INTERNATIONAL ASSOCIATION OF HYDROGEOLOGISTS (IRISH GROUP)

Presents

GROUNDWATER CHALLENGES OF THE NATIONAL DEVELOPMENT PLAN

PROCEEDINGS

OF THE

IAH (IRISH GROUP)

24th ANNUAL GROUNDWATER SEMINAR

Tullamore Court Hotel, Co. Offaly

Tuesday 20th and Wednesday 21st April 2004

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IAH (Irish Group) are very grateful to the Geological Survey of Ireland for helping us with the registration aspects of this seminar.

International Association of Hydrogeologists (Irish Group)

The International Association of Hydrogeologists (IAH) was founded in 1956 to promote co-operation amongst hydrogeologists, to advance the science of hydrogeology world wide, and to facilitate the international exchange of information on groundwater. The IAH is a worldwide scientific and educational organisation with more than 3,500 members in 135 countries. ***www.iah.org***

The Irish Group of the IAH started in 1976 and has over 130 members. It hosts an annual groundwater seminar in the Irish Midlands and holds technical discussion meetings on the first Tuesday of every month between October and June in the Geological Survey of Ireland offices in Dublin. The following members are serving on the 2004 IAH (Irish Group) committee:

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SEMINAR OBJECTIVE

The National Development Programme is in progress. It involves major and minor public infrastructure developments with associated private developments. The foundation upon which these developments are constructed is a static framework of soils and rock, through which flows a dynamic fluid; groundwater. Groundwater resources and flow systems form part of the foundation of the country and are a very valuable part of the nations natural resources. Therefore the system and the resource also underpin the National Spatial Strategy and form an important component of the new guidelines for Strategic Environmental Assessment for local authorities.

The current budgetary restraint, after the boom around the millennium, has encouraged evaluation of past projects and a search for improved standards and efficiency. Groundwater and hydrogeology work is often perceived by others as a root cause of unexpected delays in large projects. This need not be so, and this seminar is aimed at finding ways of improving groundwater work and communication of groundwater knowledge, in order to effectively implement the NDP and consequent private developments in a sustainable manner. One of the first steps is to hear and clarify the up-to-date perspectives of relevant authorities and other disciplines.

In this year's two-day seminar we will, for example, look at planning perspectives with an emphasis on the realistic scoping of groundwater issues in the early stage of projects. We will also address groundwater challenges facing large-scale contracts like for improved rural water supplies, waste management and road development. Concepts will be punctuated with examples throughout the seminar to illustrate the importance of groundwater integration in the country's national development strategy.

PROGRAMME DAY I
TUESDAY, 20th APRIL

10:00 **Registration**
Tea, Coffee, & Exhibits
11:00 **Welcome and Introduction**
David Ball, President IAH (Irish Group).

SESSION I: THE NATIONAL DEVELOPMENT PLAN SPATIAL STRATEGY AND STRATEGIC ENVIRONMENTAL ASSESSMENT

11:10 **The National Development Plan and Spatial Strategy; Current requirements and future challenges for the Groundwater Community.**
Niall Cussen DEHLG
11:45 **Hydrogeology and the future of Irish Planning**
Conor Skehan, Dublin Institute of Technology
12:30 **Panel Discussion**

12.45 Buffet Lunch & Exhibits

SESSION II: GROUNDWATER CHALLENGES OF THE NDP – PLANNING PROCESS

14:00 **An Bord Pleanàla: Proposed infrastructure developments; the requirements and expectations of the Board that would assist in an effective implementation of the NDP**
Brian Hunt, deputy chairperson of An Bord Pleanàla
14:25 **A County Engineer's perspective of groundwater issues the planning process and development of infrastructure**
Billy Moore, until recently County Engineer, Monaghan
14:50 **An Taisce and Environmental NGO perspectives; current problems with groundwater information and future improvements to avert public mis-understanding**
Tony Lowes, (Former Head of Natural Environment Group of An Taisce, Coordinator of Friends of the Irish Environment)
15:10 **The Developer's Perspective with regard to power generation and the hydrogeology of upland areas**
Brendan Layden, Arigna Fuels
15:30 **Panel Discussion**

15:50 Tea, Coffee & Exhibits

SESSION III: WATER PROVISION & TREATMENT IN THE NDP

16:20 **Source Protection Strategies for Group Water Schemes**
Maurice J. O'Connell, M.J. O'Connell & Co.
16:40 **Developing Groundwater Supplies in Rural Areas**
Liam Clear, TJ O'Connor
17:00 **The role of the Geological Survey of Ireland in supporting water resource development**
Geoff Wright, Geological Survey of Ireland
17:30 **Panel Discussion (Close at 17:45)**

The panel discussion will be followed by a wine reception in the Tullamore Court Hotel provided courtesy of City Analysts Ltd.

iah aih International Association of Hydrogeologists (Irish Group)

PROGRAMME DAY 2
WEDNESDAY, 21st APRIL

SESSION IV: GROUNDWATER CHALLENGES OF WASTE MANAGEMENT

09.00 **Groundwater challenges in waste management**
Ted Nealon, A1 Waste
09.25 **Contaminated Land and Risk Assessment: the basics**
Malcolm Doak and Jonathan Derham, EPA
09:50 **Brownfields and Urban Sustainability**
Dr. Niamh Moore, Dept. of Geography, UCD
10:15 **Assessing the risks, costs and benefits of managing/redeveloping contaminated sites**
Simon Firth, Rob Bracken, Jane Dottridge, Komex
10:45 **Panel Discussion**

11:00 Coffee, Tea and Exhibits

SESSION V: GROUNDWATER CHALLENGES OF ROAD DEVELOPMENTS

11:25 **Groundwater challenges for the National Roads Authority (NRA)**
Michael Egan, NRA
11:50 **Potential impacts of road infrastructure on groundwater and sensitive environments – lessons learnt from developments to date**
Jim Ryan, Duchas
12:15 **Case study of groundwater challenges of road construction in a karst environment**
Anita Furey (Tobin Consulting Engineers) and Alistair Moseley (Hyder Consulting)
12:35 Panel Discussion
12.50 **Closing Address**
Patrick Laffly, Seminar Secretary IAH (Irish Group)

13:00 Buffet Lunch

14:30 **Golf Outing sponsored by Komex**

SESSION I: THE NATIONAL DEVELOPMENT PLAN SPATIAL STRATEGY AND STRATEGIC ENVIRONMENTAL ASSESSMENT

THE NATIONAL DEVELOPMENT PLAN AND SPATIAL STRATEGY; CURRENT REQUIREMENTS AND FUTURE CHALLENGES FOR THE GROUNDWATER COMMUNITY

Niall Cussens, DEHLG

NOTES:

HYDROGEOLOGY AND THE FUTURE OF IRISH PLANNING

CONOR SKEHAN – DUBLIN INSTITUTE OF TECHNOLOGY

ABSTRACT

The role of hydrogeology in planning is about to change significantly in the near future. It will become a critical parameter for spatially specific planning and as such, will change from playing a reactive role, involved with individual applications, to a proactive role, involved with high levels of large scale strategic planning.

Changes will arise due to a re-organisation of the Irish countryside, principally arising from the restructuring of agriculture – combined with changes in legislation both for groundwater protection as well as legislation for the Strategic Environmental Assessment. These will cause new large scale, specific plans to be drawn up to organise activities and landuses on the basis of intrinsic environmental capacities.

These new circumstances will contrast with the current typical role of hydrogeologists whose role in planning tends to be limited to project specific advice and site investigation. Hydrogeology is otherwise used by planners in simplistic ways or for a very narrow range of applications.

In future, hydrogeologists will need to become involved at an early stage. They will need to supply much of the basic data on which the River Basin Management Plans will be based. They will need to develop the skills to work with planners in translating the resultant evaluations into proactive strategies. The latter tasks will prove challenging because of the need for hydrogeologists – trained as scientists – to work closely in the more speculative and political field of strategic planning

Changes in legislation, circumstances and practices will rapidly bring Hydrogeology into a central role in Irish Planning. This is not a forecast but a trend. The legislation and circumstances already exist and practices will begin to change from July this year onward.

The central thrust of this paper will be to show how hydrogeological factors will become fundamental in a new type of large scale planning. The role of the discipline and it's practitioners will change. They are currently required to react to development projects. In future they will be required to proactively participate in the preparation of plans and policies that will guide and direct development. Experience of other disciplines involved in planning suggest that the transition to this new role will present new challenges to the profession.

To understand how these changes will occur,[1] it is first necessary to examine the background and context of Planning in Ireland. When the Planning Acts were introduced in 1963 the County Development Plan – which provides the framework for all planning – was principally used to illustrate the locations of settlements, roads, and other infrastructure – as well as to record the locations of important cultural and scenic amenities. Larger settlements had specific plans that designated the most appropriate landuses for each location (zoning). Rural areas, however, were unzoned. Development in the countryside would be considered on the merits of the application. This pragmatic approach was made possible because agriculture provided a pre-existent comprehensive and cohesive organising framework for the countryside. 'Landuses' were synonymous with the

[1] Local Government (Planning and Development) Act 1963 – as amended 1976, 1982, 1983, 1990, 1992, 1993, 1998, 1999 and superceded by the Planning and Development Act 2000.

agricultural practices of a working landscape – as has been the case for much of Ireland since the introduction of agriculture nearly six thousand years ago.

Since the 1960's agriculture's central role in the economy has been displaced by the services and manufacturing sectors. In parallel the reform of the EU's Common Agricultural Policy has begun a process that will result in a dramatic contraction of the intensity and extent of areas under active agricultural management. Thus a new countryside is beginning to develop where agriculture no longer sets the pattern – except by its contraction.

New value systems are currently emerging that are beginning to replace agriculture's role as the underlying paradigm. Unlike agriculture, which sought to provide a livelihood from the land, these new value systems aim to manage the land. The objective is to protect or promote various 'public goods' which include habitats for flora and fauna[2], cultural and historical landscapes, areas of scenic significance, 'Greenbelts' to structure settlements and amenity areas for urban recreation[3]. Most significant it also includes the public good for protecting water. A series of designations and other legal instruments are being deployed to protect these assets, however, to date, there has been little planned coordination of such designations with each other, much less with any pro-active vision of a planned future. Designations tend to emphasise prohibitions and restrictions, limiting their vision of the future to 'sustaining and enhancing' the resource in question. Thus a collection of designations on a map should never be mistaken for a plan for the future.

The growth in new designations has occurred at a time when an array of new landuses are emerging on the Irish landscape at a scale and speed without precedence. These have included coniferous afforestation, urban expansion, motorways, engineered landfills, metaliferous mining, windfarms, intensive stock rearing, rural housing and tourism developments – non of which were contemplated when the original Planning Acts were drafted.

In response there has been a notable increase in the number and detail of plans and guidelines published in recent years including National Development Plans, the National Spatial Strategy, Regional Plans and Guidelines, as well as sectoral plans (for forestry, roads and windfarming for example[4]).

These plans are beginning to become more co-ordinated and organised into rationale hierarchies of subsidiary. Furthermore, they are beginning to become more spatially specific – i.e. including maps indicating which parts of the countryside are more or less suitable for different landuses (such as forestry or wind energy strategies at a country scale).

These developments strongly point to the likelihood that spatially-specific, large-scale landuse plans will become the norm in Irish planning in the near future. It will emerge slowly because of the reluctance of the political process to publically accept future explicit limitations on the scope for decision making. Notwithstanding this reluctance a number of legal processes have commenced that will bring about such plans. Groundwater lies at the heart of them.

The *European Union Water Framework Directive (2000/60/EC*) - which came into force on 22nd December 2000 provides for water management - on the basis of River Basin Districts. Furthermore a proposal for a 'Daughter Directive' on the Protection of Groundwater against pollution was published

[2] European Communities (Natural Habitats) Regulations (1997) as amended (SI no94 of 1997, SI no 233 of 1998).
[3] Planning and Development Act 2000
[4] National Spatial Strategy (DEHLG 2002); National Development Plan 2000 – 2006; National Biodiversity Plan (2002) ; National Heritage Plan 2002; DEHLG Guidelines for Local Authorities Windfarm Developments (1996 – 2003); Residential Density (1999); landscape Character Assessment (2002).

in September 2003[5]. Together these will bring about the publication of spatially specific plans for the protection of surface and groundwater that will provide the first comprehensive and objective mapped basis for landuse planning in Ireland. The mapping will differ significantly from 'constraint mapping' such as ecological designations which contain only representative samples of valued habitats. Mapping and water quality parameter will provide objective, comprehensive data that will determine the *intrinsic* suitability or vulnerability of lands.

Developments in the mapping and protection of waters will not take place in isolation from other legal advances – the most significant of which is the introduction of Strategic Environmental Assessment[6]. This directive becomes operational on July 21st 2004 and requires Development Plans (*inter alia*) to be subjected to an assessment of the likely effects on the environment. The compliance strategies that will be one of the critical components of River Basin Management Plans will undoubtedly form one of the principal evaluations criteria against which future County Development Plans will be assessed.

This role in shaping the future will be discussed in detail later. It should be noted here that it will contrast strongly with the current role of hydrogeology in planning where the role is usually limited to project-specific tasks (such as a site-search for a landfill) or site-specific investigations – both of which are likely to employ the services of professional hydrogeologists.

Other considerations of hydrogeology tend to rely (excessively) on generalised mapping of aquifer vulnerability – particularly as part of a layered analysis along with other mapped environmental resources.

There is very little, if any, use of hydrogeology data for predictive applications – such as attempting to calculate the carrying capacity of aquifers to provide growth limits – nor of Strategic Integration – such as combining Aquifer protection with the development of synergistic strategies for wind energy, forestry or tourism for example.

The proliferation of GIS systems within planning departments presents a further challenge due to a poor understanding of the origin or limitations of the base data. It is not unusual to see a geological unit being used as the origin of a policy area within a GIS system for landuse planning –those responsible having little appreciation that the 'line on the map' is little more than a generalisation of complex conditions occurring at depths that may have been extrapolated from a small number of surface exposures and (occasionally) widely spaced drilling.

The context may be summarised therefore as being in a state of rapid change due to agricultural decline and new legislation which will force the need for hydrogeological data to provide a critical factual base for future large scale plans, However, these changes must be accompanied by a broadening of the general geological knowledge among the community of planners and consultants who are likely to use the data. With this context in mind the future role of hydrogeology in Irish Planning can be assessed in detail.

Large scale land use plans will emerge. At the Regional scale they will move from being symbolic, general and aspirational towards being quantitative, specific and measurable. Such plans will use River Basins as the basic unit of policy and this will necessitate co-ordination across traditional administrative boundaries. There will be two fundamental types of mapping, namely the locational *objectives* for policies and the area-specific *constraints,* the latter forming the framework into which the former must be accommodated.

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5 Proposal for a Directive of the European Parliament and of the Council on the Protection of Groundwater against Pollution. 19.9.2003 COM (2003) 550 Final

6 Directive 2001/42/EC of the European Parliament and Council of 27 June 2001 on the Assessment of Certain Plans and Programmes on the Environment.

Geology is the most comprehensive and fundamental natural factor to influence planning because it determines topography, drainage and vegetation which in turn give rise to settlement and land use. For planning purposes 'Geology' is taken to include the suite of disciplines including hydrogeology, solid geology, soils and geomorphology.

These geological factors, which are specific and intrinsic to each area, form a unique data set because they are comprehensive, stable, objective and verifiable. By comparison other comprehensive 'mapping' of environmental factors are partial (designations of representative habitats,); ephemeral (landuse and demographics); subjective (landscape character and vulnerability) or speculative (archaeological/historical cultural landscapes).

In the matter of the River Basin Management Plans - these will provide a high level of objective data on the characteristics and status of waters. More significantly this data will be integrated into an analysis of human activity and associated economic activity in the context of water quality standards – both for the present and in the context of long term forecasts for supply and demand within the river basis district.

The resultant mapping and evaluation will provide two powerful components for future landuse planning at a Regional and County scale, namely an awareness of the natural limits and capacity of the basin and also dynamic inputs for future planning in the form of Strategies (or options) for present and future compliance.

SEA will require future development plans to be formulated by a process of identifying a number of alternative development strategies for an area that is capable of fulfilling the necessary policy objectives. These will be evaluated against relevant planning and environmental policy options to establish the most suitable option. Experience elsewhere suggests that this evaluation of alternative strategies against environmental policy options will initially take the form of relatively non specific matrices ranking a narrative of strategy elements against key points of policy. As systems mature these become more specific and the data from elements such as the River Basin Management Plan begin to become key determinants.

This latter process of evaluating strategies is where the role of the hydrogeologist will begin to be challenged and will change. Development Strategies are complex. They involve many criteria – economic, political, technical, ethical, environmental and cultural – to name a few. Few environmental problems – such as a sensitive aquifer -are likely to present an absolute prohibition to *any* development. A technical/engineering solution is almost always possible. Sophisticated evaluation, however, will involve an examination of whether such technical 'fixes' are practical, reliable and economic – not to mention acceptable in terms of strategy, precedence, policy and other 'softer' considerations. This type of proactive participation, working simultaneously with a multiplicity of criteria, is likely to present new challenges to the hydrogeologist. It will require new skills, new training and (for some) new outlooks.

Hydrogeologists are more accustomed than most scientists to working with uncertainty. They are comfortable with it and know the limitations of accuracy and confidence that apply within their discipline. One of the challenges that they will face, as they become more actively involved in planning, will be to give early and clear notice of such limitations to others within the planning system.

'Risk' is a particularly insidious form of uncertainty. It erodes confidence, misdirects debates (and resources) and can greatly distort or damage decision making. '*In the absence of facts arguments abound'* is an old truism which is particularly applicable to hydrogeology. Unseen and largely unknown, or little understood, underground processes combined with concerns about insidious contamination of a fundamental resource provide fertile grounds for the wild application of the 'Precautionary Principle'. Drawing attention to the differences between 'probable', 'possible' and 'plausible' effects; to the difference between 'toxicity' and 'dose' or to the difference between

'significant' and 'measurable' effects will all become increasingly important parts of the hydrogeologists role on the planning team.

With knowledge comes influence and power. Hydrogeologists should be mindful of the need to avoid the fatal lure of establishing and exclusive discipline. Precedents for the self aggrandisement of Professions by that predictable path of jargon-shrouded mystification of a specialist field using the privilege of knowledge as leverage to extract power and influence. The success of this strategy is as short-lived as it is predictable. Witness the relentlessness with which the EU are now pursuing those monopolistic professions that gained such power in the past.

The alternative is to adopt, from the outset a position of leadership based on openness, education and dissemination of knowledge, to avoid prescriptivness or exclusionary practices. Hand in hand goes the need to retain objectivity about the (relative) robustness and assimilative capacity of natural systems and to avoid being drawn in into debates where knowledge is used (or withheld) as a weapon.

The Irish countryside is changing because agriculture is in transition due to reform of the common Agricultural Policy. It's future will increasingly be directed by large scale development plans which will be based on a framework of environmental data. Much of the basic data will need to be prepared and assessed by hydrogeologists in the preparation of River Basin Management Plans.

Planning in the future will require a much greater degree of active participation in the planning process by hydrogeologists - particularly in the evaluation of the likely environmental compatibility of alternative future development strategies.

This participation will bring hydrogeologists to a more central role in future Irish Planning – a move which the profession would be wise to plan for.

Bibliography

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SESSION II: GROUNDWATER CHALLENGES OF THE NDP – PLANNING PROCESS

AN BORD PLEANÀLA: PROPOSED INFRASTRUCTURE DEVELOPMENTS; THE REQUIREMENTS AND EXPECTATIONS OF THE BOARD THAT WOULD ASSIST IN AN EFFECTIVE IMPLEMENTATION OF THE NDP

Brian Hunt, deputy chairperson of An Bord Pleanàla

NOTES:

GROUNDWATER PROTECTION ISSUES IN THE PLANNING PROCESS

Billy Moore, BE, MSc, MBA.

INTRODUCTION

Ireland is experiencing a continuation of the high level of infrastructural development, which commenced with the previous Development Plan. The current National Development Plan, 2000-2006, comprises a comprehensive seven-year plan with an investment of €51.5 billion (in 1999 money terms) of public, EU and private finance. The Plan sets out a coherent strategy in relation to infrastructural development.

Given the sustained and unprecedented level of development, which is now taking place, particularly under the 'Economic and Social Infrastructure Operational Programme', it is important that environmental protection remains an integral part of the process. Planning Authorities have a key role to play in protecting the environment in progressing their own infrastructure projects and also in exercising their planning control function in relation to private sector development. Groundwater is one of the key areas, which warrants this protection.

This paper deals with the Environmental Impact Assessment process for major public sector and private sector infrastructure projects and, in particular, deals with the groundwater issues and the level of geoscientific information required to properly address the issues.

The paper also deals with the issue of one-off rural housing, which is currently at the top of the public and political agenda, and addresses groundwater protection aspects in this regard.

ENVIRONMENTAL IMPACT ASSESSMENT AND INFRASTRUCTURAL DEVELOPMENT PROJECTS

Major infrastructural development, whether private sector or public sector, requires that an Environmental Impact Assessment (EIA) be carried out as part of the development control process. This is an exercise designed to enable the environmental impacts of a proposed development/project to be anticipated, before the project is carried out. Developers are required to prepare an Environmental Impact Statement (EIS) for large scale private and public sector development of a particular type or scale as specified in Schedule 5, of the Planning & Development Regulations, 2001.

An Environmental Impact Statement is defined as: *"A Statement of the effects, if any, which the proposed development, if carried out, would have on the environment"* (S.I. No. 349 of 1989). Not all effects or sources of environmental change need to be investigated but rather the EIS should confine itself to those effects or changes in environmental conditions, which are considered significant.

The key objectives of an Environmental Impact Assessment are:

- To encourage developers to integrate environmental considerations into project design/planning.
- To bring greater information/clarity into the decision making process by competent authorities.
    - Planning Authorities
    - An Bord Pleanála
- To facilitate public participation.

The basic characteristics of a good EIS are:

- Balance: Completeness and practicality.
- Relevance: Development, location, etc.
- Significance: Ignoring trifles, side issues, etc.
- Thoroughness: Quality.
- Clarity: To the public/decision makers.

Environmental Impact Assessment is part of the development control process. It should not be part of the project promotion process and should definitely not just be research.
It is understood that the European Commission has been unhappy for some time about Ireland's implementation of the EIA Directive, *"particularly the narrow interpretation taken by the Irish regulations, which effectively allows developers to hire their own consultants to assess individual projects.* ***As a result, environmental impact statements submitted with various planning applications are increasingly seen as being 'biased'"***.

The key steps involved in preparing an EIS generally follow the sequence below:

- **Screening**
  This step involves assessing the need for an EIA. Projects which of the type listed in Schedule 5 of the Planning & Development Regulations, 2001 require the preparation of an EIS.
- **Scoping**
  This step generally involves consultation with Planning Authority. The information to be contained in an EIS is indicated in Schedule 6 of the Regulations.
- **Setting up Project Team**
  This usually involves a multi-disciplinary team with each member tasked with addressing specific aspects of the Study.
- **Initial studies/fieldwork**
  This step involves the carrying out of baseline studies as considered necessary.
- **Preparation of EIS**
  This step involves the compilation of all of the contributions of the Project Team members into a draft EIS
- **Consultation with planning authority**
- **Submission of EIS with planning application**

The initial stages in the process involve 'Screening' and 'Scoping'. Screening is the process of determining whether an Environmental Impact Statement will need to be prepared. The Planning & Development Regulations set out the types of projects and the thresholds or sizes of these classes of projects for which an EIS must be prepared. 'Sub-threshold development' means development of a type set out in Schedule 5 of the Regulations, which does not exceed a quantity, area or other limit specified in that Schedule in respect of the relevant class of development. Where a planning application for sub-threshold development is not accompanied by an EIS and the Planning Authority considers that the development would be likely to have significant effects on the environment, it shall, by notice in writing, require the applicant to submit an EIS.
Once a decision has been taken that an EIA is required or where the developer decides to submit and EIS, 'scoping' can be defined as the activity of deciding on the matters to be investigated in the EIS to be submitted to the competent authority. One of the recent changes in the Regulations is the provision whereby a developer can formally request the competent authority to provide an opinion on the issues and emphasis that are considered as important in the EIS. There are several benefits to the scoping process. It can save the developer time and avoid exhaustive unnecessary studies. The exercise can identify key issues of importance or concern and this is very relevant in the case of groundwater issues. A good scoping exercise will ensure that no important issue is ignored and this can be very useful for the developer or Project Team leader in facilitating the preparation of a Brief for each of the contributors or sub-consultants involved in the various elements of the EIS.

A number of principles underpin the scoping process. Developers are only required to supply information to the standards of current knowledge and methods of assessment. This aspect is very relevant in relation to collection of information on groundwater and of geoscientific information

generally. The determination of the sufficiency of an EIS is solely a matter for the adjudicating authority and such authorities should, as a starting point, have regard to the Guidelines prepared by the Environmental Protection Agency. An early scoping process can offer several benefits for the developer in saving time and cost while retaining quality. The scoping exercise can change during the course of the preparing the EIS and flexibility is required to respond to new issues and new information, which may emerge during the process.
A number of techniques are available to planning authorities in the scoping process. These include, but are not limited to the following:

- Examination of the project and the proposed location.
- Examination of similar projects elsewhere.
- Consultation with other competent authorities; with other public bodies such as the EPA, Fisheries Boards, etc.; with experts or specialists or with other stakeholders/ local interests.
- Use of Checklists and Matrices.
- Having careful regard to the EPA Guidelines, 2000.
- Meetings and formal request for written opinion.

In some cases the planning authority may consider establishing a 'Scoping Panel', which might consist of representatives of various public bodies with an interest in the development.

Geology, hydrogeology and groundwater aspects are very relevant in many infrastructural projects. I am aware that the Institute of Geologists of Ireland (IGI) has developed Guidelines for the assessment of these issues. Geological and hydrogeological information is very relevant in the appreciation of soils and water in the EIS and in the understanding the role of rocks and groundwater in the transmission and attenuation of pollutants.

The issue of risk analysis underpins the assessment of groundwater issues in the EIA process. Vulnerability and risk are combined in the 'Hazard-Pathway-Target' model, which has been developed by Donal Daly of the Geological Survey of Ireland. Groundwater Protection Schemes can prove a very useful point of reference in the EIS scoping process. In scoping groundwater aspects are a key issue in determining the extent of the geoscientific information required in each case.

During my time as Director of Services and County Engineer in Monaghan I arranged for the preparation of a Groundwater Protection Plan, which I saw as an invaluable tool in the planning control process, particularly for major infrastructural projects. The maps which form the backbone of the GPS include the Aquifer Classification Map, the Vulnerability Classification Map, the Map showing the Resource Protection Zones and the suite of maps showing the groundwater protection responses for various categories of development such as landfills.

Good planning requires accessible, reliable information on relevant issues. I believe that Groundwater Protection Schemes are a means of integrating geology and groundwater data into land-use planning and decision-making on environmental management issues generally. They are a means of providing information in a form specifically orientated to decision-makers in planning authorities, An Bord Pleanála, etc.

Geoscientific information is often essential for major infrastructural projects and using the Groundwater Protection Scheme is a useful first step in this regard. In addition to groundwater protection aspects, Groundwater Protection Schemes can also yield valuable information on groundwater quality, groundwater sources and on groundwater resources in the County. In addition, the information can be imported directly into Catchment Management Plans and into the River Basin District Plans, which will be undertaken under the Water Framework Directive.

The extent of the geoscientific information required in an EIS is determined by a number of factors including:

- Nature and level of importance of the groundwater resources.
- Whether or not groundwater is used for water supply.
- Groundwater quality.
- Vulnerability considerations.
- Groundwater protection issues.

Given the above range of determinants it is clear that one size does not fit all cases. Designing the scope and extent of the information should be undertaken on a project-by-project and situation-by-situation basis. The ultimate objective of the exercise is the development of a three-dimensional model of the geology and hydrogeology for the area of interest.

There are a number of tools and techniques available in gathering geoscientific information. These include:

- Desk Study, including the use of Groundwater Protection Schemes.
- Non-invasive techniques such as geophysical methods.
- Invasive techniques such as trial pits, shell and auger, rotary core boreholes etc.

The selection of the appropriate techniques is important in an environment where time and cost competitiveness in an ever-present issue, particularly on the part of the developer.

CASE STUDY - GEOSCIENTIFIC INVESTIGATIONS CARRIED OUT IN RELATION TO A LANDFILL PROJECT IN SOUTH TIPPERARY

The Council had identified an area near Ballyclerihan as a potential landfill site from the groundwater protection maps, which had been prepared as part of the Groundwater Protection Scheme for the County (Stage 1). An option arrangement was agreed with the landowner to allow further investigations to be carried out. Stage 2 investigations were then carried out which involved the excavation of a number of trial pits and extensive geophysical testing over the property. These tests threw up certain anomalies, which were evidenced by discontinuities in the contours generated by the resistivity survey results. Shell and auger boreholes were then drilled through the overburden in Stage 3 but these did not explain the anomalies. In the final stage, Stage 4, rotary core boreholes were drilled into the bedrock underlying the area. The boreholes indicated a fault in the bedrock running across the site. At this stage it was considered that the choice of site for a landfill could not be defended and the Council moved its investigations to another location. The Council has since been successful in progressing a Landfill Licence application for another site at Hardbog, near Grangemockler.

KEY ISSUES FOR PLANNING AUTHORITIES IN EIA:

The key issues for planning authorities in assessing Environmental Impact Statements can be compiled under the headings of time, cost and quality.

Time:
Planning authorities must deal with all planning applications irrespective of scale of complexity within the 8 week period allowed following receipt of the application or the further information submitted.

Cost:
Planning application fees rarely cover the cost of assessing the issues and determining the application. In the case of large-scale projects where an EIS has been submitted the assessment costs can be significant. The maximum planning application fee allowed is €38,000. For a large-scale complex development the cost of preparing an EIS could be as high as €1 million. For example a large mining proposal with significant groundwater issues would pose a challenge to most planning authorities. Small rural authorities may lack the in-house competence to give proper consideration to the complex

issues involved. Planning authorities may need to employ the services of a specialist consultant in such cases.

Quality:
This related to the quality of the EIS submitted and also to the competence and resources available to the planning authority in determining the application.
Objectors, in particular, will criticise EIS preparation on a number of issues:

- The EIS did not address all possible effects.
- The impacts addressed were not examined in sufficient detail.
- The investigations carried out were inadequate, either in scope or duration.
- The methodologies used were inappropriate and seasonal factors were not adequately allowed for (e.g. height of water table).
- Alternatives were not adequately examined in the EIS (e.g. processes, locations, operations etc.).

ONE-OFF RURAL HOUSING ISSUE

The issue of one-off rural housing is currently at the top of the public and political agenda, particularly with the publication of the Consultation Draft this year. Many column inches have been devoted to this topic in the national press in recent weeks. Planning authorities are witnessing an increasing use of Section 104 Motions, by Councillors, in seeking to get planning permission for one-off houses in many rural authorities. Appeals by third parties to An Bord Pleanála are increasing.

A number of Government policy documents are relevant in this regard.

Sustainable Development: A Strategy for Ireland, DOE, 1997 states: *"In general there must be a presumption against urban-generated one-off rural housing adjacent to towns".*

The National Spatial Strategy, DEHLG, 2002 states: *"There should be a strong focus on facilitating the housing requirements of persons with clear roots in or links to rural areas on suitable sites throughout the country".*

The Consultation Draft on Sustainable Rural Housing, DEHLG, 2004 is based on the *"presumption that people who have roots or links to rural areas and are part of and contribute to the rural community, will get planning permission for houses, provided that they meet the normal planning requirements".*
Approximately 20,000 one-off rural houses are now built each year**.** The statistics indicate that the current refusal rate for planning applications is approximately 15%. One of the main reasons for refusal is on environmental/health grounds: i.e. Site unsuitable for an on-site wastewater system (i.e. septic tank system, etc.), over concentration of on-site systems in one area, and risk to groundwater. The Draft Guidelines point out that development must not have an adverse impact on habitats, environmentally sensitive areas, important scenic landscapes, ground and surface waters.

On-Site Wastewater Treatment Systems:
Septic tank systems are the primary on-site wastewater treatment system used in Ireland and approximately 350,000 units are installed. The EPA Manual on on-site Systems points out that a properly constructed and maintained S.T. system remains *"one of the most appropriate and cost-effective means on on-site treatment of wastewater".* However, in Ireland a significant number of S.T. systems do not function properly, for a number of reasons:

- They are located in areas with unsuitable subsoils.
- They are poorly designed, constructed, installed, and/or maintained.
- Soakaways, rather than percolation areas are used.

Groundwater is generally acknowledged as one of the main targets at risk but there is little consistency of approach among planning authorities in this regard. There is more microbial pollution of groundwater in Ireland than in any other EU country. Some 38% of groundwaters show evidence of contamination, with on-site wastewater systems cited as a significant source of this. The main causes of problems with on-site systems are:

- Unsuitable sites (e.g. rock too close to surface).
- Inadequate permeability/percolation.
- Use of soakage pits rather than percolation areas (50% of cases).
- General absence of percolation areas (14% of cases).
- Inadequate design of system.
- Direct discharge to watercourses (29% of cases).
- Poor construction/installation of on-site systems.
- Inadequate inspection/maintenance.
- Rainwater/surface water connected to wastewater treatment system.

Protecting groundwater and ensuring effective wastewater treatment for one-off rural houses requires proper site suitability assessment, as a first step. This includes:

- Desk Study (e.g. Groundwater Protection Scheme, County Development Plan, etc.).
- Visual Assessment.
- Trial Pits.
- Percolation Tests.
- Assessment of Site Suitability.
- Selection of the appropriate system.

Advanced Systems:
Advanced wastewater treatment systems are now increasingly used for one-off rural housing applications. Again, there is little evidence of any consistency or uniformity of approach in relation to advanced systems, among planning authorities. Lack of proper maintenance is seen as a major problem and most planning authorities will require a maintenance contract to be in place as a pre-condition to the granting of planning permission.

Advanced systems can be broadly categorised into filter systems and mechanical aeration systems:

- FILTER SYSTEMS:
  - Soil Filter System
  - Constructed Soil Filter System (‘Mound’ system)
  - Intermittent Sand Filter/Peat Filter System
  - Constructed Wetlands
- MECHANICAL AERATION SYSTEMS:
  - Biofilm Aerated (BAF) Systems
  - Rotating Biological Contactor (RBC) Systems
  - Sequencing Batch reactors (SBR)

Several proprietary systems have been granted Agrément Certification.

Site suitability remains a key planning issue for rural authorities. Although about two thirds of areas of rural counties are readily suitable for on-site systems, not all sites are suitable or are capable of being rendered suitable for on-site wastewater treatment. On-site systems pose a significant threat to preserving groundwater quality. Proper site suitability assessment and the selection of the proper system are key ways to minimise this threat.

From a groundwater perspective, advance systems can prove a viable option in cases where septic tanks are not acceptable (e.g. in shallow rock areas, where overburden is less than 2m). However,

advanced systems are not an option when the risk of ponding and surface water contamination is high. This can occur:

Where 'P' and 'T' values > 50 (a failed site)Where 'P' is between 1-50, but 'T' is > ~ 90

Certain sites are not suitable for on-site systems and planning permission should not be granted in such circumstances.

Conclusions in Relation to On-site Systems:

- Proper site suitability assessment should be a prerequisite for all one-off rural houses.
- The EPA pro-forma should be used in all site suitability assessments. This is recommended in Circular Letter 05/03 from the DEHLG.
- The issue of who should carry out site suitability assessment needs to be addressed.
- Proper design, installation and ongoing inspection and maintenance of on-site systems are issues of paramount importance, particularly in the case of advanced systems.

A comprehensive, competency-based Training Programme, funded by FAS, has now been put in place. This Programme, which is co-ordinated by the GSI and the EPA, addresses all of the above issues and has been successfully delivered on a number of occasions.

OVERALL CONCLUSIONS

Good decisions require reliable information. This is apposite in the case of geological, hydrogeological and groundwater information. It is crucially important that information is presented in a clear, comprehensive, concise, and unambiguous form in systematically and objectively describing all of the issues by those involved in carrying out investigations and compiling reports submitted in support of planning applications.

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THE ROLE OF AN TAISCE IN GROUNDWATER AND PLANNING ISSUES

Tony Lowes, Director Friends of the Irish Environment, ex-Chairman An Taisce's Natural Environment Committee

ABSTRACT

An Taisce is Ireland's oldest environmental organisation with a prescribed consultative role in applications for planning permissions in sensitive areas, for aquaculture, and for forestry. Like the 24 other Environmental Non Governmental Organisations [ENGOs], it is increasingly unable to draw on academic and professional expertise once available on a voluntary basis. ENGOs rely on hydrogeologists and other professions to ensure that the impacts of proposals are comprehensively explained at the development consent stage. Concerns over the National Development Plan [NDP] were detailed in correspondence by ENGOs with the Regional Development Commissioner of the European Commission in 1999 but the required ex-ante *evaluation of the Plan was entirely inadequate. A number of suggestions relating to clarity of presentation, improved information and more time and resources allocated by developers to hydrogeologists and engineers are advanced so that ENGOs can do their jobs properly. To prevent unnecessary objections from them, it is argued that fuller and more easily accessible information should be provided not only by the private sector but also by the State itself. Of particular concern to Irish environmentalists (and the subject of their submission to the Department's 2003 – 2005 Strategy Review) is the torturous reluctance of the Department of Finance to addresses the issue of staffing in the Geological Service of Ireland [GSI] or to address its imbalanced over use of temporary staff. It is argued that the suspension of the Groundwater Protection Schemes [GPS] with 11 counties uncompleted undermines any assessment of the NDP, even if the necessary Guidelines and Regulations are created. The demands of the NDP have not been met with commensurate resources for the protection of our groundwater resources.*

AN TAISCE, FRIENDS OF THE IRISH ENVIRONMENT AND OTHER ENVIRONMENTAL NON-GOVERNMENT ORGANISATIONS

AN TAISCE

You see before you today a devil, an evil spirit, a cruel and forceful person – in fact, a demon. You may take this as gospel as it has been in the Irish Times twice of late, once from environmental correspondent Frank McDonald, and once from social commentator Fintan O'Toole[1].

An Taisce, according to these pundits, has become 'demonised by politicians at every level' because of its campaign against one-off rural housing.

It seems a strange state of affairs for Ireland's oldest environmental organisation. Its first Chairman (1947) was Robert Lloyd Praeger, author of '*The Way That I Went'*[2]. Praeger, a naturalist and librarian, exemplified an early An Taisce where ramblers and naturalists sought 'the preservation of places of Places of Interest or Beauty in Ireland'.

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[1] *'An Taisce planning to soldier on against the odds'*, Frank McDonald, Irish Times, Saturday March 20, 2004; *"Tearing up lessons on planning"*, Fintan O'Toole, Irish Times, January 13th, 2004.

[2] *'The Way that I Went'*, Robert Lloyd Praeger; in many editions, the latest from Cork University Press (1986) with an introduction by Michael Viney.

With the coming of the Planning Act in 1963, An Taisce became a prescribed organisation, along with Bord Failte and the Arts Council; in this role they are sent planning applications in sensitive areas. An Taisce's role extends now to aquaculture and forestry applications while other specialist organisations have augmented the list of prescribed bodies.

An Taisce traditionally worked through national committees that served its National Council, a 48-member body elected by Local Associations throughout Ireland, although with a preponderance of Dublin interests. Drawing on academic and voluntary expertise, policy input was prepared and individual cases fought through the planning system.

Some of these committees went on to become organisations in their own right, such as the Tree Council. Other organisations arose to specialise where An Taisce failed to develop – BirdWatch for birds, Crann for forests, Coastwatch for the coastal zone, Dublin City Trust for the Dublin built heritage.

Perhaps the greatest shibboleth is that An Taisce is a government-funded watchdog. The truth is that the little funding provided for the last three years by the Department of the Environment - €70,000 – vanished last year. An Taisce relies on a modest annual subscriptions from its 4,000 members - and very little else.

It must also be said that there are times too when An Taisce has got it wrong. But we actually are not devils. We are not vexatious troublemakers. Nor are we stupid. We our concerned citizens who want to see things done properly – by Europe, by our Government – of whatever party – by our local authorities, our semi-states, our developers and our consultants.

Unfortunately, the situation An Taisce found itself in by the time I became involved in the early 1990's was a very different one from the more leisurely 1960's and 1970s.

As our Universities have developed over the years the expertise that was offered so freely by the academic community has become less and less readily available. This is largely due to the increasing demands upon the Universities and their need to seek funding for research if they are to play a meaningful role. Our best academics simply don't have time to devote to voluntary meetings and the necessary work to make policy submissions. In this regard, I must note the exemption that proves the rule - Professor Frank Convery, of UCD's Environmental Institute under whose Chairmanship An Taisce flourished previous to the current regime.

Another notable exception is the legal profession, whose *pro bono* work has contributed greatly to the clarification of environmental and heritage legislation in Ireland.

But the professions gathered here today generally find it difficult to balance the demands of their professional lives with the needs of voluntary organisations. Members of our professions – engineers, geologists, planners – all now have professional bodies to represent their interests and so have little need for a multi-advocacy body like An Taisce.

FRIENDS OF THE IRISH ENVIRONMENT

Some say that Friends of the Irish Environment [FIE] is the provisional wing of An Taisce – or more recently, Hammas Ireland. While clearly exaggerated, like many sobriquets they are not without their point.

In 1997, a small group of conservationists who felt that the European Directives were not being properly taken on board in Ireland (and who were frustrated by the slow pace of existing

organisations) formed an informal network called Friends of the Irish Environment. Several like myself were key An Taisce activists – but there were others working in on legal and planning issues as well as crossing over into the green and even the socialist spectrum of Irish politics. Key figures were undoubtedly Dr. Sara Dillon, an Irish American who was lecturing at University College Dublin in Environmental law and Roger Garland, the first Green TD.

FIE, however, eschews the project funding and grants that follow on membership organisations. It became a limited company in 2000 in order to be able to take legal cases on a level playing field with developers. Its audited accounts for 2003 show a turnover 4020 euros. An Taisce has a national Council that meets in the Tailor's Hall where the revolutionaries of the past once met. FIE meets in the Library Bar of the Central Hotel.

But it has been extraordinarily effective by choosing cases that exemplify systemic weaknesses – in particular relating to the Environmental Impact Assessment Directive, the whole area of Access to Information on the Environment, and assessment – or not - of peat extraction for the proposed new peat powered plants.

The FIE website[3] is the most advanced amongst the ENGOs [environmental non-governmental organisations] and offers a daily free news service circulating 15 or more environmental stories each day relating to Ireland, Northern Ireland, and the European Union. The site also hosts the Forest Network Newsletter [FNN], a weekly campaigning vehicle that seeks to change both the species balance – Sitka spruce - and the method of forestry – plantations rather than continuous forest cover. Set up originally to inform the environmentalists themselves, FNN now engages in debates with a wide variety of academics and foresters and regularly publishes articles about advances in forestry and alternatives to our current practices.

24 Environmental ENGOs in Ireland are registered with the ENGO Secretariat and so qualify for part of a Department of the Environment grant €130,000. Grants running from €1,000 to about €4,000 a year are allocated by the ENGOs themselves as core funding. A travel budget for international conferences is included. A full time Secretariat serves as a conduit for liaisons with the Government about attendance at international conferences and input into national policy papers, as well as distributing the funding.

Limited and often only matching funding can be found through Heritage Council's annual grant scheme, although this organisation is also under threat. The Heritage Council was establish under the 1995 Heritage Act and has a budget of just over €5 million a year. An Taisce was awarded three grants this year – all relating to the natural environment - to the value of €18,000. The Environmental Protection Agency, ENFO, and partnerships with local authorities offer some funding for organisation with the resources to make such applications. ENGOs with EU and international connections can avail of franchised schemes. An Taisce thus runs Blue Flags and Green Schools, to name but two that have been developed by the Foundation for Environmental Education in Europe [FEEE], certainly one of the best environmental umbrella bodies in the world.

Government funded environmental initiatives, however, can create problems for a watchdog that must have independence.

THE NATIONAL DEVELOPMENT PLAN [NDP] 2000 – 2006

I hope I have painted a picture of the ill-resourced and fragmented environmental sector in Ireland. Isolated from both the ivory towers and – perhaps consequently – from the corridors of power – and certainly from much of rural Ireland - what can An Taisce or any of the other 24 ENGOs - do when faced then with development of the scale that is proposed in our National Development Plan?

[3] http//www.friendsoftheirishenvironment.net

We welcome the National Development Plan. We welcome The National Spatial Strategy'[4]. We even welcome the Minister for the Environment's Guidelines on Sustainable Rural Housing. Though we may differ with policy balance or individual elements, at last we have something in writing.

Of course we fear the best elements will not be valued in practice. We fear local and sectoral political interference in the implementation of these strategies. And we have problems too with how the NDP fits into other polices and statuary requirements. A good example is the Habitats Directive.

An Taisce's Senior Planner and Heritage Officer jointly authored a study of the NPD that pointed out that the NDP never specifically mentioned Special Areas of Conservation [SAC], the 360+ areas of Ireland designated under the European Directive[5]. 'The omission of direct reference to the protection of Habitats and Special Protection Areas for birds is an indication of the absence of any commitment to the intrinsic value of the environment and more significantly, to the importance of biodiversity for future well being'[6].

This unwillingness to accept European designations continues to the present in countless cases – particularly in the refusal of the Judiciary to refer questions of EU law to the Court in Luxemburg. Only last month An Taisce appealed against Aer Rianta's Shannon Airport proposed sewage plant's lack of tertiary treatment when discharging into a SAC. In spite of the fact that the Department of the Environment specifically requested this treatment, the Local Authority reached its decision on the basis that the waters were not included in the Environmental Protection Agency's [EPA] list of sensitive water bodies and so tertiary treatment was not required. And yet the site's status as an SAC imposes a legal obligation to maintain the favourable conservation status of the site.[7]

In theory, the NDP should have come with an ex-ante [to signify before] Environmental Audit. The Member of the Commission in charge of Regional Policy, Michel Barnier, wrote in reply to FIE's concerns about the lack of assessment of the NDP to say:

> 'I would draw your attention to the fact that the plan must be accompanied by a comprehensive ex-ante evaluation which is specifically required to cover the environmental dimension, setting out clearly the expected environmental impact of the new development strategy. It must also describe the practical arrangements for ensuring compliance with Community rules on the environment.'[8]

This 'comprehensive ex-ante evaluation' in the end was relegated to an Appendix and consisted of only four pages. None of those pages referred to the potential for damage to groundwater.

Disturbed, Irish ENGOs wrote to Brussels, only to be told by Environmental Commissioner Margot Wallstrom of the 'positive' aspects of the plan:

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[4] *The National Spatial Strategy*, Department of the Environment and Local Government, 1997. This has been modified by draft '*Guidelines for Planning Authorities on Sustainable Rural Housing'* published by the DoE on 4 March, 2004.

[5] The selection of sites occupied 5 of Ireland's leading ENGOs for more than three years and resulted in *'The ENGO SAC Shadow List'*. On the basis of these reports Ireland's was judged inadequate for both species and habitats and these were significantly expanded. Funded by the Heritage Council and represented at the Commission's European Nature Topic Centre Bio Geographical Seminars by the Irish Peatland Conservation Council [IPCC], these public negotiations at meetings in Europe demonstrated Irish EENGO cooperation and professionalism at its best. *'Protecting Nature in Ireland, the ENGO SAC Shadow List'*, Dwyer, R.B., 2000: 'A report prepared for An Taisce, The Irish Peatland Conservation Council, Coastwatch Europe, BirdWatch, and the Irish Wildlife Trust', Irish Peatland Conservation Council, Dublin, 2000. See also Crushell P, 2002, *'SACs in Ireland, An ENGO Review'*, Irish Peatland Conservation Council, Dublin, 2002.

[6] Jeanne Meldon and David Hickie, *Evaluation of the National Development Plan Ireland 2000 – 2006*, WWF European Policy Office, November 1999

[7] This was particularly inexplicable as the original 1997 planning permission stated: in condition 1 that the effluent 'shall be treated to a standard appropriate to the receiving waters to which it is to be discharged and shall have regard to the conservation status if any of such waters.' Clare County Council P97/1277.

[8] Commission Michael Barnier to Friends of the Irish Environment, 26 October 1999.

> 'Positive elements in the report are recognised. In particular, its recommended range of measures, such as transport demand management, the introduction of a carbon tax to reduce greenhouse gases, the preparation of a strategic physical planning framework and the application of the polluter pays principle in relation to domestic water and waste treatment, as well as recommendations for a significant investment in public transport, would have positive environmental impacts and would represent a departure from current government policy. It remains, of course, to be seen to what extent the final plan incorporates such elements.'

WHAT DO WE WANT FROM YOU?

Against this background, what is an ENGO to do when faced with a situation like the Kildare Bypass? What are we to do when we wish to assess the potential danger of an unauthorised quarry, like the one at Moycullen, Co. Galway? How do we judge when further investigation is required? How can we assess mitigation measures?

The Taoiseach will not let progress be delayed by 'snails and swans'.[9] The snails, of course, were the Government's 'spin' on why the Kildare Bypass was delayed – an obscurification repeated recently by Martin Mansergh in the Irish Times[10]. The issue was 5 million gallons of groundwater that were originally designed to be pumped out of the cutting every day to keep the 3 kilometre cutting into the aquifer dry. Certainly An Taisce's complaint to the European Commission was legally grounded in the Habitats Directive which protects Pollardstown Fen (and the tufa springs and a snail). But the issue was far wider. It was about protecting the largest aquifer in Ireland, the Japanese Gardens, and the water supply for the Grand Canal. To suggest that there was a 'ridiculous delay to the N7 bypass at Kildare because of a supposedly threatened species of snail' is grossly misleading and can only further confuse the public about the nature of groundwater issues.[11]

In this case, the documentation supplied[12] was characterised by the Legal Affairs Division of the European Commission as the worst case of the disregard of scientific advice which they had encountered. The Commission intervened incisively and a solution was found. The value of 'post consent conditions' was considered in a Reasoned Opinion from the Commission.

But perhaps my main regret is that we did not try to grapple with the Kildare Bypass issue earlier. If we had managed to get a clear picture of the complex issues during the three-year Ministerial delay in announcing the decision of the public enquiry, earlier pressure from Brussels might have helped speed up the process that has led to a resolution and avoided a public confrontation. The doubts were there, on the record. But we were busy, and no one told us at the time.

Water, and particularly groundwater, is of interest and personal importance to almost everyone in the country. This is why An Taisce challenges ribbon development of rural one off houses each with its own, sometimes less than satisfactory, septic tank and cheaply constructed borehole. Instead, we try to encourage nucleated settlements that can be economically joined to professionally operated local authority water supplies and sewage treatment plants.

An Taisce's appeals on rural housing are not based on begrudgery or solely on a criticism of inappropriate suburban housing styles in a rural setting, as the press and public seem to believe.

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[9] 'When the Taoiseach loftily dismisses all infidels to the great god of motorways as "swans, snails, and people hanging out of trees" he gives voice to a deep contempt for anything that can't be measured in tonnes of concrete and loads of money.' '*Bulldozing history and landscape'*, Fintan O'Toole, Irish Times, March 16, 2004.

[10] 'There was the ridiculous delay to the N7 bypass at Kildare because of a supposedly threatened species of snail. I am deeply suspicious of an expertise that cannot be verified. Common sense and experience tells us that snails are virtually ineradicable, and the minuscule risk of a marginal change in the biodiversity of this particular species is surely a tolerable one.' Martin Mansergh, Irish Times, March 13, 2004

[11] On the occasion of a visit by a French group of engineers in 2001, a spokesman for the local authority said their interest was in the new surfacing of the road, which was designed to 'keep it dry'.

[12] The report prepared for the Oral Hearing in 1993 by the Office of Public Works and the Kildare Senior Planner's Report.

Instead we realise that water consumption has increased in line with increasing wealth. As a result the effluent output from a family home has also increased enormously. I do not have to labour this point with this audience. We are all aware that in days gone by one or two isolated cottages along a rural road produced very little effluent. Nowadays rural housing often seems to be a ribbon development of 4-5 bedroom 'McMansions' with two garages, three 'ensuites', modern kitchens, sink waste disposal systems, utility rooms, washing machines, dishwashers, power washers for cars and even Canadian hot tubs containing gallons of chemically treated water.

Groundwater pollution was why An Taisce and FIE appealed a planning permission given to our President for a large home on a lakeshore in Roscommon. The proposed septic tank percolation area was in boggy ground next to the lake. We did not think that the ground could take the output from a house of this size. We appealed. The septic tank and percolation area were moved - but in fact the site still failed the SR 6 test performed by agreement between ourselves and the developer's planning consultant. The Planning Appeals Board permitted the development regardless.

We are concerned whether the land can take such a loading of effluent in some parts of the country, particularly in areas of low permeability rocks and soils, and especially along roads around our lakeshores in the midlands and the west.

We need to know where you, the experts, think that our waters and groundwater can cope with large quantities of rural effluent and where they can't. If you don't provide this basic information, which we consider essential for proper planning and development of our nation, then we, and the state's planning authorities, will make mistakes. We will sometimes not draw attention to potential pollution risks when we should. Conversely we may appeal a planning decision unfairly because we have only been given access to incomplete or inaccurate information, or maybe there is no information and we appeal on the basis of the precautionary principle. We make mistakes, but these are not made through malice, but arise from the paucity or poor quality of the information presented to us and the public.

For us to have a proper role and meet high standards we need sound technical support and good information. It is all very well for lawyers to do pro bono work for us (lawyers can make legal arguments on the basis of little science) but what is needed is pro bono inputs from hydrogeologists engineers, foresters, planners, waste consultants, water quality experts. This assistance can also help the planning process because we provide a conduit for information through to concerned local residents. Concerned local residents need sound information. It is probably true to say that some appeals by local residents are based on misunderstandings. Groundwater is an area in which misunderstandings are common because the resource is hidden from view.

ENGOs value to society and the planning process is that they are truly independent of government control. This means that we can ask the questions that many civil servants or others inside government may wish to ask, but can't, because of the Cabinet and Ministerial policy of the political party in power. This is exemplified by the current Minister for the Environment's reluctance to approve appeals even when a development clearly threatens the favourable conservation status required by European law – as in Aer Rianta's sewage treatment plant for Shannon airport.

To assist us perhaps you could use diagrams or illustrations that do not just show an idealised perfect scenario. Perhaps you could illustrate what might happen if something goes wrong and then, in a transparent honest manner, consider the implications. We naturally give much greater credibility to documents that openly explore the 'what - if' scenarios. We appreciate the integrity of 'experts' who are sufficiently expert that they can admit that they don't know all the answers, and who are confident enough to explore the possibility that they might get something wrong. Acknowledgement of uncertainty is not a weakness. Trying to measure and understand the dynamic processes in the hidden subsurface is a piece of work that is bound to be riddled with uncertainty.

Arising from our concern about the capacity of the land (and groundwater system) to be able to cope with the modern effluent output of a house, it becomes obvious that we, as one of the voices of concern, need better information from you the groundwater community - planners engineers as well as hydrogeologists.

We recognise that it takes time, money and effort to obtain sufficient information to understand the workings of a hidden groundwater system. Often there is little existing information; a developer and their consultants may in fact be starting from scratch. We would like to see developers (state or private) giving more time and resources to hydrogeologists and engineers so that they can do their jobs properly. In our opinion many of the delays and cost overruns to the NDP could have been avoided if the uncertainties surrounding the groundwater component had been adequately resolved at the Environmental Impact Statement [EIS] stage.

Professional advisors must ensure that their assessment for local authorities is as full as possible, rather than supplying as little information as possible and awaiting requests for further information – requests that may be beyond the resources of the planning authority.

As representatives of the general concerned public we need clear coherent and credible information - information that stands up to common sense scrutiny. We are anything but experts in hydrogeology but we are not idiots either. Members of our organisations are bright, dedicated and use common sense. We know that water flows down hill on the surface and underground. Thus we want the groundwater community to fully and realistically consider developments in relation to the groundwater system up stream and down stream, and not just limit your consideration to the extent of the specific site for which permission is sought.

We would appreciate it if you could describe your data and interpretations without the use of technical jargon terms, or if these terms must be used, perhaps you could, without being patronising, translate your findings into more 'everyday language', in order to ensure that the common sense layperson can understand. 'Transmissivity' is not an everyday expression. Permeabilities given as "10 to the minus nine" (10^{-9}) are difficult to imagine.

In the recent case of proposed wind turbines in North Tipperary, there was no hydrogeological survey – in spite a history of significant landslides. The EIS for this project even lacked a non-technical summary[13]. Notwithstanding, the Planning Appeals Board appeared not to have noticed either absence and reversed the local authority refusal.[14] The recent landslide during construction of wind turbines at Derrybrien, Co. Galway refers.

There are wider issues on which we urgently need informed discussion. Certainly landfills highlight many of these. We need credible information on the effects on landfill liners of exposure to aggressive elements. We need to know if its possible to ensure that water does not infiltrate the capping of containment landfills in the long term.

Suitable siting of landfills and their leachate – which may be up to 200 times stronger than raw sewage – is challenging local and regional authorities across Ireland. The fate of leachate in unsaturated zones is less certain than previously believed. The inhomogeneity of most geological

[13] It was the failures in the non-technical summary that the EU ruled infringed the EIA Directive at Carrickmines on foot of a Petition to the President of the European Commission. *Knapsac Report*, European Commission, 2003.

[14] Wind Farm including six turbines, substation, access road, temporary monitoring mast and permanent monitoring mast at Curraghafoil, Doon, Co. Limerick. The lack of information on hydrology was given by the Council's Environment Section as one of the reasons for refusal. The absence of a non-technical summary was not raised by An Taisce or any of the other appellants and was not noted by the An Bord Pleanàla Inspector, who reversed the Local Authority's decision and recommended development consent on 4 June, 2003. PA 01/1385, ABP PL 13.130938.

formations makes necessary site investigation uneconomic in most cases.[15] And of course groundwater pollution may take several decades to manifest itself at the nearest abstraction point.

We need to know if it is realistic to design controllable and reparable landfill systems that harness the inevitable biological reactions. Can large urban landfills be treated as bioreactors and supply useful gas while treating the leachate in attached treatment plants? Can these, like the municipal sewage system in Marseille in the south of France, be located in urban areas? Are we simply trying to hide the problem by locating our landfills in remote upland areas that may be less than hydrogeologically ideal?

GROUNDWATER PROTECTION SURVEYS

It would be naïve for FIE or An Taisce or any of the other ENGOs to expect developers and consultants to provide all the answers. We therefore need impartial national authorities or centres of excellence – such as the GSI or the EPA – to provide sound background maps, reports, and guidelines which we can use to base our evaluations of environmental proposals.

We need the Heritage Council's proposed National Biological Records Centre. But most of all, we need the completion of the Groundwater Protection Survey [GPS]. The GPS integrates bedrock, subsoils, geotechnical and hydrogeological information in a form that is specifically oriented towards decision makers in the environmental planning area. This vulnerability mapping is used both by local authorities in development consent procedures and by the national Environmental Protection Agency in their Integrated Pollution Control [IPC] licensing.

Yet in order to meet the commitments of the Water Framework Directive [WFD], work on the groundwater Protections Schemes was suspended in 2002 with 11 counties uncompleted.[16] It is not planned to be resumed until 2005.

While some of the work for the WFD will provide the aquifer component it will not provide vulnerability mapping – that it is it will not show us the degree to which the mapped aquifers are vulnerable to groundwater pollution. [17] Submissions by the GSI to the Minister for Finance indicate that once "reactivation" takes place in 2005 it will take 8 years to complete the GPS of Ireland.

Why has this happened?

By virtue of Government policies at various times requiring the non-filling of vacancies in the GSI, the complement of permanent professional staff have become reduced and aged. On an average, one professional staff has retired or will retire each year between 1997 and 2005. A request was made in 1997 for conversion of 6 temporary staff to permanent staff and the filling of six vacancies[18] - including two new posts on the Groundwater Protection Scheme. In fact, since April 2001 that request was considered lapsed.

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[15] *Changing attitudes to Leachate Migration and Water Resource Protection*, Harris, R.C. (1986) The Proceedings of the Landfill Water Management Symposium, ETSU, Harwell Laboratory.

[17] FIE argued in its submission to the Department's Strategy 2002 – 2005 that the failure to complete the GPS was in fact an infringement of the Groundwater Directive. However, Margot Wallstrom has since suggested that the current Groundwater Directive has not created the legal requirements that would ensure member states complete schemes like the GPS but that this will shortly be rectified: 'Existing EU groundwater policy, that is Directive 80/68/EEC on the protection of groundwater against pollution caused by certain dangerous substances, has been aimed at protecting groundwater from direct and indirect discharges of a number of pollutants. But this Directive does not set any clear quality objectives nor does it require comprehensive monitoring. As a result, there is not much data available about the quality of groundwater in Europe. The proposed Directive will change this situation.' Commission Press Release, 14 July 2003.

[18] 'In 1998 it sought additional staff from Department of Finance and requested assistance from Department of the Environment and Local Government in doing so. This was unsuccessful.' Letter from: Peadar McArdle, Director, GSI, to Terry McGuinness. FoI Officer, 29 November 2002.

In negotiations on new requests that are by their nature torturous, proposals have now been approved to appoint two new permanent staff – but with one retirement, the true increase is a single post. In the first phases of this agreement, 5 temporary staff have been converted to permanent, at least enabling more contract work. In spite of this, the groundwater section of the GSI now has 10 employed, down from 18 a year ago.[19]

When the number of temporary staff outnumbers the number of permanent staff[20], the result is low morale and unequal salary increments and regulations, such as tenure and superannuation. Further, while an element of temporary staff provides training and experience for the national pool of professional talent and many have made important contributions, only permanent staff can effectively supervise them and ensure new knowledge is transmitted through the GSI. Skills and standards cannot be passed on if there are breaks in continuity.

Even though the Local Authorities are contributors to the costs of the GPS and there have been requests from four additional local authorities for groundwater survey work in their counties, insufficient staff is available to supervise and carry out key functions. The failure to provide sufficient resources and the additional requirements of the WFD has meant the GSI has had to refuse these requests.

The GSI's Consultative Committee has been adamant about the staffing problems, including motions suggesting that there is 'serious concern that its key targets will not be achieved if the organisation's significant staffing issues, especially those relating to contract staff, are not resolved in a timely way.'[21]

The GSI has served under ten Departments and reported to fourteen Assistant Secretaries since 1971. The status of the GSI is reflected in the fact that there continues to be no geological presence on the Irish Council for Science, Technology and Innovation and that no one agency coordinates Research and Development. The idea of relocating the GSI - the national depository for geological information on land and sea - in Cavan is even more perplexing. Surely this is akin to locating the National Museum in Donegal? And Cavan? Regardless of the county's assets – and I am sure there are many – must not all relocations be well served by public transport?

Pressure on the GSI must result in 'reallocation' of resources and must curtail educational ventures, such as the admirable '*The Karst of Ireland'*.[22] This is turn must slow the education of the public that would create support for measures that are required to protect groundwater. Most urgently of all, in view of the Minister's recent Guidelines on Sustainable Rural Development, must be guidelines for drillers and boreholes and protocols for assessment of septic tank discharges. But even if we had these guidelines, how effective can they be unless we know which areas of the country are vulnerable?

CONCLUSION

The National Development Plan 2000 – 2006 represented the largest commitment of funding for infrastructure development in the history of the State. Without a balanced investment by the State in ascertaining the hydrogeology of Ireland, by developers in allocating resources, and by the professions insisting on the highest standards, it is not only the ENGOs who will be unable to meet the groundwater challenges to the NDP.

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[19] P. McArdle, Director GSI, *pers. com.*
[20] TPG and TUG [Temporary Project Geologists and Temporary Unestablished Geologists]. Figures supplied by the Geological Service of Ireland, 4 February 2003 to FIE.
[21] Minutes of the GSI Consultative Committee, 8.16, 24 October, 2002
[22] '*The Karst of Ireland, Limestone Landscapes, Caves and Groundwater Drainage Systems'*, Karst Working Group, Geological Service of Ireland, 2000

SESSION III: WATER PROVISION & TREATMENT IN THE NDP

SOURCE PROTECTION STRATEGIES FOR GROUP WATER SCHEMES

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ABSTRACT

A pilot study is to be undertaken in the Churchill Oram GWS catchment area situated in Co Monaghan to assist in the formulation of a national strategy for source protection as it applies to the provision of rural group water services. This strategy, the formulation of a participatory, user-driven model of water catchment protection will, once implemented, improve the quality of the water supply leading to a possible reduction in treatment costs and provide a sustainable protected water source for the foreseeable future. This will facilitate and greatly simplify the implementation of the Water Framework Directive amongst the 750 Group Water Schemes nationwide. The focus, therefore, is on building knowledge, skills, organisational capacity and ownership amongst users on all aspects of catchment protection. The overall aim of providing a strategy for water resource protection driven by group water schemes will be achieved by undertaking an extensive pilot project at the Churchill/ Oram Group Water Scheme in Co. Monaghan. A knowledge-based GIS/ Data management system, which can be used for the identification, management and protection of water resources, will be produced.

BACKGROUND

The aim of the proposed project is to formulate a strategy that outlines the implementation of a water source protection plan and to identify the means by which the community, represented by a local Group Water Scheme, can drive this implementation with the assistance of the National Federation of Group Water Schemes (NFGWS).

This strategy, the formulation of a participatory, user driven model of water catchment protection, will once implemented, improve the quality of the water supply leading to a possible reduction in treatment costs and provide a sustainable protected water source for the foreseeable future. This will facilitate and greatly simplify the implementation of the Water Framework Directive amongst the 750 Group Water Schemes nationwide. The focus, therefore, is on building knowledge, skills, organisational capacity and ownership amongst users on all aspects of catchment protection. The overall aim of providing a strategy for water resource protection driven by group water schemes will be achieved by undertaking an extensive pilot project at the Churchill/Oram Group Water Scheme in Co. Monaghan. A knowledge-based GIS/Data management system, which can be used for the identification, management and protection of water resources, will be produced.

OBJECTIVES AND TARGETS

The primary objective is the formulation of a framework that can be used to meet current and future objectives within a national strategy on water source protection of small group water schemes. This framework will be replicable and transferable to similar schemes throughout Ireland. The proposed study will be in line with the requirements in the European Water Framework Directive (2000/60/EC). The project will be locally driven and applied, provide the knowledge base for a sustainable water resource, and will include an education, demonstration, evaluation and dissemination dimension.

The project is focused on a pilot catchment in the area of the Churchill/Oram group water scheme in Co. Monaghan. The specific objectives and targets for the pilot project are to bring together the following work within a GIS Management system:

1. To qualify the current quality of the drinking water source.
2. To identify the main activities contributing to source water pollution.
3. To identify, quantify and classify potential sources of contamination.
4. To collect data on current seasonal variations in water quality.
5. To interpret the data and to produce models for the susceptibility of the drinking water source to contamination, including existing hydrological, geological and hydrogeological information.
6. To review the findings and produce recommendations for water quality improvement strategies/remedies.
7. To establish and implement a source management plan including the formulation of a contingency plan.
8. To measure the improvements in source water quality and to quantify the effect on water treatment operations.

MAIN ELEMENTS OF THE PROPOSED STUDY

The following provide an outline of the tasks to be undertaken in the proposed study.

A. Start-up
B. Source Water Assessment
C. Source Water Protection
D. Education and Awareness Programme
E. Review and Evaluation
F. Completion and Final Reporting

Catchment area showing proposed sampling points

TASK A: START-UP

This task aims to set up the basic elements necessary for the proposed work. This includes the building of a web site for dissemination of findings, an initial study in order to create a background database of information on the study area and a day in which all participants will meet in order to further familiarise all parties with all aspects of the project.

Initial Desktop Study: This will involve the gathering of available data for the study area, including any previous investigation and relevant literature and legislation. This is required in this work package to create a background database of information on the study area, which should be contained within a Geographical Information System (GIS). Already published or otherwise available data such as previous work by the EPA/GSI and work carried out by Monaghan County Council for mapping agricultural ways in the county will be obtained. Information gathered will include:

Geology Maps (Solid & Quaternary); Soils Maps (including any information on soil hydrology); Ordnance Survey Maps (showing locations of all buildings); Slopes (elevation and angle); Borehole records (including information on strata conductivities and water strikes); Meteorological data; River data (Quality and Quantity); Agricultural loadings; Industrial, domestic, agricultural and commercial discharges; Septic tank locations (and information on age and design if known); Storage tanks (silo's, chemicals etc.) and information on water discharges or extraction in the area.

The initial desktop study will provide an indication of those areas that pose the greatest threat to the quality of water supply in the area. This will include both point source (domestic, commercial, industrial and rural) and non-point source (mainly rural) pollutants, which will be identified within the area. Through the creation of a grid (50m x 50m) in the GIS for the study area, all potential pollution and hydrogeological factors in the area can be considered for each grid cell. Initial data is also available from the Irish EPA on existing water quality in the area. This will provide an indicator of those areas that are deemed to cause pollution and those areas that are receiving pollution and should provide a very good indicator of the pollution pathway.

All information will be gathered at the most detailed scale available. This information will be maintained in a GIS and will be geo-referenced to original Ordnance Survey Maps.

TASK B: SOURCE WATER ASSESSMENT PROCESS

This is a process of information gathering to learn about a community's source of drinking water. During this data gathering stage potential sources of contamination will be identified. Those locations within the study area that are deemed to be potentially polluting i.e. "pollution hotspots", should be investigated further with both soil and water sampling to confirm the exact location of the pollution problems, the source of the pollution and the pathway of the pollutants as well as the quantity of pollutants and possible effects that seasonality has on the pollution levels

Sampling and Analysis: The initial desktop study will identify the study areas that require sampling, in order to confirm that they are causing a decline of the overall water quality in the area. Sampling will include both soil and water sampling, the former being required to identify non-point source pollution levels and the latter being required to identify those areas of water (both surface and groundwater) that have higher levels of pollution. This sampling will include a seasonality study, with sampling taken at set intervals during the year to provide indicators of seasonal pollution. Initial sampling of the feeder streams will involve a classification using the EPA Q rating in use nationally. At a very early stage this will allow the study to focus on the significant pollution problem areas.

CHEMICAL & BIOLOGICAL ASSESSMENT OF MUCKNO MILL LOUGH

It is intended that Chemical & Biological assessment will be undertaken at an early stage to establish a baseline of conditions in the Lough against which any future changes can be monitored. Such a baseline assessment should include periodic sampling of the lake for a range of variables relevant to compliance with the surface water directive i.e.

European Communities (Quality of Surface water intended for the abstraction of Drinking Water) Regulations 1989. Under this Directive Raw Water is classified as A1, A2, A3 and this classification governs the type of treatment required. A1 is the highest quality and requires the least amount of treatment. It would be the intention to bring the raw water source up to the A1 category.

Sampling should also include measurement of total phosphorus, orthophosphate and chlorophyll as indicators of the trophic status of the lake. It would also be desirable to have the species composition of the phytoplankton (free floating algae) periodically characterised to determine in particular the prevalence of potentially toxic cyanophyte (blue green algal) species.

Such a "broad brush stroke" approach requiring relative small investment of resources can result in a significant improvement in lake water quality. However, sources of nutrient export from a catchment are in some cases difficult to pin down. Streams that normally have satisfactory conditions and low nutrient concentrations can for brief periods under specific weather and seasonal conditions export very significant quantities of nutrient. Such nutrient 'flushes' may be of such short duration as to have little impact on the biological quality of the stream but very significant impact on the quality of the receiving lake waters. Such short-term peaks in nutrient export are likely to go undetected by chemical monitoring programs unless the frequency of sampling is very high. It is therefore intended that fortnightly sampling will be undertaken for these parameters at possibly up to five locations to be identified from the initial biological assessment

All sample location grid references will be recorded and sampling will be carried out at the same locations throughout the year to provide an indication of seasonality.

Vulnerability investigation and Protection maps: Once data gathering is complete, an overall vulnerability map for the study area can be created, based on the hydrogeology of the area. In conjunction with this a pollution map can be created showing sources, pathways and vulnerable zones (water), which can be incorporated with the vulnerability map. The combination of these maps will indicate which areas are causing pollution and what areas require the introduction of prediction/pollution studies.

To allow replication of this investigation a clear description of the methodology used is required, with an indication of all data formats and all techniques used. This information should be provided, along with all data, outputs and the resulting recommendations for public access.

TASK C: SOURCE WATER PROTECTION PROCESS

The goal of this project is to prevent contamination, thereby effecting an overall increase in water quality. Once vulnerable areas and areas that are causing increased pollutant loadings have been identified, management strategies are required which aid planners and local land users in reducing pollutant loadings in the area. The implementation of this process consists of two components:

- Contamination Source Management
- Contingency Planning

CONTAMINATION SOURCE MANAGEMENT

These strategies should involve all relevant stakeholders in the area, including:

- Local Authorities
- State Agencies
- Environmental Representatives
- Representatives of the Group Water Schemes
- Farming community
- Business community
- Developers

The vulnerability and pollution assessment will clearly identify the source areas for pollution, the water bodies being polluted and the pathways the contaminants have taken. A number of solutions are then available to remedy the problem and the implementation of these strategies requires cooperation between community members and the relevant government bodies in the area in order to proceed. There are four potential types of strategy:

- *Regulatory* – Implementation by law or ensuring compliance with existing legislation
- *Voluntary* – Advice on possible strategies to reduce pollution, which may not be required by law, but should be enforced as 'good practice', in the area
- *Structural* – Built structures or devices to prevent or contain contaminants, whether it be maintaining older structures or developing new ones
- *Non-Structural* – Education and awareness programs, highlighting the problem areas and offering suggestions to groups or individuals on how to remedy the problem

Implementation of these strategies will depend on the nature of the pollution problem. For example, if septic tanks are causing a significant pollution problem, then strategies can be suggested to reduce the problem through the building of structures. If the problem was deemed to be one of agricultural land spreading, then regulations could be implemented or methods devised to reduce the application of fertilizers or prevent them from reaching the water bodies.

Regulatory Management strategies could include:

Zoning – i.e. Nitrate Vulnerable Zones.
Spot Checks – Regular monitoring of farming activity in particular.

Voluntary Management Strategies could include:

- *"Free" land* – Advice could be provided to the public on which areas of land are particularly susceptible to pollution and allow the rapid transfer of contaminants to the water body. Landowners could be advised that if this land was not used or if pollutant loadings on this area were reduced, an overall improvement in water quality would be seen.
- *Protection Zones* – Land acquired around particularly sensitive areas, to prevent further contamination.
- *"In house" monitoring* – This could be carried out by landowners, allowing them to carry out their own measures, with possible subsidies for sampling equipment.
- *Storage* – Advice on the best containers for storage, with a record kept of all updates to storage facilities and chemicals, waste etc. stored.
- *Advice* – Suggestions for more efficient practices that would minimise the need for excessive agricultural chemicals and reduce pollution from industrial, commercial or domestic sources.
- *Waste* – Encourage waste prevention and minimization for the whole area.

Structural Management Strategies could include:

- *Drainage* – Improve drainage in rural areas, reducing water logging and surface runoff. This could include trenches and ridges that allow water storage and reduce surface runoff.
- *Wetlands* – Including reed beds, which are already proven to reduce pesticide and nitrate loadings in vulnerable areas
- *Storm water ponds* – These will act as settling tanks, reducing flooding and surface water contamination
- *Waste Management* – This could include recycle bins and compost heaps

Non Structural Management Strategies could include:

- *Group Management* – Getting areas to combine resources in order to prevent wastage of resources and effort
- *Group Schemes* - Local awareness plans and booklets advising the public on methods to reduce contamination

CONTINGENCY PLANNING

Although prevention measures and management strategies can cause a reduction in the overall contamination in an area, plans are required in the event of a pollution threat, should the other measures put in place fail. These schemes also provide quick and easy guidelines to the public and planners, should problems occur. They also act as guidelines for future development and provide a basis for future studies in the area.

Contingency planning should consist of two strands that run parallel with each other, namely:

- *An Emergency Plan* – Consisting of contact details for relevant parties in the event of an emergency
- *A Detailed Plan* – Consisting of specific contacts for certain types of contamination, different approaches to combat each problem and identification of all possible implications should problems occur

TASK D: INFORMATION AND AWARENESS PROGRAMME

The success of a water source protection strategy will be significantly affected by levels of public awareness of the determinants of water quality and their understanding of routes to quality enhancement and protection. This work package will provide additional value to the project by providing structured activities and opportunities designed to raise levels of public information and awareness on the importance of community engagement in the development and ownership of their water source protection strategy.

The level of public commitment to a protection strategy will be significantly influenced by social and psychological factors. The interpretation of facts concerning risks to water quality will affected by levels of public information and awareness. Thus, the design and implementation of an effective information and awareness programme is crucial to the success of the overall process. It is particularly important when addressing issues of community participation in, and response to, a group water source protection scheme. The perceived role of external organizations is itself a potential source of threat to the success of a scheme because communities are, understandably, likely to be wary of the interventions of external consultants who may imply that they know best for a community. Thus, it is proposed to adopt an approach designed to help communities develop more intensive involvement in the quality assurance of their group water schemes.

This approach involves focusing on: supporting key leaders within communities, mapping their interests, developing their resources, and enhancing their power to act on their communities' interests.

It is crucially important to have a framework and a range of options for informing the public about the Drinking Water Source Assessment and Protection Process and for bringing the public into the process. Frameworks will be put in place for each and all of the stakeholders involved in the process.

Within the Drinking Water Source Assessment and Protection Process the aim is that all participants will:

a. Understand the key terms, legislation, concepts and history behind source water assessment and protection.
b. Understand the susceptibility of drinking water sources to pollution.
c. Recognise opportunities and responsibilities for involvement in the process.
d. Identify key contacts in the community that should be involved in the process.
e. Recognise what the community and other stakeholders have done previously to protect water.
f. Understand the actions that need to be taken to protect the drinking water source.

TASK E: REVIEW AND EVALUATION PROCESS

A steering group will assess the project on a regular basis. This steering group will be made up of members of the management team complemented by local community leaders and external experts.

TASK F: FINAL REPORTING OF PROJECT

The following will be available at the end of the project:

- A final report containing all data and findings including a one page summary report with the key results and conclusions
- Data on water quantity and quality in the area, showing any seasonal trends
- A vulnerability map in digital form for the Churchill/Oram area
- A source pollution map in digital form for the Churchill/Oram area
- A source management plan in digital form for the Churchill/Oram area
- All information stored within a GIS database, which is compatible with existing Irish EPA technology
- A complete methodology which allows all work carried out to be reproduced
- A user friendly website with interactive maps that are compatible with the current Irish EPA interactive data
- Recommendations on remedial strategies that will improve water quality in the area

IMPROVING GROUNDWATER SUPPLIES IN RURAL AREAS USING DESIGN BUILD AND OPERATE CONTRACTS

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ABSTRACT

Groundwater is the most popular source of supply for rural water scheme, accounting for more than 80% of schemes registered with local authorities under the drinking water regulations. The quality of the water supplied to rural areas has been the subject of much controversy in recent years. Following clarification from the European Commission regarding the applicability of the drinking water directive to small private water schemes, an amendment to the Irish drinking water regulations in 1999 effectively broadened the scope of the regulations to include all private water supply schemes serving more than 50 persons. This position was reinforced under the replacement regulations which came into effect in 2004. The legislation imposes the same requirements in respect of water quality on small private schemes as large municipal schemes with defined standards for bacteriological and chemical water quality. The broadening effectively brought more than 650 private schemes under the scope of the regulations. Extensive water quality testing over the period since has established that many of these schemes are supplying water which does not comply with the regulations. These water quality deficiencies have now been well documented primarily as a result of sampling and analyses undertaken by local authorities under the drinking water regulations but also and separately by the National Rural Water Monitoring Committee under a programme launched in 2000. The water quality problems commonly include coliform contamination, cryptosporidium, high levels of nitrates, iron, manganese, water colour, low pH and less commonly radon, copper and fluorides.

In response the Department of the Environment, Heritage and Local Government (DOEHLG) has launched a series initiatives designed to bring about the required improvements to the quality of water supplied. The first such initiative involved the preparation of Rural Water Strategic Plans to identify the most cost effective means of supplying water of the required quality in rural areas. These were prepared by county councils and set out broad engineering proposals to address the quality and supply issues identified.

The implementation vehicle chosen by the DOEHLG to advance the procurement and operation of the treatments works required has been bundled Design, Build and Operate (DBO) contracts. Under these DBO contracts several geographically close group and public water supply schemes come together to form a single Employer entity with the aim of achieving whatever economies of scale may present and to ultimately provide affordable water supplies of the required quality for a 20 year period. The task of putting these contracts together involves the development of outline design proposals for each scheme which meet defined criteria in terms of affordability and water quality. This paper outlines the author's experiences in developing practical engineering proposals for the advancement of such schemes and details the particular problems associated with the development of affordable groundwater supplies in this context.

1. AFFORDABLE WATER TREATMENT

In the context of the current DOHELG and local authority initiative to improve the quality of water supplied to rural areas, affordability has a reasonably well defined basis this being related to the cap on grant aid for the development or upgrading of schemes and the subvention payable to participating schemes for the operation and maintenance of the treatment plants. Grant aid for the procurement of capital works to develop new schemes or improve the quality of water supplied by existing rural schemes is currently capped at €7,618 per domestic connection. For schemes participating in the bundled DBO contracts referred to in the introduction, payments to meet the costs of operating treatment plants and the distribution systems are available from the state at €196 per domestic connection. In accordance with the polluter pays principle, no funding is available for non-domestic connections.

Private schemes can provide some additional funding outside the above limits by levying their membership, but scope for this is limited particularly where it is perceived that water supplies to DOMESTIC consumers on public schemes are available free of charge. The development of affordable water supply schemes must therefore be cognisant of the above coupled with an awareness of the costs likely to be incurred by a DBO contractor for constructing and operating different types and sizes of treatment plants. These are related to the demand for water and to the quality of the raw water as discussed below.

2. DEMAND ESTIMATION

Estimation of the future water demand for rural water supply schemes begins with estimation of the existing demand. For existing schemes this is ideally achieved by measuring and logging the flow rate into the distribution system for a period of a week or more. The different components of the total demand may often be discerned by examining the diurnal pattern particularly the estimation of Unaccounted For Water (UFW) from night-time flows. For existing schemes this is commonly 50% or more of the total demand but this varies considerably with factors such as the operating pressures as well as the age and length of the distribution system being among the determining factors. Domestic consumption currently averages 448 l/house/day nationally. This figure has been repeatedly verified in the course of recent investigations.

For rural water supply schemes agricultural usage is of particular importance. Currently it is not usual to have meter readings available for individual farm connections but local authority funding to install such meters is available. In the absence of such readings estimates may be based on farm surveys or Census of Agriculture (2000) figures for livestock numbers together with standard Teagasc allowances for animal consumption. This may be expected to produce a conservative approach with respect to actual agricultural consumption.

Future water demand is normally estimated over a 20 year design horizon consistent with the duration of the operation and maintenance contract. For domestic consumption it is usual to provide for additional connections to the scheme on the basis of housing patterns in the area generally and any specific provisions in the relevant county development plan. Agricultural demand is widely expected to reduce over the coming years in response to reform of the Common Agricultural Policy and other measures which are expected to result in a decline in livestock numbers. Currently it is common practice to assume that this element of the total demand will remain static but this may be reviewed in the light of operational experiences.

DOHELG guidelines for rural water schemes provide that funding for schemes is on the basis of UFW levels of 25% or less. In some instance this can result in a future total demand which is less than the current demand. This places an onus on participating schemes to tackle leakage on the distribution scheme as a matter of some urgency.

3. COMMON WATER QUALITY PROBLEMS ON GROUNDWATER SCHEMES

The advantages of using groundwater for water supply purposes in preference to surface waters are well known. These would include a reduced vulnerability to contamination by surface activities and filtering of precipitation over the recharge areas by the overburden layers. However these advantages are often less pronounced in spring sources and shallow wells which are often the dominant sources of water supply on existing rural water supply schemes. The use of extremely vulnerable groundwater supplies together with inadequate source protection measures feature commonly in existing rural water supply schemes. Raw water sampling results from spring sources in particular often show levels of colour, nitrate and bacteriological contamination which would not be dissimilar to surface waters in the same area.

For schemes using deep well boreholes bacteriological and chemical water quality is often excellent and many schemes require no treatment to comply with the regulations. Chlorination to protect against contamination of the water supply in the distribution system is widely practised in this country and this has featured as a mandatory treatment requirement in all DBO contracts to-date. Nitrates, iron, manganese and radon are well documented problems and these often appear in groundwater sources in excessive levels. Fluoride copper and aluminium have also been found to be present in excessive concentrations but this is much less common.

4. TYPICAL CAPITAL AND OPERATING COSTS FOR SMALL RURAL WATER TREATMENT SCHEMES

Information with respect to market-place costs under the bundled DBO type of procurement method for rural water supply schemes is limited to that available from a small number of such contracts that have been awarded in recent years. These contracts have been mainly associated with the treatment of surface waters in which flocculation and chemical coagulation and settlement/flotation have been the dominant processes. As these processes would not generally be necessary in the case of groundwater, information in respect of actual market costs for groundwater is more limited. Nonetheless the following table has been prepared to provide typical costs for the removal of compounds commonly found in groundwater based on the available information and consultations with experienced suppliers and manufacturers. These would be based on typical raw water concentrations of up to 2 times permissible limits for a small scheme supplying $100m^3$/day. This level of demand would be associated with a typical 50 house scheme incorporating significant agricultural usage associated with (say) 300 dairy cattle. The type of treatment required and the associated costs could vary considerably where the concentrations are much higher than those assumed and may also be influenced by the pH of the raw water.

Table 1 – Typical capital and production costs associated with different treatment requirements for small (100 m^3/day) groundwater treatment schemes

Type of treatment	Process	Capital Cost (€)	Unit Production Cost (€/m^3)
Chlorination (Cl_2)	***Cl_2 gas injection***	***€62,000***	***0.08***
Cl_2 + Fe + Mn	***Cl_2 + pH + 2 stage filtration***	***€182,000***	***0.11***
Cl_2 + Nitrate	***Cl_2 + Ion exchange***	***€114,000***	***0.28***
Cl_2 + Radon	***Cl_2 + Aeration***	***€73,000***	***0.09***

The above capital costs would be inclusive of the building and civil engineering elements of the contract as well as pumping. The production costs given refer only to the direct costs of treated water production and would not include other costs borne by the contractor.

5. STRATEGIES IN ACHIEVING AFFORDABLE TREATMENT

For most schemes the available grant aid in respect of the capital works would cover the costs of the treatment required and such schemes would normally be considered suitable for participation in a potential DBO bundle. For other schemes particularly those with a small number of domestic connections and high agricultural consumption, the costs of the necessary treatment may be unaffordable. Where the raw water characteristics are such that the cost of the necessary treatment is unaffordable, it is usual to seek a replacement source or a supplementary water source with which to dilute the concentration of the offending compound to an acceptable level. For nitrates in particular the high costs of water production and difficulties in disposing in the residue from the ion exchange process make treatment for small rural water supply schemes particularly unattractive. Replacement sources are sought as a matter of routine in these cases.

Where it has been established that local treatment cannot provide the required quality on an affordable basis, connections to existing public schemes or amalgamation with other group water schemes is often considered.

6. EXPERIENCES TO-DATE

A number of bundled rural water DBO contracts have now been awarded and these are at various stages of completion. Several other bundles are now at or approaching tender stage. In order to advance the works the first task is often persuading existing group water schemes of the need to improve the standard of treatment on their scheme and addressing concerns about cost. Experiences to-date would indicate that there is a general acceptance in the group water sector of the need to improve standards of treatment and a willingness to participate in the bundling process. This is helped by an appreciation of the proposed Water Services bill the provisions of which are expected to include a requirement for licensing of private water supplies which would only be granted where the scheme has demonstrated that it can provide water in compliance with the drinking water regulations.

On the more advanced bundles, some water treatment plants have now been in operation for almost 1 year and payments made for the operation and maintenance of the treatment plants. The participating groups are reportedly very satisfied with the improvements in water quality and have had no difficulties in meeting their payment obligations under the contract. On-going monitoring by local authorities in accordance with the drinking water regulations has shown that the plants are working well with no exceedances recorded over the period. Access to the results of on-line monitoring of some key water quality indicators and production details at these plants is provided to participating group and public water schemes via a modem connection to the SCADA system for the plant. This includes turbidity, residual chlorine, as well as flow rates, pump status, emergency call-out and levels in service reservoirs etc. The availability of this information to participating groups during the operation and maintenance phase of the contract has proved particularly popular.

7. CONCLUSIONS

The development and upgrading of rural water supplies by means of bundled DBO contracts has been proceeding for some three years. Despite some initial reluctance on the part of group water supply schemes, there is now a widespread appreciation of the need to invest in improvements in water quality and to pay for the services of a private contractor to operate and maintain the necessary treatment facilities. The provisions of the proposed Water Services Bill which have been widely anticipated and experiences on newly commissioned schemes, have helped to create a climate in which private water supply schemes are willing to participate in the DBO approach. Experiences to-date have shown that this approach can yield affordable water supplies treated to the required standards. At European level the bundled DBO strategy is perceived to be highly successful and the Irish example has been put forward as a possible model for other EU countries and accession states with similar water quality problems on rural schemes.

THE ROLE OF THE GEOLOGICAL SURVEY OF IRELAND IN SUPPORTING GROUNDWATER RESOURCE DEVELOPMENT

Geoff Wright, Geological Survey of Ireland

Abstract

The Groundwater Programme of the Geological Survey of Ireland (GSI) has made substantial contributions to the development of Ireland's groundwater resources over the past 30-40 years. Over the past decade the main vehicle for our contribution has been the preparation of county groundwater protection schemes, which have now been completed for about half of the country. Over the past two years, we have concentrated on contributing to the River Basin District Management Projects which are aimed at the implementation of the EU Water Framework Directive.

GSI's current and likely future contributions to groundwater resource development in Ireland can be outlined under eight headings: groundwater databases; aquifer mapping & classification; groundwater vulnerability mapping; source protection areas; groundwater protection schemes; river basin district characterisation; education; and improving hydrogeological understanding. I also attempt to highlight a few key issues for the future.

INTRODUCTION

The Geological Survey of Ireland (GSI) summarises its objectives under five Strategic Goals, the second of which is "To support sustainable development, environmental protection and the nationaldevelopment plan". GSI pursues this goal through all of its programmes, for example through our geological mapping programmes, the National Seabed Survey, our county Mineral Potential and Aggregate Potential mapping, and our Geotechnical Database project. All these programmes are interrelated to a greater or lesser extent, and most of them have a significant connection to GSI's Groundwater Programme, with which this paper is concerned.

A BIT OF HISTORY

GSI has been contributing to the development of groundwater water resources in Ireland since the 1940s, at least. Until the 1970s this was normally limited to advice on the likely outcome of drilling in a specified location, and for rather small supplies. From the 1970s onwards, the advice became progressively more concerned with larger supplies and with regional resource development.

Before the 1970s, the private consultancy sector was very small and the GSI was essentially attempting to cover all needs while also encouraging private sector involvement. Since then the consultancy sector has expanded many times over and GSI has deliberately withdrawn from that type of work in order to concentrate on strategic resource issues.

In this paper I shall reflect on the main aspects of our work and speculate a little on our future.

GROUNDWATER DATABASES

In summary, GSI has four main groundwater datasets:

Our *Wells Database* has details of over 35,000 wells and springs in Ireland. The amount of detail recorded on each well is very variable, and in many cases the site location is only approximately known, but overall they help to answer the question such as "what is the previous experience of groundwater development in the area? How deep should a well be? Where should water be struck?"

The *Karst database* has details of over 1500 karst features around the country, all quite accurately located, which help in identifying the pollution risks which such features pose.

Our *Groundwater levels database* has records of groundwater level fluctuations at over XXX sites in several counties, which help in assessing the likely range of groundwater level fluctuation in an area, and also provide a long-term context in which to view shorter monitoring records.

The *Groundwater chemistry databank* (not yet computerised) has over XXX records of groundwater chemistry in a range of aquifer types, and helps in predicting the likely hydrochemistry at a prospective site.

All of these databases are available for enquiries to assist in any aspect of national development. Most of our work depends on these key databases.

AQUIFER MAPPING & CLASSIFICATION

In recent years nne of our primary objectives has been the mapping and classification of Irish aquifers. GSI first engaged in aquifer classification in the early 1970s for an IAH-UNESCO map, and later for the 1982 map produced for the European Commission. However, our approach changed in the early 1990s as the first county groundwater protection schemes (GWPSs) got under way.

Our aquifer mapping is based on the foundation of the GSI Bedrock maps and, for the gravel aquifers, on both GSI Quaternary maps and, most recently, on the new Teagasc subsoil maps, some of which are still in progress.

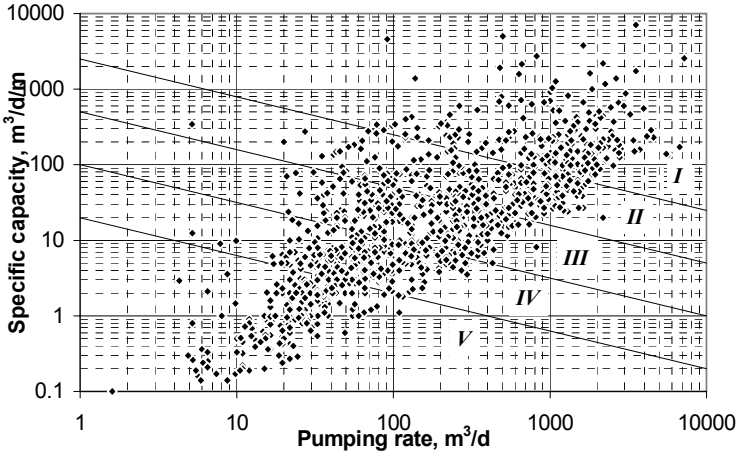
The GSI aquifer classification is based on several factors:

- Lithology (bedding, grain size, purity)
- Karstification and Dolomitisation (in limestones)
- Geomorphological history
- Fracturing - frequency / intensity / openness
- Hydrological indicators - drainage density, baseflow index
- Occurrence & size of springs
- Aquifer characteristics - especially Transmissivity
- Well characteristics – 'Yields', 'Productivities', Q/SC graphs / profiles

'*Productivity'*

For a long time we have used the term 'productivity' loosely in describing aquifers, with the understanding that it is a qualitative 'proxy' for Transmissivity (= permeability x aquifer thickness). In recent years I have proposed the use of a 'productivity index' by examining borehole specific capacities (SC) in the context of the pumping rate (Q) at which the SC is measured. I proposed five productivity categories from **I** (highest) to **V** (lowest), as in the graph below:

Figure 1: Q/SC graph for whole data set



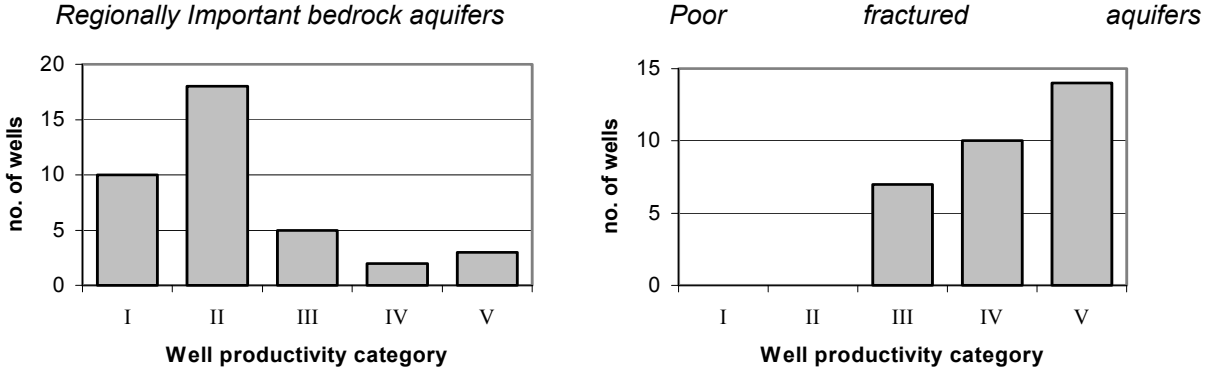
In using the Productivity Index to help in classifying aquifers, we examine the relative frequency of occurrence of each productivity class in a given aquifer. However, data on well yields and productivities need interpretation!

Regionally Important bedrock aquifers generally comprise: Pure bedded limestones & dolomites; mixed volcanics / slates (mainly in Co. Wexford); s*ome* sandstones, notably the Kiltorcan Sandstone in the south and southeast.

Locally Important or Variable Aquifers include: impure or shaly limestones (e.g. the Ballysteen Limestone and the Calp); massive unbedded limestones (the Waulsortian 'reef' limestones in the midlands and north); mixed shale/sandstone successions (e.g. the 'Cork Beds'); and the Old Red Sandstone (widespread).

Poor Aquifers include: Granites & Metamorphic Rocks; most Lower Palaeozoic Slates, Greywackes.

Figure 2: Q/SC profiles



Some cautionary notes on aquifer classification can be illustrated by considering two of the more difficult classes:

Rk$^{d:}$ Regionally Important Karstified Aquifer:

- Limestones with conduit flow dominant
- Limited development potential
- Most development via springs
- Generally very vulnerable to pollution, especially because of the likely input from sinking streams
- ZOCs are normally very difficult to identify

Ll: Locally Important Aquifer, moderately productive only in local zones:

- Very widespread, including, for instance, most of the Old Red sandstone succession, as well as most of the shaly limestones around the country.
- Rocks which are generally not very productive, but cannot be dismissed as 'Poor' aquifers
- In many places have proved able to yield significant local water supplies from what are clearly limited zones of higher permeability.
- In trying to develop these aquifers it is important to identify these 'local zones' - e.g. by remote sensing or geophysical surveys.

An Alternative View of Aquifer Classes

Our original view of the aquifer classification system was basically heirarchical:

Rk > Rf/Rg > Lm/Lg > Ll > Pl > Pu

However, I think it is more instructive to view the system as three columns:

	Gravel Aquifers	Fissured Bedrock Aquifers	Very Variable Bedrock Aquifers		^^^^^^^^^^^^^^^^^^^^ Increasing Prductivity
Highly Productive		*Rf*	**Rk**^{d}	**Rk**^{c}	
Moderately Productive					
Poorly Productive	*'non-aquifers'*				
	Increasing variability >>>>>>>>>>>>>>>>				

In aquifer classification, the degree of variability is important

Productivity in Aquifer Classification

QSC graphs allow Q (well 'yield') and SC (specific capacity) to be viewed simultaneously in the context of other boreholes in the same aquifer, and thus to see whether the yield/drawdown characteristics of the well are typical or not.

QSC profiles are useful in characterisation of an aquifer but often not definitive – other factors also need to be considered. And it always seems that there are never enough data points!

Confined aquifers need different criteria – normally the specific capacity of a borehole in a confined aquifer shows little or no decrease as the pumping rate is increased.

Transmissivity values from pumping tests in fissured aquifers have very limited applicability.

What's the point of aquifer classification?

- 'Groundwater Resource Value' in Groundwater Protection Schemes – influences Groundwater Protection Responses – how much protection does a given aquifer require?
- Groundwater body characterisation for RBD Management Projects -
- Groundwater monitoring programmes – where should monitoring be focussed? Where should monitoring points be located? What monitoring frequency is appropriate?
- Groundwater resource and source development – which aquifers offer the best prospects?
- Environmental Impact Assessment

GROUNDWATER VULNERABILITY MAPPING

Groundwater vulnerability mapping was designed primarily to assist in assessing the pollution risk from various kinds of development. This normally involves examining a site, or group of sites, and considering the pollution risk posed by a given development on that site. However, groundwater vulnerability maps can and should also be used, as it were, in reverse, i.e. when considering potential sites for developing groundwater supplies, a developer should consider firstly, the likely zone of contribution (ZOC) to a borehole at that site, and secondly, the groundwater vulnerability within that ZOC. Thus, as far as practicable, water supplies should be developed in areas which afford good protection from pollution.

SOURCE PROTECTION AREAS (SPAs)

GSI has delineated SPAs for about 120 public groundwater supply sources in 14 counties around the country. We believe that such SPAs should become the norm, at least for sources abstracting more than a certain amount, perhaps 100 m^3/day. We also believe that SPA delineation should become a routine part of site selection for new supplies.

GSI uses a range of methods for SPA delineation:

- Hydrogeological mapping
- Mapping surface water/groundwater catchments
- Ascertaining groundwater flow direction
- Analytical modelling
- Numerical modelling
- Groundwater tracing

Two source protection areas are normally delineated for each source – and Inner Area, based on the inferred 100-day travel time to the source, which aims at protecting from bacteriological protection, and an Outer Area, which comprises the remainder of the total Zone of Contribution to the source.
The extent of the work involved in delineating SPAs for a given source will depend on several factors. It is made much simpler if good data are collected at the time of commissioning.

GROUNDWATER PROTECTION SCHEMES (GWPSs)

To date, GSI has undertaken GWPSs in 15 counties (about 50% of the country) over a period of about 10 years. Some (undertaken in the 1990s) now need significant up-dating and upgrading – in fact we are just completing this for County Meath. This has involved (a) re-registering the data to the OSi 1:50,000 map series; (b) taking account of new geological mapping; (c) using the aquifer classifications as undertaken for the River Basin District (RBD) management projects; (d) revising the groundwater vulnerability maps in the light of our improved methodology; (e) taking account of all available new borehole data received since the first scheme; (f) converting the output to a GIS format.

The remaining 50% of the country now has aquifer mapping (under the RBD projects), but needs vulnerability mapping and SPA delineation.

RIVER BASIN DISTRICT (RBD) CHARACTERISATION

GSI is making a substantial contribution to the various RBD management projects which are being undertaken on foot of the EU Water Framework Directive:

- Input to the project steering committees, particularly in guiding the work on groundwater aspects such as the groundwater monitoring programme.
- Input to the groundwater characterisation of the river basins, primarily in delineating and describing the groundwater bodies in each basin, and assisting in aspects of the surface water characterisation. A lot of the work undertaken by our contract hydrogeologists was directed towards a thorough nationwide review of all our aquifers. All our existing mapping of groundwater vulnerability has been contributed, but additional mapping to delineate areas of ‘extreme’ vulnerability is being carried out by the project consultants, including some addition shallow drilling to help map the depth to bedrock in certain areas.
- Other inputs which depend on other GSI programmes include mapping of potential pressures from current and abandoned mine sites.

Outcomes from the RBD projects will include:

- Integrated water resource management
- Improved groundwater monitoring

We hope that, on conclusion of the RBD projects, GSI will be able to continue to guide groundwater aspects of the ongoing RBD Management Plans.

EDUCATION

GSI currently contributes to various kinds of education and training, both formal (e.g. the joint GSI/EPA/FAS course in 'septic tank' site evaluation) and informal (e.g. this seminar). In the context of the needs of the National Development Plan, and particularly water resource development, the following suggest themselves as potential topics:

- Groundwater exploration
- Well design and construction
- Developing gravel aquifers
- Delineating Groundwater Source Protection Areas
- Groundwater monitoring – both groundwater levels and groundwater quality

IMPROVING HYDROGEOLOGICAL UNDERSTANDING

GSI's Groundwater Section has always tried to work towards improving the understanding of Ireland's hydrogeology, which is very different from, for instance, English hydrogeology. Particular aspects which seem to need further work include:

- Conceptual modelling
- Effective aquifer thickness (in most Irish aquifers, the effective aquifer thickness will depend on the depth of significant fracturing, rather than the actual thickness of the geological unit.
- Shapes of Zones of Contribution (ZOCs) to groundwater supply sources.
- Sustainable yield of aquifers and groundwater sources.
- Influence of subsoil / unsaturated zone on groundwater quality, protection and recharge.
- Recharge – amounts, timing and location.

THE FUTURE

- Insofar as it is possible (or prudent!) to look into the future, I offer a few thoughts about what appear to be some important issues on our horizon:
- The GSI Bill –proposed new legislation which would underpin all GSI activities for many years to come. One particular provision is a proposal to give GSI statutory powers to acquire geological data.
- Decentralisation to Cavan - a key issue is our planned decentralisation. However, at the time of writing, the implications of this are unclear. In a positive sense, it could herald a new start with many new opportunities. On the other hand, it could in the short term lead to the loss of much expertise and experience.
- Recruitment - plans are in hand for major recruitment to GSI to strengthen our capacity in key areas, including groundwater.
- Data collection - continuing and improved data collection is envisaged under all scenarios.
- Additional GWPSs and updates - having completed groundwater protection schemes for 14 counties, we expect to embark on additional schemes when our work on the RBDMPs subsides. However, continuing up-dating of both the GWPSs and the RBDMPs will be essential over the coming years. Perhaps these could be undertaken on foot of some type of service contracts between GSI and the commissioning local authorities?
- Emergency Water Resources: This refers to standby water resources for use in the event of a major emergency, e.g. a Chernobyl-type fallout incident or chemical spillage affecting a major surface water source supplying large urban areas. This would probably concentrate on identifying productive confined aquifers and/or other well-protected aquifers (with ZOCs in areas of low vulnerability).
- Water Well Drilling Standards: Unlike many developed countries, Ireland has no statutory regulations or comprehensive guidelines concerning water well drilling, groundwater abstraction

or well decommissioning. The poor quality of many rural groundwater supplies in Ireland demonstrates the need for such regulations. This would be a sustainable approach aimed at improving the water source and reducing the need for 'end-of-pipe' solutions. GSI is contributing to work by the Institute of Geologists of Ireland (IGI) on drafting standards for borehole drilling, testing and decommissioning. It is envisaged that, in a new regulated context, GSI would have a continuing significant role.

- GIS - in recent years we have begun to harness the increasing power of GIS tools in our work, and we envisage increasing use of GIS to improve our services in all areas. One aspect which we have not tapped so far is the potential for combining GIS with numerical groundwater modelling.
- Numerical modelling - we need to keep abreast of advances in numerical modelling of fractured rocks – to a great extent, this is still in the realm of academic research, but there are indications that more practical applications are not far away.
- E-business - finally, we envisage advances in making web access to GSI data available to most customers.

Acknowledgements

Thanks are due to my colleagues (too numerous to mention by name) in GSI Groundwater Section, especially over the past decade.

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SESSION IV: GROUNDWATER CHALLENGES OF WASTE MANAGEMENT

GROUNDWATER CHALLENGES IN WASTE MANAGEMENT

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ABSTRACT

Waste management in Ireland today poses a number of challenges to groundwater. Chief amongst these challenges are the following:

- *The continued rise in the quantities and types of wastes being produced;*
- *The acute shortage of existing, properly located and engineered waste facilities;*
- *The existence of unauthorised waste facilities;*
- *The location of existing, historical waste facilities;*
- *The development of new waste infrastructure*

The National Development Plan is concerned with the economic and social development of Ireland and covers the period 2000 to 2006. The Plan notes that "Appropriate waste management infrastructure is vital not only for environmental protection reasons, but also for industrial development reasons, where lack of appropriate facilities may hamper development". The Plan also notes that the recent economic development has placed a considerable strain on the existing waste management infrastructure

The growth in our economy in recent years has resulted in significant growth in the quantity of waste arising. This has not been matched by a corresponding development in waste infrastructure due to the low starting base and the long lead –in times for such development. Estimates suggest that there is 1 million tonnes of waste arising in the country each year in excess of the current landfill capacity. This excess is expected to continue until 2010, when the situation will further deteriorate. This excess takes into account planned recycling rates and the introduction of waste to energy plant. Such an excess of waste over management capacity poses significant challenges for groundwater as well as for economic development over the next few years.

Significant advances in the protection of groundwater have occurred since the waste licensing regime was introduced. The granting of waste licences is required to take a number of factors into account, such as the risk of environmental pollution.

1. INTRODUCTION

Waste, by its nature, if not properly handled and managed may result in the release of emissions which may cause the contamination or pollution of groundwaters. Historically, there was insufficient care and attention given to the management of waste and insufficient investment in the provision of appropriate waste facilities. This arose because waste is so defined due to it being discarded by the holder and it is discarded because it has, or is perceived to have, no value to the holder. Today, the management of waste is controlled by European and National legislation and much of this legislation is concerned with the prevention of contamination and pollution, including the contamination and pollution of groundwaters.

In Ireland today, the groundwater challenges associated with waste management arise from a number of issues. The principal issues are as follows:

- The continued rise in the quantities and types of wastes being produced;
- The acute shortage of existing, properly located and engineered waste facilities;
- The existence of unauthorised waste facilities;
- The location of existing, historical waste facilities;
- The development of new waste infrastructure

The National Development Plan, (NDP), is often considered to be concerned only with development, the building of roads and other transport infrastructure in particular. However, the Plan is primarily concerned with Ireland's continued economic and social development and the infrastructure included in the Plan is a means to achieving these targets. The NDP identifies that appropriate and sufficient waste management infrastructure is one of the necessary requirements for such economic and social development.

There is a national waste crisis in Ireland today due to the lack of appropriate waste facilities and the continuing increase in the quantities and types of wastes being generated. The economic boom of the Celtic Tiger has contributed significantly to the quantities of waste being produced in the country but the lead in time for the development of waste infrastructure and the fact that we were starting from a very low base, has meant that we have failed to keep up with the provision of sufficient capacity to deal with the wastes we generate.

The development of waste infrastructure in Ireland today is subject to both authorisation requirements, such as planning permission and waste licences or waste permits, and policy requirements. Waste infrastructure proposed for development must also comply with national waste policy objectives in addition to complying with the requirements of the statutory Waste Management Plans.

Historically, where groundwater protection from waste infrastructure was achieved, it was through the planning legislation, either by the refusal of applications for development or by the conditions attached to planning permissions which were issued. When waste legislation was introduced in 1996 via the Waste Management Act, responsibility for the environmental impacts of waste infrastructure which required waste licences, switched to the EPA and the planning authorities were debarred by the legislation from the consideration of such issues. However, subsequent amendments to the legislation, allows for more consultation between the planning authorities and the EPA and allows for the refusal of planning applications on environmental grounds, even where a waste licence is also required.

Groundwater protection is an integral part of waste licensing and permitting, and is relevant in the siting of most waste facilities. Increasingly, the development of waste facilities, such as transfer stations, on brownfield sites includes a requirement for the remediation of those sites prior to development. This requirement may be part of the planning permission or the waste licence and in many cases is included in both. Increasingly, also, local authorities are requiring that landspreading activities require authorisations by way of waste permits and the nutrient management plans associated with these waste activities must have due regard to groundwater issues.

Groundwater protection is of particular importance in the siting of landfill sites and in the consideration by the EPA of the relevant waste licence application. The joint development of Groundwater Protection Schemes by the Geological Survey of Ireland, the EPA and the Department of the Environment, Heritage and Local Government was of particular significance in this area.

In addition to groundwater challenges in waste management, there are, also, of course, significant surface water challenges too. However, for the purpose of this paper, as indicated by the title, I have concentrated on groundwater issues.

2. NATIONAL DEVELOPMENT PLAN

The National Development Plan is concerned with the economic and social development of Ireland. The Plan identifies infrastructure deficiencies which exist and which may delay or prevent such development.

In relation to waste management, the NDP states as one of its intended objectives, to achieve, "better management of solid waste". The Plan notes that "Appropriate waste management infrastructure is vital not only for environmental protection reasons, but also for industrial development reasons, where lack of appropriate facilities may hamper development". The Plan also notes that the recent economic development has placed a considerable strain on the existing waste management infrastructure.

In relation to the waste infrastructure required, the NDP refers to the waste policy statement "Changing Our Ways (1998)" which calls for an increase in recycling, a dramatic reduction in our reliance on landfill, and the introduction of an integrated waste management approach which utilises a range of waste treatment options.

In particular, the NDP refers to the need for adequate national waste infrastructure to facilitate the achievement of the following targets by the year 2013:

- A diversion of 50% of overall household waste from landfill;
- A minimum 65% reduction in biodegradable wastes consigned to landfill;
- The development of waste recovery facilities employing environmentally beneficial technologies as an alternative to landfill, including the development of composting and other feasible biological treatment facilities capable of treating up to 300,000 tonnes of biodegradable waste per annum;
- Recycling of 35% of municipal waste; and
- Rationalisation of municipal waste landfills, leading to an integrated network of some 20 state-of-the-art facilities.

The NDP also refers to the Waste Management Plans developed by the local authorise and envisaged that an investment of some €825 million would be required to achieve the necessary infrastructure. The NDP considered that Public Private Partnership would be used to fund most of the required infrastructure.

3. WASTE QUANTITIES ARISING IN IRELAND

3.1 NON-AGRICULTURAL WASTES

The National Waste Database Report 2001 published by the EPA, states that an estimated 17,384,194 tonnes of waste, other than agricultural waste, was generated in Ireland in 2001. This represented a 12.6% increase in the quantity of waste generated in the three years since 1998. A report by Peter Bacon and Associates in 2002 indicated a landfill capacity shortfall of over 1 million tonnes of waste in 2003. The report calculates that this short-fall will continue each year until 2010, i.e. there will be a landfill shortfall of c. 1 million tonnes per annum every year in Ireland until the year 2010. This 1 million tonnes per annum shortfall assumes the full achievement of the recycling targets set out in the local authority Waste Management Plans – targets which are generally

considered to be overly optimistic – the full achievement of the thermal treatment capacity laid out in those plans and the development of additional landfill capacity.

The report also estimates that after 2010 the situation will continue to deteriorate with an ongoing increase in the landfill shortfall, potentially as high as 1.4 million tonnes by 2014. Local authorities have a legal obligation to provide for the disposal of household waste but do not have any similar obligations for other waste types, such as Commercial and Industrial wastes. In this projected scenario where there is such a serious landfill shortage and given this legal obligation on the behalf of the local authorities, it is likely that there will be little or no acceptance of wastes, other than household wastes, at local authority landfills in the near future.

This shortfall in capacity of waste infrastructure poses a serious problem for the economic development of this country. In addition, it poses a potential serious challenge to groundwater as, historically, the shortage of waste infrastructure capacity has resulted in the development of unauthorised landfills both north and south of the border. In addition, this waste crisis increases the pressure to extend the life, the foot-print, or the annual quantities of waste deposited in existing landfills, some of which are less than ideally suited in terms of groundwater protection.

Attempts in Ireland and other countries to decouple growth in waste arising from economic development have, to date, failed. The rate of growth in Commercial and Industrial waste is determined by the rate of economic growth. Peter Bacon and associates estimate that the growth in C&I waste will be in line with real GDP over the period. The growth in household waste is controlled by growth in population, numbers of homes, and income growth – all areas which have seen significant growth in Ireland over recent years and which are expected to continue growing over the next few years.

These figures quoted above do not include Construction and Demolition (C&D) waste. It is estimated that some 4.5 million tonnes of C&D waste will be produced annually by 2012. The quantities of C&D waste arising also continue to grow and the management of these wastes are also impacted by the limitations in waste infrastructure capacity.

3.2 AGRICULTURAL WASTES

In addition, some 56,687, 440 tonnes of agricultural wastes were also generated. The agricultural wastes account for some 76% of the total wastes generated in Ireland. However, most attention is given to the other 24% of wastes, which include Household waste, Commercial waste, Industrial waste, etc. This is not without justification as much of the agricultural wastes are dealt with on the lands where they are produced. Moreover, the non-agricultural wastes are much more diverse in type and therefore, in many cases, more difficult to handle.

Nonetheless, the quantity and the mainly organic nature of the agricultural wastes pose a considerable threat to the quality of our groundwaters. The National Waste Database notes that much of this agricultural waste is managed by landspreading and that, in general, it is assumed that this landspreading is carried out with a consequential benefit of improving soil conditions for crop growth and, hence, constitutes a waste recovery activity. The Database report points out that if waste is landspread in quantities exceeding agronomic requirements, then the waste is being disposed of, rather than being recovered. In order to determine the correct agronomic requirements for the soil, a Nutrient Management Plan should be carried out prior to landspreading and the landspreading should be carried out in appropriate weather conditions.

The Waste Management Act 1996 exempts the recovery of agricultural waste, such as blood of animal or poultry origin and faecal matter from animals or poultry from the requirements of waste licensing or permitting. However, several local authorities have introduced byelaws in an attempt to provide control of landspreading activities and adequate protection of groundwaters and surface waters.

4. WASTE LICENSING AND THE DEVELOPMENT OF NEW WASTE INFRASTRUCTURE

The Waste Management Act 1996, (the Act), and the waste licensing system sets out to prevent the pollution of groundwater or other environmental media by waste activities and facilities. All significant waste facilities require a waste licence from the EPA. The criteria under which the EPA may grant a waste licence are established under the Act. Section 40 (4) of the Act states that the EPA shall not grant a waste licence unless it is satisfied of the following:

- Any emissions from the waste activity will not result in the contravention of any relevant standard, including any standard for an environmental medium, or any relevant emission limit value, prescribed under any other enactment;
- The waste activity concerned, carried on in accordance with such conditions as may be attached to the waste licence, will not cause environmental pollution;
- BATNEEC, Best Available Technology Not Entailing Excessive Cost, will be used to prevent, eliminate or, where that is not practicable, to limit, abate or reduce an emission from the waste activity concerned;
- Other than in the case of a local authority, the applicant is a fit and proper person.

In relation to groundwater, the following are relevant;

1. emission standards are set for discharge of substances, such as List I substances to groundwater;
2. direct discharges to groundwater are prohibited;
3. discharges are prohibited from causing environmental pollution. Environmental pollution is defined in the Act as follows, "the holding, transport, recovery or disposal of waste in a manner which would, to a significant extent, endanger human health or harm the environment, and in particular –
   (a) create a risk to waters, the atmosphere, land, soil, plants or animals,….". There is much in this definition which must be considered, such as the meaning of the word "significant" and the assessment of whether or not environmental pollution is likely to be caused is not a simple matter;
4. The design of the facility, for example the lining of a landfill, is controlled by the principle of BATNEEC, or BAT as is now established;
5. The principle of a "fit and proper person" relates to the technical competent of the management as well as to the financial well-being of the applicant.

Section 40 (2) of the Act also specifies the information and documents which must be considered by the EPA in their assessment of a waste licence application. These include the following:

1. any relevant air quality management plan;
2. any environmental impact statement in respect of the proposed development, (which usually contains siting criteria, including an assessment of the local groundwater conditions);
3. any submissions or observations made to the EPA;
4. were appropriate, views of other Member States;
5. such other matters related to the prevention, limitation, elimination abatement or reduction of environmental pollution from the activity concerned as it considers necessary.

The Section also states that the EPA may carry our or cause to be carried out such investigations as it deems necessary for the purposes of the consideration of a waste licence application. This is a particularly relevant section in relation to groundwater, as the EPA has often required additional groundwater investigations to be carried out to assist in their consideration of a waste licence application.

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CONTAMINATED LAND AND RISK ASSSESSMENT: THE BASICS
Necessary Steps Prior to Remediation and Development

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ABSTRACT

Co-incident with the onset of the 2000 – 2006 NDP, the skills and complexities required to communicate risk associated with contaminated land to the satisfaction of the competent authorities have risen considerably. Greater pressures for the redevelopment of derelict and contaminated land are occurring in the major cities in Ireland such as Dublin, Cork, and Limerick. Larger towns such as Kilkenny or Youghal require the remediation of former town gas facilities to make way for new commercial developments. The application of the risk assessment philosophy to contaminated land cleanup in Ireland has increased due to the EPA's involvement in contaminated land/risk assessment networks, such as CARACAS and CLARINET, as well as an overall increasing awareness of risk assessment at an EU level. In the UK there has been Government policy to promote redevelopment of brownfield sites, which has been comprehensively supported by a large suite of documentation and guidance issued internationally (UK EA, US EPA, etc.). This paper summarises the most useful UK EA documents regarding risk assessment procedures and arising remedial strategy. In particular this paper urges that contaminated land specialists in Ireland should implement the Investigation of Contaminated Sites - Code of Practice (BS 10175:2001). Furthermore, it is considered best practice that all contaminated land remedial strategy reports detail a conceptual site model (CSM). The main purpose of this paper is to assist environmental consultants, engineers, hydrogeologists, and contaminated land specialists, in reporting remedial strategy and hence achieve faster regulatory decisions at the EPA and Local Authorities, for the remainder of the NDP period, and beyond 2006.

1. INTRODUCTION

The number of brownfield[1] sites or facilities with contaminated land problems are significantly less in Ireland than those of most other European countries, due to Ireland's relative late arrival into the industrial age. The extent of contaminated land sites in Ireland is modest, in the region of 2000 sites (Brogan *et al,* 1999), occurring in the petroleum retail sector, at various industrial sites, at closed landfill sites, timber treatment yards, scrap yards, railway yards and former gasworks sites.
Small-scale developer-driven remediation projects became common during the *Celtic Tiger* economy of the mid 1990s, where the cleanup of contaminated sites, typically petrol stations and miscellaneous industrial/storage yards were undertaken as part of environmental due-diligence requirements.

[1] Brownfields are sites that:
- have been affected by the former uses of the site and surrounding land
- are derelict or underused
- have real or perceived contamination problems
- are mainly in developed urban areas

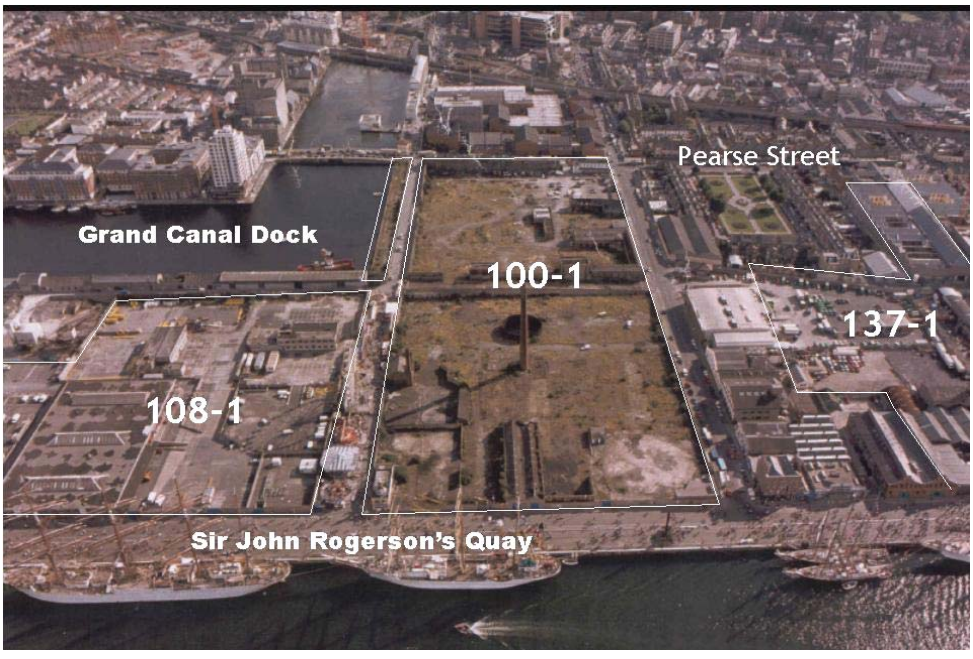
and require intervention to bring them back to beneficial use.
From: Brownfields and Redevelopment of Urban Areas. 2002. Report prepared by Working Group "Brownfield Redevelopment" of the Concerted Action "Contaminated Land Rehabilitation Network for Environmental Technologies" (CLARINET), funded by the European Commission, DG Research.

The EPA has seen an increase in the number of queries arising from environmental consultants, engineers, and Local Authorities regarding contaminated land remediation over recent years, and has written many decision letters notifying proposed remediation projects of waste licence or permit requirements, if any. Too often the EPA receives reports based on Dutch Intervention/Target Values and UK ICRCL (which were withdrawn in 2000 and replaced by CLEA) with no conceptual model of pathway or receptors, and often with no clarity or logic to the proposed remedial strategy. Frequently reports strive to achieve the end result of a clean soil rather than factor in the end use, causing the unnecessary removal of large amounts of soil as a waste. Reports achieving such target values implies that the remediation goal is the recovery of the soil's or groundwater's functional properties to support human, plant and animal life (Nathanial & Bardos 2002), rather than the more practical and sustainable goal of cleanup for an intended use/end user.

The purpose of this paper is to aid interested parties in reporting remedial strategy and hence achieve faster regulatory decisions at the EPA and Local Authorities. Much of the following is based on EPA experience of agreeing remediation strategies at over 30 (IPC) facilities where there is significant contamination and from the processing and assessment of seven brownfield *waste* licence applications into their resultant decisions (Waste Licences 80-1, 100-1, 108-1, 137-1, 164-1, 181-1, and proposed decision 190-1[2]). Each waste facility and six of the IPC facilities have a remediation strategy based on a quantified, site specific risk assessment. Furthermore, the IPC sites are using MNA[3] technology. Figure 1 shows some of the Dublin facilities.

Details on the legal aspects of contaminated land cleanup in Ireland including EPA and Local Authority positions can be found in Doak, Carty, & Lynott (2003).

Figure 1: Aerial view of Sir John Rogerson's Quay Dublin 2, facing south. Outlines show three individual brownfield sites (with their waste licence register numbers) which are/were remediated during 2000 – 2003. 100-1 had up to 15 gasometers, only the original chimney remains, preserved for heritage purposes. 100-1 and 108-1 were successfully remediated – both waste licences were surrendered by EPA decisions in 2002 and 2003, respectively. 137-1 started remediation in summer



[2] These licences and proposed decision are available to view on the EPA website (www.epa.ie) and their inspector reports are available via the author's email address. (Four facilities in Dublin, two unauthorised landfills in Co.Wicklow, and a gasworks in Waterford).

[3] MNA: Monitored Natural Attenuation.

2. RISK ASSESSMENT AND CONTAMINATED LAND

The Licensing Unit of the EPA has reviewed the UK EA approach to risk assessment and contaminated land, and supports its application in Ireland. The UK EA and National House Building Council (EA & NHBC 2000) note that the safe development of contaminated land for housing can be achieved consistently by applying appropriate risk management techniques[4]. In order for land to be affected by contamination there must be a source of contamination (*ie* toxic substance in the ground), a receptor that can be harmed (*ie* a person's health or a controlled water) and a pathway that the receptor can be exposed to the contamination (*ie* direct skin exposure/drinking of contaminated water). The source-pathway-receptor concept is central to the UK statutory definition of contaminated land[5]. In Ireland the source-pathway-receptor concept has been championed by the Geological Survey of Ireland over the last 10 years (and in particular by Donal Daly, Head of Groundwater Section), where it has been used as a basis for the implementation of the many county scale GSI Groundwater Protection Schemes.

The UK EA consider that where the risk to a receptor is considered to be unacceptably high, the risk needs to be reduced, which normally means that remedial treatment will be required. However, the presence of a contaminant does not necessarily mean that there is a risk of harm to a receptor. The pollutant linkage must be established before the existence of an unacceptable risk can be confirmed. These concepts are more often referred to as the 'suitable for use' principle. The Irish EPA has licensed the five gasworks brownfield projects on a similar *suitable for use* basis, where remediation is achieved by removing or treating the contamination, and/or blocking the groundwater pathway (by cement-bentonite cut-off wall), and protecting the receptor (human health and nearby surface water bodies).

3. RISK ASSESSMENT AT EU LEVEL & ITS COMMUNICATION

A recent European Environment Agency (EEA) report (EEA 2001) on the precautionary principle[6] states that the regulation of scientific uncertainty or unpredicted effects can be managed by risk assessment, where risk is a function of probability theory. They determine that risk assessment is a valid technique to prevent damage to the environment and provides a robust basis for decision-making. However the report concludes that risk assessment may be too narrow in scope to determine general uncertainty (which instead can be accounted for by using safety factors or sensitivity analysis), and cannot account for the possibility of the unknown (ignorance). Moreover, the EEA finds that there is a deep dislocation between regulatory agencies and the public about scientific uncertainty and ignorance. Public surveys in relation to GMOs on both sides of the Atlantic indicate that scientific risk assessment focuses on uncertainties while public concerns centre on ignorance. The EEA considers that the concepts of risk, uncertainty, and ignorance need to be better communicated to the public to regain their confidence in adopting risk assessment and arising remedial strategies:

> *'It is for these reasons that the involvement of stakeholders in regulatory appraisal needs to begin at the beginning rather than being artificially confined to the later remediation phases. The stages of hazard*

[4] In 1998, the UK Government set a target of 60% of new homes in the UK to be built on previously developed land (brownfield sites), a significant proportion of which is contaminated and would require remedial treatment.

[5] Contaminated Land, is land that appears to the local authority in whose area it is situated to be in such a condition, by reason of substance in, on or under the land, that significant harm is being caused or there is significant possibility of such harm being caused; or pollution of controlled waters is being, or is likely to be caused. *UK Part IIA Environmental Protection Act 1990* (inserted by Environment Act 1995).

[6] **Precautionary Principle**. From *Communication on the precautionary principle*, EU COM(2000)1 (February 2000). The precautionary principle is not defined in the Treaty, which prescribes it only once - to protect the environment. The precautionary principle should be considered within a structured approach to the analysis of risk, which comprises three elements: risk assessment, risk management, risk communication. The precautionary principle is particularly relevant to the management of risk.

and risk appraisal, management, and communication are not sequential, as in the traditional model, but require stakeholder involvement at the earliest stage.' p 186 (EEA 2001).

The UK Interdepartmental Liaison Group on Risk Assessment has produced an excellent guide to Risk Communication (ILGRA, 1998) including a 'five minute guide for speaking about risk issues – for the harassed manager'. Many companies and consultancies will experience problems with contaminated land and communication with stakeholders. Some common communication problems and suggested solutions are described in eight steps for the UK sector (Wylie *et al*, 2001), and as 'do's and don'ts of written contaminated land communication' in Wehrmeyer (2001).

4. A PROCEDURE FOR RISK ASSESSMENT

The EA & NHBC (2000) report best describes a logical procedure for the risk assessment of contaminated land. The report divides risk assessment into four stages to be carried out before any remedial works begin:

Hazard Identification > Hazard Assessment > Risk Estimation > Risk Evaluation

the details of which appear in Table 1 below, and Diagram 1 overleaf:

TABLE 1: Details of Stage Requirements for Risk Assessment (after EA & NHBC 2000)

Hazard Identification Stage 1a	Hazard Assessment Stage 1b	Risk Estimation Stage 2a	Risk Evaluation Stage 2b
Walkover/Deskstudy Identify Contaminants of Concern	Develop **Conceptual Site Model** (CSM)	Design & Implement Site Investigations Qualitative/Quantitative Risk Assessment Determine risks to human health, surface & groundwater using models such as CLEA, SNIFFER, R&D 20 etc	Evaluate the Critical Receptor and the Risk Management Objectives (human health? prevent pollution of groundwater/ prevent gas migration to buildings? etc) Decide Risk Management Techniques (remedial works)

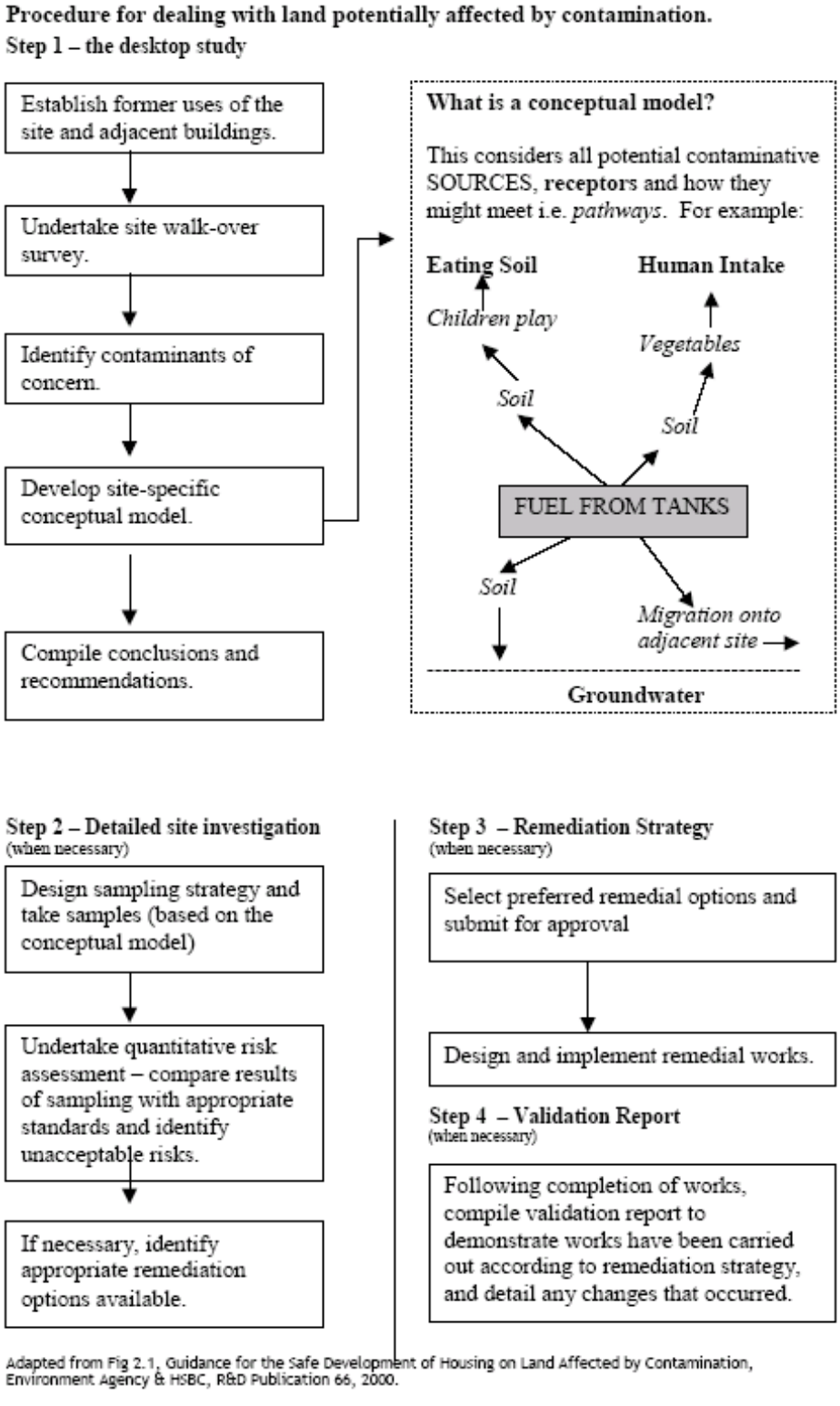
To support the above risk assessment approach, the EA and UK Dept for Environment, Food and Rural Affairs (DEFRA 2002) developed new CLEA (Contaminated Land Exposure Assessment Model) guideline values for a number of parameters in order to determine risks to human health. The CLEA values can be accessed via the UK EA website[7] where there are free model downloads and factsheets. In addition to the assessment of risks to human health the risk assessment procedure should work on other potential receptors identified in the Phase 1 walkover and arising *Conceptual Site Model* such as groundwater, rivers, or an SPA. Again the EA has published tools to aid assessment of risks to waters, namely R&D Publication 20 (EA 1999)[8], and has published consultation documents on ecological risk assessment (EA 2003a). Furthermore the EA has published two other useful documents on hydrogeological risk assessment for landfills (EA 2003b) and the assessment of health risks from petroleum hydrocarbons in contaminated soil (EA 2003c).

[7] www.environment-agency.gov.uk

[8] The European Commission in October 2000 issued a 20-page document on Environmental Risk Assessment for contaminated land (EU Commission, 2000), which is loosely based on the UK EA R&D Publication 20.

The details and guidance to carrying out the field/site aspects for the first three stages (1a, 1b, & 2a) of a risk assessment as outlined in Table 1 are prescribed in British Standard 10175:2001[9]; an important slimline guidance document.

Diagram 1: Procedure for Dealing with Contaminated Land (extract of London Borough Publication UK (page 2): *Contaminated Land. A Guide to Help Developers Meet Planning Requirements*).



Boxes 1 and 2, below, are useful risk definitions and concepts defined in BS 10175. Particular note should be made of the definition of a conceptual model.

BOX 1

RISK ASSESSMENT

Risk:

Probability of the occurrence of, and magnitude of the consequences of, and unwanted adverse effect on a receptor

Risk Assessment:

Process of establishing, to the extent possible, the existence, nature and significance of risk

from BS10175:2001

BOX 2

KEY CONCEPTS to RISK ASSESSMENT

Conceptual Model:

Text/schematic hypothesis of the nature and sources of contamination, potential migration pathways (including description of the ground and groundwater) and potential receptors, developed on the basis of information from the phase 1 investigation and refined during subsequent phases of investigation

Source – Pathway – Receptor

from BS10175:2001

The Irish EPA has proposed a methodology and flowchart for assessing groundwater quality and suggests *interim guideline values* to gauge any remedial action (EPA 2003). Where *interim guideline values* in groundwater are exceeded further assessment will be required by risk assessment.

Recent EPA brownfield licences for the remediation of illegal landfills (*eg.* 80-1) require that a conceptual site model be submitted to the EPA to identify potential contaminants, pathways and receptors, prior to the development of any risk assessment. The risk assessment is required (by a grid system) to scope the necessary remediation strategy and the site specific clean-up target levels. Furthermore, all of the above EA/NHBC procedures and BS 10175 guidance have been implemented by applicants in applying for a gasworks remediation licence at the behest of the Agency. Local Authorities may also require a risk assessment to be carried out at the smaller contaminated land projects they authorise. Figure 2 below, represents the type of schematic conceptual model that the EPA requires.

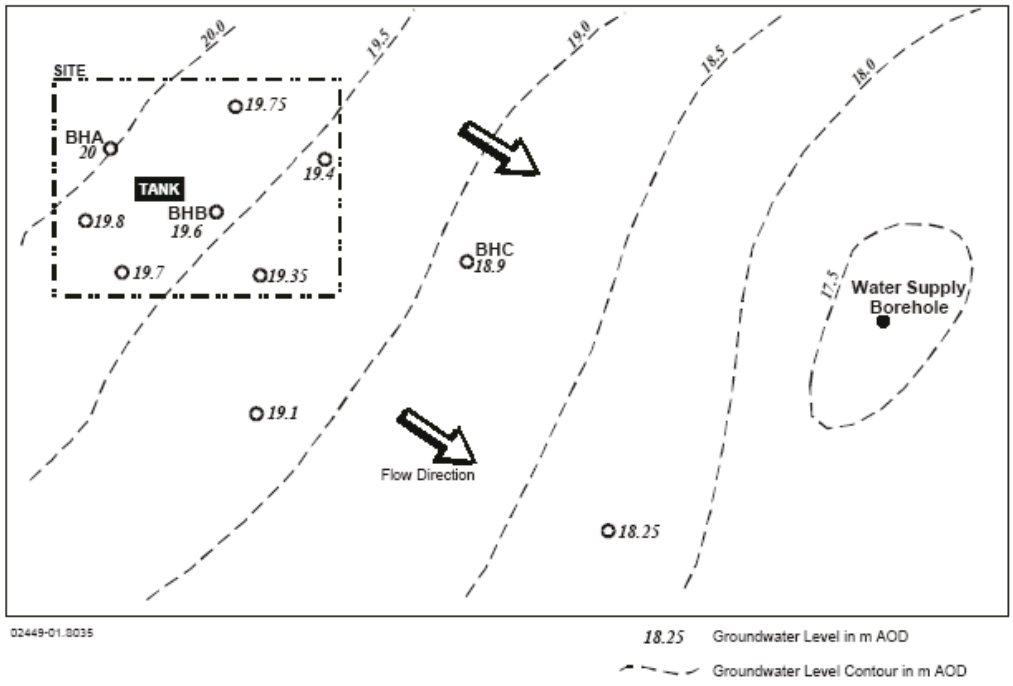
Overall the EPA has applied all aspects of the EU precautionary principle - risk assessment, risk management, risk communication - into the contaminated land remediation projects it has licensed.

5. THE CONCEPTUAL SITE MODEL AND PRACTICALITIES

The Licensing Unit of the EPA recommends the full implementation of BS 10175:2001 *Investigation of Contaminated Sites - Code of Practice*, and the risk assessment procedures described in Section 4, above. The EPA's main objective is to see that all contaminated land remedial strategy reports detail a conceptual site model (CSM), a proposed remediation design, and a monitoring programme. Detailed guidance on the development of a conceptual model for groundwater - source pathway receptor - is available at (EA 2001).

In practice, the CSM can be used as a simple medium to explain all stages of the risk assessment. The benefits are obvious. A CSM will bring clarity and logic to all discussions between either the client/developer/consultant/regulatory authority. The CSM can be updated throughout the remedial project, and is presented at the end of the project at validation/licence surrender/project completion. Figure 3 is a copy of the CSM submitted for the surrender of Waste Licence 108-1.

Figure 2: Example Conceptual Model for Groundwater from EA 2001. Plan view of groundwater contours, and cross-section view showing source-pathway-receptor.



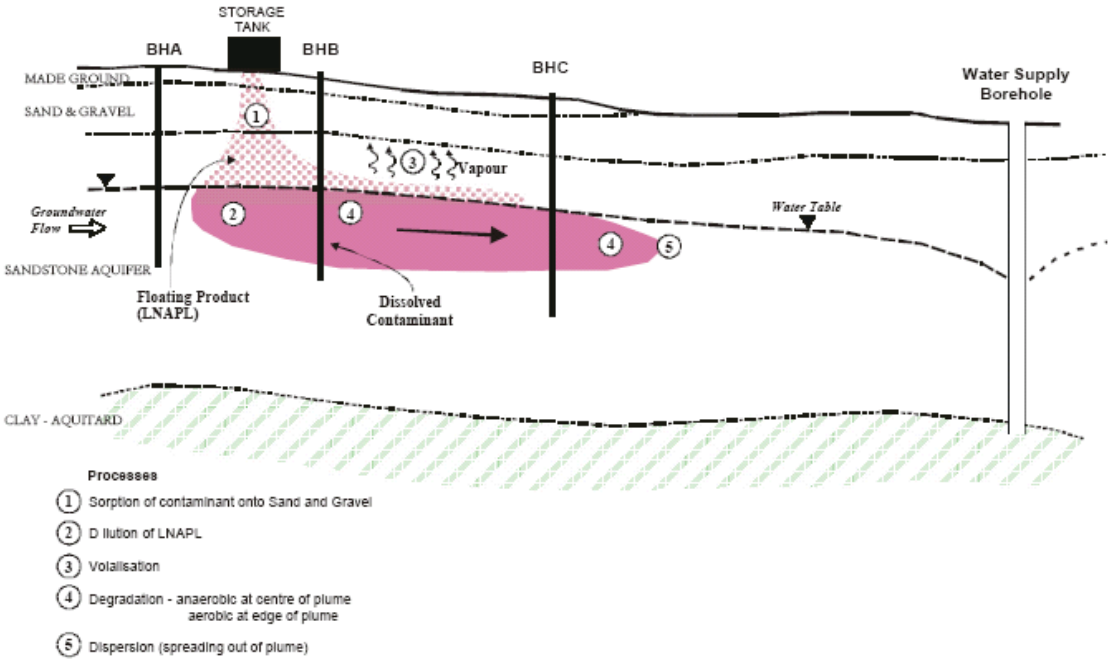
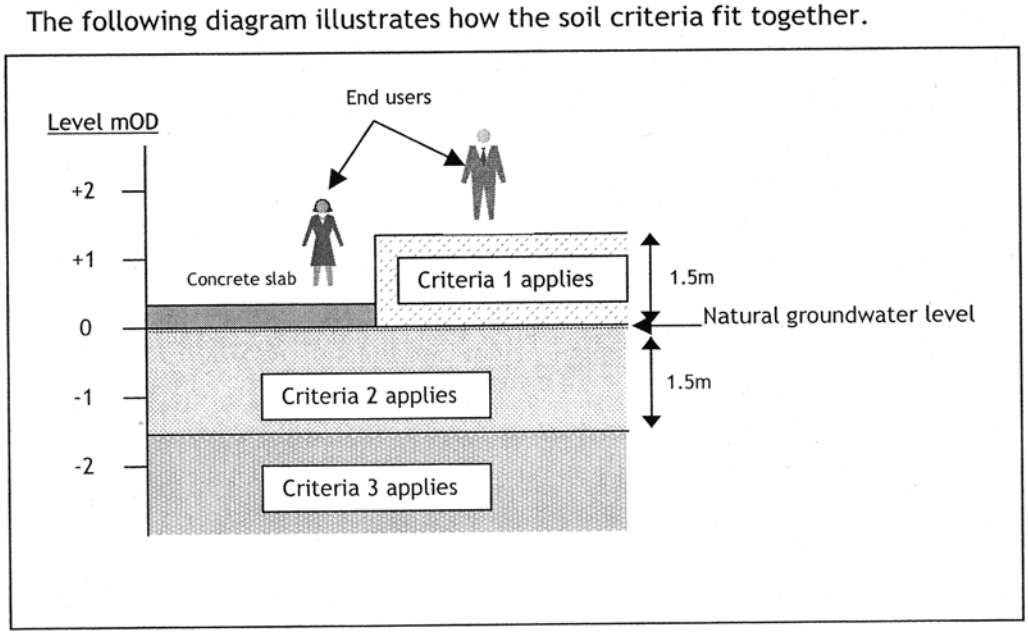


Figure 3: Conceptual Model for the 108-1 DDDA facility in a finished state with three types of soil. Main receptor is human health. The diagram refers to soil criteria (extract of Validation/Surrender report 13 Dec 2002):

- Criteria 1- Imported clean soils or soils from site that meet criteria 1 site action values. Suitable for use as top/subsoil.
- Criteria 2- Soils emplaced below a concrete slab to c. 1.5m depth. Soils are 'cleaned soils' to a value discerned in the human health and/or groundwater risk assessment.
- Criteria 3- Any soils deeper than 1.5m. These soils are not considered to pose a risk to human health. However any leachable substances that may re-contaminate groundwater (when site is flooded) are removed.



6. CONCLUDING REMARKS

The EPA supports the remediation of brownfields particularly in central urban areas to support sustainable economic development, reduce the generation of contaminated soils waste, and help safeguard and improve the quality of life of city citizens.

A key tool for the assessment of cleanup is the development of a *conceptual site model* and a *quantitative risk assessment,* using clear risk based decisions and logic built on the intended future use of the effected and adjacent land. The excavated soils can be treated on-site by permit or licence (if hazardous); or exported from site to authorised facilities in Ireland or Europe. Brownfield remediated sites in Ireland have significant development potential and when remediated, are catalysts for urban regeneration.

ACKNOWLEDGEMENTS

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BROWNFIELDS AND URBAN SUSTAINABILITY: WHERE WE ARE AND WHERE WE NEED TO GO

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ABSTRACT

This paper examines the link between brownfield redevelopment and urban sustainability, highlighting the gap between the rhetoric of brownfield regeneration and the reality of what is happening in practice in Ireland. This disparity is attributed to a number of key issues, namely a knowledge deficit, weak policy and the contentious issue of liability. The experience of other countries is drawn upon to identify possible future directions for remediation and regeneration policy and practice in Ireland.

1.0 INTRODUCTION

'For cities which are fixed in place, the ability to restore and recycle brownfield sites is vital to their economic, environmental and social health' (Bjelland, 2000:1).

Perhaps the greatest barrier to the widespread embedding of the concept of sustainability within public policy is human nature. Rather than considering it an additional burden imposing limitations and regulations on society, a move towards a normative approach emphasising pro-active policy debate and prioritising implementation is necessary. This demands a decommissioning of mindsets and restructuring of knowledge that is far more complex than simply introducing new legislation. It requires a here-to-fore unprecedented holistic approach to land management and development, an integration of all environmental policy areas including those impacting on human health through soil, air, water or groundwater pollution and the courage to embrace a range of actors and techniques within the urban environment. Brownfield areas provide all of these challenges but perhaps because of this, have been sidelined and dealt with in a piecemeal fashion, only when absolutely necessary. The realisation that brownfields emerge because of economic structural change is the first step towards developing an integrated approach to problem-solving, given that this automatically demands not just environmental, but also social and community solutions to be considered. But orchestrating the competing goals of economic growth, ecological integrity and social vitality at national and providing the tools to implement them at local level are probably the biggest difficulty.

In an Irish context, Williams & Shiels (2002) have identified the three greatest challenges to the viability of contemporary towns and cities as housing, transportation and waste disposal management. Although all local authorities have been encouraged to produce a Local Agenda 21 strategy most have failed to do so, due to lack of resources, know-how and the will to engage. I believe that the key problem is one of perception: there is a lack of awareness and a conceptual gap yet to be surmounted between the well-meaning principles of sustainability and the mechanisms to put them into practice.

Recognising and attempting to redress this problem, Satterthwaite (1997) has identified five areas of action for municipal authorities in the United Kingdom that could be used as potential indicators of progress towards sustainability in Ireland. These include controlling disease, reducing chemical and physical hazards, improving the quality of the urban environment; internalising and minimising the costs of development and adopting new and more sustainable consumption patterns. In an earlier effort

[1] This paper is a work in progress. It will be published in its final form in Moore, N. & Scott, M. (eds) *Renewing urban communities: Environment, citizenship and sustainability in Ireland*, Aldershot: Ashgate, forthcoming

to promote development in this manner, the European Sustainable Cities Project (1996) argued that as well as accepting that land is a finite resource, policy should be supply- rather than demand-driven, and land recycling encouraged. Recognising that the problems of urban sustainability are most acute in 'areas where residential densities are low and where day-to-day activities (home, work, shopping) are widely separated' (European Union, 2001: 2), the Union has favoured the adoption of local responses to urban issues within the Fifth Environmental Action Programme. In the Treaty of Amsterdam (1997) sustainable development, assigning equal importance to economic and environmental issues, was explicitly identified as a key strategy for the European Union. To ensure that policy translates into action, a set of Guiding principles for Sustainable Spatial Development of the European Continent have been published. The major recommendations within this report are to control the expansion of urban areas through activating gap sites and increasing the supply of land within cities. This can be achieved primarily by recycling previously-used land, revitalising deprived neighbourhoods, and engaging in environmental regeneration of former industrial sites, in other words brownfield regeneration. These districts provide an opportunity to implement many of the objectives identified at the Earth Summit, the City Summit and since, including the adoption of good urban management practices; a reduction in chemical and physical hazards to the urban population whether through soil, air, water or groundwater contamination; the integration of sustainable transport and other infrastructure policies; and the development of sustainable construction industry practices. Although recommendations have been made in many countries to adopt a sequential approach to planning by favouring development on brownfield rather than greenfield sites, the difficulties inherent in doing this in different cultural contexts have been acknowledged. Across the European Union, the result has been vagueness in policy and an inability on the part of all major players to agree a common set of measures. Some countries, such as the United Kingdom, have been to the fore in promoting this activity from which many lessons can be learnt while others, such as Ireland, are lagging far behind.

2.0 IRELAND IN INTERNATIONAL PERSPECTIVE

Perhaps one of the reasons why Ireland has taken longer to realise both the problem and potential of brownfields is historical. Unlike many other European countries which had their social and economic fabric entirely re-written by the Industrial Revolution, Ireland was affected to a much lesser extent. A common perception appears to abound that this country has made a direct transition from an agriculturally-based to post-industrial economy, and therefore brownfields as relics of the industrial period are not very extensive. It is true that in comparison to Germany, which has approximately 128,000 hectares of brownfield land or the Netherlands, which has in the region of 9,000-11,000 hectares, the extent of the problem in Ireland is small. Brogan et al. (1999) have compiled a best-guess figure of 1,900-2,400 brownfields in Ireland. However the size of these has not been determined, one aspect of the knowledge deficit that currently exists.

In the United States, a range of policy initiatives has been taken to deal with the restoration of previously-developed land including the introduction of the Superfund. This federal scheme provides the financial and legislative support to engage in regeneration, through financial incentives and subsidies, the provision of liability protection mechanisms and the guarantee of reasonable clean-up standards. However at present, the best lessons for us can perhaps be learnt from the UK, which has a similar legislative system to Ireland and appear to be successfully introducing a range of policies to deal with brownfield areas. Since 1997, responsibility for environmental and very specifically brownfield policy has been vested in the Office of the Deputy Prime Minister. In the original renewal programmes in Britain, an emphasis on new industry for previously-developed land was highly apparent but given the changing nature of the world economy this provided limited opportunities for innovation. In recent years, government policy has encouraged re-development for mixed-use activities, with an emphasis on reaching a target of constructing 60% of all new housing on brownfield land by 2008. Already this has been exceeded:

- In 2000, 61 per cent of new developments were on brownfield land.

- In 2001, the figure was 63 per cent.
- Sixty four per cent of all new housing developments, including conversions, were built on brownfields in 2002 (Office of the Deputy Prime Minister).

Given the difficulties in identifying brownfields and the negative perception held by many stakeholders of these areas, what mechanisms have the UK government put in place to achieve this target so rapidly?

The National Land Use Database
This is a partnership project between the Office of the Deputy Prime Minister, English Partnerships, the Improvement and Development Agency (representing the interests of local government) and Ordnance Survey. There are two strands to the NLUD project, the first of which collects data on vacant and derelict sites and other previously developed land and buildings that may be available for redevelopment. The second element is the production of an up-to-date large-scale land use map that may be used in future years as a baseline study map.

However, in recognition of the fact that all previously-developed land may not be suitable for redevelopment, given its small size or some other attribute, a second institution / mechanism has been established.

The Land Restoration Trust
A partnership of four national organisations in England – Groundwork, English Partnerships, the Forestry Commission and the Environment Agency – is developing the Land Restoration Trust. The overall aim is to improve the quality of the environment through the acquisition of derelict land that is not suitable for redevelopment. The Trust will work with local organisations to create new 'green amenities' providing benefits both for society and the natural and built environment. As such, this bottom-up approach to brownfield regeneration complements the top-down National Land Use Database and fosters confidence in the potential of former industrial sites.

Other policy measures emanating from and encouraged by the ODPM have been the introduction of fiscal incentives in Budget 2001; reform of urban renewal legislation; guidance for local authorities and developers on unlocking the potential of empty properties and the introduction of pathfinder projects to help local authorities tackle low demand and abandoned homes where the problems are most acute.

3.0 THE IRISH POLICY CONTEXT

Unlike in the United Kingdom where a distinct urban policy has been evident since the late 1960s and a brownfield policy evident from the 1990s, it is only in recent years in response to rapid and unprecedented urbanisation that urban management has become a critical issue in Ireland. In 1997, in response to commitments made at the Rio Conference five years earlier, the government published *Sustainable development: A strategy for Ireland,* without a chapter on sustainable urban development. The only reference made to this issue is in a general chapter on the built environment and architectural heritage. The promotion of sustainable urban development is aspired to in generic terms, with a focus on effectively utilising existing developed urban areas. This would appear to signal a role for brownfield regeneration, as the document aspires 'to promoting higher residential densities, particularly in redeveloping brownfield sites and in proximity to town centres, public transport nodes and access points, in consultation with local authorities, the architectural, planning and auctioneering professions and the house building industry' (Department of the Environment, 1997: 149). Yet no attempt has been made at national level to devise an effective land use policy to engage in land recycling outside specially designated areas.

At a municipal level, the situation is not much better with only one reference to brownfields in the local authorities' agenda 21 strategy, *Aspirations for Dublin*, occurring in the appendix as part of a sustainability checklist. Unlike in the United Kingdom where a stringent sequential planning approach is being put in place, Dublin City Council gives nothing more than lip-service to the recycling of former industrial land. However this may change in response to the *'National Spatial Strategy 2002-2020: People, places and potential'*. This latest document provides a framework within which balanced and sustainable regional development could take place in Ireland over the next two decades, and argues for a strengthening of existing policies of counter-urbanisation to halt the further development of a large urban conurbation on the eastern seaboard. In order for this to occur, a policy of containment, focused on promoting land recycling in urban areas through direct and indirect incentives, is needed. The overall objectives are to implement effective land use and public transport policies and for the first time in Irish urban policy, the potential for brownfields to contribute to intensification and compaction is made explicit. The document argues that within the Metropolitan area 'a systematic and comprehensive audit of all vacant, derelict and underused land [should be undertaken] to establish its capacity to accommodate housing and other suitable uses'. It continues that 'where appropriate, local authorities should be pro-active in using their existing powers (such as those under the Derelict Sites Act, 1991) to facilitate the assembly of fragmented sites and to encourage the relocation to more suitable sites where there is inappropriate land use within city / district centres', that 'intensification can be achieved without compromising amenity' and the document further encourages local authorities to 'examine the potential of declining industrial and warehouse estates for re-development for new economic activity' (para 3.3.1.a). A practical prescription to ensure consolidation of the Greater Dublin Area and other large urban centres within Ireland is given: 'the efficient use of land by consolidating existing settlements, focusing in particular on development capacity within central urban areas through re-use of under-utilised land and buildings as a priority'. This suggests that brownfield regeneration has the potential to become a cornerstone of future spatial development, but much work remains to be done to ensure that opportunities are maximised. Given the manner in which many key provisions of the National Spatial Strategy appear to have already been undermined for political expediency, it is questionable whether brownfield regeneration will be encouraged given the scale of the challenge that this poses.

4.0 PROBLEMS OF BROWNFIELDS IN IRELAND

4.1 THEIR EXTENT AND DEFINITION

One of the most critical issues at present in Ireland is the lack of any formal research about the extent of brownfields, and the small number of individuals with limited resources trying to plug the information gap. There is currently no up-to-date and comprehensive survey in Ireland of the number of former industrial sites, although the Environmental Protection Agency (EPA) estimate that even after the large urban regeneration projects that were completed through the 1990s, between 2,000 and 2,400 potentially contaminated sites remain, mostly located in Dublin and Cork (CLARINET, 2002). These include former gasworks, closed mines, dockyards, landfills, fertiliser plants, railyards, old petrol depots and stations. This emphasis on contamination as a characteristic of 'brownfields' has resulted in the identification of 487 sites previously used for hazardous activities in the Republic of Ireland through the National Hazardous Waste Management Plan, and gives some indication of the potential effect that brownfields may have on ground and surface water resources. This number is not large in comparison to other countries, but until the figures compiled by Brogan et al. (1999) are up-dated and clarified the true extent of the problem and the potential that these areas may provide for environmental restoration will remain unknown. One of the primary difficulties is that this issue falls between many stools, encompassing a broad range of aspects from waste management, to groundwater protection, pollution control, planning and development and both human and ecological health. However, one of the major problems associated with estimating the extent of and dealing with brownfields is a lack of clarity surrounding their definition. In contrast to the emphasis on pollutants

and contaminants at the core of the Environmental Protection Agency's definition, the approach adopted in the National Spatial strategy published in 2002 is more akin to the UK definition of brownfields as vacant, derelict and abandoned areas that need not necessarily also be contaminated (Alker, 2000).

In response, the European Union specialist group on brownfields (CABERNET) have produced a definition that bears more resemblance to that in the National Spatial Strategy than the description adopted by the EPA. CABERNET (http://www.cabernet.org.uk/mission/defbrownfield.php) state that brownfields are 'sites which have been affected by former uses of the site or surrounding land; are derelict or underused; have real or perceived contamination problems; are mainly in fully or partly developed urban areas; and require intervention to bring them back to beneficial use'. This is the most useful definition for 'brownfield' in an Irish context, where intervention in the property market and land development process is becoming increasingly apparent. *Therefore, the first step required of government to facilitate inter-agency and cross-policy co-operation is to adopt this standard definition.*

4.2 WEAK POLICY

In the US and Canada, the introduction in the late-1990s of clear policies addressing the legal, political and financial aspects of brownfield remediation resulted in a significant increase in interest from potential investors. In Ireland, the primary legislation dealing with brownfield sites is the Derelict Sites Act, 1991 introduced to address the issue of urban blight in urban cores. This legislation compels local authorities in urban areas to keep a register of all derelict sites, including the location of the property, the name and address of the owner and details of any action that the local authority has taken regarding the site. If the owner of a site does not engage in improvement, the local authority is empowered to fine them 3% of the market value of the site per annum until such a time as the necessary changes are made. The legislation also grants the local authorities power to buy derelict sites or dangerous land in their areas, either by agreement with the owner or compulsorily. However this legislation has proved highly ineffective, as it has only provided a framework within which local authorities may act without compelling them to do so. In some instances, private landowners have avoided penalties under this Act by erecting a palisade fence and thereby 'tidying' the site, even though it may remain vacant or under-utilised. Between 1993 and 1999, fines under this legislation yielded Dublin Corporation (now Dublin City Council) £90,000. However, as the local authority did not force acquiescence with the legislation, over £70,000 was left unpaid by private landowners (McDonald, 1998). The punitive nature of the legislation has been totally ineffective due to lack of enforcement and the management of the Derelict Sites Register. Many of the large and more obviously derelict sites throughout the city have not been entered on this list because of the poor procedures utilised to manage the database. It is also totally ineffective in determining whether a site is contaminated, as there is no indication of the characteristics of that place. Given that brownfield regeneration has been identified numerous times in the National Spatial Strategy (NSS) as the tool through which consolidation of the capital city will be delivered, this *laissez-faire* approach to the identification of such sites demands either radical policy change or the significant investment of resources for enforcement. *As local authorities have already been compelled by the NSS to undertake a comprehensive and rigorous audit of derelict land, the resources should be allocated to local government to undertake such analysis to prioritise brownfields as future growth centres through a sequential planning approach.*

4.3 LIABILITY

Perhaps the greatest concern from the developers' perspective is the lack of clarity regarding liability for derelict, and particularly contaminated, sites. Internationally this has been a major stumbling block to regeneration as a number of critical questions including who pays for the clean up of contaminated sites, how clean is clean, and who is responsible for these sites once they have been de-contaminated,

are left unanswered. Whether the polluter or new owner bears responsibility for any future liability from historical contamination is a critical issue, particularly given that the national media and politicians are increasingly referring to the emergence of a 'compo' culture in Ireland. Potential investors in brownfield areas may be unwilling to accept the risk that they could become liable for future compensation claims, and therefore the public sector may need to intervene with liability protection mechanism similar to the US Superfund programme.

4.4 POLITICAL WILL

Of equal importance to structural change and given that sustainability is also about changing mindsets, one of the greatest problems in promoting land recycling in this country is a lack of political will. I would argue that the distinct lack of an urban policy is symptomatic of an anti-urbanism that prevails in Ireland. In many ways and perhaps given our rural history, Irish politics is rural politics. One clear example emerged following the amendment of Rural Planning Guidelines relating to one-off housing in March 2004. Minister O'Cuiv argued that this change was designed to help rural communities given that urban areas have benefited from the RAPID programme. What the Minister failed to acknowledge was that rural areas have also benefited from an equivalent programme, CLÁR, run from his own department with similar objectives to RAPID. Continuously pitting the urban against the rural is not a sustainable strategy for the future.

While it is indisputable that, in recent years, a significant disparity in levels of regional development within Ireland has become apparent as Dublin and the eastern part of Ireland have benefited from unprecedented economic growth, this is not an excuse to shy away from the introduction of clear criteria and targets for urban sustainability. Encouraging brownfield regeneration, perceived as a 'Dublin' or 'urban' problem, may be considered a political time-bomb for some politicians given the country's strong urban-rural divide, but it could be reversed and sold as a positive step for rural Ireland. If previously-developed land is recycled, it has many positive benefits for rural areas as more agricultural land is protected, greenbelts are preserved and small rural villages do not become dormitory towns. The short-sighted nature of land policy is characteristic of most Irish policy which tends to favour immediate change over long-term strategic planning. Rather than conceiving of brownfields as a potential resource, political inaction has rendered them a major problem. The will to intensify activity in the existing built-up area is lacking, even though many argue that the growth of Dublin has destroyed the rural character of towns on the edge of the city.

If politicians shift their focus to intensifying development in the inner city, they stand to be accused of favouring the development of urban cores over the rest of the country. In the near future, it appears likely that developing towns on the edge of our major cities will be more politically expedient than making hard, and in some cases, unpalatable decisions. *Regional development and policies of decentralisation must be counter-balanced with a sincere desire to maximise land efficiency and consolidate the urban core in order to ensure that the principles of sustainability are mainstreamed in all urban policy.*

5.0 CONCLUSION: A WAY FORWARD

As this paper has demonstrated, unlike Ireland's record in other environmental areas, the record on recognising the problems and potential of brownfield redevelopment is poor. In 1997, the Irish government led the way in dealing with water management introducing a new approach to basin management that pre-empted the EU Water Framework Directive of 2000. Given that a similar integrated approach to land management does not exist, previous innovations will be squandered if we do not focus on areas such as brownfields, which pose a significant risk to and impact on groundwater vulnerability. The first step in doing this is to raise the profile of this issue at local, regional and national level, which may be achieved in a number of ways.

5.1 CREATING AN APPROPRIATE POLICY ENVIRONMENT

- Realising that brownfield regeneration cuts across all policy areas, and requires a co-ordinated policy effort, establish a **Brownfield Working Group**. This should include representatives of all levels of government; a large number of government departments; other agencies and academics to chart an appropriate and feasible way forward and would fulfil one of the key principles for sustainable development in Ireland (good decision-making) identified by the National Sustainable Development Partnership (Comhar, 2002).
- Develop a strategic and **specific urban policy** based on the manner in which the Water Framework Directive integrates all aspects of water management at the level of the river basin.
- Through a change of mindset at central government level, **change the perception** that brownfield regeneration is just an urban problem, but demonstrate its direct and indirect implications for all parts of the country whether urban or rural.

5.2 ESTABLISH PRINCIPLES

- Drawing on the experience of the UK, adopt a **sequential approach to development** favouring brownfield over greenfield sites for new development. A similar policy to that introduced in Ottawa, Ontario in 1995, which stated that extensions to the settlement area would only be permitted if 'the amount of land included within the extensions is justified, based on the amount of land available for development in the settlement area, and on population projections and employment targets for the municipality for a horizon of 15-20 years', could have immediate benefits.
- Drawing on the experience of the Netherlands, to build in **flexibility**. One of the problems identified in the Dutch system has been an excess of regulation and laws that have proved incapable of dealing with changing circumstances. An ongoing review of progress and international best practice should be encouraged, fulfilling one of the key elements of sustainable development 'not as an endpoint, but more as a process and an evolving and dynamic approach to decision-making' (Kelly, date unknown).
- State i**ndemnification** against future liability from historically contaminated sites. This is perhaps the most critical issue given the lack of statutory regulations dealing with contaminated sites, unlike in the United Kingdom. European Commission directives and guidelines are of little use in this regard given that they do not cover contamination retrospectively. McIntyre (2003: 117) concludes that because of legal and constitutional difficulties in this jurisdiction, 'responsibility [for regulating liability] is ultimately likely to pass to the public sector, perhaps explaining the Irish authorities lack of resolve to tackle this problem'.

5.3 FINANCING

Perhaps the issue that is easiest to solve is a gap in the knowledge base. Although Brogan et al. (1999) have made best guess estimates for the number of brownfield sites in Ireland, their location and extent is still a mystery. Only when we know what we are dealing with can appropriate policy decisions be made. As a priority, government must:

- **Fund Research & Development projects**. These could include the development of a comprehensive and meaningful brownfield register and a National Land Use Database, through the universities in conjunction with the EPA. In the NDP, waste management programmes are allocated €991.67m while water management projects are designated €639.2million across the two regional authorities. In contrast, there is no specific mention of brownfields in the NDP and the current allocation of €0.18 million to ERTDI projects is insufficient given that these do not specifically identify brownfield research as a priority.
- Improve the legislative basis for dealing with brownfields and actively enforce the existing provisions. Better **financial support to local authorities** for environmental restoration

projects and forced compliance with regulations for developers could prove highly successful. This 'stick' approach should be provided in conjunction with **incentives** to developers, which could include the allocation of tax incentives over the next five-years only to brownfield sites and the imposition of a greenfield tax if a sequential approach to development is shunned.

Given the challenges and relatively small-scale nature of the brownfield problem in Ireland, it is not surprising that a policy vacuum exists. Contrary to government policies on waste management and both supranational and national policies on integrated water management, the National Development Plan and National Spatial Strategy do not provide any practical guidance to local authorities and developers, or financial supports to reduce the risks to human health, soils, groundwater and biodiversity from brownfield sites. This is a major difficulty at the present time when the rhetoric of sustainability permeates almost all government policy, from environmental to social programmes. It is time that Irish government policy, rather than paying lip-service to the issue of urban sustainability, seriously heed the conclusions of the OECD (1996: 14-17) that *'Cities cannot solve environmental problems when national policies are incoherent, or leave in place fiscal or regulatory instruments that promote environmental degradation, or deny cities the technical and financial resources they need … An ecological city is distinguished by the degree to which environmental considerations are incorporated into decision-making in public and private sectors alike'*.

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ASSESSING THE RISKS, COSTS AND BENEFITS OF MANAGING/REDEVELOPING CONTAMINATED SITES

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ABSTRACT

Cost benefit analysis used in conjunction with risk assessment can provide a useful decision making tool when considering remediation of contaminated sites. Cost benefit analysis compares the real overall cost of pollution, including private costs (to the problem holder) and external costs (to society), and the benefits accruing from remediation and the avoidance of future damages. Overall decisions on the required level of remediation can thus be made with an understanding of the full economic implications, including the wider implications for the environment and society as a whole. The benefits analysis should include net private benefits and wider external benefits, often described as the value of damage averted by taking action. The results of risk assessment are used to quantify and monetise the damages which would have occurred if remediation did not take place – the avoided damages or benefits. Benefits are compared with expected costs for achieving a range of possible remedial objectives. This allows selection of the economically optimal objective and identification of a threshold cost (less than or equivalent to the total benefits of remediation). Once the objective and constraints have been clearly identified, a range of possible remedial approaches and technologies can be developed to achieve the set goal, and each option evaluated on a comparative basis. In this paper these concepts are applied to a coal-tar contaminated site in the UK. A variety of remedial objectives are evaluated, and cost-benefit analyses conducted, using notional least-cost solutions, and partially monetised private and social benefits. A short list of economically viable remedial objectives is developed, and least-cost solutions developed for each. The results show the variability in cost-benefit ratio which can occur when comparing widely differing remedial objectives, and the economic implications associated with the use of passive techniques such as natural attenuation.

INTRODUCTION

Recent European development policies use the concept of sustainability. These policies encourage the redevelopment of brownfield sites and require that the decline of land and water quality be reversed. Decisions as to whether a site should be remediated and to what level are now more important than ever. This decision continues to be a difficult and often contentious issue.

Up until recent years, the level of clean-up required tended to be based on a set of non site specific guidelines. The use of one set of guideline values made decision making easy for developer and regulator alike but often resulted in vast amounts of money being spent needlessly, only to move the problem from one location (the contaminated site) to another (a landfill).

Risk assessment provides a tool for allowing these decisions to be made in an objective manner. It can be used to define and justify remedial clean-up criteria for a contaminated site and for prioritising remedial action when considering multiple sites. In many cases, it will result in a set of remedial objectives on which all stakeholders can agree.

However, the use of risk assessment alone does not always allow such amicable agreements to be reached. At some sites, the set of remedial criteria derived using quantitative risk assessment are either unachievable or onerously expensive. This is arguably most often the case when groundwater has been impacted, especially where the source of contamination is below the water table. The question is then raised: "Is it worth spending X million euros to reduce risk to Y level?" Cost benefit analysis (CBA) provides a methodology for addressing these type of "value for money" questions. By quantifying the benefits as well as the costs for a range of remedial options it is possible to objectively assess the optimum environmental management solution for the site, thus facilitating the decision making process and allowing agreement to be reached by all stakeholders.

LEVELS OF DECISION MAKING

Decision making for contaminated sites can be spilt into three main levels: 1) *policy level* (government), 2) *remedial objective level*, and 3) *technology selection level*. An intermediate step between the objective (2) and the most applicable technology (3) is the remedial approach. This forms a link between the objective and technology levels, and needs to be considered at both of these levels. For the purposes of this discussion, policy level is considered to be set and is not considered further.

REMEDIAL OBJECTIVE LEVEL

Only a limited number of remedial (or risk management) objectives are available: the receptor is protected, impacts to the receptor are reduced or eliminated, the contamination is removed, or contamination is reduced to a set pre-determined regulatory level (Table 1). Risk management is now generally considered the best method for dealing with contaminated land and therefore the latter objective is rapidly becoming obsolete. Setting the remedial objective for a given contamination problem should explicitly incorporate risk assessment. Contaminated land risk assessment involves the derivation of a conceptual model of risk whereby potential contaminant sources (S), migration pathways (P) and receptors (R) are identified and plausible pollutant linkages (i.e. SPR combinations) are qualitatively assessed. It may then be necessary to quantify the risks for some or all of the potentially significant pollutant linkages.

Table 1: Possible Remedial Objective Categories

A	Protect potential receptor to risk-based level
B	Reduce impact to current receptor to prevent unacceptable risk
C	Eliminate impact to current receptor
D	Remove all contamination (source)
E	Reduce contamination to risk-based level
F	Institutional control of water resource (prevent use and monitor)

The remedial objective should be the level at which the benefits of remediation (e.g. reduction of risk) are most readily and fundamentally determined. If a valuable receptor is protected, a benefit to society accrues. If a receptor is not protected, a damage results. In this framework, benefits are tied clearly to the fundamental objective, and the basic approach used to achieve it. The choice of whether to achieve that objective using pump-and-treat, a bio-barrier, or natural attenuation (for instance), has a direct impact on costs (including any dis-benefits associated with the method (such as release of off-gases to the atmosphere, for instance), but benefits remain essentially constant.

REMEDIAL APPROACH

The remedial approach (sometimes called remedial strategy) does not focus on technology, but on ways of breaking the pollutant linkage which causes (or will cause) damage. The list of possible

remedial approaches is relatively short: either remove the source, eliminate the pathway, or protect/move/manage the receptor. Consideration of remedial approach can be very useful in streamlining the CBA process, since a limited number of approaches need be considered. In this way, it provides a link between remedial objectives, and the hundreds of technologies available.

REMEDIAL TECHNOLOGY SELECTION LEVEL

The remedial technology selection level involves choosing the most cost-effective way of achieving a remedial objective. This requires detailed comparison of capital and operation and maintenance (O&M) costs for technologies, over the estimated project life span. Costs associated with production of secondary damages would be incorporated into the cost analysis. Application of various constraints provides a life-cycle cost analysis (Hardisty et al, 1996). By using the intermediary remedial approach step, an iterative analysis of the project is possible. Remedial technology selection (essentially a least-cost exercise) is used to determine the lowest cost option to achieve a given remedial objective.

COST BENEFIT ANALYSIS

As discussed above, the remedial objective should be the level at which the benefits of remediation are most readily and fundamentally determined. In many cases, the remedial objective will simply be to reduce risks to all receptors to acceptable levels. In these cases, the risk assessor will be called upon to derive site-specific clean-up criteria that can then be used for selecting an appropriate remedial approach and technology. However, in cases where the costs of achieving this objective appear to far outweigh the benefits, a more rigorous economic analysis may be required to ensure that the most appropriate objective and remedial approach are selected.

Cost benefit analysis involves the monetisation of costs and benefits for a range of remedial objectives and approaches over a pre-determined planning horizon. Costs will include investigation, design and monitoring costs as well as the remedial capital and operation/maintenance costs. Environmental costs such as additional emissions to atmosphere during remedial works and increased road use should also be considered. The benefits of remediation tend to be much harder to monetise. These may include a reduction in liability, increased land value (of site and surrounding properties), resource protection/repair and removal of disamenity.

The following example illustrates how such an analysis is conducted. In this analysis, we consider a contaminated site where a known impact on groundwater is occurring. To keep the methodology simple, we assume that there are just two actions in response to the known contamination:

1. Avoidance : prevention of further damage – for which we use the notation A, and
2. Clean-up of existing damage – for which we use the notation, R.

BENEFITS – PREVENTION ONLY

Remedial objective setting must consider the benefits of the action. If the over-arching policy is to maximise human welfare, in the context of present value, then we would select the action and time-phasing that maximises the Net Present Value (NPV) of benefits minus costs. Let ‘baseline’ damages be D(t) [damages that occur when no action is taken]. Typically, $dD/dt > 0$ since the ‘plume’ migrates over time, potentially impacting a greater number of receptors. D(t) can in fact be a complex function, depending on nature of the contaminant, speed of movement, assets at risk and the economic value of those assets. For instance, should plume migration also result in a high degree of contaminant attenuation (through dilution, dispersion, adsorption, and chemical and biological breakdown), the severity of the impact to receptors may decrease with time, despite more receptors being affected. These concepts are illustrated schematically in Figure 1 using a simple benefits-costs-damages versus time construction.

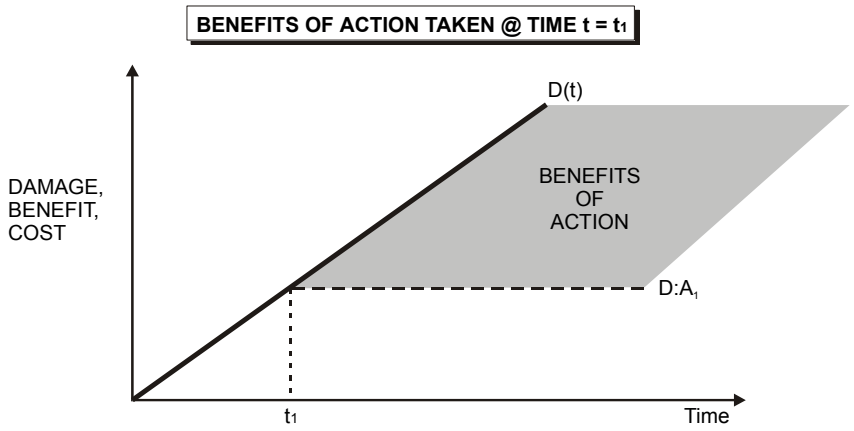

Figure 1: Benefits of Action as Avoidance of Damage

If we assume that the only action is prevention, and if we act at time t_1, we get $D:A_1$ and so on. In all cases $D:A_n$ starts at 0. The exact shape of $D:A_n$ will depend on plume behaviour over time. The benefits (B) of taking action A_n are expressed as:

$$B : A_n = \sum_{0}^{T} D_t$$

Where T is the planning horizon, and D_t is the baseline damage in year t.

BENEFITS – PREVENTION AND REMEDIATION

If we now also consider remediation within the analysis, benefits become the damages minus the avoided damage from the period of remediation onwards. Note that remediation is taken to mean clean-up of the damage already incurred. In Figure 2, the benefits of intervention are given by the shaded area. The area represented by the small triangle below D(t), from t_0 to t_2 represents the value of the damage which occurred before the combined remedial and prevention action was taken. In this case, the remedial action has prevented any future damages.

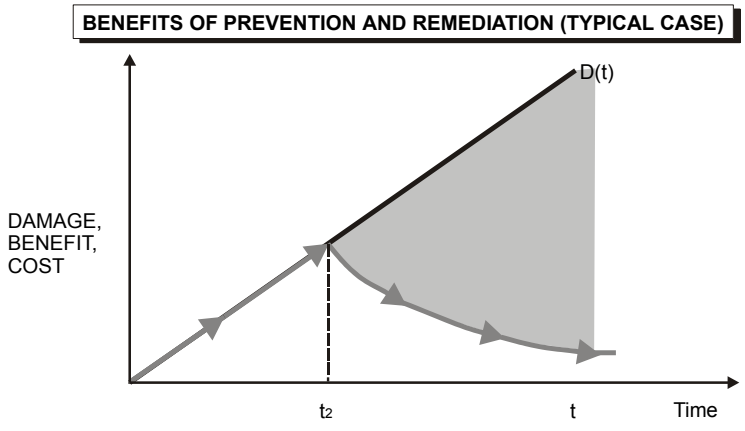

Figure 2. Benefits of Prevention and Remediation

NET BENEFITS

What is important in a decision making process is not only the magnitude of benefits, but also the magnitude of costs that will bring about the said benefits, and hence the term 'cost-benefit' analysis. For simplicity, assume prevention costs (C_p), are the same regardless of when we intervene, i.e. $C_{p,t} = C_{p,t+1}$ and so on. This implies that it costs the same (in current year prices) to adopt a preventive policy, regardless of when we act. In practice, C_p may vary. Remediation costs, on the other hand, will tend to vary with size of plume, type of contaminants, and the nature of the aquifer material and properties. So at least in some cases, the later we intervene, the higher the cost of remediation (C_r) will be. To find net benefits, we deduct the flow of costs from the flow of benefits. As an example, the net (undiscounted) benefits of prevention – costs of the selected remediation policy in any year, t, is given by the following equation:

$$\sum B_t : AR_t - \sum C_t : AR_t = \sum_0^T \left[D_t - D_t : AR_t - C_p : AR_t - C_r : AR_t \right]$$

For simplicity, the above analysis was presented for un-discounted flows. When discounting is introduced, the net benefit equation for prevention and remediation intervention becomes:

$$NPV : AR_t = \sum_0^T \left[\frac{D_t - D_t : AR_t - C : AR_t}{(1+r)^t} \right]$$

Where NPV is Net Present Value of the net benefits over time, $NPV:AR_t$ is NPV conditional upon the A and R mix of intervention which takes place, C is the aggregate cost of prevention and remediation (C_p+C_r), and r is the discount rate.

EXAMPLE - REMEDIATION OF COAL-TAR CONTAMINATED SITE IN THE UK

BACKGROUND

A hybrid site has been developed for this study based on field data gathered from a number of industrial sites in the East Midlands of the United Kingdom. Studying a hybrid site has enabled real data and a variety of existing and potential groundwater remediation issues to be investigated. The hybrid site is a former gasworks, located close to a town centre in the UK, and covers an area of approximately 2 hectares (ha). The site is situated in a shallow valley associated with the partially culverted River S which runs adjacent to the western site boundary. The generalised geological sequence is approximately 5 m of sand, gravel and made-ground, overlying 25 m of fractured Triassic sandstone aquifer, overlying a competent marl. The sandstone is a major aquifer in the region, used for water supply. Groundwater exists within the shallow sand and gravels at a depth of approximately 3mbgl, and in the sandstone – the two units are in hydraulic continuity.

Gas manufacturing operations over the years have left a legacy of significant subsurface contamination. Coal tar dense non aqueous phase liquids (DNAPLs) are present over a large part of the site, predominantly in areas used for coal gas manufacture (retort houses, tar tanks, purifiers). Tars are composed primarily of polyaromatic hydrocarbons (PAHs), but also contain significant amounts of benzene and aliphatic hydrocarbons. Coal tar DNAPL exists predominantly in the made ground and the sand and gravels but has also penetrated into the fractured sandstone bedrock to a depth of 25 m. This contamination has resulted in migration of dissolved phase contaminants in groundwater towards the river and off-site in the fractured sandstone. Currently a 500 m long

benzene plume exists in the sandstone aquifer. The plume appears to be stable at present. Modelling has shown that the presence of this plume eliminates 4600 m^3/day of potential groundwater abstraction from the aquifer, including the volume of aquifer currently contaminated, and the volume which would become contaminated by nearby wells capturing the plume over time.

RISK ASSESSMENT

A risk assessment carried out for the site identified eleven SPR linkages which exist at the site. These are listed in Table 2, below. The possible remedial objectives that could manage the risks associated with each pollutant linkage are also shown in Table 2. Objectives which are clearly inappropriate or which would fail to achieve legal requirements have been eliminated. Note the limited number of possible remedial objective categories (A through F) in Table 1.

Table 2: SPR Linkages and Remedial Objective Options

	RECEPTOR	PATHWAY	SOURCE	REMEDIAL OBJECTIVE OPTIONS
1A	River	NAPL via sediments	NAPL in sediments	C D E
1B	River	Aqueous phase via sediments	NAPL in sediments	B C D E
2	River	Aqueous phase via bedrock	NAPL in bedrock	B C
3A	Surface Water User	NAPL via sediments	NAPL in sediments	A D E
3B	Surface Water User	Aqueous phase via sediments	NAPL in sediments	A D E
4	Surface Water User	Aqueous phase via bedrock	NAPL in bedrock	A E
5	Aquifer and users	Aqueous phase via bedrock	NAPL in bedrock	A B E F
6A	Residents off-site	Vapour from NAPL in sediments	NAPL in sediments	A E
6B	Residents off-site	Vapour from NAPL in bedrock	NAPL in bedrock	A D E
7A	Workers on and off-site	Vapour from NAPL in sediments	NAPL in sediments	A D E
7B	Workers on and off-site	Vapour from NAPL in bedrock	NAPL in bedrock	A E

REMEDIAL APPROACH ANALYSIS

Next, remedial approach options able to reach each of the remedial objectives short-listed in Table 2, above, were developed, considering site conditions and the results of the risk assessment. In this example, 20 different approaches (alone or in combination) were evaluated on a preliminary basis, considering the type of technologies which would be entailed and their overall cost and practicability at the site. By iterating back up to the objective level, a short-list was developed of feasible remedial approaches able to achieve the various objectives for the 11 SPR linkages. The description of the most appropriate approaches is provided in Table 3. The most appropriate approach for each objective for each SPR-linkage is then determined. In this case, only eight remedial approaches (alone or in combination) have been found worthy of more detailed analysis by CBA for this site.

Table 3: Remedial Approach Alternatives

DESIGNATION	APPROACH DESRIPTION	RELATIVE COST
Source methods		
S1	Remove NAPL in sediments	High
S1P	Partial removal of NAPL in sediments	Moderate
S2P	Partial removal of NAPL in bedrock	Moderate
Pathway methods		
P1D	Contain dissolved phase in sediments	High
P2D	Contain dissolved phase in bedrock	High
P4N	Contain vapour at limit of NAPL plume	Moderate
Receptor Methods		
R1	Collect and treat discharge to river at river	Very high
Other		
N3MNA	monitor natural attenuation processes acting on plume	Low to moderate

BENEFITS ANALYSIS

The risk analysis for the site indicates that there are only four main benefit categories, if the damage avoided concept is followed. In this case, benefits of remediation accrue if damage to the river and its users is avoided, if damage to the aquifer and its users are avoided, and if damage to the property itself and the neighbouring properties is avoided. The methodology does not incorporate directly the benefits of avoiding damage to human health, and so these are not directly monetised. There is regulatory control over the use of water for potable supply in the UK. If groundwater is polluted the source will be condemned, and consequently the damage is equivalent to the cost of replacing that source. There is no option to continue using the water supply in a way that would cause harm to human health. Instead, benefits of remediation to workers and off-site residents are valued by the increase in property value realized by remediation, or the elimination of negative effects on property values which accrue due to remediation of the site. The benefits of remediation that could be readily monetised for this study are listed in Table 4, below. There are other benefits that could be also discussed, and included in the analysis, such as positive public relations benefits to the problem holder in undertaking the remediation, and the avoidance of fines and prosecution. These and other benefits which are more difficult to monetise are left out of this analysis, but could be included in a more rigorous treatment of the example.

Table 4: Remedial Benefits

BENEFIT CATEGORY	**ONE TIME BENEFIT (£)**	**ANNUAL DAMAGE AVOIDED (£/PA)**	**PLANNING HORIZON (yrs)**	**VALUATION METHOD**
Prevention of river water quality degrading to the point where the next lowest UK river category is reached	N/a	Negligible < £ 0.01 M	20 yrs	Recreation value is minimal due to poor current river water quality, and location in industrial area. Water not used for abstraction or supply. No ecological significance currently.
Lost potential water production from portion of aquifer rendered unusable by contamination in bedrock	N/a	Approx £ 0.05 M/pa for first 10 years, and then £ 0.2 M/pa for next 10 years	20 years for full restoration of plume through natural attenuation once source is removed	Modelled lost potential water production due to presence of plume, multiplied by current commercial market value of water in UK
Sale of property as commercial site, once made suitable for such use	£ 1.05 M	N/a	One time benefit	Current market value of commercial property in this part of the UK
Recovery of property value in sites within the vicinity of the site, as a result of remediation	£ 0.40 M	N/a	One time benefit	Notional improvement of 10% in average property value in adjacent sites, based on current market values, due to elimination of "blight".

The costs of the various remedial approaches are provided in Table 5. These are based on current market costs in the UK. The presumed least cost technology, based on Komex's experience in the market on many similar sites, was used to cost the approach. For a more complete analysis, a formal least-cost analysis of technology options can be performed for each approach, and the results used to check and if necessary modify the initial high level analysis.

Table 5: Remedial Approach Cost Analysis

REMEDIAL APPROACH	REMEDIAL TECHNOLOGY FOR COSTING	CAPITAL COST (£M)	ANNUAL OPERATION COSTS (£M)	OPERATION TIME (yrs)	ASSUMPTIONS
S1	Complete excavation and treatment of contaminated sediments	1.1	-	-	Soil washing on-site is used
S1P	Partial excavation of contaminated sediments	0.5	-	-	Material is land-filled
S2P	Partial removal of NAPL in bedrock using angled wells and pumping, surfactant flushing	0.5	0.1	10	Sufficient NAPL is removed to have positive impact on dissolved mass flux.
P1D	Contain dissolved phase and NAPL in sediments using slurry wall and pumping with treatment.	0.3	0.1	20	System must remain operational over long term, shallow source remains in place.
P2D	Contain dissolved phase in bedrock by installing hydraulic containment system	0.3	0.1	20	System must remain operational over long term.
P4N	Contain vapour at limit of LNAPL plume by installing soil vapour extraction system around site perimeter	0.25	0.05	20	20 yrs without NAPL removal, 2 yrs with.
R1	Collect and treat discharge to river at river, using cofferdam at river's edge	0.7	0.1	20	System must remain operational over long term, shallow source remains in place
N3MNA	Monitored natural attenuation of groundwater contamination over time, assuming MNA effective	0.1	0.05	20	Increased monitoring capability

COST BENEFIT ANALYSIS

Using the calculated partial benefits and the remedial costs for various approaches, an economic comparison can be made of the remedial objective options available for dealing with each of the identified significant pollutant linkages associated with the site. Varying the start time of implementation also has an effect on the calculated benefits. Table 6 shows the analysis of costs and benefits assuming immediate implementation of remediation, using a 5% discount rate. For each approach and combination of approaches, the benefit-cost ratio (BCR) is calculated. BCR values above unity indicate net positive economic benefits. A 20 year planning horizon has been used.

Table 6: Cost Benefit Analysis

REMEDIAL APPROACH	DESCRIPTION	COMPLEMENTARY APPROACH	BENEFITS WHEN APPLIED ALONE (NPV £M)	BENEFITS WHEN APPLIED TOGETHER (NPV £M)	TOTAL NPV COST ALONE/ COMPL. (NPV £M)	BCR ALONE/ COMPL. (NPV £M)
S1	Complete excavation and treatment of contaminated sediments	P2D + N3MNA	1.57	1.94	1.10 / 3.37	1.43 / 0.58
S1P	Partial excavation of contaminated sediments	P2D + N3MNA	1.57	1.74	0.5 / 2.77	3.14 / 0.63
S2P	Partial removal of NAPL in bedrock	S1P + N3MNA	0.17	1.94	1.27 / 2.25	0.14 / 0.86
P1D	Contain dissolved phase and NAPL in sediments		0.13	-	1.75	0.07
P2D	Contain dissolved phase in bedrock	S2P	0.37	0.59	1.54 / 2.05	0.02 / 0.29
P4N	Contain vapour at limit of LNAPL plume by	S1P	0.2	1.77	0.64 / 1.14	0.31 / 1.55
R1	Collect and treat discharge to river at river,		0.13	-	1.95	0.07
N3MNA	Monitored natural attenuation	S1P	0.17	1.62	0.72 / 1.22	0.24 / 1.33

ANALYSIS AND DISCUSSION

Examination of the CBA results in Table 6, and the remedial approach short-list matrix in Table 3, above, yields some interesting observations. First is that the benefit cost ratio is maximized when approach S1P (partial excavation of contaminated sediments) is used (BCR= 3.14). This represents the lowest ratio of cost to the problem holder to benefits to society (including the problem holder, who in this case achieves a significant benefit from selling a property which has become fit for commercial use). Using this approach would manage 6 of the 11 SPR linkages outright (Table 4). However, combining this limited source removal (S1P) with a programme of monitored natural attenuation (N3MNA) still provides a positive BCR (1.33), while perhaps more completely serving the interests of society as a whole. This choice of objective would reflect a decision to consider the distribution of benefits as a key parameter in decision-making. Only SPR linkages 2 and 4, both involving the river would not be satisfied with this solution. However, the associated risk assessment points to the fact that relatively low mass flux to the river in the form of dissolved phase contamination, does not result in serious environmental impact. This is due to the poor current quality of the river, situated in a heavily industrialized area, and subject to other discharges along its reach. This situation could of course change over time, and it is a requirement of the Water Framework Directive to improve surface water quality.

Other remedial approaches considered, such as an active attempt to remove some of the NAPL contained in fractured bedrock, are not economically attractive to society at this site. This approach entails high costs, for relatively few overall benefits (BCR=0.14). This analysis shows that in situations involving complex conditions, consideration of the wider costs and benefits of groundwater remediation can assist in setting realistic and appropriate remedial objectives.

CONCLUSIONS

Risk assessment and economic analysis, encompassing both private (the problem holder) and external (the rest of society) costs and benefits, provides a tool for answering one of the fundamental questions of contaminated site remediation – should we remediate? And if so, to what level? Simply put, if the sum of all the benefits of aquifer remediation, including those which accrue to the problem holder and more widely to society as a whole, exceed the total costs of repairing the aquifer (given some discount rate and planning horizon, and including the secondary costs of damage to the environment caused during the remediation process [and there are many, depending on the methods used]), then economic theory states that the project would be worth doing.

Once a decision has been made to remediate, a specific remedial objective is required. Remedial objectives may take many forms, from a basic containment strategy (ensure no further migration of contaminants within the aquifer), to a program of extensive clean-up, perhaps to some risk-based standard. The full costs and benefits of these different objectives will typically vary considerably. Here, economic analysis can be used to rank remedial objectives, and assist in choosing an objective that makes economic sense for all stakeholders. Once an economically optimal objective has been set, then selection of appropriate remedial methods and technologies becomes essentially a least-cost exercise, in which secondary costs must also be included. A wide range of remedial techniques and approaches for aquifer remediation and the control of contaminant plumes are available, covering a wide range of costs, time scales for implementation, and probabilities of success. Many innovative and experimental techniques are currently being developed.

In the end, economics is simply the study of people's preferences and the daily priorities of individuals, who decide which commodities, issues, and resources are most valuable to them. Of course, economic analysis of remedial objective options is only part of a complete decision making process. Any decision must take place in a wider context of the constraints of remediation (time, budgets, physical limitations, legal and legislative regulations, and the requirements of government

policy). Each of the stakeholders involved in a particular site or issue will have their own view on each of these considerations, and a complete and fair decision making process must include and value all of these.

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SESSION V: GROUNDWATER CHALLENGES OF ROAD DEVELOPMENTS

GROUNDWATER CHALLENGES FOR THE NATIONAL ROADS AUTHORITY

Michael Egan, Head of Corporate Affairs, National Roads Authority

ABSTRACT

The paper outlines the policy context for the national roads programme and describes the road transport objectives to be delivered. The procedures developed by the National Roads Authority (NRA) in planning road schemes are described. A multi-phased approach is followed. As scheme proposals progress, the area of study decreases while the level of detail increases in studies informing the EIA and decisions to be taken by An Bord Pleanála (ABP). Considerations relating to groundwater, including dependent ecosystems, are integral to this process which is aimed at devising a road scheme proposal that is robust, capable of withstanding scrutiny at ABP hearings and is consistent with sustainable development objectives. The importance of adequate baseline information, including data on groundwater and related ecosystems, to inform decision making is emphasised. The paper calls for the allocation of the required resources to complete the mapping of groundwater resources and to further advance preparation of groundwater vulnerability and protection schemes. Such measures are opportune given the new regulatory environment obtaining under the Water Framework Directive (2000/60/EC) and the obligations and challenges it presents. Reference is made to special aquifer modelling and monitoring work for the Kildare By-Pass. Details are outlined of a current NRA funded research project assessing the impacts of highway drainage on the aquatic environment. Findings will be considered by the Authority as part of ongoing efforts to integrate the environment into road scheme planning and the pursuit of sustainable development.

INTRODUCTION

The National Roads Authority, together with local authorities, is now at mid-point in the implementation of the most ambitious roads improvement programme in the history of the State. The agenda was set by Government in the National Development Plan, 2000-2006 and has been supported by record funding from Exchequer sources, supplemented by finance from the private sector directed to road schemes constructed under Public Private Partnership arrangements. The scale of road building activity has the potential to adversely affect our environment, including our water resources and the habitats they support. The Authority is fully alert to its responsibilities in these areas and is committed to making every effort to avoid unacceptable impacts to the extent possible; failing this, mitigation measures are a standard feature of road planning and construction and, in appropriate circumstances, special measures compensating for habitat loss are pursued. The environmental dimension is integrated into the overall planning process as the Authority endeavours to ensure that all relevant issues are considered and that planning decisions are properly informed. Ultimately, road scheme proposals must be robust and be capable of withstanding close scrutiny at An Bord Pleanála hearings if approvals to go to construction are to be obtained.

ROADS PROGRAMME POLICY CONTEXT

Ireland's public road network carries 96% of passenger traffic and 93% of freight traffic, reflecting a reliance on roads which is one of the highest in the EU. National roads account for only 6% of the overall length of public roads but carry almost 40% of all traffic, emphasising their significance to the economy and Irish life generally. In view of our small land area and dispersed pattern of population

settlement and economic activity, the road network is and will continue to be the dominant mode of internal transport in Ireland.

The country's peripheral island location makes it all the more important that we have high quality internal transport arrangements. A well-functioning roads system is of critical importance:

- in the efficient and cost effective movement of persons and freight within, and into and out of, the country;
- in the achievement of balanced regional development and the diffusion of employment opportunities;
- in contributing to the competitiveness of the economy thereby creating an environment conducive to sustaining employment and attracting further job generating investment, and
- in minimising the adverse effects of transport activities on the environment.

In 1998 the Authority published the findings of a comprehensive review of future road investment needs based on an assessment of the level of service being delivered by the network and anticipated trends taking account of forecasts for traffic growth up to 2020. These findings (the National Road Needs Study) were presented to Government and considered in conjunction with other submissions from a range of interests, including employment and economic development agencies, as part of the process leading to the determination of official policy for upgrading national roads as set out in the current National Development Plan (NDP). The primary objectives of this policy are:

- to improve the reliability of the road transport system by removing bottlenecks, remedying capacity deficiencies and reducing absolute journey times and journey time variance;
- to improve internal road transport infrastructure between regions and within regions, contribute to the competitiveness of the productive sector and foster balanced regional development;
- to facilitate better access to and from the main ports and airports with the main objective of offsetting the negative effects of peripherality;
- to contribute to sustainable transport policies, facilitating continued economic growth and regional development while ensuring a high level of environmental protection, and
- to help to achieve the objectives of the Government's Road to Safety Strategy in relation to significantly reducing the number of fatalities and serious injuries caused by road accidents.

Government policy for the improvement of national roads, as outlined in the NDP, focuses on:

- development of five major inter-urban routes (Dublin to the Border, Dublin to Galway, Dublin to Cork, Dublin to Limerick, Dublin to Waterford) to motorway/high quality dual carriageway standard;
- a programme of major improvement works on many other national primary routes;
- completion of the M50/Dublin C-Ring and the Dublin Port Tunnel;
- improvement of national secondary routes of particular importance to economic development, and
- the continuing assignment, in the design and construction of road projects, of a high priority to the safety of road users.

The programme outlined includes construction of 900 km of motorway and high quality dual carriageway. Roads of this standard will do much to improve Ireland's ranking internationally as regards road transport infrastructure – in 1997 Ireland was placed twentythird of 28 OECD countries because of our limited extent of motorway. Completion of the five major inter-urban routes to/from Dublin will achieve combined journey time savings of at least 180 minutes, including almost 60 minutes on the Dublin-Cork route, compared to travel times in 1999. Benefits will not be confined to economic and social gains; because of the significantly better safety record of motorways and dual carriageways more than 50 lives per annum will be saved as a direct result of the construction of 900 kms of motorway and dual carriageway. Additional lives will be saved as a consequence of the Authority's recent decision to pilot a new type of road, 2 plus 1 (two lanes in one direction of travel and one lane in the opposite direction with the second lane alternating from one side to the other at about 2 km intervals; the centre median on these roads will incorporate safety barriers, virtually eliminating head-on collisions).

The Authority and local authorities have faced many challenges in the roll-out of the NDP mandated national roads programme. We are constantly reviewing and updating our procedures in the light of experience and emerging issues. Overall, we can take considerable satisfaction from the progress made to date notwithstanding difficulties and delays encountered on a small number of high profile schemes like the Kildare By-Pass (Pollardstown Fen). The Economic and Social Infrastructure Operational Programme, 2000-2006 mid-term targets for delivery of the major inter-urban routes have been largely achieved (29.8% completion achieved; target 31%). The Authority's performance was the subject of favourable comment by Fitzpatrick Associates, consultants engaged by the NDP/CSF Evaluation Unit of the Department of Finance (Evaluation of Investment in the Road Network) who concluded that:

"The 2000-06 national roads programme represents a historic increase in the level of infrastructural investment. Getting this programme up and running, and operating effectively on the ground, has been a major achievement in Irish public administration terms. The contribution of the relevant Departments, the National Roads Authority, the local authorities and the construction industry must be acknowledged."

If the Authority is to maintain and possibly accelerate the rate of progress made to date on programme implementation it will be essential to ensure that our procedures on road planning and environmental assessment meet a rigorous "fit for purpose" criterion.

ROAD PROJECT PLANNING

BACKGROUND AND RATIONALE

The procedures followed by the National Roads Authority and local authorities in the planning, design and implementation of road schemes are specified in the Roads Act, 1993, as amended by the Planning and Development Act, 2000, and in the Authority's National Roads Project Management Guidelines (NRPMG), 2000. A key objective of the NRPMG is to ensure the efficient delivery of the national roads programme in a manner which minimises adverse human and environmental effects while maximising the benefits of the new road infrastructure and respecting all applicable legislation. The Guidelines have been supplemented by other guidance produced by the Authority, including those concerning Assessment of Ecological Impacts of National Road Schemes. A primary purpose of these guidelines is to achieve appropriate consistency and standards when assessing and reporting on the likely significant impacts of road schemes.

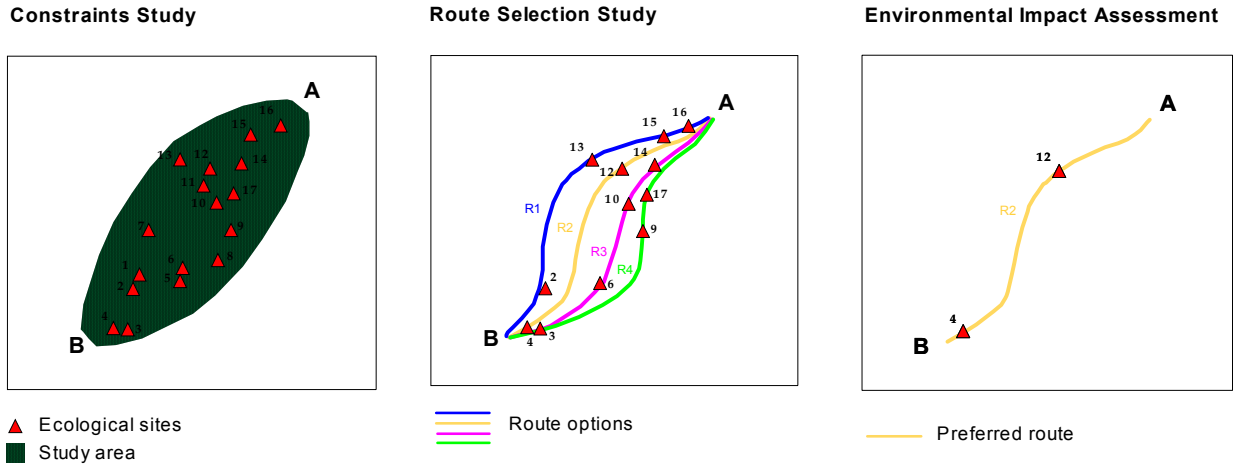
National road schemes are large developments that have potential impacts on the natural environment, including surface and groundwaters, along their length. Concomitant with the need for new and safer roads, there has been a growing awareness of the need to conserve and protect Ireland's natural heritage and biodiversity. One of the objectives of the planning stages of road schemes is to avoid or

reduce the negative impacts of the final route on the natural environment. This is achieved in part through the Environmental Impact Assessment process that, for road schemes, is carried out in a series of project management phases developed by the Authority, including Constraints Study, Route Selection and Environmental Impact Statement (EIS).

An EIS is prepared as part of the application for development consent. It provides environmental information that is used by the competent authority, i.e. An Bord Pleanála in the case of national road schemes, to determine whether or not to grant consent. All relevant issues that are likely to be important during the process are identified and addressed at an early stage and to an appropriate level of detail. The methods to be used for the evaluation must also be addressed. Ideally, the resultant EIS is a document that records this process, showing how environmental considerations helped the project to achieve a sustainable integration with the local environment.

OUTLINE OF PROJECT MANAGEMENT PHASES

In the National Roads Project Management Guidelines, planning for road schemes is divided into four phases. Phase 1 involves the overall planning of the scheme, including defining the road need and making appropriate provision for the scheme in the local development plan. Phases 2 and 3, the Constraints and Route Corridor Selection studies, are primarily concerned with the avoidance of impacts where feasible, and the consideration of alternatives, two fundamental components of the EIA process. Phase 4 includes the Environmental Impact Statement (EIS) for the preferred route. As the scheme progresses through these stages the area of study generally decreases, or becomes more focused, while the level of detail in the studies increases. This progression is illustrated in Figure 1.



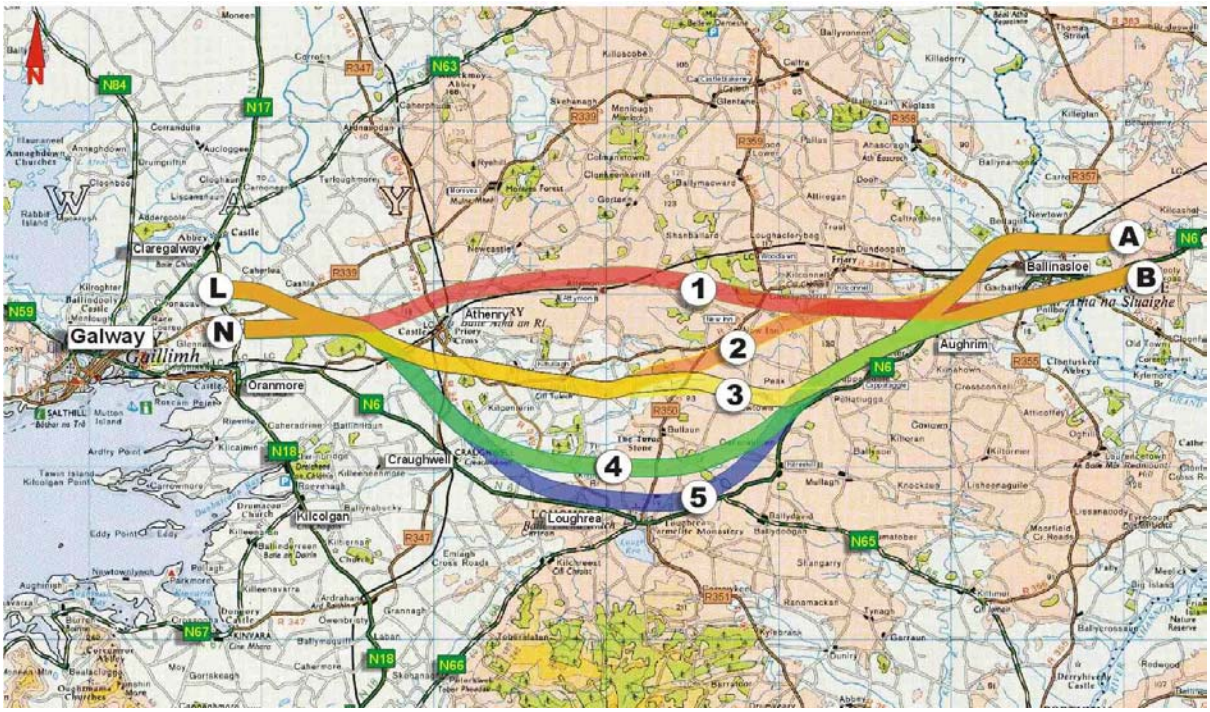
Some elaboration on the key phases involved will serve to explain the dynamic and evolving nature of the planning process and the basis on which preferred routes are identified.

CONSTRAINTS STUDY PHASE

The natural environment section of the Constraints Study is primarily based on a desk exercise involving a search for available information, or information that can be readily obtained. The ecological constraints, associated with a broadly defined study area, such as designated conservation areas, major aquifers and dependent ecosystems, catchment management systems, etc., should be identified and mapped. Potential ecological constraints outside the given study area should also be considered as in the case of sites, such as wetland systems or river catchments, which could be indirectly impacted. The result of the assessment, the Constraints Study Report, should include a statement of the ecological interest of the study area, the main ecological constraints and a map that shows the location and extent of these constraints.

ROUTE CORRIDOR SELECTION PHASE

Route corridor selection typically involves a comparative evaluation of a number of routes (indicative alignments) or route corridors. The objective of the study is to evaluate and compare the alternative route options taking account of engineering, environmental, traffic and cost considerations. The ecological impacts for each of the options are identified so that those with unacceptably high levels of impact can be avoided to the extent feasible as part of the overall route assessment process. This process also considers traffic, engineering and cost implications of the alternatives. Route corridor selection is the single most effective means of avoiding or reducing ecological impacts. Figure 2 shows an example of route corridors under review.



Each route corridor selection process within the country will have unique features and the constraints may vary. In some cases the optimum route from an ecological perspective may not be the overall optimum route when other impacts and considerations are evaluated. However, ecological considerations should receive detailed consideration and, in some cases, these may be the most

important factors to be considered during route selection and subsequent design of the road scheme. For example, where a Natura 2000 site (SAC or SPA) is impacted by a proposed route, then ecological criteria (under Article 6(3) of the EU Habitats Directive 92/43/EEC) may exercise a heavy weighting in the overall evaluation of route options.

Route Corridor Selection involves a combination of desk study and field survey to identify, map, describe and evaluate sites of known or potential ecological value, and to assess the significance of the likely impacts of the route options on them.

The completed Corridor Selection Report should include a brief overview of the existing environment and ecological interests of the study area (i.e. area through which the routes pass), including topographic, geomorphological, hydrological and landscape features, designated areas, the dominant landuses, the main habitats of ecological significance and the main water or drainage features. The report should also contain an assessment of likely impacts taking account of the ecological value of sites and water resources, as well as the scale and duration of the expected impact. The level of impact assigned to particular routes should make the assumption that general mitigation measures will be implemented and the position in this regard should be clearly stated. Site specific mitigation measures are normally excluded in the assessment of impacts of the scheme during this phase of planning and, instead, are usually dealt with in the Environmental Impact Statement.

ENVIRONMENTAL IMPACT STATEMENT PHASE

The objective of the Environmental Impact Statement (EIS) is to undertake sufficient assessment to identify and quantify any significant impacts on the natural environment likely to arise from construction of the preferred route. The baseline ecological (or biodiversity) conditions in the area of the proposed road project are described, based on information provided by consultees, background sources of information and the results of any surveys carried out for the EIS.

The natural environment section of the EIS builds on the information contained in the earlier Constraints Study and the Route Corridor Selection Study. Matters addressed should include:

- desk study, including review of published/unpublished sources/literature;
- field/walkover survey of entire route, link roads, realigned roads and any other areas likely to be affected;
- specialist surveys (if required);
- evaluation;
- impact assessment, and
- proposed mitigation measures for likely significant adverse impacts.

As prediction of impacts and change is only as effective as the baseline information available, field surveys should be sufficient to characterize the local environment and to make defensible and robust impact predictions about the area or features of value likely to be affected.

The natural environment and impacts should be considered under the following criteria:

Context: Describe the location, extent and magnitude of the environmental factor.
Character: Indicate the distinguishing aspects of the environment under consideration.
Significance: Describe the quality, value or designation assigned to aspects of the environment.

Sensitivity: Indicate changes that would significantly alter the character of an aspect of the environment.

The EIS must also address the significance of impacts, guided by consideration of:

- Magnitude and intensity.
- Integrity of environmental component affected.
- Duration.

Finally the EIS should include a description of the measures envisaged to avoid, reduce and, if possible, remedy significant adverse effects.

ROAD SCHEMES AND GROUNDWATER

The groundwater resource is addressed as part of the structured approach to route selection and road scheme planning already described. The effectiveness of this effort and, as a consequence, the quality of the EIA process will be influenced significantly by the adequacy of available baseline information on groundwater. Key data of interest to road planners and promoters of other forms of critical infrastructure development include:

- Location and extent of aquifers.
- Condition and quantity of groundwater resource.
- Nature and significance of any dependent habitat.
- Current and future potential uses.
- Vulnerability to pollution/nature of overburden and water-bearing strata.
- Recharge sources and rate/timescale.

It is in the national interest to pursue data collection on the foregoing, thereby having in place an authoritative baseline against which to plan infrastructure and to assess potential impacts in an informed manner. With this in mind the necessary resources should be put in place to complete the mapping of groundwaters on a county basis and to further advance the preparation of groundwater vulnerability and protection schemes.

The time is opportune to review the approach adopted at national level to groundwaters. A comprehensive legislative mechanism is now in place under the EU Water Framework Directive (2000/60/EC). As a consequence, water resources, including groundwater, must be addressed in a holistic manner so as to achieve a sustainable water policy and ensure that waters are at least of "good status" as defined in the Directive. Strategies focusing on water catchments represent positive initiatives and should be progressed taking full account of the groundwater dimension. Benefits would be many-fold, in relation to improved management and protection of our water resources and also in the area of development generally which should be placed on a more sustainable footing.

Promoters of development proposals, including the Authority, have a role to play in gathering relevant data by way of input to the EIA process. However, it would be unreasonable should they be expected to carry the entire burden of generating baseline data in addition to assessing potential impacts of their projects. The developers remit should ideally extend to specialist studies where these are warranted for the purposes of supplementing appropriate baseline data and, in exceptional cases, the financing of

research projects and monitoring programmes where environmental resources of national or international status merit special attention.

The Authority has funded specialist studies of this nature in relation to the Kildare By-Pass scheme as part of the efforts to ensure the protection of Pollardstown Fen A mathematical model of the Mid-Kildare aquifer has been prepared under this strategy, together with a mitigation plan for implementation should the need arise. The model and plan constitute a significant advance on the earlier state of knowledge concerning the aquifer and its relationship to Pollardstown Fen. The model will have relevance beyond the road scheme – it should provide a practical management tool for use by the Department of the Environment, Heritage and Local Government in the ongoing protection of the Fen.

The engineering challenges posed by the construction of the Kildare By-Pass and the tanking solution adopted because of groundwater considerations have been well documented. The synergy between ecologists, hydrogeologists and engineers who have overseen the project has received less attention but has been no less effective.

Special engineering challenges also arise where road construction passes through a karst environment as in the case of the N18 (see Anita Furey paper).

ENVIRONMENTAL RESEARCH

The National Roads Authority has promoted and is financially supporting a number of research projects relating to the environmental impact of road schemes including projects promoted under the Environmental Research, Technical Development and Innovation (RTDI) Sub-measure of the Operational Programme for the Productive Sector, 2000-2006. One project now underway concerns the assessment of the performance and environmental impact of current road drainage systems and practices on the aquatic environment in Ireland.

Issues being considered include:

- increased runoff intensity in the absence of appropriate measures; this may increase flood flows in smaller rivers and streams which may be considered a problem where there is already a history of, or significant risk of, flooding of property;

- the potential for adverse water quality impacts in rivers and streams receiving road drainage associated with dissolved and suspended matter washed from road surfaces;

- the effect of road drainage sediments on riverine and other habitats, and

- the potential for contamination of groundwaters by infiltrating road drainage.

The Authority will consider the findings of this research project as part of our continuing efforts to integrate the environment into national roads programme planning and implementation and our pursuit of sustainable development strategies.

In preparing this paper, the author has drawn on the NRA's Guidelines for the Assessment of Ecological Impacts of National Road Schemes which was prepared by NATURA Environmental Consultants.

POTENTIAL IMPACTS OF ROAD INFRASTRUCTURE ON GROUNDWATER AND SENSITIVE ENVIRONMENTS – LESSONS LEARNT FROM DEVELOPMENTS TO DATE

Jim Ryan, Duchas

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CASE STUDY OF GROUNDWATER CHALLENGES OF ROAD CONSTRUCTION IN A KARST ENVIRONMENT

Anita Furey (Tobin Consulting Engineers) and
Alistair Moseley (Hyder Consulting)

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