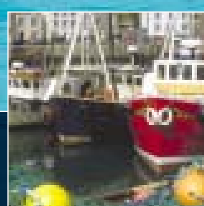
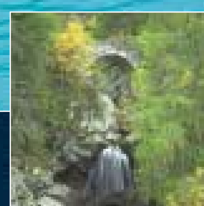
The Future for Scotland's Waters

GUIDING PRINCIPLES ON THE TECHNICAL REQUIREMENTS OF THE WATER FRAMEWORK DIRECTIVE

SEPA
Scottish Environment
Protection Agency

The Future for Scotland's Waters

GUIDING PRINCIPLES ON THE TECHNICAL REQUIREMENTS
OF THE WATER FRAMEWORK DIRECTIVE

A Consultation Document Issued by
the Scottish Environment Protection Agency, May 2002

SCOTTISH WATER

SCOTTISH NATURAL HERITAGE

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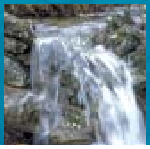
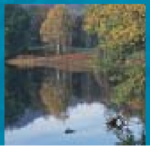



Contents

1 Purpose of this Document

The EC Water Framework Directive, which came into force on 22 December 2000, establishes a new, integrated approach to the protection, improvement and sustainable use of Europe's rivers, lochs, estuaries, coastal waters and groundwater. The Scottish Executive plans to transpose the Directive's administrative and regulatory requirements into Scots Law by introducing the Water Environment and Water Services Bill in the Scottish Parliament later this year.

Scottish Ministers have expressed a commitment to implementing the Water Framework Directive ("the Directive") in a way that achieves the best possible balance between the protection and improvement of the water environment and the interests of those who depend upon it for their prosperity and quality of life. The Scottish Executive has already consulted on the policies it believes should form the basis of the Bill. In June 2001, it issued a consultation paper entitled *Rivers, Lochs, Coasts: The Future for Scotland's Waters.* In February 2002, it consulted on firmer proposals for legislation in a paper entitled *The Future for Scotland's Waters - Proposals for Legislation*[1]. It also held a series of stakeholder seminars, some co-organised with the Scottish Environment Protection Agency (SEPA). Others were run with Scottish Environment Link, the umbrella organisation for Scotland's voluntary environmental organisations. The Executive is committed to continuing such consultations and believes them to be vital for implementing the Directive in a way that delivers the best for Scotland.

This paper is part of this consultation process. It was prepared by SEPA on behalf of the Scottish Executive over the period July 2001 to April 2002 and focuses on the Directive's important but complex technical Annexes, Annex II and Annex V. These set out how the condition of the water environment will be assessed, monitored and classified. The Directive sets a challenging timetable for delivering the requirements of the Annexes. The first assessment of impacts on the water environment must be completed by the end of 2004. This work will effectively translate the Directive's environmental objectives into real, measurable standards. It will also identify where these standards are not being met and therefore where regulatory controls or other measures may be needed.

There are three reasons to consult on the technical Annexes:

First, the Annexes provide the context for understanding the scope and purpose of the administrative and regulatory provisions that will be proposed in the Water Environment and Water Services Bill and subsequent regulations. The consultation paper is structured to help water environment experts and other interested parties extract the information they need to understand this context.

Second, the implementation of the Annexes needs to be guided by the right principles. It is important that implementation is focused on delivering real environmental benefits while keeping sight of the benefits water uses bring to Scotland. Promoting the sustainable use of the water environment is a central purpose of the Directive. It is also important that implementation is planned carefully so that the Directive's objectives are achieved in the most efficient way. This consultation paper sets out a series of technical guiding principles for the implementation of the Annexes. Your views on whether these are the right principles are invited.

Third, it is important to get your views on how, and at what stages, you wish to be involved in the technical implementation process. The consultation paper sets out the technical tasks and challenges of implementation. The Scottish Executive proposed in its consultation in February 2002 that SEPA should take the lead role in delivering these requirements. However, the Executive recognised that the full range of necessary expertise and information does not reside in any one organisation. Successful implementation will therefore rely on a partnership approach involving public bodies, water users, academic organisations and other interested parties. The right working relationships will need to be established to enable appropriate organisations to contribute.

[1] www.scotland.gov.uk

Of course, Scotland is not alone in facing the technical challenges of implementation. At European level, the UK and the other Member States are working with the European Commission on a series of Common Implementation Strategy projects to provide guidance for Member States on good practice in implementing different aspects of the Directive. The projects are expected to report later in 2002 and will consider nearly all of the major technical themes covered in this consultation paper. In the light of the guidance from the projects, some of the proposals described in this consultation may need to be modified. Experts from the UK agencies are involved in all of the Common Implementation Strategy projects. Your views on the issues raised by this consultation paper will be relayed to these representatives.

At a UK level, the environment and conservation agencies from the different parts of the UK are working together and with colleagues from the Republic of Ireland. This is helping to share experience and ensure a co-ordinated technical approach right across the British Isles. The consultation on the technical Annexes is one example of this collaboration. It will take place separately in Scotland and in England and Wales, although the consultation documents used in each of these parts of the UK have been built around a shared technical understanding of the Directive's requirements. A core text was adapted to reflect differences in specific issues and management practices in the different parts of the British Isles.

This version of the consultation paper was produced by a working group chaired by SEPA and involving representatives from Scottish Natural Heritage (SNH), the Scottish Executive's Fisheries Research Services (FRS), the Scottish Water Authorities (now Scottish Water), the Environment Agency for England and Wales and the Environment and Heritage Service of Northern Ireland. In producing the document, the working group sought input from a wide range of bodies and organisations. This was helped, in particular, by a workshop held in Perth on 5 November 2001.

Although the principles of the Directive are straightforward, the issues involved in implementing the Annexes are complicated and challenging. Parts of the consultation paper are therefore inevitably quite technical. Section 2 provides a non-technical overview of the role implementation of the Annexes will play in river basin management planning. Sections 3 to 8 go into some detail on the main requirements and include specialist sections aimed only at the most technically minded consultees. Section 9 discusses the need for, and role of, a monitoring strategy for Scotland's water environment.

Your views on any of the guiding principles or specific questions raised throughout the paper are particularly sought. Of course, there may be other issues related to the implementation of the technical Annexes that you feel are important. Your comments on these will also be welcome.

Please send your views on this consultation document to:

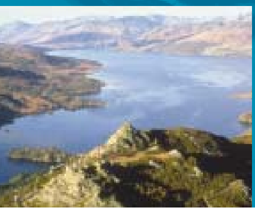
Donny Morrison,
Technical Secretary,
Water Framework Directive Annexes 2 and 5
Working Group,
c/o Scottish Environment Protection Agency,
Corporate Office,
Erskine Court,
Castle Business Park,
Stirling FK9 4TR

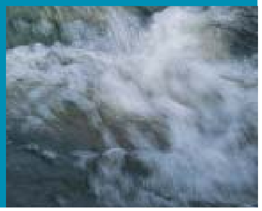
Or by e-mail to: **wfdtechreqs@sepa.org.uk**

The deadline for responses is 23 August 2002.
Earlier responses would be welcome.

Under the Code of Practice on open government, responses will be made publicly available unless respondents ask for their comments to remain confidential.

2 Executive Summary



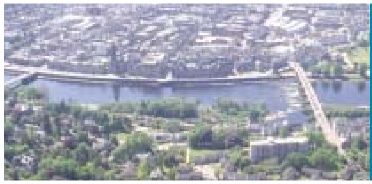
2.1 Importance of the Technical Annexes

The Water Framework Directive establishes a new planning system for the protection, improvement and sustainable use of Europe's water environment. The technical heart of this planning system is set out in the Directive's Annexes, in particular Annexes II and V. These are lengthy and complicated. However, the principles upon which they are based are straightforward. This section outlines these principles and explains the role the Annexes will play in river basin management planning.

The Directive introduces two key changes to the way the water environment must be managed across the European Union (EU). The first relates to the types of environmental objectives it is designed to deliver. Previous European water legislation set objectives to protect particular uses of the water environment from the effects of pollution and to protect the water environment itself from especially dangerous chemical substances. These types of objectives are taken forward in the Directive's provisions for Protected Areas (see Section 3.2) and Priority Substances (see Section 4.3) respectively. However, the Directive also introduces new, broader ecological objectives, designed to protect and, where necessary, restore the structure and function of aquatic ecosystems themselves, and thereby safeguard the sustainable use of water resources. Future success in managing Europe's water environment will be judged principally by the ecological outcomes specified by these objectives. The implementation of the Annexes will establish the classification schemes needed to define these ecological objectives. It will also identify where these objectives are not being achieved and where controls may therefore be necessary.

The shift to ecological objectives has significant implications for Scotland. To achieve such objectives, appropriate controls on the wide range of pressures that can adversely affect aquatic ecosystems will be required. Consequently, the Scottish Executive consulted in February 2002 on legislative proposals for establishing new control regimes for activities such as surface and groundwater abstraction, impoundment of surface waters, engineering works on surface waters and the causes of diffuse pollution. The Executive have said that the new controls will be selective and proportionate so that where environmental problems exist they can be tackled in the most efficient and effective way.

The second key change is the introduction of a river basin management planning system. This will be the key mechanism for ensuring the integrated management of groundwater, rivers, canals, lochs, reservoirs, estuaries and other brackish waters, coastal waters and the water needs of terrestrial ecosystems, such as wetlands. It will provide the decision-making framework within which costs and benefits can be properly taken into account when setting environmental objectives, and proportionate and cost-effective combinations of measures to achieve the objectives can be designed and implemented. It will also provide new opportunities for anyone to become actively involved in shaping the management of river basin districts - neighbouring river catchments, together with their associated stretches of coastal waters. No such comprehensive planning system for the water environment currently exists in Scotland. The Scottish Executive's consultation in February 2002 set out proposals for setting up a river basin planning system. The Annexes of the Directive deal with the key technical tasks involved in river basin planning. In particular, they detail the analyses, assessments and monitoring that will be necessary to underpin the setting of environmental objectives and the design of proportionate and cost-effective measures (see Figure 2.1).



2.2 River Basin Planning

2.2.1 River Basin Planning and the Role of the Technical Annexes

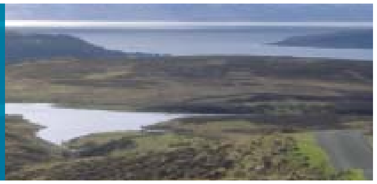
River basin management planning is the delivery mechanism for the Directive's environmental objectives. The Directive envisages a cyclical process, where river basin management plans (RBMPs) are prepared, implemented and then reviewed every six years. There are four distinct elements to the river basin planning cycle:

- **characterisation of**, and **assessment** of **impacts** on, river basin districts;
- **environmental monitoring;**
- setting **environmental objectives**; and
- the design and implementation of the **programme of measures** needed to achieve the objectives.

The plans themselves will be published at the start of each six-year cycle following an extended period of public consultation. The Directive sets deadlines by which the various stages of this planning cycle are to be achieved, summarised in Table 2.1.

Table 2.1 River Basin Management Plan (RBMP) Timetable

Year	Requirement
2003	Transpose Directive into domestic law. Identify river basin districts and the competent authorities that will be empowered to implement the Directive.
2004	Complete first characterisation and assessment of impacts on river basin districts. Complete first economic analysis of water use. Establish a register of protected areas (see Section 3.2.1) in each river basin district.
2006	Establish environmental monitoring programmes. Publish a work programme for producing the first RBMPs.
2007	Publish an interim overview of the significant water management issues in each river basin district for general consultation.
2008	Publish draft RBMPs for consultation.
2009	Finalise and publish first RBMPs. Finalise programme of measures to meet the objectives.
2012	Ensure all measures are fully operational. Publish timetable and work programme for second RBMPs.
2013	Review characterisation and impact assessment for river basin districts. Review economic analysis of water use. Publish an interim overview of the significant water management issues.
2014	Publish second draft RBMPs for consultation.
2015	Achieve environmental objectives specified in first RBMPs. Finalise and publish second RBMP with revised programme of measures.
2021	Achieve environmental objectives specified in second RBMPs. Publish third RBMPs.
2027	Achieve environmental objectives specified in third RBMPs. Publish fourth RBMPs.



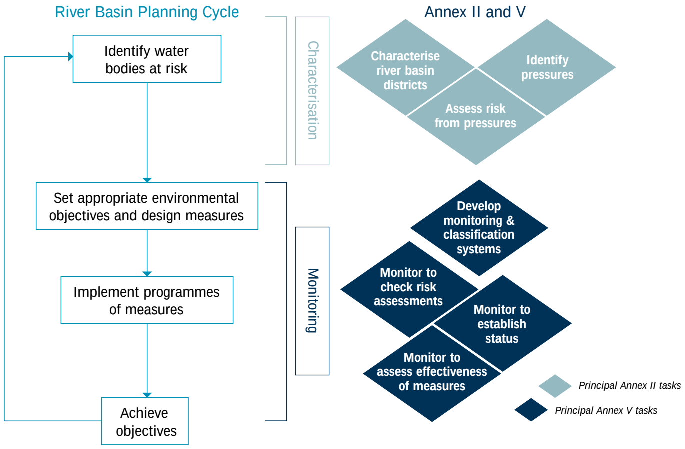


Figure 2.1 Relationship of Annexes II and V Tasks to the River Basin Planning Cycle

2.2.2 Water Bodies

While the Directive requires RBMPs to be drawn up for river basin districts, the basic management unit for which environmental objectives will be set is the water body (see Section 3.1.2). Water bodies can be rivers, burns, lochs or estuaries, parts of rivers, burns, lochs or estuaries, stretches of coastal water or distinct volumes of groundwater. The purpose of identifying water bodies is to enable appropriate objectives to be set in relation to significant pressures or sets of pressures. SEPA already divides rivers, estuaries and coastal waters into stretches to help target the management of point source discharges of pollutants. This approach will need to be extended to groundwater and developed to help manage the effects of other pressures, such as abstraction, diffuse pollution and physical modifications. One of the main requirements of the technical annexes is to identify pressures and their effects (see Section 7.1). Water body identification will be based on this information.

One of the key purposes of river basin management planning is to establish a framework for protecting inland surface waters, groundwater, estuaries and other waters transitional between freshwater and seawater, and coastal waters. This does not mean that every part of the water environment will need to be identified as a water body. The Directive implies that any burn or estuary with a catchment greater than 10 square kilometres, and any freshwater loch with surface water area greater than 0.5 square kilometres, should automatically be identified as a water body, or part of a water body on size criteria alone. However, there are large numbers of lochans, brackish lagoons, burns, some no more than drainage ditches, and ponds that are smaller than these thresholds. Many will simply not represent sufficiently significant management units to warrant identification as water bodies. They will still need to be protected from pollution and other pressures, or in some cases improved, so that the objectives of their neighbouring water bodies can be achieved.

There may also be small lochs, burns, estuaries and lagoons that should be regarded as significant management units in their own right on account of their ecological, conservation or water resource importance. Your views are sought on whether, and under what circumstances, such small waters should be identified as water bodies and managed and reported accordingly (see Section 3.1.4).

The Directive requires surface water bodies to be differentiated into types on the basis of their natural characteristics (see Section 3.1.3). Each water body will be of one type or another. For example, deep coastal waters have different ecological characteristics to shallow coastal waters. The depth influences the animals and plants that live on the seabed. The criteria used to differentiate water body types will be designed to reflect such ecologically relevant differences.

2.2.3 Risk Assessment

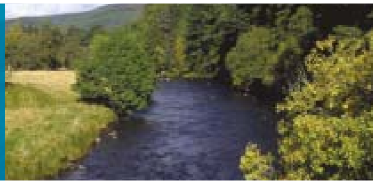
Risk assessment is at the heart of effective river basin planning (see Section 7). It will allow environmental problems to be identified and appropriate, cost-effective protection and improvement measures to be designed and implemented. The methods used to identify risks should be clear to anyone with an interest in the water environment. This will help water users and others understand, and contribute to, the assessment process. A comprehensive assessment of the risk of water bodies failing to meet the Directive's environmental objectives is required by the end of 2004. The output will be a list of water bodies considered to be at risk, and which may consequently need appropriate protection and improvement measures. This is a major task in which information on the pressures on, and natural characteristics of, water bodies will be collated and analysed. SEPA will need to work with a number of public bodies, other organisations and water users to obtain the necessary information and expertise.

The risk assessments will be structured so that the level of detail needed for any one assessment is proportionate to the difficulty in judging whether a water body is at risk or not. The risk assessment process will not end in 2004. The first assessments will only serve as a first view. They will be refined where necessary during the planning cycle by further assessments and the use of new monitoring information from the Directive's monitoring programmes (see Section 8).

2.2.4 Monitoring

The purpose of monitoring is to provide targeted information to help identify, assess and manage environmental problems (see Section 8.1). The amount and quality of monitoring undertaken must be fit for this purpose. If decisions are taken on the basis of unreliable monitoring information, unnecessary and costly measures could be required of water users. The Directive requires monitoring programmes to be established by the end of 2006. The key objectives of these programmes will be to supplement and validate the risk assessments, establish the status of bodies at risk, provide information on long-term trends and evaluate the effectiveness of the programmes of measures.

The amount of monitoring information needed to validate the risk assessments will vary, depending on the confidence in the results of the risk assessments and on the similarity of a river basin district's water bodies in terms of their natural characteristics and the pressures on them. Similar water bodies can be grouped if monitoring a representative selection will adequately validate the assessments. For example, if a water body, or a group of water bodies, is clearly heavily polluted, little if any additional monitoring will be needed to confirm that the objective of good status is not being achieved. Similarly, if a body, or a group of water bodies, is not subject to any significant pressures, only limited monitoring will be needed to confirm that there is no risk of failing to achieve one



of the Directive's objectives. Most monitoring effort will be targeted at water bodies and groups of water bodies identified as being at risk from specific pressures. The amount of monitoring information needed for such bodies will vary depending on the difficulty involved in achieving reliable classification and on the implications of misclassification (see Section 4.4). Water bodies on the borderline between status classes or for which expensive protection and restoration measures may be necessary on the basis of monitoring results will tend to need more monitoring than other water bodies.

The monitoring programmes will evolve and change dynamically in response to changing pressures, improvements in risk assessments and success in restoring water bodies to achieve the Directive's objectives. In turn, the monitoring programmes will help provide the information needed to improve understanding of the way human pressures interact with the water environment. This will ensure that the programmes of measures can be effectively and efficiently targeted.

2.3 Environmental Objectives

The purposes of establishing a river basin management planning system are to allow environmental quality objectives to be set that balance environmental, social and economic priorities and to ensure that such objectives are then achieved by targeted and cost-effective measures.

The Directive specifies three principal environmental objectives for surface water bodies and bodies of groundwater, which are to:

- prevent deterioration in status;
- restore to good status by 2015; and
- protect and restore, where applicable, to achieve the objectives for Protected Areas established under Community legislation.

These objectives will be the most important drivers for the future management of Scotland's waters. However, in certain circumstances, different objectives may be specified through the river basin planning process. For example, for surface waters designated as heavily modified or artificial (see Section 5), the status objectives that must be achieved by 2015 are good ecological potential and good surface water chemical status. Different objectives may also be set for water bodies for which the restoration of good status would be technically unfeasible or disproportionately expensive.

Setting such environmental objectives requires a means of judging the state of the environment. Accordingly, the Directive's Annexes set out the details for establishing status classification schemes for surface water bodies and groundwater bodies.

2.3.1 Classification Schemes for Surface Waters

The status of a surface water body will be determined by the poorer of its chemical or ecological status.

Chemical status describes whether or not the concentration of any pollutant exceeds standards that have been set for it at European Community level. The relevant pollutants include those for which standards have been set under the 1976 Dangerous Substances Directive (76/464/EEC). They will also include a new set of priority substances for Community action, once appropriate standards for these have been established (see Section 4.3).

Ecological status is principally a measure of the cumulative effects of human activities on river, loch, estuary or coastal water ecosystems. Each of the five ecological status classes defined by the Directive represents a different level of disturbance from a reference state in which there are no, or only very minor, human alterations to the natural ecological condition of the water body. The more a water body has been changed from its natural condition, the lower will be its ecological status class.

One of the key tasks in developing the classification systems for surface water bodies will be to identify the appropriate reference conditions.

A water body at **good ecological status** is allowed only a slightly greater level of human alterations than it would at its reference conditions. The Directive requires a European benchmarking, or inter-calibration, exercise to be undertaken to ensure that good ecological status represents the same level of ecological quality everywhere in Europe. The exercise is intended to establish a network of sites on the upper and lower boundaries of the good status class by the end of 2004. These sites will then be used to calibrate the monitoring methods Member States use to measure ecological status. It will be important that the benchmark sites represent a standard for good ecological status that helps protect and enhance the quality of Scotland's water environment and so safeguards and encourages sustainable water use. The translation of the Directive's definition of reference conditions into environmental standards is also important. The top ecological status class, high ecological status, is equivalent to meeting reference conditions. However, water bodies at high status will still be able to support a range of sustainable water uses that have no or only very minor effects on ecological quality.

The difficulty in developing ecological status classification systems should not be underestimated. Classifying the ecological status of a water body will require, among other things, the condition of its aquatic plants and animals to be estimated from monitoring information and then compared with their predicted reference conditions. This is a particular challenge because of the natural variability in biological communities. There will always be uncertainties in both the estimate of the present conditions and of the reference conditions, as no monitoring system is error free. If the errors are not properly taken into account, misclassification could occur and could result in unnecessary measures and their associated costs being imposed on water users. One of the key tasks in implementing the Directive will be to develop monitoring systems that ensure the risk of misclassification is kept to a minimum. Monitoring systems will be needed from the end of 2006, when the Directive's monitoring programmes must be operational. The work to develop such systems will focus principally on building on and adapting the wide range of existing monitoring methods.

2.3.2 Classification Schemes for Heavily Modified and Artificial Surface Waters

Some activities such as navigation, generating hydroelectricity and storing drinking water depend on substantial physical modifications to surface water bodies. Restoring these water bodies to good ecological status could have significant adverse effects on the important social, economic and environmental benefits provided by such activities. Where this would be the case, and there is no significantly better environmental alternative to the modifications that could reasonably be used to deliver the benefits, the Directive allows the water bodies to be designated as heavily modified. Once designated, such bodies still have to achieve good chemical status. However, the objective of good ecological status will switch to good ecological potential. The main ecological objective for artificial water bodies, such as canals, is also good ecological potential.

The classification schemes specified for heavily modified and artificial water bodies describe the ecological potential such bodies achieve given the constraints imposed upon them by their modified or artificial characteristics. **Good ecological potential** is defined as a "slight" shortfall from the maximum ecological potential such bodies could achieve.

Maximum ecological potential defines the reference conditions for the classification scheme. Its translation into real environmental standards will require both an understanding of the needs of the different types of human activities for which bodies can be designated and the ecological potential that could be realised given these constraints. The consultation paper seeks views on how water users and others should be involved in the development of suitable classification schemes.

2.3.3 Classification of Groundwater Status

The objective of good groundwater status is designed to ensure a long-term supply of water for people's use while protecting and, where necessary, restoring the water needs of those surface water bodies and terrestrial ecosystems, such as wetlands, that depend on groundwater flows (see Section 6).

The Directive also requires the European Commission to put proposals for a daughter directive on groundwater forward by the end of 2002. These proposals will set out specific measures to prevent and control groundwater pollution. They may include additional criteria, such as environmental quality standards, for assessing good groundwater status, and may therefore affect the existing requirements of the Directive. With this caveat, the consultation paper describes the criteria already specified by the Directive for classifying the status of groundwater bodies.

The classification scheme for groundwater status must describe whether human alterations to the quality or quantity of groundwater have significantly affected associated surface water bodies and terrestrial ecosystems and whether over-abstraction is causing saltwater or water of a different chemical composition to be drawn into a body of groundwater, or is consuming groundwater supplies faster than they are being replenished. A groundwater body will be classed as poor status if there are any such adverse effects. Otherwise, it will be classed as good status.

The Directive also introduces a requirement to reverse any significant and sustained upward trends in the concentration of pollutants in groundwater in order to reduce pollution of groundwater. Upward trends in pollutants in groundwater could jeopardise the achievement of good groundwater status or result in an increase in purification treatment in a Drinking Water Protected Area (see Section 2.3.5). The river basin management planning process must be designed to identify such environmentally significant trends and then implement appropriate measures to reverse them.

2.3.4 Drinking Water Protected Area Objectives

The Directive requires surface water and groundwater bodies to be designated as Drinking Water Protected Areas if they provide more than 10 cubic metres of drinking water a day or serve more than 50 people, or are intended to do so in the future (see Section 3.2). These important drinking water sources must be protected from pollution. About 97% of Scotland's public drinking water supply comes from surface waters. However, there are also many thousands of small private groundwater wells supplying drinking water to rural communities. Consequently, many bodies of groundwater across Scotland will need to be identified as Drinking Water Protected Areas.

2.3.5 Wetlands and the Directive

The Directive does not set environmental objectives for wetlands in the way it does for rivers, lochs, estuaries, coastal waters and groundwater. However, it will contribute to the protection, restoration and recreation of wetlands in the following ways.

First, the effects of groundwater pollution or over-abstraction on terrestrial ecosystems that depend on bodies of groundwater, such as wetlands, must be controlled to achieve good groundwater status. To do this, it will be necessary to develop a technical understanding of the water needs of these terrestrial ecosystems and to establish criteria for defining what constitutes **significant** damage to them. The consultation paper seeks your views on how to assess the significance of any damage to wetlands.

Second, the ecological quality of surface waters depends to some extent on the structure and condition of the land immediately surrounding them. Wetlands immediately adjacent to rivers and lochs, or within the tidal area of estuaries and coastal waters, such as salt marshes, must be protected and restored where necessary to achieve the ecological and chemical status objectives for those waters.

Third, wetlands can provide an effective means of trapping and breaking down pollutants that would otherwise end up in surface waters and of controlling the influence of land use on the rate of rainwater run-off to surface waters. Artificial wetland recreation may therefore be an important and cost-effective means of controlling pressures from urban and agricultural activities.

Fourth, the Directive establishes a planning mechanism designed in part to help achieve the objectives of Protected Areas. These include areas designated for the protection of wetland habitats and species under Community legislation[2] where the maintenance or improvement of the status of water is an important factor in their protection.

2.4 Towards a Monitoring Strategy for Scotland's Water Environment

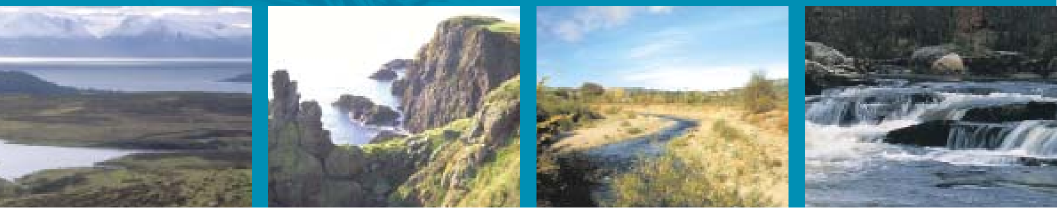
Implementation of the technical annexes will require existing information on the water environment to be collated and new information to be collected in a targeted way. This information gathering is important. Having the right information will be essential to ensure that real environmental problems can be identified and then dealt with by the most cost-effective combinations of measures[3].

At present, a wide range of public, private and voluntary sector organisations hold information on the environment in Scotland. Some of these organisations also carry out monitoring work. Much of this information, and the expertise associated with it, are likely to be valuable in river basin planning. However, at the moment only a small proportion of such information is collected together in one place. The Scottish Executive consultations in June 2001 and February 2002 identified that the work undertaken by public bodies needed to be co-ordinated for effective implementation of the Directive and proposed that SEPA should provide this co-ordination. It also suggested that SEPA be required to draw up a strategy for the assessment and monitoring of Scotland's water environment (see Section 9). To provide this co-ordination, and to develop the strategy, SEPA will need to work closely with other public bodies. However, much information is also held in the private and voluntary sectors and by interested members of the public. It will be important to provide appropriate opportunities for organisations and individuals to be involved in the implementation of the technical requirements of the Directive. This consultation paper seeks your views on how this should be done.

[2] Natura 2000 sites designated under the Habitats Directive (92/43/EEC) or the Birds Directive (79/409/EEC)

[3] Article 5 and Annex III of the Directive require an economic analysis of water use in each river basin district. The analysis must include sufficient information to make judgements about the most cost-effective combination of measures. The Scottish Executive's proposals for legislation published in February 2002 proposed that SEPA should be responsible for this analysis.

3 Water Bodies



Directive provisions: Articles 2, 4.1c and 6; Annex II, Sections 1 and 2; and Annex IV

3.1 Water Body Identification

3.1.1 River Basin Districts and Water Bodies

River basins are made up of lochs, burns, rivers, groundwater, estuaries and other brackish waters, together with the land that drains into these waters. The water cycle links all the parts of the river basin from highest hilltops to the sea at a river mouth, estuary or delta. Coastal inlets and bays and open coastal waters also play a key role in the ecology of the river basins. For example, sea trout migrate from coastal waters into river basins to spawn in parts of burns often far from the river mouth.

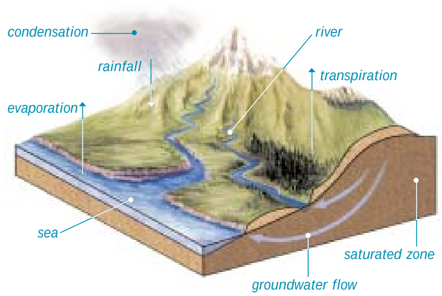


Figure 3.1
The Water Cycle

Their young hatch and then grow, some moving to other burns and rivers, before leaving the basin to reach adulthood in coastal waters. Coastal waters also provide a link between one river basin and another so that the ecological quality of each basin depends to some degree on that of its neighbouring basins. These river basin districts, comprising neighbouring river basins and their associated coastal waters, will be the main units for coordinating the management of the water environment.

The Directive recognises that decisions about the different parts, or water bodies, of a river basin district should not be made in isolation. Its river basin management planning system is designed to ensure that the management of these bodies takes account of their importance to the condition of the district as a whole. For example, a badly designed dam on a river or a badly polluted estuary could disrupt the life cycle of migratory animals like the sea trout.

3.1.2 Role of Water Bodies

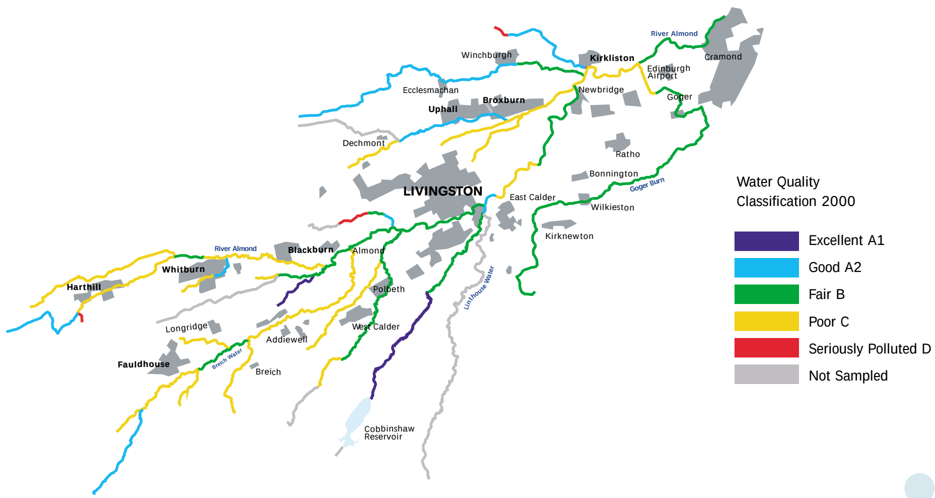
One of the first tasks in implementing the Directive is to identify the water bodies that make up each of Scotland's river basin districts. This is important because water bodies will be the units for which environmental objectives are set. These objectives will protect and improve the environmental quality of water bodies and thereby the quality of the district as a whole. The condition of water bodies must be reported using colour-coded maps and management efforts targeted to the bodies that do not match up to the required standards. Water bodies will therefore be central to how the quality of the water environment is understood and how success in managing it is judged.

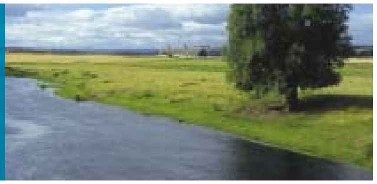
Of course, it has been the practice to sub-divide Scotland's surface waters to help manage the impacts of pollution for many years. For example, SEPA divides rivers and coasts into stretches and reports on the water quality of each stretch (see example in Figure 3.2). By identifying stretches that are affected by particular discharges of pollutants, improvement objectives can be set for, and achieved by reasonable controls on, those discharges.
This is a good starting point for identifying water bodies for river basin management planning purposes. However, the Directive requires the impacts of all human activities, not just pollution, to be taken into account. It will therefore be necessary to modify the existing approach so that the most appropriate water bodies for managing the range of pressures on Scotland's river basin districts can be identified.

> ***Guiding principle***
> The key purpose of identifying water bodies is to allow objectives to be clearly defined in relation to the pressures acting on Scotland's river basin districts. Consequently, the water bodies identified must represent appropriate units for managing particular pressures or sets of pressures. They will be distinct parts of the river basin district in terms of the level of any impact on them and the types of pressures causing those impacts.

In particular, it will be important to avoid identifying water bodies that have substantially different levels of impact within them. This could result in the extent of Scotland's good status waters being under-reported. Accordingly, water bodies will be variable in size but the size selected will match the issues involved.

Figure 3.2 Water Quality in the River Almond Catchment (SEPA Data)



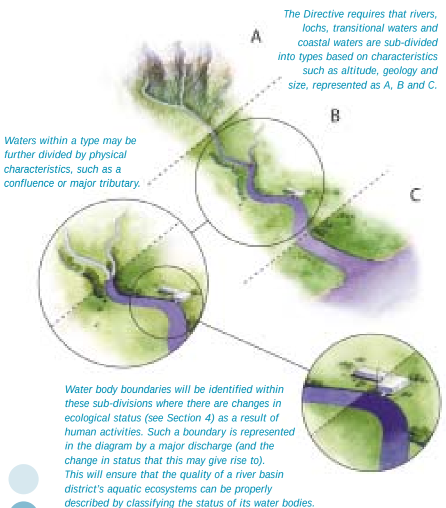


3.1.3 Identifying Surface Water Bodies

The Directive defines surface water bodies as discrete and environmentally significant elements of a river basin district. They can be parts of rivers, burns, lochs, estuaries and other brackish waters, or stretches of coastal water. They will include artificial water bodies such as canals and man-made reservoirs and heavily modified water bodies such as rivers that have been deepened and straightened for land drainage purposes. Section 5 contains more detail on artificial and heavily modified water bodies.

The identification of surface water bodies needs to proceed by a series of steps to ensure that the bodies that are identified represent the most suitable management units. Before defining individual water bodies, it will be necessary to sub-divide river basin districts by natural characteristics judged to be of management significance. Water bodies can subsequently be identified within each of these sub-divisions (see Figure 3.3). This should reduce the likelihood of significant differences in natural characteristics occurring within any one water body.

Figure 3.3 Steps Involved in Identifying Surface Water Bodies

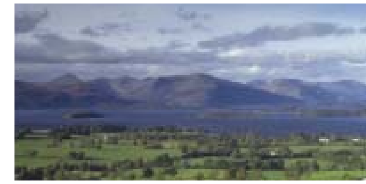


A water body's natural characteristics will affect the way it needs to be managed. Some parts of a river basin district will have characteristics that make the water bodies identified within it more sensitive to pressures than others. For example, the natural characteristics of some mountain burns and lochs make them very vulnerable to acidification.Correctly identifying the major natural sub-divisions will facilitate the tasks of assessing risks, monitoring and appropriately managing the pressures on the water bodies that are subsequently identified. For example, it will be possible to group water bodies with similar natural characteristics for some aspects of management (see Sections 7 and 8).

Step 1: Typology

The Directive first requires river basin districts to be sub-divided into the different water categories: rivers, lochs, estuaries and other transitional waters, and coastal waters. Section 4 describes how the Directive then requires sub-division of these categories into types based on natural factors that might significantly influence the presence and abundance of plants and animals. For example, differences in geology can affect the range of animals and plants that water bodies are able to support by contributing minerals through groundwater to the water chemistry of a river or loch. The UK conservation agencies have for many years identified different types of water within estuaries, coastal waters, lochs and rivers using typologies based on observed patterns in biological communities. This experience may help identify the key factors appropriate to establishing typologies for the Directive. Since the typologies are intended to identify natural differences, it will be important to characterise the types using factors that are not normally altered by human activities.

The Directive obliges the use of a core set of factors in the typologies for each surface water category. These are reproduced in Table 3.1 opposite. The factors can be specified as ranges. For example, all Scottish rivers, lochs, estuaries, brackish lagoons and coastal waters could be included in one latitude and longitude class.



Step 2: Relevant further natural divisions

The division of the surface water categories into types may not differentiate all the major features of a river basin's natural characteristics that are relevant to water body management. As mentioned above, typology is intended to define types using natural factors that might be important to the distribution and abundance of aquatic animals and plants. However, some factors relevant to the management of the hydromorphological or physico-chemical conditions of surface waters may not be reflected in such a typology.

For example, differences in the habitats of rivers or of coastal waters and estuaries arise for a number of reasons, including variations in:

- power of the water movements to erode and transport sediments, and
- size and availability of sediments upon which the water can act from resistant rocks to more easily displaced sands and silts.

The different habitats have different ecological roles and different vulnerabilities to disturbance that may be relevant to the management of a river basin district's surface waters. For many areas of the Scottish coastline, for example, the majority of sediment movements take place in discrete stretches between major headlands or within large bays. For the most part, these "sediment transport cells" reflect the sub-divisions of coastal waters within which the hydromorphological effects of any particular human activity tend to be contained. Where there would be management benefits, the different surface water types of the basin districts may be further sub-divided to account for important differences in natural characteristics.

The number of typology and other relevant natural sub-divisions in a river basin district will depend on the number of important changes in its natural characteristics that can be discerned. Most individual lochs or estuaries, for example, are not obviously sub-dividable. However, some large estuaries and lochs, such as the Firth of Forth and Loch Lomond, contain areas that are in many respects almost separate units because of their ecology, physical habitats and their vulnerability to human activities. In such cases, it may be desirable to clarify the differences in management requirements of these areas by sub-dividing the loch or estuary.

Step 3: Pressures

Once the important natural sub-divisions of the river basin district have been determined, the final step is to identify the individual water bodies that are appropriate for managing the pressures on the river basin district. Accordingly, water body identification will be informed first by the initial characterisation of the basin districts described above, and then by the assessment of risks to the Directive's objectives from those human activities (see Section 7).

One of the things to be considered during this stage is whether the scale of the water bodies enables and encourages interested parties to participate in managing the part of the river basin district that matters most to them. Such involvement will be vital if the Directive's objectives are to be achieved.

Table 3.1 Obligatory Factors for Sub-dividing Surface Water Categories into Types

Rivers	Lochs	Estuaries and Brackish Lagoons	Coastal Waters
latitude	latitude	latitude	latitude
longitude	longitude	longitude	longitude
altitude	altitude	tidal range	tidal range
depth	depth	salinity	salinity
geology	geology		
size	size		

3.1.4 Small Surface Water Bodies

The Directive implies[4] that all burns, rivers and estuaries and brackish lagoons that receive their water from catchments greater than 10 square kilometres, all freshwater lochs that have a surface area of greater than 0.5 square kilometres and all coastal waters up to one mile seaward of the territorial baseline should be included among the water bodies that are identified.

There are substantial numbers of burns, lochans, estuaries and brackish lagoons that are smaller than these thresholds. Many of these will be adequately managed by being included in an appropriate larger water body. However, it would not make much sense to include small lochs or small burns flowing directly into the sea or into substantial lochs as part of these larger and very different water bodies. Nor would it seem sensible for management purposes to assign small lochs and small brackish lagoons to larger water bodies. A decision has to be made on whether to identify these small lochs, burns and lagoons as discrete water bodies.

It would be an inappropriate use of resources to set objectives for, and send reports to the European Commission on, garden ponds. Nor would it seem worthwhile to attempt to achieve comprehensive ecological objectives through the river basin planning process for burns that are no more than drainage ditches or storm channels. On the other hand, some small lochs, burns, estuaries and brackish lagoons are important in their own right or because of their ecological role in the basin district as a whole. Such waters could be regarded as significant management units. It may therefore be appropriate to identify them as individual water bodies or as groups of water bodies.

Some may serve as important breeding or nursery grounds for a river basin's fish populations. Others may provide locally important drinking water supplies or perhaps support valuable local fisheries. Some may be part of a Natura 2000 site, a Site of Special Scientific Interest (SSSI) or a site containing UK Biodiversity Action Plan priority species or habitats. For example, Butterstone Loch, which is part of Dunkeld-Blairgowrie lochs, is a candidate Special Area of Conservation (SAC) for the rare aquatic plant, slender naiad. Hoselaw Loch is part of the Din Moss-Hoselaw Loch SSSI and Special Protection Area (SPA) for greylag geese and other wildfowl. Both these lochs are less than 0.5 square kilometres in surface area. One of the Directive's environmental objectives is to ensure that surface waters are managed in a way that supports the achievement of the objectives for Natura 2000 sites. Identifying any small lochs and burns, upon which such sites rely, as water bodies may be an important means of demonstrating that this objective has been achieved. There may also be cases where a small loch or burn is subject to an impact that has significant repercussions elsewhere in the basin district. Identifying such a loch or burn as a water body may facilitate the mitigation of the impact.

This does not mean that burns, freshwater lochs, estuaries and brackish lagoons that are not identified as water bodies or parts of larger water bodies can be ignored. They will still have to be protected from pollution, for example, so that the water bodies into which they flow do not end up being adversely affected. In some cases, they may need to be improved to help achieve the objectives for neighbouring water bodies.

[4] As part of the characterisation of water bodies (See Section 4.2.2), the Directive requires Member States to use one of two approaches called System A and System B. System A specifies the descriptors that must be used to characterise water bodies whichever system is used (See Table 3.1). However for System A these descriptors are specified as fixed ranges. The smallest range specified for describing a river's characteristics is a catchment area of between 10 and 100 square kilometres, and a surface area of 0.5 to 1 square kilometres for a loch.

Question

It is intended that small tributaries will generally be managed as part of larger river water bodies. However, should the thousands of isolated small lochs (less than 0.5 square kilometre surface area), and very small watercourses and ditches (less than 10 square kilometre catchments), which discharge directly into the sea be individually identified as water bodies?

Should such small waters never be identified, avoiding the administrative burden of separately identifying such minor water bodies?

Should only those small lochs and rivers which are of particular significance be identified? "Particular significance" may arise because of their ecological, conservation or social resource value, or an adverse impact on another water body. If such small water bodies are to be created, what screening criteria should be used to decide if they should be separately identified and managed?

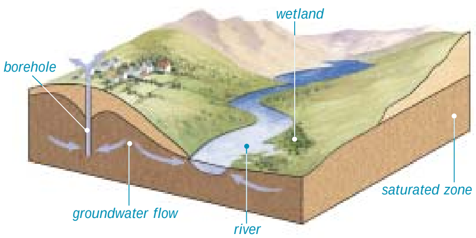


Figure 3.4
The Interaction of Groundwater with Surface Waters, Wetlands and Water Supplies

3.1.5 Bodies of Groundwater

Groundwater is water below the water table in rocks or other geological strata. The water table is the upper limit of the saturated zone, within which, broadly speaking, the tiny pore spaces between small grains of rock and other strata and the cracks in those strata are filled with water. The Directive requires that **all** such groundwater be protected from pollution. However, it also requires the identification of "bodies of groundwater" for which more specific environmental objectives will be set.

The Directive describes bodies of groundwater as distinct volumes of groundwater. The objectives for them (see Section 6) are principally defined in terms of the roles the groundwater they contain plays in:

(i) maintaining the ecological quality of surface waters and terrestrial ecosystems (e.g. by supporting river flows); and

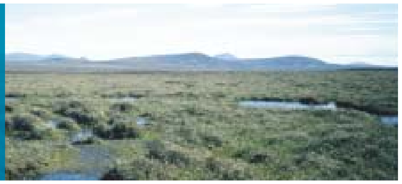
(ii) providing water for abstraction.

A body of groundwater is therefore the unit of groundwater that enables the most effective management of risks to surface water bodies, directly dependent terrestrial ecosystems or to water users relying on groundwater abstractions.

3.1.6 Aquifers and Bodies of Groundwater

The Directive requires that a body of groundwater must be part of an aquifer or aquifers. Accordingly, the first step in identifying bodies of groundwater is to determine which geological strata constitute aquifers.

Aquifers are any rocks or other geological strata in the saturated zone that can support a significant level of abstraction or provide a significant flow of groundwater. The significance of groundwater flow can be considered in terms of its importance to the ecological quality of surface waters or terrestrial ecosystems or to other surface water objectives. The significance of groundwater abstraction can be related to the amount that can be abstracted. The Directive requires any body of groundwater that supplies, or is intended to supply, more than 10 cubic metres per of day drinking water on average, or water for 50 people, to be identified as a Drinking Water Protected Area (see Section 3.2.3). It is therefore reasonable to assume that the Directive regards this level of abstraction as significant. In many parts of rural Scotland, people rely on groundwater for their private water supply needs. These small local abstractions are often derived from rocks which are only weakly permeable. Nevertheless, such aquifers can and do allow the abstraction of more than 10 cubic metres a day.



Guiding principle

The decision on whether groundwater constitutes an aquifer, and thus potentially a body of groundwater, should be made on the basis of whether the groundwater is:

- of potential significance to surface water ecosystems, terrestrial ecosystems, or other surface water objectives; or
- capable of allowing the abstraction of greater than 10 cubic metres a day, or drinking water for 50 people.

Although peat contains groundwater, it has such a low permeability and limited thickness that it cannot usefully serve as a source of water for abstraction. The Directive will require the protection of the ecosystems on the surface of peatlands from the effects of abstraction from other sources, such as the groundwater in underlying rocks. It will also require peatlands to be managed where necessary to meet the objectives for associated surface waters. This is because the groundwater in peat can be important to the hydrological and chemical conditions in the surface waters into which it flows. In addition, the Directive requires inputs of pollutants to the groundwater in peatlands to be prevented or limited. Peatlands will not be regarded as aquifers, and hence potentially bodies of groundwater. However, they will enjoy considerable protection from pollution. Key peatlands will also continue to be managed to achieve conservation objectives established in national and international legislation and in peatland conservation policies.

3.1.7 Identifying Bodies of Groundwater

The Directive's groundwater objectives (see Section 6) effectively require management of the quality and quantity of flows of groundwater to relevant receptors: surface water bodies, terrestrial ecosystems and drinking water abstraction points. Groundwater flow is the critical consideration in identifying suitable groundwater management units as it determines which receptors are likely to be affected by abstractions or by changes to the chemical quality of groundwater. It is therefore important that the sub-divisions of aquifers used to define bodies of groundwater describe boundaries that are relevant to, and facilitate assessment of, the way groundwater flows to its receptors. Such boundaries will normally be geological, such as a fault or a different rock type, or hydraulic, such as a groundwater flow divide. Box 3.1 discusses some of the technical considerations in identifying bodies of groundwater.

Box: 3.1 Technical Considerations for Groundwater Body Identification

Where a localised impact adversely affects one of an aquifer's receptors, such as a surface water body, but most of the aquifer and its receptors are unaffected, it may not be desirable to downgrade all of the aquifer that might be defined by relatively easily discernable geological or hydraulic flow boundaries. For example, a major source of pollution may only affect a surface water body receptor in one part of an aquifer. Identifying the polluted part of groundwater between the source of pollution and the relevant surface receptor as a body of groundwater would, in theory, highlight the problem area and allow effective targeting of management measures. However, the difficulty in doing this should not be underestimated. It would require patterns in the overall groundwater flow to be defined as the boundaries of the groundwater body. This would potentially require detailed and complicated assessment of the groundwater system.

In practice, the scale at which an adequate understanding, or conceptual model, can be developed of the interaction of a groundwater system with its receptors will determine the size of any groundwater body. The level of understanding needed will depend on the risk to the Directive's objectives and the implications of misjudging that risk. Where costs may be imposed on water users on the basis of a risk assessment, the confidence in the accuracy of that assessment will need to be high. The appropriate level of understanding of the groundwater system will need to be developed as part of the groundwater characterisation process (see Section 7). Where a very detailed characterisation is necessary, the information it provides may enable the complementary refinement of the delineation of the body of groundwater into the sort of problem-targeted management unit described above. However, the overriding consideration will be the ability to achieve an appropriate degree of confidence in the conceptual model of the groundwater system.

As with surface waters, the identification of groundwater bodies will be informed by, and be dependent on, the characterisation of the groundwater system and then the identification of pressures and the assessment of risks to the Directive's objectives from those pressures. However, it will also be dependent on the identification of bodies of surface water, as these will be one of the key receptors driving groundwater management and hence groundwater body identification.

For Scotland, the requirement to identify groundwater bodies is a major new challenge. There is little information on how groundwater is connected to surface waters and terrestrial ecosystems, limited monitoring data on groundwater levels or quality (except, in certain parts of Scotland, where groundwater monitoring is undertaken to fulfill the EC Nitrates Directive) and little information on abstractions of groundwater. To identify bodies of groundwater, a substantial increase in knowledge and understanding of how Scotland's groundwater systems work is required.

3.2 Protected Areas and Water Bodies

3.2.1 Protected Area Register

Protected Areas are areas that have been designated as requiring special protection under EU legislation, either to protect their surface water or groundwater or to conserve habitats and species that directly depend on those waters. For each river basin district, the Directive requires a register of Protected Areas. This will help ensure that the management of the relevant water bodies is geared towards achieving the Protected Area objectives. The Directive lists the Protected Areas to be included in the register (see Table 3.2).

With the exception of the new Drinking Water Protected Areas, Protected Areas may encompass part of a water body or may extend fully or partially over several water bodies. For some Natura sites, water bodies, or parts of water bodies, may be only a small part of the overall Protected Area or may only be an external influence on the objectives of the area.

Table 3.2 The Register will Consist of the Following Protected Areas

Water bodies used for the abstraction of drinking water
This is a new Protected Area. The provisions for these areas will replace the system of drinking water protection currently provided by the Surface Water Abstraction Directive (75/440/EEC). This older Directive will be repealed at the end of 2007. Each Protected Area will be an identified surface water body, groundwater body or group of such bodies.
Areas designated to protect economically significant aquatic species
These are Protected Areas established under an earlier EC Directive aimed at protecting shellfish (79/923/EEC).
Recreational waters
These are bathing waters designated under the Bathing Water Directive (76/160/EEC)
Nutrient sensitive areas
These comprise Nitrate Vulnerable Zones designated under the Nitrates Directive (91/676/EEC) and areas designated as nutrient sensitive areas under the Urban Wastewater Treatment Directive (91/271/EEC).
Areas designated for the protection of habitats or species where the maintenance or improvement of the status of water is an important factor in their protection
These areas include all Natura 2000 sites proposed for lochs, rivers, estuaries, brackish lagoons and coastal waters. However, other Natura 2000 habitats and species are also dependent to varying degrees on the quality of the water environment.

3.2.2 Protected Area and Water Body Objectives

Appropriate objectives and standards must be set for any water body when its use could affect the objectives of a Protected Area. The management of such water bodies should be designed to ensure the achievement of the Protected Area objectives by 2015, unless an earlier date is required in the legislation under which the Protected Area has been established.

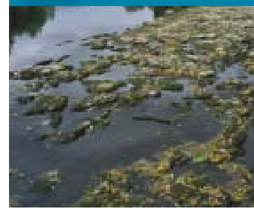
In some cases, the standards required to achieve good status could be more stringent than those needed to achieve a specific Protected Area objective. It is even possible that achieving good status might actually compromise the Protected Area objective. For example, an area designated for the protection of its birds might rely on the modified state of a water body to maintain its conservation value. Restoring the water body by undoing the modification could damage the conservation interest. In such cases, the Directive provides mechanisms in its planning process for setting objectives that take account of the special importance of Protected Areas. For example, where a physical modification is an important feature of the Protected Area, it may be possible to designate the water body or bodies concerned as heavily modified (see Section 5).

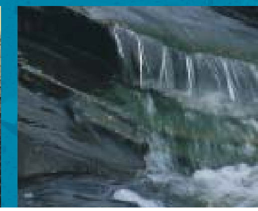
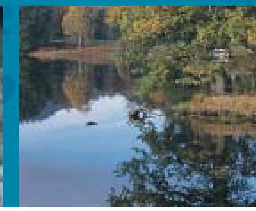
3.2.3 Drinking Water Protected Areas

The Directive requires certain sources of drinking water to be designated as Protected Areas. These are surface water bodies and groundwater bodies that provide more than 10 cubic metres of drinking water a day on average, or serve more than 50 people, or which have been identified during the river basin planning process as being intended to support such levels of drinking water abstraction in the future. Many water bodies in Scotland, including a large proportion of groundwater bodies, could meet these criteria when the sum of all the abstractions from them is taken into account.

The Directive requires that such water bodies be protected with the aim of avoiding deterioration in their quality in order to reduce the level of purification treatment required to produce drinking water. In practice, this will require measures to ensure the level of purification treatment required is not increased as a result of deterioration in the water quality of the bodies. The appropriate measures may include establishing safeguard zones, within which certain activities are tightly controlled.

4 Surface Water Classification



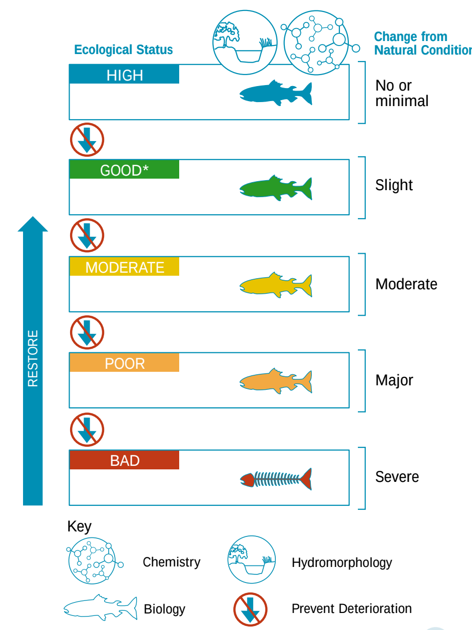
Directive provisions: Articles 4.1a; and 16; Annex II, Section 1; and Annex V, Sections 1.1 - 1.4

4.1 Purpose of Surface Water Status Classification

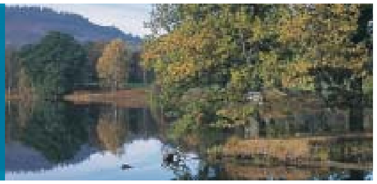
The Directive is aimed at maintaining and improving the quality of aquatic ecosystems in the EU. Success in caring for the water environment across Europe will be judged in the future by the environmental outcomes that are achieved. In Scotland, success has been measured for many years in terms of the chemical quality of water and the effects of that quality on aquatic life. However, meeting water quality standards is not the whole story. The Directive requires a means of describing the full impact of all human pressures on aquatic ecosystems. In future, the principal factor for describing the state of surface waters will be the condition of the animals and plants that depend on them. Accordingly, the Directive requires the development of new status classification schemes for rivers, lochs, coastal waters and for waters transitional between freshwater and seawater, such as estuaries and brackish lagoons ("transitional waters"). The classification schemes will describe a water body's ecological status (see Section 4.2) and its chemical status (see Section 4.3). The overall status of a surface water body will be determined by whichever of these is the poorest.

Figure 4.1 Status Classification and Environmental Objectives for Surface Waters

High status represents only very minor changes to the hydromorphology, physico-chemistry and biology of a water body. Good status requires no more than slight changes to the biology of the water body and compliance with quality standards for pollutants. The other status classes are defined according to the level of impact upon their biology.



** Good status also requires good water quality*



Most of the Directive's objectives for surface waters are defined in relation to these status classification schemes. The Directive requires that deterioration from one status class to another be prevented. It also requires the river basin management planning process to aim to restore all water bodies to good status. Sometimes this may be technically unfeasible or disproportionately expensive. In such cases, the Directive allows a less stringent objective to be set representing the highest status possible under the circumstances.

The status of water bodies has to be reported to the European Commission. The river basin management plans will therefore include colour-coded maps representing water body status in much the same way that SEPA reports water quality classes (see Figure 3.2). The colour coding for the status classes that will be used in these maps is indicated in Figure 4.1.

4.2 Ecological Status

4.2.1 Status Classes

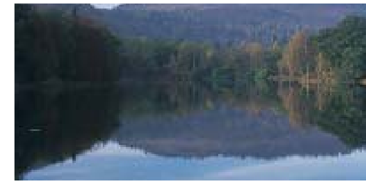
The Directive provides generic descriptions for five ecological status classes for each of the surface water categories: river, loch, transitional water and coastal water. The status classes are termed high, good, moderate, poor and bad (see Figure 4.1). Each class represents a different degree of human disturbance to the condition of a particular sub-set of the many biological, hydromorphological and physico-chemical elements that constitute an aquatic ecosystem. The Directive calls this sub-set quality elements (see Sections 4.2.6; 4.2.7 and 4.2.8). They are features of aquatic ecosystems that can be measured, such as the concentration of a pollutant or the number of different species of types of plant.

Different levels of disturbance to the biological quality elements are defined for each status class. However, for high status, specific requirements are also defined for the hydromorphological and physico-chemical quality elements. For good status, specific standards for the physico-chemical quality elements must be established. The various requirements are summarised in Table 4.1.

The ecological status of all surface water bodies has to be classified unless they are designated as heavily modified or artificial. In such cases, the bodies' ecological conditions will be described by a separate scheme. This is described in Section 5.

Table 4.1 Requirements for the Different Ecological Status Classes

High ecological status
Each of the relevant biological, hydromorphological and physico-chemical quality elements match their reference conditions (see Section 4.2.3).
Good ecological status
The relevant biological quality elements are only slightly changed from their reference conditions as a result of human activities. Environmental quality standards are achieved for the relevant physico-chemical quality elements.
Moderate ecological status
The relevant biological quality elements are moderately changed from their reference conditions as a result of human activities.
Poor ecological status
The relevant quality biological elements show major changes from their reference conditions as a result of human activities (i.e. there are substantial changes to the reference biological communities).
Bad ecological status
The relevant biological quality elements are severely changed from their reference conditions as a result of human activities (i.e. large portions of the reference biological communities are absent).



4.2.2 Typology and Reference Conditions

Role of Reference Conditions

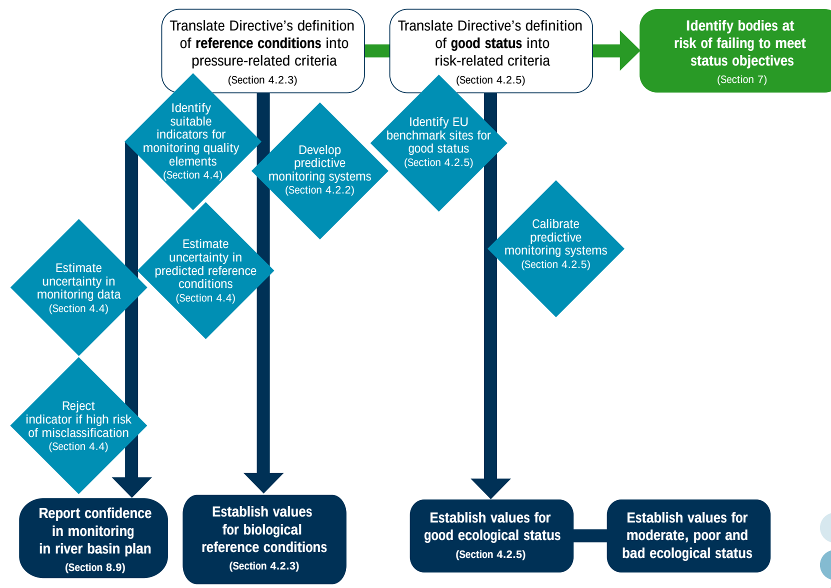
To translate the Directive's ecological status classification scheme into a system for classifying the status of Scotland's surface waters, one of the first steps is to develop criteria for identifying what the relevant aspects of a water body's biology, hydromorphology and physico-chemistry would be like if there were "no or only very minor alterations" to the body resulting from human activities.

This is important because these nearly undisturbed conditions will be the reference conditions around which the whole classification scheme will be built. Once the criteria are clear, values for the reference conditions can be established as part of the development of monitoring systems. Such systems will need to include a means of predicting the reference conditions for a water body even where that body has been substantially affected by human activities.

Having established the reference condition values, it will be possible to use the monitoring systems to measure by how much the ecological conditions of the water body have been affected by the pressures on it. That is, by how much the water body falls short of its reference conditions (see Figure 4.2). For example, if a water body has not been changed from its reference conditions, it will be classed as being at high ecological status. If there are only slight changes to the condition of a water body's aquatic plants and animals as a result of all the pressures to which the body is subject, then, provided its water quality is satisfactory, the body will be classified as being at good ecological status.

The Directive requires the reference conditions to be translated into relevant criteria and values alongside an appropriate typology system. The following section describes the Directive's typology requirements and the issues that they raise.

Figure 4.2 Development of an Ecological Status Classification Scheme



Typology

Rivers, lochs, transitional waters and coastal waters are clearly different. The differences arise from each of these surface water category's distinctive physical characteristics. These differences indicate, in very general terms, the sorts of plants and animals that might be present. As part of the process of characterising river basin districts, the Directive requires that further sub-divisions, or types, of surface water also be differentiated. Digital maps of these types must be sent to the European Commission. As described in Section 3, the types of surface waters within each river basin district need to be identified before the identification of water bodies, so that every water body will be of one type or another.

The Directive specifies that reference hydromorphological, physico-chemical and biological conditions that are specific to each water body type must be identified. In fact, the Directive goes further and implies that it should be possible to derive the biological reference conditions for a water body from the physical and chemical factors that define its type.

The animals and plants in any one part of a river basin district depend to some extent on the particular local hydromorphological and physico-chemical characteristics. For example, where waters are naturally poor in nutrients, plants that can best use those nutrients tend to flourish. Which particular plants flourish depends on a whole range of other factors. In theory, if the natural factors that matter can be identified, then the plants that should be present in the absence of human disturbance can be predicted and then compared with the plants that are actually present. The difference between what is predicted and what is actually present provides a measure of the impact of human activities. Just such a system is used in river monitoring throughout the UK for predicting the invertebrates that would be expected in a particular stretch of river from aspects of its physical and physico-chemical characteristics.

Biological communities can show a significant degree of variation between locations that have only slightly different physical and chemical characteristics. For a biological reference condition to reflect a manageable degree of variation, it will need to be specific to locations that have fairly similar characteristics. If the natural variation described by a biological reference condition were so large that it always overlapped with the biological variation caused by the effects of human activities, it would be impossible to determine the effects of those activities. The physical and chemical factors used to predict reference conditions will consequently need to tightly define the specific characteristics of the locations to which the reference conditions are relevant. If the factors used to define a water body type were to be used to predict biological reference conditions with the precision needed to allow the effects of human activities to be reliably detected, a very large number of water body types would be needed. The establishment of large numbers of types would undermine the flexibility to identify appropriate water bodies for managing pressures and would also create a major logistical problem in reporting water body types to the European Commission. On the other hand, trying to use fewer, coarser types to predict biological communities at a particular site could make it impossible to distinguish adverse effects from natural background variation until substantial environmental degradation had occurred.

Assuming a manageable number of general types are identified, there would need to be a range of predicted biological reference conditions reflecting the range of potential monitoring location characteristics within the type. This would allow the monitoring systems to detect the effects of pressures at any monitored location.

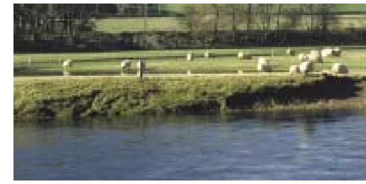
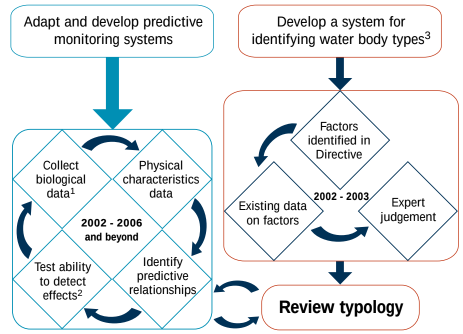


Figure 4.3 Development of Typology Systems and Identification of Reference Condition Values for Use in Monitoring Systems



[1] Spatial network, temporal network (eg palaeolimnologyl) or modelled (eg hindcast) biological data (see Section 4.2.4).

[2] Monitoring system development proceeds until the systems can distinguish the effects of human activities from background variation.

[3] A working typology must be available in 2002 - 2003 to allow the identification of water bodies to proceed.

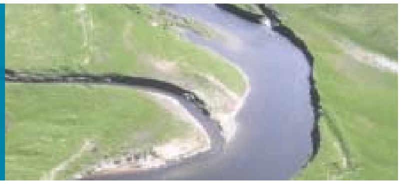
For good reason, most monitoring systems are not based on the definition of the whole biological community. Instead, specific monitoring tools have been developed to estimate the values for particular biological quality elements, such as plankton abundance or invertebrate composition. The identity and the values of the physical and chemical factors that can be used to predict the values of each of these biological elements at particular locations will be different. This is because different biological groups tend to exploit different ecological niches and are influenced by the factors that describe those different niches. For example, the natural abundance and composition of phytoplankton communities drifting in coastal waters could be influenced, and hence potentially predicted, by factors such as temperature, day-length and nutrient concentrations. In contrast, the invertebrate communities living on the seabed might be influenced by factors such as the substrate of the bed, which have little relevance to the condition of the phytoplankton community.

There may be some circumstances where the set of factors that can be used to predict the reference conditions for one group of biological quality elements will also predict the reference condition values for another. However, in most cases, it will be necessary to identify separate sets of predictors for each group of quality elements. The practical identification of these predictors, along with their associated biological quality element reference conditions, will be one of the key tasks in developing the monitoring systems for classifying the status of surface waters (see Figure 4.3).

Guiding principle

Typology is one of the implementation tasks that will be the subject of guidance from the European Community Common Implementation Strategy Projects referred to in Section 1. This guidance may require changes to the approach being considered for Scotland. The following guiding principle outlines the current view.

The central principle of the Directive's classification schemes is that the status of surface water bodies is classified using an assessment of how far human activities have disturbed the bodies from their reference conditions. Operationally, reference conditions will be identified as part of the development of predictive monitoring systems and will be specific to locations with particular characteristics. The characteristics of these locations will be sufficiently narrowly defined to enable the monitoring systems to distinguish the effects of pressures from natural background variation.
In most cases, the characteristics defining the locations relevant to the reference conditions for one group of biological quality elements will be different to those defining the reference conditions for another. In practice there will therefore be multiple type-specific reference conditions for each quality element within a water body type.



In the first instance, water body types will be differentiated according to those major ecologically relevant characteristics of surface waters that can be discerned using expert judgement (see Box 4.1). For rivers and lakes, a single set of types for Great Britain will be developed. For transitional waters and coastal waters, the intention is to develop a shared typology system with other countries bordering the Atlantic and the North Sea.

The types will be used in the inter-calibration exercise as required by the Directive (see Section 4.2.5). This will ensure that the classification boundaries for good ecological status in the main types of surface waters in Scotland, England and Wales can be compared with the status boundaries proposed by other Member States.

4.2.3 Guiding Principles for Reference Conditions

The Directive says that reference conditions must represent a state of "no, or only very minor" changes to a water body's quality elements as a result of human activities (see Section 4.2.2). The provision to accommodate minor changes is important. Water bodies do not have to be restored to their reference conditions. However, because good ecological status, the objective bodies must achieve, is defined as a slight change from the reference conditions, the reference conditions will dictate the direction restoration takes. Equating reference conditions with a notion of pristine conditions, lacking any human influence whatsoever, could lead to an operational definition of good ecological status that would nearly always be unattainable. Consequently, the standard for reference conditions must take account of an appropriate vision for good ecological status. The purpose of the Directive is to promote sustainable use of the water environment and not to return it to pristine conditions.

For example, the land in which they are located and from which their water, sediments and nutrients flow shapes aquatic ecosystems. Human land uses affect the land and cause changes to aquatic ecosystems. However, it would clearly be inappropriate to base reference conditions on a historic landscape that bears no comparison with modern Scotland, such as a medieval landscape. It is important to strike the right balance between the extremes of drawing reference conditions from landscapes which are completely incompatible with today's world, and from modern landscapes that are so affected by land uses that the restoration template they would provide could result in an unacceptably low target for good ecological status. Tilling soils for agriculture inevitably changes the flow of nutrients into surface waters to some extent. It would not be appropriate to define a reference condition for a farmed catchment that did not accommodate the effects of properly managed soil tillage.

Of course, land uses are not the only pressures that have to be considered when quantifying the degree of change acceptable at reference conditions. Section 7 outlines some of the range of pressures that can affect surface waters. In each case, the definition of what is acceptable as a very minor change in terms of the effects of those pressures needs to keep in mind a vision for good ecological status.

Sea level rise due to climate change could reduce the extent of inter-tidal habitat in transitional waters and coastal waters. Making space in appropriate places in estuaries for the sea to effectively move inland and form new inter-tidal areas is already being considered as a means of reducing flooding pressure on other areas where such retreat is not possible. Clearly, the underlying causes of human effects on climate are beyond the scope of river basin planning. But river basin planning could provide a means to identify and implement measures to mitigate some of the adverse effects of this change on the water environment. There will be adverse effects of this change that cannot be avoided, even with co-ordinated action at a European level. Consequently, it would seem appropriate to adjust reference conditions over time to accommodate those effects that cannot reasonably be mitigated.

Many other human activities can be undertaken in ways and at levels that cause no more than very minor ecological impacts. Where this is the case, those activities will be compatible with the definition of reference conditions. Water bodies at high status (i.e. reference condition) should not be off-limits to sustainable low impact uses. For example, unless catches are returned, fishing inevitably changes the abundance of the fish and shellfish species in a water body to some extent. However, what matters ecologically is that the changes in abundance do not:

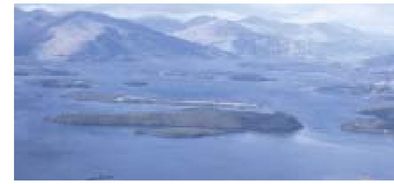
- pose a risk to the viability of the exploited species by significantly reducing its ability to reproduce; or
- adversely affect the condition of other aquatic animals and plants which depend in some way upon the abundance of the exploited species.

If a fishery met these conditions, it would be compatible with high status.

Introductions of plant and animal species can also change pristine conditions. However, where introductions have become established without causing ecologically significant changes to the native plants and animals, it would seem appropriate to regard them as a minor impact. If not, achieving good ecological status could become impractical because of the enormous difficulty in removing species once they have become established.

Guiding principle

The first task in translating the Directive's definition of reference conditions into real values is to decide what effects of pressures should be regarded as only very minor and therefore ignored. The key to this task is to make sure that the reference conditions provide a suitable template against which to define a practical vision for good ecological status.



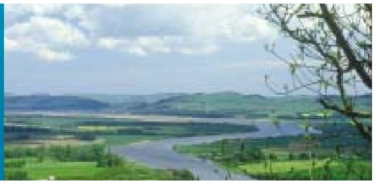
Question

Bearing in mind the above principles and the Directive's definitions, are there specific examples of water bodies you think are at high status?
If so, please give the reasons behind your views.

4.2.4 Methods for Establishing Reference Conditions

Establishing values for the reference conditions will be one of the major technical challenges in implementing the Directive. The Directive allows a range of approaches to establishing reliable values for the biological reference conditions. In the best option, reference conditions would be derived directly from a network of water bodies at reference conditions. However, this will not always be possible. In some cases, there may no longer be sufficient water bodies at high status from which to derive appropriate reference conditions for all the locations in the water body types that may need to be monitored. If this is the case, it will be necessary to use other methods such as modelling to estimate the values for the reference conditions.

Modelling involves developing a conceptual model of an ecosystem that captures the main factors that determine reference conditions. The validity of the model can then be tested using any data that are available, including historical records. At its most basic level, such a model is simply an expert judgement. However, with adequate validation and refinement, models can become objective and reliable. Because of the limited time available, it will be necessary to concentrate initially on improving on the range of existing systems for identifying reference conditions. These methods can be expanded so that reliability in assessing water status can be continually improved.



4.2.5 Guiding Principles for the Good Status Class Boundaries

Good ecological status is one of the key objectives for surface water bodies (see Section 4.1.1). Therefore, until good ecological status is clearly defined, it will be difficult to know exactly what the Directive will mean in practice. The Directive defines good ecological status and the other status classes using generic, rather than specific, descriptions of the changes from the relevant biological reference conditions that the class accommodates (see Table 4.1). This has to be the case. The natural ecology of surface waters differs substantially between and within each Member State. The classification systems each country develops must therefore be able to incorporate their country's particular ecological characteristics. This means, however, that the Directive's generic definitions, which say that good ecological status represents a slight change from the biological reference conditions, now need to be translated into clear criteria and values, suited to the individual characteristics of Scotland's different aquatic ecosystems.

By the end of 2004, water bodies at risk of failing to achieve good status must be identified (see Section 7). To do this, it will be necessary to establish risk assessment criteria that can be easily related to the levels of pressure, or combinations of pressures on water bodies and to the particular characteristics, and therefore vulnerability to pressures, of those bodies. Good ecological status must also be defined in terms of specific values for the biological quality elements so that surface water bodies at risk can be classified using information from the Directive's monitoring programmes, which are scheduled to begin at the end of 2006 (see Section 8). To enable status classification, good ecological status and the other status classes must be expressed as numerical divisions on an ecological quality ratio scale. An ecological quality ratio represents the shortfall of the measured condition of a biological quality element (Section 8) from its predicted reference condition. If a water body is at high status, the ratio will be close to one. If it is at bad status, the ratio will be closer to zero. The identification of the values defining good ecological status will therefore require the development of monitoring systems capable of predicting the reference conditions for the biological quality elements in a water body (see Section 4.2.2).

The Directive intends that good ecological status should represent the same level of ecological quality wherever you live in Europe. The European Commission is therefore required to co-ordinate a benchmarking, or inter-calibration, exercise. This will be designed to ensure that the values assigned by each Member State to the good ecological status class boundaries are consistent with the Directive's generic definitions of those boundaries and comparable with the boundaries proposed by other Member States. The Commission must publish the results of this exercise by the end of 2006. However, work has already begun to map out how inter-calibration can be achieved. The task is not straightforward. For example, it will not be possible to simply take one Member State's monitoring system and apply it to water bodies in another country to see if the results are the same. Biological monitoring systems will only give reliable predictions of reference conditions for sites with similar characteristics to the reference sites used to develop the systems. The UK's river invertebrate prediction system, for example, cannot at present be used in the Northern Isles let alone other parts of Europe. This is because the ecological characteristics of the islands and continental Europe are too dissimilar from the characteristics of the reference sites the system uses as the basis for making its predictions.

The first task for inter-calibration is to identify sites that are on the boundaries of the good ecological status class. This task must be completed by the end of 2004. However, the Commission has to prepare a draft list of sites by the end of 2003. The sites will be selected by expert judgement based on joint inspections and an analysis of all other available information. The sites on any one boundary should reflect an equivalent degree of human impact. Once agreed, the inter-calibration sites will act as benchmarks for calibrating each Member State's monitoring systems. The selection of the right sites is therefore important, as the sites will effectively define what is meant by good ecological status. The UK will need to contribute to the identification of sites for the inter-calibration network. It will be important that, in doing so, the vision for good ecological status that is promoted achieves the right balance between sustainable use, public expectations and ecological quality and that it is based on the same criteria used to assess risks to the Directive's objectives in the river basin planning process (see Section 7).

Guiding principle

The principal aim of the Directive is to achieve good status. Determining the boundaries for good ecological status is therefore of fundamental importance. The establishment of these boundaries is part of a Europe-wide exercise. However, the UK will seek to ensure that they are based on sound ecological principles and that good ecological status accommodates and promotes sustainable water uses.

Question

The starting point for identifying the boundaries for good ecological status will be to identify real examples of water bodies that are currently considered to be at good status. Bearing in mind the principles referred to above and the Directive's definitions of the status classes (see Table 4.1), are there specific examples of water bodies that you consider would fall into the good status class? If so, please give the reasons behind your views.

The Directive recognises that there are important water uses that will not be compatible with the achievement of good ecological status. It therefore allows other objectives to be set through the river basin planning process. For example, less stringent objectives can be set if it would be technically unfeasible or disproportionately expensive to restore a water body to good status.

4.2.6 Biological Quality Elements

The sub-set of an aquatic ecosystem's biological elements, which are relevant to the classification of ecological status, is called biological quality elements. They are listed in Table 4.2.

Table 4.2 Relevant Biological Quality Elements for Ecological Status Classification in Different Categories of Surface Water.

	Phytoplankton	Other Aquatic Plants*	Invertebrates	Fish
Composition	Rivers Lochs Transitional waters Coastal waters	Rivers Lochs Transitional waters Coastal waters	Rivers Lochs Transitional waters Coastal waters	Rivers Lochs Transitional waters
Abundance	Rivers Lochs Transitional waters Coastal waters	Rivers Lochs Transitional waters Coastal waters	Rivers Lochs Transitional waters Coastal waters	Rivers Lochs Transitional waters
Biomass	Lochs Transitional waters Coastal waters			
Age Structure				Rivers Lochs

** The aquatic plants in rivers and lochs are macrophytes and phytobenthos. In coastal waters, they are angiosperms and macroalgae.*

The list in Table 4.2 includes phytoplankton quality elements for rivers. However, in most UK rivers, true phytoplankton communities do not develop. This is because of the limited time water resides in these rivers before reaching the sea. On the continent, where rivers can be very large and sometimes slow flowing, phytoplankton quality elements are likely to be important in assessing ecological status. However, in Scotland they will not be relevant to ecological status classification.

The Directive's generic definitions for good ecological status permit a slight shortfall from reference condition values for any or all of the biological quality elements as a result of any pressure or combination of pressures. The acceptable shortfall is further qualified in some cases. For example, in lochs the phytoplankton quality elements, composition, abundance and biomass may show slight signs of disturbance at good ecological status. However, any resulting increase in the frequency and intensity of the naturally occurring planktonic blooms must also only be slight. In addition, there must not be an undesirable disturbance to the balance of organisms present in the water body or to the quality of the water. For example, a change in abundance of a planktonic species promoted by human-induced changes to the nutrient concentrations in the water body that resulted in a toxic algal bloom would represent an undesirable disturbance to the balance of organisms.

Fish quality elements

For good ecological status in river, loch and transitional water bodies, no more than slight changes are permitted to the fish quality elements (see Table 4.2) as a result of impacts on the hydromorphological (see Section 4.2.7) or physico-chemical quality elements (see Section 4.2.8). However, the Directive does not include fish quality elements in its classification scheme for coastal waters (Table 4.2).

Guiding principle

For the purposes of status classification in Scotland, it is proposed that, when determining if a freshwater or transitional water body is at good ecological status, the effects of direct impacts on fish populations caused by over-fishing will not be considered. This means that if the fish community in a freshwater or transitional water body is significantly impaired as a result of over-fishing rather than alterations to the hydromorphological or physico-chemical conditions, the water body may still be classed at good ecological status. However, when determining if a water body is at high ecological status, the effects of all pressures, including fishing, will be taken into account.

4.2.7 Hydromorphological Quality Elements

The sub-set of an aquatic ecosystem's hydromorphological elements that is relevant to status classification is called the hydromorphological quality elements. They are listed in Table 4.3. The quality elements for rivers are illustrated in Figure 4.4.

For high status to be achieved, the Directive requires that there are no more than very minor human alterations to the hydromorphological quality elements. However, the good, moderate, poor and bad ecological status classes are only defined by the shortfall of the biological quality elements from the biological reference conditions and, in the case of good ecological status, by the condition of the physico-chemical quality elements (see Section 4.2.8). Therefore, at good status and the lower status classes, the required values for the hydromorphological quality elements are not defined by the degree of change from their reference conditions. Instead, their values must be such as to support the required biological and physico-chemical quality element values for the relevant class.

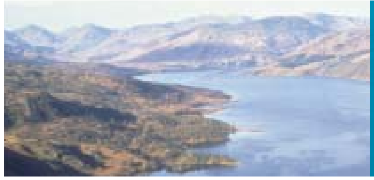


Table 4.3 Hydromorphological Quality Elements for the Different Surface Water Categories

Hydromorphological Quality Elements	Rivers	Lochs	Transitional Waters	Coastal Waters
Quantity and dynamics of water flow				
Freshwater flow				
Dominant currents				
Wave exposure				
Residence time				
Connection to groundwater				
Continuity				
Depth variation				
Width variation				
Structure and substrate of the bed				
Quantity of bed				
Structure and condition of the riparian, shore or inter-tidal zone				

4.2.8 Physico-chemical Quality Elements

The physico-chemical quality elements describe the water quality of a water body. They include naturally occurring substances, such as nitrates and phosphates, and physical properties, such as transparency and temperature (see Table 4.4). These quality elements are collectively called the general physico-chemical elements. At high status, they must be within their natural background ranges.

Figure 4.4 Hydromorphological Quality Elements for River Water Bodies

The hydromorphological quality elements for rivers include the structure and substrate of the river bed, variation in the river's depth and width and the structure and condition of its riparian zone. The riparian zone is land adjacent to the river that is important to the quality of the river and is in turn influenced by the river.

Table 4.4 Physico-chemical Quality Elements for the Different Surface Water Categories

Physico-chemical Quality Elements	Rivers	Lochs	Transitional Waters	Coastal Waters
General Physico-chemical Quality Elements				
Transparency				
Thermal conditions				
Oxygen conditions				
Salinity				
Acidification status				
Nutrient conditions				
Specific Pollutant Quality Elements				
Pollution by other substances discharged in significant quantities into a water body				

At good ecological status, the Directive requires that the general physico-chemical quality elements do not exceed levels established to protect the functioning of the natural ecosystem. One of the necessary tasks in developing the classification scheme will be to define the appropriate standards for the general physico-chemical elements at good ecological status. Having reference conditions for these parameters, as the Directive requires, will be useful in this context.

The Directive does not define ecosystem functioning. It will therefore be necessary to identify the key functions of aquatic ecosystems that could be affected by changes in the general physico-chemical elements. Appropriate standards can then be established to help protect these functions. Relevant ecosystem functions could include:

- nutrient cycling including decomposition of organic matter, such as leaf litter;
- breakdown of pollutants;
- providing the water needs of humans and the natural heritage;
- maintaining species of noted conservation value such as species listed in the Natura 2000 Directives; and
- maintaining species of recreational or commercial value, such as exploited shellfish and exploited freshwater fish.

As well as the general quality elements, the physico-chemical quality elements include specific pollutants. These specific pollutants are listed in points 1 to 9 of Annex VIII of the Directive and are reproduced in Table 4.5. They include non-synthetic and synthetic substances.

Specific Pollutants and High Status

For high status, the Directive requires that the concentration of any specific non-synthetic pollutant is within the range expected for those substances under undisturbed conditions. For specific synthetic pollutants, it requires that concentrations are "close to zero and at least below the limits of detection of the most advanced analytical techniques in general use".

Table 4.5

Specific Pollutants
1. Organohalogen compounds and substances which may form such compounds in the aquatic environment.
2. Organophosphorus compounds.
3. Organotin compounds.
4. Substances and preparations, or the breakdown products of such, which have been proved to possess carcinogenic or mutagenic properties or properties, which may affect steroidogenic, thyroid, reproduction or other endocrine-related functions in or via the aquatic environment.
5. Persistent hydrocarbons and persistent and bioaccumulable organic toxic substances.
6. Cyanides.
7. Metals and their compounds.
8. Arsenic and its compounds.
9. Biocides and plant protection products.

Some synthetic substances are very persistent. They can consequently become widespread in the water environment. The majority never reach environmentally significant concentrations. Others have effects at concentrations that cannot be directly measured in water or sediments. For example, tributyl tin (TBT), once used widely as an anti-foulant on small boats and ships, was only detectable by its effects on aquatic flora and fauna in coastal waters. Requiring that the concentration of every synthetic substance in a water body be at least below the limits of detection could result in the high status class being defined by the state of development of analytical techniques rather than the environmental significance of the concentrations of the pollutants. Many ecologically unimpaired water bodies would be downgraded from high ecological status to good ecological status.

Issue

If no traces of any synthetic substances are permitted for high ecological status to be achieved, whether or not those traces are of environmental significance, there will be little possibility of high status waters being found anywhere in Europe. There could also be considerable monitoring costs in demonstrating the ubiquitous nature of traces of synthetic substances in the water environment.

The criteria for reference conditions for synthetic pollutants is one of the implementation issues that will be the subject of guidance from the European Community Common Implementation Projects referred to in Section 1.

Specific Pollutants and Good Ecological Status

Good ecological status requires that environmental quality standards are not exceeded for the specific pollutants. To derive these standards, the Directive requires a risk-based protocol to be followed. This protocol takes account of the toxicity of a substance and, where data is available, its persistence and potential to accumulate in plants and animals. It is already good practice in Great Britain to use information on toxicity, persistence and potential to bioaccumulate in determining environmental quality standards.

The protocol also requires safety factors to be applied in producing the standards. The less information on the risks that is available, the bigger the safety factor that must be applied. The Directive allows the standards for the concentrations of the pollutants to be set for water, sediment or the tissues of living plants and animals. The approach taken will be to set the standard for that part of the environment that is ecologically relevant and can be reliably monitored.

All environmental quality standards that are derived have to be the subject of future public consultation.

For naturally occurring specific pollutants, the protocol for developing environmental quality standards could result in a standard that is lower than the natural background concentrations in some water bodies. It would not be of any ecological benefit to set standards lower than the natural background concentrations for such waters. Animals and plants in these waters will be naturally adapted to the presence of those concentrations. The Directive does not require reductions of pollutant concentrations below background levels. Standards that are relevant to the protection of the biological communities will need to be set for such water bodies.

Physico-chemical Quality Elements at Moderate, Poor and Bad Status

A water body would fail good ecological status if an environmental quality standard for a specific pollutant or for a general physico-chemical element were exceeded. The Directive says that its actual status would then be dictated by the values of the biological quality elements. It does not require different status-specific environmental quality standards to be established for every potential pollutant. For example, if the biological quality elements show substantial impacts, the body will be classified as poor status. However, significant impacts on the biological elements will sometimes not be detectable despite the environmental quality standard for a pollutant being exceeded. It seems logical in such cases to classify the water body as being at moderate status.

4.3 Good Surface Water Chemical Status

Chemical status has to be described for all surface waters. Good surface water chemical status is achieved when none of the environmental quality standards established at Community level are exceeded. These standards include those that have been established under the Dangerous Substances Directive (76/464/EEC). They will also include quality standards for any priority substances, and groups of such substances identified for Community-level action under the Water Framework Directive.

So far, 33 priority substances have been identified (Decision No. 2455/2001/EC) (see Table 4.6). The European Commission is required to propose environmental quality standards for these substances by the end of 2003.

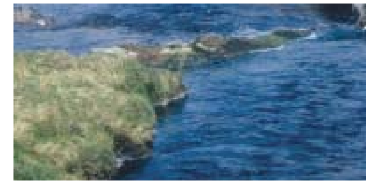
If the standards relevant to good surface water chemical status are not achieved, a water body must be reported as "failing to meet good surface water chemical status". The purpose of reporting chemical status is to highlight the effectiveness of measures to tackle pollution of water by pollutants presenting a particularly significant risk to or via the aquatic environment.

The Directive also establishes specific objectives for priority substances. Measures must be implemented with the aim of progressively reducing pollution from all priority substances and ceasing or phasing out emissions, discharges and losses of priority hazardous substances. By the end of 2003, the European Commission is required to come forward with proposals for appropriate cost-effective combinations of product and process control measures for the substances on the first priority list (see Table 4.6). Acting on the Commission's proposals, Member States and the European Parliament will then adopt specific measures.

Table 4.6 Priority Substances Identified Under the Water Framework Directive.

PRIORITY SUBSTANCES		
Priority Hazardous Substances	Priority Substances Subject to Review to Priority Hazardous Substances*	Priority Substances
1. Brominated diphenylether (only pentabromobiphenylether);	1. Anthracene;	1. Alachlor;
2. Cadmium and its compounds;	2. Atrazine;	2. Benzene;
3. C_{10-13}-chloroalkanes;	3. Chlorpyrifos;	3. Chlorfenvinphos;
4. Hexachlorobenzene;	4. Di (2-ethylhexyl) phthalate (DEHP);	4. 1,2-Dichloroethane;
5. Hexachlorobutadiene;	5. Diuron;	5. Dichloromethane;
6. Hexachlorocyclohexane;	6. Endosulfan;	6. Fluoranthene;
7. Mercury and its compounds;	7. Isoproturon;	7. Nickel and its compounds;
8. Nonylphenols;	8. Lead and its compounds;	8. Trichloromethane.
9. Pentachlorobenzene;	9. Naphthalene;	
10. Polyaromatic hydrocarbons (PAHs);	10. Octylphenols;	
11. Tributyl tin compounds.	11. Pentachlorophenol;	
	12. Simazine;	
	13. Trichlorobenzenes;	
	14. Trifluralin.	

*The Commission will make a proposal to the European Parliament and Council for the final classification of these substances by 15 December 2002.



4.4 Reliability of Classification Schemes

The ecological status of a water body will depend largely on the condition of its biological quality elements. The Directive specifies the maximum shortfall permitted for each biological quality element at any particular status. So if one quality element does not meet the condition required for the status class, the water body will be placed in an appropriate lower ecological status class.

The composition and abundance of animals and plants in surface waters can be naturally very variable. As described in Section 4.2.2, the values established for the biological reference conditions must describe this natural variation so it can be distinguished from any variation that is attributable to human impacts. It is important that natural variation is not confused with any variation caused by the effects of human pressures. This would result in the status of a water body being incorrectly classified. Misclassification could result in restoration measures and their associated costs being unnecessarily imposed on water users. However, the difficulties in distinguishing natural variation from human influence should not be underestimated.

The natural variability of a biological quality element will not necessarily affect the reliability of classification, provided that the variability can be reliably estimated and appropriately taken into account in classification decisions. However, there will always be uncertainty in any estimate of the reference conditions. There will also always be uncertainty in the measurement of the actual condition of a quality element in a water body because monitoring can never be continuous and error-free. Ecological status is determined by how much a water body falls short of its reference conditions. This calculation tends to sum the errors in the estimate of the reference condition with those in the estimate of the current conditions. To understand the risk of misclassification, it is necessary to know the potential size of these two errors. Accordingly, the Directive requires that the risks of error in the reference conditions and in the results of monitoring be calculated.

Because the estimates for each quality element will have errors associated with them, the risk of wrongly downgrading a water body to a lower class will increase in proportion to the number of different quality elements that are eventually combined to assess status. It will be important, as the classification systems are developed, to ensure that they are based on rules that prevent water bodies being downgraded if the downgrade is very likely to be wrong. To do this, it will be necessary, among other things, to decide the statistical confidence (i.e. the risk of error) that is acceptable in the status classification systems. Estimates of the confidence attained by the monitoring systems have to be reported in the river basin management plans.

There is, of course, a risk that the errors may turn out to be too large to allow the shortfall from reference conditions to be reliably detected. The Directive allows any biological quality element to be excluded from the status classification system if reliable reference conditions for it cannot be established due to high degrees of natural variability. Where the risks of error in a reference condition cannot reasonably be determined or are so large that the risk of misclassification is appreciable, it would be wrong to include estimates for the quality element in classification decisions, unless such decisions can take full account of the uncertainties.

Monitoring frequency and intensity will affect confidence in any estimates of biological quality elements. Biological quality elements showing large natural variability will generally require a higher frequency of sampling to achieve an equivalent level of reliability than low variability elements. Where the intensity of monitoring necessary to avoid large errors in the results is high, it may simply not be cost effective to attempt to estimate the values of the quality element for status classification.

The Directive requires that the status of a water body at risk be established through operational monitoring (see Section 8). Operational monitoring will use indicators to estimate the values of the biological quality element or elements most sensitive to the pressures on the water body. This requirement has two important implications for status classification and for the related development of suitable monitoring systems.

First, only estimates of the condition of the most sensitive quality elements need to be made and subsequently combined in making difficult classification judgements. It will not be necessary to include estimates of the condition of other less sensitive quality elements. If estimates of every quality element had to be combined, the errors could be too large and spurious downgrades could result.

Second, sets of indicators capable of providing a high degree of confidence in the estimate of the quality element they provide can be chosen. For example, simple presence or absence scores for indicator species are likely to have fewer errors than estimates of the abundance of a species or group of species. An appropriate selection of indicators for a quality element could be combined so that the results for each could be checked against those for the others in deriving a suitably reliable estimate of the condition of the quality element. Nevertheless, in some cases, the errors in the biological reference conditions and in biological monitoring results may mean that the classification system is unworkable or unable to record significant damage until that damage becomes very severe.

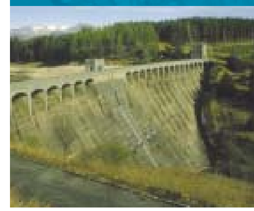
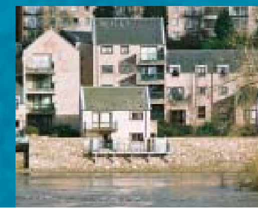
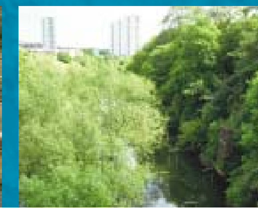
Physical or physico-chemical characteristics, such as water transparency, could be used as supporting indicators of the condition of a biological quality element. Such indicators would have to be closely correlated with the quality element and be influenced by the pressures that are affecting the quality element. Where such non-biological indicators can be measured reliably, their combination with biological indicators could provide a better estimate for a quality element than the use of a biological indicator alone.

Guiding principle

It is important that an adequate level of confidence is achieved in the classification of water body status. A high level of confidence will be particularly important where the implications of misclassification could be costly and result in unnecessary measures being required of water users.

The Directive specifies that a biological quality element need not be considered in classifying ecological status if it is not possible to establish reliable reference conditions for that element. This provision should be used to exclude biological quality elements from the classification of ecological status if their inclusion would result in a significant risk of misclassification. When this is done, the reasons for exclusion must be stated in the relevant river basin management plan.

5 Heavily Modified & Artificial Water Bodies


Directive provisions: Articles 4.1a and 4.3; Annex II, Section 1; and Annex V, Section 1.2.5

5.1 Designation of Heavily Modified and Artificial Water Bodies

5.1.1 Heavily Modified Water Bodies

Sometimes it will not be possible to achieve good ecological status for a surface water body because of substantial physical alterations that have been made to it for activities such as navigation, water storage, flood defence and land drainage. The Directive recognises that the benefits of such uses need to be retained. The Directive allows such water bodies to be designated as heavily modified water bodies (HMWBs).

Figure 5.1 Designation of HMWBs and AWBs.
Under the Directive, reservoirs may be designated as HMWBs or AWBs.

The presence of physical modifications does not lead automatically to designation and nor does designation mean that mitigation measures will not be required. Designation enables objectives to be set that allow the benefits of the water body's use to be maintained but ensure that other pressures can be managed and that, where possible, the adverse effects of the physical modifications can be appropriately mitigated. To enable such objectives to be set, the Directive requires a separate classification scheme for HMWBs to be developed. This is necessary because classifying an HMWB by comparing its current state with its undisturbed reference condition (see Section 4.2.2), as is required for other surface water bodies, would tend to highlight the effect of the modifications but not the effects of other pressures.

5.1.2 Artificial Water Bodies

The Directive requires objectives to be set for artificial water bodies (AWBs). These are man-made surface water bodies, which have been designed to serve a particular purpose but which can also support important aquatic ecosystems. They will mostly comprise canals, some docks and man-made reservoirs. Because AWBs are, by definition, not natural water bodies, it would make no sense to try and measure their ecological status against a reference state representing natural or nearly natural conditions. As with HMWBs, the Directive requires a separate classification system to be used as the basis for setting appropriate objectives.

5.1.3 Identification of Heavily Modified and Artificial Water Bodies

The Directive requires that all surface water bodies that could qualify as HMWBs or as AWBs are provisionally identified by the end of 2004. The main principles outlined in Section 3 for the identification of other surface water bodies apply equally to the identification of HMWBs and AWBs. In other words, the water bodies identified should be appropriate units for which to set objectives relating to the management of significant pressures, including those pressures arising from aspects of the modifications that can reasonably be mitigated. This does not mean that the same steps used for identifying other surface water bodies must be followed for HMWBs and AWBs. For example, there is no requirement to develop a separate typology system for HMWBs or AWBs (see Section 3.1.3). Identification of HMWBs also involves specific additional criteria, which are not relevant to the identification of other surface water bodies. These relate to the Directive's designation conditions and require in particular that:

- the improvements to the hydromorphological characteristics of the water body that would be needed to achieve good ecological status must have significant adverse effects on one or more of a range of specified human uses[5] that rely upon the modified characteristics; and
- physical alterations (i.e. changes to morphology), not other pressures, must be the cause of the hydromorphological characteristics of the water body being unable to support the biological quality element conditions required for good ecological status.

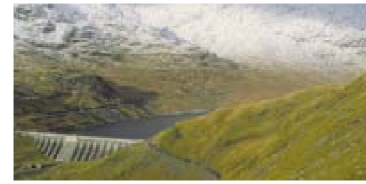
The Directive also provides for designating water bodies as HMWBs when the improvements to their hydromorphological conditions needed to achieve good ecological status would have significant adverse effects on the wider environment. For example, the disturbance to a water body's bed associated with improvement works might result in the release of pollutants long trapped in sediments. Alternatively, the improvements might have significant adverse effects on an important conservation objective relying on the modified characteristics.

The effects of some types of physical alterations will lend themselves to management in a single water body. However, other physical alterations will create more than one heavily modified water body. For example, a water storage reservoir constructed by impounding a river is likely to result in at least two HMWBs with very different hydromorphological characteristics, namely the reservoir and part of the river downstream, which is affected by the changed flows.

In some circumstances, the physical alterations necessary for a particular activity may have significant ecological repercussions over a large part of the river basin district. For example, a dam constructed near a river mouth may prevent migratory animals such as salmon, sea trout and eels from reaching parts of the river system to complete their life cycles. However, the hydromorphological characteristics of most of such a river system will be unaffected and so the river system's water bodies could not be designated as HMWBs. However, the Directive does provide alternative means of setting less stringent objectives than good ecological status for water bodies affected as a consequence of such a dam.

The designation principles established in the Directive will need to be developed into clear criteria before decisions can be made on whether a water body warrants designation as an HMWB. If these criteria are chosen correctly, they will help ensure that when good ecological status is deferred, it is for good reason. To help develop suitable criteria, the Scotland and Northern Ireland Forum for Environmental Research (SNIFFER) and the Scottish Executive are jointly funding research into the application of the Directive's HMWB provisions.

[5] Navigation, recreation, water storage, water regulation, flood protection, land drainage or other equally important sustainable human development activities.



The research is taking a case study approach. Three Scottish case study areas have been identified: the River Tummel, the River Dee in Dumfries and Galloway and the Forth Estuary. There is also one study area in Northern Ireland in the River Lagan catchment. These case studies, together with others from across Europe, will contribute to the development of Europe-wide guidance on the designation and classification of HMWBs.

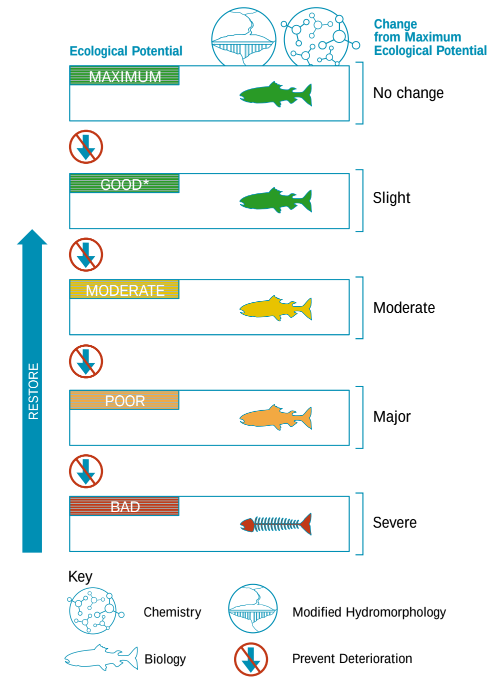
5.2 Classification Scheme for Heavily Modified and Artificial Water Bodies

5.2.1 Objectives for Heavily Modified and Artificial Water Bodies

As with other surface water bodies (see Section 4), the classification schemes required by the Directive to describe the condition of HMWBs or AWBs comprise five classes (see Figure 5.2). However, these classes are called ecological potential classes rather than ecological status classes. The Directive requires that deterioration from one ecological potential class to another be prevented. It also sets the restoration target of good ecological potential for all HMWBs and AWBs. Good ecological potential, like good ecological status, allows slight changes to the reference conditions, which underpin the classification scheme. Sometimes, the achievement of good ecological potential may be technically unfeasible or disproportionately expensive. In such cases, the Directive allows a lower restoration objective to be set, provided this represents the highest ecological potential possible, given the adverse effects that cannot be mitigated.

The ecological potential class of AWBs and heavily modified rivers, lochs, transitional waters and coastal water bodies have to be reported to the European Commission and published in the river basin management plans using colour-coded maps. The colour coding systems are required to indicate if a water body is an HMWB or AWB.

Figure 5.2 Environmental Objectives for Heavily Modified and Artificial Water Bodies.



** Good status also requires good water quality*

5.2.2 Principles of Heavily Modified and Artificial Water Body Classification

The reference condition, or benchmark, against which the condition of any HMWB or AWB has to be measured is called maximum ecological potential. It effectively represents the maximum ecological quality that an HMWB could achieve, given the effects of the physical alterations that are necessary to: (i) deliver the benefits provided by the human activity justifying designation; or (ii) avoid significant adverse effects upon the wider environment. The classification system is intended to describe how close an HMWB comes to meeting its maximum ecological potential. For example, the achievement of good ecological potential requires that a water body falls only "slightly" short of its maximum ecological potential. Maximum ecological potential must be defined in such a way that good ecological potential can be achieved without requiring improvements that would have significant adverse effects upon the type of use for which the water body has been designated.

5.2.3 Hydromorphological Reference Conditions

The Directive specifies that maximum ecological potential is the condition that would be expected for HMWB or AWB hydromorphological quality elements if particular mitigation measures were implemented. The specified mitigation measures are those that would be needed to ensure the "best approximation to ecological continuum" compatible with the use for which the physical alterations have been made or for which the artificial characteristics of the body serve.

Ecological continuum conveys the idea of an aquatic ecosystem sustaining itself over time and space. This requires that there are viable numbers of individuals of the species that comprise the biological community. Too few and reproductive failure could result or the ecosystem food web could be disrupted. The ability to maintain viable numbers requires at least a minimum complement of the habitats that are necessary for the different species in the community to complete their life cycles. It also requires that the relevant species can access these habitats at the right stages of their life cycle. The Directive specifically identifies that maximum ecological potential should define the best approximation, compatible with the water body's use, to the hydromorphological conditions necessary for spawning and breeding and for migration.

For example, the best approximation to the hydromorphological conditions necessary for the migration of Atlantic salmon in a river affected by a dam might be a well designed and operated fish pass, together with appropriately timed flow augmentation for the river downstream. However, it would clearly be pointless for maximum ecological potential to specify such passage facilities if there was no potential for fish migration or no useable habitat above the dam.

Question

The translation of the Directive's definition of maximum ecological potential for an HMWB or AWB into detailed criteria and values will also dictate the measures required to achieve good ecological potential. It will be important that any measures required deliver real benefits to the water environment on the one hand while at the same time being compatible with the purpose for which an HMWB or AWB is designated. To achieve this balance will require a detailed understanding of the needs of the different types of uses for which water bodies can be designated.

To establish reference conditions for the classification scheme that are compatible with the types of use for which the bodies are designated, how should the competent authorities work with users of HMWBs and AWBs and other interested parties?

In the case of an HMWB, the most appropriate definition of maximum ecological potential may not always be an approximation to the hydromorphological conditions found in the water body prior to its modification. For example, land drainage schemes tend to deepen and straighten natural river channels. In such cases, maximum ecological potential could be defined in terms of measures that approximate the hydromorphological conditions of naturally deep and relatively straight channels. This might provide the most environmentally beneficial definition of good ecological potential compatible with land drainage requirements.

If an AWB, such as a canal, is no longer being used for the purpose it was originally intended, there appear to be several options for defining maximum ecological potential. It could be defined such that the reference hydromorphological, and hence biological, conditions are compatible with the canal's original navigation purpose. For example, the reference hydromorphological conditions might define the depths, widths, lock gate operations etc that are necessary for navigation. Alternatively, maximum ecological potential could be defined so that it is compatible with another purpose, such as wildlife conservation. In this case, if the canal were subsequently re-established as a transport route, it might not be possible for it to achieve a good ecological potential. This is because it would be judged against a reference condition defined to promote wildlife conservation. The Directive would still allow the purpose of the canal to be switched back to navigation. However it would have to be shown that:

- the benefits of so doing outweighed the benefits of achieving the defined target of good ecological potential, and
- all practicable mitigation steps to minimise the effects of the change had been taken.

It should be possible to establish the intended uses of a canal within the river basin planning process, and define maximum ecological potential accordingly. Each river basin planning cycle would provide the opportunity for the position to be reviewed.

Question

There appear to be several options for deciding on appropriate reference conditions for those AWBs that are no longer used for their original purpose:

(i) set the reference conditions so that they are compatible with the original purpose;

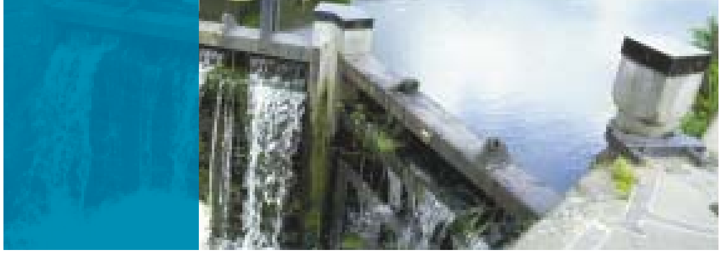
(ii) set the reference conditions so that they are compatible with the current purpose; or

(iii) establish the intended purpose as part of each river basin planning cycle and set reference conditions accordingly.

Which approach do you think is the most appropriate?

5.2.4 Biological Reference Conditions

Maximum ecological potential is intended to describe conditions that mimic as far as possible those of a natural ecosystem. Accordingly, the reference conditions for the biological quality elements must reflect, as far as possible, those associated with the closest comparable water bodies. For example, where an impounding dam has created a reservoir in place of a river, the closest comparable water bodies will be natural lochs. It is implicit that the comparisons are based on the artificial or heavily modified hydromorphological characteristics specified for the HMWB at maximum ecological potential (see Section 5.2.3). The biological quality elements for the classification of ecological potential will be those relevant to natural lochs (see Table 4.2). The reference condition values for these elements should represent those expected in the absence of all but very minor disturbances from pressures other than the reference artificial or heavily modified hydromorphological characteristics themselves.



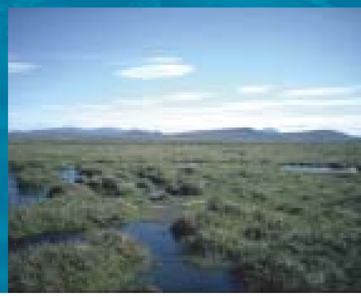
This means that the maximum ecological potential values should be as close as possible to the high ecological status values for the quality elements in the closest comparable lochs.

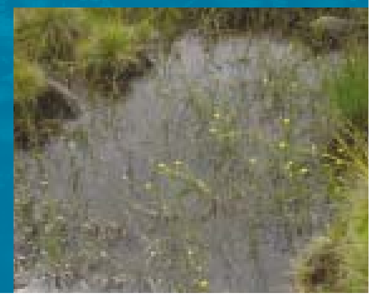
The methods for deriving the biological reference condition values for HMWBs and AWBs are the same as for other surface waters and are outlined in Section 4.2.4. A range of approaches can be used. These may develop estimates of the reference biological values using a spatial network of closely comparable natural surface water bodies or other HMWBs or AWBs that meet maximum ecological potential conditions, or various modelling approaches. To be able to assess the status of an HMWB or AWB, the values for reference conditions will need to be established as part of the development of predictive monitoring systems (see Section 4.2.2). Such systems should enable an estimate of the reference conditions to be made for any HMWB or AWB, whatever the actual condition of the water body.

5.2.5 Physico-chemical Quality Elements for Heavily Modified and Artificial Water Bodies

The Directive also requires that the reference conditions for the general physico-chemical quality elements for HMWBs and AWBs, such as oxygen, nutrients and pH, correspond to those associated with the closest comparable water bodies. Again, it is implicit that this comparison is based on the heavily modified or artificial hydromorphological characteristics specified for the water body at maximum ecological potential. In the example of the water storage reservoir constructed by impounding a river, the temperature, oxygen conditions, transparency, acidification status, salinity and nutrient conditions would be those expected for a comparable high status loch rather than the conditions that existed in the river. For specific non-synthetic pollutants, the maximum ecological potential concentrations must be within the background range expected for the most closely comparable water bodies. For specific synthetic pollutants, the Directive specifies identical reference condition requirements to those expected for any surface water body (see Section 4.2.8).

6 Groundwater Classification



Directive provisions: Article 4.1(b); and Annex V, Sections 2.1, 2.3 and 2.5

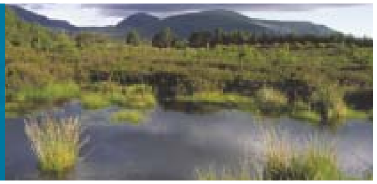
6.1 Purpose of Groundwater Classification

6.1.1 Status Classification and Groundwater Objectives

At present in Scotland, there is no system for reporting the overall condition of groundwater. The Directive requires the introduction of a classification scheme to describe whether a body of groundwater is in a good or poor state. The Directive's principal objectives for groundwater bodies, and consequently the management measures that may be needed, hinge upon this status classification system. Good status groundwater bodies must be protected from deterioration. Poor status groundwater bodies should be restored, where possible, to good status by 22 December 2015. However, as with surface waters, the achievement of good status for a particular body of groundwater by this deadline may be technically unfeasible or disproportionately expensive. In such cases, the Directive allows the deadline to be extended or appropriate objectives to be set, representing the least possible changes to good status, given the impacts that cannot reasonably be addressed.
The status of groundwater bodies must be reported in each river basin management plan using colour-coded maps.

In addition to these status objectives, the Directive requires that groundwater is protected and, where necessary, restored to enable the achievement of the objectives for Protected Areas (see Section 3.2). These areas include areas designated for the abstraction of water intended for human consumption (see Section 3.2.3). The Directive also establishes a general requirement that inputs of pollutants into groundwater be prevented or limited and a requirement that any significant and sustained upward trends in the concentration of any pollutant in groundwater must be reversed in order to progressively reduce pollution of groundwater (see Section 6.5). The new provisions will operate alongside existing European legislation for the protection of groundwater such as the Nitrates Directive (91/676/EEC) and the 1980 Groundwater Directive (80/68/EEC), although the latter will be repealed at the end of 2013.

The European Commission is required to publish proposals for a daughter directive on groundwater by 22 December 2002. The proposals are expected to include specific measures to prevent and control groundwater pollution. The measures may include further criteria for assessing good groundwater chemical status (see Section 6.3) and criteria for the identification of significant and sustained upward trends in pollutant concentrations and the definition of starting points for their reversal (see Section 6.5).



The criteria may include specific environmental quality standards for certain pollutants. This paper discusses only what the Water Framework Directive already requires. However, it should be noted that the provisions of the daughter directive might affect these requirements.

6.1.2 Principles of a Groundwater Classification Scheme

The status of a groundwater body will depend primarily on the effects of uses of the groundwater on the ecosystems that depend on it, associated surface water bodies and directly dependent terrestrial ecosystems. Surface water bodies and terrestrial ecosystems associated with any body of groundwater can be affected by changes in the quantity of groundwater and in its chemical quality. For example, over-abstraction of groundwater could lead to a reduction in the contribution of groundwater flow to a river. At times when the river flow is low, this reduction could exacerbate drought effects and reduce the dilution available to pollutants in the river. Where the groundwater itself is polluted, its entry into surface water could cause harm depending on, for example, the concentration of pollutants in the groundwater and the degree of dilution provided by other sources of river flows. To reflect these two aspects of overall groundwater status, the Directive sub-divides its definition of good status into good groundwater chemical status and good groundwater quantitative status. Both must be achieved for a body of groundwater to be classified as being at good status. The principles of the classification system provide a means of understanding and sustainably managing groundwater as a key part of the water cycle.

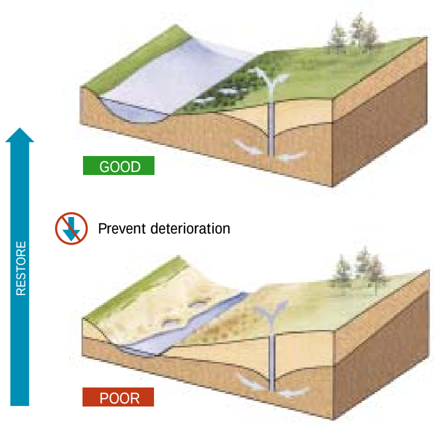
The Directive's definitions of chemical and quantitative groundwater status are not based on Community-wide values. However, it should be borne in mind that the Directive does make provision for the daughter directive (see Section 6.1.1) to identify existing Community standards or new standards for defining good groundwater chemical status. The effects of groundwater level or quality change on surface water bodies or terrestrial ecosystems will vary with the unique way in which each groundwater body interacts with those ecosystems. The Directive's present definition of good groundwater status therefore requires the determination of locally appropriate groundwater standards that will protect dependent surface water and terrestrial ecosystems and the legitimate uses of those ecosystems.

6.2 Groundwater Quantitative Status

6.2.1 Water Flow Needs of Surface Ecosystems

Quantitative status (see Figure 6.1) describes the effects of changes to the level of a groundwater body resulting from, for example, groundwater abstraction. Good quantitative status requires an appropriate balance between abstraction, the water needs of dependent ecosystems and the recharge of groundwater. Groundwater is recharged from rainfall, snow melt and even leaking water pipes.

Figure 6.1 Groundwater Quantitative Status Classification and Groundwater Objectives



It would clearly be unsustainable to allow abstractions to exhaust groundwater supplies. For good quantitative status, therefore, groundwater must not be abstracted at a rate that exceeds its replenishment. Of course, most groundwater feeds into wetlands and surface waters before eventually reaching the sea. If abstractors were permitted to take all the recharge received by groundwater bodies, this would lead to a lowering of groundwater levels and a reduction in the amount of water feeding into surface waters and wetlands. Accordingly, good quantitative status also requires that alterations made to the levels of groundwater, and hence flows to its dependent surface ecosystems, must not result in:

1. A failure to achieve the Directive's objectives for any associated surface water bodies (see Sections 4 and 5). This requirement means that the status of groundwater would be poor if groundwater over-abstraction had resulted, or would result, in:
(i) a failure to achieve the relevant status objectives for a surface water body (see Section 4.1) or
(ii) a failure to achieve relevant surface water Protected Area objectives.

2. Any significant diminution in the status of surface water bodies. This objective means that if alterations to groundwater levels have created a significant risk of, or resulted in, a surface water body achieving a lower status than it otherwise would, the body of groundwater will be classed as poor status.

3. Significant damage to the terrestrial ecosystems that depend directly on the groundwater body. This objective means that if groundwater dependent terrestrial ecosystems, such as wetlands, have been, or would be, significantly damaged as a consequence of level alterations, the body of groundwater will be classed as being at poor status.

6.2.2 Quality Changes Resulting from Alterations in Flow Direction

Abstractions and other activities, such as drilling and mining, can change the flow direction of groundwater. Near to the coast, for example, over-abstraction could draw salt water from beneath the sea into fresh groundwater. Where a body of groundwater is next to a source of polluted water or a source of water with a different natural chemical composition, abstraction from the groundwater body could cause this different quality water to be sucked into the groundwater. The source of the water that may be drawn in could be a surface water body to which the groundwater body is connected or it could be an adjacent body of groundwater. Where such effects constitute an intrusion, they indicate unsustainable levels of abstraction. Accordingly, good groundwater quantitative status requires that:

alterations to flow direction have not resulted in, and are not likely to result in, intrusions of saltwater or water of a different chemical composition into the body of groundwater.

The chemical status of a groundwater body (see Section 6.3) will also be recorded as poor if changes in its conductivity indicate saltwater or other sorts of intrusion, even though the remedy may be to reduce abstraction.

Guiding principle

The Directive does not define intrusion. Like surface water, groundwater can be naturally very variable in chemical composition. The changes in groundwater flow patterns that inevitably result from groundwater abstractions will often have the potential to induce localised movements of waters of different natural or anthropogenically influenced qualities between bodies of groundwater or between bodies of groundwater and surface water. These exchanges should be considered as intrusions when:

- the affected volume continues to expand because of unsustainable levels of abstraction; or
- the changes to the chemical composition of the body of groundwater would result in significant effects on the ecological or chemical quality of surface waters, significant damage to terrestrial ecosystems, a failure to achieve the objectives of a Protected Area or significant impairment of other uses of the body of groundwater.

6.2.3 Technical Challenges and Groundwater Quantitative Status

The principles of good groundwater quantitative status are straightforward. However, translating them into practice will be a substantial challenge. Historically, groundwater and surface water have tended to be studied and managed as separate entities. This is largely because the interaction of surface waters and groundwaters is complex and hidden from view. However, the Directive demands that the scientific difficulties of treating groundwater, wetlands and surface waters as component parts of a single water system are now resolved. The key balance that matters for sustainability, between groundwater replenishment, ecosystem needs and water abstraction, will be at the heart of groundwater management in the future.

6.3 Groundwater Chemical Status

6.3.1 Criteria for Defining Good Groundwater Chemical Status

The Directive sets out a series of criteria for defining good groundwater chemical status. These include the provision that the concentrations of pollutants in a body of groundwater at good chemical status should not exceed the quality standards applicable under other relevant Community legislation. The requirements of this provision are intended to be defined by the proposed daughter directive (see Section 6.1.1) The standards will include those in existing Community legislation, although it is unclear which existing standards may be considered relevant, and any new standards established under the daughter directive.

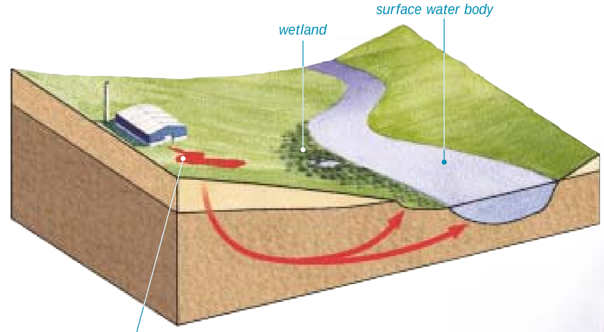
In addition to this provision, the Directive defines groundwater chemical status (see Figure 6.2) in terms of: (i) the effects on associated surface water and terrestrial ecosystems of the concentrations of pollutants in bodies of groundwater, and (ii) any changes in conductivity that indicate saline or other intrusion into the body of groundwater (see Section 6.2.2). For the former of these criteria, the concentrations of pollutants that matter at any point in a particular body of groundwater will depend on the dilution and breakdown of those pollutants prior to their entry into a surface water body or terrestrial ecosystem and on the capacity of the surface ecosystem to receive those pollutant inputs without experiencing significant adverse effects. For a body of groundwater to achieve good groundwater chemical status, the adverse effects on surface ecosystems that must be considered are:

1. A failure to achieve one of the Directive's environmental objectives for an associated surface water body. This requirement means that the chemical status of a groundwater body will be described as poor if the concentration of pollutants within it have caused, or are such as would cause: (i) a deterioration in the status of the surface water body; (ii) a failure to achieve the objectives set for a surface water body in the river basin management planning process; (iii) a failure to achieve a relevant surface water Protected Area objective; or (iv) a failure to achieve the objectives for discharges of priority hazardous substances to surface waters.

2. A significant diminution in the ecological or chemical quality of an associated surface water body. Section 6.3.2 discusses the interpretation of this requirement in detail.

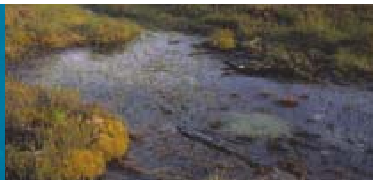
3. Significant damage to any terrestrial ecosystem which directly depends on the groundwater body. This objective means that if groundwater-dependent terrestrial ecosystems, such as wetlands, have been, or will be, significantly damaged as a consequence of the concentrations of pollutants in a body of groundwater, that body will be classed as being at poor status.

Figure 6.2 Groundwater Chemical Objectives



Good groundwater chemical status requires that the concentrations of pollutants in groundwater would not cause significant damage to the ecological quality of a surface water body or to a terrestrial ecosystem, such as a wetland.

The Directive's definition of groundwater chemical status prevents the status of a body of groundwater being classified as good if the concentrations of pollutants in the body are likely to result in significant adverse effects on surface ecosystems. Once pollutants have entered groundwater, it can take some time for them to be carried by groundwater flows into surface water or terrestrial ecosystems and thereby affect the quality of those ecosystems. The Directive intends that a body with such pollutant concentrations within it should be classified from the outset as poor status and appropriate environmental objectives and measures established.



6.3.2 Effects on the Ecological or Chemical Quality of Surface Waters

The Directive's definition of good groundwater chemical status introduces the requirement that the concentrations of pollutants in groundwater must not be such as would result in any "significant diminution in the ecological quality or chemical quality of a surface water body". The Directive does not provide a detailed list of criteria for assessing the significance of a diminution in surface water quality. However, much of the Directive itself is given over to identifying environmentally significant outcomes for surface water bodies (see Section 4). A significant diminution in surface water quality must have occurred if one of these outcomes has been compromised or placed at risk. For example, if a surface water body were at moderate status rather than good status because of the pollutant inputs it receives from a body of groundwater, the concentrations of pollutants in the groundwater would clearly have had an environmentally significant effect on the quality of the surface water.

Guiding principle

Among other criteria (see Section 6.3.1), the Directive's definition of good groundwater chemical status implies that a body of groundwater will be classified as being at poor status if the concentrations of pollutants in that body are such as would:

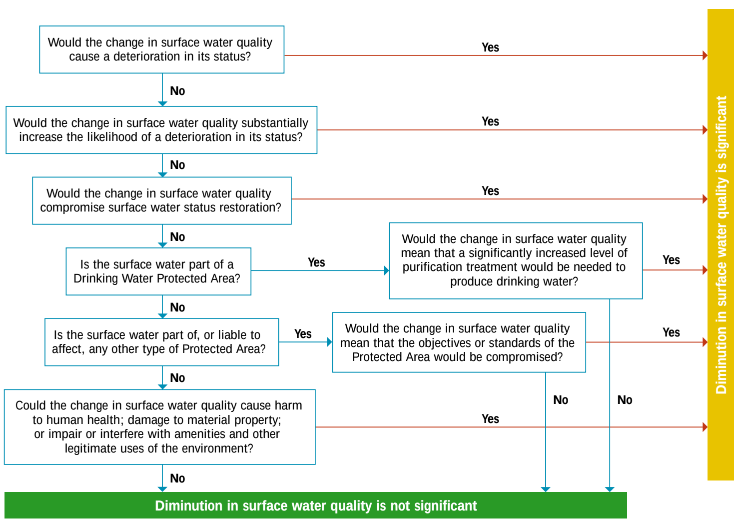
(i) lower the status that would otherwise be achieved by a surface water body;

(ii) compromise the restoration of a surface water body; or

(iii) significantly increase the risk of one the objectives for a surface water body being compromised.

A framework for assessing the significance of the effects of groundwater quality on surface water quality is suggested in Figure 6.3.

Figure 6.3 Proposed Criteria for Assessing the Significance of Surface Water Quality Changes Resulting from the Effects of Pollutant Inputs from Groundwater.



The tests start with the surface water in the condition expected for it with no pollutant inputs from groundwater. The inputs are then added back to test their effects against each of the proposed criteria.

6.4 Significant Impacts on Directly Dependent Terrestrial Ecosystems

The terrestrial ecosystems that are directly dependent on groundwater are those associated with surface expressions of groundwater, such as springs, or those that form where the water table is close to the surface. This causes the ground to be constantly or seasonally wet, creating habitats such as wetlands. The Directive's groundwater objectives are intended to secure the water needs of such terrestrial ecosystems. They do not extend to other aspects of terrestrial ecosystem protection and restoration.

The Directive requires that significant damage to terrestrial ecosystems as a result of groundwater abstraction or pollution is prevented and reversed (Sections 6.2.1 and 6.3.1). Two aspects of the meaning of environmentally significant might be relevant in deciding whether a groundwater body is at poor status because of its impact on dependent terrestrial ecosystems.

First, it might be appropriate to take account of the significance, or potential significance, of an affected terrestrial ecosystem in terms of its conservation or socio-economic value. For example, if a terrestrial ecosystem has no conservation or socio-economic value, it might be difficult to define what could represent significant damage to it. Taking account of the significance of a terrestrial ecosystem would also ensure that the subsequent definition of significant damage directed the river basin planning process to address real environmental problems. Many terrestrial ecosystems that have significant conservation value have already been identified for other purposes. They include SACs, SPAs, SSSIs and Ramsar sites. Other important conservation sites are still being identified through the national biodiversity action planning process.

Second, the extent of damage to any particular terrestrial ecosystem is clearly relevant in deciding whether it has been significantly damaged. Deciding upon the level of acceptable change to the structure and function of a terrestrial ecosystem will be important in this respect. Again, the conservation or socio-economic value of the ecosystem would be expected to inform this decision.

Question

The effects of alterations to the quantity or quality of groundwater flows on directly dependent terrestrial ecosystems, such as wetlands, partly define whether good groundwater status is achieved. Where such alterations have resulted, or would result, in significant damage to a terrestrial ecosystem, the body of groundwater will fail to achieve good status. To ensure that efforts to restore bodies of groundwater to good status tackle real environmental problems, what criteria do you think should be used to define significant damage to directly dependent terrestrial ecosystems?

6.5 Significant Pollutant Trends in Groundwater

The Directive requires that any significant and sustained upward trend in the concentration of any pollutant in groundwater is identified and reversed in order to progressively reduce pollution of groundwater. The purpose of trend reversal is therefore quite clear. It is to reduce pollution of groundwater or, in other words, to manage risks to aquatic ecosystems, terrestrial ecosystems directly dependent on aquatic ecosystems and legitimate uses of the water environment[6]. The good groundwater chemical status objective described in Section 6.3 is thus closely linked to the trend reversal objective since it defines the quality of the environment that the trend reversal objective is designed to protect.

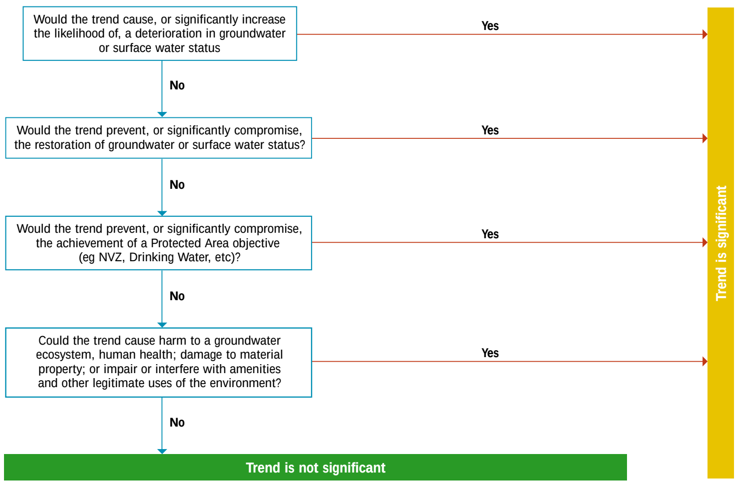
[6] The Directive defines pollution as the direct or indirect introduction, as a result of human activity, of substances or heat into the air, water or land which: may be harmful to human health or the quality of aquatic ecosystems or terrestrial ecosystems directly depending on aquatic ecosystems; result in damage to material property; or impair or interfere with amenities and other legitimate uses of the environment.

Guiding principle

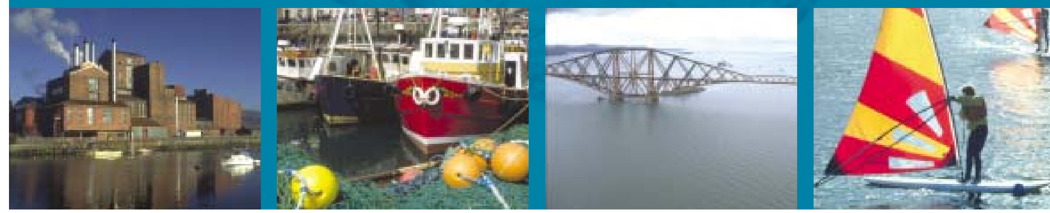
Any trend in the concentration of pollutants in groundwater that could threaten the achievement of good groundwater status or a Protected Area objective is of obvious environmental significance. Figure 6.4 proposes a series of criteria for defining environmentally significant trends. Each criterion is intended to allow the significance of a trend to be assessed against the risk it presents to an environmental outcome defined by the Directive.

If significant trends are defined using these criteria, each trend will, by definition, be associated with a risk to an identified receptor, such as a surface water body or a drinking water abstraction point. Each receptor will also be subject to an environmental objective, such as good ecological status, or a target level of purification treatment. The starting point for trend reversal will be dictated by the need to take effective action to protect or restore the specified outcomes for the receptors, and the end point of reversal will be reached when the objectives for the receptors are no longer at risk.

Figure 6.4 Proposed Criteria for Determining the Significance of a Pollutant Trend in Groundwater



7 Review of the Impacts of Human Activity



Directive provisions: Article 5; and Annex II, Sections 1 and 2

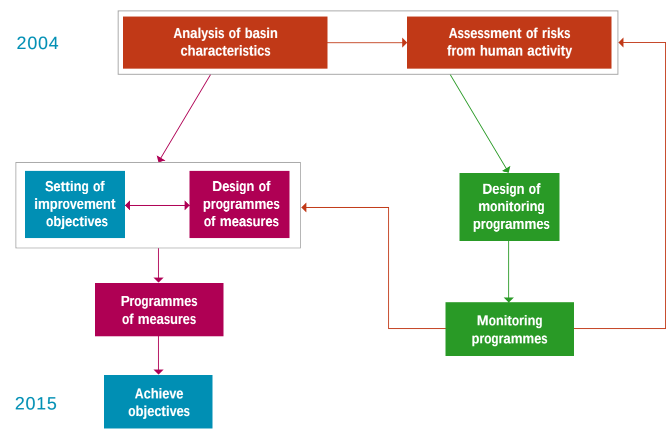
7.1. Purpose of the Review of Impacts

7.1.1 Role in River Basin Planning Process

The Directive's river basin planning system (Figure 7.1) will be built around a comprehensive "review of the impacts of human activity". The review will be informed by an "analysis of the characteristics" of the river basin districts. In practice, what the Directive requires from the review is an assessment of which water bodies are at risk of failing to meet the Directive's environmental objectives.

The information this risk assessment provides will contribute to the design of programmes of measures and the design of the monitoring programmes (see Section 8). It will also contribute to the identification of water bodies for which lower objectives may be needed because the restoration of good status or good ecological potential would be technically unfeasible or disproportionately expensive.

Figure 7.1 Role of Characterisation and Risk Assessment in the River Basin Planning Process



7.1.2 Risks to the Environmental Objectives

The first comprehensive assessment of risk must be completed by the end of 2004. The required output is a list of water bodies that are at risk of failing to achieve one of the relevant objectives set out in Table 7.1, unless appropriate measures are taken. This risk assessment will not need to establish the status of water bodies, although an estimate of a body's likely status is clearly central to the assessment.

The time available to complete the first risk assessments is very short. Consequently, it will be necessary to draw heavily on existing information and risk assessment methods. The Directive requires the review to be updated by the end of 2013. This will inform the production of the second river basin management plans.

Further risk assessments will be undertaken between 2004 and 2013 using information from the monitoring programmes (see Section 8) and from water users applying for the relevant authorisations. These will use the latest advances in assessment methods.

7.2 Requirements of Risk Assessment

7.2.1 Major Components of the Directive's Risk Assessment Process

The Directive describes three major components for the assessment of risks to bodies of surface water and bodies of groundwater (see Figure 7.2). These are characterisation, identification of pressures and risk assessment (see Table 7.2). The technical considerations involved in risk assessment are described in Box 7.1.

Box 7.1 Technical Requirements of Risk Assessment

For the purposes of Directive, risk assessment (Figure 7.2) is a scientific estimate of the likelihood that human interactions with the environment will cause a failure to meet the environmental objectives set by the Directive.The starting point for such assessments is an understanding of the environmental outcomes specified by the objectives.

The assessments also require an understanding of the potential ways human activities can affect these objectives. For example, discharges of different pollutants into surface waters can affect ecological status in several ways. They can result in concentrations of pollutants reaching toxic levels; accelerated growth of some plants at the expense of others because of changes in nutrient balances; or perhaps physical smothering of plants and animals as substances settle out on the bed of the water body. Any change in the environment brought about by human activity that has the potential to affect one of the environmental objectives is defined as a pressure. Pressures include a wide range of activities such as abstraction, the discharge of pollutants and the physical modification of water bodies for engineering or other purposes. The collection of information on the location and magnitude of pressures will provide the raw data for risk assessment.

The risk is the likelihood of the potential effects of pressures actually occurring. This depends on the magnitude of the pressures and the sensitivity to the pressures of the potentially affected water body or group of water bodies. The sensitivity will depend on a water body's natural characteristics, the other pressures on it and the requirements of the objectives applying to it. For example, groundwater overlain only by thin, sandy soils will be naturally more vulnerable to inputs of pollutants draining from sources on the surface than groundwater which is overlain by a protective layer of thick, relatively impermeable clay soils. A water body will be more sensitive to the effects of abstraction if it relies on the dilution of pollutant inputs to achieve its objectives. A water body subject to stringent Protected Area objectives may tolerate fewer pressures than other water bodies before its objectives are compromised. The Directive's objectives will need to be translated into simple, surrogate objectives against which risks can be easily assessed from basic information on the location and magnitude of the pressures. For example, the risks from water abstractions could be estimated by assessing their effects on ecologically defined flow objectives. The risks from pollutant discharges could be assessed, as they are now, against predetermined environmental quality standards set to protect aquatic animals and plants from harm. In practice, risk assessment can be complicated by the fact that there are many types of pressures with many different potential effects. Pressures also rarely act alone and water bodies can be more sensitive to one sort of pressure than to others.

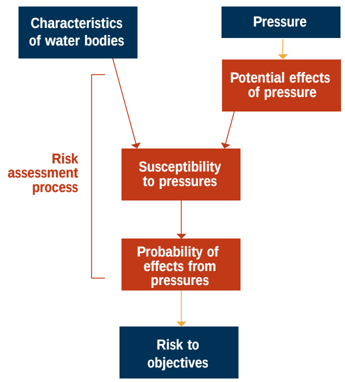
Table 7.1

Objectives Relevant to Risk Assessment
• prevention of deterioration in status of surface waters and groundwater;
• achievement of good ecological status and good surface water chemical status;
• achievement of good groundwater status;
• achievement of good ecological potential and good surface water chemical status for HMWBs and AWBs;
• achievement of objectives and standards for Protected Areas;
• reversal of any significant and sustained upward trends in pollutant concentrations in groundwater; and
• cessation of discharges of Priority Hazardous Substances into surface waters (see Section 4.3).

Table 7.2 Outline of the Requirements for the Analysis of River Basin District Characteristics and the Assessment of Risks to the Directive's Objectives From Human Activity.

1. Characterisation
For surface water bodies, this includes the differentiation of water bodies into types (see Sections 3 and 4) and the identification of reference condition criteria for water bodies. Further characterisation will be needed in some cases to optimise the design of monitoring programmes and the programmes of measures. For bodies of groundwater, the process is described in two stages: an initial characterisation, followed by a further characterisation for bodies identified as being at risk as a result of the initial characterisation. The further characterisation process is directed at providing the information necessary to develop a more precise assessment of the risks and to identify the measures likely to be required to achieve the objectives. For example, the vulnerability of groundwater to pollutants leaking through the soils and sub-soils overlying the water table depends on the characteristics of those soils, such as their composition and thickness, and the speed water flows through them to the groundwater. The amount of pollutant reaching the groundwater depends on how much it is broken down, trapped or delayed in the overlying layers.
2. Identification of Pressures
The Directive requires the identification of any human activity that has the potential, on its own or in conjunction with other pressures, to jeopardise the achievement of the Directive's environmental objectives, including the objectives for Protected Areas.
3. Assessment of Risk
This requires an assessment of the susceptibility of the water body's objectives to the identified pressures. That is, given the characteristics (point 1 above) of the water body, how likely are the identified pressures (point 2 above) to cause a failure of one of the Directive's environmental objectives? Water bodies can be grouped for risk assessment purposes. For example, water bodies with similar sensitivities and subject to similar pressures will be subject to similar levels of impact and can therefore be grouped for risk assessment purposes. If a series of water bodies are at risk from a particular pressure they could also be grouped where an assessment of risk to the most sensitive or insensitive bodies in the group could be used to estimate likely impacts on the other bodies in the group. Criteria for defining the boundaries of good status and good ecological potential for surface waters and good status for groundwater bodies will be required before 2004 to enable the risk assessments to be undertaken. For bodies of groundwater, the assessment process includes a requirement to identify bodies for which lower objectives are to be specified (see Section 7.4.1).

Figure 7.2 Interrelationship of the Tasks Required by the Directive in Identifying Water Bodies at Risk

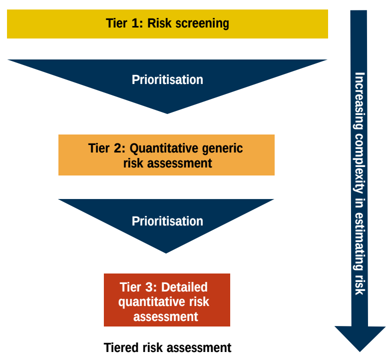


7.2.2 Principles of Risk Assessment Methods

Risk assessment methods should be designed so that the level of information and analyses required to complete any assessment is proportional to the likely difficulty in judging the significance of the risk and to the implications of misjudging that risk (see Figure 7.3). For example, the confidence in the accuracy of an assessment will need to be high if its results are to be used as the basis for setting objectives and designing regulatory controls. High confidence can be achieved without the need for onerous assessments if a water body is either clearly not at risk or is so heavily polluted that it would clearly fail to meet the Directive's objectives. Judgements on risk will be most difficult where a water body is close to the boundary between, for example, good and moderate surface water status. The risk assessments required by the end of 2004 will effectively operate as a screening process to differentiate bodies and groups of bodies at risk from those not at risk. Their purpose is to help to focus subsequent and more detailed assessments. These further assessments will be necessary to help set objectives and design appropriate measures for managing specific pressures on the water bodies identified as being at risk. Information from the monitoring programmes (see Section 8) will also be used to supplement and validate the earlier risk assessments and so improve the level of confidence in them.

In developing approaches to risk assessment, it will be important to make best use of existing methods. SEPA and other organisations already have considerable experience in the use of risk assessments.

Figure 7.3 Framework for a Tiered Approach to Risk Assessment.



The level of effort put into assessing any particular risk is proportionate to its (i) priority in relation to other risks and the potential threats to the Directive's objectives, and (ii) complexity in relation to the difficulty involved in understanding the likely impacts. The tiered approach ensures that the greatest effort is reserved for significant and complex risks. This framework is based on principles recommended in Guidelines for Environmental Risk Assessment (DEFRA / EA 2001) and adapted to the Directive's needs.

Although this experience focuses on the assessment of risks from point source discharges of pollutants, it is developing in other areas. For example, MLURI and BGS have undertaken risk assessment and modelling work to predict where the risk of nitrates pollution from agriculture is most likely to occur.

Nevertheless, significant method development work will be needed in particular areas. For example, methods for assessing risks to groundwater quantitative status are presently poorly developed in Scotland. Some of this further development work will be needed in time to help deliver the first risk assessments by the end of the 2004 deadline. These methods will be refined and supplemented during the first and subsequent river basin planning cycles.

Guiding principle

Risk assessments will be at the heart of the river basin planning process. It is important that the methods used to identify risks to the Directive's objectives are clear to anyone with an interest in the water environment. This will help water users and others to understand, and contribute to, the assessment process.

Question

How, and at what stage of development, should information on risk assessment methods be made available?

7.3 Identification of Pressures

7.3.1 Types of Pressure

Before the risk assessments can be undertaken, information on potentially significant pressures on surface waters and groundwater needs to be collated. Different types of pressure can act together to cause significant effects. For example, a water abstraction could lower the dilution available to pollutants from a discharge, and so increase their concentrations to harmful levels. Without adequate information on each different type of pressure, the risk assessments could miss significant impacts. Accordingly, the Directive requires that information on the type and magnitude of any significant pressures is collected and maintained. A list of key types of pressures which, in some circumstances, may cause significant adverse effects on the status of surface waters or groundwater, or on the objectives for Protected Areas, is set out in the Directive and reproduced in Table 7.3.

Table 7.3 Pressures Identified by the Directive

Types of Pressures on Surface Waters and Groundwater Specifically Identified by the Directive
• point source pollution from urban, industrial, agricultural sources, and other installations and activities;
• diffuse sources of pollution from urban, industrial, agricultural sources, and other installations and activities;
• water abstraction for urban, industrial, agricultural and other uses;
• regulation of surface water flows, including water transfer and diversion;
• alterations to the morphology of surface water bodies;
• artificial recharge of groundwater, namely water pumped into an aquifer or irrigated on the soil surface, generally for water supply or treatment reasons;
• land uses patterns, including identification of the main urban, industrial and agricultural areas and, where relevant, fisheries and forests;
• alterations to the recharge characteristics of groundwater bodies such as rainwater and run-off diversion through land sealing, (e.g. as a result of overlaying with an impermeable surface, compacting the soil, etc), damming or land drainage; and
• other significant pressures on the status of surface waters.

The Directive requires information on significant pressures to be collected and maintained for risk assessment purposes.

The Directive implicitly requires that all significant pressures be identified. It includes the catchall category of "other potentially significant impacts" among the types of pressures (see Table 7.3). Some of the potential pressures that might be relevant in this category are listed in Table 7.5.

The pressure types listed in the Directive encompass a substantial range of activities affecting surface waters and groundwater. At present, there is no single management system collecting and assessing information on all these potential pressures. The risks from pressures such as discharges of pollutants, for which information is collected by SEPA, have been assessed against water quality targets. These may be different in some cases to the environmental objectives required by the Directive (see Sections 4, 5 and 6). This means that it may be necessary to adapt and develop the way familiar pressures have been considered up till now, as well as identify and assess the risks from pressures that have not previously received the same level of attention.

7.3.2 Identifying Significant Pressures

Identifying all potentially significant pressures is a substantial task. It will be important to avoid being diverted into collecting information on minor pressures. This should be ensured by screening risk assessments to decide which pressures can be ignored altogether and which will only be of concern under certain identifiable circumstances (see Tables 7.4 and 7.5). The development of such filtering tools will be aided by inter-disciplinary and co-ordinated approaches. For example, the UK's Marine Pollution Monitoring Management Group (MPMMG) is developing a strategy for a coherent approach to defining, and identifying information on, potentially significant pressures on coastal and marine waters.

Table 7.4 Examples of Pressures on the Morphology of Coastal and Transitional Waters that can have Significant Effects in Some Circumstances

Pressure	Morphological Alteration	Possible Effect on Biological Quality Elements
Land claim for agriculture, ports, industry, housing, transport.	Loss or damage to inter-tidal zones; reduction in sub-tidal bed.	Loss or damage to species supported by such habitats.
Spoil disposal from dredging works.	Damage to structure or condition of bed.	Smothering action; alteration of invertebrate assemblage.
Disturbance or removal of bed substrate as a result of seabed trawling and dredging works.	Loss or damage to structure and condition of bed.	Loss and disturbance to habitats and species.
Structures for flood control, sea defences.	Loss or damage to inter-tidal zones.	Loss of inter-tidal habitats and the species they support.
Structures for coast protection or sea defence, erosion control, navigation, jetties and piers, road crossings, etc.	Interruption of long-shore coastal sediment transport, or upstream/ downstream tidal river transport of sediment, leading to enhanced erosion rates for habitats downstream of barrier.	Degradation or loss of sedimentary habitats causing changes in species composition.

Table 7.5 Examples of Other Pressures

Examples of Other Pressures Which May Pose a Significant Risk in Certain Circumstances.
• direct removal of biological quality elements for other purposes such as vegetation clearing for flood management or navigation;
• boat traffic; or
• displacement of biological quality elements by introduced species.

Failing to identify key pressures on a water body could result in impacts going unnoticed or effects being wrongly attributed to other causes. For this reason, the river basin management plan will rely heavily on accurate information and careful risk assessment of significant pressures.

7.4 Risk Assessment and Objective Setting

7.4.1 Groundwater Bodies for which Lower Objectives may be Necessary

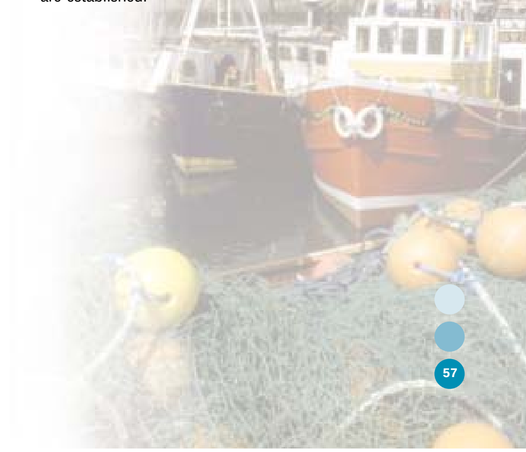
The risk assessments for bodies of groundwater required by the end of 2004 have to do more than identify the bodies likely to fail to achieve good groundwater status. The Directive requires them to identify the bodies which will have lower objectives specified in the river basin planning process. There is no equivalent requirement at this stage of the planning process for surface water bodies. Lower objectives will be appropriate if achieving good status by 2015 is technically unfeasible, or disproportionately expensive.

Groundwater can take a long time to recover once it is polluted. Dilution and natural breakdown processes gradually reduce the concentration of pollutants but will often be very slow. In addition, it is usually not possible to shorten recovery times by artificial means. The identification of groundwater bodies that will need lower objectives requires an evaluation of the feasibility of natural or artificially assisted restoration.

This evaluation has to start with an assessment of the natural characteristics of the groundwater body and the estimate of its actual condition provided by the risk assessment. The monitoring programmes (see Section 8) may subsequently show that the risk assessment, and consequently the evaluation of restoration potential, was wrong. In some cases, this may mean that lower objectives will not be applied where they were previously considered necessary.

7.4.2 Risk Assessments and Heavily Modified Water Bodies

An important risk assessment is built into the process of provisionally identifying those bodies likely to be designated as HMWBs (see Section 5). A risk assessment is needed to determine whether the effects of physical alterations to a surface water body are likely to prevent the achievement of good ecological status. If it is concluded that they are, a further assessment is required to determine what improvements to the hydromorphological conditions would be needed to achieve good ecological status, and whether such improvements would have significantly adverse effects on the activity served by the modifications. If, as a result of these assessments, a body is provisionally identified as an HMWB, a third assessment will be required to determine the risk of the water body failing to achieve good ecological potential. Such assessments will need to be refined before designation as an HMWB is confirmed and appropriate measures are established.



7.4.3 Risks from Trans-boundary Pressures

When pressures cannot adequately be managed, even with concerted action at the UK level, the Directive proposes that the matter should be referred, along with any suggestions for its resolution, to the European Commission. Such pressures could include airborne pollutants reaching the UK from other countries.

7.5 Approaches to Collecting Information on Pressures

7.5.1 Sources of Information

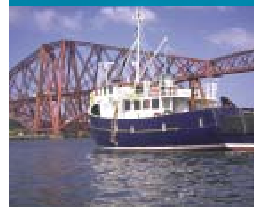
Implementation of the Directive will require the development of a comprehensive and centrally accessible database of all significant pressures in each river basin district. No such databases exist at present. However, there are many sources of existing information and the primary task in the short term will be to collate and make best use of this resource. Nevertheless, there are still significant data gaps. The most notable of these relate to diffuse pollution, water flow regulation, abstraction and morphological pressures.

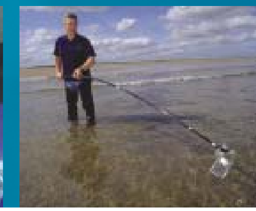
Section 9 describes the production, management and assessment of information related to pressures and impacts in Scotland, now and in the future.

7.5.2 Trends in Pressure

Pressures are rarely constant over time, as demands on surface waters and groundwater inevitably change. For example, population changes tend to cause increases in water demand in some areas and decreases in others. Part of any river basin planning process is to attempt to forecast trends in pressures so that management decisions do not limit options for the future. To produce such forecasts, it may be necessary to study and model the driving forces behind a pressure and the likely effects of any management already planned.

8 Monitoring Requirements





Directive provisions: Articles 7 and 8; and Annex V, Sections 1.3, 2.2 and 2.4

8.1 Purpose and Principles of Monitoring Requirements

8.1.1 Purpose of Monitoring Programmes

The Directive requires the establishment of monitoring programmes for surface waters and groundwater by the end of 2006. This section describes its specific requirements for these programmes.

The monitoring programmes will not provide all the information needed to implement the Directive. Other sources of information will be needed to identify and characterise water bodies (Section 3), identify pressures (Section 7) and develop the monitoring systems to be used in the monitoring programmes (see Section 4).

The main objectives defined by the Directive for the monitoring programmes are to:

- **check that the environmental risk assessments (see Section 7) correctly identified all water bodies at risk of failing to achieve the Directive's objectives;**
- **enable the status of those water bodies to be established; and**
- **assess the effectiveness of the measures taken to achieve the environmental objectives.**

The development of the Directive's monitoring programmes provides an opportunity to review existing monitoring in Scotland (see Section 9). The new monitoring networks will be multi-purpose. They will be designed to efficiently and effectively deliver the Directive's monitoring requirements, as well as other existing monitoring obligations, by adapting and building on the existing networks. The networks will be established with the specific purpose of helping to improve the understanding of the way pressures affect the status of surface water and groundwater bodies. Monitoring information will therefore increase confidence in evaluating risks and improve the targeting of management measures.

8.1.2 Principles of Monitoring Programmes

The Directive intends the monitoring programmes to be designed using information from the risk assessments and characterisation of water bodies (see Sections 3 and 7, and Figure 8.1). Existing monitoring information will be important in both the risk assessments and the design of the programmes. The monitoring programmes will need to evolve in response to changing pressures on water bodies, improvements in risk assessments and success in restoring water bodies.

Environmental risk assessment is one of the cornerstones of the river basin planning process. It has a particularly important relationship to the monitoring programmes. If every pressure could be reliably identified and its effects accurately predicted, monitoring would be largely redundant. However, risk assessments can never be perfect. They all need to be tested. The risk assessments completed by the end of 2004 will provide an estimate of which bodies could be at risk of failing to achieve key objectives like good status (see Section 7). The monitoring programmes must provide the information needed to supplement and validate these assessments and to establish the status of the bodies identified as being at risk. The more diverse the characteristics of water bodies and human pressures in a river basin district, the more validation monitoring that will tend to be required. This is because it will be easier to group similar water bodies and monitor a representative selection where the variation in characteristics and the pressures in a river basin district, or part of it, are low.

Figure 8.1 Roles of Surface Water Monitoring Programmes

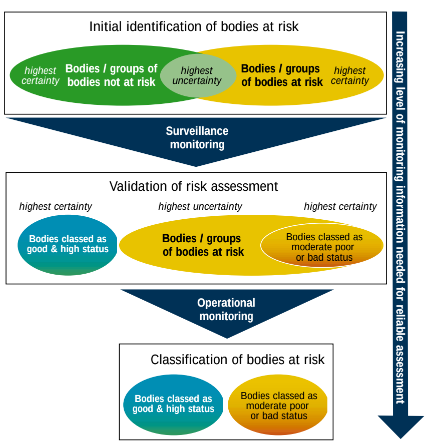


Illustration of the relationships between, and key outputs of, risk assessment, surveillance monitoring and operational monitoring for surface waters. Similar principles apply to groundwater monitoring. Surveillance monitoring will be used to validate the risk assessments. It will also provide sufficient information to classify the status of some bodies at risk. However, information from operational monitoring, which utilises parameters indicative of the quality elements most sensitive to the identified pressures, will be necessary to achieve an acceptable level of confidence in the classification of many bodies at risk (see Section 4.4).

The risk assessments for such a river basin district will also have been less varied and will therefore require less monitoring information for validation purposes.

The bulk of the monitoring work will be targeted on bodies at risk. Its objectives will be to establish the status of those bodies and help inform the targeting of any measures that may be needed. The Directive provides that if several water bodies at risk have similar natural characteristics and are subject to similar pressures, then these may be grouped where monitoring a representative or indicative selection of the group would provide a reliable estimate of the status of the other bodies in the group or of the effectiveness of measures applied to the group. The amount of monitoring required will be proportionate to the difficulty in judging the status of a water body and to the implications of making an error in that judgement. For example, little monitoring will be required to judge that a heavily polluted groundwater body is at poor status if it is clearly causing significant impacts on a surface water body.

A map of the monitoring networks must be published in the river basin management plans. The status of water bodies, and the presence of any pollutant trends in bodies of groundwater, will be reported using colour-coded maps (see Sections 4, 5 and 6).

8.2. Types of Monitoring

The Directive describes five types of monitoring programme covering surface water and groundwater monitoring requirements. The environmental objectives for groundwater and surface water are closely interlinked (see Section 6). The respective monitoring networks will be designed as far as possible to be complementary to enable information from one to be used in risk validation or status assessment for the other.

The Directive specifies a different purpose for each of the monitoring programmes. However, in practice, information provided by the different programmes will often be used for more than one purpose (see Figure 8.1). In conjunction with the information on pressures and risks (see Section 7), the combined monitoring information will provide a coherent and comprehensive overview of water status in each river basin district. The five programmes comprise:

1. **Surveillance Monitoring**
   - surface water bodies;
   - groundwater bodies (for chemical status and pollutant trends).
2. **Operational Monitoring**
   - surface water bodies at risk;
   - groundwater bodies at risk (for chemical status or pollutant trends).
3. **Groundwater Level Monitoring**
   - groundwater bodies (for quantitative status).
4. **Investigative Monitoring**
   - surface water bodies at risk.
5. **Protected Area Monitoring**
   - surface water bodies and groundwater bodies at risk (for Protected Area objectives).

The following sections outline the purposes of the programmes and what will need to be done in establishing them.

8.3 Surveillance Monitoring

8.3.1. Purposes and Scope of Surveillance Monitoring

The principal objective of surveillance monitoring is to supplement and validate the risk assessments. It must therefore be designed to identify where the risk assessments have missed risks or suggested impacts that are not in fact present. Results from the groundwater surveillance monitoring programme will supplement and validate the assessment of risks of failing to achieve good groundwater chemical status. The groundwater level monitoring programme will consider groundwater quantitative status (see Section 8.5). The information from the surface water and groundwater surveillance programmes will be used to refine the risk assessments and help decide where operational (see Section 8.4) or, for surface waters, investigative monitoring (see Section 8.6) is needed to establish the status of a water body.

Surveillance monitoring must also be capable of detecting underlying long-term changes in the water environment. For example, over the long term, climate change and land cover changes could affect the condition of aquatic plants and animals in surface waters by increasing the frequency of droughts and floods. Information on such changes will be needed to avoid wrongly attributing their affects to other pressures. Groundwater surveillance monitoring must be designed to provide information for assessing long-term trends in the concentration of pollutants in groundwater.

The Directive requires surveillance monitoring information from a sufficient number of water bodies to validate the risk assessments and pick up long-term environmental changes. To achieve the first objective, a representative selection of water bodies will have to be monitored including both bodies at risk and not at risk as identified by the risk assessment procedure (see Section 7.2). The number of water bodies that need to be monitored will depend on, among other things, the level of confidence in the risk assessments, the similarity of the water bodies and the diversity of pressures on them. For example, where uncertainty in the risk assessments is high, a greater amount of surveillance monitoring will be needed than if the uncertainties in the risk assessments are low. It is anticipated that the amount of surveillance monitoring required will reduce over time as confidence in the risk assessments increases.

8.3.2 Surveillance Monitoring and Classification

The results of surveillance monitoring will improve the assessment of which bodies are at risk of failing to meet the Directive's objectives and which are not. This will provide a coherent and comprehensive overview of where within a river basin district the status of surface water bodies and the chemical status of bodies of groundwater are likely to be less than good or at risk of deterioration. The results of the risk assessments and the validation provided by the surveillance monitoring programmes will be used to classify the status of the water bodies that are not at risk. For example, the risk assessments may indicate that the pressures on a surface water body, or group of such bodies, are likely to have no more than very minor effects on its hydromorphology, physico-chemistry and biology. If this assessment were validated by the results of surveillance monitoring, the water body, or group of water bodies, would be classed as high ecological status. In some cases, the information provided by surveillance monitoring may also be sufficient to reliably classify the status of bodies at risk. However, where reliable classification cannot be achieved, additional information from operational monitoring will be needed.

8.4 Operational Monitoring Programmes

8.4.1 Scope of Operational Monitoring Programme

Operational monitoring programmes are exclusively focused on those water bodies that, on the basis of the risk assessments and the surveillance monitoring programmes, are at risk of failing to meet the Directive's environmental objectives. The groundwater level monitoring programmes will include bodies of groundwater at risk because of level alterations.

8.4.2 Status Assessment

The Directive requires that operational monitoring is used to establish the status of surface water bodies at risk and the chemical status of bodies of groundwater that are at risk. Water bodies may be grouped where their characteristics are such that monitoring of a representative or indicative selection of the bodies can provide a reliable estimate of the status of the bodies.

For surface water bodies at risk of failing to achieve their environmental objectives because of significant point source discharges of pollutants, the Directive specifies that there must be sufficient monitoring points within each body to assess the magnitude and impact of the point source. The number of monitoring points in any one body necessary to do this will depend on what is required to enable reliable impact assessment. Sometimes multiple monitoring points will be required. In other cases, monitoring information from, for example, neighbouring water bodies will be sufficient. This is not dissimilar to the approach SEPA uses at the moment in its water quality monitoring. Information from such existing regimes will be important in developing the operational monitoring networks.

8.4.3 Trend Assessment

As well as establishing the chemical status of groundwater bodies, the groundwater operational monitoring programmes have to confirm the presence of significant upward trends in the concentration of pollutants in groundwater (see Section 6.5). Trend monitoring will be targeted at those groundwater bodies in which, on the basis of the characterisation, risk assessments and surveillance monitoring programmes, there is liable to be a significant upward trend.

To provide information for assessing trends, operational monitoring will need to target the right part of the body of groundwater in relation to the source of pollutants that might be causing an upward trend and the potential receptor that could be affected by the trend, such as a dependent wetland. An understanding, or conceptual model, of the nature of the groundwater system and its interaction with surface receptors will be necessary to interpret monitoring results.

8.4.4 Assessment of Measures

Environmental objectives will be set in the river basin planning process for water bodies at risk. A key role of the operational monitoring programmes will be to assess any changes in the condition of bodies or groups of bodies that result from the measures taken to achieve their objectives. Some surface water bodies may be at risk of deteriorating from one status class to another. Information from operational monitoring of such bodies will be important in designing appropriate preventative measures.

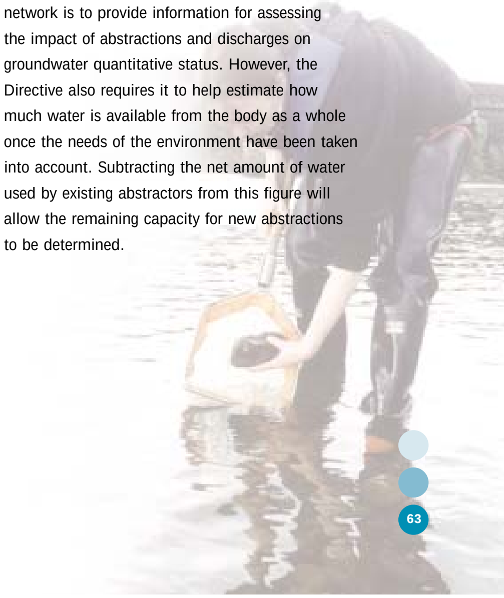
8.5 Groundwater Level Monitoring

The Directive requires the establishment of a groundwater level monitoring network capable of providing a reliable assessment of the quantitative status of all groundwater bodies or groups of groundwater bodies. Of course, monitoring data contributes to, but does not itself provide, an assessment. An assessment requires an appropriate understanding (some form of conceptual model) of the groundwater system. In particular, it requires an understanding of how the groundwater is replenished and how it interacts with surface waters and terrestrial ecosystems such as wetlands. The monitoring network will provide the information to help develop and refine this model. Information from the surface water monitoring networks will also be important. This is because groundwater status is defined, in part, by its effects on surface waters (see Section 6), and also because surface water is often an outcrop of groundwater.

Although the quantitative status of all bodies of groundwater must be assessed, the Directive does not expect level monitoring points in each body of groundwater to do this. In areas with high rainfall and only low levels of abstraction, for example, existing data and monitoring information from a representative selection of bodies should provide sufficient information to validate the risk assessments and confirm that the bodies achieve good quantitative status.

The Directive rightly requires level monitoring effort to be focused on bodies or groups of bodies at risk. A sufficient and reliable understanding of these bodies will therefore be needed so that effective and proportionate measures can be designed.

The principal purpose of the level monitoring network is to provide information for assessing the impact of abstractions and discharges on groundwater quantitative status. However, the Directive also requires it to help estimate how much water is available from the body as a whole once the needs of the environment have been taken into account. Subtracting the net amount of water used by existing abstractors from this figure will allow the remaining capacity for new abstractions to be determined.



8.6 Surface Water Investigative Monitoring

Sometimes the results of surveillance monitoring, or some other information, will indicate that a surface water body is at risk of failing to achieve the Directive's objectives but the cause will not be clear. In such cases, operational monitoring may not provide the best means of identifying the cause or quantifying the impact. This is because operational monitoring is based on indicators sensitive to identified pressures (see Section 8.8.1). Accordingly, the Directive requires investigative monitoring to be used to ascertain the cause and effects of the problem and to help design the appropriate management measures.

Investigative monitoring is also required to assess the effects of accidental pollution. Such assessments will be necessary to inform the design of appropriate remedial measures and to ensure the effects of the accident are not wrongly attributed to other pressures.

8.7 Protected Area Monitoring

The Directive requires that the monitoring programmes described above be supplemented with any additional water-related monitoring that is required for Protected Areas (see Section 3.2).

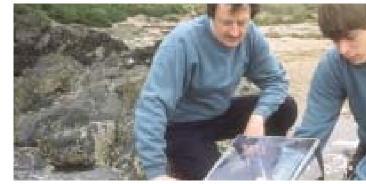
8.7.1 Monitoring of Areas Designated for the Conservation of Species and Habitats

For many Protected Areas, monitoring programmes are already in place or will be before the Directive's monitoring programmes are due to commence at the end of 2006. For example, SNH has, in conjunction with the other UK Conservation Agencies, developed a monitoring programme designed to assess the condition of species and habitats within sites intended for the Natura 2000 network of SACs and SPAs (see Table 8.1).

Table 8.1 SNH's Monitoring Programme for Natura 2000 Sites

Site Condition Monitoring Includes, as Relevant to the Objective of the Particular Protected Area
• plants of fresh waters, e.g. slender naiad;
• invertebrates of fresh waters, e.g. freshwater pearl mussel;
• fish of fresh waters, e.g. salmon, brook lamprey;
• amphibians of fresh waters, e.g. great-crested newt;
• birds of fresh waters, e.g. osprey, black-throated diver;
• mammals of fresh waters, e.g. otter;
• plants of transitional and coastal waters;
• invertebrates of transitional and coastal waters;
• birds of transitional and coastal waters, e.g. sandwich tern, common tern; and
• mammals of transitional and coastal waters, e.g. grey seal, bottlenose dolphin.
Monitoring of physical and chemical habitat features is also carried out to complement biological monitoring.

If a water body forming part of a Protected Area for habitat and species conservation is found to be subject to pressures that are liable to cause a failure to achieve the Protected Area's objectives (see Section 7), the Directive requires that the body is monitored by the relevant surface water or groundwater operational monitoring programme or groundwater level monitoring programme until the relevant environmental objectives are achieved.



8.7.2 Monitoring of Drinking Water Protected Areas

The Directive requires that surface water bodies designated as Drinking Water Protected Areas and providing more than 100 cubic metres a day on average are designated as monitoring sites. Bodies designated as monitoring sites must be monitored if:

- priority substances are being discharged into them, or
- any other substances are being discharged in quantities which could affect their status and which are relevant to drinking water quality.

The Directive prescribes specific minimum monitoring frequencies for these water bodies, depending on the population they serve. For example, if more than 30,000 people obtain drinking water from the Protected Area, the body must be monitored at least 12 times a year.

In contrast, the Directive does not propose any specific monitoring requirements for bodies of groundwater designated as Drinking Water Protected Areas. However, where any body of groundwater is at risk because of the concentration of pollutants within it, the Directive does require that information on the chemical composition of water abstracted from it is collected and maintained.

8.8 Monitoring Methods

8.8.1 Methods Required for Surface Water Monitoring

Sections 4 and 5 describe the process of establishing the standards required for bodies of surface water and the issues involved in developing appropriate monitoring systems for classifying ecological status. The status of a surface water body is dictated by the condition of the biological quality element or physico-chemical element that is worst affected by the pressures on the water body. Accordingly, classification only requires **operational** monitoring to provide the information needed to reliably estimate the condition of the quality element or elements most sensitive to the pressure or pressures to which a water body is subject. For example, if a pressure on a body is a discharge of nutrients, it is likely that one of the plants that derive nutrients directly from the water, such as phytoplankton or phytobenthos, will be more sensitive than animals such as fish and invertebrates. The estimate obtained for the most sensitive quality element will dictate the status of the body.

Use of Indicators

The Directive requires surface water **operational** monitoring to measure indicators of the condition of the most sensitive quality elements (see Section 4.4). An indicator of a biological quality element could be a sensitive species or group of species selected from all those that make up the quality element as a whole. It could also be a factor, such as the growth rate of a species or group of species or the photosynthetic pigment levels in the water body's phytoplankton, where such a factor provides a reliable indication of the status of the relevant biological quality element. The most appropriate indicators will be those that are not only representative of the condition of the sensitive biological quality elements, but can also be monitored easily and reliably. The need to ensure that the monitoring systems used in classification are as reliable as possible is explained in Section 4.4. Sometimes it will be necessary to use combinations of indicators to produce a reliable estimate of the effects of pressures on a quality element. For example, taking a sample of invertebrates from the bed of an estuary will not provide an estimate of the effects of land claim on the abundance of invertebrates in the estuary as a whole. However, a combination of information on morphological changes to the estuary and information on the abundance of invertebrates found in habitats similar to those lost to the land claim could be used to provide a suitable estimate.

The targeted indicators developed for operational monitoring will also be useful in surface water **surveillance** monitoring programmes. However, the Directive requires appropriate indicators of all the relevant quality elements of the ecosystem to be used in the surveillance programmes. This is because these programmes must be able to detect pressures that may not have been identified in the risk assessments. Using only indicators sensitive to specific pressures could leave the monitoring systems blind to new problems. To avoid missing important pressures, indicators such as eco-toxicity tests could be used in surveillance monitoring to detect the presence of a wide range of pollutants more efficiently and effectively than speculatively attempting to analyse water samples for large numbers of individual pollutants.

Innovative monitoring techniques, such as remote sensing (e.g. aerial surveys, sonar surveys, etc), may also be useful. For example, aerial surveys may provide the most effective means of monitoring long-term changes in morphological quality elements or trends in biological quality elements such as the cover of macro-algal mats in estuaries.

Guiding principle

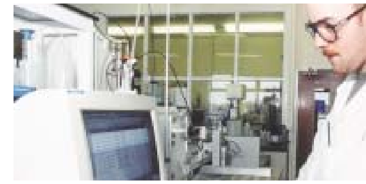
The basis for some of the monitoring tools that will be needed already exists. However, the indicators used most widely are those sensitive to the effects of pollutants. It will be necessary to add to this range of indicators to ensure that the effects of any type of pressure on surface waters can be effectively and reliably assessed. The development of appropriate monitoring systems will involve identifying suitable indicators and establishing reference conditions for them. This is one of the biggest technical challenges in implementing the Directive.

8.8.2 Methods Required for Groundwater Monitoring

Groundwater, by its very nature, is difficult to measure. Various types of approaches will therefore be needed to monitor bodies of groundwater. The method chosen will largely depend on the natural characteristics of the body and the confidence in the risk assessments. The most common methods of obtaining data on groundwater quality is by taking a sample from a spring that forms one of the natural surface outlets for groundwater or by pumping from a borehole.

There are, however, some disadvantages to these methods. Although boreholes will often be the preferred method of obtaining information, installing and using boreholes is very expensive. In addition, in some geological strata, such as granite, where groundwater flows mainly through irregular cracks and fractures, the use of boreholes may not provide representative information for assessing flows or pollutant fluxes. One alternative to the more traditional methods is to monitor surface water quality during dry weather. At these times, the water in burns and rivers is nearly all derived from groundwater. Such an approach is likely to be used in upland areas where the pressures are low and the area is dominated by low permeability rocks. It is also likely to be used where a groundwater body is so heavily contaminated that its effects upon river quality are substantial. In such cases, the assessment that the body is at poor chemical status will be straightforward.

For groundwater surveillance monitoring, the Directive requires a core set of parameters to be monitored in each body in the monitoring network as well as parameters indicative of the effects of the pressures identified in the risk assessments (see Section 7.4). The core parameters are oxygen content, pH value, conductivity, nitrate and ammonium.



The groundwater level monitoring network must be designed to provide information on the effects of level alterations on the way groundwater flows to surface ecosystems, since it is the quality and quantity of groundwater flows to these ecosystems that plays a major role in determining the status of a body of groundwater (see Section 6). To do this, the Directive requires that the groundwater level regime must be monitored. Depending on the circumstances, this will require information on levels in boreholes, rates of flow in springs, flows in rivers at times when groundwater is their main source of supply, rainfall and snowfall information and rates of abstraction from the body of groundwater.

8.9 Frequency of Monitoring

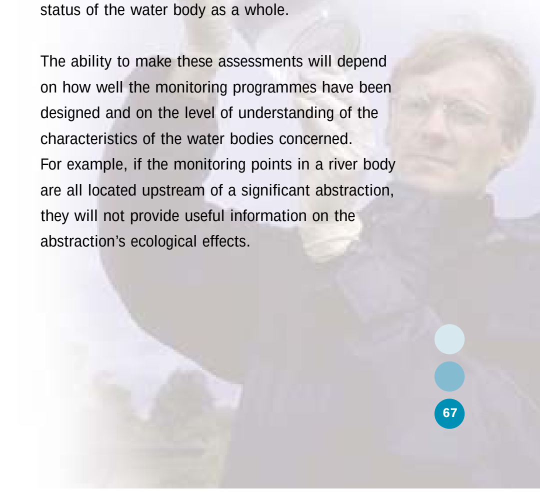
Monitoring is only useful if it provides information that can help manage water bodies to achieve the relevant environmental objectives. How often, and where, monitoring is undertaken influences the reliability and, hence, usefulness of monitoring information. The Directive requires that the frequency and timing of monitoring are capable of picking out the effects of pressures on the water environment from natural background variation. The level of confidence in the results of monitoring programmes must be reported in the river basin management plans. Section 4.4 discusses some of the implications of errors in monitoring information for surface water classification.

For the surface water surveillance monitoring programmes, minimum monitoring frequencies are specified. Each site in the surface water surveillance network must be monitored for a period of one year in every river basin planning cycle. However, if a particular water body in the surveillance monitoring network is found to be at good status, the Directive allows this frequency to be reduced. Within each of the one year monitoring periods, there are also minimum monitoring frequencies that must be observed. For example, the condition of hydromorphological and biological quality elements must be monitored at least once. The physico-chemical quality elements should normally be monitored every three months, except for priority substances, which should be monitored monthly. However, the frequencies for the physico-chemical elements can be reduced if it is judged that lower frequencies would provide the necessary management information. The Directive also requires the minimum monitoring frequencies it specifies for surveillance monitoring to be considered as guidelines for the surface water operational monitoring programmes. These minimum frequencies may be appropriate in some cases. However, they will certainly not be adequate in others. For example, if they were applied to detect trends in surface water quality, it could take over 50 years to confidently show the presence of a trend.

8.10 Assessing the Status of a Water Body as a Whole

One of key purposes of operational monitoring programmes for surface waters and groundwater, and the level monitoring programme for groundwater, is to help establish the status of bodies at risk. To do this, it will be necessary to assess what the results from monitoring points in a water body, or in other similar water bodies, indicate about the status of the water body as a whole.

The ability to make these assessments will depend on how well the monitoring programmes have been designed and on the level of understanding of the characteristics of the water bodies concerned. For example, if the monitoring points in a river body are all located upstream of a significant abstraction, they will not provide useful information on the abstraction's ecological effects.



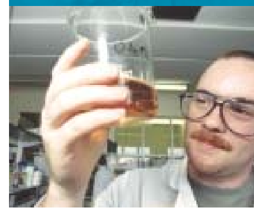
If, on the other hand, a monitoring point is located immediately downstream of the abstraction, any effects detected may not be important as far as the status of the body as a whole is concerned. To ensure monitoring information is useful, monitoring points need to be selected to help answer specific questions, such as do the identified pressures (see Section 7) have a significant ecological effect on water body status? Answering this question involves deciding what types of effects would be significant, and then designing monitoring to find out if such effects have occurred.

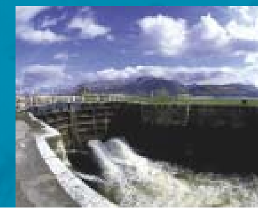
Similar considerations need to be made in interpreting the results of groundwater monitoring. When assessing groundwater chemical status, the Directive requires that the results from monitoring across the water body be aggregated to assess the status for the body as a whole. This aggregation should be used to highlight significant environmental effects. If a surface water body, as one of the key receptors relevant to groundwater status, is not achieving good status because of the concentrations of pollutants in the groundwater, it would be wrong to classify the groundwater as being at good groundwater chemical status.

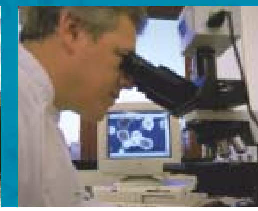
Guiding principle

The rules and criteria used for aggregating and interpreting monitoring results will need to be carefully designed to enable the environmentally significant effects of pressures on the status of water bodies to be differentiated from minor or environmentally irrelevant ones. Monitoring data needs to be collected and evaluated so that its results reflect the intended criteria for defining the status classes (see Section 4.2.5).

9 Monitoring Strategy for Scotland's Water Environment







9.1 Monitoring Strategy for Scotland's Water Environment

Implementing Annexes II and V of the Water Framework Directive in Scotland will involve the production and assessment of a wide range of information by a large number of organisations. To ensure efficient use, access and management of information, it is proposed to set up a monitoring strategy for Scotland's water environment, delivered through a partnership approach.

The Directive will require not only environmental monitoring data, but also information about pressures and impacts, which will be used to produce the Characterisation Report. The overall aims of the monitoring strategy for Scotland's water environment will therefore be two-fold:

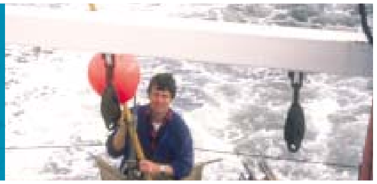
- To produce, manage and assess information relevant to the Water Framework Directive Characterisation Reports on pressures and impacts, and
- To develop, coordinate and maintain the Water Framework Directive Monitoring Programmes, ensuring consistent standards, as well as the production and management of high quality data.

9.1.1 Using Existing Data, Expertise and Monitoring Networks

There is a long history of environmental monitoring and assessment in Scotland. Much of the information required for the Directive is already available and the monitoring strategy for Scotland's water environment will simply need to build on these existing networks and databases. For example, in the marine environment, a co-ordinated national marine monitoring programme (NMMP) already exists in which the relevant UK government agencies and departments with marine environmental protection responsibilities participate.

In Scotland, there are several public bodies with well-established general or specific monitoring and assessment functions, for example SEPA, SNH, Scottish Water and the FRS. The Scottish Executive manages information relevant to various environmental pressures and specific locations, often a requirement of European legislation.

In addition, there are various other public, private and academic organisations which may be able to provide valuable information on certain aspects of the water environment, often gathered for specific purposes. Local authorities have a duty to monitor the quality of private drinking water supplies.



The Fisheries Boards and Trusts, together with the Fisheries Research Service (FRS), carry out monitoring of specific fish populations. The British Geological Survey (BGS) has a groundwater database on which they hold certain information about wells, boreholes and springs. Non-governmental organisations, such as the Royal Society for the Protection of Birds, or catchment management groups, such as the various integrated coastal zone management initiatives, may also gather and hold useful information on specific geographical locations. The Forestry Commission are developing sustainable soil and water use indicators. Private organisations and industry often gather site-specific information for a variety of purposes, including operational needs and environmental impact assessments.

9.1.2 Who will Manage the Monitoring Strategy for Scotland's Water Environment?

The logic of the Directive implies close integration of monitoring work, risk assessment and regulatory or management control measures. A single competent authority responsible for designing, co-ordinating and managing the monitoring programmes in each river basin would facilitate integration and co-ordination. It has been proposed that SEPA should fulfil this role and would be the overall co-ordinator of the monitoring strategy for Scotland's water environment.

As mentioned above, there are several other organisations and existing networks with an important role to play in developing and delivering the strategy. It is therefore proposed that a monitoring strategy forum should be formed, composed of SEPA, SNH, Scottish Water, FRS and representatives of other organisations as appropriate. With SEPA as Chair, this forum would have responsibility for developing and co-ordinating the monitoring strategy for Scotland's water environment.

9.1.3 Partnership Agreements

The monitoring strategy will comprise a series of partnership agreements, describing each partner's responsibilities and specifying the nature, provision, acquisition and management of the relevant data.

In practice, partnership agreements could take several different possible forms, including Memoranda of Understanding, Service Level Agreements, voluntary agreements, contractual arrangements, etc.

Various levels of involvement for partners could be envisaged:

- **data producers,** responsible for the production, quality assurance and provision of raw data to the monitoring strategy for Scotland's water environment;
- **data assessors,** responsible for developing assessment methods and interpreting data;
- **data managers,** responsible for co-ordinating networks, storing and maintaining any major databases; and
- **data users,** e.g. other organisations wishing to have regular access to specific data.

To be valuable, data will need to be co-ordinated, quality-assured and produced regularly. This will have to be specified carefully in the strategy and partnership agreements. Data requirements are likely to evolve over time so partnership agreements may have to be revised periodically.

The production or provision of some data produced by private organisations may be subject to fees or to confidentiality agreements. Similarly, some data may be subject to intellectual property rights. These aspects will all need to be taken into account within each partner's agreement.

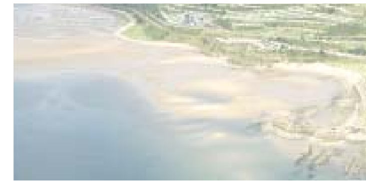
For public bodies, it may be necessary to ensure that some organisations have a statutory duty to provide the relevant information. Indeed, it is likely that the Water Environment and Water Services Bill will give SEPA appropriate powers to issue notices requiring information from water users that is reasonably required to undertake a proper assessment of pressures and impacts on the water environment. Clearly, however, these duties need to be carefully integrated with other policy considerations and existing duties.

Discussions have already taken place during autumn 2001 on producing, managing and assessing fish data between representatives of a number of organisations in Scotland. A number of proposals relating to organisational responsibilities and partnership agreements are currently being explored by the organisations concerned. Experience from a number of other data sharing initiatives, such as the NMMP, the Environmental Change Network (a UK partnership sponsored by the National Environmental Research Council which aims to provide long-term, high quality ecological information) and the National Biodiversity Network (a union of UK conservation organisations, non-governmental organisations and academic establishments that are collaborating to create an information network of biodiversity data that is accessible through the internet) may also prove useful in developing the best collaborative approach for the Water Framework Directive.

Questions

How do you view the aims and arrangements proposed for a monitoring strategy for Scotland's water environment?

What role do you think your organisation should have in the strategy?



9.2 Delivering the Characterisation Report

9.2.1 Using Existing Information

A good deal of water environment monitoring which will be directly relevant to the characterisation report required by the Directive is already carried out in Scotland. It is expected that this report will be largely based on existing information relating to water body characteristics, pressures and impacts. The first step is to identify, collect and assess this information. Given the timescales for the first characterisation report (to be delivered by the end of 2004), it is likely that only a limited amount of supplementary monitoring or data collection will be possible.

It is, however, important that the strategy for this first report sets the foundations for subsequent characterisation reports (in 2013 and thereafter six yearly) by identifying gaps in data and management responsibilities so that the assessments can be improved in the future. While subsequent reports will rely on the Directive's future monitoring networks for information about impacts, there will be an ongoing need to improve and maintain information about pressures and water body characteristics.

9.2.2 Information on Pressures

Table 9.1 summarises existing duties and data ownership that are likely to be relevant to identifying and estimating pressures for the characterisation report. While relevant data are expected to be available on point source discharges, gaps exist and further work is needed to identify and assess all other types of pressures more comprehensively.

With the exception of point source discharges (where a public register of consented discharges is maintained by SEPA), it is clear that the existing datasets are highly fragmented. Given the large number of organisations involved and the need to consider all significant pressures on each water body, it would seem advisable to combine or link datasets where appropriate. For example, comprehensive information on water abstractions in Scotland is judged a pre-requisite to enable these pressures to be assessed.

SEPA would appear best placed to co-ordinate this work for pressures relating to point source pollution, diffuse pollution (which is predicted to exceed point source pollution in significance by 2010, and for which an expanded monitoring network will be required, which is more responsive to subtle changes), abstraction, recharge, flow regulation and morphological alterations. Integrated coastal zone management projects hold data on pressures for coastal areas.

The Scottish Executive's consultation documents for transposing the Water Framework Directive in Scotland proposed new regulatory regimes for abstraction, impoundment and engineering pressures. Under the proposals, these would include a legal requirement to notify the regulatory authority of certain activities. Such a notification would clearly provide useful information for identifying significant pressures in future characterisation reports.

Question

To ensure that the risk assessments in the characterisation report are as reliable as possible, accurate information about pressures is needed. Clearly, existing data sources should be used as far as possible. There are, however, a number of options for addressing the major information gaps in 2004 relating to abstraction, impoundment and engineering works, including: postal questionnaires, detailed ground surveys or a voluntary notification scheme. Which do you consider to be the best approach?

9.2.3 Monitoring Information Relevant to the Review of Impacts

Tables 9.2 and 9.3 summarise existing monitoring information likely to be relevant to the main types of water body within Scotland and indicate which national organisations are currently involved. These vary from extensive national monitoring networks (such as SEPA's 2,500 benthic invertebrate river sampling sites) to special studies carried out for limited time periods in a specific locality (such as site-specific environmental impact assessment studies).

Local organisations or catchment management groups may also hold relevant information. In the case of fish monitoring data, unpublished reports are anticipated to be a potentially useful source of complementary information to the longer established monitoring sites operated by certain Fishery Boards and Trusts.

For most protected areas, some information is already available or planned to be collected, though in some cases it may have been intended to serve different purposes:

- Monitoring of areas to protect economically significant species and recreational waters is already carried out under relevant EU Directives, mainly by SEPA and SNH.
- Scottish Water monitors yields, flows, abstracted water quality and operational water quality of many drinking water sources for the purposes of protecting drinking water. Environmental assessments and information about diffuse pollution are available for some catchments.
- SNH and the other UK conservation agencies are developing monitoring programmes to assess the condition of certain sites designated for the conservation of species and habitats (Section 8.7.1). Some aquatic sites have already been monitored by SNH and other bodies for many years under existing conservation obligations.

Where little impact information is available, the Directive's risk assessment will also need to use information about water bodies' characteristics to determine whether an identified pressure is likely to have an impact. For groundwater, further characterisation will include an assessment of the vulnerability of the groundwater body, based on geological, hydrogeological and soil cover information.

Question

Do you know of other major sources of existing information on pressures and impacts not mentioned in this section?

9.3 Developing the Monitoring Networks

9.3.1 Existing Monitoring Programmes

The monitoring strategy for Scotland's water environment should take as its starting point the existing monitoring programmes and the existing responsibilities of various organisations (as described in Tables 9.2 and 9.3).

In some cases, existing networks are likely to evolve towards delivering the Directive's requirements. For example, the NMMP is expected to form an important part of the Directive's marine monitoring network, this being coupled to the OSPAR Joint Assessment and Monitoring Programme (JAMP) which is currently under review. The NMMP integrates national and international monitoring programmes in UK estuaries and coastal waters across UK agencies, including SEPA, FRS, the Centre for Environment, Fisheries and Aquaculture Science and the Joint Nature Conservation Committee. Although its current main drivers are OSPAR monitoring requirements and existing EC Directive compliance monitoring (e.g. reporting under the EC Dangerous Substances Directive), the Water Framework Directive has been identified as a driver for future programmes. This is also the case with respect to the revision of the OSPAR JAMP.

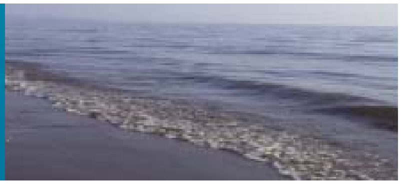
Other existing networks may contribute to the Directive's requirements as well as continuing to fulfil their original purpose. SNH has initiated major site condition monitoring programmes for conservation sites designated under European (EC Habitats Directive) and national legislation (see Section 8.7.1). Under the Water Framework Directive, some of these sites relating to aquatic habitats and species will be designated as Protected Areas. Since the monitoring requirements of the Water Framework and Habitats Directives are concerned with similar aspects of the environment, methods being developed and monitoring information from these sites are likely to be directly relevant to the Directive's Protected Areas monitoring requirements.

Other examples of existing joint partnership networks include the Environmental Change Network and the National Biodiversity Network.

In developing the monitoring strategy, the forum will need to explore how these existing programmes can contribute and link to the future Directive monitoring network. This should be the best way to ensure that resources are used most efficiently, duplication is avoided and organisational roles are clear.

9.3.2 Gaps

For some quality elements, there is limited monitoring capacity, and in some cases, limited expertise in Scotland (Tables 9.2 and 9.3). For example, there are no significant ongoing assessments of fish populations in standing waters and large rivers and few major surveys of non-salmonid species. These gaps may need to be addressed for the surveillance monitoring network, although monitoring of some quality elements may not be required for operational monitoring (see Section 8). A number of research and development projects are underway, or planned, to tackle some of these gaps.



Question

Where existing monitoring does not meet the requirements of the Water Framework Directive, it may be appropriate to designate new responsibilities for producing, assessing and managing Directive monitoring data management among one or more organisations with the relevant expertise and capacity.

Does your organisation consider it could play a future role in delivering the Directive's monitoring requirements?

9.4 Data Quality and Management

An important aspect of the monitoring strategy for Scotland's water environment should be high quality data production and management.

All data produced under the monitoring strategy must conform to the relevant international and national protocols and quality assurance schemes. Procedures for ensuring high quality data transfer and management will also be needed.

Generally, the responsibility for quality assurance should lie with the data producer.

It is proposed that the monitoring strategy for Scotland's water environment should have its own water data management network. Modern internet-based technology means that a single database may not be the obvious solution; a series of compatible databases with specified data managers may be found to be more appropriate. Special provisions and access arrangements will have to be made for confidential or intellectual property data.

Table 9.1 Existing Information on Pressures in Scotland

Pressures	SEPA	SE	SNH	FRS	Scottish Water	Local Authorities	BGS	Operators	Research establishments	NGOs CMPs	Gaps
Point Source	✓✓			✓✓	✓			✓			•No major gaps
Diffuse Source	✓	✓		✓	✓				✓		•No national data management of diffuse pollution pressures
Water Abstraction	✓				✓	✓✓	✓✓	✓			•Fragmented data on industrial and public use •Private water supplies data may require upgrading
Artificial Recharge of Groundwater								?			•No data sources. Operators may hold relevant information
Water Flow Regulation	✓	✓✓			✓			✓			•No national data management
Morphological Alterations (e.g. engineering works)	✓	✓	✓	✓		✓✓		✓		✓	•Data not managed for WFD purposes
Land Use		✓	✓	✓	✓	✓✓			✓✓	✓	•Data not managed for WFD purposes
Other Pressures (e.g. boat traffic, introduced species, clearing of vegetation)	✓		✓	✓✓	✓	✓		✓		✓	•Various organisations may hold relevant data

Key: ✓✓ = existing data management duty, ✓ = anticipated to hold relevant information
(NB existing data is not necessarily available for all water body types)

Table 9.2 Indicative Existing Monitoring Information Relevant to the Review of Impacts Held by National Organisations (Surface Waters)

Monitoring Information	Rivers	Lochs	Transitional Waters	Coastal Waters
Physico-chemical	✓✓✓ SEPA, FRS	✓✓ SEPA,*SNH, FRS	✓✓✓ SEPA, FRS	✓✓✓ SEPA, FRS
Specific Synthetic Non-Synthetic Pollutants	✓✓ SEPA, *S Water	✓ SEPA, *S Water	✓✓✓ SEPA, FRS	✓✓✓ SEPA, FRS
Hydrological, Tidal Regime River Continuity	✓✓ SEPA, *S Water	✓ *S Water	✕ *SNH, SEPA	✓ *SNH, SEPA, FRS
Morphology	✓✓ SEPA, *SNH	✕ *SNH	✓ *SNH, SEPA	✓ *SNH, SEPA, FRS
Phytoplankton	◆	✓ *S Water, *SNH	✓✓ FRS, SEPA	✓✓ FRS, SEPA
Macrophytes, Phytobenthos	✓ SEPA, *SNH	✓✓ *SNH	N/a	N/a
Angiosperms	N/A	N/A	✕ *SNH	✕ *SNH
Benthic Invertebrates	✓✓✓ SEPA, *SNH, FRS	✕ FRS	✓✓✓ SEPA, *SNH	✓✓ SEPA, *SNH, FRS
Macroalgae	N/A	N/A	✓ SEPA, *SNH	✓ SEPA, *SNH
Fish	✓✓ SFCC, FRS	✓ SFCC, FRS	✓✓ FRS	N/A

Table 9.3 Indicative Existing Monitoring Information Relevant to the Review of Impacts Held by National Organisations (Groundwater)

Monitoring Information	Organisation
Groundwater Levels	✓ BGS, *S Water
Groundwater Chemical Status	✓✓ SEPA, BGS
Groundwater Vulnerability (hydrogeology, soils etc.)	✓✓ BGS, MLURI, SEPA

Key:
The symbols provide an overall indication of existing monitoring information available in Scotland.
The various national organisations listed may individually hold different levels of information than is indicated.
✓✓✓ = existing national monitoring capacity likely to meet Directive requirements
✓✓ =existing national monitoring falls significantly short of Directive requirements
✓ =local or infrequent monitoring currently carried out
✕ =very limited monitoring information currently exists
◆ =not expected to be an ecological issue in Scotland
N/A = not relevant under the Directive
* = largely for what will be WFD Protected Areas
S Water = Scottish Water

SUMMARY OF QUESTIONS

Question 1 (Section 3.1.4)
It is intended that small tributaries will generally be managed as part of larger river water bodies. However, should the thousands of isolated small lochs (less than 0.5 square kilometre surface area), and very small watercourses and ditches (less than 10 square kilometre catchments), which discharge directly into the sea be individually identified as water bodies?

Should such small waters never be identified, avoiding the administrative burden of separately identifying such minor water bodies?

Should only those small lochs and rivers which are of particular significance be identified? "Particular significance" may arise because of their ecological, conservation or social resource value, or an adverse impact on another water body. If such small water bodies are to be created, what screening criteria should be used to decide if they should be separately identified and managed?

Question 2 (Section 4.2.3)
Bearing in mind the principles outlined in Section 4.2.3 and the Directive's definitions, are there specific examples of water bodies you think are at high status? If so, please give the reasons behind your views.

Question 3 (Section 4.2.5)
The starting point for identifying the boundaries for good ecological status will be to identify real examples of water bodies that are currently considered to be at good status. Bearing in mind the principles referred to above and the Directive's definitions of the status classes (see Table 4.1), are there specific examples of water bodies that you consider would fall into the good status class? If so, please give the reasons behind your views.

Question 4 (Section 5.2.3)
The translation of the Directive's definition of maximum ecological potential for an HMWB or AWB into detailed criteria and values will also dictate the measures required to achieve good ecological potential. It will be important that any measures required deliver real benefits to the water environment on the one hand while at the same time being compatible with the purpose for which an HMWB or AWB is designated. To achieve this balance will require a detailed understanding of the needs of the different types of uses for which water bodies can be designated.

To establish reference conditions for the classification scheme that are compatible with the types of use for which the bodies are designated, how should the competent authorities work with users of HMWBs and AWBs and other interested parties?

Question 5 (Section 5.2.3)
There appear to be several options for deciding on appropriate reference conditions for those AWBs that are no longer used for their original purpose:

(i) set the reference conditions so that they are compatible with the original purpose;

(ii) set the reference conditions so that they are compatible with the current purpose; or

(iii) establish the intended purpose as part of each river basin planning cycle and set reference conditions accordingly.

Which approach do you think is the most appropriate?

Question 6 (Section 6.4)
The effects of alterations to the quantity or quality of groundwater flows on directly dependent terrestrial ecosystems, such as wetlands, partly define whether good groundwater status is achieved. Where such alterations have resulted, or would result, in significant damage to a terrestrial ecosystem, the body of groundwater will fail to achieve good status. To ensure that efforts to restore bodies of groundwater to good status tackle real environmental problems, what criteria do you think should be used to define significant damage to directly dependent terrestrial ecosystems?

Question 7 (Section 7.2.2)
How, and at what stage of development, should information on risk assessment methods be made available?

Question 8 (Section 9.1.3)
How do you view the aims and arrangements proposed for a monitoring strategy for Scotland's water environment?

What role do you think your organisation should have in the strategy?

Question 9 (Section 9.2.2)
To ensure that the risk assessments in the characterisation report are as reliable as possible, accurate information about pressures is needed. Clearly, existing data sources should be used as far as possible. There are, however, a number of options for addressing the major information gaps in 2004 relating to abstraction, impoundment and engineering works, including: postal questionnaires, detailed ground surveys or a voluntary notification scheme. Which do you consider to be the best approach?

Question 10 (Section 9.2.3)
Do you know of other major sources of existing information on pressures and impacts not mentioned in this section?

Question 11 (Section 9.3.2)
Where existing monitoring does not meet the requirements of the Water Framework Directive, it may be appropriate to designate new responsibilities for producing, assessing and managing Directive monitoring data management among one or more organisations with the relevant expertise and capacity.

Does your organisation consider it could play a future role in delivering the Directive's monitoring requirements?

GLOSSARY

Angiosperms
The flowering plants. The group is specified in the Directive as a relevant biological element in transitional and coastal waters. In these waters, they include sea grasses and the flowering plants found in salt marshes.

Aquifer
A subsurface layer or layers of rock or other geological strata of sufficient porosity and permeability to allow either a significant flow of groundwater or the abstraction of significant quantities of groundwater.

Artificial Water Body (AWB)
A man-made water body, rather than a modified natural water body, which supports important aquatic ecosystems. Includes canals, some docks and some man-made reservoirs.

Bathing Water Directive
European Community Directive (76/160/EEC) that requires Member States to take all necessary measures to ensure identified bathing waters meet certain quality standards prescribed for the protection of the environment and public health.

Biodiversity Action Plans
National, local and sector-specific plans established under the UK Biodiversity Action Plan, with the intention of securing the conservation and sustainable use of biodiversity.

Biological element
A collective term for a particular characteristic group of animals or plants present in an aquatic ecosystem (e.g. phytoplankton; benthic invertebrates; phytobenthos; macrophytes; macroalgae; phytobenthos; angiosperms; fish).

Biological quality element
A characteristic or property of a biological element that is specifically listed in Annex V of the Directive for the definition of the ecological status of a water body (e.g. composition of invertebrates; abundance of angiosperms; age structure of fish etc).

BGS
British Geological Survey.

Classification
Method for distinguishing the environmental condition or status of water bodies.

CMP
Catchment Management Plan.

Competent authority
Public bodies with specific authority and competences in relation to the implementation of the Directive (e.g. regulatory powers, monitoring responsibilities, etc).

The Scottish Executive has proposed that SEPA be identified as the lead competent authority in Scotland.

Diffuse pollution
Pollution resulting from scattered or dispersed sources that are collectively significant but to which effects are difficult to attribute individually.

Ecological continuum
The persistence of the ecological structure and functioning of aquatic ecosystems over time and space.

Ecological potential
The status of a heavily modified or artificial water body measured against the maximum ecological quality it could achieve given the constraints imposed upon it by those heavily modified or artificial characteristics necessary for its use. There are five ecological potential classes (maximum, good, moderate, poor and bad).

Ecological status
One of the two components of surface water status, the other being chemical status. There are five classes of ecological status of surface waters (high, good, moderate, poor or bad).

EU
European Union.

FRS
Fisheries Research Services.

Groundwater
All water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil. Groundwater flows through tiny pore spaces, cracks and fissures in underground rocks, emerging naturally at springs and wetlands and running into rivers, lochs or the sea. During dry weather, the only natural contribution to rivers is from groundwater. The minerals in the rocks with which groundwater is in contact influence its chemistry, which in turn influences the natural chemical composition of associated surface waters and terrestrial ecosystems. This affects the natural composition and abundance of the plants and animals that make up those ecosystems.

Habitat Action Plans
See Biodiversity Action Plans above.

Heavily Modified Water Body (HMWB)
A surface water body that does not achieve good ecological status because of substantial changes to its physical character resulting from physical alterations caused by human activity, and which has been designated, in accordance with criteria specified in the Directive, as "heavily modified".

Hydromorphology
See Section 4.2.7.

Indicators
A parameter that can be monitored to estimate the value of a biological, hydromorphological or physico-chemical quality element. Indicators may include the presence or absence of a particularly sensitive species.

Macroalgae
Multicellular algae such as seaweed.

Macrophyte
Larger plants, typically including flowering plants, mosses and larger algae, but not including single-celled phytoplankton or diatoms.

Marine Pollution Monitoring Management Group (MPMMG)
Group comprises government departments, agencies and government research institutes. They co-ordinate a UK programme of estuarine and coastal monitoring designed to satisfy a number of requirements including trend monitoring for OSPAR, compliance with EC directives and international conventions, local needs and for research and development.

MLURI
Macaulay Land Use Research Institute.

Natura 2000 sites
Protected Areas established for the protection of habitats or species under the Birds Directive (79/409/EEC) (Special Protection Areas) and the Habitats Directive (92/43/EEC) (Special Areas of Conservation).

NGO
Non-governmental organisation.

NMMP
National Marine Monitoring Programme.

NVZ
Nitrate Vulnerable Zone, designated under the EC Nitrates Directive (91/676/EEC). In NVZs, statutory measures are applied to reduce pollution by agricultural nitrates.

OSPAR
Oslo and Paris Conventions for the protection of the marine environment of the north-east Atlantic.

Phytobenthos
Bottom-dwelling multi-cellular and unicellular aquatic plants such as some species of diatom.

Phytoplankton
Unicellular algae and cyanobacteria, both solitary and colonial, that live, at least for part of their lifecycle, in the water column.

Point source pollution
Pollution arising from an identifiable and localised area, structure or facility, such as a discharge pipe.

Pollution
The direct or indirect introduction, as a result of human activity, of substances or heat into the air, water or land which: (i) may be harmful to human health or the quality of aquatic ecosystems or terrestrial ecosystems directly depending on aquatic ecosystems; (ii) result in damage to material property; or (iii) impair or interfere with amenities and other legitimate uses of the environment.

Pressures
Human activities such as abstraction, effluent discharges or engineering works that have the potential to have adverse effects on the water environment.

Priority Hazardous Substances
A pollutant, or group of pollutants identified at Community level under Article 16 of the Directive that presents a significant risk to or via the aquatic environment because of its toxicity, persistence and liability to bioaccumulate, or because of other characteristics which give rise to an equivalent level of concern.

Priority Substances
A pollutant, or group of pollutants, presenting a significant risk to or via the aquatic environment that has been identified at Community level under Article 16 of the Directive. They include priority hazardous substances. The first list of 33 priority substances was published on 15 December 2001. It includes 11 substances or groups of substances identified as priority hazardous substances and 14 substances that are subject to review for identification as possible priority hazardous substances.

Protected Areas
Areas that have been designated as requiring special protection under Community legislation for the protection of their surface waters and groundwater or for the protection of habitats and species directly depending on water.

Quality element
A feature of an aquatic ecosystem that can be described as a number for the purposes of calculating an ecological quality ratio, such as the concentration of a pollutant, the number of species of a type of plant, etc.

Ramsar site
A wetlands area designated for its conservation value under The Convention on Wetlands of International Importance Especially as Waterfowl Habitat. The Ramsar Convention seeks to promote the conservation of listed wetlands and their wise use.

Reference conditions
The benchmark against which the effects on surface water ecosystems of human activities can be measured and reported in the relevant classification scheme. For waters not designated as heavily modified or artificial, the reference conditions are synonymous with the high ecological status class. For waters designated as heavily modified or artificial, they are synonymous with the maximum ecological potential class.

River basin
Sometimes known as a river catchment, a river basin is the area of land from which all surface run-off flows through a sequence of streams, rivers and, possibly, freshwater lochs into the sea at a single river mouth, estuary or delta.

River basin district
A river basin or several small river basins combined with larger river basins or joined with neighbouring small basins together with stretches of coastal waters.

River basin management plan (RBMP)
For each river basin district, the Directive requires a river basin management plan to be published. The plan must set out the environmental objectives for water bodies and provide a summary of the measures that are being used to achieve them. The plans must be reviewed every six years.

SAC
Special Area of Conservation (see Natura 2000 sites).

Saturated zone
Subsurface rock or other geological strata within which the pore spaces between the particles of rock or other strata, and the cracks in those strata, are filled with water.

SE
Scottish Executive.

SEPA
Scottish Environment Protection Agency.

SFCC
Scottish Fisheries Coordination Centre.

SNH
Scottish Natural Heritage.

Site of Special Scientific Interest (SSSI)
An area of land notified under the Wildlife and Countryside Act 1981 by the appropriate nature conservation body (SNH in Scotland) as being of special interest by virtue of its flora and fauna, geological or physiogeographical features.

SPA
Special Protection Area (see Natura 2000 sites).

Transitional water
Surface waters in the vicinity of river mouths which are partly saline in character as a result of their proximity to coastal waters but which are substantially influenced by freshwater flows. They include estuaries and brackish lagoons. The extent of some estuaries has previously been defined for the purposes of the Urban Waste Water Treatment Directive (91/271/EEC).

Typology
The means by which the Directive requires surface water bodies to be differentiated according to their physical and physico-chemical characteristics.

Water body
A "body of surface water" is a discrete and significant element of surface water such as part of a burn, river or canal, or a loch or a reservoir, or a transitional water such as an estuary or brackish lagoon, or a stretch of coastal water. A "body of groundwater" is a distinct volume of underground water within an aquifer or aquifers.

Water services
All services which provide, for households, public institutions or any economic activity:
(a) abstraction, impoundment, storage, treatment and distribution of surface water or groundwater; and
(b) waste water collection and treatment facilities which subsequently discharge into surface water.

Water table
The upper limit of the saturated zone.

Water use
Water services together with any other human activity identified as having a significant impact upon the status of water.

WFD
Water Framework Directive.

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