

National River Contaminants Program

...integrated management of nutrients,
sediment and salt in Australian rivers

**PROGRAM PLAN
2001/02–2004/05**

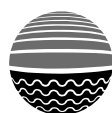




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Land & Water
AUSTRALIA
research • development • innovation

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Foreword

The National River Contaminants Program is a significant research and development program jointly funded by Land & Water Australia and the Murray–Darling Basin Commission. It expands and builds on the highly successful National Eutrophication Management Program, which concluded in 2000.

Whilst the National River Contaminants Program will have a strong scientific base, it will also produce practical research results that will contribute to developing natural resource management initiatives across Australia. From a natural resource management perspective we expect the National River Contaminants Program will provide:

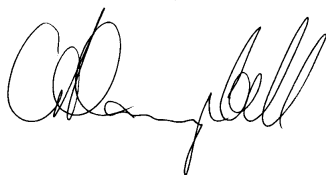
- a whole-of-ecosystem approach which focuses on the combined impacts of major riverine contaminants—nutrients, sediments and salts—and their role in ecosystem processes;
- scientific input to end-of-catchment target-setting frameworks currently being established at national, State, basin and local scales; and
- practical support for operational decisions regarding the management of river contaminants.

The National River Contaminants Program will provide practical technical information to directly support river management at national and catchment scales, and will fill information gaps to improve our understanding of the impact of contaminants on ecosystem processes.

Although the broad basis for this document is to develop a detailed Program Plan for the National River Contaminants Program, we recognise the importance of building relationships with relevant partners and stakeholders. This is vital to reduce overlap and to ensure that the research produced by the program is relevant to all users.

We believe the Program will add value to important natural resource management initiatives, including the National Action Plan for Salinity and Water Quality, and the Murray–Darling Basin Commission Integrated Catchment Management Policy (MDBMC, 2001a).

The National River Contaminants Program is an opportunity for research and development organisations to contribute to the development of an integrated approach to managing the major river contaminants identified by Australian water managers and scientists. We encourage you to be involved!



Andrew Campbell
Executive Director
Land & Water Australia



Don Blackmore
Chief Executive
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Contents

Foreword	3
1 Background	5
1.1 Strategic Plan (Atech Group, 2000)	5
1.2 Implementation Plan (Hart and Davis, 2000)	5
1.3 Scientific Workshop	6
2 The National Land and Water Resources Audit	8
3 Program Goal	8
4 Program Objectives	8
4.1 Developing a whole-of-ecosystem approach and integrated management for major contaminants	8
4.2 Applying an understanding of contaminant processes to management and policy	8
5 Research Priorities	9
5.1 Whole-of-ecosystem approach and integrated management	10
5.2 Knowledge gaps for ecological impacts of individual contaminants	10
6 Program Management	11
7 Budget	12
7.1 Income	12
7.2 Expenditure	12
8 Knowledge Exchange and Capacity Building	12
9 Program Evaluation	13
10 References	14
Figures	
1. Indicative national significance of major river contaminants. Regional significance may be different.	5
2. Nutrient enrichment of rivers stimulates primary production, accelerating aquatic plant growth, but—more commonly—causing excessive algal growth.	7
3. The Dawson River, Queensland: turbid rivers such as this can carry a large load of nutrients and contaminants bound to suspended sediments.	9
4. The Murrumbidgee River near Canberra, showing a sand slug, a shallow stream bed and eroded banks. Sediments, as well as carrying nutrients, pesticides and other contaminants, can be a significant pollutant in their own right.	11

1 Background

IN JUNE 1999, the Land & Water Australia Board requested the development of a new program of research and development (R&D) activity to build on and expand the National Eutrophication Management Program (NEMP), which concluded on 30 June 2000. This was on the basis that river contaminants affect not only the health and ecological value of our riverine systems (including wetlands and floodplains) but also threaten consumptive and commercial uses of the water resource.

The new program would also contribute to the implementation of important natural resource management initiatives, including the National Action Plan for Salinity and Water Quality and the Murray–Darling Basin Commission’s Integrated Catchment Management Policy and Salinity Management Strategy (MDBMC, 2001a,b).

To assist in the process of establishing the National River Contaminants Program and preparing a detailed Program Plan, several initiatives were commissioned by Land & Water Australia. These reflect the highly complex ecological processes associated with major river contaminants and their interactions. These initiatives included:

- a Strategic Plan (Atech Group, 2000);
- an Implementation Plan (Hart and Davis, 2000); and
- a Scientific Workshop (LWA, 2001).

As these have all contributed to the final composition of the National River Contaminants Program, they are described in detail in this Program Plan.

1.1 Strategic Plan (Atech Group, 2000)

The Atech Group report included a survey of water managers which illustrated that, across Australia, salinity, nutrients and sediments were the most significant river contamination issues, although there were regional differences in importance. The results of the stakeholder survey and interviews conducted within seven geographical divisions of Australia, including (for example) the Murray–Darling Basin, the wet tropics, and warm temperate areas, are summarised in Figure 1.

The Atech plan proposed that the new program incorporate a long-term, whole-of-ecosystem view that focused on the combined effects of river contaminants and integrated solutions to their management. Recognition was to be taken of commonalities and synergistic/antagonistic features of contaminant transport, impact and management processes.

In particular, it was recognised that issue-based river and catchment management strategies in a number of areas were posing significant contradictions and inefficiencies. An important outcome of any new contaminants program was for the research results to lead naturally to integrated management strategies and policies.

1.2 Implementation Plan (Hart and Davis, 2000)

Both Land & Water Australia and the Murray–Darling Basin Commission sought additional detail in a number of areas before determining the final allocation of resources to the Program. Professor Barry Hart (Cooperative Research Centre (CRC) for Freshwater Ecology and Water Studies Centre, Monash University) and Dr Richard Davis (NEMP Coordinator, CSIRO Land & Water) were subsequently commissioned to recommend a more detailed Implementation Plan for the National River Contaminants Program (Hart and Davis, 2000). They identified three important roles for the Program:

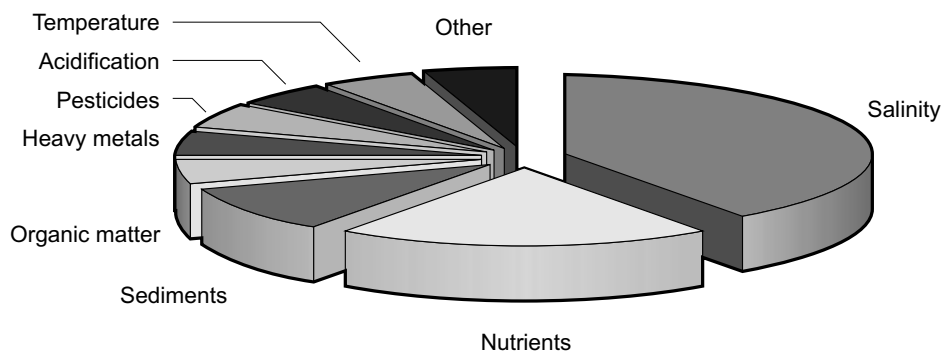


Figure 1. Indicative national significance of major river contaminants. Regional significance may be different.

- to study the effects of river contaminants on whole ecosystems;
- to generate new knowledge on the sources, pathways and transformations of specific river contaminants, and to develop and test new solutions and tools for reducing ecological impacts from contaminants; and
- to disseminate information and build capacity in the area of river contaminants.

These roles translated to the following **objectives** identified in the Implementation Plan:

- *Gain new knowledge*—to assist in developing sufficient knowledge to be able to manage the environmental impact and predict the ecological risks due to key contaminants in Australian rivers.
- *Devise new solutions and tools*—to assist in better packaging new and existing knowledge in ways that can be more effectively used to minimise these risks.
- *Get new and existing knowledge used*—to assist in developing innovative methods to ensure the new solutions and tools are effectively used.
- *Build capacity in research and management*—to assist in improving research and management agency capacity to better manage aquatic systems to minimise ecological risks from contaminants.

The Implementation Plan emphasised that these broad national objectives will only be achievable through strong partnerships with R&D providers and with resource management agencies at both State and federal levels.

1.3 Scientific Workshop

In May 2001, a Scientific Workshop was held in Canberra to develop an accepted conceptual framework for examining the transport, interactions, response time-scales, processes and transformations between sediment, nutrients (phosphorus and nitrogen) and salt, and resultant ecological responses, in Australia's river systems. The workshop also sought to identify any synergies and differences in the processes and management of these contaminants.

An outline of the papers prepared as background for the workshop is provided in Land & Water Australia's RipRap edition 20 on river contaminants. A summary of the outcomes of the workshop follows.

Context

River contaminants fall into two broad categories—those substances that occur naturally, but for which significant increases in amounts contaminate the environment (eg. salt, nutrients and sediment); and secondly, those that do not occur naturally, and for which even small amounts contaminate the environment (eg. pesticides and other agricultural chemicals).

Knowledge about river contaminants is patchy, with research into salt, nutrients and sediments providing some understanding of individual contaminants including sources, ecological impact, and options for improved management. The need to apply a whole-of-catchment perspective in understanding the cycling of these contaminants in ecosystems was emphasised.

Salt

Salinisation of landscapes has been identified as one of Australia's most serious environmental issues. This is true for dryland environments as well as rivers, which are a high priority for the Murray–Darling Basin and in warm temperate and dry tropics regions. In areas already affected, salinisation has devastated ecosystems with massive loss of habitat, biodiversity, native vegetation and water resource value. Trends indicate rapid expansion of salinisation in southern Australia, with many rivers in the Murray–Darling Basin likely to become seriously affected over the next 10–100 years.

Much is now known about the causes of salinity, and several effective strategies have been demonstrated to reduce the problem, but little R&D has been conducted on the specific environmental impacts of salinisation. In attempting to identify synergies in the processing of the three major contaminants, this information gap was identified as the major impediment to integrating salinity management.

Few investigations have examined the biological changes in salinised rivers or wetlands, the ecological impacts of salinisation, or the protection and remediation of threatened freshwater systems. A review of salinity tolerance data indicates that, although some information on the sensitivity to increased salt concentrations of certain animal and plant species is available, there is little information on the impacts on certain life-history stages, or behavioural responses. In addition, there is a lack of information relating to the effects of salinity on communities. For example, the effects on certain important taxa or groups of taxa in a community are likely to have more significant effects on ecosystem processes, such as production of organic matter, than effects on other groups in that community.

Nutrients

River nutrient levels do not generally constitute a serious issue for irrigation or drinking water quality. Rather, it is the ecological effects of nutrient enrichment (eutrophication) and the associated water-quality degradation that present a problem. Nutrient enrichment of rivers stimulates primary production, stimulating aquatic plant growth, but—more commonly—excessive algal growth (see Figure 2).

Much of the Australian eutrophication research on inland aquatic systems has focused on phytoplankton blooms, and understanding the roles of phosphorus supply and flow conditions. There is a good understanding of the basic processes of eutrophication in Australian freshwaters, although there are still important omissions such as the nitrogen cycle and its role in controlling algal biomass and species composition.

Recently, it has been demonstrated that nitrogen is the nutrient that initially limits phytoplankton growth in a number of inland waters, and research is required to better understand the role of nitrogen in river ecological processes. This should include consideration of the range of potential sources of nitrogen such as groundwater, hyporheic, riparian and river, and to use our current knowledge and available data to hypothesise on the dominant nitrogen processes in a range of environments, and to then undertake experimental studies to test these hypotheses. Past efforts have tended to focus on management of point sources of nitrogen pollution, however it is becoming increasingly recognised that diffuse sources, particularly as agriculture intensifies, are a major source of stream contamination and reduced health due to in-stream growth of nuisance plants and algae.

Sediment

Sediment is one of the most common river contaminants although, traditionally, concern has focused on the ability of soils to carry nutrients, pesticides and other contaminants into waterways, releasing them directly or at a later time from bottom sediments (see Figure 3). Sediments though, are a significant pollutant in their own right (see Figure 4).

Coarse sediments (eg. gravel, cobbles) alter river habitats by infilling the bed and degrading the benthic (river bottom) habitat. Fine sediments that are carried in suspension interfere with the respiration and feeding of many river animals, so that fish such as carp, that are not visual feeders, are favoured. By increasing turbidity and hence decreasing light penetration, suspended sediments also reduce submerged plant photosynthesis and alter the light regime for phytoplankton. Reduced light penetration favours algal species, such as some toxic cyanobacteria, in stratified systems, where they are able to regulate their cell buoyancy and move into the narrow upper light zone and continue to spread.

Recovery of a large proportion of Australian streams will not occur unless sediment is better managed.

Understanding large-scale patterns of sediment transport and the potential effects on river ecology is important in assisting catchment and resource managers to predict the hazard of sediment delivery to streams; to identify the major river reaches that are impacted by sediment; and to estimate the resultant sediment delivery to estuaries and the coast.

The sourcing and movement of sediments at the property and local scale are quite well understood. The processes governing nutrient releases from sediments, including the links to flow, stratification and anoxia, are also becoming understood for temperate and sub-tropical rivers. The National Land and Water Resources Audit has undertaken work that has contributed to improved understanding of sediment movement at the catchment and national scales.



Figure 2. Nutrient enrichment of rivers stimulates primary production, accelerating aquatic plant growth, but — more commonly — causing excessive algal growth. Photo: W. Van Aken.

2 The National Land and Water Resources Audit

THE NATIONAL Land and Water Resources Audit's *Australian Water Resources Assessment* (NL&WA, 2000) identified major water-quality issues across Australia's river basins. Similar to the Atech Group review, the Audit identified turbidity and nutrients as the most widespread water-quality issues, followed by salinity and acidity/alkalinity. The report emphasised that better information on the nature and extent of existing water-quality problems is fundamental to improving management.

3 Program Goal

To CONTRIBUTE to healthy river systems by reducing the ecological impact of river contaminants.

4 Program Objectives

4.1 Developing a whole-of-ecosystem approach and integrated management for major contaminants

- Generate new knowledge in our understanding of the ecological impacts of, and ecological risks due to, key river contaminants.
- Utilise existing and new knowledge of individual contaminant processes and, where possible, identify synergistic/antagonistic features of their interactions.
- Develop and test new solutions to reduce the ecological impact of contaminants.

There is increasing recognition that most ecosystems are subject to the effects of more than one contaminant, and that it is often the interactions between these multiple contaminants that can lead to more serious adverse effects. For example, the risk of algal blooms occurring is related to a complex interaction between light, turbidity, stratification and flow in addition to nutrient levels, which are in turn a product of catchment activities or system cycling.

Research is often conducted on a particular contaminant without consideration of other factors that may increase or decrease the effect of that contaminant on the ecosystem. The National River Contaminants Program wishes to develop conceptual models of these interactions for representative ecosystems that incorporate new knowledge, as well as contaminant interactions that are already understood. For example, suspended particulate matter can transport nutrients and pesticides and there is a close interaction between ecological processing of these contaminants. One of the benefits of this integrated approach to contaminants is the necessity for multidisciplinary research.

Whilst the majority of research under the National River Contaminants Program is expected to concentrate on the three key contaminants of nutrients, salt and sediment, there is scope for including other contaminants, such as pesticides, in meeting this objective. With the budget constraints of the Program, it is anticipated that existing knowledge will be utilised in identifying interactions between contaminants, with new knowledge generated for the major contaminants of nutrients, salt and sediment.

Although this integrated approach is the focus of the National River Contaminants Program, there are several knowledge gaps relating to individual contaminants, as highlighted by the Scientific Workshop. This research will improve understanding of the ecological impact of individual contaminants on whole ecosystems. This knowledge is necessary before identifying synergies in ecological processes and management between contaminants. In addition, it will contribute important information to current catchment and end-of-valley target-setting processes which are usually based on single contaminants.

4.2 Applying an understanding of contaminant processes to management and policy

Produce information which:

- contributes to target-setting frameworks currently being established at the national, basin, catchment and local scales;
- is relevant to operational processes for river managers in both regulated and unregulated systems; and
- can be effectively applied through innovative methods to promote new solutions and management tools.

The research focus on developing a whole-of-ecosystem approach and integrated management of major contaminants aims to generate sufficient knowledge to manage the environmental impact of these in Australian rivers. To ensure that this research provides practical guidance and support for river operators and managers, preference will be given to new research proposals or

re-packaged existing information that can be applied to current natural resource management strategies and policies.

Catchment-based targets, for example, are increasingly being utilised to drive improvements in catchment and river management across Australia. For example the Integrated Catchment Management (ICM) Policy for the Murray–Darling Basin 2001–2010 (MDBMC, 2001a) aims to develop management systems that allow the community and governments at all levels to work together for both public and private good. Like other current target-setting processes, the policy uses targets as a way to guide actions and to measure progress toward achieving outcomes.

The Murray–Darling Basin Salinity Management Strategy, a component of the ICM Policy, released in 2001, guides communities and governments in working together to control salinity and protect key natural resource values within their catchments. A key feature of the 15-year Basin Salinity Management Strategy is the adoption by the Ministerial Council of end-of-valley salinity targets for each tributary catchment, as well as a Basin target at Morgan in South Australia. The Basin target is to maintain the salinity at Morgan at less than 800 electrical conductivity (EC) units for 95% of the time. These targets reflect the shared responsibility for action between valley communities and States.

There is a need to incorporate relevant scientific understanding of contaminant processes and impacts in both the establishment and monitoring of these targets.

The National River Contaminants Program is well placed to provide a scientific base for the progression and support of target setting for river contaminants that are meaningful, at appropriate scales, comparable across catchments and basins, and linked to ecological outcomes and catchment and river health.

Increasingly, river managers are expected to apply an integrated approach to management of rivers including, for example, daily decisions on river-flow operations that incorporate water-quality considerations. Scientific understanding of river contaminant processes, impacts and interactions must be translated into information that can directly assist these management decisions.

5 Research Priorities

THE RESEARCH priorities for the National River Contaminants Program reflect the Program Objectives detailed in Sections 4.1 and 4.2. Whilst the first of these objectives relates to the generation of knowledge, the second objective specifies the application of this knowledge to current natural resource management. Priority will be given to proposals that meet both objectives by generating a new understanding of contaminants and a practical application of these findings.



Figure 3. The Dawson River, Queensland: turbid rivers such as this can carry a large load of nutrients and contaminants bound to suspended sediments. Photo: Anthony Scott.

5.1 Whole-of-ecosystem approach and integrated management

A complete ecosystem approach should include the range of physical, chemical and biological interactions within the waterbody and the surrounding catchment as well as the social and economic influences on its management. It is recognised that such an encompassing program could be very expensive for one ecosystem, let alone a number of representative ecosystems.

For this reason, the National River Contaminants Program aims to base integrated management on the interactions of contaminants for which there is sufficient existing information. Consequently, this aspect of the program will need to select ecosystems for which a good knowledge base is already developed. In addition, the research programs will have to ensure that research processes or findings are relevant to other ecosystems. This will require that the natural temporal and spatial variability inherent in Australian rivers be explicitly addressed.

Research priorities:

- Understanding of the sources, pathways, transformations and interactions of river contaminants within ecosystems and catchments.
- Development of conceptual and quantitative models to illustrate contaminant processes and any interactions between these, and to provide a predictive capability of cause/effect and ecological risk.
- Development of integrative tools for considering the combined effect of multiple contaminants including, for example, modelling approaches.

Preference will be given to those proposals incorporating management applications such as:

- Effective education and knowledge-exchange methods for river operators and managers to contribute to minimising ecological risks.
- Assessment of the relevant importance of current target-setting practices in relation to contaminant processes and interactions between contaminants.
- Identification of new solutions to reduce the ecological impacts of contaminants.

5.2 Knowledge gaps for ecological impacts of individual contaminants

Preference for funding research relating to individual contaminants will be given to proposals addressing management and policy applications or demonstrating how research will contribute to improved ecosystem understanding and potential for identifying synergistic and antagonistic interactions. In relation to management applications, proposals could include:

- Improved systems for setting catchment targets, assessing performance in reaching targets, and measuring the effectiveness of catchment rehabilitation.
- Links between ecological risks for key contaminants and appropriate target levels.
- Management tools for key contaminants to ensure that the risk of ecological impact is minimised and that actions designed to meet targets are relevant.
- Investigation of the ecological impact of individual contaminants, including identification of potential synergistic/antagonistic interactions with other contaminants and options for integrated management.

Salinity research priorities:

- Improved knowledge of salinity hazard by investigation of salinity sensitivity of key groups of aquatic organisms (eg. macrophytes) and of key ecosystem processes (eg. primary production). This should include investigations on possible sensitive life-history stages, behavioural responses, and of sub-lethal effects on individuals, as well as knowledge generation for the effects of salinity on communities of plants and animals and their interactions.
- Investigation of ecosystems where salinity is the dominant contaminant, to enhance knowledge concerning the extent and magnitude of the likely impacts of increasing salinity in riverine and wetland ecosystems.
- Examination of salinity effects in aquatic systems with increased interaction between groundwater hydrologists and biologists/ecologists.
- Greater knowledge is required on the importance of leaching, draw-down events and flushing in changing salinity regimes over time and re-setting salinity levels, ie. the impacts of hydrological practices on salinity in wetlands and rivers, especially given that wetland and river systems are increasingly being regulated.

Nutrients research priorities:

Land & Water Australia's National Riparian Lands Program is contributing additional resources to promote new research relating to the key contaminant nutrients. In particular, this additional budget is to identify and quantify nitrogen movement through riparian zones and to investigate possible methods of nitrogen management in riparian areas. Because nitrogen transformations, including loss mechanisms, are closely associated with carbon sources necessary for metabolism, work is also required to examine carbon sources, flow pathways and transformations.

- Review of available data for nitrogen in a whole-catchment context, and construction of catchment-based nitrogen budgets (extended to multiple contaminants, if appropriate) based on measurement and modelling to determine critical processes and knowledge gaps.
- Investigation and quantification of the links between surface and sub-surface nitrogen movement through riparian zones, and interactions with adjacent streams, including their water columns and hyporheic zones. Estimation of the relative importance of riparian denitrification, versus groundwater and instream processes, and under which flow conditions each component dominates.
- Investigation of circumstances under which nitrogen is, or is likely to be, a significant management issue, and development and testing of practical management options, particularly in areas with intensive farming systems.
- Conversion of nitrogen process information into guidelines, techniques, decision-support systems, and other knowledge products for managers at farm, community, region and State and national levels.
- Improvement of river and storage management for algal management, building on the outcomes of the National Eutrophication Management Program.

Sediment research priorities:

- Improved understanding of sediment transport processes down large river systems, especially in sub-tropical and tropical Australia, and an improved understanding of their ecological effects.

- Investigation of the processes of formation and destruction of habitat for different organisms and communities within the river channel, floodplains, wetlands and riparian areas, and testing of practical management options.

Greater knowledge is required on the extent and magnitude of the ecological impact of sediment, its role in driving ecological processes within naturally turbid systems, and the response of taxa and communities to increased sedimentation.

6 Program Management

THE NATIONAL River Contaminants Program will be managed by Land & Water Australia on behalf of the funding partners and overseen by a Program Management Committee comprising senior representation from Land & Water Australia and the Murray–Darling Basin Commission. A Program Coordinator has been appointed to manage projects and communication activities.

A Technical Committee comprising the Program Coordinator, a representative from the Murray–Darling Basin Commission and independent technical specialists from various State agencies will oversee implementation of this Program Plan. The Program Management Committee has approved the Program Plan and will



Figure 4. The Murrumbidgee River near Canberra, showing a sand slug, a shallow stream bed and eroded banks. Sediments, as well as carrying nutrients, pesticides and other contaminants, can be a significant pollutant in their own right.

approve project proposals and the detailed budget. Additional technical support and scientific expertise for program development and project review will be contracted on an as-needs basis.

First-round calls for proposals will be advertised nationally, seeking expressions of interest from research providers against priority research topics. These expressions of interest will be shortlisted by a selection panel, and successful proponents will be requested to submit full proposals for final evaluation. There is a high likelihood that proposals that proceed to the second round will be funded.

Proposals and potential R&D providers will be assessed against the following criteria:

- Evidence that the aims of the proposal are consistent with the objectives of the Program Plan.
- Evidence that the proposed methodology, including dissemination of knowledge, is sound.
- Demonstrated linkage between the impact of the program (outputs and outcomes) and relevance to natural resource management strategies and policies.
- Demonstrated R&D leadership, knowledge and skills related to the particular river contaminant subject area.
- Demonstrated experience in generating innovative ideas and solutions to relevant contaminant issues.
- Experience in the integration of research across different contaminants.
- Demonstrated ability to develop and manage interdisciplinary teams.
- Contribution of substantial in-kind and cash resources to the agreed R&D project.
- Demonstrated experience in working with the community, local government, catchment and agency river managers and policy developers.
- Strong evidence of abilities and methods of translating R&D into successful on-ground practice.
- Project leader with high-level communication, interpersonal, negotiation, team management and R&D leadership skills.
- Clear understanding of the responsibilities, roles and organisational arrangements for river management across the community and government.

7 Budget

THE FOLLOWING indicative four-year budget 2001/02 to 2004/05 shows the expected usage of program funds (in A\$).

7.1 Income

Murray–Darling Basin Commission	1,500,000
Land & Water Australia, Contaminants Program	1,500,000
Land & Water Australia, Riparian Program	265,000
Total	3,265,000

7.2 Expenditure

Research proposals	2,765,000
Knowledge exchange and communication	100,000
Program management and evaluation	400,000
Total	3,265,000

8 Knowledge Exchange and Capacity Building

THE NATIONAL River Contaminants Program will focus on ensuring that new knowledge generated by the program and existing knowledge is effectively used. The program will link its knowledge exchange and capacity-building activities with the existing resources of the Land & Water Australia communications program, Rivers Arena and the National Rivers Consortium, and establish new links with other research providers and State agencies.

Potential initiatives include:

- A focus on specialist workshops to provide useful syntheses of current knowledge.
- Enhancing the capacity and skills of those involved in river management through the development of appropriate tools and communication products, and training courses.

Linking with Environment Australia on work that will be on-going to upgrade the ANZECC/ARMCANZ¹ water-quality guidelines—a major component of this work will

¹ ANZECC = Australia and New Zealand Environment and Conservation Council; ARMCANZ = Agricultural and Resource Management Council of Australia and New Zealand.

be to update the current knowledge base related to contaminants.

- Incorporating river contaminant information on Land & Water Australia's River Landscapes website (<<http://www.rivers.gov.au>>), including research papers, management information, conferences and general information in the contaminants area.
- Incorporating river contaminant information into Land & Water Australia's rivers arena information products including RipRap, fact sheets, and technical guidelines and manuals.
- Establishing interactive management tools (models, conceptual models, protocols) related to managing ecological risk from contaminants.

9 Program Evaluation

EVALUATION ACTIVITIES will provide the required information for reallocating funds within the program. They will also demonstrate to program partners and stakeholders that research has been directed towards practical outcomes. The following monitoring and evaluation activities will be maintained over the life of the program:

- All projects will be evaluated annually to assess progress against annual milestones. Each research project will be required to submit an annual report, against agreed milestones, before the annual review.
- A selection of projects will be subject to an independent, external assessment during the life of the program.
- The program will be subjected to an external review immediately before its completion in order to determine whether its goals and objectives have been met.

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