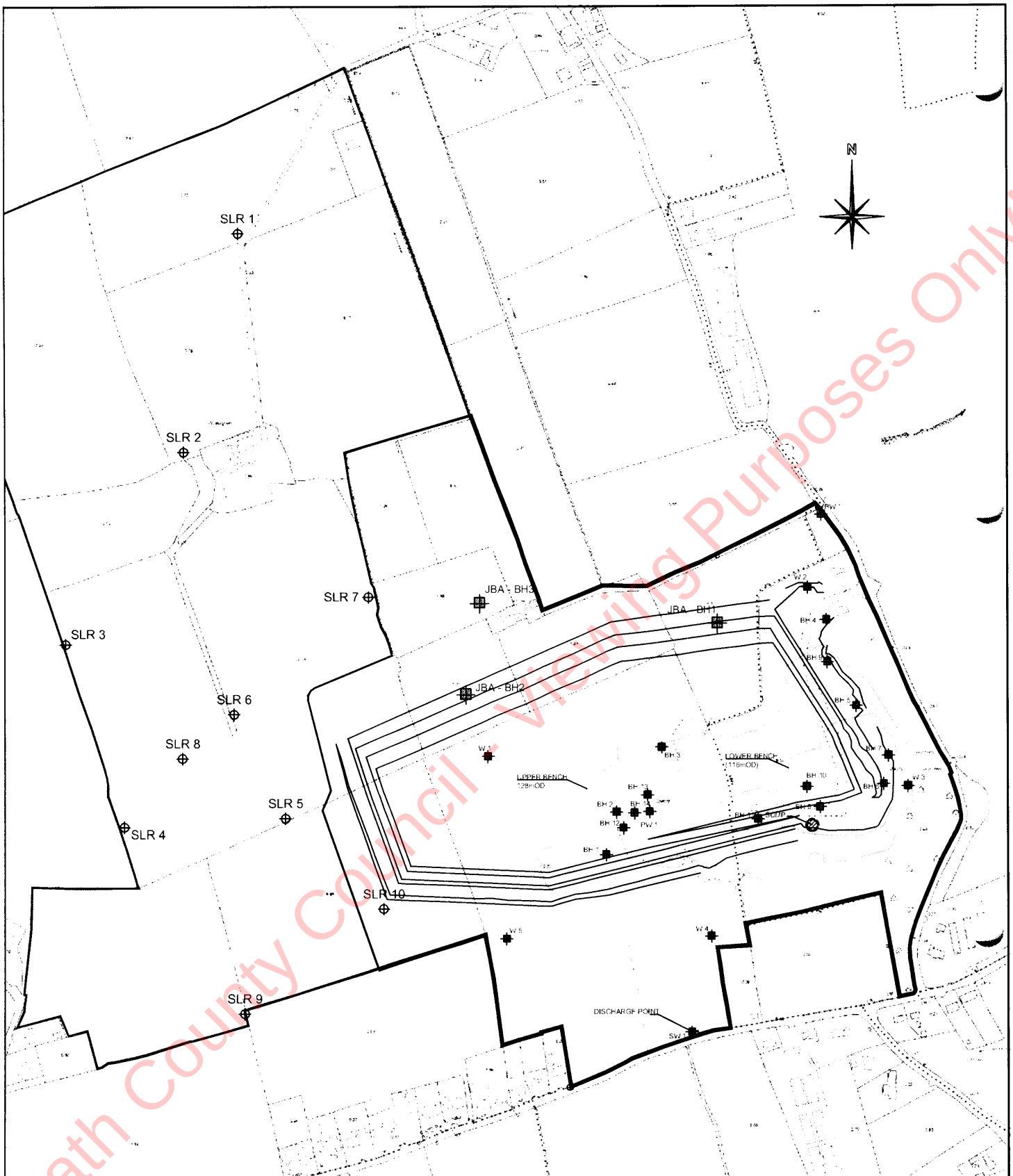
APPENDIX 7.4: BOREHOLE LOCATIONS FOR THE SITE INVESTIGATION POINTS.

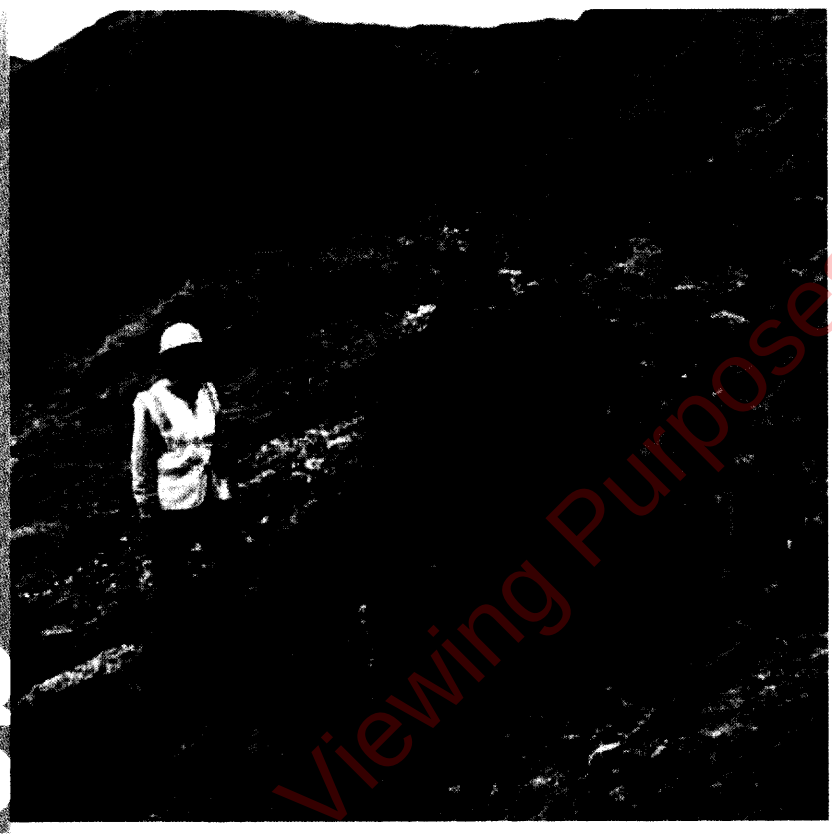


Kilsaran
build

Site Investigation Layout Drawing

APPENDIX 7.5: *GUIDELINES ON GEOLOGICAL HERITAGE – GUIDELINES FOR THE EXTRACTIVE INDUSTRY*, 2008 JOINTLY ISSUED BY GSI AND ICF

Guidelines

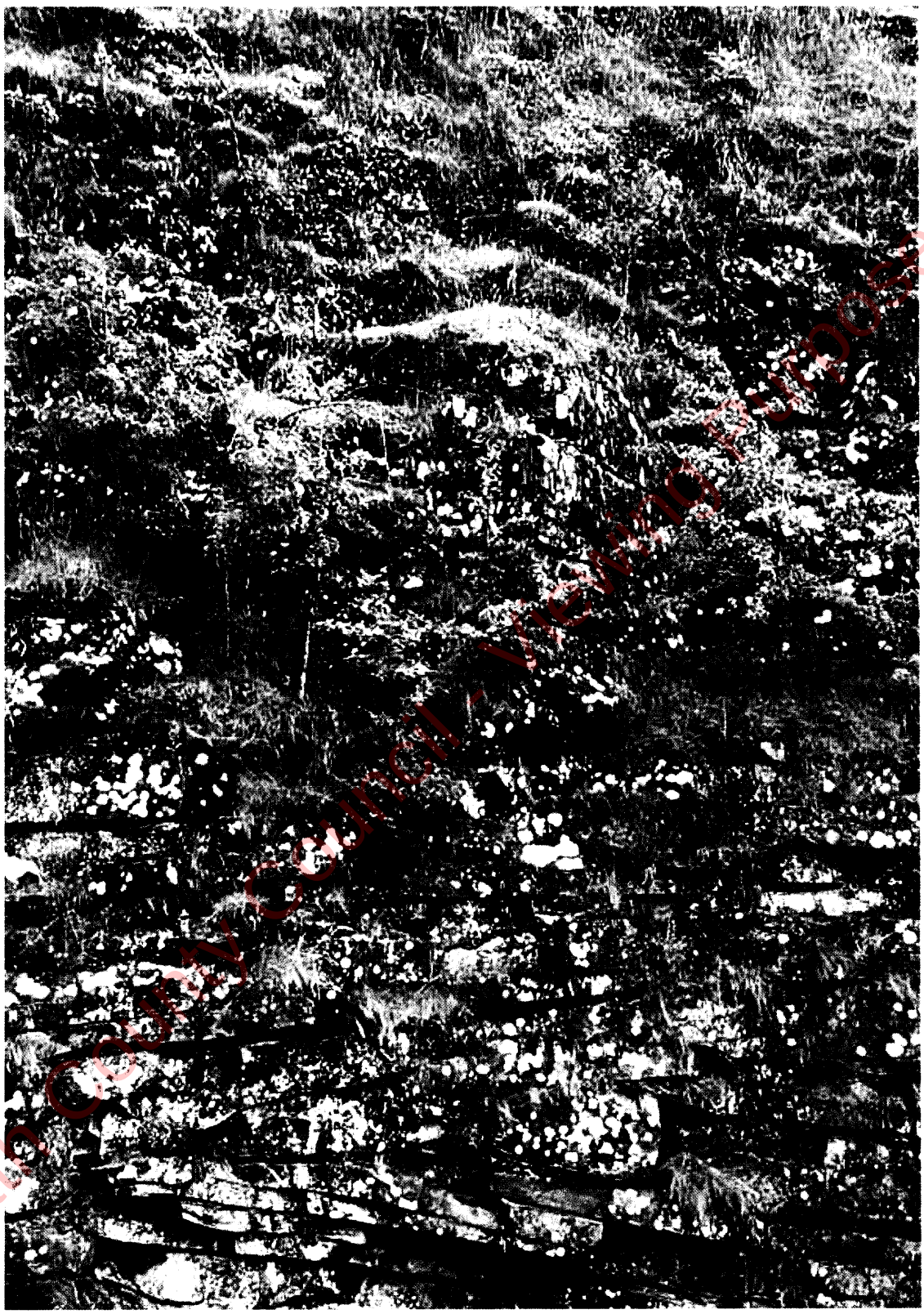


Geological Heritage Guidelines for the Extractive Industry

IRISH CONCRETE FEDERATION
Set for life

GSI

planetearth
Earth Sciences for Society



Guidelines

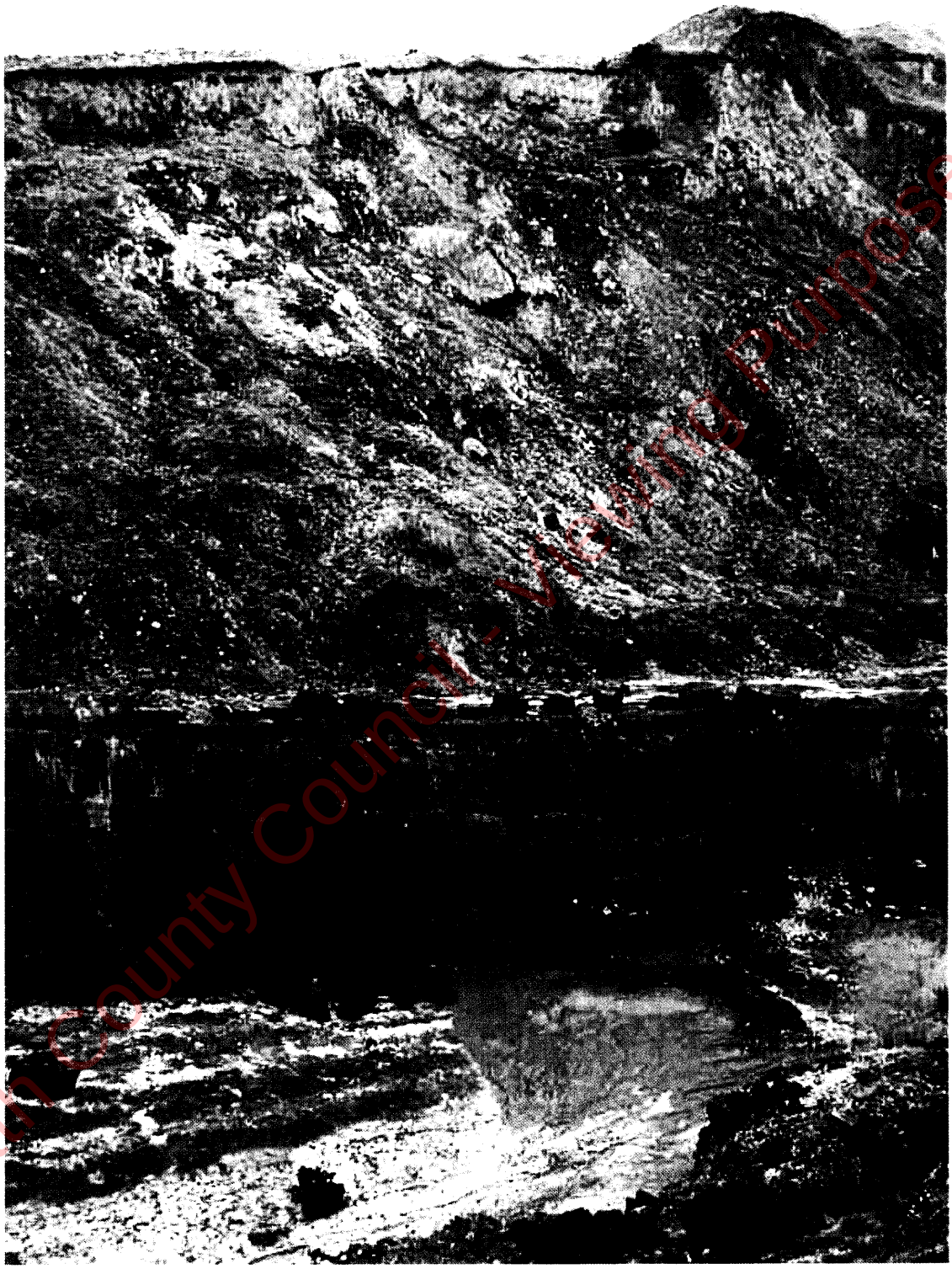
These guidelines are intended for Irish Concrete Federation (ICF) members so that they may follow best practice and receive clear information concerning geological heritage in relation to any proposed quarry or related development or land purchase.

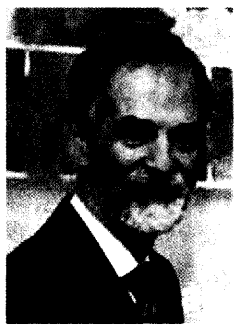
They are also intended as a useful template for any quarry operator in addressing geodiversity issues and thereby contributing to the databases of the Geological Survey of Ireland.

This furtherance of geological knowledge will ultimately feed back into Ireland's extractive industry as well as help provide other benefits to society.

Dr. Sarah Gatley, Irish Geological Heritage Programme,
Geological Survey of Ireland

Dr. Matthew Parkes, National Museum of Ireland – Natural History





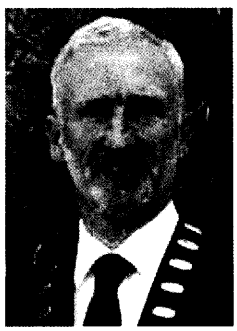
Foreword from the Director of the Geological Survey of Ireland

Ireland, with its diverse geological framework, has a wide variety of geological heritage features. Many of these are well known to visitors as well as to those with a special interest in heritage – indeed areas such as the Burren have world-class geological heritage. But not all geological heritage features occur in natural exposures and there has been a long history of remarkable discoveries in operating and disused quarries. Think of the exquisite fossil plants discovered in the nineteenth century in a quarry near Ballyhale in County Kilkenny. Widely illustrated in books and journals, these are among the world's earliest fossils of land plants and provide rich insights into how plant life evolved on land. It is therefore not surprising that geologists and quarry operators have had a long – and mutually beneficial – relationship.

I hope these guidelines on geological heritage will build on that relationship. I am very pleased to welcome their preparation in conjunction with the Irish Concrete Federation. I trust they will be helpful and informative, and that they will be applied widely by the quarrying sector.

Dr. Peadar McArdle
Director, Geological Survey of Ireland

Left: A depression in Carboniferous limestone filled with clays and gravel, probably derived from Tertiary weathering of the Leinster Granite. Ballyellin Quarry, County Carlow.



Foreword from the President of the Irish Concrete Federation

I warmly welcome this joint publication with the Geological Survey of Ireland and would like to thank all involved in its preparation, especially Dr. Sarah Gatley of GSI and Dr. Matthew Parkes of the National Museum. These Guidelines give an excellent introduction and overview of our Geoheritage and how the extractive industry positively contributes to this fascinating area.

It will be of great interest to students and academics in this field as well as other professionals in related disciplines, in addition to its main focus, practitioners within the extractive industry itself. Their application can significantly enhance national databases such as recording of rock formations and groundwater monitoring and is entirely compatible with the ongoing extraction of aggregates to serve the needs of society. Indeed, it is only through extraction that much is learned about the origins of this island and the physical forces that have come to bear over many millions of years.

I am confident that the professional extractive sector will adopt these Guidelines quickly and view them, as I do, as a very necessary and worthwhile part of extraction planning and an appropriate contribution to the International Year of Planet Earth 2008.

Alan Haugh
President, Irish Concrete Federation

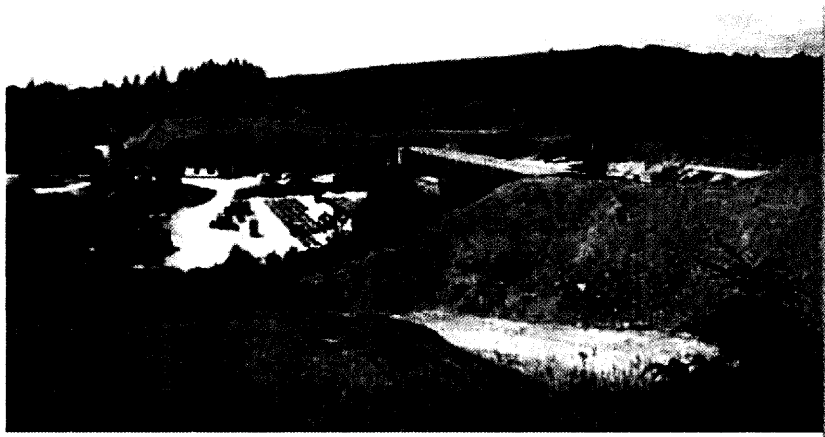
findings

1. Legislative Foundation

Ireland's Geological Heritage is included in several pieces of legislation (see Appendix 1). The Irish Geological Heritage (IGH) Programme of the Geological Survey of Ireland (GSI) aims to identify, protect and promote the best of this heritage, along with its partners in the National Parks and Wildlife Service (NPWS). GSI, as a line division of the Department of Communications, Energy and Natural Resources, is a prescribed body, to be consulted on any development, but notably, where the application relates to minerals extraction, quarry developments/extensions and developments involving excavations greater than 50,000 m^3 in volume or 1 hectare in area.

Above: Sand martin burrows in Ballysax Quarry, County Kildare

Opposite: Slate Quarries Townland, County Kildare.



2. Geological Heritage Sites

The IGH Programme identifies and selects a complete range of sites that represent Ireland's geological heritage under sixteen themes (see Appendix 2). The development of an indicative site list has involved panels of experts for each geological theme, to ensure a robust and defensible selection process, based on scientific criteria. The list includes all those sites which require further assessment before any possible designation may be applied.

The most important geological and geomorphological scientific sites are to be designated as **Natural Heritage Areas** (NHAs) by NPWS. Many selected sites overlap with existing proposed NHAs for their biodiversity or habitats. Geodiversity is often the foundation for biodiversity. Many sites have featured in more than one theme, enhancing their overall importance.

As a second non-statutory classification, the National Heritage Plan (2002) included **County Geological Sites** (CGS). These are sites recommended to local authorities for inclusion in the County Development Plan as a scheduled list of sites, with a council policy to protect them from damage through any proposed development. Though they have no statutory protection like NHAs, they receive recognition in the planning system and thus may not be destroyed or damaged through any lack of awareness outside of geological circles.

The selection of CGS may involve the audit of geological heritage sites throughout a county through the mechanism of the County Heritage Plan. The process may also include local democratic participation that modifies the site list put forward by GSI. Sites which have educational, tourism, amenity or other local heritage values, may be included.

Guidelines

Six Simple Guidelines

The IGH Programme requests its consultees to assist with developing the work on Irish geological heritage by following these guidelines:

EIS Stage

i) **Consult with IGH** at the scoping stage of a proposed development or EIS. All environmental/other designations (e.g. NHA, SAC) should be identified via the NPWS website [www.npws.ie]. IGH will conduct a data search to advise of any potential impact on a geological heritage site, forming a basis for ongoing dialogue. IGH aims for compromise, but where a rare direct conflict of interest arises, reserves the right to object throughout the consultation process. The IGH database search is conducted confidentially and without charge (contact S.Gatley or S.Preteseille). [GSI has other relevant datasets, including Bedrock, Minerals, Quaternary, Groundwater: see www.gsi.ie];

Provide good OSI maps of the proposed site [1:50,000 and 1:10,560 (6 inch) scale, including co-ordinates in National Irish Grid X,Y format]. Show the location of groundwater monitoring points, where relevant (see v);

Design the quarry operation with end use in mind at this stage (see vi); Consider how any IGH interest or new geological feature can be included in restoration plans.

ii) **Liaise with IGH** during the early stages of site investigation: provide geological data e.g. exploratory borehole, trial pit logs, sections, site investigation reports, to contribute to GSI national databases and further knowledge on the geology of Ireland (that you may need to access in future);

Quarry Operation Stage

iii) **Facilitate periodic visits from IGH** during the quarry operation, to advise on future geo-conservation issues, e.g. preserving a representative section of the geology; **Permit access for research by bona fide geologists**, which may include recording new data and sample collecting, and for educational purposes - health and safety considerations permitting. Off-track parking areas would be ideal for examination of sections.

iv) **Notify IGH about any significant new section or feature**, temporary or permanent, that may become exposed by quarrying, e.g. after blasting (or send a digital photograph that can be quickly assessed – see v). New faces can be examined by IGH or other relevant expert, with minimal interruption to the quarrying operation, and may facilitate optimum extraction as well as enhance geological understanding of the area. Discuss with IGH how new features can be accommodated in closure plans;

v) **Monitor and, ideally, maintain a digital photographic record of the extraction process**, so that new faces are documented, as well as any new or significant feature flagged to IGH. These can be examined if needed, adding to GSI's knowledge base and facilitating a smooth quarrying operation; IGH can advise on ideal monitoring and photographic methods. Forward any annual reporting groundwater monitoring data digitally to the GSI Groundwater Programme (as submitted to the EPA and local authorities as per the EU Water Framework Directive or planning condition).

End operation stage

vi) **Finalise restoration plans in consultation with IGH**, ideally having designed the operation of the quarry to consider end use. Plan for maximum geodiversity on closure, if appropriate. In particular, leave rock faces visible as exposure rather than covered with soil, vegetation or rock debris); make rock faces safely available to geologists, and to the public if possible, by creating public pathways and viewing areas with furniture and information panels (IGH can advise on interpretative materials).

Maintaining access to the geological heritage interest promotes geoconservation in the community. There are more imaginative, and economical, end uses for quarries than the backfilling method that obliterates existing and newly created geodiversity and biodiversity, such as their modification as open-air amphitheatres or rock climbing facilities. Even if converted to light industrial use, the quarry walls can be retained for geodiversity interest.

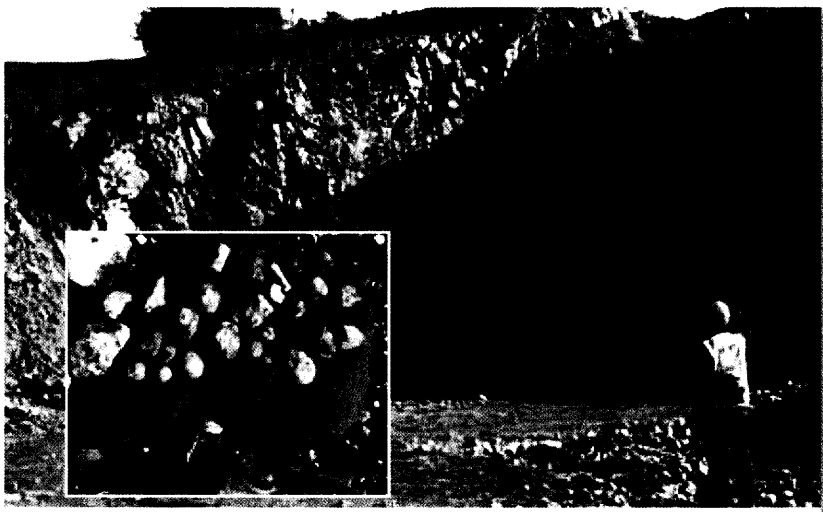
Through these guidelines, ICF and IGH can promote geodiversity and enhance the public perception of quarrying by making visible the working relationship between the extractive industry and geological heritage.

3. Geological heritage site management issues

It is most important to record the major differences between many geological heritage sites and the management concerns for most archaeological or ecological sites which may conflict with the interests of the quarry or plant operator. Paradoxically, some geological heritage sites are only known about because of past or present extraction of earth resources such as rock, clays or sands and gravels. In many cases almost no management of geological heritage sites is required as they are robust, although some finite sites such as mineral or fossil localities, eskers or unique features will require some protection. Most management issues relate to access to and promotion of appropriate sites.

There are working quarries which may have been selected as either NHA or CGS, but for which there has been no imposition of restrictions under Section 261 or Section 34 to date, on the legal operation of the quarry. The selection is a recognition that these quarries are the best, and in some cases, only place in which a particular representative rock sequence may be examined. In time, the NHA or CGS designation may involve some discussion between operators, the IGH Programme and the relevant authorities about eventual end use and possible variation in closure plans to accommodate preservation of representative sections of exposure and permit public access, for example. It should therefore be seen as a positive opportunity.

For many Quaternary deposits, left during the Ice Age, conflicts may arise between conservation of scientifically important landforms and their potential as a sand and gravel resource. The IGH Programme, along with partners, is trying to identify the most important sites nationally, of features such as eskers, which should be protected as part of our national heritage, and thus provide clarity to operators and planners about all other potential resources. This can be integrated with GSI's renewed Aggregate Potential Mapping (APM) programme which is vital in classifying land use, and should not conflict with proposed EU legislation to ensure sustainable and long term access to mineral resources.



4. Accessing information about geological heritage sites

GSI has a policy of free access to data, that is increasingly available on its website at www.gsi.ie. More and more information on geological heritage sites will become available to consultants through the public domain, including:

- NPWS publicly available NHA data via NPWS website;
- County Development Plan listings of CGS as plans are revised on a cycle;
- County geological heritage audits (e.g. Carlow, Clare, Fingal, Kildare, Kilkenny, Meath, Sligo);
- GSI and other guides to sites or areas.

However, there are sensitivities about protection of some vulnerable sites before formal designation as an NHA may take place, and about the important wider issue of consultation with landowners as evaluation of indicative sites takes place. Therefore direct consultation with the IGH Programme provides the most effective current assessment of quarry development issues in relation to geological heritage sites. The ongoing IGH Programme work is expanding its detailed records on individual sites, with particular respect to boundary definition or limits of interest. For more information on the IGH Programme see the references in Appendix 3.

Top: Edenderry Oolite on Waulsortian limestone, Ballykane Hill new quarry, County Kildare.
Inset: Fossils collected by school group at Carmean Limeworks, Northstone (NI) Ltd.
Left: Morrissey's Quarry, Carlow

5. Confidential pre-land purchase enquiries

Any ICF member may make totally confidential enquiries about the existence of any identified geological heritage interest in prospective land purchases, through Dr Charles Mount, ICF Archaeology Manager or other designated manager, who would consult with the IGH Programme personally.

For all geological heritage enquiries, the ICF member or their consultants should contact:
Dr Sarah Gatley,
IGH Programme, Geological Survey of Ireland,
Beggars Bush, Haddington Road, Dublin 4
Email: sarah.gatley@gsi.ie or sophie.preteseille@gsi.ie

6. Preparation of an Environmental Impact Statement (EIS)

There are guidelines on the preparation of EISs (Geology in Environmental Impact Statements – A Guide: Institute of Geologists of Ireland, 2002; Recommended Collection, Presentation and Interpretation of Geological and Hydrogeological Information for Quarry Developments: Institute of Geologists of Ireland, 2007; Code of Practice for Site Investigations B.S. 5930 of 1999) which, along with these Guidelines, should be followed to ensure the preparation of comprehensive reports.

The Geological Survey of Ireland (GSI) is the national earth science agency and has datasets on Bedrock Geology, Quaternary Geology, Mineral Deposits, Groundwater Resources and the Geology of the Irish Seabed area. These consist of maps, reports, and extensive databases including mineral occurrences, site investigation boreholes, mineral exploration boreholes, karst features, wells and springs. These datasets may be consulted, in addition to the heritage site listing, in the formulation of an EIS for any particular quarry site. **The GSI, as a prescribed body, should routinely be consulted at the planning stage and in the preparation of an EIA/EIS.**

Left: Hill of Allen Quarry, County Kildare.

Top: Fossil collecting in Carmean Limeworks, Northstone (NI) Ltd.

Guidelines

Appendix 1

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.

Appendix 2

The 16 geological themes under the IGH programme are:

IGH 1 - Karst;
IGH 2 - Precambrian to Devonian Palaeontology;
IGH 3 - Carboniferous to Pliocene Palaeontology;
IGH 4 - Cambrian-Silurian;
IGH 5 - Precambrian;
IGH 6 - Mineralogy;
IGH 7 - Quaternary;
IGH 8 - Lower Carboniferous;
IGH 9 - Upper Carboniferous and Permian;
IGH 10 - Devonian;
IGH 11 - Igneous Intrusions;
IGH 12 - Mesozoic and Cenozoic;
IGH 13 - Coastal Geomorphology;
IGH 14 - Fluvial and Lacustrine Geomorphology;
IGH 15 - Economic Geology;
IGH 16 - Hydrogeology

Above: Morrissey's Quarry, County Carlow.
Left: Karstic solution pipe in Carboniferous limestone, Ballintra Quarry, Roadstone Ltd. Such features can be significant problems for quarry operators, but may contain valuable scientific data to record as they are exposed.

Appendix 3

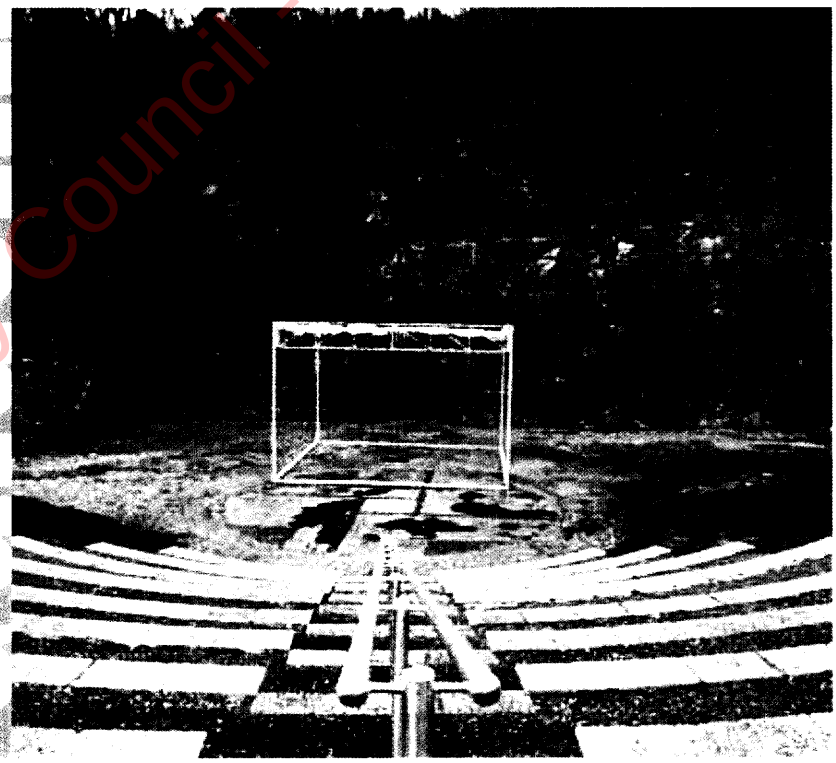
If you wish to find out more about the Irish Geological Heritage Programme the following references are good starting points.

Parkes. M.A. and Morris. J.H.M. 2001. Earth Science Conservation in Ireland: The Irish Geological Heritage *Programme. Irish Journal of Earth Sciences*, 19. 79-90.

Parkes. M.A. (Editor) 2004. *Natural and Cultural Landscapes – the Geological Foundation. Proceedings of a Conference 9-11 September, 2002, Dublin Castle*. Royal Irish Academy. Dublin. 329pp.

Parkes. M. 2005. Geological heritage in the Emerald Isle. *Earth Heritage*. **25**. 20-22.

Parkes. M.A. 2008. A history of geoconservation in the Republic of Ireland. 237- 248. In Burek, C.V. and Prosser, C.D. (eds) *The History of Geoconservation*. Geological Society, London. Special Publications. **300**.



Above: Morrissey's Quarry, County Carlow.
Left: Ballykeefe Quarry, County Kilkenny. The local community make an imaginative use of this old quarry as a performance venue and rock climbing centre.

Irish Concrete Federation

Geological Survey of Ireland

APPENDIX 7.6: GEOLOGICAL SITE REPORT BELLEWSTOWN.

MEATH - COUNTY GEOLOGICAL SITE REPORT

NAME OF SITE	**Bellewstown**		
Other names used for site			
IGH THEME:	IGH 2 (Precambrian to Devonian Palaeontology)		
TOWNLAND(S)	Bellewstown		
NEAREST TOWN	Duleek		
SIX INCH MAP NUMBER	27		
NATIONAL GRID REFERENCE	307870 267130 = O07870 67130		
1:50,000 O.S. SHEET NUMBER	43	**1/2 inch Sheet No.**	13

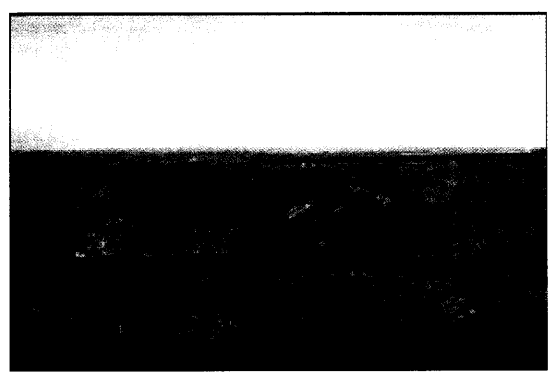
Outline Site Description
Working quarry and natural exposures in agricultural fields with rock close to surface beneath soil.

Geological System/Age and Primary Rock Type
Ordovician volcanic and sedimentary rocks.

Main Geological or Geomorphological Interest
This site exhibits a few exposures but has significant rocks below the soil surface of the Bellewstown site. This geological terrane represents volcanic and sedimentary rocks that existed as a volcanic island in the middle of an ancient ocean called Iapetus during the Ordovician Period about 460 million years ago. Brachiopod fossils within the sedimentary rocks are similar to other island faunas – part of a so called 'Celtic' brachiopod province. There is also a younger, thin limestone deposit which may represent a very long time period, perhaps ten million years. Even younger shales include fossils showing plate tectonics had moved the island closer to adjacent continents. The biogeographical and stratigraphical information of these fossiliferous rocks is important in understanding how Ireland has moved throughout geological time.

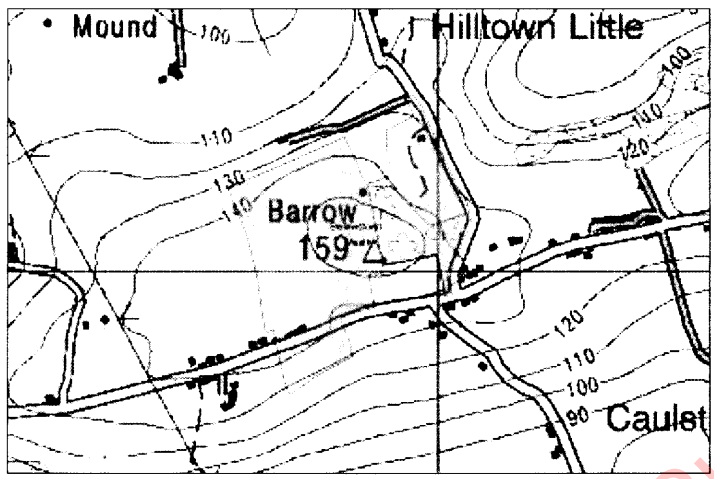
Site Importance
The ongoing quarry extension provides a new opportunity for significant improvement in knowledge of the detailed geology and stratigraphy of the Bellewstown Inlier. The additional exposures may yield a clearer picture of the relationships of different geological formations, enabling a more accurate interpretation of events during Ireland's geological past. This will be recommended as an NHA.

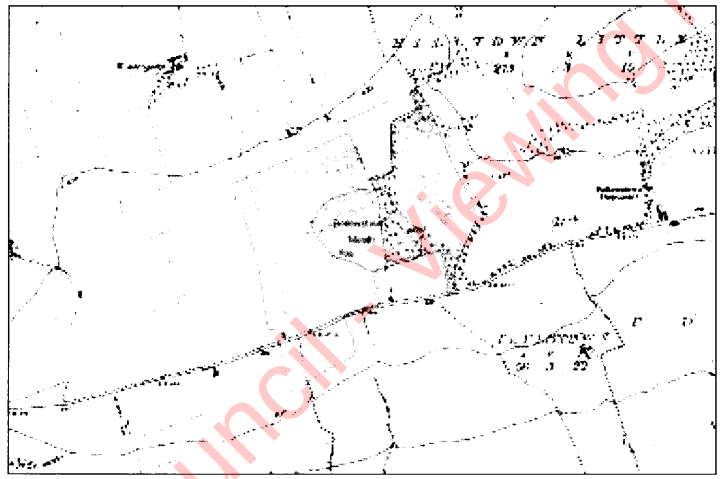
Management/promotion issues
The site is a Kilsaran Concrete working quarry, with part of it extending into some privately owned adjacent farmland. A formal proposal for access by a geological research team for fossil collecting and research has been given positive response by Kilsaran Concrete, and is anticipated to provide a model of best practice for industry operators of extraction sites of geological heritage importance. The model may also include the future provision of interpretation panels and viewing areas to further promote geological heritage to the public, particularly within the context of active quarrying.

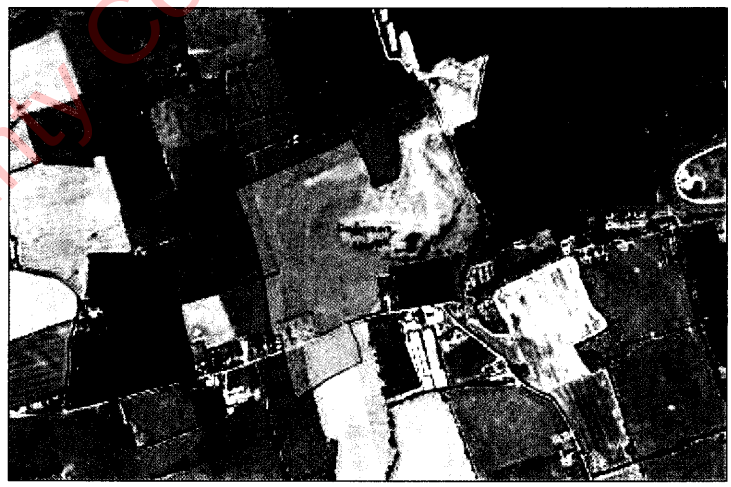


Left: Exposures of Hilltown Formation yielding 'Celtic' brachiopod fauna, with planned future excavations (late 2008).
Right: Looking northwards across quarry exposures of the Bellewstown Inlier volcanic sequence (late 2008).

Bellewstown



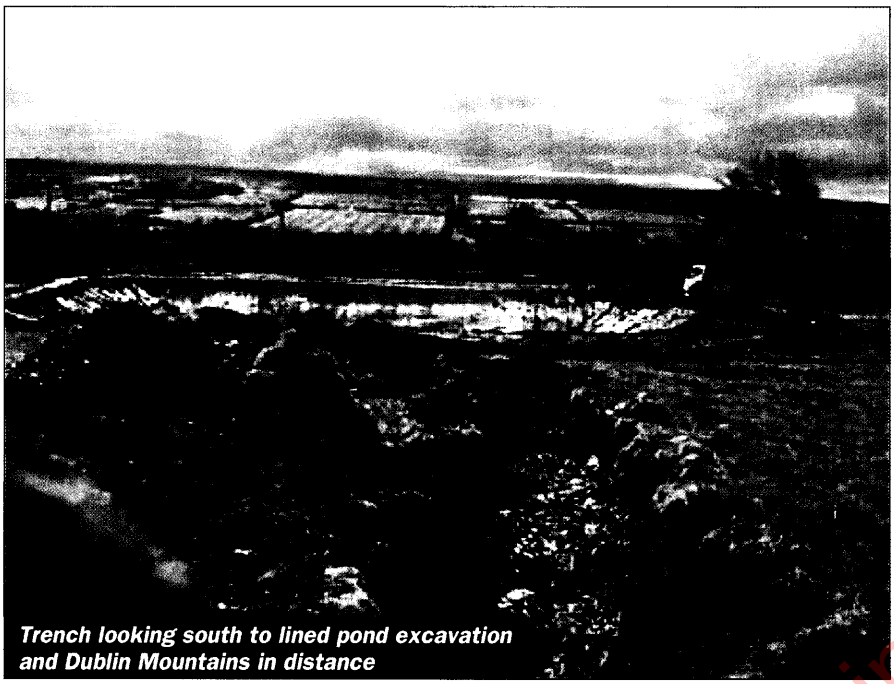




APPENDIX 7.7: *EARTH SCIENCE IRELAND MAGAZINE, ISSUE 9.*

Kilsaran International dig deeper

Matthew Parkes, Natural History Museum, Dublin, reports



Trench looking south to lined pond excavation and Dublin Mountains in distance

Recent work on new ponds to safeguard water discharge from a quarry has yielded significant benefits for geological research at Bellewstown, Co Meath. Positive co-operation with the quarry operators, Kilsaran International, shows how industry working with geologists can enhance our rocky heritage.

The enigmatic Bellewstown Limestone

At Bellewstown there are rocks of Ordovician age (about 450 million years old) surrounded by younger rocks on all sides (it is what is termed an *inlier*). The last detailed survey was by J.C. Harper and N. Rast in 1964. Their report made it clear that the evidence of the age of a thin limestone (the Bellewstown Limestone) in the otherwise mostly shaly mudstone and volcanic rock sequence, was imprecise. Its age was not known to within 10 million years (somewhere between the Llanvirn and the Caradoc stages). Rare fossils from the older rocks however, show that Bellewstown was once a volcanic island in the middle of the Iapetus Ocean, when Ireland was composed of two separate bits of the Earth's crust, later brought together by plate tectonics. So these are especially interesting rocks.

Fast forward to recent years.

The area of the hill with the best fossil evidence was flagged some years ago by the Irish Geological Heritage Programme of the Geological Survey of Ireland as a possible geological NHA. More recently the adjacent Mullagh quarry was sold to Kilsaran and in 2009 an audit of County Geological Sites in County Meath included the site at Bellewstown.

The audit process had made Kilsaran International aware of the geological interest of the site. Through the constructive engagement of its Planning & Environmental Manager, Fergus Gallagher, it has been most helpful in facilitating geologists at Bellewstown, with a formal agreement put in writing to cover access and research matters.

The most beneficial recent development has been in an area just outside the main quarry. For years the natural accumulation of ground water in the base of the quarry has been pumped via a pipe to a natural stream course on the south side of the hill. However, to eliminate any potential risk of suspended solids or of a spill of diesel or oil in the quarry from getting into the stream, Kilsaran International have invested heavily in creating two ponds and an interceptor for hydrocarbons. The outflow, when pumped, will enter a deeper pond to settle solids, pass through a filter unit for hydrocarbons and then a shallower reed bed pond before discharge.

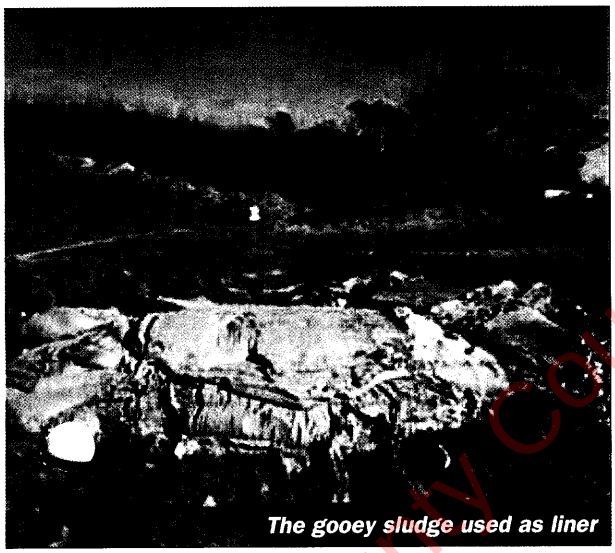
NHM/GSI team

As the excavations have been dug, a team from the National Museum of Ireland (the author) and from the Geological Survey of Ireland (Sarah Gatley, Sophie Preteseille and Brian McConnell) have been paying visits to monitor the new exposures. Initially trial pits were dug for us in the centre of the pond sites, but once it was clear that bedrock was only a metre or less below the surface, the ponds themselves became very large trial pits! It was hoped that these ponds would intersect the poorly known Bellewstown Limestone. That didn't happen, but we were very fortunate that Fergus Gallagher asked his contractor, John Taffe. to dig a trench above the ponds to help our research.

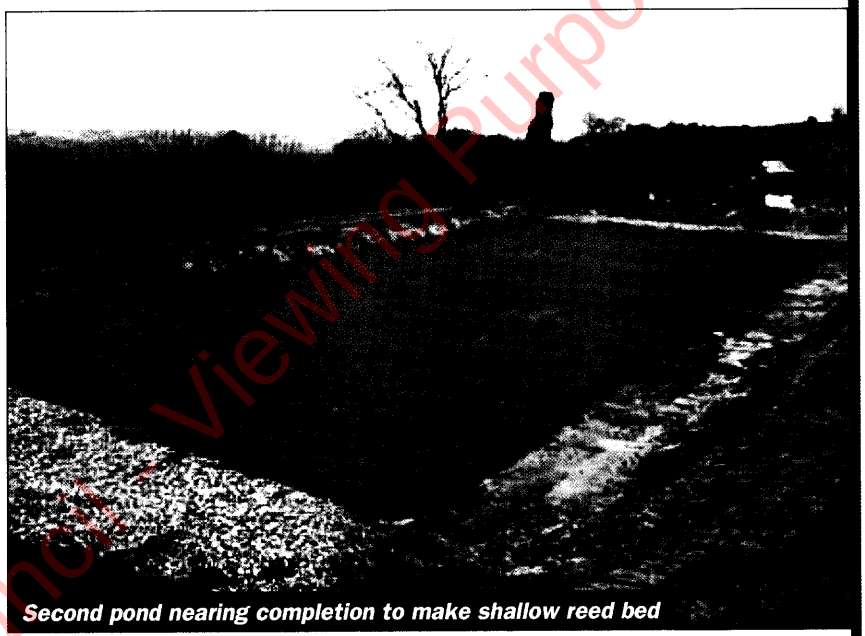
Fergus Gallagher, Sophie Preteseille and Sarah Gatley with trench up hill behind them

Limestone found at last! Right at the top of the hill.

Limestone spoil



The gooey sludge used as liner



Second pond nearing completion to make shallow reed bed

This trench was already being dug when we first arrived. It certainly put a smile on my face. I had worked on the brachiopod shells found a decade before in the older volcanic rocks, which indicated that Bellewstown was an oceanic volcanic island. I had also spent time digging in the soil trying to locate the phantom limestone but only found loose blocks – nothing conclusive.

Got it!

The two ponds and the 40m of trench up the hillside mostly exposed only older unfossiliferous slaty rocks but right at the very top of the trench I recognised the right stuff in the spoil! A few minutes work with the mechanical digger excavated down to bedrock, a muddy limestone. So the top of the limestone was found and a series of samples taken. These will be dissolved in Trinity College, Dublin, and the residues examined for conodont microfossils. *Conodonts are extinct soft-bodied eel-like organisms that are mostly only known from their hard feeding apparatus or teeth. These teeth can be numerous and closely dated so are very useful in determining the age of the rocks in which they are found.* Thin sections of the limestone may reveal other fossil content. Samples of the slaty rocks below the limestone will also be closely examined for fossils but without real expectation of finding any.

Jigsaw coming together

Altogether, the new excavations have given us a new piece of the jigsaw, filling in a patch that was just a grassy field with no exposure before the digger commenced work. The work on the ponds is almost complete. They have been lined with a gooey sludge of fines from another quarry to act as a liner to the ponds. The trench will be backfilled but the processing and hopefully description of the microfossils will finally date the previously rather enigmatic Bellewstown Limestone. Our thanks go to John Taffe, for his great work and precision with a digger, and to Fergus Gallagher of Kilsaran International for his support of scientific endeavour.

(We hope the author might photograph some of the conodonts to show our readers in a future issue – Editor)