POLICY AND PRACTICE FOR THE PROTECTION OF GROUNDWATER IN NORTHERN IRELAND

Environment and Heritage Service
An Agency within the Department of the Environment, Northern Ireland

An Agency within the Department of the Environment

JULY 2001

ENVIRONMENT AND HERITAGE SERVICE

FOREWORD

I am pleased to introduce a 'Policy and Practice for the Protection of Groundwater in Northern Ireland'. This document outlines the approach Environment and Heritage Service (EHS) will take towards the protection of both groundwater resources and groundwater quality in Northern Ireland. It represents a major step towards addressing, in a comprehensive and consistent manner, those activities which have the potential to have an impact on this valuable resource.

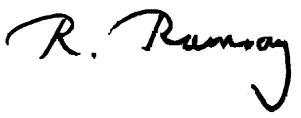
Groundwater in Northern Ireland has historically had a lower profile than surface water - both as a result of it being, by its very nature, 'out of sight' and due to the predominance of surface water as the main source of drinking water. Nevertheless it represents an important component of supply to both the public and private sectors. In addition, and perhaps less recognised, groundwater forms an important contribution of flow to surface waters, and a variety of wetland sites and subsequently influences the ecological quality of such features.

For the above reasons water resources, including groundwater, must be managed in a sustainable manner to ensure they remain available for present and future generations.

Groundwater quality is also of great significance particularly as it can be very costly to clean-up once quality deteriorates and can take a long time to recover. For these reasons, prevention of deterioration of groundwater quality is the most important aspect of groundwater quality management. EHS has already produced a map indicating where groundwater is most vulnerable. This policy document proposes further protection zoning around key abstractions. Consideration needs to be given to the potential impact on groundwater from a wide variety of activities and this policy will greatly help our assessment of what those impacts may be and establish where some activities are unacceptable. It is the intention of this 'Policy and Practice' to offer a consistent approach to the consideration of such matters but it also recognises that site specific factors will have an important influence on decisions and recommendations.

The 'Policy and Practice' is aimed at all those involved in the regulation and protection of the water environment, directly and indirectly, as well as those involved in the planning control and carrying out of activities where the impact on the water environment needs to be a consideration.

I commend this document to you and hope you find it to be a useful reference when consideration is being given to activities which influence the quantity and/or quality of our valuable groundwater resources.



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SUMMARY

This groundwater protection policy statement (hereafter referred to as 'the Policy') explains how Environment and Heritage Service (EHS), an Executive Agency of the Department of Environment (DOE), Northern Ireland, will meet the responsibilities of the DOE, for the protection and conservation of groundwater resources in Northern Ireland. This document has been prepared following public consultation. EHS wish to acknowledge the comments made by respondents who are listed in Appendix 1.

Under the Water Act (Northern Ireland) 1972, Environment and Heritage Service, on behalf of DOE, is required to promote the conservation of the water resources of Northern Ireland and to promote the cleanliness of water in waterways and underground strata. For the purposes of the Act, underground strata means strata subjacent to the surface of any land. Furthermore, no person shall without consent from the EHS make any discharge into any underground stratum of (a) any trade or sewage effluent; (b) any poisonous, noxious or polluting matter not falling within (a).

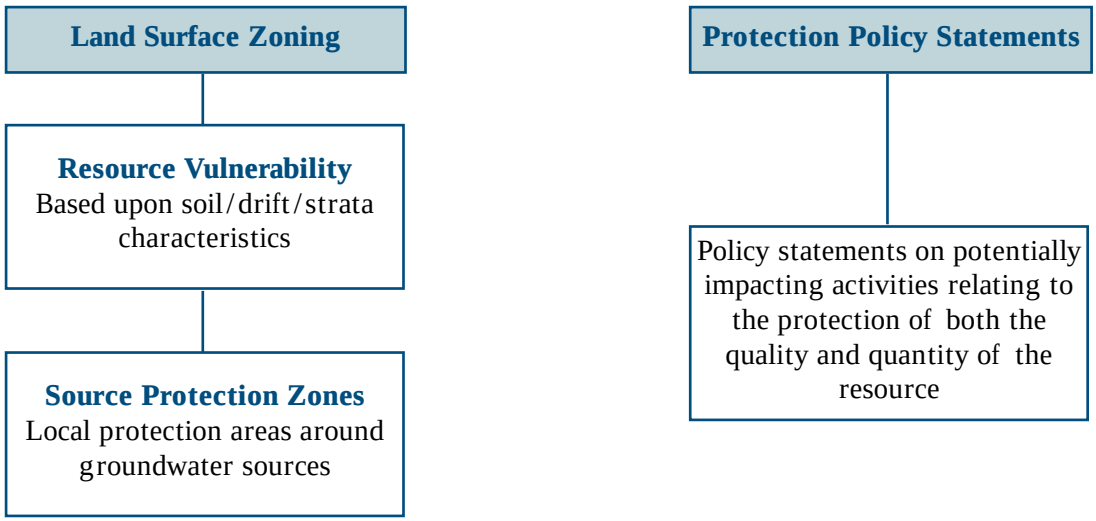
In exercising its functions under the Act the main objectives for EHS in relation to groundwater are:

- to ensure that all risks to groundwater from point and diffuse pollution sources are dealt with in a common framework which promotes best practice and a standardised approach to groundwater protection and management;
- to ensure the sustainable management of groundwater resources; and
- to encourage compatibility of approach between Environment and Heritage Service and other bodies with a role in groundwater protection in Northern Ireland.

In support of these objectives Environment and Heritage Service commissioned the British Geological Survey to undertake a Hydrogeological and Hydrogeochemical Reconnaissance Survey and to produce both a Hydrogeological Map and an Aquifer Vulnerability Map for Northern Ireland.

The Policy document has taken into consideration current European policy for the protection of groundwater and closely follows the policy adopted in England and Wales by the Environment Agency[1]. Environment and Heritage Service will apply the Policy, not only in the use of its own powers, but also in seeking to influence the policies and decisions of others whose actions can affect the protection of groundwater; for example, in response to consultation relating to planning issues. By publishing the Policy, Environment and Heritage Service is establishing a technical framework which will form the basis of future policies.

The key elements of the Policy are, Land Surface Zoning and Protection Policy Statements as indicated below:



[1]*Environment Agency (1997) Policy and Practice for the Protection of Groundwater*

This document:

- explains the importance of groundwater for both water supply and the general water environment and associated ecology.
- outlines European and local legislation relevant to groundwater.
- describes the concepts of vulnerability and risk in relation to groundwater protection.
- introduces the concept of source protection zones around abstraction sites.
- defines policy statements on issues relating to the protection of groundwater quality and quantity.

Groundwater protection decisions are complex. They involve consideration of geology, soils, hydrogeology and geochemistry. They must also take into account the interaction with surface waters, land and air. They may require very detailed site investigation and monitoring before decisions can be made. Consideration will often need to be given to the balance of interests both within the water sector and in a wider environmental context. Decisions will be made with consideration for their impact on individuals and local communities. The Policy and supporting maps provide a framework for decision making, but they are not prescriptive and need to be qualified by site specific investigation.

It is a key approach of The Sixth Environment Action Programme of the EU 2001-2010 entitled "Environment 2010: Our Future, Our Choice" to ensure that existing environmental legislation is fully implemented. In addition environmental concerns should be integrated into all relevant policy areas and Members States should ensure better and more accessible information on the environment for the public. The Sixth Action Programme also identifies the need to involve business and consumers in identifying solutions to environmental problems and Member States should develop a more environmentally conscious attitude towards land use. This Policy document seeks to support the delivery of these approaches in Northern Ireland.

1. INTRODUCTION

PROTECTION OF GROUNDWATER

Groundwater is an integral part of the water cycle (Figure 1). A significant component of the rainfall percolates through the soil zone to pores and cracks within the underlying permeable strata; either porous sands, gravels or sandstones, or fractured rocks such as limestone, chalk or basalt. In all cases the percolating water travels vertically downwards under gravity until it reaches the saturated zone at the water table. It is then transported down the prevailing hydraulic gradient towards a discharge point which may be a stream or river, lake or sea, a spring or a pumped borehole. Weakly permeable strata such as granite and the ancient rocks of County Londonderry may also possess some cracks and fractures, sufficient to allow small volumes of groundwater storage and transport.

Groundwater sustains an important component of the water supply of Northern Ireland. About 8% of the water in the public supply system is drawn directly from boreholes and springs[2], and additional supplies are taken from private groundwater sources for industrial, agricultural or domestic use. In addition, groundwater storage contributes baseflow to surface waters such as streams and rivers that in turn provide water for public supply and this amounts to a further 60% of the total supply. Wetlands can also be fed from groundwater with the ecology particularly sensitive to changes in the level of the water table.

Groundwater therefore is an important and valuable resource which requires protection. It is important that the volume of groundwater available is not depleted and that the quality of the water is maintained at its current high standard. This can be done by managing the land in selected areas.

The risks to groundwater are twofold. One is that over abstraction from an aquifer may reduce the level of the water table and so deplete baseflow to surface waterways or may cause lower yields for some groundwater users. Such depletion may, in turn, have an adverse effect on groundwater quality by encouraging deeper perhaps salty water to come into circulation. The second risk is that the activities of man on the land surface might pollute the groundwater. These risks can be assessed and managed to prevent or minimise the probability of a contamination event. Such potentially polluting activities include waste disposal, industry and agriculture. Distribution of the pollutant might be diffuse as in the application of agrochemicals, or it might originate from more discrete sources such as a landfill or industrial sites. Even quarrying for roadstone or excavation of aggregate material may adversely affect the quality and quantity of groundwater in a particular vicinity.

Groundwater flow paths may be short and relatively shallow, or they may be longer and deeper. In Northern Ireland groundwater may typically be a few tens of years old, but there is some older slow moving water, for example, at depth beneath the basalts of County Antrim. This means that a pollution event occurring at the surface today may not manifest itself in the groundwater body for several years or even decades. A worst case situation is a diffuse or dispersed pollutant accumulating over a long period of time, which may be extremely difficult and costly to deal with, even after the source of the pollution is removed.

[2] *Water Service (1998) Drinking Water Quality Report*

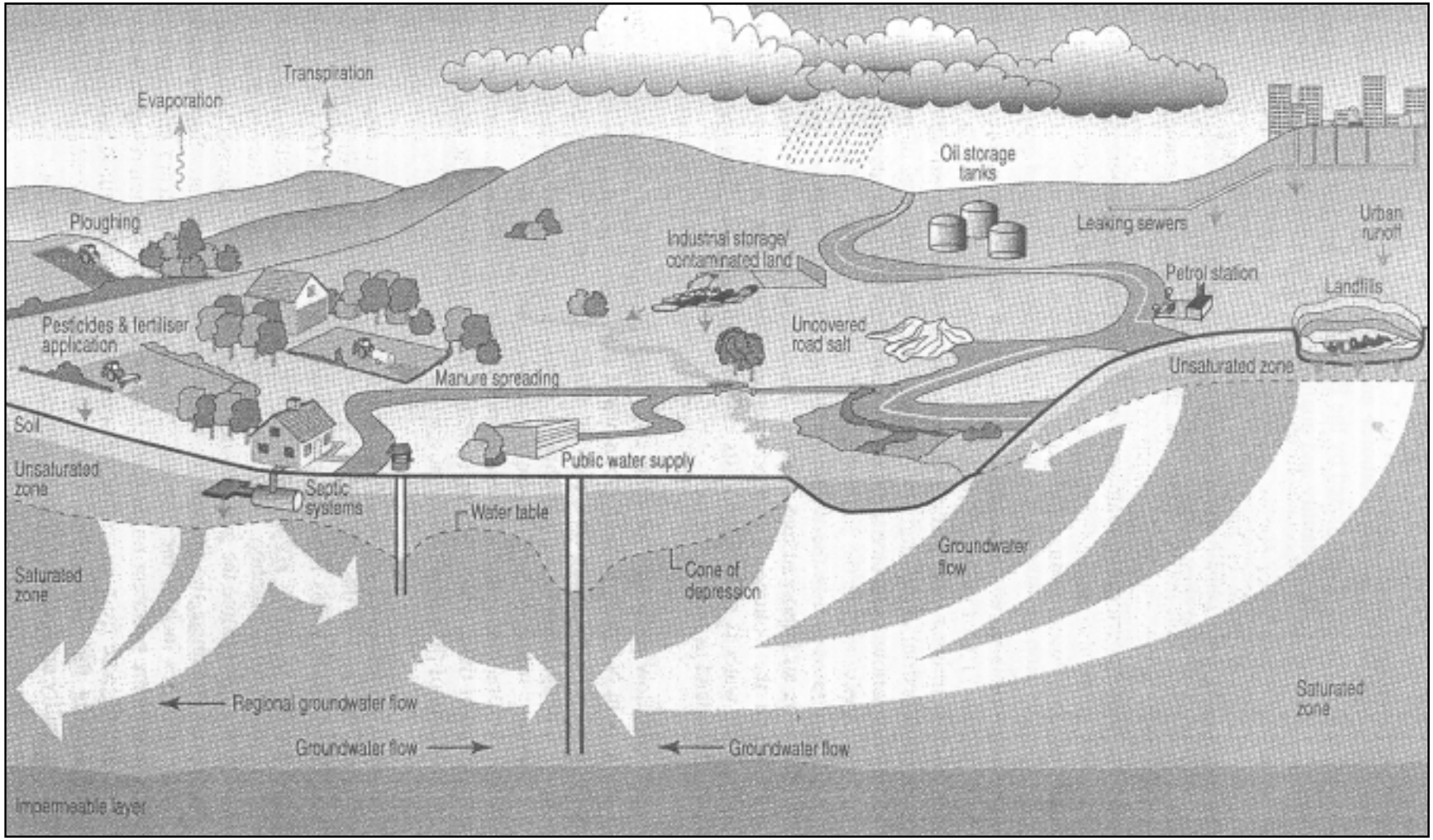


Figure 1: Diagrammatic Representation of the Water Cycle Showing Groundwater and Surface Water Relationships with Groundwater Pollution Risks.

EUROPEAN POLICY

In 1980 the European Commission introduced a Groundwater Directive (80/68/EEC) which was aimed largely at the control of discharges of specified substances (Appendix 2) to groundwater. The impact of the Directive has been limited and only a restricted range of substances is controlled. It does not address either diffuse pollution or the essential links to the management of abstraction and it does not establish a comprehensive system for the monitoring of groundwater.

Recognising the limitations of existing community wide regulations, the European Commission published a proposal for an action programme for integrated groundwater protection and management (96/C355/01). This follows a declaration of the Ministerial Seminar held at the Hague in 1991 which recognised that:

- groundwater is a natural resource with both ecological and economic value, which is of vital importance for sustaining life, health, agriculture and the integrity of ecosystems;
- groundwater resources are limited and should therefore be managed and protected on a sustainable basis; and
- it is essential to protect groundwater resources against over-exploitation, adverse changes in hydrological systems resulting from human activities, and pollution, many forms of which can produce irreversible damage.

The declaration stresses that the objective of sustainability should be implemented through an integrated approach, which means that:

- surface water and groundwater should be managed as a whole, paying equal attention to both quality and quantity aspects;
- all interaction with soil and atmosphere should be taken into account; and
- water management policies should be integrated within the wider environmental framework as well as with other policies dealing with human activities such as agriculture, industry, energy, transport and tourism.

The action programme has been incorporated into the Council Directive establishing a framework for Community action in the field of water policy. This EC Water Framework Directive (2000/60/EC) will ultimately replace the Groundwater Directive along with several other relevant water Directives.

The EC Water Framework Directive is intended to promote an integrated approach to water protection and management and will focus on the quantity and quality of groundwater within a river basin context. It will:

- seek to prevent deterioration of, and protect and enhance aquatic ecosystems, as well as terrestrial ecosystems to the extent that they are dependent on water;
- promote sustainable consumption of water based on long term protection of water resources; and
- contribute to the provision of a supply of water in terms of the quality and quantity needed for sustainable use of these resources.

The Directive recognises that most Member States have insufficient monitoring capacity to allow adequate planning for water protection. An integrated approach for the protection of groundwater resources from the effects of human activity is just one part of the total protection of the entire water system and its interaction with the soil and the atmosphere. Water management and protection polices must, therefore, be integrated within the wider environmental framework and within policies dealing with the full range of human activities.

ENVIRONMENT AND HERITAGE SERVICE POLICY

The Policy contains four main components:

- land zoning according to the classification of groundwater vulnerability to pollution, both where an effective soil cover exists for dispersed pollutants and without an effective soil cover in the case of point source discharges from soakaways and septic tanks;
- source protection by means of groundwater protection zones;
- specific policy statements on the control of groundwater quantity and quality, including groundwater abstraction, as well as waste disposal, contaminated land and other potentially polluting sources; and
- monitoring, databasing and analysis.

The Policy, the related vulnerability map[3] and protection zones will enable Environment and Heritage Service to apply its existing statutory powers in a uniform and consistent manner and help guide its response within the consultation processes, for example in development planning, with other organisations.

The range of hydrogeological and hydrogeochemical conditions, as well as preventative measures which can be taken, may result in complex and localised site specific solutions. In these cases the Policy will not be prescriptive, although Environment and Heritage Service will determine its position within the framework of the Policy.

THE GENERAL APPROACH

The Policy is based upon a procedure for land-surface zoning comprising:

- division of the entire land surface on the basis of the vulnerability of aquifers to pollution, which relates to protection of groundwater resources; and
- a series of special protection areas for individual sources of supply (i.e. boreholes and springs), in which various potentially polluting activities are either restricted or controlled.

There is an overriding case for land-surface zoning as a general framework for the development and implementation of an effective groundwater protection policy because:

- decisions will be made affecting groundwater in any event, and if land-use planners have no hydrogeological guidance this will mean less (not more) consultation;
- treating every case on an individual basis makes poor use of available professional and financial resources;
- it is unrealistic to expect exclusive protection for all groundwater and a zoning strategy is an important element in ensuring that, where appropriate, an objective balance is achieved between socio-economic development and groundwater protection; and
- zoning strategies enable the setting of priorities for groundwater monitoring, environmental audits and pollution control whilst providing a tool for raising public awareness of the importance of groundwater.

[3] *Groundwater Vulnerability Map of Northern Ireland, 1:250,000 scale (1994) Available from GSNI.*

2. KEY PRINCIPLES

IMPORTANCE OF GROUNDWATER PROTECTION

There is a lot of interest in the development of private groundwater supplies in Northern Ireland, particularly from the agricultural community and industry. However, these supplies are at risk from a variety of hazards and protection of groundwater quality is of great importance for the following reasons:

- when groundwater becomes polluted, it is difficult, if not impossible to fully rehabilitate, even when the source of pollution has been removed. It is better to prevent or reduce the risk of groundwater contamination than to deal with its consequences;
- a high standard of water quality must be maintained to satisfy current and future groundwater users;
- EC policy requires that pollution must be prevented as part of sustainable groundwater management practice; and
- groundwater baseflow is important to surface streams. The quality and quantity of baseflow is critical to environmental conservation and to the maintenance of good ecological status of surface water.

RELATIONSHIP TO SURFACE WATER RESOURCE PROTECTION

Any potentially polluting activity occurring close to a watercourse that loses flow to groundwater could lead to rapid transport of contaminant to the aquifer. Therefore, surface-water catchments upstream of 'losing' sections of rivers should be considered as part of the groundwater system. Conversely, ensuring the protection of groundwater can be critical to both the quantity and quality of baseflow to surface waters.

Sink holes, mine shafts, abandoned boreholes and any other form of conduit between the surface and an aquifer are also potential entry points to groundwater. Any activity which might involve substantial reduction in thickness of any protecting surface strata (e.g. quarrying or road cutting) should be carefully assessed.

It is important that policies relating to surface water protection, including catchment monitoring, catchment surveys and site audits are reviewed and standardised to ensure harmonisation of policies in water resource protection.

RELATIONSHIP TO LAND USE PLANNING

Consideration of the natural contaminant attenuation capacity of the strata overlying a particular aquifer is essential when prescribing controls on particular activities at the land surface. Such an approach allows a pragmatic balance between the demands of economic development and the need for protection of the groundwater (on which the economic development itself can depend). Land use planning policies and procedures should include consideration of threats to groundwater quality and quantity.

POLLUTION OF GROUNDWATER

A potential major source of pollution derives from point sources, such as underground storage tanks (e.g. beneath petrol stations) and landfill sites. These enable a pollutant to enter the subsurface at a localised point.

Diffuse pollution may occur principally from certain agricultural activities as well as from the deposition of atmospheric pollutants. It may derive from organic and inorganic chemicals spread over an area of ground and over an extended period of time. It is often difficult to detect and difficult to relate to a specific hazard, because of the time delay in a diffuse pollutant arriving at the water table via the unsaturated zone. In general, groundwater is significantly shallower in Northern Ireland than in many areas of Great Britain and the time delay is correspondingly shorter.

Diffuse pollution may also include numerous, localised point sources such as refueling areas or industrial solvent spillages, which may have been small in scale but have occurred persistently for a long period of time over a large area.

The classification of aquifer vulnerability and development of protection zones provides a technical basis with which to implement the EC Nitrate (91/676/EEC) and Groundwater (80/68/EEC) Directives.

3. POWERS AND RESPONSIBILITIES FOR GROUNDWATER PROTECTION

The Environment and Heritage Service has a duty to conserve and protect the quality and yield of the groundwater resources of Northern Ireland. For this it has statutory powers of its own, which are listed in Table 1, and procedures for statutory and non-statutory consultation with other regulatory agencies. In exercising its functions Environment and Heritage Service must have regard to the needs of industry and agriculture, the protection of fisheries, the protection of public health, the preservation of amenity and the conservation of flora and fauna. Other bodies which have a responsibility in groundwater protection are listed in Table 2.

In addition to the legislation referenced in Table 1, certain aquatic surface water habitats sustained by ground water flow and designated as having particular conservation value may be afforded statutory protection under the Nature Conservation and Amenity Lands (NI) Order 1985 (as amended 1989) and The Conservation (Natural Habitats, etc) Regulations (NI) 1995. Environment and Heritage Service is also responsible for the implementation of this legislation.

Table 1: Current Legislation Relevant to Groundwater Protection Implemented by Environment and Heritage Service

Origin	Legislation	Purpose
European	Water Framework Directive (2000/60/EC)	Aims to maintain and improve the aquatic environment
	Dangerous Substances Directive (76/464/EEC)	Protection of aquatic environment from discharge of dangerous substances
	Groundwater Directive (80/68/EEC)	Protection of groundwater against pollution caused by specified dangerous substances
	Quality of Water Intended for Human Consumption (80/778/EEC) and Quality of Water Intended for Human Consumption Directives (98/83/EC)	Defines quality standards and monitoring requirements.
	Urban Waste Water Treatment Directive (91/272/EEC)	Defines treatment standards and monitoring requirements
	Nitrates Directive (91/676/EEC)	Promotes reduction of contamination by nitrate from agricultural practices
	Sewage Sludge Used in Agriculture (86/278/EEC)	Controls the disposal of sludges to land
Northern Ireland	Water Act (Northern Ireland) 1972	Powers in relation to water conservation and cleanliness; promotion of water management programmes; powers to make regulations controlling water abstractions and powers to control discharges to surface and groundwaters
	Water (Northern Ireland) Order 1999	When fully implemented replaces, with revisions, the Water Act (NI) 1972
	Waste and Contaminated Land (Northern Ireland) Order 1997	Powers to license waste treatment and disposal operations. Specific powers on contaminated land
	Industrial Pollution Control (Northern Ireland) Order 1997	Powers to grant authorisations for prescribed processes and substances
	The Surface Waters (Dangerous Substances) (Classification) Regulations (NI) 1998	Implements Dangerous Substances Directive (76/464/EEC)
	The Sludge (Use in Agriculture) Regulations (Northern Ireland) 1990	Powers to control the disposal of sludges to land
	The Urban Waste Water Treatment Regulations (Northern Ireland) 1995	Implements Urban Waste Water Treatment Directive (91/271/EEC)
	The Groundwater Regulations (Northern Ireland) 1998	Implements Groundwater Directive (80/68/EEC). Controls discharges of List I and List II substances to Groundwater
	The Protection of Water Against Agricultural Nitrate Pollution (Amendment) Regulations (NI) 1997	Implements Nitrates Directive (91/676/EEC) protection of waters by pollution caused by nitrates from agricultural sources
	The Action Programme for Nitrate Vulnerable Zones Regulations (Northern Ireland) 1999	Powers to control nitrate usage in sensitive catchments
	The Water Quality Regulations (NI) 1994 The Private Water Supplies Regulations (NI) 1994	Independent audit of Drinking Water Quality for public water and certain private supplies

Table 2: Bodies with responsibility for aspects of Groundwater Protection in Northern Ireland (Government, Local Government and Advisory)

Body	Area of Responsibility	Relevant Legislation
Environment and Heritage Service (an Agency of the Department of Environment)	Groundwater Protection	See Table 1
Water Appeals Commission	Determination of appeals on discharge consents	Water Act (Northern Ireland) 1972 Water (Northern Ireland) Order 1999
Water Service (an Agency of Department of Regional Development)	Provision of Water and Sewerage Services	Water & Sewerage Services (Northern Ireland) Order 1973
Planning Service (an Agency of Department of Environment)	Development control and planning policies	The Planning (Northern Ireland) Order 1972; The Planning (Northern Ireland) Order 1991
Department of Agriculture and Rural Development	Nitrate Vulnerable Zones. Code of Practice - Preventing Pollution - by Nitrate	Nitrate Regulations
Food Standards Agency/ District Councils	Bottled Water, Mineral Water	Natural Mineral Water, Spring Water and Bottled Water Regulations (Northern Ireland) 1999
District Councils	Waste Disposal	Pollution Control and Local Government (Northern Ireland) Order 1978; The Waste Collection and Disposal Regulations (Northern Ireland 1992
Northern Ireland Water Council	Advice to DOE	Water Act (Northern Ireland) 1972 Water (Northern Ireland) Order 1999

4. VULNERABILITY AND RISK

In the current terminology of risk assessment, a target or receptor is only at risk if there exists both a hazard and a pathway by which that hazard might be transmitted to the receptor. So for example, a particular groundwater body (receptor) will only be at risk of pollution if a potentially polluting activity (hazard) is occurring in the vicinity of the groundwater body and if there exists a route (pathway) by which the pollutant can reach the groundwater, i.e. a highly permeable unsaturated zone above the water table.

Many human activities present a potential hazard to groundwater quality (Figure 2). Risk assessment for any given activity requires an assessment of the total exposure of the groundwater system to that hazard. Exposure to a particular hazard can be mitigated by preventative measures such as lining of landfills, bunding of storage tanks, etc. However, in most cases a significant part of the potential total exposure to the hazard will depend on the "natural" pathway by which potential pollutants may reach the groundwater and this will depend upon the local soil and geological conditions. The concept of aquifer vulnerability to pollution recognises this variation and is an important element of risk management for groundwater resource protection.

Aquifer vulnerability to pollution is an intrinsic attribute of individual groundwater systems, i.e. independent of hazard. The Groundwater Policy Statements (Section 7) include a consideration of the aquifer vulnerability and various hazards. They show which combinations of these elements result in acceptable risks and which result in unacceptable risks for groundwater resource protection.

A distinction is drawn between the general protection of the groundwater resource and the specific protection against particular hazards which may be appropriate for individual sources. Groundwater abstraction from boreholes and springs alters the natural flow regime in the aquifer. Depending upon the amount of data available on the aquifer, it is possible to define the source catchment land area needed to sustain the groundwater abstraction by natural recharge. Thus Section 7 also includes groundwater quality protection statements based on a consideration of the hazards posed by particular activities and their acceptability or otherwise within different areas of the source protection zone.

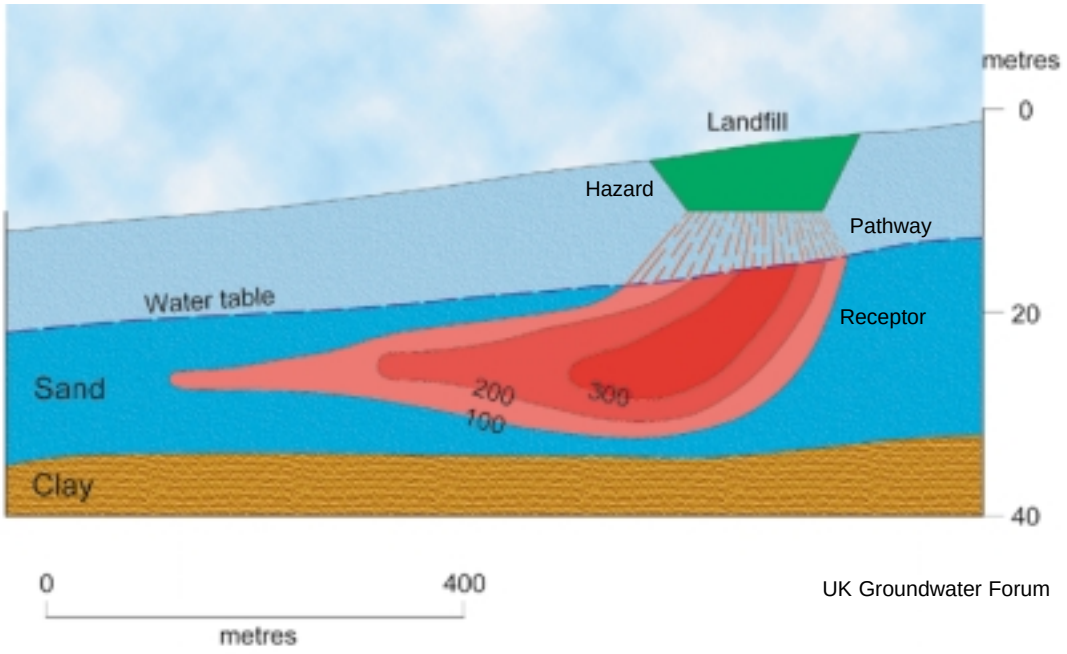


Figure 2: Examples of Hazard - Pathway - Receptor

5. DESCRIPTION OF THE VULNERABILITY OF GROUNDWATER RESOURCES

The vulnerability of groundwater resources in Northern Ireland is described in terms of three intrinsic variables:

- the presence and nature of overlying soil;
- the presence and nature of superficial cover; and
- the nature of the strata.

The depth of the unsaturated zone also has a bearing on the attenuation and adsorption potential of a pollutant. However, the depth of the unsaturated zone in Northern Ireland is generally less than 25 m and the effect of this narrow range variable on the degree of vulnerability is limited.

PRESENCE AND NATURE OF THE OVERLYING SOIL

The degree of risk from diffuse types of pollution depends to a large extent on the attenuating characteristics of the soil. The soil is a 1-2 m thick upper layer comprising topsoil, a dark coloured zone with decomposed plant residues in which the maximum biological activity takes place, and the subsoil which is altered parent material from the underlying strata, with some plant roots. Variations depend on the physical properties of the soil, which affect the downward passage of water, and on the ability of the soil to attenuate three types of pollutant:

- diffuse source pollutants, eg certain pesticides, which can be retained in the soil horizon;
- diffuse source pollutants, eg nitrate, which can pass through the soil horizon; and
- liquids, such as slurry and manure.

The physical properties of soil which affect the downward movement of water and the attenuation of pollutants include:

- texture and structure;
- soil water regime; and
- the presence of distinctive layers such as Raw Peaty Topsoil and rock or gravel at shallow depth.

The wide range of soils that occur in Northern Ireland can be grouped into three broad categories of 'soil-leaching' potential. Individual circumstances may require more detailed evaluation, because the variety of soils and possible pollutants is wide and the classification necessarily generalised. Examples of soil series which fall within the three categories of soil vulnerability are given in Appendix 3. The categories are:

(1) Soils of High Leaching Potential

These are soils with little ability to attenuate diffuse contaminants and from which non-adsorbed diffuse contaminants and liquid discharges will leach rapidly, including:

- soils which are exceptionally vulnerable to liquid discharges because they are either very shallow, or susceptible to rapid by-pass flow directly to rock, gravel or groundwater;
- deep, permeable, coarse textured soils which are vulnerable to most types of contaminant because of their rapid drainage and low attenuation potential; and
- coarse textured or moderately shallow soils which are vulnerable to non-adsorbed contaminants and liquid discharges but which have some ability to attenuate adsorbed contaminants because of their relatively high clay or organic matter content.

The High Leaching Potential soils include: Brown Rankers, Shallow Brown Earths and Brown Earths over sands and gravels.

(2) Soils of Intermediate Leaching Potential

These include soils with a moderate ability to attenuate diffuse contaminants or in which it is possible that some non-adsorbed diffuse contaminants and liquid discharges could penetrate the soil layer. They include soils which can transmit a wide range of pollutants and those which can transmit non- or weakly-adsorbed diffuse contaminants and liquid discharges, but are unlikely to transmit adsorbed contaminants.

Intermediate Leaching Potential soils include: most Brown Earths and Brown Podzolic Soils, some Gleyed Brown Earths and drained peats.

(3) Soils of Low Leaching Potential

Soils in which contaminants are unlikely to penetrate the soil layer because water and contaminant movement is largely horizontal or they have a large ability to attenuate diffuse contaminants. Generally, these are soils with a high clay content. It must be recognised that run-off from these soils may contribute to groundwater recharge elsewhere in the catchment.

Low Leaching Potential soils include: Raw (Permanently Wet) Peaty Topsoil and Surface Water Gleys.

Where the soil layer has been removed by excavation, or where it has been largely concealed in, for example, an urban environment the nature of the soil need not be considered.

For the purpose of the Groundwater Vulnerability Map of Northern Ireland (Fig 4) the soil classification is applied to Highly Permeable and Moderately Permeable aquifer classes only, there being little significance to the soil cover above weakly permeable aquifers.

PRESENCE AND NATURE OF SUPERFICIAL DEPOSITS

A large percentage of the land area of Northern Ireland is covered in a mantle of glacial till. This is generally a low permeability clay but can be silty or sandy and may contain sand or even gravel lenses. Available geological mapping does not readily differentiate between lithologies and does not reflect the thickness of the cover. Clearly a substantial thickness of 5 or 10 m of low permeability clay will effect a good seal to an underlying aquifer, and greatly reduce its vulnerability to pollution. However a thin cover, perhaps 1-2 m, of sandy silt or other more permeable till will not protect the underlying aquifer to any significant effect. Wherever till is present its actual character must be determined by site specific investigations.

In all cases, therefore, investigations are necessary to assess the specific local characteristics of the superficial cover.

On the Groundwater Vulnerability Map, in the case of permeable superficial strata such as glacial sands and gravels, a ***geological*** *classification of Moderately Permeable is applied unless the underlying strata are Highly Permeable. In the latter case the sand and gravel is upgraded to Highly Permeable.*

NATURE OF STRATA

Geological strata which contain groundwater in exploitable quantities are called aquifers, whereas those rocks which do not readily allow the storage and transport of groundwater are called non-aquifers. The hydraulic character of an aquifer may vary from porous, as for example in a loose sand, to fissured, as in the Upper Limestone of County Fermanagh where the groundwater moves along fractures and fissures within the rock, rather than through the matrix of the rock itself. Many rocks such as the Lagan Valley sandstones, may offer a combination of both fissure and porous characters.

Aquifers are ranked into Highly Permeable[4], Moderately Permeable[5] and Weakly Permeable[6] geological classes (see Appendix 4):

[4] *Highly Permeable generally equates to Major Aquifers in the Environment Agency policy document for England and Wales.*

[5] *Moderately Permeable generally equates to Minor Aquifers in the Environment Agency policy document for England and Wales.*

[6] *Weakly Permeable generally equates to Non-Aquifers in the Environment Agency policy document for England and Wales.*

Highly Permeable

These are highly permeable formations usually with a known or probable presence of significant fissuring or fracturing. They are usually highly productive and able to support large abstractions for public supply and other purposes.

Moderately Permeable

These can be fractured or potentially fractured rocks which do not have a high primary permeability, or other formations which possess a variable permeability. These aquifers seldom produce large quantities of groundwater but they may be important for local supply and as the main source of baseflow to rivers.

Weakly Permeable

These are formations with low permeability that are generally regarded as not containing groundwater in exploitable quantities. However, some of these formations can yield sufficient groundwater to satisfy small domestic and farm demands and hence still require a degree of protection.

Bedrock on the Groundwater Vulnerability Map is defined as it would outcrop at the land surface (assuming no drift cover). In some cases a Highly Permeable aquifer may be present beneath Moderately or Weakly Permeable strata.

The presence of low permeability drift deposits of any thickness occurring at the surface is identified by stippled shading on the groundwater vulnerability map.

ASSESSING TOTAL VULNERABILITY

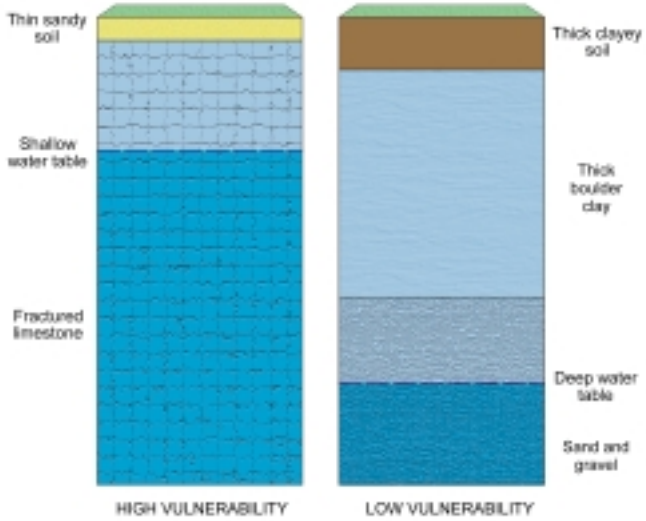
The combination of geological and soil classification coupled with knowledge of the character of the superficial strata enables a total assessment of aquifer vulnerability to pollution to be derived (Figure 3).

Consideration of the depth to water table or the thickness of the unsaturated zone is relevant. The unsaturated zone assists in attenuating pollutants through physical, chemical or biochemical means, and it can act as a delay mechanism, but the processes may vary with the nature of the rock. However, the water table is generally within only 10 to 30 m of the ground surface throughout much of Northern Ireland, and soils are near field saturation capacity for much of the year so that the time delay is generally small.

AQUIFER VULNERABILITY MAPS

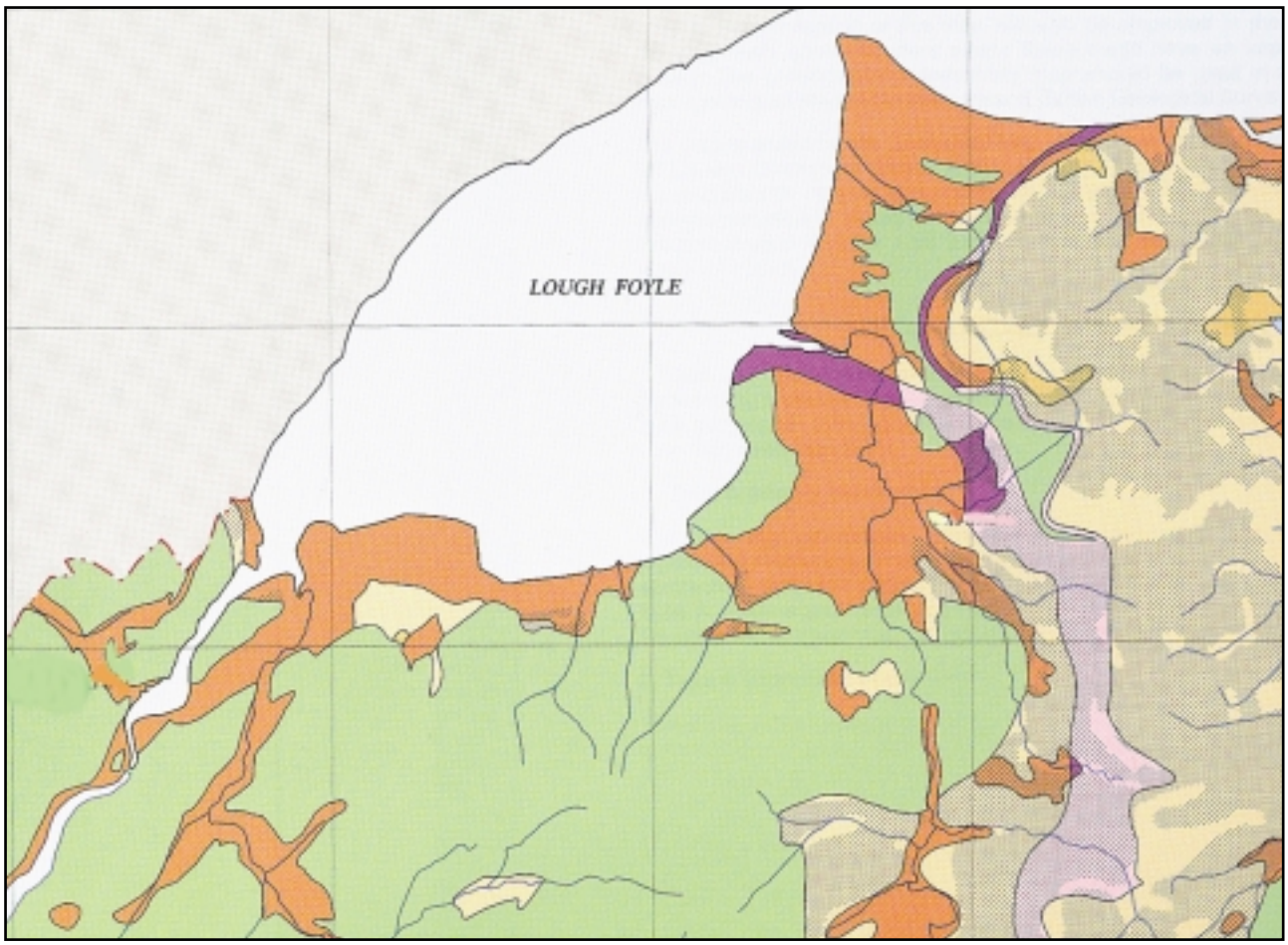
A full assessment of aquifer vulnerability can only be achieved by local and site specific study and investigation. However, in the context of strategic land use planning it is useful to provide a broad indication of land use zoning according to existing soil and geological databases. Additionally, such maps will increase public awareness of groundwater pollution risk.

The Groundwater Vulnerability Map of Northern Ireland published in 1994, divides land into one of seven vulnerability classes depending upon the local soil leaching characteristics and nature of underlying strata as described previously. The seven categories are shown in Figure 4.



UK Groundwater Forum

Figure 3: Factors Affecting the Vulnerability of Aquifers to Pollution



- Highly permeable geology, high soil leaching potential
- Highly permeable geology, intermediate soil leaching potential
- Highly permeable geology, low soil leaching potential
- Moderately permeable geology, high soil leaching potential
- Moderately permeable geology, intermediate soil leaching potential
- Moderately permeable geology, low soil leaching potential
- Weakly permeable geology

Figure 4: Groundwater Vulnerability Map of Lough Foyle Area without Till Cover.

6. DEFINITION OF SOURCE PROTECTION ZONES

The main component of risk to individual groundwater sources of supply (i.e. boreholes, wells and springs) is the presence of a potentially polluting activity within the recharge capture area to that source. This is the source catchment or the area within which all aquifer recharge, whether derived from precipitation or surface water, will be captured at the source concerned (Figure 5). In order to delineate the recharge capture zone the annual recharge and abstraction of the borehole will normally be used; in the case of springs the total discharge is used rather than that portion abstracted for supply purposes.

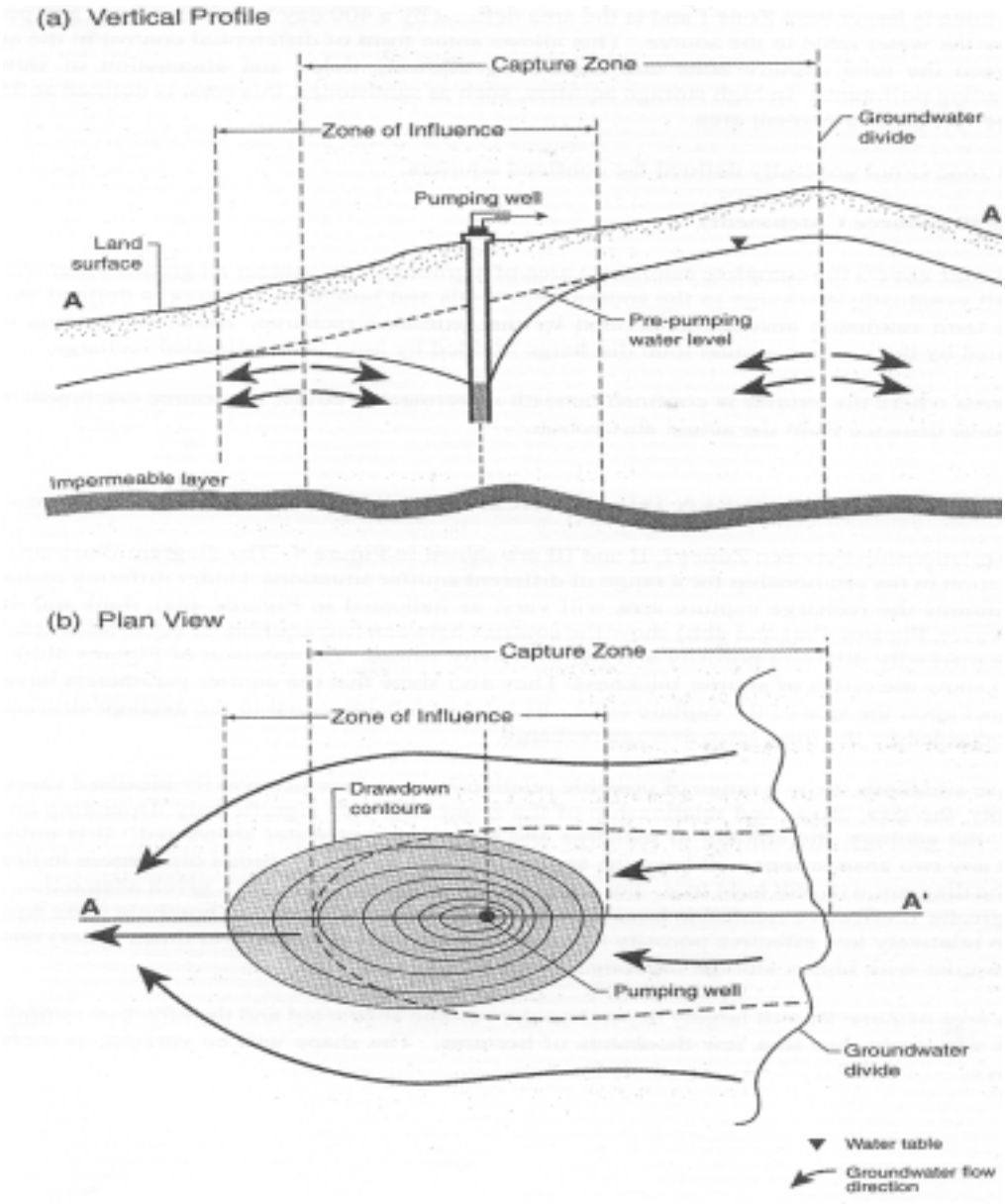


Figure 5: Zone of Influence and Capture Zone of a Pumping Borehole.

The recharge capture area is subdivided into three Source Protection Zones (Figure 6):

Zone I (Inner Source Protection Zone)

Zone II (Outer Source Protection Zone)

Zone III (Remainder of the Source Catchment)

The orientation and size of zones is determined by the hydrogeological characteristics of the strata and the direction of groundwater flow. It is appropriate to define Source Protection Zones for groundwater sources that are used for public supply and certain private potable water supplies, as well as commercial food and drink production uses including mineral and bottled waters.

The small area of land around the source, usually owned by the groundwater abstractor, should exclude all potentially polluting activities not directly related to the abstraction of water. The lack of good practice by source operators is recognised as a common cause of pollution at the source.

Zone I (Inner Source Protection Zone)

This zone is designed to protect against the effects of human activities which might have an immediate effect upon the source, particularly against microbial pollution. In Northern Ireland this area will be defined by a 50 day travel time from any point below the water table to the source and as a minimum of 50 metres radius from the source; the 50 day travel time is based on the time it takes biological contaminants to decay and is an established standard used in many other countries.

The zone is not defined where the aquifer is confined beneath a substantial thickness of covering strata of very low permeability since in such cases the cover will prevent infiltration. Where there is a deep unsaturated zone or thick cover of till, the attenuating properties of the strata and/or the time of travel to the water table may be sufficient to prevent contamination from minor hazards. However, due to the uncertainties of unsaturated flow this aspect is generally not taken into account.

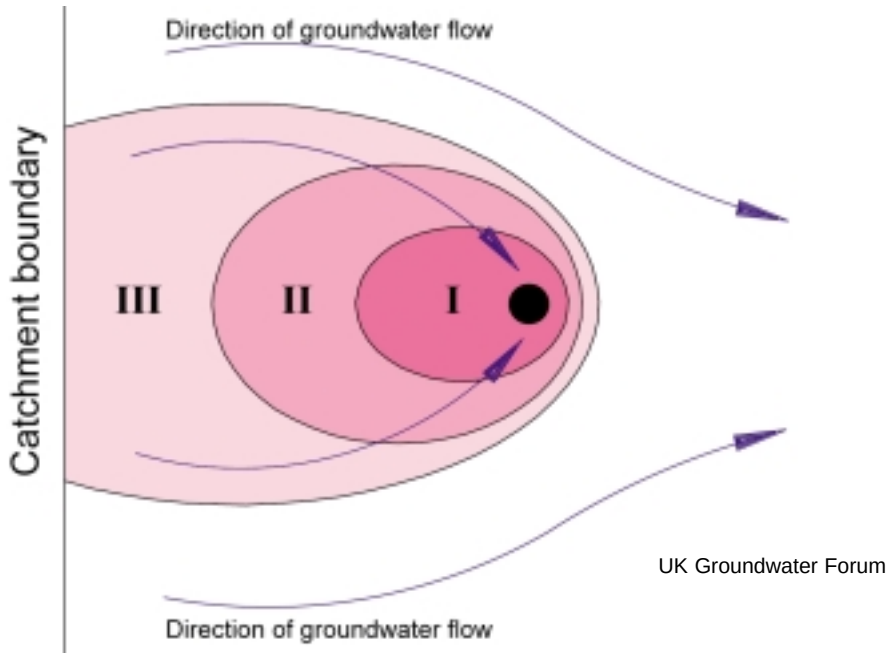


Figure 6: Protection Zones Around a Borehole

Zone II (Outer Source Protection Zone)

This zone is larger than Zone I and is the area defined by a 400 day travel time from any point below the water table to the source. This allows some form of differential control in the area between the total capture zone and Zone I by allowing delay and attenuation of slowly degrading pollutants. In high storage aquifers, such as sandstones, this zone is generally defined as 25% of the recharge catchment area.

This zone is not usually defined for confined aquifers.

Zone III (Source Catchment)

This zone covers the complete catchment area of a groundwater source; all groundwater within it will eventually discharge to the source. For wells and boreholes the area is defined as the average abstraction divided by the estimated average recharge, whilst for springs it is defined by the average annual total discharge divided by average recharge.

In areas where the aquifer is confined beneath impermeable cover, the source catchment can be some distance from the actual abstraction.

RELATIONSHIP BETWEEN THE SOURCE PROTECTION ZONES

The relationship between Zones I, II and III are shown in Figure 7. The diagram illustrates the variation in the relationship for a range of different aquifer situations. Under differing recharge conditions the recharge capture area will vary, as indicated in Figure 7a. However, Figures 7b(i) and 7b(ii) show the contrast between two aquifers of equal thickness but with markedly different porosity and transmissivity values. Comparison of Figures 7b(ii) and 7b(iii) show the effect of aquifer thickness. They also show that the aquifer parameters have no impact upon the size of the capture zone - its total area being equal to the average abstraction rate divided by the long-term average recharge.

These situations show a range of possible relationships and are necessarily idealised cases. In reality, the size, shape and relationship of the zones will vary significantly depending on the soil, the geology, the amount of recharge and the volume of water abstracted. It is unlikely that any two abstractions will have the same shaped zones but the broad differences indicated in the diagram will still hold true. For example the catchment area for a given abstraction will be greater if effective rainfall is less. The area drawn on by a pumping borehole in an aquifer with relatively low effective porosity or storage, is greater (and the travel times faster) than in an aquifer with higher storage capacity.

The area of Zone III will largely depend on the volume abstracted and the effective rainfall. It may vary from tens to a few thousands of hectares. The shape will be variable as outlined above.

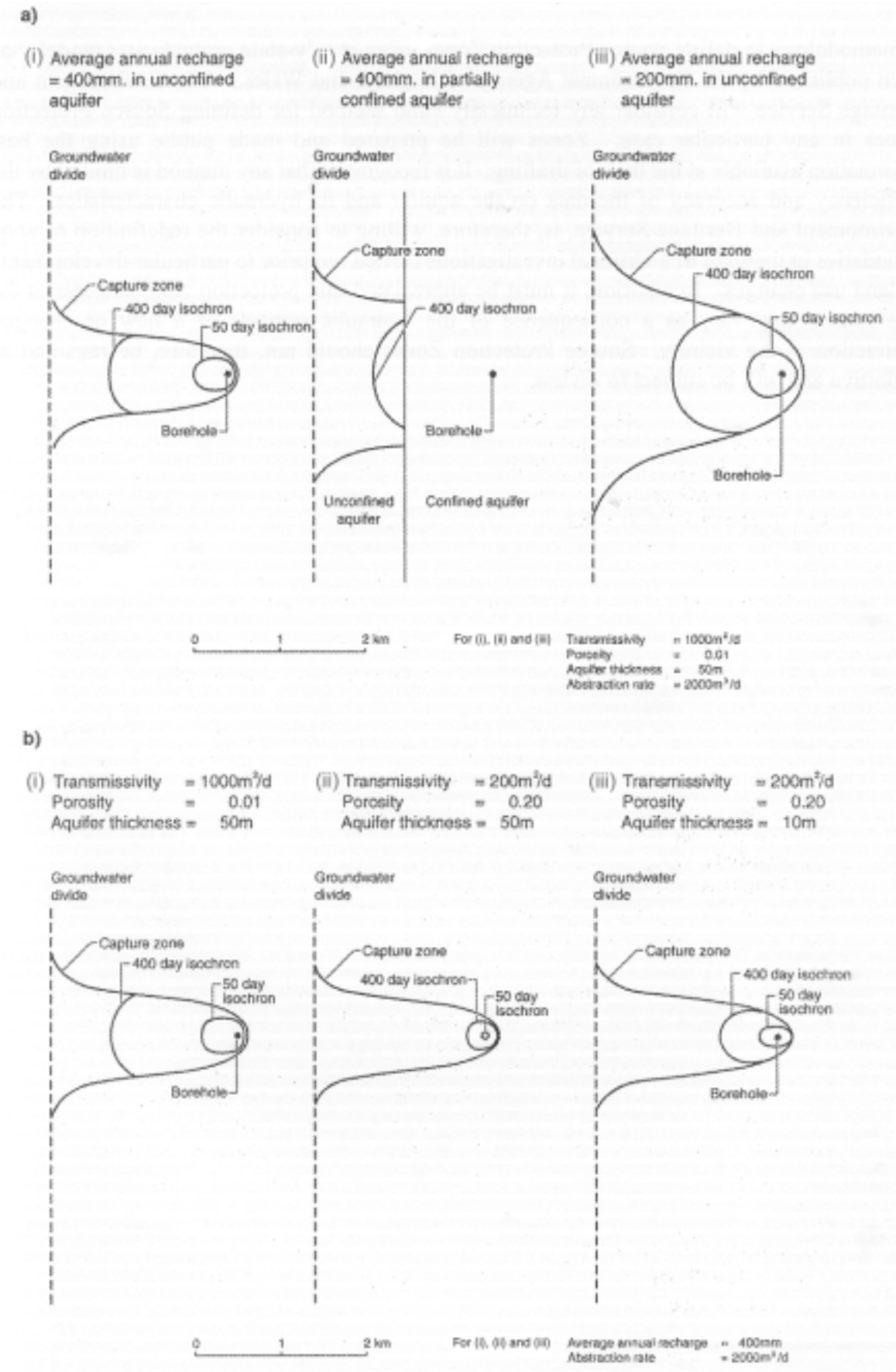


Figure 7: Comparison of Source Protection Zones for
(a) different recharge conditions, and
(b) different aquifer conditions.

DEFINING SOURCE PROTECTION ZONES

A methodology to define Source Protection Zones using steady-state groundwater models has been published by the Environment Agency of England and Wales[7]. The Environment and Heritage Service will consider any technically valid method for defining Source Protection Zones in any particular case. It is recognised that any method is limited by the sufficiency and accuracy of the data on the aquifer and its hydraulic characteristics. Zone definition can be particularly complicated where river-aquifer interaction occurs and where karstic flow conditions predominate such as in the limestone around County Fermanagh. Environment and Heritage Service, is, therefore, willing to consider the redefinition of zone boundaries in the light of additional investigations carried out prior to particular developments or land use changes. In addition, it must be appreciated that protection zone boundaries for one source may vary as a consequence of the hydraulic impacts of a new or changed abstraction in the vicinity. Source Protection Zones should not, therefore, be regarded as definitive and will be subject to review.

Sources for which zones will be produced will be prioritised dependent upon a number of factors including water use and size of abstraction. Sources used for Public Water Supply will have the highest priority for zoning.

The anticipated designation of zones in the vicinity of a development would be considered a factor when assessing the risk from that development.

For lower priority sources where no zones exist, the potential impact on the catchment of the source will be a consideration for the Environment and Heritage Service when assessing the impact from a development.

A programme of source protection zoning will be established dependent upon resources made available to the Environment and Heritage Service.

[7] *National Rivers Authority (1995) Guide to Groundwater Protection Zones in England and Wales.*

7. GROUNDWATER PROTECTION POLICY STATEMENTS

Environment and Heritage Service Groundwater Protection Policy Statements relate to the following areas:

- control of groundwater abstractions in selected areas;
- interference with aquifers and groundwater;
- waste disposal to land;
- contaminated land;
- disposal of liquids including sludges, slurries and pesticides to land;
- discharges underground;
- diffuse pollution of groundwater;
- miscellaneous activities that may affect groundwater quality.

CONTROL OF GROUNDWATER ABSTRACTIONS IN SELECTED AREAS

Environment and Heritage Service has not yet made Regulations to license groundwater abstraction, but may oppose new proposed development of groundwater abstraction under the planning process. Abstraction that may not be sustainable in the long term can cause:

- the loss of future water resources;
- damage to environmental features which are dependent upon the presence or level of the groundwater table, including depletion of river baseflow; and
- the deterioration of groundwater quality.

Environment and Heritage Service will endeavour to ensure that:

1) Total abstraction from any single hydrogeological unit or groundwater resource area is not likely to exceed the long term estimate of the annual renewable resource or average annual rate of replenishment.

Environment and Heritage Service wishes to help maintain groundwater levels at an acceptable level for the long term in order to ensure that groundwater resources are not exploited at rates that cannot be sustained by recharge.

2) Groundwater baseflow contributions to surface waterways (eg, rivers, lakes and wetlands) are maintained at an acceptable level.

Environment and Heritage Service recognises that there is a need to preserve groundwater levels and baseflows to rivers and lakes for general environmental benefit, to satisfy minimum acceptable flows to sustain biodiversity and to maintain the current high standards of water quality. This will likely require that total abstraction from an aquifer unit be less than the estimated annual renewable resource.

3) Abstraction should not cause a deterioration in groundwater quality.

Best practice should be adopted to minimise damage to the aquifer resource.

INTERFERENCE WITH AQUIFERS AND GROUNDWATER

There are a variety of activities in which Environment and Heritage Service has a direct interest because such activities might impact on groundwater. These activities include:

- quarrying, mining and gravel extraction both above and below the water table;
- construction of roads, railways, tunnels, etc.;
- landfill using low permeability liners and seals which might impede groundwater cross-flow; and
- borehole construction and borehole abandonment.

4) Equivalent protection for water resources and the water environment will be sought from the physical disturbance of groundwater levels or impedance of groundwater flow as from that caused by groundwater abstraction.

In order to achieve a sustainable resource, Environment and Heritage Service will seek to protect existing abstractions and the quantity and quality of the groundwater using the planning process and other available powers unless mitigation measures have been satisfactorily applied.

5) Environment and Heritage Service will object to proposed mineral workings or engineered underground barriers which are likely to cause harm to the groundwater environment unless mitigation measures can be agreed through the planning process.

Proposed development in Source Protection Zones are of most concern, but so too is the removal of all or part of the unsaturated zone of an aquifer. The unsaturated zone may act to protect the groundwater by filtration of solids and the breakdown of pollutants by oxygenation and biological degradation. Proposed barriers to groundwater flow may cause the water table to rise or to divert groundwater flow, lead to surface flooding, or in the case of a groundwater cut-off, to the derogation of existing abstraction points.

6) Best practice is essential for the construction and backfilling of boreholes, tunnels, shafts and wells.

Improperly constructed or abandoned boreholes and shafts can act as preferential pathways for movement of contaminants from the surface to the water table or from one aquifer unit to another. Short-circuiting of the natural soil and drift/strata layers means that only minimal natural breakdown of the contaminant may occur leading to potentially greater impact on groundwater quality.

With regard to mineral workings and their potential impact on the water environment, particular attention will be given to issues and guidance detailed in the DETR document "Reducing the Effects of Surface Mineral Workings on the Water Environment - A Good Practice Guide" 1998.

WASTE DISPOSAL TO LAND

There is a wide range of waste disposal activities including scrap yards, transfer stations, incinerators, waste storage and treatment, as well as landfill. Of these, landfill poses the most significant threat to groundwater quality. Matrix 1 summarises the policy of Environment and Heritage Service with regard to the acceptability of landfill and this should be read in conjunction with the following Policy Statements. Consideration of the potential impact on groundwater and surface water would be expected to form part of the initial assessment of the suitability of a site in the context of best practicable environmental option (BPEO) and any relevant waste management plan.

7) Landfill is not normally acceptable in the Inner Source Protection Zones (Zone I).

No potentially polluting activities are normally acceptable in the Inner Source Protection Zone, and Environment and Heritage Service will oppose such developments.

8) Landfill in the Outer Source and Catchment Protection Zones and over Highly Permeable and Moderately Permeable Strata may be acceptable

following risk assessment and only if the potential for pollution can be adequately mitigated by engineering measures and operational safeguards.

The scale of engineering measures will depend on the waste type, the local vulnerability of the groundwater and the distance to the nearest receptor. For the most part, engineered containment of landfill leachate will be required.

9) **Landfill over Weakly Permeable aquifers will normally be acceptable where risk to groundwater is low.**

10) **Adequate provision for monitoring and site closure must be made.**

The landfill operator must agree monitoring facilities and programmes with both Environment and Heritage Service and Planning Service, for the operational life of the landfill and for the longer term following closure of the site.

CONTAMINATED LAND

Contaminated land may take a variety of forms due to current or former activities, including:

- former coal-gas works;
- landfill and other waste handling and disposal activities;
- heavy industry; and
- hydrocarbon storage.

The hazard potential of derelict sites may increase during subsequent redevelopment. The policy of Environment and Heritage Service towards these sites, in keeping with the Waste and Contaminated Land (Northern Ireland) Order 1997, is as follows:

11) **Remedial measures should aim to prevent pollution from existing discharges from a contaminated site.**

12) **Where Environment and Heritage Service is consulted by the Planning Service about any application for development or other works on contaminated land, it will recommend against permission to proceed unless it is satisfied that effective measures for the protection of groundwater and surface water are included, and Planning Permissions should contain conditions designed to protect water resources.**

A detailed site investigation is normally required prior to applying for planning permission. It should review the leaching characteristics of the ground, and details of the geology and hydrogeology. It should also include a strategy for dealing with and minimising pollution of groundwater and surface water. Recommendations will be given to Planning Service to enter into planning agreements with the developer to control and monitor ground conditions and the quality of groundwater during and after development. Planning obligations should include a remediation plan or method statement which shall include details of further site investigation, chemical analysis, criteria and standards for removal or treatment of contaminated material and final restoration .

13) **Environment and Heritage Service requires that any discharge, seepage or drainage caused by redevelopment of a contaminated site will be of a quality that will not contaminate groundwater and/or surface water.**

Target concentrations for specific pollutants must be identified and predictions of quality and quantity made for the foreseeable future.

DISPOSAL OF LIQUIDS INCLUDING SLUDGES, SLURRIES AND PESTICIDES TO LAND

Standard agricultural practice requires the disposal of a variety of liquids and slurries to land. These activities must, however, be carried out with due regard to the prevailing soil moisture conditions and the vulnerability of local surface and groundwater to pollution. Best practice is described in the Department of Agriculture and Rural Development Codes of Good Practice. Disposal of waste to land, other than agricultural waste and sewage sludge applied for the benefit of the ground, is controlled by Pollution Control and Local Government (Northern Ireland) Order 1978. The nitrogen content of these applications must not exceed the nitrogen requirements of grassland or any other crop. Wastes can be categorised according to the industry from which they originate:

- controlled wastes including both organic and inorganic industrial effluent sludges;
- sewage sludge; and
- agricultural waste.

The policy is summarised in Matrix 2.

Sections 5 and 6 of the Groundwater Regulations (NI) 1998 applies measures to prevent the introduction into groundwater of List I and II substances respectively. These Lists include pesticides and herbicides. Direct discharge of List I substances to groundwater will not be permitted. Any disposal on land of either List I or List II substances which might lead to indirect discharges to groundwater is to be subject to prior investigation and must be authorised by Environment and Heritage Service. Any other activity likely to lead to indirect discharges of List I substances is also to be controlled.

14) Environment and Heritage Service must be informed of all notifications for the disposal of controlled waste to land and will normally refuse to authorise the disposal of any waste that contains significant amounts of List 1 substances (see Appendix 2), in high risk areas such as source capture zones or over Highly Permeable or Moderately Permeable Aquifers where there is inadequate protection from overlying superficial deposits.

15) Sewerage undertakers and receiving farmers must adopt best practice over the disposal of sewage sludge to land demonstrating compliance with the Sludge (Use in Agriculture) Regulations (Northern Ireland) 1990.

The Aquifer Vulnerability Map of Northern Ireland identifies areas where groundwater is at most risk, and here the soil vulnerability classification must be considered in order to minimise any impact on groundwater.

The nature and extent of local superficial deposits above aquifers in the area of disposal can be an additional factor in assessing its acceptability.

DISCHARGES UNDERGROUND

Discharges to underground strata principally concern soakaways and septic tanks. These are widespread in Northern Ireland, and can comprise domestic discharges, soakaways from road and hard standing drains, and some trade effluent discharges. They also include field drain discharges to groundwater by way of sumps. Environment and Heritage Service will not authorise any discharge to underground strata which may result in the pollution of groundwater.

The role of the Aquifer Vulnerability Map in assessing potential risk is greatly reduced in the case of underground discharges because the soil zone is by-passed. The strata permeability classification remains applicable.

16) An application must be submitted to Environment and Heritage Service for any proposal involving the discharge of sewage, trade effluent or contaminated surface run-off to underground strata.

17) Environment and Heritage Service will normally refuse consent for the direct discharge of List I substances into groundwater and will limit the discharge of List II substances according to The Groundwater Regulations (Northern Ireland) 1998

Exceptions may be made where the concentrations of the substances can be shown not to pollute groundwater.

18) Under no circumstances will a consent be granted for the discharge of sewage or trade effluent directly into an aquifer from a soakaway system at or below the water table.

19) Disposal of surface drainage water to underground strata should have due regard to the contamination risk posed to groundwater.

DIFFUSE POLLUTION OF GROUNDWATER

Problems from nitrate leaching to groundwater from the application of agricultural fertiliser or farm slurry may be minimised by the adoption of best agricultural practice. Regulations describing compulsory action programmes within Nitrate Vulnerable Zones came into force in June 1999. The use and application of pesticides is described in the Department of Agriculture and Rural Development Code of Good Practice which advises farmers how to avoid water pollution. The use of water soluble and persistent pesticides on hard standings, roads and railways may also lead to pollution. Care is also needed not to allow drainage of treated hard standings to soakaways. Prior authorisation is required from Environment and Heritage Service for the disposal of pesticides (Groundwater Regulations (NI) 1998).

20) **Environment and Heritage Service will promote practices which protect groundwater resources in general from diffuse pollution through minimising the leaching of potential pollutants within vulnerable areas.**

21) **Environment and Heritage Service will oppose certain activities in Source Protection Areas where such activities present a general threat to the water environment.**

MISCELLANEOUS ACTIVITIES THAT MAY AFFECT GROUNDWATER QUALITY

There are numerous activities which pose a hazard to groundwater and surface water and which are not described above. Some are controlled by the basic planning legislation, others through a variety of codes of practice, whereas others are not controlled. Because they are for the most part, point source polluting activities, the degree of control sought will vary with the proximity to an abstraction source or other vulnerable receptors. However, Environment and Heritage Service may seek to have new codes of practice introduced under existing legislation to cover, for example, the storage of chemicals.

22) **Environment and Heritage Service will assist in the promotion of awareness of the risks to groundwater amongst industry, agriculture and the general public.**

MATRIX 1 - LANDFILL ACCEPTABILITY

Landfill Type	Inner Zone	Outer Zone and Source Catchment	Highly Permeable and Moderately Permeable	Weakly Permeable
High pollution potential (landfill accepting domestic, commercial and industrial waste)	Not acceptable	Only acceptable following risk assessment with engineered containment and operational safeguards	Only acceptable following risk assessment with engineered containment and operational safeguards	Acceptable only with adequate operational safeguards. Engineered containment would normally be required
Medium pollution potential (landfill accepting construction waste)	Not acceptable	Acceptable subject to site evaluation and appropriate operational safeguards	Acceptable subject to site evaluation and appropriate operational safeguards	Acceptable only with adequate operational safeguards
Low potential (landfill accepting inert waste)	Not normally acceptable	Acceptable only with adequate operational safeguard	Acceptable	Acceptable

MATRIX 2 - APPLICATION OF LIQUID EFFLUENTS, SLURRIES AND SLUDGES TO LAND

Nature/Origin	Inner Zone	Outer Zone and Source Catchment	Highly Permeable and Moderately Permeable	Weakly Permeable
Inorganic or non-biodegradable	Not acceptable	Not acceptable	Not acceptable	Acceptable subject to evaluation
Strong organic and biodegradable	Not acceptable	Acceptable subject to evaluation	Acceptable subject to evaluation	Acceptable subject to evaluation
Low pollution potential/ high dilution	Not acceptable	Acceptable subject to evaluation	Acceptable	Acceptable

APPENDIX 1

LIST OF RESPONDENTS

Ards Borough Council
Construction Service
Council for Nature Conservation & The Countryside
Department of Agriculture and Rural Development
Department of Enterprise Trade and Investment
Environment Agency for England and Wales
Fermanagh District Council
Fisheries Conservancy Board for Northern Ireland
Forest Service
Housing Executive
Industrial Research and Technology Unit
James Leslie (MLA)
Jim Shannon (MLA)
Laganside Corporation
Lough Neagh & Lower Bann Advisory Committees
Northern Ireland Environment Link
Planning Service
Rivers Agency
Roads Service
Royal Society for the Protection of Birds
Scottish Environment Protection Agency
Strabane District Council
Strangford Lough Management Committee
Ulster Unionist Party (NI Assembly)
Water Service

APPENDIX 2

LIST I AND II SUBSTANCES DEFINED BY

EC GROUNDWATER DIRECTIVE 80/68/EEC

LIST I OF FAMILIES AND GROUPS OF SUBSTANCES

These substances should be prevented from being discharged into groundwater.

List I contains the individual substances which belong to the families and groups of substances specified below, with the exception of those which are considered inappropriate to List I on the basis of a low risk toxicity, persistence and bioaccumulation.

Such substances which with regard to toxicity, persistence and bioaccumulation are appropriate to List II are classed in List II.

1) Organohalogen compounds and substances which may form such compounds in the aquatic environment.

2) Organophosphorous compounds.

3) Organotin compounds.

4) Substances which possess carcinogenic, mutagenic or teratogenic properties in or via the aquatic environment.

5) Mercury and its compounds.

6) Cadmium and its compounds.

7) Mineral oils and hydrocarbons.

8) Cyanides.

LIST II OF FAMILIES AND GROUPS OF SUBSTANCES

Discharges of these substances into groundwater should be minimised.

List II contains the individual substances and the categories of substances belonging to the families and groups of substances listed below which could have a harmful effect on groundwater.

1) The following metalloids and metals and their compounds:

1.	Zinc	11.	Tin
2.	Copper	12.	Barium
3.	Nickel	13.	Beryllium
4.	Chrome	14.	Boron
5.	Lead	15.	Uranium
6.	Selenium	16.	Vanadium
7.	Arsenic	17.	Cobalt
8.	Antimony	18.	Thallium
9.	Molybdenum	19.	Tellurium
10.	Titanium	20.	Silver

2) Biocides and their derivatives not appearing in List I.

3) Substances which have a deleterious effect on the taste and/or odour of groundwater and compounds liable to cause the formation of such substances in such water and to render it unfit for human consumption.

4) Toxic or persistent organic compounds of silicon and substances which may cause the formation of such compounds in water, excluding those which are biologically harmless or are rapidly converted in water into harmless substances.

5) Inorganic compounds of phosphorous and elemental phosphorous.

6) Fluorides.

7) Ammonia and nitrate.

APPENDIX 3

COMMONLY OCCURRING SOIL SERIES WITHIN SOIL LEACHING POTENTIAL CLASSES

The vulnerability classification of soil cover is based on specific physico-chemical properties of soil. Some of the properties used to define class limits can vary with land use or other local factors and because of this, the correlations with soil series given below are examples only.

High Leaching Potential:

Brown Rankers

Shallow Brown Earths

Brown Earths over Sands and Gravels

Intermediate Leaching Potential:

Brown Earths

Brown Podzolic Soils

Gleyed Brown Earths

Drained Peats

Low Leaching Potential:

Raw (Permanently Wet) Peaty Topsoil

Surface Water Gley

APPENDIX 4

CLASSIFICATION OF TYPES OF STRATA

Highly Permeable:

Chalk and Hibernian Greensand

Sherwood Sandstone

Permian Sandstone and Magnesian Limestone

Carboniferous Upper and Lower Limestone

Moderately Permeable:

Blown Sand and Raised Beach Deposits

Glacial Sand and Gravel

Alluvium

Lough Neagh Clays

Palaeogene Basalts

Carboniferous Rocks other than the Upper and Lower Limestone

Devonian

Weakly Permeable:

Lower Lias

Rhaetic

Mercia Mudstone

Permian Marls

Silurian

Ordovician

Precambrian and Intrusive Igneous Rocks

APPENDIX 5

GLOSSARY

Abstraction	Removal of water from surface water or groundwater, usually by pumping.
Adsorbtion	Process by which a thin layer of a substance accumulates on the surface of a solid substance.
Aquifer	Permeable rock that stores and readily transmits groundwater.
Attenuation	Break down or dilution of a contaminant in water.
Baseflow	That part of the flow in a waterway made up of groundwater discharges. It sustains the waterway in dry weather.
Confined	Where permeable strata are covered by a substantial depth of impermeable strata such that the cover prevents infiltration.
Controlled Waste	Includes household, industrial and commercial waste.
Diffuse Source Pollution	Pollution from widespread activities with no one discrete source.
Discharge Consent	Consent issued under the Water Act (Northern Ireland) 1972.
Drawdown	Difference between original water level and water level when abstraction is taking place from a borehole.
Drift Deposits	Term used to include all unconsolidated superficial deposits (e.g. fluvioglacial, alluvium, etc) overlying solid rocks.
Effective Porosity	That part of the total porosity which can transmit water.
Effective Rainfall	Proportion of rainfall that can infiltrate to an aquifer after evapotranspiration.
Formation	Term used to describe a sequence of rock layers.
Fractures/Fissures	Natural cracks in rocks that enhance rapid water movement.
Groundwater	Water existing in strata within the saturated zone.
Hydrogeological Characteristics	Characteristics relating to flow of water through rock e.g. permeability, transmissivity, porosity etc.
Hydrological Cycle	Circulation of the earth's water in atmosphere, surface water, oceans and groundwater and their relationships.
Intergranular Flow	Groundwater flow between individual grains of rock.
Intergranular Permeability	See primary permeability.
Landfill	Site used for waste disposal into/onto land.
Leachate	Liquor formed by the act of leaching.
Leaching	Removal of soluble substances by action of water percolating through soil, waste or rock.
List I and II Substances	Defined by EC Groundwater Directive 80/68/EEC.
Non-degradable Pollutants	Pollutants that do not readily break down.
Outcrop	Where strata are at the surface even though they may be obscured by soil cover.
Permeability	Measure of the ability to transmit water.
Point Source Pollution	Pollution from a discrete sources e.g. petrol station, septic tank, landfill.

Porosity	Ratio of volume of void space to the total volume of the rock.
Porous	Having microscopic pores between the rock grains (not necessarily interconnected).
Potable Water	Water of suitable quality for drinking.
Prescribed Processes/Substances	Related to Integrated Pollution Control.
Primary Permeability	Permeability related to flow between grains within the aquifer.
Receptor	Site or resource such as a borehole, spring, waterway or groundwater body.
Recharge	Water which percolates downward from the surface into groundwater.
Rehabilitation	Restoring good quality by natural or artificial means.
Saturated Zone	Zone of aquifer where all fissures and pores contain water (i.e. below water table).
Secondary Permeability	Permeability related to groundwater flow within fissures rather than between grains (see Primary Permeability).
Septic Tank	Small tank receiving and treating sewage by bacteria where effluent overflows.
Soakaway	System for allowing water or effluent to soak into the ground, commonly used in conjunction with septic tanks.
Source	Point of abstraction of water e.g. well, borehole, spring.
Spring	Natural emergence of groundwater at surface.
Strata	Layers of rock, including unconsolidated materials such as sands and gravels.
Trade Effluent	Effluent derived from a commercial process/ premises.
Transmissivity	The ability of an aquifer to transport water
Unsaturated Zone	Zone of aquifer between soil and water table which is partly saturated (i.e. that part of the aquifer above the water table).
Water Cycle	See hydrological cycle.
Water Table	Top surface of the saturated zone within the aquifer.
Weathered Zone	Vertical zone within soil/rock affected by weathering from the action of water, heat, ice etc.
Yield	Quantity of water able to be removed from an abstraction source.

Related Documentation:

BGS/SSLRC 1994 Groundwater Vulnerability Map of Northern Ireland 1:250,000*

BGS 1994 Hydrogeological Map of Northern Ireland 1:250,000*

Robins, N S 1996 Hydrogeology of Northern Ireland. LONDON: HMSO*

Environment and Heritage Service (DOE) - A Groundwater Monitoring Strategy for Northern Ireland September 2000

* Available from the Geological Survey of Northern Ireland (GSNI), 20 College Gardens Belfast BT9 6BS, Telephone 028 9066 6595. Email: gsni@bgs.ac.uk.

ENVIRONMENT
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SERVICE

Our aim is to protect and conserve the natural and built environment and to promote its appreciation for the benefit of present and future generations.

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