A CONSULTATIVE PROJECT TO SITUATE, CONTEXTUALISE AND PLAN FOR A WATER REHABILITATION PROGRAM IN SOUTH AFRICA, TO LINK THIS TO RELEVANT WATER-RELATED INITIATIVES; AND TO TRIAL THE AUSTRALIAN PROCEDURE FOR RIVER REHABILITATION ON A SMALL DEGRADED URBAN STREAM

AC Uys

WRC Report No. 1309/1/04

Water Research Commission

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RESEARCH, DEVELOPMENT AND APPLICATION NEEDS FOR THE FIELD OF RIVER REHABILITATION IN SOUTH AFRICA

BASED ON CONSULTATIVE PROCESS

VOLUME 1

by

AC Uys
Laughing Waters

Report to the Water Research Commission

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1.6 Definitions

The mixed use of the terms 'restoration' and 'rehabilitation', amidst a host of others, is confusing. For the purposes of this report, the following definitions apply: river 'rehabilitation' aims to return the structure and function of a degraded river ecosystem to the *closest achievable approximation* of its natural (pre-impact) state. The term 'restoration', while commonly used with the same meaning, is thought to imply to imply a return to natural pre-impact state, and thus to be largely unattainable. The term 'remediation' is appropriate in cases where it is not possible to rehabilitate due to a river system being irretrievably degraded, or where a system has been fundamentally altered in character but has, over time, adjusted and achieved a state of dynamic equilibrium.

2. RESEARCH, DEVELOPMENT AND APPLICATION (RD&A) IN THE FIELD OF RIVER REHABILITATION

2.1 An understanding of these terms

Research in a rehabilitation context is defined by Rutherfurd et al. (1998) as '*any activity that helps us to better understand how and why things are the way they are, how and why things happen, or how, whey and when to apply particular rehabilitation techniques*'. Research should consider the ecological or social system itself: the natural and non-natural influences on it, and the effects of these on form and function.

Development *enables and drives* the practice, from legal, institutional and methodological perspectives. The development process lies to some extent in the hands of controlling authorities and institutions tasked with the creation, implementation and management of enabling policies and regulations, and the monitoring of compliance with these.

Application is the practical implementation of rehabilitation: the ground-truthing, testing and refinement of the products of the R&D process. This process is real and can be grasped by the public and media as a sign that 'something is being done'.

A number of 'Key RD&A Areas' were identified: Agriculture, Economics, Ecosystems (general), Ecosystems (classification), Ecosystems (monitoring and evaluation), Ecosystems (prioritisation); Information transfer, Information storage, Integration, Policy, Political, Institutional, Social, Strategic, and Structural. These form the broad categories under which 'Focus areas' (information needs) were determined, and RD&A 'Tasks' to address these were considered.

3. THE PROJECT PROCESS

3.1 The development of a preliminary Register of Expertise

The aims in compiling a preliminary Register of Expertise were to address the apparent lack of synergy and information-sharing in the field, and to provide relevant contact information to groups requiring assistance in rehabilitation projects. During 2002 and 2003, a request for relevant information was sent out by email to individuals in a range of fields, including government; parastatal; non-government organisations; water resource management; academic and specialist; engineering and bio-engineering; landscape architecture; planning; policy; funding; and materials supply. All respondents were later given the opportunity to contribute to the regional workshop process.

3.2 The consultative process to identify R,D&A needs

The Water Research Commission and the Project Leader organised six workshops in different regions during March and April 2003, with the aim of consultatively identifying R, D& A needs in the field. Workshop participants numbered over a hundred in total (Appendix A). At each workshop, an introductory talk was given on the subject of river rehabilitation, and a background provided to the forthcoming WRC Research Programme. Invited speakers then made presentations (Appendix B). The interactive sessions were tailored differently per workshop, but with the same aim of listing needs under the agreed 'Key RDA Areas' and 'Focus Areas'. The outputs of the individual workshops were first listed individually, and then integrated into a single list. From this, a subset of research priorities was selected in consultation with WRC. Finally, those research needs considered by WRC to have the highest priority were drafted into a Terms of Reference for the Programme. This was reviewed by key individuals, and finally advertised as WRC Solicited Research (request for proposals) in June 2003.

4. PROJECT RESULTS AND DISCUSSION

4.1 Preliminary Register of Expertise

The responses received to the request for directory-type information were compiled into a preliminary Register of Expertise for Aquatic Ecosystem Rehabilitation (Appendix C). This is by no means a comprehensive register, but serves as a starting point.

4.2 Results of the consultative process

The final outputs of the workshop process were each listed under the relevant 'Key RDA Area', 'Focus Area' and 'Task' categories already described. These are presented in tabular form in the report. Each item under these categories was assigned a ranking of 1-6, the lower numbers representing those needs considered to be most important to address initially in development of the field. A possible research team or student appropriate for each study is listed alongside each need.

The listed requirements reflect the disposition of the participants of the workshop, and are necessarily not the opinion of WRC or the Project Leader.

As WRC is not in a position to address the full range of priority R&D needs that arose, many of these remain as areas requiring attention. Ideally these will be addressed (in cooperation with the WRC Programme), by other appropriate institutions or organisations.

4.3 Principal outputs

The workshop process highlighted three major areas of concern:

- Rehabilitation has not yet been accorded its 'place' as a recognisable field of expertise in water resource management or water law in South Africa. Ideally, as in other countries, the field should be centrally organised and managed, ideally alongside wetland and estuarine rehabilitation. The initiation of a dedicated WRC research programme represents significant progress, but development and application needs must also be met. There is a need for a centralised programme.
- There was a general caution regarding 'where to start' in a rehabilitation project and how to address the many facets of the work. Much of this information can be borrowed from international guidelines, however, information on the river system itself naturally pertains to rivers in the country of origin, and would need to be replaced with appropriate local information.
- The lack of an institutional framework within which resource protection and rehabilitation isorganised and controlled is a source of concern. , particularly for those in local and provincial government.

4.4 Priority R&D areas

WRC developed a Terms of Reference for the upcoming Programme on the basis of perceived fundamental needs without which this field cannot develop on a sound basis. This was approached as objectively as possible, with the intention that the workshop participants' views should be reflected in the outcomes. The prioritised areas are:

- Development of a comprehensive Programme for Aquatic Ecosystem Rehabilitation
- Development of a legal framework for rehabilitation
- Production of comprehensive rehabilitation guidelines
- Determination and generation of public awareness of the value of rivers and of rehabilitation.
- Analysis of the costs and cost-benefits associated with river rehabilitation
- Development of a national-level protocol for the prioritisation of rivers for protection and rehabilitation
- Evaluation of river management or rehabilitation projects already completed or underway in SA
- Research into various terrestrial and riparian zone issues
- Development of a DSS for urban stream rehabilitation
- Development of an index of rehabilitation potential.

Report on a working meeting regarding a Programme for Rehabilitation

Linked to the first of these priorities, during May 2004, a tele-conference was organised between a number of key individuals representing relevant departments or programmes: WRC, Department of Water Affairs and Forestry (DWAF), Department of Environmental Affairs and Tourism (DEAT), Working for Water (WfW), Working for Wetlands (WfWet), National Department of Agriculture (NDA) and their LandCare initiative, Cooperative Research Centre for Catchment Hydrology, Melbourne University (development of Australian rehabilitation guidelines), and Laughing Waters. The aim was to hold a first discussion regarding the range of options for a coordinated Programme for river rehabilitation in South Africa (possibly incorporating the WRC Research Programme).

All participants of the meeting agreed that the WRC, DEAT, DWAF, and NDA should be involved in the development of this field. Delegates agreed that the programmes already contributing to aquatic and terrestrial ecosystem rehabilitation should be coordinating via a formal structure of sorts. The roles and responsibilities of different departments and organisations required further thought and discussion. In concluding, most participants agreed that the WRC should be the lead agent in Research and Development, and that Working for Wetlands could be an appropriate agency for the coordination of Application (trials), with the provision that a strong planning process be incorporated in all projects. It was agreed that there should be further discussions to develop an action plan for the way forward for river rehabilitation in South Africa.

4.5 Concluding remarks

The extensive list of research needs and priorities has highlighted a number of areas requiring research, development or application in the field of river rehabilitation. The activities that support the early development of the field from a legal, scientific and management perspective been given priority. The outcomes of the workshops indicate that across many sectors, there is a growing awareness of the rationale for river rehabilitation, and a recognition of some of the core requirements of this field in South Africa. It is also clear that the need for integration and information sharing, both within and between institutions and organisations. There is a call for this need to be addressed through institutional means, including the establishment of interdepartmental working groups and formal communication structures, and the development of an overall communication strategy. There is also a need for increased integration of management, conservation and rehabilitation efforts across different ecosystems within a catchment.

The outcomes of this project were used in defining research needs for the first funding phase of the Water Research Commission Programme for River Rehabilitation. To some extent, a small network of rehabilitation practitioners has been informally established through the consultative processes followed in this Project, and it is hoped that the 'Preliminary Register of Rehabilitation Expertise' will evolve into a useful and formal resource in the future. The critical importance of integrating approaches to terrestrial, wetland, river and estuarine rehabilitation has been acknowledged and acted upon both by WRC and numerous other parties. The concluding message is that there is clearly a need for, and enormous value in, investing energy and resources in: the development of a central programme or hub for river (or aquatic ecosystem) rehabilitation, focussed cooperative governance, the creation of structures to enable practical linkage of relevant programmes and processes, the sharing of information and expertise (both national and international), and the initiation of trial rehabilitation projects at a catchment or sub-catchment scale (addressing all ecosystems).

ACKNOWLEDGEMENTS

The Water Research Commission is gratefully acknowledged for their support, which went well beyond funding and logistical assistance. In particular, Dr Steve Mitchell is thanked for his ongoing enthusiasm and involvement in the project and workshop processes, and his uncanny ability to make time for discussions and practical progress. Mrs Una Wium of WRC is thanked for her competence and her cheery and efficient assistance in logistical support of the project, and in co-organising workshops. I am also grateful to Mrs Agnes Molubi for her assistance in co-organising workshops. The role of WRC in supporting the development of the field of river rehabilitation in South Africa is to be applauded.

Grateful thanks to Mr Dave Lindley of the Mondi Wetlands Project, who has walked a similar path as one of the initiators of formal wetland conservation and rehabilitation, and the development of a central coordinating organisation for this. Dave lent of his time and wisdom, and his comments and experiences were of great value and inspiration in tackling this project. His passion for protection of wetlands is contagious.

Dr Cornelius Ruiters (DWAF, then Scientific and Social Services) co-authored a paper on 'The emerging field of river rehabilitation in South Africa. He is gratefully acknowledged for his inputs to the text, his assistance with organising presentations at the 2002 Ecohydraulics Conference in Cape Town, and for his insights into the legal and institutional issues of concern.

Thanks also to the following kind folks who made time for meetings and/or discussions, even prior to the project being proposed, and were clearly driven by a common, almost-missionary, zeal for protection and rehabilitation of rivers or wetlands: Prof Ian Rutherfurd and Dr Mike Stewardson of the Centre for Cooperative Research for Hydrology, Melbourne University, Australia; Dr Chris Gippel of Fluvial Systems in New South Wales, Australia; Dr Dirk Roux of the River Health Programme, SA; Dr Drew Birkhead of Streamflow Solutions, SA; Mr John Dini and Mr Japie Buckle of Working for Wetlands; Ms Delana Louw of IWR Source to Sea; Dr Guy Preston of Working for Water; Mr Bill Rowlston of Department of Water Affairs and Forestry (Director: Strategic Planning); and Mr Gary Marneweck and Mr Alan Batchelor of Wetland Consulting Services.

The workshop process had to be accelerated to meet WRC's deadlines. Grateful thanks for all those who so kindly and efficiently assisted in organising venues and other aspects of the workshops, including Ms Julia Woods (then City of Cape Town), Mr Peet Joubert (Cape Nature Conservation), Dr Johan Engelbrecht (Mpumalanga Parks Board), and Dr Neville Quinn (then University of Natal, Pietermaritzburg). Grateful thanks also to all those who made presentations at the various workshops.

Finally to all those who participated in both the work and fun of this consultative process, but are not mentioned by name, a huge thanks for your time, energy and inputs. I hope they are adequately reflected in this report. I feel that we are at last moving along the same road, mostly in the same direction, and at a manageable speed.

Kind Regards

Mandy Uys

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1. INTRODUCTION

1.1 Background

The practice of rehabilitating (or restoring) degraded river systems has provided many countries of the world with an additional focus in catchment management: the protection of the resource, and the return of ecological function and process to the riverine ecosystem. In the past, river management has classically focussed on the water resource rather than the health of the ecosystem, and engineering options were commonly adopted in the development and maintenance of these systems. Traditional engineering practices and classical approaches to flood management have given way to more sensitive bio-engineering and eco-engineering options, which meet the structural and material requirements of urban river management, but with a minimum of effects to the river. The interest in this activity stems not only from academic environments, but from government agencies, catchment management agencies, local authorities, non-government organisations, educators, and community bodies (e.g. King et al. in press, Brizga et al. 1999).

In the US, Britain, parts of Europe, Australia, New Zealand and Asia, this interest has over recent decades been supported and further directed by large government agencies or public-private partnerships, through various programmes and initiatives. The US Environmental Protection Agency (EPA), for example, works in close partnership with other federal agencies, state and local government and native American tribes to provide environmental protection at a catchment scale, in keeping with their Watershed Protection Approach (WPA). Each state has a regional EPA office coordinating numerous large-scale projects and programmes related to river restoration (EPA 2003). Many other federal- and state-level bodies, public-private partnerships and community organisations have also been developed with this focus. For example, CALFED is a joint state-federal process which seeks to end California's water wars by linking with the Bay Institute in San Fransisco to run the Ecosystem Restoration Project. The goals of this project include the habitat restoration of the extensive San Francisco Bay-Delta ecosystem, including the San Joachim and Sacramento Rivers running into the delta (CALFED 2003, Bay Institute 2003).

In Australia, the multi-funded Cooperative Research Centres for Catchment Hydrology (CRCCH) and Freshwater Ecology (CRCFE) are responsible for a national-level River Rehabilitation Programme with a number of major projects, and '*aims to provide stream managers with tools, and with an understanding of processes that will lead to more effective expenditure on restoration, and ultimately on streams*' (CRCCH 2002). The River Restoration Centre in Britain coordinates much of the river restoration work undertaken nationally (RRC 2003). The International Commission for the Protection of the Rhine (ICPR), which has a number of European member states, aims for sustainable development of the entire Rhine Ecosystem, safe drinking water production from the river, improvement in sediment quality, environmentally sound flood protection, and improvement of North Sea quality (ICPR 2003).

These are some examples of national or state-level programmes which seek to effect ecosystem restoration. In South Africa, terrestrial ecosystem rehabilitation, and particularly erosion and land-cover control, is presently under the spotlight of the organisation LandCare, under the auspices of the National Department of Agriculture (NDA). Wetland conservation and management is catalysed by the Mondi Wetland Project (www.wetland.org.za), and wetland rehabilitation is chiefly driven by the Working for Wetlands Programme (www.ccwr.ac.za/wetlands/rehab.htm). The WRC and other organisations fund wetland-related research. The clearing of alien vegetation out of heavily infested catchments is organised at a national level through the Department of Water Affairs and Forestry's (DWAF) Working for Water Programme, which is funded by Poverty Relief, and provides extensive employment and capacity building around the country.

There is as yet no central programme coordinating and directing river rehabilitation in this country. The need for both of these initiatives has been apparent to those involved in these fields in South Africa for several years, particularly in the light of the effects that international programmes have had on rehabilitation development (Uys, 2003) and that the aforementioned South African programmes have had on both alien clearing and wetland rehabilitation. South Africa is out of kilter with the international trends in river restoration/rehabilitation, the field of which is now considered an integral part of catchment management in some countries (e.g. Gippel 1999).

1.2 The current situation in South Africa

The river rehabilitation field in South Africa is still largely characterised by:

- Poor definition of terminology, leading to a perception that engineering projects focussed on storm-water management, flood control, or remediation, constitute rehabilitation efforts.
- An apparent misunderstanding of the spatial and temporal scales at which rehabilitation should be planned.
- Relatively ad-hoc projects, characterised by poor planning, few if any ecological objectives, and rare evaluation of outcomes, reporting or accountability (e.g. Day pers. comm, Woods pers.comm).
- A reliance on protocols and guidelines developed for Australian, British or American river systems (which are adequate but not tailored to SA needs);
- A lack of centralised coordination of projects, research, development and application;
- A lack of an overall strategy, policy, or legislative framework for the rehabilitation of South Africa's rivers.

The protection of water resources in South Africa would be enormously assisted by: (i) a strategic (top-down) decision to develop a national approach or a policy regarding the coordinated development of the field in South Africa, and (ii) ground level (bottom-up) river rehabilitation guidelines, and trials.

1.3 Rationale for the current study

The need for 'situating and contextualising' river rehabilitation was included as one of a number of recommendations made by Uys (2003) in a report entitled 'The Australian experience in river rehabilitation: Lessons for South Africa':

It is recommended that within the next two to five years, a multi-disciplinary effort is directed towards identifying and establishing the logical 'home' for river rehabilitation in South Africa, first at a national level and later at regional and local (or catchment) levels. This is a measure to provide the field with a national identity. The 'home' may take the form of a National Department, an alliance of Departments (such as the Working for Water Programme), a partnership with a current, appropriate National Programme (such as the SA River Health Programme), a new and separate programme, or a privately-funded venture with credible, accountable ownership. The process of centralising the science and practice of river rehabilitation should, ideally, be broadly consultative. The issues to consider in the process include: the prevailing socio-political and economic milieu, funding mechanisms, legislative and policy frameworks, logistical requirements and constraints, existing linkages to build on, required linkages, resource management priorities and constraints in South Africa, and appropriate models of leadership.

This and other related recommendations (see Text Frame 1) formed the original basis for this current project, which was entitled "*A project to situate and contextualise river rehabilitation in South Africa, to plan for a national programme for river rehabilitation, and to trial the Australian method for river rehabilitation on a small degraded urban stream*" (WRC Project No.K5/1309, 2002/3). This project had as its major aims the consultative development of a plan for a river rehabilitation programme for South Africa (to be workshopped), the development of a preliminary Register of Expertise in the field, and the production of a list of research and development needs. The last of these aims was influenced and informed by a similar process undertaken in Australia in 1998 (Rutherfurd et al. 1998).

1.4 Amendment to the original project aims

During the course of the project, the focus was altered somewhat from the original aims, to meet with the changing needs of the Water Research Commission. The changes arose out of a situation in which the large percentage of the research proposals received in 2002 by the WRC for Key Strategic Area 2 (KSA2), 'Water-linked Ecosystems' sought funding for research into some aspect of river rehabilitation. In response to this and other signals regarding the growth in the field, Dr Steve Mitchell (Head of KSA2), decided to initiate a dedicated research programme for River Rehabilitation in 2004.

under KSA2, Thrust 3 (Ecosystem Rehabilitation). The first requirement was for a list of research needs which would be used as the basis of a Terms of Reference for this programme. It was agreed that this list should be developed in consultation with a range of stakeholders across the country who had either experience and/or interest in the field. It was agreed that in order to prevent duplication of effort and to simplify logistics, the original project aims should be amended to align with the WRC requirements.

However, as the original intention of this research project was to develop a plan for a river rehabilitation programme which addressed *all* facets of the field (at a minimum, research, development and application/trials), this has also been addressed to a lesser extent, and the options in this regard are presented and discussed briefly.

1.5 Aims

The revised aims of this study were:

- to develop, through consultation, a list of Research, Development and Application needs for the field of river rehabilitation in South Africa;
- to present the priority needs to WRC for use in a Terms of Reference for the upcoming River Rehabilitation Research Programme;
- to explore and discuss options for a comprehensive Programme for River Rehabilitation, at a somewhat larger scale than the WRC Research Programme, and covering Development and Application; and
- to develop a preliminary Directory of Expertise for individuals or organisations involved in (or working in related fields to) river rehabilitation in South Africa.

1.6 Definitions

The mixed use of the terms 'restoration' and 'rehabilitation', amidst a host of others, is confusing. In general, the term gaining favour in Britain and Australia seems to be 'river rehabilitation' (RRC 2000, Rutherfurd et al. 2000a,b), while that in the US remains 'river restoration' (e.g. USEPA 2000). In most of the contemporary literature, both are essentially aiming for the same outcome: the return of the structure and function of a degraded river ecosystem to the *closest achievable approximation* of its natural (pre-impact) state. The term 'rehabilitation' is preferred by many because that it is felt that 'restoration' implies a return to natural pre-impact state and is thus aspirational and seldom achievable, while rehabilitation focusses on achievable objectives and also aims for improvement and protection. Rutherfurd et al. (2000a) argue that to achieve true 'restoration', the following objectives would need to be fulfilled: the restoration of the natural range of water quality functioning; the restoration of the natural sediment and flow regime; restoration of a natural channel geometry and stability; restoration of the natural riparian communities; restoration of native aquatic plants and animals. The goal of rehabilitation, on the other hand, would be the improvement of important aspects of the stream environment with the aim of the system eventually resembling its pre-impact state. The term 'remediation' is appropriate in cases where it is not possible to rehabilitate due to a river system being irretrievably degraded, or where a system has been fundamentally altered in character but has, over time, adjusted and achieved a state of dynamic equilibrium. This is often the case of a river channel downstream of a dam. The aim of remediation is to improve the ecological condition of the river, while not aiming for an endpoint which resembles its original condition (Breen and Walsh 1999).

Text Frame 1.1 Suggestions for future directions in river rehabilitation in South Africa.

1. Adopt, trial and adapt. It is recommended that Australian River Rehabilitation process and related methodologies be adopted, adapted and trialled on a number of different river types in South Africa. This will allow refinement and tailoring of a rehabilitation process to fit the various regional river types in South Africa. This is also a first step towards the development of guidelines for rehabilitation.

2. Situate river rehabilitation. *As detailed in the text.*

3. Build on available methods and initiatives. The links between the generic processes of Resource Directed Measures (RDM) and River Rehabilitation are emphasised. Means of developing and building on these linkages should be investigated.

4. Develop partnerships and exchange information. The structured creation of links, partnerships and alliances at a number of levels is recommended.

5. Access available information. A wealth of information is available to inform rehabilitation practitioners about present and historic river conditions. An effort should be made to ensure that pertinent information is easily or centrally accessible for this purpose.

6. Identify research and information needs. It is recommended that a interdisciplinary effort be directed towards the identification of knowledge gaps and scientific research and information needs for the development of river rehabilitation.

7. Prioritise rivers for rehabilitation. At a national level, rivers should be prioritised for protection and rehabilitation, on the basis of ecological, economic and social criteria.

8. Develop expertise, tools and guidelines. It should not be assumed that river rehabilitation is common sense. It is a unique and complex discipline. Even at the specialist level, expertise must be developed to meet its needs. Scientific tools and guidelines appropriate to South African rivers will increasingly be needed.

9. Review legislative frameworks and identify policy needs. A review of national-level legislation pertaining in any way to river rehabilitation is required and should be commissioned. Conflicts between different National Acts, and between Acts and regional/local-level laws, which are implemented by different authorities, should be investigated. The interface between national level and local-authority level jurisdictions need to be clarified.

From: *Executive Summary*, Uys (2003)

2. RESEARCH, DEVELOPMENT AND APPLICATION (RD&A) IN THE FIELD OF RIVER REHABILITATION

2.1 An understanding of these terms

Research in a rehabilitation context is defined by Rutherfurd et al. (1998) as '*any activity that helps us to better understand how and why things are the way they are, how and why things happen, or how, whey and when to apply particular rehabilitation techniques*'. Research should consider the ecological or social system itself (in terms of individual components, their interactions, processes and function, and sensitivity and importance), the natural and non-natural influences on the system, and the effects of these (system response). The task of research is to come up with a series of possible hypotheses addressing the 'why-what-where-how-when' questions surrounding river degradation, to test a number of these, and on the basis of the outcomes, to report on the most appropriate options for future management of the system.

To ensure adequate growth and an increase in knowledge in the field, however, research efforts must be augmented by development in order to *enable* and drive the practice from legal, institutional and methodological perspectives. Rutherfurd et al. (1998) define such development as '*transforming that knowledge (gained in research) into a form that can be applied in decisions and active management*'. The development process lies to some extent in the hands of controlling authorities (at all tiers of government), who are tasked with the creation, implementation and management of enabling policies and regulations, and the monitoring of compliance with these.

The creation of meaningful linkages between different authorities, agencies and programmes, and the development of information-sharing mechanisms, and various institutional arrangements is a further critical element in the development of this field. This relies on, *inter alia*, the ongoing enactment of cooperative governance processes as required by the National Environmental Management Act (NEMA, Act No. 107 of 1998).

Finally, the research and development in a field remains intellectual and largely ineffectual if there is no practical implementation component. This is 'application': the ground-truthing, testing and refinement of the processes, methods, tools, and standards emerging from the research and development (R&D) process. The outcomes of the application process should indicate how *practically*, legally and scientifically relevant and effective the R&D have been in creating enabling policies or frameworks, conceptual approaches, methods, guidelines, designs, materials and other tools for enacting the rehabilitation process. The application process is real and can be grasped by the public and media as a sign that 'something is being done' and that they can engage in this process. It also serves to build knowledge and to drive further growth in R&D through an adaptive management-type feedback process.

Figure 2.1 is a preliminary suggestion of the types of activities which may fall under the titles "Research", "Research and Development" (R&D), "Development" and "Application" in the field of river rehabilitation in South Africa. Figure 2.2 provides a suggestion of the types of organisations that would ideally be involved in each of these fields.

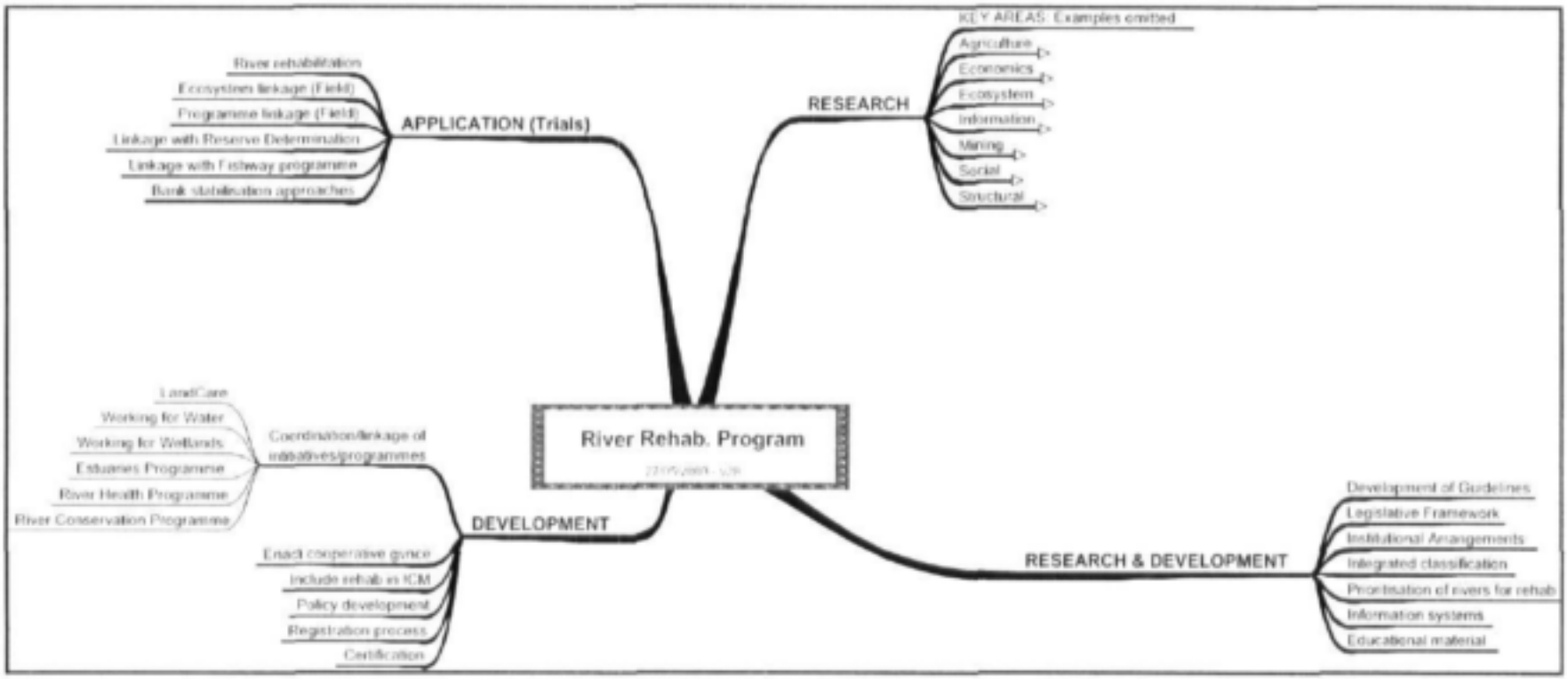

Figure 2.1 Types of activities envisioned under the headings of Research, R&D, Development, and Application

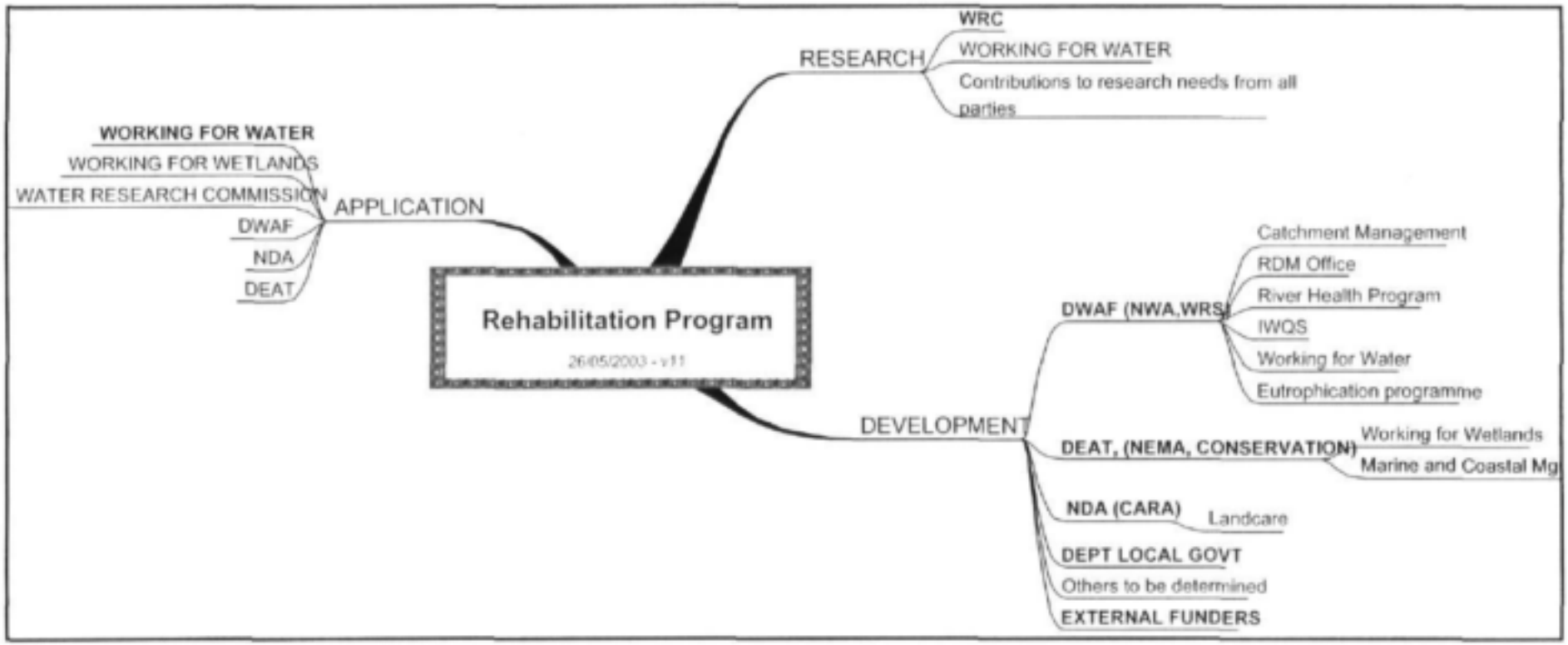

Figure 2.2 A diagram showing the organisations envisioned as lead agents (bold) and additional partners within a programme that addresses research, development and application in the field of river rehabilitation.
DEAT – Department of Environment Affairs and Tourism
DWAF – Department of Water Affairs and Forestry NWA – National Water Act NWRS - National Water Resource Strategy
NDA – National Department of Agriculture CARA – Conservation of Agricultural Resources Act
WRC – Water Research Commission

2.2 RD&A areas

On the basis of global research directions in the field and on the recommendations for the development of the field in South Africa (Text Frame 1), a checklist of preliminary key areas for consideration in both short and long-term RD&A were identified and are presented in Table 2.1. These are not comprehensive, and clearly there are many linkages and overlaps between areas, so that this format is ultimately not practical. It simply serves to list some of the considerations to be integrated into more comprehensive and complex RD&A needs. This outline was developed to serve as the basis for consultation with a wide variety of South Africans in the field of ecosystem rehabilitation (Section 3).

Table 2.1 Key RD&A areas, focus points and aspects of relevance for river rehabilitation

KEY RDA AREA	FOCUS AREAS	EXAMPLES OF ASPECTS OF RELEVANCE
AGRICULTURE	Farming practices	Cultivation of, and grazing in, the riparian zone
		Fertilizer use leading to nutrient enrichment
APPLICATION	Rehab. pilot trials	3 Regional rivers: Linking of wetlands, estuaries, rivers in planning. Collaborating with Working for Water in planning and implementation
	Reserve Determination	Reserve Determination incorporating non-flow related problems and rehabilitation planning
	Physical interventions	Trials of various physical interventions using bioengineering to determine best practice per regions and river type
ECONOMICS	Costing	Cost-benefit analyses
	Funding	Project funding
	Incentives	Creation of incentives e.g. fencing of riparian areas (advantages/disadvantages)
	Levies	Consideration of levies (advantages/disadvantages)
	Market economics	The economic value of rehabilitated river systems to different sectors
	Resource economics	The value of the functional river in terms of its resources
ECOSYSTEM	Classification	Integration of classification systems for river systems
	Components	Water quality, water quantity, geomorphology, riparian vegetation, in-stream vegetation, fish, invertebrates
	Evaluation	Evaluation of system or biotic response to imposed disturbance and to rehabilitation measures
	Function	Criteria for functionality
	Monitoring	Monitoring of physical, chemical and biotic change and trends
	Prioritisation	Prioritisation of rivers for rehabilitation
	Structure (Physical)	Understanding of physical changes to the channel, bed, banks, floodplain. Concerns regarding equilibrium, stabilisation, degradation, trajectory of change.
	Response	System response to natural and non-natural disturbances, and to natural and non-natural interventions
	Recovery	System recovery post-disturbance, and post-intervention

Table 2.1 Continued

KEY RDA AREA	FOCUS AREAS	EXAMPLES OF ASPECTS OF RELEVANCE
INFORMATION	Retrieval	Web-based information systems for info access
	Transfer	Guidelines and protocols
	Storage	Databases (expertise, projects)
	Systems	Decision support systems (urban rivers)
INSTITUTIONS	Structure	Lines of authority within an organisation
	Function	Requirements of the authority
	Organisation	Benefits and disadvantages of current structure
	Jurisdiction	Jurisdictions of the relevant authorities
INTEGRATION	Authorities	Cooperative governance
	Programmes	Cooperative planning, data collection and information sharing
	Ecosystems	Linkage of river, wetland, estuary, land ecosystems in rehabilitation planning
MINING	Sand mining	Impacts, compliance with policy
POLICY	Guidelines	Guidelines as to legal requirements and constraints in rehabilitation projects, plus contact people per region
	Legislation	Legislative framework for river rehabilitation
	New policy	Creation of new policy for ecosystem rehabilitation
POLITICAL	Support	Generating political buy-in
SOCIAL	Capacity bldg	Adding social value through capacity building
	Communication	Using information mechanisms to disseminate info
	Education	Content: Primary, secondary, tertiary curricula
	Public awareness	Media, Publicity requirements and drives
	Stakeholders	Protocols & expertise for stakeholder participation
	Traditional knowledge	Gaining recognition for sites and river areas of cultural, spiritual and historic significance
STRATEGIC	Planning	National plan and programme for river rehabilitation
	Objectives	Development of objectives for rehabilitation (short/long-term; strategic to project level)
	Evaluation	Methods for evaluation and auditing of programme and project outcomes and cost-effectiveness
STRUCTURAL	Classical engineering	Advantages, disadvantages, costs
	Bio & Eco engineering	Designs, costing, advantages, disadvantages

3. THE PROJECT PROCESS

3.1 The development of a preliminary Register of Expertise

The two aims in compiling a preliminary Register of Expertise were:

- to address the apparent lack of synergy and information-sharing in the field of aquatic ecosystem rehabilitation in South Africa; and
- to provide a service to those requiring assistance or expertise in planning their own rehabilitation projects.

Addressing the first of these was considered a small step in the development of a network of individuals actively involved, or interested, in the many aspects of the field. Addressing the second required the identification of the areas in which information or assistance would be required during a rehabilitation project. These were: government (national to local); parastatal; non-government organisations; water resource management; academic and specialist (in the disciplines of ecology, botany, geomorphology, hydrology; geology); engineering and bio-engineering; landscape architecture; planning; policy; funding; and materials supply.

During 2002 and 2003, a request for information was sent out by email to extensive lists of individuals within these identified areas. The South African Society of Aquatic Scientists (SASAqS), the Water Institute of South Africa (WISA), the SAICE (South African Institute of Consulting Engineers) and the Institute for Municipal Engineers (IMIESA) assisted by either advertising the request or forwarding it to their members. A notice was also posted to the home page of the WRC website. Respondents were requested to provide information in the following fields:

Full Name	
Category	Government, Management, Research, Consulting, Planning, Engineering, Law, Private, Interested individual etc.
Institution or Organisation	
Portfolio in Organisation	
Training or specialisation	
Work phone	
Mobile phone	
Fax	
Email Address	
Postal Address	
Website	
Names of projects undertaken which are associated with, or pertain to, river rehabilitation	
Tools being used in your work which could benefit rehabilitation development	
Three key words describing your expertise as it pertains to this field	
Key areas of interest	
Interest in further participation or receipt of information	

All respondents were informed that they would have the opportunity to contribute to a workshop process relating to the development of the rehabilitation field in South Africa. During 2003, several additional requests and reminders for directory information were sent out to targeted organisations and individuals.

3.2 The consultative process to identify R,D&A needs

As a joint initative between Water Research Commission and the Project Leader, six regional workshops were organised and run during March and April 2003 to develop a Terms of Reference for the WRC's intended Programme for River Rehabilitation Research. These were held in Southern Cape (Knysna), Western Cape (Cape Town), Eastern Cape (Grahamstown), Gauteng (Pretoria), Natal (Pietermaritzburg) and Mpumalanga (Nelspruit).

The identification of R,D&A needs for the field required the input of a broad range of individuals representing the areas identified in the previous section. The intention was to gather individuals with some experience in the field of rehabilitation, who would provide insight into the particular concerns in their own fields of expertise. The challenge was to consult with groups comprising people from very different professional backgrounds, work approaches and needs-paradigms (some of which were, at times, in conflict), and to generate an list of RD&A needs which both encapsulated their diverse requirements, and addressed the multiple and complex facets of river degradation. It was necessary to consider issues at various scales, and to balance "top-down" (strategic-level) and "bottom-up" (project-level) approaches.

Those who provided information for the 'Register of Expertise' (see Section 3.1) were invited to attend workshops in their regions. Additional representatives of key areas of concern (national to local government, bio-engineering) were identified and invited. Workshop participants numbered over a hundred in total, with a further fifty people showing interest but unable to attend. The names and affiliations of participants are listed in Appendix A.

At each workshop, an introductory talk was given on the subject of river rehabilitation, and a background provided to the forthcoming WRC Research Programme. Following this, one or more invited speakers made presentations on work and issues related to the aquatic ecosystem rehabilitation in their organisation or region (Appendix B). The rest of the workshop entailed consultation with participants.

The process of consultation was tailored somewhat differently for each workshop, on the basis of both the range of participants and their interests, and on what had been learnt in previous workshops. All the workshops aimed to achieve the same output: a list of issues relating to the state of rivers in South Africa, the information needs, and the means of addressing these through research, development and application (RDA), both in the short and the long term. The participants had been requested to read the 'checklist' of components, focus areas, and aspects of relevance pertaining to river rehabilitation (Table 2.1), prior to the workshop. At the majority of workshops, participants were requested to either write down or discuss river degradation issues and the various information needs which arose out of these. Each need was then grouped into one of the various component categories on the checklist. The type of study or activity required to meet this need was then discussed, where time allowed, or was alternatively conceptualised at a later stage by the Dr Mitchell and the project leader. At the Grahamstown workshop, participants chose to rather list what they considered to be the three major outcomes they would like to see materialise from the WRC Research Programme over a period of five years. These were translated back into information or development needs, and the participants then discussed what sort of studies could potentially meet these needs.

The outputs of the individual workshops were first listed individually, and then integrated into a single list to prevent duplication and overlap. Individual research, development and/or application needs were then grouped under the various headings used throughout the workshop process (Table 2.1). On the basis of this list, a subset of research priorities was devised in consultation with Dr Mitchell, on the basis of the number of times the requirement was reiterated during the 6-workshop process, the importance it was considered to have during workshop discussions, and expert opinion.

The research needs considered by WRC to have the highest priority were subsequently drafted into a Terms of Reference, which was sent out for external review to a small group of key individuals in the field, and finally advertised as WRC Solicited Research in June 2003.

4. PROJECT RESULTS AND DISCUSSION

4.1 Preliminary Register of Expertise

The responses received to the request for directory-type information were compiled into a preliminary Register of Expertise for Aquatic Ecosystem Rehabilitation in different regions of the country. This is by no means a comprehensive list, but serves as a practical basis for the future development of a more sophisticated database of individuals and organisations working in this field. The Register is presented in Appendix C.

4.2 Results of the consultative process

The outputs of the workshop process are provided in a summarised format in Tables 4.1 to 4.3, which are presented at the end of Section 4. These outputs represents the perceived Research, Development and Application (RDA) needs for river rehabilitation. They have been grouped into the 'Key RDA Area' categories listed in Table 2.1: Agriculture, Economics, Ecosystems (general), Ecosystems (classification), Ecosystems (monitoring and evaluation), Ecosystems (prioritisation); Information transfer, Information storage, Integration, Policy, Political, Institutional, Social, Strategic, and Structural.

Table 4.1 focusses on Research and Development (R&D) needs, Table 4.2 on Development needs, and Table 4.3 on Application needs. In each of the Tables, the 'Focus' represents the issue of concern, and the 'Task' the type of R&D study required to address this issue. Each Task has been assigned a ranking of 1-6 on the basis of the number of workshops in which it was raised, the importance it was attributed in the workshop discussion, and the author's knowledge of the sequence of both development of river rehabilitation in other parts of the world, and key needs for its development in South Africa. The ranks are as follows:

1 Directly relevant, should be considered for inclusion in the WRC Research Programme in the first funding cycle (2004/5).
1 Relevant, should be either funded another appropriate agency, or addressed in the second funding cycle (2005/6).
2 Necessary but not urgent, should be addressed in the second or third funding cycle.
3 Necessary but not of direct relevance to this programme, should be addressed by an appropriate external agency, possibly in conjunction with the river rehabilitation programme.
4 Not considered relevant to present river rehabilitation development needs.
5 This information is likely to exist already, and may require review and adaptation for South African needs.

A possible research team or student appropriate for each study is listed alongside the R&D need.

As already discussed, the prioritised R&D requirements (Table 4.1) were considered for inclusion in the WRC Programme for River Rehabilitation Research. These key needs are discussed further in the following sections. The listed requirements reflect the disposition of the participants of the workshop, and are necessarily not the opinion of WRC or the Project Leader

As WRC is not in a position to address the full range of priority R&D needs that arose from this process, many of these will remain as gaps in our knowledge, and areas requiring attention. Ideally these will be addressed by institutions or organisations such as the Department of Water Affairs and Forestry (DWAF), Department of Environment Affairs and Tourism (DEAT), Working for Water (WfW), Working for Wetlands (WfWet) and the National Department of Agriculture (NDA). This is considered further in Section 5.

4.3 Principal outputs

The workshop process highlighted three major areas of concern which will be discussed further here. Firstly, that rehabilitation had not yet been accorded its 'place' as a recognisable field of expertise in water resource management or water law in South Africa. It is commonly perceived to be an extension of resource protection and/or environmental flow determination (and thus the Ecological Reserve). In the National Water Act (No. 36 of 1998), the definition of the term 'protection' in terms of a water resource includes 'the rehabilitation of the water resource' (S1 (xvii). There is however little further reference to, or guidance regarding, rehabilitation in the Act (Uys & Ruiters 2002, Appendix E).

The international experience suggests that resource protection and rehabilitation, given sufficient attention, can eventually become synonomous with water resource management and naturally interlinked with resource protection. It should encompass, rather than being an extension of, environmental flow determination (Uys 2003, Gippel, pers.comm. 2004). Ideally, as in other countries, the field should be centrally organised and managed, ideally alongside wetland and estuarine rehabilitation. While the initiation of a dedicated WRC research programme represents significant progress, research is not sufficient to drive and develop the field in this country. A far larger and coordinated effort between relevant government departments and agencies is called for. The need for a centralised programme to direct the development of this field in the country was raised on a number of occasions during the workshop process.

Secondly, and at a different scale, it was noteworthy that the majority of participants (and even experienced river scientists) wishing to attempt a rehabilitation project were not entirely comfortable with "where to start". Their concerns included:

- the legalities of rehabilitation,
- the time frames for a project,
- the scale at which to work,
- what process to follow,
- how to underpin the project with sound science,
- who to contact for authorisation and assistance,
- how to source support funding,
- what sequence of activities to follow,
- what representation is required on a specialist team,
- how to involve the community meaningfully,
- how to cost the project,
- how to formulate meaningful ecological and social objectives,
- how to integrate urban river management needs with rehabilitation planning,
- how to prioritise needs,
- what materials, designs and techniques to use in the process of rehabilitating a river,
- where to source these,
- how to implement a rehabilitation plan,
- how to evaluate project outcomes, and
- how to monitor system response to the rehabilitation interventions.

These questions require answers from a suite of different but interrelated fields. Many of these answers already exist in guidelines for rehabilitation produced in other countries. While there is a great deal that could be borrowed from these guidelines for use in South Africa, certain of the information naturally pertains specifically to the country of origin, and would need to be replaced with appropriate information for the local context.

Thirdly, the institutional framework within which resource protection and rehabilitation must be organised and controlled was clearly a source of concern, particularly for those in local and provincial government. The lack of cooperative governance at a national level, the lack of organised interdepartmental and intradepartmental coordination, and the poor internal communication between different hierarchies in government and institutions were raised as key issues. Without these

concerns being addressed, even the most progressive legislation and guidelines lose their value, as the power to implement is compromised.

4.4 Priority R&D areas

A limited number of research needs could be addressed by the WRC programme in the first funding cycle (2004/5). In order for WRC to develop a Terms of Reference for this required research, the manifold R&D requirements listed in Table 4.1 had to be prioritised. This exercise was completed in consultation with Dr Mitchell of the WRC. While there remains a host of smaller and more technical research requirements (which it is hoped will be pursued by academics and their students), the fundamental needs, without which this field cannot develop on a sound basis, were prioritised for the first cycle. This was approached as objectively as possible, with the intention that the workshop participants' views should be reflected in the outcomes. The following served as a basis for prioritisation:

- Frequency with which the need was raised in the workshop process (Tables 4.1 – 4.3),
- Importance attributed to the need during workshop discussions,
- Experience in the field both in SA and outside, and expert opinion.

Key needs were listed and are discussed in the following sections.

4.4.1 A Programme for Aquatic Ecosystem Rehabilitation

This need cannot be addressed by the WRC Programme, but provides the context within which the prioritised needs can be considered.

The Convention for Wetlands developed in Ramsar, Iran in 1971 (the 'Ramsar Convention') recognised that the degradation and loss of wetlands and their biodiversity represented enormous economic and social losses and costs to the humans living within these catchments. It provided a framework for the global conservation and wise use of wetlands. At present, 138 countries are contracting parties to the Convention (Peck 2003), including South Africa. Ramsar created, at a massive scale, a clear understanding that appropriate protection and allocation of water to wetlands was essential to enable these ecosystems to survive and continue to provide important goods and services to local communities.

Rivers are included under the Ramsar definition of 'wetlands': *"For the purpose of this Convention, wetlands are areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres."(Article 1.1, Ramsar 1971).*

The 8th meeting of the contracting parties focussed on providing principles and guidelines for wetland restoration (Resolution VIII.16 of the Convention). The preamble included the recommendation that *'a national programme and priorities for wetland restoration should be established, based on a national inventory of wetlands with potential for restoration, as a component of the national wetland policy, plan or strategy, so as to maximise the benefit to the overall conservation status and wise use of wetlands of the efforts and resources applied to wetland restoration'.*

Many of the contracting countries now have a National Wetland Policy, which can be viewed on the Ramsar website (www.ramsar.org). Operational Objective 2.2 of the Ramsar Strategic Plan 1997-2002, approved at the 6th Conference of Parties (COP6), urged contracting Parties *"to integrate conservation and wise use of wetlands . . . into national, provincial and local planning and decision making on land use, groundwater management, catchment/river basin and coastal zone planning and all other environmental management".*

The issue of South Africa developing a centralised programme for river (or aquatic ecosystem) rehabilitation, which would incorporate the proposed Water Research Commission research programme, was a need which discussed in various ways throughout this project, with workshop

participants, certain programme leaders, and representatives of national government. This e represents a development requirement rather than a research need.

There is little question that such a programme, as a component of a greater Aquatic Ecosystem Protection and Rehabilitation Strategy (which is a separate requirement, not discussed here), would provide a central means of coordinating the numerous components of resource rehabilitation and protection. The first question this raises is what organisation should coordinate and fund such a programme: a national government department, an agency, an alliance of departments and agencies, or an independent, privately funded organisation? Two major programmes have been active for a number of years in addressing certain of the practical aspects of catchment rehabilitation in South Africa: the Working for Water Programme, which focuses on alien vegetation clearing linked to job creation (funded by Poverty Relief), and the Working for Wetlands Programme, which focusses on wetland management, conservation and rehabilitation. Both programs represent a wealth of practical experience and significant outcomes (not all of which are positive). The restoration and remediation work done to date by Working for Wetlands and the Mondi Wetland Project (www.wetland.org) places the field of wetland rehabilitation well ahead of 'river' rehabilitation in South Africa in terms of practical learning and experience. Funding for this work is on a significant scale. This raises the further question of whether or not the rehabilitation of rivers (which as discussed fall within the Ramsar definition of 'wetlands'), should be incorporated under the banner' of Working for Wetlands.

Report on a working meeting regarding a Programme for Rehabilitation

In response to the issues discussed, a number of key individuals were invited to convene for a first discussion regarding the range of options for a Programme. A tele-conference was scheduled during May 2004, between senior individuals representing relevant departments or programmes:

Dr Guy Preston (GP)	Director, Working for Water (WfW)
Ms Nonhlanhla Mkhize (NM)	Working for Water (WfW)
Mr Piet-Louis Grundlingh (PLG)	Working for Wetlands (WfWet)
Mr John Dini (JD)	Department of Environmental Affairs and Tourism
Prof. Ian Rutherfurd (IR)	Key River Rehabilitation specialist, University of Melbourne, Australia
Dr Steve Mitchell (SM)	Water Research Commission
Mr Harrison Pienaar (HP)	Manager, Resource Directed Measures Directorate (DWAF) Department of Water Affairs and Forestry (DWAF)
Mr Morne Lizamore (ML)	Department of Water Affairs and Forestry (DWAF)
Ms Noxolo Ncapayi (NN)	Department of Water Affairs and Forestry (DWAF)
Mr David Kleyn (DK)	National Department of Agriculture (NDA)
Mr Ivan Riggs (Iri)	National Department of Agriculture (LandCare Coordinator)
Dr Mandy Uys (MU)	Laughing Waters (Rehabilitation R&D).

It was agreed that research, development and application (R,D & A) were urgently needed in the field of river rehabilitation in South Africa. Clearly, practical wetland rehabilitation had already advanced significantly ahead of river rehabilitation. This having been said, the agreed aims of the meeting were:

- To ascertain the extent to which all stakeholders present would be able to contribute to the development and implementation of a river rehabilitation programme in South Africa.
- To outline the roles and responsibilities of the WfW, WRC and WfWetlands in this regard, and
- To consider the possibilities for funding of river rehabilitation R,D & A.

Professor Rutherfurd gave a brief background on Australia's river rehabilitation programme and commented that athough WfW and WfWet were actively involved in river rehabilitation, it must be recognised that their current activities only addressed certain of the factors that had compromised South Africa's rivers and wetlands. He stated that river rehabilitation had developed into a successful field in Australia for a number of reasons, including:

- Effective stakeholder participation and communication through an international river rehabilitation and management conference (Melbourne, Australia, 1998). This had aided the coordination of all river rehabilitation activities, and had promoted networking and effective communication between all parties involved in river rehabilitation; and

- A clear definition of river rehabilitation values and objectives. This was critical, as it had ensured that all parties understood the objectives of river rehabilitation.

All participants of the meeting agreed that the WRC, DEAT, DWAF, and NDA should be involved in the development of this field. Water Research Commission would be involved through the launching a river rehabilitation research programme during 2004, and should be considered a key role player in future. It was agreed that the focus of a centralised Programme for river rehabilitation should extend beyond research, and into the areas of development and application. There was some support for the concept of incorporating river rehabilitation under the umbrella of Working for Water and/or Working for Wetlands.

The advantages of this would be that the logistical frameworks and funding bases of both these programmes are established, and this arrangement could lead to effective linkage of all 'wetlands' in catchment rehabilitation (under the Ramsar definition, rivers, estuaries and coral reefs with a depth less than 6m are considered 'wetlands'). The latter point however leads to some concerns. The classical understanding of rivers and wetlands is that rivers generally have clearly defined channels, while wetlands lack channels, have hydric soils and diffuse water distributions (depending on hydrology). While it is important to recognise the linkages and dependencies between the systems, this distinction is functional in a management sense in that the systems are sufficiently physically, chemically and ecologically different to warrant entirely different techniques in the assessment of condition, water quality, environmental flow allocations, etc. This is not always recognised: for example, Butcher (2003), discussing wetland assessment techniques, pointed out that an incorrect assumption was often made that if a biological monitoring method was effective in a flowing river, it was likely to be effective in a wetland. Another perceived disadvantage of incorporation into 'Working for Wetlands' is that the imperative for Working for Water and Working for Wetlands to "deliver" (to meet funder requirements) means that projects must be expedited to implementation and completion, with *little time for studies of present and pre-impact state, and for structured* rehabilitation planning and objective-setting, following a standardised process. This is a disadvantage in a field which is newly-developing and clearly in need of establishing a strong planning process in rehabilitation projects. These issues would need to be explored further in further meetings between key individuals.

The delegates agreed that the numerous programmes in South Africa which were contributing to aquatic and terrestrial ecosystem rehabilitation should be coordinating. There was a stated need for key stakeholders in the various fields of rehabilitation to develop a structure that would address and meet all of their needs.

It was agreed that the roles and responsibilities of different departments and organisations with respect to river rehabilitation required further thought and discussion. This process was considered critical, and would influence the development of an action plan for river rehabilitation. In closing, it was agreed that all the institutions or organisations participating in the tele-conference should contribute further to the development of this field. Most participants agreed that the Water Research Commission should be the lead agency for Research and Development, and that Working for Wetlands would be the most appropriate agency to coordinate Application (trials), with the provision that a strong planning process be incorporated in all projects. Though the meeting agreed that there should be further strategic discussions for developing an action plan for the way forward for river rehabilitation in South Africa, no further meetings have been convened.

4.4.2 A legal framework for rehabilitation

On the basis of extensive case-studies on watershed management programmes in the US, Riley (1999) remarks that it is fair to conclude that those cases which can show success in quantifiable terms of lands and resources protected, acquired or restored, would most likely not have occurred without strong enabling legislation. She refers to the renowned grand-scale State of Florida project to restore the Kissimmee River and its wetlands, after the consequences of channelising were discovered. For this project, the Kissimmee River Restoration Act, the state-established Kissimee River Resource Management and Planning Committee, and aggressive leadership by Florida Governor Bob Graham resulted in funding, research and project implementation through partnerships with the US federal government (Riley 1999).

There is little in the current South African legislation that could be used to *drive* a rehabilitation project of any scale. A legal framework for the rehabilitation of aquatic ecosystems in South Africa, and a practical guideline to its application and relevance, are urgently needed. In Australia, the recognition of this requirement led to the production of an agency-funded report by Maher et al. (1999), entitled 'Australian River Restoration and Management – Criteria for the legislative framework for the Twenty-First Century'. The study team adopted a catchment management-scale approach, and investigated both the existing legislation, the criteria for a best practice legislative framework for river restoration and management across the ten jurisdictions in Australia, and a way forward.

In South Africa there is a need to examine existing legislation pertaining to river rehabilitation, to identify gaps, and to consider a position for rehabilitation within law (e.g. to what extent it should be incorporated into existing law, if so – which law/s, and whether to develop a national policy for aquatic ecosystem rehabilitation, as it has been done in many countries for wetlands (Peck 2003)). An initial study would be required to establish what form a national legislative framework should take. Uys and Ruiters (2002) have explored some of these issues issue at the level of national legislation, but a more thorough investigation is required, with additional coverage of provincial and local level laws, and consideration of new legislation (e.g. the Biodiversity Bill and the Protected Areas Act). Further, the issue of whether or not to regulate the requirement for, and the practice of, aquatic ecosystem rehabilitation, now or in the future, should be dealt with in a formal specialist study. In the interim, consideration should be given to what legal measures could be put in place to protect rivers identified as high conservation-priority systems by the River Conservation Project presently underway by CSIR.

There are a number of other questions regarding protection and rehabilitation of water resources which should be considered at the strategic and/or legal level (and indeed, already may be): for example, what proportion of South Africa's river length should be given high protection status, what does this mean in law and in management terms, what proportion of rivers can remain in (or be managed for) A or B class for example, when does rehabilitation or remediation become necessary, what proportion of rivers can we afford to maintain at C and D classes without intervention; at what stage of river degradation should there be a consideration of, or a legal requirement for, rehabilitation action; to what extent is rehabilitation a government responsibility; which authority or authorities should be given responsibility for organising it; what type of specialists are key to the process; what form of training or certification is required of these specialists; etc. In terms of detailed actions, such as interventions in the channel, should the same form of authorisation be required for rehabilitation projects as for stormwater control and development projects which cause alterations to the channel for a series of different objectives (NWA Chapter 4, Part 1, Section 21).

4.4.3 Comprehensive rehabilitation guidelines

This emerged as a major need from many of the workshop participants, as recorded in Table 4.1e. While guidelines addressing several of the more detailed issues in rehabilitation were requested, the over-arching need is for a simple, practical, hands-on guide to provide an understanding of river processes, river protection and rehabilitation philosophy; and to guide conceptualisation, planning, implementation and evaluation of rehabilitation projects. Ideally, two sets of guidelines should be developed: one at a technical level, for specialist use, and another at a community and student level, providing guidance as to how to go about the process of river rehabilitation, and recommending specialist input at appropriate phases.

As discussed, comprehensive guidelines for this field have already been produced in the US (FISRWG 2000), Australia (Rutherfurd et al. 2000), and UK (River Restoration Centre 2000). These provide a great deal of the basic generic information required in order to initiate a restoration project, and aspects are transferable to South Africa (see Uys, in prep, Vols 1&2). However, extensive additional work and development is required to tailor guidelines to South African legal, political, institutional, ecophysical, social and economic conditions.

For a guideline to be meaningful, it will need to include information and background on basic river ecology and processes, river degradation, the rationale for river rehabilitation, the costs involved, the institutional setting, etc. Many of these issues require further investigation and studies before they could be incorporated. This is discussed in the following sections.

Workshop participants suggested a wide range of specific guidelines (Table 4.1e (i)) including those for:

- Best Management Practices for urban rivers,
- who to contact at the outset of a project, including funding sources
- community involvement and capacity building,
- resolving conflicts between social, ecological and development objectives,
- setting of appropriate and attainable goals,
- mapping requirements,
- appropriate interventions under different conditions (this lends itself to a DSS, discussed later),
- creation of instream habitat,
- post-project evaluation and maintenance.

4.4.4 The Value of Rivers

Related to the motivations for rehabilitation, there was discussion during the workshops around the need to understand and record the 'value' of rivers, and to use this both as the rationale and leverage for rehabilitation, and for prioritising rivers for rehabilitation.

The value of rivers is currently understood in terms of the 'natural capital' they represent. This in turn incorporates the 'goods and services' they deliver. Natural capital is defined as *'renewable and non-renewable resources that occur independently of human action or fabrication'* (Daly & Cobb 1989; Costanza & Daly 1992; Clewell 2000). The 'goods' delivered to humans by healthy ecosystems refer to items given a monetary value in the market place, for example: water, food, construction materials, medicinal plants, wild genes for domestic plants and animals, and tourism and recreation. The services delivered are valued, but are seldom bought or sold. For a variety of ecosystems, these include: maintainance of hydrological cycles; regulation of climate; cleansing of water and air, maintaining the gaseous composition of the atmosphere, pollinating crops, storing and cycling essential nutrients, absorbing and detoxifying pollutants, and providing beauty, inspiration, recreation, and spiritual and cultural sense of place. The greater the natural capital, the more sustainable and enduring the ecosystem services.

As Aronson and Milton (2003) argue, the extensive loss of biodiversity, natural areas and natural capital during the 20th century must be addressed during the 21st century through conservation and repair of this damage or loss, via ecological restoration or rehabilitation. These authors argue for a focus on holistic evaluation and restoration of natural capital. They point out that in order for a reorganisation of economics and business to take natural capital into account, the high costs required for restoration have yet to be well analysed from an ecological economics point of view.

There is a need to begin with an inventory focussing on assessment of the value of individual catchments in South Africa; followed by an assessment of the collective potential value, and the loss of value represented by the current and further degradation of these catchments. Once this is more clearly understood and mapped, a framework will exist within which to assess the costs of rehabilitation actions and the consequences of inaction. This information would also be useful in the development of a protocol for prioritisation

This informatiis necessary hing for a me setting rehabilitation priorities, and for determining generic targets for rehabilitation in the country. The ongoing process of classifying rivers from an ecophysical perspective (the EcoRegional classification of Thirion and Kleynhans *in prep.*), and the rivers identified as conservation priorities in SA (River Conservation Project), should provide input to this process.

4.4.5 An analysis of the costs and cost-benefits associated with river rehabilitation

Without a clear idea of what the costs of 'doing' rehabilitation, and the eventual costs of 'not doing' rehabilitation are, there is no basis from which to make a strong case for it. In South Africa, it is not likely to be possible to spend extensively on rehabilitation projects as in Europe and the USA. Neither should it be considered a requirement: as Rutherfurd et al. (1998) point out, in some cases these large-scale, expensive projects have had a great deal of money to spend, strong legislation, and a boutique fishing industry.

At present, river rehabilitation projects designed with primarily ecological objectives may be perceived by many to be an unaffordable luxury. This is to be expected, particularly in the case of local authorities with jurisdiction over urban rivers. Their responsibility for stormwater management, flood control, and development and maintenance of wastewater infrastructure, all relate in large part to rivers and their surrounds. However, budgets are usually limited, and there is little chance of additional funding or human resources for activities aiming for ecological endpoints. In these situations, rehabilitation economics will have to be cleverly marketed! For instance, it is likely to be advantageous to a local authority to feature rehabilitation interventions as one aspect of a larger urban river improvement project.

There are several aspects to the economics of rehabilitation. These have been divided into Monetary (market-related) Costs, Non-monetary Costs, and Cost-benefit analyses. Selected R&D needs identified during the workshops are listed below each of these:

- **Monetary (market-related) costs**

Under this category a number of studies were needed, including:

  - The cradle-to-grave price of a rehabilitation project (including the costs of planning, design, engineering, materials, plant, construction, maintenance, and monitoring of system response to the intervention).
  - The costs of individual interventions in a river, per unit area or length of river. The known alternative options for an intervention (e.g. bank stabilisation) should be costed comparatively, and advantages/disadvantages of the option listed. Bio-engineering options, in which vegetation and natural materials are used together with more traditional engineering materials, should also be costed.
  - The change in market value of property adjacent to a watercourse, in response to both severe deterioration in river condition, and to river improvement following rehabilitation (e.g. Riley 1999);
  - The benefits to tourism of having a healthy river and an aesthetically attractive estuary.
  - A review of the international literature to establish who, typically, bears the costs of river rehabilitation planning and projects, and post-project evaluation and maintenance.
  - A review of the different forms of levies and incentives used around the world in rehabilitation, e.g. incentives or compensation offered for renaturalisation of cultivated riparian land and formation of buffer strips.
  - A review of 'who pays' for rehabilitation projects and implementation, around the world, and what the budgets associated with these projects are.
  - A literature review of the costs of rehabilitation projects around the world. Although there is unlikely to be a great deal of literature to assist one, it may be possible to contact practitioners around the world and request their assistance with figures from individual actions within project. This project should provide the basis for an analysis of costs for a South African river rehabilitation project.

- **Non-monetary (environmental and social) costs**

Under this category the following studies were included:

  - An analysis of the costs of impaired ecosystems to the functioning, sustainability, integrity, yield and supply-assurance of the resource; catchment hydrology; society; human and animal health; political outcomes; and the human and natural environments.

  - The costs to the human and natural environments (including water users) of 'not doing' rehabilitation. This is a long-term cost which may increase over time. It can be valued in terms of the resources and goods and services lost to a catchment and its people when a river can no longer function optimally. This should include opportunity costs associated with loss of potential for tourism and development.

- The increase in positive urban values (amenity, recreation, sport, aesthetics, open space, safety) and the improvement of living conditions for residents that accumulate following rehabilitation.

- The increase in natural capital (and therefore in delivery of goods and services) associated with a healthily functioning ecosystem. Linked to this an investigation of public perceptions regarding "whether or not there is worth in river rehabilitation, and if so, in what senses"

- **Cost-benefit analyses**

  - The costs and benefits of having rivers in particular DWAF categories.
  - The cost-benefit of individual rehabilitation studies already undertaken (case study-based)
  - The means of optimising the cost-benefit relationship within individual projects.

4.4.6 Prioritisation of rivers for rehabilitation

This was another area highlighted during the workshops for further investigation. For rehabilitation to be managed in such a way that it is affordable and sustainable, Rutherfurd et al. (2000) advise hierarchical prioritisation of catchments, from national down to local scale, from large catchments down to sub-catchments and reaches of sub-catchments.

In South Africa, catchment management is to be vested in Catchment Management Agencies (CMAs), as required by the National Water Act (No. 36 of 1998). A CMA will be set up for each of the 19 Water Management Areas (WMAs). Within this context, a possible hierarchical structure for the development of prioritisation protocols would be as follows:

- National: at this level, an inventory of the criteria for prioritisation of catchments for protection and rehabilitation are identified. Means of incorporating these into a Multi-Criteria Decision Analysis (MCDA)-type framework, and weighting them where relevant, are developed. Information already available, such as ecoregion, conservation importance and present ecological state, represent inputs to the MCDA, which are then filtered. If the basis for the prioritisation is the restoration of natural capital, as discussed, then decisions should be taken as to what proportion of the country's aquatic resources are required to be in a 'healthy' state (category A or B) in order to supply ecosystem goods and services for the nation (e.g. Rutherfurd et al. 1998). Simplistically, the task at this scale would be to use the MCDA model to rank catchments within each WMA for protection and rehabilitation. Decisions must be taken in terms of levels of protection of current state, and what is allowable in terms of loss of ecosystem integrity.

- Water Management Areas: Once national priorities have been set at this coarse scale, the CMAs are in a position to consult with stakeholders to set criteria for prioritisation of catchments and sub-catchments for protection and rehabilitation. Criteria for prioritisation may differ from one to another CMA, and may include water yield, land-use type, present ecological state, proximity to urban areas, percentage of resource allocated, environmental importance and sensitivity, political and social importance. As catchments may stretch across WMA boundaries, it may be preferable at the national scale to earmark a minimum proportion of each prioritised catchment within the WMA area, for protection and rehabilitation-type activities. Rehabilitation funds and effort are then distributed across a number of smaller areas

- Local and project-level: The priorities which are set by the CMA should influence what happens at a local level. This level may be coordinated by local government (municipalities) within their Integrated Development Plans (IDPs), and the decisions at this level will relate to which sub-catchments and river reaches to prioritise for protection and rehabilitation. This is at a pre-project and a project level. The following issues should be considered:

  - Priorities should be set in terms of how much natural biodiversity (or some other measure of stream health) would be achieved for the money or effort

- Protect what is in good condition before rehabilitating rivers that are already damaged. Once major stream assets are protected, then the focus should turn to improving stream condition.
- It is more efficient to halt deterioration than to address it at a later stage
- Fatal or limiting problems in a stream or stream section should be identified and treated first.
- Identify the most important problems – e.g. the most obvious problems may seem to be eroded banks, but the more serious problem could be water pollution in storm-water runoff (Rutherfurd et al. 2000);
- Attempt to address the source of the problem rather than (or in addition to) the symptom. For example, the cause of channel incision may be increased stormwater runoff – this should be investigated and addressed before the channel incision is addressed.

At a project level, Rutherfurd et al. (2000) provide a procedure for prioritising both between different reaches of the stream being treated, and for prioritising actions within a reach. This procedure has been trialled (Uys in prep.) in a coastal, urban South African river. Based on this experience, it is considered likely that a more systematic, detailed and quantitative procedure (incorporating multiple criteria) is required for this level of prioritisation, particularly due to the low budgets likely to be allocated for river rehabilitation at a local level.

4.4.7 An evaluation of river management projects in SA

There is an old argument that *'in order to know where you are going, you need to know where you have been'*. For a similar reason, it is important to know what has historically been done and what is currently being done in river rehabilitation projects in South Africa. A study in which a number of simple questions are asked about the numerous projects would provide insight into the state of the field in South Africa, and should illustrate which knowledge gaps are critical to address to refine approaches. These questions could include the following:

- What is the primary reason for the project (this is likely to be stormwater management or flood control in many of the urban river cases)?
- Who is funding the project?
- Who is on the project team and what is their field of specialisation?
- What are the objectives of the project?
- Have present and historic ecological state been determined?
- Are ecological objectives and targets being set?
- Is a known rehabilitation method being followed?
- What design has been used to meet the objectives?
- Have bioengineering options been considered?
- What materials are being used in implementation?
- What evaluation is planned?

The recommendation made during the workshops was for a countrywide, standardised evaluation of river improvement, rehabilitation, or management projects done in the past 3-5 years. This is an attempt to establish the state of rehabilitation in South Africa relative to the rest of the world, to record projects, to discuss procedures, and to evaluate both positive and negative outcomes of projects. There was some discussion around the idea that a central register of river-related projects should also be kept at a CMA or local-government level for the following purposes:

- To inventorise all minor and major alterations to rivers in the area;
- To encourage the use of standard methods, consultation with specialist advisors, and setting of ecological objectives and targets; and
- To enable assessment of project process and outcomes (and successes and failures) and to learn from these.

Ideally, both the current and historic project information would be captured on a GIS platform, to eventually build an inventory or database of critical assessments of rehabilitation, remediation, river enhancement, or river protection projects within the country.

Over the longer term, this would assist practitioners in avoiding past mistakes, and in developing criteria for the planning, design, engineering, and evaluation of future projects. It would also provide a method for assessing project proposals.

4.4.8 Development of a DSS for urban stream rehabilitation

The rehabilitation of urban rivers is complicated by the infrastructural and management issues associated with these systems, in the form of water provision, stormwater runoff, flood management, water quality remediation, road crossings, receipt of treated wastewater return flows, etc. It is seldom likely to be possible to initiate a rehabilitation project with purely ecological and social objectives in such a setting. More commonly, urban river renewal will have a joint focus on the improvement of stormwater or sewerage infrastructure, and the simultaneous improvement of ecological function. The field of bio-engineering, which makes use of vegetation together with traditional hard structures, is well suited to this approach (although not yet common practice in many parts of South Africa).

The competing demands on urban rivers result in a suite of considerations and options when considering river protection and management actions. The idea of a Decision Support System to assist in decision-making was discussed during the workshop process, and was felt to merit further research attention. Such a DSS could potentially (and if all permissions were forthcoming) be modelled on a 'Basic Decision Support System for Management of Urban Streams' developed for use in Australia as part of Land and Water Australia's National River Health Programme Urban Sub-Programme (Anderson 1999). This is a software-based classification system for the management of urban waterways. It uses biologically important physical attributes to classify the streams and waterways in terms of asset value, capability for rehabilitation or enhancement, physical and environmental condition, and key constraints limiting restoration. This DSS can be used to:

- prepare an audit on the condition of waterways,
- classify the waterways into various types (extent of modification, habitat types), and
- show how to begin the task of fixing urban streams.

The system has a number of major features:

- It uses a multiple classification system (a series of classifications rather than an integrated one), wherein a database system is used and various derived data can be selected in various combinations to address specific issues.
- Condition ratings for a wide range of habitat and other components are calculated as percentages of the original pristine value, function or utility that is retained. This provides a multi-faceted environmental audit.
- Specific-purpose surveys are required to consistently and completely assess entire catchments, and all the waterways within a drainage network that have a permanent and defined channel.
- The sampling strategy is based on sub-dividing all the waterways in the drainage network into 'homogenous stream sections' of varying length. One or more sites (= reaches) representative of the sections are selected, and these data are applied to the entire section. A local sub-catchment element is defined for each of the sections. The entire drainage network and catchment area are included for a project.
- A total of 13 data sheets, designed for rapid surveys of urban corridors (one site per hour) are completed on site by 'non-expert' personnel who undertake a 2-day training exercise.
- The software system consists of a set of 14 linked databases (one for each data sheet and one for the sections). It also includes programmes for generating the ratings and for producing a comprehensive set of reports, maps, data downloads and other outputs. The outputs that can be produced include: audits of stream corridor condition, report cards, outputs for GIS, skeleton maps, comprehensive statistical maps, bed, bank and buffer zone modification index, baselines for benchmarking, determining trends, rates of change and monitoring.
- It provides a powerful tool for selecting, rating and mapping the condition and suitability of various waterway sections, for various purposes.
- Major evaluation trials of the various components of the DSS have been completed in Brisbane. The outputs of these trials were used to refine the DSS. As an indication of the time requirements, surveys of six catchments were successfully completed within three weeks by five 2-person teams, including City Council staff, university students, and community group volunteers.

In South Africa, many of the methods to be used in this DSS (e.g. sub-division of rivers into segments and reaches, determination of present condition) are already available either under the River Health Programme (www.csir.co.za/rhp/) or within the DWAF Reserve Determination Process (www.dwaf.gov.za/Documents/Policies/). The consideration of additional data collection notably, the river value assessment and the rehabilitation opportunities, constraints, etc.), as required by the Australian DSS, would benefit our rehabilitation development enormously.

4.4.9 Development of teaching courses, post-graduate projects, and consideration of certification

Several universities around the country have already developed short courses on the principles and practice of river rehabilitation (Quinn, pers. comm.). Further development of these teaching modules was considered by workshop participants to be a necessary step in the development of this discipline in South Africa. This situation is reminiscent of the development of Integrated Environmental Management practice and Environmental Impact Assessment methods and practices in South Africa in the 1980s and 1990s. This field is now strongly supported by training courses offered around the country at tertiary and professional levels, and more recently, by certification requirements for practitioners.

The production team of a technical and practical series of guidelines for aquatic ecosystem rehabilitation would be wise to take into account the likely future need for a textbook on this subject at secondary and tertiary training levels. It would however be recommended that at least initially, rehabilitation courses should be developed and taught by individuals with some experience in the field.

The subject of post-graduate projects with rehabilitation themes was raised at one of the workshops. One of the examples of possible (and achievable) projects was to coordinate a 'team' of Honours-level students from History or Life Sciences disciplines around the country, to work on the collection of historic data, maps and information (including anecdotal) pertaining to individual catchments around South Africa. This is a simple means of initiating a large-scale collection of data and information on SA rivers around the country, which could then be captured on a central GIS-linked information system.

Finally, as the global field of 'restoration ecology' is increasingly extending scientific and resource management knowledge, it would be wise to apply standards to the procedures and practitioners. The medium-term plan should be to recommend or require registration of South African practitioners with a professional body, to ensure maintenance of professional standards, and to aim towards certification of practitioners within 5 years.

4.4.10 Continued research and testing of bio-engineering methods

"*The (bioengineering) approach should start from 'zero option' – that simply means leaving the river to its natural evolution (where this is practical and does not have a negative effect on the overall situation). Where there is a real need to make changes, an alternative range of solutions should be considered using living plants or their combination with inert materials such as timber, geosynthetics, and stone-filled woven wire mesh products. The choice has to be made not only in relation to the acting stresses (hydraulic and or geotechnical) and the structural limits of the material , but also in relation to the basic concept of "minimum level of energy". This means that solutions must relate to the problems, avoiding both technical and ethical mistakes, and without excess, all within a multidisciplinary approach where engineers, biologists, botanists and architects do not prevaricate each other. The solution must: supply the immediate required stabilisation; typically use materials that logically increase the performance, from plants to inert materials; and promote a positive evolution (renaturalisation) of the new ecosystem created from the river training works.*'
(African Gabions- Macaferri).

Bio-engineering is an accepted practice in other parts of the world, and is gradually taking hold in certain applications in South Africa, particularly in erosion control and in wetland rehabilitation.

Although the use of gabions for bed and bank stabilisation is still generally the dominant default option, this is increasingly augmented with planting of indigenous grasses, shrubs and trees, and/or natural stabilisation products such as Biomac® and Reinforced Eco-logs®.

The Stream Corridor Restoration Guidelines produced by the US EPA (FISRWG 2000) includes a series of possible designs for a suite of structural interventions into rivers. Typically, bio-engineering options are offered, and these incorporate cuttings of willows and other soft woods. In borrowing these techniques and adapting them for use in South African rivers, it is necessary to investigate the most appropriate indigenous plant types for use in the different applications, and in different regions. Research has already been initiated at the University of Natal (Pietermaritzburg) to ascertain and test regionally-appropriate indigenous plant species for such applications. Extensive further work on this subject is required, and was encouraged during the workshops.

The critical need is for trials of various intervention techniques, particularly those relating to bank and bed stabilisation and weir and fishway design, and - incorporated within these - trials of potentially-suitable indigenous plant types for use in bio-engineering applications.

4.4.11 Development of an index of rehabilitation potential

Although the River Health Programme (www.csir.co.za/rhp/) and the DWAF Reserve Determination Process (DWAF 1999) have been key drivers in the development of indices to assess the physical, hydrological, biological and geomorphological condition of river channels, banks and riparian zones, none of the methods used explicitly address (in semi-quantitative terms) system functionality, trajectory of change, or rehabilitation potential. This was raised and discussed in a number of workshops.

The prioritisation of river reaches (within a catchment or sub-catchment) for rehabilitation would be assisted by data on all three of these variables. There was a recommendation from one workshop that system functionality could be assessed on the basis of biotic community structure, and that an index along these lines should be developed. Means of assessing system function in wetlands are currently in development in South Africa (Lindley, pers.comm. 2004, Marneweck, pers.comm. 2003), and 40 such methods already exist in the US (Bartoldus 1999). In terms of system trajectory, the ability to structure one's thinking and collect present-state information to compare with reference (natural) state information to illustrate whether a reach is stable, degrading or improving, would improve levels of resolution and decision significantly. At present the specialist scientists in the Reserve Determination teams assess trajectory of change on the basis of their data, present state relative to reference/natural state, experience of similar river systems, and expert opinion.

Rehabilitation potential is a complex issue, and would require a knowledge of at least: system value (rarity, representivity, present state, social and ecological importance); system functionality; extent of change from natural; trajectory of change; extent of physical and ecological measures required to restore ecosystem function; likelihood of these being effective; opportunities in this regard (e.g. the likelihood of linking with river management or infrastructure maintenance programmes); constraints (e.g. lack of cooperation from landowners or authorities), and limiting variables (e.g. water quality impairment which may be complex and expensive to attend to).

4.4.12 Terrestrial and riparian zone issues

The terrestrial areas within catchments and the riparian zone of rivers received a fair amount of attention in the workshops, particulary those well-attended by Conservation or Department of Agriculture officials (Knysna, Nelspruit). There are a number of practical issues requiring investigation and experimentation, some of which would be suited to academic research, and others of which require consideration or investigation by conservation and management bodies, supported assisted by policy-creation units. These included:

- Reclamation of selected cultivated lands within the riparian zone. Investigation into the different reclamation approaches adopted (and different incentives offered or levies imposed) around the world was urged. An understanding of the methods used to rehabilitate the cultivated lands would be necessary and could form part of a rehabilitation guideline series.

The effectiveness of incentives offered to, or penalties imposed on, farmers with planted lands abutting the river channel, should be reviewed.

- The fencing of riparian (buffer) zones to allow cattle limited or seasonal access has been used as a protective measure by LandCare projects in Australia. It was queried whether this would work in South Africa (considering the value of fencing materials). This would be an A project to consider this could potentially be co-funded by the South African LandCare (an initiative of the Department of Agriculture).
- Review and study the impact of trees on general river health and social health, with an urban focus. This could possibly take the form of a series of short-term Honours-level projects. Consider particularly the provision of trees in the riparian zone, floodplain area and adjacent open spaces, and areas where grassland savannah was the original biosphere. Provide recommendations and guidelines for the appropriate use of trees in rehabilitation (e.g. when, where, what densities, what species).
- Develop a model to assist farmers and landowners with an analysis of the actual costs of clearing alien vegetation or cultivated lands from riparian strips, and replacing this with indigenous vegetation. A post-graduate research project to capture the response of a range of farmers to the option of reclaiming cultivated riparian lands (under various different scenarios) would be a useful public-participation exercise.

4.5 Concluding remarks

The extensive list of research needs and the priorities presented in Tables 4.1 to 4.3 and Section 4.4 has highlighted a number of areas requiring research, development or application in the field of river rehabilitation in South Africa. As expected, it is largely the activities that support the early development of the field (from a scientific and practical perspectives) that were reiterated in the workshop sessions and have been given priority in this report.

From the general comments during and after the workshops, it seems there remain a number of basic questions which still concern those in the field, including:

- why should we rehabilitate rivers,
- which rivers do we rehabilitate first,
- how much will this cost,
- what are the benefits in the short and long term (cost and cost-benefit);
- how do we value different river ecosystems and how does this value change with degradation;
- what process should be followed in rehabilitation,
- what ecosystem information do we have on which to base decisions on (primary research).

It is important that these and other basic questions be answered at a high level by the relevant government bodies, with the aim of eventual development of a framework, strategy or policy for river rehabilitation.

The outcomes of the workshops indicate that there is a growing awareness of the rationale for river rehabilitation, and a recognition of some of the requirements of this field in South Africa, such as the need for:

- a centralised programme to coordinate research, development and testing,
- an understanding of the values associated with rivers,
- greater cohesion, integration and communication between practitioners within the field,
- legislative and policy frameworks and support,
- increased cooperative governance between key departments,
- more basic information on river ecosystem function and catchment processes,
- guidelines, methodologies and standards for use at project level,
- provincial directories of authorities, key stakeholders, and types of individuals to contact before initiating a project,
- the basic science supporting rehabilitation,
- bio-engineering principles (particularly for urban rivers).

These needs have been expressed by representatives of several sectors, including academia, agriculture, government, management, business, engineering, and consultancy.

It is also clear that the need for integration and information sharing, both within and between organisations (e.g. Working for Water, Working for Wetlands, River Health Programme, River Conservation Programme, LandCare), government departments, local authorities, programmes and researchers is strongly felt. There is a call for this need to be addressed through institutional means, including the enactment of interdepartmental working groups, the establishment of formal communication structures, and the development of an overall communication strategy.

There is also a stated need for increased integration of management, conservation and rehabilitation efforts across different ecosystems within a catchment, and an awareness of the importance of reconnecting different ecosystem components (e.g. improving channel-floodplain linkage) through rehabilitation.

The outcomes of this project were used in defining research needs for the first funding phase of the Water Research Commission Programme for River Rehabilitation (Key Strategic Area 2: Water Linked Ecosystems, 2004/5). The consultation process is felt to have been useful in raising awareness regarding 'what' river rehabilitation is (or should be), 'why' it is necessary, 'how' it should be done, and 'who' is doing it or working towards doing it in South Africa.

To some extent, a small network of rehabilitation practitioners has been informally established through the consultative processes followed in this Project, and it is hoped that the 'Preliminary register of rehabilitation expertise' (Appendix C) will evolve into a useful and formal resource in the future. There is a far greater understanding of the development needs within the field as a result of interested parties having shared their views in workshops. Many voices have been heard, and the critical process of considering future needs and options is underway. A number of representatives of key government departments and relevant funding or development agencies have recognised the implications of attending to rehabilitation development, and the hazards of ignoring the need to make urgent progress in this field. It is hoped that this process, and the cooperative attitude which has characterised interactions, will continue.

The critical importance of integrating approaches to terrestrial, wetland, river and estuarine rehabilitation has been acknowledged and acted upon both by WRC and numerous other parties, and many linkages have been forged between practitioners in these fields. The timing of these interactions has been fortunate, and it is possible that this synergy will be a feature of ongoing development in these fields.

The concluding message is that there is clearly a need for, and enormous value in, investing energy and resources in: the development of a central programme or hub for river (or aquatic ecosystem) rehabilitation, focussed cooperative governance, the creation of structures to enable practical linkage of relevant programmes and processes, the sharing of information and expertise (both national and international), and the initiation of trial rehabilitation projects at a catchment or sub-catchment scale (addressing all ecosystems). Achieving these aims would greatly assist South Africa in addressing the critical needs that exist within the field of rehabilitation.

Table 4.1. RESEARCH AND DEVELOPMENT (R&D) NEEDS.

Results of the consultative process to determine R&D needs in the field of river rehabilitation. Needs are listed under the key research area and focus area to which it has been assigned. They are ranked (PR) from 1 – 6, as described in the text. Suggestions are made for the types of researchers who may be appropriate for the work. The workshops (Wk) at which the research need was raised are coded as: 1 (Knysna), 2 (Cape Town), 3 (Grahamstown), 4 (Pretoria), 5 (Pietermaritzburg), and 6 (Nelspruit, Mpumalanga). The requirement is categorised (Cat.) as R for Research, and RD for Research and Development.

Table 4.1a. KEY R&D AREA: AGRICULTURE

FOCUS	TASK	PR	RESEARCHERS	Wk	Cat
Land cover	Expand land cover assessments to derive better sediment yield models for selected rivers.	2	Postgrad : Agric.	5	R
Reservoirs	Review literature and investigate the use of on-farm storage dams to capture and manage irrigation return flows (include beneficial usage of such dams e.g. aquaculture to finance dams and drainage).	4	Postgrad: Agric.	5	R
Riparian Zones	Experiment with different approaches to the reclamation and stabilisation, or rehabilitation of selected cultivated riparian areas. Investigate the perceptions of farmers regarding compensation for riparian land presently under cultivation. Consider and document the alternatives to cultivation. Review the international literature regarding riparian reclamation. Report on the effectiveness of various riparian rehabilitation measures, and the potential for introducing policies and incentives for rehabilitation of these areas in the future.	2	Research Team	1 4	R
Riparian Rehabilitation Costs	Develop a model to assist farmers with calculating the actual costs of clearing alien vegetation from riparian strips, and planting the cleared areas with indigenous vegetation, or rehabilitating riparian strips presently under cultivation through replanting.	1	Research Team: Agricultural Economics	4	R

Table 4.1b. KEY R&D AREA: ECONOMICS

FOCUS	TASK	PR	RESEARCHERS	Wk	Cat
Bargaining Tools	Develop the capacity and the information-base to enable bargaining with confidence about the various values that rivers have (economic, recreational, environmental, social, cultural etc), within the catchment or river management arena.	1	R&D Team	3 4	RD
Cost-benefit of DWAF categories	Analyse the cost-benefit of having a river in a particular DWAF category. Link this output to the present DWAF classification system.	4	DWAF, RDM Office	5	RD
Cost-bearing	Review the international literature to establish who, typically, bears the costs of river rehabilitation planning and projects, and post-project evaluation and maintenance. Take into account catchment-based costs, and benefits of rehabilitation. Also consider different forms of levies, and incentives. Make recommendations as to how this could work in SA	1	Postgrad: Resource Economics	4	R
Cost-benefit of rehabilitation	Undertake cost-benefit calculations (in terms of actual costs, environmental costs, and tangible and intangible benefits to environment and society), and assess the costs of 'doing' versus the costs of 'not doing' (in terms of risk reduction and potential damage-loss reduction). Develop a means of formalising cost-benefit analyses such that they can be used to argue for bioengineering type interventions rather than conventional hard engineering options.	1	Research Team:Life Sciences /Economics	2	R
Costs of interventions	Assign actual costs to different rehabilitation actions per unit area.	1	Postgrad:Life Sciences /Economics	2 3 4	R
Levies in river rehabilitation	Research the use of environmental levies in river and riparian protection and rehabilitation in other parts of the world.	2	DWAF Riparian Protection Policy development	1 4 5	R

Table 4.1b KEY R&D AREA: Economics *Cont.*

FOCUS	TASK	PR	RESEARCHERS	Wk	Cat
Effect of degradation & rehabilitation on property values	Review literature and undertake an analytical study or questionnaire-based study regarding the changes in real estate and business location values brought about by (i) river degradation and associated security risks; (ii) river improvement, provision of recreational amenities, and improvement of security. Focus on economic changes that can be associated with the ability of a waterway to create a higher quality of life for the area in which it is located.	2	Research Team incl. Property Expertise	4	RD
Return on investment from rehabilitation	Develop an economic model (based on experiences in other parts of the world, and based on local economic drivers) to quantify the environmental return from rehabilitation or bio-engineering interventions relative to that from conventional river engineering methods; and the costs of 'not doing' anything (both invisible and real costs). This should be effective in providing a rationale for why investment in rehabilitation is possible and desirable.	1		4	R
System valuation	Determine the social and environmental values (or ranges of values) of river systems.	4	Research: Resource Economist	3	R
Total costs of rehabilitation	Review and analyse the costs involved in rehabilitating urban rivers and non-urban rivers. What costs are saved by ensuring system/resource reliability through rehabilitation or remediation? Develop a method for cost-benefit assessments of various rehabilitation exercises and projects. Include risk-based assessment.	1	PhD: Life sciences, economics or engineering	3,4	R
Tourism	Make links with the tourism industry, and illustrate to tourists the benefits of river rehabilitation on the environmental quality of life.	4	Representatives of DEAT	4	D
Economic value of rehabilitation in urban rivers	Undertake a review of the literature relating to the economic effects of both degradation of, and improvement to, urban rivers.	1	Postgrad.: Economics	4	R

Table 4.1c KEY R&D AREA: ECOSYSTEMS

FOCUS	TASK	PR	RESEARCHERS	Wk	Cat
Assets and Problems	Decide what are assets and what are problems in a river system. Build on existing information. Define different types of 'assets' (in terms of a river and its riparian zone). As a pilot study, identify, in one river, the assets in the system. Make provision for collective data storage. Develop means of representing these assets on different map types. Recommend a change in the requirements of field data - such that, for example, RHP practitioners when in the field also list assets and problems and this output is added to the RHP State of the Rivers output.	6	Postgraduate. : Life Sciences	5,6	R
Creation of desired state	Develop a clear definition of what river characteristics and processes will support the creation of a desired state, or a move in the direction of a desired state.	2	Senior Researcher: Life Sciences	4	R
Ecological endpoints	Develop, iteratively and based on literature reviews and workshopping, a set of broad criteria for the ecological endpoints for rehabilitation of urban and non-urban rivers.	3 ,6	R&D Team	4	D
Factors driving degradation (focus on sedimentation)	Revisit or derive basic understanding of factors driving degradation and possible rehabilitation at appropriate scales. This requires that research be undertaken on basic river processes and functions. This is a broad field, but it was suggested that probably the most important issue is sedimentation and the modelling of sediment regimes and changes to them as a result of poor farming practices and the building of dirt roads, bridges, culverts, etc.	1,6	Research Team	6	R
Fish (endangered and exotic)	Map the extent of endangered fish populations; map the extent of exotic fish within those; establish alien fish eradication programmes; develop a method for eradication and monitoring of alien fish. Identify appropriate management interventions regarding alien fish.	4	Research Team and Institutional	3	RD
Fishways	Link river rehabilitation research programme (RRP) to the WRC Fishways Project, with the eventual aim of installing fishways in migration barriers in rivers	1	River rehabilitation programme and Fishways programme representatives	6	D

Table 4.1d KEY R&D REA: ECOSYSTEMS *Cont.*

FOCUS	TASK	PR	RESEARCHERS	Wk	Cat
Indicator organisms	Investigate the use of biological communities (particularly invertebrates) as indicators of diversity and of system functionality. Use this information alongside, or in a similar sense to, typing or classification.	1	Research Team	3	R
Litter collection and removal	Review international and national literature on different methods of litter collection along river courses (including recycling and disposal). Consider artificially-constructed methods, natural methods, and contrived methods for both, versus assisted methods for both. If possible, research (via case studies for example) the effectiveness of various treatments already in situ.	1	Research Team	4	R
Prioritisation	Develop a method for the prioritisation of rivers for rehabilitation. Identify and map broad river rehabilitation requirements at a national scale.	1	Research Team; working with agencies and programmes	3	RD
Reinstatement of natural form	Review existing methods for reinstatement of natural form to highly modified channels. As a case study, plan and cost the reinstatement of a natural channel where highly modified channels presently exist, either in a rural environment, or in an urban environment (particular reference was made to the Crocodile West/Marico Catchment Management Area where intensive aggregation of different sectors has taken place over time).	1	Postgraduate: Life sciences, engineering	Ext	RA
Reserve Determination	Trial the inclusion of non-flow related issues in the Reserve Determination, such that rehabilitation comes into play.	1	R&D Team	4	ADR
Riparian trees: Effects	Review and study (possibly on the basis of case histories) the impact of trees on general river health and social health in an urban focus. Consider particularly the provision of trees in the floodplain area and adjacent open spaces of the riverine zone; and areas where grassland savannah was the original biosphere. Provide recommendations for where and when trees are appropriate for use in rehabilitation, in what numbers, and what species.	1,6	Research team	4	R

Table 4.1d KEY R&D AREA: ECOSYSTEMS *Cont.*

	TASK	PR	RESEARCHERS	Wk	Cat
Riparian Zones: Inventory	Develop, initially at a small scale, an inventory of riparian zones (natural and present state). Develop methods for prioritisation of riparian zones for protection and rehabilitation.	2,6	R&D team working with DWAF RDM office on Policy for protection of riparian zones	6	RD
Riparian Zones: Rehabilitation	Develop a long-term plan for the rehabilitation of riparian zones, particularly targeting those affected by agricultural practice.	2	R&D team working with DWAF RDM office on Policy for protection of riparian zones.	6	RD
Riverine & Riparian Zone (Delineation)	Develop methods for defining the outer effective limit of the Riverine Zone in urban and rural environments. Take into account the following condition classes: highly modified, slightly modified, unmodified. Possibly extend this to different stream orders and different regions.	1/ 4	Research team	1 4	RD
Root architecture	Prepare engineering specifications for the use of vegetation in erosion protection. Alongside and linked to this, undertake research on the root architecture of plants. (*Background: According to George Annandale (pers.comm 2003), in the US, Engineers calculate the root architecture and habitat requirements for plants that could be used to protect against erosion/scour. The rehabilitation ecologist then selects the plants with the appropriate root architecture and habit. Following this approach they have found that there is not a great deal ,known about the root architecture of plants. This is a research topic that they wish to promote in the US."*	1/ 4	Dual research team: Engineer and plant scientist	Ext	R
Sand budgets	Characterise sand budgets for a selected rivers, and integrate with catchment-scale sediment yield and sediment transport measurement.	2	Postgraduate: Geomorphology/Agric	5	R
Water quality	Develop a uniform water quality grading, which is understandable and is bought into by the local community	4	Research with DWAF	4	RD

Table 4.1d KEY R&D AREA: ECOSYSTEMS *Cont.*

FOCUS	TASK	PR	RESEARCHERS	Wk	Cat
Water quality	Research water quality improvement by natural means and processes, either artificially boosted (e.g. chemically) or not. Investigate in-stream treatments relative to extra-stream treatments. Give consideration to natural gravitational flows, artificially reversed flows, and the pros and cons of re-circulated flows.	2	Research team	Ext.	R
Water quality terminology	Translate water quality guidelines and scientific measurements into formats which are understandable by the public.	4	DWAF	4	D
Wetland beneficiation	Study the environmental, social and economic benefits accruing from a rehabilitated or artificial wetland within an urban environment (case study). Within or outside of this project, design methods of assessing effective beneficiation (include non-academic measuring).	4	Working for Wetlands	Ext.	RA
Wetlands for water purification	Review international literature on the use of wetlands and artificial wetlands for water purification. Research, over a period of 3-5 years, the effects on water quality of both natural rehabilitated wetlands and of artificially built wetlands uality. Of particular importance is the degree to which contamination (due to poor incoming water quality) occurs over time and can affect wetland function.	4	Working for Wetlands	Ext.	R

Table 4.1d (i) KEY R&D AREA: ECOSYSTEMS (CLASSIFICATION)

FOCUS	TASK	PR	RESEARCHERS	Wkshp	Cat
Applicability of rehabilitation actions	Expand present core-classification research to investigate the applicability, viability and effectiveness of different rehabilitation measures in a range of climatic, terrain, and land-use environments.	3	Research team	5	R
Goods and services classification	Document the goods and services of a river in a particular class. Link this output to the present DWAF classification system.	4	RD Team	5	RD
Index of degradation	Develop an index which provides a score for the degradation of the riverine section, based on a number of criteria. This should become part of an SoE monitoring exercise, and should link to the present DWAF classification system.	1	RD Team	2 3 4	RD
Integrated classification system	This is the basis for the prioritisation of systems for conservation and for rehabilitation. The research need in this case is for (i) an assessment of the practical value of different classification systems presently in use; (ii) development of a system which types rivers or river segments on the basis of their system values (in terms of rare biota, habitat representivity, etc); present trajectory of change; rehabilitation and/or recovery potential; system functionality (as demonstrated by indicator biotic communities; and risks to and from the system; (iii) integration of present functional river biophysical river classification systems, such as the Ecoregional Classification (Thirion & Kleynhans in prep.), the Resource Classification of Department of Water Affairs and Forestry (DWAF), and the river signatures concept of the River Conservation Programme (Roux, pers. comm.), with the system/s developed in (ii). It was recommended that in developing such a classification, attention should be paid to working at a coarse rather than a fine scale initially. Consider a DSS.	1	R&D Team	3 5	R&D

Table 4.1d (ii). KEY R&D AREA: ECOSYSTEMS (MONITORING AND EVALUATION)

FOCUS	TASK	PR	RESEARCHERS	
Audit system	Develop an audit system for river rehabilitation or remediation projects. This would require that there were three steps: monitoring, reporting and acting on the information thus reported. The development of key performance indicators would assist this step.	1/6	Review existing.	5
Criteria and process	Develop a criteria and process for monitoring rehabilitation implementation. Evaluate case studies of projects already undertaken in SA and elsewhere, particularly in terms of successes and failures.	1/6	Review existing.	5
Experimental evaluation of project success	Research the criteria for a valid scientific experiment to evaluate the response of a river system to interventions which form part of a river rehabilitation project. There are many issues here, one of which was raised at the Cape Town workshop: that often these projects are undertaken at the lower end of catchments in high-order streams, where there is a great deal of activity (other than your intervention) affecting the system. How does one evaluate the system response to your intervention in terms of a few select variables, and eliminate the 'noise'?	1/6	Research team with collaborative links	2
Success of structures	Filter literature and overseas network for monitoring tools which will assist in evaluating the success of new 'habitat' structures (on beds or banks). Links with wetlanders and individuals studying fishways.	1/6	R&D Team	7
Techniques	Develop/refine appropriate monitoring technologies to measure the success and failures of rehabilitation. Apply and monitor rehabilitation on test catchment basis. Develop a programme to coordinate and guide monitoring activities.	1/6	Review existing	4 ,5

Table 4.12d (iii). KEY R&D AREA: ECOSYSTEMS (PRIORITISATION)

FOCUS	TASK	PR	RESEARCHERS	Wk	Cat.
Prioritisation	Develop a system wherein rivers are classified and prioritised for river rehabilitation (at national-regional and local scales). This should be based on multiple criteria, including trajectories of change (this requires some understanding of how to determine trajectory of change of a system), and available information regarding historic, present and attainable states. Use legislation already in place to get started with the rehabilitation of the priority rivers. Prioritisation should consider the available funds and how most effectively to distribute them.	1	RD Team (National level). Work with RHP and River Conservation Project. Review existing prioritisation protocols.	6	RD
Prioritisation for fishways	Develop a method for prioritising rivers for rehabilitation and fishway construction. Link to the WRC Fishways Project.	1	R&D Team	3	RD
River types	Establish and prioritise the rehabilitation needs of rivers or river sections fitting into the present DWAF river categories.	1	R&D Team	5	RD
Tier System for Prioritisation	Develop a tiered system for defining river state and status. This should then be used to set objectives for rivers. For example, Tier 1 may be for rivers for protection and conservation, based on a number of criteria. The objective for these may be to return to as close as possible to natural state. Tier 4 rivers may be considered to have attained a new physical and ecological state, and the objective for these may be simply to ensure they are not degrading further, and ultimately to return some ecological structure and function to the system. Obtain simple measures for assessing the current status, assigning the Tier level, and determining what would improve the system, and/or what is the natural system (like delineation model for wetlands). This should be implementable by landowners (i.e. in smaller rivers).	1	R&D Team	3	RD

Table 4.1e (i). KEY R&D AREA: INFORMATION-TRANSFER: GUIDELINES AND PROTOCOLS

The requirement for guidelines to address different aspects of rehabilitation was one of the dominant themes of the workshops. It is assumed that were comprehensive guidelines to be written for river rehabilitation, they would address a wide range of issues including those recorded here.

FOCUS	TASK	PR	RESEARCHERS	Wk	Cat.
BMP for urban rivers	Develop a guideline for best management practices in urban rivers. This should in the future be included at some level in policy.	1/6	RD Team	5	RD
CEPA	Develop guidelines for community capacity building; for harnessing community participation, involvement, and responsibility (ownership/management); and for changing social and cultural perceptions of river value through education.	1/6	RD Team	5	RD
Checklists	Develop a series of checklists for both the management of a rehabilitation project, and the science of a project.	1/6	RD Team	2	RD
Community objectives	Create formats which support the development of community-based (urban and rural) objectives for river rehabilitation, and the articulation of these needs in such a way that they both become incorporated on the agenda and translated into technical.	1/6	RD Team, Review existing	4	R
Comprehensive	Develop comprehensive guidelines for river rehabilitation at both national and at regional levels. These should address processes and the criteria for different interventions.	1/6	RD Team	3, 6	RD
Conflict resolution	Develop guidelines for prioritising or resolving conflicts which arise between social and ecological objectives.	1/6	RD Team	4	RD
Controlling authorities and stakeholders	Develop a set of directions regarding who to contact at the beginning of a project to ensure that the relevant controlling authorities have been informed of intentions, and what organisations and individuals to contact to ensure that a stakeholder group representing all interests in the catchment is established.	1	RD Team	2	RD

Table 4.1e (i). KEY R&D AREA: INFORMATION - TRANSFER – GUIDELINES AND PROTOCOLS *Cont.*

FOCUS	TASK	PR	RESEARCHERS	Wk	Cat.
Cost of individual interventions	Develop a guideline of the costs of individual interventions involving structures such as fishways, or materials such as gabions, reno mattresses etc. Alternative options and classical solutions should also be costed for comparison.	1/6	R&D Team	2	RD
Dam removal	Develop guidelines for what sort of dams should be removed and how. Note that the DWAF Dam Safety Regulations are currently being rewritten.	1/6	RD Team	6	RD
Engineering infrastructure	Develop guidelines and costings for the upgrading and/or rehabilitation of aging infrastructure. Introduce new conceptual approaches, and verify with case studies (e.g. daylighting of rivers). Provide alternatives to classical engineering practices (e.g. encourage the use of trenchless technology). Provide motivations (including economic) for the use of these alternatives.	1	RD Team	4	RD
Engineering BMP in urban rivers	Develop guidelines for BMP for stormwater, flood control and sewerage engineering related to urban rivers.	4	RD Team	5	RD
Financing	Provide guidelines for mechanisms for financing rehabilitation.	1	RD Team	5	RD
Floodplain developments	Investigate and review literature on developments (formal and informal) on flood plains. Produce a guideline which both documents the impacts of such developments and provides alternatives.	1	RD Team	5	RD

Table 4.1e (i). KEY R&D AREA: INFORMATION-TRANSFER: GUIDELINES AND PROTOCOLS *Cont.*

FOCUS	TASK	PR	RESEARCHERS	Wk	Cat.
Goal-setting	Within the comprehensive guidelines, provide guidance for the setting of attainable goals and objectives in a river rehabilitation project. This research need links in to the greater process of developing overall guidelines for river rehabilitation.	1 6	RD Team	2	RD
Goods and services	Explicitly link river rehab goals to societal needs by supplying stakeholders and participants with information relating to goods and services.	1 6	RD Team: Review existing	4	RD
Habitat and flow regulation	Develop guidelines to focus on creation of habitat and flow regulation.	1 6	RD Team	3	RD
Hydraulic and hydrological info.	Provide information on the means of gathering existing hydraulic and hydrological information on a system.	1	RD Team	5	RD
Identifying rivers for rehabilitation	Develop a protocol for inclusion in the comprehensive guidelines, which addresses the identification of rivers for rehabilitation: what are the criteria for rehabilitating? Which factors should one consider? How does one prioritise? This should be evaluated on the basis of international models and modified to fit South African conditions.	1	Review and adapt available literature.	4	RD
Institutional roles and responsibilities	Clarify the roles and responsibilities of different local, regional and national authorities or institutions (following available legal frameworks). Define the roles of each (i.t.o legislation). Identify relevant expertise in these organisations and encourage involvement early on in a project.	1	RD Team	5	RD
Integration of project team and stakeholders	Create mechanisms for maximising communication and synergies between different organisations or groups working on different problems in the river simultaneously.	1	RD Team	2	RD

Table 4.1e (i). KEY R&D AREA: INFORMATION-TRANSFER: GUIDELINES AND PROTOCOLS *Cont.*

FOCUS	TASK	PR	RESEARCHERS	Wk	Cat.
Legal	Develop a policy guideline to define what rehabilitation is, in terms of the law, when it is required, what it involves, and when it is complete (i.e. when does one's responsibility to the process end and what happens then). Identify laws, regulations, bylaws etc relevant to the fields of river remediation and rehabilitation; spell out of what the legal requirements are and ramifications are to an individual wanting to intervene in a degraded river; . This must provide information from the level of national legislation down to local bylaws and regulations. It should also provide directions as to exactly what a practitioner is required to do from a legal perspective, how to go about it, who to contact, what documentation and permission is required or desirable, what the risks may be, etc. Provide a listing per region and regional authority area of local departments, their jurisdictions, what their roles are in the catchment, and how to contact them. Include information on compliance mechanisms to simplify the EIA process.	1	RD Team	6	RD
Lessons learnt	Identify the lessons learnt in a selection of rehabilitation projects, so that information can be applied elsewhere with focus on the process, and not generating cookbook guidelines.	1/6	RD Team	6	RD
Mapping	Provide guidelines for different mapping requirements, techniques and software.	1/6	RD Team	5	RD
Post-project maintenance	Guidelines, mechanisms and requirements for maintaining and protecting built and environmental assets created as a result of river improvement or rehabilitation efforts.	1/6	RD Team	5	RD
Post-project monitoring	Develop (through review and practical application) a guideline for the monitoring requirements once river rehabilitation interventions are complete. These should be both practical and implementable.	1/6	RD Team	6	RD

Table 4.1e (i). KEY R&D AREA: INFORMATION-TRANSFER: GUIDELINES AND PROTOCOLS *Cont.*

FOCUS	TASK	PR	RESEARCHERS	Wk	Cat.
Post-project monitoring	Guidelines and requirements for monitoring and evaluation of project outcomes, using appropriate methods and a range of indices, and based on appropriate criteria for success. This requires that criteria or ranges of what constitutes project success be researched and developed.		RD Team	2	RD
Problem identification	Guidelines as to how to identify problems and their causes in rivers, particularly urban rivers, and following from this, guidelines for alternative ways of addressing these problems within the context of a river rehabilitation plan. This should lead to the development of a Decision Support System (DSS).	1/6	RD Team	2	RD
Rehabilitation post sand-mining	Develop practical guidelines for the rehabilitation of sand mining projects on river banks and in-channel. Provide species lists and planting plans. Include a practical component such as a set of experiments or trials to determine best practice mechanisms in different areas with varying geophysical conditions.	1/6	RD Team	1	RD
Reserve Determination	Further identify and develop action plans to address the points of linkage and of overlap between river rehabilitation and DWAF's Reserve determination process	1	RRP, DWAF	4	D
Resources	Within comprehensive guidelines, create an awareness of the importance of food supply both to a river's fauna and to those humans depending on the system.	1/6	RD Team	3	RD
Revegetation	Develop a guideline for the appropriate techniques and species to use in revegetation of the riparian zone, and guidelines for the drafting of comprehensive planting plans.	1/6	RD Team	4	RD
Riparian zone management	Prepare guidelines for the management of buffers and riparian zones (SA specific; width; species/structure)	4	RD Team with DWAF RDM office	5	RD

Table 4.1e (i) KEY R&D AREA: INFORMATION-TRANSFER: GUIDELINES AND PROTOCOLS *Cont.*

FOCUS	TASK	PR	RESEARCHERS	Wk	Cat.
Post-project monitoring	Develop guidelines and requirements for monitoring and evaluation of project outcomes, using appropriate methods and a range of indices, and based on appropriate criteria for success. This requires that criteria or ranges of what constitutes project success be researched and developed.		RD Team	2	RD
River valuation	Within a comprehensive RR guideline, provide a value to rivers of different importance and state. The criteria for these values would have to be economic, physical, biological, social, political.	1	RD Team	6	RD
Rural Water Quality Reporting System	Convey to authorities the need for physical and chemical reporting systems which are usable and understandable by rural communities.	2	RRRP to discuss with DWAF(IWQS)	4	D
Stakeholder participation	Guidelines for a structured means of interacting with stakeholders in projects, including lists of who should be included on stakeholder forums, how often it may be desirable to meet, creative means of harnessing stakeholder efforts, etc.	1	RD Team	2	RD
Storms or flood treatment and attenuation	Develop guidelines for, and trial, various measures for floodplain rehabilitation.	1	RD Team	4	RD
Structural materials	Assess the suitability of different structures for bank, channel or river rehabilitation actions, through case studies and review. On the basis of the outcome of this assessment, develop, over time, a guideline for the use of small structures and that have (in individual projects) been evaluated as successful, both structurally and ecologically.	1 6	RD Team	3	RD
Stuctures	Develop a toolbox of methodologies for intervention, plus guidelines for where and when to use these. Develop guidelines and designs for appropriate structures to be used in the course of remediation or rehabilitation.	1 6	RD Team	1	RD

Table 4.1e (i). KEY R&D AREA: INFORMATION-TRANSFER: GUIDELINES AND PROTOCOLS *Cont.*

FOCUS	TASK	PR	RESEARCHERS	Wk	Cat.
Urban rivers	Develop a guideline for present and future impacts of development on our urban rivers. Develop detailed urban river rehab guidelines. Include the reduction of storm water runoff in urban areas e.g. placement of more green absorption buffers, swales.	1 6	RD Team	5	RD
Water quality effects	Develop an information series on the effects of pesticides and fertilizers on water quality.	4	DWAF & RRP	4	RD
Water quality impacts	Identify and draw up a protocol for how specific water quality impacts can be ameliorated (mining effluent, agric return flows, siltation, salinisation, sewerage)	4	DWAF and RD Team	3	D
Water quality remediation	Develop guidelines for appropriate practices designed to remediate water quality, such as artificial wetlands, buffer zones, bioremediation, etc. These should be incorporated into a DSS which informs which option will be most effective at a particular site.	4	RD Team	4	RD
Water quality: BMP	Provide information for standardised best management practices in both water quality data collection and in reporting.	4	RD Team	4	RD

Table 4.1e (ii). KEY R&D AREA: INFORMATION-STORAGE: DATABASES, INVENTORIES

FOCUS	TASK	PR	RESEARCHERS	Wk	Cat.
Catchment Information System	Develop a web-based, password-protected information system (on a GIS platform) for the major catchments per region. This website would serve as a 'clearing house' for information relating to this/these catchment/s, including ecoregions, land-use, hydrology, vegetation, geology, historic and current projects in the catchment (and their data), historic, current and future development descriptions, historic and present planting and afforestation in the catchment, etc.	2	RD Team with buy in from various government Departments	1 5 6	RD
Database of bio-engineers	Develop a database of expertise in the field, and their localities. Include recommended bio-engineering practitioners in SA.	6	Already underway	1 6	R
Inventory of catchment histories	Create an inventory of the history of selected catchments from pre-impact conditions through to present day, incorporating where possible, photographic records, plans, maps, historic information and anecdotes of developments throughout the catchment and of the river and its banks through time. Initially this could be done for a number of small catchments, with the longer-term aim of a national inventory of river history for major rivers. Produce a simple guideline on how to go about reconstructing historic state of a system.	1	Initially postgraduate History / Life Sciences students, compilation by larger team.	2 5	RD

Table 4.1e (iii). KEY R&D AREA: INFORMATION-SYSTEMS and DSS

FOCUS	TASK	PR	RESEARCHERS	Wk	Cat.
DSS for appropriate technology and BMP	Develop a DSS which informs, at a particular site, which of the appropriate technology choices and options is likely to be the best practice. Provide steps for manually valuating or selecting the best practice.	3	RD Team	5	
DSS for rehab in agricultural areas	Develop a DSS for the remediation of rivers and riparian zones affected by different types of farming and forest activities.	3		6	
DSS for river rehabilitation	Develop, over time, a DSS for rehabilitation of rivers in urban and non-urban areas, in different regions and different land-use types.	6	Review existing.	1 5 6	
DSS for scenario planning	Develop a DSS which, on the basis of an input of objectives and desired quantifiable outcomes (e.g. the target water yield for the river within a period of 5 years), displays the end-point and/or a number of scenarios. This should allow one to plan different rehabilitation scenarios just by changing certain inputs. This needs a highly graphic front end for use with communities.	3	RD Team	3 5 6	
DSS for trajectories of change	Develop a DSS to assist in understanding and identifying trajectories of change of rivers, and the impacts of our interventions in rivers.	3	R&D Team	3	
Scenario model: impact of action and inaction	Develop a model to predict, or generate scenarios regarding, the biological and physical consequences of action (intervention in a rehabilitative sense) and of inaction in a degraded river system.	3	PhD: Life sciences with modelling exp	4	

Table 4.1f KEY R&D AREA: *INSTITUTIONAL*

The majority of concerns in this category fall in the ambit of Development and are recorded in Table 4.3. Only one concern that could be addressed directly by Research was recorded.

FOCUS	TASK	PR	RESEARCHERS	Wk	Cat.
Map institutions and links	Develop a map of institutional authorities, links, present synergies, histories, possible future lines of cooperation and avenues (directorates) which would be most effective way to pursue this, etc.	1	Collaborative exercise	6	R

Table 4.1g KEY R&D AREA: INTEGRATION

The concerns regarding integration also need to be addressed by Development and Application, and are presented in Tables 4.2 – 4.4.

Table 4.1h KEY R&D AREA: MINING

Only sand mining was raised as a concern during the consultative process.

FOCUS	TASK	PR	RESEARCHERS	Wk	Cat.
Sand mining	Assess the adequacy of licensing of sand mining, in the light of channel sedimentation requirements and the capacity (or non-) of the channel and banks to recover after required rehabilitation steps.	2 .	Post graduate research: geomorphologist	1	R

Table 4.1i KEY R&D AREA: POLICY

The majority of the concerns regarding policy are addressed under Development (Table 4.2).

FOCUS	TASK	PR	RESEARCHERS	Wk	Cat.
Drainage bylaws	Review international and local drainage laws, regulation and bylaws in the light of water quality objectives and river protection and rehabilitation, and provide recommendations for further adjustments to the local laws.	3	Postgraduate: law; engineering	1	R
Policy review and framework	Review all available policy relating to river conservation, management and/or rehabilitation. Make recommendations for the development of a robust policy and legislative framework / environment to facilitate and support rehabilitation. This policy framework is a fundamental need for aquatic ecosystem rehabilitation (e.g. Maher et al. 2000). Ensure that this is based on the integration of all presently available laws, policies and regulations. Establish landowner responsibilities regarding the river and its riparian zone, in terms of present legislation. Encourage the roll-out of present policy (e.g. CMAs). Summarise this information and transfer to practitioners and others, for example Catchment Management Forums.	1	Researcher: environmental law	1 2 3 4 5 6	RD

Table 4.1j KEY R&D AREA: POLITICAL

The majority of concerns in this area are addressed under Development (Table 4.2).

FOCUS	TASK	PR	RESEARCHERS	Wk	Cat.
Winning Political Support	Determine the mechanisms by which local political support has been won for protection of riverine environments, and how these needs can be prioritised in the budget.	1	Postgraduate: Life sciences	4	R

Table 4.1k KEY R&D AREA: SOCIAL and CEPA (Communication, Education, Public Awareness)

FOCUS	TASK	PR	RESEARCHERS	Wk	Cat.
Addition of Social Value (Poverty alleviation)	Assessment and case-studies of means by which social value has been added to catchment problems through projects such as Working for Water, and how value could be added to the rehabilitation effort, through training and capacity-building of volunteers, creation of secondary industries; optimisation of poverty-relief potential; offering incentives and non-related benefits; and building awareness at many different levels.	1	Researcher (link to Working for Water); Development through collaboration with WfW	2,6	RD
CEPA	Launch an initiative to raise community awareness and provide education regarding river rehabilitation and remediation. Identify community problems through consultation. Identify common types of community needs and goals for their rivers.	1	RRP in collaboration with Relevant Depts and Media; Research Team; Review existing	5	RD
CEPA	Create awareness about need for river rehabilitation and the value importance of rivers in terms of the goods and services they provide.	1	Linkage with various media	6	D
Human health	Research how river degradation impacts on human health, and conversely, the effects of river rehabilitation on human health.	3	Researcher: Life Sciences or Medical	4	RD
Indigenous knowledge practices	Clarify, through linkages with appropriate indigenous people's knowledge programmes, the objectives for the spiritual uses of parts of rivers. Ensure that this is recorded in guidelines.	1	Linkage with IPKP	5	RD
Practitioner training	Develop a certificated teaching and practical course to train and certify rehabilitation practitioners.	3	Collaborative exercise; best to be undertaken after guideline production	Ext	R&D

Table 4.1 k KEY R&D AREA: SOCIAL and CEPA (Communication, Education, Public Awareness) *Cont.*

FOCUS	TASK	PR	RESEARCHERS	Wk	Cat.
Recreational	Develop a model with which to assess recreational carrying capacity of unit areas of rivers and estuaries	3	Research Team	3	R
Round-tabling	Create structures and plan formats to enable role player involvement at all stages of the process (possibly in different formats). Develop stakeholder participation protocols.	2	Research Team. Review existing.	3	R
Social effects of rehabilitation	Undertake a review and study the potential social effects of river rehabilitation, both in the urban and non-urban environments, in terms of: temporary and permanent job creation (economic beneficiation); provision (growing) of raw materials for indigenous crafts; alleviation of poverty; provision of community recreational facilities; the pros and cons of utilising floodplains for recreational areas; and the associated safety issues (before, during and after flooding).	3	Researcher: Link with WfW	4	R
Social importance	Social side: assess the social importance of rivers in terms of tourism (birds, fishing, etc). Develop the capacity to argue with confidence about the values that rivers have in the river management arena.	1	Research: Link to DEAT	3	RD
Stakeholders	Undertake research on the goods and services provided by rivers, drawing in catchment communities to gather their inputs on which of these are considered important.	6	Review existing	7	R
Student training	Develop a short course on river rehabilitation to be included in primary, secondary and tertiary level education.	3	Collaborate with Dept. of Education	5	R&D
Valuation of alien eradication	Analyse, through literature review, case studies and consultation, the various values of alien plant eradication in urban and non-urban areas (economic, ecological, aesthetic).	1	Collaborate with WfW	5	R

Table 4.1l KEY R&D AREA: STRUCTURAL

FOCUS	TASK	PR	RESEARCHERS	Wk	Cat.
Assessment of technical and structural effects of remediation and rehabilitation	Undertake a critical review using case studies of the potential scientific, environmental and technical results and effects of river remediation and rehabilitation, both in the urban and non-urban environments, in terms of: water quality remediation, remediation of in-stream fauna and flora, remediation of channel, banks and floodplain, flood control, remediation of riparian fauna and flora.	1	Post graduates: Life sciences, engineering	4	R
Benefits of the technical/scientific and vegetation effects on riverside communities	Assess the beneficiation accruing as a result of the effects of both increased number of trees on the river banks, and improved technical aspects of the river post-rehabilitation. Are the benefits superficial or can real social impacts result, in terms of: economics, social welfare and societal health; reduction or increase in crime; educational opportunities (increase of environmental awareness, basic life skills education etc)?	3	Researchers: Life sciences, Resource economics. Review existing literature	4	R
Dams	Develop a rationale for the removal of small dams, weirs, bridges that have no functions. This requires intersection with the scientific community which has experience in the removal of small dams and the consequences thereof.	2	Team, including DWAF, DEAT, NDA	7	RD
Roads over rivers	Develop an inventory of roads in both a rural and urban areas of a single catchment, using a GIS platform. Research the effect of a number of different types of road crossings on rivers over the space of 2-3 years, in terms of obstructions to flow, undercutting, sediment input, bank destabilisation etc. This relates particularly to sedimentation effects caused by construction activities, and specifically the building and poor rehabilitation of coffer dams during construction. A study should include a cost analysis of planning and construction methods and materials, and an investigation of alternatives being used around the world. This project should review mechanisms for upgrading roads and make recommendations for upgrading, for improved design features on new roads, and for minimising road crossings within the catchment.	1	Research Team: GIS, Engineering, Life Sciences	7 & Ext	R

Table 4.1l KEY R&D AREA: STRUCTURAL

FOCUS	TASK	PR	RESEARCHERS	Wk	Cat.
Structural materials and small structures	Identify through review and investigation the material and biological alternatives to classical engineering for structural developments. Research and trial selected small structures for channel and bank stabilisation, which promote habitat diversity without increasing flood risks in urban rivers.	1	Researcher: Engineer	5	R&D
Urban runoff	Review literature and investigate the use of gutters and rain tanks for the reduction of urban flooding and the improvement of stormwater drainage.	4	Researcher: Engineering	5	RD

Table 4.2. DEVELOPMENT NEEDS. Results of the consultative process to determine R&D needs in the field of river rehabilitation. Needs are listed under the key research area and focus area to which it has been assigned. They are ranked (PR) from 1 – 6, as described in the text. Suggestions are made for the types of researchers who may be appropriate for the work. The workshops (Wk) at which the research need was raised are coded as: 1 (Knysna), 2 (Cape Town), 3 (Grahamstown), 4 (Pretoria), 5 (Pietermaritzburg), and 6 (Nelspruit, Mpumalanga). The requirement is categorised (Cat.) as R for Research, and RD for Research and Development.

Table 4.2a. KEY DEVELOPMENT AREA: AGRICULTURE

This area is also addressed in more detail under Research, R&D, and Application.

FOCUS	TASK	PR	RESEARCHERS	Wkshp	Cat
Link with LandCare	Link the initiative of river rehabilitation with NDA's LandCare initiative (and other relevant programmes, including Working for Water and Working for Wetlands) in a collaborative programme context.	1	Discussions and planning with relevant programmes	1 & Ext	D

Table 4.2b. KEY DEVELOPMENT AREA: ECONOMICS

FOCUS	TASK	PR	RESEARCHERS	Wkshp	Cat
Analysis: Rehabilitation team	Assess the economic benefits of ensuring that the full project team of engineers, ecologists, managers and local authorities are integrally involved in river rehabilitation projects from the beginning to the end of the project .	4	Project team	2	D
Motivate for funding	Use the outputs of a cost/benefit study on river rehabilitation (see Research) to motivate for private and public funding. Provide public relations and advertising incentives to private funders.	6	Rehabilitation Team	5	D

Table 4.2 c. KEY DEVELOPMENT AREA: INSTITUTIONAL

FOCUS	TASK	PR	RESEARCHERS	Wk	Cat
Accountability	Investigate accountability in relation to river rehabilitation. How should accountability be defined, how should individuals, organisations or government bodies be held accountable. Develop a "road map" to clarify ways in which to track accountability.	4	Link to Legal Review	4	D
Alignment of goals	Develop a means whereby it becomes possible to align goals at different institutional levels.	4	Intra-institution	2 4	D
Coordination	Develop a clearing house both within and outside of relevant organisations for catchment resource-related projects. Develop mechanisms to encourage project planning to syncronise where possible with monitoring, research and engineering. The knowledge accumulated should be well archived for any one of these disciplines.	4	Collaborative exercise	2 7	D
Goal alignment	Align goals for catchments (and within these, for river, wetland, estuary, and terrestrial and their rehabilitation) to ensure that a coordinated effort is initiated in an appropriate and manageable manner. This requires the creation of structures to ensure communication between the various organisations and programmes who may be active in catchment and water resources planning at any one time.	4	Process underway. Link WRC and relevant departments and programmes	3 4 7	D, A
***Institutional* Collaboration**	Set up structures for collaboration between authorities on practical implementation of their roles regarding river rehab. Enact and enforce legislation.	4	Inter-institution	4	D
Institutional roles and links in rehabilitation	Create/formalise structures to find out the following regarding catchments: Who is doing what, and where; why are they doing it; is there room for collaboration; is there room to change present institutional arrangements to facilitate some level of leverage within the field of rehabilitation. Regarding the last point, undertake a small-scale test case (e.g. the realignment of a stream) to attempt to 'trial' inter-institutional links.	4	Inter and intra-institution and programmes. Coordinator required	5	D
FOCUS	TASK	PR	RESEARCHERS	Wk	Cat

Table 4.2 c. KEY DEVELOPMENT AREA: INSTITUTIONAL

Integrated Development Plans	Make generic and specific input regarding rehabilitation available to municipalities and local government. Indicate areas of possible short term and long term linkage between the IDP and the river/wetland rehabilitation projects. Attempt to create linkages, particularly with funding.	2	Project team, DWAF and IDP	1 2 3 4 5 6	R&D
Link to planning	Link river rehabilitation to land-use planning (first at a local level).	4	Project team, Local authorities.	4	D,R
Linking objectives	Create mechanisms for linking the objectives of river rehabilitation to other regional objectives.	4	Inter and intra-institution and programmes. Coordinator required	4	D
Map institutions and links	Develop a map of institutional authorities, links, present synergies, histories, possible future lines of cooperation and avenues (directorates) which would be most effective way to pursue this, etc.	1	Collaborative exercise	6	R
Training for implementation	Train technical officers to implement policy.	4	Relevant institutions	4	D

Table 4.2d KEY DEVELOPMENT AREA: INTEGRATION

FOCUS	TASK	PR	RESEARCHERS	Wk	Cat
Development projects	Encourage development projects (urban and rural projects) to include a budget for rehabilitation .	4	Discuss with various development projects	5	D
Link programmes	Create mechanisms for integration of present programmes and initiatives, e.g. river rehabilitation, LandCare, Working for Water, Working for Wetlands, estuarine rehabilitation. Link at local and national scales to ensure a tie-up with, for example, the removal of invasive vegetation and the addressing of open drainage lines in forestry areas.	4	Discussions with various programmes and organisations	1 2 3 4 5 6	D
Linking with IDP	Link with one municipal or metropolitan IDP planner, with a project to determine, alongside the IDP process, which rivers in your area should be afforded which status, and why.	1 4	Researchers with local IDP	1 2 4 6	R&D
Link to Planners	Develop linkages to planning, such that developers are obliged (or at least encouraged) to take cognisance of resource limitations, not merely resource impacts.	4	Relevant organisations	1 2 7	D
Management	Make a case for incorporating river rehabilitation as an integral part of catchment management.	4	Discussions and workshops with CM	3	D
River Health Programme	Link to the River Health Programme to acquire a short-term cumulative picture of river health in major catchments around the country.	4	Reps: RHP, RRRP	6	D
Stakeholders	Develop mechanisms and a process for ensuring that the correct parties are involved and coordinating / cooperating throughout the process. In order for this to be effective, a legislative / authority framework needs to be in place.	4	Research Team. Review existing. Link with legal review. Adopt for SA.	7	D

Table 4.2e KEY DEVELOPMENT AREA: POLICY and REGULATIONS

FOCUS	TASK	PR	RESEARCHERS	Wk	Cat
EIA: Procedures and Costs	Simplify EIA process for river rehabilitation, yet maintain 'compliance' with regulations/laws. Consider means of reducing the EIA cost implications to the rehabilitation project, including time delay considerations before 'approval' is given by the regulating authority.	2 4	Collaborative exercise with relevant departments and programmes	4	D
EIA: Applicability to rehabilitation	Investigate the requirements for compliance of individual rehabilitation projects with the NEMA EIA regulations. This could include:(i) Refining and simplifying the EIA administrative process specifically for *bona fide* river rehabilitation projects; (ii) Developing methods of sifting the genuine rehabilitation project from the 'window dressing' type projects ; (iii) Developing methods of identifying projects which genuinely attempt to ameliorate mining development impacts from those which represent 'window dressing'; (iv) Working towards a way of achieving an exemption status for genuine river rehabilitation projects, considering rural and urban aspects. (v) Developing the practical application of the Environmental Scoping Report in order to achieve exemption, where the contents of the report would focus on: details of rehabilitation objectives; methods/technologies to be applied; practical Implementation of interventions; project time frames and the use of phasing techniques; measurement of progress or results re: the desired objectives; monitoring of the rehabilitation status of the river; long-term applications / monitoring/ practical implementation strategies.	2 4	Collaborative exercise with relevant departments and programmes	Ext	D
Implementation of legislation	Encourage/ oblige government to implement its own existing legislation (various court actions were cited). Government is now obliged constitutionally to finance any reasonable court case brought by any individual on behalf of the environment, even if the case is lost by the individual.	2 4	RRP in discussion with departments	6	D
Interim policies	Create interim policies or regulations throughout the country to support rehabilitation in the short term. This is only possible once a legal review has been done and a legislative framework is available.	?	RRP in collaboratin with Relevant Depts	5	D

Table 4.2f KEY DEVELOPMENT AREA: POLICY

FOCUS	TASK	PR	RESEARCHERS	Wkshp	Cat
Policy review and framework	Review all available policy relating to river conservation, management and/or rehabilitation. Make recommendations for the development of a robust policy and a legislative framework / environment to facilitate and support rehabilitation. This policy framework is a fundamental need for aquatic ecosystem rehabilitation (e.g. Maher et al. 2000). Ensure that this is based on the integration of all presently available laws, policies and regulations. Establish landowner responsibilities regarding the river and its riparian zone, in terms of present legislation. Encourage the roll-out of present policy (e.g. CMAs). Summarise this information and transfer to practitioners and others, for example Catchment Management Forums.	1	Senior researcher: Environmental law	1 2 3 4 5 6	RD
Regulation through registration	Determine, on the basis of present legislation and regulations, the ideal form of regulation or registration process, and certification and training of practitioners, to ensure that within 5 years, rehabilitation projects are registered and require the supervision of a qualified and certified practitioner.	2	Collaborative exercise with relevant departments and programmes	4 & Ext	D
Rehabilitation policy	Over the longer term, set out the framework for a robust policy that promotes stream rehabilitation.	3	Collaborative exercise with relevant departments and programmes	5	D

Table 4.2g KEY DEVELOPMENT AREA: STRATEGIC

FOCUS	TASK	PR	RESEARCHERS
Anchor rehabilitation	Ground/anchor rehabilitation in the context of current initiatives e.g. RHP	4	Relevant department and programme representatives
Compliance with WQ guidelines	Strive towards the acceptance of minimum water quality standards by SA ; require that industries with pollution permits produce a plan to reduce water quality pollution to these limits within five years.	4	DWAF
Framework for river rehabilitation	Establish a framework to ensure effective institutional arrangements for the management and rehabilitation of rivers	4	Intra and inter-institution
Identify targets	Develop a multidisciplinary national plan or programme to practise river rehabilitation in an organised manner. Pursue available mechanisms to ensure that river rehabilitation is 'on the agenda' of government departments, organisations, programmes and funders. Ensure a decision-making or analysis phase in terms of 'what must be done' in river rehabilitation. Beware of ad hoc studies. Identify both local-scale and national-scale targets for river rehabilitation both in the short and the longer term.	4	Discussions with WRC, DWAF, DEAT, NDA, various programmes and organisations

Table 4.3 APPLICATION.

The needs which emerged as key areas for testing or application are not categorised under headings as R&D and Development were.

FOCUS	TASK	PR	RESEARCHERS	Wkshp	Cat
Extending the Reserve - trial	Trial the inclusion of non-flow related issues in the Reserve Determination, such that rehabilitation comes into play.	1	R&D Team	4	ADR
Linking with IDP	Link with one municipal or metro IDP planner, with a project to determine, alongside the IDP process, which rivers in your area should be afforded which status, and why.	1,4	Research Team with local IDP	6	ADR
Reserve Determination	Further identify and develop action plans to address the points of linkage and of overlap between river rehabilitation and DWAF's Reserve Determination process	1	RRP, DWAF		D
Reserve implementation trial	Trial the implementation of a Reserve and monitor it. Ensure objectives are set for the expected outcomes. Achieve, through implementation, biological verification of Reserve Determinations. If possible, use the information from the Reserve Determination study as the basis of a rehabilitation plan for a section of the river.	1	Implementation and monitoring teams	6	ADR
Reserve information as a basis for planning	Undertake a pilot study to use info already generated on the management class of a river (e.g. through a Reserve Determination study), as the starting point for a rehabilitation planning exercise. Include non-flow related problems.	2	Research Team: Various	4 5	ADR
River rehabilitation trials	Initiate river rehabilitation pilot trials on three rivers in different regions, using the same international method. This should run in parallel with, and provide information to the process of developing river rehabilitation guidelines. If the river is an urban system, link strongly with IDP.	1	Research Team: Various	1 2 3 4 5 6	A
Rural rehabilitation trial	Trial the planning of a rehabilitation exercise in a rural area, with the focus on making the planning process inclusive and accessible to rural people. Evaluate the method used. On the basis of this, develop a generic process to be followed in rural river rehabilitation.	1	PhD: Life sciences (Kat River is one example)	6	ADR
Small scale trials of approaches/techniques	Undertake, on a small scale, testing and further development of selected known approaches and techniques for river rehabilitation.	1	Research Team Various	5	ADR

Table 4.3 Cont.

Anchor rehabilitation	Ground/anchor rehabilitation in the context of current initiatives e.g. RHP.	4	Relevant department and programme representatives	2 3 4 5 6	D
Compliance with WQ guidelines	Strive towards the acceptance of minimum water quality standards by SA ; require that industries with pollution permits produce a plan to reduce water quality pollution to these limits within five years.	4	DWAF	3	D
Framework for river rehabilitation	Establish a framework to ensure effective institutional arrangements for the management and rehabilitation of rivers.	4	Intra and inter-institution	4	D

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Rodgers, Stan	Limpopo Env. Affairs	rodgerssm@finpib.norprov.gov.za
Reference Group:		
Pollard, Sharon	Rainfall Harvesting	sharon@award.org.za

APPENDIX B. WORKSHOP SPEAKERS AND PRESENTATIONS

SPEAKER	WORKSHOP	SUBJECT
Mr Japie Buckle Working for Water Eastern Cape	Grahamstown	Working for Water and Working for Wetlands: approaches, projects and possible future linkages with river rehabilitation.
Mr Michael Braack Working for Wetlands Mpumalanga	Nelspruit	Working for Wetlands in Mpumalanga.
Mr Gerhard Cilliers Strategic Environmental Focus Consultants, Pretoria	Pretoria	The Fourways River: A case study in rehabilitation or remediation.
Dr Chris Dickens Umgeni Water Pietermaritzburg	Pietermaritzburg	River rehabilitation from the perspective of Umgeni Water Board.
Prof Martin Hill Rhodes University Grahamstown	Grahamstown	Approaches to biocontrol in the region, and possible intersection with river rehabilitation.
Dr Steve Mitchell Water Research Commission Pretoria	Cape Town Grahamstown Pretoria	A background to the WRC Programme for River Rehabilitation Research.
Mr Hannes Muller Agriculture Resource Conservation Southern Cape	Knysna	Case Study: Mechanical rehabilitation of the Buffeljachts River, Southern Cape.
Mr Harrison Pienaar DWAF RDM Office Pretoria	Pretoria	The DWAF perspective on water resource protection and rehabilitation.
Dr Guy Preston Working for Water Cape Town	Cape Town	Working for Water and Working for Wetlands.
Dr Nevill Quinn University of Natal Pietermaritzburg	Pietermaritzburg	Teaching courses, and current research in river rehabilitation at University of Natal, Pmbg.
Prof Kate Rowntree Rhodes University Grahamstown	Grahamstown	The Landcare-supported Kat River Catchment Project.
Dr Dirk Roux CSIR Environmentek Pretoria	Pretoria	The River Health Programme and the River Conservation Project: Exploring linkages with rehabilitation.
Dr Ian Rutherfurd CRCCH University of Melbourne Australia	Grahamstown	River Rehab in an International context, with a focus on Australia.
Dr Mandy Uys Laughing Waters East London	All	An introduction to river rehabilitation.
Ms Julia Wood City of Cape Town (now National Botanical Institute)	Cape Town	River Rehabilitation in a Regional and Local context.

APPENDIX C. PRELIMINARY REGISTER OF REHABILITATION EXPERTISE IN SOUTH AFRICA

CONTACT INDIVIDUAL	CATEGORY	ORGANISATION	TRAINING OR SPECIALISATION	KEY AREA/S OF INTEREST	WORK PHONE	MOBILE PHONE	FAX	EMAIL ADDRESS	POSTAL ADDRESS	WEBSITE	KEYWORD	KEYWORD	KEYWORD	PROJECTS PERTAINING TO REHABILITATION
Adams, Ms Janine	Specialist Scientist	Department of Botany, University of Port Elizabeth	Estuarine Science	Salt marsh rehabilitation, estuarine plants	041 5042421		041 5832317	btajba@upe.ac.za	Department of Botany, University of Port Elizabeth, P O Box 1600, Port Elizabeth,		Salt Marshes	Estuaries		
Allanson, Prof Brian	Research Scientist and Consultant	Dr B R Allanson Associates	Aquatic Ecology & Systems	Rivers/lakes/estuaries	044 3840658	082 5519738	044 3840658	ba11@mweb.co.za	P.O.Box 1186, Knysna 6570		Hydrobiology/ekp	Lakes, Estuaries		Knysna Basin Project
Angliss, Mr Mick	Environmental Scientist - aquatic systems	Limpopo Province Environmental Affairs, Dept. of Finance and Economic Development.	BSc. Fisheries Science	Planning, implementation and monitoring of river rehabilitation projects.	015 295 9300	082 806 3234	015 295 5015	anglissmk@finptb.norprov.gov.za	P.O. Box 217, Polokwane 0700		River Health,	Reserve determination	Fishways	
Armitage, Dr Neil	Senior Lecturer, Researcher	Dept of Civil Engineering, UCT	GDE (Water Treatment), MSc(Eng) (Hydraulics), PhD (Sediment transport)	Urban drainage. Planning, implementation and evaluation of river rehabilitation projects. Modeling of scour and deposition in rivers.	021 650 2589	082 970 4527	021 689 7471	armitage@eng.uct.ac.za	Dept. of Civil Engineering, University of Cape Town, Private Bag, RONDEBOSCH, 7701	In development	River Rehab, River modeling Drainage modeling	Engineering	Modeling	Specialist input into WRC K5/1161: Ecological and geomorphological principles for river rehabilitation
Armour, Mr Jack	Research Scientist	University of the Free State	MScAgric Cum Laude Water Quality Economics	Irrigation economics & policy	051 401 2213	082 77 181 03	051 401 3473	ArmourRJ@sci.uovs.ac.za	P O Box 339 (56), UFS, Bloemfotein, 9300	www.ucvs.ac.za	SALMOD	Salinity	Irrigation	WRC 947/1/01: The economic impact of changing water quality on irrigated agriculture in the lower Vaal and Riet Rivers
Barker, Mr Andrew	Town Planner, Professional Facilitator	Andrew Barker Development Consultant	TRP (SA), BSc TRP, CVE(SA) - Registered Town & Regional Planner, Certified Value Engineer, Professional facilitator	Conceptualisation, development and management of projects involving stakeholders.	011 680 9791	083 247 4424	011 680 9791	abarker@icon.co.za	PO Box 1073, Mondeor, 2110		Value engineering	Public participation	Project priorities	Various organisational development and urban planning processes and projects
Barlow-Weilbach, Ms Deryl	Environmental scientist/Ecologist	Development Bank of Southern Africa	Environmental risk assessment/Freshwater Ecology		011 313 3049	082 920 7420	011 313 3416							
Barnard, Mr Johan	Professional Consultant	Newtown Landscape Architects	Masters in Environmental Planning & Urban Design	Planning, implementation and evaluation of river rehabilitation projects.	011 462-6967	082 442-6114	011 462-9284	jchan@newla.co.za	P O Box 36, FOURWAYS, 2055, Johannesburg	www.newla.co.za	River Rehab.	Planning & Design		Klipspruit Strategic Development Framework study for City of Johannesburg (SMLC); Moroka Dam & wetland Rehabilitation pilot project.
Bills, Mr Ian Roger	Specialist Scientist	SAIAB	Taxonomy, systematics and conservation of freshwater fishes	Rehabilitation programmes for endangered freshwater fishes.	046 6035832	none	046 6222403	r.bills@ru.ac.za	SAIAB, Somerset Street, Private Bag 1015, Grahamstown 6140	http://www.jlbsmith.ru.ac.za/index.htm				
Birkhead, Dr Drew	Research scientist, consultant (river & wetland hydraulics)	Streamflow Solutions cc	PhD Civil Engineering	River & wetland hydraulics, fluvial geomorphology, design of environmetally sensitive structures (e.g. fishways).	011 6163017	082 3369838	011 6163017	streamflow@icon.co.za	P O Box 889, Gonubie, 5256, East London		River & wetland hydraulics	Research and development	Sediment transport	WRC K5/1174: Hydraulic analysis for the determination of the ecological reserve for rivers. The hydrologic and hydraulic study of the behaviour of the Nyl River floodplain.
Bok, Dr Anton	Environmenal Scientist	Anton Bok Aquatic Consultants cc	Aquatic Ecology, fish	Conceptual design of fishways for man-made barriers in rivers.	041-3733464 -	083 4491801	041 - 3733464	antbok@mweb.co.za	5 Young Lane, Mill Park, Port Elizabeth 6001		Fishways	captive breeding of fish	Restoration of indigenous fish populations	1) WRC Project No. 1275: Flow measurement at natural river controls and the provision of fishways. Also a number of fishway design projects, including follow-up monitoring, for water development schemes. 2) Captive breeding of indigenous fish species for restocking natural habitats
Booth, Mrs Lyn	Chief Technician	KZN Wildlife (In:Greater St Lucia Wetland Park, Wetland and Terrestrial section of the Coastal Zone	Conservation	Wetlands/Coastal forest	035 590 1342		035 590 1343 (att L Booth)	research@kznwildlife.com	P/Bag X01, St Lucia Estuary, 3936	www.rhino.org.za	Wetland	Plantations	Coastal Forest	Numerous in area
Botha, Dr Greg	Quaternary and environmental geologist	Council for Geoscience	PhD Quaternary geology, experience in donga erosion, coastal plain dunes	Stream habitat restoration, bank erosion control, structural protection and stabilization of river banks.	033 3456265		033 3949342	gabotha@mweb.co.za	P.O. Box 900, Pietermaritzburg, 3200	http://www.geoscience.org.za	river rehabilitation, habitat restoration	small structures		
Boucher, Dr Charlie	Charlie Boucher	Univ Stellenbosch	Botany	River rehab, vegetation rehab	021-8083068	private	021-8083607	cb@sun.ac.za	Botany Dept, Univ Stellenbosch, Private Bag X1, Matieland, 7602					Lesotho, Breede, Palmiet, Berg, Eerste, Lourens, Kuils in rivers and others terrestrial
Braack, Mr Michael		Working for Wetlands		Wetland rehabilitation and conservation.	013 7513539	082 8229935	013 7513537	braackm@dwaf.gov.za	PO Box 3171 White River 1240					Sand River Rehab, Blyde River Rehab, White River Rehab, Usutu River Rehab,
Braune, Mr Matt	Consulting Engineer	SRK Consulting	Bsc (Eng) Civil	Stormwater Management and river engineering.	012 3619821	082 6005993	012 3619912	mbraune@srk.co.za	p.o.box 35309 Menlopark, Pretoria 0102		Stormwater	River restoration	Engineering	Fourways stream Rehabilitation Klein jukskei stream rehab work.
Brooker, Mr Chris	Consulting Engineer	Chris Brooker & Associates cc (t/a CBA Specilaist Engineers)	MSc(Eng) stormwater working on PhD in river rehab	Implementation of river rehab & wetland projects. Interface between environmental science and engineering implementation.	011 465-0510	083 453-4645	011 465-0509	cbrooker@yahoo.com	PO Box 259, Fourways, 2055, Johannesburg	No	River Rehab.	Engineering		Rehab of Moroka Dam & Wetland as WSSD showcase project for City of Johannesburg, Hydrological studies of Jukskei & Klipspruit, Implementation of rehab projects on Jukskei, Fourways Stream, North Riding Stream etc
Brown, Dr Cate	Research Scientist; Consultant	Southern Waters	PhD River Ecology	Planning, implementation and evaluation of river rehabilitation projects.	021-4653135	082-9256699	021-4653901	cbrown@southernwaters.co.za	P O Box 13280, Mowbray, 7705, Cape Town	www.southernwaters.co.za	River Rehab.	Research and Development	Pilot Trials	Lourens River - Somerset West; Moddergat River - Macassar; Silvermine River - Cape Town; N2 Wetland - Cape Town; etc
Buckle, Mr Japie	Environmental Scientist	NBI: Working for Wetlands Programme	BSc (Forestry/Nature Conservation), BSc Hons. Wildlife Management. Experience in restoration ecology	Restoraion ecology, wetland rehabilitation, alien plant control, biological control, holistic planning.	041-5864884	082-8207083	041-5864210	buckle@nbi.ac.za	31 Newcombe Avenue, Port Elizabeth, 6070		Wetland rehabilitation			Involved with planning and implementation of wetland rehabilitation interventions in the Kromme, Seekoei Rivers, Garberg and Nbukem wetland systems. Recently involved with Western Cape wetland rehabilitation planning.

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Cambray, Dr Jim	Specialist Scientist	Albany Museum	PhD Ichthyology	Planning, implementation and evaluation of river rehabilitation projects.	046 6222312		046 6222398	J.Cambray@ru.ac.za	Albany Museum, Somerset St, Grahamstown 6139	http://www.ru.ac.za/affiliates/am/ http://www.ru.ac.za/affiliates/am/ichthy.html	Alien species	Endangered species	Sanctuaries	Alien fish eradication awareness project: http://www.ru.ac.za/affiliates/amim&g.html http://www.ru.ac.za/affiliates/amwwf/wwf.htm
Chutter, Dr Mark	Ecological consultant (retired)	AfriDev Associates	PhD River Ecology	Planning, implementation and evaluation of river rehabilitation projects.	043 7400120	012 361 6056	012 361 6056	afridevp@iafrica.com	P O Box 35650, MENLO Park, 0102	None	River Management.	Application of existing knowledge	Project planning and review	
Cilliers, Mr Gerhard	Environmental Scientist	Strategic Environmental Focus	B.Sc Hon. (Zoology), Masters Degree in Environmental Management	1) Planning, implementation and evaluation of river rehabilitation projects. 1)SEA, Fourways Stream, Fourways, Gauteng. 2) Kaalsprut Upgrade Planning, Gauteng. 3)Storm water management policies for Rietsprut and Kaalsprut, Gauteng.	012-349 1307	082 336 8643	012-349 1229	gerhard@sefsa.co.za	P O Box 74785, Lynnwood Ridge, Pretoria, 0040	www.sefsa.co.za	River Rehab., Constructed wetlands	Implementation and monitoring	Biomonitoring, Strategic Planning, GIS, Storm water management	1)SEA, Fourways Stream, Fourways, Gauteng.
Collins, Mr Nacelle	Ecologist (Wetland)	Department of Tourism, environmental and Economic Affairs	None - Just started with PhD on classification of wetland vegetation & ecology	Planning, implementation and evaluation of wetland rehabilitation projects.	05862 23520	082 4499012	05862 21772	nbc@ons.dorea.co.za	P O Box 24, Harrismith, 9880	None	Wetland rehabilitation	Rehabilitation, Research, Promising	Pilot trials, Implementation	Wetland rehabilitation in the Upper Wilge River Catchment
Daneel, Ms Joanne	EIA Practitioner (Specialist in roads construction)	Terreco Consulting	MSc Agric (Grassland Ecology/ Agronomy), Arid Zone Ecology	EIAs, auditing	043 7402475	082 4935646	043 7401767	daneelj@terreco.co.za	P O Box 1007, Gonubie, 5256	None	Deserts.	Roads & Mines (Construction, operation and Rehabilitation)		Road Construction EIAs and EMPRs, Mining Environmental Management
Day, Dr Liz	Consultant	The Freshwater Consulting Group	Rivers and wetlands	rehabilitation / opportunistic remediation of urban wetlands / rivers	021 7058672	083 4542309	021-7058672	lizday@mweb.co.za	6 Flamingo Crescent, Zeekoevlei, 7941		urban wetlands	urban rivers	habitat heterogeneity	Langevlei Canal, Mocke River, High Constantia; Diep River; Rondevlei; Silvermine; Assessment of river / wetland intervention projects in the CMA; Ecological guidelines for river/wetland intervention in the City of Cape Town; Bokramsprut River; Sillery Wetlands; etc
de Fontaine, Mr Marc	Scientist (Water Scientist)	Rand Water	Water Resource Management - MSC Wits River Ecology	Sustainable management of river systems.	011 6820548	082 6824254	011 6820733	marcdef@randwater.co.za	PO Box 1127 Johannesburg 2000	www.randwater.co.za	Quality	Quantity	Resource	Rand Water Working for Water Wetland Rehabilitation Programme
Deacon, Dr Andrew	Scientist (Specialist Scientist)	SANParks KNP	Phd Zoology	Research and Monitoring.	013 7354237	082 325 5583	013 7354055	andrewd@parks-sa.co.za	P/bag X402 Skukuza, 1350	KNP	Fishways	Research and Monitoring		12 fishways in KNP
Deacon, Dr Andrew	Research Scientist	SANParks	PhD Fish physiology	Planning, implementation and evaluation of fishways.	013-7354237		013-7354055	andrewd@parks-sa.co.za	Pbag x402, Skukuza 1350	http://www.parks-sa.co.za	Fishways	Research and Development	Monitoring	Fishways
Delport, Mr Eddie	City Engineer	Stellenbosch Council	Civil Eng, MBA	Implementation and evaluation of river rehabilitation projects.	021 8088301		021 8088315	eddiedelport@mweb.co.za	POBox 17, Stellenbosch 7599		River Rehab.	Completed projects	Pilot Trials	Various projects on the Eerste River
Dickens, Dr Chris	Scientist (Principal Scientist)	Umgeni Water	PhD Botany	Dam releases, IFRs, Reserve implementation, River health monitoring, SASS5.	033 3411151	083 2696207	033 3411501	chris.dickens@umgeni.co.za	P O Box 9, Pietermaritzburg, 3200	www.umgeni.co.za	Invertebrates, fish, riparian veg, Reserve dam releases			Routine monitoring of river health at Umgeni Water for 10 years. Biomonitoring for ISCOR in Richards Bay. Control of algal blooms in several dams over many years. Assessment of IFRs and Reserve for several rivers, with plans for implementation.
Dini, Mr John	Programme manager	Working for Wetlands	BSc (Hons) Zoology, but currently active in field of wetland ecology	Consolidation and further development of a national wetland rehabilitation and conservation programme.	012 804 3200	083 420 7988	012 804 3211	dini@nbi.ac.za	National Botanical Institute, Private Bag X101, Pretoria, 0001	www.nbi.ac.za	Wetland rehab.	Poverty relief	cooperative governance	Wetland rehabilitation projects implemented under the Working for Wetlands partnership (DEAT, DWAF, DoA, Working for Water, Mondi Wetlands Project). Some of these have a riverine component
Dowling, Mr Patrick	Environmentalist	Wildlife and Environment Society	B.Ed Environmental Education	Training of local communities and workers, lobbying, advocacy and media.	021 7011397	none	021 7011399	patrick@wessa.wcape.school.za	P.O. Box 30145, Tokai, 7966	http://www.wcape.school.za/wessa/	Wetlands	Training	Policy	Noordhoek Wetlands Rehabilitation Project, Keyser River Restoration Project, Investigation into illegal dumping in the Philippi wetlands
Durgapersad, Mrs Kaajial		Rand Water	BSc (Zoology and Microbiology)	Klip River Catchment	011 6820729	082 3892350	011 682 0733	kugrasen@randwater.co.za	P O Box 1127 Johannesburg 2000	www.randwater.co.za				
Chaychuk, Mr Dale	Erosion Control Specialists / Manufacturer	African Gabions - Maccaferri	Environmentally Engineered Solutions	Planning, implementation	011 7081102	082 8064628	011 7083230	jhb3@africangabions.co.za	P O Box 133, Kya Sands, 2163, Johannesburg	www.africangabions.co.za	River Rehabilitation	Research & Development	Pilot Trials	Preffered partner with Working For Water
Chutter, Dr Mark	Retiree	Private	PhD River Ecology	Planning, implementation and evaluation of river rehabilitation projects.	N/A	N/A	012 3616056	afridevp@africa.com	P O Box 35650, MENLO PARK, 0102	N/A	Rivers in their environment	Review		Development of SASS4 and many others
Driver, Mr Colin	Consulting Civil Engineer	Hamish Scott Consulting	BSc Eng (CIV), PrEng	Engineering & implementation of river rehabilitation projects	043 743 9528	082 320 1462	043 743 5347	colin@hscons.co.za	PO Box 11166, Southernwood, 5213, EL	In development	Engineering			
Durrheim, Mr Graham	Government (Regional)	DWAF	Indigenous forest management	Indigenous forests, invader plant control.	044 3825466		044 3825461	durrheg@dwaf.gov.za	Private Bag X12, Knysna, 6570					
Ellery, Prof. W. (Fred)	Research Scientist	University of KwaZulu-N	PhD - Ecology	Wetland ecology and biogeomophology.	031 2601278		031 260 1391	Ellery@ukzn.ac.za	School of Life & Environmental Sciences, University of KwaZulu-Natal,		Wetlands	Ecosystem	Rehabilitation	WRC Wetland Rehabilitation Programme
Engelbrecht, Dr Johan	Conservation Scientist	Mpumalanga Parks Board	PhD Zoology	Conservation	013 235 1673	082 3369838	013 235 1674	jseng@intekom.co.za	Private Bag X1088, Lydenburg, 1120	None	Aquatic systems	Research and Development	monitoring	
Engelsman, Mr Bruce	Engineer (Civil/geotechnical)	SRK Consulting	Bsc Eng Pr Eng	River rehabilitation and implementation of engineering systems in a social context.	021 421 7182	-	021 425 4648	bengelsman@srk.co.za	PO Box 6824, Roggebaai, 8012	srk.co.za	River Rehab. Contamination remediation	Litter removal, reasearch, implementation	Implemented systems and performance	Bokramsprut River rehabilitation (Ocean View - Western Cape), Kyamandi litter and biological contamination interception (Stellenbosch - Western Cape), Construction of artificial wetland at Wildevoorvlei to treat contaminated stormwater.

CONTACT INDIVIDUAL	CATEGORY	ORGANISATION	TRAINING OR SPECIALISATION	KEY AREA/S OF INTEREST	WORK PHONE	MOBILE PHONE	FAX	EMAIL ADDRESS	POSTAL ADDRESS	WEBSITE	KEYWORD	KEYWORD	KEYWORD	PROJECTS PERTAINING TO REHABILITATION
Fisher, Ms Ruth-Mary	Research Scientist	University of Western Cape	MSc (Urban river recovery)	Role of geomorphology in river rehabilitation.	021 959 2683	083 527 3780		rmfisher@uwc.ac.za						WRC project K5/1181 Ecological and geomorphological principles for river rehabilitation
Fouche, Mr Paul	Research Scientist	University of Venda	MSc (Zoology) Specialising in Fish	Evaluation of river conditions, implementing rehabilitation, research.	015 9626383		015 9626648	pso@univen.ac.za	PO Box 308, LOUIS TRICHARDT 0920	N/A	River Rehab.	Fish	Riparian vegetation	WRC714/3/01: An index of biotic integrity based on rheophilic fish. Biomonitoring of the Luvuvhu & Letaba Rivers, 1999. Biomonitoring of the Mokolo River, 2002. Ecological Reserve Determination of the Letaba River (ongoing)
Gilli, Mr Adriano	Sales and marketing manager	African Gabions	Degree in Geological Sciences	Identification of projects involving flood protection measures, diversion structures and bio-engineered rehabilitation works.	031 700 8456	083 630 2134	031 700 8469	salesmgr@africangabions.co.za	P.O Box 15777, Westmead 3608, KZN	www.africangabions.co.za	weirs	groynes	river training	Wadi Beihan, Wadi Mahania, Wadi Bana, Wadi Hassan rehabilitation - Yemen Protection of the city of Tuleur against flooding - Madagascar
Glen, Mrs Rene	Scientist	National Botanical Institute	MSc Nanoplankton of the Swartkops Estuary, Port Elizabeth	Monitoring aquatic flora in rivers	012 8043200	082 9048716	012 8043211	rpg@nbipre.nbi.ac.za	Private Bag X101, Pretoria,0001		Identification	aquatic, wetland	flora	The Aquatic and wetland flora of southern Africa By CDK Cook & RP Glen
Graham, Mr Mark	Scientist (Hydrobiologist)	Umgeni Water	MSc Biological Sc	Planning, implementation and evaluation of river rehabilitation projects. Monitoring of river health.	033 3411140		033 3411501	mark.graham@umgeni.co.za	PO Box 9, PMB, 3200	www.umgeni.co.za	River Rehab.	Research and Development		
Griffith, Ms Michelle	Environmental Consultant	Coastal & Environmental Services	MSc Zoology (Lizard behaviour)	Alien clearing and rehabilitation with indigenous species	046 622 2364		046 6226564	m.griffith@cesnet.co.za	P.O. Box 934, Grahamstown, 6140	www.cesnet.co.za				Rehabilitation of a small stream in Grahamstown and in conjunction with a committee formed for the Year of Freshwater (2003), encourage others in Grahamstown to rehabilitate all streams in Grahamstown.
Grobler, Mr Dana	Private Consultant	Blue Science	Water Resources Management		012 6645824		012 6641559	dana@bluescience.co.za	PO Box 14443 Lyttleton 0140	www.bluescience.co.za				None
Grundeling, Mr Piet-Louis			MSc Geology (Peatlands)	Peatland conservation, management, inventorising and rehabilitation	27 12 808 5342	83 231 3489	012 808 5303	peatland@mweb.co.za	P O Box 912024, Silverton 0127	None	Peatland rehabilitation	Peatland inventory	Peatland conservation and management	Defining peat wetland Eco-regions South Africa; Project: Rehabilitation of the Gauteng and Northwest wetlands; IMPESA: Inventory and Mapping of Peatlands in Southern Africa.
Haigh, Mrs Elirla (Lil)	Research Scientist	Institute for Water Research	MSc Zoology (Fisheries)	Wetland mapping and rehabilitation	046 6222428			lil@iwr.ru.ac.za	IWR, P O Box 94, Grahamstown, 6140	www.iwr.ru.ac.za	Wetland	Rehabilitation		Wetland Delineation
Hanekom, Dr Nick	Scientist (Research Scientist)	South African National Parks	Generalist marine & estuaries		044 - 3431302	082 3369836	044-3432331	nickh@parks-sa.co.za	P.O. Box 176, Sedgefield, 6573	In development	Wetland Rehab.		Training	Training course with Dave Lindley
Harding, Dr WR (Bill)	Aquatic ecologist/limnologist	DH Environmental Consulting	Limnology/wetlands	Aquatic ecosystems	021-8552528	82802637	021-8552528	info@dhec.co.za	P O Box 5429 Helderberg 7135	www.dhec.co.za				Most of projects are rehabilitation related
Haskins, Ms Candice	Ecologist	City of Cape Town	MSc Quantitative Conservation Biology	Planning, implementation and evaluation of river rehabilitation projects	021 6841000		021 6386083	candice.haskins@capetown.gov.za	Scientific Services Department, PO Box 16548, Vlaeberg 8018	www.capetown.gov.za				
Heath, Dr Ralph	Consultant/reseacher	Pulles Howard & de Lange	PhD Freshwater and Marine Ecology	Planning, implementation and research of river rehabilitation projects	011 726 7027	836574884	011 7266913	ralphh@phd.co.za	P O Box 871 Auckland Park 2006	www.phd.co.za	Mine closure	Research and Development	consulting	Mine closure plans for Durnacoal and Hlobane coal mines (Kumba Resources).
Henman-Weir, Ms Felicity		Private Consultant			013 7512661	082 806 4391								
Herbst, Mr Paul	Water Quality Manager	Department of Water Affairs and Forestry	Bsc (Hons) Biochemistry	Legal, Policy, measures, levels of rehabilitation.	(012) 336 8692	(082) 804 3002	(012 323 0321	herbstp@dwaf.gov.za	P/Bag X313 Pretoria 0001	http://www.dwaf.gov.za/	Rehabilitation	Policy and legal requirements		Involvement in rehabilitation from industrial sites.
Hill, Prof. Martin	Scientists (Research Scientist) University Lecturer	Department of Zoology and Entomology, Rhodes University	PhD Entomology	Biological and integrated control of invading alien aquatic plant species.	TBA	073 177 0041	TBA	m.p.hill@ru.ac.za	P.O. Box 94, Grahamstown, 6140	Water hyacinth site in development	Invasive species	Biological control		Nothing specific to river rehabilitation. Several projects in conjunction with DWAF, WfW, WRC, Nat Parks and foreign agencies.
Hinsch, Ms. Manda	Policy developer	DWAF	BSc Hons. Water Utilisation	Management of water quality impacts.	(012)336754 8	82808993	012 3230321	manda@dwaf.gov.za	Private Bag X313, Pretoria, 0001		Policy	Regulation	Risk Assessment	Development of a policy for the rehabilitation of water quality impacts
Holgate, Ms Claudia	Researcher lecturer	Monash University South Africa	MSc Environmental science (wetland Ecology)	Catchment management including wetland and river rehabilitation.	011 950 4181	082 899 4990	011 48602567	claudia.holgate@arts.monash.edu	P.O. Box 97497 Petervale 2151		wetland and river rehab	research and development		Managing water for African Cities
Huisamen, Mr Johan	Provincial Government	Cape Nature Conservation	Nature conservation		044 3431655	082 9289471		jhuisamen@mweb.co.za						
Illgner, Mr Pete	Specialist scientist /Consultant	Coastal & Environmental Services	Geomorphology	Environmental hazards, landscape evolution	046-6222364	083 5155 938		p.illgner@cesnet.co.za	PO Box 934, Grahamstown, South Africa, 6140.	www.cesnet.co.za	erosion	wetlands		Featherstone Kloof
Impson, Mr Dean	Scientist (Conservation scientist)	Western Cape Nature Conservation Board	MSc Ichthyology	Impact of invasive alien fishes and plants, eradiacting these from rivers	021 8891570	n/a	021 8891523	impsond@oncjnk.wcape.gov.za	private bag x5014, Stellenbosch, 7599	the Board has a website	River Rehab.	alien fishes	pilot project	Rondegat River rehab project 2002-2005 funded by WWF-SA
CONTACT INDIVIDUAL	CATEGORY	ORGANISATION	TRAINING OR SPECIALISATION	KEY AREA/S OF INTEREST	WORK PHONE	MOBILE PHONE	FAX	EMAIL ADDRESS	POSTAL ADDRESS	WEBSITE	KEYWORD	KEYWORD	KEYWORD	PROJECTS PERTAINING TO REHABILITATION
James, Prof. Chris	Engineer, Scientist (Research Scientist)	Centre for Water in the Environment, School of Civil & Environmental Engineering, University of the Witwatersrand	PhD Hydraulics	River and wetland hydraulics and sedimentation for addressing environmental issues	011 717 7115		011 339 1762	csj@civil.wits.ac.za	School of Civil & Environmental Engineering, University of the Witwatersrand, Private Bag 3, Wits, 2050	www.wits.ac.za	River Hydraulics	Sedimentation	Habitat Hydraulics	WRC 856/1/98-2001: Interaction of reed distribution, hydraulics and geomorphology in semi-arid rivers. WRC 1174/2/001-2003: Hydraulic analyses for the determination of the ecological reserve for rivers.
Jonker, Mr Verno	Consulting Engineering /Research	Ninham Shand Consulting Services	PhD River hydraulics (Dec 2002); Hydrology	River hydraulics, River morphology, Hydrology	021 424 5544	082 924 6577	021 424 5588	verno.jonker@shands.co.za	P O Box 1347 Cape Town 8000	www.shands.co.za	River Hydraulics, Hydrology, Morphology Ecohydraulics, Sediment	Research and Development		WRC K5/979/0/1: Hydraulic characteristics of ecological flow requirement components in winter rainfall rivers.

Muller, Mr Piet	Local Authority	DACEL - Gauteng RHP	Champ - RHP Gauteng		011 355 1487	072 1105075		pietmu@gpg.gov.za							
Obree, Mr Mark	Local Authority	City of Cape Town	Civil Engineer	Water Quality	021 487 2205	083 630 7459	021 487 2441	mark.obree@capetown.gov.za	PO Box 16548, Vlaeberg, 8018	www.capetown.gov.za	River Upgrading	Flood Control	Urban Catchment Management	Various river upgrading projects in Cape Town	
O'Keeffe, Prof Jay	Research Director	Institute for Water research	River Ecology	Environmental flow requirements	046 622 2428	082 390 8011		jay@iwr.ru.ac.za	Institute for Water Research, Rhodes University.	www.ru.ac.za/iwr	Instream Flow Requirements	Reserve		Review of Australian Rehab projects; IFR assessments	
Oliver, Ms Kirsten	Masters Student - EnvDev	Centre for Environment and Development	Physical Geography Honours	Alien plants, river rehabilitation and management		083 3696040	033 3874624	kayokir@hotmail.com	Postnet Suite 142, Private bag X9118, Pietermaritzburg, 3200		River Rehab.	Research and Development		Alien Plant Mapping - Pietermaritzburg	
Otto, Mr. Daniel	Research Scientist	Digby Wells & Associates Environmental Solutions Provider	M.Sc Environmental Management	Wetland and riparian vegetation rehabilitation	011 789 9495	082 440 9633	011 789 9498	danie@digbywells.co.za	Private Bag x10046, Randburg, 2125	In development	Wetlands	Geomorphology	Phytoremediation	Passive treatment research for WRC projects. Amicoal etc. EIA's for river crossings, water management plans for mines, enhanced wetlands and phyto-remediation	
Owen, Dr Rodney	Scientist (Research Scientist)	Department of Zoology, University of Zululand	PhD Estuarine Ecology	Upland river ecology in the KZN Drakensberg	035 9026737	082 9248837	035 9026750	rowen@pan.uzulu.ac.za	Pvt Bag X1001, KWADLANGEZWA, 3886	http://www.uzulu.ac.za				None as yet.	
Palmer, Prof. Carolyn	Research Scientist	Unilever Centre for Aquatic Toxicology/Institute for Water Research	PhD Freshwater Ecology	Policy development, water in the environment	046 622 2428			tally@iwr.ru.ac.za	P O Box 94, Grahamstown, 6140	www.iwr.ru.ac.za	Aquatic toxicity	Water Quality	Water Law	Environmental Water Quality in Water Resources Management	
Palmer, Dr Rob	Consultant (Environmental)	AfriDev Consultants	PhD River Ecology	Planning, implementation and evaluation of river rehabilitation projects.	013 751 1533	082 57 444 86	082 131 3369838	afridevr@iafrica.com	PO Box 4349, White River, 1240		River Rehab.	Lieberbergsvlei	Wetlands	As River: Rapid determination of Resource Directed Measures for the Protection of Aquatic Ecosystems (DWAF)	
Parsons, Mr Roger	Scientist (Research Scientist) and Consultant (Groundwater)	Parsons and Associates Specialist Groundwater Consultants	M.Sc. (Geohydrology)	Groundwater	021 855-2480	083 310 6504	021 855-2363	roger@pasgc.co.za	PO Box 2606, Somerset West, 7129	www.pasgc.co.za	Groundwater			Geohydrological assessment of Zeekoevlei and Rondevlei, Princessvlei and Little Princessvlei	
Pithey, Ms Sonja	Local Authority	City of Cape Town - Catchment Management Department	BSc(Hons) Environmental Science	Catchment planning. Line function integration Water quality management	021 487 2221	083 6307458	021 487 2221	sonja.pithey@capetown.gov.za	P O Box 16548, Vlaeberg, 8018	www.cmc.gov.za/w&ww/CatchmentMgmt/index.htm	Catchment management plan Water quality index	Employment creation		1. Noordhoek wetlands management plan 2. Water Quality Monitoring Review	
Preston, Dr Guy	Parastatal Organisation	Working for Water	PhD		021 405 2200	083 325 8700	021 405 7880	gpreston@mweb.co.za	Private Bag X4390, Cape Town, 8000	www.wfw.co.za	Alien veg. Removal				
Pretorius, Mr Willem	Integrated Management Systems	V&V Holdings	B Eng Civil	Management Systems	011 315 8344	082 373 4455	011 805 0411	willemp@netactive.co.za	PO Box 4026, Halfway House,1685	vvholdings.com	Management system	Storm-water management system	Flood hydrology	Various integrated asset management systems in particular Storm-water management systems	
Price, Mr Allen	Supplier	Timber Plastics N.E.W. Cape			051 - 933 6223	083 33 106 77	051 - 933 6223	price@worldonline.co.za	P O Box 99, Ficksburg, 9730	www.timberplastics.co.za					
Pryor, Mr Johnathon	Project coordinator (Rehabilitation)	Albany Working-For-Water	Silviculture/reforestation	Growing and planting of indigenous endemic tree, shrub and grass species in volume.	046 6361449		046 6362983	albanywfw@intekom.co.za	Po Box 491 Grahamstown 6140	See Dept. Of Water Affairs and Forestry	rehabilitation of all ecosystems where alien vegetation has been eradicated.	R&D	Pilot Trails	Working-For-Water Eastern Cape, Western Cape, Northern Province	
Quinn, Dr Nevil	Scientist (Research Scientist) and University Lecturer	Centre for Environment and Development, University of Natal	PhD Environmental Hydrology	River Rehabilitation, Wetland Rehabilitation, Training, Development of Decision Support Products, Environmental Hydrology aspects	033 2605664	083 534 9035	033 260 6118	quinnNW@nu.ac.za	Private Bag X01, Scottsville,3209	In development	River Rehab	Wetlands Reahb	Environmental Hydrology	WRC K5/1064 A decision support systems for the rehabilitation and management of riparian systems	
Reinecke, Mr Karl	Research Scientist	University of Cape Town	Competing M.Sc (River ecology, rehabilitation and recovery). Starting new riparian botany, alien invasion of riparian zones project)	Riparian botany, alien invasion, ecosystem thresholds and ecosystem engineers.	021 6504634	082 9258309	021 650 3301	Reinecke@botzoo.uct.ac.za	Zoology Dept. University Ave, UCT, Rondebosch, 7700, CT	http://www.zoology.uct.ac.za				1. WRC project: River Rehapitation: case studies and literature review (complete). 2. WRC project: The nature and rehabilitation of alien invaded riparian zones (2003-2006).	
Reynhart, Ms Debbie	Consultant	Down to Earth Design	Ndip. Horticulture Landscape design	Landscape planning, Biomonitoring, Vegetation rehabilitation.	043 7265859	083 5088977	043 7265859	downtoearth@telkomsa.net	65 Garcia St, Cambridge East London 5247	In development	Riparian vegetation Eastern Cape	Landscape design		Assistance with planning of Pilanza river rehabilitation section of WRC project (K5/1309)	
Rowlston, Mr. Bill	Strategic planner (water resources)	Department of Water Affairs & Forestry, National Office, Pretoria	BSC Civil Engineering, Water-related policy and law.	Development and use of policy, legislative and regulatory instruments to promote and facilitate river rehabilitation. Development of national State of Water Resources reporting (linked to the NWRS).	(012) 336 8768	082 808 0413	(012) 336 8934	billr@dwaf.gov.za	P/Bag X313, Pretoria, 0001	www.dwaf.gov.za (departmental site)				Participation in a number of dam-related EIAs and Reserve determinations. Contributions to DWAF's approach to the provision of fish passage facilities. Design of the Neusberg fishway on the Orange River	
Rowntree, Prof Kate	University lecturer	Rhodes University	PhD Geomorphology	Science and practice of river rehabilitation, research into fluvial processes at a catchment and channel scale, research rural communities promoting catchment management	046 6038024	083 2783482	046 6361199	k.rowntree@ru.ac.za	Department of Geography, Rhodes University, PO Box 94, Grahamstown, South Africa		geomorphology	land care	training	WRC PROJECTS:1. 'A methodology for the geomorphological classification of South African rivers'. 2. Geomorphological research for the conservation and management of Southern African rivers. 4. The development and coordination of catchment forums through empowerment of rural communities.	
Scherman, Dr Patsy	Environmental consultant	Coastal & Environmental Services	PhD Biotechnology	Monitoring and evaluation of river rehabilitation.	046 622 2364	082 503 6070	046 622 6564	p.scherman@cesnet.co.za	PO Box 934, Grahamstown, 6140	www.cesnet.co.za				Involvement in projects developing biomonitoring tools.	

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Snyman, Dr Heidi	Research section of Utility company	ERWAT	PhD Microbiology	Wastewater treatment and management	011 9297130	083 6767041	011 9297031	snymanh@postino.up.ac.za	P O Box 13106, Norkem Park, 1631	erwat.co.za	Wastewater Management	Research and Development	Sludge management	Monitoring river quality. Research projects. EIA for new developments
Spears, Mr Hilary	Interested person	Sundays River Control Committee	None	Conservation	041 4680354	082 4446132	041 4680354	spears@worldonline.co.za	PO Box 73, Colchester, 6175, PE		None			None
Stacey, Mr Trevor	FARMER	Buffelshoek		I would like to start the process of rehabilitating a local river that has been abused by upstream farmers!	083 2847077	083 2847077	021 7155247	trevors@plantechsa.co.za	PO Box 6349, Roggebaai, 8012	N/A	River Rehabilitation			
Steyn, Mr Francis	Provincial Government	Dept of Agriculture Western Cape			021 8085090	082 9072813		FrancisS@elsenburg.com						
Steytler, Mr Nick	Specialist Consultant	SRK, Cape Town	MSc - Riparian ecology	River restoration and Integrated Catchment Planning	021 4092400	082 3224074	021 4244648	nsteytler@srk.co.za	PO Box 6824, Roggebaai, 8012	www.srk.com				Dwars River Project (Cores); Bokramspruit River Restoration Project (Cape Town); Response to Flooding in the Msunduzi River Catchment (Pietermaritzburg); Development of a decision support tool (RIPARI-MAN) for urban riparian systems management (Pietermaritzburg)
Strydom, Dr Nadine	Research Scientist	South African Institute for Aquatic Biodiversity	PhD estuarine and nearshore larval fish biology and ecology	Planning, implementation and biological monitoring of river rehabilitation projects that have downstream implications for estuaries or rehabilitation of estuaries	046 6361002	083 3478739	046 222403	N.Strydom@ru.ac.za	Private Bag x1015, Grahamstown, 6140	http://www.saiab.ru.ac.za	Research and education	Sustainable use	Conservation and Management	Dam release into Kromme Estuary in attempt at managing unnatural euhaline conditions (Water SA 26 (3):319-328.Assessing upper limits of river flow into the Great Fish Estuary - identifying flushing effects of unnatural elevated flow on resident fish larvae (Marine & Freshwater Research 53 (2)
Suthers, Mrs Ronel	Erosion Control	African Gabions	BSc (Hons.) Hydrology GDE (Civil)	Soil bioengineering	021 7060032	083 6302136	021 7060031	enviro@africangabions.co.za	P O Box 22150, Fish Hoek, 7974, Cape Town	www.africangabions.co.za	Bioengineering, Erosion Control, River rehabilitation	Gabions, Erosion Control Blankets	Capacity Building through technical design assistance and training	Over 100 years experience as the Maccaferri Group in in river rehabilitaion and erosion control
Taylor, Dr Llew	Zoological scientist	Taylor Environmental	PhD Ecological Genetics	Theory on river riparian zones, effective approaches to river rehabilitation	083 259 4568	083 259 4568		taylorenviro@yahoo.com	PO Box 4670, White River, 1240, Mpumalanga		River rehabilitation	Research and Development		Involved in the past with Prof K Rogers initiative in collaborative effort with USA on development of river rehabilitation programme
Ter Morhuizen, Dr Leslie	Research Science	Anguilid Research Institute	Aquaculture and Fisheries	Flow and habitat requirements for riverine fish species	046 622 3690	083 4060 208		leslie@aquaafrica.co.za	PO Box 2179, Grahamstown, 6140	www.aquaafrica.co.za (private) corporate website under construction	anguillidae, eel, catadromous, fishery, aquaculture, flow requirement			
Thirion, Ms Christa	Scientist	IWQS, Water Affairs & Forestry	Msc Zoology (Limnology)	Biomonitoring, Development of Ecoregional Classification	012 8080374	082 8089846	012 8082702	ThirionC@dwaf.gov.za	Private Bag X313, Pretoria, 0001					
Thompson, Mr Mark	Applications / Research Scientist	Geospace International (Remote Sensing)	Satellite image and aerial photo mapping, GIS data	remote sensing, satellite imagery, land-cover, GIS, aerial photos	012 361 6036	082 330 7992	012 361 8355	mark@geospace.co.za	PO Box 73382, Lynnwood Ridge, Pta 0040	www.geospace.com	remote sensing, satellite imagery, land-cover, GIS, aerial photos			DEA&T Pilot Study for National Wetland Inventory
Tunha, Mr Washington	Engineer	Department of Water Affairs and Forestry	Msc. Engineering Hydrology	River and wetlands rehabilitation projects and their practical implementation	015 290 1288	082 801 4561	015 295 3249	Tunhaw@dwaf.gov.za	P Bag X9506, Pietersburg, 0700		River Rehab.	Research and Development	Pilot Trials	
Turton, Mr Anthony	Research Scientist	African Water Issues Research Unit (AWIRU)	Institutional Dynamics & Policy Aspects (D.Phil almost completed)	Institutional dynamics	011-665-3645	082 450 7967	012-420-3527	ant@icon.co.za	PO Box 302, Rant en Dal, 1751	http://www.up.ac.za/academic/libarts/polsci/awiru	Institution	Institutional Development	Policy	Crocodile River Riparian Association (1980's)
Uys, Dr Mandy	Research Scientist / Consultant / Freelance media	Laughing Waters	PhD River Ecology	Development of the field of river rehabilitation in SA. Planning, implementation and evaluation of river rehabilitation projects.	043 7402475	082 3369838	043 7401767	laughingh2o@icon.co.za	P O Box 889, Gonubie, 5256, East London	In development	River Rehab.	Research and Development	Pilot Trials	WRC KV144/03: Development of River Rehabilitation in Australia: Lessons for South Africa. WRC K5/1309, Part 1 Research, Development and Application Needs for River Rehabilitation in South Africa. Part 2: A rehabilitation plan for the Ihlanza River, East London, SA, based on the Australian River Rehabilitation Guidelines.
van den Berg, Mr Cornelis		Consultant		Grassland Rehab & Fire Management	056 817 2816	082 739 1111	056 817 2816	ecoscope@absamail.co.za	PO Box 1030 Parys 9585					Acre: Wolkberg Wilderness
van der Waal, Prof Ben C W	Lecturer/researcher	Department of Biological Sciences, University of Venda	PhD in fish ecology, research on inland fisheries	Development of sustainable fisheries on water bodies	015 962 8479	082 4340871	015 962 8648	bcw@univen.ac.za	P/Bag X 5050, Thohoyandou, 0950		sustained use of fish resources in dams and rivers	Research and training	projects	WRC714/1/01: A socio-biological study of the aquatic resources and their utilization in an underdeveloped rural region: the Mutshindudi River Catchment, Funduda Wetland rehabilitation, project proposal submitted to the DEAT, 2002
van der Westhuizen, Mr Sakkie	Policy developer	DWAF	B.Ing PP	Management of water quality impacts	(012)3367542	083 6275921	012 3230321	sakkie@dwaf.gov.za	Private Bag X313, Pretoria, 0001		Policy	Regulation	Risk Assessment	Development of a policy for the rehabilitation of water quality impacts
van Deventer, Mr P	Research Rehabilitation	Envirogreen (Pty) Ltd	Ecology, Soil Science, Environmental Rehabilitation	Planning, implementation evaluation and monitoring of ecological rehabilitation projects.	018 297 7455	082 855 4533	018 297 7458	pietvd@envirogreen.co.za	P O Box 20813, Noordbrug, 2522	www.envirogreen.co.za	Environmental Rehab	Research and Development	Pilot Trials	
Van Driel, Dr Dirk	Local Authority	Scientific Services Department, City of Cape Town	M.Sc., Ph.D., MBA, Pr.Sci.Na		021 684 1023		021 638 5083	email: dirk.vandriel@capetown.gov.za	PO Box 16548, VLAEBERG, 8018					

van Veelen, Mr Martin	Engineer, Aquatic Scientist	BKS (Pty) Ltd	M Eng (Water Utilisation)	Water quality, water resource development	012 421 3652	082 575 3690	012 421 3895	martinw@bks.co.za	PO Box 3173, Pretoria, 0001		River Rehab	Water Quality	Waste Standards	Jukskei River water quality management plan, Olifants River Ecosystem Water Requirements, Orange River Ecosystem Water Requirements, Resource Directed Waste Discharge Standards
Van Wyk, Ms Ernita	Scientist, Researcher	CSIR, Environmentek	MSc Ecology	Developing ecosystem services thinking in support of effective and fair decision-making around river resource management.	012 841 3672	none	012 841 2689	evwyk@csir.co.za	PO Box 395, Scientia, Pretoria, 0001		ecosystem state in terms of goods and services	trade-offs around state of ecosystem	Drivers, pressure, state, response' reporting model	No projects/experience directly in river rehabilitation, but involved in projects with potential links to. Project wrt and zone rehabilitation as part of alien plant management.
Van Wyk, Mr Niel	National Government	DWAF National	Integrated Water Resources Management, Reserve Determination, Trans	River/estuary protection and integrated water resources management, environmental procedure	012 3368327	082 8085651	012 3368295	ida@dwaf.gov.za	DWAF, Private Bag X313, Pretoria 0001					
Venter, Dr Freek	Specialist Scientist / Manager	SANParks / Kruger Nat Park / Scientific Services	PhD Land Classification	River conservation, wilderness stewardship, river management strategies	013 7356519	082 8771018	013 7356518	freekv@parks-sa.co.za	Private Bag X1021, Phalaborwa 1390	http://www.parks-sa.co.za	River Rehab	River restoration	River research & management	Demolition of dams in KNP, Implementation of IFR, Reserve and water quality improvements
CONTACT INDIVIDUAL	CATEGORY	ORGANISATION	TRAINING OR SPECIALISATION	KEY AREAS OF INTEREST	WORK PHONE	MOBILE PHONE	FAX	EMAIL ADDRESS	POSTAL ADDRESS	WEBSITE	KEYWORD	KEYWORD	KEYWORD	PROJECTS PERTAINING TO REHABILITATION
von der Heyden, Dr Constantin	Research Scientist	Oxford University, UK	PhD wetland remediation	Research and construction of remediation wetlands	(+44 1865 271919) UK; (021 9872400) SA	(+44 7796844930) UK	(+441865271 929) UK	constantin.vonderheyden@bnc.ox.ac.uk	School of Geography, Mansfield rd, Oxford University, OX1 3TB			Research		Benchmarking the use of natural wetlands for mine effluent remediation, Copperbelt, Zambia
Ward, Mr Norman	Manager	DWAF			031 3362737	082 8082721		WardN@dwaf.kznfl.gov.za			DAMS			
Wood, Mr Barry	Manager: Catchments	City of Cape Town	Civil Engineer		021 4872478	083 6356401	021 4872441	Barry.Wood@capetown.gov.za	PO Box 16548, Vlaeberg, 801	www.capetown.gov.za	Moddergat Ri	Kuils River		Manual currently under development
Wood, Mr James	Project manager	Green Belt Mapping	Agricultural Engineer	Planning, implementation and evaluation of river rehabilitation projects	083 654 2979	086 654 2979		greenmap@iafrica.com	PO Box 434, Linkhills, KZN, 3652		River Rehab			Project Manager: eMofana Riparian Rehabilitation Project (Umgeni Water), rehabilitation of 240kms of river in the Lions River catchment. Value R3 000 000. Rehabilitation of 100ha of wetlands on the Lions River, KZN (Umgeni Water, Sappi Forests).
Wood, Ms Julia	Project Management	Table Mountain Fund	MSc Botany	Rehabilitation	021 7628525		021 7621902	jwood@wwfsa.org.za	Table Mountain Fund, P Bag X2, Die Boord					

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River rehabilitation: Literature review, case studies and emerging principles.

King JM; Scheepers ACT; Fisher RC; Reinecke MK; Smith LB

Decades of poor catchment management, over-abstraction of water, use of rivers as waste disposal systems, destruction of riparian buffer strips and river beds have contributed to the toll of badly degraded rivers. The costs of poorly functioning rivers are largely externalised in any development activities, and so unknown. At present, there is not a developed science to deal with this in South Africa. There are no guidelines for, or even general principles, guiding such rehabilitation. The aim of this project is to pilot river rehabilitation in the Western Cape and to develop generic guidelines for rehabilitation, while at the same time building capacity for the science in 2 students

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