LOWER BRISTOL AVON CATCHMENT MANAGEMENT PLAN CONSULTATION REPORT

NRA

National Rivers Authority
South Western Region
March 1995

Published March 1995

FOREWORD

This is the second Catchment Management Plan Consultation Report produced in North Wessex Area and it covers the Lower Bristol Avon downstream from Avoncliff Weir near Bradford-on-Avon together with all tributaries draining to the Avon below that point. We have dealt with the Avon catchment upstream of Avoncliff Weir in a separate management plan, for which a Consultation Report was published in June 1994 and an Action Plan published in March 1995.

This report describes the physical features and factors such as geology and climate, for the Lower Bristol Avon. Importantly, we set out the NRA's Vision for the catchment. We describe:

- the activities in the catchment which affect the water environment and the uses made of water
- the NRA's objectives and targets for the water environment, described under five headings - water quality, water quantity, groundwater protection, physical features and flood defence
- the state of the catchment is assessed in relation to the five categories of objectives.

From this comparison we identify issues which need to be addressed by the NRA and others. These issues are intended to be the focus for consultation.

In the treatment of the Upper and Lower Avon, there are many issues to consider, but in both catchments there are a small number which dominate discussion. In the Upper Avon, the abstraction of water for public supply from aquifers in the Malmesbury area is a major issue and long term solutions could have implications for the Lower Avon.

In August 1994 the NRA completed a two year study which examined the impact on groundwater and river flows caused by these abstractions. Together with the water companies - Bristol Water and Wessex Water - we are working to improve the situation and this is covered in the Upper Bristol Avon Action Plan. There are, however, no easy solutions. If the measures being taken over the next few years prove insufficient, one option may be to substantially reduce abstractions from the Malmesbury area and replace them with equivalent increased abstraction from the lower reaches of the river. Such a proposal would be subject to conditions to ensure there was no adverse impact on the water environment.

The Government sets out a strategy for meeting national current and forecast needs for aggregates and provides guidance to the Mineral Planning Authorities (MPA). As MPA the County Councils are then responsible for the preparation of Minerals Plans which meet the needs identified by the Government, while taking account of local factors such as the water environment. Individual quarrying activity is controlled through the Town and Country Planning legislation by the County Council. As a consultee on planning applications the NRA can therefore influence but not directly control such activity.

Limestone quarrying in the Mendip Hills and the consequential effects on water resources is of major concern. The East Mendip hills include some of the largest stone quarries in Britain. In 1993, six quarries in that area produced about fifteen million tonnes of aggregate. Some 90% of this was Carboniferous Limestone taken from an important aquifer which supplies high-quality drinking water to over 600,000 people in Bristol, Avon and Somerset. Mineral quarrying removes the aquifer and in the process interrupts flows from boreholes, springs and streams, and causes water pollution. This is in direct conflict with the interests of water users who rely on the aquifer to provide sustainable

sources of supply. One of our key objectives is the protection of groundwater from all types of threat, and the NRA publication Policy and Practice for the Protection of Groundwater sets out a framework by which this can be achieved. However, the issue of quarrying on the Mendips is one which goes far beyond the scope of this Report.

We recognise the pressure that development puts on the water environment. The County and District Planning Authorities, though the preparation of Structure Plans, Minerals Plans, Waste Local Plans, District Wide Local Plans and the planning control system have a major role to play in helping to safeguard the water environment. Some rivers in the Lower Bristol Avon have suffered from the effects of past development and we will seek to ensure that Development Plans contain suitable policy options to allow environmental matters to be fully considered along with economic and social factors.

This report identifies thirty seven issues affecting the Lower Bristol Avon. In addition to the concerns outlined above, it covers all aspects of the water environment which we need to consider if we are to succeed both in protecting the water environment and aspiring towards a goal of sustainable development.

We invite your comments and welcome your views on our treatment of the catchment. If there are omissions from the list please let us know. After a three month public consultation period we will prepare an Action Plan based on the issues arising from the report and public consultation.

CHRIS BIRKS
Area Manager, North Wessex

YOUR VIEWS

The Lower Bristol Avon Catchment Management Plan Consultation Report is the NRA's initial analysis of the issues facing the catchment.

We want to hear your views.

* Have we identified all the issues?
* Have we identified all the options for solutions?
* Have you any comments on the issues and options listed?

If so, we would like to hear from you.

Comments on the Lower Bristol Avon Catchment Management Consultation Report are best sent in writing and should be received by 30 June 1995.

To comment, please write to:

Alan Turner
North Wessex Area Catchment Planner
NRA South Western Region
Rivers House
East Quay
Bridgwater
Somerset
TA6 4YS

Tel: Bridgwater (01278) 457333 Ext 4765

THE NATIONAL RIVERS AUTHORITY

The NRA's mission and aims are as follows:

We will protect and improve the water environment by the effective management of water resources and by substantial reductions in pollution. We will aim to provide effective defence for people and property against flooding from rivers and the sea. In discharging our duties we will operate openly and balance the interest of all who benefit from and use rivers, groundwaters, estuaries, and coastal waters. We will be businesslike, efficient and caring towards our employees.

AIMS

- Achieve a continuing overall improvement in the quality of rivers, estuaries and coastal waters, through the control of pollution.
- Manage water resources to achieve the right balance between the needs of the environment and those of the abstractors.
- Provide effective defence for people and property against flooding from rivers and the sea.
- Provide adequate arrangements for flood forecasting and warning.
- Maintain, improve and develop fisheries.
- Develop the amenity and recreational potential of inland and coastal waters and associated lands.
- Conserve and enhance wildlife, landscape and archaeological features associated with inland and coastal waters of England and Wales.
- Improve and maintain inland waters and their facilities for use by the public where the NRA is the navigation authority.
- Ensure that dischargers pay the costs of the consequences of their discharges, and, as far as possible, to recover the costs of water environment improvements from those who benefit.
- Improve public understanding of the water environment and the NRA's work.
- Improve efficiency in the exercise of the NRA's functions and to provide challenge and opportunity for employees and show concern for their welfare.

LOWER BRISTOL AVON CATCHMENT MANAGEMENT PLAN

CONTENTS

APPENDICES

LOWER BRISTOL AVON

1.1. THE NATIONAL RIVERS AUTHORITY

The National Rivers Authority (NRA) is responsible for protecting and improving the water environment within England and Wales. It has a wide range of responsibilities which include:

- flood defence, including the protection of people and property
- flood warning
- effective management of water resources
- control of pollution and improving the quality of rivers, lakes, canals, groundwaters, estuaries and coastal waters
- maintenance and improvement of fisheries
- promotion of water based recreation, including navigation where the NRA is the navigation authority
- conservation of the natural water environment

To achieve its aims, the NRA must work with or seek to influence central government, local government, industry, commerce, farming, environmental organisations, riparian owners and the general public. Successful management of the water environment requires consideration of a wide range of interests and requirements which may sometimes be in conflict.

To assist in its work, the NRA has developed the concept of **Catchment Management Plans (CMPs).** These allow the full range of water management issues to be identified and considered within a geographical area which is relevant and meaningful.

1.2. SCOPE AND PROCESS OF CATCHMENT MANAGEMENT PLANNING

The model for the production of Catchment Management Plans within the NRA has two stages:

- Catchment Management Consultation Report and
- Catchment Management Action Plan

The **Consultation Report** includes the following sections:

- **Uses**

  The uses of the catchment are identified and discussed. Information is normally presented in the form of a map with one or more pages of supporting text. Uses may have impacts on the water environment and/or impose requirements on the water environment. Wherever appropriate, objectives and targets are identified in terms of:

  - water quality requirements
  - water quantity requirements
  - physical features requirements.

- **Objectives**

  By taking the objectives and targets relevant to the area where each use takes place, overall objectives and targets for the catchment are derived. At any location it is the most stringent use related target which must be achieved.

- **State of the Catchment**

  The state of the catchment is assessed against the objectives and targets which apply. Areas where objectives are not met and issues which need to be addressed in order to meet objectives are identified.

- **Issues and Options**

  The identified issues are discussed and where possible some options for their resolution are proposed.

The Catchment Management Consultation Report is intended to form a basis for consultation between the NRA and all those with interests in the catchment. Consultees may wish to:

- raise additional issues not identified in the report
- comment on the issues and options identified in the report
- suggest alternative options for resolving identified issues
- comment on targets set for Catchment

The NRA recognises that many of the options for action identified by the Consultation Report will involve organisations or individuals other than the NRA and their views will be crucial to the preparation of the Action Plan.

The **Action Plan** will be produced following consultation and will have regard to the comments received. The Action Plan will form a basis for the NRA's actions within the catchment and also provide a public document which will form a framework for the NRA's interaction with other organisations. The NRA will be seeking commitment to planned actions by others wherever possible.

Please see inside title sheet for details of how to make your views known to us.

1.3. LIMITATIONS

The finished Catchment Action Plan will inevitably be subject to some limitations, the major examples of which are as follows.

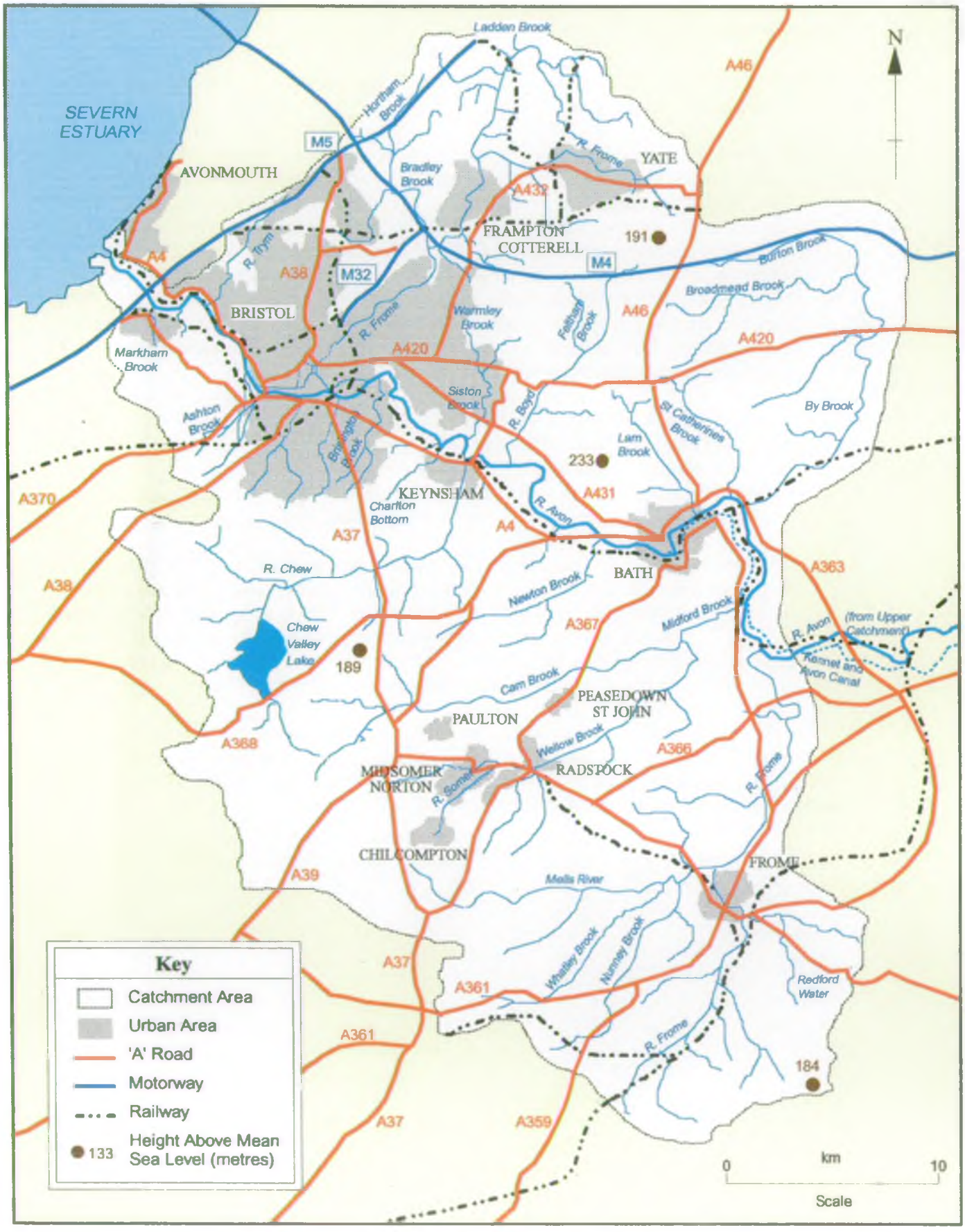
- Where improvement works are required to overcome catchment problems, these works will in many cases be the responsibility of other organisations or individuals. This Authority may have no powers to control the necessary actions directly. Therefore we must ensure that this plan is perceived as an agreed strategy for realising the environmental potential of a catchment within the prevailing economic and political constraints. Improvements required to address catchment problems must be prioritised in the context of the funds available to the appropriate agency. This may be a company or individual who may see little or no financial benefit in carrying out the actions, local authorities with government capping or water service companies with investment programmes approved by OFWAT and the DOE.

- It will inevitably be the case that the achievement of some objectives will depend upon the Town and Country Planning Policy of the County or District Council. The NRA is a consultee to such policy, but it is recognised that the councils are subject to many other constraints in meeting their obligations to the planning process and will not always be able to put needs of the river catchment first.

- The land-use within a catchment is a major contributor to the state of that catchment, as is apparent from this report. In area terms, the largest land use is agriculture, over which, apart from restricted areas (such as SSSI), there are few relevant controls. In cases where farming practice will need to change to permit the catchment improvements to proceed, it will be necessary to obtain the support of the landowners concerned and for them to make such changes voluntarily.

Whilst these limitations will inevitably constrain the achievement of some of the plan objectives, it is essential that these objectives should still be set and pursued. Alternative means of achieving them might be identified, or the very fact of their identification and publication might bring the necessary pressure to encourage those involved to work towards their achievement.

LOWER BRISTOL AVON
The Catchment



2.1. INTRODUCTION

This major watercourse has a large, complex catchment and for the purpose of catchment management plans the Bristol Avon has been divided into two sections, the Upper and Lower Catchments. This report deals with the Lower Bristol Avon from the Avoncliff Weir just west of Bradford-on-Avon to a line drawn between Portbury Dock pierhead and the seaward end of Avonmouth Dock south pier. The Upper Bristol Avon Consultation Report was published in June 1994, and the Upper Bristol Avon Action Plan was published in March 1995. The Avonmouth area will be included in the River Severn - Lower Reaches Consultation Report to be jointly published by Severn Trent and South Western Regions in May 1995.

The Bristol Avon fulfils a number of functions including conveying floodwater to the sea, as a water resource, the disposal of effluents, and recreation and amenity. The river corridor provides a valuable variety of wildlife habitats, is a major landscape feature and contains a number of structures of historical and archaeological importance.

The largest part of the catchment lies within Avon with small areas in Wiltshire and Somerset. The Kennet and Avon Canal, which is managed by British Waterways, closely follows the river from Bradford-on-Avon to the centre of Bath, where it joins the river. The Lower Bristol Avon catchment has three different geological areas which generate three distinct river types in terms of gradient, flow regime, bed material, clarity of water and communities of plants and animals. The Cotswolds to the north and east of Bath form an oolitic limestone escarpment with steep interlocking valleys. The Mendip Hills are carboniferous limestone which is harder than the soft oolite of the Cotswolds, with different landscape and steeper sided gorges. The remaining areas are mainly clays such as Keuper Marl, Oxford Clay, Lias Clay and Coal Measures which tend to form the softer lowlands.

The main River Avon is a slow flowing clay-lowland river, which has been modified by historical impoundment, river engineering for the purpose of land drainage and flood alleviation, and by intensive agriculture in the floodplain, so there are very few wetlands remaining in the catchment. However, the river corridor acts as a vital link between other scattered habitats and wildlife corridors in the wider countryside and is a valuable habitat in its own right. Historically the river and many of its tributaries were impounded (ponded) to serve the many water mills along their length, but subsequent silting and changes of depth brought about changes in plant communities.

The river corridors have many listed and important historical structures including bridges, water mills, weirs and hatches, as well as other archaeological features, because the development and wealth of the area was intimately linked with the river. In the wider catchment, changes in land use have brought about an impoverishment of the landscape so that the river corridors have become increasingly important linear landscape elements which must be conserved and enhanced where they have become degraded.

The Lower Bristol Avon provides opportunities for recreation and amenity. In addition to angling, the river itself is used for a small amount of sailing and canoeing whilst in some

places public footpaths and open spaces allow access to the banks for bird watching and walking. In Bath trip-boats ply their trade and the Bristol Floating Harbour is a major leisure boating facility. A river bus also operates from Temple Meads Station.

Surface abstractions for public drinking water occur from the Lower Bristol Avon at Monkswood Reservoir near Bath (fed by the spring sources in St Catherine's Valley); Barrow Tanks and Chew Valley Lake. Newton Meadows which is a large licensed direct river abstraction is not used at present.

The Lower Bristol Avon catchment supports a diverse fish fauna and at least twenty species of coarse fish are known to be present. It is highly regarded as a coarse fishery and is important for match and pleasure fishing.

The major settlements within the catchment include Bristol and its surrounding area (500,000) Bath (82,000), Bristol (390,000), Keynsham (16,000), Yate and Chipping Sodbury (24,500), Radstock and Midsomer Norton (20,500) and Frome (23,500). The river system receives effluent from forty four Wessex Water plc sewage treatments works and this number may increase due to expansion especially around the Bristol area.

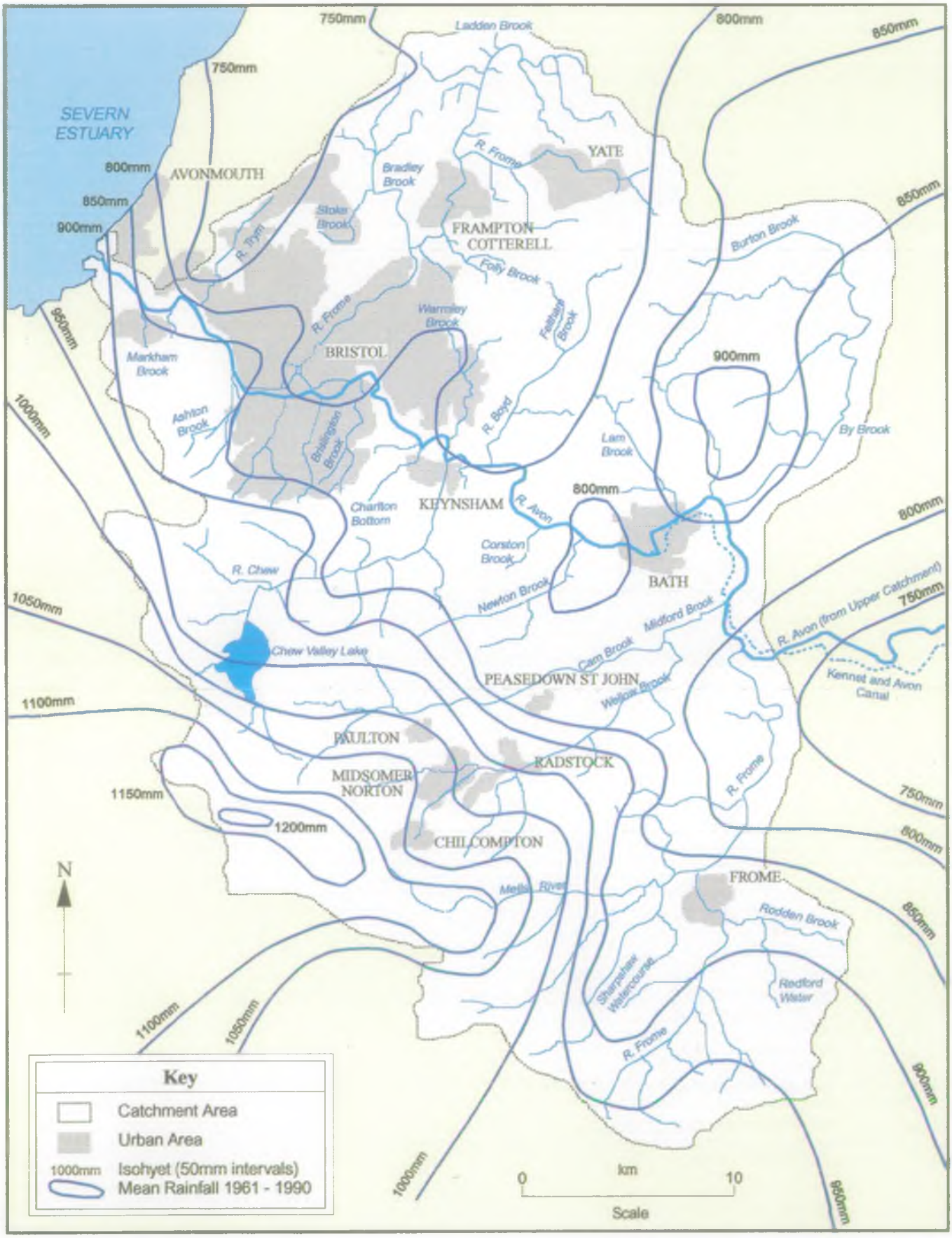
Outside the substantial and increasing urban areas, much of the pasture land of the rural catchment has been improved for dairy and beef production. There has also been an increase in the amount of land devoted to arable farming over the last thirty years. The steeper valleys of the Mells, Cam, Wellow, By Brook and St Catherines support more permanent pasture, often used for sheep grazing.

Industry and employment in the area is diverse. Bath and Bristol are centres of tourism and Bristol is also an important financial centre. The Ministry of Defence has a strong presence in the area. Rolls Royce and British Aerospace occupy a large complex in North Bristol. The food industry is well represented, eg Courage Brewery (Bristol), Cadbury (Keynsham) and Eden Vale Food Ingredients (near Frome). Printing and packaging are an important activity being centred mainly in Bristol and the Midsomer Norton/Radstock area. A major manufacturer of wood care products, Cuprinol, is based in Frome. Quarrying and its associated industries are very important especially in the East Mendips. As previously mentioned, the Avonmouth industrial area is not part of this plan as the drainage is directly into the Severn Estuary. It will be covered in the River Severn - Lower Reaches and Severn Estuary CMPs.

2.2. CLIMATE

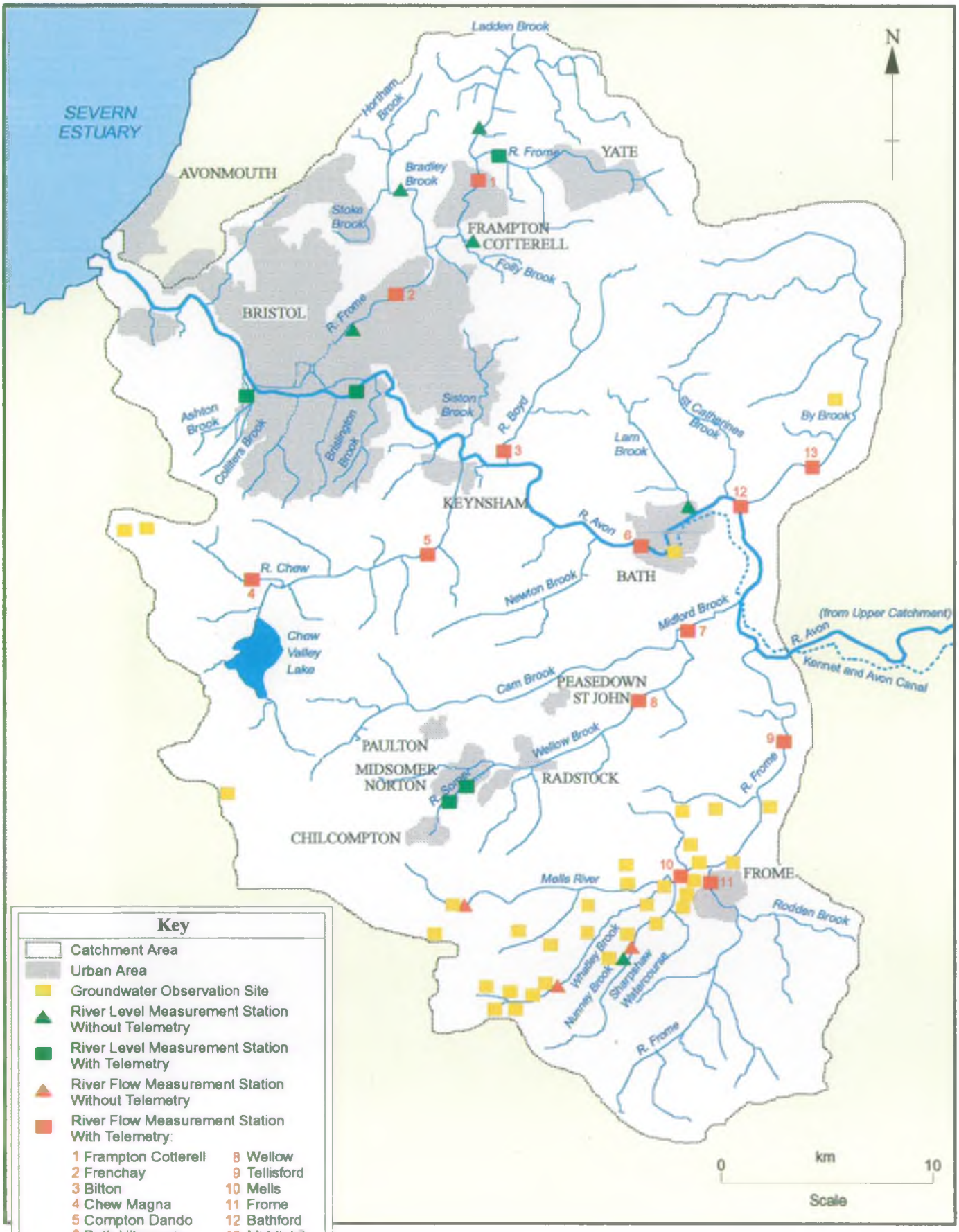
The distribution of rainfall across the catchment is shown in the Distribution of Rainfall map. The range varies from more than 1200 millimetres per year (mm/year) over the Mendips to less than 800 mm/year in parts of the Bristol Avon and Bristol Frome Valleys. The catchment rainfall (1961-90 average) is 880.5 mm/year and the normal loss through evaporation (1961-90 average) is estimated at 522.6 mm/year. The data is collected from a network of different types of rain gauge. Their distribution is shown in Appendix 11 - Locations of Rainfall Measurement Gauges (map).

LOWER BRISTOL AVON
Distribution of Rainfall



LOWER BRISTOL AVON

Locations of River Level, Flow Measurement and Groundwater Observation Stations



2.3. HYDROLOGY

Discounting human influences, the natural flow of water exiting the catchment at the mouth of the Bristol Avon to the Severn Estuary is estimated at 1979 million litres per day (Ml/d) on average. This compares with an input from the Upper Bristol Avon catchment of 817 Ml/d on average. Looking down river, on the left hand bank, the major inputs to the Bristol Avon come from the Somerset Frome and tributaries (Long Term Average Flow 321 Ml/d measured at Tellisford Gauging Station (GS)), Midford Brook and tributaries (190 Ml/d at Midford GS), and the River Chew (91 Ml/d at Compton Dando GS). On the right bank the major tributaries are the By Brook (124 Ml/d at Middlehill GS), the River Boyd (48 Ml/d at Bitton GS) and the Bristol Frome (144 Ml/d at Frenchay GS). The gauging stations are located on the flow measurement stations map.

The limestone aquifers of the Mendip Hills are a very important aspect of the hydrology and water resources of the area. The relatively large amounts of rain falling over the Mendips first percolate through an unsaturated zone up to 200 m thick, which filters and purifies the water making it ideal for public water supply. The water then moves through fissures and caves before emerging from springs in the headwaters of the Somerset Frome, Midford Brook and Chew catchments. The relatively low storage capacity of the rock, together with the rainfall pattern, and the lack of evapotranspiration in winter, causes flows to be much higher in winter than summer. Much of this water is collected at the spring sources (by impounding river flows) during the winter months and stored in reservoirs such as Chew Valley Lake for use in public water supply throughout the year.

Spring flows from the Upper Greensand to the south east of Frome, and from the Cotswold Oolites to the north of Bath, make an important contribution to the baseflows of the Somerset Frome and By Brook catchments respectively. In spring and summer, as groundwater levels fall below the bed of the stream, flows decrease. Some watercourses in the catchment, such as the upper reaches of the By Brook in the Cotswolds, and the Whatley Brook and Finger Stream in the East Mendips, are or have been winterbournes, ceasing to flow in dry summers.

Quarrying has a major hydrological impact. The area has one of the largest concentrations of quarries in Britain, extracting Carboniferous Limestone from the hills to the north of Bristol, but mainly from the Mendips. Young, relatively shallow quarries tend to remove stone from the unsaturated zone above the water table. Removal of this 'buffer zone' results in more flashy rivers with higher flood peaks and lower flows in dry weather. Importantly the purifying effect of the rock is lost leading to poorer quality water for public water supply and the storage from the unsaturated zone is also lost.

As the quarries deepen, they extend below the water table requiring large quantities of water to be pumped out in order to keep the workings dry. This 'dewatering' can have a serious and widespread effect on water resources with springs and streams within a radius of several kilometres exhibiting reduced flows or drying up. Four large springs in the East Mendips have been dried up by quarrying since 1980 and the yield of a public water supply borehole at Oldford was significantly reduced in 1990 by the deepening of Whatley Quarry, 6 kms away. At a Public Enquiry in 1992 the Assessor indicated that dewatering of Whatley Quarry could reduce the flow of water at Bath Hot Springs over 20-30 km distant.

Bath Hot Springs, with a daily output of 1.2 Ml/d of water at 45 °C, is the largest Hot Spring system in North West Europe (see Mineral Extraction and Waste Disposal section 3.6).

The water resources of the catchment are monitored using a network of sixteen flow gauging stations, ten river level gauges, fifteen intensity rain-gauges, thirty storage rain-gauges and thirty nine groundwater observation sites (see map). The data is stored mainly on computer systems at NRA Area Office at Bridgwater, Somerset.

2.4. GEOLOGY, SOILS, HYDROGEOLOGY

Geology

The rocks of the Lower Bristol Avon consist of Cambrian to Jurassic strata (600 to 135 million years old). The oldest strata are generally towards the west of the catchment and the youngest to the east. The oldest rocks are Cambrian and Silurian in age and form the effective base to the groundwater catchment. These rocks are principally sandstones and shales which have been extensively folded and faulted. On top of the Silurian are sandstones and limestones of the Devonian and Carboniferous periods. These too are extensively folded and faulted. The Carboniferous also contains the Coal Measures strata which outcrop in a north-south direction through the middle of the catchment.

Overlying the Carboniferous rocks are the sandstones, conglomerates and mudstones of the Permian and Triassic periods. These formations surround the outcrops of the older rocks in the west. The remainder of the catchment, to the east, is covered by Jurassic strata. The rock types are principally limestones and clays with lesser sandstones. The base of the Jurassic is known as the Lias. Overlying the Lias is the Inferior Oolite Limestone, the Fullers Earth Clay and the Great Oolite Limestone. Above the Great Oolite the occurrence of limestone decreases until, just east of Frome, an extensive outcrop of heavy clay, the Oxford Clay, is encountered.

Alluvial sands, gravels and silts of recent age are widespread in river valleys throughout the catchment.

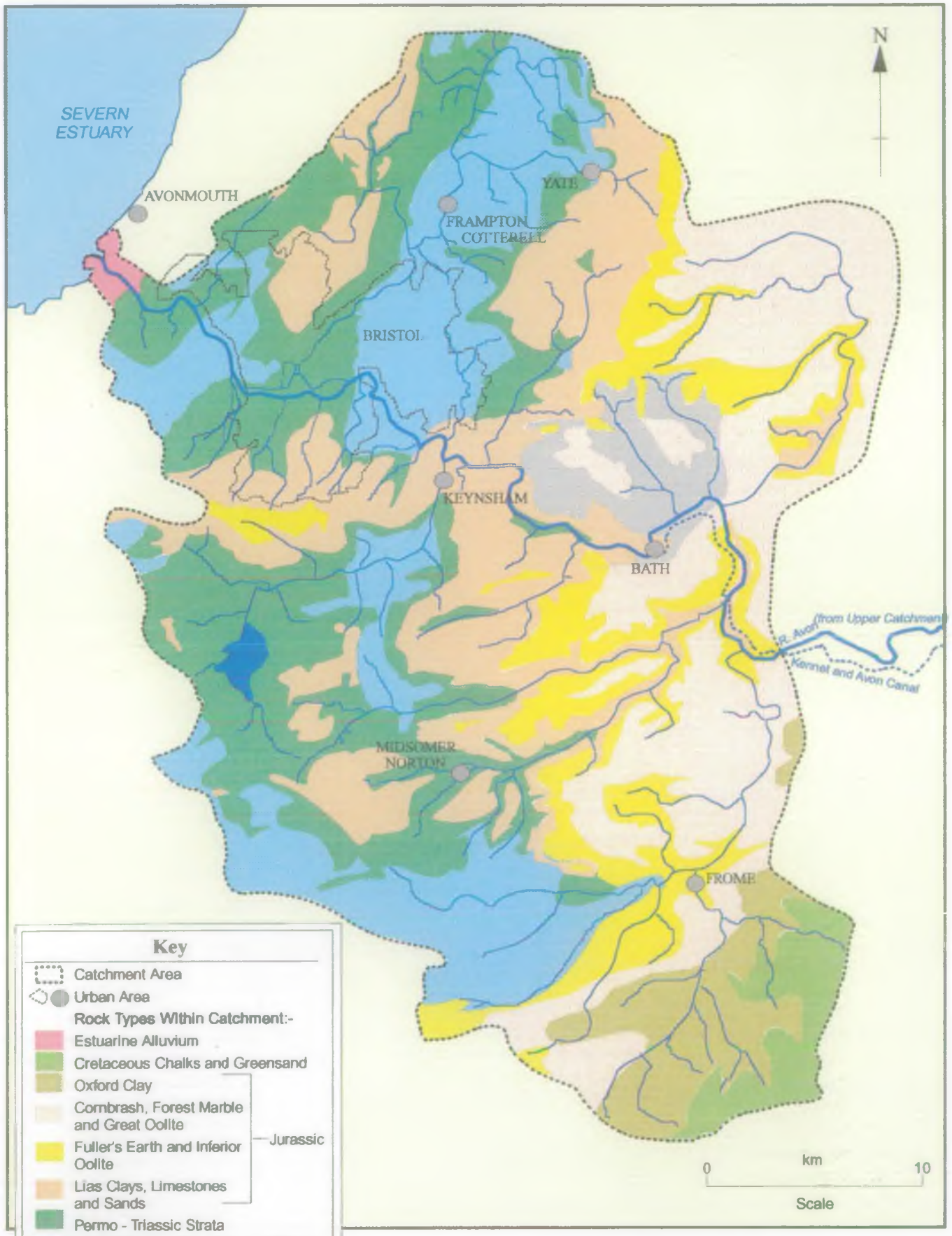
Soils

Soil type is very closely dependent on the underlying rock. Soils overlying Carboniferous Limestone are, for example, frequently silty and well drained. Over Permo-Triassic clays and mudstones however, soils are typically slowly draining permeable loams. Over Jurassic Limestone soils are shallow, well drained, fine loams whereas over Jurassic clay they are slowly permeable, loamy and clayey.

Hydrogeology

The principal aquifers of the Lower Bristol Avon catchment are the Carboniferous Limestone and Triassic Dolomitic Conglomerate of the Mendip Hills and the Jurassic Great and Inferior Ooolite of the Cotswolds north and east of Bath. Other minor aquifers include the Triassic Mercian Mudstone, the Blue and White Lias limestones of the Lower Lias, the

LOWER BRISTOL AVON
Geology



LOWER BRISTOL AVON
1993 General Quality Assessment

Cotteswold Sand of the Upper Lias and the Forest Marble and Cornbrash of the Middle Jurassic. The remaining strata are poor aquifers either because they yield water only in small quantities or, in the case of the Coal Measures, because the quality is often poor.

2.5. RIVER WATER QUALITY

The NRA uses two principal schemes for the reporting and management of river water quality: the general quality assessment (GQA) scheme, and the water quality objectives (WQOs) scheme. These schemes have replaced the water quality classification system used previously by the NRA (the National Water Council classification) see section 4.1 on Water Quality Targets.

The GQA scheme is used to make periodic assessments of the quality of river water in order to monitor geographical and temporal trends. The scheme comprises four components - general chemistry, nutrients, aesthetics and biology - each providing a discrete "window" upon the quality of river stretches. The general chemistry component of the GQA is in current use, and comprises six tiered grades defined by standards for Dissolved Oxygen, BOD and Total Ammonia (Appendix 9). The remaining three windows are still under development and will be applied when available.

An assessment of water quality in the Lower Bristol Avon catchment has been made by applying the General Quality Assessment (GQA) chemical grading system to data stored on the Public Register from 1991 to 1993. The 1993 river quality survey indicated that the catchment was of either good quality (Class A and B) or fair quality (Class C and D) except for one stretch on the River Chew, from Chewton Mendip to Litton, which was of poor quality (Class E) (see General Quality Assessment map).

2.6. CATCHMENT FACTS

General

Area	1225 km^2
Population (1991)	791,300

Water Resources

Average Annual Rainfall (1961 - 1990)		880.5 mm
Average Annual Evaporative Loss (1961 - 1990)		522.6 mm
Mean daily flow (estimated using Micro-low-flows discounts human influences		1979 Ml/d
Total Licensed Abstraction	Daily	399 Ml
	Annual	92,265 Ml

Flood Defences

Length of Statutory Main River	442 kms

2.7. NRA VISION

The community within the catchment has two potentially conflicting visions:

1 most societies want to achieve economic development to secure a better quality of life, now and in the future,

2 they also seek to protect their environment now and for their children in the future.

Sustainable development tries to reconcile these two objectives - meeting the needs of the present without compromising the ability of future generations to meet their own needs.

To achieve this judgements have to be made about the weight to be put on different factors in particular cases. Sometimes environmental costs have to be accepted as the price of economic development but on other occasions a site, or an ecosystem, or some other aspect of the environment has to be regarded as so valuable that it should be protected from exploitation.

As Guardians of The Water Environment in the Lower Bristol Avon Catchment it is the role of the National Rivers Authority to present the case to protect the water environment from damage; sustaining and extending its environmental value and interest whilst commercial, industrial and recreational use continues to be made of it.

In an area of such high amenity and ecological value as the Lower Bristol Avon the NRA's vision of the future is towards a catchment where:

- minimal compromise of water quality, quantity and physical structure of the water environment is accepted to facilitate economic development;
- improvements continue to be made to existing discharges, meeting the most stringent appropriate standards;
- the risk to the water environment from abandoned mine workings is eliminated;
- an agricultural and forestry system develops which reduces the risk of diffuse pollution and improves the physical habitat of the river system and wetlands for wildlife;
- the enjoyment and appreciation of the river system by the public continues to grow;
- the aquatic biodiversity of the catchment is maintained and extended;
- the landscape and archaeological features are conserved and where possible enhanced;
- there is minimal risk to people and property from flooding.

LOWER BRISTOL AVON
River Corridor and Catchment Land Use

3.1. RIVER CORRIDOR AND CATCHMENT LAND USE

3.1.1. General

Rural land use in the Lower Bristol Avon catchment is mainly intensive agriculture, and this has a strong influence on the river. Semi-natural habitats which depend upon a high water table are very sparse. The few remaining floodplain wetlands are therefore extremely valuable.

The river corridors are significant nature conservation and landscape features because of their ecological diversity and integrity, particularly when compared with intensively farmed land and scattered semi-natural habitats. They are also a vitally important component of the natural heritage resource of this large area of land. They make a strong contribution to the landscape and often bear the hallmarks of historical industrial development, with many sites and features of archaeological value such as mills and bridges.

The river Avon in this lower part of the catchment flows through steep-sided valleys and gorge sections, apart from the stretch between Bath and Keynsham. The cities of Bristol and Bath occupy considerable lengths of the river, which provides a green corridor through the urban areas. The By Brook, Lam Brook and St Catherines Brook rise on the Oolite limestone plateau to the north and east of Bath and flow through deeply incised river valleys. Here, cattle and sheep grazing are prevalent, on permanent often unimproved limestone grasslands. The Mells River rises in the Mendip Hills and flows through a steep sided valley where the land use is predominantly ancient woodland and unimproved grasslands. These tributaries are of extremely high wildlife and landscape value.

The Cam Brook and Wellow Brook also flow from the limestone, but the valleys are shallower, thus enabling more intensive agricultural practices. The Somerset Frome flows through intensively managed dairy pasture, as does the Ladden Brook, whilst the catchment of the River Chew has more arable cultivation in its middle and lower reaches.

3.1.2. Management and land use change

The most significant changes within the catchment over the last fifty years arise partly from the intensification of agricultural production helped by land drainage schemes; partly from increasing urbanisation and the resultant increase in demand for potable water; and partly from changes in industrial land use.

Intensification of Agriculture

The land drainage schemes promoted by past government policies have reduced seasonal flooding and groundwater levels, and hastened the passage of water from source to sea. This has permitted more intensive agriculture, but diminished the characteristic wetland elements of the floodplain ecosystem. The Ladden Brook is a prime example of the impact of a pump drainage scheme, installed to enable more intensive agricultural use of the catchment. (See Floodplain and Land Drainage Improvement map, section 3.4).

Run-off from intensively managed land contains silt, nitrates, inorganic fertilisers and pesticide residues. These enrich the nutrient status of the water and can encourage the more

aggressive and vigorous plants at the expense of those less tolerant of such conditions. The primary impact of agriculture on the wildlife of river systems has been the loss of habitats and a reduction in species diversity, both within the channel and on adjoining land. There is also a loss of variety of physical channel features such as bays, inlets, pools, riffles and different bank slopes. This is accompanied by a loss of plant diversity leading to degraded landscape and much reduced wildlife interest. Many of these changes may be irreversible.

Urban development

Increasing urban development and associated schemes such as leisure developments, out-of-town supermarkets and new roads place additional stress on the system both directly and indirectly. The direct effects stem from development of land adjacent to rivers and the resultant increase in human use and disturbance, while the main indirect effect is alterations to the hydrological regime of watercourses, resulting from the increased impermeable surface and tendency towards lower summer flows and increased flash flooding. The challenge here is to seek sustainable levels of development whereby the current landscape and ecological quality of the river corridors is maintained, and enhancements are actively sought. The promotion of nature conservation in these instances can only be achieved by working in conjunction with local planning authorities and developers.

Ecological Impact of Reservoirs

The increase in demand for potable water led to the impoundment of the River Chew and creation of Chew Valley Lake in 1950. This resulted in the loss of a landscape of historic importance, with many features of ecological interest. However, Chew Valley Lake and some of the surrounding land has now been designated as an SSSI and SPA in its own right.

The other principal supply reservoir is Monkswood in the St Catherine's Valley. The adverse ecological effects resulting from the deprivation of this river of its spring flows have been occurring since the late 1800s. This is now the subject of a joint study between the NRA and Wessex Water Services.

Industrial and Commercial Use

The Lower Bristol Avon catchment has areas of intensive industrial use including Frome, an historic woollen mill town in Somerset; Radstock and Midsomer Norton which were centred on the coal mining industry; Bath with its various light industries; Yate with various industrial estates; and Bristol, which has a variety of industry and commerce.

For centuries polluting industrial effluents have been discharged into the river. Many contaminated land sites still exist where former riverside industry was based. Disturbance of these sites could lead to increased pollution.

Landscape

Landscape changes are characterised by a loss of tree and shrub cover and wet floodplain pastures, caused by the increase in cultivated land. Hedgerow removal and the loss of hedgerow trees have resulted in a more open landscape. There has been an increase in new

farm buildings. Urban development, industrialisation, power lines and transport routes have had a more localised but severe impact. The impacts of loss of varied bank and channel shape have already been described.

Examples include the construction of motorways which greatly altered the upper reaches of several watercourses such as the By Brook and River Boyd, which now take motorway surface water run-off. The M4 crosses the Bristol Frome, the Bradley Brook, (which is particularly affected), and the M5 crosses the main River Avon at Avonmouth.

Past urban flood alleviation schemes in particular have resulted in visually unattractive landscapes and degraded river environments. The loss of visual amenity and bankside habitats have been particularly severe in the elegant Georgian City of Bath, now a World Heritage Site, where the sheet steel piling and concrete capped river banks, in conjunction with a major impoundment create a particularly sterile corridor from a wildlife point of view. Here, working in conjunction with the local authority, a River Corridor Strategy is urgently needed to guide future development. Such a strategy should seek to safeguard all sections of the river with natural banks, to consider zoning use (ie recreation, boating, etc) and to use every opportunity to enhance the river corridor when adjacent sites are being re-developed.

Other examples where improvements should be sought include Keynsham, where the River Chew flows through the town centre park in a steep and trapezoidal channel; Bitton, where the River Boyd flows through a massive concrete-based and sheet steel piling lined channel and Frome, where a highly utilitarian and unsafe river channel, engineered in the 1970s, flows right through the town centre. Here, a river restoration scheme appears to be a distinct possibility, with the imminent re-development of the town centre. Local interest in the river is extremely high, and there is much support for these aims.

3.1.3. Ecological impact of Impounding structures

The main River Avon is impounded throughout its length by a number of river control structures, originally introduced to generate power for milling. Many of these are now obsolete and no longer function; others have been replaced by flood defence structures such as radial gates. Their principal effect is to impound the river, which alters its ecology. In the impounded section through Bath, for example, from Bathampton weir to Twerton, the nationally rare Lodden pondweed appears to be declining as conditions are no longer suitable. Here additional adverse factors include physical damage from boat propellers and the resultant increase in the turbidity of the water which reduces light availability.

The river is tidal until Netham Weir in Bristol. The Bristol Development Corporation proposes to create a new weir (and tidal limit) downstream at Goal Ferry Bridge. This will have the effect of retaining bankful conditions throughout the City Centre, to provide greater amenity value and recreational opportunity, but at the same time this will increase pressure on the wildlife in that reach.

Any further proposals to impound the river artificially should be carefully evaluated. There is a proposal to establish a barrage adjacent to the M5 between Avonmouth and Portbury, which would effectively block a sub-estuary of the Severn estuary SSSI. This would cause substantial changes and potential problems in water quality and flood defence maintenance.

It would turn a natural river into a long pond, and would also result in potential conflict between amenity and recreation on the one hand and wildlife conservation on the other.

Particular problems are caused by existing impoundments at:

1 Bitton on the River Boyd, which prevents the passage of fish, including eels.

2 The weir on the Wellow Brook which again prevents fish movement and requires constant maintenance to clear blockages.

3.1.4. Aims

In conjunction with appropriate organisations and individuals to:

- locate vulnerable landscape, wildlife and historic features which it is important to conserve,

- identify those wildlife and landscape features which require enhancement, and note areas with the capacity to provide informal recreation,

- restore floodplain habitats and enhance river corridors so as to restore biological and morphological diversity. This may be further defined as:

  (i) the re-establishment of seasonally inundated floodplain meadows and woodlands, and the establishment of buffer zones alongside watercourses to reduce the impact of nitrate leaching into the system and the mobilisation of sediments,

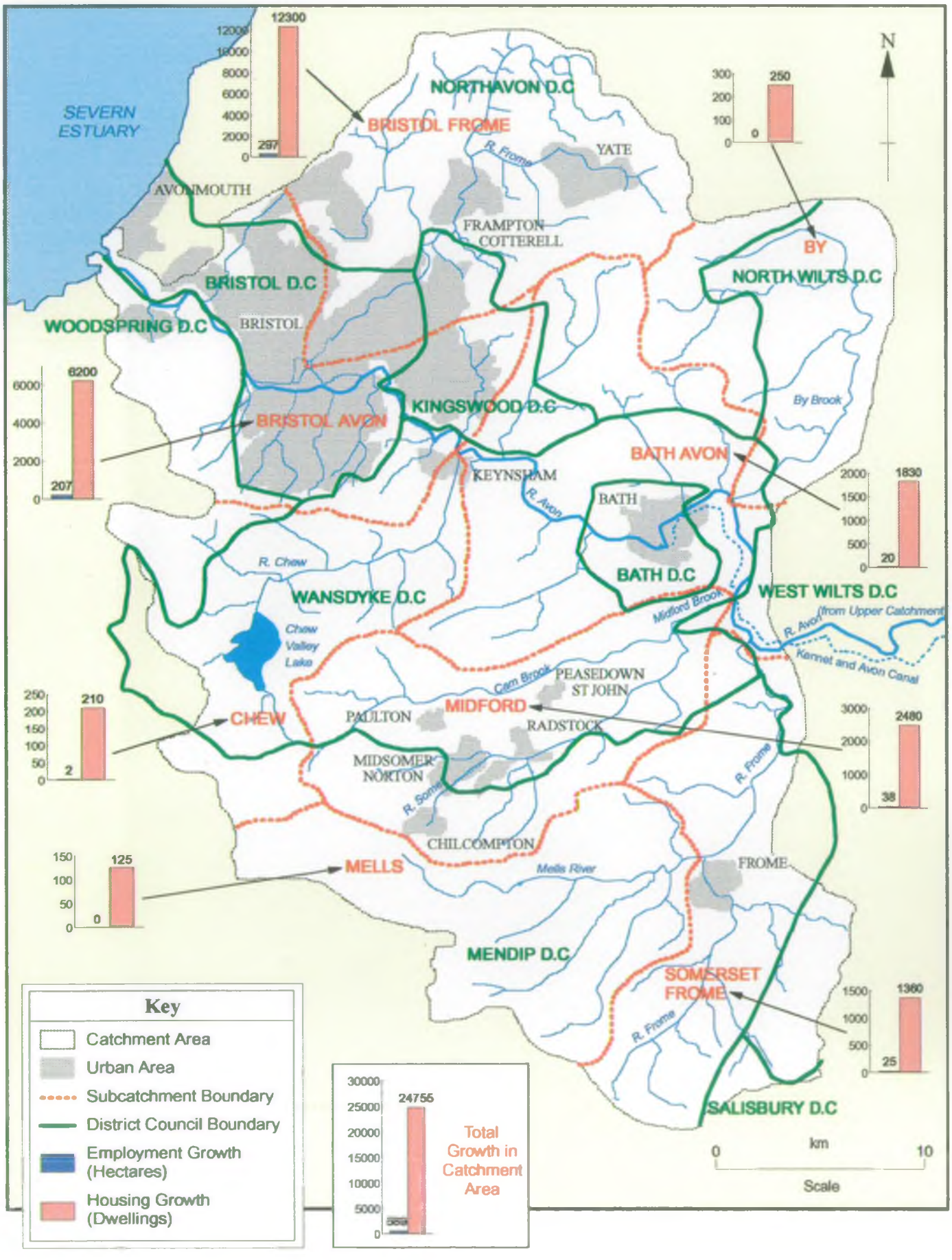
  (ii) the maintenance or restoration of a varied river channel with features such as riffles, pools, meanders, shoals and natural bank profiles,

  (iii) the restoration of tree and shrub cover on engineered and de-forested river sections through planting and natural regeneration to provide shade, suppress the growth of aquatic plants and reduce the need for intensive river maintenance,

- complete river corridor surveys for the catchment and re-survey the main Bristol Avon River (last surveyed in 1988),

- analyse aerial photographs of the catchment.

LOWER BRISTOL AVON
Development Growth to 2001



3.2. TOWN AND COUNTRY PLANNING STRATEGY

3.2.1. General

The majority of the catchment is within The Avon County Council (ACC) administrative area and contains Bristol, the largest city in the South West, which with its immediate suburbs has some 500,000 residents. To the south the catchment extends into Somerset and in the east into Wiltshire.

Green Belt Planning Policies apply around Bristol and Bath and have the purpose of maintaining the countryside and preventing coalescence of settlements. Three Areas of Outstanding Natural Beauty (AONB) have also been designated to protect the nationally important landscapes of Cranborne Chase and the West Wiltshire Downs in the South East, Mendip Hills in the South West and the Cotswolds in the North East.

The Regional Planning Guidance for the South West 1994 recognises the potential for further economic investment in Bristol stimulated particularly by the Second Severn Crossing and improved communications. The City Council and an Urban Development Corporation are already active in regenerating development, investment and enhancing the City's facilities. There are however difficulties in providing adequate and developable housing and employment sites in the urban areas and also there is a continuing trend towards smaller households. These factors have partly contributed to the Avon County Structure Plan (CSP) Third Alteration 1994 concentrating future housing and employment in Bristol's suburbs, its fringes and in nearby settlements. In the Lower Bristol Avon catchment area housing and employment developments are proposed within Bristol and in the adjoining District Council areas; however the commercial success of a major new industrial and commercial development area adjoining Avonmouth and linked to the new Severn Crossing (west of this catchment) will have a long term influence upon the economy of the Bristol area.

The CSPs and Local Plans (LPs) contain policies in various forms relating to flood and floodplain protection, disposal of surface water, protection of water resources, contaminated land and other matters relating to the protection of the water environment.

3.2.2. Growth - the Local Plans

The Local Plans of Northavon and Kingswood District Planning Authorities reflect the Avon CSP by allocating land on the Bristol northern fringes at Bradley Stoke, Emersons Green, Patchway, Filton and Yate. Improved transport facilities are being promoted by a Rapid Transit Project for Bristol which is intended to contain a network of routes linking the main employment and residential areas. The first stage will be a link between Bradley Stoke and Central Bristol.

Additional development sites are being made available on a more limited scale for development/redevelopment by Bath and Wansdyke Districts in Bath, Midsomer Norton and Radstock. In Somerset a Landscape Protection Policy of the County Structure Plan applies. However, Mendip District are planning for some growth in dwellings and employment in Frome. The Catchment area of Wiltshire is in a rural area and within the Cotswolds AONB; little change is anticipated. The Development Growth map indicates the distribution of anticipated housing and employment growth in the eight sub-catchments of the area by 2001.

It amounts to about 25,000 dwellings and 590 hectares of land allocations for employment purposes. An approximation of the present population suggests it contains some 795,000 people and that depending on circumstances it could increase to about 810,000 by 2001.

The housing development growth in each District Council area is shown on the Development Growth map.

Additionally, extensive improvements are planned to the highway network in the area, the major proposals are:

(i) capacity improvement to M4 and M5 (limiting new routes to the Second Severn Crossing);

(ii) an eastern ring road network around Bristol;

(iii) improved links to the M4 from Bath, Yate/Chipping Sodbury and Emersons Green;

(iv) a Bypass to Batheaston linking to a new road to Beckington.

3.2.3. Planning for the Environment

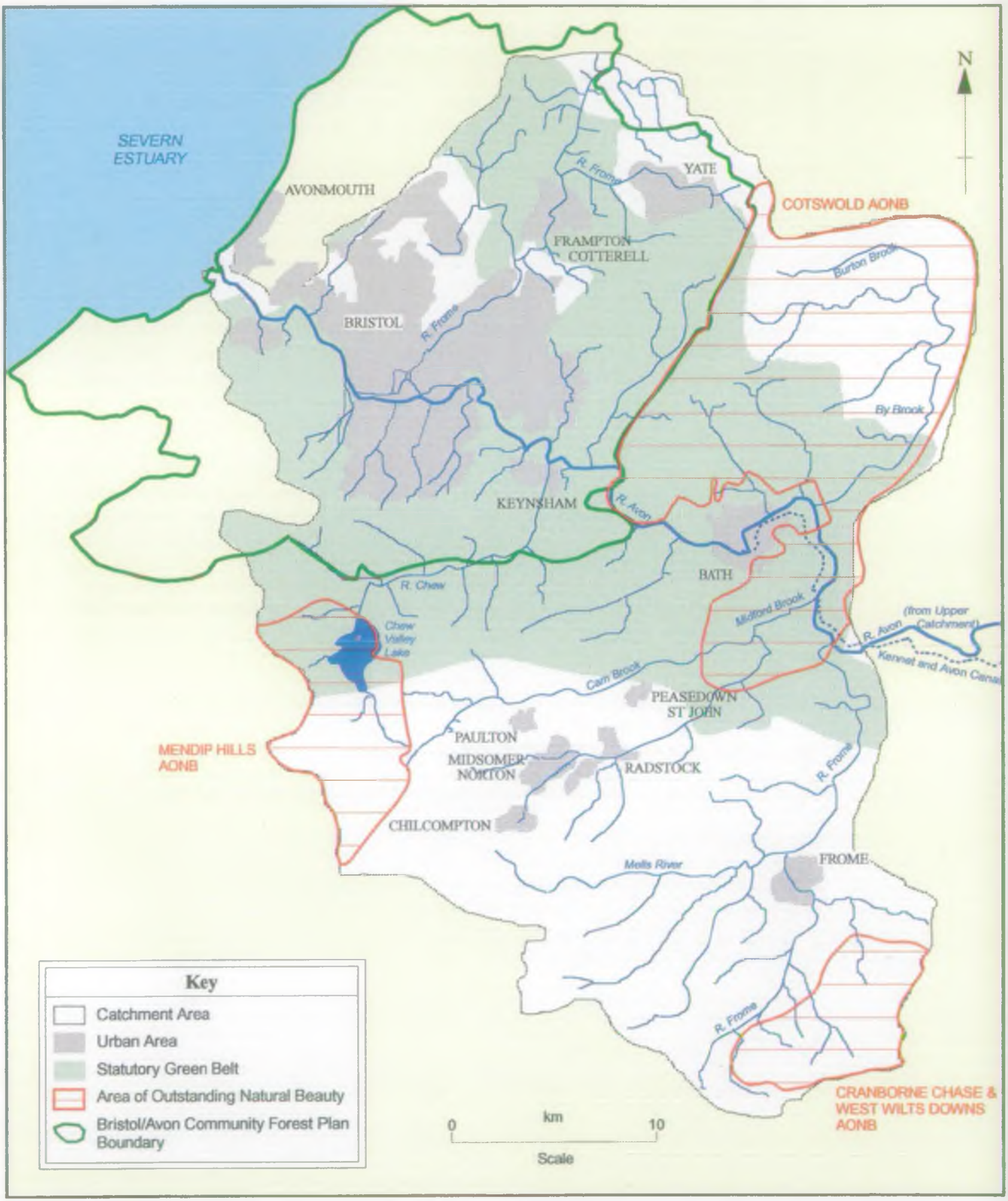
The Town & Country Planning policies for the area includes positive steps to balance development proposals with the maintenance and improvement of environmental qualities. In general terms the Local Plans recognise the value of the natural environment and propose that developments should be integrated, as far as possible, with the needs of wildlife, nature conservation, natural beauty and landscape. The plans also include Policies to prevent pollution of the water environment and for the protection of water resources.

The implementation of development is frequently seen as a catalyst to improve environments, facilities and amenities, particularly within regeneration schemes. A twenty four hectare harbour-side site in Bristol is being promoted for major leisure, housing and offices. Following recent successful development schemes, the waterside has become recognised as attractive for tourism, leisure, business and living; this has endorsed the need for a continuous waterside walk-way system. In Bath the river and canal are seen as important features that have been neglected in the past and it is recognised that riparian developments can improve their value. The Draft City Plan (1993) indicates the need for a strategy to be devised for the River Avon through Bath to address issues of new development, ecology, leisure use, river management, moorings and flood protection.

3.2.4. Landscape and Wildlife Corridors

The CSPs identify rivers and river valleys as important features that add to the landscape and visual character, indicating that the preparation of conservation, enhancement and management measures are needed as part of safeguarding measures. The Mells River, parts of the Avon Valley and the Gorge, the Mendip Lakes and the Frome Valley are highlighted. The ACC "Avon Landscape Strategy" 1988 assesses the features; setting priorities for landscaping, conservation management, protection and improvement proposals. Arising from this the LPs of the District Authorities in Avon contain policies in support of this strategy. Within Kingswood for example, a "Priority Landscape Improvement Area" on the

LOWER BRISTOL AVON
Landscape Policy Areas



east fringe of Bristol, which includes the Avon, River Boyd (The Golden Valley) and Siston Brook is supported in the Local Plan. The Council will also be promoting an Article IV Direction that will restrict permitted development rights. This supports a similar Direction (1979) relating to the Avon Valley at Hanham. A policy in the Kingswood Local Plan for the Avon Valley indicates that obtrusive or detrimental development will be resisted.

Northavon District published the "Northavon Landscape and Conservation Strategy" in 1992 and this emphasises the importance of rivers and river valleys of the area, particularly as wildlife corridors. The subsequent Consultative Local Plan 1994 contains policies to resist development that will disrupt or affect the corridors that include the Stoke Brook, Bradley Brook, Ladden Brook, Bristol Frome, River Boyd and the Feltham Brook. Woodspring Local Plan (Consultation Draft) 1993 emphasises the importance of wildlife corridors and the need to protect them along with water features and also the need to create new habitats. The Wansdyke Local Plan Consultation Draft (Dec 1994) identifies the important role of the River Avon and its river corridor and also addresses water environment issues. The Local Plan for Mendip is in the course of preparation and it is understood that it will contain Policies that are pro-active and sympathetic to the needs of the water environment.

3.2.5. Community Forest

A non-statutory Bristol/Avon Community Forest Plan (Consultation Draft) was published in June 1994. Prepared jointly by a project team comprising the Countryside Commission, Forestry Commission and the Local Planning Authorities it relates to diversification of the countryside aiming to co-ordinate nature conservation, agriculture, sport and recreation, access etc. It is basically a countryside/townscape enhancement plan and the water environment is seen as a key element and proposals include its protection particularly for recreation and quiet enjoyment. Rivers are again seen as part of the wildlife corridor system of the area and their future is identified as providing landscape "lungs", from open countryside into the urbanised city. The area is divided into seven "local strategy areas" most of which have water interests. Suggestions include:

<u>The North Avon Vale including The Bristol Frome Valley</u>

Maintain its strong wildlife corridor, strengthen and enhance the valley corridor.

<u>The Bradley Brook</u>

Create recreational corridor including cycle way along river and enhance wildlife. New lake as part of flood control to be used for fishing.

<u>Bristol Frome Valley (South)</u>

New management on concept of countryside into city; improve river walkway.

<u>South East Corner - Westerleigh</u>

Conserve and enhance wildlife of river and wetland sites.

Cotswold Edge

Promote recreation to relieve Avon Valley pressures. Appropriate management of land next to river and wetland sites. Protection of wildlife on the Boyd and create pedestrian route. Investigate opportunities to maintain and enhance flows.

Dundry & River Valleys

Enhance wetlands, protect and enhance riverside habitats. Interpret the history of the river, tree planting, walking, riding and cycling by the rivers.

Avon Gorge

Enhance road/rail corridor on north bank, enhance wildlife, provide interpretation and enhance access.

The City

Enhance links to countryside paying attention to river corridors and valleys.

3.2.6. Aims

1 To identify the way in which the NRA can help with the implementation of water environmental policies and proposals contained in Development and other Plans within the catchment for:

(i) the protection, enhancement, rehabilitation and improved management of rivers, wetlands and the creation of new wetland and water features

(ii) recreational and Leisure facilities

(iii) strengthening wildlife and "green" corridors

(iv) flood prevention

(v) prevention of pollution to water resources and watercourses

2 To ensure that prior to development proposals being formulated within the catchment area, developers and their professional advisers are aware of all relevant water environment issues and aspirations that must be addressed.

3 To ensure that NRA proposals and works meet the environmental strategy/policies of Local Planning Authority and other Agencies.

4 To ensure measures are implemented to prevent pollution of the water environment and any risks of increased flooding in relation to new and improved highways, industrial, commercial, housing and other developments.

5 To ensure that plans are implemented which cater for uncontaminated surface water discharges arising from development that prevent flood risks and, where attenuation features are formed, they are planned as landscape features and used to advantage.

6 To formulate river management strategies that maintain and enhance the character of towns and rural areas which cater for flow characteristics, water quality and physical setting. Such strategies to address nature conservation, landscaping, interpretation, rehabilitation of river corridors and integrate with Local Planning Authority proposals and programmes.

7 To identify how, during the construction and engineering stages of planned developments:

a) flooding and pollution risks plus risks to habitats and wetland features can be effectively controlled

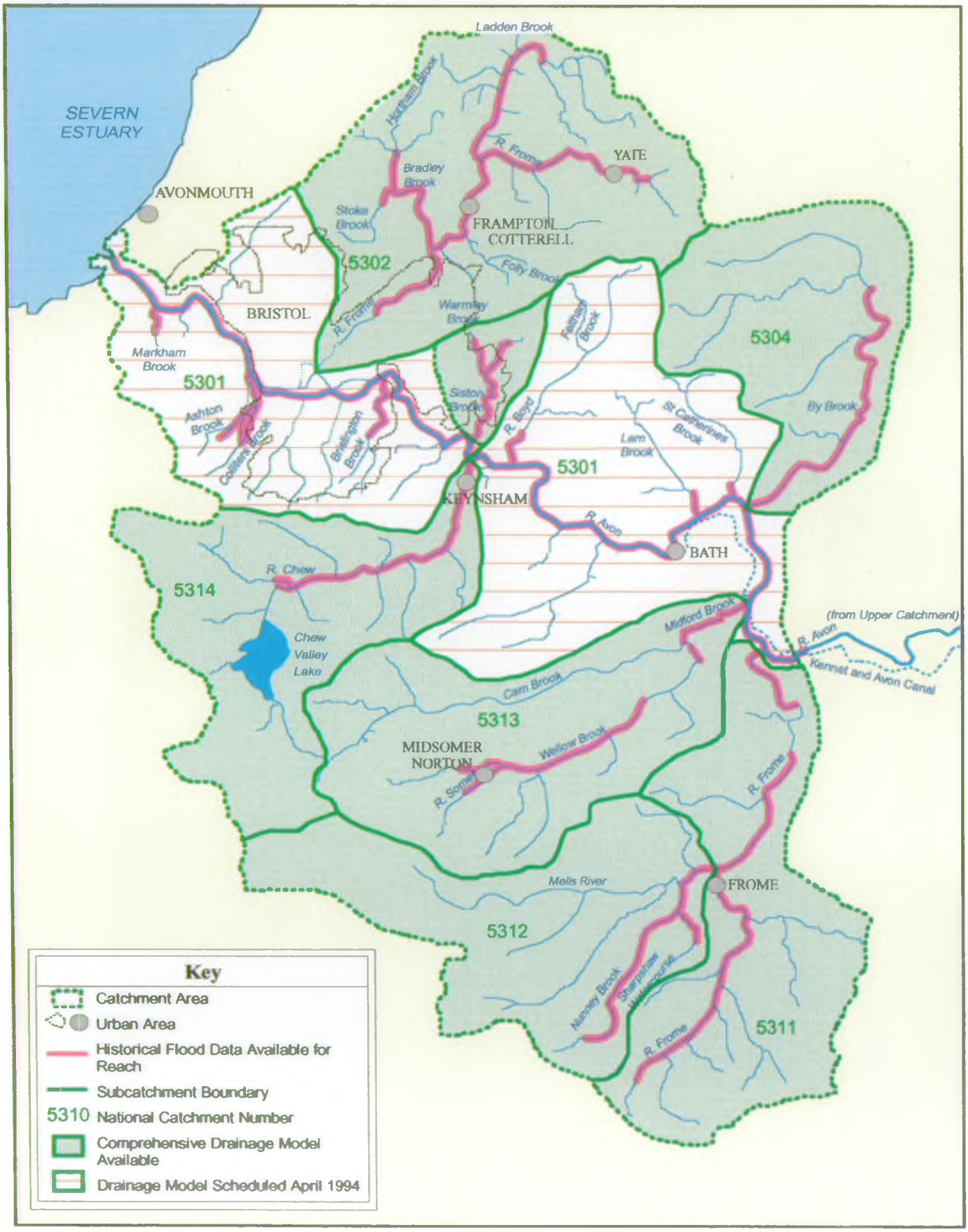
b) where unavoidable destruction to wetlands and riverine habitats occur, equivalent replacements can be created elsewhere.

8 To ensure adequacy of water supply and sewage disposal facilities for planned growth within the catchment.

9 To ensure that future reviews of Regional Strategy, Structure Plans and Local Plans identifying residential and employment growth are drafted with full regard to the demands upon and limitations of water resources and criteria necessary to maintain a satisfactory water environment.

10 To identify historically unsympathetic river improvements and investigate where amendments are possible to agree a strategy and programme for their enhancement.

LOWER BRISTOL AVON
Catchment Drainage Plan (CDP) Availability



3.3. CATCHMENT URBANISATION

3.3.1. General

The Government view is that development should be guided away from areas that may be affected by flooding and should be restricted where it would increase the risk of flooding. To achieve this, it expects Local Authorities to use their planning powers and the NRA to assist them by providing advice on development in relation to flood risk.

Under S24 (5) Water Act 1973, national surveys of flooding problems (Flood Plans) were sent to all Planning Authorities in accordance with DOE Circular 17/82. These surveys are to be replaced by new ones carried out under S105 Water Resources Act 1991. Consultation with Planning Authorities is taking place prior to the production of the S105 surveys to meet the requirements of DOE Circular 30/92 "Development and Flood Risk".

Because of its perceived importance in terms of new development, the Lower Bristol Avon Catchment is being prioritized as a pilot study within the Region. It is anticipated that the S105 survey for the catchment will be completed in early 1995. The data will also be formatted for inclusion into Planning Authority GIS systems.

Catchment Drainage Plans (CDPs) (see map for availability) are produced by the NRA to provide a strategic and local framework to assist in the control of surface water runoff from new developments. CDPs examine how normal and flood flow regimes may change with time and respond to activities within a catchment. Measures to mitigate any potential increase in flood risk can then be investigated and passed to the Local Authority. Such measures might involve local or strategic surface water attenuation, more widespread use of soakaways, increasing river capacity or flood protection works. To be approved, a measure must be environmentally acceptable.

3.3.2. Local Perspective

Development runoff is proportional to the amount of urban area within a catchment. The table overleaf shows the size of existing areas within the Lower Bristol Avon Catchment by subcatchment area, the existing development area, and the increases proposed in County Structure and Local Plans, which are also shown as a percentage of the corresponding sub-catchment area on the map.

This information, together with the number and location of known flood problems (see Catchment Urbanisation map) has been used to prioritize a programme of works to develop CDPs for the Lower Bristol Avon.

All the sub-catchment drainage modelling for the Lower Bristol Avon Catchment will be completed by early 1995 and it is anticipated that the CDPs will be complete by mid 1995.

LOWER BRISTOL AVON
Catchment Urbanisation

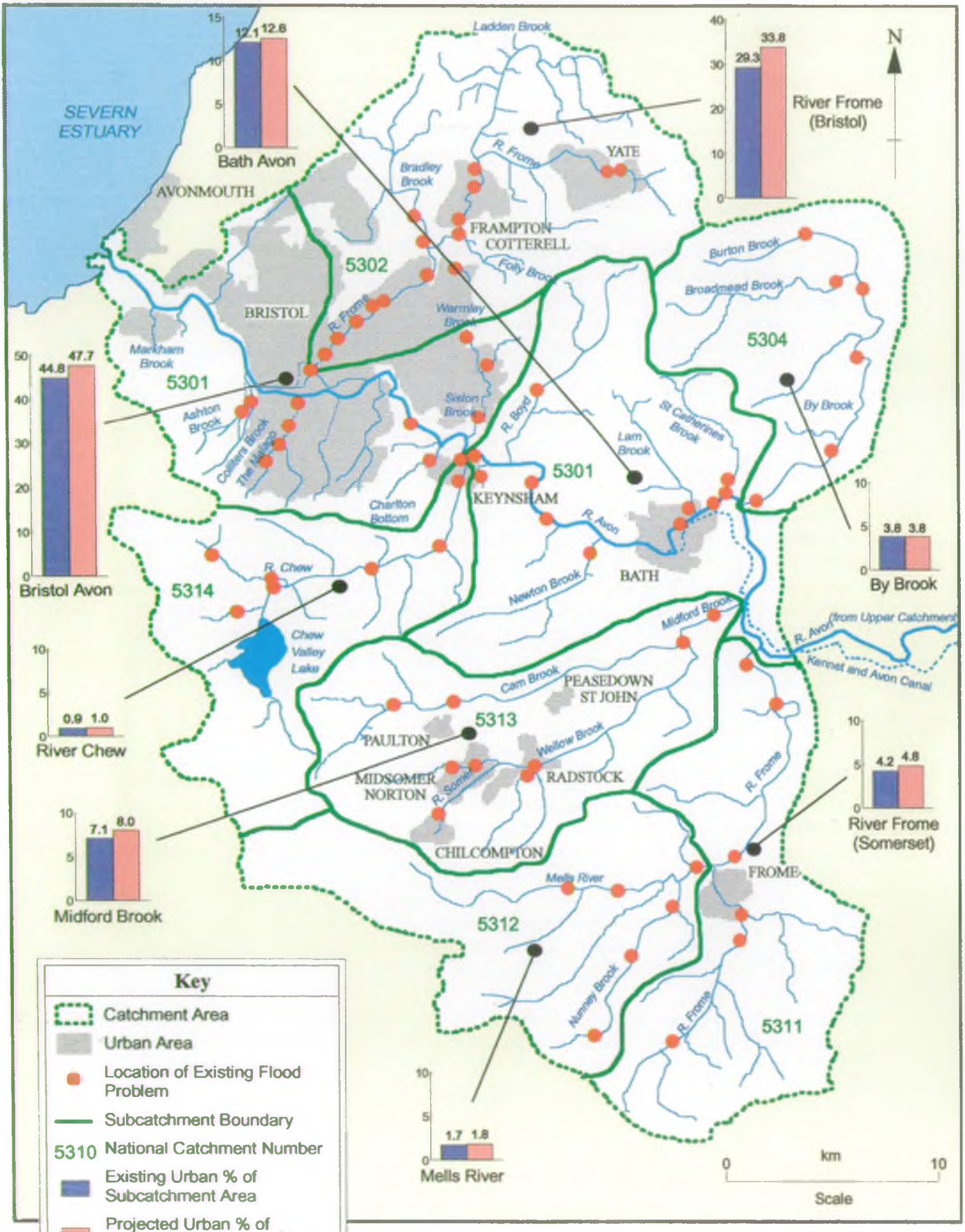


TABLE 1: SUMMARY OF FIGURES OBTAINED FOR THE LOWER BRISTOL AVON CATCHMENT MANAGEMENT PLAN (SEPT 1994)

Sub-Catchment Number	Principal Settlements	Sub-Catchment Area (ha)	Existing Development Area (ha) * (1991)	Proposed area of Development to 2001 ** (ha)					Development area as a percentage of the Sub-catchment area		Catchment Drainage Plan status
				Housing a		Employment Land (ha) b	Strategic Road Schemes (ha) c	Total (a+b+c) (ha)			
				Units	Hectares				Existing	Proposed	
Bristol Avon 5301	City of Bristol and Environs	15100	6759.0	6200	207	207	36.0	450.0	44.76%	47.74%	Scheduled April 1995
Bath Avon 5301	City of Bath and Environs	18000	2177.5	1830	72	20	8.4	100.4	12.10%	12.66%	Scheduled April 1995
River Frome (Somerset) 5311	Frome, Westwood, Farleigh Hungerford Rode, Beckington	14800	623.7	1360	45	25	9.0	79.0	4.21%	4.75%	Drainage model complete
Mells River 5312	Mells, Oakhill, Nunney, Binegar, Midsomer Norton	13300	230.0	125	5	0	0.0	5.0	1.73%	1.77%	Drainage model complete
Midford Brook 5313	Midsomer Norton, Radstock, Paulton, Peasedown St John	15200	1072.0	2480	98	38	0.0	136.0	7.05%	7.95%	Catchment Drainage Plan complete
River Chew 5314	Keynsham, Chew Magna, Pensford	14200	123.6	210	8	2	0.0	10.0	0.87%	0.94%	Drainage model complete
By Brook 5304	Castle Combe, Box	10700	401.0	250	9	0	0.0	9.0	3.75%	3.83%	Drainage model complete
River Frome (Bristol) 5302	Bristol (Part), Chipping Sodbury, Yate, Frampton Cotterell	17200	5046.0	12300	410	297	52.0	759.0	29.34%	33.75%	Drainage model complete
	Lower Bristol Avon Catchment Totals	**118500**	**16432.8**	**24755**	**854**	**589**	**105.4**	**1548.4**	**13.87%**	**15.17%**	

Note:

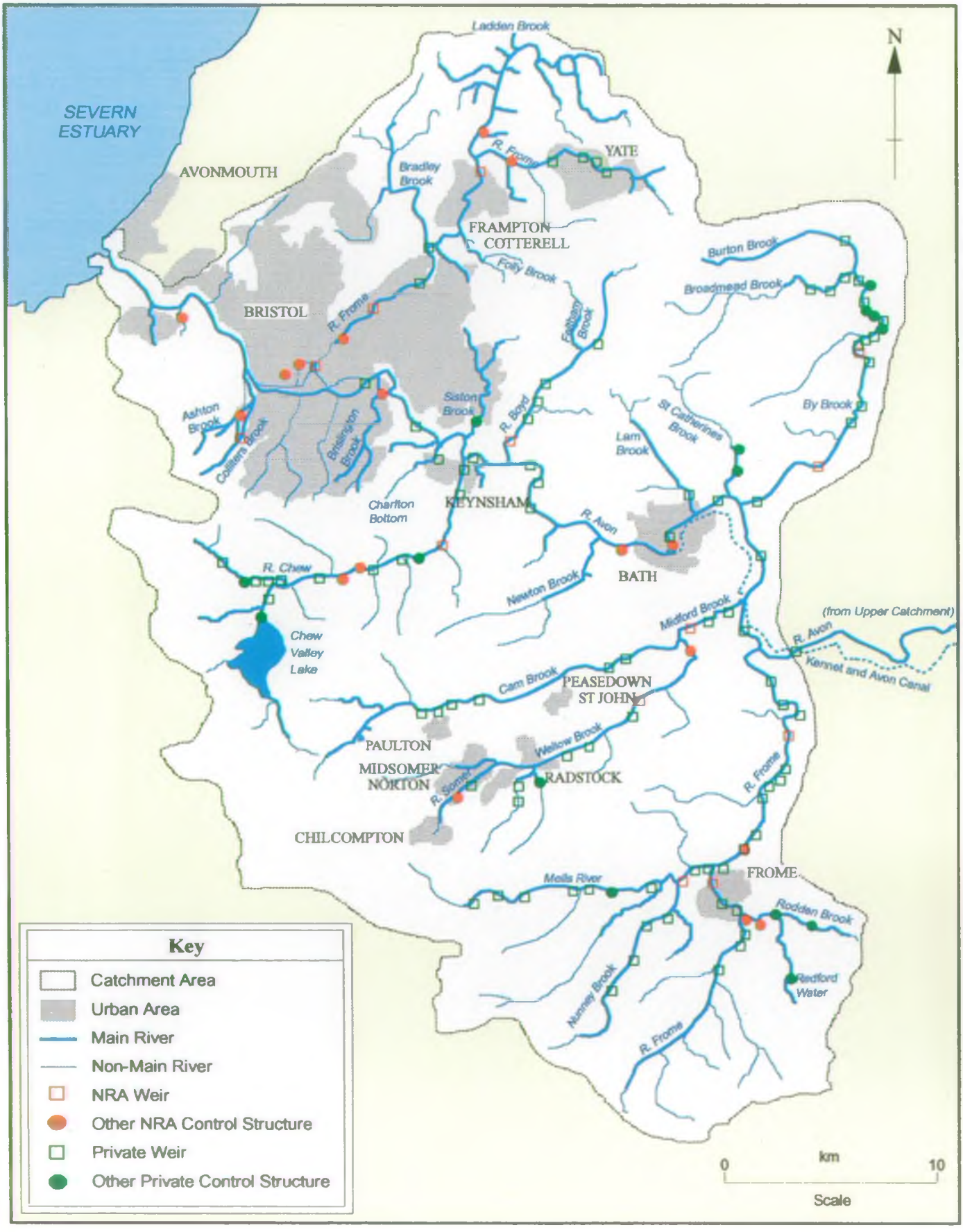
1)* Only Principal towns and villages used to compile existing housing and industrial numbers: Source second series O.S. 1:25000 maps.

2)** Proposed housing, and employment land projections taken from Avon, Somerset, and Wiltshire County Council figures.

3) All figures are indicative of the existing and proposed levels of urbanisation, as some smaller settlements and roads have been ignored for the purposes of this excercise.

4) Strategic road scheme coverage assumes approximate road widths and lengths per sub-catchment.

LOWER BRISTOL AVON
River Control Structures and Statutory Main River



3.4. CATCHMENT DRAINAGE

3.4.1. RIVER CONTROL STRUCTURES AND STATUTORY MAIN RIVER

3.4.1.1. General

This use identifies the basic role of the river as the conveyance of water from land in the catchment to the sea. There is a clear requirement for the provision of effective defence for people and property against flooding from rivers.

Normally, flooding is a result of extreme climatic conditions, such as very heavy rainfall. Flood events are described in terms of the frequency at which, on average, a certain severity of flood is exceeded. This frequency is usually expressed as a return period in years eg 1 in 50 years. The effectiveness of flood defences can be measured in terms of the return period up to which they prevent flooding. Different types of land use, for example urban areas and pasture land, require different levels of effectiveness for the defences.

3.4.1.2. River Control Structures and Statutory Main Rivers

The responsibility for the maintenance of any watercourse normally rests with the riparian landowner, whose ownership extends to the centre line of any such river, unless his deeds specifically mention another interest.

The NRA has a flood defence operational maintenance department which deals with emergencies (flooding and some pollution control) together with 'permissive' powers to carry out river maintenance. This work is targeted at past flood alleviation and drainage schemes to ensure they function as required and maintenance work is carried out to a standard consistent with existing land use.

Certain channels in the river system are designated statutory Main River. This means that the NRA can use its powers for the maintenance of the channel. At the same time, powers to control the activities of others can be used.

Where reasonable, the NRA can control the construction of any structure in or close to the statutory Main River. This, and other activities likely to affect the bed or bank of the river, require the formal consent of the NRA.

In addition, the NRA has limited powers in respect of consents for weirs, dams, culverts and similar obstructions on watercourses which are not designated statutory Main River. District and County Councils have powers to carry out maintenance and improvement schemes on such watercourses, but no legal obligation to do so. They would require the NRA's consent under its requirements for overall supervisory duty of drainage matters.

3.4.1.3. Local Perspective

Significant lengths have been designated Main River in the catchment, see River Control Structures and Statutory Main River map.

Historically, river control structures were introduced to generate water power for milling.

Now, these structures mainly provide amenity levels, with modifications to allow for more efficient passage of flood flows. Exceptions to this include water supply reservoirs at Chew Magna and Chew Valley Lake, flood control at Midsomer Norton, Ashton Vale, Brislington, Eastville and Tubbs Bottom and control at the Floating Harbour on the River Avon in Bristol.

The map shows the control structures on the Main River channel, of which only eighteen are operated by the NRA. Controversy sometimes arises over the responsibility and operation of hatches and sluices by private individuals.

At seven of its sluice structures, the NRA has introduced automatic control ensuring a reliable way of providing a stable amenity level at all flows except flood flows.

A pumping station on the Ladden Brook at Iron Acton provides lower levels for improved agricultural drainage upstream whilst the pumping station at Pill allows the Markham Brook to outfall through the Tidal Defence with tide-locked conditions.

3.4.1.4. Aims

- To control development and works in or adjacent to Main River in accordance with the NRA's Flood Defence By-law - "to ensure that the ability of the watercourse and its floodplain to convey and store flood waters now and in the future is not compromised".

- To ensure the correct operation of hatches and other water level controls under both flood and normal flows.

3.4.1.5. Requirements

To sustain appropriate agricultural and amenity levels, flood defences and river control structures need to be maintained in good working order. Considerable funding is required.

3.4.2. FLOODING AND FLOOD ALLEVIATION

3.4.2.1. General

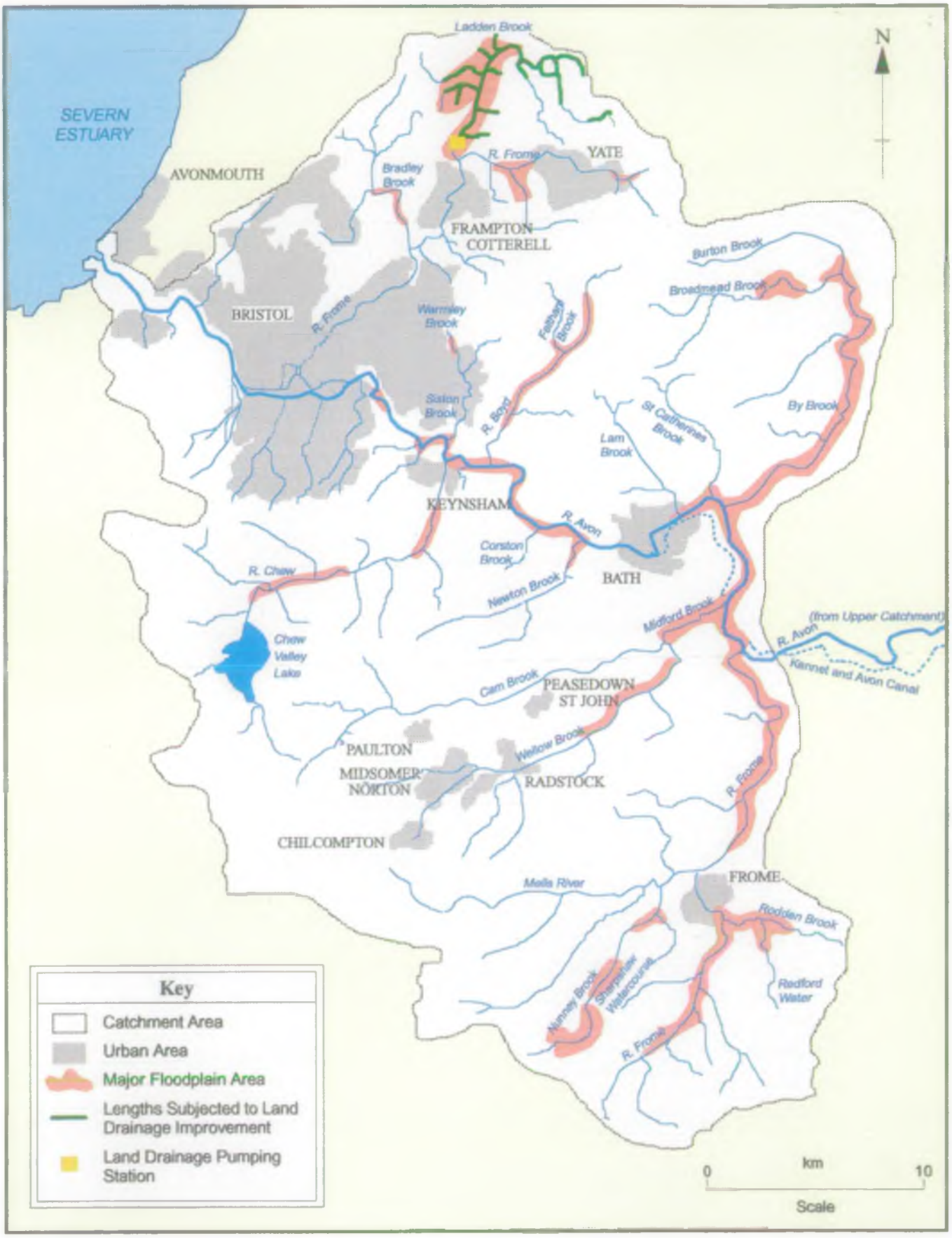
Floodplain

The floodplain is an important element of the overall river system for the conveyance of flood flows. In a major flood event, water is 'stored' temporarily in the floodplain, thereby decreasing peak flows downstream. Normally, the wider the floodplain, the more important it is in attenuating flood levels. Within its by-laws, the NRA can control any activity in the floodplain which is likely to worsen flood conditions unless planning permission has already been granted. Planning Authorities seek the NRA's advice and take this into account when deciding on planning consent for proposals within the floodplain.

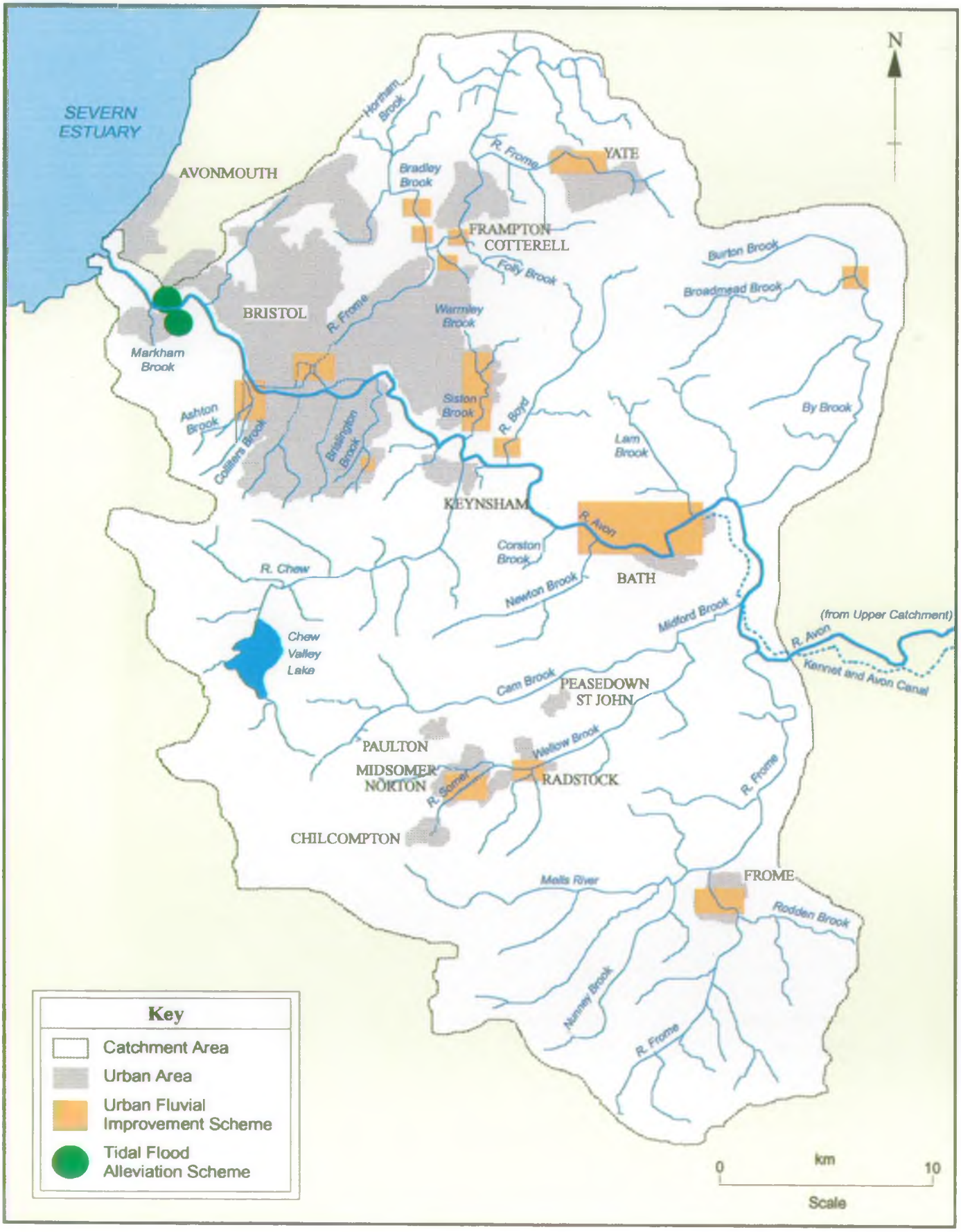
Urban Flooding

Historically, the need for the river to provide transport, power supply and sewage disposal,

LOWER BRISTOL AVON
Floodplain and Land Drainage Improvement



LOWER BRISTOL AVON
Urban and Tidal Improvement Schemes



led to towns developing in the floodplain and flood risk being accepted. However, since the Industrial Revolution, the concentration of wealth and commerce in these flood risk areas has meant that flooding is no longer so acceptable.

Rural Drainage

Until the 1980's, the overriding importance of agriculture meant that both capital schemes and major maintenance programmes were carried out to ensure reduced water levels and to minimise flood losses in order to increase agricultural production. Now, with the shift away from the need for intensive agriculture, NRA activity concentrates on the protection of urban communities from river and sea flooding.

3.4.2.2. Local Perspective

The majority of flood events in the Lower Bristol Avon occur from storms from the south west, causing exceptional rainfall on the north facing slopes of the Mendips. This results in a quick response in the Rivers Chew, Frome, Midford Brook and tributaries, and long peaks on the Avon at Bath as levels are kept high, due to Mendip runoff, with later peaks from the Upper Catchment.

The predominance of south-west storms also means that the watercourses draining from the north flood less frequently, although the steepness and urban nature of the Bristol Frome gives it the fastest rise to peak compared with any other Lower Bristol Avon stream.

Flood alleviation schemes of varying protection levels have been undertaken at many urban risk locations in the catchment, as shown on the Urban Improvement Scheme map. Many of these involve diverting flood flow past a risk area, whilst some include channel widening and regrading and alterations to existing weir structures. On the Frome, north of Bristol, a major detention reservoir stores flood water during peak flood flow.

Major fluvial flood events, causing significant damage to property, occurred in recent times in 1960, 1965, 1968, 1974 and 1979. Since these events, several schemes have been completed, though property protection is still below standard in Chew Magna and Nunney in particular.

Tidal events caused property damage downstream from Bristol in 1981 and 1989. Since then, schemes have been completed in Pill, Shirehampton and Totterdown.

3.4.2.3. Flood Warning

As part of the NRA's commitment to maintaining a good standard of flood warning, a set of procedures has been produced for the Region on a river by river basis.

In the Lower Bristol Avon Catchment, separate procedures exist for the Somerset Frome and tributaries, Midford Brook and tributaries, River Chew and tributaries, Bristol Frome and tributaries, Colliters, Longmoor and Ashton Brooks, Middle Avon and Lower Avon. Each procedure is documented and outlines the catchment type and response to rainfall, sites

considered to be at special risk, data gathering points in the catchment and specific flood warning data, which will form the basis of any warning issued. Such procedures are reassessed and modified if necessary in response to each flooding or near flooding event.

3.4.2.4. Operational Maintenance

This involves a variety of activities, such as aquatic plant (weed) spraying, tree and debris removal, trimming of bankside vegetation, maintenance and operation of control gates, flood bypass tunnels, embankments and walls and pumping stations, to ensure the efficient use of the river system for its basic purpose of conveying water.

In some instances, dredging will be required to maintain the carrying capacity of the channel. The frequency of this practice is reduced by controlling emergent weed growth in channel beds. To this end, annual herbicide spraying is being complemented by a programme of tree planting on south banks to reduce weed growth by providing shade.

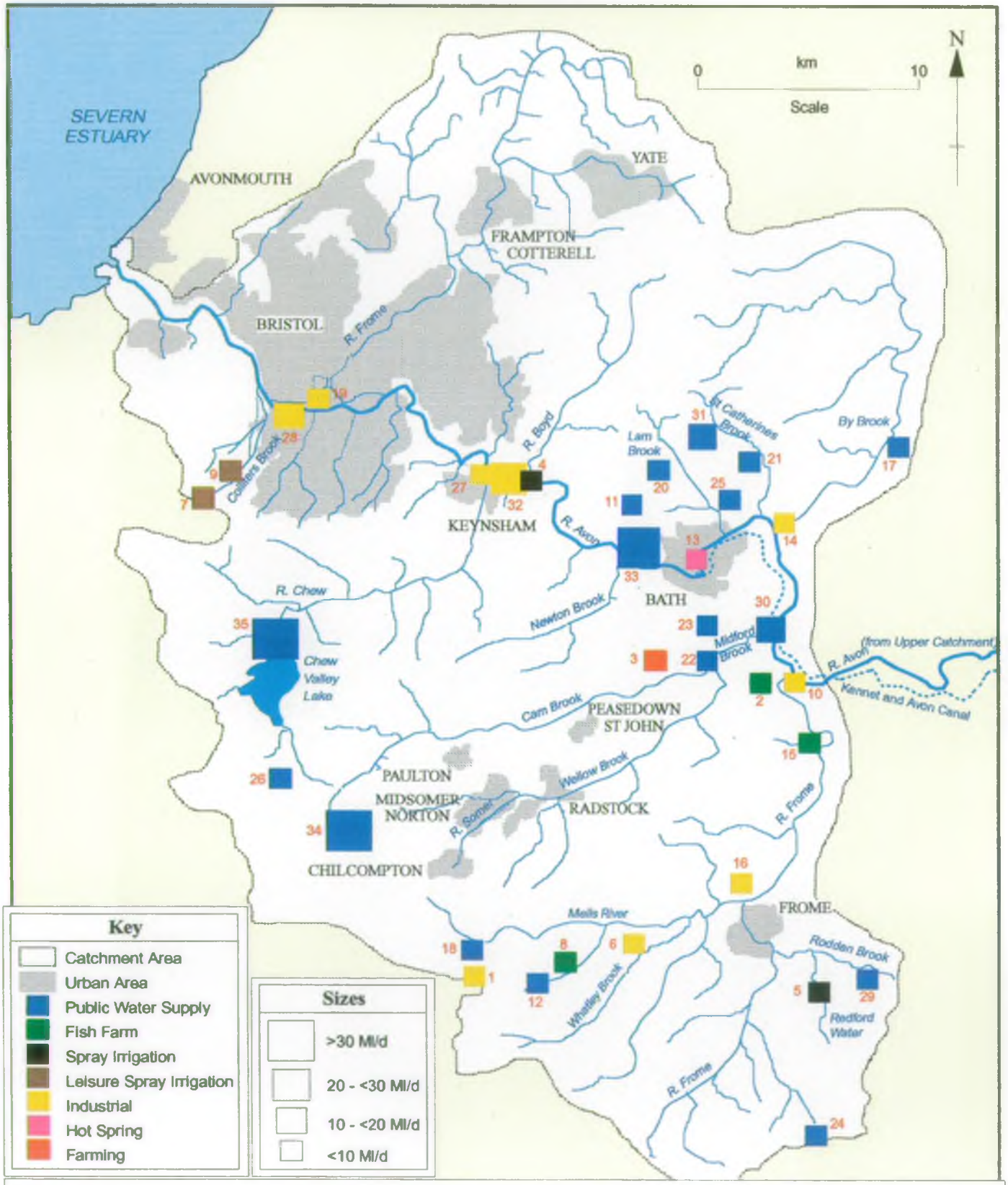
3.4.2.5. Aims

- To control development and other works in rivers or the floodplain such that risks of flooding are not increased.
- To provide effective flood defences for the protection of people and property to a standard appropriate to land use if cost effective (see section 4.5.).
- To provide adequate arrangements for flood forecasting and warning.
- To reduce weed growth in the long term.
- To take account of environmental requirements when undertaking flood defence works.
- To optimise control of flood diversion structures to minimise risk and maximise efficiency.
- To review justification for maintenance of drainage regime at Ladden Brook and tributaries as part of the Bristol Frome Action Plan.

3.4.2.6. Requirement

To sustain existing housing/industrial development and agriculture in the floodplain by minimising flooding. Flood defences have to be maintained to appropriate standards. Considerable resources must be available for this work.

LOWER BRISTOL AVON
Surface Water Abstractions



Licensed Daily Quantity (Ml/d) *(Note : BWC = Bristol Water Co.; WWS = Wessex Water Services)*

1	Wainwright's Quarry	0.55	10	Peradin Ltd Factory (now closed)	0.9	18	BWC Stoke Bottom	3.18	27	Cadburys	9.2
2	Avon & Tribs. Angling Assoc.	0.6				19	Courage PLC	3.3	28	Lloyds Bank	10.0
3	Farming	0.64	11	WWS Weston	1.1	20	WWS Longridge & Lansdown	3.7	29	WWS Divers Bridge	15.0
4	Avon Valley Farm	0.7	12	BWC Downhead	1.14	21	WWS Oakford	3.9	30	WWS Monkton Combe	15.0
5	Farm (Spray Irrigation)	0.73	13	Bath Hot Springs	1.35	22	WWS Midford Springs	5.0	31	WWS Monkswood	15.0
6	Whatley (ARC) Quarry	0.78	14	Portals Paper Mill	1.36	23	WWS Tucking Mill	6.0	32	Sappi Paper Mill	22.8
7	Golf Course (Spray Irrigation)	0.8	15	Farley Trout Farm	1.43	24	WWS Dunkerton	6.8	33	WWS Newton Meadows	31.1
8	Old Mill Fish Farm	0.8	16	Express Foods	2.7	25	WWS Batheaston	7.0	34	BWC Chew Line of Works	48.0
9	Carlton Projects Ltd	0.8	17	WWS Widdenham	2.7	26	BWC Sherborne Springs	9.0	35	BWC Chew Stoke	113.0

3.5. WATER ABSTRACTION AND SUPPLY

3.5.1. General

Each abstraction is controlled by the NRA through a licence which stipulates the total daily and annual quantities that may be used. The licence may include a condition that the abstractor must leave a minimum flow or level of water in the river to protect existing uses and users of water. The governing legislation is the Water Resources Act 1991.

Licences are generally only granted subject to an appraisal of their impact on other water users and uses. However, a number of water sources developed before 1963 were granted licences of right under the Water Resources Act 1963. In 1990/1991 a number of users previously exempt from requiring a licence were granted licences of entitlement.

Abstractions are made from surface water and groundwater sources. Surface waters generally comprise rivers, canals, rhynes and impounding reservoirs. Groundwater abstraction generally takes place from boreholes, wells and springs. Groundwater makes an important contribution to the baseflow of rivers, particularly in their upper reaches where, in dry weather, it provides most or all of the flow.

Within the Lower Bristol Avon catchment, there are 243 abstraction and impoundment licences of which 123 are licensed as surface water sources and 120 as groundwater sources. The total quantity licensed for abstraction is 92,265 million litres per annum (Ml/a). Of this total, 80,498 Ml/a, or 87%, may be abstracted from surface waters and 11,767 Ml/a, or 13%, can be abstracted from groundwater sources.

3.5.2. SURFACE WATER ABSTRACTIONS

3.5.2.1. Local Perspective

The Surface Water Abstraction Map shows the location and use of licensed surface water abstractions larger than 0.45 Ml/d.

Abstraction for public water supply by Bristol Water Company and Wessex Water Services accounts for 82% of the total licensed surface water resource. Bristol Water Company is licensed to abstract 39,320 Ml/a, or 49% of the total, and Wessex Water Services may abstract 26,449 Ml/a, or 33% of the licensed quantity.

Virtually all the water taken by Bristol Water Company in the Lower Bristol Avon catchment area is drawn from the Chew Valley Lake, to the south of Bristol, and from spring sources in the catchment above the lake. The Company also import a large quantity of water into the catchment, drawing water from the River Severn via the Gloucester and Sharpness canal at Purton to the north of Bristol.

For Wessex Water Services, the principal sources of water are the River Avon and springs in the St Catherines Brook, Lam Brook and Midford Brook catchments around Bath.

In addition to public water supply, industrial processes account for 12,606 Ml/a, or 15.7% of the total licensed surface water abstractions in the catchment. Fish farmers and water

cress growers may abstract a further 831 Ml/a, or 1%, and spray irrigators 284 Ml/a, or 0.4%.

3.5.2.2. Aims

- To ensure that surface water resources are managed and developed in a way that protects existing licenses, other water uses and environmental interests.

- To secure, where possible, appropriate measures for the benefit of the catchment within any new licences.

3.5.2.3. Environmental Requirements

Water Quality - compliance with EC Directive on the Quality of Surface Water Intended for the Abstraction of Drinking Water (75/440/EEC) and NRA Water Quality Objectives.

Water Quantity - water resources to be available within the terms specified in abstraction licences, having regard for residual quantities required for other water uses.

3.5.3. GROUNDWATER ABSTRACTIONS

3.5.3.1. Local Perspective

The Groundwater Abstractions Map shows the location and use of licensed groundwater abstractions larger than 0.45 Ml/d.

Groundwater abstraction accounts for 13% of the total licensed quantity. Abstraction for public water supply is the dominant use with Bristol Water Company licensed to abstract 9,385 Ml/a, or 80% of all groundwater abstraction. Virtually all the water is taken from three sources in the south of the area near Frome, as shown on the Groundwater Abstractions map.

Industry is licensed to abstract 2,012 Ml/a, or 17% of the groundwater total, general agriculture 237 Ml/a (2%) and spray irrigation 51 Ml/a (0.4%) of the licensed quantity.

It should be noted that an abstraction licence is not required for pumping or dewatering of quarries and, therefore, the activity is not subject to the same controls as other abstractions. Some Mendip quarries pump as much as 20 Ml/d, equivalent to a large public water supply abstraction. Quarry owners who submit planning applications to extend quarries that remove water bearing rock must now fully investigate the effect that the quarry will have on water resources.

3.5.3.2. Aims

- To safeguard existing licensed sources and the resources required for other catchment uses.

- To ensure surface water sources are not adversely affected by groundwater abstractions.

- To provide for the protection, and where possible the enhancement, of the water environment.

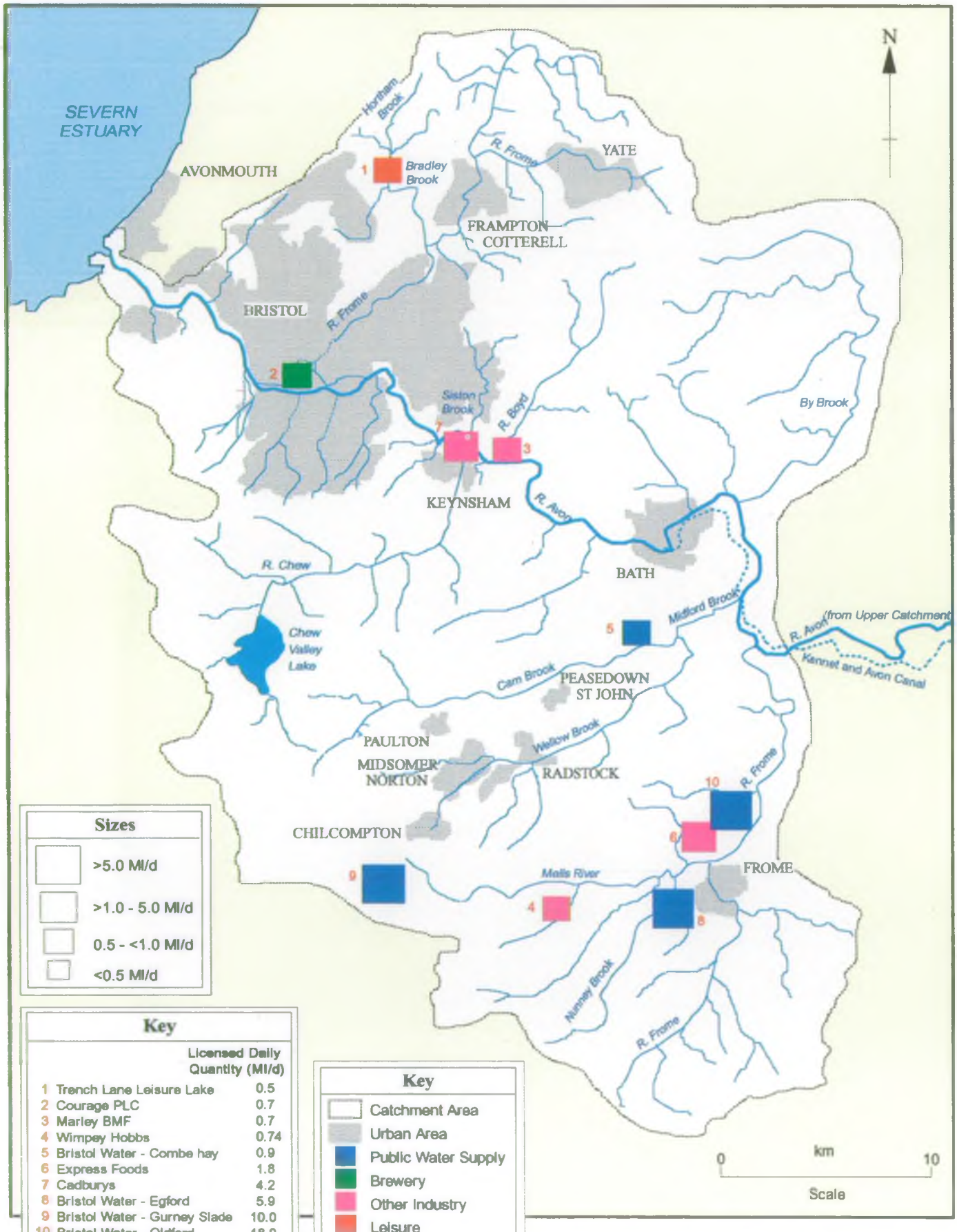
- To protect the quality of groundwaters by implementing the NRA's Policy and Practice for the Protection of Groundwater.

3.5.3.3. Environmental Requirements

Water Quality - treated water supplied for human consumption must comply with the relevant parts of the EC Directive relating to the Quality of Water intended for Human Consumption (80/778EC)

Water Quantity - water resources to be available within the terms specified in abstraction licences, having regard for residual quantities required for other uses.

LOWER BRISTOL AVON
Groundwater Abstractions Greater Than 0.45 Ml/Day

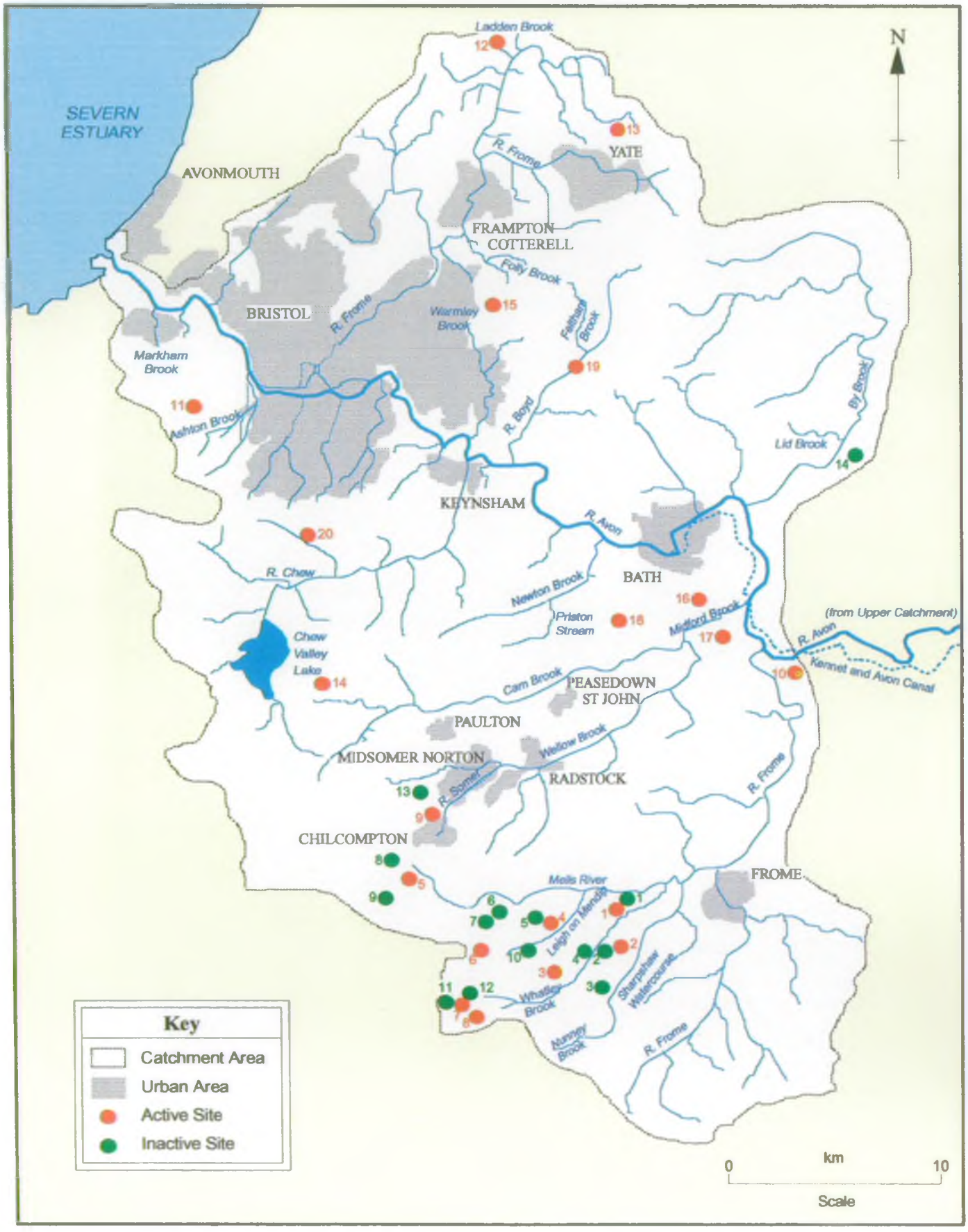


Sizes
>5.0 Ml/d
>1.0 - 5.0 Ml/d
0.5 - <1.0 Ml/d
<0.5 Ml/d

Key		Licensed Daily Quantity (Ml/d)
1	Trench Lane Leisure Lake	0.5
2	Courage PLC	0.7
3	Marley BMF	0.7
4	Wimpey Hobbs	0.74
5	Bristol Water - Combe hay	0.9
6	Express Foods	1.8
7	Cadburys	4.2
8	Bristol Water - Egford	5.9
9	Bristol Water - Gurney Slade	10.0
10	Bristol Water - Oldford	18.0

Key
Catchment Area
Urban Area
Public Water Supply
Brewery
Other Industry
Leisure

LOWER BRISTOL AVON
Mineral Extraction



3.6. MINERAL EXTRACTION AND WASTE DISPOSAL

3.6.1 General - Mineral Extraction

Mineral extraction and waste disposal are sometimes interrelated as it can be a condition of a mineral working permission to restore the site by means of landfill. Alternatively the site may be left as it is, if for instance a feature of geological interest is exposed. Some sites may be left flooded as recreational, amenity or compensation lakes.

Mineral extractions can affect both groundwater quantity and quality. For instance, the lowering of groundwater levels to facilitate dry working can lead to the loss of water supplies from nearby wells and boreholes, the removal of natural springs feeding ponds and streams and the drying up of wetlands. Headwaters of streams often support invertebrate species which are not found elsewhere. The water-table may in some cases be permanently lowered leading to an irretrievable reduction or loss of spring and stream flows. Also the loss of the unsaturated zone of rock above the natural water-table reduces the purifying effects of filtration and biological action. It also changes the flow regimes due to loss of buffer storage which otherwise delays and attenuates flood peaks and allows contribution to dry weather flows. Surface water runoff from workings and spoil heaps, and discharges from quarries and mines often contain silt and toxic material which is harmful to plant and animal life. This risk continues after a mineral working is abandoned. New risks to water quality may be introduced if any abandoned quarry is used as an industrial site.

The NRA has a duty to control by means of Consents to Discharge the discharges from mineral workings (see also Section 4.3 Groundwater Protection Objectives)

3.6.2. Local perspective - Mineral Extraction

Mineral Extraction Map - Key

Active Sites	Active Sites	Inactive Sites
1 Whatley Quarry	11 Durnford Quarry	1 Lime Kiln Hill Quarry
2 Holwell Quarry	12 Tytherington Quarry	2 Westdown Quarry
3 Torr Works	13 Chipping Sodbury Quarry	3 Cloford Quarry
4 Halecombe Quarry	14 Stowey Quarry	4 Asham Quarry
5 Gurney Slade Quarry	15 Shortwood Claypit	5 Barnclose Quarry
6 Moons Hill Quarry	16 Upper Lawn Quarry	6 Cookswood Quarry
7 Chelynch Quarry	17 Hayes Wood Mine	7 Stoke Lane Quarry
8 West Cranmore Quarry	18 Combe Hay Mine	8 Emborough Quarry
9 Chilcompton Quarry	19 Wick Quarries	9 Highcroft Quarry
10 Westwood Mine	20 North Wick Claypit	10 Tadhill Quarry
		11 St Andrews Quarry
		12 Farrington Quarry
		13 Clapton Quarry
		14 Corsham Quarry

Several of the largest stone quarries in Britain are concentrated in the southern part of this catchment. Six quarries in the East Mendips, five in limestone and one in andesite lava, produced about 15 million tonnes of aggregate in 1993. This was the bulk of Somerset's stone production, which in Britain is only exceeded by Derbyshire.

Unfortunately for water resources and the water environment, more than 90% of the rock extracted was Carboniferous Limestone, one of the 3 most important aquifers in the South Western Region of the NRA. There is an inescapable conflict between mineral developers and water users: the limestone aquifer of the Mendip Hills supplies high-quality drinking water to some 600,000 people in Bristol, Avon and Somerset on a sustainable basis but the quarry operators continue to remove this aquifer, causing water pollution and the interruption of flows from boreholes, springs and streams in the process.

Other minerals including building stone, clay and celestite (strontium sulphate) are extracted in the catchment but their impact on water resources is relatively small. Coal mining was a major industry for several centuries, in the coalfields north and south of Bristol, but it ceased in the 1970s. A Fuller's Earth mine south of Bath closed in the 1980s.

MINERAL PLANNING AUTHORITIES

The Mineral Planning Authorities are Avon County Council (Carboniferous Limestone, clay building stone and celestite); Somerset County Council (Carboniferous Limestone, andesite hardstone and building stone) and Wiltshire County Council (building stone).

THE MINERAL OCCURRENCES

Carboniferous Limestone is a hard rock that, in this catchment, forms the eastern end of the Mendip Hills and the steep rocky gorges of the River Avon at Clifton, the River Boyd at Wick and the River Trym in North Bristol. In the subdued topography north and northwest of Chipping Sodbury it forms a distinct escarpment.

The andesite hardstones (used for non-skid road surfaces) of the East Mendips outcrop in the core of the Mendip anticlinal fold. Although very hard, they do not stand above the adjacent Old Red Sandstone strata.

All the building stones worked in the catchment are varieties of limestone. The Great Oolite (Bath Stone) caps the plateaux around Bath but descends to near river level at the Westwood mine. The Inferior Oolite (Doulting Stone) and the Blue and White Lias also cap lesser plateaux including Dundry Hill and through their relative hardness, form escarpments.

The clay strata are soft and have no particular topographic expression. Commercial celestite deposits are associated with residual soils and are normally worked in valley floors and other low ground.

MAJOR QUARRIES AND MINES

Carboniferous Limestone quarries

The large quarries at Chipping Sodbury are working below the natural water-table. To keep the lower levels dry they pump several thousand cubic metres of water daily to the River Frome and the Brimsham Stream (Ladden Brook). The bed of the latter has begun to leak seriously and is now dry for much of the year upstream of the pump discharge point. This group of quarries has reserves for several decades and is expected to fill with water when working ceases. The NRA has resisted proposals to quarry through the Brimsham Stream and has argued that the stream bed should be waterproofed to restore all-year flow.

Sub-water-table quarries at Tytherington have dried up natural springs feeding the Ladden Brook and replaced them by dewatering pumpage. The Durnford Quarry at Long Ashton which produces one million tonnes per year is not sub-water-table. It has consented reserves for two and a half to four years.

At Wick the limestone is quarried on both sides of the River Boyd which now flows along the crest of an artificial ridge separating the sub-water-table pits. Reserves are probably adequate for several decades. The pumping sumps are currently at approximately 40 metres Above Ordnance Datum (AOD) and the NRA is concerned that if they deepen much below 30 m AOD some or all of the thermal water that rises from the same limestones to form the Bath Hot Springs (25-30 m AOD) could be diverted to Wick. The NRA has therefore asked the Mineral Planning Authority (Avon County Council) to impose appropriate depth restrictions on the Wick quarries.

The largest quarry in the East Mendips is Torr Quarry which produces about 6 million tonnes (Mt) of stone per year. In 1994 only part of the quarry floor was sub-water-table; even so, dewatering pumpage has been as much as 20 million litres per day (Ml/d) in wet winter months. If the quarry is allowed to deepen below the present floor level it will have reserves for several decades. Lowering the adjacent water-table will reduce the natural output of springs and the flows in three streams. The operator has therefore constructed a sump of 570 Ml capacity on the quarry floor and pumps from it to augment low flows in the Alham Stream, the Nunney Brook and the Whatley Brook. The operator has also promised appropriate compensation to local water users whose supply is adversely affected by the quarry.

Whatley Quarry in the East Mendips is almost as large as Torr Quarry, with an annual limestone production of about 5 Mt (1994). It is in the catchment area of the Oldford Boreholes which are licensed to supply 21 Ml/d of high quality water for public supply and the dairy industry. The quarry floor is now about 53 m AOD, some 20 m below the natural water-table, and up to 23 Ml/d is pumped from it. The effect on local water resources has been severely damaging: one large spring has totally failed, several others have been seriously diminished, and in the dry summer of 1990 the yield of the Oldford boreholes was reduced by up to 20%. It is believed that continued deepening of the quarry may adversely affect the Hot Springs of Bath. Following a Public Inquiry in 1992 The Secretary of State refused to allow a large westward extension of the quarry; a smaller application has since been made to the Mineral Planning Authority. The NRA will seek full mitigation of the damage that would result to water resources as a consequence of the proposals.

The quarry at Gurney Slade produces approximately 1 Mt of stone per year and has a life of several decades. It is very close (approximately 200 m) to the Gurney Slade Well, an important groundwater source that can supply up to 10 Ml of drinking water per day. Since 1989 the well has suffered episodes of pollution by suspended sediment, thought to derive from the quarry, that made the water unusable. The quarry is already sub-water-table, pumping up to 6 Ml per day into the adjacent River Mells, and any deepening below the current floor level of 179 m AOD would severely reduce the yield of the well. It is also believed that the Gurney Slade area may be a source of supply to the Hot Springs of Bath. The NRA is therefore resisting proposals to deepen or extend the quarry beyond current planning limits.

There are several quarries between Gurney Slade and Whatley but the only active one is Halecombe Quarry. Like Whatley Quarry it is in the Oldford Boreholes catchment. It produces approximately 1 Mt of stone per year and has been sub-water-table since 1985. Up to 8 Ml/d is pumped to the adjacent Finger Stream. A nearby spring was so reduced by pumping in 1986 and following years that fish kills occurred in the spring-fed lakes. The operators are implementing a hydrogeological monitoring programme to assess the effects of deeper working and have agreed to mitigate any adverse effects caused by their dewatering operation.

Coleman's Quarry has been sub-water-table since 1993, pumping about 7 Ml/d on average to the Nunney Brook. As a result the nearby Holwell Springs totally fail in dry weather. The quarry produces approximately 1 Mt of stone per year and has a life of several decades. Part of the working area is in the catchment of the Egford Wells, licensed to abstract up to 5.9 Ml per day for public water supply. An extension into the Egford catchment was granted in 1993 on condition that a compensation pond would be created and maintained in perpetuity to mitigate for any loss of groundwater to the source, and that there should be no other sub-water-table quarrying. The operators began to monitor the effects of quarrying on water resources in 1987 and the study will continue throughout the quarry life.

In the East Mendips the Carboniferous Limestone outcrops are separated by an anticlinal structure trending east-west in which relatively impermeable strata are present. Quarries in the northern outcrop (Gurney Slade, Halecombe, Whatley and the inactive Bector Wood, Barnclose and Limekiln Hill quarries) are in the catchments of three important public water sources (Gurney Slade, Stoke Bottom and Oldford) and also threaten to affect the Bath Hot Springs. In contrast the southern outcrop quarries (Torr, Coleman's and the inactive Asham, West Down and Cloford quarries) will affect the Egford source alone. Both groups of quarries will adversely affect flows from springs and in streams, requiring extensive compensation pumping and other works to prevent environmental damage and to maintain the rights of all water users.

NRA's Groundwater Protection Policy requires the Authority to object to mineral extraction proposals where there will be demonstrable harm to water resources and the water environment, unless measures to mitigate any effects can be agreed within planning controls. Mitigatory measures can include compensation ponds (a permanent water-table lake of

appropriate size), support pumping from boreholes or reservoirs to make good depleted flows to their natural levels, or financial compensation where appropriate.

Where there is an evident serious risk to water resources that cannot be quantified (as to Bath Hot Springs) the NRA has asked the Mineral Planning Authority to use the precautionary "one lift at a time" principle. By this measure, before quarry operators can be granted planning permission to deepen their workings by another lift, they must convince the MPA that they have not damaged water resources by removing the previous lift, and, if such damage has been caused, that they can and will make it good effectively and permanently.

In the East Mendips the northern group of limestone quarries clearly poses the greater risk to water resources but both groups seriously affect the water environment in general. Given that crushed rock aggregate can be obtained from other rocks (eg granite) that are not important aquifers, the NRA's long term objective, and the nation's interest must be to encourage a run-down of quarrying in major limestone aquifers.

The East Mendip limestone quarries are so large and will be so deep, in most cases, that the only appropriate end use may be as lakes. It has been argued that these could be used for water supply, but such a use would not be straightforward. Most of the lakes would have very small catchment areas compared to their size, so they would need to be filled by pumping from a distant river when the river flow was in surplus. Then, when the water level in them was drawn down in summer, all the problems of derogation of springs, streams and boreholes that are associated with quarry dewatering would recur.

Andesite Lava ("hardstone") quarries

The Moons Hill complex of quarries in East Mendip produces up to 1 Mt of hardstone aggregate per year and has a life of several decades. The rock is a minor aquifer and several Ml/d are pumped out of the workings which exceed 100 m in depth. The difficulty of settling out suspended sediment in the pumped water contributed to the abandonment (temporarily) of the Stoke Bottom Springs which are fed, via the Stoke Lane Slocker cave system, by the stream leaving the quarry and are licensed to yield 3 Ml/d for public supply. A large settlement lagoon has recently been installed. Landfill would not be a simple end-use for these huge sub-water-table quarries, but as the rock is less permeable than limestone a water supply reservoir might be practicable.

There is an inactive andesite quarry at Downhead, east of Moons Hill.

Building stone mines and quarries

The Doulting Stone (Inferior Oolite) is worked in two small shallow quarries east of Shepton Mallet. Production is a few thousand tonnes per year and reserves are likely to last for several decades.

The Bath Stone (Great Oolite) is extracted from underground "pillar and stall" mines at Westwood and Hayes Wood and from a surface quarry at Combe Down, Bath. The underground reserves are large, allowing for a life of several decades.

White Lias and Blue Lias limestones are quarried from shallow workings at Chilcompton and Stowey, near Bishops Sutton. Production is very small.

None of the building stone workings are sub-water-table. Their effect on water resources is limited to loss of temporary water storage in the unsaturated zone which, because of their limited size, is not great. None of the active quarries is in the catchment area of a borehole or spring used for public supply.

In the vicinity of Bath there are larger worked-out underground mines in the Bath Stone strata. One, at Combe Down, is in the catchment area of Whittaker's Spring, a public water supply source. The implications of a proposal to stabilize the mines with concrete are discussed in Section 5.2.6. Issue 23.

Some of the underground mines have been adapted for uses such as secure storage, mushroom growing, manufacturing (during World War 2) or tourism. In such cases it is important that there is no input of polluting materials to the aquifer. Restoration in the sense of infilling is not appropriate to the deep mines, which are of considerable educational and environmental value, not least as safe habitats for bats which are a legally protected species.

Clay pits

Clay, mostly for brick making, is dug at Shortwood, northeast Bristol, from weathered mudstone beds of the Coal Measures. Some was previously won from adjacent Mercia Mudstone strata. Worked-out areas of the large pit are used for landfill. The Coal Measures here are a relatively unimportant aquifer and the main risk to water resources is to the surface water that receives the dewatering pumpage from the claypit.

A small pit in Lias Clay at Northwick south of Bristol was abandoned in 1993 and is now partly infilled with inert wastes. While working it caused serious pollution of the adjacent stream.

Celestite pits

This mineral is obtained from small shallow opencast pits widely dispersed over the catchment north of Yate. The life of any one deposit is usually one to two years. Restoration to agricultural use normally follows. The only likely risk to water resources is that of suspended sediment entering a surface watercourse.

Coal mines

The abandoned coal mines in the Radstock, Bristol and other coalfields are now mostly flooded. Some are drained by adits to the nearest river or stream. The drainage water tends to have slightly elevated levels of iron and sulphate but no serious problems have resulted. Recent proposals to explore for coal bed methane by deep boreholes have not yet been implemented.

3.6.3. The role and objectives of the NRA - Mineral Extraction

The NRA's main objective must be to mitigate or remove the huge damage to water

resources and the water environment caused by quarrying of the major Carboniferous Limestone aquifer. Secondary objectives extend that need to minor aquifers and smaller workings and to ensuring that abandoned mineral workings are restored or otherwise used in such a way that neither the quantity nor the quality of water resources are put at risk.

In the short term the NRA is required by its Groundwater Protection Policy, and Policy Statements B1 and B2 in particular, to oppose any new proposal for mineral working that will not provide complete mitigation for the damage that it causes to water resources and the water environment. The mitigation may take the form of compensation ponds, replication of natural flows from springs or in streams, deepening or replacement of supply boreholes etc. Unfortunately, to achieve true mitigation it must continue forever, and no matter how legally binding the promises may appear there must be doubt as to their reliability.

The NRA's long term objective must therefore be to achieve the diversion of mineral extraction from major aquifer rocks to rocks that are of less value to water resources and the water environment, like granite, basalt or gritstone. For some uses secondary aggregates like builders' rubble, road planings or slate waste can replace freshly quarried limestone. Although there is currently a move towards developing "coastal super quarries" that provide granite or basalt aggregate for shipment to English ports in 100,000 tonne bulk carriers it could be several decades before there is a significant slackening of the rate at which the East Mendip aquifers are quarried away. While this is an issue for the Catchment Management Plan it requires the will to change present national policies for satisfying the demands for mineral aggregates from traditional but damaging sources.

3.6.4. General - Waste Disposal

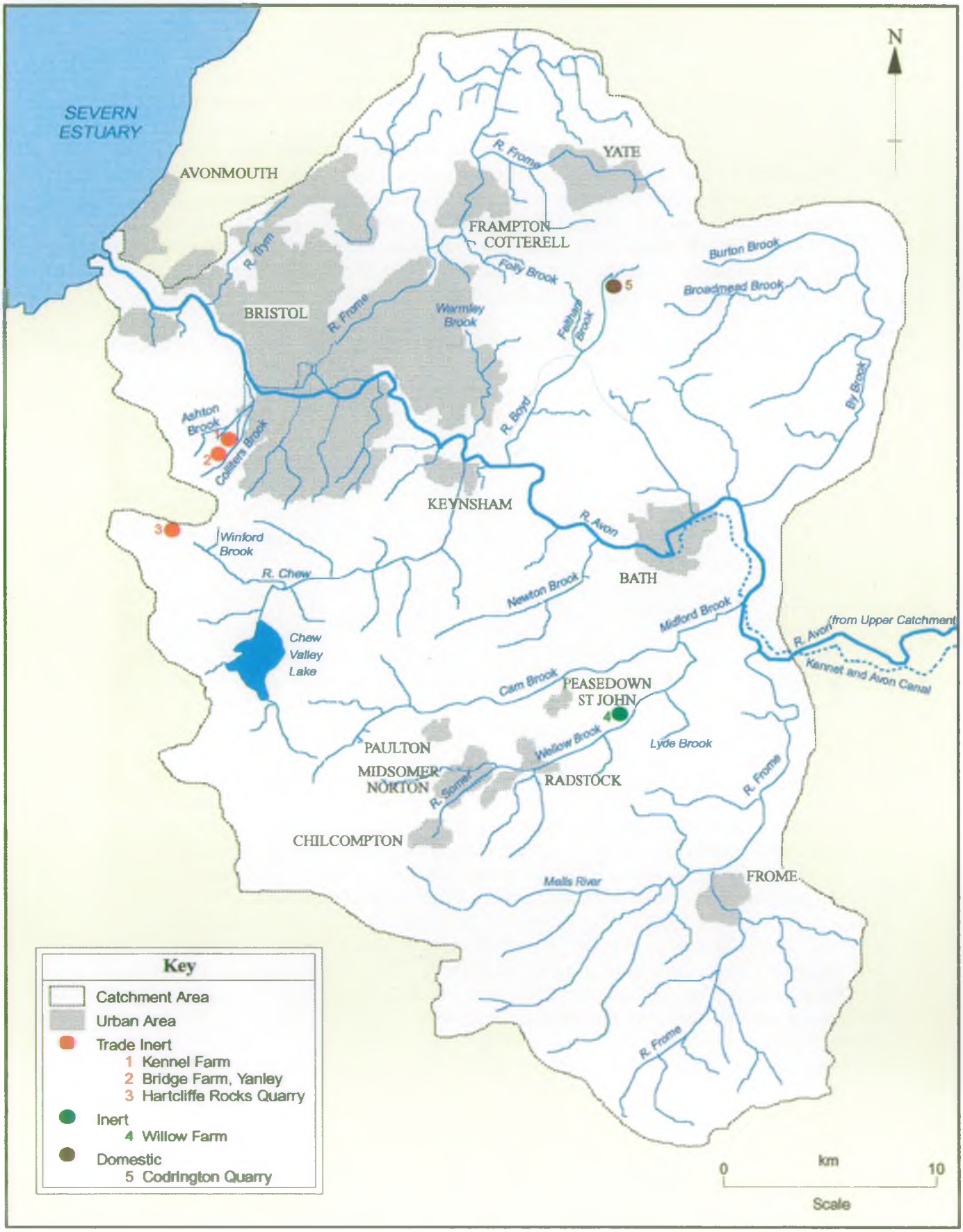
The NRA recognises that landfill is a potential threat to both groundwater and surface water. Solid wastes invariably generate a liquor (known as leachate) when buried in landfills, through the breakdown of waste and the ingress of water and depending on the nature of waste involved this can vary in polluting potential.

The NRA supports strategies of waste minimisation recycling and pretreatment that result in less waste being landfilled or decreases its polluting potential. A reduction in the amount of controlled wastes disposed to landfill will decrease the pollution threat to ground and surface waters though it is recognised that waste minimisation strategy will require significant legislative and financial incentives for implementation. Landfill is therefore likely to remain the primary means of solid waste disposal for the foreseeable future.

The NRA will play a key role in the strategic planning process relating to landfill by supporting and contributing to waste local plans. The NRA encourages the siting of new landfills away from major aquifer areas, and will seek to promote land raising where this is clearly the best option for the water environment.

Landfill sites are currently licensed by County Waste Regulation Authorities (WRA) under the Waste Management Licensing Regulations 1994, enacted under the Environmental Protection Act 1990. The waste management licence sets conditions to ensure there is no pollution of the environment, harm to human health or serious detriment to the amenities of the locality. The WRA is also the competent authority for ensuring control over potential discharges to groundwater under the Groundwater Directive (80/68/EEC). The NRA is a

LOWER BRISTOL AVON
Waste Disposal



statutory consultee on all applications for Waste Management licences and would require appropriate safeguards to protect the water environment.

3.6.5. The role and objectives of the NRA - Waste Disposal

The aim of the NRA is to prevent the pollution of ground and surface water resources through the control and influence of solid waste disposal policy and practice.

The NRA has duties and powers to:

i) require pollution prevention and control measures through Waste Management Licensing Statutory consultation

ii) to monitor controlled waters around waste disposal sites

iii) to take enforcement action where there is shown to be pollution of ground or surface waters.

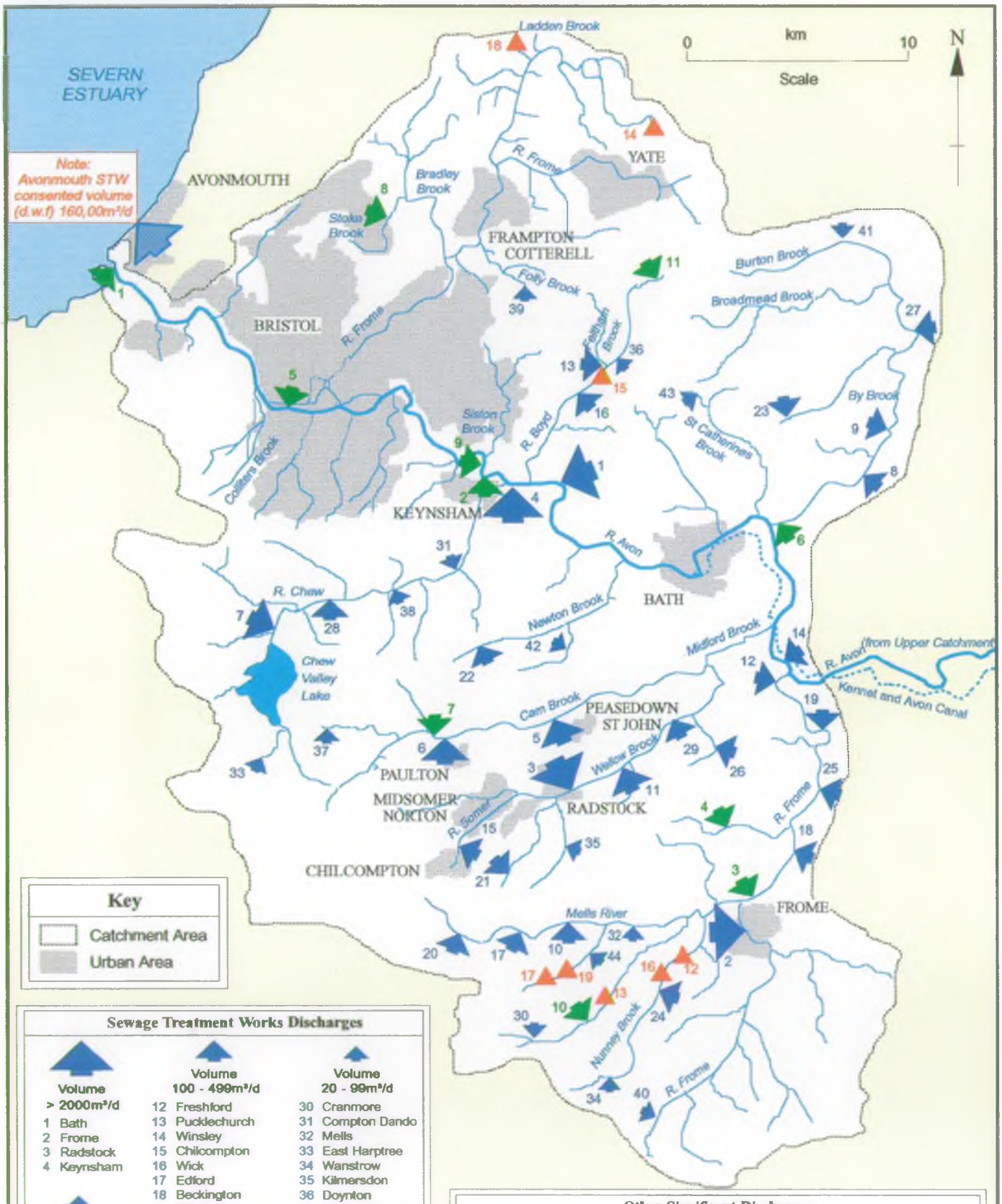
NB The NRA has recently published a Position Statement on Landfill and the Water Environment. (Available from Principal Officer, (Groundwater Protection) at our Exeter office).

3.6.6. Local perspective - Waste Disposal

There are currently twenty five operating landfills within the catchment, mostly receiving inert or commercial and industrial waste (see Waste Disposal map). The majority of domestic waste arising is disposed of outside the catchment by a combination of rail-transfer to a landfill in Buckinghamshire and direct incineration at the Avonmouth refuse incinerator. There is one landfill licensed to receive domestic waste, Codrington Quarry, though to date this has received commercial and industrial wastes only.

The waste disposal plans for Avon, Somerset and Wiltshire County Councils have yet to be published and thus the future need for strategic landfills within the catchment has yet to be defined within the Development Plan process.

LOWER BRISTOL AVON
Effluent Disposal



Sewage Treatment Works Discharges

Volume > 2000m³/d		Volume 100 - 499m³/d		Volume 20 - 99m³/d	
1	Bath	12	Freshford	30	Cranmore
2	Frome	13	Pucklechurch	31	Compton Dando
3	Radstock	14	Winsley	32	Mells
4	Keynsham	15	Chilcompton	33	East Harptree
		16	Wick	34	Wanstrow
		17	Edford	35	Kilmersdon
		18	Beckington	36	Doynton
		19	Westwood	37	Hinton Blewett
		20	Oakhill	38	Pensford
		21	Stratton on Fosse	39	Parkfield
		22	Farmborough	40	Upton Noble
		23	Marshfield	41	Burton
		24	Nunney	42	Priston
		25	Rode	43	Cold Ashton
		26	Norton St Phillip	44	Leigh on Mendip
		27	Long Dean		
		28	Stanton Drew		
		29	Wellow		

Volume 500 - 1999m³/d

5	Cam Valley
6	Paulton
7	Chew Stoke
8	Box
9	Colerne
10	Coleford
11	Shoscombe

Other Significant Discharges

Trade

1	Bristol Bulk Co Ltd	9	Cadbury (Somerdale)
2	Sappi Specialities	10	Permanite Asphalt
3	Edenvale Food Ingredients	11	Codrington Quarry Landfill Site
4	Hinton Poultry Ltd		
5	Lloyds Bank Development		
6	Portals (Bathford) Ltd		
7	BPC Purnell Ltd		
8	Rolls Royce		

Quarries

12	Whatley Quarry	15	Wick Quarry
13	Torr Works Quarry	16	ECC Holwell Quarry
14	Barnhill & Hampstead Quarries	17	Moons Hill Quarry
		18	Tytherington Quarry
		19	Halecombe Quarry

3.7. EFFLUENT DISPOSAL

3.7.1. General

The NRA has duties and powers to:

- License discharges through a system of consents. The NRA must issue a consent to discharge unless there is a good reason for refusal. The decision is made with reference to upstream water quality, river flows and the water quality objectives in the receiving watercourse. This enables consent limits to be derived which constrain the impact of both quality and volume of the discharges within acceptable levels. Where the receiving water quality is unsatisfactory the NRA may reasonably refuse applications for new discharges. Consenting procedures are detailed in Schedule 10 of the Water Resources Act 1991.

- Monitor the discharges and assess compliance against the standards. Dischargers may be prosecuted where they significantly contravene the consent conditions.

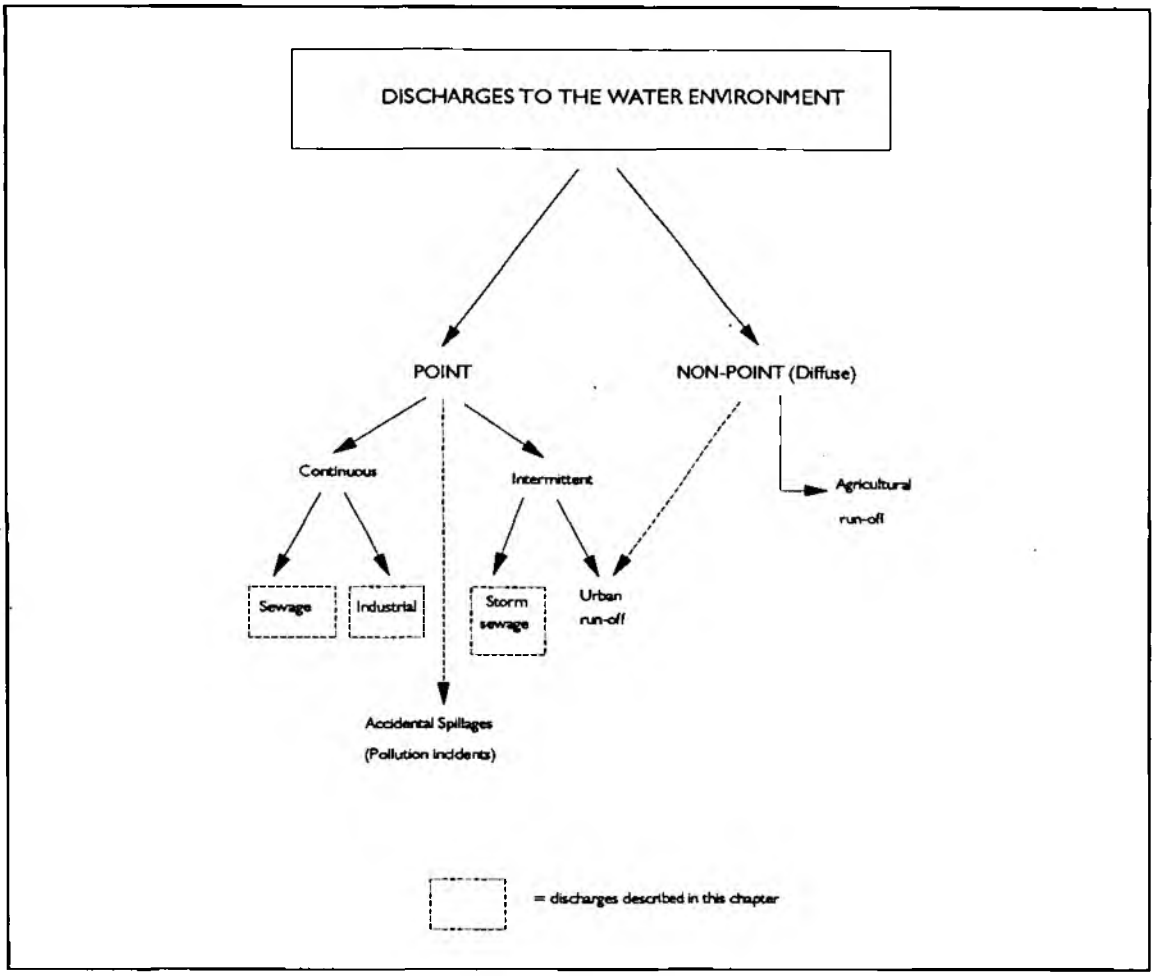
- Prevent illegal discharges as it is an offence to cause pollution or permit it to occur by discharging sewage effluent or trade effluent without the NRA's consent.

- Direct investment priorities for the water companies, with OFWAT, for sewage treatment.

Additionally, through liaison with other relevant organisations in its day to day activities, and research and development initiatives the NRA is committed to:

- maintaining links with local planning authorities to control development where further effluent disposal could cause a decline in water quality. See Town & Country Planning Strategy, Section 3.2.

- liaising with trade dischargers, farmers and water undertakers and carrying out regular site inspections.



The effluents described in this chapter are highlighted by boxes with dashed lines.

As illustrated above, this section covers consented sewage, industrial and agricultural discharges, both continuous and intermittent. Non-consented accidental spillages and non-point discharges are discussed in the Water Quality State of Catchment, section 5.1.5.

3.7.2. Local Perspective

Continuous Discharges

Sewage: Details of the major consented sewage discharges are shown on the Effluent Disposal map. Conditions (quality standards) are set on an individual case-by-case basis and are dependent on the quality that must be maintained downstream of the discharge. In the areas serviced by mains sewerage systems, individual industrial and sewage effluents are usually treated at the local sewage works. In some cases eg Radstock and Frome, the proportion of industrial effluent treated at the sewage works can be quite high.

In this catchment, there are forty four sewage treatment works with a daily flow of greater than 20 cubic metres, the two largest being Bath (Saltford) and Frome. Sewage from the Bristol urban area is piped to the Avonmouth works and from there to the Severn Estuary and is thereby removed from the catchment.

List I substances (EC Dangerous Substances Directive see Appendix 3) have been detected in the following discharges within the catchment:

-	Bath STW	cadmium
-	Keynsham STW	cadmium
-	Frome STW	lindane
-	Pensford STW	mercury (but note Pensford STW is to close soon and then this discharge will stop as it is believed to come from the mercury seals on the biological filters).

In all the above cases the Environmental Quality Standard (EQS) for the receiving watercourse has not been exceeded (up to end 1993).

Non Sewage: The major trade discharges are shown on the map as 'Other Significant Discharges'. These are predominantly discharges of high volume but relatively uncontaminated cooling and quarry waters. For this reason, volumes have not been quoted for these discharges. However Rolls Royce is consented for zinc, chromium, copper, nickel, cadmium and iron; BPC Purnell Ltd for chromium, copper and zinc; and Portals (Bathford) Ltd for cyanides and a wide variety of metals (presently under review). The results of EC dangerous substances monitoring in the catchment is discussed in section 5.1.3.2.

Fish Farms: This activity is virtually absent in the Lower Bristol Avon Catchment. Consents are held for small operations on the River Frome by Farleigh Natural Springs and Avon and Tributaries Angling Association.

IPC (Integrated Pollution Control): Two processes in the catchment come under the control of Her Majesty's Inspectorate of Pollution (HMIP). These are Cuprinol Ltd., Frome and Permanite Asphalt, Shepton Mallet. The former has recently been issued with an IPC authorization but the NRA will continue to consent the aqueous (cooling water) discharge. The latter is due to be authorized by Mendip District Council after the change in regulations effective 1 December 1994.

Intermittent Discharges

These are predominantly associated with the large urban areas in the catchment.

Bristol: There are in excess of 450 storm overflows in the sewerage system which serves Bristol and surrounding areas. A large number of these overflows are made to the various tributaries of the Avon in Bristol itself, including the Trym, the Siston Brook, the Brislington Brook and the Malago. In some cases these discharges are having an impact on the receiving watercourse, and in these cases improvements to the sewerage system are being sought. Improvements to the sewerage infrastructure in the Bristol area are continuing to be made. Major schemes have included the Frome Valley Relief sewer (phases I, II and IV) and the

Northern Foul Water Interceptor which involved tunnelling under Bristol. A number of schemes have also been undertaken to intercept various discharges of crude sewage to the river Avon.

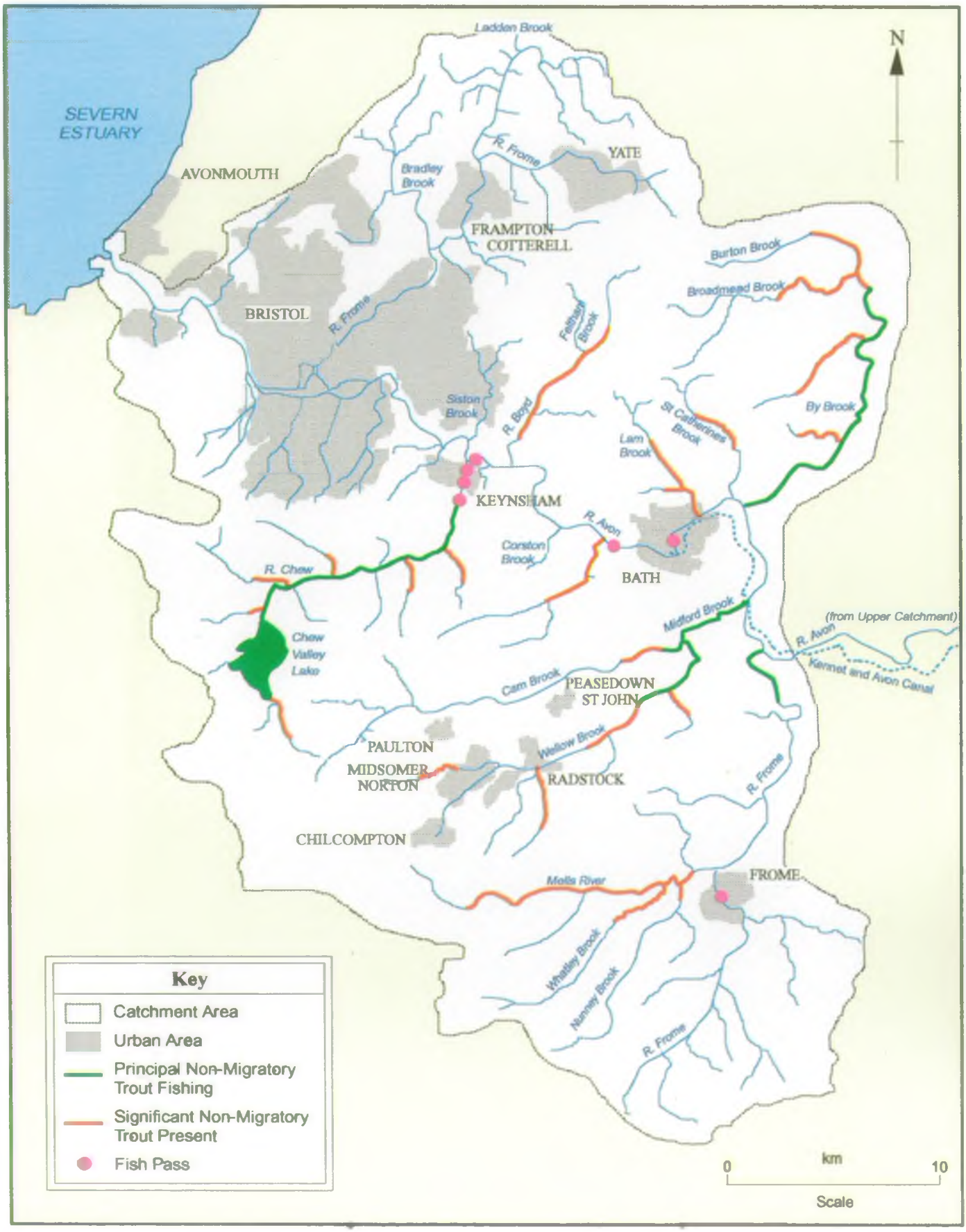
Bath: The principal discharge of storm sewage takes place at Twerton which is approximately 7 km upstream of the treatment works at Saltford. Moreover, there are approximately 150 other storm overflows on this sewerage system. The operation of these overflows gives rise to a public nuisance from the resulting sewage debris.

An assessment has been made of the performance of these discharges. Discussions have been taking place with Wessex Water Services about the options available for the improvement of the overflows that have been found to be unsatisfactory.

3.7.4. Aims

To control effluent disposal so as to ensure environmental water quality and relevant EC directive standards are achieved and maintained, and to ensure that other uses are not compromised by effluent disposal.

LOWER BRISTOL AVON
Game Fishery



3.8. FISHERIES - GAME AND COARSE

3.8.1. GAME FISHERY

3.8.1.1. General

This use refers to the conservation of wild populations of salmonid fish and their habitats and to recreational trout fisheries.

3.8.1.2. Local Perspective

Every three years NRA Fisheries staff conduct electric fishing surveys of salmonids at selected sites throughout the Lower Bristol Avon catchment to assess populations and any spatial or temporal changes.

A large number of the tributaries of the Lower Bristol Avon support brown trout and, although many are not significant as rod fisheries, these wild populations of trout are nevertheless worthy of conservation.

The main trout fishing lengths are shown on the Game Fishery map. On the lower Bristol Avon, the trout fishing is mainly carried out on the tributaries.

The By Brook is spring fed from the Oolitic Limestone aquifer and is a productive brown trout tributary. Fishing takes place between Castle Combe and Bathford, where supplementary stocking by angling interests includes both rainbow trout and brown trout.

The lower section of the Wellow Brook (downstream from Wellow) and the lower section of the Cam Brook (downstream from Twinhoe) are managed as trout fisheries, including the Midford Brook. The trout fishing is dependent on regular stocking by the angling club.

The River Chew is fed from spring sources in the Mendip Hills arising from the carboniferous limestone aquifer. The flows downstream from Chew Magna are influenced by the presence of Chew Valley water supply reservoir and other public water supply abstractions occurring upstream. Trout fishing takes place throughout the section from Chew Magna to Chewton Keynsham and relies on regular stocking by angling interests.

The lower section of the Somerset Frome, from Farleigh Hungerford down to Freshford, supports good stocks of coarse fish. In addition, trout are stocked by the angling club providing game fishing throughout the stretch. Wild brown trout are found throughout the river but mainly in some of the upper tributaries above Frome.

Wild brown trout are present throughout the By Brook, extending up into the smaller tributaries, and also in the St Catherines Brook, Lam Brook, Newton Brook, Mells River, the middle to upper section of the River Boyd and in the upper Bristol Frome, although they are not generally fished for. The Mells River and its tributaries are a productive brown trout fishery with angling occurring generally in the lower section from Great Elm to the confluence with the Somerset Frome.

The smaller tributaries are particularly important to the brown trout populations as spawning and juvenile habitats. On the River Chew, the Bathford Brook and Lord's Wood Stream are notable in this respect.

Brown trout are found in the lower main River Avon, as a minority species often occupying the weirpools below the impounded stretches.

The Lower Bristol Avon has a small run of migratory salmonids. Small numbers of salmon ascend the Bristol Avon each year, although information on their numbers and the sustainability of these fish as a Bristol Avon stock is sparse. Similarly, a component of the brown trout population is migratory, with small runs of sea trout occurring up the Bristol Avon. The catchment would appear to be more suitable to sea trout than salmon. There is no commercial or recognised rod fishery for these fish.

It is the policy of the NRA to install fish passes into weirs during any reconstruction work. Fish passes have been built in the past on the Lower River Avon at Keynsham Weir, and at Twerton and Pulteney weirs in Bath. Access for migratory fish on the main lower Bristol Avon would, in practice, extend up as far as Bathampton Weir in summer flows but beyond in high flows. A fish pass exists on the Somerset Frome at Welsh Mill which, in isolation, has little benefit to migratory salmonids although there is evidence that fish passes built for salmonids also have benefits for coarse fish.

The River Chew has had three fish passes built in its lower reach, opening up access to fish up as far as Woollard. Two passes (Keynsham Park and Chewton Keynsham) were constructed by the NRA, and the third, at Albert Mill, was built in conjunction with the site developers.

The low flow problems of the Upper Bristol Avon naturally affect the lower river. Although much of the lower river is impounded, and is not a significant salmonid habitat, it is a reach that migratory salmonids will pass through and initially be attracted to via its flow regime.

Stillwater trout fishing takes place at several lakes throughout the catchment, most notably at Chew Valley Lake (486 ha).

3.8.1.3. Aims

- To maintain, improve and develop the wild salmonid resource of the Lower Bristol Avon catchment in accordance with Regional and National Policy (see NRA Fisheries Strategy document, available from the Regional Office, Public Relations Department).

- To promote salmonid angling in the catchment in accordance with the NRA's own recreational strategies and codes of practice, and without prejudice to its other statutory duties (see NRA Recreation Strategy document, available from the Regional Office, Public Relations Department).

- To monitor salmonid populations and their habitats by means of periodic strategic surveys, investigate the cause of any significant changes in salmonid populations or habitat and take appropriate actions.

- To achieve the construction of fish passes, if considered appropriate, when weirs are altered or rebuilt by either the Authority or by the riparian owner.

- To achieve the efficient operation of river control structures in a manner that is beneficial to salmonids by the promotion of a code of good practice.

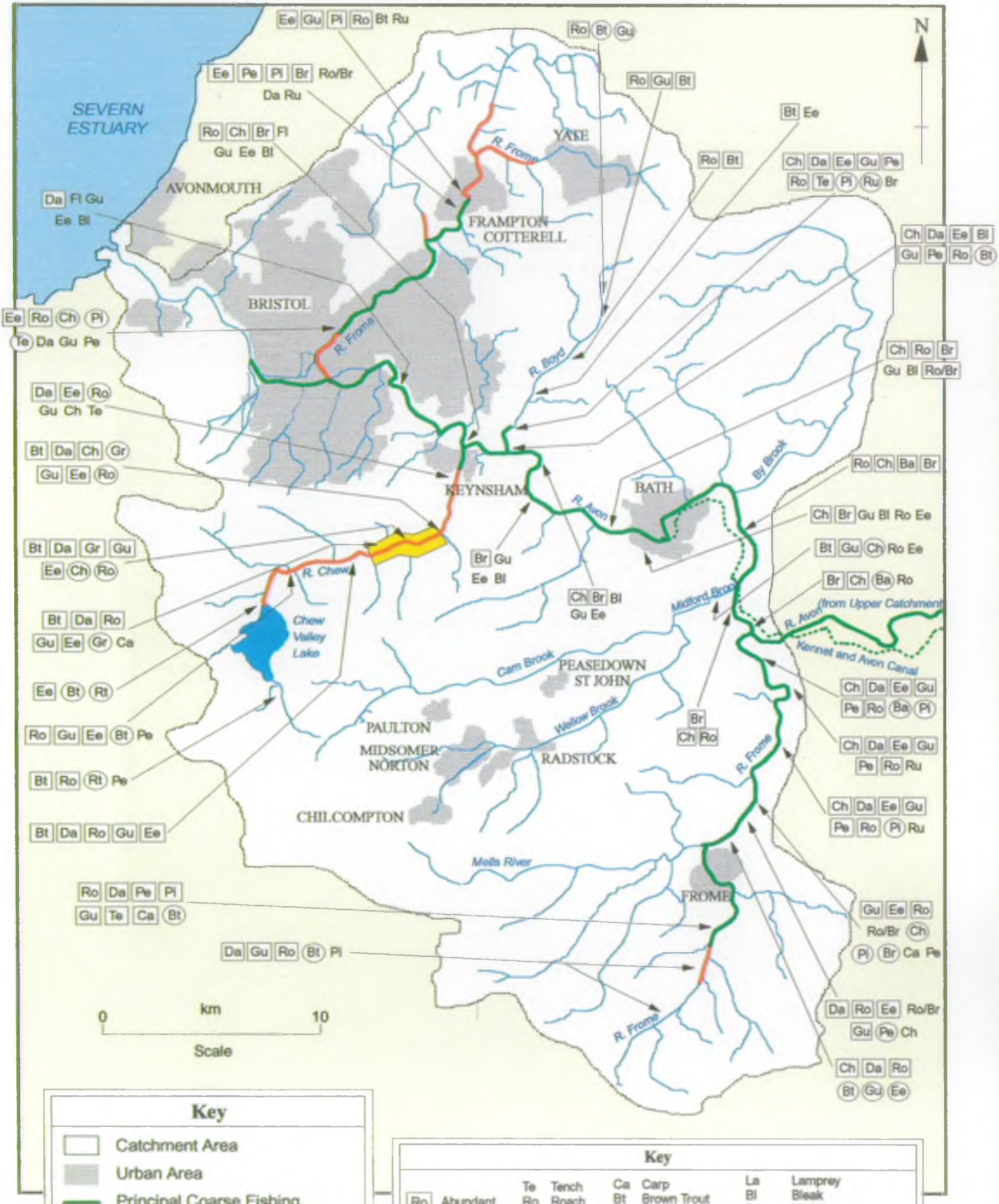
- To prevent habitat degradation, particularly resulting from siltation and/or a loss of river bed complexity, due to engineering works. In sensitive areas for salmonids, to arrange, whenever possible, that works of this nature should be undertaken outside the period November - April (inclusive).

3.8.1.4. Fisheries Requirements

Water quality, water quantity and physical habitat adequate to sustain wild populations of salmonids at a level appropriate for the river, more specifically:

Water Quality	-	chemical water quality not to deteriorate below the mandatory limits for pollutants as specified in the EC Freshwater Fish Directive (78/659/EEC) for salmonid fisheries. Ideally water quality should meet the more rigorous guideline limits for pollutants as specified in the EC Freshwater Fish Directive (78/659/EEC) (see Appendix 2).
Physical Features	-	operation of river control structures in accordance with a code of good practice.
	-	lack of siltation, especially in gravel spawning beds.
	-	river bed complexity to provide necessary habitat.

LOWER BRISTOL AVON
Coarse Fishery



Key

- Catchment Area
- Urban Area
- Principal Coarse Fishing
- Significant Coarse Fish Present
- Principal Grayling Fishing

Key

Ro	Abundant	Te	Tench	Ca	Carp	La	Lamprey
(Ro)	Frequent	Ro	Roach	Bt	Brown Trout	Bl	Bleak
Ro	Rare	Da	Dace	Rt	Rainbow Trout	Ba	Barbel
		Ch	Chub	Pe	Perch	Pi	Pike
		Br	Bream	Ee	Eel	Gu	Gudgeon
		Ru	Rudd	Gr	Grayling	Fl	Flounder
						Ro/Br	Roach/Bream Hybrid

3.8.2. COARSE FISHERY

3.8.2.1. General

This use refers to the conservation of wild populations of non-salmonid fish, and their habitats, and to recreational fishing for species other than salmon and trout.

3.8.2.2. Local Perspective

Triennial electric fishing surveys of coarse fish at selected sites are undertaken to assess populations and any spatial or temporal changes. On the tributaries, the widths and depths are within the capability of the NRA's sampling methods, but the main Lower River Avon has given practical difficulties. The building of an electric fishing boom boat by the NRA, to sample larger deep rivers, should redress the deficiency in the data.

The Lower Bristol Avon catchment supports a diverse fish fauna and at least twenty species of non-salmonid fish are known to be present (see Coarse Fishery map). The Lower Bristol Avon is highly regarded as a coarse fishery and provides good sport for pleasure and match anglers and, in some areas, for specimen anglers. The whole length, from below Avoncliff Weir through Bath down to Netham Weir in Bristol, is important for match and pleasure fishing. The area of main river from Limpley Stoke through to Claverton is notable for specimen barbel.

The Somerset Frome provides good coarse fishing from its confluence at Freshford upstream to above Frome. Coarse fishing is also carried out on the River Chew, although mainly in the section below Chewton Keynsham. Coarse fishing on the Bristol Frome takes place from Frampton Cotterell down to Eastville in Bristol. The lower reaches of the River Boyd around Bitton are also fished.

In Bristol, the Floating Harbour and Feeder Canal provide good coarse fishing. The River Avon below Netham Weir is tidal and is not fished to any extent.

The tidal fluctuations in river level are apparent as far upstream as Keynsham Weir, which appears to be the upstream limit of the flounder.

Each spring, elvers (young eels) arrive in the Bristol Avon estuary and ascend the main river and the tributaries within the catchment. There is no significant commercial elver fishing in the Lower Bristol Avon catchment.

The mature 'silver' eels descend the catchment in the summer months and the occasional commercial fishing licence is issued.

Stillwater coarse fishing takes place at a large number of ponds and lakes and a few gravel pits throughout the catchment. The Kennet and Avon Canal managed by British Waterways, also provides a very significant coarse fishery. There is a great demand for recreational stillwater coarse fisheries and the NRA has taken an active role in promoting and, to some extent, funding the development of new fisheries.

3.8.2.3. Aims

- To maintain, improve and develop the wild non-salmonid resource within the upper Bristol Avon catchment, in accordance with Regional and National policy. Without prejudice to its statutory duties the NRA will seek to promote the use of watercourses and stillwater within the catchment for non-salmonid angling in accordance with its own strategies and codes of practice (see NRA Fisheries and Recreation Strategy documents available from the Regional Office, Public Relations Department).

- To monitor coarse fish populations and their habitats by means of periodic strategic surveys, investigate the cause of any significant changes in coarse fish populations or habitat and take appropriate actions.

- Wherever possible, ensure that potentially harmful activities such as dredging and engineering works are undertaken in a manner likely to cause least harm to the fisheries resource and to its recreational value to angling.

- To consider undertaking works to improve coarse fish habitats such as the renovation of weirs and hatches, providing sufficient potential fisheries benefits would be achieved to justify the expenditure and no prejudice to the NRA's other statutory duties results.

- Ensure adequate diversity of habitat to provide spawning, nursery and holding areas.

- Construct fish passes where physical barriers are found to constrain coarse fish populations, but only within their existing distribution range.

- Construct elver passes where physical barriers seriously impede their movement.

3.8.2.4. Fisheries Requirements

To maintain water quality, water quantity and habitat so as to sustain wild populations of non-salmonid fish at a level appropriate for the river, more specifically:-

Water Quality - chemical water quality not to deteriorate below the mandatory limits for non-salmonid fisheries as specified in the EC Freshwater Fish Directive (78/659/EEC) (see Appendix 2).

Physical Features - adequate diversity of habitat to provide spawning, nursery and holding areas.

- fish passes where physical barriers are found to constrain coarse fish populations, but only within their existing distribution range.

- elver passes where physical barriers seriously impede the movement of elvers.

3.9. CONSERVATION, LANDSCAPE, WILDLIFE AND ARCHAEOLOGY

3.9.1. General

The primary aim of conservation related to the aquatic environment is the protection of the characteristic features of watercourses and the enhancement of their natural beauty, wildlife, landscape, archaeology and geomorphological features.

Watercourses are important landscape features in their own right, and have played a large part in shaping the land form. They provide vital linking features in the network of habitats and wildlife corridors in the countryside. They add a lively and ever-changing dimension to the landscape, which is strengthened by the diversity of plant and animal species which they support.

3.9.2. Designated Sites and Areas

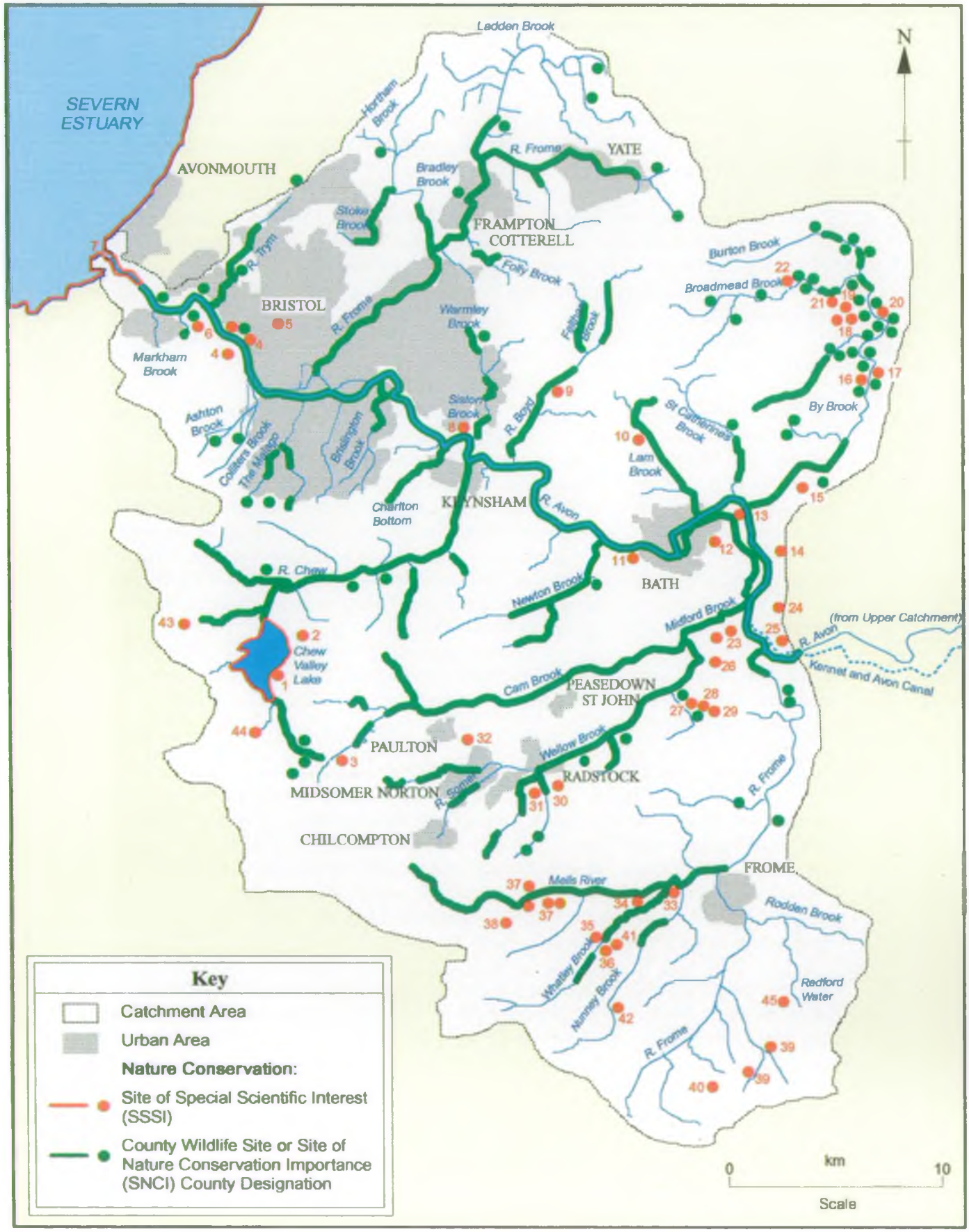
The Lower Bristol Avon is essentially a slow flowing lowland clay river which has been greatly modified by historical impoundment, river engineering in the interests of land drainage and flood alleviation, industrial use and urban development, and intensive agriculture in the floodplain. The river is alkaline and has an abundance of nutrients and fine sediments resulting from the rich variety of rock types. Combined with the major impoundments, these factors have the greatest influence on the ecology of the main river. Each tributary has a different character, but the lack of complete strategic river corridor survey information hampers relative evaluation. (See River Corridor and Catchment Land Use map in Section 3.1.). Several of the tributaries have their major source of water from limestone aquifers, and are vulnerable to low flows.

Of the forty five Sites of Special Scientific Interest (SSSIs) in the area, only eight are directly related to the river (ie floodplain, wet meadows or woodland). (See Conservation - Designated Sites map).

There are few wetland County Wildlife Sites (CWSs) other than those clustered around the River Mells and the By Brook. It is notable that the majority of watercourses in Avon and Somerset are County Wildlife Sites in contrast to Wiltshire, where the Wildlife Sites Project is still in the development phase. The network of non-statutory CWSs is of fundamental importance in the protection of semi-natural habitats within the wider countryside. Planning policies and Government Guidance are increasingly recognising the value of these sites, and organisations such as the Wildlife Trust and Local Planning Authorities are working to achieve their conservation and management.

There are three Areas of Outstanding Natural Beauty (AONB) within the Catchment - the Cotswolds in the north east, the Mendip Hills in the south west, and Cranborne Chase and West Wilts Downs in the south east; (see Landscape Policy Areas map in Section 3.2.).

LOWER BRISTOL AVON
Conservation-Designated Sites



KEY TO CONSERVATION - DESIGNATED SITES

1	Chew Valley Lake	24	Inwood Warleigh
2	Folly Farm	25	Winsley Mines
3	Long Dole Wood and Meadow	26	Writhlington
4	Avon Gorge and Leigh Woods	27	Cleaves Wood
5	Quarry Steps Durdham Down	28	Hinton Charterhouse Field
6	Ham Green	29	Hinton Charterhouse Pit
7	Severn Estuary, SPA and RAMSAR	30	Huish Colliery Quarry
8	Cleeve Wood	31	Kilmersdon Road Quarry
9	Wick Quarry	32	Bowlditch Quarry
10	Monks Wood Valley	33	Vallis Vale
11	Newton St Loe	34	Old Ironstone Works
12	North Road Quarry	35	Asham Wood
13	Hampton Rocks Cutting	36	Leighton Road Cutting
14	Browns Folly	37	Edford Woods and Meadows
15	Box Mine	38	St Dunstans Wells Catchment
16	Coleme Park and Monks Wood	39	Longleat Woods
17	Honeybrook Farm	40	Bradley Wood
18	Danks Down and Truckle Hill	41	Cloford Quarry
19	Out Woods	42	Postlebury Woods
20	Rack Hill	43	Plasters Green Meadow
21	Little Grubbins	44	Compton Martin Ochre Mine
22	West Kington Lane Exposure	45	Cley Hill
23	Midford Valley Woods		

3.9.3. Ecological importance of watercourses

All the watercourses of the Catchment are of nature conservation value, and this is reflected by the designation of many as County Wildlife Sites.

The communities of plants and animals which characterise the rivers differ between each sub-catchment as a result of factors such as geology, water chemistry, flow velocity and size of river. Other external factors which play an important role include land use, type of management, changes in water quality and past engineering work.

Many of the tributaries are fast flowing, sinuous rivers and streams with a well developed pool and riffle sequence. Most are also fairly well shaded by bankside trees and shrubs and thus support fairly limited aquatic plant communities.

The By Brook and River Mells are particularly outstanding in terms of their habitat diversity and wildlife value. Both are spring fed calcareous rivers, the By Brook rising on oolitic limestone, the Mells on carboniferous rock. The River Chew, by contrast, is a clay river with excellent tree cover, forming a valuable landscape and amenity feature. The Cam, Wellow and Midford Brooks flow over limestone and clays and are spring fed. They flow through an attractive rural landscape with historic villages. The St Catherine's Brook flows through a landscape of great scenic beauty, but suffers from low flows due to the historical effects of spring water abstraction for Bath City's water supply. The Somerset Frome is a slower flowing deeper river, flowing over soft limestone and clays and is thus prone to siltation. It supports a semi-eutrophic vegetation community.

The watercourses of the highly urbanised sections of the catchment are also of importance to wildlife, often providing the only semi-natural habitat within otherwise built up areas, despite the sometimes copious build up of rubbish. These streams can be crucial to the total wildlife resource of town or city, providing a green corridor and linking rural and urban areas, thus enabling the free movement of many species of plants and animals.

Flora

Aquatic plants fulfil many vital functions within a river, providing food and shelter for fish, birds, amphibians and mammals. They help to regulate water chemistry and control bankside erosion processes. Many aquatic plants also have great aesthetic appeal, thus helping to increase public appreciation of rivers and their wildlife value.

The following plants are typical of many watercourses within the catchment: In-channel species include the water crowfoots, curled and broadleaved pondweed, branched and unbranched bur-reed, yellow water lily and flowering rush. Marginal species include brooklime, water forget-me-not, fools watercress, marsh marigold, watercress and yellow flag iris. Comfrey, angelica, bittersweet, great willowherb and purple loosestrife are common bankside species. Nettles predominate where management has impacted on bank communities and can play host to the nationally rare parasitic plant great dodder.

The most typical woody species are ash, alder and crack willow, with sallow, hawthorn and bramble.

The main River Avon is one of the few river systems in Britain where the Lodden pondweed occurs. This nationally rare plant species is under threat from the effects of impoundments, the increased use by motor boats, and engineering works such as the construction of road bridges.

Non-native species, particularly Himalayan balsam and Japanese knotweed, are now widespread within the catchment, particularly on the Bristol Frome but also on the Avon and its tributaries. Control is now difficult to achieve.

The major threats to the riverine plant communities are the impact of agriculture (siltation and use of herbicides) and river engineering. The greater the uniformity, the fewer niches are present and diversity will suffer as a result.

Birds

Characteristic species of the catchment include little grebe, mallard, mute swan, moorhen, grey heron, coot and kingfisher. Where bankside reed and scrub habitat is extensive, reed and sedge warblers occur. Those tributaries exhibiting upland characteristics support species such as dipper and grey wagtail.

Chew Valley Lake and the River Avon between Avonmouth and Portbury Docks are of international importance for wintering and passage waders and wildfowl.

Cormorants are now increasingly found in greater numbers on inland water. Anglers, in particular wish to see cormorants controlled. The NRA in conjunction with the Institute for Terrestrial Ecology has undertaken a recent R & D project to investigate "Fish-Eating Birds" (NRA 1994 R & D Report 15).

The report finds that there is no conclusive evidence that "serious damage" has occurred to the freshwater fishery in general. However, it accepts that there may be a few specific locations where cormorants may have been affecting fish stocks.

The report recommends no change to the current NRA policy regarding population control measures. It also recommends that continued research and monitoring of the situation is required before any reform to that policy can be considered.

The NRA will continue to work closely with the Ministry of Agriculture Fisheries and Food (MAFF), English Nature (EN), Welsh Office, Agriculture Department (WOAD) and Countryside Commission for Wales.

Mammals

Water vole and water shrew are native species which occur within the catchment and which are in decline. The cause is unknown. Mink, an introduced species which became established in Britain in the 1950s, are widespread. (See Section 3.10.2 Other Activities).

The otter has also been recorded but the numbers are small, probably in single figures. This may be otters passing through the area rather than resident animals. An Action plan to encourage natural re-colonisation would need to:

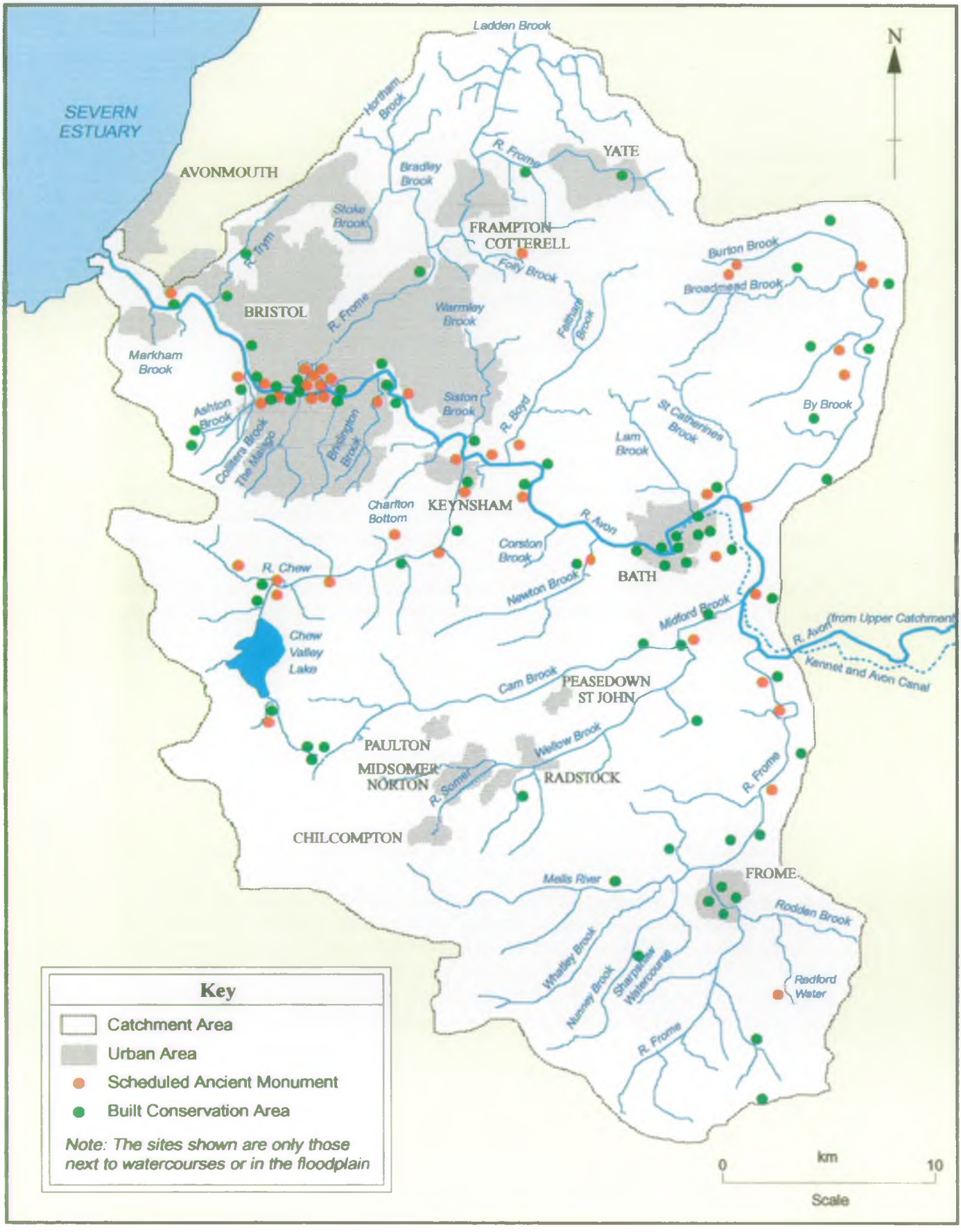
- ensure a link to the Congresbury Yeo by providing a safe overland route between Chew Valley and Blagdon Lakes,
- maintain/increase bankside cover, particularly scrub and mature trees,
- create otter holt log piles when pollarding,
- ensure sufficient prey and adequate water quality, free from toxic pollutants.

Bats are found in association with the watercourses of the catchment. Of the fifteen British species, Daubenton's, whiskered, natterers, noctule and pipistrelle bats are particularly dependent on watercourses. Mature riverside trees and old buildings provide vital roost sites, whilst any adjacent unimproved grasslands, marshes and ancient woodlands provide important feeding areas. The area around Bath is a national stronghold for greater horseshoe bats which make use of the river corridors in summer for feeding.

Dragonflies

The dragonflies of several rivers in the catchment have been recorded (Randolph 1992, Dragonflies of the Bristol Region). Particularly notable species include the white legged damselfly, scarce chaser, migrant hawker and brown hawker. A small number of tributaries

LOWER BRISTOL AVON
Built Conservation and Archaeology Sites



support the beautiful and banded demoiselles. Fourteen species have been recorded from the catchment in total, including the scarce emerald damselfly and black tailed skimmer, present on Chew Valley Lake.

Crayfish

There is a need for a survey to establish the status and distribution of native crayfish. The population in the Mells River was completely replaced by American signal crayfish by 1989.

3.9.4 Built conservation and archaeology

There are many features of archaeological, built conservation (listed buildings etc) and historical interest associated with the river, principally those resulting from the milling industry and transport. See Built Conservation and Archaeology map).

The water levels of much of the Bristol Avon and its tributaries have historically been manipulated to provide a source of energy to power mills used in the processing of cloth, feedstuffs and paper. The By Brook for example once supported twenty mills on a length of only 25 miles, and the wealth of towns such as Castle Combe and Frome was founded on these industries.

The catchment has also provided water for several canals which once existed to provide transport links between some of the smaller industrial towns such as Radstock and Midsomer Norton and the cities of Bristol and Bath. Whilst only the Feeder Canal in Bristol and the Kennet and Avon Canal are still in use, many of the features and structures associated with the former canals remain.

The railway and road network also provided features of significant historical interest, with bridges and viaducts of impressive design and scale such as at Midford, the Dundas and Avoncliff aqueducts on the Kennet and Avon Canal, and the Clifton Suspension Bridge. Other important structures include the many historic bridges on the River Chew, and over the Avon at Bathford, Bathampton and Pulteney. Some of these structures are scheduled or listed; others are not, such as the old railway viaduct over the River Cam which the Angling Association is actively seeking to restore.

Throughout the catchment area there are many buried archaeological sites of prehistoric, Roman or Medieval origin whose existence depended on the use of the rivers as an economic resource. These sites are frequently found on or just above the river floodplains.

3.9.5 Aims

- To conserve the biodiversity of the Lower Bristol Avon, its tributaries and associated watercourses.

- To safeguard all semi-natural habitats associated with wetlands and watercourses.

- To restore and enhance degraded wildlife habitats, particularly wetlands and bankside vegetation.

- To safeguard riverside landscapes, historical features and archaeological remains.

- To bring about the enhancement of the rivers which flow through town centres, and develop their potential for education and recreational use.

It is not the NRA's responsibility to develop action plans for specific species but we will work closely with English Nature which is the Government Agency likely to be responsible.

NRA policy is outlined in the national document entitled "NRA Conservation Strategy" (available from the Regional Office, PR Department).

3.9.6 Environmental Requirements

- Minimum ecologically acceptable flows in all rivers in the catchment.

- Adequate bankside cover, particularly reed/sedge beds, scrub and trees.

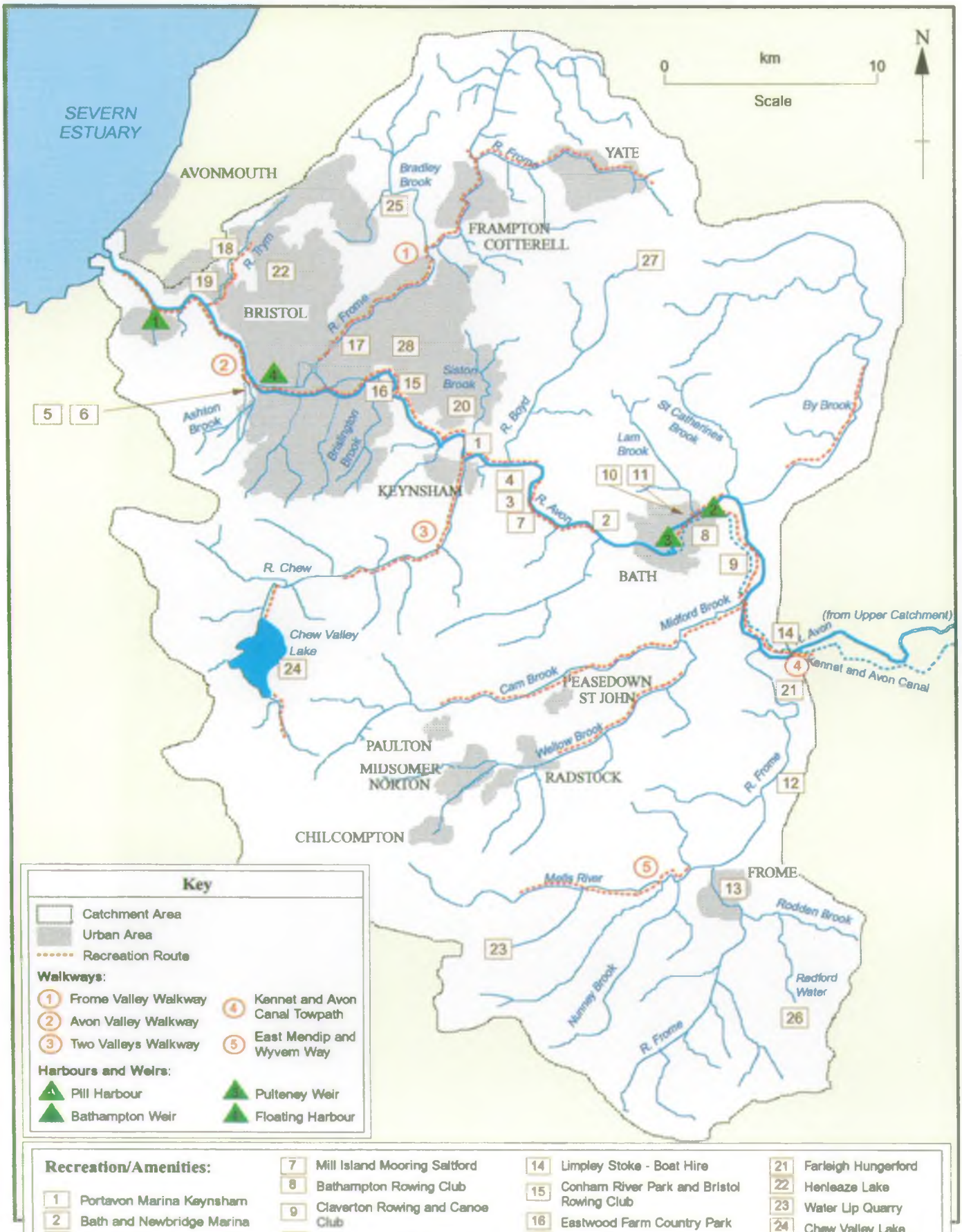
- Diversity of river channel physical features.

- Adequate wetland habitat such as seasonally inundated grassland, marsh and fen vegetation.

- Environmentally sensitive management of watercourses and bankside vegetation.

- Collaborative enhancement projects particularly for urban watercourses.

LOWER BRISTOL AVON
Water-Based Recreation and Amenity



Key

- Catchment Area
- Urban Area
- Recreation Route

Walkways:

1. Frome Valley Walkway
2. Avon Valley Walkway
3. Two Valleys Walkway
4. Kennet and Avon Canal Towpath
5. East Mendip and Wyvern Way

Harbours and Weirs:

- Pill Harbour
- Bathampton Weir
- Pulteney Weir
- Floating Harbour

Recreation/Amenities:

1. Portavon Marina Keynsham
2. Bath and Newbridge Marina
3. Saltford Marina
4. Avon Canal Boat Centre
5. Bristol Yacht Centre
6. Bristol Marina
7. Mill Island Mooring Saltford
8. Bathampton Rowing Club
9. Claverton Rowing and Canoe Club
10. Grosvenor Slalom Course
11. Bath Boating Station
12. Rode - Canoeing
13. Slalom Course- Frome
14. Limpley Stoke - Boat Hire
15. Conham River Park and Bristol Rowing Club
16. Eastwood Farm Country Park
17. Eastville Park
18. Blaise Castle Estate
19. Combe Dingle
20. Willsbridge Mill
21. Farleigh Hungerford
22. Henleaze Lake
23. Water Lip Quarry
24. Chew Valley Lake
25. Bradley Stoke Lake
26. Longleat Lake
27. Lydes Farm Dodington
28. St Geoges Lake

NRA South Western Region

3.10. WATER BASED RECREATION AND AMENITY

3.10.1. General

This refers to water-based recreation, other than angling, which takes place in the river corridor, and to the more general enjoyment of the riverine environment. The water environment forms an important component of many leisure pursuits. Walking is perhaps the most popular outdoor pursuit, enjoyed regularly by around 19% of the population. It is estimated that more than 6 million people participate in sailing, canoeing or boating each year. Other activities include bird watching, horse riding, cycling and swimming.

3.10.2. Local Perspective

The main Bristol Avon is navigable via a system of locks from the Severn Estuary to Bath where the Kennet and Avon Canal joins the river. Upstream of this point, there is no public right of navigation, and boats may therefore only operate with the permission of each riparian owner. The principal boating activities are thus centred on the navigable stretch from the Severn Estuary to Bath City Centre. The small harbour at Pill is a locally popular amenity, with sailing craft utilising the river, Severn Estuary and Sea Mills.

In June 1994 the Bristol/Avon Community Forest Plan (Consultation Draft) was published. (See section 3.2.5.). This details countryside/townscape enhancement plans with the water environment as a key element.

Bristol Centre

The Floating Harbour in Bristol City Centre is a magnet for a variety of water based recreation activities, under the control of the Harbour Master in Bristol. These include floating pubs, restaurants and windsurfing. The Harbour Authority control which activities can or cannot take place.

Bristol Development Corporation

Bristol Development Corporation (BDC) have parliamentary consent to construct a weir at Gaol Ferry Bridge, which will, if built, create bankfull conditions over approximately three miles of river. The NRA has therefore had discussions with the BDC over the desirability of formulating a zoning strategy for the river corridor through the city to limit the potential impact such increased use would inevitably bring. The NRA's strategy incorporated:

1 areas where recreational activities, including mooring, could occur without detriment to the river environment.

2 sections which would benefit greatly from enhancement, both by landscaping and upgrading the riverside walkway and associated facilities (ie seating, fishing platforms) and by positive habitat creation within the channel (principally marginal reed fringes) to stabilise banks, assist with improving water quality and to provide cover for wildlife.

3 sections which have considerable wildlife value at present where positive conservation management would be beneficial.

4 the requirement for a MAFF approved fish pass for migrating salmonids.

Bath City Council

Bath City Council's draft City Plan contains policies regarding the use of the river through the City. The Council states that it will bring forward a strategy with policies for the management of the river controlling its use, and safeguarding the environment and wildlife. This management strategy will be prepared in consultation with the riparian owners, amenity groups and the NRA.

In particular policy L19 states "The City Council, British Waterways and the NRA will work together to devise a strategy for the River Avon through Bath to address the issues of new development, ecology, leisure use, river management, moorings and flood prevention".

Wansdyke District Council

Wansdyke District Council have published their "Wansdyke - Landscape and Nature Conservation Strategy" document which includes policies for recreation and amenity in the river corridors.

This approach was not fully adopted by the BDC, but the NRA is likely to press for such a strategy if the weir is constructed.

Control of Navigation

From Avonmouth upstream to Cumberland Basin, Bristol Port Company are the Navigation Authority.

From Cumberland Basin upstream to Hanham, Bristol Harbour Authority are the controlling body and a licence is required for every boat user.

From Hanham Lock to Widcombe Lock (Thimble Mill), British Waterways Board (BWB) control the navigation and BWB licences are required.

From Widcombe Lock to upstream of Pulteney Weir, Bath City Council are the controlling Authority.

The Lower Avon Users Organisation was set up in 1975 to resolve conflicts between the various user groups on these navigable stretches.

Although the NRA is not the navigation authority, the Authority will work within its duties and strategy to assist in the resolution of the problems of multiple use.

Boating occurs regularly through Bath, with trip-boats operating up to Pulteney Weir, and above Pulteney Weir to Bathampton Weir. In the absence of a Navigation Authority (above

Thimble Mill) and an imposed speed limit, there have been complaints to the NRA and Bath City Council that the recently introduced larger trip-boats may be causing bank erosion as a direct result of their wash. Aquatic plant growth may also suffer from both physical damage by propellers and the increased turbidity of the water, which decreases available light. This has particularly critical implications for the distribution and abundance of Lodden pondweed which is already in decline as a result of the impounded conditions through the City. Concern has also been expressed over the safety of other river users affected by the larger trip boats.

A group called ROAR (Riparian Owners Avon River), formed in 1991, have expressed concern regarding the "increasing rate of erosion of the Bath and Wansdyke riverside banks, and resultant loss of trees and wildlife habitat". The group are seeking to restrict larger boats to the section below Pulteney Weir, maintaining the Avon upstream of this point for the use of canoes, rowing boats and punts. They advocate control through regulations and boat registration.

There is a need to establish if the rate of erosion is increased by the boats and that this is detrimental. This could be done using aerial photography, old maps, markers and fixed point photography.

Marinas and Moorings

There are now several marinas on the navigable Bristol Avon at Keynsham (Portavon Marina), Bath and Newbridge Marina, Bristol and Saltford, and other areas where moorings can occur on private land. With approximately 300 licensed boats, British Waterways Board have judged that the number of craft has reached capacity. The marinas are:

Portavon Marina, Keynsham
Bath and Newbridge Marina
Saltford Marina
Avon Canal Boat Centre
Bristol Yacht Centre
Bristol Marina
Mill Island Mooring, Saltford

Rowing Clubs

Bath University operate a rowing club from Bathampton, where a launching platform was recently constructed. Monkton Combe School have a boating club at Claverton (rowing and canoe club), the Bath Canoe Club has a slalom course at Grosvenor and Bristol Rowing Club is based at Conham.

Canoeing

The Saltford Shallows are regularly used by various organisations and clubs for canoeing, whilst camping and canoeing occur in the vicinity of the Jolly Sailor and Brass Mill at Saltford. Canoeing is also practised by the Minerva Rowing Club, Bath Sea Cadets, Bath City Scouts and from the Bath Boating Station. It occurs at Langham Farm, Rode, on the Somerset Frome (and in the centre of Frome) where slalom courses have been set up.

Kennet and Avon Canal

British Waterways have produced a (draft) plan for the Environment, Tourism and Leisure use of the Kennet and Avon Canal (1991). Included is a section on the NRA's responsibility regarding the canal, which is limited to pollution control and the monitoring of water quality. Recreation and nature conservation issues are dealt with by British Waterways.

The canal can be canoed by anyone with a British Waterways licence. Individual members and members of canoe clubs affiliated to the British Canoe Union receive a free licence as part of their membership entitlement. The British Canoe Union have estimated (1991) there are about 100,000 regular canoeists in Britain.

Cycling is permitted on certain stretches of towpath, providing cyclists display a valid British Waterways permit and observe a safety code.

Hire boats are operated from Limpley Stoke.

Recreation Routes

A number of local authorities are exploring further the opportunities for extending the network of footpaths, cycleways and bridleways, some of which follow watercourses. Routes such as the Avon Valley Walkway (which goes from Pill to Dundas Aquaduct), the (Bristol) Frome Valley Walkway, the Two Valleys Walkway, and East Mendip and Wyvern Ways (which follow the River Mells) and the Bristol to Bath cycleway are proving by their increasing popularity that demand for long distance routes is growing.

Several of the watercourses within the catchment have public footpaths running alongside for substantial distances, including the Wellow Brook, Mells River, St Catherines and By Brooks. The development and upgrading of further routes will also create opportunities for habitat enhancements and interpretation. There is great potential for promoting greater use and understanding to encourage people from all walks of life to use and enjoy rivers in a passive way. A good example is the riverside walkway through Frome. However, care is needed to ensure that such developments take place in appropriate locations where damage and disturbance to nature conservation, landscape and archaeology will not occur. The NRA will look into such proposals on an individual basis.

Other activities

Various country parks are situated next to the river, including Conham River Park and Eastwood Farm Country Park on the edge of Bristol, with a summer ferry operating between. These are extremely popular recreation areas and fishing locations.

Watercourses in the catchment provide an attractive feature within several other important areas of public open space including Eastville Park, Combe Dingle and Blaise Castle Estate in Bristol and also in the Midsomer Norton/Radstock area (where enhancements are needed). The amenity value of these watercourses is high and there is therefore a need for good water quality (including an absence of litter), sympathetic management and collaborative enhancement schemes.

The Wildlife Trust (Bath, Bristol and Avon) has a nature conservation/interpretive centre at Willsbridge Mill on the Siston Brook, where the NRA has funded a stream dipping platform and water quality sampling display. This is an excellent example of how the NRA can work in partnership with a charitable organisation to inform and educate large numbers of people, particularly school children, in the ecology of the water environment.

There are swimming clubs at Farleigh Hungerford on the Somerset Frome and at Henleaze Lake in Bristol.

'Duck' races are common and frequent occurrences. Plastic ducks are set free to float downstream and the furthest travelled or first past the post wins. These are usually organised fund raising events and bring people and cars to the riverside.

Sub-aqua takes place at Water Lip Quarry on the Mendips.

Mink hunting using dogs occurs on some rivers such as the River Chew. Mink have a varied diet but will take, amongst other things, rabbits, wildfowl, water voles, fish and nesting birds. Although the wild mink are considered vermin and the hunting is legal, the NRA is concerned about the damage and disturbance to wildlife and the stirring up of silt from the river bed. MAFF advice (ADAS Leaflet 794) states 'mink are best caught using cage traps ....' and 'some mink are shot and others killed by packs of hounds but neither method of control is effective as a means of preventing damage.'.

Lakes

Chew Valley Lake (SSSI) - an extremely popular location for bird watching, with two areas zoned and managed for nature conservation. It is also popular for sailing, circular walks and picnicking sites.

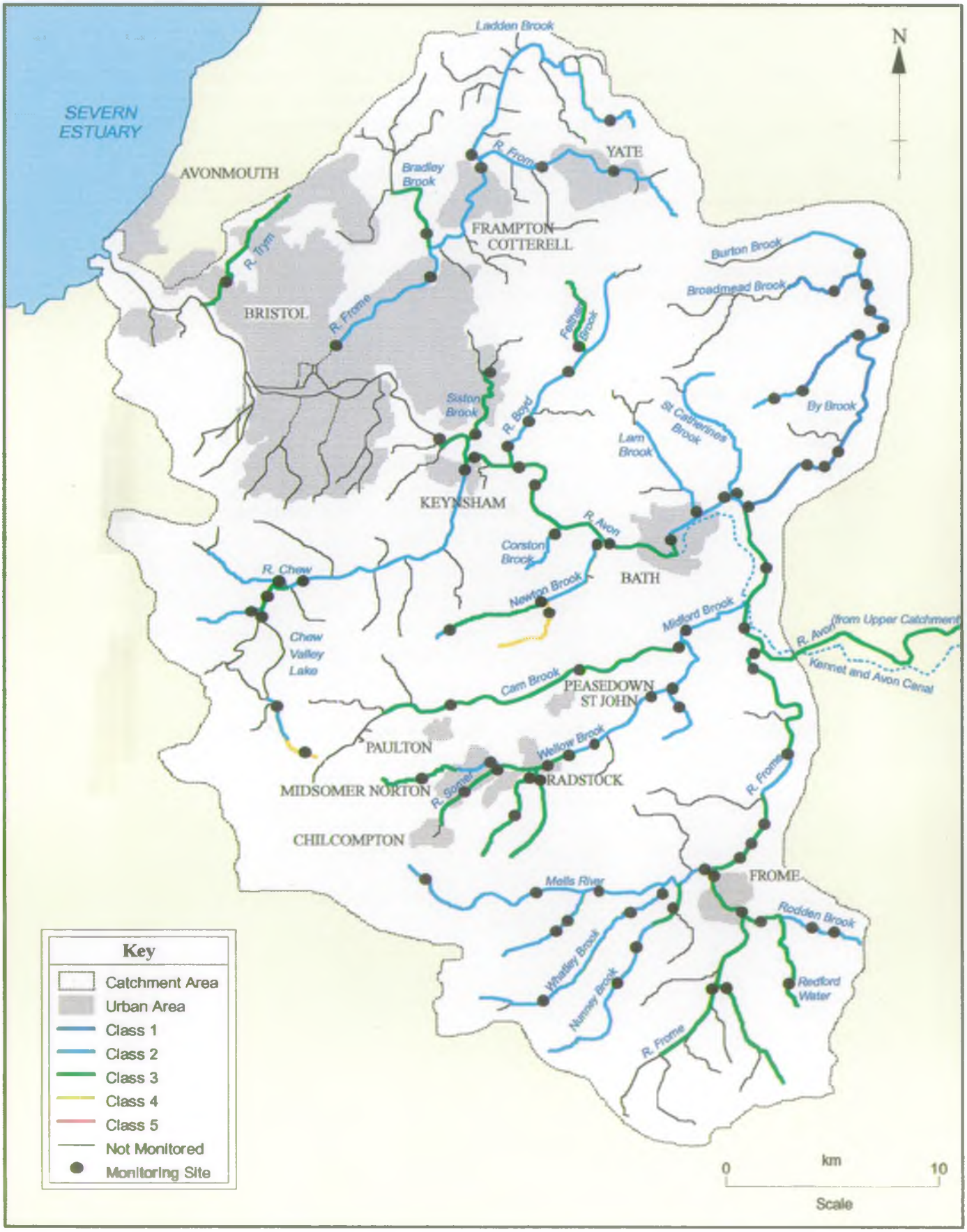
Bradley Stoke - near M4/M5 junction. This is a new lake which is very popular for windsurfing.

Longleat Lake - an amenity and fishing lake.

Lydes Farm, Dodington - a very popular lake for jet-skiers.

St George's Lake, Bristol - includes a childrens' area with small rowing and paddle boating facilities. The lake is also used for fishing.

LOWER BRISTOL AVON
Water Quality Objectives - River Ecosystem Classification



4.1. WATER QUALITY TARGETS

4.1.1. General

The NRA aims to maintain and improve, where appropriate, the quality of water for all those who use it. This is achieved by setting targets for the catchment based on Water Quality Objectives (WQOs) to protect recognised uses and by ensuring compliance with the standards laid down in EC Directives.

4.1.2. Water Quality Objectives

The Water Resources Act 1991 contains legislation which allows the Secretaries of State to prescribe classification schemes for water quality and to use them for the setting of Water Quality Objectives (WQOs). Previous references to water quality have been based on the National Water Council (NWC) classification system. The NWC system was interpreted subjectively and had a limited range of chemical parameters, therefore it has been replaced with a dual system of use-related classifications and a General Quality Assessment (GQA) system (See Section 2.5). These reporting facilities will operate in parallel and will represent a neutral translation in standards from the NWC scheme. Whilst the WQO system will examine compliance with specific use-related standards, the purpose of the GQA is to make periodic assessments of river water quality in order to monitor geographical and temporal trends.

A Use-Related Scheme: The classification scheme proposed for establishing WQOs is based upon the recognised uses to which a river stretch may be put. These uses include River Ecosystem (RE), Abstraction for Drinking Water Supply, Agricultural Abstraction, Industrial Abstraction, Special Ecosystem, and Watersports. The first phase of WQO implementation will be restricted to the River Ecosystem Use Class only; the standards for further uses are still under development. For each stretch, a WQO River Ecosystem Use Class will be proposed, including a date by which this level of water quality should be achieved. Until WQOs are formally established by legal notice served by the Secretary of State, they will be applied on a **non-statutory** basis through a translation of River Quality Objectives (RQOs) from NWC classes to appropriate WQO RE classes with target dates for compliance.

River Ecosystem Use Class: The standards defining the five tiered River Ecosystem (RE) use classes were introduced by *The Surface Waters (River Ecosystem) (Classification) Regulations 1994*. The term "River Ecosystem" is used in recognition of the need to protect the ecosystem that is sustained in a healthy river. The standards for the five RE classes (contained in Appendix 1) are based on the chemical water quality requirements of different types of ecosystem, and consequently the types of fisheries they are capable of supporting.

The proposed water quality objectives, " The River Ecosystem Use Classes" for the Lower Bristol Avon are shown on the map opposite. These WQOs will apply as from 1st January 1995. However, the following stretches will not have to comply with their WQOs until 1998 or the year 2000:

Bristol River Frome:	Yate to Goose Green - 1998
Bristol River Frome:	Goose Green to Algars Manor - 1998
Bristol River Frome:	Algars Manor to confluence with Laddon Brook - 1998
Wellow Brook:	Foxecote to Long Barrow - 2000
Wellow Brook:	Long Barrow to Wellow - 2000
Wellow Brook:	Wellow to confluence with Lyde Brook - 2000
Wellow Brook:	confluence with Lyde Brook to Confluence with Midford Brook - 2000

In addition, visionary WQOs, which represent an improvement compared to the NWC RQOs, have been set for the Lower Bristol Avon catchment which represent long term aspirations for water quality within the catchment. Visionary WQOs of RE Class 2 have been set for the following stretches in order to protect their use as salmonid fisheries:

Somerset Frome:	West Barn farms to Tytherington
Somerset Frome:	Confluence with Mells to Confluence with Henhambridge Brook
Somerset Frome:	Tellisford to confluence with Avon
Maiden Bradley Brook:	Maiden Bradley to confluence with Frome
Rodden Brook:	Confluence with Redford Water to confluence with Frome
Cam Brook:	Hanham House to confluence with Midford Brook
River Somer:	Chilcompton to confluence with Wellow Brook
Snails Brook:	Stratton on the Fosse to confluence with Kilmersdon stream
Kilmersdon Stream:	Kilmersdon to confluence with Snails Brook

A visionary WQO of RE Class 2 has also been set for the Wellow Brook from Ston Easton to Welton, and from Confluence with Somer to Tyning. Even though there is no salmonid fishery in these stretches it is felt that a WQO of RE 2 is desirable for the general ecosystem of the Wellow Brook.

4.1.3. EC Directives

There are five EC Directives that currently apply to the Lower Bristol Avon catchment and the designated sites and river stretches are shown on the Monitoring for EC Directives map.

The **Freshwater Fish Directive** "on the quality of waters needing protection or improvement in order to support fish life", 78/659/EEC, is concerned with ensuring that water quality in designated stretches of water is suitable for supporting fisheries. This Directive contains two sets of quality standards, one at levels to support a cyprinid fish population (see Glossary Appendix 13)) and another set at stricter levels to support a salmonid fish population (see Glossary Appendix 13). There are two sets of standards for each fishery type, imperative standards which must be achieved, and guideline standards which Member States should aim to achieve (Appendix 2).

LOWER BRISTOL AVON
Monitoring for EC Directives

The **Dangerous Substances Directive** "on pollution caused by certain substances discharged in the aquatic environment of the community", 76/464/EEC, is concerned with controlling certain substances considered harmful which are discharged to the aquatic environment. The Directive established two lists of compounds. List I contains substances regarded as particularly dangerous because of their toxicity, persistence and bioaccumulation. Discharges of List I substances must be controlled by Environmental Quality Standards (EQSs) issued through Daughter Directives (Appendix 3). List II contains substances which are considered to be less dangerous but which still can have a deleterious effect on the aquatic environment. Discharges of List II substances are controlled by EQSs set by the individual Member States.

The **EC Directive "concerning urban wastewater treatment"**, (91/271/EEC) lays down minimum standards for the provision of sewage collection systems and sewage treatment. Extracts from the Directive are contained in Appendix 4. The Directive specifies secondary treatment for all discharges serving population equivalents greater than 2000 to inland waters and estuaries, but provides for higher standards of treatment for discharges to "sensitive" areas. Sensitive areas are those surface waters which receive discharges serving population equivalents of greater than 10,000, and are or may become eutrophic in the near future. Discharges below the specified population equivalents for inland waters and estuaries must also receive "appropriate" treatment as defined in the Wessex Water Services Asset Management Plan 2 (AMP2 Guidelines, Version 2 approved by the quadripartite meeting 14/12/93).

The Lower Bristol Avon, from downstream of the River Frome and Frome STW to Keynsham (downstream of Saltford and Keynsham STWs), has been identified for specific monitoring for evidence of eutrophication. Chemical and biological data will be collected in relation to the potential nomination of the stretch as a Sensitive Area.

The **Directive "concerning the quality required of surface water intended for the abstraction of drinking water in the Member States"** (75/440/EEC), ensures that surface water abstracted for use as drinking water meets certain standards and is given adequate treatment before entering public water supplies. The Directive sets out imperative standards which must be achieved, and guideline standards which Member States should aim to achieve, for water for public supply which is to be given different levels of treatment (Appendix 5).

There are three identified surface water abstraction points in the Lower Bristol Avon Catchment and these are shown on the Map for Section 3.5 Surface Water Abstractions. However, it should be noted that one of these sites (Avon Newton Meadows) is not used as an abstraction although it still retains a licence.

The **Directive "on the protection of groundwater against pollution caused by certain dangerous substances"**, (80/68/EEC) is concerned with protecting groundwaters from pollution from certain substances considered dangerous on the basis of their toxicity, persistence, bioaccumulation and carcinogenic, mutagenic or teratogenic (see Glossary Appendix 13) properties in the aquatic environment. The Directive identifies two lists of compounds similar to those listed in the Dangerous Substances Directive (76/464/EEC). List I contains substances which are not allowed to enter groundwaters, and List II contains

substances which must only have a restricted entry to groundwaters. (Directive extracts are contained in Appendix 7). Implementation of the NRA's Policy and Practice for the Protection of Groundwater, discussed in Section 4.3, is the means by which the NRA aims to ensure compliance with this Directive regarding Discharges to Underground Strata.

This Directive also applies to discharges to groundwaters from waste disposal sites. The NRA carries out its duties under this Directive as statutory consultee to the Waste Regulation Authorities (WRAs), providing advice during the issuing of waste disposal licences, and auditing the monitoring data collected by waste disposal site operators.

4.1.4. Annex 1A Reduction Programme

At the second and third North Sea Conferences, the UK Government made a commitment to reduce the loadings (concentration x flow) of certain substances ('Annex 1A' substances) (Appendix 6) entering tidal waters from rivers and direct discharges by 50% (70% for mercury, cadmium and lead) by 1995 compared to a 1985 baseline, or a 1991/1992 baseline where data for 1985 is unavailable. In England and Wales the NRA is responsible for identifying inputs where reductions must be made in order to meet this commitment.

The River Avon at Keynsham is monitored for Annex 1A purposes.

4.2. WATER QUANTITY OBJECTIVES

4.2.1. General

The management of water resources within the catchment, whatever the water is used for, will be in accordance with the statutory duties of the NRA to preserve or enhance the water environment, whilst having regard for the legal obligations to licensed water abstractions.

4.2.2. Further demands for water use

The NRA has analysed information on water use and produced a National Water Resources Strategy, published in 1993. The South Western Regional Water Resources Strategy is being prepared for publication in 1995, taking into account responses to the consultation document 'Wessex Areas Water Resources Strategy', published earlier in 1994.

For public water supplies, in order to optimise the usage of catchment water resources, the NRA expect demand management techniques such as leakage control and household metering to be introduced where they are likely to be of benefit. These will help reduce the number of new resources needed to meet increases in consumption.

Further resources that are required to satisfy increasing demands but which involve a significant loss of water from part or all of the catchment will be considered at downstream locations where the resources are more plentiful and the environment less sensitive. This objective will be applied when considering the Avon catchment as a whole, including the Upper Avon.

4.2.3. River low flows

River flows that have declined, or are thought to be at an unacceptable level as a consequence of licensed groundwater and surface water abstractions will be investigated in accordance with considered priorities. In some circumstances it will be appropriate to restore these flows to a more favourable condition. This could involve variations to existing abstraction licences or the introduction of a management scheme to provide a more balanced distribution of water resources, which may include alleviation from other resources together with the determination of prescribed flows where necessary. Consultation with the local communities regarding their needs and wishes will play an integral part in the procedure. See the Upper Bristol Avon CMP for an account of the Malmesbury Low Flow Study.

4.2.4. River flow protection

It has been customary for many years to set standards commonly known as 'prescribed minimum flows' (pmf), for the protection of rivers in dry weather conditions against losses from newly authorised abstractions of water. These pmf have often been set with reference to some statistical measure of low flow occurrence but otherwise frequently on the basis of experienced judgement. In the past there has been difficulty in achieving a consensus in the scientific community on a suitable objective measure for environmental protection. The NRA is currently investigating the feasibility of methods for implementing statutory 'minimum acceptable flows' and is concurrently studying ways of assessing scientifically the habitat

needs of a range of aquatic species. In the medium term it is to be expected that a national method will be available for prescribing the flows to be conserved on a seasonally varying basis. In the immediate future it will be normal to maintain as a minimum standard for river protection, that newly authorised abstractions shall not diminish flows that on average would endure over 18 days of the summer low flow season. (5%ile flow).

4.2.5 New abstractions

The NRA will consider all applications for new licences to abstract water within the framework of the Water Resources Act 1991. However, licences may be restricted to maintain both the environmental quality of the catchment and the statutory obligations of the NRA to existing licence holders. The Lower Bristol Avon will be affected by the NRA's policy of not allowing further public supply abstraction licences in the Malmesbury area where these could be prejudicial to flows, (see the Upper Bristol Avon CMP). Future new abstractions will be favoured in more downstream locations of the Avon catchment where adequate protection of the river flow regime can be demonstrated. It will remain acceptable to licence minor abstractions that do not have a measurable impact upon existing water resources in upstream catchment areas, and prescribed minimum river flows should have regard for these. The NRA will also seek to improve controls on existing licences whenever the opportunity or need arises.

4.2.6 Water storage reservoirs

The intention of the NRA to restrict further major abstraction to the downstream reaches of the Bristol Avon catchment may require the construction of bankside storage facilities. Even at these downstream locations, new abstractions are likely to be available only at times of river flow excess and thus a continuous supply at other times would be dependent on the availability of previously stored water.

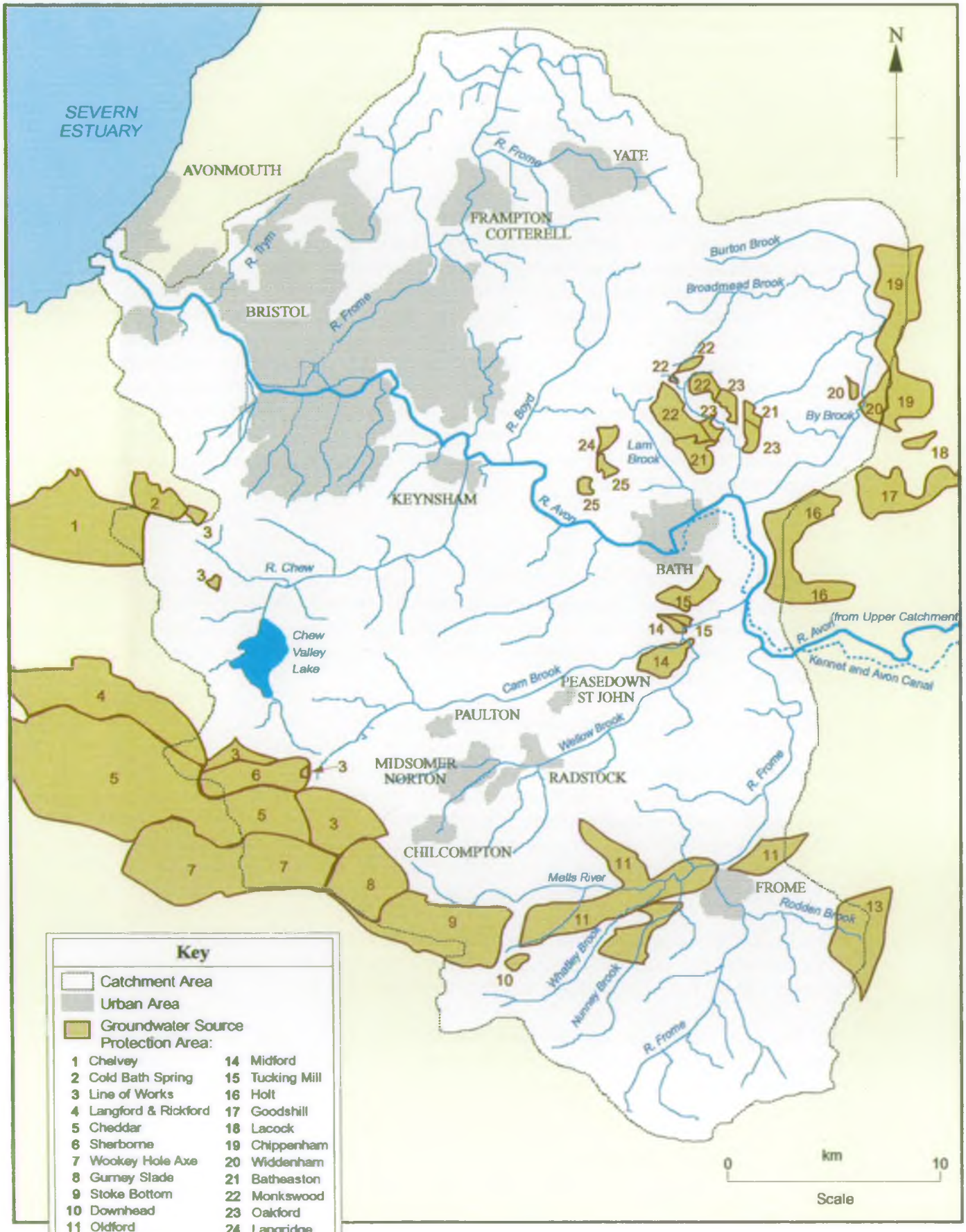
4.2.7 Physical disturbance of aquifers and groundwater flow

Activities which physically disturb aquifers and groundwater flow can, in some cases, have a consequential effect on springs, streamflow, ponds and wetlands. Activities such as quarrying and gravel extraction above and below the water table, mining, construction of highways and landfill likely to impede groundwater flow are not covered by the NRA's own powers under the Water Resources Act 1991. All of these activities are prevalent in the Lower Bristol Avon catchment area.

The NRA has published its guidelines and responsibilities for the management and protection of groundwater on a sustainable basis in its document 'Policy and Practice for the Protection of Groundwater' (PPPG), published in 1992. (See Section 4.3).

With regard to mining and associated activities the NRA, in its advice to Mineral Planning Authorities, will have regard to its duties under the Water Resources Act 1991, and seek to conserve and protect water resources and to preserve and, where appropriate enhance, the water environment. The NRA is a statutory consultee under the Town and Country Planning Act for most relevant activities and will seek to safeguard water resources when responding to planning application consultations. (See Section 3.6).

LOWER BRISTOL AVON
Groundwater Protection Objectives



4.3. GROUNDWATER PROTECTION

4.3.1. General

A key objective of the NRA is to protect groundwater from all types of threat, large and small, from point and non-point (diffuse) origins, and by both persistent and degradable pollutants. In the preparation of any CMP, groundwater must form a major part of the considerations; thus the Authority's policy towards groundwater must form part of that plan, which will in turn become one vehicle by which individual policies are implemented. In order to provide a framework for decision making, the NRA published its "Policy and Practice for the Protection of Groundwater" (PPPG) in December 1992. This document is available separately (details from our Public Relations department).

The PPPG contains policy statements on the following aspects of groundwater protection:

- Control of Groundwater Abstractions
- Physical disturbance of aquifers (water bearing rocks) affecting quality and quantity
- Waste disposal to land
- Contaminated land
- Disposal of sludges and slurries to land
- Discharges to underground rocks
- Non-point (Diffuse) pollution
- Unacceptable activities in the inner protection zone (see below)

The PPPG sets out the framework for assessing risks and provides guidance in terms of policy statements and Acceptability Matrices regarding various activities. The policies are related to the risk posed by the activity taking into account the vulnerability of groundwater to pollution and paying particular attention to protecting groundwater used for public water supply.

4.3.2. The Groundwater Protection Objectives map shows the NRA's current assessment of the groundwater catchment area feeding public groundwater supplies within the Lower Bristol Avon. The NRA is engaged in a national programme of designating Source Protection Zones within these catchments according to agreed criteria and following a timetable which should see completion by 1998. In accordance with the PPPG three zones of decreasing risk will be defined.

Zone 1 - The Inner Source Protection Zone will be that area defined by a 50 day travel time from any point below the water table to the source (and as a minimum of 50 metres radius from the source).

Zone 2 - The Outer Source Protection Zone is that area defined by a 400 day travel time from any point below the water table to the source.

Zone 3 - The Source Catchment is that area within which all groundwater will eventually discharge to the source.

The PPPG provides guidance on the acceptability of activities within such zones and in the absence of completion of the zonation maps the NRA will advise on the suitability of proposed development locations on the basis of existing information.

In order to ensure sources will be properly protected prior to these zones being established, we are also defining Source Consultation Zones within which we will seek referral of particular development activities to assess source protection requirements.

4.3.3. Another key element in the strategy to protect groundwater resources on a regional scale is the production of Groundwater Vulnerability Maps covering England and Wales at a scale of 1:100,000 identifying areas in which groundwater resources are vulnerable according to properties of the soil and underlying strata and require protection from potentially polluting activities. The maps are designed to be used by planners, developers, consultants and regulatory bodies to ensure that development conforms to PPPG. The programme of map production is on-going with maps covering the Lower Bristol Avon catchment expected during 1997/98. In the absence of such map information the NRA will advise on the suitability of proposed development locations.

4.3.4. Outlined below are the key policy areas and NRA concerns regarding the protection of groundwater. In some cases the NRA can utilise its own powers but more often the NRA will need to influence other bodies, particularly local planning authorities and developers in order to achieve pollution prevention objectives. Please refer to the full PPPG document for detailed and informed policy interpretation.

Control of Groundwater Abstractions - Policy A1

No unacceptable detriment to watercourse or water feature dependent on groundwater. No deterioration to water quality by incursion of saline or polluted waters. Controls through Authorisations under Water Resources Act (WRA) 1991.

Physical Disturbance of Aquifers and Groundwater Flow - Policies B1-B4

Effects on water resources from proposals that physically disturb aquifers, lower groundwater levels, impede or intercept groundwater flow eg quarrying and gravel extraction, mining, construction of highways, railways, cuttings and tunnels, landfill using impermeable materials, borehole construction and abandonment activities that interconnect naturally separate aquifers. Interception of recharge waters. Controls through NRA representation in the Planning process.

Waste Disposal To Land - Policies C1-C9

Pollution risks to groundwater from landfill and other waste related activities including, incinerators, transfer stations, civic amenity sites waste chemical treatment plants, storage of special wastes and scrapyards. Controls as statutory consultee to Planning and Waste Regulation Authorities.

Contaminated Land - Policies D1-D9

Pollution risks from derelict land in a contaminated state or due to disturbance during re-development or from active industrial sites. Contaminated land may include land currently or previously used in connection with coal gas production, landfill sites and other waste disposal activities, waste lagoons, chemical manufacture, heavy industry, mining, sewage treatment works, metal and oil refining and hydrocarbon storage. Controls through NRA representation in the planning process.

The Application of Liquid Effluent, Sludges and Slurry to Land - Policies E1-E5

Risk to groundwater quality dependent upon the chemical and microbiological content of the waste, the rate, method and timing of application and groundwater vulnerability.

Agricultural Wastes - produced from various farming activities including animal wastes and silage liquors. The NRA will liaise with farmers and seek to encourage them in the preparation of waste management plans for their farms. These should include the drawing up of a map identifying land suitable for the spreading of farm effluent without detriment to groundwater. NRA seeks control through the MAFF Code of Good Agricultural Practice for the Protection of Water.

Sewage Sludge - produced exclusively at sewage works and disposed of by sewerage undertakers or their contractors. NRA seeks control through consultation with Statutory Undertakers. HMIP is the competent Authority for the Sludge (Use in Agriculture) Regulations 1989.

Controlled Waste - industrial effluent sludges, both organic and inorganic in nature and including septic tanks and cesspool contents. Control through consultation with Waste Regulation Authority on Registration of Exemptions under Environmental Protection Act 1990.

Discharges to Underground Strata - Policies F1-F7

Protection of groundwater quality by NRA control of discharges under the Water Resources Act 1991 through consenting or prohibiting discharges to groundwater either direct or via a soakaway. No consented discharge of List 1 substances to underground strata. Sealed effluent storage tanks for domestic sewage effluent in Zone 1 in the absence of main sewer.

Diffuse Pollution of Groundwater - Policies G1-G4

Groundwater contamination arising through areal spread of pollutants eg nitrates/pesticides, and cumulative effects of many individual events eg farm wastes or industrial solvent spillages. Controls possible under Sections 93 and 94 of Water Resources Act 1991 ie Water Protection Zones and Nitrate Sensitive Areas, eg Egford NSA. Consents Controls, and Regulations (Section 92) of Water Resources Act 1991 eg Silage, Slurry and Agricultural Fuel Oil Regulations 1991.

Additional Threats. Production, Storage and Use of Chemicals (Raw and Waste) - Policy H1

Point source risk to groundwater quality. Controls through NRA representation in the process planning. Normally NRA will object to proposals within Zones 1 and 2. Storage of waste may require a Waste Disposal Licence (NRA Statutory Consultee).

Storage of Farm Wastes and Intensive Livestock Housing - Policy H2

In vulnerable locations leachate from stored wastes or effluent from intensive livestock housing can be highly polluting. Control through the Silage, Slurry and Agricultural Fuel Oil Regulations 1991 for all new, substantially enlarged or reconstructed installations. The Code of Good Agricultural Practice for the Protection of Water (MAFF 1991) offers guidance generally. The NRA wishes to discourage the establishment of farm waste storage areas and substantial livestock housing within the Inner Source Protection Zone (Zone 1) unless adequate measures can be agreed to minimise the risk of pollution. The NRA welcomes discussion on a case by case basis.

Graveyard and Animal Burial Sites - Policy H3

Large graveyards are a potential threat to groundwater quality. Oppose new sites or extensions within Zone 1 through NRA representation in the planning process. Animal burial sites rejected in Zone 1. Code of Good Agricultural Practice provides guidance.

Sewage Works, Foul Sewers and Storm Overflows - Policy H4

Risk of contamination to groundwater resources. New STWs opposed in Zones 1 and 2. New sewers opposed in Zone 2. Controls through planning process. Storm overflows controlled by Discharge Consents through Water Resources Act 1991.

Oil and Petroleum Storage and Transport via Pipelines - Policy H5

Groundwater pollution from leakage from underground tanks and accidental rupturing of tanks and pipework. New hydrocarbon storage opposed to in Zone 1. Underground storage of hydrocarbons discouraged in Zones 2 and 3. Controls through the planning process. Oil pipeline routes opposed in Zone 1 and discouraged in Zones 2 and 3. Controls through the planning process.

Major Developments and Infrastructure - Policy H6

Drainage from major roads or railways can pose risks to groundwater due to spillages after accidents. Major communication routes opposed in Zone 1. Developments such as airfields, industrial parks and large areas of vehicle parking may involve storage/loading/unloading of hydrocarbons, solvents and other potentially contaminating substances. Such developments opposed in Zone 1. Control through the planning process.

4.4. PHYSICAL FEATURES OBJECTIVES

4.4.1. General

This section sets objectives for the physical environment of the river such as habitat improvement, landscape enhancement, channel features and historical features conservation. General objectives are:

- To secure the natural physical processes of the river and its ecological and landscape value against further adverse modification.
- To provide the necessary variety of channel conditions including depth, flow and substrate type, to support the plant and animal communities characteristic of the catchment.
- To protect historic and archaeological features within the river corridor.
- To enhance the landscape features and character of the river corridor.

The NRA will operate on the principle of maintaining rivers of high landscape and ecological quality, and rehabilitating those sections which have been degraded.

More specific objectives are:

4.4.2. Impoundment

The NRA will review, in conjunction with landowners, each impounding structure and consider whether or not they could be removed and/or replaced with, for example, stepped weirs. In doing so, consideration will be given to reducing obstructions to fish movements.

This review is consistent with the aim of restoring diversity and naturalness.

4.4.3. Restoration of Floodplain Habitats

The restoration of floodplain wet meadows is seen as a priority, but can only be achieved by working in close co-operation with landowners and grant aiding bodies such as MAFF and the Countryside Commission. Any restoration will need to be achieved without causing additional undesirable impoundment to watercourses.

A suitable strategy would be to concentrate on the conservation of all existing examples and explore the possibilities of expansion from these sites. This would be particularly appropriate in the Ladden Brook catchment, for example, and is identified as a priority in the Bristol Frome Action Plan.

4.4.4. Habitat Rehabilitation

To rehabilitate habitats on rivers where extensive works, intensive agriculture and urban/industrial development have resulted in a loss of diversity and naturalness. Appropriate

works will include the restoration of meanders and pool/riffle sequences, alterations to channel shape (particularly where past dredging has resulted in steep and uniform bank profiles), tree, shrub and wetland planting and the creation of buffer zones.

Sites in the Bristol Frome catchment where such works would be appropriate have been identified in the Action Plan, and include sections through Yate and downstream to Algars Manor. Other urban watercourses such as the Ashton, Longmoor and Colliters Brooks would benefit from such treatment.

4.4.5. Rivers with high landscape and ecological quality

Those rivers and river stretches which are of high landscape and ecological quality should be maintained as important features in their own right. This will be achieved through resisting damaging proposals and working closely with riparian owners and users.

4.4.6. Historic Features

The NRA will support where appropriate the conservation of historic features associated with the watercourses in the catchment. Some of these structures are Scheduled Ancient Monuments, others are listed in the county sites and monument register or are listed buildings, or are within conservation areas.

4.4.7. Riverside Enhancement

The NRA will, so far as is possible, ensure that all new and proposed developments within the catchment result in the enhancement of river corridor habitats, as is consistent with its stand-alone duty to promote nature conservation. This will involve continuing close cooperation with local authorities and developers. Some local authorities have already incorporated these objectives into their Structure or District Wide Local Plans. The NRA will work to ensure that all local authorities have such objectives in their Plans.

The NRA will seek to:

- enhance the riverside environment through town centres and improve their value for education, recreation and landscape amenity,

- continue to actively support local action groups and local authorities to promote the concept of town centre riverside walks.

4.4.8. Agriculture

The NRA will work to ensure grant aided schemes are targeted effectively. This will include working closely with the Countryside Commission (landscape improvement grants, Countryside Stewardship) and MAFF (long-term set-aside and buffer zones).

4.4.9. Conservation

The NRA will seek to:

increase the area of bankside reedbeds and ensure the conservation of uncommon aquatic plant species;

increase the proportion of bankside tree and shrub cover where appropriate, to help suppress the growth of invasive marginal plants and control bankside erosion;

increase knowledge of the catchment by completing River Corridor Survey coverage, analysing aerial photographic coverage and obtaining species information, particularly birds, dragonflies, mammals, rare plants and crayfish distribution in order to inform decisions on conservation and enhancement.

4.4.10. Recreation

The NRA will seek to:

safeguard access to the rivers for recreation and support the provision of facilities such as riverside open spaces, car parks, landing stages, moorings, angling stages and paths, where appropriate. Much of this provision will be made by the riparian owner. The NRA will consider the provision of such facilities only on its own land.

The NRA's land ownership in this catchment is very small, consisting generally of small plots, such as those around river flow gauging stations.

LOWER BRISTOL AVON
Flood Defence - Objectives

Key

- Catchment Area
- Urban Area

Number of House Equivalents/km

Band A	50.00	or	more	
Band B	25.00	to	49.99	
Band C	5.00	to	24.99	
Band D	1.25	to	4.99	
Band E	0.01	to	1.24	

- No Flood Objectives Set

4.5. FLOOD DEFENCE OBJECTIVES

4.5.1. General

Standards for the provision of flood defence may be prescribed (eg the time allowed to determine a flood defence consent), inactive (eg relating to the level of flood protection appropriate to a particular land use), or business (eg a commitment which the NRA has imposed upon itself to improve efficiency or cost effectiveness).

Flood events are usually described in terms of the frequency with which they can be expected to occur on average. Hence a (once in) 10 year flood can be expected to be equalled or exceeded once every 10 years on average. This is also described as the "return period", although the interval before another similar event "returns" is subject to chance and only averages over a long period.

Similarly the standard of protection at a location is expressed as the worst flood event which can be withstood without significant flooding. It is important to note that defence schemes alleviate flooding up to the design standard, but a worse event can still occur.

It is necessary to operate within a management framework which sets appropriate target standards, measures the existing standards, and addresses the difference.

4.5.2. General Target

FD1 To manage flood defence by addressing the differences between target and actual standards of service, by 1998.

4.5.3. Regulation Targets

The NRA is a statutory advisEr to planning authorities on flood defence matters. It also issues consents and by-law approvals for certain works which are likely to affect the flow of water or impede any drainage work.

FD2 To provide planning authorities with sufficient information to ensure that the effects of development on flood risk are properly considered in accordance with the Department of Environment Circular 30/92.

FD3 To ensure that development does not reduce the standard of flood defence and that opportunities for environmental enhancement are taken. Minimum standards of protection advised for urban development is a 1 in 100 year event.

FD4 To deal with 100% of consent and by-law applications within the prescribed time.

4.5.4. Maintenance Targets

Maintenance work is undertaken to ensure the efficient working of the natural drainage system, and to keep flood alleviation schemes up to their design standard.

Reaches of river, or coast, maintained by the NRA are classified by their land use in terms of the number of House Equivalents (HEs) per kilometre, on which the target Standard of Service (SoS) depends.

Efficient management depends upon having detailed knowledge of the location, type and condition of all assets which affect the performance of the physical river system. The NRA is undertaking a programme of asset survey to provide this information.

FD5 To apply a consistent approach to flood defence maintenance with work targeted at areas of greatest need. The Lower Bristol Avon Land Use Bands are shown on the Flood Defence Objectives map. The tributaries are still be assessed. The target standards for each Land Use Band are still being developed. In managing main river and tidal defences the NRA has a duty towards the conservation of flora and fauna, particularly in those sites dependent upon an aquatic environment.

FD6 To balance and integrate the water level requirements for a range of activities, including agriculture, flood defence and conservation in sites of high environmental value.

4.5.5. Improvements Targets

Flood defence improvement works may be carried out where the Standard of Service is below the indicative standard. All schemes must satisfy technical, economic and environmental criteria. The NRA maintains a Programme of Capital Works for the future which takes account of the priority of each. Although inclusion on the Programme indicates a budget provision, each scheme must satisfy the appraisal criteria before it can proceed. It should also be noted that all schemes are subject to approval by the relevant Flood Defence Committee and are usually dependent upon grant aid from the Ministry of Agriculture Fisheries and Food.

FD7 To identify and investigate all flood risk locations in the context of the following standards:

The following indicative standards (return period in years) apply:

Current Land Use	**Tidal**	**Non-Tidal**
High density urban, containing significant residential and non-residential property	200	100
Medium density urban	150	76
Low density or rural communities. Highly productive agricultural land	50	25
Generally arable farming with isolated properties	20	10

Current Land Use	Tidal	Non-Tidal
Low productivity land with few properties at risk	5	1

Indicative standards do not indicate an entitlement or minimum level to be aimed at.

4.5.6. Emergency Response Targets

Absolute flood protection is not possible. Procedures are necessary for those who may be affected by an event greater than the current standard of service, whether that standard is less or greater than the target standard. The NRA has a strategy on Emergency Response Levels of Service (ERLOS) to clarify requirements for system performance and thereby prioritise and make more efficient use of resources.

FD8 Where possible, to issue a warning at least 2 hours in advance of flooding in accordance with a nationally agreed and consistent procedure, identifying the river reach or coastal zone at risk, together with an indication of public safety aspects, property and land at risk and an assessment of certainty.

LOWER BRISTOL AVON

Compliance with Water Quality Objectives
River Ecosystem Classification

5.1. STATE OF CATCHMENT WATER QUALITY

5.1.1. General

The state of Water Quality in the catchment has been assessed against the targets identified in Section 4.1. The reasons for the non-compliance of river stretches is discussed and later summarised as issues. In addition water quality issues have been identified as a result of operational experience.

5.1.2. Non-compliance with Water Quality Objectives

An assessment of current water quality based on the River Ecosystem use classes (Appendix 1) in the catchment has been made using data (held on the Public Register) from the routine water quality sampling programme taken over the three year period 1991-1993 inclusive. A comparison of current water quality with the objectives identified in section 4.1 shows that there are several stretches where current water quality does not comply with the objectives for those stretches, see the Compliance with Water Quality Objectives map.

Of the 143 classified river stretches in the catchment, 8 significantly fail to meet their objectives and a further 23 stretches marginally fail to meet their objectives. The reasons for the significant and marginal non-compliance with water quality objectives (WQOs) for individual stretches are discussed in 5.1.2.1-19 below.

Compliance is expressed in terms of significant and marginal failures. Significant failures are those where there is 95% confidence that the river stretch has failed its WQO. Marginal failures are those where there is at least 50% confidence, but less than 95% confidence, that the river stretch has failed its WQO.

5.1.2.1. Bristol River Frome

The three river stretches of the River Frome, from Yate to Goose Green, Goose Green to Algars Manor, and Algars Manor to Confluence with Ladden Brook, significantly fail to comply with their WQO of RE Class 2 due to elevated levels of BOD, however the target date for compliance is not until 1998.

The two stretches, Confluence with Ladden Brook to Confluence with Bradley Brook, and Broomhill to Floating Harbour, marginally fail to comply with their current WQO of RE Class 2 because of elevated BOD concentrations.

The growth of the conurbation of Yate and Chipping Sodbury has resulted in increased pressure on the sewerage systems and frequent pollution incidents from the trading estates have occurred. NRA Investigations Technicians are undertaking to visit all trading estate premises in Yate. The results of these visits will be used to prioritize site visits by Water Quality staff who will advise companies on pollution prevention, as part of the Bristol Frome Action Plan. Wessex Water Services Ltd (WWSL) are currently building the Frome Valley Relief Sewer, and phases 1 and 4 are completed. When the scheme is finished problems with sewerage and storm overflows should be alleviated.

5.1.2.2. Ladden Brook

Two stretches of the Ladden Brook, Bagstone to Sheephouse Farm and Sheephouse Farm to Confluence with Bristol Frome, marginally fail to comply with their WQO of RE Class 2 due to low DO concentrations and elevated BOD levels.

These marginal failures may be due to farming activity. In the past an active campaign of farm visits by the NRA led to improvements in effluent containment within the Ladden Brook catchment. The pumped drainage regime may also contribute to the problem (see section 3.4.1.3.).

5.1.2.3. River Chew

The stretch from Chewton Mendip to Litton marginally fails to comply with its WQO of RE Class 4 because of elevated BOD levels.

There are several possible reasons for this marginal non-compliance. The headwaters of the River Chew are affected by farming activity on the upper plateau of the Mendips, farm waste which is sprayed or spread onto the land may seep through the limestone bedrock and contaminate groundwater. The lack of mains drainage at Chewton Mendip and Litton, and the reliance on small package plants and septic tanks, also contributes to poor water quality.

5.1.2.4. Winford Brook

The whole of the Winford Brook, i.e. the stretches Winford to Littleton and Littleton to Confluence with Chew, marginally fails to comply with its WQO of RE Class 2 due to elevated BOD levels. The reason for this marginal non-compliance is unknown.

5.1.2.5. Priston Stream

The Priston Stream (Northfield to Confluence with Conygre Brook) marginally fails to comply with its WQO of RE Class 3 because of high concentrations of unionised ammonia. A recent impoundment above Priston STW may be exacerbating the problem of low dilution of the Priston STW effluent in the stream.

5.1.2.6. St Catherine's Brook

The whole of St Catherine's Brook (Source to Northend, and Northend to Confluence with Avon) marginally fails to comply with its WQO of RE Class 2. The marginal non-compliance with the WQO for St Catherine's Brook is due to slightly elevated BOD levels, however the cause of this is unknown.

5.1.2.7. By Brook

The upper stretch of the By Brook, Burton to Confluence with Broadmead Brook, marginally fails to comply with its WQO of RE Class 2. Two other stretches, Downstream Lid Brook to Box Mill, and Box Mill to Box Bridge, also marginally fail to comply with their WQO of RE Class 1.

Marginal non-compliance at the upper stretch of the By Brook is due to depressed levels of DO in the summer months. This stretch is near the headwaters of the brook where river flows are small. Slightly elevated levels of BOD in the stretches Downstream Lid Brook to Box Mill and Box Mill to Box Bridge result in marginal non-compliance with the WQO. The cause of these elevated BOD levels is unknown. Sewage fungus has recently appeared in the By Brook at Bathford. This stretch may be affected by runoff from the M4 and the stretch is also near the headwaters of the Brook where river flows are small.

5.1.2.8. Doncombe Brook

The stretch of the Doncombe Brook from upstream Marshfield STW to Downstream Marshfield STW significantly fails to comply with its WQO of RE Class 2.

The significant non-compliance with the WQO is due to elevated BOD and total ammonia, and low DO. The reasons for non-compliance are unknown and will be investigated.

5.1.2.9. Cam Brook

The stretch Combe to Confluence with Midford Brook marginally fails to comply with its WQO of RE Class 3.

This marginal non-compliance is due to elevated BOD levels. Although the Brook receives STW and industrial discharges it is thought that these do not cause the failure. It is possible that farming activity in the Cam Valley, which has steep sides prone to agricultural runoff, may be the reason for the elevated BOD concentrations.

Three stretches of the Cam Brook, Hanham House to Splott Farm, Splott Farm to Combe Hay and Combe to Confluence with Midford Brook, have been assigned visionary WQOs of RE Class 2. At present two of the stretches, Hanham House to Splott Farm and Splott Farm to Combe Hay, marginally fail and a third stretch, Combe to Confluence with Midford Brook, significantly fails to comply with the visionary WQO. The cause of the marginal and significant non compliance with the visionary WQO is elevated BOD levels.

5.1.2.10. Wellow Brook

Three stretches of the Wellow Brook significantly fail to comply with their WQO of RE Class 2: Foxcote to Long Barrow, Wellow to Confluence with Lyde Brook, and Confluence with Lyde Brook to Confluence with Midford Brook. In addition, the stretch Long Barrow to Wellow marginally fails to comply with its WQO of RE Class 2. The target for compliance for these stretches is the year 2000. The monitoring point for the stretch Foxcote to Long Barrow will need to be relocated to below Stony Littleton as it currently lies within the 3 km stretch of RE Class 3 allowed from Radstock STW.

The significant and marginal non-compliance is caused by elevated BOD levels; there is a pattern of high concentrations of BOD travelling down the catchment at times of heavy rainfall. In addition the significant failure at the stretch Foxcote to Long Barrow was also caused by low DO.

The Wellow Brook is in a steep sided valley in an area of mixed farming, and is therefore prone to receiving farm runoff which when combined with urban runnoff from Radstock, could cause high BOD concentrations. The Wellow Brook receives inputs from the River Somer, Snails Brook and Kilmersdon Stream which generally have water quality of RE Class 3.

Visionary WQOs of RE Class 2 have been set for the following four stretches of the Wellow Brook, Ston Easton-Midsomer Norton, Midsomer Norton-Welton, Confluence with Somer-Confluence with Snails Brook, and Confluence with Snails Brook-Tyning. Currently, all of these stretches marginally fail to comply with their visionary WQO due to BOD levels.

5.1.2.11. Kilmersdon Stream

The Kilmersdon Stream complies with its current WQO of RE Class 3. However it significantly fails to comply with its visionary WQO of RE Class 2.

The significant failure to comply with the visionary WQO of RE Class 2 is due to high BOD concentrations which may be a result of farm discharges and low dilution. Although this will need to be investigated by the NRA, it is deemed to be of lower priority than investigations into non-compliance with current WQOs elsewhere in the Lower Bristol Avon Catchment.

5.1.2.12. Snails Brook

The stretch from Stratton on the Fosse to Confluence with Westfield Stream marginally fails to comply with its WQO of RE Class 3 and significantly fails to comply with its visionary WQO of RE Class 2. The stretch from Confluence with Westfield Stream to Confluence with Kilmersdon Stream marginally fails to comply with its visionary WQO of RE Class 2.

The reason for these failures is elevated BOD concentrations, although low DO also contributes to the failure to comply with the visionary WQO for the stretch Stratton on the Fosse to Confluence with Westfield Stream. In the upper catchment the elevated BOD levels may be a result of farming activity, while in the lower stretches of the Snails Brook elevated BOD may be due to surface water inputs from the urban area of Radstock.

5.1.2.13. River Somer

The lowest stretch of the River Somer, from the B3355 road to Confluence with Wellow Brook marginally fails to comply with its WQO of RE Class 3. This non-compliance is due to elevated BOD levels, however the specific cause is unknown although this stretch receives surface water inputs as it passes through Midsomer Norton.

The upper stretch of the River Somer, Chilcompton to Downstream Manor Farm marginally fails to comply with its visionary WQO of RE Class 2, and the lower stretches, Downstream Manor Farm to B3355 and B3355 to Confluence with Wellow Brook significantly fail to comply with their visionary WQO of RE Class 2. The reason for non compliance with the visionary WQO is due to elevated BOD levels. The upper reaches of the River Somer may be affected by farming activity on the Upper Plateau of the Mendips, agricultural runoff and

low dilution, while the lower reaches may be affected by surface water runoff from Midsomer Norton.

5.1.2.14. Somerset Frome

The stretch from Innox Hill to Confluence with Mells significantly fails to comply with its WQO of RE Class 3.

This stretch is influenced by the urban area of Frome: trading estates, urban runoff and discharges from Frome STW. There have been improvements at Frome STW and since August 1993 the BOD levels at the site downstream of the STW have decreased. It is possible that the monitoring point for the stretch Innox Hill to Confluence with Mells is located too close to Frome STW and so may be unduly influenced by the discharge, therefore the monitoring point may need to be relocated.

The stretches on the River Frome from West Barn Farms to Tytherington, Confluence with Mells to Henhambridge Brook, and Tellisford to Confluence with Avon have a visionary WQO of RE Class 2. The upper stretches of the River Frome significantly fail to comply with the visionary WQO due to elevated BOD concentrations and low DO, while the lower stretches marginally fail to comply due to elevated BOD only.

The upper stretches of the River Frome are affected by farming activities, however, this area has been targeted by ADAS under a pilot do-it-yourself Farm Waste Management Plan scheme and improvements have been made by individual farms. The lower stretches of the river also pass through a farming area.

5.1.2.15. Nunney Brook

The stretches Wanstrow to Cloford, Cloford to Holwell and Southfield House to Confluence with Mells Brook marginally fail to comply with their WQOs of RE Class 2 due to elevated BOD and total ammonia concentrations.

Farming activities are believed to be affecting the Nunney Brook and this together with an average daily flow (adf) of <0.31 cumecs, providing insufficient dilution, could account for the poor water quality.

5.1.2.16. Leigh-on-Mendip Water Course

The stretch Tadhill to Halecombe Quarry marginally fails to comply with its WQO of RE Class 2 due to low DO, elevated total and unionised ammonia concentrations.

This is a low flow (<0.31 cumecs adf) watercourse within an area of intense farming and quarrying activity.

5.1.2.17. Rodden Brook

The stretch Cley Hill Farm to Corsley marginally fails to comply with its WQO of RE Class 2 due to elevated BOD and low DO levels.

Poor water quality in the upper stretch of the Rodden Brook is caused by a lack of mains drainage.

The stretch Confluence with Redford Water to Confluence with Frome has a visionary target of RE Class 2. Currently this stretch significantly fails to comply with its visionary WQO due to elevated BOD concentrations.

5.1.2.18. Redford Water

Redford Water marginally fails to comply with its WQO of RE Class 3 due to elevated BOD concentrations.

Redford Water passes through the Longleat Estate and Wildlife Park, it also receives the discharge from Longleat private STW. The NRA is investigating the water quality influences in the catchment.

5.1.2.19. Maiden Bradley Brook

The Maiden Bradley Brook significantly fails to comply with its visionary WQO of RE 2. The cause of the elevated BOD concentrations which result in non-compliance is unknown and will have to be investigated.

5.1.3 Non-compliance with EC Directives

5.1.3.1. Freshwater Fish Directive

In 1992 the imperative standard for total ammonia was exceeded in the designated salmonid fishery of the Nunney Brook from Holwell to Confluence with River Mells. This was due to diffuse farm inputs.

In 1992 the imperative standards for total ammonia and total zinc were exceeded for the salmonid stretch of the Mells River. Despite an investigation at the time the reason for these failures is unknown, however it is possible that quarrying activity may have caused the exceedence of the zinc standard.

5.1.3.2. EC Dangerous Substances Directive

There have been no exceedences of the environmental quality standards for List I and II dangerous substances at monitored sites within the Lower Bristol Avon catchment.

5.1.3.3. EC Urban Wastewater Treatment Directive

High orthophosphate and chlorophyll-a concentrations in the Lower Bristol Avon suggest that it is eutrophic, however data for dissolved oxygen does not show exaggerated diurnal cycles indicative of eutrophic waters. Further studies will need to be undertaken between 1 January 1995 to 31 December 1996 to ascertain whether the River Avon is eutrophic, and to identify the relative contribution of sources of nutrients to the catchment.

5.1.5. Pollution Incidents

Hydrometric Catchment	53/01 Avon (Bristol)		53/02 Frome (Bristol)		53/03 Boyd		53/04 By		53/11 Frome (Som)		53/12 Mells		53/13 Cam/ Wellow		53/14 Chew		53/27 Mells	
Year	92/3	93/4	92/3	93/4	92/3	93/4	92/3	93/4	92/3	93/4	92/3	93/4	92/3	93/4	92/3	93/4	92/3	93/4
Confirmed Pollutions																		
Cat 1*	8	4	1	1	0	0	1	0	0	0	0	0	1	1	0	1	0	0
Cat 2*	35	32	13	12	2	6	0	3	0	1	5	1	8	6	2	2	3	0
Cat 3*	153	216	24	46	2	6	6	13	10	19	9	8	22	26	12	23	10	4
Fish Kill	5	8	2	6	0	0	0	0	2	0	2	0	1	1	1	1	0	0

*** - Please refer to Appendix 10**

5.1.3.4. EC Surface Water Abstraction Directive

The three identified surface water abstraction points (Chew Reservoir, Barrow Reservoir and Avon Newton Meadows) in the Lower Bristol Avon exceeded the dissolved and emulsified hydrocarbons standard. However, Avon Newton Meadows is not currently used as an abstraction point although the licence is still valid. The cause of these exceedences is unknown.

5.1.4. Annex 1A Substances Reduction Programme

Significant loads of cadmium, copper, zinc, lead, chromium, nickel, arsenic, total hexachlorocyclohexane (HCH), gamma HCH, dieldrin, hexachlorobenzene, fenitrothion, atrazine and simazine were recorded in the River Avon at Keynsham in 1993. In addition, significant loads of mercury and trichloroethylene were reported in 1991. The NRA is currently examining sites nationally where reductions of Annex 1A loads may have to be achieved, the River Avon at Keynsham may or may not be targeted for load reductions.

5.1.5. Pollution Incidents

In addition to continuous and intermittent discharges, as discussed in Section 3.7, accidental spillages (pollution incidents) impact on water quality (see Pollution Incidents Table). Water quality officers and inspectors investigate all reported (alleged) incidents although subsequently not all are confirmed. Some incidents result in the death of fish and are recorded as "fish kill" (usually when fifty or more fish are killed).

5.1.6. Biological Quality

Chemical water quality monitoring is supported by biological monitoring using benthic macroinvertebrates. These are small animals which inhabit the river sediments. They are unable to move far and so respond to long-term conditions within the watercourse throughout the year. The biological monitoring is important as it can pick up the impact of intermittent pollution which might be missed by the routine chemical point sampling programme.

Samples are collected during spring, summer, and autumn, and are analysed to give a complete list of macroinvertebrate families (taxa) present. The diversity of taxa found is related to water quality using the Biological Monitoring Working Party (BMWP) scoring system. The actual score is compared for a predicted score for a physically similar river of good ecological quality and the difference between what was found and what was predicted is used to classify the river as given below:

Biological Class	Description
A	Good
B	Moderate
C	Poor
D	Very poor

The biological monitoring results for the catchment for 1990 to 1992 are summarised below. Most of the waters in the Lower Bristol Avon were of good ecological quality, with only three stretches showing a deterioration in class between and five showing an improvement.

The Somerset Frome, Rodden Brook, Mells River, Whatley Brook and Nunney Brook, Midford Brook, River Somer, Snails Brook, Kilmersdon Stream, Lyde Brook, Cam Brook, Broadmead Brook, Newton Brook, Conygre Brook, Priston Stream, River Boyd and Feltham Brook achieved Class A in 1992.

Biological quality in the Bristol Frome was Class A in 1992, quality had improved since 1991 at Cog Mill (ST 6700 8320) and at Stapleton (ST 6190 7600).

The By Brook achieved Class A in 1992, the site at Rudloe (ST 8319 6983) improved in biological quality. In 1991 it only achieved Class B.

In 1992 biological quality of the River Avon was Class A in some stretches and in others Class B. Biological quality at Crews Hole (ST 6210 7310) improved significantly from Class D in 1991 to Class B in 1992.

Sites on the River Chew achieved either Class A or Class B in 1992, there was a deterioration in biological quality at Keynsham (ST 6560 6830) and an improvement at Chew Magna (ST 5760 6290) compared to 1991 quality.

The biological quality of the Wellow Brook was mostly Class A in 1992, however the site at Radstock West (ST 6880 5490) was Class B, and the site at Writhlington (ST 7060 5540) was Class C which represents a deterioration in biological quality at this site since 1991.

Biological quality in the Doncombe Stream deteriorated from Class A to Class B from 1990 to 1992.

St Catherine's Brook and Siston Brook achieved Class B in 1992.

5.1.7. Issues Identified

Issue 1 - Impact of farming activity on water quality

Farming activities cause:

1 exceedence of the EC Freshwater Fish Directive standards on the Nunney Brook.
2 significant non-compliance with WQOs in the Ladden Brook,
3 marginal non-compliance with WQOs in the headwaters of the River Chew, Nunney Brook

Farming activities may be responsible for:

1 significant and marginal non-compliance with WQOs in the Wellow Brook
2 marginal non-compliance with the WQOs for Cam Brook, Snails Brook, Leigh-on-Mendip Watercourse.

Options

Visit farms within the sub-catchment areas identified, assess current agricultural practice and negotiate with farmers to improve effluent containment and disposal.

Issue 2 - Low dilution

Low dilution causes/contributes to:

1 marginal non-compliance with WQOs in the Priston Stream. In addition the impoundment above Priston STW may be a contributory factor in the lack of dilution for the STW effluent
2 seasonally depressed DO due to low flows in the upper stretch of the By Brook
3 marginal non compliance with the WQO for the upper stretch of the Leigh-on-Mendip Water Course.

Options

Investigate low dilution on the headwaters of the River Chew.

Investigate the impact of the impoundment situated above Priston STW.

Issue 3 - Urbanisation/trading estates

Road run off, trading estate drainage problems cause:

1 significant non-compliance with WQOs on the Bristol Frome and Somerset Frome
2 marginal non-compliance with WQOs on the Bristol Frome
3 marginal non-compliance with WQO in the Snails Brook may be due to surface water inputs from the urban area of Radstock
4 poor water quality in many of the small watercourses in the Greater Bristol conurbation.

Options

Work with planning authorities to ensure that adequate silt and oil traps are fitted on industrial area discharges.

Liaise with the Waste Regulation Authority to ensure that traders are conforming to the Environmental Protection Act 1990, Environmental Protection (Duty of Care) Regulations 1991.

Target trading estates and industrial areas with pollution prevention visits or Roadshows. (Also see Issue 16). Follow up with enforcement action where necessary. The Bristol Frome sites will be visited as part of the Bristol Frome Action Plan.

Issue 4 - Sewerage

Poor sewerage and Combined Sewer Overflows (CSOs) cause/contribute to:

1 significant non-compliance with WQOs on the Bristol Frome
2 marginal non-compliance with WQOs on the Bristol Frome
3 CSOs may have contributed to significant and marginal non-compliance of WQOs on the Wellow Brook
4 CSOs may have contributed to marginal non-compliance with the WQO for the lowest stretch of the River Somer
5 poor water quality in many of the small watercourses in the Greater Bristol conurbation

Wessex Water Services are proceeding with improvements to some CSOs.

Options

Continue to liaise with Wessex Water Services over CSO improvements.

Issue 5 - Lack of mains drainage

Lack of mains drainage, private discharges, septic tanks and badly operated package plants cause or contribute to marginal non-compliance with WQOs in the headwaters of the River Chew and Rodden Brook.

Options

Renew attempts to promote a main drainage/sewage treatment scheme for Chewton Mendip/Litton using new information and ideas recently developed by the NRA's Rural Sewerage Forum.

Issue 6 - Unknown cause(s) of elevated BOD levels

BOD from unknown sources result in marginal non-compliance with WQOs in the Winford Brook, St Catherine's Brook, By Brook and River Somer.

Options

Investigate the cause of these marginal failures due to elevated BOD levels.

Issue 7 - Groundwater Protection

This river catchment includes large areas of important aquifers which provide high quality water supplies to many thousands of people and essential summer baseflows to rivers.

The NRA objectives for Groundwater Protection have been detailed in section 4.3. The NRA will seek to protect groundwater from all types of threat. In this catchment the effects of quarrying of aquifers is of particular concern - see also issues 10 and 17-19. Another threat

can arise from the disposal of farm wastes (see Issue 1). Specifically, concern has also been expressed at the potential threat of contamination of groundwater supplies from the practice of farming free range pigs on the Mendips. Free range pigs churn up the shallow soil covering the aquifer, killing ground plant cover. Thus, at the same time as spreading waste products they destroy the essential microbiological activity in the topsoil which under normal conditions can filter, purify and oxygenate infiltrating rain water. The permanently bare soil is vulnerable to excessive erosion by rain in winter and wind in summer. As yet the areas used for this type of farming drain to an adjacent catchment (Cheddar). The Lower Avon Catchment is therefore not affected at the present time but could be at risk if free range pigs are introduced to areas on the northern Mendips.

Options

1 Implement the NRA's 'Policy and Practice for the Protection of Groundwater'.
2 Liaise with farmers on the Mendips to encourage them to produce waste management plans and avoid farming free range pigs within the Inner Source Protection Zone of water sources.
3 Seek new controls on damaging farm practices in Zone 1 (SPA).

Issue 8 - Exceedence of EC Hydrocarbon Standard

The reason(s) for the exceedence of the dissolved and emulsified hydrocarbon standard of the EC Surface Water Abstraction Directive at Chew and Barrow Reservoirs are unknown.

Options

Investigate the reason(s) for the exceedence of the EC Surface Water Abstraction Directive standards.

Issue 9 - Inappropriate location of sampling point

Sampling points should be located far enough downstream from a discharge to allow adequate mixing of the effluent and river water.

1 The monitoring point for the stretch of the Wellow Brook from Foxcote to Long Barrow (which has a WQO of RE 2) will need to be relocated to below Stony Littleton as it currently lies within the 3 km stretch of RE Class 3 allowed for Radstock STW.
2 The monitoring point for the stretch of the River Frome (Somerset) from Innox Hill to Confluence with Mells may be located too close to Frome STW and so may be the cause of the apparently significant non-compliance with the WQO.

Options

Investigate the location of these monitoring sites and change locations where appropriate.

Issue 10 - Quarrying activity - impact on water quality non-compliance

Quarrying activity may cause:

1 marginal non-compliance with the WQO for Leigh-on-Mendip Watercourse
2 exceedence of the EC Freshwater Fish Directive total zinc standard in the River Mells.

Options

Investigate the impact of quarrying in the above locations

Issue 11 - Poor water quality in Redford Water catchment

Marginal non-compliance of the WQO for Redford Water.

Options

Investigate the causes of marginal non-compliance in the Redford Water catchment.

Issue 12 - Possible eutrophication of the River Avon

There is some indication that the Lower Bristol Avon may be eutrophic, however further monitoring is required in order to determine whether the river should be nominated as a Sensitive Area (Eutrophic) under the UWWTD.

Options

During 1995 and 1996 the NRA will undertake studies to investigate whether the River Avon is eutrophic and will assess inputs of nutrients in order to ascertain whether or not the River Avon should be designated as a Sensitive Area.

Issue 13 - Oil pollution of the Feeder Canal and Floating Harbour, Bristol

Discharges of oil regularly enter the Feeder Canal and Floating Harbour at Bristol and as a result the mute swans on the Floating Harbour have been badly oiled on several occasions and have required treatment. The oil often comes from a surface water outfall at the junction of Short Street and Feeder Road, St Philips. This is an industrial/commercial area where there is a predominance of motor trade and transport premises and railway locomotive facilities. Investigations are in progress and have suggested possible sources which are being further investigated/followed up.

Options

Continue investigations work currently under way as part of the Short Street Action Plan and act on findings. Liaise with the Waste Regulation Authority to ensure that traders are conforming to the Environmental Protection Act 1990, Environmental Protection (Duty of Care) Regulations 1991.

Issue 14 - Sewage debris and litter in the River Avon downstream of Bath

Sewage derived, and wind blown plastic and paper debris are often found along the banks of the River Avon from Twerton to Conham. The problem is partly due to CSOs in Bath. The NRA is currently undertaking work in relation to Wessex Water's Bath Drainage Area Plan aimed at identifying those combined sewer overflows (CSOs) in Bath which operate prematurely and those which discharge significant quantities of sewage debris due to poor screening.

Continue to monitor the extent of the problem. Although agreement has been reached with Wessex Water Services to improve some combined storm sewer overflows in the Bath area, there is a need to continue to negotiate with Wessex Water Services to reduce the frequency of operation of other CSOs and to improve screening facilities.

Issue 15 - High metals concentrations in the Avon estuary at South Pier

Limited data, collected at different tidal states, show that high metals concentrations occur on occasions in the Avon estuary at South Pier. In 1992 the annual average dissolved copper concentration was 9.5 µg/l and so exceeded the EQS (5 µg/l as an annual average); in 1993 concentrations occasionally exceeded the EQS. Although the EQS for dissolved mercury (0.3 µg/l as an annual average) was not exceeded in 1992 or 1993, on one occasion in June 1993 the level of total mercury was 0.4 µg/l. It is possible that high loads of copper measured in the River Avon at Keynsham may contribute to the copper concentrations at the mouth of the Avon estuary, and the Severn Estuary may also be a source of copper and mercury.

Options

Investigate the metals concentrations at Avonmouth.

Issue 16 - Poor water quality and amenity value of urban watercourses in the Greater Bristol conurbation

Many of the small watercourses in the Greater Bristol conurbation suffer from poor water quality due to wrongly connected domestic drainage, sewerage infrastructure faults, road runoff, industrial site drainage, litter and illegal dumping e.g. Brislington Brook, the Malago and its tributaries, Combe Brook. Within the City of Bristol a campaign to locate and correct wrong connections and sewerage faults, 'Operation Streamclean' was initiated in 1992 with the collaboration of Bristol City Council and Wessex Water Services. The campaign is proving successful and many problems have been pinpointed and remedial work is progressing.

Options

Encourage local action groups, possibly by setting up a help-fund. Target trading estates/industrial areas with pollution prevention visits or 'Pollution Preventions Roadshows'. Create a forum to promote collaboration between NRA, local government, action groups and industry. Continue the 'Operation Streamclean' programme if funding is available.

5.2. STATE OF CATCHMENT WATER QUANTITY

5.2.1. General

Where water abstraction requirements are competing directly with other river uses and/or aquatic needs, it is essential that the available water resources are apportioned to sustain a suitable balance. The NRA published a national Water Resources Development Strategy in March 1994. The first water resources development strategy for the South Western region, (of which the Lower Bristol Avon catchment is a part) due for publication in April 1995, sets out some of the options for meeting the demands of water users whilst aiming to conserve and protect the water environment.

The rate of increase in demand for water can be controlled by effective demand management measures such as metering and efficient use of water, including reuse, along with improved leakage control. Only when the NRA is satisfied that adequate measures have been taken to reduce losses and to improve efficiency, will new major resource developments be considered necessary. New resources will have to be sustainable and developed in sympathy with environmental needs and those of other water users. Where there is scope for further development of resources this is likely to involve a move from up-catchment groundwater supplies to downstream surface water intakes that afford greater and a more extensive protection to other river uses.

5.2.2. Rainfall

The annual rainfall fluctuates from year to year and also shows trends over a longer period. Residual rainfall, or that portion of the rainfall that is not lost through evapotranspiration, together with the ability of the catchment to store water, are the dominant factors affecting the availability of water resources within the catchment. This availability is then reduced by the exploitation of resources through surface and groundwater abstractions.

Sub-surface storage within the Jurassic (Oolitic) Limestones and Chalk/Upper Greensand aquifers becomes important during periods of low rainfall, however, over longer drought periods even this large underground storage begins to suffer from exploitation. This will in turn affect rivers that rely on groundwater to supplement their flows.

5.2.3. Abstraction licences

The majority of water abstracted from resources within the catchment is used for public water supply, and to a lesser extent industrial purposes, fish farming and agriculture. Each of these uses is subject to licensing requirements even if, as in many situations, the abstraction involves negligible water loss since the abstracted water is returned to the water body. In granting new licences, existing licences must be safeguarded as must other uses of the river environment.

5.2.4. Groundwater resources

The major catchment aquifers are the Carboniferous Limestones of the Mendip Hills together with the Upper Greensands to the south east of Frome and the Cotswold Oolites to the north

of Bath. Concern has been expressed at the effect of quarrying activities on the aquifers, particularly in the Mendips. In the short-term the major concerns and beliefs are that quarrying and particularly the dewatering aspects associated with the activity have resulted in the pollution and diminution of flows from spring sources and streams in the area. There is also concern over the impact of quarry dewatering on the Hot Springs of Bath. In the long-term there is also concern that at current rates of limestone removal the viability of the Mendip Hills as a water resource will be severely impaired.

5.2.5. Surface water resources

Both the Bristol Avon river itself and impounding reservoirs, especially Chew Valley Lake, are particularly important surface water resources, particularly for public water supply.

Both Bristol Water Company and Wessex Water Services have options to develop abstraction sources in the Lower Bristol Avon. These related abstractions are described in Issue 21 below.

Another increasing demand for water arises from the restoration of the Kennet and Avon Canal (see Issue 22 below).

5.2.6. Issues identified

Issue 17 - Impact of quarrying in East Mendip on water resources

The Mendip Hills have the largest concentration of hard-rock quarries in Britain. Most of them are located in the Lower Avon catchment, in the East Mendips. In 1992 they produced more than 10 million tonnes of crushed stone.

The active East Mendip quarries are all working below the water table. In 1993 their dewatering pumpage amounted to approximately 13 billion litres, significantly more than the approximately 10.4 billion litres that can be pumped annually from the East Mendips for public water supply.

The effect on water resources has been significant. Seven limestone springs that once were large and clear have been reduced, and in some cases completely dried up and the quality of water has also suffered. On the other hand, the pumped water maintains relatively high flow in the streams, particularly the Whatley and Nunney Brooks, into which it discharges, but it is more liable to contamination than the natural springwater that it replaces and the flow is subject to sudden changes when pumps switch on and off.

The deep quarry at Whatley discharges up to 30 million litres daily. As much as a quarter of this is water that sinks through fissures and caves in the bed of the River Mells near Mells village. The effect of pumping at Whatley Quarry is now felt 6 km away at the Oldford public supply, where the full authorised quantities are no longer obtainable in dry summers.

Action taken

The NRA and its predecessors recognised the quarry threat to water resources in the 1970s. Since 1974 they have continuously monitored the effects of quarry expansion on springs, streams and the water table. By prosecutions, negotiations and in cooperation with the planning authorities they have greatly reduced the contamination of streams by quarry discharges, usually by requiring the pumped water to pass through deep settlement lagoons. By introducing the concept of "compensation ponds" they have, it is hoped, compensated for the loss of temporary water storage caused by quarries working above the water table. Planning consent to extend and deepen Torr Quarry at Cranmore is dependent on the operators pumping water from a deep sump in the quarry through several kilometres of pipelines to maintain flows in distant streams that would be reduced by the quarry. At public inquiries the NRA has sought to ensure that quarry operators fully compensate, in perpetuity where necessary, for the damage they cause to the water environment.

Options

There is a fundamental conflict between those who rely on the renewable water resources of the Carboniferous Limestone aquifer for water supply, tourism, amenity etc and those who, by quarrying, destroy the aquifer itself. In 1994 it was forecast that Somerset alone would soon face a demand for 28 million tonnes of crushed limestone per year; at which rate all the limestone Mendip Hills would be removed down to sea level in 2400 years. In the face of this time scale, options range from recognising the special values of the limestone (which go far beyond its water-bearing properties) and planning for the rundown and eventual stoppage of limestone quarrying, replacing it by less socially valuable rocks like granite or basalt, or continuing to remove the limestone for short-term advantage regardless of permanent losses.

The Authority will seek to apply the principles laid down in its Policy and Practice for the Protection of Groundwater document (NRA 1992). Specifically policies B1 and B2 will be applied (see also 4.3.4).

Issue 18 - Quarrying and the Brimsham Stream

The Ladden Brook, a main tributary of the Bristol Frome, rises north of Chipping Sodbury where it is called the Brimsham Stream. After flowing for about 2 km over impermeable clay strata it crosses the Carboniferous Limestone outcrop that forms the east rim of the North Bristol Coal Basin. Immediately to the south, large limestone quarries are dewatered by pumping.

The stream is recorded as having failed for the first time ever in 1976, when the nearest quarry had approached to within a few hundred metres of it. The water sank into fissures in the limestone bed and reappeared in the quarry. In subsequent years the loss has increased until for much of 1994 the whole limestone length of the stream would have been dry had not the quarry dewatering pumpage (approximately 4 million litres per day) been discharged into it at Brimsham Bridge, where it flows under the B4060 road.

In 1994 the quarry operators argued that the dry length of the Brimsham Stream was now of little ecological value. Proposals were made to quarry through the stream bed and maintain the flow on the downstream side by pumping. The stream on the upstream side would fall into the quarry.

Action taken

The NRA had long known of the threat to the Brimsham Stream. In 1979 Wessex Water Authority calculated that a 1 in 10 year flood would generate a maximum flow of 230 million litres per day in the stream. In 1994 the NRA presented a case to the Mineral Planning Authority (Avon County Council) for preserving the stream from quarrying. A strip of land 30 m wide would be left unquarried on either side of the stream, the bed would be sealed against leakage and the quarry on the far side would be reached by a tunnel.

Options

If the Brimsham Stream is left unquarried and its bed sealed, the pre-quarry status quo will be largely preserved. If it is quarried through, the value of extra stone extracted (if any) would have to be balanced against the cost of the works needed to maintain satisfactory flow regimes in the upper Ladden Brook and the Bristol Frome, in perpetuity.

The Authority will seek to apply the principles laid down in its Policy and Practice for the Protection of Groundwater document (NRA 1992). Specifically policies B1 and B2 will be applied (see also 4.3.4).

Issue 19 - Impact of quarry dewatering on the Hot Springs of Bath

It is now generally believed that the Hot Springs are fed by rainfall on the Mendip Hills, some 20 - 30 km south and southwest of Bath. Water tables in the carboniferous limestone aquifer of the Central Mendips stand as much as 170 m higher than the spring outlets at Bath. Between these two locations the limestone aquifer descends to depths of 2 - 3 km beneath the Radstock Coal Basin, where the rock temperature is around 80 °C. Driven by the hydrostatic head of up to 170 m, and also by a thermal effect (hot water rising to the springs is less dense than cold water sinking below the Mendips) water passes through fissures and caves in the limestone to Bath, where the Hot Springs flow at 1.3 Ml/d at 45 °C.

Many millions of tonnes of Carboniferous Limestone are quarried from the Mendips each year and some of the quarries are now so deep that they have passed below the water table. To prevent flooding they pump millions of litres of water daily out of the workings, an action which depresses the water table in the adjacent limestone aquifer. If the effect extends into the source areas of the Hot Springs, the hydrostatic head driving the flow to Bath will be reduced, the flow will slow down, and the spring output will diminish.

A different problem is posed by the limestone quarries at Wick, 9 km northwest of Bath. In 1994 dewatering operations at these quarries had lowered the water table to approximately 40 m Above Ordnance Datum (AOD), only approximately 10 m higher than water levels in the same aquifer at the Hot Springs. If, as is technically possible, Wick Quarries were deepened to sea level or below, part or all of the flow of hot water from the Mendips, could

be diverted from Bath to Wick where the quarries would provide the lowest outlet for Carboniferous Limestone groundwater in the whole region.

Action Taken

The NRA has acted on three fronts.

At Bath, together with Bath City Council, we have been measuring and recording the output of thermal water from springs and boreholes since 1980. Early tests showed that the least variable feature is the natural thermal output (approximately 55,000 megacalories per day) and this is being monitored with sufficient precision to detect significant long-term changes or trends.

In the Mendips we monitor water level changes in our own boreholes and in borehole networks that quarry operators must maintain in order that the effect of quarry development on water resources is understood. Quarry development is monitored so that if, and when, changes affect the Hot Springs all the possible causes are known. Somerset County Council, as the Mineral Planning Authority operates a "one lift at a time" policy that requires an operator to demonstrate that the quarry is not damaging water resources at its current depth before it can be deepened further.

At Wick the NRA began regular monitoring of the groundwater seeping into the quarries in 1992. Temperature and chemistry, distinctive features of the Bath thermal water, are measured. In addition we have asked the Mineral Planning Authority, Avon County Council, to set a depth limit of 30 m AOD on quarry workings wherever possible.

Options

Continue the monitoring programme described above, investigating the cause of any deterioration in flow or heat output of the Hot Springs. Continue to resist any proposed quarry development that would increase or prolong the risk to the Hot Springs.

Issue 20 - Impact of major road runoff on water resources

The runoff from major roads during rain is contaminated by materials that derive from the traffic flow and build up on the road surface, such as oils, greases, lead-rich dust and synthetic rubber. They are washed off the road by rain and enter ditches leading to rivers or, where the ground is permeable, the runoff may be disposed of into soakaways. They pose a significant threat to water purity, above and below ground.

Traffic accidents, especially those involving oil or chemical tankers, have polluted public water sources, as happened in 1968 when an oil tanker crashed on the A46 north of Bath. Motorways and dual carriageways, with their wide impermeable surfaces, can generate large volumes of flash runoff. In the Lower Avon catchment the stream most affected by runoff is the By Brook, which receives drainage from around 11 km of the M4 motorway.

The hazard to groundwater quality is most acute where major roads cross permeable aquifers from which groundwater is abstracted for public supply. In the Lower Avon catchment the

motorways have avoided such areas. Short stretches of major road cross Carboniferous Limestone catchments on the Mendips between Chewton Mendip and Oakhill and near Frome, Chalk catchments near Westbury, and Oolitic Limestone catchments between Chippenham and Bath but the impact is small.

The most efficient soakaway is one that drains into open natural fissures, as occur in most limestone aquifers, but the risk to groundwater sources is maximised in such cases because contaminated water can flow rapidly, within hours, to a spring or borehole.

Options

Continue to liaise with planning and highway authorities. In discussing road improvement plans the NRA has advised that runoff should be led via interceptors to vegetated lagoons, such as grassland areas surrounded by impermeable clay banks, underlain by permeable aquifer. Temporary ponds form, which lose their water gradually by infiltration. Passing through the soil, contaminated water is subjected to filtration, adsorption, oxygenation, breakdown of contaminants by microorganisms and take-up of nutrients by plant roots. A high degree of purification is achieved by natural means. The term "biofiltration ponds" was coined by Dorset County Council when it installed them on a new dual carriageway near Puddletown in 1992. They are developing a wetland flora and fauna, and have a further value in that road runoff recharges the aquifer instead of being discharged into a stream.

Issue 21 - The potential for increased licensed abstractions for public water supply from the Lower Avon

Background

As part of the NRA Regional Water Resources Strategy, an existing licensed abstraction at Newton Meadows, Bath, has been identified as one potential source to meet the growing demand within the Avon/Wiltshire supply zone of Wessex Water. This as yet-unused source will help postpone the need for Wessex Water to develop any major additional sources to supply the Bath area by as much as twenty years. However, it is possible that further resources would be needed sooner. This could happen if:

a) water companies and water users do not implement adequate demand management and leakage control practices to restrain growth in the demand for water,

b) demand continues to rise in spite of demand management measures being in place,

c) the option of abstraction from the lower reaches of the Avon, to compensate for reduced abstractions around Malmesbury, is pursued.

The Upper Bristol Avon Catchment Management Plan identified abstractions from groundwater by both Wessex Water and Bristol Water in the Malmesbury area, which affect river flows, as a major issue for concern. A two year NRA study, concluded in August 1994, identified a series of short and long term options to consider for improving the situation. The short term options are being investigated. If these prove inadequate, one of the long term options is to reduce abstractions in the Upper Catchment and balance the

reduction with an increase in licensed abstraction from the Lower Avon. Under this scenario, an increase in the existing Newton Meadows licensed quantity would provide Wessex Water's additional needs.

Bristol Water benefits from a well integrated supply system, supplemented in the north by imported water from the Gloucester and Sharpness Canal via the Purton treatment works. Recent enlargement of the treatment works now provides for an additional 55 Ml\d and there is provision for another phase of development to allow a further similar increase. A third phase will depend upon development of resources in the River Severn and Wye Catchments.

As an alternative to additional phases of importing water, and as part of a potential solution to river low flows in the Malmesbury area, the possibility of providing a pumped storage facility to Chew Valley Lake in the Mendips could be investigated. The source would be the Lower Bristol Avon above Bristol, possibly at Newton Meadows where Wessex Water already hold a licence to abstract. It is apparent that such a pumped storage scheme would represent some loss of water from the catchment. However, the Chew system supplies much of the demand in Bristol as well as local demand to the south of the City. Subject to a thorough investigation and environmental assessment, a proposal for a pumped storage scheme from the Avon to Chew Valley Lake should be encouraged; especially if the scheme also allowed for a commensurate reduction in abstraction from the boreholes in the Upper Avon.

Another option for increasing the yield of the reservoir might be to raise the height of the dam, thus potentially doubling the volume of water abstracted for pumped storage from the Avon. This option may not become practicable for another half a century. Therefore all the environmental considerations would need to be assessed in the light of prevailing environmental policy at that time.

A pumped storage scheme would be controlled under licence and be subject to conditions to protect river flows. So far there has been little investigation into what would constitute adequate protection because discussions between the NRA and Bristol Water have yet to be initiated. Investigations would also need to consider the costs and benefits associated with any proposed schemes.

Options

Seek resolution to the problems associated with groundwater abstraction on the Upper Catchment, in conjunction with Wessex Water and Bristol Water. Initiate discussions between NRA and Bristol Water on the need for and timing of the detailed investigation of a pumped storage scheme for Chew Valley Reservoir.

Promote (NRA) and implement (water companies) appropriate demand management and leakage control policies.

Evaluate the potential for increasing the authorized abstraction from the Avon at Newton Meadows. Proposals would only be considered where it could be demonstrated that there would be adequate mitigating works to avoid adverse impact on the water environment.

Issue 22 - Intake at Claverton to supply the Kennet and Avon Canal

Restoration of the Kennet and Avon Canal, largely stimulated by the Kennet and Avon Canal Trust, has progressed steadily over the past few years to leave one major section in North Wiltshire due for completion. This section, the 15 mile 'Long Pound', between Devizes and Crofton Peak, is currently being examined by British Waterways with a view to structural repairs and water supplies to provide all-seasons navigation. In the absence of a currently effective water supply system, water resources are required to maintain the navigation. Even with improvements to the waterway the residual leakage rates and requirements for locks will still leave a substantial water demand. One option to satisfy demand is to increase the quantity of water supplied to the canal from the Lower Bristol Avon intake at Claverton, just upstream from Bath.

Action Taken

The NRA South Western Region and its predecessor authority have been in periodic discussion with British Waterways since 1986 when it was first decided that the Canal should be resourced by back pumping from the Lower Avon at Claverton and this system has been implemented to the foot of the Devizes flight of locks. To the east of the Long Pound water is supplied from the Kennet catchment in Thames Region with water from Wilton Water Springs near Wootton Rivers being available to service the flight of locks at Crofton Summit at the eastern end of the Long Pound. Additional water to maintain a navigable depth in the Long Pound and to service the Devizes flight of locks is required and the NRA was requested to consider whether this should be sourced from the Bristol Avon or the Hampshire Avon Catchment.

Options

A significant proportion of a new water supply to the Long Pound would be used to operate the locks at Devizes. For this reason the options of groundwater abstractions from the Hampshire Avon Catchment or the interception of streams in that catchment or the Upper Bristol Avon area were considered to be unacceptable since the residual lockage water would be lost to headwater areas that can ill afford it. At the same time it is apparent that the present condition of the 'Long Pound' should be improved to minimise leakage.

The NRA has recommended that the 'Long Pound' be sourced by a continuation of the present sequence of back-pumping arrangements starting at Claverton on the Lower Bristol Avon. This would eliminate interference with headwaters streams and provide a reliable source in all but the driest seasonal weather, when it might reasonably be expected that a public water supply licence downstream of Bath should have priority of entitlement over recreational purposes. The impact on the Upper Bristol Avon would be negligible though some minor benefits emerge from any leakage from the canal in the section between Devizes and Bradford-on-Avon.

British Waterways are in the process of installing a pumping scheme at Devizes to supplement existing arrangements to provide water for the Caen Hill locks. The scheme should be complete by March 1996.

Issue 23 - Combe Down stone mine infilling

The Combe Down plateau on the southern margin of Bath was intensively mined for Bath Stone (Great Oolite) in the 18th and 19th centuries. The best stone lay only a few metres beneath the ground surface. Now the built-up areas of Combe Down are supported, in many places, by no more than 6 m of soil and rock overlying empty mine workings in which the roof is held up by pillars of unexcavated Bath Stone. Doubts as to their long term stability led to a proposal, in 1992, to infill large parts of them with concrete made with pulverised fuel ash (PFA) to save from £5m - £10m.

The Great Oolite is an important aquifer. At Combe Down it transmits groundwater to several springs of which the largest, Whittaker's Spring, is used for public water supply. Wessex Water Plc and the NRA were concerned that the main constituent of the concrete, pulverized fuel ash (PFA) could leach harmful chemicals into the water supply. It also appeared possible that the huge underground slabs of impermeable concrete could divert groundwater away from its normal flow channels and hamper infiltration, causing waterlogging of gardens and cellars.

Action Taken

The consultant, Sir William Halcrows Ltd, submitted an Environmental Statement to the Environment Committee of Bath City Council in December 1994 to support their preferred option of using the PFA concrete.

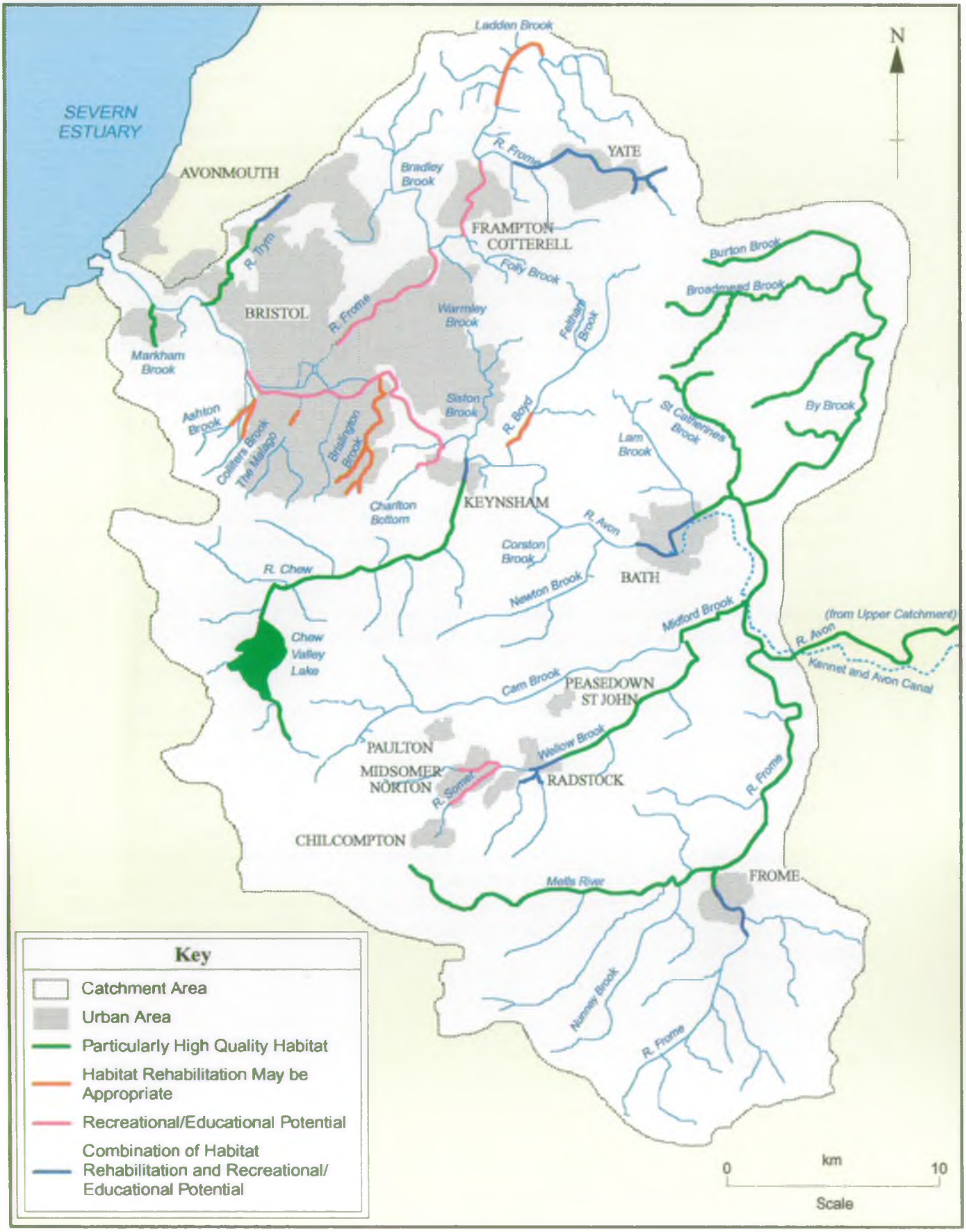
Subsequent leaching tests have gone some way towards demonstrating that the proposed PFA concrete will not be damaging to water supply if properly controlled, but the NRA needs to be satisfied that the proposed controls will be effective in practice.

It now seems unlikely that groundwater flow channels will be significantly changed because the concreted areas of the mines will be broken at frequent intervals by areas which, for various reasons, will remain untouched.

Options

The NRA still has to be satisfied (at the time of going to press) that groundwater quality will not suffer, before Halcrows can submit a formal planning application to Bath City Council Planning Authority. The planning application is expected in early spring (1995) and the NRA will be a statutory consultee. The application will also be subject to an Environmental Impact Assessment.

LOWER BRISTOL AVON
State of the Catchment - Physical Features



5.3. PHYSICAL FEATURES

5.3.1. General

The aspects of physical features for which objectives were identified in Section 4.4 are considered here and issues which arise are then outlined.

5.3.2. Impoundment

The River Avon is an historically impounded watercourse, modified initially by past industrial use as a power source for milling, and more recently by extensive land drainage schemes and agricultural intensification. The change in the use of the river from a power supply to principally an amenity resource brings with it the need to review the function of each impounding structure. The flood gate structures installed from 1950 - 1970, particularly those in prominent town centre locations such as Bath and Bitton, but also at Tubb's Bottom, near Yate, are visually intrusive, potentially dangerous and expensive to maintain. A redundant impounding structure on the Bristol Frome at Frenchay was recently modified to give a more attractive appearance.

5.3.3. Flood Plain Wetland Habitat

As a result of the extensive land drainage schemes of the past there are very few wetland habitats remaining in the catchment. This has an indirect effect on the conservation of water resources and makes the Avon and its tributaries more prone to flash flooding as well as accentuating the problem of low summer flows in periods of drought.

5.3.4. River Corridor Habitat

A high proportion of watercourses in the catchment have been subject to land drainage and flood alleviation schemes often involving dredging, straightening and the removal of features, for example, works at Frome, Bitton and at Tubb's Bottom. The channel modifications have resulted in a loss of landscape and biological diversity.

There are a relatively high number of urban watercourses in the catchment, principally in Yate and Bristol, which suffer from poor water quality, excessive rubbish problems, and degraded river corridors. Sections of the Malago are particularly bad where adjacent to industrial sites such as Locks Mill. The Horfield Brook suffers from rubbish which usually includes shopping trolleys. The Trym is a river of contrast, with a sterile section flowing through public open space at Doncaster and Shetland Road comparing unfavourably to attractive, semi-natural sections as at Baddocks Wood Public Open Space and Coombe Farm. The Henbury Trym is another example of a small watercourse affected in a piecemeal fashion by urban development, requiring a comprehensive improvement scheme both for conservation and as a public amenity. This river rises at Cribbs Causeway where it is adversely affected by pollution, rubbish, a particularly unsympathetic urban flood alleviation scheme and further threatened by proposed development. It then flows through Blaise Castle Estate and Combe Dingle, where it is a most attractive feature.

There is scope to work with the local authorities and their parks departments to implement a collaborative programme of works to enhance these urban river corridors.

There is also considerable scope for physical improvements through habitat rehabilitation work, with major potential benefits to conservation, fisheries and flood defence maintenance eg Frome Town Centre, the Boyd at Bitton, the Chew at Keynsham, Bristol's urban watercourses and the Bristol Frome through Yate.

5.3.5. Historic Features

There are many historic features associated with watercourses in the catchment. All are of importance and worthy of conservation. The NRA will protect such features when carrying out work in the river corridor.

5.3.6. Agriculture

There has been a significant increase in intensive farming and conversion of meadows to pasture and arable in the catchment over the last 50 years. The resultant gradual reduction of bankside tree and shrub cover may have led to an increase in invasive aquatic plant species in particular locations, whilst the increased silt loading has an adverse effect on plant communities and water quality. The loss of corridor vegetation has reduced diversity and increased bank instability in places. This loss of bankside cover has led to the need for a Flood Defence maintenance programme of regular spraying to reduce aquatic plant growth as this traps excessive amounts of silt. The removal of aquatic plant growth may be limiting to the recolonisation of the river by species such as the otter.

5.3.7. Planning

The earlier lack of Local Plan policies to define, protect and enhance river corridors, particularly through town centres and industrial areas, has led in the past to environmental degradation, with developments backing on to and obscuring the rivers. The town centre flood alleviation schemes of the past, carried out when environmental awareness and legislative duties were less strong, have in general tended to exacerbate the situation. However since then, greater understanding of environmental problems have been demonstrated by the local planning authorities (LPAs) in carrying out their development control function which has lead to improvements in the design of recent schemes. The DoE/Government have also encouraged the LPAs to take more stringent measures in the design and control of such schemes. There remains a great deal of scope for comprehensive programmes of work to enhance and restore the wildlife and recreational potential of urbanised river corridors.

Bristol and Bath have dominant roles in the South West; Bristol's commercial economic prosperity and growth has been associated with its geographical location. It is considered that future prosperity will depend to a large extent on retaining and improving transportation links, economic investment, urban regeneration and seizing opportunities for improving the city's environs. Success of developments outside the city's boundary are seen as crucial. Key sites include an extensive area to the west of this catchment, at Avonmouth/Severnside where strategic roads presently under construction, will link the area to the Second Severn

Crossing and the M4 and M5 motorways. Bristol's travel facilities are also to be improved by a Rapid Transit System and other road improvements.

Bath is a World Heritage Site and the Local Planning Authority is committed to conserve and protect the fabric of the City. The City provides a nucleus of employment in the service sector and to add to the variety of existing manufacturing further land has been identified for such firms. A strong conservation remit exists in the Local Plan which not only promotes the conservation of Georgian Bath but includes anti-pollution policies, an enhancement project based on the River Avon, water quality improvements plus landscape and townscape objectives.

The rural surroundings of the two cities has been protected by Green Belt Policies that have controlled the loss of countryside and minimised coalescence of settlements in much of the catchment. The theme in all Development Plans in the catchment is one of sustaining and improving environmental quality whilst allowing growth in housing, jobs, facilities and amenities. In doing so there is recognition of the need for protecting the water environment in the area and the value of rivers and their corridors for recreation and wildlife. Within the main urban areas and smaller towns, rivers are seen as an element that can provide a finger of countryside into built up areas. Unfortunately engineered flood alleviation and river works of the past have not been sympathetic to rural or urban locations. Recent "greening" of attitudes suggests that the possibilities for softening engineered structures should be investigated. The Bristol/Avon Community Forest Plan and the Local Plans contain positive courses of action for the river environment that are supported in principle by the NRA.

5.3.8. Issues Identified

Issue 24 - The degradation of river corridor habitats

Since the 1940s, agricultural intensification and accompanying land drainage schemes have resulted in the widespread loss of wetlands and the reduction of the river corridor in many places to a thin strip of bankside trees, shrubs and tall herbs. The loss of floodplain wetlands is particularly marked on the Rodden Brook. Significant examples can now only be found on the By Brook and Mells River valleys.

The associated river engineering works were unsympathetic to landscape and nature conservation, resulting in stretches of the Bristol Avon being artificially straightened and having unnaturally regular bank profiles. Examples of degraded habitats and visually unattractive environments are:

- Bath (sheet steel piling and concrete caps in a World Heritage site)
- Keynsham (unattractive river channel through town centre park)
- Frome (highly utilitarian and rather unsafe channel through town centre)
- Bitton (unattractive, unsafe, unnatural river channel)

River corridor biological diversity is further reduced by the increasing use of agricultural chemicals; land ploughed to the river bank increases silt loading in the river and can lead to pressure to remove or trim bankside trees; intensive grazing impoverishes bankside vegetation, reducing dominant species to nettles and tall herbs.

Changes have undoubtedly occurred in the aquatic plant communities of the Lower Bristol Avon and some of its tributaries. It is very difficult to quantify or confirm these perceived changes in the absence of baseline studies and long term monitoring work.

Changes have included the spread of non-native bankside species such as Himalayan balsam and Japanese knotweed, which are now widespread, particularly on the Bristol Frome catchment and through the City itself.

Community changes are due to a number of interacting factors including:

- eutrophication
- changes in flow regime (particularly impoundments)
- flood defence schemes
- river maintenance
- reduction in bankside shade.

The restoration of the Bristol Avon floodplain habitats and river corridor biological and morphological diversity poses a major challenge. An example of a river suffering from these impacts is the Bristol Frome (see Issue 28).

Options

Work with MAFF, the Countryside Commission and riparian landowners to limit the effects of intensive agriculture on the river corridor. This could include:

1 improving the quantification and assessment of land use changes.
2 promoting the use of permanent set-aside/buffer zones in river valleys.
3 schemes to enhance waterside landscapes, such as the Bristol Frome Action Plan.
4 schemes to restore seasonally inundated floodplain meadows, managed without the use of chemicals.
5 good opportunities to create large areas of floodplain wet meadows exist on the Ladden Brook where the pumping station could be closed, and on the River Chew through for example the Countryside Stewardship Scheme.
6 develop a management strategy to maintain a balanced aquatic flora. This would include:

- the identification of the natural changes
- the identification of adverse effects occurring as a result of increased nutrients or reduced flow.

Issue 25 - The effect of development pressure on the river corridor

The growth of urban areas such as Bristol (eg Emerson's Green) and see Issue 28, Bath, Frome and Yate has led to increasing pressures on the river corridor such as:

- the increasing population creates more demand for recreation and amenity. The Lower Bristol Avon is increasingly well used for angling, canoeing, boating, walking, bird-watching and cycling. There is a need for integrated conservation and recreation

strategies, building on existing schemes such as the Greater Bristol Nature Conservation Strategy, the Avon Valley Project (Bath) and Nature in Bath.

- increasing use of the river for recreational and commercial boating - see Issue 26

- increasing use has led to increased amounts of litter (see Issue 32) including shopping trolleys.

- expansion of industrial estates in areas such as Yate and Radstock have caused poor water quality, with buildings and car parks developed right up to the edge of the river channel.

- a demand for new roads is generated (see Issue 27). Examples include roads which affect:

    - the Malago at Locks Mill
    - the Trym at Cribbs Causeway, Doncaster and Shetland Road
    - the Horfield Brook
    - the Brislington Brook

Options

- Ensure that local authority Local Development Plans contain policies which will safeguard and where possible enhance the water environment

- Work with local authorities, riparian owners and user groups to develop Management Plans and set up management groups to improve the visual amenity and access to the urban river corridor, especially where the river flows through open space. Linear walkways can be created and long distance footpaths such as the Avon Valley walkways. The management plans could organise anti-litter campaigns and develop strategies for improving water quality in urban stretches

Issue 26 - Recreation and amenity

In addition to its duty for recreation on its own land and water, the National Rivers Authority has a duty generally to promote the recreational use of inland and coastal waters and associated land.

The NRA owns little land or water in the catchment but recognises an increasing population creates demand for access, recreation and amenities. This demand must be set in the context of the NRA's other duties (conservation, fisheries, flood defence, water quality and quantity) and the strategies of other statutory authorities. The NRA is not the navigation authority in any part of the Lower Avon.

Of particular concern is the increase in use of the river for recreational and commercial boating with its attendant likely effects of bank erosion, decline in aquatic plants and in the Avon upstream of Pulteney weir, deep local concern for the safety of small craft.

Options

To promote NRA strategy and policy in Local Development Plans.

To work with local authorities in the resolution of problems caused by multiple use of the river.

Issue 27 - Impact of new road schemes

New road schemes can have a variety of adverse impacts on the water environment. During the construction phase there is a threat to water quality from eg silt, oil, fuel and tar. There is the possibility of increased flood risk from runoff, the loss of floodplain storage, risk to groundwater and surface water through discharge of roadside drainage especially from spillage after accidents, also see Issue 20. Additionally there are adverse effects on the ecology of the river corridor through direct shading and modification to banks. There is also the possible loss of floodplain habitat through the construction of embankments.

Currently, there are at least six major road schemes under consideration and development within the catchment. These include:

- A46 Batheason by-pass and improvements (currently under construction),
- A36 trunk road,
- M4/M5 widening,
- Bulls Green Link Road,
- Avon Ring Road,
- Winterbourne by-pass.

Options

The NRA will seek increased involvement at the earliest stages of Local Authority Development Plan preparation.

The NRA will seek early discussion of proposed new road schemes so that the possible impacts on the water environment can be fully evaluated and any necessary modifications obtained. With regard to water quality requirements, all new road schemes and road enhancements are reviewed to determine the appropriate level of protection required for the watercourse/groundwater and the design of the drainage system is agreed with the design engineers. The use of reed bed filtration should be considered to slow the flow and improve water quality. Where necessary the NRA can exert statutory control over these water quality matters by serving a prohibition notice.

The NRA will lobby to make it a requirement that the developers of new road schemes should be required to undertake full environmental assessments.

Issue 28 - Degradation of the Bristol Frome

The Bristol Frome catchment has long been recognised as a river system under stress from a number of different factors including:

- increasing development and urbanisation (especially Bradley Brook and Folly Brook),
- intensive agriculture and land drainage (especially Ladden Brook),
- industrial pollution,
- intensive and increasing public use.

Options

A River Corridor Survey was commissioned in 1992/93, and the resulting information was translated into an Action Plan in 1994.

Bristol Frome Action Plan

It is intended that a multi-functional, collaborative programme of works, to be carried out in conjunction with a variety of different agencies, will be implemented over a 5-10 year rolling programme. Partners involved will include the LPAs, Countryside Commission (particularly through Countryside Stewardship grant scheme and the Bristol/Avon Community Forest), Forestry Authority, Local Parish Councils and Community Groups.

Issue 29 - Conservation and enhancement of landscape and archaeological features associated with watercourses

Changing land use and development have often played a major part in degrading river landscapes. There is a need to conserve existing attractive landscapes and features of archaeological interest, and protect them from damaging development, such as road schemes and golf courses. Visible archaeological features include bridges, mills, weirs and hatches. The enhancement of town centre landscapes and restoration of degraded landscapes is also an issue which should be addressed.

Bath is a World Heritage Site and as such demands special attention.

Options

Work with local authorities to develop suitable policies to include in their Local Plans and the "Action Plans and Proposals" that derive from them.

Ensure river corridor developments are not detrimental to landscape and archaeological features.

Encourage the owners of monuments, bridges and other archaeological features on the river to ensure that they are free of damaging vegetation, and in a good state of repair.

Use existing conservation and fisheries improvement techniques to restore and enhance degraded landscapes. This can be achieved by:

- restoring more natural bank profiles,
- restoring wetland features such as ponds, oxbows, wet meadows, woodlands and reedbeds,
- restoring in-channel features such as pool and riffle sequences and aquatic vegetation,

- planting trees and shrubs to restore bankside cover.

Improve the NRA's database of Scheduled Ancient Monuments and listed buildings.

In partnership with local authorities and others, enhance town centre landscapes where opportunities for amenity use and interpretation are high, (see Issue 24), such as the old canal viaduct over Cam Brook where the local angling association have taken the lead in restoration.

Issue 30 - River structures

There are a number of river structures in the Bristol Avon Catchment which were originally installed to provide impounded reaches for past water use and amenity. Some of these are now redundant. The problems caused are that they:

1 reduce the lengths of the river where natural flows still exist,
2 can create a build up of marginal silt and the encroachment of one or two dominant aquatic plant species (eg branched bur-reed, bulrush and arrowhead),
3 can cause the loss of clean gravels which is detrimental to fisheries.

However, the removal of river structures changes the flow regime and can sometimes adversely affect conditions upstream and downstream. People who use the river may also prefer to retain an impounded, rather that a natural river reach as an amenity.

Privately owned structures may be operated very infrequently and require substantial NRA commitment for their repair and maintenance to ensure satisfactory operation under flood conditions.

New impoundments are proposed at Bristol namely the Bristol Avon Weir and the River Avon Barrage. The implications of these proposals on the ecosystem due to loss of tidal flats, deep channels, declining water quality, increased recreational pressure and the impact on fisheries are significant. There would also be a commitment for NRA Flood Defence staff to carry out maintenance.

Options

As statutory consultees liaise with the local authorities and developers over the proposed Weir and Barrage.

Review the structures on the Bristol Avon and draw up plans where appropriate to remove those that are redundant.

Work with landowners to improve the operation of other sluices.

Issue 31 - Low flows in rivers

River flows vary due to natural factors such as changes in the seasons and variations in rainfall, and generally reach their lowest point in late summer. The effects are usually most

obvious in river headwaters. Human activities such as land drainage, river engineering works, water abstraction and quarrying can affect river flows.

An example of a stream where concerns regarding low flows have been raised is St Catherine's Brook north of Bath.

The Monkswood Springs at the head of the St Catherine's Valley have been utilised as a source of water for Bath City since 1874. Wessex Water collects water from twenty three springs, which is then stored in two reservoirs at Monkswood.

In 1993 Wessex Water applied for planning permission to install engineering works to utilise their licensed abstraction from the River Avon at Newton Meadows. During the planning application process the local parish councils raised concerns that St Catherine's Brook was suffering from low flows. As a result, Wessex Water agreed to undertake a study of St Catherine's Brook, in conjunction with the NRA. The phase one report was produced in November 1993. This collated historical information and identified further survey work necessary to evaluate the extent of any low flow problems and to consider any remedial works which might be possible. Wessex Water undertook to continue the flow gauging of the brook. The NRA agreed to carry out fishery and invertebrate surveys and more frequent water quality sampling.

Options

Progress study of St Catherine's Brook.

Issue 32 - Litter

Litter is a problem in rivers and river corridors. It seriously detracts from the amenity value of the river environment especially in urban areas such as Yate and Bristol, where the problem is particularly noticeable. In rural areas there may be discarded rubbish left by anglers or walkers.

There is also the problem of litter removal which is very costly to the community. Dead animals have to be removed by the Local Authority Environmental Health Department. Although the NRA receives many complaints about litter, its removal is the responsibility of the Local Authority, unless the litter is of a polluting nature or an obstruction to flood flow. Hard rubbish such as supermarket trolleys and old bicycles have to be removed and disposed of to a licensed waste disposal facility during river dredging works. The urban watercourses, particularly Brislington Brook and Lower Bristol Frome near Eastville culvert, cause problems for Flood Defence staff.

Many types of litter can be harmful to wildlife, for example, wildfowl get caught in plastic bags and discarded fishing line.

Options

Liaise with district councils to develop better ways of dealing with litter prevention and removal, eg to encourage supermarkets to use deposit lockable trolleys. Other measures

might be the provision of adequate litter bins plus a programme for their regular emptying.

Encourage local conservation groups, youth groups, civic amenity societies etc to carry out voluntary litter picking in their local areas.

Continue or increase the programme of talks to schools by NRA Officers and emphasise the need for a litter free river environment.

Liaise with commerce and industry to solve the problem of light packaging such as plastic bags and polystyrene which is blown around in the wind.

Issue 33 - The decline of native white clawed crayfish on the Lower Bristol Avon

Historically native crayfish have been present in very large numbers on the River Avon and its tributaries for many years. Research has shown that an extensive population existed at the end of the 19th century. From the 1920s through to the 1960s a small industry existed exploiting these crayfish and such were the numbers present that they supported this industry without any noticeable decline in their numbers. Crayfish were caught using dip pan nets, held in cages and sold on to dealers where they were distributed to colleges and schools for biological studies. A small number were also sold to local hotels. Crayfish were also caught by local people for personal consumption. As a result of these activities it has been possible through local knowledge to document accurately the continuity of crayfish populations on the Bristol Avon and their impact on the local inhabitants.

In the early 1980s the Bristol Avon crayfish became infected with crayfish plague - *Aphanomyces astaci.* This fungus is an extremely virulent disease and is lethal to the native species. The infection came from an unknown source but its effect on the crayfish populations was such that it had totally destroyed them with the exception of the upstream end of the Sherston Avon and where small populations avoided infection and survived in some tributary streams. Our native crayfish occupy an important niche in the environment recycling nutrients, controlling plant growth and in the conversion of detrital and plant material into body tissue thus providing an important food source for fish, mammals and birds.

The problem of declining native crayfish populations has now become a nationwide problem affecting all the major river systems south of the Pennines. Because of this the NRA commissioned a national research project from Nottingham University to assess the impact of introductions of alien crayfish and outbreaks of crayfish plague and to formulate a strategy for the conservation of our native species. The final Project Report has been received and the Joint Nature Conservation Committee has produced an Action Plan.

Options

Review future work in the light of the recently completed research.

Once crayfish plague has infected a watercourse that has a population of native crayfish nothing can be done to prevent their demise. However crayfish plague will only survive in a watercourse if a host is present. Providing no alien crayfish such as American Signal

crayfish are present in the system, crayfish plague will eventually die out with the native populations. The NRA successfully re-introduced native crayfish back into the Tetbury Avon in 1987 and so far this re-introduced population has not become re-infected with crayfish plague and appears to be expanding. The setting up of "Noah's Ark" populations in gravel pits would ensure a plague free supply of native crayfish for any further re-introductions in suitable tributaries.

5.4. FLOOD DEFENCE

5.4.1. Flood defence targets (FD1-8) were detailed in Section 4.5. In this section the state of the catchment is assessed against these targets, issues are identified and options for action are described.

5.4.2. Managing flood defence resources

The management framework to meet target FD1 has been agreed, and the techniques are being piloted in 1995/96.

Issue 34 - Targeting flood defence resources

A fully integrated Flood Defence Management Manual and supporting system are required to improve targeting of resources to the greatest needs.

Option

A Flood Defence Management System will be introduced into the Region during 1996. Data collection is programmed for completion by March 1996.

5.4.3. Supply of flood risk advice to planning authorities

Information to planning authorities to meet target FD2 is currently provided on the basis of historic flood records and survey data. The requirements for improved information have been agreed with planning authorities.

Issues 35 - The need for flood risk data

A programme of flood risk data survey, interpretation and provision to planning authorities is necessary. This should take account of the timetable for preparation of the District Wide Local Plan(s).

Option

Pilot work on producing indicative floodplains for the Lower Bristol Avon is programmed to be completed by April 1995.

5.4.4. Urban development

The NRA's Development Control section provide input to consultation on planning applications, District Wide Local Plans, and County Structure Plans. This is channelled to the local authorities via Planning Liaison in order to meet target FD3.

Issue 36 - Inappropriate development in floodplains

Inappropriate development, particularly in floodplains, may affect standards of flood defence and damage environmental interest.

Option

The NRA aims through the District Wide Local Plans process to influence land use planning and ensure that watercourses and their floodplains can continue to pass and store flood waters now or in the future without any degradation of their ecological interest.

5.4.5. Compliance with target times for application processing

98.5% of land drainage consent and by-law applications are actually dealt with within the prescribed time, compared with the target of 100% (FD4).

Issue 37 - The need to speed up and improve application processing

Option

Provision of technical information sheets to aid applicants on the more common areas of works.

5.4.6. Maintenance - Standards of Service

As described in Section 4.5, target FD5, the formal method of assessing compliance with maintenance Standards of Service (SoS) is not yet in operation, but initial results do not suggest a large variation from current practices and frequencies, all of which have been reassessed in the last five years. The NRA Tidal Defence Survey has been completed and the SoS methodology is being introduced.

Introduction of the Flood Defence Management Framework will improve objective management of Flood Defence assets.

Asset surveys are being undertaken for Bristol Avon in 1995. River reaches will be classified in accordance with the SoS methodology by April 1995. Target standards will be compared to the current state, and differences addressed by 1996.

5.4.7. Water level management

In order to meet target FD6 Water Level Management Plans are required for those Sites of Special Scientific Interest where the NRA controls water levels, by 1998. There are no SSSI sites within the catchment where English Nature (EN) have identified a Water Level Management Plan requirement, in accordance with Ministry of Agriculture Fisheries & Food (MAFF) guidelines.

5.4.8. Flood defence improvements

The various urban flood alleviation schemes that have been carried out are shown on the map included with Section 4.5. Most fluvial schemes completed since the 1970s afford protection against a 100 year return period flood. Whilst those for Bath and Bristol introduced higher protection, tide-locking reduces the standard at Ashton Vale. Tidal schemes at Shirehampton

and Totterdown protect against 1:200 year tidal events, whilst Pill has an extra element of protection against sea level rise due to global warming.

The presence of a flood alleviation scheme does not remove entirely the risk of flooding. Whatever the level of protection afforded, there is always a risk of some event exceeding that level. In addition, no matter what type of scheme has been implemented, a continuing programme of maintenance will be required to maintain the level of protection. All existing schemes have performed satisfactorily in flood events following their construction.

To comply with target FD7 all existing flood risk locations in the catchment have been identified and flood alleviation schemes have been completed in most cases.

The remaining locations have been the subject of feasibility studies which concluded that there was no financial or environmental justification for improvements, except for Chew Magna where a scheme is proposed for 1996/97. As a result the level of protection at these locations is below standard. These are:

- Chipping Sodbury, where one commercial property at Bowling Hill and three residences at Brook Street are at risk from an event of return period in excess of 1 in 10 years due to restrictive bridge arches. These properties were last flooded in 1968.

- Frampton Cottrell, where three residences would be a risk from a 1 in 15 year return period event, a slight improvement being currently enjoyed due to the throttling of the Tubbs Bottom detention reservoir pending increased development draining to it. Last flooded in 1968.

- The Dingle, Winterbourne Down, where four properties are at risk, the lowest affected by a 1 in 5 year return period event. Properties on the opposite bank have been flood proofed.

- Frenchay village, where one industrial and eight residential properties would be affected by a 1 in 10 year return period event.

- Eastville, where improvements in 1988 did not include protection of Eastville Stadium, which is at risk from a 1 in 15 year event.

- Pye Corner, where five residences are at risk from a 1 in 20 year return period event.

- Ashton Vale, where a tunnel scheme in 1975 provided a 1 in 100 year protection for some 500 properties when the tunnel outfall to the River Avon is tide-free. However, the frequency of tide-locked conditions reduces this protection to 1 in 32 years.

- Brislington Square, where 140 commercial and residential properties were flooded in 1968. Improvements have raised protection to that from a 1 in 45 year return period event only.

- Stockwood Vale, Keynsham, where six properties were last flooded in 1979. Properties are first affected by a 1 in 10 year return period event.

- A420, Warmley, where four properties, last flooded in 1974, are outside the protection afforded by the Siston Brook Flood Alleviation Scheme, and would be affected by a 1 in 10 year return period event.

- Chew Magna, where twenty six properties are at risk from events of between 1 in 7 and 1 in 25 year return period. Property here was last affected in 1981. The NRA has proposed a scheme to be carried out in 1996/97.

- Midford, where three properties, one last flooded in 1979, are at risk from events of return periods between 1 in 10 and 1 in 20 year.

- Radstock, where a scheme completed in 1975 afforded a 1 in 20 year protection to some thirty properties.

- Welton Vale, Midsomer Norton, where a factory complex is at risk from a 1 in 20 year return period event.

- Nunney, where fifteen properties, last flooded 1972, are at risk from a 1 in 8 year return period event due to the risk of blockage of a road bridge arch.

- Farleigh Hungerford, where a 1 in 50 year event would damage six cottages, one of which is first affected by a 1 in 10 year event, last flooded in 1993.

- Wallbridge, Frome, where three residential properties and a collection of industrial units are at risk from a 1 in 5 year event, last flooded in 1992.

5.4.9. Emergency response levels of service (ERLOS)

A programme of work has been identified to develop ERLOS. The scheme is still under development.

6.0. ISSUES LIST

APPENDIX 1

STANDARDS FOR THE FIVE RIVER ECOSYSTEM USE CLASSES

Use Class	DO % sat 10%ile	BOD (ATU) mg/l 90%ile	Total Ammonia mgN/l 90%ile	Un-ionised Ammonia mgN/l 95%ile	pH 5%ile & 95%ile	Hardness mg/l $CaCO_3$	Dissolved Copper µg/l 95%ile	Total Zinc µg/l 95%ile	Class Description
1	80	2.5	0.25	0.021	6.0 - 9.0	≤10 >10 and ≤50 >50 and ≤100 >100	5 22 40 112	30 200 300 500	Water of very good quality suitable for all fish species
2	70	4.0	0.6	0.021	6.0 - 9.0	≤10 >10 and ≤50 >50 and ≤100 >100	5 22 40 112	30 200 300 500	Water of good quality suitable for all fish species
3	60	6.0	1.3	0.021	6.0 - 9.0	≤10 >10 and ≤50 >50 and ≤100 >100	5 22 40 112	300 700 1000 2000	Water of fair quality suitable for high class coarse fish populations
4	50	8.0	2.5	-	6.0 - 9.0	≤10 >10 and ≤50 >50 and ≤100 >100	5 22 40 112	300 700 1000 2000	Water of fair quality suitable for coarse fish populations
5	20	15.0	9.0	-	-	-	-	-	Water of poor quality which is likely to limit coarse fish populations

EC DIRECTIVE ON THE QUALITY OF FRESHWATERS NEEDING PROTECTING OR IMPROVEMENT IN ORDER TO SUPPORT FISH LIFE (78/659/EEC)

DETERMINAND		SALMONID WATERS 'G'	SALMONID WATERS 'I'	CYPRINID WATERS 'G'	CYPRINID WATERS 'I'
Dissolved Oxygen as mg/l 0_2 *a		100% > 7	50% > 9	100% > 5	50% > 7
pH as pH units		-	6.0-9.0	-	6.0-9.0
Suspended Solids at mg/l *b		25	-	25	-
BOD (Total) as mg/l 0_2		5	-	8	-
Nitrite as mg/l N		0.150	-	0.460	-
Non-ionised Ammonia as mg/l N		0.004	0.021	0.004	0.021
Ammonia (Total) as mg/l N		0.030	0.780	0.160	0.780
Total Residual Chlorine as mg/l HOCl		-	0.005	-	0.005
Zinc (Total) as mg/l Zn					
Water Hardness	0-50	-	0.03	-	0.30
(mg/l $CaCO_3$)	50-100	-	0.20	-	0.70
	100-250	-	0.30	-	1.00
	>250	-	0.50	-	2.00
Copper (Dissolved) as mg/l Cu					
Water Hardness	0-50	0.005	-	0.005	-
(mg/l $CaCO_3$)	50-100	0.022	-	0.022	-
	100-250	0.040	-	0.040	-
	>250	0.112	-	0.112	-

*a For dissolved oxygen, 50% median and 100% minimum standard.
*b For suspended solids, the 'G' value is an annual average concentration.

For application of these standards, reference must be made to Article 6 and the Annexes of the Directive, and the appropriate DoE Implementation Guidelines.

'G' = Guideline

'I' = Imperative

EC DANGEROUS SUBSTANCES DIRECTIVE ON POLLUTION CAUSED BY CERTAIN SUBSTANCES DISCHARGED IN THE AQUATIC ENVIRONMENT OF THE COMMUNITY, (76/464/EC)

EQSs FOR LIST I SUBSTANCES (INLAND WATERS)

Parameter	Units	Value	Status (1)
Mercury	µg Hg/l	1.0	AA,T
Cadmium (2)	µg Cd/l	5.0 1.0	AA,T AA,T,B (4)
Hexachlorocyclohexane (HCH) (2)	µg/l	0.1 0.05	AA,T AA,T,B (4)
Tetrachloromethane (CTC)	µg/l	12	AA,T
DDT (para-para DDT isomer) (2)	µg/l	0.01	AA,T
Total DDT (2)	µg/l	0.025	AA,T
Pentachlorophenol (PCP) (2)	µg/l	2	AA,T
'The Drins' (from 1 Jan 1989)	µg/l	0.03 (3)	AA,T
Aldrin (from 1 Jan 1994)	µg/l	0.01	AA,T
Dieldrin (from 1 Jan 1994)	µg/l	0.01	AA,T
Endrin (from 1 Jan 1994)	µg/l	0.005	AA,T
Isodrin (from 1 Jan 1994)	µg/l	0.005	AA,T
Hexachlorobenzene (HCB) (2)	µg/l	0.03	AA,T
Hexachlorobutadiene (HCBD) (2)	µg/l	0.1	AA,T
Chloroform	µg/l	12	AA,T
1,2-dichloroethane	µg/l	10	AA,T
Trichloroethylene	µg/l	10	AA,T
Perchloroethylene	µg/l	10	AA,T
Trichlorobenzene(TCB)	µg/l	0.4	AA,T

EQSs FOR LIST I SUBSTANCES (TIDAL WATERS)

Parameter	Units	Value	Status (1)
Mercury (2)	µg Hg/l	0.3	AA,D
Cadmium (2)	µg Cd/l	2.5	AA,D
Hexachlorocyclohexane (HCH) (2)	µg/l	0.02	AA,T
Tetrachloromethane (CTC)	µg/l	12	AA
DDT (para-para DDT isomer) (2)	µg/l	0.01	AA
Total DDT (2)	µg/l	0.025	AA
Pentachlorophenol (PCP) (2)	µg/l	2	AA
'The Drins' (from 1 Jan 1989)	µg/l	0.03 (3)	AA,T
Aldrin (from 1 Jan 1994)	µg/l	0.01	AA
Dieldrin (from 1 Jan 1994)	µg/l	0.01	AA
Endrin (from 1 Jan 1994)	µg/l	0.005	AA
Isodrin (from 1 Jan 1994)	µg/l	0.005	AA
Hexachlorobenzene (HCB) (2)	µg/l	0.03	AA
Hexachlorobutadiene (HCBD) (2)	µg/l	0.1	AA
Chloroform	µg/l	12	AA
1,2-dichloroethane	µg/l	5	AA
Trichloroethylene	µg/l	10	AA
Perchloroethylene	µg/l	10	AA
Trichlorobenzene(TCB)	µg/l	0.4	AA

Proposals have been published for the following List I substances but these have not, so far, been adopted:

Trifluralin, endosulphan, simazine, triorganotin compounds (tributyltin oxide, triphenyltin acetate, triphenyltin oxide, triphenyltin hydroxide), atrazine, organophosphorus substances (azinphos-methyl, azinphos-ethyl, fenitrothion, fenthion, malathion, parathion and parathion-methyl, dichlorvos).

Notes: (1) AA=Annual Average, T=Total, B=Background Monitoring, D= Dissolved
(2) A 'standstill' provision exists for concentrations in sediments and/or shellfish and/or fish
(3) Maximum of 0.005 for Endrin
(4) B=Background Monitoring: only applies at designated end of catchment sites

EQSs FOR LIST II SUBSTANCES (INLAND WATERS) (1)

Parameter	Units	Value (3)		Hardness (mg $CaCO_3$/l)	Status (2)
		A Std	B Std		
Lead	µg Pb/l	4	50	0 to 50	AA,D
		10	125	50 to 100	
		10	125	100 to 150	
		20	250	150 to 200	
		20	250	200 to 250	
		20	250	>250	
Chromium	µg Cr/l	5	150	0 to 50	AA,D
		10	175	50 to 100	
		20	200	100 to 150	
		20	200	150 to 200	
		50	250	200 to 250	
		50	250	>250	
Zinc	µg Zn/l	8	75	0 to 50	AA,T
		50	175	50 to 100	
		75	250	100 to 150	
		75	250	150 to 200	
		75	250	200 to 250	
		125	500	>250	
Copper	µg Cu/l	1	1	0 to 50	AA,D
		6	6	50 to 100	
		10	10	100 to 150	
		10	10	150 to 200	
		10	10	200 to 250	
		28	28	>250	
Nickel	µg Ni/l	50	50	0 to 50	AA,D
		100	100	50 to 100	
		150	150	100 to 150	
		150	150	150 to 200	
		200	200	200 to 250	
		200	200	>250	
Arsenic	µg As/l	50		All	AA,D
Boron	µg B/l	2000		All	AA,T
Iron	µg Fe/l	1000		All	AA,D
pH	pH values	6 to 9		All	95% of samples
Vanadium	µg V/l	20	20	0 to 200	AA,T
		60	60	200+	
Tributyltin	µg/l	0.02		All	M,T
Triphenyltin	µg/l	0.02		All	M,T
Polychlorochlormethyl-sulphonamidodiphenyl ether (PCSDs)	µg/l	0.05		All	T, 95% of samples
Sulcofuron	µg/l	25		All	T, 95% of samples
Flucofuron	µg/l	1.0		All	T, 95% of samples
Permethrin	µg/l	0.01		All	T, 95% of samples
Cyfluthrin	µg/l	0.001		All	T, 95% of samples

EQSs FOR LIST II SUBSTANCES (TIDAL WATERS)

Parameter	Units	Value (1)	Status
Lead	μg Pb/l	25	AA,D
Chromium	μg Cr/l	15	AA,D
Zinc	μg Zn/l	40	AA,D
Copper	μg Cu/l	5	AA,D
Nickel	μg Ni/l	30	AA,D
Arsenic	μg As/l	25	AA,D
Boron	μg B/l	7000	AA,D
Iron	μg Fe/l	1000	AA,D
pH	pH values	6 to 8.5 (3)	95% of samples
Vanadium	μg V/l	100	AA,T
Tributyltin	μg/l	0.002	M,T
Triphenyltin	μg/l	0.008	M,T
Polychlorochlormethyl-sulphonamidodiphenyl ether (PCSDs)	μg/l	0.05	T, 95% of samples
Sulcofuron	μg/l	25	T, 95% of samples
Flucofuron	μg/l	1.0	T, 95% of samples
Permethrin	μg/l	0.01	T, 95% of samples
Cyfluthrin	μg/l	0.001	T, 95% of samples

Notes:

(1) National environmental quality standards recommended for the UK.

(2) AA=Annual Average; D=Dissolved; T=Total;
M=Maximum Allowable Concentration

(3) A Std denotes standards for the protection of sensitive aquatic life
B Std denotes standards for the protection of other aquatic life

APPENDIX 4

EC DIRECTIVES CONCERNING URBAN WASTEWATER TREATMENT (91/271/EEC) AND CONCERNING THE PROTECTION OF WATERS AGAINST POLLUTION CAUSED BY NITRATES FROM AGRICULTURAL SOURCES (91/676/EEC)

Indicative standards for the identification of Sensitive Waters (Eutrophic) and Polluted Waters (Eutrophic)

INLAND WATERS

Determinand	Indicative Standard		Notes[2]
	Running Water	Still Water	
Orthophosphate (μg P/l)	>100	>50	AA
Nitrate (μg NO_3/l)	>50	>50	P, At major public water supply abstractions
Dissolved oxygen (% saturation)	>150 daytime < 50 nighttime	Excessive supersaturation in surface layers, depletion in hypolimnion	
Chlorophyll a (μg/l)	>25	>30	
Algal Biomass	>100 g/m^2	-	Excessive growth of attached algae esp. *Cladophora*
Water Clarity (m)	-	<3, predominantly green colour	AA, Secchi Disc
Water Retention Time (days)	>5	-	Sufficient retention time for algal multiplication
Effects on fauna	Reduction in abundance of fish and invertebrate fauna		Attributed to nutrient enrichment
Effects on macroflora	Substantial adverse changes in macrophyte abundance and diversity		
Effects on microflora	Exceptional increases in plankton, and/or biomass leading to blooms, scum or discolouration		Includes blue-green algae

Notes: [1] It is not necessary that adverse effects should be found in all factors. Evidence should be considered on a site specific basis.

[2] AA: Annual average (Geometric Mean) P: 95%ile (parametric)

TIDAL WATERS

Determinand	Indicative Standard		Notes
	Estuaries	Coastal Waters	
Nitrate (mg N/l)	>0.21	>0.21	Winter concentrations
Phosphorus (μg P/l)	>6.2	>6.2	DAIP[1], Winter concentrations
Chlorophyll a (μg/l)	>10	>10	
Algal Bloom Cell Density (cells/l)	$>5x10^5$	$>5x10^5$	
Dissolved Oxygen	Daytime O_2 depletion	-	Linked to algal decay NOT organic inputs from discharges
Effects on fauna	Invertebrate, shellfish, fish mortalities		NOT associated with organic pollution
Effects on macroalgae	>10 hectares (>25% of available intertidal area) in which algal cover exceeds 25%		Especially *Enteromorpha* and *Ulva*
Effects on microalgae	Presence of significant blooms leading to accumulation of scum/foam on beaches; public complaints/concern		
Estuary Flushing Times (weeks)	>1 to 2	-	

Notes: [1] DAIP Dissolved available inorganic phosphorous

The assessment of whether a stretch of water is actually or potentially eutrophic is not possible simply by reference to numeric chemical criteria, however, they do provide an indication of symptoms, and the importance of each of the criteria should be assessed on a local basis.

APPENDIX 5

EC DIRECTIVE CONCERNING THE QUALITY REQUIRED OF SURFACE WATER INTENDED FOR THE ABSTRACTION OF DRINKING WATER IN THE MEMBER STATES (75/440/EEC)

Definition of the Standard Methods of Treatment for Transforming Surface Water of Categories A1, A2 and A3 into Drinking Water

Category A1

Simple physical treatment and disinfection, eg rapid filtration and disinfection.

Category A2

Normal physical treatment, chemical treatment and disinfection, eg pre-chlorination, coagulation, flocculation, decantation, filtration, disinfection (final chlorination).

Category A3

Intensive physical and chemical treatment, extended treatment and disinfection, eg chlorination to break-point, coagulation, flocculation, decantation, filtration, absorption (activated carbon), disinfection (ozone, final chlorination).

I	=	**mandatory**
G	=	**guide**
O	=	**exceptional climatic or geographical conditions**

CHARACTERISTICS OF SURFACE WATER INTENDED FOR THE ABSTRACTION OF DRINKING WATER			CATEGORIES					
			A1		A2		A3	
PARAMETERS			G	I	G	I	G	I
1	pH		6.5 to 8.5	-	5.5 to 9	-	5.5 to 9	-
2	Coloration (after simple filtration)	mg/l Pt scale	10	20 (0)	50	100 (0)	50	200 (0)
3	Total suspended solids	mg/l SS	25	-	-	-	-	-
4	Temperature	°C	22	25 (0)	22	25 (0)	22	25 (0)
5	Conductivity	$\mu s/cm^{-1}$ at 20°C	1000	-	1000	-	1000	-
6	Odour	(dilution factor at 25°C)	3	-	10	-	20	-
7	Nitrates	mg/l NO_3	25	50 (0)	-	50 (0)	-	50 (0)
8	Fluorides	mg/l F	0.7 to 1	1.5	0.7 to 1.7	-	0.7 to 1.7	-
9	Total extractable organic chlorine	mg/l Cl	-	-	-	-	-	-
10	Dissolved Iron	mg/l Fe	0.1	0.3	1	2	1	-
11	Manganese	mg/l Mn	0.05	-	0.1	-	1	-
12	Copper	mg/l Cu	0.02	0.05 (0)	0.05	-	1	-
13	Zinc	mg/l Zn	0.5	3	1	5	1	5
14	Boron	mg/l B	1	-	1	-	1	-
15	Beryllium	mg/l Be	-	-	-	-	-	-
16	Cobalt	mg/l Co	-	-	-	-	-	-
17	Nickel	mg/l Ni	-	-	-	-	-	-
18	Vanadium	mg/l V	-	-	-	-	-	-

CHARACTERISTICS OF SURFACE WATER INTENDED FOR THE ABSTRACTION OF DRINKING WATER			CATEGORIES					
			A1		A2		A3	
PARAMETERS			G	I	G	I	G	I
19	Arsenic	mg/l As	0.01	0.05	-	0.05	0.05	0.1
20	Cadmium	mg/l Cd	0.001	0.005	0.001	0.005	0.001	0.005
21	Total Chromium	mg/l Cr	-	0.05	-	0.05	-	0.05
22	Lead	mg/l Pb	-	0.05	-	0.05	-	0.05
23	Selenium	mg/l Se	-	0.01	-	0.01	-	0.01
24	Mercury	mg/l Hg	0.0005	0.001	0.0005	0.001	0.0005	0.001
25	Barium	mg/l BA	-	0.1	-	1	-	1
26	Cyanide	mg/l Cn	-	0.05	-	0.05	-	0.05
27	Sulphates	mg/l SO_4	150	250	150	250 (0)	150	250 (0)
28	Chlorides	mg/l Cl	200	-	200	-	200	-
29	Surfactants (reacting with methyl blue)	mg/l (laurylsulphate)	0.2	-	0.2	-	0.5	-
30	Phosphates	mg/l P_2O_5	0.4	-	0.7	-	0.7	-
31	Phenols (phenol index) paranitraniline 4 aminoantipyrine	mg/l C_6H_5OH	-	0.001	0.001	0.005	0.01	0.1
32	Dissolved or emulsified hydrocarbons (after extraction by petroleum ether)	mg/l	-	0.05	-	0.2	0.5	1
33	Polycyclic aromatic hydrocarbons	mg/l	-	0.0002	-	0.0002	-	0.001

CHARACTERISTICS OF SURFACE WATER INTENDED FOR THE ABSTRACTION OF DRINKING WATER			CATEGORIES					
			A1		A2		A3	
PARAMETERS			G	I	G	I	G	I
34	Total pesticides (parathion, BHC, dieldrin)	mg/l	-	0.001	-	0.0025	-	0.005
35	Chemical oxygen demand (COD)	mg/l 0_2	-	-	-	-	30	-
36	Dissolved oxygen oxygen saturation rate	% 0_2	>70	-	>50	-	>30	-
37	Biochemical oxygen demand (BOD_5) (at 20 °C with nitrification)	mg/l 0_2	<3	-	<5	-	<7	-
38	Nitrogen by Kjeldahl method (except NO_3)	mg/l N	1	-	2	-	3	-
39	Ammonia	mg/l NH_4	0.05	-	1	1.5	2	4(0)
40	Substances extractable with chloroform	mg/l SEC	0.1	-	0.2	-	0.5	-
41	Total organic carbon	mg/l C	-	-	-	-	-	-
42	Residual organic carbon after flocculation and membrane filtrations (5 μ) TOC	mg/l C	-	-	-	-	-	-
43	Total coliforms 37 °C	/100 ml	50	-	5000	-	50000	-
44	Faecal coliforms	/100 ml	20	-	2000	-	20000	-
45	Faecal streptococci	/100 ml	20	-	1000	-	10000	-
46	Salmonella		Not present in 5000 ml	-	Not present in 1000 ml	-	-	-

3RD NORTH SEA CONFERENCE - PRIORITY HAZARDOUS SUBSTANCES (ANNEX 1A LIST OF SUBSTANCES)

Mercury
Cadmium
Copper
Zinc
Lead
Arsenic
Chromium
Nickel
Aldrin
Dieldrin
Endrin
Isodrin
HCH
DDT
Pentachlorophenol
Hexachlorobenzene
Hexachlorobutadiene
Carbon tetrachloride
Chloroform
Endosulphan
Trifluralin
Simazine
Atrazine
Triorganotin compounds
Azinphos-ethyl
Azinphos-methyl
Fenitrothion
Fenthion
Malathion
Parathion
Parathion-methyl
Dichlorvos
Trichloroethylene
Tetrachloroethylene
1,1,1-trichloroethane
Trichlorobenzene
1,2-dichloroethane
Polychlorinated biphenyls
Dioxins (*)

At the 3rd North Sea Conference, the UK Government undertook to reduce loadings (flow x concentration) of the 'Annex 1A' list of substances except dioxins (*) entering UK tidal waters from rivers and direct discharges by 50% (70% for Hg, Cd, Pb) by 1995, against a 1985 baseline.

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

EXTRACTS

Article 1

1. The purpose of this Directive is to prevent the pollution of groundwater by substances belonging to the families and groups of substances in List I or II in the Annex, hereinafter referred to as 'substances in Lists I or II', and as far as possible to check or eliminate the consequences of pollution which has already occurred.

2. For the purposes of this Directive:

   (a) 'groundwater' means all water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil;

   (b) 'direct discharge' means the introduction into groundwater of substances in Lists I or II without percolation through the ground or subsoil;

   (c) 'indirect discharge' means the introduction into groundwater of substances in Lists I or II after percolation through the ground or subsoil;

   (d) 'pollution' means the discharge by man, directly or indirectly, of substances or energy into groundwater, the results of which are such as to endanger human health or water supplies, harm living resources and the aquatic ecosystem or interfere with other legitimate uses of water.

Article 3

Member States shall take the necessary steps to:

   (a) prevent the introduction into groundwater of substances in List I; and

   (b) limit the introduction into groundwater of substances in List II so as to avoid pollution of this water by these substances.

ANNEX

LIST I OF FAMILIES AND GROUPS OF SUBSTANCES

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

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

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

2 Organophosphorus compounds.

3 Organotin compounds.

4 Substances which possess carcinogenic mutagenic or teratogenic properties in or via the aquatic environment([1]).

5 Mercury and its compounds.

6 Cadmium and its compounds.

7 Mineral oils and hydrocarbons.

8 Cyanides.

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[1] Where certain substances in List II are carcinogenic, mutagenic or teratogenic, they are included in category 4 of this list.

ANNEX Continued

LIST II OF FAMILIES AND GROUPS OF SUBSTANCES

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

1 The following metalloids and metals and their compounds:

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

2 Biocides and their derivatives not appearing in List I.

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

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

5 Inorganic compounds of phosphorus and elemental phosphorus.

6 Fluorides.

7 Ammonia and nitrites.

EC DIRECTIVE 'CONCERNING THE PROTECTION OF WATERS AGAINST POLLUTION CAUSED BY NITRATES FROM AGRICULTURAL SOURCES' (91/676/EEC)

(Directive notified in December 1991)

EXTRACTS (SEE ALSO APPENDIX 4)

Article 1

This Directive has the objective of:-

- reducing water pollution caused or induced by nitrates from agricultural sources and

- preventing further such pollution.

Article 3

1 Waters affected by pollution and waters which could be affected by pollution if action under Article 5 is not taken shall be identified by the Member States in accordance with the criteria set out in Annex 1.

2 Member States shall, within a two-year period following the notification of this Directive, designate as vulnerable zones all known areas of land in their territories which drain into the waters identified according to paragraph 1 and which contribute to pollution. They shall notify the Commission of this initial designation within six months.

3 When any waters identified by a Member State in accordance with paragraph 1 are affected by pollution from waters from another Member State draining directly or indirectly into them, the Member State whose waters are affected may notify the other Member State and the Commission of the relevant facts.

The Member States concerned shall organize, where appropriate with the Commission, the concertation necessary to identify the sources in question and the measures to be taken to protect the waters that are affected in order to ensure conformity with this Directive.

4 Member States shall review and if necessary revise or add to the designations of vulnerable zones as appropriate, and at least every four years, to take into account changes and factors unforeseen at the time of the previous designation. They shall notify the Commission of any revision or addition to the designations within six months.

5 Member States shall be exempt from the obligation to identify specific vulnerable zones, if they establish and apply action programmes referred to in Article 5 in accordance with this Directive throughout their national territory.

Article 6

1 For the purpose of designating and revising the designation of vulnerable zones, Member States shall:

(a) within two years of notification of the Directive (December 1993), monitor the nitrate concentration in freshwaters over a period of one year:

(i) at surface water sampling stations, laid down in Article 5(4) of Directive 75/440/EEC and/or at other sampling stations which are representative of surface waters of Member States, at least monthly and more frequently during flood periods;

(ii) at sampling stations which are representative of the groundwater aquifers of Member States, at regular intervals and taking into account the provisions of Directive 80/778/EEC;

(b) repeat the monitoring programme outlined in (a) at least every four years, except for those sampling stations where the nitrate concentration in all previous samples has been below 25 mg/l and no new factor likely to increase the nitrate content has appeared, in which case the monitoring programme need be repeated only every eight years;

(c) review the eutrophic state of their fresh surface waters, esturial and coastal waters every four years.

ANNEX 1 - CRITERIA FOR IDENTIFYING WATERS REFERRED TO IN ARTICLE 3(1)

A Waters referred to in Article 3(1) shall be identified making use, inter alia, of the following criteria:

(1) whether surface freshwaters, in particular those used or intended for the abstraction of drinking water, contain or could contain, if action under Article 5 is not taken, more than the concentration of nitrates laid down in accordance with Directive 75/440/EEC;
(2) whether groundwaters contain more than 50 mg/l nitrates or could contain more than 50 mg/l nitrates if action under Article 5 is not taken;
(3) whether natural freshwater lakes, other freshwater bodies, estuaries, coastal waters and marine waters are found to be eutrophic or in the near future may become eutrophic if action under Article 5 is not taken.

B In applying these criteria, Member States shall also take account of:

(1) the physical and environmental characteristics of the waters and land;
(2) the current understanding of the behaviour of nitrogen compounds in the environment (water and soil);
(3) the current understanding of the impact of the action taken under Article 5.

APPENDIX 9

CHEMICAL COMPONENT OF THE GENERAL QUALITY ASSESSMENT SCHEME FOR RIVERS AND CANALS

Grade	Dissolved Oxygen % Saturation	BOD (ATU) mg/l	Total Ammonia mg N/l
	10 percentile	90 percentile	90 percentile
A	80	2.5	0.25
B	70	4	0.6
C	60	6	1.3
D	50	8	2.5
E	20	15	9.0
F	<20	-	-

APPENDIX 10

Pollution Incident Categories

Category 1

A major incident involving one or more of the following:

a) potential or actual persistent effect on water quality or aquatic life;

b) closure of potable water, industrial or agricultural abstraction necessary;

c) extensive fish kill;

d) excessive breaches of consent conditions;

e) extensive remedial measures necessary;

f) major effect on amenity value.

Category 2

A significant pollution which involves one or more of the following:

a) notification to abstractors necessary;

b) significant fish kill;

c) measurable effect on invertebrate life;

d) water unfit for stock;

e) bed of watercourse contaminated;

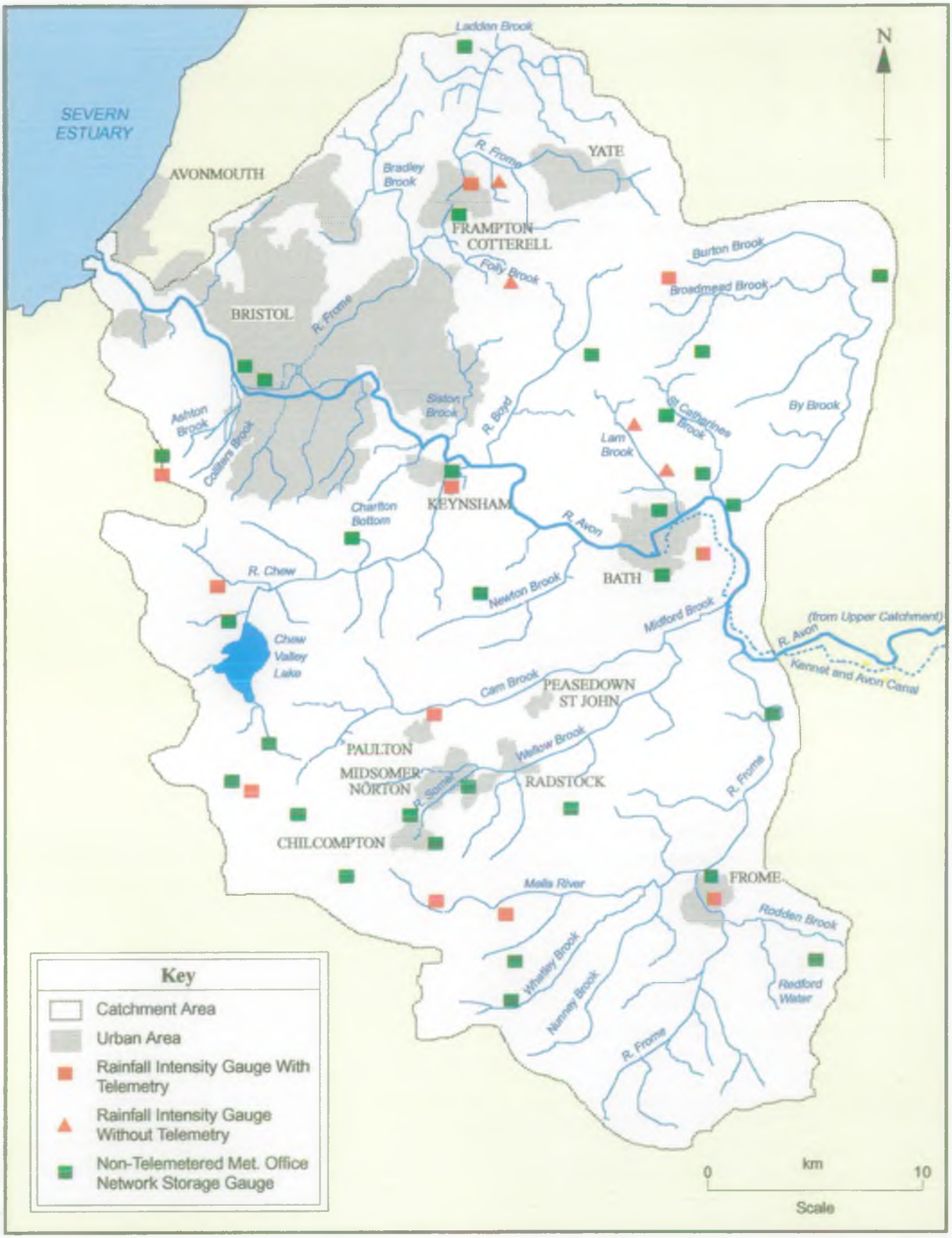
f) amenity value to the public, owners or users reduced by odour or appearance.

Category 3

Minor

Suspected or probable pollution which on investigation proves unlikely to be capable of substantiation or to have no notable effect.

LOWER BRISTOL AVON
Locations of Rainfall Measurement Gauges



NATURE CONSERVATION AND ARCHAEOLOGICAL DESIGNATIONS

Area of Outstanding Natural Beauty (AONB)
Designated by the Countryside Commission under the National Parks and Access to the Countryside Act 1949, to conserve and enhance the natural beauty of the landscape, mainly through Planning controls.

Local Nature Reserve (LNR)
Nature reserves established, and usually managed, by district/borough councils. Local authorities are empowered to designate such sites under the National Parks and Access to the Countryside Act 1949.

National Nature Reserve (NNR)
Sites owned or leased and managed by English Nature and established as reserves under the National Parks and Access to the Countryside Act 1949.

RAMSAR sites
Sites identified by UK Government under the Convention on Wetlands of International Importance which was ratified by the UK Government in 1976.

Scheduled Ancient Monument (SAM)
Sites of national importance designated under the Ancient Monuments and Archaeological Areas Act 1979.

Sites of Nature Conservation Interest (SNCI)
Sites selected (usually by County Wildlife Trusts) as sites of 'County' ecological importance.

Sites of Special Scientific Interest (SSSI)
Sites of national importance designated under the Wildlife and Countryside Act 1981. Usually in private ownership, habitats, sites for individual species, geology and land forms may be designated.

Special Landscape Areas (SLAs)
Areas of special landscape quality, designated by the County (ie not nationally endorsed), justifying the adoption, by the County, of particular development control policies and other safeguarding measures.

Special Protection Areas (SPAs)
Sites identified by UK Government under the EC Directive on the Conservation of Wild Birds (79/409/EC).

World Heritage Site
Designated by UNESCO for their international importance.

Sites and Monuments Record
Sites and features of County importance selected by the County Council.

Listed Building
Listed by the Department of National Heritage on advice from English Heritage.

Conservation Areas
Designated by local authorities, normally to protect a group of, or setting for listed buildings.

GLOSSARY

Aardvark	Water Quality data statistical analysis package
AOD	Above Ordnance Datum
AONB	Area of Outstanding Natural Beauty. Designated by the Countryside Commission under the National Parks and Access to the Countryside Act 1942, to conserve and enhance the natural beauty of the landscape, mainly through Planning controls
Aquifer	Rock which holds substantial amounts of water in structure or fissures eg chalk, sandstones, limestones
Bed Loss	Loss of water through a permeable stream bed
BOD	Biochemical Oxygen Demand
BOD(ATU)	Biochemical Oxygen Demand with nitrification suppressed by allylthiourea
Brown Field Site	Piece of land in rural context that has been subjected to some sort of development, eg airfield, tip etc
Buffer Zone	Strip of land, 10-100m wide, alongside rivers which is removed from intensive agricultural use and managed to provide appropriate habitat types. Benefits include reduction of inputs into the river such as silt, nutrients, livestock waste, as well as improving habitat diversity and landscape
Calcareous	Of, or containing, carbonate of lime or sandstone
Carcinogenic	Cancer causing
CDP	Catchment Drainage Plan
CMP	Catchment Management Plan
Coarse fish	This is a lay-man's term for cyprinid fish and other commonly associated species such as pike, perch and eels of angling significance. Does not normally refer to minor species such as bullhead, stone loach, minnow and stickleback
Consent (Discharge Consent)	A legal document raised by the National Rivers Authority which specifies the conditions under which a discharge may be made
Containment Bund	An earth bank intended to retain liquids
CSO	Combined sewer overflow. A combined sewer is one which takes both surface and foul drainage - usually in older developments

Cyprinid	Fish of the family Cyprinidae (eg roach, bream, carp, chub). In the strict sense pike, perch, eel and some other fish species are not cyprinids
Derogate	Loss or impairment of water resource, action causing such loss or impairment
DO	Dissolved Oxygen
DoE	Department of the Environment
DWLP	District Wide Local Plan
Dry Weather Flow (DWF)	When sewage flow is mainly domestic in character, the average daily flow to the treatment works during seven consecutive days without rain (excluding a period which includes public or local holidays) following seven days during which the rainfall did not exceed 0.25mm on any one day. With an industrial sewage the dry-weather flow should be based on the flows during five working days if production is limited to that period. Preferably, the flows during two periods in the year, one in the summer and one in the winter, should be averaged to obtain the average dry-weather flow
EIFAC	European Inland Fisheries Advisory Commission
ESA	Environmentally Sensitive Area (MAFF scheme)
Eutrophication	Nutrient enrichment of water, eg increased nitrogen input leaching into rivers from soil treated with chemicals, this chemical enrichment resulting in increased productivity
"Flashy"	Watercourse which has a rapid response to rainfall. Typically has long periods of low flows and high flows may be several hundred times low flow
Foundered strata	Geological term - normal succession of rock types is disturbed by large scale collapses
Geomorphological	The natural processes which produce river features such as channel form
Groundwater	Underground water that has come mainly from the seepage of surface water and is held in the soil and in pervious rocks
HMIP	Her Majesty's Inspectorate of Pollution
IFE	Institute of Freshwater Ecology
Improved Pasture	Regularly reseeded grassland on which fertilizers and herbicides are typically applied

LNR	Local Nature Reserve. Nature reserves established, and usually managed, by district/borough councils. Local authorities are empowered to designate such sites under the National Parks and Access to the Countryside Act 1949
Macrophyte	Plants clearly visible without the aid of a microscope but excluding lichens, fungi, mosses and algae
MAFF	Ministry of Agriculture, Fisheries and Food
Marly	Rock type made up of marl - a calcareous mudstone
Mutagenic	Causing genetic change which when transmitted to offspring causes heritable abnormal variation
MOD	Ministry of Defence
NNR	National Nature Reserve. Sites owned or leased and managed by English Nature and established as reserves under the National Parks and Access to the Countryside Act 1949
Non-Salmonid	See Salmonid - fish not belonging to the salmonid family ie coarse fish and minor species
NRA	National Rivers Authority
NSA	Nitrate Sensitive Area
Nutrient	Chemical essential for plant growth, eg nitrate, phosphate
NVZ	Nitrate Vulnerable Zone
Odonata	Group of insects comprising dragonflies and damselflies
Percentile	One of 99 values of a variable dividing its distribution into 100 groups with equal frequencies
Population Equivalent (pe)	The volume and strength of an industrial waste water expressed in terms of an equivalent population, based upon a figure of 0.060 kilogramme BOD per capita per day; the population equivalent of an industrial waste water is therefore calculated using the relationship: $\text{population equivalent} = \frac{\text{5-day BOD (mg/l) x flow}(m^3/d)}{0.060 \times 10^3}$
Prescribed Minimum Flow (pmf)	Prescribed minimum flow is the low flow which is used to control abstractions to prevent adverse impact on other users, the environment or water quality

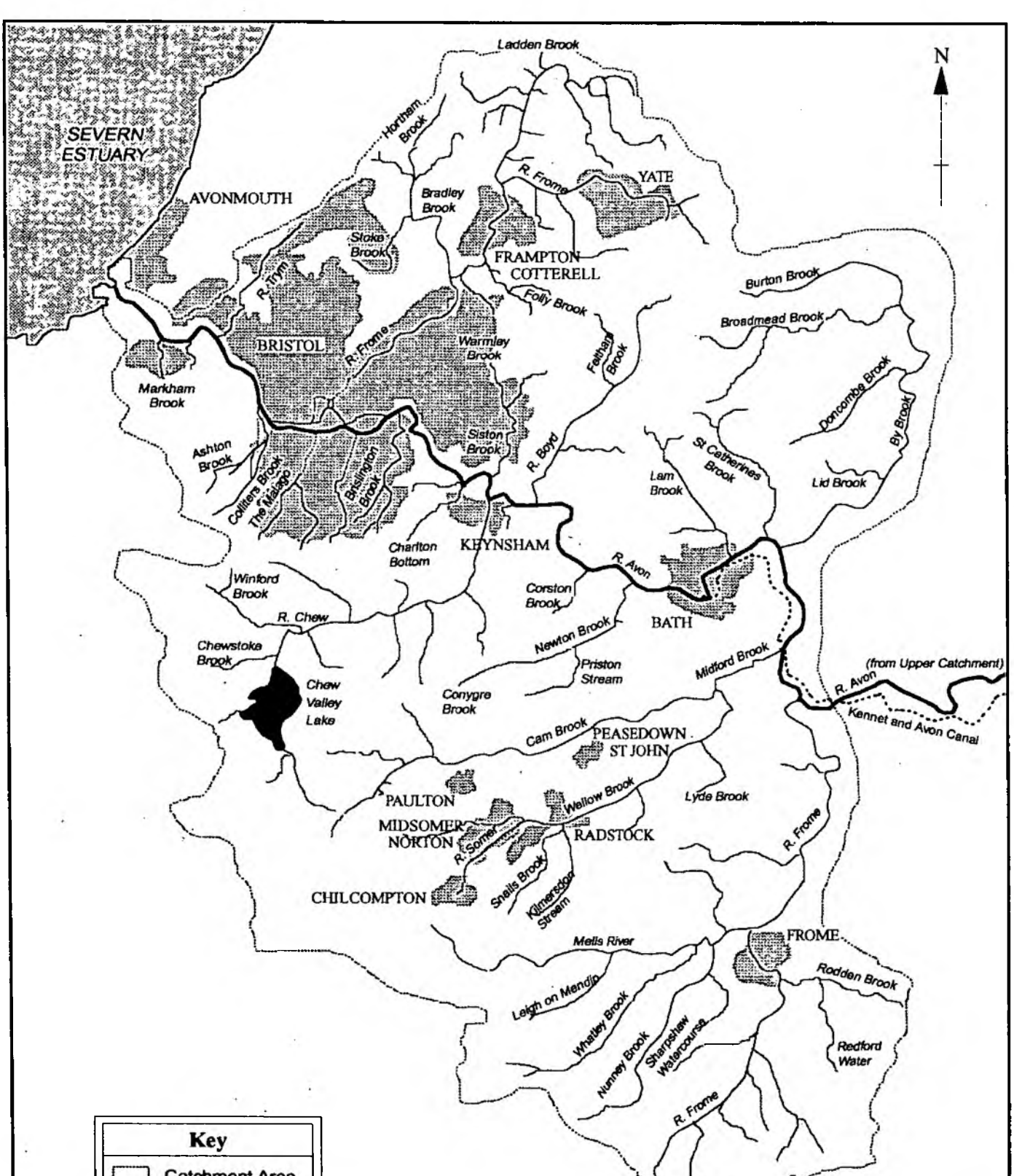
Primary Porosity	A measure of the capacity of a rock to store water in natural intergranular voids
PSA	Property Services Agency
RAMSAR sites	Sites identified by UK Government under the Convention on Wetlands of International Importance which was ratified by the UK Government in 1976
Riffle	Stony or gravelly part of stream or river bed shallow in dry flow (opposite of pool). Fast streams on most non-chalk areas have alternating riffles and pools
Riparian Owner	Owner of land next to river; normally owns river bed and rights to mid-line of channel
Salmonid	Fish belonging to the family Salmonidae (salmon, trout, grayling)
SAM	Scheduled Ancient Monument. Sites of national importance designated under the Ancient Monuments and Archaeological Areas Act 1979
Semi-Improved Pasture	Reseeded or undisturbed grassland which contains some species typical of unimproved pasture. Receives relatively little artificial fertilizers or herbicides
SLA	Special Landscape Area. Areas of special landscape quality, designated by the County (ie not nationally endorsed), justifying the adoption, by the County, of particular development control policies and other safeguarding measures
SNCI	Sites of Nature Conservation Interest. Sites selected (usually by County Trusts) as sites of 'County' ecological importance
Source	Point of abstraction of water, eg well, borehole, spring
SPA	Special Protection Area. Sites identified by UK Government under the EC Directive on the Conservation of Wild Birds (79/409/EC)
Special Landscape Area	A non-statutory designation used by County Planning Authorities
SSSI	Site of Special Scientific Interest. Sites of national importance designated under the Wildlife and Countryside Act 1981. Usually in private ownership, habitats, sites of individual species, geology and land forms may be designated
STW	Sewage Treatment Works
Substrate	Material making up bed and underwater part of banks of stream. Gravels, silts etc

Surface Water	General term used to describe all the water features such as rivers, streams, springs, ponds and lakes
SWQO	Statutory Water Quality Objectives
Teratogenic	Causing abnormal monster growth in organisms
Unimproved Pasture	Permanent grassland which has not been disturbed for many decades and typically receives no artificial fertilizers or herbicides. Rich in grasses, sedges and flowers
Unsaturated Zone	That part of an aquifer, above the water table, in which cracks, fissures and other large voids are normally air-filled
Weil's Disease	Also known as Leptospirosis - disease associated with rats' urine. Infection can enter through broken skin or eyes, nose, mouth, etc. River users may be at risk
WOAD	Welsh Office Agriculture Department
WQO	Water Quality Objective
WWS	Wessex Water Services

Units

%ile	Percentile
%sat	% saturation (of oxygen)
mg/l	Milligrams per litre
m^3/d	Cubic metres per day
Ml/a	Megalitres per year (one million litres per year)
Ml/d	Megalitres/day (one million litres per day)

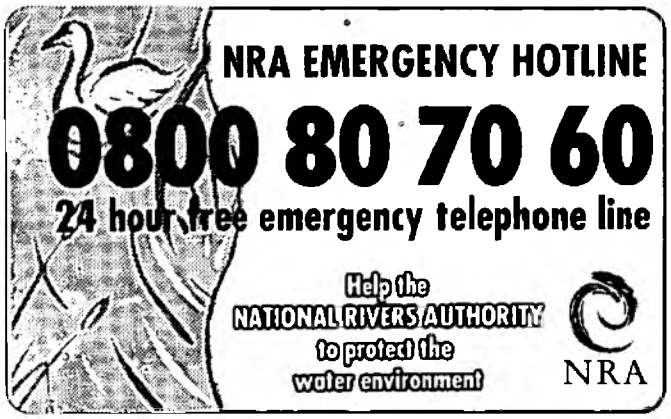
LOWER BRISTOL AVON
All Rivers



Telephone the emergency hotline to report all environmental incidents, such as pollution, poaching and flooding, or any signs of damage or danger to our rivers, lakes and coastal waters. Your prompt action will help the NRA to protect water, wildlife, people and property.

NRA Emergency Hotline

0800 80 70 60



Further copies can be obtained from:

Alan Turner
North Wessex Area Catchment Planner
NRA South Western Region
Rivers House
East Quay
BRIDGWATER
Somerset
TA6 4YS

Tel: Bridgwater (01278) 457333 Ext 4765

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