



**POLICY AND PRACTICE
FOR THE PROTECTION
OF GROUNDWATER**

Environment Agency
INFORMATION CENTRE



NRA

National Rivers Authority



NATIONAL RIVERS AUTHORITY

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**POLICY AND PRACTICE
FOR THE
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CONTENTS

PREFACE	1
1. INTRODUCTION	2
Groundwater Protection	
European Community Policy	
NRA Powers	
NRA Policy	
2. KEY PRINCIPLES	6
Importance of Groundwater Protection	
Statutory Quality Objectives for groundwater	
Relationship to surface water resource protection	
Relationship to land use planning	
Awareness of Groundwater Protection Policy	
Objectives of the Groundwater Protection Policy	
Approach to groundwater protection decisions	
3. POWERS AND RESPONSIBILITIES FOR GROUNDWATER PROTECTION	9
EC Directive on the Protection of Groundwater Caused by Certain Dangerous Substances	
Control of Pollution Act 1974	
Environmental Protection Act 1990	
Water Resources Act 1991	
Water Industry Act 1991	
Town and Country Planning Act 1990	
The Planning and Compensation Act 1991	
4. CONCEPTS OF VULNERABILITY AND RISK	14
5. DESCRIPTION OF VULNERABILITY OF GROUNDWATER RESOURCES	15
Presence and nature of overlying soil	
Presence and nature of Drift	
Nature of strata	
Depth of unsaturated zone	
Assessing total vulnerability	
Vulnerability maps	
6. DEFINITION OF SOURCE PROTECTION ZONES	19
Zone II (Inner Source Protection)	
Zone II (Outer Source Protection)	
Zone III (Source Catchment)	
Defining Source Protection Zones	

7. GROUNDWATER PROTECTION POLICY STATEMENTS:	23
A. Control of groundwater abstractions	25
B. Physical disturbance of aquifers and groundwater flow	26
C. Waste disposal to land	28
D. Contaminated land	31
E. The application of liquid effluents, sludges and slurries to land	34
F. Discharges to underground strata	37
G. Diffuse pollution of groundwater	43
H. Additional activities which pose a threat to groundwater quality	46

APPENDICES

Appendix 1 List I and II substances defined by EC Groundwater Directive (80/68/EEC)	48
Appendix 2 Commonly occurring soil series within soil vulnerability classes	49
Appendix 3 Classification of types of strata	49
Appendix 4 Glossary of terms used throughout the document	50

FIGURES

Figure 1 Diagrammatic representation of the Water Cycle showing groundwater and surface water relationships and groundwater pollution risks	7
Figure 2 Examples to illustrate vulnerability	17
Figure 3 Groundwater vulnerability classification	18
Figure 4 Schematic diagrams of the relationship between source protection zones	20

TABLES

Table 1 Groundwater protection legislation directly implemented by the National Rivers Authority	12
Table 2 Bodies with responsibility for aspects of groundwater protection in England and Wales	13

MAP

Groundwater Vulnerability of England and Wales	Inside back cover
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PREFACE

- The National Rivers Authority (NRA) has a duty under the Water Resources Act 1991 to monitor and protect the quality of groundwater (Section 84) and to conserve its use for water resources (Section 19). It also has a duty (Section 16) to maintain and, where appropriate, enhance conservation of the surface water environment which in many cases is dependent upon proper management of groundwater. These duties relate only to England and Wales.
- At a meeting in The Hague in November 1991 the Environment Ministers of the European Community adopted a resolution which recognised the need for the management and protection of groundwater on a sustainable basis, by preventing its over-exploitation and pollution. The NRA therefore intends to give high priority to promoting this national framework policy for groundwater protection.
- The NRA will apply this 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 under planning legislation. By publishing this policy the NRA is not seeking new statutory powers but it is establishing a technical framework which could form the basis of future regulations if these were necessary.
- For its implementation the policy partly relies on a series of vulnerability and protection zone maps which will be prepared over the next three years. They will be made accessible to the public to allow the widest appreciation of groundwater protection issues.
- Groundwater protection decisions are complex. They involve consideration of geology, soils, hydrogeology, geochemistry and ecology. They must take account of interaction with surface waters, land and air. They may require very detailed site investigations and monitoring over time before decisions can be made. Consideration will often need to be given to the balance of interests both within the water environment and in a wider context. The policy and the supporting maps provide a framework for decision-making, but they are not prescriptive and need to be qualified by site-specific considerations.
- There will be situations where existing facilities or activities do not meet the requirements of the policy. The NRA recognises that the solution to historic problems needs to take account of what is practically achievable and by giving priority to the cases of greatest concern. The NRA will give consideration to the results of environmental monitoring and to the assessment of actual risk in determining priorities for change.



An abandoned ironstone excavation in Northampton Sand, which is overlain by Lincolnshire Limestone and has intercepted the water table

1. INTRODUCTION

GROUNDWATER PROTECTION

Groundwater forms the part of the natural water cycle which is present within underground strata (aquifers); out of sight and, unfortunately, all too often out of mind.

The volume of water stored in the pores and fractures of the strata vastly exceeds the volumes of fresh surface water. Groundwaters have a substantial strategic significance in public water supply; they provide 35 per cent of present demand and in some areas are the only available future resource. They also provide supplies for private abstractors who cannot obtain, or prefer not to use, water from the public mains.

The volume and quality of groundwater must be preserved by proper management. This is a difficult task. There is a problem of space because, unlike rivers which flow in defined channels, in many parts of the country groundwater is present everywhere beneath our feet, at risk from human activity. There is also a problem of time, because due to the very slow movement of groundwater through the strata, effects can take a long time to manifest themselves. Groundwater is particularly at risk from distributed and diffuse sources of pollution which accumulate over many years. These may be virtually impossible to clean up, (regardless of cost) even when the source of the problem is removed. The protection of groundwater quality and yield is therefore of paramount concern.

A landfill site in an old opencast coal excavation

The risk of pollution is increasing both from the disposal of waste materials and from the widespread use by industry and agriculture of potentially polluting chemicals in the environment. Pollution can occur either as discrete, point sources, such as from the landfilling of wastes, or from the wider, more diffuse use of chemicals, such as the application to land of fertilizers and pesticides. Through mineral extraction and changes in land use, humans can also affect the

future availability of groundwater resources by restricting recharge and diverting flow.

Groundwater is not only protected to maintain water supplies from aquifers. It naturally feeds surface waters through springs and by base flows to rivers. Its presence is often important in supporting wetlands and their ecosystems. Removal or diversion of groundwater can affect total river flow. A reduction in either the quantity or the quality of the contributing groundwater can significantly influence surface water and the achievement of water quality standards. Surface water and groundwater are thus intimately linked in the water cycle, with many common issues. The protection of groundwater resources from the effects of human activity is, therefore, just one part of the total protection of the water environment.

EUROPEAN COMMUNITY 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 1) to groundwater. The impact of the directive has been limited. Only a restricted range of substances is controlled. It did not address either diffuse pollution or the essential links to the management of abstraction and it did not establish a comprehensive system for the monitoring of groundwater.

Recognising the limitations of existing community wide regulations, EC Environment Ministers, at a Seminar on Groundwater held in the Hague in November 1991, adopted an action programme for the future protection of groundwater. In their declaration they 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;
- it is essential to protect groundwater resources against overexploitation, adverse changes in hydrological systems resulting from human activities, and pollution, many forms of which can produce irreversible damage.



Dry bed of the River Granta resulting from a lowered water table caused by groundwater abstraction

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;
- 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.

NRA POWERS

The powers and duties of the NRA for the protection of groundwater are set out in the Water Resources Act 1991.

In respect of groundwater quality these powers and duties are to:

- achieve Statutory Quality Objectives for groundwater which may be set by the Secretary of State;

- control discharges to groundwater through the discharge consent process;
- prevent pollution through regulations set by the Secretary of State;
- enforce against pollution events; and
- take remedial action when pollution has occurred.

In respect of groundwater yield and quantity these powers and duties are to:

- conserve water resources and ensure their proper use;
- manage groundwater so that it does not prevent the maintenance of acceptable flows in rivers;
- control abstraction of groundwater through the abstraction licensing process;
- enforce against illegal abstraction;
- take action to redistribute or augment resources where necessary.

Road sign in Germany delineating the edge of a groundwater protection zone



The NRA also has indirect powers, enforced through other bodies under the Environmental Protection Act 1990, and the Control of Pollution Act 1974 to:

- control discharges from prescribed industrial processes to natural waters;
- control waste disposal to land where it may cause pollution of water resources.

The NRA, as a statutory consultee under the Planning Acts, can influence planning decisions which may have an impact on the yield or quality of groundwater. The NRA is not a statutory consultee on all relevant planning matters but Planning Authorities are encouraged by Government to consult the NRA in any event.

In carrying out all these duties the NRA must have regard for the preservation, enhancement and conservation of the water environment.

NRA POLICY

The NRA inherited various Groundwater Protection Policies from the Water Authorities. These evolved to meet the groundwater protection duties without any specific national coordination. They are different in approach and in their technical foundation and this has led to differences in practice across the country. In order to consolidate and standardise the existing policies, to take account of new duties imposed on the NRA in 1989, and to support the EC objective of sustainability of groundwater quality and quantity through an integrated approach, the NRA has adopted a new policy framework for protecting groundwater.

In going about this task the NRA has reviewed the practices of the former Water Authorities. It has also reviewed practices in Europe, the United States of America and Canada. The British Geological Survey (BGS) and the Soil Survey and Land Research Centre (SSLRC), have both provided specialist technical advice and, through their geological and soils databases, have contributed to the vulnerability mapping which forms the basis of the definition of risk to groundwaters.

A key objective has been to devise a framework which covers all types of threat to groundwater, whether large or small, from point or diffuse sources, and by both conservative or degradable pollutants. It is designed to provide a basis for implementation of legislation in England and Wales and anticipates, as far as possible, the likely requirements of future European legislation on the landfilling of wastes and from diffuse agricultural pollutants.

This document provides:

Classification of Groundwater Vulnerability based upon the key variables which determine vulnerability:

- nature of overlying soil cover;
- presence and nature of Drift;
- nature of strata;
- depth to water table (thickness of the unsaturated zone).

Definition of Source Protection Zones determined by:

- travel time of potential pollutants;
- source catchment areas.

Statements on Groundwater Protection Policy in relation to:

- control of groundwater abstractions;
- physical disturbance of aquifers and groundwater flow;

- waste disposal to land;
- contaminated land;
- disposal of sludges and slurries to land;
- discharges to underground strata;
- diffuse pollution;
- additional threats to groundwater quality.

The policy statements and related maps and zones do not, of themselves, have a statutory status. They will enable the NRA to use its existing statutory powers in a consistent and uniform manner and they will guide it in its response to the various statutory and non-statutory consultations it has with other organisations, whose decisions can affect groundwater; an example of this is in development planning. The NRA is publishing its policies so that land users and potential developers may anticipate the likely response of the NRA to a proposal or activity and to influence other organisations in the development of their own policy. The technical framework of the policy could, however, be used in regulations to increase legislative protection for groundwater under existing statutory powers, but this would be a matter for Government on advice from the NRA and others.

The variability of geology and soils, of hydrogeology, of waters in the natural environment and of the various preventative measures which might be taken can result in groundwater protection decisions being complex, dependent on local circumstances, and not capable of prescription within a general policy. The NRA will determine its position on any issue by the assessment of relevant local factors, but within the framework of this policy.

The NRA is engaged upon a programme of mapping groundwater vulnerability in terms of geology and soils at a scale of 1:100,000 and these maps will be progressively published over the period 1992 to 1996. The programme is being carried out by the British Geological Survey and the Soil Survey and Land Research Centre. It is based upon existing classifications of strata and soils and therefore, if required in advance of publication, the policy can be applied by reference to existing reference maps. The NRA is also progressively mapping Source Protection Zones for the major public water supply sources and 750 are expected to be completed by mid-1993. The methodology used by the NRA will be published and open to public review. In addition the NRA is publishing, as an adjunct to this document, a separate appendix for each of its 10 regions, which will provide a source of reference relating the maps and zones used in any previous regional policy to the new framework. (Available from NRA Regional Offices, addresses on the back cover of this document.)



Trial pit investigation at a contaminated land site

2. KEY PRINCIPLES

IMPORTANCE OF GROUNDWATER PROTECTION

Groundwaters make up a very high proportion of the freshwater resources of England and Wales. Approximately 75 per cent of all abstracted groundwater is used for public supply and it makes up 35 per cent of the total public supply. The vast majority of people in England and Wales who rely on private water supplies use groundwater. Groundwater is also an important source for industry and agriculture as well as sustaining the base flow of rivers. The protection of groundwater quality is of critical importance for the following reasons:

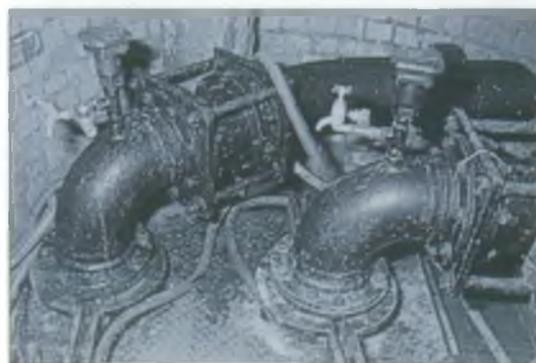
- If groundwater becomes polluted, it is difficult, if not impossible, to rehabilitate. The slow rates of groundwater flow and low microbiological activity limit any self-purification. Processes which take place in days or weeks in surface water systems are likely to take decades in groundwaters. It is therefore better to prevent or reduce the risk of groundwater contamination than to deal with its consequences.
- Its major and ubiquitous use is for potable supply which means that a high quality standard must be maintained for all resources.
- Aquifers provide storage for considerable volumes of high quality water which requires little treatment prior to use, even for potable supply. The loss of this widely available low cost water resource would require more expensive water resource options to be developed. Private potable supplies, independent of the public system, are also widely used. Examples of usage can be found in hospitals and in bottling and food processing.
- Groundwater provides the baseflow of many surface water systems. Some of these are used for potable, industrial and agricultural supplies as well as for fishing and other recreational uses. For these reasons and others of general amenity and conservation, the quality of the baseflow is

critical. Hence the protection of groundwater resources in such areas is an important aspect of sustaining surface water quality.

STATUTORY QUALITY OBJECTIVES FOR GROUNDWATER

The Water Resources Act 1991 establishes a framework for quality objectives which applies to all controlled waters. This framework includes a system for classifying water quality and for the Secretary of State to set Statutory Water Quality Objectives (SWQOs) which require that specific targets for water quality should be achieved and maintained. The NRA must achieve this through exercising its powers under the Water Resources Act 1991, including the use of powers granted by Regulations. Protection policies are one means by which these requirements can be met. With the publication of this policy the NRA intends to influence the activities of other relevant organisations, such as Planning Authorities, to support the achievement of these objectives.

It is intended that Statutory Water Quality Objectives for groundwaters should be established after those for rivers. The principal general use for groundwater is for water supply and, the quality of groundwater is generally much better than the requirements for potable waters under the EC Directive on the Quality of Water Intended for Human Consumption (80/778/EEC), as implemented and extended by the Water Supply (Water Quality) Regulations 1989. It is the statutory duty of the NRA to achieve and maintain SWQOs for groundwater. In setting appropriate standards it will be necessary to take into consideration SWQOs for surface waters, and the use to be made of groundwaters. Due regard will be taken of those groundwaters where natural water quality



The top of a public supply borehole

Courtesy Severn Trent Water

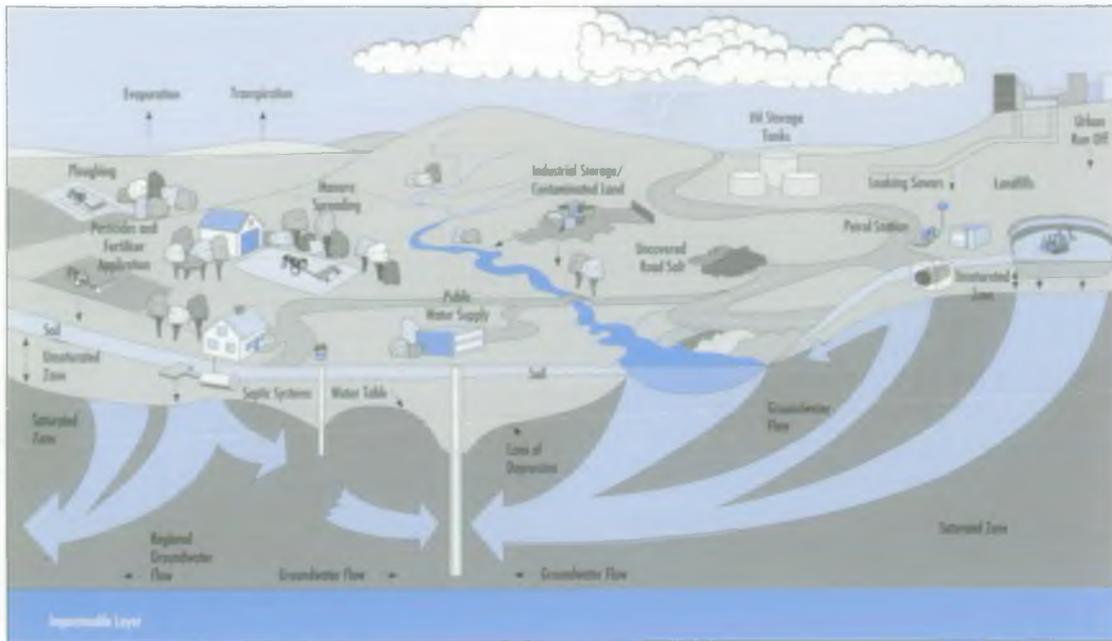


Figure 1
Diagrammatic representation of the Water Cycle showing groundwater and surface water relationships and groundwater pollution risks

fails – or is likely to fail – the standards which are set, or where historical long-term pollution from numerous sources has led to a deterioration in quality (see Policy Statement D7).

In anticipation of Regulations being made by the Secretary of State enforcing SWQOs for groundwater and in compliance with its general duties to monitor controlled waters, the Authority will be developing and extending its existing groundwater monitoring networks. These networks will complement those which exist for monitoring groundwater levels.

RELATIONSHIP TO SURFACE WATER RESOURCE PROTECTION

Surface waters and groundwaters are closely integrated in the water cycle. Figure 1 shows how groundwater, rivers and different land uses can be related. Policies to protect groundwater tend to direct activities to areas where the soils and strata are less permeable. Here run-off can be greater and more immediate and the activities may, therefore, pose a threat to surface waters. Better control of discharges to soakaways may increase demand for surface water discharge facilities. The EC Ministerial Declaration on Groundwater (November 1991) emphasised the need for an integrated approach for the management of both surface waters and groundwaters.

Where surface waters are naturally (or as a consequence of the effects of abstraction) influent to groundwater, the surface water catchment upstream

of that point needs to be considered as part of the groundwater catchment for resource protection purposes. Conversely, ensuring the protection of groundwater can be critical in both the quantity and quality of baseflow to watercourses. Hence the maintenance of SWQOs for surface waters may be dependent on the achievement of water quality objectives for groundwaters.

In order to harmonise policies on water resource protection, the NRA's practices for surface water protection, including catchment monitoring, catchment surveys and site audits are in the process of being reviewed and standardised to complement this document.

RELATIONSHIP TO LAND USE PLANNING

Development and use of land is the one consistent element in the list of potential threats to the quality of groundwater; land use planning policies and procedures, therefore, play a significant role in effective groundwater protection.

The process begins at the development plan level. The Regional Planning Guidance procedures now in force provide an obvious route for appropriate policies to be incorporated which will have an impact on the whole of the development planning process. The Planning Policy Guidance Document PPG12 (February 1992) draws particular attention to the protection of groundwater as a relevant and important environmental objective. Local Plans, particularly the mineral and waste plans, are also very relevant to groundwater protection issues. The

NRA will be incorporating groundwater protection objectives into its own model planning policies for Local Planning Authorities to consider as part of the development planning process.

AWARENESS OF GROUNDWATER PROTECTION

Because groundwater resources are “out of sight” there is always the risk that they will be too much “out of mind” when land use management decisions are made. Both within and outside the field of water and environment specialists, there is a lack of awareness of the importance of groundwater protection. Publicity and education about the risks and the means of overcoming them are, therefore, an essential part of a national policy for groundwater protection.

OBJECTIVES OF THE GROUNDWATER PROTECTION POLICY

The policy sets out how the NRA will meet its statutory responsibilities for the protection and conservation of groundwater resources.

In particular it aims to:

- ensure that all risks to groundwater resources, point source and diffuse, are dealt with in a common framework;
- provide a common basis for decisions affecting groundwater resources within and between its regions;
- encourage compatibility of approach between the NRA and other bodies with statutory responsibilities for the protection of groundwater.

APPROACH TO GROUNDWATER PROTECTION DECISIONS

The NRA recognises that there are many factors affecting the risk of groundwater contamination at any location. These will vary according to the type of activity proposed and the vulnerability of the underlying groundwater to pollution from the surface. In considering the risks in any given situation there needs to be a professional assessment of the local circumstances before any decision is made. Consideration must also be given to the balancing of interests in the water environment as well as in a wider context. Therefore the policies and principles outlined here are seen as a framework for decision making and are not necessarily prescriptive in any individual circumstance.



NRA officer discussing farm waste management plans with a farmer

Pulverised fuel ash from power stations is deposited in sand and gravel excavations in the Trent valley



3. POWERS AND RESPONSIBILITIES FOR GROUNDWATER PROTECTION

The NRA has a duty to maintain and protect the quality and yield of groundwater resources for abstracted and indirect uses. It does this by using its own powers (Table 1) and through statutory and non statutory consultation with other regulatory agencies. There are other bodies responsible for aspects of groundwater protection in England and Wales. These are listed in Table 2.

The UK legislation relating to groundwater protection implements the EC Directive on the Protection of Groundwater Against Pollution Caused by Certain Dangerous Substances (80/68/EEC) in which pollution is defined as "the discharge by man, directly or indirectly, of substances or energy into groundwater, the results of which are such as to endanger human health or water supplies, harm living resources and the aquatic ecosystem or interfere with other legitimate uses of water". The Department of the Environment/Welsh Office, in Circulars 4/82 and 20/90, state that any discharge containing certain specific substances (Appendix 1) in such quantity as to require a significant difference in the degree of treatment in the receiving water before use should be regarded as falling within the scope of the Directive. The main legislative provisions implementing the protection of groundwater in England and Wales are outlined below. They are shown together with other UK and European legislation in Tables 1 and 2.

EC DIRECTIVE ON THE PROTECTION OF GROUNDWATER CAUSED BY CERTAIN DANGEROUS SUBSTANCES (80/68/EEC)

This Directive prohibits the direct or indirect discharge into groundwater of List I substances and limits discharges of List II substances, unless prior investigation can establish that pollution of groundwater will not occur, or unless the groundwater is permanently unsuitable for other uses. In England and Wales it is currently implemented by the Control of Pollution Act 1974, the Environmental Protection Act 1990 (which will eventually completely supersede the Control of Pollution Act), the Water Resources Act 1991 and the Town & Country Planning Acts. The

designated substances are listed in Appendix 1 of this document.

The classification of substances into Lists I and II is dependent on their intrinsic characteristics. A national scheme of classification has been drawn up by Government who have designated the NRA as the responsible body for determining whether a specific substance falls into either of the lists for the purposes of the Groundwater Directive.

CONTROL OF POLLUTION ACT, 1974

Part I deals with the disposal of waste to land. The Act is administered by the Waste Regulation Authorities (District Councils in Wales and the former Metropolitan County areas and Shire County Councils in England). The NRA is a statutory consultee of each Waste Regulation Authority (WRA) and may object to the Secretary of State if a WRA proposes to issue a licence to handle waste or operate a waste disposal site which does not comply with its requirements to protect the water environment.

ENVIRONMENTAL PROTECTION ACT 1990

Part I of the Environmental Protection Act 1990 relates to the application of Integrated Pollution Control to those industries designated on the basis of the prescribed substances list. Part I is enforced by HM Inspectorate of Pollution (HMIP). Authorisations by HMIP may not be granted if the NRA considers that any Statutory Water Quality Objective will be breached and the NRA may require, under Section 28(3) of the Act, that HMIP include conditions (in relation to releases to controlled waters) in such authorisations. HMIP may, however, include conditions which are more onerous than those notified by the NRA.



The haphazard storage of chemical drums can lead to groundwater pollution

Part II of this Act, when fully implemented, will supersede the provisions of Part I of the Control of Pollution Act 1974. Waste management will be controlled by Waste Regulation Authorities through the granting of Waste Management Licences. These licences will remain in force until such time as their surrender is accepted. The NRA is a statutory consultee over both the issue and surrender of licences with similar powers of representation to the Secretary of State as under the Control of Pollution Act.

WATER RESOURCES ACT 1991

The NRA has powers to control the direct and indirect discharge of the majority of trade and all sewage effluent into controlled waters under Part III of the Water Resources Act 1991. A discharge occurring as a result of a waste disposal site licence issued under Part I of the Control of Pollution Act 1974 (or Part II of the Environmental Protection Act 1990 when implemented) may obviate the need for a further consent.

Sections 92, 93 and 94 of the Act give additional preventative powers to the NRA by Regulation. Regulations made under Section 92 relate to specific activities and are being progressively drawn up. The Control of Pollution (Silage, Slurry and Agricultural Fuel Oil) Regulations were the first of these, although they were made under the Water Act 1989. They are enforced by the NRA. They set out minimum standards for silage, slurry and agricultural fuel oil installations in England and Wales. Powers under Sections 93 and 94 relate to water protection zones and are described more fully in Section G of this document.

The Water Resources Act 1991 consolidates all the provisions of the Water Resources Act 1963 in respect of the control of abstraction from groundwater. The dewatering of mines, quarries and engineering works are exempt from control. However, discharges from these activities require consents under the Act from the NRA unless a mine is abandoned. Domestic abstractions for the use of single households are also exempt.

WATER INDUSTRY ACT 1991

The Private Water Supplies Regulations 1991 made under the Water Industry Act 1991 cover the monitoring and enforcement of quality standards in water used for private supply. Because most of these are exempt from control under the Water Resources Act 1991 the private supply registers, when set up by local authorities, will provide a more comprehensive list of small groundwater sources (Circular 24/91 (DOE), 68/91 (Welsh Office)). Results from monitoring will also indicate situations where improved resource protection is required. Where contamination is found the NRA should be informed so that potential sources of pollution can be investigated.

TOWN AND COUNTRY PLANNING ACT 1990/ THE PLANNING AND COMPENSATION ACT 1991

Many developments may pose a direct or indirect threat to groundwater resources. Where planning permission is required (eg chemical stores, residential development, mineral extraction, industrial development) often the only control is by means of conditions on the permission document, an obligation (agreement or undertaking) under Section 106 of the Act, or by refusal of permission. It is, therefore, important to recognise developments that may be a potential risk to groundwater.



The spreading of farm waste onto grassland

Courtesy Severn Trent Water

The latter Act introduces a “plan-led” system for Town and Country Planning for the first time. Regional guidance is issued by the Department of the Environment. Structure Plans, Mineral Local Plans and Waste Local Plans are prepared by County Councils and other Local Plans produced by District Councils. The concepts detailed in this document are highly relevant for inclusion in these more strategic documents which can influence the locations of individual developments.

The NRA is a statutory consultee on development plans and many aspects of development control. In

the case of plans, the NRA’s views must be considered unless the Planning Authority can justify why its requirements are not to be included. The NRA is also a statutory consultee on Environmental Assessments when these are required.

Guidance to Planning Authorities is given by Government in the form of Minerals Planning and Planning Policy Guidance Notes. Recent issues (eg MPG 9 and PPG 12) emphasise the environmental importance of planning decisions and refer specifically to the need to ensure that groundwaters are adequately protected.



The lining of a new landfill on the Chalk with an artificial membrane in order to protect groundwater

Table 1
Groundwater protection legislation directly implemented by the National Rivers Authority

ORIGIN	LEGISLATION	NRA ROLE
European	EC Groundwater Directive (80/68/EEC)	Competent authority in association with Waste Regulation Authorities and Mineral Planning Authorities
	EC Directive on Diffuse Pollution by Nitrates (91/676/EEC)	Direction to monitor, Identification of vulnerable zones
UK	Water Industry Act 1991 (s.71(1))	Powers to control waste of water resources by artesian overflow
	Water Resources Act 1991 (s.24)	Powers to control by licence most types of abstraction
	Water Resources Act 1991 (s.30)	Powers to protect groundwater resources during dewatering
	Water Resources Act 1991 (s.83)	Provides for definition of Water Quality Objectives for controlled waters
	Water Resources Act 1991 (s.88)	Powers to control discharges to controlled waters
	Water Resources Act 1991 (s.92)	Powers under regulations to require pollution prevention measures to be taken
	Water Resources Act 1991 (s.93)	Provision for statutory water protection zones
	Water Resources Act 1991 (s.94)	Provision for Nitrate Sensitive Areas (which may be used to implement the EC Nitrate Directive)
	Water Resources Act 1991 (s.161)	Powers to take remedial action to prevent pollution occurring or continuing
	Water Resources Act 1991 (s.199)	Powers to preserve and protect groundwater during mineral exploration
	Control of Pollution (Silage, Slurry & Agricultural Fuel Oil) Regulations	Powers to ensure high standards on all new and enlarged installations for silage, slurry and fuel oil to minimise the risk of pollution



Sand and gravel extraction in River Terrace deposits

Table 2

Bodies with responsibility for aspects of groundwater protection in England and Wales

AGENCY	AREA OF RESPONSIBILITY	RELEVANT LEGISLATION	LOCUS OF NRA
Department of the Environment	Sponsoring ministry of NRA	Water Resources Act 1991	Direct Liaison
	Making of regulations and directions under the Water Resources Act 1991	Water Resources Act 1991	Direct Liaison
	Determination of appeals on licences to abstract from, and consents to discharge to, groundwater	Water Resources Act 1991	Regulating Body
	Determination of appeals on waste management licences	Control of Pollution Act, Part I/ Environmental Protection Act 1990	Statutory Consultee
	Determination of planning appeals	Town & Country Planning Acts	Statutory Consultee
	EC Groundwater Directive	80/68/EEC	Competent Authority with others
	EC Nitrate Directive	91/676/EEC	Competent Authority
	Mineral Extraction policy, Land Use Planning Policies and legislation	Town & country Planning Acts and related Regulations	Consultee
	Contaminated Land Policy		Direct Liaison
Her Majesty's Inspectorate of Pollution	Waste Management policy		Direct Liaison
	Discharge to groundwater from prescribed processes	Environmental Protection Act 1990	Direct Liaison
	Prevention of land contamination from certain substances	Environmental Protection Act 1990	No formal contact
Ministry of Agriculture	Discharge of radioactive substances to groundwater	Radioactive Substances Act 1960	No formal contact
	Nitrate Sensitive Areas	Water Resources Act 1991	Direct Liaison
	Control of Pesticide Regulations	Food and Environmental Protection Act 1985 S.I. 1510 1986	Consultee
	Code of Good Agricultural Practice	Water Resources Act 1991	Consultee
English County Councils, Metropolitan Borough Councils, Welsh District Councils	Natural Mineral Water Regulations	S.I. 1985 No. 71	No formal contact
	Waste Disposal Regulation, Waste Disposal Plans	Control of Pollution Act 1974 Town & Country Planning Acts, Environmental Protection Act 1990	Statutory Consultee
County Councils, Metropolitan Borough Councils, National Parks Authorities	Competent Authority for waste to land and redevelopment of contaminated land	EC Groundwater Directive (80/68/EEC)	None
	Development control over mineral extraction	Town & Country Planning Act 1990	Statutory Consultee
District Council and Unitary Authorities	Development planning	Town & Country Planning Act 1990	Statutory Consultee
	Storage of Hazardous Substances	Planning (Hazardous Substances) Act 1990	Statutory Consultee for new consents
	Competent Authority for drawing up Registers of Contaminated Land	Environmental Protection Act 1990	Direct Contact
	Competent Authority	EC Mineral Water Directive (80/777)	No formal contact
	Private water supply register /monitoring	Private Water Supply Regulations	Advisory contact
Local and Regional Regional Planning Authorities	Forward Planning Policies Local, Structure and Subject Plans (Minerals/Waste Disposal)	Town & Country Planning Acts 1990 (Planning & Compensation) 1991	Statutory Consultee
National Park Authorities	Development control Local and Structure Plans	Town & Country Planning Acts National Parks Acts	Statutory Consultee
English Nature and and Countryside Commission for Wales	Consultee on issue of licences to abstract and consents to discharge with conservation implications	Water Resources Act 1991	Direct Contact



The operation of a chemical works can pose a significant risk to groundwater

4. CONCEPTS OF VULNERABILITY AND RISK

Wherever groundwater is present there is the potential for it to be affected by human activity. No soil or rock is completely impermeable, no pollutant completely immobile. The concept of groundwater vulnerability recognises that risks of pollution from a given activity are greater in certain hydrological, geological and soil situations than others.

Many human activities present a potential hazard to groundwater. In trying to assess the level of risk of contamination from any given activity in order to make judgements about its acceptability, it is necessary to assess the total exposure of the groundwater system to that hazard. Exposure of groundwater to hazard may be mitigated by preventative measures (such as bunding of storage tanks, lining of landfills or by specific management practices). However, in most cases, a significant element of the total exposure to hazard will depend on the natural geological and soil conditions. These define the **vulnerability**, that is the susceptibility of the groundwater to pollution.

Vulnerability depends upon the natural characteristics of a site and is assessed on the physical, chemical and biological properties of the soil and rocks beneath the site which control the ease with which an unprotected hazard can affect groundwater.

Risk arises when an activity is proposed at a given location. Risk is assessed by taking account of the nature of the hazard, the natural vulnerability of the groundwater and the scale of preventative measures proposed.



The possibility of accidental spillage on transport systems must be considered in planning new routes

Vulnerability of Groundwater The factors which together define the vulnerability of groundwater resources to a given pollutant or activity are the:

- presence and nature of overlying soil;
- presence and nature of Drift;
- nature of strata;
- depth of unsaturated zone.

Any or all of these factors can be relevant in assessing a specific risk to groundwater resources. Criteria have been developed based on soil, geological and hydrogeological characteristics to identify vulnerability in each of the above factors. The vulnerability of groundwater resources at any location can be inferred from known nearby circumstances and can be mapped with varying precision depending on the availability of relevant data. However, it can only be established with confidence by direct site investigation.

The above factors define the vulnerability of all underground waters, whether they are exploited or not. Both European and national legislation require that all groundwater should be afforded protection, regardless of whether, or how, it is currently used. Since these measures relate to the whole of the groundwater resource they are referred to as **Groundwater Resource Protection**. The concepts are further described in Section 5.

A distinction needs to be made between the general protection of the groundwater resource and the specific protection which may be appropriate for individual sources. The abstraction of groundwater modifies 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 area. This is the area of land needed to sustain the groundwater abstraction by natural recharge. These considerations lead to the separate definition of **Groundwater Source Protection** zones, which is discussed in Section 6. Source Protection Zones are to be regarded as additional to the general consideration of overall resource protection.

5. DESCRIPTION OF VULNERABILITY OF GROUNDWATER RESOURCES

In this section the vulnerability of groundwater resources is described in terms of the four variables which have been listed above: presence and nature of overlying soil; presence and nature of drift; nature of strata; depth of unsaturated zone.

PRESENCE AND NATURE OF OVERLYING SOIL

Risk of pollution by activities such as spreading of sludges and manures and from many types of diffuse pollution depends upon the attenuating characteristics of the soil. For this purpose the soil is taken to be the weathered zone affected by living organisms and undergoing seasonal change in moisture, temperature and gaseous composition. In the UK it may be up to two metres in depth. Variations in soil vulnerability can be recognised on the basis of 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 which under certain circumstances can be retained in the soil layer (eg pesticides);
- diffuse source pollutants which can readily pass through the soil layer (eg nitrate);
- liquids (eg from slurries and manures).

The Soil Survey and Land Research Centre have developed a three-fold classification of soil types for the NRA that is based on physical soil properties. The physical properties include soil texture, structure, soil water regime and the presence of distinctive layers, such as raw peaty topsoil and rock or gravel at shallow depth. The variety of soils and possible pollutants is wide and classification is necessarily generalised. This means that individual circumstances will require more detailed evaluation. Appendix 2 gives examples of soil series which fall into the three soil vulnerability classes described below.

Soils of High Leaching Potential, H:

These soils have little ability to attenuate diffuse source pollutants. Non-adsorbed diffuse source

pollutants and liquid discharges will percolate rapidly through them. Three sub-classes are recognised:

- H1 soils which readily transmit liquid discharges because they are either shallow, or susceptible to rapid by-pass flow directly to rock, gravel or groundwater;
- H2 deep, permeable coarse textured soils which readily transmit a wide range of pollutants because of their rapid drainage and low attenuation potential;
- H3 coarse textured or moderately shallow soils which readily transmit non-adsorbed pollutants and liquid discharges but which have some ability to attenuate adsorbed pollutants because of their large organic matter or clay content.

Soils of Intermediate Leaching Potential, I:

These are soils which have a moderate ability to attenuate diffuse source pollutants or in which it is possible that some non-adsorbed diffuse source pollutants and liquid discharges could penetrate the soil layer. Two subdivisions are recognised on the vulnerability maps:

- I1 soils which can possibly transmit a wide range of pollutants; and
- I2 soils which can possibly transmit non- or weakly adsorbed pollutants and liquid discharges, but which are unlikely to transmit adsorbed pollutants.

The injection of sewage sludge into grassland

Courtesy Severn Trent Water





Large diameter sewer being constructed at depth

Courtesy Severn Trent Water

Soils of Low Leaching Potential, L:

These are soils in which pollutants are unlikely to penetrate the soil layer because water movement is largely horizontal or which have a large ability to attenuate diffuse source pollutants. Generally, these are likely to be 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.

The nature of the overlying soil need not be considered where the soil layer has been removed (eg landfill, quarrying). For the purposes of the groundwater vulnerability maps the soils overlying Minor and Non-Aquifers have not been differentiated.

PRESENCE AND NATURE OF DRIFT

In many areas Drift deposits are present overlying the solid geology. These deposits are variable vertically and horizontally in both thickness and lithology. Where the Drift is of substantial thickness and of low permeability it can provide an effective barrier to surface pollutant migration. It is relevant to the assessment of vulnerability, but in all cases investigations are necessary to assess the local characteristics of the Drift deposits because detailed mapping has seldom been carried out. Permeable drift is classified as a Minor Aquifer except where it occurs in probable hydraulic continuity with a Major Aquifer (defined below). In such cases it is regarded as part of the underlying Major Aquifer unless specific studies prove otherwise.

NATURE OF STRATA

Geological strata which contain groundwater in exploitable quantities are called **aquifers**, whereas rocks which are largely impermeable and which do not readily transmit water are called **non-aquifers**. Aquifers vary in their general and hydraulic characteristics (fissured, fissure-porous and porous) and in the unsaturated zone this variation determines the vulnerability of the groundwater to pollution. The distribution of the outcrop of aquifers and non-aquifers over England and Wales is approximately half and half.

All groundwaters are controlled waters, but it is convenient to subdivide permeable strata into the categories of Major Aquifers and Minor Aquifers, the former having generally less capacity for attenuating contaminated recharge entering at their

surface. This division is to a considerable extent also co-incident with their water resource potential.

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

Minor Aquifers: These can be fractured or potentially fractured rocks which do not have a high primary permeability, or other formations of variable permeability. Although these aquifers will seldom produce large quantities of water for abstractions, they are important both for local supplies and in supplying base flow for rivers. In certain local circumstances minor aquifers can be highly vulnerable to pollution.

Non-Aquifers: These are formations with negligible permeability that are generally regarded as not containing groundwater in exploitable quantities. However, groundwater flow through such rocks, although imperceptible, does take place, and needs to be considered when assessing the risk associated with very slowly degrading pollutants.

For the purposes of mapping, the aquifers are defined as they outcrop at the land surface, but in many cases a Major Aquifer will be present beneath Minor or Non-Aquifers. In certain locations Non-Aquifers may be present as a thin covering layer or even be totally removed by quarrying. In these situations the vulnerability of the groundwater will be related to that of the underlying strata.

Rocks with the same geological classification can give rise to different groundwater vulnerability because of differences in hydrogeology in different parts of the country. Appendix 3 gives the standard national classification produced by the NRA on information provided by the British Geological Survey, but this may be varied in detail from region to region of the NRA to reflect local circumstances.

DEPTH OF UNSATURATED ZONE

The unsaturated zone is the part of the aquifer which lies above the water table. It can play an important role in both attenuating the concentration of pollutants through physical, chemical and biochemical processes, and by acting as a delay mechanism. Travel times through the unsaturated

zone can vary depending on the geology and the rainfall recharge. Fissures in the aquifer will allow faster movement whilst rocks where intergranular flow is predominant may act as an impediment to a significant degree. Low permeability horizons, such as clay layers, can also play an important part in inhibiting infiltration. In these latter cases a deep unsaturated zone may help to protect groundwater quality, whilst in fissured limestone strata for example, little benefit will be gained. For non-degradable pollutants the delay mechanism may only be effective in allowing longer term of remedial action to be developed. The unsaturated zone in fissured aquifers can also act as a means of delaying and smoothing out the effects of severe rainfall events. These would otherwise be reflected in higher surface water flows through rapid spring discharge.

ASSESSING TOTAL VULNERABILITY

Figure 2 illustrates two situations of differing vulnerability. The fissured limestone aquifer with a permeable soil cover, no drift and high water table is an example of very high vulnerability, whereas the sand and gravel aquifer, overlain by low permeability clay drift and soil, is much less vulnerable. Not all the above factors are relevant in all circumstances. For example the type of soil is very important in assessing risk from diffuse pollution. It is not relevant when assessing risk from most types of landfilling which takes place below or in the absence of a soil layer. The different factors should only be considered when relevant. Their cumulative effect will give an assessment of the total vulnerability of the resource.

VULNERABILITY MAPS

A full assessment of groundwater resource vulnerability can only be achieved by local studies which, in many cases, will involve hydrogeological and soil investigations. However the NRA considers that it is valuable, especially in the context of strategic land use planning, to take advantage of the existing geological and soil databases held by the BGS and SSLRC to produce groundwater vulnerability maps of England and Wales. The availability of these maps will also help to increase general public awareness of the location of the groundwater resources at risk.

The maps are based upon the geological and soil vulnerability classification. Figure 3 shows the way in which the soil and geological elements combine to give the various resource vulnerability categories.

A national map at a scale of 1:1,000,000 is included with this document. On this map the sub divisions of the high vulnerability soil class are not differentiated. The presence of drift is shown but because of local variability in permeability and thickness it is not possible to illustrate reliably these differences which will need to be established on the basis of detailed local knowledge or investigation.

The NRA is producing vulnerability maps at a scale of 1:100,000 in a three year programme. These show the greater detail in soil classification. The maps do not show the depth of the unsaturated zone, because of its local variability both seasonally and from place to place. In many cases specific local information on water table depth is available from the NRA.

Figure 2
Examples to illustrate vulnerability

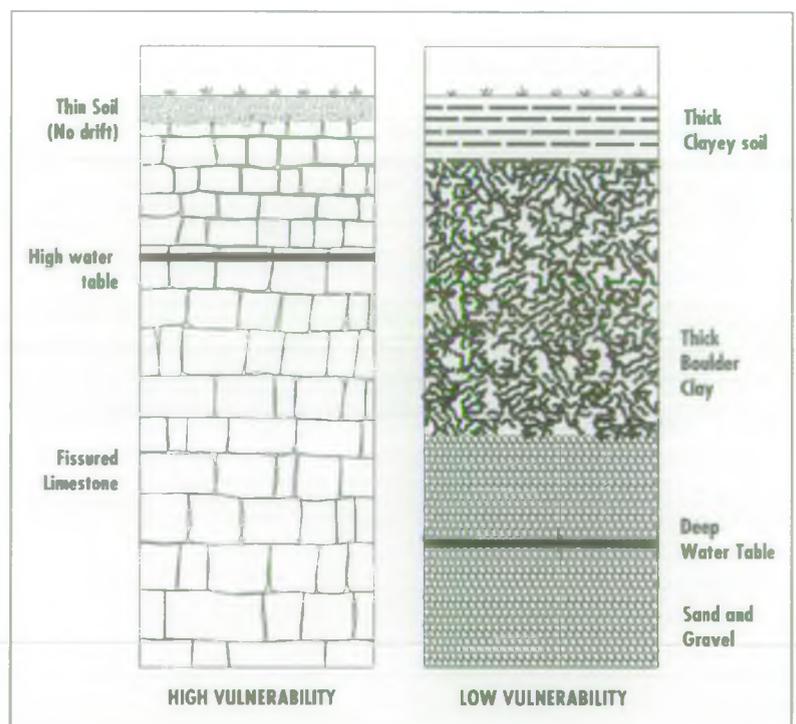
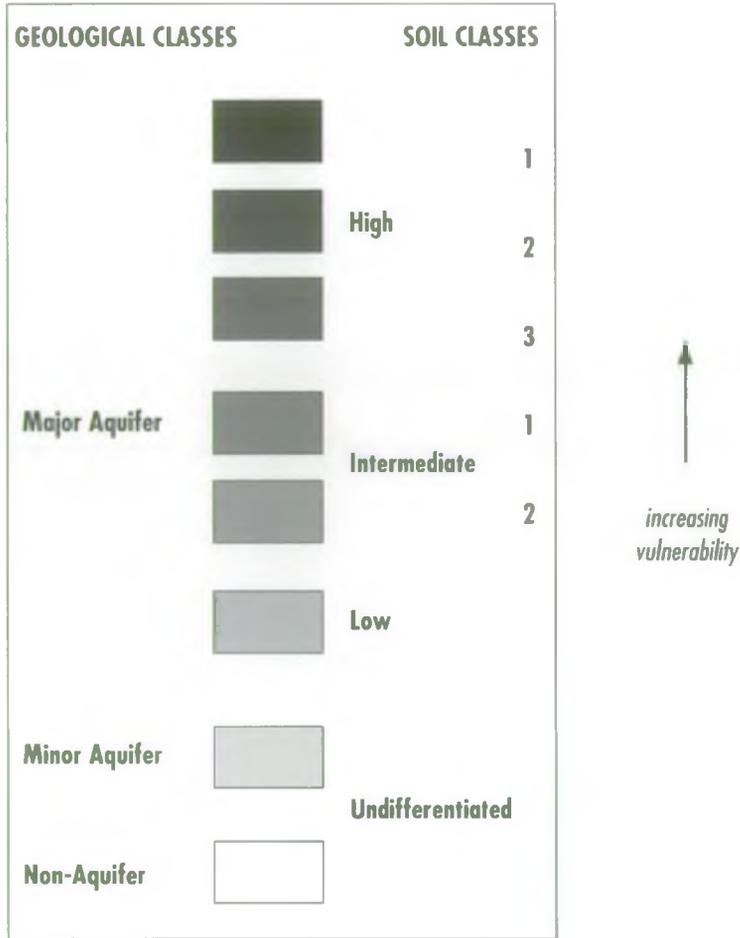


Figure 3
Groundwater
vulnerability
classification



Leachate from a
waste disposal
site discharging
via a spring to
surface water

6. DEFINITION OF SOURCE PROTECTION ZONES

The proximity of an activity to a groundwater abstraction is one of the most important factors in assessing the risk to an existing groundwater source. All sources, including springs, wells and boreholes, are liable to contamination and need to be protected.

Three groundwater Source Protection Zones are recognised:

- Zone I (Inner Source Protection)
- Zone II (Outer Source Protection)
- Zone III (Source Catchment).

The orientation, shape and size of the zones are determined by the hydrogeological characteristics of the strata and the direction of groundwater flow. The sources for which it is appropriate to define zones are those which are used for public supply, other private potable supply (including mineral and bottled water) or in commercial food and drink production.

The total number of groundwater abstractions in England and Wales is estimated to be in excess of 100,000. There are nearly 2,000 major public supply sources and a larger number of licensed private sources. The remainder are unlicensed sources used for private domestic water supply. These will be listed in the private water registers to be set up by District Councils and Metropolitan Boroughs.

ZONE I (INNER SOURCE PROTECTION)

This zone is located immediately adjacent to the groundwater source. It is designed to protect against the effects of human activity which might have an immediate effect upon the source. The area is 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. This 50-day travel time zone is based on the time it takes for biological contaminants to decay. It is an established standard used in many other countries. The zone is not defined where the aquifer is confined beneath substantial covering strata of very low permeability since in such cases the cover will prevent infiltration.

In situations where there is a deep unsaturated zone or thick Drift cover, the attenuating properties of the strata 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 (for example the presence of fissuring) this has not been taken into account in defining the limits of Zone I.

The land immediately adjacent to the source and controlled by the operator of the source is included within this zone. Operating procedures designed to minimise pollution should be in force. The lack of good housekeeping by source owners/operators is one of the commonest sources of pollution to groundwater. The NRA has set out best practice which source owners should apply in this operational area.

ZONE II (OUTER SOURCE PROTECTION)

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. The travel time is based upon that required to provide delay and attenuation of slowly degrading pollutants. It is necessary to define further the Outer Source Protection Zone in high storage aquifers such as sandstones to be the larger of either the 400 day travel isochron or the recharge catchment area calculated using 25 per cent of the long term abstraction rate (usually the licensed rate) for the source. This will ensure an adequate Zone II in all situations.

This zone is not generally 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. It is defined as an area needed to support an abstraction from long-term annual groundwater recharge (effective rainfall). For wells and boreholes the area will be defined on the authorised abstraction rate whilst, for springs, it will be defined by the best known value of average annual total discharge. In areas where the aquifer is confined beneath impermeable cover, the source catchment may be some distance from the actual abstraction.

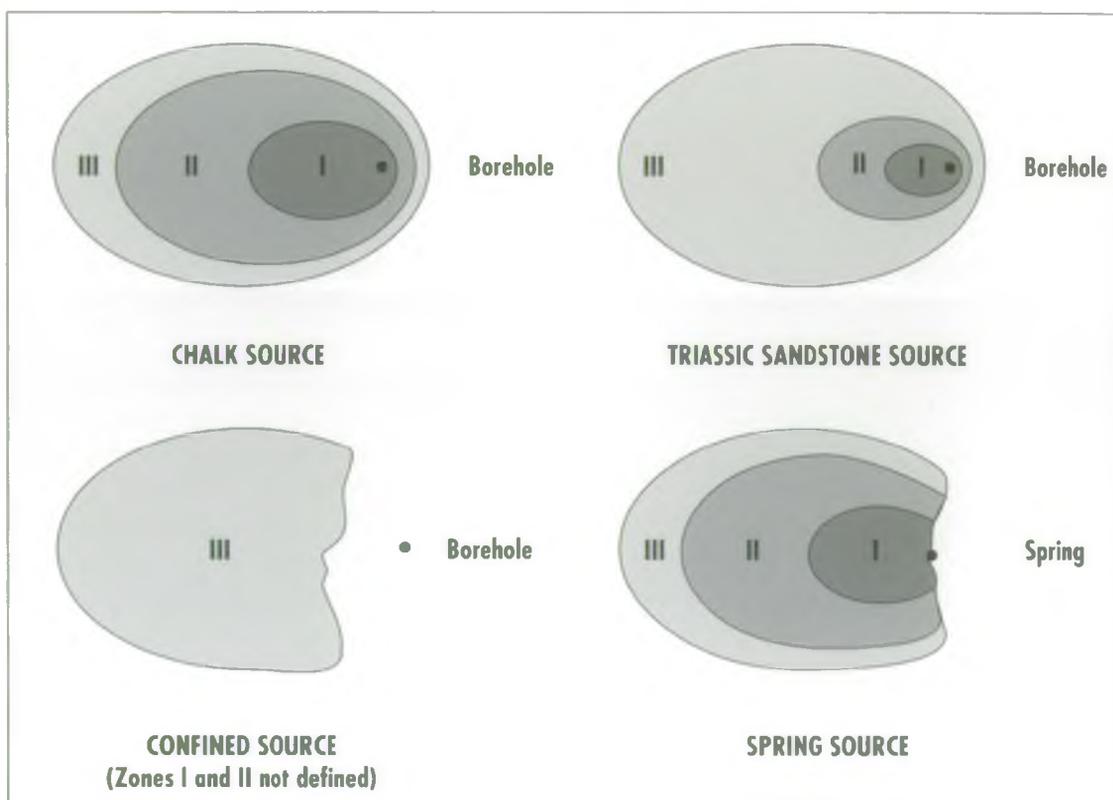
The relationship between the three zones and the

Drilling rig engaged in borehole construction

Courtesy Severn Trent Water



Figure 4
Schematic diagrams
of the relationships
between source
protection zones



groundwater source is shown in Figure 4. The diagram illustrates the variation in the relationship of the zones in four situations. These are abstractions from a low effective porosity Chalk aquifer, a high effective porosity Triassic sandstones aquifer, a confined aquifer and a spring. 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, like the Chalk, is greater (and the travel times faster) than in an aquifer with higher storage capacity like the Triassic sandstones. This will have the effect that in a sandstone aquifer Zone II is likely to be significantly smaller than Zone III whereas in a Chalk aquifer the areas will be more comparable.

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

edge of Zone III will be a few kilometres from an average source in the Triassic sandstones but will be significantly greater than this for a large borehole in the Chalk situated in the drier eastern part of the country.

DEFINING SOURCE PROTECTION ZONES

The NRA has developed a methodology to define Source Protection Zones using steady-state groundwater models which are readily available. The methodology will be published and open for technical evaluation. The NRA will be willing to consider any technically valid method for defining Source Protection Zones in any particular case. Zones will be prepared and made public using the best information available at the time of drafting. The NRA recognises that any method is limited by the sufficiency of the data on the aquifer and its hydraulic characteristics. It 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, especially in heavily used aquifers, protection zones 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 can therefore rarely be regarded as definitive and will be subject to regular reappraisal in the light of new knowledge or changed circumstances. For this

reason the NRA does not propose to publish definitive Source Protection Zone maps in the same manner as the vulnerability maps, although maps at a sub-regional scale of the currently defined zones for individual, or groups of, sources will be made publically available. NRA staff will also be able to advise on current or anticipated revisions.

The definition of an initial 750 zones, covering nearly half of the existing major potable water sources in England and Wales, is expected to be completed by August 1993. Thereafter NRA regions will continue this programme giving priority to those sites where proposals for development arise. It will be some years before zones have been defined for all smaller sources which are not perceived to be subject to current pollution risks. There will be consultation on the

definition of the zones with the source owners. When new sources are developed the urgency to define zones will be determined by the vulnerability of the source and the potential impact on any adjacent zones previously determined.

In heavily exploited aquifers, the Source Catchment Zones of adjacent sources will coalesce and may, in some cases, occupy most, if not all, of the aquifer outcrop. Otherwise, outside the Source Catchment, the resource protection concepts described in Section 5 will apply. In most cases the protection criteria in the Source Catchment Zone and for vulnerable major aquifers will be similar. This reflects both the importance of resource protection and the scope for periodic redefinition of the Source Protection Zones.



Collecting groundwater level and quality information from a datalogger

GROUNDWATER PROTECTION POLICY STATEMENTS

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It is part of our policy to publicise and promote our work to a wide range of people and organisations.

As a result, there are no copyright restrictions on the following policy statements. We would stress, however, that any copied document should be used in their entirety and not consist of isolated sections which could be used out of context.

7. GROUNDWATER PROTECTION POLICY STATEMENTS

Groundwater resources, both in quality and yield, are put at risk by a wide range of human activities. These can range from specific point sources of potential pollution to diffuse pollution spreading over a wide area. These activities are controllable to varying degrees by legislation, which is either operated by the NRA or by other bodies. They may also be subject to guidelines and codes of practice which will have varying degrees of statutory force.

The following sections set out the policy objectives of the NRA with respect to different types of threat to groundwater resources.

The policy statements are divided into eight:

- A. Control of groundwater abstractions;
- B. Physical disturbance of aquifers and groundwater flow;
- C. Waste disposal to land;
- D. Contaminated land;
- E. Disposal of liquid effluents, sludges and slurries to land;
- F. Discharges to underground strata;
- G. Diffuse pollution of groundwater;
- H. Additional activities or developments which pose a threat to groundwater quality

The policy statements are supported by "Acceptability Matrices". These relate the activities to Source Protection Zones and Groundwater Resource Vulnerability. These apply the concepts of vulnerability so that more stringent controls or protection measures will be sought in situations of greatest risk.

Where the protection of an existing use is important, then the Source Protection Zones are paramount and for this reason these are shown in the upper part of the matrix.

The NRA will seek to achieve the objectives in the statements either through its own authorisations or by statutory and non-statutory consultation with other agencies. Where objectives cannot be met through existing provisions the NRA may, in appropriate cases, seek additional powers; for example under Section 93 of the Water Resources Act 1991, to establish statutory water protection zones.

A. CONTROL OF GROUNDWATER ABSTRACTIONS

The NRA is responsible for the granting of authorisations to abstract groundwater under the Water Resources Act 1991. The grant of new authorisations should not detract from the rights of existing authorised abstractors and abstraction from the groundwater resource should be both sustainable and environmentally acceptable. These powers have existed in their present form since the enactment of the Water Resources Act 1963. Within the scope of a policy for Groundwater Protection the NRA must ensure that abstractions are managed to prevent:

- the loss of future water resources by over-abstraction;
- damage to environmental features which are dependent upon the presence or level of the groundwater table, including the unacceptable depletion of river base flows;
- the deterioration of groundwater quality.

A.1 The NRA will only authorise abstractions of groundwater within the scope of the Water Resources Act 1991 which will ensure that:

A) Total abstraction from any groundwater resource area does not exceed the long-term annual average rate of replenishment.

The NRA wishes to ensure that groundwater levels are stable at an acceptable level in the long-term and that groundwater resources are not depleted at rates that cannot be sustained by recharge.

B) There is, in the view of the NRA, no unacceptable detriment to any watercourse or other environmental feature dependent upon groundwater.

The need to preserve groundwater levels or groundwater baseflows to rivers for general environmental benefit, or to meet Minimum Acceptable Flows or Statutory Water Quality Objectives, will often result in the practical limit on abstractions being less than the long term average rate of replenishment. In some cases the optimum use of water resources may be achieved by artificial support of rivers or wetlands.

C) Any abstraction does not cause a deterioration of groundwater quality through the incursion of saline or polluted waters.

In the interests of the conservation of water resources, and to maintain compliance with Statutory Water Quality Objectives, the NRA will not authorise abstractions if there is evidence that they will unacceptably introduce saline waters, from either the sea or from natural connate waters, or water from existing polluted surfacewaters or groundwaters, into an aquifer.

Where existing groundwater abstractions conflict with these policy objectives the NRA will not issue any new permanent licences in the relevant groundwater catchment and will take opportunities as they arise to reduce authorised abstraction.

B. PHYSICAL DISTURBANCE OF AQUIFERS AND GROUNDWATER FLOW

The NRA has an interest in the range and intensity of activities which physically disturb aquifers and groundwater flow. In some cases there is a consequential effect on springs, streamflow, ponds and wetlands.

The NRA's powers under the Water Resources Act 1991 are limited to the control of licensable abstractions (Section 32) and to a limited range of other activities which may disturb aquifers and affect groundwater flow under Sections 30 and 199. Activities which may affect groundwater and which are not covered by the NRA's own powers include:

- all forms of groundwater abstraction outside those controlled by abstraction licences;
- quarrying and gravel extraction above and below the water table whether worked wet, or dry by dewatering;
- mining;
- construction of highways, railways, cuttings and tunnels;
- landfill using low permeability materials and any other activities likely to impede groundwater flow;
- borehole construction (and abandonment);
- any activity which interconnects naturally separate aquifers;
- field drainage that intercepts recharge water.

The NRA recognises the economic importance of many of these activities. The major raw materials of the minerals industry often come from major aquifers and there are therefore potential conflicts of interest. The NRA, in its advice to Mineral Planning Authorities, will have regard to its duties under the Water Resources Act 1991 to conserve and protect water resources and to preserve and, where appropriate enhance, conservation of the water environment. The NRA is a statutory consultee under the Town and Country Planning Acts for

most relevant activities and will make appropriate representations to the determining authority.

The following policies will be applied:

B.1 For any proposal which would physically disturb aquifers, lower groundwater levels, or impede or intercept groundwater flow, the NRA will seek to achieve equivalent protection for water resources and the water environment as if the effect were caused by an abstraction controllable under the Water Resources Act 1991

The remit of the NRA is to achieve the management and protection of water resources on a sustainable basis. Policy Statement A1 of this document sets out those policies to be applied to preserve existing abstraction rights, the quality and quantity of water resources and to prevent consequential effects upon the water environment. Where this cannot be achieved through the Authority's own powers under the Water Resources Act 1991, the NRA will, through representations under planning and other appropriate legislation, seek to achieve an equivalent level of protection of water interests. Where it is not feasible or realistic to prevent effects occurring, the NRA will object unless satisfactory measures can be taken in mitigation.

Mining, quarrying and other below-ground engineering and construction operations often involve dewatering, sometimes for substantial periods of time. Such dewatering can lead to the loss of water supply from wells and boreholes, the removal of natural groundwater discharges to ponds and streams, and can affect wetlands. All of these may require protection or the loss to be mitigated in some way. The water table may in some cases be permanently lowered, leading to irretrievable reduction or loss of spring and stream flows.

Where the effects of dewatering can be mitigated by measures enforceable under the planning controls, the NRA will seek the use of agreements under Section 106 of the Town and Country Planning Act 1990 to put such measures into effect. In addition the NRA may serve a Conservation Notice under Section 30(2) of the Water Resources Act 1991 to require reasonable conservation measures to be taken to protect water resources.

Activities such as mining, the construction of highways and railways with their associated tunnels, cuttings and borrow pits, the construction of impermeable barriers below the water table and exploration drilling for oil and minerals can, in certain circumstances, cause problems by draining groundwater from an aquifer, diverting groundwater, or by interconnecting two separate aquifers. They should, therefore, also be subject to planning controls, unless they constitute "permitted development" under the General Development Order. The use of Conservation Notices for the control of exploratory drilling would be paramount in such cases.

B.2 The NRA will object to a new proposal for mineral extraction where there will be demonstrable harm to water resources and the water environment, unless measures to mitigate any effects can be agreed within planning controls.

The paramount concern is for water resources within Source Protection Zones, although in fissure flow aquifers the concern could apply to the whole of the relevant aquifer.

It is therefore essential that applicants consult the NRA at the earliest possible stage so that any potential impact upon water interests can be identified and appropriate investigations initiated. The NRA will require that any Environmental Assessment includes an adequate hydrogeological study to meet its concerns, covering any resultant impacts upon the water environment generally and Statutory Water Quality Objectives in particular. Of specific concern are operations below the water table where dewatering takes place. The hydrogeological study should include details of proposed water management and reuse.

The unsaturated zone is vital to both the quality and quantity of water resources. Water percolating through this zone can be purified by the filtration of suspended solids and the breakdown of pollutants by oxygenation and biological action. The

unsaturated zone can act as a buffer which delays and attenuates flood peaks and makes an important contribution to dry weather flows. The NRA will require a developer to demonstrate that removal of mineral from the unsaturated zone and any subsequent restoration will not lead to a significant reduction in the quality or quantity of water resources. Where low-level restoration which permanently reduces the thickness of the unsaturated zone is proposed, the proposals should have regard to impacts upon groundwater quality and the NRA may seek restrictions on subsequent agricultural practices or other land uses.

B.3 The NRA will normally object to proposals where the obstruction of groundwater flow is likely to cause undesirably high groundwater levels or cut-off groundwater flow, unless measures to mitigate any effects can be agreed.

Impermeable constructions below the water table, such as bentonite/concrete slurry walls and lined landfills can impede groundwater flow and cause the water table to rise further up the groundwater gradient. This may lead to flooding or put subterranean structures at risk. Similarly the cutting-off of groundwater flow can cause serious problems to abstractors and groundwater dependent features down the groundwater gradient.

B.4 The NRA will encourage best practice regarding the backfilling of any abandoned shaft, well, borehole, tunnel or adit in order to prevent pollution or loss of water resources.

There are preferred methods for dealing with these, largely dependent upon geology. The NRA will offer guidance on the correct method of filling or sealing disused boreholes, shafts and tunnels.

The NRA will also exercise its powers under Section 71(6) of the Water Industry Act 1991 to prevent the waste of water resources from uncontrolled artesian overflow of any borehole or shaft.

C. WASTE DISPOSAL TO LAND

The NRA is a statutory consultee of the Waste Regulation Authorities (WRAs) for the issue of Waste Disposal Licences under the Control of Pollution Act 1974 and will actively liaise with WRAs throughout the life of any landfill site. It is also a statutory consultee of the Planning Authorities under the Town and Country Planning Acts. A valid Planning Permission or a Certificate of Lawfulness of proposed use or development is required before a Waste Disposal Licence can be issued. The planning permission is the means by which aftercare provisions on closed landfill sites can be regulated, because the Waste Disposal Licence only relates to the operational phase of any site. This is mainly achieved through the use of Section 106 obligations (Town and Country Planning Act 1990) between the applicant and the Planning Authority. However, the provisions of the Environmental Protection Act 1990 will require Waste Management Licences to regulate the landfill in its post-operative phase until the hazard and the risk of pollution has reduced to a minimum and the surrender of the licence can be accepted. The NRA will be a statutory consultee over the issuing of a certificate of completion. However, in cases where companies go into liquidation, planning permissions, obligations and agreements may well remain appropriate in order to control the pollution risks since they relate to the land and not the operator.

A wide range of waste disposal activities require a Waste Management Licence. These include scrap yards, transfer stations, incinerators, waste storage and treatment etc. However, the greatest threat to groundwater from waste disposal operations is posed by landfilling activities. In view of this major pollution risk the following policy statements relate mainly to waste disposal to land. The matrix following the policy statements refers only to landfill.

C.1 The NRA will liaise with Planning Authorities and others to encourage the location of new landfill sites in areas where groundwater is least vulnerable to pollution.

The NRA wishes to encourage developers and planning authorities to consider Non-Aquifers preferentially for new waste disposal activities. In

some areas above-ground landfills will need to be considered where sufficient below ground void space is not available. The NRA will make maps available and these should be taken into account in the drawing up of Structure and Waste Local Plans.

C.2 The NRA will normally object to all activities requiring a Waste Management Licence within Zone I (Inner Source Protection)

The risk of contamination to groundwater sources by waste handling activities is greatest within Zone I. Besides landfilling, other activities which require a waste management licence, (such as incinerators, transfer stations, civic amenity sites, waste chemical treatment plants, storage of special wastes or scrapyards) can present a significant threat to groundwater quality. Because of the variable nature of these operations they will be considered on a case by case basis, but there will be a presumption against them.

C.3 The NRA will normally object to landfilling within Zone II (Outer Source Protection) unless it is satisfied that the waste materials do not contain significant biodegradable or other potentially polluting matter and that the site will have acceptable operational safeguards.

There is a presumption against landfilling in Zone II unless it can be shown that the waste itself is non-polluting. This covers essentially inert, naturally occurring excavated materials, but construction and demolition waste may be acceptable depending on its origin, the local conditions and the proposed method of operation of the landfill.

C.4 The NRA will not object to the landfilling of wastes with a high or medium pollution potential within Zone III and on Major and Minor Aquifers if it is satisfied that the risk of pollution to groundwater can be adequately mitigated by engineering measures and operational management controls.

The scale of engineering measures will be mainly dependent upon the waste type, the local vulnerability of the groundwater and the proximity of any abstractions. Engineering measures for wastes which could produce leachate of significant polluting potential must provide for total containment and the collection and disposal of leachate in an approved management scheme.

If the nature of the waste and the hydrogeological conditions are such that the NRA judges that its deposit does not pose a threat to groundwater, then the NRA may agree to a site being operated on non-containment principles, providing acceptable operational safeguards are implemented.

C.5 The NRA will not normally object to the landfilling of waste on non-aquifers for groundwater pollution reasons but the protection of surface water quality, flood defence and fisheries interests must be considered.

This refers to Non-Aquifers where groundwater protection issues may not be of paramount concern, but the infrastructure and control for leachate management will need to be rigorous at any site where controlled waters other than groundwater may be placed at risk of pollution.

C.6 The NRA will normally object to waste disposal activities which extend to or below the water table in Source Protection Zones. Elsewhere the presence of an unsaturated zone will normally be required but a landfill, operated on containment principles, may be considered on a site specific basis.

Wastes deposited below the water table will quickly generate leachate if groundwater ingress is not impeded. This may present operational difficulties and lead to rapid contamination of groundwater. The presence of an unsaturated zone gives an opportunity for attenuation to occur and leads to a delay in any impact on the water environment. The engineering of quarries excavated significantly below the water table will be difficult and expensive to achieve successfully in permeable strata. In such cases the NRA is likely to object to the deposition of potentially polluting wastes below the water table unless it considers the engineering measures effective.

C.7 The NRA will seek to ensure that, as part of the Planning Permission, or Waste Management Licence, adequate provision is made for monitoring and preventing pollution of controlled waters. Adequate provision must also be made for long-term maintenance and monitoring of leachate control and disposal systems and for the integrity of any cap, basal or side seals.

To achieve this policy objective the NRA will request Planning Authorities to use Section 106 of

the Town and Country Planning Act 1990, until Section 39 of the Environmental Protection Act, 1990 is implemented.

The operator must agree monitoring facilities and programmes with the NRA in conjunction with the WRA.

C.8 The NRA will liaise regularly with Waste Regulation Authorities in reviewing Waste Management Licences at intervals according to Department of the Environment advice (currently every five years).

This allows the update of licence conditions in line with best current landfilling practices.

C.9 The NRA will advise a Waste Regulation Authority not to accept the surrender of a licence unless and until it is satisfied (by the results of monitoring or site investigation) that the landfill is unlikely to cause pollution of the water environment.

This statement addresses the long term problems which are likely to arise after the active operation of the site has ended and when daily supervision and control have ended. Co-operation between the NRA and WRAs will be necessary to agree criteria for surrendering licences under the Environmental Protection Act 1990.

NOTE ON TERMINOLOGY

Prior to the Environmental Protection Act 1990 being fully implemented, the relevant sections of the Control of Pollution Act 1974 Part 1 remain in force to control the disposal of waste to land and other waste related activities. Until the full implementation of the relevant sections of the Environmental Protection Act 1990 the term 'Waste Management Licence' in this document refers to all authorisations for waste disposal operations including 'Waste Disposal Licences'.

Matrix I
Landfill Acceptability

SOURCE PROTECTION			
SITE TYPE	I INNER ZONE	II OUTER ZONE	III CATCHMENT ZONE
1. High pollution potential (landfills accepting domestic, commercial and industrial waste either individually or on a co-disposal basis)	Not acceptable	Not acceptable	Only acceptable with engineered containment and operational safeguards
2. Medium pollution potential (landfills accepting construction, demolition industry wastes and similar)	Not acceptable	Acceptable subject to evaluation on a case by case basis and adequate operational safeguards	Acceptable subject to evaluation on a case by case basis and adequate operational safeguards
3. Low pollution potential (landfills accepting inert, uncontaminated waste)	Not normally acceptable	Acceptable only with adequate operational safeguards	Acceptable only with adequate operational safeguards
RESOURCE PROTECTION			
SITE TYPE	MAJOR AQUIFER	MINOR AQUIFER	NON- AQUIFER
1. High pollution potential (landfills accepting domestic, commercial and industrial waste either individually or on a co-disposal basis)	Only acceptable with engineered containment and operational safeguards	Only acceptable with engineered containment and operational safeguards	Acceptable only with adequate operational safeguards. Engineering measures may be necessary in order to protect surface waters
2. Medium pollution potential (landfills accepting construction, demolition industry wastes and similar)	Acceptable only with adequate operational safeguards	Acceptable only with adequate operational safeguards	Acceptable only with adequate operational safeguards
3. Low pollution potential (landfills accepting inert, uncontaminated waste)	Acceptable	Acceptable	Acceptable

Footnotes

- 1) This matrix refers specifically to groundwater protection. In case of Non-Aquifers, operational safeguards will relate mainly to the protection of surface water resources.
- 2) Operational safeguards will include, inter alia, appropriate site management, leachate control and management and monitoring controls.

3) Mono disposal of hazardous industrial wastes will only be acceptable in non-aquifer areas.

4) For sites which accept wastes of mixed pollution potential, the comments relating to the highest category of site type will apply.

This matrix is a summary only and must be read in conjunction with the policy statements.

D. CONTAMINATED LAND

The NRA is concerned about the pollution risks associated with contaminated land whether in a derelict state, as a result of the disturbance caused during redevelopment or from active industrial sites.

The NRA will seek appropriate controls to protect the water environment from the redevelopment of contaminated land by liaising with Local Planning Authorities under the Town and Country Planning Acts. The NRA will also liaise with Her Majesty's Inspectorate of Pollution (HMIP) in respect of its powers to promote Integrated Pollution Control.

Contaminated Sites may include land currently or previously used in connection with the following activities:-

- coal-gas manufacture
- landfill sites and other waste disposal activities, waste lagoons
- chemical manufacture
- heavy industry
- mining
- sewage treatment works
- metal refining
- oil refining and hydrocarbon storage.

The following policies will apply in dealing with this issue.

D.1 The NRA will encourage the implementation of effective remedial measures to prevent pollution of groundwater by existing direct or indirect discharges from any contaminated site. Where pollution occurs the NRA will prosecute in appropriate cases under Section 85 of the Water Resources Act 1991.

The NRA will always seek to co-operate with landowners and occupiers to encourage investigation and a programme of remedial measures which will prevent continuing pollution. Where co-operation is not forthcoming the NRA will use its powers of prosecution in appropriate cases under Section 85 of

the Water Resources Act 1991. The NRA has powers under Section 161 of the Water Resources Act 1991 to carry out remedial works to remedy or forestall pollution. Under Section 61 of the Environmental Protection Act 1991, the Waste Regulation Authorities have a duty to monitor closed landfill sites and take remedial measures where appropriate. The NRA will liaise with the WRAs concerning this category of contaminated land and with other bodies/site owners for other categories to achieve its objectives

D.2 The NRA will seek to be consulted by Local Planning Authorities about any application for development or other works on sites likely to be contaminated.

To ensure that groundwater quality interests are covered on sites where redevelopment is proposed, it is essential that consultation takes place between the developer and the NRA as early as possible before any site investigations commence. The possibility of contamination should be clearly indicated by the Local Planning Authority or the applicant.

D.3 The NRA will recommend to the Local Planning Authority that it refuse Planning Permission for the redevelopment of contaminated sites where water resources could be adversely affected unless it is satisfied that the proposals include effective measures for the protection of groundwater and surface water quality. It will advise Local Planning Authorities where insufficient or technically weak information has been provided so that they can require the applicant to supplement the details provided.

On sites where contamination of the ground and groundwater pollution is highly likely, a thorough site investigation should take place prior to any application for Planning Permission. Investigations should include an assessment of the leaching characteristics of contaminants in the ground and of the geology/hydrogeology of the site, including existing groundwater quality. This information should support subsequent Planning Applications. These should include a strategy for dealing with contamination and minimising water-pollution.

Where the site investigation reveals significant groundwater pollution the development proposals should include details of the proposed remedial action.

D.4 The NRA will seek to ensure that Planning Permissions contain conditions designed to protect water resources. The NRA will strongly encourage the Local Planning Authorities to enter into planning obligations with developers under Section 106 of the Town and Country Planning Act, 1991 (as substituted by Section 12 of the Planning and Compensation Act, 1991) to control and monitor ground and groundwater contamination during and after redevelopment.

Planning obligations should require a remediation plan/method statement to be submitted for the approval of the local planning authority in consultation with the NRA. They should include details of further site investigation, chemical analysis, criteria and standards for removal or treatment of contaminated soil and final restoration. Details of foundations, covering material, drainage and groundwater quality monitoring programmes should also be included.

D.5 The NRA will wish to ensure that any discharge, seepage or drainage resulting from the redevelopment of a contaminated site will be of a quality and quantity that will not pollute groundwater.

When contaminated sites are cleaned-up, and where groundwater resources are at risk, the NRA will advocate the removal or suitable treatment of material with a significant water pollution potential. Target concentrations for key contaminants should be specified. These should relate to the leached concentration, not total concentrations specified in guidance issued by the Interdepartmental Committee on the Reclamation of Contaminated Land (ICRCL). An estimate of the quantity and quality of any continuing discharge from the developed site should be made.

D.6 In areas where historical industrial development is known to have caused widespread groundwater contamination, the NRA will review the merits and feasibility of groundwater clean-up depending upon local circumstances and available funding.

In some areas where historical groundwater pollution has resulted from a number of possible sources it would be extremely difficult to pinpoint individual sites or incidents. Where old urbanised industrial areas are located on aquifer outcrop, groundwater pollution is almost inevitable. In these situations the benefits and feasibility of any

groundwater clean-up operation must be carefully considered. In many cases the situation may be beyond repair and efforts should then be directed towards the removal of any remaining source and the monitoring of groundwater quality to ensure that any redevelopment does not cause further deterioration. Containment of polluted groundwater by engineering methods or sacrificial pumping may also be appropriate.

D.7 The NRA will encourage the manufacturing industry and others to improve operational practices to eliminate unauthorised discharges to land. Where contamination of groundwater or of surface water through contaminated groundwater flow is apparent the NRA will require remedial measures to be undertaken to prevent further pollution.

Manufacturing industry involves the storage and use of chemical compounds which can, over time, contaminate the land surface at many locations through accidental spillage, leakage and poor management practices. The resultant groundwater pollution can affect surface water quality where the opportunity for shallow sub-surface flow exists.

For existing sites in areas vulnerable to groundwater pollution (and where pollution is known, suspected or anticipated), the NRA will seek to discuss with the local management the need for improved operational practices and remedial measures, where necessary, on a progressive basis. The NRA has recommended further Regulations are made under Section 92 of the Water Resources Act 1991 to prevent pollution at source from oil storage facilities. The storage of other potentially polluting substances is also being examined in the context of Regulations under Section 92 of the Act.

D.8 The NRA will, by liaison with Planning Authorities and industry, seek to influence the preferential location of new industrial development in areas which are not vulnerable to groundwater pollution.

The NRA will also, by liaison with HMIP and other regulatory bodies, seek to ensure that authorisations granted to industry prevent future contamination of land and groundwater.

It is important to recognise that land is continually being contaminated. The NRA wishes to ensure that these areas are minimised in the future,

especially where new industries are located in green field sites. Through consultation on Draft Development Plans, the NRA will indicate areas vulnerable to groundwater pollution.

The NRA seeks to influence any new proposal involving the significant use, storage or manufacture of Lists I and II chemicals whether in raw or waste form, so that they are preferentially located on Non-Aquifers.

Proposals for the siting of such activities within Source Protection Zones or on Major Aquifer areas would only meet with approval subject to adequate measures to prevent the migration of

pollutants to groundwater. Such measures would include:-

- minimisation of underground storage of List I substances (prohibited within Zone I);
- no open storage areas for List I substances;
- secure bulk storage of potentially polluting substances with impermeable bunding;
- adequate containment and safe disposal for spillages;
- above ground pipework in positions not vulnerable to accidental damage.

E. THE APPLICATION OF LIQUID EFFLUENTS, SLUDGES AND SLURRIES TO LAND

A significant proportion of all liquid and semi-liquid wastes are disposed of by spreading them onto land. Some of these wastes can be beneficial to agricultural land. The disposal of liquid effluents and sludges to the land surface can present a risk to groundwater quality. The risk is dependant upon the chemical and microbiological content of the waste, the rate, method and timing of application and the groundwater vulnerability.

Soils can play an important role in mitigating the impact of many potential pollutants and the groundwater vulnerability map series will be a valuable aid to decision-making when choosing suitable locations. However, where groundwater is least vulnerable, surface waters are likely to be most vulnerable and the interaction of this policy with the protection of surface water is particularly relevant.

The Control of Pollution Act 1974 and the Water Resources Act 1991 form the primary legislation which controls the deposit of waste materials onto land. The Collection and Disposal of Waste Regulations 1988 (No 819) define those categories of waste which are a) controlled and b) exempted from the licensing provisions of the Control of Pollution Act 1974. Certain controlled wastes may be exempted from these provisions and these are listed in Schedule 6 of the Regulations. They include any wastes deposited on land used for agricultural purposes, "for the purpose of fertilizing or otherwise beneficially conditioning the land". Its disposal must not present an environmental hazard and the Waste Regulation Authority (WRA) must receive prior notification. Provided the above criteria are met, then the operation does not require a Waste Management Licence and there is no formal consultation with the NRA. Particulars of regular or frequent deposits of wastes of similar composition need only be given to the WRA every six months.

Sewage sludge deposited directly onto land for agricultural purposes is not a controlled waste and, therefore, is presently exempt from licensing provisions (Schedule 3 of the 1988 Regulations). Sewage sludge deposition is also addressed by The Sludge (Use in Agriculture) Regulations 1989 (No

1263). The control of these is vested in Her Majesty's Inspectorate of Pollution (HMIP)..

The disposal of agricultural wastes is presently exempt from any controls other than those relating to their storage (The Control of Pollution (Silage, Slurry & Agricultural Fuel Oil) Regulations 1991 (No 324)) and general guidelines within the Ministry of Agriculture Code of Good Agricultural Practice for the Protection of Water.

The wastes can be divided into three categories depending upon the degree of control the NRA can influence in each case and the industry from which they originate:

- Controlled wastes (industrial effluent sludges, both organic and inorganic in nature and including cesspool contents).
- Sewage sludges (produced exclusively at sewage works and disposed of by Sewerage Undertakers or their contractors).
- Agricultural wastes (produced from various farming activities, including animal wastes and silage liquors).

E.1 The NRA will seek to ensure by close liaison with Waste Regulation Authorities, that it is informed of all notifications of sludge or liquid waste disposal to land. Where the NRA considers that such a deposit will give rise to a significant risk of polluting groundwater (or surface water), it will ask the relevant WRA to require that the operation is subject to the provisions of Section 5 of the control of Pollution Act 1974 (or Section 36 of the Environmental Protection Act 1990 when implemented).

E.2 The NRA will request WRAs to curtail the disposal of any sludge or liquid waste which contains significant concentrations of List I (Appendix 1) substances to land within Source Protection Zones or on Major and Minor Aquifers, unless prior investigation shows, to the satisfaction of the NRA, that pollution of groundwater will not occur.

The disposal of dilute solutions of pesticides from the cleaning of spraying equipment onto uncropped land which, supports only poor vegetation, is of minimal wildlife value and has no hedges, trees or bushes nearby, is an acceptable practice and should

be used in preference to soakaways (see policy statement F4). However, these areas must be located with due regard to soil and aquifer conditions and proximity to sources of water supply.

To avoid undue leaching of nitrate, controlled wastes, agricultural wastes which have a significant nutrient content and sewage sludges must be applied according to the nutrient requirement of the crop and take account of other sources of nitrogen. In any case, the nitrogen content must not exceed 250kg/ha in any 12 month period.

E.3 The NRA will liaise with sewerage undertakers and recipient farmers over the disposal of sewage sludge to land. It will seek to influence the location, quantity and timing of applications in order to prevent pollution of water resources.

The NRA will make groundwater vulnerability maps available so that Water Companies and others may plan disposal areas in relation to groundwater vulnerability. Areas of Non-Aquifer or Minor Aquifer are preferred to Major Aquifers. However, disposal plans will also have to take account of surface water vulnerability. Where there is little option other than to spread sludge on Major Aquifers, the soil vulnerability classification must be considered to minimise any impact on groundwater. The development of new areas of dedicated land will be discouraged by the NRA.

E.4 The NRA will liaise with farmers and seek to encourage them in the preparation of waste management plans for their farms. These should include the drawing up of a map identifying land available for spreading.

The NRA recognises the beneficial effects of applying sludges and slurries, (whether for fertilization or soil conditioning), but this must be carried out without causing contamination of water resources, including contributing to excessive leaching of nitrate. Best practice for the management of farm wastes in relation to the protection of water is given in the MAFF Code of Good Agricultural Practice for the Protection of Water and should be followed at all times.

E.5 The NRA will advise Local Planning Authorities to refuse permission for proposed, relevant agricultural developments which could lead to the disposal of sludges and slurries, unless it is satisfied that sufficient, suitable land is available for disposal purposes.

The rate and method of application of farm wastes and sewage sludge to land must take account of the risks of water pollution and be determined by the crop requirements and soil characteristics. Farm waste and sewage sludge applications to land should be beneficial to agriculture and should not be carried out for waste disposal purposes. Whether the land is suitable depends upon its proximity to abstractions, the soil type, the degree of slope, etc. The Code of Good Agriculture Practice for the Protection of Water and the groundwater vulnerability maps which will be published by the NRA will provide some guidance. This will need to be supplemented by local information.

Matrix 2

The application of liquid effluents, sludges and slurries to land

SOURCE PROTECTION			
NATURE/ORIGIN OF SLUDGE	I INNER ZONE	II OUTER ZONE	III CATCHMENT ZONE
INORGANIC OR NON-BIODEGRADABLE			
Containing significant concentrations of List I substances	Not acceptable	Not acceptable	Not acceptable
Containing significant List II substances and other persistent chemicals	Not acceptable	Not acceptable	Only acceptable subject to evaluation and constraints (presumption against)
STRONG ORGANIC AND BIODEGRADABLE			
Low nutrient content/industrial	Not acceptable	Not acceptable	Only acceptable subject after full investigation and subject to strict control (presumption against)
Sewage sludge	Not acceptable	Acceptable subject to evaluation	Acceptable subject to evaluation
Farm wastes	Not acceptable	Acceptable subject to evaluation	Acceptable subject to evaluation
LOW POLLUTION POTENTIAL/HIGH DILUTION	Not acceptable	Acceptable subject to evaluation	Acceptable
RESOURCE PROTECTION			
NATURE/ORIGIN OF SLUDGE	MAJOR AQUIFER	MINOR AQUIFER	NON-AQUIFER
INORGANIC OR NON-BIODEGRADABLE			
Containing significant concentrations of List I substances	Not acceptable	Not acceptable	Only acceptable subject to evaluation and constraints (presumption against)
Containing significant List II substances and other persistent chemicals	Only acceptable subject to evaluation and constraints (presumption against)	Only acceptable subject to evaluation and constraints (presumption against)	Acceptable subject to evaluation
STRONG ORGANIC AND BIODEGRADABLE			
Low nutrient content/industrial	Only acceptable subject to evaluation and constraints (presumption against)	Only acceptable subject to evaluation and constraints (presumption against)	Acceptable subject to evaluation
Sewage sludge	Acceptable subject to evaluation	Acceptable subject to evaluation	Acceptable subject to evaluation
Farm wastes	Acceptable subject to evaluation	Acceptable subject to evaluation	Acceptable subject to evaluation
LOW POLLUTION POTENTIAL/HIGH DILUTION	Acceptable	Acceptable	Acceptable

Footnotes

- Sludges containing significant concentrations of nitrogen compounds must be evaluated in the context of the existing crop requirement for nutrients and also take other sources of nitrogen into account. In Nitrate Sensitive Areas (NSAs) there may be a requirement to deposit sludges generated within the NSA outside the designated area. Advice given in the MAFF Code of Good Agricultural Practice for the Protection of Water should be followed in all cases.
- Evaluation of the acceptability of wastes at locations where there are low-permeability soils and/or strata should take account of potential run-off into surface waters. This may mean that situations considered acceptable for groundwater protection are unacceptable for surface water reasons.
- Where disposal of sludges on Major Aquifers is unavoidable the relevant groundwater vulnerability map should be used to determine locations where the soil is least permeable and/or affords a degree of protection. These areas should be used in preference to other, more vulnerable, areas.
- The injection of sludges in such a way that it can by-pass the protective features of the soil layer is an increasing practice. The proposed method of sludge application will be taken into account in evaluating the risks of disposal to groundwater in any location.
- Where waste treatment sludges containing significant concentrations of List I (Appendix 1) substances are mixed with sewage sludge prior to spreading on land, restrictions will relate to the most polluting component.

This matrix is a summary only and must be read in conjunction with the policy statements.

F. DISCHARGES TO UNDERGROUND STRATA

The NRA has powers under the Water Resources Act 1991 to exert considerable influence over discharges to underground strata. Such discharges normally reach underground strata via a soakaway system. There are three main areas of concern:-

- Sewage effluent discharges which include septic tank and sewage treatment plant effluents from individual properties, small housing estates and commercial developments.
- Trade effluent discharges which include dewatering and cooling waters, and process effluents.
- Surface water discharges which include contaminated runoff from roofs and impermeable areas, such as major roads, amenity areas, car/lorry parks, storage areas etc.

The NRA often becomes aware of activities which may result in a discharge to ground through the planning consultation process or through referrals from Local Authorities under Building Regulations. These discharges are controlled by issuing consents to discharge or prohibition notices supported by monitoring and appropriate enforcement.

A consent may be issued under Section 85 of the Water Resources Act 1991 including appropriate conditions for quality and quantity so that a discharge of sewage or trade effluent does not pollute controlled waters. A relevant prohibition notice may be served on a person under Section 86 of the Water Resources Act 1991 to prohibit new or existing discharges which may (or are currently) causing pollution. The need for consents or prohibition notices in respect of the three main areas of concern is summarised below:-

- sewage and trade effluents discharged directly to groundwater will always need consents;
- sewage and trade effluents discharged to soakaway from fixed plant or a building may be controlled either by the serving of prohibition notices or issuing of consents dependant upon the pollution potential of the effluent;

- surface runoff discharged directly to groundwater, or via pipe to soakaway, may be controlled by the serving of prohibition notices.

F.1 The NRA will seek to prevent any discharge into underground strata which may result in pollution of water resources.

F.2 The NRA expects to be consulted by local and other authorities to identify any proposal involving discharge of sewage, trade effluent or contaminated surface water into underground strata. The NRA will object if water resources are judged to be at risk

The NRA may become aware of a proposed discharge to soakaway via a number of different routes. These include consultation procedures with Local Authorities (District and Borough Councils) under the Town and Country Planning Act 1990 and Building Regulations 1985 (amended regulation 1990). Others arise through direct consultation between the NRA and the person proposing to make a discharge, their agent or consultant.

At the pre-planning or planning application stage the NRA will identify, where possible, whether the discharge requires control. For discharges from multiple dwellings or commercial developments there is seldom enough information accompanying the application to enable a detailed assessment to be made. The NRA will not be able to assess an application until sufficient information has been provided. This will include use of its powers under the Water Resources Act 1991. An objection will avoid creating a situation where construction can take place but it is only subsequently found out that discharge consent conditions cannot be met or the discharge is not allowable.

F.3 The NRA will control discharges into underground strata within areas where groundwater is judged to be at risk in accordance with Sections 85 and 86 of the Water Resources Act 1991.

Discharges of sewage effluent to ground from new septic tanks or sewage treatment plants serving small developments which discharge less than 5 m³/d are only controlled by the NRA in designated areas where groundwater is at risk of pollution. All discharges of sewage effluent to ground greater than 5 m³/d will be controlled. Storm sewage overflows

can vary considerably in flow and quality and discharge to ground is only acceptable where prior investigation proves favourable.

All discharges of trade effluent to ground will be controlled. Applications for consent to discharge trade effluent will be assessed according to the potential impact of the proposal. This will depend upon the characteristics of the effluent and the local soil and aquifer conditions.

Surface water runoff (with the exception of clean roof drainage) will be controlled whenever possible in areas where groundwater is at risk. It will generally be subject to standard conditions, such as installation of petrol/oil interception where applicable. Where control is necessary, the NRA will require a hydrogeological assessment to be carried out to identify the potential impact of the discharge on water resources.

F.4 The NRA will refuse to consent the discharge of List I substances into underground strata and will limit the entry of List II substances in accordance with the EC Groundwater Directive (80/68/EEC).

These substances are present within some industrial and agricultural effluents. Disposal of toxic and persistent contaminants to ground poses a significant risk of groundwater pollution and alternative acceptable disposal arrangements should be found. Exceptions may be made where the quality and concentration of the substances will not pollute groundwater; eg for discharges of domestic effluent from an isolated dwelling; for the purposes of aquifer recharge of water used for geothermal purposes; where the groundwater is found to be permanently unusable for other uses.

F.5 The NRA will normally refuse to consent the discharge of sewage or trade effluent below the water table. A direct discharge will only be considered where the groundwater is permanently unsuitable for any use and is isolated from the water cycle.

Within all Source Protection Zones and Major and Minor Aquifers the NRA will seek to control the depths of soakaway systems used for the disposal of sewage and/or trade effluent by means of the consent to discharge procedure. A limit on the depth of a soakaway system will be imposed. This will be based on the information provided on the

quality and quantity of the effluent to be disposed, the thickness of the unsaturated zone, the geological conditions and the proximity of existing water resource interests.

This policy statement also covers deep well injection of trade effluents and other matter.

F.6 The NRA will seek to control the depths of all boreholes, wells and deep soakaway systems for the discharge of surface water drainage.

The NRA is concerned that boreholes, wells and deep soakaways designed for clean water disposal could offer a conduit for the rapid transport of contaminants to groundwater. The NRA will seek to control the depths of these soakaway systems by recommending maximum penetration depths and a requirement that the water table should not be intersected. In general, groups of shallow soakaways are preferable to one or two deep boreholes.

F.7 Where access to a main sewer is unavailable, the NRA will only agree to the disposal of domestic sewage effluent within Zone I providing it is to properly managed sealed effluent storage tanks (cess pits/pools).

The NRA opposes the use of septic tank systems for the disposal of domestic sewage effluent in Zone I. Close liaison between the Local Planning Authority, the building control inspectorate and the NRA is needed to control these installations. Within Zone I the only system of disposal acceptable to the NRA, where access to main sewer is unavailable, is the use of sealed effluent storage tanks (cess pits/pools). These are often poorly constructed and maintained and discharge polluting effluent to groundwater, and often, indirectly, to adjacent surface waters. The NRA will request the local planning authority to include conditions on any planning permission requiring the construction of a sealed system to approved standards. Where possible, via Section 106 obligations, there should be a requirement for adequate records to be kept of maintenance and emptying records (date, volume and contractor used). The NRA will wish to see and encourage the proper disposal of tank effluent to a sewage treatment works or approved disposal site and, for properties in Zone I, subsequent connection to mains drainage if such facilities become available.

Matrix 3a

Discharges of sewage effluent to underground strata

SOURCE PROTECTION			
ACTIVITY	I INNER ZONE	II OUTER ZONE	III CATCHMENT ZONE
A. DISCHARGES OF SEPTIC TANK OR TREATED SEWAGE EFFLUENT INTO UNDERGROUND STRATA <2m ³ /d (single dwelling)	Not acceptable (R1)	Acceptable (R3/4) (subject to investigation and standard conditions)	Acceptable (R4) (subject to standard conditions)
2m ³ /d to 5m ³ /d	Not acceptable (R1)	Only acceptable after investigation and assessment (R3)	Acceptable (3/4) (subject to investigation/standard conditions)
>5m ³ /d	Not acceptable (R1)	Presumption Against (R2) (subject to investigation)	Only acceptable after investigation and assessment (R3)
Storm Sewage Overflows to Soakaway	Not acceptable (R1)	Not acceptable (R1)	Presumption Against (R2) (only acceptable in exceptional circumstances)
RESOURCE PROTECTION			
ACTIVITY	MAJOR AQUIFER	MINOR AQUIFER	NON- AQUIFER
A. DISCHARGES OF SEPTIC TANK OR TREATED SEWAGE EFFLUENT INTO UNDERGROUND STRATA <2m ³ /d (single dwelling)	Acceptable (R4) (subject to standard conditions)	Acceptable (R4) (subject to standard conditions)	Acceptable (R4) (subject to standard conditions)
2m ³ /d to 5m ³ /d	Acceptable (R3/4) (subject to investigation/standard conditions)	Acceptable (R3/4) (subject to investigation/standard conditions)	Acceptable (R4) (subject to standard conditions)
>5m ³ /d	Acceptable (R3) (subject to investigation)	Acceptable (R3) (subject to investigation)	Acceptable (R4) (subject to standard conditions)
Storm Sewage Overflows to Soakaway	Presumption Against (R2) (only acceptable in exceptional circumstances)	Presumption Against (R2) (only acceptable in exceptional circumstances)	Acceptable (R4) (subject to standard conditions)

Footnotes

1. Direct discharge of sewage effluent to groundwater is normally not acceptable.
2. Discharge of more than 25m³/d of sewage effluent to ground will only be acceptable in exceptional circumstances.

This matrix is a summary only and must be read in conjunction with the policy statements and the key on page 42.

Matrix 3b
Discharges of trade effluent to underground strata

SOURCE PROTECTION			
ACTIVITY	I INNER ZONE	II OUTER ZONE	III CATCHMENT ZONE
B. DISCHARGE OF TRADE EFFLUENT INTO UNDERGROUND STRATA			
Cooling Water- free from additives	Presumption Against (R2) (acceptable only if investigation favourable)	Acceptable (R3) (subject to investigation)	Acceptable (R3) (subject to investigation)
Dewatering Water - subject to analysis	Not acceptable (R1)	Acceptable (R3) (subject to investigation)	Acceptable (R3) (subject to investigation)
Process Effluent - via Soakaway or Permeable Lagoons	Not acceptable (R1)	Presumption Against (R2) (acceptable only if investigation favourable)	Presumption against (R2) (acceptable only if investigation favourable)
RESOURCE PROTECTION			
ACTIVITY	MAJOR AQUIFER	MINOR AQUIFER	NON- AQUIFER
B. DISCHARGE OF TRADE EFFLUENT INTO UNDERGROUND STRATA			
Cooling Water - free from additives	Acceptable (R3) (subject to investigation)	Acceptable (R3) (subject to investigation)	Acceptable (R4) (subject to standard conditions)
Dewatering Water - subject to analysis	Acceptable (R3) (subject to investigation)	Acceptable (R3/4) (subject to investigation/ standard conditions)	Acceptable (R4) (subject to standard conditions)
Process Effluent - via Soakaway or Permeable Lagoons	Presumption Against (R2) (acceptable only if investigation favourable)	Acceptable (R3) (subject to investigation)	Acceptable (R3) (subject to investigation)

Footnotes

3. Direct discharge of trade effluent to groundwater is not acceptable with the exception of some cooling water and geothermal return waters, subject to investigation.

4. Where the cooling water is discharged to an aquifer where the natural groundwater has a similar chemical composition the NRA will have no objection subject to standard conditions. (R4)

This matrix is a summary only and must be read in conjunction with the policy statements and the key on page 42.

Matrix 3c

Discharges of surface water to underground strata

SOURCE PROTECTION			
ACTIVITY	I INNER ZONE	II OUTER ZONE	III CATCHMENT ZONE
C. DISCHARGES OF SURFACE WATER TO SOAKAWAY FROM:			
Roof Drainage	No Objection (R5) (provided for sole use of roof drainage)	No objection (R5)	No objection (R5)
Impermeable Areas - public/amenity - large car parks - lorry parks - garage forecourts - major roads	Not acceptable (R1)	Acceptable (R4)	Acceptable (R4)
	Not acceptable (R1)	Acceptable (R3/4) (with interceptor)	Acceptable (R4) (with interceptor)
	Not acceptable (R1)	Presumption Against (R2)	Acceptable (R3/4) (with interceptor)
	Not acceptable (R1)	Presumption against (R2)	Acceptable (R4) (with interceptor)
	Not acceptable (R1)	Presumption Against (R2) Acceptable only in exceptional circumstances	Acceptable only if investigation favourable and with adequate precautions (R4)
Industrial Sites	Not acceptable (R1)	Presumption Against (R2)	Acceptable only if investigation favourable and with adequate precautions (R3/4)
RESOURCE PROTECTION			
ACTIVITY	MAJOR AQUIFER	MINOR AQUIFER	NON- AQUIFER
C. DISCHARGES OF SURFACE WATER TO SOAKAWAY FROM:			
Roof Drainage	No Objection (R5)	No objection (R5)	No objection (R5)
Impermeable Areas - public/amenity - large car parks - lorry parks - garage forecourts - major roads	Acceptable (R4)	Acceptable (R4)	Acceptable (R4)
	Acceptable (R4) (with interceptor)	Acceptable (R4) (with interceptor)	Acceptable (R4) (with interceptor)
	Acceptable (R4) (with interceptor)	Acceptable (R4) (with interceptor)	Acceptable (R4) (with interceptor)
	Acceptable (R4) (with interceptor)	Acceptable (R4) (with interceptor)	Acceptable (R4) (with interceptor)
	Acceptable (R4) (subject to investigation and with interceptor)	Acceptable (R4) (subject to investigation and with interceptor)	Acceptable (R4) (with interceptor)
Industrial Sites	Acceptable only if investigation favourable and with adequate precautions (R3/4)	Acceptable (R4) (subject to investigation) with interceptor	Acceptable (R4) (subject to investigation) with interceptor

Footnote

5. Direct discharge into groundwater of surface water runoff is normally not acceptable

This matrix is a summary only and must be read in conjunction with the policy statements and the key on page 42.

**Discharges to underground strata
Key to Matrices 3a, b and c.**

Response 1 - Prohibit/object in principle - The (R1)
NRA will normally object in principle to such activities which would involve a high risk of contamination to controlled waters or a source.

Response 2 - Presumption against - The NRA (R2)
will seek to prohibit this activity by serving an absolute prohibition notice wherever possible. An objection will only be withdrawn in exceptional circumstances or where detailed investigation can demonstrate that the activity does not represent a high risk of contamination to controlled waters and can be adequately controlled by conditions that form part of a statutory consent or agreement.

Response 3 - Prohibition notice/Consent to (R3)
discharge - The NRA will normally have no objection in principle to this type of discharge, providing it is controlled through the use of a prohibition notice with conditions and a consent to discharge is obtained where appropriate.

Initial screening of a consent application will identify whether further investigation and assessment is required prior to consent being determined. Consent conditions may restrict the quality and quantity of effluent discharged and where assessment identifies a potential for significant change in groundwater quality, long term monitoring of both the discharge and remote observation points may be required.

Response 4 - No objection subject to standard (R4)
conditions - The NRA will normally have no objection in principle to this discharge subject to standard conditions on a prohibition notice or planning permission to protect the quality of controlled waters or a source. An investigation may be required to determine the risk of contamination and the formulation of appropriate conditions. Long term monitoring of controlled waters in the vicinity of such activities may be required.

Response 5 - No objection -The NRA will (R5)
normally have no objection in principle to this discharge which it considers will have no discernible impact on water resources or quality. No conditions or monitoring are likely to be required.

G. DIFFUSE POLLUTION OF GROUNDWATER

Diffuse pollution is pollution spread over space and time which is not caused by local and specific discharges or events. It is caused by the areal spread of pollutants or by the cumulative effect of many individual and ill-defined events. Examples of the former are the deposition of atmospheric pollutants and the leaching to groundwater of fertilisers and pesticides. Examples of the latter are the combined effects within a catchment of bad management practices involving potential pollutants, such as industrial solvents or farm wastes, which individually are small and hard to detect but which cumulatively have a significant impact on water quality.

Diffuse pollution is a problem for both surface waters and groundwater. It is hard to detect and it is hard to relate cause to effect. Both because of this, and because a specific identifiable discharge is often not involved, control under normal pollution control legislation is seldom possible.

For groundwater, the problem is greater because long residence times in aquifers result in diffuse pollutants accumulating for many years before being detected. Once detected the cause may be remote in time and space. A good example is the problem of high and rising nitrate concentrations in groundwater, where current land management practices may have no relation to the quality of water in the aquifer beneath. The groundwater may have been polluted by action taken in a different location many years previously.

Where an individual discharge can be identified, it can be controlled by the NRA under Sections 85 and 88 of the Water Resources Act, 1991. Where new developments are proposed which, in the NRA's experience, are likely to give rise to the risk of diffuse pollution, the NRA has often been successful in getting controls imposed through the Town and Country Planning Act 1990, depending on the degree of support the Local Planning Authority is prepared to offer.

Under Section 93 of the Water Resources Act 1991 the NRA may request Government to make an order designating a water protection zone and prohibiting or restricting specific activities within that zone. No orders have yet been made under this

section of the Act. Although the orders could be used to cover any risk of pollution, from point or diffuse sources, powers of this type are one means of establishing statutory control over potential sources of diffuse pollution.

Section 94 of the Water Resources Act 1991 makes similar provision to Section 93 but only in relation to practices leading to contamination by nitrate, which is excluded from Section 93. Designated areas under Section 94 are called Nitrate Sensitive Areas and ten designations have been made as part of the voluntary pilot scheme to investigate methods of controlling nitrate in groundwater. Farmers within these areas are encouraged to enter into agreements to follow a defined scheme of agricultural management practices.

The classification of groundwater vulnerability and the definition of Source Protection Zones in this policy have been drawn up to provide a technical basis for the definition of areas to implement Sections 93 and 94. The pilot Nitrate Sensitive Areas were defined according to the same principles as the definition of the Source Catchment Zone. Further designations, according to criteria not yet determined by Government, will be necessary to meet the requirements of the definition of vulnerable areas under the EC Nitrate Directive (91/676/EEC).

The classification by the NRA of groundwater vulnerability and the identification of Source Protection Zones is to assist the NRA and other regulatory agencies in the use of current legislative powers. The application of powers under Sections 93 and 94 would be a further step and subject to the procedure for implementation set out, respectively, in Schedules 11 and 12 of the Water Resources Act 1991.

TYPES OF DIFFUSE POLLUTION

Diffuse pollution varies in character between urban and rural areas. It affects groundwater resources used for potable supply and also has an impact upon the environment through baseflow into rivers.

Urban

Most urban pollution of groundwater is due to individual point discharges. However, some problems are diffuse in character because of the number of discharges and the uncertainty over their

location. The two most notable examples are pollution from industrial solvents used in the metal finishing, engineering and dry cleaning industries and discharges from sewerage systems which can cause increased nitrate concentrations. Many of the problems are historic and even though, the sources of the problem have been reduced through better design and better management practices, the legacy of the past remains.

Rural

Nitrate is a significant diffuse source pollutant. In areas of low effective rainfall (the east, south and midlands of England) upon vulnerable aquifers it is difficult, if not impossible, to have intensive arable and livestock husbandry and avoid leaching from the soil to groundwater resulting in concentrations in excess of the drinking water limit for nitrate. The application of best practice to minimise nitrate leaching is a basic requirement to sustain groundwater quality in vulnerable areas and in many cases, particularly in Source Catchment Zones, restrictions going beyond "best practice" will be required. These measures will be driven by the EC Nitrate Directive adopted in December 1991 (91/676/EEC).

Pesticide pollution of groundwater has some of the characteristics of nitrate contamination but there are significant differences. Since the term "pesticides" encompasses a wide and diverse range of chemical compounds, the interaction of these compounds with different soils and aquifers will vary. Hence some will be less mobile than others and have little impact on groundwater other than by a direct discharge. There is little evidence from the UK at present to suggest that the application of pesticides and herbicides to agricultural land at recommended rates poses a threat to groundwater quality. However, more research is needed in this area and a degree of caution must be used, especially in the most vulnerable situations. The Code of Practice for the Safe Use of Pesticides on Farms and Holdings, issued by MAFF and the Health & Safety Executive (HSE), contains advice on how to avoid water pollution and should be followed where appropriate.

The localised, repeated application of pesticides which are water soluble and persistent (eg atrazine and simazine) may give rise to groundwater contamination. Such instances arise in non-agricultural use (railways, roads, car-parks)

particularly where the soil layer is non-existent (railway and road cuttings). The use of soakaways for drainage from treated surfaces or as a disposal route for sprayer washings present a similar risk.

The NRA will seek to ensure that the use of pesticides/herbicides for non-agricultural purposes is restricted within Source Catchment Zones. Wherever possible, non-persistent, degradable compounds should be used. In areas of high groundwater vulnerability the NRA will co-operate with pesticide users over the choice of pesticide and method of application.

POLICIES ON DIFFUSE POLLUTION

G.1 The NRA, in making requests for orders under Section 93 and 94 of the Water Resources Act 1991 will:

- 1) Follow the principles of resource and source protection established in this policy document.**
- 2) In consultation with abstractors, have regard for the priorities for resource protection.**
- 3) Have regard for the results of research on the effectiveness and timing of the impact which land management changes can have on groundwater quality.**

The strategy for managing diffuse pollution must be to protect all resources in vulnerable areas. This can only be achieved by prohibiting or controlling those practices or use of those substances which will lead to a failure of the relevant quality standard over the whole of the area concerned. However, because of slow response times in groundwater systems, control measures should be targeted on sources of water supply, that is within Source Catchment Zones. Even where a need has been identified, it may not be immediately practical to formulate proposals because of the considerable complexity of the technical information required. The imposition of controls may cause considerable hardship to organisations or individuals who have to change their established and previously acceptable practices. The measure must, therefore, be seen to be both necessary and soundly based. Proposals for control of diffuse pollution from nitrate will be governed by the programme for implementation of the EC Nitrate Directive.

G.2 The NRA will directly and indirectly, by seeking the support of other bodies, promote practices which protect groundwater resources in general from diffuse pollution through minimising the leaching of potential pollutants within vulnerable areas.

This policy will be fulfilled by:

- preparing and making available national and regional groundwater vulnerability maps, so that areas of risk can be made known,
- directly promoting awareness of the risks to groundwater among industry and agriculture,
- seeking the support of Government, other regulatory bodies and trade associations to incorporate the concepts of groundwater vulnerability in their own regulations and guidelines, and providing technical support and research advice to make this possible.

G.3 The NRA will use its own powers under Section 85 and 86 of the Water Resources Act 1991 and seek the support of Local Planning Authorities to use powers under the Town and Country Planning Act 1990 to support, where appropriate, controls on diffuse pollution.

Where an area has been designated for the control of certain practices then the NRA will seek to ensure that parallel controls are put in place through other legislation so that complementary practices which frustrate its objectives, are not allowed. As an example, the NRA would expect the controls on agricultural practices in Nitrate Sensitive Areas to be supported by controls on non-agricultural activities which release nitrate. The NRA's own direct powers of prevention are limited and the most appropriate method in many cases will be through development controls.

G.4 Where appropriate, the NRA will seek general controls or prohibitions on practices or processes which might lead to groundwater pollution.

The localised nature of groundwater sources and vulnerable aquifers makes the control or prohibition of practices within a given area a practical management proposition. Where these practices present a general threat to the water environment the only realistic course of action may be to recommend Regulations under Section 92 of the Water Resources Act 1991.

H. ADDITIONAL ACTIVITIES OR DEVELOPMENTS WHICH POSE A THREAT TO GROUNDWATER QUALITY

In addition to the threats to the quality of groundwater resources identified in Sections C to F, there are many other activities which can pose a risk to groundwater quality through their operational impact or initial development. Because of the general point source nature of these activities they pose the greatest threat to individual abstractions. Hence the degree of control sought will increase with increasing proximity to any groundwater source.

Some of these activities are controlled through the planning legislation and others through various Codes of Practice and Regulations. However, there is as yet no adequate controlling mechanism for some activities.

THE PRODUCTION, STORAGE AND USE OF CHEMICALS (RAW AND WASTE)

Abandoned and operating chemical manufacturing plants, or manufacturing industrial premises where chemicals are widely used, are a major category of contaminated land. Many instances of groundwater pollution and surface water pollution by diffuse seepage due to shallow groundwater flow have arisen as a result (see Section D).

Where significant quantities of specified hazardous substances are stored the provisions of the Planning (Hazardous Substances) Act 1990 may be relevant (Regulations SI 1992 No. 656). The NRA is a statutory consultee of the Hazardous Substances Authority (Local Planning Authority) over the issuing of new consents which may be refused or granted with conditions. However, deemed consents for existing, established facilities (prior to 1.12.92) are not subject to consultation.

The manufacture and use of organic liquid chemicals, particularly chlorinated solvents and acid metallic solutions, present a significant hazard, but the use of any chemical under Lists I and II of the EC Groundwater Directive (see Appendix I) could give rise to groundwater pollution if not subject to proper control. Although the Water Resources Act 1991 (Section 92) gives the Secretary of State powers to make regulations controlling these activities, none have yet been made specific to non-

agricultural storage. Hence, for new sites, the use of planning legislation is important. For existing sites the NRA advocates a proactive approach of prioritising sites posing the greatest risk and co-operating with industry to rectify deficiencies. The NRA would normally object to proposals relating to these activities within Source Protection Zones I and II and would encourage new development in areas of low vulnerability to groundwater.

The storage of waste materials may require the issue of a waste management licence. The NRA will influence the operation of waste chemical storage in such instances through the consultation stage of site licensing.

Guidance is available for certain aspects of chemical storage, although not targeted specifically at groundwater pollution prevention. Health and Safety Executive Guidelines on the storage of flammable liquids in containers HS(G)51 and in fixed tanks HS(G)50 and HS(G)52 are relevant.

For prescribed processes the handling of raw materials, waste and products to prevent the pollution of all media, including groundwater, is controlled by HMIP. NRA may request conditions on authorisations granted by HMIP in order that groundwater quality is preserved.

STORAGE OF FARM WASTES AND INTENSIVE LIVESTOCK HOUSING

In vulnerable locations the leachate from stored wastes or the effluent from livestock units managed on an intensive basis can be highly polluting to groundwater. Apart from the nutrient content, the high organic loading and microbiological content can threaten individual groundwater sources.

Regulations have been introduced under Section 110 and Section 185(2)(c) of the Water Act 1989 to control the storage of silage, slurry and agricultural fuel oil. Farmers must comply with these regulations for all new, substantially enlarged or reconstructed installations.

Farmers should also abide by the Code of Good Agricultural Practice for the Protection of Water (Ministry of Agriculture, Fisheries & Food, 1991) where guidance is given on storage and disposal of wastes and effluent.

The NRA would wish to discourage the establishment of farm waste storage areas and substantial livestock housing within the Inner Source Protection Zone of any borehole (Zone I) unless adequate measures can be agreed to minimise the risk of pollution. For the larger public supply abstractions on fissured aquifer this could exceed the 50m distance from the borehole set out for the prohibition of waste disposal in the Code of Good Agricultural Practice, but the NRA would welcome discussion on a case by case basis.

GRAVEYARDS AND ANIMAL BURIAL SITES

Large graveyards can be a potential threat to groundwater quality and as such the establishment of new sites or extensions within Zone I areas would be opposed through the planning process. Similarly the NRA would object to animal burial sites within Zone I areas. Guidance with respect to the latter is given in the Code of Good Agricultural Practice for the Protection of Water, 1991 and should be followed. Restrictions may also be likely within Zone II (Outer Source Protection) subject to evaluation and assessment.

SEWAGE WORKS, FOUL SEWERS AND STORM OVERFLOWS

The presence of sewage works and the associated sewerage system present a risk of both bacteriological and chemical contamination to groundwater sources. The NRA would object to the creation of new works within both Source Protection Zones I and II. It would also oppose the laying of new main sewerage systems within Zone I, although the use of pipework which is less vulnerable to leakage would be considered on a case by case basis. There must be no storm overflow facility to the aquifer within either Zones I or II. Indeed such a proposal would only be permitted in other areas in exceptional circumstances (see policy statements F1 to F4).

OIL AND PETROLEUM STORAGE AND TRANSPORT VIA PIPELINES

Oil and petroleum storage has resulted in many instances of groundwater pollution, both from leakage from (underground) storage tanks and the accidental rupturing of tanks and pipework.

Subject to the outcome of consultation the Government intends to make Regulations under Section 92 of the Water Resources Act 1991 relating

to industrial oil storage, on a basis similar to those relating to farm wastes.

The NRA would object to the siting of new hydrocarbon storage tanks within Zone I which are located underground. Underground storage of hydrocarbons is discouraged within Zone II (Outer Source Protection) and III (Source Catchment) and on Major Aquifers in general. Where necessary they must conform to the requirements in the Regulations and be subject to rigorous periodic testing. Guidance issued by the Health & Safety Executive should also be followed. (Petrol Filling Stations: Construction and Operation HS(G)41).

The NRA will object to oil pipelines for the strategic transfer of hydrocarbons within Zone I areas and will discourage them within Zones II and III. The NRA would wish to liaise at an early stage with the relevant agencies regarding pipeline routes with a view to discouraging construction over major aquifer areas.

MAJOR INFRASTRUCTURE DEVELOPMENTS

The NRA will seek to ensure that the line of new major communication routes avoids Zone I areas. Where new major roads or railways are located within Zone II (and Zone III on fissured strata) it will discourage the discharge of roadside or track drainage to underground strata via soakaway systems because of the risk of spillage after accidents (see Matrix 3c). Early discussion over new routes is encouraged.

Other new infrastructure development where there is the possibility of drainage from large areas of hardstanding used for vehicle loading/unloading, maintenance etc or where there may be significant storage of hydrocarbons, solvents or other potentially contaminating substances will be opposed within Zone I and resisted within Zone II unless the NRA can be satisfied over the provision and maintenance of adequate safeguards. Such developments include airfields, industrial parks and large areas of vehicle parking.

Any agreement to discharges in the Source Protection Zones would be subject to site specific evaluation, depth restrictions on soakaways and the provision of large oil interception facilities equipped with cut-off valves.

APPENDIX I

LIST I AND LIST II SUBSTANCES AS 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 to be classed in List II.

- 1 Organohalogen compounds and substances which may form such compounds in the aquatic environment.
- 2 Organophosphorus compounds.
- 3 Organotin compounds.
- 4 Substances which possess carcinogenic, mutagenic or teratogenic properties in or via the aquatic environment (1).
- 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 phosphorus and elemental phosphorus.
- 6 Fluorides.
- 7 Ammonia and nitrites.

(1) Where certain substances in List II are carcinogenic, mutagenic or teratogenic they are included in category 4 of List I.

APPENDIX 2

Commonly occurring soil series within soil vulnerability classes

HIGH VULNERABILITY			INTERMEDIATE VULNERABILITY		LOW VULNERABILITY
H1	H2	H3	I1	I2	L
Andover	Bearsted	Aberford	Batcombe	Adventurers	Bercles
Blackwood	Bridgnorth	Anlgezarke	Blacktoft	Altcar	Brickfield
Downholland	Bromsgrove	Badsey	Bromyard		Cegin
Elmtan	Cuckney	Eardiston	Burlingham		Clifton
Fladbury	Fyfield	Munslow	Corstons		Denchurch
Holstow	Newport	Neath	Coombe		Dunkeswick
Longmoss	Wick	Panholes	Curtisden		Foggathorpe
Newchurch		Rivington	Denbigh		Hafren
Sherbourne		Shirrel-Heath	East Keswick		Ragdale
Sollom		Sonning	Evesham		Salop
Wallaseo		Swaffham Prior	Hanslope		Wickham
Wisbech		Waltham	Ludford		Willocks
			Manod		Windsor
			Milford		Winter Hill
			Whimble		
			Worcester		

Footnote

The vulnerability classification of soil cover is based on specific physio-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 in the table above are examples and should not necessarily be considered definitive.

APPENDIX 3

Classification of types of strata

MAJOR AQUIFERS	MINOR AQUIFERS		NON-AQUIFERS
Highly permeable formations usually with the known or probable presence of significant fracturing. Highly productive strata of regional importance, often used for large potable abstractions.	Fractured or potentially fractured but with high intergranular permeability. Generally only support locally important abstractions	Variably porous/permeable but without significant fracturing. Generally only support locally important abstractions	Formations with negligible permeability. Only support very minor abstractions, if any
Chalk and Upper Greensand Jurassic Limestones Permo-Triassic Sandstones Magnesian Limestones Carboniferous Limestones Lower Greensand	Coal Measures Milkstone Grit Old Red Sandstone Some igneous and metamorphic formations	River gravels Glacial sands and gravels Tertiary sands and gravels	All clays, shales, marls and siltstones. Most igneous and metamorphic formations. Mercia Mudstones

Footnote

This may be subject to minor variations in some NRA Regions to reflect local circumstances and the relative importance of different strata.

APPENDIX 4

GLOSSARY OF TERMS USED THROUGHOUT THE DOCUMENT

Abstraction	removal of water from surface water or groundwater, usually by pumping.	Controlled Waters	defined by Water Resources Act 1991 Part III Section 104. They include all groundwaters and inland waters and estuaries.
Abstraction under Licence	licence issued by the NRA S.38 of the Water Resources Act 1991 to permit water to be abstracted.	Dedicated Land	land used for spreading sewage sludge above the normal requirements for agricultural use.
Adsorbtion	process by which a thin layer of a substance accumulates on the surface of a solid substance.	Degradable Pollutants	pollutants which readily break down.
Artesian Flow	overflow of groundwater where water rises under pressure above the top of the aquifer.	Derogation	term used for loss of water resources or deterioration in water quality (usually relating to a particular source).
Attenuation	break down or dilution of a contaminant in water.	Diffuse Source Pollution	pollution from widespread activities with no one discrete source.
Baseflow	that part of the flow in a watercourse made up of groundwater and discharges. It sustains the watercourse in dry weather.	Discharge Consent	Consent issued by NRA under Schedule 10 of Water Resources Act 1991.
Cess pit/pool	sealed tank used to collect sewage. It has no outlet and requires periodic emptying.	Drift Deposits	term used to include all unconsolidated superficial deposits (eg, fluvioglacial, alluvium etc) overlying solid rocks.
Confined	where permeable strata are covered by a substantial depth of impermeable strata such that the cover prevents infiltration.	Effective Porosity	that part of the total porosity which can transmit water.
Conservative Pollutants	pollutants which can move readily through the aquifer with little reaction with the rock matrix and which are unaffected by biodegradation (eg chloride).	Effective Rainfall	proportion of rainfall that can infiltrate to an aquifer after evapotranspiration.
Controlled Waste	defined by Control of Pollution Act 1974, Part I Section 30. It includes household industrial and commercial waste.	Formation	term used to describe a sequence of rock layers.
		Fractures/ Fissures	natural cracks in rocks that enhance rapid water movement.

Hydrogeological Characteristics	characteristics relating to flow of water through rock eg. permeability, transmissivity, porosity etc	Porous	having microscopic pores between the rock grains (not necessarily interconnected).
Hydrological Cycle	circulation of the earth's water in atmosphere, surface water, oceans and groundwater and their relationship.	Potable Water	water of suitable quality for drinking.
Intergranular Flow	groundwater flow between individual grains of rock.	Prescribed Processes/ Substances	related to Integrated Pollution Control defined in Environmental Protection Act 1990 Part 1 section 2.
Intergranular Permeability	see primary permeability.	Primary Permeability	permeability related to flow between grains within the aquifer.
Landfill	site used for waste disposal into/onto land.	Prohibition Notice	notice served by NRA under S.86 of Water Resources Act 1991 to prevent or control a discharge of effluent.
Leachate	liquor formed by the act of leaching.	Recharge	water which percolates downward from the surface into groundwater.
Leaching	removal of soluble substances by action of water percolating through soil, waste or rock.	Rehabilitation	restoring good quality by natural or artificial means.
List I and II Substances	defined by EC Groundwater Directive (see Appendix 1).	Saturated Zone	zone of aquifer where all fissures and pores contain water (ie below water table).
Non-degradable Pollutants	pollutants that do not readily break down.	Secondary Permeability	permeability related to groundwater flow within fissures rather than between grains (see Primary Permeability).
Outcrop	where strata are at the surface, even though they may be obscured by soil cover.	Septic Tank	small tank receiving and treating sewage by bacteria where effluent overflows.
Perched Water Table	water level supported by low permeability layer above main water table.	Soakaway	system for allowing water or effluent to soak into the ground, commonly used in conjunction with septic tanks.
Permeability	measure of the ability to transmit water.	Source	point of abstraction of water eg. well, borehole, spring.
Point Source Pollution	pollution from a discrete source eg. petrol station, septic tank, landfill.	Spring	natural emergence of groundwater at surface.
Porosity	ratio of volume of void space to the total volume of the rock.		

Statutory Water Quality Objectives (SWQOs)	water quality objectives set by the Secretaries of State, in relation to controlled waters.	Unsaturated Zone	zone of aquifer between soil and watertable which is partly saturated (ie that part of the aquifer above the water table).
Strata	layers of rock, including unconsolidated materials such as sands and gravels.	Water Cycle	see hydrological cycle.
Trade Effluent	effluent derived from a commercial process/premises.	Water Table	top surface of the saturated zone within the aquifer.
Transfer Station	waste disposal facility where waste is collected prior to transport to final disposal point.	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.



NRA

National Rivers Authority

To obtain copies of any of the following documents, please send cheque (made payable to the National Rivers Authority) or postal order to:

National Rivers Authority
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- Policy & Practice for the Protection of Groundwater (including the Groundwater Vulnerability Map) Price £15
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 - Summary Leaflets for the Groundwater Protection Policy Document No Charge
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