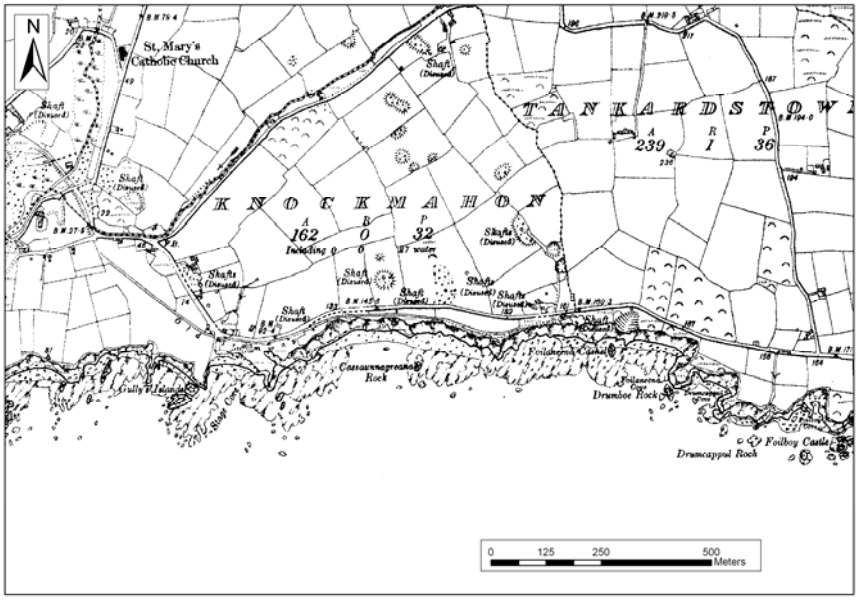
Mine adits in the cliff.

A panorama view of Knockmahon site looking west.

A panorama view of Knockmahon site looking east, with the Pipes of Baidhb in the near cliff.


Ballynasissala
R675
Kilduane
Bohernamuck
Cr. Rds.
Tankardstown
Sch
99
Knockmahon
PO
P
53
Coast and
Cliff Rescue
Slip
Bunmahon
Bun Machan
Templeyvrick
Promontory
Fort
Cassaunnagreana
Rock
Knockmahon
and Stage Cove
Drumboe
Rock
Drumcappul
Rock
Foilboy
Castle
Gull Isd
98
Bunmahon Bay


N
Knockmahon and Stage Ciove
Site Extent
Stage
Cove
0
125
250
500
Meters


N
St. Mary's
Catholic Church
KNOCKMAHON
TANKARDSTOWN
Cassaunnagreana
Rock
Drumcappol Rock
0
125
250
500
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Copper Coast – Bunmahon Head**		
Other names used for site			
IGH THEME	**IGH4 Cambrian – Silurian, IGH10 Devonian**		
TOWNLAND(S)	**Templeyvrick**		
NEAREST TOWN	**Bunmahon**		
SIX INCH MAP NUMBER	**Waterford 24**		
NATIONAL GRID REFERENCE	**242755 98170**		
1:50,000 O.S. SHEET NUMBER	82	**1/2 inch Sheet No.**	22

Outline Site Description
The site comprises a rocky headland and Trawnamoe beach to the west.

Geological System/Age and Primary Rock Type
The rocks of Bunmahon headland are Devonian age sandstones and conglomerates. The adjacent rocks in the bay to the west are Ordovician volcanic and sedimentary rocks.

Main Geological or Geomorphological Interest
Mining heritage is highly visible in the bay with small adits cut into the rocks. The volcanic lavas at the western end of the Trawnamoe beach show very interesting features, which are called peperitic intrusion. When andesite lava was being injected into wet sediments, it broke up into rounded blobs and was extensively altered by hot fluids.

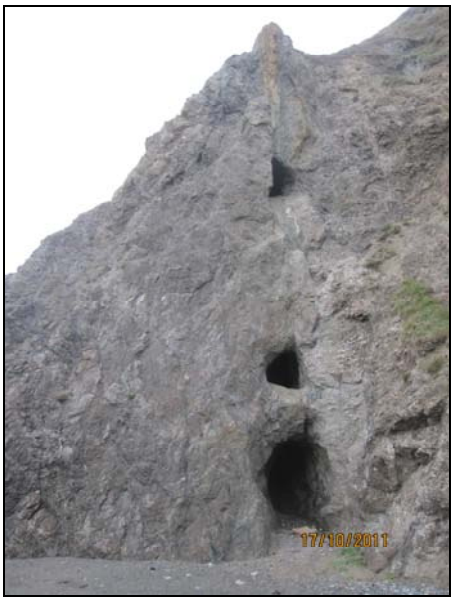
The headland of Bunmahon Head is composed of Devonian age red sandstones and conglomerates. These are tilted to vertical and form impressive cliffs. A fault runs to the west of the headland separating them from the Ordovician rocks.

Site Importance
The site is part of the complex of sites along the Copper Coast, which collectively are of national importance and which are already part of a proposed NHA (Ballyvoyle Head to Tramore No 1693).

Management/promotion issues
There is reasonable access via a cliff top track from Bunmahon, and a path onto the headland or down into the bay via a grassy slope. The remote feel of this place is perhaps best left untouched by explanatory panels, but the clifftop viewpoint into the bay or the car park at the end of the rough track would be the place to install any such interpretation or explanation.

A panorama view of Trawnamoe Bay and Bunmahon Head.

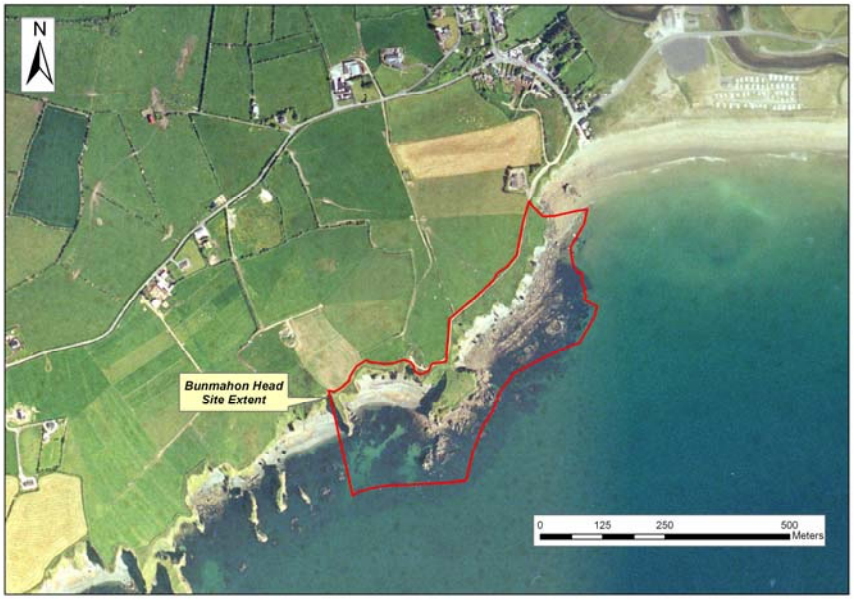
Peperites at western end of Trawnamoe.

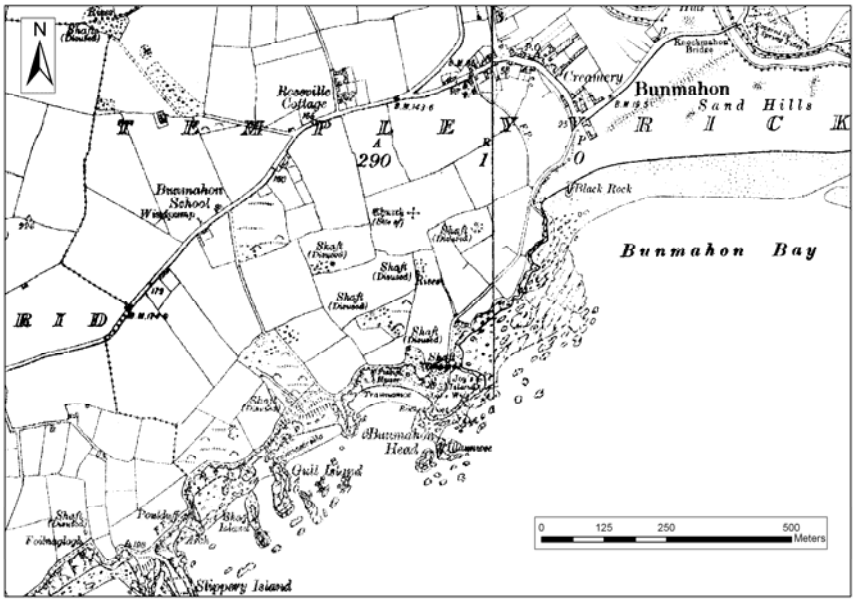


Mine adits in Trawnamoe.


A view of Bunmahon Head from the top of the cliff above Trawnamoe.


Bunmahon Head
Bunmahon Bay
Cuan Bhunmachan
Dunabrattin Bay
Cuan Dhún na mBreatan
Dunabrattin Head
Ceann Dhún mBreatan
Bun Machan
Knockmahon
97
99


N
Bunmahon Head
Site Extent
0
125
250
500
Meters


N
Bunmahon
Sand Hills
Bunmahon Bay
Black Rock
Bunmahon Head
Guil Island
Stippery Island
0
125
250
500
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Copper Coast – Ballydowane Bay**		
Other names used for site			
IGH THEME	**IGH4 Cambrian – Silurian, IGH10 Devonian**		
TOWNLAND(S)	**Ballydowane West, Ballydowane East**		
NEAREST TOWN	**Bunmahon**		
SIX INCH MAP NUMBER	**Waterford 24, 32**		
NATIONAL GRID REFERENCE	**240760 97870**		
1:50,000 O.S. SHEET NUMBER	82	**1/2 inch Sheet No.**	22

Outline Site Description
The site comprises cliffs in a coastal embayment.

Geological System/Age and Primary Rock Type
Devonian age conglomerates and sandstones are the main rock types seen in the bay, but they are in unconformable contact with Ordovician andesite volcanic rock towards the eastern end.

Main Geological or Geomorphological Interest
High, vertical cliffs at the back of the beach in Ballydowane Bay are composed of conglomerate and sandstone rocks of Devonian age. These are red in colour and have abundant pebbles of white vein quartz within them.

A feature of particular interest is seen at the eastern end of the beach. The red conglomerates are seen in an unconformable contact with Ordovician volcanic rock. This reflects a time gap of about 80 million years, and the red rocks were deposited by rivers on a weathered land surface of Ordovician volcanic andesite rocks. Lumps of the greenish andesite can be seen in the conglomerates near the unconformity.

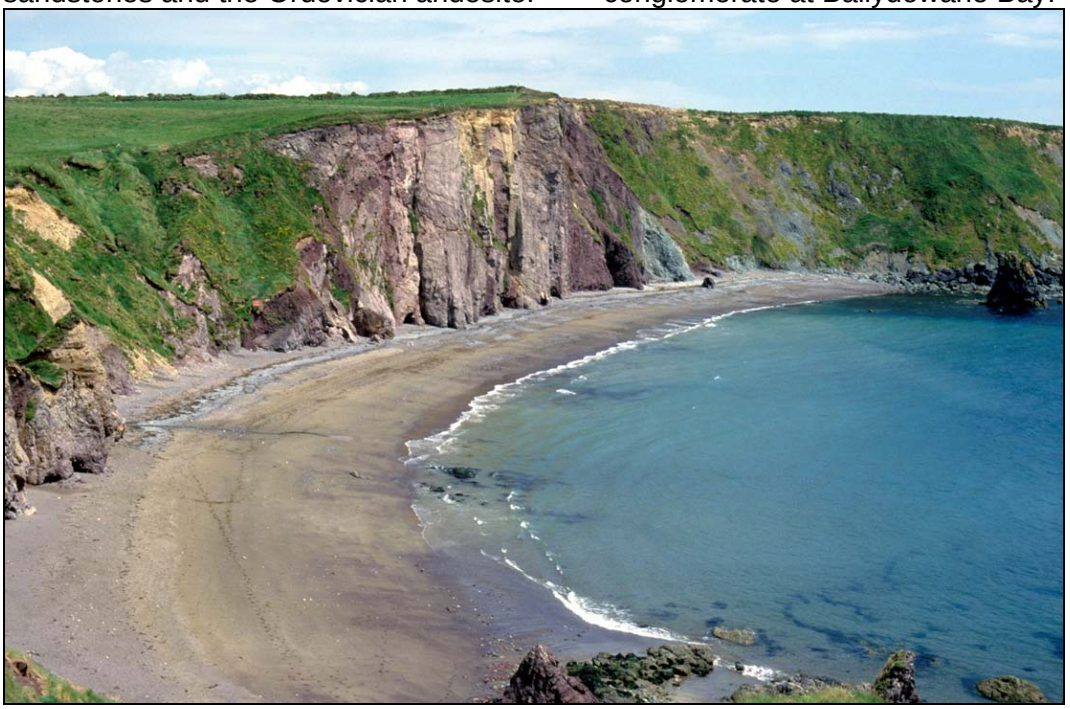
At the southwest corner of the bay there is a fault and is now the location of a landslip. Another is found at the eastern end of the beach. In the sea stack towards the eastern end of the beach, there is a ventilation shaft dug to get air into 18th century silver mines, which were dug below the seabed. This is now filled with sand.

Site Importance
The site is part of the complex of sites along the Copper Coast, which collectively are of national importance and which are already part of a proposed NHA (Ballyvoyle Head to Tramore No 1693).

Management/promotion issues
The beach is accessible with a public road and a car park to a narrow slipway. However, the cliffs are very high and also have potential for rockfalls and landslips, so general promotion is perhaps not advisable. Well prepared geological parties can negotiate the section but there is perhaps the need for a warning sign at the car park. The Copper Coast Geopark information panel about Ballydowane Bay in the car park by the beach has not stood up well to light exposure and has faded badly.

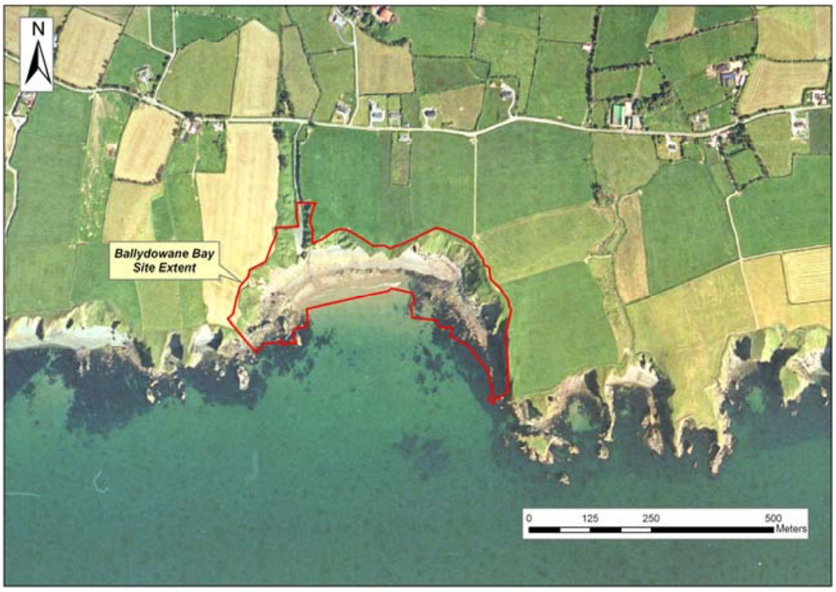
The unconformity between Devonian red sandstones and the Ordovician andesite.

Vertical beds of red sandstone and conglomerate at Ballydowane Bay.

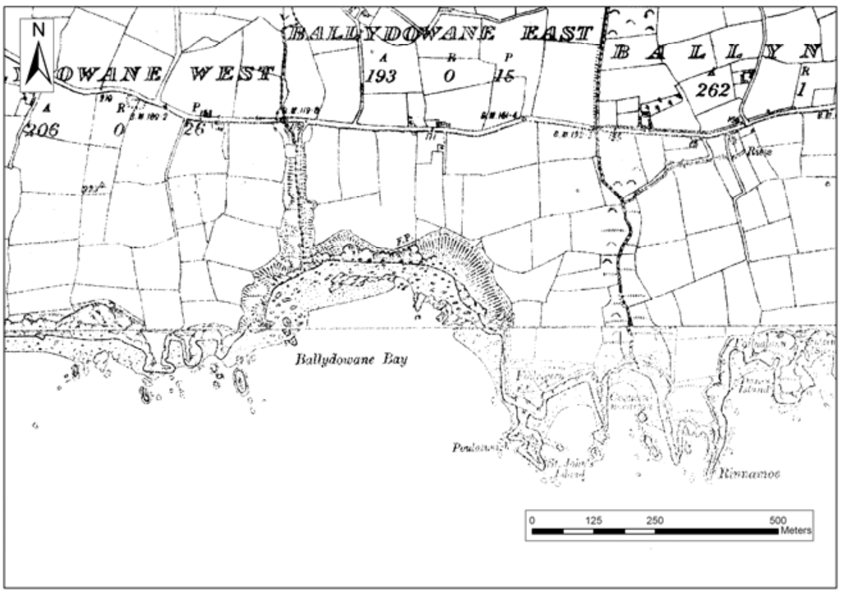


The red sandstones clearly contrast with the green andesites just right of centre.

Ballydowane Bay
Stradbally
An tSraidbhaile
Bunmahon
Bun Machan
Williamstown
Newtown
Ballydowane East
Ballydowane West
Ballynarrid
Templeyvrick
Ballygarran
Ballynahila
Seafield
Lisard
Rathnaskilloge
Graiguenageena
Carrickbarrahane
Gull Isd
Ballydowane Bay
Cuan Bhaile Ui Dhubháin
Bunmahon
Cuan Bhunm



N
Ballydowane Bay
Site Extent
0
125
250
500
Meters



N
BALLYDOWANE EAST
DOWANE WEST
BALLYN
Ballydowane Bay
0
125
250
500
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Copper Coast – Stradbally Cove**		
Other names used for site			
IGH THEME	**IGH4 Cambrian - Silurian**		
TOWNLAND(S)	**Woodhouse**		
NEAREST TOWN	**Stradbally**		
SIX INCH MAP NUMBER	**Waterford 32**		
NATIONAL GRID REFERENCE	**236975 96922**		
1:50,000 O.S. SHEET NUMBER	82	**1/2 inch Sheet No.**	22

Outline Site Description
Low cliffs beside the sandy beach on the western side of Stradbally Cove.

Geological System/Age and Primary Rock Type
Ordovician sedimentary rocks such as slates and mudstones are intruded by thin units of volcanic rocks like andesite.

Main Geological or Geomorphological Interest
There are indications the sediments were still wet or only partially consolidated when the lavas were injected into them and so there is disturbance of the sediments. Some later minor faults are seen by their associated veins of white quartz. Other sedimentary features provide evidence of earthquakes and quiet periods in between.

There is also a lime kiln here for use with coal and limestone brought in by boat.

Site Importance
The site is part of the complex of sites along the Copper Coast, which collectively are of national importance and which are already part of a proposed NHA (Ballyvoyle Head to Tramore No 1693).

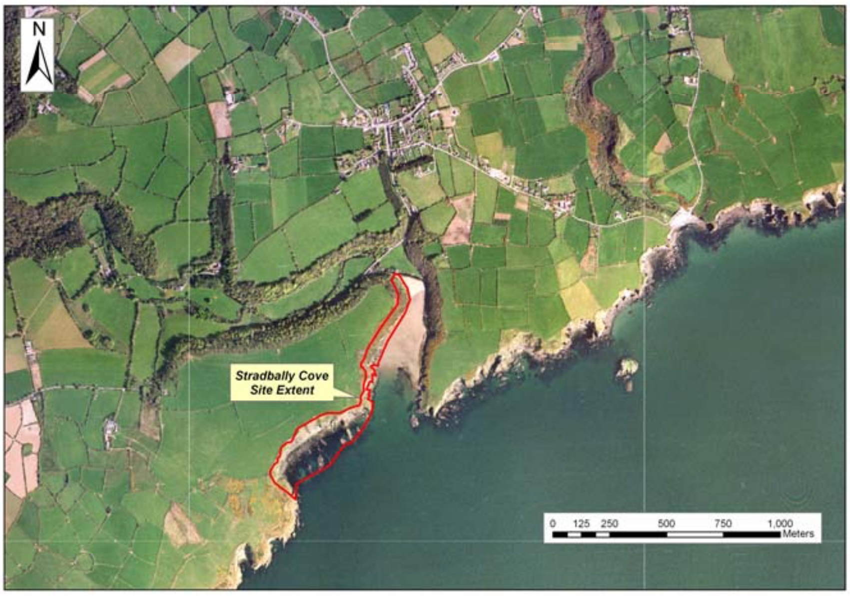
Management/promotion issues
The beach access allows easy and safe access to the rocks. The Copper Coast Geopark has emplaced some picnic seats and a table made of stone, and explanatory signboards. Little else is suggested except for maintenance of the facilities and boards, especially when faded with UV in sunlight.

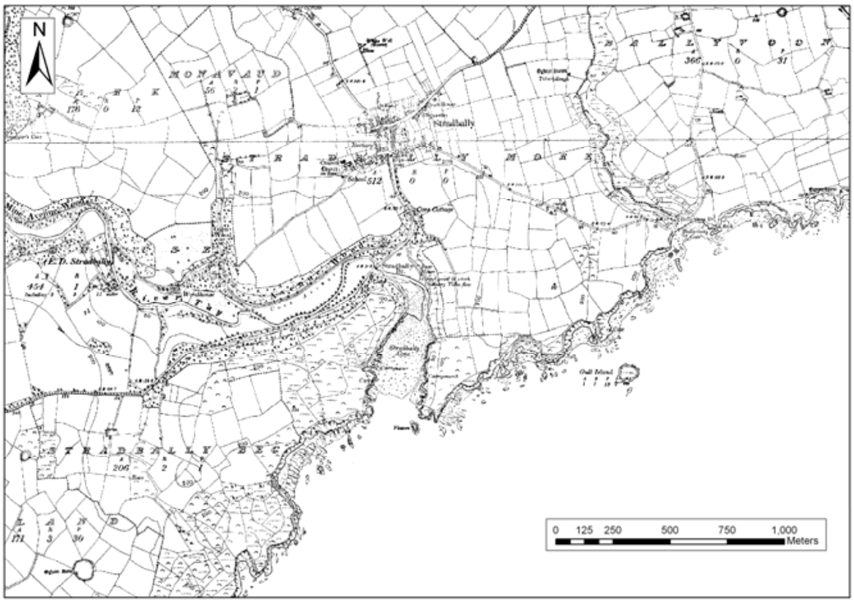
The visitor facilities and Copper Coast Geopark tables and signs at Stradbally Cove.

The cliff section along the west side of Stradbally Cove.

Some of the sediments at Stradbally Cove.


Stradbally Cove
Stradbally
An tSraidbhaile
Bunmahon
Bun Machan
Ballydowane Bay
Cuan Bhaile Ui Dhubhain
Gull Isd
Williamstown
Newtown
Ballyvoony
Killelton
Ballydowane West
Ballydowane East
Ballynarrid
Templeyvrick
Seafield
Lisard
Ballynahila
Graiguenageeha
Rathnaskilloge
Drumlohan
Monavaud
Stradbally More
Stradbally Beg


N
Stradbally Cove
Site Extent
0 125 250 500 750 1,000
Meters


N
Stradbally
0 125 250 500 750 1,000
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Croughaun Hill**
Other names used for site	
IGH THEME	**IGH4 Cambrian to Silurian, IGH 10 Devonian**
TOWNLAND(S)	**Knockaturnory, Monminane, Killerguile, Kilcanavee, Cummeen, Ashtown**
NEAREST TOWN	**Kilmacthomas**
SIX INCH MAP NUMBER	**Waterford 15**
NATIONAL GRID REFERENCE	**238135 110274 (Devonian conglomerates)** **238296 110231 (Ordovician slate quarry)**
1:50,000 O.S. SHEET NUMBER	75 **1/2 inch Sheet No.** 22

Outline Site Description
Croughaun Hill is a high, solitary hill which lies a few kilometres east of the Comeragh Mountains. The site comprises an area on the southeast flank of the hill.

Geological System/Age and Primary Rock Type
The hill is comprised of conglomerates, sandstones and siltstones which are of Devonian age and which include the Coumshingaun Conglomerate Formation and the Croughaun Formation. The feature is ice-scoured and has thin soils and subsoils, but bedrock outcrop is actually quite rare, occurring on occasional crags across the feature. The site includes an exposure of Devonian bedrock and a quarry of Lower Ordovician Kilmacthomas Formation.

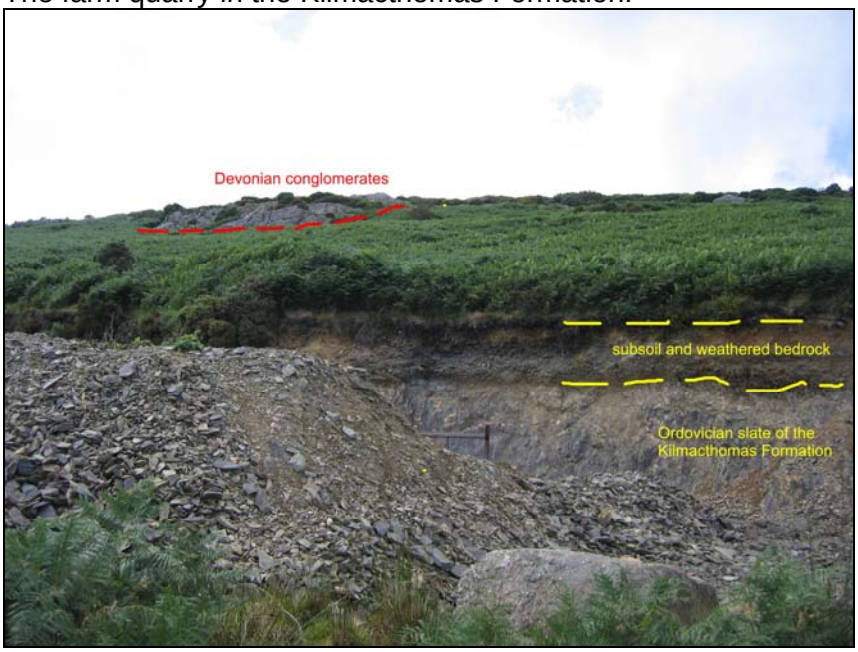
Main Geological or Geomorphological Interest
The site includes the rarely exposed Kilmacthomas Formation of early Ordovician age, which only occurs in this area of the county. It is seen in a small farm quarry and is a grey slaty rock. A short distance further up the hill track exposures of the Devonian conglomerates are seen and the gap between conglomerate and slate rocks includes a large fault line which juxtaposes these two rock types, which are about 100 million years apart in age.

Geologists have argued over whether the conglomerates of Croughaun Hill are different from those of Coumshingaun, but there is no visible difference to a non-specialist.

Site Importance
This is of County Geological Site importance only.

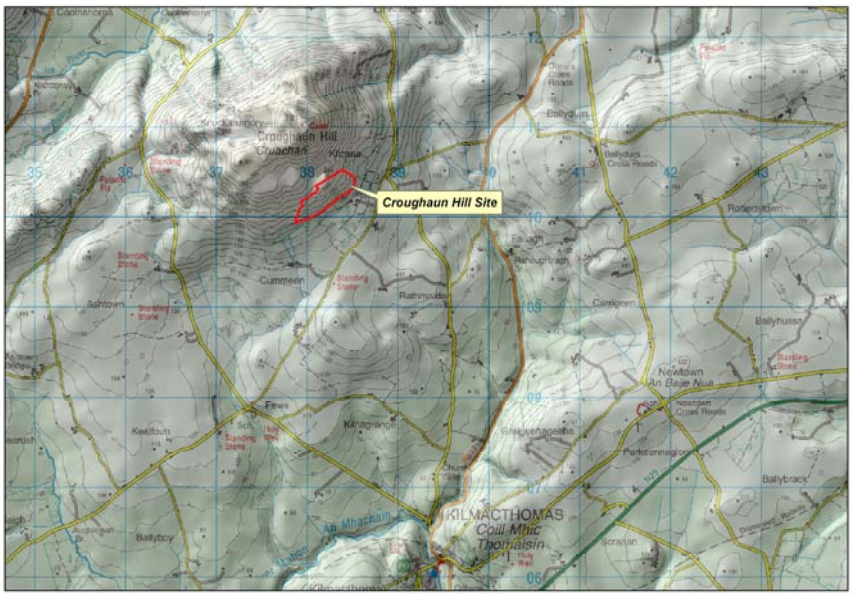
Management/promotion issues
Access is only through a private farm and the site is not suitable for general promotion.

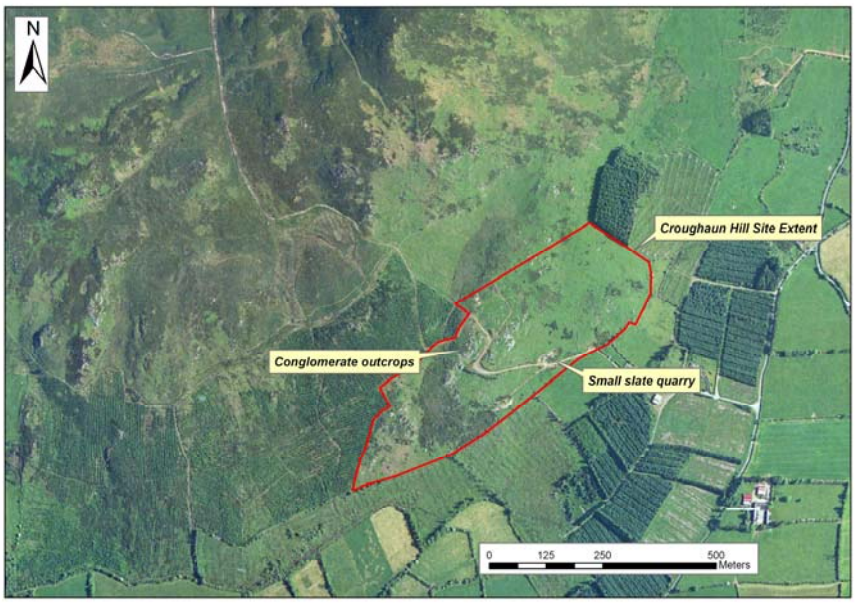
The farm quarry in the Kilmacthomas Formation.

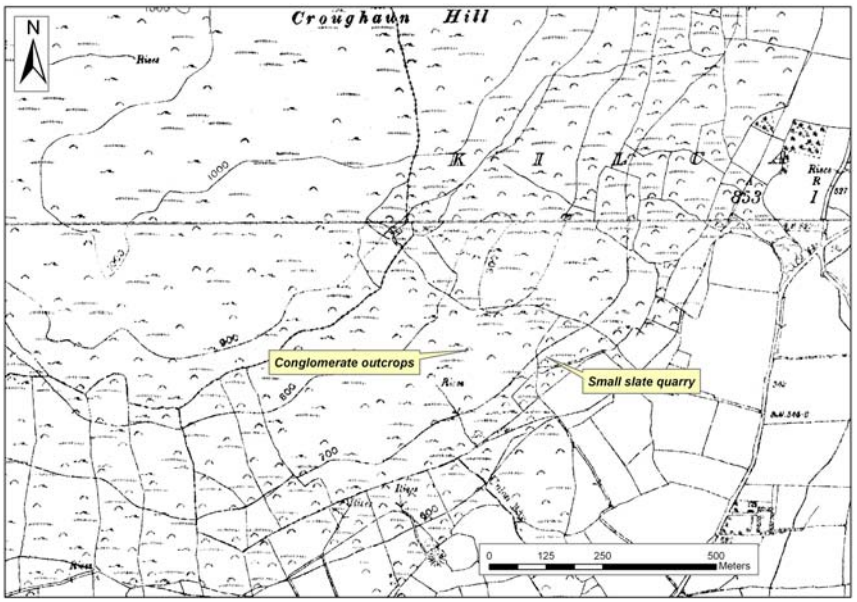


The quarry in the Kilmacthomas Formation with exposures of Devonian conglomerate visible in the short distance beyond.

A view of the exposures of Devonian conglomerates adjacent to the farm track.


Croughaun Hill Site
KILMACTHOMAS
Coill Mhic Thomáisín
Newtown
An Baile Nua


N
Croughaun Hill Site Extent
Conglomerate outcrops
Small slate quarry
0 125 250 500
Meters


Croughaun Hill
N
Conglomerate outcrops
Small slate quarry
0 125 250 500
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Dunhill Quarry**		
Other names used for site			
IGH THEME	**IGH4 Cambrian - Silurian**		
TOWNLAND(S)	**Dunhill Lodge**		
NEAREST TOWN	**Annestown**		
SIX INCH MAP NUMBER	**Waterford 25**		
NATIONAL GRID REFERENCE	**250607 100888**		
1:50,000 O.S. SHEET NUMBER	82	**1/2 inch Sheet No.**	23

Outline Site Description
Dunhill Quarry is a small, disused and heavily vegetated old quarry on the east side of the Annestown Stream valley, opposite the landmark of Dunhill Castle ruins.

Geological System/Age and Primary Rock Type
The quarry is cut into Ordovician rocks, which date from about 460 million years ago. The rocks are bedded tuffs.

Main Geological or Geomorphological Interest
The bedded tuffs here are the product of a volcanic eruption, which spread ash and debris into air around the volcano. These ashes fell down into the sea around the volcano and then sank to the sea floor. Tuffs are simply the ashes reconstituted as a new rock, either as sedimentary particles in water, or sometime as a welded deposit where their own retained heat helped them recombine.

The quarry has been closely examined by geologists and the tuffs show a lot of details, which help understand how many of the Copper Coast volcanic rocks developed and formed. At least 5 different tuff units or beds are seen with grading of different sized particles, indicating they have settled in water. Specific features seen include laminations in the finer grained tops of each tuff and coarser grained layers made of larger particles called lapilli by volcanologists. There are also some larger blocks, which have fallen directly to the sea floor, and indented the last tuff deposit. Some units of tuff have larger pumice fragments at the top, where the gas holes in pumice helped it float, but eventually the fragments became waterlogged and sank, after the finest particles had settled out already. One face is a very clean cut through the dipping tuff units, like a cheese wire had been cut through the rock for geological exhibition purposes.

Site Importance
The site is of national importance in the Cambrian – Silurian theme, and recognition as a County Geological Site will help protect it until it is formally put forward for designation as a geological NHA.

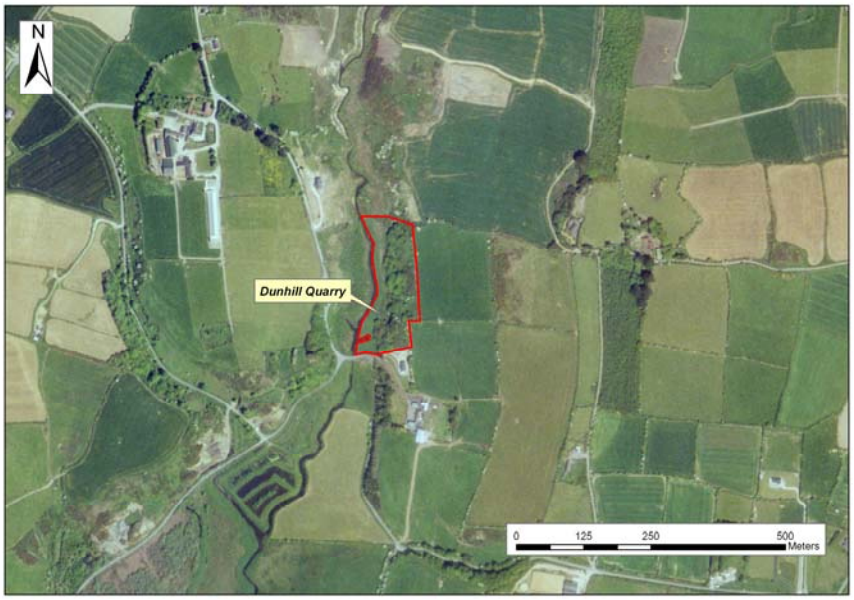
Management/promotion issues
The site is on private land and access would need to be agreed with the landowner before any promotion can take place. However, the subtlety of what it shows is probably of primary interest for geological groups, rather than the general public. For management of the site, clearance of ivy and other vegetation from the main face would be a priority to maintain the excellent display of the tuff units in a clean face. With low face heights and competent rock, there is low risk from loose rocks falling down.

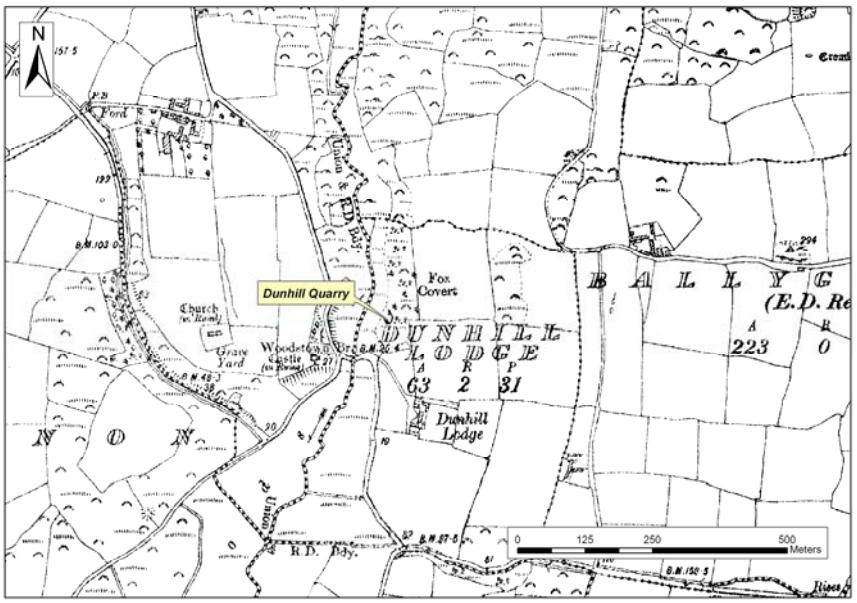
A view of the main face of bedded tuffs in Dunhill Quarry.

Close up of a graded tuff unit.

The quarry is situated in the trees, on the left side.


Dunhill Quarry
TRAMORE
Trá Mhór
Tramore Bay
Cuan
Thrá Mhór
Newtown
Monamelagh
Islandikane
Burke's Island
Great Newlown Head
Brownstown


N
Dunhill Quarry
0
125
250
500
Meters


N
Dunhill Quarry
Fox
Covert
DUNHILL
LODGE
A R P
63 2 31
Dunhill
Lodge
Church
Grave
Yard
Castle
Ford
B A L L Y G
(E.D. Re
A R
223 0
0
125
250
500
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**N25 New road cuttings**		
Other names used for site			
IGH THEME	**IGH4 Cambrian - Silurian**		
TOWNLAND(S)			
NEAREST TOWN	**Kilmeadan**		
SIX INCH MAP NUMBER	**Waterford 16, 17**		
NATIONAL GRID REFERENCE	**251720 110100 (western cutting)**		
	252560 109520 (middle cutting)		
	254285 109620 (eastern cutting)		
1:50,000 O.S. SHEET NUMBER	75	**1/2 inch Sheet No.**	22, 23

Outline Site Description
The site comprises three separate road cuttings excavated on the N25, west of Waterford City, and east of Kilmeadan.

Geological System/Age and Primary Rock Type
The cuttings are made into mostly slaty sedimentary rocks of the Campile Formation, of Ordovician age.

Main Geological or Geomorphological Interest
The cuttings are excellent windows into rock types that are normally not well exposed in the visible rock exposures seen across the Waterford landscape. The Campile Formation comprises a belt of rocks extending from north Wexford down to the Copper Coast and is commonly characterised as being principally volcanic rocks. However, the volcanic rocks are more resistant and tend to be the visible exposures, but the major part of the Campile Formation comprises slaty sediments, such as those in these cuttings.

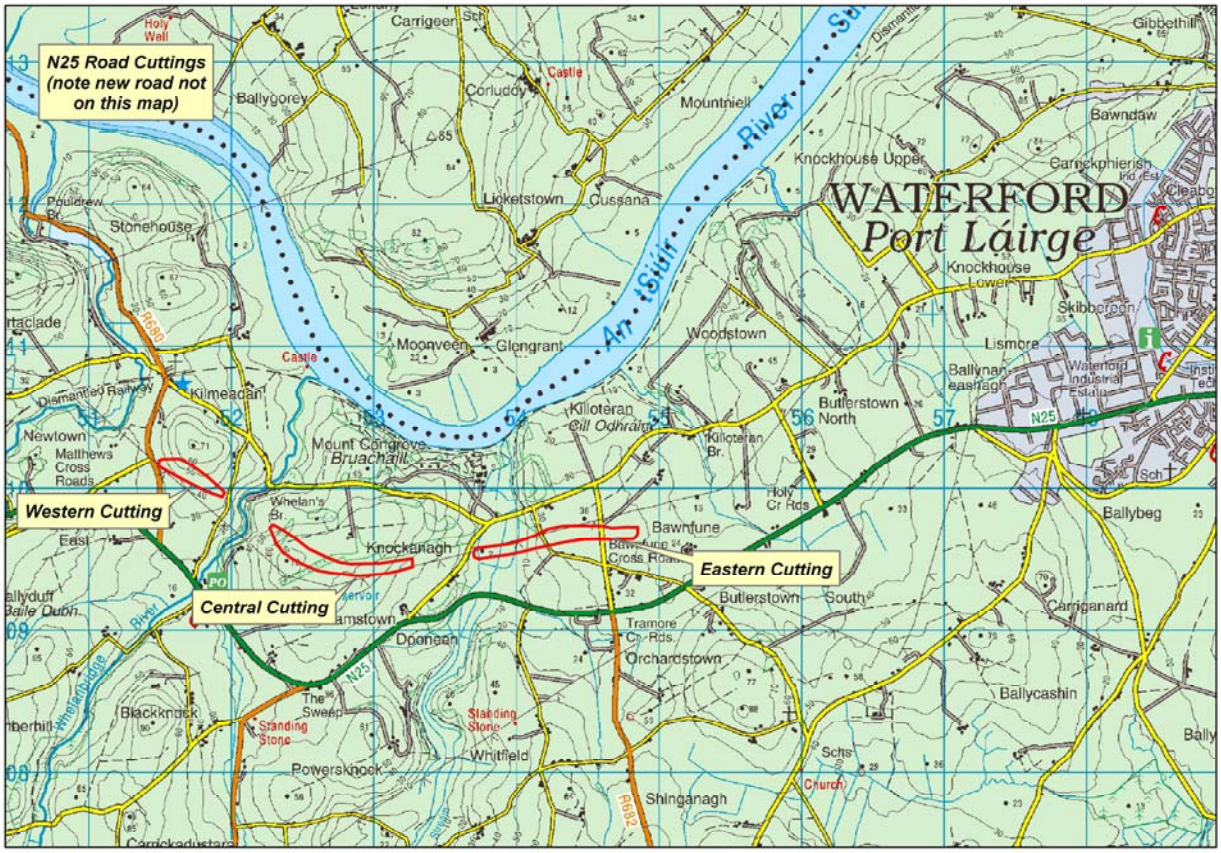
Site Importance
The three cuttings are good representative sections of the sedimentary rocks associated with the Ordovician volcanic bedrock that underlies most of eastern Waterford. They are of County Geological Site importance.

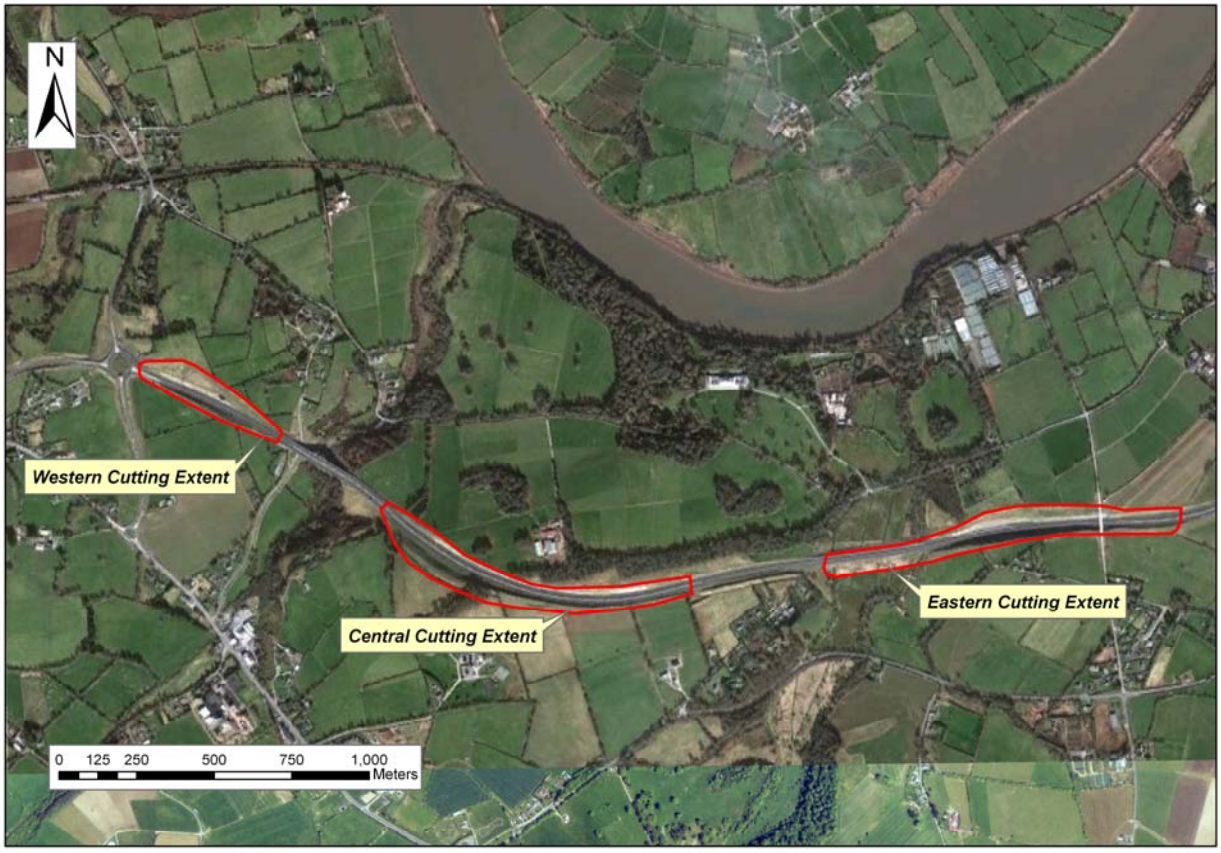
Management/promotion issues
The cuttings are very fresh and unvegetated at present, but will inevitably degrade with weathering and begin to get vegetated. Normal road maintenance will mean that any major problems will get attention. Promotion is difficult because of road safety issues, although the eastern cutting has a large lay-by that allows safe parking, but the rocks are fenced off. The cuttings will become new landmarks and some names and signs may be desirable to reinforce this in public perception.

The easternmost cutting, with a lay-by.

The middle cutting northern face.

The western cutting, northern face, near the roundabout for Kilmeadan.


N25 Road Cuttings
(note new road not
on this map)
Western Cutting
Central Cutting
Eastern Cutting
WATERFORD
Port Láirge
River
Carrigeen
Ballygorey
Corluddy
Mountneill
Knockhouse Upper
Gibbethill
Bawndaw
Liketstown
Gussana
Stonehouse
Knockhouse Lower
Skibbereen
Lismore
Woodstown
Moonveen
Glengrant
Kilmeadan
Killoteran
Cill Odhráin
Butlerstown North
Mount Congrove
Bruachaill
Newtown
Matthews
Cross
Roads
Knockanagh
Bawnfune
Ballybeg
Butlerstown South
Carriganard
Tramore
Ch. Rds.
Orchardstown
Ballycashin
Dooneen
Blackknock
Standing
Stone
Whitfield
Powersknock
Shinganagh
Church
Schs
Dismantled Railway
R680
R682
N25


N
Western Cutting Extent
Central Cutting Extent
Eastern Cutting Extent
0 125 250 500 750 1,000
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Comeragh Mountains (OVERVIEW)**
Other names used for site	
IGH THEME	**IGH7 Quaternary**
TOWNLAND(S)	Curraheen, Knockanaffrin, Carrigeen, Graigavalla, Ross, Boolacloghagh, Coolnalingaddy, Commons, Kilclooney, Curraghduff, Lyre Mountain, Tooreen Mountain, Comeragh Mountain, Carrigbrack, Ashtown, Barracreemountain Upper, Cutteen North, Coummahon.
NEAREST TOWN	**Kilmacthomas**
SIX INCH MAP NUMBER	**Waterford 14, 6, 7**
NATIONAL GRID REFERENCE	**230400 110200 (centre of site)**
1:50,000 O.S. SHEET NUMBER	75 **1/2 inch Sheet No.** 22

Outline Site Description
The Comeragh Mountains site is a mountain plateau heavily ice-sculpted with corries.

Geological System/Age and Primary Rock Type
The mountains have been shaped and moulded during the Quaternary (Ice Age) by glacier ice abrading the mountain tops and flanks. The mountains therefore comprise ice-scoured bedrock, which itself is Devonian Old Red Sandstone.

Main Geological or Geomorphological Interest
The corries comprise deep, wide hollows which are sometimes several kilometres wide, and include discrete as well as composite corrie features. Many hold tarns (corrie lakes) and also show excellent examples of lateral and corrie-edge recessional moraines. The moraines are often strewn with very large erratic boulders, dropped from the ice and weighing several hundred tonnes in some cases.

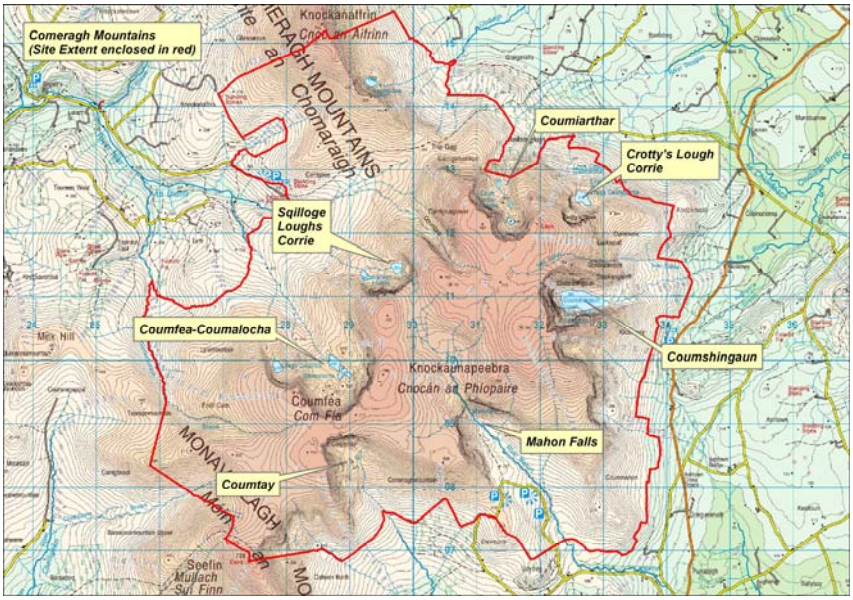
The features have almost-vertical back walls, with the highest at Coumshingaun up to 400m in height. Coumshingaun and Coumfea-Coumalocha are flanked by fine arête ridges, which are very jagged, sometimes knife-edged, craggy rock walls, which separate two corrie features. Coum Mahon holds one of Ireland's finest waterfalls, which cascades down its backwall (Mahon Falls).

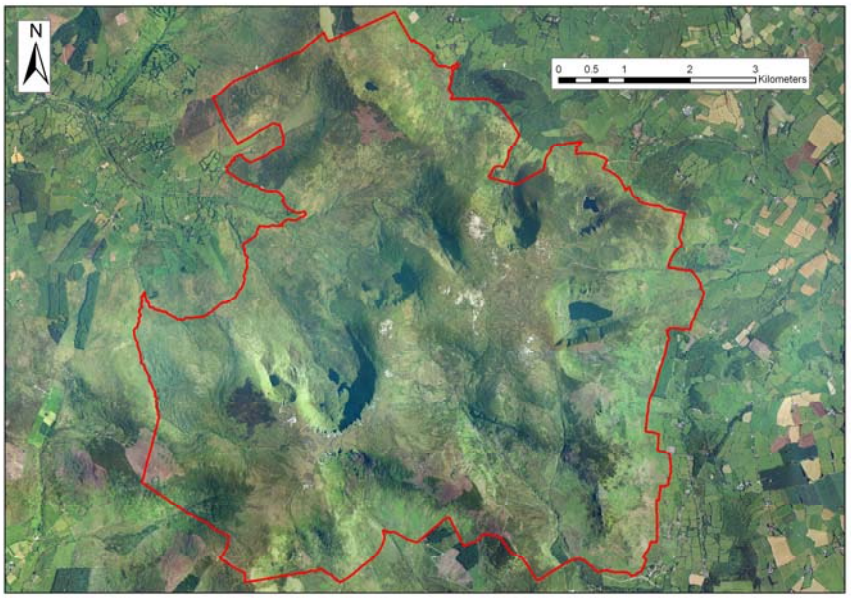
The summit of the Comeragh Mountains is blanketed by several metres depth of blanket peat, which has formed across the summit since the Ice Age. This peat has been cutover in places and displays high peat hags in some localities, particularly between Coumtay and Coumfea-Coumalocha. The Devonian sandstones and conglomerates, which make up the Comeraghs, are also well displayed and include some localised development of paleosols – Devonian soils.

The entire plateau will provide evidence, which can be read by a geologist, but the following site reports are brief focused descriptions of some of the highlights and by default these are large scale features. Other smaller sites and sections are also important, but not all the plateau can be described in full.

Site Importance
The mountains provide the best corrie landscape in the country within a relatively restricted (50 square kilometres) extent. They are already a pNHA and SAC (Site 001952, Comeragh Mountains) for biodiversity reasons and the corrie landscape itself is of national importance.

Management/promotion issues
Access to the mountains is restricted to hillwalkers and climbers, as there is no road access.


Comeragh Mountains
(Site Extent enclosed in red)
Knockanaffrin
Cnocán an Aifrinn
COMERAGH MOUNTAINS
Chomaraigh
Coumiarthar
Crotty's Lough
Corrie
Sqilloge
Loughs
Corrie
Coumfea-Coumalocha
Knockaunapeebra
Cnocán an Phiopaire
Coumfea
Com Fia
Coumshingaun
Mahon Falls
Coumtay
Mick Hill
Sgeilin
Mullach
Sul Finn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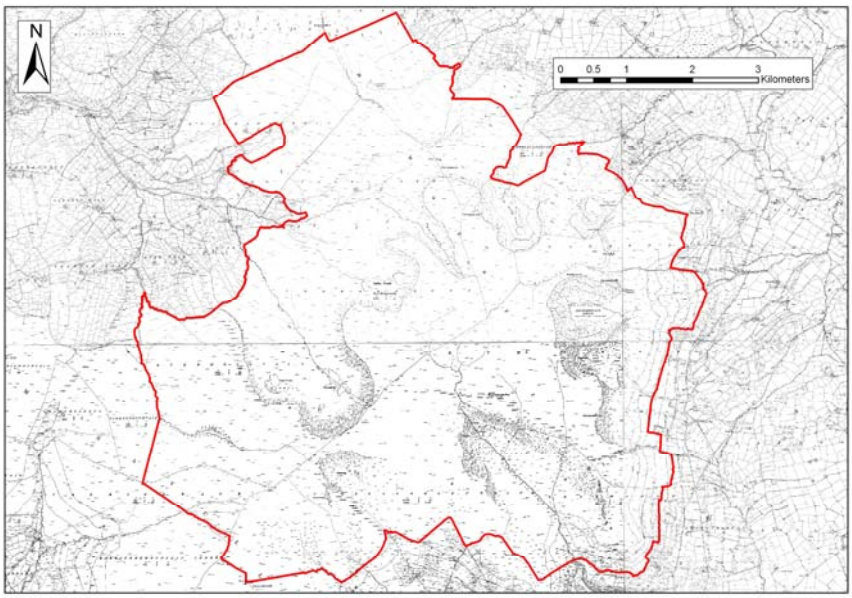
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WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Coumshingaun**		
Other names used for site	Com Seangan, Glen of the Ants, Pissmire Valley		
IGH THEME	**IGH7 Quaternary**		
TOWNLAND(S)	**Kilclooney**		
NEAREST TOWN	**Kilmacthomas**		
SIX INCH MAP NUMBER	**Waterford 6 and 7**		
NATIONAL GRID REFERENCE	**232563 110900**		
1:50,000 O.S. SHEET NUMBER	75	**1/2 inch Sheet No.**	22

Outline Site Description
Coumshingaun is a deep glacial corrie, situated along the eastern flank of the Comeragh Mountains, eight kilometres northwest of Kilmacthomas along the R676 road.

Geological System/Age and Primary Rock Type
The feature was formed during the Quaternary (Ice Age), by glacier ice scouring out a deep, armchair-shaped hollow at the edge of the mountains.

The majority of the feature therefore comprises ice-scoured bedrock, which itself is Devonian Old Red Sandstone, and is mostly conglomerate rocks composed of large pebbles and cobbles.

Main Geological or Geomorphological Interest
This corrie has an almost-vertical backwall up to 400m in height. A lake floors the feature and the corrie is bounded on the eastern side by a moraine, which has been dissected by a Holocene (post-glacial) river draining the lake. The moraine comprises well-drained, bouldery material, and the area around and east of Coumshingaun is littered with large erratic boulders up to 15m across. Many of these erratics weigh several hundred tonnes and bear testament to the power of the ice sheet which transported them.

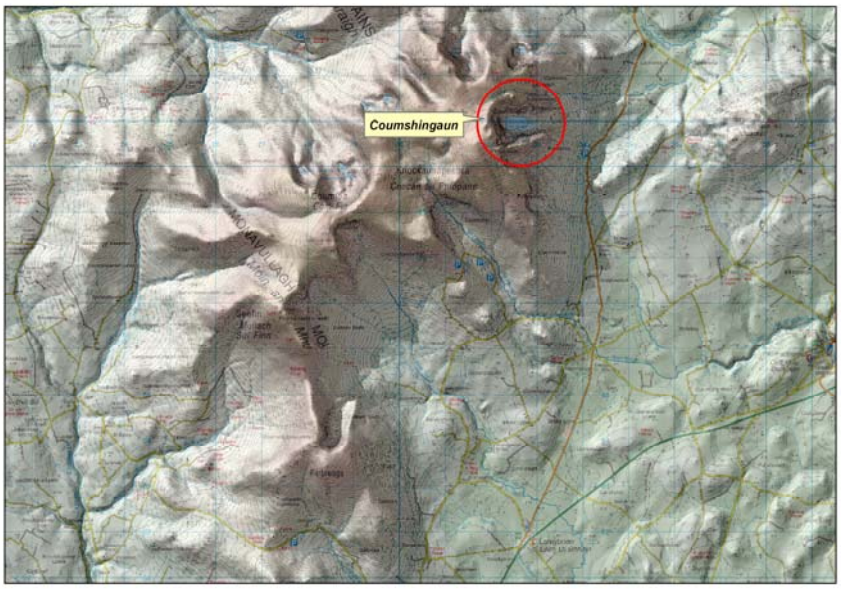
The northern and southern sides of the corrie are both arêtes, where two corries eroding towards each other result in a narrow sharp ridge of rock remaining between them.

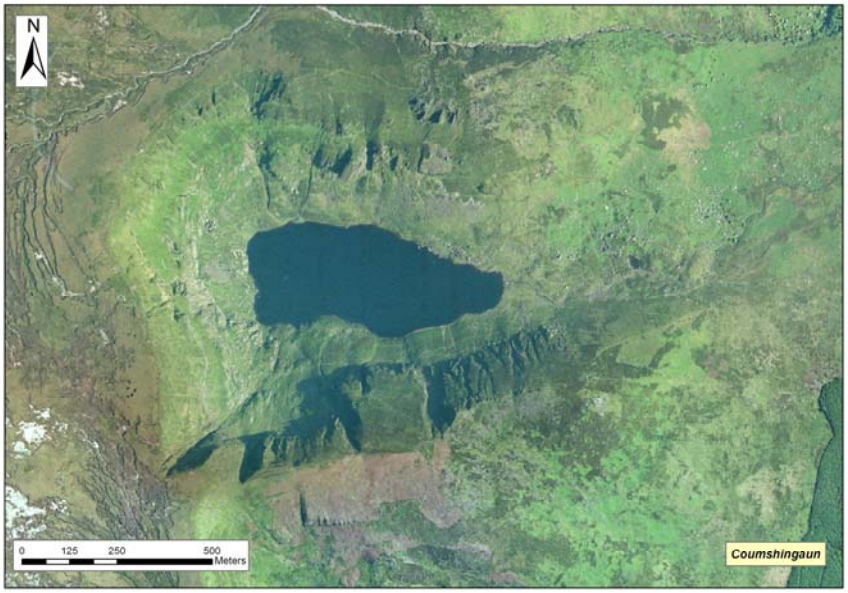
Site Importance
This is probably Ireland's finest example of a corrie. This corrie is part of a complex of Quaternary geology of national importance.

Management/promotion issues
The corrie has a rough pathway up to it, and little promotional signage in the general area. Though the feature is potentially under-promoted, the absence of a cut/built path and signs in fact helps to protect the locality as a pristine portion of montane terrain. The site is already part of the Comeraghs Mountains Special Area of Conservation and pNHA (SAC – 001952).

The view into the corrie from the arête on the southern side of Coumshingaun.

The view into the corrie backwall from the floor of the basin.


Coumshingaun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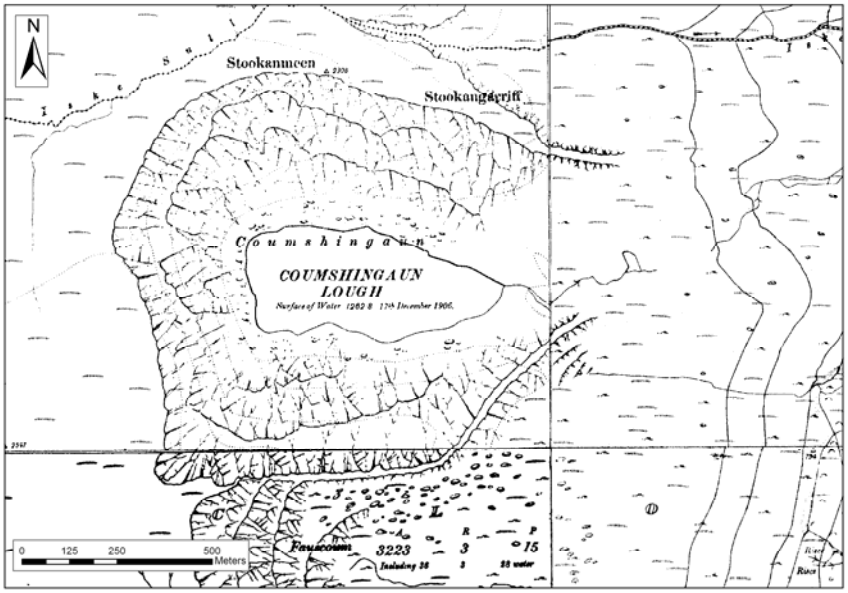
Meters
Coumshingaun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Stookangarriff
Coumshingaun
COUMSHINGAUN
LOUGH
Surface of Water 1282 ft 17th December 1906.
0 125 250 500
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Coumfea - Coumalocha**		
Other names used for site	Deer Valley (Coumfea)		
IGH THEME	**IGH7 Quaternary**		
TOWNLAND(S)	**Curraghduff. Lyre Mountain, Comeragh Mountain**		
NEAREST TOWN	**Ballymacarbry**		
SIX INCH MAP NUMBER	**Waterford 6 (and 14)**		
NATIONAL GRID REFERENCE	**228810 109980**		
1:50,000 O.S. SHEET NUMBER	75	**1/2 inch Sheet No.**	22

Outline Site Description
Coumfea and Coumalocha are two deep glacial corries, which together make up one large bowl-shaped hollow along the western flank of the Comeragh Mountains, ten kilometres east of Ballymacarbry. The features are one of three sets of corries at the head of the Nire Valley.

Geological System/Age and Primary Rock Type
The features were formed during the Quaternary (Ice Age), by glacier ice scouring out two side-by-side, deep, armchair-shaped hollows at the edge of the mountains.

The majority of the features therefore comprise ice-scoured bedrock, which itself is Devonian Old Red Sandstone. The rock itself is mostly conglomerate.

Main Geological or Geomorphological Interest
The corries comprise a wide, deep hollow, which is up to 1.5 km wide, and which contains two individual corries separated by an arête. The features have an almost-vertical backwall up to 210m in height, and the smaller, western corrie is floored by Lough Coumfea which is at a higher elevation than the floor of the eastern corrie at Coumalocha. Coumalocha is a wider, larger feature and is floored by three individual lakes (only two of which are shown on the first edition O.S. Discovery Series Map).

Both corries are bounded by particularly hummocky moraine features at their northern edges. The moraine comprises well-drained, bouldery material.

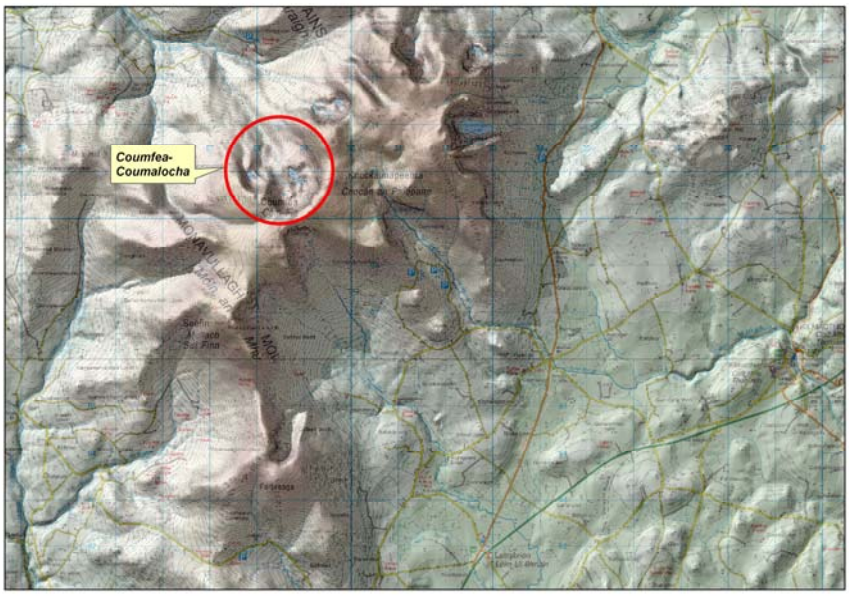
Site Importance
This is an excellent example of a composite corrie and an important County Geological Site, and this site is part of a complex of Quaternary geology of national importance. It is a particularly areally-extensive feature and its composite nature adds to its significance.

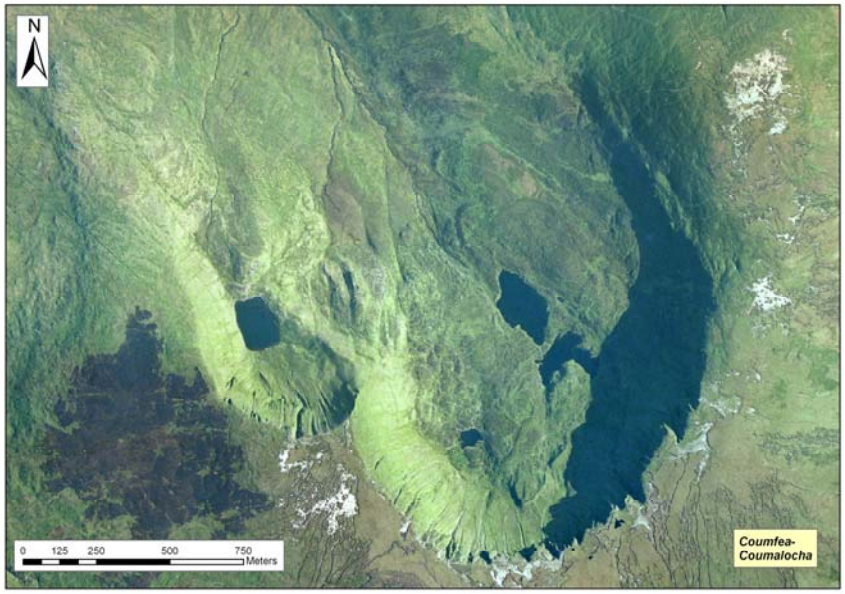
Management/promotion issues
Access to the corrie is restricted to hillwalkers and climbers, as there is no road access. Again though the feature is potentially under-promoted, the absence of a cut/built path and signs in fact helps to protect the locality as a pristine portion of montane terrain. The site is already part of the Comeraghs Mountains Special Area of Conservation and pNHA (SAC – 001952).

The western backwall of Coumalocha.

View north across Coumalocha, with two of the three lakes.

The eastern backwall of Coumalocha.


Coumfea-
Coumalocha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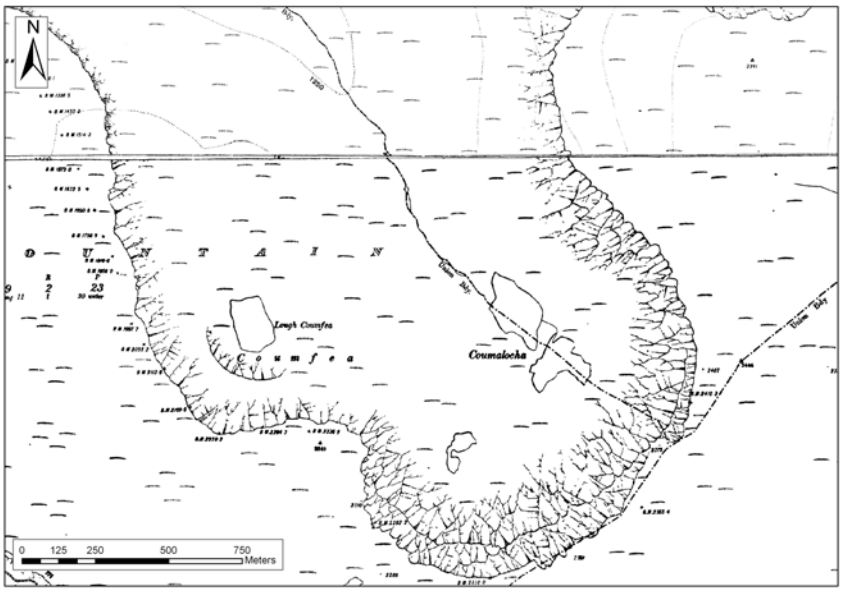
Coumfea-
Coumalocha


N
D U N T A I N
Lough Coumfea
C o u m f e a
Coumalocha
0 125 250 500 750
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Crotty's Lough Corrie**		
Other names used for site	Lough Coum Gabhartha		
IGH THEME	**IGH7 Quaternary**		
TOWNLAND(S)	**Ross, Coolnalingady**		
NEAREST TOWN	**Kilmacthomas**		
SIX INCH MAP NUMBER	**Waterford 6 and 7**		
NATIONAL GRID REFERENCE	**232670 112600**		
1:50,000 O.S. SHEET NUMBER	75	**1/2 inch Sheet No.**	22

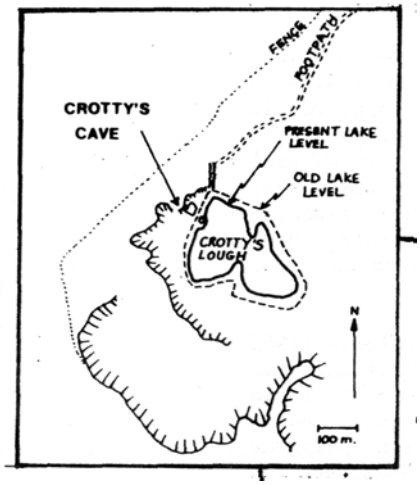
Outline Site Description
Crotty's Lough Corrie is a deep glacial corrie situated along the northeastern flank of the Comeragh Mountains.

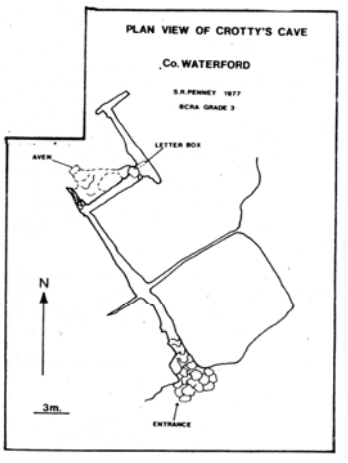
Geological System/Age and Primary Rock Type
The feature was formed during the Quaternary (Ice Age) by glacier ice scouring out a deep, armchair-shaped hollow at the edge of the mountains. The majority of the feature therefore comprises ice-scoured bedrock, which is of Devonian age, informally called the Old Red Sandstone. The rock itself is mostly conglomerate.

Main Geological or Geomorphological Interest
This corrie has an almost-vertical backwall up to 250m in height. Crotty's lake floors the feature and the corrie is bounded on the northeastern side by a high moraine feature, which itself is up to 30m high. The moraine comprises well-drained, bouldery material, and the area around and northeast of Crotty's Lough Corrie is littered with large erratic boulders. The backwall of the corrie is formed in well bedded sandstone, which has beds up to 2m thick, and which has been eroded and fractured to form some unusual, blocky, rock formations. The most impressive of these is Crotty's Rock itself. They also include Crotty's Cave, which is a fissure cave, not a karstic cave.

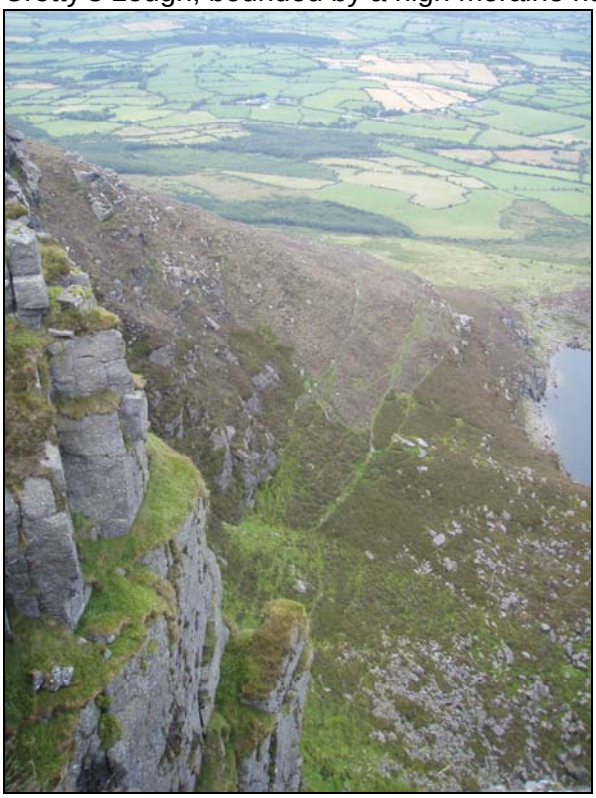
Site Importance
This is a fine example of a corrie and as the feature is particularly narrow (only 400m across) the steepness and height of the backwall is marked. This corrie is part of a complex of Quaternary geology of national importance.

Management/promotion issues
The corrie has a rough pathway up to it, and no promotional signage in the general area. Though the feature is potentially under-promoted, the absence of a cut/built path and signs in fact helps to protect the locality as a pristine portion of montane terrain. The site is already part of the Comeraghs Mountains Special Area of Conservation and pNHA (SAC – 001952).



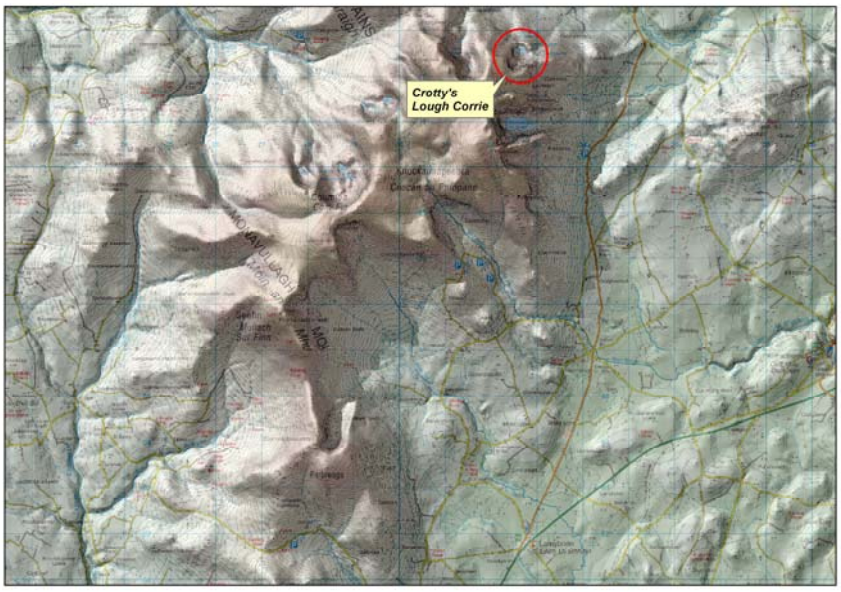


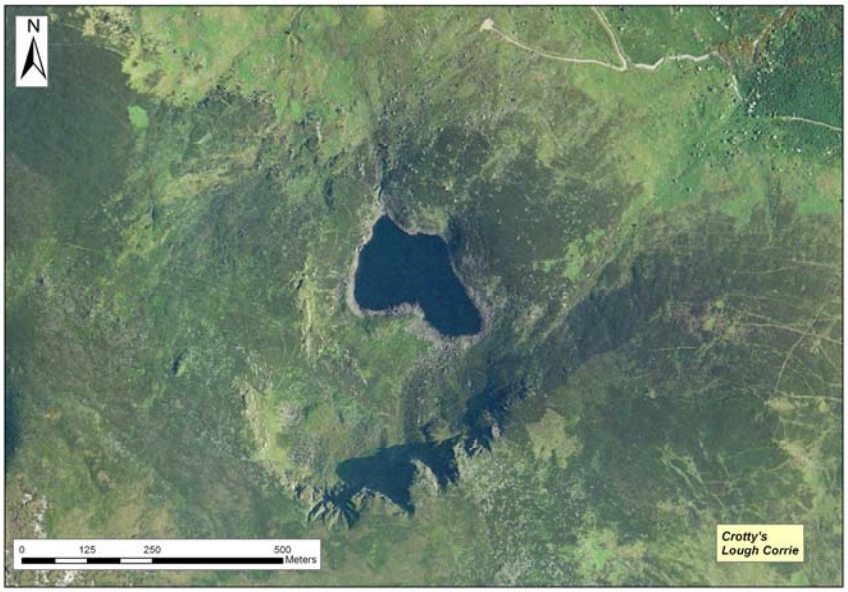
Crotty’s Lough, bounded by a high moraine ridge at its northern side.



The steep northwestern backwall of Crotty’s Lough corrie.

Some of notable rock buttresses in the backwall of Crotty’s Lough corrie.


Crotty's
Lough Corrie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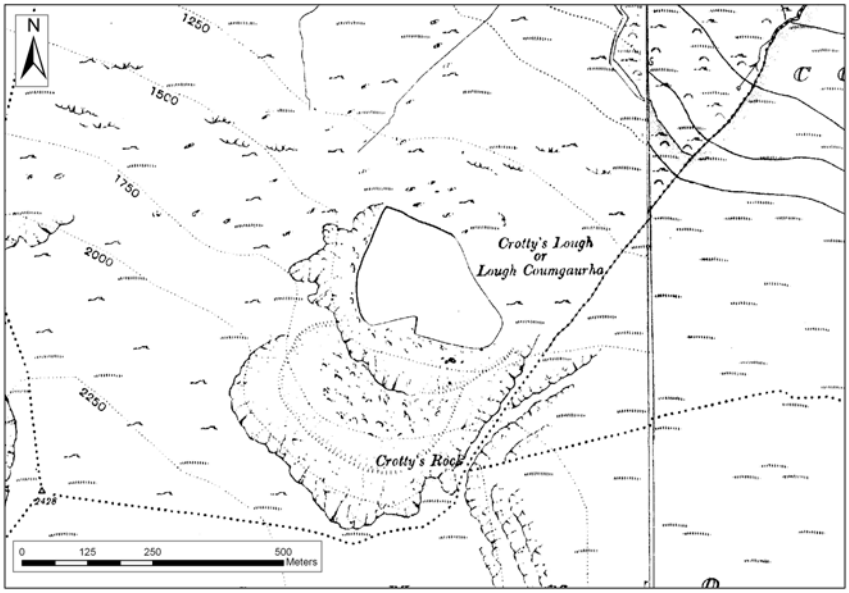
Meters
Crotty's
Lough Corrie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Crotty's Lough
or
Lough Coumgaurha
Crotty's Rock
0
125
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Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Coumtay**		
Other names used for site			
IGH THEME	**IGH7 Quaternary**		
TOWNLAND(S)	**Comeragh Mountain**		
NEAREST TOWN	**Lemybrien**		
SIX INCH MAP NUMBER	**Waterford 14**		
NATIONAL GRID REFERENCE	**229178 108560**		
1:50,000 O.S. SHEET NUMBER	75	**1/2 inch Sheet No.**	22

Outline Site Description
Coumtay is a deep glacial corrie, situated along the southern flank of the Comeragh Mountains, seven kilometres northwest of Lemybrien.

Geological System/Age and Primary Rock Type
The feature was formed during the Quaternary (Ice Age), by glacier ice scouring out a deep, armchair-shaped hollow at the edge of the mountains.

The majority of the feature therefore comprises ice-scoured bedrock, which itself is Devonian Old Red Sandstone age. The rock itself is mostly conglomerate.

Main Geological or Geomorphological Interest
This corrie comprises a wide, deep hollow, which is up to 600m wide, with a particularly steep, rocky, western backwall. The corrie itself is up to 180m in height and a number of small lakes lie at the base of the feature, nestled within fine hummocky moraines.

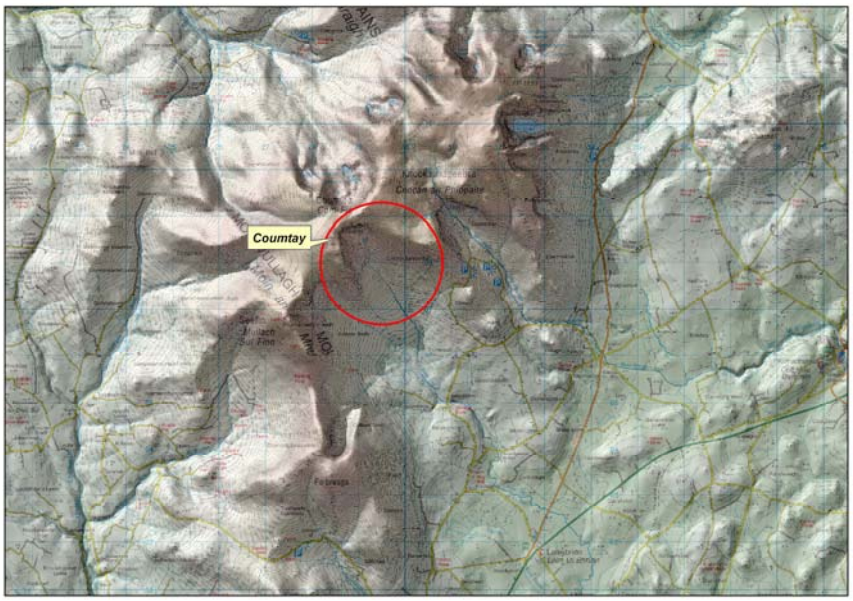
The moraines are accumulations of boulders and bouldery debris, which built up at the edge of the glacier which occupied the corrie at the end of the last Ice Age.

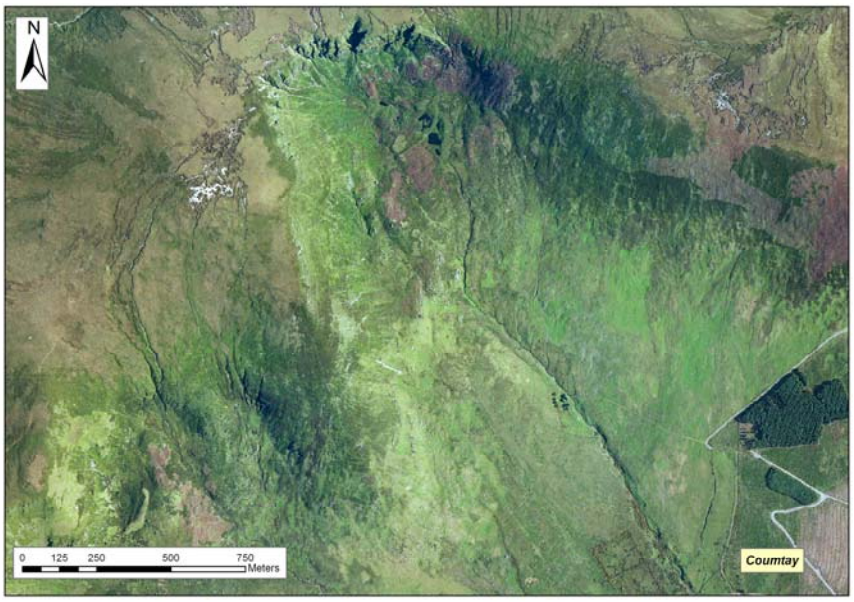
Site Importance
This is a nice example of a wide, deep corrie, which is a particularly areally-extensive feature. The fact that the feature backs on the Coumfea means the corrie experience is heightened from walking the separating ridge between them. This is part of a complex of Quaternary geology of national importance.

Management/promotion issues
Access to the corrie is restricted to hillwalkers and climbers, as there is no road access. Again though the feature is potentially under-promoted, the absence of a cut/built path and signs in fact helps to protect the locality as a pristine portion of montane terrain. The site is already part of the Comeraghs Mountains Special Area of Conservation and pNHA (SAC – 001952).

Coumtay viewed from the east side.

The backwall at the northern end of Coumtay.


Coumtay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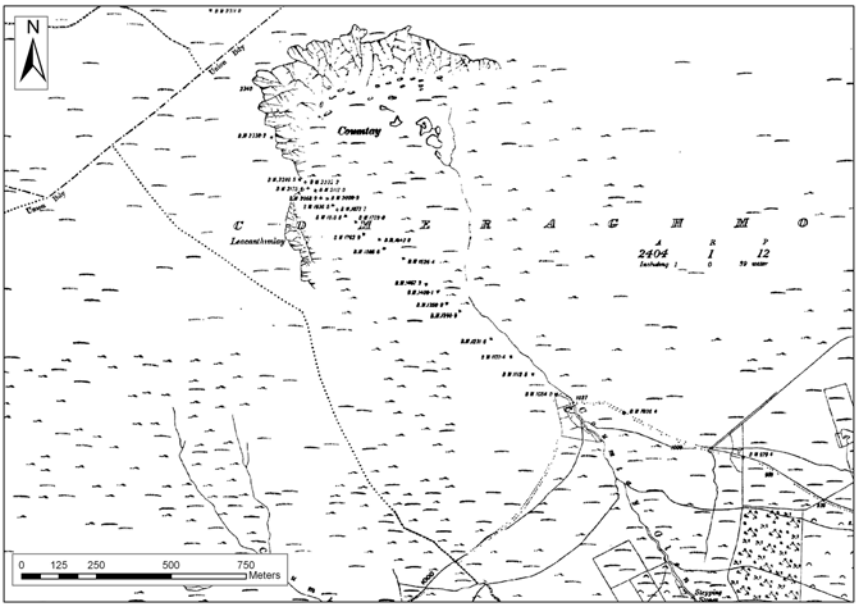
Meters
Coumtay


N
Coumtay
0 125 250 500 750
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Mahon Falls**		
Other names used for site	Coum Mahon		
IGH THEME	**IGH7 Quaternary,**		
	IGH 14 Fluvial and lacustrine geomorphology		
TOWNLAND(S)	**Kilclooney, Coummahon, Comeragh Mountain**		
NEAREST TOWN	**Kilmacthomas**		
SIX INCH MAP NUMBER	**Waterford 6 and 14**		
NATIONAL GRID REFERENCE	**230869 109230**		
1:50,000 O.S. SHEET NUMBER	75	**1/2 inch Sheet No.**	22

Outline Site Description
Mahon Falls are a series of cascading waterfalls, which flow down the backwall of a glacial corrie, situated along the southern flank of the Comeragh Mountains.

Geological System/Age and Primary Rock Type
The corrie feature was formed during the Quaternary (Ice Age), by glacier ice scouring out a deep, armchair-shaped hollow at the edge of the mountains.

The majority of the corrie feature therefore comprises ice-scoured bedrock, which itself is Devonian Old Red Sandstone. The Mahon River, which rises from a series of seeps in blanket peat in the high plateau of the Comeraghs, flows down the backwall of the corrie creating a series of stepped waterfalls, or cascades, over each of the thicker conglomerate or sandstone beds.

Main Geological or Geomorphological Interest
This corrie has a very steep backwall up to 300m in height and the Mahon River has gullied the backwall, creating a shallow gorge along part of the stretch of waterfalls. Owing to this, the falls have a stepped appearance.

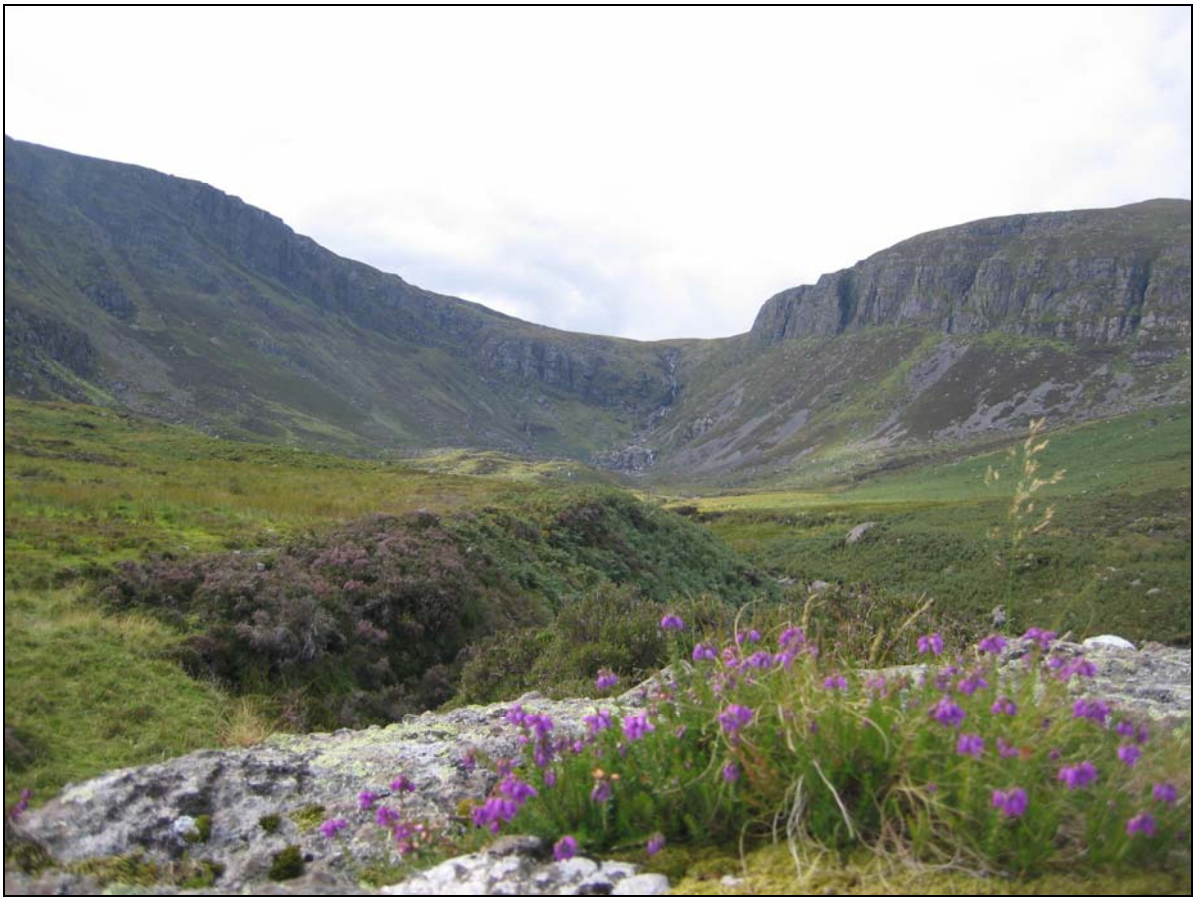
The base of the corrie hosts no lakes, but the Mahon River flows through the centre of this along a meandering path, which is initially surrounded by hummocks and boulder moraines, but further down-valley becomes a flatter, less stony, till plain. The moraines comprise well-drained material, which is strewn with erratic boulders, many of which are several metres across.

The eastern side of the corrie has some well-expressed scree slopes.

As corries usually only take flows of water from a relatively restricted up-gradient catchment, the waterfalls are unusual in that a sizeable stream happens to flow across the backwall. Owing to this, the falls can become a torrent in wet weather as the river swells.

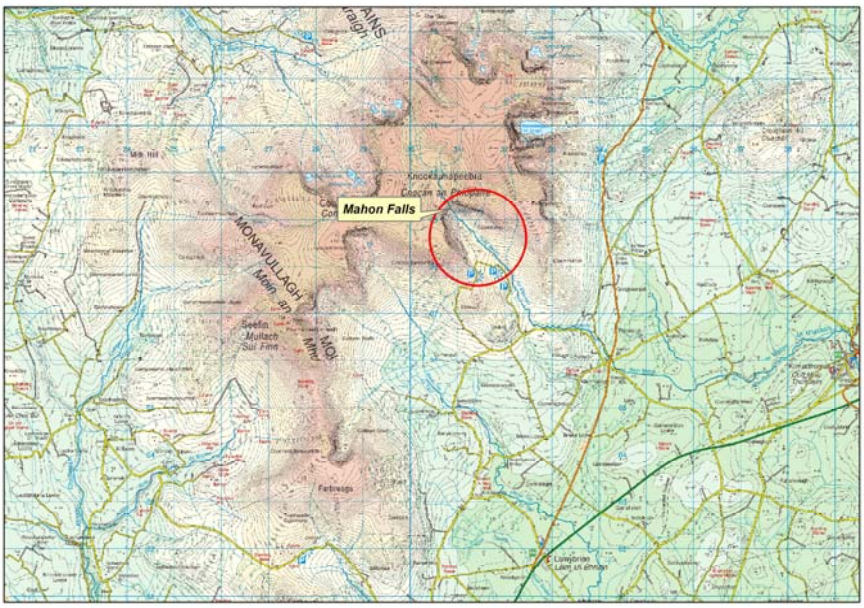
Site Importance
The site is of national importance and is arguably Ireland's finest waterfall. This site is part of a complex of Quaternary geology of national importance, and is of national importance in the fluvial and lacustrine geomorphology theme also.

Management/promotion issues
The corrie has a built pathway up to it and a well developed network of promotional signage in the general region surrounding. A discreet signboard at the falls themselves might prove a worthwhile addition. The site is already part of the Comeraghs Mountains Special Area of Conservation and pNHA (SAC – 001952).



Mahon falls, viewed from the south.

Mahon falls, viewed from the access path for visitors.


Mahon Falls
MONAVULLAGH
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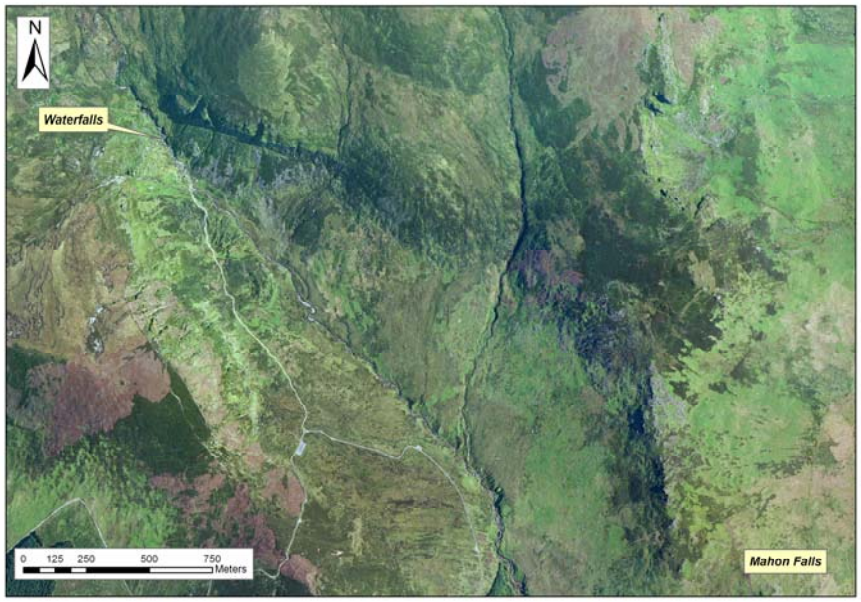
N
Waterfalls
Mahon Falls
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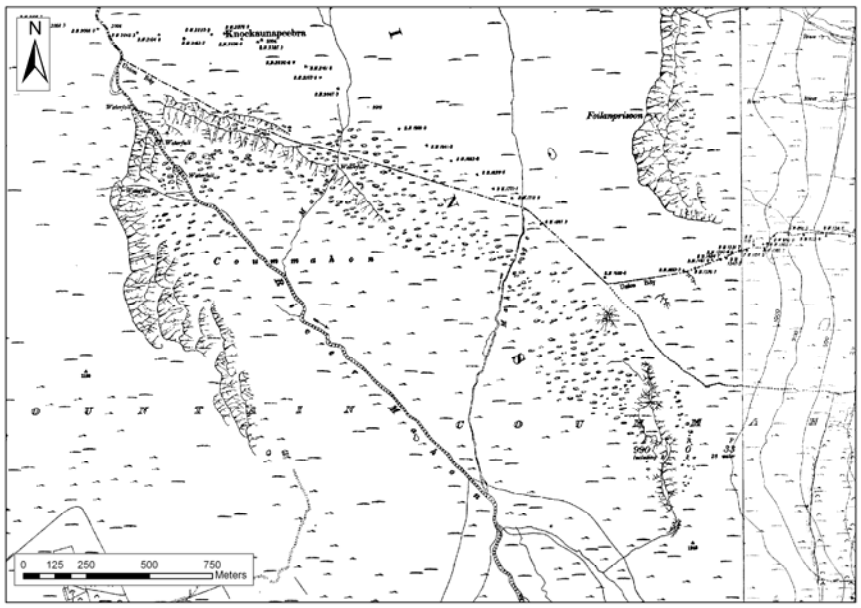
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Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Coumiarthar**		
Other names used for site	Coum Iarthar, Boola Lakes		
IGH THEME	**IGH7 Quaternary**		
TOWNLAND(S)	**Boolacloghagh**		
NEAREST TOWN	**Rathgormack**		
SIX INCH MAP NUMBER	**Waterford 6**		
NATIONAL GRID REFERENCE	**231590 112190**		
1:50,000 O.S. SHEET NUMBER	75	**1/2 inch Sheet No.**	22

Outline Site Description
Coumiarthar is a deep glacial corrie, situated along the northern flank of the Comeragh Mountains.

Geological System/Age and Primary Rock Type
The feature was formed during the Quaternary (Ice Age), by glacier ice scouring out a deep, armchair-shaped hollow at the edge of the mountains.

The majority of the feature therefore comprises ice-scoured bedrock, which itself is Devonian Old Red Sandstone, and is composed of conglomerates of pebbles and cobbles.

Main Geological or Geomorphological Interest
This corrie has an almost-vertical backwall up to 200m in height. Three pater noster lakes floor the feature, so called because they form a series of linear lakes connected by a single stream, similar to the form and outline of rosary beads (hence ‘Pater Noster’, which means ‘Our Father’ in Latin).

The corrie is bounded by both lateral moraines, which form a pile of debris around the back and sides of the feature (lateral to the ice which floored the valley), and end moraines, which stretch across the entrance to the valley and partially bound the lake features. The moraines comprise well-drained, bouldery material, and the area around Coumiarthair is littered with large erratic boulders.

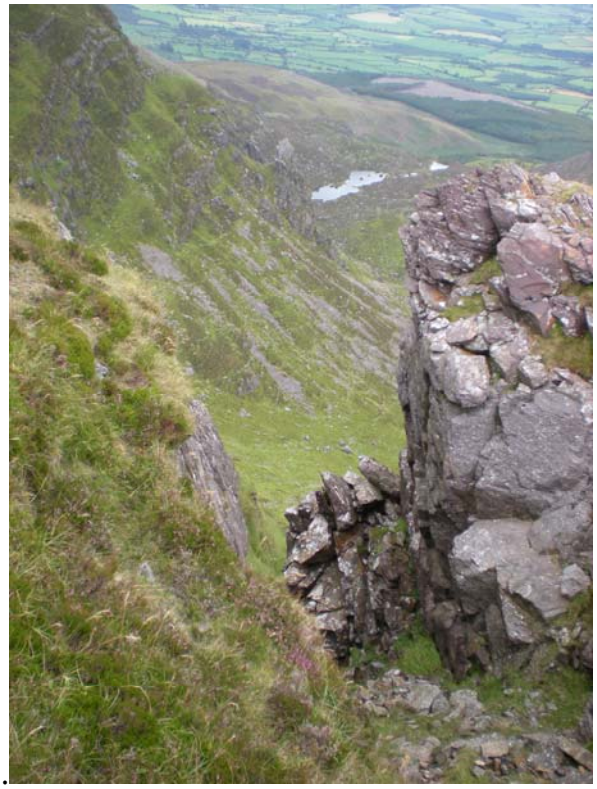
As the beds of rock at the sides and back of the corrie are relatively steeply-dipping, the ice has scoured out blocks of these leaving some spectacular rock crags (cliffs) along the valley sides.

Site Importance
This is a particularly impressive corrie feature, being narrow and steep, and having a form different to that seen elsewhere in the Comeraghs with the lateral moraines and chain of lakes. The rock crags also add to its uniqueness. This is part of a complex of Quaternary geology of national importance.

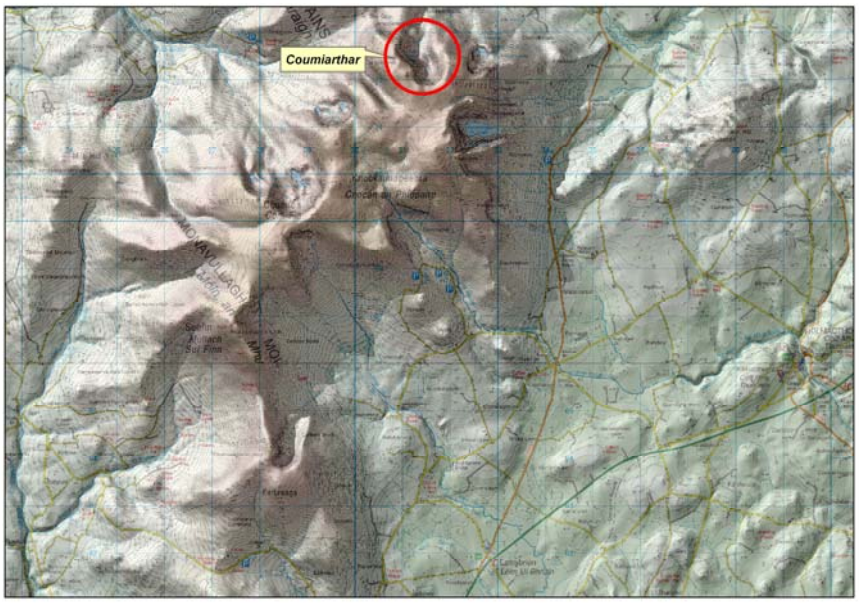
Management/promotion issues
The corrie has a rough pathway up to it and little promotional signage in the general area. Though the feature is potentially under-promoted, the absence of a cut/built path and signs in fact helps to protect the locality as a pristine portion of montane terrain. The site is already part of the Comeraghs Mountains Special Area of Conservation and pNHA (SAC – 001952).

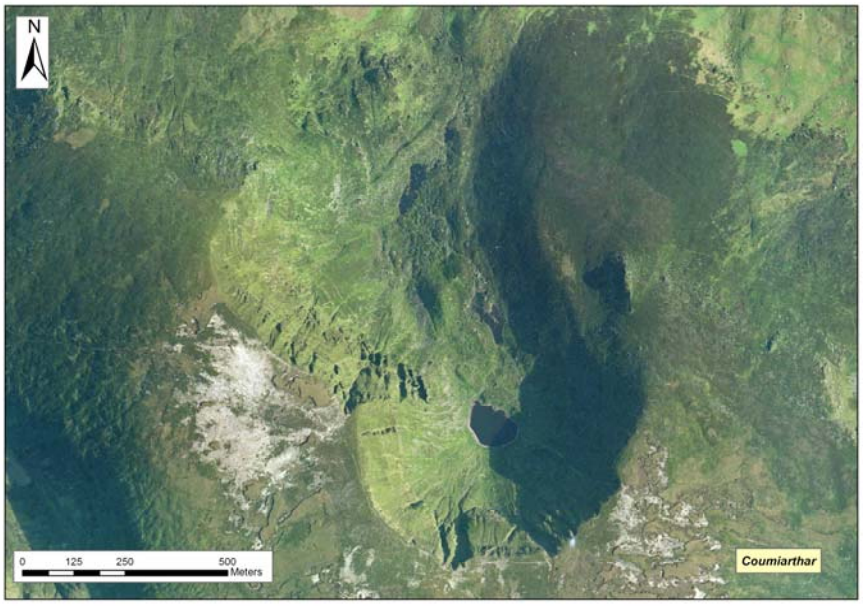
Pater noster lakes at the base of Coumiarthar.

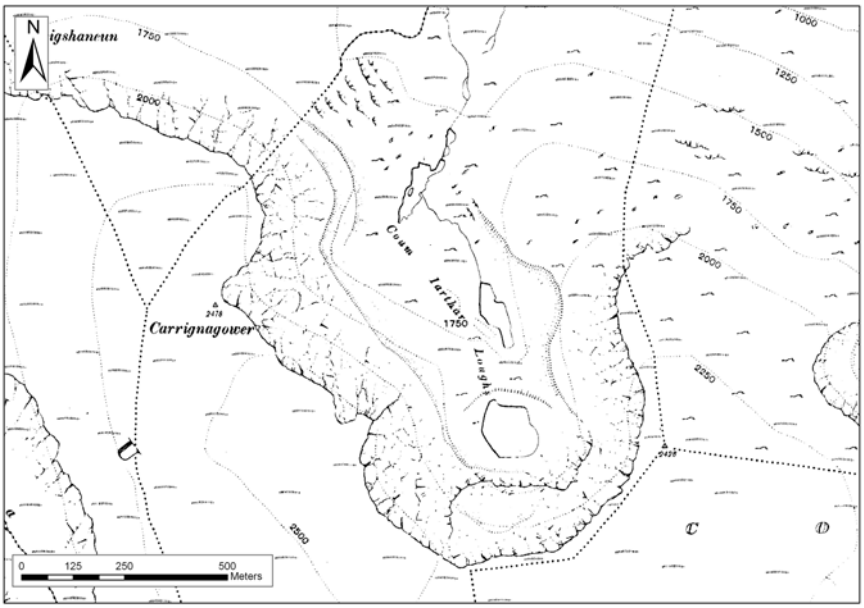
View of corrie backwall, the lakes and moraine at the corrie entrance of Coumiarthar.



Steep gully in the backwall of Coumiarthar.


Coumiarthar


N
0 125 250 500
Meters
Coumiarthar


N
1750
2000
1000
1250
1500
1750
2000
2250
2500
Carrignagower
2478
1750
Lough
0 125 250 500
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Sgilloge Loughs Corrie**		
Other names used for site			
IGH THEME	**IGH7 Quaternary**		
TOWNLAND(S)	**Curraghduff**		
NEAREST TOWN	**Ballymacarbry**		
SIX INCH MAP NUMBER	**Waterford 6 and 14**		
NATIONAL GRID REFERENCE	**230000 111400**		
1:50,000 O.S. SHEET NUMBER	75	**1/2 inch Sheet No.**	22

Outline Site Description
Sgilloge Loughs Corrie is a deep glacial corrie situated along the northern flank of the Comeragh Mountains.

Geological System/Age and Primary Rock Type
The feature was formed during the Quaternary (Ice Age) by glacier ice scouring out a deep, armchair-shaped hollow at the edge of the mountains.

The majority of the feature therefore comprises ice-scoured bedrock, which itself is of Devonian age, informally called the Old Red Sandstone. The rock itself is mostly conglomerate.

Main Geological or Geomorphological Interest
This corrie has an almost-vertical backwall up to 230m in height. Two pater noster lakes floor the feature, so called because they form a series of linear lakes connected by a single stream, similar to the form and outline of rosary beads (hence ‘Pater Noster’, or ‘Our Father’ in Latin).

The corrie is bounded by a particularly impressive end moraine ridge, which stretches across the entrance to the valley and partially bounds the lake features. The moraine comprises well-drained, bouldery material, and the area around Sgilloge Loughs Corrie is littered with large erratic boulders.

The ice has scoured out blocks of these leaving some spectacular rock crags and benches along the valley backwall and sides.

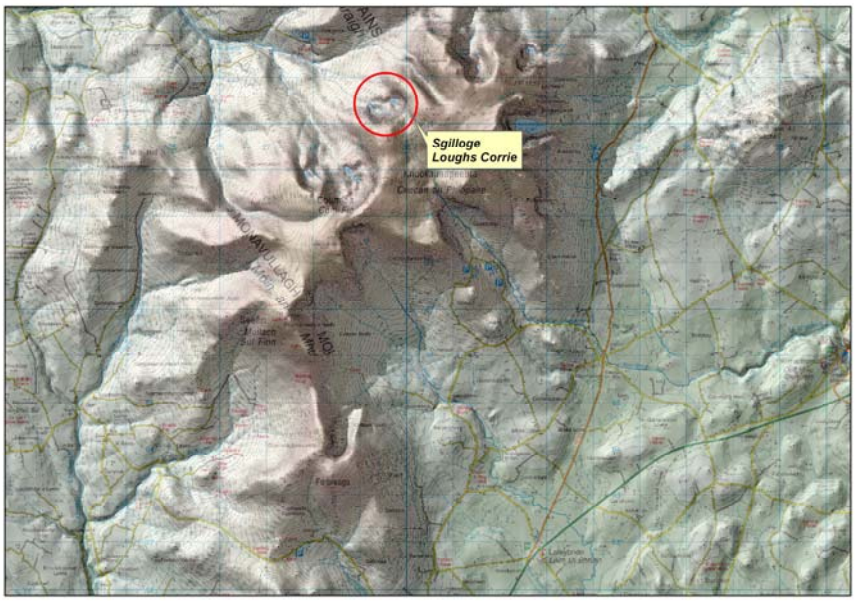
Site Importance
This is a particularly impressive corrie feature, being wide and steep. The rock crags and benches also add to its uniqueness. This is part of a complex of Quaternary geology of national importance.

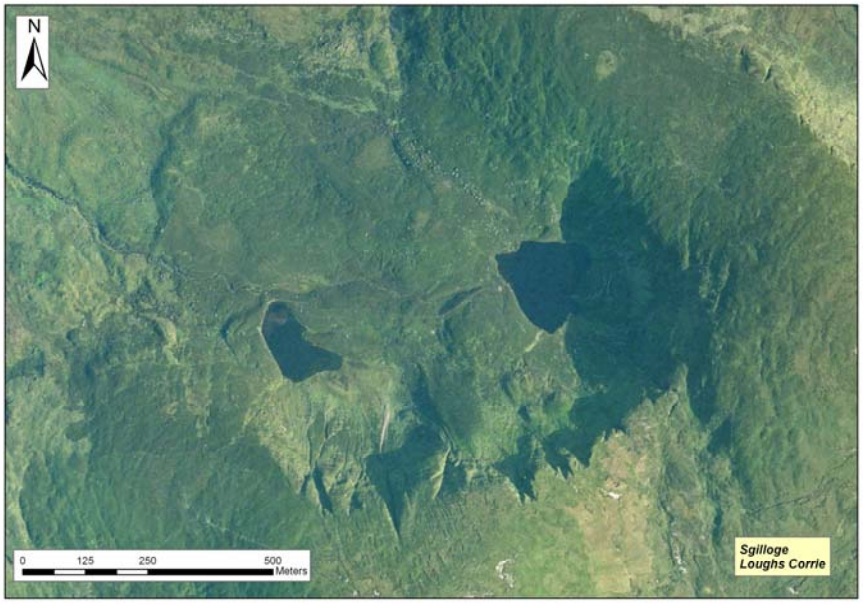
Management/promotion issues
The corrie has a rough pathway up to it and little promotional signage in the general area. Though the feature is potentially under-promoted, the absence of a cut/built path and signs in fact helps to protect the locality as a pristine portion of montane terrain. The site is already part of the Comeraghs Mountains Special Area of Conservation and pNHA (SAC – 001952).

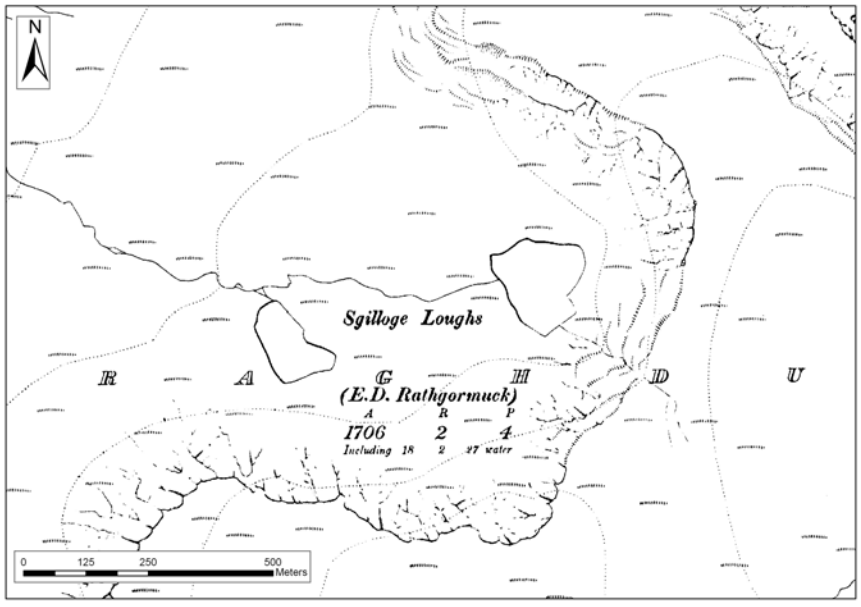
Sgilloge Loughs Corrie, with two lakes at its base.

View west across the corrie backwall.

The large end moraine ridge can be clearly seen at the far side of the lake viewed from the corrie backwall.


Sgilloge
Loughs Corrie


N
0 125 250 500
Meters
Sgilloge
Loughs Corrie


N
Sgilloge Loughs
R A G H D U
(E.D. Rathgormuck)
A R P
1706 2 4
Including 18 2 27 water
0 125 250 500
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Ballyquin Shore**		
Other names used for site			
IGH THEME	**IGH 7 Quaternary; IGH 10 Devonian**		
TOWNLAND(S)	**Ballyquin**		
NEAREST TOWN	**Ardmore**		
SIX INCH MAP NUMBER	**Waterford 38**		
NATIONAL GRID REFERENCE	**220900 80230**		
1:50,000 O.S. SHEET NUMBER	82	**1/2 inch Sheet No.**	22

Outline Site Description
Coastal section of bedrock on foreshore, and cliffs in unconsolidated deposits.

Geological System/Age and Primary Rock Type
Devonian sandstones and mudstones, with Quaternary tills overlying and thick deposits of postglacial head which is weathered rock fragments accumulations on lower slopes, as a result of periglacial freezing and thawing action.

Main Geological or Geomorphological Interest
At Ballyquin a small river valley exploits a fault line, with two different successions of rocks on each side, exposed in the foreshore. In addition there are two different types of unconsolidated deposits overlying the bedrock, exposed in the cliffs on either side of the fault line. The bedrock west of the valley in the fault line is called the Crows Point Formation and is probably early Carboniferous in age. To the east of it a colourful sequence of sandstone and mudstone rocks is seen. These are classified as the Ballyquin Member of the Gyleen Formation by geologists. The rocks are quite variable in colour, and with different features showing their original sedimentary environment. They are from the last part of the Devonian Period.

In the low cliffs west of the fault, two different units of subsoil may be seen. The subsoils at Ballyquin are mixed deposits of rocks, sand, silt and clay completely jumbled together. These were deposited below an ice sheet and are called “till”. At Ballyquinn a dark brown till, mostly composed of clays and with some shells, was deposited by ice which came onto the land from the sea. Overlying this is a paler rusty brown, more stony till from the last main cold period of the Ice age, where ice moved off the land towards the lower ground. These can be seen together in places despite the frequent slumps of the higher till over the more consolidated “Irish Sea” till at the base of the low cliffs. Active marine erosion of the cliffs means slumps and exposures will regularly change and slowly retreat the cliff line.

On the eastern side of the fault line, a different unconsolidated deposit forms vertical cliff faces up to 8m high. This is called head. It is a very stony deposit of weathered rocks fragments which have slowly slid and slumped downhill from higher ground and accumulated in lower slopes. They have principally moved under the influence of gravity combined with freeze-thaw cycles, mostly in the immediate post-glacial period around 10,000 years ago.

Site Importance
The site is of CGS importance but is under possible consideration for NHA status in the IGH 7 Quaternary theme.

Management/promotion issues
The site is publicly accessible from a beach car park at the eastern end, and via the local road in the fault guided valley. Aside from normal warnings about safety from cliff falls of rock (especially from the head cliffs) and caution with tides along foreshore settings, this site is one which could be promoted in publications, websites, and other ways.

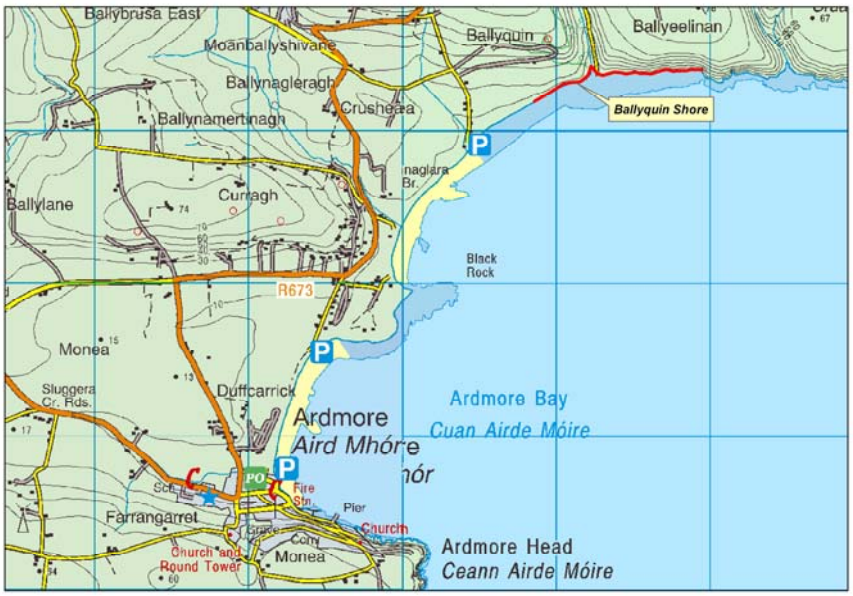
The valley on the fault line.

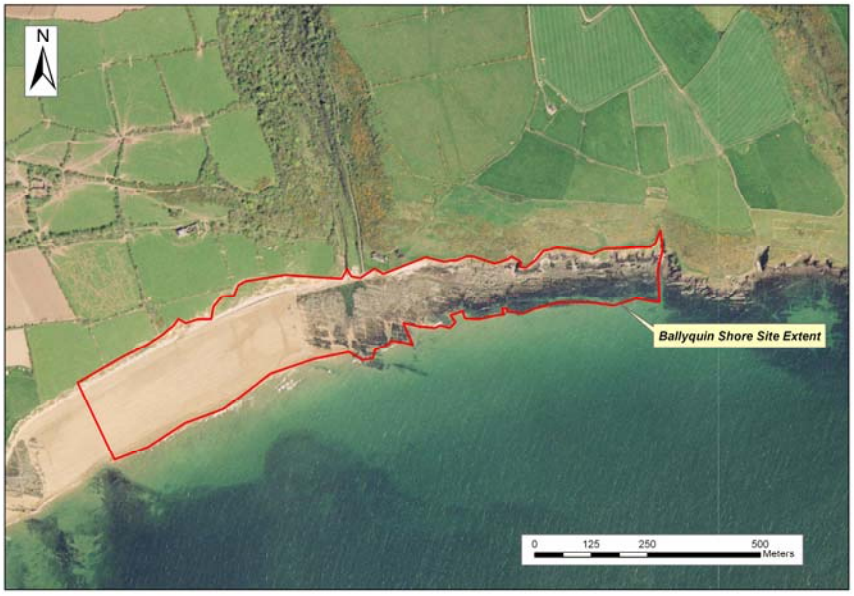
Ballyquin Member channel beds.

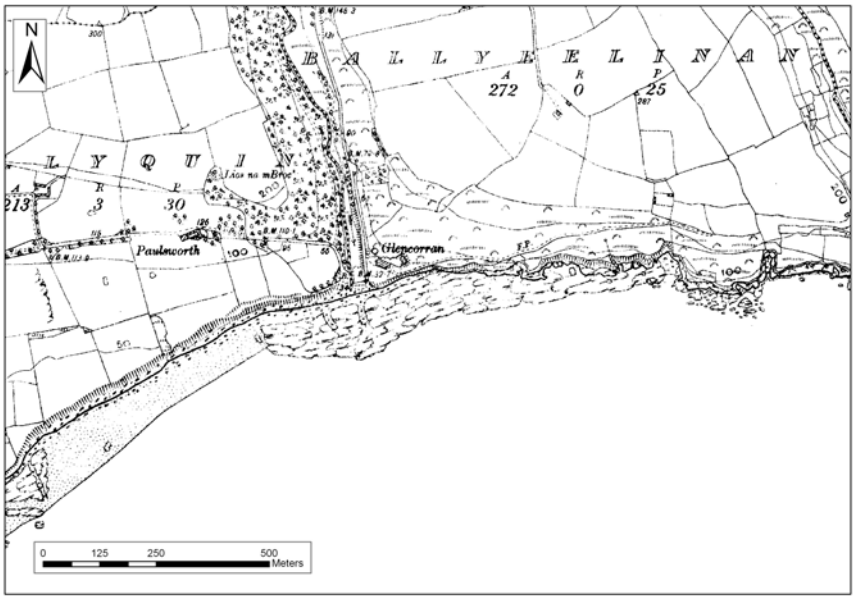
The head deposits, east of the fault line valley.

Red mudstone rocks in the Ballyquin Member rocks, looking west.

The slumped tills west of the fault line valley.


Ballybrusa East
Moanballyshivane
Ballynagleragh
Ballynamertinagh
Crusheaa
Ballyquin
Ballyeelinan
Ballyquin Shore
Ballylane
Curragh
naglara Br.
Black Rock
R673
Monea
Sluggera Cr. Rds.
Duffcarrick
Ardmore
Aird Mhóre
Ardmore Bay
Cuan Airde Móire
PO
Fire Stn.
Pier
Church
Farrangarret
Church and Round Tower
Ardmore Head
Ceann Airde Móire


N
Ballyquin Shore Site Extent
0 125 250 500 Meters


N
B A L L Y E E L I N A N
272
25
L Y Q U I N
213
30
Paulscorth
Glencorran
0 125 250 500 Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Newtown**		
Other names used for site			
IGH THEME	**IGH7 Quaternary**		
TOWNLAND(S)	**Newtown, Crooke**		
NEAREST TOWN	**Passage East**		
SIX INCH MAP NUMBER	**Waterford 18**		
NATIONAL GRID REFERENCE	**269995, 107310**		
1:50,000 O.S. SHEET NUMBER	76	**1/2 inch Sheet No.**	23

Outline Site Description
This site includes a low coastal cliff section that extends for *c*. several hundred metres and is *c*. 6m-8m high over the majority of its extent.

Geological System/Age and Primary Rock Type
The cliff section along the Newtown portion of the beach at Raheen-Newtown is comprised of Quaternary Age glacial sediments.

Main Geological or Geomorphological Interest
The cliff exposes long-studied sediments, which have made this a type-site for glacial stratigraphic work in Ireland. Summarising, the cliff was previously interpreted as being comprised of a till overlying a head deposit which again overlies silts with interspersed thin peat, which has been dated at 38,000 years BP. The silt overlies beach gravels which again lie on top of a shore platform in bedrock. Lower Ordovician Ribband Group rocks of stripy slates are well displayed in places on this platform.

The silt and peat deposits were considered by some researchers to be from the penultimate interglacial but others considered them to be from the last interglacial period.

Examining the sedimentology of the cliff shows that there are two tills, a less consolidated, more stony and more haphazard till about 2m-3m thick, overlying a competent, stiff, finer-grained till in the basal 4m-6m. This sequence may be simply a subglacial till at the base of the section, overlain by a melt-out till 'dropped' out of the ice.

The lower till includes gravel beds and clay lenses, and is dominated by erratic Old Red Sandstone rocks. Large boulders of Leinster granite and Ordovician rocks are also seen in the section and strewn across the beach.

At the base of the section today, a yellow clay overlies reddish brown silty clay material in the central portion of the section: this may be where the original peat find was recorded.

Site Importance
This is a particularly impressive exposure into deep glacial tills, with several sedimentological characteristics well exposed. The site is effectively included within the existing proposed Waterford Harbour NHA (pNHA 000787). It is also part of the River Barrow and River Nore SAC 002162. County Geological Site status will help protect it until it is formally put forward for designation as a geological NHA.

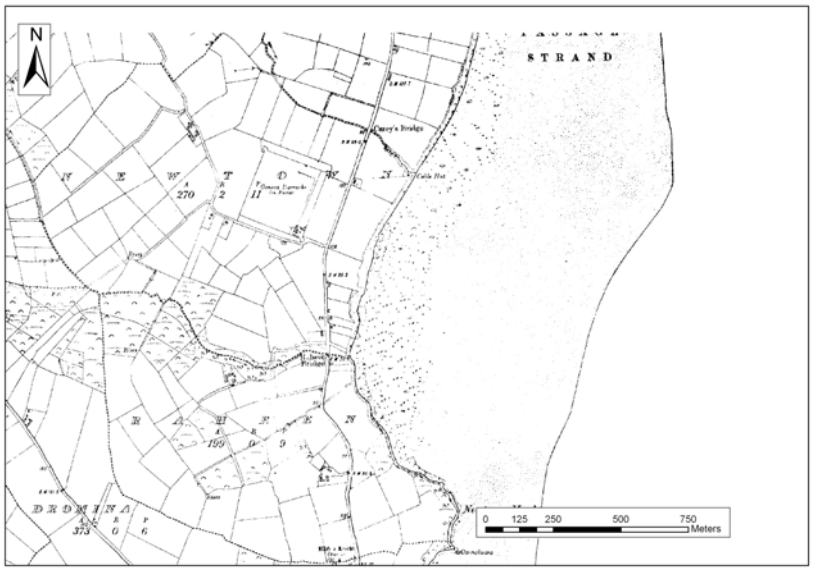
Management/promotion issues
The site is accessible through public beach access and is therefore easily visited. The cliffs are prone to slumping, however, and care must be taken when close to the faces. The importance of the section could be highlighted in promotional material for the Waterford Harbour proposed NHA. The site is entirely contiguous with the Raheen Shore section but the different geological interests have been kept as two separate sites.

Newtown section looking south towards the Raheen Shore site in the distance.

Newtown section looking north.


WATERFORD
Port Láirge
RIVER SUIR
BALLYHACK
Newtown


N
Newtown Site Extent
Access point
0 125 250 500 750
Meters


N
STRAND
DRUMINA
0 125 250 500 750
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**St Declan's Stone**		
Other names used for site			
IGH THEME	**IGH7 Quaternary**		
TOWNLAND(S)	**Duffcarrick**		
NEAREST TOWN	**Ardmore**		
SIX INCH MAP NUMBER	**Waterford 40**		
NATIONAL GRID REFERENCE	**219323 77537**		
1:50,000 O.S. SHEET NUMBER	75	**1/2 inch Sheet No.**	22

Outline Site Description
St Declan's Stone is a glacial erratic boulder, which rests on outcropping bedrock beside Ardmore Pier.

Geological System/Age and Primary Rock Type
The erratic was dropped on to the bedrock outcrop by glacier ice, having been transported from its source. The erratic is of Devonian-age conglomerate rock and rests on bedded sandstone of much younger Lower Carboniferous (Dinantian) age.

Main Geological or Geomorphological Interest
Erratic boulders are rare in the valleys of Waterford and east Cork. Though the subsoils on the Lower Carboniferous rocks commonly have erratic sandstone and conglomerate lithologies, these materials usually comprise tills with admixtures of sands, silts, clays, gravels and cobbles, with boulder sized clasts being rare. It is also unusual to see any boulders at the ground surface.

The boulder is 2m x 1m across and is perched on top of two beds of limestone with a marked void beneath. A rock pool has formed beneath the void and the boulder.

Site Importance
This is a relatively unique erratic block and erratics of this size are unusual in this part of Waterford. The site is of County Geological Site status.

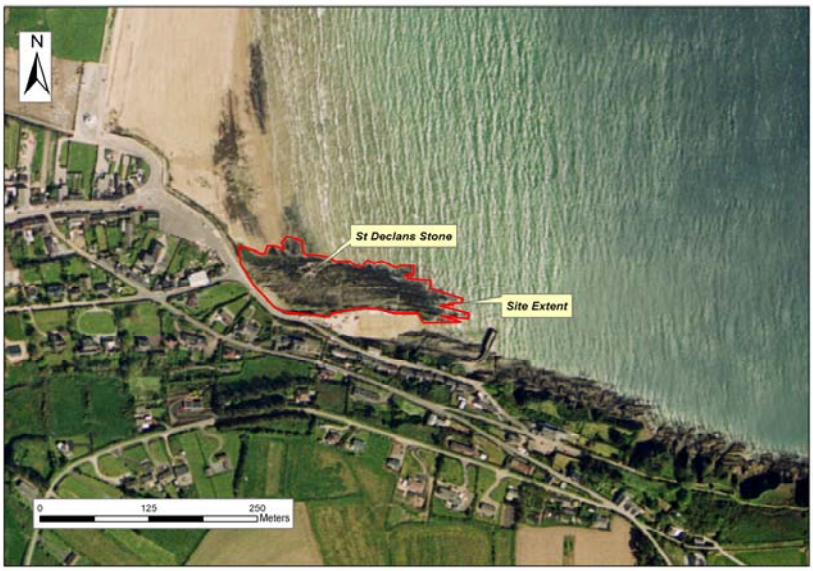
Management/promotion issues
Though the stone is signposted in the town of Ardmore itself, it is difficult to know exactly where the stone is. A promotional sign at the entrance to the beach area might prove useful, with a simple explanation of what an erratic is, at least in parallel to any religious significance that the stone has been imbued with. Secular explanation is as valid as spiritual in this case.

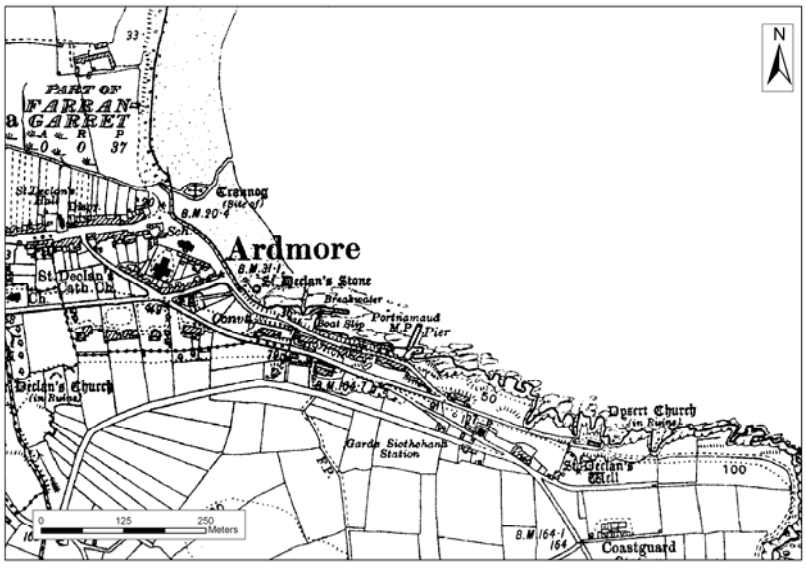
St. Declan's Stone – a large glacial erratic, seen from the roadside.

The conglomeratic nature of the rock can be Seen close-up to the stone.

The existing direction sign to the stone.


Monea
Sluggera
Cr. Rds.
Duffcarrick
Ardmore
Aird Mhór
Ardmore
Cuan Aird
amona
Farrangarret
Fire
Stn.
St Declans Stone
Pier
Church
Church and
Round Tower
Monea
Ardmore
Ceann Ai
Dysert
Ardocheasty
Watch
Tower
Ram Hea
Ceann an
Ardoginna


N
St Declans Stone
Site Extent
0
125
250
Meters


N
PART OF
FARRAN-
GARRET
Tranog
Ardmore
St Declan's Stone
Portnamaud
Pier
Declan's Church
Dysert Church
Garda Siothchana
Station
Coastguard
0
125
250
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Whiting Bay – Goat Island Cove**		
Other names used for site			
IGH THEME	**IGH8 Lower Carboniferous, IGH7 Quaternary IGH15 Economic Geology**		
TOWNLAND(S)	**Ballysallagh, Clashanahy, Cappagh, Ardoginna**		
NEAREST TOWN	**Ardmore**		
SIX INCH MAP NUMBER	**Waterford 40**		
NATIONAL GRID REFERENCE	**216000 77600 (entry to beach)**		
1:50,000 O.S. SHEET NUMBER	82	**1/2 inch Sheet No.**	22

Outline Site Description
Around Whiting Bay and as far east as Goat Island Cove, approximately 2km of coastal cliffs, beach and foreshore occur, displaying a variety of rocks and unconsolidated glacial sediments.

Geological System/Age and Primary Rock Type
A varied sequence of early Carboniferous aged sedimentary rocks, including sandstones, mudstones and limestones occurs along the eastern end of the section. The site also includes a long section of Quaternary (Ice Age) tills at the western half.

Main Geological or Geomorphological Interest
A varied sequence of early Carboniferous aged sedimentary rocks at Whiting Bay provide a link for geologists in correlating the Carboniferous rocks between the larger areas of similar aged rocks in the Cork Syncline to the southwest and the Lismore and Tallow Syncline to the north. Whiting Bay itself occurs on the edge of the smaller Ardmore Syncline.

There are rapid transitions between rock types along the beach and a varied range of sedimentary features and structures which, in detail, provide a lot of evidence for the changes of environment, both across the geographical spread of the Carboniferous seas and through time as the marine basins changed and evolved.

The site includes a minor example of mineralisation associated with faults, easily visible in the cliffs of Goat Island Cove at the eastern end. There is also a minor example of a raised beach deposit here, where beach gravels have been cemented together across the top of steeply dipping Carboniferous rocks. A disused limekiln in reasonable repair is found on the access track at Goat Island Cove, adding some extra interest.

The western half of the site has a sandy beach backed with cliffs of glacial till, which was deposited by ice streaming down the Irish Sea and pushing onshore across south Waterford. These show a long section in till of several hundred metres length, although the cliffs are quite slumped.

Site Importance
Cumulatively, the site has a wide range of features of interest, such that it has national importance for the Lower Carboniferous geology and may be considered for geological NHA status as the GSI's work on Irish Geological Heritage progresses to that theme.

Management/promotion issues
There are two public beach car parks for access to the site and road access at Goat Island Cove. Consideration could be given to providing geological information on a signboard at any or all of these places. Access to the rocks around the headland is probably tidally controlled and caution must be advised in any promotional effort.

Whiting Bay, viewed from the eastern end.

Goat Island Cove, exposing Carboniferous rocks along its extent.

Raised beach deposit of cemented gravels.

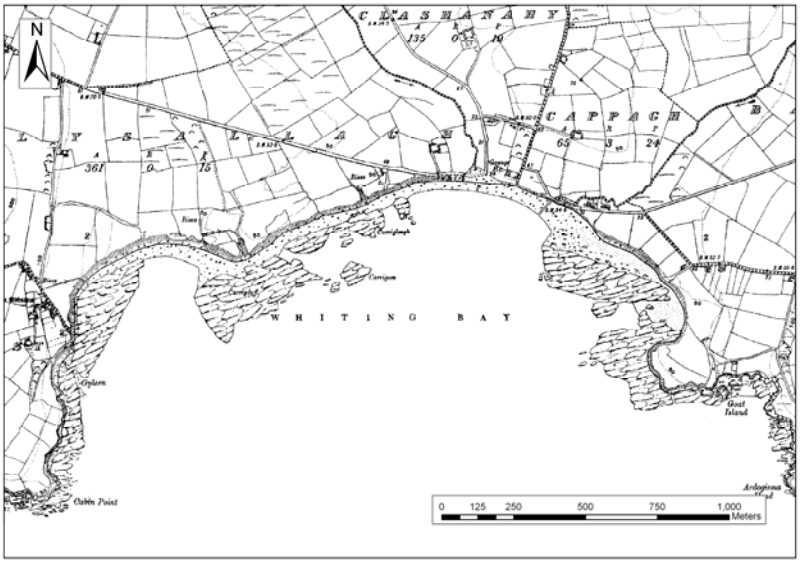
A fault with minor mineralisation at Goat Island Cove.

Profile of muddy Irish Sea till exposed along the rest of Whiting Bay.

View eastwards to rocks at end of Whiting Bay.


Kinsalebeg
Baile an Phoill
Grange
Ballykilmurry
Ballyane
Curragh
Rath
Moore
Shanbally
Crossford
R673
Black Rock
Bawnacommera
Listeige
Monea
Mortgage
Clashanahy
Foxhole
Duffcarrick
Ardmore
Aird Mhóre
Springfield Upper
Ballysaraigh
Cappagh
Ballynamona
Farrangarret
Whiting Bay
Béal Abha
Monatray East
Cable Point
Goat Island
Ardoginna Head
Ard Ó gCinnéa
Ardocheasty
Dysert
Ardoginna


N
Whiting Bay-Goat Island
Site Extent
0 125 250 500 750 1,000
Meters


N
CLASHANAHY
CAPPAGH
WHITING BAY
Goat Island
Cable Point
0 125 250 500 750 1,000
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Ballynacourty**		
Other names used for site			
IGH THEME	**IGH8 Lower Carboniferous**		
TOWNLAND(S)	**Ballynacourty**		
NEAREST TOWN	**Dungarvan**		
SIX INCH MAP NUMBER	**Waterford 31**		
NATIONAL GRID REFERENCE	**230945, 92425**		
1:50,000 O.S. SHEET NUMBER	82	**1/2 inch Sheet No.**	22

Outline Site Description
The Ballynacourty site comprises coastal foreshore rock exposures at the south end of Clonea Strand.

Geological System/Age and Primary Rock Type
The rocks are of Carboniferous Limestone, of the Waulsortian Formation.

Main Geological or Geomorphological Interest
The Carboniferous Limestone rocks of the Dungarvan Syncline (the term for the geological structure of the east-west trending valley inland from Dungarvan Harbour) are poorly exposed inland. This coastal site offers a good visible and accessible section through the main rock formation, the Waulsortian, which is especially diverse here. Many different characteristic features of the Waulsortian limestone rock, derived from its original sedimentary environment and process of deposition, have been described in a detailed study of this area.

At the southern end of the site there is a fault which separates the Waulsortian Limestone from the Ballysteen Limestone Formation which lies beneath it, but it is not easily seen. Some of the rock exposures of the Ballysteen Limestone Formation are very rich in crinoid fossils.

Site Importance
The coastal sections are very important for geological understanding of the regional structures and Ballynacourty is locally significant for exhibiting many of the different sedimentary facies of the Waulsortian limestone rock which underlies the Dungarvan valley. It is of County Geological Site importance.

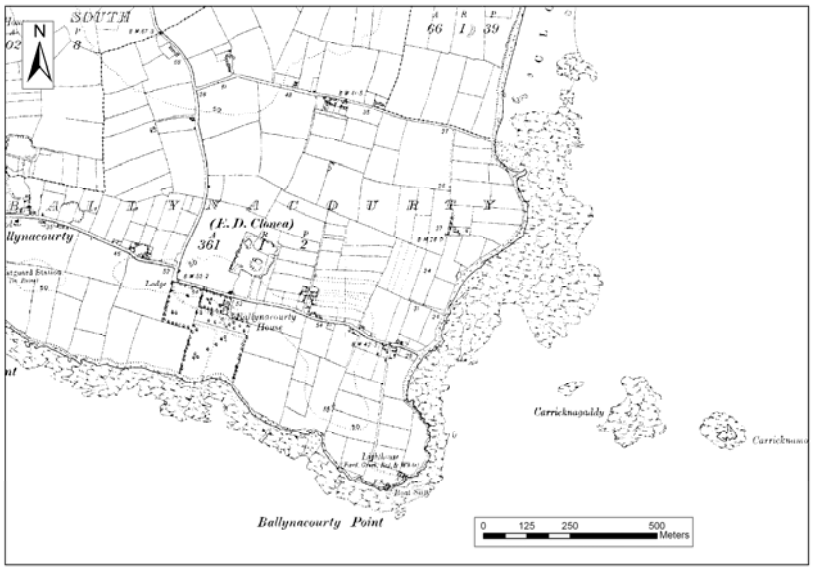
Management/promotion issues
The site is not at any great risk, although dumping of exotic rock boulders in any kind of coastal protection measure should be avoided. Given that Clonea Strand has safe access for the public and a car park, the site could be promoted. However, the geological stories that it displays are quite complex and not easily presented in a straightforward way.

A view northwards from the southern end of Ballynacourty. Ballysteen Limestone Formation is in the foreground. Rocks across the sandy bay are part of the Waulsortian.

Ballysteen Limestone Formation with crinoid fossils, at the southern end of the site. Coin is €2 for scale.


Abbeyside
Tournore
R675
Monkeal
Skeheacrine
Spit Bank
Devonshire Br.
Pier
Castle
Priory
Slip
DUNGARVAN
Dún Garbhán
Cunnigar Point
Cunnigar
An Coinigéar
Deadman Sand
Whitehouse Bank
Banc an Tí Ghil
Dungarvan Harbour
Cuan Dhún Garbhán
Ballyrandle
Railway
Scart
Scartore
Ballynalahessery North Acres
Glendine River
Tallacoolbeg
Tallacoolmore
Dismantled Railway
Clonea Strand
Ballynalahessery South
Kilgrovan
Ballynacourty
Slip Pier
Wyse's Point
18
Ballynacourty Site
Ballynacourty Point
An Rinn Bhán


N
Ballynacourty Site Extent
0 125 250 500
Meters


N
SOUTH
66 I 39
(E. D. Clonea)
361
Ballynacourty
Carricknagoldy
Ballynacourty Point
0 125 250 500
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Clonea Strand**		
Other names used for site	'The Gold Coast'		
IGH THEME	**IGH8 Lower Carboniferous**		
TOWNLAND(S)	**Clonea Lower**		
NEAREST TOWN	**Dungarvan**		
SIX INCH MAP NUMBER	**Waterford 31**		
NATIONAL GRID REFERENCE	**231788 94195 (entry to strand)**		
1:50,000 O.S. SHEET NUMBER	82	**1/2 inch Sheet No.**	22

Outline Site Description
Coastal foreshore rock exposures at the north end of Clonea Strand.

Geological System/Age and Primary Rock Type
The rocks are of Carboniferous Limestone.

Main Geological or Geomorphological Interest
At this end of the beach are rock exposures around the short headland of Clonea Castle, showing the older Ballysteen Limestone Formation and the transition into the younger Waulsortian Formation which underlies most of the Dungarvan Syncline. This name, meaning a downfold or rock, is the term for the geological structure of the east-west trending valley inland from Dungarvan Harbour. The relationship between the formations is not often seen as there are few rock exposures inland, but this site shows that it was a gradual change in sedimentation patterns, and not a sudden event. However the transition is partially obscured by concrete and stone walls constructed around an outflow pipe.

The exposures of the Ballysteen Limestone Formation show an interesting feature when seen from their northern side. They have a strong cleavage in them which is the property of splitting along particular directions, given to the rock by the history of being squeezed at high pressure by major tectonic forces around 300 million years ago. The cleavage is nearly vertical in these beds, which dip generally southward. A feature seen especially well at Clonea is cleavage refraction, where the direction changes as it passes from coarser grained beds to finer grained ones and back again.

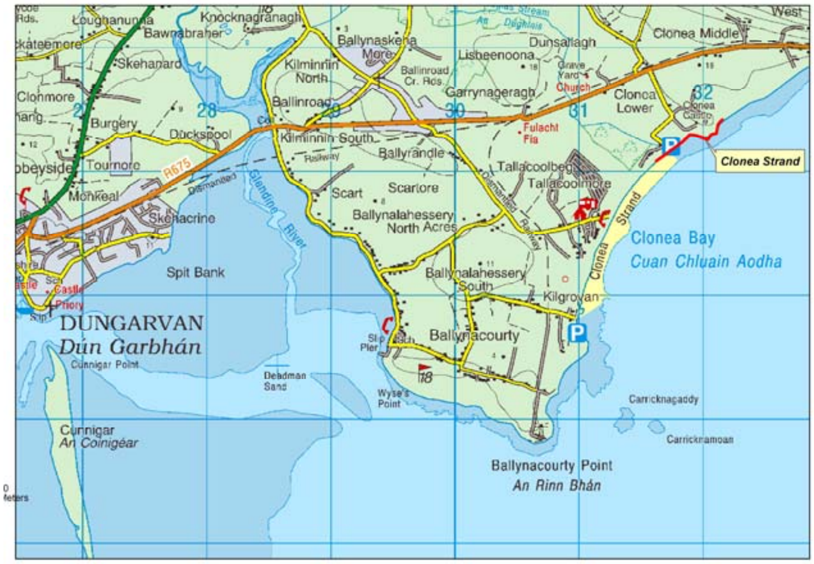
Site Importance
It is a site of local importance in understanding the geology of the Dungarvan area and worthy of County Geological Site status.

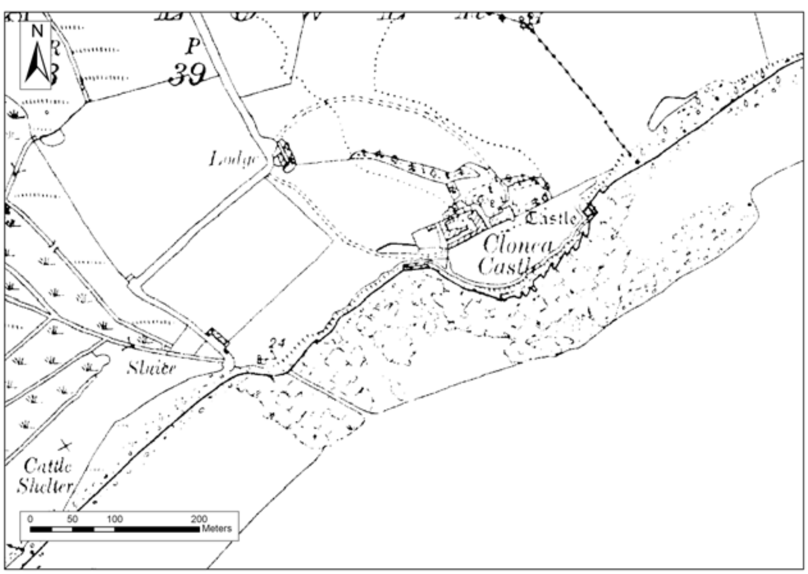
Management/promotion issues
The site is not at any great risk, although dumping of exotic rock boulders in any kind of coastal protection measure should be avoided. Given that it has safe access from the public access and car park services, Clonea Strand could be promoted more as an interesting geological locality. However, the geological stories that it displays are quite complex and not easily presented in a straightforward way and would need expert interpretive geologist input.

A panorama view of the rocks at the immediate north end of the beach at Clonea Strand.

A view of the rocks below Clonea Castle, showing well developed cleavage refraction.

A view of the rocks at the immediate north end of the beach at Clonea Strand, with the transition from Ballysteen Limestone into Waulsortian Limestone roughly where the outfall pipe is protected by concrete and stone (Robbie Meehan is on this line).


Clonea Strand
Clonea Bay
Cuan Chluain Aodha
DUNGARVAN
Dún Garbhán
Spit Bank
Cunnigar Point
Cunnigar
An Coinigéar
Deadman Sand
Wyse's Point
Ballynacourty Point
An Rinn Bhán
Carricknagaddy
Carricknamoan
Ballynacourty
Kilgrovan
Ballynalahessery South
Ballynalahessery North Acres
Scart
Scartore
Ballyrandle
Tallacoolbeg
Tallacoolmore
Clonea Lower
Clonea Middle
Dunsallagh
Lisbeenoona
Garrynageragh
Ballinroad
Kilminnin North
Kilminnin South
Ballynaskeha More
Knocknagranagh
Burgery
Duckspool
Tournore
Monkeal
Skehacrine
Skehanard
Clonmore
Loughanunna
Bawnabraher
Fulacht Fia
Church
Colligan River
Clonea Strand
R675

N
0 50 100 200 Meters
Clonea Strand

N
P
39
Lodge
Castle
Clonea Castle
Sluice
Cattle Shelter
0 50 100 200 Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Ardoginna**
Other names used for site	
IGH THEME	**IGH 13 Coastal Geomorphology, IGH 10 Devonian**
TOWNLAND(S)	**Ardoginna**
NEAREST TOWN	**Ardmore**
SIX INCH MAP NUMBER	**Waterford 40**
NATIONAL GRID REFERENCE	**217434 76387 (at western edge of geo)**
1:50,000 O.S. SHEET NUMBER	82 **1/2 inch Sheet No.** 22

Outline Site Description
Ardoginna is a coastal cliff and geo (long narrow inlet).

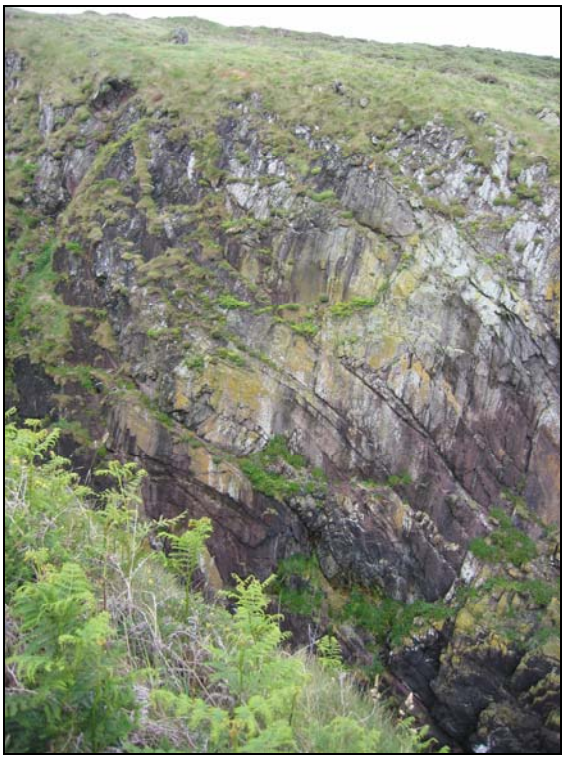
Geological System/Age and Primary Rock Type
The rocks are of Devonian age (approximately 360 million years); the structural feature is of Variscan age (a period of large scale folding about 300 million years ago) and the erosion of the coastal cliffs to the present features is relatively recent, mostly since the last Ice Age.

Main Geological or Geomorphological Interest
The coastal cliffs include three geos, or long narrow inlets in the coastal profile, typically with steep sides and small width compared to length. These landforms of coastal erosion can form in many different ways but usually exploit some structural weakness in the bedrock. This is most often a fault, where rocks have shifted along a single brittle fracture. The axis of folds can also be lines of weakness. It is not clear at Ardoginna what has caused the geos to form and it is difficult to map structures in dangerous cliffs.

The easternmost geo includes an excellent exposure of a monocline. Most structural deformation of rocks creates folds (anticlines or upfolds, and synclines, or downfolds) which have two limbs. Monoclines are a relatively rare feature of a one-sided or one-limbed fold. Seen in cross section or in any view, the feature most resembles a step. In this geo the rock beds are tilted to nearly vertical, and the monocline occupies nearly all the visible cliff section.

Site Importance
The site is of County Geological Site importance.

Management/promotion issues
Ardoginna is completely unsuitable for any general public promotion, as there is no public cliff path access to view it. In order to access it for this report, a difficult approach across 500m of private farmland through Ardoginna House was made, but this is not easy and only one geo was visited due to dangerous cliffs and extensive vegetation on the cliff top. It may be worth investigating access and promotion within the sea kayaking community.



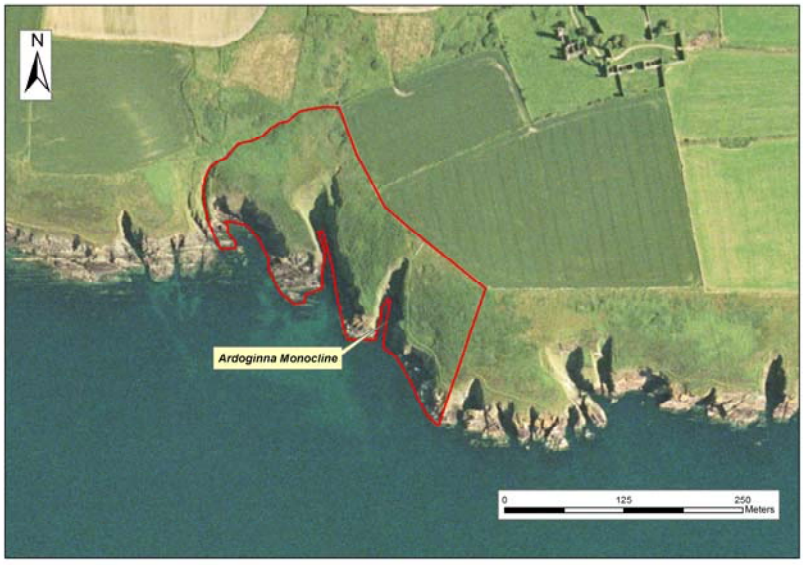
The monocline in the east wall of a geo.

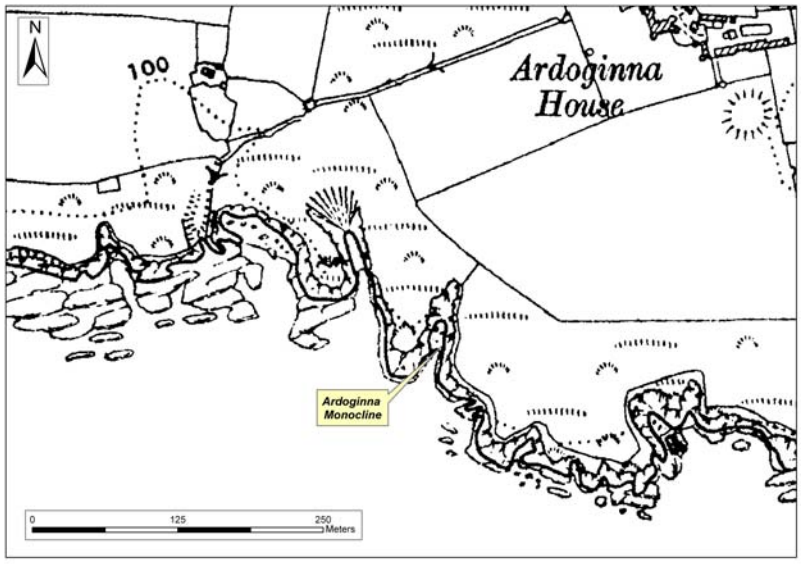
The monocline, close up.

The main geo with the monocline in the left wall.

The geo to the west side of the site.


Sluggera
Cr. Rds.
Duffcarrick
Ardmore
Aird Mhór
PO
Fire
Stn.
Pier
Farrangarret
Church and
Round Tower
Monea
Dysert
Ardocheasty
Watch
Tower
Ardoginna
Ardoginna
Monocline


N
Ardoginna Monocline
0
125
250
Meters


N
100
Ardoginna
House
Ardoginna
Monocline
0
125
250
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Comeragh volcanics**		
Other names used for site	Carrigduff		
IGH THEME	**IGH10 Devonian**		
TOWNLAND(S)	**Coolnahorna, Kilclooney**		
NEAREST TOWN	**Kilmacthomas**		
SIX INCH MAP NUMBER	**Waterford 15**		
NATIONAL GRID REFERENCE	**234092 111915**		
1:50,000 O.S. SHEET NUMBER	75	**1/2 inch Sheet No.**	22

Outline Site Description
This site comprises rock exposures in the vicinity of Carrigduff, a prominent cliff, and exposures in a stream bed and forest tracks.

Geological System/Age and Primary Rock Type
The rocks are volcanic lavas of Upper Devonian age.

Main Geological or Geomorphological Interest
Volcanic rocks are relatively rare in the Devonian rocks of Ireland, which are largely sedimentary rocks – sandstones and conglomerates laid down by large rivers and floods, on a land surface. This site is one of only two known in Waterford, and one of only seventeen across southern Ireland. As with all of them, the eruptions were localised and only small areas of volcanic lavas remain. In the lower slopes of the Comeraghs, close to Coumshingaun, two volcanic units are interbedded with the conglomerates there.

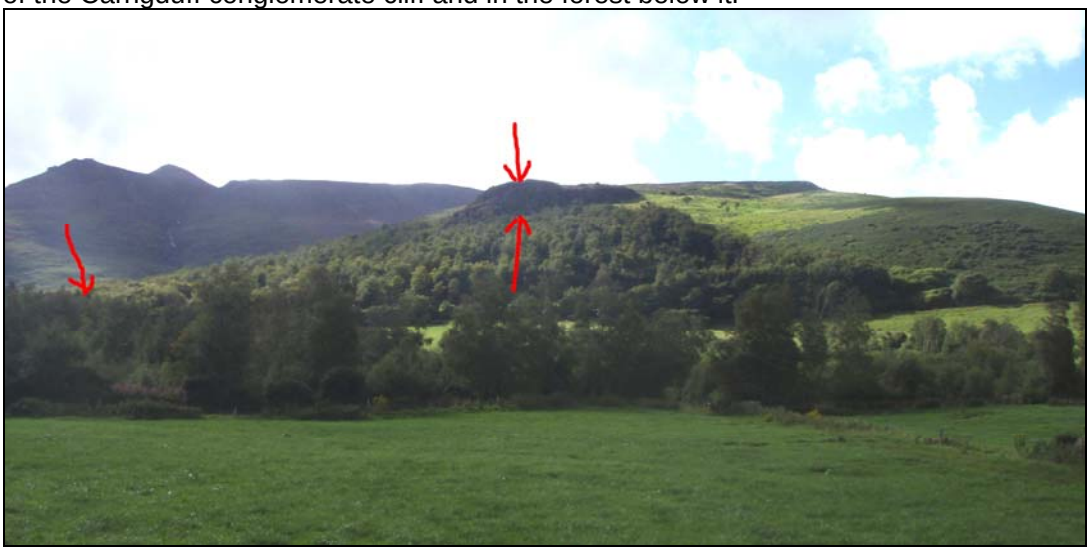
One unit, called the Coolnahorna Volcanic Member, was recorded in the bed of the Iske Sullas stream and then in forest tracks that were probably freshly made in 1978. The forest is so dense now that these exposures are not easily found.

Above this in the stratigraphy, making it a little younger, is the Carrigduff Volcanic Member, which is exposed above the big cliff of Carrigduff. Individual lava flows are only about 2m thick and the rocks have been partly cleared into heaps by a landowner.

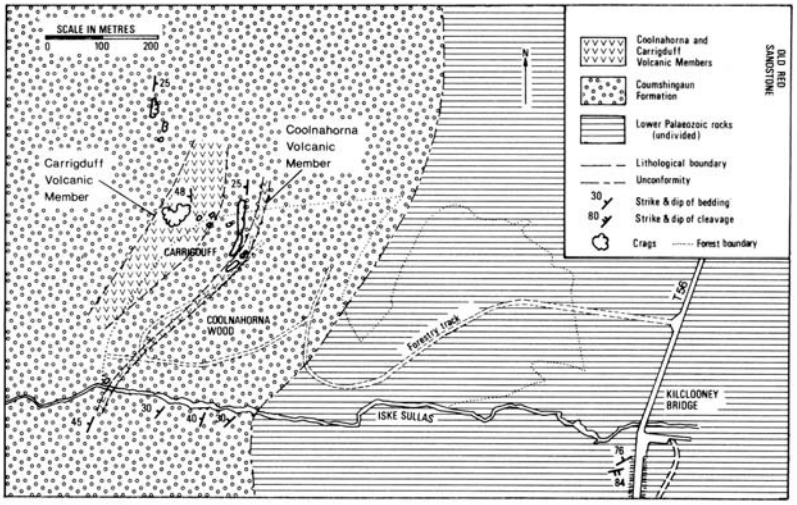
Site Importance
The site is of County Geological Site Importance.

Management/promotion issues
The inaccessibility of these rocks, due to forestry and lack of any obvious access paths, makes promotion in any form a difficult task, and not advisable. The rocks lack excellent exposure and contacts are not seen between lavas and the surrounding rocks. If forest clear felling were to take place then it may open up access, and potentially create new exposures in the rocks and this activity should be advised to the Geological Survey of Ireland if it is scheduled.

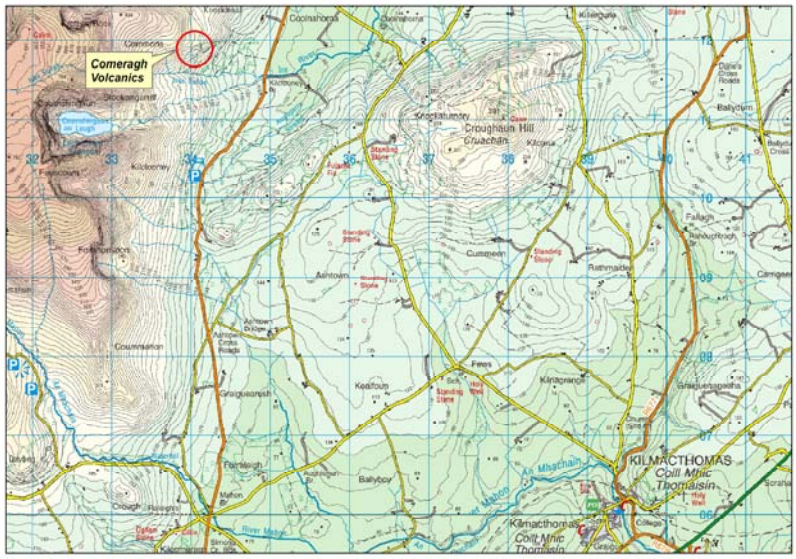
A distant side view of Carrgiduff, from the north, with volcanic rocks (arrowed) on the top right of the Carrigduff conglomerate cliff and in the forest below it.

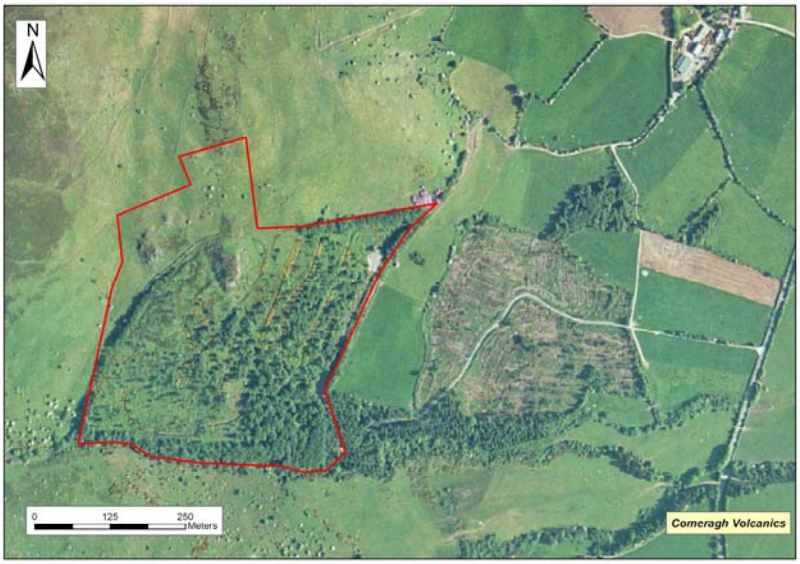


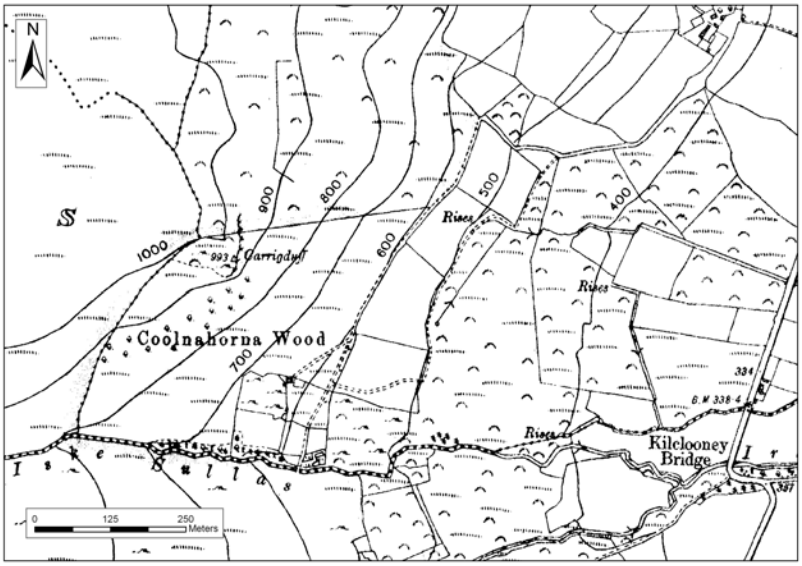
A front view of Carrigduff, from the road near Kilclooney Bridge, with volcanic rocks (arrowed) on the top of the conglomerate cliff and in the forest directly below it, also down in the Iske Sullas stream gully on the left.



The locality map from the original paper describing these Comeragh volcanic rocks.


Comeragh Volcanics
Croughaun Hill
Cruachán
KILMACTHOMAS
Coill Mhic Thomáisín
Kilmacthomas
Coill Mhic Thomáisín


N
0
125
250
Meters
Comeragh Volcanics


N
S
1000
900
800
600
500
400
993 Carrigdyl
Coolnahorna Wood
700
Rises
Rises
Rises
334
B.M 338·4
Kilelooney Bridge
0
125
250
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Rathmoylan Cove**
Other names used for site	
IGH THEME	**IGH 10 Devonian, IGH13 Coastal Geomorphology**
TOWNLAND(S)	**Rathmoylan**
NEAREST TOWN	**Dunmore East**
SIX INCH MAP NUMBER	**Waterford 27**
NATIONAL GRID REFERENCE	**265675 98775 (cave at 265740 98660)**
1:50,000 O.S. SHEET NUMBER	76 **1/2 inch Sheet No.** 23

Outline Site Description
This site comprises bedrock exposed on each side of a well developed, long, linear cove.

Geological System/Age and Primary Rock Type
Red sandstones and conglomerates of the Harrylock Formation, of earliest Carboniferous age.

Main Geological or Geomorphological Interest
The rocks seen here are a good representative section of the red sedimentary rocks formed on land, which are similar to classical Devonian 'Old Red Sandstone' but which are of early Carboniferous age. Their deposition preceded the flooding of the land surface, which then created the Carboniferous limestone across Ireland. These rocks display bright red siltstone and sandstone beds, interbedded with thick conglomerate units. These represent river channels, which meandered over a floodplain.

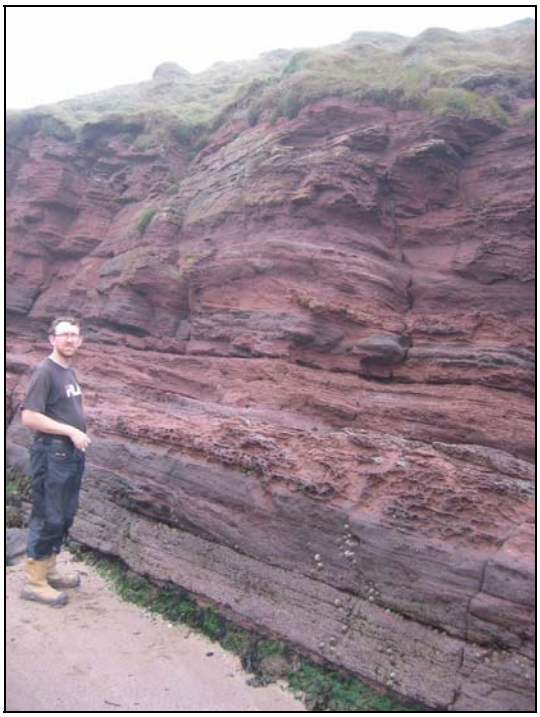
Weathering processes are well represented here with honeycomb weathering seen on the eastern side of the cove particularly. On the west side, there is deep erosion of fractures by the sea, leaving bed surfaces appearing like a limestone pavement. There are many classic erosion features with large blocks of conglomerate breaking off as the weaker sandstone beds beneath are removed by the sea.

Of particular importance at this site is a superb sea cave at the eastern edge of the cove. This sea cave has eroded in underground at least 60m in length, and is between 10 and 11m in width for most of its length, narrowing to 5m wide at the innermost part. It is around 8m high and has a thick conglomerate bed as its roof, therefore with an overall square profile. It may be Ireland's largest sea cave. A second smaller one occurs just alongside and parallel to it, to the east.

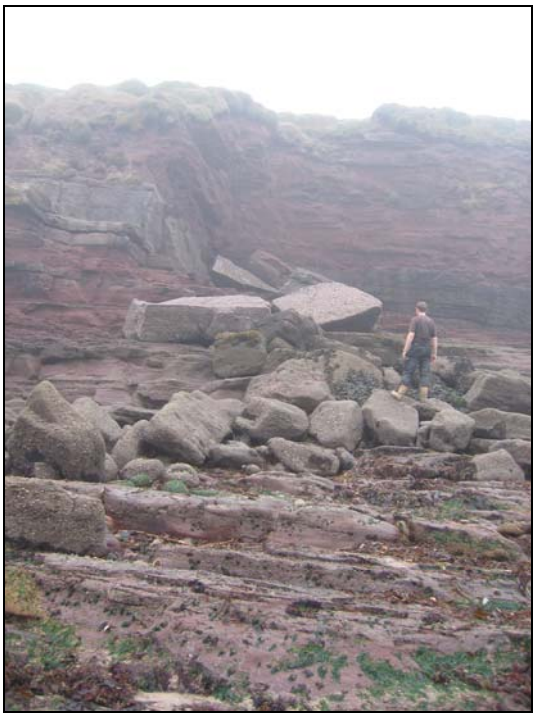
Site Importance
The site is a good representative for the red rocks produced in a continental environment, which occur in the centre of the Dunmore East and Brownstown Head area, and across the River Suir in the Hook Peninsula.

The sea cave is particularly impressive example, amongst many erosional and weathering features displayed here. The site may be considered for NHA status, but definitely merits County Geological Site status.

Management/promotion issues
Public access is easy and relatively safe by the beach. Access to the sea cave requires scrambling across rocks and may be only possible at low tide. Consideration should be given to active promotion of the geological interest through panels, leaflets, guidebooks or other means.



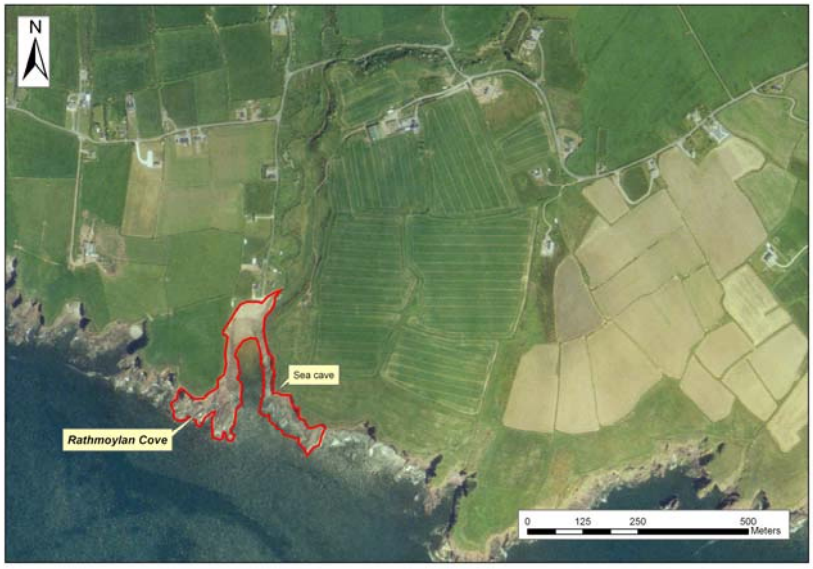
Honeycomb weathering at Rathmoylan Cove.

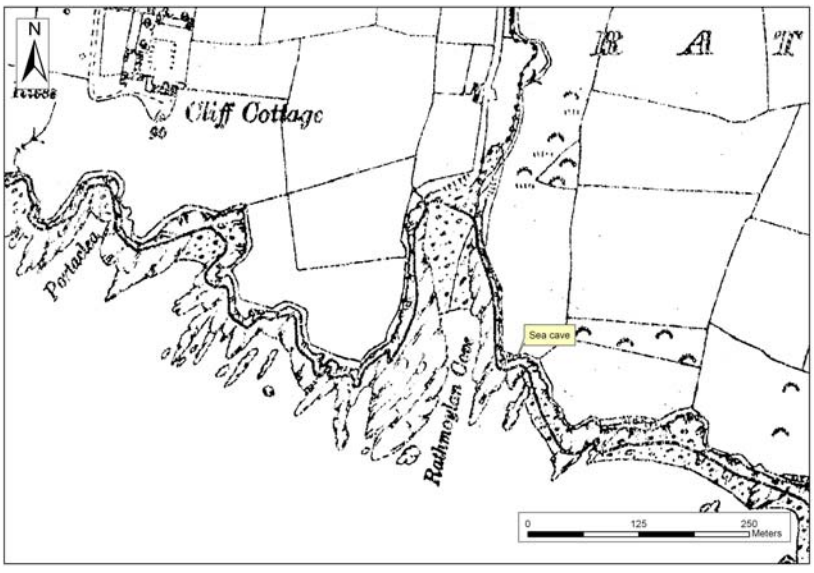


Block collapse of thick conglomerate beds at Rathmoylan Cove, with freshest falls Being the most angular blocks.

The entrances to the sea caves at Rathmoylan Cove.


DUNMORE EAST
Dún Mór
Rathmoylan Cove
Beenlea Head
An Bhinn Liath
Swines Head
Ceann Muice
Portally Head
Ceann Phort Ailigh
Red Head
An Bhinn Rua
Black Knob
Coxtown West
Coxtown East
Knockanaddin
Rathmoylan
Ballymacaw
Coolum
Gortahilly
Graigue
Corbally More
Corbally Beg
Kilmacleague
Graigariddy
Ballymabin
Knockacurrin
Askurra
Dunmore Bay
Prementory Fort
Portally
Port Ailigh
98
97
99


N
Sea cave
Rathmoylan Cove
0
125
250
500
Meters


N
Cliff Cottage
Sea cave
Rathmoylan Cove
0
125
250
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Copper Coast – Kilmurrin Cove**		
Other names used for site	The Goal		
IGH THEME	**IGH13 Coastal geomorphology**		
TOWNLAND(S)	**Dunabrattin**		
NEAREST TOWN	**Bunmahon**		
SIX INCH MAP NUMBER	**Waterford 25**		
NATIONAL GRID REFERENCE	**246688 98597 (blowhole)**		
1:50,000 O.S. SHEET NUMBER	82	**1/2 inch Sheet No.**	22

Outline Site Description
Coastal cliffs and fields, with a blowhole included.

Geological System/Age and Primary Rock Type
The rocks are of Ordovician age, but the blowhole is a Holocene feature eroded by the sea.

Main Geological or Geomorphological Interest
A classic blowhole is displayed on the clifftop on the eastern side of Kilmurrin Cove. The sea has eroded a sea cave inland until there has been a collapse to surface at the inner, landward end. This has been progressively enlarged by tides and now a steep sided depression is seen with the sea entering and leaving by a short cave, or natural tunnel.

Site Importance
Alone, this is of County Geological Site importance but is part of a complex of sites along the Copper Coast, which collectively are of national importance, and which are already part of a proposed NHA (Ballyvoyle Head to Tramore No 1693).

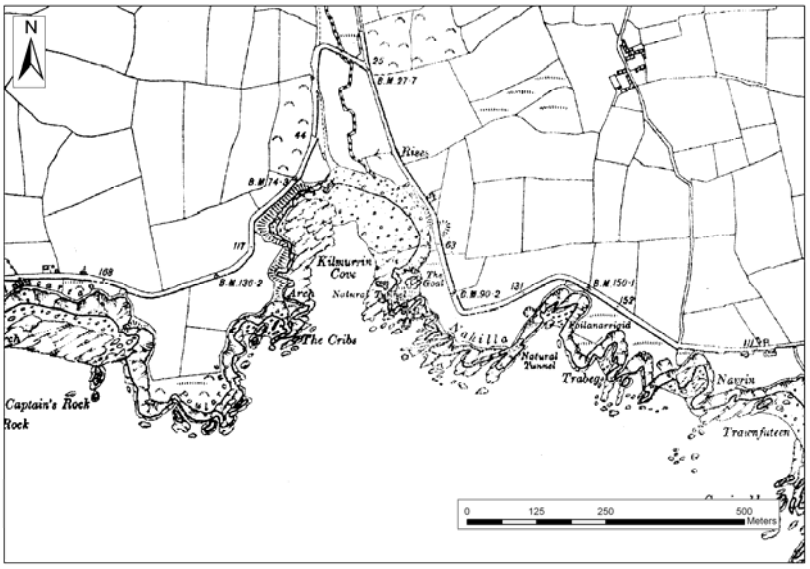
Management/promotion issues
As the feature is on private farmland it should not be promoted except by arrangement with the landowner. It is easily viewed from the western side of the cove at the bend in the road there, where there is a small lay-by. Consideration could be given to a signboard being placed there explaining its origin and including pictures of the feature.

The blowhole at Kilmurrin Cove viewed from the road at the western side of the cove.


The blowhole at Kilmurrin Cove viewed from the edge of the collapsed depression.


Ballingarry
Rathquage
Lissaviron
Kilsteague
Ballyna-gigla
Ballynasissala
Kilduane
Kilmurrin
Knockane
Dunabrattin
Tankardstown
Knockmahon
Bunmahon
Bun Machan
Kilmurrin Cove
Trabog
Carrigaseeach
Dunabrattin Head
Ceann Dhún mBreatan
Bunmahon Bay
Cuan Bhunmachan
Cuan Dhún na
Knockane Strand
Carrigaddas
Drumeappul Rock
Carrickadda Rock
Captain Rock
Promontory Fort
Slip
Boat Strand
Cove
99
98
97


N
Blowhole
Kilmurrin Cove
Site Extent
0
125
250
500
Meters


N
Kilmurrin Cove
The Cribs
Captain's Rock
Rock
Natural Tunnel
Trabeg
Navin
Trawnfuteen
0
125
250
500
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Tramore Burrow**		
Other names used for site	Tramore Spit		
IGH THEME	**IGH13 Coastal geomorphology**		
TOWNLAND(S)	**Tramore Burrow**		
NEAREST TOWN	**Tramore**		
SIX INCH MAP NUMBER	**Waterford 27 and28**		
NATIONAL GRID REFERENCE	**260650 100575**		
1:50,000 O.S. SHEET NUMBER	**76**	**1/2 inch Sheet No.**	22

Outline Site Description
The Tramore Burrow is a long, wide sand spit, which has formed across the mouth of Tramore Harbour. The Burrow is oriented west-northwest to east-southeast and is just under four kilometres long.

Geological System/Age and Primary Rock Type
The feature has been formed in the Holocene Period since the last glaciation, and is comprised of unconsolidated sand sediment only.

Main Geological or Geomorphological Interest
Spits form as a result of deposition by longshore drift, which is the movement of sand along the coast by the waves. The spit is formed when the sand material that is being carried by the waves gets deposited due to a loss of the waves energy, because of the river water emerging in the estuary at the north of the bay slows it down. As time progresses, the deposited material has formed a spit.

The spit has been the result of wind erosion and deposition over the millennia since the Ice Age and several large dunes have formed across it. The highest of these dunes is almost 30m high, and is therefore one of the highest dunes in the country.

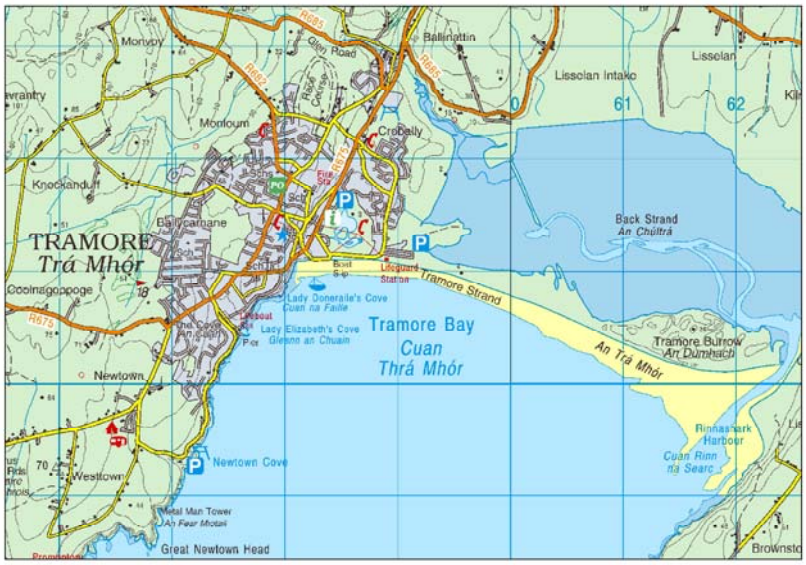
Site Importance
The spit is one of the longest in the country and the associated beach, dune and backstrand features, make this a textbook locality for the recognition of coastal deposition features. It is of County Geological Site importance. It may be considered as of national importance once comparisons are made with similar sites across the country. It is already part of Tramore Dunes and Backstrand pNHA and SAC 000671.

Management/promotion issues
The location of the features means they are easily accessible, and Tramore is a popular holiday destination, principally for its long beach and associated dune system. The site is owned by Waterford County Council and therefore management for human activity is fully controllable. It should be noted that in geological and geomorphological terms and timescales, landforms such as this are mobile and attempting to control dynamic processes on this scale is practically impossible.

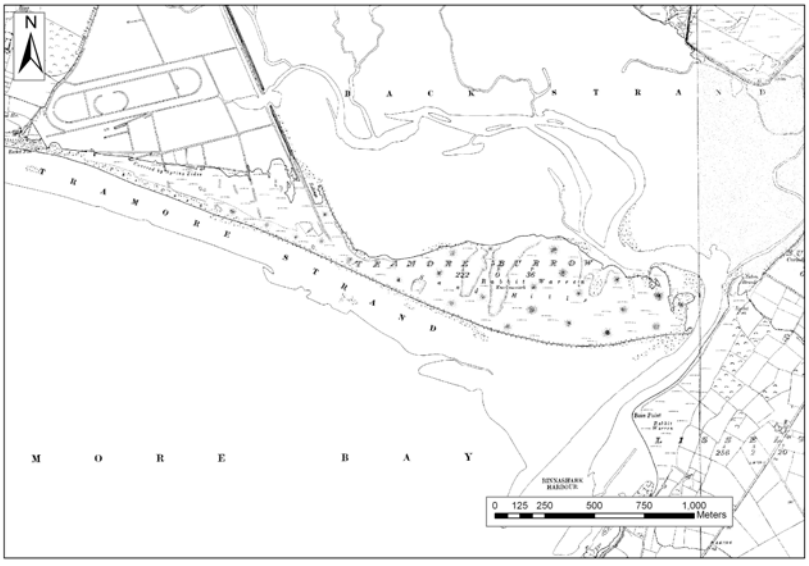
Tramore Burrow, viewed from the road to Brownstown Head.

The highest of the dunes on the spit is up to 30m high.

The spit and beach viewed from the cliff top at the western side of Tramore Bay.


TRAMORE
Trá Mhór
Tramore Bay
Cuan
Thrá Mhór
Back Strand
An Cheiltrá
Tramore Strand
An Trá Mhór
Tramore Burrow
An Dumhach
Lisselan Intake
Lisselan
Ballinattin
Monroe
Monroum
Cro Bally
Knockanduff
Ballycarnane
Coolnagoppoge
Newtown
Newtown Cove
Westtown
Great Newtown Head
Lady Donerale's Cove
Cuan na Failte
Lacy Elizabeth's Cove
Gleann an Chuain
Rinnashark Harbour
Cuan Rinn na Searc
Metal Man Tower
An Fear Miotal
Glen Road
Lifeguard Station
R685
R675
61
62
70


N
0 125 250 500 750 1,000
Meters


N
BACK STRAND
TRAMORE STRAND
MORE BAY
0 125 250 500 750 1,000
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Dungarvan Harbour (including Cunnigar Spit)**		
Other names used for site			
IGH THEME	**IGH13 Coastal geomorphology**		
TOWNLAND(S)	**Cunnigar, Ballynacourty North**		
NEAREST TOWN	**Dungarvan**		
SIX INCH MAP NUMBER	**Waterford 31, 36**		
NATIONAL GRID REFERENCE	**226870 91670 (Cunnigar Spit)**		
1:50,000 O.S. SHEET NUMBER	82	**1/2 inch Sheet No.**	22

Outline Site Description
Dungarvan Harbour is a wide coastal embayment, flanked on either side by protruding bedrock headlands and incorporating coastal flats and an exceptionally straight sand spit at Cunnigar.

Geological System/Age and Primary Rock Type
The feature has been formed in the Holocene Period, since the last glaciation, and the harbour itself hosts soft mud, silt and sand sediment washed into it during that time.

It is likely that the macro-structure of the harbour dates back through the Quaternary (Ice Age) to the Tertiary Period.

Main Geological or Geomorphological Interest
The harbour is almost perfectly symmetrical and is bordered on the north by Ballynacourty Point and to the south by Helvick Head, both well-defined protruberances of bedrock which form headlands. Freshwater feeds into the harbour *via* the Colligan River, which flows through Dungarvan. The central portion of the harbour comprises mud, silt and sand flats, which dry out at low tide. Salt marshes occur in pockets around the harbour edge and there is a narrow sand or gravel beach in places also.

Cunnigar spit has formed as a result of deposition by longshore drift, which is the movement of sand along the coast by the waves. The spit is formed when the sand material - that is being carried by the waves - gets deposited due to a loss of the waves energy, because the estuary emerging at the north of the bay slows it down. As time progresses, the deposited material has formed a spit, which is 2.6 km long and which almost closes the harbour at its northern end. The sand flats to the east of Cunnigar support an extensive oyster farming operation.

The spit has been the result of wind erosion and deposition over the millennia since the Ice Age and several large dunes have formed across it. Dune slacks occur between these, which are low, narrow, marshy localities.

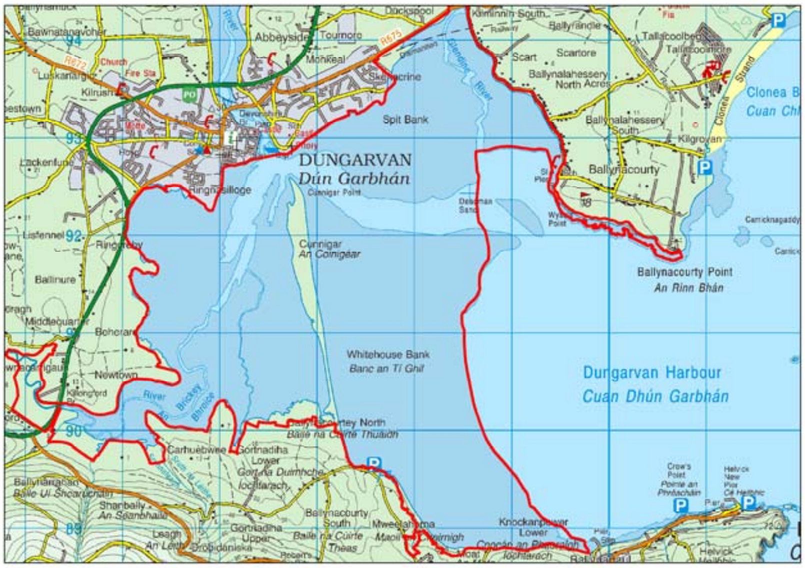
Site Importance
Cunnigar spit is an impressive feature and the associated beach, dune and slack features, as well as the surrounding beaches, salt marshes and headlands, make Dungarvan Harbour a textbook locality for the recognition of coastal erosion and deposition features. The Harbour is already a proposed NHA (pNHA 00663, Dungarvan Harbour) for biodiversity reasons and the geodiversity of an active sedimentation system should be highlighted in any promotion of this.

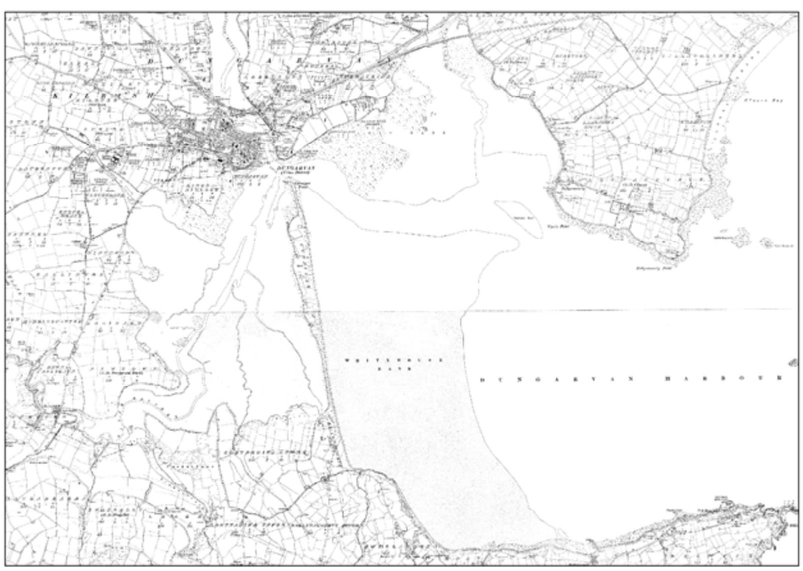
Management/promotion issues
The location of the features means they are easily accessible, and Dungarvan is a popular holiday destination. An information board at Cunnigar may prove a worthy addition to the site, explaining the formation of the feature and its associated habitats, flora and fauna.

A panorama view of Dungarvan Harbour showing sandbars and mudflats at low tide.

The Cunnigar sand spit extends almost across the harbour, viewed from the ridge to the south of the harbour.

The Cunnigar sand spit extends almost across the harbour, viewed from Helvick Head.


DUNGARVAN
Dún Garbhán
Spit Bank
Cunnigar
An Coinigéar
Whitehouse Bank
Banc an Tí Ghil
Dungarvan Harbour
Cuan Dhún Garbhán
Ballynacourty Point
An Rinn Bhán
Ballynacourty
Abbeyside
Tournore
Skehacrine
Ballynalahessery North Acres
Ballynalahessery South
Kilgrovan
Clonea Strand
Scart
Scartore
Tallacoolbeg
Ringnasilloge
Ringagaby
Ballinure
Boheraun
Newtown
River Brickey
Carhuebwee
Gortnadiha Lower
Ballynacourty South
Gortnadiha Upper
Shanbally
An Seanbhaile
Mweelahorna
Knockanpower Lower
Crow's Point
Helvick
Lisfennel
Lackenfune
Kilrush
Luskanargid
Bawnatanavoher
Ballynamuck
Middlequarter
Ballyharrahan
Ballynacourty North
Baile na Cuirte Thuaidh
Leagh
An Léim
Drohideniska

N
0 250 500 1,000 1,500 2,000
Meters

DUNGARVAN HARBOUR
WHITEHOUSE BANK

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Ballymacart River**
Other names used for site	
IGH THEME	**IGH14 Fluvial and lacustrine geomorphology**
TOWNLAND(S)	**Ballymacart Upper, Ballintlea South, Ballintlea North**
NEAREST TOWN	**Ardmore**
SIX INCH MAP NUMBER	**Waterford 39**
NATIONAL GRID REFERENCE	**224670 83775 (at the bridge inland)**
	225270 81035 (at the mouth)
1:50,000 O.S. SHEET NUMBER	82 **1/2 inch Sheet No.** 22

Outline Site Description
The Ballymacart River channel is deeply incised at the portion of its reach closest to the sea, for a stretch of approximately two kilometres. The channel is oriented north-south and is V-shaped, and up to 50m deep.

Geological System/Age and Primary Rock Type
The feature in its' current form has been eroded in the Holocene (post-glacial) Period, but the macro-morphology of the feature may be a relict of late Quaternary (Ice Age) meltwater erosion.

Main Geological or Geomorphological Interest
The river is deeply incised to a depth of approximately 50m within the south Waterford landscape. Much of the seaward stretch has been etched in bedrock, with that length further inland etched in a mixture of glacial till and bedrock.

The majority of the channel is V-shaped, with the portion closest to the sea U shaped, which may suggest that this portion was shaped by glacial meltwaters. The Ballymacart River is essentially a misfit stream along this stretch of river, as it is much smaller than the valley is lies within.

Site Importance
This is a very good example of an incised stream gully and is a site of County Geological Site importance. It is also part of Glenanna Wood pNHA 001698.

Management/promotion issues
This is a macro-scale feature and has few management issues as the bend can be seen from many roads which lie adjacent to the feature. An information board at the beach car park at the southern end of the channel may prove a worthy addition to the site, explaining the formation of the valley channel.

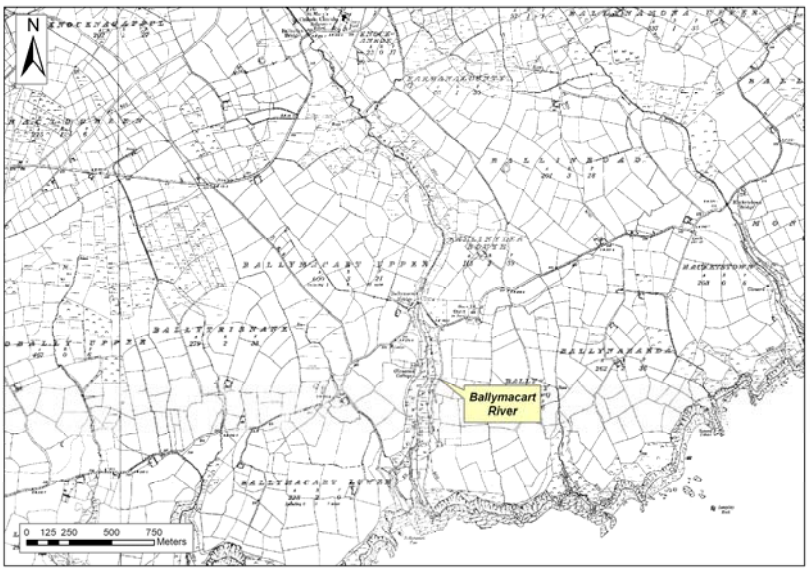
The downstream end of the Ballymacart river valley.

The upstream end of the Ballymacart River site, only gently incised.

Looking upstream into Ballymacart river valley from the sea.


Ballymacart River
Ardmore Bay
Cuan Aird Mhóir
Ardmore
Aird Mhóir
Ardmore Head
Ceann Aird Mhóir
Ram Head
Ceann an Ráma
80
79
78
77


N
Ballymacart River
0 125 250 500 750
Meters


N
Ballymacart River
0 125 250 500 750
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Blackwater Bend**		
Other names used for site			
IGH THEME	**IGH14 Fluvial and Lacustrine geomorphology**		
TOWNLAND(S)	**Cappoquin, Kilbree East**		
NEAREST TOWN	**Cappoquin**		
SIX INCH MAP NUMBER	**Waterford 21**		
NATIONAL GRID REFERENCE	**210040 99547**		
1:50,000 O.S. SHEET NUMBER	81	**1/2 inch Sheet No.**	22

Outline Site Description
The Bend in the Blackwater River at Cappoquin is a point in the river course where the flow direction changes ninety degrees, from an eastwards flow to a southerly flow through gorges into high rock ridges, even though a valley floor continues eastwards to Dungarvan.

Geological System/Age and Primary Rock Type
The feature in its current form has been formed in the late Quaternary (Ice Age) Period, but the macro-morphology of the feature can probably be traced back to earlier Tertiary times.

Main Geological or Geomorphological Interest
In 1862, J.B. Jukes, the Director of the Geological Survey of Ireland (GSI), thought that the bend in the river was a result of two drainage patterns of different ages overprinting each other, as the north-south orientation was of an earlier river flowing along that plane in late Carboniferous times and the west-east was from later Armorican times.

In 1878 Kinahan, also from the Geological Survey of Ireland, thought that the change in direction was a result of fault-fissures while Edward Hull, another Director of the GSI, writing in1894, had thought that an obstruction had prevented the rivers flowing eastwards and had forced them southwards. In 1905, the geologist Lamplugh suggested that the drainage was diverted by blocking glacier ice in the valley, east of Cappoquin.

Two geographers, Davies and Whittow, analysing the issue in 1975, supposed that the southwards orientation south of Cappoquin was a relict of an earlier, southerly drainage channel which was active during the Tertiary when the Carboniferous limestone was drained by a river flowing underground through subsurface channels, southwards. The surface drainage above this was from east to west, and over time as the surface drainage and the surface itself lowered in elevation, the west to east-flowing river met and joined with the underground, north-south channel. Hence the river was ‘captured’ by the earlier formed, and previously underground, channel.

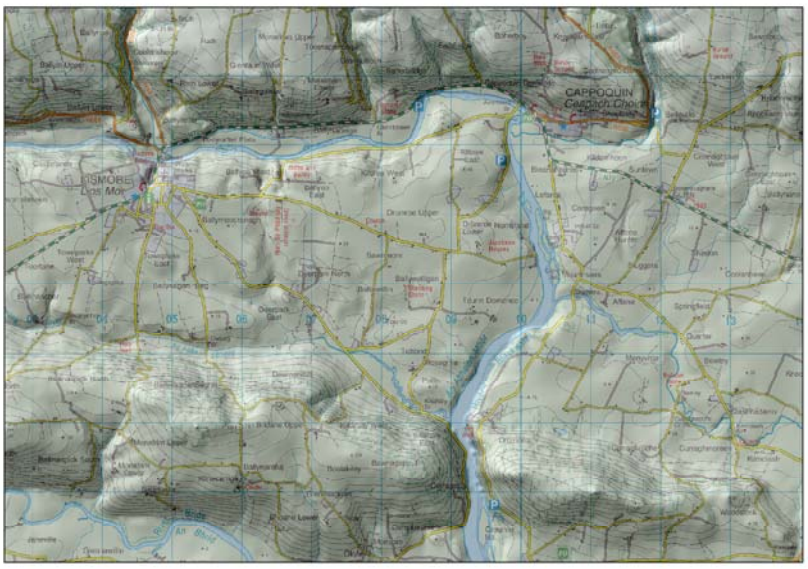
Site Importance
The site is the best example of river capture in the country, and no other large river has a similar ninety-degree bend of such size. Owing to this, and the variety of theories that have abounded discussing its formation, the site is considered to be of potential NHA status on geological grounds alone. The site already lies within the Blackwater River and Estuary SAC/pNHA 000072.

Management/promotion issues
This is a macro-scale feature and has few management issues as the bend can be seen from the main roads which pass adjacent to the feature. An information board along the river may prove a worthy addition to the site, although the geological concepts of how the bend formed are quite complex and somewhat difficult to explain.

Panorama of the bend from the south side.

View over Cappoquin and the Blackwater Bend from high ground to the west.

The southward bend of the river in Cappoquin from the Avonmore Bridge, and from the south side, adjacent to disused railway bridge.


CAPPOQUIN
Cappoquin Church
ISMORE
Lios Mór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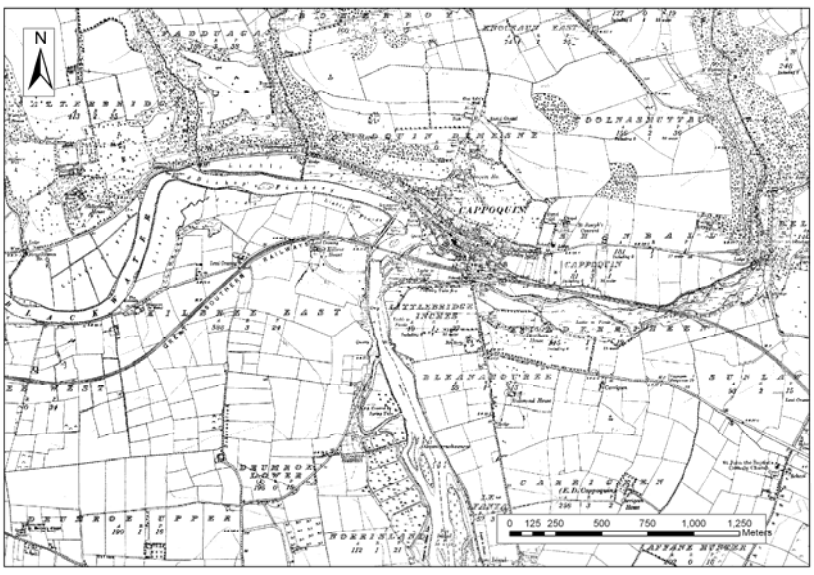
0 125 250 500 750 1,000
Meters


N
CAPPOQUIN
0 125 250 500 750 1,000 1,250
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Knockmealdown gullies**
Other names used for site	Reanabarna channels, Knockmealdown channels
IGH THEME	**IGH14 Fluvial and lacustrine geomorphology**
TOWNLAND(S)	**Reanabarna, Dyrick, Knockmealdown**
NEAREST TOWN	**Cappoquin**
SIX INCH MAP NUMBER	**Waterford 12 and 21**
NATIONAL GRID REFERENCE	**206267 106016 and 206790 105473**
1:50,000 O.S. SHEET NUMBER	74 **1/2 inch Sheet No.** 22

Outline Site Description
The Knockmealdown gullies comprise two deep gully channels, which have been formed by river incision since the last Ice Age on the southern flank of the Knockmealdown Mountains.

The gullies are oriented northeast to southwest and stretch for lateral distances of 600m-1200m to the northeast off the R669 road, northwest of Cappoquin.

Geological System/Age and Primary Rock Type
The features are formed in an area of glacial till of varying depths, with portions of bedrock outcrop or subcrop along their stretches. This till forms a flat to gently undulating plateau below the backslopes of the Knockmealdown Mountain ridges.

The bedrock in the locality is Devonian Old Red Sandstone of the Knockmealdown Sandstone Formation.

Main Geological or Geomorphological Interest
The gullies are up to 45m deep and that of the Rough Glen River has a particularly V-shaped profile. The stream gully northwest of this has both V and U-shaped profiles along different stretches of its extent.

Though no dating has been completed on the features, they are considered to have formed completely in the Holocene (post-glacial) Period. Given that the Rough Glen River gully is the deepest and up to 45m deep, this implies an erosion rate of 4.5mm/yr since the last Ice Age.

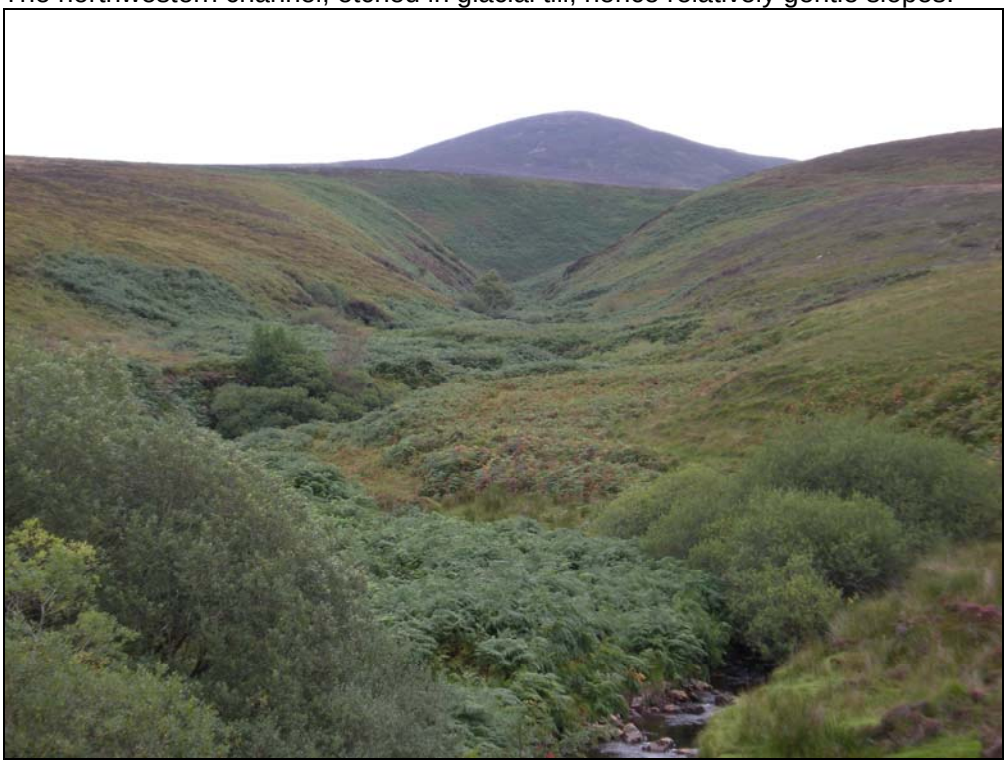
Gullies of such depth, which have formed wholly in the Holocene, are unusual around Ireland.

Site Importance
Gullies of such depth and size are rare in Ireland and this is a site with good teaching potential on river erosion. It is definitely of County Geological Site importance, but may be considered to be of national importance when further work on comparative sites is completed.

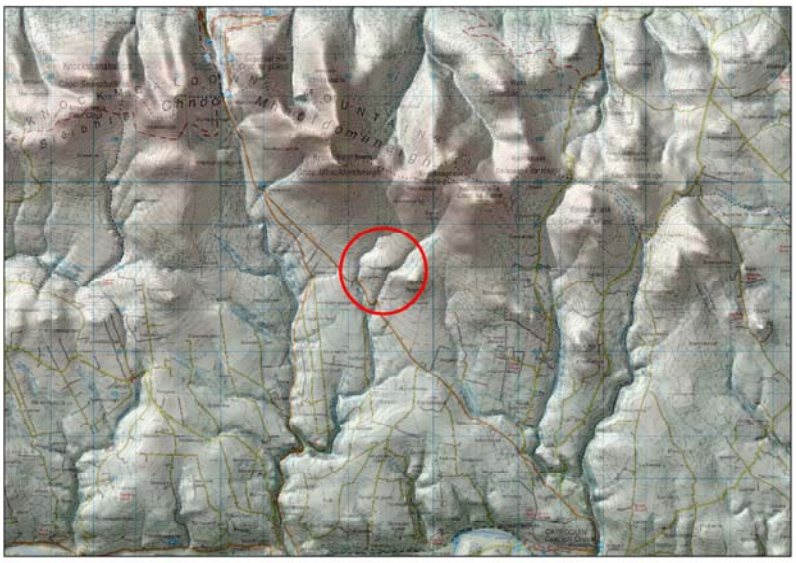
Management/promotion issues
The roadside location of the features means they are easily accessible, although they are presumably either privately owned or in commonage. However, there is no parking provided and it is difficult to stop at the features. A disused roadside quarry is present at the edge of the northwestern channel, but no more than 1-2 cars may stop and park at any one time. There is no safe parking space at the Rough Glen River gully.

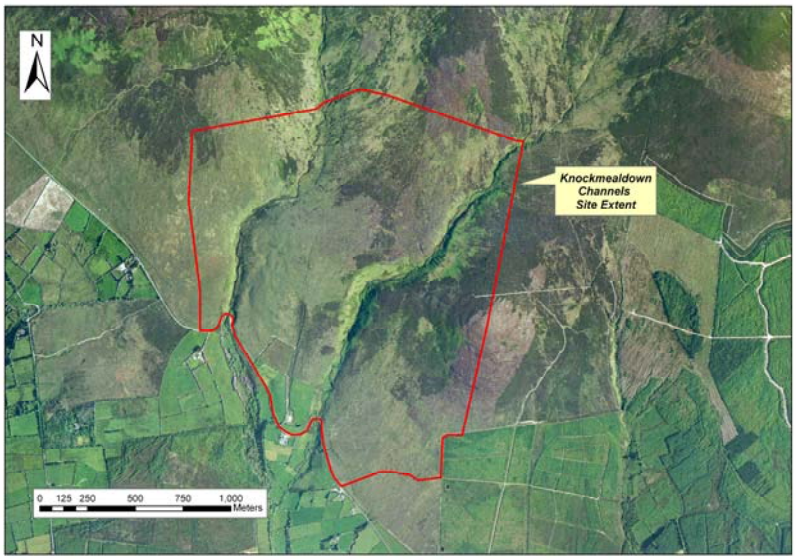
Steep ‘V’ shaped profile along bedrock stretch of the northwestern channel, with Knockmealdown in the distance.

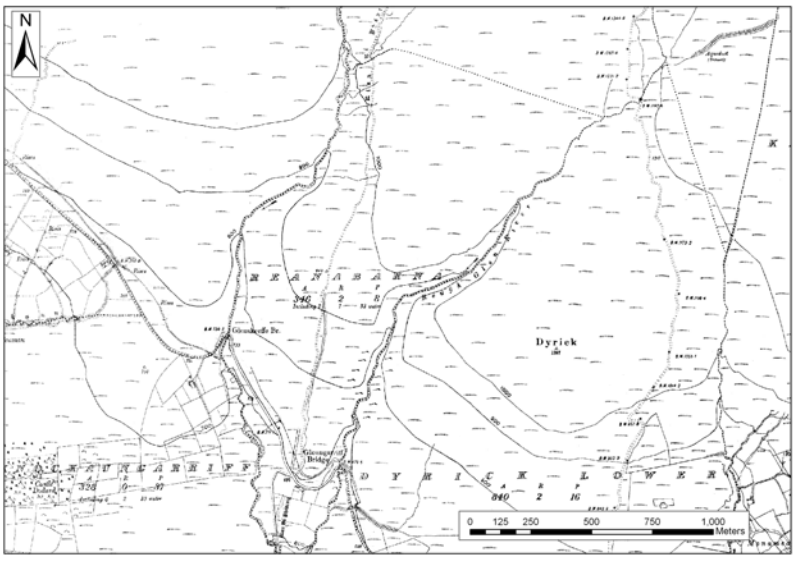
The northwestern channel, etched in glacial till, hence relatively gentle slopes.



Steep ‘V’ shaped profile of the Rough Glen gully, Knocknagnauv in the distance.




N
Knockmealdown
Channels
Site Extent
0 125 250 500 750 1,000
Meters


N
Dyriek
0 125 250 500 750 1,000
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Ardmore Mine**		
Other names used for site			
IGH THEME	**IGH15 Economic Geology**		
TOWNLAND(S)	**Dysert**		
NEAREST TOWN	**Ardmore**		
SIX INCH MAP NUMBER	**Waterford 40**		
NATIONAL GRID REFERENCE	**220141 77268**		
1:50,000 O.S. SHEET NUMBER	82	**1/2 inch Sheet No.**	22

Outline Site Description
Historical mine workings in coastal cliffs.

Geological System/Age and Primary Rock Type
The rocks at Ardmore Head are the youngest Devonian rocks, and may include some which are just Carboniferous in age. They have thin mineral veins sparsely distributed within the tunnels.

Main Geological or Geomorphological Interest
A complex of small mined tunnels penetrate the lower cliff as much as 50m inland in horizontal tunnels called adits. These are on several different levels and have side branches and possible interconnections between levels.

The limited published and archival record of the mine suggests it may have been worked in the 1600s and 1700s, and has remained unaffected by 19th century mining, unlike most mining districts.

The mineralogy is also slightly unusual compared to many smaller Irish mines with iron, copper and lead having been reported as coming from the mine, as well as silver. There are actually two separate workings, one at the head itself and one called the “Putty Hole” beneath the ruined Dysert Church.

An apparent revival attempt by Harry Ferguson and Mr Spargo is reported in local oral history, but it was either abandoned rapidly or was a scam to raise investment.

Site Importance
The Ardmore Mine is of County Geological Site importance. It is also part of Ardmore Head SAC 002123.

Management/promotion issues
Given the location off the coast path and on steep cliffs, this site is not suitable for general promotion to the public, and should not be highlighted. For those with a direct interest in geology or mining heritage they can be found and examined but they are not apparent to a casual walker. The warren of tunnels is relatively stable, but areas exist where small sections of roof could break down or the internal walls of unwanted rock may not be as securely built as they appear to be. Underground exploration of these mines is best left to experienced groups. An additional hazard encountered in the mine are numerous piles of faeces left by mink.

The mine adit entrances below the cliff path.

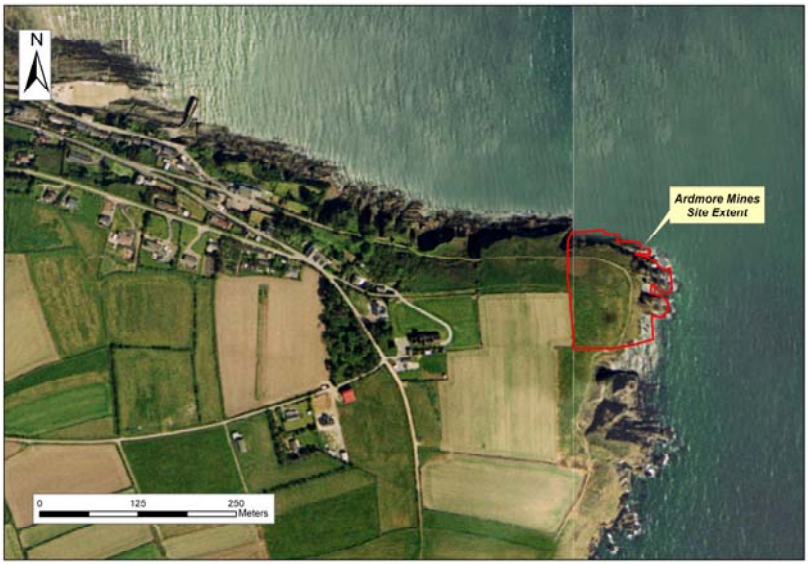
A view out of an adit.

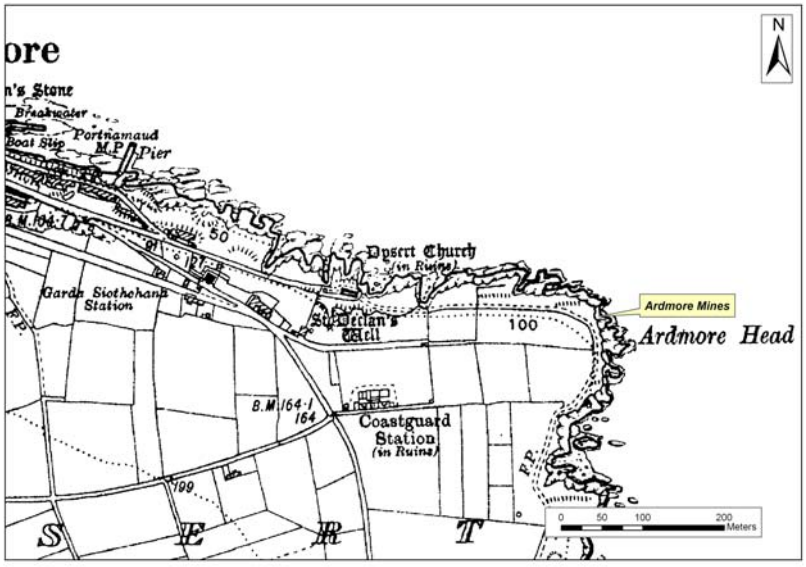
The Ardmore mines are in the headland east of the hotel on the edge of the village.

Most passages are very low.

An iron mineral vein.


Duffcarrick
Ardmore
Aird Mhór
Ardmore Bay
Cuan Airde Móire
PO
Fire Stn.
Pier
Church
Ardmore Mines
Ardmore Head
Ceann Airde Móire
Grave
Corn
Church and Round Tower
Monea
Dysert
Ardocheasty
Watch Tower
Ram Head
Ceann an Ráma


N
Ardmore Mines Site Extent
0
125
250
Meters


N
Portnamaud
M.P. Pier
Dysert Church
Garda Siothchana Station
St. Declan's Well
Ardmore Mines
Ardmore Head
Coastguard Station
0
50
100
200
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Drumslig**		
Other names used for site			
IGH THEME	**IGH 15 Economic geology**		
TOWNLAND(S)	**Drumslig**		
NEAREST TOWN	**Ardmore**		
SIX INCH MAP NUMBER	**Waterford 35**		
NATIONAL GRID REFERENCE	**220542 86864**		
1:50,000 O.S. SHEET NUMBER	82	**1/2 inch Sheet No.**	22

Outline Site Description
A shallow quarry working, now heavily vegetated, in wet grassland cover.

Geological System/Age and Primary Rock Type
The iron deposits are contained in Upper Devonian rocks – which are the mudstones and sandstones of the Gyleen Formation.

Main Geological or Geomorphological Interest
The locality is reported on the 19th century Geological Survey of Ireland geologists' fieldsheets as having a vein of hematite within the shale rocks, which was exploited. Hematite is a common oxide ore of iron, but occurrences in Ireland are rare. Most iron deposits that have been exploited in the past are either bog iron ore or nodular deposits of iron carbonate or phosphate in Roscommon, Leitrim and several other counties.

It is reported that some hematite veins in this district were worked by Sir Walter Raleigh in around the year 1600, Drumslig was presumably the main source. Shafts (vertical holes into the ground) are recorded on some maps but no easily visible trace of them is seen today under vegetation.

Site Importance
The site is confirmed here as of County Geological Site importance, but it is also under consideration for NHA status within the IGH 15 Economic Geology theme, as a rare example of hematite vein mineralisation.

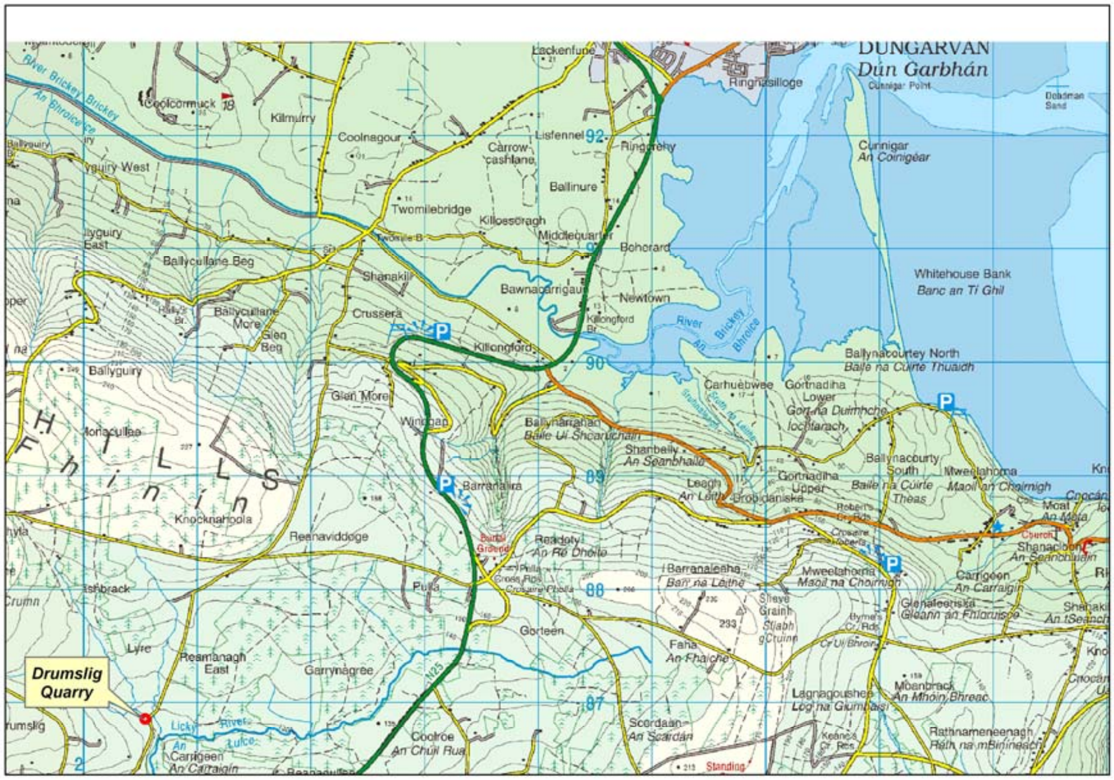
Management/promotion issues
Depending on land ownership and the potential amenability of the landowner, there may be scope for minor promotion of this site. The faces are not high and shale rock is not likely to create any risk of rock fall, nor dangerous slope profiles. Vegetation (mostly brambles) would need to be cleared off any face to allow access to the rocks and any trace of hematite that may be present. However, aside from occasional visits by geological parties, the historical interest is probably of more local importance.

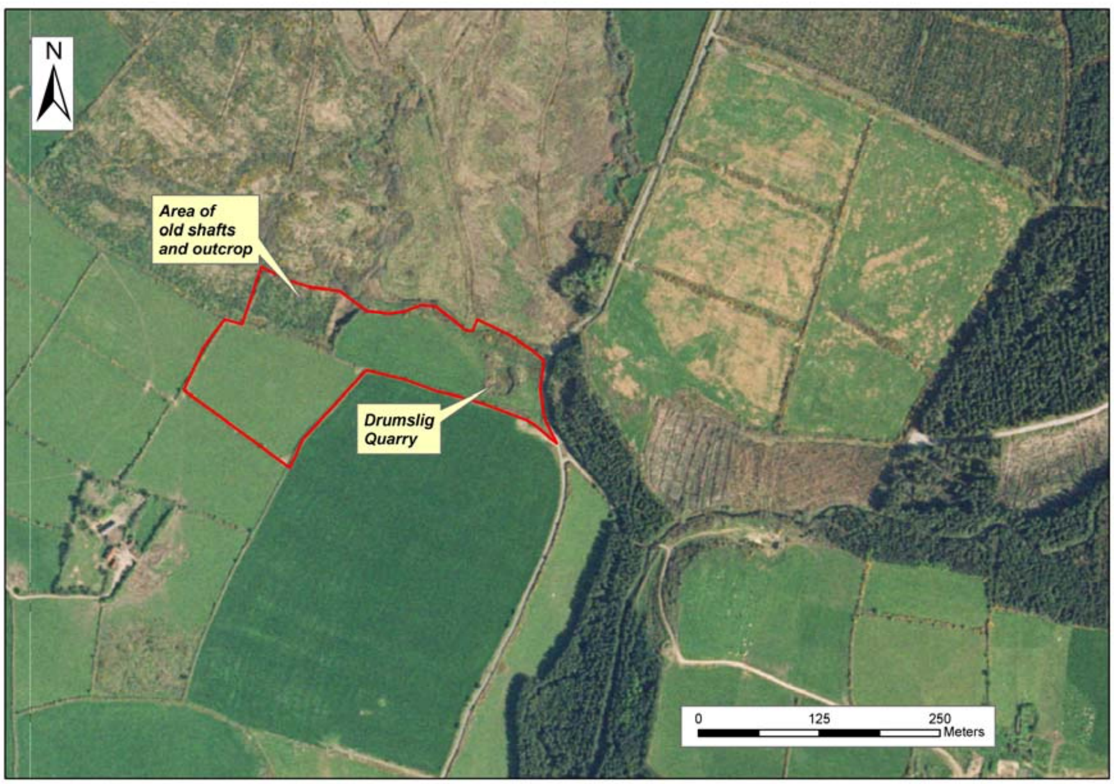
A panorama view of the shallow pit at Drumslig, with a probable mound of spoil in centre.

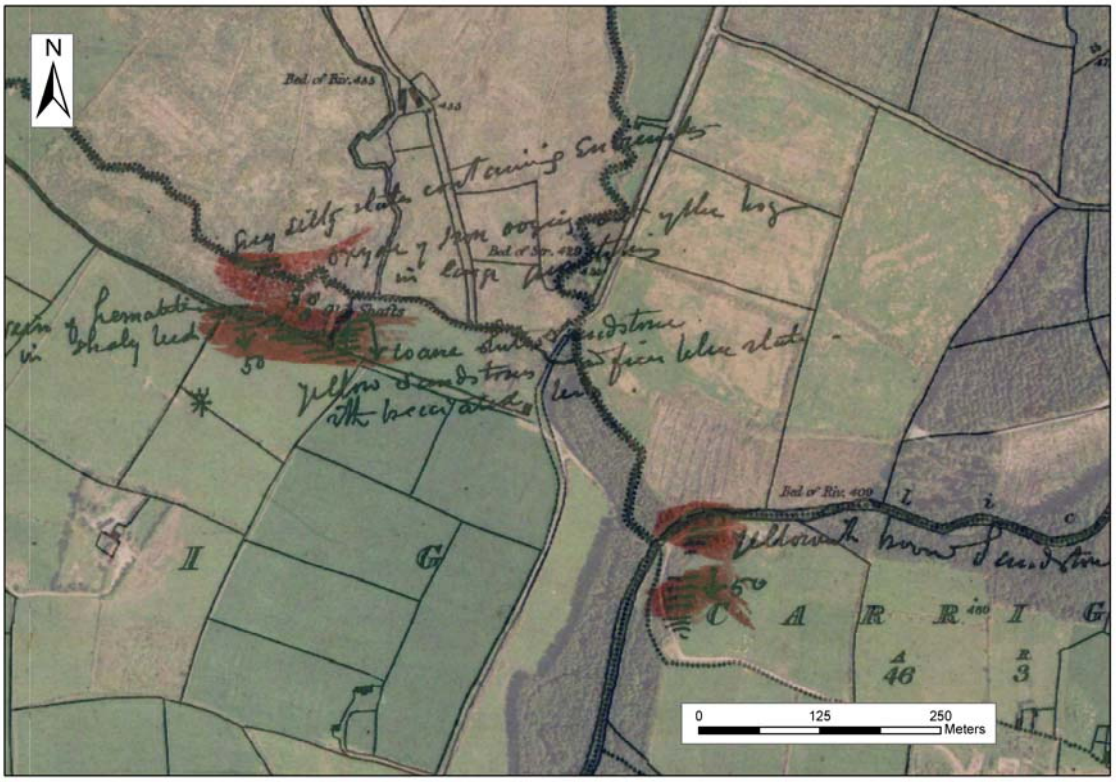
A small piece of hematite ore from Drumslig (two views).

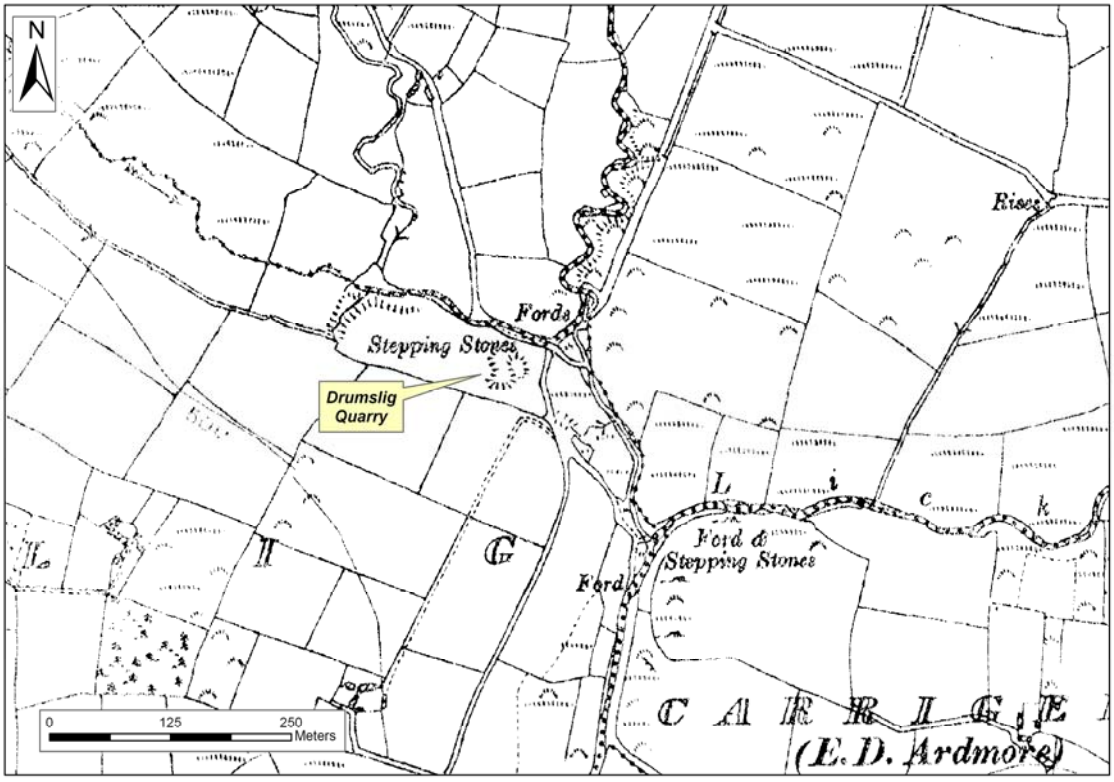
A panorama view of the shallow pit at Drumslig from the top of the spoil mound.

A panorama view of the shallow pit at Drumslig.


DUNGARVAN
Dún Garbhán
Drumslig Quarry
Whitehouse Bank
Banc an Tí Ghil
Ballynacourtey North
Baile na Cúirte Thuaidh
Cunnigar
An Coinigéar
Twomilebridge
Killongford
Glen More
Knocknahoola
Reanaviddoge
Garrynagree
Coolroe
An Chúil Rua
Gorteen
Lagnagoushee
Rathnameneenagh
Ráth na mBininéach
Mweelahorna
Maoil na Choirrigh
Scordaan
An Scardán


N
Area of
old shafts
and outcrop
Drumslig
Quarry
0
125
250
Meters


N
Bnd. of Rie. 433
Bnd. of Rie. 429
Bnd. of Rie. 409
0
125
250
Meters


N
Fords
Stepping Stones
Drumslig Quarry
Rises
Ford & Stepping Stones
Ford
0
125
250
Meters
(E. D. Ardmore)

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Ross Slate Quarry**		
Other names used for site			
IGH THEME	**IGH15 Economic Geology, IGH 4 Cambrian-Silurian**		
TOWNLAND(S)	**Ross**		
NEAREST TOWN	**Kilmacthomas**		
SIX INCH MAP NUMBER	**Waterford 16**		
NATIONAL GRID REFERENCE	**245655 108668**		
1:50,000 O.S. SHEET NUMBER	82	**1/2 inch Sheet No.**	22

Outline Site Description
This is a disused slate quarry, with associated spoil heaps and a water powered mill building.

Geological System/Age and Primary Rock Type
The quarry is cut in the Ross Member of the Campile Formation, which is an Ordovician rock.

Main Geological or Geomorphological Interest
The quarry was a major local producer of slate, based on the volume of the now flooded pit and the scale of the spoil heaps, which comprise the waste rock found to be unsuitable for purpose. In scale and interest, this matches the historical slate quarrying operations at Ahenny and many of the old quarries around Portroe, both in Tipperary. A waterwheel pit adjoins a building shell, which presumably housed machinery to pump water out of the quarry, but which may also have powered hoists or slate saws. The waterwheel pit is largely in good condition but has been slightly modified with concrete at the eastern end.

The Ross Member is the name given by geologists to the slates occurring only in this area, which are part of the Campile Formation. This formation extends from east Wicklow through County Wexford and through east Waterford. It comprises mostly volcanic rocks and associated sediments, but the Ross slate is a thick mud deposit that has been pressured enough by tectonic forces to create a well cleaved slate, in a narrow belt east of Kilmacthomas.

Site Importance
The site is of County Geological Site importance.

Management/promotion issues
This site is not suitable for public promotion due to being on private property (landowner is unknown to audit) and also has safety concerns. Loose rock faces in the spoil heaps show signs of being dug out occasionally and they are steep and potentially dangerous. The main quarry is flooded, is probably very deep, and difficult to exit from if anyone fell in. The mill building is still largely intact, but shows some signs of risk of damage, especially in the wall opening facing the west.

Remedial conservation works to stabilise this building would be desirable if funds and owner agreement can be found. No leats (constructed wooden or stone channels to bring water to the wheel) or other evidence was seen as to whether this was an undershot or overshot water wheel, but the carrying out of a more expert assessment is also advisable, e.g. by the Mining Heritage Trust of Ireland or the Mills and Millers Association.

The Ross Slate Quarry main face, viewed from the west.

View north across one of the spoil heaps (showing more recent excavation).

View of the Ross Slate Quarry road entrance, viewed from the southwest.

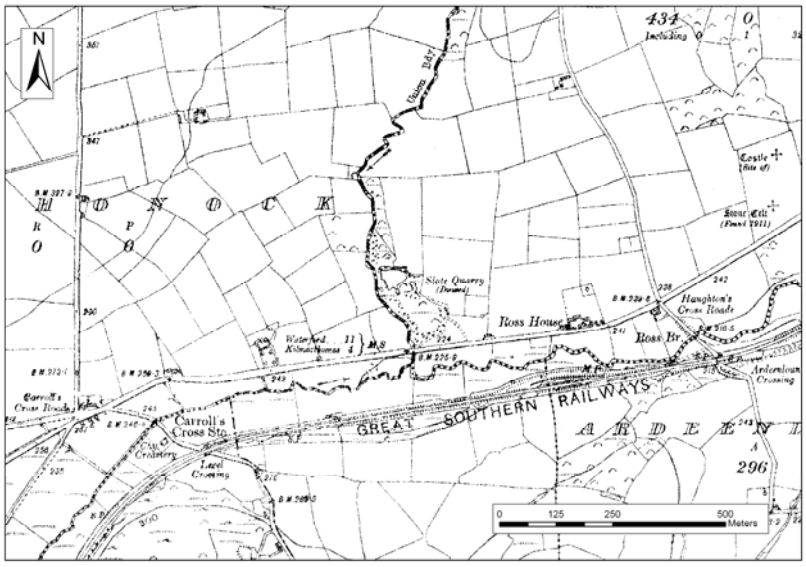
The wheelpit.

The water mill from the south.

The water mill from the north.


WATERFORD
Port Láirge
Ross Slate Quarry


N
Ross Slate Quarry
Site Extent
0
125
250
500
Meters


N
Ross House
Ross Br.
Haughton's Cross Roads
Carroll's Cross Sto.
GREAT SOUTHERN RAILWAYS
0
125
250
500
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Ballynamuck Boreholes**		
Other names used for site			
IGH THEME	**IGH16 Hydrogeology**		
TOWNLAND(S)	**Ballynamuck West**		
NEAREST TOWN	**Dungarvan**		
SIX INCH MAP NUMBER	**Waterford 31**		
NATIONAL GRID REFERENCE	**223634 94718**		
1:50,000 O.S. SHEET NUMBER	82	**1/2 inch Sheet No.**	22

Outline Site Description
The Ballynamuck Boreholes are the public water supply source for the Dungarvan area. The source consists of four bored wells which together provide approximately 6,000m^3 of water per day.

Geological System/Age and Primary Rock Type
The wells are between 12.7m and 27.5m deep and are bored into a sequence of alluvial clays, glacial till and Waulsortian limestones. The alluvial clays are 6m deep, with the clay underlain by glacial till, and the depth to bedrock at the site approximately 11m-12m.

The lower portion of the boreholes is drilled into Waulsortian limestone bedrock, which is known to be karstified in the Dungarvan area and which has the potential to yield large quantities of groundwater through conduit flow.

Main Geological or Geomorphological Interest
Combined, the four boreholes have been proven to be capable of supplying up to 10,000m^3 per day, or 10 million litres of water. These boreholes comprise therefore potentially some of the best yielding wells in Ireland.

It is considered that the River Colligan, which is only metres from the boreholes laterally, is perched on top of the alluvial clay deposits. Temperature and conductivity readings taken from the well water during a pumping test at Ballynamuck in 1994 suggested that the boreholes were not drawing any water from the river.

Site Importance
These are exceptionally productive bored wells which are among the top-yielding wells in the country. They are of County Geological Site importance.

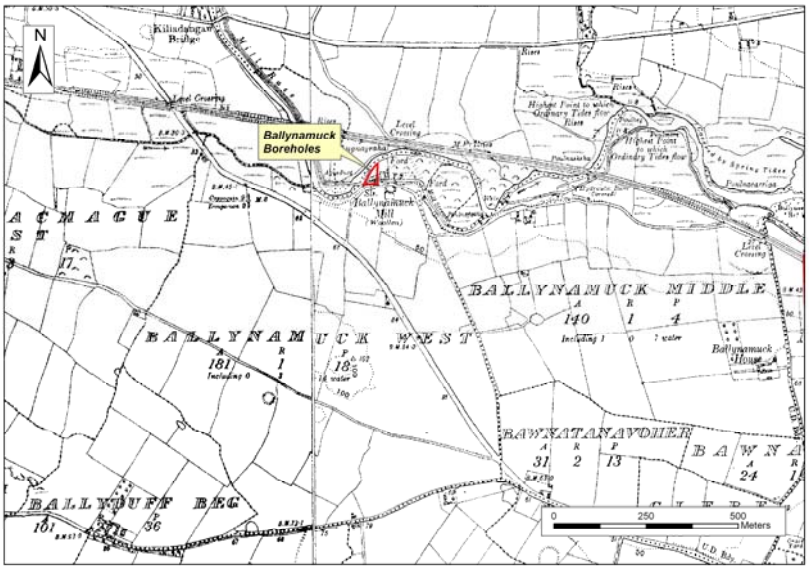
Management/promotion issues
The boreholes are well protected with secure fencing surrounding and secure concrete, sunken chambers containing their caps.

Two of the four boreholes are underneath the traffic cones.

Four boreholes are contained in the yard at Ballynamuck West, underneath manhole covers.


Ballynamuck Boreholes
Shandon Island
Colligan River
Knockateemore
Bawnabraher
Skehanard
Ringaphuca
Clonmore
Monang
Burgery
Ducksboo
Ballynamuck
Bawnatanavoher
Abbeyside
Tournore
R675
R672
Church
Fire Sta
Monkeal
Skehacrine
Luskanargid
Kilrush
PO
Mapestown
Devonshire Br
Spit Bank
Motte
Castle
Priory
Hosp
Lackenfune
DUNGARVAN
Dún Garbhán
Cunnigar Point
Ringnasilloge
Lisfennel
Carrow-
Ringrohy
Cunnigar


N
Ballynamuck Boreholes
0
250
500
Meters


N
Ballynamuck Boreholes
ACMACUE
BALLYNAMUCK WEST
BALLYNAMUCK MIDDLE
BAWNATANAVDHER
BALLYDUFF BEG
0
250
500
Meters

WATERFORD - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Fenor Bog**		
Other names used for site			
IGH THEME	**IGH16 Hydrogeology**		
TOWNLAND(S)	**Fennor North, Ballyscanlan**		
NEAREST TOWN	**Tramore**		
SIX INCH MAP NUMBER	**Waterford 26**		
NATIONAL GRID REFERENCE	**253035 101680 (centre of bog)**		
1:50,000 O.S. SHEET NUMBER	75	**1/2 inch Sheet No.**	23

Outline Site Description
Fenor Bog is a small acidic fen peat area, formed among crags of Ordovician age rocks in southeast Waterford.

Geological System/Age and Primary Rock Type
The fen itself has been formed in the Holocene (post-glacial) Period, though the hollow and surrounding crags have been moulded by glacial ice during the Quaternary (Ice Age).

Main Geological or Geomorphological Interest
The fen is an area where slightly acidic groundwater seeps out from surrounding land and collects in a bowl-shaped depression, thus forming a marshy mire. Peat has formed within this hollow from the partial decay of plant remains over the last few millennia.

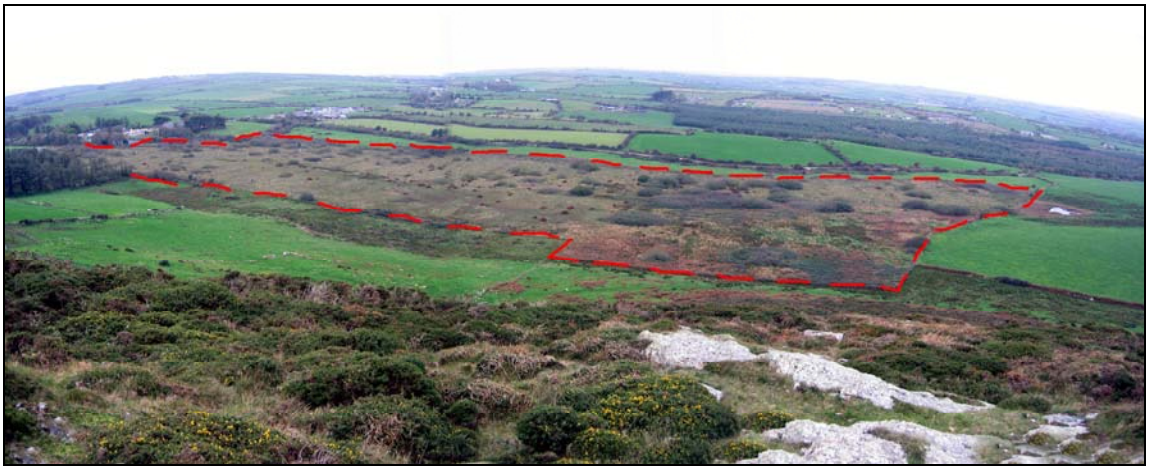
The fen is just over a kilometre long (north-south) and approx. 200m wide, occupying a hollow scoured out by ice among rock crags during the last Ice Age.

As with many fen features, the flora is somewhat unique in Waterford, although a number of such, similar features do occur in the surrounding area. Wetland plants abound and unusual species have been recorded here. The wettest patches are dominated by bogbean (*Menyanthes trifoliata*), water horsetail (*Equisetum fluviatile*) and bog pond weed (*Potamogeton plygonifolius*).

In drier places these species become less common and the dominant species is the moss *Aulacomnium palustre*, with cotton grass (*Eriophorum angustifolium*), marsh bedstraw (*Galium palustre*) and sedge (*Carex rostrata)* all frequent. In addition the bog St. John's Wort (*Hypericum elodes*) is very common, a local species in Ireland and Britain. The abundance of St. John's Wort is one of the more unusual aspects of the fen.

Site Importance
This is a very good example of an acidic fen peat environment, and it is an example of the most recent geological deposit still in the process of forming. The site is of County Geological Site status for its geological importance, but it is a national Nature Reserve and a pNHA (No. 1697).

Management/promotion issues
This is a well managed site by the local community and complements the local Copper Coast Geopark initiative. It is owned by Móin Fhionnúrach Development Association and the Irish Peatland Conservation Council [http://www.ipcc.ie/sitefenornnr.html].

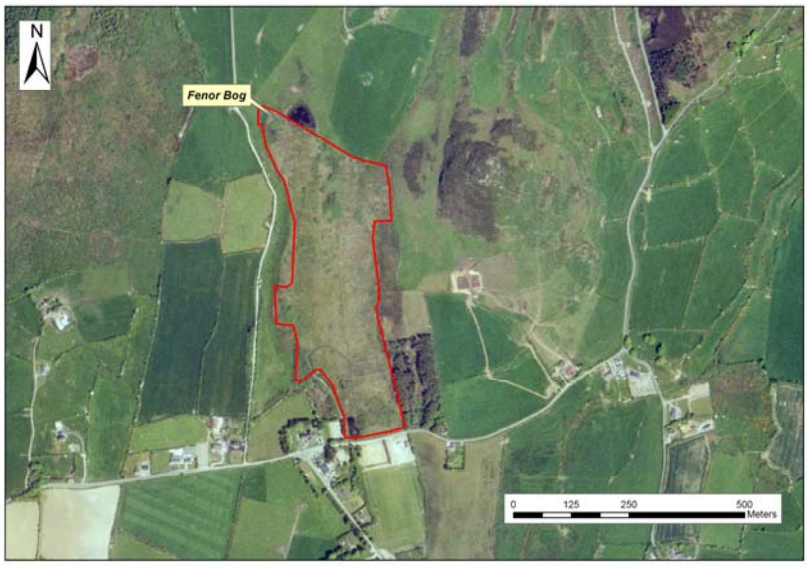


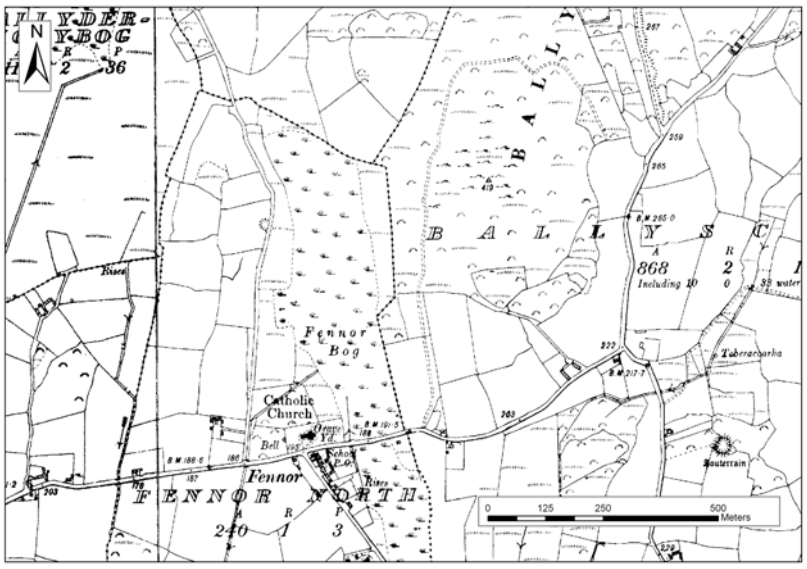
A view of Fenor Bog from the high ground to the east in the Ballyscanlan Hills.

Some of the visitor facilities and information panel at Fenor Bog. The artistically carved stone seats are by John O'Connor, and are part of a commissioned series along the Copper Coast.

A section of the boardwalk at Fenor Bog.


Fenor Bog
TRAMORE
Trá Mhór
Tramore Bay
Cuan
Trá Mhór
Great Newtown Head
Brownstown
Burke's Island


N
Fenor Bog
0
125
250
500
Meters


N
YDER
YBOG
2
36
B A L L Y
B A L L Y S
868
Including 10
2
0
Fennor
Bog
Catholic
Church
Bell
Fennor
F E N N O R N O R T H
240
1
3
Tobrearbarha
Souterrain
0
125
250
500
Meters

Appendix 1 – Bibliography – Geology of County Waterford

This bibliography, and those following are quite comprehensive, but are certainly not claimed to be definitive. Any additional references (and preferably a copy of the publication) relating to the geology, geomorphology or hydrogeology of County Waterford will be welcomed by the Heritage Officer. References specifically about the caves of Waterford are included in Appendix 2. References specifically about the mining heritage of County Waterford are included in Appendix 3. The references about the Quaternary, or Ice Age, geology of County Waterford are included in Appendix 4.

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Appendix 2 – Bibliography – Caves of County Waterford

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Appendix 3 – Bibliography – Mining heritage of County Waterford

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Appendix 5 – Rejected sites

A range of sites had been previously flagged for consideration in the IGH Master site list, and some were assessed as unsuitable for County Geological Site status in this audit. Similarly a range of additional sites were assessed in the audit, based on the authors' expert knowledge of Waterford's geology and especially the caves. It was known, for example, that caves in Waterford had not been adequately considered in the preparation of the IGH Master site list. Other sites were visited on spec during fieldwork. The rejected sites are listed below with brief notes as to why they were assessed as unsuitable for inclusion.

'Shandon Cave'
Although this was historically a significant locality for discoveries of a Pleistocene cave fauna in 1859, the bone cave itself has been completely removed from the location, which is now a large quarry housing a co-op and cattle market. There are very minor cave passages extant in the quarry walls but none meriting attention. The bone cave could also have been in a quarry area which is now a housing estate on the north facing section of the road by the River Colligan. Ryder (2009) lists five caves in the Shandon area, and discusses the details. One short cave is now in a quarry wall, behind Traveller accommodation but has been blocked by concrete, presumably on safety grounds. The only significant accessible cave remaining is the 'Shandon Railway Cutting Cave' described in the site report.

Top left: The Shandon quarry and mart.
Top right: The concreted in entrance to one of the Shandon caves.
Left: The Traveller accommodation in the floor of a Shandon quarrying area. The cave above is at the right end of the wall.

Oonagaloor (Coolanav)
This very large cavern is probably the largest in Waterford, about 30m wide and 40m long, and around 6m high. Sadly, between 1988 and 2011, but probably several years ago a major episode of waste dumping has made the cave highly unpleasant and potentially hazardous. It should be cleared out and made safe for protection of the groundwater in the area, aside from aesthetic and other grounds.



Dumping in Oonagaloor (Coolnanav), from outside and inside the cave.

Kilbride North
In 2001 this site was still extant and was advised to the National Parks and Wildlife Service for designation as a geological NHA for its Ordovician palaeontological importance. However on a visit in July 2011, it was found that a large new house had been built in the old quarry locality, and the main rock exposures of value were totally obscured. Whilst there has been some extension of the quarry back wall to accommodate the house, these exposures were volcanic rocks with no fossils in previous research visits. However, due to security measures and guard dogs these could not be checked. It is now considered that this site is not suitable for neither NHA or CGS status.


The new house built on the site of a small former quarry, obscuring the fossiliferous outcrops.

Cappagh Quarry Cave
This cave is now totally inaccessible as it is fenced in with a settling pond for quarry aggregate washings. Aside from this the survey and description of the cave itself were assessed as relatively unimportant. However the quarry itself is worthy of CGS status for karstic and Carboniferous geology interest.


Cappagh quarry Cave entrance is now inaccessible behind the settling pond.

Ballynacourty Quarry Cave
This cave was visited but is small and was deemed to be relatively unimportant compared to other sites which are included with site reports.


Entrance location, inner view and entrance to Ballynacourty Quarry Cave.

Cappoquin sluggera

The karstic collapses or swallowholes known as sluggeras in some parts of Ireland are discussed in the report as geological hazards. Although the Townland named Sluggara to the east of Cappoquin has had many reported collapses and some visible minor dolines, we were unable to define any site that was suitable for inclusion as a County Geological Site. The collapse of a roadway at Cappoquin industrial estate in approximately November 2010 has been entirely filled and repaired and whilst interesting in its own right, it was deemed unsuitable for CGS status in its present condition.

Panorama of the Cappoquin collapse of November 2010, picked out by the newly graded fresh earth in the road verges.

Little Island

Little Island is a bedrock island in the River Suir, which was considered as a site in the Fluvial and Lacustrine Geomorphology Theme (IGH14), but it is rejected here as being just an island that splits the channel, and not as part of an oxbow feature as it had been listed for in the IGH preliminary lists.

Panorama view of Little Island from the southeast side.

Cheekpoint to Ballyhack, River Suir

This section of the River Suir was originally under consideration as a gorge in the Fluvial and Lacustrine Geomorphology Theme (IGH14), since it is largely cut in rock. However, it is simply a rock walled gorge of which there are many examples across the country and although large it is unremarkable as a geomorphological feature.

Panorama view of the Cheekpoint (left) to Ballyhack (right) section of the River Suir, taken from the west bank.

Greenan Hill, Roadstone Carroll's Cross Quarry

Any sizeable quarry may provide a valuable window into the bedrock below the veneer of green vegetation or Ice Age deposits of till or sand and gravel. Whilst apparently a large quarry in volcanic rhyolite rock when seen from the road, the quarry has long ceased working. It is completely unsuited to being a County Geological Site since it has had most of the available rock exposures obscured and buried beneath volumes of construction and demolition waste. There is very little geological interest left to recommend it for.

Panorama view of part of Roadstone Carroll's Cross Quarry, showing the C&D waste that covers much of the quarry.

New quarry or borrow pit

A quarry is visible from the N25 road when travelling towards Waterford from Dungarvan, in the hillside above the gorge section of the Dawn River before reaching Kilmeadan. Examination of this showed very little of geological interest, in shallow workings of fractured and weathered Ordovician bedrock (probably the Kilmacthomas Formation), excavated for farm rock fill purposes.

Panorama view of this farm pit.

Appendix 6 – Unassessed sites

A small range of additional sites were considered during the progress of the audit, but were not reported on for different reasons. These sites are listed below with brief notes as to why they remain unassessed, but they could be added to the Waterford County Geological Site list if new information proves they are suitable and important.

Glenbeg Cave

This site was visited but the cave could not be found. No landowner was present to ask for its precise whereabouts. The likely location is associated with a small quarry but no cave was found in the quarry when inspected as part of this audit. It is possible that the entrance has been obscured or obliterated by construction of adjacent silage or other farm concrete yards.

Lismore Cave

This is mentioned in J.C. Coleman's *The Caves of Ireland* from 1965, but no other reference to it is known. It was not searched for in the vicinity of Lismore Castle, due to time constraints. Enquiries of other cave scientists yielded no direct knowledge of it. The description in Coleman (1965) suggests it is not significant, but further investigation may prove otherwise in the future.

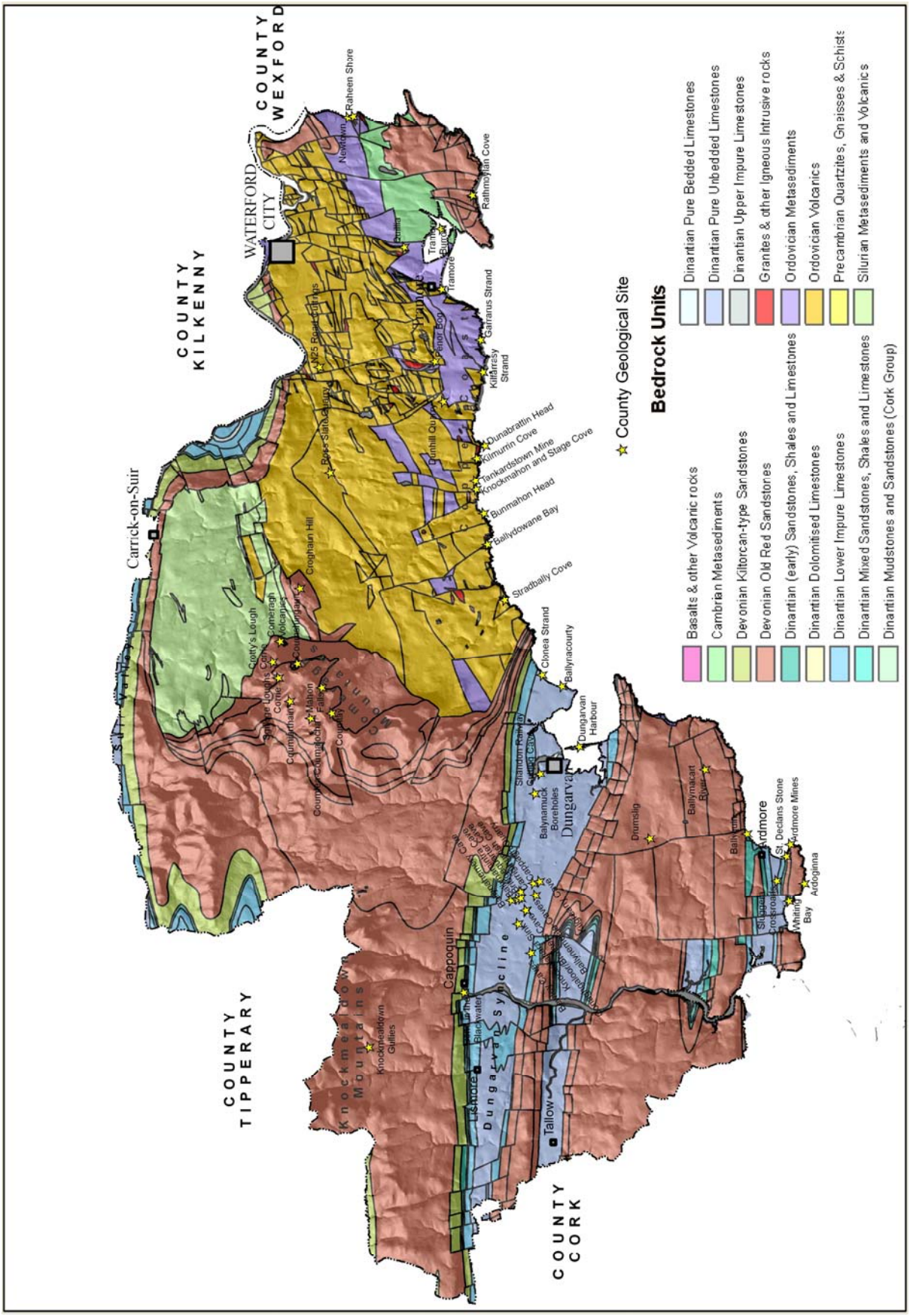
'The Putty Hole', Ardmore Mines

This is a slightly separate working from the main complex of mine workings on Ardmore Head. It is situated in the cliffs below St. Declan's Well. It was not yet visited, because it is reportedly impossible to access without a boat. Further work on Ardmore Mine is being conducted by Matthew Parkes and others with intentions of publishing a paper on the site in the Journal of the Mining Heritage Trust of Ireland. Access to the Putty Hole will be made and a recommendation made for its inclusion as a County Geological Site or not, depending on the assessment.

Andesite Quarry

A working quarry in andesite off the R675 near Stradbally was reported at a late stage in the audit after fieldwork had been completed and it was not visited.

Appendix 7 – Detailed geology map of County Waterford



Appendix 8 – Geological heritage audits and the planning process

This appendix contains more detail on the legal framework behind geological heritage audits conducted by County Councils, and the process which operates as a partnership between the Geological Heritage and Planning Section of the GSI and the local authority Heritage Officer.

Geology is now recognised as an intrinsic component of natural heritage in three separate pieces of legislation or regulations, which empower and require various branches of Government, and statutory agencies, to consult and take due regard for conservation of geological heritage features: Planning and Development Act 2000 [e.g. Sections 212 (1)f; Part IV, 6; First Schedule Condition 21], Planning and Development Regulations 2001, Wildlife (Amendment) Act 2000 (enabling Natural Heritage Areas) and the Heritage Act 1995. The Planning and Development Act and the Planning Regulations in particular, place responsibility upon Local Authorities to ensure that geological heritage is protected. Implementation of the Heritage Act 1995, through Heritage Officers and Heritage Plans, and the National Heritage Plan 2002, allow County Geological Sites to be integrated into County Development Plans.

The chart below illustrates the essential process, established by the Irish Geological Heritage Programme in the GSI, over the course of eight county audits since 2004.

County Geological Sites - a step by step guide