TOWARDS SETTING GUIDELINE VALUES FOR THE PROTECTION OF GROUNDWATER IN IRELAND

Interim Report

10 YEARS
Guardians of the Environment

ENVIRONMENTAL PROTECTION AGENCY
An Ghníomhaireacht um Chaomhnú Comhshaoil

ENVIRONMENTAL PROTECTION AGENCY

ESTABLISHMENT
The Environmental Protection Agency Act, 1992, was enacted on 23 April, 1992 and under this legislation the Agency was formally established on 26 July, 1993.

RESPONSIBILITIES
The Agency has a wide range of statutory duties and powers under the Act. The main responsibilities of the Agency include the following:

- the licensing and regulation of large/complex industrial and other processes with significant polluting potential, on the basis of integrated pollution control (IPC) and the application of best available technologies for this purpose;
- the monitoring of environmental quality, including the establishment of databases to which the public will have access, and the publication of periodic reports on the state of the environment;
- advising public authorities in respect of environmental functions and assisting local authorities in the performance of their environmental protection functions;
- the promotion of environmentally sound practices through, for example, the encouragement of the use of environmental audits, the establishment of an eco-labelling scheme, the setting of environmental quality objectives and the issuing of codes of practice on matters affecting the environment;
- the promotion and coordination of environmental research;
- the licensing and regulation of all significant waste disposal and recovery activities, including landfills and the preparation and periodic updating of a national hazardous waste management plan for implementation by other bodies;
- preparation and implementation of a national hydrometric programme for the collection, analysis and publication of information on the levels, volumes and flows of water in rivers, lakes and groundwaters; and
- generally overseeing the performance by local authorities of their statutory environmental protection functions.

STATUS
The Agency is an independent public body. Its sponsor in Government is the Department of the Environment and Local Government. Independence is assured through the selection procedures for the Director General and Directors and the freedom, as provided in the legislation, to act on its own initiative. The assignment, under the legislation, of direct responsibility for a wide range of functions underpins this independence. Under the legislation, it is a specific offence to attempt to influence the Agency, or anyone acting on its behalf, in an improper manner.

ORGANISATION
The Agency's headquarters are located in Wexford and it operates five regional inspectorates, located in Dublin, Cork, Kilkenny, Castlebar and Monaghan.

MANAGEMENT
The Agency is managed by a full-time Executive Board consisting of a Director General and four Directors. The Executive Board is appointed by the Government following detailed procedures laid down in the Act.

ADVISORY COMMITTEE
The Agency is assisted by an Advisory Committee of twelve members. The members are appointed by the Minister for the Environment and Local Government and are selected mainly from those nominated by organisations with an interest in environmental and developmental matters. The Committee has been given a wide range of advisory functions under the Act, both in relation to the Agency and to the Minister.

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PREFACE

Section 75 of the Environmental Protection Agency Act, 1992, permits the EPA to specify and publish Environmental Quality Objectives (EQOs) "which the Agency considers reasonable and desirable for the purpose of environmental protection". In 1997, the EPA published its first discussion document on the topic of setting environmental quality objectives and standards. That document, to which the reader is referred, set out the overall framework within which the EPA would propose Environmental Quality Objectives for environmental media. The document dealt specifically with the aquatic environment, with a particular focus on surface waters. Following on from the publication of that document, Environmental Quality Standards for waters were set by the Minister for the Environment and Local Government for phosphorus and for a range of dangerous substances. The EPA is currently finalising a scheme of recommendations, arising from the various contributions received from interested parties and taking into account the implications of the Water Framework Directive, for submission to the Minister for the Environment and Local Government.

This document presents proposals for the setting of environmental quality objectives and standards for groundwaters through the use of 'guideline values'. A separate document is considered necessary for groundwaters because the issues involved in the setting of environmental quality objectives and standards for groundwaters are quite different to those that arise in the setting of environmental quality objectives and standards for surface waters. This is because groundwaters, in their pristine condition, can vary considerably from one groundwater body to another due to the influence exerted by the particular geology of the area within which the body exists.

Since the enactment of the Water Framework Directive, the setting of environmental quality objectives for waters is a relatively straightforward exercise because Article 4 of the Directive specifies clear environmental objectives for various waters including groundwater. The objectives for groundwater are as follows:

- To achieve "good status" for all groundwater by 2015. Good groundwater status is the status achieved by a groundwater body when both its quantitative status and its chemical status are at least good.
- To reverse any significant and sustained upward trend in concentration of any pollutant resulting from the impact of human activity.

A proposal for a new Groundwater Directive, which will include criteria for good groundwater chemical status, is expected during 2003.

However, determining whether or not a particular groundwater body is meeting this environmental quality objective is not so straight forward because it is not practical to assign a universal set of standards for groundwater due to natural variation in hydrochemistry. Instead of setting universal standards for groundwater, the approach being developed at EU level is to specify criteria or indicators for assessing good groundwater status, which takes account of natural variation in quality.

In the absence of published criteria for good groundwater chemical status and to provide a consistent framework for the characterisation of groundwaters in Ireland, the EPA is now proposing a list of interim guideline values (IGVs) for groundwater. The values are to be used to assist with the characterisation of groundwater bodies and to establish the need for additional investigations or further actions in the event of the guideline values being exceeded.

The EPA is also proposing that a specified list of parameters (a characterisation list) be used to characterise groundwater quality in Ireland. The main function of the characterisation list is to provide a consistent suite of parameters termed the 'Core Group' or 'Natural Substances' that

would be analysed for in all cases and a guide list of ‘Site Specific’ or ‘Synthetic Substances’ to be added to the ‘Core Group’ where appropriate. This approach will also provide assistance in meeting monitoring requirements under various EC decisions and directives.

Finally, the report sets out a methodology for assessing groundwater chemical status and assigning either ‘good’ or ‘poor’ groundwater status to a groundwater body. The application of this methodology will provide a consistent basis for assessing groundwater status throughout the country.

This document should be viewed as an Interim Report based on the best available information at the time of publication and it may be subject to review following the adoption of the new Groundwater Directive.

This document does not propose restoration target values or clean up levels for groundwater, as these are best derived through a site-specific risk assessment approach.

ABBREVIATIONS

BAT	Best Available Techniques
BOD	*Biochemical Oxygen Demand.* A measure of the amount of oxygen used by bacteria in the degradation of organic matter.
BTEX	Group of soluble organic aromatic hydrocarbons, which includes benzene, toluene, ethylbenzene and xylene compounds.
COD	*Chemical Oxygen Demand.* A quick chemical test to measure the oxygen equivalent of the organic matter content of leachate/wastewater that is susceptible to oxidation by a strong chemical.
COM	EU Communication prior to implementation of legislation.
COMMPS	Combined Monitoring-based and Modelling-based Priority Setting.
ELV	Emission Limit Values.
EPER	European Pollution Emission Register.
EQO	Environmental Quality Objective.
EQS	Environmental Quality Standard.
IGVs	Interim Guideline Values.
IPPC	Integrated Pollution Prevention and Control.
List I	Substances contained in List I in the Annex of Council Directive on the protection of groundwater against pollution caused by certain dangerous substances (80/68/EEC).
List II	Substances contained in List II in the Annex of Council Directive on the protection of groundwater against pollution caused by certain dangerous substances (80/68/EEC).
LUST	Leaking underground storage tank.
MAC	Maximum Admissible Concentration.
MCL	Maximum Contaminant Level.
MTBE	Methyl-tert-butyl-ether.
NGO	Non-Governmental Organisation.
NVZ	Nitrate Vulnerable Zone.
PAHs	Polycyclic Aromatic Hydrocarbons.

PRTR	Pollutant Release and Transfer Register.
PWS	Public Water Supply.
RBCA	Risk Based Corrective Action.
TOC	Total Organic Carbon.
WFD	Water Framework Directive.
WHO	World Health Organisation.

1. INTRODUCTION

1.1 BACKGROUND

Groundwater is an important water resource in the Republic of Ireland and accounts for up to 15% of total water supplied by local authorities and about 25% of all water supplies (Daly, D. 1993; EPA 1999a). A very large number of groundwater supply sources exist, e.g. Wright (1999) estimates that there are at least 200,000 wells in the country. However, only a small proportion of the available groundwater resource is currently being used. Hence, there is potential for increased usage in the future and this is likely to occur as domestic and industrial demand expands in areas with limited surface waters. This will heighten the need for aquifer protection and the treatment of groundwater to ensure that the quality of drinking water conforms to the requirements of the Drinking Water Regulations. In addition groundwater quality and quantity must be protected in its own right under the requirements of the Water Framework Directive (2000/60/EEC).

As well as providing potable water supplies, groundwater is an important source of water for food processing industries, creameries, meat factories, farms, golf courses and bottled waters. In addition, groundwater plays a key role in the hydrological cycle in terms of its baseflow contribution to rivers and in maintaining wetland habitats.

The main aquifers are found in Quaternary deposits and in Palaeozoic bedrock formations, including Carboniferous limestones and sandstones, Devonian Old Red Sandstone and Ordovician volcanics. The aquifers are classified according to their extent, hydraulic properties, potential well yields, and so forth. There are three main groupings: Regionally Important, Locally Important and Poor aquifers; these are further sub-divided into eight sub-groups (see Daly, D. 1995, Wright 1997). These aquifers will have to be designated into groundwater bodies in line with the requirements of the Water Framework Directive.

Widespread faulting means that bedrock aquifers often occur as relatively small, discrete units with complex boundaries. The bedrock aquifers are all characterised by groundwater flow in fissures. The main flow horizons generally occur in the top 30-40 m, and hence most wells are relatively shallow (Daly, E. 1995a). In some of the limestone aquifers, extensive karstification has produced conduit systems with rapid groundwater flow rates (e.g. Coxon and Drew, 1999).

The bedrock aquifers often have a covering of glacial till or other superficial deposit (usually referred to as subsoil/overburden). Where the subsoil cover is thin or absent, the aquifer can be highly vulnerable to contamination, especially in karst areas where contaminants may enter the aquifer directly via swallow holes and sinking streams. On the other hand, the risk of groundwater contamination is significantly reduced if there is a thick layer of low permeability subsoil (such as a clayey till) overlying the aquifer.

The Geological Survey of Ireland (GSI) has completed, or is nearing the completion of, a number of groundwater protection schemes for various local authorities and is planning to have developed such schemes for much of the country by 2010 (Daly, D. 1999). A groundwater protection scheme takes account of the nature of the hazard to groundwater (the potentially polluting activity), the pathway for contaminant migration to the aquifer (the groundwater vulnerability) and the value of the target (aquifer, spring or well) (Daly, D. 1995, Misstear *et al.* 1998, Department of Environment and Local Government (DELG) *et al.* 1999a). The GSI

in combination with the DELG and the EPA published 'Groundwater Protection Schemes' in 1999, a methodology for Ireland that incorporates these elements of risk assessment.

Another aspect of groundwater protection is the management of the risk. This involves making an appropriate response to a potentially polluting activity. To date, responses have been published for landfills, landspreading of organic wastes and location of on-site wastewater treatment systems for single houses, and responses for the storage and disposal of sheep dip, location of storage tanks and siting of farmyards are planned (DELG *et al.* 1999b, DELG *et al.* 1999c and DELG *et al.* 2001).

1.2 GROUNDWATER QUALITY IN IRELAND

Groundwater quality is a function of natural processes as well as anthropogenic activities. Natural groundwater quality is generally good, although concentrations of certain ions can occur naturally and lead to problems e.g. iron, manganese, sulphate, hydrogen sulphide and, near coasts, sodium and chloride (Daly, D 1994). Natural hydrochemical variations should be taken into account in establishing any baseline quality criteria, and in interpreting results of groundwater monitoring programmes.

The concentrations of any contaminants detected in a groundwater monitoring programme will be influenced by source characteristics and proximity, the nature of the contaminant and the geological and hydrogeological influences, including, for example:

- the type of contaminant source (point source or diffuse);
- how far the source is located from the well or spring;
- the characteristics of the contaminant (solubility, mobility, *etc.*);
- the characteristics of the aquifer (primary or secondary permeability, presence of karst); and,
- the aquifer vulnerability (*e.g.* the presence or absence of a protective layer of thick low permeability subsoil above the aquifer).

Vulnerability is 'a term used to represent the intrinsic geological and hydrogeological characteristics that determine the ease with which groundwater may be contaminated by human activities' (Daly and Warren, 1998).

The monitoring results will also be influenced by the monitoring regime itself, including:

- the type of groundwater sampling point (well or spring);
- the design of the well (e.g. for a discrete sampling depth or open hole completion);
- the construction of the wellhead (whether the surface casing has been properly sealed);
- the abstraction rate and hence zone of contribution (ZOC) to the well;
- the depth of sampling, and the method of sampling (pumped or bailed);
- the time of year;
- whether analyses are carried out on site or in the laboratory; and
- sample storage procedures, *etc.* (see, for example, Hayes, 1997).

Regarding the abstraction rate, large capacity public water supply wells draw water from a relatively large area, and hence there will be a significant dilution of any small point source

pollution within the Zone of Contribution (ZOC) (Daly, E. 1995b, Daly, E. and Woods, 1995). Small domestic or farm supply wells, on the other hand, will have smaller ZOCs, and are often located close to contaminant sources such as farmyards and on-site wastewater treatment systems, and hence will tend to indicate poorer groundwater quality. This is borne out by monitoring results collected by the EPA and others.

The quality of groundwater is assessed through different monitoring programmes for drinking water supplies, licensed activities, and the EPA national groundwater monitoring programme. The quality in Ireland is generally good.

- *Nitrate* contamination is not considered to be widespread and is generally observed in low yielding wells, in close proximity to waste sources such as silage and slurry pits. However, it is of particular concern in some areas of Carlow, Cork, Kerry, Louth and Waterford. The Nitrates Directive requires that these areas be designated as Nitrate Vulnerable Zones (NVZs) or that national general binding rules be applied. A national expert group has recommended that a national approach be adopted.
- *Phosphorus* (P) is not a problem in groundwater however it may act as a pathway for P to receptors such as lakes, rivers and wetlands.
- *Trace metals* are generally found at low levels owing to their low solubilities at normal groundwater pH values. However, iron (Fe) and manganese (Mn) can occur at elevated levels in certain natural hydrogeological conditions, or where organic pollution has resulted in de-oxygenation of the water.
- Trace *organic* contamination in groundwater was found to occur in close proximity to point sources of contamination (DOE, 1994).
- The EPA groundwater results (EPA, 1999a) and earlier studies (e.g. Daly, D. 1994, Daly, E. and Woods, 1995) indicate that the main groundwater quality problems are associated with local microbiological contaminants rather than chemical contamination. In practice, faecal coliforms (e.g. E. coli) are the main microbiological contamination indicators analysed but other microbiological contaminants could be significant (e.g. viruses and cryptosporidium). The widespread occurrence of coliform contamination is a significant concern. In general the majority of private groundwater supplies do not undergo any treatment prior to use.

1.3 PRESSURES ON GROUNDWATER IN IRELAND

In contrast to many other western countries, Ireland does not have a legacy of widespread industrial contamination of soil and groundwater or large areas of intensive arable agriculture. The most significant pressures on groundwater quality in Ireland are generally from a large number of comparatively small point sources, such as farmyards and on-site wastewater treatment systems. There is also the threat of diffuse pollution from landspreading of organic wastes and application of inorganic fertilisers. Other significant pressures include waste disposal, industry, mining, pesticide applications, storage and disposal of sheep dip, sewers, and other infrastructure, including fuel distribution and roads.

The most serious groundwater problems are likely to arise from activities that are not subject to a licensing regime either under the control of the EPA or local authority or other strict control e.g. agricultural and small scale industrial activities and poorly operated small scale wastewater treatment systems.

The most significant groundwater contaminants and/or contaminant indicators in Ireland are:

- Faecal bacteria (viruses and other microbiological contaminants may also be significant) (from farmyard runoff, landspreading, sewage, etc.).

- Nitrogen species, most notably ammonia and nitrate (from sewage, fertilisers, farmyard runoff, landspreading, landfills, etc.).
- Chloride (from farmyard runoff, landspreading of organic wastes, sewage effluent, road salt, landfill leachate, saline intrusion, coastal precipitation, urban areas etc.).
- Potassium (from farmyard runoff, landspreading, sewage, etc.).
- Phosphorus (from sewage, on-site wastewater treatment systems, fertilisers, etc.): significant mainly as a contributor to eutrophication where groundwater discharges into sensitive surface waters.
- Sulphate (from agriculture, atmospheric depositions (acid rain), urban areas).
- Iron and manganese: significant mainly as indicators of organic contamination from silage and sewage; however, they are also naturally occurring.
- pH (from atmospheric deposition (acid rain)).
- Electrical conductivity: an easy to measure gross contaminant indicator.
- Hydrocarbon compounds (from industry, petrol stations, etc.), including BTEX and MTBE.

Other important potential contaminants and indicators are:

- BOD, COD, TOC (from organic pollution from leachate, sewage, silage, etc.).
- Chlorinated solvents (from industries including tanneries, metal workshops, dry cleaning etc.).
- Phenols (from gasworks and other industries).
- PAHs (from a wide range of sources).
- Pesticides (from agricultural spraying, road and railway lines, sheep dips, etc.).
- Heavy metals such as arsenic, cadmium, chromium, lead, mercury, copper, zinc etc. (from industries, mining and landfills).
- Boron (from detergents, and therefore an indicator of quality issues from sewers).
- Fluoride (from industry).

1.4 EXISTING OBJECTIVES AND STANDARDS

Quality standards for many important uses of water have been prescribed in EU legislation and implemented by Irish regulations. Effluent or emission standards which relate to particular discharges from point sources have, likewise, been prescribed for some of the more environmentally dangerous substances (Scannell, 1995). Most of the water quality standards as prescribed in the various EU water quality directives have been implemented into Irish law. These relate primarily to directives for the protection of surface water. The Groundwater Directive and the Water Framework Directives are the only pieces of EC legislation relating specifically to groundwater.

The only specific standards related to groundwater in Irish Legislation are the EQS set for List 1 substances in the Water Pollution Regulations, 1999 (S.I. No. 42 of 1999).

1.4.1 Water Framework Directive

In December 2000 the Water Framework Directive (2000/60/EEC) came into force. It establishes a strategic framework for managing the water environment and sets out a common approach to protecting and setting environmental objectives for all groundwaters and surface waters within the European Community. Specifically for groundwater the Directive aims to protect, enhance and restore all bodies of groundwater, as well as maintaining and/or attainment of 'good chemical status'. However, the exact requirements of the WFD are not yet fully determined and, in particular, the European Parliament and the Council have yet to adopt specific measures to prevent and control groundwater pollution (Article 17) which shall include:

- Criteria for assessing good groundwater chemical status, in accordance with Annex II 2.2 and Annex V 2.3.2 and 2.4.5 of the Directive, and

- Criteria for the identification of significant and sustained upward trends in concentration of contaminants and for the definition of starting points for trend reversals to be used in accordance with Annex V 2.4.4 of the Directive.

In the absence of criteria adopted at Community level, Member States are required to establish appropriate criteria at the latest five years after the date of entry into force of the Directive (McGarrigle, M. *et al*. 2002).

Article 17 of the WFD requires that the Parliament and Council adopt measures to prevent and control groundwater pollution. These measures will be in the form of a new groundwater directive. To assist in this the EC established an Expert Advisory Forum on Groundwater (EAF). This group first met in November 2001 and set up five drafting groups to provide technical advice on different groundwater aspects. A proposal for a Directive establishing strategies to prevent and control pollution of groundwater is expected in 2003.

In Ireland initial implementation of the Water Framework Directive will take place through the River Basin Management System (RBMS) Projects. These are being established on the basis of a small number of River Basin Districts and local authorities will have the primary role in promoting, establishing and implementing these projects which are being funded by the Department of the Environment and Local Government. These project will provide much of the basic data requirements and necessary analysis for the characterisation of river basins, the identification of pressures and impacts, the mapping of location and boundaries of water bodies, the establishment of integrated water monitoring programmes and the establishment of programmes of measures for the preparation of River Basin Management Plans (Daly, D. *et al*. 2001).

2. CHARACTERISATION LIST

2.1 PROPOSED CHARACTERISATION LIST FOR GROUNDWATER IN IRELAND

The Agency is proposing that a consistent list of parameters should be used to characterise the quality of groundwater in Ireland. The main function of the characterisation list is to provide a consistent suite of parameters termed the 'Core Group' or 'Natural Substances' that would be analysed for in all cases where background concentrations are being established in groundwater bodies and a guide list of 'Site Specific' or 'Synthetic Substances' to be added to the 'Core Group' where appropriate. This approach will also provide assistance in meeting monitoring requirements under various EC decisions and directives.

The 'Core Group' of parameters provides a hydrochemical characterisation of the groundwater plus a few indicator parameters such as Electrical Conductivity. The list of 'Site Specific' parameters has been developed following a review of the requirements of decisions, directives and national legislation relating to water quality and dangerous substances as well as the use of dangerous substances in Ireland.

In drawing up the characterisation list the Agency has considered the following:

The proposal for a Decision of the European Parliament and of the Council establishing a list of priority substances, including substances identified as priority hazardous substances (ENV 36 COM (2001) 17 final).

- The proposal includes a list of 32 substances identified as "priority substances". Within this group there is a sub group of 11 substances, which have been identified as being "priority hazardous substances"[1]. Another 11 priority substances have been earmarked for review to determine whether they are to be included in the "priority hazardous substances" list. The remaining 10 substances remain as priority substances and are not included as priority hazardous substances. The list of priority substances, including substances identified as priority hazardous substances, will replace the EU emission control policy established under the dangerous substances directive (76/464/EEC) and the corresponding 'List of 129'.

Directive 2000/60/EC establishing a framework for Community action in the field of water policy (Water Framework Directive)

- The Water Framework Directive (2000/60/EC) requires the monitoring of oxygen content, pH value, conductivity, nitrate and ammonium as part of the surveillance monitoring.

Proposal for a Directive establishing strategies to prevent and control pollution of groundwater (March 2003)

- The most recent EAF proposal (March 2003) proposes the use of a range of concentrations of groundwater common indicators to determine groundwater chemical status. The list of indicators and associated ranges of values will be open to regular review. The proposed list of common indicators are as follows: aluminium, ammonium, arsenic, cadmium, chloride, chromium, copper, mercury, nickel, nitrate,

[1] While tributyltin was identified as a priority hazardous substance, it is not included in this document as a substance to be monitored in groundwater as it is mainly of relevance to the marine environment.

oxygen, potassium, sodium, sulphate, zinc and TOC. In addition, physico-chemical parameters should be considered: conductivity, Eh and pH.

- Member States are recommended to undertake monitoring for a wider range of major ions or anthropogenic substances to aid in the conceptual understanding of the groundwater body.

Directive 1999/31/EC on the landfill of waste

- The following are the recommended parameters for trigger levels in groundwater at landfill sites (pH, TOC, phenols, heavy metals, fluoride, anionic surfactants and oil/hydrocarbons), that are set out in Annex III 4c, of the Landfill Directive.

European Pollutant Emission Register (EPER)

- Of the 26 parameters set out in the EPER, 11 are not covered by the Priority List of 32 discussed above. These 11 parameters have therefore been added to the characterisation list. The EPER does not apply specifically to groundwater but its requirements have been included in the absence of a specific list for groundwater.

Study on Inventory and Tracking of Dangerous Substances

- A study entitled '*Inventory and tracking of dangerous substances used in Ireland and development of measures to reduce their emission/losses to the environment'* (CTC, 1998) was carried out by the Clean Technology Centre in Cork Institute of Technology. It was funded under the Environmental Monitoring, EPA R&D sub-programme of the Operational Programme for Environmental Services (1994-1999). It established a number of representative substances of concern believed to be relevant in an Irish context. Of the 22 parameters selected by CTC, 11 had not already been included in the proposed characterisation list and therefore have been added.

Geological Survey of Ireland Trigger Values

- The GSI (1999) review of groundwater quality identified six parameters that serve as quality indicators (nitrate, potassium, chloride, ammonia, K/Na ratio, and faecal bacteria). Five of the parameters (apart from the K/Na ratio) have been included as components of the 'Core Group'.

Others

- Ten parameters have been added to the 'Core Group' for general hydrochemical characterisation and completeness in regard to ionic balance calculations; these are, alkalinity, bicarbonate, calcium, carbonate, hardness, magnesium, nitrite, sodium, sulphate and temperature.

- Parameters have been added to the 'Site Specific' parameters group, which have been determined as contaminants and/or useful contaminant indicators from sectors including agriculture, waste management and industry, and which need to be controlled in order to protect Irish groundwater. Additional parameters that have been detected in groundwater during compliance and other groundwater monitoring of licensed IPC and Waste facilities have also been placed in the 'Site Specific' parameters group.

The resultant proposed characterisation list for groundwater quality in Ireland is presented in Table 2.1, in the form of a Core Group of 35 parameters, and a separate listing of 76 'Site Specific' parameters.

2.2 'CORE GROUP' OR 'NATURAL SUBSTANCES'

The use of a standardised list of core parameters will assist in the collection of data required for the identification of background concentration of naturally occurring substances and also in the definition of reference conditions for groundwater bodies in Ireland.

These core parameters should be analysed for in all cases where background concentrations are being established in groundwater bodies.

2.3 'SITE SPECIFIC' PARAMETERS OR 'SYNTHETIC SUBSTANCES'

The list of site specific parameters is a combination of the priority contaminants, which appear in the priority list (COM (2001) 17 final), the EPER decision, the EU Landfill Directive, Water Framework Directive, and the CTC study as well as parameters monitored for at IPC and /or waste facilities and/or widely used in Ireland. The selection of parameters for analysis is dependent on site specific factors. It is necessary to assess the site history as well as the purpose of the monitoring when selecting the suite of parameters to be monitored. The method of analysis used should be capable of measuring concentrations equal to 10% of the appropriate drinking water standard except in the case of the following: pesticides (25%), PAHs (25%), Benzo(a) pyrene (25%), Benzene (25%), Mercury (25%) as required by the Drinking Water Regulations.

Table 2.1: Characterisation List of Parameters for Irish Groundwater Quality

PARAMETER	SOURCES					
	COM (2001) 17 final	Water Framework Directive 2000/60/EC	Landfill Directive 1999/31/EC	EPER List	CTC List	Other
CORE PARAMETERS or NATURAL SUBSTANCES						
Physicochemical-Microbiological						
Coliforms (faecal)						√
Coliforms (total)						√
Electrical Conductivity		√				
Temperature						√
TOC			√	√		
Colour						
pH (H ion concentration)		√	√			√
Inorganic						
Alkalinity						√
Ammonia (as ammonium)		√				
Bicarbonate						√
Calcium						√
Carbonate						√
Chloride				√		
Dissolved Oxygen		√				
Hardness as CaCO3						√
Iron						√
Magnesium						√
Manganese						√
Nitrate		√		√		
Nitrite						√
Orthophosphate						√
Potassium						√
Sodium						√
Sulphate						√
Metals						
Aluminium						√
Arsenic			√	√	√	
Boron						√
Cadmium	√			√	√	
Chromium				√		
Copper				√		
Mercury	√			√	√	
Nickel	√			√		
Zinc				√		
Organics						
TON						√
Total Hydrocarbons to include mineral oil by GC**			√			
SITE SPECIFIC PARAMETERS OR SYNTHETIC SUBSTANCES						
Physicochemical						
Total dissolved solids						√

** TPH by Gas Chromatography: This analysis can serve as a 'catch-all' and will present results for the general term 'Petroluem Range Organics' and the separate 'BTEX' parameters including MTBE. 'Diesel Range Organics' (DRO) should also be specified in order to determine mineral oil concentration.

PARAMETER	SOURCES					
	COM (2001) 17 final	Water Framework Directive 2000/60/EC	Landfill Directive 1999/31/EC	EPER List	CTC List	Other
Inorganic						
Barium						√
Cyanide				√		
Fluoride			√	√		
Silica						√
Total dissolved solids						√
Metals						
Lead	√			√	√	
Uranium						√
Organics						
1,2 Dicholorobenzene						√
1,2-Dichloroethane (DCA)					√	
1,2-Dichloromethane	√					
2, 4, 6 Trichlorophenol						√
2, Chlorophenol						√
Anionic Surfactants (AS)			√			
Benzene	√			√		
Brominated diphenylether				√	√	
Butylbenzylphthalate (BBP)						
Chlorobenzene					√	
Di 2 ethylhexyladiapate (DEHA)						√
Di –n- butyl phthalate (DBP)						√
Di(2-ethylhexyl)phthalate (DEHP)	√				√	
Dichloroethene						√
Dichloromethane (DCM)	√			√		
Ethylbenzene				√		
Halogenated organic compounds (as AOX)				√		
Hexachlorobenzene (HCB)	√			√		
Hexachlorobutadiene(HCBD)	√			√		
MTBE						
Nitrobenzene					√	
Nonylphenols, (4-(para)-nonylphenol)	√				√	
Octylphenols, (para-tert-octylphenol)	√					
Organo-tin compounds (as Sn)				√	√	
Pentabromodiphenylether	√					
Pentachlorobenzene	√					
Pentachlorophenol	√					
Perchloroethylene (PER) (Tetrachloroethylene)						√
Phenols			√	√		
Phthalates					√	
Tetrachlorethene						√
Tetrachloromethane						√
Toluene				√		
Trichlorobenzenes (1,2,4-Trichlorobenzene)	√				√	
1, 1, 1 -Trichloroethane						√
Trichloroethene						√
Trichloroethylene (TCE)					√	
Trichloromethane (Chloroform)	√					

PARAMETER	SOURCES					
	COM (2001) 17 final	Water Framework Directive 2000/60/EC	Landfill Directive 1999/31/EC	EPER List	CTC List	Other
Xylenes				√	√	
Polyaromatic hydrocarbons (PAH)	√			√	√	
Anthracene	√					
Benzo(b)fluoranthene						
Benzo(g,h,I)perylene						
Benzo(a)pyrene						
Benzo(k)fluoroanthene						
Fluoroanthene						
Indeno(1,2,3-cd)pyrene						
Naphthalene	√					
PCBs						√
Pesticides/Herbicides						
Alachlor	√					
Aldrin						√
Atrazine	√					
Bromoxynil						√
Chlorfenvinphos	√					
Chlorpyrifos	√					
Dichlorprop						√
Dichlorvos					√	
Dieldrin						√
Diuron	√					
Endosulfan,(alpha-endosulphan)	√					
Hexachlorocyclohexane, Lindane (HCH)	√			√		
*Individual Pesticides						√
Isoproturon	√					
Malathion						√
Mecoprop					√	
Permethrin					√	
Simazine	√				√	
**Total Pesticides						√
Triflualin	√				√	

* Individual Pesticides – Only those pesticides, which are likely to be present in a given supply require to be monitored. The parametric value 0.01 ug/l applies to each individual parameter.

** Total Pesticides – Total means the sum of all individual pesticides detected and quantified in the course of the monitoring procedure.

3. PROPOSED INTERIM GUIDELINE VALUES FOR THE PROTECTION OF GROUNDWATER IN IRELAND

3.1 INFORMATION SOURCES

A number of information sources were taken into account when considering interim guideline values for the core and site specific parameters. These were:

- Existing national Environmental Quality Standards for Groundwater
- Proposed common indicators from the new Groundwater Directive
- Drinking Water Standards
- Existing and proposed Environmental Quality Standards for the aquatic environment
- GSI Trigger Values

3.1.1 Existing national Environmental Quality Standards for Groundwater

Consideration has been given to current Irish legislation and in particular the Water Pollution Regulations 1999 (S.I. No. 42 of 1999). The only specific standards related to groundwater in Irish Legislation is the EQS set for List 1 substances in the Water Pollution Regulations, 1999 (S.I. No. 42 of 1999). The regulations have set an EQS of 0 mg/l for List I substances, however, it also states that the competent authority has discretion not to apply the 0 mg/l quality standard referred to in Article 41(1) and 41(2) if the substance 'is present in so small a quantity and concentration as to obviate present or future danger of deterioration of the water in the aquifer'. The Agency considers that based on the Commission vs Germany case (Case C-131/88), the drinking water standard (at a minimum) should be considered for List I substances. However if List I substances are detected in groundwater irrespective of their concentration then an investigation should be carried out into the source of the substance and actions taken to cease the discharge.

In the absence of a definitive list of substances that fall within the scope of List I category of the Groundwater Directive, a conservative approach has been taken to designate all substances belonging to the families of groups presented in the Annex of the Directive as List I irrespective of their toxicity, persistence and bio-accumulation.

3.1.2 Proposed common indicators from the new Groundwater Directive

The latest draft of the proposed Groundwater Directive (March 2003) does not include Environmental Quality Standards for groundwater, instead it proposes the use of EU groundwater common indicators. Member States will have to establish a range of concentrations of groundwater common indicators on the basis of extensive surveys of European groundwaters. This range should reflect the natural variability of groundwater composition for the different types of groundwater bodies (typologies). The list of proposed parameters are included in Section 2.1. It proposes that MS should use the common indicators as follows:

a. The 95%iles of the selected parameter distribution should be used as a threshold values for the groundwater body. Using data from the initial characterisation or from monitoring programmes for the groundwater body, concentrations at individual monitoring sites should be examined to determine whether they exceed one of more of the 95%ile threshold value.

b. In the case where the threshold values are exceeded for one or more of the common indicators then MS should take action. The action may include further investigation, assessment and reversal of trends, investigation of potential sources of pollutants.

3.1.3 Drinking Water Standards

Currently drinking water standards are generally used for the assessment of groundwater quality. However, the standards apply only to waters used for human consumption and apply at the point of use and not in the groundwater body itself. Drinking water guideline values or standards from national and European legislation have been applied to the characterisation list of parameters and are included in Table 3.1. In cases where there is no guideline value or standard stated in Irish or EU legislation then the World Health Organisation values are used. In other cases where there is a range of values following the international review then the lowest drinking water value is taken. In three cases the Australian drinking water guideline values were used in the absence of other sources and the ANZEEC Freshwater Ecotox guidelines were used for *Di-n-butyl phthalate (DBP)*.

However, it has not been possible at this stage to allocate drinking water standards to the following parameters:

	Potential Endocrine Disrupters
C_{10-13} chloroalkanes [1, 2]	Brominated diphenylether [1, 2, 3]
Halogenated organic compounds (as AOX) [2]	Butylbenzylphthalate (BBP)
	Octylphenols, (para-tert-octylphenol) [1]
	Pentabromodiphenylether [1]

KEY
[1] COM (2001) 17 final
[2] EPER list of 26
[3] CTC list of 22

Two of the parameters (C_{10-13} chloroalkanes, halogenated organic compounds) are actually family/group headings as set out in the EU EPER or Priority List (COM (2001) 17 final) documents, for which international values have not been found at this stage.

The remaining four other parameters are listed as potential endocrine disrupters. The Commission issued a proposal in 1999 for a strategy on endocrine disrupters. The main elements of the strategy are:

- In the absence of a recognised test method, potential endocrine disrupting substances should be classified as potential priority substances.
- In the medium term (2-4 years) test methods to prove endocrine disruption and research on causal links between exposure to and adverse effects of endocrine disrupters be intensified.
- In the long term (>4 years) the EU chemicals legislation as well as the Water Framework Directive and legislation on pesticides, drinking water quality etc. should be amended to take account of endocrine disrupters.

In March 2000 the EU Member States endorsed the proposed strategy, application of the precautionary principle and improved risk management leading to the gradual elimination of certain substances. Because of the concern relating to endocrine disrupters and the work currently being undertaken in this area the parameters are still included in the characterisation list and once appropriate values are determined then they can be added to Table 3.1.

3.1.4 Existing and proposed EQSs for the Aquatic Environment

The EPA published a discussion document on Environmental Quality Objectives and Environmental Quality Standards for the Aquatic Environment in 1997. This document sets out a list of priority substances and proposed EQS's. The EQS's were based on existing standards which have been laid down by Directives or national regulations, or in adopted Water Quality Management Plans, while for others CSTE (Scientific Advisory Committee on Toxicity and Ecotoxicity of Chemicals – EU established group) has proposed suitable EQSs. In addition, the EPA has proposed tentative EQSs for relevant parameters not otherwise covered. The EQSs are focussed on the principal use category of fishery waters (EQOs) for surface fresh waters. Some of the proposed EQSs may be applied to groundwaters but the document does not specifically address EQSs for groundwater.

Following on from the publication of that document, Environmental Quality Standards for waters were set by the Minister for the Environment and Local Government for phosphorus and for a range of dangerous substances.

- The Water Pollution Act, 1977 (Water Quality Standards for Phosphorus) Regulations (S.I. No. 258 of 1998) sets standards for phosphorus in surface waters.
- The Dangerous Substances Regulations (S.I. No. 12 of 2001) sets standards for 14 dangerous substances, which apply to all waters (except groundwaters).

The WFD states that the chemical composition of the groundwater body should not be such that it would result in failure to achieve good chemical or ecological status in associated surface waters nor any significant damage to terrestrial ecosystems dependent on the groundwater body. Alternatively, interactions with surface waters should not result in the failure to achieve good groundwater status for associated groundwater bodies. In light of these requirements of the WFD, the proposed EQSs for the Aquatic Environment and the Dangerous Substances EQSs have been considered for the setting of the IGVs for groundwater (Table 3.1).

3.1.5 Geological Survey of Ireland (GSI) Trigger Values

The GSI has set trigger values for five parameters (nitrate, potassium, chloride, ammonia and faecal coliforms). The GSI has found that in practice these values act as a warning that an appreciable impact may be occurring. In all cases, apart from faecal bacteria, the GSI warning levels are lower than the EU MAC for drinking water. These trigger levels are set out in Table 3.1.

3.2 Approach Taken to Setting Interim Guideline Values

3.2.1 Current Approach

The following approach was taken to the setting of interim guideline values. Should additional parameters be added to the characterisation list, the same approach should be used to assign an interim guideline value for that parameter. In setting the interim guideline values a prioritised ranking system was used. The interim guideline value chosen was the GSI Trigger Value (background concentration) where it applied, and where is did not apply the most stringent value of

- The Drinking Water Standard, or
- The EQS for the Aquatic Environment/ Dangerous Substances, where appropriate.

In general, the interim guideline value (Table 3.1) derives from the drinking water standards however, for some synthetic substances the EQS for the aquatic environment is used to provide additional protection for surface water features and their associated ecosystems. In Ireland, most of the groundwater bodies will have associated surface water features and ecosystems, which have to be protected. The interaction of groundwater with these features should not lead to a deterioration of surface water status or result in adverse effects to the terrestrial ecosystems and this additional protection is therefore warranted.

3.2.2 Possible Future Approach

Reference conditions (and/or typologies) will have to be established for groundwater bodies in each Member State due to the new Groundwater Directive. However, currently the national groundwater quality monitoring database does not have sufficient information on the monitoring station, i.e., hydrochemical monitoring, aquifer unit, depth of sampling, well construction, potential sources of pollution in ZOC etc., to enable reference conditions to be defined. When the approach adopted in this document is applied to all systematic sampling of groundwater then this information can be used to establish a range of concentrations as proposed by the new Groundwater Directive.

The Agency in its ERTDI programme for research under the WFD (2002) has a project on the 'Characterisation of Unpolluted Groundwater' which will provide information that will assist in the development of an approach to establishing typologies in line with the requirements of the new Groundwater Directive.

The River Basin Management System projects will be reviewing the existing monitoring programmes and will have to collect standardised information for all monitoring stations. Monitoring data collected during the course of these projects will further assist in the elaboration of national groundwater criteria.

Table 3.1: Interim Guideline Values for Characterisation List of Parameters

PARAMETER	*List I or List II*	*Drinking Water Standards (units)*	*GSI Trigger Values*	*EQSs for Surface Waters*	***Interim Guideline Value***	*Source of Interim GVs*
CORE PARAMETERS or NATURAL SUBSTANCES						
Physicochemical-Microbiological						
Coliforms (faecal)		0 counts per 100ml	0 counts per 100ml		**0 counts per 100ml**	B, I
Coliforms (total))		0 counts per 100ml	0 counts per 100ml		**0 counts per 100ml**	B, I
Electrical Conductivity		1500 µS/cm		1000µS/cm	**1000µS/cm**	K
Temperature		25^0C			**25^0C**	B
TOC		*No abnormal change*			***No abnormal change***	-
Colour					*No abnormal change*	A
pH (pH units)		≥ 6.5 and ≤ 9.5			**≥ 6.5 and ≤ 9.5**	A
Inorganic						
Alkalinity					***No abnormal change***	-
Ammonia (as ammonium)	*II*	0.30 mg/l	0.15 mg/l	0.02 NH3	**0.15 mg/l**	I
Bicarbonate		*No abnormal change*			***No abnormal change***	-
Calcium		200 mg/l			**200 mg/l**	B
Carbonate		*No abnormal change*			***No abnormal change***	-
Chloride		250 mg/l	30 mg/l	250 mg/l	**30 mg/l**	I
Dissolved Oxygen		*No abnormal change*			***No abnormal change***	-
Hardness (as $CaCO_3$)		200 mg/l			**200 mg/l**	G
Iron		0.2 mg/l		1.0 mg/l	**0.2 mg/l**	A
Magnesium		50 mg/l			**50 mg/l**	B
Manganese		0.05 mg/l		0.3 mg/l	**0.05 mg/l**	A
Nitrate (as NO_3)		50 mg/l	25 mg/l	50 mg/l	**25 mg/l**	I
Nitrite (as NO_2)	*II*	0.1 mg/l		0.2 mg/l	**0.1 mg/l**	A
Orthophosphate		0.03 mg/l			**0.03 mg/l**	F
Potassium		12 mg/l	5 mg/l		**5 mg/l**	I
Sodium		150 mg/l			**150 mg/l**	B
Sulphate mg/l		250 mg/l		200 mg/l	**200 mg/l**	K
Metals						
Aluminium		0.2 mg/l		0.2 mg/l	**0.2 mg/l**	A, K
Arsenic and its compounds	*II*	0.01 mg/l		0.025mg/l [#]	**0.01 mg/l**	A
Boron	*II*	1.0 mg/l		2.0 mg/l	**1.0 mg/l**	A
Cadmium and its compounds	**I**	0.005 mg/l		0.005 mg/l	**0.005 mg/l**	A, K
Chromium and its compounds	*II*	0.05 mg/l		0.03 mg/l [#]	**0.03 mg/l** [#]	J
Copper and its compounds	*II*	2.0 mg/l		0.03 mg/l [#]	**0.03 mg/l** [#]	J
Mercury and its compounds	***I***	0.001 mg/l		0.001 mg/l	**0.001 mg/l**	A, K
Nickel and its compounds	*II*	0.02 mg/l		0.05 mg/l [#]	**0.02 mg/l**	A
Zinc and its compounds	*II*	5.0 mg/l		0.1 mg/l [#]	**0.1 mg/l** [#]	J
Organics						
TON mg/l		*No abnormal change*			***No abnormal change***	-
Total Hydrocarbons to include mineral oil by GC** mg/l	*I*	0.01 mg/l		0.01 mg/l	**0.01 mg/l**	B, K

** TPH by Gas Chromatography: This analysis can serve as a 'catch-all' and will present results for the general term 'Gasoline Range Organics' and the separate 'BTEX' parameters including MTBE. 'Diesel Range Organics' (DRO) should also be specified in order to determine mineral oil concentration.

PARAMETER	*List I or List II*	*Drinking Water Standards (units)*	*GSI Trigger Values*	*EQSs for Surface Waters*	***Interim Guideline Value***	*Source of Interim GVs*
SITE SPECIFIC PARAMETERS OR SYNTHETIC SUBSTANCES						
Physicochemical						
Total dissolved solids		1000 mg/l			**1000 mg/l**	D
Inorganic						
Barium		0.5 mg/l		0.1 mg/l	**0.1 mg/l**	K
Cyanide	**I**	0.05 mg/l		0.01 mg/l #	**0.01 mg/l** #	J
Fluoride	*II*	1.0 mg/l		5.0 mg/l #	**1.0 mg/l**	A, J
Silica		*No abnormal change*			***No abnormal change***	-
Metals						
Lead	*II*	0.01 mg/l		0.01 mg/l #	**0.01 mg/l**	A, J
Uranium		0.009 mg/l		0.02 mg/l	**0.009 mg/l**	D*
Organics						
1,2 Dicholorobenzene	**I**	1000 µg/l		10 µg/l	**10 µg/l**	K
1,2-Dichloroethane (DCA)	**I**	3.0 µg/l		10 µg/l	**3.0 µg/l**	C
1,2-Dichloromethane	*II*	0.04 µg/l		10 µg/l	**0.04 µg/l**	D
2, 4, 6 Trichlorophenol	**I**	200 µg/l			**200 µg/l**	D
2, Chlorophenol	**I**	200 µg/l			**200 µg/l**	E
Anionic Surfactants (AS)	*II*	200 µg/l		200 µg/l	**200 µg/l**	B, K
Benzene	**I**	1.0 µg/l		10 µg/l	**1.0 µg/l**	C
Brominated diphenylether	*II*	-			-	-
Butylbenzylphthalate (BBP)	*II*	-			-	-
Chlorobenzene	**I**	100 µg/l		1.0 µg/l	**1.0 µg/l**	K
Di 2 ethylhexyladiapate (DEHA)	*II*	80 µg/l			**80 µg/l**	D
Di –n- butyl phthalate (DBP)	*II*	2.0 µg/l			**2.0 µg/l**	H
Di(2-ethylhexyl)phthalate (DEHP)	*II*	8.0 µg/l			**8.0 µg/l**	D
Dichloroethene	*II*	30 µg/l			**30 µg/l**	D
Dichloromethane (DCM)	*II*	20 µg/l		10 µg/l	**10 µg/l**	J
Ethylbenzene	*II*	300 µg/l		10 µg/l	**10 µg/l**	K
Halogenated organic compounds (as AOX)	*II*	-			-	-
Hexachlorobenzene (HCB)	**I**	1.0 µg/l		0.03 µg/l	**0.03 µg/l**	K
Hexachlorobutadiene(HCBD)	*I*	0.6 µg/l		0.10 µg/l	**0.10 µg/l**	K
MTBE	*II*	30 µg/l			**30 µg/l**	E
Nitrobenzene	*II*	10 µg/l			**10 µg/l**	E
Nonylphenols, (4-(para)-nonylphenol)	*II*	2.5 µg/l			**2.5 µg/l**	E
Octylphenols, (para-tert-octylphenol)	*II*	-			-	-
Organo-tin compounds (as Sn)	**I**	0.7 µg/l			**0.7 µg/l**	E
Pentabromodiphenylether	*II*	-			-	-
Pentachlorobenzene	**I**	1.0 µg/l			**1.0 µg/l**	E
Pentachlorophenol	**I**	9.0 µg/l		2.0 µg/l	**2.0 µg/l**	K
Perchloroethylene (PER) (Tetrachloroethylene)	*I*	-		10 µg/l	**10 µg/l**	K
Phenols	*II*	0.5 µg/l		0.5 µg/l	**0.5 µg/l**	B, K
Phthalates	*II*	5 µg/l			**5 µg/l**	E
Tetrachlorethene	*I*	40 µg/l			**40 µg/l**	D
Tetrachloromethane	*II*	2.0 µg/l			**2.0 µg/l**	E
Toluene	**I**	700 µg/l		10 µg/l	**10 µg/l**	K, J
Trichlorobenzenes (1,2,4-Trichlorobenzene)	**I**	20 µg/l		0.40 µg/l	**0.40 µg/l**	K
1, 1, 1 -Trichloroethane	**I**	2000 µg/l		500 µg/l	**500 µg/l**	K
Trichloroethene	*II*	70 µg/l			**70 µg/l**	D
Trichloroethylene (TCE)	**I**	50 µg/l		10 µg/l	**10 µg/l**	K
Trichloromethane (Chloroform)	*I*	200 µg/l		12 µg/l	**12 µg/l**	K

PARAMETER	*List I or List II*	*Drinking Water Standards (units)*	*GSI Trigger Values*	*EQSs for Surface Waters*	***Interim Guideline Value***	*Source of Interim GVs*
Xylenes	*II*	500 µg/l		10 µg/l	**10 µg/l**	J, K
Polyaromatic hydrocarbons (PAH)	*II*	0.1 µg/l		0.2 µg/l	**0.1 µg/l**	A
Anthracene	*II*	10000 µg/l			**10000 µg/l**	E
Benzo(b)fluoranthene	*II*	0.5 µg/l			**0.5 µg/l**	E
Benzo(g,h,I)perylene	*II*	0.05 µg/l			**0.05 µg/l**	E
Benzo(a)pyrene	*II*	0.01 µg/l			**0.01 µg/l**	E
Benzo(k)fluoroanthene	*II*	0.05 µg/l			**0.05 µg/l**	E
Fluoroanthene	*II*	1.0 µg/l			**1.0 µg/l**	E
Indeno(1,2,3-cd)pyrene	*II*	0.05µg/l			**0.05µg/l**	E
Naphthalene	*II*	1.0 µg/l			**1.0 µg/l**	E
PCBs	*II*	0.01 µg/l		0.1 µg/l	**0.01 µg/l**	E
Pesticides/Herbicides						
Alachlor	*II*	20 µg/l			**20 µg/l**	D
Aldrin	**I**	0.03 µg/l		0.01 µg/l	**0.01 µg/l**	K
Atrazine	*II*	2.0 µg/l		1.0 µg/l	**1.0 µg/l**	J, K
Bromoxynil	**I**	5.0 µg/l			**5.0 µg/l**	E
Chlorfenvinphos	**I**	5.0 µg/l			**5.0 µg/l**	G
Chloropyrifos	**I**	90 µg/l			**90 µg/l**	E
Dichlorprop	**I**	100 µg/l			**100 µg/l**	D
Dichlorvos	**I**	1.0 µg/l		0.001 µg/l	**0.001 µg/l**	K
Dieldrin	**I**	0.03 µg/l		0.01 µg/l	**0.01 µg/l**	K
Diuron	**I**	150 µg/l		25 µg/l	**25 µg/l**	K
Endosulfan,(alpha-endosulphan)	**I**	30 µg/l		0.001 µg/l	**0.001 µg/l**	K
Hexachlorocyclohexane, Lindane (HCH)	*I*	2.0 µg/l		0.1 µg/l	**0.1 µg/l**	K
Individual Pesticides	*II*	0.1 µg/l		0.1 µg/l	**0.1 µg/l**	A, K
Isoproturon	*II*	9.0 µg/l		0.5 µg/l	**0.5 µg/l**	K
Malathion	**I**	190 µg/l		0.01 µg/l	**0.01 µg/l**	K
Mecoprop	*II*	10 µg/l		10 µg/l	**10 µg/l**	D, K
Permethrin	**I**	20 µg/l			**20 µg/l**	D
Simazine	**I**	2.0 µg/l		1.0 µg/l	**1.0 µg/l**	J, K
Total Pesticides	**I**	0.5 µg/l			**0.5 µg/l**	A
Triflualin	**I**	20 µg/l		0.1 µg/l	**0.1 µg/l**	K

Note:

A Irish Drinking Water Regulations, 2000 (S.I. No. 439 of 2000).
B Irish Drinking Water Regulations, 1988 (S.I. No. 81 of 1988).
C EC Drinking Water Directive, 1998 (98/83/EC).
D World Health Organisation Drinking Water Guidelines, 1993 and amended in 1996.
D* World Health Organisation Drinking Water Proposed Guideline February 2003.
E Lowest Drinking Water Guideline Value (or Intervention Value) of the countries reviewed.
F Water Pollution Act, 1977 (Water Quality Standards for Phosphorus) Regulations (S.I. No. 258 of 1998).
G Australian Drinking Water Guidelines 1996.
H ANZEEC Freshwater Ecotox Guidelines.
I Geological Survey of Ireland Trigger Values
J Dangerous Substances Regulations, SI No. 12 of 2001
K EQS for the Aquatic Environment, EPA Discussion Document
Standard where hardness of water is > 100 mg/l Ca CO_3

I List I Substance - 'Classification of Listed Substances for the Purposes of the EC Groundwater Directive (80/68/EEC)', Environment Agency Report 1999 or Hydrogeological Risk Assessment for Landfills and the Derivation of Groundwater Control and Trigger Levels, Environmental Agency, May 2002.

I *List I Substance – as listed in Daughter Directives to the Dangerous Substance Directive 76/464/EEC.*

II List II Substance or candidate List I.

No abnormal change – refers to no significant change compared to background concentrations.

3.3 COMPARISON OF INTERIM GUIDELINE VALUES WITH NATURAL HYDROCHEMISTRY OF DIFFERENT AQUIFERS

3.3.1 Background

There is a difference between groundwater chemistry (hydrochemistry) and groundwater quality. This difference arises because hydrochemistry is dependent on the nature of the subsoils and rocks that the groundwater passes through. In Ireland, limestone bedrock and limestone dominated subsoils are common and consequently groundwater is often hard, containing high concentrations of calcium, magnesium and bicarbonate. However, in areas where volcanic rock or sandstones are present, softer water is normal (Daly, D. 2001).

3.3.1.1 Core Group or Natural Substances

Because of the complex geology in Ireland, there is variable hydrochemistry depending on the aquifer type. The natural hydrochemistry of four different aquifer types in Ireland; limestone, sandstone, sand and gravels and volcanic aquifers have been compared to the interim guideline values for a selection of the 'Core Group' for which information was available (see Table 3.2). The comparison indicates that the analysis of natural groundwater generally complies with the interim guideline values (IGVs) for the 'Core Group' of parameters. There are some exceptions in that there are parameters such as Iron (Fe) and Manganese (Mn) that occur naturally in groundwater and may exceed the IGV in certain geological and geographical settings. The current IGVs (drinking water standard) for iron and manganese are set because of aesthetic and taste reasons and not for health reasons. The source of iron in groundwater can either be natural or from pollution by organic wastes (Daly, D. 2001).

Table 3.2: Groundwater Hydrochemistry

PARAMETER	**Ordovician Volcanics**	**Devonian Sandstones**	**Carboniferous Limestone**	**Westphalian Sandstone**	**Sand and Gravel**	**Interim Guideline Value**
CORE PARAMETERS mg/l						
Inorganic						
Ammonia (as ammonium)	0.1	0.02	0.13	0.04	0.05	***0.15***
Calcium	80	54	102	60	118	200
Chloride	35	20	26	17	22	***30***
Hardness as CaCO3	60	185	307	225	320	200
Iron	0.1	ND	ND	ND	ND	0.2
Magnesium	9.7	12.2	12.9	13.4	6.3	50
Manganese	ND	ND	ND	ND	0.01	0.05
Nitrate	0.5	3.0	0.9	1.4	2.8	***25***
Potassium	3.1	1.9	3.0	1.3	0.6	***5***
Sodium	24	16	8.8	18.8	12.0	150
Sulphate	45	ND	ND	2.0	2.0	200

ND – not determined

Aquifer type	*Location*
Ordovician Volcanics	Gorey, Wexford
Devonian Sandstones	Knocktopher, Kilkenny
Carboniferous Limestones	Ballaghdereen, Roscommon
Westphalian Sandstones	Ballincurry, Tipperary
Sand and Gravel	Mortarstown, Carlow

So while in some areas the natural background levels are such that they may exceed the IGVs this does not mean the groundwater has been polluted. However in many other cases it can be seen that the IGVs are orders of magnitude greater than the background levels in groundwater. This also has been recognised by the Geological Survey of Ireland who developed trigger values for use during their assessment of groundwater quality and also in the development of the new Groundwater Directive.

3.3.1.2 Site Specific or Synthetic Substances

The groundwater monitoring programme undertaken by the EPA (raw data provided by the EPA regional chemists) indicates the following range of values for select synthetic substances found in groundwaters in Ireland (Table 3.3). A comparison of background values and the corresponding IGV has been made. It indicates that significant proportions of the IGVs are orders of magnitude higher than the background level, which is not surprising since these substances are not naturally found in groundwaters.

Table 3.3: Range of Values for Selected Synthetic Substances

Parameter	No. of Samples	Range of values	Maximum	Interim Guideline Value
1,2 Dichloroethane	22	<0.02 to 0.037 µg/l	0.037 µg/l	3 µg/l
1,2,4 Trichlorobenzene	90	<0.01 to 0.215 µg/l	0.215 µg/l	0.4 µg/l
Benzene	58		0.11 µg/l	1 µg/l
Chlorobenzene	69	<0.02 to 0.21 µg/l	0.21 µg/l	1 µg/l
Chloroform	70	<0.1 to 2.037 µg/l	2.037 µg/l	12 µg/l
Chloropyrifos	1	<10 µg/l	<10 µg/l	90 µg/l
Chromium	269	< 0.0005 to 0.008 mg/l	0.008 mg/l	0.03 mg/l
Diuron	100	<0.05 µg/l to 0.05 µg/l	0.05 µg	25 µg/l
Endosulphan - alpha	30	<0.1 µg/l	<0.1 µg/l	0.001 µg/l
Ethyl benzene	69	< 0.02 µg/l to 0.163 µg/l	0.163 µg/l	10 µg/l
Hexachlorobutadiene (HCBD)	96	<0.01 to <0.1 µg/l	<0.1 µg/l	0.1 µg/l
Isoproturan	101	<0.05 to 0.28 µg/l	0.28 µg/l	0.5 µg/l
Lindane	51	<0.01 to 10µg/l	10 µg/l	0.1 µg/l
m&p- xylene	70	<0.02 µg/l to 0.185 µg/l	0.185 µg/l	10µg/l
MTBE	210	< 0.1 µg/l	< 0.1 µg/l	30 µg/l
Napthalene	70	<0.02 to 0.28 µg/l	0.28 µg/l	1 µg/l
o- xylene	69	<0.02 µg/l to 0.158 µg/l	0.158 µg/l	10µg/l
TOC	698	<0.1 to 374 mg/l	374 mg/l 3 samples > 50mg/l	No Abnormal Change
Toluene	69	< 0.1 µg/l to 0.38 µg/l	0.38 µg/l	10 µg/l

4. PROPOSED METHODOLOGY FOR ASSESSING GROUNDWATER QUALITY

4.1 MODEL APPLICATION

This section presents a methodology for assessing groundwater quality in Ireland. When applying the methodology an appreciation of the natural hydrochemistry of the groundwater must be built into the assessment of the groundwater quality.

Assessment of groundwater quality should proceed using the general approach described below on the basis that groundwater analysis results are compared with the Interim Guideline Values (IGVs) and the need for any further action determined as follows:

- All parameters in groundwater are below the IGVs – direct action is not likely to be required. Ongoing monitoring of groundwater quality is recommended to ensure that the quality does not deteriorate.
- If List I substances are detected then an investigation should be undertaken to identify the source of the substances and an assessment of what further action, if any, should be made.
- One or more parameter concentrations are above the IGVs – further assessment is required if natural hydrochemistry has been ruled out and should include sampling, analysis and site-specific risk assessment, as appropriate. Direct remedial action may be required and the scope of such action will be determined upon conclusion of the further assessment. The objective of the remedial action must be to reduce the parameter concentrations below the IGV, unless the exceedance is naturally occurring and to ensure continued improvement in the quality of the groundwater. Remedial action could, depending on the circumstances, involve anything from changes in land use at the surface (e.g. changes in farming practice or replacement of a septic tank soakaway by a percolation field, or replacement of a leaking underground storage tank (LUST) at a service station) to groundwater management or cleanup.

4.2 PROCEDURE FOR THE ASSESSMENT OF GROUNDWATER CHEMICAL STATUS

This procedure should be applied when characterising groundwater status of a groundwater body and assessing whether action is required to bring a groundwater body back to 'good status'. In addition, the methodology can be used for assessing the groundwater quality at a monitoring point or at a public supply well. A working assumption will be that representative groundwater samples have been taken and that analytical protocols are robust.

The approach suggested is presented in Figure 4.1 and described below.

Step 1. Characterise/Investigate Groundwater Quality

Field, laboratory and microbiological analysis of groundwater samples should be undertaken to determine representative levels for assessment, either at points of interest including monitoring wells, abstraction wells, springs, up-gradient and down-gradient of site boundary, etc., or in the vicinity of a suspected source of contamination. Guidance on designing a sampling programme and technical aspects such as borehole installation and sample recovery are outside the scope of this document. The reader is referred to the Landfill Monitoring Manual (EPA 1995) and documents such as the EA Consultative document *Guidance on Monitoring of Landfill Leachate, Groundwater and Surface Water* (EA, 2002) and *Guidance on requirements for*

"requisite surveillance of groundwater" for activities authorised under the Groundwater Regulations. 1998 (EA 2002a) for guidance on the procedures to be followed.

Certain chemical parameters (pH, Electrical Conductivity, temperature, and dissolved oxygen (DO)) should be measured at the wellhead, as laboratory results may not be representative of groundwater conditions. Also, the type of sampling point, the method of collecting the sample, etc. will influence the analysis results. Much information can be gained from pH and EC parameters alone with instantaneous results. Field hand-held meters for pH and EC are inexpensive and can be used for several years if correctly maintained.

Chemical and microbiological analysis should focus on the characterisation list presented in Table 2.1. The 'Core Group' parameters should be included at all sites where background concentrations (typologies) are being determined, regardless of any existing information that might be available.

Additionally, 'Site Specific' parameters should be identified using any available data, including site history information, existing monitoring results and anecdotal observations. The characterisation list of parameters (Table 2.1) should be consulted and any parameters that can reasonably be expected to be present should be included. Analysis for these 'Site Specific' parameters should be done at the same time as the 'Core Group' analyses. The 'Core Group' parameters are primarily indicators of groundwater quality and hydrochemistry rather than being indicators of contamination.

Step 2. What is the Status of the Groundwater?

Groundwater quality data should be compared with background concentrations or reference conditions. At this stage reference conditions or typologies have not been developed for groundwaters in Ireland. The collection of relevant hydrochemical and indicator parameter concentrations through the RBMS projects will enable the typologies to be documented. In the absence of these typologies (reference conditions); the data should be compared to up-gradient monitoring boreholes when available. In the interim, to determine whether Good Chemical Status is achieved, compare to the IGVs.

If appropriate sampling and analytical procedures have been followed and all measured parameter concentrations fall below the IGVs then action will not be required and the procedure can be exited (Figure 4.1). A monitoring programme should be implemented to ensure that conditions do not change over time and that groundwater status is maintained. Should a significant and sustained upward negative trend be identified as a result of on-going monitoring (or existing monitoring), then appropriate measures will be required to reverse this trend, even where the interim guideline value has not been exceeded.

If one or more parameters are detected at concentrations higher than the IGVs then further assessment is required if the exceedance has not been shown to be naturally occurring, and, in the case of the detection of the presence of List I substances, the relevant local authority or licensing authority should be notified immediately.

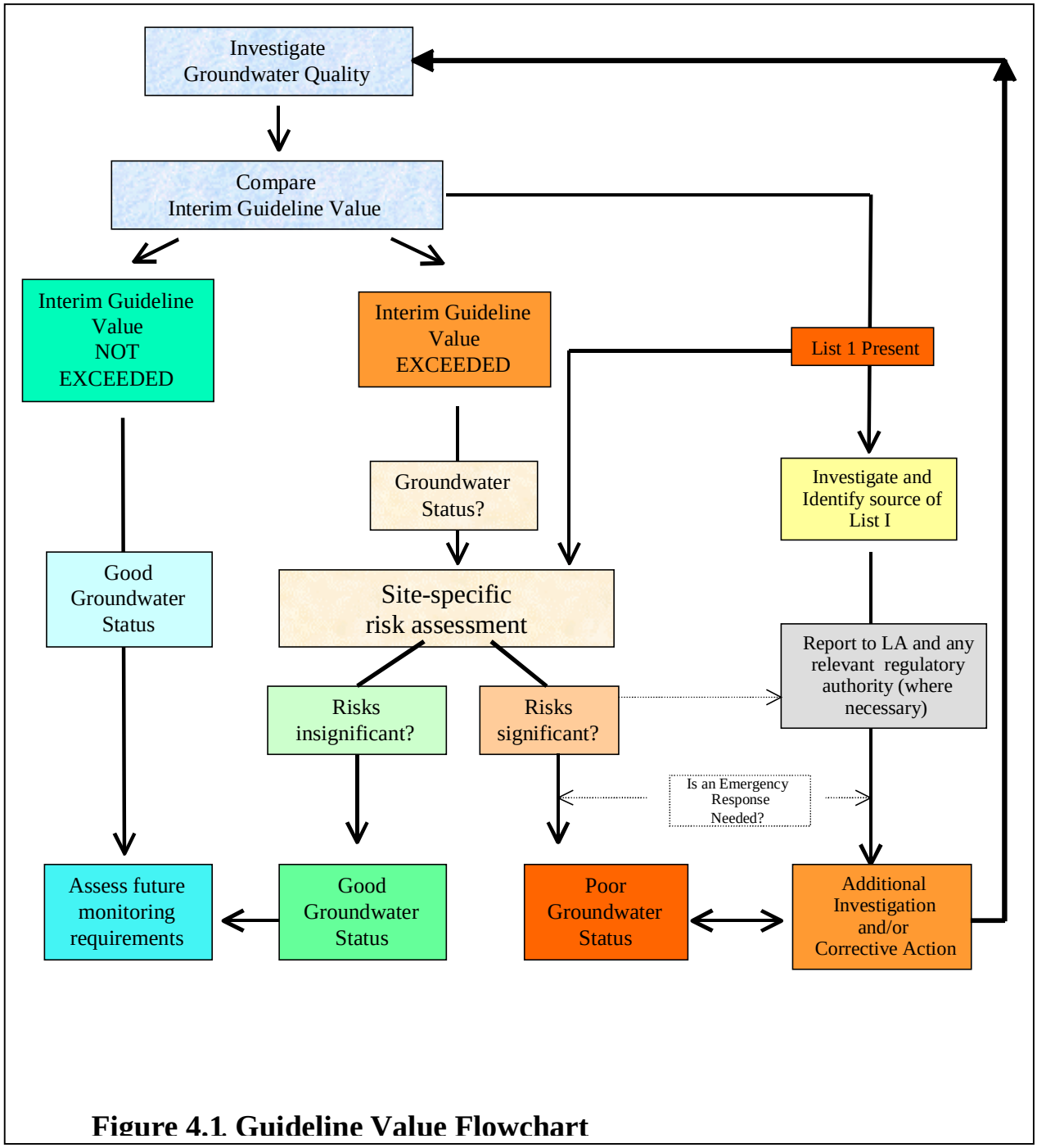

Figure 4.1 Guideline Value Flowchart

Step 3. Actions where there is an Exceedance

List I Exceedance

If List I substances (Groundwater Directive 80/68/EEC) are detected and are continuing to enter groundwater then the situation should be reported to the relevant local authority, and the EPA. Steps must be taken to ensure compliance with the Local Government (Water Pollution) Regulations (S.I. No. 271/1992, as amended S.I. No. 42 of 1999).

Is an Emergency Response Needed?

Where exceedances occur, the need for an emergency response should be evaluated as soon as possible, in liaison with the appropriate regulatory authority. All available evidence should be considered in order to determine if there is a need to instigate urgent action to address quality issues. Reports of accidental spills of chemicals to ground or indications such as discoloration of groundwater, chemical odours and adverse environmental impacts (e.g., stressed vegetation) should be taken into account and appropriate action taken.

Risk Assessment

Groundwater chemistry varies according to the aquifer geology and experience of flow (fast or slow). Quality problems may not have an anthropogenic origin: for example, elevated concentrations of metals may occur in the vicinity of an ore body, or high dissolved solids concentrations in a coastal aquifer. Background concentrations of many chemicals at industrial/waste areas can be effectively assumed to be below limit of detection, as studies have revealed that contamination in these sectors is generally associated with point sources. Agricultural quality issues can be both from point and diffuse sources and so are more widespread than most of the industrial contaminants.

If the assessment indicates a *significant* increase in the concentration of the parameter in question compared to the IGVs then further action is necessary. Any action should consider the actual and potential risks that the contamination poses to the relevant receptors and may involve fate and transport modelling and quantitative risk assessment.

It is outside the scope of this document to provide detailed guidance with respect to follow-on assessment. However, if a quantitative risk assessment indicates that risks are insignificant then the procedure can be exited. If, on the other hand, risks are determined to be significant then some form of remedial action is likely to be required and the most appropriate course of action should be determined. This assessment should consider all options that afford protection to the potentially “at-risk” receptors, taking costs and benefits into account if appropriate.

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NOTE: Completed comments to be forwarded to: The Environmental Management and Planning Division, Environmental Protection Agency, P.O. 3000, Johnstown Castle Estate, Wexford

Document Title: **Interim Guideline Values for the Protection of Groundwater in Ireland**

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AN GHNÍOMHAIREACHT UM CHAOMHNÚ COMHSHAOIL

BUNÚ
Achtaíodh an tAcht fán nGníomhaireacht um Chaomhnú Comhshaoil ar an 23ú lá d'Aibreán, 1992 agus faoin reachtaiocht seo bunaiodh an Ghníomhaireacht go hoifigiúil ar an 26ú lá d'lúil, 1993.

CÚRAIMÍ
Tá réimse leathan de dhualgais reachtúla ar an nGníomhaireacht agus de chumhachtaí reachtúla aici faoin Acht. Tá na nithe seo a leanas san áireamh i bpríomhfhreagrachtaí na Gníomhaireachta:

- ceadúnú agus rialáil próiseas mór/ilchasta tionsclaíoch agus próiseas eile a d'fhéadfadh a bheith an-truaillitheach, ar bhonn rialú comhtháite ar thruailliú (Integrated Pollution Control-IPC) agus cur chun feidhme na dteicneolaíochtaí is fearr atá ar fáil chun na críche sin;
- faireachán a dhéanamh ar cháiliocht comhshaoil, lena n-áiritear bunachair sonraí a chur ar bun a mbeidh rochtain ag an bpobal orthu, agus foilsiú tuarascálacha treimhsiula ar staid an chomhshaoil;
- comhairle a chur ar údaráis phoiblí maidir le feidhmeanna comhshaoil agus cuidiú le húdaráis áitiúla a bhfeidhmeannas caomhnaithe a chomhlíonadh;
- cleachtais atá fónta ó thaobh an chomhshaoil de a chur chun cinn, mar shampla, trí úsáid iniúchtaí comhshaoil a spreagadh, scéim éicilipéadaithe a bhunú, cuspóirí cáilíochta comhshaoil a leagan síos agus cóid chleachtais a eisiúint maidir le nithe a théann i bhfeidhm ar an gcomhshaol;
- taighde comhshaoil a chur chun cinn agus a chomhordú;
- gach gníomhaiocht thábhachtach diúscartha agus aisghabhála dramhaíola, lena n-áirítear líontaí talún, a cheadúnú agus a rialáil agus plean náisiúnta bainistíochta um dhramháil ghuaiseach, a bheidh le cur i ngníomh ag comhlachtaí eile, a ullmhú agus a thabhairt cothrom le dáta go tréimhsiúil;
- clár hidriméadach náisiúnta a ullmhú agus a chur i ngníomh chun faisnéis maidir le leibhéil, toirteanna agus sruthanna uisce in aibhneacha, i lochanna agus i screamhuiscí a bhailiú, a anailisiú agus a fhoilsiú; agus
- maoirseacht i gcoitinne a dhéanamh ar chomhlíonadh a bhfeidhmeanna reachtúla caomhnaithe comhshaoil ag údarás áitiúla.

STÁDAS
Is eagras poiblí neamhspleách í an Ghníomhaireacht. Is í an Roinn Comhshaoil agus Rialtais Áitiúil an coimirceoir rialtais atá aici. Cinntítear a neamhspleáchas tri na modhanna a úsaidtear chun an tArd-Stiúrthóir agus na Stiúrthóirí a roghnú, agus trid an tsaoirse a dhearbhaionn an reachtaíocht di gníomhú ar a conlán féin. Tá freagracht dhíreach faoin reachtaíocht aici as réimse leathan feidhmeannas agus cuireann sé seo taca breise lena neamhspleáchas. Faoin reachtaíocht, is coir é iarracht a dhéanamh dul i gcion go míchuí ar an nGníomhaireacht nó ar aon duine atá ag gníomhú thar a ceann.

EAGRÚ
Tá ceanncheathrú na Gníornhaireachta lonnaithe i Loch Garman agus tá cúig fhoireann chigireachta aici, atá lonnaithe i mBaile Átha Cliath, Corcaigh, Cill Chainnigh, Caisleán an Bharraigh agus Muineachán.

BAINISTÍOCHT
Riarann Bord Feidhmiúcháin lánaimseartha an Ghníomhaireacht. Tá Ard-Stiúrthóir agus ceathrar Stiúrthóirí ar an mBord. Ceapann an Rialtas an Bord Feidhmieúcháin de réir mionrialacha atá leagtha síos san Acht.

COISTE COMHAIRLEACH
Tugann Coiste Comhairleach ar a bhfuil dáréag ball cunamh don Ghníomhaireacht. Ceapann an tAire Comhshaoil agus Rialtais Áitiúil na baill agus roghnaítear iad, den chuid is mó, ó dhaoine a ainmnionn eagraíochtaí a bhfuil suim acu i gcúrsai comhshaoil nó forbartha.Tá réimse fairsing feidhmeannas comhairleach ag an gCoiste faoin Acht, i leith na Gníomhaireachta agus i leith an Aire araon.