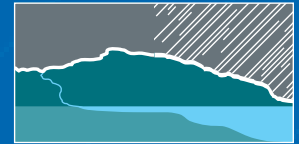


COOPERATIVE RESEARCH CENTRE FOR



CATCHMENT HYDROLOGY

Cooperative Research Centre for **Catchment Hydrology** **ANNUAL REPORT**
2002-2003



Established and supported under the
Australian Government's Cooperative
Research Centres Programme

Mission

The Cooperative Research Centre for Catchment Hydrology will deliver to resource managers the capability to assess the hydrologic impact of land-use and water-management decisions at whole-of-catchment scale.

Catchment hydrology is the study of water flows and material budgets in the landscape. It takes into account the many and varied factors impacting upon catchment land and water resources, such as climate, land use, water allocation, river management and environmental values.

Objectives

To achieve its mission, this CRC will:

- mount a quality research program, targeted to meet national objectives in catchment hydrology, by focussing on achieving predictive capability at whole-of-catchment scale;
- maximise the synergies of collaboration among its Parties and with related organisations;
- involve end-users in the identification, formulation, conduct, and utilisation of its research activities;
- provide training to increase awareness of, and the national skill base available in, catchment hydrology;
- train and equip postgraduate students as future leaders in land and water management;
- seek to sustain continuity of research effort in catchment hydrology consistent with the widespread and persistent nature of land and water problems.

Predictive capability is the key

One of the main deliverables expected from this CRC between 2003 and 2006 is the application of sustainable water resource management by catchment

managers through the provision of modelling capability designed to support the prediction of catchment behaviour.

New portfolio of research projects

Developing a 'culture of integration' across research projects is an important part of this CRC's activities.

In January 2003 the Centre commenced work on a new research portfolio, comprising:

- fifteen linked research projects to produce an integrated catchment modelling capability;
- five development projects to build modelling capacity within the land and water industry; and
- two support projects to aid and sustain adoption of the modelling capability by the land and water industry.

The development projects involve five focus catchments, namely the Yarra, Goulburn-Broken, Murrumbidgee, Brisbane and Fitzroy river catchments. The two support programs focus on communication and adoption, and education and training.

A key consideration in developing this new portfolio of research was to address

the following aims in this CRC's business plan:

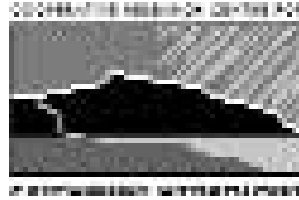
1. To develop a capacity to predict the consequences of land-use change, climate variability and river management at whole-of-catchment scale.
2. To ensure this predictive capacity is 'integrated' such that a holistic analysis of catchment response and management trade-offs is possible.
3. To deliver that capacity to resource managers.

Applying research in the field

The key deliverable expected from this CRC over the next three years is the provision of modelling capability to support the prediction of catchment behaviour.

Development of new generation catchment models and support tools integrated within a software system known as the Catchment Modelling Toolkit is a focus of all research programs.

The Toolkit will improve the standard and efficiency of catchment modelling and will provide much needed enhancements in predictive capability for resource managers.



A cooperative venture between:

- Brisbane City Council
- Bureau of Meteorology
- CSIRO Land and Water
- Department of Infrastructure, Planning and Natural Resources, NSW
- Department of Sustainability and Environment, Vic
- Goulburn-Murray Water
- Griffith University
- Melbourne Water
- Monash University
- Murray-Darling Basin Commission
- Natural Resources and Mines, Qld
- Southern Rural Water
- The University of Melbourne
- Wimmera Mallee Water

Associate:

- Water Corporation of Western Australia

Research Affiliates:

- Australian National University
- National Institute of Water and Atmospheric Research, New Zealand
- University of New South Wales

Industry Affiliate:

- WBM



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Contents

Chairman's Foreword	6
Director's Report	8
Program Highlights	12
Structure and Management	14
Cooperative Linkages	18
Research	24
Program 1 Predicting Catchment Behaviour	24
Program 2 Land-use Impacts on Rivers	28
Program 3 Sustainable Water Allocation	34
Program 4 Urban Stormwater Quality	38
Program 5 Climate Variability	42
Program 6 River Restoration	46
Utilisation and Adoption of Research	52
Program 7 Communication and Adoption	52
Education and Training	64
Program 8 Education and Training	64
Staffing and Administration	72
Public Presentations, Public Relations and Communications	74
Grants and Awards	80
Publications	82
Glossary	93
Performance Indicators	95
Budget	107
Audit	115
Appendix - Staff Resources	125

Chairman's Foreword

“Considerable effort and resources have been applied this year to the establishment of our five development projects. We see these as an absolutely vital means of transferring the technology and methods we have developed into the catchment management community.”

We are particularly conscious of our mission, which is to deliver to resource managers the capability to assess the hydrologic impact of land-use and water management decisions at whole-of-catchment scale. Specific goals this year were to:

1. define the research agenda for the second round of projects;
2. progress the first round of projects to the point of finalisation;
3. support Rob Vertessy in his new role as Director.

The Board has a forward looking, strategic, and policy-based perspective. It is insistent that the prediction of hydrologic behaviour of big catchments and the integration of modelling products into “real life” operations is the core of what this CRC is all about.

When we started to plan our new research portfolio we were determined to focus on those two issues - prediction and integration.

Under the direction of Rob Vertessy, we fulfilled our first goal by establishing a very comprehensive suite of new projects.

The other area that we have concentrated our efforts on this year is establishing the development projects in the five focus catchments. Our Parties have and continue to allocate significant resources to these projects. We see these as an absolutely vital means of transferring our technology and methods into the catchment management community and gaining essential feedback on how we can improve what we are doing.

Highlights

Appointment of our new Director, Rob Vertessy, early in the year and watching him grow into the role has certainly been a highlight for the Board.

Our focus this year has been on planning an inter-related set of research projects designed to meet our prediction and integration goals. In particular I am referring to the development and integration projects such as the Catchment Modelling Toolkit. Much energy and time was put into their strategic planning.

Rob played a key part in this process. He has embraced his new role, demonstrating that his collaborative and consultative approach achieves results.

Annual Workshop

The Board considers the annual workshop to be a very important event. It is an opportunity to bring CRC staff who are geographically scattered, together at least once a year to meet, network and share ideas.

Board members Scott Keyworth from the Murray-Darling Basin Commission, Ross Williams, Department of Infrastructure, Planning and Natural Resources NSW, Rae Moran, Department of Sustainability and Environment Victoria (DSE), and independent Board member Denis Hussey attended this year's workshop at Yanco in the Murrumbidgee catchment.

In Scott Keyworth's address to workshop participants he talked about the need to "encourage more disciples to integrated catchment management".

Rae Moran commented on the CRC's Catchment Modelling Toolkit as a major benefit of the DSE's investment in the CRC.

We have worked hard to build a spirit of collaboration and comradeship amongst all those in this CRC, and the annual workshop is one important means of enhancing that spirit.

Thanks

I would like to thank the Board for the important role they played this year in formulating the ongoing strategic direction of this CRC and maintaining a collaborative and creative environment for our participants

On behalf of the Board I would also like to thank and farewell Board representatives Prof Mike Brisk of Monash University, and Dr Chris Moran of CSIRO, and acknowledge their contributions to the CRC.

Future

For 2003-20004, a fifth year review will be a major milestone and I foreshadow the preparation for a new bid and subsequent third life for this CRC.

John Langford Chairman

Dr John Langford
Chairman



Director's Report

In applying the CRC's models to real-world management questions in the focus catchments, the Development Project teams will not only put our models through the ultimate acid-test, but they will also demonstrate the utility of these tools to catchment stakeholders.

Getting started

As newly appointed Director of this CRC, following the retirement of Professor Russell Mein in June 2002, I have taken on four main roles for myself. The first is to nurture the solid foundation established under Russell's outstanding leadership since 1995. Russell engendered a terrific cooperative spirit in our CRC, and I see evidence that this is strengthening all the time. The second is to ensure that our new project portfolio is well conceived and managed, and capitalises on the great outcomes from the first round of projects. Our new research portfolio is now up and running, thanks to the tremendous efforts of our talented Program and Project Leaders. Already, after only six months, some outstanding achievements are evident. The third is to ensure that we achieve the ambitious goals we set ourselves in our Business Plan, particularly the delivery to land and water managers of an integrated, whole-of-catchment modelling capability. We're not there yet but our new research portfolio certainly sets us up to fulfil our mission statement within the next three years. The heightened interest of our industry Parties in the modelling tools we are developing suggests that adoption of our research will happen if we set up the right mechanisms. The fourth is to plot a course for our CRC beyond our current term which ends in July, 2006. We have already begun the task of formulating a re-bid for continued Commonwealth funding beyond 2006.

After a year in the saddle, I'm feeling relaxed and optimistic about a bright future for our CRC and the land and water industry that we serve. My initiation into the role of Director has been greatly aided by the guidance of our Board Chairman, John Langford and our Business Manager, John Molloy. I thank them both for their wisdom and generosity. I am also indebted to our Governing Board and Program Leaders for the support and encouragement they have given me over the last twelve months.

Looking back at the last year

The last year has been a tremendously busy and productive one for our CRC. Some highlights include:

- completion of our first round of projects
- the implementation of our new project portfolio, including the launching of five focus-catchment-based 'Development Projects';
- significant progress in the development of the Catchment Modelling Toolkit;
- our Annual Workshop;
- the introduction of new staff and students into the CRC;
- delivery of the 'Bushfires and Hydrology' web site;
- commencement of a future CRC re-bid process.

Completion of first round projects

We have now completed all of the first round of research projects, capping off three intense years of research and development effort. Throughout this Annual Report you will read about the many great outcomes generated by our project teams.

A major highlight for our CRC this year has been the successful industry release in July 2002 of MUSIC (Model for Urban Stormwater Improvement Conceptualisation). This model has been the prime deliverable from Program 4 (Urban Stormwater Quality) and our CRC's most outstanding achievement in terms of industry adoption. Due to the strong support and involvement of Melbourne Water and the Brisbane City Council, MUSIC has been quickly adopted by the stormwater management industry; over 300 software licences were issued within six months of its release. MUSIC has revolutionised how stormwater managers make decisions and implement stormwater management systems both in regional planning and in the design of urban stormwater infrastructure.

Other proud achievements for our CRC this year include:

- major technical development of 'The Invisible Modelling Environment' (TIME), enabling rapid and effective development and integration of models within the Catchment Modelling Toolkit;
- significant development of the Rainfall-Runoff modelling Library (RRL);
- broad-based recognition of our work on the impacts of afforestation on catchment water yield;
- completion of Version 1 of the Mwater water trading software;

- industry uptake of the S_PROG rainfall nowcasting model;
- application of the Flow Events Method (FEM) in several Victorian environmental flow studies.
- application by Development Project teams of the Environmental Management Support System (EMSS) in each of our focus catchments;
- outstanding research contributions by our talented cohort of postgraduate students.

Our new project portfolio

A new round of projects commenced in January 2003, following the exhaustive efforts of Program and Project Leaders and Focus Catchment Coordinators in preparing a new research portfolio approved by the CRC Governing Board in November 2002.

Our new research portfolio includes 15 research projects, five development projects and two support projects, involving a total investment of about \$30 million over the next three years. A key consideration underpinning the development of this portfolio of new projects was that it addressed the 'three pillars', detailed in our 1998 Business Plan. These are:

- to provide a capacity to predict, at whole-of-catchment scale, the consequences of land-use change, climate variability and river management.
- to ensure this predictive capacity is integrated such that a holistic analysis of catchment response and management trade-offs is possible.
- to deliver that capacity to land and water managers.

Our new research portfolio tackles these challenges in a systematic and effective way, setting us up to deliver on our Business Plan by 2006.

A particularly innovative aspect of our new portfolio is the five 'Development Projects', one for each of our focus catchments. The intent of these development projects is to:

- build the capacity within our Industry Parties to apply the CRC's modelling tools;
- demonstrate the utility of the tools by applying them to a range of problems at whole-of-catchment scale; and
- provide our researchers with feedback from end-users on the suitability of the models for operational use.

In applying the CRC's models to real-world management questions in the focus catchments, the Development Project teams will not only put our models through the ultimate acid-test, but they will also demonstrate the utility of these tools to catchment stakeholders.

Our CRC's commitment to integration, adoption and meeting end-user needs is exemplified by the Development Projects. The Industry Parties involved in these five projects have made a huge commitment, providing almost \$1million of additional resources to meet project needs. This is both compelling and heartening evidence of a transition from 'research Party push' to 'industry Party pull', something all CRC's yearn for.

Prof Rob Vertessy
Director



Director's Report - continued

The Catchment Modelling Toolkit takes shape

Industry Parties that invest in CRCs expect they will gain access to useful knowledge and products that would otherwise be unavailable or difficult to harness without a CRC devoted to their needs. For this reason, our CRC places a strong accent on the development of tangible products designed to meet end-user needs. We are placing particular emphasis on the Catchment Modelling Toolkit, a modelling software resource that will allow catchment managers to deal with a wide range of land and river management issues in a holistic manner.

Over the last year, the Catchment Modelling Toolkit initiative has progressed rapidly. All of our research Programs are now building specific modelling software for the Toolkit and representatives from all of our Industry Parties are involved in the design and evaluation of the various Toolkit software products. I believe that never before in Australia have we seen such a number of talented researchers and practitioners working collectively to achieve such an outcome.

We now have a dedicated web site for the Toolkit at www.toolkit.net.au. Through this site we provide end-users with access to all of our models, as well as supporting documentation and data sets. It is still early days in terms of content at this site, but end-users can now glimpse the future of the Toolkit. The leader of our Communication and Adoption Program, David Perry, has been a vital driving force in the design and development of this site.

With our focus on product adoption, planning for the 'Catchment Modelling School' is well underway. Between 9-20 February 2004 Toolkit users will receive training on the application of various Toolkit software products.

Annual Workshop

The Annual Workshop is a keystone for our CRC; a forum to reflect on our achievements and aspirations and to plot a collective course forward. It stimulates and energises all involved, and helps everyone understand the importance of their contribution to the overall mission of our CRC. The workshop also provides the opportunity to network with colleagues, to socialise and forge friendships.

Yanco Agricultural College, situated in the Murrumbidgee River focus catchment, was the venue for this year's workshop. Some 92 participants, including four Board members, travelled from all over the country to partake in an extensive workshop program.

In closing the workshop, independent Board member, Denis Hussey summed up by strongly reinforcing the importance of this CRC saying "that our work is some of the most important that is going on in the country".

Key staff changes

CRCs are dynamic entities owing to their continually evolving research and development agenda. We continue to experience a considerable flux of staff and students in and out of our operations, which I believe is one of our great strengths.

I would like to sincerely thank outgoing Program Leaders Ian Rutherford (Program 6) and John Fien (Program 8). Ian was an outstanding and long-serving Program Leader in our CRC and is now succeeded by Mike Stewardson, based at The University of Melbourne. Luckily for us, Ian remains involved in a research and teaching role within our CRC. John Fien made a great contribution in getting our Education and Training Program off the ground and has been succeeded by Tim Smith, based at Griffith University. Tim has also been a Theme Leader with the Coastal Zone CRC, providing a bridge between our two Centres.

I was delighted to welcome Geoff Podger (Department of Infrastructure, Planning and Natural Resources, NSW) as the new leader of Program 1. Geoff has filled the role I had prior to becoming Director and has brought new flair to the role, coming as he does from a very strong industry background. It's great to have Geoff on board.

Dan Figucio, our web master for the past six years has also moved on. Our website is our interface to many clients and is often the first point of contact with our CRC. As the builder of our website, Dan created and maintained it over the years using his expert design and communication skills. Dan is succeeded by Jake MacMullin, based at CSIRO in Canberra. In association with Susan Daly (our new graphic designer based at Monash University), Jake will take our web sites to a new level.

Finally, I was pleased to welcome the appointment of Erwin Weinmann from July 2002 as our latest Deputy Director, based at Monash.

Bushfire and Hydrology web site

In the wake of the devastating bushfires over the 2002-2003 summer, there were many issues for land and water management agencies to confront in assessing the potential threats to water values. We experienced a huge demand for technical input from catchment managers, the community and the media. In parallel with fielding queries, conducting briefings and participating in workshops, we launched a website called 'Bushfires and Hydrology' at www.catchment.crc.org.au/bushfires. The information contained on this site assisted land and water managers with their impact assessment and rehabilitation planning. We received a lot of praise for this site and I'd like to thank all those who contributed to it.

The future

Although we are only four years into our seven-year life, planning is already underway for a new seven-year program to start in July 2005. We are preparing a re-bid which will need to be submitted around mid-2004. Over the next year there will be a lot of consultation with the land and water management industry to determine what a new CRC for Catchment Hydrology should set out to do. Now, more than ever, it is vital to listen to the land and water management industry and craft a research agenda tailored to the management questions of the future. Why? Because land and water issues are enjoying unprecedented public and political attention at the moment and it behoves us to work hand-in-glove with the industry to 'get it right'.

By the time we submit our next Annual Report we will have got much closer to delivering on our Business Plan, but we will also have a blueprint in place for taking us through to 2012. Until then, I look forward to another stimulating and productive year for our CRC.

Rob Vertessy Director



Program 1: Predicting Catchment Behaviour

Catchment modelling toolkit moves to next development phase

- The evaluation of the modelling frameworks ICMS, Tarsier and TIME was completed, resulting in the adoption of TIME as the framework for the development of CRC software modelling products.
- The software modelling framework TIME has undergone significant development resulting in improved and expanded functionality, which has seen the development of the following product modules or components:
 - the Rainfall Runoff modelling Library (RRL);
 - the Sediment Network model (SedNet); and
 - the River Analysis Package (RAP).

These products are currently being standardised and tested prior to release on the CRC's Catchment Modelling Toolkit website (www.toolkit.net.au).

Program 2: Land-use impacts on rivers

Development of conceptual frameworks for modelling on schedule

- Project 2.2 has further enhanced the SedNet tool to improve predictions of sediment and nutrient movement through all non-arid catchments in Australia.
- The CRC has developed a capability to predict the impact of soil conservation measures such as contour banks and filter strips on water quality downstream of cropping land. The recently developed software tool called 'Pathways' enables the benefits of soil erosion-minimisation structures to be included in catchment-wide predictions.
- The Project 2.3 team has extended their understanding of the impact of land-use change on stream flow. The team now has developed tools to predict changes to the seasonal patterns of stream flow associated with major changes to land use (such as new plantations).
- The study of the effectiveness of riparian zones on the movement of nitrate to streams was completed by the Project 2.5 team during the year. Nitrate is a key pollutant in European and North American catchments and this study enables Australian catchment managers to understand the management options based on data from local landscapes.

Program 3: Sustainable water allocation

Mwater gets thumbs up

- The operational development of an experimental water market environment (Mwater) was completed in which policy makers can explore alternative instruments under controlled conditions
- A Water Re-Allocation Model (WRAM) was developed which combines an economic model with the hydrological data underpinning IQQM.
- A variety of reports was completed including a comprehensive review of water reform in Australia and models exploring the redistribution of surplus water in catchments.

Program 4: Urban stormwater quality

Strong industry support for MUSIC

- The public release of the MUSIC model has been very well received by industry with over 300 licensed local and international users. It has significantly changed stormwater management planning in Australia.
- Valuable in-kind support from both Brisbane City Council and Melbourne Water has been critical to the success of this Program.
- The Stormwater 'Best Management Practices' project has yielded useful outcomes for industry and provided a strong basis for future research with four technical reports being published and results being used to refine calibrations of MUSIC for application in Brisbane.

Program 5: Climate variability

Models now in use throughout industry

- The uptake of models by the water industry is increasing with the Bureau of Meteorology and other international forecasting centres employing the S_PROG rainfall nowcasting model. MOTIVATE, the space-time rainfall model, is being used by Melbourne Water and Sydney Water. The seasonal stream flow forecasting model and the stochastic models are already in use by some agencies.
- The Murray-Darling River Basin was accepted this year as one of several GEWEX (Global Energy Water Cycle Experiment) CSE (Continental Scale Experiment) Basins. The Murrumbidgee data monitoring program and the land surface modelling

study in Project 5.1 are key components of the GEWEX CSE work. Results from the land surface modelling study were presented at several high profile international conferences throughout the year.

- Development and testing of stochastic models for generating rainfall and climate variables were completed this year, enabling their future incorporation into the Catchment Modelling Toolkit.

Program 6: River Restoration

Stream management benefits from new tools

- Projects 6.1 and 6.2 have provided a hierarchy of evaluation methods and planning approaches for stream managers. Priority setting for industry management was developed in conjunction with the CRC for Freshwater Ecology.
- Development of a beta version of the River Analysis Package (RAP) as a Catchment Modelling Toolkit product was a highlight this year. Interim results on Project 6.4 were presented to the Australian Society of Limnology conference.
- The Flow Events Method developed in Project 6.7 has already been applied in several Victorian studies and is recommended for use as part of the State-wide environmental flow setting procedures.

Program 7 Communication and Adoption

Development projects - facilitating adoption of CRC's research products.

The establishment and progress of Development projects in each of the five Focus Catchments was a significant highlight for the Communication and Adoption Program over the last year. The projects provide a focus for the delivery of the CRC's catchment modelling capability and its development to address local catchment issues.

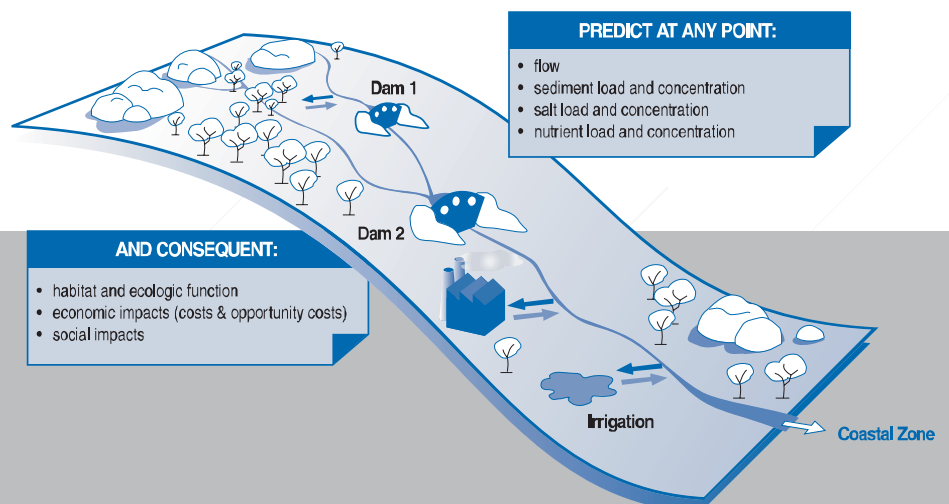
- Development Projects were established in the Fitzroy, South-East Queensland, Murrumbidgee, Goulburn-Broken and Yarra catchments
- Each project demonstrates the commitment of Industry Parties to the adoption and application of the CRC's predictive capability through the provision of staff and resources to meet relevant catchment objectives.
- Excellent progress has been made in each of the projects through ongoing training and dialogue involving the research teams, the Development Project teams and Focus Catchment communities.
- Importantly the application of the modelling tools has provided research teams with feedback as to how best to further develop these tools for industry use.

Program 8 Education and Training

CRC takes professional development to another level

- Successful adoption of CRC knowledge and products requires an effective education and training strategy. This year Program 8 devised a training framework comprising tools and templates that will aid in the education and training of CRC researchers, Parties and stakeholders involved in CRC projects.
- This CRC's commitment to the on-going professional development of CRC postgraduate students was demonstrated once again through the industry placement and professional development programs that operated this year.
- The 'We All Use Water' workshop series, a joint promotion between this CRC and the Australian Water Association, was successfully completed.

OUR TARGET:
A whole-of-catchment modelling capability



Centre Structure

The CRC is a cooperative, unincorporated joint venture between the following industry and research participants in land and water issues:

Land and Water Management Authorities

Department of Infrastructure, Planning and Natural Resources, NSW [formerly: Department of Land and Water Conservation, NSW]

Department of Sustainability and Environment, Vic [formerly: Department of Natural Resources and Environment, Vic]

Goulburn-Murray Water

Murray-Darling Basin Commission

Natural Resources and Mines, Qld

Southern Rural Water

Wimmera Mallee Water

Urban Water Authorities

Brisbane City Council

Melbourne Water

CSIRO

CSIRO Land and Water

Universities

Griffith University

Monash University

The University of Melbourne

National Meteorological Body

Bureau of Meteorology

Governing Board

The role of the Board is to provide long-term strategic and policy planning with supervision of the management of the Centre and support of its operations.

Board membership as at 30 June 2003 was:

Dr John Langford (Independent Chairman), Executive Director, Water Services Association of Australia

Mr Barry Ball, Manager Water Resources, Urban Management Division, Brisbane City Council

Mr Geoff Earl, Manager, Production and Catchments, Goulburn-Murray Water

Ms Christine Forster (Independent Board Member), Chair, Victorian Catchment Management Council

Mr Graham Hawke, Deputy Chief Executive, Southern Rural Water (non-voting participant)

Professor Jane Hughes, Faculty of Environmental Sciences, Griffith University [Alternate - Professor Bill Lovegrove]

Mr Denis Hussey (Independent Board Member), formerly Senior Associate, ACIL Tasman

Mr Peter Jackson, Manager of Technical Services, Wimmera Mallee Water (non-voting participant)

Mr Scott Keyworth, Director Landscapes and Industries, Murray-Darling Basin Commission (Alternate - Dr Sharon Davis) (Mr Warwick McDonald, Director ICM Unit, succeeded Mr Keyworth from August 2003)

Professor Clive Fraser, Associate Dean Research, Faculty of Engineering, The University of Melbourne (Alternate - Professor Graham Hutchinson)

Dr Wayne Meyer, Business Director, CSIRO Land and Water (replacing Dr Chris Moran, Chief Scientist, Healthy Country Flagship Program, CSIRO)

Ms Rae Moran, Senior Hydrologist, Catchment and Water Division, Department of Sustainability and Environment, Vic

Mr Chris Robson, Executive Director, Natural Resources and Sciences, Natural Resources and Mines, Qld

Mr Bruce Stewart, Assistant Director Climate, Consultative and Hydrological Services, Bureau of Meteorology (Alternates - Mr Jim Elliott, Dr Alan Seed)

Professor Rob Vertessy, CSIRO Land and Water

Mr Ross Williams, General Manager, Centre for Natural Resources, Department of Infrastructure, Planning and Natural Resources, NSW

Mr Ross Young, General Manager Planning, Melbourne Water (Alternate - Mr Graham Rooney)

Professor William Young, Head of Department of Civil Engineering, Monash University (replacing Professor Mike Brisk, Dean, Faculty of Engineering, following Professor Brisk's retirement) (Alternate - Professor John Sheridan)

The Governing Board met on the following dates:

29 July 2002

30 August 2002

18 November 2002

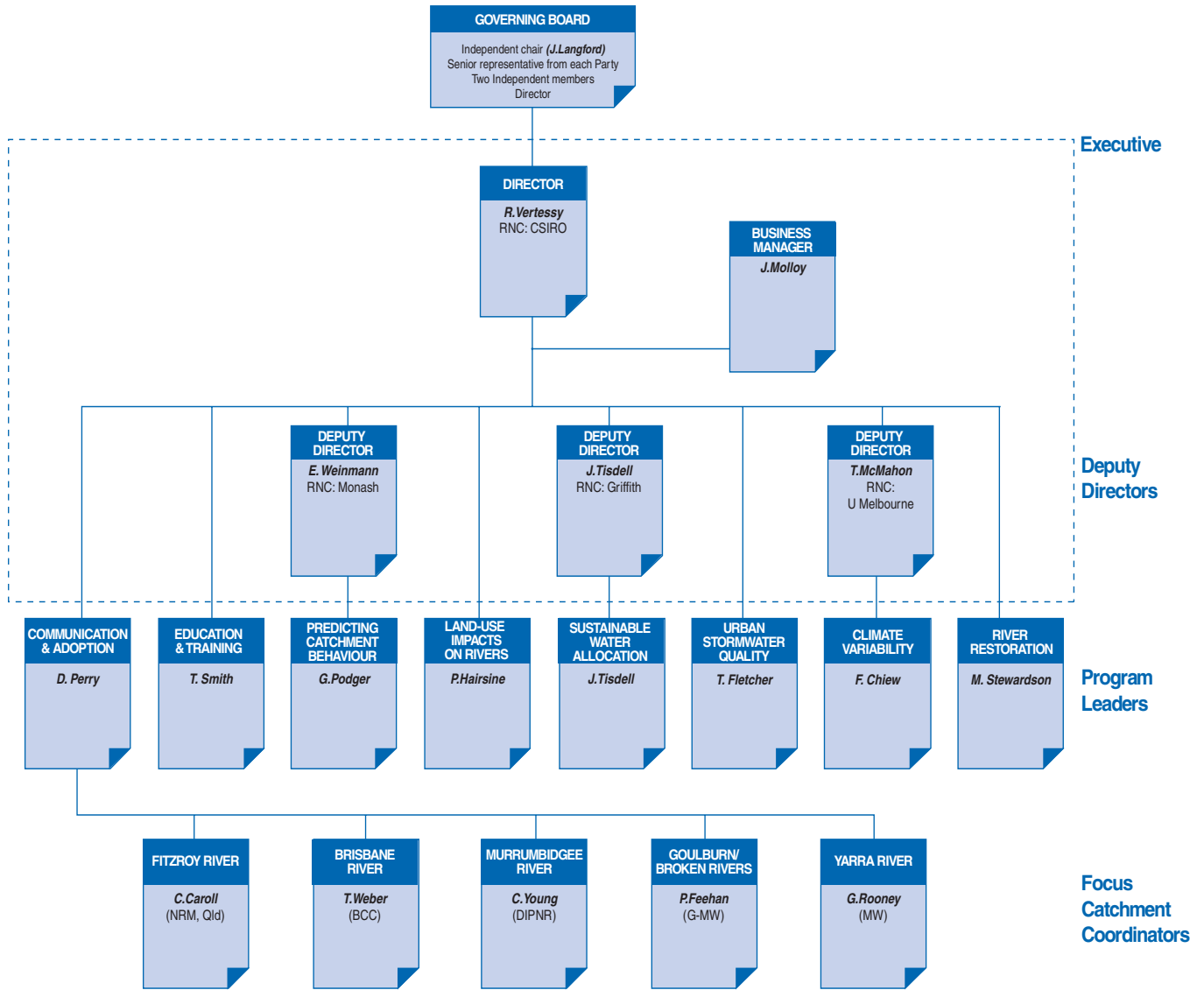
28 February 2003

30 May 2003



1. Governing Board participants, at May 2003 meeting in Canberra
2. Presentation at Annual Workshop by Prof Rob Vertessy of award for outstanding service to Dr Peter Hairsine, Program Leader

Centre Structure and Links Between Programs



GOVERNING BOARD	EXECUTIVE	PROGRAM LEADERS	PROJECT LEADERS	FOCUS CATCHMENT COORDINATORS	Roles
Strategic direction, policy, budget allocation, overview of achievement of whole-of-catchment approach.	Day to day operational management of the CRC (business, science, and the delivery of outcomes), ensuring programs link in an integrated way. Node Coordinators.	Program management (including project development, quality of science, Programs and Projects.	Project management (including supervision of project staff and budgets, meeting of milestones, reporting), liason with Node Coordinators and other Project Leaders	Coordination of site activities with Program/Project Leaders (eg. data, access, field staff), coordination with regional bodies, utilisation of research.	

RNC: Research Node Coordinator

Structure and Management

Centre Management

The Centre's Director is based at CSIRO Land and Water, Canberra, whilst the Centre Office is based at Monash University, Melbourne.

There are four main research facilities, located at: Monash University, Clayton Vic; CSIRO Land and Water, Canberra; Griffith University, Brisbane; and The University of Melbourne. Research is also conducted in various other Party locations including Bureau of Meteorology, Melbourne; Natural Resources and Mines, Indooroopilly, Qld; Department of Sustainability and Environment, Tatura and Rutherglen, Vic.

Deputy Directors oversee the operations at the three University sites - Mr Erwin Weinmann at Monash University, Prof Tom McMahon at The University of Melbourne and Dr John Tisdell at Griffith University.

Strategic Directions

The Business Plan as developed during the CRC bid, guides the strategic directions and operations of the Centre. Strategic directions were reviewed in November 2001 and specific items such as the Commercialisation Strategy were re-visited for review during 2002-03.

Research Programs

An expansion in the number of projects this year sees the Centre now supporting 15 new projects within the following six research programs:

- Program 1 Predicting Catchment Behaviour
- Program 2 Land-use Impacts on Rivers
- Program 3 Sustainable Water Allocation
- Program 4 Urban Stormwater Quality
- Program 5 Climate Variability
- Program 6 River Restoration

These are complemented by a further seven projects in the following programs:

- Program 7 Communication and Adoption
- Program 8 Education and Training

A major initiative was the establishment of five development projects, each related to a CRC focus catchment. The development projects are seen as major vehicles for further adoption and application of CRC research.

Annual Workshop

This year's annual workshop was held at the Murrumbidgee Agricultural College in the small NSW rural town of Yanco. Chosen for its location in the Murrumbidgee catchment - one of the CRC's focus catchments - more than 90 participants took part in an extensive three-day program. Four Board members also attended.

These annual workshops underpin the philosophy of this Centre. They are a forum to reflect on past achievements and to plot a collective course forward. They provide participants with an opportunity to see how individual projects and programs are progressing and how these fit into the overall catchment approach. Sharing ideas and meeting new participants were also important aspects of the workshop.

Most importantly, these annual events provide an opportunity to demonstrate the vital contribution each project and each individual is making towards the Centre's mission.

Director, Rob Vertessy opened the workshop by presenting an overview of the CRC, the Centre's research agenda and portfolio of new research projects.

A key message reinforced throughout the workshop was the role the Centre plays in integrating science into delivery mechanisms for end-user application.

Postgraduates presented updates on their projects and the four Board members in attendance reiterated the importance of this Centre's work. Independent Board member, Denis Hussey, told participants that the work of this CRC is some of the most important work that is going on in the country.



1. Participants from CRC Parties at Annual Workshop, Yanco, April 2003

Participation Arrangements

Organisations can participate in the CRC via one of the following arrangements:

CRC Party

Direct involvement in setting priorities and sharing outcomes in research and technology adoption

CRC Associate

Direct involvement with a selected project activity and sharing of outcomes; alternatively a broader-based access to research findings

CRC Research Affiliate

An opportunity for major research collaboration with organisations outside the CRC

CRC Industry Affiliate

An opportunity for collaboration with commercial organisations within the industry but outside the CRC

Centre Visitor

The CRC Visitor scheme was established in 1993 to assist CRC Committees in the following ways:

- providing an independent link between the Commonwealth and individual CRC's;
- as an independent, experienced and objective advisor.

In March 2003, the Hon David Wotton was appointed by the Commonwealth as the new CRC Visitor following nomination and endorsement by the Governing Board of the CRC. He replaces Mr Jim Miller, who held the position for the previous three years.

The Hon David Wotton has had a distinguished public life, much of it closely linked to land and water issues. He entered Parliament in South Australia in 1975 and was Shadow Minister for Environment and Planning from 1976 to 1979. In 1979 he was appointed Minister for Environment and Planning in South Australia and served in that role until 1982. In 1993 Mr Wotton became Minister for Environment and Natural Resources. From 1993-1997 he was lead Minister for the Murray-Darling Basin Ministerial Council, a position he held while Minister for Environment and Natural Resources for South Australia.

In 1999-2001 the Hon David Wotton chaired a Parliamentary Select Committee on the River Murray. He is the current Chairman of the River Murray Catchment Water Management Board.

1. CRC Visitor the Hon David Wotton



“The collaboration and exposure to some of this Centre’s research ideas combined with the kudos of being an Industry Affiliate has been good for us.”

Tony McAllister WBM Oceanics.

Expanding participation arrangements

The Commonwealth CRC Programme was established to promote the development of new knowledge and technology. Industry adoption is a key performance measure for all CRCs. For this reason, this CRC’s priority is to develop useful knowledge and technology and promote its uptake by land and water resource managers.

This CRC has been fortunate in establishing working relationships with fourteen Parties from the land and water industry and research organisations, one Associate, three Research Affiliates and four Industry Affiliates (see Structure and Management for explanation on participation).

Industry Parties that invest in CRCs expect to gain access to useful knowledge and products that would otherwise be unavailable or difficult to harness without a CRC.

This Centre is focussing its energies on the development and delivery of the Catchment Modelling Toolkit. Importantly, representatives from all industry Parties are involved in the design, evaluation and promotion of Toolkit software products.

The Industry Affiliate arrangement provides a collaborative opportunity for industry stakeholders and the CRC. The arrangement encourages establishment of strategic relationships with some of Australia’s leading environmental engineering consultants. To date the Centre has built a very successful working relationship with WBM Oceanics, its first Industry Affiliate. Negotiations have commenced for a further three Industry Affiliates to join the CRC in the next year.

We view our relationship with the CRC very positively. There are clear benefits to both parties. For WBM Oceanics we have found the exposure to new tools, ideas and new ways of thinking very beneficial.

The relationship has been good for the CRC as well because we provide a link to the real world - a channel through which to test and evaluate their tools and ideas in the field.

Without a doubt, the kudos of being an Industry Affiliate of the CRC’s is valuable. So we make a point of promoting this fact at every opportunity.

During our 12-month partnership with the CRC we have undertaken and won several projects in the South East Queensland region. Working together with the CRC on these jobs has been great.

Tony McAlister, Director, WBM Oceanics.



Links between Parties

This Centre's collaborative and cooperative links with industry and research Parties are stronger than ever, reflected by the following:

- Development projects, a major focus in encouraging adoption of this Centre's research.
- Research and industry representatives jointly formulate research projects.
- All projects involve at least two Parties.
- Parties participate in project review panels, generally twice yearly.
- Focus research sites bring industry, researchers and regional representatives together.
- Staff are seconded from industry to research sites and vice versa.
- Postgraduate supervisory panels include non-university members.
- Parties are encouraged to participate in the Centre's Annual Workshop.
- Interaction and information on Parties' involvement in the CRC through *Catchword*, the CRC's monthly newsletter and the internal news bulletin *CatchUp*.

Building catchment modelling capacity within industry Parties is essential to obtaining end-user feedback and securing industry adoption. Interaction between Parties on the Catchment Modelling Toolkit and other activities included:

- Second round projects in Program 1 concerning the implementation of the Catchment Modelling Toolkit and Integration methods have involved industry and research Parties at a detailed level with meeting end-users needs being a key ingredient of the work.
- Water and catchment management Parties from Queensland(NRM), NSW(DIPNR), and Victoria (DSE, G-MW) have been major participants in the development and implementation of the new round of Program 2 projects on land-use impacts on rivers.
- Water allocation modelling and water market evaluations in Program 3 have been initiated with the active support of industry Parties working with university researchers.

- Brisbane City Council and Melbourne Water have continued very supportive collaborative roles in the research and formulation of Program 4 work on urban stormwater quality with CSIRO and university researchers.
- Goulburn-Murray Water and the Bureau of Meteorology have pursued joint activity with CSIRO and The University of Melbourne for the new round of Program 5 projects.
- Natural resource management Parties in Queensland, NSW and Victoria are key stakeholders in Program 6 projects on river restoration
- Development projects in the five CRC Focus Catchments represent substantial collaborative commitments by industry and research Parties.

1. Board members at Annual Workshop — Ms Rae Moran (DSE), Mr Scott Keyworth (MDBC)
2. Mr Denis Hussey (Board independent member)
3. Program Leaders, Focus Catchment Coordinators and other industry Party participants — project planning, October 2003



Cooperative Linkages



Working with other research groups and agencies

This CRC works closely with some of the country's leading land and water research groups and management authorities.

- The Australian National University iCAM centre collaborated in Program 1 (catchment modelling aspects) and Program 3 (hydrologic and economic aspects of water allocation).
- Project 5.06 (5B) worked with Associate Professor George Kuczera, University of Newcastle, on modelling longer-term variability in stochastic models of annual rainfall using and testing models developed by the Centre.
- CSIRO Atmospheric Research was involved in collaboration in Program 5, Climate Variability.
- The CRC for Coastal Zone, Estuary and Waterway Management have proposed projects which link to Project 2.20 (2D), and collaborative linkages have been previously established with Program 2, first round projects.
- The CRC for Freshwater Ecology is actively involved in Program 4 and 6 projects, funding closely-linked 'sister' projects.
- Land and Water Australia funds CRC research over various areas including projects on contaminant cycle modelling, dryland salinity, water market reform, riparian zones and ephemeral streams, in-stream and riparian zone nitrogen dynamics.
- The EPA (NSW) had consultations with Program 4 to evaluate gaps in knowledge of stormwater quality and treatment, and to formulate future work.

- The NSW Department of Agriculture collaborated with aspects of Program 3, Sustainable Water Allocation.
- Involvement with the newly established CRC for Irrigation Futures included collaboration in and part funding of Project 2.19 (2A).

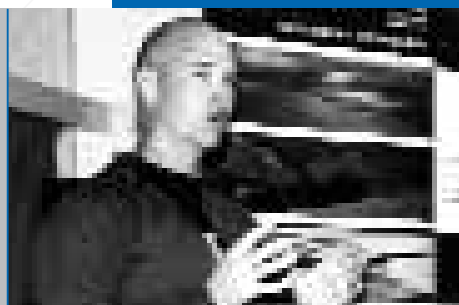
International Collaboration

World-class research requires involvement and collaboration with international agencies. This Centre continues to work with leading international institutions in pursuit of state-of-the-art catchment modelling science.

- Cooperative links with the European Union 'Harmon' projects were established by Dr Robert Argent. Projects on related modelling, notably HarmonIT and HarmoniCA, share common goals and approaches with some of this Centre's programs. The establishment of links with these projects will aid in the development of modelling tools, integration and participatory processes over the coming years.
- Dr Fred Watson, California State University Monterey Bay, USA maintained collaboration on the modelling frameworks for the Catchment Modelling Toolkit and continued to provide specialist advice in the Centre's water yield prediction work.
- Dr Tim McVicar and Dr Lu Zhang, Program 2, worked with colleagues in China in Associated / Additional Project 2.24 on regional impacts of re-vegetation on water resources.
- Program 5 researchers have been working with international institutions in New Zealand, South Africa, Canada, and the USA.
- The S_PROG model in Program 5 is under evaluation by NIWA (NZ), the UK's Met Office, and Spain's Catalan Technical University.
- Professor John Dracup, University of California, San Francisco and the CRC's Dr Francis Chiew worked collaboratively on ENSO-stream flow teleconnection and the development of a seasonal forecasting model.
- The CRC's Dr Sri Srikanthan has been consulting with Professor Van-Thanh-Van Nguyen from McGill University, Canada on disaggregation of rainfall data, incorporation of climate change effects in stochastic models and derivation of optimal design storms.
- Collaboration was developed with researchers from Sweden's Chalmers University to evaluate European models and compare their performance against MUSIC as part of Project 4.08 (4A).
- Dr Peter Wallbrink during May 2003 furthered links with the International Atomic Energy Agency - IAEA at Vienna, Austria, on the use of tracers in large catchments. The International working group on the application of fallout nuclides to catchment sustainability (Dr Felipe Zapata, Dr Jeff Turner) was a key group for the linkage.
- The Research Institute for Tropical Forestry, South China Institute of Botany, China Eucalypt Research Centre, and Leizhou Forest Bureau, Guangdong province, China, continued research collaboration and training in connection with Project 2.7, Eucalypts and Water. Dr Jim Morris visited the groups during August - September 2002 and March - April 2003.



1. CRC researchers Dr Lu Zhang (far left) and Dr Tim McVicar (third from right) with stakeholders from the Yellow River Committee, P.R. China
2. Melbourne Water Researcher Matt Francey - seconded postgraduate at Monash University



Cooperative Linkages

International visitors

- Dr John Bright, Lincoln Ventures, New Zealand, visited The University of Melbourne and Dr Robert Argent (Project 1.10 (1B)). Discussions were held on modelling aspects of the Centre's research. Dr Ralf Denzer, HTW Saarlandes (Germany), visited Dr Argent in connection with Program 1. Aspects of modelling systems and data management relevant to the Catchment Modelling Toolkit were discussed.
- Dr Richard Soppe from the USDA Agricultural Research Service Water Management Laboratory in Fresno, California, spent 10 weeks with Dr Evan Christen (Project 2.19 (2A)) for further modelling and data analysis work on upflow of water from shallow water tables.
- Dr Gert Verstraeten from Belgium's Catholic University of Leuven visited the Project 2.20 (2B) team in Canberra for three months to learn about SedNet software and how to incorporate it into hill slope-scale modelling.
- Two visitors from the Chinese Academy of Sciences, Prof Hunag Minbing from the Institute of Soil and Water Conservation, and Prof Li Lijuan from the Institute of Geographical Science and National Resources, spent time in Canberra with Dr Lu Zhang.
- Mr Earl Shaver from the Auckland Regional Council NZ, toured key water-sensitive urban design sites with the Program 4 leader and took part in a review of Program 4 projects.
- This year Program 5 hosted a number of international visitors.
 - Associate Professor Fred Ogden, University of Connecticut, USA, worked with Dr's Francis Chew and Andrew Western on modelling land surface hydrology in the different climate and landscapes across the Murrumbidgee River Basin.
 - Professor Geoff Pegram, University of Natal, South Africa, together with Dr's Alan Seed, Francis Chiew and Sri Srikanthan worked on modelling dry and wet spells and wet spell rainfall amounts for areal average rainfall over large regions.
- Dr Neill Bowler from the Met Office, UK, and Dr Alan Seed worked on stochastic rainfall nowcasting, in particular the adaption of the S_PROG model for use in the UK Met Office.
- Dr Paul Cowpertwait, Massey University, Auckland, NZ spent time working in Australia on applying the Neymann Scott Rectangular Pulse model to Australian data to generate short duration rainfall data.
- Josef Kiessner, a visiting student from the University of Agriculture, Vienna, visited Program 6. During his visit he completed his thesis.
- A delegation from the Sustainable Water Resources Research Centre, Seoul, and Pusan University Korea visited CRC groups in Canberra and Melbourne during February 2003.

1. Visiting researcher Dr Richard Soppe, US Dept of Agriculture
- collaborating in Program 2



International visits

- Meander migration and the effect of catchment-scale land use change on channel morphology was the thrust of Assoc Prof Ian Rutherford's three-month visit to Rhodes University, South Africa.
- A joint Met Office, UK, Bureau of Meteorology and CRC project was undertaken to extend S_PROG into a stochastic nowcasting system, and to investigate merging numerical weather prediction and nowcasting products. The UK Met Office invited CRC's Dr Alan Seed (Project 5.05 (5A)) to assist with the trial of S_PROG in the UK.
- Project 1.10 (1B's) Dr Robert Argent visited members of the European Union 'Harmon' set of projects in the UK, Netherlands and Germany. The outcome of this visit was the establishment of important links that may aid in the development of modelling tools, and integration and participatory processes over the coming years.
- Mr Joel Rahman, Mr Shane Seaton and Dr Robert Argent travelled to California during February and March 2003 as part of the Catchment Modelling Toolkit team. Dr Argent presented a seminar to members of the CALFED Bay-Delta Program focussing on Toolkit developments and integrated hydrological/ecological modelling. All three attended the California Water and Environmental Modelling Forum and then spent time with Dr Fred Watson (CSU, Monterey Bay) working on the development of TIME.

1. Dr Lil Haig of the 'Working for Wetlands' Project, Rhodes University, a colleague of Assoc Prof Ian Rutherford during his research in South Africa
2. Dr Andrew Gordon, Institute for Water Research, Rhodes University, and postgraduate student, colleagues of Assoc Prof Ian Rutherford in South Africa at work on stream restoration, Kat River



Research

Program 1: Predicting Catchment Behaviour

Aim

To provide land and water managers with the tools and skills to make informed decisions on whole catchments.

Program Leader

Mr Geoff Podger, NSW Department of Infrastructure, Planning and Natural Resources.

Program Outputs

This Program builds on two earlier projects and comprises two new research projects designed to help fulfil the CRC's core requirement of building a Catchment Modelling Toolkit.

The Catchment Modelling Toolkit is an integrated software solution comprising modelling tools and modules capable of predicting catchment behaviour.

Outcomes and Benefits

In this CRC's new portfolio of projects there is a major emphasis on integration of all modelling tools. A 'culture of integration' has been developed across research projects and industry Parties to ensure outputs comply with integration needs.

The development of new generation catchment models and modelling support tools within a new model development environment called TIME (The Invisible Modelling Environment) is consistent with this culture. The software products developed by this CRC will be delivered via a web interface and will form the basis of the Catchment Modelling Toolkit.

The Toolkit will improve the standard and efficiency of catchment modelling and provide much needed enhancements in predictive capability for land and water managers. This system of software will enable them to evaluate and better predict the short and long-term outcomes of land and water policy decisions at regional scales.

The Catchment Modelling Toolkit will provide:

- demonstrated ability to plan for changes in catchments, and manage them accordingly to maximise environmental, economic, and social values; and
- a collection of packaged models, data products, and high-quality user documentation.

Importantly, when adopted by catchment and resource managers, the Toolkit will greatly assist in sustainable land and water management.

1. Program Leader Geoff Podger



End-users

Users can be segmented into primary and secondary users.

Primary user groups

- researchers
- technical planning units within urban, rural and state resource management authorities
- consultants
- graduate students

Secondary user groups

- catchment management authorities
- community-based catchment groups
- policy and extension groups at all levels of government
- undergraduates

Program highlights 2002-2003

- The evaluation of the modelling frameworks ICMS, Tarsier and TIME was completed and subsequently TIME was adopted as the framework for the development of CRC software modelling products.
- The software modelling framework TIME has undergone significant development resulting in improved and expanded functionality, which has seen the development of the following product modules or components:
 - the Rainfall Runoff modelling Library (RRL);
 - the Sediment Network model (SedNet); and
 - the River Analysis Package (RAP).

These products are currently being standardised and tested prior to release on the CRC's Catchment Modelling Toolkit website (www.toolkit.net.au).

- TIME has created a lot of interest from Industry Parties, other CRCs and software developers. In particular, the Department of Infrastructure, Planning and Natural Resources NSW has adopted the TIME modelling environment for development of some of its models.
- The Toolkit Strategy Group (TSG) was established to coordinate the development of the Toolkit. The TSG has developed standards and procedures that ensure Toolkit products have a common style and provides user support in the form of documentation, on-line help and training material.

The TSG has developed procedures covering: roles of product managers, the product induction process, the management of revenue gained through the delivery of Toolkit software, software version numbering system, and a standard software licence agreement.

The TSG plans the development of TIME and the staged delivery of products. The TSG also assesses whether new products developed both within and outside the CRC should be included in the Catchment Modelling Toolkit.

Other highlights this year included:

- Successful completion of first round research Project 1.1 under the leadership of Dr Robert Argent, with development of the Toolkit moving to new Projects 1.09 (1A) and 1.10 (1B).
- Successful completion of first round research Project 1.2 under the leadership of Assoc Prof Rodger Grayson, with research from this project assisting in the incorporation and integration of models within the Toolkit.

- Successful completion of Associated/Additional Project 1.7, a local scale EMSS (LEMSS) implementation in the Pine Rivers Catchment in South East Queensland. The LEMSS simulates the health of aquatic ecosystems by predicting the generation of sediment and nutrients and their delivery to the reservoirs Lake Samsonvale and Lake Kurwongbah.
- Dr Robert Argent, Project Leader 1.1 and 1.10 (1B), was invited to the International Review Panel for the European 5th Framework Program project HarmonIT in the UK. This project is developing the European Open Modelling Interface and Environment (OMI).



1. Predicting Catchment Behaviour Program group
2. Data mapping for process-based modelling at large scales



Research

Program 1 Predicting Catchment Behaviour

Project 1.1 Development of a Catchment Modelling Toolkit

(First round project)

Project Leader: Dr Robert Argent, The University of Melbourne

Aim: To provide a generic 'Toolkit' of compatible models from which land and water practitioners can select components suitable for their particular purposes.

Achievements 2002-2003

- This project was successfully completed in December 2002 with development of the Catchment Modelling Toolkit moved to new Projects, 1.09 (1A) - Implementation of the Catchment Modelling Toolkit, and 1.10 (1B) - Methods for integration in catchment prediction.
- Detailed evaluation of the ICMS and Tarsier catchment modelling frameworks.
- Development of the TIME modelling framework, building on the strengths of ICMS and Tarsier.

Project 1.2 Scaling procedures to support process-based modelling at large scales

(First round project)

Project Leader: Associate Professor Rodger Grayson, The University of Melbourne

Aim: To develop efficient algorithms that can represent the effects of small-scale variability both in space and time in large-scale hydrological models.

Achievements 2002-2003

- Analysis and prioritisation of the modelling needs of the hydrological modelling and management community
- Investigation and analysis of hydrological and ecological modelling frameworks
- Development of an advanced integrated environmental modelling framework to support development and deployment of the Catchment Modelling Toolkit.

Project 1.09 (1A) Implementation of the Catchment Modelling Toolkit

(Second round project)

Project Leader: Mr Joel Rahman, CSIRO Land and Water

Aim: To construct the Catchment Modelling Toolkit using the CRC's TIME modelling framework to interlink models and model support tools developed by other programs.

Achievements 2002-2003

- Continued development of TIME, with an encouraging level of adoption both by CRC staff and other staff in the Parties.
- Development of beta versions of the RRL, RAP and SedNet software products using the TIME framework.
- Support to Development Projects, including workshop training in the application and calibration of the EMSS software.

Project 1.10 (1B) Methods for integration in catchment prediction

(Second round project)

Project Leader: Dr Robert Argent, The University of Melbourne

Aim: Considered the 'engine room' of the CRC's integration activity, this project ensures that the discrete models built by each project will conform to an overall conceptual design that can be encoded into the Toolkit.

Achievements 2002-2003

- An active coordinating role in the development of project specifications for all second-round projects.
- Completion of the first version of the "Integration Blueprint" to the Toolkit Strategy Group. The Blueprint is a plan detailing the conceptual links between various projects and the information flows between various Toolkit modules.
- A second version of the Blueprint is well underway.

1. Project Leader Dr Robert Argent - Projects 1.1, 1.10 (1B)
2. Project Leader Dr Rodger Grayson - Project 1.2
3. Project Leader Joel Rahman - Project 1.09 (1A)



Milestones

Progress

Years 1 and 2

Conduct a stakeholders' workshop and prepare a summary report listing the key catchment management questions being asked of models	Three surveys conducted instead of a workshop. More than 200 catchment managers, model-users and model-developers surveyed, with 44% replying. Results compiled and disseminated to respondents. Report published in August 2001
Conduct a modellers' workshop to assess the suitability of existing models to answer these questions; prepare a summary report which identifies gaps in our ability to model particular problems at particular scales	User survey on existing models conducted. Toolkit team ran two major sessions at the International MODSIM2001 symposium in December, 2001. Two major sessions were run at the IEMSS Conference in Switzerland in June, 2002
Develop specifications for new models to be developed for the modelling Toolkit; these will take advantage of the latest environmental data products such as rainfall radar, laser altimetry, airborne geomagnetics, and hyperspectral scanners	We have settled on TIME as the modelling framework for the Toolkit, however, other products will also be supported. A modelling Blueprint has been written that covers the models that will be developed and how they will link together. Second round projects will build on the research in round 1.
Develop a software engineering strategy for the development and maintenance of the modelling Toolkit	A software engineering strategy has been agreed upon that involves the staged development of models within the TIME environment. The strategy provides for porting routines in existing models such as MUSIC, EMSS and IQQM into the Toolkit. Existing models will still be supported. There will be a coordinated approach to incorporating models developed in the new round of projects into TIME. All models will be supported by a designated product manager.
Develop a model documentation and training strategy	A standard template for documentation has been completed. Documentation is at different stages for various Toolkit products and will need to be standardised.
Commence development of the modelling Toolkit, starting with the integration of existing models	We have implemented a small number of models in the Toolkit including the SedNet erosion model (Program 2) and the BC2C salt loads model (Program 2). A library of conceptual rainfall-runoff models was completed. There has also been a considerable development of the River Analysis Package (RAP)(Program 6) within TIME.

Years 3, 4 and 5

Adapt existing, and develop new, models of catchment function, applicable to regional scales and suited to co-evaluation of multiple issues (eg. relationship between vegetation management, water yield, salinity, erosion and sedimentation)	Some good progress was made already with the EMSS and the new LEMSS developments. Progress has also been made on GIS capabilities within TIME which will assist in the development of catchment models. River Analysis Package allows for investigating relationships between flow, channel geomorphology and the environment
Link hydrologic, pollutant-transport, ecologic, geomorphic, meteorologic and socio-economic models to enable holistic analyses of catchment behaviour	Good ecologic links underway in the LEMSS project and River Analysis Package. Linkages being developed between industry river basin models and economic models. Draft Blueprint developed on how models are to be linked together.
Develop techniques to scale detailed process representation to larger scales	Good progress already made in Project 1.2 with effective demonstration in Project 5.1.
Develop and incorporate an uncertainty analysis methodology into the Toolkit; this will be used to put error margins on model predictions	No progress yet. The scope of this project has been reduced to cover techniques for displaying model uncertainty.
Commence application of the modelling Toolkit on the five Focus Catchments	Extensive project planning and consultation has occurred for Toolkit work in Focus Catchments via Development Projects. Development Projects are progressing and have been supported with training.
Conduct first public release of the modelling Toolkit	Scheduled for release in 2003-2004.
Conduct training workshops on the use of the modelling Toolkit	Some workshops held already (EMSS, Tarsier, ICMS). There has also been some training for model developers using the modelling environment TIME.

Research

Program 2: Land-use Impacts on Rivers

Aim:

To provide a better understanding of the effects of land use on catchment water balance and pollutant delivery to streams.

Program Leader:

Dr Peter Hairsine, CSIRO Land and Water

Program Output:

This Program is expected to provide the following:

Identification of catchment 'hot spots' that contribute to land and river degradation, and development of effective strategies to treat them.

A biophysical understanding of catchment pollutant dynamics needed to underpin catchment management plans and major works initiatives such as the Natural Heritage Trust (NHT) program.

Establishment of practical field knowledge and new theory to assist in the development and testing of predictive models.

Outcomes and benefits

Land use and management activities are widely recognised as contributing to downstream water quality problems in many catchments.

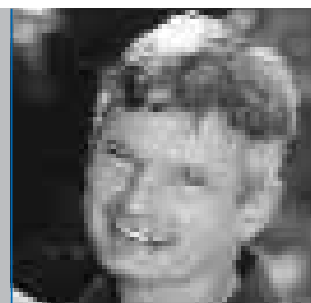
Considerable national investment is being directed towards salinity and nutrient management strategies and afforestation programs, despite relatively poor knowledge of their efficacy or how they might impact on downstream users.

Broad-scale afforestation is being considered for groundwater recharge control, but the consequent water-yield decreases may exacerbate the salinity problem downstream. For large catchments there is a need to clarify the role of pollutant stores and the manner in which pollutants are conveyed from hill slopes to the channel system.

A critical issue is the extent to which riparian vegetation and aquifer management can mediate sediment or pollutant delivery to channels. Preliminary research suggests that 90 percent of the excessive movement of nutrients from land to streams can be stopped by better management of 10 percent of the land area.

This Program seeks to determine the impact of vegetation and land cover on inter-relationships between catchment water yield, groundwater recharge and salt load concentrations in rivers.

It will also aid in the understanding of pollutant delivery to stream channels and the effect of riparian vegetation in stream health and downstream water quality. Ultimately Program 2 will deliver cost-effective catchment rehabilitation measures to improve river water quality.



End-users

State land and water resource management departments, catchment management authorities and boards, resource management consultants and researchers

Program highlights 2002-2003

- Project 2.2 has further enhanced the SedNet tool to improve predictions of sediment and nutrient movement through non-arid catchments in Australia. For our Focus Catchments, the team has made use of higher resolution data to improve the calibration of the model thus improving the confidence in predictions. The ability of SedNet to predict the details of sediment movement including the sediment size distribution and the delivery of hill slope-derived sediment in different landscapes is being improved in new project work.
- The CRC has developed a capability to predict the impact of soil conservation measures such as contour banks and filter strips on water quality downstream of cropping land. The model was evaluated on a long-term monitoring site on the Darling Downs and found to reproduce the observed data to a high level of reliability. This tool enables the benefits of structures designed to minimise soil erosion to be included in the catchment-wide predictions.
- The Project 2.3 (Predicting the effects of land-use changes on catchment water yield and stream salinity) team have extended the conclusions concerning the impact of land use change on stream flow. Previously they could confidently forecast only annual average changes to the quantity of water leaving a catchment. The team now have enabled the prediction of changes to the seasonal patterns of stream flow associated with major changes to land use (such as new plantations). This development will feed into the Catchment Modelling Toolkit via the current Project 2.23 (2E).
- The study of the effectiveness of riparian zones on the movement of nitrate to streams was completed by the Project 2.5 team during the year. Nitrate is a key pollutant in European and North American catchments and this study enables Australian catchment managers to understand the management options based on data from local landscapes. This study will also feed into the Catchment Modelling Toolkit via the current Project 2.22 (2D).



1. Land - use Impacts on Rivers Program group

Research

Program 2: Land-use Impacts on Rivers

Project 2.1 Sediment movement, physical habitat and water quantity in large river systems

(First round project)

Project Leader: Dr Jon Olley, CSIRO Land and Water

Aim: To build models of river behaviour on a large scale and acquire data to calibrate them.

Achievements 2002-2003

- Framework developed for constructing sediment and nutrient budgets in large catchments
- SedNet model for sediment and nutrient delivery and transport implemented in the Murrumbidgee and Brisbane River catchment with model predictions tested using sediment tracing techniques
- Major gaps in previously constructed sediment budgets identified

Project 2.2 Managing pollutant delivery in dryland upland catchments

(First round project)

Project Leader: Dr Peter Hairsine, CSIRO Land and Water

Aim: To build modelling capability to predict the delivery of pollutants to the stream network at the catchment scales.

To link models with those for climate and nutrient behaviour within streams.

Achievements 2002-2003

- Draft report describing user interaction with ICMS in the design of land management measures was completed in December 2002.
- Handover of suitable algorithms to Project 1.1 was successfully completed in January 2003.
- In association with Project 1.09 (1A), development of a beta version of the Pathways model using the TIME framework.

Project 2.3 Predicting the effects of land-use changes on catchment water yield and stream salinity

(First round Project)

Project Leader: Dr Lu Zhang, CSIRO Land and Water

Aim: To develop the ability and tools to predict the regional scale impacts of afforestation and other land-use changes on water yield, groundwater recharge and stream salinity.

Achievements 2002 - 2003

- A simple statistical method was developed for estimating the effects of afforestation on annual flow regime. The work involved the use of flow duration curves and analysis of paired catchment data. It can be used to determine changes in stream flows following afforestation and provides an alternative approach to traditional paired catchment studies.
- A CRC Technical Report was published on a study designed to evaluate the impact of blue gum plantations on flow regime and water allocation in the Goulburn-Broken catchment.
- Two modelling approaches were explored by the Project team: a simple empirical water balance model, and a physically based deterministic model.
- A CRC Technical Report was produced describing both modelling approaches and the method used to account for the partitioning of non-transpired water into groundwater recharge and surface runoff.
- A case study was completed, and the results may be used to develop generalised rules that account for soil type, pasture species and grazing enterprises to help catchment and resource managers to deal with land-use change and water yield reduction issues.



1. Project Leader Dr Jon Olley - Project 2.1
2. Project Leader Dr Lu Zhang - Projects 2.3, 2.23 (2E)

Project 2.5 Nitrogen and carbon dynamics in riparian buffer zones

(First round project)

Project Leader: Dr Heather Hunter, Natural Resources and Mines, Qld

Aim: To develop a model to predict denitrification in riparian zones for incorporation into the Toolkit's catchment water quality model/s.

Achievements 2002-2003

- Findings from laboratory and field studies of combined biological, geophysical and chemical processes in riparian soils and quantification of the denitrification of these soils are being used to refine conceptual models that identify the key processes affecting nitrogen and carbon dynamics in riparian zones.
- Progress reports were submitted to a review panel throughout the year and a final report including key research findings, conceptual models of key processes, and implications for land and water managers in the Brisbane and Fitzroy catchments, is expected to be available in 2003-2004.

Project 2.19 (2A) Reducing the impacts of irrigation and drainage on river water salinity

(Second round project)

Project Leader: Dr Evan Christen, CSIRO Land and Water

Aim: To provide the ability to predict the impact of irrigation management on river water quality.

Achievements 2002-2003

- Compilation of recent works and development of conceptual frameworks for modelling irrigation drainage has commenced.
- Major stakeholders have been consulted to ascertain their expectations of this project.
- Secured project participation by the new CRC for Irrigation Futures.

Project 2.20 (2B) Improved suspended sediment and nutrient modelling through river networks.

(Second round project)

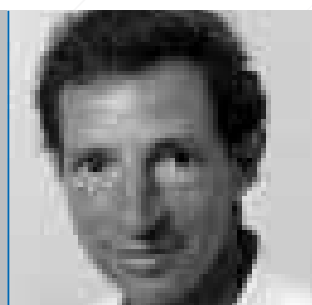
Project Leader: Dr Ian Prosser, (now with Land and Water Australia)

Aim: To refine and extend the capability of SedNet to permit prediction of erosion hot spots within focus catchments and the likelihood of sediment and nutrient delivery to particular reaches of river networks.

Achievements 2002-2003

- Commenced collecting supporting data to underpin the development of a new nutrient model to be included in SedNet. This will permit assessment of the sources and transport of nutrients in large catchments.
- A first draft nutrient model has been completed.

1. Project Leader Dr Heather Hunter - Projects 2.5, 2.22 (2D)
2. Project Leader Dr Evan Christen - Project 2.19 (2A)
3. Project Leader Dr Ian Prosser - Project 2.20 (2B)



Research

Program 2: Land-use Impacts on Rivers

Project 2.21 (2C) Predicting salt movement in catchments

(Second round projects)

Project Leader: Dr Mark Littleboy, Department of Infrastructure, Planning and Natural Resources, NSW

Aim: To deliver the capacity to identify salinity 'hot spots' in focus catchments and to predict the effectiveness of revegetation in reducing salt loads into rivers.

Achievements 2002-2003

- Agreement on the design of a new salinity model was the focus of a stakeholder workshop held in May 2003.
- A salinity model design specification was successfully completed in June 2003 and was presented at the Murray-Darling Basin Commission salinity modelling forum.

Project 2.22 (2D) Modelling and managing nitrogen in riparian zones to improve water quality

(Second round projects)

Project Leader: Dr Heather Hunter, Natural Resources and Mines, Qld

Aim: To provide the ability to predict nitrogen influx into streams from shallow groundwater, and to estimate the ability of riparian and in-stream areas to 'consume' nitrogen through denitrification.

Achievements 2002-2003

- The first milestone for this project has already been successfully completed - development of a denitrification kinetics module for inclusion in the Catchment Modelling Toolkit. Denitrification is a process of microbial conversion of nitrate to nitrogen gas, which when converted is removed from the atmosphere.
- The team also developed a simple 'bucket' model designed to estimate nitrate removal in riparian zones. The model takes into account variable groundwater detention time and a variable denitrification rate depending on soil profile and time.

Project 2.23 (2E) Modulating daily flow duration series to reflect the impact of land-use change

(Second round projects)

Project Leader: Dr Lu Zhang, CSIRO Land and Water

Aim: To develop a simple method to quantify how the daily flow duration series for a catchment will vary in response to a major change in land use, for example from agriculture to plantation.

Achievements 2002-2003

- Three flow duration curve models have been evaluated and a conference paper was accepted for presentation at the MODSIM 2003 Modelling and Simulation Conference, July 2003.



Milestones

Progress

Years 1 and 2

Compilation of the water quantity and water quality measures relevant to ecological response and delivery mechanisms for the three rural Focus Catchments

In the Murrumbidgee, Brisbane, Fitzroy and Goulburn, Program members have obtained data and quality assured much of it. It is now input to much of the model evaluation which is occurring. There are clear ecological connections in Projects 2.1 and 2.5 with the physical habitat and riparian zone research. A major dataset on hydraulic habitat in the Murrumbidgee is now available through the work of Project 2.1. Also a new sediment and attached nutrient property dataset will shortly be available for five major soils in both the Fitzroy and the Murrumbidgee catchments.

Identification and specification of technical impediments to cross-disciplinary transfer functions

The Program has a very wide-ranging collaboration with many disciplines including ecologists, geomorphologists, climatologists and pollutant chemists. The Fitzroy AEAM stakeholder workshop in May 2003 linked the Program's understanding with that of the coastal zone, estuarine and ecological modellers. This lays the foundation for a development project in this catchment. The modelling workshop jointly hosted by Project 2.3 recently specified remaining technical impediments to the adoption of the BC2C stream salinity model into operational environments. This lays the foundation for Project 2.21 (2C).

Inter-disciplinary meeting to evaluate proposed transfer functions across a range of agro-ecological zones

This Program continues to be involved in several cross-disciplinary meetings including biophysical and ecological work associated with the LEMSS in the Brisbane, physical habitat work in the Murrumbidgee, and AEAM Fitzroy workshops

Years 3, 4 and 5

Develop methodology for predicting responses to land-use change

Five products have been developed or enhanced: MAYA (water yield), SEDNET (sediment at catchment scale), ANNEX (nutrient for catchment scale), ICMS (sediment and nutrients for cropping on hillslopes) and TERRAPENE/BC2C (water yield and stream salinity). SedNet and ANNEX are NLWRA products developed by CSIRO that are being enhanced. BC2C, SedNet and MAYA are now part of the CRC's Catchment Modelling Toolkit and together with EMSS form the basis of most of the development projects.

Predict the spatial distribution of pollutant sources for the three rural Focus Catchments

The above tools predict the spatial distribution of pollutant sources and link with important data layers contributed from a range of organisations including the new Ground Water Systems map (from the Catchment Categorisation Project), several NLWRA layers and land-use change scenarios as provided by regional planning groups.

Higher resolution data with local ground truthing have been incorporated in several instances including better gully mapping, land-use mapping and DEM in the Murrumbidgee catchment, and better land-use maps in the Goulburn Broken catchment.

Evaluate spatial predictions of existing land uses with a range of conventional and new remotely sensed data

The above products are being tested using a range of available data, primarily in the Focus Catchments. Recent progress on fine temporal scale water yield predictions has been a highlight. Remotely sensed data is still primarily being used for point input data interpolation. All Focus Catchments are using available in-stream measures of water quality and quantity as evaluation datasets. The Program has recently trialled high resolution (25 m) ASTER data as an input to a method of interpolating catchment functions in the Fitzroy catchment. This work is on-going as part of a PhD project.

Riparian zone Project 2.5 is now starting to feed into the CRC modelling frameworks as planned. Complex issues of scaling remain, but assistance of experienced modellers from other parts of the CRC is leading to a pragmatic approach.

Research

Program 3: Sustainable Water Allocation

Aim:

To provide water managers and users with a set of principles, guidelines, and practical tools for managing water allocation and use in a sustainable and efficient manner.

Program Leader:

Dr John Tisdell, Griffith University

Program Output:

Many hydrologic issues need to be resolved before land and water managers can be confident that the current water allocation and trading system is sustainable.

By identifying and characterising the key factors that lead to uncertainty in water availability (e.g. farm dams, land-use management, forest plantations, climate variability) this Program will develop and add a water trading model to existing models. The Program will also provide fundamental insights into the behaviour of water markets.

Outcomes and Benefits

Management of water use over the next decade will be challenging as water markets enter into a mature phase and demands for environmental and extractive water increase. This Program will provide stakeholders with a set of economic tools to assist them in managing the complexities of mature water economies.

1. Program, Project Leader Dr John Tisdell - Projects 3.2, 3.09 (3B)



End-users

The end-users of the tools are likely to be operationally diverse, extensive and geographically dispersed. The response to the research outputs and subsequent level of adoption will be a function of their operational goals, primary motivations and strategic planning in the use of water, the organisational or corporate agenda in satisfying the COAG water reforms, and their role in the irrigation and water sector. Identification of individual contacts in the communication pathways and the implementation chain for adoption or advocacy remains incomplete. The end-users are likely to include:

- Federal and State natural resource managers;
- water regulators, authorities and agencies;
- peak environmental, farming and irrigator organisations;
- experimental economics groups;
- universities (local and international);
- water and natural resource management departments;
- environmental protection authorities;
- rural development agencies;
- National Competition Council; and
- non-government organisations (e.g. ACF or WWF).

Program highlights 2002-2003

The program highlights for 2002-2003 include:

- The development of an experimental water market environment (Mwater) in which policy makers can explore alternative instruments under controlled conditions.
- The development of the Water Re-Allocation Model (WRAM) which combines an economic model with the hydrological data underpinning IQQM.
- A variety of reports including a comprehensive review of water reform in Australia and models exploring the redistribution of surplus water in catchments.



1. Sustainable Water Allocation Program group

Research

Program 3: Sustainable Water Allocation

Project 3.1 Integration of water balance, climatic and economic models

(First round project)

Project Leader: Assoc Prof Gary Codner, Monash University

Aim: To devise and implement an integrated planning and seasonal water allocation modelling approach that allows the optimisation of the economic and environmental value of water; and takes into consideration hydrological and climatic constraints.

Achievements 2002-2003

- Summary of capabilities and knowledge gaps related to the water allocation models REALM and IQQM used by industry
- Development of framework for integration of hydrologic, climate and economic models
- Development of modules to provide sensitivity analysis of REALM and IQQM models thus allowing assessments to be made on where calibration effort should be put in applying either model to a catchment
- A conceptual framework for exchange rates in water trading, with a rationale for exchange rates and a basis for calculation, has been developed (An exchange rate for water markets is a conversion factor applied to the traded entitlement volume to account for impacts caused when the water is consumed in a new location)

Project 3.2 Enhancement of the water market reform process

(First round project)

Project Leader: Dr John Tisdell, Griffith University

Aim: To conduct a socio-economic analysis of the guidelines and procedures for trading in water markets, which in turn will provide guidance for future policies.

Achievements 2002-2003

- The project developed a platform for conducting water market experiments. *
- Laboratory experiments were completed in February 2003 followed by extensive data analysis and completion of a final project report and review.
- A methodology was developed to evaluate alternative water policy options under controlled laboratory conditions including software, and methods and procedures
- Policies associated with the allocation of water entitlements in the Fitzroy and Goulburn Broken catchments were analysed, together with self-management of environmental flow regimes by water users.

Project 3.08 (3A) Hydrologic and economic modelling for sustainable water allocation

(Second round project)

Project Leader: Dr Bofu Yu, Griffith University

Aim: To develop a water-trading model that simulates the economic consequences of reallocating water resources through trading.

Achievements 2002-2003

- Development of a water-trading model that interacts with IQQM is well underway.
- Dr Bofu Yu was invited to prepare a paper on this model for presentation at the MODSIM 2003 Modelling and Simulation Conference.
- A beta version of the WRAM software was successfully developed in Fortran .95 and VB.NET for future integration into the Catchment Modelling Toolkit.
- This Project harnesses new economic modelling techniques in the area of economic input-output analysis. The Murrumbidgee catchment will be the first to benefit from this analysis when work commences in 2003-2004.

Project 3.09 (3B) An evaluation of permanent water markets

(Second round project)

Project Leader: Dr John Tisdell, Griffith University

Aim: To provide fundamental insights into the behaviour of water markets and to use this information in building water allocation scenarios modelled in Project 3.08 (3A).

Achievements 2002-2003

- Project 3.09 (3B) has developed experimental economic tools to evaluate the hydrological and economic impacts of permanent water trading. The project team produced an experimental economic evaluation of:
 - alternative property right regimes in terms of unbundling water entitlements;
 - establishment of in-stream entitlements and modification of sleeper or dozer entitlements;
 - the impact of thin markets and anti-competitive behaviour.
- The research team is also developing protocols for the analysis of:
 - permanent water markets;
 - options for managing the tradeoffs between extractive and environmental water requirements;
 - the consequences of reactivation of sleeper licenses;
 - unbundling extractive and use rights;
 - common pool water usage problems associated with information uncertainty related to property rights and the scientific knowledge surrounding the consequences of long term water extraction on river systems;
 - possible markets for non-point pollution in river systems.



1. Project Leader Assoc Prof Gary Codner - Project 3.1
2. Project Leader Dr Bofu Yu - Project 3.08 (3A)

Milestones Program 3

Milestones

Years 1 and 2

Assess the implications of the COAG task force recommendations on water in Australia.

Characterise the nature of the impacts of the various sources of uncertainty in supply on the performance of surface and groundwater systems.

Review current water entitlement regimes for surface and ground water in the Focus Catchments in terms of their ability to take account of climate variability and hydrological constraints on catchment yield and water supply.

Investigate behavioural, social and economic characteristics of the Focus Catchments and how they may impact on the development of water allocation strategies.

Identify appropriate management techniques to reduce the risk of change and/or to manage change.

Outline the potential impacts of significant water entitlement movement through trade on supply systems, social structures and efficiency of water use.

Commence development of water allocation and trading frameworks that take account of economic efficiency, social interactions and equity issues, environmental flow requirements, hydrological constraints and uncertainties of supply.

Commence development of water allocation models and institutional structures that maximise socio-economic objectives, given tradable water entitlements, hydrologic, climatic and other catchment behavioural characteristics.

Progress

The implications of the COAG task force have been included in a detailed review of the literature and commentary on water reform in Australia.

An extensive survey (leading to three reports) has investigated the behavioural, social and economic characteristics of the Focus Catchments and how they may impact on the development of water allocation strategies.

The Program completed a review of IQQM and REALM in terms of their ability to take account of climate variability and hydrological constraints on catchment yield and water supply, as well as socio-economic factors.

Work commenced through Project 3.1.

In 2003-2004 work will commence on developing water allocation models and institutional structures that maximise socio-economic objectives.

Once these tasks are complete, work will commence on identifying appropriate management techniques to reduce the risk of change and/or to manage change.

Development of a water allocation and trading framework has commenced and is continually evolving. A schematic will be reported as part of Project 3.1. Calibration of the IQQM package on the Murrumbidgee catchment has been completed by DIPNR and has been under review as part of Project 3.1.

Development of water allocation models and institutional structures has commenced as part of the experimental phase of Project 3.2. Trials of the methodology have been conducted at Griffith University and with irrigators in the Murrumbidgee Focus Catchment.

Project 3.1 has rejected the use of economic optimisation models as they disempower industry stakeholders.

Years 3, 4 and 5

Develop a series of socio-economic water allocation models that integrate the climatic and catchment models derived in the other programs and take account of exchange rates and limits or constraints on trading.

Evaluate the water allocation models for methodological soundness and application to the Focus Catchments.

Explore land-use practices and possible constraints to, and exchange rates for, trade in a sample of Focus Catchments.

Model the impact of alternative property right regimes and constraints on trade in Focus Catchments in terms of supply systems, social structures and efficiency of water use.

Test the sensitivity of the supply system performance to modelling assumptions and to changes in physical system factors.

Develop improved techniques for managing flows in channel systems, and better match water diverted from rivers to predicted extractive user water needs.

Develop methods to improve efficiency in water use decision-making in order to maximise efficiency and minimise seepage and evaporation losses.

Amendment of Milestone approved by Commonwealth, 16 July 2003 with replacement by:

Develop method to improve efficiency in water use decision making in order to maximise efficiency.

Involve stakeholders in the development of research, evaluation of the models, and development of adoption strategies.

Stage 1 was completed for developing a set of economic indicators. A draft report was written by iCAM, ANU.

Work on methodologies to calculate exchange rates is well underway.

Modules have been developed to evaluate error levels in IQQM and REALM.

Work on methodologies to calculate exchange rates is well underway.

Work is being addressed in the current round of projects.

Sensitivity analysis of IQQM and REALM to model parameters is complete. A report is underway.

Work being addressed in the current round of projects.

Work being addressed in the current round of projects.

Ongoing, through meetings with stakeholders.

Research

Program 4: Urban Stormwater Quality

Aim:

To develop stormwater management solutions for the protection of environmental and community values.

Program Leader:

Dr Tim Fletcher, Monash University

Program Output:

The Model for Urban Stormwater Improvement Conceptualisation (MUSIC) has been established to translate stormwater research findings into successful industry application. It will be the principal mechanism for the dissemination of this CRC's research into urban stormwater quality.

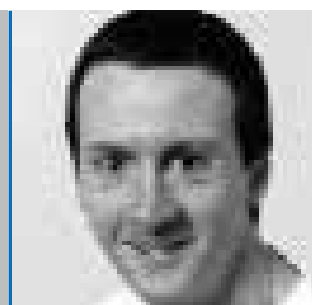
MUSIC provides a planning framework and software to support regional planning and the design of wetlands and other stormwater systems to remove pollutants from stormwater. If left unchecked, these pollutants would impact on the quality of stormwater entering streams, rivers, beaches and bays.

Outcomes and benefits

Urban stormwater is a major contributor to the pollution of rivers and bays; runoff quality and quantity has been responsible for the degradation of most urban streams. Efforts to capture key pollutants to control urban stormwater pollution do not necessarily match the needs of the downstream environment. The evaluation of stormwater-management techniques is therefore an important economic and environmental objective, particularly in sub-tropical and tropical catchments.

This Program is conducting scientific assessments of stormwater treatment systems and ecologically-based drainage systems. Ultimately it will provide cost-effective strategies and a decision support system employing the use of models to assist end-users and stakeholders to improve urban stormwater quality. The innovative tools developed by this Program will facilitate best practice urban stormwater management. On adoption, this will mean cleaner urban streams, beaches, and bays.

1. Program, Project Leader Dr Tim Fletcher - Projects 4.1, 4.09 (4B)



End-users

There are a number of users and stakeholders including:

- local government;
- regional urban catchment management authorities;
- state planning and environment protection agencies;
- consultants;
- land developers; and
- research organisations.

Program highlights 2002-2003

- The release of MUSIC has been very well received by industry with over 300 licensed local and international users. It has significantly changed stormwater management planning in Australia.
- A collaborative project with the CRC for Freshwater Ecology has provided a strong basis for understanding the relationship between catchment urbanisation and ecosystem responses.
- Valuable in-kind support from both Brisbane City Council and Melbourne Water has been critical to the success of this project to date.
- The Stormwater Best Management Practices project has provided a strong basis for future research with four technical reports now published and results being used to refine calibrations in MUSIC for application in Brisbane.
- The project on Predicting Urban Stormwater Quality, Treatment and Impact is in its infancy but is progressing well with new research activity underway.

Project 4.1 Stormwater pollutant sources, pathways and impacts

(First round project)

Project Leader: Dr Tim Fletcher, Monash University

Aim: To develop a suite of models for estimating stormwater pollutant loads from different source areas, defining their impacts on aquatic ecosystems and predicting performance of stormwater management practices.

To formulate a Decision Support System (DSS) for the development of cost-effective strategies for improving stormwater quality, and communicate the benefits of employing these strategies to non-technical decision makers.

Achievements 2002-2003

- Following the release of MUSIC in May 2002, MUSIC has fundamentally changed stormwater management planning throughout Australia.
- Uptake of MUSIC by industry has exceeded expectations with over 300 local and international licensed users. Interest in this product continues to be strong.
- Establishment of the MUSIC Users Forum has been highly successful, providing the development team with important feedback that is used to refine the product.
- Collaboration with the CRC for Freshwater Ecology has been vital in assisting the development team to understand the interaction between catchment urbanisation and aquatic ecosystems. This knowledge has been incorporated in the MUSIC model.



1. Urban Stormwater Quality Program group

Research

Program 4: Urban Stormwater Quality

Project 4.2 Stormwater best management practices

(First round project)

Project Leader: Assoc Prof Margaret Greenway, Griffith University

Aim: To monitor the efficiency and efficacy of structural Australian stormwater management practices (e.g. constructed wetlands, vegetated swales, bio-filtration systems.)

To review current non-structural measures such as education, enforcement and training measures through the use of field experimentation.

Achievements 2002-2003

- The team conducted an extensive review of non-structural measures for managing urban stormwater from which four technical reports were published during 2002-2003.
- Brisbane City Council worked together with researchers conducting a number of stormwater treatment experiments, the results of which will be used to further refine calibrations in MUSIC for application in Brisbane.
- The Lynbrook Estate Water Sensitive Urban Design system is a fine example of this CRC's collaborative work, based as it is on a strong partnership with Melbourne Water. Experiments have provided useful insights into the performance and benefits of these systems and results were published in the CRC's Industry Report, Water Sensitive Urban Design - A Stormwater Management Perspective.

Project 4.08 (4A) Development of integrated stormwater models

(Second round project)

Project Leader: Assoc Prof Tony Wong, Monash University

Aim: To refine and extend the development of MUSIC and promote its use throughout industry.

To integrate MUSIC within the Catchment Modelling Toolkit.

Achievements 2002-2003

- The Project team has undertaken significant enhancement work of the MUSIC software with the project on target to achieve a release of version 2.00 in 2003-2004.

Project 4.09 (4B) Predicting urban stormwater quality, treatment and impacts

(Second round project)

Project Leader: Dr Tim Fletcher, Monash University

Aim: To improve the reliability of MUSIC using superior algorithms and the acquisition of validation data.

Achievements 2002-2003

- This Project is tightly linked to Project 4.08 (4A) therefore a detailed project integration plan was prepared and completed in March 2003.
- New research project activity and significant data collection underway.
- Significant development of MUSIC Version 2.00 for release in 2003-2004.

1. Project Leader Assoc Prof Margaret Greenway - Project 4.2
2. Postgraduate Courtney Henderson - research into vegetation effects on pollution removal
3. Project Leader Assoc Prof Tony Wong - Project 4.08 (4A)
4. Research supervisor Dr Graham Jenkins and postgraduate David Newton - research into porous pavement impacts on stormwater treatment



Milestones

Years 1 and 2

Establish collaborative linkages with other research organisations relevant to the objectives of the Program, specifically the CRC for Freshwater Ecology and the CRC for Coastal Zone, Estuary and Waterway Management.

Collate and review information on stormwater treatment/management options and formulate the basic structures of predictive models for a range of stormwater treatment techniques.

Develop conceptual models of stormwater quality treatment techniques and the framework for their integration into a decision support system.

Establish urban stormwater quality monitoring protocols for use in evaluating pilot stormwater quality treatment facilities in the Focus Catchments.

Select suitable sites and establish stormwater quality monitoring systems for stormwater quality treatment facilities in the Focus Catchments.

Develop technology transfer and adoption strategy.

Progress

Linkages with CRC for Freshwater Ecology established with very strong ongoing research collaboration. Linkage with CRC for Coastal Zone, Estuary and Waterway Management established, with collaboration on ecological responses of urban estuaries to incidences of sewer overflows.

Completed. The information was critically reviewed and used to develop the pilot DSS for urban stormwater quality management.

Completed. MUSIC was released as a pilot version of the DSS in March 2001, for testing by the Brisbane City Council and Melbourne Water. Public release followed in May 2002.

Completed. Urban stormwater quality monitoring protocol developed after a workshop of industry practitioners and researchers, and published in June 2001.

Completed. Monitoring sites in Melbourne and sites in Brisbane are operational and providing useful data.

Completed. The Communication and Adoption strategy for Program 4 uses MUSIC as one of its main vehicles for engaging industry. Other initiatives include targeted demonstration projects, seminar lectures and collaborative projects with industry. The pilot version of MUSIC was evaluated by the Brisbane City Council and Melbourne Water and given wider release in 2002. Over 650 attended Industry Seminars for the release of MUSIC, and over 120 have attended training courses.

Years 3, 4 and 5

Determine critical pollutants and required pollution concentrations vs discharge relationships for the sustainability of healthy urban aquatic ecosystems.

Amendment of Milestone approved by Commonwealth, 16 July 2003 with replacement by:

Develop approaches to predict ecosystem response to catchment-scale indicators of land use.

Monitor and evaluate the performance of stormwater treatment facilities at pilot catchment sites in the Focus Catchments.

Evaluate the life-cycle cost of stormwater treatment systems investigated.

Commence the validation and refinement of conceptual models of stormwater quality treatment techniques.

Commence technology transfer activities to provide interim guidelines on the selection and design of stormwater quality treatment measures.

With MUSIC's release, research activities over the next three years will focus on better defining stormwater management targets for improved urban aquatic ecosystem health.

On-track and being pursued as part of Project 4.09 (4B).

Progress on-track. Stormwater treatment facilities have been designed and constructed by the Brisbane City Council and Melbourne Water, and have subsequently been the subject of field monitoring and evaluation, and field experiments to improve performance prediction.

The monitoring sites are:

- Ruffeys Creek Wetland, Melbourne
- Lynbrook Estate Paired Catchment monitoring, Melbourne
- Pinjarra Hills swale, Brisbane
- Bridgewater Creek Wetland, Brisbane
- Hoyland Street Bioretention System, Brisbane
- An Associated/Additional project involving the construction of bioretention systems in Nerang by the Gold Coast City Council
- Other Melbourne and Brisbane sites under development

On track. Initial lifecycle cost estimates have been developed and published for a range of stormwater treatment measures, based on a survey of industry practice. An Associated/Additional Project, funded by Victorian EPA, will enhance these estimates to include social costs/benefits, treatment of externalities for incorporation into MUSIC.

The testing and validation of the MUSIC's algorithms continues as field experiments and monitoring and evaluation of existing stormwater treatment facilities are undertaken. A combination of field experiments and literature survey are being used, and this activity is on target.

Many activities involving industry seminars, technical publications and industry training courses and field trips have been undertaken, including:

- short course on Planning and Design of Stormwater Management Measures, Brisbane
- Industry Seminar on Urban Stormwater Modelling (involving MUSIC), in Canberra, Sydney, Brisbane, Melbourne, Adelaide and Perth
- MUSIC Training conducted in NSW, Qld, Vic.
- Very strong adoption of Program 4 research outcomes (e.g. over 300 licensed MUSIC users to date).

Research

Program 5: Climate Variability

Aim:

This Program aims to provide the water industry with tools to quantify climatic variability, and through the application of climate forecasting, reduce the hydrologic risk associated with a wide range of water-related issues.

Program Leader:

Dr Francis Chiew, The University of Melbourne

Program Output:

Australian rainfall and river flows are more variable than in most parts of the world. The resultant cost of flood and drought is massive. Large savings are achievable if hydrologic risk can be quantified and included in the management plans of organisations affected by climate and runoff.

Exciting recent developments by this CRC and researchers in Australia and overseas in the area of stochastic data and hydroclimate forecasting are raising the prospect of significant reductions in the economic impact of hydrologic uncertainties.

This Program will provide water authorities and catchment managers with important rainfall and runoff forecasting capabilities to improve water system operations. It will also provide practical applications for inclusion in the Catchment Modelling Toolkit.

Outcomes and benefits

The development of stochastic models of point and spatial rainfall (and climate) for input into hydrologic and water resources models is a key outcome for this Program together with the development of space-time rainfall models for forecasting rainfall up to three hours ahead.

In addition, researchers will aim to improve catchment scale hydrological and land surface modelling in climate models. The Program will also aim to advance the initialisation of surface variables in numerical weather prediction models, leading to improved weather forecasts and develop models for forecasting seasonal rainfall and stream flow several months ahead.

1. Program Leader Dr Francis Chiew - Program 5



End-users

- Researchers involved in hydrological modelling and scaling studies
- Bureau of Meteorology
- Agricultural and water agencies
- Water engineering consultants

Program highlights 2002-2003

- This Program has been accepted in the Global Energy and Water Cycle Experiment GEWEX (a component of the World Climate Research Program) using the Murray-Darling Basin as a focus catchment. The coupling of this Program's land surface modelling study in Project 5.1 and the Murrumbidgee data monitoring program are key components of this international program.
- The Project team has developed and tested stochastic models for generating point rainfall and climate at annual, monthly and daily time steps. Program modules have been written for inclusion into the Catchment Modelling Toolkit.
- The Bureau of Meteorology is developing systems to employ the S_PROG rainfall forecasting model to generate rainfall nowcasts at 50 locations throughout the Australian radar network. These forecasts will provide vital flash flood warnings in urban centres.
- International interest has been shown in S-PROG with New Zealand's National Institute of Water and Atmospheric Research (NIWA), the Met Office in the UK, and Spain's Catalan Technical University exploring its potential use in their countries.

- Other models developed in Program 5 are increasingly being used by local water authorities:
 - MOTIVATE, the space-time rainfall model being used by Melbourne Water and Sydney Water.
 - SIMHYD the rainfall-runoff model and calibration techniques used by EMSS modellers in the CRC's Development Projects.
 - the seasonal streamflow forecasting model and the stochastic models being used by water agencies.

Project 5.1 Modelling and forecasting hydroclimate variables in space and time

(First round project)

Project Leader: Dr Alan Seed, Bureau of Meteorology

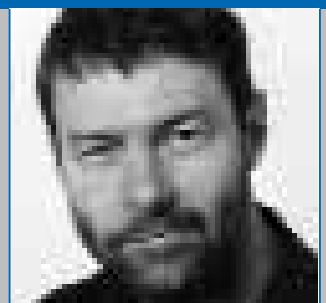
Aim: To reduce land and water managers' uncertainty about resource management (which is compounded by high variability in rainfall and streamflow) by developing forecasting models with forecasts several hours to several months ahead.

Achievements 2002-2003

- The Murrumbidgee data monitoring program is operating successfully with 18 months of data collated and analysed. This data forms the basis for the development of specific hydrological models and provides for testing model simulations against runoff and soil moisture.
- Testing of the stand-alone VB95 land surface model used by the Bureau of Meteorology was completed. The results will lead to improved weather forecasting for operational water management.
- A stochastic downscaling model for the Murrumbidgee River Basin was developed. The model provides present and future daily rainfall across 30 sites in the Basin.
- The Project team also developed and tested a non-parametric model for forecasting exceedance probabilities of rainfall and runoff several months ahead. An important consideration in developing this model is the relationship between El Nino/Southern Oscillation and rainfall/runoff, and the serial correlation in runoff.



1. Climate Variability Program group
2. Project Leader Dr Alan Seed - Projects 5.1, 5.05 (5A)



Research Program 5: Climate Variability

Project 5.2 National data bank of stochastic climate and streamflow models

(First round project)

Project Leader: Dr Sri Srikanthan, Bureau of Meteorology

Aim: To develop a robust set of stochastic models for the generation of climate and streamflow data anywhere in Australia at different time scales.

Achievements 2002-2003

- A major achievement this year was the development and testing of stochastic models for generating point rainfall at annual, monthly and daily time steps.
- The Project team also extensively tested the multivariate model for generating stochastic daily climate data conditioned on daily rainfall.
- Modules for the various stochastic models have been completed and are awaiting incorporation into the Catchment Modelling Toolkit.

Project 5.05 (5A) Hydrologic modelling for weather forecasting

(Second round project)

Project Leader: Dr Alan Seed, Bureau of Meteorology

Aim: To improve catchment scale hydrologic modelling and land surface modelling, and the initialisation of surface variables in the Bureau of Meteorology's numerical weather prediction models.

Achievements 2002-2003

- Dr Alan Seed spent 12 months in the UK Met Office, from March 2002 to March 2003, assisting in the UK trial of S_PROG.
- A collaborative decision was recently reached between the UK Met Office, Australia's Bureau of Meteorology and the CRC to extend S_PROG into a stochastic nowcasting system. This joint research project will also investigate merging numerical weather prediction and nowcasting products.
- Dr Neill Bowler from the UK Met Office visited Melbourne in May 2003. He worked with Dr Alan Seed on stochastic rainfall nowcasting, in particular, its application in the UK.
- A methodology for estimating parameter values for the hydrologic model in the EMSS has been developed. Software for the model calibration has been written and presented in a Development Project workshop on EMSS application in the focus catchments.
- Testing of the numerical weather prediction model with irrigation data is well underway. This will provide more realistic weather forecasts for operational irrigation water management.

Project 5.06 (5B) Stochastic rainfall data generation models

(Second round project)

Project Leader: Dr Sri Srikanthan, Bureau of Meteorology

Aim: To continue building and testing a suite of software programs designed to generate stochastic rainfall data at whole-of-catchment scales for input into the CRC's Catchment Modelling Toolkit software products.

Achievements 2002-2003

- Professor Geoff Pegram (University of Natal, South Africa) worked with the project team to develop models to simulate wet spells and dry spells in areal rainfall data.
- A review of spatial modelling of daily rainfall has been completed, and some of the more promising models will be tested and developed further.
- Preliminary testing of sub-daily point rainfall models is underway.

1. Project Leader Sri Srikanthan - Projects 5.2, 5.06 (5B) and Program 5 researcher Dr Harold Richter
2. Soil moisture survey planning
3. Soil moisture mapping, Murrumbidgee catchment



Milestones

Years 1 and 2

Specify through a workshop the boundaries of current data generation algorithms - the climatic and streamflow variables, time steps and spatial scales.

Identify the most appropriate methods to generate stochastically climate and related hydrologic data sequences for any point in Australia. Write and test computer programs to generate climate data. Distribute via targeted workshops to other CRC programs.

Conduct a stakeholders' workshop to identify key stakeholder interests and involvement in the project. Establish the project as a component of the Global Energy and Water Experiment (GEWEX) CSE by satisfying acceptance criteria.

Develop a catchment routing scheme to link with the numerical weather prediction (NWP) model output in order to verify gridded model runoff estimates against observations of streamflow at gauging stations. *This milestone was deleted from the Commonwealth Agreement Schedule 1 as approved by the Commonwealth on 16 November 2000.*

Adapt the land surface scheme, currently used in the Bureau's operational forecast model, to improve the NWP capability for the simulation and prediction of the surface water budget on basin and catchment scales, with a focus on the MDB and Murrumbidgee Catchment.

For climate linked space-time modelling, determine the best way to stratify past climate (eg wet vs dry years) in a way that makes sense from a water management perspective (ie focussing on runoff volumes rather than rainfall).

Characterise and develop models for spatial and temporal rainfall patterns in terms of their statistical structure for the different climate stratifications identified within a Bayesian or other framework.

Examine existing seasonal forecasting techniques suitable for forecasting streamflow for water resources management.
(As amended with Commonwealth approval, 16 November 2000)

Progress

The workshop was held in March 2000 and the climatic variables to be generated during the first three years of the Program were identified.

The methods were identified via an extensive literature review and tested and compared.

For point rainfall, AR(1) and HSM annual models, method of fragments and nonparametric monthly models and TPMB and DMM daily models were recommended for the Catchment Modelling Toolkit.

For daily climate, a multivariate model conditioned on the rainfall state was recommended.

For multi-site data, the Matalas multi-site annual generator with monthly fragments was recommended. Research on stochastic generation of daily spatial rainfall and sub-daily space-time rainfall is being carried out.

Several workshops were conducted as part of the Communication and Adoption strategy (March 2000 in Melbourne, July 2001 in Melbourne, August 2001 in Brisbane and June and December 2001 in Tatura).

The Murray-Darling Basin was accepted as a GEWEX CSE basin in March 2002.

The routing scheme was developed externally from the CRC and a paper has been published about the technique.

Testing of the stand-alone land surface scheme in the Bureau of Meteorology's NWP model, using parameters that are dependent on soil and vegetation characteristics, was completed. Monitoring of soil moisture, soil temperature and climate data at 18 sites across the Murrumbidgee started in September 2001. The data will be used for more detailed model testing and model improvements.

This research is no longer a priority because approaches for forecasting seasonal rainfall and streamflow have been developed elsewhere in the Program.

The space-time rainfall model for homogeneous areas, MOTIVATE, has been developed and calibrated against radar data from key locations across Australia. The model gives stochastic realisations of design storms.

A non-parametric model for forecasting exceedance probabilities of rainfall and runoff several months ahead has been developed and tested using data from across Australia. The model exploits the relationship between El Niño/Southern Oscillation and rainfall and runoff and the serial correlation in runoff.

Years 3, 4 and 5

Review the outcomes of the stochastic generation software; plan the project expansion to include the development and testing of more accurate algorithms where appropriate.

Conduct research as required to develop new stochastic data generation methodologies.

Test the new climate generation methodologies for areas within the five focussed catchments in addition to regions in Australia that are recognised as having extreme variability.

Develop a prototype end-to-end system, incorporating the NWP and hydrological models, to demonstrate an improved predictive capability for catchment management purposes.

Conduct a stakeholder workshop to review progress and outputs and outcomes of the project, with a particular focus on technology transfer to water managers.

Apply, test and refine the space-time climate modelling methodology to one or more of the selected catchments/regions.

Package the developed space-time climate model to suit user applications and conduct workshops throughout Australia.

Project 5.2 has delivered stochastic models of rainfall and climate at a point, down to the daily time scale. Models are currently being programmed for inclusion into the CRC Catchment Modelling Toolkit.

The main research areas in Years 4, 5 and 6 (Project 5.06 (5B)) concern the stochastic generation of daily and sub-daily spatial rainfall, and sub-daily point rainfall.

The models for generating point stochastic climate data have been tested using data from across Australia. The spatial models that will be developed in Project 5.06 (5B) will be tested, where appropriate, on all the Focus Catchments.

Research on hydrological models and NWP models are continuing, using data from the soil moisture monitoring program in the Murrumbidgee catchment.

Workshops are conducted regularly as part of the Communication and Adoption strategy, to review the projects, and to disseminate the models developed.

The MOTIVATE model (which provides stochastic realisations of space-time rainfall for design storms) and S_PROG model (which 'nowcasts' rainfall up to two hours ahead) have been developed. Some of the ideas behind the models will be used in the space-time stochastic data research in Projects 5.05 (5A) and 5.06 (5B).

Workshops for these and other models will be conducted when the model developments and incorporation into the Catchment Modelling Toolkit are completed.

Research

Program 6: River Restoration

Aim:

River restoration (a term used synonymously with rehabilitation) aims to return natural, environmental values to streams. This Program's research seeks to provide stream managers with a better understanding of stream processes. It also aims to provide them with tools that will lead to more effective expenditure on restoration, and ultimately, healthier streams.

Program Leader:

Dr Michael Stewardson, The University of Melbourne

Program Output:

The Program focusses on catchment-scale responses to changes in and restoration of river networks within entire catchments.

Physical habitat assessment and biological prediction are included in the River Analysis Package (RAP) software developed in the Program. Models of channel dimensions for flow routing and riparian zone processes are also addressed

Outcomes and benefits

The strength that this CRC brings to stream restoration is in disciplines relating to the physical processes of hydrology, hydraulics and geomorphology.

In particular, Program 6 will devise techniques to better manage stream sediment.

It will also establish best practice guidelines for adoption by land and water managers to maximise environmental returns to channels, based on available flows.

Assessment of the secondary consequences of restoration works on streams is also an important part of this program. Adoption of assessment outcomes will help improve planning, design and implementation of certain rehabilitation activities.

1. Program, Project Leader Dr Mike Stewardson -
Projects 6.7, 6.12 (6B)



End-users

- stream managers
- catchment management agencies
- technical staff
- consultants

Program highlights 2002-2003

- Few studies have tackled the issues of how best to operate water schemes to efficiently meet environmental flow targets so it is pleasing to note that the Program 6 research team completed an investigation into this during the year.
- The team completed development of a beta version of the River Analysis Package (RAP) as a Catchment Modelling Toolkit product.
- Collection of channel data was completed and is in use in Project 6.12 (6B)
- The Flow Events Method developed in Project 6.7 has already been applied in several Victorian river studies and has been recommended for use in the approach for environmental flow methods

Project 6.1 Developing criteria and concepts for planning the evaluation of stream restoration projects

(First round project)

Project Leader: Assoc Prof Ian Rutherford, The University of Melbourne

Aim: To provide guidance for stream rehabilitation practitioners and to explore the potential for planning the evaluation of a major stream habitat restoration project.

Achievements 2002-2003

- Report on riparian restoration submitted for publication by the CRC.
- PhD being completed on priority setting for stream restoration.
- The project has provided a hierarchy of evaluation methods which can be used by catchment and river managers.
- An evaluation training program for managers was developed.
- An evaluation plan for stream rehabilitation projects was accepted by agencies as the basis for a long-term catchment scale experiment in the Murray-Darling Basin

Project 6.2 Optimising urban stream rehabilitation planning and execution

(First round project)

Project Leader: Dr Tony Ladson, Monash University

Aim: To identify constraints to urban stream restoration - a detention basin experiment - and to model the effectiveness and feasibility of a stream rehabilitation planning procedure.

Achievements 2002-2003

- Important collaborative work was completed this year between Melbourne Water and the CRC for Freshwater Ecology to resolve macroinvertebrate monitoring issues.
- A project steering committee was established between researchers in Project 6.2 and Project 4.09 (4B) to take this project to the next level by building on the important work previously completed by the CRC for Freshwater Ecology on the factors affecting stream health.
- A draft final project report was completed in June 2003 and is expected to be published in 2003-2004



1. River Restoration Program group

Research Program 6: River Restoration

Project 6.3 Restoration ecology in the Granite Creeks, Victoria

(First round project)

Project Leader: Assoc Prof Ian Rutherford,
The University of Melbourne

Aim: To implement a rigorously planned, documented and evaluated stream restoration project designed to measure the hydraulic, geomorphic and biological response of streams to timber debris.

Achievements 2002-2003

- Exceptional collaboration with the CRC for Freshwater Ecology and Goulburn Broken Catchment Management Authority. This has resulted in design and structures being completed efficiently.
- Stochastic approach developed for depicting scour in streams.
- The project has shown that modest variability in stream beds leads to a measurable increase in fish numbers and diversity
- Sand slug movement through a stream is important and sand slug recovery models were seen to be critical for advancing stream rehabilitation.
- Lessons on recovery of sand slugs are being incorporated in a new version of the Victorian Index of Stream Condition

Project 6.4 Evaluation of the effectiveness of riparian management in South East Queensland

(First round project)

Project Leader: Prof Stuart Bunn, Griffith
University.

Aim: To evaluate a whole-of-catchment riparian rehabilitation project at the Echidna Creek catchment, north of Brisbane, Queensland.

Achievements 2002-2003

- Measurement of physical and biological variables continued throughout the year and was completed in June 2003.
- The project demonstrated that continuous monitoring of suspended sediment (via turbidity) can be a cost effective and accurate method of quantifying sediment transport from a stream system
- The detailed topographic survey of the treatment stream (approx 3km) before and after revegetation showed the source of sediment movement over the treatment period. Data can be used to validate the SedNet model.
- Continuous temperature monitoring has led to an understanding of the role of riparian vegetation in stream temperature control by observing changes in stream temperature as vegetation has regrown.

Project 6.5 Research to improve the effectiveness of Australian fishway design

(First round project)

Project Leader: Assoc Prof Robert Keller,
Monash University

Aim: Concentrating on vertical slot fishways in the Murray River, this Project will:

- detail hydraulics in existing fishways;
- investigate conditions that attract native fish to fishway entrances;
- explore the burst and sustained swimming ability of native and exotic fish; and
- examine the response of fish to local turbulence within fishways.

Achievements 2002-2003

- Manual of Best Practice on Fishway Design has been drafted and is scheduled for completion in 2003-2004.
- Masters thesis on numerical modelling of fishway submitted.

1. Program, Project Leader Assoc Prof Ian Rutherford - Projects 6.1, 6.3
2. Project Leader Prof Stuart Bunn - Project 6.4
3. Downloading data logger - Project 6.4
4. Project Leader Dr Tony Ladson - Project 6.2



Project 6.6 Developing tools to predict scour of rehabilitation works

(First round project)

Project Leader: Assoc Prof Robert Keller,
Monash University

Aim: To develop tools to predict the probability of various objects surviving in a streambed and strategies to better manage woody debris, snags and other beneficial objects in streams.

Achievements 2002-2003

- Development of a Windows-based computer program CHUTE, for the hydraulic design of rock chute bed protection; this will be incorporated into the Catchment Modelling Toolkit in 2003-4
- The work on rock chutes showed that the critical hydraulic conditions on a rock chute occur at a flow that may be substantially less than the maximum flow for which the channel is designed. The design procedure for rock chutes to stabilise channel beds was presented at an international symposium in June 2003.

Project 6.7 Developing an improved method for designing and optimising environmental flow

(First round project)

Project Leader: Dr Michael Stewardson, The
University of Melbourne

Aim: To develop a generic environmental flow methodology that integrates hydrology, geomorphology and ecology.

Achievements 2002-2003

- Trials for environmental flows in the Snowy, Broken, Thomson and Loddon rivers were completed and documented
- The Flow Events Method developed in Project 6.7 has been applied in several Victorian river studies for determining environmental flows
- The Flow Events Method has been applied to the Goulburn River catchment, an application to be used for the CRC's Goulburn Broken Development Project, Project 7.11 (7A).

Project 6.11 (6A) Development of flow- ecological response models

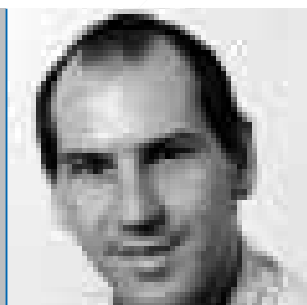
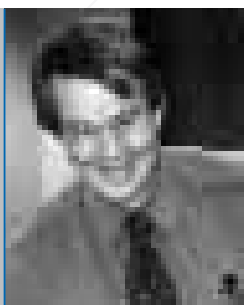
Project Leader: Dr Nick Marsh, Griffith
University

Aim: To develop software for the Catchment Modelling Toolkit that will allow water managers to quantify the ecological impacts of alternative flow regimes.

Achievements 2002-2003

- An extensive document search and review commenced in early 2003. This is an important first step in the team's development of conceptual models of flow-biota interactions.
- Development of a beta version of the River Analysis Package (RAP) computer software suitable as a product for the Catchment Modelling Toolkit was completed.

1. Project Leader Assoc Prof Bob Keller - Projects 6.5, 6.6
2. Project Leader Dr Nick Marsh - Project 6.11 (6A)



Research Program 6: River Restoration

Project 6.12 (6B) Predicting spatial and temporal variations in channel form

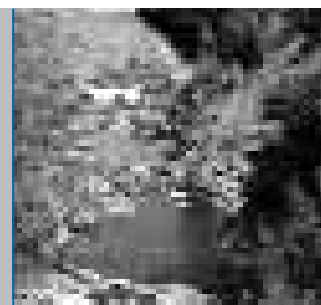
Project Leader: Dr Michael Stewardson, The University of Melbourne

Aim: To develop a channel metrics model for incorporation in the Catchment Modelling Toolkit and for use in large scale modelling studies. The model will relate changes in river flow to changes in channel geometry and aquatic behaviour.

Achievements 2002-2003

- The first stage of the project was completed in which a large set of channel data was collated, data to be used in the development of the channel metrics model

1. River restoration work linked to urban stormwater quality studies



Milestones Program 6

Milestones

Progress

Years 1 and 2

Formalise links with partner CRCs in joint projects	Completed
Complete evaluation of existing rehabilitation projects in Australia	<i>Milestone deleted as approved by Commonwealth, 16 November 2000</i>
Select catchments and sites for trial rehabilitation	Completed
Trial stream rehabilitation planning procedure at target sites	Rehabilitation planning completed for all relevant projects
Select models for assessing stream rehabilitation plans in target catchment <i>Milestone amended as approved by Commonwealth, 16 November 2000 and replaced by:</i>	Completed recommendations for planning evaluation Completing procedure for planning environmental flow regimes Completed Flow Events Method for developing environmental flow regimes and adopted in Victoria
Develop improved criteria for rehabilitation planning <i>Modified milestone as approved by Commonwealth, 16 November 2000</i>	Revised CHUTE model for designing rock chutes complete Completed draft report on fishways design Improved procedure for scour prediction for rehabilitation planning is under development
Develop and calibrate hydraulic and hydrological models of rehabilitation sites and assess viability of projects	<i>Milestone deleted as approved by Commonwealth, 16 November 2000</i>
Begin construction of works if appropriate	Completed
Design associated rehabilitation experiments	Completed
Develop a stream rehabilitation training program	Proceedings for environmental flows seminar and fishways workshop held and proceedings published Other adoption and training activities are in planning

Years 3, 4 and 5

Complete all rehabilitation construction work	All completed
Deliver stream rehabilitation training program to target managers in eastern states <i>Amendment of milestone approved by Commonwealth, 16 July 2003 with replacement by:</i>	Training is in planning for 2003-2004
Deliver an environmental flow assessment method for natural resource managers	
Update rehabilitation planning procedures	Yet to commence.
Complete first round of geomorphic recovery projects <i>Milestone amended as approved by Commonwealth, 16 November 2000, and replaced by:</i>	RAP, CHUTE and MEL software all close to completion
Complete development of design models for rehabilitation tools	
Complete first round of rehabilitation experiments	Experiments have already yielded strong results
Incorporate modelling tools into the toolkit of Program 1: Predicting Catchment Behaviour	RAP and CHUTE will be included in Catchment Modelling Toolkit website later in 2003-2004

Utilisation and Application of Research

Program 7: Communication and Adoption

Aim:

To provide leadership and support for each CRC research program and project in planning and implementing activities to achieve the highest possible level of adoption of this CRC's research outcomes.

Program Leader:

David Perry, Monash University

Program Output:

Application of a series of integrated communication and adoption tools and techniques to facilitate the uptake and use of research outcomes by end-users.

The Catchment Modelling Toolkit is the key adoption vehicle, and it is ultimately the means by which this CRC will achieve its mission. The Toolkit is required in a format accessible by the various user groups.

Outcomes and benefits

The core business of this CRC is world-class research in land and water issues. A challenge for the CRC is to integrate the various multi-disciplinary threads of its research programs, and to achieve a holistic view of catchments.

Through employment of an effective and integrated communication and adoption strategy, this CRC's research outcomes will improve the understanding and management of Australia's land and water resources.

Development Projects in Focus Catchments

To demonstrate its commitment to this end, research is targeted on a new project portfolio of development projects in the CRC's Focus Catchments.

The intent of these projects is to:

1. Build the capacity within Industry Parties to apply the CRC's modelling tools;
2. Demonstrate the utility of the tools by applying them to a range of problems at whole-of-catchment scale; and
3. Provide researchers with feedback from end-users on the suitability of the models for operational use.

Each of the six research programs targets effort on at least two of the five Focus Catchments, with Program 1 (Predicting Catchment Behaviour) being highly relevant to all five sites.

1. Program Leader David Perry



Stakeholder and end-user involvement

The Development Projects in Focus Catchments are vital in the adoption of research outcomes as they provide a means by which modelling products can be tested and applied in the field.

Ultimately the end-users of this CRC's research and modelling tools will be:

- Land and water managers
- Researchers
- Government departments
- Local governments
- Weather forecasting agencies
- Catchment managers

Program highlights 2002-2003

- The successful establishment of Development Projects in the CRC's five Focus Catchments
- The Toolkit Strategy Group was established throughout the year to coordinate the development and delivery of the Catchment Modelling Toolkit.
- Substantial progress on design, construction and deployment of Stage 1 of the Catchment Modelling Toolkit website.

The close involvement of CRC Parties and the efforts of the Focus Catchment Coordinators has been a significant factor in the CRC's success to date.

Selection of Focus Catchments

The five Focus Catchments were selected to:

- cover a spectrum of spatial scales and catchment characteristics
- span the range of issue-based problems confronting catchment managers
- build upon existing catchment management initiatives at those sites
- link to research networks outside the bounds of the Centre
- satisfy the specific interests of each of the participating industry Parties.

Each Focus Catchment or site is managed by a Focus Catchment Coordinator selected from relevant Industry Parties, to:

- work with the Communication and Adoption Program and regional groups to ensure two-way information flow;
- assist in the definition of research problems and desired research outcomes;
- facilitate access to data and field sites managed by the industry Parties;
- work with the Program Leaders to ensure integration of our research themes;
- lead or assist with the Development Project in the Focus Catchment.

The five Focus Catchments are:

- Fitzroy River, Qld
- Brisbane River, Qld
- Murrumbidgee River, NSW
- Goulburn Broken Rivers, Vic
- Yarra River, Vic

A summary of each Focus Catchment and highlights for 2002-2003 follows.

Brisbane River, Queensland

The impact of urban stormwater quality on the river and Moreton Bay is a key concern. It is uncertain whether the primary source of pollutants is the urban or the outer-urban areas.

'From the research that has been undertaken within the Brisbane Focus Catchment and the establishment of the Development Project in the region, the CRC's mission of delivering predictive capability to resource and catchment managers to assess land-use and water management decisions will be realised.'

'This research has largely been possible due to the high degree of cooperation between researchers, Industry Parties and the relevant stakeholders within the Focus Catchment.'

Tony Weber, Focus Catchment Coordinator

Yarra River, Victoria

The impact of urban stormwater quality on the river and Port Phillip Bay is a key concern. Rehabilitation of tributary streams to encourage aquatic life is a priority. Management of upstream storages to optimise water-supply reliability is a major challenge.

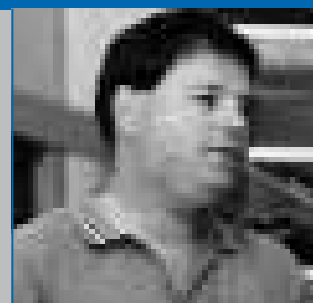
'The Yarra Development Project represents a means to engage in more holistic water cycle management. Information will be gleaned and decisions made about drinking water quality, stream water quality and ecosystem response from the one catchment simulation product.'

'We are slowly moving towards real integration of catchment management.'

Graham Rooney, Focus Catchment Coordinator



1. Communication and Adoption Program group
2. Tony Weber - Focus Catchment Coordinator, Brisbane River, Development Project Leader, Project 7.15 (7E)



Utilisation and Application of Research Program 7: Communication and Adoption

Fitzroy River, Queensland

This catchment has undergone rapid clearing; high sediment and nutrient loads are a major concern, both in the river and coastal waters. Water allocation for development and for maintaining river health are important catchment issues. A major new dam is proposed for the catchment, raising concern about potential impacts on flow regimes and river health.

'The ability to model catchment processes at a very large basin scale is a major challenge for the CRC, and the main reason that the Fitzroy was chosen as a Focus Catchment. This catchment will test the capacity of CRC tools to model large basin scale processes and responses.'

Bruce Cowie, Development Project Leader

Goulburn-Broken Rivers, Victoria

This is the 'food-bowl' of Victoria, responsible for about \$1.5 billion worth of food production each year. Salinity and nutrient management are key issues here, as are afforestation and water allocation under the tradeable water-rights system. System yield is affected by land use, losses from channels, and operation for irrigation supply.

'From a Focus Catchment Coordinator's perspective there are a number of great things about the concept and delivery of Development Projects. These include:

- *strong support of the CRC (and some pretty good brains) in developing local solutions to our issues;*
- *access to the most up-to-date modelling tools available;*
- *developing and building a regional capacity to utilise the CRC's modelling tools into the future; and*
- *raising researchers' awareness of the local and regional catchment issues for which they are developing tools.'*

Pat Feehan, Focus Catchment Coordinator

Murrumbidgee River, New South Wales

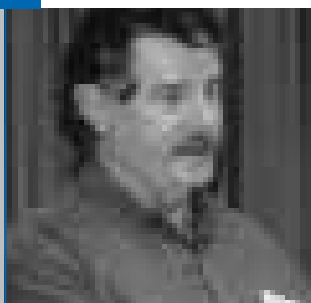
Dryland salinity in the middle reaches is a major issue, with no sure means of forecasting/managing its impact. Afforestation of large areas of the upper and middle catchment is underway, with unknown consequences for salinity and water security.

'With the first round of CRC projects at a close, it is now appropriate to review some of the research findings in the context of the Murrumbidgee Catchment, particularly the decision support tools and the advancements made in our knowledge of how catchments work.'

The second round of projects includes Development Projects - an exciting new method of facilitating adoption of research products.'

Carolyn Young, Focus Catchment Coordinator

1. Chris Carroll - Focus Catchment Coordinator, Fitzroy River
2. Carolyn Young - Focus Catchment Coordinator, Murrumbidgee River, Development Project Leader, Project 7.12 (7B)



Project 7.11 (7A) Development Project for the Goulburn-Broken Focus Catchment - Modelling and managing land-use impacts in and around water storages in Northern Victoria

(Second round project)

Project Leader: Pat Feehan, Goulburn-Murray Water

Aim: To utilise and further develop this CRC's capabilities in predicting land-use impacts on pollutant delivery and transport, and water yield in the Goulburn-Broken catchment.

To aid development of cost effective, targeted management strategies and guidelines aimed at improving catchment and storage water quality and protect water yield.

Achievements 2002-2003

- Project approval and commencement was a major achievement this year. Its establishment was highly dependent on the availability of additional resources that are now in place.
- A Stakeholder Reference Group for the project was established in December 2002
- Papers on catchment and storage issues affecting water quality were prepared for the Tullaroop Reservoir and Mid-Upper Goulburn Catchments.

Project 7.12 (7B) Development Project for the Murrumbidgee Focus Catchment - Modelling sediments and nutrients in the Murrumbidgee Catchment to inform investment

(Second round project)

Project Leader: Carolyn Young, Department of Infrastructure, Planning and Natural Resources, NSW

Aim: To operationalise within DIPNR, the modelling tools developed in the first round of projects. These tools, namely EMSS and SedNet will enable the Department to improve estimates of pollutant sources and transport and to target management strategies aimed at improving water quality.

Achievements 2002-2003

- The project continues to receive strong interest and support from potential end-users in the region
- A project steering committee has been established and held its first meeting in June 2003.
- The research team commenced building the catchment's nutrient and sediment model, scheduled to be operational in 2003-2004.

Project 7.13 (7C) Development Project for the Yarra Focus Catchment - Modelling river water quality in the Yarra catchment

(Second round project)

Project Leader: Graham Rooney, Melbourne Water

Aim: To predict river water quality at the lower end of the Yarra River.

Achievements 2002-2003

- Project staffing and departmental involvement in the project was finalised in June 2003.
- Initial training of a newly-appointed modeller on the EMSS modelling package was also completed in June.

1. Pat Feehan - Focus Catchment Coordinator, Goulburn/Broken Rivers, Development Project Leader, Project 7.11 (7A)
2. Graham Rooney - Focus Catchment Coordinator, Yarra River Development Project Leader, Project 7.13 (7C)



Utilisation and Application of Research

Program 7: Communication and Adoption

Project 7.15 (7E) Development Project for the Brisbane River Focus Catchment - Enhancing stakeholder capacity in prioritising water quality management actions in southeast Queensland

(Second round project)

Project Leader: Tony Weber, Consultant to Brisbane City Council

Aim: To promote awareness of existing CRC models within the region by building the technical capacity of land and water agencies to use, modify and interpret these models.

To use the models in regional water quality planning in the Northern, Western and Lower Brisbane catchments.

Achievements 2002-2003

- Sign-off on the Project Agreement and appointment of a Project team in March 2003.
- In-depth training has followed with team members learning about the Catchment Modelling Toolkit.
- A series of sessions with the Moreton Bay Waterways and Catchment Partnership were held in June to raise its level of awareness of the project

Project 7.16 (7F) Development Project for the Fitzroy Focus Catchment - Modelling river water quality in the Fitzroy Catchment in partnership with regional strategy groups

(Second round project)

Project Leader: Bruce Cowie, Natural Resources and Mines, Queensland

Aim: To apply the CRC's water quality models to the Fitzroy Catchment and smaller sub-catchments within it.

Achievements 2002-2003

- Draft proposal for the project was approved in December 2002 by all stakeholders involved.
- A steering committee has been established to oversee the project.

- Spatial data on the Fitzroy has been collated for use in the project.
- Team member training commenced in February 2003 and is being staged over several months.
- The Fitzroy and/or sub-basin model was built in June 2003.

Other features of the Communication and Adoption Program

MUSIC revolutionises stormwater management

The Model for Urban Stormwater Improvement Conceptualisation (MUSIC) research and development project was established to rapidly translate research findings into industry success. MUSIC has revolutionised access to expertise and technology in the stormwater industry. It brings together leading edge stormwater management technology and the best available data in a user friendly and professionally designed analysis tool.

To maximise the uptake of this extremely valuable tool the CRC conducted a series of seminars and training courses throughout Australia. The success of these courses is reflected in the rapid adoption of MUSIC by industry. Within six months of its mid-2002 launch, over 300 licences were issued throughout Australia and overseas. And interest continues to grow.

Catchment Modelling Toolkit

The focus of this current CRC is the development and delivery of the Catchment Modelling Toolkit, a set of software tools that will ultimately provide a quantitative basis for integrated catchment management. All research Program groups are building specific modelling software for the Toolkit, and importantly, representatives from all industry Parties are involved in the design and evaluation of the software. They also play a vital role in promotion of the Toolkit to colleagues and peers.

The prime delivery pathway will be a dedicated website. All Toolkit products will eventually be downloadable from this site at low or no cost.

A Toolkit Strategy Group was established this year to work on coordinating the development and delivery of the Toolkit.

Most products within the Toolkit will be released to industry for the first time. The Toolkit Strategy Group have been working on a training needs analysis and training program. Workshops on individual Toolkit products will be run and at least one major Catchment Modelling School per year will be conducted, the first to be held in February 2004.

Effective communication

Integrated, effective communication will result in the successful acceptance and adoption of research outcomes by end-users. To this end this CRC continues to utilise a variety of different means to inform, educate and train current and potential users of CRC tools and products.

Catchword

This highly successful monthly newsletter includes regular updates on CRC research and support programs, provides details of forthcoming workshops and seminars, and also includes information on new publications and videos produced by the Centre.

It continues to be a very effective way for stakeholders and other interested parties to keep in touch with the CRC's progress.

Demand remains high with over 1300 people receiving a free copy of *Catchword* each month either by post or electronic mail.

Websites

A successful website is dependent on three key elements; accuracy, relevance and simplicity. Ongoing and dedicated attention to the website throughout the year meant readily and easily accessible, up-to-date information for all visitors to the CRC website.

Responding to stakeholder and community need, the CRC also promptly established a special bushfire website. It was a highly successful initiative that delivered information to catchment and water supply managers and landholders about the hydrologic impacts of the bushfires that ravaged the landscape during the 2002 summer.

Industry seminars, workshops and conferences

Seminars and workshops have been an important plank in this CRC's communication and adoption strategy, and this year was no different. Researchers and industry representatives continue to find these workshops a valuable source of information as they provide practical information of immediate relevance based on world-renowned research.

Articles, conference papers, presentations

A number of technical reports, presentations and articles were prepared by CRC researchers throughout the year.

Presentations are listed under the Public Presentations, Public Relations and Communication chapter. Publications are listed in a separate chapter.

Publications and videos

The CRC's comprehensive list of videos, industry reports and project sheets continues to grow as does demand for these tools. Orders and electronic downloads continued steadily throughout the year.

Workshops, field tours, demonstrations and continuing professional education

Interaction with community groups, industry practitioners and other stakeholders is vital if this CRC is to succeed in its adoption goal. Workshops and field tours provide an opportunity for information sharing and feedback on the impact of this CRC's research.

A list of workshops, field tours, demonstrations and short courses undertaken in 2002-2003 is also provided in the chapter on Public Presentations, Public Relations and Communication.

Advocacy

Is science catchment prediction a vital part of the landscape renewal process? This CRC believes so and therefore continues to influence debate and awareness about catchment issues at a national, state and local level.

Examples of CRC advocacy in 2002-2003 included:

- Dr Michael Stewardson and Assoc Prof Ian Rutherford were commissioned to participate in the Goulburn River Regional Evaluation Group, as part of the Living Murray Project.

- Dr Tony Ladson continued as a member of the reference panel for the Physical Habitat Theme of the Murray-Darling Basin Commission's Sustainable Rivers Audit.
- Assoc Prof Ian Rutherford, Prof Tom McMahon and Dr Michael Stewardson were appointed to the Victorian Technical Audit Panel for reviewing groundwater and streamflow management plans.
- Dr Robert Argent continued to work with Melbourne Water, EPA Victoria, and Department of Sustainability and Environment on modelling and conceptual planning for combined Port Phillip and Westernport Bays pollutant management.
- Dr Tim Fletcher and Urban Stormwater Quality Program colleagues were engaged by EPA Victoria and EPA NSW in developing strategic approaches to urban stormwater management.
- Prof Rob Vertessy continues to provide briefings to various government departments on the water yield implications of plantation development.

Intellectual property management

During the year the CRC reviewed its approach to Commercialisation of Intellectual Property and confirmed its strategy for the dissemination of its research outputs on a public good basis. Some research outputs and products represent an opportunity for financial return with further commercialisation under development. The CRC has recognised that putting a price on the products coming out of the Centre creates a sense of value and worth amongst end-users, but should not be at such a level to impede adoption.

For the management of intellectual property, the CRC:

- Identifies and documents (background) intellectual property brought into the Centre;
- Develops a value-adding assessment procedure;

- Protects products with commercial potential;
- Negotiates agreements for commercial application and dissemination;
- Maintains an Intellectual Property Register for each software product made available through the Catchment Modelling Toolkit;
- Develops a policy for sharing royalties accruing from product sales.

Interaction with research users

The CRC's involvement and interaction with industry and other organisations as research users is outlined in a table overleaf.

Contract research and consultancies

Strategic research contracts were once again actively targeted throughout the year with over \$1.2 million in funding provided to the CRC. Details of contract research projects and consultancies are shown in a table toward the end of this chapter.

Several research contracts were completed during 2002-2003. Project 2.13 (Basin-wide mapping of sediment and nutrient exports in dryland regions), Project 3.4 (Enhancement of water market reform process) and Project 4.4 (Monitoring protocols and selection guidance for primary stormwater treatment measures) were completed.

1. Bruce Cowie, Fitzroy River Development Project Leader, Project 7.16 (7F)
2. Susan Daly, Web Site and Graphic Designer



Utilisation and Application of Research Program 7: Communication and Adoption

Interaction with Research Users

Research User (Industry and other organisations)	Organisation size (small & medium sized enterprises, large firms)	Basis of interaction (core participant, consultancy, grant collaboration)	CRC product or service involved
Australia National University iCAM (Integrated Catchment Assessment and Management Centre)	SME	Research affiliate	<i>Interactive Component Modelling System</i> <ul style="list-style-type: none"> Software being used to model water quality in Ben Chiffely Dam catchment (NSW) Software also used to model water allocation in Murrumbidgee and Namoi catchments.
Australian Centre for International Agricultural Research (ACIAR)	SME	Contract research/grant collaboration	<i>Land-use impacts on rivers</i> <ul style="list-style-type: none"> Eucalypts and water: Managing forest plantations in China and Australia for sustained productivity and environmental benefits Regional impacts of revegetation on water resources of the Loess Plateau China and the middle and upper Murrumbidgee catchment, Australia
Brisbane City Council	Large	Core participant	<i>Draft Stormwater Quality Monitoring Protocol</i> <ul style="list-style-type: none"> Advice to Brisbane City Council on stormwater and SQID monitoring to support the protocol <i>Model for Urban Stormwater Improvement Conceptualisation (MUSIC)</i> <ul style="list-style-type: none"> Regional defaults for MUSIC parameters developed for Brisbane users Guidelines for MUSIC being developed
Bureau of Meteorology	Large	Core participant	<i>Motivate Program</i> <ul style="list-style-type: none"> The Motivate Program was applied to a contract between the Bureau of Meteorology and Melbourne Water to determine the time-area rainfall for a one in five storm.
Bureau of Rural Sciences	SME	User consultant	<i>Zhang model</i> <ul style="list-style-type: none"> The Bureau of Rural Sciences used the Zhang model in predictions of the performance of plantations in the middle Macquarie catchment (part of a major study).
Coomes Consulting	SME	Industry user	<i>Model for Urban Stormwater Improvement Conceptualisation (MUSIC)</i> <ul style="list-style-type: none"> Cairnlea Estate, Melbourne
CSIRO	Large	Core participant	<i>Tarsier software environment</i> <ul style="list-style-type: none"> CSIRO researcher outside the CRC, applying Tarsier to model salinity for the Water and Rivers Commission (WA) Staff at CSIRO Townsville using Tarsier for ecological modelling (stock track development) <i>Model for Urban Stormwater Improvement Conceptualisation (MUSIC)</i> <ul style="list-style-type: none"> Brasil Development, Brisbane application
Department of Infrastructure, Planning and Natural Resources, NSW (DIPNR)	Large	Core Participant	<i>Sediment tracing budget methodology</i> <ul style="list-style-type: none"> Involvement of DIPNR staff in CRC research (Geoff Podger, Mark Littleboy, Guy Geeves, Carolyn Young and Christoph Zierholz), DIPNR (also NSW SF and NSW EPA) reassessing impacts of relevant reforestation water quality and water quality strategies in the catchment and impacts on water availability to irrigators and Macquarie Marshes <i>Strategic Landscape Investment Model (SLIM)</i> <ul style="list-style-type: none"> Involvement of CRC staff with DIPNR in the SLIM tool that permits multi-criteria analysis to identify revegetation optimal sites and other Murray-Darling Basin investments
Department of Sustainability and Environment (DSE)	Large	Core Participant	<i>Flow events methodology (FEM)</i> <ul style="list-style-type: none"> DSE commissioned an independent report to advise on integration of FEM into statewide environmental flow method.
Earth Tech Pty. Ltd.	SME	Consultant user, Industry Affiliate	<i>Flow events methodology (FEM)</i> <ul style="list-style-type: none"> Report on Evaluation of Method (FEM) Earth Tech Pty. Ltd. is applying FEM in environmental study of Thomson River.

Interaction with Research Users (continued)

Research User (Industry and other organisations)	Organisation size (small & medium sized enterprises, large firms)	Basis of interaction (core participant, consultancy, grant collaboration)	CRC product or service involved
Ecological Engineering	SME	Consultant user, Industry Affiliate	<i>Model for Urban Stormwater Improvement Conceptualisation (MUSIC)</i> <ul style="list-style-type: none"> (Applications in Melbourne) - Wakerley Area Wetland & Water Sensitive Urban Design, Brisbane; Police Road Retarding Basin, Melbourne; Association of Bayside Municipalities Project, Melbourne
Environment Protection Authority Victoria	Large	Consultancy, Grant Collaboration	<i>Urban Stormwater Quality</i> <ul style="list-style-type: none"> Monitoring protocols and selection guidance for primary stormwater treatment measures Monitoring and evaluation protocols and selection guidance for non-structural stormwater management measures
Gutteridge Haskins & Davey	Large	Consultant user	<i>Model for Urban Stormwater Improvement Conceptualisation (MUSIC)</i> <ul style="list-style-type: none"> (Application in Brisbane) - Park Hill Village, Brisbane
Land and Water Australia	SME	Grant collaboration	<i>River Restoration</i> <ul style="list-style-type: none"> Riparian land management: Concepts, floods and erosion <i>Land-use impacts on rivers</i> <ul style="list-style-type: none"> Predicting the combined environmental impact of catchment management regimes on dryland salinity <i>Sustainable water allocation</i> <ul style="list-style-type: none"> Enhancement of the water market reform process: A socioeconomic analysis of guidelines and procedures for trading in mature water markets (Project No:[GRU25]) <i>Predicting catchment behaviour</i> <ul style="list-style-type: none"> Development of a catchment contaminant cycle for stakeholder use
Melbourne Enterprises International	SME	Consultancy	<i>Flow events methodology (FEM)</i> <ul style="list-style-type: none"> Mike Stewardson led project through Melbourne Enterprises International to apply methodology to the Loddon River for the North Central CMA.
Melbourne Water	Large	Core participant	<i>Motivate Program</i> <ul style="list-style-type: none"> The Motivate Program applied to contract between Bureau of Meteorology and Melbourne Water to determine time-area rainfall for one in five year storm. <i>Draft Stormwater Quality Monitoring Protocol</i> <ul style="list-style-type: none"> Melbourne Water and Brisbane City Council have also adopted protocol for stormwater monitoring programs <i>Water Sensitive Urban Design (WSUD)</i> <ul style="list-style-type: none"> Consumer responses to residential developments incorporating WSUD <i>Model for Urban Stormwater Improvement Conceptualisation (MUSIC)</i> <ul style="list-style-type: none"> Guidelines for MUSIC developed
Murray-Darling Basin Commission	SME	Core participant, Contract research	<i>MDBC report</i> <ul style="list-style-type: none"> CRC Report to MDBC has highlighted strategic impact of afforestation on water yield in Murray-Darling Basin. <i>Flow events methodology</i> <ul style="list-style-type: none"> Report on Evaluation of Method (FEM) Final report to MDBC 'Evaluating the Effectiveness of Habitat Reconstruction' <i>Land-use impacts on rivers</i> <ul style="list-style-type: none"> Basin-wide mapping of sediment and nutrient exports in dryland regions Integrated assessment of the effects of land-use changes on water yield and salt loads Predicting salt movement in catchments
Murrumbidgee Catchment Management Board	SME	Activity by core participant DIPNR	<i>SedNet and EMSS</i> <ul style="list-style-type: none"> Project will demonstrate the relevance and applicability of models to assist in setting end-of-valley targets

(Continued next page)

Utilisation and Application of Research Program 7: Communication and Adoption

Interaction with Research Users

Research User (Industry and other organisations)	Organisation size (small & medium sized enterprises, large firms)	Basis of interaction (core participant, consultancy, grant collaboration)	CRC product or service involved
National Institute of Water and Atmospheric Research, New Zealand	SME	Research affiliate	<i>Climate variability</i> <ul style="list-style-type: none"> The National Institute of Water and Atmospheric Research, New Zealand has successfully trialled S_Prog and is investigating its use as the nowcasting component of a flash flood warning system.
Natural Heritage Trust, Dept of Agriculture, Fisheries and Forestry - Aust.(AFFA)	Large	Grant collaboration	<i>River restoration</i> <ul style="list-style-type: none"> Research to improve the effectiveness of Australian fishway design
NSW EPA	Large	Consultancy-user	<i>Draft Stormwater Quality Monitoring Protocol</i> <ul style="list-style-type: none"> NSW EPA adopted draft protocol and now recommended procedure for monitoring stormwater treatment measures by NSW councils
Pine Rivers Shire Council	SME	Consultancy	<i>EMSS software</i> <ul style="list-style-type: none"> Development of a pilot local-scale Environmental Management Support System for use in water supply sub-catchments in Pine Rivers Shire, Qld
Water and Rivers Commission (WA)	SME	Consultancy-user	<i>Tarsier software environment</i> <ul style="list-style-type: none"> Following a Tarsier workshop in Canberra, a workshop participant at CSIRO is applying Tarsier by using it to model salinity for the Water and Rivers Commission (WA)
South East Queensland Water Corporation	SME	Consultancy-user	<i>EMSS Software</i> <ul style="list-style-type: none"> Development of a pilot local-scale Environmental Management Support System for use in water supply sub-catchments in Pine Rivers Shire, Qld
South East Queensland Regional Water Quality Management Committee (SEQRWQMC) (succeeded by Moreton Bay Waterways and Catchment Partnership)	SME	Consultancy-user	<i>SedNet - a model that predicts the sources and distribution of sediment through a river network</i> <ul style="list-style-type: none"> The results of the SedNet application and validation in the Brisbane River catchment have formed the basis for targeting catchment works under the SEQRWQMS - this modelling work has formed the basis of the agenda for Phase 4 of the strategy <i>EMSS software</i> <ul style="list-style-type: none"> Development of an environmental management support system (EMSS) for catchments in south east Queensland <i>Predicting catchment behaviour</i> <ul style="list-style-type: none"> Modelling and estimating sediment and nutrient loads in south east Queensland catchments - Phase 1 <i>Land-use impacts on rivers</i> <ul style="list-style-type: none"> SEQRWQMS, Stage 3, Project Sediment and Nutrient Sourcing
State Water, an arm of DNRM, Qld	Large	Core participant	<i>Fitzroy catchment survey results</i> <ul style="list-style-type: none"> State Water, an arm of DNRM, used the result of the Fitzroy community and irrigator attitude survey to highlight potential issues and problems to the implementation of the Fitzroy Resource Operations Plan (ROP)
UK Meteorological Office	Large	International collaboration	<i>Radar forecasting</i> <ul style="list-style-type: none"> UK Bureau of Meteorology requested an MOU with BoM to apply the radar forecasting technology in the UK.
Urban and Regional Land Corporation	SME	User - grant collaboration	<i>Water sensitive urban design</i> <ul style="list-style-type: none"> Consumer responses to residential developments incorporating Water Sensitive Urban Design (WSUD)
WBM Oceanics	SME	Consultancy, Industry Affiliate	<i>EMSS software</i> <ul style="list-style-type: none"> EMSS (Tarsier) has been delivered and being used by CRC project teams and WBM Oceanics Development of a pilot local-scale Environmental Management Support System for use in water supply sub-catchments in Pine Rivers Shire, Qld <i>Model for Urban Stormwater Improvement Conceptualisation (MUSIC)</i> (Brisbane & Melbourne offices) - Lenworth Lake Development, Brisbane; Forrest Lake, Brisbane; Geelong Stormwater Management Plan, Victoria; Craigieburn Bypass Water Sensitive Road Design, Victoria.

Contract Research Activity

CRC Associated / Additional Projects External Funding & Direct CRC Contract Research / Consulting

CRC Project No.	Project Title / Project Leader	Related CRC Focus Catchment(s)	Total Project Resources (\$000s)	Total Funding Agency Resources Input (\$000s)	CRC Resource Input (\$000s)	CRC Input as % Total Project	Funding Agency Input for 1999/2000 (\$000s)	Funding Agency Input for 2000/01 (\$000s)	Funding Agency Input for 2001/02 (\$000s)	Funding Agency Input for 2002/03 (\$000s)	Cumulative Funding Agency Input to June 2003 (\$000s)	Project Start / Finish Date	CRC Parties Involved	Principal External Funding Agency
1.3	Development of an environmental management support system (EMSS) for catchments in south east Queensland/ Prof Rob Vertessy	Brisbane catchment	263	151	112	43	0	110	41	0	151	May 00 to Aug 01	CSIRO, Univ Melb, Monash Univ, BCC	South East Queensland Regional Water Quality Management Committee (SEQRWQMC)
1.4	Modelling and estimating sediment and nutrient loads in south east Queensland catchments - Phase 1/ Dr Francis Chiew	Brisbane catchment	72	54	18	25	0	54	0	0	54	May 00 to Jan 01	CSIRO, Univ Melb, Monash Univ, BCC	South East Queensland Regional Water Quality Management Committee (SEQRWQMC)
1.7	Development of a pilot local-scale Environmental Management Support System for use in water supply sub-catchments in Pine Rivers Shire, Qld / Prof Rob Vertessy	Brisbane catchment	222	125	97	44	0	0	125	0	125	May 01 to Jun 02	CSIRO, NRM Qld, BCC	Pine Rivers Shire Council; South East Queensland Water Corporation; WBM Oceanics, Consultants
1.11	Development of a catchment contaminant cycle for stakeholder use / Prof Rob Vertessy	Brisbane and Murrumbidgee catchments	702	400	106	15	0	0	0	107	107	Dec 02 to Jun 05	CSIRO, Monash Univ	Land and Water Australia
2.6	Predicting the combined environmental impact of catchment management regimes on dryland salinity / Dr Lu Zhang	Goulburn-Broken catchment, Murrumbidgee catchment	812	150	500	62	0	71	79	0	150	Jul 00 to Jun 02	CSIRO, DNRE, DLWC-NSW, Univ Melb	Land and Water Resources Research and Development Corporation (LWRRDC)
2.7	Eucalypts and water: Managing forest plantations in China and Australia for sustained productivity and environmental benefits / Dr Jim Morris	Goulburn-Broken Catchment	1,621	821	300	19	223	205	195	198	821	Jul 99 to Jun 03	Centre for Forest Tree Technology DNRE, Univ Melb Dept of Forestry, CSIRO	Australian Centre for International Agricultural Research (ACIAR)
2.10	SEQRWQMS, Stage 3, Project SS:Sediment and Nutrient Sourcing / Dr Jon Olley	Brisbane River catchment	397	277	120	30	223	54	0	0	277	Aug 99 to Jun 01	CSIRO, NRM Qld	South East Queensland Regional Water Quality Management Committee (SEQRWQMC)
2.13	Basin-wide mapping of sediment and nutrient exports in dryland regions / Dr Chris Moran	Goulburn-Murray; Murrumbidgee are addressed by this study. The methodologies are of value to the other focus catchments	1500	492	0	0	24	109	229	130	492	Mar 00 to Mar 03	CSIRO, Univ Melb, Monash Univ, MDBC	Murray-Darling Basin Commission (MDBC) Strategic Investigations and Education Program
2.15	Integrated assessment of the effects of landuse changes on water yield and salt loads / Dr Lu Zhang	Part of work in Murrumbidgee and Goulburn Broken catchments. Some work in catchments in WA	1295	753	542	42	0	0	283	188	471	Feb 01 to Oct 03	NRE Vic, DLWC NSW, CSIRO Land and Water	Murray-Darling Basin Commission (MDBC) Strategic Investigations and Education Program
2.24	Regional impacts of re-vegetation on water resources of the Loess Plateau China, and the middle and upper Murrumbidgee catchment, Australia / Dr Tim McVicar	Murrumbidgee catchment	1946	415	141	7	0	0	0	81	81	Apr 03 to Mar 06	CSIRO, [links with DIPNR - NSW]	Chinese Academy of Sciences - Institute of Soils and Water Conservation; Australian Centre for International Agricultural Research (ACIAR)
3.4	Enhancement of the water market reform process: A socioeconomic analysis of guidelines and procedures for trading in mature water markets (Project No:[GRU25]) / Dr John Tisdell	Murrumbidgee catchment	833	208	625	75	0	60	72	76	208	Jul 00 to May 03	Griffith Univ, DLWC-NSW, Monash University	Land and Water Resources Research and Development Corporation (LWRRDC)
3.10	The valuation of the water quality ecosystem service of the mid-Brisbane River / Dr John Tisdell	Brisbane catchment	40	30	10	25	0	0	0	0	0	June 03 to Aug 03	BCC, Griffith Univ	South East Queensland Water Corporation

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Utilisation and Application of Research

Program 7: Communication and Adoption

Contract Research Activity

CRC Associated / Additional Projects External Funding
& Direct CRC Contract Research / Consulting

CRC Project No.	Project Title / Project Leader	Related CRC Focus Catchment(s)	Total Project Resources (\$'000s)	Total Funding Agency Resources (\$'000s)	CRC Resource Input (\$'000s)	CRC Input as % Total Project	Funding Agency Input for 1999/2000 (\$'000s)	Funding Agency Input for 2000/01 (\$'000s)	Funding Agency Input for 2001/02 (\$'000s)	Funding Agency Input for 2002/03 (\$'000s)	Cumulative Funding Agency Input to June 2003 (\$'000s)	Project Start / Finish Date	CRC Parties Involved	Principal External Funding Agency
4.3	Consumer responses to residential developments incorporating Water Sensitive Urban Design (WSUD)/ Dr Tim Fletcher	Yarra catchment	106	100	6	6	0	0	90	0	90	Sep 01 to Jun 02	Melbourne Water, Monash Univ	Melbourne Water, Urban and Regional Land Corporation
4.4	Monitoring protocols and selection guidance for primary stormwater treatment measures/ Dr Tim Fletcher	Yarra catchment	220	200	20	9	0	0	200	170	370	Sep 01 to Jul 03	Melbourne Water, Monash Univ	Environment Protection Authority Victoria
4.5	Monitoring and evaluation protocols and selection guidance for non-structural stormwater management measures/ Dr Tim Fletcher	Yarra catchment	120	100	20	17	0	0	100	0	100	Sep 01 to Jul 02	Melbourne Water, Monash Univ	Environment Protection Authority Victoria
6.8	Research to improve the effectiveness of Australian fishway design / Assoc Prof Bob Keller	Applies generally to Murray-Darling Basin	672	362	310	46	18	134	210	0	362	May 00 to Jun 02	Monash Univ, Univ of Melbourne	Natural Heritage Trust, Dept of Agriculture, Fisheries and Forestry - Aust.(AFFA)
6.9	Riparian land management: Concepts, floods and erosion / Assoc Prof Ian Rutherford	Feeds into Project 2.1 - with focus on Murrumbidgee and Goulburn Broken	691	500	50	7	0	0	81	196	277	July 01 to Jun 05	Univ of Melbourne, CSIRO, [Interest expressed by Melb Water, Brisbane CC, NRM Qld]	Land and Water Australia
6.14	Quantifying health in ephemeral rivers / Justin Costelloe & Fran Sheldon (CRCFE)	Field sites required by LWA to be located in South Aust ephemeral rivers	885	113	210	24	-	-	-	Note 2	-	Mar 03 to Feb 05	Univ Melb, Monash Univ	Land and Water Australia
Totals (\$'000s)			12397	5251	2977		488	797	1705	1146	4136			
Associate/Additional Projects External Funding Agency Input total (\$'000s)							488	797	1705	1146	4136			
CRC Direct Contract Research/Consulting Income total (\$'000s)							32	152	30	125	339	Note 1		
Total Contract Research/Consulting total (\$'000s)							520	949	1735	1271	4475			
Commonwealth Agreement Contract Research totals (\$'000s)							300	700	1000	1400	3400			

Notes

- Actuals for 99/2000, 2000/01, 2001/02, 2002/03 as reported in Profit and Loss Account
- Income processed through CRC direct financial reporting for 2002/03

Milestones

Years 1 and 2

All project agreements have a communication and adoption strategy that details the needs of end-users and a strategy for adoption of research outcomes.

Existing Centre communication and adoption activities reviewed in conjunction with existing and new Parties to determine requirements and further improve the communication and adoption strategies during Years 1 and 2.

Development of a communication strategy to engage the interest and collaboration of a wide range of stakeholders in preparation for the delivery of the Centre's research outcomes.

Communication and adoption activities benchmarked by independent consultants through review after Year 1.

Further improvement of the CRC's website to increase access to research outcomes and products

Establish strategy for communication within the CRC Parties and between Focus Catchments to ensure integration with overall Communication and Adoption and research program objectives.

Level of commitment to contract research is on target set in Strategic Plan

Years 3, 4 and 5

Preparation completed (Year 3) for the communication of research outcomes to targeted end-users. Individual program and project Communication and Adoption strategies commenced

Communication and adoption activities measured by independent consultants (Years 3 and 5)

Best practice communication and adoption workshop to assess and implement recommendations from independent reviews (Years 2 and 4)

Level of commitment to contract research is on target set in Strategic Plan.

Progress

The Communication and Adoption (C&A) program trialled a C&A framework in conjunction with Program 4 during late 2000. The framework was subsequently implemented by all research programs during 2001. C&A strategies for the first round of projects have been largely implemented as projects finished during 2002-2003. Remaining C&A activity for first round projects has focussed on delivery through the Catchment Modelling Toolkit website.

External communication review by Econnect completed April 2001 and included an assessment of existing communication vehicles and recommendations to improve product range. Assessing the value of each product to target groups is part of the C&A Program's Planning Framework undertaken in each Program.

C&A planning framework completed November 2000. The external communication review included recommendations for improvements to developed strategies. A broad communication strategy has been pursued based on the CRC's established communication vehicles, and the activities of Focus Catchment Coordinators.

Econnect successfully tendered for the communications review and completed it by May 2001. Key communicators from other similar organisations (10), key CRC investors (25), and internal (73) and external stakeholders (175) were surveyed to benchmark the CRC's communication performance. The results of review were very positive.

Stage 1 of CRC website redesign was completed in early 2002 and included improved navigation, research model downloads, technical report summaries, project information, events calendar, news pages, *Catchword* subscription, events notification and publications lists.

Stage 2 includes construction and deployment of the Catchment Modelling Toolkit website (near complete) and redesign of CRC website (scheduled for 2003 - 2004).

Initial strategy comprises FCCs as communication links via: email newsletters to target audience in catchments; AEAM project in Fitzroy; involvement of FCCs in developing C&A plans; regular FCC meetings in person and via phone. Completed December 2001. Implementation is ongoing.

External projects for endorsement represent 136% of target to June, 2001: SEQRWQMS Projects 1.3, 1.4, 2.10; L&WA Projects 2.6, 3.2; NHT/AFFA Project 6.5; MDBC Project 2.13; ACIAR Project 2.7

Preparation for delivery completed by all Programs.

First round projects have largely completed delivery of strategies.

Year 3 communications review postponed to 2003 - 2004 to correspond with completed C&A delivery of first round projects and a two year period since the first review (May 2001).

The Executive Summary of the May 2001 communications review described the CRC as a 'leader in its approach to planning, implementing and evaluating communication'. The recommendations from the review did not warrant the follow-up best-practice workshop in Year 2. Resources were redirected to the establishment of the Development Projects in the Focus Catchments during 2002. The best practice workshop scheduled for Year 4 is scheduled for early 2004 and subject to the preceding independent review.

External projects for endorsement represent 132% of the target to June 2003. South East Queensland Regional Water Quality Management Strategy Projects 1.3, 1.4, 1.7, 2.10; Pine Rivers Shire Project 1.7; Land & Water Australia Projects 1.11, 2.6, 3.4, 6.9, 6.14; Natural Heritage Trust/Agriculture, Fisheries and Forestry - Australia Project 6.8; Murray-Darling Basin Commission Projs 2.13, 2.15; ACIAR Projects 2.7, 2.24; URLC/Melb Water Proj 4.3; EPA Vic Projs 4.4, 4.5.

Education and Training

Program 8: Education and Training

Aim:

To increase the knowledge and skill base of land and water managers in Australia.

Program Leader:

Dr Tim Smith, Griffith University (Dr Smith stepped down as Program Leader in August 2003. A replacement for Dr Smith is being sought.)

Deputy Program Leader:

Dr James Whelan, Griffith University

Program Output:

Program 8 is responsible for a range of outputs, the most notable being:

1. Delivery of a range of needs-based courses for postgraduate students designed to assist in their professional and personal development.
2. Establishment of a skills-based and industry placement postgraduate database.
3. Facilitation of industry placements for CRC postgraduates.
4. Development of an education and training framework for a comprehensive and consistent approach to stakeholder education and training across the CRC.
5. Implementation of train-the-trainer workshops in preparation for the upcoming Catchment Modelling Toolkit and other CRC stakeholder education initiatives.

Outcomes and benefits

The CRC for Catchment Hydrology is committed to the adoption of its tools and integrated modelling capability. Building the capacity of CRC researchers to effectively undertake and evaluate education and training in the use of these tools, together with postgraduate education and training are now the main foci of Program 8.

Education and training is a core element of the adoption process. The outcomes of effective education and training in CRC products are a commitment by end-users to these products, and establishment of a satisfactory level of competency in their use.

This CRC has continued to provide and broker education and training initiatives to meet the needs of postgraduates, researchers and stakeholders. These initiatives are based on a firm commitment by CRC management to equip staff with the necessary skills and materials to effectively design, conduct and assess education and training activities for users of CRC products.

Other key initiatives within Program 8 include providing postgraduate students with additional skills and experiences. Industry placements and other forms of professional development enable students to contribute to future developments in catchment hydrology in industry, government and research settings.

Evidence of the success of these initiatives is that CRC postgraduates are highly regarded throughout the industry with several having won or been nominated for science awards over recent years.

The Program 8 social science research has also contributed to a greater understanding of the roles and drivers of communities in effective catchment management. The results of this research will be communicated through the Respect, Reflect, React symposium series planned for 2003-2004. There will also be contributions to an on-line toolbox of community participation strategies (developed in conjunction with the CRC for Coastal Zone, Estuary and Waterway Management).

The adoption of the social science research generated from Program 8 will mean more effective strategies to engage communities in catchment management processes.

1. Program, Project Leader Dr Tim Smith - Projects 8.1, 8.2, 8.08 (8A)
2. Deputy Program Leader, Education and training workshop convener Dr James Whelan



End-users

- CRC industry Parties
- Regional catchment management groups
- State policy and extension agencies
- Local government
- Consultants
- Research organisations
- Non-government organisations
- Communities

Program highlights 2002-2003

- Training CRC researchers about the tools and in the education and training principles that ultimately underpin effective adoption of CRC products.
- On-going high quality postgraduate student research.
- Improving catchment management skills through the provision of on-going professional development of CRC postgraduate students. This was achieved through a range of initiatives including industry placements and professional development courses.
- Contributing to the capacity building of catchment management stakeholders through the successful completion of the 'We All Use Water' workshop series.
- Postgraduate Teri Etchells was a finalist in the Australian Young Water Scientist of the Year competition.

Project 8.1 Capacity building, education and training

(First round project)

Project Leader: Dr Tim Smith, Griffith University

Achievements 2002-2003

- In total forty-two postgraduate students were involved in research across core and Associated/Additional CRC projects this year. Areas of study ranged from vegetation change and the effect on stream flow, riparian vegetation functions in the Fitzroy catchment, property rights and water trading, use of biofiltration devices in stormwater quality and nitrogen in urban stormwater runoff (refer to Tables A and B in this chapter).
- Five postgraduates completed their higher degrees and took up appointments in industry and research.
- A continuing emphasis on bringing researchers up-to-date on research across the CRC was reflected in the annual workshop program at Yanco. This year the program included presentations from seventeen postgraduates.
- A range of needs-based courses were delivered for postgraduate students (eg. programming in Visual Basic). External courses that may be relevant to the postgraduate group were also advertised via the student e-group (established and facilitated by Program 8)

- A survey of postgraduate students regarding industry placements was conducted and informed the development of a database of student skills and industry placement preferences. Program 8 has since been involved in the facilitation of actual industry placements, for example with Melbourne Water.
- The CRC managed the Young Water Scientist of the Year Award in 2003. Postgraduates Teri Etchells and Dana Thomsen were nominated and Teri was selected as a finalist to represent the CRC at the OzWater 2003 conference in Perth in April 2003. Dana's nomination received favourable comments from the Award judges
- Program 8 developed a framework for education and training for the CRC including the development of a number of tools and templates, for example a planning matrix and template for evaluation. Program 8 assisted CRC research teams with the use of these templates as well as assisting in the actual education and training planning, design, facilitation and evaluation.
- In March and May 2003 Dr Tim Smith, Dr James Whelan and Nicholas Murray conducted a series of education and training workshops in Brisbane, Melbourne and Canberra for CRC researchers. These workshops focused on train-the-trainer principles, tutorials, and the design of the upcoming Catchment Modelling School (planned for February 2004)



1. Postgraduates group
2. Vacation student Nerida Beard, Griffith Univ.



Education and Training

Program 8: Education and Training

Project 8.2 Public participation and community change

(First round project)

Project Leader: Dr Tim Smith, Griffith University

Achievements 2002-2003

- Social science research in the upper Fitzroy - relating to stakeholder knowledge seeking and attitude change - is being finalised. Program 8 PhD students Margaret Gooch and Dana Thomsen expect to submit their PhD theses during 2003-04. Their research is contributing to the on-line toolbox of community participation strategies that have been developed jointly with the Coastal CRC.
- Collaboration between this CRC and the Coastal CRC regarding social science research continued throughout the year. In particular it included joint contributions to the on-line community participation toolbox and complementary social science research in the upper and lower Fitzroy, which is being used to inform research into the development of social indicators for the region.
- Citizen science researchers in both this CRC and the Coastal CRC have established a network of professionals with an interest in the human dimensions of natural resource management. The network includes approximately 50 members who are community engagement professionals and practitioners, researchers and community representatives. The group members exchange material through a new electronic discussion group and convene regular symposia at the Brisbane CRC node.
- During the AWA/CRC 'We All Use Water' workshop series, strong linkages were established with State and national science and society and environment education groups. A large percentage of participants were teachers. Many have integrated the materials into secondary education programs.

Industry seeks out CRC graduates.

Dr Scott Wilkinson spent just over four years at the CRC for Catchment Hydrology and was recruited by CSIRO Land and Water in March 2002 following completion of his PhD.

Scott started with the CRC back in 1997 on a three-month vacation studentship looking into the effects of vegetation on riverbank stability. He successfully applied to do his PhD through the CRC at the Monash University node in 1998.

"At the time I applied for my PhD I was still working on the waterway management program of the previous CRC," says Scott.

Scott's PhD focussed on identifying the flow conditions required to generate scour of pools in alluvial rivers and prevent pool riffle morphology from silting up.

"The results of this research can be used to design constructed pool riffle sequences in urban waterways so that the habitat they provide will be self maintaining. It can also assist in designing environmental flows to prevent pool sedimentation in regulated rivers."

"People managing streams where pool-riffle sequence habitat is important for fish and macroinvertebrates can now do so with nature's principle in mind. They now have the ability, through the work undertaken by the CRC, to mimic the processes that are occurring in natural systems," says Scott.

Scott believes that his involvement with the CRC was a key factor in securing his current position. "The CRC provided me a sound background in stream rehabilitation and management practices. Through my involvement with the CRC I was well aware of current trends in the water catchment industry and the issues facing stakeholders," he says.

"When I applied for the job at CSIRO it was felt that my background with the CRC was certainly beneficial. Not only did I have technical skills to conceptualise and tackle research problems, but I also had established contacts and networks."

Scott looks forward to continuing involvement with the CRC in his role at CSIRO as both organisations are committed to providing assistance to catchment managers at whole-of-catchment scales.



1. (Above) Scott Wilkinson
2. Vacation students Nicola Van Beurden and Laura Richardson at CSIRO
3. 4-wheel-drive training for postgraduates and staff



Table A Postgraduates - CRC Core Projects 2002-2003

Name	University	Type of postgraduate enrolment (PhD, MEngSc etc)	Supervisor and Associate Supervisors	Funding source(s) ARC/CRC/Uni/etc	Topic (Related CRC Program/Project)
Brett Anderson	Melbourne	PhD	I.D. Rutherford (UM) A. Western (UM)	APA#	The impact of riparian vegetation on catchment-scale flood characteristics (6, 2.1)
Yinbang Bao	Melbourne	PhD	R. Argent (UM) A. Western (UM)	APA#	Scaling and analysis issues of hydrological modelling (1.1)
Andrew Barton	Monash	MEngSc	R.J. Keller (Monash)	MDS (AFFA funded)	A numerical model for the hydraulics of the vertical slot fishway (6.5)
Mark Bayley	Griffith	PhD	M. Greenway (Griffith) G. Jenkins (Griffith)	GUPRAΩ	Nitrogen, phosphorus and carbon removal processes in stormwater wetlands (4)
Alice Best	Melbourne (2)	PhD	L. Zhang (CSIRO) T.A. McMahon (UM) A. Western (UM)	MRS##, UMSPS†	The impact of land use change on seasonal water yield (2.3)
Margot Biggin	Monash (1)	PhD	G. Codner (Monash) S. Schreider (Monash) M.J. Stewardson (UM)	MDS*	Evaluating the impact of water allocations on hydraulic environments (3) and (6)
Dominic Blackham	Melbourne	PhD	I.D. Rutherford (UM) M. J. Stewardson (UM)	MIRSø	The role of riparian grass in controlling degraded stream recovery (6)
Daniel Borg	Melbourne	MEngSc	I.D. Rutherford (UM) J.D. Fenton (UM)	UMSPS†, MRS##	Monitoring and modelling the persistence of large woody debris scour (6)
Tim Capon	Griffith	PhD	J Tisdell (Griffith) A. Arthington (Griffith)	GUPRAΩ	To examine the risks and uncertainties associated with defining property rights for water entitlements and environmental flows (3)
Daniel Clowes	Griffith	PhD	J. Tisdell (Griffith) G. McDonald (CSIRO)	GUPRAΩ	Integration between catchment biophysical models and economic models for the management of nonpoint source pollution (3)
Teri Etchells	Melbourne	PhD	H. Malano (UM) T. A. McMahon (UM) B. James (DSE)	APA#, UMSPS†	A methodology for calculating water trading exchange rates in the Murray-Darling Basin (3.1)
Matthew Francey	Monash	MEngSc	T. Fletcher (Monash) A. Deletic (Monash) H. Duncan (Melbourne Water)	Melbourne Water, VSAP	Investigation into the relationship between rainfall intensity and pollutant generation in urban catchments (4)
Myriam Ghali	Melbourne	PhD	I.D. Rutherford (UM) R. Grayson (UM) A. Curtis (Bureau of Rural Sciences - BRS)	IPRS øø, MIRS ø	Evaluating existing prioritisation procedures in the field of stream rehabilitation (6)

(Continued next page)

† University of Melbourne Special Postgraduate Studentship supported by CRC

†† Monash University Graduate Scholarship

* Monash University Department Scholarship supported by CRC

** Melbourne University Postgraduate Scholarship

Australian Postgraduate Award

Melbourne Research Scholarship

ø Melbourne International Research Scholarship (fee remission)

øø International Postgraduate Research Scholarship

Δ Australian Postgraduate Award Industry

ΔΔ Monash Graduate Scholarship

Ω Griffith University Postgraduate Research Award (ENS Faculty)

(1) Also located at University of Melbourne

(2) Also located at CSIRO, Canberra

(3) Also located at CSIRO, Adelaide

Education and Training

Program 8: Education and Training

Table A Postgraduates - CRC Core Projects 2002-2003

Name	University	Type of postgraduate enrolment (PhD, MEngSc etc)	Supervisor and Associate Supervisors	Funding source(s) ARC/CRC/Uni/etc	Topic (Related CRC Program/Project)
Margaret Gooch	Griffith	PhD	J. Fien (Griffith) J. Warburton (UQ) R. Rickson (Griffith)	GUPRAΩ	Volunteers and sustainable catchment management (8)
Janice Green	Monash	PhD	P.E. Weinmann (Monash) R. Nathan (Sinclair Knight Merz)	APAIΔ	Estimation of extreme rainfall risk (D3)
Marnie Griffith	Monash	PhD	G. Codner (Monash) S. Schreider (Monash) I. Wills (Monash)	MDS*	Irrigated agriculture and the COAG reforms under uncertainty (3)
Courtney Henderson	Griffith	PhD	M. Greenway (Griffith) I. Phillips (Griffith)	GUPRAΩ with CRC top-up	Assessing the effect of vegetation in biofiltration devices for nutrient pollution removal from stormwater (4.2)
Elisa Howes	Melbourne	MEngSc	M.J. Stewardson (UM) R. Grayson (UM)	UMSPS†, MRS##	Modelling hydraulic habitat condition within catchments (6)
Subhadra Jha	Melbourne	PhD	R. Grayson (UM) I.D. Rutherford (UM)	IPRS ∅∅, MIRS ∅	Modelling stream bank erosion at basin scale (6.6)
Sarah Johnson	Monash	MEngSc	T. Fletcher (Monash) C.J. Walsh (Monash) A. Ladson (Monash)	MDS*	The response of stream macroinvertebrates to urban stormwater quality (4)
Dean Judd	Monash	PhD	R.J. Keller (Monash) I.D. Rutherford (UM) J. Tilleard (Earth Tech)	MDS*, MUGS††	The anastomosing rivers of the Riverine Plain (6)
Durga Kandel	Melbourne	PhD	R. Grayson (UM) A. Western (UM) H. Turrall (IWMP, Sri Lanka)	IPRS ∅∅, MIRS ∅	Temporal scaling issues in surface runoff and soil erosion modelling (1.2)
Peter Kolotelo	Monash	MSc	J. Baldwin (Monash) R.J. Keller (Monash)	MDS (AFFA funded)	Improving the effectiveness of Australian fishway design (6)
Sara Lloyd	Monash	PhD	T.H.F. Wong (Monash)	APA#, MDS*	Exploring impediments and opportunities of sustainable stormwater management schemes (4.2)
Leo Lymburner	Melbourne (2)	PhD	P.B. Hairsine (CSIRO) A. Held (CSIRO) J. Walker (UM)	UMSPS†	Describing riparian vegetation functions in the Fitzroy catchment using remote sensing and spatial analysis (2)
Lucy McKergow	Melbourne (2)	PhD	I. Prosser (L&WA) R. Grayson (UM)	MRS##, UMSPS†	Monitoring riparian lands for water quality improvement (W3)
Muthukaruppan Muthukumar	Melbourne	PhD	F.H.S. Chiew (UM) T.H.F. Wong (Monash)	MRS##, UMSPS†	Modelling quality and size distribution of contaminants in stormwater (4)
David Newton	Griffith	PhD	G.A. Jenkins (Griffith) I. Phillips (Griffith)	GUPRAΩ	The effectiveness of modular porous pavement as a stormwater treatment device (4)
Nicholas Potter	Melbourne (2)	PhD	L. Zhang (CSIRO) T. A. McMahon (UM) A. Jakeman (ANU)	UMSPS†	Statistical-dynamical modelling of catchment water balance (2.3)
Avijet Ramchurn	Monash	MEngSc	P.E. Weinmann (Monash) G. Codner (Monash)	IPRS ∅∅, MGS ΔΔ	Understanding the role of on-farm storages in the regulated Gwydir System (3)
Marella Rebgetz	Melbourne	PhD	F.H.S. Chiew (UM) H.M. Malano (UM)	APA#	An investigation of the benefits of seasonal streamflow forecasting for water catchment management (5)

Table A Postgraduates - CRC Core Projects 2002-2003 (continued)

Name	University	Type of postgraduate enrolment (PhD, MEngSc etc)	Supervisor and Associate Supervisors	Funding source(s) ARC/CRC/Uni/etc	Topic (Related CRC Program/Project)
Geoff Taylor	Monash	PhD	T.H.F. Wong (Monash) T. Fletcher (Monash) P. Breen (Ecological Engineering)	MDS*	Nitrogen composition of urban runoff and treatment processes in constructed wetland that promote nitrogen transformation and removal (4.1)
Dana Thomsen	Griffith	PhD	J. Fien (Griffith) M. Greenway (Griffith)	GUPRAΩ	Community-based research (8.2)
Geoff Vietz	Melbourne	PhD	M. J. Stewardson (UM) B. Finlayson (UM) I. Prosser (L&WA)	UMSPS†	Utilising geomorphology to define environmental flow regimes (6.12)
Clayton White	Griffith	PhD	J. Fien (Griffith) R. Rickson (Griffith)	GUPRAΩ	The role of communication in citizen participation in catchment management (8.2)
Lindsay White	Monash	PhD	R.J. Keller (Monash) J.H. Harris (CRCFE) I.D. Rutherford (UM)	APA#, MDS*	Advancements in the engineering and scientific basis of the design of fishways: with an emphasis on the Murray-Darling Basin, Australia (6.5)
Debbie Woods	Melbourne	MSc	I.D. Rutherford (UM) M.J. Stewardson (UM)	UMSPS†	Assessing the capacity to deliver environmental floods from Victorian Dams (6.7)
Juliette Woods	Adelaide (3)	PhD	K. Narayan (CSIRO) M. Teubner (U Adelaide) C. Simmons (Flinders Univ of SA)	APA#, CRC project support	Improving the accuracy of numerical simulations of density-dependent groundwater flow and transport (S2)
Asif Zaman	Melbourne	PhD	H.M. Malano (UM) B. Davidson (UM)	Northcote Trust (UK), UMSPS†	Estimating regional impacts of temporary water trading through integrated hydro-economic modelling (3)

Table B Postgraduates - CRC Associated /Additional Projects 2002-2003

Name	University	Type of postgraduate enrolment (PhD, MEngSc etc)	Supervisor and Associate Supervisors	Funding source(s) ARC/CRC/Uni/etc	Topic (Related CRC Program/Project)
Wijedasa Hewa Alankarage	Melbourne	PhD	H.M. Malano (UM) H.N. Tural (UM) T.A. McMahon (UM) G. Smith (G-MW)	MRS##, MIRSΔ	Implication of water trading on system management and environmental flow: The case of Goulburn-Murray Irrigation Scheme, Victoria (3.6)
Josephine Brown	Melbourne	PhD	I. Simmonds (UM)	MRS##	Modelling stable water isotopes in the atmosphere and surface ocean (5.3)
Pandora Hope	Melbourne	PhD	I. Simmonds (UM)	MRS##	Shifts in Australia's circulation and rainfall source regions (5.3)

† University of Melbourne Special Postgraduate Studentship supported by CRC

†† Monash University Graduate Scholarship

* Monash University Department Scholarship supported by CRC

** Melbourne University Postgraduate Scholarship

Australian Postgraduate Award

Melbourne Research Scholarship

o Melbourne International Research Scholarship (fee remission)

oo International Postgraduate Research Scholarship

Δ Australian Postgraduate Award Industry

ΔΔ Monash Graduate Scholarship

Ω Griffith University Postgraduate Research Award (ENS Faculty)

(1) Also located at University of Melbourne

(2) Also located at CSIRO, Canberra

(3) Also located at CSIRO, Adelaide

Education and Training

Program 8: Education and Training

Table C Higher Degrees (Research) Completed and Destination of Postgraduates 2002-2003

Name	Degree, University	Supervisor(s)	Topic	Date Research Thesis Submitted	Destination
Andrew Barton	MEngSc, Monash	R.J. Keller (Monash)	A numerical model for the hydraulics of the vertical slot fishway (6.5)	Submitted 30 May 2003	University of Tasmania School of Engineering, and Hydro Tasmania (PhD Student)
Lucy McKergow	PhD, UM	I. Prosser (L&WA) R. Grayson (UM)	Monitoring riparian lands for water quality improvement (W3)	Submitted October 2002, passed 30 June 2003	University of Otago, New Zealand (Lecturer - Geography Dept)
Avijeet Ramchurn	MEngSc, Monash	P.E. Weinmann (Monash) G. Codner (Monash)	Understanding the role of on-farm storages in the regulated Gwydir system	Submitted October 2002, passed 12 May 2003	Short term position in Mauritius
Lindsay White	PhD, Monash	R.J. Keller (Monash) J.H. Harris (CRCFE) I.D. Rutherford (UM)	Advancements in the engineering and scientific basis of the design of fishways: with an emphasis on the Murray-Darling Basin, Australia (6.5)	Submitted 17 March 2003, passed 29 July 2003	Murray-Darling Basin Commission (Team Manager, Technical Development Team, The Living Murray)
Juliette Woods	PhD, Adelaide	K. Narayan (CSIRO) M. Teubner (U Adelaide) C. Simmons (Flinders Univ of SA)	Improving the accuracy of numerical simulations of density-dependent groundwater flow and transport (S2)	Submitted March 2003	Australian Water Environments, South Australia

Milestones

Progress

Years 1 and 2

Package of courses and industry placements for PhD students in operation.	A survey of postgraduate students regarding industry placements was conducted and informed the development of a database of student skills and industry placement preferences. Program 8 has since been involved in the facilitation of industry placements with agencies including Melbourne Water. Industry placement profiles of the CRC postgraduates have been developed and presented to CRC Parties at recent CRC Board meetings. Several CRC postgraduate students receive industry co-supervision. A range of needs-based courses was delivered for postgraduate students (eg. Visual Basic). External courses that may be relevant to the PhD cohort were also advertised via the student e-group.
Selected masters coursework subjects available for participating universities to share	On the basis of a review of postgraduate offerings in this field, the CRC's strategic approach to this milestone has been to negotiate with providers rather than duplicate existing offerings
Framework for collaborative offering of courses developed	The CRC supports researchers' training by organising regular events, maintaining an email bulletin to alert students to training opportunities, and by organising personal and professional activities in conjunction with the postgraduate support programs of Coastal and Sustainable Tourism CRCs.
Protocols for flexible delivery of courses in place	On the basis of a review of postgraduate offerings in this field, the CRC's strategic approach to this milestone has been to negotiate with providers rather than duplicate existing offerings
Training needs analysis for industry completed	The training needs of industry stakeholders are identified and addressed by each research program through Communication and Adoption planning. "Train-the-trainer" materials were developed as an element of the "We All Use Water" curriculum package
Action plan for community education, including schools, in catchment hydrology	The CRC (in partnership with the Australian Water Association) completed a series of five workshops to promulgate the "We All Use Water" community education kit. The participants included approximately 100 local government and industry professionals engaged in community extension and education.

Years 3, 4 and 5

Regular program of short courses and workshops for all stakeholders operating	Program 8 supports needs-basis courses for CRC postgraduates, researchers and stakeholders. These courses have supported the adoption of research outcomes within the CRC's six research programs.
<i>A new milestone, as follows, was approved by the Commonwealth, 16 July 2003:</i> Run social science symposia in major capital cities to disseminate research outputs of social science knowledge developed during the first four years of Program 8 activity.	Program 8 staff have been involved in numerous industry and other stakeholder training activities such as the 'Respect Reflect React' symposium held in Brisbane in 2002. An expanded symposium series has been planned for 2003-2004.
Collaborative delivery of postgraduate coursework programs <i>Deletion of this milestone was approved by the Commonwealth, 16 July 2003 and the following new milestone was approved:</i> Development of an education and training framework for a consistent and informed approach to education and training across the CRC, including the development of education and training approaches or templates for use by CRC researchers	On the basis of a review of postgraduate offerings in this field, the CRC's strategic approach to this milestone has been to negotiate with providers rather than duplicate existing offerings. There has been an increasing shift in focus of the CRC towards adoption of an integrated modelling toolkit. Due to this shift there has been a subsequent shift in Program 8 - from the development of school and university curricula to building the capacity of CRC researchers to effectively undertake and evaluate education and training in the use of the tools produced by the CRC for increased adoption.
Action plan to meet the requirements identified in the training needs analysis	The CRC has provided and brokered education and training activities to meet the needs of CRC postgraduates, researchers and stakeholders. Education and training activities conducted range from visual basic programming to train-the-trainer workshops.
Guidelines for systems approach to catchment management teaching methodology in undergraduate programs <i>Deletion of this milestone was approved by the Commonwealth, 16 July 2003 and a new milestone as follows approved:</i> Provide education and training workshops for CRC researchers to assist them with the delivery of products to end-users	The CRC has made a shift towards adoption of an integrated Catchment Modelling Toolkit rather than systems approaches in undergraduate programs.

New appointments

Deputy Director

Mr Erwin Weinmann, Monash University
(Succeeded Prof Rob Vertessy, CSIRO, from July 2002)

Program Leaders

Mr Geoff Podger, Department of Infrastructure, Planning and Natural Resources, NSW
Program Leader, Program 1: Predicting Catchment Behaviour
(Succeeded Prof Rob Vertessy)

Dr Tim Smith, Griffith University
Program Leader, Program 8: Education and Training
(Succeeded Prof John Fien)

Researcher	Percentage Time	
	Actual	Agreement
Mr Erwin Weinmann	76	40
Mr Geoff Podger	25	50
Prof Tom McMahon	39	10
Dr Francis Chiew	87	80
Dr John Tisdell	100	70
Prof Rob Vertessy	100	100
Dr Peter Hairsine	82	75
Dr Mike Stewardson	100	100
Dr Tim Fletcher	100	100
Dr Tim Smith	50	50

Specified Research Personnel

Prof Rob Vertessy, CSIRO Land and Water (Centre Director)

Prof Tom McMahon, Department of Civil and Environmental Engineering, The University of Melbourne (Centre Deputy Director,)

Dr John Tisdell, Faculty of Environmental Sciences, Griffith University (Centre Deputy Director, Program 3 Leader - Sustainable Water Allocation)

Mr Erwin Weinmann, Department of Civil Engineering, Monash University (Centre Deputy Director)

Mr Geoff Podger, Department of Infrastructure, Planning and Natural Resources, NSW (Program 1 Leader - Predicting Catchment Behaviour)

Dr Peter Hairsine, CSIRO Land and Water (Program 2 Leader - Land-use Impacts on Rivers)

Dr Tim Fletcher, Department of Civil Engineering, Monash University (Program 4 Leader - Urban Stormwater Quality)

Dr Francis Chiew, Department of Civil and Environmental Engineering, The University of Melbourne (Program 5 Leader - Climate Variability)

Dr Mike Stewardson, School of Anthropology, Geography and Environmental Studies, The University of Melbourne (Program 6 Leader - River Restoration)

Dr Tim Smith, Faculty of Engineering Sciences, Griffith University (Program 8 Leader - Education and Training)

1. Executive and Program Leaders at Canberra, February 2003



Staff on contract

Short-term contract staff employed during 2002-2003 included Susan Hayes, Justin Lewis, Peter Poelsma and David Verrelli

Postgraduates

Thirty-nine postgraduates were involved in CRC core programs and projects during 2002-2003. A further three were engaged on Associated/Additional research projects. (Details are outlined in the Education and Training chapter).

Research Facilities

The principal research facilities for the CRC are located at:

- CSIRO Land and Water, Canberra
- Griffith University, Nathan Campus
- Monash University, Clayton
- Natural Resources and Mines, Qld, Indooroopilly
- The University of Melbourne, Parkville

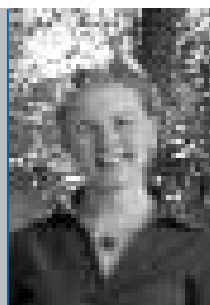
Research infrastructure such as laboratories, technical equipment, computer resources and libraries was once again provided at these principal locations; however significant research facilities are also made available by other CRC Parties.

Other

The CRC's five Focus Catchments represented substantial components in the research sites and facilities available to the CRC and will continue to do so during the life of this CRC. Development Projects, as established during 2002-2003, build on the CRC resources made available in the CRC Focus Catchments

Other important research resources were supplied this year by CRC Parties including Brisbane City Council; Bureau of Meteorology; Department of Infrastructure, Planning and Natural Resources, NSW; Department of Sustainability and Environment, Vic; Goulburn-Murray Water, and Melbourne Water.

1. Virginia Verrelli and Maeve O'Leary, Centre Office, Monash Univ
2. Amanda Norman, CRC Office, Griffith Univ



Public Presentations, Public Relations and Communications

Communication Activities

With an increasing public awareness of land and water issues, heightened by public experience of bushfires and continued drought during 2002-03, the CRC was in demand to communicate its science and outline its approaches to natural resources challenges.

Development Projects were established during the year in the five Focus Catchments and engaged CRC Parties, local groups and stakeholders in their objectives and operations. The issues addressed by the Development Projects, ranging from land-use impacts around water storages in northern Victoria, to river quality in the Fitzroy catchment, reflected the priorities for tackling environmental issues.

Public presentations by CRC staff, and an expanded web site with the introduction of a dedicated web site for the CRC's Catchment Modelling Toolkit, contributed to an active and comprehensive communications approach.

The CRC's monthly newsletter *Catchword* and the fortnightly internal news bulletin *CatchUp*, continued to provide concise and regular updates of CRC activities for the research community and prospective end-users of the CRC's technologies and outcomes.

Web site

The CRC web site (www.catchment.crc.org.au) averages about 3500 different visitors per month from all across the world. About 25% of the visitors return to the web site twice or more each month (based on a January 2003 audit). This is a direct result of the practical value of the site to land and water managers and researchers.

Newsletters

The monthly newsletter *Catchword* undergoes a subscription review process. In July 1999 subscribers were asked to renew their interest in the newsletter by returning a form - the response rate was high at around 80%. In September 2001, 1130 people subscribed to *Catchword* (780 received the newsletter by post; 345 by email - some 31%).

By March 2003, 1320 people subscribed to *Catchword* (784 received the newsletter by post; 536 by email - 41%). The CRC has received additional requests for subscriptions through the CRC web site (some 5 per week). A follow up subscription review process is scheduled for 2003-04.

Catchment Modelling Toolkit

The establishment and role of the Toolkit Strategy group (TSG) has been a key aspect in communicating Toolkit activities. After commencing with a list of over 60 individual issues that required addressing, the TSG has articulated six policies and establish a robust structure to support the Catchment Modelling Toolkit's development and delivery.

Communications have been enhanced with the employment of a graphic designer based at Monash University to support the design and development of the Toolkit and other key CRC activities.

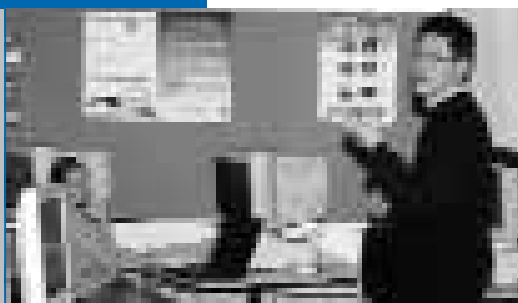
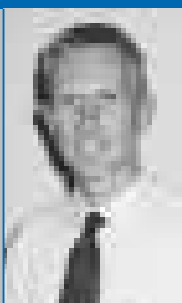
Public presentations, briefings, seminars, workshops

The following tables outline the active communications across the CRC's various Programs through public presentations, briefings, seminars and workshops.

Public relations - interactions with communications media

Links with the media were also of value in communicating the CRC's views. Interactions with the media are listed in a following table.

1. Visiting speaker Scott Lawson - DIPNR Murrumbidgee region - at annual workshop, Yanco
2. Training in MUSIC - urban stormwater modelling software
3. Demonstration of water allocation model Mwater



Public Presentations 2002 - 2003

Date	Speaker(s)	Topic	Venue
24 - 25 July 2002	Dr Tony Ladson (Uni Melb/Monash)	Adaptive Management	Charles Sturt University, Lake Hume Resort, Vic
5 August 2002	Dr Alan Seed (BoM)	Quantitative Radar Rainfall Measurements	Malaysian Meteorological Service
28 August 2002	Prof Stuart Bunn‡ (Griffith)	How Healthy are our Waterways?	Healthy Waterways Partnership, Woodford, Qld
2-4 September 2002	Assoc Prof Tony Wong (Monash)	Design of Water Sensitive Urban Design Elements	Second Water Sensitive Urban Design Conference Brisbane, Qld
5 September 2002	Dr Tim Fletcher (Monash)	Urban Stormwater (Presenter on Regional Tour)	Victorian Stormwater Advisory Committee
8-13 September 2002	Assoc Prof Tony Wong (Monash)	Water Sensitive Urban Design in Australia (Keynote Speaker)	9th International Conference on Urban Drainage Portland, Oregon USA
9 September 2002	André Taylor (Monash)	Promoting Water Sensitive Urban Design - The Brisbane Experience	WA Water Symposium Public Forum Perth, WA
11 September 2002	Prof Rob Vertessy (CSIRO)	The Environmental Management Support System	Moreton Bay Waterways and Catchment Partnership Stakeholder Workshop, Brisbane, Qld
12 September 2002	Prof Rob Vertessy (CSIRO)	Water Quality Modelling (Keynote address)	Stormwater Industry Association of Queensland, Annual Conference, Hervey Bay, Qld
9 October 2002	André Taylor (Monash)	Water Sensitive Urban Design - A 10 Step Plan to Move Forward in Perth	WA Water Symposium WA Parliament House, Perth, WA
29 October 2002	Dr Tim Fletcher (Monash)	Water Sensitive Urban Design	Warrnambool, Vic
13 November 2002	Dr Rob Argent (Uni Melb)	CRC for Catchment Hydrology Research Portfolio and the Catchment Modelling Toolkit	Department of Sustainability and Environment, Attwood Centre, Vic
21 November 2002	Prof Rob Vertessy (CSIRO)	A New Predictive Capability for Catchment Managers	Victorian Catchment Management Association Conference, Bendigo, Vic
28 November 2002	Prof Stuart Bunn‡ (Griffith)	Rehabilitating Riparian Lands to Improve Aquatic Ecosystem Health	Moggill Creek Catchment Group, Qld
6 December 2002	Prof Stuart Bunn‡ (Griffith)	How Healthy are our Waterways?	Healthy Waterways Partnership, Crows Nest, Qld
6 December, 2002.	Assoc Prof Brian Finlayson (Uni Melb)	Who Speaks for the Environment?	River Protection and Water Law Forum "Through the Good Times and the Bad: Who Protects Our Rivers?" Invited guest speaker: Environment Victoria and the Environment Defenders Office.
9 December 2002	Assoc Prof Tony Wong (Monash)	Water Sensitive Urban Design	Workshop on Integrated Concepts for Advancing Sustainable Urban Water Management University of Wollongong, NSW
12 February 2003	Dr Alan Seed (BoM)	Using Weather Radars for Hydrological Applications	Centre for Water Research Environmental Dynamics, The University of Western Australia, WA
20 February 2003	Dr Robert Argent (Uni Melb)	Using the Catchment Modelling Toolkit for Integrated Environmental Modelling	Science and Ecosystem Restoration Programs of CALFED, Sacramento, California, USA
21 February 2003	Dr Robert Argent (Uni Melb)	Integrated Environmental Modelling and the Catchment (Watershed) Modelling Toolkit	UC Berkeley, California, USA
26 February 2003	Dr Robert Argent (Uni Melb)	Integrated Environmental Modelling: Components, Frameworks, Semantics	California Water & Environmental Modelling Forum Asilomar, California, USA
28 May 2003	Prof Rob Vertessy (CSIRO)	The CRC Water Forum	CRC Association Conference, Canberra, ACT

‡ CRC personnel also involved in CRC for Freshwater Ecology

Public Presentations, Public Relations and Communications

Presentations / Briefings to Government, Industry, Research and other Organisations 2002-2003

Date	Speaker(s)	Topic	Venue
4 July 2002	Prof Stuart Bunn‡ (Griffith)	Ecological Processes and River Health Assessment	Mekong River Commission, Phnom Penh, Cambodia
5 July 2002	Prof Stuart Bunn‡ (Griffith)	Design and Implementation of an Ecosystem Health Monitoring Program for Streams and Rivers	Mekong River Commission, Phnom Penh, Cambodia
19 August 2002	Carolyn Young (DIPNR)	Murrumbidgee Development Project	DLWC Murrumbidgee Region, NSW
28 August 2002	Dr Ian Prosser (CSIRO, now with L&WA)	Managing Regional Water Quality	DLWC Murray Region, Albury, NSW
30 August 2002	Dr Tim Fletcher (Monash)	Assessing Stormwater Management Programs	Victorian Stormwater Action Program (EPA)
2 September 2002	Prof Stuart Bunn‡ (Griffith)	Overview of Freshwater Studies in South East Queensland	Gatton City Council, Qld
2 October 2002	Prof Stuart Bunn‡ (Griffith)	Designing an Ecosystem Health Monitoring Program for Streams and Rivers in Southeast Queensland, Australia	Dept of Biology, University of New Brunswick, St Johns Campus, Canada
9 October 2002	Dr Tim Fletcher (Monash) Assoc Prof Margaret Greenway (Griffith)	Discussion of Stormwater Research Priorities	Brisbane City Council, Brisbane, Qld
10 October, 2002	Assoc Prof Brian Finlayson (Uni Melb)	Water Management in Victoria	Breakfast Meeting Briefing to the Victorian Parliamentary Liberal Party Agriculture and Water Committees, Melbourne, Vic
17 October 2002	Prof Rob Vertessy (CSIRO)	Local Scale Environmental Management Support System	Pine Rivers Shire Council and South East Queensland Water Corporation, Qld
30 October 2002	Dr Lu Zhang (CSIRO)	Afforestation and Water Yield	National Dryland Salinity Programme, Canberra
November 2002	Carolyn Young (DIPNR)	Murrumbidgee Development Project	Murrumbidgee Catchment Management Board
31 January 2003	Dr Tim Fletcher (Monash) Hugh Duncan (Melb Water) Dr Ana Deletic (Monash)	Workshop to Discuss Stormwater Research Priorities	Victorian EPA, Melbourne Water
18 February 2003	Dr Harald Richter (BoM)	Convective Initiation	National Severe Storms Laboratory, Norman Oklahoma, USA
5 March 2003	Prof Rob Vertessy (CSIRO)	Hydrologic Impacts of the Bushfires	Briefing to Land and Water Australia, Canberra, ACT
5 March 2003	Andre Taylor (Monash)	City-wide or Regional Erosion and Sediment Control Programs - What Works	MAV/SlAV Professional Forum, Sunbury, Victoria
14 March, 2003	Teri Etchells (Uni Melb)	Exchange Rates for Water Trading	MDBC Irrigators Workshop, Albury, NSW
25 March 2003	Dr Lu Zhang (CSIRO)	Predicting the Combined Environmental Impact of Catchment Management Regimes on Dryland Salinity	National Dryland Salinity Programme, Adelaide, SA
26 March 2003	Prof Stuart Bunn‡ (Griffith)	River Floodplains in Semi-arid and Arid Australia: Present State and Future Trends	5th International Conference on Environmental Future, Zurich, Switzerland
2 April 2003	Teri Etchells (Uni Melb)	Exchange Rates for Water Trading	AATSE Joint Australia-South Africa Workshop on Water Resources Management, Kilmore, Vic
24 April 2003	Dr Tim McVicar (CSIRO)	Remote Sensing of Climate Variability	Bureau of Rural Sciences and CSIRO Land and Water, Canberra, ACT
1 May 2003	Prof Rob Vertessy (CSIRO) Joel Rahman (CSIRO)	The Catchment Modelling Toolkit	CSIRO Land and Water, Perth, WA
1 June 2003	Prof Stuart Bunn‡ (Griffith)	Ecosystem measures of river health	51st Annual Meeting, North American Benthological Society, Athens, Georgia, USA

‡CRC personnel also involved in CRC for Freshwater Ecology

CRC Seminars 2002-2003

Date	Speaker(s)	Topic	Venue
10 July 2002	Dr Hua Lu (CSIRO)	Hydrological controls on sediment delivery : Spatial-temporal interaction	CSIRO Land and Water, Canberra, ACT
24 July 2002	Dr John Gallant (CSIRO)	Mr VBF - who is he and what is he good for?	CSIRO Land and Water, Canberra, ACT
1 August 2002	Dr Manuel Maass (Universidad Nacional Autónoma de México)	Ecology of the tropical dry deciduous forest: a long-term watershed study in Mexico	CSIRO Land and Water, Canberra, ACT
21 August 2002	Assoc Prof. Tony Wong Dr Tim Fletcher (Monash) Hugh Duncan (Monash) Chris Chesterfield (Melb Water)	Modelling Urban Stormwater Quality - Industry Seminar (MUSIC)	CSIRO Centre for Environment and Life Sciences, Floreat Park, WA
4 September 2002	Dr Jason Evans (Yale)	From Productive Rangelands to Desert in 30 years - the Middle East Experience	CSIRO Land and Water, Canberra, ACT
30 October 2002	Dr Ralph Ogden (CSIRO, now at CRC for Freshwater Ecology)	Process-based predictions of instream habitat attributes in the Murrumbidgee Catchment above Wagga NSW	CSIRO Land and Water, Canberra, ACT
11 December 2002	Dr Gert Verstraeten (Catholic Uni of Leuven, Belgium)	Spatially Distributed Modelling of Sediment Delivery on a River Basin Scale: A Tool for Catchment Management?	CSIRO Land and Water, Canberra, ACT
6 February 2003	Dr Manuel Maass (Universidad Nacional Autónoma de México)	Eco-hydrology of Tropical Dry Forests: Responses to strong rainfall seasonality	CSIRO Land and Water, Canberra, ACT

Other Seminars 2002-2003

Date	Speaker(s)	Topic	Venue
1 July 2002	Dr Lu Zhang (CSIRO)	Modelling Catchment Scale Hydrological Processes Using the Top-Down Approach	Xinjiang University, Urumqi, China
15 November 2002	Andre Taylor (Monash)	Water Sensitive Urban Design - A 10 Step Plan to Move Forward in Perth	Seminar to the Local Government Association of WA, Perth.
25 February 2003	Prof Rob Vertessy (CSIRO)	The Catchment Modelling Toolkit Initiative	Australian Water Association, CSIRO Black Mountain Laboratories, Canberra, ACT
12 April 2003	Dr Jim Morris (DSE)	3PG Forest Growth Model for Chinese Forest Managers	Zhanjiang Medical University
29 May 2003	Durga Kandel (Uni Melb)	Representation of Short-Time-Scale Processes in Daily Time-Step Surface Runoff and Erosion Modelling.	Department of Civil and Environmental Engineering, The University of Melbourne, Australia

Public Presentations, Public Relations and Communications

CRC Workshops / Fieldtrips 2002 - 2003

Date	Speaker (s)	Topic	Venue
8 – 9 July 2002	Assoc Prof Tony Wong (Monash) Dr Tim Fletcher (Monash) Dr Graham Jenkins (Griffith)	MUSIC Workshop	Brisbane, Qld
11 – 12 July 2002	Assoc Prof Tony Wong (Monash) Dr Tim Fletcher (Monash) Dr Graham Jenkins (Griffith)	MUSIC Workshop	Sydney, NSW
15 July 2002	Dr John Tisdell (Griffith)	Water trading workshop (<i>First group</i>)	Yanco Agricultural College, NSW
15 – 16 July 2002	Assoc Prof Tony Wong (Monash) Dr Tim Fletcher (Monash) Hugh Duncan (Melb Water)	MUSIC Workshop	Melbourne, Vic
16 July 2002	Dr John Tisdell (Griffith)	Water Trading Workshop (<i>Second Group</i>)	Yanco Agricultural College, NSW
18 July 2002	Dr John Tisdell (Griffith)	Water Trading Workshop	Goulburn-Murray Water, Tatura Training Centre, Vic
18-19 July 2002	Assoc Prof Tony Wong (Monash) Dr Tim Fletcher (Monash) Dr Graham Jenkins (Griffith)	MUSIC Training Course	Adelaide, SA
23-26 July 2002	Dr Nick Marsh (Griffith) Assoc Prof Rodger Grayson (Uni Melb)	Four-day field course on field methods for data acquisition	Healesville, Vic
29-30 August 2002	Dr James Whelan (Griffith)	We All Use Water	AWA, Melbourne, Vic
5 September 2002	Dr James Whelan (Griffith) Peter Oliver (Griffith)	The Characteristics of Effective Natural Resource Management Groups	Respect, Reflect, React: Social Solutions to Environmental Futures Symposium, Griffith University EcoCentre
11 September 2002	Prof Rob Vertessy (CSIRO) Joel Rahman (CSIRO) Shane Seaton (CSIRO)	Design and application of the Local Scale Environmental Management Support System	Brisbane, Qld
16 September 2002	Dr Tim Fletcher (Monash)	MUSIC training	Melbourne Water, Melbourne, Vic
23 September 2002	Dr Tim Fletcher (Monash)	MUSIC training	Melbourne Water, Melbourne, Vic
4 October 2002	Dr Tim Fletcher (Monash)	Brisbane City Council Stormwater Quality Monitoring Review	Brisbane City Council, Brisbane, Qld
5-6 November 2002	Dr John Tisdell (Griffith)	Workshops using Mwater in the Murrumbidgee catchment	Yanco Agricultural College, NSW
7 November 2002	Dr John Tisdell (Griffith)	Mwater demonstration workshop with GMW staff.	Goulburn-Murray Water, Shepparton
12 November 2002	Dr Mike Stewardson (Uni Melb) Assoc Prof Bob Keller (Monash) Dr Tony Ladson (Monash)	Stream Restoration Products That May be Useful for Melbourne Water	Melbourne, Vic
27 November 2002	Dr Tim Fletcher (Monash) Assoc Prof Tony Wong (Monash) Dr Graham Jenkins (Griffith) Dr Francis Chiew (Uni Melb) Hugh Duncan (Melb Water) John Coleman (CSIRO)	Model for Urban Stormwater Improvement Conceptualisation: Users Forum	Melbourne, Vic
28-29 November 2002	Assoc Prof Tony Wong (Monash) Dr Tim Fletcher (Monash) Hugh Duncan (Melb Water)	MUSIC Training Course	Melbourne, Vic
10 December 2002	Dr Graham Jenkins (Griffith) Dr Tim Fletcher (Monash) David Newton (Griffith)	Brisbane MUSIC Users Group	Brisbane, Qld
10-12 December 2002	Erwin Weinmann (Monash) Dr Nanda Nandakumar (DIPNR, NSW)	CRC-FORGE Application in WA (Part 1)	Water & Rivers Commission, Perth, WA
10 February 2003	David Verrelli (Uni Melb) Dr Mike Stewardson (Uni Melb)	River Analysis Package - Industry Appraisal	Melbourne, Vic
20-21 February, 2003	Prof Rob Vertessy (CSIRO) Joel Rahman (CSIRO) Shane Seaton (CSIRO) Susan Cuddy (CSIRO)	EMSS Training for Development Project Teams	CSIRO Land and Water, Canberra, ACT

CRC Workshops / Fieldtrips 2002 - 2003 (continued)

Date	Speaker (s)	Topic	Venue
11 March 2003	Dr Nick Marsh (Griffith) Prof Angela Arthington (Griffith) Mark Kennard Dr Tony Ladson (Monash) Ben Gawne Gerry Quinn Dr Barbara Downes (Uni Melb) Leon Metzeling Ivor Grows Brad Pusey	Review of Biometrics Methods Used in CRC for Catchment Hydrology Project 6A and CRC for Freshwater Ecology Project A2	Griffith University, Qld
28 March 2003	Dr John Tisdell (Griffith)	Water Markets in Action (Mwater)	Canberra, ACT
6-7 April 2003	Brett Anderson (Uni Melb) Joel Rahman (CSIRO) Dr Mike Stewardson (Uni Melb) Dr Rob Argent (Uni Melb) Dr Mike Stewardson (Uni Melb) Joel Rahman (CSIRO)	Numerical Modeling Tools and Approaches for Environmental Research: Programming with Visual Basic (CRC Postgraduate Workshop)	The University of Melbourne, Vic,
29-30 April, 2003	Dr Francis Chiew (Uni Melb) Lionel Siriwardena (Uni Melb) Joel Rahman (CSIRO) Nick Murray (CSIRO) Shane Seaton (CSIRO) Prof Rob Vertessy (CSIRO)	Calibration of SIMHYD Rainfall-runoff Model and Water Quality Modelling for the EMSS	CSIRO Land and Water, Canberra, ACT
14-15 May 2003	Erwin Weinmann (Monash) Dr Nanda Nandakumar (DIPNR, NSW)	CRC-FORGE Application in WA (Part 2)	Water & Rivers Commission, Perth, WA
4-5 June 2003	Dr Tim Fletcher (Monash)	Experimental Data Analysis	Brisbane City Council, Brisbane, Qld
24 June 2003	Prof Rob Vertessy (CSIRO)	Water Quality Modelling Decision Support	Douglas Shire Council, Port Douglas, Qld

CRC Media References 2002 - 2003

Medium	Publisher	Issue/Date (Page)	Title of Article/Item
Land and Water News	Hallmark Editions	8 October 2002 (12)	Warning on plantation impacts
Australian Financial Review	Australian Financial Review	9 November 2002 (24)	Forests: the argument goes to water
The Mercury	News Limited	15 November 2002 (3)	Tree farms water thirst
The Burnie Advocate	The Advocate News PtyLtd	16 November 2002 (7)	CSIRO warning on water policy
The Age	Fairfax	15 January 2003 (8)	Land study queries tree plantations
The Weekly Times	News Limited	7 May 2003 (18)	Regrowth to slow river flow
Victorian Salinity Update Newsletter	National Dryland Salinity Program Communications Victoria	May 2003 (2)	Bushfire information for catchment managers

Grants and Awards

Grants 2002 - 2003

Name of researcher	Researcher's Organisation	Title of Grant Project	Source of Grant	Period	Amount
Daniel Clowes (supervisor Dr John Tisdell)	Griffith University	Sustainable water allocation - support for PhD project	Moreton Bay Waterways and Catchment Partnership	2003	\$20,000
Dr Tim Fletcher (with André Taylor)	Monash University	Tools for evaluating the economic and social performance of stormwater management	EPA Vic Victoria Stormwater Action Program Strategic Grant and support from Brisbane City Council and Melbourne Water	January 2003 to January 2004	\$165,000
Dr Tim Fletcher (with Dr Ana Deletic and Hugh Duncan)	Monash University	Victorian Stormwater Quality Assessment: Developing reliable models of pollutant loads for stormwater managers	EPA Vic Victoria Stormwater Action Program Strategic Grant and support from Melbourne Water	May 2003 to December 2005	\$511,000
Assoc Prof Rodger Grayson (with Dr Jeff Walker)	The University of Melbourne	Gravity changes, soil moisture and data assimilation	ARC Discovery	January 2003 to December 2005	\$500,000
Assoc Prof Rodger Grayson (with Dr Jeff Walker)	The University of Melbourne	Validation of the AMSR-E Soil Moisture Product	The University of Melbourne, Collaborative Grant with support from NASA	2003	\$10,000
Assoc Prof Rodger Grayson	The University of Melbourne	Mapping Soil Moisture across New Zealand	National Institute of Water and Atmospheric Research (NIWA), New Zealand, Visiting Fellowship	2003	\$4,000
Dr Tim McVicar	CSIRO Land and Water	WWW-based delivery and use of CSIRO AVHRR Time Series (CATS)	CSIRO Earth System Science (ESS) Postdoctoral Fellowship Program	April 2003 to March 2006	\$750,000
Dr Andrew Western	The University of Melbourne	Evapotranspiration and CO ₂ flux monitoring system	The University of Melbourne, Major Equipment Grant	2003	\$35,000

(Contract research and consultancies awarded in 2002-2003 are listed separately in the chapter on Utilisation and Application of Research)

Awards 2002-2003

Prof Rob Vertessy, Shane Seaton, and Joel Rahman (CSIRO) gained a highly commended award for the 'Local Environmental Management Support System' in the Stormwater Industry Association of Queensland, Innovation and Research Award.



1. Dr Andrew Western, awarded major equipment grant by The University of Melbourne

Publications

Books and Book Chapters

Bloschl, G., Vertessy, R., Sivapalan, M. and Zhang, L. (Editors) (2003) Downward Approach to Hydrological Prediction, Special Issue of Hydrological Processes, Volume 17, Issue 11.

Chiew, F.H.S., Peel, M.C. and Western, A.W. (2002) Application and testing of the simple rainfall-runoff model SIMHYD. In: V.P. Singh and D.K. Frevert (eds), *Mathematical Models of Small Watershed Hydrology and Applications*. Water Resources Publication, Littleton, Colorado, pp.335-367.

Cox, J.W., McVicar, T.R., Reuter, D.J., Wang, H., Cape, J. and Fitzpatrick, R.W. (2002) Assessing Rain-fed and Irrigated Farm Performance Using Measures of Water Use Efficiency. In: T.R. McVicar, L.Rui, J. Walker, R.W. Fitzpatrick and L. Changming (eds), *Regional Water and Soil Assessment for Managing Sustainable Agriculture in China and Australia*. ACIAR Monograph 84, pp.70-81.

McVicar, T.R. (2002) Overview. In: T.R. McVicar, L.Rui, J. Walker, R.W. Fitzpatrick and L. Changming (eds), *Regional water and soil assessment for managing sustainable agriculture in China and Australia*. ACIAR Monograph 84, pp.12-27.

McVicar, T.R., Davies, P.J., Qinke, Y., Zhang, G. (2002) An Introduction to Temporal—Geographic Information Systems (TGIS) for assessing, monitoring and modelling regional water and soil processes. In: T.R. McVicar, L.Rui, J. Walker, R.W. Fitzpatrick and L. Changming (eds), *Regional Water and Soil Assessment for Managing Sustainable Agriculture in China and Australia*. ACIAR Monograph 84, pp.205-223.

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Qinke, Y., McVicar, T.R., Rui, L., and Xiaoping, Z. (2002) Assessing cropland using GIS and land survey data: an example from China. In: T.R. McVicar, L.Rui, J. Walker, R.W. Fitzpatrick and L. Changming (eds), *Regional Water and Soil Assessment for Managing Sustainable Agriculture in China and Australia*. ACIAR Monograph 84, pp.311-319.

Wallbrink, P.J. Olley, J.M. and Hancock, G. (2002) Estimating residence times of fine sediment in river channels using fallout Pb-210. In: F. Dyer, M. Thoms and J.M. Olley (eds), *The Structure Function and Management Implications of Fluvial Sedimentary Systems*. IAHS Publ. No. 276, pp.425-433.

Western, A.W., Grayson, R.B., Blöschl, G. D. and Wilson, D.J. (2003) Spatial variability of soil moisture and its implications for scaling. Chapter 8 In: Y. Pachepsky, D.E. Radcliffe and H.M. Selim (eds), *Scaling Methods in Soil Physics*. CRC Press, pp.119-142.

Reports

Best, A., Zhang, L., McMahon, T., Western, A. and Vertessy, R. (In press) A critical review of paired catchment studies with reference to the seasonal flows and climate variability. Cooperative Research Centre for Catchment Hydrology Technical Report, Report 03/04.

Borg, D. and Stewardson, M. J. (2002) Modelling the influence of riparian restoration on the abiotic functions of the riparian ecotone: A literature review. Draft Report to the Murray Darling Basin Commission as part of Project R10008 - Evaluating the Effectiveness of Habitat Reconstruction in the Murray Darling Basin. Cooperative Research Centre for Catchment Hydrology, The University of Melbourne and CRC for Freshwater Ecology, Monash University.

Collopy, J. and Morris, J. (2002) Collection of tree water use and environmental data for validating water use prediction using the 3PG growth model: Progress report 2002. Forest Science Centre Report No. 2002/038.

Gippel, C., Anderson, B. and Marsh, N. (2002) Trial of Snowy River Rehabilitation Concept Plan: Scoping study to review structural rehabilitation options. Final Report. Fluvial Systems Pty Ltd. Report to Snowy River Rehabilitation Project, East Gippsland Catchment Management Authority.*

Grayson, R.B. and Argent, R.M. (2002) A tool for investigating broad-scale nutrient and sediment sources from the catchments of the Gippsland Lakes. CEAH report 1/ 02, 45pp.*

Hickel, K. and Zhang, L. (In press) A conceptual framework for estimating seasonality impact on mean annual water balance. CRC for Catchment Hydrology Technical Report.

Reports (continued)

Lane, P., Hickel, K., Best, A., and Zhang, L. (2003) The effect of afforestation on annual streamflow regime. Cooperative Research Centre for Catchment Hydrology Technical Report, Report 03/6, 25pp.

Lloyd, S.D., Wong, T.H.F. and Chesterfield, C.J. (2002) Water Sensitive Urban Design: A stormwater management perspective. Cooperative Research Centre for Catchment Hydrology Industry Report, Report 02/10, 38pp.

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Wijedasa, H.A., Malano, H.M., Mc Mahon, T.A., Tural, H.N. and Smith, G. (2002) Water trading in the Goulburn-Murray Irrigation Scheme. Cooperative Research Centre for Catchment Hydrology Technical Report, Report 02/9, 113pp.

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*Publication related to CRC activities and involving CRC participants but not directly arising from CRC Core or Associated/Additional Projects

†CRC personnel also involved in CRC for Coastal Zone, Waterway and Estuary Management and/or CRC for Sustainable Tourism

‡CRC personnel also involved in CRC for Freshwater Ecology

Publications

Working Documents

Cottingham, P., Bunn, S., Brooks, A., Croker, K., Davies, P.M., Glaister, A., Hughes, V., Jackson, M., Koehn, J., Lake, S., Marsh, N., Nicol, S., Rutherford, I., Seymour, S., and Treadwell, S. (2003) Managing wood in streams. Unpublished report, National Riparian Lands Program, Land and Water Australia. †

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†CRC personnel also involved in CRC for Coastal Zone, Waterway and Estuary Management and/or CRC for Sustainable Tourism

‡CRC personnel also involved in CRC for Freshwater Ecology

Glossary

AEAM	Adaptive Environmental Assessment Modelling
AFFA	Agriculture, Fisheries and Forestry - Australia (Commonwealth Department)
BCC	Brisbane City Council
BC2C	Biological capacity to change - software model for catchment land and water analysis
BoM	Bureau of Meteorology
CCDSM	Catchment Categorisation for Dryland Salinity Management project
COAG	Council of Australian Governments
CRC	Cooperative Research Centre
CRC-Forge	Computer software methodology for extreme rainfall analysis
DIPNR	Department of Infrastructure, Planning and Natural Resources, NSW
DSE	Department of Sustainability and Environment, Vic
DSS	Decision Support System
EMSS	Environmental Management Support System
ET	Evapotranspiration
FCC	Focus Catchment Coordinator
GEWEX	Global Energy and Water Experiment (a component of the World Climate Research Program)
ICMS	Interactive Component Modelling System (formerly Integrated Catchment Management System); one of three frameworks for building and linking catchment hydrology models being used by the CRC Toolkit Project (see also TARSIER and TIME)
IQQM	Integrated Quantity and Quality Monitoring - water allocation software methodology and model
L&WA	Land and Water Australia (formerly Land and Water Resources Research and Development Corporation) (Commonwealth R&D Corporation)
LEMSS	Local-Scale Environmental Management Support System
Macaque	Computer model for forest hydrology applications in large catchments
MDBC	Murray-Darling Basin Commission
MUSIC	Model for Urban Stormwater Improvement Conceptualisation - CRC computer software methodology
Mwater	A water market experimental methodology to evaluate alternative water trading rules and procedures in mature water markets
NHT	Natural Heritage Trust (Commonwealth Government)
NLWRA	National Land and Water Resources Audit (Commonwealth Government, funded by NHT)
NRM	Natural Resources and Mines, Qld
NWP	Numerical Weather Prediction
R&D	Research and development
REALM	Computer model for predicting catchment water balance
SedNet	Computer model for sediment and nutrient delivery and transport
SEQRWQMS	South East Queensland Regional Water Quality Management Strategy
S_PROG	Model for nowcasting (forecasting rainfall one to two hours in advance)
TAG	Technical Advisory Group (expert panel for CRC projects)
TARSIER	A framework for building and linking catchment hydrology models; one of three being used by the CRC Catchment Modelling Toolkit Project (see also TIME and ICMS)
TIME	The Invisible Modelling Environment; one of three frameworks for building and linking catchment hydrology models being used by the CRC Catchment Modelling Toolkit Project (see also TARSIER and ICMS)
TOPOG	Computer model developed for forest hydrology applications in small or experimental catchments
WSUD	Water Sensitive Urban Design



Performance Indicators

Performance Indicators

Objectives of the Centre

Nature of Indicator	Performance Indicator	Target over life of Centre	Measure - Lending	Measure - Real Time	Measure - Lagging	Report of Activities and Achievements for 1999/2000	Report of Activities and Achievements for 2000/2001	Report of Activities and Achievements for 2001/2002	Report of Activities and Achievements for 2002/2003
Outcome	Economic benefit to Centre	Adding value to intellectual capital at least equal to CRC Commonwealth funding	Building Centre intellectual capital	Maximising value of intellectual capital	Demonstrated application of Centre's public good research	11 major collaborative research projects Research projects (11) underway. Further 3 in July 2000.	19 collaborative core research projects and 5 major contract research projects underway. Research projects (17 core projects) underway.	19 collaborative core research projects and 11 major contract research projects with two completed.	34 collaborative core research projects including 15 new projects and 13 major contract research projects. 9 core research projects completed.
		Additional income (contract research) of \$10.1 m over life of Centre	Budget provision	Additional contract income in year	Cumulative income	Research Contracts with AFFA, LWRDRC, MDIBC, SEQRWQMS. Contract income \$0.05m for 99/2000 of total \$0.92m in contracts to date. [Includes \$0.03m from direct CRC contract/consulting work]	Research Contracts with AFFA, LWRDRC, MDIBC, SEQRWQMS. Contract income \$0.79m for 2000/01 of total \$1.47m in contracts to date. [Includes \$0.18m from direct CRC contract/consulting work]	Research Contracts with AFFA, LWA, MDIBC, SEQRWQMS, EPA. Contract income \$1.70m for 2001/02 of total \$3.20m in contracts to date. [Includes \$0.21m from direct CRC contract/consulting work]	Research Contracts with ACAIR, AFFA, LWA, MDIBC, SEQRWQMS, EPA. Contract income \$1.27m for 2002/03 of total \$4.47m in contracts to date. [Includes \$0.34m from direct CRC contract/consulting work]
	Economic benefit to core participants	Actual or future potential benefits more than 3 times total resources committed	Dissemination of Centre IP to Parties.	Access to Centre IP and know-how	Actual benefit achieved or achievable by core user participants	IP access: Communication and Adoption Program underway. Seminars and dissemination of reports, videos continuing.	IP access: Communication and Adoption Program continuing. Seminars and dissemination of reports, videos continuing.	IP access: Communication and Adoption Program continuing. Seminars and dissemination of reports, videos continuing.	IP access: Communication and Adoption Program continuing. Seminars and dissemination of reports, videos continuing.
		Potential economic benefit assessed				Overall indicative economic benefits highlighted in Business Plan. Individual assessments of Party economic benefits to follow project completions.	Overall indicative economic benefits highlighted in Business Plan. Individual assessments of Party economic benefits to follow project completions.	Overall indicative economic benefits highlighted in Business Plan. Individual assessments of Party economic benefits to follow project completions.	Overall indicative economic benefits highlighted in Business Plan. Individual assessments of Party economic benefits to follow project completions.
	Economic benefit to Australia	Actual or future potential benefits more than 5 times total resources committed	Potential economic benefit assessed	Completed economic benefit assessments for projects	Actual benefit achieved or achievable	Overall indicative economic benefits highlighted in Business Plan. Individual assessments of Party economic benefits to follow project completions.	Overall indicative economic benefits highlighted in Business Plan. Individual assessments of Party economic benefits to follow project completions.	Overall indicative economic benefits highlighted in Business Plan. Individual assessments of Party economic benefits to follow project completions.	Overall indicative economic benefits highlighted in Business Plan. Individual assessments of Party economic benefits to follow project completions.
	Economic benefit - other	Public benefit from positive environmental impact	Public good potential identified	Completed assessments of public good potential benefit for projects	Public good benefit achieved	Assessments of national economic benefits to follow project completions	Assessments of national economic benefits to follow project completions	Assessments of national economic benefits to follow project completions	Assessments of national economic benefits to follow project completions
Input	Total resources	\$67.7m total resources Total leverage > 4.1 vs Commonwealth cash	Agreement	Actually committed	Cumulative resources	Parties/Grant Total Agreement commitment of \$57.6m. \$6.1 m committed to 30 June 2000.	Parties/Grant Total Agreement commitment of \$57.6m. \$18.0m committed by Parties to 30 June 2001.	Parties/Grant Total Agreement commitment of \$57.6m. \$24.1m committed by Parties to 30 June 2002.	Parties/Grant Total Agreement commitment of \$57.6m. \$24.1m committed by Parties to 30 June 2003.
	Cash resources	\$33.6m cash resources Cash 49% of total resources	Agreement	Actually committed	Cumulative resources	Total Agreement cash budget of \$33.6m. \$3.3m cash committed to 30 June 2000.	Total Agreement cash budget of \$33.6m. \$3.6m Grant/Parties cash committed in year to 30 June 2001.	Total Agreement cash budget of \$33.6m. \$3.6m Grant/Parties cash committed in year to 30 June 2002.	Total Agreement cash budget of \$33.6m. \$3.6m Grant/Parties cash committed in year to 30 June 2003. Cumulative \$14.2m Grant/Parties.

Objectives of the Centre (continued)

Nature of Indicator	Performance Indicator	Target over life of Centre	Measure - Lending	Measure - Real Time	Measure - Lagging	Report of Activities and Achievements for 1999/2000	Report of Activities and Achievements for 2000/2001	Report of Activities and Achievements for 2001/2002	Report of Activities and Achievements for 2002/2003
Process	Program/Project Management	Project initiation, management, review and evaluation systems	Adoption of project management approach	Quarterly reports Regular project reviews	Projects completed on time and on budget	Monthly Project finance reporting continuing. Quarterly Project reporting continuing. Reporting format upgraded.	Monthly Project finance reporting continuing. Quarterly Project reporting continuing.	Monthly Project finance reporting continuing. Quarterly Project reporting continuing.	Monthly Project finance reporting continuing. Quarterly Project reporting continuing.
Outputs	Centre Publications transferring research outcomes and technology to industry	50 Centre reports	Number planned	Number in preparation	Number issued	3 Industry Reports [one 2nd Ed], 14 Technical Reports, 5 videos and 5 Working Documents published since July 99. Email notification and database established with 590 recipients. 11 issues of monthly newsletter issued (800 in hard copy, 200 emailed – includes Website posting).	12 Technical Reports and 2 Videos published. Email notification and database established with 760 recipients. 11 issues of monthly newsletter issued (890 in hard copy, 360 emailed – includes Website posting). Approx 2000 visits to CRC website per month with over 700 visiting more than twice per month.	10 Technical Reports and 1 Manual published. Email notification and database established with 850 recipients. 11 issues of monthly newsletter issued (950 in hard copy, 450 emailed – includes Website posting). Approx 3000 visits to CRC website per month with over 900 visiting more than twice per month.	11 Technical Reports and one Industry Report published. Email notification and database established with 850 recipients. 11 issues of monthly newsletter issued (780 in hard copy, 540 emailed – includes Website posting). Approx 3500 visits to CRC website per month with over 900 visiting more than twice per month.
	Industry Seminars	50 Seminars	Number planned	Number each year	Total number completed	5 Industry Seminars presented since July 99. 14 Technical Seminars	19 CRC Technical Seminars presented	31 CRC Technical Seminars presented	8 CRC Technical Seminars presented
	Industry Workshops	20 Workshops	Number planned	Number each year	Total number completed	7 CRC workshops since July 99	14 CRC Workshops/field tours given	18 CRC Workshops/field tours given	30 CRC Workshops/field tours/short courses given

Performance Indicators

Quality and relevance of the research program

Nature of Indicator	Performance Indicator	Target over life of Centre	Measure - Lending	Measure - Real Time	Measure - Lagging	Report of Activities and Achievements for 1999/2000	Report of Activities and Achievements for 2000/2001	Report of Activities and Achievements for 2001/2002	Report of Activities and Achievements for 2002/2003
Outcome	Scientific status and user satisfaction	Demonstrated research quality	Scientific review of planned projects	Annual review for scientific status and user satisfaction	Cumulative results	Technical Advisory Groups involved in developing projects. Project review panels established for projects. Independent science review included in project review panel tasks.	Technical Advisory Groups involved in developing projects. Project review panels established June 2001 covering all projects. Independent science review included in project review panel tasks.	Technical Advisory Groups involved in developing projects. 11 Project review panels held in year to June 2002. Independent science review included in project review panel tasks.	Technical Advisory Groups involved in developing projects. 13 Project review panels held in year to June 2003. Independent science review included in project review panel tasks.
Input	Research program resources	Demonstrated user satisfaction	User input to planned projects	Strategic plan	Cumulative resources	Industry users represented in Technical Advisory Groups for Projects. Participation also in Project Review panels	Industry users represented in Technical Advisory Groups for Projects. Participation also in Project Review panels	Industry users represented in Technical Advisory Groups for Projects. Participation also in Project Review panels	Industry users represented in Technical Advisory Groups for Projects. Participation also in Project Review panels
Process	Advisory committees/groups	\$46m total cash and in-kind resources on research program	Roles defined, meetings scheduled	Membership, meetings held	Extent of involvement and contribution to research directions and management	\$3.5m research expenditure (cash and in-kind) for 99/2000	\$5.2m research expenditure (cash and in-kind) for 2000/01	\$5.8m research expenditure (cash and in-kind) for 2001/02	\$5.5m research expenditure (cash and in-kind) for 2002/03
Involvement of research users	User driven selection, review and termination of applied projects	Technical Advisory Groups (TAGs) for Research Programs	Project selection	Consultation and project monitoring	Project reviews	Technical Advisory Groups established and used in developing projects.	Technical Advisory Groups established and used in developing projects.	Technical Advisory Groups established and used in developing projects.	Technical Advisory Groups established and used in developing projects.
External publications	100 publications in refereed journals	100 papers in international conferences	Number planned	Number of publications submitted	Total number published	Research users strongly represented in project formulation stages and Technical Advisory Groups. Project review panels established for projects. Independent science review included in project review panel tasks	Research users strongly represented in project formulation stages and Technical Advisory Groups. Project review panels held for all core projects. Independent science review included in project review panel tasks	Research users strongly represented in project formulation stages, Technical Advisory Groups and Communication and Adoption Plans. Project review panels held for core projects. Independent science review included in project review panel tasks	Research users strongly represented in project formulation stages, Technical Advisory Groups and Communication and Adoption Plans. Project review panels held for core projects. Independent science review included in project review panel tasks
Outputs	100 publications in refereed journals	100 papers in international conferences	Number planned	Number of publications submitted	Total number published	Over 40 refereed papers submitted 99/2000.	69 refereed papers published/accepted in 2000/01.	33 refereed papers published/accepted in 2001/02.	66 refereed papers published/accepted in 2002/03.
100 papers in national conferences	100 papers in national conferences	100 papers in national conferences	Number planned	Number of publications submitted	Total number published	16 international conference papers submitted 99/2000	24 international conference papers accepted/published 2000/01	35 international conference papers accepted/published in 2001/02	51 international conference papers accepted/published in 2002/03
100 papers in national conferences	100 papers in national conferences	100 papers in national conferences	Number planned	Number of publications submitted	Total number published	41 Australian conference papers submitted 99/2000	37 Australian conference papers in 2000/01	96 Australian conference papers in 2001/02	41 Australian conference papers in 2002/03

Strategy for utilisation and application of research outputs

Nature of Indicator	Performance Indicator	Target over life of Centre	Measure - Lending	Measure - Real Time	Measure - Lagging	Report of Activities and Achievements for 1999/2000	Report of Activities and Achievements for 2000/2001	Report of Activities and Achievements for 2001/2002	Report of Activities and Achievements for 2002/2003
Outcome	Development of approaches to improve land and water management and adoption by end-users	Development of approaches to improve land and waste management in Centre's 5 focus catchments	Communication and adoption activities planned	Communication and adoption activities completed	Demonstrated adoption of Centre research outcomes and approaches by end-users in focus catchments	Communication and Adoption planning framework developed for new Programs. Pilot undertaken with industry users for Urban Stormwater Quality Program.	Communication and Adoption planning framework adopted for Programs.	Communication and Adoption planning framework adopted for Programs.	Communication and Adoption planning framework adopted for Programs.
						Continuing activity with take-up of CRC products by users for Urban Hydrology, Predictive tools, Flood hydrology.	Continuing activity with take-up of CRC products by users for all Programs	Continuing activity with take-up of CRC products by users for all Programs	Five Development Projects established in CRC Focus Catchments. Continuing activity with take-up of CRC products by users for all Programs
Input	Resources devoted to communication and adoption program	Minimum \$13m cash and in-kind on communication and adoption program	Strategic plan – Commercialisation and adoption strategy	Actually committed	Cumulative resources	Total \$1.5m cash and in-kind expenditure for 99/2000 on Communication and Adoption Program	Total \$2.2m cash and in-kind expenditure for 2000/01 on Communication and Adoption Program Cumulative total \$3.7m	Total \$3.1m cash and in-kind expenditure for 2001/02 on Communication and Adoption Program Cumulative total \$6.8m	Total \$2.8m cash and in-kind expenditure for 2002/03 on Communication and Adoption Program. Cumulative total \$9.6m
	User core participant resources	\$21m core user participant resources	Agreement	Actually committed	Cumulative resources	Total \$21.8 committed by core user Parties in Agreement. Contributions of \$2.3m 99/2000	Total \$21.8 committed by core user Parties in Agreement. Contributions of \$3.2m 2000/01	Total \$21.8 committed by core user Parties in Agreement. Contributions of \$3.8m 2001/02	Total \$21.8 committed by core user Parties in Agreement. Contributions of \$3.3m in 2002/03
	Core user participant resources	32% of total resources				46% of total contributions by core users, 99/2000.	Cumulative total \$5.5m	Cumulative total \$7.0m	Cumulative total \$10.3m
						50% of total contributions by core users, 2000/01.	56% of total contributions by core users, 2001/02.	54% of total contributions by core users, 2002/03.	
Process	Communication and implementation of Centre research outcomes and technology	Integration of communication and adoption (technology transfer) principles into Programs/projects and focus catchments	Appointment of Program Leader – Communication and Adoption.	Number of meetings held by program leaders and site coordinators with stakeholders on communication and adoption	External independent review of Communication and Adoption Program at end of years 1, 3 & 5	Appointments completed for Program Leader and Focus Catchment Coordinators. Meetings held December 99 and February 2000. Workshop early April 2000 for Program Leaders and Focus Catchment Coordinators.	Workshops held October 2000 and early April 2001 for Program Leaders and Focus Catchment Coordinators.	Workshops held October 2001, January 2002 and April 2002 for Program Leaders and Focus Catchment Coordinators.	Workshops held September 2002, October 2002 and April 2003 for Program Leaders and Focus Catchment Coordinators.

Performance Indicators

Strategy for utilisation and application of research outputs (continued)

Nature of Indicator	Performance Indicator	Target over life of Centre	Measure - Lending	Measure - Real Time	Measure - Lagging	Report of Activities and Achievements for 1999/2000	Report of Activities and Achievements for 2000/2001	Report of Activities and Achievements for 2001/2002	Report of Activities and Achievements for 2002/2003
Centre products	Centre products	Monthly newsletter to over 1400 industry end-users. 14 Major updates of Centre Web site. 20 Industry seminars 30 Technical seminars 15 Industry reports and videos 35 Technical reports 15 Field tours and demonstrations of Centre products. 20 Workshops 20 Targeted short courses. 4 Contributions to influential trade journals.	Number planned	Number each year	Total number completed	Monthly newsletter continuing: copies to 1000 subscribers (surveyed need) and available on CRC website. Since July 99, second major update of Website underway. 5 Industry Seminars presented since July 99. 14 technical seminars since July 99. 3 Industry Reports, four 14 Technical Reports, 5 Videos and 5 Working Documents issued since July 99. 2 Field ours held since July 99 5 Works held since July 99 4 day Stormwater Management short course planned for October 2000 5 industry articles. CRC contribution/ features for AWA Journal 'Water' being prepared for Nov/Dec 2000 issue	Monthly newsletter continuing: copies to 1250 subscribers (surveyed need) and available on CRC website. Second major update of Website completed. 19 Technical seminars. 12 Technical Reports, 2Videos issued, 1 Field tour 13 CRC workshops held, 15 industry articles. 9 CRC contribution/ features in AWA Journal 'Water' Cumulative totals: 2 Website upgrades 5 Industry seminars 33 Technical Seminars 3 Industry Reports 26 Technical Reports 3 Field Tours 18 Workshops 20 Industry/trade articles	Monthly newsletter continuing: copies to 1400 subscribers (surveyed need) and available on CRC website. 30 Technical seminars. 10 Technical Reports, 1 Manual, 3 Field Tours, 18 CRC workshops held, 6 industry articles. Cumulative totals: 2 Website upgrades 5 Industry Seminars 63 Technical Seminars 3 Industry Reports 36 Technical Reports 6 Field Tours 36 Workshops 26 Industry/trade articles	Monthly newsletter continuing: copies to 1320 subscribers (surveyed need) and available on CRC website. 8 Technical seminars. 11 Technical Reports and one Industry Report, 3 Short Courses [1 field course, 2 training courses], 27 CRC workshops held, 4 industry articles. Cumulative totals: 2 Website upgrades 5 Industry Seminars 71 Technical Seminars 4 Industry Reports 47 Technical Reports 3 Short Courses 6 Field Tours 63 Workshops 30 Industry/trade articles

Collaborative arrangements

Nature of Indicator	Performance Indicator	Target over life of Centre	Measure - Lending	Measure - Real Time	Measure - Lagging	Report of Activities and Achievements for 1999/2000	Report of Activities and Achievements for 2000/2001	Report of Activities and Achievements for 2001/2002	Report of Activities and Achievements for 2002/2003
Outcome	Cooperation in research within Australian and overseas and more efficient use of resources	Twenty collaborative arrangements	Number planned	Number implemented	Total number completed	New collaborative arrangements being established with ANU; Coastal Zone CRC and Freshwater Ecology CRC; others being planned	New collaborative arrangements being established with ICAM(ANU); NIWA(NZ); close collaboration with University of Texas and Univ Nth Carolina, USA.	New collaborative arrangements being established with UNSW; close collaboration with University of Natal, Univ Nth Carolina, USA, Univ of Leuven, Belgium.	New collaborative arrangements being established with WBM, Earth Tech, Ecological Engineering, SKM, and Sustainable Water Resources Research Centre, Korea; close collaboration with University of Natal, Rhodes Univ, S. Africa; State Univ Calif – Monterey; Univ of Leuven, Belgium; Met Office UK; NIWA NZ; ICAM ANU.
Input	Research providers contributed resources	\$19.5m total cash and in-kind	Agreement	Actually committed	Cumulative resources	\$2.6m committed by Research providers to 99/2000.	\$3.1m committed by Research providers in 2000/01.	\$3.0m committed by Research providers in 2001/02.	\$2.8m committed by Research providers in 2002/03.
	Research providers FTEs in-kind	11.4 FTE in-kind	Agreement	Actually committed	Cumulative resources	10.7 FTE for 99/2000 Increased level expected for later years.	13.0 FTE for 2000/01 26.3 FTE Cumulative	12.7 FTE for 2001/02 36.3 FTE Cumulative	11.7 FTE for 2002/03 48.0 FTE Cumulative
Process	Collaboration between researchers	All projects to involve two or more Parties	Average number of Parties proposed per agreement	Average number for projects initiated within year	Average cumulative number of Parties per project	Average of 5 Parties for 11 Agreements signed February 2000.	Average of 4.4 Parties for 11 Agreements signed February 2000 to June 2001	Average of 4.4 Parties for 21 Core Project Agreements signed to June 2002.	Average of 4.1 Parties for 41 Core Project Agreements signed to June 2003.
	Collaboration between researchers and research users	Participants workshop each year	Workshop planned for year	Number attending	Total number of participant workshops held and cumulative attendance	Workshop held 4-6 April 2000 (Mt Buffalo) 68 attended	Workshop held 3-5 April 2001 (Cobram-Barooga) 93 attended 161 Cumulative	Workshop held 16-18 April 2002 (Ballarat) 96 attended 257 Cumulative	Workshop held 8-10 April 2003 92 attended (Yanco, NSW) 349 Cumulative
	International collaboration	Centre researchers involved in 3 international collaborations per year	Number planned for year	Number of collaborations in year	Cumulative number of international collaborations	Currently over 50% of postgraduates have both university and non-university supervisors	Currently over 34% of postgraduates have both university and non-university supervisors	Currently 29% of postgraduates have both university and non-university supervisors	Currently 36% of postgraduates have both university and non-university supervisors
	International collaboration	Centre researchers involved in 3 international collaborations per year	Number planned for year	Number of collaborations in year	Cumulative number of international collaborations	Collaborative arrangements developed for projects including Projects 1.1(Univ Edinburgh), 4.1(Univ Essen), 5.1(WMO), 6.5 (Univ Alberta), Other collaborations occurred with Prog 1-IUFRO(Vertessy), Prog 2-NIWA,NZ(Seed) – 6 in total listed	Collaborative arrangements developed for projects including Projects 1.1(Univ of Texas, Univ of N.Carolina), 1.2 (Univ of Vienna, Univ of Uppsala), 2.2 (C. Univ of Leuven) 4.1/4.2 (Colorado State Univ), 5.1(Univ. Calif.)(WMO), 5.2 (Univ of Natal),6.5 (Univ Alberta), Other collaborations occurred with Prog 1- Univ of Cincinnati (Vertessy); Prog 5-NIWA,NZ(Seed) – 12 in total listed	Collaborative arrangements developed for projects including Projects 1.1, 1.09 (HTW, Saarlandes, Germany; California State Univ), 1.2 (Univ of Vienna); 2.2, 2.20 (C. Univ of Leuven), 2.7 (China EucaRYPT Centre, Leizhou Forest Bureau), 2.19 (USDA); 4.08 (Chalmers Univ Sweden); 5.1, 5.05 (NIWA NZ, Catalan Tech Univ Spain ; Univ Connecticut; Met Office UK), 5.2, 5.06 (Univ of Natal; Massey Univ, NZ), 6.2 (Univ Agric Vienna), 15 in total listed	

Performance Indicators

Collaborative arrangements (continued)

Nature of Indicator	Performance Indicator	Target over life of Centre	Measure - Lending	Measure - Real Time	Measure - Lagging	Report of Activities and Achievements for 1999/2000	Report of Activities and Achievements for 2000/2001	Report of Activities and Achievements for 2001/2002	Report of Activities and Achievements for 2002/2003
Process (continued)			Number planned for year	Number attended in year	Cumulative number	Presentations in 99/2000 by 5 postgraduates at Intl confs: Haupt, Hoang, Jordan, McLannet, Wilkinson.	Presentations in 2000/01 by 2 postgraduates at Intl confs: Lloyd, Wilkinson. Cumulative total 7	Presentations in 2001/02 by 3 postgraduates at Intl confs: Bartley, Eley, McKergow. Cumulative total 10	Presentations in 2002/03 by 2 postgraduates at Intl confs: Barton, Lloyd Cumulative total 12
	Associate membership program	5 Associates (by Year 4)	Number planned in year	Number joined in year	Total number	SA Water joined. State Forests of NSW renewed.	SA Water continuing involvement. State Forests of NSW renewed.	WA Water Corporation joined as Associate.	WA Water Corporation continuing involvement as Associate.
	Secondments of industry staff to research providers	12 secondments to research providers	Secondments planned in year	Number of secondments in year	Cumulative number of secondments	H Duncan (Melb Water) and J Green (DLWC)(part of year) at Monash Univ.	H Duncan (Melb Water) and (part of year) R O'Neill (DLWC), M Seker (Goulburn-Murray Water), B James (DNRE) at Monash Univ. Cumulative 6 (part) secondments	H Duncan (Melb Water), J Green (DLWC) at Monash Univ. Cumulative 8 (part) secondments	H Duncan (Melb Water) and M Francey (Melb Water)(part-time) at Monash; G Podger and M Littleboy (DIPNR) part-time at CSIRO. Cumulative 12 (part) secondments
	Secondments of research provider staff to industry	12 secondments to industry	Secondments planned in year	Number of secondments in year	Cumulative number of secondments	L Sriwardena located at Bureau of Met for part of year	S Lloyd and J Lewis located at Melbourne Water for part of year Cumulative 3 (part) secondments	Cumulative 3(part) secondments	J-M Perraud (CSIRO) part-time at DIPNR offices in Parramatta, NSW Cumulative 4(part) secondments
Outputs	Collaborative publications (Centre researchers and authors from other organisations)	100 collaborative publications	Number planned in year	Number published in year	Total number	10 refereed journal papers with external collaborators and 12 conference papers – all	14 refereed journal papers and 12 conference papers - all with external collaborators	14 refereed journal papers and 23 conference papers - all with external collaborators	11 refereed journal papers and 17 conference papers - all with external collaborators

Education and training

Nature of Indicator	Performance Indicator	Target over life of Centre	Measure - Lending	Measure - Real Time	Measure - Lagging	Report of Activities and Achievements for 1999/2000	Report of Activities and Achievements for 2000/2001	Report of Activities and Achievements for 2001/2002	Report of Activities and Achievements for 2002/2003
Outcome	Training and equipping postgraduate students as future leaders in research and management	All postgraduates employed	Students trained in job skills	Employment of graduating students	Number employed, % employed in user or related industry	Postgraduate skills training being planned. Further interaction with industry provided in Annual workshop.	Postgraduate skills workshop held April 2001. Further interaction with industry provided in Annual workshop.	Postgraduate Project Management workshop held April 2002. Further interaction with industry provided in Annual workshop.	Postgraduate Numerical modelling - Visual Basic workshop held April 2003. Further interaction with industry provided in Annual workshop.
Education benefit - postgraduate	50% of postgraduate students employed in user or related industry				% employed in user or related industry	Postgraduates*: Feikema, Haupt, Jordan, Richards, Sirwardhena, Herron, McLannet, Scanlon, and Stewardson with research providers *Submitted theses in 99/2000	Postgraduates*: Hoang, Lewis, Sabaratnam, Tilbeard with user industry, Roberts with research providers. *Submitted theses in 2000/01	Postgraduates*: Akeroyd, Bailey, Linton, Vaze with user industry. Bartley, Marsh, Motha, Petheram Thomas, Wilkinson with research providers. *Submitted theses in 2001/02	Postgraduate Numerical modelling - Visual Basic workshop held April 2003. Further interaction with industry provided in Annual workshop. Postgraduates*: White, Woods with user industry. Barton, McKergow with research providers. *Submitted theses in 2002/03
Increase in knowledge and skill base available for land and water management in Australia:	Short courses attended by 500 industry persons		Number planned	Number per year and number attending	Cumulative number of courses and attendees	208 attended courses/workshops on: Continuous simulation system for design flood estimation Nov 99(15); Planning and design of stormwater management measures, Nov 99 (30); Setting priorities for stream restoration, Dec 99(25); Hydrology and Hydraulics for Floodplain Managers May 2000 (33); Urban stormwater monitoring Protocol workshop May 2000 (25); Urban Stormwater Field workshop – examples of best practice (80)	Over 490 attended courses/workshops on: Hydrology and hydraulics for floodplain managers - Design flood flow estimation, July 2000(45); Water sensitive urban design – Field trip, July 2000 (90); Murrumbidgee 2000, July 2000 (85); Water sensitive urban design, Aug 2000 (40); Hydrology and hydraulics for floodplain managers - Flood level estimation, Oct 2000(35); Regional hydrologic modelling, Oct 2000 (24); Planning and design of urban stormwater management measures, Oct 2000 (17); Hydrology and hydraulics for floodplain managers – Design of flood mitigation measures, Nov 2000 (31); Stochastic hydrology, Feb 2001 (25); Environmental management support system, March 2001 (25); MUSIC(Model for urban stormwater improvement conceptualisation, April 2001 (12); MUSIC(Model for urban stormwater improvement conceptualisation, May 2001(14); Tarsier developers workshop, May 2001 (12); Future issues workshop, May 2001(38). Cumulative total 698	Over 440 attended courses/workshops on: Fitzroy AEAM, Building the shell for AEAM process, Aug 2001(15); Stochastic data – risks in water resources management, Sept 2001(23); Fitzroy AEAM, Understanding Fitzroy catchment, Sept 2001 (25); Design flood flow estimation, Sept 2001 (28); Application of MUSIC, Oct 2002 (5); EMSS Training, Oct 2001(35); ICMS Training, Oct 2001 (12); Climate Variability Research, Oct 2001 (40); MUSIC users, Oct 2001 (12); Modelling Toolkit concepts and activities, Nov 2001 (23); Water experiment trials, Jan 2002 (12); ICMS, Feb 2002 (10); Water experiment trials, Feb 2002 (12); We all use water, Feb 2002 (15); Field investigation, river rehabilitation design, Mar 2002 (6); Field demonstration, stream restoration, Mar 2002 (50); We all use water, Mar 2002 (17); Project management, Apr 2002 (17); We all use water, May 2002 (15); Fitzroy AEAM stakeholders, May 2002 (30); WSUD field tour, June 2002(40). Cumulative total 1138	Over 640 attended courses/workshops on: MUSIC, 8-9 July 2002 (30); MUSIC, 10-12 July 2002 (30); Water Trading, 15 July 2002 (12); Water Trading, 16 July 2002 (12); MUSIC, 15-16 July 2002 (30); Water Trading, 18 July 2002 (12); MUSIC, 18-19 July 2002 (30); Field methods for data acquisition, 23-26 July 2002 (40); We all use water, 29-30 August 2002 (25); Characteristics of effective NRM groups, 5 Sept 2002 (80); Local scale EMSS, 11 Sept 2002 (15); MUSIC, 16 Sept 2002 (20); MUSIC, 23 Sept 2002 (12); Stormwater quality monitoring, 4 Oct 2002 (6); Mwater Murrumbidgee, 5-6 Nov 2002 (14); Mwater G-MW, 7 Nov 2002 (10); Stream restoration products, 12 Nov 2002 (30); MUSIC users forum, 27 Nov 2002 (35); MUSIC training, 28-29 Nov 2002 (25); MUSIC users forum, 10 Dec 2002 (35); CRC-Forge, 10 Dec 2002 (9); River Analysis Package, 10 Feb 2003 (6); EMSS development project training, 20-21 Feb 2003 (20); Biometrics methods, 11 Mar 2003 (10); Water markets – Mwater, 28 Mar 2003 (12); Numerical modelling – Visual Basic, 6-7 April 2003 (24); SIMHYD for EMSS, 29-30 April 2003 (18); CRC-FORGE, 14-15 May 2003 (7); Experimental data analysis, 4-5 June 2003 (4); Water quality modelling decision support, 24 June 2003 (30). Cumulative total 1778

Performance Indicators

Education and training (continued)

Nature of Indicator	Performance Indicator	Target over life of Centre	Measure - Lending	Measure - Real Time	Measure - Lagging	Report of Activities and Achievements for 1999/2000	Report of Activities and Achievements for 2000/2001	Report of Activities and Achievements for 2001/2002	Report of Activities and Achievements for 2002/2003
Input	Education and training Program resources	\$6.1m cash and in-kind resources	Strategic plan	Actually committed	Cumulative resources used	\$0.53m for 99/2000	\$1.05m for 2000/01 \$1.58m Cumulative	\$1.09m for 2001/02 \$2.67m Cumulative	\$1.20m for 2002/03 \$3.87m Cumulative
Process	Industry training	All students to undergo industry induction	Planning of induction	Number of students inducted in year	Cumulative number inducted	Induction program to be planned	Industry placements program being developed (S. Lloyd with Melbourne Water on specific project)	Industry placements program being developed	Industry placements program commenced. (S. Johnson at Melbourne Water)
Outputs	PhD program 12 full scholarships 12 top-up scholarships		Number planned	Number in year	Cumulative number Awarded	Two rounds of scholarships advertised. Lloyd, Muthukumarar, Anderson, Ghali awarded scholarships and/or top-ups from first round.	Five rounds of scholarships advertised [Aug, Sept., Oct., Nov. 2000; Mar/April 2001], Best Etchells, Gooch, Grudzinski, Lymburner, Newton, Ramchurn, Thomsen, White C. awarded scholarships and/or top-ups .	One round of scholarships advertised [Oct 2001] Biggin, Griffith, Henderson, Johnson, Judd, Potter, Taylor, Woods awarded scholarships and/or top-ups.	One round of scholarships advertised [Oct 2002] Bayley, Borg, Capon, Clowes, Francey, Howes, Rebgelz, Vietz, Zaman, awarded scholarships, industry support, and/or top-ups. 30 Cumulative total scholarships/top-ups/industry support

Management structure and arrangements

Nature of Indicator	Performance Indicator	Target over life of Centre	Measure - Lending	Measure - Real Time	Measure - Lagging	Report of Activities and Achievements for 1999/2000	Report of Activities and Achievements for 2000/2001	Report of Activities and Achievements for 2001/2002	Report of Activities and Achievements for 2002/2003
Outcome	Continuity of long term research effort	Satisfaction of Parties	Survey of Parties satisfaction	Annual Party survey results	Cumulative results	Survey to be planned.	Survey to be planned. (CRC Parties included in Communications survey in 2000/01)	Board reviewed its performance in 2001/02. Parties' further survey to be planned.	Parties confirmed support and involvement with new round of three-year projects.
Input	Total cash and in-kind resources in general administration program	\$2m cash and in-kind	Strategic plan	Actually committed	Cumulative resources	\$0.54m total expenditure 99/2000.	\$0.35m total expenditure 2000/01. Cumulative total \$0.89m	\$0.41m total expenditure 2001/02. Cumulative total \$1.30m	\$0.43m total expenditure 2002/03. Cumulative total \$1.73m
Process	Governing Board	Representatives for each Party. Majority of user and independent members on Governing Board	Chair and number of members	Number of meetings held in year	Performance review	Each Party* represented on Governing Board. Two independents appointed (in addition to independent Chair) Independents and users form majority on Board (3 independents, 8* users, 4 research providers) (* 3 Rural Water Authorities share one Board representative)	Each Party* represented on Governing Board. Two independents appointed (in addition to independent Chair) Independents and users form majority on Board (3 independents, 8* users, 4 research providers) (* 3 Rural Water Authorities share one Board representative)	Each Party* represented on Governing Board. Two independents appointed (in addition to independent Chair) Independents and users form majority on Board (3 independents, 8* users, 4 research providers) (* 3 Rural Water Authorities share one Board representative)	Each Party* represented on Governing Board. Two independents appointed (in addition to independent Chair) Independents and users form majority on Board (3 independents, 8* users, 4 research providers) (* 3 Rural Water Authorities share one Board representative)
	Occupational Health and Safety	Incident and accident free workplaces	OH&S training. Risk identification and assessment procedures	OH&S to be part of project meetings and reviews	OH&S incident/accident performance	First Aid courses attended by selected staff and postgrads. OH&S field policies from Parties used to aim at overall compliance for visiting researchers	First Aid courses attended by selected staff and postgrads. OH&S field policies from Parties used to aim at overall compliance for visiting researchers	First Aid courses attended by selected staff and postgrads. OH&S field policies from Parties used to aim at overall compliance for visiting researchers	First Aid courses/laboratory safety training/defensive driving/4WD training attended by selected staff and postgrads. OH&S field policies from Parties used to aim at overall compliance for visiting researchers
	Project management skills	All program/ project leaders to attend one course	Selection and planning of Project Management/leader ship training for Program/projects	Number of project leaders attending training courses in year	Cumulative number of program/project leaders who attended courses	New Program/Project leaders to be invited to attend training courses where appropriate.	New Program/Project leaders to be invited to attend training courses where appropriate. Budget provided for Program/Project leaders to attend training courses where appropriate.	Project management course held for postgraduates, April 2002 Budget provided for Program/Project leaders to attend training courses where appropriate.	Program/Project leaders funded to attend training courses where appropriate.

Performance Indicators

Management structure and arrangements (continued)

Nature of Indicator	Performance Indicator	Target over life of Centre	Measure - Lending	Measure - Real Time	Measure - Lagging	Report of Activities and Achievements for 1999/2000	Report of Activities and Achievements for 2000/2001	Report of Activities and Achievements for 2001/2002	Report of Activities and Achievements for 2002/2003
Financial management	Outputs	Programs and projects within budget	Program budgeting for year ahead and three years	Budget versus actual performance within year	Cumulative income and expenditure budget performance	<p>Program budgeting: Program budgeting for initial projects on three year basis. Program budget approved May 2000 Board (14 projects)</p> <p>Project Budget performance: All projects under budget for 99/2000.</p>	<p>Program budgeting: Program budgeting for initial projects on three year basis. Program budget approved May 2001 Board (21 projects)</p> <p>Project Budget performance: 17 projects under cash budget for 2000/01. Total cash 83% of budget.</p>	<p>Program budgeting: Program budgeting for initial projects on three year basis. Program budget approved May 2002 Board (22 projects)</p> <p>Project Budget performance: 12 projects under cash budget for 2001/02. Total cash 95% of budget.</p>	<p>Program budgeting: Program budgeting for initial projects on three-year basis. Program budget for new round of three-year projects (22 projects) approved Nov 2002, and May 2003 Board</p> <p>Project Budget performance: 20 projects under cash budget for 2002/03. Total cash 96% of budget.</p>
Monthly, quarterly and Annual report on time		Completion by required dates each year	Preparation of reports	Timeliness within year	Cumulative performance	<p>Parties provided monthly cash reporting Quarterly in-kind reports submitted in time.</p>	<p>Parties provided monthly cash reporting Quarterly in-kind reports submitted in time.</p>	<p>Parties provided monthly cash reporting Quarterly in-kind reports submitted in time.</p>	<p>Parties provided monthly cash reporting Quarterly in-kind reports submitted in time.</p>



Budget 2002 - 2003

Budget

Table 1 (a) In-Kind Contributions From Parties (Dollars in \$'000's)

Participant	ACTUAL EXPENDITURE							CUMULATIVE TOTAL TO DATE Actual Agr'mt	03/04 YEAR 5		04/05 YEAR 6		05/06 YEAR 7		GRAND TOTAL Total Agr'mt 7 Yrs	Diff 7 Yrs
	99/00 YEAR 1 Actual	00/01 YEAR 2 Actual	01/02 YEAR 3 Actual	02/03 YEAR 4 Actual	02/03 YEAR 4 Agr'mt	03/04 YEAR 5 Budget	03/04 YEAR 5 Agr'mt		04/05 YEAR 6 Budget	04/05 YEAR 6 Agr'mt	05/06 YEAR 7 Budget	05/06 YEAR 7 Agr'mt				
Brisbane City Council																
Salaries	147	11	12	34	28	28	204	112	28	28	28	28	28	288	196	92
Capital	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other	263	359	364	376	372	372	1,362	1,488	372	372	372	372	372	2,478	2,604	(126)
TOTAL	410	370	376	410	400	400	1,566	1,600	400	400	400	400	400	2,766	2,800	(34)
Bureau of Meteorology																
Salaries	80	189	142	124	137	137	535	548	137	137	137	137	137	946	959	(13)
Capital	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other	160	358	293	268	284	284	1,079	1,136	284	284	284	284	284	1,931	1,988	(57)
TOTAL	240	547	435	392	421	421	1,614	1,684	421	421	421	421	421	2,877	2,947	(70)
CSIRO Land & Water																
Salaries	417	451	470	381	423	423	1,719	1,692	423	423	423	423	423	2,988	2,961	27
Capital	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other	552	598	623	505	561	561	2,278	2,244	561	561	561	561	561	3,961	3,927	34
TOTAL	969	1,049	1,093	886	984	984	3,997	3,936	984	984	984	984	984	6,949	6,888	61
Department of Infrastructure, Planning & Natural Resources NSW (formerly DLWC)																
Salaries	107	77	167	159	151	151	510	604	151	151	151	151	151	963	1,057	(94)
Capital	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other	74	58	112	107	102	102	351	408	102	102	102	102	102	657	714	(57)
TOTAL	181	135	279	266	253	253	861	1,012	253	253	253	253	253	1,620	1,771	(151)
Department of Natural Resources & Mines, Qld.																
Salaries	110	94	447	249	180	180	900	720	180	180	180	180	180	1,440	1,260	180
Capital	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other	189	216	727	439	338	338	1,571	1,352	338	338	338	338	338	2,585	2,366	219
TOTAL	299	310	1,174	688	518	518	2,471	2,072	518	518	518	518	518	4,025	3,626	399

Table 1 (b) In-Kind Contributions From Parties (Dollars in \$'000's)

Participant	ACTUAL EXPENDITURE												CUMULATIVE		04/05		05/06		GRAND TOTAL	
	99/00		00/01		01/02		02/03		02/03		03/04		04/05		05/06		Total	Agr'mt	Diff	
	Year 1	Actual	Year 2	Actual	Year 3	Actual	Year 4	Actual	Year 4	Actual	Year 5	Budget	Agr'mt	Year 6	Budget	Agr'mt				7 Yrs
Department of Sustainability and Environment, Vic.																				
Salaries	75	318	194	158	187	187	187	748	745	748	187	187	187	187	187	187	1,306	1,309	(3)	
Capital	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Other	122	356	236	202	230	230	920	920	916	920	230	230	230	230	230	230	1,606	1,610	(4)	
TOTAL	197	674	430	360	417	417	1,668	1,668	1,661	1,668	417	417	417	417	417	417	2,912	2,919	(7)	
Griffith University																				
Salaries	200	237	255	246	231	231	917	917	938	917	231	231	231	231	231	231	1,631	1,610	21	
Capital	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Other	214	344	317	308	292	292	1,161	1,161	1,183	1,161	292	292	292	292	292	292	2,059	2,037	22	
TOTAL	414	581	572	554	523	523	2,078	2,078	2,121	2,078	523	523	523	523	523	523	3,690	3,647	43	
Melbourne Water																				
Salaries	69	93	100	106	76	76	304	304	368	304	76	76	76	76	76	76	596	532	64	
Capital	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Other	93	236	244	250	226	226	904	904	823	904	226	226	226	226	226	226	1,501	1,582	(81)	
TOTAL	162	329	344	356	302	302	1,208	1,208	1,191	1,208	302	302	302	302	302	302	2,097	2,114	(17)	
Monash University																				
Salaries	334	257	292	250	270	270	1,080	1,080	1,133	1,080	270	270	270	270	270	270	1,943	1,890	53	
Capital	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Other	384	305	340	298	318	318	1,272	1,272	1,327	1,272	318	318	318	318	318	318	2,281	2,226	55	
TOTAL	718	562	632	548	588	588	2,352	2,352	2,460	2,352	588	588	588	588	588	588	4,224	4,116	108	
Goulburn-Murray Water																				
Salaries	18	16	23	22	22	22	88	88	79	88	22	22	11	11	11	11	123	132	(9)	
Capital	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
Other	52	50	59	48	47	47	218	218	209	218	48	48	24	24	24	24	305	314	(9)	
TOTAL	70	66	82	70	69	69	306	306	288	306	70	70	35	35	35	35	428	446	(18)	

Budget

Table 1 (c) In-Kind Contributions From Parties (Dollars in \$'000's)

Participant	ACTUAL EXPENDITURE												GRAND TOTAL		
	99/00 YEAR 1 Actual	00/01 YEAR 2 Actual	01/02 YEAR 3 Actual	02/03 YEAR 4 Actual	02/03 YEAR 4 Agrmt	CUMULATIVE TOTAL TO DATE Actual	03/04 YEAR 5 Budget	03/04 YEAR 5 Agrmt	04/05 YEAR 6 Budget	04/05 YEAR 6 Agrmt	05/06 YEAR 7 Budget	05/06 YEAR 7 Agrmt	Total 7 Yrs	Diff 7 Yrs	
The University of Melbourne															
Salaries	112	306	184	234	200	836	200	200	200	200	200	200	1,436	1,400	36
Capital	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other	116	316	190	241	206	863	206	206	206	206	206	206	1,481	1,442	39
TOTAL	228	622	374	475	406	1,699	406	406	406	406	406	406	2,917	2,842	75
Total In-Kind Contributions															
Salaries	1,669	2,049	2,286	1,963	1,905	7,967	1,905	1,905	1,894	1,894	1,894	1,894	13,660	13,306	354
Capital	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Other	2,219	3,196	3,505	3,042	2,976	11,962	2,977	2,977	2,953	2,953	2,953	2,953	20,845	20,810	35
Grand Total In-Kind (T1)	3,888	5,245	5,791	5,005	4,881	19,929	4,882	4,882	4,847	4,847	4,847	4,847	34,505	34,116	389

Table 2 Cash Contributions (Dollars in \$'000's)

	ACTUAL EXPENDITURE														GRAND TOTAL				
	99/00		00/01		01/02		02/03		02/03		03/04		04/05		05/06		Total 7 Yrs	Diff 7 Yrs	
	Actual	Year 1	Actual	Year 2	Actual	Year 3	Actual	Year 4	Actual	Year 4	Budget	Agmt	Budget	Agmt	Budget	Agmt			
Partners																			
Brisbane City Council	50		50	50	50	50	50	50	200	200	50	50	50	50	50	50	350	350	-
Bureau of Meteorology	50		50	50	50	50	50	50	200	200	100	100	50	50	-	-	350	350	-
CSIRO Land & Water	100		100	100	100	100	100	100	400	400	100	100	100	100	100	100	700	700	-
Dept. Infrastructure, Planning & Nat Res, NSW	100		100	100	100	100	100	100	400	400	125	125	100	100	75	75	700	700	-
Dept. Natural Resources & Mines, Qld.	100		100	100	100	100	100	100	400	400	100	100	100	100	100	100	700	700	-
Dept. Sustainability & Environment, Vic.	100		100	100	100	100	100	100	400	400	100	100	100	100	100	100	700	700	-
Griffith University	50		50	50	50	50	50	50	200	200	50	50	50	50	50	50	350	350	-
Melbourne Water	50		50	50	50	50	50	50	200	200	50	50	50	50	50	50	350	350	-
Monash University	100		100	100	100	100	100	100	400	400	150	150	100	100	50	50	700	700	-
Murray-Darling Basin Commission	50		50	50	50	50	50	50	200	200	100	100	50	50	-	-	350	350	-
Goulburn-Murray Water	150		150	150	150	150	150	600	600	600	150	150	150	150	150	150	1,050	1,050	-
Southern Rural Water	30		30	30	30	30	30	120	120	120	30	30	30	30	30	30	210	210	-
Wimmera Mallee Water	60		60	60	60	60	60	240	240	240	60	60	60	60	60	420	420	-	
The University of Melbourne	50		50	50	50	50	50	200	200	200	75	75	50	50	25	25	350	350	-
Total Cash from Participants	1,040		1,040	1,040	1,040	1,040	1,040	4,160	4,160	4,160	1,240	1,240	1,040	1,040	840	840	7,280	7,280	-
Other Cash																			
Non-participants	78		83	30	-	-	-	-	191	-	-	-	-	-	-	-	191	-	191
External Grants	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Contract Research (See Note B below)	32		152	30	125	1,400	1,400	3,400	339	3,400	1,800	1,800	2,300	2,300	2,600	2,600	7,039	10,100	(3,061)
Commercialisation	61		-	118	176	-	-	355	-	-	-	-	-	-	-	-	355	-	355
Education	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Interest	66		118	105	68	-	-	357	-	-	-	-	-	-	-	-	357	-	357
Total Other Cash	237		353	283	369	1,400	1,400	3,400	1,242	3,400	1,800	1,800	2,300	2,300	2,600	2,600	7,942	10,100	(2,158)
CRC Grant																			
Total CRC Cash Contribution (T2)	2,242		2,600	2,600	2,600	2,600	2,600	10,042	10,042	10,042	2,600	2,600	2,600	2,600	1,000	1,000	16,242	16,242	-
	3,519		3,993	3,923	4,009	5,040	5,040	15,444	17,602	17,602	5,640	5,640	5,940	5,940	4,440	4,440	31,464	33,622	(2,158)
Cash From Previous Year	527		1,775	2,118	1,388														
Less Unspent Balance	1,775		2,118	1,388	528														
Total Cash Expenditure (T3)	2,271		3,650	4,653	4,869	5,040	5,040	15,443	17,602	17,602	5,640	5,640	5,940	5,940	4,440	4,440	31,463	33,622	(2,159)

See Note A below

Budget

Table 2 Cash Contributions (Dollars in \$'000's) (continued)

		ACTUAL EXPENDITURE				CUMULATIVE		04/05		05/06		GRAND TOTAL		
99/00	00/01	01/02	02/03	02/03	03/04	04/05	04/05	04/05	05/06	05/06	05/06	05/06	05/06	
YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 4	YEAR 5	YEAR 6	YEAR 6	YEAR 7	YEAR 7	YEAR 7	YEAR 7	YEAR 7	YEAR 7	
Actual	Actual	Actual	Actual	Actual	Budget	Budget	Budget	Budget	Budget	Budget	Budget	Budget	Budget	
Actual	Actual	Actual	Actual	Actual	Actual	Actual	Actual	Actual	Actual	Actual	Actual	Actual	Actual	
1,232	2,067	2,349	2,424	2,685	3,005	3,165	3,165	2,366	2,366	2,366	2,366	16,608	17,913	
-	-	-	27	-	-	-	-	-	-	-	-	27	-	
1,039	1,583	2,304	2,418	2,355	2,635	2,775	2,775	2,074	2,074	2,074	2,074	14,828	15,709	
2,271	3,650	4,653	4,869	5,040	5,640	5,940	5,940	4,440	4,440	4,440	4,440	31,463	33,622	
Total Cash Expenditure (T3)														
Salaries					8,072	9,377	3,005	3,165	2,366	2,366	2,366	16,608	17,913	(1,305)
Capital					27	-	-	-	-	-	-	27	-	27
Other					7,344	8,225	2,635	2,775	2,074	2,074	2,074	14,828	15,709	(881)
Total Cash Expenditure (T3)					15,443	17,602	5,640	5,940	4,440	4,440	4,440	31,463	33,622	(2,159)

Note A: Changes in timing of cash contributions for years 5 and 7 approved by Commonwealth, 16 July 2003

Note B: See also Externally Funded Contract Research listed in chapter on "Utilisation and Application of Research".

Table 3 Summary of Resources Applied to Activities of Centre (Dollars in \$,000)

Grand Total In-kind Table 1 (T1)	3,888	5,245	5,791	5,005	4,881	19,929	19,540	4,882	4,847	4,847	4,847	34,505	34,116	389
Grand Total Cash Table 2 (T3)	2,271	3,650	4,653	4,869	5,040	15,443	17,602	5,640	5,940	4,440	4,440	31,463	33,622	(2,159)
Total Resources Applied to														
Activities of Centre (T1+T3)	6,159	8,895	10,444	9,874	9,921	35,372	37,142	10,522	10,787	9,287	9,287	65,968	67,738	(1,770)

Allocation of Total Resources Applied to Activities of Centre Between Heads of Expenditure

Total Salaries (Cash and In-Kind)	2,901	4,116	4,635	4,387	4,590	16,039	16,990	4,910	5,059	5,059	4,260	30,268	31,219	(951)
Total Capital (Cash and In-Kind)	-	-	-	27	-	27	-	-	-	-	-	27	-	27
Total Other (Cash and In-Kind)	3,258	4,779	5,809	5,460	5,331	19,306	20,152	5,612	5,728	5,027	5,027	35,673	36,519	(846)

Table 4 Allocation of resources between categories of activities (\$'000s)

Program	RESOURCE USAGE			
	\$ Cash (1)	\$ In-kind	Staff Contrib. (2)	Staff Funded by CRC (2)
Research	2,490	3,000	20.84	20.19
Education	573	631	1.03	0.78
External Communication	1,199	977	2.63	2.14
Commercialisation/Tech. Transfer	272	305	0.66	0.54
Administration	335	92	0.26	2.31
TOTAL	4,869	5,005	25.42	25.96

(1) Cash from all sources, including CRC Program

(2) Person years, Professional and support staff

(3) Resources allocated to "Commercialisation/Technology Transfer" and "Education" also cover relevant Research Program/Project resources, including part of time contributed and funded staff under Research in columns 3 & 4.



Audit 2002 - 2003



CRC for Catchment Hydrology

Statement of Financial Performance For the Year Ended 30 June 2003

	NOTE	2003 \$	2002 \$
Revenue From Ordinary Activities			
Commonwealth Grant		2,600,000	2,600,000
Interest		67,663	104,740
Other		301,373	177,614
Expenses From Ordinary Activities			
Salary and Related Expenses of Researchers		(3,233,685)	(3,118,399)
Operating Expenses of Researchers		(1,635,262)	(1,534,595)
Inkind Research Expenses		(5,005,077)	(5,790,967)
Loss From Ordinary Activities Before Income Tax Expense		(6,904,988)	(7,561,607)
Income Tax Expense		-	-
Net Loss		(6,904,988)	(7,561,607)
Total Changes in Equity Other Than Those Resulting From			
Transactions with Participants as Participants		(6,904,988)	(7,561,607)

The above Statement of Financial Performance should be read in conjunction with the accompanying notes.

CRC for Catchment Hydrology
Statement of Financial Position as at 30 June 2003

	NOTE	2003 \$	2002 \$
Current Assets			
Cash Assets	3(a)	715,957	1,540,345
Receivables	4	295,411	243,467
Total Current Assets		1,011,368	1,783,812
Total Assets		1,011,368	1,783,812
Current Liabilities			
Payables		22,230	22,264
Party Contributions in Advance		462,500	375,000
Total Current Liabilities		484,730	397,264
Total Liabilities		484,730	397,264
Net Assets		526,638	1,386,548
Researchers' Funds			
Contributions by Parties	2	24,616,723	18,571,645
Accumulated losses	5	(24,090,085)	(17,185,097)
		526,638	1,386,548

The above Statement of Financial Position should be read in conjunction with the accompanying notes.



CRC for Catchment Hydrology

Statement of Cash Flows For the Year Ended 30 June 2003

	NOTE	2003 \$	2002 \$
Cash Flows From Operating Activities:			
Receipts from the Commonwealth Government		2,600,000	2,600,000
Interest Received		67,871	105,971
Other Income		298,747	87,720
Payments for Research		(4,868,506)	(4,639,759)
Net Cash Used in Operating Activities	3(b)	(1,901,888)	(1,846,068)
Cash Flows From Financing Activities:			
Cash Contributions by Parties		1,077,500	1,377,500
Net Cash Provided by Financing Activities		1,077,500	1,377,500
Net Decreases in Cash Held		(824,388)	(468,568)
Cash at the Beginning of the Financial Year		1,540,345	2,008,913
Cash at the End of the Financial Year	3(a)	715,957	1,540,345

The above Statement of Cash Flows should be read in conjunction with the accompanying notes.

Note 1. Summary of Accounting Policies

Financial Reporting Framework

The Cooperative Research Centre for Catchment Hydrology (CRC) is not a reporting entity because in the opinion of the Governing Board there are unlikely to exist users of the financial report who are unable to command preparation of reports tailored so as to satisfy specifically all of their information needs.

Accordingly, this "special purpose financial report" has been prepared to satisfy the Governing Board's reporting requirements under the Commonwealth Agreement.

The financial report has been prepared on the basis of historical cost and except where stated, does not take in to account changing money values or current valuations of non-current assets. Cost is based on the fair values of the consideration given in exchange for assets.

The financial report has been prepared in accordance with the basis of accounting and disclosure requirements specified by all Accounting Standards and UIG Consensus Views, except the disclosure requirements of:

AAS1	Statement of Financial Performance
AAS15	Revenue
AAS22	Related Party Disclosure
AAS33	Presentation and Disclosure of Financial Instruments
AAS36	Statement of Financial Position
AAS37	Financial Report Presentation and Disclosure

Significant Accounting policies

The following significant accounting policies have been adopted in the preparation and presentation of the financial statement.

(a) Income Tax

The Cooperative Research Centre for Catchment Hydrology (CRC) is an unincorporated Joint Venture and is defined as a Partnership for income tax purposes. The CRC does not lodge a Partnership tax return as it has been granted an exemption from doing so by the Australian Taxation Office, on the basis that all of the parties to the Joint Venture are tax exempt entities. As the CRC is not a separate tax paying entity it has not provided for income tax expense in the financial statements.

(b) Revenue Recognition

Commonwealth Grants

Grant revenue is recognised on an accrual basis.

Rendering of Services

Revenue from a contract to provide services is recognised by reference to the stage of completion of the contract.

Interest

Interest revenue is recognised on an accrual basis.

(c) Inkind Contributions

Pursuant to an agreement between the parties, Inkind contributions to the Centre have been included in the Statement of Financial Performance as expenditure on behalf of the Centre. The agreed value of Inkind contributions has been credited to the parties' equity in the Joint Venture and is included in Researchers' Funds in the Statement of Financial Position.

(d) Research and Development

The Governing Board of the Centre have considered the requirements of Australian Accounting Standard 13 (AAS 13) Accounting for Research and Development and have resolved that none of the expenditure by the Centre meets the requirements of AAS 13 concerning deferral of expenditure to future years. Accordingly all expenditure has been recorded in the Statement of Financial Performance as an expense from ordinary activities.

(e) Accounts Payable

Trade payables and other accounts payable are recognised when the Centre becomes obliged to make future payments resulting from the purchase of goods and services.

(f) Goods and Services Tax

Revenues, expenses and assets are recognised net of the amount of goods and services tax (GST), except:

- i. where the amount of GST incurred is not recoverable from the taxation authority, it is recognised as part of the cost of acquisition of an asset or as part of an item of expense; or
- ii. for receivables and payables which are recognised inclusive of GST.

The net amount of GST recoverable from, or payable to, the taxation authority is included as part of receivables or payables.

(g) Receivables

Receivables are recorded at amounts due less any allowance for doubtful debts.

CRC for Catchment Hydrology
Notes to the Financial Statements 30 June 2003

	2003	2002
	\$	\$
Note 2: Contributions by Parties (Excluding advance contributions)		
Cash		
Brisbane City Council	50,000	50,000
Bureau of Meteorology	50,000	50,000
CSIRO Land & Water	100,000	100,000
Department of Infrastructure, Planning & Natural Resources, NSW	100,000	100,000
Department of Natural Resources and Mines, Qld.	100,000	100,000
Department of Sustainability & Environment, Vic.	100,000	100,000
Griffith University	50,000	50,000
Melbourne Water Corporation	50,000	50,000
Monash University	100,000	100,000
Murray-Darling Basin Commission	50,000	50,000
Goulburn-Murray Rural Water Authority	150,000	150,000
Gippsland & Southern Rural Water Authority	30,000	30,000
Wimmera-Mallee Rural Water Authority	60,000	60,000
The University of Melbourne	50,000	50,000
	1,040,000	1,040,000
In-kind		
Brisbane City Council	409,665	375,896
Bureau of Meteorology	392,416	435,251
CSIRO Land & Water	886,441	1,092,683
Department of Infrastructure, Planning & Natural Resources, NSW	265,751	279,004
Department of Natural Resources and Mines, Qld.	688,347	1,173,895
Department of Sustainability & Environment, Vic.	359,827	430,207
Griffith University	554,024	572,349
Melbourne Water Corporation	356,376	343,543
Monash University	547,412	632,296
Murray-Darling Basin Commission	-	-
Goulburn-Murray Rural Water Authority	69,690	82,313
Gippsland & Southern Rural Water Authority	-	-
Wimmera-Mallee Rural Water Authority	-	-
The University of Melbourne	475,128	373,530
	5,005,077	5,790,967
Total Cash and In-Kind Contributions		
Brisbane City Council	459,665	425,896
Bureau of Meteorology	442,416	485,251
CSIRO Land & Water	986,441	1,192,683
Department of Infrastructure, Planning & Natural Resources, NSW	365,751	379,004
Department of Natural Resources and Mines, Qld.	788,347	1,273,895
Department of Sustainability & Environment, Vic.	459,827	530,207
Griffith University	604,024	622,349
Melbourne Water Corporation	406,376	393,543
Monash University	647,412	732,296
Murray-Darling Basin Commission	50,000	50,000
Goulburn-Murray Rural Water Authority	219,690	232,313
Gippsland & Southern Rural Water Authority	30,000	30,000
Wimmera-Mallee Rural Water Authority	60,000	60,000
The University of Melbourne	525,128	423,530
	6,045,077	6,830,967
Opening balance Party Contributions	18,571,646	11,740,679
Contributions this year, cash and inkind	6,045,077	6,830,967
Closing balance Party contributions	24,616,723	18,571,646

	2003	2002
	\$	\$

Note 3: Notes to the Statement of Cash Flows

(a) Reconciliation of Cash

Cash at the end of the financial year as shown in the Statement of Cash Flows is reconciled to the related items in the Statement of Financial Position as follows:

Cash Assets	715,957	1,540,345
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(b) Reconciliation of Loss from Ordinary Activities After Related Income Tax Expense to Net Cash Flows from Operating Activities

Loss from Ordinary Activities after related income tax	(6,904,988)	(7,561,607)
Non cash flows in Loss from Ordinary Activities after income tax:		
In-Kind expenditure	5,005,077	5,790,967
Changes in assets and liabilities:		
Increase / (Decrease) in Payables	(33)	22,180
(Increase) / Decrease in Receivables	(1,944)	(97,608)
Net cash provided/used in Operating Activities	(1,901,988)	(1,846,068)

Note 4: Receivables

Interest Receivable	6,202	6,409
Other Receivables	289,209	237,058
	295,411	243,467

Note 5: Accumulated Losses

Balance at beginning of financial year	(17,185,097)	(9,623,490)
Net Loss	(6,904,988)	(7,561,607)
Balance at end of financial year.	(24,090,085)	(17,185,097)



CRC for Catchment Hydrology Statement by Governing Board of the Centre

In the opinion of the Governing Board of the CRC for Catchment Hydrology, the financial statements present fairly the sources of funding, the application of funding and the financial position of the Centre in accordance with Applicable Accounting Standards, and in terms of clauses 4, 5.1, 5.2, 5.3, 9.1, 9.5 and 12.2 of the Commonwealth Agreement.

In particular:

- 1 (a) The Researchers' Contributions were made in accordance with the Budget as specified in the Agreement and their total value has equalled or exceeded the Grant (Clause 4). The actual cash and inkind contributions compared to the amounts committed in the Agreement are shown in Table 1 and Table 2.

(b) The valuation of In-kind contributions, including where appropriate, the use of salary multipliers has been in accordance with that specified in the Agreement and such valuations have been made on a fair and reasonable basis.

(c) The Researcher has used the Grant and the Researchers' Contributions only for the Activities of the Centre and not for any other purpose (Clause 5.1).

(d) A comparison of actual and agreement expenditure by Heads of Expenditure as shown in Table 3 for the 12 months to 30 June 2003 shows that the variation between actual and agreement figures is within the limits imposed by Clause 5.2

(e) Capital Items, as defined by Clause 5.3, acquired from the Grant or the Researchers' Contributions are vested as provided in the Joint Venture Agreement.

(f) Intellectual Property in all Contract Material is vested as provided in the Joint Venture Agreement and no Intellectual Property has been assigned or licensed without the prior approval of the Board and the Commonwealth (Clause 9.1, 9.5)

(g) Proper accounting standards and controls have been exercised in respect of the Grant and Researchers' Contributions and income and expenditure in relation to the Activities of the Centre has been recorded separately from other transactions of the Researcher (Clause 12.2).
2. The Financial Statements of the CRC for Catchment Hydrology, the Statement of Financial Performance, Statement of Financial Position, Statement of Cash Flows and accompanying Notes to the Financial Statements are drawn up to give a true and fair view of the state of affairs as at 30 June 2003.

This statement is made in accordance with a resolution of the Governing Board and is signed on behalf of the Governing Board.



John Langford Chairman, Governing Board



R.A. Vertessy Chief Executive Officer

Dated this 29th day of August 2003

INDEPENDENT REVIEW REPORT

**TO THE COOPERATIVE RESEARCH CENTRES PROGRAM, DEPARTMENT OF EDUCATION, SCIENCE
AND TRAINING, REPRESENTING THE COMMONWEALTH IN RESPECT OF THE COOPERATIVE
RESEARCH CENTRE FOR CARBONANT HYDROLOGY**

FINANCIAL INFORMATION FOR THE YEAR ENDED 30 JUNE 2013

Scope

We have reviewed the financial statements of the Cooperative Research Centre for Carbonant Hydrology ("CRC") for the financial year ended 30 June 2013 as set out in the attached tables 1 to 4. The parties to the CRC are responsible for the preparation and presentation of the financial information and fulfilling the requirements of the Commonwealth Agreement. We have performed an independent review of the financial statements in order to state whether, on the basis of the procedures described, anything has come to our attention that would indicate that the financial information is not presented fairly in accordance with the requirements of the Commonwealth Agreement in terms of Clauses 4, 5(1), 5(2), 4(3), 5(1), 5(2) and 12(2).

The financial information has been prepared for the parties to the CRC for the purposes of fulfilling their annual reporting obligations under clause 12(2) of the Commonwealth Agreement and for distribution to the Cooperative Research Centres Program, Department of Education, Science and Training, representing the Commonwealth of Australia. We disclaim any assumption of responsibility for any reliance on this review report or on the financial information to which it relates to any purpose other than the purpose of the CRC, or for any purpose other than that for which it was prepared.

This review has been conducted in accordance with Australian Auditing Standards applied to its review programme. The review was limited to specific procedures consisting primarily of:

- inspection of and written representations from CRC personnel as to:
 - the continued effectiveness of internal accounting controls;
 - the existence of material matters relating to the financial position and results of the CRC;
 - compliance with the terms of Clauses 4, 5(1), 5(2), 5(3), 5(4), 5(5) and 12(2) of the Commonwealth Agreement; and
- analytical procedures applied to the financial data.

Material Limitations

Because of the inherent limitations of any control system and reported structure it is possible that fraud, error, or other non-compliance with laws and regulations may occur and not be detected. Further, the limited nature of our work, under which the limited procedures that we have reviewed operate, has not been designed and we were not expected to detect all non-compliance.

A review is not designed to detect all weaknesses in control procedures as it is not performed continuously throughout the period and the tests performed are on a sample basis. Also, a review does not provide all the evidence that would be required in an audit, thus the level of assurance provided is less than given in an audit. We have not performed an audit and, accordingly, we do not express an audit opinion.

Any progression of the evaluation of control procedures to future periods is subject to the risk that the procedures may become inadequate because of a change in conditions, or that the degree of compliance with them may deteriorate.

Qualification

1. As a result of our review, we noted four instances of non-compliance with clause 1 of the Commission's Agreement, whereby the Marine's In Kind Contributions were lower than the amount agreed with the Commission:

Party	Amount Contributed (\$K)	Amount Contributed (\$K)
Bureau of Microbiology	421	360
CSIRO Land & Water	491	506
Department of Naturalistic and Environmental, NRM	417	380
Monash University	508	518

Qualifications

Based on our review, which is not an audit, except for the effects on the financial information of the marine, referred to in the qualification paragraph, nothing has drawn to our attention that causes us to believe that:

- the methodologies adopted by the Centre to value in-kind contributions other than salary costs do not have a material and reasonable basis, and each partner's contribution of the Researcher's Contributions for the year ended 30 June 2019 has not been provided at face value but that amount committed in the Budget as specified in the Commission's Agreement;
- the total value of all contributions for the year under review does not equal or exceed the amount of the grant paid during the year;
- the Researcher has used the Centre and the Researcher's Contributions to fund other than the Centre;
- there are material reporting irregularities;
- capital assets acquired from the Centre and Researcher's Contributions are not valued as provided in the Joint Venture Agreement;
- proper accounting, recording and controls have not been exercised in respect of the Centre and Researcher's Contributions;
- income and expenditure in relation to the activities of the Centre have not been recorded separately from other transactions of the Researcher;
- the Researcher's allocation of the budgetary resources between blocks of expenditure have been lower or higher than the allocation in the budget by \$200,000 or 20% (whichever is the greater amount) without prior approval by the Commission;
- intellectual property or all contract material is not valued as provided in the Joint Venture Agreement and intellectual property has been assigned or licensed without the prior approval of the Commission;

Deloitte Touche Tohmatsu
DELOITTE TOUCHE TOHMATSU

John Hetherington
JOHN HETHERINGTON
Partner
Chartered Accountant

Sydney, 17 September 2019



Appendix - Staff Resources
2002 - 2003

Appendix Staff Resources 2002 - 2003

Research Staff - Contributed as In-Kind Resources (100% = 1 person year)

Name	Main Activity	Total % Time	% Spent on Research Program (R)							Total on Research	% Spent on Education Program (8)/(E)	% Spent on Commercialisation Program (7)/(C)	% Spent on Administration Program (9)/(A)
			Subprograms										
			1	2	3	4	5	6	10				
Brisbane City Council													
Ms L. Peljo	R	9	0	0	0	5	0	0	0	5	0	4	0
Mr T. Weber	R	28	0	0	0	1	0	0	0	1	0	27	0
Total		37	0	0	0	6	0	0	0	6	0	31	0
Bureau of Meteorology													
Dr E. Ebert	R	6	0	0	0	0	6	0	0	6	0	0	0
Mr J. Elliott	R	1	0	0	0	0	0	0	0	0	0	1	0
Dr D. Gunasekera	C	4	0	0	0	0	0	0	0	0	0	4	0
Dr M. Manton	R	6	0	0	0	0	6	0	0	6	0	0	0
Dr G. Mills	R	11	0	0	0	0	11	0	0	11	0	0	0
Dr A. Seed	R	49	0	0	0	0	49	0	0	49	0	0	0
Dr S. Srikanthan	R	91	0	0	0	0	86	0	0	86	0	5	0
Mr B. Stewart	C	1	0	0	0	0	0	0	0	0	0	1	0
Total		169	0	0	0	0	158	0	0	158	0	11	0
CSIRO Land and Water													
Mr J. Coleman	R	7	0	0	0	7	0	0	0	7	0	0	0
Ms S. Cuddy	R	31	31	0	0	0	0	0	0	31	0	0	0
Mr W. Dawes	R	20	9	11	0	0	0	0	0	20	0	0	0
Dr J. Gallant	R	2	2	0	0	0	0	0	0	2	0	0	0
Dr M. Gilfedder	R	6	0	6	0	0	0	0	0	6	0	0	0
Dr P. Hairsine	R	51	19	27	0	0	0	0	0	46	0	5	0
Dr N. McKenzie	R	1	0	1	0	0	0	0	0	1	0	0	0
Ms F. Marston	R	17	17	0	0	0	0	0	0	17	0	0	0
Mr N. Murray	R	4	4	0	0	0	0	0	0	4	0	0	0
Dr J. Olley	R	18	0	18	0	0	0	0	0	18	0	0	0
Dr I. Prosser	R	42	0	38	0	0	0	4	0	42	0	0	0
Mr J. Rahman	R	51	50	0	0	0	0	0	0	50	0	1	0
Mr S. Seaton	R	18	18	0	0	0	0	0	0	18	0	0	0
Dr R. Silberstein	R	10	0	10	0	0	0	0	0	10	0	0	0
Prof R. Vertessy	A	50	15	0	0	0	0	0	0	15	0	10	25
Dr N. Viney	R	23	0	0	0	0	23	0	0	23	0	0	0
Dr G. Walker	R	22	0	22	0	0	0	0	0	22	0	0	0
Dr P. Wallbrink	R	25	0	25	0	0	0	0	0	25	0	0	0
Dr W. Young	R	5	0	5	0	0	0	0	0	5	0	0	0
Dr L. Zhang	R	19	0	19	0	0	0	0	0	19	0	0	0
Total		422	165	182	0	7	23	4	0	381	0	16	25
Dept of Infrastructure, Planning and Natural Resources, NSW													
Dr G. Geeves	R	8	0	4	0	0	0	0	0	4	0	4	0
Dr M. Littleboy	R	25	5	20	0	0	0	0	0	25	0	0	0
Dr N. Nandakumar	C	5	0	0	0	0	0	0	1	1	0	4	0
Mr G. Podger	R	20	20	0	0	0	0	0	0	20	0	0	0
Mr G. Summerell	R	56	0	56	0	0	0	0	0	56	0	0	0
Dr N. Tuteja	R	3	0	1	0	0	0	0	2	3	0	0	0
Ms C. Young	C	50	0	19	0	0	0	0	0	19	0	31	0
Mr C. Zierholz	C	37	5	3	0	0	0	0	0	8	0	29	0
Total		204	30	103	0	0	0	0	3	136	0	68	0

Research Staff - Contributed as In-Kind Resources (100% = 1 person year)

Name	Main Activity	Total % Time	% Spent on Research Program (R)							Total on Research	% Spent on Education Program (8)/(E)	% Spent on Commercialisation Program (7)/(C)	% Spent on Administration Program (9)/(A)
			Subprograms										
			1	2	3	4	5	6	10				
Department of Natural Resources and Mines, Qld													
Mr C. Carroll	C	22	0	10	0	0	0	0	0	10	0	12	0
Mr B. Cowie	C	10	0	0	0	0	0	0	0	0	0	10	0
Mr R. DeHayr	R	61	0	61	0	0	0	0	0	61	0	0	0
Mr R. Gillespie	R	15	0	15	0	0	0	0	0	15	0	0	0
Mr M. Gooda	R	6	4	0	0	0	0	0	0	4	0	2	0
Dr H. Hunter	R	39	0	39	0	0	0	0	0	39	0	0	0
Mr G. Miller	R	82	0	74	0	0	0	0	0	74	0	8	0
Mr B. Powell	R	10	0	10	0	0	0	0	0	10	0	0	0
Dr D. Rassam	R	67	0	62	0	0	0	0	0	62	0	5	0
Mr J. Ruffini	R	4	1	1	1	0	0	0	0	3	0	1	0
Mr M. Sallaway	C	25	2	4	1	1	0	0	0	8	5	12	0
Mr R. Searle	C	16	0	0	0	0	0	0	0	0	0	16	0
Mr M. Sillburn	R	22	0	22	0	0	0	0	0	22	0	0	0
Mr S. Stevens	R	56	0	15	0	0	0	0	0	15	0	41	0
Total		435	7	313	2	1	0	0	0	323	5	107	0
Department of Sustainability and Environment, Vic													
Dr B. Christy	R	61	0	61	0	0	0	0	0	61	0	0	0
Mr M. Bethune	R	43	0	43	0	0	0	0	0	43	0	0	0
Dr C. Beverley	R	60	0	60	0	0	0	0	0	60	0	0	0
Mr M. Eigenraam	R	4	0	3	1	0	0	0	0	4	0	0	0
Mr B. James	R	9	0	0	9	0	0	0	0	9	0	0	0
Dr P. Lane	R	69	0	69	0	0	0	0	0	69	0	0	0
Dr J. Morris	R	100	0	100	0	0	0	0	0	100	0	0	0
Dr Q. Wang	R	4	0	4	0	0	0	0	0	4	0	0	0
Mr R. Wimalasuriya	R	4	0	0	4	0	0	0	0	4	0	0	0
Total		354	0	340	14	0	0	0	0	354	0	0	0
Goulburn-Murray Water													
Mr S. Dharmadi	R	3	0	0	3	0	0	0	0	3	0	0	0
Mr G. Earl	R	1	0	0	1	0	0	0	0	1	0	0	0
Mr P. Feehan	C	7	0	0	0	0	0	0	0	0	0	7	0
Mrs S. Hawthorne	R	2	0	0	1	0	0	0	0	1	0	1	0
Mr S. Papworth	C	19	0	0	0	0	0	0	0	0	0	19	0
Mr M. Seeker	R	2	0	0	2	0	0	0	0	2	0	0	0
Total		34	0	0	7	0	0	0	0	7	0	27	0
Griffith University													
Prof S. Bunn	R	7	0	4	0	0	0	3	0	7	0	0	0
Dr C. Fellows	R	7	0	7	0	0	0	0	0	7	0	0	0
Assoc Prof J. Fien	E	19	0	0	0	0	0	0	0	0	19	0	0
Assoc Prof M. Greenway	R	30	0	0	0	30	0	0	0	30	0	0	0
Prof J. Hughes	A	1	0	0	0	0	0	0	0	0	0	0	1
Dr G. Jenkins	R	6	0	0	0	6	0	0	0	6	0	0	0
Dr I. Phillips	R	1	0	0	0	1	0	0	0	1	0	0	0

(continued next page)

Appendix Staff Resources 2002 - 2003

Research Staff - Contributed as In-Kind Resources (100% = 1 person year)

Name	Main Activity	Total % Time	% Spent on Research Program (R)							Total on Research	% Spent on Education Program (8)/(E)	% Spent on Commercialisation Program (7)/(C)	% Spent on Administration Program (9)/(A)
			Subprograms										
			1	2	3	4	5	6	10				
Griffith University (continued)													
Prof R. Rickson	C	10	0	0	0	0	0	0	0	0	0	10	0
Dr T. Smith	E	50	0	0	0	0	0	0	0	0	50	0	0
Dr J. Tisdell	R	50	0	0	45	0	0	0	0	45	0	5	0
Prof R. Tomlinson	R	7	0	0	0	7	0	0	0	7	0	0	0
Dr B. Yu	R	50	0	1	49	0	0	0	0	50	0	0	0
Total		238	0	12	94	44	0	3	0	153	69	15	1

Melbourne Water

Mr H. Duncan	R	100	0	0	0	100	0	0	0	100	0	0	0
Mr M. Francey	R	12	0	0	0	12	0	0	0	12	0	0	0
Ms C. Hughes	C	9	0	0	0	0	0	0	0	0	9	0	0
Mr G. Rooney	C	9	0	0	0	2	0	0	0	2	0	7	0
Mr S. Seymour	R	2	0	0	0	2	0	0	0	2	0	0	0
Mr I. Watson	R	1	0	1	0	0	0	0	0	1	0	0	0
Total		133	0	1	0	116	0	0	0	117	0	16	0

Monash University

Assoc Prof G. Codner	R	19	7	0	11	0	0	0	0	18	0	1	0
Dr A. Deletic	R	24	0	0	0	21	0	0	0	21	0	3	0
Assoc Prof R. Keller	R	42	0	3	0	0	0	38	0	41	0	1	0
Dr A. Ladson	R	37	1	0	0	6	0	30	0	37	0	0	0
Mr E. Weinmann	R	76	0	0	37	3	1	11	4	56	3	17	0
Assoc Prof I. Wills	R	2	0	0	2	0	0	0	0	2	0	0	0
Assoc Prof T. Wong	R	41	0	0	0	35	0	0	0	35	3	3	0
Mr R. Wootton	R	12	0	0	0	7	0	0	0	7	5	0	0
Total		253	8	3	50	72	1	79	4	217	11	25	0

The University of Melbourne

Dr R. Argent	R	3	2	1	0	0	0	0	0	3	0	0	0
Dr F. Chiew	R	7	0	0	0	7	0	0	0	7	0	0	0
Dr B. Downes	R	4	0	0	0	0	0	4	0	4	0	0	0
Prof J. Fenton	R	1	0	0	0	0	0	1	0	1	0	0	0
Assoc Prof B. Finlayson	R	8	0	0	0	0	0	6	0	6	1	1	0
Assoc Prof R. Grayson	R	26	14	3	1	0	2	2	2	24	0	2	0
Prof T. McMahon	R	30	0	11	11	0	5	0	0	27	1	2	0
Assoc Prof H. Malano	R	27	0	0	27	0	0	0	0	27	0	0	0
Dr M. Peel	R	76	0	48	0	0	28	0	0	76	0	0	0
Assoc Prof I. Rutherford	R	17	0	1	0	1	2	11	0	15	0	2	0
Assoc Prof I. Simmonds	R	7	0	0	0	0	7	0	0	7	0	0	0
Mr L. Siriwardena	R	34	0	0	0	4	24	0	0	28	0	6	0
Mr J. Styles	R	1	0	0	0	0	0	1	0	1	0	0	0
Dr T. Weaver	E	16	0	0	0	0	0	0	0	0	16	0	0
Dr A. Western	R	3	1	1	0	0	0	1	0	3	0	0	0
Dr S. Zhou	R	3	0	0	0	0	3	0	0	3	0	0	0
Total		263	17	65	39	12	71	26	2	232	18	13	0

Appendix Staff Resources 2002 - 2003

Research Staff - CRC Funded Resources (100% = 1 person year)

Name	Employing Organisation	Main Activity	Total % Time	% Spent on Research Program (R)						Total on Research	% Spent on Education Program (8)	% Spent on Commercialisation Program (7)	% Spent on Administration Program (9)
				Subprograms									
				1	2	3	4	5	6				
Dr A. Frost	Bureau of Met	R	13					13					
Dr H. Richter	Bureau of Met	R	100					100					
Ms A. Best	CSIRO	R	50		50								
Dr G. Caitcheon	CSIRO	R	38		38								
Dr E. Christen	CSIRO	R	6		6								
Mr J. Coleman	CSIRO	R	68	51			17						
Dr H. Cresswell	CSIRO	R	3		3								
Ms S. Cuddy	CSIRO	R	7	7									
Mr T. Dowling	CSIRO	C	28		10					18			
Ms L. Gregory	CSIRO	R	5		5								
Dr P. Hairsine	CSIRO	R	31		13					5		13	
Mr H. Hotham	CSIRO	R	17	17									
Dr A. Hughes	CSIRO	R	40		40								
Dr S. Khan	CSIRO	R	5		5								
Dr N. McKenzie	CSIRO	R	3		3								
Mr N. Murray	CSIRO	R	10	10									
Mr J. Perraud	CSIRO	R	17	17									
Mr J. Rahman	CSIRO	R	40	40									
Mr L. Richardson	CSIRO	R	8		8								
Mr S. Seaton	CSIRO	R	48	48									
Dr R. Silberstein	CSIRO	R	5		5								
Prof R. Vertessy	CSIRO	R	50						30	7		13	
Dr L. Zhang	CSIRO	R	18		18								
Dr M. Littleboy	DIPNR, NSW	R	5		5								
Mr G. Podger	DIPNR, NSW	R	5	5									
Mr M. Bethune	DSE/DPI (DNRE)	R	10		10								
Mr P. Burger	DNRM	R	8		8								
Ms R. Duncan	DNRM	R	25		25								
Mr G. Peck	DNRM	R	14		14								
Mr L. Pink	DNRM	R	8		8								
Dr D. Rassam	DNRM	R	30		30								
Ms N. Beard	Griffith Univ.	R	6		6								
Dr C. Fellows	Griffith Univ.	R	15		15								
Dr N. Marsh	Griffith Univ.	R	20				20						
Dr J. Tisdell	Griffith Univ.	R	50			50							
Dr J. Ward	Griffith Univ.	R	50			50							
Dr J. Whelan	Griffith Univ.	E	38						38				
Dr B. Yu	Griffith Univ.	R	10		10								
Mr A. Barton	Mon. Univ.	R	6				6						
Dr T. Fletcher	Mon. Univ.	R	100				100						
Ms S. Johnson	Mon. Univ.	R	5				5						
Mr J. Lewis	Mon. Univ.	R	64				64						
Ms S. Lloyd	Mon. Univ.	R	1				1						
Mr D. Perry	Mon. Univ.	R	100						10	90			
Mr P. Poelsma	Mon. Univ.	R	85				85						
Mr A. Ramchurn	Mon. Univ.	R	15			15							
Dr S. Schreider	Mon. Univ.	R	100			100							
Mr G. Taylor	Mon. Univ.	R	6				6						
Mr F. Winston	Mon. Univ.	R	16					16					
Assoc Prof T. Wong	Mon. Univ.	R	12				12						

Appendix Staff Resources 2002 - 2003

Research Staff - CRC Funded Resources (100% = 1 person year)

Name	Employing Organisation	Main Activity	Total % Time	% Spent on Research Program (R)							Total on Research	% Spent on Education Program (8)	% Spent on Commercialisation Program (7)	% Spent on Administration Program (9)		
				Subprograms												
				1	2	3	4	5	6	10						
Dr R. Argent	Univ. Melb.	R	67	67									67			
Mr D. Bennett	Univ. Melb.	R	6		3					3			6			
Mr D. Borg	Univ. Melb.	R	16							16			16			
Dr F. Chiew	Univ. Melb.	R	80				2	78					80			
Assoc Prof R. Grayson	Univ. Melb.	R	30	30									30			
Mr C. Harman	Univ. Melb.	R	5							5			5			
Ms Hayes	Univ. Melb.	R	13							13			13			
Mr D. Kandel	Univ. Melb.	R	24	24									24			
Dr G. Lacey	Univ. Melb.	R	3							3			3			
Mr M. Leahy	Univ. Melb.	R	13					13					13			
Dr A. Ladson	Univ. Melb.	R	19		7					12			19			
Mr McCabe	Univ. Melb.	R	54	36				18					54			
Prof. T. McMahon	Univ. Melb.	R	9									4	0		5	
Mr R. Pipunic	Univ. Melb.	R	20	20									20			
Assoc Prof I. Rutherford	Univ. Melb.	R	20							20			20			
Mr L. Siriwardena	Univ. Melb.	R	56				15	41					56			
Mr A. Smith	Univ. Melb.	R	4					4					4			
Dr M. Stewardson	Univ. Melb.	R	100							100			100			
Mr D. Verrelli	Univ. Melb.	R	80	58	7					15			80			
Mr Wealands	Univ. Melb.	R	5					4	1				5			
Dr A. Western	Univ. Melb.	R	78	44				34					78			
Mr D. Wilson	Univ. Melb.	R	10	10									10			
Mr R. Young	Univ. Melb.	R	61	13				48					61			
Dr S. Zhou	Univ. Melb.	R	65					65					65			
TOTAL			2,252	497	352	215	333	418	204	0	2,019	78	124	31		

Summary of Contributions in Person Years

	Total Equivalent Person Years	Person Years Spent on Research Programs Subprogram								Total on Research	Person Years Spent on Education Program	Person Years Spent on Education Program	Person Years Spent on Education Program
		1	2	3	4	5	6	10					
Total Contributed as In-Kind	25.42	2.27	10.19	2.06	2.58	2.53	1.12	0.09	20.84	1.03	3.29	0.26	
Total Funded by CRC	22.52	4.97	3.52	2.15	3.33	4.18	2.04	0.00	20.19	0.78	1.24	0.31	
Grand Total	47.94	7.24	13.71	4.21	5.91	6.71	3.16	0.09	41.03	1.81	4.53	0.57	

Proportion of total professional staff resources in each activity

100	15	29	9	12	14	7	0	86	4	9	1
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Support Staff

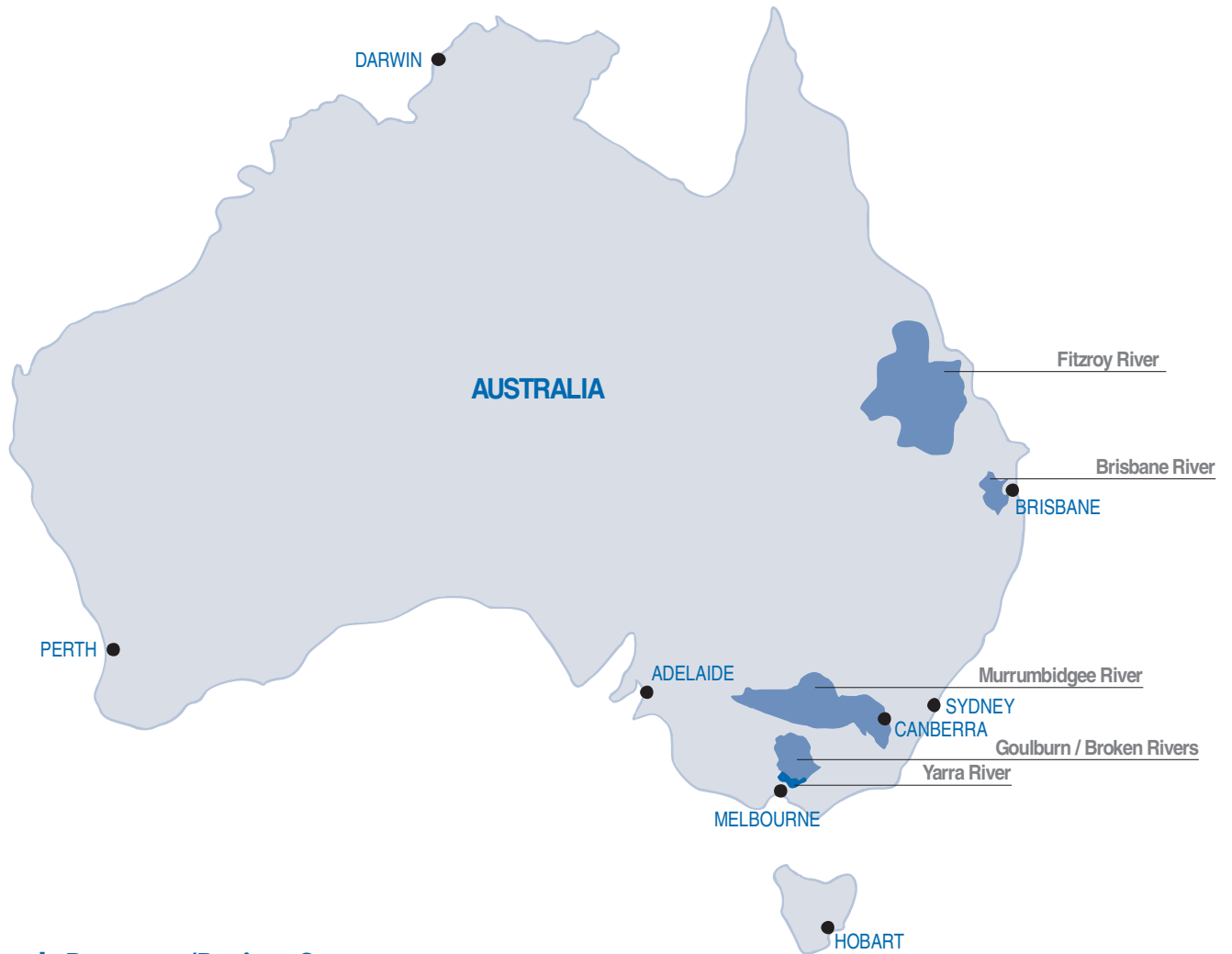
(1) Contributed

Organisation	Number of Staff Person Years
CSIRO	0.00
Monash University	0.00
The University of Melbourne	0.00
TOTAL	0.00

(2) CRC Funded

Organisation	Number of Staff Person Years
CSIRO	1.28
Monash University	2.16
The University of Melbourne	0.00
TOTAL	3.44

Focus Catchments (at June 2003)



Research Program/Project Structure

Core Projects

Program 1

Predicting Catchment Behaviour

- 1.1 Development of a catchment modelling toolkit
- 1.2 Scaling procedures to support process-based modelling at large scales
- 1.09 (1A) Implementation of the Catchment Modelling Toolkit
- 1.10 (1B) Methods for integration in catchment prediction

Program 2

Land-use Impacts on Rivers

- 2.1 Sediment movement, water quality and physical habitat in large river systems
- 2.2 Managing pollutant delivery in dryland upland catchments
- 2.3 Predicting the effects of land-use changes on catchment water yield and stream salinity
- 2.5 Nitrogen and carbon dynamics in riparian buffer zones
- 2.19 (2A) Reducing the impacts of irrigation and drainage on river water salinity
- 2.20 (2B) Improved suspended sediment and nutrient modelling through river networks
- 2.21 (2C) Predicting salt movement in catchments
- 2.22 (2D) Modelling and managing nitrogen in riparian zones to improve water quality
- 2.23 (2E) Modulating daily flow duration curves to reflect the impact of land-use change

Program 3

Sustainable Water Allocation

- 3.1 Integration of water balance, climatic and economic models
- 3.2 Enhancement of the water market reform process
- 3.08 (3A) Hydrologic and economic modelling for water allocation
- 3.09 (3B) An evaluation of permanent water markets

Program 4

Urban Stormwater Quality

- 4.1 Stormwater pollutant sources, pathways and impacts
- 4.2 Stormwater best management practices
- 4.08 (4A) Development of integrated stormwater models
- 4.09 (4B) Predicting urban stormwater quality, treatment and impacts

Program 5

Climate Variability

- 5.1 Modelling and forecasting hydroclimate variables in space and time
- 5.2 National data bank of stochastic climate and streamflow models
- 5.05 (5A) Hydrological modelling for weather forecasting
- 5.06 (5B) Stochastic rainfall data generation models

Program 6

River Restoration

Project Group A: Stream Restoration - Procedures and Evaluation

- 6.1 Developing criteria and concepts for planning the evaluation of stream rehabilitation projects
 - 6.2 Optimising urban stream rehabilitation planning and execution
 - 6.3 Restoration ecology in the Granite Creeks, Victoria
 - 6.4 Evaluation of riparian revegetation in a south-east Queensland catchment
- Project Group B: Tools for Stream Restoration
- 6.5 Hydraulics and performance of fishways in Australian Streams
 - 6.6 Developing tools to predict scour of rehabilitation works
 - 6.7 Developing an improved method for designing and optimising environmental flow
 - 6.11 (6A) Development of flow-ecological response models
 - 6.12 (6B) Predicting spatial and temporal variations in channel form



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Australian Government's Cooperative
Research Centres Programme

The Cooperative Research Centre for Catchment Hydrology is a cooperative venture formed under the Australian Government's CRC Programme between:

Brisbane City Council
Bureau of Meteorology
CSIRO Land and Water
Department of Infrastructure, Planning and Natural Resources, NSW
Department of Sustainability and Environment, Vic
Goulburn-Murray Water
Griffith University

Melbourne Water
Monash University
Murray-Darling Basin Commission
Natural Resources and Mines, Qld
Southern Rural Water
The University of Melbourne
Wimmera Mallee Water

Associate:

Water Corporation of Western Australia

Industry Affiliate:

WBM

Research Affiliates:

Australian National University
National Institute of Water and Atmospheric Research,
New Zealand
University of New South Wales

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