INTERNATIONAL ASSOCIATION OF HYDROGEOLOGISTS (IRISH GROUP)

presents

Groundwater: Its Stakeholders

PROCEEDINGS

OF THE

IAH (IRISH GROUP)

23rd ANNUAL GROUNDWATER SEMINAR

VENUE:

Tullamore Court Hotel, Co. Offaly.

DATES:

TUESDAY 29th & WEDNESDAY 30th APRIL 2003

INTERNATIONAL ASSOCIATION OF HYDROGEOLOGISTS

IRISH GROUP

Presents

GROUNDWATER: its Stakeholders

23rd ANNUAL IAH (IRISH GROUP) GROUNDWATER SEMINAR

TULLAMORE COURT HOTEL
TULLAMORE
Co. OFFALY

Tuesday 29th & Wednesday 30th April, 2003

IAH (Irish Group) are very grateful to White Young Green Ireland Ltd for helping us with the registration aspects of this conference. THANK YOU.

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 3,000 members in over 120 countries. Web address: www.iah.org

The Irish Group of the IAH was initiated in 1976 and has over 90 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 2003 IAH (Irish Group) committee:

President: Catherine Coxon Lecturer, Dept Geology, TCD	☎(01) 608 2235
Secretary: Vincent Fitzsimons Senior Hydrogeologist, GSI	☎(01) 678 2824
Treasurer: Shane Herlihy Environmental Director, RPS McHugh	☎(01) 450 4922
Fieldtrip Secretary: Fionnuala Collins Senior Scientist, M.C. O' Sullivan & Co.	☎(01) 202 0870
Education Publicity: Sonja Masterson Hydrogeologist, Minerex Environmental	☎(01) 296 4435
Conference Secretary: Malcolm Doak Inspector, EPA, Wexford	☎(053) 60 600
Conference Subcommittee:	
- **Edel O'Hannelly** URS, Cork	☎(021) 431 9193
- **Kevin Cleary** White Young Green Irl	☎(01) 294 1717
- **Morgan Burke** Minerex Environmental	☎(01) 296 4435
- **Anita Furey** Tobin Consulting Engineers	☎(091) 565 211

WHO SHOULD ATTEND?

- hydrogeologists, legal advisors, insurers, environmental consultants, and developing world aid workers;
- groundwater suppliers, water well drillers, rural developers, and associated service industry providers;
- civil engineers, local authorities, regulators, central government, fisheries, and advisors to industry;
- university lecturers and students in relevant disciplines.

SEMINAR OBJECTIVE

The IAH Irish Group is an Association of people working in the realm of groundwater. In this year's two day seminar we examine our role and relationship with the wider community both here and abroad. **The first day** covers a wide range of topics mostly centred on our work in the 'developed world'. The theme on the **second day** is the role of hydrogeologists, engineers and other professions in disaster relief and groundwater development. The content of the second day relates strongly to the first; the role we should fulfil overseas and the lessons that we learn there, directly relate back to the hydrogeologist or water engineer in Ireland. The range of work needed to achieve a sustainable good water supply in Uganda is the same as the work needed for a Group Scheme in central Ireland. The range of skills needed by an engineer/ programme manager in a disaster abroad, are the same as the skills we need to effectively execute the National Development Programme at home.

PROGRAMME DAY 1

SESSION I: GROUNDWATER, WATER & THE WIDER COMMUNITY

SESSION II: FOCUS ON GROUNDWATER ISSUES IN IRELAND

SESSION III: FOCUS ON GROUNDWATER EDUCATION

PROGRAMME DAY 2

SESSION IV: DISASTER RELIEF & DEVELOPMENT -NEW ROLES FOR HYDROGEOLOGISTS ENGINEERS & AGENCIES

SESSION V: THE DAVID BURDON MEMORIAL LECTURE

International Association of Hydrogeologists (Irish Group)

PROGRAMME DAY 1
TUESDAY, 29th APRIL

10:00 *Registration*

Tea, Coffee, & Exhibits

10:45 ***Conference Secretary Introduction & Welcome***
Malcolm Doak, Inspector & Hydrogeologist, Waste Licensing, Environmental Protection Agency.

SESSION I: GROUNDWATER, WATER & THE WIDER COMMUNITY

11:00 **Protecting Groundwater in US Communities -The Groundwater Guardian Programme**
Susan Seacrest, President. Groundwater Foundation Nebraska USA

11:35 **The City Of New York Water Supply System - Watershed Management**
Richard I. Coombe, Chair & CEO, Watershed Agriculture Council. New York.

12:10 **Three Rivers Project – Boyne, Liffey, & Suir - Water Quality Monitoring and Management**
Suzanne Dempsey. MCOS

12:30 ***Panel Discussion***

12.45 Buffet Lunch & Exhibits

SESSION II: FOCUS ON GROUNDWATER ISSUES IN IRELAND

14:00 **Oral Hearings and Groundwater Aspects**
Dara Lynott Senior Inspector, EPA

14:25 **Site Suitability Assessments for On-Site Wastewater Management : Relevance of a Multi-Disciplinary Training Course**
Donal Daly, Head of Groundwater Section. GSI.

14:45 **Groundwater Group Schemes : Past Present & Future Problems**
Pat Harrington, Executive Engineer. Carlow Co. Co.

15:05 **Groundwater Issues and the Farmer's Perspective**
Matt Dempsey, Editor, Irish Farmers Journal

15:25 ***Panel Discussion.*** 15:40 *Tea, Coffee & Exhibits*

SESSION III: FOCUS ON GROUNDWATER EDUCATION

16:20 **The Economic and Environmental Importance of Ground Water**
- Education programs that work for citizens, communities and decision-makers.
Andrew Stone (Executive Director) American Ground Water Trust, New Hampshire, USA

17:00 **Groundwater Teaching in Ireland & UK**
Bruce Misstear, Dept Civil Engineering, TCD.

17:20 **Professional Registration & CPD**
Kevin Cullen. IGI and White Young Green.

17:30 ***Panel Discussion***

The panel discussion will be followed by a wine reception in the Tullamore Court Hotel provided courtesy of Minerex Environmental Ltd

PROGRAMME DAY 2
WEDNESDAY, 30th APRIL

SESSION IV: DISASTER RELIEF & DEVELOPMENT - NEW ROLES FOR HYDROGEOLOGISTS ENGINEERS & AGENCIES

09.00 **The Role of Hydrogeologists in Africa**
Cecil Shine, Director Minerex Environmental.

09:20 **The Role of Hydrogeologists in Reducing Poverty in Sub-Saharan Africa**
Alan MacDonald, Senior Hydrogeologist, British Geological Survey, Edinburgh.

09:55 **Concern Projects in Africa**
Niall Roche. Health Support Manager & Env. Health Adviser. Concern Worldwide

10:25 *Coffee, Tea and Exhibits*

11:05 **Groundwater and Water Resources Development in Uganda- an African Perspective**
Callist Tindimugaya, Principal Hydrogeologist, Ministry of Water Lands & Environment, Uganda

11:35 **Water, Sanitation and Health in Uganda - important Changes for Donors, Government Agencies, Communities and the Private Sector**
Jacinta Barrins, Dept Hydrology, NUI Galway (& formerly of Norconult Norway, Ireland Aid).

12:10 **Water Projects & Issues in the Developing World**
David Ball, Consultant Hydrogeologist.

12:30 ***Panel Discussion.*** 13:00 *Buffet Lunch*

SESSION V: DAVID BURDON MEMORIAL LECTURE

14.15 **The Role of Hydrogeology in the Rebuilding of Afghanistan**
David Banks, Hydrogeological Consultant, Holymoor Consultancy, Derbyshire, UK.

15.15 **Closing Address**
Catherine Coxon, President IAH (Irish Group), Lecturer, Dept. of Geology, TCD.

THE 23rd ANNUAL IAH (IRISH GROUP) GROUNDWATER SEMINAR

GROUNDWATER – its Stakeholders

Venue: Tullamore Court Hotel. Phone: (0506) 46 666
Dates: Tuesday, 29th and Wednesday, 30th April 2003

NOTES

SESSION I: GROUNDWATER, WATER & THE WIDER COMMUNITY

"PROTECTING GROUNDWATER IN US COMMUNITIES: THE GROUNDWATER GUARDIAN PROGRAM"

By Susan S. Seacrest
President, The Groundwater Foundation

ABSTRACT:

The author describes the mission and background of Groundwater Foundation (GF) with an emphasis on the work the GF has done with community stakeholders. The paper describes a major GF program, Groundwater Guardian (GG) and how GG builds on local teams representing such key stakeholder groups as local government officials, educators, citizen activists, and local business and agricultural representatives. Examples of local stakeholder achievements in groundwater protection in the US are provided and benefits of community involvement in groundwater protection activities are described.

INTRODUCTION:

Thank you so much for the opportunity to speak today and for the meeting's focus on the importance of stakeholder involvement in groundwater protection. Since its inception in 1985, The Groundwater Foundation (GF) has been working closely with stakeholders from many walks of life because our mission is to educate as many citizens as possible about the nature and value of groundwater. With a firm knowledge about groundwater, we believe stakeholders will be more likely to act on its behalf. Today, in the brief time I have with you, I will focus on one of the Foundation's programs that works directly with stakeholders and the ways in which both groundwater and stakeholders help us make the connections that are vital to our future.

The Foundation's stakeholder focus has been on youth and the interested citizen-especially through the program I will focus on today, Groundwater Guardian (GG). However, in recent years, in large measure because of our work with communities, the Foundation has become more active in the field as opposed to spending administrative time in the Lincoln Nebraska office. In other words, we've learned that it is valuable to travel to stakeholders and work directly with them on various groundwater protection projects. Some of these recent efforts have included: completing local inventories of potential sources of contamination, teaching citizens to use new technology effectively, conducting seminars on the proper construction and maintenance of on-site waste water treatment systems and learning along with our stakeholders about collaborative decision-making and local leadership.

One of our more high profile stakeholder groups has been Nebraska youth. This group is on my mind right now because just over a month ago the GF held the 15th annual Children's Groundwater Festival—an annual water education event for 2,000 Nebraska 4th and 5th graders. We follow up the Festival with another youth event, "Groundwater University" (GU), a groundwater education camp for 12-15 year-olds. And because our goal is to share program ideas with others, both the Festival and GU include training for environmental educators who wish to replicate the events in their own communities.

We also do our best to keep our members, program partners, and constituents in the environmental education community well informed though various products and publications such as the Awesome Aquifer Education Kit for teachers and The Groundwater Catalog—a collection of groundwater education products for children and adults. The Foundation also publishes *The Aquifer*—a quarterly print newsletter for Groundwater Foundation members and *The Recharge Report*—a free online newsletter published eight times per year.

GG PROGRAM OVERVIEW:

However, in the middle of all this activity, the GG program remains the centerpiece of our program efforts and is the primary way in which we have learned about the value of stakeholder involvement in groundwater protection.

GG began in 1992 with a grant from the W.K. Kellogg Foundation. The purpose of this grant was to create a network of local groundwater protection projects. Understanding that it is common experiences, rather than common interests that create real and vital networks, the GF developed GG as a common framework for local groundwater protection action. The most important element of the GG program is the willingness of local citizens to organize a team of local stakeholders. These stakeholders who represent key local groups are in an excellent position to identify local groundwater problems, develop an education/action plan to address the issues and document their progress and success. We provide administrative assistance, information resources and official recognition, but it is community stakeholders who lead, implement, and benefit from the program.

This high level of citizen involvement is vitally important because many small groundwater dependent communities lack the financial resources and/or professional expertise to insure protection of this vital resource. The "best practice" for many of these communities is an educated and empowered citizenry acting responsibly on behalf of their community. It has been the experience of the GF that when citizens understand the vital importance of groundwater to their environmental and economic future, they are able to develop innovative cost efficient strategies for its protection. Communities without a safe and ample water supply are communities without a viable future.

How do community stakeholders get involved in groundwater protection and the GG program? To answer this question, it is important to define "community" within the context of the GG program. Within the GG program, the term "community" is broadly defined because there is such a wide array of individuals who can become interested and active. As a result, any geographical area can become a GG community. Some GG communities are traditional incorporated municipalities. Other GG communities are counties, rural areas, water districts, watersheds, schools, military bases or geographical areas that share groundwater and surface water resources. Essentially, GG communities are groups of diverse stakeholders who live in a defined geographic area, share an interest in a specific groundwater resource or system, and are willing to become involved. This is important because groundwater often defies traditional political boundaries and can physically link numerous entities around a common aquifer system.

GROUNDWATER GUARDIAN TEAMS AS EFFECTIVE STAKEHOLDER GROUPS:

However diverse the communities that become GG communities are, they each begin the groundwater protection process in the same way: through the efforts of a local team of stakeholders. Effective local leaders understand the importance of including diverse groups in the groundwater protection process. The presence of diverse stakeholders is the most important part of the GG program because a credible, broad based team immediately commands respect within the community, represents community interests effectively, and shares the responsibility for groundwater protection among key community groups. The

GF is very rigorous in requiring that each GG team include at least one representative from local government agencies, educational institutions, citizen interest organizations, and local businesses and/or agricultural producers. Other interest groups or multiple representatives from these categories are also encouraged to participate on the team.

Recruiting the team and making sure stakeholders on the team share a strong interest in groundwater and the important role it plays in the community can be a long and difficult process. The GF provides as much support as possible in this process and is currently involved in developing its own capacity for finding and training local leaders. We have found the most common approach to team building is to find an especially committed and enthusiastic individual, a "spark plug." The "spark plug" is frequently responsible for starting the GG process by organizing an initial meeting and recruiting stakeholders to join the team. Spark plugs and their colleagues form core stakeholder groups who in turn build teams in various ways including using an existing environmental organization, starting a new group, or re-focusing the efforts of a non-environmental group towards water education and protection.

No matter what their methodology is, these local leaders tend to share common values including:

- A commitment to continuing their own learning about water resources and in doing so helping to bridge the gap between what is known and what is commonly practiced on the community level.
- The need to stay in touch with the needs and priorities of their communities
- Understanding that local problems are often most effectively addressed through local resources and ideas
- A belief that every citizen, without regard to educational level, profession, or personal experience can make a difference by becoming involved
- A sense of optimism in spite of the fact that protecting groundwater is long-term and enormously complex
- An appreciation for the past combined with enthusiasm to create a better future

The spark plug and/or stakeholder core group usually begins its work by staying true to the first value described above-educating team members about local groundwater and identifying the issues that are most important to the community. The GF provides information and support to the team during this phase of the program. When the team is in place and its members have a good idea about the issues they want to address, the team submits an official GG entry form to the GF identifying the various members of its team and describing the area's groundwater and geographical conditions.

Next the stakeholder team develops its action plan-consisting of "Results Oriented Activities" (ROAs). The GF does not prescribe what the stakeholders will do. This is because the GF believes that stakeholders are in the best position to determine the relative importance of local issues and can find and use resources in innovative ways to address problems. Through the years stakeholder action plans have addressed the following groundwater protection categories: education and public involvement, pollution prevention, public policy, best practices, and conservation.

After determining their plan, the stakeholders work hard to implement their projects in the community. Community groundwater festivals, newspaper articles, retrofitting homes and businesses with conservation devices; developing local ordinances that include best practices and/or protective land-uses are among the common activities undertaken by GG teams. Activities can be held anytime throughout the year and the team can also use ongoing groundwater protection projects as part of their GG program.

Specific examples of local issues addressed through a variety of local stakeholders within the GG program include:

- ***Central Platte Natural Resources District in Grand Island, Nebraska.*** Landowners have been participating in a groundwater education program since 1973. Beginning in 1986 and continuing to this day, a unique nitrogen management program that includes a multitude of voluntary, groundwater protective land use practices has successfully stabilized nitrate levels throughout the Central Platte Basin.

- ***Anaheim, California and El Paso, Texas.*** Older citizens on GG teams led programs to carefully locate and promote the sealing of abandoned wells in each of the communities. These voluntary initiatives have protected hundreds of wells from spills and thousands of people from potential harm.

- ***Cape Girardeau, Missouri and Desert Hot Springs, California.*** League of Women Voters GG team leaders in Cape Girardeau and Mission Springs Water District leaders in Desert Hot Springs implemented community education campaigns to help citizens understand the importance of pollution prevention. Both communities have vulnerable groundwater because of local springs. The end result: sewer systems and ongoing pollution prevention activities.

- ***Upper Republican Natural Resources District near Imperial, Nebraska.*** An innovative well metering and allocation program in place since the early 1980s has maintained groundwater supplies and agricultural production in an area that saw serious depletion during previous decades. Area farmers are given a five-year water account and use best practices to conserve water to maintain a constant supply. The practical result is less water use from the account in wet years so more will be available in dry years.

- ***East Lansing, Michigan.*** An innovative multi-jurisdictional approach to groundwater protection has helped the area around East Lansing protect groundwater quality and supply. Local leaders on the GG team have created partnerships and cost-effective initiatives that are making a difference in the long term. A common water supply has created the ability to share a resource across jurisdictional boundaries in order to maintain a safe and ample water supply. This model will be increasingly common and will create an expanded sense of community in the future.

GG COMMUNITY BENEFITS:

In addition to tangible benefits like the ones described above, GG communities are also sending important messages to other communities in their area and prospective residents. Seeing the GG logo on the community water tower or on a road side sign, a visitor will know that this is a community where:

- A cadre of stakeholders are actively addressing groundwater issues
- Citizens are becoming more aware of groundwater's value and use
- Innovative solutions to problems that reflect local conditions are being developed and implemented
- Citizens have easy access to a regional and national network of activity ideas
- There are accessible and high quality groundwater educational materials and resources from a wide variety of organizations and institutions
- Residents frequently participate in special projects and regional and national events
- Citizens from all walks of life are inspired and motivated to make their community a better place to live in the future.

Currently there are 190 designated GG communities and partners. The 2003 GG Designation will be held in connection with the GF National Conference to be held in Las Vegas Nevada in November and plans are underway to celebrate the program's 10th anniversary in Washington DC in 2003.

CONCLUSION:

There are many milestones like these ahead for the GG program but stakeholder involvement will always remain the centerpiece. Where multiple stakeholders are not involved, GG is of limited duration and impact. When a community takes the time to recruit an interested and committed team, groundwater protection is likely to be understood and valued by the community as a whole. Innovation and effectiveness are the order of the day. And, perhaps most importantly, the effort can be sustained over the long-term.

The effective GG stakeholder team understands the importance of leading by example and sharing lessons learned with other communities-thus expanding the scope and impact of the team's activities. Effective teams understand that there is much to be gained by generously collaborating rather than competing because they know communities are connected through the common bonds of human experience as well as the groundwater that nourishes their families, neighborhoods and communities.

This spirit of collaboration is also furthered by the fact that GG is purposefully inclusive. Stakeholder groups and communities do not compete against each other because there is no limit on the number of GG communities that are designated in any given year. Any community that wants to work on groundwater protection through the efforts of its stakeholders is welcome to enter and strive towards GG Designation.

And finally, the most effective GG stakeholders welcome and embrace diverse members and provide meaningful activities to each team member from the beginning. The team's diversity, inclusiveness, and partnerships reflect the nature of groundwater itself as a shared resource. As result, it is appropriate that a groundwater meeting such as this explore both hydrologic and human connections. By focusing on the importance of stakeholders in the groundwater protection process, we are explaining why we are protecting groundwater as well as expanding our vision of how we can do so.

I'll close with a poem by Walter McDonald—a good Irishman that perfectly expresses this idea:

> "And when it doesn't rain, we water, pumping the purest water three hundred feet straight up from nothing we've ever seen, raising bumper crops by faith alone. Even in snow we sit in firelight and watch our fields fill up, stranded these dark evenings between towns and miles from mountains, but knowing wherever others on the road a mile away are going; we are there."

WATERSHED PROTECTION: A BETTER WAY

Richard I. Coombe, Director
Watershed Agricultural Council, Inc.
Walton, NY 13856-9751 USA

Abstract
The NYC Watershed: Watershed Agricultural Council Programs

Outstanding water quality links farmers in the Catskill Mountains to more than nine million consumers of New York City's water supply. This link is manifested in the Watershed Agricultural Program, managed locally by watershed farmers with assistance from New York City. The Program promotes "whole farm planning". This holistic approach, which balances water quality protection and economic viability for farmers, is a reliable and cost-effective partnership for protecting water quality. The Watershed Agricultural Program reconciles environmental, economic and public health concerns based on scientific research and local leadership. New York State, the New York City Department of Environmental Protection, the US EPA, and the scientific/environmental community endorse it. Forestry, Easements, and Economic Development programs have been implemented to encourage agriculture and forestry as preferred land uses.

The 1989 United States Surface Water Treatment rule specified circumstances and conditions that require filtration of drinking water derived from surface water sources, and criteria that would allow water suppliers to avoid filtration. The rules set specific standards for microbial contaminants, including bacteria, viruses and protozoan parasites. The cost to New York City of filtering its water was estimated at $5 to $8 billion for construction, and $200 to $500 million in annual operation costs. The City, therefore, sought to avoid filtration and the resulting costs by establishing a traditional watershed protection program through a regulation and land acquisition program. In 1990, the New York City Department of Environmental Protection released a discussion draft of new regulations for the watersheds. Hard hit were the farmers of the Catskill/Delaware watersheds. The discussion draft required farmers "to eliminate the surface runoff of storm water from grazing areas into any watercourse; stating as well that the "discharge of drainage from barnyards, feedlots, and yarding areas into any watercourse...is prohibited".

The stage for confrontation was set! An alternative to filtration under the Surface Water Treatment Rule was for the City to develop a comprehensive watershed management program. Any such program needs local cooperation and support. High motivation based on self-preservation and survival, plus a willingness to take a risk on both sides, led to dialogue. The following consensus was developed. It would be far better for New York City to "withdraw the proposed regulations on agriculture" and implement "a voluntary, locally developed and administered program of best management practices." The program is proceeding in phases.

Website: www.nycwatershed.org

WATERSHED PROTECTION:
A BETTER WAY

The objectives of the Ground Water Protection Council and the Safe Drinking Water Act are: "to promote and expedite the voluntary use of pollution prevention practices, to identify existing private sector support, and to aid rural residents in taking actions to reduce pollution risks". Our experience in the New York City watersheds since 1990 is a real life demonstration of these objectives being carried out. Our unique program and partnership structure provides a basis for a new and better way to protect America's rural surface and groundwater supplies. I welcome the opportunity to tell our story and to suggest a model for future watershed protection.

HISTORIC OVERVIEW

The natural beauty of the watersheds and their proximity to New York City has encouraged land development. Indeed, the mid-Hudson valley and the Catskill Mountain regions of New York State are among the most beautiful and desirable places to visit and to live in the entire country. Close to the City, development has been very rapid, resulting in high-density subdivisions and increased pollution. For example, since the Second World War, suburban development in the Croton system has caused serious degradation of the reservoir.

In 1850, a growing, thirsty New York City looked northward for a clean, reliable source of potable water. The Croton system (1850) supplies 10 percent; the Catskill system (1920-30) and the Delaware system (1950-60) provide the other 90 percent of the City's water supply. New York City, through the power of eminent domain, took our valleys and forced entire hamlets and surrounding farms to be physically moved to the hillsides. Historic neglect and broken promises fostered tension and distrust between watershed residents and New York City regulators. In fact, this reservoir development has left a legacy of distrust and even hatred of the City.

The New York City water supply system is the largest surface storage and supply complex in the world, covering over 1,900 square miles or 1,216,000 acres of land area. The watersheds yield 1.2 billion gallons of water daily. The water has traditionally been of such high quality that it has been singled out for awards. In addition to its residents, the City supplies drinking water to one million residents in upstate counties, as well as millions of daily commuters, tourists and visitors to the City.

In 1906, New York State law gave the right to New York City to oversee and regulate upstate watersheds. In 1953, New York City updated and upgraded their watershed regulations but chose an enforcement strategy of benign neglect. In 1986, the Federal Safe Drinking Water Act required filtration of surface water systems. Think of the difficulty of New York City complying with the Safe Drinking Water Act. Imagine filtering 1.2 billion gallons of water daily . . .

The 1989 Surface Water Treatment rule specified circumstances and conditions that require filtration of drinking water derived from surface water sources, and criteria that would allow water suppliers to avoid filtration. The rule set specific standards for microbial contaminants, including bacteria, viruses and protozoan parasites. The cost to New York City of filtering its water was estimated at $5 to $8 billion for construction, and $200 to $500 million in annual operation costs.

The City, therefore, sought to avoid filtration and the resulting costs by establishing a traditional watershed protection program through a regulation and land acquisition program.

CONFRONTATION

In 1990, a discussion draft of new regulations for the watersheds was released by the New York City Department of Environmental Protection. The residents of the watersheds were asked to accept superimposed, costly, and onerous regulations. The traditional watershed protection methods of strict regulations, enforcement by police power and land acquisition were once again being used to protect the City water supply and/or to save $5 to $8 billion dollars in filtration costs.

The residents of the watersheds saw a clear and present danger to life as they know it, a threat to their roots, hopes and dreams. Once again, a new generation was to be abused by an unsympathetic city.

Especially hard hit were the farmers of the Catskill/Delaware watersheds. The discussion draft required farmers "to eliminate the surface runoff of storm water from grazing areas into any watercourse", and stated that the "discharge of drainage from barnyards, feedlots, and yarding areas into any watercourse...is prohibited". Watercourse was defined as "any perennial river, stream, creek, spring, pond, lake, wetland...". In short, if strictly enforced, the 1990 regulations doomed agriculture as a land use in the New York City watersheds. In addition, agriculture was singled out as a source of non-point pollution and blamed as a major source of giardia and cryptosporidium.

The stage for confrontation was set! A series of debates took place between Commissioner Albert Appleton of the NYC Department of Environmental Protection and members of the agricultural community. As a member of the New York State Assembly, I debated vigorously against the regulations.

My perspective was straightforward. The highly developed and suburban Croton watershed (Westchester, Putnam and Duchess counties) required filtration. The Catskill and Delaware, less densely populated watersheds, were so clean that the water met avoidance criteria. The current low-density land use patterns based on agriculture, forestry, and tourism were indeed desired land uses, as demonstrated by the quality of water supplied from the Catskill/Delaware watersheds.

If the 1990 regulations were adopted and enforced, agriculture and forestry would be forced to sell to the highest bidder. The resulting subdivision of the land would result in the "Crotonization" of the Catskills, resulting in degradation of the City's water supply and assuring filtration. We believe crops, grassland, agriculture and forestry as land uses, are environmentally preferable to subdivisions.

Civil War loomed.

ACTION

An alternative to filtration under the Surface Water Treatment Rule was for the City to develop a comprehensive watershed management program. Any such program needs local cooperation and support.

Adversity fosters creative invention. The City was facing $5 to $8 billion dollar filtration costs and the watershed farmers were facing elimination. The stage was set. High motivation based on self-preservation and survival, plus a willingness to take a risk on both sides, led to dialogue. Then Department of Environmental Protection Commissioner Appleton and the agricultural community agreed to establish an inter-agency/farmer task force to be convened by the NYS Department of Agriculture and Markets to address the 1990 discussion draft regulations. The challenge for the policy group of the Ad Hoc Task Force was to recommend regulations and/or programs that protect New York City's water supply, while also sustaining the long term viability of agriculture within the watersheds. Agriculture was quickly acknowledged as a preferred land use.

The Task Force had three goals: to improve mutual understanding of the laws and public policies that shape the City's watershed program, to review and advance the scientific basis of farm planning conceived to protect water quality, and most importantly, the farmers business interests, and to explore ways in which the City may work in partnership with farms and the network of agricultural support institutions to encourage a sustainable farm economy in the watersheds, yet achieve the City's water quality objectives. The challenge for the Technical Support Group was to provide technical information and provide practical input on ways to address the agricultural elements of policy.

The following consensus was developed by the Task Force. Farming in the New York City water supply watersheds presents a complicated environmental management problem. Farm practices are a potentially significant source of non-point source pollution and present a risk of pathogen introduction. Farm practice pollution control is critical for meeting the City's anti-degradation objectives, as well as the avoidance criteria of the Federal Surface Water Treatment Rule and the State Filtration Rule. On the other hand, farming is a preferred land use with significant long-term environmental benefits, and the City wants to take all appropriate steps to support it. This represents a significant challenge since agriculture is a rapidly declining industry in the region. However, with the application of the best scientific understanding, we hope this decline can be reversed while we meet water quality aims.

They concluded it would be far better for New York City to "withdraw the proposed regulations on agriculture" and implement "a voluntary, locally developed and administered program of best management practices". Compulsion will not succeed with fiercely independent farmers, and the program should be a voluntary one based on providing incentives to farmers to participate. A willful and negligent pollution clause remains in the regulations.

PROGRAM MISSION STATEMENT

To assist the agricultural community in adopting operational and management techniques which environmentally protect water quality, as well as enhance economic competitiveness and viability. The Program will champion a Whole Farm Planning process that strengthens working relationships between landowners, New York City, local, state, and federal government, and the agriculture-support infrastructure.

The Watershed Agricultural Council (WAC) was established in 1993 to promote voluntary participation of the landowners and farmers in the New York City (NYC) watershed area. As a 505c3 not-for-profit corporation, the Agricultural Council is a partnership between watershed farmers and New York City Department of Environmental Protection that balances pollution prevention, economic viability, and public health concerns. It enables farmers and woodland owners to control their own destinies while protecting the quality of New York City's water supply. WAC has two main programs: Agriculture and Forestry, which are now considered a successful model for utilizing partnerships to resolve conflicts about privately owned natural resources. WAC Chair, Richard I. Coombe, recently traveled with the USDA to the World Summit on Sustainability as a U.S. delegate to provide technical advice on successful partnership programs.

PRIMARY OBJECTIVES

Allow the New York City water supply to continually meet water quality protection policies of New York State, City and Federal law.

Promote improved understanding of the impacts that innovative, practical, field-tested solutions to individual farm situations have on water quality.

Encourage a high level of voluntary project participation by demonstrating, promoting, and educating producers on the economic and environmental benefits of Whole Farm Planning.

Advance the reality that a vibrant agricultural economy of well-managed farms is preferred and compatible with maintaining and protecting water quality in the watershed.

Foster community pride, enthusiasm, and empowerment through local leadership and involvement in a nationally recognized, innovative, cooperative approach to a highly complex environmental situation.

Identify, develop and present farmland retention incentives that recognize the benefits of a strong agricultural base to the local economy and the watershed communities.

*The Program began with the desire to meet water quality protection policies to ensure continued safe drinking water for nine million consumers of water from the New York City water supply system.

*Well-managed farms are the building blocks of the Program. Whole Farm Plans combine water quality protection measures with business, strengthening measures to fulfill the Program's dual purpose of water quality protection and business enhancement.

*A vibrant agricultural economy depends on those well-managed farms, a supportive infrastructure, and effective marketing of farm products.

*The Program is voluntary, based on incentives, such as withdrawal of the City's proposed regulations for agriculture. The Program sought to attract participation by 85 percent of the watershed's farms by 1997. If that goal had not been met by 1997, then the City and the Watershed Agricultural Council were required to review progress to determine what changes might be needed, including the implementation of a regulatory approach to protecting the water supply from agricultural pollution.

*Local leadership will improve participation by keeping the "ownership" of the Program within the watersheds. The WAC is the key non-governmental, farmer-guided leader.

WATERSHED AGRICULTURE PROGRAM

Our vision is clear. Maintaining well-managed agriculture is a superior way to protect water quality in the New York City watersheds as part of a comprehensive watershed protection program. A voluntarily involved farmer, aided technically and financially to match their business activities more closely to New York City's needs, is one of the best water quality protection agents that New York City can have. The high quality of the water yielded by the Catskill and Delaware system watersheds, sufficient to meet federal filtration avoidance criteria, is supported by the current low intensity land uses and land management patterns, including agriculture.

The Program has proceeded in phases which are largely funded by the City of New York. From 1992-1994, we developed and implemented demonstration "Whole Farm Plans" based on scientific research and technical data, for ten pioneering farms in five counties. The plans applied and tested multiple ways to manage pathogens, nutrients and sediment. The plans also aided farms as businesses. We have monitored and evaluated the process very carefully so it will develop in accordance with the needs of our farmers and New York City. As a result, a comprehensive farm management program was established under the title, "Whole Farm Program". The Program is endorsed by New York State agencies, New York City, the farmers themselves and the Environmental Protection Agency.

The Watershed Agriculture Program promotes Whole Farm Planning and utilization of Best Management Practices (BMP's) that protect the land and the water supply. The Farm Program utilizes the expertise of soil and water conservation specialists, civil engineers, agricultural engineers, architects, and stream area (riparian) technicians. These people work to create whole farm stewardship plans to protect the water and the land, in due respect to the landowners agriculture objectives. Most of the funding comes from NYC and covers farm improvements. Approximately 350 dairy and livestock farms operate throughout the watershed, in addition to some 90 other agricultural enterprises. Participating farmers agree to maintain the improvements made to their farms for a period of 5 years. Ninety two percent (92%) of the watershed farms are presently registered in the Program.

Conservation Reserve Enhancement Program (CREP) is a voluntary program that protects sensitive steam side land by placing it riparian forest buffers for ten to fifteen years. In return, farmers receive annual rental payments and reimbursement for establishing good conservation practices like livestock fencing, stream crossings and alternate water sources. CREP improves water quality by removing animals and providing filtration for surface water. This reduces sediment, decreases fertilizer/pesticide runoff, and improves wildlife and aquatic habitat.

Small farm operations in the watershed vary widely and grow a range of products from meat, eggs and vegetables to Christmas trees and maple syrup. Presently more than 200 of a possible 600 small farms have enrolled to learn about best management practices for water quality while gaining new access to technical assistance through contact with WAC

The Watershed Forestry Program (WFP) of the Watershed Agricultural Council is funded by the USDA Forest Service (USFS) as well as New York City funds. WFP develops and supports economic development strategies to encourage the retention and growth of the forest products industry. The **Watershed Forestry Economic Action Program** benefits to the forestry sector by funding and partnering in research, technology transfer, infrastructure development, secondary processing of forest products and development of "value-added." To date, 30 grants have been awarded to wood-based businesses in the Watershed region, for a cost-share investment of over a million dollars.
Through a partnership with the USFS (**Forest Stewardship Grants Program**) and the existing contract between the Watershed Agricultural Council and NYC Department of Environmental Protection (DEP), the Watershed Forestry Program offers funding, technical expertise and services, planting stock material, equipment loans and rentals to forest landowners and loggers in the areas of forest management planning, stream banks enhancement (riparian area delineation and management), forest road construction and/or remediation through the application of Forest BMP's.

Research, technology transfer, education and outreach are strategic elements of the Watershed Forestry Program aimed at forest sustainability and water/soil protection and conservation. WFP has developed a network of four demonstration and research sites included in a **Model Forests Program**. Dr. Rene Germain (rhgermai@mailbox.syr.edu), of SUNY ESF, heads this program. The Model Forest sites offer research and education opportunities, and are utilized in conjunction with other WFP activities for landowner, logger and professional forester training and accreditation.

Education and information on forest sustainability, working forests, biodiversity in the Catskills, and water resource protection in the watershed is offered to the general public and target clienteles (media information, editorial board visits, bus tours for visitors, academia, reporters and decision makers, traveling information kiosks at local fairs, semi permanent kiosks at strategic locations and service centers on thruways, and other entry points of the watershed. The Watershed Forestry Institute for Teachers is being run in tandem with a Green Connections program in environmental education for school clientele's upstate (Catskills) and downstate (New York City).

The Farm Easement Program offers farmers with approved Whole Farm Plans the opportunity to sell development rights on land they own. This program preserves farmland in perpetuity by offering Agriculture Conservation Easements while maintaining present land use. It provides incentives for family farms to continue operating in a competitive market environment and prevents land use conversion to commercial, industrial or residential development. It prevents parcelization and provides immediate economic benefits with estate planning guidance for participating farmers. The Watershed Agricultural Council is currently in the process of reviewing the policy and mechanisms of property easement rights acquisition to include land rented by active farmers, and forested properties and working woodlots into the Easement Program.

The Watershed Agricultural Council has a web site that will give further information about these programs and the people involved at www.nycwatershed.org. Our partners in education and environmental protection: the New York City Department of Environmental Protection (NYC DEP) www.ci.nyc.ny.us/dep, the Catskill Watershed Corporation www.cwconline.org, the Catskill Forest Association www.catskillforest.org, the Catskill Center for Conservation and Development www.catskillcenter.org, the Natural Resource Conservation Service (NRCS) www.ny.nrcs.usda.gov and the New York State Department of Conservation (NYS DEC) www.dec.state.ny.us

TOOLS OR CONCEPTS THAT CAN BE REPLICATED

Our five common principles of success include: Active participation by all stakeholders, relevant and personal link of projects to those impacted most, critical reflection on and evaluation of projects and constant changes in program, envisioning the development process including commonality of interests and dealing with inevitable conflict, and dialogue – including listening skills and communication skills. There exists a constant need for action, equity, a holistic and systems approach, and empowerment.

Oversight and accountability require five evaluation criteria and a watershed specific approach. The criteria include farmer participation, acceptance, implementation and maintenance of Whole Farm Plans by farmers, reduction of phosphorus and parasite loading risk from farm to watercourse, efficacy of Whole Farm Planning and the implementation process, and science of whole farm planning.
WAC internal accountability is based on operation and maintenance, annual reviews, spot checks, implementation oversight, biannual peer-to-peer evaluation and program evaluation. Written work deliverables and performance measurements are critical.

Challenges include measuring behavioral change, continually balancing regulations against cooperation; securing research that validates BMPs, and dealing with short-term contracts.

Many valuable lessons have been learned. It is critical to include all stakeholders, to meet goals and deliverables, to integrate water quality and economic viability, to apply sound science, and to think long term.

Public outreach has resulted in 92% participation of eligible large farms, provided strong support from regulatory and environmental communities, yielded peer-to-peer signups, and the withdrawal of initial regulations with the proviso that regulations shall be promulgated if the program fails.

CONCLUSION

The Watershed Agricultural Council and its professional staff are privileged to work on programs that are cutting edge and widely recognized. The environmental community realizes the importance of

biodiversity in areas surrounding the major cities of the world to protect water, open spaces, environment, wildlife, and scenic beauty. All too often biodiversity falls victim to an expanding city. When WAC was formed, we never realized we were fighting a battle for the very survival of our environment, farms, forests, and the city itself.

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THE THREE RIVERS PROJECT – INVOLVING STAKEHOLDERS IN WATER MANAGEMENT

Suzanne Dempsey; M. C. O'Sullivan and Company Ltd. (MCOS).

Abstract

The Three Rivers Project is a government initiative to develop catchment based water quality monitoring and management systems for three of Ireland's major river catchments, the Boyne, Liffey and Suir, with the primary objective to halt deterioration in water quality and to restore "good ecological status" to the 3 systems. In line with the Water Framework Directive, the Project encouraged the involvement of all major stakeholders in the development and implementation of the management system. Relevant stakeholders were identified following detailed characterisation of the river catchments and the pressures influencing the current water status of those systems. A major challenge for the project was to foster a sense of ownership among stakeholders of both the problems and solutions facing water management into the future, without which the successful implementation of management measures aimed at all sectors of the community would be in doubt.

This paper examines the methods used to identify major stakeholders and foster this ownership and involvement. It also identifies constraints to successful implementation of water management on a catchment/river basin scale.

INTRODUCTION

The EU Water Framework Directive advocates an integrated approach to the management of all water environments on a catchment basis. It also advocates the consultation and involvement of stakeholders and the public in water management. Based on this approach, and given the significant interactions between surface, marine and groundwater environments, the involvement all stakeholders in each water environment is essential to achieve an integrated management system. Thus the lessons learned from water management projects such as the Three Rivers Project, which focused primarily on the management of surface waters, are applicable to the management of groundwater and other water environments.

Indeed stakeholders in groundwater are similar to, if less numerous than, those in surface waters. However, establishing ownership of water management (quality/quantity) problems among groundwater stakeholder tends to be more difficult as the causes, pathways and effects of poor management on groundwater are less visible than on surface waters.

THE THREE RIVERS PROJECT

The Three Rivers Project is a government initiative to develop catchment based water quality monitoring and management systems for the Boyne Liffey and Suir catchments. The Three Rivers Project focused on the management and reduction of nutrient pollution to surface waters in these catchments with the emphasis on the reduction of phosphorus load and the key target stakeholders being those contributing to diffuse pollution. Physico-chemical and ecology quality was the primary concern with water quantity a secondary consideration, except in the Liffey catchment where the abstraction of large volumes of water for Dublin's water supply and the management of the river for hydro-electricty generation has a significant influence on water quality and ecology.

The Project was supported by the European Union Cohesion Fund and sponsored by the Department of the Environment and Local Government (DOELG). It was carried out on behalf of the government by a group of consultants led by MCOS under the guidance of a single Steering Group and an Operational Management Group for each catchment. Field teams were deployed in each catchment supported by a technical and management team and two Project Co-ordinators (Boyne/Liffey and

Suir) providing an interface between the Client and the Consultant Team. The project commenced in 1998 and the Project Final Report was published in November 2002. The catchment monitoring systems continue to be implemented by local authority personnel based in Project laboratories in Trim (Boyne and Liffey) and Clonmel (Suir). The Suir monitoring and management systems will be incorporated into the South-eastern River Basin District Project and the Boyne and Liffey systems into the Eastern River Basin District Project. The River Basin District Projects are the next phase in the Irish government's implementation of the EU Water Framework Directive.

The Three Rivers Project Final Report is available on the project website; www.threeriversproject.ie

THE MAJOR STAKEHOLDERS IN THE BOYNE, LIFFEY AND SUIR CATCHMENTS

For the purposes of the Three Rivers Project relevant stakeholders were defined as;

- Those charged with the legal responsibility for managing the status of the river systems (quality, quantity, ecology/natural heritage)
- Beneficial users of the systems
- Those carrying out activities which exert direct or indirect pressures on water status of the systems, referred to as "pressure users"

with many stakeholders falling into the each of the three categories.

Under current legislation the Local Authority has the primary responsibility and authority for managing water status in Ireland. The Regional Fisheries Boards have the statutory authority for the protection of fisheries resources while Dúchas the Heritage Service has statutory authority for the protection of natural heritage. The Office of Public Works is responsible for hydrological management of rivers covered by the Arterial Drainage Act (e.g. the Boyne system) while the EPA is responsible for national environmental monitoring programmes including surface waters and for IPC licensing of discharges.

Major beneficial users include those abstracting water, fishermen, amenity and water sport users, natural heritage and hydroelectric generation. These users are represented by statutory bodies such as Local Authorities (most major drinking water abstractions), Dúchas and the Regional Fisheries Boards and by clubs and community associations.

Activities that exert direct or indirect pressures include regulated and unregulated point source discharges, land management practices which can result in diffuse discharges such as agriculture, forestry, land spreading of sludges and slurries and peat abstraction, rural housing and industrial and private abstractions or impoundments. These "pressure users" are represented by Local Authorities, semi-state companies such as Cóillte, the ESB, Bórd na Móna and organisations such as the Irish Farmers Association, Teagasc and IBEC.

A "Sensitive Areas" map was produced for each of the Three Rivers catchments identifying water bodies that may be considered particularly sensitive to pollution due to current or future beneficial uses (water abstraction, fisheries resources, amenity and natural heritage importance).

Landuse maps, L.A. databases (Section 4 discharge licences, Section 12 notices, water abstraction, municipal wastewater treatment discharges), EPA IPC registers and the Forestry Services database were used to identify and map direct and indirect pressures in the three catchments. The percentage of land falling into different landuse categories and the percentage contribution of each sector to the overall (nutrient) pollution load in the rivers were calculated in order to identify the major "pressure users" and target management measures for maximum effect.

Agriculture accounts for 75 to 91% of landuse in the three catchments and accounts for approximately 60% of the pollution load. Urban development accounts for only 1 to 7% of the landuse in the catchments but municipal discharges from wastewater treatment plants account for up to 19% of the pollution load. Licensed discharges account for up to 14 % of the pollution load while rural populations relying on septic tanks contribute up to 8 % of the load. Thus the major "pressure users" were identified as the agricultural community and regulated point source discharges. *See Figure 1.*

INVOLVING STAKEHOLDERS IN THE MANAGEMENT SYSTEM

The Steering Group of the Three Rivers Project was composed of Stakeholders with the legal responsibility for managing our river systems;

- The Department of the Environment and Local Government,
- The lead Local Authority for each of the catchments; Meath, Kildare and Tipperary SR.
- The EPA
- The Central Fisheries Board.
- The project co-ordinators

It was felt (by the consultants) that the Group would have been more balanced if the "poachers" (i.e. the pressure users) as well as the "game keepers" were represented, the Local Authorities largely choosing to ignore their alternative role as "poachers". The Department of Agriculture, Food and Rural Development are the obvious candidate for future Steering Groups. Ways to resolve possible inter-departmental conflicts of interest such as the implementation of agricultural practices that can impact on the environment, the implementation of cross compliance on grants and subsidies or the authority to source useful information such as the LPIS (Land Parcel Identification System) database, could best be discussed and resolved at Steering Group level.

The Operational Management Group (OMGs) for each catchment, who's brief was to advise the Steering Group and Consultants on matters pertinent to specific catchments and act as conduits between the project and stakeholders, was composed of all three stakeholder categories. A list of the stakeholders involved is given in Table 1. Representatives from three of the major farming organisations were co-opted onto the OMGs in the second year of the project to represent grass roots farming interests. The one major stakeholder that was not represented on the OMGs was industry as the focus of the project was primarily on diffuse pollution.

The consultants felt that the full potential of the OMGs was not utilised during the project and that a more active role for the OMGs in delivering the implementation of agreed management measures would have enhanced the outcome of the project. Similarly we understand that there was frustration on the part of the OMG members who felt that their suggestions were not always implemented.

In the project Final Report a **proposed Management Structure** for future management of water resources at catchment or river basin district level is proposed. The structure is similar to that of the Three Rivers Project management structure but with an enhanced implementation role for the OMGs. The structure is headed by a Management Group comprising the main constituent L.A. whose role it is to determine management policies and strategies and ensure and audit implementation. The implementation of these policies and strategies would be carried out by an Implementation Group composed of representatives of all major stakeholders (legal, beneficial and pressure users) in the catchment/district. Each representative would have the responsibility and authority to ensure that relevant management measures are implemented by the stakeholders they represent and would be answerable to the Management Group, should regular audits identify gaps in implementation. The Management and Implementation Groups would be assisted by a panel of Experts and a Support Team providing advice and support services. A schematic of the proposed Management Structure is shown in *Figure 2*.

Stakeholder Participation and Public Information Programmes were implemented by the project at individual stakeholder level and aimed at a broad range of stakeholder sectors. These campaigns were somewhat limited by the funding available for this work within the project.

1. The most demanding of these in terms of time and resources was the development and implementation of **Best Farm Management Plans** in pilot mini catchments in the Boyne and Suir catchments. The aim of the programme was two fold; firstly to engender environmental responsibility and ownership of water management among the agricultural community in these catchments by illustrating "cause and effect" and secondly to ensure that suggested measures were implemented so that the impact of such measures could be monitored.

Following protracted negotiations with farm organisations and individual farms over 133 farmers, who were not participating in REPS (Rural Environmental Protection Scheme), took part in the programme and in fact farmers from an area adjacent to one of the mini catchments successfully lobbied to be included in the programme. A further 75 farmers who were participating in REPS also participated in farm surveys

Each farmer participating in the scheme received free agri-environmental advice and soil sampling and participated in the development of a farm management plan. Plans were developed on a field-by-field basis and included a hydrological risk assessment of overland or sub-surface run-off from each field if slurry was spread during unsuitable weather conditions. Each field was colour coded and mapped, the highest risk fields being those with poorly or excessively drained soils which were in close proximity or directly connected to water courses. Advice on the appropriate period for land spreading was related to the risk coding and the overall storage capacity requirement of the farm was related to the hydrological risk of its spreadlands with a minimum requirement of 16 weeks.

A farmyard assessment was also included and recommendations made on remedial/improvements works for each yard to minimise environmental risk and maximise slurry storage capacity with minimum cost, e.g. diverting clean rainwater from the roofs of farm buildings away from slurry tanks and minimising the open areas assessable by livestock in the yard.

Farms were visited on 3-4 occasions over an 18-month period and received a hard copy farm plan in spreadsheet and map format at the end of that period. The methods used to calculate storage capacity, nutrient requirements and spreading regions were also made available to the farmer. A number of "Republic" Progress meetings were also held in each pilot catchment and were well attended.

The success of the programme in terms of raising awareness of environmental issues is not in doubt. However, its success in terms of continued implementation of the plans in the coming years and their success in reducing water pollution can only be confirmed by continued regular auditing and monitoring.

2. To compliment the Agricultural Stakeholder Programme outlined above, **training programmes** were **run for Local Authority staff** that are responsible for carrying out farm surveys aimed at identifying pollution risk. These programmes included training in the computer programme developed by the project to produce the individual farm management plans. It also included on site training in farmyard surveys and hydrological risk assessment. The project recommended that all farms would have a best farm management plan. Ideally Local Authority staff should have the capacity to audit any farm plan and check its implementation.

   Around 50 staff from constituent Local Authorities in the 3 catchments took part in the training courses. The project received positive feedback from the Local Authorities though many participants felt that they would not have the resources to audit farm plans on an individual basis.

3. Because **rural housing** is estimated to be a significant contributor to pollution, an information booklet on the proper operation and maintenance of **septic tanks** and other single dwelling treatment systems was produced by the project. The booklets adopted a light-hearted and pictorial approach to getting the message across to the average householder, accessibility rather than technical detail was the emphasis. The booklet was distributed to households in each of the pilot catchments. However no "follow up" surveys were carried out to estimate the effectiveness of these booklets.

4. One of the most successful programmes instigated by the project in terms of participation and feedback was "**The Happy Fish Campaign**" aimed at primary & secondary school children. The targeted audience was both the children and their parents who covered a broad spectrum of stakeholders. The primary school children were given a simple presentation about the sources of pollution effecting the health and happiness of fish living in our rivers. They were given a "fish"

to colour in and their parents asked to sign the fish giving an undertaking to keep the fish happy by only using detergents that are phosphate free. All the happy fish were then places on a paper river making a colourful picture to exhibit on the classroom wall and keep the idea alive in the children's minds.

A **work pack** was also devised for secondary school children illustrating the impact of polluting substances on the freshwater environment and how the community could avoid water pollution. Students were also encouraged to pass on the message by implementing the "Happy Fish Campaign" in primary schools in their own area. These work packs were passed to Environmental Education Officers in each of the constituent Local Authorities.

Field trips for secondary school children were also organised and students were given the opportunity to examine the current health of a river stretch based on the composition of benthic fauna in the river.

5. **Presentations** on the project were given to interest groups, statutory bodies and at a number of conferences over the course of the project. Considerable interest was generated among "Fishing Clubs" based in the catchments who are major beneficial users of the river systems.

6. **A Project website** was developed giving details of the project and posting the most recent project reports. Unfortunately resources were not available to make this site interactive.

MANAGEMENT MEASURES

The Three Rivers Project identified a suite of management measures to minimise the impact of all major "pressure users" in the three catchments. The measures include;

- **Capital Investment** (upgrading of WWTPs, improvements in farmyard infrastructure and storage, Sustainable Urban Drainage Systems)
- **Statutory Measures** (licensing and regulations, planning control, Bye-laws, cross compliance in grant aid/subsidies, Polluter Pays Principle)
- **Voluntary Agreements and Schemes** (Codes of Good Practice, Rural Environmental Protection Scheme (REPS))
- **Public Awareness/Environmental Education** programmes aimed at all sectors of the community

Measures are proposed for managing municipal wastewater, trade and industrial discharges (regulated point sources), urban drainage and septic tanks (unregulated point sources) and agriculture, forestry, peat abstraction and land-spreading of municipal and industrial sludges (diffuse sources).

The programme for implementation of these measures in each of the catchments is prioritised on a geographical basis based on the following factors;

1. **Current Water Quality** - with priority given to areas where poor water quality and/or high nutrient load is identified (*aimed at achieving compliance with Phosphorus Regulations, Nitrates Directive and Water Framework* Directive) based on physico-chemical and biological monitoring.
2. **Sensitivity of Water Resource** – priority given to areas of "beneficial use" with high sensitivity to pollution (*aimed at protecting specific water resources*)
3. **Risk Characteristics** - priority given to "high risk" areas where intensification of existing activities or new activities may lead to deterioration in water quality in the future (*forward planning aimed at avoiding problems in the future*).

CONSTRAINTS TO SUCSSFUL MANAGEMENT OF WATER RESOURCES

Based on the experience of the Three Rivers Project and other water resources management projects we can identify a number of key constraints to successful management that are largely inter-related.

- The **lack of implementation** of measures and recommendations. Quite simply management measures can only be effective if implemented properly and their success evaluated if effectively audited. Significant resources have been expended on municipal wastewater treatment systems, farmyard improvement schemes and REPS over the last number of decades with little significant improvement in our river waters until very recently. It is difficult, however, to judge whether it is the management measure or the implementation which has been unsuccessful.

- **Lack of resources** is frequently the major reason for lack of implementation. The implementation of measures proposed by the project will require significant manpower and monetary resources to be made available to Local Authorities. Improvements in farmyard infrastructure such as increasing slurry storage capacity may require significant investment for individual farmers many of whom will argue that in today's climate they simply don't have the resources to farm in an environmentally sustainable manner.

- **Political commitment** is required to allocate sufficient resources for effective implementation for water management. Furthermore, political commitment is needed to ensure that legislation is enacted to enforce measures that may be unpopular with certain sectors of the electorate, such as the designation of Nitrate Vulnerable Zones, Planning restrictions to limit rural housing near lakes and sensitive water bodies etc.

- **The continuity of management systems,** structures and measures must be maintained in order to be effective in managing water environments. Frequently, the momentum gathered and effort expended on initiatives such as the Three River Projects is lost due to lack of continuity. Where possible The Three Rivers Project utilised established monitoring stations in their monitoring networks and proposed management measures utilising available statutory measures and structures. There is a danger however that the impetus created among stakeholders during project will be lost if monitoring systems, management measures and pilot studies are not continued by the River Basin District Projects.

CONCLUSION

The Three Rivers Project has provided a testing ground for the implementation of the "participatory approach" to water management advocated by the Water Framework Directive. The Project successfully involved a broad range of stakeholders in the identification and pilot implementation of management measures and the lessons learned form the project will be useful in implementing future integrated approaches to water management.

However, the ownership of the causes and solutions to water quality problems has yet to be firmly established with many stakeholders, particularly those contributing to diffuse pollution. Continued monitoring of water quality and auditing of the implementation of Best Farm Management Plans in pilot catchments of the Three Rivers will be significant in establishing cause and effect pathways among agricultural stakeholders.

The successful implementation of management systems in the three catchments now rests with the relevant Local Authorities and statutory bodies. The suite of management measures proposed relies heavily on the implementation of statutory regulations. Strict application of these regulations is required to improve water quality. The availability of resources at a governmental and individual stakeholder level and the political commitment to apply proposed regulation will have a major influence on the successful outcome of these systems.

Table 1

THE THREE RIVERS PROJECT PARTNERS

The Three Rivers Project is sponsored by the Department of the Environment and Local Government, with 85% financial support from the European Union Cohesion Fund.
The project is jointly administered by Meath County Council, Kildare County Council and Tipperary (S.R.) County Council.

The overall project is managed by a Steering Group, which consists of representatives of the following organisations:

Environmental Protection Agency

Department of the Environment and Local Government

Central Fisheries Board

Kildare County Council

Meath County Council

Tipperary (S.R.) County Council

The project is being carried out in partnership with the following constituent Local Authorities in the catchment :

Cavan County Council

Cork County Council

Drogheda Borough Council

Dublin City Council

Fingal County Council

Kildare County Council

Kilkenny County Council

Limerick County Council

Louth County Council

Meath County Council

Offaly County Council

South Dublin County Council

Tipperary (NR) County Council

Tipperary (SR) County Council

Waterford City Council

Waterford County Council

Westmeath County Council

Wicklow County Council

Other participating agencies are :

Bord na Móna

Coillte

Department of Agriculture and Food

Dúchas

Eastern Regional Fisheries Board

Electricity Supply Board

Forest Service

Geological Survey of Ireland

Irish Cattle Traders and Stockowners Association (ICSA)

Irish Creamery Milk Suppliers Association (ICMSA)

Irish Farmers Association (IFA)

Local Government Computer Services Board

Office of Public Works

Southern Regional Fisheries Board

Teagasc

The Three Rivers Project is 85% funded by the European Union Cohesion Fund

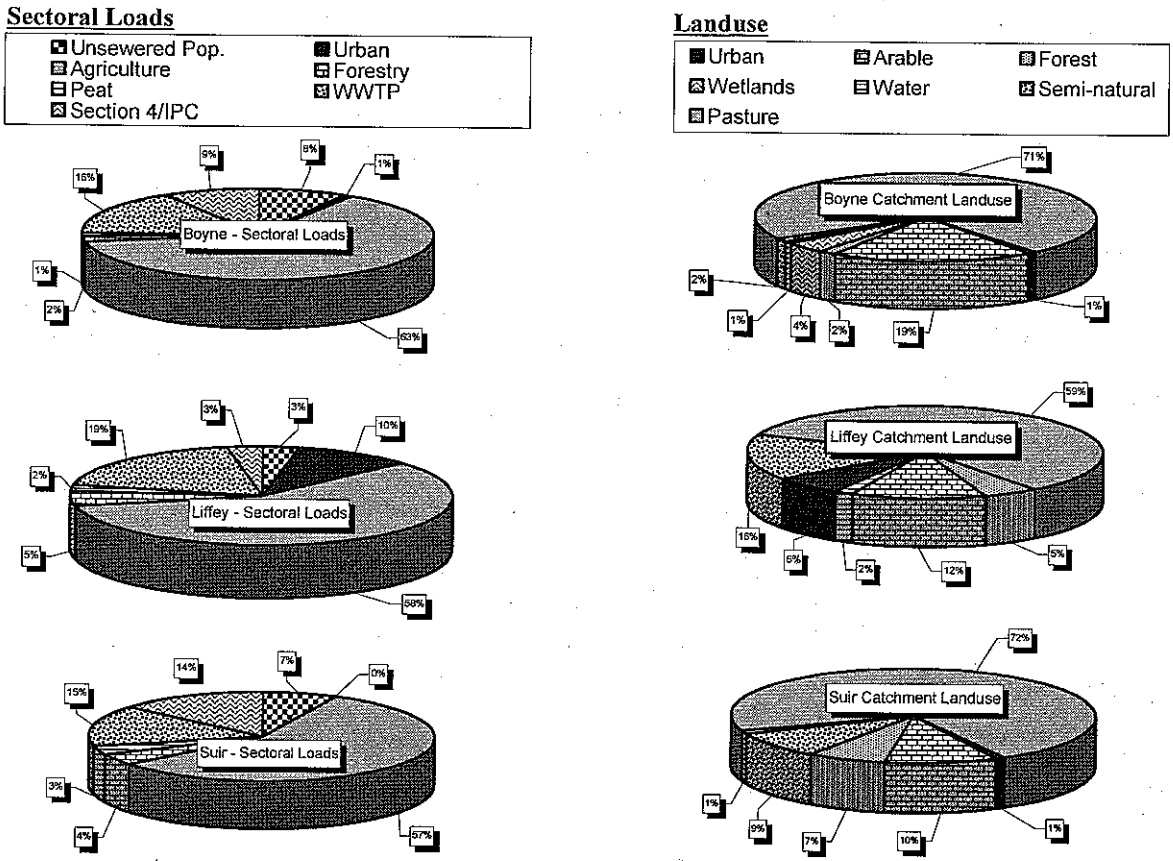

Figure 1. Sectoral Pressures (TP Loads) and Landuse

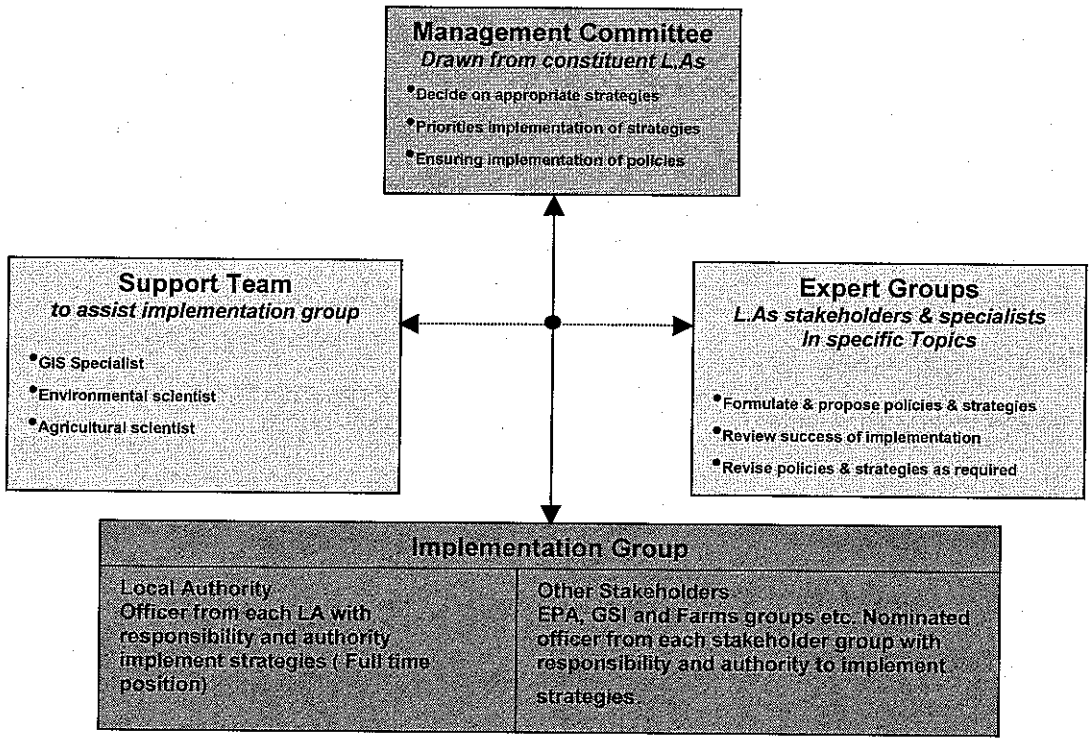

Figure 2. Proposed Management Structures - Catchment / Regional Scale

SESSION II: FOCUS ON GROUNDWATER ISSUES IN IRELAND

EPA ORAL HEARINGS AND GROUNDWATER

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ABSTRACT

The EPA as part of its statutory function, licences activities with a potential for causing pollution. In carrying out its licensing function the EPA from time to time decides to conduct Oral Hearings to air objections to draft decisions taken by the Agency. This paper briefly describes the process that leads to a decision to hold an Oral Hearing and describes the Agency's experience with Oral Hearing to-date. Groundwater issues have been a feature of some but not all of the Oral Hearing and these experiences are also described. They are many stakeholders involved in conducting an Oral Hearing these include the applicant, the resident, the consultant, and the legal team. All of these parties aim to present their best case at the Oral Hearing, this paper provides some observations on how to derive the most benefit from their involvement.

INTRODUCTION

As most people are aware the Environmental Protection Agency is an independent public service organisation, established in 1993. The statutory obligations of the EPA are set out in the Environmental Protection Agency Act, 1992, the Waste Management Act, 1996 and other legislation. The brief of the Agency includes the following:

- Licensing and regulating activities specified in legislation with a potentially high risk of causing pollution.
- Enforcing environmental legislation in specified areas in both private and public sector activities.
- Monitoring and reporting on the state of the environment.

In carrying out its brief of licensing the Agency decides from time to time to conduct an Oral Hearing of the objections received on a proposed decision on a waste or IPC facility. In 2002 the Agency conducted 3 Oral Hearings on Proposed Decisions for Waste facilities. The increase in Oral Hearings has given rise to an awareness of the role of Oral Hearings in the Agency's decision making. While the decision to hold an Oral Hearing is at the discretion of the Agency the increase in applications for new large waste recovery and disposal facilities in new locations does give rise to the potential for more Oral Hearing been held in the future.

This paper aims to review briefly the context in which Oral Hearing are held and what participants can expect at an Agency Oral Hearing. This paper details the outcome of previously held Oral Hearings and focuses on the Groundwater issues that were raised at these Hearings. The paper concludes with some observations on how groundwater professionals can learn from the se past experiences.

OBJECTING TO A DRAFT WASTE LICENCE

The process of applying for a Waste licence has been well documented in previous EPA publications and will not be dealt with in any detail in this paper; however, it is worth reviewing the main milestones to an Oral Hearing once a Proposed Decision has been made by the Agency.

After a Proposed Decision (draft Licence) has been issued there is a period of 28 days for lodging objections with the Agency or requesting an Oral Hearing. The Objection must be in writing and state in full the grounds of the objection and the reasons, considerations and arguments on which they are based. Each valid objection received by the Agency is then circulated to the applicant and all other persons who have lodged valid objections.

The decision to hold an Oral Hearing

The decision to hold an Oral Hearing rests solely with the Agency and while there are no specific statutory criteria that govern the decision to hold an Oral Hearing the following criteria are taken into consideration:

- New issues not previously raised that are specific to the location or the development.
- The sensitivity of the location/local environment.
- Whether it is a matter of national or regional importance.
- The scale or complexity of the development.
- Significant new information.

If the Agency decides to hold an Oral Hearing it will appoint a person to act as chairperson and advise all the relevant parties of the date and venue of the Hearing. The chairperson has total discretion as to the conduct of the Hearing but in any event the Hearings are informal and provide a forum for the expression of objections and concerns about the Proposed Decision. Electronic recording is generally not permitted.

WHAT HAPPENS AT AN ORAL HEARING?

Format of Oral Hearing

In general Oral Hearings to date have followed the following format

- Opening of the Hearing by the Chairman.
- Presentations of evidence by the applicant and objectors.
- legal submissions and Closing statements.

Opening of the Oral Hearing the Chairman

In general the Chairman will use this opportunity to introduce the Oral Hearing team consisting of the Chair, assistants and legal advisor. Following on from that will go through a few formalities such as declaring the hearing to be open, read out letters of appointment and determine the objectors that are present. A brief summary of the application history is read out followed by a discussion on the number of witnesses and order of presentations.

Presentation of evidence

Since the Oral Hearing is required to be an informal one, participants are asked to give their evidence without undue formality, and in non-technical language where possible. In giving evidence witnesses are usually asked to

- Highlight the areas of importance or areas that they wish to draw the chair's attention to.
- Emphasis new information and
- Minimise repetition

All witnesses are open to cross examination by the chair and other parties as are members of the public; however, the public are generally restricted to giving evidence until after the formal parties have given theirs.

The Chair can require evidence to be given under oath or require Objectors, Agency or Local Authority staff to attend the Oral Hearing and to produce documents in their control.

Legal Submissions and Closing Statements

These submissions are generally restricted to legal opinion on points of law and are not open to cross-examination. Whereas closing statements are an opportunity by the rest of the participants to reiterate the key points of their earlier presentations. Again closing statements are not open to cross-examination. It is worth noting; however, that the Hearing can be adjourned or resumed with appropriate notice or re-opened on the instructions of the Agency;

AFTER THE ORAL HEARING

The Oral Hearing Report

On completion of an Oral Hearing the chairperson will submit a report of the Hearing to the Agency which will include a recommendation as to the granting of a waste licence. The recommendation can be to grant the licence unchanged from the draft decision, to refuse the licence or to grant the licence with a number of amendments. Copies of the report on the Oral Hearing to the Agency are available to the public.

The final Decision

In making the final decision the Board of the Agency has sole discretion whether to accept or reject, in its entirety or in part, the recommendation of the Chair. After the final Decision has been made any person can apply to the High Court and seek leave to apply for a judicial review of the validity of a decision of the Agency within two months of the date on which the decision was given.

THE EXPERIENCE OF THE AGENCY WITH ORAL HEARINGS

The details of all the Oral Hearings held by the EPA to date are included in Annex 1 and 2 of this paper. A few facts are worth noting:

- Nine hearing have been held to date.
- 3 for IPC facilities 6 for waste activities.
- two Decisions have been appealed to the high Court, one successfully.
- All recommendation has been different from the draft decision.
- Two recommendations have been to refuse a licence despite inspector recommendations to grant.
- One recommendation has been to grant a licence despite an Inspector recommendation to refuse.
- 7 Board decisions have agreed with the Chairman's recommendation with amendments.
- One Board Decision was to refuse despite the Chairman's recommendation to Grant.
- Two Decisions are currently with the period allowed for judicial review.
- One oral hearing report is currently awaited.
- 8 of the 9 Hearings were chaired by EPA Staff.

GROUNDWATER ISSUES THAT AROSE AT EPA ORAL HEARINGS

In the following section the groundwater issues detailed in a number of Oral Hearings reports are presented. Nine major issues were identified within three areas these were as follows:

1. Characterisation
   - Quality of the groundwater aquifer.
   - Groundwater characterisation in the EIS.
   - The Quality of baseline groundwater assessment.
   - Monitoring well construction and infrastructure.
2. Control of impacts.
   - The monitoring of Groundwater.
   - Effects of groundwater pumping on riverbank, fish and agriculture.
3. Remediation of impacts.
   - Concerns over the safety of private wells.
   - Sources of groundwater contamination.
   - Remediation measures.

Hardbog, Grangemockler, County Tipperary

Following the Agency's decision to grant a licence with amended conditions for a landfill facility at Hardbog, Grangemockler, County Tipperary, the decision was successfully appealed to the High Court. The decision was subsequently withdrawn by the Agency and the application is currently being considered again.

Groundwater issues identified in the Oral Hearing Report

- artesian conditions in the groundwater creating difficulties in the construction of the landfill.
- the use of groundwater as a water supply for the site.
- The quality of the Aquifer in terms of groundwater flow, area of recharge, depth to groundwater, transmissivity values obtained and the boundaries of the aquifer.
- The response of the well to pumping.
- The resultant discharge of groundwater into the river and the direct/indirect effects such as erosion of the river banks and the impact on river stocks.
- The extent to which these works were described in the EIS.

Chairman's assessment

- He stated that with a hydraulic trap the piezometric level of the groundwater would be higher than the head of leachate within the waste and that any leakage through the liner will result in the ingress of groundwater, rather than the egress of leachate. He considered that the presence of such a hydraulic trap would be beneficial for the protection of the environment.
- He noted the difficulties posed by the presence of such artesian conditions in the engineering of the facility and the measurement of the piezometric level of the groundwater in the fractured zone of the bedrock for the purpose of monitoring the hydraulic head.
- He indicated that the methods for the construction and testing of some of the wells did not comply with best practice.
- He required the re-assessment of the design of the stormwater retention pond to ensure that it provides sufficient capacity for the retention.

Safeway Warehousing Ltd.

The application was for a waste licence pertained to a hazardous waste storage facility and transfer station, and associated activities including blending, mixing and repackaging of waste for recovery and disposal. The proposed maximum annual quantity of waste is circa 32,000 tonnes.

Groundwater issues identified in the Oral Hearing Report

- Potential contamination of private wells and the contamination source, pathway and receptor.
- Monitoring requirements for groundwater.
- The quality of the aquifer.

Chairman's assessment

The Inspector recommended that the condition of site surfaces be revised in addition to the degree of monitoring including baseline monitoring. The inspector also addressed the lack of bunding.

Landfill at Tullybardan, Mohill, Co. Leitrim

The application was for a waste licence was for a landfill, and associated waste activities, for the recovery and disposal of Municipal Waste and Industrial Non-Hazardous Waste. The proposed maximum annual input of waste was 7,500 tonnes. While no specific groundwater issues were raised the Chairman determined that there was a significant risk of environmental pollution to surface and groundwaters by allowing the disposal of municipal waste without the landfill being lined. He also recommended that, in the absence of any specific lining proposals, it would be in contravention of Section 40(4) of the Waste Management Act 1996 to allow landfilling. He recommended the closure and restoration of the landfill immediate effect.

Mr P Kiernan, Mullaghboy, Kilnaleck, Co Cavan

The application by Mr P Kiernan, Mullaghboy, Kilnaleck, Co Cavan was to operate a 550 sow integrated pig rearing unit at Drumrockady, Corlesmore, Co Cavan. In refusing this application three reasons were given by the Board:

- This development would add to the pollution burden on the environment and increase the risk of significant environmental pollution.
- The standards for water quality in the Local Government (Water Pollution) Act, 1977 (Water Quality Standards for Phosphorus) Regulations, 1998 (S.I. 258 of 1998).
- This development does not represent BATNEEC considering the proposed location of the activity and the associated spreading activity.

In recommending that the Board grant the licence the Chairman made a number of recommendations including the following:

- That the Teagasc 1998 Nutrient recommendations are employed in Nutrient Management Planning.
- That the landbank increase to 150% of units requirement prior to the commencement of the activity.
- That a feed additive be used to improve the animals absorption of phosphorus.
- That a $25m^3$ /ha single load application limit be required on lands in the Erne Catchment.

The Board's final Decision was to refuse a licence.

Knockharley landfill

The application was for a landfill designed to receive 180,000 tonnes of waste per annum for disposal over an operating life of approximately 14 years. The proposed development is on a 135 hectare Greenfield site.

Groundwater issues identified in the Oral Hearing Report

- Concerns were raised about the base groundwater quality assessment.
- Any rise in groundwater levels would impact on adjacent tillage activities.
- Level of testing to determine groundwater levels.

Chairman's Assessment

- Determined that Groundwater was adequately protected by the measures described within the Licence.

AES Oral Hearing

The application was for a waste transfer station, recycling facility, and proposed burner unit for the disposal and recovery of some 23,000 tonnes of non-hazardous waste per annum. at Deerpark Crossroads, Ballymorris, Kilbride, Portarlington, Co. Laois.

Groundwater issues identified in the Oral Hearing Report

- The presence of nickel and DRO in the groundwater.
- Regionally Important Aquifer.
- Source of contamination industrial Vs agricultural.
- Natural levels of parameters in soils.
- the need for additional monitoring and boreholes.
- Remediation measures.
- Detection and concentration limits for sample parameters.
- Safety of private water wells for drinking.

Chairman's assessment

In reaching his recommendation the Inspector noted that:

- The Geological Survey of Ireland has classified the underlying aquifer as regionally important and the groundwater vulnerability at the site as extreme.
- There was a continuing risk of environmental pollution from the drainage system that discharges into a percolation area.
- Site activities were impacting on groundwater quality.
- Groundwater movement was towards the River Barrow with nine springs discharging 2,000m^3 per day to the river.
- There were potential users of groundwater down gradient of this facility.

The Chairman recommended that the licence be refused and that Laois County Council require the applicant:

- To carry out a detailed groundwater risk assessment and remediate the groundwater pollution linked to the facility.
- To clean up the area around the oil tank and remediate any contaminated soil.
- That a closure plan for the facility be prepared and implemented.

INTERACTING WITH THE ORAL HEARING PROCESS

In reviewing the Oral Hearing Reports prepared by the EPA a number of conclusion can be drawn on participation at Oral Hearing. It would appear that oral hearing bring about change from the original Draft Decision, indeed in some cases this change is substantial. If this is the case then the challenge is to bring about the changes that are most beneficial for the environment and also for the participants. Some suggestions are given below:

Preparation for an Oral Hearing

- Review recent submissions, draft and final licenses, objections and technical committee reports for similar activities.
- Review previous Oral Hearing Reports.

Technical Aspects

- Use extensive Local Knowledge on issues such as wildlife, flooding, underground drainage, previous uses of land and farming practices.
- expertise may be required to develop understanding of the more complex issues.

Community

- Dual approach is sometimes required (seeking a refusal but also influence on decision).
- Investigate benefits for the community.
- Restoration and aftercare .
- Landscape features that will have long term benefit.
- Transfer of land.

Making Submissions

- Talk to other Residents Groups.
- Study the Arguments that were made by other Residents groups.
- How did inspectors address these arguments?
- Review the inspector, Technical committee and Board Decision.
- Note differences between inspector, chairman and Board views.
- Suggest revised wordings of conditions.
- Look for the lack of detail, location, frequency, method.
- Quality over quantity.
- Avoid repetition.

CONCLUSION

The Oral Hearing process is essentially a democratic process that allows citizens the opportunity to voice in a public forum their concerns about proposed activities in their area. From this paper it could be concluded that the process as implemented by the EPA is a robust one in which there is an exchange of views and where differences in opinion and interpretation are argued in an non-adversarial fashion. The process is highly transparent and accessible by the Public.

Where Groundwater issues are discussed it would appear that there are a number of issues that arise repeatedly and where the real concerns of residents not been addressed. This present a challenge for groundwater professionals engaged in the design, implementation and regulation of Waste and Industrial Activities.

ACKNOWLEDGEMENTS

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REFERENCES

Report on Waste Licensing 1997-1999 - EPA
Waste Management Licensing: Aspects of Licensing Procedures: Objection, Oral Hearings - EPA
Annual Report and Accounts 2001 - EPA
Oral Hearing reports for the Facilities listed in Annex 1 -EPA

ANNEX 1

Oral Hearings Held by the EPA				
Year	Applicant	Facility	Location	Reg. #
1996	Roche Ireland Ltd. formally Syntex	hazardous waste incinerator	Clarecastle Co Clare	12
1997	Aughinish Alumina Ltd	Alumina Plant	Askeaton Co. Limerick	35
2000	Tipperary South Riding County Council	Landfill	Hardbog, Grangemockler, Co. Tipperary	19-1
2000	Safeway Warehousing Ltd	hazardous waste transfer station	Fermoy, Co. Cork	50-1
2000	Mr P. Kiernan	Piggery	Mullaghboy, Kilnaleck, Co Cavan	295
2001	Leitrim County Council	Landfill	Tullybardan, Mohill	65-1
2002	Celtic Waste Ltd.	Landfill	Knockharley, Co Meath	146-1
2002	AES	Transfer Station	Ballymorris, Kilbride, Portarlington, Co. Laois.	96-1
2002	Cork Co. Co.	Landfill	Bottle Hill Co. Cork	161-1

ANNEX 2

The final Decisions arising from Oral Hearings held by the EPA					
Applicant	**PD** Decision	**Oral Hearing Report** Recommendation	**Final Determination**	**Judicial Review**	**Supreme Court Appeal**
Roche Ireland Ltd. formally Syntex	Grant a licence with Conditions	Grant a licence with Amended Condition	Grant a licence with Amended Condition	1997 application for review 1998 application refused	1999 agreement with High Court
Aughinish Alumina Ltd	Grant a licence with Conditions	Grant a licence with Amended Condition	Grant a licence with Amended Condition	none	none
Tipperary South Riding County Council	Grant a licence with Conditions	Grant a licence with Amended Condition	Grant a licence with Amended Condition	Application for review Decision Withdrawn	None
Safeway Warehousing Ltd	Grant a licence with Conditions	Grant a licence with Amended Condition	Grant a licence with Amended Condition	none	none
Mr P Kiernan	Refuse a Licence	Grant a licence with Amended Condition	Refuse a licence	none	none
Leitrim County Council	Grant a licence with Conditions	Refuse a licence	Refuse a licence	none	none
Celtic Waste Ltd.	Grant a licence with Conditions	Grant a licence with Amended Condition	Grant a licence with Amended Condition	Within the period	N/a
AES	Grant a licence with Conditions	Refuse a licence	Refuse a licence	Within the period	N/a
Cork Co. Co.	Grant a licence with Conditions	N/a	N/a	N/a	N/a

"SITE SUITABILITY ASSESSMENTS FOR ON-SITE WASTEWATER MANAGEMENT" – RELEVANCE OF A MULTI-DISCIPLINARY TRAINING COURSE

Donal Daly[1], Frank Clinton[2], Vincent Fitzsimons[1], Margaret Keegan[2], Billy Moore[3], Ger O'Leary[4] and Kevin Sheridan[5]
[1] Geological Survey of Ireland; [2] Environmental Protection Agency; [3] Monaghan County Council; [4] National Roads Authority; [5]FÁS.

ABSTRACT

Effluent from on-site wastewater treatment systems for single houses poses a significant threat to human health and the environment in Ireland. The location and design of these systems is an important land-use planning issue, which has generally not received sufficient priority to-date. Our complex and variable geology and hydrogeology further complicates decision-making. The EPA Manual on treatment systems for single houses and the groundwater protection responses provide the guidance to enable the proper location of on-site systems. However, even with these documents, decision-making requires multi-disciplinary expertise and the use of expert judgement – the 'cook book' or 'get a number' approaches are not feasible. The FÁS Course 'Site Suitability Assessments for On-site Wastewater Systems' provides the opportunity to give specific training to site assessors in all the relevant topics – geology (bedrock, subsoils and soils); hydrogeology; risk; groundwater and surface water quality; site characterisation by means of a desk study, visual assessment, trial hole test and percolation test; and septic tanks, mechanical aeration systems, percolation areas and filter systems. The challenge now is to ensure that the trained staff are used as a crucial component of decision-making.

BACKGROUND

ON-SITE SYSTEM EFFLUENT – A SIGNIFICANT HAZARD

Effluent Quality

Conventional septic tank systems produce an effluent that poses a significant threat to both human health and the environment, particularly through the entry of the following contaminants to groundwater and surface water:

- Microbial pathogens like bacteria, viruses and *Cryptospiridium*; perhaps 10^7 - 10^8 total coliforms per 100 ml of the effluent (EPA, 2000).
- Nitrogen; perhaps 50 mg/l as N. in the effluent.
- Phosphorus; perhaps 10 mg/l as total P. in the effluent.

Advanced systems provide additional treatment in reducing BOB and COD (i.e. organic matter), however a significant hazard still remains in the wastewater, particularly from microbial pathogens.

Effluent Quantity

Over 50 million gallons of effluent, from over 1.2 million people, are produced by on-site systems daily. This effluent is disposed of in the ground. In addition, almost 36% of new houses in recent years are 'one-off', using on-site wastewater treatment systems. Many tens of thousands of new houses in the coming years will use on-site systems in unsewered areas. Advanced systems do **not**

reduce the quantity of effluent generated. Clearly, when the quality and quantity are combined, the hazard posed by on-site wastewater treatment systems is significant.

GROUNDWATER WATER QUALITY

The degree of microbial contamination of groundwater in Ireland is very high, probably higher than any other country in the EU. The most recent EPA survey of groundwater quality for the period 1998-2000 (EPA, 2002) recorded positive faecal coliform counts in 38% of samples taken at 134 monitoring stations, and 20% of samples had faecal coliform counts greater that 10/100 ml, indicating gross contamination. It is likely that there are areas in Ireland where more than 70% of private wells contain faecal bacteria at some time during their use. Arguably, microbial pathogens are the single greatest threat to groundwater in Ireland and effluent from on-site systems is likely to be one of the two main potential sources.

While nitrogen in effluent may not be a significant contributor to regional nitrate levels, it can be significant at the local scale, where dilution may not be sufficient to mitigate the effects (Daly and Fitzsimons, 2003). The worst case scenario is in a situation where there is direct recycling of wastewater from the percolation area to a private well. The resulting NO_3 concentration in the well water could theoretically be as high as 220 mg/l. A five-fold dilution would be required to bring the concentration below the EU MAC (50 mg/l). Problems can arise in particular where there is a grouped housing scheme with each site having both a well and on-site system, or where there is a small group scheme or public supply with several on-site systems in the zone of contribution (ZOC).

For many houses in rural areas, private wells and on-site systems are (or for future houses, will be) on the same site or nearby. This is inherently risky, unless the ground conditions are suitable, particularly with regard to the depth to bedrock.

SURFACE WATER QUALITY

Effluent from on-site systems can contribute phosphorus to surface water by both over ground and underground routes. In areas of low permeability soils and subsoils, runoff of phosphorus can occur. In areas of shallow soils and subsoils, infiltration of phosphorus, via preferential flowpaths, can occur to groundwater, which then transmits the phosphorus to surface water. In the recently published Final Report of the Three Rivers Project (MCOS, 2002), unsewered populations were estimated to contribute 7%, 8% and 3% of the Total Phosphorus loss in the Suir, Boyne and Liffey catchments, respectively. Septic tanks are reported to contribute 12% of the estimated sectoral MRP contributions in the Lough Leane catchment in 1999 (Kirk McClure Morton and Pettit, 2000).

ROLE OF IRELAND'S HYDROGEOLOGICAL SETTING

For proper treatment and disposal of wastewater, with minimal environmental and health risks, a minimum of 0.6-2.0 m (depending on the type of system and the hydrogeology) of suitable free-draining soil and subsoil is required. There must be adequate soakage and adequate attenuation. In other words, the depth and permeability of subsoil over bedrock are the critical factors in keeping our groundwater and surface water clean and safe, and the critical consideration in the assessment of site suitability for on-site systems. This is one of the reasons that soakaways are not considered to be suitable for the treatment and disposal of wastewater.

Relevant aspects of the geological and hydrogeological situation in Ireland are as follows:

- Our bedrock is fissured and usually provides little purification once effluent enters the bedrock. Consequently it is critical that treatment occurs in the overlying soil and subsoil (particularly the subsoil as soil often exhibits bypass flow).
- The depth and permeability of the subsoil is highly variable in many areas in Ireland. There are many areas of shallow rock, where there is an inadequate thickness of soil and subsoil to treat

wastewater. This area could be up to 20% of the land surface, although this would include upland areas where housing would not be present.

- Inadequate soakage may be present in the following areas: a) gley soils; b) low permeability subsoils; c) where low permeability bedrock (those underlain by poor (Pu and Pl) aquifers) is present near the ground surface and where there is no layer of shattered bedrock (e.g. some granite areas) causing a high water table in winter; and d) in flat areas (but not river flood plains) due to a high water table.
- Excessive soakage may arise in high permeability sand/gravel, although these areas are likely to be uncommon. In addition, even if the sand/gravel has T values between 1-5 (i.e. adequate according to the EPA Manual (2000)), there is likely to be inadequate attenuation where the thickness of sand/gravel beneath the invert of the percolation pipe is <2.0 m and probably even where it is <3.0 m.
- There is no abstraction regulation for domestic wells in Ireland and the location of most of these wells can only be established by field checking.

The implications are as follows:

1) In Ireland, a significant proportion of the land surface (perhaps up to 40%) is not **readily** suitable for on-site systems.
2) The complex and variable nature of our geology and hydrogeology makes evaluation of site suitability for on-site systems a relatively difficult process, requiring site-specific information and specific expertise in geology and hydrogeology.

TECHNICAL EXPERTISE OF SITE ASSESSORS

In order to be able to carry out an adequate site evaluation, the assessor must have a substantial knowledge of geology (including soils), hydrogeology and sanitary engineering, and should have a 'feel' for water movement in the landscape. Currently, most personnel assessing site suitability are engineers, technicians, architects and environmental health officers, with expertise in specific areas rather than in all the required areas.

EPA MANUAL AND GROUNDWATER PROTECTION RESPONSES

Two recent publications have set out a robust framework for locating on-site systems in a way that minimises their impact on the environment and human health. The Environmental Protection Agency (EPA) published a Wastewater Treatment Manual on Treatment Systems for Single Houses in 2000. This publication is intended to replace S.R.6: 1991 and the various Agrément Certificates. In 2001 the Department of Environment and Local Government (DoELG), the EPA and the Geological Survey of Ireland (GSI) published Groundwater Protection Responses for On-site Systems to accompany the national methodology for producing groundwater protection schemes (DoELG/EPA/GSI, 1999) and to be used in conjunction with the EPA's wastewater treatment manual. Implementation of these publications requires that a multidisciplinary approach is required for site suitability assessments.

FÁS TRAINING COURSE "SITE SUITABILITY ASSESSMENTS FOR ON-SITE WASTEWATER SYSTEMS"

INITIATION OF COURSE

The Course was initiated by Billy Moore, Donal Daly and Kevin Sheridan in the mid to late 1990s due to concern about the impact of on-site systems and the level of training of site assessors. The first course was run under the aegis of South Tipperary County Council, and a Steering Group chaired by Mr. Edmund Flynn. Subsequently, three further courses have been organised jointly by the Geological Survey of Ireland and the Environmental Protection Agency. To-date 170 people have undertaken the courses, with 50 (out of the 95 who attended the first three Courses) completing and passing the competency assessments – not all those attending the Course undertake the full competency assessment.

COURSE AIM AND SCOPE

The overall aim of the Training Course is to enable site assessors to have a sufficient knowledge and understanding to be able to carry out site suitability assessments in relation to on-site treatment systems (septic tank systems or mechanical aeration treatment systems) for single houses. The course includes a competency-based assessment of participants on completion.

The course provides:

- A basic practical knowledge of geology (soil, subsoil and bedrock), hydrogeology and contaminant attenuation.
- Information on the risk posed by on-site systems to the environment, and in particular to groundwater and surface water.
- Comprehensive details on site suitability assessment.
- Field experience in assessing site suitability.
- Information on the various on-site systems, including conventional septic tank systems, filter systems, constructed wetlands and mechanical aeration systems.
- A comprehensive manual.

COURSE TRAINERS

In selecting people to prepare the courseware and to deliver the course, a group with a broad range of experience and with specialist expertise in the relevant areas – engineering, planning, wastewater treatment, geology, hydrogeology, soils, risk assessment, water pollution and health aspects – were chosen. The last course, held in 2002, involved the following trainers:

Organisation	**Trainers**	**Topics**
GSI	Donal Daly, Vincent Fitzsimons and Una Leader	Relevant bedrock and subsoils aspects (in particular use of BS5930 to describe subsoils); hydrogeology; risk; site characterisation theory and practice – desk study, visual assessment and trial hole test.
EPA	Frank Clinton, Margaret Keegan, Ger O'Leary, Conor Cleneghan, Darragh Page	Regulatory aspects; practical aspects of site evaluation and selecting treatment options; surface water aspects.
Monaghan County Council	Billy Moore	Desk study; local authority experiences; Agrément Certificates; septic tanks and percolation areas.
Carlow County Council	Gerard Murphy	Percolation test theory and practice.
FÁS	Kevin Sheridan	Health and Safety; competency assessment
Teagasc	Robbie Meehan	Soils
TCD	Bruce Misstear and Cormac Ó Suilleabháin	Hydrogeology and field site characterisation

COURSE DURATION

The course duration is 6.5 days in two segments, including a half day fieldtrip to examine soils and the relevant hydrogeological properties of subsoils, and one day undertaking the three field components of site characterisation – visual assessment, trial hole test and percolation test.

COURSE PARTICIPANTS

The course is intended for professional and technical staff involved in building control, environmental, planning, health and sanitary services areas. Participants may be engineers, planners,

architects, technicians, environmental health officers, hydrogeologists, etc. It is assumed that participants will have been involved with and will have a background knowledge of the siting of on-site systems.

COURSE CONTENT

Content Development

The Course content needed to be:

- Linked directly to the EPA Manual (2000) and the DoELG/EPA/GSI Groundwater Protection Responses (2001).
- Based on existing, suitable courses elsewhere. There are no similar courses in Britain or in continental Europe, consequently it was decided to undertake a study trip to the US (North Carolina, Virginia and West Virginia) where site suitability assessments are given a high priority. Excellent courseware material and advice was obtained, which have been adapted to the Irish situation.
- Presented in a user-friendly, applied, and readily-understandable way, allowing professionals from a wide variety of disciplines to grasp all the key concepts.

In considering the issue of site suitability assessment, it was quickly concluded that the 'cook book' or 'ticking boxes' or 'get a number' approaches are not adequate. This was primarily because of the variability of hydrogeological conditions in Ireland. However, moving away from a 'cook book' approach would inevitably make the course much more difficult to teach (given the criteria above). Site assessors would have to be given a good conceptual understanding of the movement of water and contaminants from an on-site system to potential receptors, as well as a sufficient knowledge of the different treatment options. In essence, site assessors would be expected to be able to visualise, for each site visited, the movement of water on the site in 3-D, as a basis of good decision-making.

Therefore, the structure and content of the course is influenced by the conventional ***source-pathway-target*** model for environmental management and the ***risk*** and ***risk management*** concepts, which are increasingly being used as an aid in decision-making. Particular emphasis is placed on the likely ***pathway***, usually either or both underground in geological materials or overground as ponded effluent and surface runoff. As disposal of effluent is into the ground and as this is the main area for effluent treatment, particular emphasis is given to relevant geological and hydrogeological aspects. Potential ***targets*** **at risk** must be located and potential impacts assessed, with nearby wells and possible ponding given the highest priority. ***Risk management*** is based on consideration of the hazards, assessment of the potential pathways, deciding on the target/s at risk, followed by a response to the risk. This response includes the assessment and selection of solutions and the implementation of measures to prevent or minimise the consequences and probability of a contamination event. The preventive measures may include, for instance: refusing permission, changing the location on a site, engineering measures, requiring an advanced system.

The EPA Manual (2000) includes a 'site characterisation form'. Completion of this form, as part of site suitability assessment, is the single most important means of encouraging and ensuring proper decision-making. Consequently, great emphasis is placed on filling in the form, in a manner that links and integrates the various components, namely, desk study, visual assessment, trial hole, percolation test, treatment options, and conclusions and recommendations.

Course Manual Content

Consisting of a total of 370 pages, the Manual (Daly *et al.*, 2002) provides comprehensive information, practical advice and reference material on all the required aspects. The content is summarised below.

Chapter 2 presents a short background to septic tank systems, which are the on-site system most used in Ireland, advanced systems, which will increasingly be used, and the potential detrimental impacts, both health (written by Martin Beirne) and environmental, from on-site wastewater disposal. It also gives the regulatory and planning aspects.

Chapter 3 introduces the basic geological concepts, vocabulary and skills necessary to enable earth materials to be examined, described and recognised in the site evaluation process. In particular it focuses on the use of BS5930 in describing subsoils.

While effluent is usually introduced to the ground below the topsoil, on occasions it may be necessary to dispose of effluent at shallow depths. Therefore, *Chapter 4* describes the basic concepts of soil science.

Chapter 5 deals with groundwater: groundwater flow; permeability; wells; aquifers; and groundwater quality. As effluent invariably ends up in groundwater and as wells are common, a good understanding of this Chapter and a good conceptualisation of groundwater flow is essential.

Chapter 6 includes a brief description of relevant surface water concepts.

Chapter 7 introduces the concepts of risk, risk management and the *'source-pathway-target'* model for environmental management. These are used as a framework for decision making.

Chapter 8 gives brief details on the hazard posed by septic tank effluent.

"Will the treatment provided by the geological materials be adequate?" This question is critical, so an understanding of what happens to effluent underground is vital. This is described in *Chapter 9*, together with information on the national groundwater protection scheme.

Chapter 10 briefly outlines 'what happens to effluent at the surface'.

Chapter11 is the first of three chapters on site characterisation, giving general guidelines; *Chapter 12* outlines the various elements on the desk study component of site characterisation; and *Chapter 13* gives comprehensive details on the three components of on-site assessment – visual assessment, trial hole test and percolation test.

Chapter 14 gives an introduction to the various treatment options.

Chapter 15 gives extensive details on septic tanks and percolation areas, and includes filter systems.

Lastly, *Chapter 16* deals with mechanical aeration systems.

COMPETENCY ASSESSMENT

As the final component of the Course, course participants may choose to undergo a competency-based assessment. This involves:

- multiple choice questions;
- presentation of site suitability assessments, using the EPA Manual site characterisation form, for two contrasting sites.

CHALLENGES

While at 'first glance' locating on-site systems for single houses may seem a simple, 'low level' area of decision-making, it is in fact a difficult area that can have serious health, environmental and land-use planning implications. It requires: a) knowledge of several disciplines; b) having a good conceptual understanding in 3-D of water (and contaminant) movement; c) use of 'expert judgement' and d) the ability to make a defensible scientific decision in a short period of time, and based on fairly minimal site investigations.

While hydrogeologists are used to considering the 'underground' environment and to visualising sites/areas/regions in 3-D, this is less automatic for other professions. Teaching and enabling this ability is a significant challenge. However, hydrogeologists do not have usually have the relevant expertise on, for instance, the technical aspects of on-site systems.

One of the main initial challenges was to put together a multi-disciplinary, multi-organisational team to prepare and present the course in an agreed, co-ordinated way. Differing personnel experiences, expertises and priorities had to be welded together by means of discussion, developing mutual respect and formulating shared objectives.

CONCLUSIONS

In our view, decision-making on the location and design of on-site systems should follow the requirements of the EPA Manual (2000) and the Groundwater Protection Responses (2001), if environmental and health threats are to be minimised. However, site assessors must be specifically trained so that they can take a holistic, multi-disciplinary approach to site characterisation and system selection. The only way to gain the required expertise currently is by undertaking this Course. We recommend that the medium term (3-4 years) objective should be for local authorities to require that all site assessments be undertaken by a 'competent person'. Someone who has successfully completed the Course and the competency assessment would be deemed to be a 'competent person' in this regard. Consequently, membership of professional bodies, such as the IEI and the IGI, would not be sufficient unless combined with the Course. Achieving this objective will be difficult. However, it will be helped if support is given by the professional bodies.

ACKNOWLEDGEMENTS

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GROUNDWATER GROUP SCHEMES: PAST PRESENT & FUTURE PROBLEMS.

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1 INTRODUCTION

There are many stakeholders in groundwater. In my paper to day I will discuss the very topical Group Water Sector. We will look at the background and need, which brought Group Water Schemes into existence, the poor water quality being experienced by these schemes, European Court of justice ruling and its implication and the solution to this 'issue'. Finally I will give a brief outline of the setting up of the 'Four Counties DBO Bundle' for which Carlow County Council is acting as lead authority.

2 BACKGROUND

The Group Water Sector grew out of necessity from the early 1960's. It was a community involvement programme where with the good intentions of communities (often clergy lead) and a matching grant from central government, communities procured a water source and pipe network. This was seen to be a cost effective mechanism in which to provide water to a community. The thrust of the policy was 'quantity'. In many cases if the water looked clean it was clean!

In parallel to this development the part private Group water Schemes sprang up. These use as their source the local authority mains for providing water and again represented a cost effective mechanism for providing water into an area.

Little if any effort was made in the area of water quality. Source protection and treatment were not high on the agenda. In the majority of schemes no treatment whatsoever took place, in a handful of schemes sodium hypochlorite was used (it will be seen later in my paper that this is not an acceptable form of treatment though sodium hypochlorite or equivalent must be used after treatment of water to maintain its quality within the pipe network). In all some 6000 group schemes were developed throughout the country. These schemes varied in size from two house schemes to 500+ house schemes.

3 WATER QUALITY

In January 1998, the EU Commission believing Ireland was not respecting the EU drinking water directive, issued a letter of Formal Notice signalling its intent to take proceedings at the European Court of Justice. The then Environment Minster, Noel Dempsey, stated, "we do have a problem with group water schemes" (1). He added that problems with private group water schemes are added to by the fact that poor records relating to their quality and maintenance exist. Following tests by the EPA during the coarse of 1998 it was finally revealed that some 42% of Group Water Schemes were contaminated by faecal material.

3.1 EUROPEAN COURT OF JUSTICE RULING (2) AND ITS IMPLICATIONS

The Advocate General of the European Court has rejected Ireland's defence of the infringement proceedings brought by the EU in 1998 under the Water Quality Directive [80/778/EEC] (3). Ireland had claimed that the Directive does not impose an obligation as to the result to be achieved, but "merely an obligation of diligence, to be assessed in the light of the principle of reasonableness and proportionality". More than 40% of the Group Water Schemes in Ireland are polluted and a significant number of public supplies also fail to meet the Directive's Standards.

The Opinion sustains three complaints.

1) Ireland has not ensured compliance with the parameters of the Directive in relation to the public water mains network and certain parts of that network in particular.
2) Ireland has not ensured compliance with the parameters concerning total and faecal coliforms of the Directive in relation to certain Group Water Schemes.
3) Ireland has no binding national legislation, which it could apply to Group Water Schemes.

Of particular concern to the Irish authorities, who have put up a stiffer fight than usual, will be the Opinion's firm and detailed rejection of the Irish defence that Group Water Schemes do not come under the scope of the Directive, as they are "private" rather than "public".

In reality, the Opinion concludes, Group Water Schemes are established and managed with the approval and under the control of the public authorities, which on top of everything else finance them, because "they can thereby fill the gaps which exist in the public system of water distribution".

Opinions of the Advocate General are the final step before the Court Judgment, which is expected later this year. At this point, Ireland will face the possibility of daily fines for continuing non-compliance with the Water Quality Directive. Precedent for this form of ruling comes from the ECJ ruling against Greece (4), in which works were not carried out on a dump and a penalty of €20,000/ day was laid down. This fine is still being paid out three and a half years later. It was indicated at the time that Ireland would be allowed a further 24 months to rectify the situation before penalties would be levied.

In parallel to informal advice to the Department of the Environment, the Commission has supported FIE's arguments that the Irish authorities are wrong to concentrate solely on "end of pipe" solutions rather than protecting the quality of the water source. This advice suggests that chlorination itself can be a source of problems and that ignoring the protection of water sources exposes Ireland to further infringement proceedings under this Directive for allowing a "deterioration of water quality".

The only exception to the above ruling are Group Schemes which serve less that 50 persons or supply less than 10 cubic meters of water per day.

Details of schemes which are covered by the above ruling

County	Sources	Schemes
Carlow	15	15
Cavan	28	28
Clare	13	12
Cork North	18	17
Cork South	16	11
Cork West	8	7
Donegal	28	28
Galway	135	134
Kerry	15	15
Kildare	7	7
Kilkenny	19	18
Laois	25	16
Leitrim	27	27
Limerick	70	49
Longford	10	10
Louth	10	10
Mayo	146	145
Meath	2	2
Monaghan	13	12
Offaly	21	19
Sligo	15	15
Tipperary Nth	48	40
Tipperary Sth	4	3
Waterford	4	4
Westmeath	2	2
Wexford	12	8
Wicklow	13	10

In total there are 500 Group Water Schemes, which must comply with the EU (drinking water) Directive. This represents approximately 55,000 households (quarter of a million people).

3.2 THE SOLUTION TO THE PROBLEM

3.2.1 Legislation

There are three sections of legislation, which together remove any ambiguity as to the quality, water is to be produced to and whom is responsible. These are the EU (Drinking water) Directive which states that water is a foodstuff; the new drinking water regulations (SI 439/2000) stating the QUALITY which must be achieved; and the New Water Services Bill requiring that all GWS be licensed to produce and distribute water.

3.2.2 Monitoring of Water Quality

The then Minster Noel Dempsey eluded to the fact that little if any records pertaining to water quality was available on schemes in 1998. Following a major Raw Water Quality testing programme on Group Water Schemes in 2001/2002 a base line of water quality (at the source) was ascertained. Testing on all schemes is now carried out on a two monthly basis, at a point approximately two thirds of the way along the pipe network (to comply with EU Legislation). Finally all schemes will have to operate a Performance Management System (PMS) (5) in order to receive and renew their licences as allowed for under the New Water Services Bill. One of the functions of the PMS will be to catalogue water quality tests, both post treatment and at point of use.

3.2.3 Treatment of Raw Water

Treatment on schemes will be procured using Design/Build/Operate contracts. These contracts are based on the 'FIDIC' conditions of contract. The Employers Representative (Consulting Engineer) produces the contract documentation in such a manner so as to provide the bidders with the maximum flexibility in relation to the treatment process that can be afforded. Under the procurement rules the type of treatment cannot be specified. If the process offered is capable of treating the raw water (not experimental) to comply with the National Drinking Water Regulations and it is also the most economically advantageous solution then that is the process that has to be accepted. This is an example of the 'Black Box Solution' and the detailing of the performance specification is critical.

The DBO will:

- Produce water in compliance with SI 439/2000 365 days a year
- Best whole value (O & M contracts are for 20 years)
- Conventional and Innovative technology
- Shorter time scale

Features which will be common to all DBO Water Treatment Works:

- All supplies will have FULL treatment.
- The number of elements to the treatment process will vary depending on the quality of the raw water.
- All supplies will have disinfection with Sodium Hypochlorite or equivalent to complement full treatment
- All supplies will have a contact tank to allow the chlorine to take effect
- Balancing storage equal to 24 hours usage will be provided through the contract.

However to take the concept to a greater level of efficiency DBO contracts will be 'bundled' together. The advantages to be gained by 'bundling' DBO contracts together are:

- The reduction of the overall number of projects (from 500 to 50)
- More attractive to contractors as the value of the contract/O&M contract is greater.
- Due to the greater 'buying' strength Group Schemes can expect savings in the order of - O & M 20%; Capital cost 20%

3.2.4 What progress has being made to date?

- Active Implementation 23,000 houses
- Planned Implementation 10,000 houses
- Government Policy
- Construction of Plants:
  Monaghan (6,000 domestic consumers)
- Clients Reps appointed for Bundles in:
  Mayo (3,500)
  Sligo (2,000)
  Galway (1,200)
  Clare (2,500)
  Limerick (2,500)
  Cavan (5,000)Four Counties Bundle (2029+)

3.2.4.1 Brief Background to the Four Counties 'DBO Bundle'

Approximately twelve months ago we in County Carlow along with our colleagues in Counties Kilkenny, Wexford and Wicklow began information meetings with our respective Group Water Schemes (those of which fell within the requirements of the EU Directive 98/83). The impact of existing and up coming legalisation was discussed at length. The schemes were left in no doubt whatsoever that there was major work to be done. Some schemes, and I must admit the majority, grabbed the opportunity to up grade and modernise their schemes with both hands. However a number of schemes required more persuasion. The schemes were informed of the grants, which would be made available, and what exactly their contributions would be.

Grant for Mech. & Elec. Items 100%
Grant for civil works,Employers Rep., land purchase.....85%
Duration of contract.....20years
Operational subsidy.....€198/house.

All schemes signed up to become part of the bundle and these are listed below.

Scheme			No. of houses	Non-domestic	Approx consumption
Carlow Area					
Ballyloo			32	2	23
Ballyellen			37	1	27
Crann/Newtown			22	17	65
Killerig/Strboe			77	13	132
Knock/Ballyglisheen			16	16	45
Nurney			33	0	24
Ballinabrannagh			223	9	160
Glynn/St. Mullins			122	88	590
		total	**562**	**146**	**1066**
Wexford Area					
Blackstairs			700	200	?
Borromounrh			83	7	?
Mullown			16		
Templeudigan			170	48	?
		total	**969**	**255**	
Wicklow Area					
Ballingate	Carnew		27	3	?
Tombrean			33	15	?
Tomchork			55	7	?
Askanagap			17	3	?
		total	**132**	**28**	
Kilkenny Area					
Castlewarren			114	30	443
Windgap			46	9	70
Cuffsgrange			40	8	50
Ovenstown			48	18	110
Castleinch			16	0	13
Ballycallen			102	46	364
		total	**366**	**111**	1050
This represents 21 schemes, 2029 houses and 7.5% of the national issue to be addressed.					

Very quickly it became apparent, based on information received from the pilot schemes in County Monaghan, that for a DBO to be cost effective the number of houses involved needed to exceed a certain 'critical mass'. It was accepted that this number was 1500 houses.

In examining the above table it is quite obvious that the Four Counties had to approach the issue as one 'DBO Bundle' and following a meeting in September 2002 in Wexford County Hall this approach was adopted.

Carlow County Council will act as lead authority in this project. A Section 85 agreement has being drawn up vesting the relevant powers of the participating counties in Carlow County Council, apart from planning. Carlow County Council will now appoint a project manager for the project and a steering committee.

The Project Manager and Steering Committee will prepare the schemes for DBO.
Items, which require immediate attention:

- Fitting of bulk meters
- Clarification of land ownership and relevant way leaves
- Access to relevant sources
- Appointment of Employers Rep. (Consulting Engineer)

and later;

- Appointment of Contractors.

4 Conclusion

Ireland is acting on the findings of the ECJ. The Group schemes are playing their part to regularise the situation (their contribution to the cost approx. 15%). The Group Schemes will require much more proactive response from its members. In this year alone the allocation from the department will increase from €52m to €100M as stated by Minster Cullen and the issue will be resolved during 'his watch'.

However this is the beginning of the process. Items to be tackled in ascending order of importance are:

- Source Protection - this can be addressed along side DBO
- Conservation - critical if only from an economic stand point.
- Metering - all non domestic consumers must be metered by Jan. 1st 2006

5 REFERENCES

(1) Sunday Tribune 3rd January 1998 - paragraph 5.

(2) Judgement of the Court (Sixth Chamber), 14th November 2002,' Failure of a member state to fulfil its obligations'

(3) Directive 80/778 was subsequent ally replaced by Council Directive 98/83/EU

(4) Case C-215/98 - Commission V Greece (1999)

(5) Circular L17/02 - 30th

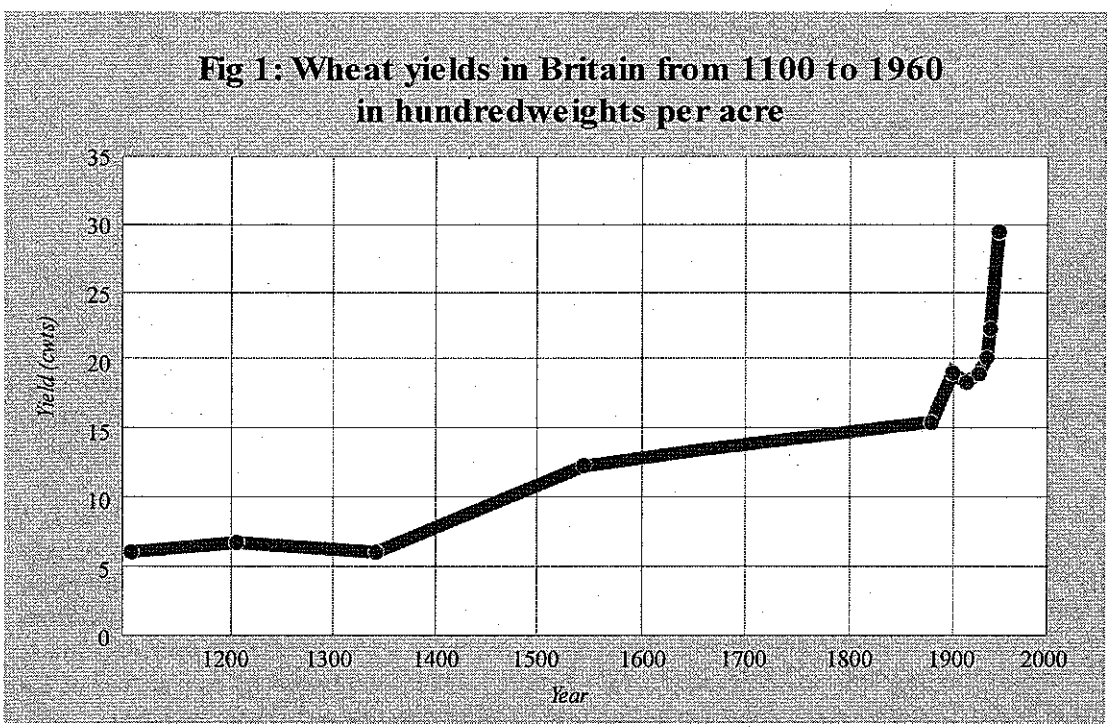
GROUNDWATER ISSUES – THE FARMER'S PERSPECTIVE

Matt Dempsey, Editor, Irish Farmers Journal.

1 INTRODUCTION – PRODUCTION AGRICULTURE

Rising populations and increasing urbanisation result in increasing demands for food, water and heat and in the production of large amounts of human and animal wastes. Agriculture has had to respond to these challenges. The driving force behind much intensification of production has been an increased demand for meat products as standards of living increase and economies of scale are realised in production by "clustering" large numbers of animals in small geographic areas. Modern agriculture is based on intensive use of fertilisers and (in arable farming) herbicides and pesticides to obtain high crop yields of consistently high quality.

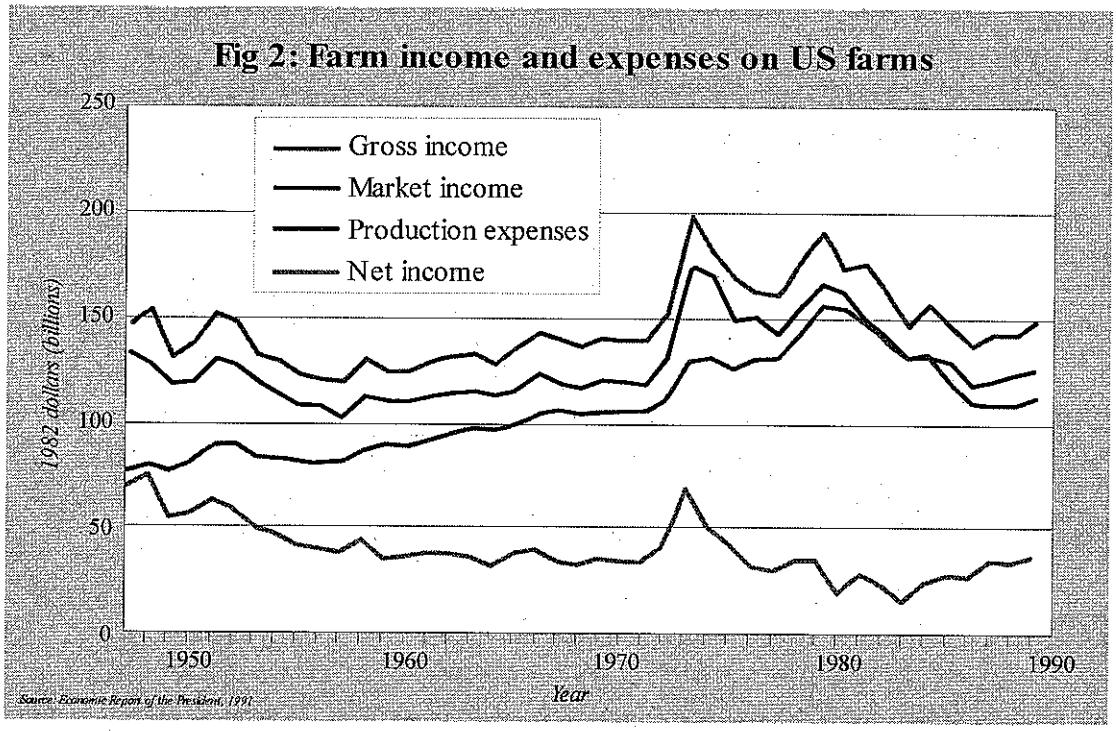
Fig. 1 Shows that wheat yields hardly changed in Britain until about 1940 when a national war-time fertiliser policy was formulated. Since 1960 yields have continued to climb.



Crops including grass have high fixed costs and production expenses (planting and harvesting costs etc) and high yields are necessary to offset these costs.

Fig.2 Shows typical relationships between income and expenses over a 40-year period in the US. The curves are as follows: bottom- net income; dashed curve -production expenses including fixed costs, fertiliser and pesticides and planting/harvesting costs; the strong black curve -income from sales to the market place and; the top curve market revenues + government subsidies. In the early '80's market income just covered production expenses and the only net income came from government subsidies. It is also apparent that production expenses climbed faster than market returns from 1950 to the mid-seventies and that net income, small compared with production costs, declined from 1950- 1975.

The crop yields obtained, including milk and meat, depend largely on the input of fertilisers and in the case of arable crops, such as cereals, potatoes and sugar beet, also on pesticides and herbicides. While great improvements have been made to fine-tune application rates and in the case of herbicides and pesticides in developing more efficient low application-rate chemicals and accompanying technology (band and mist sprayers etc), the fact remains that significant amounts of nutrient and herb/pest control chemicals are required to maximise crop yield and crop quality to feed the bourgeoning human population. In this context, it takes practically the same amount of energy and money to plant and harvest a 10-ton/hectare crop of wheat as it does a 5-ton/hectare crop.



Livestock farming is the predominant land use in Ireland, dictated by a wet climate. It is carried on in 93% of the land area with somewhat less than 10% devoted to arable farming. Exports of livestock products and livestock comprise 20% of gross exports and a much greater proportion of net exports.

Livestock produce large quantities of faeces and urine, nowadays mostly in slurry form. This is a valuable source of nutrients and presents a challenge to farmers to manage it to maximum benefit without causing pollution (**Table 1 illustrates the variability in composition and availability).** In addition, significant quantities of mushroom compost, municipal composts and bio solids from municipal and industrial wastewater treatment plants are available to agriculture. However, bio solids must be regarded as low-grade N and P fertilisers (3% N and 1.4% P) and primarily as a source of Ca with reduced N when lime stabilised. All organic manures must be supplemented and balanced.

Parameter	Dry Matter (%)		Nitrogen (kg/m^3)		Phosphorous (kg/m^3)	
	Mean	Range	Mean	Range	Mean	Range
Cattle	6.9	2-12	3.6	1.0-7.0	0.6	0.1-1.2
Pig	3.2	1-10	4.6	1.5-9.5	0.9	0.1-3.2
% Availability*	Cattle		25		50	
	Pig		50		57	
* in season following application						

Table 1. Variability in Composition of and availability of nutrients from cattle and pig manures

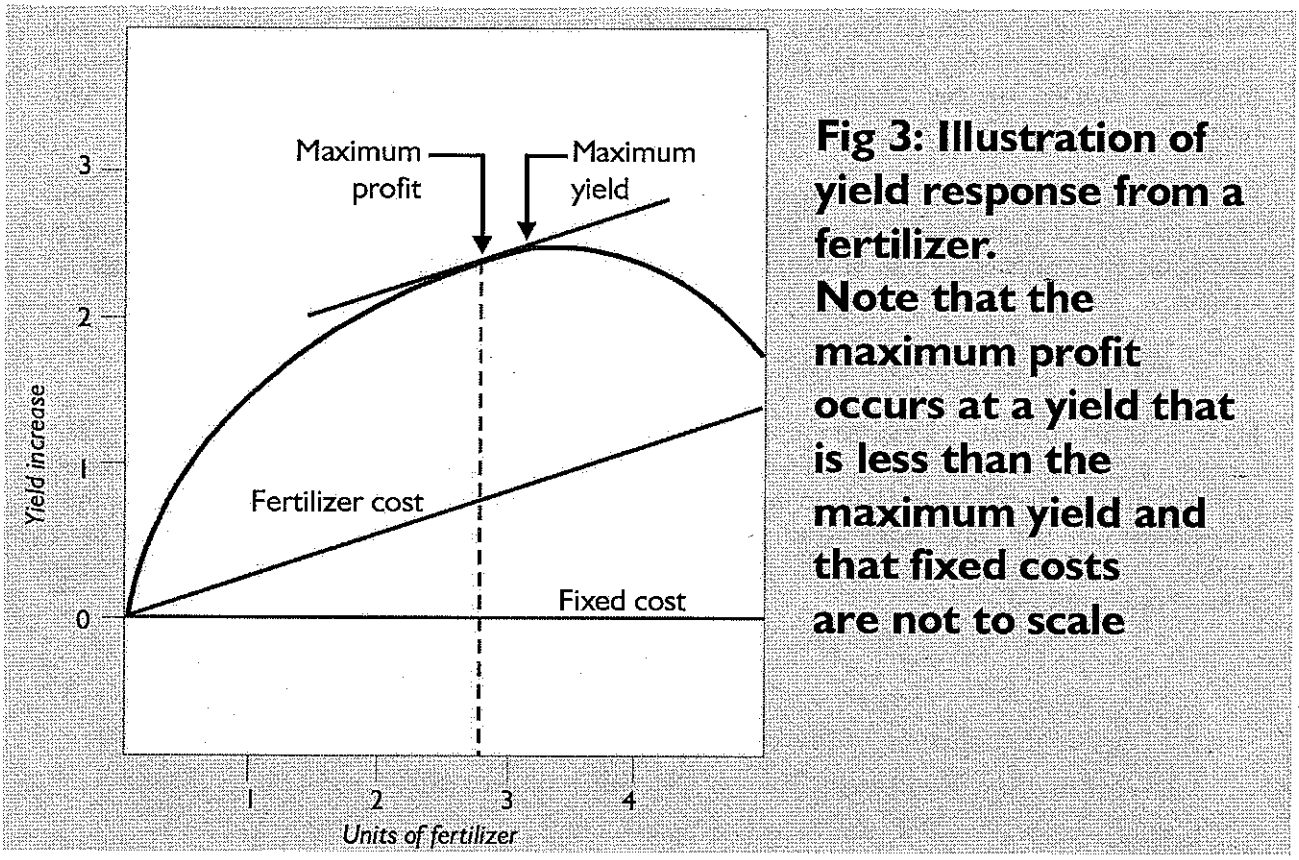


Fig 3: Illustration of yield response from a fertilizer. Note that the maximum profit occurs at a yield that is less than the maximum yield and that fixed costs are not to scale

2 FARMING & GROUNDWATER

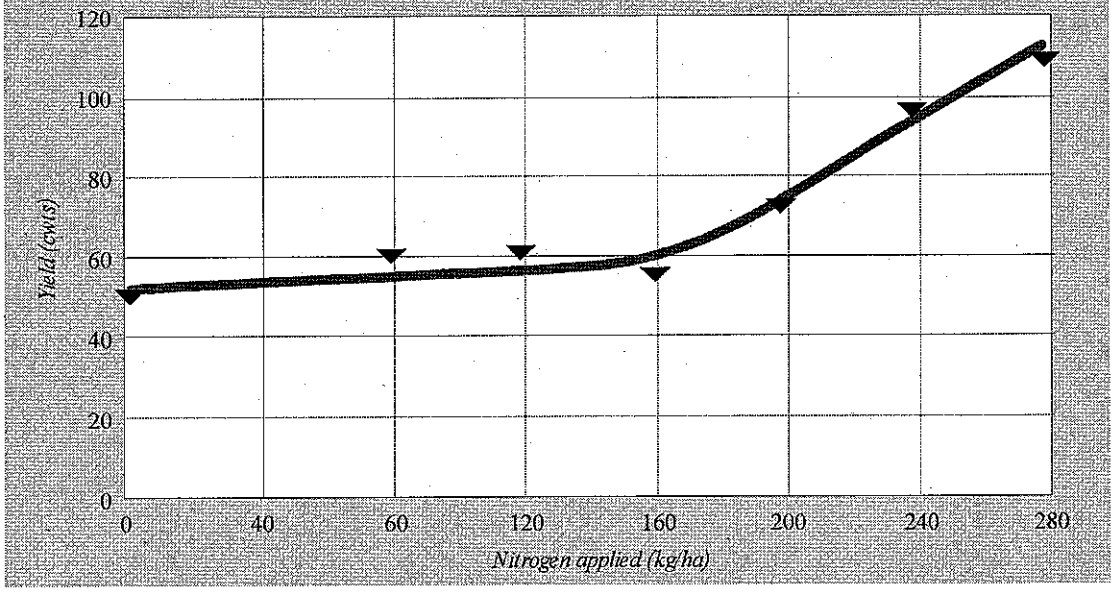
Farmers have a vested interest in high quality groundwater. Many farmers rely on groundwater for supply of potable water and for supply of water for cleaning purposes in dairy parlours and livestock housing to comply with hygiene regulations and good practice. Farmers in many cases also rely on groundwater at dairy, meat, vegetable sugar beet and other farm products processing plants for added value on the market place. Surveys have shown that once farmers become aware of new developments, they readily respond. This is well illustrated in the one-third fall in phosphate usage following revision of the Teagasc 1994 Fertiliser Recommendation Handbook by the 1996 recommendations and 2001 revised handbook.

Farming can potentially impact on groundwater through nitrate leaching and contamination with coliforms and other pathogenic organisms. Leaching of P in Ireland is minimal and the maximum admissible concentration is high at 2 mg/l and unlikely to be breached either by leaching or sinking streams.

2.1 NITRATE LEACHING IN ARABLE FARMING

Up to a certain application rate, the amount of nitrate (NO3-N) fertiliser left over, after the crop has taken up all it can, is called the "surplus nitrate curve". Along the horizontal line in Fig.4, the amount of N left over is relatively small, up to the point at which the curve begins to rise sharply. This point also happens to fall fairly close by to the economic optimum at realistic grain/price ratios. It is unlikely that farmers exceed this option due to the risk of lodging a cereal crop, when the crop falls flat and can be ruined.

Fig 4: Relationship between the nitrogen applied to winter wheat and the remaining unused in the soil (surplus nitrate curve)



The major scenarios in arable farming inducing leaching of nitrate-nitrogen (NO3-N) are ploughing and fallow (bare soil). Ploughing results in improved aeration leading to increased carbonaceous oxidation and nitrification. Stimulating NO3-N production without a crop -pre germination of cereals or other arable crops -results in increased NO3-N availability to leaching by percolating rainfall. Minimum tillage (Min- Till) offers a significant reduction in NO3-N leaching but additional research is required in a variety of soils to insure that grain yields are not significantly compromised. Also, leaving the soil bare for as short a period as possible minimises leaching.

Not surprisingly, the logistics of such options need to be carefully researched in a variety of soils to determine their risk-benefit ratios before they are recommended. It is important to realise that detailed studies show that N left over following a crop harvest, from fertiliser applied at normal rates in spring to winter wheat, is in an organic form and that of 10-35% of the N (average 15%) is lost -2/3rds of it by denitrification and 1/3rd by leaching. Only about 6% of the applied fertiliser is lost in leaching, amounting to only about 10 kg/ha N.

This only accounts for about 2.5 mg/l NO3-N compared with the upper EU limit of I 1.3 mg/l NO3-N. Where NO3-N fertiliser has contributed to the nitrate problem, it is largely because an amount of organic matter has been built up that microbes can break down later to produce NO3-N.

In other words, today's problem of nitrate enrichment under arable farming is to a large extent the result of breaking down the soil's organic matter and releasing nitrate; it is not the result of this year's fertilising.

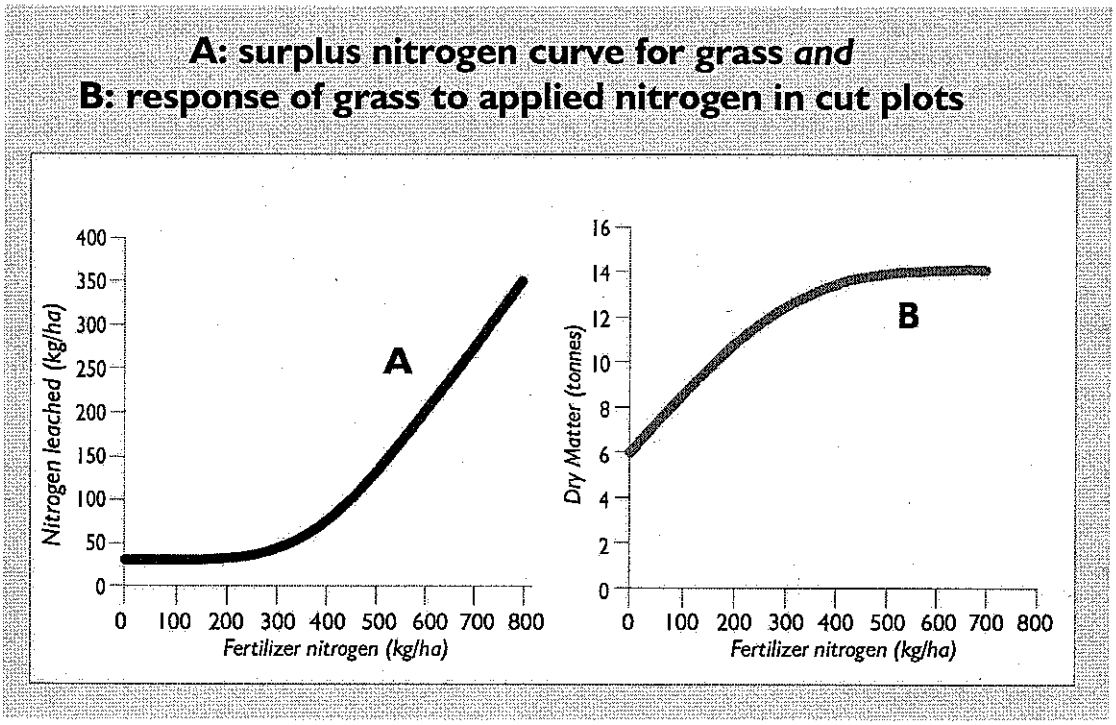


Fig. 5 (a) Surplus nitrogen curve for grass and (b) response to applied nitrogen in cut plots

2.2 NITRATE LEACHING IN GRASSLAND FARMING

The main problem with grazed grass systems is that they use N inefficiently. This is because more than 80% of the N consumed is returned to the soil in dung and urine. Cows urinate 2 litres at a time over an area of $0.4m^2$. This can represent an application of 400-1200 kg N/ha, an enormous rate applied instantaneously.

However, the grass can uptake only 400 kg N annually. Moreover, farmers use about 75% as much N in concentrates as they apply in fertilisers; the 80% loss ends up in urine and faeces deposited on land or in a slurry pit.

Accordingly, the more N (in fertiliser and feed) the greater the loss of N because of the 80% rule. In Ireland because of the damp climate, a significant proportion of the loss is in dentrification to nitrogen gas (N2) into the atmosphere as at Athenry where only about 2mg/l NO3-N in the groundwater under an intensive dairy farm was measured but leaching can be significant in some soils under certain circumstances.

2.3 NITRATE LEACHING - SLURRY STORES AND FARMYARDS

Numerous surveys have shown that there is a significant deficit of storage for slurries on many farms in Ireland. There is also a problem with leakage of soiled water from yards serving silage pits, dairy parlours and animal handling facilities. Shortage of storage often forces farmers to apply slurry to land in the November/early January period when there is no growth, the soil is wet and effective rainfall is high. Leakage of soiled waters and sometimes of slurries from overflowing stores gives rise to a continuous hydraulic load of N rich liquid which following nitrification in the soil can leach to the groundwater, although there is undoubtedly significant denitrification. The solutions are obvious - sufficient storage of slurries and management of soiled waters and leakages at the farmyard followed by land application such as tanker spreading and spray irrigation. Good housekeeping is a significant component of any management system.

The problem with increasing slurry and occasionally soiled water storage is the very high cost. Bearing in mind that farming in many cases is only marginally profitable (Fig. 2), capital grant-aid is required to supplement and re-organise storage when required. Earthbank storage tanks and (in suitable sites) constructed wetlands can offer cheaper solutions, but they still cost a significant amount.

Farmyard slurries are best spread following silage harvesting, usually 1st and 2nd cut. This creates a logistical problem for farms and contractors in that heavy duty tractors are required for silage harvesting and for slurry spreading, both taking place about the same time. As a result over-mechanisation is required with resulting financial risks in wet years. As a result the agricultural contracting business has one of the highest failure rates (insolvency) of any business in Ireland. A problem with farmyard slurries and manures is the variability in composition (Table 1), with the result that precision fertilisation becomes difficult. As already alluded to, organic manures must be supplemented and balanced.

2.4 INTENSIVE AGRICULTURAL ENTERPRISES - PIGS, POULTRY & MUSHROOMS

As already noted in the introduction, intensive agricultural enterprises have developed in response to demand and economies of scale that can be realised by concentrating large numbers in small geographic areas. Pig and poultry farms above small thresholds are now licensable by the EPA in Ireland. An integral component of this licensing is that it must be demonstrated that the farmer has

sufficient suitable land on which to spread the manure and that he does not pollute the groundwater at the farm site.

Where there is good liaison between the farmer and the EPA, the system can work well. Overzealous policing or inaction by either party can give rise to problems.

2.5 WAYS TO DECREASE NITRATE LEACHING

The nitrate problem is complicated. The rise in NO3-N concentrations in aquifers and drinking water has increased in line with population growth and as farming has intensified to feed the increased numbers with less labour. Food has become plentiful and relatively cheap and there is plenty of good quality water on tap in Ireland. Faced no longer with famine or water scarcity (as people were during and after the world wars) people in affluent society have turned attention to health factors and nitrate in water is one of these. The perception is that increased NO3-N fertilisation is causing the problem but we know that this is an oversimplification. (Each person produces 6- 7 kg N per year in waste and this has to be included in the balance sheet).

A simplistic solution is that cuts in the use of N fertiliser by the farmer will solve the problem but we know that this on its own will not, at least in the short term. There are significant knock-on effects from such a solution: #1 cuts in production and declining earnings in rural areas; #2 reductions in crop yields leading to increased cost of food in the shops; #3 decreasing food production at home results in more imports with effects on the balance of payments and diversion of food away from needy people. The nitrate problem has no simple origin and no simple solution.

Farming in accordance with the DAFF/DOELG Code of Good Agricultural Practice 'Protect Waters from Pollution by Nitrates' will help to prevent contamination of groundwater with NO3-N. Many simple things can be done on the farm to limit NO3-N leaching. Good housekeeping limits washwaters and open hardcore areas, leading to less soiled water to landspread or otherwise dispose of. Landspreading soiled waters at low to medium rates increases retention time in the soil. Limiting N fertiliser applications to about 300 kg N/hectare per year and avoiding out-of-season fertilising or slurry spreading on grassland farms and minimum tillage with shorter fallow periods on arable farms contribute to reducing NO3-N leakage.

Expensive measures include enlarged storage capacity for slurries and re-organised farmyards. Apart from Government Capital Grant-aid, cheaper options to the storage problem must be explored to minimise costs. Earthbank tanks and wetlands have already been referred to.

Whatever policies or regulations are implemented must be carefully thought out to insure that the nitrate problem is reduced and it or any other is not made worse or simply transferred somewhere else.

3 SOCIETY & ACTION ON GROUNDWATER PROTECTION FROM NITRATES & COLIFORMS

Each individual consumer of water and farm products has a vested interest in promoting the protection of groundwater from nitrates and coliforms. Current medical evidence is that nitrate is beneficial to health and there is little evidence of adverse effects. Despite claims of the dangers, there has never been a case of 'Blue Baby' or methaemoglobinaemia recorded in Ireland. However, each individual person must decide if nitrate is a matter of health concern and take appropriate measures such as restricting intakes of green leafy vegetables (such as lettuce), checking processed meats for nitrite and nitrate and increasing use of bottled waters. The mandatory provision of water free from coliforms by

Local Authorities and Group Water Schemes can be complied with by chlorination or ultra-violet sterilisation.

Positive relations should be developed between farmers, regulators, policy makers, scientists and educators in determining best management practices to insure clean wholesome groundwater. After all, everybody contributes to the problem -and must contribute to the solution.

SESSION III: FOCUS ON GROUNDWATER EDUCATION

THE ECONOMIC AND ENVIRONMENTAL IMPORTANCE OF GROUND WATER
EDUCATION PROGRAMS THAT WORK FOR CITIZENS, COMMUNITIES AND DECISION MAKERS

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ABSTRACT

The sub-surface part of the hydrologic system is playing an increasingly significant role in local and regional economy for utility supply, irrigation and industry. There is also a growing recognition for ground water's role in aquatic and riparian ecosystem ecology. The challenge of developing water policy and implementing effective management strategies is growing in complexity, and with a finite (although renewable) resource base, the process is becoming progressively politicized. Water supply is under stress throughout the world and the challenge of balancing competing demands has provided an impetus to the development of education strategies for citizens, communities and decision-makers.

The challenge of communicating ground water information has been taken up by government agencies, professional organizations and NGOs. Education is a process, and to be effective needs to be crafted to suit particular purposes. Education strategies related to ground water are best developed around specific learning and behavior-change objectives. With the "stakeholder" involvement concept gaining momentum, ground water education to bring science to the non-expert can help stakeholders frame the issues, understand hydrologic cause and effect, and be involved as meaningful participants in protection and management decisions.

RESOURCE PRESSURES

As countries become more crowded and consuming there are increasing demands for land, energy, materials, goods and services; especially water supply. Two thousand years ago, the world=s total human population was less than 3% of the present total. Currently world population is increasing by approximately 150 people per minute and now exceeds 6 billion with absolute numbers increasing by 80 million people per year. By 2025 more than 3.3 billion people in 50 countries will face water stress or scarcity (Gardner-Outlaw & Engelman, 1997).

Eighty percent of all disease in the world can be traced to drinking and washing with unsafe water supplies. Even with low per capita water use (20-40 liters minimum for drinking and sanitation), lack of water limits community health, economic progress, and food production. Ground water sources are the only supply option in most rural areas.

Globally, 80 million hectares of farmland have been degraded by a combination of salinization and waterlogging (Hinrichsen, et.al., 1998) but world food production will require a two to threefold increase per hectare to meet 2025 projected minimum food requirements. Overall efficiency of irrigation worldwide is estimated as 40% (Postel, 1997). Ground water sources, and/ or conjunctively managed surface and ground water will become even more critical for food production.

Increased pumping and diversion of water is causing damage to ecosystems (Falkenmark & Widstrand, 1992). Publications such as Gore=s *Earth in the Balance* (1992) Gleick=s *Water in Crisis,* (1993), and Simon=s *Tapped Out* (1998) have helped promote scientific and political awareness of the interdependence of society and the environment. If aquifers are exploited in excess of natural recharge or become contaminated, there is real risk of environmental, economic and social crisis. The challenge is to meet growing needs from finite resources while maintaining (and restoring) the planet=s life support system.

SUSTAINABILITY

The ADublin Principles@ established by the International Conference on Water and the Environment in January 1992 recognized that water resources are finite and vulnerable and that sustainability should be a management objective. Sustainability is a logical basis for ground water management and protection policy. Sustainable water use supports the ability of human society to endure and flourish into the indefinite future without undermining the integrity of the hydrological cycle of the ecological systems that depend on it (Gleick et al., 1995).

Implicit in the word sustainability is a defined a level of water use. As a resource with great economic, environmental and political significance, ground water is of interest and concern to a wide number of constituents. The determinations of levels of use move beyond hydrology and encompass economics and political decisions. In reality, ground water policy may be a hybrid artifact occurring as a by-product of policies developed for areas such as public health, endangered species or agriculture

POLICY

It is important to integrate hydrologic information, economic forecasting and social planning into resource policy decisions. Information and informed explanation (education) are important for policy, particularly because many issues are complex. ABenign problems@ are those with a clear and logical definition with a specific disciplinary variable. AWicked problems@ have multiple and conflicting criteria for defining solutions (Rittel & Webber, 1973). Virtually all ground water policy issues are by definition Awicked@ even although some individual components, for example defining aquifer boundaries or estimating local population growth, may be Abenign.@ There can be a Awicked problem@ disconnect between scientists, policy makers and the public because technical, academic and engineering professionals may not be adequately integrated into the political decision-making process. An additional reality is that science may be neutral but scientists are not necessarily neutral (Walker & Mairs, 1999). Data sets do not in themselves provide answers. Education of the constituent groups that can influence policy makers can reduce the effects of misinformation from exaggerated "spin" of hired-gun experts.

Agency authority can provide regulations but regulations should follow policy; policy should not be formed by regulation. Acceptance by the regulated that there is a rational need for regulations is an important prerequisite to making rules workable. Education needs to be a key element of regulation in order to achieve cooperation and compliance. Voluntary self-policing is important for many aspects of ground water protection

In educating the public, the messenger can be as least as important as the message. There is an inherent tendency to disbelieve information from parties with a vested interest in a policy decision. One of the most important aspects of water resources policy is to ensure that those affected have an opportunity to participate. The earlier on in the process citizens are involved, the more likely they are to cooperate. Ideally the whole community should be involved in decision-making that balances the risks, costs and

benefits of water development/ protection/ allocation policy. Most policy makers want to have the support of the people they serve. Policies with public support are more likely to work!

MANAGEMENT

A management process is required to implement water policy. This can occur at many different scales and involve many different jurisdictions. Table 1 lists six decision-making criteria that are suggested as important for effective ground water management (Stone, 1998). Some of the criteria are outlined below, with the educational aspects discussed in more detail later.

COMPREHENSIVE APPROACH

The sustainability paradigm implies a long time frame for ground water management. Changing social demographics, evolving regional economics and potential technological innovations are ingredients for planning. Water management strategies should involve the interests of current and potential users. Including a broad base of technical experts can avoid professional bias in decisions, and collaborative agency oversight can preclude overarching claims of decision-making jurisdiction.

GROUND WATER A COMMODITY

The value of ground water includes its environmental/ecological values in addition to the direct benefits derived by private sector enterprise and the local, regional and national economy. There are some key economic questions that require assessment, such as: who is profiting from the current use of water? What is the value of water if used for some other purpose? Will a particular water management decision benefit one group more than another? Who has rights to the water? Carving up the water pie presupposes that someone knows the size of the pie? Mother Nature may unpredictably provide annual water pies of different sizes. In an arena of shortage, the calculation and prediction of pie-size puts the ground water scientists' work under close public scrutiny.

MANAGEMENT TIME FRAME

Water policy should address more than the short-term economic benefits that accrue to the direct user. If the policy includes built-in over-exploitation, then social costs of non-sustainability should be factored in and the price of the "exit strategy" from an over-exploitive development should be borne by the beneficiaries. Enlightened policies provide management frameworks to equably reconcile water availability and needs. Good science, informed citizens, and a long-term perspective of economic development priorities are essential ingredients to avert the social and economic consequences of over use. Sustainability has moved from a scientific exercise to political reality because of stress between human population and natural resources. The resource management principle is changing from, how much water is needed and where do we get it? to how much is there and how can it best be used? Management objectives are set by policy. Education can powerfully influence policy decisions.

HYDROLOGIC SYSTEM

There is a logical reason to consider all water, surface water or sub-surface water as a single resource. In the integrated resource concept, one person's down-stream is another person's up-stream; one community's wastewater is another community's source water and today's ground water is tomorrow's river base flow. The drainage basin (watershed) has long been recommended as an ideal unit for water management (Chorley, 1969). It is a fundamental prerequisite of ground water management that policy is based on an understanding of the local hydrologic conditions. A regional perspective is needed in cases where the groundwater occurs as part of a wider geologic system of recharge and storage (Stone, 1990). There may be strong jurisdictional precedent for separate surface water/ ground water management strategies but it is likely that an integrated approach will become even more prevalent. As watershed-focused management becomes more established and more data are shared there should be less "turf wars" among overlapping jurisdictions.

DECISION MAKING CRITERIA FOR EFFECTIVE GROUNDWATER MANAGEMENT (from, Stone, 1998)	
1	**Take Comprehensive Approach**
	☐ integrate hydrologic, economic and social planning ☐ consider all potential uses and users ☐ involve technical experts to ensure the practicality of decisions ☐ establish cooperative joint government/ agency authority over resources ☐ factor-in all alternate supply strategies
2	**Consider Groundwater a Commodity**
	☐ calculate the true costs of providing water ☐ factor-in the value of government subsidies or tax breaks ☐ make cost benefit analyses for all possible use options ☐ use appropriate predictive models of water need
3	**Define Management Time-frame**
	☐ take long term time frame in cost benefit calculations ☐ adhere to the water supply sustainability paradigm ☐ recognize potential implications of climate change
4	**Make the Hydrologic System the Basis for Management**
	☐ make decisions based on hydrological / ecological science ☐ use watersheds or aquifer regions as basis for assessment & management ☐ verify past hydrologic data and ensure integrity of current data sets ☐ consider full range of potential environmental impacts ☐ review case studies from similar geologic/ climatic areas
5	**Include Assessment of Social Costs**
	☐ review full range of national, regional and local impacts ☐ cost /benefit economic projections to include long term social costs ☐ assess impact of decisions on basic community water needs ☐ include basic "environmental justice" considerations
6	**Involve the Public and All Stakeholders**
	☐ identify a role for public in decisions ☐ develop the water use "stakeholder" concept ☐ provide "cause & effect" education to empower public to meaningfully participate ☐ include area residents and those directly involved in the "local water economy" ☐ allow national professional groups and researchers to participate ☐ prepare a comprehensive citizen awareness and decision-maker education program

SOCIAL COSTS

Legal ownership of ground water varies considerably among and within countries. The uniqueness of water as a basic human need elevates the resource to a high plane of consideration in terms of equable allocation decisions. State by state in the US and throughout the world, there is a sad litany of instances of ground water resources being degraded by contamination. The concept of environmental justice has been applied to management decisions relating to environmental impacts as well as to resource allocation such as deepening large wells for "big-users" at the hydrologic (and social) expense of "little users."

PUBLIC AND STAKEHOLDERS

Decisions about water resources are usually too important to be made by a single group of specialists. Education can broaden the boundaries of inclusion. The challenge for the groundwater-educated super-elite (hydrogeologists & engineers) is to explain ground water's scientific "mysteries" to a range of constituencies so that the resource may be appropriately valued, cherished, protected and managed.

EDUCATION STRATEGIES

VESTED INTERESTS

The role of the media in highlighting local environmental issues and the ease of communication via the Internet has made it difficult for environmental issues to remain hidden. There is a growing recognition among the public of wider societal concerns for health, the environment and the quality of life. With demand greater than supply, overall public awareness and concern about ground water issues is also influenced by a greater recognition of vested interests (I want it for my water utility, I want it for my trout stream, I want to irrigate my crops, Its mine by right, I want it, I want it....). There are very strong territorial and possessive emotions concerning ground water that are particularly apparent when there are private sector proposals to develop resources, or if regional water plans involve water transfers. The possessive psychology with regard to water is particularly manifested if a development proposal involves transfer across political boundaries. The response can generate great interest in education strategies to educate the community about the value (scarcity) of its resources.

TOP DOWN

Many excellent ground water education programs are tactical elements of a public policy strategy, and are typically related to public health issues and often funded by government. Targets of such programs include informing the public about hazardous waste collection, creating homeowner awareness about the importance of testing private wells, encouraging riparian buffers and providing information about benign alternates to lawn & garden chemicals. An extension of this form of ground water education outreach extends to agricultural and construction practices where education is seen as a critical adjunct to regulation. Education is especially relevant in areas where individual behavior can have an impact.

The relative role of government and independent NGO groups in environmental education varies considerably. The ground water education programs of independent education groups may be funded from tax-based revenues, often on the basis of competitive grants. There can also be inter-government department funding of education programs that usually involves an agency transferring funds to a local unit of government for a specific education purpose.

BOTOM UP

Citizen groups, usually self-financed or with private sector funding, may use ground water education as a tactical element to influence public policy or proposed local water management strategies. Examples of citizen concerns are; local opposition to planned industrial development near a local aquifer or a local campaign for government funding for regional wastewater disposal system. In such cases, education endeavors are often directed at fellow citizens with the intent of influencing ballots for specific legislation

or management proposals. Many citizen concerns relate to land use proposals. The concern for water is often the most potent card to play in influencing opinion, but there may well be other issues such as increased traffic, opposition to low-income housing development, pressure on schools etc. which are the main underlying reasons for an awareness and information campaign in the name of ground water.

TRAINING

While much public education is aimed at non-experts, there is an important element of public education in many of the training programs for people directly or indirectly involved in water supply. This is particularly the case with development projects involving ground water. Community education is often an essential project element for ground water based supply infrastructure improvements. Community buy-in and acceptance of new water supply sources is essential for behavior changes needed to protect resources from contamination or overuse (Stone, 2000).

In all countries there are professions such as sanitarians, building inspectors, realtors, and septic system designers that are peripherally involved with ground water issues. Basic ground water education can greatly enhance their capability to "speak-up" for ground water as they go about their daily work. For example, when realtor (estate agent) lists a property with a well, knowledge of the significance of basic well construction and local ground water conditions can allow for a more accurate description. A sanitarian may be highly trained about the biology of organisms, but without some geologic and well construction education would have an imperfect understanding about potential contamination vectors.

STAKEHOLDERS

There is every reason to inform the public about the scientific, technical and economic aspects of water problems so that citizens can be involved in helping to formulate policy options. The concept of Astakeholders@ is based on the notion that many different groups may have an interest in being involved with policy decisions An important element of ground water education is to create forums for stakeholders to voice opinions and to support or challenge the scientific and economic basis for water policy. Framing the issues is a major challenge when creating a forum that has the intent of influencing public policy. Such forums or meetings should be seen to be balanced, collaborative and inclusive and not proscriptive or one-sided. There may be suspicion if one agency or entity dominates the process of selecting and promoting education forums or meetings.

ROLES FOR GROUND WATER PROFESSIONALS

Ground water scientists can play an important education role in selling their science to the public and hence serve as a link between science and decision-making. Ground water educators benefit from mobilizing armies of foot-soldier volunteers to carry the messages to their targets. Enthusiasm is a most critical element for a successful volunteer. Professional background in the arena of ground water, when appropriately channeled, can be a very powerful adjunct to enthusiasm for the resource. There are several obvious ways in which ground water specialists, in a volunteer role, can help bridge some of the "us and them" attitudes among, the public, interest groups, regulators and decision-makers. For example; by volunteering to support local education programs as a presenter; by offering to talk to school students; by encouraging clients to include a line-item for ground water education in contract budgets, and by promoting active education outreach as an objective for professional associations (Stone, 1993). Volunteer public education assistance can be particularly effective from academics, most of whom have ready teaching material that can be adapted for citizen audiences. Ivory towers can serve as lighthouses to illuminate ground water issues, and hence lead to enlightened management decisions. Providing objective information without bias is a prerequisite for effectively communicating with the public and local communities. Citizens view universities and their academics as sources of unbiased information.

JARGON & EDUCATION TOOLS

Awareness, information, training, teaching, public relations and outreach are words often used indiscriminately under a broad umbrella of education. They are all important! Choosing the best teachable moment can have a positive impact on the effectiveness of the message. Targeting education information by Arifle-shot@ may achieve more results than making a lot of education noise by a Ashotgun@ approach. Workshops, water festivals, site visits, development of school curriculum materials, interactive simulation programs, videos, teacher training, posters, pamphlets, informational press releases, etc. are a few examples of the potential educational tools that can be used. In all cases, the objective of a proposed education initiative needs to be established in order to prepare the best strategy. Almost any initiative can incrementally add to overall understanding of the importance of ground water management and protection. One of the greatest problems in helping people understand the issues is to "educate" those people who think that they understand!

EDUCATION RESOURCES

The development of education programs can benefit from professional input. Just as experts are needed to advise on technical aspects of water science and engineering, so too should community education experts be consulted to help choose among the huge arsenal of potential techniques. The constant need for promoting awareness can be compared with the annual advertising campaigns of multi-national companies. Everybody knows that the particular products or services exist – but constant reminders, via a variety of media stimuli are judged to be important for sales. Educators are sales-people too, and an effective education campaign will benefit from a level of attention and planning similar to a major commercial marketing campaign.

There is an extensive range of educational experiences and case studies that can be used or modified to suit local ground water education needs. The proceedings from an AWRA water education conference (Warwick, 1997) and a US Environmental Protection Agency conference (USEPA, 1995) are a good starting point for ideas on education. There are hundreds of education resources available from organizations such as the US Environmental Protection Agency and the US Geological Survey. These, and other sites can be accessed from the LINK sections of web sites of ground water education organizations such as the Groundwater Foundation (www.groundwater.org) and American Ground Water Trust (www.agwt.org and www.privatewell.com).

CONCLUSION

The achievement of a basic understanding of ground water science by decision-makers helps the successful transition from awareness to concern, and from concern to action. The key to long-term education success is teaching decision makers how science works, not simply what science has discovered. Citizens made more aware of their local aquifers will feel connected in a way that enhances a feeling of natural synergy between people and their resource base. There is an important resource stewardship role for "ground water literate" stakeholders at all levels of decision-making. Ground water educators speak for the water molecules in all the world's aquifers. Like evangelical preachers – ground water's cadre of educators is convinced that the environment, the economy and quality of life are enhanced by their work. We need more converts!

Note - [One of the most important elements of ground water education initiatives is to get them paid for! Grant funding can only go so far, and achieving sustainability for education programs is a major challenge for NGO education administrators. Program financing and program evaluation are two crucial components of ground water education that justify attention but are not considered in this text.]

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IRISH HYDROGEOLOGY AND THIRD-LEVEL EDUCATION

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ABSTRACT

There are no specialist hydrogeology degree programmes in Ireland. Most Irish hydrogeologists obtain their postgraduate qualifications in Britain, but hydrogeology education there is in a state of flux. The implementation of the Bologna Declaration on European education may impact further on the specialist one-year taught Masters over the next decade, perhaps creating a need for more short courses in hydrogeology. In the USA, recent journal editorials have raised concerns about the 'recipe book' approaches being adopted in hydrogeology, especially in the groundwater remediation area. It is important that those involved in the education and training of hydrogeologists continue to emphasise a problem-solving approach based on a good understanding of the fundamental concepts.

INTRODUCTION

Let me say at the outset that I am going to break with convention and write this paper in the first person. I am doing this for two reasons: firstly, the paper contains a lot of personal opinion as well as fact so the first person seems appropriate; secondly, by adopting an informal style I hope to stimulate more discussion of the paper at the seminar.

Hydrogeology is a specialist subject that is currently taught in universities mainly at the postgraduate level. There are undergraduate degree courses in civil engineering, environmental sciences, geography and geology (the list is alphabetical, no priorities are intended!) that include some instruction in hydrogeology, but this is naturally at a fairly introductory level. Under the present university system, it is likely that hydrogeology will remain a postgraduate specialisation.

In the following sections I will attempt to summarise the situation vis-à-vis the education of Irish hydrogeologists on postgraduate taught course programmes in Ireland, Britain and North America. I will then look at the changes that are likely to occur in third-level education throughout Europe as a consequence of the Bologna Declaration. Finally, I have been spurred by some recent editorials in hydrogeology journals to add a few comments on the dangers of adopting a 'recipe book' approach in hydrogeology, not least in its teaching.

Having indicated what I am going to speak about I feel I should mention what I will not be covering. I am not going to address the issue of hydrogeology education through Masters or Doctoral research degrees, other than to confirm that many Irish hydrogeologists have acquired excellent qualifications and training through research. Also, I am not proposing to talk about continuing professional development (CPD) programmes for hydrogeologists since these will be covered in a separate presentation at this seminar.

POSTGRADUATE COURSES IN HYDROGEOLOGY

THE SITUATION IN IRELAND

There are no taught course Masters programmes in hydrogeology available in Ireland. There are Masters courses in civil engineering (Trinity), environmental engineering (Queens) and environmental science (Trinity) that contain substantial modules on hydrogeology, mainly focusing on the water quality aspects and on the links between hydrogeology and those broader disciplines. These courses are valuable in educating engineers and scientists in aspects of hydrogeology, but they are not hydrogeology programmes *per se*.

Is there sufficient demand to warrant running a hydrogeology Masters course in Ireland? If we look at the IAH (Irish Group) as a barometer of the level of interest in our subject, then the last 10 years has seen unprecedented growth in membership, from around 40 members in 1993 to just under a 100 now. I estimate that perhaps a quarter or a third of the 60 new members have a Masters qualification in hydrogeology suggesting that, on average, two Irish (or Ireland-based) graduates pursue a Masters in hydrogeology each year. If a course were available in Ireland, then the demand might increase somewhat, but it is difficult to envisage a steady demand for say the 15 places per year that would be needed to make such a degree programme viable. Of course, the local intake would be supplemented by students from outside Ireland; however, the high cost of living makes studying in Ireland increasingly difficult for foreign students, and the fees for students from outside the EU are very high. So, the numbers of foreign students would be likely to be limited unless financial support were available – and this seems a remote prospect in the current climate of Government cutbacks in funding for the third-level sector.

In reviewing a draft of this paper Geoff Wright expressed the view that Ireland should have a taught Masters programme in applied geology, which would include options in hydrogeology, engineering geology, mineral exploration, etc. With the implementation of the Bologna Declaration - which I talk about later in this paper – I think it likely that Irish universities will include more applied geology courses within their degree programmes (specifically, within the second cycle of the proposed two-cycle Masters degree).

POSTGRADUATE COURSES IN BRITAIN

Those Irish hydrogeologists who have taken a taught course Masters in hydrogeology have generally done so in Britain. Postgraduate education in hydrogeology in Britain has been in a state of flux in the last 20 to 30 years. In the 1970s and early 1980s there were two taught Masters degree courses in hydrogeology (Birmingham and University College London), by the mid 1990s this had increased to five (Birmingham, East Anglia, Reading, UCL plus the groundwater engineering course at Newcastle) and now there are again only two (Birmingham and Reading) – see Table 1. As I understand it, the decline from five to two courses in the last few years is the result of a reduction in UK and European funding for studentships, and does not in any way reflect a decline in the popularity of the subject. The situation remains fluid, as it were, and I believe that UCL plans to relaunch its Diploma in hydrogeology and that Newcastle plans to reintroduce its Masters course in groundwater engineering and also introduce a new Masters in applied hydrogeology, both using a web-based learning platform (which might be an attractive option for Irish students).

The two taught Masters hydrogeology programmes currently being run at Birmingham and Reading are both one-year, full time courses. They consist of a taught component followed by a research project. The taught modules are summarised in Table 2. If these syllabuses were listed alongside those offered by Birmingham and UCL 30 years ago (and some of us are old enough to remember these), we would see a

significant increase in the teaching time devoted to groundwater quality issues and to mathematical modelling. This change in emphasis is not surprising, as it reflects the changing skills required by the modern hydrogeologist.

As well as the two hydrogeology Masters, there are several other postgraduate programmes in Britain that include substantial hydrogeology elements. These include: East Anglia (Environmental Impact Assessment, Auditing and Management; Environmental Sciences), Imperial College London (Engineering Geology, Hydrology and Environmental Management; Environmental Engineering), Newcastle (Sustainable Management of the Water Environment), Sheffield (Urban Land and Water), Silsoe/Cranfield (Water Management) and University of Wales, Bangor (Water Resources),

NORTH AMERICA

Since the 1960s, a few Irish graduates have pursued postgraduate studies in hydrogeology in North America where there are numerous taught Masters programmes available (in both the USA and Canada). As with the British examples, these comprise both a taught course component and a research project. There tends to be a greater emphasis placed on the research project and so the American courses generally run over two years.

Many of the American Masters (MS) programmes offer a wide range of study options. Perhaps only a small number carry the title MS in Hydrogeology; many provide an MS in Hydrology or MS in Hydrologic Science, etc. (In the USA hydrogeology is regarded by many as a branch of hydrology – which it is – and the term 'groundwater hydrologist' is in more frequent use there than on this side of the Atlantic). Universities in the USA that offer Masters programmes with a significant groundwater component include: Arizona, California (Davis), Nevada (Reno), New Mexico Tech, Ohio State, Oklahoma State, Penn State and Wisconsin. In Canada, there are Masters programmes at British Columbia, Toronto and Waterloo.

HYDROGEOLOGY EDUCATION ELSEWHERE

There are many postgraduate courses in hydrogeology in continental Europe, Australia and elsewhere. Time does not permit me to go into detail about these. I would like to point out, however, that there are specialist courses offered through English by academic institutions in continental Europe; for example, the University of Tubingen in Germany offers a Masters in Applied Environmental Geoscience through English, and the syllabus of this course contains an appreciable amount of hydrogeology. With the increased mobility of students likely to result from implementation of the Bologna Declaration (see below), opportunities for English-speaking students (and graduates) to study in Europe may increase in the future.

THE BOLOGNA DECLARATION AND ITS IMPLICATIONS

The Bologna Declaration was signed by European Ministers of Education (or their representatives) in June 1999. It seeks greater harmonisation in third-level education across the EU, with the overall aim of promoting greater mobility of graduates. In Ireland, the Bologna Declaration has been the subject of much discussion and head-scratching amongst academics and professional organisations, whereas some of our European partners, including Germany and Italy, have already enthusiastically implemented some of the provisions of Bologna. In Britain, I gather that the Bologna debate is still in its infancy; however, some of its aspirations have already been anticipated with the introduction of undergraduate degree programmes leading directly to a Masters qualification.

The preferred model for third-level education according to the Bologna Declaration is a two-cycle degree programme comprising a three-year primary degree followed by a two-year Masters (a '4+1' model is also possible under Bologna). Many of the academic institutions in Europe already offer a five-year Masters as a single cycle (in Britain the equivalent is a four-year MEng or MSci 'primary' degree) and it seems likely that the five-year Masters degree will become the normal requirement for certification in professional disciplines such as civil engineering. In Ireland, a discussion document on implementing Bologna supports the '3+2' Bachelors/Masters degree structure (Institution of Engineers of Ireland 2002).

So, if scientific and civil engineering academic programmes move to this two-cycle approach, where does this leave the specialist one-year taught Masters in hydrogeology? I do not know the answer to this question, but there must be some concern that the one-year stand-alone Masters course will not survive in Europe, at least not in its present form. The second cycle of a two-cycle geology (or other) degree programme may include some hydrogeology modules - and hence increase the awareness of hydrogeology among non-specialists - but it seems unlikely that it would be given over wholly to the teaching of hydrogeology.

One result of this might be a greater emphasis on short postgraduate courses in hydrogeology, perhaps involving distance learning in some cases (I cannot envisage a demand for long, residential courses if students have already spent five expensive years at university gaining their Masters). Short courses might provide the opportunity for Irish academics and professionals to cooperate in the continuing professional development of Ireland's hydrogeologists, promoting the combined benefits of sound theory and hands on experience.

'THE LOST TRIBE OF HYDROGEOLOGISTS'?

In the July-August 2002 issue of *Ground Water* Boyd Possin reminds us that the demand for hydrogeologists in the USA increased enormously in the 1980s and 1990s following the implementation of various pieces of legislation requiring cleanup of hazardous waste sites and also sites affected by leaking underground storage tanks. Possin argues that a large amount of the groundwater remediation work during this period followed a 'recipe book' approach as set down in standard operating procedure documents. According to Possin, the hydrogeologists who specialised in hazardous waste cleanup are a 'Lost Tribe of Hydrogeologists', dislocated from the other world where hydrogeologists are occupied in other water resources issues. He adds: "I further fear that, for many in the Lost Tribe, the too-often mindless nature of their work has caused them to lose a significant portion of their own self-awareness of professionalism".

This theme is taken up by Evan Nyer in his editorial 'A Lost Generation', which appeared in the 'Fall' 2002 issue of *Ground Water Monitoring and Remediation.* Nyer points out that "we have created a generation of hydrogeologists that have had a very limited variety of experiences". He is not worried about the ability of this generation to learn e.g. new drilling techniques; rather, he is more concerned that some of the old wisdom is not being passed down to the current generation. Assisted by a couple of his colleagues (Pedro Fierro and Brian Guillette) Nyer gives - often amusingly – some examples of the kind of problems that can result from a recipe book approach. One of the examples that appeals to me involves a geologist explaining to Nyer that the well was installed in clay rather than in the overlying shallow aquifer because "you said the wells should be installed to 35 feet". ("I guess this one is my fault", admits Nyer - no doubt, with tongue firmly placed in cheek).

In their editorial 'Is Hydrogeologic Science on the Right Track?', published in the November-December 2002 issue of *Ground Water,* Harry LeGrand and Lars Rosen again refer to the Lost Tribe. The recipe book approach combined with large funds available for contamination studies encourages data collection.

LeGrand and Rosen feel there should be more emphasis on developing good conceptual models. They say that a "data-collecting mindset....neither encourages nor leads to early-stage conceptual models". They also point out that despite frequent talk about conceptual models, there are few publications available that deal with the principles involved.

I do not know whether we have such a Lost Tribe on this side of the Atlantic. But I do feel that our profession also suffers from the recipe book approach, although not necessarily in connection with groundwater cleanups. In an editorial in *Hydrogeology Journal* a couple of years ago (April 2001) I pointed out that there is a tendency for hydrogeologists to adopt a prescriptive approach to the analysis of pumping test data, in which standard methods such as those of Theis and Jacob are applied to time-drawdown data with little or no regard to the assumptions that underlie these formulae. To quote: "Thus, in a Jacob analysis, it is not uncommon to encounter a straight line drawn as a best fit through a semi-log data plot that is clearly non-linear, with no discussion of the reasons for the variance between theory and the conditions at the site under investigation. Such an approach can obviously lead to large errors in estimates of aquifer properties. Again, it is not uncommon to see tabulated pumping test results in which the specific capacities of the wells exceed the interpreted aquifer transmissivities – with the clear implication that the wells are more productive than the aquifers!".

The pitfalls of the recipe book approach should be highlighted by educationalists and professionals alike. Thus in teaching the Theis method I feel it is very important to explain to students the principles behind type curve matching, and to get them to plot their time and drawdown data on log-log paper by hand at least once. In my experience, a large number of students have never seen log-log paper or understand its function. After doing an analysis by hand, and after discussing the results, then by all means turn to the software that enables more rapid analysis and provides tidier graphics for future examples.

CONCLUSIONS

I have attempted to summarise the opportunities currently available to Irish graduates to study hydrogeology. I have also tried to crystal ball gaze as to what may happen to hydrogeology education in the future. In my view there is a risk that the stand-alone taught course Masters will decline in Britain and Europe following the implementation of the Bologna Declaration with its five-year, two-cycle degree programme. If this happens - and I would very much regret the passing of the hydrogeology Masters - there may be increasing demand for academic and professional institutions to provide short, specialist hydrogeology courses. And instructors on such courses should be wary of the recipe book approach to our discipline, and should encourage a problem-solving approach involving good conceptual models.

ACKNOWLEDGEMENTS

Many thanks to Paul Johnston, Geoff Wright and Paul Younger for reviewing a draft of this paper.

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Table 1 Taught Masters in hydrogeology and groundwater engineering in Britain, 1965 to present

Date	*University*	*Title of Masters course*
1965 – 2001	University College London	Hydrogeology
1972 – present	Birmingham	Hydrogeology
1987 – 1999	Newcastle upon Tyne	Groundwater Engineering
1992 – present	Reading	Hydrogeology and Groundwater Quality[1]
1992 – 1999	East Anglia	Hydrogeology

[1]Formerly 'Hydrogeology and Groundwater Chemistry'

Table 2 Outline syllabuses of the current taught Masters hydrogeology courses in Britain

University of Birmingham	*University of Reading*
MSc Hydrogeology	*MSc Hydrogeology and Groundwater Quality*
Groundwater Flow Theory I and II	Hydrometeorology, the Hydrological Cycle and Water Occurrence
Surface Water Interactions	Soil Hydrology and Solute Leaching
Hydraulic Properties	Groundwater Hydraulics and Aquifer Testing
Borehole Design, Construction and Maintenance	Principles of Groundwater Chemistry
Environmental Geophysics	Environmental Hydrogeochemistry
Inorganic Chemistry and Groundwater	Groundwater Flow Modelling and Contaminant Transport
Organic Contaminant Hydrogeology	Geophysics
Regional Groundwater Modelling	Aquifer Microbiology
Solute Transport Processes and Modelling	Water Quality, Pollution and Aquifer Protection
Water Resources Studies	Engineering Aspects of Hydrogeology
Contaminated Land – Groundwater Remediation	

PROFESSIONAL REGISTRATION & CPD
(Edited Extract from IGI Web Page)

Eur Geol Kevin Cullen P Geo, Managing Director, White Young Green Environmental.

ABSTRACT

The Institute of Geologists of Ireland (IGI) was formed in 1999 in order to promote the geosciences in Ireland and to represent the professional interests of its members. Membership is open to all practising geoscientists and entitles a member to use the title Professional Geologist (PGeo.) which is an assurance of the highest professional standards.

The IGI underpins the title PGeo with the requirement that each member enters into a programme of Continuing Professional Development (CPD) which is the systematic maintenance, improvement and broadening of knowledge and skill and the development of personal qualities necessary for the execution of professional and technical duties throughout a practitioner's working life.

1.0 INTRODUCTION

The Institute of Geologists of Ireland (IGI) was formed in 1999 in order to promote the geosciences in Ireland and to represent the professional interests of its members. Membership is open to all practising geoscientists who meet the required standards of qualification and experience, and the IGI operates with the support of all the major geoscience based technical societies.

2.0 IGI MISSION STATEMENT

To promote and advance the science of geology and its professional application in all disciplines, especially the geosciences, and to facilitate the exchange of information and ideas in relation thereto.

To require its members to uphold, develop and maintain the highest professional standards in the practice of their profession, as described in the Code of Ethics and Conduct.

3.0 PROFESSIONAL DEVELOPMENT

Professional membership of the IGI gives geoscientists the right to use the title 'PGeo' which is increasingly becoming a quality standard and contractual requirement for provision of geological services. This scope of this requirement is likely to be extended with the ongoing harmonisation of Irish and EU standards and legislation.

The IGI also recognises the importance of promoting the status and use of geology and geoscience in industry and in the community in general. Among the ways this can be achieved are in the responsible development of our natural resources, in development of our infrastructure and in the extension of academic knowledge.

The main objectives of the IGI are:

- To promote the interests of the geoscience professions and advance the science and practice of the geosciences in Ireland.
- To require its members to uphold and maintain the highest professional standards in the practice of their profession.
- To increase the confidence of the community in the employment of recognised geologists by admitting to the IGI only such persons as have an adequate knowledge and experience of the geosciences.

- To promote improvements in the law and take any other steps and proceedings as may be deemed necessary in the interests of the IG I and its members.

- To improve professional standards by organising appropriate professional development programmes for its members.

- To represent members' professional interests with government, appropriate committees, media and society as a whole.

- To develop good relations with other relevant geological bodies in Ireland and elsewhere in the world.

- To encourage and assist in the education of, and develop course accreditation for, geologists and geoscientists in Ireland.

4.0 CONTINUING PROFESSIONAL DEVELOPMENT

The nature of professionalism at work is going through major changes as we move into the 21st century. Major changes are taking place in the nature of our jobs, the work we are doing, the responsibility we carry and the effects our work has on other professions in multi-disciplinary teams.

The Institute of Geologists of Ireland (IGI) has set a goal to help members improve their skills and provide structures and support for professionals to engage in a programme of lifelong learning. The Institute established a CPD programme in 2000 to achieve these aims

Continuing professional development is the systematic maintenance, improvement and broadening of knowledge and skill and the development of personal qualities necessary for the execution of professional and technical duties throughout a practitioner's working life.

The IGI considers that its Professional Members have a responsibility to the profession to maintain and develop their abilities as practitioners by a commitment to continuing professional development. CPD helps to ensure the quality of professional products and services and is a valuable investment for both individuals and their employers.

The Institute's Members-in-Training also follow a CPD programme. A successful CPD programme is of considerable assistance to Members-in-Training seeking election to full membership.

The Institute's CPD programme consists of three parts. These are:

- A Professional Development Programme (PDP) for its members.

- A permanent Professional Development Committee to run the CPD programme, analyse CPD returns and develop procedures to assess and audit members' individual programmes.

- The dissemination of information on relevant and available courses, the provision of a programme of professional courses required by members and a system for certifying courses.

Many North American state and provincial engineering and geoscience professional bodies have been operating CPD programmes since the mid-1990's. The United Kingdom and Irish engineering professional institutions, the Institution of Materials, Minerals and Mining (IOM^3), the Geological Society, the European Federation of Geologists and many other professional bodies also have CPD programmes in operation. The IGI has adapted certain aspects of these programmes (especially that of the Association of Professional Engineers, Geologists and Geophysicists of Alberta, Canada) to develop its own programme.

The Institute runs workshops on the CPD programme from time to time. Attendance at one of the workshops makes completion of the forms a relatively straightforward task.

4.1 The Professional Development Programme

IGI members work in most fields of the geosciences and in organisations that operate in the different sectors of the economy. The Institute's Professional Development Programme is designed to be flexible and accommodate the variety in members' activities. It is each professional member's responsibility to decide what to learn and which methods best suit his or her specific needs. Members design their individual programmes within the overall framework provided by the IGI and tailor them specifically to their needs.

Many geologists are already operating, on an informal basis, a professional development programme of their own. The IGI programme provides a formal framework within which to operate. It will be useful in seeking employment/promotion and assist employers to sell their services.

The individual's PDP is based on the Continuing Professional Development cycle (Figure 1) which consists of four main parts:

- Initial review and appraisal;
- Formulate a personal development plan;
- Undertake development activities;
- Complete a personal development record and assessment of achievements.

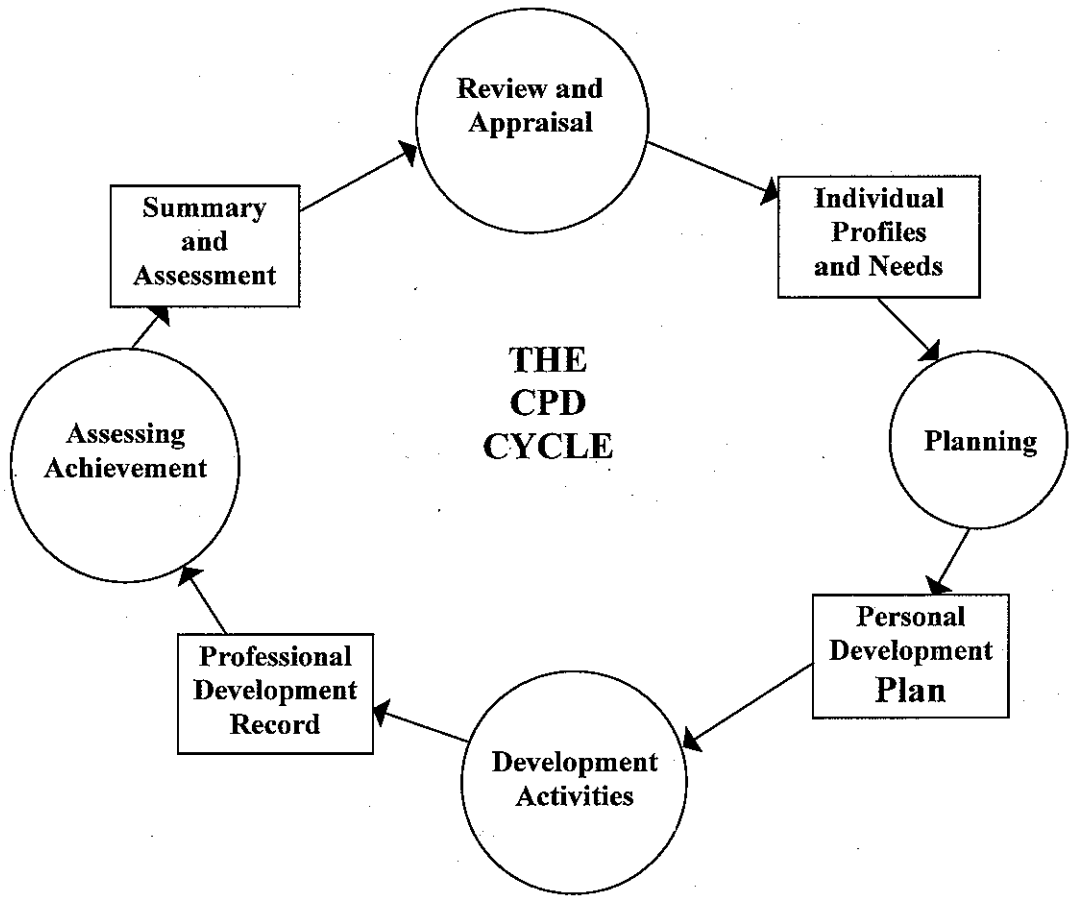

Figure 1 The Continuing Professional Development Cycle

A set of forms is provided to assist members compile the information required for each of the four parts of the cycle. Each form is a worksheet in an *Excel* spreadsheet.

4.2 Role of the Employer

The employer has a role to play in professional development. Professional Members of the IGI are obliged to actively encourage and support those professionals under their direction to advance their knowledge and experience. Members are encouraged to discuss their programmes and plans with their employers or mentors. Through discussion and agreement the employer and professional can decide on professional development requirements and the type and level of employer support. Employer support will help employees develop an on-going interest in lifelong learning, which in turn will provide increased value and commitment to the organisation.

Although employers have a role in defining requirements and are actively encouraged to support their employees' professional development programmes, the primary responsibility for CPD rests with the individual professional.

4.3 Auditing of Members Programmes

As part of the privilege of self-governance, the Institute is responsible for auditing the CPD programmes of its members. The IGI Board maintain an Audit Sub-Committee of at least two senior members to undertake the task of auditing members' programmes. It is intended to audit 10-20% of members' returns each year.

Auditing of selected individual members' programmes may be undertaken:

- by random selection
- as part of a high risk industry review
- in response to specific complaints from clients, the public or regulators
- as part of a practice review or investigation.

The purpose of such an audit will be to confirm that those members selected have a CPD programme in place and that they meet the goals of the CPD programme.

SESSION IV: DISASTER RELIEF & DEVELOPMENT - NEW ROLES FOR HYDROGEOLOGISTS ENGINEERS & AGENCIES

GROUNDWATER AND RURAL WATER SUPPLY IN SUB-SAHARAN AFRICA

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Poverty and the lack of clean reliable water supplies are strongly linked throughout sub-Saharan Africa. The widespread development of groundwater is the only affordable and sustainable way of improving access to clean water and meeting the International Development Targets for 2015.

Sub-Saharan Africa can be divided into four hydrogeological provinces. (1) Crystalline basement occupies 40% of the land area and supports 220 million rural inhabitants; (2) volcanic rocks occupy 6% of the land area and sustain a rural population of 45 million, many of whom live in the drought stricken areas of the Horn of Africa; (3) consolidated sedimentary rocks occupy 32% of the land area and sustain a rural population of 110 million; and (4) unconsolidated sediments occupy 22% of the land area and sustain a rural population of 60 million. For an aquifer to sustain the yield of a borehole equipped with a hand pump transmissivity should generally be in excess of 1 m^2d^{-1} and storage coefficient greater than approximately 0.001.

Although there are now many choices of proven techniques to help site boreholes and wells for rural water supply these are not effectively used throughout Africa, primarily because they are too complex and costly or hidden in general textbooks or scientific journals. Hydrogeologists have a key role in communicating these techniques to those actually implementing rural water supply projects. Research and expertise can then be targeted to finding and developing groundwater resources in difficult hydrogeological environments, where some of the poorest and most vulnerable people of sub-Saharan Africa live.

INTRODUCTION

At least 38% of the population in Africa do not have access to clean reliable water supplies (WHO/UNICEF 2000). Many of those without access live in the rural areas of sub-Saharan Africa (SSA) where the consequent poverty and ill health disproportionately affect women and children. The international community has now set new development targets which commit the UN membership to reduce by half the proportion of people who are unable to reach, or afford, safe drinking water by the year 2015. Poverty reduction and sustainable development are now given highest priority.

In order to meet these new targets, strategies are being devised which draw on the lessons learned from past experience. Increasingly, the social and economic aspects of water projects are given priority to ensure that water supply solutions are easily and sustainably managed by local communities (e.g. DFID 2001). Whilst this approach is welcome, an unwanted outcome is that the focus on social and economic aspects of water supply is often at the expense of technical and hydrogeological considerations. It is within this framework that hydrogeologists now need to operate within Africa. Increasingly, emphasis on technical aspects of water supply, particularly if they involve new research, is seen as regressive and moving away from community development and demand responsive approaches. It is incumbent on the hydrogeological community to demonstrate that its skills are necessary to help meet the international development targets; indeed, without these skills, the ambitious goals will never be achieved.

This paper discusses the groundwater resources in sub-Saharan Africa in the context of the International Development Targets. An extended reference list is given to help follow up technical aspects of the hydrogeology of Africa, which are not discussed in detail here.

CURRENT APPROACHES TO RURAL WATER SUPPLY IN SUB-SAHARAN AFRICA

There has been a fundamental shift in the design, management and implementation of rural water supply over the past 30 years (Black 1998). Starting with the widespread adoption of appropriate technology in the 1970s, the focus of rural water supply evolved from 'hardware' to 'software' through the late 1980s and 1990s. Sustainability, community participation and the increased role of women are central to rural water supply projects. The Dublin Principles, agreed in preparation for the Rio de Janeiro Earth Summit in 1992 are a useful summary of the basis for policy among donors and government (Well 1998):

1. Freshwater is a finite and vulnerable resource, essential to sustain life, development and the environment.
2. Water development and management should be based on a participatory approach, involving users, planners and policy makers at all levels.
3. Women play a central role in the provision, management and safeguarding of water
4. Water has an economic value in all competing uses and should be recognised as an economic good.

The fourth principle, recognising water as an economic good, has had revolutionary implications for the provision of community water supplies. The need for water in a community can be expressed in terms of 'cost' and 'willingness to pay'. If consumers can attach a quantifiable value to their water supply it has a much better chance of being sustained. The same principles have led to the adoption of 'demand responsive approaches' (DRA). Successful projects are more likely if a community expresses a demand for water. However, these approaches can sometimes be at odds with poverty-focussed aid: the poorest and most vulnerable communities may be the least likely to articulate need.

Where groundwater is readily available, wells and boreholes can be sited using mainly social criteria qualified by simple hydrogeological considerations. However, problems arise in areas where communities are underlain by difficult geological conditions, where groundwater resources are limited and hard to find. In these areas, simple 'rule of thumb' criteria are not sufficient to site sustainable wells and boreholes, and following an exclusively social approach, with minimal technical input, can result in many dry wells and boreholes.

To have successful and sustainable rural water supply projects it is essential to understand the hydrogeological environment of the project area. Different methods are required for developing groundwater in different areas. For example, in some rock types dug wells are appropriate; in others, only boreholes will be sustainable. The hydrogeological conditions determine the technical capacity required for both finding and abstracting groundwater. Meeting the challenge posed by the International Development Targets to 'scale up' from small pilot projects to effective implementation across larger areas, appropriate and effective hydrogeological expertise is required by the engineers and technicians who actually implement projects.

GROUNDWATER IN SUB-SAHARAN AFRICA

Groundwater is well suited to rural water supply in sub-Saharan Africa. Since groundwater responds slowly to changes in rainfall, the impacts of droughts are often buffered (Calow et al. 1997). In areas with a long dry season, groundwater is still available when sources such as rivers and streams have run dry. The resource is relatively cheap to develop, since large surface reservoirs are not required and water sources can usually be constructed close to areas of demand. These characteristics make groundwater well suited to the more demand responsive and participatory approaches that are being introduced into most rural water and sanitation programmes.

WHAT CONSTITUTES AN AQUIFER?

The hydrogeology of sub-Saharan Africa has to be studied in the context of the amount of water required by rural communities. In rural Africa water is required mainly for basic needs and is hand-carried from sources to households. The WHO recommended daily minimum usage is 25 litres per

capita (although many people make do with less if the source is more than a few hundred metres away (Kerr 1990)). Most social scientists involved in rural water supply suggest that community boreholes or wells should supply no more than 250 people (Davis et al. 1993) – anymore becomes difficult to manage. Therefore, one source should supply about 6.25 m^3d^{-1}. This small amount of water can be exploited from poor aquifers (see Table 1). Simple modelling using finite-well-diameter equations (Barker & Macdonald 2000) shows that transmissivity of greater than 1 m^2d^{-1} and storage coefficient of 0.001 is generally sufficient to sustain such a yield from a borehole or well (MacDonald 2001).

Recharge of less than 12 mm per annum should be sufficient to sustain such yields (given a well spacing of 500 m). Studies in an area in the Sahel with average rainfall 280 mm per annum indicated an active recharge of about 13 mm per year (Edmunds & Gaye 1994) and in Zimbabwe significant recharge can be measured from individual rainfall events (Butterworth et al. 1999).

Table 1 **Summary of groundwater potential of hydrogeological domains in sub-Saharan Africa with indicative costs of development.**

Groundwater Domains	Groundwater Sub-Domains	Groundwater Potential	Average Yields (Litres per second)	Groundwater Targets	Costs* and technical difficulty** of developing groundwater sources	
					Rural Domestic Supply	Small Scale Irrigation
Basement Rocks	Highly weathered and/or fractured basement	Moderate	0.1- 1	Fractures at the base of the deep weathered zone	£ - ££ # - ##	££ - £££ ## - ###
	Poorly weathered and/or sparsely fractured basement	Low	0.1- 0.5	Widely spaced fractures and pockets of deep weathering	£££ ###	Generally not possible
Volcanic Rocks	Mountainous areas	Moderate	0.5 - 5	Horizontal fracture zones between basalt layers. More fractured basalts	£ - ££ # - ###	£ - ££ # - ###
	Plains or plateaux	Moderate	0.5 - 5	Horizontal fracture zones between basalt layers. More fractured basalts	££ - £££ # - ###	££ - £££ # - ###
Consolidated sedimentary rocks	Sandstones	Moderate - High	1 - 20	Porous or fractured sandstone	£ - ££ # - ##	£ - £££ # - ##
	Mudstones	Low	0 - 0.5	Hard fractured mudstones; igneous intrusions or thin limestone/sandstone layers	££ - £££ ## - ###	Generally not possible
	Limestones	Moderate	1- 10	Karstic and fractured limestones	££ - £££ ## - ###	£ - £££ # - ##
Uncon-solidated sediments	Large basins	Moderate - High	1 - 20	Sand and gravel layers	£ - ££ # - ##	£ - £££ # - ##
	Small dispersed deposits, such as riverside alluvium	Moderate	1 - 20	Sand and gravel	£ - ££ # - ##	£ - £££ # - ##

*The approximate costs of siting and constructing one source, including the "hidden" cost of dry sources: £ = < £1000; ££ = £1000 to £10 000 and £££ = > £10 000.

** The technical difficulty of finding and exploiting the groundwater is roughly classified as: # = requires little hydrogeological skill; ## = can apply standard hydrogeological techniques; ### = needs new techniques or innovative hydrogeological interpretation.

HYDROGEOLOGICAL PROVINCES

There have been various attempts at summarising the hydrogeology of sub-Saharan Africa (Foster 1984; Guiraud 1988; UNTCD 1988; UNTCD 1989). A simplified hydrogeological map is shown in Figure 1 based on a synthesis of these studies and using the 1:20 000 000 scale geological map of Africa (USGS 1997) as a base. The classifications reflect the different manner in which groundwater occurs, constrained by the geological information available throughout sub-Saharan Africa. The four provinces are: Precambrian "basement" rocks; volcanic rocks; unconsolidated sediments; and consolidated sedimentary rocks. Basement rocks form the largest hydrogeological province, occupying 40% of the 23.6 million square kilometres; volcanic rocks are the smallest hydrogeological province with only 6% of the land area.

The potential of each hydrogeological province to contribute to rural water supply is best indicated by the rural population living in each one. As discussed above, the rural communities are most dependent on local resources for water supply, since transportation is often prohibitively expensive and difficult to manage.

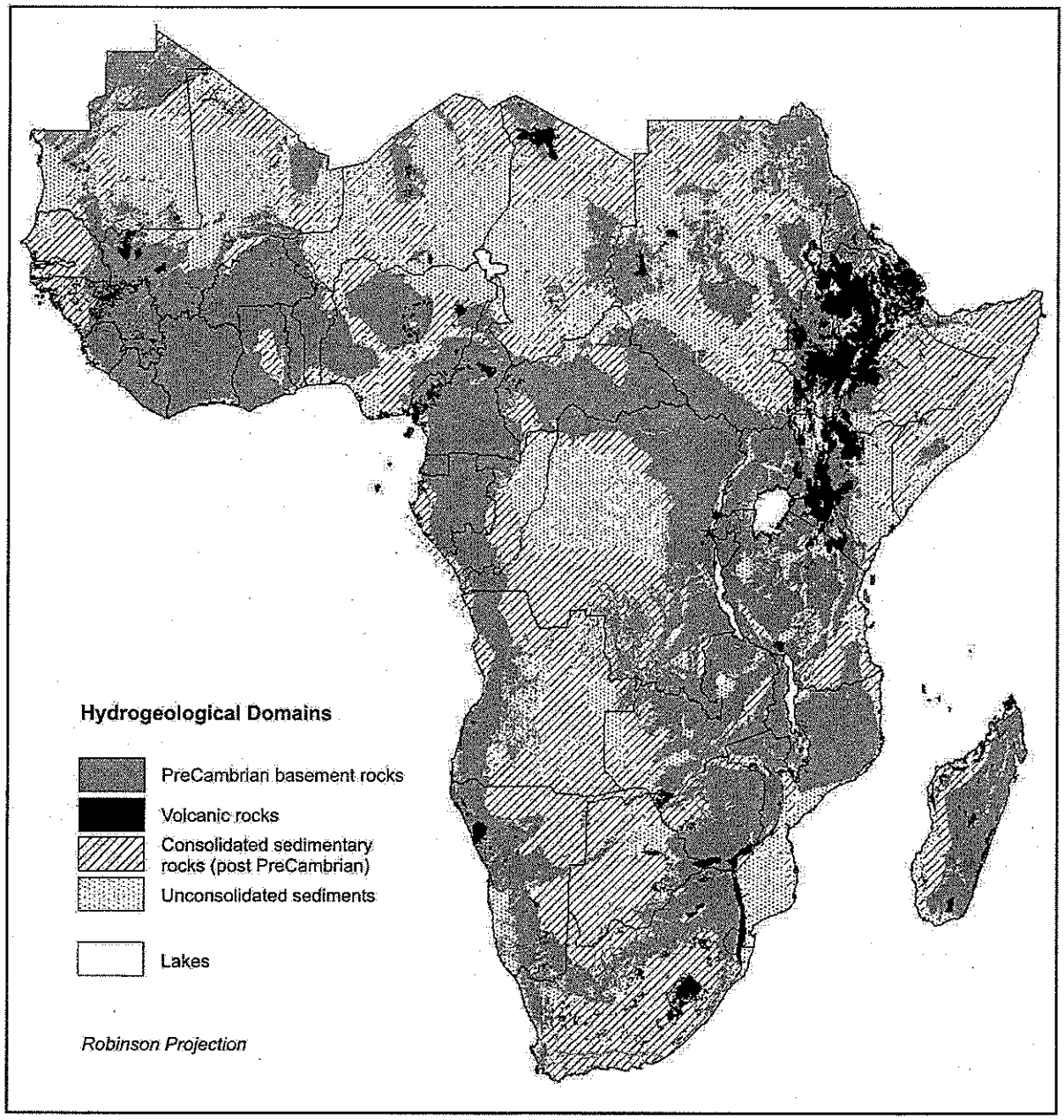

Figure 1 Hydrogeological provinces of sub-Saharan Africa.

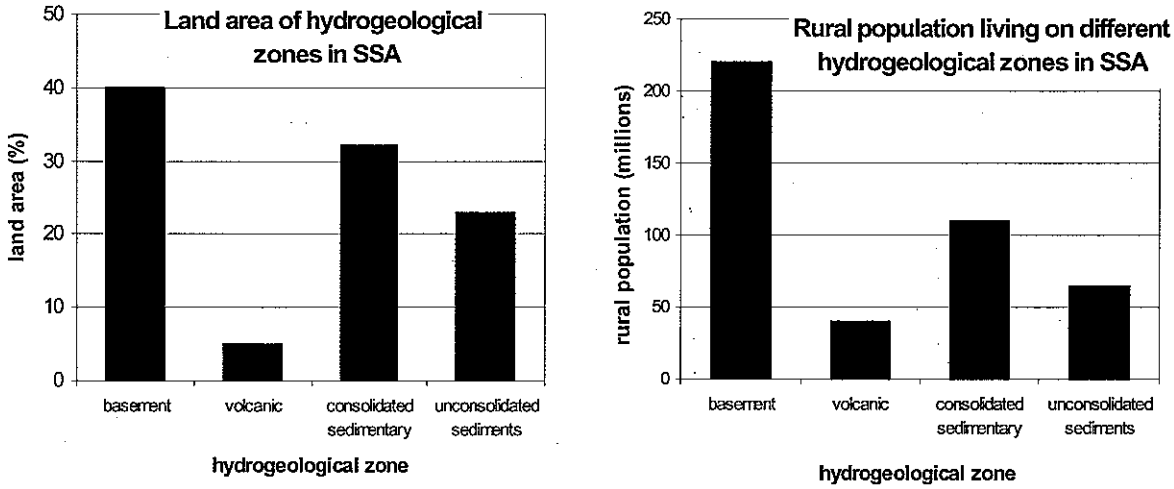

Figure 2 **Land area and rural population of the different hydrogeological provinces of sub-Saharan Africa.**

Using data from the World Bank (2000) and ESRI (1996), an approximation was made of the distribution of rural population throughout SSA. This was combined with the hydrogeological information on a Geographical Information System to assess the number of rural people living on each hydrogeological province. The results are shown in Figure 2. Basement rocks support the largest population (220 million) and volcanic rocks the least (45 million). Further analysis based on the proportion of clay material in sediments indicates that up to 70 million rural inhabitants of sub-Saharan Africa live directly on poor yielding mudstones.

Basement rocks

Basement aquifers underlie 40% of sub-Saharan Africa and comprise crystalline and metamorphic rocks over 550 million years old. Unweathered basement rock contains negligible groundwater. Significant aquifers, however, develop within the weathered overburden and fractured bedrock (see Figure 3). The presence and thickness of weathering depends on past and current geomorphology, tectonics, climate, and mineralogy (Key 1992). Permeability is generally greatest at the base of the weathered zone, where the rock is highly fractured (see Figure 2). Detailed descriptions of groundwater occurrence in basement aquifers are given in Wright & Burgess (1992), Chilton & Foster (1995), Singhal & Gupta (1999), Taylor & Howard (2000).

Volcanic rocks

Volcanic rocks occupy 6% of the land area of sub-Saharan Africa and are mostly confined to East Africa. Most of the volcanic rocks were formed in three phases of activity during Cenozoic times, associated with the opening of the East African rift valley. These events gave rise to a thick complex sequence of lava flows, sheet basalts and pyroclastic rocks such as agglomerate and ash. Thick paleosoils or loose pyroclastic material between lava flows are often highly permeable along with cooling joints at the top of lava flows (see Figure 4). Gas bubbles within lava flows, and porosity within ashes and agglomerates can provide significant groundwater storage. There have been few systematic studies of the hydrogeology of volcanic rocks in Africa, although good site studies are given by Kehinde & Loenhert (1989), Aberra (1990) and Vernier (1993). However, the Deccan basalts of India have been extensively studied (Kulkarni et al. 2000).

Consolidated sedimentary rocks

Consolidated sedimentary rocks occupy 32% of the land area of sub-Saharan Africa (Figure 1). Sedimentary rocks tend to be deposited in large basins containing several kilometres of sediment. Examples are the Karroo, and Kalahari sediments of Southern Africa (Truswell, 1970), sediments within the Somali basin of East Africa and the Benue Trough of West Africa (Selley 1997). Yields are

highest where the sandstones are weakly cemented or fractured (see Figure 5). This makes the aquifers highly suited to large-scale development for reticulated urban supply, industrial uses and agricultural irrigation. However, rural water supply generally relies on shallow boreholes or wells close to communities. Only rocks immediately surrounding the community and to a depth of less than 100 m are usually considered. Although mudstone and siltstone are poor aquifers, groundwater can often be found in these environments with careful exploration (MacDonald et al. 2001).

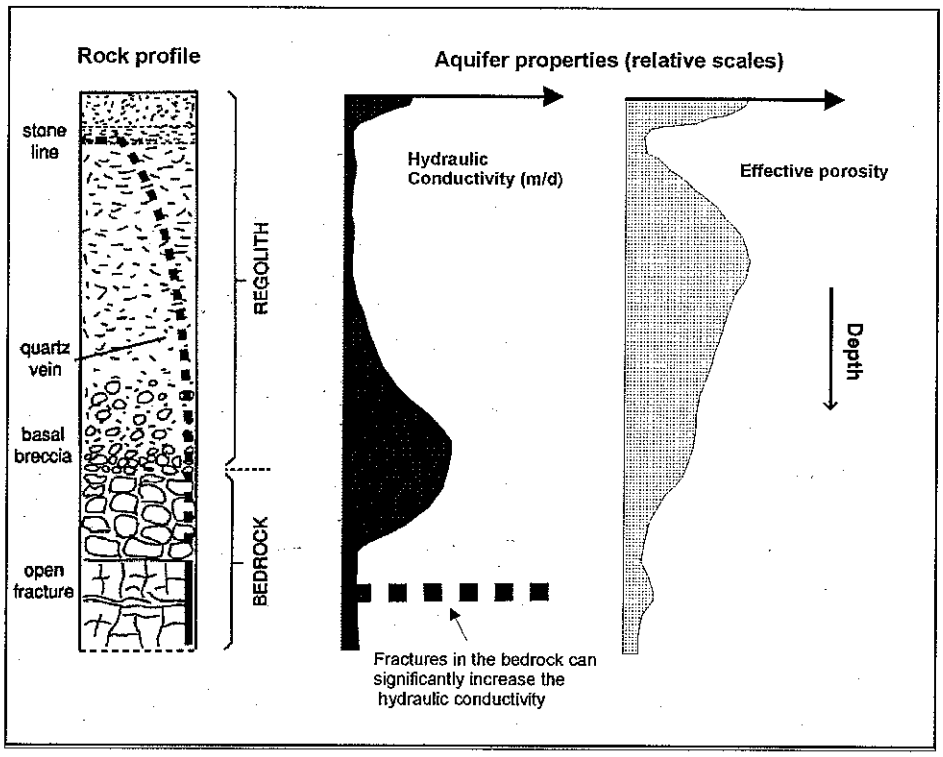

Figure 3 **Variation of permeability and porosity with depth in basement aquifers (based on Chilton and Foster, 1995).**

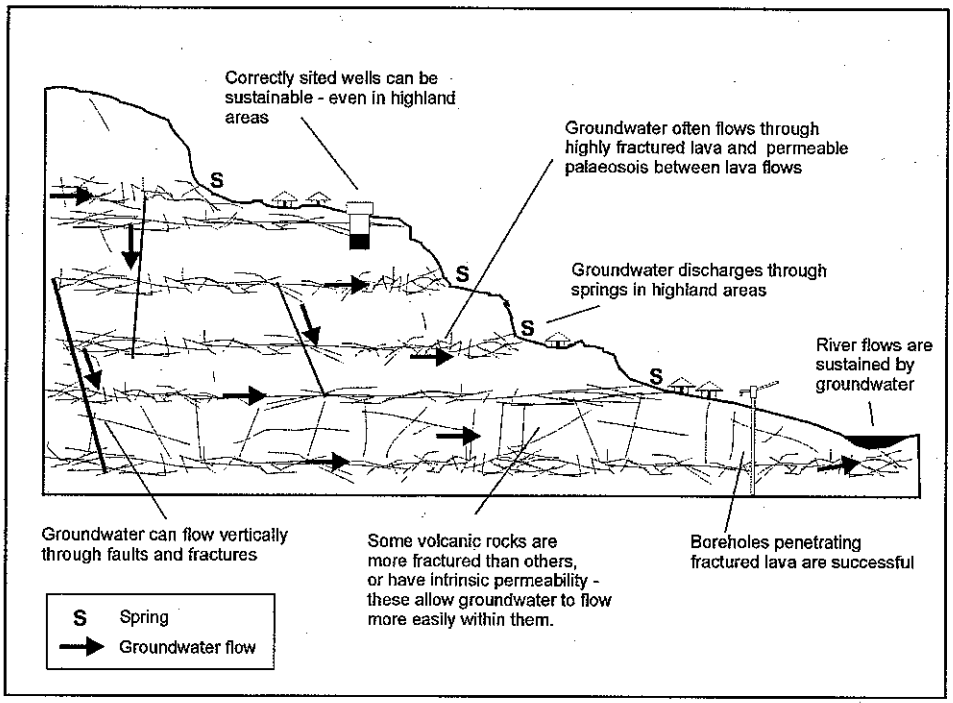

Figure 4 **Cross-section of flow in highland volcanic areas.**

Unconsolidated sediments

Unconsolidated sediments form some of the most productive aquifers in sub-Saharan Africa. They cover approximately 22% of the land surface (Figure 1). This is probably an underestimate of their true importance since unconsolidated sedimentary aquifers (UNSAs) are also present in many river valleys throughout Africa. Examples of extensive deposits are found in Chad, Zaire and Mozambique and in the coastal areas of Nigeria, Somalia, Namibia and Kenya. Guiraud (1988) describes several of the major UNSAs in Africa. The size and physical characteristics of the aquifer depend on how the sediment was deposited. Sand and gravel beds can be continuous over hundreds of kilometres, but are often multi-layered, with sands and gravels interbedded with silts and clays (see Figure 6). Small UNSAs are found throughout sub-Saharan Africa deposited by present day rivers. Here, groundwater is close to the surface, so pumping lifts are small; also the proximity to the rivers offers a reliable source of recharge. Carter & Alkali (1996) and Herbert et al. (1997) give some examples of the small UNSAs in Africa.

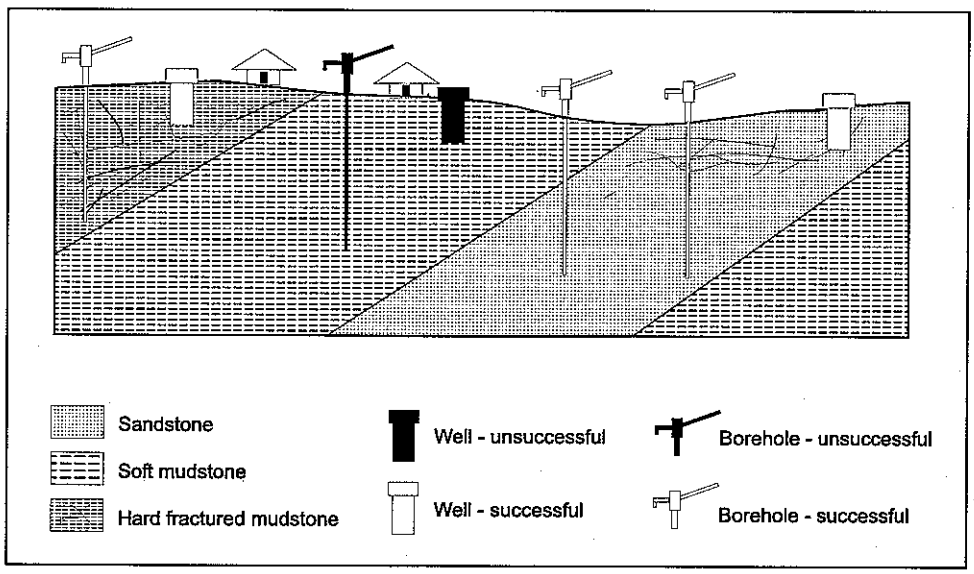

Figure 5 **Groundwater occurrence in consolidated sedimentary rocks.**

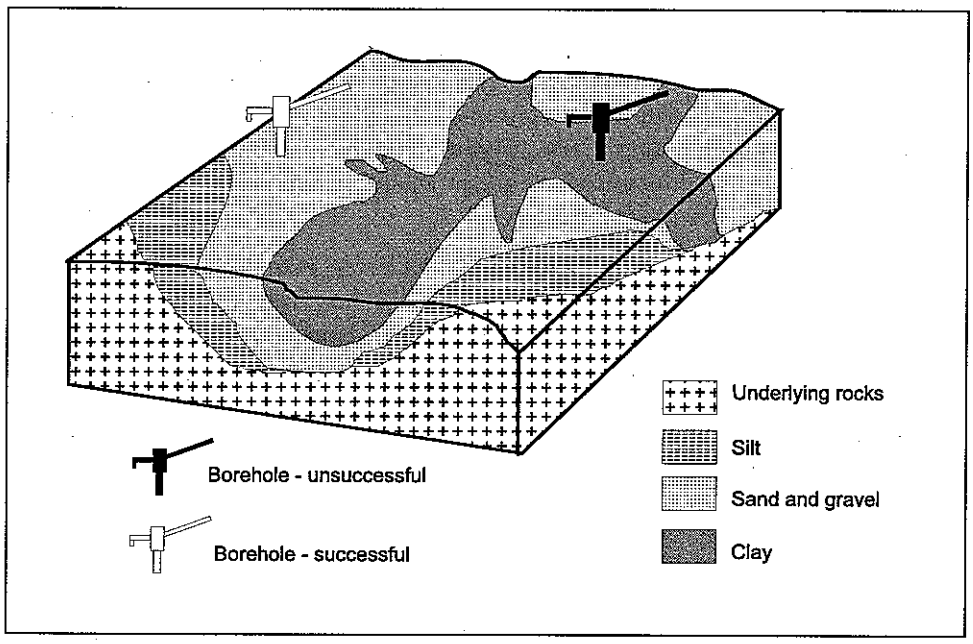

Figure 6 **Groundwater occurrence in unconsolidated sediments.**

HYDROGEOLOGY, HYDROGEOLOGISTS AND RURAL WATER SUPPLY

The basic models for how groundwater occurs in the various hydrogeological environments presented above have been developed from research and experience both in Africa and other similar hydrogeological areas worldwide. Despite much research there remain significant uncertainties and unknowns. Table 1 gives a summary of the current knowledge of the groundwater resources of each hydrogeological environment. Indicative costs of developing a groundwater source are given to help reflect the implications for rural water supply of the varying hydrogeological conditions and the current knowledge base of different aquifers.

Addressing the knowledge deficiencies of hydrogeology in sub-Saharan Africa has significant cost implications. Appropriate levels of investigations can be used for different environments. Simple cost-benefit analysis can help if data are available on drilling costs and success rates 'with' and 'without' different levels of investigation. As noted in Farr et al. (1982) the use of a particular search technique is only justified if it increases the chances of subsequent boreholes being successful, such that the overall saving in drilling costs (through drilling fewer unsuccessful boreholes) is greater than the cost of the search. In some environments, where groundwater is readily available, expensive methods may not be justified. In other environments, however, seemingly expensive methods or studies may be entirely justified by long term savings in drilling costs.

The technical capacity required to develop groundwater also changes with the hydrogeology: in some environments little expertise is required, while in others considerable research and money is required to develop groundwater. MacDonald et al. (2002) summarise geophysical techniques and interpretations in various hydrogeological environments.

1. Where groundwater is easily found (e.g. UNSAs, sandstone aquifers) little expertise is required for wells and boreholes. Although overexploitation and falling water-levels may be a problem.
2. In other areas where groundwater is not ubiquitous, but siting methods are well established standard techniques can be used (e.g. weathered basement rocks). In these areas project engineers and technicians can successfully site wells and boreholes using standard 'rules of thumb'.
3. There are many hydrogeological environments which are complex and no standard techniques are available for siting wells and boreholes (low permeability sediments, poorly weathered basement). In these areas, geophysical and other techniques must be tested to provide new rules of thumb that are appropriate for that environment.

Hydrogeologists have a key role communicating their knowledge to those involved in planning and implementing rural water supply projects. In environments where standard techniques have been developed these should be widely and effectively disseminated so that they can be used by project staff actually involved in implementing projects. Hydrogeological expertise and research budgets can then focus on more difficult hydrogeological areas where groundwater occurrence is not well understood and rural water supplies rarely effective.

Targeting research to difficult areas may not be justified using economic criteria alone. If water projects were judged only on the costs of individual boreholes, then water projects should all be concentrated on areas where it is easy to find groundwater. However, the areas where sustainable groundwater sources are hard to find often have the greatest problems with health and poverty. In these areas, women have to walk further to find water and waterborne diseases such as guinea worm are more common. Helping to solve water problems in these difficult areas may have greater impact on reducing poverty in sub-Saharan Africa than drilling many more boreholes in areas where it is relatively easy to find water.

Acknowledgements

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CONCERN PROJECTS IN THE DEVELOPING WORLD

By: Niall Roche, Health Support Manager and Environmental Health Adviser, Concern Worldwide, Dublin 2, Ireland.

ABSTRACT

Concern Worldwide is a medium size Non Governmental Organisation with a working budget in 2003 of just under €80 million. It is engaged in working towards the elimination of poverty since its foundation in 1968. Ground water has and continues to remain an integral part of Concern's work. Concern's work within groundwater is placed under the health banner and forms an integral part of Primary Health Care. Groundwater forms a part of the water and sanitation part of PHC and is complemented by the other components of Engineering and Environmental Health as described in the Concern Health Policy. These include excreta disposal, liquid and solid waste, vector control, shelter and site planning, the promotion of hygiene and the control of pollution. Ground water work is put alongside these other components in order to achieve an impact in reducing the burden of disease for the poor in developing countries. Ultimately Concern's impact in ground water is to be measured in its contribution to the meeting of the International Development Targets or Millennium Development Goals regarding infant and child mortality in addition to meeting targets for those who have access to water and sanitation.

INTRODUCTION

Concern Worldwide, for whom I work, has been in existence since 1968. The trigger for its creation was the famine in Biafra which resulted from the Nigerian Civil War. Since then Concern has expanded firstly into Bangladesh and more recently into Niger and is now operational in approximately thirty countries worldwide. The bulk of targeted countries are in sub-saharan Africa but there are also activities in parts of central and south east Asia in addition to a smaller presence in the Caribbean and Central America. The sort of countries we are talking about include Liberia, Sierra Leone, Sudan, Somalia, Ethiopia, Mozambique, Malawi, Afghanistan, North Korea and Cambodia to name a few.

Concern sometimes works in emergency situations and some of the more recent emergencies include the current food crisis in Ethiopia and Eritrea, a response to the aftermath of the war on the Taliban in Afghanistan, a volcanic eruption in the Democratic Republic of Congo and an earthquake in Gujarat, India. However perhaps less well known is some of the development work which quietly goes on in countries such as Bangladesh, Tanzania, Uganda, Cambodia and India. A third component which is present in both emergency and development contexts is advocacy. Concern is currently trying to establish advocacy to a greater extent

The range of activities is wide. Concern would not be known as a specialist agency and our latest Strategic Plan gives the organisation broad direction under five areas of programme focus. The five areas of Programme focus are Emergencies, HIV/AIDS, Primary Education, Livelihood Security and Health. This is quite a holistic approach, as Concern believes in tackling poverty on many fronts in order to achieve impact. Our work in the area of ground water falls under the heading of health, which is broadly divided up into three sub-headings matching the key components of Primary Health Care. They are Nutrition, Engineering and Env. Health (water and sanitation) plus the remaining components of Primary Health Care.

Engineering and Env. Health is further broken down into a list of activity types. They include water supply, the disposal of excreta, liquid and solid waste, vector control, shelter and site planning, the promotion of hygiene and the control of pollution with particular emphasis on indoor air pollution.

In total the Concern expenditure for 2003 is expected to be just short of €80 million and of this expenditure somewhere in the region of 16-20 countries are engaged in water and sanitation activities. Some in country budgets for water and sanitation activities are around the €1 million mark but most would be less than that. At this point we don't have a breakdown on the precise or even approximated expenditure under the health sector or the env. health component but this is something we are planning to assess during the course of this year.

Within the theme of this conference Groundwater – its Stakeholders I would hope the following talk gives some insight into how an international NGO (an important stakeholder in groundwater) like Concern operates, what gives direction to Concern's work in groundwater and what we also include as part of a holistic approach in order for our groundwater work to have an impact.

THE BURDEN OF DISEASE

As described in the introduction Concern is quite active in the environmental health sector. The reasons for this are that Concern aims to make a contribution to the International Development Targets otherwise known as the Millennium Development Goals. One of the key International Development Targets is contributing to a reduction in infant and child mortality in developing countries to two thirds of the 1990 level by 2015.

In order to make a contribution to this target Concern feels it needs to tackle the main causes of disease in developing countries. The following outlines the main burden of disease in developing countries and one can see that many of these diseases are water and sanitation or environmental health related. WHO once stated that 80% of all diseases in the developing world were water and sanitation related. Although this statement was made prior to the onset of HIV/AIDS the bulk of the burden still fits under the water and sanitation umbrella.

In percentage terms there are some interesting comparisons. In the latest World Health Report 2002 published by the World Health Organisation there is an interesting comparison between Africa and Europe. The following information is extrapolated from this report.

Cause of Death	**AFRICA**	**EUROPE**
Communicable Diseases, Maternal and Perinatal Conditions and Nutritional Diseases	**70.90%**	**6.00%**
Non communicable conditions	**22.10%**	**86.10%**

Within the category of communicable diseases, maternal and perinatal conditions and nutritional diseases the following are the major killers.

1/ HIV/AIDS – In 2000 HIV/AIDS accounted for 2.6 million deaths with 89.8 million people infected. In Africa HIV/AIDS accounted for over 20% of all deaths in 2002.

2/ Malaria – Estimated to kill 1.1 million people per annum with 300 – 500 million cases per year.

3/ Diarrhoeal diseases – Estimated to account for a minimum of 2.2 million deaths per year and countless episodes but estimated around 1.5 billion.

4/ Acute lower respiratory infections – 3.9 million deaths of which 2.3 million could be attributable to indoor air pollution.

5/ Perinatal conditions – 2.3 million deaths per year

6/ Measles – 875,000 deaths per year. There is a significant link between nutrition and death in measles cases.

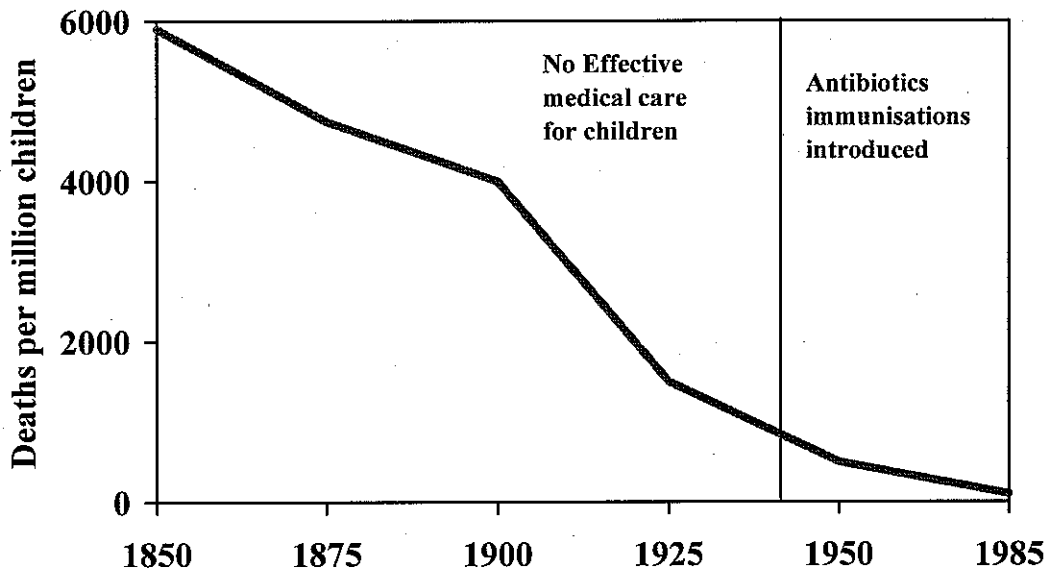
There is nothing to suggest that the burden will be reduced in the near future. In fact HIV/AIDS is expected to continue its rapid increase with southern Africa being particularly hard hit. Non-communicable diseases are also predicted to increase and smoking and tobacco related deaths are expected to rise from the current 3.5 million deaths per year to 10 million deaths per year by 2030 of which 70% are predicted to occur in middle to low income countries.

"Prevention is better than cure"

History tells us that one of the main solutions to death and illness from communicable diseases lies in public health engineering. The following graph illustrates the decline in specific communicable diseases in our part of Europe over a 150 year period. The graph demonstrates a decline in deaths from a number of infectious diseases from 1850 onwards to the present day. As can be seen the decline is very dramatic and almost complete before the introduction of antibiotics and immunisations. In fact the majority of the decline was achieved for the following key reasons:-

(a) Improved nutrition
(b) Improved housing
(c) Improved water supply and sanitation

Deaths below 15 years attributed to scarlet fever, diptheria, whooping cough and measles, England and Wales



Concern's work as outlined earlier attempts to tackle each of these components within primary health care in addition to essential drugs and immunisations thus ensuring a comprehensive public health approach to the disease burden. In addition our work in livelihood security would also work on the nutrition aspect to enable people grow their own food or generate enough cash income to purchase their food needs.

The Global Water Supply and Sanitation Assessment 2000

The burden of disease, the history of how to tackle communicable diseases plus our knowledge on the ground indicates that Concern needs to continue working in the water and sanitation sector. The Global Water Supply and Sanitation Assessment carried out by WHO, Unicef and the Water Supply and Sanitation Collaborative Council published in 2000 also highlights the distance still to go if infant and child mortality is to be reduced to target levels by 2015.

In essence the assessment states that an enormous number of people gained access to improved water supply and excreta disposal facilities over the decade 1990 to 2000. The figures given show that 816 million additional people gained access to water supplies bringing the total number with access up to 4.9 billion people or 82% of the global population. 747 million additional people gained access to sanitation facilities bringing the number up to 3.6 billion or 60% of the global population.

However this still leaves a major shortfall. As of 2000 the following people still did not have access to water and sanitation.

1.1 billion people (one sixth of the global population) do not have access to improved water supply.

2.4 billion people (two fifths of the global population) do not have access to excreta disposal facilities.

In summary the number of people sick and dying of water and sanitation diseases is huge and the predominant cause of death and illness in low and middle income countries plus the numbers of people without access to adequate facilities is still a long way short of complete coverage. These sorts of figures justify our response in the sector.

If everyone in Africa, Asia and Latin America was to obtain access to improved water and sanitation services by 2015 this requires that improved water be provided to an additional 1.5 billion people and improved sanitation access to 2.2 billion people, which takes into account population growth over the 15 year period 2000 – 2015. In day to day terms this means providing additional water supply services to 280,000 people and additional sanitation facilities to 384,000 people every day for the next 15 years. The International Development Target only aims to halve the proportion of poor people without secure access to water and sanitation by 2015 thus meaning providing water to 140,000 people and sanitation facilities to 192,000 people every day up to 2015.

The work Concern does

As described earlier the work Concern does in the water and sanitation sector is quite varied. The different components again are:-

(a) water supply
(b) the disposal of excreta, liquid and solid waste
(c) vector control
(d) shelter and site planning

(e) the promotion of hygiene
(f) the control of pollution with particular emphasis on indoor air pollution.

Rather than give a descriptive account of what we do in each country or a number of countries I've decided to try and pick out one case example. In this case I've picked Liberia, which has engineering and environmental health activities under both the emergency and development banners. Liberia is also the last country I visited on a technical support basis back in October/November of 2002 and so is freshest in my memory.

Liberia: Liberia is a country ranked amongst the poorest in the world. On the UNDP Human Development Index in 1999 Liberia was placed 174th out of 175 countries. Considering that Concern targets countries in the bottom forty of the HDI Liberia is well within our target group of countries. It is a country that has experienced prolonged periods of conflict since the end of 1989 when a civil war erupted. Conflict continues with tens of thousands being recently displaced within Liberia or have fled across the border into Guinea. NGO staff have been caught up in the renewed fighting, some were kidnapped and Concern staff were evacuated to Sierra Leone. Economically Liberia's GDP is estimated at US$169.8, adult literacy levels are at 22% and infant mortality at 167 per thousand live births. In Ireland recently we had an infant mortality rate of 6 per thousand live births, which illustrates the gulf between the developed and developing world. The percentage of the rural population with access to safe drinking water is only 13%. It is against this backdrop that the Concern programme operates.

Emergency Context: Our emergency work takes place in Bong County, which is located north of the capital Monrovia. Here the programme is focused on internally displaced people housed in a number of internally displaced person or IDP camps. Very recent fighting has disrupted the programme but in November we were working in IDP camps called CARI 1, CARI 2, Maimu 1 and Maimu 2 which housed somewhere in the region of 30,000 IDPs.

Activities included:

1/ Excreta disposal – blocks of pit latrines (each block housing four units) aiming to improve the ratio for one latrine for every 70 people to one for every 40 people. This is still short of the minimum standard for emergencies of one for every 20 people.

2/ Water supply – drilled or hand dug shallow wells fitted with handpumps. Such a measure follows on from a temporary water supply arrangement organised by MSF (Medecins Sans Frontieres) who pumped spring water up to bladder tanks, which was batch chlorinated. Water is supplied to a standard of 10 litres per person per day which is also below the minimum standard but with high availability of surface water for non-consumption purposes 10 litres/per person/day is considered sufficient. By way of comparison most of us would flush that amount of water down the toilet in one visit to the toilet.

3/ Liquid and Solid Waste – Waste water comes from the bathhouses used for personal cleaning and laundry activities. The ratio in November was one bath house for every 97 people (a long queue if you want to have a wash) which caused problems as the soakpits were unable to cope. The team were hoping to improve the ratio to 1 for every 70 people. Solid waste is disposed of in large open pits dug at various points throughout the camps. People simply place their rubbish in the pits (it is not collected). Ideally pits should be covered with a layer of soil every day to prevent access for vectors such as rats and flies.

4/ Vector Control – the main vector borne disease in Liberia is Malaria. Recommendations on my visit included improved drainage within and around the camps to limit potential breeding sites for mosquitos. Other potential activities included the promotion of bednets and education on personal protection measures. At one site chemical control was used to kill adult mosquitoes. Chemical control was also adopted to try and limit the proliferation of flies, which are associated with diarrhoeal diseases in latrines.

5/ Shelter and Site Planning – Concern has provided plastic sheeting to most of the families displaced in order to help them put a suitable roof over their heads. A typical family receives one piece of plastic sheeting measuring 6m x 4m. Site Planning has been near impossible resulting in camps that local authorities have "planned" in a very poor way. Numerous problems exist, housing is too close together which is a fire and communicable diseases risk, space has not been allocated for services such as latrines and bath houses many of which are now located on the periphery and vehicular access also has not been allocated.
Promotion of Hygiene – Hygiene education activities were due to start shortly after my visit and were to focus on the delivery of hygiene education messages through the schools that had been set up in the camps utilising the child to child approach. A complete strategy was to be designed identifying existing hygiene behaviours as a basis for measuring success, identifying key messages to deliver, the mechanisms by which those messages were to be delivered such as leaflets, video, focus groups, house to house visits etc. and the recruitment of skilled staff and/or training of such staff.

Control of Pollution – This was an area that had received little attention up to my visit partly due to the huge amount of work to do in a short time providing water and sanitation. However Liberia is a very wet country (it receives something like 4 metres of rain a year) and many people have to cook indoors creating excessive exposure to indoor air pollutants. A recommendation was made to examine ways of reducing exposure. Possibilities include changing the location of cooking, improving ventilation over cooking fires and using fuel efficient methods through the use of fuel efficient stoves and proper preparation of fuel wood.

Note: In Emergencies Concern would aim where possible to meet and go beyond the minimum standards in Disaster Response as set out in a publication called the Sphere Project.

Development context: In a development context Concern is currently working on an ECHO funded project in Grand Bassa county which is more to the east of Monrovia. It aims to construct more than 43 wells and nearly 2,000 latrines. Like the emergency programme there is a strong emphasis on ensuring that the provision of ground water is integrated alongside sanitation (meaning latrines) and hygiene education aimed at achieving impact. Demand for latrines is high and 100% of families are requesting assistance in the provision of simple pit latrines at the ratio of one per family.

There are numerous key issues to think about in all water and sanitation programmes and in particular watsan programmes in the development context. Concern utilises a DFID Guidance Manual on Water Supply and Sanitation Programmes plus an Ireland Aid policy document to come up with a checklist of issues from a technical and a non-technical or soft point of view. This paper does not have the time to address all of these issues but in the Liberia programme some of the key ones are as follows:

Sustainability – In this part of Liberia handpumps were provided in the past but when they broke down they were rarely fixed. Two reasons explain this (a) a lack of demand for clean ground water when other sources of surface water were easily accessed and (b) a lack of

emphasis in programme design on how to ensure handpumps were operated and maintained continuously. In this case communities have set up their own small farms to grows crops such as plantain bananas which they can sell and use the proceeds to buy spare parts.

Technology choice – In this case the donor, ECHO have insisted that the handpumps supplied are of the Consallen variety, a handpump that is produced in the UK. These handpumps come at a unit cost nearly three times that of Afridev, which is a very familiar handpump utilised in many of the countries we operate. Consallen it said to be a much more durable handpump than the Afridev and it was claimed that once fitted they would not break down for 3-4 years and then rarely thereafter.

Access – The current programme targets those villages that are accessible by vehicle which could easily be argued are not the poorest of villages in the targeted counties. Concern has worked on the construction of bridges and the next phase of the water project may have to include the construction of bridges in order to allow access for the delivery of materials and equipment. This will have the added benefit of giving these communities access to markets for the sale of produce.

Partnerships – One of the key aims of the latest Concern strategic plan is to work in partnership with local institutions be they national government, local government, local NGOs or local CBOs (Community Based Organisations). In the Liberia context the type of partnership is more like sub-contracting. Local NGOs are sub-contracted to cast squatting slabs for latrines and concrete rings for shallow well construction. It is hoped that in the future we can move to working with partners where there is an element of capacity building.

Conclusion

The 3rd World Water Forum recently held in Kyoto and two other cities of Japan highlighted that the world needs to spend $180 billion dollars annually in order to produce global water security over the next 25 years. This puts the role of Concern into perspective and can be viewed as very small indeed. However the approximate $5-10 million dollars we might be spending on water and associated environmental health will make a small but not insignificant contribution to the meeting of the IDTs. The IDTs aimed at are not only in relation to those that have access to water and sanitation but also in reducing infant and child mortality. This is where the impact of our work should ultimately be measured. The challenge we continue to face is utilising that money effectively and responding to the demands of our clients, the poor.

I hope the above presentation gives an insight into the workings of Concern, how we operate and how groundwater and its stakeholders feature in our strategic actions towards the elimination of poverty.

GROUNDWATER AND WATER RESOURCES DEVELOPMENT IN UGANDA – AN AFRICAN PERSPECTIVE

Callist Tindimugaya, Principal Hydrogeologist, Ministry of Water, Lands and Environment, Uganda

ABSTRACT

Uganda is well endowed with water resources but they vary seasonally and spatially due to uneven temporal and spatial distribution of rainfall. These resources are also under increasing pressure from domestic, industrial, agricultural and hydropower demands and environmental degradation. Strategies for water resources development based on Water Sector Reform are targeting groundwater for meeting domestic water demands for over 80% of Uganda's population that lives mainly in rural areas. Although reasonable progress has been achieved regarding safe domestic water supply, much still remains to be done to ensure sustainable groundwater resources development because of lack of crucial data and information about the state of the groundwater resources. A number of problems are threatening sustainable use of groundwater resources, which include pollution in peri- urban areas, lack of information on recharge and poor understanding of the groundwater potential in most of the country. Any opportunities for sustainable groundwater development therefore need to be fully utilised while efforts should be put into reducing the impacts of the constraints to sustainable groundwater development. In order to realise the above a number of issues which include stakeholder involvement, local capacity building and awareness raising need to be given special attention.

1.0 INTRODUCTION

1.1 BACKGROUND

Uganda is located in East Africa along the Equator between longitudes 30^0 E and 34^0 E and latitudes 1° N and 1° S as shown in Figure 1 below. It is bordered by Tanzania to the south, Kenya to the east, Sudan to the north, Democratic Republic of Congo to the west and Rwanda to the southeast. The country has a population of about 24 million people and covers an area of 249,000 square kilometers 15% of which is covered by surface water resources including, most notably, Lake Victoria.

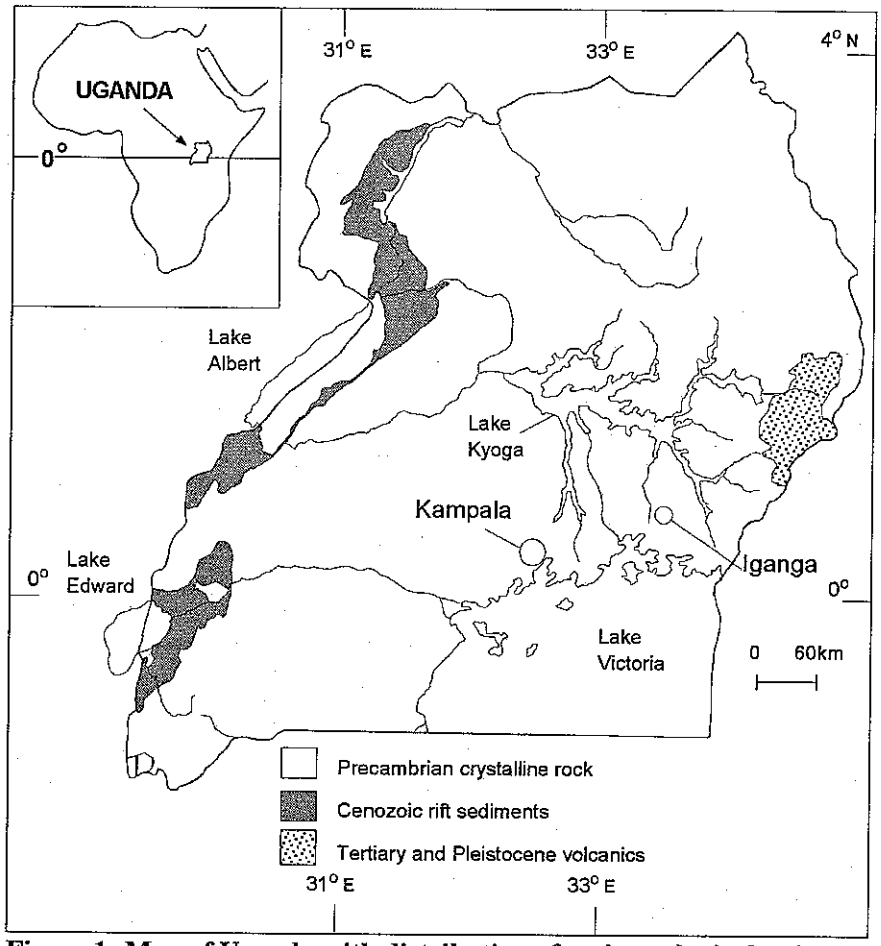


Figure 1: Map of Uganda with distribution of main geological units

1.2 WATER RESOURCES DEVELOPMENT

Uganda is well endowed with rainfall, surface water and groundwater. With ample rainfall for crop production in most of the places, water resources development has traditionally focused mainly on provision of domestic water supply. Uganda's freshwater, like anywhere else, is thus a key strategic resource, which is vital for sustaining life, promoting development and maintaining the environment. However, Uganda's water resources are variable seasonally and spatially due to uneven temporal and spatial distribution of rainfall. In addition, the increased demand from various uses combined with environmental degradation are putting pressure on the quantity and quality of water resources.

In Uganda, safe water and sanitation for all is a top priority and high on the political agenda. Access to safe drinking water and good sanitation is a fundamental human right as enshrined in the Constitution of the Republic of Uganda of 1995, and as such government has an obligation to ensure availability of adequate water and sanitation services for all.

The water sector is one of the core government priority areas and is vital for poverty eradication as it directly contributes to the healthy well being of the people, thus increasing their productivity. The government with assistance from a number of development partners has continued to

implement water and sanitation activities with the target of providing safe water and sanitation for all by the year 2025. Current figures of safe rural water supply and sanitation coverage stand at 53% and 51% respectively. The figures for urban water supply and sanitation coverage stand at 68% and 60% respectively.

1.3 WATER SECTOR REFORMS

The Water Sector in Uganda is undergoing reforms with the objective to ensure that services are provided and managed with increased performance and cost effectiveness, to decrease the government burden while maintaining the government's commitment to equitable and sustainable provision of services. A number of constraints have hindered progress in implementation of water and sanitation activities, leading to the realization that reform is necessary to increase both the efficiencies of sector outputs and effective use of sector inputs.

The water sector reform is undertaken under four sub-component studies namely; Rural Water and Sanitation Development, Urban Water and Sanitation Services, Water for Production and Water Resources Management. The rural water sub-sector reform study completed in 2000, produced a 15-year Strategy and Investment Plan. According to this plan access to safe water supply and sanitation facilities will increase from 50% (2000) to 100% (2015). The Urban Water Sub- Sector Reform study, completed in January 2001, proposed strategy and investment needs for the next ten years for the Sub-sector. The Water for production study is due to end in Mid 2003, while the Water Resources Management has just commenced. Based on the Rural water and Urban water sub-sector reform strategies, it is evident that groundwater is the main target for meeting domestic water demands. Bearing in mind that over 80% of Uganda's population lives in rural areas and need to be provided with clean and safe water the importance of groundwater cannot be overemphasized.

Implementation of the recommendations of the 4 sub-sector reform studies will inevitably put a lot of pressure on the country if it is to sustainably develop and manage its water resources. There will be not only be a need for a better understanding of the distribution of water resources of the country but also to regulate water use and pollution in order to avoid overexploitation, conflicts and degradation of water resources. Similarly, there will be a need for proper operation and management of water supply systems to ensure sustainability.

2.0 GROUNDWATER RESOURCES DEVELOPMENT

2.1 HYDROGEOLOGICAL CONDITIONS

Groundwater development in Uganda is greatly influenced by the varied geological conditions which consist of very old Precambrian rocks that underlie over 90% of the country, and Cenozoic rift valley sediments and tertiary and Pleistocene volcanics that occur in a few areas and cover less than 10% of the country. Hydrogeological conditions are typical of Precambrian Basement terrain and aquifers occur in the weathered overburden (regolith) and in the fractured bedrock. In most of Uganda, boreholes are typically drilled into fractured bedrock, while shallow wells are drilled in the regolith. In-situ weathering is the primary process in overburden development, and weathering is usually most intense in fractured rocks. Schematic profile of a typical basement regolith aquifer system is presented in Figure 2 below.

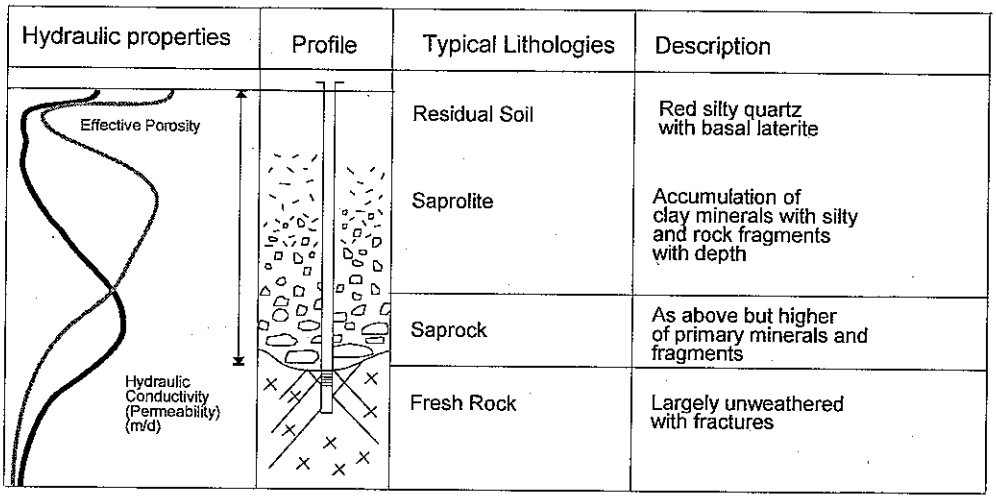


Figure 2: Schematic Profile of a Typical Basement Regolith Aquifer System

2.2 OVERVIEW OF GROUNDWATER DEVELOPMENT

Groundwater plays a significant role in domestic water supply and its development has been ongoing since the 1930s mainly for rural water supply through deep boreholes and springs. There are approximately 20,000 deep boreholes, 3000 shallow wells and 12,000 protected springs in the country constructed mainly for rural domestic water supply. Deep boreholes are small diameter wells that are deeper than 30 metres while shallow wells are wells that are shallower than 30 metres and constructed in the unconsolidated formation. The average depth of boreholes in Uganda is 60 metres while shallow wells are on average 15 metres deep. Boreholes and shallow wells are normally installed with handpumps with capacity of $1m^3$/hour and their yields commonly range between 0.5 and 5 m^3/hour.

There has however been an increase in groundwater development for town water supply since early 1990s due to the need to have water supply systems that can easily be operated and managed by the users. In addition, groundwater normally has good quality and requires little or no treatment unlike surface water. This therefore makes investment and operational costs of groundwater based systems much lower than those of surface water based systems. Boreholes with yields greater than $3m^3$/hour are thus normally considered for installation with motorized pumps for piped water supply.

Under the rural water supply investment plans it is intended to improve significantly the safe water supply coverage in the whole country to at least 95 percent by 2015. The focus is on groundwater development using low-cost, simple water-supply technologies. In order to achieve this it is planned to construct an additional 40,000 hand pumped boreholes, 30,000 shallow wells and protect a few thousand remaining springs. Under the urban water supply investment plans, it is planned to supply piped water to over 250 small towns and most of these will be based on groundwater through deep boreholes. Groundwater development is, however, being carried out with very limited knowledge of the groundwater systems making it difficult to predict whether future water demands will be met from groundwater and how the groundwater development should be carried out to avoid adverse effects to the environment. This information is essential for sustainability of water supply systems.

In mid 1990, Uganda Government realized the need to understand the nature and behavior of groundwater resources as a way of ensuring sustainability of water supply systems. Studies aimed at assessment of the groundwater resources for sustainable town water supply were initiated in 1996 under the Danida funded "Water Resources Assessment Project" (WRAP) and have continued up to now in a few areas of the country. Information so far obtained includes distribution and behavior of aquifers, groundwater recharge, aquifer vulnerability to pollution, impact of motorized abstraction on groundwater resources and conceptual model of groundwater dynamics.

Currently, there are a number of initiatives that have been put in place and supported by donors to address some of the identified water resources development and management objectives. These include the Rural Water supply and Sanitation Programme, the Small Towns Water and Sanitation Programme and the Capacity building for Water Resources Management.

2.3 KEY GROUNDWATER DEVELOPMENT ISSUES

As mentioned above, groundwater development is on the increase for both rural and urban water supply. However, plans for groundwater development are being made with very little information on the hydrogeological conditions and groundwater potential of different areas of the country. For example, Uganda does not have a hydrogeological map with which to plan the development of groundwater resources. Similarly, at the district level, very little is known about (i) the nature and extent of aquifers; (ii) their potential for both large and small-scale groundwater development; (iii) the quantity and quality of available water resources; and (iv) the feasible water supply technologies in different parts of the district.

With the exception of recent pilot activities in 10 districts of the country out of a total of 56, hydrogeological (groundwater resources) mapping has generally not been conducted because data collected during the development of groundwater resources have not been synthesized to depict groundwater resources both spatially and with depth. The quality of some of these data is also poor and may not meet the requirements of mapping.

District administrations often seek financial support for water supply without due consideration of the most appropriate and cost-effective technologies. Districts regularly opt for technologies which may work but are expensive to construct, operate and maintain. Hydrogeological mapping of the country is a necessity as generated maps will assist in rational and sustainable decisions regarding the development of groundwater for rural and urban populations of Uganda.

Several limitations hinder sustainable use and management of groundwater resources of Uganda. Aquifers are limited in yield, extent and hydrogeological characteristics and recharge is low in many areas, which implies that groundwater abstractions for say irrigation, municipal water supplies are unlikely to be sustainable. Similarly, pollution in peri-urban areas and poor understanding of the groundwater potential in most of the country pose serious problems.

Groundwater issues of concern include:

- Limited yield of both hand pump and motorized wells
- Impact of increased abstractions on surrounding water sources especially in towns

- Pollution from sewage disposal systems especially in urban areas.
- Unreliable information on which to plan groundwater development activities
- Limited groundwater potential and recharge in most of the country

3.0 OPPORTUNITIES FOR SUSTAINABLE GROUNDWATER DEVELOPMENT

3.1 LEGAL FRAMEWORK

Uganda has a favorable legal framework for sustainable development and management of water resources. This includes the Constitution, Water Statute, Water Policy and Water Resources Regulations. The Water Statute details management procedures for water extraction and wastewater discharge to be used in preparation of regulations governing water resources development.

3.2 INSTITUTIONAL FRAMEWORK

Uganda has an adequate institutional framework for sustainable development and management of water resources. This includes the Ministry of Water, Lands and Environment and District Local Governments. The Ministry of Water, Lands and Environment is responsible for setting policies and standard and developing plans for water resources development while implementation of water development activities is a responsibility of local governments. Actual implementation of activities is however carried out by the private sector and non- governmental organizations and community-based organizations.

3.3 WATER SECTOR REFORMS

Water Sector reforms have provided a framework for sustainable and effective water resources development and management through involvement of all stakeholders so as to increase both the efficiency of sector outputs and effective use of sector inputs.

3.4 DECENTRALISATION

Implementation of water development activities has been decentralized from the central government to the district level and is now a responsibility of local governments. Through this process, the user communities and other stakeholders are directly involved in groundwater development and management thus ensuring sustainability.

3.5 PRIVATISATION

Decentralisation of implementation of water development activities has gone hand in hand with privatisation. This has lead to the growth of the private sector and resulted in demand for specialised technical input. This will not only ensure that the private sector is fully involved but will inevitably result in sustainable groundwater development.

3.6 STAKEHOLDER INVOLVEMENT

The water sector reforms have realised the importance of involving all the stakeholders in water resources development such as local governments, donors, NGOs, CBOs, private sector and the communities. This thus ensures that they will play their expected roles resulting in sustainable water resources development.

3.7 GROUNDWATER RESOURCES MAPPING

As a follow up of the pilot groundwater mapping activities, a programme named "Groundwater Resources Mapping Programme" (GREMP) has been proposed, with the overall objective to assess and map groundwater resources at district, regional and national level in order to guide efficient and cost-effective water resources planning and development. Under the programme, the whole country will be mapped over a five-year period. Once maps have been prepared for all districts, regional maps will be produced and will be followed by a groundwater resources map of the whole country. Groundwater reports will be prepared to accompany the maps. The maps and reports will primarily be for district use, and as such will be prepared on a district basis, though it may be necessary to produce catchment groundwater maps and reports in the future.

Funding for the GREMP is yet to be secured but requests have been submitted to the British and Swedish Governments and a response is awaited. If this programme is implemented, it will improve the knowledge of the distribution of available groundwater resources resulting in sustainable groundwater development.

4.0 CONSTRAINT TO SUSTAINABLE GROUNDWATER DEVELOPMENT

4.1 COMPLEX GEOLOGY

Groundwater in Uganda occurs in fractures and weathered zone found in complex geological formations. The complex geology makes understanding of the nature of groundwater occurrence and movement very difficult. This, in turn, presents a serious challenge to sustainable groundwater development.

4.2 LIMITED KNOWLEDGE OF GROUNDWATER RESOURCES

There is limited knowledge of groundwater resources in Uganda. This has resulted in haphazard groundwater development that also constrains sustainable groundwater development.

4.3 LIMITED TECHNICAL CAPACITY

Technical capacity for sustainable groundwater development in Uganda is limited. The number of hydrogeologists is not only small but also their expertise is low due to the nature of training they receive. There are currently slightly over 10 hydrogeologists in the country with postgraduate training in hydrogeology while most of the hydrogeologists (currently over 50) have undergraduate education in geology where they have only done a hydrogeology course of about 8 hours. This state of affairs inevitably results in poor quality professional work and hence unsustainable groundwater development.

4.4 LIMITED FINANCIAL RESOURCES

Due to limited financial resources, the available resources are usually committed to water supply development with limited or no groundwater resources assessment. This therefore results in groundwater development without any knowledge of the available resource.

4.5 POOR QUALITY OF GROUNDWATER DATA

Good quality data are required to plan effectively groundwater development activities. Data collection is, however, often done by unqualified people who do not understand and appreciate the importance of the data. Thus, hydrogeological data for groundwater resources development planning are typically of poor quality and can lead to inaccurate or ineffective decisions.

5.0 CONCLUSIONS AND WAY FORWARD

Reliance on groundwater for domestic water supply in Uganda has increased greatly over the past years and is slated to increase further as the country tries to achieve its objectives of safe water for all by the year 2015. Although reasonable progress has been achieved in this endeavour, much still remains to be done with respect to the overall groundwater resources development, not least because of lack of crucial data and information about the state of the water resources. There are a number of problems that are threatening sustainable use of groundwater resources namely pollution in peri urban areas, lack of information on recharge and poor understanding of the groundwater potential in most of the country among others.

In order to ensure that groundwater resources are sustainably developed, concerted efforts involving all stakeholders are needed. Any opportunities for sustainable groundwater development need to be utilised and much effort should be put into reducing the impacts of the constraints to sustainable groundwater development. In order to realise the above, a number of issues need to be given special attention as discussed below.

5.1 STAKEHOLDER INVOLVEMENT

All the stakeholders including water users should be fully involved in all aspects of groundwater development and management. Each one's roles should be clearly highlighted and efforts should be put into encouraging them to take up their respective roles.

5.2 LOCAL TECHNICAL CAPACITY BUILDING

There is a need to build the local capacity of hydrogeologists and other groundwater professionals so that they are able to carryout their work in the most professional manner. This could be done through support to curriculum development and implementation and refresher courses

5.3 AWARENESS RAISING

Groundwater development has often times been taken for granted and very few efforts have been put into groundwater resources assessment and management. There is, therefore, a need for raising awareness on the vulnerability of groundwater to overexploitation and pollution so that efforts can be put into developing and managing the resources better. The awareness raising should target policy makers, donors and other major stakeholders.

WATER AND SANITATION REFORM IN UGANDA AND THE IMPLICATONS FOR STAKEHOLDERS

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ABSTRACT

Over the last decade, most African governments assisted by donors, have seen the need to embark on reforms to address the problems of water and sanitation services. These reforms involve public-private partnerships, institutional, legal, structural and regulatory initiatives that seek to find new ways of working to achieve new goals. Uganda is undertaking one of the most ambitious reform programmes on the African continent. Recently, it embarked on a reform process for the water and sanitation sector in which it moved from implementing a series of piecemeal donor-supported projects, with questions over ownership, sustainability and coordination, to a process in which donors and the Government of Uganda(GoU) have come together to develop a national strategy and a comprehensive sector-wide investment programme, to include global best practices for rural water and sanitation. As a result of this development, donors are beginning to pool their resources into one basket in support of the programme. This reform represents a monumental change in less than ten years. It has many implications for the GoU, at the central, district and lower levels, as well as for donors, the private sector, non-governmental organizations (NGOs), Community Based Organisations (CBOs) and, of course, for the hydro(geo)logist. But will the reform programme produce the outputs that are expected?

1.0 INTRODUCTION

Over the last decade, most African governments assisted by donors, have embarked on reforms to address the problems of water and sanitation services. These reforms involve public-private partnerships, institutional, legal, structural and regulatory initiatives that seek to find new ways of working to achieve new goals. They are taking place in the context of several other structural changes in the political and economic governance of African countries, including political pluralism, decentralisation and redefinition of the role of the state, and increased reliance on market forces and the private sector. This paper seeks to outline the reform process in Uganda. It will briefly outline the pre-reform approach to water and sanitation which focused on a series of piecemeal donor supported projects with questions over ownership and sustainability. It will then go on to examine the key principles of one component, rural water and sanitation sub sector where donors and Government of Uganda have come together to develop a national strategy and a comprehensive strategic sector-wide investment programme as part of the reform process. It will outline the implications for the donors, the GoU both at the central, district and lower levels, the private sector and NGOs and, ultimately, the hydro(geo)logist, concluding with an analysis of the performance of the reform process.

2. 0 UGANDA AND ITS CIVIL SERVICE REFORM

Uganda has, over the past 15 years, emerged from economic decline, conflict, and repressive governments, to macroeconomic stability. High growth and considerable political freedom represent a major turnaround in Africa after the tyranny in the 1970s under Idi Amin and the later regime of Milton Obote. Uganda has undergone a major transformation since Yoweri Museveni's government came to power in 1986. It has been recognized as undertaking one of the most ambitious programmes of economic liberation on the African continent.

The reform programme followed a prolonged period of economic decline and civil strife that devastated human and physical capital and destroyed the economy's formal sectors, not least

because this period witnessed a significant erosion of much of the institutional framework that is required to support transactions in a modern economy.
Uganda in the early 90's began a civil service reform programme closely linked with a national programme of five distinct initiatives namely; economic reform, liberalisation, privatisation, constitutional reform, decentralisation and army demobilisation. In 1997, GoU prepared a Poverty Eradication Action Plan (PEAP). A Poverty Action Fund (PAF) was created in 1998 in order to channel funds resulting from debt relief from the Highly Indebted Poor Countries (HIPC) initiative, as well as for mobilising donor funds for key priority sectors. The PEAP has guided the formulation of government policy since its inception in 1997. The aim of this plan is to transform Uganda into a modern economy.

2.1 PHYSICAL, ECONOMIC AND SOCIAL CHARACTERISTICS

Uganda lies astride the equator and is roughly the same size as Great Britain. It is bounded by Kenya to the east, Sudan to the North, Congo to the west and Tanzania and Rwanda to the south. It has an area of 241,139km^2 of which 42.000km (17%) is made up of swamps and open fresh water, 30,000 km^2 (12%) forest reserves and game parks. Uganda lies on the great African plateau with an average altitude of 1200m (4000ft) above sea level broken by the Great Rift valley on the western side. Elevated areas are the Ruwenzori Mountains in the west (5000m) and Mount Elgon (4300m)in the east. The world's second largest river, the Nile commences its northward flow from the world's second largest fresh water body - Lake Victoria at Jinja. Mean annual temperature is 26°C. Average annual rainfall is 1000mm in most parts of the country but ranges from 500mm in the arid northeast, in Karamoja, to 2000mm in the Ssese Islands in Lake Victoria. Its economy is based on agriculture, earning 70% of the country's GDP and from which over 90% of the population derives its livelihood. Coffee is a major, although variable foreign exchange earner (65% of the total), as is tea, fish, tourism, fruits, flowers, electricity, finished timber and leather. However, GDP growth rate since 1988 has averaged 6% per annum.
Infant mortality rate (per thousand live births) was 97 in 1998 with a total fertility rate (births per woman) of 6.9. The literacy rate is an estimated 62% of the total adult population (47% female, 73% male) and there is a general life expectancy of 47 years.

3. 0 BACKGROUND TO UGANDA'S WATER AND SANITATION REFORM

3. 1 CENTRAL

The Ministry of Water, Lands and Environment (MWLE) and the Directorate of Water Development (DWD), a division within MWLE, have the overall policy responsibility for rural, urban and institutional water development. However, little attention was given to this function in the early 90's. DWD, in practice, negotiated and oversaw externally funded development projects which included most investment in the sector. Nevertheless, DWD did begin to move away from implementation of siting and drilling of deep and shallow wells to an increasing reliance on the private sector.

There were two major Rural Water and Sanitation Projects being implemented in Uganda in the 90's, the Rural Water and Sanitation project (RUWASA), a $50m programme supported by the Danish government, and the Water and Environmental Sanitation project (WES) sponsored by Sweden (SIDA) through UNICEF. In addition, there were several smaller more localised projects supported and implemented by donors and NGOs. Table I sets out the larger schemes.

Table 1: List of Major projects

External Support Agency	Project	District(s)
EU through SNV	Gravity Feed System 1997-2000 $3.75m annually	Arua, Nebbi, Moyo, Moroto, Kotido, Kasese,Kabarole, Rukungiri, Bundibugyo
DANIDA	RUWASA 1996-2001 $7.2m annually	Mukono, Jinja, Kamuli, Iganga, Soroti,Tororo, Mbale Soronko,Palisa, Busia Buguri, Kapchorwa
DFID	Rural WATSAN North	Katakwi
Japan International Cooperation Agency (JICA)	Rural Water Central	Mubende, Mpigi, Kibogo
LWF/ACAV/UNHCR/CARE/ICD/ PLAN Int'l	Rural Watsan Drilling	Moroto, Kotido, Arua,Nebbi, Moyo,Luwero
IFAD/BSF	Masindi Integrated Project	Masindi
Ireland Aid	Kibaale Drilling Project	Kibale
SIDA/UNICEF	WES Programme 1995-2000 $7.0m annually	All except Kampala/RUWASA project area

Compiled from a paper "Overview of Sector Stakeholders" presented by Eng. S. Bomukama, Commissioner for Department of Water Supply, DWD, and Water Sector Reform and Sanitation Component, Wardrop, Oct 1999.

During the 'project approach' times, there was no clear, commonly agreed and systematic demarcation of roles and responsibilities, appropriate standard regulatory framework, or assignments of authority between the several players including NGOs, Project Implementation Units, Central and District levels, politicians and community members. Time and effort was put into project implementation with little regard for maintenance issues. Some projects did address gender issues but overall, the rush to see measurable outputs for investments caused 'software' activities to be smothered by 'hardware' activities.

3.2 DISTRICTS

Districts, more especially those most newly created, lacked logistics, offices, office equipment, and reliable sources of energy. The sub-county levels were worse off. Decentralisation which was introduced gradually after 1994 had multiplied the number of political structures and persons who have to be paid from public funds. Decentralisation had also left District Departments isolated from the support and guidance they were used to receiving from their Ministry's headquarters and more dependent on the good will of the local politicians. During the early 1990s, small numbers of staff were recruited at District level but those in official positions often had inadequate or inappropriate qualifications.

3.3 COMMUNITIES

Most of the rural population which constitutes 87% of the total population of 22.7 million live in scattered homesteads and are largely served through communal water point sources such as protected springs, boreholes and stand pipes. Most communities participated in their projects but generally this was limited to contributions of labour and funds. Community-based maintenance of sources was weak.

3.4 NON-GOVERNMENT ORGANISATIONS

A large number (>50) of non-government organisations (NGOs) were involved in rural water and sanitation development. These included the main churches, Protestant, Catholic, Moslem and several component Protestant denominations such as Pentecostal and Baptist congregations. Other international NGOs included CARE, Plan International and World Vision, Action Aid, and specialist NGOs including Water Aid. Most had their own specific requirements with respect to local involvement especially in the construction phase. Frequently, different organizations worked in the same District, using different approaches, causing confusion to community members.

3.5 THE PRIVATE SECTOR

The private sector in the early 90s, with few exceptions, was dominated by either foreign-based, large drilling companies or by small "jua kali" operations of local firms. The local drilling contractors were assisted by DWD with drilling rigs hired out to them. The private sector was small and undercapitalised. Local companies relied on poor, often second-hand equipment. There was a general lack of qualified manpower so companies competed for the few available reliable experts.

3.6 SANITATION

Sanitation was, and continues to be, the responsibility of each individual householder and commonly is some form of a pit latrine. Genuine attempts were made by a number of projects to integrate sanitation with water projects but the focus in the early 90's generally was on the facility with little attention to hygiene promotion.

3.7 FUNDS

The GoU secured major external funding from a variety of donors for water and sanitation development. For example, in the 1997/98 financial year, donor funds of US$39.4 million accounted for 87% of the total, whilst GoU contributed $5.5 million for capital development and $375, 000 for recurrent expenditure. Donor grants or loans covered not only investments in water and sanitation facilities but also construction or repairs of offices, running and maintenance of vehicles, and performance-related allowances for essential district staff..

Central government grants covered salaries of most district staff. In the past, MWLE had an extension service managed through District offices. These have now been taken over by the respective District government who are responsible for their organisation and activities under the process of decentralisation. Only a skeleton staff were hired at first, due to an earlier ban on new public service recruitment. The Districts depended heavily on the central government for funding through unconditional, conditional and equalization grants.

3.8 SUMMARY

Notwithstanding this piecemeal approach, there is no doubt that these projects embarked on genuine attempts to develop many practices that have now been accepted as key principles/guidelines in Uganda's fifteen year water and sanitation strategy, namely, the integration of water, sanitation, and hygiene promotion, gender mainstreaming, adoption of contract management guidelines, demand-driven approaches, capacity building, decentralisation, community-based management, the use of the private sector, NGOs/CBOs. It is acknowledged that the push to have 'software' activities merit their place alongside 'hardware' activities has its roots in the project-based approach.

4. 0 WATER AND SANITATION REFORM IN UGANDA

4.1 INTRODUCTION

From this background, the GoU, with support from donors, embarked on a water and sanitation reform programme within the broader policies of poverty eradication, decentralisation, good governance and effective participation by the private sector and other stakeholders in service delivery. It launched reforms in four area of the water sector, namely: rural water and sanitation, urban water and sanitation, water for production and water resources management. The following concentrates on the rural water and sanitation component.

4.2 AIMS, IMPLICATIONS AND EXPECTED OUTPUTS FROM THE REFORM

The reforms aim to identify key issues, determine investments required and set up new strategies to increase coverage and ensure sustainability of services and facilities. The following key issues and challenges are being addressed: the needs of the poor, cost recovery for utilities, sanitation and hygiene, water resources management, ensuring transparency, and the devolution of power and responsibility to local government. In the water and sanitation sector, 60 % of the urban and 50% of the rural population now have access to safe water and sanitation systems. The main objective of the government reform programme is to improve coverage and basic service levels at an affordable price, to give 100% of the population access to safe water and appropriate sanitation within 15 years.

Implications of the reform

The new initiatives will require the following actions by all sector players:

1. Rationalization of policies and changes to legislation
2. Government and development partners will have to commit to new sector strategies and investment plans
3. Rationalization of roles and responsibilities of national and local governments and
4. Restructuring of existing sector institutions

Expected outputs of the reform process

1. A governance, institutional and regulatory framework to support reform, with appropriate incentives for effective management.
2. Financially sustainable and cost-effective operation with improved investment efficiency
3. A decrease in public financial burden
4. Increased private sector participation and
5. Increased coverage of water and sanitation services

5. 0 RURAL WATER SECTOR REFORM

5.1 STRATEGY, INVESTMENT PLAN, OBJECTIVES AND PRINCIPLES

In 1999, the MWLE and DWD carried out a Rural Water Sector Reform Study. Arising from this study, a Rural Water and Sanitation Strategy emerged. Subsequently, the strategy was further refined and supplemented with a 15-year investment plan (2000-2015), constituting a White Paper for the Government of Uganda's approval in 2001. In addition, the plan outlines roles and procedures for the procurement of goods and services as well as modalities for capacity building and accountability. The strategy and investment plan is supplemented by detailed implementation and operational guidelines now being used for planning, budgeting, and handling conditional grants for water and sanitation sector developments in the Districts.

The plan presents both the national policy and strategic concepts for the rural water and sanitation sector. The premise of the strategy is that people have the aspirations to fulfil the

human rights of access to hygienic conditions, sanitation and water for everyone. The long-term objective of the rural water supply and sanitation sub-sector reform is:
"Sustainable safe water supply and sanitation facilities, based on management responsibilities and ownership by the users, within easy reach of 65% of the rural population by the year 2005 with 80-90% effective use and functionality of facilities; thence, eventually to 100% of the rural population by the year 2015."

The following are the key 'guiding principles' of how water development in the rural water and sanitation sector is to be achieved in the next fifteen years. These are outlined below together with the implications for the various stakeholders, including the hydro(geo)logist.

1. An overall Sector-Wide Approach to Planning (SWAP)
2. A decentralised approach combined with an
3. Integrated methodology – an integrated community management approach to water, sanitation and hygiene promotion
4. Demand-driven
5. Sustainability
6. Financial viability
7. Private sector participation and NGO involvement
8. Appropriate water technology options

5.2 AN OVERALL SECTOR WIDE APPROACH TO PLANNING (SWAP)

The Government of Uganda's water development activities were, in the past, focused on implementation through series of discrete projects. This approach had several weaknesses as already indicated.
Thus, a radical shift from a project-driven approach was necessary. GoU and its development partners entered into a new partnership to develop a comprehensive sector-wide programme and investment plan to achieve improvements in sector performance, increased resource flows, and more effective use of resources, other than through the medium of 'projects'. The specific aim of developing SWAP in the water and sanitation sector is to accelerate the achievement of sector goals through:

- A defined institutional framework within which all stakeholders work
- Improving value for money of services being provided
- Developing common approaches for the sector in the whole country
- Increasing the capacity of government through the use of government systems
- Improving sustainability of services
- Improved monitoring, transparency and reporting.

The adoption of SWAP for water and sanitation inevitably implies the following features :

1. The development of *A Sectoral Investment Plan* which set out the outcomes and outputs desired in the sector, the investment required to achieve the outputs/outcomes and the roles and responsibilities of different actors in the process.
2. The development of *modalities for basket funding* :- a basic principle of SWAPs is that funding is provided through the government budget.
3. Periodic reviews-stakeholders are brought together to review the progress of implementation and to correct/improve the implementation of the programme, as required.

Since 2001, MWLE/DWD has made considerable progress in the implementation of SWAP for water and sanitation. The sectoral investment plan is in place, and monitoring/implementation is underway. The modalities for basket funding are still under consideration.

The SWAP approach has had major implications for donor support. The project approach adopted by many bilateral donors and NGOs in the past is being phased out. NGOs wanting to assist must now register themselves in the private sector to be employed by Districts to implement District Plans under national guidelines. Gone are the days when donor agreements included expatriate staff for managing projects. Gone too are the days when such project mangers were free to experiment and introduce new approaches and new technologies, oblivious to government structures. National guidelines and standards are now established, including recommendations for water pump types. Conditional aid is been phased out in favour of a coordinated approach by all donors. Donors are now expected to pool resources in a 'basket', to support national policies and strategies. The expatriate hydro(geo)logist, if s/he does exist, will generally be an "advisor" to central government, representing a number of donors, on strategic matters. If s/he is employed in the private sector, s/he must be aware of all the national guidelines before s/he bids for any job. The nationally-based hydro(geo)logist who was employed on projects is now more commonly employed by the public and the private sector within the new strategy. Salaries in the private sector are currently more attractive than the public sector. There are a number of opportunities for employment in the private sector with over 50,000 wells planned to be constructed in the next 15 years.

5.3 A DECENTRALISATION APPROACH

Decentralisation was introduced in Uganda in 1994. The government embarked on a process under which Districts have been invested with new mandates, new resources and responsibilities for the management, administration and provision of such fundamental services as education, health, water and roads. Through the passage of the Local Government Statute in 1993 and the 1995 Constitution, Uganda had dramatically changed the framework within which its local government operates. Essentially, Districts have more power, more resources, responsibilities and decision-making autonomy than under the old, centralised system. In consequence, the fifty-six decentralised Districts, and their respective municipalities, are active in trying to develop the necessary capabilities for performing their new duties effectively.

Decision making on all matters of local significance have been decentralised. Central government departments operating at District level have become constituent units of the Local District Council and operate under the control of the Districts. Each District has been empowered to employ its own staff. The transfer of responsibilities to local authorities was planned to go hand-in-hand with financial decentralisation although this has not yet been achieved.

The institutional structure begins with the lowest level, Local Village Council (LC1), Parish Council, (LC2), Sub-county Council, (LC3), County Council, (LC4), District Council, (LC5), and Central Government Level (GoU)

The decentralisation of rural water and sanitation activities, however, only began in earnest in 2000 with the advent of the PAF funds. Under decentralisation, institutional roles and responsibilities have also changed. The Directorate of Water Development at the centre is responsible for the following functions: a) policy development, b) resource mobilisation, c) overall sector planning, d) monitoring and evaluation, e) inspection and quality assurance, f) providing technical advice to the local governments, g) sector co-ordination.

All other activities are the responsibility of the District Local Council. The Districts manage the implementation using the private sector, extension staff and NGOs, community–based organisations (CBOs). However, trained staff have become a major issue at District and lower levels and capacity building has become a 'focus issue' for central government. To this effect, temporary Technical Support Units (TSUs) have been set up, operating at regional

level, to offer advice to all Districts. These are staffed with a water engineer, hygiene education/ social mobilization specialists, and a hydro(geo)logist.

Recruitment of trained staff in Districts remains a challenge with the more qualified seeking employment near the centre and few wishing to be located in remote areas. All this ultimately affects the rate of implementation in Districts and, therefore, water and sanitation coverage.

So where is the hydro(geo)logist in all of this? A hydro(geo)logist may seek employment either in the public sector (at central level or in the temporary TSUs or, at District level, as a district officer) or in the private sector. If s/he is employed at the central level, the focus of the work will be on strategic planning, mapping, and monitoring. If s/he is located at District level, s/he will be involved in the *management* of water development contracts, (as districts themselves will no longer be involved in the execution of water development schemes). The standard required from the private sector in siting, drilling, supervision, water quality testing, pump testing, construction of gravity flow schemes, and development of springs is high and therefore the hydro(geo)logist at District level has ample opportunity to use their talents in contract management. If s/he is located in the private sector, then their role will generally be in hands-on siting, supervision, drilling, construction, hand pump installation and report writing. The expertise required for each position is different.

5.4 INTEGRATED APPROACH TO WATER, SANITATION, HYGIENE PROMOTION AND COMMUNITY MANAGEMENT

Without the support of adequate sanitation and hygiene promotion it has been demonstrated that water supply alone has a limited impact on public health. The GoU WS&S strategy has recognized that improved water supplies, adequate sanitation facilities and hygiene behaviour are all vital and interlocking elements in the water supply and sanitation sector. They recognise that investment in one element without complementary efforts in the others carries a strong risk that health benefits will not be achieved. It has long been accepted that the greatest risk to the poor is from faecal-oral disease transmission and that sanitation and hygiene promotion activities have to accompany all poverty-focused water supply interventions.

It is also accepted that water has always taken a central role in people's cultures and priorities and that sanitation and personal hygiene is a far more difficult issue involving taboos and shyness. It is generally not been acknowledged that changing hygiene household behaviour is one of the most effective ways to prevent disease transmission. It is not always appreciated that it is the *use* of the hardware that changes the quality of people's lives not its mere construction/ installation. Water supply is seen as the highest priority. To date, the sanitation coverage is 47%. For this reason, a specific budget has been allocated to focus on increasing the knowledge which will bring about a change in attitude that, in turn, will result in a shift in behaviour. Hygiene education can prevent clean safe water from the community well becoming contaminated in the home from dirty containers, contaminated well heads and platforms.

The integration of these elements is further complicated as sanitation and hygiene promotion for rural households is the responsibility of Ministry of Health,(MoH) while sanitation and hygiene promotion for schools is the responsibility of Ministry of Education and Sports (MoES) and Sanitation for Urban water supplies in MLWE and community management the responsibility of Ministry of Gender, Labour and Social Development (MGLSD). Bringing all sectors on board to agree away forward has proved over the years to be a challenge.

So where is the hydro(geo)logist within this synergy? At a national level, s/he has to ensure that these elements are included in sector plans and that resources are provided. At District level, contracts for the private sector must include regulations on the siting of wells and

springs relative to sanitation facilities and other possible sources of contamination. The hydro(geo)logist must be aware of the points of contamination of community wells and design according.

5.5 A DEMAND-DRIVEN APPROACH

The Dublin Principles state that "A demand – responsive approach is essential to promote efficient capital investment and sustain existing investment. The institutional interface will have the lowest appropriate administrative level on one side to ensure legal grounding, and on the other, a users' (water supply and sanitation) organisation to ensure users' full participation in decision-making". MWLE accepts this principle and is promoting a combination of bottom-up and top-down approaches through which demand for services by a community will be expressed, after receiving appropriate information and advice. They decide on what type of facilities they want, pay their share of the construction costs (2-5%) and pay the full cost for operation and maintenance and replacement. The local governments are responsible for influencing and regulating demand by (a) promoting appropriate demand and (b) supporting poor communities.

However, progress is slow in ensuring that communities know they have the primary responsibility for planning and implementing their water supplies. At present, community involvement tends to be dominated by strategies for community consultation and mobilisation rather than by a demand-responsive approach. Efforts to increase a community's role include the identification of gender issues, appreciating that the largest and most significant group in water and sanitation activities are the women and girl members of the communities. Increasing their influence and control is regarded as a key element in empowering communities.

The awareness of this aspect is paramount, particularly to the male hydrogeologist. The hydro(geo)logist has a role to play at all levels in ensuring a demand-driven approach is embraced so as to ensure that access to water and sanitation is extended to the poorest groups in Uganda. The District hydro(geo)logist must be party to ensuring that a demand-responsive approach has been used in the District's plans for improving equity. The hydro(geo)logist for the private sector must also have the social skills to be able to encourage a participatory approach in relevant decision making, such as on the location of a well, in order to avoid "while elephants". This may require several visits to a community until an agreed location emerges in which the women and the voiceless have had a say. Both the social and technical skills of siting are now considered fundamental to the development of a successful community well. Training manuals have been developed to support these necessary skills.

5.6 SUSTAINABILITY

Sustainability is the prime objective of all water and sanitation interventions. In order to ensure sustainability of each water source, the full community water project cycle has to be adopted. The management of each stage and the sequencing of stages is basic to a successful outcome. It is important that each stage is implemented before embarking on the next. Experience has been that efforts have concentrated on the hardware aspects with little recognition of the software elements of the other stages. This has resulted in many projects being abandoned after the first breakdown. Considerable experience in Uganda has shown that when there is harmony between the software and hardware elements that the functionality and durability of the water source is greater. The acceptance of the idea that a hydro(geo)logist must become concerned with social aspects in the construction of water sources is often a slow and painful experience, but for those who have adopted this path, their careers have been enhanced.

The water and sanitation sector in Uganda has adopted a Community Based Maintenance System (CBMS). Operation and maintenance (O&M) costs for rural water supplies are to be fully borne by user communities although the central and local governments are to provide support and subsidies for rehabilitation (re-drilling and complete pipe replacements) as this is expensive and, it is recognized, beyond the scope of most communities, given the rural income levels and poor management for O & M funds.

At village level, a water user committee (WUC) - of which, half are women - is formed and at least two caretakers appointed and trained for each source. The WUC collects funds for preventative maintenance and repairs, and in all respects, is responsible for maintenance of the installation, including the use of bank accounts, where appropriate, to safeguard the maintenance of funds.
Private hand pump mechanics undertake repairs and half yearly preventative maintenance of hand pumps. Retail distribution of spare parts is done through local dealers at sub-county level. Each Gravity Flow Scheme (GFS) has one or two scheme attendants. At district level wholesale and retail distribution of spares is through district level spare parts dealers. DWD will monitor the general performance (through regular studies).

5.7 FINANCIAL VIABILITY

Even well-developed plans can gather dust if they are not accompanied by resources. The total investment for rural water supply in Uganda is estimated to be approximately US$910 million and $45.5 million for sanitation over the 15 years of the plan. The following table represents investment needs, committed funds and shortfall over a five years (financial years 2000 to 2005) for the rural water sanitation sub-sector.

Table 2: Five Year (2000-2005) Water and Sanitation Investment Needs

	2000/01 US $m	2001/02 US $m	2002/3 US $m	2003/4 US $m	2004/5 US $m
Investments needs					
Water Development	27.62	36	38.72	40.78	42.97
Sanitation Services	1.73	1.73	1.73	1.73	1.73
Nat Prog. Support (Water)	10	9.7	9.4	9.13	8.85
Nat Prog.Support (Sanitation)	1.26	1.26	1.26	1.26	1.26
Total	**40.61**	**48.69**	**51.12**	**52.90**	**54.81**
Committed Funds					
District Water Dev. grant	13.5	16.5	18.5	20.7	23.2
Central Support (RWSS)	2.5	2.5	2.5	2.5	2.5
Donors	19.75	16.25	4.75	4.75	4.75
Total	**35.75**	**35.25**	**25.75**	**27.95**	**30.44**
Shortfall	4.86	13.44	25.37	24.95	24.37

As depicted in Table 2, funds from HIPC debt relief will be given as District water development grants together with support from the central government and donors. Despite GoU's commitment to funding, there is still a shortfall, but it is expected that donors will make this up.

5.8 PRIVATE SECTOR PARTICIPATION AND NGO INVOLVEMENT

The GoU is firmly committed to the privatisation process. The private sector can be categorised into five main divisions characterised by the following major activities;

1. Consultants : These are active in providing professional services for project and/or programme design and supervision

2. Contractors: Their major tasks are borehole drilling and rehabilitation: construction of gravity flow schemes, laying reticulation networks, and institutional sanitation
3. Systems Developers and Operators: The private sector is increasingly investing in the development of private water supply sources which are operated on a commercial basis. Likewise, investing in public toilets, especially in the rural growth centres, has become attractive as a business concern to investors
4. Spare part dealers: these stock and deal in parts for borehole hand pumps.
5. Pump mechanics : Locally based mechanics and artisans are given skills and are retooled so that they can avail their services for an agreed payment with the beneficiary community.

The rate at which the private sector is developing is encouraging. As contract management skills improve, the adherence to contracts is being enforced which is helping to raise standards. However, this is still a challenge. Contracts tend to be offered to local contractors but this is also changing as demand increases. Drilling companies are worried that the size of contracts is smaller and more fragmented than under the project approach. Economies of scale are being considered to take account of this issue. They also worry that Districts may not pay. However, this has proved to be unfounded, based on experience to date.

NGOs/CBOs have played an important role in the rural water sub-sector in Uganda over many years. They will supplement the efforts of the public sector mainly in capacity building, development of training and promotional materials, carrying out socio-economic reviews, hydrogeological studies and design, undertaking construction of water and sanitation facilities and provision of financial support. A national forum has been established to coordinated the activities of NGOs and CBOs.

5.9 WATER TECHNOLOGY OPTIONS

The current water source types installed are shown in Table 3 below.

Table 3 : Rural Water Facilities, 2000

WATER SOURCE TYPE	NUMBER
Protected Springs	17,783
Deep boreholes	16,967
Shallow wells	3284
GFS (public taps)	96 (2945)
Population Served	9,344,614

Preference is given to point sources such as protected springs, hand-pump equipped shallow wells or boreholes and gravity–fed piped schemes for the scattered homesteads.

1. Protected springs: offer the lowest cost per capita, serving 150 individuals. This resource is now almost fully utilized.
2. Boreholes: Drilled boreholes are and will continue to be the main option for rural water supply. Acceptable yields are deemed to be in the order of 700 litres per hour, to cater for the estimated 300 people per installation.
3. Shallow wells (augered) offer low costs and generally reliable sources for water supply, to cater for approx 300 people per installation with handpump.
4. Gravity flow systems are relatively expensive to construct although they are relatively cheap to maintain.
5. Other water supply sources that are acceptable on a quality basis include rainwater harvesting systems, but are usually limited to individual households.

For communities of over 1500 population, in a Rural Growth Centre, consideration is given to a limited, mechanized piped-water system. A typical mechanized system might consist of a borehole(s) with motorized pumps with a reticulation piped supply system of various sizes, storage reservoir(s) and standpipes for distribution.

The District water officer is expected to be technically competent in all technology types. S/he is expected to know the water potential of the area and to encourage communities to plan accordingly. For example, the RUWASA project developed hydrogeological maps for all water points in 11 Districts in eastern Uganda. District hydro(geo)logist are expected to keep these maps updated. At national level the hydro(geo)logist is expected to develop national water resource potential maps.

6. 0 CONCLUSION

The reform process is a continuing one with the support of the GoU and donor agencies. It is too early to judge whether the outcomes will be achieved. However, the progress so far is promising.. Strategies are developed, policies are being put in place and government partners are accepting their new roles and responsibilities. So too are central government, District staff, private sector organizations and NGOs. Periodic reviews by all stakeholders are conducted and the restructuring of DWD is underway. A regulatory framework has been established, monitoring is being carried out and efforts have begun to strengthen the Community Based Operation and Maintenance system. Donors are beginning to pool and coordinate resources and financial decentralisation is also underway. Nevertheless, it is recognised that the experiences gained from the project approach in the 90's has firmly contributed and provided the springboard for the success of the reform .

Implementation in some districts is going as planned while others are below targets. Capacity building of institutions and staff remains a key issue and an obstacle to service delivery. The private sector is growing (in 6years, 32 registered drilling companies of whom 14 are foreign-based) and measures to improve standards and skills are underway. Contract management is and will remain for some time a challenge. However, efforts are being put in place to minimise risks and corruption so methods of accountability are improving. I believe that when a certain level of capacity building has been reached (possibly within the next three/four years) in the public and private sector that the rate of service delivery will increase to greater levels than before the reform process began which should, in turn, trigger a corresponding decrease in unit costs of service delivery. In any event, what is sure is that a number of elements that encompass the reform process are here to stay, and are not just another development fad.

The reform of the water sector is, in an African context, in the vanguard of such processes, in the ongoing effort to meet the basic human right of a clean and adequate water supply. The process is driven by several pressures. Firstly, there is a recognition that the development of water supplies should be holistic – water development (hardware) cannot be divorced from the wastewater management and all the cultural attitudes and traditions that that encompasses (software). Secondly, the primary stakeholders are the community that needs the water and should be the initiators/managers of the development with due regard to the gender issues involved. Thirdly, the financial and political driving forces are towards sourcing the requirements of water development from the private sector. Taken together, the strands in this reform represent fundamental (and rapid) change in so many ways for the ultimate consumers as well as for traditional water providers. Provided the capacity building keeps pace in supplying the required skills, the evidence so far indicates that the outcome will be a more sustainable water supply environment. Developments in Ireland under the Water Framework Directive have similar and parallel thinking underlying them - the lessons from the experience in Uganda are very relevant.

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"Light a fire so that I can hear you better"
The Development of Sustainable Rural Water Supplies - the importance of a listening Hydrogeologist

David Ball

Hydrogeology is an exciting profession or discipline. I am not sure that we all realise the full extent and importance of our full profession. I sense that for many, our profession is seen within the limits of the current project. It could be contaminant sampling according to an EPA protocol, or data compilation for a groundwater protection scheme, or carrying out an EIS, again under the requirements of a set of regulations. In other words our role and perspective is constrained. The papers presented this morning open up the full role, importance and range of the work of a hydrogeologist. They illustrate that hydrogeology, particularly with reference to water supplies and sanitation, requires a wide view; to absorb a large range of factors. It is not just a profession prescribed by protocols. The term holistic is used, and implied. The scope of the profession overseas should be the scope of the profession in Ireland.

There are three components, or parts, to a hydrogeologists work on a water supply:

- The technology part (construction, equipment, designs, materials)
- The science part (geology, water resources, engineering science, water quality)
- The people part (individuals, communities, administration, money, power and control)

Alan MacDonald's paper and the Manuals that he is producing for BGS and DFID, and Callist Tindimugaya's paper admirably illustrate the science and technology. Niall Roche's and Jacinta Barrin's papers, amongst much else, illustrate the importance of the people part.

All three parts are equally important. It is easy to understand the need for a balance, but this balance is difficult to achieve. The revolution that has been taking place is, as Jacinta puts it, balancing the 'Hardware' and the 'Software'. In the past the project approach emphasised the hardware solution to problems and often assumed that some central government department would take responsibility for operation, maintenance and management. The NGO's, such as Concern, were the leaders when it came to realising the fallacy of this naïve assumption. Now it is recognised that, particularly with rural water supplies, the water users must feel comfortable and confident with the science and technology components. They, or their committees, are going to be the ones who take responsibility.

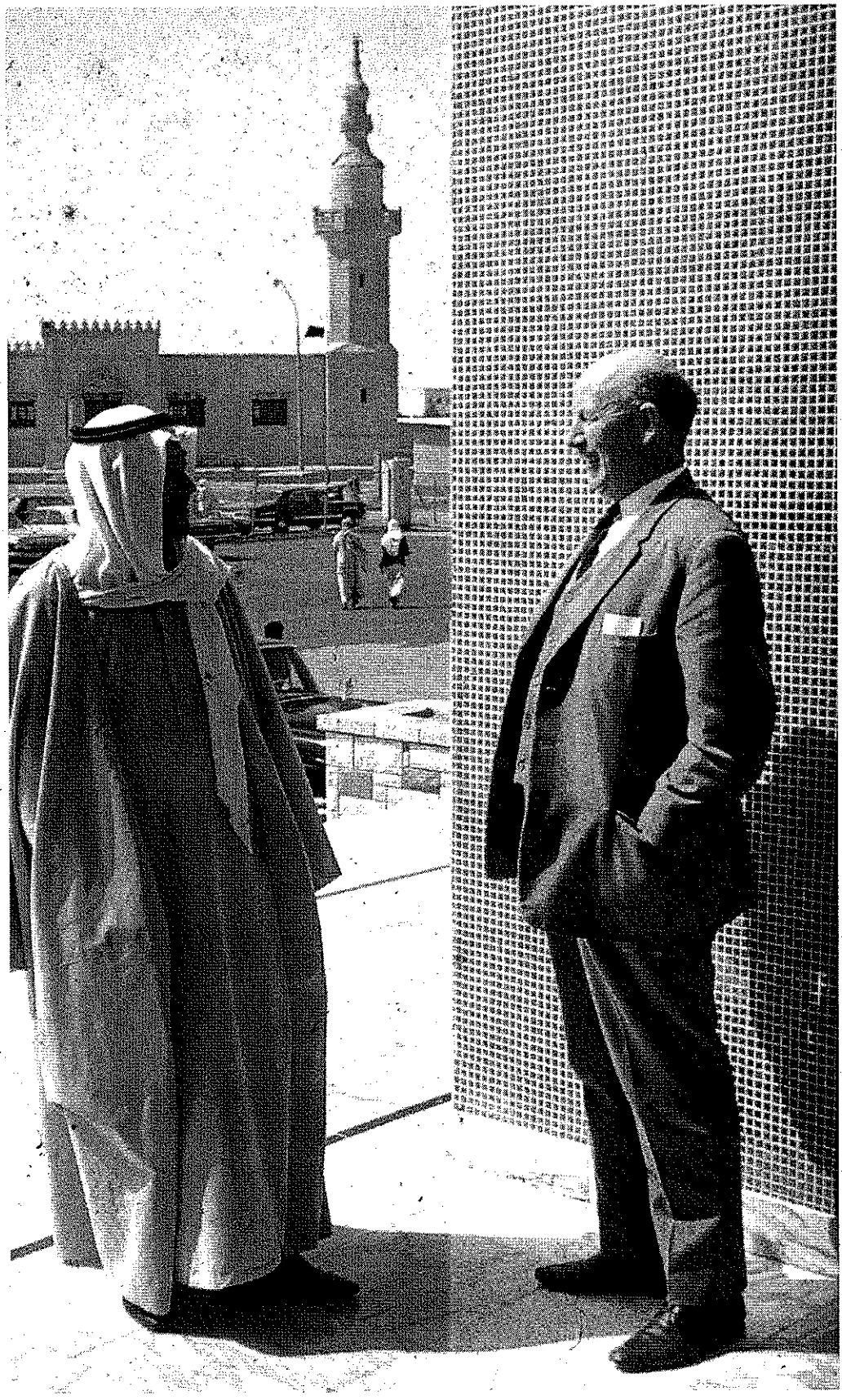
Hydrogeologists and engineers can learn and gain experience of the technologies. This is the easy part. The technologies are fairly standard, they have been used for years and they are easy to control. Hydrogeologists and engineers have usually been to university and spent years studying the science part. This part is also relatively easy and it is interesting because it contains fewer certainties. It is difficult to predict and control nature.

Water is for people. For fifteen years we have stressed the importance of sustainable water supplies. Yet whenever they are discussed it is almost always within the context of technology and science. What we have to recognise is that water supplies are sustained by people. The science and technology may be perfect, but if the people cannot handle and take responsibility for it, then they will not sustain it. Therefore there will not be 'a sustainable water supply'.

The part that is the most difficult and contains the most uncertainties is the people part. We think we are not trained to deal with people issues, whereas we are trained for the other parts. Therefore the temptation is to leave the people part to others. In other words we try to avoid or distance ourselves from a core element of our work, particularly if we are working in a different country with different customs. However we cannot ignore it, if we want to be full hydrogeologists, and see our work make a useful contribution. In 1989 the World Bank estimated that there were 600,000 'dead', or no longer used, boreholes and dug wells put in by governments, NGO's and aid agencies across the Sahel. Most of these were probably technically and scientifically correct. You can calculate the cost, disappointment and disillusionment arising from our professional avoidance of the people part of our work.

It is natural to think that we cannot handle the people part of our work because we have not received training. However, though training would be useful, we actually can deal with it if we shift perspective and agendas. If we start to focus ourselves on just being a person, and stop thinking of ourselves as scientists and technologists, then, with experience, we will find that we can handle the people part of our job. We must focus on listening. It is important to realise that listening is not just a passive role. It involves hearing but also making a response. Just about everyone in the world has now been effected by a 'project'. In all projects an unspoken game is being played. It's called the 'donor - beneficiary' game. This game has rules and roles. It is a negative game because it acts as a barrier to real communication and real understanding. If we collude and play the game we remain stuck. We repeat the mistakes of the 600,000 dead holes, and we don't move on as Jacinta and Callist have shown we can. The role of the listening hydrogeologist is to break this game, and I will give an example from Somalia. We are fortunate that we now have a gender balance in our profession. I would urge the women in our profession to pick up from the lead Jacinta has given and challenge the old, somewhat male, pursuit of science and technology solutions. As Niall has said we need to be holistic. To be full professionals we need to actively listen to the real people on the ground and then work within their broader perspective. We also must recognise that the people who intuitively and practically care most about water supplies are women.

SESSION V: THE DAVID BURDON MEMORIAL LECTURE



THE ROLE OF HYDROGEOLOGY IN REBUILDING AFGHANISTAN

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ABSTRACT

Norwegian Church Aid, in common with several other aid organisations, has a long history of involvement in Afghanistan. It has traditionally focused its efforts in the water and sanitation sector on grassroots rural projects. In the last months of the Taliban era and the first months of the allied "occupation", it broke with tradition and became involved with policy formulation in the area of rural groundwater management and institutional capacity building at Ministerial level in the field of urban water supply. Such a "professionalization" of humanitarian assistance is broadly to be welcomed (provided it does not detract from the humanitarian aid organisations' main strength: a rooting in the service of the urban and rural poor), as it allows new possibilities for collaboration between national and international NGOs, state institutions, academia and consultancy. Within a proper management framework, Afghanistan's substantial (and largely under-utilised) groundwater resources can be harnessed, in conjunction with surface water, to rebuild the country's shattered agricultural economy, to provide safe drinking water and to "drought-proof" rural communities.

1.0 AN INTRODUCTION TO AFGHANISTAN

The climate of Afghanistan is extreme, with summer temperatures up to 50°C and winter temperatures tens of degrees below freezing in some areas. Annual precipitation is reported to vary between <50 mm/a in the south-west to over 1000 mm/a in the north-eastern highlands (SS Shobair, FAO Peshawar, *pers. comm.* 23/6/01). It will be noted that annual potential evapotranspiration vastly exceeds rainfall at most locations (Fig. 1). On a monthly basis, monthly potential evapotranspiration exceeds precipitation for most months of the year, whereas, in December-February, the two parameters are broadly similar. Thus, in most of these (lowland) areas, direct recharge of precipitation to groundwater is likely to be low. The most likely period for direct recharge will be around March, where the melting of accumulated snow or frost may temporarily exceed evapotranspiration.

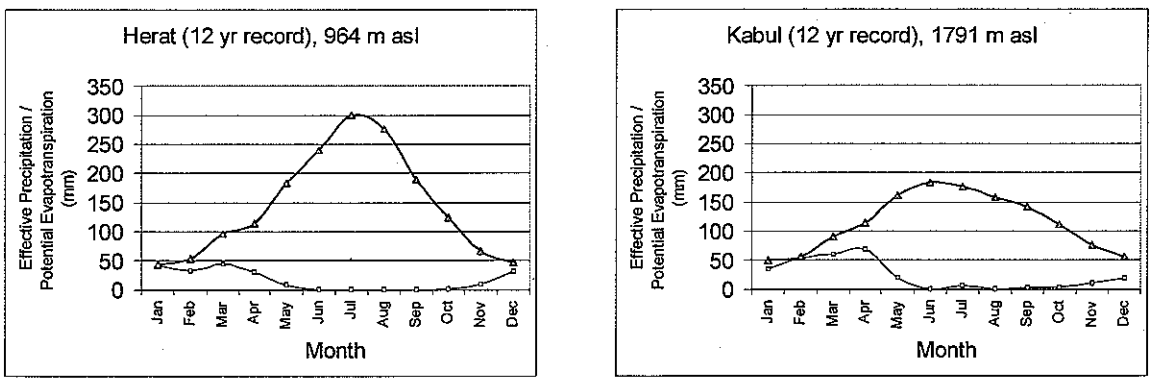

Figure 1 Monthly precipitation(circles) and potential evapotranspiration (triangles) for Kabul and lowland Herat (after data in Shobair 2001).

Afghanistan's geology and topography is dominated by the central Hindu-Kush / Kuh-e-Baba mountain ranges of dominantly WSW-ENE trend, composed of metasediments, sedimentary and igneous rocks of pre-Palaeogene age (Wittekindt 1973, Wittekindt & Weippert 1973, ESCAP 1995). The plains surrounding the mountain ranges and the valleys between the mountain ridges are filled

with Neogene and Quaternary sediments, which are the products of erosion of the mountains. They comprise relatively undeformed, alternating layers of unlithified or partially lithified pebbles/gravels, sands and silts/clays, with occasional tuffs and lavas. Adjacent to the mountains, the sediments would be expected to be dominated by coarse deposits such as gravels and pebbles, deposited as the proximal facies of alluvial fans washing down from the mountains. Further away from the mountains, the deposits would be expected to become increasingly dominated by finer, distal sediments such as fine sands/silts. Even here, however, layers of coarse material can be found, possibly related to old river channels or glacial melt episodes. Along current river valleys, modern alluvial deposits occur. These can be several tens of metres thick and can be extremely coarse-grained.

The geology, climate and, presumably, hydrogeology of Afghanistan bear considerable resemblance to other semi-arid intermontane areas such as that between the Greater and Lesser Caucasus of Azerbaijan, and that of the South American Altiplano. On the basis of analogy with these provinces:

- Neogene / Quaternary aquifers are likely to be recharged in foothills by rivers and streams descending from the high mountains and infiltrating into dominantly coarse-grained alluvial fans. Thus groundwater recharge is highly dependent on quantities of meltwater from winter snowfall.
- Further away from the mountains, some recharge to Neogene / Quaternary aquifers is likely to take place by infiltration of water through the beds of perennial rivers.
- In irrigated areas, substantial recharge is likely to occur via leakage from irrigation channels.

Groundwater chemistry seems to support this interpretation (Anon 1976). The Neogene and Quaternary deposits surrounding the mountainous central massif contain fresh groundwater (total mineralization <1000 mg/l) of generally bicarbonate-dominated type. In the low-lying desert areas away from the mountains, there is some tendency to sodium-sulphate-chloride salinization with mineralizations of up to *c.*3000 mg/l recorded. This is especially the case in the deserts of the south-west (southern Kandahar, Helmand, Nimroz) and extreme west (western Farah, Herat), and the lowlands in the north (e.g. around and north of Mazar-e-Sharif). Even in areas of saline groundwater, fresh pockets or zones of groundwater are reported to occur in valleys of rivers, creeks and ravines.

Groundwater is, in most areas, an underexploited resource. Huge reserves are stored in the coarse deposits in valleys and at the feet of the central mountainous massif. Groundwater is used to supply limited quantities of drinking water to the larger cities from motorised boreholes, and to villages from hand-pumps and karezes. It has not, until recently, been intensively used for irrigation purposes.

2.0 RURAL WATER: DROUGHT, DISPLACEMENT AND OVERABSTRACTION

2.1 THE PROBLEM

Afghanistan has, for several years, been in the grip of a sustained drought. Two decades of civil war and refugee displacement have resulted in resource conflicts and have damaged normal coping mechanisms. Traditionally, villages would have employed a *mirab* or water manager to allocate water resources and local artisans to regularly maintain *karezes* (qanats) or dig wells. The drought has affected rural communities' ability to produce crops and their access to safe drinking water. Traditionally, types of irrigation have been three-fold:

- Rain-fed agriculture is typical of upland areas such as Hazarajat (*e.g.* around 80% of land in the Lal area of Ghor is rain-fed). It is often practised on very steep mountain slopes and has been heavily affected by drought.
- Irrigation from traditional groundwater sources such as karezes and springs. A karez (or *qanat* – Ruden 1993) is a slightly sloping tunnel driven back into proluvial deposits at the foot of hills or mountains (Figure 2) to intersect the water table and provide a gravity flow of water. Both springs and karezes are susceptible to rather small variations in water table. This type of irrigation has also been significantly impacted by drought.

- Rivers are used for irrigation both in mountain valleys and on river flood plains in lowland areas. Being largely fed by accumulated snow melt, the larger rivers often sustain some flow even in drought periods, and this type of agriculture is least susceptible to drought.

Communities whose crops have failed due to drought will eventually be tempted to displace to cities or internally displaced person (IDP) camps in search of food, water and/or a livelihood. Such displacement is expensive (provision of services in a camp), leads to potential conflicts (e.g. between IDPs and existing inhabitants) and social disruption. It is recognised both by government and aid agencies that interventions should aim to prevent displacement of rural communities. Food shortages *can* be realistically solved by trucking grain to affected villages. However, tankering of drinking water is too expensive and logistically difficult. Thus, provision of drinking water in drought-affected communities can be the *make-or-break* factor in deciding whether a family displaces or not. Aid agencies' drought responses have thus focussed on developing water sources in affected communities.

2.2 THE INITIAL RESPONSE

The Taliban regime, until 2001, employed a civil service staffed largely by clerics. In practice, no effective state management of water resources or supply took place. Specialist water engineers and hydrogeologists either left the country or found that they could not work effectively in the State sector. It was thus largely left to international non-government organisations (NGOs), in partnership with local NGOs, to fund and implement rural and urban water supply and sanitation. Under this regime, around 90% of work in the field of rural water supply was undertaken by and handful of organisations such UNICEF, the Danish Committee for Aid to Afghan Refugees (DACAAR), German AgriAction, the Swedish Afghanistan Committee and Norwegian Church Aid (NCA). These organisations had developed a policy for water supply based on low-technology interventions: dug wells or narrow-diameter boreholes fitted with hand-pumps or buckets, rehabilitation of karezes, small dams, gravity-fed pipe networks and training of well-diggers and *mirabs*. During the drought, increased activity in the fields of dug well-deepening and drilling has taken place to "chase" a water table that has been declining at up to 2 m/year.

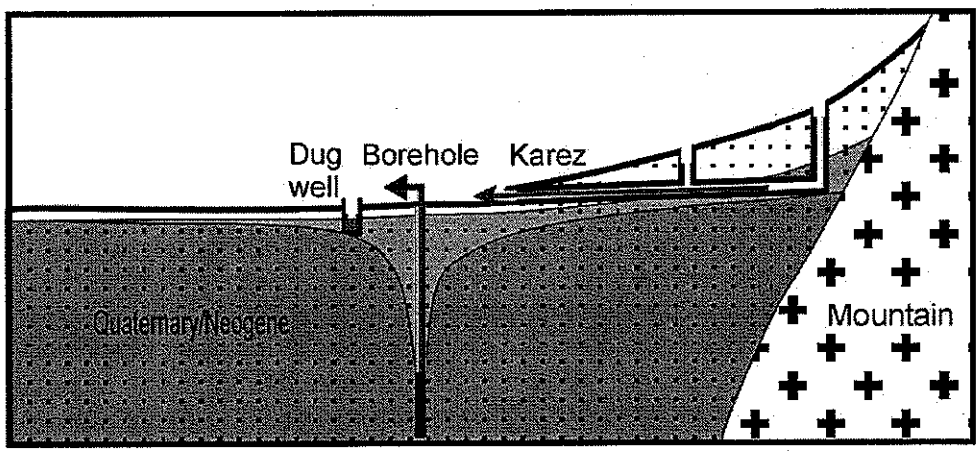

Figure 2. Effect of pumping a deep borehole on dug wells and karezes (Light shading = water table before borehole, dark shading = after borehole)

Seeing the huge potential that groundwater offers, certain NGOs and some richer landlords decided to sink wide-diameter lift-irrigation wells (with large down-well diesel pumps) or deep boreholes. These provided a significant, reliable supply of water for irrigation, but led to four major problems. It was feared:

- that motorised (or uncontrolled artesian) extraction of groundwater could derogate shallow, traditional sources, such as springs, karezes and dug wells (Figure 2), i.e. the sources that are used by the poorer, more vulnerable sections of the community.

- That unrestricted used of motorised wells would lead to more regional aquifer overabstraction.
- That groundwater is being liberally used for irrigation in the absence of chemical analysis. Banks & Soldal (2001) demonstrate that salinity, sodium adsorption ratios and boron reach problematic levels in some areas.
- That these issues may lead to a backlash against the use of groundwater in some NGOs.

2.3 THE CHOSEN APPROACH

At the request of several NGOs, Norwegian Church Aid (NCA) provided, in June 2001, hydrogeological expertise to develop a guidance document, for use by the NGOs, on how groundwater could be used effectively but sustainably to alleviate drought conditions, while avoiding problems due to overabstraction, derogation and water quality. The resulting document is available on the Internet (http://www.nca.no/article/articleview/2291/1/280/) and has been published in abridged form by Banks & Soldal (2001). The document concluded *inter alia*, that:

- The use of groundwater, abstracted by a bucket or hand-pump, for drinking water purposes has little significance in terms of aquifer water balances.
- There should be a presumption against the use of motor-pumped or artesian groundwater for irrigation purposes by NGOs, until a proper management framework exists to license abstractions.
- If use of motor-pumped or artesian groundwater for irrigation is absolutely necessary to prevent unacceptable poverty or population displacement, the following guidelines should be observed:
  - Usage of motor-pumped or artesian groundwater for irrigation should only be temporary, during a drought period. The recipient community should revert to traditional sources (surface waters, karezes, and springs) following the drought.
  - All artesian wells must be fitted with a control valve and usage strictly regulated, by agreement with the community
  - Where motor-pumped or artesian groundwater is planned for irrigation, a simple risk assessment should be carried out on a form provided. This includes identification of wells, springs and karezes within a 1 km radius and assessment of existing abstraction density ($l/s/km^2$) within a 3 km radius of the proposed well
  - The proposed irrigation well should not be within 500 m of existing wells, springs or karezes in order to avoid derogation of sources, unless (i) the owners of the wells, springs or karezes are the same community that will benefit from the irrigation water (and have agreed that derogation is acceptable), or (ii) derogated parties have been offered and accepted compensation or (iii) a cogent hydrogeological argument is forwarded that local hydrogeological conditions will prevent derogation of nearby sources.
  - New motor-pumped or artesian wells for irrigation should not be constructed if the long term net abstraction density within a 3 km radius of the new well will exceed 1 $l/s/km^2$, including abstraction from the new well (dependent on local climatic conditions).
- Groundwater used for irrigation should have a salinity in class C2 or lower (EC<750 µS/cm), and a sodium absorption ratio in class S2 or lower, unless drainage can be shown to be adequate to prevent accumulation of salts in the soil. It has been demonstrated that groundwater salinity can be an issue of concern in parts of Wardak, Ghazni, Zabul, Herat, Badghis and, especially, Kandahar.

Since the fall of the Taliban regime, a civilian government has been installed which has taken up the challenge of water policy and management. At the current time, the division of responsibility is unclear, with at least five ministries (Water Resources and Power, Irrigation, Mines and Industry, Rural Rehabilitation and Development, Public Works) claiming overlapping roles in the field of groundwater supply and management. It is to be hoped that the guidance document developed by NCA will form the seed of a more rigorous policy for the sustainable development of rural groundwater resources, in conjunction with surface water, as a means of decreasing vulnerability to drought and enhancing economic development. At the current time, the Ministry for Rural

Rehabilitation and Development have requested that NCA assist in seconding a hydrogeological specialist to assist in policy formulation in this field.

3.0 URBAN WATER: MAINTENANCE, MANAGEMENT, INSTITUTIONAL SUPPORT

3.1 THE PROBLEM

The hydrogeology of Kabul is described by Homilius (1966), Solidarités (1995), Timmins (1996), and Ehsanullah (1996). Kabul has never had a global water supply system, but rather several local systems, fed by largely independent sources. The first, the Paghman Water Supply Network, based on a karez and led under gravity some 18 km into Kabul was constructed in the 1890s. This was followed by the Qargha spring/karez system and the Alaudin wellfield in the 1930s – 1950s. During the 1960s/1970s, the Afshar and Logar wellfields were developed. At the end of the Soviet occupation and immediately prior to the civil war (around 1990), some 60% of the city's population had access to piped water, mostly from the three largest (Logar, Afshar and Alaudin) networks. The rest of the city sourced its water from an estimated 100,000 shallow wells (Solidarités 1995). Most of these sources are based on coarse fluvial aquifer deposits. The population was some 1.4 million, and the maximum capacity of the piped networks was some 86,000 m^3/day (1000 l/s), distributed between:

- Afshar, 6 boreholes to 80-90 m, adjacent to Paghman River, 11,500 m^3/day (133 l/s)
- Alaudin, 7 boreholes to c.80 m, southern part of city along Kabul River, 32,000 m^3/day (370 l/s)
- Logar, 10 boreholes to 60-70 m, SE of city adjacent to Logar River, 34,000 m^3/day (394 l/s)
- Qargha karez, 5000 m^3/day (58 l/s)
- Individual well systems, 3500-4000 m^3/day (41 – 46 l/s)

In the post-Soviet civil war, supply plummeted due to war damage and lack of maintenance (Fig. 3).

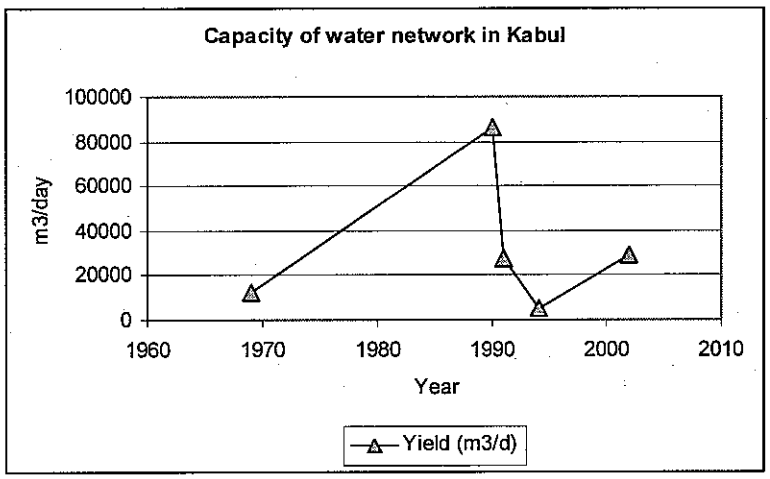

Figure 3. Capacity of Kabul water supply network by year

By 1994, the capacity was only 5000 m^3/day and the population reverted to unprotected shallow groundwater sources. Cholera became rife. Currently (2001-2002), some 20,000 m^3/day are supplied via the piped network, with an estimated loss rate of 30-50% (Hamid 2002, KfW 2002). The poor coverage and intermittent water supply are not primarily due to lack of water resources: the main problem is ensuring an electricity supply to the system. In particular, there is a lack of money to pay pumping costs and to buy diesel for power generators. Attempts have been made to rehabilitate parts of the piped water supply network but interventions by NGOs have been characterised by (Timmins 1996) generally poor sustainability, inadequate long-term planning, lack of payment ability on the part of consumers and lack of comprehensive feasibility studies prior to rehabilitation. UN HABITAT currently estimate that 30% of the population use public shallow wells with hand pump, 20% receive

water from piped distribution networks and 50% use private shallow wells (typically open wells with poor well-head protection).

Kabul has only a minimal sewerage capacity, and most people rely on drop-vault latrines, served by night-soil collectors who transport wastes to landfill or market it as manure to farmers around Kabul. Concerns over pathogen transfer to agricultural produce have led NGOs to promote the concept of night soil composting (Solidarités 1995). Not surprisingly, the intimate proximity of numerous shallow family wells and latrines has caused major water quality problems (Timmins 1996), with bacterial contamination of wells (Table 1) and nitrate contamination of groundwater (Table 2).

TABLE 1. RESULTS OF TIMMINS (1996) SURVEY (*c.* 1400 SAMPLES) OF *E. COLI* IN KABUL'S WATER SOURCES. WHO STANDARD = 5 *E. COLI* PER 100 ml

Source	*E. coli* > 5 per 100 ml	*E. coli* > 100 per 100 ml	*E. coli* > 500 per 100 ml
Well with hand pumps	45.2%	11.1%	1.3%
Open wells	76.5%	31.9%	4.2%
Distribution networks	49.0%	15.7%	1.96%

TABLE 2. RESULTS OF TIMMINS (1996) SURVEY FOR NITRATE IN SAMPLED WELLS AND SPRINGS. < = BELOW DETECTION LIMIT.

Source	Average nitrate concentration mg/l NO_3^-	Minimum concentration	Maximum concentration	Percentage >45 mg/l NO_3^-
All sources	41.65	<	150	10.8%
Well with hand pumps	39.5	<	150	32.5%
Open wells	51.25	4	140	44.3%
Deep wells	37.6	8	85	24.1%
Springs /karezes	34.1	<	90	33%

3.2 THE INITIAL RESPONSE

In January 2002, shortly after the overthrow of the Taliban regime, NCA despatched a team of their own staff and professional consultants, to assess the most efficient means to intervene with international aid to assist in securing adequate drinking water provision in Afghanistan's urban centres. The team initially observed that:

- The poor state of urban water coverage in Afghanistan is for the most part not due to recent allied bombing or associated hostilities, but to over a decade of civil war and misrule, coupled with gross underfunding.
- Other international aid agencies had struggled merely to maintain a most basic level of urban water supply coverage. CARE, for example, had essentially taken over the operation of Kabul's Alaudin system: an honourable task, but with no clear exit strategy. Other agencies had given up on maintaining pumped supplies and had focused on promoting protected hand-dug wells with Afridev-type pumps. This approach has some logic, given the water quality indices above, demonstrating that water quality from protected dug wells is better than that supplied by the public networks (Table 1). However, even here, agencies were struggling to maintain hand-pumps: in May 2001, of 3258 wells with hand-pumps in Kabul, 423 were non-operational due to a low water table (drought and/or overabstraction) and 916 were out of action due to technical issues (a functionality rate of only 59%).
- Kabul had never had any ambition to provide drinking water round the clock via a fully pressurised system to all households. It merely aimed to distribute water to most parts of the city for a limited number of hours. This has implications for water quality. An elevated ambition level, to bring vastly increased quantities of water into the city would (a) necessitate major infrastructural investment in power supply and distribution capacity and (b) rapidly lead to the necessity for a canalised sewage system to remove waste-water: a hugely expensive venture.
- Few rigorously documented assessments of groundwater resources from the Kabul wellfields were available.

Against this background, the NCA team concluded that the problems faced by Kabul and other major cities were not solely technical and hydrogeological, but issues of management and economy.

3.3 THE CHOSEN APPROACH

NCA's team concluded that aid money would be best expended on a program of institutional capacity building, to be implemented in collaboration with other aid agencies and international banks, aimed at the Ministry of Public Works and their agent, the Central Authority for Water Supply and Sanitation (CAWSS). Elements of suggested input to the program included:

- a program of rehabilitation of CAWSS offices, and basic equipment
- a program of classroom-based and on-the-job training for CAWSS staff in the field of management, planning and policy, financial strategy and income generation and technical issues.
- assistance in reconstructing databases, and recovering *inter alia* hydrogeological knowledge and documents.
- a modest program of practical water network rehabilitation projects, where international and local engineers can work side-by-side and learn from each other
- a program of mobilisation and reconciliation: meetings of CAWSS staff from Kabul (formerly Taliban-controlled) with staff from provinces (which may have been under Northern Alliance or factional control)
- international banks such as German KfW expressed their intention of assisting CAWSS in developing a tariff and management structure aiming at eventual financial self-sustainability.

4.0 THE ROLE OF THE HYDROGEOLOGIST IN HUMANITARIAN AID

In the minds of many, there exist two stereotypes in the field of humanitarian aid: (i) the highly motivated, human-focused, non-specialist *"Well-Meaning Idealist"* and the World-Bank-funded, technical/management specialist *"International Development Consultant"*. It is highly doubtful whether such polarities ever existed, but now they are gradually disappearing. Humanitarian Aid organisations are becoming increasingly "professional". They set high standards for employment of permanent staff and are learning to deal with the mass media so as to maximise their exposure amongst the viewing public. They are willing to enter dialogue with suppliers and industrial "sponsors". Organisations such as Oxfam and Norwegian Church Aid (NCA) commission academic research, collaborate with state geological surveys and employ consultancy firms where required. Projects no longer solely focus on grass-roots solutions; Aid Organisations are willing to engage in Institutional Capacity Building and Policy Formulation at Ministerial level, as can be seen by the experiences of NCA in Afghanistan. Furthermore, Humanitarian Aid has begun engage in quality management: standards of performance and service to disaster victims have been developed (SPHERE 2000). Where aid has failed, legal liability may be incurred: humanitarian organisations face lawsuits brought by victims of arsenic poisoning from groundwater in Bangladesh (Pearce 2001). Moreover, the Consultancy sector is beginning to realise that technical solutions are not enough. Awareness of human factors and social issues in problem-solving is no longer a luxury item. Consultants are increasingly willing to collaborate with, and draw on the experience and contacts of Humanitarian Aid organisations. Sharing of personnel is recognised as being of benefit to both Consultant and Aid Organisation, as demonstrated by the success of Red-R (Register of Engineers for Disaster Relief) and the NCA Emergency Water and Sanitation Preparedness Roster.

Hydrogeology is one key brick in the eventual reconstruction of the Afghani state edifice. Afghanistan is blessed with huge reserves of groundwater that *can* be exploited sustainably to supply pure drinking water to urban and rural populations and that can be used, in conjunction with surface water, to increase agricultural productivity and to help communities to better weather drought. Regrettably, hydrogeological know-how has largely fled the country. Remaining native Afghani hydrogeologists have a huge responsibility as repositories of experience and knowledge. They need also to encourage

refugee practitioners of the science to return to their homeland. International hydrogeologists also have a role to play: but they must be aware that hydrogeology is only one part of the reconstruction process. They should be willing to enter dialogue with water and sanitation engineers, agriculturalists, politicians, bureaucrats and economists to ensure that solutions addressing the *whole* issue of water supply and sanitation are developed. They must be aware of the various possible constellations within which they can collaborate, both nationally and internationally: with consultants, international banks, NGOs, United Nations organs, state institutions and academia. Finally, while being professional, they should retain the awareness of the need for constructive dialogue with and service to those who have endured decades of occupation, war and civil decay – the people of Afghanistan.

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