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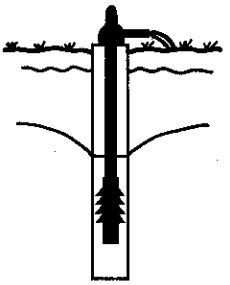
THE GSI GROUNDWATER NEWSLETTER



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GROUNDWATER DEVELOPMENT AND MANAGEMENT

An Aquifer Protection Programme for North County Cork

Groundwater is the major source of both public and private water supply schemes in north County Cork providing some 72% of all water used. Proposed new schemes will be mainly based on groundwater sources developed from aquifers in the Devonian sandstones or Carboniferous limestones, both of which provide an excellent quality water.

In 1982 the County Council decided that an aquifer protection policy should be drawn up to protect the aquifers of north County Cork from pollution. The aquifers were identified and zoned according to their potential vulnerability to pollution and the quantities of water they were capable of providing. It was decided to use a protection scheme that not only protected the sources but also the resource (i.e. the aquifers themselves). The system selected was that developed by Severn-Trent Water Authority and recommended by the Geological Survey of Ireland. Not only were the local Authority sources included in the survey but also large privately owned groundwater sources. A list of prohibited activities were drawn up for each of the aquifer protection zones.

On completion of the initial programme, the Zone 1 or Source Protection Zones around the major sources were subject to an on-site investigation and maps showing overburden thickness, aquifer details and groundwater flow directions, were prepared. From these the most vulnerable areas with a high potential pollution risk were detected. A list of prohibited activities was drawn up for these areas and recommendations were made to rectify existing developments and activities which had the potential to cause pollution to the aquifer. A programme of water quality monitoring was initiated for each of the investigated sources.

This information was incorporated in the County Development Plans and any planning applications for developments within the selected areas are now automatically referred to the Sanitary Services Department of the Council for

examination. To date, one developer, who was refused permission for a development on the grounds that the activity would have a pollution risk to a Council source, has appealed to the Planning Board and has had his appeal turned down. The strict enforcement of the protection programme is necessary to maintain the quality of the aquifer water. Discussions were also held with the Department of Agriculture and ACOT officials and maps of the sensitive areas of the aquifer protection zones were given to them so that they would be aware of the potential problems when dealing with Farm Improvement Grants.

Brendan Devlin, Deputy County Engineer, Cork County Council and
Brian Connor, Geoex Limited.

Groundwater from Poor Aquifers - Clifden area, Co. Galway

Over ten years ago the Land Commission was required to build seventeen new houses for families being re-housed from Turbot Island off Clifden Bay, Co. Galway. Building sites were acquired on the mainland in various locations around Clifden and a water supply was required for each site.

The area consists of schists, granites and quartzite with typical landscape of bare mountain peaks, massive rock outcrops, bogs, many lakes and streams with some low-lying deposits of sand and gravel near the streams.

Each site was surveyed initially and all features noted. Only two could be supplied from existing schemes. It was hope that three or four could be supplied from impounded streams but it was found the streams went dry in long dry spells. Two could be supplied from lakes but the cost would have been excessive due to the difficulties of pipe-laying through rock outcrops.

Trial holes were dug at all sites and testing showed that six of these could be developed further. Failures were due either to rock occurring close to the surface, the presence of dry impermeable clay or high elevation over the water table giving a dry hole. The six trial holes were then deepened and constructed into dug wells using 42" diameter concrete pipes. Care was taken to properly protect the wells from surface contamination. The depths varied from 12 feet to 18 feet. The best of these was located in low-lying gravel near the sea and was suitable to supply four sites replacing three trial holes at elevations up to 50 feet higher. One other well located in gravel near a stream supplied three houses.

Four sites were then left with no supply and despite the misgivings of ourselves and the Geological Survey it was decided to attempt boring. This

was done using our own Ruston Bucyrus 22RW drilling rig. The first bore, drilled in winter time on a granite outcrop to a depth of 116ft, was artesian. This gave great encouragement especially when a bailing test gave a yield of 700 gallons per hour.

The second bore was also drilled in wintertime on a quartzite outcrop to a depth of 90ft and gave a good bailing test.

Two more bores were drilled in summertime to depths of 36ft and 108ft.' The 36ft bore was located on a site only 200ft from a cliff on Kingstown Bay at a level of 38ft above high water mark. A permeable vein was hit at 35ft and drilling stopped at 36ft. The final bore, which was 108ft deep in granite, gave a poor output mainly due to its high elevation. The bores were all on isolated sites and each was required to supply one house only.

The water requirements were modest. It was felt that 1000 gallons per day or three gallons per minute would be adequate. All the wells were tested for as long as possible in the summer/autumn months. The boreholes yielded 135-250gph with drawdowns varying from 7-78ft. The dug wells yielded 160-650gph with drawndowns varying from 4-8ft.

Automatic pressure systems were installed on all the wells and they have worked satisfactorily for about eight years. The maintenance of the systems has been handed over to the occupiers and no failures have been reported.

Harry McEvoy, Land Commission.

An Unusual Aquifer in Australia!

In a recent publication* from Australia, R.E. Read describes a very unusual aquifer discovered during exploratory drilling for a new water supply for the town of Leigh Creek, South Australia, in 1982-3. In a sequence of dolomitic siltstones, the boreholes found some conglomerates in which the large fragments consisted of pellets of magnesite (magnesium carbonate). In the course of time (probably about 5 million years) the magnesite had been largely dissolved away by circulating groundwater, leaving large holes in the rock, resulting in a porosity of up to 80 per cent - a rock-hard sponge!

These rocks, with such a huge porosity, yielded up to 30 litres/second (about 24,000 gallons per hour). Magnesite is considerably more soluble in water than dolomite or calcite, hence the preferential dissolution of the pellets.

* Read, R.E. - An unusual aquifer at Windy Creek. Quarterly Geological Notes, Geological Survey of South Australia, No. 99, July 1986, pp 13-15.

Geoff Wright, Geological Survey of Ireland.

GROUNDWATER QUALITY AND POLLUTION

Hazard Analysis in Emergency Planning - The Yorkshire Example

Following a pollution incident in 1980, the Yorkshire Water Authority instigated an assessment of the pollution risk to all of their 95 public supply boreholes*. The approach taken may have relevance for Irish local authorities following the issuing of the 'Guidelines for Emergency Planning to Protect Water Resources' by the Department of the Environment in May 1986.

For each borehole, information on the geology, hydrogeology, construction details and discharge rate were obtained. An area within a one kilometre radius around each public supply source was examined for potential pollution risk from municipal, agricultural, industrial and environmental sources. A summary sheet for each site was prepared which included details on the following: land usage; roads and road drainage systems; railways; streams; sewers and sewage works; soakaway systems; industrial premises; agricultural buildings; tip sites; bacteriological history and some chemical water quality data; and type of disinfection equipment. From this information each source was categorised and the degree of risk was assessed.

Each site was placed in an overall decreasing risk category of I, II or III, based primarily on bacteriological history and disinfection equipment available on site. Category I was used where there was any notable record of bacteriological pollution, Category II was adopted when either occasional bacterial pollution had occurred or where surface activities in the locality indicated a risk, and Category III where there was no obvious risk. These categories were sub-divided further based on the disinfection systems installed or required and on the need for further investigations. Yorkshire Water are currently preparing an aquifer protection policy to improve the situation further.

Could this approach be relevant in Ireland? It seems to be a fairly pragmatic approach which could be used in hazard analysis and in the initial stages of general source protection.

* Chadra, D.S., 1987. Pollution risk to public water supply boreholes in the Yorkshire Water Authority Area. Personal communication.

A copy of the paper can be obtained on request from me.

Donal Daly, Geological Survey of Ireland.

Septic Tanks and Groundwater Contamination Problems: Why and Where?

Septic tanks are collectively major sources of groundwater contamination for the following reasons:

1. They discharge a high volume of wastewater into groundwater - over 25 million gpd.
2. They are often sited too close to wells.
3. They are sometimes located in areas where the geological and hydro-geological conditions allow the effluent to enter groundwater with minimal purification.
4. Soakage pits are frequently used rather than percolation areas. A soakage pit, although easy to construct, is usually an inadequate means of disposing of effluent because it releases the effluent over a small area which may become clogged or lose the ability to treat the effluent. Also they are deep and so reduce the depth of overburden above the water table or above fissured rocks.
5. In many areas, the planning requirement for percolation areas is not enforced.
6. Septic tanks are seldom maintained and are usually not emptied regularly.

However, there are solutions to these problems and they will be outlined in future issues of **The Newsletter.**

Problems of groundwater contamination occur where:

1. The water table is close to the bottom of the soakage pit or percolation area so that the unsaturated zone is insufficient to treat the effluent adequately.
2. The overburden consists of highly permeable sand and gravel.
3. The overburden is thin and karstic or fissured rocks are present at or close to the ground surface. Parts of Galway, Roscommon and Clare are particularly vulnerable <u>but there are areas in every county in Ireland where these conditions are present and wells could be contaminated by septic tanks</u>.

(This contribution is the third in a series on septic tanks. If you have points to make, write in to **The Newletter.)**

(A paper entitled "Septic Tanks and Groundwater" was given at the annual I.A.H. seminar in Portlaoise. Copies can be obtained on request from me).

Donal Daly, Geological Survey of Ireland.

The Migration of Enteric Coliform Bacteria from a Septic Tank

One of the most critical aspects of the use of a septic tank system as a method of domestic sewage treatment is the contamination of groundwater supplies by enteric bacteria contained within the effluents. Of prime importance in determining the amount of movement of these bacteria towards groundwater is the physical and chemical nature of the regolith.

As part of an ongoing study of septic tank systems and groundwater quality in the Sligo area deep soil sampling and influent/effluent analyses were carried out on a septic tank system in order to assess the amount of bacterial movement from the system. The septic tank system incorporated a soakaway for the disposal of the effluent and was located in an area with sandy soil (82% sand and gravel) and a low C.E.C. (10 meq/100g). A borehole 5m downgradient of the soakaway had a standing water level at the time of the investigation (late winter) of 9.8m below ground level.

High numbers of coliform bacteria (6.0×10^3/g) were recorded adjacent to the seepage pit but by 5.0m from the pit none were present in the soil. There was a noticeable decrease in the number detected in the soil with increasing distance from the pit. An unpumped water sample from the nearby borehole yielded a faecal coliform count of 1.0×10^3/100ml.

One interesting aspect of the investigation was the effect of climatic conditions, notably rainfall, on the numbers of bacteria present in the soil. Following a wet month (January, 1986 - total rainfall 159.2mm) the numbers of bacteria in the soil were as much as ten times higher than following a dry month (February, 1986 - total rainfall 1.5mm). It would appear that heavy rainfall has the effect of flushing the organisms through the soil. Thus under wet conditions contamination of groundwater may be more likely.

A more detailed assessment of bacterial and viral movement in soils in the vicinity of septic tank systems is currently being undertaken at Sligo R.T.C. as part of an M.Sc. thesis on septic tank effluent attenuation in soils.

An earlier issue of the **GSI Groundwater Newsletter** (No. 3, February, 1987) has dealt wit the attenuation of inorganic nutrients in the septic tank system described above.

Hubert Henry, Eugene Brady and Richard Thorn - Sligo R.T.C.

I.A.H. NEWS

7th Annual Groundwater Seminar, Portlaoise. 7-8 April 1987

Another successful seminar was held recently in the Killeshin Hotel, Portlaoise. Thirteen speakers presented papers on four major themes: Aquifer Protection Policies, Septic Tanks, Groundwater Resource Assessment and Groundwater Development Overseas.

Dr. Andrew Skinner, Severn-Trent Water, gave the keynote paper on Policy for Aquifer Protection as it applies in the UK. This was followed by papers from Michael Hand and Kevin Cullen on applying aquifer protection in Ireland.

The series of presentations on septic tanks by Donal Daly, Anne Deacon and Richard Thorn, in particular was followed by an animated question time since it is a topic directly relevant to many of the delegates. On the second day a very practical paper by Paul Walsh (North Cork) on the Charleville and Mitchelstown schemes was also much appreciated.

In all approximately 126 delegates attended the seminar, including representatives of 20 local authorities, the Departments of Environment and Agriculture, An Bord Pleanala, Geological Survey of Ireland and Geological Survey of Northern Ireland, An Foras Taluntais, An Foras Forbartha, IIRS, S.E. Health Board, consultants, drillers, with staff and students from Trinity College, University College Galway and Sligo R.T.C.

A large number of delegates stayed overnight in the hotel, where animated discussions on hydrogeological and other topics continued until the late hours.

If anyone has any suggestions for topics they would like discussed at the 1988 seminar, please contact Geoff Wright (01-687395) or Breda Naughton (01-602511). All ideas will be considered.

Breda Naughton, Secretary, Irish Branch I.A.H.

REVIEWS

Paper : Nitrate in Water
Report by the Nitrate Co-ordination Group
Pollution Paper No. 26 (1986) - D.O.E., U.K.
Publisher: Her Majesty's Stationery Office, London
(104pp Price £6.30 sterling)

This report includes a review of up-to-date factual information on nitrate concentration in groundwater and in rivers which serve as important sources of drinking water in the U.K. Trends show that nitrates rose consistently for the decade prior to 1976 but have been variable since then although most tend to show a gradual increase.

The cost of adopting the current EC Drinking Water Directive limit of 50mg NO_3/l has been estimated at £50m for immediate capital expenditure and a further £150m within twenty years if current trends continue. By the end of that period running costs would be about £10m/year. While blending of high and low nitrate waters is currently the favoured option for treatment, denitrification plants may have to be installed in future.

A variety of agricultural factors known to affect nitrate leaching losses, notably soil cultivation, cropping practice, rate and timing of fertiliser application and rate of crop uptake are considered in detail and a list of recommended practices are outlined which would help to reduce losses if adopted generally. The report suggests that where action can be taken to limit nitrate leaching losses without creating financial problems for farmers, such action should be taken. It also concludes that it would be difficult to apply the Polluter Pays Principle effectively and fairly to nitrate pollution.

An integrated approach to the problem is strongly recommended including improved liaison between water authorities, agricultural advisory personnel, representatives of farmer organisations and fertiliser manufacturers. Research priorities are also identified.

Finally, the Report contains a short but useful chapter outlining the situation in other European countries where nitrates are a problem and it is envisaged that proposals on a Community-wide approach may be forthcoming in the near future.

Marie Sherwood, An Foras Talúntais

Paper : **Factors affecting the leaching of nitrate to groundwater in the Republic of Ireland.**

Author : R.H. Thorn.

Journal : Irish Geography, Vol. 19, pp 23-31 (1986).

While there is very little conclusive evidence that nitrate in drinking water is a health hazard to other than young infants (causing methaemoglobinaemia) the possiblility that it may contribute to the formation of nitrosamines (potential carcinogens) cannot be overlooked and is an important factor considered by both the World Health Organisation and the EEC in setting limits for nitrate concentration in drinking water.

Theoretical considerations indicate that the amount of nitrate leached under Irish agricultural practices should not exceed the prescribed limits. Richards Thorn's study is an important advance in that it comprises actual measurements of nitrate in soil profiles under both grassland and arable (spring barley) systems receiving different rates of N fertiliser at four locations with varying soil conditions. His results indicate that nitrate concentrations in the recharge water beneath spring barley and grassland receiving less than 210kg N/ha do not exceed EEC limits whereas he found variability in the nitrate levels beneath grassland receiving higher amounts of N. Such variation could be expected in grazed grassland where uneven deposition of very high amounts of N by grazing animals in dung and urine patches may result in abnormally high nitrate in the soil profiles beneath them. Some of the high values reported may have resulted from samples taken on former urine patches, which are not always recognisable in the field.

Thorn found evidence that split applications of N fertilizer to grassland tended to reduce leaching, but found no clear relationship between soil texture and the amount of nitrate leached.

Marie Sherwood, An Foras Talúntais

NEWS FROM ABROAD

Britain to be sued by EEC over polluted drinking water.

Britain is facing legal action from the EEC for supplying at least one million people with water containing greater than 50mg/l NO_3 for more than three months. This situation exists in the southeast midlands where, unlike Ireland, rainfall amounts are relatively low and tillage is the dominant land use. Britain have applied for 52 supplies to be exempted from the EEC rules but this is unlikely to be acceptable. However, the action may enable the Department of the Environment to set up water protection zones where farmers would only be allowed to use limited amounts of fertilizer, a move that was previously blocked by the Department of Agriculture.
(Source: Observer Newspaper, 1 February, 1987.)

Donal Daly, Geological Survey of Ireland.

RECENT PUBLICATIONS ON WASTE DISPOSAL

The Chemical Industries Association in the UK has published a booklet entitled **"The Responsible Use of Landfill"** which "particularly refers to those wastes which should only be landfilled after very careful consideration and after prior consultation with the Waste Disposal Authority about the suitability of the waste disposal site". (Source: Waste Management Vol LXXVII No. 4, April 1987).

I haven't seen this booklet but it sounds useful.

The Geological Survey Library has just received the **D.O.E. (UK) Waste Management Paper No. 26** entitled **"Landfilling Wastes"** which was reviewed in the last issue of the **Newsletter.** This is the best and most practical publication I have seen on waste disposal and I strongly recommend it to everyone dealing with waste disposal sites. It is published by H.M.S.O. and costs £15.00 sterling.

Donal Daly, Geological Survey of Ireland.

EDUCATION

'Down to Earth' Exhibition

The Geological Survey's new headquarters at Beggars Bush contains a very fine exhibition area, formally opened by the Director, Dr. C.E. Williams on 16 December 1986 and officially named the Ganly Gallery, in honour of Patrick Ganly (1809-1899) one of Ireland's foremost geological surveyors.

The 'Down to Earth' exhibition currently showing in the Ganly Gallery is the core of a permanent display on Ireland's geological structure and mineral resources. The exhibition is open to the public every weekday afternoon, except Bank Holidays, from 2.30p.m. to 4.30p.m.

Designed to be of general interest, the 'Down to Earth' exhibition is divided into three sections. The first, 'Rock Solid', introduces rocks and geology, outlines Ireland's geological history and describes the use of rocks as raw materials. The second section 'Buried Treasure' is devoted to Ireland's very considerable mineral resources. The non-metallic minerals sub-section includes displays on groundwater, industrial minerals, building materials and decorative stones. The metallic minerals sub-section has an historical as well as a geological component and outlines the stages of a mineral exploration programme. The Extraction and Processing sub-section contains three fine displays sponsored by Cement - Roadstone Holdings, Gypsum Industries and Tara Mines on their respective operations in Ireland. The Fossil Fuel section introduces Ireland's indigenous geological sources of energy. The final section of the exhibition outlines the work of the Geological Survey.

Groundwater makes two appearances in the exhibition. Firstly under the guise of a non-metallic mineral in a display that (1) emphasises the importance of groundwater to Irish society, (2) explains groundwater's occurrence, (3) underscores the increasing threat to Irish groundwater from pollution and (4) outlines means of preventing or at least minimising groundwater pollution.

Groundwater makes its second appearance in the exhibition in the section devoted to the work of the Geological Survey, which is the principal public sector employer of hydrogeologists in Ireland. Aspects of the GSI's hydrogeological activities, such as regional groundwater assessments and farm advisory work, are illustrated by means of photographs, charts and maps.

Throughout the exhibition, large hands-on specimens are on open display. Specimens in display cases include some of the first known

specimens of visible gold in Irish bedrock, presented by Tara Exploration Ltd. from one of the very recently found bedrock gold prospects.

A visit to the exhibition can be combined with consultation and/or purchase of maps, GSI publications or vertical aerial photographs in the GSI's Public Office, or use of the GSI's Library, or even, perhaps, consultation with some of the GSI's hydrogeologists.

Jean Archer, Geological Survey of Ireland.

CONTRIBUTIONS FOR THE NEXT ISSUE OF THE NEWLETTER

The **GSI Groundwater Newsletter** aims to improve communication among the many scientists and engineers involved with groundwater. It will include news, developments, reviews and opinions on all aspects of groundwater - exploration, development, management, water quality, pollution and energy. It will be published at three-monthly intervals.

Your contribution to the dialogue would be welcome. For the next issue it should reach the Geological Survey before **1st August, 1987.** All items should be as short (maximum 300 words), interesting and newsworthy as possible.
