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THE GSI GROUNDWATER NEWSLETTER

NUACHTÁN SCREAMHUISCE SGÉ

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Edited by: Donal Daly

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IN THIS ISSUE

The use of **engineered or constructed wetlands for wastewater treatment** is a new concept for me - is this the case for you also? Ciaran Costello outlines some of the theoretical aspects on page 6. How practical and effective is this system? Does it have applications in Ireland, particularly for the disposal of tip site leachate or piggery and hatchery wastes in areas where either groundwater or surface water is at risk?

What is the "safe" distance between a well and a septic tank percolation area? Is a 30m distance adequate in all situations? The answers to these questions are given on page 3. Niall Torpey sends us news (page 7) that the existing I.I.R.S. recommendations on septic tanks - S.R.6: 1975 - are being revised and that the draft revision is now available for comment.

On page 4 Patrick Johnston outlines the problems being posed in Britain by **landfill gas** and provides us with a timely warning that similar "explosive" problems could arise here if preventative measures are not taken.

These are some of the highlights of this **Newsletter** but many other interesting topics are raised. Why not contribute to the dialogue by sending in an item for the next issue?

Donal Daly, Geological Survey of Ireland.

GROUNDWATER QUALITY AND POLLUTION

Nitrate in Groundwater - The Origin of this Contentious Ion

High nitrate levels in the UK and Europe, which are a major cause for concern, are generally attributable to the leaching of fertiliser nitrogen from agricultural soils. Catherine Coxon showed in a recent issue of the **GSI Groundwater Newsletter** (No. 5, September, p.10) that it is not only in the UK and on mainland Europe that there is cause for concern over high nitrate levels in groundwater. Catherine's survey of wells in the Barrow Valley showed that very high nitrate concentrations (up to 22.8 mg/l NO_3-N) were often found associated with point sources of pollution. Given that the Barrow Valley is, arguable, the most agriculturally intensive area in Ireland, and thus an area in which one might expect leaching of fertiliser nitrogen to be a major contributor of nitrate in groundwater, the question arises as to what extent the high nitrate levels encountered by Catherine are due to point sources and to what extent diffuse?

A post-graduate research project conducted by the author between 1981 and 1983 aimed to determine the factors affecting the leaching of nitrate to groundwater from agricultural soils. Full details of the project can be found in Thorn, R.H. (1984), "Nitrate leaching in the unsaturated zone",Ph.D. Thesis, Trinity College Dublin and in "Factors affecting the leaching of nitrate to groundwater in the Republic of Ireland", (1986). Irish Geography, 19, 23-32.

The results of the investigation can be summarised as follows:

1. Where applications of fertiliser nitrogen to grassland are less than approximately 200 kg/ha the amount of nitrogen leached is small - usually less than 10% of the amount applied.

2. The leaching of fertiliser nitrogen from grassland where application rates are greater than 200 kg N/ha is much more variable with, in extreme cases, more than 50% of the applied nitrogen being leached.

3. Beneath sugar beet and spring barley the amount of fertiliser leached is proportionately much greater than beneath grassland with, in most cases, 20-40% of the applied nitrogen leached.

4. The amounts of nitrate in recharge water were highest beneath Johnstown Castle (11 mg/l NO_3-N on average), slightly lower (7 mg/l) at Oakpark and no higher than background groundwater levels (1-3 mg/l) in general at Mellowes and Rockwell Colleges.

It is clear from point (4) above that the leaching of fertiliser nitrogen alone is unlikely to be responsible for the very high nitrate levels encountered by Catherine Coxon but that it may assist in raising background levels.

Richard Thorn, Sligo R.T.C.

Septic Tank Systems and Groundwater Pollution: Further Remedies

Distances between percolation areas and groundwater sources: The level of effluent contamination of groundwater sources normally decreases with distance from the percolation area. This distance depends on a number of complex geological and hydrogeological factors, many of which are difficult to quantify. While it is not possible to specify with certainty the minimum safe distances between percolation areas and groundwater sources, those in the table below are suggested as a guide. These distances are based chiefly on the most important geological and hydrogeological factors e.g. the type and depth of subsoil and depth to the water table, all of which can be assessed. If these distances are adhered to, the risk of pollution of wells should be minimised.

Suggested distance of a well from a percolation area

Type of Subsoil	Minimum depth subsoil above rock (m)	Minimum depth to water table (m)	Minimum distance from percolation area (m)
Clay (low percolation rate)	1.0	1.0	30
Sandy clay (medium percolation rate)	1.0 2.0-5.0 5.0	1.0 1.0 1.0	45 30-45 30
Sand and Gravel (high percolation rate)	1.0 2.0-5.0 5.0	1.0 1.0 5.0	60 40-60 30

Notes: i) Depths are from the level of the percolation pipe and not from ground level.
ii) If the depth of subsoil and/or minimum depth to water table is less than 1.0m, remedial measures are necessary.
iii) A distance less than 30m can be justified in certain circumstances, for instance (a) where the depth of clay is several metres and the well is upslope of the percolation area or (b) where both the thickness of sandy clay and the depth to the water table is greater than 5m.

The paragraph and table above are copied from the Draft Revision of S.R.6 : 1975 (see item by Niall Torpey on page 10).

The need for adherence to the distances shown in the table rather than the usual 30m distance is illustrated by the many private wells polluted by septic tank effluent and by several studies which have shown bacteria and viruses travelling more than 30m underground. The table also illustrates the importance of the subsoil type and depth and the thickness of the unsaturated zone - factors which should be estimated beforehand at every proposed site.

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

Donal Daly, Geological Survey of Ireland.

Concern Grows about Gas Emissions from Waste Disposal Sites in the U.K.

The H.M. Inspectorate of Pollution (H.M.I.P.) have warned that some 500 sites in England and Wales are emitting methane and carbon dioxide which are a danger both to the safety and property of people living nearby. They estimate that the cost of making these 500 sites acceptably safe would be about £160 million. However, much of the remedial work may not be carried out due to the lack of legislative control over closed sites, many of which are in private ownership.

Last year six Waste Disposal Authorities had to evacuate homes threatened by migrating gas on a total of 14 occasions. The most significant incident to date was an explosion at Loscoe in Derbyshire in 1986 which demolished a bungalow, causing severe injury to the occupants. Concern is also growing about the number of housing and other developments close to or on landfills known to be emitting gas, which are receiving planning permission without adequate precautions.

Earlier this year all U.K. Authorities were urged by H.M.I.P. and the Scottish Development Department to check all active and closed landfill sites in their areas. They have also been asked to monitor and control gas emissions at landfills by attaching appropriate conditions to site licences. The sites most likely to cause problems are those which take a high volume of household and commercial wastes, are relatively deep, and are located close to residential properties. The need for a thorough geological survey before commencement of tipping is highlighted by the fact that methane gas can travel through fractured rock as well as permeable sand.

Regular gas monitoring for landfill gas emissions will in future become a standard requirement of site licences and it is thought that gas monitoring may be required for up to 20 years after sites are closed. The pumping and flaring of landfill gas will become a regular feature of sites. Many private operators and some local authorities are now actively investigating the possible utilisation of gas for electricity generation or as a fuel source in view of the necessity to control landfill gas in the future.

Patrick Johnston, Waste Management Consultant.

Iron in Steel-Lined Hand Pump Wells: The Land Commission Experience

Since 1945 almost 2000 wells have been drilled or dug by the Irish Land Commission. Prior to 1960 a hand pump was provided on each well but with the more widespread availability of electricity, electric pumps have been installed since then. This article will only deal with hand pumps.

Iron contamination is always a potential problem with steel lined boreholes where aggressive water with high CO_2 attacks the steel and dissolves the iron. Contact with air causes oxidation of the iron and the precipitate which forms gives the rusty appearance which stains clothes, utensils, etc.

Solutions to the Problem:

1. Install an electric pump. This reduces the iron content close to that of the source water. This was not always possible in earlier years.
2. Install a Kildare type tank which is a small filtration and settlement unit fitted with a draw off near the base. Because of its size,aeration was limited and was best achieved by slow pumping. The tank was only suitable for a very small draw off and because some maintenance was necessary it did not find favour.
3. Reline well with P.V.C. and remove steel liners i.e. 5" P.V.C. inside 6" steel or 7" P.V.C. inside 8" steel. P.V.C. water main was used with adhesive compriband at the bottom which expanded to give a seal with the rock and prevented loose material gaining access when the steel was removed. The bore was then air lifted to remove the iron oxide and other debris and the space outside the P.V.C. filled in. Concrete does not adhere to P.V.C. (as it does to steel) and to get a proper seal at the pump platform it was necessary to coat the P.V.C. with P.V.C. cement and quickly rub in coarse sand before allowing the cement/sand coat to dry fully. Concrete was later tamped in around the P.V.C. and gave a secure seal. Care was also necessary to ensure that the pump was erected independently of the P.V.C. This generally brought the iron content down to 0.3 - 0.6 ppm.
4. Replace the GB rising main with class 7 hard P.V.C. which was also screwed and socketed to G.B. specification. All steel plates joining the rods were replaced by brass.
5. If ground and watertable conditions were suitable, a dug well or large diameter borehole lined with slotted P.V.C. was provided instead of a steel lined borehole. The risk of bacterial pollution however was high and proper protection for the well was essential.

Harry McEvoy, Land Commission

Engineered or Constructed Wetlands Used for Pollution Control.

The control of effluent conventionally requires the construction of elaborate and expensive engineering structures for the biotechnological treatment of wastes. These structures and equipment incorporate a number of unit operations such as screening, primary settling, mechanical aeration, secondary settling, thickening and filtering. They may also require chlorination and the land spreading of sludge. This in turn requires the input of management, chemicals, maintenance, energy, and operational staff. In using biotechnology nature is imitated but in a very expensive and elaborate manner. Instead of confining our imitation of nature to the use of microbiological processes and fusing engineering technology to create a suitable environment for these processes we could also imitate a natural environment to achieve the same result.

Wetlands offer a suitable model for such a natural treatment system. These are areas where the water is at or above the land surface for long enough each year to promote the formation of hydric soils and to support the growth of hydrophates as long as other environmental conditions are favourable. The productivity of wetlands can be very high. They receive, hold, and recycle nutrients continually washed from upland regions. As a result of their high productivity and diversity of plant life, wetlands are also rich habitats for insects, microorganisms, zooplankton, crustaceans, reptiles, amphibians, fish, birds and mammals. It is this very diversity, and the ability of the aquatic plants to create an aerobic zone at the rhizosphere by transporting oxygen from the leaves to the roots, that give wetland ecosystems their unique ability to remove aquatic pollutants. Wetlands remove pollutants through a variety of physical, chemical, and biological processes.

Wetlands can perform integrated wastewater treatment, combining secondary as well as advanced treatment in a single system. This ability to renovate waste water has been well established in a large number of studies in a variety of geographical settings and wetland types such as bogs, marshes, estuarine and freshwater systems, as well as specially constructed wetlands. The oxidized rhizosphere and its associated aerobic bacteria allows nitrification / denitrification at significant rates in the same general area leading to **N** removal as N_2 and N_2O . These microorganisms also use the plant wastes as a food source and this interaction removes the organics from the wastewater. Electric charges on the plant root hairs attract suspended solids from the wastewater and they are used by the plant and its microorganisms.

Existing treatment systems show ammonia and total **N** removal of nearly 90%. The mean **BOD** and suspended solids removal in wetlands are over 90% in existing treatment systems. Total coliform bacteria are also removed with over 90% efficiency. **P** is removed and the adsorption of various metals, toxic wastes and other chemicals effected.

Ciaran Costello*

* Ciaran presented a paper on this topic at a recent International conference entitled "Constructed Wetlands for Wastewater Treatment" in Chattanooga, Tennessee.

LOCAL NEWS

Revision of SR6: 1975

The National Standards Authority of Ireland (NSAI) announces that a revision of SR6: 1975 **"Septic tank drainage systems suitable for single houses"** has been prepared and is available for comment.*

This is the first time that a revision of SR6 has been carried out and the NSAI was assisted in the revision by a committee drawn from the Department of the Environment, the Geological Survey of Ireland, an Bord Pleanála, Eolas, Meath County Council, Sligo R.T.C. and the South Eastern Health Board.

The revision is, like most other changes, a little bit of 'good news - bad news'.

Some of the important changes are:

- Site test requirements are a bit more severe and an overall site assessment is now suggested.
- Minimum distances from wells to percolation areas are given.
- Suggested maximum densities of septic tank systems in a particular area are given.

Readers of the draft will decide which of the changes are good news or bad news!

* Copies are available, price £6, from Standards Sales Office, NSAI, Glasnevin, Dublin 9.

Niall Torpey, NSAI.

REVIEW

Paper: HDPE liner protects groundwater from wastewater

Author: Mark Cadwallader

Journal: Water and Wastewater International, Volume 3, Issue 1.

This paper describes the use of high density polyethylene (HDPE) liner at a 26-acre municipal waste disposal site in Alaska. The use of HDPE liner is becoming more common in many countries particularly for co-disposal and industrial waste sites. The impetus for the use of these liners has grown particularly since research has shown that organic chemicals are not always contained properly by traditional clay liners as chemical interactions of the organic chemicals with the surface of clay particles are believed to cause structural changes that increase the clay permeability.

What interested me particularly about this article was the contention that many chemicals which cause industrial wastes to be classified as hazardous are also present in municipal wastes. This is shown in the table below which is copied from the paper.

Organic solvents in household cleaning products

1.	Orthodichlorobenzene	Drain degreaser.
2.	Paradichlorobenzene	Drain degreaser.
3.	1,1,1, Trichloroethane	Septic tank drain field cleaner, drain opener, oven cleaner, cleaning fluid, furniture polish.
4.	Trichlorethylene	Cleaning fluid.
5.	Perchloroethylene	Laundry degreaser, home and auto parts cleaner.
6.	Aliphatic, aromatic	Septic tank drain field cleaner, laundry degreaser, cleaning fluid, engine degreaser, car wash.
7.	Petroleum distillates	Septic tank drain field cleaner, drain opener, oil and grease dissolver, garage degreaser, cleaning fluid, engine degreaser, spray cleaner, floor cleaners, furniture polish, spot remover.
8.	Methylene chloride	Oven cleaners, graffiti remover, brush cleaner.
9.	Chlorinated solvents	Laundry degreaser.

Presumably solvent wastes from garages and dry cleaning establishements could also end up in the local town tip site thereby adding to potential problems.

Is a paper such as this purely a marketing promotion for HDPE liner manufacturers hoping to influence already hard-pressed environment engineers or do these liners have a role to play in waste disposal practice in Ireland?

Donal Daly, Geological Survey of Ireland.

PEOPLE

Geoff Wright. This summer Geoff took a mid-career break and headed off to the Sultanate of Oman and the sun. There he has joined the Environment and Water Resources (EWR) Department and will stay for at least two years. Geoff has been a regular contributor to the **Newsletter** and hopefully he will find time to send us some material on groundwater problems in the desert.

In Oman, Geoff will join Dai Ede, a former colleague in the Geological Survey. We wish them both well and hope they enjoy the change of scenery.

Harry McEvoy. At the beginning of September Harry joined the Geological Survey from the Land Commission. During his time with the Well Boring Section of the Land Commission he had a close working relationship with the Survey. Harry will head the Engineering and Drilling Services Unit of the Geological Survey. He will also be involved in the work of the Groundwater Section.

Accompanying Harry are the logs of over 2,000 boreholes drilled by the Land Commission throughout the country and some valuable drilling equipment. These drilling logs will make a significant contribution to the well records held in the Groundwater Section.

Eugene Daly, Geological Survey of Ireland.

EDUCATION

International Conference on "Domestic and Industrial Wastes".
The Sherkin Marine Station is organising a conference entitled "Domestic and Industrial Wastes" which will be held at the Imperial Hotel, Cork on Thursday 3rd - Friday 4th November. For further information contact Matt Murphy, Sherkin Island Marine Station, Sherkin Island, Co. Cork. Telephone: (028)20187.

Seminar on "EC Directive 80/778 EEC and Disinfection - the Alternatives.
The Republic of Ireland Branch of the Institution of Water and Environmental Management (IWEM) is organising the above seminar, which will be held at the Royal Marine Hotel, Dun Laoghaire on Tuesday 25th October. For further information contact Michael Hand, c/o P.H. McCarthy Son and Partners, Rosemount Hall, Dundrum Road, Dublin 14. Telephone (01)989377.

Editor

I.A.H. NEWS

Future Events

10-16 October.	I.A.H. World Congress at Guilin, China. Three members - Catherine Coxon, Breda Naughton and Richard Thorn - will be attending and papers will be presented by Richard and Catherine.
29th November (date provisional)	A talk and slide presentation on the Guilin Congress at 6 p.m. at the Geological Survey of Ireland. The A.G.M. of the Irish Branch of I.A.H. will precede the presentation.

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

NEWS FROM ABROAD

Aldicarb Pesticide in Groundwater: U.S. EPA Proposals.

The U.S. EPA is proposing that Aldicarb use should be prohibited within 300 feet of all drinking water wells and that in addition to labelling and monitoring requirements, States would have to implement plans in areas identified as having a high potential to leach.

Aldicarb is registered for use on 14 crops and has been found in the groundwater of 48 counties within 16 States at levels varying from "level of detection "to 515 ppb. The EPA limit is 10 ppb. The EPA conclude that on a national basis the risks posed by Aldicarb contamination of groundwater outweigh the benefits of use but that by imposing certain regulatory restrictions short of cancellation, exposure would be reduced to the point where remaining benefits outweigh the risks of use.

(Source: The Groundwater Newsletter Vol. 17, No. 13).

Aldicarb is used as insecticide mainly in potato and sugar beef production. Although the quantities used in Ireland are small it is interesting to note the approach taken by the U.S. EPA.

Editor

CONTRIBUTIONS FOR THE NEXT ISSUE OF THE NEWSLETTER

These should reach the Geological Survey before **15th November 1988.** All items should be as short **(maximum 350 words),** interesting and newsworthy as possible.
