STATE OF THE RIVERS PROJECT

TRAINING MANUAL

PREPARED BY: **LAND AND ENVIRONMENT ASSESSMENT**

In consultation with Dr John Anderson

NATURAL RESOURCE SCIENCES CENTRE

DEPARTMENT OF NATURAL RESOURCES AND MINES

JULY 2003

Queensland Government
Natural Resources and Mines

CONTENTS

1. INTRODUCTION

1.1 Aim and Purpose of the Project

The 'State of the Rivers' Project originated from a clear need for detailed and comprehensive information on the physical and environmental condition of rivers and streams in Queensland, especially in terms of the instream habitats, values and condition. The Integrated Catchment Working Committee prepared a Discussion Paper on "The State of the Catchments". This paper reviewed and brought together current knowledge of catchment issues in Queensland. The paper successfully showed that problems exist but it also showed that data on many issues were lacking or were only in a qualitative form and were insufficient for designing or assessing programs of action.

As the principal agency responsible for the management of the water resources in the State, the Queensland Department of Natural Resources and Mines (DNRM) requires objective information on the physical and environmental condition of watercourses throughout Queensland.

The DNRM has already established programs for monitoring water quality and stream flows on a statewide basis. Assessment of the condition of some river sections has been undertaken by several agencies, but these assessments are restricted in scope, usually focusing on only one aspect of condition such as flooding impacts or fisheries. What was needed was an assessment of the ecological and physical condition of all the State's watercourses, which could be conducted on a catchment-by-catchment basis using a consistent and objective methodology. The data collected should be able to be related to other available databases (particularly GIS), and should establish a baseline for use in long-term monitoring of watercourse condition.

The State of the Rivers Project was initiated to satisfy these needs. Information was required to assess the effects of past activities undertaken or regulated by the DNRM and other bodies, and to plan for activities and programs to monitor and to protect the beneficial uses of the State's watercourses. The project was seen as providing fundamental data on instream condition and values, which could only be obtained by conducting specific surveys. Remote sensing of various types such and Landsat and aerial photography and catchment based data collection cannot provide this information.

The project is therefore seen as an important part of the ICM process, which can provide information for identifying key issues, problems and priorities, for recognising the processes causing the degradation and for initiating the first steps to finding the solutions.

The purpose of the surveys is to take a 'snap-shot' of the current environmental and physical condition of stream sections within catchments which can be assessed against a local standard representing desirable or pristine conditions (using representative pristine or little disturbed sites in the catchment or region). These data are required to identify processes and causes of the deterioration in condition, and thereby to pinpoint actions needed to rectify the situation. One important outcome is to establish priorities within and between catchments so that the limited resources can be focused on the most serious problems, or the processes, which can be most efficiently tackled to reduce the degradation or to start the process of rehabilitation. Establishing the size, extent and seriousness of the problem is a necessary first step in improving the condition of rivers and streams throughout Queensland.

The project is not directed at establishing the trend or rate of change in condition, either now or at some time in the past. It is quite likely that the major changes in condition are not continuous but are

related to natural events such as major floods and cyclones coupled with man-made impacts such as periodic changes in land use or agricultural practices. It was decided that establishing trends was impossible except in a very general way was using historical records, because no consistent and comprehensive data are available.

However, the project does provide an objective and comprehensive benchmark against which future trends and rates of change of conditions can be assessed by conducting follow-up surveys. The methodology is focused on precisely locating the sites so that they can be re-surveyed easily, using the same techniques. Once surveys have been conducted future trends can be established.

The project is also directed providing some of the fundamental information required to classify rivers streams. Such information is crucial for their management and for identifying river and stream sections, which have high conservation and ecological values. It is also important quantifying natural resource type, values and use potential. Currently such classifications can only be based on hydrology and land system information, which is clearly inadequate without the detailed instream data.

The project also aims to provide an overview to help identify resource management and utilization practices contributing to the deterioration in physical and ecological condition of rivers. This includes water extraction and diversion, sand and gravel extraction, mining activities and various agricultural and land use management practices.

This assessment of the State of the Rivers will also be of use to the Environment Protection Agency (EPA) in compiling "State of the Environment" reports and in preparing and implementing the proposed Nature Conservation Strategy. Other users may include Fisheries Branch of DPI, Local Government Authorities, and River Improvement Trusts and local Integrated Catchment Management and Land Care Groups.

A primary consideration in developing the methodology was the resources available in terms of time, equipment and personnel (education experience and training). It was anticipated that the study would be conducted progressively on a catchment-by-catchment basis throughout Queensland, primarily through the use of in-house resources of the DNRM. The methodology had to be suitable for implementation by the DNRM Environmental Scientists with field work undertaken by Regional Technical Officers after a short training program. The method also had to provide for the data needs of ICM and to be compatible with the DNRM's Geographic Information System (GIS) application. These aspects were the fundamental constraints for the development of the methodology.

1.2 The Training Manual

The Training Manual describes the implementation of the State of the Rivers project methodology. The Manual contains:

- background to the State of the Rivers project,
- a brief discussion of the Survey methodology,
- a training package,
- an outline of the procedures and steps for implementing the methodology.

The reader is directed to Anderson (1993) for full details of the development of the methodology itself, the pilot survey, validation of the method, the literature review and justification f the approach taken.

The developed methodology includes the following aspects:

- An overview of the aims, objectives and approach adopted for the project.
- An outline of the steps required to implement the methodology.
- Procedures for gathering the relevant information and for planning the surveys in a new catchment.
- Methods for initially sub-sectioning the rivers and streams into 'homogenous' stream sections in terms of their natural physical and ecological attributes, and their current condition.
- The design and development of the set of 11 datasheets, one for each of the major components to be used in surveying and classifying the sites:

Sub-catchment Element;	Hydrology and Water Quality;
Site Description;	Reach Environs -Temporal and Spatial;
Channel Habitat;	Cross-sections;
Bank, Bed and Bar Condition;	Vegetation;
Aquatic Habitat;	Scenic, Recreational and Conservation Values.

- Procedures for selecting survey sites during a reconnoitre survey and for conducting a full survey at the selected sites using the data sheets.
- Procedures for subdividing the catchment into a series of sub-catchment elements each corresponding with one of the 'homogeneous' stream or river sections.
- The design of a series of 11 linked databases for recording and analysing the data on each data sheet and a set of input and output summary programs using the DBASE IV package.
- Methods for linking the 'State of the Rivers' database to other sources of data including HYDSYS and the DRNM's GIS package, and for providing data and analyses in a form suitable for Integrated Catchment Management.

The aims and objectives of this training manual are to:

1. Establish an organizational structure for implementation of the 'State of the Rivers' Project on a Statewide and Regional basis.

2. Outline the methodology of the State of the Rivers project sampling and analysis procedures.

3. Outline and explain all the steps required for implementing the methodology in a practical and simple way including a proposed organizational structure for the project.

4. Provide a package for training regional staff to implement the 'State of the Rivers' Project and steps in the planning and implementation of the project within each Region.

This Training Manual is one of a three-part set that covers the full implementation process of the surveying for the State of the rivers project. The companion manuals are:

Field Manual - Describing the resources needed for the survey; the steps in implementing the survey; collection of the data.

Data Management Manual - describing database procedures for DBASE IV; attribute ratings and condition classification; GIS, and map production options; data sheet database entry; the Maroochy River Case Study data.

2. DEVELOPMENT OF THE METHODOLOGY

2.1 "Scoping" of the Project

It is important to ensure, from the outset, that the data collected for the State of the Rivers surveys is relevant to the specific needs of all potential users in the land and river management. It is also necessary to carefully consider and plan the methodology to accommodate present and future needs as the methodology is intended to become a standard practice for many years to come.
Eight major issues have been identified:

- Provision of environmental flows;
- Conserving aquatic and riparian fauna and flora;
- Managing sand and gravel resources;
- Controlling and reducing erosion and deposition in streams;
- Protecting water quality;
- Conserving instream and riparian habitats;
- Understanding the effects of land management on water quality, habitat and flora/fauna;
- Protecting areas of scenic and recreational value.

Specific considerations identified of the methodology to include are:

- The need to identify trends in river condition;
- The problem of monitoring the effects of extreme events;
- The need to identify response times for variables;
- The benefits of developing a database of projects and studies;
- The need to establish links to related studies (e.g. wetlands survey and marine park monitoring).

2.2 Major Concepts and Elements of the Methodology

2.2.1 Habitat Assessment - Not biological, community or ecosystem measurements

The basic approach was to estimate the ecological condition in terms the condition of the instream habitat rather than by conducting flora or faunal (fish and macroinvertebrate) surveys.

Such an approach was justified in terms of the limited knowledge of the staff to be involved in the survey and the basic lack of understanding of how to interpret the results of such surveys. There are also practical difficulties of dealing with variations in season and flow, which mean that a single 'snap-shot' would be inadequate. Also no system for classifying the communities and habitat types in different areas has been developed so that it is difficult to decide when, where and what to survey.

The approach therefore has been to focus on the broad habitat attributes recognized as being of general, rather than of specific importance, to instream and riparian flora and fauna such as fish, macroinvertebrates, birds, mammals, and riparian and aquatic vegetation. The habitat was surveyed comprehensively for many attributes of general importance rather than individual attributes essential for specific species or communities. Many of the attributes surveyed have relevance both for the physical and the ecological condition, for example the particle size of the sediments on the bed and banks.

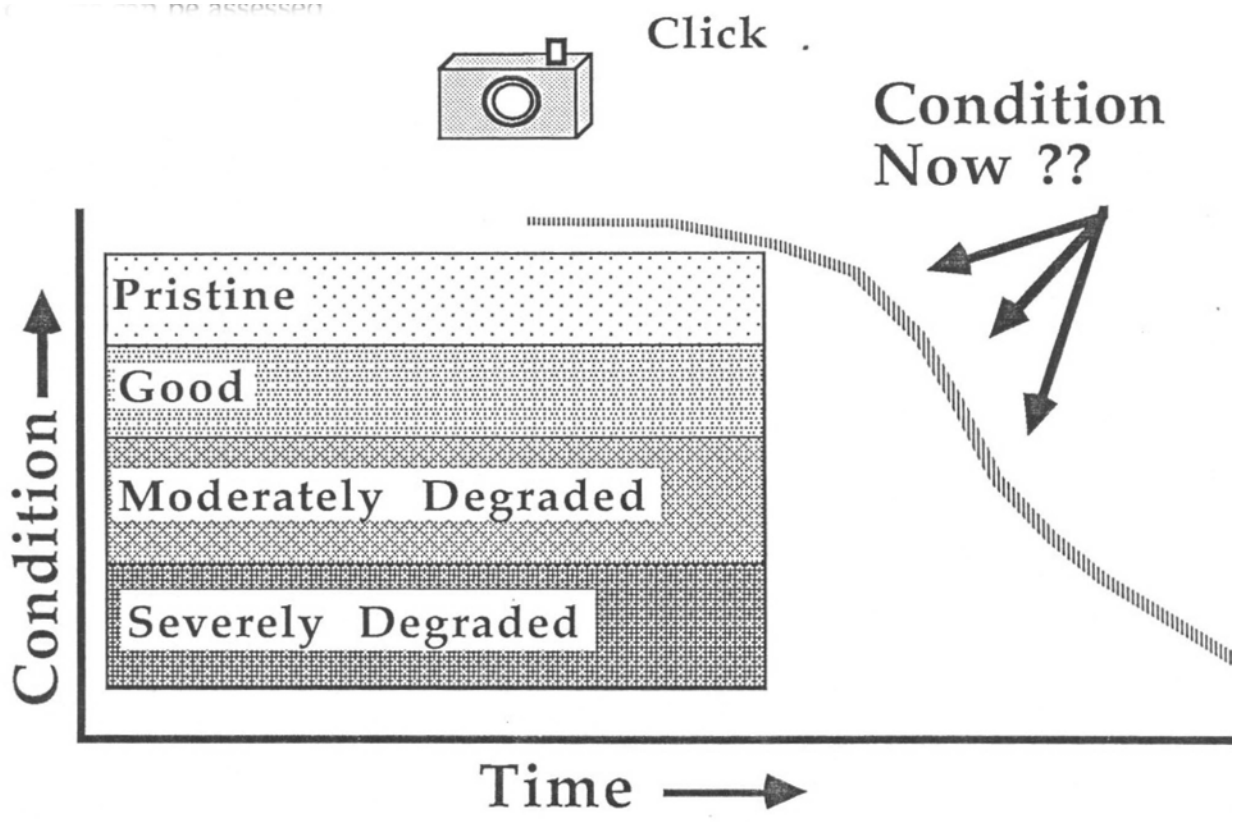
2.2.2 A “Snap-shot” Approach used to Assess Condition

What is meant by condition and how is it assessed?

The method adopted is a 'snap-shot' approach. The aim is to compare different stream sections within catchment, and different catchments in terms of their current condition now, and to assess the extent to which that condition has deteriorated from the original pristine condition or some other standard in terms of the parameters being assessed. Such a 'snap shot' also sets a benchmark for future comparisons.

The “snap-shot” does not itself directly measure the rate of change or trend. The problem with assessing trends and the rate of change is that there is no consistent set of historical data against which to compare the present condition of the stream. Historic data such as aerial photographs, local photographic records or recollections or local residents may give a valuable perspective for the 'snap-shot' taken now, but the method does not really focus on establishing the timeframe nor the trends for the changes observed, nor do it depend on the availability of such historical information. The availability of such information is obviously a bonus and it should be used during the analysis and interpretation of the data.

The objective of the project is therefore to provide a “snap-shot” of the physical and ecological condition of the stream now to highlight the most severe and urgent problems and to set a consistent and comprehensive baseline against which future trends and the rate of change can be assessed.



2.2.3 Establishing a baseline or benchmark for follow-up surveys

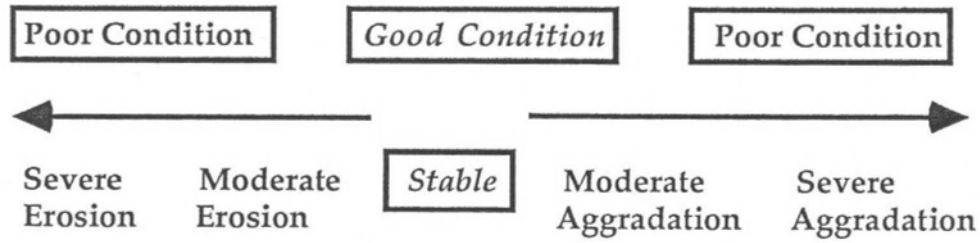
It is important that the methodology allow for future partial or complete follow-up surveys to assess the rate of change or perhaps to assess the effectiveness of remedial measures. This is achieved by adopting a standard methodology which can be easily repeated at a latter date, by including a standard set of photographs, and by precisely locating each survey site using GPS equipment (accurate to between 30-100m).

2.2.4 How is Condition Assessed?

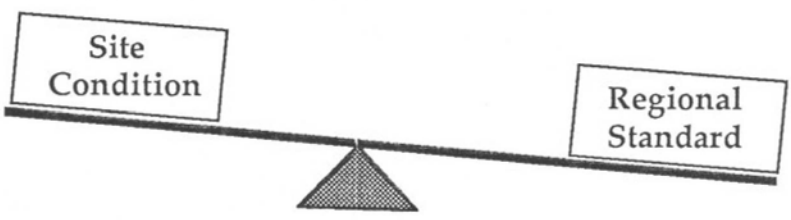
In most instances key concern is the extent to which the attributes, values or perceived functions of streams or rivers have declined from their pristine or undisturbed conditions. The concept of values, uses or functions is important because we are not only interested in conservation values, or protection of the animal and plant communities, but also in the recreational and aesthetic values of streams. We are also interested in their functions and natural resources in conveying and providing water of good quality, in their sand and gravel resources, their biological resources and in their various attributes which affect their functions and utility such as bed and bank stability.

What are the standards against which the change in condition can be assessed? Both absolute and relative standards are used. The stability of the bed and banks is an example of an absolute standard. In assessing the condition of bed and banks we are interested in determining the extent to which the banks have become unstable through either erosion, slumping, gullying, or the excessive build up of sediments on the bed or banks. Streams and rivers in good condition are assumed to be stable or in a graded state with some form of dynamic equilibrium prevailing between sediment supply, channel form and the sediment carrying capacity of the stream.

Bed and Banks



In other instances the use of an absolute standard may be inappropriate or impossible. For example it would be inappropriate to try to compare the shoreline vegetation of a stream in a tropical rainforest area with that of a stream in southeast Queensland or streams the Murray-Darling Basin in southwest Queensland. In these instances the current condition has to be assessed against the attributes for the stream or river in its pristine state or condition. Without historical data we have to rely upon locating pristine or relatively undisturbed sites within the catchment or local region, which can be used as standards.



If no remnant sites in good condition area available we have to established the presumed original pristine condition from the data available, including historical data or use sites in other catchments on the same general region. This concept will have to be developed during the course of the implementation of the project as the database is built up and there is more experience with the range of habitat types and conditions present in each area. As an interim measure these standards should be established within each catchment or major sub-catchment type.

2.2.5 Sampling Strategy

As in any sampling procedure the final choice is a compromise between the ideals of ensuring a valid statistical procedure is adopted that adequately represents the conditions present, and the pragmatic constraints of available resources, existing information and access. The following points are relevant:

- Random sampling is likely to be very inefficient than stratified sampling because neither the natural attributes of the streams nor or their condition are randomly distributed.

- Rivers are linear systems with their sections interconnected through the drainage network. Therefore what happens upstream in a tributary channel or a sub-catchment area in the headwaters will affect a series of interconnected stream sections downstream in a cumulative way. Therefore we expect rivers to change progressively down the drainage lines and for adjacent sections of rivers to be relatively homogeneous both in terms of their natural attributes and their condition.

- It is expected that the classification of streams into various types and their condition will not be independent. Certain types of streams will be more susceptible to deterioration than others. For example, streams with rock, cobble and boulder substrates will be less susceptible to head ward erosion than section with sands or mud.

Therefore a stratified sampling technique is likely to be much more efficient and more relevant for the survey.

The other major consideration is the method for the stratification and the availability of relevant data upon which it can be conducted. To-date there is no habitat classification system for streams in Australia that covers the diversity of stream types present in Queensland. The methods and data for conducting such a classification are inadequate or unavailable. There is a reasonably good hydrological record, but there has been no agreed approach to producing a hydrological classification in Australia, which is meaningful ecologically. The other important data as substrate particle size, channel depths, widths and gradients, etc. are not available. Indeed the State of the Rivers project is seen as representing a major potential source of the comprehensive data required for such a classification.

Likewise it is known that changes in the catchments and sub-catchments through clearing and other land use changes are largely responsible for changes in condition of the stream by changing runoff dynamics, nutrient loads and movements and a range of other influences. Also the construction of dams and weirs, and water extraction and stream diversion have major influences on flow regimes and sediment transport patterns in downstream areas. Various catchment information is therefore also a good potential basis for stratification as well as the natural attributes of the stream.

However, again we lack any comprehensive and consistent data about catchments and sufficient understanding of the processes involved to apply such information to streams.

Nevertheless, despite the lack of comprehensive data it is still important that we use whatever data is available as the basis for such stratification and the allocation of the restricted sampling effort. The approach adopted is somewhat of a compromise but it allows for a flexible approach using the limited data that is available at the time, and encouraging the use of more of this data as it becomes more widely available in a useable form as a GIS. The focus is on using existing data to allocate the samples and then using the data collected to re-assign the sites to the strata after the data collected is analysed. This can continue as an on-going process as more data becomes available.

2.2.6 Preliminary System of Classifying Catchments and Sub-catchments

Naiman et al. (1992) provide an excellent review of the general principles of classification and the assessment of conservation potential in rivers.

> "Ideally, a classification scheme should be based on a hierarchical ranking of linkages between the geologic and climatic settings, the stream habitat and the biota. These - the geomorphic and climatic processes that shape the abiotic and biotic features of streams - provide a conceptual and practical foundation for understanding the structure and processes of fluvial systems." page 96.

> "A successful classification system should be able to categorize the types and frequencies of disturbance that may impact the stream and predict adjustments in the physical and biotic characteristics." page 98.

Various attempts have been made to recognise the physical and biological attributes which are of fundamental importance for classifying catchments and sub-sections of catchments (Larsen et al. 1986; Rogers and Singh 1986; Miller and Onesti 1988; Huang & Ferng, 1990; Anon 1992; Naiman et al., 1992). The 1 and 2 summarise the most important attributes.

Table 1. Important attributes at the Catchment and Sub-catchment Level

Type	Attributes
Topography	Altitude
	Catchment Slope
	Stream Gradient
Geology	Geology of the Catchment and stream bed or base
Soils	Parent Material
	Texture
	Drainage
	Source of bed and bank sediments/supply
Climate	Rainfall pattern & season
	Temperature
	Evapo-transpiration
Vegetation	Type
	Cover
	Forestry Practices
Land System	
Terrestrial Ecosystem	
Aquatic Ecosystem	
Drainage basin pattern & network	Number of streams
	Stream Order
	Mean Basin Elevation
	Total stream length
	Width/depth Ratio
	Frequency
	Drainage density
	Bifurcation ratio
	Substrates
	Stream Gradient
	Sinuosity
Channel morphology and flow	Stream discharge
	Width
	Depth
	Wetted area/perimeter
	Mean velocity
	Pool volume/remnant pool volume
	Gradient
	Habitat types
	Diversity of channel habitat types (pool, riffle, etc.)
River Management	Channelisation
	Bank and bed stabilisation works
Extraction Activities	Mining (gold, sand-dredging, etc.)
	Sand and gravel extraction
Water Abstraction and diversion	Dams, weirs
Natural and Artificial barriers diversions	Waterfalls, cascades, barrages, weirs, dams
Hydrology and water management practices	Flow regimes
	Flooding frequency and hydrograph patterns
	Variability, seasonality and consistency of flow

	Low flow events and droughts Environmental flows
Stream Assimilative Capacity Ecosystem Indices Indexes of Biological and community Integrity Water quality indices	

Table 2. Important Attributes at the Reach Habitat and Microhabitat Level

Type	Attribute
Physico-chemical parameters	Temperature
	Water chemistry Pollutants
Habitat structure	Diversity of Habitats
	Instream cover
	Substrate
	Bank cover
	Riparian aquatic and emergent vegetation
	Depth, velocity and substrate patterns
	Invertebrate drift abundance Specific habitat attributes
	Bed and bank stability

The systematic use of these concepts and parameters to classify the streams as part of the sampling procedures is not possible because no such classification system has been developed in Australia and very little data is available. Nevertheless the fundamental importance of such a classification means that **what data is available should be used to identify stream sections, which have similar basic features and attributes as the basis for the sampling**. This is initial subdivision is made using **vegetation, land use, geology and topographic maps and other data sources.**

This initial sub-division is then followed up by visual inspection of the sites during a reconnoitre phase of the survey. The establishment of sub-catchment elements associated with each of the stream subsections and their location in the drainage network (discussed later) allows relevant catchment data to be incorporated into the database, and for the sub-sectioning to be upgraded and refined as more data becomes available.

2.2.7 Why biological and ecological indicators were not surveyed to provide the classification?

Classification systems based on biotic communities serving as integrators of ecological conditions demand exhaustive field monitoring, including sampling for seasonal variation; highly trained staff for sorting, identification and analysis of the samples; and a basic knowledge of the distribution and biogeography of the species and communities concerned. Also the specific impact of various types of disturbance on these indicators has to be known as well as the ability to sort out which type of disturbance has cause the changes observed.

These aspects are well beyond the current state of such knowledge in Queensland. Clearly such an approach was beyond the resources and constraints for the "State of the Rivers Project".

The needs of the project, especially in providing data to support Integrated Catchment Management, are therefore more likely to be satisfied by using a broad scale approach collecting a wide range of information about the physical condition and biological habitat features and condition. This

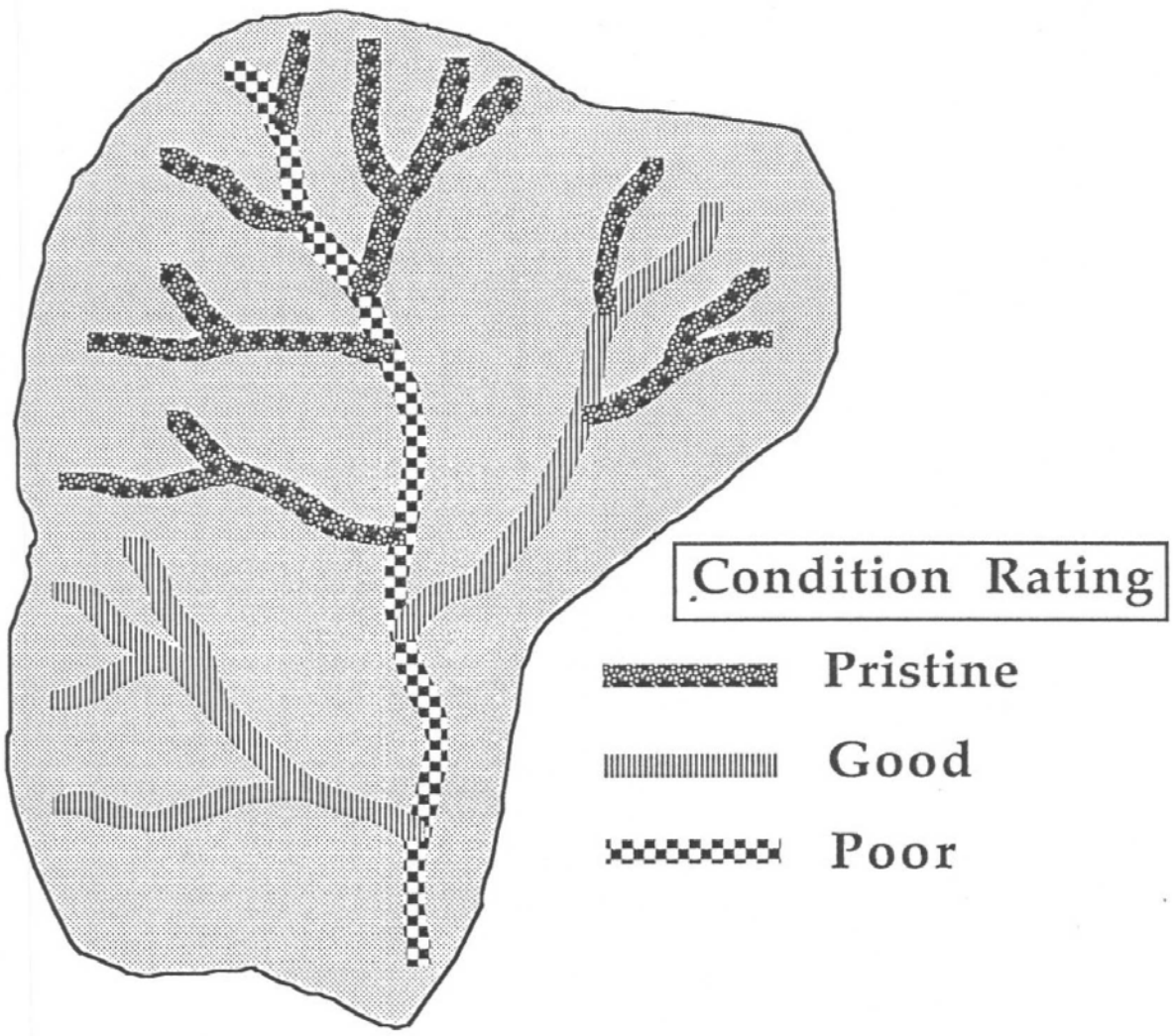
approach not only allows identification of the problem, but also provides some of the basic information on the processes, causes and location of the potential causes of the problems.

2.2.8 "Homogeneous" Stream Sections

The target of the methodology is to identify and classify the sections or rivers and streams in a catchment and between catchments into what are termed "homogeneous stream sections".

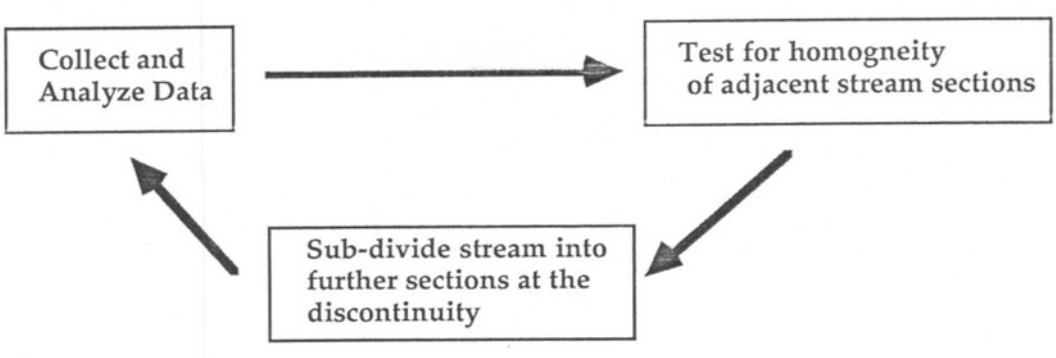
These stream sections are homogeneous in terms of the natural attributes (physical, chemical, biological and utilitarian values and resources) and in terms of their current condition as a result of human activities within the streams themselves and in the catchments. The identification of the homogeneous stream sections is a flexible process as well as an objective or target. It is an on-going process because it depends on the scale and range of attributes, which are used to define the homogeneity of various classified stream sections. Additional data can also be added from other sources and the sub-sectioning reviewed and upgraded.

Target = Classified Stream Sections



Similar classifications could be made for different combinations of attributes such as substrates, or instream aquatic habitat types. The process of reaching this target is an interactive one proceeding by successive subdivision of the stream network to satisfy the notion of homogeneity using various sources of data. The similarity of the stream conditions and habitat is tested against the set of criteria established for defining "homogeneity" at the scale relevant for the study (see diagram).

The streams are divided into subcatchments and then using available information and various boundary criteria until the notion of homogeneity within each sub-section is satisfied at the level of resolution required. The process continues initially using map scale attributes, then the results of the reconnoitre, then the results of the survey and compilation of the catchment data.



This process is carried out hierarchically in various stages (described in more detail later):

1. Map exercise using available catchment and stream information (including location of dams and weirs) and the major sub-catchment divisions (soils, geology, slopes, land use, vegetation type and cover).

2. Visual reconnoitre of catchment to test the initial homogeneity and to further subdivide the rivers and streams at appropriate boundaries.

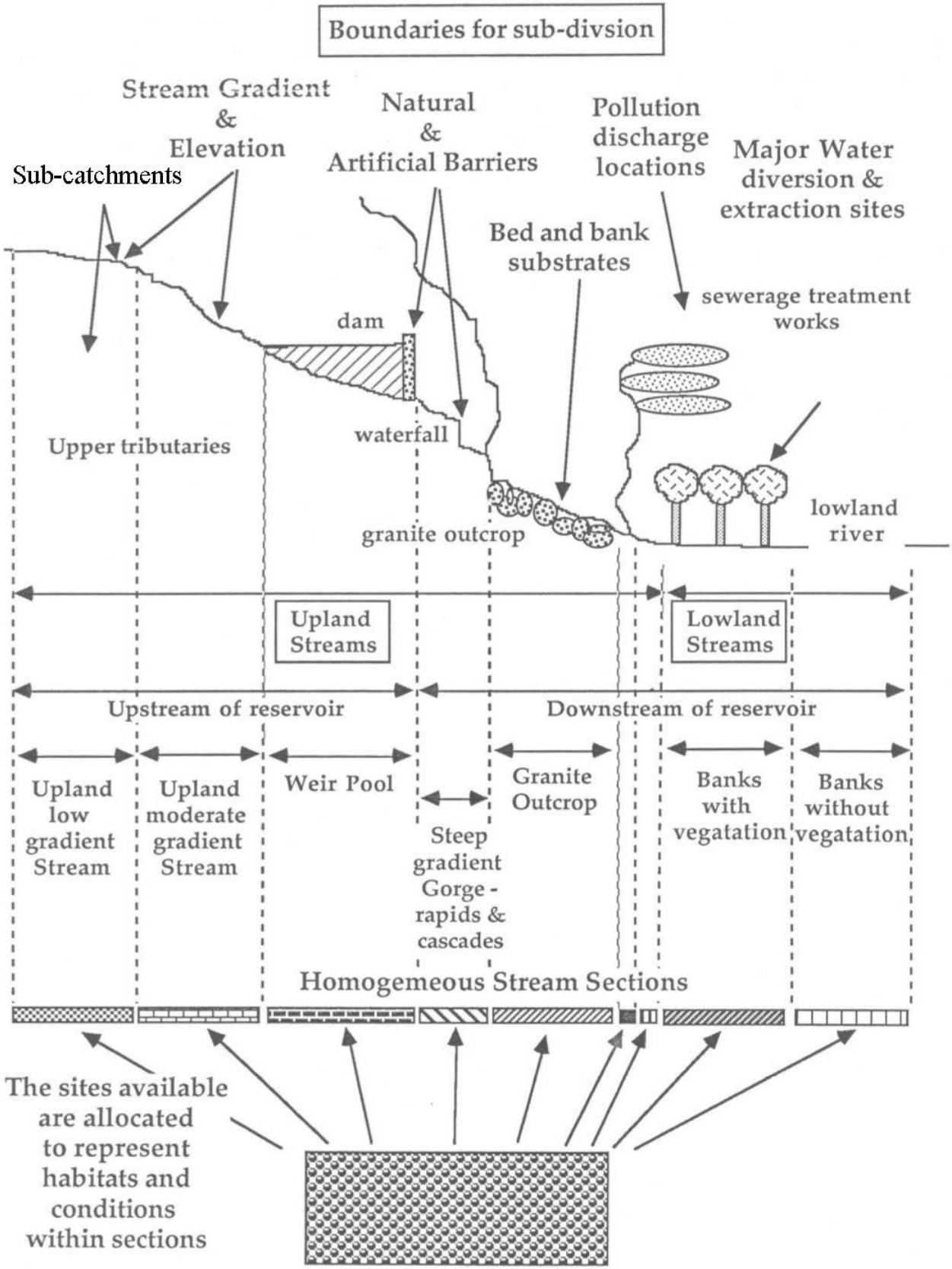
3. Further sub-sectioning is made in the course of conducting the instream surveys.

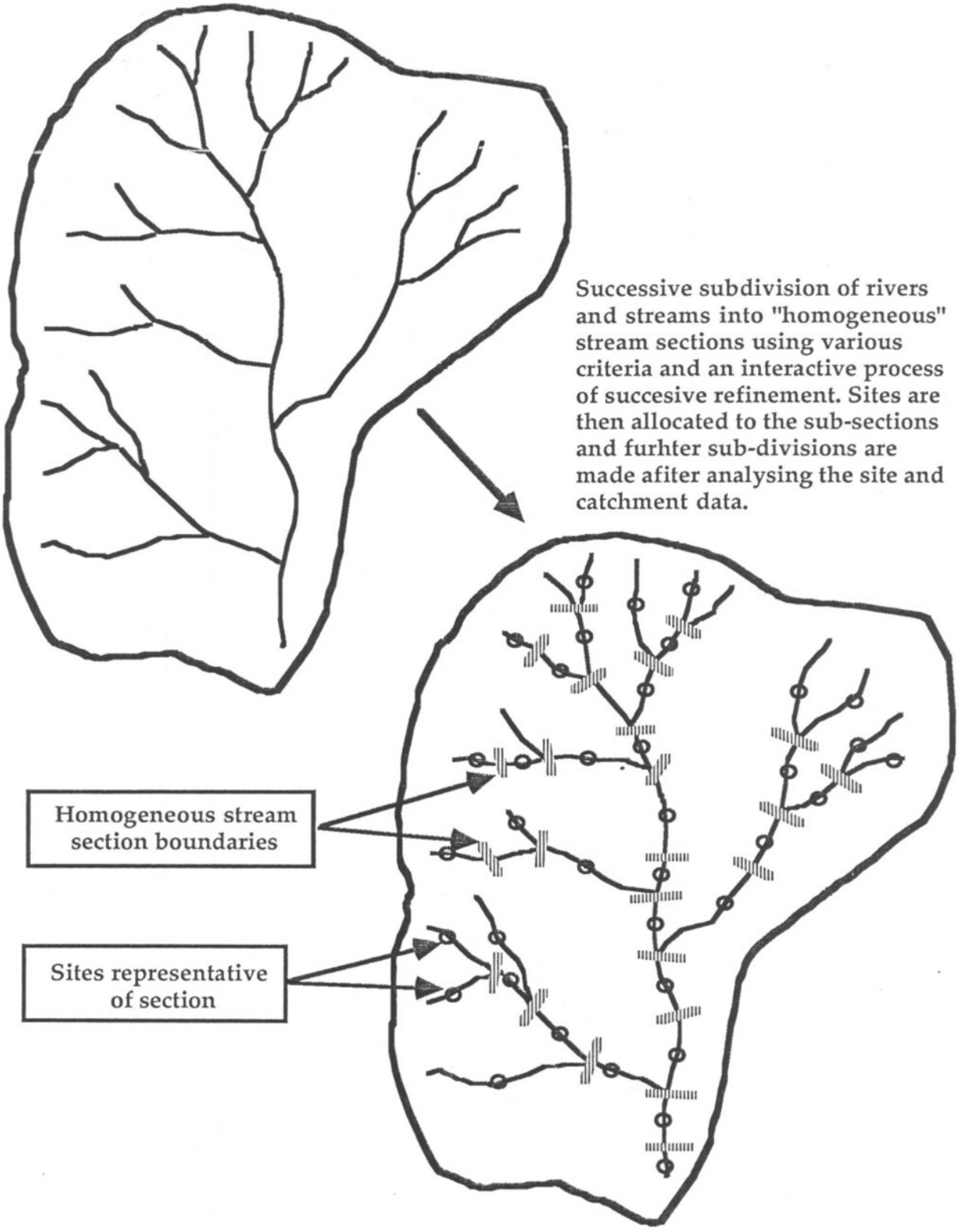
4. Analysis of the instream site data and testing of homogeneity between sites in the same section may lead to further sub-divisions.

5. Compilation of relevant catchment data, with further possible revision of sections

6. Final classification of stream sections using different combinations of the attributes for different purposes. These classifications will group the sub-sections in various ways. Permanent amalgamation of the sub-sections may be justified.

Homogeneous Stream Sections




Successive subdivision of rivers and streams into "homogeneous" stream sections using various criteria and an interactive process of succesive refinement. Sites are then allocated to the sub-sections and furhter sub-divisions are made afiter analysing the site and catchment data.
Homogeneous stream section boundaries
Sites representative of section

The stratification procedure for allocating the samples is therefore based upon the initial mapping exercise, a set of criteria used to initially determine the location of section boundaries, and the visual inspection of rivers and streams throughout the reconnoitre phase.

The limited number of samples, determined by the available resources, are then allocated and sites selected to be representative of the habitats and condition within the subsections. Multiple sites within sections are usually allocated systematically (at set distances along the channels).

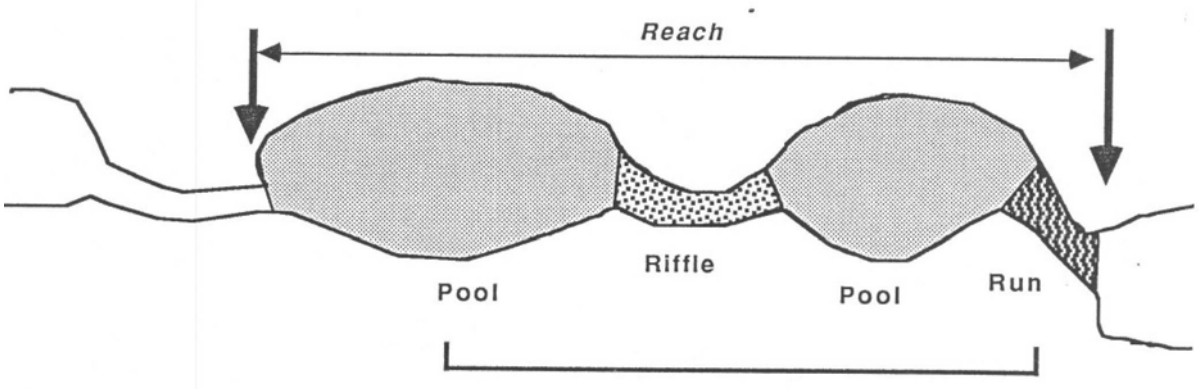
Access is the main determinant of the precise location of the sites most of which are located upstream of ford, bridges and other areas close to vehicular access. The sites are located well upstream of the bridge or ford to get away from any effect it may have on the stream condition. Simple and easy access is essential for minimising the time spent at each site. The extra time required to sample more remote sites is only justified for sampling the pristine sites.

The sampling procedure was therefore a stratified systematic one, but was purposeful and practical rather than being strictly valid statistically. The stratification was based on predictive attributes rather than actual available data. The collection of the actual catchment data such as slope, geology soils, land system classification, vegetative cover etc. is seen as a future option to upgrade the sub-division process rather an obligate part of the sampling. These compromises were justified by the lack of data and the practical requirements of access and limited sampling effort and time.

2.2.9 "Reaches" as the basis for survey

The sampling element or site unit was a representative reach of the river or stream. Access is a dominant consideration in locating the reaches. The reach were selected using the following criteria:-

- The reach should be representative of the types habitat, morphology and physical and ecological condition of the river or stream in the stream section;
- Preferably the reach should contain at least 2 complete pools and riffle / run habitats (represent diversity);
- The whole length of the reach should be visible at one location;
- The reach should contain at least one pool, which should be the largest and deepest in the area.



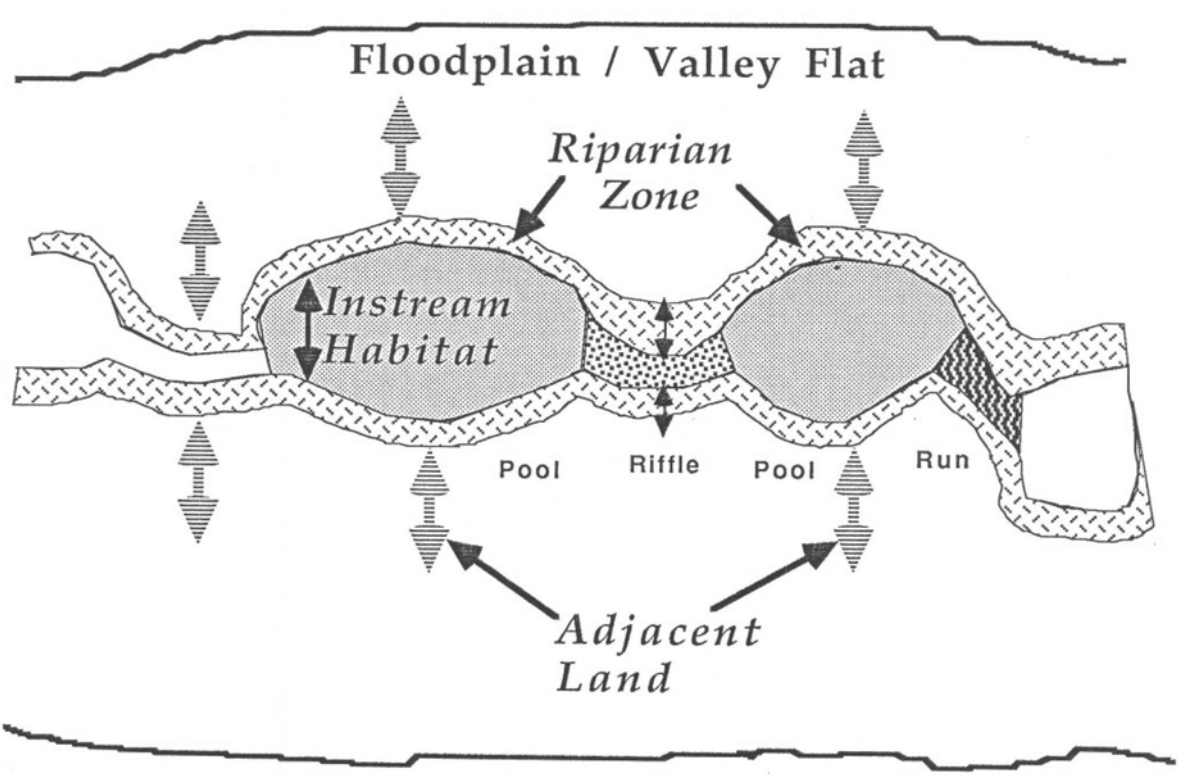
Channel Habitat Types

2.2.10 Survey Focused on Instream Data

The focus of the survey was on the instream and riparian habitat that is on the:

- aquatic habitat;
- bed, bar and banks within the confines of the channel;
- riparian zone (defined in the datasheet section) ;
- valley flat and floodplain land immediately adjacent to the riparian zone (land use and general attributes only).

The detailed survey did not include the floodplain beyond the boundaries of the riparian zone, nor the catchment. Only general assessments of the land tenure, land use and vegetative cover were made for the land (valley flat and floodplain) immediately adjacent to the riparian zone. These restrictions were justified by maintaining a focus on the streams themselves. Information about the floodplains, catchments can usually be obtained from other sources.



Adjacent Land = Land bordering
The riparian zone along the reach

2.2.11 Preliminary Resources Requirements

It was necessary to set preliminary resource requirements in terms of time, people and equipment to ensure that the survey method was realistic and achievable. In designing the survey it was inevitable that compromises would have to be made between the details collected and time spent at each site and the number of sites, which could be surveyed in the time allocated. The emphasis in this methodology has been on surveying as many sites as possible.

The basic practical criteria for developing the methodology are:

1. The survey was designed to be completed by teams of two persons spending about 3/4 - 1 hour at each site, including travelling time. This meant that each team would have a target of 6-10 sites per day. This allows for two teams of two people to survey about 150-200 sites in a two week period (adequate for a catchment of same size as the Mary River).

2. The reconnoitre would require an additional week for two people for a catchment the size of the Mary River, and another week would be required for planning, gathering the available information, meetings with local groups and the training program.

3. Only a minimal set of equipment should be required (tapes, portable echo-sounder, boat, GPS, inclinometer, camera etc.), and only minimal training and experience in the use of the equipment should be necessary.

4. The survey was expandable dependent on the scale of resolution required an for specific purposes, for example to deal with a known problem of bank erosion in a particular sub-catchment, and the resources available.

2.2.12 How many sites are required?

There is no absolute answer to this question. It really depends on the resolution required and the way the data collected is to be used. It also depends on the variability and diversity of habitat types, the condition and range of conditions present in each catchment, the range of issues, which need to be addressed, and practical aspects of access and travel times in remote or difficult areas.

The following aspects are relevant:-

- The larger river systems will require fewer sites per river kilometre or area of catchment, but this will be offset by the longer travel times between sites.

- Allowance needs to be made for equipment breakdowns, bad weather etc.

- The survey should ideally be done over a relatively short period of intense activity by a small group of people to maintain consistency rather than being done over a longer period. This is necessary to ensure that the data are collected under comparable flow and seasonal conditions.

  The entire catchment should be surveyed at the one time, with possible exception of the larger catchments such as the Burdekin and Fitzroy Rivers.

- It may be desirable to allocated the limited resources unequally in the catchments or sub-catchments to address specific problems or priorities.

Ultimately, the final numbers of sites required will only become clear after several surveys have been conducted and the data analysed, used and evaluated. Some form of sensitivity analysis could be used to determine the effects of reduced sample size on the results obtained. Also the final determinant of the number of sites, which can be surveyed, will be the number of staff that can be made available for a set period of time. It is therefore usually a matter of deciding how to

best use the available resources to give minimum coverage of the whole catchment whilst focusing on particular areas.

The pilot survey of the Maroochy River can be used to provide an initial guide as to the number of sites and survey days required. About 180 full survey sites were surveyed in the Maroochy River by two teams of two people over a two week period, with an average of about 8-10 sites a day being completed by each team. In retrospect the minimal number of sites for the Maroochy River would be about 100-120 sites, requiring about 8 days by the two teams. The Maroochy River is one of the smallest rivers in Queensland with a catchment area of about 1410 sq. km, but it has many tributaries which extend almost to the estuary, relatively high population and many catchment issues and so the site density of 1 site for every 15 sq km and about 1 site for every 5 km of major tributary is justified to service the needs of integrated catchment management. The following table gives an initial idea of the *minimum* number of sites required for some of the catchments on the east coast of Queensland

Catchment Area (km^2)	Sites	Weeks (2 teams)	Examples on the east coast
<2000	100-120	1.5	Maroochy, Pine, Noosa, Pioneer, Ross,
2000-4000	150	2	Murray, Tully Logan-Albert, Burrum, Kolan, Boyne, Styx,
4000-10,000	200	3	Haughton, Johnstone Mary River, Olive-Pascoe, Don, Herbert
10,000-50,000	250	4	Brisbane, Normanby, Burnett
> 50,000	300-400	5-6	Fitzroy, Burdekin

It should be emphasized that these are suggestions only, which do not take account of the diversity of habitats, existing condition or range issues present in each specific catchment. An additional period of 1-3 weeks would be required by one of the teams for the reconnoitre survey. More time has been allowed for the larger catchments, but again these are only estimates to give some idea of what is required. The increase in travelling time between sites means that the number of sites to be surveyed in a day by each team will decrease in the larger catchments.

2.2.13 When should the survey be conducted?

The best time for conducting the survey is the dry season. This avoids problems with bad weather and access problems, but it is also more practical for many aspects of the survey, which are best done when water levels are low and water clarity is highest. Standardizing the time and flow conditions during the survey are also important for comparative purposes so that stream depths and channel dimensions all relate to a low flow and low discharge period. The interpretation of the results obviously needs to take account of when the survey was conducted. The survey methodology includes simple methods of standardizing water depths and channel dimension measurements.

2.2.14 Upstream and Downstream limits

The upstream limits of the rivers and streams included are established by only including streams, which have a clearly defined channel. The survey methods allow for intermittent streams and streams with braided channels to be included, but they are mostly focused on the larger

permanent streams (or streams with more or less permanent channels or permanent pools or billabongs).

The survey does not include lakes or wetlands unless they occur along defined stream channels. For example, floodplain wetlands (billabongs and oxbows) or coastal dune wetlands are not included.

The survey includes estuaries. The downstream limit is the defined mouth of the river. The inclusion of estuaries was important for completeness, but the survey methodology is primarily designed for the non-estuarine sections of rivers and streams, and so certain additions have been made to allow for estuaries to be included, rather than specifically designing estuarine survey techniques.

2.2.15 Water Quality, Flow and Discharge

Modifications to the natural flow regime and water quality changes are obviously very important parts of assessing the overall condition of streams and rivers. However, a single survey of flows and discharges and water quality throughout the catchment will provide little information on the average, range or longer-term changes in flows and water quality. This requires analysis and interpretation on long-term records to deal with the temporal component, including specific and relatively rare events such as floods and peak flows. It was therefore decided that water quality and stream flow measurements would not be an obligate part of the surveys.

However, appropriate interfaces and links with flow and water quality data were required so that summaries from other sources could be used in the analysis. Also it was recognized that water quality assessments and flow measurements across the whole catchments at one point in time could be very useful to examine the spatial variability and the adequacy and representativeness of the existing long-term monitoring programs based on very few sites. Specific surveys water quality and hydrology surveys may therefore be useful and should be accommodated within the methodology. Therefore it was decided that flow and water quality measurements could be included as an option during the surveys.

2.2.16 Data Sheet Design Concepts

The following aspects were important in designing the datasheets:

1. The datasheets had to be easily understood by technical staff of the DPI with little or no previously experience in stream survey. A graphic approach was adopted to simply the understanding of the concepts and choice between the various criteria.

   The datasheets also avoid any reliance on coding sheets, as these often make it more difficult for inexperienced staff to complete the datasheets. All the information required had therefore to be provided on the datasheets themselves.

2. The procedures for conducting the survey and completing the datasheets had to be largely self-explanatory and able to be taught during a short training period.

3. The datasheets had to be designed for simple and efficient transfer into the databases and had to interface with the database design concepts.

4. The method included a set of standard photographs, which had to be properly archived and linked to the data through the databases.

Types of data

Various types of data were included on the datasheets:

- **Non-Survey Data** - This included site location information, various codes and information about catchment areas, elevation and other data derived from maps and other sources. The methodology was designed to allow ready links with GIS system to gain access to site and catchment information available now and in the future. Stream gauging sites with their relevant identification codes were included as special sites during the survey to provide easy access to the hydrologic record for stream classification, and to the water quality information which will be incorporated into the HYDSYS system.

- **Survey Data -** this included a range of data types collected during the surveys. These data are collated in the database and can be used in the following forms:

    1. **Raw Data** - Raw data of various types were collected. These data will be used independently for various purposes in integrated catchment management and in providing condition ratings (e.g. proportion of the bank which is eroding or the average width of the riparian vegetation).

    2. **Derived Ratings** - Various formulae will be used to derive the various overall condition assessments. The method used will be explicit and easily modified.

        E.g. Physical Condition = $A(w_1) + B(w_2) + C(w_3) + D(w_4)$

        where A,B,C & D are raw attributes and w_1, w_2, w_3, & w_4 are weightings applied to each attribute.

    3. **Semi-Subjective Ratings** - The recorders will be asked to make an overall assessment of the component. The value of these ratings will be increased by asking for the assessments to be made after the raw data have been collected. These ratings will provide a valuable 'first-go' assessment, which can be qualified using the derived ratings.

    4. **Codes and Links to other Sources of Data** - Various codes and other items have been recorded to enable a simple interface with GIS and with HYDSYS (hydrology and water quality data sets).

    5. **Photographic Records and Comments** - The methodology includes a standard set of photographs for each site taken looking:- upstream, downstream, towards the left bank, towards the right bank, a photograph of the general environs of the site. Provision is also made to include photographs of specific features at the site. Records of the photographs are included in the database and the photographs (colour slides) will be properly archived to establish a baseline for future reference.

3. OVERVIEW OF THE ORGANIZATIONAL STRUCTURE, IMPLEMENTATION STRATEGY AND STEPS FOR IMPLEMENTING THE METHODOLOGY

3.1 Organisational Structure

The proposed organizational structure for implementation of the 'State of the Rivers' Project is shown below. Also shown is the proposed implementation strategy.

Organizational Structure

Group	Representation	Roles and Responsibilities
State-Wide Implementation and Coordination Group	Head-Office Dept. and Representatives or Inter-Regional Group	- Coordination and establishment of Statewide priorities. - Program development and consistency in application Promotion of the project. - Planning and organising the training programs. - Liaise with and support for Regional and Catchment Implementation Groups - Maintain links with ICM and various other Departments and groups.
Regional Implementation Groups	Regional Officers designated as representatives for the project within each Region.	- Implementation of the project within Regions including joint - efforts required for catchments extending into more than one region. - Planning and organization of the project within the regions - Liaison with the Statewide Group. - Establishment and supervision of the Catchment Implementation Groups.
Catchment Implementation Groups	Regional Officers with representatives from Local Government, ICM and other local co unity groups	- Planning and implementation of the project within each catchment. - Collection and analysis of all existing relevant data.
Regional Catchment Survey Leaders	Regional Scientific Officer(s)	- Organize and maintain equipment and other resources required for the survey. - Day to day organization. Data entry, verification and sub-sectioning. - Preparation of reports and data summaries
Regional Survey Teams	Regional Scientific and Technical Officers and others selected to conduct the survey.	- Surveys and data collection for each catchment or sub-catchment.

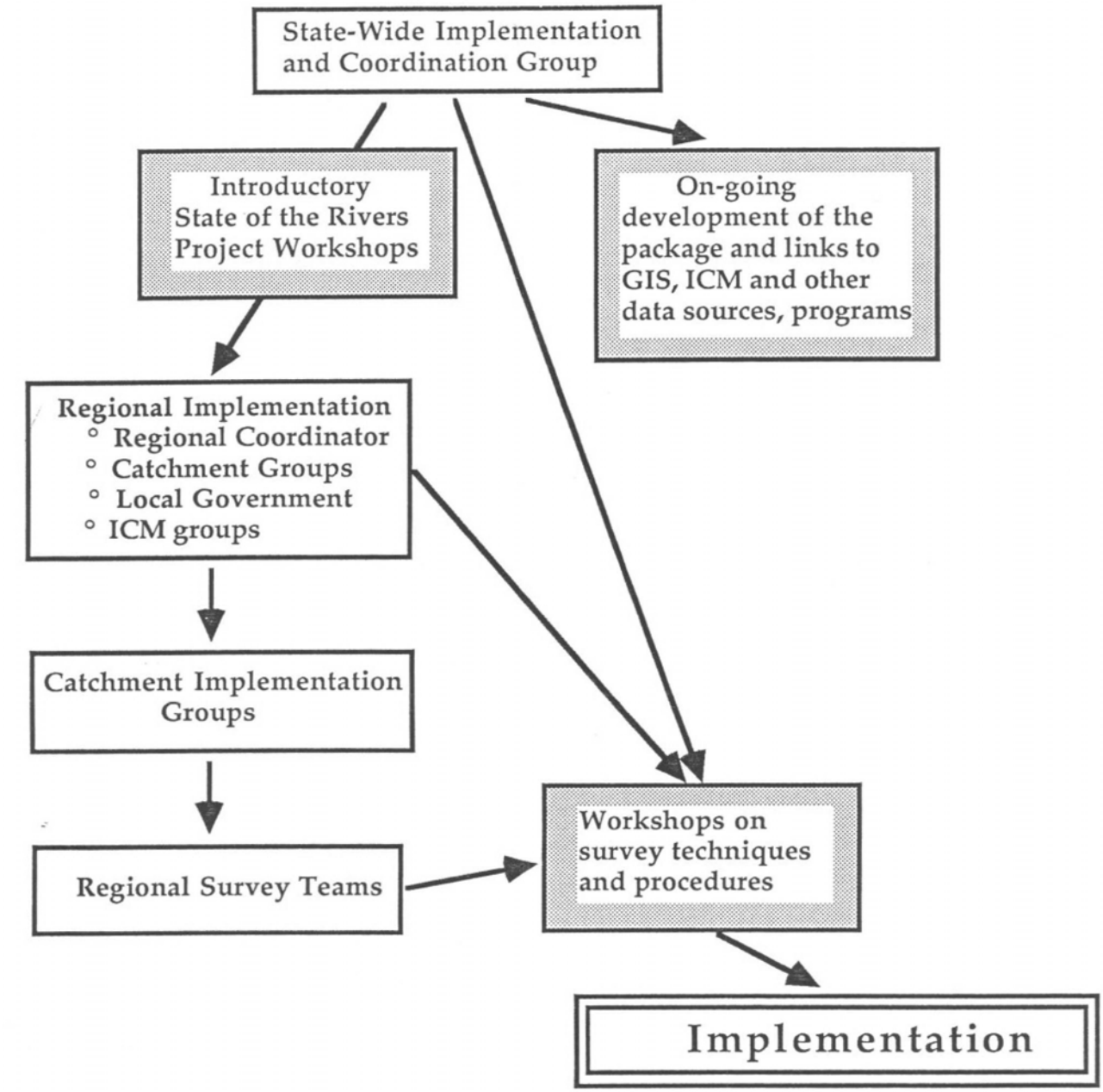
The 'State of the Rivers' Project is implemented by the Statewide Implementation and coordination Group's three manuals:

- Training Manual
- Field Manual
- Data Management manual

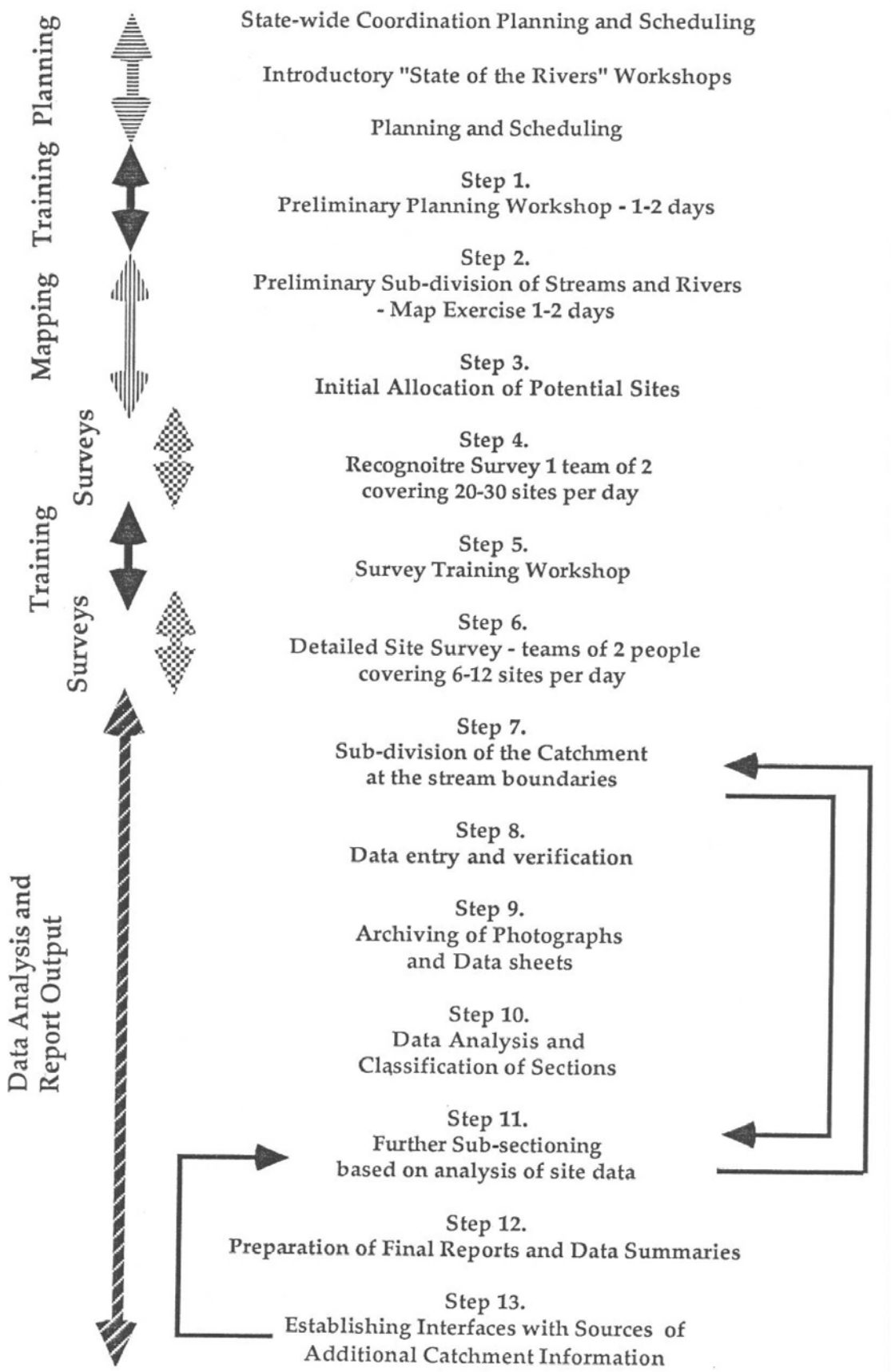
and two training packages for workshops:

- an introduction to the concepts and broad scale aspects of the methodology,
- a practical training workshop for staff to be engaged in conducting the surveys.

Outlines of the workshops and graphics materials for presentation at these workshops are included in this Training Manual as Appendix 1. Appendix 2 provides a guide to completing the datasheets.
It should be emphasised that the approach taken to training is a 'hands-on' approach focused on 'learning by doing' rather than an elaborate seminar program.



Outline of the steps in the Methodology



3.2 State-Wide Implementation and Coordination Group

This Group is needed to oversee the implementation of the project throughout the State within a reasonable time-frame. It is suggested that the entire State would need to be surveyed in a 3-5 year period. This group would also set priorities, run the training programs, establish liaison with other relevant groups and links with other Government programs, and generally promote and monitor the implementation of the project.

Statewide supervision is also required to maintain consistency in the data collected and in the analyses and reports generated from the surveys. This group should also be responsible for planning a Statewide 'State of the Rivers' assessment within a 3-5 year period combining the results of surveys in all the catchments in Queensland.

There is a need for on-going development of the different components of the package and potential modifications required for its implementation in different areas of the State (e.g. the channel country, and wet tropics areas).

This Group would be responsible for running the introductory workshops and the survey methodology workshops, which are required to implement the project through the Regions.

There is also a need for further development of the analysis programs and the condition classification criteria integrating all the component information. The links between the 'State of the Rivers' database and other sources of data, for example the GIS package, hydrology (through HYDSYS), and water quality (through HYDSYS and other sources of information) also need to be maintained.

Without the State-wide Group, the project would be unlikely to succeed, and the consistency crucial for comparisons between catchments would be impossible to maintain. This group is also required to ensure that the established targets and objectives are met on time.

3.3 Regional Implementation Groups

Regional Implementation Groups and Officers should be established in each Region to schedule, plan and supervise the implementation of the project on a catchment-by-catchment basis within each Region. Some of the catchments will occur in more than one region requiring a coordinated approach between regions. It is essential that all of the surveys within the one catchment be carried out by the same small survey team to ensure consistency.

Regional workshops organised by the State-Wide Group would introduce Regional staff, Local Government, ICM groups and other interested groups and individuals to the methodology. This group would then set up the catchment implementation groups and plan the implementation within the region. This would include scheduling, staff allocation and training. It would also include the gathering of the resources required for the surveys, establishing the databases and the software and hardware required for analysis of the data.

These groups should include scientific officers (Project Officers) designated to be responsible for the running of the surveys in each catchment including the compilation of existing information and the initial subdivision of the stream and rivers into 'homogenous' sub-sections. These officers should also be responsible for data entry and data analyses, on-going maintenance of the database system and the production of the data summaries and reports.

These Regional groups should liaise with the statewide group on a regular basis for updates on changes to the methodology and for answering queries about the methods and their application in particular catchments.

The surveys and condition summaries should be undertaken within catchment boundaries as the fundamental unit of assessment. The particular Group should oversee the collation of all relevant information, set priorities for surveys in different areas and establish links to the community to establish local contacts and to advertise and promote the project locally. This Group, through the Project Officer, should also be responsible for archiving the data, maintaining the databases and producing the output required for various purposes. Some knowledge of DBASE IV would be an advantage for this task. This Group would also plan and schedule the survey training exercise with initial assistance from the State-Wide Group.

3.4 Regional Catchment Project Leaders and Survey Teams

A Project Officer would lead each group for the surveys. Each survey team would consist of two staff - either Regional Scientific and/or Technical Officers. Each team will require its own set of equipment and a vehicle. Generally 2-4 teams of 2 staff would be required. A minimum of two teams will ensure that the.- surveys can be completed rapidly, and therefore under similar discharge and other river conditions. Spreading the load between two or more groups also helps to ensure that the surveys are completed quickly to minimise disturbance to other activities. It also generates a sense of competition and team spirit, which helps to achieve a good result.

It is suggested that the more experienced or qualified staff act as the survey team leaders. These leaders would be expected to be more committed to the project, being available for the reconnoitre survey and for most of the time during the full survey of the sites. Keeping the number of these leaders small will improve the consistency and will reduce training costs. It is suggested that these leaders attend surveys in another catchment as observers prior to undertaking their own surveys.

Again there are advantages in keeping the number of other staff involved in the full survey small (less than 8 staff for each catchment) to increase consistency and reduce staff training requirements. This has to be offset against the need to 'spread the load' allowing the task to be spread out so that the other commitments for each participant in the Regional Office can still be met. There are obvious advantages in choosing staff with good local knowledge of the catchment and with suitable experience and qualifications.

The question of whether people other than the staff of the DNRM could be involved in the surveys depends on the circumstances applying in each Region. There is no doubt that many outside people would have more than adequate qualifications and experience to undertake the surveys which were designed to have minimal requirements in terms of qualifications or previous experience.

There are practical issues of insurance cover, availability and approvals for use of DNRM vehicles and equipment and possible travel expenses, which need to be addressed. However, *a priori* there would be no real reason why outside people could not be involved, and there may be many advantages such as local knowledge and specific skills such as in plant identification, which would be an asset. Involving members of local Integrated Catchment Management groups in the surveys would have many advantages in allowing them to fully understand the project. The surveys would benefit from their local knowledge.

However, it is important that the objectivity and consistency of the surveys are maintained, and so the decision will require a case-by-case decision. Setting minimal qualification requirements (such as a degree or diploma) or demonstrated previous experience in a related field would help to ensure that the people involved were capable of the work involved.

4. IMPLEMENTATION STRATEGY

4.1 The Strategy

The 'State of the Rivers' Project should be implemented as a Regional project under the direction of the State-Wide Implementation Group. This group would be responsible for the co-ordination of the project and supervision of the Regional Implementation Groups. The project would be implemented through two training exercises: Regional Introductory Workshops, and Workshops on Survey Techniques and Procedures.

The State-Wide Group would be responsible for setting priorities, establishing targets and schedules and liaising with the regions to implement the project. This group would provide the initial training staff and would act to provide advice and support for the Regions. It would also be responsible for the on-going development of the project and compilation of data on a statewide basis.

Once statewide priorities have been established, the Regions involved should be contacted and given general advice on the project, resource requirements and scheduling. In establishing the schedules and implementation plans the following points should be considered:

- Each Region will have to be involved in surveys of a number of catchments.
- The surveys should be scheduled for the dry season or the drier times of the year. Seasonal rainfall patterns are therefore a consideration in scheduling the surveys in different areas.
- An implementation plan to cover the whole State within a reasonable period of time (3-5 years) should be developed to direct and schedule the Regional implementation.
- Initially at least, the training staff to run the workshops should come from the State-Wide Implementation Group. There will be a need to schedule the various workshops in terms of the availability of the staff available.
- While there would appear to be advantages in perhaps organising a single major introductory workshop for all regions, there is merit in keeping the workshops small and dealing with individual local issues and differences in application of the project in different areas of the State.
- There are major advantages in having the Regional Project Officers, and Survey Team leaders attend surveys in other Regions as observers before commencing implementation in their own areas.
- The major catchments may need to be surveyed by major sub-catchments rather than all at once.
- Some of the catchments will cross Regional boundaries requiring a joint approach between Regions.

4.2 Regional Introductory Workshops

The aim of the introductory workshops is to introduce regional staff to the "State of the Rivers" Project:

- its aims and objectives
- its resource requirements
- its targets and outputs
- its linkages with other data sources
- the requirements to implement the project within the Regions.

This workshop of about 2-3 hours duration, should be in the form of a seminar followed by group discussion. It should involve all the Regional staff to be involved in the project, including the survey staff, as well as representatives from Local Government, ICM groups and other groups and individuals for which the project is relevant.

As the project develops, the Introductory Workshop could involve participation of staff who have been involved in previously completed projects in their Regions. Completed reports and data summaries would be very useful to demonstrate the type of output - which can be produced.

This workshop should also be directed at identifying:

- the major issues which are relevant for the Region,
- the staff and other resources which are available, and
- the priority areas needing special attention.

The major sources of information and contacts relevant for the survey should also be identified, including:

- the availability of maps (topographic, soils, geology and land use),
- relevant previous studies (environmental, resource surveys, local plans, flood studies, water resource development plans)
- specific information (such as local vegetation keys, list of rare and endangered plants and animals and their habitats, aquatic and riparian floral' and faunal surveys).

Appendix 1 provides a set of overheads, which could be used for the seminar. This should be accompanied by summary documents (possibly including copies of this manual) and copies of the data sheets and explanatory notes (Appendix 2).

A Regional Implementation Group should be set up before (preferable) or after the workshop. This group would then proceed to plan and organise the implementation the of the project with assistance from the State-Wide Group (see S.6. Steps for Implementing the Methodology). The project would be implemented on a catchment-by-catchment basis with people from the local community being drawn into the group for each separate catchment. Once the surveys have been planned and scheduled the training program for teaching the survey techniques and procedures can be organised.

4.3 Initial Sub-sectioning of the Rivers and Streams and Reconnoiter Survey

The Regional Implementation Group and the Project Officers carry out this task, with assistance from the State-wide Group if required, depending on the experience and confidence of the Regional staff. This Training Manual provides a guide as to what is required. For the first catchment survey in each Region, the State-wide Group may need to provide someone to assist in this aspect of the project, including the reconnoitre survey, as it is a crucial aspect of the methodology.

It is preferable for permanent Survey Team Leaders to be selected for the surveys. It is these leaders who should be involved in the reconnoitre surveys. This will be invaluable in locating the sites for the full surveys, which follow.

4.4 Workshops on Survey Techniques and Procedures

The workshops to train staff in the use of the datasheets, survey equipment and techniques should be focused on a 'learn as you do' approach and therefore should be scheduled to occur at the start of

the first catchment survey in the Region. These Workshops should initially be run by members of the State-Wide Group or other staff who have been involved in previous surveys in other Regions.

Once the Project has started, the experienced staff who have completed a survey could act as trainers for other staff in their own Regions and in neighbouring Regions.

It would be very helpful to have staff from other Regions attend surveys in other Regions as observers prior to undertaking their own surveys.

On-going feedback and advice from the State-wide Group is necessary to maintain consistency and standards.

5. MAPS, EQUIPMENT, RESOURCE REQUIREMENTS AND OPTIONS

5.1 Human Resources

The basic resource requirements for the project include preliminary estimates of the minimum number of sites, staff and time required for surveys in catchments of different size (see S. 2.2.11 and 2.2.12). The methodology is expandable allowing more sites to be surveyed in particular catchments or subcatchments as required for specific uses of the data. Some advice on these aspects may be required during the course of the project. Some form of sensitivity analysis and assessment of the output amongst users may be undertaken to modify the suggested allocation.

It is suggested that the ideal arrangement is for 2 independent teams of 2 staff to conduct the full surveys and for one of these teams to conduct the reconnoitre surveys. The surveys could be done by one team or by three or more teams. There are obvious advantages and disadvantages in this. It is suggested that two teams is the right balance between the requirements, training effort and objective of completing the survey in a reasonable period of time. Most surveys can be completed in a 2-3 week period, which again would seem to be a reasonable compromise between the resources available and the resolutions required.

A Regional Project Officer would be required to conduct the initial sub-sectioning of the stream and rivers prior to the surveys, and to define the sub-catchment elements. This Officer would also be responsible for the data entry and verification, and for conducting the data analyses and generating the output. Final database information should be transferred to the State-Wide Group for compiling into a statewide database.

The following section outlines details of the other equipment and resources required for the project.

5.2 Maps

5.2.1 Map Scales for Initial Sub-division of the Streams and Rivers

The main issue is the map scale preferred for different aspects of the project. It is suggested that a scale of 1:100,000 or 1:250,000 would be adequate for use in conducting the initial subdivision using soils, geology, land use, vegetation cover and basic topography. Locating the barriers and major changes in instream habitats should be done using 1:25,000 maps if available. Recognising the upstream limits of streams in terms of a map scale is probably not appropriate as it is best done by on-site inspection during the reconnoitre survey. There will be considerable variation in different areas of the State.

5.2.2 Initial Sub-sectioning of the Streams and Rivers and Site Allocation

It is suggested that the idea scale for the working maps and the catchment base map is 1:25,000.

This may be impractical or too expensive in the larger catchments where 1:50,000 may be more appropriate. Where maps at these scales are not available then the finer scale maps available should be used. Maps at 1:25,000 include many details on the location of falls, rapids, weirs, fords and other details on the in stream habitat which are invaluable for the surveys. This scale of map is also ideal for navigation and locating potential survey sites that are easily assessable.

5.2.3 Map Scales for Output and Linkage to GIS

The ideal scale is difficult to define because it partially depends on the resolution required for different uses of the data. The major consideration is the availability of digitised map information. Currently there is very little digitised information available at scales finer than 1:250,000 and it is unlikely that information finer than 1:100,000 will be available for only a very small percentage of the State. This in fact limits the dependency of the project on GIS for output.

It would be unwise to set map scales for output and analysis in GIS when these were neither achievable nor operable because such scales were unavailable or too expansive to capture. In fact it means that an alternative output system independent of GIS should be developed as an interim measure.

It is suggested that if available the information should be linked to GIS topographic and digitised streams and rivers at a scale of 1:50,000 or 1:100,000. The latter is probably what can be realistically set as a target given the current situation in terms of the GIS program.

5.3 Equipment

The following list of equipment is required for each survey team (2 people):

- Four-wheel drive vehicle with radio equipment and recovery gear.
- 3-5m long punt or small boat on roof rack (preferred) or trailer with suitable outboard motor and other equipment. Larger boat for large rivers and estuaries where several sites can be surveyed from the one launch spot.
- Compass and rangefinder for large estuaries and rivers.
- Portable GPS unit (e.g. "Magellan") with back-up batteries and operational manual. Additional high-resolution antennae are preferred.
- Survey staff and survey tapes (50m).
- Portable, battery operated echo sounder with transducer mounted into a 'kick- board' or other suitable float and attachment points for ropes and survey tapes.
- Inclinometer
- Sediment sampler - "Ekman" grab type, or simply a closed length of pipe with attached chain and rope for collecting surface sediment samples in deep water.
- 35mm camera and colour slide film (64-100ASA) - average of 5 shots for each site.
- Set of 1:25,000 or 1:50,000 laminated working maps with sites and other information marked on them with waterproof markers.
- Sets of data sheets, staplers, pencils and erasers.
- Vegetation keys, or photographs for identifying key plant species.
- 30m length of rope.
- Field box and protective containers for the equipment.
- Personal field equipment such as waders, boots, wet-weather gear.

6. STEPS FOR IMPLEMENTING THE METHODOLOGY

The fundamental details of the steps for implementing the methodology are provided in (Anderson 1993); and an outline is presented in S. 3 and S. 4 of this Manual. The aim here is to outline the more practical aspects of the implementation from the stage of the preliminary planning workshop for a particular catchment after the introductory workshop has been held.

6.1 Step 1. Preliminary Planning Workshop – 1 – 2 days

The aim of the workshop is to examine various local maps and data relevant for the study and to discuss important local issues. The various relevant data sources should be gathered together and examined before the meeting, including relevant maps (topographic, soils, geology, land use, vegetative over, land use planning), flood studies, flora and fauna surveys, water quality studies and records.

The workshop should involve local government representatives, land care and integrated catchment management groups and other interested groups and individuals who may provide information and assistance for the survey, or who are potential users of the information.

6.2 Step 2. Preliminary Sub-division of Streams and Rivers - Map Exercise 1-2 days

6.2.1 Introduction

The concept of "homogeneous stream sections" is fundamental to the methodology. The natural and modified attributes of streams are not randomly distributed. Streams within the same sub-catchment are likely to be more similar to each other than to streams in other sub-catchments. Likewise the stream drainage network provides the basic link between stream sections. What happens upstream, or in the upper catchment affects downstream sections in a cumulative way. For example, if the upper catchment is cleared, all downstream sections if the river will be affected by the changes in runoff dynamics and sediment yield which may be produced.

The concept of stream order recognizes that the flow characteristics, channel dimensions and most physical and biological characteristics of streams will change progressively as more and more tributaries combine into larger streams. This is the basic thrust for integrated catchment management - that is because the streams are interconnected in the drainage network they have to be managed in an integrated way considering this linkage and processes for upstream impacts to be expressed downstream. This concept also provides the basis for the sampling strategy for the "State of the Rivers" methodology. It is a stratified sampling strategy, based on using available information to subdivide the area to be sampled into strata or regions, which share similar characteristics. The areas within the strata are much more similar to each other than to areas in other strata.

This concept is extended to encompass a basic mechanism for sub-dividing all the stream and river sections in the catchment into units, which basically share the same natural, and disturbance features. The basic unit is referred to as the "homogeneous stream section". The length of stream within these sections is "homogeneous", that is basically similar in the attributes that we are interested in. This includes the physical and ecological features and condition, and the basic characteristics of the stream that is present (size, substrates, flow regime, etc.). Obviously how far

this process continues depends on the scale of resolution and the priority given for the various sources of information judged to be important for the purposes of the methodology.

In essence the process of sub-dividing the rivers and streams into homogeneous sections involves an hierarchical procedure of using various sources of information to successively sub-divide the rivers and streams into smaller and smaller units until the notion of homogeneity is satisfied.

Initially the rivers and streams in the catchment are divided into sub-catchment sections in terms of the major tributaries. Then barriers, geology, soils, slopes and other information is used to assign further boundaries for subdivision.

This process continues using the visual inspections carried out in the reconnoitre. Sites are then located in each the subsections identified which are *representative* of the attributes and condition within the section. Finally the analysis of the site surveys may reveal heterogeneity within the sections, which requires that additional section boundaries have to be added. The process is therefore an on-going one aimed at ensuring that the sections are homogeneous and are adequately described by the sites chosen to be representative of them.

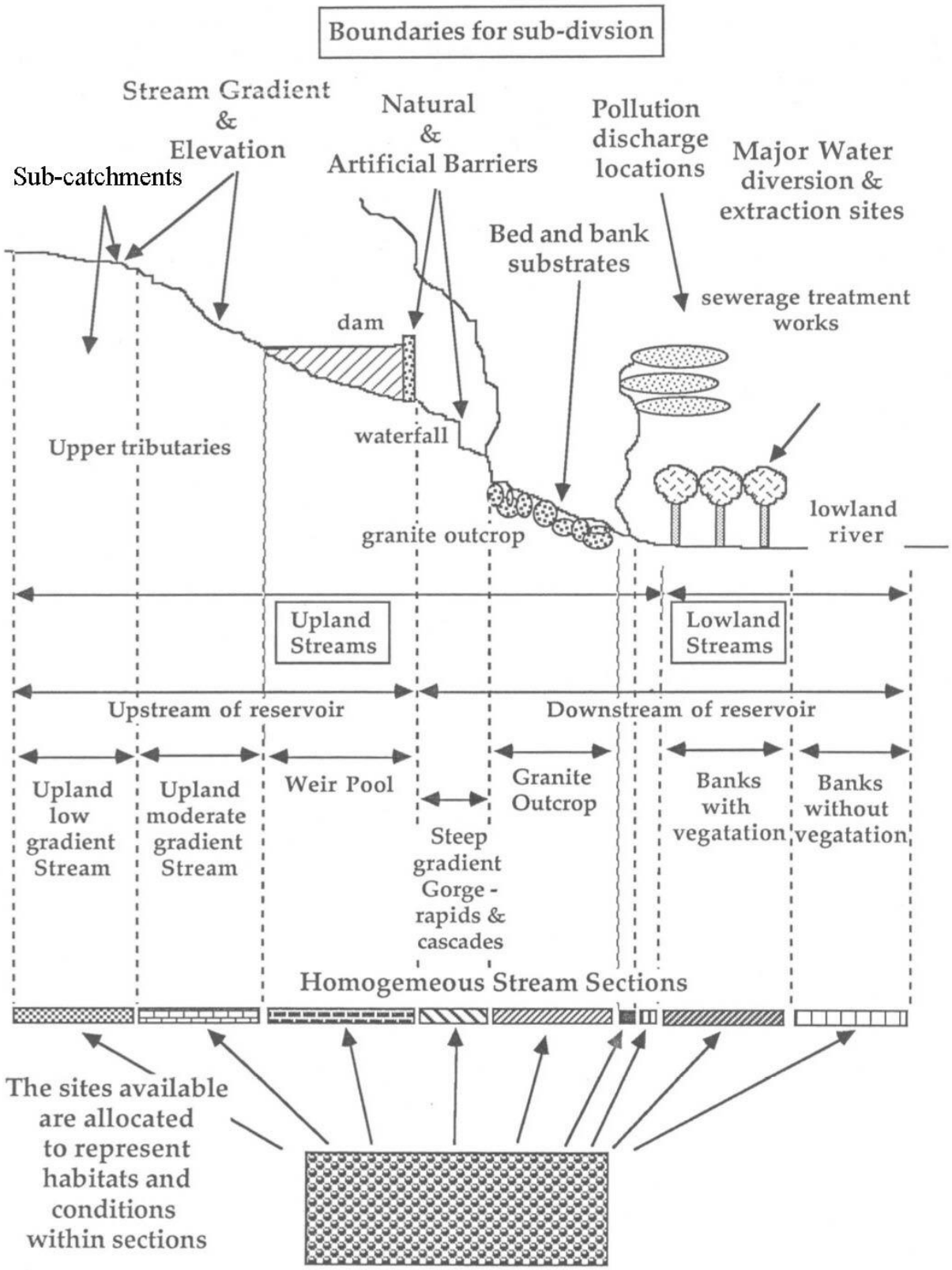
6.2.2 Mapping

The aim of the initial mapping exercise is to take all the available information and maps, and to select and use appropriate attributes to begin subdivision of the streams and rivers into "homogeneous stream sections". The type and extent of information available will vary greatly in different catchments. When available 1:25,000 series maps should be used for this initial subdivision as these maps show some in stream river characteristics such as the location of falls, large pools, fords roads and tracks and other details important for the survey. When these maps are unavailable the finest scale maps possible should be used to prepare a base map. The preliminary sub-section boundaries are drawn directly onto laminated base maps using waterproof markers.

This first stage is directed at identifying the boundaries the 'homogeneous stream sections' without actually collecting any information. It should be emphasised that this is only a mapping exercise designed to initially recognize the major types of streams and rivers present and their condition, and also to initially allocate the sites. The section boundaries may easily be changed during the reconnoitre phase, during the actual survey, or later in response to the analysis of the site data or the actual compilation of the catchment data. The sub-sectioning of the rivers and streams into homogeneous sections is therefore an on-going iterative process.

Key attributes controlling the natural physical and ecological features of the stream are used dependent on the information availability in each catchment. A set procedure for sub-dividing the rivers and streams cannot be formally established because the type of information and its relevance and importance will vary in different areas of the State. It should be emphasised that no data is complied at this stage; it is only an exercise to allocate the sampling effort. Data complied during and after the survey is compiled and used for a more formal classification.

Homogeneous Stream Sections



Some of the more important attributes listed in approximate order of importance for the project are:

- **Sub-catchment structure / stream order** - the addition of each new tributary to the major channel changes the hydrology and also affects sediments, channel morphology, channel habitat diversity (pools riffles runs etc.), substrates, bed and bank condition and the general features and the ecology of the stream. Sub-section boundaries are therefore established at each tributary junction, up to a scale of about 1:100,000. The tributaries are similarly divided into sub-section elements.

- **Natural and Artificial Barriers and Obstructions** - barriers are established at major artificial dams and weirs; at natural barriers such as water falls, rapids, in stream wetlands; and at other locations of barriers and obstructions. Dams and weirs act as sediment traps and lead to changes in flow regimes downstream. The entire reservoir, weir pool or natural lake is designated as one or more distinct sections because of the different habitat upstream of such barriers. These and other barriers such as waterfalls and rapids act as barriers to fish movement and the passage of other animals often leading to changes in community structure.

- **Altitude, catchment slope and stream gradient** - Altitude itself is an important parameter affecting local climate and the of many plant and animal species. Catchment slope affects run-off dynamics and this influences channel morphology. Stream gradient is also of fundamental importance for stream classification as it affects flows, sediments and many other physical and biological features of streams. The altitude categories chosen will depend on the catchment its topography and location.

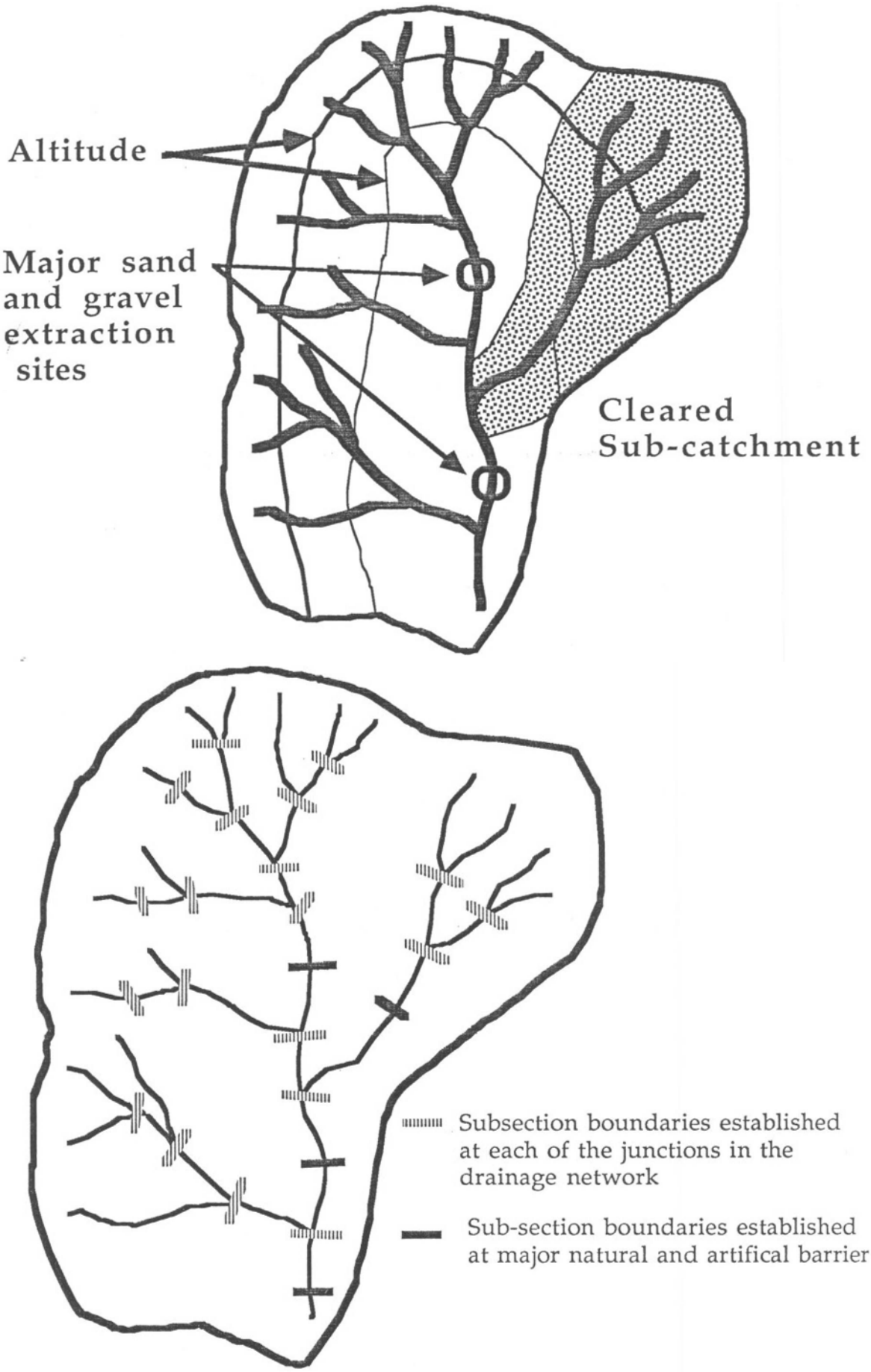
  Likewise the categories for stream gradients will depend on local conditions. Some of the obvious boundaries are the upstream and downstream ends of gorges where streams descend rapidly from coastal escarpments, waterfalls and rapids, tidal limits and the upstream, limits of the broad alluvial floodplains. Climatic and rainfall maps may also help to identify suitable boundaries.

- **Geology and soils** - Again the geology and soils of the catchment and the geology beneath the stream bed are important in affecting the channel morphology and other features of streams.

- **Land Use, Vegetation type and Vegetative cover** - Sub-section boundaries should be established at major discontinuities in existing vegetation, for example conservation areas (National Parks, State Parks and conservation areas and other reserves), forests, plantation areas, and boundaries of natural vegetation types. Major land use types, and urban boundaries may also be used to identify different stream sections.

- **Land System and climatological boundaries** - Land system and climatological boundaries can also be used to sub-section the streams. Again the locations where the boundaries between different land system types intercept drainage lines can be used as the location of stream section boundaries.

- **Tidal limit and boundaries between intermittent and permanent streams** - Boundaries are also established at the tidal limits and between permanent and intermittent stream sections.


Altitude
Major sand and gravel extraction sites
Cleared Sub-catchment
Subsection boundaries established at each of the junctions in the drainage network
Sub-section boundaries established at major natural and artifical barrier

- **Source or discharge points for pollution or disturbances -** Pollution discharge points and locations of major sources of disturbances are also important. Sites downstream will be affected. Examples of such sites and disturbances are:
  - sewerage and industrial discharge points
  - sand and gravel extraction
  - dairies, piggeries and cattle feedlots
  - sites with flood gates, levee banks, other control structures, tide barrages, etc.

- **Sites of major stream diversion -** These represent potential sources of disturbance to conditions downstream.

- **Locations of major discontinuities of stream condition or river management activities -** These disturbances including Channelisation and bank protection works.

- **Aerial Photography and reconnaissance by plane of helicopter -** Good quality, recent aerial photography is an excellent source of information for conducting the initial subdivision and inspections from the air may also be useful. However, it should be emphasised that the focus of the study is on the instream attributes, most of which cannot be seen or assessed remotely. The use of these techniques depends on the availability of materials and staff trained in their use. The time and financial resources required may be better used in expanding the reconnoitre, ground-level inspections, except in the larger catchments. This provides information at the scale needed for the sub-section rather than the broad scale overview.

6.3 Step 3 - Initial Allocation of Potential Sites

Using this preliminary information, the potential number of sites that can be surveyed dependent of the resources available, and the established resolution and priorities can be allocated to the sub-sections. This can be done on based relative sub-catchment size or length of streams present. However, it may be decided that more detail is required in one particular sub-catchment for various reasons.

Approximately 120-130% the projected maximum number of sites predicted to be completed in the time allocated should be assigned to the catchment. This allows for choice between potential site locations after the reconnoitre phase. The allocation of the sites is a hierarchical process moving down through the various levels of stream and river classification made after the sub-section boundaries have been assigned.

6.4 Step 4 - Reconnoiter Survey - one team of 2 covering 20-30 sites per day

Using the base map prepared by this initial subdivision a reconnoitre survey is conducted to further test the notion of homogeneity of the sections and to continue the subdivision process using visual assessment.

A series of potential survey sites, representative of the habitats and condition within the sections are also identified, located and photographed. Once again this is essentially a map exercise at this stage with only the 'Site Description' datasheet being completed and a set of photographs taken. This saves considerable time during the full survey of the sites. Again this

process is directed by the number of sites, which can be allocated to the catchment and in turn to each of the sub-section.

Each sub-section should include at least one representative site. Additional sites can be allocated at approximately equal distances apart along the stream length within the sections (systematically allocated to the strata).

The major consideration in selecting the Reconnoitre Survey sites is the extent to which they represent the stream or river characteristics and physical and ecological conditions within the sections. An overriding consideration in the choice of sites is ease access. Sites selected should be easily accessible and easily located. In practice most of the sites will be locate upstream of bridges, or fords or locations where the river of stream is close to roads or tracks. Locating the actual survey site 50 – l00m upstream of a ford or bridge should eliminate the effects of the structure on the conditions at the site.

Allowing more travelling time for negotiating difficult tracks, or for walking across farm land without road access may be justified for the less disturbed sites with difficult access. But it must be remembered that each site should be able to be completed in about one hour including travelling time. Having local residents accompany the survey team during the reconnoitre is invaluable both in navigating and finding potential sites.

Contacting local land owners is also very helpful but the benefits have to be balanced by the extra time taken. This means that it is probably only justified in upstream less disturbed sections where no fords or other access points are readily available.

Sites should be selected which are representative of the local habitats and conditions in the area, but which also include the deepest pool in the area and the range of channel habitat types (pools, riffles, runs etc.) present in the section. Sites may be located immediately upstream and downstream of barriers such as waterfalls, rapids and weirs as this saves travelling time.

The locations of potential sites are marked onto the working maps. It is also a good idea to also record a summary of key features as notes on the map. These notes can then be used to check existing subsection boundaries, to add new ones and also to select sites for the full survey. The notes should include maximum depth and width of pools, condition of riparian vegetation, channel habitat type and bed substrates.

The sense of scale and resolution need to be kept in mind when conducting the reconnoitre survey. Initially allocating numbers site to the subsections helps with this process.

6.5 Step 5 - Training Workshop, 1 day

The workshops will require 1 full day, but the first few days of the actual survey should also be seen as part of the training process. It should consist of a 2-3 hour seminar in the morning introducing the data sheets, the equipment to be used and the survey techniques and procedures. Appendix 1 provides a set of overheads for this first part of the workshop. Appendix 2 provides a guide to completing the datasheets.

The afternoon should be devoted to a trial survey of a set 2-3 local sites selected to include a range of conditions and stream types in the catchment. The people present should be split into teams of two with experienced staff moving between groups to answer questions and to help

explain how the survey should be conducted. Each person present should be asked to complete at least one of all the datasheets. The experienced staff should also be available to lead the teams during the first one or two days of the actual survey, and to check the datasheets to ensure that they are being completed adequately.

These first surveys should be done slowly to allow the staff to become more familiar with the techniques. The team leaders should be responsible for checking that all sheets have been completed adequately at each site. The Project Officer leading the survey should be responsible for allocating the set of sites to be surveyed by each team each day.

Some minor modifications to the datasheets may be required for the different Regions. This mostly involves vegetation surveys. The methods allow for a checklist of species to be recorded, which includes species, which are to be surveyed at every sites and a local or regional group of species. Some modification of the procedures may be needed to cope with surveys in unusual areas such as intermittent streams or areas where the streams and rivers does not have a defined permanent channel or set of anabranches. These modifications and further developments of the methodology are the responsibility of the State-Wide Group.

6.6 Step 6 - Detailed Site Survey - teams of 2 covering 6-12 sites per day

The detailed site survey is then conducted at the series of potential sites allocated for each section. Some sites may only be partially surveyed, with only a location and a set of photographs being taken. Additional sites may be added at this stage. The precise location of the survey reaches may also be varied from that described due the reconnoitre survey. Notes taken during the reconnoitre can be used to select between several potential sites available for each area.

A set list of sites within a small local area should be allocated to each survey group each day. This reduces travelling times between sites. The emphasis should be on meeting the target of 8-10 sites per day. Spending too long at one site is to be avoided, by sticking to a maximum time of one hour per site including travelling times. The sets of data sheets should be checked for completeness before moving onto the next site.

Taking a photograph of an appropriate label for each film (date and first site number) on each film will help to sort out the films when they are returned after processing.

At the end of each day the completed data sheets should be collected and safely stored, and the location of any new sites added to the base map and working sets of maps.

6.7 Step 7 - Sub-division of the Catchment at the Stream Boundaries

Sub-catchment boundaries are drawn on the base maps for each of the stream and river sections. This can be done manually using the elevations on the topographic maps, or later using the GIS if the topographic information has been captured.

The data sheets for the sub-catchment boundaries can then be completed including the numbering code and the location of the centroid for the element, the downstream limit on the major drainage line and other information. Each homogeneous stream section then has its associated sub-catchment element and one or more sites representative of the physical and environmental conditions and habitat features within the section.

Optionally these sub-catchment elements can then be digitised or scanned and entered into a GIS system, which can then be used to obtain information on the catchment area, average elevation, major and minor stream lengths and other relevant information. This depends on the availability of **digitised river and streams** and topography for the area. Otherwise the basic information can be obtained manually.

6.8 Step 8 - Data entry and verification

The data recorded on the set of datasheets for each site are then entered into the databases and verified. Additional non-survey data can be added. Data entry formats and programs are available which simplify this task. Careful checking of the data entered is essential.

6.9 Step 9 - Archiving of Photographs and Data sheets

The photographic record and the data sheets themselves should be properly archived so as to provide an efficient benchmark for future studies.

6.10 Step 10 - Data Analysis and Classification of Sections

Once the data entry has been completed the various data analysis, classification and report generating programs can be run and the results examined. The classification can then be revised and verified against other available information on the condition of the streams and rivers in the catchment. Various analysis and report generating programs are included in the package.

Data relating to the sites themselves, either individually or grouped in various ways can be produced as summary reports. This includes grouping the sites into sub-catchments or using other criteria. Classified site and section groups can be generated using various criteria that can be transferred to the GIS for producing summary maps. Reports and data summaries can also be produced relating the 'homogeneous' sub-sections.

6.11 Step 11 - Further Sub-sectioning

The analysis of the site data and the verification of the output may reveal that further sub-sectioning may be required. This can be done by reworking the base map and modifying the sub-sectional information.

6.12 Step 12 - Preparation of Final Reports and Data Summaries

The final reports and data summaries can then be prepared.

6.13 Step 13. -Establishing Interfaces with Sources of Additional Catchment Information

For subsequent more detailed analyses including investigation of the sources and processes of problems relevant for integrated catchment management it will be necessary to establish links with other sources of information. Each of the stream sections and is associated sub-catchment land parcels can be linked to a GIS for producing output and accessing other

sources of information, especially catchment information such as land use, soils, vegetation cover, land system, ecoregion etc.

A GIS system can be used for this purpose by making use of the sub-catchment and subsection boundaries. Alternatively separate linked databases can be established in DBASE IV, Visual Foxpro 6.0 or in other databases compatible with DBASE IV (see 5.3.11 in Anderson 1993).

7. REFERENCES

Anderson, J. R. 1993. "State of the Rivers Project. Report 1. Development and validation of the Methodology." A report to Water Resources, Queensland Department of Primary Industries.

Anderson, J. R. 1993. "State of the Rivers Project. Report 2. Implementation Manual." A report to Water Resources, Queensland Department of Primary Industries.

Anon. 1992. "Environmental Indicators – A Literature Review." New South Wales Rivers and Estuaries Policy. State of the Rivers and Estuaries. Draft. Department of Water Resources, NSW.

Huang, S-L., Ferng, J-J 1990. "Applied land classification for surface water quality management: 1. Watershed Classification." *Journal of Environmental Management* 31:107-126.

Larsen, D.P., Omernik, J.M., Hughes, R.M., Rohm, C.M., Whittier, T.R., Kinney, A.J., Gallant, A.L. and Dudley, D.R. 1986. "Correspondence between spatial patterns in fish assemblages in Ohio streams and aquatic ecoregions." *Journal of Environmental Management* 10: 815-828.

Naiman, R.J., Lonzarich, D.G., Beechie, T.J. and Ralph, S.C. 1992. "General principles of classification and the assessment of conservation potential in rivers." In: Boon, P.J., Calow, P and Petts, G.E. (1992) *River Conservation and Management* John Wiley & Sons, pp. 93-123.

Appendix 1

Overheads

State of the Rivers Project

Methodology

Preliminary Overview

Outline

Introduction

Objectives

Features of the Method

Components of the Method

Sampling Strategy

'homogeneous stream sections'

Instream Survey - approach and constraints

Data Components

FEATURES OF THE METHOD

1. **To be undertaken on a catchment-by-catchment basis.**

2. **To be undertaken by Regional Staff of Natural Resources and Mines, after a short training programme.**

3. **The focus of the survey is on the streams and rivers themselves – the beds, banks, aquatic and riparian habitats, not on the catchment land areas.**

4. **The methodology will provide an interface with GIS as a source of catchment (land) data and a s a method for producing summary information.**

5. **The method will provide a comprehensive set of data and an analysis system for Integrated Catchment management, focused on instream habitat processes.**

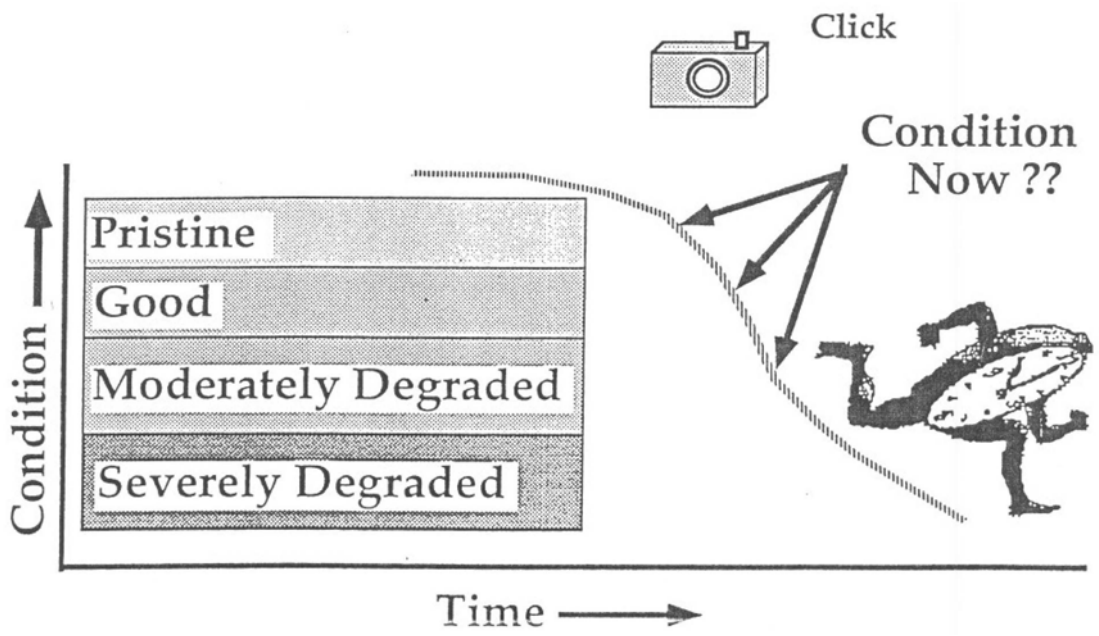
OBJECTIVE

To provide an assessment of the physical and environmental condition of streams and rivers throughout Queensland.

What is meant by Condition?

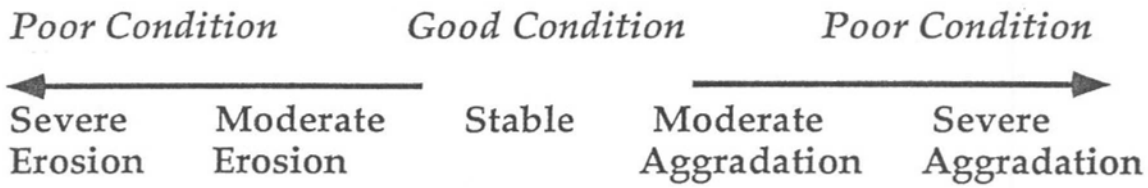
The method is a 'snap-shot' approach. The aim is to compare different stream sections within catchment, and different catchments in terms of their current condition. It sets a benchmark for future comparisons, but does not directly measure the rate of change.

The aim is to provide a relative assessment of the State of the Rivers now, and the relative condition of various sections so that the limited resources can be focused on the most severe and urgent problems. Historic data may give a valuable perspective to the 'snap-shot' taken now.

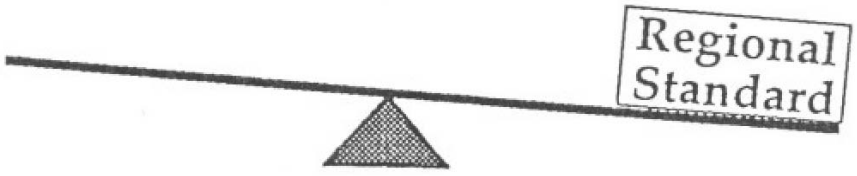


HOW IS CONDITION ASSESSED?

In most instances we are rating the extent to which the attributes in the stream or river have declined from their pristine or undisturbed condition. In most instances we will be judging this in terms of the extent to which some perceived value, use or function of the stream have been lost or altered. In some we can use an absolute standard. For example, in relation to bank condition, we will be trying to determine the extent to which the banks have become unstable and have either eroded or aggraded.



In other instances the use of an absolute standard may be inappropriate or impossible. For example it would be inappropriate to try to compare the shoreline vegetation of a stream in a rainforest with that in a western drainage area stream. In these instances the condition will be assessed by' comparison with the best area of similar type in the region or catchment.



COMPONENTS

1. **A Procedure Manual outlining the methods to be used to conduct the survey and to analyse the data**

2. **A Set of Data Sheets and Instructions for conducting the survey.**

3. **A Training Manual used to instruct how the survey is to be conducted and the specific details on the data sheets.**

4. **A Database System for Compiling and Analysing the data.**

    - **User-friendly system using Visual Foxpro 6.0 on a PC.**
    - **Each data sheet corresponds to a linked database in a relational system.**
    - **Designed to be linked to GIS for input and output.**
    - **Includes a system for real integration within the catchment using the drainage network and a coding system.**

5. **An implementation Programme.**

SAMPLING STRATEGY

1. **Random Sampling is likely to be very inefficient.**

2. **Rivers are linear systems - what happens upstream affects sections down stream in a cumulative way. Therefore we expect rivers to change progressively down the drainage lines and for adjacent sections of rivers to be relatively homogeneous.**

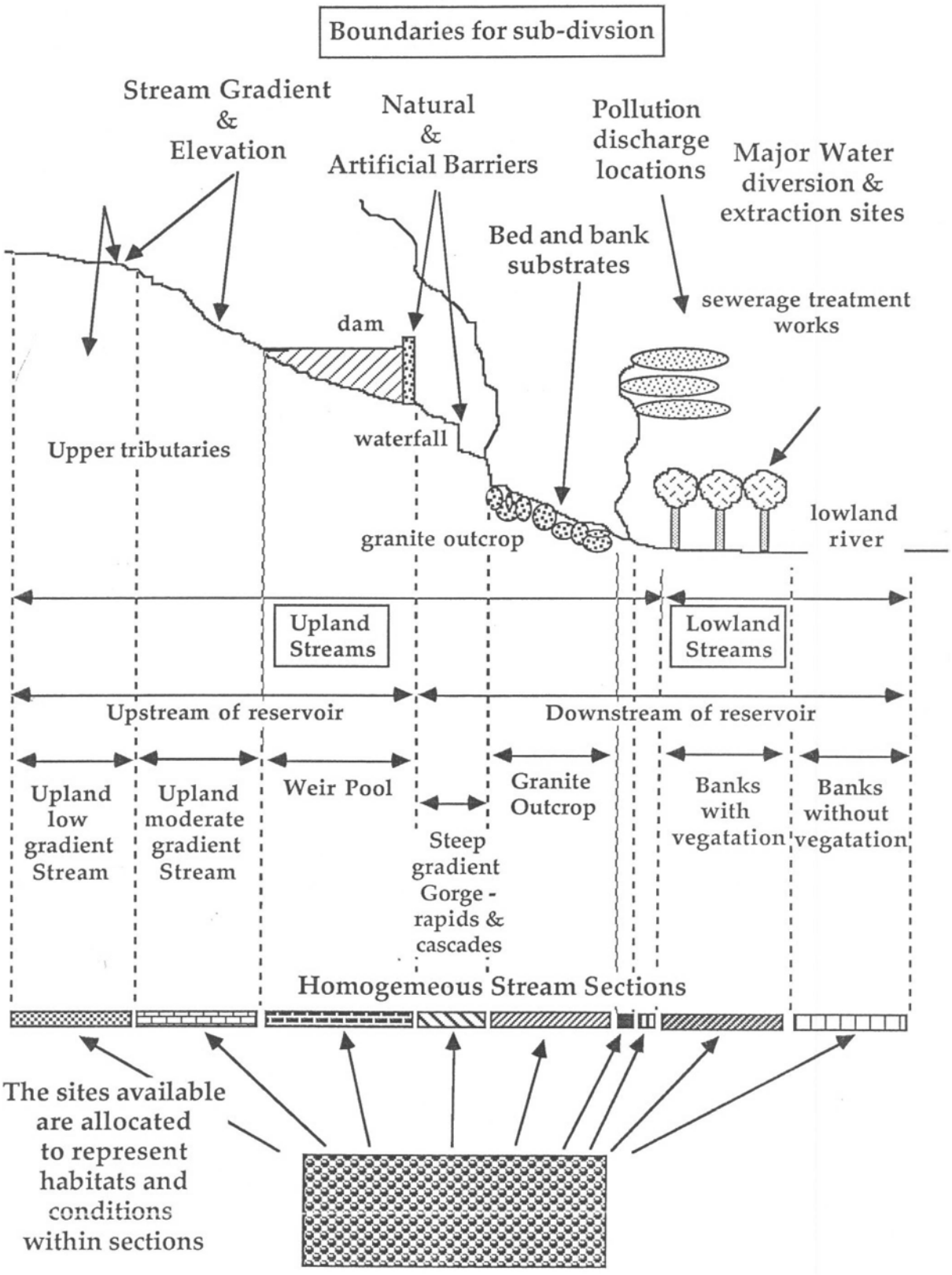
3. **Therefore a Stratified Sampling Technique is likely to be much more efficient. This means that we use available information to initially subdivide that rivers and streams in the drainage network into areas or Strata, which will basically have similar features, and then we sample at representative sites within these areas.**

4. **The aim of the method is to identify what is termed:**

   "Homogeneous Stream Sections"

   i.e. homogeneous for the attributes we are interested in and at the size and scale relevant for the study.

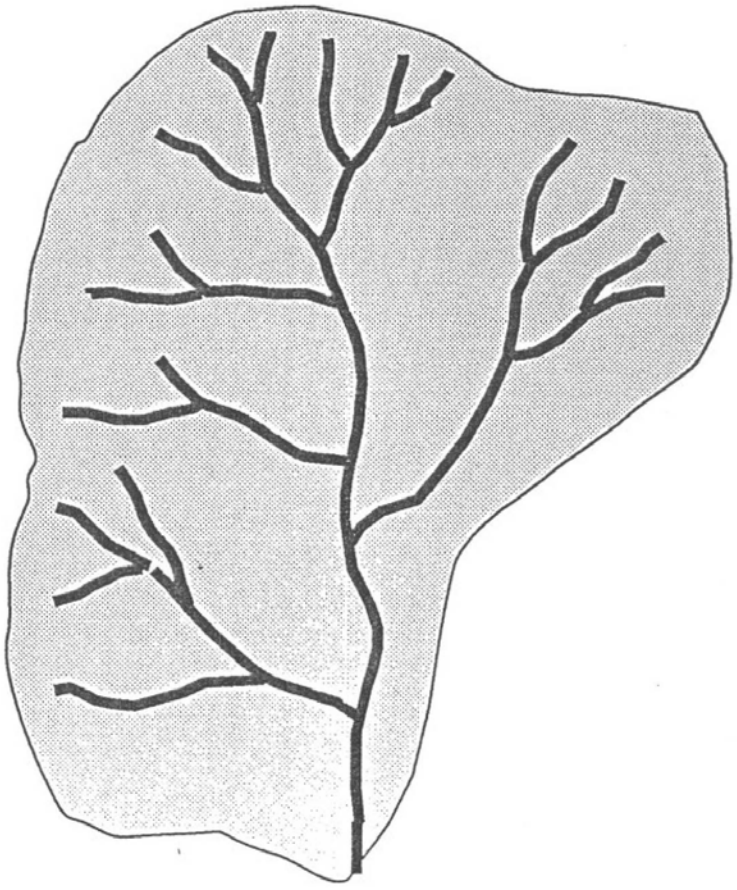
Homogeneous Stream Sections



HOMOGENEOUS STREAM SECTIONS

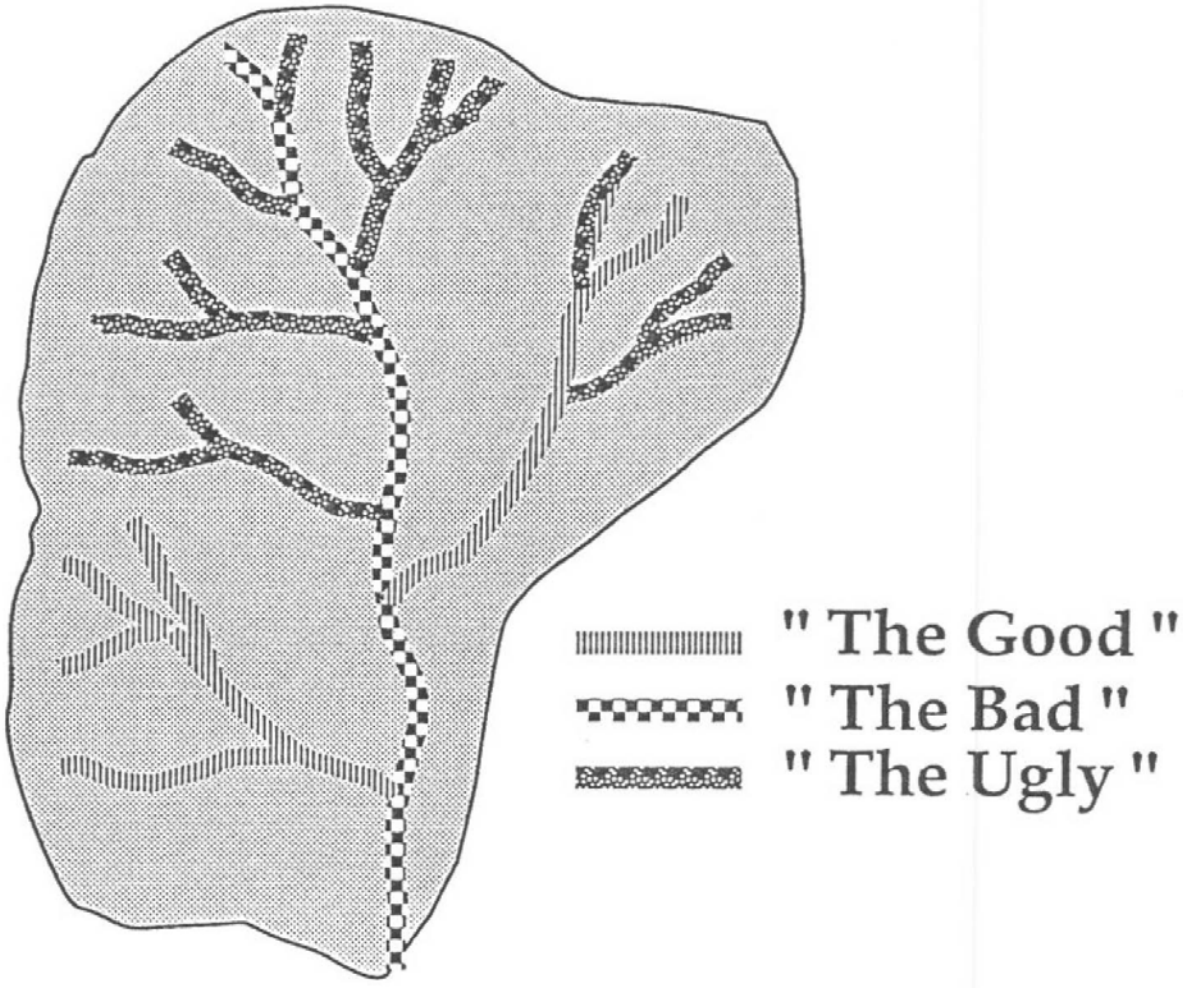
1. **In assessing the condition of streams and rivers we have to deal with sections of rivers not points or individual sites.**

2. **A lot of this is common sense. River sections in different tributaries throughout the catchment will be fundamentally different because their catchments are different. Similarly, the general features of a river will change as it increases in size, as more a more tributaries are added to it.**



HOMOGENEOUS STREAM SECTIONS

3. Ultimately what we need is a way of classifying all the river and stream sections in a catchment in terms of their features and overall condition.

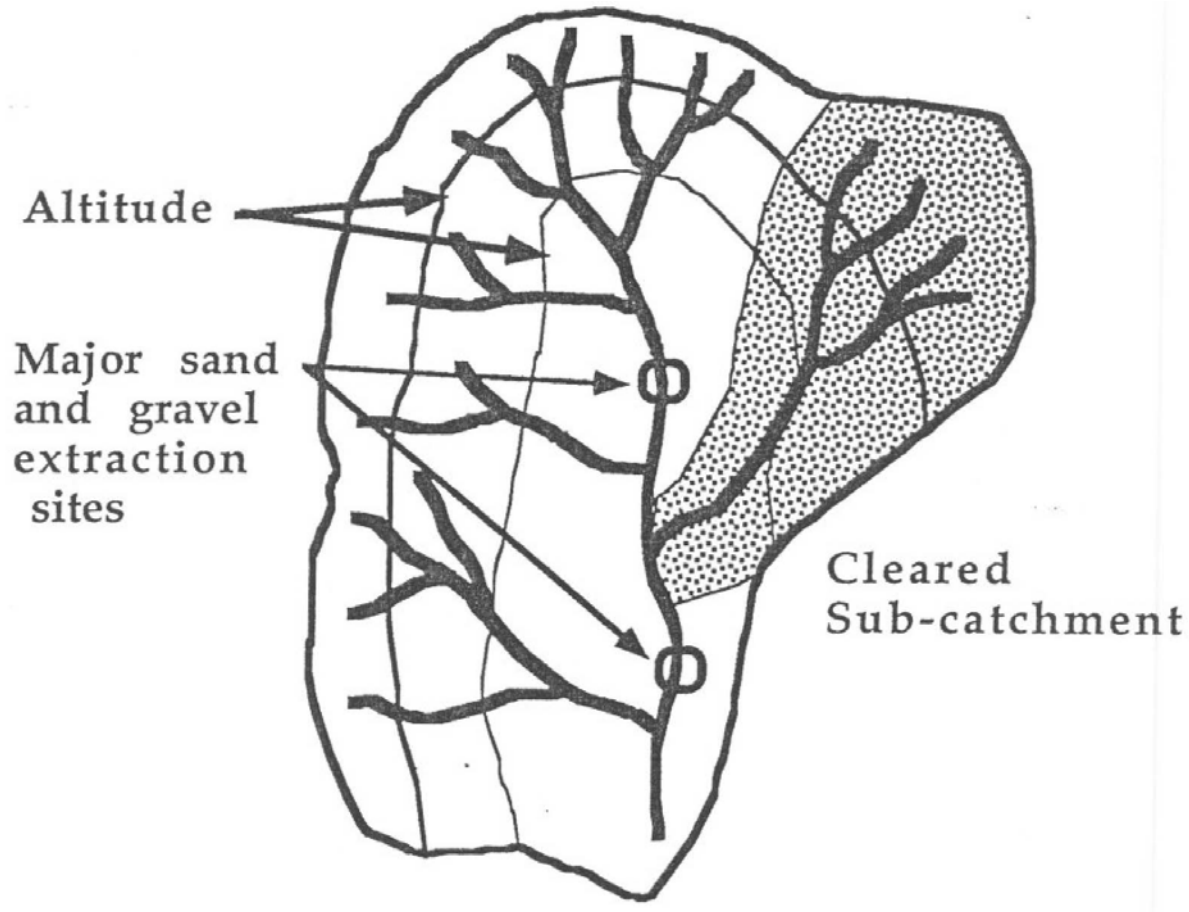


HOMOGENEOUS STREAM SECTIONS

4. Subdivision Procedure

A. Preliminary Sub-division - Map Exercise

The rivers and catchment is initially subdivided into major sections at the sub-catchment boundaries, and using other available information such as altitude, slope, stream gradient, geology and vegetation cover and land use.

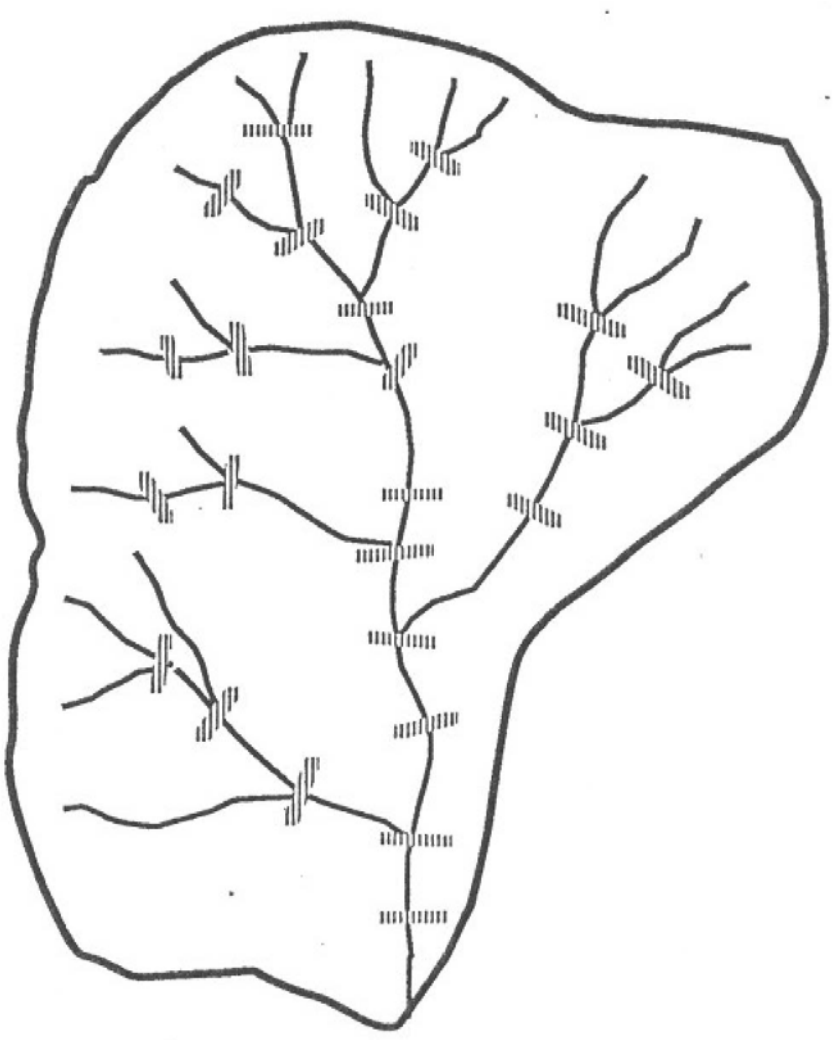


HOMOGENEOUS STREAM SECTIONS

4. Subdivision Procedure (cont.)

B. Reconnoitre Survey

Using the initial base map a reconnoitre survey is conducted to visually assess the river sections. More sections boundaries are added to maintain the notion of homogeneous stream sections.

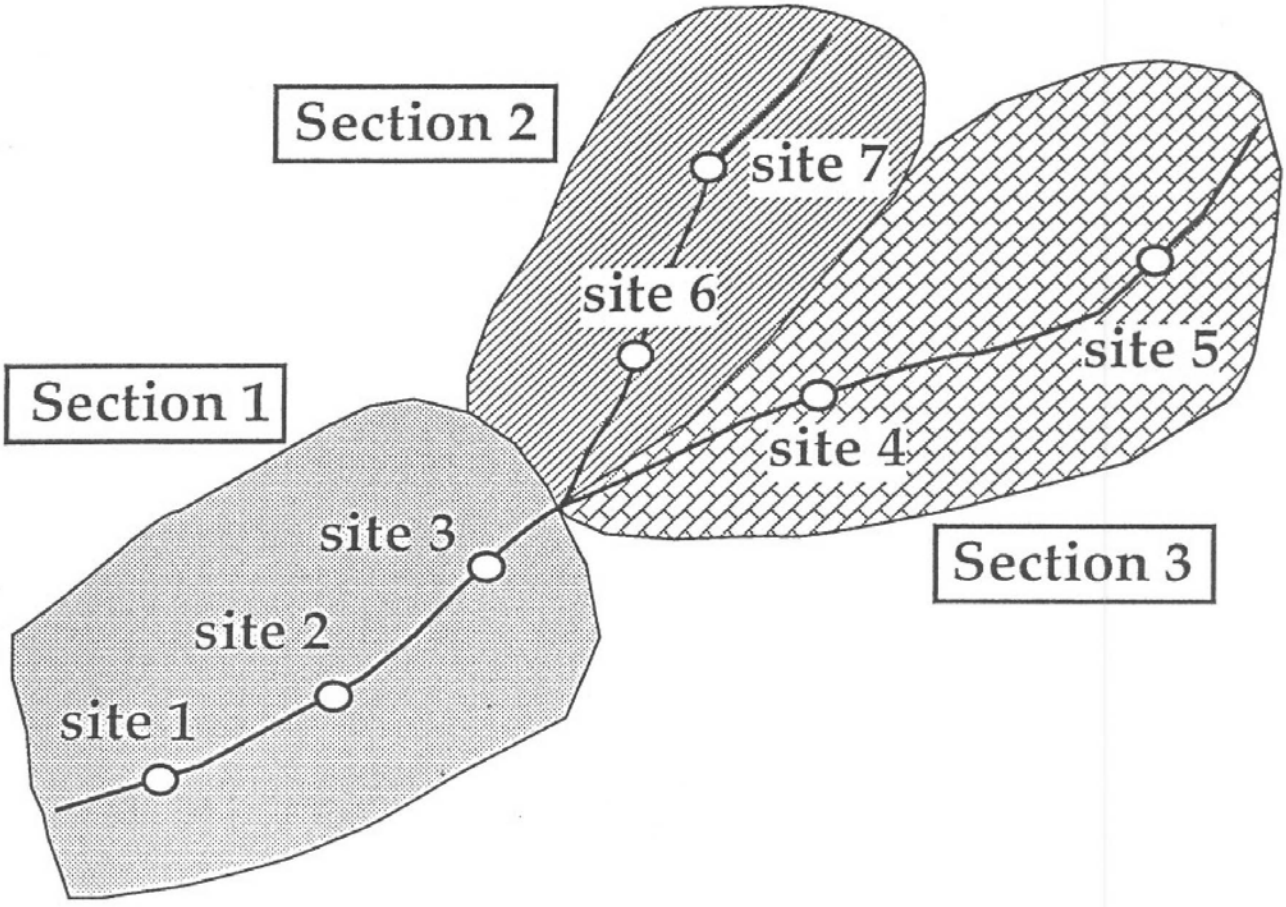


HOMOGENEOUS STREAM SECTIONS

4. Subdivision Procedure (cont.)

C. Sub-division of the Catchment

Whenever a new section boundary is added the catchment is subdivided also. Each homogeneous stream section then has it's associated sub-catchment element. Sites representative of the section are also chosen during the reconnoitre survey.

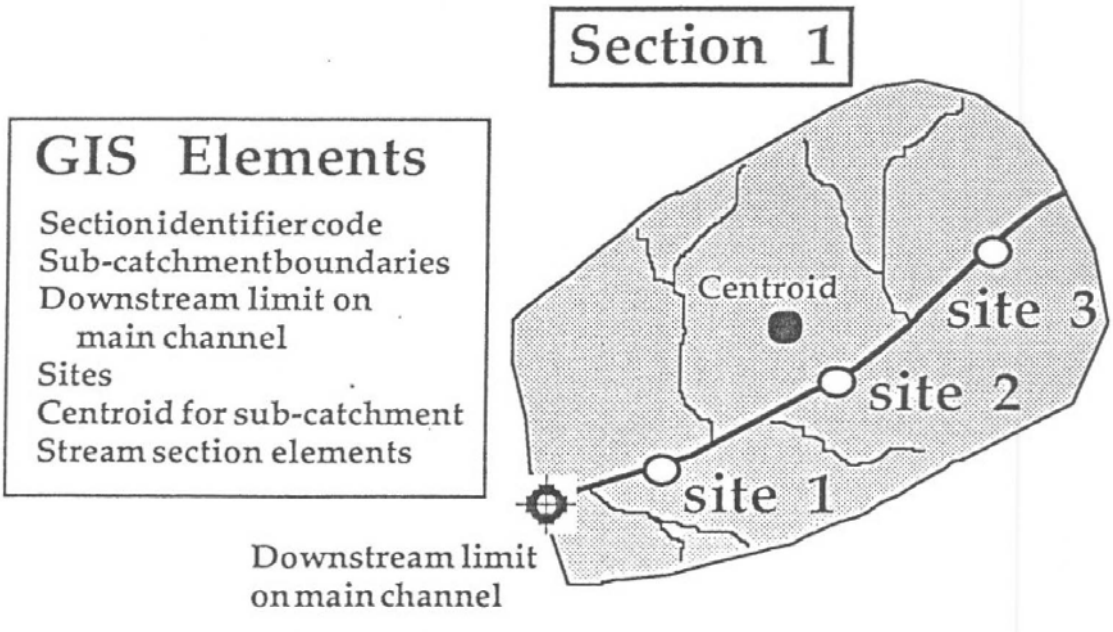


HOMOGENEOUS STREAM SECTIONS

4. Subdivision Procedure (cont.)

D. Site Survey & Link to GIS

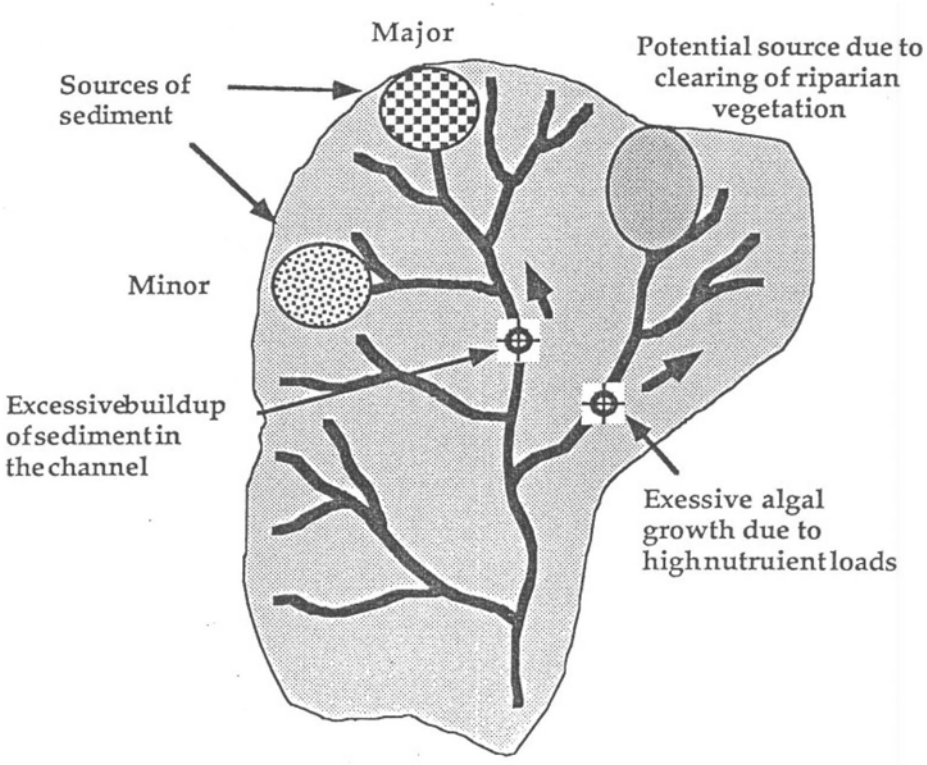
The detailed site survey is then conducted at the series of sites allocated for each section. Once the survey data has been analysed the decision may be made to add further sub-sections in order to keep the sections 'homogeneous' in terms of the criteria selected. The system is expandable allowing varying scales of resolution and specificity. Each of the stream sections and it's associated land parcel element becomes an element in the GIS for compiling spatial information throughout the catchment such as land use, soils, vegetation cover etc.



HOMOGENEOUS STREAM SECTIONS

5. Methods for Integration

In order to provide a method for real integration we need a way to instantly determine which stream sections and sub-catchment land parcels are upstream of a given location in the stream drainage network. A simple hierarchical numbering system has been developed to do this within the database.



The sections and sub catchment parcels upstream of any point can be recognised and their order in the drainage network determined.

DATA COMPILATION & ANALYSIS

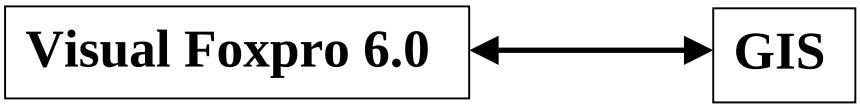
The data collected will be compiled into a series of relational databases using Visual Foxpro 6.0. The data collection unit is the stream section and sub-catchment land parcel.

Types of Data

1. **Non Survey Data**

   A. **Section location and definition**

   B. **GIS derived data – the numbering system allows a two-way transfer of data**



   C. **Hydrological Summary – The gauging stations are incorporated as special sites in the data base. Hydrological summary data will be extracted using HYDSYS package and included in the database. Water quality data could be included in a similar way, although it is not currently.**

2. **Survey Data – includes information collected at one or more sites in each section.**

INSTREAM SURVEYS

1. *Approach and Constraints*

In conducting these surveys there will never be enough sites and there is always more data that could be collected. The basic practical criteria for the surveys are:

1. **The survey is designed to be completed by teams of two members spending about 1 hour at each site.**

2. **This allows for two teams of two people to survey about 150-200 sites in a three-week period (adequate for a catchment of same size as the Mary River).**

3. **The reconnoitre would require an additional week for two people.**

4. **Only a minimal set of equipment is required (tapes, portable echo-sounder, boat, GPS, inclinometer, camera etc.).**

5. **The survey is expandable dependent on the scale of resolution required and the resources available.**

INSTREAM SURVEYS

2. *Strategy*

The survey approach is to collect the following types of data:

1. **<u>Raw Data</u> - Raw data will be collected. It will be used to compile the derived data, and will be itself used for specific purposes such as in integrated catchment management e.g. The distribution of a certain weed species or erosion.**

2. **<u>Derived Ratings</u> - Various formulae will be used to derive the various overall condition assessments. The method used will be explicit and easily modified.**

   e.g. Physical Condition =
   $$A(w_1) + B(w_2) + C(w_3) + D(w_4)$$
   where A,B,C & D are raw attributes
   and w's are weightings

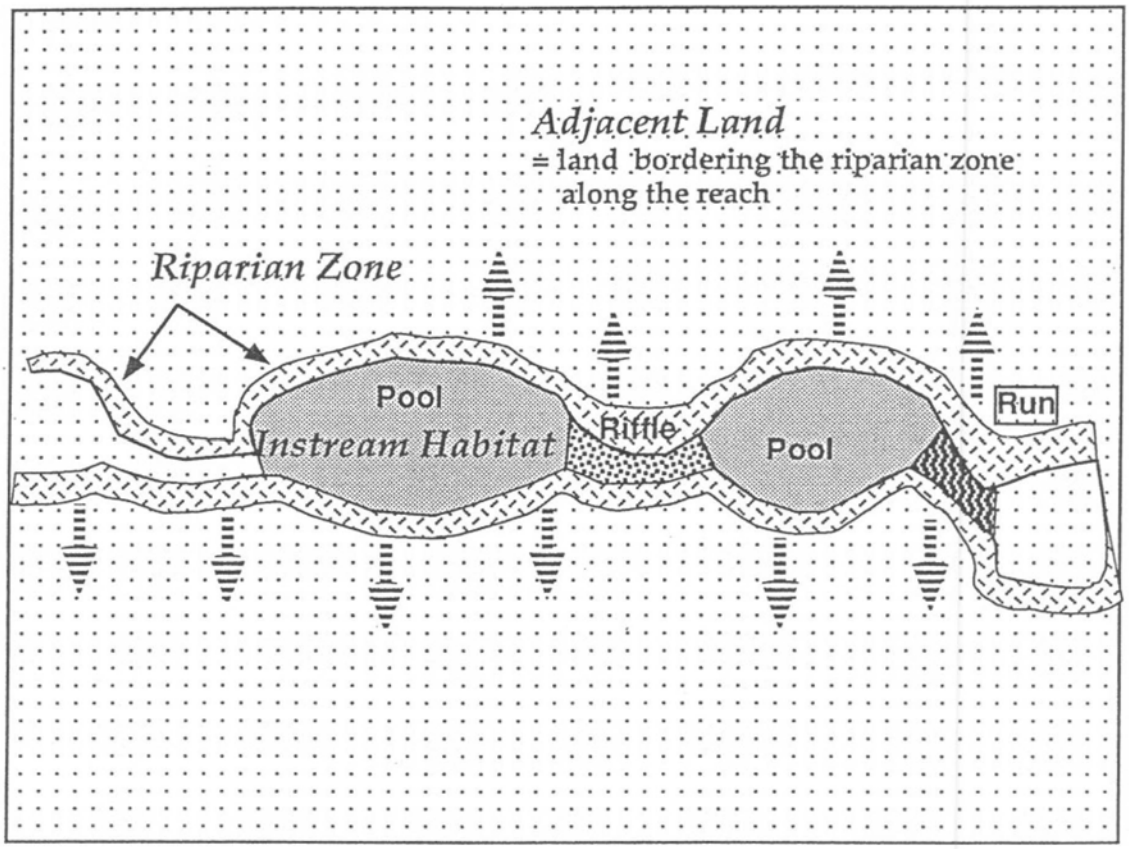
3. **<u>Semi-Subjective Ratings</u> - The recorders will be asked to make an overall assessment of the component. The value of these ratings will be increased by asking for the assessments after the raw data has been collected. These ratings will provide a valuable 'first-go' assessment, which can be qualified using the derived ratings.**

INSTREAM HABITAT

The Focus of the Study is on the Instream Habitat i.e. on the condition of the stream itself

- **the bed, bar and banks,**
- **the Riparian Zone,**
- **and the land immediately adjacent to the riparian zone,**

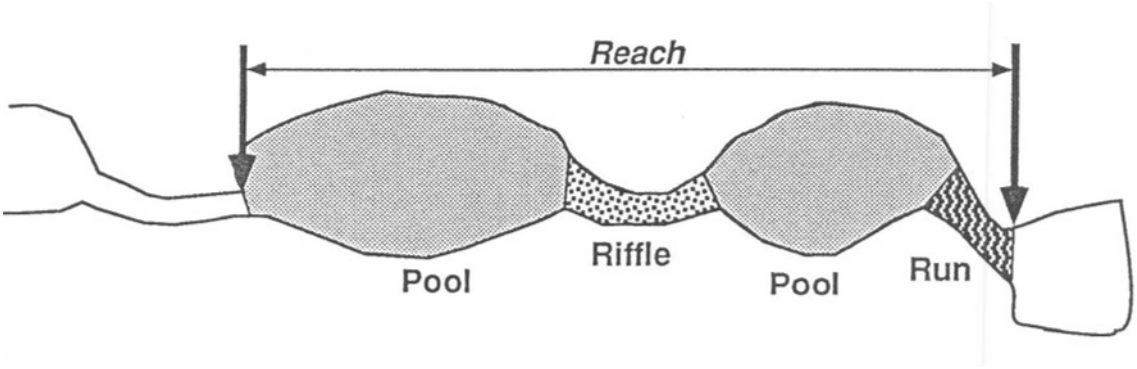
within the boundaries of the selected reach.



SITES = REACHES

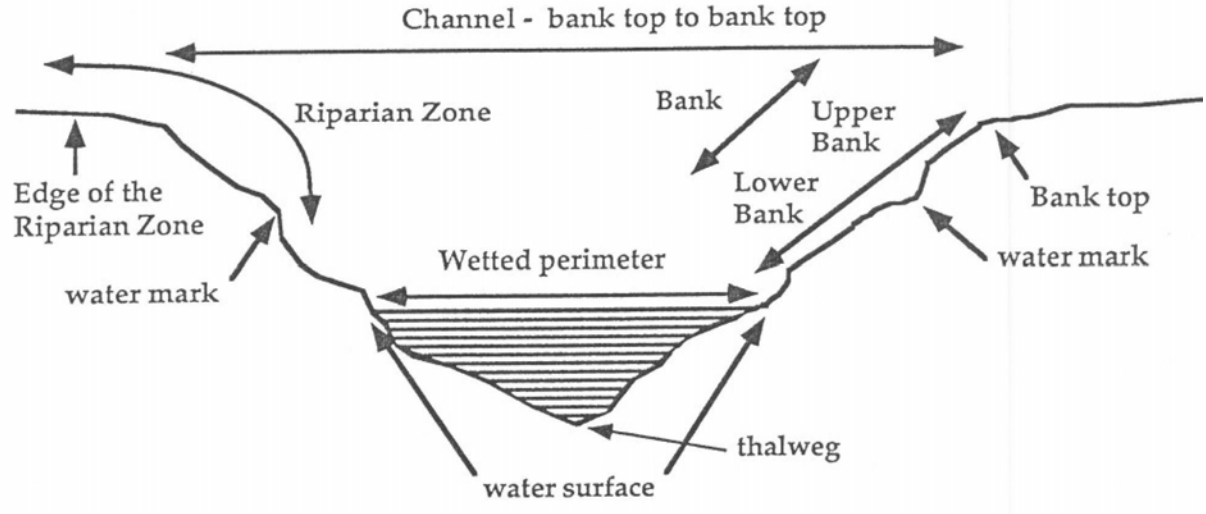
A representative reach is selected at each designated site. The reach should represent the channel habitats present in the section and it should meet the following criteria:

1. **Preferably the reach should contain at least 2 complete pools and riffle / run habitats (represent diversity).**
2. **The whole length of the reach should be visible at one location.**
3. **The pool should be the largest and deepest in the area.**



BOUNDARIES

Most of the boundaries used for the various assessments are explained on the appropriate datasheets. The following summary gives an initial guide.

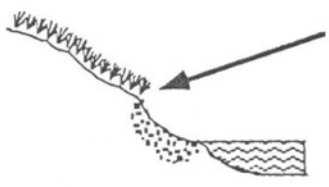


Thalweg - This is the deepest point across a transect. It is important because cross-sections in pools should be taken to intercept the deepest point in a pool, and the 'shallowest' thalweg in a riffle, run or glide.

Bank top, Banks - From a measurement point of view the banks extend from the water's surface (or the water marks if the bed is dry) to the bank top that is to the point of inflexion the channel profile.

Water Surface - This is obvious. It is used for taking depth measurements for the cross-section profiles and for assessing the instream organic debris cover available for fish and invertebrates. When the bed is dry assessment is made at the 'water mark', i.e. assuming that the channel was filled with water to the 'water mark'.

Water Mark - The concept of a 'water mark' is used to provide a reference point for standardising the channel measurements and for marking the boundary between the lower and upper banks. A mark is left on the bank at the normal inundation level for the stream. It is delineated by either the edge of the terrestrial grasses and other vegetation, which cannot tolerate more frequent inundation, or an obvious point of erosion or substrate differences along the bank.



A 'Water Mark' is left at the normal inundation level in the stream. It's location is shown by the edge of the terrestial grasses etc., which can not tolerate more frequent innundation, or by an area of erosion or the boundary between different types of sediment on the bank.

BOUNDARIES CONTINUED

Riparian Zone - It is difficult to derive a precise definition of a riparian zone, particularly for untrained staff. There are many possible definitions. The most relevant feature for our purposes is the vegetation. Ideally it should be possible to identify such a zone irrespective of disturbance or condition, and it should have a fixed with for each size and type of stream, relating to how far and how often the stream or river floods or reaches bank-full stage. However, this is not possible in this survey and so the focus is on identifying the remnant riparian zone using its distinct vegetation.

The riparian zone is an interface between the stream and the surrounding land. The vegetation in it is different because of the influence of the stream in increasing available moisture, flooding and soil characteristics. The vegetation is important or the stream because it contributes organic debris, stabilises the banks and provides shade, and cover for the instream communities.

The general perception of there being a strip of vegetation along the edge of the stream, which is different from the rest of the vegetation in the landscape, is generally obvious and recognisable by most people. The strategy adopted was to simply record the width of the remnant strip of clearly distinguishable vegetation along the stream margins, on the banks and partially extending onto the floodplain, and to assess the cover by various types of plants within the boundaries of this zone along both banks.

INSTREAM SURVEYS

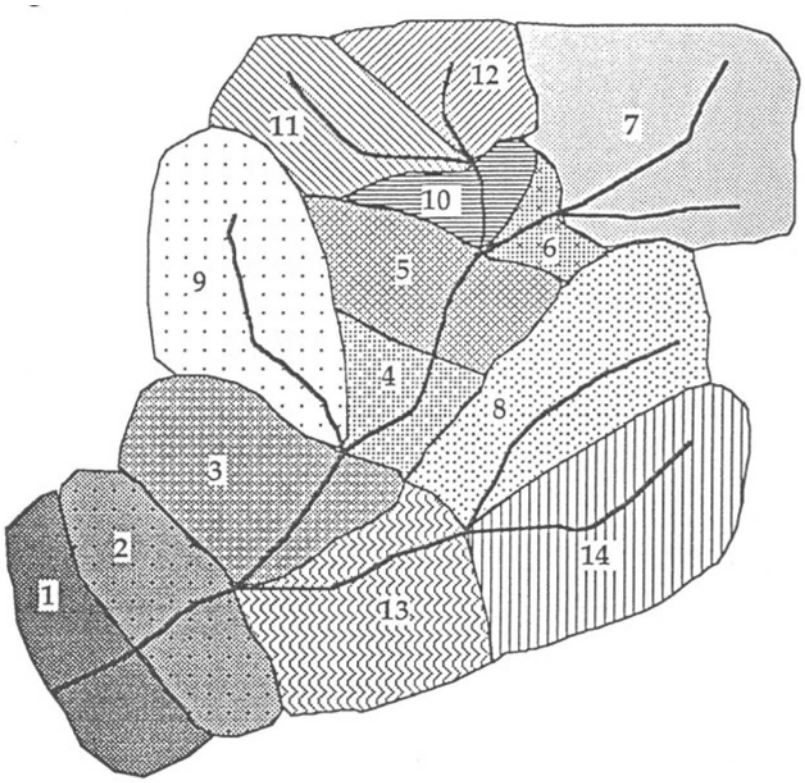
3. *Components*

The following components will included in the surveys (each represents a data sheet and database):

1. **Stream Section Information *(Non-survey)***
2. **Hydrology and Water Level/Flow conditions *(Non-survey)***
3. **Site Description - site location**
4. **Reach Environs - adjacent land features**
5. **Channel Habitat - pool, riffle, run, cascade, etc.**
6. **Cross-sections - profiles / bed and banks**
7. **Bank Condition**
8. **Bed and Bar Condition**
9. **Vegetation - riparian, bank and aquatic**
10. **Aquatic Habitat**
11. **Scenic, Recreational and Conservation Values**

SUB-SECTION NUMBERING SYSTEM

A simple numbering system for the stream sections is used to achieve integration through the drainage network.



The sections along the major channel are first assigned sequential numbers -large numbers are used to allow additional sub-sections to be added with minimal changes. Tributary sub-catchment sections are assigned the number of the main tributary section into which they drain plus a sequential number at successive levels of the hierarchical code. The codes allocated to the stream sections shown above are as follows:

Section	Code			Section	Code		
Number	A	B	C	Number	A	B	C
1.	1000	0	0	8	2000	1000	1000
2.	2000	0	0	9	3000	1000	0
3.	3000	0	0	10	5000	1000	0
4.	4000	0	0	11	5000	2000	0
5.	5000	0	0	12	5000	2000	1000
6.	6000	0	0	13	2000	1000	0
7.	7000	0	0	14	2000	2000	0

State of the Rivers Project
Major Types of Data

1. Catchment in the Regional Context
   * *climate, regional land system*

2. Sub-catchment Features
   * *Land use, soils, geology, slope, gradient*

3. Site Description, Location, Drainage code
   * *grid reference, AMTD, identifiers*

4. Reach Environs Information - Spatial
   * *floodplain land use and type, channel pattern, land administration, disturbance*

5. Reach Environs Information - Temporal
   * *conditions prevailing at the time of the survey*

6. Channel Form, Shape & Dimensions

7. Hydrology and Water Quality
   * *Summaries derived from other sources*

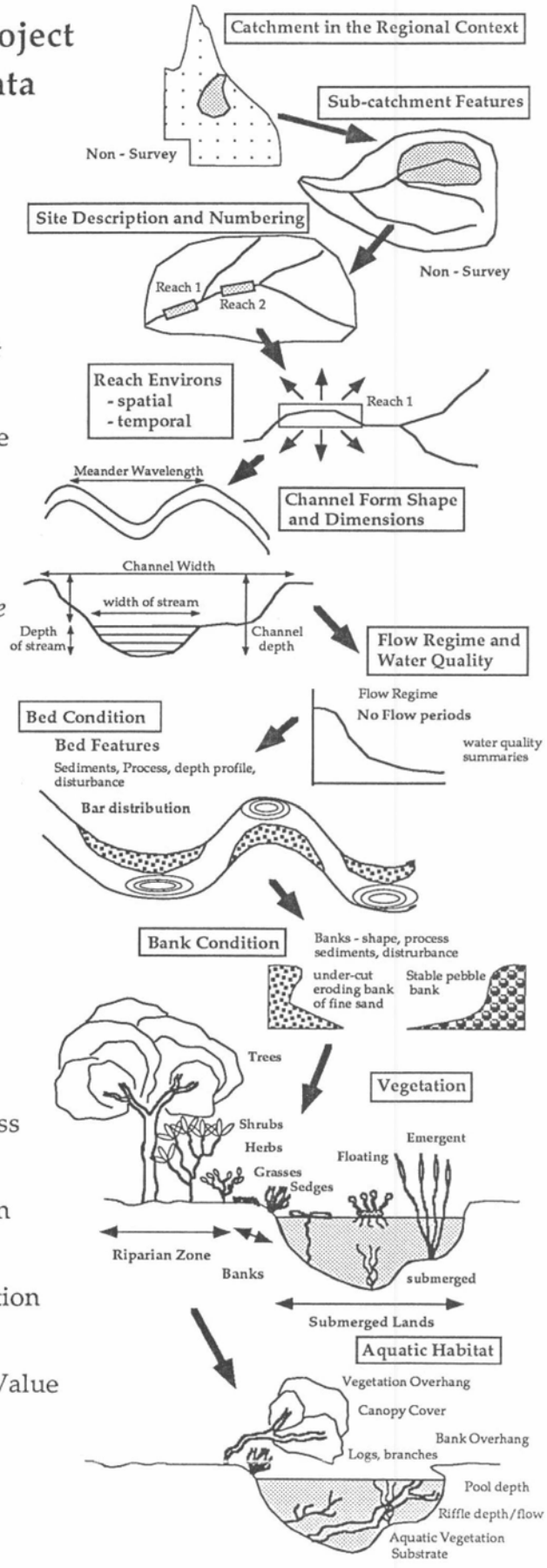
8. Banks - Physical Condition & Process

9. Bed & Bars - Physical Condition & Process

10. Vegetation - Aquatic, Bank and Riparian

11. Aquatic Habitat Classification & Condition

12. Scenic, Conservation and Recreational Value



Appendix 2

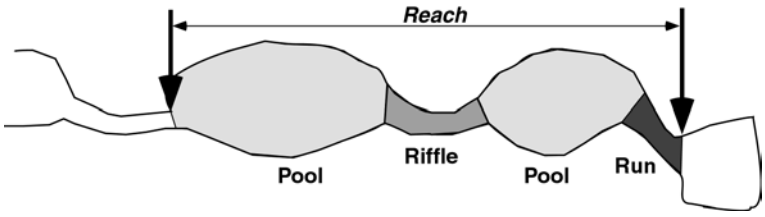
Guide to Datasheets

(useful to produce separately as a Field Manual)

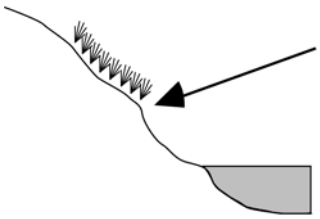
At the Site

- When you have located the site fill in Sheet 3 if it has not already been done in a Reconnoitre Survey.

- Determine the 'Reach' with your team member. This is a length of stream that is representative of the stream section and the range and relative size of the channel habitats present.



- Together determine where the water mark is and where measurements will be taken from.



The "Water Mark" is left at the normal inundation level in the stream. It's location is shown by the edge of the terrestial grasses etc., which can not tolerate more frequent inundation, or by an area or erosion or the boundary between different types of sediment on the bank.

- Divide datasheets and determine who will do what sheets. You may like to fill out the same sheets at all the sites or swap them around.

- Fill out all the datasheets except the cross-section sheets.

- Together complete the cross-section sheets. Two people are required to conduct the cross-section – one for taking the measurements and the other for recording the results.

- Check that all parts of the datasheets have been completed and re-staple the sheets together.

- Mark site on the topographic map to indicate that the site has been completed.

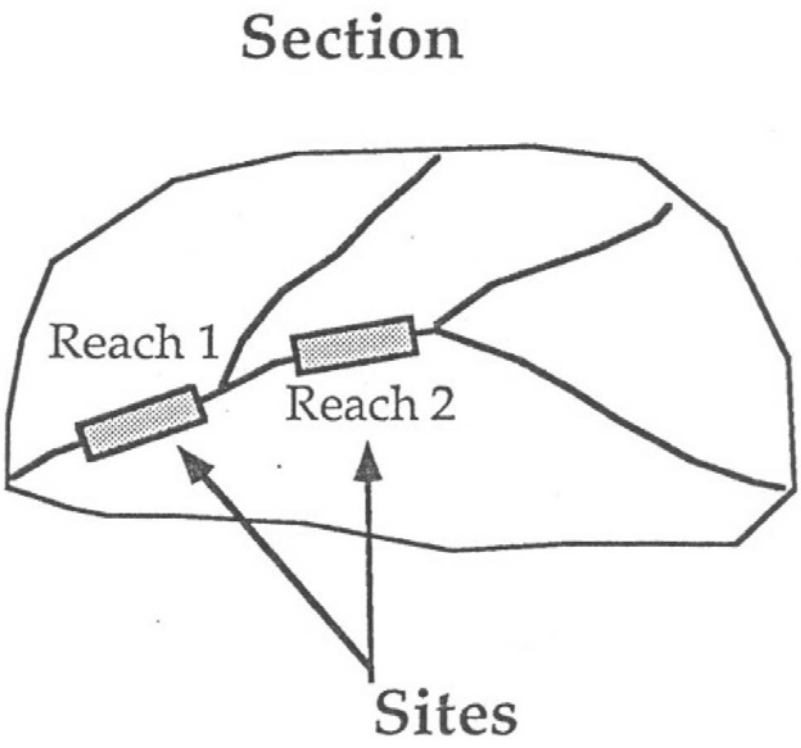
**It is IMPORTANT that ALL the information is completed at each site. It is hard to distinguish between a real zero and a failure to complete the data sheets. Therefore we ask, if you have assessed an attribute and there is nothing to record place a slash through the section to indicate that it has been assessed and not merely forgotten. Thank-you!

State of the Rivers

NOTES:

Site Description

The aim here is to provide a description of the location of the site using a grid reference or a lat/long (GPS preferred), and using local land marks. The description should be adequate for precisely relocating the site for follow-up surveys. A standard set of photographs is taken of the site.



Site Description – Sheet 3

1. Assign Site Number, Tributary Name, Date, Recorder/Assistant

2. Flows Into – name of stream Tributary flows into, e.g. Seven Mile Creek flows into Granite Creek, which flows into Baffle Creek.

3. **Site Description** – broad description on how to get to the site, e.g. Turn left into Three Mile Ck Rd, 500m after Bruce Highway crossing of Granite Creek. Go along 4km to low level crossing.

4. **Location Description** – the location of the site on the actual stream, e.g. 200m upstream of the low level crossing.

5. **Sketch** – Draw mud map to aid in finding the site. Adding any distinguishing features to make it easier to find.

6. **Type of Site** – mark the box corresponding to the type of site it is. In most cases it will be a 'Full Survey Site'.

7. **Map Number** – number of topographic Map where site is located, e.g. 9248

8. **Grid Reference** – Eastings and Northings read off Topographic Map

9. **Latitude and Longitude** – coordinates given by GPS in Degrees, Minutes, Seconds.

10. **GPS** – mark this box if the Latitude and Longitude were from a GPS unit. If not mark the 'Other' box.

11. **Map Scale** – scale of Topographic Map, e.g. 1:100 000

12. **Tidal/Non-Tidal** – mark the relevant box whether the site is 'Tidal' or 'Non-tidal'.

13. **Photographs** – For each new film a number should be allocated to it and written on the film canister. That number is the 'Film No'. Take photos Upstream, Downstream, Lateral Left and Lateral Right, Reach Environs and any distinguishing feature or activity at the site. Please Note: to determine left and right bank you must be facing downstream. Place the Shot No's off the camera in the appropriate box to correspond with the photo you have taken.

	Film No.			Shot		
Upstream		3	2		1	0
Downstream		3	2		1	1
Lateral Left		3	2		1	5
Lateral Right		3	2		1	3
Reach Environs		3	2		1	2
Distant View						
Feature Logjam		3	2		1	4
Feature_____						

STATE OF THE RIVERS --- SHEET 3 *Site Description*

Date (dd/mm/yy) ☐☐/☐☐/☐☐

Recorder _____

Assistant _____

Basin ☐☐☐ Sub-section ☐☐☐☐ Site ☐☐☐☐

SITE CODE

Tributary Name _____ Flows into _____ Flows into _____

Gauging Station ☐☐☐☐☐☐☐ Type ☐☐ Region ☐☐☐

Site Description (locality name) _____

Location Description (how to find it again) _____

Type of Site

1 ☐ Photograph Only
2 ☐ Full Survey Site
3 ☐ Stream Gauge
4 ☐ Water Quality
5 ☐ Other _____
6 ☐ Other _____
7 ☐ Other _____

Map Number ☐☐☐☐-☐☐☐☐

Grid Reference E ☐☐☐☐☐☐ N ☐☐☐☐☐☐☐

Latitude ☐☐ deg : ☐☐ min : ☐☐ sec

Longitude ☐☐☐ deg : ☐☐ min : ☐☐ sec

GPS ? ☐ Other ☐ Est. Position Error ± ☐☐☐☐ m

Map Scale 1: ☐☐☐☐☐☐

AMTD (from map) ☐☐☐.☐☐

Total U/S Distance (add AMTD's) ☐☐☐.☐☐

Is the Site Tidal ? ☐ Non - Tidal ☐

Catchment Area (sq. km) ☐☐☐☐☐☐.☐☐☐

Sketch : Show location of survey, access points, landmarks and key features such as roads, houses and other buildings. Also show the key features about the stream environs and its location. Also mark the boundaries for the survey (the reach). Include an arrow for NORTH and also indicate the direction of flow. Also mark the position where the GPS latitude and longitude were determined. The sketch should be adequate for quickly finding the site again for future follow-up surveys.

Photographs - The standard set consists of one shot looking upstream, downstream, lateral left (at left bank), lateral right (at right bank), reach environs (overview of the reach from a distance) and other relevant photographs

Altitude (m) ☐☐☐

	Film No.	Shot	Shot	Shot	Shot
Upstream	☐☐☐	☐☐☐	☐☐☐	☐☐☐	☐☐☐
Downstream	☐☐☐	☐☐☐	☐☐☐	☐☐☐	☐☐☐
Lateral Left	☐☐☐	☐☐☐	☐☐☐	☐☐☐	☐☐☐
Lateral Right	☐☐☐	☐☐☐	☐☐☐	☐☐☐	☐☐☐
Reach Environs	☐☐☐	☐☐☐	☐☐☐	☐☐☐	☐☐☐
Distant View	☐☐☐	☐☐☐	☐☐☐	☐☐☐	☐☐☐
Feature _____	☐☐☐	☐☐☐	☐☐☐	☐☐☐	☐☐☐
Feature _____	☐☐☐	☐☐☐	☐☐☐	☐☐☐	☐☐☐

NOTES:

Notes:

Reach Environs

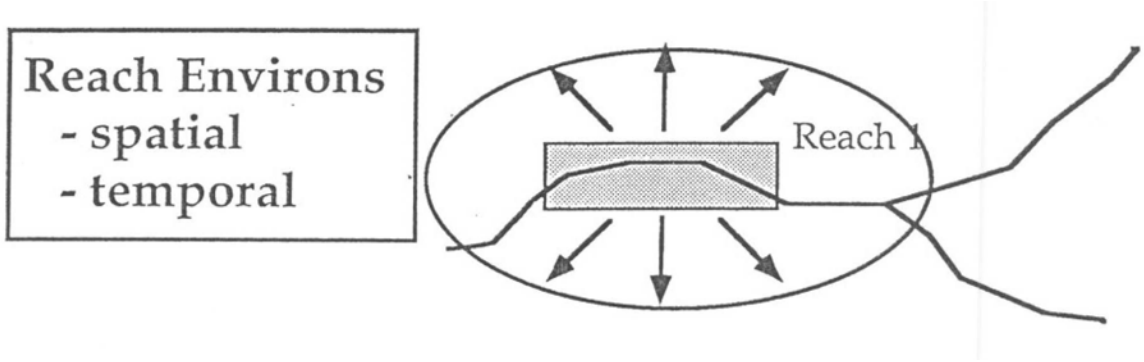
The aim here is to record local information about the land immediately adjacent to the reach. This includes information about the flow and water level conditions prevailing at the time of the survey.

It also includes:

local land use
local disturbance
local vegetation type
floodplain features (billabongs etc.)
local land tenure

An *overall disturbance rating* also made in relation to the extent of clearing and replacement of vegetation by exotic species in the riparian zone and adjacent land.

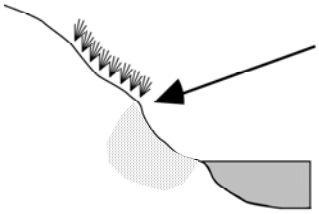
This local data complements the broader data available form the GIS (spatial) and flow conditions at the gauges (temporal).



Reach Environs – Sheet 4

**Site Number, Tributary Name, Date, Recorder

1. **Water Level at Sampling Time** – mark **1** box corresponding to the current water level in the stream. See below for definition of 'Water Mark'



The "Water Mark" is left at the normal inundation level in the stream. It's location is shown by the edge of the terrestial grasses etc., which can not tolerate more frequent inundation, or by an area or erosion or the boundary between different types of sediment on the bank.

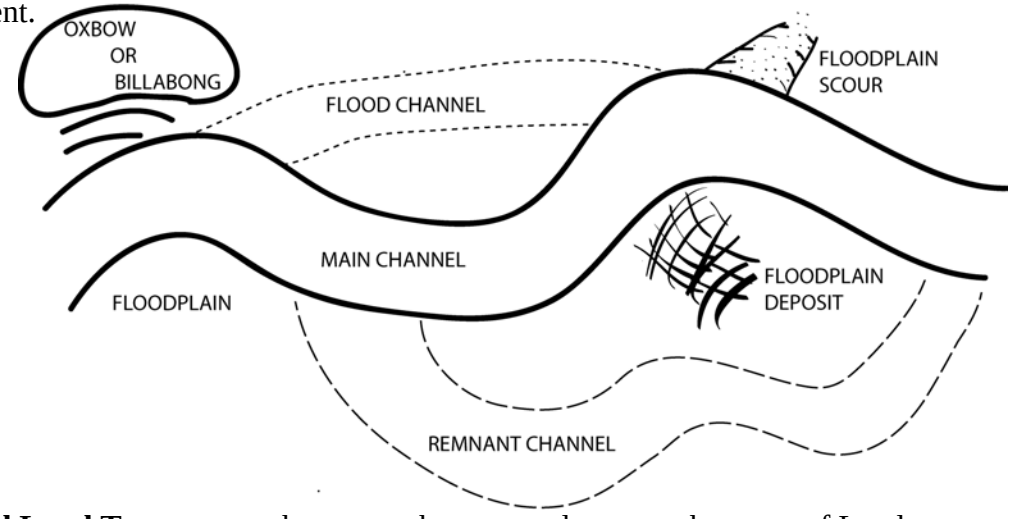
3. **Channel Pattern** – mark **1** box for 'Map Scale' (channel pattern on Topographic Map) and **1** box for 'Local Scale' (channel pattern on the ground). If either Map Scale or Local Scale are not determined mark the 'Not Determined' box.

4. **Local Land Use** – mark as many boxes as relevant to the types of land use occurring on both sides of the stream. If a land use is not listed then mark the 'Other' box and indicate what it is.

5. **Local Disturbance** - mark as many boxes as relevant to the types of disturbance occurring on both sides of the stream. If a disturbance is not listed then mark the 'Other' box and indicate what it is.

6. **Present Vegetation in Local Vacinity** – mark as many boxes as relevant to the types of vegetation that occurs at present on both sides of the stream. If a vegetation type is not listed then mark the 'Other' box and indicate what it is.

7. **Floodplain Features** – mark as many boxes as relevant to the types of floodplain features present.



8. **Local Land Tenure** – mark as many boxes as relevant to the types of Land tenure present on both sides of stream. May need to refer to map. If a Land Tenure is not listed or it is unknown then mark the 'Other/Unknown' box.

9. **Overall Disturbance Rating** – mark **1** box that best describes the overall disturbance of the site. Use the diagrams and explanations to choose the "Best Fit".

STATE OF THE RIVERS --- SHEET 4 Reach Envions -temporal & spatial

Date (dd/mm/yy) / / Recorder

Basin | Sub-section | Site | Tributary Name

SITE CODE

Record information about the local land adjacent to the reach on each side and about the conditions prevailing at the time of the sampling. The assessment should be restricted to the immediate vicinity of the reach-- i.e. not beyond the land bordering the riparian zone

1 Water Level at sampling time

1. Completely dry
2. Isolated pools, no flow
3. Low Flow/ low level
4. Moderate < water mark
5. Normal at water mark
6. High > water mark
7. Flood > bankfull
8. Within 1 hr of High Tide
9. Within 1 hr of Low Tide
10. Incoming/between Tide
11. Out-going/between Tide

3 Channel Pattern

Map Scale | Not Determined (0) | Local Scale (0)

1. Straight
2. Mildly sinuous
3. Irregular
4. Reg. Meanders
5. Irreg. Meanders
6. Tortuous
7. Braided
8. Swampy
9. Channelised
10. Overland Flow

4 Local Land Use

1. Sugar Cane
2. Horticulture small crops/ vines
3. Horticulture tree crops/ fruit
4. Irrigated broadacre row crops
5. Rainfed broadacre row crops
6. Grazing - sown pasture
7. Grazing -native --- cleared
8. Grazing -native --- thinned
9. Grazing -native --- virgin timber
10. Intensive Livestock-pig,fowl,cow
11. Urban residential
12. Urban manufact/ processing
13. Park or Reserve / National, envir
14. Urban Park or Reserve
15. Rural Residential / hobby farm
16. Other _____

5 Local Disturbance

1. Sand / gravel mine
2. Other mine
3. Road
4. Bridge / culvert / wharf
5. Ford / ramp
6. Discharge Pipe
7. Forestry activities
8. Sugar Mill
9. Sewerage Effluent
10. Irrig. runoff, pipe outlet
11. Channelisation
12. River improvement
13. Water Extraction
14. Dredging
15. Grazing
16. Other_____

6 Record Present Vegetation in Local Vicinity

1. Rainforest
2. Eucalypt Wet Sclerophyl
3. Eucalypt Open Forest
4. Eucalypt woodland
5. Eucalypt open woodland
6. Cypruss Pine forest
7. Belah/ Brigalow/ Gidgee
8. Mulga scrub-open forest
9. Mulga Shrubland
10. Bendee/lancewood scrub
11. Softwood Scrub
12. Melaleuca forest
13. Grassland(isolated trees)
14. Other Shrubland
15. Heathland
16. Mangrove
17. Salt marsh / salt pans
18. Freshwater marsh
19. Pine plantation
20. Banana plantation
21. Sugar Cane
22. Other _____

7 Floodplain features

1. Oxbows / billabongs
2. Remnant Channels
3. Floodplain scours
4. Floodplain deposits
5. Prominent flood channels

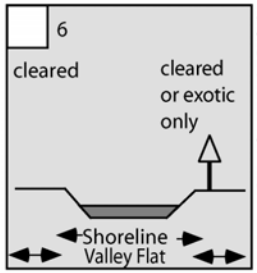
8 Local Land Tenure

1. Freehold/ leasehold
2. National Park
3. State Park
4. Reserve-timber,envir P
5. State Forest
6. Urban Reserve
7. Urban
8. Other / Unknown

9 OVERALL DISTURBANCE RATING

Tick one box for the overall rating

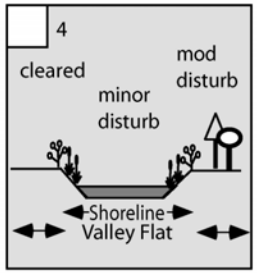
EXTREME DISTURBANCE



Valley Flat Vegetation - Agriculture and/or cleared land BOTH sides. Plants present are virtually all exotic species (willows, pines etc.)

Shoreline Vegetation - Absent or severely reduced. Vegetation present is extremely disturbed - i.e. dominated by exotic species. Native species rare or completely absent.

HIGH DISTURBANCE

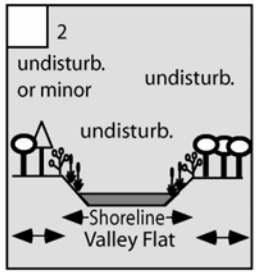


Valley Flat Vegetation - Agricultural land and/or cleared on ONE side; native vegetation on the other clearly disturbed or with a high percentage of introduced species present.

Shoreline Vegetation - Bank vegetation moderately disturbed by stock or through the intrusion of introduced species, though native species remain.

Note: Sites with valley flat vegetaion cleared BOTH sides, but with shoreline vegetation in good condition, for example when it is fenced off, should be included in this category.

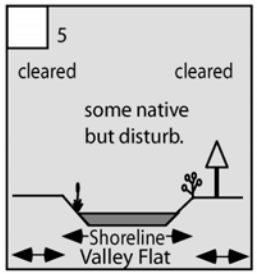
LOW DISTURBANCE



Valley Flat Vegetation - Native vegetation present on BOTH sides of the river with a virtually intact canopy. Minor disturbances present through introduced species.

Shoreline Vegetation - Native vegetation on BOTH sides of the river is generally in good condition with few introduced species present. Any disturbance is minor.

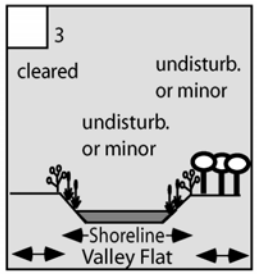
VERY HIGH DISTURBANCE



Valley Flat Vegetation - Agriculture and/or cleared land BOTH sides. Plants present are virtually all exotic species (willows, pines, etc.).

Shoreline Vegetation - Some native vegetation present, but it is severely modified BOTH sides by grazing or the intrusion of introduced species. Native species severely reduced in numbers and cover.

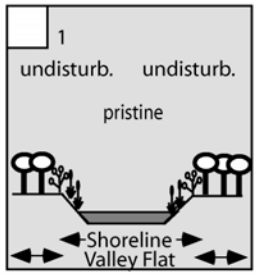
MODERATE DISTURBANCE



Valley Flat Vegetation - Agricultural land and/or cleared on ONE side; native vegetation on the other in reasonably undisturbed state.

Shoreline Vegetation - Native vegetation on BOTH sides with canopy intact or with native species widespread and common in the shoreline zone. The intrusion of introduced species is minor and of moderate impact.

V.LOW DISTURBANCE



Valley Flat Vegetation - Native vegetation present on both sides of the river with an intact canopy. Introduced species are absent or insignificant. No evidence of outside interference. Representative of natural vegetation in excellent condition .

Shoreline Vegetation - Native vegetation on both sides of the river in an undisturbed state. Introduced species are rare or insignificant. Representative of natural vegetation in excellent condition

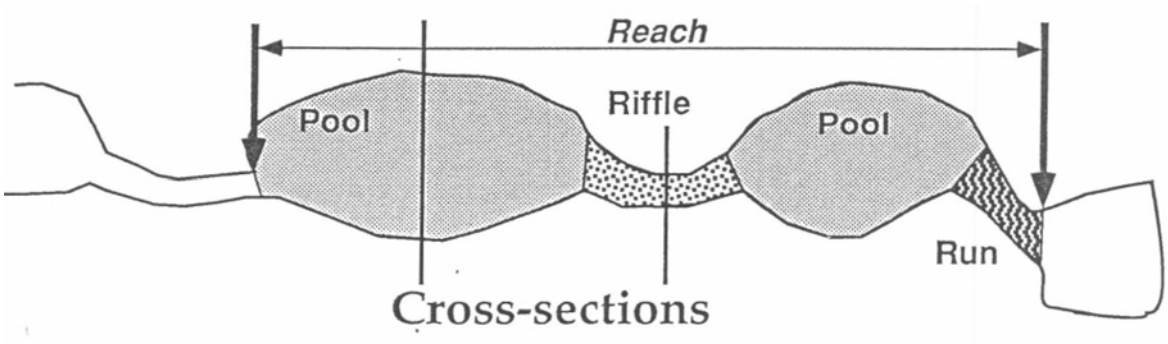
Notes:

Channel Habitat Classification

The aim here is to classify the segments of the reach into the following broad types:

waterfall
cascade
rapid
riffle
glide
run
pool
backwater

These represent the broad range of aquatic habitats present and the range of sediments, flows and depths present in the reach. This classification is important for both the physical and environmental condition of the stream.



Cross-sections are taken at the point of maximum thalweg depth (pool) and at the point of minimum thalweg depth (max. bed height)(riffle) in the reach.

State of the Rivers

Channel Habitat – Sheet 5

**Site Number, Tributary Name, Date, Recorder

*Select your Reach see data sheet for guidelines

NB: You may find it easier to do this one back to front.

3. **Sketch** – draw the reach including all habitat types, widths, lengths, direction of flow and any other key features. TIP: Use diagrams and descriptions on data sheet to help you identify habitat types.

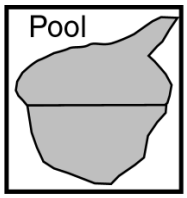
2. **Total Length of Reach** - in metres

1. **Channel Habitat Types** – for each habitat you have identified in the reach indicate what proportion of that reach is made up of those habitats out of 100% and place this percentage in the '% of section' box. For each habitat estimate the AVERAGE length, depth, width and height and gradient (where applicable). Please note it is the Average, therefore if you have two pool habitats and one is 15 m long and the other is 23 m long, then the average is 19m.

EXAMPLE

Total Length of Reach = 50m

Depth > 0.5 m where stream widens or deepens and current declines

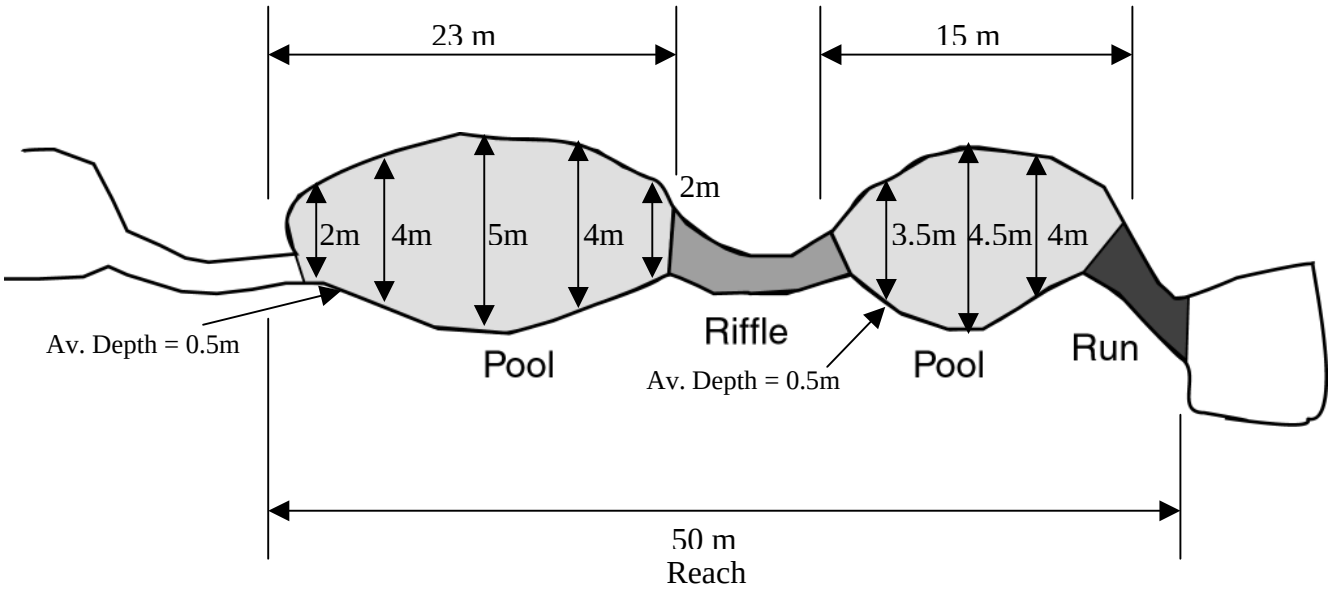


7	6	% of section
1	9	Est. Av. length (m)
0 •	5	Est. Av. depth (m)
3 •	6	Est. Av. Width (m)

% of Section = $\frac{23 + 15}{50}$

Av Length = $\frac{23 + 15}{2}$

Av Width = $\frac{2 + 4 + 5 + 4 + 2 + 3.5 + 4.5 + 4}{8}$



Planform View

STATE OF THE RIVERS --- SHEET 5 *Channel Habitat*

Basin | Sub-section | Site | Tributary Name

SITE CODE

Date (dd/mm/yy) / /

Recorder

1 Channel Habitat Types

Waterfall
Height > 1m
Gradient > 60 deg
% of section
Est. Av. length (m)
Est. Av. height (m)
Est. Av. Gradient (deg.)

Cascade
Step Height < 1m
Gradient 5 - 60 deg
Strong Currents
% of section
Est. Av. length (m)
Est. Av. height (m)
Est. Av. Gradient (deg.)

Rapid
Depth > 0.3 m
Gradient 3 - 5 deg
Strong Currents
Rocks break surface
% of section
Est. Av. length (m)
Est. Av. depth (m)
Est. Av. Width (m)

Riffle
Depth 0.1 - 0.3 m
Gradient 1- 3 deg
Moderate Currents
Surface unbroken but unsmooth
% of section
Est. Av. length (m)
Est. Av. depth (m)
Est. Av. Width (m)

Glide
Depth < 0.1 m
Gradient 1- 3 deg
Small Currents
Surface unbroken and smooth
% of section
Est. Av. length (m)
Est. Av. depth (m)
Est. Av. Width (m)

Run
Depth > 0.3 m
Gradient 1- 3 deg
Small but distinct & uniform current
Surface unbroken
% of section
Est. Av. length (m)
Est. Av. depth (m)
Est. Av. Width (m)

Pool
Depth > 0.5 m
where stream widens or deepens and current declines
% of section
Est. Av. length (m)
Est. Av. depth (m)
Est. Av. Width (m)

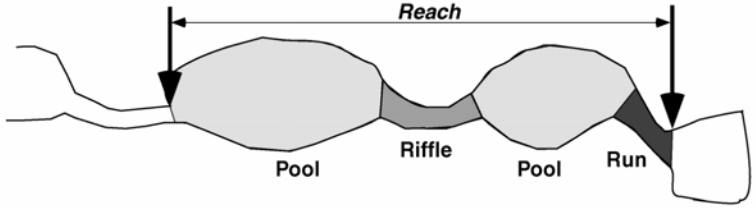
Backwater
Depth < 0.3m
a reaonable size (>20% of channel width) cut-off section away from the channel
% of section
Est. Av. length (m)
Est. Av. depth (m)
Est. Av. Width (m)

Selecting a Reach

Choose an appropriate *Reach* for the remaining assessment. It should:-

1. Preferably contains at least 2 complete pools and riffle / run habitats
2. The whole length of the reach should be visible at one location.
3. The pool should be the largest and deepest in the area.

Sketch the reach showing the location and dimensions of the major habitat types. Measure the length width of each channel habitat type and take a transect across each type located at right angles to the shoreline and passing over the point of maximum depth in a pool (low flow area) and maximum flow / bed height for a run or riffle habitat i.e. the transect where flows would be expected to be maximal.



REACH DETAILS

2 Total Length of reach (m)

3

Sketch the reach showing the channel pattern and the distribution of channel habitat types and key features. A cross-section profile showing the bank shape and vegetation types would also be helpful if there is time

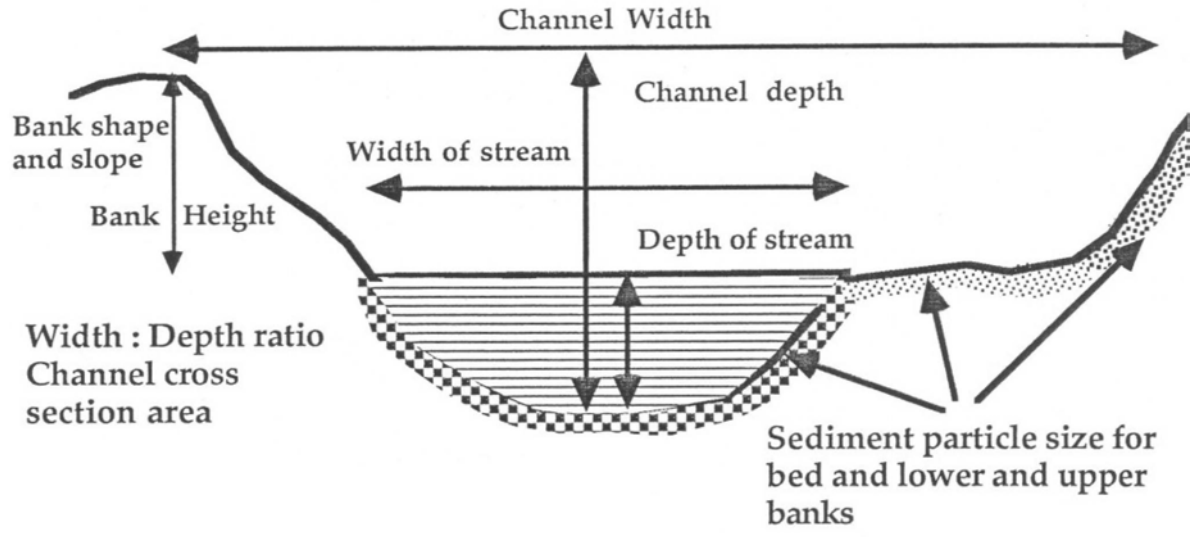
Notes:

Cross-sections

Cross-sections are taken to provide a basic picture of the channel size, shape and form. A series of sediment samples are taken across the bed and also on the banks.

The particle-size composition of the sediments is determined. This is fundamentally important for classifying the aquatic habitat as stream invertebrate distribution and abundance is very much influenced by the type of substrate present.

The cross-sections also provide base-line information for follow-up surveys and also for understanding the processes affecting the channel e.g. headward erosion of the bed.



Cross-sections – Sheet 6

**Site Number, Tributary Name, Date, Recorder

**Do at least 2 cross-sections where possible – preferably 2 different habitat types.

1. **Type** – mark **1** box to indicate which habitat type you are doing the cross-section on.

2. **Dimensions –** insert the length, average width and average depth for just the habitat you are doing the cross-section in.

3. **Bed Dry/Watermark –** If the bed is dry you need to take your measurements from the watermark. If this is the case, mark the 'Bed Dry' box. If the water level covers the water mark there is no lower bank. If this is the case, mark the 'Water Mark covered' box. If the water level is below watermark leave these boxes blank and take measurements from the actual water level.

4. **The Cross-section –** Starting from Left Bank, at each reading record the distance from bank, depth and sediment and organic matter proportions. The Sediment proportions must **add up to 100%** (not including the organic matter). The Organic Matter proportion is also **out of 100%.**

   To do this you take a hand full of surface sediment. Out of that handful, what percentage is made up of Organic Matter (out of 100%)? Now remove/ignore that portion of organic matter and you are now starting with a full 100% again to do the sediment. Work out how much of that handful is made up of fines, sands, cobbles, etc., to add up to 100%. If a sediment size is present but not enough to provide 5% cover, simply mark it as present by placing 'X' in the 'Presence' box. TIP: Use Sediment Classification guide on the top right hand corner of the data sheet to help determine sediment sizes!

5. **Total Width –** record Total Width of cross-section in metres.

6. & 7. **Bank Dimensions –** take the width, height and slope of both the upper and lower banks on the Left Bank. Slope is determined by using a Clinometer. The overall dominant slope of the bank is what is required here. There may be many steps/slopes in a bank and this is why the dominant slope is what is recorded. TIP: if you have marked either the 'Bed Dry' or the 'Water Mark covered' boxes at **3.** then there is no lower bank!

8. **Bank Sediments –** Determine the proportion of Organic Matter and Sediments in the lower and upper banks on the Left Bank using the same method for bed sediments in the cross-section **4.** TIP: if you have marked either the 'Bed Dry' or the 'Water Mark covered' boxes at **3.** then there is no lower bank!

9. & 10. **Bank Dimensions** – same as **6.** & **7**. but for the Right Bank.

11. **Bank Sediments** – same as **8.** but for the Right Bank.

12. **Rock Outcrops** – mark as many boxes according to where rock outcrop is present in the bed and banks. If there is no rock outcrop present mark the 'None' box. TIP: submerged boulders are not classed as rock outcrop.

STATE OF THE RIVERS --- SHEET 6 Cross- Sections

Page __ of __ Date (dd/mm/yy) __/__/__ Recorder _____

Basin | Sub-section | Site | Section Number for This reach

SITE CODE

One or more cross-sections (separate sheets) are required for each channel habitat type within the reach. Begin at the water's margin on the left bank and take a series of distance and depth measurements. A minimum of 3 measurements is required for each cross-section including the width of stream. Also measure the width, height and slope for the left and right banks.

Lower bank = surface to water mark. If bed dry measure depth at water mark level.
Upper bank = water mark to inflexion point on the bank

1 TYPE

1 Pool
2 Riffle
3 Run
4 Glide
5 Cascade
6 Rapid
7 Backwater
8 Other _____

2 Length of Type (m)
Av. Width of Type (m)
Av. Depth of Type (m)

Sediment Classification

Sediment classes are those of the SAA which are easier to estimate visually - estimate % of total inorganic volume occupied by each catgeory. Estimate organics as % of total vol. Record presence of each type (esp. max. and min. sizes) and % vols for major fractions.

Fines	Sand		Gravel			Cobbles	Boulder+Rock
	fine	medium	fine	medium	course		

salt 0.1mm; sugar grain 0.5mm; raw sugar 2mm; pea 5mm; 10 cent coin 20mm; tennis ball 60 mm; Head 300 mm

P. Organics = particulate organics - estimate as % of the total volume. Inorganic components are estimated from the inorganic fraction only (i.e. omitting the organics)

Bank Sediments

8 Left

	mm	Lower pres. % by vol.	Upper pres. % by vol.
fines	< 0.06		
sand	.06 - 0.5		
	0.5 - 2		
gravel	2 - 5		
	5 -20		
	20 - 60		
cob	60 - 300		
	Bould > 300		
	P.Organics		

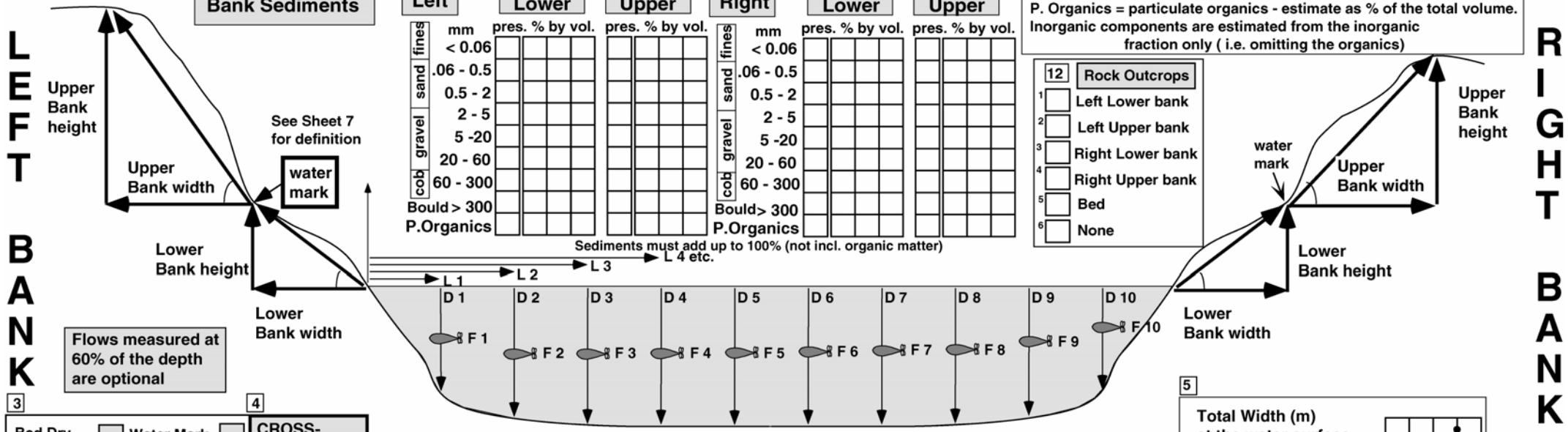
11 Right

	mm	Lower pres. % by vol.	Upper pres. % by vol.
fines	< 0.06		
sand	.06 - 0.5		
	0.5 - 2		
gravel	2 - 5		
	5 -20		
	20 - 60		
cob	60 - 300		
	Bould > 300		
	P.Organics		

Sediments must add up to 100% (not incl. organic matter)

12 Rock Outcrops

1 Left Lower bank
2 Left Upper bank
3 Right Lower bank
4 Right Upper bank
5 Bed
6 None



Flows measured at 60% of the depth are optional

3 Bed Dry - Depths @ water mark ☐ Water Mark covered -no lower bank

4 CROSS-SECTION AT SURFACE

Cross- section readings across the bed (minimum of 3, maximum 15)

5 Total Width (m) at the water surface or where transect taken

	Reading 1	Reading 2	Reading 3	Reading 4	Reading 5	Reading 6	Reading 7	Reading 8
Dist (m)								
Depth (m)								

☐☐ Page No. for Extra Readings

Sediments must add up to 100% (not incl. organic matter)

	mm	pres. % by vol.	pres. % by vol.	pres. % by vol.	pres. % by vol.	pres. % by vol.	pres. % by vol.	pres. % by vol.	pres. % by vol.
fines	< 0.06								
sand	.06 - 0.5								
	0.5 - 2								
gravel	2 - 5								
	5 -20								
	20 - 60								
cob	60 - 300								
	Bould > 300								
	P.Organics (out of 100%)								

6 LEFT LOWER BANK

Width (m)
Height (m)
Slope (deg.)

7 LEFT UPPER BANK

Width (m)
Height (m)
Slope (deg.)

9 RIGHT LOWER BANK

Width (m)
Height (m)
Slope (deg.)

10 RIGHT UPPER BANK

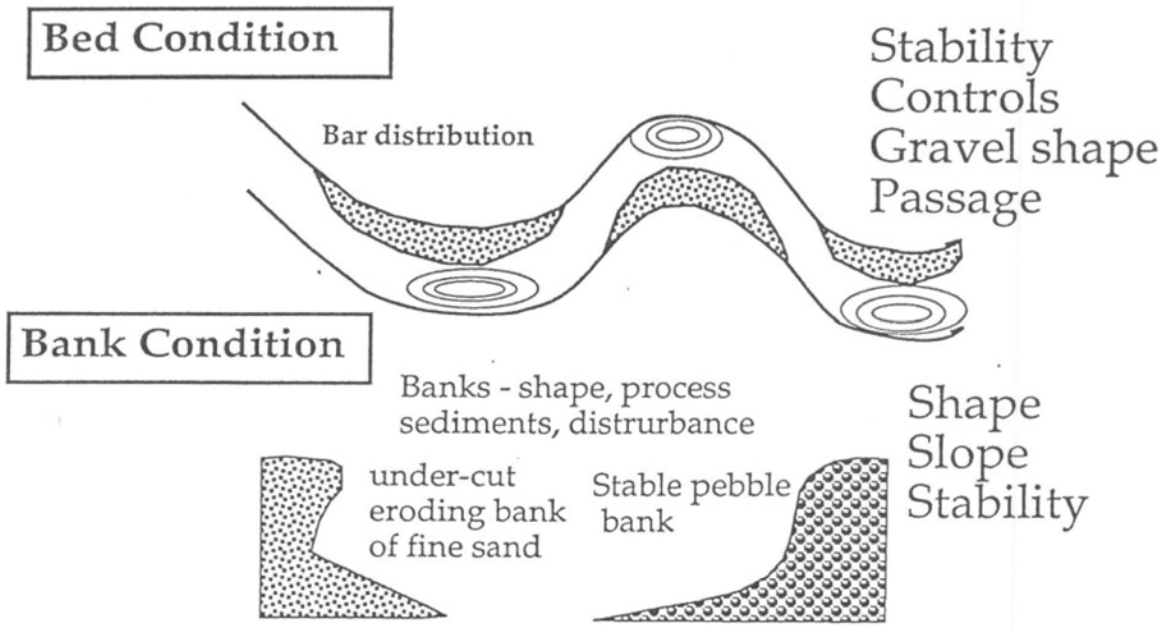
Width (m)
Height (m)
Slope (deg.)

Notes:

Bed, Bar and Bank Condition

Two data sheets are used to assess the condition of the bed bar and banks. The assessment is made in terms of the percentage of the bank length, and surface area of the bed, which is stable, eroding or aggrading. The location of the instability (bends, obstacles etc.) and the local factors affecting stability are also assessed to identify the processes involved. Overall ratings of the bed and bank stability are made.

The suitability of the site for general fish passage and for specific barriers at the site is also assessed in relation to the stage at the time the survey is made and of the stage required for the barrier to be effectively by-passed or over-topped.



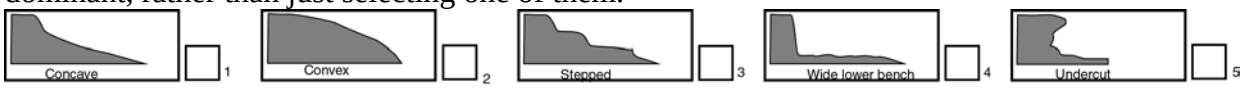
Bank Condition – Sheet 7

**Site Number, Tributary Name, Date, Recorder

1. & 2. Bank Stability – For the Lower Left Bank assess what proportion of the bank length is bare of vegetation, **out of 100%**. Assess what proportion of the Lower Bank length that is Stable, Eroding (loss of material), Aggrading (deposition of material), Slumping (material slip/slides down bank). These four figures must **add up to 100%**. Mark as many boxes to indicate the locations where Erosion, Aggradation and Slumping is occurring on Lower Bank, using the diagrams as a guide. **Repeat** for Upper Left Bank.

3. Bank Slope – For the Left Bank **RANK** the boxes according to what bank slope is present. There may be many steps/slopes in a bank this is why the bank slope types should be ranked from 1 being most dominant to 2, 3, or 4 being present /least dominant, rather than just selecting one of them.

4. Bank Shape – For the Left Bank **RANK** the boxes according to what bank shape is present. Bank shapes should be ranked from 1 being most dominant to 2, 3, or 4 being present /least dominant, rather than just selecting one of them.



5. Overall Condition of the Left Bank – Mark **1** box for 'Overall Instability' and **1** box for 'Susceptibility to erosion'.

6. & 7. Bank Stability – Same as **1.** & **2.** but for Right Bank.

8. Bank Slope – Same as **3.** but for Right Bank.

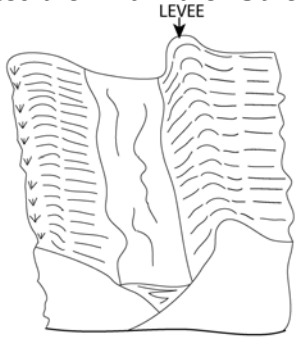
9. Bank Shape – Same as **4**. but for Right Bank.

10. Overall Condition of the Right Bank - Mark **1** box for 'Overall Instability' and **1** box for 'Susceptibility to erosion'.

11. Factors Affecting Stability – **RANK** as many boxes relevant as to what you consider to be affecting the stability of the banks. 1 being most dominant to 2, 3, or 4 being present /least dominant. If a Factor is not listed then mark the 'Other' box and indicate what it is.

12. Artificial Bank Protection Measures - **RANK** as many boxes relevant to indicate what Bank Protection Measures have been installed. 1 being most dominant to 2, 3, or 4 being present /least dominant. If a Bank Protection Measure is not listed then mark the 'Other' box and indicate what it is.

13. Levee Banks – Mark **1** of the boxes to indicate whether Levee Banks are present or 'Absent' and whether they are 'Natural' or 'Manmade'. If present, note the height and width of the levee bank for the appropriate Bank.



STATE OF THE RIVERS --- SHEET 7 BankCondition

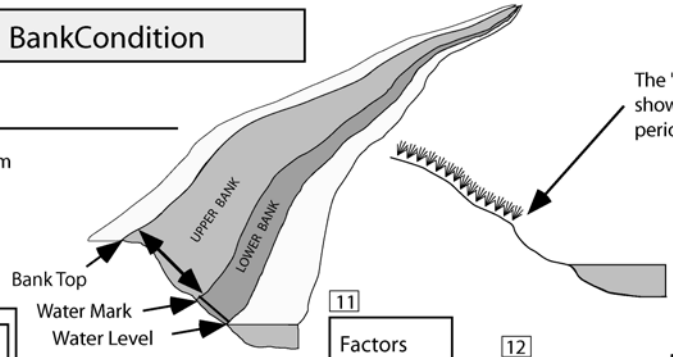
Basin | Sub-section | Site | Tributary Name

SITE CODE

Date (dd/mm/yy) / /

Recorder

Assess the condition of the banks on the left and right side of the stream (facing downstream). Identify the major types of instability (eroding, slumping & aggrading) and mark the location where they occur on the lower and upper banks. Also record and the slope and shape of the banks, and make nn overall assessment of instability.



The "Water Mark" is left at the normal inundation level in the stream. It's location is shown by the limit of the terrestial grasses etc. which can only withstand short periods of inundation, or by an eroded area or boundary in the bank sediment types.

13 Levee Banks

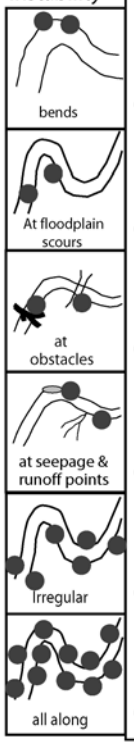
1 Natural
2 Man-made
3 Absent

LEFT		RIGHT	
Height	Width	Height	Width

LEFT BANK

Record % of bank length

LOCATION for Instability



1 LOWER BANK

Bare of Veg

NOTE: The 4 % figures below must = 100%

Stable

Eroding | Aggrading

Slumping

where | where

2 UPPER BANK

Bare of Veg

NOTE: The 4 % figures below must = 100%

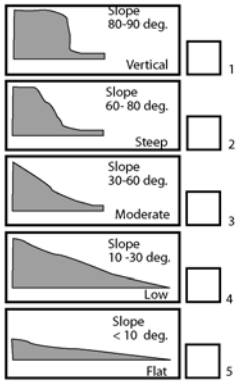
Stable

Eroding | Aggrading

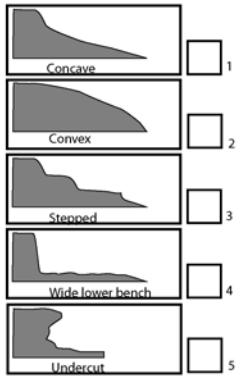
Slumping

where | where

3 LEFT BANK Slope (RANK types)



4 LEFT BANK Shape (RANK types)



11 Factors Affecting Stability

Flow & Waves 1
Seepage 2
Runoff 3
Floodplain Scours 4
Stock 5
People tracks 6
Vermin, Ferals 7
Ford, road culvert , bridge, Weir 8
Clearing of Vegetation 9
Gravel/sand extraction 10
Mining 11
Other

** RANKS **

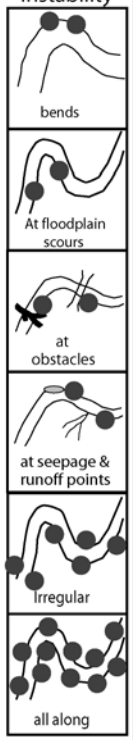
12 Artificial Bank Protection Measures

Trees & Other Plants 1
Rock wall or layer 2
Fence Structures 3
Fenced watering points 4
Fenced human access 5
Logs strapped to bank 6
Concrete Wall 7
Break - water 8
Other 9
Other 10
None 11

RIGHT BANK

Record % of bank length

LOCATION for Instability



6 LOWER BANK

Bare of Veg

NOTE: The 4 % figures below must = 100%

Stable

Eroding | Aggrading

Slumping

where | where

7 UPPER BANK

Bare of Veg

NOTE: The 4 % figures below must = 100%

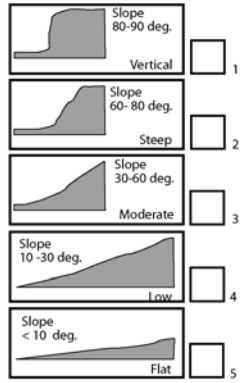
Stable

Eroding | Aggrading

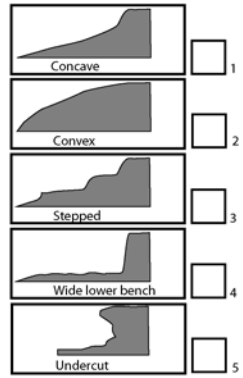
Slumping

where | where

8 RIGHT BANK Slope (RANK types)



9 RIGHT BANK Shape (RANK types)



5 Rate the Overall Condition of the Left Bank

	High	Mod	Low	Min
Overall Instability				
Susceptibility to erosion	1	2	3	4

10 Rate the Overall Condition of the Right Bank

	High	Mod	Low	Min
Overall Instability				
Susceptibility to erosion	1	2	3	4

Bed and Bar Condition – Sheet 8

**Site Number, Tributary Name, Date, Recorder

1. **Bar Type** – Identify the different types of bars present at the site and mark as many boxes as relevant. Use diagrams on the data sheet as a guide. If there are no bars present mark the 'Bars Absent' box. A Bar is formed when material is protruding out of the water at the watermark.

2. **Bar Size** – Estimate the proportion of the bed area that is bar (out of 100%).

3. **Bed Features** (NB: this refers to Bed & Bar sediment not just Bar sediment)

    - **Most Common Substrate** – list the most common bed substrate type, i.e. fines, fine sand, cobbles etc.
    - **Angularity** – mark **1** box that best describes bed sediment angularity.
    - **Shape** – mark **1** box that best describes bed sediment shape.

4. **Bed Surface** – mark **1** box to indicate whether the bed surface is clean or algae/silt covered.

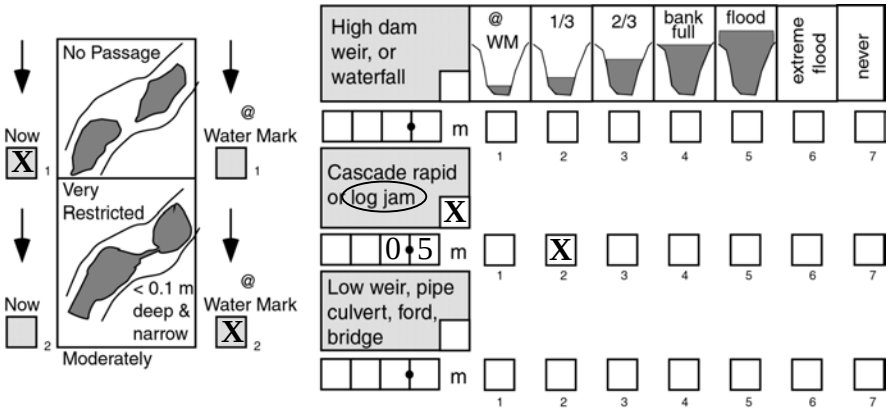
5. **Bed Compaction** – mark **1** box that best describes the bed compaction using the descriptions on the data sheet as a guide.

6. **Factors Affecting Stability** – If present, mark as many boxes relevant to what you think are affecting bed stability. If a Factor is not listed then mark the 'Other' box and indicate what it is. It is not necessary to rank these. TIP: If in doubt always rank! We can always change a rank to a 'X' but not a 'X' to a rank.

7. **Controls Stabilising the Bed** –If present, mark as many boxes relevant to indicate what controls are present that help stabilise the bed. If a Bed Control is not listed then mark the 'Other' box and indicate what it is. It is not necessary to rank these. TIP: If in doubt always rank! We can always change a rank to a 'X' but not a 'X' to a rank.

8. **Overall Bed Stability Rating** – mark **1** box the best describes the stability of the bed. Use the descriptions on the datasheet as a guide to choose the "Best Fit".

9. **Passage for Fish and Other Organisms** – First, on the left hand side mark **1** box to indicate the passage 'Now' at the time of the survey. Then mark **1** box to indicate the passage if the water level was at 'Water Mark'. If there is a barrier/s in the stream obstructing fish passage mark the box to indicate the type of barrier/s it is. Note the height of that barrier in metres and then mark **1** box to indicate what the water level needs to be so that fish and other organisms can pass the obstruction.



STATE OF THE RIVERS --- SHEET 8 Bed and Bar Condition

Basin | Sub-section | Site (SITE CODE) | Tributary Name _____

Date (dd/mm/yy) ☐☐/☐☐/☐☐ Recorder _____

Record the total % of bed surface along the reach protruding out of the water at the water mark and forming a bar. Identify its type, the features of the bed & gravel if present, the overall stability of the bed and the controls and factors affecting the stability of the bed.

1 BAR TYPE

- Bars Absent
- Point
- Alternate / side Irregular
- Mid-channel Island
- Encroaching Vegetation
- Around Obstructions
- Channel bar plain
- Low flow Meander infilled channel
- High Flow deposits

2 BAR SIZE

% of bed surface forming a bar ☐☐☐

3 Bed Features

(Only if dominant particle size > 2mm)

Most Common Substrate Type & Size: _____

(e.g fine sand,medium gravel,large boulders)

Angularity

- Very Angular 1
- Angular 2
- Sub Angular 3
- Rounded 4
- Well Rounded 5

Shape

- Sphere: short= interm interm = long 1
- Disc: short < interm interm = long 2
- Blade: short << interm interm < long 3
- Rod: short << interm interm = long 4

4 Bed Surface

- Gravel covered by algae / silt 1
- Gravel - 'clean' 2

5 Bed Compaction

- Tightly packed, armoured: array of sizes, tightly packed, overlapping, hard to dislodge 1
- Packed, but not armoured: array of sizes, tightly packed, overlapping, can be dislodged 2
- Moderate Compaction: array of sizes, some packing, little overlapping, can be dislodged 3
- Low Compaction: poor grading, some packing & structure, little overlap, can be dislodged easily 4
- Loose Compaction: loose array, no packing or structure, no overlap, easily moved 5

6 Factors Affecting Stability

- Sand & Gravel extraction
- Bed deepening
- Bank Erosion
- Channelisation
- Cut-off of supply of alluvial materials
- Mining
- Grazing
- Other _____

7 Controls Stabilising the Bed

- Bridge Ford or Culvert
- Rock Outcrops
- Fallen Trees
- Vegetation
- Bed stabilising structures
- Laid Stone
- Concrete Lining
- Other _____
- None

9 PASSAGE FOR FISH AND OTHER ORGANISMS

1. Score the general passage for the prevailing conditions (now) and for the stage equivalent to the water mark.
2. For Obstructions give type, height from bed level and stage when by-passed or over-topped.

	Now	@ Water Mark
No Passage	1	1
Very Restricted < 0.1 m deep & narrow	2	2
Moderately Restricted < 0.3 m deep & narrow	3	3
Partly Restricted < 0.5 m deep & narrow	4	4
Good Passage 0.5 -1 m deep wide no torrent	5	5
Unrestricted > 1 m deep & almost channel wide	6	6

	@ WM	1/3	2/3	bank full	flood	extreme flood	never
High dam weir, or waterfall ☐	☐	☐	☐	☐	☐	☐	☐
☐☐☐ m	1	2	3	4	5	6	7
Cascade rapid or log jam ☐	☐	☐	☐	☐	☐	☐	☐
☐☐☐ m	1	2	3	4	5	6	7
Low weir, pipe culvert, ford, bridge ☐	☐	☐	☐	☐	☐	☐	☐
☐☐☐ m	1	2	3	4	5	6	7
Single log branch pile, rock ☐	☐	☐	☐	☐	☐	☐	☐
☐☐☐ m	1	2	3	4	5	6	7
Low feature easily by-passed ☐	☐	☐	☐	☐	☐	☐	☐
☐☐☐ m	1	2	3	4	5	6	7
None ☐ Other ☐	☐	☐	☐	☐	☐	☐	☐
☐☐☐ m	1	2	3	4	5	6	7

8 Overall Bed Stability Rating

Unstable / Eroding ← Stable → Unstable / Aggrading

Severe Erosion	Moderate Erosion	Bed Stable	Mod. Aggradation	Severe Aggrad.
Bed scoured of sand Signs of deepening Bare eroded banks Erosion heads Erosion causes Steep bed 1	Little alluvium Signs of deepening Eroded banks Bed deep & narrow Steep bed Unconsoildated 2	Bed consolidated algae covered Bed & bar material the same size Alluvium balanced Banks stable 3	Mod. build-up at obstructions & bars Bed flat and uniform Bed wide & shallow Some minor over-bank siltation 4	Flat bed, channel blocked & wide but shallow. Bars large, covering most of bed / bank bed loose, unconsolidated 5

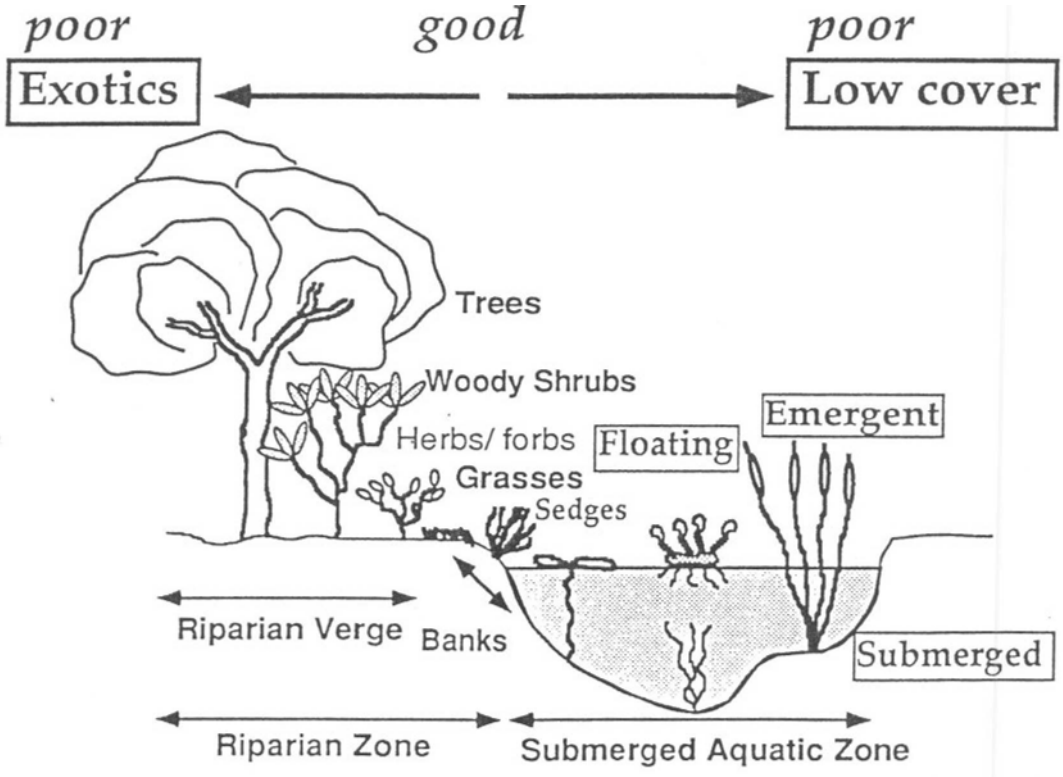
Notes:

Vegetation

Riparian and aquatic vegetation is becoming recognised as one of the most important features for assessing the condition of streams. Riparian Vegetation acts to:

Stabilise the banks
Provide shade and shelter
Provide leaf litter and other organic debris to the stream
Provide a remnant wildlife corridor
Provide for enhanced fish habitat
Provide a buffer zone for intercepting sediments and nutrients.

Riparian and aquatic vegetation is assessed in terms of percentage cover for various growth forms and key local native & weed species. The percentage of each group, which has been replaced by exotic species, is also assessed.



Notes:

Vegetation – Sheet 9

**Site Number, Tributary Name, Date, Recorder

RIPARIAN VEGETATION

1. **Left Bank Vegetation**

   - **Width of Existing Vegetation –** this includes the width of the remnant riparian vegetation and the width of the vegetation extending out onto the floodplain in metres.
   - **Width of Riparian Vegetation** - this is just the width of the remnant riparian vegetation in metres.
   - **% Bare of Vegetation** – assess what proportion of the riparian zone is bare of vegetation (**out of 100%**). TIP: Vegetation includes leaf litter.

2. **Scaling Factor** – Mark **1** box that best describes the condition/density of the riparian and existing vegetation. See explanatory notes for scaling factor descriptions.

3. **Vegetation Cover** – <u>% cover</u> - for each structural type, assess the cover it provides to the riparian area. Each structural type is assessed independently of the others and is **out of 100%**. If a structural type is present but not enough to provide 5% cover, simply mark it as present by placing a '1' in the box. TIP: Sheet 10 has some % cover examples.
   <u>% exotic</u> – now assess what proportion of the cover provided by the structural type is actually provided by exotic species.

Type	% Cover	% Exotic spp.
Trees > 30 m	1	
Trees 10 - 30 m	70	20
Trees < 10 m	60	15

   EXAMPLE: Trees 10-30m tall provide cover over 70% of the riparian area and of that 70% cover, 20% is provided by exotic species. Trees <10m tall provide cover over 60% and of that 60% cover, 15% is provided by exotic species. Trees >10m are present.

4. **Total % Exotics** – what percentage of the total cover provided by the riparian vegetation is actually provided by exotic species.

5. **Local Species Checklist** – Mark the 'Yes' or 'No' box to indicate whether or not you did the Local Species Checklist. Then below, if a listed species is present in the riparian zone mark the relevant box whether it is 'Rare' or 'Common'. If a species is not listed but is dominant or important for the site list it in the blank spaces provided next to the Aquatic Vegetation boxes.

6. to 10. – same as 1. to 5. but for Right Bank.

11. **Signs of Regeneration** – mark **1** box for the Left Bank and **1** box for the Right Bank to indicate whether native regeneration is occurring and to what extent.

Vegetation – Sheet 9 con't

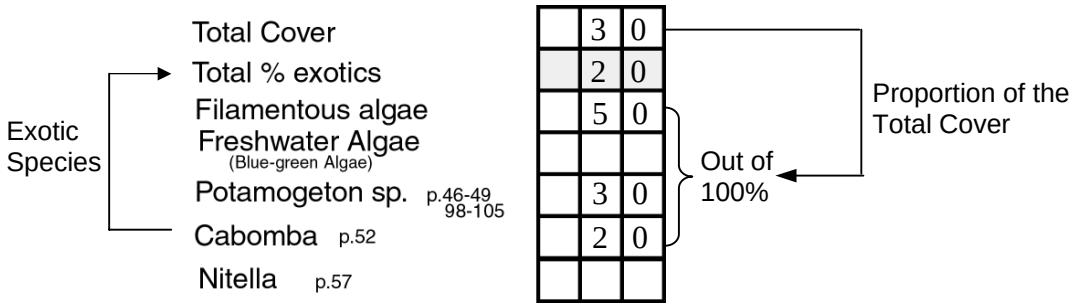
AQUATIC VEGETATION

12. All Aquatic Vegetation

- **Visible Depth** – record to what depth can you see into the water
- **Too turbid – pres only** – mark this box if you cannot see into the water at all. This means you will only be recording the presence of aquatic vegetation by placing a '**1**' in the box and do not need to record the % cover for each type.
- **% Bare – no vegetation** – what percentage of the bed area is not covered by aquatic vegetation (i.e. bare of vegetation).
- **Tot. % Exotic sp**. – what proportion of the total cover provided by the aquatic vegetation is actually provided by exotic species.

13. Submerged/Floating leaf

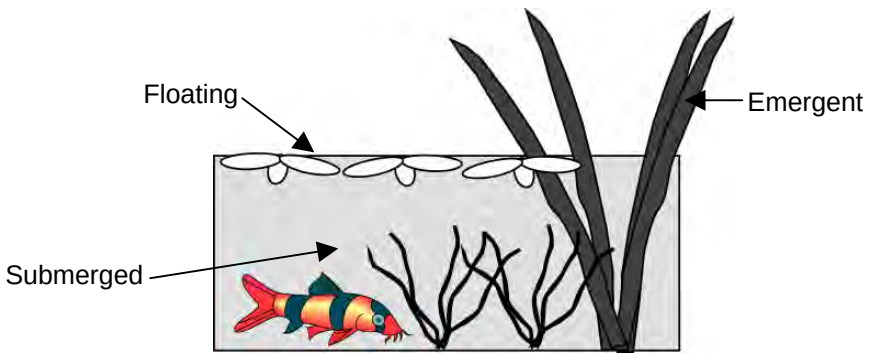
- **Total Cover** – what percentage of the bed area is covered by Submerged aquatic vegetation (**out of 100%**).
- **Total % exotics** – what proportion of the cover provided by Submerged vegetation is actually provided by exotic species.
- **Species Composition** – for each Submerged vegetation species present assess the <u>proportion of the Total Cover</u> that is provided by that species. These values must add up to 100%.



EXAMPLE: Submerged vegetation provides cover over 30% of the bed surface. Of that 30%, 50% is Filamentous Algae, 30% is Potamogeton sp. And the remaining 20% is Cabomba. This also means that the cover is made up of 20% exotic species because Cabomba is an introduced species.

14. & 15. – same as **13**. but for Floating and Emergent aquatic vegetation.

NB: The Total Covers for Submerged, Floating and Emergent Aquatic Vegetation can add up to more than 100% as the zone of habitation for each type may overlap. See diagram below.



STATE OF THE RIVERS --- SHEET 9 *Vegetation*

Date (dd/mm/yy) ☐☐/☐☐/☐☐ Recorder _____

Basin ☐☐☐ Sub-section ☐☐☐☐ Site ☐☐☐☐ Tributary Name _____

The Riparian Zone The Riparian Zone is the corridor of vegetation along the edge of a stream or river which is immediately linked with the stream both in providing leaf and branch litter to the stream and being affected by the extra moisture available. It is the distinct vegetation zone along the stream. The strip chosen should be relatively homogeneous. Disturbed zones may be very thin.

1 LEFT BANK VEGETATION
Refer definition of the Riparian Zone

☐☐☐.☐ Width of Existing Vegetation (m) (riparian & non riparian vegetation)
☐☐☐.☐ Width of Riparian Vegetation (m)
☐☐☐ % Bare - no vegetation

Vegetation Cover of the Riparian Zone - *overlaps allowed*
record presence for rare types % cover for abundant sp.

3

Type	% Cover	% Exotic spp.
Trees > 30 m	☐☐☐	☐☐☐
Trees 10 - 30 m	☐☐☐	☐☐☐
Trees < 10 m	☐☐☐	☐☐☐
Woody Shrubs (> 2m)	☐☐☐	☐☐☐
Woody Shrubs (< 2m)	☐☐☐	☐☐☐
Vines	☐☐☐	☐☐☐
Rushes & Sedges	☐☐☐	☐☐☐
Herbs/Forbs (NOT WOODY)	☐☐☐	☐☐☐
Grasses	☐☐☐	☐☐☐
Tree Ferns	☐☐☐	☐☐☐
Ferns / Bracken	☐☐☐	☐☐☐
Mosses	☐☐☐	☐☐☐
Palms	☐☐☐	☐☐☐
Freshwater Wetland	☐☐☐	☐☐☐

4 ☐☐☐ Total % Exotic spp. in zone

Local Species Checklist - *Recorded* - *Yes* ☐1 *No* ☐2

5

	rare	common		rare	common
Rainforest	☐1	☐2	Parthenium*	☐1	☐2
Eucalyptus/ Corymbia	☐	☐	Parkinsonia*	☐	☐
Angophora spp.	☐	☐	Tridax daisy*	☐	☐
Casuarina spp.	☐	☐	Sida spp.*	☐	☐
Melaleuca spp. (paperbark)	☐	☐	Wild Tobacco*	☐	☐
Callistemon spp. (bottlebrush)	☐	☐	Castor Oil*	☐	☐
Callitris spp. (Native Pine)	☐	☐	Lantana*	☐	☐
Acacia spp. (native)	☐	☐	Mayne's Pest*	☐	☐
Grevillia spp.	☐	☐	Noogoora burr*	☐	☐
Ficus spp. (figs)	☐	☐	Thistles*	☐	☐
Waterhousia sp. (weeping lilly pilly)	☐	☐	Milky weed spp.	☐	☐
Bauhinia spp.	☐	☐	Rubbervine*	☐	☐
Brachychiton spp.	☐	☐	Passion Vine*	☐	☐
Lignum	☐	☐	Cats Claw Creeper*	☐	☐
Lomandra	☐	☐	Balloon Vine*	☐	☐

* Exotic Species

2 & 7 Vegetation Scaling Factor

	L	R
Highly disturbed, distinct boundary on vegetation. Width less than bank width. 1	☐	☐
Disturbed & non-grass species extend only to the bank top. 2	☐	☐
Disturbed & non-grass species extend partially into the floodplain. 3	☐	☐
Thinned, semi-natural in cover and width. 4	☐	☐
Virtually natural cover & width. 5	☐	☐

12 & 13 Canopy Health & Intactness

	L	R
Canopy appears intact; no/few standing dead spars. 1	☐	☐
Canopy slightly iregular &/or with some gaps; no/few dead spars. 2	☐	☐
Canopy +/- sparse or lacking vigour; dead spars maybe evident; minor crown dieback 3	☐	☐
Canopy sparse, individuals exhibit crown dieback; dead spars prevalent. 4	☐	☐
Canopy very sprase/non-existent; shrubs &/or grasses prevalent (spars may occur) 5	☐	☐

14 All Aquatic Vegetation
- submerged bed, within the wetted perimeter of the stream

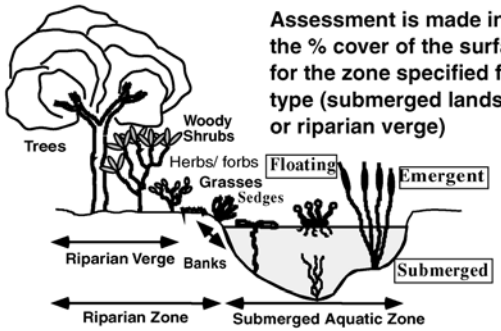
Visible depth (m) ☐☐.☐
Too turbid - pres only ☐
% Bare - no vegetation ☐☐☐
Tot.% Exotic spp. ☐☐☐

15 Submerged/Floating leaf % cover

Total Cover	☐☐☐
Total % exotics	☐☐☐
Filamentous algae	☐☐☐
Freshwater Algae (Blue-green Algae)	☐☐☐
Marine / estuarine algae	☐☐☐
Chara / Nitella p. 57	☐☐☐
Vallisneria/strap like forms p. 108-111	☐☐☐
Herb like forms	☐☐☐
Myriophyllumspp. p. 62-73	☐☐☐
Potamogeton spp. p. 46-49 96-105	☐☐☐
Triglochin spp. p. 178-181	☐☐☐
Water Primrose p. 27	☐☐☐
Other _____	☐☐☐

16 Floating Vegetation % cover

Total Floating	☐☐☐
Total % Exotic Floating	☐☐☐
Water Hyacinth* p. 57	☐☐☐
Azolla p. 3	☐☐☐
Cape Waterlily* p.33	☐☐☐
Duckweeds p. 7	☐☐☐
Salvinia* p. 13	☐☐☐
Water Snowflake p. 41	☐☐☐
Other _____	☐☐☐



Assessment is made in terms of the % cover of the surface area for the zone specified for each type (submerged lands, banks or riparian verge)

Other Species Identified

L = left R = right

	rare	common
Joyweed	☐1	☐2
Buffel Grass*	☐1	☐2
Saltbush	☐1	☐2
Red natal grass*	☐1	☐2
Eremophila spp.	☐1	☐2
Mexican Poppy*	☐1	☐2
_____	☐1	☐2
_____	☐1	☐2

11 Signs of Regeneration (natives)

	Left	Right
None	☐	☐
Major	☐	☐
Minor	☐	☐

17 Emergent Vegetation % cover

Total emergents	☐☐☐
Total % exotic emergents	☐☐☐
Phragmites p. 168	☐☐☐
Typha (bull rush) p. 182	☐☐☐
Para Grass* p. 125	☐☐☐
Other Rushes	☐☐☐
Other Sedges	☐☐☐
Persicaria sp. p. 210	☐☐☐
Melaleucas	☐☐☐
Encroaching willows*	☐☐☐
Other Shrubs & Trees	☐☐☐
Local Sp. 1_____	☐☐☐
Local Sp. 2_____	☐☐☐

6 RIGHT BANK VEGETATION
Refer definition of the Riparian Zone

☐☐☐.☐ Width of Existing Vegetation (m) (riparian & non riparian vegetation)
☐☐☐.☐ Width of Riparian Vegetation (m)
☐☐☐ % Bare - no vegetation

Vegetation Cover of the Riparian Zone -*overlaps allowed*
record presence for rare types % cover for abundant sp.

8

Type	% Cover	% Exotic spp.
Trees > 30 m	☐☐☐	☐☐☐
Trees 10 - 30 m	☐☐☐	☐☐☐
Trees < 10 m	☐☐☐	☐☐☐
Woody Shrubs (> 2m)	☐☐☐	☐☐☐
Woody Shrubs (< 2m)	☐☐☐	☐☐☐
Vines	☐☐☐	☐☐☐
Rushes & Sedges	☐☐☐	☐☐☐
Herbs/Forbs (NOT WOODY)	☐☐☐	☐☐☐
Grasses	☐☐☐	☐☐☐
Tree Ferns	☐☐☐	☐☐☐
Ferns / Bracken	☐☐☐	☐☐☐
Mosses	☐☐☐	☐☐☐
Palms	☐☐☐	☐☐☐
Freshwater Wetland	☐☐☐	☐☐☐

9 ☐☐☐ Total % Exotic spp. in zone

Local Species Checklist - *Recorded* - *Yes* ☐1 *No* ☐2

10

	rare	common		rare	common
Rainforest	☐1	☐2	Parthenium*	☐1	☐2
Eucalyptus/ Corymbia	☐	☐	Parkinsonia*	☐	☐
Angophora spp.	☐	☐	Tridax daisy*	☐	☐
Casuarina spp.	☐	☐	Sida spp.*	☐	☐
Melaleuca spp. (paperbark)	☐	☐	Wild Tobacco*	☐	☐
Callistemon spp. (bottlebrush)	☐	☐	Castor Oil*	☐	☐
Callitris spp. (Native Pine)	☐	☐	Lantana*	☐	☐
Acacia spp. (native)	☐	☐	Mayne's Pest*	☐	☐
Grevillia spp.	☐	☐	Noogoora burr*	☐	☐
Ficus spp. (figs)	☐	☐	Thistles*	☐	☐
Waterhousia sp. (weeping lilly pilly)	☐	☐	Milky weed spp.	☐	☐
Bauhinia spp.	☐	☐	Rubbervine*	☐	☐
Brachychiton spp.	☐	☐	Passion Vine*	☐	☐
Lignum	☐	☐	Cats Claw Creeper*	☐	☐
Lomandra	☐	☐	Balloon Vine*	☐	☐

* Exotic Species

SHEET 9 - *Vegetation*

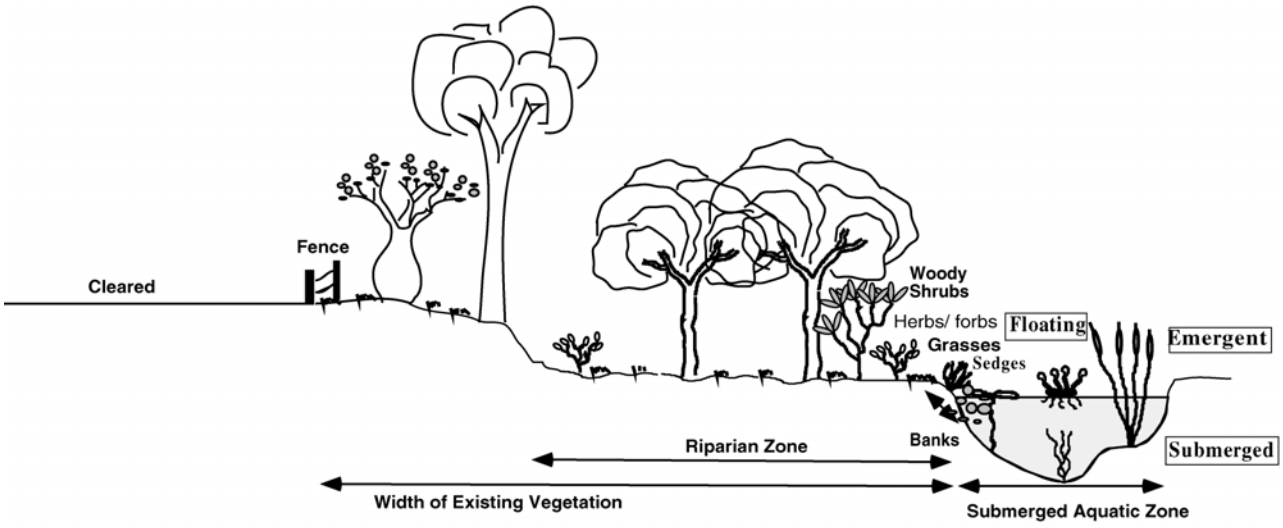
The Vegetation Rating used in the SOR methodology requires a calculation of both the 'quality' of the riparian flora (in terms of habitat structure) and the 'quantity' of riparian zone (in terms of width of the riparian zone). 'Quality' is estimated through the recording of % cover of both native and weed vegetation community types (i.e. large trees, shrubs, grasses, etc.). 'Quantity' is estimated through the recording of the **Riparian Zone Width**, **Width of Existing Vegetation** (max. 50 metres), and the **Vegetation Scaling Factor**,which are manipulated by a computer analysis program in order to rate the riparian zone's environmental value to that stream section.

The vegetation 'quantity' factors are recorded in ***Sheet Subsections 1 and 2*** for the left bank, and ***Subsections 6 and 7*** for the right bank. Some simple guidelines will ensure that this critical section of the Vegetation Datasheet will be correctly filled out.

1. Always enter a figure in ***all Boxes in Subsections 1 and 6***;
2. Only ***tick one Box in the Vegetation Scaling Factor Subsections 2 and 7***;
3. The width of the ***Existing Vegetation will always be greater than or equal to the Riparian Zone Width***;
4. 'Existing Vegetation' does not include agricultural or pasture crops; and,
5. You may record an Existing Vegetation Width of greater than 50 metres, but the analysis program will automatically reduce this to 50 metres maximum.

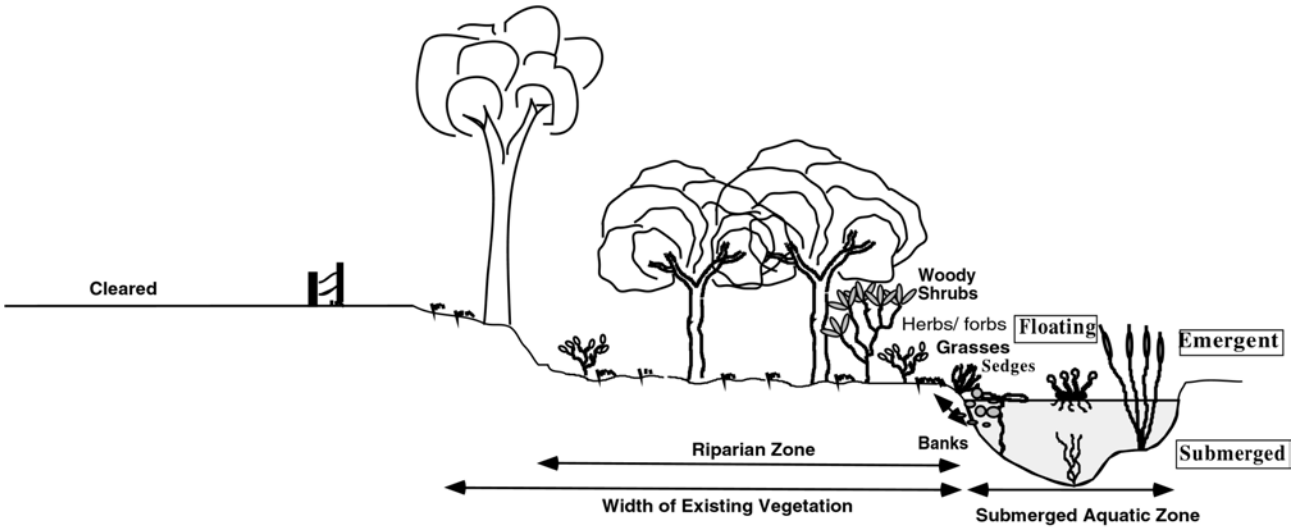
An explanation of the Vegetation Scaling Factors is provided below.

VEGETATION SCALING FACTOR #1



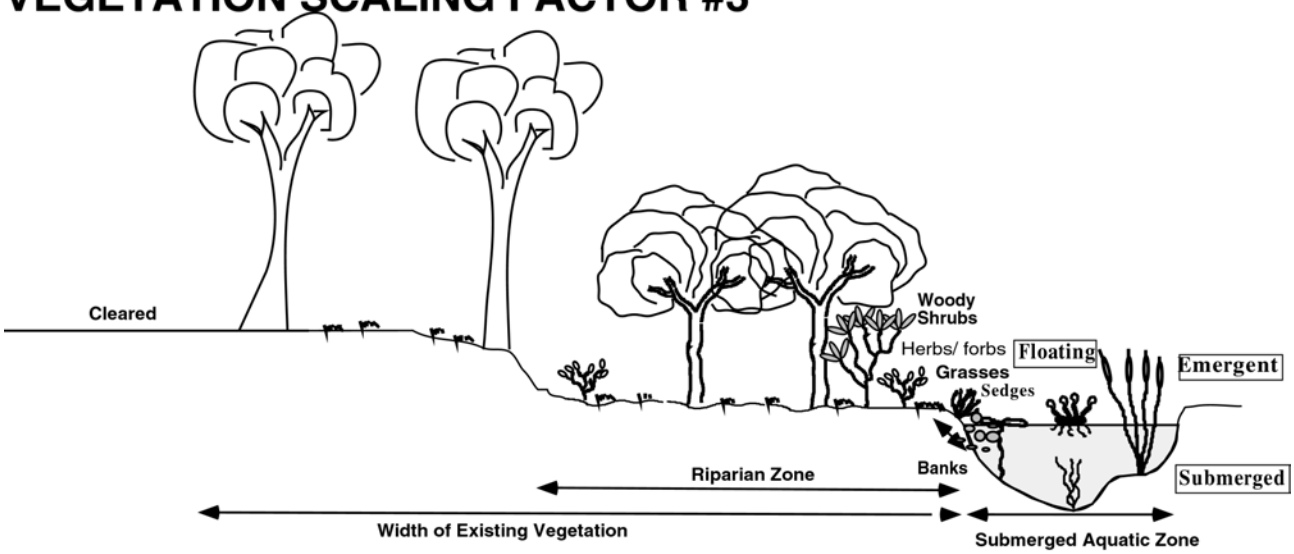
Tick BOX 1 in the SCALING FACTOR section of the Vegetation Datasheet when the vegetation within 50 metres of the stream bank is either highly disturbed or has a distinct boundary on the vegetation edge (as portrayed in the figure above). 1 ☑

VEGETATION SCALING FACTOR #2



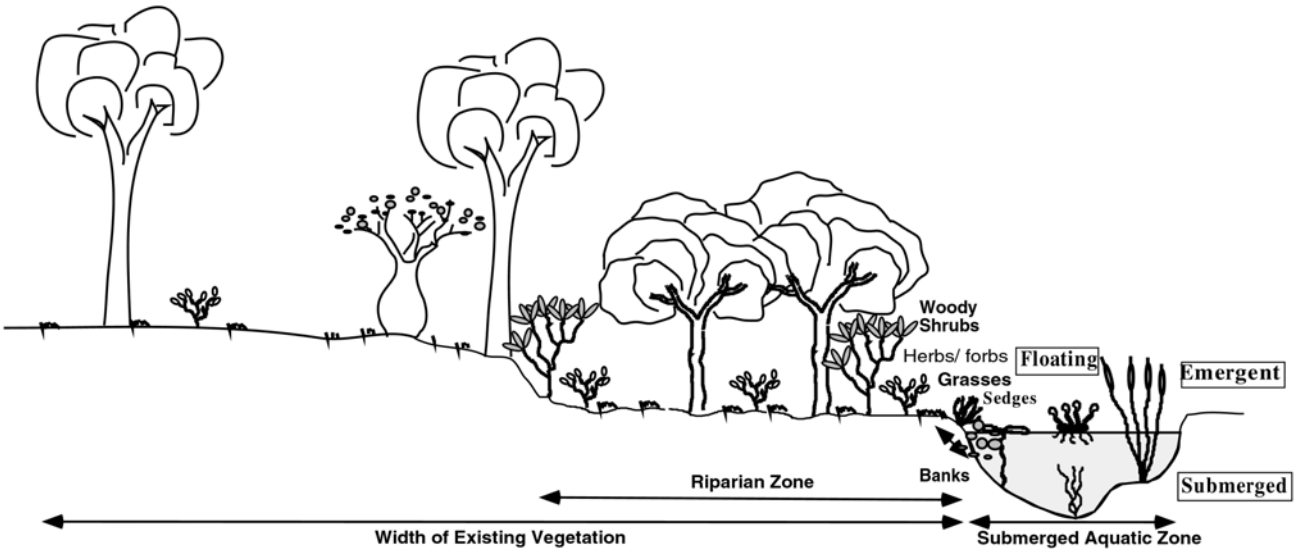
Tick BOX 2 in the SCALING FACTOR section of the Vegetation Datasheet when the vegetation within 50 metres of the stream bank is either disturbed and non-grass species extend only to the top of the bank (as portrayed in the figure above). 2 ☑

VEGETATION SCALING FACTOR #3



Tick BOX 3 in the SCALING FACTOR section of the Vegetation Datasheet when the vegetation within 50 metres of the stream bank is disturbed and non-grassed species extend partially into the origianl zone (floodplain) (as portrayed in the figure above). 3 ☑

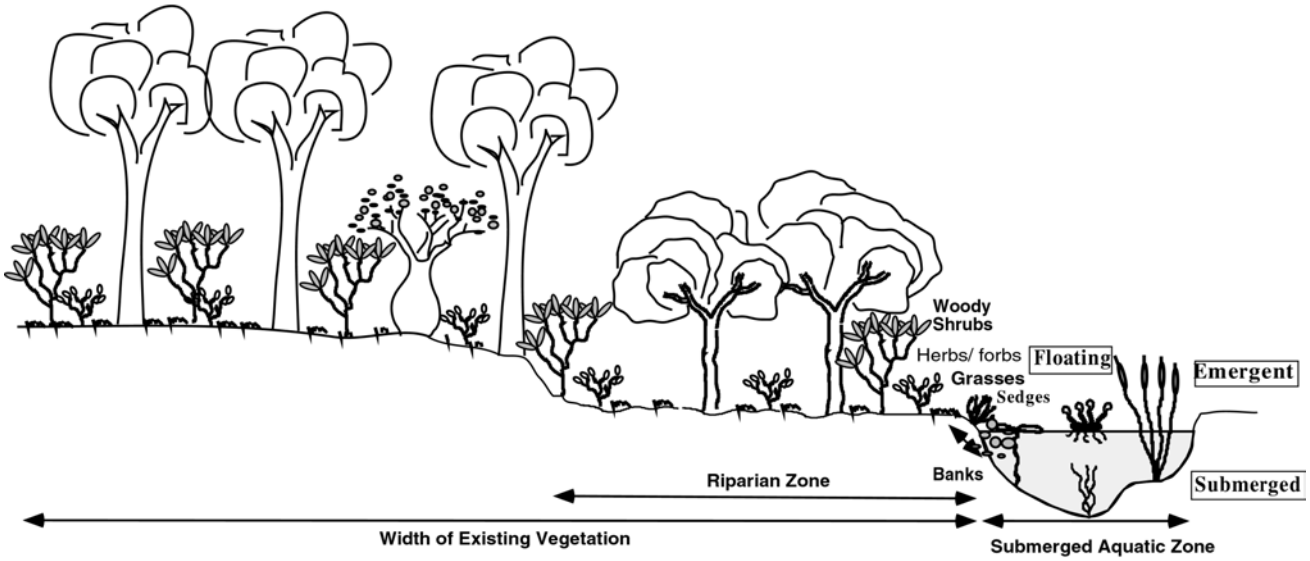
VEGETATION SCALING FACTOR #4



Tick **BOX 4** in the ***SCALING FACTOR*** section of the Vegetation Datasheet when the vegetation extends for greater than 50 metres from the stream bank but is either disturbed or thinly cleared (such as in the figure above).

4 ☑

VEGETATION SCALING FACTOR #5



Tick **BOX 5** in the ***SCALING FACTOR*** section of the Vegetation Datasheet when the vegetation exends greater than 50 metres from the stream bank and is in a natural and relatively undisturbed state (as portrayed in the figure above).

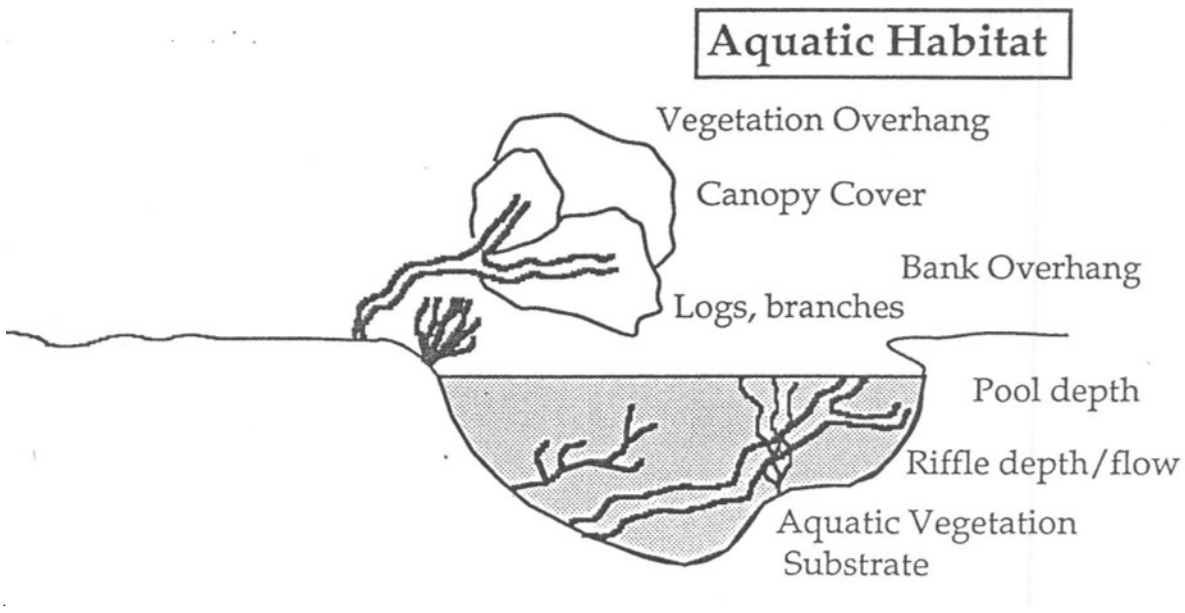
5 ☑

Aquatic Habitat

Some of the attributes collected on the other sheets are important for assessing aquatic habitat. These include:

Channel habitats (pool, riffles and runs)
Depth
Bed Substrates

Cover of various types is also important for fish and invertebrates. Instream cover in the form of logs and branches provide shelter and attachment points, and also increases the diversity of flow and depth in the channel. Bank and vegetation cover also provide shade and shelter for the stream.



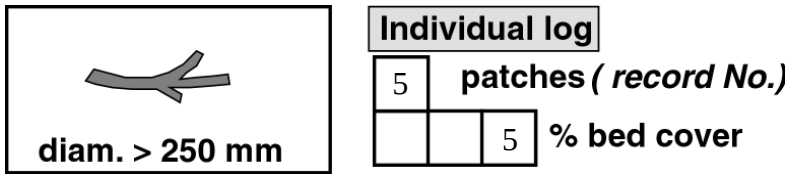
State of the Rivers

Aquatic Habitat – Sheet 10

**Site Number, Tributary Name, Date, Recorder

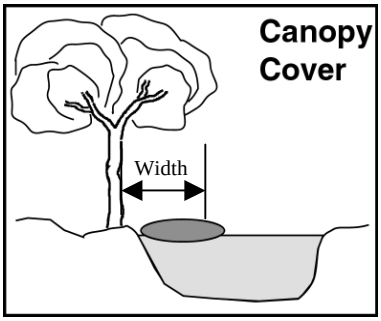
1. **Too Turbid** – if the water is too turbid then mark this box. Only record the 'Presence' of Instream Debris. TIP: This means you indicate presence by putting a '1' in the patches box and do not need to record % cover.

2. **Instream Debris Cover** – for each debris type record the number of patches and the percentage of the bed area covered by the debris. TIP: in the bottom left hand corner of the datasheet there are examples of what certain % cover may look like.



EXAMPLE: There are 5 individual logs that provide cover over 5% of the bed area.

3. **Stream Cover** – For the Left and Right Banks determine the percentage of the bank length that provides Canopy Cover, Vegetation Overhang, Root Overhang, Bank Overhang and Man-made Overhang over the stream. Record the average width of the stream bed that is covered by each of the cover types.



4. **Overall Aquatic Rating** – using all the information you just recorded mark **1** box to best describe the overall condition of the aquatic habitat of the site

STATE OF THE RIVERS --- SHEET 10 *Aquatic Habitat*

Basin | Sub-section | Site | Tributary Name

SITE CODE

Date (dd/mm/yy) / /

Recorder

1 Water too turbid to estimate pres. only recorded

2 INSTREAM DEBRIS COVER

Assessment is made in terms of the % cover of the surface area for the zone specified for each type.

diam. > 250 mm	Individual log	Large / deep submerged Veg. (Freshwater)
diam. > 300 mm	Log jam < 50% dense	Large / deep submerged Veg. (Marine - zostera etc)
diam. > 300 mm	Log jam > 50% dense	Mangroves. (Marine)
diam. < 300 mm	Individual Branch	Large patches of Floating Veg.
diam. < 300 mm	Branch pile < 50% dense	Emergents perm. water > 0.5 m deep
diam. < 300 mm	Branch pile > 50% dense	Tree Roots
	Terrestial leaves & twigs	Rock faces, boulders, cobbles
	Macrophyte Fragments	Perm. pool hab. deeper than 1 m
	Algal clumps and debris	Man-made structures and debris

For each: patches (*record No.*) / % bed cover

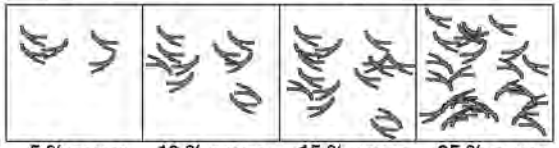
3 LEFT BANK

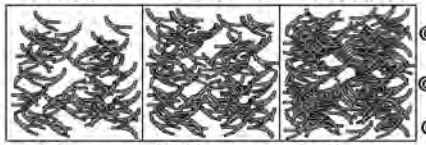
Canopy Cover	% bank length type present; Est. Av. width (m)
Vegetation Overhang	% bank length type present; Est. Av. width (m)
Root Overhang	% bank length type present; Est. Av. width (m)
Bank Overhang	% bank length type present; Est. Av. width (m)
Man-made Overhang	% bank length type present; Est. Av. width (m)

RIGHT BANK

Canopy Cover	% bank length type present; Est. Av. width (m)
Vegetation Overhang	% bank length type present; Est. Av. width (m)
Root Overhang	% bank length type present; Est. Av. width (m)
Bank Overhang	% bank length type present; Est. Av. width (m)
Man-made Overhang	% bank length type present; Est. Av. width (m)

Record the number of patches of each type present, and % cover or presence





©1© = presence only record
©-99© = not assessed
©0© = absent

4 OVERALL AQUATIC RATING FOR ALL AQUATIC LIFE

Combining all the assessment items and the general signs at the site, give it an overall rating for fish, invertebrates, birds & mammals

1 VERY HIGH / PRISTINE * high diversity of depths and substrates * little or no disturbance * abundant and diverse cover * excellent vegetation cover	2 HIGH * good diversity of depths and substrates * little disturbance * diverse cover * excellent canopy & other veg. cover	
3 GOOD * mod. diversity of depths and substrates * little disturbance * some diversity of cover * moderate canopy & other veg. cover	4 POOR * low diversity of depths and substrates * moderate disturbance * low diversity of cover * poor canopy & other veg. cover	5 VERY POOR * no diversity of depths and substrates * high disturbance * no cover or low diversity * no canopy cover, other cover poor

Notes:

Scenic, Recreational and Conservation Values

A preliminary assessment of these' values is made at each site. The sites are classified according to their recreational opportunity type, using remoteness, access, human contact and impact, and facilities available at the site.

The suitability of the site for various types of recreation, and their scenic values are also assessed.

A preliminary assessment of the conservation values of the sites is made in terms of ratings for the sites as remnant habitats for rare or endangered species of animals or plants, or as wildlife corridors.

State of the Rivers

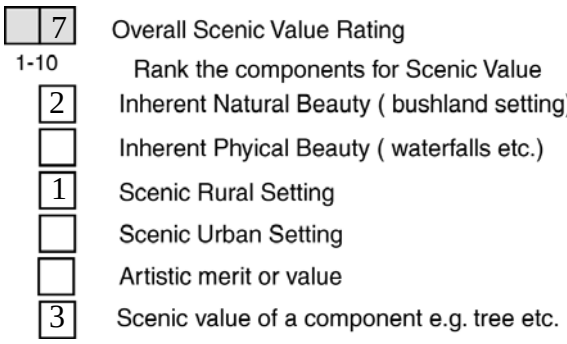
Scenic, Recreation & Conservation Values – Sheet 11

**Site Number, Tributary Name, Date, Recorder

1. **Recreational Opportunity –** working through the descriptions mark **1** box that best describes the Recreational Opportunity of the site.

2. **Recreation Types –** mark in boxes where relevant a '1' for a potential recreation type (something you think might be good to do at this site) or '2' for a recreation type that has/is actually occurring at the site. If a Recreation Type is not listed then mark the 'Other' box and indicate what it is. TIP: Be realistic! Would you travel to this site to do the activity?

3. **Scenic Value Assessment –** Rate the site 1- 10 for it's Overall Scenic Value. 10 being the best! Then RANK the components listed to indicate what makes up that Scenic Value. If a scenic Component is not listed then mark the 'Other' box and indicate what it is.



4. **Initial Conservation Value Assessment –** Rate the site 1-10 as a remnant habitat for AQUATIC plant and animal species. 10 being the best!
   Rate the site 1-10 as a remnant habitat for RIPARIAN plant and animal species. 10 being the best!
   Rate the site 1-10 for it's value as a Wildlife Corridor. 10 being the best!

5. **Representativeness** - Rate site 1-10 in terms of its quality as a representative AQUATIC Habitat for this type of site in the catchment.
   Rate site 1-10 in terms of its quality as a representative RIPARIAN Habitat for this type of site in the catchment.

STATE OF THE RIVERS --- SHEET 11 Scenic, Recr & Conserv. Values

Date (dd/mm/yy) ☐☐/☐☐/☐☐ Recorder _____

Basin ☐☐☐ Sub-section ☐☐☐☐ Site ☐☐☐☐ SITE CODE

Tributary Name _____

1 Recreational Opportunity Type

Allocate the site to ONE of the following types considering all aspects

	☐ Natural 1. [1] Near Pristine National Parks or, undeveloped, naturally vegetated areas	☐ Natural 2. [2] Semi - Natural Infrequent, low-level disturbances; Native Forestry; Remnant areas; Reserves.	☐ Natural 3. [3] Roaded- Natural Environmental Parks; Camping/Rest Areas with structured sites and facilities.	☐ Rural 1. [4] Undeveloped Rural Recreational settings in rural landscapes that are modified	☐ Rural 2. [5] Developed Rural Rural areas cleared for camping grounds, within rural towns	☐ Urban 1. [6] Undeveloped Urban Undeveloped urban parks and bushland kept semi-natural	☐ Urban 2. [7] Developed Urban Urban Parks and Sports grounds Walls along stream	☐ Urban 3. [8] Highly Developed Urban Towns; Suburbs; Resort developments
LANDUSE	National Park or Watercourse in a large stand of undisturbed, natural vegetation	Watercourse with relatively undisturbed vegetation extending on both banks	Watercourse with modification and some disturbed or cleared vegetation; vegetation extends on both banks	Agriculture; Grazing; etc,or large scale clearing of natural vegetation on one or both sides of banks	Watercourses running through Rural Towns or Rural Residential areas; cleared or modified vegetation	Watercources in natural parklands or through semi-natural vegetation less than 500m from urban areas	Watercourses running through built urban areas; modified surrounds with some natural vegetation	Watercourses running through highly developed Urban areas with highly modified surrounds
ACCESS	only by foot and 4 WD vehicle into the area tertiary roads only	only by foot and 4 WD vehicle into the area, tertiary roads only	Moderate road access primary & secondary roads	good road access primary & secondary roads	accessible to all vehicles	primary road access	no limit to access	no limit to access
HUMAN IMPACT & DEVELOPMENT	no structures or exotic plants, pristine condition	only minor human influence, but small clearings O.K.	Moderate disturbance and development of facilities	natural setting but greatly modified	substantial modifications, rural residential	remnant bushland urban parkland with near natural veg.	modified open space	dominated by buildings etc.
EXPECTED HUMAN CONTACT & EVIDENCE OF VISITATION	few other visitors expected; very little evidence of human visitation	contact with people at site rare; some evidence of human visitation (litter,etc)	Moderate disturbance and some contact with groups; ample evidence of visitation	moderate contact on roads and trial sites	moderate to high interaction	Regular use by local residents	moderate to high density use	high density and frequent use
FACILITIES, REGULATIONS, & STRUCTURE	none	some but subtle as formed tracks and signs	Minimal facilities, no powered sites etc.	Controls obvious; facilities not necessarily present	barriers, signs & fences obvious; some facilities present (water, power)	minimal facilities, some tracks, toilets, signage, barriers, etc	well developed and extensive facilities	highly developed and extensive facilities

2 Recreation Types suitable for the area

Mark "1" for potential and "2" for actual use

- ☐ Barbeque and picnic
- ☐ Bushwalking - camping
- ☐ Bushwalking - day trips
- ☐ Camping - car access
- ☐ Canoeing / kyaking / rafting
- ☐ Dogs
- ☐ Shore Fishing
- ☐ Boat fishing - small boats
- ☐ Boat fishing - large boats
- ☐ Four Wheel driving
- ☐ Horse Riding
- ☐ Motor bikes
- ☐ Rowing
- ☐ Sailing
- ☐ Photography
- ☐ Nature appreciation
- ☐ Swimming
- ☐ Water Skiing
- ☐ Bird Watching
- ☐ Other _____
- ☐ Other _____
- ☐ Other _____
- ☐ Other _____

NOTE: BE REALISTIC.... Would you choose to travel to do these activities at this site

3 Scenic Value Assessment

Rate the site from 1 - 10 relative to other sites in the area

☐☐ Overall Scenic Value Rating (1-10)

RANK the components for Scenic Value

- ☐ Inherent Natural Beauty (bushland setting)
- ☐ Inherent Phyical Beauty (waterfalls etc.)
- ☐ Scenic Rural Setting
- ☐ Scenic Urban Setting
- ☐ Artistic merit or value
- ☐ Scenic value of a component e.g. tree etc.
- ☐ Other _____

Comments: _____

4 Initial Conservation Value Assessment

NOTE!! consider....

☐☐ Rate the site as remnant habitat for Aquatic Plant or Animal spp. (1-10)

_____

_____

_____

instream cover
instream debris
diversity of substrate
diversity of channel habitat
apparent water quality
evidence of fauna in dry beds

☐☐ Rate the site as remnant habitat for Riparian Plant or Animal spp. (1-10)

_____

_____

_____

vegetation structure
vegetation diversity
extent of disturbance
stability of banks
extent of weed invasion
width of riparian vegetation

☐☐ Rate the value of the site as a wiildlife corridor (1-10)

_____

_____

vegetation structure/diversity
width of vegetation
proximity to disturbances
continuity
linkages to other habitat areas

5

_____

☐☐ **Rank the Site (1-10) in terms of its quality as representative *Aquatic* Habitat for this type of site in this catchment.**

☐☐ **Rank the Site (1-10) in terms of its quality as representative *Riparian* Habitat for this type of site in this catchment.**

Notes:

STATE OF THE RIVERS --- SHEET 12 *Water Quality*

Date (dd/mm/yy) ☐☐/☐☐/☐☐ Recorder _____

Basin ☐☐☐ Sub-section ☐☐☐☐ Site ☐☐☐☐ *SITE CODE*

Tributary Name _____ Flows into _____ Flows into _____

1 Visual Water Quality Assessment

- ☐ Unusual Odour
- ☐ Unnatural Colour
- ☐ Foams
- ☐ Iron stains -orange bed
- ☐ Discharge pipes
- ☐ Aquatic plants dirty
- ☐ Organic slime on rocks
- ☐ Benthic algae - sparse
- ☐ Benthic algae - dense
- ☐ Organic debris
- ☐ Local pipe/ drain
- ☐ Other_____

Turbidity

- ☐ water very clear
- ☐ low - slightly cloudy
- ☐ mod - cloudy in deep water
- ☐ high - cloudy in shallows
- ☐ very high - very turbid

Water surface scum/ oils

- ☐ slick - thick oil/ grease
- ☐ sheen - thin "rainbow" coating
- ☐ flecks - thin oil areas in small flecks
- ☐ blue green algae/ other algal scum
- ☐ Other_____
- ☐ Other_____

2 Litter and Rubbish in bed and on banks

Few Items	Many Items	
☐	☐	organic material - eg. compost
☐	☐	paper / cardboard
☐	☐	wood - building materials, planks
☐	☐	wood - dumped branches, trees
☐	☐	household garbage, junk
☐	☐	building materials - bricks, concrete
☐	☐	plastics
☐	☐	glass, bottles
☐	☐	car/ truck/ bike tyres
☐	☐	small metal - corrigated iron, tins, cans
☐	☐	large metal - car bodies etc.
☐	☐	Other_____

3 Instream Water Quality Measurements

	1	2	3	4
Depth (m)	☐☐☐	☐☐☐	☐☐☐	☐☐☐
Water Temp. (deg. C)	☐☐☐	☐☐☐	☐☐☐	☐☐☐
pH	☐☐☐	☐☐☐	☐☐☐	☐☐☐
Conductivity (uS/cm)	☐☐☐☐☐	☐☐☐☐☐	☐☐☐☐☐	☐☐☐☐☐
Turbidity (NTU)	☐☐☐	☐☐☐	☐☐☐	☐☐☐
Flow (m/sec)	☐☐☐☐	☐☐☐☐	☐☐☐☐	☐☐☐☐