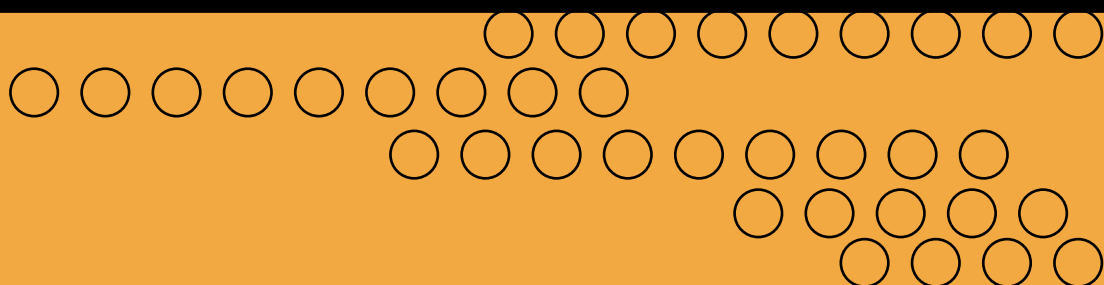


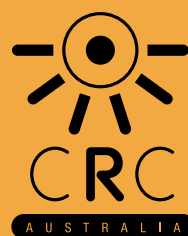


Cooperative Research Centre for Water Quality and Treatment

Annual Report 2001 - 2002



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



**Mission**

To assist the Australian water industry produce high quality drinking water at an affordable price.

Vision

By 2010, the Australian water industry will have achieved a high level of community confidence in the safety and quality of the country's water supply systems. Research undertaken by the Centre will have laid a solid foundation for evidence based investment decisions for water infrastructure, as well as providing innovative solutions for achieving enhanced aesthetic water quality that meets community needs.

Objectives

- Undertaking a high quality, targeted research program that seeks to provide the knowledge and innovative solutions required to meet national and water industry objectives for drinking water quality in the major urban centres and in regional Australia, including small rural and indigenous communities.
- Building on the success of the existing cooperation activity between the Parties to incorporate evidence-based guidelines into the Australian drinking water regulatory system.
- Involving a high proportion of the water industry end-users in the development, conduct and utilisation of the research and other activities of the CRC for Water Quality and Treatment.
- Enhancing the strategic international alliances to ensure that CRC for Water Quality and Treatment activities are well founded on the best experience and knowledge already available, and to provide, where appropriate, the benefit of Australian experience and opinion in the formulation of international water quality management strategies and guidelines.
- Providing high quality, well trained and informed professionals as future leaders in the industry through an extensive postgraduate student program.
- Effectively communicating the outcomes of the CRC for Water Quality and Treatment research activity to the industry and the community.

Cooperative Research Centre for Water Quality and Treatment

Annual Report 2001 - 2002

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Introduction by the Chairman

The CRC for Water Quality and Treatment has now entered its second life, with the first CRC officially winding up on June 30, and the new CRC completing its first full year of operations.



Emeritus Prof Nancy Millis

I would like to take this opportunity to reflect a little on what made the first Centre such a success, and on what will make the second just as successful.

There are a number of reasons for claiming success for the first CRC.

First and foremost, in the first CRC we enjoyed strong industry participation throughout; the benefit industry derived from this is reflected in the increased support we received for the second CRC, with its new and increased research program.

The Cooperative Research Centres Program is designed to initiate collaborative research that is supported generously by the industry it serves or generates returns from commercialisation of the research. Our Centre has certainly achieved this.

The level of industry support for the CRC can be seen also in the increasing demand by industry to participate in CRC activities. The number of Parties grew from 17 in 1995 to 29 in the new Centre. Interest in participating in the CRC was so great that we created an Associate membership category to accommodate smaller organisations. Workshop attendance is enthusiastic, and many industry Parties are now participating in research activity.

I was particularly pleased with the outcomes from the Fifth Year Review, in that an impressive team of international experts was asked to evaluate the quality of research being undertaken in the Centre. The reports received were an impressive endorsement of its quality, and I believe were also a ringing endorsement of the benefits of the Co-operative Research Centres concept.

It is important to recognise the attributes that contributed to the success of our first Centre, so that we can ensure they remain core aspects of the new Centre.

Most importantly, I think, all parties feel the inclusiveness that has been characteristic of the Centre to date. One aspect of the Centre's processes that tends to promote this inclusiveness is the way in which projects are developed. Each Party is encouraged to participate in all stages of project formulation from the conceptual stages through priority setting to actual conduct of the research. In addition, there is ample opportunity to participate in implementation activities, such as sharing the knowledge developed in the research and utilisation of any technological outcomes.

Another feature that has contributed to our success is the Centre's unambiguous mission – *helping the Australian water industry provide high quality water at an affordable price*. This mission gives us all a clear common goal to work towards.

The Centre enjoys the benefits of strong international links. This encourages researchers to set very high standards for their research and stimulates extensive collaboration. These links also enable industry parties to benefit from international experience and strengthens and extends valuable networks.

A very rewarding aspect of the Centre's activities is its successful Education and Training Program. Our students are the future leaders of the water industry, providing enthusiasm and a fresh perspective to the problems facing the industry. I am proud to say that 17 CRC postgraduates have completed their studies. Four more are waiting on the examination of their theses. Ten of these students are now working in the Australian water industry, with two others in environmental roles.

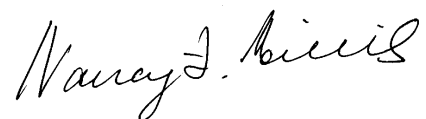
I believe that the characteristics I have just outlined are the key to a successful life for the second CRC. I have confidence that the research portfolio is a good one, with a

balance of short and longer-term projects. The commitment of the research team to achieve results, and the eagerness of the water industry to utilise research outcomes, provides me with that confidence.

The transition to the new management arrangements with a smaller, elected Board of Management is working well. The introduction of a full Member's Meeting adjacent to each Board meeting and a research presentation, has enabled the Centre to keep each Party fully informed, while streamlining the governance arrangements.

On behalf of the Board of Management, I congratulate all the Centre staff for their performance during another demanding year, and especially the leadership and dedication of the Chief Executive Officer, Prof Don Bursill.

I would also like to thank all those who have served on the Board of Management during the life of the first CRC, and welcome those who joined us this year, both Board members and Party Representatives. The enthusiasm and support from all Parties has been excellent, and made my task a very rewarding one.



Emeritus Professor Nancy Millis, AC MBE, Chairman

Chief Executive Officer's Report

This past year has been an important and challenging one for the Centre, being the first year of the CRC for Water Quality and Treatment Mark II, as well as the seventh year of Mark I.



Prof Don Bursill

These dual roles provided significant challenge for the Centre team, as we worked towards meeting our commitments for Mark I as well as developing the new research activity of Mark II. The additional requirement of integrating the new parties and getting them well engaged in all aspect of the Centre added to the demands on the Centre team.

I think the team has done a wonderful job, with people coming together from around the water industry and research community to discuss our existing and proposed work programs and set priorities for the new Centre. Working together to plan research has strengthened the cooperative links that played such a vital role in the success of Mark I, and have renewed our common sense of purpose.

The new Centre has many exciting new features that build on what we achieved in Mark I. We have more participating organisations, with 29 full Parties and nine Associate members. As the number of our participants has increased, so has their commitment of cash and in-kind resources. The budget for Mark II is over \$80 million, which will support some highly innovative research.

Mark II will build on the valuable work of Mark I, as well as moving into completely new areas of research. Our Health and Aesthetics Program Group still includes epidemiology, a strength from Mark I, but now also includes toxicology and a social research agenda.

The Catchment to Customer Program Group is adding to the extensive work already completed in the source water, water treatment and distribution management areas completed in the first Centre, and incorporates sustainable water resources and monitoring work to further enhance the research coverage for our water industry Parties.

The Policy, Regulation and Stakeholder Involvement Program Group brings together the Centre activities that have a strong element of two-way communication with end-users, to support the research programs and provide a focus for stakeholder involvement.

One of the many activities of this third Program Group is to consider the long term research and development needs of the Australian water industry. It has been my view for some time that Australia needs a national water technology centre that provides research and certain other services to the water utility industry.

The funding provided by the CRC Parties and the Commonwealth Government will cover our program of activities until June 2008. However, the Cooperative Research Centres Program was never intended to provide on-going support of new institutions and there is a reasonable expectation that Centres should become self-supporting after two rounds.

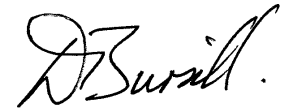
After 2008, if Australia is to have a national drinking water research centre, it will need to be entirely supported by the Australian water industry. We as a community need to begin talking about what form this national centre would take now, and not leave it until the CRC funding is about to expire.

The CRC has established a strong position in the water community in Australia and internationally for its work to date. It provides an excellent foundation on which to build a national water technology centre, and the programs in the Policy, Regulation and Stakeholder Involvement Program Group offer an ideal forum for the industry to maintain an on-going conversation on this issue.

Finally, my special thanks go to our Chairman, Emeritus Professor Nancy Millis for her outstanding leadership and for the enthusiasm she has for leading the Centre. We all look forward to her continuing guidance as we tackle the challenges of the new Centre and move towards the national research centre that we hope will succeed the CRC.

I would like to add my thanks to those of our Chairman for the support of the people who have served on the Board of Management through the life of the CRC Mark I. I think we have been privileged to have the collective wisdom of these people focused on the development of a research facility that has ambitious goals for the water industry in Australia. It is always hard to create something new and worthwhile, but it can be achieved with a good team and wise council.

I would also like to thank Dr Tony Priestley and Dr Dennis Steffensen, the Deputy Chief Executives, and each member of the Management Committee, for the support they have shown me, and their commitment to the goals of the Centre through a critical year in our history.



Prof Don Bursill
Chief Executive Officer

Highlights

In the first year of the new Centre's operations, **23 new projects** have been approved by the Governing Board.

PhD student Kim Fergusson was awarded the Water Forum's 2002 **Young Water Scientist of the Year** Award for work on identifying toxic cyanobacteria using DNA technologies.

International links were strengthened - the Centre hosted the tenth biennial meeting of the **Emerging Technologies Group** and is one of twelve founding members of the **Global Water Research Coalition**, an alliance dedicated to promoting international cooperation and collaboration in water-related research.

Nine students graduated this year, with two awaiting conferral of their awards and eight awaiting their thesis examination outcomes. The Centre has now produced **17 postgraduates**, 12 of whom work in the water industry or a related research agency.

The **Framework for Drinking Water Quality Management** has been incorporated into the Australian Drinking Water Guidelines.

A **cell culture assay method** has been developed and verified that provides a cheaper and more reliable method of studying infectivity of *Cryptosporidium*.

Due to Centre research, water authorities can now estimate the doses of PAC needed to remove the toxins **microcystins LR and LA**.

Centre researchers have identified the factors that affect the origin and nature of **natural organic matter** in catchments, resulting in better approaches to water treatment.

Water managers can achieve better control of chlorine levels in distribution systems through the use of a field-validated **chlorine decay model** developed by Centre researchers.

Research Projects

RESEARCH DIRECTIONS		RESEARCH STATUS		
		Complete	Active	Commercial
PROGRAM 1A: EPIDEMIOLOGY				
Project 1.1.1	Water Supply Modelling for Estimating and Minimising the Risk to Consumers from <i>Campylobacter</i> and <i>Cryptosporidium</i>	✓		
Project 1.1.5	Drinking Water Quality Management System			
Project 1.1.6	Drinking Water Quality Risk Guidance		✓	
Project 1.2.2	Early Detection of Outbreaks of Waterborne Gastroenteritis	✓		
Project 1.2.3	The Effect of Chlorination on the Rates of Gastroenteritis	✓		
Project 1.2.4	Fluoridation of Drinking Water Supplies	✓		
Project 1.2.5	A System for the Early Detection of Outbreaks of Water Related Gastroenteritis for Australia		✓	
Project 1.2.6	Water Quality Standards and Models for Legal Regulation	✓		
Project 1.3.1.2	Cyanobacterial Bloom Occurrence in Drinking Water Sources and Health Effects	✓		
Project 1.3.1.5	Acute Skin Irritant Effects of Cyanobacteria (Blue-Green Algae) in Healthy Volunteers	✓		
Project 1.3.3.1	The Water Quality Study	✓		
Project 1.3.3.2	Norwalk-Like Viruses and its Contribution to Drinking Water		✓	
Project 1.3.4.1	Economic Evaluation of Community Gastroenteritis	✓		
Project 1.3.5.1	Disinfection By-Products in Drinking Water and Biomarkers in Bladder Epithelial Cells	✓		
Project 1.3.5.3	DBP Exposure Assessment	✓		
Project 1.3.6.1	Environmental Arsenic Exposure and Human Absorption	✓		
Project 1.3.6.2	An Intervention Trial to Assess the Contribution of Food Chain to Total Arsenic Exposure (Bangladesh)		✓	
Project 1.3.7.2	Alice Springs Workshop	✓		
Project 1.3.7.4	Technology Transfer Officer Dealing with Water Quality and Treatment in Indigenous Communities	✓		
Project 1.3.7.5	Drinking Water and Melioidosis		✓	
Project 1.3.8.1	Validation and Pilot Study	✓		
Project 1.3.8.2	Case Control Study of Risk Factors for Sporadic Cryptosporidiosis in Melbourne		✓	
Project 1.3.8.3	Case Control Study of Risk Factors for Sporadic Cryptosporidiosis in Adelaide		✓	
Project 1.9.6.5	Framework for Management of Drinking Water Quality – Application, Implementation, Regulation		✓	
Project 1.1.0.2	Literature Review Endocrine Disrupters		✓	
PROGRAM 1B: TOXICOLOGY				
Project 1.3.1.1	Cyanobacterial Tumour Promotion		✓	
Project 1.3.1.6	Ecology and Health implications of Potentially Toxic Cyanobacteria in Queensland		✓	
Project 1.2.0.1	Recreational Exposure to Cyanobacteria		✓	
Project 1.2.0.2	Cylindrospermopsin, Carcinogenicity, Genotoxicity & Mechanism of Toxic Action – Development of Human Exposure		✓	
Project 1.2.0.3	Literature Review Endocrine Disrupters		✓	
PROGRAM 1C: PEOPLES PERSPECTIVE				
Project 1.3.0.2	National Community Survey on Attitudes to Drinking Water Quality, Phase 1		✓	
PROGRAM 2A: CATCHMENTS				
Project 2.2.1.1	Management of Pathogens in Source Waters (Vic)		✓	
Project 2.2.1.2	Management of Pathogens in Source Waters (WA)		✓	
Project 2.2.1.3	Management of Pathogens in Source Waters (SA)		✓	
Project 2.2.1.4	Management of Pathogens in Source Waters (ACT)		✓	
Project 2.2.2	Fate and Transport of Surface Water Pathogens in Watersheds		✓	
PROGRAM 2B: RESERVOIRS				
Project 2.1.1	Characterisation of Natural Organic Matter		✓	
Project 2.1.2	The Influence of NOM on the Movement of Phosphorous in Soils	✓		
Project 2.1.3	Photochemical Degradation and Remineralisation of Dissolved Organic Carbon in the Warren Reservoir		✓	
Project 2.1.4	Microbial Degradation and Remineralisation of Dissolved Organic Carbon in the Warren Reservoir		✓	
Project 2.2.1	Identification and Control of Sources of Infectious Pathogens in Catchments		✓	
Project 2.3.1.1	Development of Analytical Methods for Rapid Detection of Toxin in Water	✓		
Project 2.3.1.2	Characterisation and Determination of PSP Toxins in Neurotoxic Cyanobacteria and Methods for their Removal	✓		
Project 2.3.1.3	Determination of the Hepatoxin Cylindrospermopsin produced by the Cyanobacteria <i>Cylindrospermopsis raciborskii</i>	✓		
Project 2.3.1.4	Development of an ELISA Method for Microcystins		✓	
Project 2.3.2.1	Genetics of Microcystin Production by Cyanobacteria	✓		✓
Project 2.3.2.2	Genetics of Saxitoxin Production by <i>Anabaena circinalis</i>		✓	
Project 2.3.2.3	Characterisation of Toxins Produced by the Cyanobacterial Genus <i>Anabaena</i> in Australian Water Supplies and Factors Influencing their Production	✓		

Research Projects

RESEARCH DIRECTIONS		RESEARCH STATUS		
		Complete	Active	Commercial
Project 2.3.2.4	Regulation of Cylindrospermopsin Production by <i>Cylindrospermopsis raciborskii</i>	✓		
Project 2.3.2.7	Investigation of Growth Factors Affecting Production of Cylindrospermopsin and other Toxins by the Cyanobacterium <i>Cylindrospermopsis raciborskii</i>	✓		
Project 2.3.3.1	Application of Image Analysis to Cyanobacteria		✓	
Project 2.3.3.2	Rapid Methods for the Detection of Toxic Cyanobacteria		✓	
Project 2.3.3.3	Identification and Enumeration of Bacteria Using Flow Cytometry		✓	
Project 2.4.1	Critical Flow and Population Development of the Cyanobacteria <i>Anabaena</i> and <i>Microcystis</i> in the Murray-Darling System	✓		
Project 2.4.2	Life History and Ecology of Bloom-Forming Cyanobacteria in the Lower Murray River	✓		
Project 2.5.1	Destratification for Control of Phytoplankton		✓	
Project 2.5.2	Short-Term Forecasting of Blue-Green Algal Blooms in Drinking Water Reservoirs by Artificial Neural Network		✓	
Project 2.6.1	ARMCANZ National Algal Manager		✓	
Project 2.2.0.1	Hydrodynamic Distribution of Pathogens in Reservoirs		✓	
Project 2.2.0.4	Iron Transformations in Drinking Water Supplies and their effects on the growth survival & toxicity of Cyanobacteria		✓	
Project 2.2.0.5	Carbon & Nutrient Dynamics: Application to Reservoirs		✓	
Project 2.2.0.6	Algal Toxin – Management		✓	
Project 2.2.0.7	Algal Toxin – LPS Endotoxins		✓	
Project 2.2.0.8	Algal Toxin – Saxitoxin Assays		✓	
Project 2.2.0.9	Algal Toxin – Gene Probes		✓	
PROGRAM 2C: MEASUREMENT				
Project 2.3.0.1	The Chemistry of Halophenol Tastes in Drinking Water		✓	
Project 2.3.0.2	The Structure and Chemistry of Natural Organic Matter in Groundwaters from the Gnaragara Mound		✓	
Project 2.3.0.3	The Monitoring of Organic and Biological Contaminants in Reticulated Water by Direct Photochemical Degradation		✓	
PROGRAM 2D: TREATMENT TECHNOLOGIES				
Project 3.1.2	Polyelectrolytes in Water Treatment	✓		✓
Project 3.1.3	Hybrid Membrane Processes in Water Treatment	✓		
Project 3.1.4	Novel Methods of Pathogen Destruction		✓	
Project 3.2.1	Development of Treatment Systems for Removal of Natural Organics		✓	
Project 3.2.2	Optimisation of Adsorption Processes		✓	
Project 3.2.3	Alternative Disinfection Regimes		✓	
Project 3.2.5	Regeneration of Activated Carbon		✓	✓
Project 3.2.6	Optimisation of Adsorption Processes - Stage II		✓	
Project 3.2.7	Manganese Workshop/ Allocation	✓		
Project 3.2.8	Automated Control of Treatment Plants		✓	
Project 3.3.2	Positron Testing	✓		
PROGRAM 2E: DISTRIBUTION SYSTEMS				
Project 4.1.1	Factors Affecting Biofilm Development Under Controlled Conditions		✓	
Project 4.1.3	Modelling Biofilms and Interventions in Controlled Conditions		✓	
Project 4.2.2.1	Interactions Between <i>Cryptosporidium</i> Oocysts and Drinking Water Pipe Biofilms		✓	
Project 4.2.2.2	Characterisation of Bacterial Symbionts of Amoebae		✓	
Project 4.2.3	Physical and Chemical Effects on Distribution System Biofilms and Incorporated Pathogens		✓	
Project 4.3.1	Consolidation of Management Tools for Distribution System – Melbourne		✓	
Project 4.3.2	Optimisation of Chlorine Residuals in a Distribution System – Melbourne		✓	
Project 4.3.4	Real Time Water Quality Modelling – Perth (Terminated 30.6.2001)		✓	
Project 4.3.6	Understanding Particles in Distribution Systems – Melbourne		✓	
Project 2.5.0.1	Development of Tools for Improved Disinfection Control Within Distribution Systems		✓	
Project 2.5.0.3	Decision Support Systems to Maintain Water Quality		✓	
PROGRAM 2F: SUSTAINABLE WATER RESOURCES				
Project 2.6.0.2	Sustainable Water Management through Village Design Approach to Remote Communities		✓	
Project 2.6.0.3	Risk in the Governance of Water Reuse: The Case for the Reuse of Wastewater.		✓	
PROGRAM 3A: STRATEGIC DIRECTIONS				
Project 3.1.0.1	Global Water Research Coalition		✓	
PROGRAM 3C: REGIONAL AND RURAL WATER SUPPLIES				
Project 3.3.0.1	Technology Transfer Officer dealing with Water Quality and Treatment in Indigenous Communities		✓	
Project 3.3.0.2	Mutiitjulu Rainwater Tank and Point of Use Treatment System Trial		✓	
Project 3.3.0.3	Water and Public Health in Regional and Rural Australia		✓	

Structure & Management



DR DENNIS STEFFENSEN
DEPUTY CEO

The Cooperative Research Centre for Water Quality and Treatment is an unincorporated joint venture between 29 participants representing government, industry and research organisations. A formal agreement, known as the Centre Agreement, between the participating organisations defines the contributions of the Parties and the nature and scope of the cooperation. The Centre's head office is located at the Australian Water Quality Centre in Adelaide, with parties in all mainland states and territories.

The Centre was established in July 2001 under the Australian Government Cooperative Research Centres Program. The program incorporates the activities planned for the seventh year of the previous CRC, which began in July 1995.

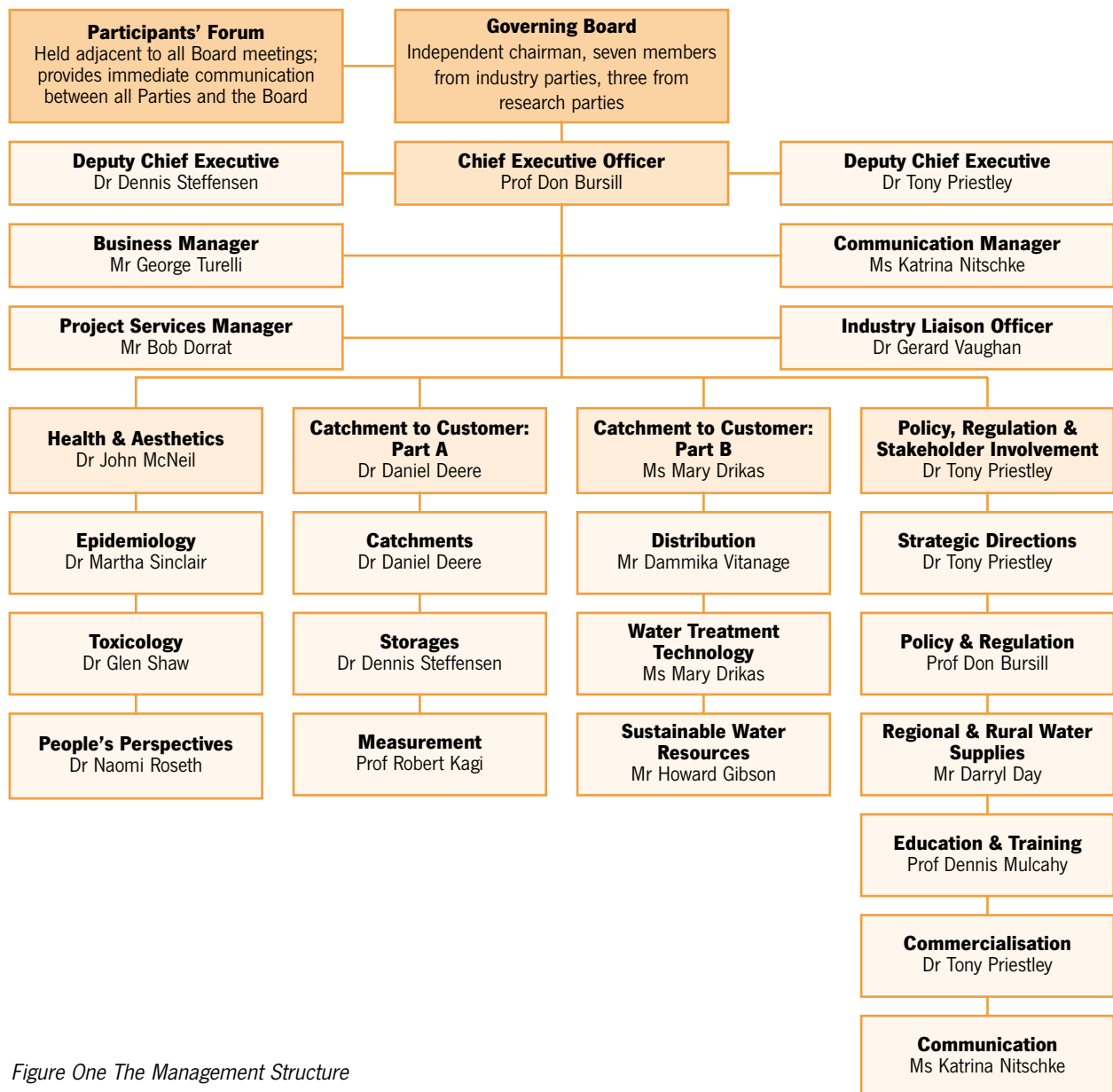


Figure One The Management Structure

Structure & Management

The Centre also operates an Associates Program as a mechanism for involving a broader spectrum of the Australian water industry in the Centre's activities. Amongst a range of benefits, Associates can be involved in various Centre activities and have access to certain of the Centre's resources. However, Associates have no role in Centre governance.

The Parties and Associate Members are listed in Tables One and Two (*below*).

GOVERNING BOARD

The Centre is an unincorporated joint venture and is managed by a Governing Board. The Board sets policy, strategic directions and budgets for the Centre, as well as monitoring the performance and progress of the full range of Centre activities. The Governing Board consists of an independent Chairman (Emeritus Professor Nancy Millis) plus a membership of ten persons selected democratically by all the parties, with seven from industry parties and three from research parties. The CEO also sits on the Board as an *ex officio* member and the Business Manager is the Board Secretary.

The following actions have been taken to ensure a high level of executive involvement, irrespective of Board representation:

- a Participants' Forum is held adjacent to all Governing Board meetings to provide immediate communication between all Parties and the Board as well as reporting on progress and other key issues
- all parties can contribute to the Governing Board agenda and all receive Board papers for comment prior to Board meetings
- any member can call an extraordinary Participants' meeting
- staggered three year terms, with predetermined members up for re-election or retirement. A minimum of seven industry members is to be maintained in the process. The Independent Chair has the casting vote if required on Governing Board decisions
- full involvement of all parties in strategic reviews and program development
- the opportunity for all industry parties to nominate for industry panels and project advisory groups
- the opportunity for all parties to nominate for Board committees, eg Commercialisation.

The Governing Board and the Participants met on four occasions in 2001-02.

CHIEF EXECUTIVE OFFICER

The Centre is managed by the Chief Executive Officer, who is appointed by, and reports to, the Governing Board. The CEO's responsibilities are to:

- provide leadership to the CRC
- manage the CRC Activities including the operation of the

CRC from day to day subject to overall control of the Board of Management

- ensure the maintenance of the Centre Account and records in accordance with the Operational Protocols
- direct the Centre Agent
- liaise with the CRC Parties to ensure adequate and timely provision of their Contributions
- direct the application of Centre Funds and Centre Resources in accordance with the Annual Budget
- monitor and report to the Governing Board the performance of the CRC in accordance with the Commonwealth Agreement
- develop and approve Project Intellectual Property Agreements
- pursue the commercialisation of Project Intellectual Property
- such other duties as are directed by the Governing Board.

DEPUTY CEOS

The Deputy CEOs are appointed by the Governing Board. A Deputy CEO's responsibilities are to act as CEO in the latter's absence and to exercise such powers and functions as the Governing Board delegates. More than one Deputy CEO, each with a specific function and set of delegations, may be appointed by the Governing Board.

One Deputy CEO oversees:

Program Group 1 Health & Aesthetics (1A Epidemiology, 1B Toxicology, 1C Peoples Perspective), Program 2A Catchments, 2B Reservoirs and 2C Measurement

The second Deputy CEO oversees:

Programs: 2D Treatment Technologies, 2E Distribution Systems and 2F Sustainable Water Sources and Program Group 3 Policy, Regulation & Stakeholder Involvement.

EXECUTIVE MANAGEMENT COMMITTEE

The CEO convenes the Executive Management Committee, whose membership comprises the CEO, the two Deputy CEO's and the Program Group Leaders. The Project Services and Business Managers provide assistance as required. The executive reviews the strategic plan and makes decisions to ensure satisfactory progress against the plan is achieved. The group met once in 2001-02

PROGRAM STRUCTURE

There are nine research programs, which fall into two broad categories, Health and Aesthetics, and Catchment to Customer. The latter is subdivided into catchment and source waters and treatment and distribution. Each of these groups is headed by a Program Group Leader. The third Program Group has six programs, covering policy, regulation, and stakeholder involvement.

- **Program Group 1 - Health and Aesthetics**
Epidemiology, Toxicology & Peoples' Perspective

Structure & Management

- **Program Group 2A - Catchment to Customer**
Catchments, Storages, Measurement
- **Program 2B - Catchment to Customer**
Treatment Technologies, Distribution Systems, Sustainable Water Sources
- **Program 3 - Policy, Regulation and Stakeholder Involvement, Education**
Strategic Directions, Policy & Regulations, Rural & Regional Water Supplies, Education & Training, Commercialisation and Communication.

MANAGEMENT COMMITTEE

The Centre is managed by the CEO, who reports to the Governing Board and is assisted by the Management Committee. This committee is primarily responsible for recommendations to the Board on program policies, priorities and budgets, and plays a key role in reviewing progress of projects, ensuring coordination between Research and Education and the Technology Transfer programs and the development of a corporate spirit within the Centre. The Management Committee consists of the CEO, DCEOs Program Leaders, and Business, Project Services and Communication Managers. The reporting structures are presented in Figure One (*above*).

The Management Committee met 12 times during the year, including two teleconferences.

The Business Manager, Mr George Turelli, provides executive-level support to the CEO and the Program Management Team and administers a framework for the Centre's financial, commercial and administrative requirements.

The Communication Manager, Ms Katrina Nitschke, is responsible for developing and implementing appropriate communication strategies for the Centre.

The Project Services Manager, Mr Bob Dorrat, provides support frameworks for Program and Project Leaders that enable them to meet their reporting requirements, including managing project milestones. He also liaises between the Centre executive, management, personnel and Parties, ensuring mutual commitments are met.

EDUCATION & TRAINING STEERING COMMITTEE

An Education and Training Steering Committee, formed in 1999, guides the development of all activities in the Education and Training Program. The Committee is chaired by Prof Felicity Roddick of RMIT University. During 2001-2002, the Education and Training Committee met four times.

COMMERCIALISATION COMMITTEE

The Commercialisation Committee comprises Party Representatives who have significant experience within the water industry. The Committee works closely with the Program Coordinators to ensure the industry relevance of

Centre research, a process that has been particularly important in refining project approval processes and providing feedback from end users of Centre research. The Committee reports directly to the Governing Board and met on four occasions during the year.

The members of the Commercialisation Committee are:

- Mr Keith Cadee, Water Corporation (Chairman)
- Dr Hung Nguyen, Orica Australia Pty Ltd
- Prof Ian Bates, RMIT University
- Prof Don Bursill, Centre CEO, Australian Water Quality Centre
- Mr Bob Gibbs, Independent Adviser
- Mr Jack McKean, SA Water Corporation
- Dr Darren Oemcke, United Water International Pty Ltd
- Dr Tony Priestley, Centre Deputy CEO, CSIRO Molecular Science
- Mr George Turelli, Centre Business Manager

The most significant commercialization activity has been the formation of a company to further develop and commercialise a process for regenerating activated carbon.

As an unincorporated joint venture, the Centre uses a centre agent for the provision of contractual services. Luminis Pty Ltd, the business arm of the University of Adelaide had been supplying this service since 1999 but was this year replaced by Lee Green and Co Pty Ltd. Legal advice to the Centre is provided by Technology Commercialisation Group Pty Ltd.

CENTRE VISITOR

The Centre Visitor is Mr Tom Fricke, a consulting engineer and Manager, Victoria for Gutteridge Haskins and Davey Pty Ltd.



Centre Chairman, Emeritus Professor Nancy Millis, was honoured as an Australian Legend in an Australia Post stamp series.

Structure & Management

TABLE ONE – PARTY REPRESENTATIVES

<i>Organisation</i>	<i>Representative</i>	<i>Position</i>
ACTEW Corporation Ltd	Mr Paul Perkins	Chief Executive Officer
Australian Water Services P/L	Mr Yves Jean-Baptiste	Directeur Commercial & Technique
Australian Water Quality Centre	Prof Don Bursill	Chief Scientist
Brisbane City Council	Mr Ralph Woolley	Senior Program Officer, Technology
CSIRO Molecular Science	Dr Gerry Wilson	Program Leader, Applied Chemistry
Curtin University of Technology	Dr Barney Glover	Director, Research and Development
Dept of Human Services, Social & Environmental Health (Vic)	Ms Jan Bowman	Manager, Environmental Health
Egis Consulting Australia	Dr Peter Nadebaum	National Manager, Environmental Management
Environmental Protection Agency	Mr Chris Patearson	Director, Sustainable Industries
Griffith University	Prof Max Standage	Pro Vice Chancellor – Science, Health GC
Melbourne Water Corporation	Mr Peter Scott	Group Manager, Research & Technology
Monash University	Prof Peter Darvall	Deputy Vice Chancellor, Research & Development
Orica Australia Pty Ltd	Dr Hung Nguyen	Research & Technology Manager
Power & Water Authority	Mr Darryl Day	General Manager, Water Services
Queensland Health Pathology & Scientific Services	Dr Peter Lewis-Hughes	State Manager
RMIT University	Prof Ian Bates	Associate Dean, Research & Development
SA Water Corporation	Mr Jack McKean	Head of Technology
South East Water Limited	Mr Greg Ryan	Manager, Water Quality
Sydney Catchment Authority	Dr Daniel Deere	Principal Scientist
Sydney Water Corporation	Ms Carol Howe	Manager - Water Cycle Planning, Group Product & Asset Planning
The University of Adelaide	Prof Graeme Dandy	Head of Civil & Environmental Engineering
The University of New South Wales	Prof Elspeth McLachlan	Pro Vice Chancellor (Research)
The University of Queensland	A/Prof JJ Mott	Strategic Research Coordinator, Natural Resource Management,
Townsville Thuringowa Water Supply Board	Mr Ken Diehm	Chief Executive Officer
United Water International Pty Ltd	Dr Darren Oemcke	Research & Development Manager
University of South Australia	Prof Ian Davey	Pro Vice Chancellor (Research)
Water Corporation	Mr Keith Cadee	General Manager, Bulk Water & Wastewater Division
Water Services Association of Australia	Dr John Langford	Executive Director
Yarra Valley Water Ltd	Mr Sam Austin	General Manager, Asset Services

Note: Members of the Governing Board are highlighted in bold.

Structure & Management

TABLE TWO – ASSOCIATE MEMBERS

<i>Organisation</i>	<i>Representative</i>	<i>Position</i>
Water Sector Services, Dept of Natural Resources & Environment (Vic)	Mr Graham Pooley	Manager, Technical Performance
Dept of Public Works & Services (NSW)	Mr John Eslake	Principal Engineer Water
Gippsland Water	Mr John Mitchell	Chief Executive Officer
Gold Coast City Council	Mr Shaun Cox	Director
Goulburn Valley Water	Mr Allen Gale	Director of Technical Services
Grampians Water	Mr Peter MacManamon	Chief Executive Officer
Hunter Water Corporation Ltd	Mr David Evans	Managing Director
Lower Murray Water	Mr Ron Leamon	Chief Executive Officer
South East Queensland Water Corporation	Mr Mark O'Donohue	Water Quality Manager



The Centre Management Committee

(l-r): Mary Drikas, Dr Gerard Vaughan (observer), Prof Dennis Mulcahy, Prof Don Bursill, Howard Gibson, Dr Martha Sinclair, Prof John McNeil, Darryl Day, Dr Naomi Roseth, Dr Daniel Deere, Dr Glen Shaw, Dr Tony Priestley, Dr Dennis Steffensen, George Turelli, Katrina Nitschke, Prof Robert Kagi, Dammika Vitanage

Absent: Bob Dorrat, Dr Karin Leder

Co-operative Linkages

The Centre is committed to developing and maintaining effective, sustainable cooperative linkages across the national and international water industry.

LINKING THE WATER INDUSTRY

The new Centre links water suppliers, water regulators, and water researchers across the country and has formal links with similar groups internationally.

With 29 participants spread across every mainland State and Territory, the extent of the links to the water industry becomes self-evident. Through the involvement of the Water Services Association of Australia, the peak body of the Australian urban water industry, those linkages are indirectly extended even further. The Centre has emerged as a truly national drinking water research centre.

The Centre has maintained the Associates Program developed in Mark I to provide a vehicle for small to medium enterprises to benefit from its activities. There were nine Centre associates at the end of this reporting period, with that number expected to increase.

STRATEGIES FOR COOPERATION

The organisations forming the Centre are a diverse group. Besides the simple division of parties into industry parties and research parties, there is further diversity reflecting the different structures of the industry in the various jurisdictions across the country.

The Centre fosters cooperative links between parties in a number of ways, including the following:

- During the second half of 2001, the Centre held strategic planning workshops for all research programs, to encourage all stakeholders in particular research areas to work together to identify the priority issues and the researchable questions. Most Parties were represented at each workshop, increasing their participation in workshops of most interest to them.
- All Parties can become involved in project planning. Those Parties most closely involved in issues generally join the project team. Project teams frequently involve members from more than one Party.
- The Centre conducts a program of issue-based technology transfer seminars and workshops, to share research outcomes with all stakeholders.
- A regular e-mail newsletter, *Neon*, is sent to all Centre personnel. *Neon* facilitates cooperation and knowledge sharing between individuals from different parties, promotes Centre events, and raises awareness amongst

Centre participants of current issues in the Australian and international water industries.

- The Centre maintains two electronic mailing lists to encourage information flow – one for all personnel with some link to the Centre, and another specialised list for postgraduate students and those associated with the Centre's Education and Training Program.
- The Centre produces a quarterly hard-copy newsletter, *Water Quality News*, to highlight the Centre's collaborative research and related activities.
- The Centre has established a "Participant's-Only" section of the web site. This password-protected section, available only to Parties of the Centre, contains a calendar of upcoming Centre events, Centre operating protocols and forms, research updates, presentations and reports on Centre activities. This web site is valued by all participants as a means of communication and information dissemination.
- Postgraduate students and their academic and industry supervisors meet biannually for a three-day Student Conference, which encourages the sharing of cross-disciplinary knowledge and the building networks across parties.

COOPERATION IN RESEARCH

The Centre is committed to a policy of maximising collaboration in research projects, linking postgraduate students with Centre research projects and involving industry parties in the research planning, its implementation and in the design of the ultimate research products.

It is particularly worth noting that a number of Program leaders are drawn from industry participants, so ensuring close industry involvement in project development.

Many examples of successful cooperation in research are described in this report, and it is to be found in all of the Centre's research activities. The range of research projects now under way in the Health and Aesthetics Program Group and in the Catchment to Customer Program Group are themselves demonstrations of the success of research cooperation within the Centre.

COOPERATION IN TECHNOLOGY TRANSFER

Cooperation is an essential component of effective technology transfer. The Centre fosters cooperation by involving end-users and researchers in research projects

Co-operative Linkages

from planning through to completion, including the design of the ultimate research products, be they operating protocols, decision support systems or of some other type.

The Centre holds regular technology transfer workshops, which typically involve 60-70 representatives from Parties. These bring together the research generators and the research users to discuss the implications of research and its application in industry. Lengthy discussion times and breaks are built into agendas, to facilitate networking between participants. Surveys reveal that many participants view such networking opportunities as amongst the most valuable aspects of the Centre's technology transfer activities.

LINKS WITH OTHER CRCs

The Centre is an active member in the Water Forum, a group consisting of the five Cooperative Research Centres involved in water-related research. The Water Forum undertakes joint education and training and promotional activities. Cooperation is fostered through regular Directors' meetings, and networks of the Education and Training and Communication Managers.

The Centre is involved in ongoing relationships with the Australian CRC for Renewable Energy and the CRC for Aboriginal and Tropical Health to develop new means of meeting the essential service needs of small and remote indigenous communities.

The Centre also actively participates in the activities of the CRC Association.

INTERNATIONAL LINKS

The Centre is committed to collaboration with other leading drinking water research centres around the world. There are real benefits for the Australian water industry from this collaboration, from research outcomes and also from influencing the research agenda and informing the regulatory environment internationally.

In October 2001, the Centre signed a Memorandum of Understanding (MOU) between international research agencies from Germany, the Netherlands, South Africa and the USA to 'promote the planning and execution of a coordinated water research agenda on selected issues'. This MOU, also referred to as the Penta Party Agreement on research collaboration, will provide a strong platform for the Centre's future international research collaboration.

The Centre is also a founding member of the Global Water Research Coalition, an alliance of twelve leading research organisations from across the world created to promote international cooperation and collaboration in water-related research. The GWRC was officially formed with the signing of

the partnership agreement at the International Water Association 3rd World Water Congress in Melbourne in April 2002.

The Centre will manage two international research topics as part of the GWRC – Algal Toxins, and Water Quality in Distribution Systems. Recently, a GWRC website has been established to provide information on the objectives and activities of the GWRC, and to facilitate communication and information sharing between member organisations. This website is maintained by the Centre.

The Centre has commenced a number of major joint research projects with one of the world's most influential drinking water research centres, the American Water Works Association Research Foundation (AWWARF). These projects, detailed elsewhere, include work on catchments, reservoirs, emerging algal toxins and the detection of cyanobacteria.

It is also worth noting that in April 2001, the Centre hosted the tenth Emerging Technologies meeting, an event sponsored by AWWARF and conducted biennially. This meeting enables the world's leading drinking water research managers to set global water research priorities and discuss common issues. The meeting was highly successful, with attendees impressed by the CRC Program and its ability to bring researchers and research users together to work on common problems.

The Centre encourages international exchange of researchers and students and has sponsored a number of such visits.



In June 2002, the Centre's head office hosted a visit by His Excellency M Piergiorgio Mazzocchi (4th from left), the Ambassador of the European Commission. The Ambassador's wife, Madame Corrine Mazzocchi (3rd from right) accompanied him.

Health & Aesthetics

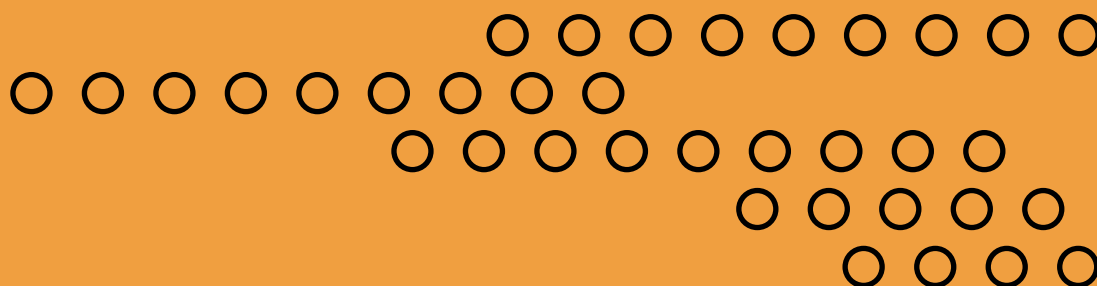
Program Group One



Aim

This Program Group has as its primary objective the need to thoroughly understand the link between human health and the quality of drinking water. Its programs will focus on microbiological and chemical risks of relevance to Australian water supplies, integrating both toxicological and epidemiological research methods. In addition, research will be undertaken to improve understanding of the factors that affect community perceptions of drinking water quality and safety.

PROGRAM GROUP LEADER
PROF JOHN MCNEIL,
MONASH UNIVERSITY



PROGRAMS

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Program 1A: Epidemiology



PROGRAM LEADER
DR KARIN LEDER, MONASH UNIVERSITY

PROGRAM AIM

To apply epidemiological techniques to characterise human health risks from microbial and chemical drinking water contaminants. This includes the conduct of specific research projects involving human participants, the development of methods to provide improved estimates of individual exposure levels, and the use of risk assessment for evaluation of perceived health risks.

PROGRAM BACKGROUND

Epidemiology provides information on the magnitude of health risks associated with a variety of individual exposures and allows judgements to be made about their relative importance to the health of the community. Microbial pathogens are recognised as the most important risk to be considered for public water supplies. Accordingly, the new projects initially approved for development under the Epidemiology Program focus on this aspect; including an intervention study of endemic waterborne disease in a water supply drawn from unprotected catchments, and establishment of a national surveillance system for waterborne disease outbreaks.

PROJECTS

1.1.5 DRINKING WATER QUALITY MANAGEMENT SYSTEM

Project Leader

Dr Peter Nadebaum (Egis Consulting)

Research Staff

Samantha Rizak (Monash University)

Budget \$404,074

Duration Oct 98 – Jun 03

Background

The Australian Drinking Water Guidelines (ADWG) recognise the primary importance of the preventive multi-barrier approach for minimising health risks in water supply systems, but there has been a tendency for both industry and regulators to focus mainly on compliance with numerical values, with consequent emphasis on reactive management

rather than comprehensive preventive strategies. This project has developed a comprehensive framework for water quality management in collaboration with the NHMRC/NRMMC Australian Drinking Water Review Coordinating Group, and key stakeholders including water and public health authorities.

Aims

- Develop a Framework for Drinking Water Quality Management from catchment to tap to assist water authorities in effectively managing their water supply systems.
- Develop and reorganise the Australian Drinking Water Guidelines to emphasise the preventive nature of drinking water quality management.

Milestones Achieved

- Framework finalised and incorporated into ADWG. Release for public consultation expected in Aug 02.
- International presentations and publications on the Framework.

Milestones For 2002-03

- Completion of ADWG revision incorporating the Framework.
- Agreement for publication of Framework as monograph by IWA.

Technology Transfer

This project will provide water authorities throughout Australia with a generic, national system for water quality management that is supported by key stakeholders and regulators. Incorporation of the Framework within the Australian Drinking Water Guidelines will promote increased awareness of a comprehensive preventive strategy for drinking water quality management, and will facilitate better operation of water supply systems nationwide.

1.1.6 DRINKING WATER QUALITY RISK GUIDANCE

Project Leader

Dr Peter Nadebaum (Egis Consulting)

Research Staff

Robert Morden, Michael Chapman (Egis Consulting), Samantha Rizak, Dr Martha Sinclair (Monash University)

Budget \$122,600

Duration Jun 00 – Sep 02

Background

Most of the elements of the Drinking Water Quality Management System under development in Project 1.1.5 are based on common sense risk management principles, however the areas of systematic risk assessment and review of management controls are complex and highly technical. This project will complement Project 1.1.5 by providing more detailed and specific guidance on risk assessment.

Program 1A: Epidemiology

Aims

- To provide water authorities and other organisations with a reference document in the form of risk 'fact sheets' to guide and assist in their assessment and management of risks to water quality.

Milestones Achieved

- Draft documents completed and reviewed.

Milestones For 2002-03

- Publication of Risk Assessment Methodology, Fact Sheets and Case Studies.

Technology Transfer

This project will assist water authorities by providing a clear, readily available compilation of information that assists in identifying and assessing risks to water quality. This is a requisite part of implementing the Drinking Water Quality Management System.

1.2.5 SYSTEM FOR THE EARLY DETECTION OF OUTBREAKS OF WATER-RELATED GASTROENTERITIS FOR AUSTRALIA

Project Leader

Dr Martha Sinclair (Monash University)

Research Staff

Dr Jim Black, Pam Lightbody (Monash University), Martyn Kirk (OzFoodNet)

Budget \$117,386

Duration Jul 98 – Feb 02

Background

Current surveillance mechanisms for infectious disease outbreaks are relatively slow and insensitive, and may fail to identify waterborne outbreaks. This project aims to develop an enhanced surveillance system from existing electronic data sources, utilising artificial neural networks to monitor and analyse information. Health statistics and water quality information will be linked using Geographic Information Systems to enable waterborne outbreaks to be rapidly detected and identified.

Aims

- Identify novel information sources and mechanisms for automatic regular acquisition by health and/or water authorities.
- Create computer programs to predict or detect outbreaks of disease.
- Develop effective ways of presenting these data, to make them easily accessible to working epidemiologists and water authorities throughout Australia.

Milestones Achieved

- Neural network software system developed for successful prediction of gastroenteritis clinical specimen analysis rates.

- MapMovie and StepGraph data display software developed.
- Completion of PhD thesis by student, Dr James Black.

Milestones For 2002-03

- Publication of project outcomes.

Technology Transfer

This project will enhance the ability of health authorities and water utilities to rapidly detect outbreaks of gastrointestinal disease and determine whether they are likely to be waterborne.

1.3.1.5 ACUTE SKIN IRRITANT EFFECTS OF CYANOBACTERIA (BLUE-GREEN ALGAE) IN HEALTHY VOLUNTEERS

Project Leader

Mike Burch (AWQC)

Research Officers

Dr Peter Hobson (AWQC), Dr Geetha Ranmuthugala (ANU), Prof Louis Pilotto (Flinders University), Dr Warren Weightman (Queen Elizabeth Hospital), Robin Attewell

Budget \$183,403

Duration Apr 01 – Jun 02

Background

One of the interesting and vexing issues associated with human exposure to cyanobacteria is the adverse allergic and skin irritation reactions reported in some individuals. These reactions are sporadic but poorly characterised and quantified. This project is being undertaken to better define the quantitative range of adverse health effects associated with human dermal contact with cyanobacteria.

Aims

- To assess dermal irritant properties of a range of cyanobacterial types/species with human volunteers, to determine thresholds for irritant effects.
- Results will help in development of guidelines for cyanobacteria and secondary contact activities.

Milestones Achieved

- Three series of skin irritation trials with human volunteers were completed for six cyanobacterial strains. These included *Microcystis aeruginosa*, *Anabaena circinalis*, *Nodularia spumigena*, *Aphanocapsa incerta* and *Cylindrospermopsis raciborskii*

Milestones For 2002-03

- Results from the trials will be reported in the literature and in a CRC final report

Technology Transfer

- This project has demonstrated that less than 20% of individuals exhibited skin irritation when exposed to each of the cyanobacterial species tested but this response was not dose related. This information will be discussed with health authorities in relation to cyanobacterial exposure, and assessed as part of the revision of NHMRC Guidelines for Healthy Recreational Water Use, which is underway during 2002-03.

Program 1A: Epidemiology

1.3.7.5 DRINKING WATER AND MELIOIDOSIS

Project Leader

Dr Martha Sinclair (Monash University)

Research Staff

Dr Tim Inglis (Pathcentre WA), Darryl Day (PAWA), Richard Walker (Water Corp), Dr Chris Saint (AWQC)

Budget \$217,672

Duration Apr 01 – Mar 03

Background

Melioidosis is a potentially fatal disease caused by the tropical soil organism *Burkholderia pseudomallei*. This disease affects mainly people with impaired immune systems and the primary route of infection is through soil contamination of cuts and sores. However, the possibility of infection through inhalation or ingestion of contaminated water has been raised by recent studies in northern Australia.

Aims

- Perform a multi-national field trial of a new selective medium for isolation of *B. pseudomallei*.

- Validate the chlorination inactivation envelope for *B. pseudomallei* and determine the effect of pH and turbidity variations typical of northern Australian potable water supplies.
- Assess the occurrence water quality parameters such as acid pH that may affect the survival or virulence of *B. pseudomallei*.

Milestones Achieved

- Field trial of selective medium commenced.
- Collaborative arrangements with laboratories in Western Australia, Queensland, Northern Territory, Thailand and Indonesia established.

Milestones For 2002-03

- Completion of all field work components of project.

Technology Transfer

This project will provide water suppliers with information on the necessary parameters for effective water disinfection to safeguard against possible transmission of *B. pseudomallei*, and the effect of physico-chemical water quality on occurrence of this organism.

COMMONWEALTH SCHEDULE MILESTONES YEARS 1 AND 2

CONTRIBUTION FROM PROJECT MILESTONES

Collaborative linkages established with research parties and other participants.	Participation in Program Planning Workshops.
Current information on relevant topics reviewed and collated.	Ongoing review of scientific literature incorporated in Project 1.4.1 <i>Health Stream Newsletter</i> .
Research participant and stakeholder workshops held to define key issues and develop research approaches and timetable.	Epidemiology Program Planning and Disinfection Byproducts Workshops conducted.
Pathogens of specific concern identified and potential methods of study assessed.	Ongoing liaison with public health regulators on waterborne pathogens of concern.
Preliminary study of exposure assessment for DBPs conducted.	Potential projects relating to DBPs being assessed following DBP Workshop.
Volunteer study to assess a potential DBP biomarker conducted.	Analysis of Project 1.3.5.3 data completed and outcomes published.
Volunteer study of dermal exposure to a range of cyanobacterial species conducted.	Experimental phase of Project 1.3.1.5 completed.
Epidemiological study of health effects of arsenic exposure conducted.	Collaboration on AUSAid funded study in Bangladesh.
A knowledge base on micropollutants in Australian drinking water sources established.	Opportunities for collaboration with Commonwealth Rural and Remote Potable Water Supplies project being explored and a literature review is underway.
Surveys for selected micropollutants in a range of representative water supplies planned.	Projects to be developed in this area.

Program 1B: Toxicology



PROGRAM LEADER DR GLEN SHAW, NRCET

PROGRAM AIM

To provide toxicological information on chemicals and agents in waters and to use these data for human health risk assessment. The overall aim of this program is to provide sufficient high quality data to establish guidelines that will enable the water industry to manage water in a manner that does not result in deleterious human health effects.

PROGRAM BACKGROUND

This program commenced in July 2001 and the first year of its existence has been devoted to the establishment of new projects in addition to developing collaborative linkages both with CRC researchers in the field of water toxicology and with other CRC programs. A feature of the program has been provision of advice to the water industry on such issues as toxins used in terrorism and the health implications of water treatment to remove cyanobacterial toxins.

As a result of the CRC workshop on "Toxicology" held in August 2001, the research directions for the program centre around provision of toxicological data on toxins of human health importance such as the cyanobacterial toxin, cylindrospermopsin, development of broad screening assays for toxins in water, and investigation of the health implications of water disinfection byproducts.

Program activities have concentrated on establishment of a comprehensive project on cylindrospermopsin mechanisms of toxicity and genotoxicity in order to produce information to enhance the development of drinking water guidelines. This project has been approved by the CRC board and is currently awaiting peer review. It features collaboration between the National Research Centre for Environmental Toxicology, University of Adelaide, Australian Water Quality Centre, Griffith University and established linkages with researchers in Germany and Hong Kong will be used to provide specific expertise that is not currently available in Australia. The project will focus on molecular interaction between the toxin and cellular macromolecules such as DNA, RNA and proteins. It will also feature very advanced technology such as DNA microarray to investigate the genetic effects of the toxin.

A project proposal for development of broad screening assays is currently in development and features use of cell lines *in*

vitro and lower trophic level organisms *in vivo*. The main aim of this project is to produce an assay that will respond to a wide variety of toxins and is capable of replacing the mouse bioassay, which is currently widely used but is likely to be discontinued due to ethical considerations. It is considered important that this program has the capability to respond to new research requirements of the water industry.

To date, toxicological evaluation of cylindrospermopsin has utilized mice as the test species. Some initial research has been undertaken on the toxicity of this toxin to cattle. This resulted from consumption of the toxin from natural sources in farm dams. Given the difference in susceptibility between cattle and mice it is envisaged that a comprehensive toxicological testing regime should be undertaken in another species before we can confidently develop guidelines for cylindrospermopsin in drinking water.

In addition, the program has been interacting with the Reservoirs Program on a CRC for Water Quality and Treatment/AwwaRF project involving determination of the significance of emerging algal toxins.

Interactive projects with other programs are regarded as being of high importance to the Toxicology Program and areas such as determination of the levels of various disinfection byproducts, their toxicological significance and human epidemiology will be integrated in the future to produce findings that are relevant for the water industry in terms of provision of water without deleterious human health effects.

Human health risk assessment is an important part of the toxicology program and a health risk assessment course that is applicable to the water industry has been organized through the Toxicology Program and was held at NRCET from 5th to 7th of August 2002.

PROJECTS

1.3.1.1 TUMOUR PROMOTION BY CYANOBACTERIAL TOXINS

Project Leader

Prof Ian Falconer (University of Adelaide)

Project Staff

Dr Andrew Humpage (AWQC), Emma Moore, Suzanne Frosio (University of Adelaide)

Duration Jul 96 – Dec 01

Budget \$756,698

Background

Cyanobacterial (blue-green algal) toxins occur in drinking and recreational water supplies at low concentrations. This project focuses on the evaluation of health risks (specifically carcinogenesis, tumour promotion and chronic toxic effects) from toxins from two species of major concern in Australia, namely cyclic peptide toxins from *Microcystis aeruginosa* and alkaloid toxins from *Cylindrospermopsis raciborskii*.

Program 1B: Toxicology

Aims

- To evaluate interactions between dietary or environmental carcinogens and promotion of tumour growth by cyanobacterial toxins.
- To investigate the potential for cancer initiation by *Cylindrospermopsis* toxins.
- To define mechanisms of action and trigger concentrations.
- To establish the safe level of *Cylindrospermopsis* toxin(s) in drinking water
- To target research outcomes of relevance to the health of Australians.

Milestones Achieved

- Successful completion of the PhD program by Suzanne Frosco.

- Publication of part of the research results from the thesis.
- Completion of histopathological examination of tissues from mice in the sub-chronic oral toxicity trial with cylindrospermopsin and collation of the data.
- Submission of the draft report on the oral toxicity trial.

Milestones Planned for Next Year.

- Publication of the final report and the remaining research from the project.

Technology Transfer

The draft report of the oral toxicity trial of cylindrospermopsin was considered by the Chemical Safety Committee of the WHO, together with other data on cyanobacterial toxins, as background for consideration on revision of the drinking water guidelines.

COMMONWEALTH SCHEDULE MILESTONES YEARS 1 AND 2

Establish collaborative linkages between research parties and other stakeholders.

Collate and review existing information on health significance of relevant chemicals and agents in water and applicable toxicological/epidemiological methods.

Collate existing data on occurrence of micropollutants in Australian water supplies.

Plan and commence sampling program to establish the occurrence of selected chemical micropollutants in selected water supplies.

Complete toxicological research on cylindrospermopsin to provide adequate information for formulation of Guideline value.

In connection with other programs and sub-programs, investigate disinfection byproduct formation from water treatment.

In connection with other programs and sub-programs, identify byproducts of treatment for cyanobacterial toxins.

CONTRIBUTION FROM PROJECT MILESTONES

Collaborative linkages have been established between CRC research parties with toxicological expertise and other expertise useful to this program. In addition, linkages have been established with various CRC industry partners.

Existing information in the literature on cylindrospermopsin and toxicity assays has been collated and reviewed in order to develop relevant projects.

A review of micropollutants and their occurrence and human health effects is currently underway.

A literature review is underway to define what action needs to be taken.

Toxicological research on cylindrospermopsin using mice dosed sub-chronically and cattle orally dosed from natural sources has been undertaken.

The toxicology program has been involved with other programs in a workshop to define research topics involving disinfection byproducts.

Treatment to remove saxitoxins from water has been investigated as part of a WSAA research project. In addition, as part of the toxicological program, research to establish the kinetics of removal of saxitoxins by chlorination has been undertaken in NRCET.

Program 1C: Peoples' Perspectives



PROGRAM LEADER
DR NAOMI ROSETH, SYDNEY WATER

PROGRAM AIM

The purpose of the program is to develop an understanding of community views, needs, expectations and preferences for water services across Australia. The research will include the views of the general community across Australia, including rural and indigenous communities as well opinion leaders.

PROGRAM BACKGROUND

The first planning workshop for the People's Perspectives program was held in August 2001, with about 50 people attending. Participants included representatives from other Centre programs, the water industry, industry regulators and other stakeholders, universities and community groups. During the workshop sessions, five broad research themes emerged for community research, namely:

- Views on water
- Trust and its drivers (in water and the authorities that deliver it)
- Risk perceptions and related behaviour
- Education and communication
- Views on price, value for money, willingness to pay

A range of community subgroups were identified during the workshop. These ranged from people living in urban, regional, rural and remote communities, people from specific cultural groups and health and water industry professionals.

PROJECTS

1.3.02 NATIONAL COMMUNITY SURVEY ON ATTITUDES TO DRINKING WATER QUALITY, PHASE ONE

Project Leader

Dr Naomi Roseth (Sydney Water)

Project Officer

Kerry Rock (Sydney Water)

Budget \$140,300

Duration Apr 02 – Sept 03

Aim

This Project builds on the outcomes from the research planning workshop and will provide information about community attitudes to water quality across the country. The project will be rolled out in three stages, commencing with capital cities. Regional and rural communities will follow.

Status

- Project commenced

Milestones for 2002-03

- Collect data
- Complete report

COMMONWEALTH SCHEDULE MILESTONES YEARS 1 AND 2

Collaborative links established with Australian water utilities, including both those who are members and those who are not members of the CRC for the purpose of conducting nation wide community surveys.

Existing social research conducted by Australian water utilities collected and reviewed.

Scope of the specific community research projects to be conducted under the CRC fully defined.

Nation wide survey on community attitudes to drinking water conducted.

CONTRIBUTION FROM PROJECT MILESTONES

- Wide ranging industry participation in planning workshops
- Participation in international events and forums.

Ongoing.

Successful planning workshop held.

Project commenced April 2002, scheduled for completion September 2003.

Catchment to Customer

Program Group Two



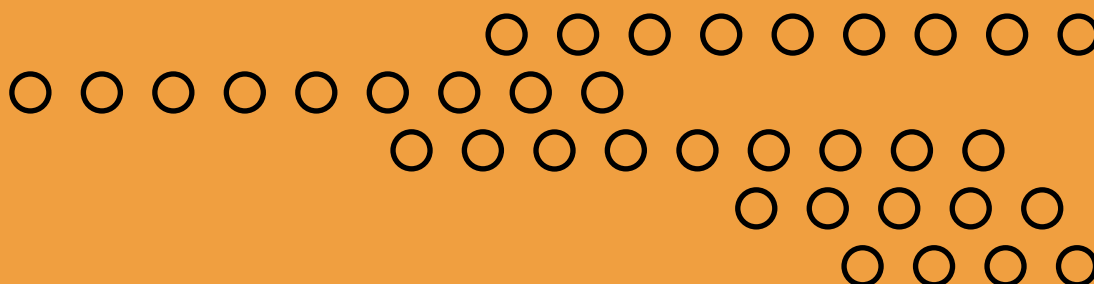
Dr Daniel Deere,
Sydney Catchment Authority
(Leader Part A)

Aims

- Identify and develop effective management processes for the control of problem microorganisms, organic and inorganic pollutants within catchments, reservoirs, treatment plants and distribution systems
- Identify and evaluate alternative approaches to the provision of a high quality water supply
- Evaluate the effectiveness of current technologies for the removal of contaminants from non-conventional water sources and, if required, develop improved treatment and management processes
- Assess current desalination technology and develop systems and process improvements appropriate to Australian water supply needs and opportunities
- Provide improved technologies and methodologies for the management of water distribution systems, with special attention to water quality objectives and system maintenance



Ms Mary Drikas,
Australian Water Quality Centre
(Leader Part B)



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Program 2A: Catchments



PROGRAM LEADER
DR DANIEL DEERE, SYDNEY CATCHMENT
AUTHORITY

PROGRAM AIM

To provide tools to water utilities, (conceptual, analytical and modelling), for them to use in understanding the relative significance of pollution sources within their catchments. Participant utilities will benefit during the program from knowledge gained within their catchments through the use and evaluation of tools. Further, to develop a quantitative understanding of the effectiveness of management practices for the control of problem hazards in catchments.

PROGRAM BACKGROUND

Each catchment is different and needs to be understood in its own right. However, there are fundamental principles that apply across different catchments, and the tools used by catchment managers to understand specific catchments are generic. This program will provide and promote the tools that catchment management functions of water utilities need in order to be able to prioritise catchment management activity. The control measures that can be applied in catchments, often called management practices, are various and not all adequately understood in relation to drinking-water-related hazards. This program will develop a quantitative understanding of the effectiveness of a selection of control measures that are common to many Australian catchments. Close collaboration with other water-related CRCs is critical to this program.

PROJECTS UNDER DEVELOPMENT

One new project has been considered by the governing board and is currently undergoing peer review. *Catchment Risk Management: A Tool to Structure Source Water Protection* will detail the processes of catchment risk management in the form of a guideline document. The guideline will be developed so that it can be applied practically to catchments varying in size, landscape and information coverage. It will also aim to link with the assessment and planning elements of the NHMRC Water Quality Framework. This project is expected to commence in 2002-03.

PROJECTS

2.2.1 MANAGEMENT OF PATHOGENS IN SURFACE AND SUBSURFACE SOURCE WATERS

(Incorporates state-based subprojects designated 2.2.1, 2.2.1.1, 2.2.1.2, 2.2.1.3, 2.2.1.4)

Project Leader

A/Prof Nick Ashbolt (UNSW)

Research Staff

Dr David Roser (UNSW)

Budget \$1,296,613

Duration Jun 01 – Nov 03

Background

Over 20 different industry, contractor and research stakeholders have been involved including Melbourne Water, South East Water, Water Corporation, ActewAGL, South Australia Water, AWQC, SA EPA, the Torrens and Onkaparinga Catchment Water Management Boards, Ecowise and CSIRO. The project has been coordinated through the University of NSW's Centre for Water and Waste Technology and involves four state based project management groups. The project is nearing completion of its first stage (December 2002).

Aims

The project was initiated in 1998 as a series of five state-based subprojects to systematically determine for model source waters:

- the range and types of pathogens and index microorganisms present by land use
- which microbial indicators/surrogates may be used in pathogen management
- options for pathogen management arising out of the research and review findings.

Milestones Achieved

The 2001-02 year has seen the collection of the majority of the experimental data, identification of project products and the production of initial scientific papers. As planned, the research work program has involved:

- assessment of analytical laboratory quality and training in novel techniques.
- measurement of 'background' pathogen, indicator and surrogate levels in source waters (dry weather in six catchments and a survey of bores in two vulnerable aquifers completed in 2000-01).
- estimation of pathogen and indicator loadings by combining hydraulic load and concentration data.
- identification of sources.
- development of products with water managers in mind.

Key project outcomes this year have included:

- the collection of the majority of a high quality assured data set on pathogen related analytes (four pathogens,

Program 2A: Catchments

nine indicators, 20 biomarkers, 10 physical and chemical parameters, particle sizing profiles) for six different surface waters during dry (12-20 samplings) and storm flow (12 of 22 as of June 2002).

- completed development and application of storm runoff event sampling protocols and technologies.
- measurement of ambient concentrations of indicators and pathogens and the differences between impacted and protected catchments (up to 100-fold based on geometric mean);.
- repeated observation of increases in indicator and pathogen concentrations during storm events of up to 100-fold, and total loading/unit time increases (up to 1 million times).
- the restricted value of surrogates such as nutrients and turbidity in assessing pathogen presence.

Technology Transfer

Consultation with all project stakeholders was undertaken (in period up to July 2002) that showed the complementary water management information (and hence project products) should address the issues of Pathogen Data Interpretation, Data management and sharing, Sampling and analysis protocols for pathogens and indicators, Techniques for fingerprinting samples, and sourcing and tracking of pollutants, Setting of Water Quality Objectives.

Milestones for 2002-03

Concluding experimental work in progress is as follows:

- measurement/identification of parameters in selected 'sources' and during rainfall events.
- identification of management options for risk reduction and better source water management.
- measurement of pathogen removal rates in an aquifer (WA).
- key products planned include a workshop on key findings and water management products (completed), a series of water manager developed. information/protocol/BMP documents, a final report structured in chapters for publishing as papers where appropriate, an event sampling methods and protocol document (in draft), results database completion and population (currently in draft), a decision support system for facilitating the use of analytical data.

The two key constraints on experimental progress have been a lack of rainfall in the ACT and SA catchment areas and the need to undertake an extensive community consultation in the experiment locality (WA). Subject to these constraints the project will complete all the key experimental work planned at its inception and provide the basic information/experience needed to develop water manager products.

2.2.2 FATE AND TRANSPORT OF SURFACE WATER PATHOGENS IN WATERSHEDS

Project Leader

A/Prof Nick Ashbolt (UNSW)

Research Staff

Dr Cheryl Davies, Christine Kaucner, Nanda Altavilla, Brendan Cullinane (UNSW), Christobel Ferguson (SCA)

Budget \$1,100,000

Duration Feb 01 – Jun 02

Background

The American Water Works Association Research Foundation funded Project 2.2.2 will report on pathogen fate and transport kinetics in key watershed components (including loss and inactivation from faecal deposits, disaggregation/reaggregation in soils, movement overland and through vegetation, and the influence of environmental factors). The objective is to enable the derivation of algorithms for use in quantitative watershed models, using *Cryptosporidium parvum*, *E. coli*, adenoviruses and MS-2 coliphages as model pathogens.

Aims

- Establish the characteristics of pathogen sources in watersheds that will serve as measurable input functions to models for predicting downstream concentrations;
- Establish the overall scale of pathogen attenuation as a function of organism characteristics, watershed-specific features (soil type, soluble organics character);
- Identify and quantify the principal factors affecting the viability of pathogens dispersed in the terrestrial environment in transit to local surface water;
- Identify and quantify the principal factors affecting transport of mobile (not attenuated) pathogens passing across the terrestrial environment to local surface water; and
- Identify and quantify principal factors contributing to disappearance of pathogens from the aquatic environment following introduction, principally from treated sewage sources.

Milestones Achieved

- A literature review has been completed which has identified and ranked the most significant knowledge gaps. A summary of the outcome of the review has been submitted to the Journal of the AWWA for publication. The complete literature review is currently being finalised, and will also be submitted for publication in a peer-reviewed journal.
- The project team have finalised validation of methods for the recovery of *Cryptosporidium* oocysts, *E. coli* and MS-2 phage from a range of fecal matrices including cattle, calves, sheep, pigs and kangaroos. A paper describing the development of the *Cryptosporidium* enumeration method for fecal matrices has been submitted to a peer reviewed journal for publication. These methods are being utilised

Program 2A: Catchments

to carry out a routine survey of these fecal types from the Sydney Catchment area.

- A mini rainfall simulator has been installed and calibrated at UNSW to investigate the impact of rainfall on the disaggregation of pathogens from fecal matrices into soil and surface runoff.

Technology Transfer

Reports to the project advisory committee have been provided and scientific papers have been submitted. The CRC for Catchment Hydrology will take the datasets to inform their models

Milestones for 2002-03

- Field work and column studies will be undertaken to provide empirical datasets. Catchment sites are yet to be confirmed, column studies will take place in the Netherlands using soil from Melbourne, Sydney and Adelaide.

COMMONWEALTH SCHEDULE MILESTONES YEARS 1 AND 2

CONTRIBUTION FROM PROJECT MILESTONES

Establishment of collaborative linkages.

A workshop has been programmed for 2002-03 with CRCCH and CRCFE to review all CRC activities from the drinking-water supply catchment perspective.

Report on the identity and primary origins of the priority contaminants in a range of Australian catchments.

The workshops in 2001-02 identified the priority contaminants for the water utilities. The risk management project will further refine the process of ranking contaminants. The pollutant budgeting project will assist utilities in identifying their primary origins and relative significance. These projects were scoped during 2001-02.

Papers developed through consultations and review processes giving current understanding of mechanisms, in a conceptual model framework, and identifying the next stage research priorities.

This will be achieved in 2002-03 as part of the risk management project. A workshop approach is likely to be used, building on conceptual models already developed by SCA and SEQW.

Documentation of an agreed detailed research plan.

A budgeted research plan has been developed during 2001-02 and will be finalised once all project scoping has completed.

Reports on pilot studies testing the feasibility of the research plan.

Pilot studies will be undertaken over the first years of the program.



Photo courtesy Melbourne Water

Program 2B: Storages



PROGRAM LEADER
DR DENNIS STEFFENSEN, CENTRE DEPUTY CEO
AND AUSTRALIAN WATER QUALITY CENTRE

PROGRAM AIM

The objective of this Program is to develop a detailed understanding of how water quality changes occur in bulk water storage reservoirs. The Program will focus on the water quality enhancements, specifically, the rates and mechanisms of contaminant attenuation and pathogen inactivation in reservoirs. In addition, attention will be given to the impacts of stratification and oxygen depletion, which leads to the release of metals, nutrients and other contaminants from the sediments. Another major focus of the program will be phytoplankton growth, especially cyanobacteria which produce taste and odour compounds and in some cases, dangerous toxins.

PROGRAM BACKGROUND

Program Two in the first CRC covered both catchment and source waters and also included method development. Program 2A: Storages in the new CRC is restricted to source waters, with the other aspects transferred to the Catchment or Measurement Programs.

Australia has a wide range of sizes of storage reservoirs, including those with very long water retention times. While there is considerable potential for water quality improvement through settlement and die-off of microorganisms, other aspects, such as cyanobacterial growth, can cause deterioration. Development of integrated, cost-effective reservoir management practices requires a detailed understanding of the physical, chemical and microbiological mechanisms occurring in reservoirs. Through a combination of specific studies on key chemical and biological processes and mathematical modelling, we will seek to further understand these mechanisms and develop scientifically based guidance manuals for system operators. The output from these studies will provide essential data for the risk based management approach used by the water industry.

This Program will address the major issues for water quality in Australia:

- Pathogens
- Cyanobacteria – toxins, and taste and odours.
- Suspended solids

- Organic carbon
- Iron and manganese
- Nutrients

PROJECTS UNDER DEVELOPMENT

The thematic approach in the new CRC will be the development of water quality models. The key project is on the hydrodynamic distribution of pathogens, which is supported by AwwaRF. The models developed in this project will be utilised in the projects on specific issues such as NOM and survival of *Cryptosporidium*. Details about new projects are provided at the conclusion of this report.

PROJECTS

2.1 CHARACTERISATION OF NATURAL ORGANIC MATTER

Project Leader

Dr Kaye Spark/Dr John Van Leeuwen (AWQC)

Research Staff

Lidia Sledz, Rolando Fabris (AWQC), Dr Declan Page, Simon Anstis (UniSA), Graham Jablonskis, Tanya Jankovic, Jon Varcoe (Adelaide University)

Budget \$907,780

Duration Jul 97 – Sept 01

Background

The amount and character of naturally occurring organic matter has significant effects on the transport of pollutants through the catchments, water treatment costs and disinfection efficiency and by-product formation. Improved knowledge of the functionality and reactivity of NOM will provide a more precise assessment of which compounds are of most concern in water treatment and which processes in the catchments or source waters hold most promise for management.

Aims

- Investigation of methods for improved characterisation of NOM.
- Determination of how the nature and concentration of NOM transported in a catchment is affected by seasonal variations, storm events and transport pathways and the effects on treatability.
- Improvement in the understanding of the interactions between NOM and phosphorus.

Status

The final report for the project is being edited for publication.

2.3 CYANOBACTERIAL TOXINS

Toxins from cyanobacterial toxins are of increasing concern within the water industry. The development of methods for the detection of toxic species and their toxins and an

Program 2B: Storages

understanding of the factors influencing toxin production is essential for management.

2.3.1.1 DEVELOPMENT OF ANALYTICAL METHODS FOR RAPID DETECTION OF TOXINS IN WATER

Project Leader

Dr Brenton Nicholson (AWQC)

Research Staff

Dr Jenny Morrall, Tamila Heresztyn (AWQC), Dr Jin Cao, Dr Nimal Chandrasena (Sydney Water)

Budget \$670,800

Duration Jul 96 – Jun 99

Background

The ability to detect toxins produced by cyanobacteria in water is essential for determining the safety of water for consumers, as well as evaluating the effectiveness of water treatment processes.

Aims

- Improved levels of detection for hepatotoxins in water by HPLC through solid phase extraction methods and selective removal of co-extracted NOM.
- Assessment of the suitability of commercial ELISA kits for Australian hepatotoxins.
- Assessment of colorimetric phosphatase assays for detection of hepatotoxins.
- Assessment of capillary electrophoresis for detection of PSPs neurotoxins.

Status

The project has been completed and the final reports produced.

2.3.2 FACTORS CONTROLLING TOXIN PRODUCTION

There is evidence that both genetic and environmental factors influence toxin production by cyanobacteria. Knowledge of the factors influencing toxin production of particular species in particular circumstances will assist in developing cost effective control measures.

2.3.2.2 GENETICS OF SAXITOXIN PRODUCTION BY ANABAENA CIRCINALIS

Project Leader

Dr Brett Neilan (UNSW)

Research Staff

Dr Carolina Tillet (UNSW)

Budget \$323,987

Duration Dec 96 – Jun 00

Background

The saxitoxin class of cyanobacterial toxins (PSPs) exhibit neurotoxic effects that can be fatal. In Australia, saxitoxins are most often associated with blooms of *A. circinalis*. This research project aims to identify the genes responsible for saxitoxins production in cyanobacteria and also to study the evolution of *A. circinalis* in the context of the genus *Anabaena* and other cyanobacteria from overseas that produce the same toxins.

Aims

- Determination of the phylogeny of saxitoxin-producing cyanobacteria and assess the relatedness of toxic and non-toxic strains of *A. circinalis*.
- Isolation and characterisation of the gene(s) responsible for saxitoxin production in *A. circinalis*.
- Determination of the influence of selected environmental factors on the regulation of saxitoxins production within natural *Anabaena* populations.

Milestones Achieved

- *A. circinalis* and other members of the genera *Anabaena*, *Aphanizomenon*, and *Nostoc* have been characterised in terms of 16S rDNA sequences. The genetic relationships and evolution of the group of saxitoxin-producing cyanobacteria and non-toxic strains of *A. circinalis* and other members of the *Nostocales* has been determined.
- Methods have been developed to determine the differences between the genomes of toxic and non-toxic strains of *A. circinalis*. This will provide us with candidate genes believed to be involved in the biosynthesis of saxitoxins.

Status

Project has been completed. The final report is being finalised.

2.3.2.4 REGULATION OF CYLINDROSPERMOPSIS PRODUCTION BY CYLINDROSPERMOPSIS RACIBORSKII

Project Leader

Dr Chris Saint (AWQC)

Research Staff

Dr Sarah Baker, Peter Baker (AWQC), Dr Peter Hawkins, Elizabeth Putt (Sydney Water), Dr Brett Neilan, Leigh Hardman (UNSW), Kim Fergusson (UniSA)

Budget \$775,629

Duration Jul 97 – Jan 01

Background

Cylindrospermopsin is a potent protein synthesis inhibitor

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produced by the cyanobacterium *Cylindrospermopsis raciborskii*. This species is common in tropical and subtropical areas of Australia. It was responsible for the most serious recorded case of human poisoning by cyanobacteria in Australia, when 149 people from Palm Island were hospitalised in 1978. It poses a major threat to the water supplies in Queensland.

Aims

- Ascertain the types and distribution of *C. raciborskii* strains.
- Determination of the environmental factors that regulate toxin production.
- Determination of the pathways concerned with toxin production and regulation.

Milestones Achieved

- A phylogenetic analysis of a range of *C. raciborskii* isolates has been completed utilising 16S rRNA and rpoC1 gene analysis; all 19 discrete isolates were found to be the same. rpoC1 analysis permitted the design of a *C. raciborskii* specific PCR test which also works with environmental samples. This can now be used for rapid diagnosis of *C. raciborskii* blooms. This work has been published in *Applied and Environmental Microbiology*.
- Candidate genes involved in cylindrospermopsin production have been characterised. One gene is a polyketide synthase and the other a peptide synthetase. Hybridisation analysis and toxin assays have proved that these two genes are always present in toxic isolates and always absent in non-toxic isolates.

Status

Final report has been completed.

2.3.2.7 GROWTH FACTORS AFFECTING PRODUCTION OF TOXINS BY CYLINDROSPERMOPSIS

Project Leader

Dr Peter Hawkins (AWT)

Research Staff

Dr Andrew Humpage, Emma Moore (Adelaide University)

Budget \$52,137

Duration Dec 99 – Jun 00

Aims

Assessment of the environmental factors influencing production of cylindrospermopsin in *C. raciborskii*.

STATUS

Project completed.

2.5 RESERVOIR MANAGEMENT

Impoundment of water can cause stagnation and stratification of the water column with serious deterioration in water quality. The most promising option for counteracting the influence of impoundment is artificial mixing or destratification. With the completion of the studies in the River Murray, reservoir management was the major focus in the latter part of the original CRC.

2.5.1 ARTIFICIAL MIXING FOR DESTRATIFICATION AND CONTROL OF CYANOBACTERIAL GROWTH IN RESERVOIRS

Project Leader

Mike Burch (AWQC)

Research Staff

Dr Justin Brookes (AWQC), Rudi Regel, David Lewis (Adelaide University)

Collaborators

A/Prof George Ganf, Dr Martin Lambert (University of Adelaide), Dr Brad Sherman (CSIRO Land and Water), Dr Jason Antenucci (Centre for Water Research)

Budget \$1,600,802

Duration Oct 98 – Mar 02

Background

Cyanobacteria and their excessive growth in reservoirs pose a major unresolved water quality problem for the water industry. They have long been recognised as a major source of tastes and odours in drinking water. Cyanobacteria also produce a range of toxins that cause various types of acute and chronic adverse health effects in mammals. Toxins, tastes and odours are very expensive to remove by treatment.

Artificial destratification to control the abundance of cyanobacteria is a potentially cheaper option and provides another line of defence. However, mixing techniques have a long history of use with variable success. They have been successful in oxygenation of hypolimnetic water to control iron and manganese remobilisation but less successful in controlling phytoplankton. The approach with this project was to evaluate the performance of a hybrid mixing system by combining bubble aerators with mechanical mixers.

Aims

- To evaluate a novel destratification technique employing raft-mounted mechanical surface mixers to mix the water column as a means of controlling the abundance of cyanobacteria in reservoirs. The mixers will be used alone and in combination with bubble plume aerators in two reservoirs of different size and average depth.
- To examine methods for reducing the cost of operating artificial mixing systems.

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Milestones Achieved

- Three surface-mounted mechanical mixers were installed in two separate reservoirs in South Australia by SA Water in the summer of 1998-99. Myponga Reservoir has two mixers in the deepest basin of the reservoir which supplement the existing bubble plume aeration system. Happy Valley Reservoir in metropolitan southern Adelaide is a shallower storage and has a single mixer.
- A monitoring program to examine the physical, chemical and biological behaviour of the two reservoirs carried out over two summers led to significant understanding of the operation of aeration and mixing in these storages.
- The development of an algorithm to incorporate the operation of the surface mixers into the hydrodynamic model DYRESM has been completed.
- Pulse Amplitude Modulation (PAM) Fluorometry has been used to examine photoinhibition in response to light dose and mixing. This work validated theoretical models of entrainment under different turbulence and offered insight into phytoplankton response to the mixing regime.

Milestones for 2002-03

- The final report for the project outlining performance and operating recommendations for mixers will be produced.

Technology Transfer

The development of the mixing algorithm for the DYRESM model allows the simulation and evaluation of mixers in a range of reservoir types. This model and algorithm is freely available from the website of the Centre for Water Research.

2.2.0.1 HYDRODYNAMIC DISTRIBUTION OF PATHOGENS IN LAKES AND RESERVOIRS

Project Leader

Mike Burch (AWQC)

Research Staff

Dr Justin Brookes, Dr Peter Hobson, Dr Paul Monis, Dr Chris Saint (AWQC), Dr Daniel Deere, Christobel Ferguson (SCA), Dr Nick Ashbolt (UNSW), Dr Melita Stevens, Shane Haydon, (Melbourne Water), Dr Peter Nadebaum (GHD)

Collaborators

American Water Works Association Research Foundation (AwwaRF); United States Environmental Protection Agency (USEPA); Dr Jason Antenucci, Matt Hipsey, Dirk Slawinski, Professor Jorg Imberger, Dr David Horn (Centre for Water Research, University of Western Australia)

Budget \$2,158,000

Duration Mar 02 – Apr 04

Background

Pathogens present a challenge to drinking water quality worldwide, as demonstrated by the Sydney water crisis in 1999. One of the major issues involved is being able to

predict potential problems at the water supply offtake to a filtration plant.

Pathogens usually enter reservoirs from the catchment following heavy rainfall, often as patchy "flood fronts". Since it is often not known how fast they move through the reservoir from inlet to outlet, they are hard to sample and so potential problems are hard to predict. Monitoring is also currently very expensive, which increases the difficulty in determining how much effort to put in to assess risk.

This project will track and model these flood and transport processes in a number of different reservoirs, including Burratorang (Sydney), Myponga (Adelaide) and Sugarloaf (Melbourne) Reservoirs. The outcome of this project, for utilities both in Australia and in the US, will be to determine the most cost-effective monitoring approach for these pathogens in reservoirs and therefore help minimise the risk they pose. The project is a collaborative venture between the CRC for Water Quality and Treatment Water Quality and Treatment, the Centre for Water Research (University of Western Australia), AwwaRF and the USEPA. It also builds upon a significant existing project being undertaken by the SCA to model reservoir processes in Burratorang Reservoir (NSW).

Aims

- The project will develop, test and verify optimum and cost-effective sampling strategies for detecting pathogens in reservoirs. This will include development of a model for pathogen movement and fate in reservoirs (pathogen module) that can be run within a reservoir 3-D hydrodynamic model. The combined models can be used to simulate pathogen transport and therefore to design a sampling scheme to detect or "capture" them with a sampling program in a flood event.

Milestones for 2002-03

- A model for pathogen movement and fate in reservoirs (pathogen module) that can be run within a reservoir 3-D hydrodynamic model will be developed.
- The 3-D hydrodynamic model will be validated for the three different reservoirs in Australia, and will be used to design an actual sampling program, which will then be applied in an inflow event.
- These events will be extensively sampled to allow for verification of the optimum sampling scheme suggested by the modelling work.

Technology Transfer

The findings will allow for the refinement and development of a validated robust sampling/detection strategy for pathogen detection in reservoirs. The optimum sampling strategy or "best-practice" scheme will be presented so that it can be utilised by utilities, with or without the operation of the coupled physical-hydrodynamic models.

Program 2B: Storages

2.2.3 DETERMINATION AND SIGNIFICANCE OF EMERGING ALGAL TOXINS (CYANOBACTERIA). AWWARF PROJECT 2789

Project Leader/Principal Investigator

Dr Dennis Steffensen (AWQC)

Co-Principal Investigators

Dr John Papageogiou, Dr Glen Shaw, (NRCET), Prof Wayne Carmichael (Wright State University), Dr Brenton Nicholson (AWQC)

Research Staff

Dr Chris Saint, Dr Andrew Humpage, (AWQC), Dr Brett Neilan (UNSW)

Budget \$1,630,000

Duration Jan 02 – Dec 04

Background

Algal toxins have been identified as an emerging issue in the USA. The Centre has signed an agreement with the American Water Works Association Research Foundation (AwwaRF) to jointly fund research in the USA and Australia to determine the significance of algal toxins in water supplies and refine the methods for their detection.

Progress

The individual project agreements have been finalised and staff have been appointed at AWQC, NRCET and Wright State University. Wayne Carmichael of WSU is negotiating the involvement of utilities in the USA. A progress report has been forwarded to AwwaRF.

PROJECTS UNDER DEVELOPMENT

This program has two new projects currently under development.

Investigation of Survival of Cryptosporidium in Environmental Waters will assess the survival of Cryptosporidium oocysts in environmental water samples using a cell culture infectivity assay. The project will be conducted in three stages (one stage per year), with each successive stage dependent on the completion of the previous stage. This project has been approved by the Governing Board and a Project Agreement is being prepared.

Impacts of De-Stratification of Reservoir Waters on the Character of NOM and its Removal Capacities by Water Treatment Processes will be multi-disciplinary, covering a range of areas such as modelling the hydrology of the Myponga catchment, the Myponga Reservoir, characterisation of NOM, assessment of reservoir processes that affect the character/concentration of NOM, and treatment capacities for removal of NOM. The proposal is currently undergoing international peer review.

COMMONWEALTH SCHEDULE MILESTONES YEARS ONE AND TWO

Establishment of collaborative linkages.

Selection of the priority contaminants for the focus of the research effort.

Papers developed detailing current understanding of mechanisms and options, in a conceptual model framework, and identifying subsequent research priorities.

Documentation of an agreed detailed research plan.

Reports on pilot studies testing the feasibility of the research plan.

CONTRIBUTION FROM PROJECT MILESTONES STRATEGIC PLANNING

A workshop was held in August 2001 to develop collaborative linkages. There is ongoing communication with industry and research leaders in the field.

Priority contaminants were identified at the August workshop.

To be completed in Year Two.
Papers presented at August workshop.

To be completed in Year Two.
The expressions of interest in research areas generated after the workshop have been assessed and the research priorities established. Two key projects, Hydrodynamic Distribution of Pathogens and Emerging Algal Toxins are underway.

To be completed in Year Two.

Program 2C: Measurement



PROGRAM LEADER
PROF ROBERT KAGI, CURTIN UNIVERSITY

PROGRAM AIM

The aim of the Measurement Program is to develop a range of measurement techniques that will support the multi-barrier concept underpinning the Australian Drinking Water Guidelines, resulting in a more cost-effective and lower risk operation of water systems from catchment to tap. This program will therefore support the other research programs with specialist analytical method development. This requires considerable exchange between the Measurement and client Programs to establish the key research areas.

PROGRAM BACKGROUND

The research planning workshops held in 2001 established the following research topics:

Enhanced Online Measurement and Monitoring Capabilities

- Remote capabilities, especially for operator alert/advanced process control
- Management of reservoirs, studies and monitoring of distribution systems
- Biosensors for MIB & geosmin
- Passive collector techniques especially for semi volatile organics/pesticides
- Devices must be robust in service

Sampling and Sampling Strategies

- Integrating samplers/passive collector techniques eg for pesticides
- Sampling program design (identified as a technology transfer issue)

Tracking of Analytes in Treatment Plants

- Removal/alteration of eg Mn, Al, NOM
- Impacts of changed treatment technologies eg MIEX, UV

Development of Practical Screening Assays

- For toxins, especially toxins not yet identified
- A field test kit for algal toxins was identified as a desirable development
- For microbes, including new potentially pathogenic microbes and viruses

Development of New Biomarkers

- A measure of exposure to toxins and contaminants is crucial for epidemiological studies

Genetic and Phenotypic Fingerprinting

- Gene-based methods for identifying and tracing algal and microbial contamination

Endocrine Modulators

- Endocrine modulators, pharmaceuticals and industrial materials are of increasing concern especially for re-used water. However, it is not yet clear whether this is a critical concern for water supplies. An extensive literature review is under way which will determine the priorities for the CRC

Disinfection By-Products

- While there is on-going concern on the health implications of disinfection by-products the priorities for research within the CRC are yet to be clarified

Tastes and Odours

- Tastes and odours are a major issue for many utilities, but this is a complex matter heavily impacted by customer perceptions
- High level analytical competencies are required to support taste and odour studies

NOM characterisation, quantitation and behaviour

- Methods for characterising NOM in relation to treatability and bioavailability

PROJECTS UNDER DEVELOPMENT

As the priorities of the Measurement Program are largely determined by the client Programs, the Measurement Projects take longer to develop.

One project has been approved by the Governing Board to start in 2002-03: *Early Detection of Cyanobacterial Toxins using Genetic Methods*.

Due to an assessment of research activities and needs, two projects (2.3.1.4 Development of an ELISA Method for Microcystins and 2.3.3 Identification and enumeration of Cyanobacteria) from Program 2B: Storages have been transferred into this program.

PROJECTS

2.3.0.1 THE CHEMISTRY OF HALOPHENOL TASTES IN DRINKING WATER

Research Student

Justin Blythe

Supervisors

Prof R Kagi, Dr Cynthia Joll, Dr Anna Heitz (Curtin University)

Duration Aug 01 – Aug 04

Background

Plastic or chemical taints have recently emerged as an issue for drinking water in Perth. The taint only occurred after the

Program 2C: Measurement

water had been boiled. The compound 2,6-dibromophenol (2,6-DBP) has been identified as the source of the taints. Investigations into possible sources of phenols did not identify any major sources related to natural organic matter but did suggest potential sources from plastic components in kitchen appliances such as kettles and fridges and plumbing items.

More recent information indicates that bromophenol formation varies considerably between waters of different sources despite similar reaction conditions. This suggests an unknown aspect of water quality may influence the taint formation.

The aims of this study are to determine the effects of various trace components of natural waters on phenol bromination rates. It will include assessing the impacts of a variety of treatment options on bromophenol formation.

2.3.0.2 THE STRUCTURE AND CHEMISTRY OF NATURAL ORGANIC MATTER IN GROUND WATERS FROM THE GNANGARA MOUND

Research Student

Daniel Couton

Supervisor

Prof R Kagi, Dr Cynthia Joll, Dr Anna Heitz (Curtin University)

Duration Jan 02 – Jan 05

Background

Natural organic matter (NOM) can cause a number of significant problems including increasing treatment costs, generation of disinfection by-products and bacterial regrowth in distribution systems. NOM is very heterogenous making structural studies difficult. Of particular interest are the large hydrophilic macromolecules that can be highly refractory and difficult to treat.

The aim of this study is to determine functional characteristics of the NOM as determined by Fourier Transform Infrared Spectroscopy and ^{13}C NMR. Groups such as ether, ester and sulphur linkages will then be targeted to provide a systematic attack on the NOM macromolecule. Recent novel synthetic methods for mild oxidation, reduction hydrolysis and enzymatic cleavage will be used with degradation product identification by GC-MS. Micro-scale sealed vessel pyrolysis GC-MS will also be used.

2.3.0.3 THE MONITORING OF ORGANIC AND BIOLOGICAL CONTAMINANTS IN RETICULATED WATER BY DIRECT PHOTOCHEMICAL DEGRADATION

Research Student

Kylie Catterall

Supervisor

Dr R John (Griffith University)

Duration Jun 02 – Jun 05

Background

There is increasing concern within the water industry regarding the use of chemicals in water treatment especially treatments such as chlorine that generates potentially harmful by-products. Photoelectrochemical degradation by TiO_2 is attracting interest due to its potential to oxidise nearly any organic or biological material.

TiO_2 can be used as suspended particles or as an immobilised system. While the former provides high degradation rates there are practical difficulties in recovering and regenerating the TiO_2 . The immobilised systems have a lower capacity and rate of degradation but are more practical for water supplies.

The aim of this study is investigate ways of improving the photocatalytic efficiency of the immobilised systems. One of the rate limiting steps in the process is the need to trap the photo-excited electron on a semi-conducting surface such as O_2 . This study will investigate electrochemical methods for trapping photoelectrons. This will involve the application of electrochemical potential bias to a TiO_2 nanoparticle coated electrode.

This approach has the potential to improve the efficiency of the photodegradation process with the rate independent of the O_2 .

2.3.1.4 DEVELOPMENT OF AN ELISA METHOD FOR MICROCYSTINS

Project Leader

Dr Brenton Nicholson (AWQC)

Research Staff

Dr Carolyn Haskard

Collaborators

Dr M Weller, Mrs A Zeck (Technical University of Munich)

Budget \$378,948

Duration Jan 97 – Feb 03

Background

The currently available ELISAs have limited cross reactivity that increases the risk of false negative results.

Aim

- Develop an ELISA based on antibodies generated to synthetic ADDA.

Milestones Achieved

- CSIRO has synthesised adequate quantities of ADDA that has been provided to the researchers in Munich.
- The Munich group has successfully generated antibodies to the synthetic ADDA and to intact microcystin.

Program 2C: Measurement

Milestones for 2002-03

- The assay has been transferred to the AWQC, where it is being evaluated against existing ELISA and chemical methods for detecting microcystins.

2.3.3.1 APPLICATION OF COMPUTER-ASSISTED IMAGE ANALYSIS TECHNIQUES TO COUNTING AND IDENTIFICATION OF CYANOBACTERIA

Project Leader

Bret Robinson (AWQC)

Research Staff

Dr Catherine Bernard (AWQC)

Budget \$194,102

Duration Mar 01 – Feb 03

Background

Excessive growth of cyanobacteria is of concern due to their production of toxins or metabolites with off-flavours and tastes. Semi-automated protocols for the analysis of cyanobacteria should provide rapid more reliable quantitative data on algal samples (including biomass estimates), while releasing expert biologists for other tasks such as data assessment and providing advice.

Aims

To semi-automate the tasks of:

- counting cyanobacteria to estimate population density,

- estimating cell size and biomass, and
- acquiring morphometric data to apply to taxon identification and recognition.

Milestones Achieved

- Protocols developed for counting and measurement of unicellular/colonial and filamentous cyanobacteria, validated using cultivated *Microcystis* and *Cylindrospermopsis* respectively. Counting of filamentous species takes account of overlapping trichomes.
- Large data-base of images collected for measurement and development of discriminating morphometric criteria (*Microcystis*, *Cylindrospermopsis* and *Anabaena*).
- Counting and measurement protocols utilised to assess the efficiency of alternative disaggregation methods for *Microcystis* colonies.

Milestones for 2002-03

- To test rigorously the counting and measurement programs developed with bright-field microscopy on fluorescence images, refining the processing of images based on chlorophyll autofluorescence.
- To link counting and measurement programs for colonial and filamentous cyanobacteria with the motorised-stage program, progressing to an integrated scanning protocol.
- Collection and analysis of environmental samples for application and refinement of image analysis programs.

COMMONWEALTH SCHEDULE MILESTONES YEARS 1 AND 2

CONTRIBUTION FROM PROJECT MILESTONES

Establishment of collaborative linkages.

Strategic planning workshop held, well attended by industry and research Parties.

Report on the priority issues for research and development. Priorities are likely to include biomarkers of exposure to DBPs, improved assessment of the effectiveness of barriers to contamination, and protocols for the study on key micropollutants.

Planning workshop identified key research priorities. Project development in these areas has commenced.

Papers developed giving current understanding of measurement technology and monitoring approaches.

To be developed 2002-03.

Documentation of an agreed detailed research plan.

Research proposals have been prepared are being evaluated by external reviewers.

Progress reports on implementation of the research plan.

To be reported 2002-03.

Program 2D: Water Treatment Technology



PROGRAM LEADER
MARY DRIKAS, AUSTRALIAN WATER QUALITY CENTRE

PROGRAM AIM

The purpose of the program is to identify and/or develop improved engineering and system management of treatment processes for control of problem organisms and compounds. This will be implemented within the framework of the multi barrier approach of managing water quality from catchment to customer to ensure the processes implemented in this program do not adversely impact on water quality within the distribution system.

PROGRAM BACKGROUND

In July 2002, an industry workshop was held to identify the research priorities and develop the new research program. The key issues for the industry in water treatment, and processes to address them, were identified. The key project areas identified, in order of priority, are listed here, with brief descriptions of the proposed focus of the projects:

1 Combined Treatment Processes for NOM–Bioavailability

To determine the effect on natural organic matter (NOM) of combining various treatment options; this includes the use of processes such as MIEX[®], and membranes as well as conventional treatment processes using enhanced coagulation. Particular emphasis was placed on optimisation to reduce the bioavailable component of NOM, the formation of disinfection by-products and to minimise the effect of chlorine and bacterial regrowth.

2 Effect of UV on Bacteria/Viruses/Protozoa and Remainder of Treatment Processes and Distribution System

To assess the effectiveness of ultraviolet irradiation for destruction of pathogens, not just *Cryptosporidium*, but to extend previous studies to include a range of key pathogens, including viruses. It was also identified that this should include an assessment of the impact of UV on other aspects of water quality, such as changes to bioavailability of NOM, and whether these changes will impact on treatment processes and distribution system performance.

3 Biodegradation of Taste and Odour Compounds and Algal Toxins

To assess the effectiveness of biodegradation of algal metabolites and develop controlled processes to produce biodegradation at will. This should include cylindrospermopsin as well as the more common metabolites. The toxicity and fate of any products that may be formed should also be determined.

4 Biological Reactors for Removal of Natural Organic Matter

A particular component of NOM (neutral hydrophilic fraction) has been identified as that fraction not removed by coagulation processes and also responsible for causing the fouling of membrane systems. The need to develop effective treatment processes, most likely biological, to remove this particular component was highlighted. In addition this should be extended to include the use of biological treatment for removal of all NOM and also organic micropollutants.

5 Optimisation of Treatment & Disinfection Processes for Destruction of Key Pathogens – Pilot Plant Studies

This project aims to focus on applied evaluation of the treatment and disinfection processes for the destruction of key pathogens by the use of pilot plants and perhaps operating treatment plant data where applicable. It is envisaged that this could involve pilot studies using surrogate organisms and pathogens to determine the effective removal at different stages of the conventional treatment process and other processes, as well as comparison of the different disinfection processes and their combination.

6 Biological Manganese Removal

Whilst this received a lower priority in this workshop, it was raised as one of three key issues within an earlier workshop that focussed on iron and manganese issues. This project aims to develop an effective bioreactor to remove manganese within a treatment plant and prevent aesthetic problems within the distribution system.

7 Pre-Treatment Options for Membrane Desalination

Whilst desalination did not receive a high priority at this workshop, it was identified as one of the key issues in the new program within the agreement with the Commonwealth. Effective desalination processes are likely to be an important issue for the program on Regional and Rural Water Supplies and it is considered necessary to focus on improved pre-treatment options for membrane technology that minimise membrane fouling.

PROJECTS UNDER DEVELOPMENT

To date three project proposals have been prepared (Projects 1, 6 and a project which combines projects 2 and 5). These have been approved by the CRC Board and are undergoing either peer review or preparation of project agreements. Proposals for projects 3 and 4 are in preparation.

Program 2D: Water Treatment Technology

PROJECTS

3.1.2 POLYELECTROLYTES IN WATER TREATMENT

Project Leader

Dr Rob Eldridge (CSIRO)

Research Staff

Norman Becker, Dr Brian Bolto, Dr David Dixon, Ngoc Le (CSIRO)

Budget \$1,209,505

Duration May 96 – Jun 01

Aims

Polyelectrolytes are used in water treatment both as coagulant aids and as primary coagulants. Most of the added polyelectrolyte will be removed along with the destabilized colloidal impurities, but some may remain in the treated water, which may cause health implications from the polymer itself, and any byproducts formed from its interaction with disinfectants. A rapid and reliable method, based on fluorescent labelling, for determining residual polymer in water treated with polymeric flocculants or coagulant aids was developed.

Milestones Achieved

- The final project report has been completed and is being reviewed.
- Poster papers were presented at two international IWA conferences.

3.1.3 HYBRID MEMBRANE PROCESSES IN WATER TREATMENT

Project Leader

Dr Stephen Gray (CSIRO)

Research Staff

John Bridger (CSIRO), Prof Tony Fane, Andrew Lee (UNSW), Linhua Fan, Dr John Harris, Prof Felicity Roddick (RMIT)

Budget \$2,052,641

Duration Jul 97 – Nov 01

Background

Membranes are reliable, use low amounts of chemical and are low maintenance, potentially making them cost effective and ideally suited for small communities. Both microfiltration (MF) and ultrafiltration membrane processes have been found to be particularly suitable in potable water treatment for the removal of finely divided suspended solids, especially bacteria, algae and protozoa such as *Giardia* and *Cryptosporidium*. They have been less successful in cost terms for the removal of dissolved contaminants such as colour and chemical pollutants.

Aims

This project aims to focus on the role of coagulation and

adsorption processes in combination with microfiltration membrane processes. It is hoped that by studying such process combinations, the removal of natural organic compounds on conventional microfiltration membranes can be achieved with minimal fouling of the membrane surface.

Milestones Achieved

- Coating of hydrophobic microfiltration membranes with positive or neutral polymers was shown to have no long term beneficial effect on the fouling rate.
- Linhua Fan was awarded his PhD for work on identifying the major membrane fouling components of NOM.
- Andrew Lee has demonstrated that compressible flocs are best filtered at low trans membrane pressures and that removal of humic acids with pre-polymerised flocs has advantages for membrane filtration over coagulating in the presence of humic acids.
- The final report was completed.

Milestones for 2002-03

- The final report will be reviewed and published.
- Andrew Lee will complete his PhD thesis.

Technology Transfer

The project has identified several simple adsorption processes that can be used in combination with low pressure microfiltration processes for the removal of dissolved as well as insoluble impurities from drinking water. However, these processes have not yet proved cost effective.

3.1.4 NOVEL METHODS OF PATHOGEN DESTRUCTION

Project Leader

Dr David Dixon (CSIRO)

Research Staff

Asoka Weerawardena, Dr Norm Pilkington, Dr Neville Anderson, Dr Brian Bolto, Dr Calum Drummond, Chris Strauss (CSIRO), Dr Alex Keegan, Dr Paul Monis, Dr Chris Saint (AWQC), Dr Franz Grieser (Uni Melbourne)

Budget \$1,184,916

Duration Jan 00 – Jun 02

Background

The major threat to the microbiological quality of drinking water is currently provided by very low concentrations of protozoa such as *Cryptosporidium* and *Giardia*. Studies have shown that whilst conventional clarification techniques such as coagulation and filtration of different modes have high removal efficiencies for these organisms, the traditional chemical-based disinfection regimes are less effective.

Aims

The concept applied in each subproject within this project is the use of conventional methods of concentration of the pathogens (eg attachment to filter media or use of a filtration

Program 2D: Water Treatment Technology

membrane), followed by a novel method of destruction such as microwave irradiation, ultrasound or advanced oxidation. Whilst in theory it may be possible to continuously treat the entire flow through a full scale plant in this manner, in practice economics will decree that only the concentrated stream that results from the intermittent backwashing of the filter or cleaning of the membrane is treated. This project is designed to examine the efficiency and cost effectiveness of these selected methods of disinfection.

Milestones Achieved

- the cell culture assay method has been developed and verified to the stage where it provides a credible alternative to the more expensive infectivity protocol.
- atomic force microscopy has been demonstrated as a versatile method for study of the interaction between inorganic substrates such as sand used in filtration and biocolloidal material such as oocysts.
- using cell culture assays MIOX has been shown to be ineffective for inactivation of *Cryptosporidium*.
- all three non-chemical destruction methods, magnetite and microwaves, membranes and ultrasound, and ultraviolet irradiation, have been shown to be cost effective on both model systems and real targets such as filter backwash waters.

Milestones for 2002-03

- Completion of final report.

Technology Transfer

The project outcome will be the demonstration of a novel, cost effective and non-chemical method of pathogen destruction in a concentrated stream such as filter backwash water.

3.2.1 DEVELOPMENT OF TREATMENT SYSTEMS FOR REMOVAL OF NATURAL ORGANICS

Project Leader

Mary Drikas (AWQC)

Research Staff

Dr Chris Chow, Jim Morran, Dr Rolando Fabris (AWQC), James Thomson, Prof Felicity Roddick (RMIT), Shaun Thomas, Dr David Davey, Prof Dennis Mulcahy (Uni SA)

Budget \$2,155,672

Duration Apr 97 – Sept 02

Background

Natural organics are one of the key factors in water treatment processes; they determine both coagulant and disinfectant dose, react with disinfectants to produce by-products, are a food source for bacterial growth in distribution systems, foul membranes limiting their use and are adsorbed strongly by activated carbon reducing its lifetime and usefulness for removal of pollutants. There is a need to reduce the amount

of NOM present in our waters if water authorities are to maximise the cost-effective use of a range of treatment processes and to meet future limits on both disinfectant dose and disinfection by-products.

Aims

This project seeks a better understanding of the removal of natural organics by a range of treatment processes, focussing on coagulation, oxidation and ion exchange resins. This should identify processes or steps in these processes that are more suited for removal of the components of the natural organic matter (NOM) that contribute to assimilable organic carbon (AOC) or are reactive to disinfection, forming by-products.

Milestones Achieved

- An automated laboratory scale conventional water treatment pilot plant was established and different coagulants including alum, ferric chloride and poly aluminium chlorohydrate were studied.
- Two artificial neural network models were completed to predict 1) alum dose based on the input of raw water quality and the desired treated water quality and 2) treated water quality based on the input of raw water quality and alum dose. Both models were implemented as a simulation software package.
- The custom made on-line aluminium speciation measurement system was tested using the pilot plant facility. The experiment was designed to measure the inorganic and organic bound aluminium in treated water. This technique can potentially be applied to evaluate flocculation behaviour.
- Oxidation using low pressure mercury vapour lamps alone and in combination with hydrogen peroxide followed by biological treatment resulted in significant reduction in NOM of Myponga water.

Milestones for 2002-03

- Pilot plant evaluation to assess the impact of changing coagulant doses on the biodegradability of the NOM completed.
- James Thomson and Shaun Thomas to complete their PhDs.
- Completion of final report.

Technology Transfer

This project will enable the modification of currently utilised treatment systems to maximise efficiency of treatment and removal of natural organic matter.

Program 2D: Water Treatment Technology

3.2.2 OPTIMISATION OF ADSORPTION PROCESSES

Project Leader

Dr Gayle Newcombe (AWQC)

Research Staff

Prof Felicity Roddick, Rebecca McCallum (RMIT)

Budget \$1,214,046

Duration May 96 – Jun 02

Background

Powdered activated carbon is used extensively for the removal of tastes and odours from drinking water, however it does not always produce the desired water quality. Preliminary studies have shown that activated carbons produced from different raw materials display a range of capacities for taste and odour removal. If the necessary characteristics of activated carbon for a particular contaminant (or a mixture of contaminants) are known, the best carbon can then be chosen (or produced), ensuring the most cost-effective use of activated carbon.

Aims

This project combines the study of adsorption of compounds that are of particular interest to the water industry of Australia (namely algal toxins, taste and odour compounds and dissolved natural organic material) and the simultaneous detailed study of the surface properties of the adsorbents. This information will define the mechanisms responsible for adsorption behaviour on different adsorbents, as well as the effect of NOM on removal of problem compounds.

Milestones Achieved

- Rebecca McCallum successfully submitted her PhD thesis.
- One paper was presented at the AWWA Water Quality Technology Conference in Nashville, Tennessee, one paper was published in *Water*, one in *Opflow*, the operators magazine of the AWWA, and three papers were accepted for publication.

Milestones for 2002-03

- Completion of project report.
- A paper will be presented at the Sixth IWA Symposium on Off-Flavours in the Aquatic Environment in Barcelona, Spain.

Technology Transfer

The outcomes from this project have been the more cost-effective use of activated carbon in water treatment by the establishment of reliable criteria for the choice of a particular adsorbent under specified water quality conditions. The potential of a low-cost, brown coal-based adsorbent for specific application in water treatment has been proven. Specific commercial outcomes, such as the production of this activated carbon at a commercial level, are still under consideration.

3.2.3 ALTERNATIVE DISINFECTION REGIMES

Project Leader

Dr Brenton Nicholson (AWQC)

Research Staff

Chris Kostakis (AWQC), Rodney Magazinovic, Dr David Davey, Prof Dennis Mulcahy (UniSA)

Budget \$621,289

Duration Mar 97 – Jun 01

Aims

An understanding of the factors affecting the formation, and the nature, of the precursors that lead to AOC and DBPs in water treatment processes involving ozone or ozone/chlorine, and factors which affect the formation of brominated DBPs such as bromate in ozonated water.

Milestones Achieved

- Project report completed.

3.2.5 REGENERATION OF ACTIVATED CARBON

Project Leader

Prof Felicity Roddick (RMIT), Prof Don Bursill (AWQC)

Research Staff

Dr Thang Nguyen (RMIT)

Budget \$519,245

Duration Dec 96 – Jun 03

Preliminary work at the AWQC demonstrated the basic concept for this novel process with regeneration efficiencies of approximately 70% being obtained at small laboratory scale. The concept has been refined and further developed at RMIT with the determination of critical factors and regeneration efficiencies. At the 1 kg scale approximately 90% removal of NOM has been consistently obtained over several regeneration cycles. After regeneration, the carbon had reduced capacity for NOM and increased capacity for the taste and odour compound, MIB. A system has been developed to enable reuse of the regenerant.

The CEO has sought the assistance of the Commercialisation Committee and an industry partner is being sought to take this process to full commercialisation.

Program 2D: Water Treatment Technology

3.2.6 DEVELOPING OPTIMUM ADSORPTION PROCESSES STAGE 2

Project Leader

Dr Gayle Newcombe (AWQC)

Research Staff

David Cook, Najwa Slyman (AWQC), Lionel Ho, Sam Brooke, Dr Gunther Klass (UniSA), Prof Felicity Roddick (RMIT)

Budget \$838,727

Duration Oct 00 – Oct 02

Background

This project builds on the existing knowledge and understanding gained through previous studies in Stage 1, and extends the investigation to the use of granular activated carbon (GAC), as an adsorber and a substrate for biodegradation, alone, or in combination with ozone. The effects of water quality will be investigated, with the emphasis on the removal of the algal metabolites, MIB, geosmin and algal toxins. This extends the work to cover all forms of activated carbon currently used in drinking water treatment.

Aims

- To identify the water quality parameters affecting the application of ozone and activated carbon for the removal of algal metabolites.
- To predict the efficacy of activated carbon for these compounds, in particular the lifetime of GAC filters.
- To identify the type, and quantity of microorganism required on a GAC filter for effective biodegradation.

Milestones Achieved

- It has been established that the range of microcystin variants display very different removal efficiencies by activated carbon. For example, microcystin RR is very readily removed by activated carbon, whereas activated carbon would not be considered a treatment option for the removal of microcystin LA.
- The adsorption of microcystins LR and LA can be predicted using the homogenous surface diffusion computer model. This allows water authorities to estimate the doses of PAC required to remove the toxins, and to make informed decisions regarding the need for more advanced treatment processes.
- It has been shown that the lag phase seen in the biofiltration of microcystin toxins can be eliminated by acclimatising the biofilm to microcystins as a food source.

Milestones for 2002-03

- The effect of coagulants on the application of PAC will be investigated in a range of waters with different NOM concentration and character, and turbidity. This will result in useful information on the size, density, strength and fractal dimension of flocs under different water quality conditions in the presence and absence of PAC.
- Another special topic session will occur at the AWWA

Water Quality Technology Conference in Seattle 2002 with strong participation from the Centre.

- Sam Brooke and Lionel Ho will complete their PhD theses and David Cook his Master's thesis.
- A Chinese researcher, Zhoa Liang, will spend six months with the Centre, funded by the Chinese government. This work will be undertaken in collaboration with the Ian Wark Research Institute at UniSA.

Technology Transfer

It is envisaged that the project will result in the provision of guidelines regarding the confident application of activated carbon, alone or in combination with oxidation processes, under a range of water quality conditions.

3.2.8 MODELLING COAGULATION TO MAXIMISE REMOVAL OF ORGANIC MATTER – A PILOT PLANT AND LABORATORY BASED STUDY.

Project Leader

Dr John van Leeuwen (AWQC)

Research Staff

Dr Rob Daly, Mary Drikas (AWQC), Tung Nguyen, Dr Ian Fisher, George Kastl, Arumugam Sathasivan, Phil Duker (Sydney Water), Mike Holmes, Dr Craig Heidenreich, Bronwyn Walsh, Dr Darren Oemcke (United Water)

Budget \$994,220

Duration Oct 01 – Sept 03

Background

Natural organic matter (NOM) in raw water is partially removed by conventional treatment using inorganic coagulants. The NOM remaining after treatment can be a substrate for microbial growth and can react with disinfectants causing both their concentration to be lowered and the formation of disinfection by-products. The NOM remaining in treated water may also comprise compounds that cause it to have an unpleasant taste and/or odour. For the above reasons there is now a greater need to maximise the removal of NOM by the water industry. The treatment of water using coagulants to maximise the removal of organics is referred to as enhanced coagulation. The ability to predict the maximum NOM removable by enhanced coagulation would assist operators to optimise the performance of their treatment plants.

Aims

- To develop models that have raw water quality parameters as input variables for feed-forward prediction of coagulant and pH control reagent doses for attainment of enhanced coagulation.
- To develop models that describe the removal of dissolved organic carbon (DOC) with variation of coagulant dose rate and pH.
- To validate the above models using water treatment pilot plants.

Program 2D: Water Treatment Technology

Milestones Achieved

- Models have been developed for prediction of alum and ferric chloride doses and pH control doses for enhanced coagulation, based on raw water quality parameters.
- A model has been developed that describes the removal of dissolved organic carbon using alum and ferric chloride coagulants at various dose rates and pH levels.
- Model/software for prediction of alum and pH control reagents have been evaluated using pilot plants at Happy Valley Water Treatment Plant (WTP) (SA) and Illawarra WTP (NSW).

Milestones for 2002-03

- Evaluate DOC removal and coagulant dose prediction models using water sources of varying water quality and pilot plants at Illawarra WTP (NSW) and Myponga, Mt Pleasant and Kangaroo Island WTP (SA).
- Integrate DOC removal models with those used to predict coagulant and pH control reagent doses.
- Evaluate the potential for a generic DOC removal model.
- Develop further the coagulant dose prediction models to include polyaluminium chloride and various types of turbidity.

Technology Transfer

- Models that enable prediction of inorganic coagulant doses and pH control reagents for enhanced coagulation will assist operators of water treatment plants to optimise treatment for DOC removal.
- Models that describe the removal of DOC in relation to coagulant dose rate and pH level will assist operators to select treatment conditions that enables attainment of target DOC removal with cost efficient use of treatment chemicals.
- Development of software that is based on the above models should enable ready application by water treatment plant operators.

3.2.9 DEVELOPMENT OF BIOLOGICAL TREATMENT SYSTEM FOR CONCENTRATED NATURAL ORGANICS STREAMS

Project Leader

Jim Morran (AWQC), Marin Slunjski (Orica)

Budget \$638,268

Duration Oct 02 – Sept 04

Background

Natural organic matter (NOM) in water results from the decomposition of vegetative and animal organic matter. NOM consists of both biodegradable and recalcitrant components that persist in the environment until the water is treated. Most of the current and new treatment methods for NOM removal are "non-destructive" processes – the NOM is

removed from raw water and disposed of, in a concentrated form, through:

- solid waste - sludge from coagulation processes, spent carbon or other adsorption media, or
- liquid waste - retentate from membrane filtration, waste regenerant from ion exchange processes.

Disposal of the liquid NOM water treatment wastes is an increasing problem, likely to impede the broader application of new treatment technologies. Generation of waste regenerant from ion exchange processes results in the periodic production of a waste stream with high total dissolved salts and an enriched NOM content. The high salt content of these wastes prevents disposal of the waste to landfill and substantial amounts of the waste discharged to sewage treatment facilities prevents reuse of the treated water for agriculture. Treatment of NOM concentrates by conventional waste-water processes is largely inefficient, resulting in production of an effluent with high colour, limiting disposal to sea outfalls.

Aims

This project will investigate biological treatment of the waste streams by studying the biodegradability of NOM and ways to improve it. This will include the development of a continuously operated bio-system to treat liquid wastes from NOM removal processes and environmentally friendly ways to dispose of biomass and treated liquid waste from this process.

Milestones Achieved

- Project approved.

Milestones for 2002-03

- Employ research officer.
- Isolate inoculum from appropriate sources (ongoing).
- Characterise NOM and biological treatment products.
- Establish a continuous bioreactor(s) with MIEX®, waste as feed and periodically inoculate with appropriate cultures.

Technology Transfer

Enable the broader application of NOM removal processes that produce liquid wastes, and/or be applicable in other industries producing high colour waste streams (pulp & papers, sugar, olive oil, etc). Isolation and/or development of a specific biomass optimised for NOM degradation may enhance activated carbon treatment or improve removal of NOM in reservoirs.

Program 2D: Water Treatment Technology



COMMONWEALTH SCHEDULE MILESTONES YEARS 1 AND 2

CONTRIBUTION FROM PROJECT MILESTONES

Establish collaborative linkages with research parties and other participants.

The Water Treatment Technology Industry Workshop was held in July and 22 partner organisations were represented. Three new projects have been established, which all involve a minimum of two research and/or industry partners.

Documentation of agreed detailed projects in appropriate research area.

To date, three new project proposals have been prepared which address the research priorities 1, 6 and a project that encompasses the priorities 2 and 5, which were identified at the industry workshop. These have been approved by the CRC Board and are undergoing either peer review or preparation of project agreements.

Commence the assessment of current technologies for the removal for the removal of contaminants present in recycled water such as endocrine disruptors and pharmaceutical compounds

The issue of contaminants present in recycled water was presented and discussed at the Industry Workshop but the consensus at this time was that a watching brief be maintained of the extensive research occurring around the world. This view was echoed in the CRC workshops held by other programs.

Evaluate the biodegradability of a representative range of natural organic matter (precursors of disinfection by-products), algal metabolites and micro contaminants.

Project 329 was approved late last year and will investigate biological treatment of waste streams by studying the biodegradability of NOM and ways to improve it. Project 326 has shown that the lag phase seen in the biofiltration of microcystin toxins can be eliminated by acclimatising the biofilm to microcystins as a food source.

Initiate the evaluation of the effectiveness of biological or physical treatment for the control of disinfection by-product formation, algal metabolites and micro contaminants.

Project 321 has evaluated the NOM removal in water using different coagulants including alum, ferric chloride and poly aluminium chlorohydrate and the impact on biodegradability of NOM and disinfection by-product formation.

Program 2E: Distribution



PROGRAM LEADER **DAMMIKA VITANGE, SYDNEY WATER**

PROGRAM AIM

The purpose of this program is to identify and develop effective management processes for the control of microorganisms, disinfection by products, organic carbon and particles within the distribution system.

PROGRAM BACKGROUND

Extensive collaboration with the industry and research partners during the year resulted in the development of industry supported new proposals. Strategic planning workshops identified a number of new project areas of importance. Two of these new projects were approved by the Board and will start late 2002: *Development of tools for improved disinfection control within distribution systems* and *Decision support systems to maintain water quality*.

Other research areas identified as high priority are:

- Understanding discoloured water at the customer's tap to reduce the level of customer dissatisfaction and to develop a method for predicting dirty water potential in distribution systems.
- Investigating the growth of opportunistic bacterial pathogens within potable and non-potable distribution mains.
- Developing HACCP for distribution system protection (to be done in collaboration with AwwaRF).

4.1.1 FACTORS AFFECTING BIOFILM DEVELOPMENT UNDER CONTROLLED CONDITIONS

Project Leader

Dr Mark Angles (Sydney Water)

Research Staff

Dr Joseph Chandy, Hopi Yip, Alice Gilyou, Malcolm Warnecke, George Kastl, Dr. Raj Shanker (Sydney Water), Mary Drikas, Naomi Withers (AWQC)

Budget \$998,000

Duration Feb 97- Dec 99

Milestones Achieved

- Project completed in 2000-01.
- Report submitted during the 2001-02 financial year.

4.1.3 MODELLING BIOFILMS AND INTERVENTIONS IN CONTROLLED CONDITIONS

Project Leader

George Kastl (Sydney Water)

Research Staff

Dr Veeriah Jegatheesan, Dr Ian Fisher (Sydney Water), Paul Chuo, A/Prof James Ball (UNSW), Mary Drikas (AWQC)

Budget \$529,000

Duration Nov 96 – Jun 02

Background

Dynamic water quality modelling within distribution systems including the interactions between bulk water, disinfectant and pipe wall.

Aim

Identify major variables and describe processes significantly affecting disinfectant decay in pipe elements, including reactions in bulk water and biofilm.

Milestones Achieved

- Bulk-biofilm-chlorine decay model
- Detailed thermal/hydraulic model for service reservoirs

Milestones for 2002-03

- To derive "zone" model from detailed hydraulic model results, for inclusion in network models

Technology Transfer

Potential uses include optimisation of investment in water treatment and distribution system infrastructure to provide specified water quality.

4.2.2.1 INTERACTIONS BETWEEN CRYPTOSPORIDIUM OOCYST AND VIRUS INTERACTIONS WITH DRINKING WATER PIPE BIOFILMS

Project Leader

Malcolm Warnecke (AWT)

Research Staff

Dr Mark Angles (Sydney Water), Michael Storey, A/Prof Nick Ashbolt, Prof Staffan Kjelleberg (UNSW)

Budget \$217,000

Duration Jan 98 – Mar 01

Program 2E: Distribution

Background

This project investigated the potential attachment and release of *Cryptosporidium* oocysts and viruses from biofilms.

Aims

- Investigation and characterisation of oocysts in relation to how they are incorporated within mature biofilms and released under various chlorination regimes.
- Establish methods for detection, characterisation and risk modelling of virus incorporation in biofilms

Milestones Achieved

- Final report on *Cryptosporidium parvum* oocyst interactions with mature biofilms published.
- PhD thesis on the ecology of enteric viruses in distribution pipe biofilms submitted.

Technology Transfer

- Sensitive detection method for *Cryptosporidium* and viruses in biofilm samples available for routine use.
- Validation of sampling tools will enable water authorities to assess biofilm and pathogen accumulation in distribution systems.
- Development of a risk model for enteric virus accumulation and release from distribution system biofilms will assist in assessing the overall health risk from exposure to distributed water.

4.2.2.2 CHARACTERISATION OF BACTERIAL SYMBIONTS OF AMOEBAE

Project Leader

Dr Chris Saint (AWQC)

Research Student

Melissa Todd (AWQC)

Budget \$24,000

Duration Feb 00 – Feb 03

Background

Some amoebae can produce disinfection resistant cysts that may contain bacterial symbionts.

Aims

- Identify bacterial symbionts and verify whether the amoeba cysts provide protection against chlorine.

Milestones Achieved

- 10 bacterial symbionts have been fully characterised and molecular fluorescent probes have been designed and constructed.
- DNA sequences analysed.
- Geosmin producing amoebae isolated and their symbionts characterised.

Milestones for 2002-03

- Transfer bacterial symbionts from one amoeba strain to another.
- Write PhD thesis.

4.2.3 PHYSICAL AND CHEMICAL EFFECTS ON DISTRIBUTION SYSTEM BIOFILMS AND INCORPORATED PATHOGENS

Project leader

Dr Mark Angles (Sydney Water)

Research Staff

Dr Joseph Chandy, Alice Gilyou, Sudhi Payyappat, Malcolm Warnecke, George Kastl, Dammika Vitanage, Gordon Aiken (Sydney Water)

Budget \$717,421

Duration Jan 00 – Jun 02

Background

The conditions that drive the attachment and release of pathogenic microorganisms from distribution system biofilms are being investigated under controlled conditions and in the field.

Aims

- Determine the effects of increased shear and disinfectant levels on pathogen incorporation and detachment from biofilms.
- Determine the main water quality parameters that drive biofilm formation.

Milestones Achieved

- Pathogen incorporation and detachment under controlled conditions.
- Water quality drivers and effect of pressure on biofilm development.

Milestones for 2002-03

- Complete final report.

Technology Transfer

Findings on the effects of shear and disinfection on pathogen recruitment and detachment as well as the tools developed have value for system operations.

4.3.1 CONSOLIDATION OF MANAGEMENT TOOLS FOR DISTRIBUTION SYSTEMS

Project Leader

Dr Ian Fisher (Sydney Water)

Research Staff

George Kastl, Percy Chen, Dr Arumugam Sathasivan (Sydney Water), Kathryn Clarkson, Rob Considine (Melbourne Water), Prof Graeme Dandy (University of Adelaide)

Program 2E: Distribution

Budget \$730,000

Duration Jun 01 – Jun 03

Background

Models of bulkwater/biofilm/chlorine decay developed and verified in earlier projects are embedded in a simple hydraulic environment.

Aims

- Develop robust toolkit in which all water quality modules can be interfaced with hydraulic network models developed.
- Validate all modules in real distribution systems and different water types.

Milestones Achieved

- Chlorine decay and simple wall reaction modules interfaced with hydraulic network models.
- THM and HAA formation models developed.
- Systems for validation studies agreed.

Milestones for 2002-03

- Experiments on decay due to pipe surface materials completed.
- Coliform/HPC occurrence probability incorporated.
- Incomplete mixing in service reservoirs incorporated.
- Validation of all modules in three systems with different water types completed.

Technology Transfer

Presented at the Biofilm and Chlorine Workshop in May 2002.

4.3.2 OPTIMISATION OF CHLORINE RESIDUAL IN A DISTRIBUTION SYSTEM – MELBOURNE

Project Leader

George Kastl (Sydney Water)

Research Staff

Robert Considine, Kathryn Clarkson, Kevin Hellier, Nataly Orr (Melbourne Water), Veeriah Jegatheesan, Dr Ian Fisher, Dr Arumugam Sathasivan (Sydney Water), Mary Drikas, Naomi Withers (AWQC)

Budget \$598,620

Duration May 99 – Jun 02

Background

An operational verification of the already developed model for chlorine decay within the Sydenham System of Melbourne Water.

Aims

- develop bulk chlorine decay model for the used source water.
- evaluate existing coliform, free and total chlorine,

temperature and HPC data to derive a probability model of coliform occurrence.

- use the model to find the optimum chlorine dosing regime.

Milestones Achieved

- Biofilm assessment (ExoSAMPLERS and Coupons).
- Chlorine decay and THM formation model of Greenvale – Sydenham, Melbourne Water.

Milestone for 2002-03

- Complete final report.

Technology Transfer

- Presented at the technology transfer workshop on Biofilms and Chlorine May 2002 in Sydney
- Biofilm sampler can be effectively used to study biofilms and corrosion.

4.3.4 REAL TIME WATER QUALITY MODELLING – PERTH

Project Leader

Carl Rouhiainen (Water Corporation)

Research Staff

Prof Graeme Dandy (University of Adelaide), George Kastl, Ian Fisher (Sydney Water)

Budget \$725,000

Duration Jul 99 – Jun 04

Status

The project status was reviewed by Centre Management and Water Corporation and was closed.

4.3.6 UNDERSTANDING PARTICLES IN DISTRIBUTION SYSTEMS – MELBOURNE

Project Leaders

Greg Ryan (South East Water Ltd), Asoka Jayaratne (Yarra Valley Water Ltd)

Research Staff

Jie Wu (CSIRO), Clive Granger (CSIRO), Bun Nguyen (CSIRO), Prem Mathes (South East Water Ltd)

Budget \$1,608,500

Duration Oct 01 – Dec 03

Background

Study about the characterisation and modeling of particles within the distribution system.

Program 2E: Distribution

Aims

- Determine the origins and characteristics of particulate material within a reticulated water system that cause 'dirty water' customer complaints.

Milestones Achieved

- Development of a preliminary computer model to simulate particle movement.
- Completion of an overseas tour of key facilities from England and Europe as derived from the literature review.

Milestones for 2002-03

- Refinement, enhancement and validation of the current computer simulation model for particles in each distribution system.

Technology Transfer

Validated particle model that can predict effectively the sediment movement within distribution systems is planned as the key potential outcome.



Photo courtesy South East Water Pty Ltd

COMMONWEALTH SCHEDULE MILESTONES YEARS 1 AND 2

Confirm critical factors impacting on biofilms and related management strategies.

Provide a manual of procedures on how, when and what methods are required of the management of mains cleaning within distribution systems.

A protocol for mains cleaning based on an improved understanding on how, when and what methods are required.

CONTRIBUTION FROM PROJECT MILESTONES

- Bulk-biofilm-chlorine decay in network model.
- Detailed thermal/hydraulic model for service reservoirs
- 10 bacterial symbionts have been fully characterised and molecular fluorescent probes have been designed and constructed.
- DNA sequences analysed.
- Geosmin producing amoebae isolated and their symbionts characterised.
- Pathogen incorporation and detachment under controlled conditions.
- Water quality drivers and effect of pressure on biofilm development.

• A draft containing a description of procedures produced in collaboration with the AWWARF Project 2688 on Pipe Cleaning Methods (AWWARF 2688 Draft Report).

- Same as above – Draft AwwaRF Report 2688.
- Technology transfer workshop presentations on mains cleaning methods and benefits.
- Networking across the Australian water industry partners on mains cleaning methods and benefits.

Program 2F: Sustainable Water Sources



PROGRAM LEADER
HOWARD GIBSON, BRISBANE CITY COUNCIL

PROGRAM AIM

The purpose of the program is to identify and evaluate alternative approaches to the provision of a high quality water supply, including an evaluation of the risks involved and the technologies required to deliver the service. The program also has the aim of establishing methodologies to determine the sustainability of water management systems for new developments and for modifying/refurbishing existing systems so they are sustainable.

PROGRAM BACKGROUND

The first planning research workshop was held in Adelaide in August 2001 to identify priority research issues. The approach for the program was identified as:

Balancing social, economic, environmental and legal risks with potential benefits from a broader total urban water cycle management approach by using demonstration projects.

The major research theme was identified as:

Comparison/Suitability of appropriate technologies over a range of scales and applications including economics, and evaluating and measuring success of sustainable options.

This led to the specific Program goal to:

Develop a methodology to determine the most sustainable water use and delivery system for any community/scheme.

The second workshop, the Project Direction Workshop, was held in Brisbane in October 2001, with the objective of finalising the overall framework of the program, as well as producing short proposals for the Management Committee. Short proposals were produced for the following areas:

- Setting the context for sustainable water sources.
- Measuring and predicting the sustainability of water sources.
- Community, governance and sustainable water sources.
- Technical performance and risk assessment of alternative integrated water systems, practices and technologies.

Final project proposals were begun to be prepared in all of these areas.

At the beginning of 2002 the use of rainwater tanks in urban areas became an issue with a number of industry partners. It was believed that this issue had not received sufficient priority in the program and that the priorities of the program should be revisited. Rather than hold more workshops, it was decided that an industry-based advisory steering committee should be formed that would advise the program on research priorities and help the program in its coordination role.

The Steering committee first met in June 2002, and after going through a priority setting process, identified the following priority projects that should be progressed as soon as possible.

Assessment of Water Quality of Water from Rainwater Tanks Installed in Different Environments.

This project would undertake monitoring of the water quality of tanks across Australia, and then carry out a preliminary risk assessment of them. It would then carry out a desktop study to determine the treatment technologies that should be investigated further to improve the water to selected standards.

Production of Water Quality Standards for Non-Potable Water.

This project would build on from the successful drinking water guidelines exercise.

Community Wants in the Area of On-Site Water Harvesting.

To trial the concept of the determination of community wants a trial project will be carried out specifically covering the area of water harvesting.

Background Data Collection.

Data collection on the technical issues associated with the program would be carried out in association with a project being done for WSAA by the Institute for Sustainable Water Futures.

Program 2F: Sustainable Water Sources

COMMONWEALTH SCHEDULE MILESTONES YEARS 1 AND 2

CONTRIBUTION FROM PROJECT MILESTONES

Establish collaborative links.

Workshops held in August, October 2001 and steering committee formed June 2002.

Compile inventory of alternative urban water projects. Complete preliminary analysis of economic, social and environmental benefits.

Scoping of existing research commenced for rainwater tank research project.

Identify specific urban water projects to be used in subsequent research and initiate research work.

Four specific urban water projects have been identified and research work will commence after approval.

Methodologies for comprehensive analysis of alternative water systems identified and application underway.

Will be commenced in Year Two.



Policy, Regulation and Stakeholder involvement

Program Group Three

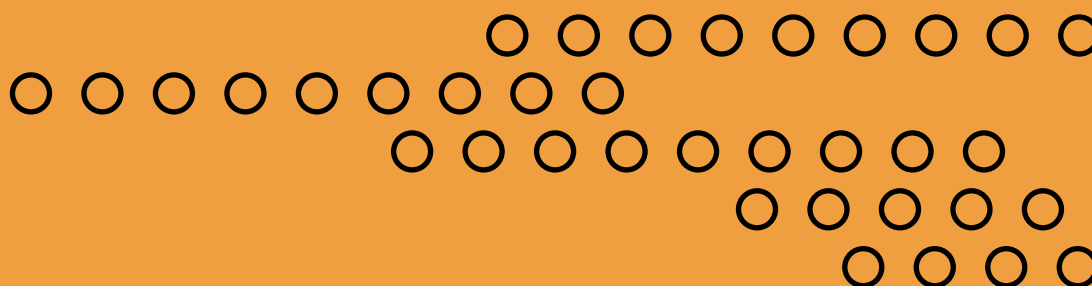


**PROGRAM GROUP LEADER:
DR TONY PRIESTLEY,
CSIRO AND
CENTRE DEPUTY CEO**

Aim

This program brings together the output of the research programs and emphasises the uptake of research outcomes by end-users. The program will:

- Coordinate water industry involvement in policy and regulatory activities.
- Direct industry involvement in forums to consider alternative approaches to the future provision of water services and the best use of the significant investment in water infrastructure in Australia.
- Examine treatment technologies for small systems, the water supply and health needs of indigenous communities and the issues associated with water supplies in tropical Australia.
- Provide education and training for the industry future leaders, with a strong emphasis on developing postgraduate students with industry focus and experience.
- Identify and exploit the intellectual property developed by the Centre.
- Maximise industry involvement in all aspects of the Centre's activities.



PROGRAMS

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3C Regional and Rural Water Supplies	Page 52
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3D Education and Training	Page 54
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3E Commercialisation	see Application of Research Page 61
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3F Communication	see Presentations and Communications Page 81
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Program 3A: Strategic Directions



PROGRAM LEADER
DR TONY PRIESTLEY, CENTRE DEPUTY CEO
AND CSIRO MOLECULAR SCIENCE

Aim

The water supply industry is characterised by a very large investment in infrastructure with asset lifetimes ranging from 20 to 100 years. As a consequence, water systems tend to be conservatively designed according to a set of principles that can only evolve slowly as the infrastructure is replaced or renewed. However, the very high replacement cost for existing infrastructure is pushing the industry to seriously study alternative approaches to the provision of water services.

The industry parties in the Centre have expressed a strong desire to give serious thought to the strategic directions of the industry and have indicated their wish for the Centre to provide a forum for consideration of these issues and the possible development and implementation of new ideas. This program will seek to identify 'over the horizon' water quality issues and develop strategies to address emerging issues before they become of major public concern.

Status

Strategic planning workshop planned for September 2002.

COMMONWEALTH SCHEDULE MILESTONES
YEARS 1 AND 2

CONTRIBUTION FROM PROJECT MILESTONES

Establish key collaborative and communication links.

Links established through extensive personal contact with industry leaders.

Foresighting exercises undertaken to identify important emerging issues.

Strategic workshop planned for 18 September 2002.

At least one research program identified to address emerging issues.

Research project on rainwater tanks identified, with scoping exercise and literature review commenced.



Photo courtesy Australian Water Quality Centre

Program 3B: Policy and Regulation



PROGRAM LEADER
PROF DON BURSILL, CENTRE CEO

PROGRAM AIM

The main objective of this Program is to apply the collective knowledge and experience of the Centre's key staff, supplemented by Centre research and international developments to the improvement of the Australian policy and regulatory framework for public water supplies.

PROGRAM BACKGROUND

This program will coordinate the Centre's role in providing coordinated, industry-wide input into the processes for changing drinking water policy and regulation. The Centre's involvement is intended to provide a better factual basis for setting guidelines, by promoting a more credible, logical use of scientific data in the delivery of an intelligent and appropriate regulatory system. The outcome for Australia should be systems and standards for public water supply regulation that are intelligently directed at achieving public health benefits and other water quality requirements that meet community needs. It is recognised that a weak regulatory regime could result in major public health incidents when inadequately designed and managed water supply systems fail to cope with major pollution or storm events. Alternatively, overly restrictive standards have the potential to incur significant infrastructure and operating costs without community or industry benefits. This Program seeks to achieve the appropriate balance.

It is only by applying the knowledge and understanding gained from the Centre's proposed research program that the most appropriate balance of regulation can be identified and implemented. While the Centre has undertaken valuable work in this area under CRC Mark 1, much remains to be done in coordinating a national approach and linking it into international developments. Given the high cost and the extensive nature of public water systems in Australia these implications are significant in national economic terms. Without the scientific and technical input of the Centre, a rational approach to drinking water quality regulation in Australia will be difficult or impossible. An outcome to be avoided is the adoption of regulatory systems based on

inappropriate approaches developed overseas. Australia is a unique country with special water related challenges which require appropriate Australian management systems.

The Productivity Commission Report on "Setting Drinking Water Standards" points out the diversity of approaches that have been taken to developing, promulgating and enforcing standards both within Australia and across a number of other countries. The Commission found that regulatory processes in many countries are not currently at best practice levels and that there is significant scope to inject greater rigour into Australian regulatory processes. The Commission's report also emphasises the importance of scientifically based cost-benefit studies, the challenge posed by new contaminant detection techniques and the need for adequate scientific and managerial resources to be made available. The Centre is providing scientific, technical and managerial resources in these areas and is playing a key role in developing and implementing a rational and scientifically based approach to regulation.

The logical and systematic approach to the upgrading of the Australian Drinking Water Guidelines that is being led by the Centre with the support of key industry, health and natural resources agencies will provide a better basis for regulation of water quality in Australia. Efforts to transfer these advances to international guidelines, such as those produced by the World Health Organisation, have been and will continue to be a feature of the Centre. Contributions have been made to WHO working groups, based on the risk based water quality management framework developed for the Australian Drinking Water Guidelines. Contributions have also been made to a key international workshop held in Bonn, Germany in October 2001, where the foundation for a uniform approach to water quality regulation at the international level was laid. This meeting was initiated by the Water Services Association of Australia, a Party to the Centre.

Contributions and assistance has also been provided to a judicial inquiry on a water borne outbreak in Canada that caused several deaths and significant long term health impacts.

A research project is also being undertaken to develop similar risk based management processes for water distribution systems in the USA.

Status

The main emphasis of the past few years has been the key changes to the water quality management provisions of the Australian Drinking Water Guidelines. As indicated above, this has been a challenging process that has involved the input and support of a broad section of the water industry as well as the Health sector and the natural resources agencies. The implementation of these Guidelines is now the key issue in this area of work. In addition, there would appear to be a need for a package of information to assist smaller regional and rural authorities to implement these changes.

The extension of the research program into areas such as water recycling and the consideration of alternative water

Program 3B: Policy and Regulation

sources such as urban stormwater presents a new set of challenges for the Policy and Regulation Program to consider. A planning workshop in this area was not possible within the overall work program during this year but is scheduled for September 2002.

COMMONWEALTH SCHEDULE MILESTONES YEARS 1 AND 2

CONTRIBUTION FROM PROJECT MILESTONES

Establish collaborative links.

Links established through personal communication with key contacts across the water industry.

Inclusion of the Water Quality Management Framework into the Australian Drinking Water Guidelines.

In process and largely completed.

Initial draft of best practice guide to drinking water regulation produced for consultation.

Completed.



Program 3C: Regional and Rural Water Supplies



PROGRAM LEADER
DARRYL DAY, POWER & WATER

PROGRAM AIM

This program aims to address the issues that affect the provision of good quality drinking water to regional and rural communities in Australia, identify research that will provide affordable and sustainable solution to water supply problems, assist with representation of the regional and rural areas in industry policy, regulation and strategic directions of the industry.

PROGRAM BACKGROUND

A planning workshop was held in August 2001 for the Regional and Rural program. Approximately 29 people participated, with representatives from industry, academia and regional areas. Issues were clearly placed into two categories: research that is covered by other Centre programs with a regional and rural focus, and research that is not currently covered. The former category was addressed, and Centre project proposals now require a consideration of regional and rural water supply relevance. The latter category will be further addressed in the planned workshops over the coming months.

PROJECTS

3.3.0.2 TECHNOLOGY TRANSFER OFFICER DEALING WITH WATER QUALITY AND TREATMENT IN INDIGENOUS COMMUNITIES

Project Leader

Darryl Day, Power and Water

Research Staff

Robyn Grey-Gardner, Centre for Appropriate Technology

Budget \$498,000

Duration Jun 01 – Jun 07

Background

This project aims to allow the Centre to make an effective contribution to improving water supplies for Indigenous communities, particularly in rural and remote locations. This is possible through collaboration with the Centre for

Appropriate Technology Inc. in Alice Springs, where the Technology Transfer Officer is located.

Aims

- To provide definitive responses to local government, Aboriginal and Torres Strait Islander Regional Councils and other appropriate bodies to improve the quality of water supplies.
- To develop research proposals to improve Indigenous health through improved water supplies in Indigenous communities.

Milestones Achieved

- Effective liaison, including interventions in 29 discrete Indigenous communities located in Central Australia, Barkly Tablelands, Kimberleys and Northern Queensland.
- Water treatment trial underway at Mutitjulu to design effective, sustainable water supply treatment technology.

Milestones for 2002-3

- Collaborative research on risk management strategies for Outstations and small Indigenous communities with a presentation of findings at a conference with stakeholders.
- 20 community projects in progress and 10 community projects completed

3.3.0.2 MUTITJULU RAINWATER TANK AND POINT OF USE TREATMENT SYSTEM TRIAL

Project Leader

Robyn Grey-Gardner, Centre for Appropriate Technology

Duration Jun 02 – Jun 04

Budget \$286,991

Background

This project developed from expressed Indigenous community need for the development of robust water harvesting and treatment systems for small remote communities.

Aims

- To design and trial best practice rainwater harvesting design.
- To trial point of use water treatment systems.
- To integrate community management of household water supplies.

Milestones Achieved

The rainwater tank infrastructure and the treatment system have been designed and installed.

Milestones for 2002-3

- Implementation of the community training program.
- Maintenance and monitoring schedule implementation.
- Commencement of the sampling and monitoring schedule.

Program 3C: Regional and Rural Water Supplies

COMMONWEALTH SCHEDULE MILESTONES YEARS 1 AND 2

CONTRIBUTION FROM PROJECT MILESTONES

Research, development and implementation of appropriate communication media.

Research into appropriate media commenced, with Web Forums the preferred application for further investigation and development for all programs.

Identification and establishment of network of stakeholders/providers and collaborative parties.

Program workshop conducted in August 2001.

Foresighting exercises undertaken to identify important current or emerging issues.

Workshop planned for August 2002 to identify important issues for Water and Public Health in regional and rural Australia and in October 2002 for examining current research and identifying emerging issues for Melioidosis.

At least one research project identified and promoted for inclusion in either Program Group One or Two.

Commencement of Project 3.3.0.2.

Processes developed for input into industry policy, regulation and strategic direction.

A regional and rural focus question has been included in the Centre project proposal form.

Photo courtesy Australian Water Quality Centre



Education and Training Program



PROGRAM LEADER
PROF DENNIS MULCAHY
UNIVERSITY OF SOUTH AUSTRALIA

AIM

The Education and Training Program aims to provide specialist undergraduate and postgraduate experience in water science and technology.

The Program encompasses:

- PhD and Masters research projects
- Coursework postgraduate activity
- Honours scholarships
- Summer Research Scholarships and some undergraduate project activity
- Postgraduate Student Conferences and other support for conference attendance, including international conferences
- Participation in the CRC Water Forum's Young Water Scientist of the Year competition
- Involvement of researchers in coursework postgraduate and under graduate lectures
- Staff training activities

2001/2002 ACTIVITIES

Summer Research Scholarships

Nine Summer Research Scholarships were offered over the 2001/2002 long vacation. Students were able to select from 26 projects promoted via the CRC website. There were 48 applications for the program.

Industry parties ECOWISE Environmental, Melbourne Water and Yarra Valley Water hosted Summer Scholars in this round and, for the second time, a student was placed at the Centre for Appropriate Technology in Alice Springs.

The Summer Research Scholarship Reporting Seminars were held in mid February at RMIT. The standard of the presentations was excellent. On the following day the students were given a tour of Yan Yean Reservoir and Water Treatment Plant.

Honours Scholarships

Honours Scholarships were introduced this year at six out of the Centre's eight member universities. The purpose of the scholarships is better articulation between Summer Research Scholarship activities and the Centre's postgraduate research training program.

Postgraduate Students

The CRC is pleased to report nine more graduates, **Geetha Ranmuthugala, Chris Kostakis, Adele Parkinson, Carolina Tillet, Anthony Moeller, Suzanne Froschio, Brent Robertson, Melanie Kaebnick** and **Rebecca McCallum**. Two students, **Robert Considine** and **Linhua Fan**, are awaiting conferral of their awards and a further eight are awaiting their thesis examination outcomes.

Forty nine students are listed in the matrix. Twelve of these have been appointed in the 2001/2002 period. Of the total, fourteen are fully supported by the CRC and thirty are receiving scholarship supplements. One has been fully supported by NHMRC, one by Sydney Catchment Authority and one by AwwaRF. One is a CRC Research Officer and another formerly held a Research Officer position. Six more students will join the ranks on July 1st. Industry supervision is widespread and it is an aim to make it universal.

Overseas Placements and Conference Presentations

Melissa Todd (UniSA) attended the 9th International Meeting on the Biology and Pathogenicity of Free-Living Amoebae in Paris, France in July 2001 and presented a paper entitled *Molecular Characterisation of Bacterial Endosymbionts of Acanthamoeba species*.

Jon Varcoe (University of Adelaide) attended the International Phosphorus Transfer Workshop in Plymouth, England in August/September 2001. He presented a poster, *The Effect of Calcium Soil Amendments on Phosphorus Mobility*.

Michelle Moffitt (UNSW) attended the Polyketides III Conference in Bristol, England in September 2001. Her paper was entitled *Functionality of Ketosynthase Domains Identified in a Diverse Range of Microorganisms*. Both prior to and following the conference (three months in all), Michelle worked in Professor Thomas Boerner's laboratory at Humboldt University, Berlin.

Sean Blasdall (UNSW), **Michael Storey** (UNSW) and **Rudi Regel** (University of Adelaide) participated in the International Water Association World Water Conference in Berlin in October 2001. Sean's paper was *Powerful Subspecies Typing of Cryptosporidium parvum by a Novel Microsatellite - Based PCR Procedure*. He also took the opportunity to visit several people who had provided samples for his research: Racheal Chalmers in Swansea, Huw Smith in Glasgow and Marilyn Marshall in Tucson, Arizona. Michael gave a platform presentation entitled *A Comparison of Methods and Models for the Analysis of Distribution Pipe Biofilms*. Rudi presented a poster, *Time Scales of Events and Threats to Water Quality Within Lakes and Reservoirs*. Michael's attendance was partly supported by IWA. He went on to spend two weeks with Professor Hans-Curt Flemming's research group at the University of Duisberg, where he was able to use AFM and

Education and Training Program

TEM techniques to further characterise viruses used in his biofilm studies. He then spent a week at the University of Karlsruhe, undertaking some fluid flow dynamics studies with Georg Donnert. Rudi chose to visit one of the world's leading marine phytoplankton/turbulence research institutes, the Institut de Ciències del Mar, in Barcelona, Spain. He gave a presentation there on destratification of reservoirs and lakes. He completed his European visit with a stop at the University of Cologne.

David Moore (NRCET) attended the Shallow Lakes Conference at Balatonfured in Hungary in May, 2002. He presented the paper *Potential Triggers of Akinete Differentiation in an Australian Strain of the Cyanobacterium Cylindrospermopsis raciborskii*. This was followed by a visit to the Lake Balaton Limnological Research Institute.

Harry Neumann, a final year undergraduate Process Engineering student from Fachhochschule Nurnberg, completed his five month placement at the AWQC in September 2001. This coincided with the visit of **Professor Dr Edgar Schicker** from the Fachhochschule. The focus of Harry's study was NOM removal at pilot plant level. He worked with **Dr Chris Chow**.

Two further students from Nurnberg, **Stefan Steinhofner** and **Heiko Engelhardt**, commenced placements at AWQC in March 2002. They are working on different aspects of pilot plant scale water treatment. Stefan is concentrating on NOM removal and Heiko is studying algal toxin removal using PAC. **Dr Chris Chow** is supervising Stefan and **David Cook** and **Dr Gayle Newcombe** are directing Heiko's work.

Coursework Masters, Undergraduate and Other Teaching Activities

Involvement of Centre researchers in the presentation of the JUMP Program at University of South Australia continued. (The acronym stands for Joint Universities Masters Program in Hydrology and Water Resources). There was a pleasing rise in enrolments in 2002. Overseas students from Belgium, Bulgaria, France and Korea were the core group. Involvement in undergraduate teaching in Civil and Water Engineering at University of South Australia did not occur in this reporting period due to a rescheduling of the relevant subject to a later year. **Mr Peter Baker** again presented a small undergraduate unit at the University of Adelaide on aspects of phytoplankton, including identification, enumeration and some ecology.

A/Prof Nicholas Ashbolt has developed postgraduate course material on microbial risk assessment that focuses on its application in the drinking water industry and application to the new NHMRC drinking water framework.

Indigenous Student Mentoring

The sponsorship and mentoring of **Angela Flynn**, an indigenous student in Chemical Engineering and Science at the University of Adelaide, has continued. The Centre is actively seeking other indigenous students to support in this way.

Internal Training

Two postgraduate students, **Lionel Ho** and **David Lewis**, attended the 5th BHERT – Melbourne Business School Leadership and Career Development Course held at Melbourne Business School in August 2001. Lionel was successful in winning one of the BHERT scholarships offered for this very worthwhile experience. They shared it with twenty nine other postgraduate students and postdoctoral fellows from CRC's all around Australia. One of the highlights of these courses is the Syndicate Teams activity in which groups of six are placed together to solve a National Research Priority issue.

The Centre's first Postgraduate Student Supervisor's Workshop was held in February 2002, in Melbourne, following the Summer Research Scholarship Reporting Seminars. The implications for CRCs of the implementation of the Research Training Scheme was a major discussion topic. Basic project management was another. New supervisors in particular found the workshop most helpful.

Environmental Engineering Research Events (EERE)

EERE 2001 was held at the North Shore Retreat, Noosa, Queensland, from 20-23 November. Postgraduate students **Sam Brooke**, **Lionel Ho** and **David Lewis** presented their work. Lionel received the Best Paper Prize in the Water Treatment and Management section. The Centre was a Gold Sponsor of the Event. **Dr Glen Shaw** of NRCET, University of Queensland, was our formal representative. The 2002 Event will be held from 3-6 December at Blackheath, NSW. **Nyree Steneke** is joint Chair of the Conference, **David Lewis** is a member of the Organising Committee and the Centre is again a Gold Sponsor.

Young Water Scientist of the Year

Kim Fergusson, Centre postgraduate student, is Young Water Scientist of the Year. Kim's submission on *Development of Rapid Methods for Detection of Toxic Cyanobacteria in Water Supplies* and her presentation at the ENVIRO 2002 Conference in Melbourne last April led to her being chosen as the winner of this CRC Water Forum competition. This is the Centre's second success. Kim is from The University of South Australia and carried out her research at the Australian Water Quality Centre in a team led by **Dr Chris Saint**.

Education and Training Steering Committee

The Committee, which drives the Education and Training Program continued to meet quarterly, with **Prof Felicity Roddick** in the Chair.

Links With Other CRC's

The CRC Water Forum's Young Water Scientist of the Year Award is an excellent example of cooperative education and training activity amongst the water-related CRC's. The Education and Training Steering Committee held one of its 2001 meetings in Brisbane. This was done to allow members to participate in an Open Forum on water issues during the River Festival in September. All the Water Forum CRC's were involved. The Program Leader regularly attends

Education and Training Program

the Education and Training Managers' Workshops linked to the CRC Association Conference. The most recent of these was held in Sydney on 24th May 2002. It was organised for the EdTraNet network by the CRC for Waste Management and Pollution Control. Many useful ideas are exchanged and contacts made through these meetings.

Graduate Employment Action Group

The Graduate Employment Action Group, with **Dr Alan Wade** as Chair, has remained active since the last Postgraduate Student Conference. This group monitors the employment success of the Centre's graduates and assists them wherever possible. There have been seventeen graduates to date. Three postgraduate students close to graduation have already found employment.

Future Plans

The Centre's next major Education and Training event will be its Third Postgraduate Student Conference, to be held from 16th - 19th October 2002. This will be the first time the Conference has been held in South Australia. Thirty students are expected to attend. A Workshop, "Taking a Broader View", will precede the Conference proper. This will be open to all Centre research staff also.

The first of a series of informal gatherings of students at the various CRC nodes will take place in Sydney on 25th July, based around a visit by the Education and Training Program Leader. A visit to The University of Queensland and Griffith University is planned for September 5th and 6th.



Summer Scholar, Alyson Wright, was based at the Centre for Appropriate Technologies in Alice Springs, working with local Indigenous communities on water conservation issues.

SUMMER SCHOLARSHIP STUDENTS

STUDENTS	SUPERVISOR(S)	LOCATION	PROJECT
FAN, Rita	R Considine K Cinque	Melbourne Water	Harvesting Strategies for Multiple Catchment Systems
HANIGAN, Ivan	Dr D Page T Whiteway I Balzer Dr A Wade	ActewAGL Ecowise Environmental	Identifying Potential 'Hotspots' for Pathogens in the Googong Catchment
KRISTIANA, Ina	Dr C Joll Dr A Heitz B O'Leary	Department of Applied Chemistry, Curtin University of Technology	Identification of New Disinfection By-Products in Drinking Water
MORGAN, Nicolas	Dr C Chow Dr H Maier	AWQC & Department of Civil & Environmental Engineering, University of Adelaide	Evaluation of Alum Coagulation Using Artificial Neural Network Modelling
SOLARSKA, Sylvia	Prof F Roddick J Thomson	Department of Civil & Chemical Engineering, RMIT	The Removal of Atrazine from Drinking Water by UV & VUV Radiation
THAI, Quyen	F Pamminger	Yarra Valley Water	Development of a Predictive Distribution-Cleaning Model Based on Sediment Mass Balance
THAPA, Kagendra	Dr Stephen Gray Dr John Bridger Prof F Roddick	CSIRO Molecular Science, Clayton & RMIT	Development of a Hybrid Membrane Process for the Removal of NOM from Drinking Water
VAN DE MEENE, Susan	Dr Karin Leder Dr Martha Sinclair	Department of Epidemiology & Preventive Medicine, Monash Medical School	Establishment of a National Waterborne Disease Database: Feasibility Study
WRIGHT, Alyson	R Gray-Gardiner S Fisher	Centre for Appropriate Technology (CAT)	Water Conservation for Remote Indigenous Communities

Education and Training Program

POSTGRADUATE STUDENTS

STUDENTS	SUPERVISOR(S)	LOCATION	PROJECT
Jim BLACK (started July 1998) PhD	Prof C Fairley Mr M Kirk *	Department of Epidemiology and Preventive Medicine, Monash University and Department of Human Services, Victoria NH&MRC support (CRC initial support)	The Early Detection of Outbreaks of Water-Borne Gastroenteritis (1.2.2) Awaiting Thesis Outcome
Sean BLASDALL (started January 2000) PhD	A/Prof N Ashbolt Dr D Roser A/Prof J Ongerth	School of Civil & Environmental Engineering, UNSW UNSW Postgraduate Award and CRC support	Molecular Typing of <i>Cryptosporidium parvum</i> (2.2.1)
Justin BLYTHE (started July 2001) PhD	Dr C. Joll Dr A. Heitz Prof R Kagi Mr B O'Leary *	School of Applied Chemistry, Curtin University and Water Corporation, WA APA and CRC support	The Chemistry of Halophenol Tastes in Drinking Water (2.3.0.1)
Sam BROOKE (started August 1999) PhD (converted from M App Sc)	Dr G Newcombe * Dr G Klass Dr B Nicholson *	Australian Water Quality Centre and School of Pharmaceutical, Molecular & Biomedical Sciences, University of South Australia, AwwaRF, SA Water and CRC support	The Destruction of Cyanobacterial Toxins in Drinking Water by Ozone. (3.2.6)
William BUCHANAN (started February 2002) PhD	Prof F Roddick Dr N Porter Mrs M Drikas *	School of Civil & Chemical Engineering, RMIT APA and CRC support	Biological Removal of UV-Pretreated Natural Organic Matter (2.4.0.6)
Kylie CATTERALL (started June 2002) PhD	Dr R John Dr P.Teasdale Dr H Zhao	School of Environmental & Applied Sciences, Griffith University, Gold Coast Campus APA and CRC support	The Monitoring of Organic & Biological Contaminants in Reticulated Water by Direct Photochemical Degradation (2.3.0.4)
Katrina CHARLES (started April 2001) PhD	A/Prof N Ashbolt Dr D Roser	School of Civil & Environmental Engineering, UNSW, Sydney Catchment Authority support	Risk Assessment of On-Site Sewage Systems in Sydney's Drinking Water Catchments (2.2.2)
Paul CHUO (started October 1997) PhD (converted from MEng)	Dr J Ball Dr I Fisher *	School of Civil & Environmental Engineering, UNSW and AWT CRC support	Hydraulic and Water Quality Modelling in Service Reservoirs (4.1.3.1) Awaiting Thesis Outcome
Robert CONSIDINE (started March 1998) PhD	Dr D Dixon * Dr C Drummond * Dr D Davey	CSIRO Molecular Science and School of Pharmaceutical, Molecular and Biomedical Sciences, University of South Australia US-APA and CRC support	A Study of <i>Cryptosporidium</i> Oocysts and Particulates (3.1.4) Awaiting Conferral of Award
David COOK (started August 2000) MAppSc	Dr G Newcombe * Dr G Klass	Australian Water Quality Centre and School of Pharmaceutical, Molecular & Biomedical Sciences, University of South Australia CRC Research Officer	Optimising Powdered Activated Carbon (PAC) Dosing to Remove Unpleasant Taste and Odour Compounds in Water Treatment (3.2.6)
Daniel COUTON (started February 2002) PhD	Dr C Joll Dr A Heitz Prof R Kagi Mr B O'Leary *	School of Applied Chemistry, Curtin University and Water Corporation, WA APA (I) and CRC Support	Novel Approaches to the Structural Elucidation of Natural Organic Matter in Source Waters (2.3.0.2)
Brendan CULLINANE (started July 2001) MSc	A/Prof N Ashbolt Dr P White Dr D Deere *	School of Biotechnology & Biomolecular Sciences, UNSW AwwaRF support	Fate & Transport of Surface Water Pathogens in Watersheds (2.2.2)
Linhua FAN (started January 1999) PhD	Dr J Harris Dr N Booker *	School of Civil & Chemical Engineering, RMIT and CSIRO Molecular Science RMIT Scholarship and CRC support	The Interaction of Natural Organic Matter and Microfiltration Membranes in Potable Water Treatment (3.1.3) Awaiting Conferral of Award
Kim FERGUSSON (nee Wilson) (started January 1999) PhD	Dr C Saint * Dr S Andrews	Australian Water Quality Centre and School of Pharmaceutical, Molecular & Biomedical Sciences, University of South Australia APA and CRC support	Rapid Methods for the Detection of Toxic Cyanobacteria (2.3.2.6)
Suzanne FROSCIO (started July 1998) PhD	Prof I Falconer Dr A Humpage* Dr P Burcham	Department of Clinical & Experimental Pharmacology, University of Adelaide CRC support	Studies into the Cyanobacterial Toxin Cylindrospermopsin (1.3.1.1) Graduated

Education and Training Program

POSTGRADUATE STUDENTS - continued

STUDENTS	SUPERVISOR(S)	LOCATION	PROJECT
Lionel HO (started August 1998) PhD	Dr G Klass Dr G Newcombe *	Australian Water Quality Centre and School of Pharmaceutical, Molecular & Biomedical Sciences, University of South Australia US-APA and CRC support	Removal of Taste and Odour Compounds and Algal Toxins from Drinking Water Using Ozone and Granular Activated Carbon (3.2.2)
Daniel HOEFEL (started February 2001) PhD	Dr C Saint * Dr W Grooby * Dr S Andrews	Australian Water Quality Centre and School of Pharmaceutical, Molecular & Biomedical Sciences, University of South Australia APA and CRC support	Identification and Enumeration of Bacteria Using Flow Cytometry (2.3.3.3)
Graeme JABLONSKAS (started October 1996) PhD	Dr F Recknagel Dr K Spark *	Department of Soil & Water, University of Adelaide and Australian Water Quality Centre SA Water and CRC support	Photochemical Degradation and Remineralisation of Dissolved Organic Carbon in the Warren Reservoir (2.1.3)
Tanja JANKOVIC (started April 1998) PhD	A/Prof D Chittleborough Dr S Rogers Dr R Smernik Dr J van Leeuwen *	Department of Soil & Water, University of Adelaide and Australian Water Quality Centre APA(I) and CRC support	The Effect of Reservoir Dynamics on Bacterioplankton Composition and Dissolved Organic Carbon Removal (2.1.3)
Melanie KAEBERNICK (started June 1997) PhD	Dr B Neilan Prof S Kjellenberg Dr P Hawkins *	School of Biotechnology & Biomolecular Sciences, UNSW and AWT APA and CRC support	Genetics of Microcystin Production by <i>Microcystis aeruginosa</i> : Regulation of Microcystin Synthetase Expression (2.3.2.1) Graduated
Michael KAZANTZIS (started February 2002) PhD	Dr H Maier Prof G Dandy Mr J Nixon *	Department of Civil & Environmental Engineering University of Adelaide University of Adelaide, S A Water, United Water & CRC support	A New Reliability – Based Approach for Optimising Water Quality in Distribution Systems (2.5.0.4)
Chris KOSTAKIS (started April 1997) MAppSc	Prof D Mulcahy Dr B Nicholson * Dr G Klass	Australian Water Quality Centre and School of Pharmaceutical, Molecular & Biomedical Sciences, University of South Australia CRC Research Officer	Effects of the Character of Naturally Occurring Organic Matter in Water on Organic Disinfection By-Products Formed with Ozone (3.2.3) Graduated
Andrew LEE (started January 1999) PhD	Prof A Fane Dr N Booker * Prof D Waite	School of Chemical Engineering & Industrial Chemistry, UNSW and CSIRO Molecular Science CRC support	Effect of Flocc Properties on Water Treatment Using Membrane Filtration (3.1.3)
David LEWIS (started February 1999) PhD	Dr M Lambert Dr J Brookes *	Department of Civil & Environmental Engineering University of Adelaide and Australian Water Quality Centre CRC support	Artificial Mixing for Destratification and Control of Cyanobacterial Growth in Reservoirs (Engineering) (2.5.1)
Daniel LIVINGSTON (started March 2002) PhD	Dr A Schaefer Mr H Gibson *	School of Civil & Environmental Engineering, UNSW APA and CRC Support	Sustainable Water Management through a Village Design Approach to Remote Communities (2.6.0.2)
Rebecca McCALLUM (started February 1997) PhD	Prof F Roddick Mrs M Drikas *	Department of Civil & Chemical & Engineering, RMIT APA and CRC support	Development of Coal-Based Carbon Adsorbents for Organics (3.2.2) Graduated
Rodney MAGAZINOVIC (started March 1997) PhD	Prof D Mulcahy Dr D Davey Dr B Nicholson*	School of Pharmaceutical, Molecular & Biomedical Sciences, University of South Australia and Australian Water Quality Centre CRC support	Effects of Halide Species on Disinfection By - Product Formation (3.2.3)
Anthony MOELLER (started January 1999) PhD	Dr J McKay Mr C Schonfeldt *	School of International Business, University of South Australia CRC support	Water Quality Standards and Models for Legal Regulation (1.2.6) Graduated
Michelle MOFFITT (started March 1999) PhD	Dr B Neilan Dr P Hawkins *	School of Biotechnology & Biomolecular Sciences, UNSW and AWT APA and CRC support	The Evolution of Toxin Production and Non-Ribosomal Biosynthetic Pathways in Nodularia (2.3.2.5)
David MOORE (started March 2001) PhD	Dr G Shaw Prof C Critchley Dr M O'Donohue	National Research Centre for Environmental Toxicity, University of Queensland and SE Queensland Water Corporation NRCET Scholarship and CRC support	Ecology and Health Implications of Potentially Toxic Cyanobacteria in Queensland (1.3.1.6)

Education and Training Program

POSTGRADUATE STUDENTS - continued

STUDENTS	SUPERVISOR(S)	LOCATION	PROJECT
Adele PARKINSON (started April 1997) PhD (converted from MAppSc)	Prof F Roddick Mrs M Drikas *	School of Civil Chemical & Engineering, RMIT CRC support	Ultraviolet Oxidation as a Pretreatment of Natural Organic Matter Prior to Removal by Biological Activated Carbon (3.2.1) Graduated
Leanne PEARSON (Started June 2002) PhD	Dr B Neilan Prof D Waite	School of Biotechnology & Biomolecular Sciences and School of Civil and Environmental Engineering, UNSW APA and CRC Support	Iron Transformations in Drinking Water Supplies & Their Effects on the Growth, Survival & Toxicity of Cyanobacteria (2.2.0.4)
Geetha RANMUTHUGALA (started April 1996) PhD	Prof R Douglas (Chair of Supervisory Panel)	National Centre for Epidemiology & Population Health, Australian National University CRC support	Chlorine, Trihalomethanes & Micronuclei (Genotoxic Change) in Bladder Epithelial Cells (1.3.5.1) Graduated
Rudi REGEL (started March 1999) PhD	Dr G Ganf Dr J Brookes *	Department of Environmental Biology, University of Adelaide and Australian Water Quality Centre Faculty of Science Scholarship and CRC support	Artificial Mixing for Destratification and Control of Cyanobacterial Growth in Reservoirs (Biology) (2.5.1)
Brent ROBERTSON (started April 1997) PhD	Prof C Fairley Mr M Kirk *	Department of Epidemiology & Preventive Medicine, Monash University and Department of Human Services, Victoria CRC support	Case Control Studies Into Specific Pathogens (1.3.8.1) Graduated
Carl ROUHAININEN (started July 1999) PhD	A/Prof G Dandy Dr I Fisher * Dr G Kastl * C Vigus *	WA Water Corporation, Department of Civil & Environmental Engineering, University of Adelaide and AWT WA Water Corporation and CRC support	Water Quality Modelling to Improve Techniques of Prediction and Control of Chlorine Residuals in a Distribution System (4.3.4)
Nyree STENEKES (started January 2002) PhD	Dr A Schaefer Dr H Colebatch Prof D Waite Mr H Gibson * Mr P Sherman * Dr N Roseth *	School of Civil & Environmental Engineering, UNSW, APA (I) and CRC Support	Risk in the Governance of Water Reuse: The Case for the Reuse of Wastewater (2.6.0.3)
Ian STEWART (started January 2002) PhD	Dr G Shaw	National Research Centre for Environmental Toxicology NRCET Scholarship & CRC Support	Freshwater Cyanobacteria: Epidemiology of Recreational Exposure & Their Dermal Toxicity (1.3.1.5)
Michael STOREY (started March 1998) PhD	A/Prof N Ashbolt Dr M Angles*	School of Civil & Environmental Engineering, UNSW and AWT APA and CRC support	The Ecology of Viruses Within Distribution Pipe Biofilms (4.2.2.1) Awaiting Thesis Outcome
Shaun THOMAS (started March 1998) PhD	Dr C Chow * Dr D Davey Prof D Mulcahy Mrs M Drikas *	Australian Water Quality Centre and School of Pharmaceutical, Molecular & Biomedical Sciences, University of South Australia CRC Support	The Role of Natural Organic Matter in Flocculation with Inorganic Coagulants (3.2.1)
James THOMSON (started July 1999) PhD	Prof F Roddick Mrs M Drikas *	School of Civil & Chemical & Engineering, RMIT CRC support	Biological Activated Carbon Treatment of Natural Organic Matter (3.2.1)
Carolina TILLET (nee Beltran) (started May 1997) PhD	Dr B Neilan Mr P Baker *	School of Biotechnology & Biomolecular Sciences, UNSW CRC support	Genetic Basis of Saxitoxin Production by <i>Anabaena circinalis</i> (2.3.2.2) Graduated
Melissa TODD (started February 2000) PhD	Dr C Saint * Dr S Andrews	Australian Water Quality Centre and School of Pharmaceutical, Molecular & Biomedical Sciences, University of South Australia APA and CRC support	Characterisation of Bacterial Symbionts of Amoebae (4.2.2.2)
Jon VARCOE (started May 1999) PhD	Dr D Chittleborough Dr J van Leeuwen * Dr J Cox	Department of Soil & Water, University of Adelaide and Australian Water Quality Centre CRC support	The Influence of Natural Organic Matter on the Movement of Phosphorus in Soils (2.1.2)

Education and Training Program

POSTGRADUATE STUDENTS - continued

STUDENTS	SUPERVISOR(S)	LOCATION	PROJECT
Todd WALLACE (started March 2002) PhD	Dr J Brookes * A/Prof G Ganf	Department of Environmental Biology, University of Adelaide and Australian Water Quality Centre APA and CRC Support	Carbon & Nutrient Dynamics: Application to Reservoirs (2.2.0.5)
Karen WESTWOOD (started April 1996) PhD	A/Prof G Ganf Mr P Baker *	Department of Environmental Biology, University of Adelaide and Australian Water Quality Centre Faculty of Science and CRC support	Blue-Green Algal Ecology (2.4.2) Awaiting Thesis Outcome
Hugh WILSON (started April 1996) PhD	Dr F Recknagel Dr H Possingham Mr M Burch *	Department of Soil & Water, University of Adelaide and Australian Water Quality Centre SA Water and CRC support	Forecasting of Blue-Green Algal Blooms in Australian Drinking Water Reservoirs and Implications for Real Time Monitoring and Control. (2.5.2) Awaiting Thesis Outcome
Cunli XIANG (started February 1998) MEng	Dr N Booker * Prof F Roddick	CSIRO Molecular Science and School of Civil & Chemical Engineering, RMIT CRC support	The Development of a Hybrid Membrane Process for the Treatment of Potable Water (3.1.3) Graduated
Huimin ZHOU (started February 1999) PhD	Dr L Doukas Dr I Fisher * Prof F Roddick	School of Civil & Chemical Engineering, RMIT and AWT RMIT Scholarship and CRC Support	Development of a Decision Support Tool for Distribution Systems (4.3.2)

Awaiting Thesis Outcome

Awaiting Conferral of Award

Graduated

HONOURS STUDENTS 2002

STUDENTS	PROJECT	SUPERVISOR(S) & UNIVERSITY
FAVIER, Maxime	Characterisation of NOM Using HPLC	Dr C Chow, AWQC/University of South Australia (Student based at Australian Water Quality Centre)
GRANT, Georgia	Manganese Adsorption by Green Sand in a Water Treatment Plant	Dr B Chiswell University of Queensland
GIBBS, Mathew & MORGAN, Nicolas	Development of Online Tools to Enable Feed Forward/Feedback Control & to Optimise Disinfectant Residual Management in a Distribution System	Dr H Maier & Prof G Dandy, University of Adelaide
HAY, Julie Ann	Evaluation of an Immuno- Assay & Lysis Methods for Rapid Detection of Microcystins	Dr C Haskard, AWQC/ University of Adelaide (Student based at Australian Water Quality Centre)
KRISTIANA, Ina	Identification of New Disinfection By-Products in Drinking Water Treatment	Dr C Joll & Dr A Heitz, Curtin University of Technology
McDOUGALL, Jill	Removal of Atrazine from Drinking Water by UV & VUV Radiation	Dr Nichola Porter & Prof. F Roddick, RMIT University
MILLS, Toby	Environmental Regulation of Non-Ribosomal Peptide Synthesis in Toxic Cyanobacteria	Dr Brett Neilan, School of Biotechnology and BiomolecularSciences, UNSW

Application of Research

The first year of the new CRC for Water Quality and Treatment was a year during which research projects from the old Centre entered their final stages, while intensive internal discussions resulted in the approval of 23 new projects.

Consequently, key activities associated with the application of research had two major facets. Firstly, there was a responsibility to make the knowledge and understanding developed in the completed or nearly completed projects available to all Centre participants. Secondly, attention had to be given to ensuring the maximum involvement of all participants, both industry and research, in new project development. With a total of 29 participants, 19 of whom come from the water industry, the achievement of these goals required significant effort.

The main form of reporting on completed research projects is the final project report and the associated scientific and technical publications. However, experience has shown that the most direct method to transfer such information to participants who were not directly involved in the projects is via specific technology transfer workshops. Towards this end, five workshops were held during the year on the following topics:

- *Filter Performance Workshop*. Sydney, September 2001.
- *Disinfection Byproducts and Health Effects Seminar*. Melbourne, October 2001.
- *Blue-Green Algae: Their Significance and Management within Water Supplies*. Melbourne, February 2002.
- *Water Environment Workshop: Policies and Practices in the Water Industry*. Melbourne, March 2002.
- *Biofilms and Chlorine in Distribution Systems*. Sydney, May 2002.

All workshops gave detailed run-downs on research project outcomes and were well attended by industry participants. Average attendances were in the range 50 to 60, with the distribution system workshop totaling around 70.

The other major activity undertaken during the year was an intensive series of research planning workshops. These workshops had two major aims.

1. Provide a mechanism for transforming the issues outlined in the Business Plan into fully fledged research projects, which reflect the priorities of the industry.
2. Ensure maximum opportunity is provided for all participants to become involved in project identification and development.

Workshops were run for all major sub-program topics, with workshops on similar themes being run on sequential days to minimise travel requirements and maximize attendance. Again, all workshops were well attended by a wide cross-section of participants. In most cases the outcomes were a list of prioritized research topics endorsed by industry attendees. Also identified were potential project leaders who were charged with the responsibility of developing full project proposals for submission to the Management Committee and subsequently the Board. As of 30 June 2002, twenty three new projects involving the large majority of Centre participants had been approved by the Board.

Another key avenue for ensuring the full application of research outcomes, particularly with small to medium sized enterprises, has been the Centre's Associates Program. This program was devised as a means for communicating research outcomes to the smaller regional water authorities that do not have the physical size or financial means to become full industry participants. The popularity of this program continues to increase, with nine current members and a recent application to join received from Central Highlands Water. A customer satisfaction survey of all program members was carried out during the year and revealed a high level of satisfaction with the communication channels and information provided.

The involvement of all Centre participants, Associate Program members and other contacts continues to evolve. An up-to-date summary of this involvement is given in Table 1.

TABLE ONE – USER ORGANISATIONS INVOLVED IN CENTRE ACTIVITY

<i>Organisation</i>	<i>Nature of Organisation</i>	<i>Involvement in Utilising Centre Research</i>
Melbourne Water	Water Supply Authority (wholesale)	Active involvement in five Centre research projects, including management systems, health studies, catchment surveys, pilot plant testing and distribution system monitoring.
ACTEW Corporation	Water Supply Authority	Active involvement in three Centre projects, including health effects of cyanobacterial blooms, disinfection byproducts and the movement of pathogens in catchments.
Brisbane City Council	Water Supply Authority	A new member (2000/2001) with active interests in all research program areas.

Application of Research

TABLE ONE – USER ORGANISATIONS INVOLVED IN CENTRE ACTIVITY

<i>Organisation</i>	<i>Nature of Organisation</i>	<i>Involvement in Utilising Centre Research</i>
Power and Water Authority of NT	Water Supply Authority	A new member (2000/2001) with particular interest in projects related to tropical diseases (Meliodosis) and the challenges facing rural and regional water supplies.
Sydney Water	Water Supply Authority	A new member (1999/2000) with active involvement in four research projects related to management systems, catchment surveys, biofilm monitoring and viruses in distribution systems.
South-East Water	Water Supply Authority (retail)	A new member (1999/2000) with active involvement in three research projects related to management systems, health studies and particles in distributions systems.
Yarra Valley Water	Water Supply Authority (retail)	A new member (1999/2000) with active involvement in research projects related to health studies and particles in distribution systems.
SA Water Corporation	Water Supply Authority	Active involvement in twelve research projects related to management systems, health effects of cyanobacterial blooms, disinfection byproducts, indigenous water supplies, reservoir management, cyanobacterial toxins and activated carbon in water treatment.
Water Corporation of WA	Water Supply Authority	Active involvement in four research projects related to management systems, pathogens in source waters, reservoir management and monitoring and control in distribution systems.
Townsville Thuringowa Water Supply Board	Water Supply Authority	A new member (2000/2001) with active interests in all aspects of water supply. Particular interest in source water protection.
Sydney Catchment Authority	Catchment Management	A new member (2000/2001) with particular interests in catchment management and source water protection. Directly involved in research projects related to fate and transport of pathogens in surface waters.
Water Services Association of Australia	Water industry association	Direct involvement in development of industry standards and policy utilising CRC output – a prime vector for communicating with the water supply industry.
Dept of Natural Resources and Environment (Vic)	Industry regulation and environmental management	Interested in intelligent environmental regulation, systems and resource management. Reduced its involvement to Associate level in 2002/02, but continues to instigate particular consultancies with the Centre to assist regional Victorian water authorities.
Dept of Human Services (Vic)	Regulation and monitoring of health standards	Interested in intelligent and cost effective regulation of human health standards and optimum management of water supply systems to achieve same.
Orica Pty Ltd	Chemical and process supply	Interested in commercialisation of CRC research output, especially that related to water treatment and treatment chemicals.

Application of Research

TABLE ONE – USER ORGANISATIONS INVOLVED IN CENTRE ACTIVITY

<i>Organisation</i>	<i>Nature of Organisation</i>	<i>Involvement in Utilising Centre Research</i>
Egis Consulting	Provision of consulting and design services	Interested in provision of consultancy services based on CRC research results. Directly involved in research projects related to management systems and risk assessment.
Australian Water Services	Contract engineering and operations services	Interested in commercialisation of CRC research output, but with specific focus on water treatment and system operation.
United Water International	Contract engineering and operations services	Interested in commercialisation of CRC research output, but with specific focus on water treatment and control of water quality in distribution systems.
Gippsland Water	Water Supply Authority	Will receive and act on information flowing from public good projects and workshops within the CRC.
South East Queensland Water	Water Supply Authority	Will receive and act on information flowing from public good projects and workshops within the CRC.
Grampians Water	Water Supply Authority	Service contracts with CRC to provide specific support services.
Gold Coast City Council	Water Supply Authority	Will receive and act on information flowing from public good projects and workshops within the CRC.
Hunter Water Corporation	Water Supply Authority	Will receive and act on information flowing from public good projects and workshops within the CRC.
Lower Murray Water	Water Supply Authority	Will receive and act on information flowing from public good projects and workshops within the CRC.
Goulburn Valley Water	Water Supply Authority	Will receive and act on information flowing from public good projects and workshops within the CRC.
NSW Department of Public Works and Services	Design and consultancy services	Will receive and act on information flowing from public good projects and workshops within the CRC.
Central Highlands Water	Water Supply Authority	Service contracts with CRC to provide specific support services. Has applied for Associate Membership.
National Health and Medical Research Council	Reviews scientific basis for public health regulation	Involved with the CRC in the rolling revision of Australian Drinking Water Guidelines and introduction of a National Water Quality Management Strategy. Joint workshop on water quality and health in regional Australia planned for August 2002.

Centre Participant

Centre Associate

Staffing and Administration



**MR GEORGE TURELLI,
BUSINESS MANAGER**

NEW CENTRE

The period under report has been a transitional year for the Centre. This year would normally have been year seven of the first CRC, but under the funding arrangements operating from the Commonwealth, the duration of the first CRC from seven to six years has resulted in commencing the second CRC one year earlier. Management has been finalising a number of major research activities from the first CRC while planning in detail the new projects arising from the business plan that will start in 2002 and making the necessary staff appointments for the new Centre.

NEW APPOINTMENTS

With the transition from the first CRC to the new CRC, there has been significant recruitment across all programs. The number of staff working for the CRC last year was 145. In the period covered by this report, 87 researchers and 12 PhD students have been added to the Centres previous years complement of 145 staff and 10 students giving a total of 232 staff and 22 students.

ADMINISTRATION

The Centre is managed through the CEO, two Deputy CEOs and the Business Manager. During the year, administrative support to the senior management was provided by Ms Jaculin O'Brien and Ms Susan Spragg. The Administration team was strengthened during May when Ms Patricia Jamieson joined the team.

During January Bob Dorrat was seconded from WSAA to assist with systems improvements in the much bigger CRC now covering 29 partners throughout Australia. No other administrative staff appointments were made during the first year.

Accounting support for the Centre was provided by Lee Green & Co Pty Ltd, a firm of Certified Practising Accountants and has proved to be a most satisfactory resource. During the year, Kelly and Co continued to provide legal and commercial advice to the Centre. Ernst and Young

provided audit services and taxation advice. The diversity, complexity and increasing participants of the CRC has continued to provide quite a challenge for the administration to provide quality support to all members. For the administrative staff of the Centre, this was again another intense year, in meeting the challenges of initiating a new CRC, the First Year Review, new staff inductions, systems improvements and settling down the GST system.

SPECIFIED RESEARCH PERSONNEL

The details of Specified Research Personnel as intended in the Commonwealth Agreement and as actually utilised in 2001/02 are shown in the table below.

PROFESSIONAL STAFF

Details of professional staff involved in the CRC projects on an organisation and program basis are shown in Appendix A. This information is summarised by in-kind and CRC-funded research staff.

The tables include Researchers shown under the activity R, Education under E, Commercialisation under C and Administration support under A.

At the end of June 2002, there were 232 researchers and support staff contributing to the Centre activities. This was equivalent to 51.8 full-time staff.

ACCOMMODATION

The administration office for the CRC is based in South Australia at the Australian Water Quality Centre, Bolivar, but research activity is being carried out in a number of sites in Victoria, NSW, Queensland, ACT, WA, NT and SA. Accommodation for the Centre's activities is being provided by the participating organisations.

COMPUTING RESOURCES

The CRC established a computing infrastructure that served the needs of management and researchers in the first CRC. This financial reporting and project management system is being upgraded to meet the needs of the new Centre and in particular, the reporting requirements of Board and Management.

The CRC administration office is connected to the AWQC area network, which allows sharing of printers, files and the provision of IT support, as part of SA Water Corporation. This support has been of great benefit during the six years of the old CRC and also in the new Centre. It is pleasing to report that difficulties were experienced as a result of the Corporations' efforts. The Centre is very appreciative of having its computing responsibility handled by SA Water Corporation under its cooperative arrangements.

Staffing and Administration

SPECIFIED RESEARCH PERSONNEL 2000/01

<i>Name</i>	<i>Title and Organisation</i>	<i>% Time Agreement</i>	<i>% Time Actual</i>
Prof D Bursill	CEO, AWQC	80	80
Dr A Priestley	Deputy CEO, CSIRO	80	80
Dr D Steffensen	Deputy CEO, AWQC	60	70
Mr G Turelli	Business Manager, SA Water Corporation	100	100
Mr R Dorrat	Project Services Manager, CRC (from 14/1/2002)	100	47
Prof J McNeil	Program Group Leader, Monash University	25	61
Dr D Deere	Program Group Leader, Sydney Catchment Authority	25	23
Ms M Drikas	Program Group Leader, AWQC	60	64
Dr M Sinclair	Program Leader, Monash University	40	64
Dr G Shaw	Program Leader, Queensland University	60	59
Dr N Roseth	Program Leader, Sydney Water Corporation	50	64
Prof R Kagi	Program Leader, Curtin University of Technology	50	36
Mr D Vitanage	Program Leader, Sydney Water Corporation	50	54
Mr H Gibson	Program Leader, Brisbane City Council	20	17
Mr D Day	Program Leader, PAWA	10	14
Prof D Mulcahy	Program Leader, University of SA	70	80
Ms K Nitschke	Communication Manager, CRC	100	100

LIBRARY

The CRC library is a valuable resource for the Centre, with an up-to-date collection of journals, periodicals and papers, as well as a wide range of basic texts books and copies of all CRC publications and students theses. The library forms part of the AWQC resource and is serviced by SA Water Corporation library staff on a regular basis. Interlibrary loans are available thorough partner universities. Regular updates to the library are available on the CRC web site.

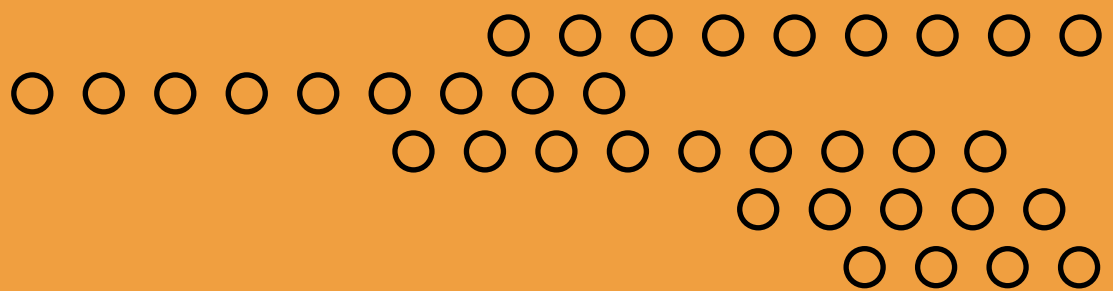
EQUIPMENT PURCHASES

There were no major equipment purchases throughout the first year.



George Turelli (r) with members of the First Year Review Panel at AWQC in March 2002.

Publications



CONFERENCE PROCEEDINGS DOMESTIC

Blasdall SA, Ongerth JE and Ashbolt NJ (2001)

Differentiation of *Cryptosporidium parvum* subtypes by a novel microsatellite-telomere PCR with PAGE.

Cryptosporidium from Molecules to Disease, Fremantle, Western Australia, October 2001.

Brooke S, Newcombe G and Nicholson B (2001) Decrease in toxicity of microcystins LA and LR in drinking water using ozone. *Proceedings of the Environmental Engineering Research Event (EERE), Noosa, Queensland. November 2001.* CD-ROM.

Chuo P, Ball JE, Fisher I (2001) Thermal stratification in drinking water service reservoirs. *Proceedings of the 6th Conference on Hydraulics in Civil Engineering, IEAust Australian Water Association.* Hobart, Tasmania. CD-ROM.

Chuo P, Ball JE, and Fisher I (2001) Modelling water quality in drinking water service reservoirs. *Proceedings of the 6th Conference on Hydraulics in Civil Engineering, IEAust Australian Water Association.* Hobart, Tasmania. CD-ROM.

Fergusson KM, Lanthois B and Saint CP (2001) Genetic characterisation of toxic Australian cyanobacteria. *Australian Society for Microbiology Conference, Perth, Western Australia.* October 2001.

Ho L, Newcombe G, Hoefel D and Saint C (2001) Biodegradation of microcystin. *Proceedings of the Environmental Engineering Research Event (EERE), Noosa, Queensland. November 2001.* CD-ROM.

Keegan AR, Gelonese S, Monis P and Saint CP (2001) The use of cell culture for the assessment of disinfection methods for *Cryptosporidium parvum*. *Cryptosporidium: from Molecules to Disease Conference, Fremantle, Western Australia, October 2001.*

Lewis DM, Antenucci JP, Brookes JD and Lambert MF (2001) Numerical simulation of surface mixers used for artificial mixing in reservoirs. *Proceedings of the Environmental Engineering Research Event (EERE), Noosa, Queensland. November 2001.* CD-ROM.

Lewis DM, Antenucci JP, Brookes JD and Lambert M (2001) Numerical simulation of surface mixers used for destratification of reservoirs. *Proceedings of MODSIM 2001 Conference, Canberra, December 2001.* CD-ROM.

Monis PT (2002) *Cryptosporidium* and *Giardia* zoonoses: fact or fiction? *Australian Veterinarians in Public Health Proceedings. Australian Veterinary Association 2002 Annual Conference.* Adelaide, South Australia.

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Note: Centre personnel are highlighted in bold.

Grants and Awards

A number of Centre researchers received recognition for their work during the year.

PhD student, Kim Fergusson was recognised with the CRC Water Forum's *Young Water Scientist of the Year Award* at Enviro2002 for her work on identifying toxic blue-green algae using DNA technology.

PhD student, Lionel Ho received the Best Paper Prize in the Water Treatment and Management section at the Environmental Engineering Research Events (EERE) 2001, held in Noosa, Queensland during November. His paper was titled *Biodegradation of Microcystin*.

PhD student **Adele Parkinson** from RMIT University won an award for the University's best multidisciplinary paper for a paper titled *Preliminary Toxicity Assessment of Water After Treatment with UV Irradiation and UVC/H2O2*.

PhD student **Brent Robertson** from Monash University won the 2001 GJ Rouch Prize awarded by the Victorian Branch of the Australasian Faculty of Public Health Medicine. The prize is awarded annually to the advanced training candidate in public health medicine who gives the best presentation of research work at a meeting of the Faculty. Brent presented his PhD work on *Case-control studies of sporadic cryptosporidiosis in Melbourne and Adelaide*.

The **Water Quality Study team** won the Alfred Hospital Senior Medical Staff Prize for a Research Poster (Clinical Section) during Alfred Research Week.

ADDITIONAL RECOGNITION

Prof Don Bursill chairs the National Health and Medical Research Council (NHMRC)/Natural Resource Management Ministerial Council (NRMCC) Drinking Water Coordinating Group.

Prof Ian Falconer is Editor of the *Environmental Toxicology* journal, published by John Wiley and Sons, New York.

Dr Andrew Humpage was Guest Editor of the *Environmental Toxicology* journal, published by John Wiley and Sons, New York.

Samantha Rizak, Dr Martha Sinclair, Dr John Howard and **Prof Steve Hrudey** are members of the Drinking Water Quality Management Working Party of the Australian Drinking Water Guidelines Rolling Review.

Dr Martha Sinclair is on the Steering Committee for the Commonwealth Department of Health and Aged Care project on Rural and Remote Potable Water Supplies, an EnHealth Council project.

Dr Dennis Steffensen is a member of the National Working Group on Pfsieteria.



PhD student Kim Fergusson is the 2002 CRC Water Forum's *Young Water Scientist of the Year*. Photo courtesy The Advertiser

Grants and Awards

EXTERNAL RESEARCH FUNDING

External research grants provide critical support for projects within the Centre. The table below outlines the grants that have been received by Centre personnel for Centre research.

Researcher	Organisation	Project Title	Granting Body	Period	2001-02 Value (\$)	Total Value (\$)
M Burch	AWQC	National algal management activities	ARMCANZ	2000-02	80,000	200,000
M Burch	AWQC	Acute skin irritant effects of cyanobacteria (blue-green algae) in healthy volunteers	Eraring Energy	2000-02	20,000	40,000
N Ashbolt	UNSW	Fate and transport of surface water pathogens in watersheds. AwwaRF Project 2694	AwwaRF	2001-04	283,000	850,000
N Ashbolt	UNSW	Development of fluorescent oocysts for testing the efficacy of water treatment plants to remove <i>Cryptosporidium</i> and <i>Giardia</i>	ARC SPIRT Scheme PhD scholarship with Biotechnology Frontiers Pty Ltd	2001-04	22,200	66,800
N Ashbolt	UNSW	Three year study of the impact of on-site systems in Sydney's catchments	Sydney Catchment Authority	2000-2003	75,000	225,000
N Ashbolt	UNSW	Investigating <i>Cryptosporidium</i> dispersion and persistence within raw water reservoirs	ARC SPIRT Scheme PhD scholarship with Egjs Consulting	2000-02	30,600	61,200
D Steffensen	AWQC	Determination and Significance of Emerging Algal Toxins (Cyanobacteria). AwwaRF Project 2789	AwwaRF	2002-04	121,300	364,000
M Burch	AWQC	Hydrodynamic Distribution of Pathogens in Lakes and reservoirs – AwwaRF Project 2752	AwwaRF	2002-04	384,000	769,000
TOTAL					1,016,100	2,576,000

Public Presentations, Public Relations & Communication



COMMUNICATION MANAGER KATRINA NITSCHKE

The Centre's mission is to help the Australian water industry provide high quality water at an affordable price. Effective communication between researchers, research users, governments and the general community plays a pivotal role in achieving this mission.

COMMUNICATION STRATEGY

The Centre has maintained its strong commitment towards communication this year, updating the Communication Strategy that was developed in 2001. The Communication Strategy supports two-way communication between Centre personnel, external researchers, the broader water industry, regulators and the community, while protecting the Centre's intellectual property.

The Communication Strategy outlines the major communication goals of the Centre for 2002:

- Ensure effective two-way communication within the CRC, so that knowledge flows between researchers and industry and across projects and programs.
- Build a strong corporate culture within the CRC, to strengthen staff and student commitment to the organisation and foster collaborative work between participants.
- Raise awareness of, and build support for, the CRC, its role and its achievements amongst the Australian water industry, water regulators, the research and education communities and the broader public.
- Work with decision-makers within the Australian water industry to understand their needs and provide scientific information that will assist them supply high quality water to Australian communities.
- Work with policy makers to develop a scientifically based water quality regulatory environment that meets the needs of Australian communities.
- Raise awareness, and improve understanding, of water quality issues amongst the Australian community.
- Promote the CRC Program and its objectives.

COMMUNICATION ACTIVITIES

The Centre uses a variety of tools to achieve the goals outlined in the Communication Strategy, including:

- Workshops, seminars and meetings
- An information-rich, frequently updated web site
- Frequent personal contact between Parties, Associates and Centre management
- Mass, specialist and trade media
- Publications, including booklets, brochures, posters and reports
- Two quarterly external newsletters, *Water Quality News* and *Health Stream*, with circulations over 3000, reaching more than 50 countries
- An internal e-mail newsletter, *Neon*, that provides keeps Centre Participants and Associates up to date with Centre activities and research.

Media Relations

The Centre has continued to build effective relationships with key media over the past year, briefing journalists and editors on emerging issues, participating in public debate as appropriate, and raising the profile of the Centre, the CRC Program and drinking water issues.

The Centre recorded over 2.8 million potential impressions in the national, state and trade print media, with 32 captured media reports (media monitoring is not continuous and hence fails to record some media mentions). This was up from last year's 2 million potential impressions. Potential impressions from radio, TV and internet mentions were not recorded, due to the difficulty in capturing ratings data.

The Centre produced or participated in six media releases/alerts during 2001-02:

- Drinking Water Not Risk Factor in Gastro
- Hunting for Bugs in Drinking Water
- Prof's Mo to Go
- All About Water: World Water Day
- DNA Fingerprinting of Toxic Algae Provides Early Warning System
- Adelaide to Host World's Drinking Water Experts

Publications

The Centre produced a number of general publications over the year, including a promotional guide to the CRC, a technical brochure on algicides in water supplies and a comprehensive *Consumer's Guide to Drinking Water*.

The Consumer's Guide is available on the Centre web site as a community reference on drinking water and is now being developed as a series of hard-copy brochures on drinking water issues suitable for the general public.

The first in this series, *Blue-Green Algae: A Guide*, has been completed, and a further six are in production. These brochures will cover a range of topics, including bottled water, drinking water and public health, disinfection by-

Public Presentations, Public Relations & Communication

products and water treatment.

The Centre produces two quarterly newsletters for external audiences.

- *Health Stream* presents relevant health research in an accessible form, and provides informed comment on the implications of research findings for the water industry. The publication has achieved a high international profile among water quality researchers. It currently has a circulation over 3500.
- *Water Quality News* discusses current issues in the water industry and features research highlights from the CRC's research programs. *Water Quality News* has a circulation of almost 3500.

See the *Publications and Patents* section in this Annual Report for detail on scientific publications and presentations.

Events

Issue-based workshops for Centre Participants and Associates play a vital role in Centre research planning and technology transfer. The Centre held seven workshops in 2001-02.

- Peoples' Perspectives Program Research Planning Workshop. Melbourne, August 2001.
- People's Perspectives National Community Survey Participants' Workshop. Adelaide, April 2002.
- Biofilms and Chlorine in Distribution Systems. Sydney, May 2002.
- Blue-Green Algae: Their Significance and Management within Water Supplies. Melbourne, February 2002.
- Water Environment Workshop: Policies and Practices in the Water Industry. Melbourne, March 2002 (with Melbourne Water Corporation, Department of Natural Resources and Environment Vic, Gutteridge Haskins Davey, Australian Water Association, and Murray Darling Basin Commission).
- Disinfection Byproducts and Health Effects Seminar. Melbourne, October 2001.
- Filter Performance Workshop. Sydney, September 2001 (with WSAA and AwwaRF).

In April, the Centre hosted the tenth biennial Emerging Technologies meeting. This meeting, sponsored by the American Water Works Association Research Foundation, enables the world's leading drinking water research managers to discuss the common problems facing water suppliers and to set global research priorities.

The Centre also sponsored a number of significant conferences:

- Cryptosporidium: From Molecules to Disease. Fremantle, October 2001.
- World Melioidosis Congress. Perth, September 2001.
- 2001: A Microbial Odyssey: Annual Scientific Meeting of the Australian Society for Microbiology. Perth, September 2001.

ASSOCIATES PROGRAM

The Associates Program was established by the Centre to enable small to medium enterprises to participate in Centre activities. There are now nine members of the Associates Program (see *Structure and Management* for detail).

Amongst a range of benefits, Associates can be involved in various Centre activities and have access to certain of the Centre's resources. Associates have no role in Centre governance. The Associates Program is managed by Dr Gerard Vaughan, the Centre's Liaison Officer.

PUBLIC PRESENTATIONS

Brookes J *Time-scales of events and the threat to water quality: examples from a suite of water-bodies.* Centre for Applied Modelling in Water Engineering Seminar, University of Adelaide, Adelaide South Australia. August 2001.

Brookes J *Coming to grips with water quality hazards: predicting, monitoring and responding. Drawing examples from a number of South Australian water-bodies.* Australian Water Association Technical meeting (SA branch) Adelaide, South Australia. March 2002.

Burch M *Copper sulphate – does it really work?* SA Water Services Research Series Seminar. Adelaide, South Australia. June 2002.

Burch M *SA Water: control of algae in reservoirs.* United Water R&D Seminar, Adelaide, South Australia. November 2002.

Bursill D *It's more than a matter of taste: bringing good water to your tap, the science of Adelaide's water supply.* Public lecture. University of Adelaide, South Australia. September 2001.

Bursill D *Water quality management - an art or a science.* Presentation to a joint meeting of the Royal Australian Chemical Institute and the Chemical Engineering Group of the Australian Institution of Engineers. Adelaide, South Australia. November 2001.

Bursill D *Keynote address.* Victorian Annual Operators' Conference (Australian Water Association). Bendigo, Victoria. September 2001.

Bursill D *Overview of Australian research on Cyanobacteria.* Presentation at the Technical University of Munich. Munich, Germany.

Bursill D *Drinking water research in Australia and its connection to water quality regulation.* An invited address to the Dutch Delegation to the International Water Association 3rd World Water Congress, Melbourne, Victoria. April 2002.

Black J *Invited seminar: artificial neural networks in disease surveillance.* Disease Surveillance Group, World Health Organization. Geneva, Switzerland. July 2001.

Black J *Some uses of artificial neural networks in epidemiology.* Australian Epidemiological Association Victoria chapter meeting, Melbourne, Victoria. June 2002.

Chow C *Sampling for water quality monitoring.* Lecture to final year University of South Australia Environmental

Public Presentations, Public Relations & Communication

Science students. Adelaide, South Australia. March 2002.

Chow C *Equilibrium modelling and chemical speciation*. Lecture to the Joint University Masters Program students. Adelaide, South Australia. May 2002.

Drikas M *Water treatment*. Lecture to Royal Australian Chemical Institute Chemical Education group. Adelaide, South Australia. May 2002.

Drikas M *Water treatment*. Lecture to the Joint University Masters Program students. University of Adelaide, Adelaide, South Australia. June 2002.

Drikas M *Report on international workshop on "UV Treatment in Drinking Water"*. Water Services Association of Australia, Research Committee meeting. Surfers Paradise, Queensland. June 2002.

Drikas M *Report on international workshop on "UV Treatment in Drinking Water"*. Australian Water Quality Centre seminar. Adelaide, South Australia. June 2002.

Fane A A series of lectures on membrane technologies for water and wastewater treatment. Sydney, Perth, Adelaide, 2002.

Ferguson CM, Altavilla N, **Ashbolt NJ** and **Deere DA** *Fate and transport of pathogens in watersheds - an AwwaRF study*. Water Quality and Catchments AWA Seminar. Melbourne, Victoria. March 2002.

Fergusson KM *Rapid methods for the detection of toxic cyanobacteria*. SA Water Board Presentation. Adelaide, South Australia. June 2002.

Haskard C *Water and Health*. University of Turku. Finland, September 2001.

Hoefel D, **Grooby WL**, **Monis PT** and **Saint CP** *Rapid detection of bacteria from water samples using flow cytometry*. Australian Society for Microbiology Becton Dickinson awards competition. Adelaide, South Australia.

Mulcahy D *Water quality: your life may depend on it*. Successful Ageing in Australia seminar. University of South Australia, Adelaide, South Australia. September 2001.

Nicholson BC *Water quality: organic aspects*. Lecture presented in the subject "Water Quality Fundamentals and Processes", Joint University Masters Program, University of Adelaide, Adelaide South Australia. April 2002.

Priestley A *Research on water quality in the CRC for Water Quality and Treatment*. Presentation to Institute of Engineers Australia, Victoria Branch. Melbourne, Victoria. June 2002.

Regel R *The influence of small and large scale mixing processes on freshwater phytoplankton*. Lecture to Centre Mediterrani d' Investigacions Marines i Ambientals (CSIC). Barcelona, Spain. October 2001

Rock K *Water use in the community*. Water Services Association of Australia Water Sensitive Urban Design Workshop. Sydney, New South Wales. December 2001.

Roseth N *Social research in Sydney Water*. American Water Works Association Research Foundation. Denver, USA. December 2001.

Roseth N *Developing tools for utilities to measure customers perceptions*. Emerging Technologies X Seminar. Adelaide, South Australia. April 2002.

Shaw GR *Chlorination of saxitoxins*. Water Services Association of Australia, Research Committee meeting. Surfers Paradise, Queensland. June 2002.

Sinclair MI *The Water Quality Study*. National Short Courses in Environmental Health. Melbourne, Victoria. December 2001.

Sinclair MI *Assessing health risks from drinking water*. CRC Water Forum Seminar series. Melbourne, Victoria. November 2001.

Steffensen D *Biological aspects of water quality*. Lecture to final year University of South Australia Environmental Science students. Adelaide, South Australia. April 2002.

Steffensen D *Pathogen projects within the CRC*. Presentation to the South Australian Water Quality Monitoring Committee. February 2002.

Steffensen D *On-Line Biological Monitoring*. Presentation to the SA Water Corporation Water Quality Working Group. April 2002.

Steffensen D *The CRC for Water Quality and Treatment*. Meeting with scientists from International Water Environment Renovation Research Team, National Institute for Environmental Studies (NIES) in Japan. March 2002.

van Leeuwen J *Natural Organic Matter: One*. Lecture to Joint University Masters Program, University of Adelaide, Adelaide South Australia. May 2002.

van Leeuwen J *Natural Organic Matter: Two*. Lecture to Joint University Masters Program, University of Adelaide, Adelaide South Australia. May 2002.

van Leeuwen J *Modelling Coagulant and pH Control Reagents for Maximising NOM Removal From Drinking Water*. United Water R&D Seminar. Adelaide, South Australia. June 2002.

Performance Indicators 2001 - 2002

In order to achieve its goals, the CRC for Water Quality and Treatment must look for high degrees of efficiency and effectiveness.

- *Efficiency* measures the extent to which the resources are utilised optimally to produce the service.
- *Effectiveness* measures the extent to which the targeted objectives are achieved.

A *performance indicator* is a quantitative or qualitative indicator, related to a particular aspect of performance or standard of service, that essentially enables the efficiency and effectiveness of the CRC to be determined. It expresses the level of actual performance achieved in respect to one of the objectives simplifying an otherwise complex evaluation.

Current CRC for Water Quality and Treatment: Targets/Goals

The major performance measure for the CRC for Water Quality and Treatment is the degree of adoption of the research outcomes and their influence on the Australian water industry.

The tables that follow show the Centre's performance against the currently approved performance indicators listed in Schedule 6 of the Commonwealth Agreement. These indicators are grouped into six categories:

Centre Objectives, Quality and Relevance of Research Program, Strategy for Utilisation and Commercialisation of Research, Education and Training, Collaborative Arrangements, and Resources – Management - Structure and Performance Evaluation.

Performance indicator	Target over life of Centre	Key measurement parameters	Performance 2001-2002
Centre Objectives			
Clarity of objective definition	Maintain clarity of definition	Acceptance of key objectives by Centre parties and review panels	Participants Forum implemented prior to each quarterly Board Meeting.
Undertake high quality research program	See next section	See next section	–
Evidence based Australian water regulatory system	Australian Water Quality Management Framework adopted by all elements of industry	Inclusion in Australian Drinking Water Guidelines	NHMRC adopted Framework and started public consultation.
Close involvement of water industry in research activities	Direct involvement of water industry parties in majority of Centre research projects	Number of projects with direct industry party involvement	All approved projects have at least one industry partner involved.
Strong international alliances	Create an international network of collaborating water research institutions	Number and size of collaborative agreements	Global Water Research Coalition formed in Berlin October 2001. CRC to manage two international research topics.
Provision of high quality future industry leaders	Significant proportion of Centre postgraduate students enter technical and managerial positions in industry	Number of graduated students who obtain employment in industry	12 out of possible 22 PhDs sponsored by the Centre are now employed within the Water or Environmental Industries. Additional three seeking employment.
Centre research outcomes effectively communicated	Water industry to be fully utilising Centre research output	Survey of industry to quantify degree of research adoption	Survey planned for 2002-03.
Benefits to Australia	Actual and future benefits more than five times resources committed	Assessment of economic, social and environmental benefits of Centre projects – to be carried out prior to 2nd and 5th Year Reviews	First year review completed March 2002.

Performance Indicators 2001 - 2002

Performance indicator	Target over life of Centre	Key measurement parameters	Performance 2001-2002
Centre Objectives (cont.)			
Benefits to the Centre	Adding value to intellectual capital at least equal to CRC Commonwealth funding	Demonstrated application of Centre IP to water supply problems	Review planned for 2003.
	Additional income of at least \$2.4 million from outside contracts for R&D	Value of external R&D contracts – evaluated at 2nd and 5th Year Reviews	External income budget over seven years is \$2.8M. External funds committed so far are \$2.48M.
Benefits to participants	Actual and future benefits worth more than three times resources committed	Assessment of value of particular Centre projects to participants – evaluated at project completion	No projects completed in first year.
Quality and Relevance of Research program			
Scientific status of research output and user acceptance	High peer recognition of research output including: – 100 publications in refereed journals – 100 papers in international conferences – 100 papers in national conferences	Number of publications in refereed journals, international and national conferences	– 12 Research Reports published – 33 refereed publications in journals and nine non-refereed – 8 papers presented (no proceedings) and 97 presented with proceedings at International Conferences and 5/16 at National Conferences – 63 presentations at CRC Workshops
	Close industry involvement in all research projects	Number of research projects involving international collaboration	AwwaRF: Four projects: (2694 Catchments, 2752 Reservoirs, 2789 Emerging Algal Toxins, 2881 Detection of Cyanobacteria), Global Research Coalition: two projects as lead agent.
	Successful reviews of scientific quality of research	Number of research projects involving industry participant collaboration	100% of projects have active industry participation. Four Programs managed by Industry party.
Projects prior to 2nd and 5th Year Reviews		Qualitative and quantitative measurement of outcome of scientific reviews in Years Two and Five	NA

Performance Indicators 2001 - 2002

Performance indicator	Target over life of Centre	Key measurement parameters	Performance 2001-2002
Strategy for utilization and commercialisation of research			
Adoption of research outputs by industry or community generally	Results from Epidemiology and Toxicology research programs used as a basis for the ongoing review of the Australian Drinking Water Guidelines and the National Water Quality Management Framework	Qualitative and quantitative assessment of impact on water quality regulation	Development of risk management procedures by major parties. Certification by major parties in HACCP.
	Results from the People's Perspective program used to guide community consultation exercises and gauge community response to water quality issues	Number and scale of community consultation exercises affected	First project on community views planned for Nov 2002.
	Future management of catchments and reservoirs to be based on information from the Catchment and Reservoirs programs	Number and scale of catchment and reservoir management plans affected	Based on CRC knowledge, SA EPA and Sydney Catchment Authority have shifted priorities more towards domestic animals and less towards sewage.
	Water quality monitoring practices to reflect lessons learnt in the Monitoring program	Qualitative assessment of impact on water quality monitoring practices	Turbidity, long proposed as a surrogate of indicators for pathogens was shown to be of limited value. Storm event grab sampling may actually be cost effective for estimating pathogens (P 2.2.1).
	New approaches to water treatment based on output from the Treatment program adopted by water authorities	Number and scale of new approaches to treatment adopted	Enhanced coagulation implemented by a number of water utilities. Ozone/granular activated carbon has been installed in at least three WTPs. Two plants incorporating MIEX® have been commissioned.
	Distribution system management practices strongly influenced by understanding generated in the Distribution program	Qualitative assessment of impact on distribution system operating practices	Improved understanding of biofilms their control and prediction of chlorine demand.
	New sustainable approaches to water supply system design, emanating from the Sustainable Water Sources program, to be tested in real systems	Number of new approaches identified and trialed	Program development has identified research themes. Program Steering Committee formed June 2002.

Performance Indicators 2001 - 2002

Performance indicator	Target over life of Centre	Key measurement parameters	Performance 2001-2002
Education and Training			
Post graduate student training and mentoring	Offer 10 new postgraduate scholarships per year 30 students enrolled at peak	Enrolment and completion of PhD theses	9 new graduates; 11 theses accepted, 12 new postgraduate students enrolled this year, 10 on scholarships, the other two independently supported; 49 active students at present. Winner of 2002 Young Scientist of the Year: Kim Ferguson.
	Postgraduate student conference every two years	Successful staging of conferences	Planning for first conference in late 2002 complete.
	Development of links with industry	Attendance of industry partners at the student conference	Invitations made.
Direct involvement of staff from outside the universities in thesis supervision		Widespread industry supervision.	
Undergraduate student training	Offer nine summer scholarships per year	Number of summer projects completed	Nine offered and completed at presentation workshop in Melbourne.
	Introduce scholarships for Honours students	Numbers of scholarships taken up	10 postgraduate, six Honours and nine summer scholarships taken up.

Performance Indicators 2001 - 2002

Performance indicator	Target over life of Centre	Key measurement parameters	Performance 2001-2002
Collaborative Arrangements			
Development of projects	All projects to be developed jointly between researchers and industry	Number and success of project development workshops	All research programs completed industry planning workshop (except Policy and Regulation and Strategic Directions – planned for Sept 2002)
Collaboration within projects	80% of all projects have more than one partner directly involved	Number of partners involved in each project	100% of all projects have partners directly involved
Development of a collegiate management culture	Involvement of all Program Group Leaders and Program Leaders in the management decisions. At least six full management meetings per year.	Number of full management meetings per year	Eight management meetings held (July, Aug, Nov 2001; Jan, Feb, Mar, Apr & May 2002)
Development of external links.	Maintain links to other water based CRCs through the Water Forum	Number of meetings of the Water Forum.	CRCWQT hosted meeting of Forum in Adelaide on 5 June 2002.
		Number of joint projects with the Water forum	Interaction with other CRCs in Education and Training and Communication Pathogens modeling potential collaboration with CRC Catchment Hydrology
Promotion and extension of international linkages	Consolidate the linkages with the leading water research centres in USA, France, The Netherlands, Germany and South Africa by signing a formal agreement on research collaboration	Signed agreements on research collaboration	Penta Party MOU signed off in Berlin Oct 2001 with Kiwa, AwwaRF, TZW & UK Water Research. The Global Water Research Coalition (12 international partners) had first Board meeting in Melbourne during March 2002. CRC to take a lead role in developing a more detailed research strategy on Algal Toxins and Water Quality in Distribution Systems.
		Continue linkages with overseas researchers.	Number of working visits between the CRC and overseas research agencies Signed Agreement with Global Water Research Coalition
		Continue to be directly involved with the water quality guideline development process with the World Health Organisation	Number of CRC staff involved with WHO

Performance Indicators 2001 - 2002

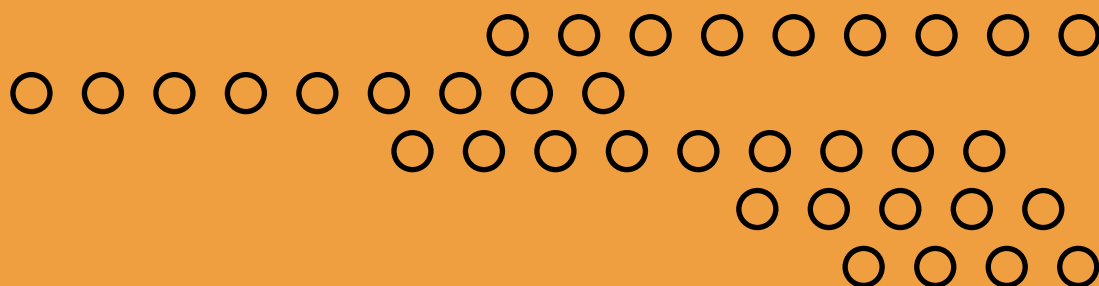
Performance indicator	Target over life of Centre	Key measurement parameters	Performance 2001-2002
Resources, Management Structure and Performance Evaluation			
Development of a collegiate management culture	Establish a management committee with representation from research and industrial partners. Establish an industry based review committee for each Research Program Group.	Number of full management, and industrial committees per year	All programs completed Planning Workshops. Industry review panels established. Steering Committee formed for Sustainable Water Sources Program
Development of clear operating guidelines	Revise and up date the existing Operating Protocols	Operating protocols in place	Protocols reviewed and updated to reflect new CRC
Project Management	Timely completion of all projects	Adherence to the project milestones	<p>Review of current project management systems and appointment of Project Services manager</p> <p>Web-based project management systems identified for detailed pilot trial next financial year.</p>
Budget control	All projects to operate within the approved budgets	Adherence to budget	Budget for 2002-03 approved by Board. Seven Year Cash-flow and budget review process initiated
Protection of intellectual property	All IP developed within the projects fully protected	IP clauses signed by all parties prior to commencement of any project	All IP agreements signed before commencement of projects
Commercialisation	Maximum commercial benefit obtained from IP developed during projects	Number of patents obtained	Formed Carbon Regen Pty Ltd for carbon regeneration process
		Number of commercialized projects	Commercialisation of reactivation of carbon in progress
Planning	Strategic plan developed in Year One	Completion of the strategic plan	Draft Plan submitted to Board June 2002. Ongoing annual review of Strategic Plan

Budget & Resources



**MR GEORGE TURELLI,
BUSINESS MANAGER**

The Centre's Governing Board and Management recognise that effective management of financial and other resources is essential for the delivery of world-class research. To achieve this, the Centre has established systems and frameworks to ensure efficient project and financial management.



TABLES

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Appendix A – Research Staff Resources

PERCENTAGE TIME ALLOCATION OF RESEARCH STAFF RESOURCES IN-KIND CONTRIBUTION FOR THE FINANCIAL YEAR 2001/2002

ACTEW Corporation Ltd

% Allocation of Time Spent

Name	Main Activity	Total % of time	Research Program			Total Research	Education	Commercial-isation Program	CRC Administration	Communication
			Sub program							
			1	2	3					
Ms Z Moore	R	20.4		20.4		20.4				
Ms R Reid	R	14.1		14.1		14.1				
Mr C Magyar	R	8.6		8.6		8.6				
Mr I Townley	R	0.8		0.8		0.8				
TOTAL		43.9	0.0	43.9	0.0	43.9	0.0	0.0	0.0	

Australian Water Quality Centre

% Allocation of Time Spent

Name	Main Activity	Total % of time	Research Program			Total Research	Education	Commercial-isation Program	CRC Administration	Communication
			Sub program							
			1	2	3					
Dr J Van Leeuwen	R	100.0		100.0		100.0				
Dr C Chow	R	67.5		67.5		67.5				
Dr G Newcombe	R	57.8		57.8		57.8				
Mr M Burch	R	47.7	4.7	43.1		47.7				
Dr C Saint	R	33.2		33.2		33.2				
Dr B Nicholson	R	26.7		26.7		26.7				
Dr W Grooby	R	22.7		22.7		22.7				
Dr P Monis	R	21.2		21.2		21.2				
Mr J Morran	R	9.8		6.8		6.8		3.0		
Mr P Baker	R	4.0		3.3		3.3	0.7			
Dr C Pelekani	R	3.5		3.5		3.5				
Ms S Brinkman	R	0.7		0.7		0.7				
Mr B Robinson	E	23.8		23.4		23.4	0.4			
Dr A Humpage	E	16.7	16.5			16.5	0.2			
Dr D Steffensen	A	71.4		1.1		1.1		70.3		
Ms M Drikas	A	65.6		18.7		18.7		46.9		
TOTAL		572.1	21.2	429.5	0.0	450.7	1.2	0.0	120.2	0.0

Brisbane City Council

% Allocation of Time Spent

Name	Main Activity	Total % of time	Research Program			Total Research	Education	Commercial-isation Program	CRC Administration	Communication
			Sub program							
			1	2	3					
Mr H Gibson	R	18.2		18.2		18.2				
TOTAL		18.2	0.0	18.2	0.0	18.2		0.0	0.0	

Appendix A – Research Staff Resources (Cont.)

CSIRO

% Allocation of Time Spent

Name	Main Activity	Total % of time	Research Program			Total Research	Education	Commercialisation Program	CRC Administration	Communication
			1	2	3					
Mr N Anderson	R	38.9		38.9		38.9				
Ms J Wu	R	33.8		33.8		33.8				
Dr D Dixon	R	24.9		24.9		24.9				
Dr R Eldridge	R	21.0		21.0		21.0				
Dr S Gray	R	16.7		16.7		16.7				
Dr B Bolto	R	4.8		4.8		4.8				
Dr N Pilkington	R	4.0		4.0		4.0				
Dr A Priestley	A	60.0				0.0		20.0	40.0	
TOTAL		204.2	0.0	144.2	0.0	144.2	0.0	20.0	40.0	0.0

Curtin University of Technology

% Allocation of Time Spent

Name	Main Activity	Total % of time	Research Program			Total Research	Education	Commercialisation Program	CRC Administration	Communication
			1	2	3					
Prof R Kagi	R	35.9		31.5		31.5			4.4	
Dr R De Marco	R	3.6		3.6		3.6				
Dr C Joll	R	1.7		1.7		1.7				
Dr A Heitz	E	6.7		2.0		2.0	4.8			
TOTAL		47.9	0.0	38.8	0.0	38.8	4.8	0.0	4.4	0.0

Department of Human Services (Vic)

% Allocation of Time Spent

Name	Main Activity	Total % of time	Research Program			Total Research	Education	Commercialisation Program	CRC Administration	Communication
			1	2	3					
Ms S Phillips	R	4.3	2.5	0.8	1.0	4.3				
Dr P Van Buynder	R	2.5	0.8	1.1	0.6	2.5				
TOTAL		6.8	3.3	1.9	1.6	6.8	0.0	0.0	0.0	0.0

Egis Consulting Australia Pty Ltd

% Allocation of Time Spent

Name	Main Activity	Total % of time	Research Program			Total Research	Education	Commercialisation Program	CRC Administration	Communication
			1	2	3					
Mr M Chapman	R	17.9	17.9			17.9				
Dr P Nadebaum	R	11.9	11.9			11.9				
TOTAL		29.8	29.8	0.0	0.0	29.8	0.0	0.0	0.0	0.0

Appendix A – Research Staff Resources (Cont.)

Melbourne Water Corporation

% Allocation of Time Spent

Name	Main Activity	Total % of time	Research Program			Total Research	Education	Commercial-isation Program	CRC Administration	Communication
			1	2	3					
Ms K Clarkson	R	15.7		15.7		15.7				
Dr M Stevens	R	3.9		3.9		3.9				
Dr R Considine	R	0.5		0.5		0.5				
TOTAL		20.1	0.0	20.1	0.0	20.1	0.0	0.0	0.0	0.0

Monash University

% Allocation of Time Spent

Name	Main Activity	Total % of time	Research Program			Total Research	Education	Commercial-isation Program	CRC Administration	Communication
			1	2	3					
Prof J McNeil	R	62.6	27.0			27.0	1.0		21.6	13.2
Ms Karin Leder	R	43.8	42.0			42.0	0.6		1.2	
Ms P Lightbody	R	39.2	29.9			29.9				9.3
Dr M Sinclair	R	35.0	15.0			15.0	2.9		3.0	14.1
Dr M Sim	R	8.6	8.6			8.6				
Dr A Forbes	R	4.3	4.3			4.3				
Ms T Mitikakis	R	2.1	2.1			2.1				
TOTAL		195.7	128.8	0.0	0.0	128.8	4.5	0.0	25.8	36.6

Orica Australia Pty Ltd

% Allocation of Time Spent

Name	Main Activity	Total % of time	Research Program			Total Research	Education	Commercial-isation Program	CRC Administration	Communication
			1	2	3					
Mr M Slunjski	A	4.2		1.4		1.4			2.8	
Dr H Nguyen	A	1.3				0.0			1.3	
Mr D Day	A	0.8				0.0			0.8	
Mr P Largier	A	0.3				0.0			0.3	
TOTAL		6.4	0.0	1.4	0.0	1.4	0.0	0.0	5.0	0.0

Power & Water Authority (NT)

% Allocation of Time Spent

Name	Main Activity	Total % of time	Research Program			Total Research	Education	Commercial-isation Program	CRC Administration	Communication
			1	2	3					
Ms N Thompson	R	32.9			32.9	32.9				
Mr D Day	R	14.9			14.9	14.9				
Mr A Mills	R	4.8			4.8	4.8				
Ms K Clarkson	R	3.6			3.6	3.6				
Mr P Heaton	R	2.7			2.7	2.7				
TOTAL		58.9	0.0	0.0	58.9	58.9	0.0	0.0	0.0	0.0

Appendix A – Research Staff Resources (Cont.)

Queensland Health Pathology & Scientific Services

% Allocation of Time Spent

Name	Main Activity	Total % of time	Research Program			Total Research	Education	Commercialisation Program	CRC Administration	Communication
			Sub program							
			1	2	3					
Mr E Lee	R	7.8	7.8			7.8				
Dr H Olszowy	R	6.7	6.7			6.7				
Mr R Francis	R	4.2	4.2			4.2				
Dr R Sadler	R	1.6	1.6			1.6				
Ms M Smith	R	1.5	1.5			1.5				
Mrs M Hodge	R	1.3	1.3			1.3				
Mr D Wruck	R			0.4		0.4				
TOTAL		23.4	23.0	0.4	0.0	23.4	0.0	0.0	0.0	

RMIT University

% Allocation of Time Spent

Name	Main Activity	Total % of time	Research Program			Total Research	Education	Commercialisation Program	CRC Administration	Communication
			Sub program							
			1	2	3					
Prof F Roddick	R	26.2		15.8		15.8	10.4			
A/Prof L Doukas	R	9.6		7.2		7.2	2.4			
Mr F Younos	R	8.7		8.7		8.7				
Dr J Harris	R	8.5		8.5		8.5				
Dr N Jayasunya	R	6.6		4.9		4.9	1.7			
Dr M Waters	R	4.3		4.3		4.3				
Dr N Porter	R	2.3		2.3		2.3				
TOTAL		66.1	0.0	51.6	0.0	51.6	14.5	0.0	0.0	

South East Water Ltd

% Allocation of Time Spent

Name	Main Activity	Total % of time	Research Program			Total Research	Education	Commercialisation Program	CRC Administration	Communication
			Sub program							
			1	2	3					
Mr G Ryan	R	15.2		15.2		15.2				
TOTAL		15.2	0.0	15.2	0.0	15.2	0.0	0.0	0.0	

Sydney Catchment Authority

% Allocation of Time Spent

Name	Main Activity	Total % of time	Research Program			Total Research	Education	Commercialisation Program	CRC Administration	Communication
			Sub program							
			1	2	3					
Ms C Ferguson	R	40.3		40.3		40.3				
Dr D Deere	R	23.0		23.0		23.0				
Mr M Krogh	R	0.6		0.6		0.6				
TOTAL		63.9	0.0	63.9	0.0	63.9	0.0	0.0	0.0	

Appendix A – Research Staff Resources (Cont.)

Sydney Water Corporation

% Allocation of Time Spent

Name	Main Activity	Total % of time	Research Program			Total Research	Education	Commercial-isation Program	CRC Administration	Communication
			1	2	3					
Dr N Roseth	R	64.1	64.1			64.1				
Mr G Kastl	R	63.7		63.7		63.7				
Mr D Vitanage	R	56.2		54.4		54.4		1.8		
Dr I Fisher	R	52.5		45.9		45.9		6.6		
Dr M Angles	R	20.2		19.9		19.9		0.3		
Dr P Hawkins	R	5.9		5.9		5.9				
Mr C Copelin	R	4.5		4.5		4.5				
Dr P Cox	R	2.5		2.5		2.5				
Ms C Doolan	R	2.1		2.1		2.1				
Mr S Powell	R	2.0		2.0		2.0				
Dr J Chandy	R	1.5		1.5		1.5				
Mr T Nguyen	R	1.4		1.4		1.4				
Mr T Tum Hong	R	0.9		0.9		0.9				
Mr L Rogerson	R	0.5		0.5		0.5				
Mr P Cresta	R	0.4		0.4		0.4				
TOTAL		278.3	64.1	205.4	0.0	269.5	0.0	0.0	8.8	0.0

United Water International Pty Ltd

% Allocation of Time Spent

Name	Main Activity	Total % of time	Research Program			Total Research	Education	Commercial-isation Program	CRC Administration	Communication
			1	2	3					
Mr M Holmes	R	19.3		19.3		19.3				
Dr C Heidenreich	R	9.4		9.4		9.4				
Dr D Oemcke	R	2.9		2.9		2.9				
Dr J Nixon	R	2.2		2.2		2.2				
Mr P Callum	R	0.7		0.7		0.7				
TOTAL		34.6	0.0	34.6	0.0	34.6	0.0	0.0	0.0	0.0

University of Adelaide

% Allocation of Time Spent

Name	Main Activity	Total % of time	Research Program			Total Research	Education	Commercial-isation Program	CRC Administration	Communication
			1	2	3					
Prof I Falconer	R	35.0	35.0			35.0				
A/Prof G Ganf	R	13.6		13.6		13.6				
Dr M Lambert	R	12.4		12.4		12.4				
Prof G Dandy	R	8.4		8.4		8.4				
Dr H Maier	R	8.0		5.3		5.3	2.7			
Dr F Recknagel	R	6.2		3.7		3.7	2.5			
TOTAL		83.6	35.0	43.4	0.0	78.4	5.2	0.0	0.0	0.0

Appendix A – Research Staff Resources (Cont.)

University of New South Wales

% Allocation of Time Spent

Name	Main Activity	Total % of time	Research Program			Total Research	Education	Commercialisation Program	CRC Administration	Communication
			1	2	3					
Ms N Altavilla	R	55.0		55.0		55.0				
Dr N Ashbolt	R	41.8		38.8		38.8	1.4	1.6		
Mr J Guan	R	2.0		2.0		2.0				
TOTAL		98.8	0.0	95.8	0.0	95.8	1.4	0.0	1.6	0.0

University of Queensland

% Allocation of Time Spent

Name	Main Activity	Total % of time	Research Program			Total Research	Education	Commercialisation Program	CRC Administration	Communication
			1	2	3					
Dr G Shaw	R	61.8	61.8			61.8				
Dr F Liu	R	51.3	51.3			51.3				
A/Prof B Noller	R	39.9	30.1	2.9	6.8	39.9				
Mr J Wang	R	24.6	24.6			24.6				
Dr S Huang	R	17.1	17.1			17.1				
Dr J Ng	R	14.0	14.0			14.0				
Prof M Moore	R	9.5	9.5			9.5				
Dr P Dart	R	7.7		7.7		7.7				
Ms H Byrnes	R	3.3	3.3			3.3				
A/Prof B Chiswell	R	1.7		1.7		1.7				
Dr D Lockington	R	1.5		1.5		1.5				
Mr R Brown	R	0.9		0.9		0.9				
Ms I Burkett	R	0.9		0.9		0.9				
A/Prof J Keller	R	0.7			0.7	0.7				
TOTAL		234.9	211.8	15.7	7.5	234.9	0.0	0.0	0.0	0.0

University of South Australia

% Allocation of Time Spent

Name	Main Activity	Total % of time	Research Program			Total Research	Education	Commercialisation Program	CRC Administration	Communication
			1	2	3					
Dr A Badalyan	R	17.9		17.9		17.9				
Prof D Mulcahy	E	80.2				0.0	80.2			
Dr G Klass	E	1.8		1.8		1.8				
Dr J McKay	E	1.7				0.0	1.7			
TOTAL		101.6	0.0	19.7	0.0	19.7	81.9	0.0	0.0	0.0

Water Corporation (WA)

% Allocation of Time Spent

Name	Main Activity	Total % of time	Research Program			Total Research	Education	Commercialisation Program	CRC Administration	Communication
			1	2	3					
Mr D Ryken-Rapp	R	20.9		20.9		20.9				
Mr P Scott	R	1.0		1.0		1.0				
Mr K Xanthis	R	0.5		0.5		0.5				
Mr R Walker	R	0.2		0.2		0.2				
TOTAL		22.6	0.0	22.6	0.0	22.6	0.0	0.0	0.0	0.0

Appendix A – Research Staff Resources (Cont.)

Yarra Valley Water Ltd

% Allocation of Time Spent

Name	Main Activity	Total % of time	Research Program			Total Research	Education	Commercial-isation Program	CRC Administration	Communication
			1	2	3					
Mr F Pamminger	R	9.0		9.0		9.0				
Mr A Jayaratne	R	5.3		5.3		5.3				
TOTAL		14.3	0.0	14.3	0.0	14.3	0.0	0.0	0.0	0.0
GRAND TOTAL		2241.4	517.0	1280.7	68.0	1865.6	113.4	20.0	205.8	36.6

Research Staff - CRC funded resources

% Allocation of Time Spent

Name	Main Activity	Total % of time	Research Program			Total Research	Education	Commercialisation Program	CRC Administration	Communication
			1	2	3					
Dr P Hobson AWQC	R	100.0	50.0	50.0		100.0				
Dr A Keegan AWQC	R	100.0		100.0		100.0				
Dr C Haskard AWQC	R	100.0		100.0		100.0				
Dr D Roser UNSW	R	100.0		100.0		100.0				
Mr A Weerawardena CSIRO	R	100.0		100.0		100.0				
Mr D Cook AWQC	R	100.0		100.0		100.0				
Mr R Fabris AWQC	R	100.0		100.0		100.0				
Ms K Rock SWC	R	100.0		100.0		100.0				
Ms R Grey-Gardner PAWA	R	100.0			100.0	100.0				
Ms S Gelonese AWQC	R	100.0		100.0		100.0				
Ms S Rizak MONASH	R	100.0	100.0			100.0				
Dr T D Nguyen RMIT	R	100.0		100.0		100.0				
Dr J Chandy SWC	R	90.2		90.2		90.2				
Ms C Kaucner UNSW	R	86.2		86.2		86.2				
Mr S Payyapat SWC	R	85.1		85.1		85.1				
Mr P Chen SWC	R	81.5		81.5		81.5				
Dr C Davies UNSW	R	79.3		79.3		79.3				
Dr J Brookes AWQC	R	75.0		75.0		75.0				
Dr C Bernard AWQC	R	66.7		66.7		66.7				
Dr M Sinclair MONASH	R	65.0	25.0			25.0		15.0	25.0	
Mr C Rouhianen WCWA	R	63.5		63.5		63.5				
Mr L Linden AWQC	R	58.4		58.4		58.4				
Mr A Sathasivan SWC	R	45.0		45.0		45.0				
Dr J Bridger CSIRO	R	40.6		40.6		40.6				
Ms N Slyman AWQC	R	33.3		33.3		33.3				
Mr P Mathes SEWL	R	31.1		31.1		31.1				
Mr R Hayes MONASH	R	24.0	24.0			24.0				
Mr C Grainger CSIRO	R	21.1		21.1		21.1				
Mr D Verrelli EGIS	R	16.1	16.1			16.1				
Ms M Fisher UNSW	R	15.5		15.5		15.5				

Research Staff - CRC funded resources (cont.)

% Allocation of Time Spent

Name	Main Activity	Total % of time	Research Program			Total Research	Education	Commercialisation Program	CRC Administration	Communication
			1	2	3					
Mr R Morden EGIS	R	12.5	12.5			12.5				
Prof I Falconer Uni of Adel	R	11.9	11.9			11.9				
Ms A Lonska SWC	R	11.7		11.7		11.7				
Mr S Ye SWC	R	9.9		9.9		9.9				
Ms A Gilyou SWC	R	8.2		8.2		8.2				
Mr V Jegatheesam SWC	R	7.3		7.3		7.3				
Dr G Shaw UQ	R	6.7	6.7			6.7				
Mr T Kilpatrick CSIRO	R	6.4		6.4		6.4				
Mr B Nguyen CSIRO	R	3.4		3.4		3.4				
Ms T Clarke SWC	R	2.8		2.8		2.8				
Mr B Robertson MONASH	R	2.8	2.8			2.8				
Ms T Mitakakis MONASH	R	2.1	2.1			2.1				
Mr J Cao SWC	R	1.8		1.8		1.8				
Mr G Kastl SWC	R	0.6		0.6		0.6				
Ms C Bellamy Uni SA	E	33.0				0.0	33.0			
Ms K Nitschke AWQC	C	100.0				0.0				100.0
Dr G Vaughan CSIRO	C	80.0				0.0				80.0
Ms P Lightbody MONASH	C	46.7	6.7			6.7				40.0
Mr G Turelli AWQC	A	100.0				0.0			100.0	
Ms J O'Brien AWQC	A	100.0				0.0			100.0	
Prof D Bursill AWQC	A	80.0				0.0			80.0	
Ms S Spragg AWQC	A	60.0				0.0			60.0	
Mr B Dorratt SEWL	A	46.7				0.0			46.7	
Dr A Priestley CSIRO	A	20.0				0.0			20.0	
Ms P Jamieson AWQC	A	12.5				0.0			12.5	
GRAND TOTAL		2944.8	257.7	1874.8	100.0	2232.5	33.0	0.0	434.2	245.0

SUMMARY OF CONTRIBUTIONS IN PERSON YEARS

100% = 1 person year	Total Equivalent Person Years	Research Program			Total Research	Education Program	Commercialisation Program	CRC Admin	Communications
		1	2	3					
Total Contributed by the Participants	22.4	5.2	12.8	0.7	18.7	1.1	0.2	2.1	0.4
Total Funded by CRC	29.4	2.5	18.7	1.0	22.3	0.3	0.0	4.3	2.5
GRAND TOTAL	51.8	7.7	31.6	1.7	41.0	1.5	0.2	6.4	2.8
Proportion of Total Professional Staff Resources in each activity	1.0	0.1	0.6	0.0	0.8	0.0	0.0	0.1	0.1

TABLE 1. IN-KIND CONTRIBUTIONS FROM PARTICIPANTS

PARTICIPANTS	ACTUAL		CUMULATIVE TOTAL TO DATE							PROJECTED							GRAND TOTAL	
	YEAR 1 2001/02	YEAR 1 2001/02	YEAR 1 2001/02	YEAR 2 2002/03	YEAR 2 2002/03	YEAR 3 2003/04	YEAR 3 2003/04	YEAR 4 2004/05	YEAR 4 2004/05	YEAR 5 2005/06	YEAR 5 2005/06	YEAR 6 2006/07	YEAR 6 2006/07	YEAR 7 2007/08	YEAR 7 2007/08	TOTAL SEVEN YEARS	TOTAL SEVEN YEARS	DIFF SEVEN YEARS
	ACTUAL	AGR/MT	ACTUAL	BUDGET	AGR/MT	BUDGET	AGR/MT	BUDGET	AGR/MT	BUDGET	AGR/MT	BUDGET	AGR/MT	BUDGET	AGR/MT	SEVEN YEARS	SEVEN YEARS	SEVEN YEARS
ACTEW Corporation Ltd																		
Salaries	37,916	26,049	37,916	26,049	26,050	26,050	26,050	26,050	26,050	26,050	26,050	26,050	26,050	26,050	194,215	182,348	11,867	
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	35,714	23,950	35,714	23,950	23,950	23,950	23,950	23,950	23,950	23,950	23,951	23,951	23,951	23,951	179,416	167,652	11,764	
TOTAL	73,630	49,999	73,630	49,999	50,000	50,000	50,000	50,000	50,000	50,000	50,001	50,001	50,001	50,001	373,631	350,000	23,631	
Australian Water Quality Centre																		
Salaries	396,876	569,039	396,876	569,492	574,488	574,488	577,389	577,389	577,389	577,389	577,389	577,389	577,388	577,388	3,850,411	4,022,574	(172,163)	
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	1,424,432	798,480	1,424,432	799,115	806,125	806,125	810,196	810,196	810,196	810,196	810,196	810,196	810,197	810,197	6,270,457	5,644,505	625,952	
TOTAL	1,821,308	1,367,519	1,821,308	1,368,607	1,380,613	1,380,613	1,387,585	1,387,585	1,387,585	1,387,585	1,387,585	1,387,585	1,387,585	1,387,585	10,120,868	9,667,079	453,789	
Australian Water Services Pty Ltd																		
Salaries	2,336	0	2,336	0	0	0	0	0	0	0	0	0	0	0	2,336	0	2,336	
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	1,382	0	1,382	0	0	0	0	0	0	0	0	0	0	0	1,382	0	1,382	
TOTAL	3,718	0	3,718	0	0	0	0	0	0	0	0	0	0	0	3,718	0	3,718	
Brisbane City Council																		
Salaries	19,723	28,646	19,723	28,646	28,646	28,646	28,646	28,646	28,646	28,646	28,646	28,646	28,646	28,646	191,599	200,522	(8,923)	
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	25,115	31,354	25,115	31,354	31,354	31,354	31,354	31,354	31,354	31,354	31,354	31,354	31,354	31,354	213,239	219,478	(6,239)	
TOTAL	44,838	60,000	44,838	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	404,838	420,000	(15,162)	
CSIRO Molecular Science																		
Salaries	238,468	205,544	238,468	205,544	205,544	205,544	205,544	205,544	205,544	205,544	205,543	205,543	205,543	205,543	1,471,730	1,438,806	32,924	
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	513,206	267,191	513,206	267,191	267,191	267,191	267,191	267,191	267,191	267,190	267,190	267,190	267,190	267,190	2,116,349	1,870,334	246,015	
TOTAL	751,674	472,735	751,674	472,735	472,735	472,735	472,735	472,735	472,734	472,733	472,733	472,733	472,733	472,733	3,588,079	3,309,140	278,939	

GRAND TOTAL

PROJECTED

CUMULATIVE TOTAL TO DATE

ACTUAL

PARTICIPANTS

	YEAR 1		YEAR 2		YEAR 3		YEAR 4		YEAR 5		YEAR 6		YEAR 7		TOTAL SEVEN YEARS	DIFF SEVEN YEARS
	2001/02	2001/02	2002/03	2002/03	2003/04	2003/04	2004/05	2004/05	2005/06	2005/06	2006/07	2006/07	2007/08	2007/08		
	ACTUAL	AGR/MT	BUDGET	AGR/MT	BUDGET	AGR/MT	BUDGET	AGR/MT	BUDGET	AGR/MT	BUDGET	AGR/MT	BUDGET	AGR/MT		

Curtin University of Technology

Salaries	57,070	183,497	183,497	183,497	183,497	183,497	183,497	183,497	183,497	183,497	183,497	183,497	183,498	1,158,053	1,284,480	(126,427)
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	65,072	217,746	217,746	217,746	217,746	217,746	217,746	217,746	217,746	217,746	217,745	217,745	217,745	1,371,546	1,524,220	(152,674)
TOTAL	122,142	401,243	401,243	401,243	401,243	401,243	401,243	401,243	401,243	401,243	401,242	401,243	401,243	2,529,599	2,808,700	(279,101)

Department of Human Services (Vic)

Salaries	8,253	12,731	12,731	12,731	12,731	12,731	12,731	12,731	12,731	12,731	12,730	12,730	12,730	84,637	89,115	(4,478)
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	9,045	17,269	17,269	17,269	17,269	17,269	17,269	17,269	17,269	17,269	17,270	17,270	17,270	112,661	120,885	(8,224)
TOTAL	17,298	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	197,298	210,000	(12,702)

EGIS Consulting Australia Pty Ltd

Salaries	46,447	50,242	50,242	50,242	50,242	50,242	50,242	50,242	50,242	50,242	50,242	50,242	50,242	347,899	351,694	(3,795)
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	49,794	49,330	49,330	49,330	49,330	49,330	49,330	49,330	49,329	49,329	49,329	49,329	49,329	345,771	345,307	464
TOTAL	96,241	99,572	99,572	99,572	99,572	99,572	99,572	99,571	99,571	99,571	99,571	99,571	99,571	693,670	697,001	(3,331)

Environmental Protection Agency (QLD)

Salaries	2,400	26,246	26,246	26,246	26,246	26,246	26,246	26,246	26,246	26,246	26,245	26,245	26,245	159,874	183,720	(23,846)
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	37,763	37,763	37,763	37,763	37,763	37,763	37,763	37,763	37,763	37,762	37,762	37,762	226,577	264,340	(37,763)
TOTAL	2,400	64,009	64,009	64,009	64,009	64,009	64,009	64,009	64,009	64,008	64,007	64,007	64,007	386,451	448,060	(61,609)

Griffith University

Salaries	3,396	101,220	101,220	101,220	101,220	101,220	101,220	101,220	101,220	101,220	101,219	101,219	101,219	610,714	708,538	(97,824)
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	1,126	125,982	125,982	125,982	125,982	125,982	125,982	125,982	125,982	125,982	125,982	125,982	125,982	757,019	881,875	(124,856)
TOTAL	4,522	227,202	227,202	227,202	227,202	227,202	227,202	227,202	227,202	227,201	227,202	227,202	227,202	1,367,733	1,590,413	(222,680)

TABLE 1. IN-KIND CONTRIBUTIONS FROM PARTICIPANTS (CONT.)

PARTICIPANTS	ACTUAL		CUMULATIVE TOTAL TO DATE		PROJECTED														GRAND TOTAL									
	YEAR 1 2001/02	YEAR 1 2001/02	ACTUAL	AGR/MT	YEAR 2 2002/03	YEAR 2 2002/03	YEAR 3 2003/04	YEAR 3 2003/04	YEAR 4 2004/05	YEAR 4 2004/05	YEAR 4 2004/05	YEAR 4 2004/05	YEAR 5 2005/06	YEAR 5 2005/06	YEAR 5 2005/06	YEAR 5 2005/06	YEAR 6 2006/07	YEAR 6 2006/07	YEAR 6 2006/07	YEAR 6 2006/07	YEAR 7 2007/08	YEAR 7 2007/08	YEAR 7 2007/08	TOTAL SEVEN YEARS	AGR/MT SEVEN YEARS	DIFF SEVEN YEARS		
	ACTUAL	AGR/MT	ACTUAL	AGR/MT	BUDGET	AGR/MT	BUDGET	AGR/MT	BUDGET	AGR/MT	BUDGET	AGR/MT	BUDGET	AGR/MT	BUDGET	AGR/MT	BUDGET	AGR/MT	BUDGET	AGR/MT	BUDGET	AGR/MT	BUDGET	AGR/MT	BUDGET	AGR/MT	BUDGET	
Melbourne Water Corporation																												
Salaries	12,980	100,193	12,980	100,193	100,194	100,194	100,194	100,194	100,194	100,194	100,194	100,194	100,194	100,194	100,194	100,195	100,195	100,195	100,195	100,196	100,196	100,196	100,196	100,196	614,147	701,360	(87,213)	
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	9,796	133,359	9,796	133,359	133,359	133,359	133,359	133,359	133,359	133,359	133,359	133,359	133,359	133,359	133,359	133,359	133,359	133,359	133,359	133,358	133,358	133,358	133,358	809,949	933,512	(123,563)		
TOTAL	22,776	233,552	22,776	233,552	233,553	233,553	233,553	233,553	233,553	233,553	233,553	233,553	233,553	233,553	233,553	233,554	233,554	233,554	233,554	233,554	233,554	233,554	233,554	1,424,096	1,634,872	(210,776)		
Monash University																												
Salaries	189,608	181,472	189,608	181,472	181,472	181,472	181,472	181,472	181,472	181,472	181,472	181,472	181,472	181,472	181,472	181,472	181,472	181,472	181,472	181,472	181,472	181,472	181,472	181,472	1,278,442	1,270,306	8,136	
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	394,896	248,999	394,896	248,999	248,999	248,999	248,999	248,999	248,999	248,999	248,999	248,999	248,999	248,999	248,999	248,999	248,999	248,999	248,999	248,998	248,998	248,998	248,998	1,888,889	1,742,992	145,897		
TOTAL	584,504	430,471	584,504	430,471	430,471	430,471	430,471	430,471	430,471	430,471	430,471	430,471	430,471	430,471	430,471	430,471	430,471	430,471	430,471	430,472	430,472	430,472	430,472	3,167,331	3,013,298	154,033		
ORICA Australia Pty Ltd																												
Salaries	11,844	20,063	11,844	20,063	21,125	21,125	22,125	23,250	23,250	23,250	24,438	24,438	25,750	25,750	26,749	26,749	26,749	26,749	26,749	26,749	26,749	26,749	26,749	26,749	155,281	163,500	(8,219)	
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	11,092	25,680	11,092	25,680	27,040	27,040	28,320	29,760	29,760	29,760	31,280	31,280	32,960	32,960	34,240	34,240	34,240	34,240	34,240	34,240	34,240	34,240	34,240	34,240	194,692	209,280	(14,588)	
TOTAL	22,936	45,743	22,936	45,743	48,165	48,165	50,445	53,010	53,010	53,010	55,718	55,718	58,710	58,710	60,989	60,989	60,989	60,989	60,989	60,989	60,989	60,989	60,989	60,989	349,973	372,780	(22,807)	
Power and Water Authority (NT)																												
Salaries	47,103	68,811	47,103	68,811	68,811	68,811	68,811	68,811	68,811	68,811	68,811	68,811	68,811	68,811	68,811	68,811	68,811	68,811	68,811	68,811	68,811	68,811	68,811	68,811	459,971	481,679	(21,708)	
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	137,093	86,028	137,093	86,028	86,028	86,028	86,028	86,028	86,028	86,028	86,028	86,028	86,028	86,028	86,028	86,028	86,028	86,028	86,028	86,025	86,025	86,025	86,025	653,257	602,192	51,065		
TOTAL	184,196	154,839	184,196	154,839	154,839	154,839	154,839	154,839	154,839	154,839	154,839	154,839	154,839	154,839	154,839	154,839	154,839	154,839	154,839	154,837	154,837	154,837	154,837	1,113,228	1,083,871	29,357		
Queensland Health Pathology & Scientific Services																												
Salaries	16,552	96,464	16,552	96,464	96,464	96,464	96,464	96,464	96,464	96,464	96,464	96,464	96,465	96,465	96,465	96,465	96,465	96,465	96,465	96,465	96,465	96,465	96,465	96,465	595,338	675,250	(79,912)	
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	32,300	230,974	32,300	230,974	230,974	230,974	230,974	230,974	230,974	230,974	230,974	230,974	230,975	230,975	230,975	230,975	230,975	230,975	230,975	230,975	230,975	230,975	230,975	1,418,146	1,616,820	(198,674)		
TOTAL	48,852	327,438	48,852	327,438	327,438	327,438	327,438	327,438	327,438	327,438	327,438	327,438	327,440	327,440	327,440	327,440	327,440	327,440	327,440	327,440	327,440	327,440	327,440	327,440	2,013,484	2,292,070	(278,586)	

GRAND TOTAL

PROJECTED

CUMULATIVE TOTAL TO DATE

ACTUAL

PARTICIPANTS	YEAR 1		YEAR 2		YEAR 3		YEAR 4		YEAR 5		YEAR 6		YEAR 7		TOTAL SEVEN YEARS	DIFF SEVEN YEARS
	2001/02 ACTUAL	2001/02 AGR'MT	2002/03 BUDGET	2002/03 AGR'MT	2003/04 BUDGET	2003/04 AGR'MT	2004/05 BUDGET	2004/05 AGR'MT	2005/06 BUDGET	2005/06 AGR'MT	2006/07 BUDGET	2006/07 AGR'MT	2007/08 BUDGET	2007/08 AGR'MT		

RMIT University

Salaries	72,837	108,666	108,666	108,666	108,666	108,666	108,666	108,666	108,666	108,666	108,667	108,667	108,669	724,837	760,666	(35,829)
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	144,961	146,947	146,947	146,947	146,947	146,947	146,947	146,947	146,947	146,947	146,948	146,948	146,948	1,026,645	1,028,631	(1,986)
TOTAL	217,798	255,613	255,613	255,613	255,613	255,613	255,613	255,613	255,613	255,613	255,615	255,617	255,617	1,751,482	1,789,297	(37,815)

SA Water Corporation

Salaries	8,064	0	0	0	0	0	0	0	0	0	0	0	0	8,064	0	8,064
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	233,007	230,000	230,000	230,000	230,000	230,000	230,000	230,000	230,000	230,000	230,000	230,000	230,000	1,613,007	1,610,000	3,007
TOTAL	241,071	230,000	230,000	230,000	230,000	230,000	230,000	230,000	230,000	230,000	230,000	230,000	230,000	1,621,071	1,610,000	11,071

South East Water Ltd

Salaries	17,979	20,116	20,116	22,303	21,549	21,549	22,303	22,303	23,084	23,084	23,891	24,727	24,727	154,353	156,490	(2,137)
Capital	0	25,000	25,000	0	0	0	0	0	0	0	0	0	0	25,000	50,000	(25,000)
Other	65,731	24,585	24,585	27,258	26,336	26,336	27,258	27,258	28,212	28,212	29,200	30,222	30,222	232,405	191,259	41,146
TOTAL	83,710	69,701	69,701	49,561	47,885	47,885	49,561	49,561	51,296	51,296	53,091	54,949	54,949	411,758	397,749	14,009

Sydney Catchment Authority

Salaries	57,151	107,653	107,653	107,653	107,653	107,653	107,653	107,653	107,653	107,653	107,653	107,653	107,653	703,069	753,571	(50,502)
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	486,147	145,847	145,847	145,847	145,847	145,847	145,847	145,847	145,847	145,847	145,847	145,847	145,847	1,361,229	1,020,929	340,300
TOTAL	543,298	253,500	253,500	253,500	253,500	253,500	253,500	253,500	253,500	253,500	253,500	253,500	253,500	2,064,298	1,774,500	289,798

Sydney Water Corporation

Salaries	312,530	288,867	288,867	192,290	192,290	192,290	192,290	192,290	192,290	192,290	192,290	192,291	192,291	1,532,738	1,509,075	23,663
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	597,465	365,804	365,804	243,505	243,505	243,505	243,505	243,505	243,505	243,505	243,505	243,505	243,505	2,142,664	1,911,003	231,661
TOTAL	909,995	654,671	654,671	435,795	435,795	435,795	435,795	435,795	435,795	435,795	435,795	435,796	435,796	3,675,402	3,420,078	255,324

PARTICIPANTS	ACTUAL		PROJECTED										GRAND TOTAL				
	YEAR 1		YEAR 2		YEAR 3		YEAR 4		YEAR 5		YEAR 6		YEAR 7		TOTAL SEVEN YEARS	DIFF SEVEN YEARS	
	2001/02	2001/02	2002/03	2002/03	2003/04	2003/04	2004/05	2004/05	2005/06	2005/06	2006/07	2006/07	2007/08	2007/08			
ACTUAL	AGR/MT	BUDGET	AGR/MT	BUDGET	AGR/MT	BUDGET	AGR/MT	BUDGET	AGR/MT	BUDGET	AGR/MT	BUDGET	AGR/MT	BUDGET	AGR/MT	AGR/MT	
Salaries	25,779	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25,779	0
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	77,225	0	0	0	0	0	0	0	0	0	0	0	0	0	0	77,225	0
TOTAL	103,004	0	0	0	0	0	0	0	0	0	0	0	0	0	0	103,004	0

Water Corporation (WA)

Water Services Association of Australia

Salaries	8,260	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8,260	0
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	2,432	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2,432	0
TOTAL	10,692	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10,692	0

Yarra Valley Water

Salaries	5,917	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5,917	0
Capital	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	18,792	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18,792	0
TOTAL	24,709	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24,709	0

TOTAL IN - KIND CONTRIBUTIONS

Salaries	2,170,017	2,832,762	2,170,017	2,832,762	2,745,131	2,745,131	2,749,911	2,749,911	2,751,881	2,754,002	2,754,002	2,755,845	2,755,845	18,731,659	19,394,404	(662,745)
Capital	0	25,000	25,000	25,000	0	0	0	0	0	0	0	0	0	25,000	50,000	(25,000)
Other	5,260,202	4,186,594	4,151,320	4,151,320	4,076,331	4,076,331	4,082,764	4,082,764	4,085,236	4,087,907	4,087,907	4,090,208	4,090,208	29,833,968	28,760,360	1,073,608
GRAND TOTAL (IN KIND) (T1)	7,430,219	7,044,356	6,981,192	6,981,192	6,821,462	6,821,462	6,832,675	6,832,675	6,837,117	6,841,909	6,841,909	6,846,053	6,846,053	48,590,627	48,204,764	385,863

Basis of Valuation

- Salaries have been valued at actual cost based on time spent on relevant activities.
- Partners contributions have been valued separately for each participant organisation utilising the multiplier shown in the Commonwealth Agreement. For partners without a derived multiplier, the average multiplier for the CRCWQT was applied.

TABLE 2. CASH CONTRIBUTIONS

PARTICIPANTS	ACTUAL		PROJECTED										GRAND TOTAL			
	YEAR 1		YEAR 2		YEAR 3		YEAR 4		YEAR 5		YEAR 6		YEAR 7		TOTAL	DIFF
	2001/02	2001/02	2002/03	2002/03	2003/04	2003/04	2004/05	2004/05	2005/06	2005/06	2006/07	2006/07	2007/08	2007/08	SEVEN YEARS	SEVEN YEARS
	ACTUAL	AGR/MT	BUDGET	AGR/MT	BUDGET	AGR/MT	BUDGET	AGR/MT	BUDGET	AGR/MT	BUDGET	AGR/MT	BUDGET	AGR/MT	SEVEN YEARS	SEVEN YEARS
ACTEW Corporation Ltd	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	350,000	0
Australian Water Quality Centre	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	140,000	0
Australian Water Services Pty Ltd	63,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000	441,000	0
Brisbane City Council	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	350,000	0
CSIRO - Molecular Science	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	105,000	0
Curtin University of Technology	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	350,000	0
Department of Human Service (Vic)	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	700,000	0
Environmental Protection Agency (Qld)	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	700,000	0
Egis Consulting Australia Pty Ltd	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Griffith University	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	280,000	0
Melbourne Water Corporation	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	350,000	0
Monash University	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	60,000	420,000	0
Orica Australia Pty Ltd	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	350,000	0
Power & Water Authority (NT)	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	350,000	0
Queensland Health Pathology & Scientific Services	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RMIT University	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	15,000	105,000	0
SA Water Corporation	400,000	400,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	250,000	1,900,000	0
South East Water Ltd	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	350,000	0
Sydney Catchment Authority	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	1,400,000	0
Sydney Water Corporation	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	1,050,000	0
Townsville Thuringowa Water Supply Board	50,000	50,000	0	0	0	0	0	0	0	0	0	0	0	0	50,000	0
United Water International Pty Ltd	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	700,000	0
University of Adelaide	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	30,000	210,000	0
University of New South Wales	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	700,000	0
University of Qld	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	350,000	0
University of South Australia	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	350,000	0
Water Corporation (WA)	175,000	175,000	175,000	175,000	175,000	175,000	175,000	175,000	175,000	175,000	175,000	175,000	175,000	175,000	1,225,000	0
Water Services Association of Australia	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	110,000	770,000	0
Yarra Valley Water Ltd	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	350,000	0
TOTAL CASH FROM PARTICIPANTS	2,228,000	2,228,000	2,028,000	2,028,000	2,028,000	2,028,000	2,028,000	2,028,000	2,028,000	2,028,000	2,028,000	2,028,000	2,028,000	2,028,000	14,396,000	0

TABLE 2. CASH CONTRIBUTIONS (CONT.)

PARTICIPANTS	ACTUAL		PROJECTED														GRAND TOTAL	
	YEAR 1	YEAR 1	YEAR 2 - YEAR 7														TOTAL	DIFF
	2001/02	2001/02	2002/03	2003/04	2003/04	2004/05	2004/05	2005/06	2005/06	2006/07	2006/07	2007/08	2007/08	2007/08	2007/08	SEVEN	SEVEN	
ACTUAL	AGRM'T	BUDGET	AGRM'T	BUDGET	AGRM'T	BUDGET	AGRM'T	BUDGET	AGRM'T	BUDGET	AGRM'T	BUDGET	AGRM'T	BUDGET	AGRM'T	SEVEN	SEVEN	
ACTUAL	AGRM'T	BUDGET	AGRM'T	BUDGET	AGRM'T	BUDGET	AGRM'T	BUDGET	AGRM'T	BUDGET	AGRM'T	BUDGET	AGRM'T	BUDGET	AGRM'T	YEARS	YEARS	
OTHER CASH																		
Participants (Note 1)	105,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	105,000	0	
Associates	90,000	90,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	100,000	690,000	690,000	0	
Interest	105,242	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	405,242	350,000	55,242	
Sundry income	430	0	0	0	0	0	0	0	0	0	0	0	0	0	430	0	430	
Contract Research (Note 2)	113,782	0	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	400,000	2,513,782	2,400,000	113,782	
TOTAL OTHER CASH	414,454	140,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000	550,000	3,714,454	3,440,000	274,454	
FUNDING FROM THE CRC GRANT	1,906,000	1,906,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	2,500,000	16,750,000	16,750,000	0	
TOTAL CASH CONTRIBUTION - CRC (T2)	4,548,454	4,274,000	5,078,000	5,078,000	5,078,000	5,078,000	5,078,000	5,078,000	5,078,000	5,078,000	5,078,000	5,078,000	5,078,000	5,078,000	34,860,454	34,586,000	274,454	
Cash carried over from previous year	1,436,122	0	1,393,716	468,000	1,351,716	384,000	1,267,716	342,000	1,225,716	300,000	1,183,716	258,000	1,436,122	0	1,436,122	0	1,436,122	
LESS Unspent Balance	1,393,716	468,000	1,351,716	426,000	1,309,716	384,000	1,267,716	300,000	1,183,716	258,000	985,716	60,000	985,716	60,000	985,716	60,000	925,716	
TOTAL CRC CASH EXPENDITURE (T3)	4,590,860	3,806,000	5,120,000	5,120,000	5,120,000	5,120,000	5,120,000	5,120,000	5,120,000	5,120,000	5,120,000	5,120,000	5,120,000	5,120,000	35,310,860	34,526,000	784,860	
ALLOCATION OF CASH EXPENDITURE BETWEEN HEADS OF EXPENDITURE																		
Salaries	2,854,782	2,093,300	2,573,500	2,573,500	2,573,500	2,573,500	2,573,500	2,573,500	2,573,500	2,573,500	2,573,500	2,573,500	2,573,500	2,573,500	18,295,782	17,534,300	761,482	
Capital	16,350	0	0	0	0	0	0	0	0	0	0	0	0	0	16,350	0	16,350	
Other	1,719,728	1,712,700	2,546,500	2,546,500	2,546,500	2,546,500	2,546,500	2,546,500	2,546,500	2,546,500	2,546,500	2,546,500	2,546,500	2,546,500	16,998,728	16,991,700	7,028	

Note 1 : Year 1 : Melbourne Water \$50,000, Water Services \$50,000, Power & Water (NT) \$5,000

Note 2 : Year 1 : Funds contributed by ARMAHNZ (\$40,000) and AWWARF (\$73,782)

TABLE 3. SUMMARY OF RESOURCES APPLIED TO ACTIVITIES

PARTICIPANTS	ACTUAL		PROJECTED														GRAND TOTAL	
	CUMULATIVE TOTAL		TO DATE														TOTAL	DIFF
	YEAR 1 2001/02 ACTUAL	YEAR 1 2001/02 AGR/MT	YEAR 2 2002/03 BUDGET	YEAR 2 2002/03 AGR/MT	YEAR 3 2003/04 BUDGET	YEAR 3 2003/04 AGR/MT	YEAR 4 2004/05 BUDGET	YEAR 4 2004/05 AGR/MT	YEAR 5 2005/06 BUDGET	YEAR 5 2005/06 AGR/MT	YEAR 6 2006/07 BUDGET	YEAR 6 2006/07 AGR/MT	YEAR 7 2007/08 BUDGET	YEAR 7 2007/08 AGR/MT	SEVEN YEARS	SEVEN YEARS		
GRAND TOTAL (IN KIND) from TABLE 1 (T1)	7,430,219	7,044,356	7,430,219	7,044,356	6,821,462	6,821,462	6,832,675	6,832,675	6,837,117	6,837,117	6,841,909	6,841,909	6,846,053	6,846,053	48,590,627	48,204,764	385,863	
GRAND TOTAL (CASH) from TABLE 2 (T3)	4,590,860	3,806,000	4,590,860	3,806,000	5,120,000	5,120,000	5,120,000	5,120,000	5,120,000	5,120,000	5,120,000	5,120,000	5,120,000	5,120,000	35,310,860	34,526,000	784,860	
TOTAL RESOURCES AVAILABLE TO CRC	12,021,079	10,850,356	12,021,079	10,850,356	11,941,462	11,941,462	11,952,675	11,952,675	11,957,117	11,957,117	11,961,909	11,961,909	11,966,053	11,966,053	83,901,487	82,730,764	1,170,723	
ALLOCATION OF TOTAL RESOURCES APPLIED TO ACTIVITIES OF CENTRE BETWEEN HEADS OF EXPENDITURE																		
TOTAL SALARIES (CASH AND IN - KIND)	5,024,799	4,926,062	5,024,799	4,926,062	5,378,372	5,378,372	5,318,631	5,318,631	5,323,411	5,323,411	5,325,381	5,325,381	5,327,502	5,327,502	37,027,441	36,928,704	98,737	
TOTAL CAPITAL (CASH AND IN - KIND)	16,350	25,000	16,350	25,000	0	0	0	0	0	0	0	0	0	0	41,350	50,000	(8,650)	
TOTAL OTHER (CASH AND IN - KIND)	6,979,930	5,899,294	6,979,930	5,899,294	6,622,831	6,622,831	6,629,264	6,629,264	6,631,736	6,631,736	6,634,407	6,634,407	6,636,708	6,636,708	46,832,696	45,752,060	1,080,636	
TOTAL ALLOCATION	12,021,079	10,850,356	12,021,079	10,850,356	11,941,462	11,941,462	11,952,675	11,952,675	11,957,117	11,957,117	11,961,909	11,961,909	11,966,053	11,966,053	83,901,487	82,730,764	1,170,723	

TABLE 4. ALLOCATION OF RESOURCES BETWEEN CATEGORIES OF ACTIVITIES

PROGRAM	RESOURCE USAGE		
	\$ Cash (1)	\$ In - kind	Staff Funded by CRC (2)
Research	3,045,784	5,777,622	18.7
Education	303,901	297,222	1.1
Commercialisation	-	11,778	0.2
Administration	996,927	892,647	2.1
Communications	244,248	450,950	0.4
TOTAL	4,590,860	7,430,219	22.4

(1) Cash from all sources, including CRC program.

(2) Person years, professional and support staff.

(3) Table 4 is unaudited.

Auditor's Report



AUDITOR'S REPORT TO THE COOPERATIVE RESEARCH CENTRES PROGRAM, DEPARTMENT OF EDUCATION, SCIENCE AND TRAINING REPRESENTING THE COMMONWEALTH IN RESPECT OF THE COOPERATIVE RESEARCH CENTRE FOR WATER QUALITY AND TREATMENT

FINANCIAL INFORMATION FOR THE YEAR ENDED 30 JUNE 2002

Scope

We have audited the financial information of the Cooperative Research Centre for Water Quality and Treatment ("the CRC") as set out in Tables 1, 2 and 3 of the Annual Report (being the tables showing in-kind and cash contributions for each party to the CRC and cash expenditure) for the year ended 30 June 2002. The parties to the Cooperative Research Centre are responsible for the preparation and presentation of the financial information. We have conducted an independent audit of the financial information in order to express an opinion on it to the parties to the CRC.

The financial information has been prepared for the parties to the CRC for the purposes of fulfilling their annual reporting obligations under clause 14(l)(f) 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 report or on financial information to which it relates to any person other than those mentioned above, or for any purpose other than that for which it was prepared.

Our audit has been conducted in accordance with Australian Auditing Standards to provide reasonable assurance as to whether the financial information is free of material misstatement. Our procedures include examination, on a test basis, of evidence supporting the amounts and other disclosures in the financial information, and the evaluation of accounting policies and significant accounting estimates. These procedures have been undertaken to form an opinion as to whether, in all material respects, the financial information is presented fairly in accordance with Australian accounting concepts and standards and requirements of the Commonwealth Agreement in terms of clauses 4 (Contributions), 5(1), 5(2), 5(3) (Application of the Grant and Contributions), 9(1), 9(5) (Intellectual Property) and 12(2) (Financial Provisions), so as to present a view of the sources of funding and the application of funding of the CRC and the application of which is consistent with our understanding of its financial activities during the year and its financial position.

While we have not performed any audit procedures upon the estimates for the next period and do not express any opinion thereon, we ascertained that they have been formally approved by the Board of Directors as required by the Joint Venture Agreement.

The audit opinion expressed in this report has been formed on the above basis.

Audit opinion

1. The multipliers adopted by the Centre to value in-kind contributions other than salary costs have a sound and

reasonable basis and each partner's component of the Researcher's Contributions for the year under report has been provided at least to the value for that year committed in the Budget as specified in the Agreement, with the following exceptions:

Organisation	Amount Committed \$	Amount Provided \$
Brisbane City Council	110,000	94,838
Curtin University of Technology	451,243	172,142
Department of Human Services (Vie)	130,000	117,298
EGIS Consulting Australia Pty Ltd	99,572	96,241
Environmental Protection Agency (Qld)	164,009	102,400
Griffith University	267,202	44,522
Melbourne Water Corporation	283,552	72,776
Orica Australia Pty Ltd	95,743	72,936
Queensland Health Pathology & Scientific Services	327,439	48,852
RMIT University	270,614	232,798
United Water International Pty Ltd	121,456	120,538
University of Queensland	705,537	521,399
University of South Australia	450,235	286,282

(Includes cash & in-kind contributions)

The total value of all Contributions for the year under report equaled or exceeded the amount of grant paid during the year (not including advances). [Clause 4]

2. The Researcher has used the Grant and the Researcher's Contributions for the Activities of the CRC and in my professional opinion there appear to be no material reporting irregularities. [Clause 5(1)]
3. The researcher's allocations of the budgetary resources between the Heads of Expenditure is higher or lower than the allocation in the budget by \$100,000 or 20% (whichever is the greater amount) without prior approval by the Commonwealth. [Clause 5(2)] The variation in relation to the Capital and Other Expenditure is as follows:

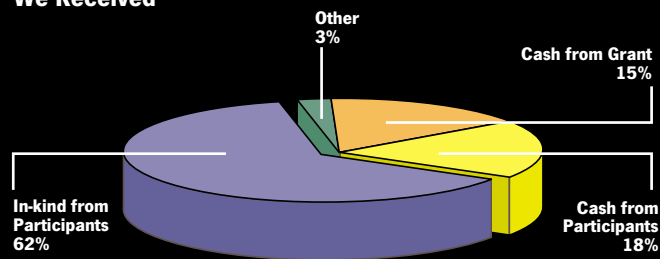
Heads of Expenditure	Actual \$	Budget \$	Variance \$	Variance %
Capital	16,350	25,000	8,650	(53.0)
Other	6,979,930	5,899,295	1,080,635	15.0

4. Capital Items acquired from the Grant and Researcher's Contributions are vested as provided in the Joint Venture Agreement. [Clause 5(3)]

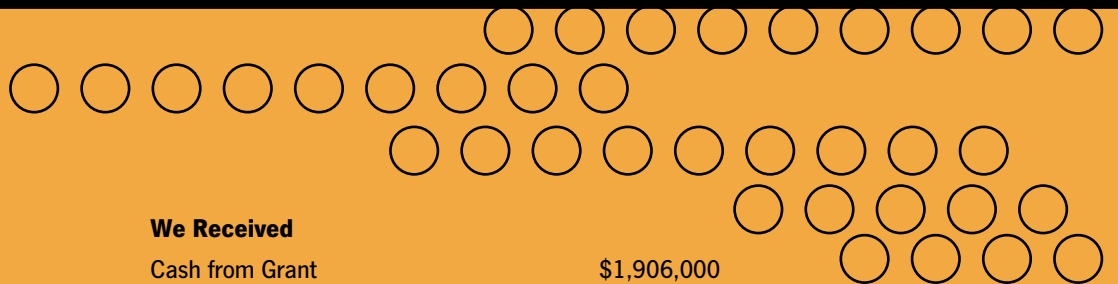
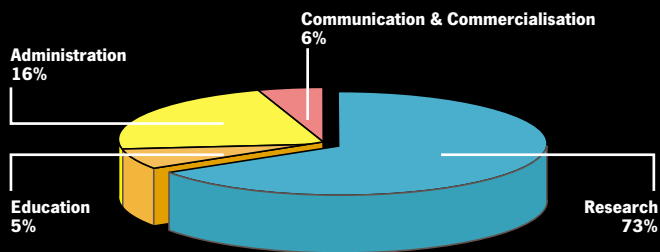
Ernst & Young

Colin Dunsford
Partner
Adelaide
23/8/2002

We Received



We Expended



We Received

Cash from Grant	\$1,906,000
Cash from Participants	\$2,228,000
In-Kind from Participants	\$7,430,219
Other Income	\$414,454
Total	\$11,978,673

We Expended

Research	\$8,823,406
Education	\$601,123
Administration	\$1,889,574
Communication & Commercialisation	\$706,976
Total	\$12,021,079

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 E-mail: crc@sawater.com.au
 Web: www.waterquality.crc.org.au

**The Cooperative Research Centre for Water Quality and Treatment
 is an unincorporated joint venture between:**

ACTEW Corporation
Australian Water Quality Centre
Australian Water Services Pty Ltd
Brisbane City Council
CSIRO
Curtin University of Technology
Department of Human Services (Victoria)
Egis Consulting Australia Pty Ltd
Environmental Protection Agency (Queensland)
Griffith University
Melbourne Water Corporation
Monash University
Orica Australia Pty Ltd
Power & Water Authority
Queensland Health Pathology & Scientific Services

RMIT University
South Australian Water Corporation
South East Water Ltd
Sydney Catchment Authority
Sydney Water Corporation
The University of Adelaide
The University of New South Wales
The University of Queensland
Townsville Thuringowa Water Supply Board
United Water International Pty Ltd
University of South Australia
Water Corporation
Water Services Association of Australia
Yarra Valley Water Ltd



CRC for Water Quality
 and Treatment

