

**NATIONAL RIVERS AUTHORITY/PO RIVER BASIN AUTHORITY
COLLABORATION PROGRAMME
'IMPROVED MONITORING SYSTEMS FOR RIVER QUALITY'**

**SECRETARIAT MEETING
PARMA 13-15 DECEMBER 1995**

PROGRAMME AND BRIEFING NOTES

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ENVIRONMENT AGENCY



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NATIONAL RIVERS AUTHORITY/PO RIVER BASIN AUTHORITY

COLLABORATION PROGRAMME

'IMPROVED MONITORING SYSTEMS FOR RIVER QUALITY'

SECRETARIAT MEETING

13-15 December 1995

At Po Authority Offices, Parma Italy

Participants

Giuseppe Caggiati	PoRA	Ian Adams	NRA
Felicita Coscioni	PoRA	Mike Owen	NRA
Francesca Ferrari	PoRA	Jane Kinniburgh	NRA
Mario Giannini	PoRA	David Jowett	NRA
Domenico Piazza	PoRA	Robin Wyatt	WRc
Angelo Pizzarotti	PoRA	John Davis	WRc
Luigi Ciarmatori	Hydrographic Service of Parma		
Giuseppe Chiaudani	University of Milano		
Marcello Benedini	IRSA		
Giuseppe Giuliano	IRSA		

Programme

Wednesday 13 December

1200 NRA/WRc party depart LHR Flight BA566

1455 Arrive Milan Linate

1705 Intercity train from Milan to Parma

1811 Arrive Parma

Overnight accommodation at Hotel Stendahl

Thursday 14 December

Note: Professor Passino will be available on this day only. It is intended therefore that brief overviews of each topic will be presented identifying the key issues to be resolved. Follow-up discussions will take place on Friday

0830 Institutional Issues

(i) Minimum Acceptable Flows

(ii) Other issues

- latest situation on establishment of Environment Agencies in UK and Italy
- Update on the European Topic Centre on Inland Waters

1400 Collaboration programme on monitoring

(i) Progress on main collaboration programme

- Actions arising from previous Steering Group Meeting
- English/Italian versions of the draft Manual of Best Practice
- Framework Document

(ii) Future programme

- Stage 3/4 Evaluation Programme and final production of Manual of Best Practice
- Staff exchanges between UK and Italy Agencies during evaluation programme

(iii) Other issues

- Links with European Environment Agency
- Arrangements for next Steering Group meeting in UK
- STREAM proposal
- Monitoring Taylor-made II Conference
- Metropolitan Areas and Rivers Conference, Rome
- Future R&D needs

Friday 15 December

0735 Ian Adams and Mike Owen return to UK 1140 Flight to LHR BA565.
(Alternative arrangements will be made if necessary)

0830 Follow up discussions on Institutional issues and the collaboration programme on monitoring

1400 NRA/WRc party leave Parma for Milan by Intercity train

1910 Flight to LHR BA569

BRIEFING NOTES

MINIMUM ACCEPTABLE FLOWS: NRA POSITION

1. LEGISLATIVE BACKGROUND

National statute law has been in place in England (and Wales) specifically for the management of water resources since 1963. It has been covered by several different Acts of Parliament since that time but the basic principles have remained unaltered.

Under this legislation the abstraction (taking) of water is controlled by licences issued by the regulatory authority which, since 1989, has been the NRA. Nearly all abstractions, for whatever purpose and from whatever source, river, lakes or groundwater, are licensable. The only significant type not licensable is the abstraction of water from rivers for navigation canals.

Since its inception, the English water resources law has included the principle of 'Minimum Acceptable Flow' (MAF). MAF's were originally conceived as a planning tool for the control of abstraction in catchments where it was already high. They would be statutory (ie, once determined, protected in law) and determined by a process of consultation with interested organisations.

The law directs that a MAF shall be set to:

- protect public health (dilution of effluents)
- protect existing lawful users
 - abstraction (for public supply, industry, agriculture)
 - navigation
 - hydropower
 - fisheries
- take account of environmental needs
 - conservation of flora and fauna
 - amenity and recreation

There is, however, no guidance on how these needs should be assessed and in fact no statutory MAF's have ever been set in the 30 years that the law has been in force, either by the NRA or the previous regulatory authorities. The main difficulty has been seen as evaluating in-stream environmental needs, in particular the flow and depth requirements to maintain habitats for appropriate plant and animal life, including fish.

2. RECENT DEVELOPMENTS IN THE NRA

Recognising that it had inherited an unsatisfactory situation and that the principle of MAF's should not be avoided any longer, the NRA embarked on two main initiatives:

- A review of the concept of MAF and the derivation of policy
- The development of techniques for determining in-stream needs for fish and other wildlife

These were seen as the two main areas of deficiency that had to be addressed before the NRA could set a course of action to deal comprehensively with the issue.

2.1 MAF Concept and Policy

A very recently completed study (Ref. 1) recommends that formal Statutory MAF's should be preceded by informal River Flow Objectives (RFO's). These will be based on use-related targets - targets for abstraction, dilution, in-stream ecology etc. RFO's must define a flow regime, not only magnitude but also seasonal timing, duration and frequency.

Targets for various uses and the complexity of the RFO rules will vary for different types of river. A system for classifying rivers is therefore required and is currently being pursued through other work.

The development of techniques for determining ecological objectives is seen as a priority and an approach defining an Ecologically Acceptable Flow Regime is proposed. This would comprise a range of target flows, which would be seasonally variable, and include a minimum threshold to sustain biota in extreme drought and high flows to maintain habitat diversity.

It is also recognised that economic factors must be considered. Under the new environment Act 1995, the NRA (the Environment Agency from April 1996) has to take into account the costs and benefits of its decisions. This may lead to a modification of the system for charging for licences to one which includes greater incentives to move or reduce abstractions which damage the environment.

2.2 Determination of In-Stream Needs

Before the study mentioned above had started it had already been recognised that the lack of scientifically based techniques in Britain for determining in-stream ecological needs was a major problem. Early in the NRA's life therefore research work was started on developing such techniques. Several pieces of work should be mentioned here.

Substantial progress has been made in adapting a technique called PHABSIM (Ref. 2) which was developed in the USA and is well established there. It is a software system comprising a suite of numerous programs which can be combined as required. Essentially it is used to calculate physical habitat availability from field measurements at a given site from hydraulic parameters for a target species. This information can then be combined with the flow record to synthesize habitat variation with flow and predict for example when low flows will start to cause reduction or ultimately total loss of habitat for the species. The technique has been most successfully applied to fish, particularly salmonids, but can be used with invertebrates and macrophytes. Potentially it is a powerful scientific tool but can be labour intensive and needs expert training.

Several studies have been carried out in recent years in the Anglian Region of the NRA looking at the interaction between flow and ecology on small groundwater fed rivers. This work has considered both minimum flows and the total flow regime and has sought to develop the use of invertebrates as well as fish leading to a suite of ecological flow standards which may ultimately be based on simple hydrological statistics. This approach would be much quicker to apply than PHABSIM but its validity for other river types would need development.

Pending the full development of scientifically robust techniques to determine ecological flow requirements, the NRA has recently produced an interim empirical approach. This is incorporated in a new policy (Ref. 3) for determining licences for abstractions direct from rivers. At present, in-stream needs in this policy are based on a consensus of opinion from relevant groups inside and outside the NRA. The basic procedure for this policy will remain fixed but when more scientific methods for determining in-stream needs are available they can be substituted for the empirical approach.

3. FUTURE PROGRAMME

From the study of MAF concept and policy and from the experience of practitioners it has always been clear that the development of a comprehensive and scientifically robust approach would take considerable time. The study envisages that a programme for full implementation of a system of informal RFO's and, where appropriate, formal statutory MAF's would take more than 10 years. A possible framework is summarised in the table below.

TIMESCALE	DEVELOP RFO	PROMOTE STATUTORY MAF
SHORT TERM (0-5 years)	<ul style="list-style-type: none"> - for test priority catchments including <ul style="list-style-type: none"> • catchments with severe artificial low flows • catchment with flow-related quality problem • estuary - Preparation for Primary Control point RFO's 	<ul style="list-style-type: none"> - Commence process for test catchments - Promote statutory MAF for selected case(s) (Phase 1)
MEDIUM TERM (5-10 years)	<ul style="list-style-type: none"> - Complete primary/secondary control point RFO development 	<ul style="list-style-type: none"> - Further statutory MAFs based on policy review at Year 5 (Phase 2)
LONG TERM (> 10 years)	<ul style="list-style-type: none"> - Complete tertiary and other RFO hierarchy 	<ul style="list-style-type: none"> - Further statutory MAFs (Phase 3)

It is likely that statutory MAF's will be set only for priority catchments where there are existing or imminent ecological or quality problems due to low flows, including the estuary. Informal RFO's may ultimately be defined for all rivers and for several reaches if the river type changes. Ecological objectives and other use-related flow targets would be defined through the structured catchment management planning process of the NRA. Within this process RFO/MAF may be linked with the setting of Water Quality Objectives. Together with flood protection standards these would provide the 'hard' parameters for setting action plans to achieve the ultimate vision for the catchment.

4. CONCLUSION

The setting of formal Minimum Acceptable Flows of informal River Flow Objectives is now seen by the NRA as essential for the proper management of water resources. These standards are needed to ensure protection of environmental needs when authorising further abstraction or seeking to reduce abstraction where problems due to low flow already exist. The development and implementation of a technically and politically robust policy over the whole of England (and Wales) is expected to take more than 10 years.

M Owen
4 December 1995

Selected References

1. Determination of Minimum Flow 1995.
University of Birmingham. (Draft NRA R&D Note).
2. Ecologically Acceptable Flows. 1993.
Institute of Hydrology and Institute of Freshwater Ecology. NRA R&D Note 185.
3. Surface Water Abstraction Licensing Policy Development 1995.
Sir William Halcrow & Partners. NRA R&D Note 438.

COLLABORATION PROGRAMME - PROGRESS TO DATE

1. INTRODUCTION

The agreement between the NRA and the Po River Basin Authority to collaborate in the area of environmental monitoring was signed in December 1993. It has the specific objective of producing best practice guidelines for undertaking planning, design and operating of river water quality monitoring programmes.

The collaboration is based on two core programmes currently being undertaken in the NRA and the Po River Basin Authority consisting of four main Stages. These cover a review of the current situation regarding monitoring in the two Authorities to identify best practice; evaluating this best practice in test catchments (two in the UK, two in Italy); and compiling the findings as Manuals of Best Practice with supporting software tools for practical use within each Authority. The key stages of the work programmes are given below with the latest, updated programme timetable shown in Figure 1.

- Stage 1 Review of current monitoring activities and needs.
- Stage 2 Development of procedures for evaluating the effectiveness of existing monitoring, selection of test catchments and producing draft Manuals of Best Practice.
- Stage 3 Application and evaluation of the draft Manuals of Best Practice.
- Stage 4 Produce final Manuals of Best Practice.

The minutes of the Steering Group Meeting held in Parma in May 1995 are given in Appendix A

2. PROGRESS TO DATE

2.1 Stage 1

Review of monitoring needs and comparison of experiences

Three reports have been produced:

- (i) "Po River Catchment Monitoring Activities" (June 1994) by the Po River Basin Authority
- (ii) "Programme for the Monitoring of Water Quality" (January 1994) by the NRA.

Both these reports deal in detail with the legislative aspects of monitoring in both Authorities and provide a comprehensive statement of current practice.

- (iii) "Comparison of Systems for River Water Quality Monitoring" (January 1995).

This report identifies the key issues to emerge from Stage 1 and compares and contrasts the situation in both Authorities.

2.2 Stage 2

Evaluation of existing monitoring practice

A consultation exercise has been completed involving designing and circulating questionnaires for determining current monitoring practice within the Po Authority and the NRA. The questionnaires were designed to elicit information on the approaches taken within each Authority in order to ascertain how monitoring is currently undertaken to meet a range of monitoring objectives.

The results of the consultation exercises have been compiled into two Stage 2 reports detailing the analysis of the data from the questionnaires for both the NRA and the Po Authority.

These are:

- (i) "Current Monitoring Practice - Questionnaire Analysis, NRA" (March 1995).
- (ii) "Current Monitoring Practice - Questionnaire Analysis, Po Authority" (March 1995).

In April 1995, representatives of the Po Authority, IRSA and the Hydrographic Service visited the NRA as part of an exchange of information on experience with continuous monitors and automatic samplers.

Development of a Draft Manual of Best Practice

The detailed information collected on current monitoring practice has formed the basis for the development of a draft Manual of Best Practice. Information was obtained on the requirements of those involved in the design and interpretation of monitoring programmes, the range of tools and procedures used, and the factors considered to be important. This, together with an understanding of the design of monitoring programmes, the use of instrumentation and the interpretation of data, has provided the structure and content of the draft Manual.

The Manual gives step-by-step guidance through the stages of a monitoring programme; from the initial statement of objectives through to the generation of management information. The user of the Manual is lead through each decision, without being given prescriptive answers; the user will therefore be able to design a monitoring programme that will be optimum for any particular set of problems and circumstances encountered. The Manual will enable the planning of monitoring programmes that are neither excessive nor insufficient for their purpose, thus optimising resource usage and maximising cost-effectiveness.

The final version of the draft Manual has now been completed as a document in English and this will be available for the Secretariat meeting in Parma.

The content of the Manual will be further developed and refined during the evaluation programme in Stage 3.

Selection of test catchments

Test catchments have been selected as follows:

- River Mole, near London
- River Weaver, near Liverpool
- River Sesia, near Vercelli
- River Enza, near Parma

Full details of these river catchments will be available at the Secretariat Meeting and a database containing their essential features will be developed.

It should be noted that test catchments will also be selected in Scotland and Northern Ireland as part of the agreed extension of the programme to include the Scottish and Northern Ireland Forum for Environment Research (Sniffer)

EVALUATION PROGRAMME

1. INTRODUCTION

The Definition Study Report (December 1993) set out the basis of the Collaboration Programme and contained Technical Annexes detailing Stages 1 and 2 of the work programme. This paper briefly summarises the main components of Stages 3 and 4, representing the final phases of the work. Figure 1 shows the tasks involved and the programme timetable.

2. FUTURE WORK PROGRAMME

Stage 3

(i) Refine/define tools

- develop additional tools for planning and designing monitoring programmes as defined in Stage 2. This is seen as an ongoing task throughout the evaluation period;
- Proposed tools are listed below and full descriptions are given in Appendix B.

Tables of typical variability (P1)

Default values of variability for use where there is no historical data.

Programme Planning worksheets (P2)

Automated worksheets for arriving at the most appropriate monitoring programme.

Precision Tool worksheets (P3)

Worksheets giving a range of options for achievable precision and confidence for a given amount of sampling effort.

Resource Allocation Tuning (P4)

Automated comparison of perceived importance, achievable precision and confidence, and risk of bias

Monitoring Programme Simulator (P5)

Simulation of results of a chosen monitoring programme to illustrate levels of uncertainty and bias.

Understanding continuous monitoring data (A1)

Will allow the extraction of useful information on trends, cycles and variation from continuous data.

Temporal trend analysis (A2)

Software for statistical identification of temporal trends in quality.

Before-after comparisons (A3)

Software for statistical identification of temporal differences in quality.

Upstream-downstream comparison (A4)

Software to give paired comparisons of data from two sites to identify differences in quality.

Spatial trends in biological data (A5)

Software to identify spatial patterns in biological data.

(ii) Test and evaluate the draft Manual of Best Practice in catchments

- Characterise existing monitoring in test catchments;
- analyse available data from the catchments using the statistical tools contained in the draft Manual of Best Practice including, for example, AARDVARK and LAPWING;
- from this analysis, and guidelines established in the draft Manual, identify procedures to be evaluated, including the determinands, sampling frequency, location of monitoring sites and staffing requirements;
- identify potential links with sampling for other purposes, for example fisheries, conservation and water resources;
- prepare an evaluation programme;
- implement selected monitoring procedures;
- monitor the cost associated with each sampling procedure;
- collate data from the monitoring programme;
- analyse the data using the procedures given in the draft Manual with a view to assessing the effectiveness of the monitoring programme;
- determine the benefits of the monitoring programme;
- refine the interim guidelines given in the draft Manual in the light of operational experience as the basis of the final version of the Manual.

Stage 4

This Stage will focus on the production of the Best Practice Manual together with supporting statistical software. The programme will result in a common version of the Manual for the Po Authority, the NRA and Sniffer, but designed to accommodate the particular local requirements of the three Agencies, with one version in English and the other in Italian. Recommendations for dissemination of the Manual and training in its use will be an important additional component of this part of the programme.

3. **OUTPUTS** (To be reviewed by the Secretariat)

- Stage 1 reviews (June 1994) (Core Projects)
- "Comparison of systems for river water quality monitoring" (draft report September 1994, final report January 1995) (Secretariat)
- Proposed future programme for completion of Stage 2 and for Stages 3 and 4 (draft September 1994, updated April 1995, final May 1995) (Secretariat)
- Contents and design specification of draft Manual of Best Practice (September 1994) (Secretariat)
- Proceedings from Steering Group Meeting (November 1994) (Secretariat)
- Stage 2 reports (April 1995) (Core Projects)
- Draft Manual of Best Practice (April 1995) (Core Projects)
- Stage 3 reports (April 1996) (Core Projects)
- Final Manual of Best Practice (August 1996) (Core Projects)

OTHER ISSUES

(i) STREAM Proposal

In 1994, DGXII of the European Commission approached the Euraqua network and the NRA with a view to submitting a proposal to create a network of organisations having an interest in water quality and water quantity instrumentation. WRc have been invited to join the NRA in the initial phase of the network. It is expected that funding will be made available to explore how the network would operate prior to the full proposal being submitted in early 1996.

Copies of the proposal will be available at the meeting.

(ii) Monitoring Taylor-made II Conference

The NRA is keen for the collaboration programme to be presented at the next conference to be held on 9-12 September 1996, Nunspeet, The Netherlands.

Peter Newman of WRc is on the Scientific Committee and advises that abstracts of papers need to be submitted before Christmas.

Possible submissions are:

- The development of a Manual of Best Practice for Water Quality Monitoring.
- A review of water quality monitoring practices in Europe, the need for best practice and overview of the collaboration programme.

(iii) Metropolitan Areas and Rivers Conference

This IAWQ, IWSA, ACEA conference will be held in Rome in May 1996 and could well be an excellent venue for publicising the work of the collaboration programme. The deadline for submission of papers is 10 December but a late entry may well be permitted.

(iv) Future R&D Needs

The collaboration programme is identifying the need for further research and development in several areas and it will be important for the Secretariat to identify and promote these for possible funding.

Examples of possible R&D needs are:

- Electronic version of current Manual - CD ROM
- Wider application of Manual of Best Practice throughout EU
- Integration with best practice for monitoring effluents
- Extension of procedures to groundwater and other surface waters
- Integration with monitoring for water resource management
- Extension of procedures to air and soil

APPENDIX A

NATIONAL RIVERS AUTHORITY/PO RIVER BASIN AUTHORITY COLLABORATION PROGRAMME

'IMPROVED MONITORING SYSTEMS FOR RIVER QUALITY'

MINUTES OF THE STEERING GROUP MEETING

TUESDAY 16 MAY 1995

at

PO RIVER BASIN AUTHORITY OFFICES, PARMA

Steering Group Participants

NRA

Lord Crickhowell
Mervyn Bramley
John Seager
Jacqui Gough
Ian Adams

PORA

Roberto Passino (Chairman)
Giuseppe Caggiati
Clara Caroli

IRSA

Marcello Benedini

WRc

John Davis

Hydrographic Service

Luigi Ciarmatori

University of Milan

Giuseppe Chiaudani

1. INTRODUCTION AND WELCOME

Professor Passino warmly welcomed the participants to the meeting. He looked forward to a productive meeting and reiterated the importance of the collaboration between the two Authorities. It was agreed that this association and exchange of information is proving to be particularly important and relevant to the current discussions on the proposed Ecological Directive where monitoring is a key issue.

Professor Passino reported that the Institutional Committee of the Po River Authority had been made aware of the collaboration programme and that the Minister of Environment had been invited to the meeting in Parma but was unable to attend.

2. FROM THE NRA TO THE ENVIRONMENT AGENCY

Lord Crickhowell thanked Professor Passino for his welcome and hospitality.

In his presentation Lord Crickhowell highlighted the similarities between the two Authorities in terms of the problems being addressed. He said that one of the biggest impacts on the work of the NRA has been EU Directives which have dictated what to do - which was not always what the NRA would have liked to do - at great cost. Additionally this legislation has given rise to a very large capital expenditure, on sewage treatment for example, with significant impact on the costs met by the consumer. The NRA itself has looked very hard at the question of cost-benefit and have successfully reduced their costs. For monitoring it will be important that programmes are undertaken in the most cost-effective way and the Manual of Best Practice will need to play a crucial role in this.

Lord Crickhowell said that the new Environment Agency in England and Wales will bring together the NRA with Her Majesty's Inspectorate of Pollution, the Waste Regulatory Authorities and the Department of the Environment's Wastes and Contaminated Land Divisions. The Bill dealing with the formation of the new organisation is currently going through Parliament and the new Agency will come into being in April 1996. It will have a total staff of some 9000 people of whom 7000 will come from the NRA.

With regard to monitoring, a major change in the UK will be a move to a greater amount of self monitoring of effluents being undertaken by industry. This would go hand in hand with on going environmental monitoring and auditing carried out by the regulatory agency. In addition industry has spent a considerable amount on pollution abatement - looking at the costs of their processes and promoting waste minimisation. Lord Crickhowell cited the Aire and Calder demonstration project and tabled reports and a video giving further information. In concluding his presentation Lord Crickhowell emphasised the need for authorities like the new Environment Agency and the Po River Authority to continue to work together.

3. WATER MANAGEMENT IN ITALY AND THE ROLE OF THE PO RIVER AUTHORITY

In summarising the situation in the Po Basin, Professor Passino said that a major problem was that of pollution from agriculture. It affected both surface and groundwaters and was particularly serious in the region around Parma. Intensive livestock units were a particular problem but the need for effective application of fertilisers and pesticides was also a concern.

In some areas demand for irrigation water in summer leads to over abstraction of the water resource. The Po Authority is active in drawing up ways in which agricultural pollution can be controlled but some regions were more vigilant with pollution control policies (eg Emilia Romagna) than others (eg Lombardy) giving rise to farmers moving from one region to another.

4. OVERVIEW OF THE COLLABORATION PROGRAMME AND ACHIEVEMENTS TO DATE

Clara Caroli presented an overview of the Collaboration Programme. The programme was on schedule and Stages 1 and 2 have now been completed.

An evaluation of existing monitoring practice had been undertaken in the NRA and the Po Basin by means of questionnaire and visits to those involved in operational monitoring. The results of this exercise were reported in two Stage 2 reports.

The detailed information collected from these exercises has formed the basis of the draft Manual of Best Practice which will now be further developed and evaluated as part of the future programme.

A mock up of the Framework Document for use in complementing the Manual was tabled. It was agreed that this would be further developed with greater emphasis being given in the text to the technical basis of the Manual and the planning of cost-effective programmes. Less text would be devoted to institutional structures, and this part would be carefully checked for political accuracy. A further draft would be circulated with a view to producing the document in English, Italian and French.

At the previous meeting of the Steering Group it was agreed that a paper be prepared for publication in a suitable international Journal. The Secretariat had considered this and recommended to the Steering Group that the proposed paper be extended to include the development of the Manual and its evaluation. This was agreed.

Further points arising during the discussion were:

- The Manual of Best Practice must make it clear that it is applied to rivers only. The document will include a glossary of terms.
- Contact should be made with RIZA in the Netherlands who are leading a UN/EU initiative on monitoring.
- It will be important to include in the Manual guidance on flow measurement in relation to the range of hydrological conditions which could occur.

Actions

- o Revise and finalise the Framework Document in the light of comments received. Finalise the document as English, Italian and French versions with Steering Group approval (by September 1995). **Secretariat**
- o Prepare a section for the Manual dealing with hydrometric issues. **IRSA/Secretariat**
- o Prepare a draft paper for external publication and for further consideration by the Steering Group (by October 1995). **Secretariat**
- o Make contact with RIZA to exchange information on individual programmes. **Secretariat,
John Seager**

5. FUTURE COLLABORATION PROGRAMME

Jacqui Gough outlined the components of Stages 3 and 4 of the programme. The draft Manual would now be completed and a detailed evaluation programme prepared in the light of the particular characteristics of the selected test catchments. Emphasis would be given to addressing cost-benefit issues during the evaluation phase.

The NRA was pleased to announce that the regulatory authorities in Scotland and Northern Ireland have agreed to join their core programme. The programme would now represent the UK as a whole. The possibility of involving other Italian river basin authorities arose in discussion and it was agreed in principle that the Tiber and Arno Authorities would be approached through the Po Authority. It was recognised, however, that the timing of this approach was important and that it would not be appropriate to follow this up until further development of the Manual had been completed. (The possibility of exchange of staff between the UK and Italy, from river basin authorities or possibly regional environmental protection agencies (ARPA), during the evaluation trials arose outside the Steering Group meeting and will be actively considered as part of the future programme).

Actions

- o Finalise selection and characterisation of test catchments. **Core Programmes,
Secretariat**
- o Prepare and undertake detailed evaluation programme. **Core Programmes,
Secretariat**
- o Finalise Manual production and recommend a programme for its implementation. **Core Programmes,
Secretariat**

6. WIDER EUROPEAN ISSUES

In introducing his presentation, John Seager was keen that against a background of some 20 EU Directives on water quality and others currently being proposed, a principal objective of the collaboration was to exert influence on the Commission so that proposed legislation is both practical and scientifically based and is discussed with regulatory agencies at an early stage. In this regard the Network of European Environmental Regulators (IMPEL) have an important influence on policy development, as will the European Environment Agency. On 20 June the Environment Committee of the European Parliament will hold an Open Hearing on the revised Drinking Water and Bathing Water Directives and the proposal for an Ecological Quality Directive. The NRA have already provided evidence to a House of Lords Committee on the revised Bathing Water Directive and the Authority now sit on a European Expert Group.

(i) European Environment Agency

The Agency was now actively recruiting staff and had appointed WRc as the lead organisation to manage their Topic Centre for Inland Waters. It was agreed that a formal approach should now be made informing the Agency of the collaboration programme and its relevance to the work of the Agency and its Topic Centres. This should build WRc's involvement in both. A paper will be produced describing the programme and this will be sent to the Agency prior to a meeting involving representatives of both Authorities, and possibly WRc.

(ii) Ecological Quality Directive

In liaison with the Commission, the NRA had recently arranged for a Workshop to be held in Brussels involving representatives from the Environment Agency's Topic Centres and regulatory agencies to discuss the proposed Ecological Quality Directive. It is clear that certain aspects of the Directive are not practical or sensible and there is a lack of clarity in the draft proposal. Also it is generally recognised that considerable R&D is required to put the Directive on a sound footing.

The recommendations from the Workshop will be made available to Member States in due course. A copy will be sent to PoRA.

(iii) EU Network on Instrumentation

The proposal for a feasibility study, identified through EURAQUA, on establishing a Europe-wide network to look at water quality and quantity instrumentation issues was strongly supported. A key issue would be the involvement of instrument manufacturers. This would be submitted by NRA for comment to the EURAQUA members during the present month, prior to discussion with DGXI.

(iv) Remote Sensing and ISPRA

It was noted that the UK Natural Environment Research Council, with support from the NRA, will be submitting a proposal to the Environment and Climate Programme, involving ISPRA, on the use of remote sensing in monitoring oil pollution and floodwaters.

(v) R&D proposals submitted to the EU Environment and Climate Programme

These proposals were noted and the Steering Group would be informed of the outcome in due course.

Actions

- o Report on Workshop on Ecological Quality Directive to be circulated **NRA**
- o Produce a paper on the collaboration programme for submission to the European Environmental Agency.
Draft for comment by Steering Group by end June
Final version by end July. **Secretariat
Secretariat**
- o Inform Steering Group of progress with various R&D submissions. **Secretariat**

7. ANY OTHER BUSINESS

(i) Information exchange

Ian Adams presented a paper identifying a number of areas where further exchange of information and operational support between the NRA and the Po Authority could take place. It was agreed that the Po Authority would respond to these ideas in due course. However, minimum acceptable flows was identified as a potential key area of interest.

Po Authority/NRA

(ii) Research Network

IRSA and WRc would explore the possibility of establishing a research network with funding being provided through the Fourth Framework Programme on 'Stimulation of training and mobility of researchers'. This could involve a workshop on regulatory aspects of monitoring.

WRc/IRSA

8. DATE OF NEXT MEETING

As indicated on the programme timetable, the next meeting of the Steering Group is scheduled for November 1995, to be held in the UK.

APPENDIX B

PROPOSED TOOLS FOR PLANNING AND DESIGNING MONITORING PROGRAMMES

Programme planning tools

P1. Tables of typical variability

One of the key inputs in planning a monitoring programme is an estimate of the likely variability in the water body being sampled. Ideally this is obtained from relevant historical data. In practice, however, there is often an absence of suitable data and so default values must instead be used. Clearly, the resulting estimates of precision in such cases will be critically dependent on the appropriateness of the defaults used. It is proposed, therefore, to develop standard tables for the most commonly required determinands giving typical values (low, medium and high) for all the major components of variability tabulated and discussed in Part B of the Manual (diurnal cycle; seasonal cycle; weekday-weekend effect; analytical error; etc).

The most fruitful source of information is likely to be continuous monitoring data; this would be supplemented by the partial information available for other determinands from previously analysed GQA data. Other gaps would be filled in from the consensus of informed opinion amongst NRA staff. For biology, data may be available from the recent IFE study on variability.

P2. Programme Planning worksheets

In its present form, the Manual requires the user to work through a sequence of proforma tick-box tables to arrive at the most appropriate monitoring programme for a given strategy. This process would lend itself readily to an automated worksheet approach that would prompt the user with the appropriate choices at each stage, and also deal automatically with the carrying forward of information from one table to another (a chore that is currently done manually).

P3. Precision Tool worksheets

For each of the strategies addressed by the Manual, statistical methodology is provided enabling the user to determine the precision and confidence likely to be achieved for any given amount of sampling effort. In most cases, however, the methodology is presented only in the form of algebraic expressions, and so needs to be made more accessible to the user. To achieve this we propose a menu-driven collection of worksheets - one per strategy - that would prompt the user for the required inputs (typically the number of samples and the estimated variability), and would then carry out all necessary calculations and present the user with a range of options for achievable precision and confidence.

P4. Resource Allocation Tuning

In arriving at the most cost-effective allocation of resources across the overall monitoring programme, a key element of the proposed methodology involves various strategy-by-strategy comparisons of (a) perceived importance, (b) achievable precision and confidence, and (c) risk of bias. At present, the Manual envisages this tuning process being driven by a simple graphical system of feedback. However, a spreadsheet-based system of information-gathering and presentation would make the

process much quicker and easier to apply, and would also enable it more readily to be refined as experience is gained during Phase 2.

P5. Monitoring Programme Simulator

Part A of the Manual provides several illustrations showing (a) the temporal and spatial extent of the population to be sampled, overlaid with (b) the actual pattern of samples that might be taken during the course of the monitoring programme. Our proposal for Phase 2 is to develop this idea further via computer simulation - a potent and well-proven method for illustrating and quantifying sampling error. The model would run in three stages:

- first, the user would specify, or 'dial up', any desired description of actual quality variations over time and space (the 'statistical population');
- next, the user would specify the number of samples to be taken, and all pertinent details of the pattern of sampling through time and space (systematic; fixed hour of day; random through year; etc);
- the model would then randomly generate many repeat sets of samples according to the prescribed pattern, calculating in each case the answer resulting from that particular set of samples (mean upstream-downstream difference; 90%ile; trend slope; etc).

The primary output from the model would be a graphical display showing for each determinand the levels of *uncertainty* (precision) and *bias* inherent in the particular choice of sampling programme. Thus it would provide a vivid illustration of the degrees of effectiveness of various monitoring strategies - thereby reinforcing the validity of the planning methodology and encouraging its acceptance by the user. It would also provide additional information about the inherent precision and bias of monitoring programmes in situations where the components of variability were too complex or numerous to be handled satisfactorily by an analytical approach alone.

Data analysis tools

A1. Understanding continuous monitoring data

From the questionnaire discussions with the Regions it emerged that there was a particularly pressing need for data analysis tools in the area of continuous monitoring. In view of the vast quantities of data generated by continuous monitors, the key requirements are (a) to *extract all pertinent information* on trends, cycles and random variation, and (b) to produce *succinct summaries* of this information.

A start has already been made on this task, and illustrative outputs from the rough prototype developed to date are shown in Appendix C of the latest draft of the Manual.

A2. Temporal trend analysis

The NRA has access to a variety of tools for the *detection of step changes through time* - including the SAD routine in the Test Data Facility, the Exception Reporting Mechanism (ERM), and the AARDVARK package. However, there is no generally available software for detecting *trends through time*. This is a particularly important strategy to address because of the notorious ease with which trend methods can be misused by the unwary.

The proposed software would apply a battery of techniques, both parametric (e.g. full and piecewise linear regression assuming Normality or logNormality) and non-parametric (e.g. Sen's test, and the seasonal Mann-Kendall test). Strong emphasis

would be placed on the validation of any identified trend by residual analysis supported by graphical displays.

A3. Before-after comparisons

Temporal comparison is the other temporal strategy not specifically addressed by existing tools. The proposed software would first identify and remove the effects of any relevant cycles or trends (e.g. seasonality, long-term drift) so as to sharpen the before-after comparison. It would also provide visual support of the reported conclusion via a graphical representation of the fitted model.

A4. Upstream-downstream comparison

The identification of spatial trends and step-change detection are both fully met by the LAPWING package. LAPWING does, however, have one notable limitation. Because it was designed primarily to cope sensibly with all patterns of sampling, however imbalanced, LAPWING does not fully exploit the special circumstances in which *sample times are matched across sites*. There is therefore a need for a program that will carry out a paired-comparison data analysis for any two collections of sampling points (generally upstream and downstream of some discharge of interest). Where discharge data is available also, this will be incorporated into a supporting 'combined-distributions' or Warn-Brew analysis.

A5. Spatial trends in biological data

Although the LAPWING package provides a comprehensive methodology for identifying spatial patterns for *chemical quality* data, there is no corresponding tool for the analysis of *biological* data. The same approach could readily be applied, however, namely a factorial ANOVA (with main factors 'year', 'season' and 'site'), followed by a methodical search for the most appropriate representation of spatial trends. Moreover, it would be relatively straightforward to develop the prototype for such a tool because of the much smaller quantities of data involved - no more than three BMWP samples at a site per year, in contrast to up to 50 chemical samples a year. A key additional input to the analysis for any particular river would be a quantitative estimate, taken from the recent definitive study carried out by IFE, of the sampling error appropriate for that river.