AN ASSESSMENT OF THE CURRENT AND POTENTIAL ROLE OF FLUVIAL GEOMORPHOLOGY IN SUPPORT OF SUSTAINABLE RIVER MANAGEMENT PRACTICE IN SOUTH AFRICA

A report to the Water Research Commission based upon a grant-aided visit to South Africa (hosted by Dr KM Rowntree, Rhodes University) between January 24th and February 8th 1995.

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Introduction

Fluvial geomorphology seeks to understand the complex behaviour of river channels at a range of scales from cross-section to catchment. However, perhaps the most individual item on its research agenda is that it seeks to investigate this range of processes and responses over very long timescales, normally within the most recent climate cycle (i.e. several thousand years). Much of its field can only be studied qualitatively, and this, together with the fact that geomorphology has traditionally been taught in university Geography or Geology departments, has led to the impression of (at best!) an inexact science. Engineers, who have needed the information which geomorphology can potentially provide, have often been put off by a lack of professional identity by the practitioners.

In the last decade, however, several developments have occurred, notably in the UK and USA, which have brought fluvial geomorphologists into the centre of river system management. The first development is the favour enjoyed by holistic treaments of the entire river basin system, a contrast to the era characterized by reach-scale, problem-solving 'can do' civil engineering. The second development is that, following a twenty-year association with hydrology in making quantitative measurements, the empirical base and quantitative predictive power of fluvial geomorphology has increased enourmously. In view of what is written below it should be stressed at this point that empiricism is inevitable because of the huge range of geological, climatological and land-use impacts on the process-response system of river channels. Quantification has, however, also been improved for the timescales of geomorphology - by improved dating of events and horizons. Finally, river managers are at last becoming prepared to enlist the support of a wide range of experts in setting the agenda of sustainable management (or at the shorter timescale, of assessing environmental impacts of individual developments); fluvial geomorphology is one of a number of 'new' river basin disciplines contributing to management information and modelling.

Perhaps the best demonstration of 'new think' in river management was provided on my return from South Africa to a Western Europe which had been ravaged by 'rare', damaging floods in late January. Press comment placed the 'blame' squarely on unplanned floodplain development and human-induced increases in runoff, rather than inadequate protection. Resource management in the 'New Environmental Age' seeks, more than ever before, to work with the forces of nature rather than to control them; fluvial geomorphology helps us to understand the forces which form and maintain river channels and floodplains over the long timescales which we must understand under every definition of 'sustainability'.

Research themes of the visit

Two themes permeated the visit (Itinerary see Appendix A): geomorphological characterization of channel habitats for instream (and riparian) biota, and catchment management planning. These represent not only the recent trajectory of the Newcastle University research group which I head but also two pressing needs of South Africa in the field of water management (Stoffberg et al., 1994). Dr Rowntree skilfully arranged the visit to be both wide and deep, the width being provided by a very hectic travel schedule from east to south to west, and the depth coming from spending sufficient time with specialists on site, from detailed seminar presentations and from the workshop on 'Modelling the effects of changing flows on Physical Biotopes' at Citrusdal, Western Cape, in which very considerable progress was made on techniques of assessing instream habitats.

During my visit I made contacts with the following WRC-supported projects:
a. The 'Wits' CWE study of the Sabie River in Kruger Park,
b. The Rhodes (Geography) geomorphological classification project,
c. The Rhodes (IWR) research on hydrological modelling, groundwater & low flows,
d. The FORESTEK study of the hydrological impacts of afforestation (NE Cape),
e. The University of Cape Town evaluation of instream habitat methods/models.

This report will deal in more detail with the following specific research and applications arranged according to the Itinerary:

1. Geomorphology and management of the Sabie River, Kruger National Park,
2. Habitat hydraulics and instream assessment: Kruger plus Buffalo River Eastern Cape, Olifants River Western Cape (including Workshop),
3. Channel change and rural channel/ land-use management (including forestry): North East Cape,
4. Catchment Management Planning: (Rhodes University, Jonkershoek, DWAF Pretoria).

1. Geomorphology and management of the Sabie River, Kruger National Park

At this site I spent four days in the company of two teams of researchers: those from Rhodes (Geography) who participate in the Sabie Joint Project and a larger team from the Centre for Water in the Environment at Witwatersrand who take a broader interdisciplinary approach to field studies in the Park (CWE, 1994). The two approaches are made compatible by the scale framework provided by Rowntree and Wadeson (in press) and Wadeson and Rowntree (in press). The Wits group have adopted this structured approach (van Niekerk et al, undated; van Niekerk and Heritage, 1994) which I consider essential bearing in mind the size of the basin and the need to extrapolate quantitative findings from necessarily small-scale research sites to the whole system. Thus, Wits are working on the impacts of changing flow and sediment delivery regimes on river response at the catchment scale, but within the same frame, are looking at riparian vegetation and channel habitat features (essential to the conservation aims of the Kruger National Park) in relation to detailed hydraulic conditions. In my experience the Sabie River Project is potentially a unique contribution; it has overcome some severe logistical problems and is delivering internationally relevant papers. As strategic research it is vulnerable in today's economic climate but should be encouraged in the light of the international focus on Kruger and the need for knowledge-based decisions (see below).

The Sabie channel, like many I saw in South Africa, is considerably influenced by bedrock controls. It became a point of detailed discussion to reconcile habitat assessment approaches between the different fluvial conditions of the UK - where glaciation and shallow weathering predominate - and South Africa, apparently not glaciated recently but with much deeper weathering profiles. The flow regime of South African rivers, though more extreme, is also more seasonal, making truly low-flow surveys more feasible and meaningful than in the unpredictably humid conditions of the UK. The important point is that the field-based empirical approach, backed by good data processing and a desire on the part of the research teams to make useful predictions, is essential to South Africa if the nation is not merely to (incorrectly) apply the alluvial process-response models of Europe and the USA. The other 'unique' circumstances of the Sabie include the unpredictable drought regime, extremely steep flood probability curves - typical of South Africa (Alexander, 1994; Jordaan, 1994), increasing pressure for dam building (upstream and downstream of the Park) and land-use practices (e.g. Sand catchment) which are apparently increasing sediment yields.

My visit to parts of the Sand catchment en route back to Johannesburg suggested to me, however, that soil erosion is not sufficiently widespread to result in wholesale river destabilisation. GIS approaches (van Niekerk and Heritage, 1994) have suggested the vulnerability of the Sand catchment and further direct investigations are suggested (e.g. land use and land management surveys) to compare the impacts of climate and human agency (see also section 3 here).

The water regime of the Kruger Park is but one example on my tour of the crucial need for good research as a backing to long-term sustainability in planning, on which the eyes of the world are fixed (because of the importance of the ecosystems concerned: I will return to this point in connection with the rivers of the Western Cape). At present maintenance of a perennial flow in the Park's rivers is achieved only by voluntary restrictions on further resource use. Whether IFIM or the 'Building Block Methodology' inspired by Dr Jackie King at the Freshwater Research Unit (Univ. of Cape Town) is used to 'fix' environmentally acceptable flows for the Park river managers will need the very best information for a good decision.

2. Habitat hydraulics and instream assessment

For decades freshwater biologists (especially those studying migratory fish) have developed descriptive terminologies for those characteristic geomorphological features of river reaches which control the scale and distribution of depths, velocities and other elements of physical habitat. In the late 1970's the need arose to set reservoir discharge regimes with sensitivity to instream biota. The so-called IFIM (Instream Flow Incremental Modelling) solutions were developed, in which calibrated hydraulic conditions at the reach scale were extrapolated to the design river system. Models, notably PHABSIM, have been extensively used in the USA and, like the Universal Soil Loss Equation before them, have been exported, perhaps without sufficient regard for local conditions, both natural and design. This appears to be the case in South Africa (King and Tharme, 1993) and also in the UK.

Recently, however, fishery biologists and geomorphologists have been working together to standardise terminology for the repeated morphological features of rivers which they hope can be used to predict hydraulic conditions (and thence habitat conditions - Wadeson, 1994). Again, detailed field calibrations are needed (velocity, depth, substrate, vegetation) but the process-response system of geomorphology becomes the basis for more reliable, more effective and above all cheaper methods of extrapolation (again using the hierarchical system of Rowntree and Wadeson).

At Newcastle, following a five-year period of geomorphological Research and Development for the National Rivers Authority (NRA), a postgraduate studentship has allowed us to select 11 river channel types (from a forthcoming national inventory by the NRA) and to investigate the regularities present in the habitat hydraulics of an established set of features, e.g. riffle, pool, run, glide, cascade, rapid. By coincidence this research programme exactly overlaps with that by Wadeson at Rhodes University and has considerable relevance to the PHABSIM programmes of NRA in UK and to investigations of PHABSIM by Dr King and colleagues at the University of Cape Town in South Africa. Contacts with all the relevant workers during this visit culminated in the Citrusdal Workshop.

Clearly the abundant need for, and large scale of, river habitat assessments in South Africa render blanket adoption of PHABSIM and other sophisticated theoretical models an impossible luxury. Boundary conditions are very different to those under which the model was established and predictions carry little validity for larger scales of application. As an alternative the geomorphologically-based method of setting out the key controls on the hydraulic elements of habitats offers a reasonably cheap, *extensive* alternative. Here is an opportunity for the Rhodes (Geography) approach to channel classification and the Cape Town experience of IFIM (more importantly: of habitat *processes*) to work jointly on a field-based channel habitat survey scheme for South Africa, to be applied on a regular basis like that of NRA in the UK. Data gathered on the surveys would become the material for a truly national river typology against which impacts of development could be judged.

Roy Wadeson (Rhodes) and I discussed field classification of channel features at two levels - the morphological unit (reach flow control) and the much smaller scale physical 'biotope' (preferred to 'habitat' because no species are specified). Considerable convergence is occurring between the Newcastle and Rhodes methodologies, an exception being the field techniques available: at Newcastle Catherine Padmore has made very rapid progress (11 reaches, three calibrations, in 18 months) simply by her use of an electromagnetic current meter (Rhodes use a propeller meter). Once again, in the discussion of biotope distributions the predominance of bedrock controls (and a sand bedload) in South Africa came to the fore. Wadeson was, for example, unfamiliar with the 'glide' biotope (typical of UK fine gravels) whilst I had not encountered the 'pool - rapid' sequences of some bedrock-controlled South African rivers. A regular exchange of information by e-Mail has been established between the two teams.

In the field visit to the Buffalo River it was possible to see boulder streams and to discuss the problems of measuring depths and velocities in such hydraulically rough environments. Relative roughness is of extreme importance to the distribution of flow types in hydraulically rough channels. The changes of depth, velocity (i.e. Froude Number) and velocity profiles with increasing flow are not linear as is assumed for 'smoother' channels. However, the paucity of field hydraulics research in such channels does not reconcile with the fact that these are the very sites likely to be impacted most by headwater impoundments; they also have the highest conservation value (see section on Western Cape below). We discussed the role of floods in depositing the much less regular morphological features of such streams. As a spin-off from the Buffalo visit I was able to observe the problems of a highly reservoired catchment (O'Keefe et al., 1990) with a considerable problem of indutrial pollution, not the least from township areas in Ciskei. This proved of considerable value to my understanding of the problems of implementing Catchment Management Planning in South Africa.

Further practical insights into water management problems came on field excursions from the Physical Biotopes Workshop at Citrusdal. According to Dr King, who knows the Olifants and its tributaries very well, the increase in numbers of farm dams in support of irrigated citrus plantations has been spectacular in the last three years. We observed channels which normally support several endemic, internationally-important fish species, completely dry because of over-abstraction; we also observed damage to riparian environments, critical to geomorphological stability of channels, as the result of converting bush to plantations. I regarded this section of the visit as reflecting badly on existing legislation and planning and have lent my name to a letter listing our concerns to the Minister for the Environment, who is also the MP for the area. As with Kruger, the eyes of the world are on the 'hot-spots' of biodiversity in the world and the Western Cape is one such. Whilst appreciating the boost given to citrus sales by the ending of sanctions, and the impacts of the recent drought period, any water management system which cannot accommodate both economic growth and extreme conditions in its legal framework is doomed to environmental disaster. Farmers here need a sound legal framework of controls, together with research guidance on channel management for instream ecosystems (the South African Workshop participants could all provide this - perhaps as a guidance manual). More hydrological research should be done on the recent impacts of farm dams (Pitman and Pullen's assessment is dated 1989).

The Workshop was a considerable success. Dr Rowntree's chairmanship forced us to complete the debate on any particular sticking point before moving on - and, as a result of the large measures of both experience and knowledge brought together by the participants, the international literature can benefit from wide distribution of the proceedings which Dr Rowntree is producing at Rhodes. For example, field visits to a range of channel types and features forced the participants to agree a physical biotope classification which can be justified strictly and applied repeatably on the basis of flow type and substrate. On return from South Africa I introduced this classification to the National Rivers Authority's River Habitat Survey system; UK surveyors will be experimenting with the 'Citrusdal method' at 1500 sites this summer!. The RHS system is recommended to South African rivers (Appendix B) simply because in all river environment problems and decisions an inventory of resources (in this case habitat) is esseential. As suggested by Padmore, Newson and Charlton (in press), RHS or similar systems are the natural link to habitat hydraulics for rapid extrapolation of biotope information for instream assessments.

I have joined SASAQS as a measure of my need to keep in touch with the freshwater community on South Africa. This small group is highly respected in the UK and is clearly making a large contribution where it can, with limited resources, e.g. to strategic thought in DWAF.

At the close of the workshop I visited a field experiment supervised by Dr King and operated by her assistant, Rebecca Tharme. This seeks, by diversion of progressively larger volumes of flow from channel reaches surveyed in very great detail, to directly experiment with the ecological impacts of low flows. This is a major improvement in experimental credibility compared with tank experiments and further strenghtens the Cape Town team's ability to predict processes of habitat hydraulics en route to a more solid prediction of biotic carrying capacity for streams.

3. Channel change and rural channel/land-use management (including forestry) N E Cape

In 1993 I had the pleasure of examining a Masters thesis by Evan Dollar (Geography, Rhodes) on the patterns of instability in the Bell River, North-East Cape. Dollar (1992) interpreted changes in the channel planform in relation to sediment delivery to the channel from surrounding land use; however, he also inferred climatic causal mechanisms - a dualism of which we have had much experience in Newcastle (e.g. Macklin, Rumsby and Newson, 1992). The climate interpretation is more difficult to compile in South Africa because of episodic drought and severe floods; there is also a general lack of established environmental change chronologies. My field visit has, however, cinformed in my mind the parallels (in terms of a broad model) of the Bell and the Tyne system in NE England; Dolar and I are to liaise on this. The Bell clearly translates either climate or sediment yield input signals into channel planform adjustments in sedimentation zones (Church, 1983), unstable (often braided) reaches, separated by single-thread channels whose function appears to be equilibrium sediment transport. The land-use interpretation of increasing instability in the Bell River catchment was confirmed by visiting spectacular recent gulley systems, some of which had been successfully controlled by planting poplar trees in their beds. Dollar has calculated 7km of gulley extension in each of the periods 1952-69 and 1969-75 within his study area.

I also inspected the efforts of two farmers to relate land use to the needs of a stable river system. At Pitlochry, Barkley East (Paul and Joe Sephton) we discussed the relevance of various forms of veld management to efficient water use and channel stability. The planning of grassland species and grazing pressure is essential to prevent erosion occurring; fire control is, however, more difficult to plan, as is drought mitigation. At the farm of Cedric Isted (Halston) I was shown how the management of channel-bank willows (partly to allow the farm workers a fuel supply) and some spectacular *ad-hoc* rock shifting could bring a 'wildly' mobile channel under control, with the added benefit that fisheries were improved. Nevertheless, without comprehensive action of this type it is highly likely (confirmed by rapid observations downstream) that the 'problem' is merely passed on to a neighbour. Our experience with NRA R&D in the UK is that such channel management schemes, however sophisticated or *ad hoc*, should be prefaced by a catchment fluvial audit to establish the sources and sinks of fluvial sediments (including an historical analysis of floods etc.) - see Sear and Newson (in press).

It was therefore heartening to meet, at Rhodes village, Dave Walker - a recreation manager - who is chairing a body known as 'A Conservancy in the Southern Drakensberg' which is effectively a grass-roots catchment management board, even though some of its aims are more immediate/vital to the local economy than catchment protection: for example prevention of cattle theft. In future, concerns over water management will heighten in the region e.g. in relation to the possible Mzimvubu transfer project and its regulation impacts on the Kraai River.

En route to Grahamstown I met officers of North East Cape Forestry at a key stage of planning their environmental management, principally of vlei areas and erosion control. Their approach is convergent with the forest plans being prepared in the UK and their needs similar to those answered by the recent three editions of the 'Forest and Water Guidelines' (Forestry Commission UK, 1993). They are receiving experienced hydrological advice and research data from Dirk Versfeld (FORESTEK). A visit to sensitive sites allowed some UK technology transfer in terms of damming schemes for wetland restoration and runoff control from steep slopes. Essentially, instead of a profit maximization motive, private forestry should be carefully controlled in a way prefaced by the Forest Permit system (about to be reformed) but without the restriction to water *yield* sensitivity. Fortunately at Jonkershoek I was able to follow the work by on a rational system for delimiting buffer zones adjacent to water courses (Bosch et al., 1994) and was given a copy of the predictive software which will be evaluated for UK conditions by a Newcastle postgraduate student, Debbie Cowen. The predictive model gives weight to other factors including habitat and water quality in delimiting a rational width for buffer zones (as opposed to a national, regional or catchment 'standard' zone).

4. Catchment Management Planning

From 1992, the NRA in England and Wales has promoted local strategies for river catchment management within a nationally set framework of resources, flood protection, pollution legislation and environmental concerns. The management tree of NRA reflects this local concern - basic units are the region (8) and the area (groups of major catchments). The main political significance of Catchment Management Plans (CMP's) is, however, the 'bid' made by river managers for a say in the planning of land use and land management over the whole catchment area by influencing the preparation of the statutory local government planning documents (Slater, Marvin and Newson, 1995). This is inherent in the concept of joint land and water management (Newson 1992).

The main opportunities for CMP's in South Africa and the constraints are as follows:

1. The strategy of sustainable resource development enunciated by Government,
2. Decision-making under uncertainty but with a general resource shortage,
3. (constraint) Weak - at present - development of local government,
4. (") Weak - at present - tradition of public consultation,
5. (") Severe need for rapid economic development reduces environmental priority.

I introduced these opinions (based largely upon remote reading of the 'Red Book' (Dept. Water Affairs, 1986) and the recent White Paper (Republic of South Africa, 1994) at seminars in Grahamstown, Jonkershoek and Pretoria to audiences of 50, 75 and 150 respectively. Discussion was lively in each instance, not so much putting obstacles in the way of South African CMP's but teasing out problems akin to 'voter education' and, obviously, stressing the inchoate nature of South African local government planning structures (Turok, 1994). The South Drakensberg rural experience is optimistic - if one accepts that the issues which group together grass-roots concerns may not be wholly, or dominated by, river issues.

It is important that the institutions of water management in South Africa facilitate catchment planning (Doig, 1994) by realising that it has two distinctive elements: the *strategic* component (holistic, research-based thinking) and the *operational* component (integrated professional pragmatism). Education in hydrology emerged as an issue in discussions with DWAF senior officers after my Pretoria seminar. If a national programme were to be instigated forthwith there would quickly develop a culture of respect for, and 'ownership' of, both clean water and dirty water. In the UK it is very common for children to force their parents to take showers, not baths, to save water. The sewage treatment works is now a poster on most UK schoolroom walls.

The universal rewards of catchment planning are that Plans:
a. Anticipate problems, avoid waste and secure rights,
b. Guide investments,
c. Secure environmental protection,
d. Link sustainability as an aim with subsidiarity of decision-making.

Other facilitating issues for CMP's in South Africa are clearly (from the Western Cape Olifants experience and others) reform of water laws and an ending of the culture of 'can do' engineering - which can get water to where it is needed without a full investigation of 'why'. It was clear from discussions with Alan Conley (Strategic Planning Chief, DWAF) and from papers he has written (e.g. Conley, undated), that other facilitating mechanisms should include land-use / water modelling. He introduced me to 'CRAM', a modelling system with clear parallels to the NELUP system being developed in Newcastle - liaison has been arranged.

It was also welcome to see the activities of the modellers at the Institute for Water Research at Rhodes University where the national needs for low flow evaluation, groundwater resource development and physically-based catchment models are being addressed by Dr Hughes and colleagues (e.g. Hughes and Sami, 1994).

Conclusions

It is important to stress that my visit was a complete success: the best organised foreign visit in twenty five years of professional research; the enthusiasm of the researchers I encountered helps to explain this impression, as well as Dr Rowntree's organisational skills and foresight.

It is clear that fluvial geomorphology has a major contribution to make to river and riparian management in South Africa and that there is a major initial task of evaluation/classification which must be empirical to reflect the special features of South African river systems and climate/vegetation controls. It is essential to abandon the application/importation of traditional hydraulic explanations for river form. Fluvial geomorphology offers the extra dimensions of both the broad (e.g. catchment land use controls) and narrow (e.g. habitat hydraulics of rough channels) understanding of the river environment over long timescales. My recommendations to WRC in terms of research are as follows:

1. Support for field-based evaluative and classificatory procedures is essential in order to build a specific inventory and typology for river systems throughout South Africa,
2. Support should be afforded to fluvial geomorphologists for drawing together, simplifying and publishing their methodologies so that they can work in teams with other disciplines; these interdisciplinary efforts need to be pre-formed so that they can be applied efficiently to operational problems like catchment planning, channel restoration, setting environmentally-acceptable flows etc. I suggest, specifically, a link between Dr King's and Dr Rowntree's research teams,
3. Flooding and sedimentation are perpetual problems in South African rivers; support for fluvial geomorphology should be applied to the problem of sedimentation patterns in river *systems*. The first results for the Sabie are tantalising, as are those for the Bell. In-system sediment storages are essential to understand because they control the efficacy of land management approaches to reducing sedimentation and flooding. There are clear links to the strategic element of catchment management planning.
4. River restoration is another multi-disciplinary activity gaining popularity world-wide. Our discussions at North East Cape Forestry revealed a practical need for geomorphological studies and prescriptions for conjunctive restoration of floodplain (wetland), riparian and channel habitats. Field trials, supported by joint research and contract funding seem an obvious requirement.

South Africa needs a larger freshwater research community in the 'new' fields, including fluvial geomorphology; research support should also be seen as providing professional continuity in a vital field.

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APPENDIX A

ITINARY 24th Jan -6th Feb 1995

24th January:	Arrive Jo'berg from U.K., drive to Kruger Park via Sabie catchment with Wits/Rhodes research teams.
25th-26th Jan:	Geomorphological Classification & Kruger Park Rivers Research Programme: Site visits along the Sabie to look at sites of geomorphological interest. We may also be able to meet with Kruger Park personnel and members of the Sabie catchment committee.
	Participants: Rowntree, Wadeson (RU), Heritage, van Niekerk (WITS)
27th Jan:	Return Jo'berg (via Sidwana caves?) and fly to East London.
28th Jan:	Geomorphological Classification: site visits in the Buffalo River
	Participants: Rowntree, Wadeson
29th Jan-1st Feb:	Visit to research area in Bell River, Eastern Cape Drakensberg. Returning to Grahamstown via the North East Cape afforestation programme (Elliot - Maclear).
	Participants: Rowntree, Wadeson (RU), Dollar (UNITRA),
2nd Feb:	Meet with water fraternity in Grahamstown; seminar on catchment management.
3rd-4th Feb:	Fly to Cape Town, & Stellenbosch. Visit to Jonkershoek Forestry Research Centre and Seminar on catchment management with Jonkershoek/ Cape Nature Conservation.
4th Feb:	Drive with UCT party to Olifants River.
5th- 6th Feb:	Field workshop in the Olifants River catchment, Western Cape: geomorphological aspects of PHABSIM and assessment of flood requirements for maintaining instream habitats.
	Participants: Rowntree, O'Keeffe, Wadeson (RU), King, Tharme (UCT), Rowlston (DWAF).
7th Feb:	Return to Cape Town, flight on to Jo'berg with Bill Rowlston
8th Feb:	Meet with policy makers and implementers in the Department of Water Affairs and Forestry (DWAF), give seminar on catchment management.
8th Feb, evening	Fly out to U.K.
9th Feb:	Arrive back exhausted in time for Anna's birthday.

APPENDIX B

NRA

RIVER HABITAT SURVEY

1994 VERIFICATION PHASE

GUIDANCE MANUAL

28 April 1994

CONTENTS

P-29465-TL

1. BACKGROUND

1.1 The NRA is developing a standard nationally applicable method for evaluating river habitats. The end products will include a working classification of rivers generated on the basis of physical features. This is intended to complement that already established for assessing water quality.

1.2 The methodology being developed is known as River Habitat Survey (RHS), and its context with respect to other methods, both existing and under development, is shown in Figure 1.

- At the catchment and sub-catchment scale, rivers can be evaluated according to their conservation status using SERCON (System for Evaluating Rivers for CONservation). This conservation assessment is achieved by processing existing physical, chemical and biological information pertaining to the river, its corridor and wider catchment, through a computer programme. The system is designed to evaluate rivers based on the conservation criteria of naturalness, rarity, representativeness, diversity and fragility. It is being developed by the nature conservation agencies, under the auspices of Scottish Natural Heritage.

- River Corridor Surveying (RCS) is a long-established, descriptive map-based method designed to highlight habitats and features of special conservation importance which need to be retained and suggest how other features can be enhanced during river management such as flood defence works.

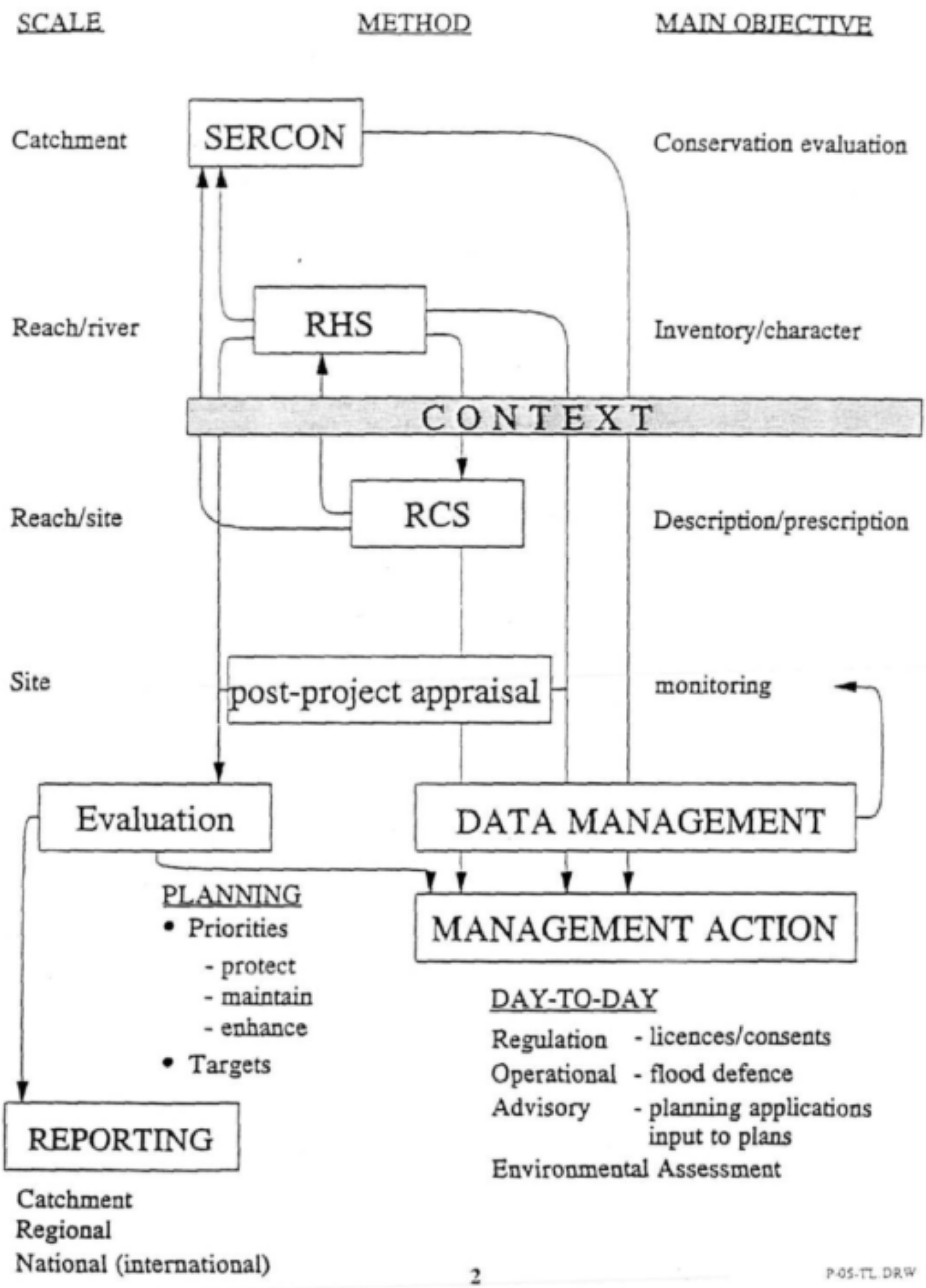
- Post-project appraisal (ppa) is essentially a method, still being developed, which compares "before and after" information on habitats and other features so that a technical audit and ecological performance measure of flood defence and other works can be produced. RHS will provide the necessary framework for ppa.

1.3 In essence, RHS provides context for assessing the quality of river habitat based on the presence, extent and pattern of physical features. To this end, it provides information crucial to catchment planning and national reporting. The physical structure of a river can be evaluated by comparing the presence and extent of features with that expected in an unmodified river of the same type.

1.4 In addition, as RHS information is collected, it can be fed into a national database thereby increasing the knowledge about the range and combinations of features found in river types that effectively make them excellent, good, fair, poor or very poor.

1.5 Although RHS resides under the national NRA initiative "Conservation Classification", it is not a form of conservation classification *per se*. It is clearly

FIGURE 1 Putting RHS into context with respect to NRA needs



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focused on the physical aspects (including vegetation structure) of the river channel, banks and adjacent corridor and is a system for assessing the intrinsic value of features in terms of their value to wildlife.

1.6 The system will be based primarily on an evaluation, the Habitat Quality Index (HQI), which is a measure indicating the presence and extent of "natural" features within a site. The range of HQI scores will therefore reflect the extent of modification to the physical features of the various river types. The final "classes" (excellent, good, fair, poor, very poor) will be determined by the range of HQI scores for a particular river type (Figure 2). One possible output is illustrated in Figure 3.

2. DEVELOPMENT SO FAR

2.1 An RHS prototype was developed in 1993 and field-tested by all NRA Regions and at sites in Northern Ireland.

2.2 The field testing comprised two Phases: Phase 1 was based on recording features along 100m lengths of river and one 1m wide transect therein; Phase 2 was based on recording features at ten 1m wide transects spaced evenly along a sample length of river equivalent to 25 times the bankfull width, together with a reach inventory of features recorded along that length.

2.3 In addition, the River Derwent in Cumbria was intensively surveyed in August-September and December 1993 to ascertain an appropriate sampling methodology.

2.4 Data from all 173 reaches and 1730 transects from Phase 2, and the River Derwent data have been computerised and analysis has provided valuable guidance for the verification phase of RHS.

2.5 The RHS sampling sheet has been modified in the light of feedback, data analysis to provide a simple but effective format which requires little specialist training (Appendix 1). Accompanying guidance is provided in Appendix 2.

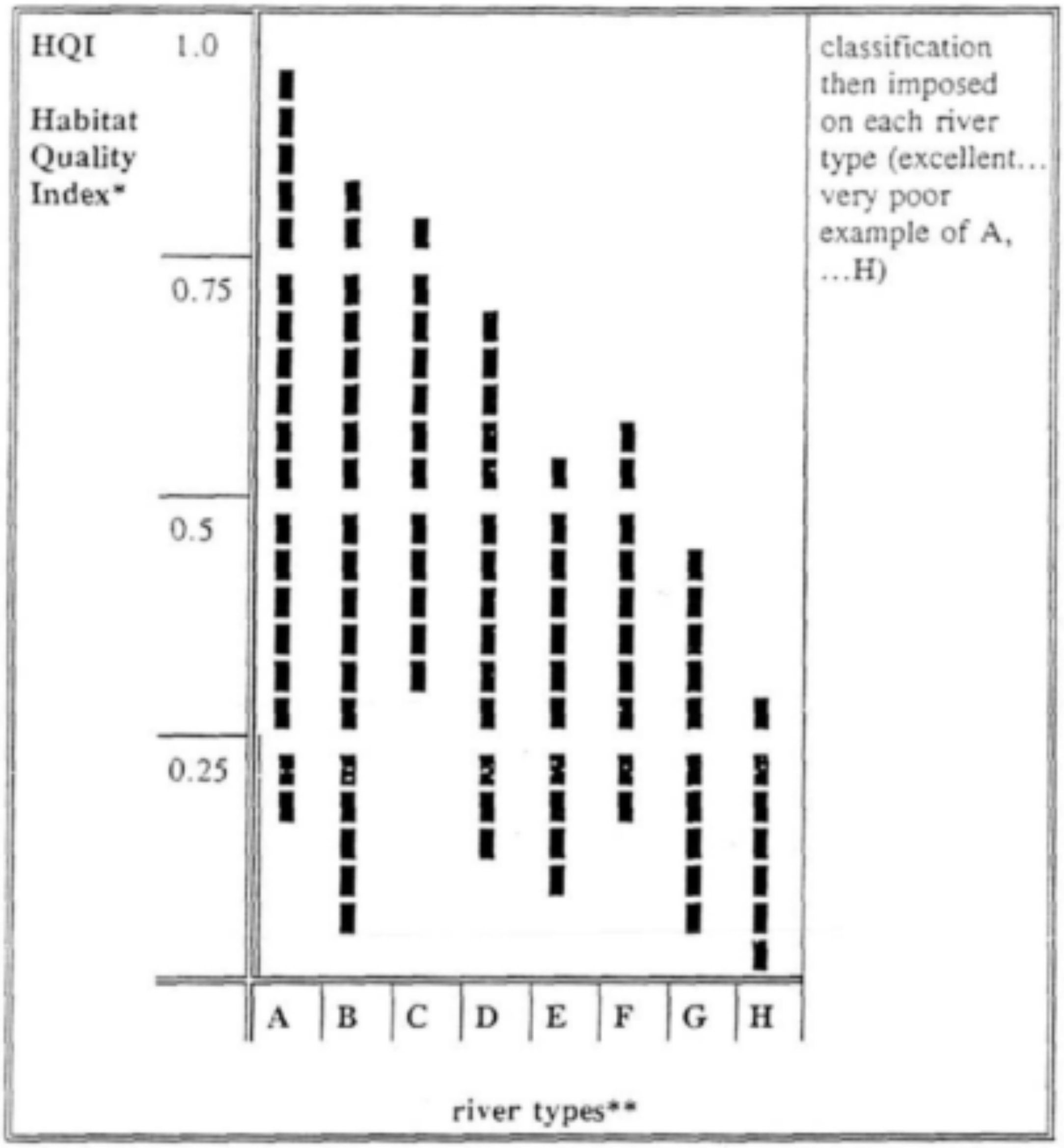
3. THE VERIFICATION PHASE

3.1 The planned analytical and development programme is indicated in Figure 4.

It should be noted that there are four parallel analytical work items being progressed:

- analysis of the RHS data collected in 1993 and 1994;
- analysis of physical data from the 10 SSSI River Community Types collected from 1500 sites during the NCC macrophyte survey in 1978-1983 and 1988=91;
- analysis of data collected by IFE at ca. 500 sites, by a method which broadly

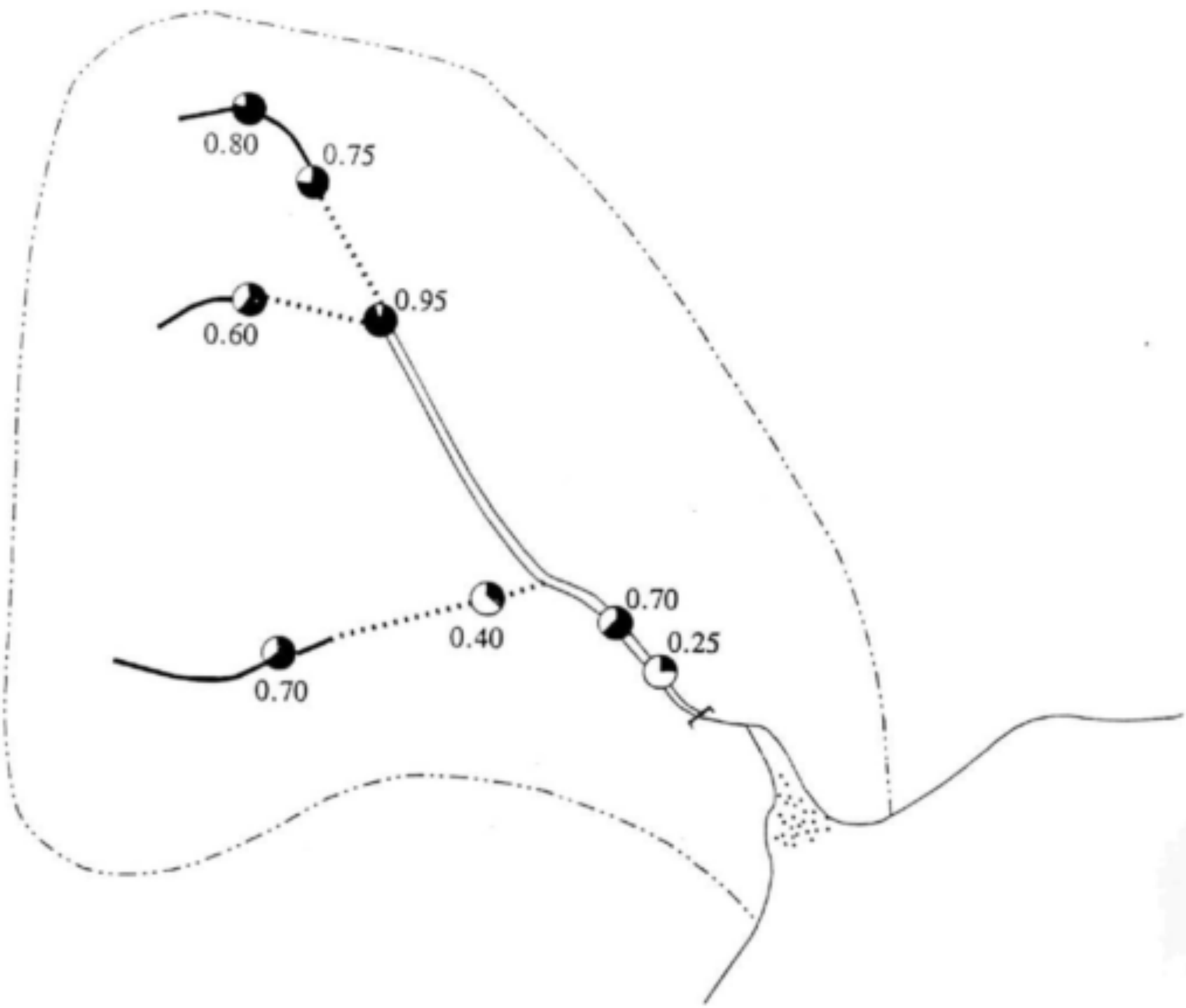
FIGURE 2 The variation in HQI associated with different river types: theoretical example.



* based on presence and expected combination of natural features

** defined on the basis of analysis if SSSI river community types and geomorphological types

FIGURE 3: VISUAL PRESENTATION OF KEY RHS SUMMARY STATISTICS



KEY

River Type:

Type A

Type B

Type C

Habitat Score:

HQI > = 1

HQI = 0

FIGURE 4 RHS: ANALYTICAL AND DEVELOPMENT PROGRAMME

		1994/95									
ITEM	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN
Analysis: 1993 RHS data	■	■									
Analysis: NCC macrophyte data	■	■	■	■							
Analysis: IFE data	■	■									
Training/preparation week		■									
Verification field survey			■	■							
Analysis: 1994 RHS					■	■	■				
Draft final methodology							■	■			
RHS workshop: Gloucester								■			
Final development								■	■	■	
Publication of RHS handbook											■

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represents a combination of RIVPACS and RHS; and

- through the auspices of an R & D project, analysis of existing information to identify geomorphological features and their pattern in various river types.

3.2 The first stage is to assess the type of physical features associated with geology, slope, altitude and river size. From this, the 10 SSSI river community types can be more precisely defined in terms of expected physical features. An alternative approach is to base river types on the basis of geomorphological principles.

3.3 The objective is to determine more precisely a sound framework for river typing during July-September 1994. RHS will also be tested, like the 1993 Phase 1 and 2 prototypes, on rivers in Northern Ireland. For the first time, it will also be tested in Scotland.

4. APPROACH

The approach has been determined largely on analysis of the 1993 RHS data.

4.1 Sampling Strategy

4.1.1 The verification survey is restricted to classified River Quality Objective (RQO) rivers as indicated on the 1985 water quality maps.

Rationale: the RQO classified rivers are most relevant for catchment planning and output purposes. The maps indicate the size of rivers (by flow) on a defined reach basis; the NRA owns the AA version of the maps on GIS.

4.1.2 The basis for a stratified random sample of sites is the 10 x 10km square grid, with one sample site per grid square, giving more than 1500 sites in England and Wales. Each site has been selected on the basis of the nearest RQO classified river stretch to the mid point in each 10 x 10km square. Squares with more than 50% inter-tidal land or sea have been omitted from the survey.

Rationale: a major weakness of the 1993 RHS sampling strategy was the limited distribution of sites and ad hoc nature of site selection. The verification survey should provide the full range of river types, with an even geographical spread and a readily identifiable scale of output. This strategy will also provide a rigorous test for any river typology.

NB For assessing intra-catchment variation, data from the 1993 RHS survey on the Derwent, Trent, Kennet, Usk and Darent can be used. It is also intended to use the River Wyre as a single catchment approach under the auspices of an MSc project.

- *A small number of sites in Scotland and Northern Ireland will be selected to ensure wider applicability of the method;*

- *Sites within 10 x 10km squares without an RQO river will be randomly selected on the basis of nearest mid-point location.*

4.2 Preparation and Background Information

4.2.1 All 1521 sites in England and Wales will have been determined before fieldwork commences in May.

Rationale: efficient preparation is essential so that fieldwork itineraries can be properly planned. In addition, a size distribution of all sites can be assessed beforehand to determine any significant bias.

4.2.2 For each site in England and Wales, information on slope, mean annual flow, altitude, solid and drift geology and sinuosity will also have been collected as a separate exercise prior to field work.

Rationale: considerable time-saving and no need for specific training, allowing major focus of effort to be concentrated on fieldwork.

4.2.3 Each NRA Region will have an RHS coordinator responsible for ensuring that the verification survey is completed properly and on time.

Rationale: it is essential to have a single point of contact with regional responsibility for quality control and tracking progress of fieldwork.

4.2.4 Each Regional RHS coordinator and field survey staff will have attended a training/preparation course in Chester, 19-21 April.

Rationale: it is essential that sufficient training is undertaken prior to the field survey to maximise consistency of survey and ensure complete understanding of the methodology and in particular the ability to recognise features included on the survey form.

4.3 Field methodology

4.3.1 Fieldwork should take place between 3 May and 1 July 1994.

Rationale: to do the survey at a suitable time of year and allow sufficient analytical time and development of a draft final method by October. Resource implications for full implementation need to be determined in sufficient time for EG and Board approval (deadline 28 October).

4.3.2 The sample unit is based on a standard 500m length of river.

Rationale: analysis of the Derwent data indicates that 500m is the sample length to most likely include the important features for characterising the river without incurring excessive data redundancy. Using a standard length is statistically sound *since larger sample units introduce significant bias in terms of features recorded.*

4.3.3 Survey data will be recorded using those features determined as useful and unambiguous in the 1993 survey.

Rationale: using combinations of associated features (particular channel and bank substrates, bank profiles) provides a better way of recording and reduces repetition on the recording form.

4.3.4 Survey information will be recorded in two ways: key physical features and vegetation structure at 10 equidistant 'spot checks', and these, together with other features in the 500m site on a "sweep-up" basis.

Rationale: it is essential that key determining features are assessed in a semi-quantitative rather than qualitative way. The use of spot checks along the reach builds on the advantages of the presence/absence information obtained by the Phase 2 transect method, but without the time penalty involved. The sweep-up ensures that the overall character within the 500m is fully accounted for.

4.3.5 The actual number of key features (eg riffles, pools, point bars) will also be estimated.

Rationale: repeat patterns of features vary according to different river types (largely based on slope, size and modification). Since a standard sample length is to be used, the frequency of features is critically important in assessing if the pattern of occurrence is 'natural' or significantly modified.

4.4 River Typing

4.4.1 The data will be used to test a river typing method based on geomorphological principles.

Rationale: although the most important aspect of verification is standardisation of data collection, the analysis can also be used to test a proposed typology based on the physical character of the channel. The typology represents one particular output which is likely to be extremely useful for catchment and river management purposes.

Potentially, it provides a method which is readily identifiable by surveyors. The parallel analysis of the 10 SSSI River Community types and IFE 'biomorphopacs' sites will provide invaluable guidance as to the practicality of the final outputs and how they could be used interactively.

4.5 Habitat Quality Index (HQI)

4.5.1 The HQI will be based on features of wildlife value of each river component (channel, banks and riparian zone).

Rationale: the underlying principle of RHS is to provide an evaluation of the physical structure of rivers. It is crucial that the component parts of the river environment are kept separate so that primary data can be interrogated, since river managers need to know the precise combination of excellent, good, fair, poor or very poor channel, banks and riparian zone in order to decide how best to protect or improve the overall structure.

The calibration of an overall HQI will need to be subjectively determined on a rule-based system decided at a brain-storming session and verified by site visits during July-September. The data collected during 1993 and 1994 will provide sufficient information for HQI to be determined. Possible options are to use a simple additive system or a step/threshold system using the channel typology for guidance.

4.6 Analysis

4.6.1 The 1994 data being analysed in North-West Region will also be made available to the contractor of the R & D project undertaking "Geomorphological basis of River Habitat Survey" (see 3.1 above).

Rationale: the R & D will be supporting RHS and by importing the 1994 data and using background information, the basis of a predictive model will be established, thus helping to determine more precisely the typology and HQI aspects.

4.7 Outputs

4.7.1 The final outputs have yet to be determined but will be based on "layers" comprising (i) predicted 'natural' river types at a catchment level (i.e. the 10 SSSI river community types), (ii) RHS river types at a reach level and (iii) HQI values at each sample site (Figure 3).

Rationale: for catchment planning purposes this overlay approach provides an excellent way of presenting the data. For national mapping, HQI alone would suffice given appropriate caveats . The data could also be presented as a bar or pie chart for each river and river type. The presentation is suited to GIS.

4.8 National Database

4.8.1 Ideally, a national RHS database will be established as part of full implementation.

Rationale: information in an RHS database can be used for archiving, further refining the HQI and typology, but most of all, an easily accessible national inventory to be used to complement water quality information in an overall assessment of the river environment.

4.9 Optical Reading Capacity

4.9.1 The final version of the RHS form ideally should be designed to accommodate an optical reading capacity. This may be developed as a specific item of work October-December 1994.

Rationale: enormous efficiency savings with respect to data input.

5 PREPARATION FOR FIELDWORK

5.1 Each NRA Region will have an RHS coordinator who will be responsible for ensuring proper preparation and completion of the field survey on time.

5.2 Only the site number needs to be transcribed onto the field record sheet as background data prior to field survey are being collected separately.

5.3 It is essential that an itinerary is carefully planned for the field survey period (May-June), so that the most efficient way of travelling between sites is identified.

5.4 On the basis that 1500 sites are to be sampled and that 40 working days are available in each of eight regions, the target will be 4-5 sites per working day (ie ca 160 sites). This is considered to be a realistic figure. A team from IFE will also be providing assistance by sampling 350 sites and will be able to visit unsurveyed sites if significant delay is caused by unforeseen weather or other circumstances.

6 FIELD SURVEY

6.1 All site boundaries will be marked on 1:50,000 scale maps and circulated to RHS coordinators before the end of April.

6.2 All selected sites or, if the location proves to be impossible, a nearby substitute site, must be sampled. Site boundary location should not be moved (particularly not just to include 'good' features) unless **absolutely essential** and if so, an explanation provided on the survey form. *If in doubt, contact Peter Fox, North West Region.*

6.3 The RHS recording sheets are large self-explanatory (Appendices 1 & 2), but training is essential in order to minimise the chance of incomplete recording.

6.4 Equipment requirements are: ring-bound file with, RHS recording form; spot-check key and guidance notes Appendices 2 and 3 (in waterproof document holders); range-finder; ranging pole. Binoculars are useful for additional scrutiny of features on the far bank of larger rivers.

6.5 It is recommended that the survey forms are completed in the field using a pencil. The number of riffles etc can be recorded as a "stick-man" tally in the first instance. The final tally can then be boldly overwritten as an integer afterwards.

7 RETURN OF FORMS

7.1 Completed RHS sheets must be returned on a weekly basis to Peter Fox in North West Region. This is imperative to enable the data to be computerised during May and June. Each regional coordinator will be contacted by Peter Fox to assess compliance on a weekly basis.

NB Photographs should not accompany the returned RHS sheets but should be catalogued separately ready for interrogation as necessary particularly in calibrating HQI. ***Photographs of the channel measurement sites will be required for the geomorphology R&D project.***

7.2 Before sending completed sheets to Peter Fox, each should be verified to ensure that they have been filled in correctly. *Erroneous sheets may be returned and a re-survey requested.*

7.3 Always ensure that for each site, and when returning the forms that the two RHS survey sheets are stapled together, the site number indicated on pages 1 and 3.

8 DATA INPUT AND ANALYSIS

8.1 All data will be computerised in North West Region. It is absolutely crucial that sample sheets are returned on a weekly basis (or more frequently) so that data from all 1500 sites can be computerised by mid-July **at the latest**.

8.2 The computerised information will form a national database which will be used, in conjunction with analysis outputs from the 1500 NCC macrophyte sites and 500 IFE sites, to produce a working classification for RHS by the end of September 1994.

8.3 With regard to resource implications for full implementation, a note should be kept on time taken to sample each site, travel time between sites and total time taken on a daily basis.

9 FINAL METHODOLOGY AND OUTPUTS

9.1 The draft final methodology, including HQI and outputs will be produced at the end of September, and circulated in good time for the RHS workshop to be held on 19/20 October in Gloucester.

9.2 Final iterations will be made thereafter and it is intended to publish a technical handbook on RHS early in 1995, ready for publication later that year.

10 HEALTH AND SAFETY

10.1 It is imperative that all field surveyors follow health and safety guidelines provided at the RHS training course in Chester. It is the responsibility of RHS coordinators to ensure a daily "reporting in" procedure so that the whereabouts of staff is known.

Although preferable to work in pairs, lone workers need to take special care that they do not put themselves in a situation in which they are not in control.

11. HELPLINE ENQUIRIES

11.1 The Chester course provided the basis for RHS training. Any cascade training should be based on this guidance manual and fieldwork examples supervised by the RHS coordinator and/or others who attended Chester. The survey form will remain in its current format, but if necessary clearer guidance will be circulated during May and June if surveyors are unsure on precise definition. To this end, it is essential that all comments are channelled back to Peter Fox (North West), Paul Raven (Bristol) or, for geomorphological aspects Andrew Brookes (Thames). Helpline numbers appear on the RHS form.

12. ACCESS AND PERMISSIONS

12.1 All NRA staff should carry full identification with them at all times. In addition, a standard "to whom it may concern" letter will be sent to RHS coordinators for distribution to non-NRA survey staff. In all instances, if challenged by landowners, offer a full explanation of what you are doing and why and offer to provide information on the site to the occupier if he/she is interested in receiving it.

13. SUMMARY OF PRINCIPLES AND REQUIREMENTS

13.1 RHS is essentially an assessment of the physical structure of watercourses and their environs 50m to either side. Since vegetation provides habitat structure, broad vegetation types are also important.

13.2 The method relies on the ability of surveyors to recognise and record features in a consistent and reliable fashion. These include geomorphological features such as point bars which are illustrated by examples in Appendix 3.

13.3 RHS is *not* a geomorphological survey although in order to recognise some habitats, a basic awareness of river processes and features expected in different conditions is required.

13.4 RHS is pitched at a level whereby site characterisation is the key driving force. Its objective is to provide habitat context in a consistent and time-efficient manner.

13.5 RHS requires full recognition of features included on the survey form and defined in Appendix 2. It does not require specialist geomorphological or botanical expertise other than the ability to recognise major river channel features and differentiate between basic vegetation types.

GLOSSARY OF ACRONYMS

CCW	Countryside Council for Wales
CMP	Catchment Management Plan
EN	English Nature
HQI	Habitat Quality Index
IFE	Institute of Freshwater Ecology
RCS	River Corridor Survey
RHS	River Habitat Survey
RIVPACS	River Invertebrate Prediction and Classification System
RQO	River Quality Objective
SERCON	System for Evaluating Rivers for Conservation
SNH	Scottish Natural Heritage
SSSI	Site of Special Scientific Interest

A BACKGROUND INFORMATION *This information is being collected separately*

Altitude(m) Slope Mean Annual Flow category (1-10)
Solid geology Drift geology Planform category
Distance from source(km)

B FIELD SURVEY DETAILS *Complete all questions*

Site number: River Mid-section grid reference if different from
Grid Reference: designated site:

Date ..../..../1994 Start time: Surveyor name . . . .

Are conditions affecting survey? No ☐ Yes ☐ *If yes, state* . . . .

Bed of river visible? No ☐ partially ☐ entirely ☐ *(tick one box)*

Photograph: general character? No ☐ Yes ☐ *(tick one box)*

Photograph of channel measurement site? No ☐ Yes ☐ *(tick one box)*

Site surveyed from: left bank ☐ right bank ☐ both banks ☐ channel ☐

C PREDOMINANT VALLEY FORM
(tick one box only)

 ☐ vee

 ☐ concave/bowl

 ☐ stepped valley floor (terraced)

 ☐ symmetrical

 ☐ asymmetrical

 ☐ gorge

D PREDOMINANT CHANNEL FORM
(tick one box only)

- predominantly culverted ☐
- open, but bed or banks predominantly artificial *(eg box reinforced)* ☐
- open, little or no obvious reinforcement, but resectioned and/or realigned ☐
- open, but predominantly artificially dug *(eg. mill leat, dyke)* ☐
- not artificial, but dammed ☐
- no obvious modification *('semi-natural')* ☐

E NAVIGATION *(tick one box only)*

Is there a functioning navigation? No ☐ Yes ☐ Don't know ☐

F PREDOMINANT FLOW TYPE *(tick one box only)*

torrential/whitewater ☐ riffle-pool ☐ static ☐
step-pool cascade ☐ approximately laminar ☐ impounded ☐

TEN SPOT CHECKS (ca 50m apart)

Spot check 1 is at: upstream end ☐ downstream end ☐ of site *(Tick one box)*

G PHYSICAL ATTRIBUTES *(to be assessed across channel within a 1m wide zone)*

Fill in each box before moving onto H and I at each spot check. Use abbreviations in spot-check key

	1	2	3	4	5	6	7	8	9	10
LEFT BANK										
Predominant bank material *(one entry only)*										
~ bank modification *(one entry only)*										
~ bank feature(s)										
CHANNEL										
Predominant channel substrate *(one entry only)*										
Predominant flow type *(one entry only)*										
~ channel modification(s)										
~ channel feature(s)										
RIGHT BANK										
Predominant bank material *(one entry only)*										
~ bank modification *(one entry only)*										
~ bank feature(s)										

H VEGETATION STRUCTURE *(to be assessed over a 10m wide swathe)* *Fill in each box with one entry only*

B = bare U = uniform S = simple C = complex *Refer to spot-check key*

LEFT RIPARIAN ZONE *(If none, enter NO)*										
LEFT BANK										
RIGHT BANK										
RIGHT RIPARIAN ZONE *(If none, enter NO)*										

I CHANNEL VEGETATION TYPES *(fill in relevant boxes with one entry: use E (≥ 33% area) or ✓ (present))*

NONE *(tick as appropriate)*											
Liverworts/mosses											
Emergent herbs											
Emergent reeds/sedges											
Floating-leaved											
Free-floating											
Amphibious											
Submerged											
Filamentous algae											

Use end column for overall assessment over 500m (use E or ✓) ↑

SWEEP-UP OVER 500m	ENTER SITE NUMBER

J LAND USE WITHIN 50m OF RIVER *Use E (≥ 33% banklength) or ✓ if present*

	L	R		L	R
Broadleaf/mixed woodland			Bog, marsh, fen		
Coniferous plantation			Improved/semi-improved grass		
Moorland/heath			Tilled land		
Scrub/rough pasture			Suburban/urban development		

K LINEAR EXTENT OF RIPARIAN ZONE *(tick "none" box or estimate percentage banklength if present)*

Left bank None ☐ Banklength % = Right bank None ☐ Banklength % =

L. BANK PROFILES WITHIN 500m *Use E (≥ 33% banklength) or ✓ if present*

Natural/unmodified	L	R	Artificial/modified	L	R
• Vertical/undercut			• Resectioned		
• Vertical + toe			• Reinforced - whole bank		
• Steep (>45°)			• Reinforced - top only		
• Gentle			• Reinforced - toe only		
• Composite			• Artificial two-stage		
			• Poached		

M EMBANKMENTS *(tick "none" box or estimate percentage banklength if present)*

Left bank None ☐ Banklength % = Right bank None ☐ Banklength % =

N EXTENT OF TREES AND ASSOCIATED FEATURES

TREES *(Tick one box per bank)* **ASSOCIATED FEATURES** *(Tick one box per feature)*

	Left	Right	*E ≥33%*	None	Present	E
None	☐	☐	Shading of channel	☐	☐	☐
Isolated/scattered	☐	☐	Overhanging boughs	☐	☐	☐
Regularly spaced, single	☐	☐	Exposed bankside roots	☐	☐	☐
Occasional clumps	☐	☐	Underwater tree roots	☐	☐	☐
Semi-continuous	☐	☐	Fallen trees	☐	☐	☐
Continuous	☐	☐	Woody debris	☐	☐	☐

O NATURAL CHANNEL FEATURES *Record actual number of riffles, pools and point bars*

Number of: Riffles= Pools= Unvegetated Point Bars= Vegetated Point Bars=

Tick one box per feature	None	Present	E		None	Present	E
Waterfall/cascade	☐	☐	☐	Unvegetated mid-channel bars	☐	☐	☐
Torrential flow (rapids)	☐	☐	☐	Vegetated mid-channel bars	☐	☐	☐
Laminar flow (run/glide)	☐	☐	☐	Mature island(s)	☐	☐	☐
Static flow (slack)	☐	☐	☐	Unvegetated side bar	☐	☐	☐
Exposed bedrock	☐	☐	☐	Vegetated side bar	☐	☐	☐
Exposed boulders	☐	☐	☐	*Artificial*	☐	☐	☐

DIMENSIONS AND INFLUENCES

P CHANNEL DIMENSIONS to be measured at one site on a straight uniform section, preferably across a riffle

LEFT BANK		CHANNEL		RIGHT BANK	
Bankfull height (m)		Bankfull width (m)		Bankfull height (m)	
Bank height if different (m)		Water width (m)		Bank height if different (m)	
Embanked height (m)		Water depth (m)		Embanked height (m)	

Bed material at site is: consolidated ☐ clues: algal growth compact, stable
unconsolidated ☐ clues: fresh clean gravel, easily dislodged, loose
unknown ☐ inaccessible or not visible (eg turbid water)

Location of measurements is: riffle ☐ run or glide ☐ other ☐ (tick one box)

Q TRIBUTARIES *(tick one box only)*

Significant tributary within 500m length? No ☐ Yes ☐

R NUMBER OF ARTIFICIAL FEATURES Use tally method, then total: tick "none" where appropriate

None ☐ Number of Culverts= Weirs= Bridges= Outfalls=

S EVIDENCE OF RECENT MANAGEMENT *Obvious signs: tick box(es)*

BANKS	L	R	CHANNEL	
None	☐	☐	None	☐
Resectioning	☐	☐	Dredging	☐
Bank-mowing	☐	☐	Weed-cutting	☐
Enhancement	☐	☐	Enhancement works	☐ State . . . .

T CHOKED CHANNEL

Is 33% or more of the channel over 500m choked with vegetation? NO ☐ YES ☐

U NOTABLE NUISANCE PLANT SPECIES tick box(es) *No need to estimate abundance*

Giant Hogweed ☐ Himalayan Balsam ☐ Japanese Knotweed ☐

V BRIEF DESCRIPTIVE SENTENCE *(indicate if spot checks representative of site as a whole)*

W SPECIAL FEATURES *eg oxbows, adjacent habitats of high interest; incidental sightings*

X RIVER TYPING *Refer to photographs of river types and indicate which resembles the site*

Number (1-14) ☐ None of them ☐

Y TIME TAKEN	

CHECK THAT THIS FORM HAS BEEN COMPLETED CORRECTLY, AND STAPLED, THEN RETURN TO:
PETER FOX, NRA NORTH WEST REGION, RICHARD FAIRCLOUGH HOUSE, WARRINGTON, WA4 1HE
HELPLINE NUMBERS: PETER FOX 7-21-2140; PAUL RAVEN 7-10-4343; ANDREW BROOKES 7-25-5712

28 April 1994

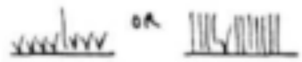
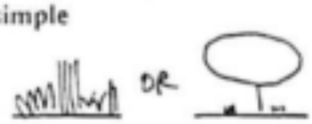
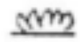
RIVER HABITAT SURVEY: VERIFICATION SPOT CHECK KEY

(Wentworth Scale overleaf)

PHYSICAL ATTRIBUTES (SECTION G)

BANKS		CHANNEL	
Predominant bank material	Bank modifications	Predominant substrate	Channel modifications
BE = bedrock	NO = none	NV = not visible	NO = none
BC = boulder/cobble	RS = resectioned	BE = bedrock	CV = culverted
GP = gravel/pebble/sand	RI = reinforced	BO = boulder	RS = resectioned
EA = earth (crumbly)		CO = cobble	RI = reinforced
PE = peat	**Bank features**	GP = gravel/pebble	DA = dam/weir
CL = sticky clay	NK = not known (eg for bank)	SA = sand	BR = bridged
	NO = none	SI = silt/mud	
CC = concrete	EC = eroding earth cliff	CL = clay	**Channel features**
SP = sheet piling	SC = stable earth cliff	AR = artificial	NO = none
WP = wood piling	FI = fining-up sequence		RO = exposed bedrock/boulders
GA = gabion	PB = point bar (unvegetated)		MB = unvegetated mid-channel bar
BR = brick/laid stone	VP = vegetated point bar	**Predominant flow**	VB = vegetated mid-channel bar
RR = rip rap	SB = unvegetated side bar	CA = cascade	MI = mature island
BW = builders waste	VS = vegetated side bar	TW = torrential/ whitewater	TR = urban debris (trash)
		RF = riffle	
		AL = approximately laminar (run/glide)	
		ST = static (slack)	
		PO = pool	
		PD = ponded	

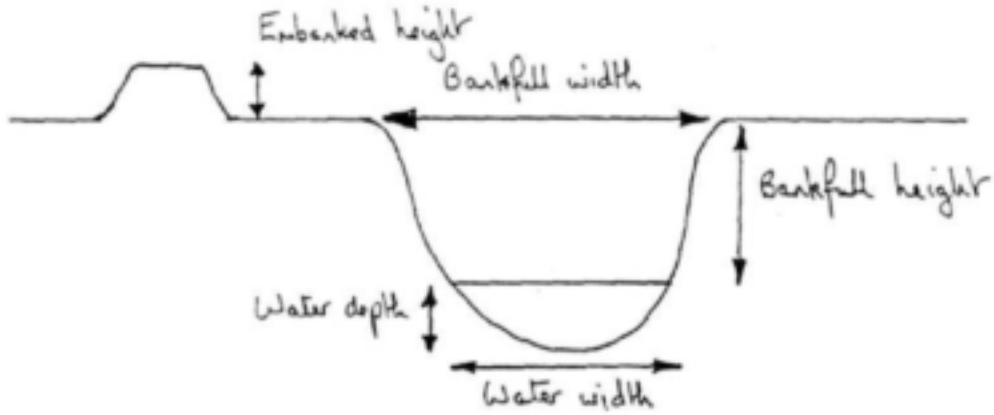
VEGETATION STRUCTURE Riparian zone and banks to be assessed within 10m swathe (SECTION H)

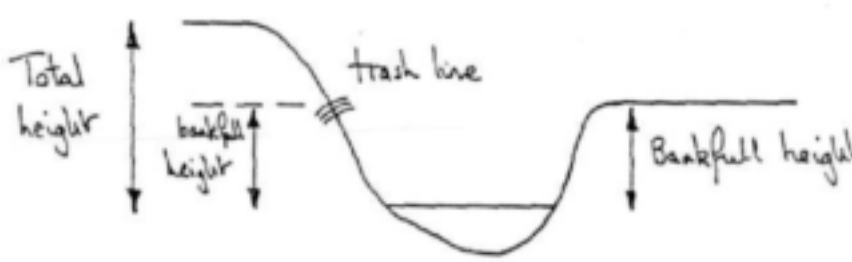
bare	B	bare earth/rock etc	Vegetation types
uniform 	U	predominantly one type (no scrub or trees)	bryophytes  short herbs/ creeping grasses
simple 	S	two or three vegetation types	 tall herbs/ grasses  scrub/brambles etc
complex 	C	four or more types	 saplings and trees

CHANNEL DIMENSIONS: GUIDANCE

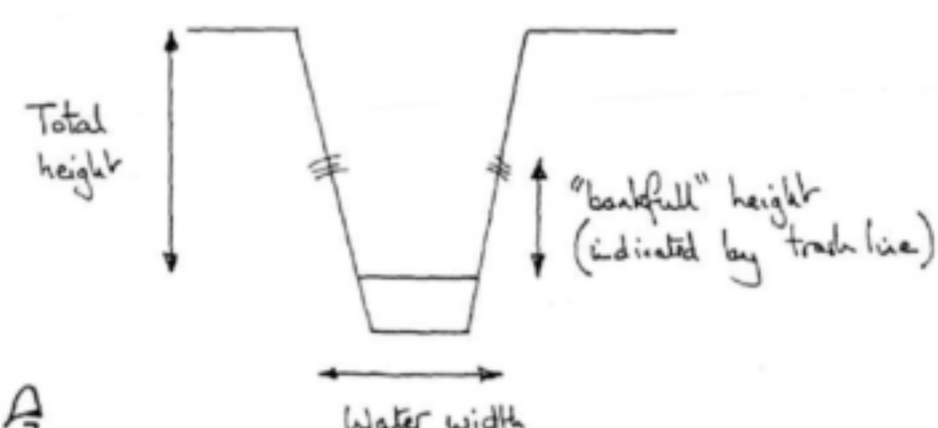
Select location on uniform section.

Where a riffle is present in the 500m measure there. If not, measurements to be made at straightest/shallowest point.





ARTIFICIAL (eg overdeepened) CHANNEL



APPENDIX 2 RIVER HABITAT SURVEY: 1994 VERIFICATION GUIDANCE NOTES

1. PREAMBLE

1.1 RHS is an assessment of the physical structure of watercourses based on a 500m sample unit. It does not require specialist geomorphological or botanical expertise but consistent recognition of features included on the form is crucial.

1.2 The RHS form (Appendix 1) is four pages long and is accompanied by a separate spot-check key. In addition, one of the questions refers to photographs in Appendix 3. *It is recommended that a clip-board or ring-binder file is used and that the spot check key is put in a separate waterproof cover or folder.*

1.3 All sites have been preselected and have been delineated on 1:50,000 scale OS maps. The upstream and downstream boundaries should not be changed unless absolutely necessary and in no circumstances should they be moved to include 'good' or bad features since this verification phase should provide an unbiased sample of rivers.

1.4 The form is designed to be as simple as possible and should be completed as far as possible, in sequence.

1.5 Page 1 can be largely completed on arrival on site or at the end of the survey as appropriate. Page 2 comprises the 10 spot checks and these should be located at equal (ca 50m) distances along the 500m. In order to do this consistently it is **recommended that each surveyor calibrates his/her stride length beforehand to identify how many paces represent 50m.**

1.6 Each spot check comprises a physical, vegetation structure and vegetation-type assessment. Physical features are assessed from a 1m wide "transect" across the channel, while both vegetation structure and type are assessed within a 10m wide "belt" or swathe across the river at the same spot.

1.7 The spot checks should be completed on the outward journey. In most instances each check should take no more than 2 minutes to complete, particularly since most boxes will have a single entry because only the predominant feature is to be recorded. With experience, and in uniform sites the time taken to complete the spot checks will be reduced significantly. The primary purpose of these spot checks is to allow greater consistency of recording.

1.8 Page 3 comprises a sweep-up to be completed on the return journey. This represents an inventory of features over the whole sample length and will sweep-up those rarer features not included in the spot checks. It is important to insert the RHS site number on page 3.

1.9 Most features over the 500m length are to be recorded as present (✓) but with those features occupying 33% or more of the channel or banklength recorded as "E" (extensive) to indicate their contribution to the overall assessment of structure.

1.10 Trees are to be recorded in a tick box format on the basis of pattern along each bank.

1.11 The actual number of specific channel features (riffles pools unvegetated and vegetated point bars) are to be recorded. This can be achieved by a tally system which can then be totalled at the end of the survey.

1.12 Page 4 contains a section (P) on channel dimensions. Channel dimensions are to be recorded at **one site** within the 500m, selected on the basis of being in a straight or uniform reach with a riffle. Where no riffles are present within the reach, a uniform location should be selected. In each instance the bankfull width, wetted water width and depth should be recorded, together with bankfull height. The site may or may not coincide with a spot check. It is recommended that range-finders are calibrated on a daily basis if at all possible.

1.13 Section V on Page 4 provides the opportunity to briefly describe the site regarding special or unusual features or character which need to be emphasised and may explain vagaries in spot check entries.

1.14 It is imperative that, at the end of each sampling episode, which should not, with experience, take more than 45-60 minutes, the form is checked for completeness. An extra five minutes for quality control, at the end will be invaluable, because incomplete forms will be returned and a resurvey requested.

1.15 The time taken to complete the survey and the number of sites per day will provide information necessary to identify resource requirements for full implementation of a national RHS monitoring programme.

1.16 RHS should only be carried out when conditions are suitable i.e. not during spate flows. If a prolonged period of heavy rain occurs then surveys should be delayed until the water level and clarity revert to suitable levels. **Any delays should be reported to Peter Fox as they occur.**

2. DEFINITIONS AND GUIDANCE FOR RHS FORMS

A. BACKGROUND INFORMATION *This information is being collected separately before the field survey for sites in England and Wales.*

Altitude (m) To be estimated from 1:50,000 OS map.

Slope To be estimated from 1:50,000 OS map as average gradient (m/km) over a 1km square or equivalent linear distance.

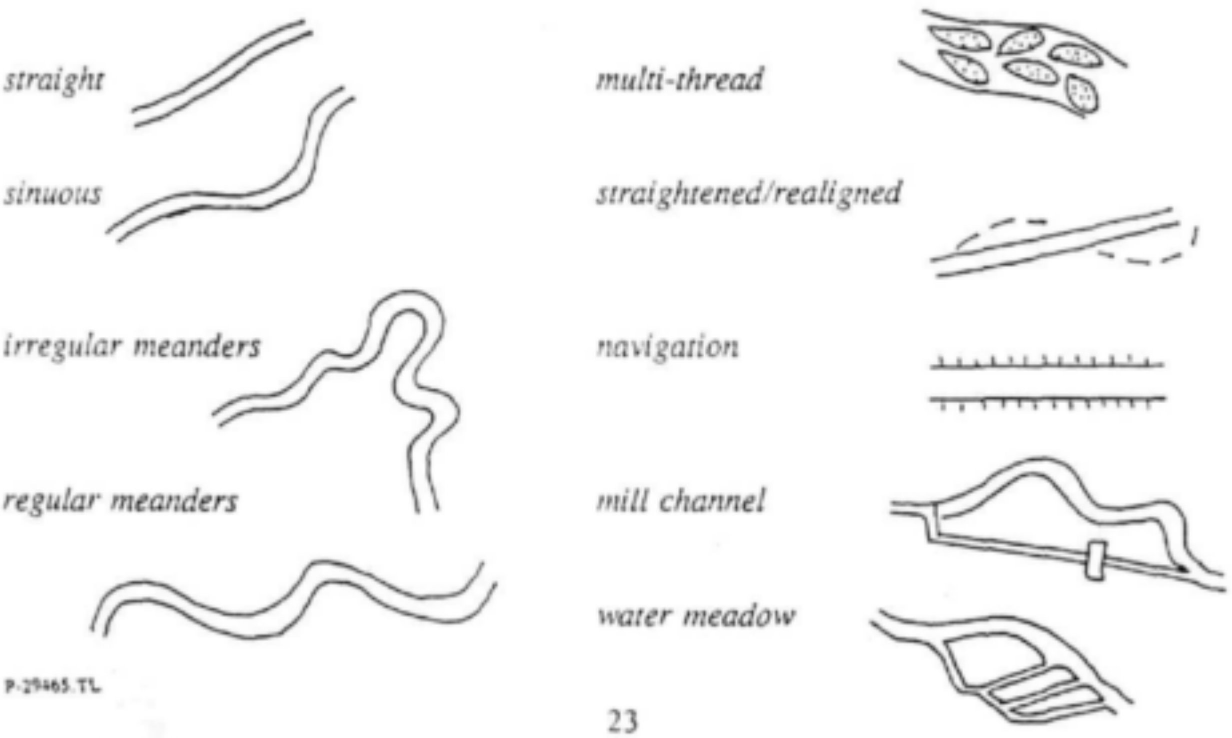
Mean Annual Flow To be a direct read-off from the 1985 Regional River Quality Objective (RQO) maps as one of 10 categories: 1 (<0.31 cumecs); 2 (0.31 - 0.62); 3(0.62 - 1.25); 4 (1.25 - 2.5); 5 (2.5 - 5.0); 6 (5.0 - 10.0); 7 (10.0 - 20.0); 8 (20.0 - 40.0); 9 (40.0 - 80.0); 10 (>80.0 cumecs).

Solid Geology Category (abbreviated) as assigned by the British Geological Survey for the 1km^2 square within which the site is located.

Drift Geology As above.

Planform category One of: straight; sinuous; irregular meanders; regular meanders; multi-thread (all natural); straightened, navigation, mill channel and water meadow system (see below). Category **to be assessed over 2.5km of river length on 1:50,000 OS map.**

Distance from source Linear distance (km) from source as on 1:50,000 scale OS map.



B. FIELD SUPERVEY DETAILS

Site number	Each site in England and Wales will be assigned beforehand.
River	Name appearing on RQO map.
Mid-section grid reference if different from designated site	For verification purposes, some pre-selected sites may be inaccessible or an excessive distance from a road. In these instances a site nearer the access is acceptable provided that the river character is similar. *Use 6 figure grid reference.*
Are conditions affecting survey?	Surveys should not be carried out in spate conditions. NB the water level (high or low) and turbidity will be important factors which will affect recording. *Tick one box.*
Photograph (general)	One photograph showing the overall character of the site should preferably be taken as a pictorial record of the site. *Tick one box only.*
Photograph of channel measurement site	In order to contribute directly to the R & D project on geomorphology which is supporting RHS please take a photograph of the site where the channel dimensions are taken, preferably a low angle shot taken from just above bankfull height with the ranging pole for scale. *Tick one box.*

C. PREDOMINANT VALLEY FORM

Shape refers to general **overall form** of valley in the context of the river channel. "Stepped valley floor" represents form produced by old river terraces. *Tick one box only.*

D. PREDOMINANT CHANNEL FORM

Category reflects the **predominant** form (>50% length) within the 500m site. *Tick one box only.*

E NAVIGATION

Indicate if channel is a working navigation used by pleasure cruisers, etc. *Tick one box only.*

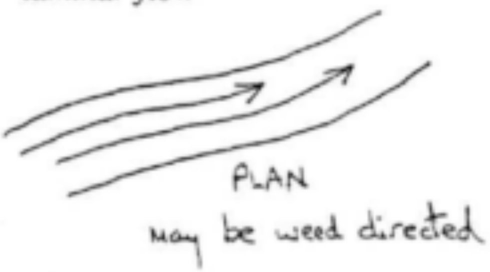
Navigations are as indicated in "Nicholson's OS Inland Waterways Map of Great Britain" (ISBN 0-319-00266-7).

F. PREDOMINANT FLOW TYPE

	Category reflects **predominant** flow pattern. *Tick one box.*
Torrential/whitewater	Chaotic turbulent flow on steep gradient channels.
Step-pool cascade	Distinctive pattern caused by bedrock and boulder outcrops in steep gradient channels.
Riffle-pool	Characteristic sequence.
Approximately laminar	Uniform flow with no obvious eddying or mixing.
Static	No perceptible flow on very low gradient channels.
Impounded	Ponding caused by dam or weir.

step-pool

laminar flow



riffle-pool

G - I. SPOT CHECKS

Ten spot checks should be completed at regular intervals along the 500m site. Stand on the bank and look across the channel and indicate **in each box** the material, modifications and features present.

Bank	Permanent side to river. Top marked by first major break in slope where water spills out of channel.
Left and Right banks	'Left' and 'right' banks determined when facing **downstream**.

For physical attributes (G) use a zone about 1m wide across the channel. Where more than one feature occurs, use a diagonal line to include a second entry. *Only one entry per box is allowed for channel substrate and modifications to bank and channel.*

For vegetation spot-check structure and type (H and I) use a 10m wide swathe (ie 5m to either side of the physical attribute guidance).

Each entry should be made clearly using the abbreviations shown in the spot check key and described below.

G. SPOT CHECKS: PHYSICAL ATTRIBUTES (use key for abbreviations)

PREDOMINANT CHANNEL SUBSTRATE *Wentworth scale shown on spot-check key*

Bedrock (BE)	Exposure of underlying solid rock
Boulder (BO)	Loose rocks > 256mm diameter (approx large head size)
Cobble (CO)	Loose material 64-256mm diameter (half-fist to large head size).
Gravel/pebble(GP)	**A combined category**. Coarse gravel is 16-64mm diameter; fine gravel is 2-16mm diameter. Pebbles are conker to half-fist size.
Sand (SA)	< 2mm diameter
Clay (CL)	Solid surface comprising sticky clay material
Silt/mud (SI)	Very fine material as a deposit
Artificial (AR)	eg concrete

PREDOMINANT FLOW TYPE

Cascade/waterfall (CA)	Distinct *vertical drop* in water
Torrential/whitewater (TW)	Rapidly flowing water with severely broken surface in steep (5^0 -89^0) channel sections [normally boulder/cobble substrate]. Includes **rapids**.
Riffle (RF)	Fast flowing shallow water (normally over gravel) with *distinctly broken or disturbed surface* (max 5^0 slope)
Approximately laminar (AL)	Water with *largely undisturbed surface* other than occasional swirls or eddies. Includes **glides** and **runs**. NB Weeds can cause considerable flow variation in glides.
Static (ST)	Area of water with no *perceptible flow* due to natural or artificial ponding (**slack**). No eddies or swirls. A stick placed in a slack will not create turbulence downstream.
Pool (PO)	A *distinct feature of deeper water* with either no perceptible surface flow or slight eddying/reverse flow. Never longer than three times channel width.
Ponded (PD)	Water ponded by natural or artificial obstruction downstream.

CHANNEL MODIFICATIONS

None (NO)	No obvious modification(s)
Culvert (CV)	Self-explanatory
Bridge (BR)	Includes footbridges, pipe crossings
Dam/weir (DA)	Self-explanatory
Resectioned (RS)	Obvious regrading/resectioning of channel bed
Reinforced (RI)	Artificial reinforcement; includes concrete aprons

CHANNEL FEATURES

None (NO)	None present or visible
Exposed bedrock/boulders (RO)	Bedrock or boulders outcropping/protruding above water level. Often covered with mosses/liverworts in upland streams
Unvegetated mid-channel bar (MB)	*Unvegetated* exposed mid-channel bar/shoal, loosely packed material.
Vegetated mid-channel Bar (VB)	Distinct, permanently exposed compacted deposit in mid-channel which has perennial vegetation, often reedgrass.
Mature island (MI)	Mid-channel bar or island with established scrub and trees often approaching or above flood level height.
Urban debris (TR)	Bricks, shopping trolleys etc.

PREDOMINANT BANK MATERIAL

Bedrock (BE)	Exposure of underlying solid rock.
Boulder/cobble (BC)	*Combined category*: loose rocks > 256mm diameter; approx large head size; and loose material 64 - 256mm diameter (half fist to large head size).
Gravel/pebble/sand (GP)	*Combined category*: coarse gravel is 16 - 64mm diameter; fine gravel 2 - 16mm diameter; and sand, < 2mm diameter.
Earth (EA)	Crumbly earth (a generic term).
Peat (PE)	Self explanatory.
Clay (CL)	Solid and cohesive. Sticky between finger and thumb. **Use ranging pole to distinguish between crumbly earth and sticky clay.**
Concrete (CC)	Concrete revetment - masonry cemented to form a solid face predominantly or totally concrete.
Sheet piling (SP)	Vertical steel piles protecting bank face.
Wood piling (WP)	Wooden poles protecting bank face (often toe only).
Gabion (GA)	Stones in wire baskets.

Brick/laid stone (BR)	Walls including stone walls.
Riprap (RR)	Loose boulders imported to protect bankface.
Builder's waste (BW)	Rubble, metal, wood, etc.

BANK MODIFICATIONS

None (NO)	No obvious modifications
Resectioned (reprofiled) bank (RS)	Profile modified **but not reinforced** often to accommodate flood flow and maintenance machinery. Normally a relatively smooth, angled slope.
Reinforced bank (RI)	Whole or part of bank artificially strengthened for bank protection purposes.

BANK FEATURES

None (NO)	None or none visible
Eroding earth cliff (EC)	Vertical cliff often with toe, showing "clean" earth face. Other clues: turf overhanging cliff, turf in channel, recently fallen trees, leaning fence posts. "Earth" defined in broadest sense (natural substrate including sandy earth, but not sticky clay).
Stable earth cliff (SC)	Vertical bank face without obvious signs of recent erosion eg with nest holes, mosses, odd patches of vegetation on face.
Fining upwards sequence (FI)	Natural bank material where particle size is coarse at base (eg cobbles, gravel) and decreases in size toward the bank top.
Unvegetated point bar (PB)	Unvegetated coarse or fine exposed deposit on inside of meander bend. Unvegetated defined as < 50% plant cover at water's edge.
Vegetated point bar (VP)	'Vegetated' defined as > 50% plant cover at water's edge often showing a successional sequence (see over).
Unvegetated side bar (SB)	Exposed coarse or fine unconsolidated deposit along toe of bank, unvegetated.
Vegetated side bar (VS)	'Vegetated' defined as > 50% plant cover.

Mid-channel bar Point bar Side bar

H. VEGETATION STRUCTURE: RIPARIAN ZONE AND BANKS

(To be assessed over 10m wide swathe at each spot check). Refer to spot check key.

The 'riparian zone' is the land immediately adjacent to rivers which may extend to the edge of the floodplain (where one exists), stretch partially across it, or merely form a narrow 'riparian strip' bordering the top of the bank. In the uplands, and in those river valleys where agricultural improvements and other developments are limited, there may not be an obvious riparian zone. In the developed lowlands, however, even a very narrow riparian zone can be important as a buffer against the impacts of floodplain developments on the river itself.

In many respect the value of riparian zones is determined by structure, extent and completeness. all of these attributes can be independent of 'naturalness'. When two rivers are compared which have riparian habitats with the same structure, extent and completeness but one is 'natural' and the other is not, the numbers of species of river corridor plants and animals associated with the former are usually much greater.

Riparian zone That portion of the river corridor (i.e. from banktop outwards) which is either

a) undeveloped and retains characteristics of riverine or floodplain habitats (i.e. Broadleaf or mixed woodland; scrub/tall herbs; marsh/fen; bog) or
b) effectively buffers the river from wider land-use practices (eg rough grassland between the river and agricultural cultivation or urban/residential/industrial development).

If absent at spot check enter NO for none.

Vegetation Structure Category	This is based on 3 categories of predominant structure representing vertical layering. (Refer to spot-check key.)
Bare (B)	bare ground
Uniform (U)	predominantly one vegetation type, but lacking scrub or trees
Simple (S)	predominantly 2-3 vegetation types, with or without scrub or trees. NB trees with little or short herb understorey to be included in this category.
Complex (C)	four or more vegetation types.

NB Since this exercises a rapid look-see, only the predominant structures are to be assessed. Time should not be spent searching for relatively inconspicuous types of vegetation.

Vegetation types to be included in assessment:

Bryophytes	Mosses and liverworts
Short/creeping herbs & grasses	Ankle-shin height (includes ivy)
Tall herbs & grasses	Knee height and taller; includes bracken and ferns
Scrub	Brambles,. shrubs
Saplings/trees	Self explanatory

I. CHANNEL VEGETATION TYPES

To be assessed within a 10m swathe across the channel at each spot check.

None visible	If no vegetation is present or visible, tick this box.
Bryophytes	Mosses and liverworts, usually growing as 'cushions'.
Emergent vegetation	Aquatic plants rooted in the river bed or edges with leaves and flowers etc above water level.
Emergent herbs	e.g. *Apium*, *Rorippa* spp
Emergent reeds/sedges	Reed fringe/mid-channel reeds e.g. *Sparganium erectum*, *Schoenoplectus*, *Typha*, *Phragmites*, *Glyceria maxima*.

Floating-leaved	Rooted in river bed but with floating leaves e.g. *Nuphar lutea*, *Potamogeton natans*.
Free-floating	e.g. duckweed *Lemna* spp. frogbit, bladderwort.
Amphibious vegetation	Rooted at edge or in bank but leaves trailing into or across the water e.g. *Polygonum amphibium*, *Agrostis stolonifera*, *Glyceria fluitans*, *Alopecurus geniculatus*, *Myosotis scorpioides*.
Submerged vegetation	Rooted or completely submerged. No need to differentiate between fine and broad-leaved. Includes *Ranunculus* spp, *Myriophyllum* spp, *Elodea* spp, *Callitriche* spp.
Filamentous algae	e.g. *Cladophora*, *Enteromorpha*, either occurring alone or coating aquatic plants or stones.

Use end column to assess overall presence and character of vegetation types occurring in 500m as a whole. Use E; (≥ 33% channel area) or ✓ as appropriate.

J. LAND USE WITHIN 50m OF RIVER

Use E (≥ 33% banklength) or ✓ (present) for both left and right banks

K. LINEAR EXTENT OF RIPARIAN ZONE

Riparian zone	For definition of riparian zone, see Section H above. If present, estimate percentage banklength occupied. *If absent tick "none" box.*

L. BANK PROFILES WITHIN 500m LENGTH

Use E (≥ 33% banklength) or ✓ (present) for left and right banks

Resectioned (reprofiled) bank	Profile modified **but not reinforced** often to accommodate flood flow and maintenance machinery. Normally a relatively smooth, angled slope.
Reinforced bank	Whole or part of bank artificially strengthened for bank protection purposes.

Artificial two-stage channel — Bank excavated laterally into the floodplain to create a shallow shelf above dry-weather flow. Water spills into the second stage channel during flood flows.

Poached — Bank significantly trampled or puddled by livestock.

M. EMBANKMENTS

Artificial embankments can be located either on the banktop or set back some distance from the channel.

Where present, indicate extent as percentage banklength along left and right banks. (*Tick "none" box if absent*)

N. EXTENT OF TREES AND ASSOCIATED FEATURES

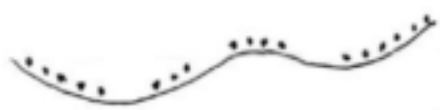
Due to the importance of trees and associated features, these warrant individual attention. *Tick appropriate box for each bank.*

Isolated/scattered, single

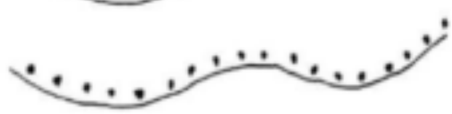
Regularly spaced, single

Occasional clumps

Semi-continuous



Continuous



Associated features — Tick appropriate box for occurrence within the whole 500m ("none"; ✓ present; E ≥ 33% by area or combined banklength) for assessing whole 500m.

Shading of channel — Extent of direct canopy shade on channel.

Overhanging boughs — Tree boughs which dip close to the water surface.

Fallen tree — Tree uprooted or collapsed *in situ* still attached to bank, either alive or dead.

Exposed bankside roots	Extensive network of large (forearm-sized) exposed roots esp.ash) and associated cavities.
Underwater tree roots	Exposed underwater fine/matted tree/shrub roots. Examples include Alder roots.
Woody debris	Trees, large branches etc swept downstream and temporarily occupying part of channel.

O. NATURAL CHANNEL FEATURES (See Appendix 3 for illustrations)

NB The actual number of riffles, pools, unvegetated and vegetated point bars need to be recorded.

Riffle	Fast-flowing shallow water (normally over gravel) with *distinctly broken or disturbed surface* (max 5° channel slope).
Pool	A *distinct feature of deeper water* with either no perceptible flow or a slight eddying/reverse flow. Never longer than three times channel width.
Unvegetated point bar	Coarse or fine exposed deposit on inside of meander bed. 'Unvegetated' defined as <50% of point bar with vegetation.
Vegetated point bar	'Vegetated' defined as >50% of point bar with vegetation.

All other features should be recorded on the sweep-up as either E (≥ 33% of channel area) or (✓) present.

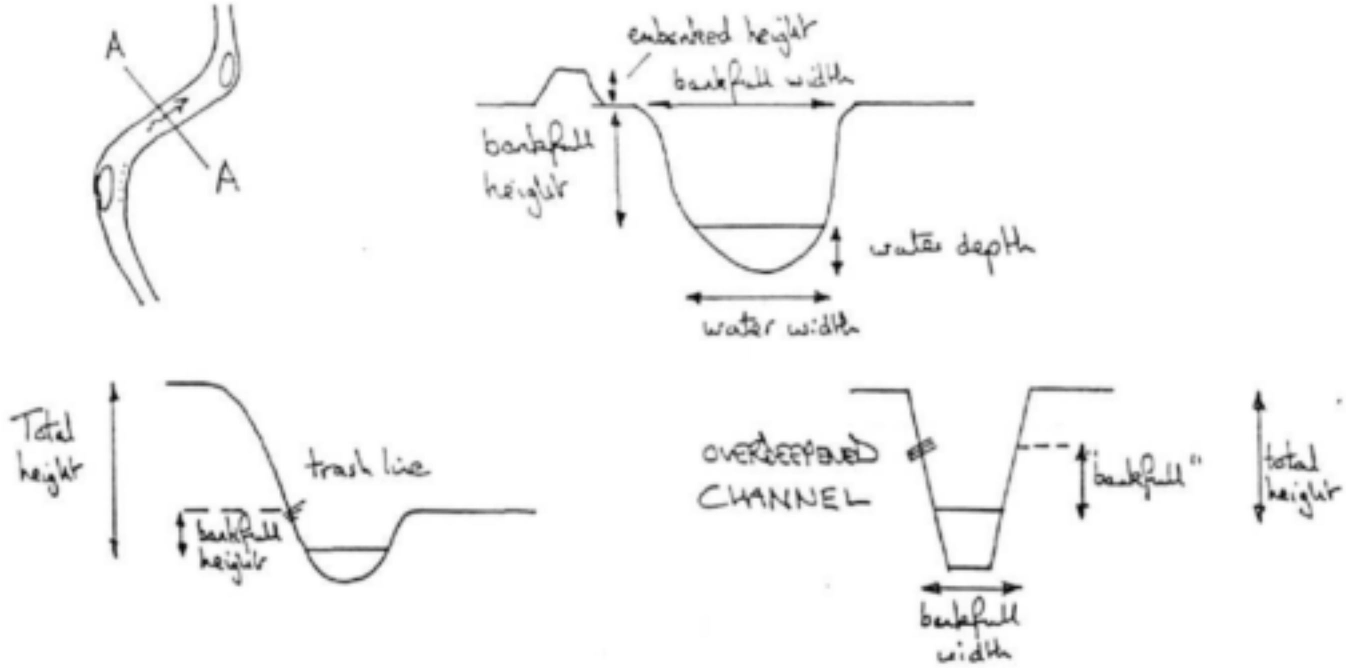
Cascade/waterfall	Distinct *vertical drop* in water.
Torrential flow	Rapidly-flowing water with *severely broken surface* in steep (5° - 89°) channel sections [normally boulder/cobble substrate]. **Includes rapids.**
Approximately laminar flow	Water with largely *undisturbed surface* other than occasional swirls or eddies. **Includes glides and runs.** NB Weeds can cause considerable variation in flow in glides and runs.
Static water	Area of water with no *perceptible flow* due to natural or artificial ponding (**slack**). No eddies or swirls. A stick placed in slack will not create turbulence downstream.
Unvegetated mid-channel bar	Exposed mid-channel shoal, unvegetated.

Vegetated mid-channel bar	Exposed mid-channel shoal often with ruderal vegetation or reedgrass.
	NB bars and islands are discrete features in single thread channels. Braided channels have a completely different pattern of bars and islands (see Section A).
Unvegetated side bar	Coarse or fine exposed deposit along side of channel.
Vegetated side bar	See section F above.
Mature island	Mid-channel bar or island with established scrub and trees often approaching or above flood level height.
Artificial	Any artificial structures on river channel bed.

P. CHANNEL DIMENSIONS

Measurements of channel width, depth and bank height.	Always choose a straight section on a riffle and measure channel and bank dimensions and assess bed consolidation there.
	Rangefinders and ranging poles will improve the degree of accuracy.
Bankfull width	Bankfull width is to be measured at a level where the river first spills out of its channel. When present, flood debris caught up in branches etc. will indicate this level.
Water width	Water width is the distance occupied by water in the channel at the same location.
Water depth	Water depth is the depth measured in mid-channel
Bankfull height	Bankfull height is the distance from water level on the day to the bank top where the river first spills out of its channel. When present flood debris caught up in branches will indicate this level.
Total bank height	Total height from water surface to bank top in artificially modified (deepened) channel, if greater than "natural" bankfull height.

Embanked height — If present, extra height produced by an artificial embankment.



Bed consolidation — **Consolidated bed** will normally be characterised by algal or macrophyte growth on gravel and a stable 'feel' when kicked.

Unconsolidated bed will comprise clean fresh gravel which is easily dislodged or moved when kicked.

NB Not all sites will have a riffle. Where there is not a riffle, indicate what flow type is present at the location. In some instances, the river bed will be in accessible and its depth and consolidation unknown. If so indicate accordingly.

Q. TRIBUTARIES

Include only those significant in the context of the site.

R. NUMBER OF ARTIFICIAL FEATURES

Indicate number within site including or "none" as appropriate.

Culvert — Self explanatory

Weirs — Any structure damming the channel

Bridges — Include footbridges, access bridges and bridging for pipes within site.

S. EVIDENCE OF RECENT MANAGEMENT

Recent activity

"Recent" is defined as showing **obvious signs** eg machinery present, excavated bare earth, weed/brash cuttings and mowings, unvegetated dredge spoil on bank etc.

Enhancement works

Examples include meander and riffle reinstatement, channel narrowing, reed-planting, tree-planting. Most will only be obvious when recent.

Tick appropriate boxes and state type if necessary.

T. CHOKED CHANNEL

If 33% or more of the channel area over the 500m length is choked with vegetation, causing significant impediment to flow, indicate by ticking appropriate box. *This will depend to some extent on seasonal influences.*

U. NOTABLE NUISANCE PLANT SPECIES

Indicate presence within 500m site as a whole by ticking appropriate box. *There is no need to estimate abundance.*

V. BRIEF DESCRIPTIVE SENTENCE

An opportunity to describe briefly, the notable features of the site characterisation or spot checks. In essence a thumb-nail sketch, which indicates the key character and any significant impacts.

W. SPECIAL FEATURES

An opportunity for recording special features of wildlife interest eg abandoned oxbows, kingfisher nest-holes, otter spraints etc. This should not represent a major investment of time, rather incidental sightings. *If appropriate, a brief list of predominant plant species can be recorded separately.*

X. RIVER TYPING

Refer to the photographs in Appendix 3 and indicate which number closest resembles the site. If a combination, write down two numbers. Indicate "none of these" if no photographs match the site.

Y. TIME TAKEN TO COMPLETE SURVEY

An important feedback mechanism to assess efficiency and effects of experience.

Z. HELPLINE NUMBERS (Internal numbers)

Peter Fox	7-21-2140
Paul Raven	7-10-4343
Andrew Brookes	7-25-5712

NRA

National Rivers Authority