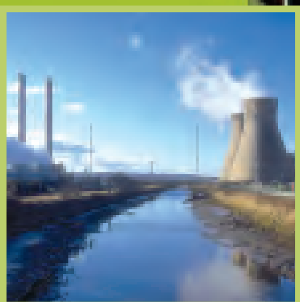
SEPA
Scottish Environment Protection Agency

An economic analysis of water use in the Scotland river basin district

SUMMARY REPORT



Foreword

Over the coming years, important decisions are going to be made about how we, in Scotland, protect and improve the valuable water resources we have and, on the pages that follow, we set out some important information about the pressures and impacts upon the water environment.

This work is one of the first steps under the Water Framework Directive which came into force in Europe in 2003 and established new and better ways of protecting, improving and using Europe's rivers, lochs, estuaries, coasts, canals, wetlands and groundwater.

We have worked hard during the last three years to collect information about the ways in which water contributes to the economy, to ensure that it is informative and useful to key organisations, individuals, and decision-makers. This information has been reported separately to the European Commission. However, there is still much to be done to fully understand the impacts, and further work is planned for the years ahead.

Throughout this document you will see references and electronic links to research reports and papers that have been produced in the course of carrying out this work. These provide more detail and technical information that you may find helpful. We will continue to collect and present information, as it becomes available, on the Scottish Environment Protection Agency (SEPA) website.

The work has been undertaken in consultation with an Economics Advisory Stakeholder Group which has provided SEPA with advice on the development of this report and the research projects upon which it is based. An important component of the report is the appendix providing sector specific reports authored by these stakeholders.

SEPA is grateful for the input of stakeholders to the process, we intend to continue this participative approach throughout our work on the Directive as we monitor, assess, plan and take action to improve the Scotland's water environment.

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Executive summary

This report represents a snapshot of our current knowledge of water use in the Scotland river basin district (RBD). Much of the underlying research provides new insights into how water is, and has been, used in the Scottish economy and provides an indication of its importance. This will inform our thinking as we progress in the implementation of the Water Framework Directive (the Directive)[1]. The Scotland RBD covers a large and diverse area ranging from the remote Shetland Isles in the north to the urban areas of Glasgow and Edinburgh. The changing landscape of Scotland has a strong influence on its economic structure; supporting whisky distilleries and hydro power in the Highlands and Islands, and the electronics industry and a sophisticated service sector economy in the central belt.

Economics forms one of the central pillars of the Water Framework Directive (WFD) and we are able to use economic evidence to rank the efficacy of potential measures necessary for Scotland's waters. This informs the decision-making process and aids the selection of the most effective combination of measures.

The value of water use in the Scotland river basin district is estimated as ranging from a fraction of a penny per cubic metre to in excess of £1 depending upon the circumstances and the use to which water is put.

The report illustrates the links between the environmental effects and the value gained from different water uses and also examines the economic sectors that are associated with point source discharges, diffuse source discharges, abstraction and impoundment and alteration to physical habitat.

In Scotland, 4,213 pressures on 1,256 water bodies are identified as coming from economic or industrial activities and a brief analysis is provided on the nature of those activities.

Preliminary analysis indicates that Scottish Water, the principal supplier of water services, is recovering the costs associated with supply, although further analysis remains to be undertaken into the extent to which this includes environmental and resource costs.

Analysis of changes in demand for water up to 2015 indicate that, in the absence of controls, demand for water is expected to increase in line with structural changes and growth in the economy although at a slightly lower rate. The greatest change in overall water use may come from an increase in the use of renewable sources of energy, however, agricultural use of water is predicted to decline as a result of anticipated changes to the structure of the common agricultural policy.

Further work is needed to support the important work that will be taking place to protect and improve the water environment in the coming years.

Appended to this report are links to a number of sector/case studies that have been written by members of the Economic Advisory Stakeholder Group (EASG). These are appended as they were submitted to SEPA and, as such, do not necessarily represent the views of SEPA. We are, however, grateful to the EASG whose assistance and advice in the underlying research and the provision of these sector reports has been most beneficial.

[1] A copy of the Water Framework Directive is available through the links page at http://www.sepa.org.uk/wfd/links.htm or through the EU at http://europa.eu.int/eur-lex/pri/en/oj/dat/2000/l_327/l_32720001222en00010072.pdf The Water Environment Water Services Act 2003 is the enabling legislation for the Water Framework Directive.

1 Introduction

1.1 Purpose

This document provides a summary of the economics of water use in the Scotland river basin district and has been prepared in order to meet the requirements of Article 5 of the Water Framework Directive.

Economic considerations will play a key part in the new system of river basin planning being established in Scotland. In particular, economic information will be used to help:

- make judgements about which combination of measures are the most cost-effective means of improving the status of the water environment;
- set improvement targets for the status of the water environment that are not disproportionately expensive to achieve; and
- ensure the recovery of an adequate contribution to the costs of water services.

The initial economic analysis of water use described in this report is the first step in integrating economic considerations into the planning process. It provides:

- a review of the quality and extent of existing data on the economic importance of the water environment in the Scotland river basin district;
- an understanding of the relative contribution of different economic sectors to the pressures on the water environment and how these contributions may change over time;
- an initial analysis of the extent to which different pressures on the water environment may interact and, therefore, the number of cases in which decisions on the most cost-effective measures may need to be made; and
- an assessment of the current extent of cost-recovery for the principal water services.

The results of this analysis provide the background needed to help identify, and prioritise the collection of, the more detailed economic data that will be necessary in some cases to design the programmes of measures for the first river basin planning cycle. Specifically, the results show that:

- the economic importance of the water environment to the Scotland river basin is substantial. This will require significant consideration in the setting of environmental objectives in the river basin planning process;
- the majority of significant pressures on the water environment are associated with only a small number of economic sectors. SEPA will, therefore, be able to prioritise further economic analysis to improve the information on these water uses and how they may be affected by environmental improvements; and
- there are likely to be relatively few cases where multiple pressures affect the same part of the water environment. This means that in most cases making judgements about the most cost-effective combination of measures for improving the water environment should not be complicated. SEPA will be able to use this information to help focus effort during the next stages of the planning process.

The draft programme of measures for the first river basin planning cycle must be established by December 2008 and an adequate contribution to the costs of water services must be ensured by 2010. More detailed and specific economic information will be needed for this work. The collection of this data has already started but can only be completed once potential measures are identified and their implications understood. Economic analysis will therefore be an integral part of the process of developing the programmes of measures over the period 2005 to 2008.

1.2 Overview

The Water Framework Directive (the Directive)[2] is a wide ranging and ambitious piece of European environmental legislation. Its overall objective is to establish a common framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater which:

- prevents deterioration and enhances the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands directly depending on the aquatic ecosystems;
- promotes sustainable water use;
- reduces pollution; and
- contributes to lessening the effects of floods and droughts.

Some of the terminology used in this report is that of the Directive. This will allow other European member states to use the document more easily because they will be familiar with this terminology and ensure consistency when the reports are submitted. In some instances, where particular Directive requirements are presented, lochs may be referred to as lakes and estuaries may be referred to as transitional waters.

Existing water management in Scotland focuses very much on the control of pollution pressures. However, the achievement of the Directive's environmental objectives will require the management and control of such other pressures as water abstraction, impoundment and engineering. Implementation of the Directive is to be achieved through the river basin management planning process which requires the preparation, implementation and review of a river basin management plan every six years for each river basin district (RBD). There are four main elements to the process:

- **environmental** and **economic characterisation** of the RBD and assessment of pressures and impacts on waters within the district;
- environmental **monitoring** informed by RBD characterisation;
- setting of environmental **objectives**; and
  design and implementation of a **programme of measures** to achieve environmental objectives.

A timetable for the Directive's main requirements is shown overleaf in Table 1.

[2] A copy of the Water Framework Directive is available through the links page at http://www.sepa.org.uk/wfd/links.htm or through the EU at http://europa.eu.int/eur-lex/pri/en/oj/dat/2000/l_327/l_32720001222en00010072.pdf

Table 1: Water framework directive implementation timetable

Year	Requirement
2000	Directive comes into force
By 2003	• Transpose requirements to member state law • Identify river basin districts (RBD) and competent authorities
By 2004	Undertake RBD characterisation to include: • Assessment of pressures and impacts on water status • Economic analysis of water use • Provisionally identify heavily modified and artificial waters • Register of protected areas
By 2006	• Monitoring programmes operational • Finalise EU register of intercalibration sites • Consult on River basin management plan (RBMP) production work programme
By 2007	• Consult on significant water management issues overview in RBD
By 2008	• Publish full draft RBMP for consultation
By 2009	Publish final first RBMP to include: • environmental objectives • programme of measures • monitoring networks • register of protected areas • heavily modified and artificial water designations
By 2010	Cost recovery
By 2012	Programme of measures operational
By 2013	Review for the first RBMP: • characterisation assessments • economic analysis
	Consult on significant water management issues overview for 2nd RBMP
By 2015	• Achieve environmental objectives of first RBMP • Publish 2nd RBMP and thereafter every six years

Achievement of 'good status' is one of the key environmental objectives of the Directive. Good status means that certain standards have been met for the ecology, chemistry and quantity of waters. In general terms, good status means that waters only show slight change from what would normally be expected under undisturbed conditions.

The implementation of the Directive raises a number of shared technical challenges for the Member States, the Commission, the Candidate and EEA Countries as well as stakeholders and interested parties. In addition, many of the European river basins are international, crossing administrative and territorial borders and, because of this, a common understanding and approach is crucial to the successful and effective implementation of the Directive. In order to address theses challenges in a co-operative and coordinated way the Member States, Norway and the Commission agreed on a **Common Implementation Strategy (CIS)**[3] for the Directive. This involved significant partnership working across Europe and between states to produce agreed and common guidance[4]. A UK Technical Advisory Group (UKTAG) has been formed to offer guidance in the interpretation of the CIS for the UK and to ensure internal consistency amongst the designated authorities.

[3] More detail on the CIS can be found at http://europa.eu.int/comm/environment/water/water-framework/implementation.html `

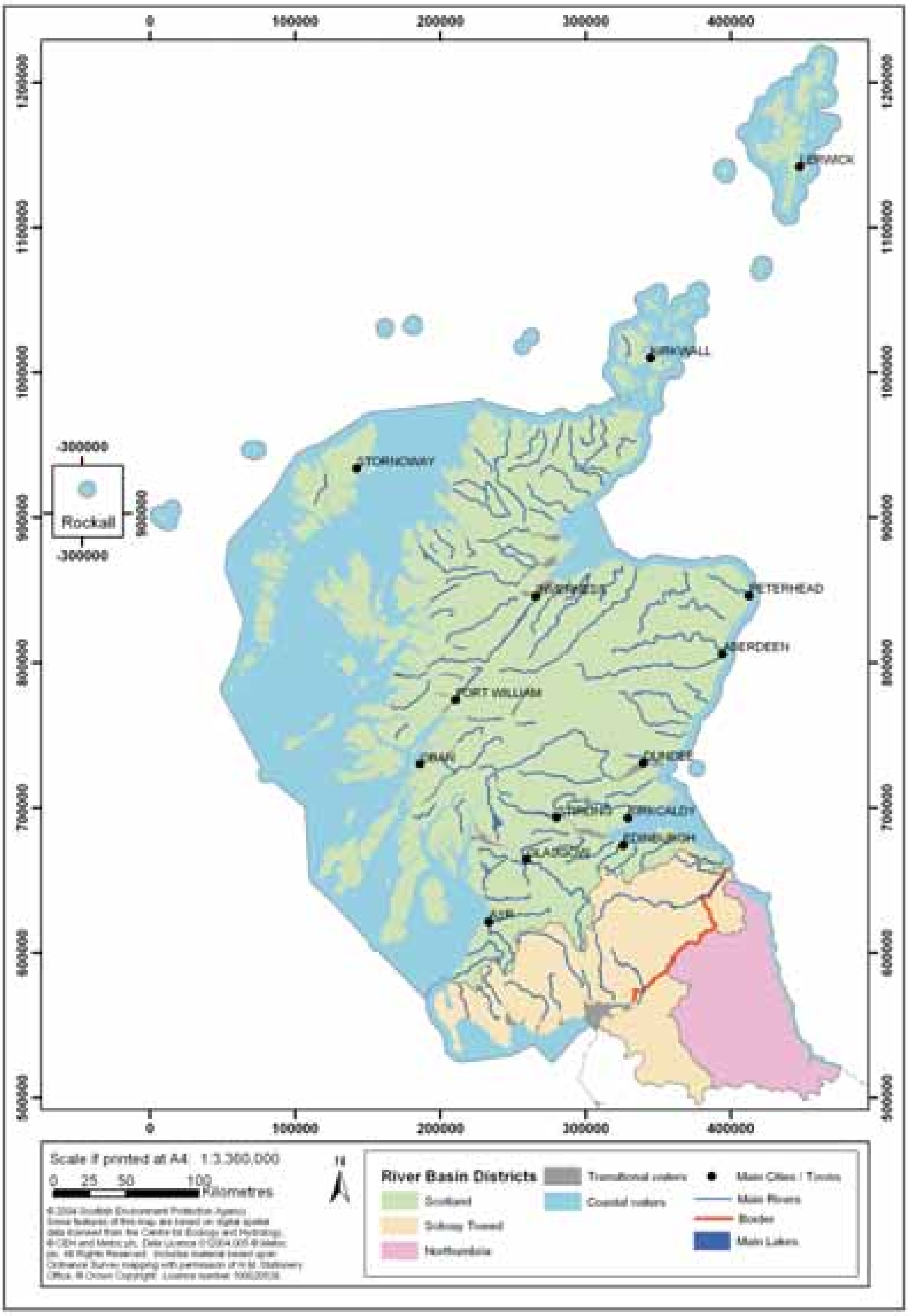
[4] This guidance builds on the Wateco guidance on the Article 5 economic analysis. More information can be found on this at http://forum.europa.eu.int/Public/irc/env/wfd/library?l=/framework_directive/guidance_documents/economic_wateco&vm=detailed&sb=Title

1.3 The Scotland river basin district

River basin districts will be the main areas used for co-ordinating the management of the water environment. They comprise individual river basins and their associated transitional waters, coastal waters and groundwaters. There are three river basin districts in Scotland: two shared with England (Solway-Tweed and Northumbria), and one entirely within Scotland. Map 1 below shows the Scottish river basin districts.

This report refers to the Scotland river basin district.

Map 1 Scotland river basin district



1.3.1 Characteristics

The Scotland river basin district (RBD) covers approximately 113,920 km^2, from Shetland in the north to Glasgow, Ayr and Edinburgh in the south. Around 4.8 million people live in the district, most in the central belt between Glasgow and Edinburgh. The number of people employed in the Scotland RBD is currently just under 2.2 million and is set to increase to over 2.2 million by 2015 on the back of forecast growth in output of 2.2% per year. The landscape is varied: from the mountainous Highlands, to the extensive, often fjordic, coastline of the west and the urban and industrial areas around Glasgow and Edinburgh.

The Highlands are mountain ranges of sandstone and granite, rising to Britain's highest peak, Ben Nevis. Much of the Scottish uplands are characterised by large tracts of blanket bog which are more extensive in Scotland and Ireland than elsewhere in Europe. The oceanic climate and varied topography of the western Highlands and Islands give rise to a diverse and rich botany. The district supports important habitats and wildlife, including 235 water dependent Special Areas of Conservation and Special Protection Areas.

Overall, the district has fewer environmental problems than most others in the UK. However, there are still significant environmental problems in parts of the district, in particular around the larger population centres of Glasgow and Edinburgh. Although many large rivers and estuaries, such as the Clyde in the west and the Forth in the east, have seen marked improvements over the last 20 years, water quality problems remain. Land use in the north eastern part of the district is largely agricultural which can give rise to diffuse pollution problems.

The Scotland RBD, particularly in the west, has a relatively high rainfall in comparison with the rest of the UK. About 90% of water supplies come from surface waters, the remainder from groundwater. It is the largely clean environment of the district that attracts tourists and supports particular industrial sectors. For example, there are many excellent salmon rivers in the district and the generally clean and reliable water supply supports sectors such as fish farming and whisky manufacturers.

1.4 Summary of the roles of economics in the Water Framework Directive

Most environmental effects are the consequence of economic activity and in order to minimise these effects we need to understand more about the linkages between business (and household) activity and the water environment. The Directive allows us to set environmental objectives that take account of the important contribution that existing (and future) activity makes to economic wellbeing. A greater understanding of the potential economic choices and their consequences is an essential part of the implementation of the Directive.

Economics will play a number of specific roles in river basin management planning process.

- Informing the setting of environmental objectives for the water environment so that the objectives set strike the right balance between social, economic and environmental considerations;
- Informing the selection of the most cost-effective combination of measures for achieving the environmental objectives for the water environment;
- Informing the design of charging schemes that ensure recovery of an adequate contribution to the costs of water services;
- Assessing whether pricing policies provide adequate incentives for users to use water resources efficiently, and thereby contribute to the environmental objectives of this Directive.

This report presents a picture of the extent of our current knowledge on the interactions between businesses (and households) and the water environment. The evidence from this report will be built upon to enable us to rank potential measures in terms of their efficiency and to interpret how they would act in combination. This will inform the selection of the most cost-effective combination of measures that allows the development of businesses and also minimises any negative impact on the water environment. It is the intention to maintain an open, transparent and accessible approach and, in doing so, to maximise the sustainable development of Scotland.

If a body of water is unlikely to achieve good status by 2015 it will be necessary to make decisions on the best action/s to take to achieve the desired status. The Directive does, however, recognise that it may not be possible for all water bodies to achieve good status by 2015 for a number of reasons. These include;

- remediation measures not being technically possible;
- suggested measures being too costly for the benefits achieved;
- measures not being able to deliver in time; and
- any combination of the above.

In these cases the Directive provides the option of delaying the achievement of good status until 2021 or even 2027, if necessary. If this target is still not be attainable it may be possible to set a lower objective. Where a lower objective is being set we will present a clear case for doing so and this may include presentation of technical, economic and social arguments used to inform this decision.

Although good status is akin to a natural condition the Directive does make allowances for water bodies that have been heavily modified (by human activities) and those that are wholly artificial.

The evidence used in making judgements about the appropriate objectives for water bodies will include economic considerations and the information provided here and in the annexes to this report will be taken into account, along with scientific and regulatory considerations such as those presented in the environmental characterisation reports[5]. This evidence will be collected to provide the fullest information possible in order to make the most effective and appropriate decisions.

1.5 Water usage

Scotland's use of water has constantly changed in the past and will continue to do so in the future. Historically, water has been used as if it possessed an infinite capacity to handle waste. It is only in relatively recent times that that we have taken responsibility for the consequences of this use and delivered significant improvements through the application of pollution control legislation.

Water in Scotland is used for a wide range of purposes beyond the discharge of waste materials. SEPA has documented a range of impacts associated with abstractions, diffuse pollution, impoundments and physical changes to habitat in the Pressures and Impacts report. Until recently, less emphasis has been placed upon delivering improvements associated with these impacts; however, the new regulations which transpose the WFD will deliver major improvements to our management of these pressures.

Section 2 shows the scale of water use in Scotland by key sectors and describes the value of their water use. This information has been based upon an research and development (R&D)[6] project and been linked to data from the parallel environmental pressures and impacts assessment process undertaken and finalised by SEPA and others during 2004[7].

A description linking the pressures and impacts to economic activity is provided in **Section 3** and this examines the complexity of Scottish water bodies.

Information about the recovery of costs for water use in Scotland is described in **Section 4**. In setting environmental objectives we have to consider who will pay and how much it will cost. This will include a consideration and balance of which (prevention or remediation) is more beneficial to both the economy and to the environment.

In order to understand how water use will change over time we have commissioned research that suggests how the economy may change and how this activity will impact on water use from the present to 2015. Information on the projected changes in water use can be found in **Section 5** and on the SEPA website[8]. This information will be used to inform decision-makers about how pressures are expected to change over time and enable them to develop appropriate policies and plans to appropriately manage such changes.

[5] http://www.sepa.org.uk/wfd/characterisation.htm

[6] http://www.sepa.org.uk/wfd/easg.htm

[7] http://www.sepa.org.uk/wfd/characterisation.htm

[8] http://www.sepa.org.uk/wfd/easg.htm

2. Results of economic analysis

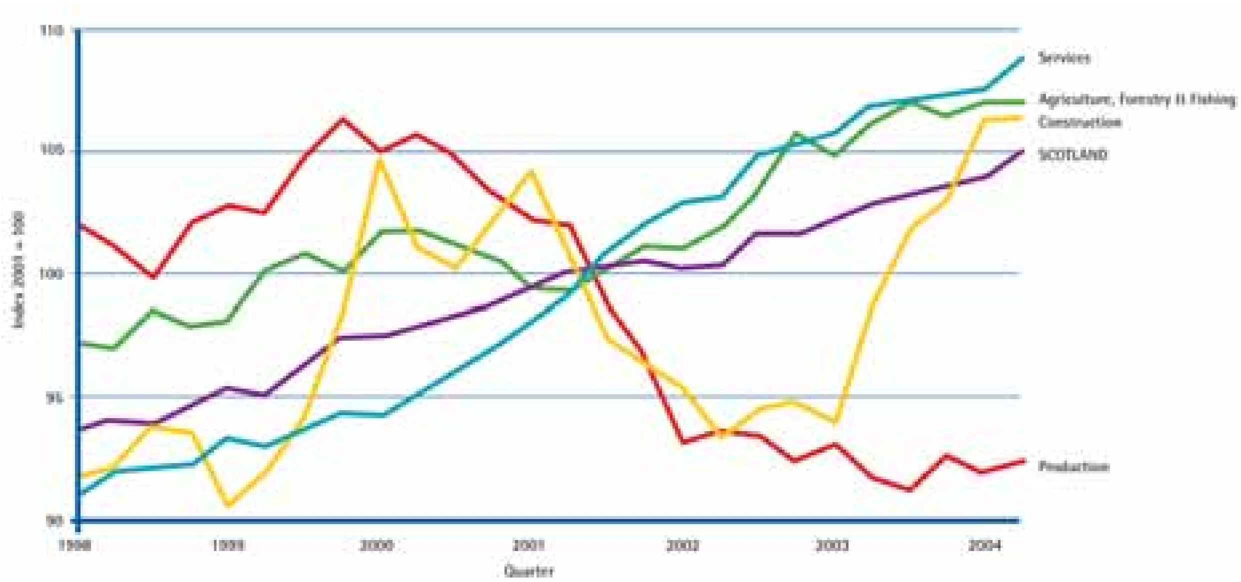
2.1 Background

Figure 1 below shows the recent trends in Scottish gross domestic product (GDP) which measures the total output of goods and services in the economy. This information is presented as an index which is adjusted for inflation and allows direct comparisons between sectors. Although Scotland's output has grown over the period (1998–2004) the performance of different sectors varies considerably. The production industries show the declining relative contribution of manufacturing and the rising prominence of the service sector. The cyclical nature of the construction sector can be clearly seen and, of course, underlying these broad sectors lies the fluctuating fortunes of individual companies in each sub-sector.

Monetary values of GDP are difficult to produce accurately for UK regions (such as Scotland) and, therefore, are often dated. The latest available breakdown is for 2001 when Scottish GDP was just over £69.623 billion. Official estimates of sub-regional GDP are not available and it is not possible to show the GDP of the Scottish or cross-border RBD individually. However, forecasters have used econometric models to estimate the output of the Scottish RBD[9] and suggest that it would be £64,362 billion: showing that over 92% of Scottish output is generated in the Scotland RBD.

Figure 1: Recent trends in Scottish gross domestic product (GDP)

Scottish Gross Value Added: First Quarter 1998 to Second Quarter 2004



Source: Scottish Executive 2004

While an index enables clear comparisons of the performance of an individual sector it conceals the relative size of the contribution that the sector makes to the Scottish economy as a whole. **Figure 2** shows the percentage of GDP generated by some of the main sectors. It clearly illustrates the current dominance of the service sector: accounting for over two-thirds of Scottish GDP. However, it is the valuable contribution that the other areas produce; in excess of £20 billion, that is of most interest to us here as their use of water makes a direct contribution to their output. Amenity and recreation uses are also valued however they do not have an industrial classification of their own. Section 2.4 discusses this and the contribution of almost £4.5 billion that tourism makes to the Scottish economy. The following sections look at all of these water using industries in more detail.

[9] Forecasts provided by Experian Business Strategies Limited

Scottish GDP share

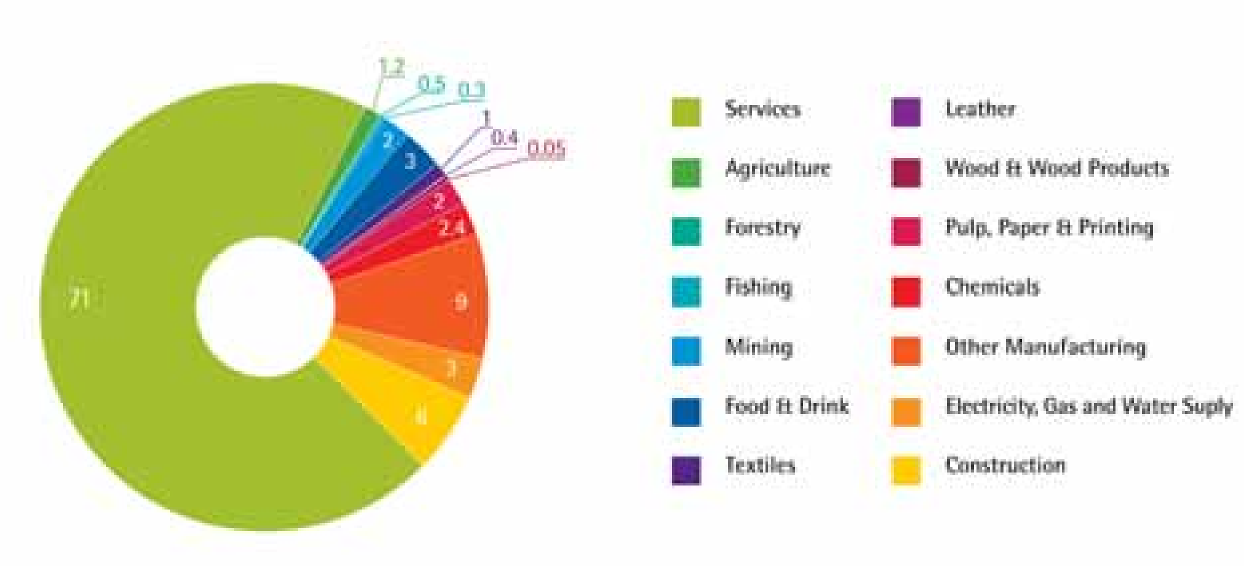


Figure 2 Scottish gross domestic product share

Source: Scottish Executive 2004

2.2 Summary of current analysis of use

2.2.1 How water is used

An analysis of how water is used in the Scottish river basin has been undertaken to identify the sectors making the greatest use of water. This also helps us to identify and prioritise the sectors where additional economic information needs to be collected as a priority in order to support the development of programmes of measures.

This report examines the four main water uses that affect the condition of the water environment in the Scottish river basin district: abstraction, impoundment, discharge (both point source and diffuse) and engineering.

The main abstracting sectors are energy, using water for cooling, and water supply, both domestic and as part of a production process. These same two sectors are also major impounders although for different purposes; energy is generated through hydropower and water is stored in reservoirs (other examples of impoundment include flood defence and canals).

Over 90% of clean water used by households is discharged to mains sewers and many other water uses are non-consumptive with water being returned in an altered state and used to dilute pollution or to dissipate heat. The most significant sectors for point source pollution, after sewage and refuse disposal, are fish farming, and manufacturing.

Harbours, canals, flood defence, river straightening and alteration through towns are all good examples of engineering activity.

2.2.2 How water use is valued

It may sometimes be difficult to decide if the costs of achieving a particular environmental objective would be justified. In such cases, information on the value of the water usage of the industrial process affected by the improvement measures may be useful in reaching a decision. This section discusses the quality and extent of existing data on the value of water usage in the Scotland river basin district.

Due to the complexity of many industrial processes, placing a value on their usage of water is not straightforward. The most appropriate methods are discussed in the Water Use report[10] but unfortunately there are not sufficient data on the water use and non-water costs of businesses to be able to apply this model to Scotland or to further local scale analyses. Therefore, it has been necessary to partly rely on estimates originally derived for Canadian industry and transfer the values to Scotland[11]. The results are given in **Table 2 and Figure 3.** Inflation factors and exchange rates have been applied to transfer the values to 2004 UK pounds.

[10] The SNIFFER Economics of Water Use Report can be accessed at http://www.sepa.org.uk/wfd/easg.htm and at http://www.sniffer.org.uk

[11] Renzetti, S. and D.P. Dupont (2003), `The Value of Water in Manufacturing`, CSERGE Working Paper ECM 03-03

Table 2 Industrial value of water use

Manufacturing industry	1991 values ($Can)	2004 values ($Can)	2004 values (£UK)
Food	0.017	0.30	0.125
Beverage	0.038	0.50	0.21
Rubber products	0.006	0.10	0.04
Plastic products	0.032	0.40	0.16
Textile products	0.005	0.10	0.04
Wood	0.020	0.30	0.125
Paper and allied products	0.031	0.40	0.16
Primary metal	0.107	0.13	0.055
Fabricated metal products	0.048	0.60	0.25
Transport equipment	0.025	0.30	0.125
Non-metallic mineral products	0.023	0.30	0.125
Refined petroleum and coal products	0.288	0.36	0.15
Chemical and chemical products	0.072	0.90	0.375

Notes: inflation calculator: http://www.bankofcanada.ca/en/inflation_calc.htm
Prevailing £–$Can exchange rate: http://www.x-rates.com/calculator.html

The information available and the needs of the research meant that the report focused on particular methods and users. **Table 3** summarises the values calculated. However, it should be noted that the values were calculated using different methods and based on different assumptions and, therefore, the results for sectors are not directly comparable. This was necessary due to differing data availability and different ways of using water. For example a high volume user such as aquaculture may have a low per m^3 value whereas another use such as irrigation may have a much higher m^3 value. The figures do provide a measure of the importance of water for certain sectors and will provide a means of tracking changes in the value derived from particular uses. Values are expressed in units appropriate to the nature of the usage under consideration.

Table 3 Summary of the valuation techniques and results for sectors considered

Sector	Valuation technique	Key assumptions	Value*
Households	Gibbons' willingness to pay formula	Assumes all consumers pay volumetric charges levied to metered customers in England, Wales and Scotland Includes value of both clean and dirty water	0.102–0.244 p/m³
	Benefits transfer from stated preference study	Only considers value of supply of clean water	0.067 p/m³
Agricultural irrigation	Net-back analysis	Assumes that the West Pfeffer catchment is representative of other areas where potatoes are irrigated Value includes both naturally available water and water applied through irrigation	£5128 /ha
	Transfer of net-back analysis	Data from England and Scotland combined despite different agricultural support arrangements and climate	23–138 p/m³
Aquaculture	Avoided Cost	Costs calculated based on running costs of the largest effluent filters bought without a loan Considers water use for disposal of solid waste only Assumes filters remove all solid waste	0.126 p/m³
Salmon angling	Benefits transfer of travel cost method study	Assumes salmon anglers in Donegal are representative of others throughout Scotland and Northern Ireland	£175 /day
Industry	Benefits transfer from marginal productivity approach study	Industrial water use in Scotland and Northern Ireland assumed to be the same as for Canada Assumes no improvements in water efficiency since 1991	4–37.5 p/m³

* p/m3 = pence per cubic metre,
/ha = per hectare

Results are based on the information available and the techniques developed at the time. However, there are a number of areas in which understanding can and should be improved. In particular, the understanding of the volume of water supplied to and discharged from different sectors could be improved. In turn, this could help to identify issues of water use at a more precise geographic level in order to facilitate assessment of the individual RBDs, such as the Solway-Tweed. As we progress towards river basin management planning this information will be refined and we will be able to use it to inform our decision-making.

2.3 Economic sectors and their water use

This section provides an overview of the ways in which different sectors currently make use of water in Scotland. In addition to this overview, some water users have provided their own sectoral analysis, each of which have been reproduced (unedited) in the appendices to this document and are also available through the SEPA website[12]. To date analysis has been received from the following groups:

Sector	Author
Agriculture:	NFU Scotland
Aquaculture:	The Federation of Scottish Aquaculture Producers
Coal:	Scottish Coal
Whisky:	Malt Distillers Association of Scotland
Tanning of Leather:	Scottish Tanning Industries
Paper and Pulp:	Confederation of Paper Industries
Hydro Power:	British Hydropower Association
Canals:	British Waterways

The availability of a separate sector report is indicated by an asterisk in the following sections.

2.3.1 Agriculture* and forestry

There is a significant agricultural sector in Scotland, employing 28,645 full-time, 35,709 part-time and nearly 4,000 casual and seasonal workers. Agriculture and forestry account for almost 1.50% of gross value added to the Scottish economy. Water is essential to the agricultural sector for irrigation, drinking water for livestock and cleaning.

Most agricultural water needs are met by precipitation, however, where irrigation is necessary, the benefits are substantial. Water also carries excess chemicals away from the land and transports them to other water bodies. Agriculture and forestry is responsible for under two-thirds of all diffuse pollution pressures.

2.3.2 Aquaculture*

Scotland's coastal waters, lochs and rivers are used for a large amount of commercial fish and shellfish farming which depend on unpolluted water. In 2002, almost 150,000 tonnes of salmon and some 3,200 tonnes of shellfish were farmed in Scotland. Many fish farms are part of large corporations, however, most shellfish producers are small enterprises employing approximately 350 people collectively, in rural areas.

2.3.3 Mining and quarrying

Mining and quarrying accounts for 1.1% of employment and 2.13% of the gross value added to the Scottish economy, with the majority of this value attributable to the mining of energy producing materials. The nature of coal exploitation has changed significantly in recent years and deep mined coal is no longer produced in Scotland. Open cast coal mining* is, however, a significant contributor to the Scottish economy, producing over 7 million tons of coal per annum. Water use in the mining sector consists of diverting groundwater and drainage with subsequent consented discharges from settlement tanks.

2.3.4 Oil and Gas

In addition to the minerals produced, Scotland acts as a focus for the production of oil and gas. None of the oil and gas fields are within three nautical miles of the shore and are therefore not included in the production statistics above or the scope of this assessment. However, the production of oil and gas is significant for the Scottish economy, and there are oil terminals at Flotta, Nigg, Sullom Voe, Grangemouth, Dalmeny and Cruden Bay, and a gas terminal at St. Fergus.

2.3.5 Manufacture of petroleum and petroleum-based products

Overall, this sector contributes 2.56% to the Scottish economy (using gross value added), although within this figure, the most significant contribution is made by the manufacture of chemicals (1.66% of gross value added).

2.3.6 Oil refining

There is a significant amount of mining for oil and gas off the North Sea coast. The refining takes place at two locations in Scotland: oil refining at Grangemouth and specialist lubricant and bitumen refining at Dundee. These account for only 0.21% of the gross value added to the Scottish economy. Oil refining and fuel processing use some mains supplied water (estimated at 1,350 m^3/day for large users[13] , which is likely to cover all use in such a concentrated sector) and also abstracted fresh water; estimated at 15,000 m^3/day[14].

2.3.7 Food processing

Food processing in Scotland is a diverse industry, although the main economic contribution from the sector is in meat and fish production. There is a notable lack of information on the nature, distribution and characteristics of the sector, and this gap is something that will be addressed in the future.

[12] http://www.sepa.org.uk/wfd/easg.htm
[13] Scottish Water, 2003
[14] CJC Consulting, 2002

The volume of water abstracted by organisations in the food processing sector was estimated as part of the study of abstraction in Scotland[15]. This study estimated the total mean use of water as 8,000 m^3 for fish processing, 49,000m^3 for vegetable processing, 63,000 m^3 for meat processing and 117,000 m^3 for dairy processing. Of these, direct abstraction was most common for vegetable processors, with a mean of 45,000 m^3, with limited abstraction in the other sectors.

2.3.8 Production of alcoholic beverages

Scotland is noted for its production of Scotch whisky*, and the sector is important both economically and culturally. There are just over one hundred distilleries in Scotland, spread in particular across the Highlands, and concentrated along the River Spey. Around 41,000 jobs depend on the production of whisky, with just over 9,500 employed in production itself and a further 20,000 jobs in businesses supplying goods and services. Whisky production also supports Scottish agriculture, and uses approximately 390,000 tonnes of barley and 486,000 tonnes of other cereals each year. The sector also generates over £800 million of income (principally in wages and salaries). Two types of whisky are produced: malt whisky and grain whisky. Malt whisky is made from malted barley, water and yeast and is sold in small quantities as single malts but most production goes to be blended, where it is mixed with grain whisky. Grain whisky is made on a larger scale and uses a different process using wheat or maize with smaller quantities of malted barley.

The precise volume of water used in whisky production is difficult to calculate and different sources provide differing numbers. Details of this discussion are available in the Scotland and Northern Ireland Forum For Environmental Research (SNIFFER) Economics of Water Use report[16]. Best estimates show that malt distillers abstract 76.49 million m^3 each year. The technical definition of water use for the whisky sector would include all water diverted for the purpose, however the sector's own definition would be merely the water abstracted from that diversion.

As the pure alcohol produced by the distillery is diluted with water to produce the final product, account must be taken of this water use as well. The SNIFFER report referred to earlier has the details of how this was estimated; however, based on an estimated 856 million litres of whisky sold in 2002, the direct water component equated to 513,000 m^3 .

2.3.9 Production of mineral waters and soft drinks

Mineral water

The Scottish mineral water companies supply approximately 35% of the UK consumption of bottled water, which was 1.8 billion litres in 2002. The production of mineral water in Scotland, as elsewhere, requires brands to be linked to specific springs. However, in some places more than one brand is linked to a single spring, most notably at Lennoxtown (Burnbrae Spring, Caledonian Spring, Campsie Spring, Glenburn Spring, Glencairn, Heather Spring, Lowland Glen, Scottish Mineral Water and Strathglen Spring). In such cases, the total abstraction would include water that is diverted and is more significant than indicated by the economic importance of individual producers.

Based on satisfying 35% of UK consumption, Scottish companies produced approximately 630 million litres (630 million m^3) in 2002. More than half of this comes from the main producer of bottled water (Highland Spring) who bottled approximately 320 million m^3[17]. This would be consistent with the estimated sector abstraction of 687 million m^3, since this larger figure would include process water and excess water discharged immediately.

2.3.10 Manufacture of textiles and leather* products

Textiles and leather is a relatively small economic sector in Scotland, accounting for only 0.87% of gross value added. However, they are significant in terms of their historic contribution to Scotland and also in terms of water use.

The tannery sector is an intensive water user; with approximately 20 m^3 of water required to process 1 tonne of raw hide into 300 kg of saleable leather. Both private and public water supplies are used. Due to the organic content of the tannery effluent (which requires treatment before discharge) and the urban location of the tanneries, primary effluent treatment is typically provided before discharge to mains sewers.

2.3.11 Manufacture of wood, pulp and paper* products

Wood, paper and pulp employs 3,380 people to produce approximately 1.25 million tones of paper per year (Confederation of Paper Industries 2004), accounting for 2.31% of gross value added in Scotland (National Statistics, 2003). Although the manufacture of paper is part of a chain from forestry through to manufacture, the industry in Scotland is focused around the manufacture of paper, and most mills import treated woodpulp for raw material (only one, Caledonian Paper, produces its own pulp). There are twelve paper mills in Scotland, concentrated in the Forth/Clyde valley and around Aberdeen where they were historically situated in proximity to suppliers and markets in towns as well as close to water sources for production processes. The industry, which specialises in high quality graphics paper, is very competitive. Five mills have closed since 2000 in response to changes in international economic conditions, domestic prices and regulation.

[15] CJC Consulting, Evaluating the economic impact of abstraction controls on high and medium volume water users in Scotland. 2002.
[16] http://www.sepa.org.uk/wfd/easg.htm

2.3.12 Chemicals

The chemicals sector is a significant water user in Scotland, both in terms of volume used and the resultant discharge. The largest company in the sector is operated by BP Chemicals at Grangemouth, although there are also a large number of small chemical companies. It is an extremely varied sector producing a wide range of different organic and inorganic chemical products. Processors may use large volumes of water for processing, generating steam for heating, cooling, and cleaning equipment and chemicals. Although there is reliance on mains water, sea water is often used for cooling and there is some abstraction in the sector in Scotland with grey water also used for cooling at some facilities.

Water treatment may be necessary as a result of many of the processes involved in the manufacture of chemicals, from overflows of the storage tanks used for supplying the raw materials, through synthesis and product separation, to leakage from pipes during product storage. The types of pollutants from chemical production that may affect water bodies vary according to the type of chemical produced and are discussed in the background research[18].

2.3.13 Other manufacturing

There are a number of other manufacturing sectors in operation in Scotland, contributing 9.78% of the gross value added to the Scottish economy. Within this, the contribution of the manufacture of electrical and optical equipment is by far the most significant, accounting for almost half of the total contribution.

2.3.14 Electricity non–hydro

These facilities are all located on the coast and are dependent on marine water to use in through flow systems for cooling. Although net abstraction is insignificant, the significant change to the water is through the increased temperature of discharge. Longannet and Cockenzie report an estimated use of river water of 1,587 million m^3 and 643.4 million m^3 respectively in 2002/3. British Energy and BNFL report any changes in radioactive content of the water close to nuclear facilities. The two major nuclear facilities are estimated to use approximately half a million m^3 of water for cooling each year.

In addition to water for cooling, fresh water supplied by Scottish Water is used to create steam to drive the turbines and for site use. Longannet and Cockenzie were supplied with 2.86 million m^3 and 1.51 million m^3 respectively in 2002/3. This is equivalent to 7,836 m^3 and 4,154 m^3 per day. Mains water use at the two nuclear facilities was 840,000 m^3 at Hunterston B and 341,000 m^3 at Torness for 2002/3, equivalent to 2,301 m^3/day and 934 m^3/day respectively. Future water uses in this sector may include wave and tidal power installations.

2.3.15 Electricity Hydro*

Hydropower schemes can be constructed on-line or off-line, depending on whether water is to be diverted from its original course. On-line schemes were popular some decades ago, but are no longer favoured, due to the impacts on migratory fish and other species and problems of siltation and larger substrate accumulation behind the structure. Off-line schemes divert the water and then return it back to the watercourse and this may have different problems, particularly due to the distance between abstraction and discharge. This may lead to low flows in a portion of the river, particularly during periods of when the river is naturally in low flow. Hydropower schemes can also use dams to create a high reservoir and increase the distance over which the water falls. The reservoir also stores water so that the flow can be regulated over periods of different rainfall and different electricity demand. Some schemes also use pumps from a low reservoir to return the water to the high reservoir, from where it can be reused during periods of high demand e.g at Cruachan. The power generated from hydroelectric schemes depends on the flow of water and the height over which the water is pressurised. Currently an estimated 3.355 billion m^3 of water are stored in reservoirs serving Hydro schemes. Consultants estimate that around 10% of electricity generated in Scotland comes from hydropower.

[18] http://www.sepa.org.uk/wfd/easg.htm

2.4 Amenity and recreation

There are a wide range of recreational and amenity uses of water resources. In order to consider a number of different areas, this category has been broken down into contribution to tourism and water-dependent visitor attractions, water-dependent recreation, non-water-dependent recreation, waterside amenity navigation and ecosystem services.

2.4.1 Tourism and water-dependent visitor attractions

Scotland is a significant tourist destination. In 2002, tourists made over 20 million trips to Scotland, spending £4,494 million (VisitScotland, annual statistics). Of these visitors, 18.5 million were from the UK, although the average length of stay and expenditure was much higher from those from further afield. For both UK and overseas visitors, the 'urban' type of tourism offered by Edinburgh and the Glasgow area comprises the main attraction. Nevertheless, the more 'natural' setting offered by the Highlands makes them the third more visited destination in the country. This, together with the importance of outdoor leisure activities such as walking and hiking, swimming, nature study, fishing, visiting theme and activity parks, suggests that the natural environment is a significant and positive element of Scottish tourism. In a survey of French, Spanish and German visitors, 47% of those surveyed stated that landscape, countryside and scenery were the main influence on their choice to holiday in Scotland, with 10% specifically mentioning lochs and rivers (Visit Scotland and SNH, 2002).

2.4.2 Water-dependent recreation

There are a wide range of recreational activities that rely on water. This includes activities on outdoor water bodies, such as jet-skiing, kayaking, rafting, windsurfing, yachting and angling, as well as activities that abstract and discharge water. Although those taking part in many of these activities are not charged for water use, they can have an impact on the economy through spending.

Activities that use outdoor water bodies, either inland or coastal waters, are affected by a number of features of the water body. In particular, bathing and paddling are influenced by water quality. The blue flag standard is a symbol of environmental quality as well as sanitary and safety facilities at beaches and marinas in Europe and South Africa. Thus the award increasingly reveals more than just the quality of the bathing water, although it is imperative that water quality is compliant with the requirements of the EU Bathing Water Directive (76/160/EEC) concerning total contaminants. Of the 105 blue flag beaches and 12 marinas in the UK, four beaches and one marina are in Scotland.

Swimming pools are slightly different to the activities that use natural water bodies, since they abstract and discharge water, altering the chemical composition of the water between times. Another indoor recreational activity using water is for indoor ski slopes and ice rinks. This is considered to be a relatively limited use, both in terms of the number of facilities and the volume of water used in each facility.

Winter activities such as skiing make use of water but as it does not effect individual water bodies or influence water quality it is not included in the analysis

2.4.3 Angling

Within Scotland, there are 36,650 km of river designated under the Freshwater Fish Directive, the vast majority (36,580 km) of which is designated as salmonid fisheries. Of the salmonid designated rivers, 770 km failed to meet water quality requirements in 2002, with no failures of cyprinid designated rivers. Angling contributed over £112 million to the Scottish economy in 2003[19].

2.4.4 Navigation*

There are a number of ports around the coast of Scotland and on the islands, with Forth, Sullom Voe, Orkney and Clyde each handling more than 10 million tonnes of freight traffic in 2001. In total, 119.6 million tonnes of freight used the main ports in 2001, with crude oil (78.8 million tonnes), oil products (11.0 million tonnes), and coal (6.7 million tonnes) accounting for the greatest proportions. A much smaller amount of freight (11.4 million tonnes) was carried for part of its journey on inland waterways, of which the majority used the Forth.

2.4.5 Non-water-dependent recreation and waterside amenity

Waterside amenity includes those individuals who chose to walk or spend time near to rivers, lochs or the coast because of the aquatic scenery. It also includes the higher value of property associated with a waterside location. For the purposes of this report, evidence has not been sought, but when such work is undertaken it is expected to be locally specific.

2.4.6 Ecosystem services

Life on earth depends on the ability of the environment to provide essential services, recycling wastes and nutrients, providing fresh water, clean air and so on. During 2002 estimates were made to quantify in monetary terms the benefits that the earth's ecosystem services within Scotland provide. This work[20] generated an estimate of the annual value of approximately £17 billion, of which more than £3 billion was directly attributable to lochs, rivers and estuaries. In many cases the value of these benefits is utilised by industrial sectors and becomes embodied in their final products. In others, the benefits are enjoyed by the population at large or by recreational users of the environment.

[19] Radford, A., G. Riddington, J. Anderson, H. Gibson (2004), The Economic Impact of Game and Coarse Angling in Scotland. Research report prepared for Scottish Executive Environment and Rural Affairs Department

[20] Williams et al 2003, The Value of Scotland's Ecosystem Services and Natural Capital, European Environment, Vol 13, 67-78

3 Economics of water use and pressures on water bodies

This section considers the economics of water use in Scotland. It focuses on the economic sectors identified as sources of potential pressure or risk of downgrading identified in the environmental characterisation work undertaken in parallel with this economic analysis. It considers all pressures collectively and does not separate them into rivers, lochs (lakes), transitional, coastal and groundwater. Instead the focus is on the main pressures of point source, diffuse, abstraction and impoundment and alteration to physical habitat. Each pressure is not scaled and it is important to remember that they will vary in magnitude considerably. It is important to consider that over 43% of Scotland's water bodies are not at risk of failing to achieve good status in 2015 and, as such, will require no remediation actions as a result of the Directive.

Before presenting the results it is important to be clear about what is implied by an 'economic value of water use'. In this analysis we provide estimates for the contribution water makes to an industrial process. In undertaking this work with stakeholders it has become clear that there are differences in views about the range of values that should be considered in this analysis. A full technical exposition of the methodologies and techniques used to establish the values presented can be found in the commissioned research[21].

The general approach taken is to recognise that water is one of a number of inputs into a process and each input makes a contribution to the final value of the output. In some cases water will become embodied in the product (such as soft drinks) in other cases water will be transformed, warmed, delayed, re-routed, or its assimilative capacity for wastes used: indeed many processes make more than one use of water simultaneously. In some catchments the same volume of water may be used several times by the same or different kinds of users. There are some catchments, for example, with several hydropower generation facilities that make use of the potential energy of the water at several different points.

A similar set of considerations can be appreciated when attempting to value non-industrial uses of water such as recreation. So far, the analysis has attempted to convert the value of water use to a value per m^3. Over the coming years other means of illustrating the value of water use will be explored which will be more appropriate for non-industrial use. For the time being we are fortunate in having a number of sector specific case studies and reports provided by representatives of the sectors themselves[22].

Table 4 shows how the economic activity of different sectors is associated with the risk of a water body failing to meet good status. Much of the risk is concentrated in certain sectors where the three sectors with the greatest number of impacts (shown in red) account for almost three-quarters of all impacts. Of these three the agriculture, forestry and fishing sector alone accounts for three out of ten risks (mostly associated with diffuse pollution and morphological changes to water bodies). This is followed closely by Energy and Water Supply with almost a quarter of all risks of failure, which are associated with abstraction and flow regulation. Around one in six risks are associated with sewage and refuse disposal and the vast majority of these are related to point source discharges.

There are some risks for which it has not been possible to attribute to a particular sector. These have been allocated to a 'not identified' sector. The sector 'other' refers to identified pressures that are from the rest of the economy; these would include things such as flood defence walls, urban development and land claim.

Each type of pressure is dominated by particular sectors (shown in red). **Table 4** shows that most impacts from abstraction emanate from the energy and water supply sector, while most diffuse pollution risk comes from agriculture. Most flow regulation risk is associated with electricity generation and agriculture is the main source of physical alterations in the form of drainage and land reclaim. The largest cause of point source discharge is waste water treatment. The key role of certain highlighted sectors within the pressure types suggests that the remediation within those sectors will be an important early focus for identifying cost effective measures in affected water bodies.

[21] http://www.sepa.org.uk/wfd/easg.htm

[22] http://www.sepa.org.uk/wfd/easg.htm

Table 4 Number of pressures per sector by source for all water bodies at risk

Main industrial groups	Abstraction	Alien species	Diffuse source pollution	Flow regulation	Morphological alterations	Point source pollution	Total
Agriculture, forestry and fishing	71	10	548	30	441	154	1254
Construction			1		4	4	9
Energy and water	363		36	397	196	10	1002
Manufacturing	42		13	2	19	113	189
Mining	9		31		4	77	121
Not identified		1	114	80	385	10	590
Other	18	11	26	11	32	10	121
Sewage and refuse disposal			61	1	1	721	7784
Transport and communications	6	6	49	19	54	22	156
Total	509	28	879	540	1136	1121	4213

Further use of this analysis will be made to help to frame the tools we develop to assess the most cost-effective combinations of measures in water bodies. The more pressures of different types from different sectors faced in any particular water body the more complex the decision-making process is likely to become.

Table 5 considers the number of pressures on a water body and shows how many water bodies are affected by multiple pressures. The more pressures per water body the more potentially complex the likely solutions and the more effort will be necessary to identify the most cost-effective combination of measures. Where there are fewer pressures, identifying mitigation measures is likely to be more straightforward.

Table 5 Total number of pressures per water body for all water bodies at risk

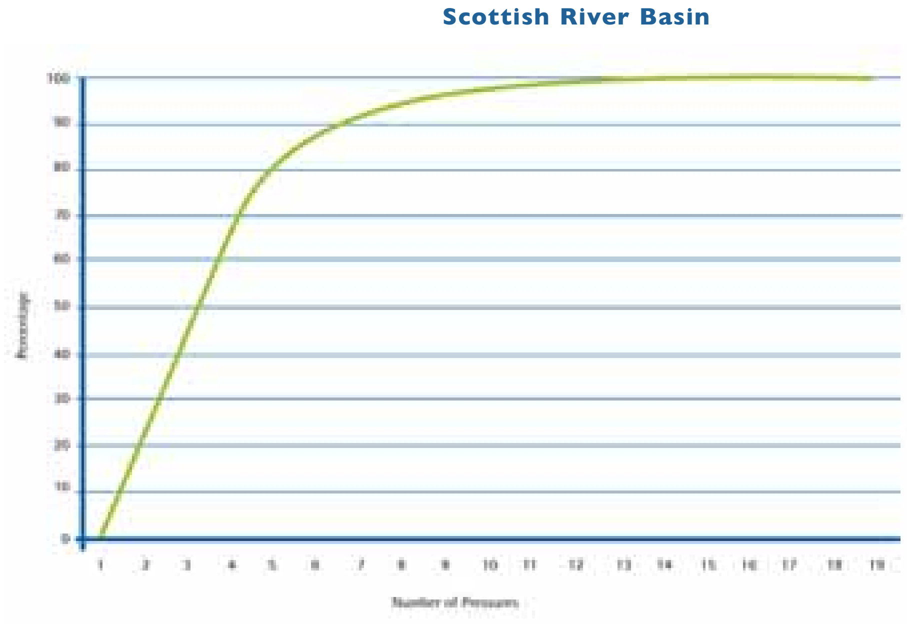
Number of pressures	Number of water bodies*	% of all water bodies with pressures	Cumulative % of water bodies with pressures	Cumulative number of water bodies with pressures
1	250	19.9	19.9	250
2	294	23.4	43.3	544
3	293	23.3	66.6	837
4	155	12.3	79.0	992
5	92	7.3	86.3	1084
6 to 10	143	11.4	97.7	1227
Over 10	29	2.3	100.0	1256
Total	**1256**	**100.0**	**100.0**	**1256**

* There are 3,349 identified water bodies in the Scotland RBD; 1,256 is the total of those at risk or likely to be at risk in 2015

This distribution of pressures is also shown in **Figure 4**. This indicates that there are relatively few waterbodies which are subject to 'multiple pressures' (more than four or five). More than two thirds of all water bodies face three or fewer pressures. This increases the likelihood of a more straightforward solution.

There are a number of water bodies with multiple pressures that emanate from the same sector. This implies that the means by which the pressure might be alleviated could come from the sector itself. Where, for example, a standard set of measures could be applied to reduce the number or complexity of the measures under consideration thereby making the assessment process more manageable.

Figure 4 Cumulative percentage of water bodies with at risk pressures



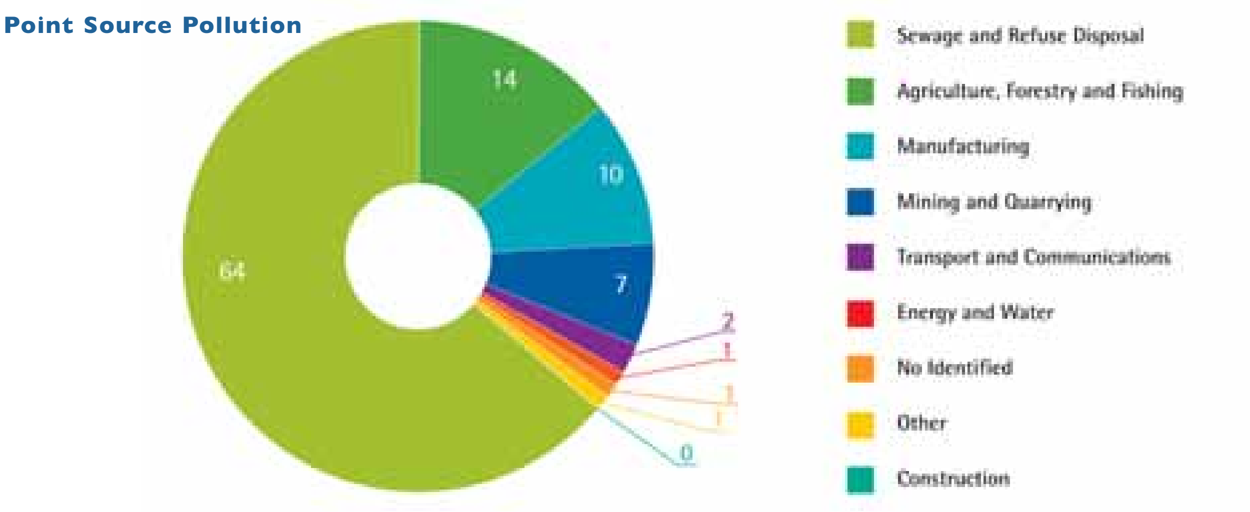
The following sections analyse the economic use of water made by each of the sectors reported as being the sources of pressures and impacts on water bodies. The commissioned research further builds on this and can be accessed at http://www.sepa.org.uk/wfd/easg.htm

3.1 Point source discharges

Table 6 Point source pressures by sector for all water bodies at risk in the Scotland river basin district

	Point Source
Sewage and refuse disposal	721
Agriculture, forestry and fishing	154
Manufacturing	113
Mining and quarrying	77
Transport and communications	22
Energy and water	10
Not identified	10
Other	10
Construction	4
Total	1121

Figure 5 Percentage if point source pressures by sector for all water bodies at risk in the Scotland river basin district



Point source pollution, such as effluent from urban wastewater treatment plants, waste management sites, industrial discharges and fish farm operations, has been controlled in Scotland for many years and as a result we have a good understanding of the effects of such discharges.

Figure 5 shows a percentage breakdown of industrial sectors that are the source of point source discharge pressures. Two thirds of all point source pollution is associated with waste water treatment (sewage) and waste management sites (domestic and commercial refuse disposal).

Although point source discharge creates 1,121 individual pressures the objectives of the Directive are only put at risk in 472 different water bodies.

The category 'other' includes identified sectors that are not classified elsewhere. While the 'not identified' classification covers pressures where it has not been possible to identify the source or where the data is incomplete.

The following table illustrates (where data are available) three measures of the economics of water use for each of these sectors. GVA 2001 (Gross Value Added) is a measure of the value of the sector to the Scottish economy, value of use is presented in pence per cubic metre and volume of use in cubic metres per year. This information is calculated in different ways on the basis of available information meaning that the figures are not directly comparable. However, these values provide an indication of the significance of a sector to the Scottish economy.

Table 7 Contribution to the Scottish economy and value/volume of water use in sectors connected with point source risk

Point Source Sector	GVA 2001[23]	Sub sector	Value of use[24] p/m³ *	Volume of use[25] million m³/year
Agriculture, forestry and fishing	£827m	Agriculture	23-138 irrigation benefits only	56.5
	£207m (fishing)	Aquaculture	0.13	1,582
Manufacturing	£1018m	Chemicals	37.5	315.9
	£2271m	Food and drink	12.5-21	260.2
	£1339m	Paper and pulp	16	87.7
Electricity, gas and water supply	£2021m electricity, Gas and Water Supply	Electricity	0.00-0.82[26]	Electricity generat'n cooling 3,783
		Sewage disposal	n/a	Scottish Water 266
	£69623m	Scotland		n/a

* p/m³ = Pence per cubic metre,

[23] http://www.statistics.gov.uk/downloads/theme_economy/Final_SIC_for_GVA_by_region_1989-2001.xls
[24] http://www.sepa.org.uk/wfd/easg.htm economics of water use research project (Tables 9.3 and 11.1)
[25] 2004 estimate (from Dynamics of use)
[26] Scottish and Southern Energy from personal correspondence consider this a significant underestimate with their internal calculations giving values up to 5.2p

In terms of sewage the value of water use is not separately identified and includes abstraction and discharge, however, water use is the main defining characteristic of Scottish Water whose turnover in 2003/04 was in excess of £958 m from an estimated water supply of 876 million m^3, some 90% of which will be subsequently discharged and treated.

3.2 Diffuse source discharges

Diffuse pollution is often difficult to attribute and many pressures remain unidentified.

Table 8 Diffuse pollution causing risk of failure in the Scottish river basin district

Main industrial groups	Diffuse source pollution
Agriculture, forestry and fishing	548
No identified	114
Sewage and refuse disposal	61
Transport & communications	49
Energy and water	36
Mining and quarrying	31
Other	26
Manufacturing	13
Construction	1
Total	879

Figure 6 Percentage of failure risk caused by diffuse pollution in the Scotland river basin district

Diffuse Pollution

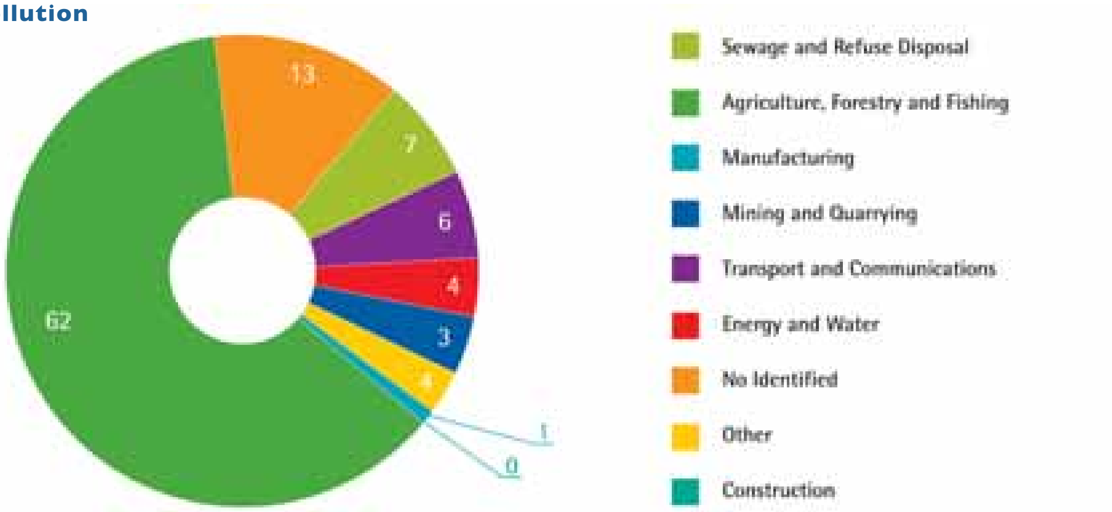


Figure 6 and table 8 above shows the breakdown for all water bodies at risk from diffuse sources of pollution in the Scotland RBD.

Agricultural diffuse pollution is caused, for example, by run off and seepage of fertilisers, weed killers and slurry.

The energy sector can be responsible for contamination of water from leaks and seepage while, especially under flood conditions, storm drains can cause sewers to overflow and discharge untreated sewage directly to water bodies. Roads can also be a source of diffuse pollution as cumulative leakage from vehicles is washed into drains and subsequently discharged. Diffuse pollution from the construction industry on the other hand is almost entirely due to spillage. Increasingly, the emissions of greenhouse gases from certain industrial activities have lead to acid rain which also contributes to diffuse pollution.

Table 9 below provides further information on some of the main sectors, illustrating (where data is available) the contribution that the sector makes to the overall Scottish economy, the value it places on water use and the volume of water that is used.

This table shows clearly the sectoral differences in use of water. For example, agriculture will use a (relatively) small quantity of water (for irrigation) at a vital time of year to add considerable value to a crop, however, electricity generators will use vast amounts of water all year round with each m^3 having a much lower value.

Table 9 Contribution to the Scottish economy and value/volume of water use in sectors connected with diffuse pollution

Diffuse Sector	GVA 2001[27]	Sub-sector	Value of use[28] p/m^3 *	Volume of use[29] million m^3/year
Agriculture, forestry & fishing	£827m	Agriculture	23–138 irrigation benefits only	56.5
Energy and water supply	t/o £958.3 million 2003/4	Water Supply+	n/a	876
Sewage and refuse disposal	Not available	Sewage and refuse disposal	n/a	n/a
Transport/ storage & comms	£5,335m	Transport/ storage & comms	n/a	n/a

* p/m^3 = Pence per cubic metre
+ = Scottish Water figures

3.3 Abstraction and flow regulation

Many manufacturing processes such as distilling, food processing, and paper and pulp production need to abstract water to produce goods. Water flow is also regulated and abstracted to supply drinking water, to produce hydropower and for navigational purposes. These types of activities may impact on the water environment. The Directive recognises that the benefits of such uses need to be retained and allows water bodies to be designated as heavily modified water bodies (HMWB) where substantial physical alterations have been made to support these uses.

Compared to many other European countries Scotland generally has sufficient supplies of water but the demand on our water supplies continues to increase. This context has meant that pressures arising from abstraction and flow regulation have not been comprehensively regulated in Scotland before now. As a result, limited quantitative information is available and the risk assessment has relied to a large extent on predicted impacts arising from water abstraction or flow regulation.

Figure 7 and Table 10 below show the distribution of pressures caused by abstraction and flow regulation for all water bodies at risk.

[27] http://www.statistics.gov.uk/downloads/theme_economy/Final_SIC_for_GVA_by_region_1989-2001.xls
[28] http://www.sepa.org.uk/wfd/easg.htm economics of water use research project (tables 9.3 and 11.1)
[29] 2004 estimate (from Dynamics of use)

Figure 7 Abstraction and flow risk sectors %

Abstraction & Flow Regulation

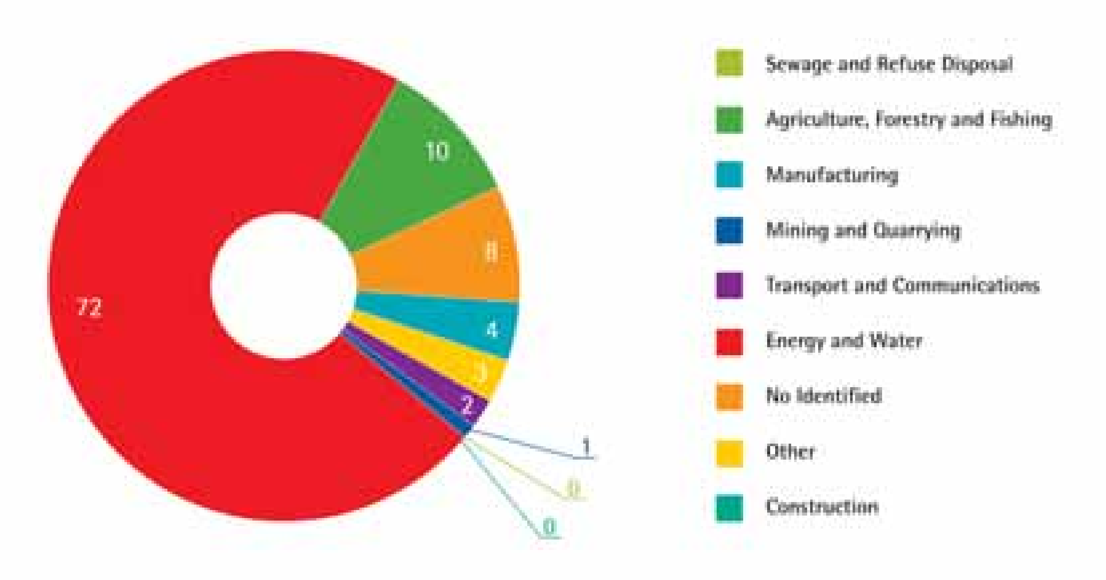


Table 10 Abstraction and flow risk sectors

		Number of Pressures	
Main Industrial Groups	Abstraction	Flow Regulation	Total
Energy and water	363	397	760
Agriculture, forestry and fishing	71	30	101
Not identified	0	80	80
Manufacturing	42	2	44
Other	18	11	29
Transport and communications	6	19	25
Mining and quarrying	9	0	9
Sewage and refuse disposal	0	1	1
Total	**509**	**540**	**1049**

The following table illustrates (where data are available) three measures for each of these sectors. GVA 2001 (Gross Value Added) is a measure of the value of the sector to the economy; value of use is presented in pence per cubic metre and volume of use in cubic metres per year

Table 11 Contribution to the Scottish economy and value/volume of water use in sectors connected with abstraction and flow regulation

Abstraction & flow regulation sector	GVA 2001[31]	Sub-sector	Value of use[32] p/m³ *	Volume of use[33] Million m³/year
Agriculture, forestry and fishing	£827m	Agriculture	23-138 irrigation benefits only	56.5
	Fishing £207m @ Scottish ports £260m	Aquaculture	0.011 to 0.126	1,582
Manufacturing	Food & Drink £2,271m	Food processing including whisky and soft drinks	12.5 food 21 beverage	260
	£516m	Textiles	4	1.8
	PP&P £1339m	Paper & pulp	16	87.7
Energy and water supply	Coke/refining/nuclear £143m	Oil	15 refined petroleum & coal	15
	Elec, Gas Water Supply £2,021m	Electricity hydro	0.00 to 0.82[34]	Est total thro'put 23,755
	Elec, Gas Water Supply £2,021m	Electricity non-hydro	n/a	(Est storage 3,355) Mains 6 Fresh 5 Sea 3,772 Total 3,783
	t/o £958.3million 2003/04	Water supply+	n/a	876

+ Scottish Water figures
* p/m³ = Pence per cubic metre

From this table it is clear that the volumes are considerable and that as a consequence of this, the value per cubic metre is low. Given the differing assessment methodologies adopted (as a result of data limitations) it is not meaningful to calculate a sector 'total' value of water use figure.

3.4 Alterations to physical habitats

Morphological alterations (also referred to as physical alterations) to surface water bodies can cause significant ecological changes. Some examples of morphological alterations and possible effects on ecology are:

- land claim for ports or housing can lead to loss/damage of intertidal zones and, therefore, loss/damage of species supported by such habitats;
- structures for coastal protection or sea defence can interrupt coastal sediment transport leading to loss of sedimentary habitats and causing changes in species composition;
- river straightening or channelisation for agricultural, urban or flood defence purposes can result in loss/damage of habitats and loss/damage of species found in such habitats;
- weirs and impoundment structures can interrupt or prevent downstream movement of sediment leading to loss of sedimentary habitats and therefore changes in species composition.

Substantial man-made alterations to a water body for activities such as navigation, water storage, flood defence or land drainage may mean that it is not realistically possible for that water body to achieve good status. The Directive recognises that the benefits of such uses need to be retained and allows such water bodies to be designated as heavily modified

[31] http://www.statistics.gov.uk/downloads/theme_economy/Final_SIC_for_GVA_by_region_1989-2001.xls
[32] http://www.sepa.org.uk/wfd/easg.htm economics of water use research project (Tables 9.3 and 11.1)
[33] http://www.sepa.org.uk/wfd/easg.htm 2004 est (from Dynamics of use)
[34] Scottish and Southern Energy, from personal correspondence, consider this a significant underestimate with their internal calculations giving values up to 5.2p

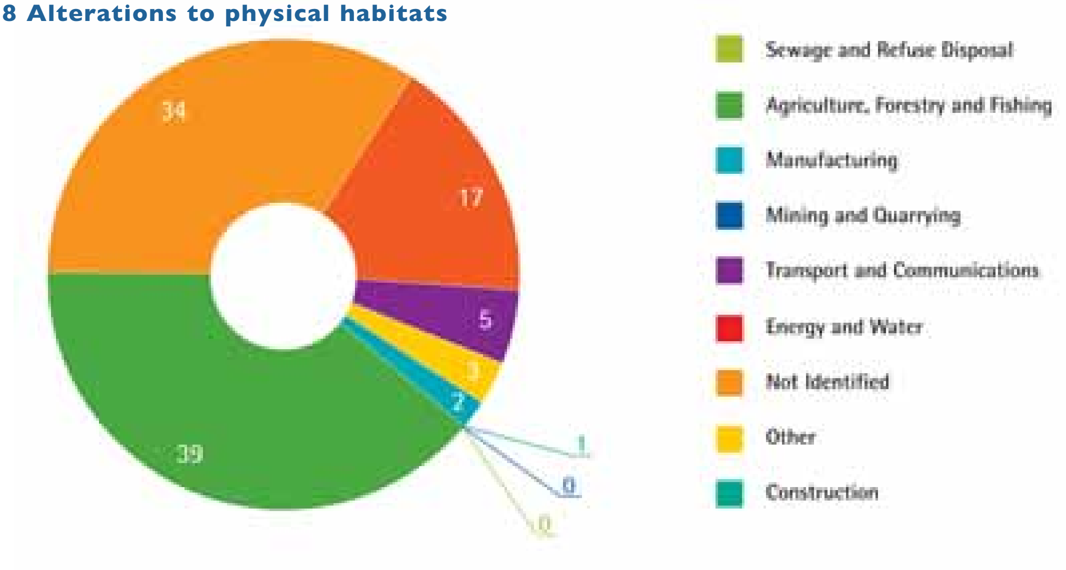
water bodies (HMWB). The presence of physical alterations does not lead automatically to designation and nor does designation mean that mitigation measures will not be required. Designation enables objectives to be set that allow the benefits of the use to be maintained but ensure that other pressures can be managed and that, where possible, the adverse effects of the morphological alterations can be mitigated. The same principles apply to artificial water bodies. Artificial water bodies (AWB) are man-made surface water bodies, such as canals, which have been designed to serve a particular purpose but which can also support important aquatic ecosystems.

Table 12 and figure 8 below show the pressures from alteration to physical habitat for all water bodies at risk

Table 12

Main Industrial Groups	Morphological Alterations
Agriculture, Forestry and Fishing	441
Not identified	385
Energy and Water	196
Transport & Communications	54
Other	32
Manufacturing	19
Construction	4
Mining and Quarrying	4
Sewage and Refuse Disposal	1
Total	1136

Figure 8 Alterations to physical habitats



The table opposite illustrates (where data are available) three measures for each of these sectors. GVA 2001 (Gross Value Added) is a measure of the value of the sector to the economy; value of use is presented in pence per cubic metre and volume of use in cubic metres per year

Table 13 Economic statistics for pressures linked to alteration to physical habitat

Alteration to physical habitat Sector	GVA 2001[35]	Sub-sector	Value of use[36] p/m^3 *	Volume of use[37] m^3/year
Agriculture, forestry and fishing	£827m	Agriculture	23-138 irrigation benefits	Irrigation 8,265,000 m^3/yr
	Fishing £207m	Aquaculture	0.011 to 0.126	Fish farming 1617million m^3/yr 4.4million m^3/day
	£92m	Forestry	n/a	1,737,400m^3/yr
Mining and quarrying	+ quarrying £1,326m	Mining	n/a	+ fuel extraction 7,891,300m^3/yr
Construction	£4,417m	Construction	n/a	383,250m^3/day

* p/m^3 = Pence per cubic metre

[35] http://www.statistics.gov.uk/downloads/theme_economy/Final_SIC_for_GVA_by_region_1989-2001.xls
[36] http://www.sepa.org.uk/wfd/easg.htm economics of water use research project (tables 9.3 and 11.1)
[37] http://www.sepa.org.uk/wfd/easg.htm est(from Dynamics of use)

4 Cost recovery

4.1 Summary of the extent of cost recovery in Scotland

There are three categories of cost associated with use of the water environment. These are:

- the direct costs associated with the use, i.e. the cost of putting in and operating the required infrastructure.
- the environmental costs that result from the use, e.g. the pollution that might be caused.
- the opportunity cost of the use. This is the cost incurred by a person as a result of another persons use, for instance a downstream user may not be able to abstract water if an upstream user has already abstracted all the water.

In Scotland we are still learning about the usage of much of the water environment and there are significant technical issues associated with quantifying environmental and opportunity costs. As a result it is often only possible to make some broad generalisations.

Research was commissioned to establish the extent of cost recovery in Scotland (the Operation of the Scottish Water Market[38]). This report highlighted the limits of our current knowledge in this area and led to the identification of gaps requiring further investigation.

Further information will be published on the SEPA website (http://www.sepa.org.uk/wfd/economics.htm) in the near future.

In England and Wales there is significantly more information available and cost recovery data for the private water companies is more readily accessible. Steps are being taken to harmonise the presentation of cost recovery data between Scotland and England and Wales; comparability will improve in future.

4.1.1 Recovery of direct costs

The vast majority of users of the water environment are private individuals or organisations that are not funded by government. While little is known about the costs incurred by these private users, it can be concluded that they pay the direct costs of their water use.

There are two large users of water that are publicly owned in Scotland: Scottish Water and British Waterways. Scottish Water is subject to economic regulation by the Water Industry Commissioner who has published a large amount of information on Scottish Water's costs and revenues. From this information it can be concluded that by meeting published efficiency targets Scottish Water would recover their direct costs from their customers.

Scottish Water charges and capital expenditure are determined by Scottish Ministers through a cycle of investment planning, called Quality and Standards (Q&S). The current investment cycle, Q&SII, runs from 1st April 2002 to 31st March 2006. This planning process is supported by a strategic review of charges, carried out by the Water Industry Commissioner, to assess the effectiveness of Scottish Water proposals against comparable water companies and set out the likely effect on customer charges. Recommendations from the review are used to inform the final determination by Scottish Ministers and set a ceiling on the total level of annual expenditure, borrowing, charges and operating efficiency to which Scottish Water must conform.

British Waterways (in Scotland) is funded by a grant from the Scottish Executive, trading income and restoration, and third party contributions. They aim to break-even each year and the level of grant and their work programme is adjusted accordingly. In recent years there has been considerable investment on a backlog of safety related issues and this has now been cleared. In 2003/04 British Waterways (Scotland) produced a small operating surplus. Overall British Waterways (UK) ran an operating loss. They have submitted an economic case study and this is available on the SEPA website[39].

4.1.2 Recovery of environmental and opportunity costs

Point source discharges are currently regulated by SEPA under the Control of Pollution Act 1974. SEPA imposes charges on dischargers so as to recover the direct regulation costs.

While this regime prevents some environmental costs being incurred as a result of point source pollution and covers the direct costs of enforcing this regulation it does not amount to cost recovery of environmental costs for point source discharges. For diffuse pollution, abstraction, impoundment and engineering works there are currently few, if any, controls and no recovery of environmental costs.

Put another way, currently some users of the water environment are restricted in the environmental damage they can impose in some activities and they pay for the costs of being regulated. However, they do not pay for the environmental costs that they cause. While it is not possible to reliably quantify this cost the environmental pressures and impacts[40] report shows the extent of the pressures caused by water users.

Opportunity costs are particularly difficult to assess and are often caused by abstraction on which data is very limited in Scotland. The lack of comprehensive regulatory or market mechanisms to ensure that opportunity costs are paid indicates that this cost is not recovered from polluters. Given the limited available data it is not possible to assess how large these costs are and hence how significant an issue this is. However, as Scotland is a water rich and sparsely populated country it can be inferred that, compared to the rest of Europe, opportunity costs of water use are likely to be low.

[38] Operation of the Scottish Water Market report available at http://www.sepa.org.uk/wfd/easg.htm
[39] http://www.sepa.org.uk/wfd/easg.htm
[40] http://www.sepa.org.uk/wfd/easg.htm

5. How pressures on water use are predicted to change over time (dynamics)

Research over the past two years has expanded our knowledge of how water is currently used and what the resultant pressures are on the water environment. Over time this use will change as technology and the underlying economic structure responds to local, national and international pressures. By forecasting the most likely industrial drivers, tying this in with demographic trends and knowledge from sectoral experts, it is possible to generate a view of the most likely future scenario for (in this case) 2015, based on currently available knowledge. Of course, there is no crystal ball and it is impossible to predict random events; these projections must be seen as indicative. They are 'if nothing alters' projections and are the consultants view of what might happen if the (pre-water framework directive) current situation continued. As a result of this the margins of error must be seen as increasing the further we move from the base year.

In this section we have examined the sources of increasing pressure on water use in the absence of constraints from the implementation of the water framework directive. In reality users will, of course, be continuing in their efforts to reduce the use of raw materials including water, and pressure will be brought to bear on existing and new water uses. The growth and structural change of the economy to 2015 might suggest the changes illustrated in the table but these are not predictions of what will actually happen. If we were to predict the actual level of water use many sectors would have much lower rates of growth of use, stable levels of use and in some cases declines in water use.

What the table is intended to illustrate is the source of future pressures. This is important because we want to understand not just how water use has occurred in the past or where water use is occurring at the present but where pressures for access to water might occur in the future. Understanding something about the sources of pressure for the future allows thought to be applied to how potential problems might be overcome before they become insurmountable. At the moment there has been no attempt to separate out these effects on a regional basis, or to relate these increases in pressure to specific water bodies. We will explore how this might be done in the coming years.

This section is based upon an research and development report on the dynamics of water use which is available on the SEPA website[41]. The section concentrates on significant water users in terms of volume. **Table 14** below provides an overview of how water use could change by 2015.

Table 14 Summary of the predicted changes in water use for selected large volume users

		Water use (m^3/yr)		% change
Sector	**Sub-sector**	**2004**	**2015**	
Industry	Electrical & instrument engineering	519.6	604.1	16%
	Chemical industry	315.9	397.2	26%
	Food and drink	260.2	279.5	7%
	Paper	87.7	105.3	20%
	Other industry	917.3	1,053.8	15%
Electricity gas and water supply	Electricity – cooling	27,537.9	33,854.0	23%+
	Hydro – Impoundment	3,355.4	4,143.8	23%+
	Household water supply	266.0	272.3	2.4%
Agriculture, forestry and fish farming	Agriculture	56.5	49.8	-12%
	Fish farming	1,582.4	1,771.3	12%

* m^3/yr= cubic metres per year

+ = The strongly held view of the Ecoonomic Advisory Stakeholder Group (EASG) was that these figures were overly optimistic.

[41] http://www.sepa.org.uk/wfd/easg.htm

The most significant user in volume terms is the electricity generation sector, which is expected to increase its demand for water by 23% over the 11 year period. Hydro power sector experts, however, cast doubt on this assumption and it is worth restating that these figures represent the views of the consultant, based on their knowledge at the time of writing. Despite considerable uncertainty regarding the likely electricity mix in 2015; due in part to the lack of any clear decision as to how to fill the gap created by the decommissioning of the ageing power stations at Cockenzie, Longannet and Chapelcross; **Table 15** shows the assumed likely mix of generating capacity.

Table 15 Predicted energy mix in Scotland in 2015

Type	% of electricity generated
Nuclear	36
Combined-cycle gas turbine	18
Non CCGT gas (i.e. Peterhead)	11
Combined heat and power	5
Wind	15
Hydro	10
Biomass	4
Other renewables	1

The assumptions[42] underlying these projections are examined in the Dynamics of Water Use report[42]

The next most significant user of water comes from fish farming/aquaculture, which is mostly direct abstraction. This sector is expected to increase its water usage by 12% in the period to 2015. **Figure 9** shows the projected growth of gross value added (output) in the sector and the resultant increase in water demand.

Fish Farming

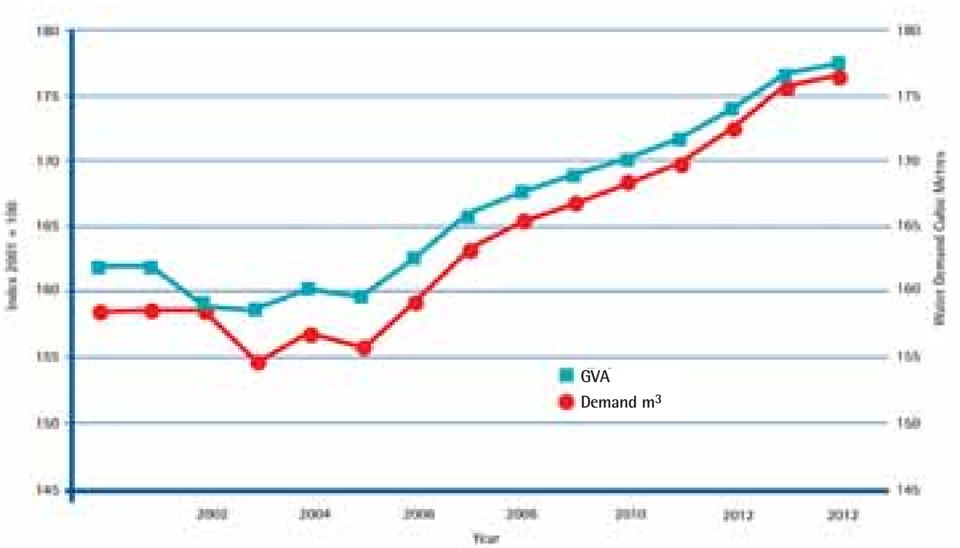


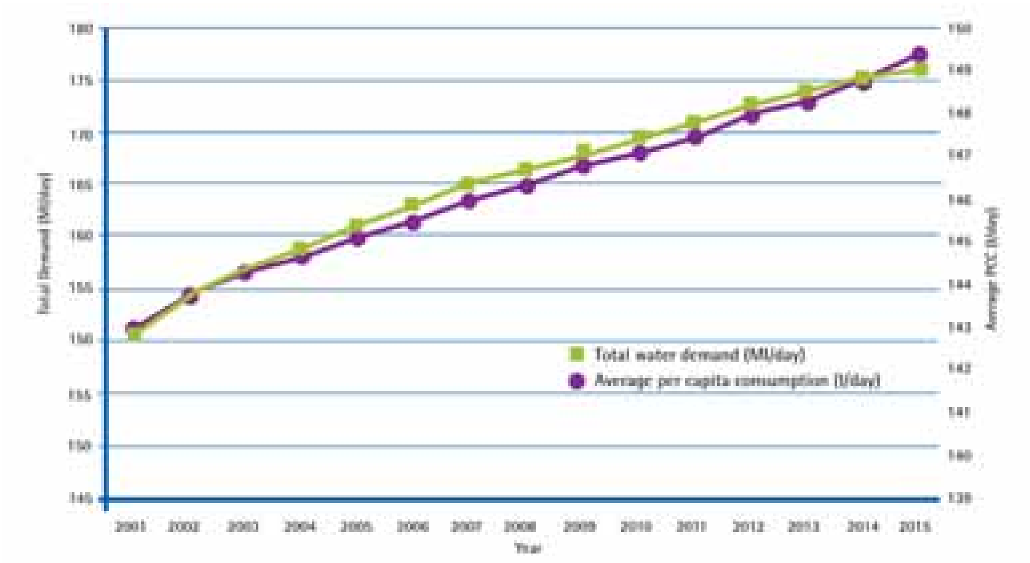
Figure 9 Forecast Gross Value Added and water demand for Fish Farming.

Household demand is also a highly significant use and water use is expected to increase by 2.4%. The population is forecast to continue its slow decline; however the number of households is set to increase as recent demographic trends predict more single parent families and smaller household sizes. Technological improvements in the efficiency of many white goods, although significant, fail to offset this trend. This increase in water usage is depicted in Figure 10 on the next page.

[42] These assumptions should in no way be taken to represent SEPA's desired, or preferred situation.

[43] http://www.sepa.org.uk/wfd/easg.htm

Figure 10: Forecast total and average per capita water demand 2001 to 2015



Agriculture is the only large sector that is forecast to decrease its use of water. Demand is expected to fall by 12% over the period as a result of reforms made to agricultural support mechanisms within the Common Agricultural Policy (CAP), associated intervention price adjustments and world price expectations. For the purpose of this analysis, the models used to forecast future agricultural land use (livestock and cropping numbers) were calibrated to reflect the following policy and market scenario[44]:

- a fully decoupled Single Farm Payment (SFP) system replacing the Arable Area Payment, Suckler Cow Premium, Beef Special Premium, Slaughter Premium and Sheep Annual Premium Schemes;
- a SFP based on historic average claims during a 2000–2002 reference period;
  - Intervention price reductions by 2008 for beef, cereals and milk as laid out by the European Commission in CAP reforms texts;
- Average world price forecasts to 2010 provided by OECD[45] and FAPRI[46] for wheat, barley, beef, milk and sheepmeat.

The effects of these assumptions can be seen in **Table 16.**

Table 16: Basic water demand result for the Agriculture sector

Sub-sector (unit of output)	Present activity level 1,000 head	Activity level 2015 1,000 head	Annual Water use per unit of output/ activity (litres/yr)	Water Use 2002 (m^3/yr)	Water Use 2015 (m^3/yr)
Beef cows (hd)	700.6	700.6	12,775	9.0	9.0
Ewes (hd)	5,251.0	4,439.2	991	5.2	4.4
Crops (ha)	1,718.8	1,671,454	2,100	3.6	3.5
Dairy cows (hd)	214.0	214.0	71,540	15.3	15.3
All other cattle (hd)	1,461.2	883.4	10,038	14.7	8.9
Pigs (hd)	483.0	483.0	10,558	5.1	5.1
Poultry (hd)	38,562.0	38,562.0	94	3.6	3.6
TOTAL				56.5	49.8

(Note: Pigs and Poultry numbers assumed unchanged)
* m^3/yr= cubic metres per year

[44] These assumptions should in no way be taken to represent SEPA's desired, or preferred situation.
[45] Organisation for Economic Co-operation and Development
[46] Food and Agricultural Policy Research Institute.

Estimates have been produced for various industrial uses (specifically electrical and engineering, fibres and, food and drink) but we are cautious about the data underlying these estimates and so do not spell out a definitive ranking. An important point with all industrial processes is the distinction in terms of public supply and that from private abstraction. The latter raises questions about the location-specific impacts and failure to meet quality targets if abstraction demand increases. Although water use in agriculture is forecast to decline by an eighth there will be significant spatial differences and water demand may increase in certain parts.

6. Further work

This is SEPA's first report on the economics of water use. Over the next three years we will further develop our understanding of the issues and enhance the quality and robustness of the available information. This will inform our assessment of the significant Water Management Issues report in 2007.

This report has focused on the uses of water which have been identified as having an environmental impact. Of immediate concern will be to work with stakeholders to develop the means by which economic data can be used to determine the most cost effective combinations of measures in water bodies at risk.

One area which needs particular development is the provision of better estimates of benefits of water use as well as estimates of the values associated with leisure and recreational uses. We will need to develop tests to identify where measures may be disproportionately expensive in time for the start of the Controlled Activities Regulations in April 2006.

Over the period to 2010 we will work towards providing more information on the issues around recovery of costs of water services.

The river basin management planning cycle will take place every six years and the environmental objectives of the first plan will be achieved by 2015, the second by 2021 and the third by 2027. This initial analysis will help us prioritise where further economic information and analysis will need to be collected to support the development of programmes of measures for addressing the significant water management issues in the first planning cycle.

It is not intended to use any of the data contained in this report as the only means by which licensing decisions should be made. However, there is a strong desire to ensure that as the data quality improves it will become increasingly helpful in ensuring an acceptable balance between environmental protection and actions by water users.

As work is undertaken the results will be made available to stakeholders and interested parties via the SEPA web pages.

7. Annexes

7.1 Stakeholder Input

As we mentioned earlier, several sectors took the opportunity to provide studies of their own sector; these studies are published below and are also available on the SEPA website[47]. These studies are published as they were submitted by stakeholders and are, therefore, produced in the writers own words and are not necessarily the views and opinions of SEPA or the Scottish Executive.

As follows:

Sector	**Author**
Agriculture:	NFU Scotland
Aquaculture:	The Federation of Scottish Aquaculture Producers
Coal:	Scottish Coal
Whisky:	Malt Distillers Association of Scotland
Tanning of Leather:	Scottish Tanning Industries
Paper and Pulp:	Confederation of Paper Industries
Hydro Power:	British Hydropower Association
Canals:	British Waterways

[47] http://www.sepa.org.uk/wfd/easg.htm

Water Framework Directive: Economic Assessment of Water Use

Agriculture Sector: NFU Scotland

Summary

1. The EU Water Framework Directive obliges consideration of water use by identifiable classes of user. However, in creating operating rules and controls on those users - to sustain or improve ecological quality of water bodies - it also says that the economic and social consequences may justify mitigation of those measures.

2. In summary, the position of NFUS which it wishes to have taken into consideration in the economic assessment of the industry's water use are:

- Water abstraction controls on agriculture should only exist where a threat to ecological quality arises from water quantity. In those areas where rainfall is high and/or water bodies' volumes are at satisfactory levels, there should be no need to license abstraction.
- Where irrigation needs can be reasonably expected, construction of farm ponds should be supported financially to create substitute water supplies.
- As regards agriculture's contribution to diffuse pollution that affects water bodies, local assessment and monitoring of water bodies should be necessary to justify variation of the Prevention of Environmental Pollution From Agricultural Activities (PEPFAA) Code for application of local standards.
- Regulation should be minimal for those operations that do not represent a hazard to ecological quality of water bodies.

3. Agriculture's principal economic use of water is to add value to precipitation. This statement of the obvious needs careful consideration, because there are two important implications.

- Firstly, if rain falls at a suitable frequency, at sufficient volume and in the right place, agriculture should, in general, have little or no call on water resources from the water bodies which are the subject of the Directive's attention. In an ideal situation, it will not have much need of water supplies from water bodies and it will not impact on these bodies' ecological quality.

- Secondly, rainfall conditions are often less than ideal.

(a) To cater for low rainfall conditions, some demand for crop irrigation and for stock watering should be expected and accommodated, subject to the ecological quality objectives of the Directive. Irrigation, when needed, is a high value water use. Stock watering from abstraction, when needed, or by direct access to watercourses, is a low value water use because farm incomes are not directly affected. However, it presents an important ethical issue because animal welfare is affected.

(b) To cater for high rainfall conditions, any controls on agriculture's impact on water bodies through diffuse pollution should be proportionate to the risks of ecological damage and to the risks of economic damage to farm businesses and their associated activities.

4. These considerations underline the variability and uncertainty of weather with which farmers, growers and crofters have to cope. It would be helpful to have this reflected in the economic assessment of water use. In that assessment's contribution to River Basin Management Plans, there should be a range of uncertainty attached to each class of water user. Agriculture may be able to claim the widest range of circumstances. Under ideal conditions, it could claim the lightest of regulations. Conditions are not always ideal and the sector's potential to pollute can be significant. Also, the sector has suffered from a long period of very low incomes. Therefore, regulation needs to be sensitive to both variable circumstances and to the fragility of the businesses concerned.

[1] Refer to Scottish Fish Farms Annual Production Survey 2002, published by Fisheries Research Service

Background

5. Because the Directive requires the categorisation of waters and a risk assessment of potential damage to ecological quality from reduced water quantity, there must be consideration of abstraction by agriculture. The potential for diffuse pollution from farming operations means that there is also a potential economic use for "waste" disposal, albeit unintentional. Additionally, agricultural businesses will have more conventional demands for water supplies, especially in the dairy sector. These supplies will be from both public and private sources.

6. The economic importance of agriculture to the Scottish economy, and to rural areas in particular, is understated by estimates for the sector's contribution to Scottish Gross Domestic Product. Absolutely, the understatement arises because a principal factor determining variation of value-added through time from market returns is relative exchange rates. Also, there are public benefits of agricultural land use that are not reflected in returns from selling products. Relatively, the contribution is understated because it takes no account of other sectors' dependence on sales to agriculture or of processing industries' input requirements from the sector.

7. About 60,000 full-time equivalent jobs are attributable to agriculture, including self- employment. To this should be added the employment multipliers that account for the effects of supplier firms and in sectors that process agricultural output. This adds a massive 140,000 jobs - to produce a total that accounts for one in ten of all jobs in Scotland. Therefore, the exposure of the Scottish economy to risks of any downturn in the sector's output is significant.

Input Water Demand by Agriculture

8. Curiously, and unlike other sectors of the economy (forestry excepted), much of farming's water supply is direct. In theory, precipitation volumes may be estimated, allowances made for evaporation/transpiration and for leakage to groundwater and to surface waters and the balance represents agriculture's direct use. This arithmetic appears to offer little advantage to the end objective in Scottish circumstances where drainage, not irrigation, is a prime water management issue. However, the choice of agricultural land use will affect the outcome of precipitation's volume contribution to water bodies. The effect of the choice between agriculture and forestry, with its greater transpiration, will be even more marked.

9. More conventional attribution of water use, derived from water bodies, is also fraught with difficulty. Farms may be supplied from public water supplies, from private impoundment, springs, groundwater and surface water. It is suspected that only the first of these is estimated directly. Given some recent difficulties with billing systems, after the amalgamation of the three former public suppliers, it is not possible to be very confident of such estimates.

10. The most recently published estimate (24 February 2004) comes from the "Scotland's Footprint" exercise, commissioned by the Scottish Executive and others. Of the 29,000 megalitres consumption which was attributed to agriculture in 2001 from all sources, 8,000 megalitres were identified as irrigation from private supplies. (This attribution assumes no public supplies of water to fish farming.) Sources for this data were various Scottish Executive publications in 2001, 2002 and 2003.

For comparison, annual household consumption of water was estimated at about 500,000 megalitres.

Water Abstraction

11. Some Scottish farmers, in some places, at some times, need to irrigate their crops. NFUS does not dispute the principle that there should be care to ensure that water abstraction for farm irrigation does not jeopardise ecological quality of abstraction sources. However, not all places are likely to need controls. Where rainfall is high and/or water bodies' volumes are at satisfactory levels, there should be no need to license abstraction for irrigation purposes, nor should there be much demand (ref. Ayrshire potatoes).

12. A 2002 MLURI study for SEERAD examined the likely economic impact of a number of abstraction control measures on irrigated potato production. This can be found at:
http://www.scotland.gov.uk/library5/agri/Potato%20study%20final%20report.pdf

13. Ecological quality of water bodies is not generally threatened by abstraction by farmers. However, the drier places on the East coast where potatoes and vegetables are grown, can require supplementary irrigation. If categorisation of waters shows that controls are needed in these areas, the problem at farm level could be circumvented by creation of ponds and wetlands. These small impoundments would create water supplies from winter rain which could be drawn down, if and when required under summer conditions. Those features would also add to diversity of on-farm habitats for wildlife.

14. Capital spending on farm ponds should be grant-aided. Also, farms that can demonstrate water self-sufficiency should be excluded from regulation.

Combating Diffuse Pollution – General

15. Diffuse-pollution-beating measures should be based on the appliance of science. NFUS has supported the principle of general binding rules but accepts that local requirements may vary. The obligation to observe any variation from the standard rules, as enshrined in the PEPFAA Code, - to meet a particular situation - could be part of that general prescription.

16. NFUS does not deny the possibility of revising the content of the PEPFAA Code, if investigations prove that it is inadequate in general or for particular circumstances. This has been stated in a submission on implementation of the Nitrates Directive.

17. In the context of the mid term review of the EU Common Agricultural Policy, NFUS proposed extension of the principle of cross compliance. It was that all farm support payments be qualified, the basis being standards of good farming practice, for example as was defined in the Rural Development Plan for Scotland. This could provide new and substantial enforcement power beyond the present cross compliance attached to the Less Favoured Areas Support Scheme and Agri-environment Schemes. Our suggestion was accepted. Consultation is underway on Scottish interpretation of the cross compliance requirements that have been set at a EU level.

18. The upside in this situation is that agriculture has an opportunity to be seen to be behaving responsibly. But in return for that, the industry will expect to see more vigorous action to ensure that its efforts are not undercut by cheap imports from countries whose farmers behave less responsibly.

19. The downside that we must guard against is "gold plating" of rules and the higher attendant administration expenses. Regulation should be restricted to known and understood problem areas. Relative to many European countries, they should be few and far between in Scotland. Here, agriculture is much more extensive than is the norm in much of the rest of Europe, particularly in relation to abstraction of water for irrigation.

Combating Diffuse Pollution – Project Support

20. The support of SEPA would be appreciated in getting the Scottish Executive to provide sufficient funding, e.g. through agri–environment schemes, to support relevant environmental projects on farms. While there is now some recognition in the awards system for the contribution that farmers can make, the competitive nature of the schemes mean that the full potential is not being realised. Incentives could be provided for projects that would help implementation of recommendations from catchment management plans.

21. There was a recent announcement of revised priorities for the Rural Stewardship Scheme so that projects relevant to amelioration of diffuse pollution threats would be more likely to be aided. Given that implementation of the Water Framework Directive is an absolute requirement for the Scottish Executive within the terms of the Scotland Act, NFUS does not understand how competitive allocation of resources in this regard can be justified. The same argument holds true for the Habitats and Birds Directives.

22. A particular example may serve to illustrate the extent of the issue. Throughout Scotland it is commonplace to allow livestock access to watercourses for drinking water. Individually, such access points may not represent any hazard to ecological quality of water bodies. Collectively, they could. Therefore, it would make sense, in the WFD context, to have a nationwide scheme of support for exclusion of livestock from watercourses and for provision of alternative drinking water, either supplied from those same water courses or from alternatives such as the aforementioned farm ponds.

23. Total exclusion of livestock from watercourses, would have adverse impacts on ecological quality in some places where the nutrient balances in water are dependent on that source. Such instances should be highlighted by the categorisation of waters and by assessment of habitats. This underlines the importance of local assessment and monitoring.

Charges

24. NFUS agreed with the Scottish Executive's suggestions in the first WFD consultation to reduce the regulatory burden associated with introducing new controls on business. "Controls should be selective, being deployed only where they are needed. The controls should be proportionate to the degree of environmental risk and the controls should be streamlined as far as possible."

25. However, NFUS was also concerned at the possible impact on an already hard-pressed industry of charges on producers to meet regulatory costs. That concern remains. The recovery of regulation costs from those who are regulated does not have any justification when a farm does not pollute or have other adverse impact on the water environment. We see parallels with how the Integrated Pollution Prevention and Control Directive and the Groundwater Directive have been implemented. Regulatory costs fall on pig, poultry and sheep producers who do not pollute the water environment.

26. The polluter-pays-principle may be brought into play in the context of regulating businesses that do have proven adverse impacts on the environment. In that event, the charges should be proportionate to the environmental cost of the activity concerned.

27. Agriculture faces an ever-increasing amount of regulatory red-tape. This can, and usually does, impose compliance costs. Regulatory costs are additional. Agriculture is rarely able to pass on such costs to customers in higher prices because the sector is overwhelmingly a price taker.

28. Burdening farmers, growers and crofters with the full cost to Government of implementing the Directive would have severe repercussions because of low farm business incomes. If existing regulations are not judged sufficient to fulfil the Directive's requirements, administrative and inspection costs of any new rules, introduced in the wider public interest, should be financed from the generality of public expenditure.

The Federation of Scottish Aquaculture Producers *Sector Report 2004*

1 Introduction

The Federation of Scottish Aquaculture Producers (FSAP) is an overarching industry body which includes the 4 main finfish farming trade associations in Scotland, covering companies working in both fresh and marine waters.

The finfish aquaculture sector in Scotland is well-established, and:

- Provides direct and indirect employment for some 8,500 people, many of them located in remote and fragile coastal and rural communities
- Contributes some 50% of Scotland's food exports by value
- Generates around £300 million per annum in farm gate sales, which translates to over £800 million per annum at retail

The industry overlaps with the entire Scottish seafood sector, since many processors and transporters are using both farmed and wild-caught seafood.

The industry is diverse in terms of activity and geographic spread, but freshwater production is generally quite widely spread over much of mainland Scotland, whilst seawater production tends to be concentrated on the West Coast of the mainland, and in Shetland, Orkney and the Western Isles. It has been estimated that aquaculture's physical 'footprint' on the coastal marine zone is some 0.2% of the total, and freshwater trout farms occupy some 2 km^2 of land in total, in comparison with 44,000 km^2 of other animal-producing land area in Scotland

The main sub sectors are[1]:

1.1 Rainbow Trout

- 9 sites using freshwater cages, producing some 3,500 tonnes per annum
- 33 sites using freshwater ponds, tanks or raceways, producing some 2,200 tonnes per annum
- 3 sites using seawater cages, producing some 1,000 tonnes per annum

1.2 Atlantic Salmon

- 81 sites using freshwater cages to produce smolts – total production volume is 409,000 m^3
- 92 sited using freshwater tanks and raceways to produce smolts – total production volume is 41,000 m^3
- Around 330 sites using seawater cages to ongrow market size salmon

1.3 New Marine Species

- 7 seawater sites licensed to produce cod (of which five will be pump-ashore hatcheries, with only two of these really active)
- 12 seawater sites licensed to produce halibut (of which there is only one major pump-ashore hatchery, the remainder being sea cage sites, or pump-ashore ongrowing sites which are currently not in use)

2 Use of water

2.1 Net Water Consumption

The aquaculture industry, no matter how or where it operates, is **not a net consumer** of water. Water provides the physical medium in which the fish live and grow. It provides the necessary dissolved oxygen for respiration (although this can be artificially augmented in some land-based systems), and it carries metabolic waste products away from the fish. In this latter regard there is an environmental consequence of the industry's use of water – just as there is an environmental consequence of all human activity. The environmental consequence of aquaculture use of water is already strictly controlled by regulation under the Control of Pollution Act (CoPA). SEPA regulates the industry, and cost-recovery is achieved for that regulation by way of SEPA charges.

2.2 Abstracted Volume

Most aquaculture takes place in floating cages, whether in seawater or in freshwater. Only a small percentage of the biomass of Scottish aquaculture uses water which is truly 'abstracted' from a water course, and that is returned directly into the water course from whence it came, rather than re-entering the catchment in more diffuse ways.

Future development of rainbow trout production in river-based units is likely (see also Section 3), but it is envisaged that such units will utilise recirculation technology. This should lead to net water quality improvements, as well as the avoidance of any further abstraction.

It has been reported that this small section of the industry abstracts 1,617 million m^3 each year, or 4.4 million m^3 per day[2]. FSAP has not been able to verify the current accuracy of these figures

2.3 Valuing Abstraction

The industry already 'pays' for its abstraction (where this takes place), by way of SEPA discharge consents under CoPA. Abstracting fish farmers are permitted to abstract a certain volume, as part of their consent. In addition, they must meet certain quality conditions for the water they replace into the water course. Non-abstracting fish farmers are regulated on the basis of quality of discharges alone – by applying biomass limits to their consent.

Industry has attempted to work with SEPA consultants in order to arrive at 'theoretical' economic valuations of the use of abstracted water. The most appropriate methodology seems to be avoided cost, and industry has proposed two theoretical models:

Avoided Cost – Oxygen	Resulting in a cost of 0.011p per m^3
Avoided Cost – Solids Removal	Resulting in a cost of 0.126p per m^3

Industry has been assured by SEPA that these sorts of calculations will not be used as the basis for any new proposed charging schemes, over and above what industry already pays.

3 Future Developpments

With rising global demand for aquaculture products, the Scottish industry anticipates further slow and careful expansion over the next few years. However, the industry does not foresee any significant further volumetric abstraction of freshwater, for the following reasons:

- Much of the expansion will come from fish grown in seawater pen systems – including rainbow trout
- The small additional demand for production capacity in the freshwater phase for Atlantic salmon will increasingly make use of the water-saving techniques which have been used as the basis for the 'avoided cost' analyses shown in Section 2. There is already quite widespread use of these techniques
- The additional production of rainbow trout in river-based systems will also utilise recirculation technology (see also section 2.2)

4 Other issues

4.1 Regulation and Cost

The Scottish aquaculture industry already considers itself to be well regulated by SEPA from the point of view of water use. It also considers itself to be one of the most heavily regulated aquaculture sectors in the world, and SEPA acknowledges this reality. Such regulation is not necessarily a bad thing, but all regulation has attached cost which i impacts on international competitiveness.

The industry is also regulated on many other aspects of its activities, not just on the use of water. We face further increases in cost in some of these, as our first look at some of the proposals for inclusion in a future Fisheries Bill confirms.

All of this is set against a clear undertaking from the Scottish Parliament to try to reduce the burden of regulation on the industry.

4.2 Cost in Primary Production

Much like our colleagues in the agriculture sector, we are primary producers of food. There is a good appreciation of the quality of our 'Scottish' products in the international market, and there is no doubt that is assisted by consumers' awareness of Scotland as a green and largely unspoiled land. It is in the interests of all our sectors to maintain that image of Scotland, which is why we broadly welcomed the development of the Water Framework Directive.

However, the 'Scottish' advantage in the market is small and finite, and food production is generally a deflationary sector. Retailers increasingly source products from all over the world, and the pressure on prices is steadily downward. This benefits consumers, but is challenging for our farming and fish farming sectors. However, we are integral to the future of a balanced Scottish economy and infrastructure – there are very few alternative sources of rural and coastal employment in much of Scotland.

Any single proposal for an increase in cost to our fish farmers needs to be considered very carefully.

4.3 Risk

Much of our own operational thinking, and our relationship with regulators and other stakeholders, now focuses on 'risk assessment'. This can sometimes be a rather vague concept, but in the case of aquaculture we have an internationally-recognised model with which to work.

Our concern about the roll-out of the Water Environment and Water Services Act (WEWS) is the potential for increased cost-recovery from our industry because of the increased workload for the regulator (SEPA). We do not dispute the workload, although we have some concerns about efficiency and the apparent lack acknowledgement of modern environmental management and self-regulation tools. However, the increased workload is because of the need for SEPA to meet its obligations under WEWS. We should, rather, be concerned about whether there is any **new** real environmental 'risk' in the aquaculture sector.

The industry would suggest that no new material or measurable risk to the Scottish water environment has suddenly emerged because WEWS has appeared – at least not from the aquaculture industry. Every real risk has already been well assessed under the existing CoPA system, and we are paying our way in 'managing' that risk in Scotland.

4.4 Grant in Aid

There are certainly areas of impact on the water environment in Scotland which can now be addressed for the first time by SEPA, under the WEWS act. The aquaculture industry welcomes this, since these areas have also impacted negatively on our businesses on occasion.

In a perfect world the sectors responsible for these areas could be identified and charged as part of SEPA's need to have demonstrable cost-recovery. If this is not possible, or limited, then we would hope and expect that SEPA's additional costs will be met from general taxation. The benefits of WEWS are ultimately for everyone in Scotland.

Opencast Coal Mining Industry in Scotland
Sectoral Study Paper

Coal Mining in Scotland

1. There is evidence that coal has been mined in Scotland since Roman times but it was the 18th century before coal production was carried out on a large scale as coal became the catalyst of the industrial revolution, which resulted in today's modern civilised society. Coal has been supported by legislation and Government policy since the 13th Century, when a charter gave the monks the right to dig coal in Fife, right up to the current Government policy of supporting the extraction of indigenous coal to provide security of energy supply.
2. Over the years the majority of coal produced in Scotland has been produced from underground mines. In common with the rest of the UK, underground coal mining in Scotland declined throughout the latter part of the 20th Century, with deep mining continuing in Scotland until 2002 when the last working colliery, Longannet Mine, closed. All coal currently mined in Scotland is produced from opencast mines.
3. Opencast mining in Scotland has developed from the small scale operations in the mid-1940's, due to the post- war demand for coal, to today's modern industry where modern heavy earthmoving plant has allowed the development of larger, deeper sites. The nature of opencast mining means that water management is a major factor in any site operation, and significant resources are targeted towards this.
4. Currently around 7 million tonnes of coal per annum is produced in Scotland from opencast mines, 4.5 million by Scottish Coal, the majority being directed towards power generation markets both in Scotland and England.
5. The need for coal as a key energy source as well as being supported by Government policy is also reflected in the Town and Country Planning Act which aims to ensure that coal forms part of an overall planning strategy by identifying coal mining areas and avoiding sterilisation of reserves. Support for coal in the UK will continue as coal fired electricity production will, for the foreseeable future, continue to form a major part of energy supply on which modern society is based.
6. Deep mine working of coal historically provided the main source of employment in many communities throughout the Central Belt of Scotland. Although that industry no longer exists, the present opencast coal industry, which is largely located within an area stretching from Fife through to Ayrshire, provides an important source of skilled and semi-skilled employment within many rural communities.
7. The number of sites and those employed fluctuates to a degree year on year as older sites close and new ones open. In 2003 there were 1,300 people employed directly in 26 opencast coal sites within Scotland, the large majority of which are situated within East Ayrshire and South Lanarkshire. There is also significant downstream employment sustained by opencast mining by way of plant and equipment supply & maintenance; coal haulage and the provision of various support and consultancy services.
8. As Scotland's largest producer of coal, Scottish Coal has a turnover in the region of £110m and an annual direct salary and wages bill (including insurance and pension payments) of £25m and pays some £4m in business rates. It also pays some £850,000 annually into community trusts which provide monies for a variety of community based projects, ranging from environmental initiatives to local community and sports groups. Based on Scottish Coal's proportion of production, the turnover of the sector would be estimated at c. £180m with labour costs of c. £40m.
9. At a wider level the coal produced from Scotland's opencast coal sites continues to be supplied to Scotland's two coal fired power stations at Cockenzie and Longannet. Its generally low sulphur and chlorine properties also make it an attractive product for use in electricity generation plant in England; these exports help sustain employment within Scotland. Opencast coal continues to have a security of supply role amongst the basket of energy sources which are used in UK electricity generation

Water Use

10. It is perhaps misleading to use the term "use", as water is not generally used as an inherent part of the industrial process. It is necessary to intercept and divert to allow the extraction of the mineral.

11. The nature of opencast mining operations, which primarily involves substantial excavations of up to 150 metres depth, means that groundwater is encountered on all sites. To facilitate operational requirements the only practical option for environmental purposes, is to carry out dewatering in advance of excavation operations by pumping from boreholes using submersible pumps. This process is only carried out where flooded old mine workings, usually containing contaminated water, are encountered and has long been recognised within the industry and by SEPA as the most advantageous in terms of environmental impact, as well as the safe operation of sites.

12. On sites where no old mine workings are present the ingress of water into the excavation is normally low because of inherent low permeability in the strata and any inflow of water is managed through local pumping to settlement lagoons for discharge via consented discharge points.

13. Approximately 54 million cubic metres of water is intercepted and diverted by Scottish Coal, the majority being produced by advance dewatering wells. There is no abstraction from rivers or surface water bodies. Most of this water is pumped to settlement lagoons for discharge via consented discharge points and only a small percentage is used for site operations.

Interception and Diversion

14. Of the 54 million cubic metres intercepted and diverted, approximately 11.5% is utilised for site operational purposes. These operations consist of coal processing and washing (1%), vehicle washing (0.5%) and dust suppression (10%). All water is returned to the local water environment through evaporation or via consented discharges to local watercourses.

15. All water that is discharged from opencast sites is via discharge points consented by SEPA. During the planning stage water management plans are developed and agreed with SEPA prior to consent to discharge applications being submitted. During site operations water management plans are developed to include an inspection and monitoring regime aimed at compliance with consents.

16. Consents to discharge normally have fixed parameters for suspended solids, pH and iron content as well as maximum flow rates and also prohibit visible traces of oil in the discharge. Water is treated in conventional settlement lagoons with chemical treatment where necessary, however additional facilities such as oil interceptors, cascades etc. are incorporated as appropriate.

17. When the requirement for pumping has ended groundwater is allowed to recover to its natural state. At this stage restoration landforms can be created to encompass environmental benefits by introducing passive water treatment systems such as reed beds, wetlands etc. with the additional benefit of creating wildlife habitats.

18. One of the unique advantages of opencast coal mining is that given the usual range of mineral to overburden ratios, overburden replaced following extraction can be designed to at least recreate the topography of what was there before. Experience within the industry has shown that through consultation with wildlife and ecology experts, the restoration can be enhanced further to create new habitats.

19. The interception and diversion of water in the opencast mining industry is already adequately covered by existing legislation, namely the Control of Pollution Act 1974 and the Groundwater Regulations 1998. The latter has recently been supplemented by a Scottish Executive Code of Practice for Mineral Operators, which reflects current industry best practice. The industry is aware of the Water Environment and Water Services Act (Scotland) 2003 and is concerned about potential financial implications and in particular those relating to charges for abstraction if these were to be confused with interception and diversion. Such charges could have a serious impact on the viability of certain sites. These sites will typically be the larger production sites which by the nature of the reserves are required to operate at greater depth. The industry is keen to point out that the interception and diversion of water during mining operations is primarily to gain access to strategically important energy reserves, not to use the water for any financial benefit.

Costs

20. The costs of water interception and diversion are not separately identifiable for the sector but can be estimated for Scottish Coal at an average annual cost of:-

	£'000's
Capital costs of boreholes/pumps	112
Repair and maintenance	20
Pump running costs (electricity)	495
Regulatory costs	30
Total	657

This would suggest a figure of c. £1m for the sector.

Trends

21. The basic interaction between water and the opencast coal industry is unlikely to change to any degree. However, volumes affected will generally vary in proportion to overall production.

Measures Available to Sector

22. It is perhaps a statement of the obvious, but it must be borne in mind, that coal is only capable of being worked where it occurs. Opencast sites, by their nature, are inherently a temporary feature, the timescale dictated by the size of the resource and its accessibility within the economic and planning disciplines.

23. Opencast working is simply another method of extracting a mineral resource. The method involves the removal of non-mineral, usually termed as "overburden", which is temporarily stored within the site boundary, to access the mineral. The acceptable ratio of mineral to overburden is broadly governed by prevailing economic factors, linked to the value of the mineral set against the cost of extraction. Water is not used in the accepted sense but is intercepted and diverted, as such, there is little or no scope for varying the location and methodology of opencast coal extraction.

Areas of Concern

24. Whilst not disagreeing with the main objectives of the Water Framework Directive, it is vital that the effectiveness of existing legislation and regulation is appreciated and dual regulation avoided.

25. The logic of applying a reasonable charge to allow SEPA to carry out additional monitoring found to be necessary is accepted under the "polluter pays" principle. However, the application of any future charges must recognise and differentiate between the economic use of water as an inherent part of a process, or indeed a raw material, and circumstances such as the opencast sector finds itself, i.e. intercepting and diverting water in order to access a national energy resource, before returning unpolluted water to its natural environment.

Further Comment

26. It should be noted that opencast mining operations can create environmental improvement by the application of modern mining practices and best available water management techniques, e.g. improving the quality of ferruginous water pumped from old mine workings during site operations and innovative restoration schemes, for example, reed beds and wetlands which can create diverse wildlife habitats for various species, particularly birds. Improved water quality leads to an increase in fresh water invertebrates, increased fish population and mammals such as otters.

27. The interception and diversion of water by the opencast industry is essential to access the nation's strategic coal reserves but is not necessarily detrimental to the environment. With the application of best available techniques in its operational activities the opencast sector can often provide a net benefit to the water environment. However, given the volume of water intercepted and diverted by the sector, and the fact that it is not being used as a commodity, confusion with any proposals to charge for abstraction on a volumetric basis is likely to involve a disproportionate economic effect on the industry and those it employs.

April 2004

Scotch Whisky Distilling Industry
Sector Report

History

The first recorded mention of the art of distilling in Scotland occurs in 1494 with an entry in the Exchequer Rolls of Scotland of "eight bolls of malt to Friar John Cor wherewith to make aqua vitae" for King James IV. Spirit distillation developed commercially over the following centuries and the main documented interest came from Parliament and the Exchequer with the imposition of various duties on spirits and attempts on occasion to restrict the amount of cereals used for production. The Excise Act of 1823 introduced the licensing of distilleries under the close control of H. M. Customs and Excise. Distilleries were established in the Highlands, the Lowlands and the Islands of Scotland and from these roots the Industry as it is today developed.

Structure

There are 87 working malt distilleries in Scotland and 7 grain distilleries. Malt distilling is a batch process using malted barley. Grain distilling is a continuous process and uses barley and other cereals. The malt distilleries produce between 140m and 150m litres of alcohol in the year depending on production requirements and the grain distilleries produce between 205m and 250m litres of alcohol. The grain distilleries also produce neutral alcohol for gin and vodka.

The distilleries are owned by a range of companies, from large international plc's to family companies owning a single malt distillery.

Certain of the distilling companies operate their own maltings in which substantial quantities of water, drawn from watercourses, boreholes and mains supplies, are used as steep water for the barley prior to germination. A substantial proportion of malted barley is also purchased from independent maltsters in Scotland, England and, on occasion, from abroad.

The Industry also has close links with the farming industry. As well as spending over £90M per year on Scottish cereals, distillers supply that industry with various forms of animal feed derived from the cereals and distillation residues and relies on it for the beneficial disposal of sludge and other effluents onto agricultural land.

There are two trade associations which represent the Industry namely, The Scotch Whisky Association based in Edinburgh (SWA) and The Malt Distillers Association of Scotland based in Elgin (MDAS). The SWA, has a wide remit for the Industry, including the protection of Scotch Whisky worldwide. The MDAS is principally involved with the production side of malt distilling, where the development of the Water Framework Directive regime is of particular relevance.

Location

The largest concentration of distilleries is in the Speyside area of North East Scotland with another group on the Island of Islay off the South West Coast. The malt distilleries are mainly situated in rural areas and have operated in sympathy with all aspects of the environment in a sustainable way for hundreds of years.

The Product

Scotch Whisky is produced from natural ingredients, malted barley, water and yeast, and can only be distilled and matured in Scotland. The process and the definition are laid down in the Scotch Whisky Act 1988 and the Scotch Whisky Order. The spirit produced by both the malt and grain distilleries requires to be matured in oak casks for a minimum of three years. For Malt Whisky the maturation period is normally between seven and fourteen years but can be, in selected cases, substantially longer.

Socio-Economic Importance

The Scotch Whisky Industry employs around 11,000 directly. In addition, over 40,000 jobs in Scotland are indirectly supported by the Industry and around 65,000 jobs in total across the UK. In Scotland, many of those employed are located in economically fragile rural and urban areas and the Industry's contribution is therefore significant.

The economic importance of the Industry to Scotland and the UK can be summarised as follows:-

Value Annual Exports – £2,285Bn

Excise Duty and VAT to UK Government – £800M

Wages and Salaries paid in the UK – £1,300M

Goods and Services purchased in the UK – £1,019M

Water Usage

Natural spring water is an essential commodity in the production process of malt whisky spirit. The malt distilleries were developed in their various locations because of the availability of the water, which is gathered from springs and burns and used for mashing in the early stages of production. This represents around 10% of the water used in malt distilling and is not significant in volume terms in any of the water catchment areas in which distilleries are situated. 90% of the water used in malt distilling is for cooling purposes – this is derived from burns and rivers. The cooling water is borrowed and returned unchanged apart from some uplift in temperature, normally to its original watercourse. On a number of watercourses, the same water may be used by several distilleries in its passage downstream. In the course of the use of the cooling water, distillery dams are often used for recycling, and heat exchange systems have frequently been developed in the interests of energy efficiency. Boreholes are also used as a source of water.

Based on the volume of spirit produced the Industry's annual usage of water would be between 2m and 3m cubic metres. This does not have any material effect on the total volume of water in the catchments affected.

Between 30m and 40m cubic metres of water is used for cooling. This is only borrowed and returned and therefore has no effect on the catchment. On tributaries of the River Spey, where there are a series of distilleries, the same water can be used for cooling several times and returned to the same watercourse, unaltered apart from some uplift in temperature.

The Industry is a traditional one and the traditional processes are adhered to in order to maintain the quality and individual characteristics of the spirit. The Industry uses the water it requires for its production, no more, no less, and there is little scope for reducing usage. Most distilleries have implemented heat exchange systems and energy efficiency schemes. Cooling water is often recycled before being discharged. There is therefore not much scope for reduction in, or more efficient use of, water. Major capital investment would be required for the installation of cooling towers, which could not be justified either on economic or environmental grounds.

At some distillery sites where there are abundant volumes of water available, there could be some scope for reducing the amounts diverted by way of lades and artificial watercourses.

Property Investment

Because of the importance of the water and the control of the water resources, distilling companies acquired, often at significant cost, the land from which their production water comes or, alternatively, acquired the legal right to draw on the water. These rights are protected by Scottish Land Law and are vested in the distillery owners, and in most cases have been for over 100 years.

Figures for capital investment in water-related infrastructure and water-related running costs are not available.

In addition to acquiring the water rights the distilling companies have made significant investments in infrastructure and wayleaves to develop their water resources and pipe water to and from the distillery. These investments and the costs of maintaining the water engineering systems represent the economic cost relating to the water. The malt distillery companies do not make any payment for their production and cooling water as it is their own water. Certain grain distilleries and a few of the malt distilleries use mains water for their production. In the blending and bottling part of the process reducing water is used to reduce the alcohol content to the minimum level of 40%. Most distillery offices and visitor centres are connected to mains water and normal water rates are paid for these supplies. It is exceedingly difficult to place an economic value on the water resources belonging to the malt distillers. A distillery without water is of no value. One could therefore capitalise a value based on 20 x the gross annual profit.

Alternatively the value of the end product (NET OF Excise Duty and VAT), excluding brand value, less the cost of materials and production, interest on the capital investment and appropriate profit for the organisation, i.e. the super profit, capitalised, could be equated to the value of the water. This would of course vary from company to company.

Implications of the Directive

At the present time there is no system of controlled water abstraction in Scotland. In general terms, Scotland has an abundant supply of natural water and it has never been considered necessary for such controls to be introduced. The Water Framework Directive has universal application in Europe and the Member States are required to bring in legislation to apply the terms of the Directive. In Scotland this is to be done through the Water Environment and Water Services Act 2002 and the Regulations which will follow thereon. The main concern for the Industry is the introduction of abstraction controls. This, however, will only be in areas where these are required. The legislation provides for exemptions from such controls where abstractions have no significant impact on the water body. The Industry anticipates that most of its abstractions will qualify for exemption. The Scottish Executive have indicated that the regulation of the water environment will be selective and proportionate, which will avoid unnecessary regulation and costs. The Industry takes the view that its use of water resources does not have an adverse impact on the water environment. It is not, in its water usage, introducing any pollution to the water environment and there is therefore no case for its being subjected to any form of environmental charging.

The new legislation requires that the social and economic impacts are taken into account. The social and economic benefits of the public water supply, the hydro-electric generation and the production of Scotch Whisky must outweigh any perceived detriment arising from the use of water resources.

Economic Costs of Regulation

It is accepted that once the new regime is in place SEPA, as the regulatory authority administering the regime, will require to apply charges on a cost recovery basis. There will therefore be costs which will fall on the distilling companies. These will apply at several levels and will relate to the extent of regulation required. As indicated above, many of the Industry's abstractions will fall into the exempt category and these will only require registration with SEPA. The cost of registration fees to SEPA and administrative manpower in the distilling companies should not be significant.

In some cases, the regulatory authority may consider, as a result of its assessment of the local position, that general binding rules be specified for the operation of the abstractions. The administrative cost of this, including SEPA's fees and Industry input, would be greater than would apply for simple registration but again the administrative time should be relatively small and the costs commensurate with that.

In situations where controls have to be put in place, the administrative time which would be involved on both sides could be substantial and the cost would likewise be greater. If, as part of the control regime, the distilling companies concerned were required to install monitoring equipment and maintain records, this could involve substantial capital expenditure and ongoing costs. At the present development stage of the regime it is not possible to know how many sites will be in the control category and what the actual requirements will be.

The Industry does not anticipate that there will be any additional water costs imposed. The Industry only uses the water it requires for its production. There is no way of reducing the amount of water used in the production process as this could affect the quality of the spirit, which would not be acceptable. The only variable in the volume of mashing water relates to the level of production required by the particular distillery.

The cooling water, which represents 90% of the water used by malt distilleries, is also used efficiently and in order to maintain discharge temperatures within SEPA Discharge Consent requirements it would be very difficult to reduce volumes. In any event, the cooling water is only borrowed and on a number of watercourses the same water may be used by several distilleries in its passage downstream.

If at some locations SEPA's discharge temperature requirements cannot be met on the basis of current operational arrangements, the construction of cooling towers would be the only way of improving the position. The costs of these would vary on a site by site basis but a capital investment of around £25M would be required with annual running costs of £2.5M. Such an investment might not be considered economically viable and could put the distillery at the risk of closure. In addition, this route is not environmentally desirable on account of the heavy energy use required.

Concerns

The principal concern that the Industry has is the cost which might be involved at some distillery sites where the water volumes available are not large and can fluctuate seasonally. The cost of compliance with conditions may be significant and production periods may be restricted. Both of these elements could affect the viability of the particular distillery concerned and could bring about closure, with considerable local social and economic impact. It is hoped that sensible application of the regulatory regime can avoid this type of scenario. Restrictions in production which amount to an intrusion on a particular distilling company's water rights could be a compensation issue.

Future Developments

The Scotch Whisky Distilling Industry is a mature one. The level of production is controlled by the current and projected levels of international sales which represent 90% of total sales. While production at the individual distilleries will vary from year to year depending on company and group requirements, there is unlikely to be a demand for a significant increase in production which might impact on the water resources available. The standard five-day production cycle can be increased to seven days and the silent season, which normally occurs over the summer period, can be lengthened or shortened. While there is always the possibility that new distilleries may be developed in the future, such developments are unlikely to be large in production terms and therefore in water usage terms. The temporary or even permanent closure of some distilleries is another possibility. It is therefore unlikely that there would be any more than a 20% increase or a 20% decrease in overall production on current levels in the medium term. There are therefore unlikely to be any major water-related investments or developments in the foreseeable future. From Scotland's point of view, we hope the Industry can maintain and build on its success.

Scottish Leather Sector
Sector report

The industry in Scotland

- The STI group comprises 5 of the larger tanneries in the UK. Four of these are based in and around Glasgow. Additionally there are 3 other dressers/ tanners and a sole fellmonger in Scotland (Total 8). In the UK as a whole, the leather sector has declined markedly over the past generation, from 400 units to less than 40 today. The industry still represents an annual export trade of c £60-100 M. In 1960 the UK produced more leather than Italy. The decline is due to many factors, not least of which is international cost competition (especially with China, Brazil, S Africa, India) and increasing environmental pressure which such competitors do not face. The surviving business occupies niche markets, with high quality, typically low volume supply to specific sectors, especially upholstery, automotive, aeronautical, book-binding and garment leathers. It is a highly traditional industry with tanning often quoted as being the "second oldest profession".
- The majority of firms are family owned businesses and constitute SME size or status often in town centre or historical locations. The economic capacity of such surviving business does not allow relocation or extensive capital investment. The vast majority are also in at least their second century of operation and operate with strong local links. One surviving UK tannery has mention within the Magna Carta. There have been no new tannery businesses within the last 20 years. It is highly unlikely that the industry will grow over the next 10-15 years.
- Leather manufacture utilises a by-product of the meat industry, which culls some 8 M bovine head in the UK each year. Overseas acquisition of this raw material tends to maintain high prices. Increasing automation over recent years has been necessary to reduce labour costs / hide.
- Scottish (and other UK domestic) hides are of high quality (husbandry and breed issues). This, in addition to plentiful "soft water" supply and a residual chemical sector are some of the reasons for local industrial survival. The recent BSE and F&M issues have placed additional burdens upon the sector though have also restricted some trading of UK hides overseas. The UK High risk status is set to end within 2004/5.

Water Use

- The manufacture of leather is an intensive water using process. Approximately 20 Tonnes of water are used for the processing of just 1 tonne of raw hide (30 hides) to finished product. This one tonne of raw hide will generate only some 300 kg of saleable leather product. The remainder of the raw hide, plus surplus and non-exhausted process chemicals constitute the effluent loading.
- The manufacture of leather (bovine) is a multi stage process, often with up to 20 separate processing steps, from soaking of hides, unhairing, deliming, bating, pickling, tanning, neutralisation, retanning, dressing and finishing. The process often takes place in open baths or drums, with rotational mechanical action. Strict process parameters are maintained within each stage. The effluent from the discrete stages is separated in order to reduce odour formation. Mechanical / physical processes of splitting, fleshing and surface coating supplement the manufacturing process.
- Water quality required for leather manufacture must be of Class 1 river quality. Many tanneries derive water from ground or privately owned surface sources. Drinking water is also applied, though often softened, prior to use.
- The high concentration of the effluent generated (average 10-20,000 mg/l COD) requires extensive treatment prior to sewer discharge. Few (if any remaining) tanneries discharge to river for this reason. Step changes in production and improved chemical exhaustion are developing, though new compounds carry additional cost burdens, restricting widespread adoption.
- Tannery effluent treatment is highly specialised. Effluents are almost all sulphur containing and accurate maintenance of pH, together with suitable coagulant dosing are imperative. Secondary treatment is applied in only 1 unit in Scotland. Trade effluent charging is therefore highly significant within operating costs. Site locations however (historical) largely preclude extensive treatment plant construction (space restriction) or operation (planning requirements, site licence conditions).
- The application of advanced treatment processes such as Membrane Bioreactors is feasible where site (economies of scale) and conditions allow.

Forward drivers

- The current cost of effluent discharged (£1-2/m^3) and water purchased (£1/m^3) facilitate investigation and instigation of advanced treatment technologies. The concern regarding future discharge consent tightening and the expected elimination of target compounds within effluents discharged (WFD et al) to sewer also facilitates a greater interest in such technology. It has been shown that these advanced systems will allow for a 4-5 year payback (2004 costs), though as discharge charges rise, (15%/year is predicted until 2006) it is widely expected that the technology will be selectively applied within surviving business units. The benefit in application is due to water recycling. A blend (e.g. 50:50) of treated : fresh water is suitable for application throughout most of the production cycle thus reducing the volume discharged (principal charging component). This may however restrict the "quality" development of the product. Further treatment requirements as determined through further tightening of discharge constraints will require subsequent tertiary stage treatments. These may not be so economically favourable.
- Increasing discharge constraints will lead to increasing tendency towards recycling. This is inevitable where increasing water costs and increasing standards are progressing. If the standards required are so stringent as to require the discharge of "river quality water" or better, then reuse becomes viable.
- It is highly unlikely that the smaller tanneries will invoke such technologies due to the capital outlay required.
- The domestic implementation of the landfill directive also places extreme pressure upon the sector. Biodegradable waste generation is a natural consequence of processing a proteinaceous raw material. However, increasing landfill taxation, site costs (pre closure) and the reduction in suitable landfill sites (50% of 2003 sites in Scotland will close by end 2007) all add further environmental pressure to the business. EU and domestic restrictions also restrict beneficial use application.
- The development of Renewable energy systems (RES) e.g. energy from waste (for energy cost saving and waste avoidance) are provisioned, though none are applied in the sector. It is likely that only 3 or 4 sites in the UK could apply such technology directly. Off-site application of the technology is also viable and the waste generated from tanneries is applicable.
- The application of these water saving (recycling) and energy recovery technologies is a pertinent economic and environmental driver for the sector survival towards 2015.
- The increasing raft of environmental legislation, climate change C taxation, REACH (European Chemicals Policy) and increasing cost competition from overseas will inevitably see the loss of further industry in Scotland (& UK). The European Chemicals Policy represents one of the biggest threats to the whole sector and is being vehemently opposed by the sector and chemical suppliers alike. Its application is likely to mean that the specialist products used by the UK leather sector (niche markets) may no longer be available in the EU (or be at vastly inflated cost) thus preventing purchase and economically competitive product manufacture.
- The development of "plastic" products or artificial leather has not had a significant impact on the sector. These products may even highlight the benefit of leather!

Looking Forward

- The Scottish Leather Industry is already consolidated. It is a mature business, with hide and product trading links, employing some 600 people. Environmental pressures, with perceived restrictions in both supply of raw materials and discharge of target compounds will threaten survival.
- It is clear that those businesses remaining will require not only a policy towards achieving "zero discharge" but also be in a position to recover energy (re CCL, ETS). The environmental costs in production are typically 5-10% of turnover and will continue to rise. Overseas competition especially has advantages in labour rates and will continue to acquire market share. Margins are extremely low.
- The continued acquisition of niche market sales, with effective business management and strong strategic development are essential to allow competitive survival of at least some of the current industry. The expansion of the EU with huge raw material and labour resources presents an unknown challenge to the (UK &) Scottish Sector. Uncertainty is the greatest challenge as the continually changing legislation prevents sound long term investment.
- The Automotive leather sector is however growing at ~5% / year, though competition also grows, with the leather manufacture and production chain becoming increasingly international.
- The relatively small leather sector in Scotland is unlikely to have a significant impact on a river catchment. The output from the sector is unlikely to increase further over the next decade. Thus it is hoped that stringent restrictions upon discharged effluent composition could be avoided or curbed. This would also facilitate continued sewer discharge and utilisation of the water industry infrastructure, as is now being heavily invested within.

W Bowden, Scottish Tanning Industries Ltd.

Cc Mr Ian Harris – Clyde Leather

Much of the above cited from discussion and used with permission from;

Mr P Pearson, BLC (British Leather Confederation).

Report on the Current and Future Significance of Water to the Paper Manufacturing Sector in Scotland

The Scottish Paper Industry

1. Paper has been made in Scotland since 1591 when Mungo and Gideon Russell set up a mill at Dalry in Edinburgh. Whilst that mill has long since passed into history, the Russell name still exists in Scottish papermaking. Now, as then, access to water was the basis of the industry and remains a key factor in paper mill location.
2. Although markets are now global, the origins of the industry can still be seen in the locations of Scottish mills. Nine of the twelve paper mills in Scotland are concentrated in the Forth/Clyde valley and Aberdeen. Apart from readily available water, the rags used as raw materials and the customers needing paper were in towns and cities, dictating where paper mills were built and using the canals and rivers for transportation.
3. The first papermaking machine installed in Scotland was at the Peterculter mill in 1807. Many of the early machines were watered powered. It was not until the middle of the century that steam took over as the power source, which also allowed the introduction of steam filled cylinders on the machine to improve drying. Over the next century, the drive for better, more reliable, all year raw material supplies led to esparto grass and then trees being used as fibre sources.
4. The structure of the industry has always been different to that in England. High quality graphics papers has been a focus, whether supplied as 10-15 tonne reels for high speed printing presses or as cut sheets for such as security papers, books, advertising, archive purposes and office printing and copying purposes. Recent trends in personal computer and associated home printing and copying have introduced a broader, if low volume, customer base.
5. Most mills use imported, treated woodpulp for raw material, although one graphics mill produces mechanical pulp from trees. Two other mills use recovered paper as raw material and produce papers for the plasterboard and packaging industries. Neither tissue nor newsprint is produced in Scotland nor is there a manufacturer of chemical pulps.
6. The Scottish paper industry has learned to adapt to wider competitive pressures over the last several decades, but even so, 5 mills have closed since 2000. Although cost efficiencies are constantly under review, continuing pressures from currency fluctuations, global economic downturn, low priced imports, and energy pricing and regulatory changes have eroded margins to the point where most mills see little profit.
7. The annual economic value of the sector to the Scottish economy in 2003 is summarised as follows:
   - Turnover: in the region of £700million
   - Capital Invested: in the region of £350million
   - Production: 1.25million tonnes
   - Recovered Paper used: 307,000 tonnes
   - Direct employees: 3380
8. In addition, there is an indeterminate number of people both directly and indirectly dependent on the industry for an income. This is especially important as a number of mills are in local communities rather than larger conurbations.

Use of Water

9. All paper mills in Scotland are permitted under the Pollution Prevention and Control (Scotland) Regulations 2000 (PPC). All data are available on SEPA's public registers. This includes efficiency of water use (and so by inference, "licensing" the amount abstracted) as well as discharge quality criteria and extends a legal structure that has existed since 1974.
10. Improved efficiency has resulted in major reductions in water demand, but it remains a fundamental part of the paper making process. Apart from steam and power generation, water is needed to separate the fibres in the raw materials and to carry them onto the papermaking machine so that the structure of the new sheet forms properly. Unless this happens, the paper quality will not be good enough for later processes such as printing. The water is then recovered and treated. The extent of re-use depends on product specification. The focus on graphics and speciality papers means the opportunities for reuse are more restricted by product quality criteria. Customers will not accept off-colour papers or marks due to contaminants being carried over from previous water use. Cleaning can remove larger solid contaminants, but adding more chemicals in intensive treatment to allow re-use is a questionable practice

environmentally, as well as making final treatment before discharge more complex. Currently, there are several studies under way in the wider UK industry on the potential of ultra filtration techniques and these are considered in the "Future Measures" section.

11. Most Scottish paper mills use ground or surface water for process and cooling purposes. The only reason for not doing so is because of salt or other mineral content. Generally, mains water is only used for catering and hygiene purposes. The used process water is then either treated in-house under the PPC permit or discharged as trade effluent under contract with local sewage providers.

12. All paper mills have boiler plant to generate steam, which then passes though banks of cylinders on the papermaking machines to dry the paper web. The residual heat is then used for ventilation to improve moisture removal and for hot water and heating in other areas of the mill. Some Scottish mills generate electricity as well using Combined Heat and Power plant (CHP). These often offer twice the efficiency levels of imported power from utility generators. The paper industry has one of the best balances between heat and power demand to make the most of the potential efficiencies such plant offers, but currently, the economics of existing CHP are very questionable due to high gas prices. New investment in CHP is not taking place.

13. A small, but positive contribution to Scotland's renewable obligation is also being made by the industry through water turbines. A number of mills have reinstated these and are reviewing the benefits, as they are very flow dependent. Where SEPA considers this necessary, which could, for example, concern turbine condenser cooling water from steam turbines, temperature is a PPC permitted condition. Adequate flow being available from surface waters is an important factor in stabilising the temperature of these efficient power generators.

14. Overall, the data show that although there are substantial inputs of water, only a small proportion is lost. In effect, water is a carrier in the process rather than being consumed. Not all of this is returned directly to rivers as effluent volumes going for external treatment will be discharged at other points. Often, effluent from paper mills is welcomed by those treatment companies as they provide dilution that they would otherwise have to pump from new sources themselves. Indicative figures for water in the Scottish paper industry are as follows. These do not include water turbines as this distorts the data in terms of mills usage, as the turbines are positioned in the water course and the water passes through.

    - Water abstracted: 34 million m^3 per annum
    - Water discharged: 33 million m^3 per annum

    The trend in PPC permitting is to require mills to retain rainwater within the in-house system. In effect this equates to mills being "bunded". This means that comparable data could be more difficult in future with the most immediate indicator being mills discharging more than they abstract.

Costs of Use

15. Mills continue to be affected by substances in incoming water, particularly when these are variable over short periods. For example:

    - the trend towards very heavy downpours in late autumn and winter raises the levels of humic and fluvic acids and produces peaty coloured river flows. This discolouration affects the paper quality and the water cannot be used for boiler purposes without additional treatment;
    - high pH levels resulting from run off from agricultural land affects the paper making process which is set up slightly to the alkaline side of neutral;
    - nutrients, which may come from either agricultural run off or sewage treatment, also affect paper quality and may interfere with effluent treatment systems.
    - bacteria from river system require use of biocides to sterilise process water before use.

16. All of these can be neutralised, but this requires increasingly sophisticated investments both to identify variability and then to treat chemically. An example of the existing costs involved for one mill for various water treatment processes are:

    - Incoming water for process purposes: £100,000 per annum
    - Demineralisation of boiler water: £183,600 per annum
    - Effluent treatment: £433,000 per annum + £300,000 for biosolids recycling.

This is in addition to the capital costs, which will be in the range £0.5 - £2.5 million.

17. Whilst mills are generally treating water discharges for materials added during their manufacturing process, those mills recovering and recycling paper are paying to deal with materials extracted. These will have been added to the surface by other processes in the supply loop. The consequence may also be that the mill finds itself in breach of its PPC permit in circumstances for which no responsibility should ensue.

Trends in Use

18. Traditionally, paper has been seen as closely linked to change in GDP. That link is becoming less obvious, particularly for the Scottish industry, which has created export opportunities. This must continue if the future of these mills is to be assured. All of the graphics mills using imported pulp as raw material are often competing in markets with products from those same pulp producing companies. The declining UK manufacturing base has also affected packaging concerns, where products are now imported complete with packaging produced in, or close to, the country of origin.

19. Much depends on product trends and changes, but this is by no means the only potential influence. Incremental change alone would be expected to be matched by efficiency improvements leading to little overall change in water demand but an improvement in relative efficiency. The more difficult question is whether there will be new investment in the Scottish industry, which is inherently linked with Scottish economic and environmental policy.

20. At present, Scotland has only two mills that recycle recovered paper and these manufacture packaging and building board grades. Newsprint can be made from 100% recovered paper, yet there is no production capacity in Scotland. Similarly, tissue, the growth market, has no Scottish production capacity either. If investment is made in such capacity, (which means 400,000 tonnes and 50,000 tonnes respectively), then water demand will increase by between 9.5 - 10 million cubic meters per annum on current best practice data.

21. The need for major water investments is probably limited. Most Scottish paper mills made changes to watercourses in earlier eras to access far higher throughput levels than are now needed. This suggests that the primary need will be to maintain existing facilities rather than to make fundamental change. This has also led to wider benefit as public access is often given to these water resources as an amenity benefit, all of which are maintained at cost to the mill.

22. Any new investment in paper machines may alter this of course, either in terms of bringing water to add to existing capacity or for handling materials and products in dock type arrangements. Similar results could occur if mill supplies come under pressure due to surrounding development and sources further away are needed.

23. Other factors affecting change are:

- that landfill reduction commitments will become increasingly stringent. Whilst export markets will become part of the trading picture for recovered papers, quality requirements will also move into line with those needed in the wider UK industry;
- if customer specifications change to include higher levels of recovered papers in traditional graphics grades. This is still unlikely to affect water demand significantly provided the quality of recovered paper is maintained. Contaminants have an adverse effect on the process and require capital investment at levels often removing the commercial viability. If this requirement is met and the market demand is judged as long term, Scottish papermakers should benefit. At present, though, there is little evidence of the wider market making this specification change and some doubt as to whether quality can actually be maintained in grades in which a large part of the Scottish industry specialises;
- trends to shorter order books and "just in time" style practices. Mills that produce a range of products, particularly where colour is involved, have to balance carrying stock against being able to supply against limited response time to gain the order. Often this means changing colours and washing down more often between product runs. The increasing emphasis, for example, on hygiene with those products likely to be used in personal or food packaging is another factor meaning increased wash through of all systems to prevent the build-up of microbiological contaminants. These are important, of course, but these trends will move water consumption away from the optimum.

Measures available to the Sector

24. Over the years, the UK industry has carried out a number of projects with various Government agencies on water reduction techniques. Apart from the normal housekeeping practices, this had led to design improvement on pumps and associated equipment used to move water around mills and the maintenance arrangements. The paper sector is one of a few where water systems dictate the design of the process and need their own management system.

25. There is much interest in the potential of alternative final treatment technologies to reduce costs, as shown in the costs data, effluent treatment plant is expensive both to install and to maintain and involves large standing costs due to the size of the "footprint". It is also becoming increasingly expensive to discharge treated water to the environment, even though the discharge quality is specified in the PPC permit. Therefore there is much incentive to develop techniques that allow reduced water use by cleaning and recycling process water.

26. Earlier mention was made of ultra filtration techniques. Electro and membrane technologies are under consideration at present. Both are feasible on incoming water, where the variants are fewer and the rate of variation less marked. Most mills using surface abstraction have to treat incoming water to gain required quality and consistency. Increasingly, though, this is also needed for borehole water, due to nitrate addition. Several research projects are in hand to determine whether these techniques will work for treating paper mill effluent, but with little success so far.

27. Although low in toxic content, paper mill effluent is high in solids, whether pulp or recovered paper based. This means that frequent maintenance is needed and the variable colour and BOD content makes it difficult to maintain an optimal operating range. There is confidence that this or a similar technology will emerge and be proven over the next decade, but at present they are not viable.

Others

28. There is a strong connection between any paper mill and the surrounding environment. There is a specific example of this in Scotland that has been formalised in law and affects both paper mills and other users. The legislation provided for the construction of sluices to control the outflow from Loch Leven and for several miles of artificial waterway, or ‘cut’, to channel the river across its flood plain. The abstraction arrangements were put in place by the River Leven Acts of 1827 to 1835. The legislation also established the River Leven Trust to maintain those works and to control water flow with a duty both to minimise flooding and to provide adequate water supplies to industry served by the river. Water drawn from the Loch is governed by the level in the Loch and not the needs of the users.

29. The Trust is a statutory local authority, reconstituted in 1949 to include representation from Fife County Council (now Fife Council). The Board of Trustees consists of Fife Councillors and representatives of the active users of the falls on the river on which rates are assessed and levied to provide income for the Trust. The place of such a Trust in the Water Framework Directive structures is being discussed by the parties involved, but currently, the Trust carries duties for capital and revenue costs to maintain the structure of the channel. This is another example of an amenity with public access and an associated ecosystem that has developed coincidentally and is now established and accepted alongside the original purpose of industrial water supply.

30. Apart from the historic environmental and legal interactions, the industry is now concerned about the interface between modern laws. The Water Framework and PPC laws provide practical concerns at several levels, not least over future costs. Paper mills pay for a PPC permit, which currently is in the range £9000 - £15000, in addition to the operating costs and trade effluent charges referred to earlier. Whilst the PPC charge is to cover SEPA's inspection regime costs, PPC also requires SEPA to test a company's compliance with the principle of Best Available Techniques. Apart from requiring minimum discharges in terms of a balance of risk to the surrounding environment likely to be affected against cost of technical measures, this also involves minimising raw material inputs, including water.

31. It will be important to clarify the relationship between these laws, as PPC sectors are already paying for the technology that minimises water needs, as well as for treatment charges, whether direct or indirect. Implementing the Water Framework Directive must result in an equable basis for all users with procedures and associated costs based on realistic and necessarily achievable environmental criteria.

March 2004

Hydropower Scotland

Case Study:

The British Hydropower Association is the trade association for the UK hydropower industry. The BHA represents about 120 companies with a wide range of interests: consulting engineers, manufacture, design, investment and operations as well as specialist service providers (e.g. legal firms). Hydropower accounts for about 40% of electricity that is generated from renewable sources at present in the UK.

Overall description of organisation's interaction with the water environment

Hydropower uses water to generate electricity in three main methods:

- Reservoir fed power plants. Storage hydropower plants involve a dam or weir across a valley or loch impounding a reservoir of water and enabling a regulated flow through turbines at the base of the dam or at a point lower down the valley. Storage hydropower plants in Scotland tend to be medium to small in output. Most of the storage plants in the UK are in Scotland. Storage schemes allow the energy to be generated when it is required and may be used to balance the intermittent output from wind and run of river hydro.
- Run-of-river plants. Run-of-river plants use the flow, or part of the flow, of a river. They often require a small barrage to regulate the flow. Overseas they can be large generators but in the UK they are small units many of which make use of existing structures, such as weirs for flood control or navigation or built on the site of disused water mills. There are many potential sites (possibly thousands) in the UK, particularly in England. The visual impact of run-of-river plant is lower when compared with the larger storage hydropower plants.
- Pumped-storage plants. Pumped storage hydropower comprises an upper storage reservoir and a lower storage reservoir connected by tunnels. In general, the greater the difference in elevation between the upper and lower reservoirs the more economical the scheme. It is the only proven technology for large-scale energy storage and could be used to store power generated by intermittant generators (such as wind) at times of low-demand for use when demand is high.

Excluding pumped storage, there is about 1,376MW of hydropower capacity generating over 40% of electricity from renewable resources. There is approximately 1, 274MW in Scotland. Additionally, there is 699MW in pumped-storage plants in Scotland out of a total of 2,787MW.

Context

The BHA has links to other trade associations active in electricity generation (e.g. the Association of Electricity Producers) or in renewable energy (Renewable Power Association).

Hydropower has a long history in Scotland where the first schemes were small schemes built by landowners building to provide power for their estates. The first public electricity supply scheme in Scotland began operations in 1890 by the extension to the villages of a private scheme built by the Benedictine monks at Fort Augusta Abbey and the first commercial hydropower scheme in the Highlands was developed by the British Aluminium Company (BAC) at the Falls of Foyers in 1896.

War, and the need for large amounts of aluminium in the defence industry, was the spur to expansion of the hydropower industry in the early part of the last century and in the inter-war years. In 1941 the Cooper Committee, appointed to investigate the potential for the development of hydropower in the Highlands, identified 102 potential schemes. The Hydro-Electric Development (Scotland) Act 1943 established the North of Scotland Hydro-Electric Board and the Board's Development Plan, carried out between 1943 and 1965, saw the development of more than 1,000MW in seven schemes. By 1960 there were still 50 schemes left undeveloped out of the 102 the Cooper Committee had identified. In southern Scotland the 16MW Falls of Clyde run-of-river scheme was completed in 1927 and the 83MW Galloway scheme in 1936.

Pumped storage in Scotland has a long history too. The earliest recorded pumped storage scheme in Scotland was a small private power station built in the 1920s to power a textile mill at Walkerburn in the Borders. At the 399MW Cruachan pumped storage plant, 12% of generation is from natural flow and at the 300MW Foyers plant 30% is generated from natural flow. The Hunterston and Torness nuclear plants and the coal-fired plant at Longannet were the original, external sources of power at the Cruachan pumped storage plant. Both plants currently fulfil an important role in balancing the energy on the grid system. This role may become even more important with the increase of intermittent renewable sources.

There is potential to build an estimated 300MW–500MW of larger hydropower plant and there are former water mill sites, water utility and riverine structures that offer potential for small hydropower developments where the BHA believes there is potential to build an additional generating capacity of 250MW-500MW.

Aggregate use and values of water use

In general hydropower is a non-consumptive user of water but in many schemes there is transfer of water between catchments.

The direct benefit of hydropower is the generation of emissions-free electricity. The existing hydropower capacity in Scotland saves approximately 21,670 tonnes/year in greenhouse gas emissions. Development of 750MW-1,000MW of new hydropower plant would save an additional 11,800-15,750 tonnes/year and would have the potential to substitute for imported natural gas, contributing to energy security and a saving to the balance of payments in the future.

The main employment benefits from hydropower plants are at the time of construction. The operations of hydropower plants are often managed remotely, making operational costs low. There are indirect socio-economic benefits, e.g. through tourism and recreation.

Measures to improve water quality available to the hydropower sector

Apart from a slight almost immeasurable rise in temperature and aeration the quality of water passing through hydropower plants is virtually unchanged. Indeed there are good examples of hydro schemes being developed between upper and lower reservoirs providing drinking water to towns and cities without any deterioration in water quality. New developments in equipment design mean that oil-free operations are common protecting from accidental oil spillage or oil releases at maintenance. Hydropower plant operators take a range of measures to safeguard the general quality of the water environment such as maintaining minimum flows through channels beyond the point of diversion.

Range of potential costs

Construction of hydro stations can fall into various categories of cost but in general smaller developments can range in cost from £2,000-£3,000 per kilowatt installed compared to larger schemes which can be installed at a lower cost of between £1,500-£2,000 per kilowatt.

Range of potential benefits

Hydro can offer a number of potential benefits from its operation –

a) larger storage schemes can be used to balance the transmission system and can be turned on and off at short notice.

b) storage schemes in particular can assist in buffering the impacts from flooding by holding back flood waters and releasing them in a regulated manner.

c) new hydro developments, especially storage, can have the benefit of buffering against available output from wind schemes.

d) the major benefit in operating hydro schemes is reduction in greenhouse gas emissions compared to other forms of fossil fuel generation.

Other

1 Hydro has been criticised for its landscape and visual effects. Equally however, it can be argued that over time, with the restoration of vegetation and ground impacts, the hydro schemes themselves become a tourist attraction and can be quite pleasant from the visual impact.

2 There is no doubt that hydro, can have impacts on fish, invertebrates and other aquatic species however in economic terms the benefits from its development far outweigh the concern caused by its negative impacts.

3 Hydro is of course dependent on climatic considerations, especially rainfall and storage schemes are more efficient in availability compared to run of river schemes because of their ability to store water. This of itself can have other positive and negative environmental impacts.

Economic Analysis for Scotland: Case Study from British Waterways

This document is a summary of a more comprehensive study by British Waterways which can be viewed at. A partner document describing BW's activities in England and Wales can be found at www.defra.gov.uk/environment/water/wfd/economics/pdf/useannexes.pdf (pages F28 to F66).

Introduction

About British Waterways

British Waterways (BW) is a public corporation that manages 3,200kms of Britain's canals and rivers (220km in Scotland), and 89 feeder reservoirs (15 in Scotland). It receives grant-in-aid from the Scottish Executive and Defra to help finance its statutory duties. In addition, it earns substantial income from its commercial operations, and has been highly successful in financing non-statutory work from funding bodies (e.g. The Millennium Commission).

BW has statutory responsibilities under the 1962 and 1968 Transport Acts and the 1971, 1983 and 1995 British Waterways Acts. Of particular note is the 1995 British Waterways Act, section 22 of which confers general environmental and recreational duties on BW.

About 70% of BW's waterways in Britain are canals. These are mostly artificial cuts, sometimes comprising sections of canalised river. Artificial canals have no natural catchments and are supplied with water using a system of reservoirs, natural lakes, river transfers and boreholes. The remainder of our waterways are river navigations. They are natural rivers made navigable by the construction of weirs and/or channel reprofiling to provide a navigable depth.

The Scottish Executive's 2002 policy paper 'Scotland's Canals: an asset for the future' sets out their aspirations for Scotland's waterways. It considers canals to be a vital part of the country's future, which, through their full and sustainable development, should deliver benefits for the widest possible range of people.

The waterway network and its uses

Rivers have been used for carrying goods and people since historical records began. During, the Industrial Revolution in the 18th and 19th centuries the need to transport coal and raw materials cheaply around the country led to these river navigations being extended with the construction of artificial canals. However, with the coming of the railways just a few decades later, the network started to fall into decline. It was only in the second half of the 20th century that its recreational, heritage and environmental value was recognised and the decline arrested and restoration started.

Paradoxically this lack of past investment has led to the preservation of the unique cultural heritage of the waterways. BW cares for over 2,800 listed structures, 130 scheduled ancient monuments, 3,270 bridges, 60 tunnels, 450 aqueducts, 1,520 locks, and 1,036 lock cottages and dwellings. In addition the waterways pass through 63 Sites of Special Scientific Interest (9 in Scotland) and numerous non-statutory local wildlife sites. This rich cultural heritage now underpins the waterway system as one of the most important recreation, leisure and tourism resources in the country.

An estimated 14 million visits p.a. are made to Scotland's canals. A wide range of recreational activities is available including: powered and unpowered boating; angling; walking & cycling; general sightseeing; and special events and waterway festivals e.g. Scottish Boat Show at the Falkirk Wheel. These activities have given rise to businesses that are dependent upon the waterways – marinas, pubs & restaurants, canalside shops, etc – which generate employment and help maintain local services, particularly in rural areas.

Other activities sustained by waterways include: freight; water sales; land drainage; regeneration; social objectives e.g. education & training; access for people with disabilities; healthy living; and other uses. e.g. telecommunication cable routes

In recent years, the waterway network has been extended through the re-opening of a number of derelict canals. The most notable Scottish example is the Millennium Link project, which restored the navigable link between Glasgow and Edinburgh across the central belt via the Forth & Clyde and Union Canals in 2002.

Water use and interaction with the water environment

BW's water use in the context of the WFD is set out in Table 1. These uses and their interaction with the water environment are discussed in more detail in Aggregate use section below.

Table 1 BW water uses

WFD definition	BW water use
"water transfer and diversion"	water management
"significant morphological alterations to water bodies"	– engineering operations, i.e. :-waterway maintenance; provision or modification of customer facilities or operational structures; restoration of abandoned waterways, and construction of new waterways
"other significant anthropogenic impacts"	• boat traffic • intensive fisheries
"abstraction, impoundment, storage, treatment and distribution of surface water or groundwater	• water sales
"waste water collection and treatment facilities which subsequently discharge into surface water"	• drainage and wastewater reception

Context

Links with other organisations and sectors

BW has links with a wide range of organisations and sectors which reflects the geographical range and diversity of its activities. These include waterway organisations, customer organisations, local and regional government, NGOs, funding bodies, the private sector, the Scottish Environment Protection Agency, water companies and highway authorities. Full details of these are given in the web based document.

Geographic spread of the organisation

The Scottish Canal network is comprised of the Crinan and Caledonian Canals in the Highlands and the Forth & Clyde, Monkland and Union Canals which link to form the Lowland Canals. All Scotland's canals are within the Scotland River Basin District. A map of our waterway network is shown at the end of this report.

Economic value generated by BW management of the network

The economic value generated by BW's management of the waterway network comprises uses both within and outside of market structures. The estimated value for, or extent of, each activity where it is known if given below. Full details of how each of these figures was derived can be found in the full document.

Market uses

The network is used as the basis of a number of distinct commercial activities, both by BW itself and by private sector business. These comprise: -

- leisure and tourism (£46 million & supporting 1400 jobs);
- water sales (6 contracts in 2002/03; £3.8m in 2002/03 for all BW)
- freight (110,000t cargo handled in 2002/03);
- property, wayleaves and drainage (£672k in 2002/03).

Within each of these, we can distinguish between: value that accrues to BW and is captured through its commercial income; and value which accrues as income to other private sector businesses. The enhanced business activity gives rise to a re-distributional spatial effect in terms of employment within local economies.

[3] A Second Waterway Age: Review of waterway restoration and development priorities. IWAAC, 2001.
[4] http://www.britishwaterways.co.uk/site/UnlockedUnlimited_761.asp
[5] Waterways 2025: Our vision for the shape of the waterway network. British Waterways, June 2004.

Non-market uses

The principal uses not captured through market transactions comprise: -

- the benefits which accrue to the many informal recreational users who are not charged for access to the network (£24m pa);
- a wider non-use / existence value held by the public for the heritage and environmental significance of the waterways (£15m pa);
- land drainage benefits (excluding property drainage listed in market uses above) (£578m capital value for whole BW network in Britain); and
- at a UK level, benefits in terms of balance of payments, particularly through inward tourism by people taking boating holidays (£27m pa).

Aggregate use and values of water use

Water management

BW has a statutory duty to maintain its waterways in a navigable and a safe condition. This involves maintaining water levels within strict limits – a minimum level for navigation, and a maximum level for safety to avoid banks overtopping.

Maintaining a minimum canal level requires feeding water from BW's water supplies when demand exceeds supplies from uncontrolled sources. This is normally the boating season – Easter to early November. BW Scotland's supplies include 15 reservoirs, and many feeder streams. Water demands in canals arise from lockage, losses, and water sales These demands have to be balanced by supplying water into the canal from reservoirs and feeder streams. Rights to these resources were mostly defined in the original canal enabling acts, and have to date been unregulated.

BW's canals and reservoirs are exposed to the risk of flooding from water entering via uncontrolled feeders and from over-land drainage. Maintaining a maximum water level involves shedding excess water in times of flood, using weirs and sluices, into adjacent watercourses.

Where a canal was built across a natural watercourse which could not be diverted into the canal, a culvert or aqueduct was built to take it underneath. These must be maintained to prevent flooding.

Engineering operations

These are activities involving significant morphological alterations to water bodies, and include:-

- maintenance (dredging, bank protection, aquatic weed control, dewatering, channel relining)
- provision or modification of customer facilities (online moorings and wharves, offline marinas)
- provision or modification of operational structures (weirs, barrages, intakes, outfalls, feeders, reservoirs)
- restoration of abandoned waterways and construction of new waterways.

Boat traffic

Boat traffic can affect ecological status through:-

- erosion of banks by wash
- sediment disturbance and mechanical damage by the propeller
- turbidity arising from the above.

Low levels of traffic usually have a positive effect by controlling excessive plant growth. BW has contributed funding to much research in this area

Water sales, drainage and wastewater reception

The total licensed volume of water sales was 246,445 Ml, of which 188,000 Ml were actually sold. There are many discharges direct to BW canals, mostly surface water drainage.

Costs of use

Capital expenditure on extraction, impoundment, discharge and engineering

Capital expenditure in 2002/03 was £4.4M and was spent on property investment, with little if any impact on WFD objectives. There are few opportunities to enlarge the waterway network, and development of new water resources has been rarely carried out, improved management of existing resources having been preferred.

Direct payments, mitigation charges etc.

Expenditure on "major repairs and renovations" in 2002/03 was £83.6M. This is higher than previously due to a temporary increase in government funding to remove the Arrears of Maintenance. We expect it to decline to a baseline level over the next few years.

The following types of engineering works are included:-

- major dredging projects (£6.8M)
- major repairs and renovations to principal assets (locks, embankments, waterway walls, reservoir dams, feeder channels, canal bed lining, pumps, bridges, aqueducts, etc) (£33.2M)
- provision of new customer services, repairs or enhancements to existing, e.g. sanitary stations
- restoration of abandoned / derelict waterways through third party funding

The cost of environmental mitigation measures and regulatory charges is included.

Expenditure on "other operating charges" in 2002/03 was £65.9M. This comprises day to day operational work such as water level control, operation of locks and bridges, aquatic weed control, mowing and hedging, litter clearance, and painting. The cost of environmental mitigation measures and regulatory charges is included.

Trends in use

The four categories of BW water use identified in Table 1 will be looked at in turn in this section. However before this is worth outlining the main driver for many of them – boating. The Lowlands Canal system has only recently been restored to navigation. Therefore boat traffic is growing from a very low base. The numbers of boats based on the canal are forecast to rise from under 300 currently to over 600 within 5 years. This growth rate is much higher than on the Crinan and Caledonian Canals, where boating activity is more mature.

Water management

The amount of water needed to supply the canal system over the next 25 years will depend on how the balance between supply and demand changes. The drivers for change are shown in Table 2.

Table 2 Drivers affecting future water supply and demand

Water supply	
Drivers likely to increase water availability	Better asset management Climate change
Drivers likely to decrease water availability	Worse asset management Climate change Increased environmental protection
Water demand	
Drivers likely to increase demand for water	More boat traffic More water loss
Drivers likely to decrease demand for water	Less water loss

Engineering operations

Waterway maintenance

By the mid 1990s, years of underfunding had left the waterways with serious structural engineering problems which would cost over £300M to repair. BW has been making good progress to clear this "Arrears of Maintenance". This has involved an increased level of engineering operations such as dredging and repairs to principal assets. Provided our projected income is maintained, we expect to completely clear the Arrears by end of 2012. Activity will then reduce to preventative maintenance and ongoing repairs.

Provision or modification of customer facilities

BW aims to double the amount of freight moved on its waterways UK-wide by 2012. The larger waterways are those most likely to be used. Wharves, dredging, bank protection, etc may be needed on some routes. BW also aims to double the numbers of visitors to its waterways by 2012. This will mean that additional boater facilities will be needed such as bank protection, dredging, moorings, marinas and sanitary stations.

Provision or modification of operational structures

The most usual need for this is to modify our water management infrastructure. Usually these are relatively small structures such as side weirs, intakes and outfalls. Major structures such as feeders, river impounding weirs, boreholes and reservoirs are rarely built or modified, but our current review of water resources may conclude that we need more. The demand for tidal barrages will probably continue to grow to improve navigation access from the sea to inland waters, and to improve landscape value by providing permanent waterspace.

Restoration of abandoned waterways and construction of new waterways

IWAAC have summarised the current status of all projects, which amount to about 100, with a total capital cost of about £700M[3]. BW works in partnership to restore those waterways that show the greatest social, economic and environmental benefits[4], with funding from external sources. In Scotland, the River Carron navigation and the River Leven have been identified as priorities[5].

Boat traffic

Levels of traffic will continue to increase as set out at the start of trends in use.

Water services

Watergrid Ltd will be taking on most new water sales business. A more integrated service will be offered to customers, which could involve tailoring treatment of raw canal water to the standard needed, and return of wastewater to the canal.

Impacts of WFD and measures available to improve water quality

The cost of BW measures to meet the new ecological objectives will not be known until the objectives are defined. Until then, costs have been estimated based on scenarios.

Water management

It is assumed that SEPA will use their new licensing powers to regulate our use of water so that the donor water body meets its ecological objectives. This will have a significant cost impact on BW in terms of licence fees, environmental appraisal, mitigation, and monitoring and control. The impact of the new regulations is being discussed with SEPA so costs are not yet known.

Engineering operations

Waterway maintenance

Dredging is essential to maintain the habitat of artificial waters like canals. Some short term impact is unavoidable, but mitigation possible by leaving some biomass in place to allow recolonisation. This is more costly though, and a worst case scenario would be an increase in dredging costs of **£3.4M per annum** UK-wide.

Bank protection is required for erosion control, towpath stability, moorings, and water conservation. "Hard" protection such as steel piling is often needed, and UK-wide, about 50% of our 4400km of canal banks are so treated. We expect that such protection will be allowed for in the ecological objectives for AWBs and HMWBs, provided ecological mitigation is applied. Retrofitting would cost about **£242M.** We do not consider this to be a sustainable or cost effective option, compared with fitting soft in front of hard protection during asset renewal. The asset life of hard bank protection is estimated to be 50 years, meaning on average we replace 44km per annum. The additional cost of fitting a soft edge to this would be **£4.84M per annum.** In addition to this there are about 75km of canal bank on embankments presently without hard bank protection but needing it for structural stability reasons. The cost of providing a soft edge would be about **£8.25M.**

Removal of contaminated sediments may be needed. A 1992 survey found that UK-wide 555km of waterway was "highly contaminated" (BW Class 6). Subsequent dredging has reduced this to about 400km. We do not know if this will cause a failure of the ecological objectives, but assuming it will, the cost of removal is estimated to be £100M.

Provision or modification of customer facilities

Online moorings and wharves require hard bank protection and so the mitigation measures described above are not feasible. Some mitigation for off line marinas is possible:-

- provide shallow margins and soft bank protection where possible, and a flow through the basin to maintain oxygen levels, as advised in BW's Design Manual Volume 3 Landscape,
- avoid sewage and oil pollution as advised in SEPA's Pollution Prevention Guidance No 14 Marinas and Craft, and BMF's Navigate with Nature.

Provision or modification of operational structures

New side weirs, intakes and outfalls are relatively small structures which can take the place of existing natural banks so where that happens we must provide compensatory soft margins nearby. Fish entrapment is avoided where feasible by using guidance in NRA R&D Report No 1 Diversion and Entrapment of Fish at Water Intakes and Outfalls (1992).

Barrages and weirs across rivers are more substantial structures, but are rarely built. They can have very significant impacts and we would expect to be required to carry out a wide range of mitigation through existing planning controls, using guidance in the HR Wallingford publication Guidelines for the Assessment and Planning of Estuarine Barrages.

New feeders or reservoirs can also have significant impacts but again are rarely built. Planning permission would usually be needed, and we would expect to be required to carry out a wide range of mitigation measures.

Restoration of abandoned waterways and construction of new waterways

All the above engineering operations could be included in such a project. As this work is not required on a statutory basis, it may be possible that some restorations may not take place because of the additional costs to comply with the WFD. In this case there will be opportunity costs in terms of the lost social and economic benefits of a restored waterway.

Boat traffic

It is essential that the ecological objectives for most waterways allow for any impacts of increased boat traffic. This is because BW have a statutory duty to make its waterways generally available to boats, and the mitigation measures available are, in most cases, impractical.

Water services

The costs arising from the regulation of canal abstractions and supporting water transfers may reduce the financial viability of some water sales business.

Water grid business involving drainage and waste water to the canal may also be affected. Discharges will continue to be regulated by SEPA, although the standards they set may be tighter to meet the new objectives, leading to increased treatment costs.

Inland waterways managed by BW