

National Rivers Authority
Thames Region



NRA

Research & Development Programme
Topic B2 : Flow Regimes

Project B2.2 :
Low Flow Conditions

INTERIM REPORT

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CONSULTING ENGINEERS

November 1990

NRA R&D PROGRAMME
TOPIC B2 : FLOW REGIMES

PROJECT B 2.2 : LOW FLOW CONDITIONS

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REFERENCES

1. INTRODUCTION

SWK were appointed on the 15th August 1990 to undertake the NRA R&D project topic B2.2. This topic is part of the larger study which is known as topic B2 : Flow Regimes. The R&D programme of the NRA is described in the Delegate's Information Pack for the NRA R&D Open Forum Meeting held on 5th June 1990.

The present report is an Interim Report as required by the project ToR. The ToR are reproduced in Annex 1. The scope of the report is to bring to the NRA's attention the Regional NRA's perception and methods of low flow assessment used by the predecessor bodies, the Regional Water Authorities. As anticipated in the R&D programme, there are considerable regional variations and these are summarised in this Interim Report. This report also contains a preliminary approach to setting up a classification framework. During consultation with the Regional NRA's ideas have been explored on methodology that can be utilised to prioritise sites affected by low flows, initially locally and then nationally.

A preliminary database of the limited information obtained from the Regional NRA's has been set up as a series of LOTUS files. If during the remaining project adequate data is obtained, a conventional database will be set up and data files transferred to it.

The project programme adopted for execution of the study was given in SWK's technical proposal. Slight modifications to the programme were required. These do not have an effect on the timing of the Final Report.

The actual programme achieved and the proposed programme for completion are discussed in Section 8 of this report.

Interim recommendations are made in Section 9.

2. INTERRELATIONSHIP WITH OTHER R&D PROJECTS

Figure 1 shows the interrelationship of the "Low Flows Conditions" project with other relevant projects. The inner ring signifies closer association with the 'low flow' project, and the outer ring a more distant, but relevant association.

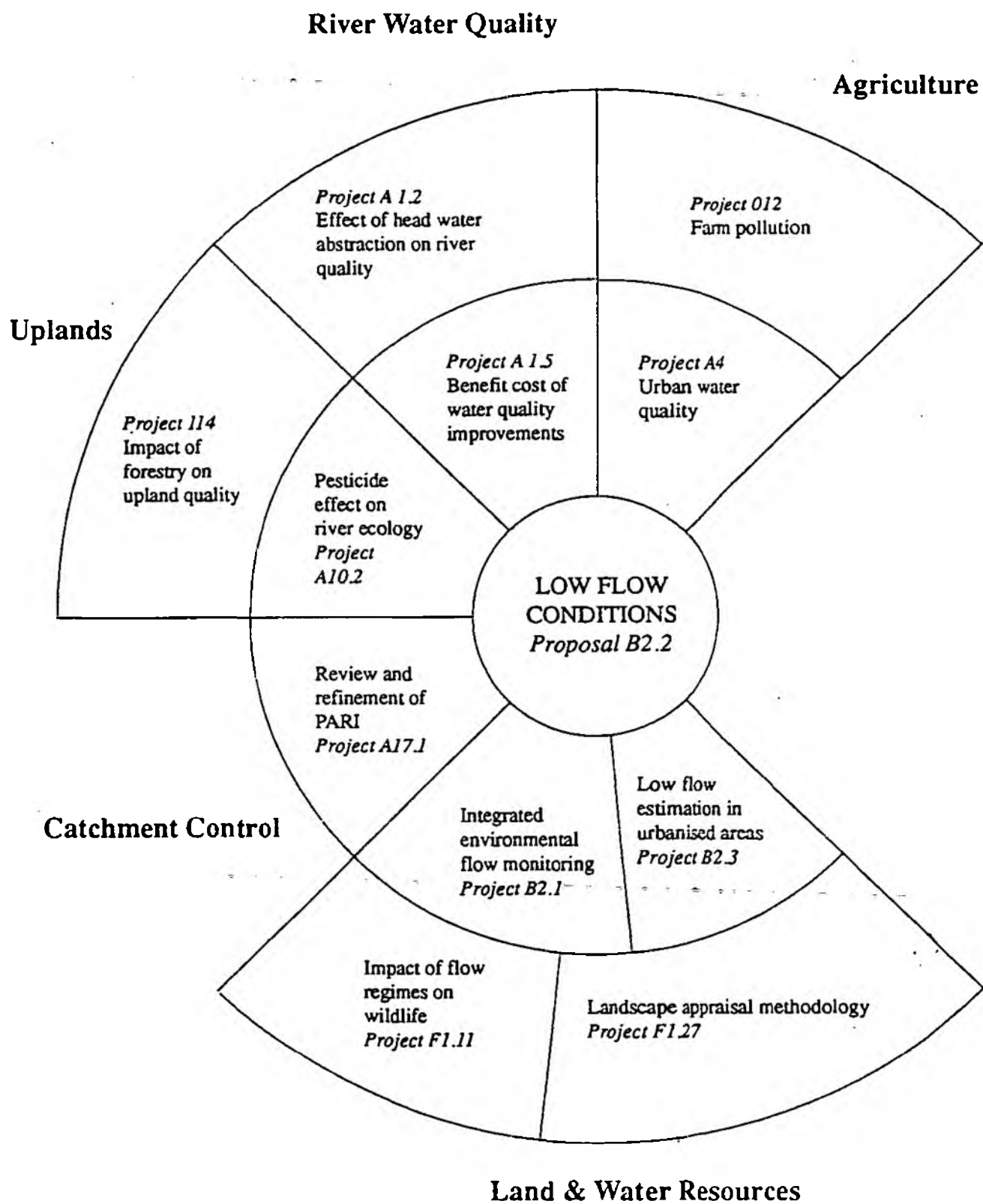
These other R&D projects have two potential impacts on the project namely:

- i) to provide specific target values for assessment parameters or alleviation objectives (e.g. Minimum Acceptable Flow).
- ii) to generate data collection or manipulation exercises which would provide data for the assessment of low flows.

We are conscious of the fact that overall data collection within the NRA should be designed to serve as many purposes as possible for the minimum cost of collection. Thus in assessing which parameters to use for the low flow assessment, preference should be given to those parameters for which data is already collected or for which the data has a number of other uses. It may be anticipated that the quantity and quality of data to be collected by the NRA may progressively change in the future particularly with the objective of ensuring that the same level of data collection is achieved in all Regions.

A summary of our discussions to date on other R&D projects is given in Annex 5.

Many of the projects which would have a bearing on the 'low flow' project, have not yet commenced and are at the early stage of initiation. Their conclusions could be important to this study but are unlikely to be available before the completion of the project. In view of this fact assumptions must be made which would permit us to proceed with concluding this project in time and within budget.



NRA R&D Projects Interrelationship
Figure 1

3. REVIEWS OF PREVIOUS NRA WORK

'Low Flows' as a problem was recognised in a number of Regional Water Authorities. However, the definitions, and therefore the perception of the problem were viewed in a variety of differing ways in each Authority.

Following vesting day, a survey was undertaken by the Anglian Region NRA of the perception in each region with a view to establishing the extent of the problem at a national level.

The following paragraphs review these findings which are based on Roger Cook's (Anglian Region Water Resources Manager) reports and other internal NRA reports. The definition of 'Categories of Problem' and summary tables from Roger Cook's Report are produced below.

Table 1 shows the number of streams by Category in each Region which are considered to have been affected.

Table 2 shows by Region and key Category the estimated costs of alleviation.

Category A - "real problems" - locations where there is a clear case for action.

Category B - "unreal problems" - locations when despite public outcry there is not a clear case for action.

Category C - "latent problems" - locations which are likely to be recognised as problems if action is seen to be taken on Category A.

During the study a fourth category was identified which can be described as "possible problems" i.e. those where there is perceived to be a problem which has not yet been publicly recognised but the cause and the solution have yet to be evaluated. These have been denoted "Category D".

TABLE 1 - NUMBER OF PROBLEM LOCATIONS IDENTIFIED

| Region | Location | | Category | | |
|--------------|---------------|-----------------|-----------------|-------------------|----|
| | A | B | C | D | |
| | Real Problems | Unreal Problems | Latent Problems | Possible Problems | |
| Anglian | 9 | 4 | 10 | 4 | 27 |
| Northumbrian | | | - | - | |
| North West | - | - | 4 | - | 4 |
| Severn Trent | 6 | 5 | 3 | 6 | 20 |
| Southern | 7 | - | 1 | - | 8 |
| South West | - | - | - | 3+ | 3 |
| Thames | 5 | 4 | - | - | 9 |
| Welsh | 7 | - | - | - | 7 |
| Wessex | 3 | - | - | 2 | 5 |
| Yorkshire | 3 | 2 | 4 | - | 9 |
| Total | 40 | 15 | 22 | 15 | 92 |

TABLE 2 - COSTS (£000)

| Category | A | | | B | | | C | | |
|--------------|---------|-----------|--------------|---------|-----------|--------------|---------|------------|--------------|
| Region | Capital | Operating | Compensation | Capital | Operating | Compensation | Capital | Operating | Compensation |
| Anglian | 2775 | 16 | - | 195 | 6 | - | 710 | 28 | 5500 |
| Northumbrian | - | - | - | - | - | - | - | - | - |
| North West | - | - | - | - | - | - | - | - | 6100 |
| Severn Trent | 295 | 30 | 500 | 530 | 50 | 300 | ---- | Not Costed | ---- |
| Southern | 20000 | 200 | 6000 | - | - | - | - | - | 5000 |
| South West | - | - | - | - | - | - | 28 | - | - |
| Thames | 9500 | 230 | - | 2300 | 60 | 1200 | - | - | - |
| Welsh | 500 | 100 | 1100 | - | - | - | - | - | - |
| Wessex | 4250 | 175 | - | - | - | - | - | - | - |
| Yorkshire | 200 | - | 60 | 500 | 10 | 50 | 750 | 10 | 560 |
| Total | 37520 | 751 | 7660 | 3525 | 126 | 1550 | 1488 | 38 | 17160 |

TABLE 3

List of Liaison Meetings with
NRA Regions

| NRA Region | NRA Staff Met | Consultants Staff | Date of Meeting |
|--------------|---|------------------------------------|-----------------|
| Anglian | Mr Roger Cook Mr David Evans | S Puri Anne Knape P Kerrison | 31/8/90 |
| South West | Mr Peter Nicholson Mr Nigel Reader Dr Janet Cochrane Dr Rosanne Proome | M Le Gouais S Puri | 14/9/90 |
| Thames | Mr Nigel Hawkes Ms Maggie Pratt Mr Alastair Driver | M Le Gouais S Puri | 19/9/90 |
| Southern | Mr Steven Oakes | S Puri | 24/9/90 |
| Welsh | Ms Jean Frost Mr Richard Howell | M Le Gouais P Kerrison | 24/9/90 |
| Wessex | Dr Terry Newman Mr Richard Symonds | M Le Gouais S Puri | 26/9/90 |
| Severn Trent | Mr Elfyn Parry Mr Bob Harris Mr Roger Goodhew | S Puri P Kerrison | 4/10/90 |
| Yorkshire | Mr P Towlson Mr D Franklin Mr I Barker Mr J Pygott | S Puri Anne Knape | 15/10/90 |
| North West | Mr M Aprahamian Mr R Ward Mr B Repton Mr R Chambers Dr M Owens | S Puri Anne Knape | 18/10/90 |
| Northumbrian | Mr David Archer (telephone discussion) | M Le Gouais | |

4. NRA REGIONAL VIEWS

As part of Stages 1 and 2 of the Study (Figure 2), nine Regions were visited (the exception being Northumbrian for reasons given below). The purpose of these visits was:

- to confirm or amend the list of low flow sites previously reported.
- to determine the basis on which the above list of sites was drawn up by each Region.
- to "talk through" a preliminary list of assessment parameters to obtain the views of the Regions on their relevance to their sites and nationally.
- to obtain sample reports for rivers/sites which have been studied.

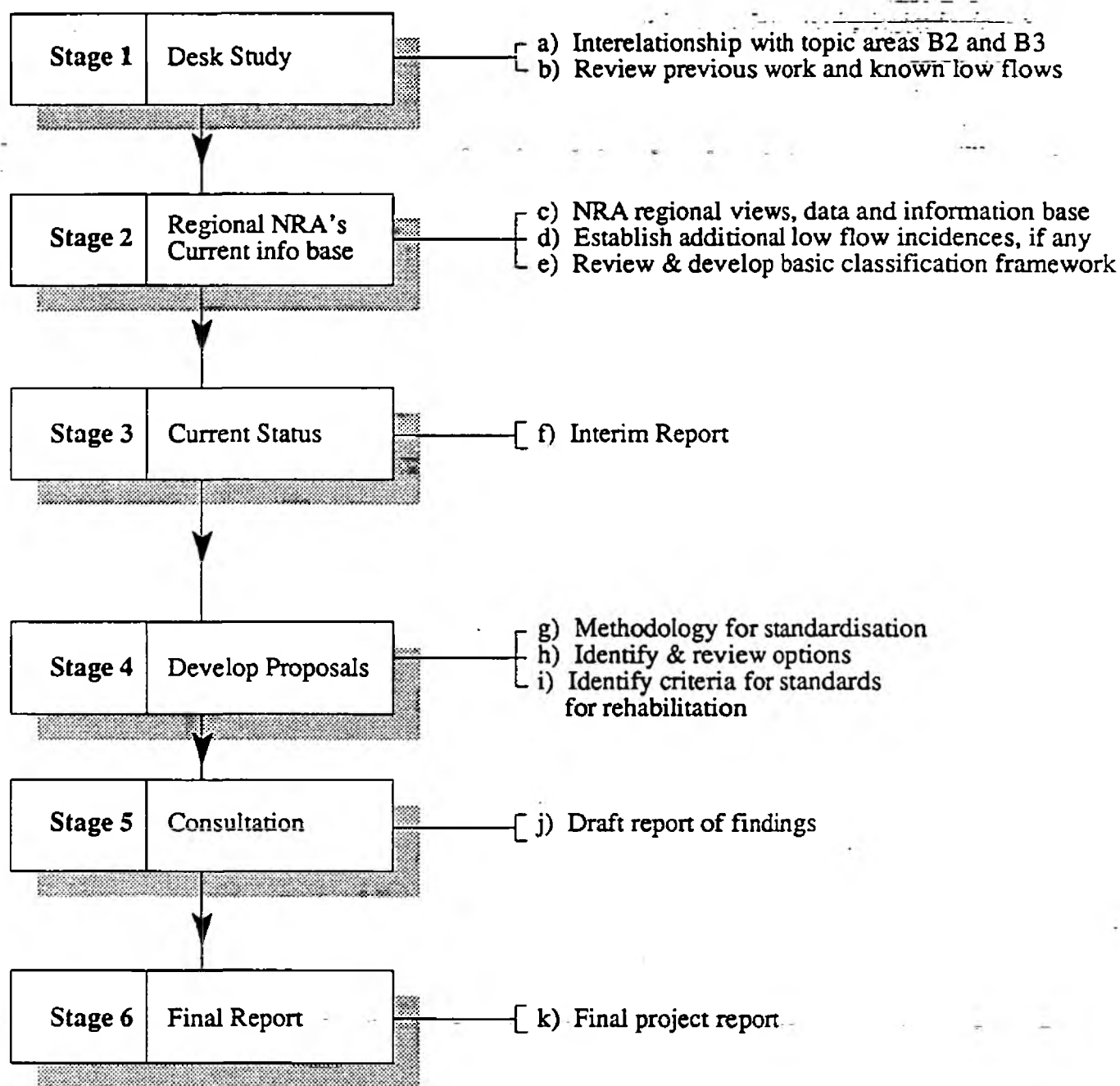
Northumbrian Region has not yet been visited since it has not identified any Category A or B sites and therefore little of the consultation procedure would be relevant at this stage. We have contacted Mr David Archer of Northumbrian Region by 'phone to discuss and agree this approach and have confirmed that they will be included in the consultation at the next stage.

4.1 Approach to Survey and Consultation

Before the programme of consultation, a standard letter was issued to each Region, setting out the objectives of the study and giving a preliminary list of parameters for the assessment procedure. This letter is produced at Annex 2 and the list of visits and staff participating is given Table 3.

At each visit the following procedure was adopted:

- i) SWK explained the scope and objectives of the study and asked for location maps of each affected site.



Study Workplan
Figure 2

- ii) SWK asked the Region to confirm that the sites listed in the returns to Roger Cook are correct or to identify any variations or additional sites.
- iii) SWK tabled a list of possible assessment parameters (which was revised in the course of consultations) and invited the Region to nominate for discussions two of the sites identified in their Region. One for which a considerable amount of data exists and the occurrence of low flows is not in question and another for which data is lacking and the evidence is not clear. This was to take account of the fact that the assessment procedure will be required to compare such differing sites on an equitable basis.
- iv) The list of assessment parameters was then talked through a) to identify which of those or which other parameters had been used by the Region to identify the two nominated sites and b) to seek the Regions's views on the relevance and relative importance of each parameter in their Region and Nationally.
- v) Finally the Regional staff were asked for any other comments or suggestions for the study.

4.2 Staffing of Consultation

Since one of the questions to be addressed by the study is the balance between water resources and conservation/environmental factors, the views obtained from the consultation are clearly influenced by the officers consulted and, to a lesser extent, by the staff fielded by SWK.

In setting up the meetings, this was pointed out to each Region but there was considerable variation in the range of disciplines fielded by each Region. In all cases a Water Resources officer attended the meeting but the representation of the Conservation/Environmental aspects varied from nil in some cases to three officers in others (i.e. Conservations, Fisheries, Biology). From SWK's side, the Water Resources aspect was dealt with by Mike Le Gouais (for predominantly surface water areas) or Shammy Puri (for

predominantly groundwater areas), with both together attending meetings easily accessible to Basingstoke in order to ensure a consistent approach.

For budgetary purposes the inputs from SWK on environmental aspects has been limited to 3 visits from each of Anne Knappe and Dr Phil Kerrison, each participating in visits to two 'groundwater' areas and one 'surface water' area with one joint visit (to Anglian Region) to ensure co-ordination.

The NRA staff also varied considerably in seniority, from those only concerned with some aspects of a few sites in one area to those at senior level who have been addressing all aspects for the whole of their Region at strategic levels.

4.3 Summary of Findings

A broad summary of the problems and perceptions of each Region is given in Annex 4.

There is considerable variation in Regional perceptions on the problem of Low Flows and the objectives that any alleviation should have. These are basically classified as follows:-

- Reduction in flow (real) in some cases to zero arising (usually) from groundwater abstraction and leading to environmental degradation and public protest.
- Reduction in flow due to surface water abstraction, leading to the same problems as above.
- Potential low flow problems arising from Licences of Right (and, following the 1989 Act Licence of Entitlement) which cumulatively exceed the river's capacity for abstraction and which may not yet be abstracted to the full licenced quantity.

Other problems such as lack of 'freshets' allowing fish migration have been mentioned in one or two regions.

Public pressure (both justified and unjustified) is a major driving force in the implementation of studies in many regions but real and potential problems have also been identified by NRA regions without, or in advance of, public pressure.

The approach adopted in resolving the problem appears to us to have been biased by discipline of the staff consulted. The Water Resources Staff have generally viewed the problems within the terms of essentially providing additional flow in the stream. Generally, the biological-ecological staff have been led by Water Resources and have followed by identifying the current ecology (in a few cases only) of the affected stream. Landscape and visual amenity staff were not met and although these aspects were often considered important no such professionals in the Regions had been involved.

Broadly, the problem causes can be defined as follows on water-resources - hydrogeological basis

- : Over abstracted Chalk (or other) aquifer
- : Over abstraction (licenced) of surface water
- : Inadequate reservoir releases
- : Other reasons : e.g. impact of land use, drainage, urbanisation, fen maturity, etc.

5. APPROACH TO SETTING CLASSIFICATION FRAMEWORK

The requirements for the method of assessment are that it should produce an equitable and reproducible assessment of the relative degree of severity of artificially-induced low flows in a wide range of watercourses, taking into account wide differences in:

- i) causes and impacts
- ii) water resources and environmental aspects
- iii) quantity and quality of data available
- iv) public awareness/perception
- v) cost of alleviation measures.

We have also concluded that, in addition to indicating the degree of severity, the method of assessment should indicate the level of confidence that can be placed in the assessment (i.e. the quantity, quality and relevance of the data used in the assessment). In addition (and perhaps most important) the method of assessment should require the minimum appropriate commitment of resources by the hard-pressed Regions. Thus it should be based as far as possible on data which is already collected for other purposes, or on new data which can be collected at minimum cost.

A further dimension to the Classification Framework is that, in addition to assessing the relative degree of severity of the problem (on which prioritising or ranking of sites would be based) it should also describe the type or quality of problem, to enable alleviation strategies to link with overall policies for environmental improvements.

This latter would probably require a separate or supplementary classification framework. Our Suggested Framework does not yet include this but is under consideration at present.

6. SUGGESTED FRAMEWORK

We propose that the Method of Assessment should be based on a list of weighted parameters, including or taking account of items i) to v) above. The assessment would be made using any combination of these parameters depending on the availability of data. The more parameters used or, more correctly, the greater the combined weight of parameters used, the more confidence can be placed in the assessment. This is set out in tabular form below.

| Parameter | Parameter Weight (a) | Weight of Parameters Used | Degree of Severity % (b) | Weighted Degree of Severity (a) x (b) |
|-----------|----------------------|---------------------------|--------------------------|---------------------------------------|
| A | 8 | 8 | 50% | 4 |
| B | 10 | 10 | 25% | 2.5 |
| C | 5 | 5 | 90% | 4.5 |
| D | 1 | - | - | - |
| E | 6 | - | - | - |
| Totals | 30 (x) | 23 (y) | - | 11 (z) |

$$\begin{aligned} \text{Severity of Problem} & & - \frac{z}{y} = \frac{11}{23} = 0.478 \\ (- \text{Interference index}) & & \end{aligned}$$

$$\begin{aligned} \text{Quality of Data} & & - \frac{y}{x} = \frac{23}{30} = 0.766 \\ (- \text{reliability of assessment}) & & \end{aligned}$$

The degree of Severity may be marked as a percentage but, more probably on a scale of 1 to 5 ranging from slight (1) to very severe (5).

Thus the assessment will assign values to two indexes i.e. Severity of Problem or Severity Index (SI) and Quality of Assessment or Reliability Index (RI).

The action arising from the assessment might be categorised as follows:

| SI | RI | Action |
|------|------|---|
| High | High | Put in Capital Programme for Alleviation |
| High | Low | Further studies required |
| Low | High | No action unless strong public pressure in which case provide public 'education'. |
| Low | Low | No action unless strong public pressure in which case initiate minimum cost further studies and provide public 'education'. |

In the following section we explain the range of parameters grouped within broad indicators of hydrology, conservation and public perception, that can be used in the above method of assessment.

7. DISCUSSION OF PARAMETERS/INDICATORS

7.1 Types of Indicator

There is a considerable divergence of views within the Regions as to the relative importance of different indicators and without yet proposing a resolution of that divergence we suggest the following overall context for the parameters. In this section we distinguish between parameters and indicators as follows: indicators can be hydrological, ecological, landscape, etc; while parameters are groupings which occur within given indicators. For example flow, ground water level etc would be parameters of the Hydrological Indicator.

We would divide the indicators into

1. Hydrological Indicator

This would be based upon quantifiable measures of flow or other parameters (e.g. ground water levels etc) which can be used in a reasonably and demonstrably objective way to assess the degree of artificial interference in low flows.

2. 'Environmental' or 'Conservation' Indicators

These comprise two groups of parameters. The first being "objective" and 'quantifiable' parameters, such as fish, invertebrate species diversity, water quality etc. The second being the 'subjective' and 'judgemental' parameters such as landscape value, historic associations, recreation and amenity. In later sections we term these as conservation indicators 1 and 2 respectively.

3. Public Perception or Pressure Indicator

This may be seen as part of "Conservation Indicators" discussed above in that public pressure is often subjective and judgemental on the

part of individuals or bodies external to the NRA. However, there is a case to treat this as a separate indicator, since it is a major driving force in majority of the studies carried out to date.

4. Other Parameters or Indicators

The cost of assessing the problem together with the relative cost benefits and impacts of solutions also need to be taken into account in some way.

7.2 Use of Parameters/Classification

The Environmental or Conservation aspects of the present assessment extend into and overlap with much wider studies of Conservation aspects for other purposes and we will need to look very carefully at a) where to draw the line between this (project B2.2) and other R&D studies and b) how to integrate them.

In particular the application of the Conservation parameters has to address the question

- i) What is the 'historic' or 'inherent' conservation value of the site
- ii) What is its current conservation value
- iii) What degree of degradation is due to low flow and what to other factors
- iv) What are those other factors.

We have, so far, avoided the concept of a Minimum (Environmentally) Acceptable Flow (MAF) because

- i) For a given site there may well be a range of MAF's varying by season, relating to a range of ecological parameters, and dependent upon duration of such MAF and

- ii) The other R&D projects addressing this question are most unlikely to reach even preliminary conclusions within the duration of this study.

It is clear therefore that within the scope and programme of this study, it will be necessary to produce a 'basic' or 'shorthand' form of assessment and classification, which is capable of subsequent expansion or 'fleshing out' to incorporate the result of other studies.

7.3 Hydrological Indicators

We believe that this should be the primary indicators for describing the severity of the problem because it is based upon parameters which:

- a) are a direct measure of the problem
- b) can be (relatively) simply quantified and expressed
- c) are more widely used (and therefore available) than other indicators
- d) are the parameters which generally, have been used by the NRA to assess low flows to date.
- e) it is likely that other indicators (e.g. environmental) can eventually be calibrated against the hydrological indicators.

The hydrological parameters which have been used and/or appear to offer the best prospect of defining the severity of the problem are:

- i) Ratio of licenced abstraction to Q95 (Q95 being the theoretical or measured, historic or 'natural' 95 percentile flow).

This indicator tends to be used in surface water areas.

- ii) Ratio of licenced abstraction to average annual recharge to groundwater.
- iii) Some other form of annual or seasonal water balance

iv) Flow accretion/depletion profiles

v) Groundwater levels

vi) Channel size/proportion occupied by low flows

7.4 Conservation Indicators 1 - Ecological Parameters

As conservation is an important but relatively new consideration for the water industry, extensive data collections have not yet taken place. Most of the habitat and community data for the purposes of our assessment are likely therefore to derive primarily from existing water quality (chemical and biological) and fisheries data bases. Assessing or 'scoring' the stretches would combine macroinvertebrate, fisheries, aquatic vascular plant and algal components of which macroinvertebrate and fisheries would be the major contributors. The basis for this is outlined below:

a) Macroinvertebrates are of great importance in the stream ecosystem as they are a food source for many fish, including the valuable game species. In addition, certain invertebrates are sensitive to particular environmental stresses. For example stoneflies require high quality cold water and therefore characterise spring-fed streams with a low effluent component. They may tolerate relatively high metal concentrations however.

In contrast, certain midge and dipteran larvae can tolerate low dissolved oxygen concentrations and the high organic component in sewage enriched streams.

In addition, the localised habitat and relatively short life cycles of invertebrates in general, allow the influence of present and recent conditions to be reflected in community structure. In order to separate water quality effects from those caused by low flows, it is necessary to analyse community structure in greater detail than is needed for general water quality monitoring. However, water quality

data would be detailed enough to allow sites to be scored in the context outlined above.

- b) The distribution of fish and particularly game species is an important consideration for similar reasons. Game fish demonstrate a fair degree of site fidelity, so their population structure can offer a reasonable record of recent conditions. They are particularly sensitive to the changes in water quality (ammonia and dissolved oxygen concentrations) and temperature. This is especially apparent overnight when photosynthesis is unable to compensate for the increased oxygen demand caused by a high sewage effluent component. Finally, low flows in headwater nursery areas can cause overcrowding and stress downstream as fish seek flowing water.
- c) Aquatic and terrestrial vascular plants are useful in that changes in stream discharge and groundwater levels affect streams, their margins and surrounding wetlands. A gradual gradient exists between terrestrial and aquatic habitats giving rise to a diverse marginal flora with associated invertebrates. This community will therefore yield useful information about water movements in the stream and surrounding land. These data may be scarce however, as they have not always been routinely collected by water authorities. This is currently being remedied with the introduction of NCC-type river corridor surveys.
- d) Algae are useful in that alterations in flows and therefore the proportion of sewage effluent to groundwater, may change the nutrient status of a water course. In this way low groundwater discharge may promote dense populations of Cladophora and other filamentous algae. Again, algae have not been routinely collected from rivers by the water authorities, so data may be patchy.

7.5 Conservation Indicators 2 - Landscape/Amenity Parameters

Landscape and amenity parameters which appear at this stage to offer the best prospect of consistent and appropriate results are:

- i) the importance of the river as a landscape feature - eg. its relationship to artefacts, vegetation, landuse and landform;
- ii) historical and cultural associations - eg. place names, literary/articles, paintings;
- iii) rarity value - eg. what is worth preserving or under threat, Is it significant in a local, regional or national context;
- iv) designation - does the river flow through areas designated as being of high landscape value, AONB, national park;
- v) impact on adjacent land - eg. agricultural, parkland, development;
- vi) amenity - eg. boating, fishing, rambling.

7.6 Public Pressure/Perception Indicators

Parameters in this section are closely allied to those above, but are generated by the views of bodies outside the NRA. Consequently it is the perception of the public bodies/individuals who have made their views known to the NRA that need to be recorded, even though they may in due course be rebutted by detailed survey work, analysis and application of the method. The following is a list of the most likely parameters.

- i) historical - knowledge of the river over time, against which changes are judged;
- ii) proximity of river to an urban area/dwellings/accessibility where visual assessment of the changes in water quality, and quantity can be regularly seen;
- iii) changes in usage - which stop activities such as boating, fishing, business.

7.7 Relative Weight of Indicators or Parameters

A dichotomy within the Regions, which this study must address and resolve, is the relative importance of Public Pressure, and other "subjective" or "judgemental" indicators in comparison with the Hydrological and Ecological Indicators.

On the one hand there is an argument that since the investigation of low flows has been largely driven by public pressure and since this pressure is based upon the public's subjective and judgemental assessment of landscape and amenity, these indicators should be given a high priority as part of NRA policy to be responsive to public concern.

On the other hand there is an argument that it would be wrong simply to seek the public's perception of a problem and alleviate the problem thus perceived. This would amount to tackling the symptom rather than the cause, and would be unlikely to prevent further problems. In addition, public perception, and recreation-amenity-landscape aspects often reflect the proximity of a site to centres of population or the activities of pressure groups. These factors may negatively bias the assessment of isolated habitats and it is argued that such a bias would be wrong.

This is a question that we will address in Stage 2 and it will be an important outcome of the study.

There is also an interaction between the weight assigned to a parameter and the amount of data which exists or is to be collected for that parameter. The existence of a large body of data would tend to increase the weight of a parameter. Conversely a parameter which has been judged to have a significant weight will justify more effort to collect than one which has a low weight.

8. PROGRAMME FOR COMPLETION OF PROJECT

The project progress and programme are on target as given in our technical proposal. It should be noted however, that other R&D projects of the NRA, some of them of specific interest to the present proposal B2.2, have either not yet started or have just been initiated. The time discrepancy between these is such that a slight delay in project B2.2 would not be of help. A project update would probably be required in a years time when the other projects have developed sufficiently.

In discussion with the NRA project manager of this project, therefore, we propose to continue as per our original programme.

One aspect which requires consideration is the possible need to consult with some of the Statutory Water Companies. The reason for this is that in any alleviation proposals one option will be some manner of revocation, modification or amendment of existing Licences of Right which induce low flows. In order to address the 'alleviation' issue it would be valuable to have an advance indication of the Water Companies' view on how their licences could be revised. Although such consultation should not affect the project programme, it may be worthwhile including such consultation in the project programme.

9. INTERIM RECOMMENDATIONS

In order to implement Stage 2 of the project we would recommend that consultation in the NRA regions take place with inputs from each of the relevant disciplines i.e. water resources, ecology, conservation and landscape and visual amenity representatives.

To obtain the strategic and policy level views of the Regions this Interim Report should be circulated to key staff in each Region. Their responses and comments on this Interim Report would be particularly valuable in formalising the outline method of assessment given here. It would also confirm (or modify) the opinions gained from our single visit - summarised in Annex 4.

We suggest that consideration should be given to consultation with selected Water Companies on the constraints to proposed alleviation especially where Licences of Right are likely to be involved.

The setting up of a conventional Dbase type database is considered irrelevant to this study because the quantity and scope of data we need to collect does not merit treatment in a database.

ANNEX 1

PROJECT TOR

TERMS OF REFERENCE

FOR NRA R&D PROJECT

LOW FLOW CONDITIONS

1. R & D Commission B - Water Resources

Topic B2 - Flow Regimes.

Project Title - Low Flow Conditions.

Proposal No. B2.2 Project No.

Classification of R & D - Applied Research with Specific Aims.

2. Project Leader

A E Jones
Hydrological Services Manager
NRA - Thames Region
Kings Meadow House
Kings Meadow Road
Reading RG1 8DQ
Tel: 0734 535305
Fax: 0734 502974

3. Research Contractor

4. Contract Details

Start date 1/8/90

End date 31/3/91

Contract type: Competitive tender

5. Objectives

Overall Project Objective

To review low flows due to abstraction and to standardise the assessment of the condition.

Specific Objectives

- a) To review the preliminary assessment of low flow conditions already made by the NRA Regions.
- b) To classify the conditions according to the magnitude of the effect and the cause (eg. ground water abstraction, surface abstraction, impoundment).
- c) To develop a methodology whereby the conditions may be assessed in an objective and standardised manner so that the NRA can make decisions on cases where action is justified.

- d) To identify and review, in outline, the range of options for alleviating low flow conditions.
- e) To propose the criteria to be taken into account in setting standards for rehabilitation.

6. Background

Following concerted public pressure over a number of years the former Thames Water Authority appointed Sir William Halcrow & Partners Ltd to undertake a study into the possible ways of alleviating low flows in six rivers which had allegedly been depleted by groundwater abstraction. The objectives of the study were to identify the areas where flow had been depleted, to determine the extent to which restoration of river flow would be desirable and practicable and to evaluate the feasibility, costs and environmental impact of the various options for improvement. The consultant's report made detailed proposals for alleviating the low flow problem in each of the six rivers concerned. A further report set out a phased programme of implementation including further investigation work.

Responsibility for the alleviation of low flows (ALF) work has now passed to the NRA. In Feb 1990 the NRA's Board approved the inclusion of the ALF scheme in the capital expenditure programme.

The creation of the NRA coupled with the Thames initiative focused attention on the problem of derogated river flows throughout the country generally. Shortly after vesting day a brief survey of the nature and extent of the problem was undertaken by all the Regions. This identified some 92 instances where there was perceived to be a low flow condition attributed directly or indirectly to abstraction. Possible remedial works were suggested together with a rough indication of cost. Subsequently, the NRA announced its intention to proceed with urgent studies at 40 sites of which 20 were to be given a high priority.

Although some attempt was made to categorise the cases according to the nature and severity of the problem the approach was necessarily rather simplistic in the timescale available.

This project is concerned with the development of a methodology or procedure to standardise the classification of any artificially induced low flow problem. With the high cost of remedial work it is vital that such techniques are developed so that the NRA can target resources where they will be most cost effective.

Context

The project links closely with other projects in this Topic Area B2 (Flow regimes) but particularly so with Topic element 6b which is concerned with the development of a methodology to determine minimum acceptable flows. Liaison may also be required with work being done in Topic Area B3 (Water Resources Management).

Account should be taken of previous work done in this area. In particular, reference should be made to the work undertaken for Thames Water by Sir William Halcrow & Partners Ltd for the alleviation of low flows in rivers now managed by the Thames and Southern Regions of the NRA. However, it should not be assumed that the work done for that project necessarily provides a basis for this study which requires

a fresh approach. Where appropriate, liaison will be established and maintained with other contractors undertaking research in this topic area.

7. Strategy

Method

Review of existing problems and development of method of standardisation undertaken by external Research Contractor supervised by project leader. NRA Regions will provide support in the provision of local knowledge of the derogated rivers and in the provision of specific data.

Outline of Activities:-

- a) Establish inter-relationship of project with other elements of Topic Area B2 and with Topic Area B3.
- b) Review previous work and acknowledged cases of low flows due to abstraction.
- c) Visit each NRA region which has identified a problem to obtain relevant information and data. Seek the views and ideas of the regional water resources engineers/hydrologists.
- d) Establish whether there are any other low flow sites not previously identified and obtain data.
- e) Undertake review and develop basic framework of classification of the conditions.
- f) Produce interim report.
- g) Develop methodology for standardising assessment of the conditions.
- h) Identify and review, in outline, options for alleviating conditions.
- i) Identify criteria to be taken into account in setting standards for rehabilitation.
- j) Complete draft report.
- k) Finalise project report after review by NRA.

Monitoring

Project monitoring by Project Leader. Project contacts established in each relevant Region for reference and review.

Project Leader/Topic Leader review following item (f).

Project Leader/Topic Leader/Regional Project Contacts review draft report following completion of item (j).

8. Targets and Timescales

| | Date Completed | (Month) |
|----------------------------------|----------------|---------|
| (c) Visit each NRA Region | 31/8/90 | (1) |
| (f) Produce interim report | 31/10/90 | (3) |
| (j) Complete draft report | 31/1/91 | (6) |
| (k) Deliver final project report | 31/3/91 | (8) |

9. Outputs

| | |
|----------------------|-------------|
| Interim report | (15 copies) |
| Draft project report | (20 copies) |
| Final project report | (30 copies) |

10. Costs

| Item | NRA | | |
|----------------------|----------|----------|----------------|
| | External | Internal | Others(shared) |
| Staff | | (5000) | |
| Travel & Subsistence | | | |
| Capital Items | | | |
| Consumables | | | |
| Final Report | | | |
| Other Costs | | | |
| Total | - | (5000) | - |

Internal costs estimated as 20 man-days associated with visits to Regions and the provision of data/information: assumed absorbed within Regional operations budgets.

R & D Budget Provision (£k)

| Budget | 1990/91 | 1991/92 |
|--------|---------|---------|
| NRA | 27 | - |
| Others | - | - |

11. Benefits

The main purpose of this work is to develop methods which standardise the assessment of the conditions in a river which has been derogated by abstraction. It will also provide a basis for distinguishing between real and perceived conditions and to identify cases where action is justified.

Public expectation that the NRA will tackle the problem of low flows in rivers is high. The principal benefit of this research will be in providing the NRA with a procedure for prioritising alleviation schemes and targeting limited capital resources where it will be most beneficial. More generally, the work will contribute to the Topic

Programme which is aimed at improving the management of water resources against a background of growing demand for water and the need for adequate environmental protection.

ANNEX 2

EXPLANATORY LETTER SENT
TO EACH REGION PRIOR TO
DISCUSSION MEETING

90EXB

17th August 1990

Dear

Re: ALLEVIATION OF LOW FLOWS: NRA R&D PROJECT

We have been appointed Research Contractor for Topic B2.2 (Review of inherited low flow conditions) of the NRA R & D programme and are writing to you as the nominated contact for Region.

Our first task is to consult with each Region to determine for their Region:

- the type and extent of problems of low flows,
- the way in which these problems have been identified and assessed,
- the causes and effects of the problems,
- the potential solutions and whether any have been implemented

The primary objective of the study is to develop a standard method of assessment and classification of low flow conditions. In allocating necessarily limited resources to the alleviation of such conditions the standard method should demonstrate to every interest group that their demand has been fairly and equitably considered.

We anticipate that this standard method will be based upon a list of parameters. Each of these would be assessed against a range of criteria with appropriate weighting of both parameters and criteria.

We attach our first and very preliminary ideas for a framework of the parameters and criteria to be used.

We will shortly contact you by phone to arrange a meeting to discuss the problems of low flows in your Region. We would like to discuss our framework and modify it to take account of your views and experience.

Cont ...

Page 2

17th August 1990

As we would like to discuss both the Water Resources and Environmental aspects we would like to meet the appropriate personnel to cover both aspects.

We will also be trying to gather as much as possible in the way of data, reports and anecdotal information on the problems in your area.

We appreciate that there are many other competing demands on your time and we will try to keep our discussions as brief and to the point as possible.

Yours faithfully
for SCOTT WILSON KIRKPATRICK & PARTNERS

S. Puri

cc: - Anne Knape, CRC - Manchester
- Phil Kerrison, Norwich
- Tony Jones, Thames HRA (Project Manager)
- MLG

ANNEX 3

SUMMARY TABLES OF
DISCUSSION WITH EACH
REGION

Anglian NRA: Low Flow alleviation
Basic data availability & Parameter value

| Schedule A sites: | Site: | River Slea | Site: | Redgrave |
|-------------------|-------------------------------------|--------------------------|-------|----------------------------|
| A | OBJECTIVES | (see report by Halcrows) | | |
| | Where is problem ? | | | Redgrave & Lopham SSSI fen |
| | How serious is it ? | | | 'Bellamy' serious |
| | What form ? | | | loss of wetland |
| | Data reliability | | | reasonable |
| | Who is end user ? | | | 'spiders' & other bugs |
| | What is the cause ? | | | multiple causes |
| | What solutions ? | | | numerous |
| B | PARAMETERS | | | |
| (i) | Hydrological & Direct | | | |
| | Mean ann flow | | | not relevant |
| | Mean seasonal flow | | | not relevant |
| | Flow duration, ann | | | not relevant |
| | Probability of shortfall | | | not relevant |
| | frequency | | | not relevant |
| | magnitude | | | not relevant |
| | duration | | | not relevant |
| | Relation to MAF | | | None set in Region |
| | Stream length | | | not relevant |
| | Groundwater levels | | | declining |
| | Flow profiles | | | not relevant |
| | Ann water balance | | | possible parameter |
| | Channel size | | | not relevant |
| (ii) | Environmental & Indirect | | | |
| | Impact on R communities: | | | |
| | macrophytes | | | * all affected but |
| | algae | | | * not clear to |
| | invertebrates | | | * what extent |
| | fish | | | * |
| | phreatophytes | | | * |
| | Water Quality | | | to preserve quality |
| | Visual/landscape | | | ?? |
| | Recreation/ Amenity | | | car parks at site |
| | Classified sites | | | very high weighting |
| | Proximity to population | | | distant |
| | Public perception | | | v important |
| | Rarity value | | | RAMSAR site |
| | Abstraction | | | not relevant |
| C | CAUSES & SOLUTIONS | | | (see project F 03A) |
| | MAF based on: | | | |
| | visual/amenity | | | possibly |
| | on diversity of R comm | | | probably |
| | historical flows | | | no |
| | Water Quality | | | |
| | Water depth | | | |
| | Impact of solution | | | compensation to drainers |
| | Economics | | | ? |
| D | WEIGHTING OF PARAMETE | | | |
| | Degree of significance: | | | |
| | real/absolute | | | lesser ? |
| | perceived | | | greater ? |
| | Historic vs current | | | historic ? |
| | Absolute targets | | | not possible |
| | Cost of alleviation | | | some influence |
| | Disbenefits | | | anticipate none |

North West NRA: Low Flow alleviation
Basic data availability & Parameter usefulness

| Schedule A sites: | | Site: | Haweswater | Site: |
|-------------------|-------------------------------------|-----------------------------------|------------|-------|
| <hr/> | | | | |
| A | OBJECTIVES | | | |
| | Where is problem ? | whole sub catchment d/s reservoir | | |
| | How serious is it ? | much publicity, serious | | |
| | What form ? | at times dry streams | | |
| | Data reliability | good | | |
| | Who is end user ? | amenity & ecology | | |
| | What is the cause ? | over abstraction | | |
| | What solutions ? | new prescribed flow; releases | | |
| <hr/> | | | | |
| B | PARAMETERS | | | |
| (i) | Hydrological & Direct | | | |
| | Mean ann flow | | | |
| | Mean seasonal flow | | | |
| | Flow duration, ann | * if available, then good | | |
| | Probability of shortfall | * | | |
| | frequency | * | | |
| | magnitude | * | | |
| | duration | for nil overflows | | |
| | Relation to MAF | not set | | |
| | Stream length | dry upto intake | | |
| | Groundwater levels | not relevant | | |
| | Flow profiles | if available, good | | |
| | Ann water balance | a good broad brush indicator | | |
| | Channel size | ? | | |
| <hr/> | | | | |
| (ii) | Environmental & Indirect | | | |
| | Impact on R communities: | * time series data appropriate | | |
| | macrophytes | most readily ident parm | | |
| | algae | Imp Indicator of low flows | | |
| | invertebrates | | | |
| | fish | | | |
| | phreatophytes | | | |
| | Water Quality | water pristine qual | | |
| | Visual/landscape | * not critical | | |
| | Recreation/ Amenity | * | | |
| | Classified sites | if SSSI, higher weighting | | |
| | Proximity to population | used in NW's scoring system | | |
| | Public perception | not critical but valuable | | |
| | Rarity value | rare fish in Haweswater ! | | |
| | Abstraction | not relevant directly | | |
| <hr/> | | | | |
| C | CAUSES & SOLUTIONS | | | |
| | MAF based on: | | | |
| | visual/amenity | * balance of these | | |
| | on diversity of R comm | * | | |
| | historical flows | not relevant | | |
| | Water Quality | to be acceptable | | |
| | Water depth | not critical, width better | | |
| | Impact of solution | additional reservoir ! | | |
| | Economics | must have benefits | | |
| <hr/> | | | | |
| D | WEIGHTING OF PARAMETE | | | |
| | Degree of significance: | | | |
| | real/absolute | more significant | | |
| | perceived | | | |
| | Historic vs current | current | | |
| | Absolute targets | to better manage abstr'n | | |
| | Cost of alleviation | | | |
| | Disbenefits | | | |
| <hr/> | | | | |

Severn Trent NRA: Low Flow alleviation
Basic data availability & Parameter usefulness

| Schedule A sites: | | Site: | Dover Beck | Site: | Bow Brook |
|-------------------|-------------------------------------|--------------------------------|------------|------------------------------|-----------|
| <hr/> | | | | | |
| A | OBJECTIVES | | | | |
| | Where is problem ? | 2 to 3 Km/ponds/2 Km | | 10 Km length of stream | |
| | How serious is it ? | top section dry, 30 yrs? | | ? serious | |
| | What form ? | reduced dilution to STW | | reduced dilution to STW | |
| | Data reliability | generally good | | not too good | |
| | Who is end user ? | riparian/agric lic/nature res | | visual/ sewage dilution | |
| | What is the cause ? | groundwater lic of right | | urbanisation, STW discharge | |
| | What solutions ? | compensation pmping | | compensation g'water pumping | |
| <hr/> | | | | | |
| B | PARAMETERS | | | | |
| (i) | Hydrological & Direct | | | | |
| | Mean ann flow | Inadequate indicator | | * no data- flow gauging | |
| | Mean seasonal flow | no indication | | * stn d/s & irrelevant | |
| | Flow duration, ann | Irrelevant | | * | |
| | Probability of shortfall | irrelevant | | * | |
| | <i>frequency</i> | irrelevant | | * | |
| | <i>magnitude</i> | irrelevant | | * | |
| | <i>duration</i> | irrelevant | | * | |
| | Relation to MAF | irrelevant | | not set | |
| | Stream length | appropriate | | no information | |
| | Groundwater levels | good indicator | | no information | |
| | Flow profiles | sparse data, good indicator | | no information | |
| | Ann water balance | good indicator | | no information | |
| | Channel size | appropriate | | reasonable indicator | |
| <hr/> | | | | | |
| (ii) | Environmental & Indirect | | | | |
| | Impact on R communities: | | | | |
| | <i>macrophytes</i> | * factors not of prime | | * not considered at this | |
| | <i>algae</i> | * significance, not yet | | * stage | |
| | <i>invertebrates</i> | * considered | | * | |
| | <i>fish</i> | * | | * | |
| | <i>phreatophytes</i> | * | | * | |
| | Water Quality | objectives under consideration | | good at present | |
| | Visual/landscape | would score high | | * of considerable | |
| | Recreation/ Amenity | would score high | | * concern | |
| | Classified sites | section 8 of Water Act | | none affected | |
| | Proximity to population | important | | important factor | |
| | Public perception | important | | v important | |
| | Rarity value | accounted for above | | no rarity value | |
| | Abstraction | not prime importance | | not of prime concern | |
| <hr/> | | | | | |
| C | CAUSES & SOLUTIONS | | | | |
| | MAF based on: | | | | |
| | <i>visual/amenity</i> | principal restoration target | | main concern | |
| | <i>on diversity of R comm</i> | | | | |
| | <i>historical flows</i> | | | | |
| | Water Quality | quality improvement intended | | to improve quality | |
| | Water depth | possible solution | | | |
| | Impact of solution | ?? | | | |
| | Economics | ?? | | cost/benefit & PR | |
| <hr/> | | | | | |
| D | WEIGHTING OF PARAMETE | | | | |
| | Degree of significance: | | | | |
| | <i>real/absolute</i> | in final solution | | | |
| | <i>perceived</i> | in first instance | | as for Dover Beck | |
| | Historic vs current | current | | | |
| | Absolute targets | based on investigations | | | |
| | Cost of alleviation | cost/benefit assesment | | | |
| | Disbenefits | ?? | | | |
| <hr/> | | | | | |

Southern NRA: Low Flow alleviation
Basic data availability & Parameter usefulness

| Schedule A sites: | Site: | Darent | Site: | Lwr Rother |
|--------------------------|--|--------|------------------------------------|------------|
| <hr/> | | | | |
| A | OBJECTIVES | | | |
| Where is problem ? | Full length 6 km | | Marsh drying; land drainage | |
| How serious is it ? | stream is dry | | not serious | |
| What form ? | disrupts ecology & amenity | | irrigation not possible | |
| Data reliability | 4 gauging stns, good data | | land drainage good; wat res medium | |
| Who is end user ? | anglers, community, 2 licences | | NFU, farmer conflict interest | |
| What is the cause ? | groundwater abstraction | | reservoir releases, siltation | |
| What solutions ? | see Halcrow report (although this is under review) | | increased Darwell releases | |
| <hr/> | | | | |
| B | PARAMETERS | | | |
| (i) | Hydrological & Direct | | | |
| Mean ann flow | not too good a measure | | * all or any combination | |
| Mean seasonal flow | more realistic ? | | * to show ditches silting up | |
| Flow duration, ann | statistical approach | | * | |
| Probability of shortfall | appropriate | | * | |
| frequency | | | * | |
| magnitude | | | * | |
| duration | | | * | |
| Relation to MAF | Ecological Acc Flow' MMM idea | | not appropriate | |
| Stream length | Atkins studying whole length | | * not applicable | |
| Groundwater levels | valley bottom data na | | * not applicable | |
| Flow profiles | good indicator | | * not applicable | |
| Ann water balance | relevant; 70% abstracted | | * not applicable | |
| Channel size | v important in Darent | | depth more important | |
| <hr/> | | | | |
| (ii) | Environmental & Indirect | | | |
| Impact on R communities: | ?? contact: | | | |
| macrophytes | ?? John Cave 0732 838858 | | * Wetland: NCC concerned | |
| algae | ?? | | * | |
| invertebrates | ?? John Morgan 0903 820692 | | * | |
| fish | ?? (for fish, env, cons) | | * | |
| phreatophytes | ?? | | * | |
| Water Quality | ?? | | * | |
| Visual/landscape | v important | | * | |
| Recreation/ Amenity | v important | | * | |
| Classified sites | Roman villa, water cress | | declared conservation area | |
| Proximity to population | close | | irrelevant | |
| Public perception | major; DRIPS | | irrelevant | |
| Rarity value | unique, only Ch str to Thames | | NCC consider it rare | |
| Abstraction | affected | | licences affected | |
| <hr/> | | | | |
| C | CAUSES & SOLUTIONS | | | |
| MAF based on: | | | | |
| visual/amenity | 'Ecologically accepted flow' | | * not applicable | |
| on diversity of R comm | has been suggested | | * | |
| historical flows | cress beds, pubs, anglers | | levels for abstraction | |
| Water Quality | river of good quality | | for crops | |
| Water depth | adequate for fish | | adequate for pumps | |
| Impact of solution | generally positive | | potential water logging | |
| Economics | ? cost/benefit | | licence fee from new holders ? | |
| <hr/> | | | | |
| D | WEIGHTING OF PARAMETER | | | |
| Degree of significance: | | | | |
| real/absolute | | | significant | |
| perceived | more important | | less important | |
| Historic vs current | data from '67; abstn from '50's | | based on current | |
| Absolute targets | absolute not important | | important | |
| Cost of alleviation | Halcrow report; review req'd | | estimate made; Darwell mgmt | |
| Disbenefits | | | water logging | |

South West NRA: Low Flow alleviation
Basic data availability & Parameter usefulness

| Schedule A sites: | Site: | Tawmarsh | Site: |
|--|------------------------------|----------|-------|
| A OBJECTIVES | | | |
| Where is problem ? | the whole stream length | | |
| How serious is it ? | v significant, political | | |
| What form ? | Fisheries, quality objective | | |
| Data reliability | reliable | | |
| Who is end user ? | the river I | | |
| What is the cause ? | groundwater abstraction | | |
| What solutions ? | cease abstraction | | |
| B PARAMETERS | | | |
| (i) Hydrological & Direct | | | |
| Mean ann flow | not available; irrelevant | | |
| Mean seasonal flow | not available; irrelevant | | |
| Flow duration, ann | not available; irrelevant | | |
| Probability of shortfall | not available; irrelevant | | |
| frequency | not available; irrelevant | | |
| magnitude | not available; irrelevant | | |
| duration | not available; irrelevant | | |
| Relation to MAF | not available; irrelevant | | |
| Stream length | unknown, fisheries interest | | |
| Groundwater levels | no data; winter above gl | | |
| Flow profiles | some available | | |
| Ann water balance | not applicable | | |
| Channel size | the whole marsh | | |
| (ii) Environmental & Indirect | | | |
| Impact on R communities: | | | |
| macrophytes | ?? | | |
| algae | impact important | | |
| invertebrates | ?? | | |
| fish | main impact | | |
| phreatophytes | ?? | | |
| Water Quality | could be an indicator | | |
| Visual/landscape | objective assesmnt difficult | | |
| Recreation/ Amenity | ?? | | |
| Classified sites | critical if SSSI, etc | | |
| Proximity to population | much of site distant | | |
| Public perception | riparian owners have views | | |
| Rarity value | as for SSSI | | |
| Abstraction | not affected | | |
| C CAUSES & SOLUTIONS | | | |
| MAF based on: | | | |
| visual/amenity | on all these aspects | | |
| on diversity of R comm | | | |
| historical flows | | | |
| Water Quality | flow restoration alone will | | |
| Water depth | not resolve all the | | |
| Impact of solution | problems | | |
| Economics | | | |
| D WEIGHTING OF PARAMETE | | | |
| Degree of significance: | | | |
| real/absolute | | | |
| perceived | | | |
| Historic vs current | | | |
| Absolute targets | from local pressure | | |
| Cost of alleviation | | | |
| Disbenefits | | | |

Thames NRA: Low Flow alleviation
Basic data availability & Parameter usefulness

| Schedule A sites: | | Site: | Misbourne | Site: | River Colne (Hert) |
|-------------------|-------------------------------------|--------------------------------------|-----------|---------------------------------|--------------------|
| <hr/> | | | | | |
| A | OBJECTIVES | | | | |
| | Where is problem ? | well established locations | | Chalk/Bldr Clay intface | |
| | How serious is it ? | known to be serious | | 'no longer as it used to be' | |
| | What form ? | dry bed conditions | | dry bed unsightly | |
| | Data reliability | reliable | | not too good | |
| | Who is end user ? | riparian owners, amenity interest | | amenity interests | |
| | What is the cause ? | overlicensed abstractions | | land drainage road development | |
| | What solutions ? | local aquifer management | | recirculation, bed sealing | |
| <hr/> | | | | | |
| B | PARAMETERS | | | | |
| (i) | Hydrological & Direct | | | | |
| | Mean ann flow | 10 yr data from d/s station | | none of these apply | |
| | Mean seasonal flow | better indicator than above | | | |
| | Flow duration, ann | * prefer not to use | | | |
| | Probability of shortfall | * statistical basis | | | |
| | frequency | * as a measure | | | |
| | magnitude | * | | | |
| | duration | * | | | |
| | Relation to MAF | none set in Region | | | |
| | Stream length | 60% of stream; poor measure | | | |
| | Groundwater levels | good records; good measure | | not clear, swallow holes | |
| | Flow profiles | useful measure | | | |
| | Ann water balance | valuable measure | | | |
| | Channel size | good measure; isolate human affect | | | |
| <hr/> | | | | | |
| (ii) | Environmental & Indirect | | | | |
| | Impact on R communities: | | | | |
| | macrophytes | these are groups; | | Biological Indicators important | |
| | algae | * river, wet pastures | | | |
| | invertebrates | * all affected | | | |
| | fish | * add "vertebrates" | | | |
| | phreatophytes | * | | | |
| | Water Quality | could be indicator | | | |
| | Visual/landscape | good indicator | | | |
| | Recreation/ Amenity | good indicator | | | |
| | Classified sites | not too important | | | |
| | Proximity to population | ? | | | |
| | Public perception | important factor | | Parish Cncl concern | |
| | Rarity value | important | | | |
| | Abstraction | unclear | | | |
| <hr/> | | | | | |
| C | CAUSES & SOLUTIONS | | | | |
| | MAF based on: | | | | |
| | visual/amenity | | | targets: r community & | |
| | on diversity of R comm | | | visual | |
| | historical flows | | | | |
| | Water Quality | not critical | | | |
| | Water depth | ecological constraint; flow required | | | |
| | Impact of solution | | | | |
| | Economics | | | costs: relatively low | |
| <hr/> | | | | | |
| D | WEIGHTING OF PARAMETE | | | | |
| | Degree of significance: | | | | |
| | real/absolute | | | | |
| | perceived | | | | |
| | Historic vs current | | | | |
| | Absolute targets | | | | |
| | Cost of alleviation | | | | |
| | Disbenefits | | | | |
| <hr/> | | | | | |

Wessex NRA: Low Flow alleviation
Basic data availability & Parameter usefulness

| Schedule A sites: | Site: | Piddle | Site: | Wey |
|--|----------------------------------|--------|-------------------------------|-----|
| A OBJECTIVES | | | | |
| Where is problem ? | 60% of length/Dorset Frome | | springs affected by PWS | |
| How serious is it ? | affecting fisheries | | serious | |
| What form ? | ? | | dry springs, fishery wat qual | |
| Data reliability | hydro data substantial | | ?? | |
| Who is end user ? | riparian owners, fishery | | tourist & trout farm | |
| What is the cause ? | groundwater abstraction | | PWS groundwater abstraction | |
| What solutions ? | none yet; revoke ? | | PWS management scheme | |
| B PARAMETERS | | | | |
| (i) Hydrological & Direct | | | | |
| Mean ann flow | Inadequate | | (records since '75) | |
| Mean seasonal flow | Inadequate | | Inadequate | |
| Flow duration, ann | Inadequate; Q95 not meaningful | | Inadequate | |
| Probability of shortfall | as above | | Inadequate | |
| frequency | as above | | Inadequate | |
| magnitude | as above | | Inadequate | |
| duration | as above | | Inadequate | |
| Relation to MAF | Not set, variable annually req'd | | Inadequate | |
| Stream length | ?? | | ? appropriate | |
| Groundwater levels | obsn holes req'd | | no data | |
| Flow profiles | available, but unused | | useful parameter | |
| Ann water balance | recharge vs abstrn- best | | ? valuable | |
| Channel size | ?? | | ? | |
| (ii) Environmental & Indirect | | | | |
| Impact on R communities: | biol monit, indir msr of qual | | | |
| macrophytes | | | | |
| algae | | | | |
| invertebrates | better, because of mobility | | | |
| fish | most important | | fish farm- licensed abstrn | |
| phreatophytes | | | | |
| Water Quality | affects algae, phosphate | | | |
| Visual/landscape | * as they affect | | important | |
| Recreation/ Amenity | * fishery interests | | important | |
| Classified sites | water meadow SSSI's | | Radipole lake | |
| Proximity to population | important indicator | | | |
| Public perception | important indicator | | | |
| Rarity value | if classified then yes | | | |
| Abstraction | PWS affected, some private | | | |
| C CAUSES & SOLUTIONS | | | | |
| MAF based on: | | | | |
| visual/amenity | | | management of source/storage | |
| on diversity of R comm | | | | |
| historical flows | unrealistic | | | |
| Water Quality | target objectives | | | |
| Water depth | for ecology | | | |
| Impact of solution | increase in charges | | | |
| Economics | ?? | | | |
| D WEIGHTING OF PARAMETERS | | | | |
| Degree of significance: | | | | |
| real/absolute | long term importance | | | |
| perceived | short term importance | | | |
| Historic vs current | | | | |
| Absolute targets | | | | |
| Cost of alleviation | | | | |
| Disbenefits | | | | |

Yorkshire NRA: Low Flow alleviation
Basic data availability & Parameter usefulness

| Schedule A sites: | Site: | West Ayton | Site: | West Driffeld |
|--------------------------|-------------------------------------|------------|--------------------------------|-------------------------|
| <hr/> | | | | |
| A | OBJECTIVES | | | |
| Where is problem ? | 6 Km length esp swallow holes | | Chalk springhead area | |
| How serious is it ? | regional & local significance | | v serious | |
| What form ? | dry bed conditions in drought | | dry winterbourne Chalk springs | |
| Data reliability | good | | not good | |
| Who is end user ? | Yorks Water, spray irrig, SSSI | | riparian owners, trout fishery | |
| What is the cause ? | natural (swallow holes) & PWS | | natural drought conditions | |
| What solutions ? | diversion channel for low flows | | compensation pumping | |
| <hr/> | | | | |
| B | PARAMETERS | | | |
| (i) | Hydrological & Direct | | | |
| Mean ann flow | not good indicator | | * flows measured, | |
| Mean seasonal flow | not good indicator | | * but parms irrelevant | |
| Flow duration, ann | a form of it (see report) | | * because stream dry at times | |
| Probability of shortfall | * length of | | * | |
| frequency | * precludes these | | * | |
| magnitude | * | | * | |
| duration | * | | * | |
| Relation to MAF | not set in Region | | not set | |
| Stream length | no, due to peculiarity | | important | |
| Groundwater levels | no, due to peculiarity | | good indicator | |
| Flow profiles | if min flows set | | ?? | |
| Ann water balance | not in this case ! | | good indicator | |
| Channel size | no, channel changes | | | |
| <hr/> | | | | |
| (ii) | Environmental & Indirect | | | |
| Impact on R communities: | | | | |
| macrophytes | * data available but | | | |
| algae | * not appropriate in | | | |
| invertebrates | * this case | | | |
| fish | * | | | Important, fish farming |
| phreatophytes | * | | | |
| Water Quality | storm sewer overflows | | | |
| Visual/landscape | good indicator | | | |
| Recreation/ Amenity | public pressure | | | |
| Classified sites | only if SSSI's affected | | | area in SSSI |
| Proximity to population | Important Indicator | | | |
| Public perception | important indicator | | | paramount importance |
| Rarity value | not in Ayton | | | probably important |
| Abstraction | not critical | | | |
| <hr/> | | | | |
| C | CAUSES & SOLUTIONS | | | |
| MAF based on: | | | | |
| visual/amenity | Important | | | |
| on diversity of R comm | irrelevant | | | maintain fishery |
| historical flows | gen inapplicable | | | |
| Water Quality | not aimed at improving qual | | | |
| Water depth | not relevant | | | |
| Impact of solution | abstraction/aquifer purge | | | |
| Economics | cost important | | | v important |
| <hr/> | | | | |
| D | WEIGHTING OF PARAMETER | | | |
| Degree of significance: | | | | |
| real/absolute | more important | | | |
| perceived | NRA should not spend on this | | | political pressure |
| Historic vs current | current; historic unsuitable | | | |
| Absolute targets | maintain seasonally var flow | | | |
| Cost of alleviation | has to be important | | | disregard ?? |
| Disbenefits | ?? | | | "what about my river" |
| <hr/> | | | | |

ANNEX 4

SUMMARY OF REGIONAL
PROBLEMS AND
PERCEPTIONS

ANNEX 4

SUMMARY OF REGIONAL PROBLEMS AND PERCEPTIONS

The following summaries represent the overview of each Region's problems and perceptions which we obtained from a single visit to each Region.

Appreciating that perhaps not all Regions have a comprehensive policy on low flows and that it is difficult to summarise such multi-faceted problems in one paragraph we have not refrained from statements which might be seen as provocative.

We anticipate, and hope, that the Regions will react to these summaries and tell us how our perceptions differ from their policies.

ANGLIAN REGION

Anglian confirmed that the list of low flow sites is as the Roger Cook Survey.

The consultation provided an overview of the whole Regional situation.

The low flows are primarily caused by over-abstraction of groundwater from Chalk aquifers under Licences of Right. The problems are real and current with a number of rivers suffering severely reduced flows. The problems occur on headwaters mainly but with some middle courses affected.

Low flows are viewed primarily as a water resources problem with studies being driven by water resources staff with some input from conservation staff.

Some considerable data is available and some studies have been carried out but the problems have not been comprehensively studied.

There is strong public pressure for action from high-profile public figures (e.g. David Bellamy).

Some alleviation measures have been implemented based on groundwater support to low flows but these are local, 'fire-fighting' measures rather than fully integrated schemes as part of a comprehensive strategy. Such measures are based on restoration to specified target flows and not 'historic' flows.

SEVERN TRENT REGION

Severn Trent confirmed the list of low flow sites as the Roger Cook survey with some minor reclassification of category of problem.

The consultation provided an overview of the Regional situation, from a Water Resources perspective with conservation in the background.

The low flows are caused by over-abstraction of groundwater and are real, current problems, occurring on headwaters to middle courses. Some rivers run dry but the ecological impact of this has not been assessed.

There is some public pressure arising from visual/amenity aspects but not as strong as in other regions. Low flow studies have started recently so the problems are as yet imperfectly understood.

No alleviation measures have been tried and proposals are not yet formulated but are most likely to be based on groundwater support.

The view was expressed that Alleviation of Low Flows is driven by a Public Relations need.

SOUTHERN REGION

Southern indicated that the list of low flow sites is thought to be as the Roger Cook survey. The consultation was with a water resources officer from one division and provided a divisional rather than regional view.

Low flows are primarily caused by over-abstraction of groundwater (mainly Chalk aquifers) under Licences of Right but there are also some reservoir release problems. The problems are real and current and affect headwaters and middle courses and in the case of Darent, the lower course. The River Darent (transferred from Thames to Southern and previously studied by Thames RWA) has well publicised problems and is the subject of strong public pressure from the Darent River Presentation Society.

Our consultation was water resource orientated but we are aware of conservation concerns in Southern Region. The problems have not been comprehensively studied apart from the R Darent. Southern Region are re-evaluating the Darent study and have initiated a study to assess a Minimum Environmentally Acceptable Flow, i.e. they are aiming for specific target flows.

Some ad-hoc alleviation measures using groundwater support have been tried but not continued or closely monitored and are 'fire-fighting' measures.

SOUTH WEST REGION

South West indicated that the sites listed in the Roger Cook survey are to be superseded by a new assessment currently under way (report received during the study).

The new assessment is based on a definition of potential low flow sites as those where the sum of the licensed abstraction quantities under Licences of Right exceeds 20% of the 'theoretical' or 'natural' 95 percentile flow. The consultation provided an overview of the whole Regional situation and was fully multi-disciplinary with no one discipline in the lead.

Low flow problems are real and current with a potential further deterioration if currently under-abstracted licenses are fully taken up. Causes include surface water and groundwater abstraction, changing land use and increased land drainage and are not restricted to the upper reaches; whole catchments are affected including estuaries.

Some studies have been carried out but the Region considers them to be very limited and based on inadequate data. There is public pressure and the question of low flows is highly political but the view was expressed that the absolute needs of the rivers, objectively assessed, should overrule public pressure and that restoration should be to 'historic' or 'natural' flows.

Fish populations are considered to be a good indicator of low flow impacts because of strong fishing interests and hence it is a noticed/ reported/'complained about' impact.

Limited work has been done on implementation or alleviation projects but buying out or varying Licences of Right amendments to reservoir operations and substituting surface water (impounded supplies) for groundwater abstractions are being pursued.

THAMES REGION

Thames confirmed that the low flow sites are as the Roger Cook survey. The consultation provided a Regional overview.

Low flows are primarily caused by over-abstraction of groundwater from Chalk aquifers under Licences of Right leading to severely reduced low flows and long dry sections. The problems are real and current and mostly affecting headwaters.

The problems are much-studied and relatively good data exists for at least some of the sites.

Low flows are viewed as equally a Water Resources and Conservation problem with Water Resources leading, since exploitation of water resources is the cause of the problem.

There is strong public pressure for alleviation of low flows. The pressure is well-organised and influential but subjective and focussed on particular issues. The public concern tends to be in respect of landscape amenity e.g. The Chiltern Society.

Specific alleviation measures have been proposed but not yet implemented. These include groundwater support, channel lining and 'created environment' to restore habitats and re-construct landscapes.

The alleviation proposals are local 'fire-fighting' measures rather than a comprehensive strategy and are based on restoration to specified target flows and not historic flows.

NORTHUMBRIAN REGION

In a telephone discussion Northumbrian confirmed that the situation is as the Roger Cook survey, i.e. that artificially induced Low Flows are not a problem in the region.

NORTH-WEST REGION

North West confirmed the list of low flow sites as the Roger Cook survey.

The consultation provided a broad regional overview from a full range of water resources and conservation disciplines with an integrated approach.

The low flow problem is primarily a conservation problem in a surface water area and arises from the development of and management of releases from surface water reservoirs. In particular catchment transfers leave downstream tributaries depleted except during winter spill.

The problems are not well studied but are well appreciated.

No alleviation measures have been implemented and no solutions are currently being pursued but discussions are under way with NW Water Plc on the overall operation of the reservoirs. Likely solutions will involve re-negotiation of compensation releases and the introduction of facilities for release from tributary reservoirs.

There is some public perception of the problem but there is not such strong pressure as in other regions.

WELSH WATER

Welsh Region confirmed that the low flow sites are as the Roger Cook survey. The consultation was orientated towards South-Western division in respect of Water Resources but Regional in respect of conservation.

The problems are potential in SW division but real and current in N and SE divisions and arise from over-abstraction of surface and groundwater resources under Licenses of Right. There is concern that Licenses of Right are not yet abstracted to their licenced quantity and the potential for further LoR abstractions has to be taken into account in assessing applications for irrigation licences.

Welsh Water RWA had a draft licencing policy which set methods of assessing a Minimum Environmental Flow (MEF) and an Acceptable Duration of MEF. This draft policy was not formally adopted but is used informally by the Region.

Welsh are concerned for the impact of low flows on Water Quality since discharge consents are related to Q95. They would like Licences to be conditioned to ensure that the MEF is left in the river.

Low flows are viewed as a conservation problem as much as a water resources problem and studies are driven by both disciplines.

MEF is related to Q95 based on 1941 to 70 historic data with transposition of data from gauged catchments to similar ungauged catchments.

There is public pressure from the NCC and National Parks and Monmouth Rowing Club! but Welsh Region like to give precedence to objective data rather than (subjective) public pressure.

Welsh have a particular problem with exempt abstractions under the 1963 Act, now being converted to Licences of Entitlement.

The view was expressed that salmonid are the most useful/important indicator species because:

- i) they are high in the food chain
- ii) they are the focus of public pressure
- iii) they are a sensitive indicator
- iv) much data is available due to a policy of annual electrofishing at 100 sites since 1974
- v) they will die before the landscape/amenity is noticeably affected.

Welsh also propose (and in some cases have implemented) that storage reservoirs should have a proportion of the stored volume under the control of the conservation officer for release when he deems necessary.

WESSEX REGION

Wessex confirmed the list of low flow sites as the Roger Cook survey but indicated that there are more sites, not subject to public pressure, which they will wish to bring forward in the future.

The consultation provided an overview of the whole Regional situation.

The low flows are caused by groundwater abstraction under Licences of Right and are real and current with severely reduced flows in headwaters and some middle courses. Low flows are viewed as both a water resources and conservation problem.

The problems have been 'much studied' but in the Regions view the studies were not conclusive.

There is much public pressure from river protection societies, CPRE, CLA and public figures such as David Puttenham. Wessex have initiated some alleviation measures with mixed results. Bed lining has not been too successful since 'leaky' beds convey water back from groundwater to surface water in the winter causing 'wash outs'.

Wessex region implied a preference for strategic solutions rather than local 'fire-fighting and to this end have a number of catchment models in development. Revoking or modifying licences may only transfer the problem elsewhere.

Alleviation would be to specific target flows, not 'historic' flows. Targets may be based on visual/amenity or (higher flows) for good fisheries. Priorities are set by Public Pressure.

The region drew attention to the related but different problem of flow depth - reduced due to the policy of removing weirs for Land Drainage but some landowners now impounding to restore depths.

The main user of water is Public Water Supplies and the alleviation of low flows would put up the cost of water.

The need for resources to implement any low flow assessment/alleviation programme was strongly stressed.

YORKSHIRE REGION

Yorkshire confirmed the list of low-flow sites as the Roger Cook survey but advised that the River Foss is upgraded to Category A.

The consultation provided an overview of the Regional situation which was balanced and well-researched.

The low flows are primarily caused by over-abstraction of groundwater under Licences of Right with some specific local problems (e.g. a 'swallow' hole in a river bed).

The problems are real and current and are seen as primarily water resources problems with a strong conservation dimension. The problems occur in headwaters to middle courses.

Fairly good data exists and the problems have been studied in reasonable depth.

There is some public pressure but there has been concern within the RWA for many years over low flows and this is reflected in the availability of data and studies. There is also pressure from Yorkshire Water Plc on water quality grounds.

Proposals for alleviation measures exist but have not been implemented. These include some local 'fire-fighting' proposals but also a well-developed strategy for positive environmental enhancement.

ANNEX 5

STATUS REPORT ON OTHER
R&D PROJECTS

ANNEX 5

STATUS REPORT ON OTHER R&D PROJECTS

Project 012 - Impact of farm pollution on river pollution - Topic Leader David Palmer (Wessex).

This work is co-ordinated by Frank Jones (Llanelli office) and the contractor in WRc. It is a well designed study in which invertebrate community structure is assessed in detail by the use of multivariate statistics. The aim is to assess the impact of dairy farming in West Wales on small headwater streams and to develop a protocol suitable for nationwide application. Sites were selected in areas where stresses on the aquatic community from factors other than farm pollution were unlikely to occur, so the study will not provide data directly relating to low flows. However, it could be of value in revealing the invertebrate community characterising unstressed stream headwaters in West Wales. This would provide baseline or control data. The study also provides information concerning the distribution of game fish which would be relevant to the low flow appraisal system.

The discussions with Frank Jones also revealed a study entitled 'Effects of abstraction on fisheries' carried out by Welsh Water during 1986. The study concluded that juvenile salmonid population densities declined as flow decreased due to abstraction. Various causes were suggested. Movements of adult fish and changes in the fishery resulted. Higher flows enhanced the survival of smolt. This study provides information which will be relevant to low flow appraisal.

Project 114 - Impact of Forestry on upland quality - Topic Leader Alistair Donald (Welsh)

Discussions by telephone with Alistair Donald yielded the following information. The study has been carried out in the Plynlimon experimental catchments at the headwaters of the Rivers Wye and Severn. Surface water acidity is influenced by the buffering capacity and chemistry of soil in a

catchment area. Direct precipitation contributes to acidification but the effect is greatly exacerbated by land use changes such as afforestation with conifers. Acidification increases the solubilities of minerals and metals such as aluminium which is extremely toxic. Afforestation lowers water yield from a catchment, which may be relevant to us but reduces the amount of acid reaching water courses. High flows which scavenge aluminium from rocks with low calcium components are a problem.

The area has been extensively studied by IOH during the past twenty years and their findings may be of value to us. The studies may yield relevant water quality data but only limited baseline ecological information, most of which will concern the distribution of trout in streams in Mid Wales.

Project A10.2 - Pesticide effect on river ecology - Topic Leader Alistair Ferguson (Anglian)

Alistair Ferguson informed us that this project would be part MAFF funded but that work was not due to begin until 1990-91. Again, it may yield data on the distribution of aquatic communities in the study regions, which could be of value as baseline information against which to measure the impact of low flows.

Project B2.1 - Integrated environmental flow monitoring - Topic Leader Mike Owen (Thames)

This is a joint IOH/IFE study of ecological/hydrological aspects of low flows which have been artificially induced in catchments. Clearly, such information would be of greater value to anyone attempting to devise a low flows assessment method. Unfortunately, our telephone conversation with Mike Owen revealed that the work has not yet started and that the course of the research has not been determined. He said that they were keeping a very open mind about what might or might not come out of the study.

We understand that the aim is to develop an integrated package to enable catchment water management and that the model developed should enable water quality, ecological and hydrological variables to be assimilated. We will discuss this and other work with IOH in stage 2 of our Study to discover the scope of their past present and future research.

Project A1.2 - Effect of headwater abstraction on river quality - Topic Leader David Stott (Thames)

Not yet investigated.

Project F1.11 - Impact of Flow Regimes on Wildlife - Project Leader Alistair Ferguson (Anglian)

A discussion with Alistair Ferguson by 'phone yielded the following.

1. F1.11 is being carried out in conjunction with project B02.1.
2. Fieldwork will be carried out next year (1991) and no results can be expected within the time frame of our study.
3. The setting of minimum acceptable flows as blanket figures will not be an objective. However, the development of methods and modelling tools for setting M.A.F.'s for particular circumstances is an objective.
4. It is not yet decided what data is to be collected but as a first guess the data required for PHABSIM is a good starting point.

AF suggested we contact him for an update early next year.

Projects F01.10 and F01.27. Topic Leader Katharine Bryan (Severn Trent).

Summary of telephone conversation with K Bryan

The 'environmental' projects most closely allied this study are F01.10

Environmental Assessments and F01.27 Landscape Appraisal Methodology. The latter is currently out to tender, whilst the former is concentrating primarily on flood defence works and is not thought to be directly relevant to this study. Although the Low Flows study will provide an overview to the Landscape Appraisal Methodology, to date the programme for the latter has not been confirmed, so it is doubtful if there will be any overlap.

REFERENCES

LIST OF NRA REPORTS RECEIVED FOR LOW FLOWS PROJECT

GENERAL

NRA (Jan 1990?) Extent of Over-Abstraction upon River Flows

NRA (June 1990) NRA Research & Development Programme - Delegates Information Pack for the Open Forum Meeting at the University of Birmingham, 5th June 1990.

ANGLIAN REGION

Sir William Halcrow & Partners (April 1987) River Slea Summary Report

Sir William Halcrow & Partners (April 1987) River Slea Investigation Final Report, Volumes 1 & 2

NORTHUMBRIAN REGION

NORTH WEST REGION

SEVERN TRENT REGION

Scott Wilson Kirkpatrick (May 1990) Study Options for Alleviation of Low Flows (Severn Trent Region) Technical and Financial Proposal

SOUTHERN REGION

SOUTH WEST REGION

Halcrow (Sept 1990) Low Flows Study Inception Report

THAMES REGION

THAMES WATER

Scott Wilson Kirkpatrick, Hydrotechnica & the Freshwater Biological Association (Oct 1986) Feasibility Study : Alleviation of Low River Flows Resulting from Groundwater Abstraction - Technical Proposal

Halcrow (May 1987) Study of Alleviation of Low River Flows Resulting from Groundwater Abstraction - Interim Report

Main Report

Annex A - River Darent Case Study

Annex B - River Misbourne Case Study (2 copies held)

Halcrow (April 1988) Study of Alleviation of Low River Flows Resulting from Groundwater Abstraction - Final Report

Volume 1 - Main Report

Volume 2 - Darent Case Study (Jan 1988)

Volume 3 - Misbourne Case Study

Volume 8 - Annexes (A. Hydrology, B. Engineering & Costs, C. Fishery Management, D. Pipeline Restoration)

NRA THAMES

Scott Wilson Kirkpatrick (July 1990) Low Flow Conditions - Proposal No. B2.2 (NRA Research & Development Programme Topic B2: Flow Regions)

THE CHILTERN SOCIETY

Wotton, W A (1987) To Rescue A River

Wotton, W A (1990) Misbourne Miscellany

WELSH REGION

WELSH WATER (May 1988) Guideline for Management of Water Abstraction in the Environment

WESSEX REGION

Wessex Water Authority, Avon & Dorset Division (Oct 1988) River Piddle Investigation - Appendix II (N.B. App A superceded by Dec 1988 report)

YORKSHIRE REGION

YORKSHIRE WATER

Howard Humphreys in assoc. with Cremer & Warner (July 1986) Management of River Abstraction in North Yorkshire