NEWSLETTER OF THE COOPERATIVE RESEARCH CENTRE FOR CATCHMENT HYDROLOGY

# CATCHWORD

NO 83 MAY 2000

## A NOTE FROM THE DIRECTOR

Professor
Russell Mein

**Inside...**



## Catchment Management Inquiry

Last year, the Standing Committee on Environment and Heritage of the Australian Government's House of Representatives initiated an Inquiry into Catchment Management. Their motivation was the better management of Australia's water resources and environment, linked to the health of streams and catchments. The scope of their review was quite wide-ranging, covering the question as to whether the catchment is the most appropriate management unit, through to the institutional issues that may remain in implementation of effective catchment management. Their brief included monitoring and evaluation issues.

To a hydrologist, it seems natural to focus on 'catchments' as an appropriate scale of investigation. In flood hydrology, this has been inescapable; after all, the catchment area is one of the major factors in the generation of flood flows. In other fields of hydrology, eg. the impact of changes in vegetation on flow, approaches in the past have most often looked at small catchments, leaving unanswered the significant question of how larger areas might behave.

We have reached the point where the large amount of research on hydrologic processes (at small scales) can be used as 'building blocks' for assembling large scale catchment models. By retaining the sub-area (or element) approach, there is potential for accounting for areal variability in a realistic way. As indicated in recent issues of '*Catchword*', the CRC is taking this approach in its overall strategy to produce simulation tools (Decision Support Systems - DSS). These are aimed at catchment land and water managers who would like to evaluate various management strategies.

Given our interest in the Inquiry topic, it was natural that we should make a submission, and this was done last August. The main point made by the CRC was the need to consider and improve the links between land cover and stream water quantity/quality (ie land-use impacts on rivers).

The Committee is now conducting public hearings, and asked me along on 2 May to speak to the CRC's submission. The Panel Chair (Hon Ian Causley, MP, NP) and other Panel members showed particular interest in the potential impact of plantations and reafforestation on streamflow volume and salinity, an important question in relation to possible strategies to manage dryland salinity. While we have some indications now, this is a question that we expect to be able to answer progressively better over the next few years as our modelling progresses.

Those interested in seeing the CRC's and other submissions can do so on:

http://www.aph.gov.au/house/committee/environ/cminq/subs.htm

### CRC ANNUAL WORKSHOP

This year's workshop, held at Mount Buffalo, Victoria from 4-6 April, was the first for the new CRC. It was an important get together for the many new people (both from 'new' and 'old' Parties) who now comprise the Centre.

Particularly useful were the opportunities to present the research programs (to give attendees the full picture), and the descriptions of issues on the five focus catchments. In the session on project development, participants were split into Program teams to explore further issues and assist in the startup phases of our core projects and supporting programs. A feature of the workshop was, as in previous years, the presentations from CRC postgraduate students - a demonstration of the large contribution this group makes to the research output.

Jim Miller, the CRC Visitor, attended the workshop, and spoke very positively about the experience. He reminded us that this CRC has a good reputation, but that the competition is getting stronger each year (ie. no resting on laurels!).

One presentation (from Dan Figucio and David Perry) introduced us to the web-site. Have a look at it on www.catchment.crc.org.au; I think you'll be impressed.

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## PLEASE NOTE

**CRC REPORTS AND VIDEOS AVAILABLE FROM THE CENTRE OFFICE ARE LISTED IN OUR PUBLICATIONS LIST.**

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## EXCESS CRC PUBLICATION STOCK

**The Centre Office has excess copies of some technical reports and working documents from 1995-1997. These are available free to all *Catchword* subscribers in multiple copies. Orders will be sent by post at no cost on a first-in first-served basis.**

If you would like to order one of the reports listed below please contact:
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CRC for Catchment Hydrology
Department of Civil Engineering
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Monash University 3800
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## TECHNICAL REPORTS

### *Forest Hydrology*

95/4 Calibration of the "Moisture Point" TDR System
*by Sam Dasberg, Haralds Alkansnis, Paul Daniel, Jetse Kalma, Steve Zegelin*

### *Flood Hydrology*

96/8 Relating baseflow to catchment properties: a scaling approach
*by Geoff Lacey*

96/6 Testing of improved inputs for design flood estimation in South-Eastern Australia
*by Peter Hill, Russell Mein, Erwin Weinmann*

96/4 Derivation of areal reduction factors for design rainfalls in Victoria – for rainfall durations 18-120 hours
*by Lionel Siriwardena, Erwin Weinmann*

95/3 A review of the methods for estimating areal reduction factors for design rainfalls
*by Sri Srikanthan*

95/1 A review of scale in hydrology
*by Geoff Lacey*

94/5 Regionalisation of hydrologic data – a review
*by Bryson Bates*

94/4 Loss modelling for flood estimation – a review
*by Nanda Nandakumar, Russell Mein, Lionel Siriwardena*

94/1 Development of regional prediction equations for the RORB runoff routing model
*by Ben Dyer, Rory Nathan, Tom McMahon, Ian O'Neill*

## WORKING DOCUMENTS

### *Forest Hydrology*

95/4 User manual for the Hillflow 3-D catchment modelling system (physically based and distributed modelling of runoff generation and soil moisture dynamics for micro-catchments)
*by Alex Bronstert*

### *Waterway Management*

96/3 Lake Eppalock silt section survey report
*by Jennifer Davis (Wilson)*

### *Flood Hydrology*

97/1 Development and testing of a variable proportional loss model
*by Lionel Siriwardena, Peter Hill, Russell Mein*

96/5 Empirical analysis of data to derive losses: methodology, programs and results
*by Peter Hill, Upala Maheepala, Russell Mein*

96/4 Development and testing of methodology to derive areal reduction factors for long duration rainfalls
*by Lionel Siriwardena, Erwin Weinmann*

96/2 Comparison of two adoptive unit hydrograph: methods for real-time flood forecasting
*by Sri Srikanthan, Soori Sooriyakumaran, Jim Elliott, Peter Hill*

96/1 The scaling of baseflow
*by Geoff Lacey*

95/6 Estimation of extreme rainfalls for Victoria – application of Schaeffer's method
*by Fiona McConachy*

95/2 Development and testing of a variable proportional loss model based on 'saturation curves' (a study on eight Victorian catchments)
*by Lionel Siriwardena and Russell Mein*

PROGRAM 1
## PREDICTING CATCHMENT BEHAVIOUR

Program Leader
ROB VERTESSY

### Report by Rob Vertessy

### Comings and goings of staff in Program 1

*Project 1.1 new team members*

I am pleased to report the appointment of two new talented software engineers to the CRC group at CSIRO Land and Water in Canberra. Joel Rahman and Peter Kin were recently appointed to work in Project 1.1 (Development of the catchment modelling toolkit) with Rob Argent (Project Leader) and his team. They will work alongside Michael Reed and John Coleman, veteran CSIRO programmers already involved in this project. Having all four working together gives us an impressive mass of coding talent in Canberra.

The Project 1.1 ranks have swelled even further with the addition of two senior scientists to our team. Dr Rodger Hadgraft (Monash University) brings strong software design and data management skills to the project, and Dr Roger Braddock (Griffith University) brings a strong background in applied mathematics and environmental modelling. It is a pleasure to have both new members aboard.

*Forest Hydrology - Thanks*

Harking back to the old Forest Hydrology Program I managed in the initial CRC, I'd like to record my thanks to Yves Bessard and Dave McJannet who have recently moved on to new pastures. Yves made a very significant contribution to our spatial prediction of water yield changes associated with afforestation in the Murrumbidgee catchment. Lu Zhang is now following up his work in Project 2.3 (Development of a regional water yield model). Soon after submitting his PhD thesis on the hydrologic behaviour of 'break of slope' plantations, Dave McJannet landed a post-doctoral appointment in the Atherton lab of CSIRO Land and Water, working for the CRC for Tropical Rainforest Ecology and Management. Dave made a huge contribution to our understanding of the function of hillslope agroforestry systems and the modelling thereof. I wish Yves and Dave all the very best in their future work.

*Water quality modelling workshop in Canberra*

Project 1.1 leader Rob Argent is certainly cracking the whip in May, convening two large meetings in Canberra. The first will be held on May 10 and 11, when a group of about fifteen modellers are getting together to exchange ideas on the design of catchment water quality models. The workshop will review the substantial number of relevant models, focussing on their intended scale of application (in space and time), their coding structure and component algorithms. Rob Argent will report on the outcomes of this workshop in the next issue of *Catchword*. The second meeting takes place on May 16 and is essentially a gathering of the entire Project 1.1 team and review panel.

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## YOUNG WATER SCIENTIST OF THE YEAR

The CRC Water Forum - the 'water' CRCs (Catchment Hydrology, Coastal Zone, Freshwater Ecology, Water Quality and Treatment, Waste Management and Pollution Control) - sponsors a competition for the Young Water Scientist of the year. Each CRC selects up to two currently enrolled or recent PhD graduates to represent them. This group was reduced by an independent judging panel to one from each CRC in the preliminary round on the basis of four page submissions. The final round of the competition included a presentation, at the Enviro 2000 Conference in Sydney, on 12-13 April.

Our representatives in this competition were Dave McJannet and Mike Stewardson, with Dave being selected to participate in the final. Although we didn't win this year, we are tremendously proud of the quality of our two representatives. The word back from the judging panel is that all entries were excellent.

Congratulations to the winner, Dr Margaret Hellard, from the CRC for Water Quality and Treatment, for being selected as this year's winner. And congratulations to Dave for his fine effort in the final.

## IEAUST. SEMINAR IN MELBOURNE

**WATER REFORM: A REPORT CARD**

**by**
**John Langford**
**(Water Services Association of Australia)**
**John Whittington**
**(CRC for Freshwater Ecology)**
**Freya Merrick**
**(Environment Victoria)**

**Presented by**
**The Water Engineering Branch, IEAust**

**Thursday, June 8, 2000**
**TIME:**
**5:00 for 5:30 PM**

**IEAust Auditorium**
**(Ground Floor)**
**21 Bedford St.,**
**North Melbourne**

The process of water reform was formally initiated in 1994 by the Council of Australian Governments. Among its objectives, water reform is intended to achieve best value from available water in terms of economic and environmental returns.

In this seminar, three speakers with different perspectives on the water industry, will comment on the success of the water reform process to date and the future potential of water reform to achieve its objectives.

**Contact Mike Stewardson on (03) 8344 7733 for further details.**

## RECENT INDUSTRY SEMINAR VIDEO

**MANAGING SEDIMENT SOURCES AND MOVEMENT IN FORESTS: THE FOREST INDUSTRY AND WATER QUALITY.**

***Presented by***

**Dr Jacky Croke**
**CSIRO Land and Water**

**Dr Peter Wallbrink**
**CSIRO Land and Water**

**Mr Peter Fogarty**
**Soil and Land Conservation Consulting**

**CRC VIDEO 00/1**

This video was recorded in Melbourne last year; the first of the three seminars held in Victoria and NSW during November.

It will be of interest to anyone involved in forest and catchment management.

PROGRAM 2
## LAND-USE IMPACTS ON RIVERS

Program Leader
PETER HAIRSINE

### Report by Heather Hunter

### Nitrogen Transport in Rural Catchments

*Initial CRC salinity research*

In project 2.5: "Nitrogen and carbon movement in riparian zones", we are proposing to gain a better understanding of how riparian buffer zones function in minimising nitrogen delivery to streams. As a background to the project, this article provides a brief overview of key issues concerning nitrogen transport in rural catchments.

*Aquatic ecosystem health – nutrient loadings an issue*

In Australia there is increasing concern that land use practices may be affecting the health of downstream aquatic ecosystems as a result of water quality degradation. There may be many contributing factors but increased nutrient loadings in streams are a prime focus, particularly regarding issues such as blue-green algal blooms. To date considerable attention has been paid to phosphorus, but it is now recognised that increased nitrogen loads may also have adverse impacts on aquatic ecosystem health.

In rural catchments, agricultural areas are considered a major source of increased stream loadings of nitrogen. At present in Australia we have only limited understanding of the extent of land use impacts on nitrogen delivery to streams and the key processes of nitrogen transport. Increased knowledge is required of the major issues involved so we can identify management options for reducing stream loadings. Concepts and strategies developed for the northern hemisphere (eg. north America and the UK) in many cases may be inappropriate for Australian conditions, due to major differences in climate, geology, flow regimes and farming systems.

*Defining land use impacts*

It is often extremely difficult to define land use impacts on water quality, because of the complexities of factors and interactions that occur at a large catchment scale. Simple analysis of monitoring data is generally inadequate and we need to rely on numerical models to help identify specific land use effects. Although errors associated with present catchment-scale water quality models can be very large (particularly for nitrogen) and data requirements extensive, models provide a powerful tool for analysing large data sets to draw out conclusions that otherwise would not be possible.

For nitrogen, a consistent feature that has been noted both in Australia and overseas is a trend for increasing nitrate concentrations to occur in catchment streams with increasing levels of development. This is likely to have important implications for aquatic ecosystem health since nitrate is a readily bio-available form of nitrogen.

*Nitrogen transformation and transport*

Nitrogen presents some unique challenges (and opportunities) because it exists in several different forms and has a tendency to readily undergo transformations from one form to another. For example, under certain conditions nitrate can be converted to nitrogen gas by the process of denitrification. Many nitrogen transformations are microbial processes that also involve organic carbon.

Past studies have shown that a high proportion of the total loads of nutrients and sediment are transported to streams during major runoff events. Typically, much of the nitrogen transported in these events is associated with the sediment load, although there can also be considerable amounts of dissolved nitrogen, eg. nitrate. Nitrate transport to streams may also involve slower sub-surface flow paths. At present we lack sufficient understanding of the processes of nitrogen transformation and transport, particularly at hill-slope and catchment scales, to allow us to develop predictive capabilities for assessing management alternatives.

*Management options – best practice guidelines*

The National Water Quality Management Strategy provides guidelines for water quality management in rural catchments, based on an integrated, stakeholder-lead approach to natural resource management. The development and adoption of best management practices by rural industries are key elements of the strategy.

*Off-site impacts*

For many farming systems, the economic costs of off-site losses of nitrogen are relatively minor compared with the overall costs of the farming enterprise. In such cases there may be little incentive for farmers to reduce nitrogen losses from a purely economic point of view. This represents a major challenge in terms of gaining widespread adoption of more ecologically sustainable farming systems.

Management practices with the potential to help minimise off-farm movement of nitrogen include those aimed at improving the efficiency of fertiliser use, reducing soil erosion, increasing soil organic matter and maintaining vegetative buffers along farm drainage lines. However,

even with the adoption of best management practices it is almost inevitable that some inefficiency of nitrogen use will occur and result in movement of nitrate.

*Effectiveness of riparian zones for controlling nitrate – a research challenge*

Once mobilised, the best opportunities for arresting nitrate delivery to streams lie in having appropriate riparian buffer zones and wetlands in place to foster denitrification and plant uptake. Defining the effectiveness of riparian zones in reducing nitrate loads has been a priority research topic in north America and Europe over the last 10-20 years but to date little research has been carried out in Australia.

We propose to address this knowledge gap in Project 2.5, a multi-disciplinary investigation of nitrogen and carbon dynamics in riparian zones currently being developed by the Centre in collaboration with the CRC for Freshwater Ecology and the CRC for Coastal Zone, Estuary and Waterway Management. Major objectives are to identify key factors influencing nitrogen and carbon transport and transformations in riparian buffer zones and to determine optimum riparian zone characteristics for reducing nitrate delivery to streams.

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## STREAM RESTORATION MANUAL

The joint CRC for Catchment Hydrology and LWRRDC publication 'A Rehabilitation Manual for Australian Streams. Volumes One and Two.' are now available in hard copy from the Agriculture, Fisheries and Forestry - Australia (AFFA) Shopfront, ph 1800 020 157, or fax your order to the Shopfront on (02) 6272 5771. The two volume set costs $25 plus $10 postage in Australia.

PROGRAM 3
SUSTAINABLE WATER ALLOCATION

Program Leader:
JOHN TISDELL

### Report by John Tisdell

**Overview of the Water (Allocation and Management) Bill in Queensland– The institutional driver of trade**

*New Water Acts – NSW and Qld*

In the April 2000 *Catchword* various drivers of socioeconomic processes operating in a catchment were outlined. One of those drivers involves the institutional structure of water management and the legislation governing the use and management of water. Institutional drivers of water management and trade are founded in the laws governing the use of water. The NSW and Queensland state governments are currently developing new legislation and in the process broadening the agenda of water management from one that dealt largely with hydrological issues to one encompassing the needs of communities and the environment. The stated basis of both proposed Water Acts would follow the COAG reforms as part of a national obligation. This article outlines the main features of the proposed Water law reform in Queensland.

*Qld Water Reform*

The Queensland Water Reform Unit of the Department of Natural Resources (1999) stated that the current Queensland Water Resources Act (1989) does not provide consideration of ecologically sustainable practices in the allocation of water or the cumulative effect of water allocation. The Act also ties water allocations to land and works. In response, the Unit has drafted the Water (Allocation and Management) Bill. The Bill focuses on water allocation rather than development and requires water resource planning at a basin-wide level, taking into account non-consumptive as well as consumptive use of water. The Bill proposes a two stage planning process for the management of water resulting in a water resource plan and a water operations plan. Water allocation can only occur once the water resource and resource operations plans are completed and approved by the Governor in Council.

## NEW CRC WEBSITE

**THE NEW CRC WEBSITE IS NOW ONLINE**

**The site contains many new features including updated information about the new CRC Research Programs as well as final reports from our first seven years of research.**

**VISIT US AT**
**www.catchment.crc.org.au**

# RECENT INDUSTRY REPORT

## THE REUSE POTENTIAL OF URBAN STORMWATER AND WASTEWATER

by

**Grace Mitchell**
**Russell Mein**
**Tom McMahon**

**Report No. 99/14**

This report deals with the feasibility of reusing storm-water and wastewater to reduce the demand on the potable water supplies in Australian cities. It also describe 'Aquacycle' - a model developed by the CRC to assist in this process.

**Copies available for $25 from the Centre Office.**

**Please contact Virginia Verrelli on tel 03 9905 2704 or email virginia.verrelli@eng.monash.edu.au.**

*Water resource plan*

*The water resource plan will bring together:*

- water management plans for sensitive areas
- existing non-statutory water allocation and management (WAMP) processes
- the declaration of sub-artesian areas into a whole-of-catchment management plan.

The plan will specify environmental and water entitlement security objectives and performance indicators, compliance and monitoring requirements, and priorities for the development of resource operations plans.

*Resource operations plans*

The resource operations plans (ROP) will deal with water management at particular locations. The plan will outline, among other things, plans for infrastructure operations, details of existing water users and how existing entitlements will be converted, environmental management monitoring and rules, water sharing rules and water allocation trading rules (including interstate transfers). Once a plan is approved, a resource operations licence (ROL) will be issued to the infrastructure operator

A resource operations licensee can issue water licenses in a regulated system. The water license will be unbundled into a water supply contract and a water allocation. The water supply contract will be held by the owner (or occupier) of a particular parcel land for the taking of water and will not be tradeable. The water allocation will specify the annual volume of water that can be extracted, the location of extraction and the use of the water. Different levels of resource reliability will be available. The water allocation will become the main tradeable chattel in water markets in Queensland.

*Separation of water allocations from water supply*

The separation of water allocations from water supply contracts breaks the nexus between land and water and allows trade in and ownership of water entitlements independent of land ownership. Under the new Act conditions of transfer will be established within each area according to its resource operations plan. Provided the transfer meets that plan the transfer must be approved without further consideration.

*Need for water trading framework*

While the Bill outlines a number of reforms in regard to promoting trade by unbundling water entitlements from licenses, it does not provide a state-wide framework for water trading. The proposed Bill, through resource operations plans, develops trading rules and procedures at a catchment or sub-catchment level. Such localised rules and procedures are necessary to deal with local issues. However, concerns have been expressed that without State-wide principles there may well be between-catchment and between-sub-catchment inconsistencies which may discourage trade. It has been suggested that State-wide principles, could address such issues as the cumulative environmental and social impacts of water trades.

*Ecologically sustainable development aspects*

The stated basis of the Bill is to achieve ecologically sustainable development (ESD). The principles underlying ESD are wide ranging and include effective integration of "...long-term and short-term economic, environmental, social and equitable conditions[1]". In the preparation of such plans the Minister may "establish a framework for managing water entitlements in a way that balances water for existing and future consumptive needs with water for the needs of aquatic ecosystems" (S.32(2)(b)). There are also concerns that the use of the word "may" rather than some stronger directive throughout does not appear to bind the Minister to consider the environment in the management of water. While the Bill does not prohibit the achievement of ESD principles it does not appear to ensure them either.

Overall, the Bill will establish a new regime of water use rights and promote trade by separating the ownership of water entitlement from land. Submissions on the proposed Bill are currently being considered and where appropriate, modifications to the Bill are being made. Project 3.2 will review the final Act once it passes though the House and its operation over the next three years of the project.

*References*

Department of Natural Resources (1999). *Water (Allocation and Management) Bill Exposure Draft Bill and Explanatory Material*. Queensland Water Reform Unit, Queensland Government.

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[1]See Water (Allocation and Management) Bill, S.5b.

PROGRAM 4
URBAN STORMWATER QUALITY

Program Leader
TONY WONG

## Report by Hugh Duncan

### Contaminant movement in the Yarra River catchment

*Study objective*

The objective of this study is to identify the sources and destinations of waterborne contaminants in the vicinity of a large urban area, and to calculate as far as possible the movement of contaminants through the area. The study commenced under Project U2 (Pollutant Sources, Movement, and Modelling in Urban Areas). Analysis is now complete, and a full report will be available from the CRC later this year.

*Study approach*

Contaminant movement is very sensitive to local conditions and layout of infrastructure, so a generic solution equally applicable to a wide range of urban areas was not attempted. The approach adopted was to select a small number of representative catchments covering a range of land uses, and to use data actually measured on the selected catchments as far as possible. Four representative catchments have been selected, all on the mainstream or tributaries of the Yarra River, which flows through the city of Melbourne (*Figure 1*). They are the Yarra above Warrandyte (5% urban), the Yarra below Warrandyte (39% urban), Gardiners Creek (100% urban), and the full Yarra catchment upstream of its confluence with the Maribyrnong River (20% urban).

*Contaminant flow paths*

There are two principal contaminant flow paths through a catchment – the modified natural pathway comprising emissions to air, atmospheric deposition, gross pollutants, and washoff to watercourses, and the wholly artificial pathway comprising reticulated water supply, sewage inputs from properties, and piped sewage, which returns to waterways either before treatment (combined system) or after treatment (separate system). Until their final convergence, contaminant movement between the two pathways is very much less than the movement within each pathway.

*Data on contaminant movement*

Contaminant movement information was obtained at each of the stages listed above, and for sewage overflows and effluent exports, from data published by Melbourne Water and the Victorian EPA, and from an extensive literature review. Sufficient information was obtained for ten water quality parameters – suspended solids, total phosphorus, total nitrogen, lead, zinc, copper, cadmium, chromium, mercury, and nickel.

*Results*

The results are presented in a series of stylised contaminant movement diagrams, for each contaminant and each representative catchment. The examples included here show suspended solids (*Figure 2*), total phosphorus (*Figure 3*), and total nitrogen (*Figure 4*), for the fully urbanised Gardiners Creek catchment. The diagrams do not represent a complete mass balance because some contaminant stores have not been measured (e.g. buildup on pervious areas, sediments in river channels). Hence each contaminant movement diagram should be viewed as a collection of snapshots, taken at the points where measurements have been made, rather than as a complete contaminant mass balance.

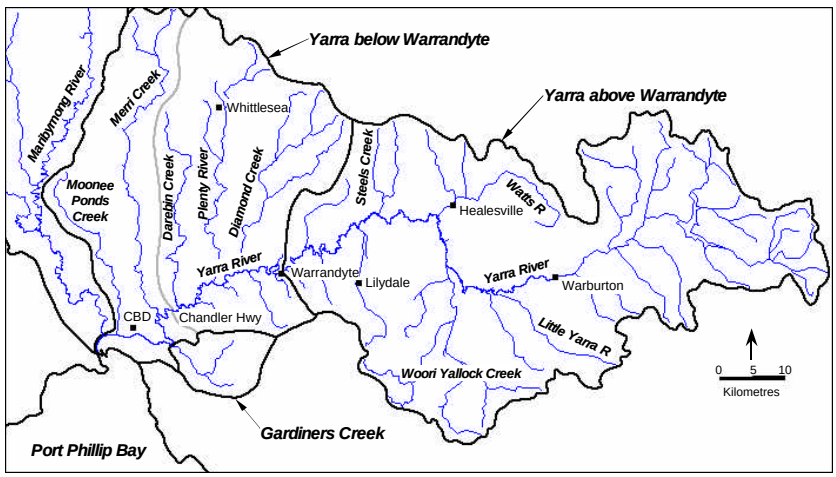


*Figure 1. Selected Catchments*

# TECHNICAL REPORT FOR STORMWATER MANAGERS

## EFFECTIVENESS OF STREET SWEEPING FOR STORMWATER POLLUTION CONTROL

by
Tracey Walker
Tony Wong

**Report 99/8**

This report investigates the effectiveness of street sweeping as a stormwater pollution source control measure. It describes a scoping study to assess the efficiency of Australian street sweeping practices in the removal of pollutants from street surfaces.

Copies of this report are available from the Centre Office for $25.

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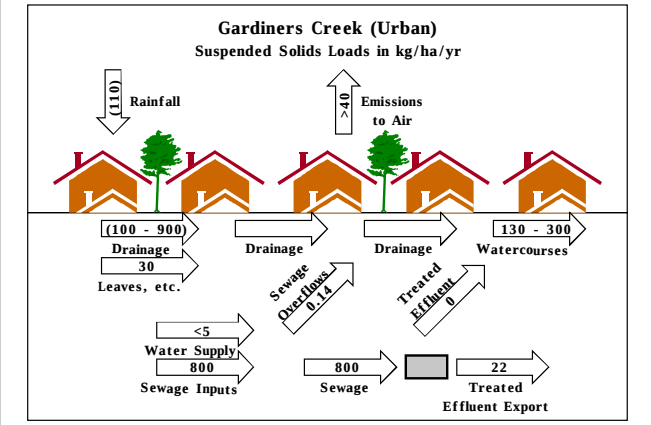


*Figure 2. Gardiners Creek Suspended Solids Load*

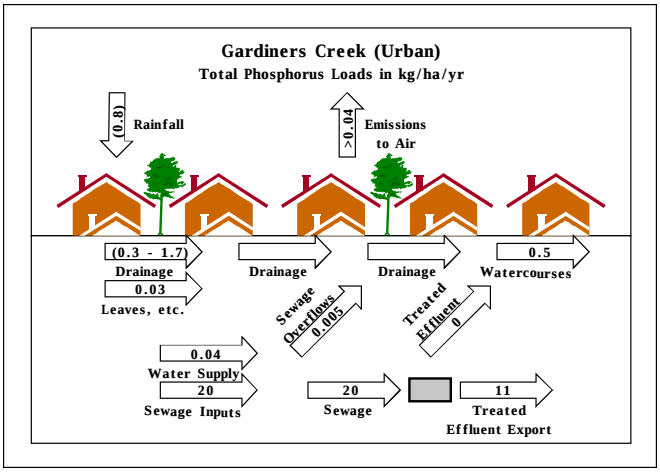


*Figure 3. Gardiners Creek Total Phosphorus Load*

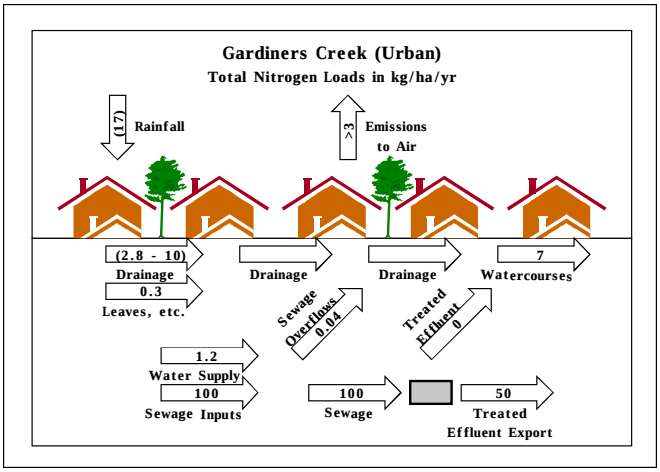


*Figure 4. Gardiners Creek Total Nitrogen Load*

*Emissions to air*

It turns out that emissions to air always form an important component of the contaminant balance. They are similar to watercourse loads for many contaminants. Lead emissions to air, however, are much larger than all measured catchment outputs. This implies either substantial storage of lead in the catchment, or removal from the catchment by unidentified pathways.

*Atmospheric deposition*

Sparse local information on atmospheric deposition was supplemented by a review of worldwide deposition studies, with interesting results. It appears that a substantial proportion of measured deposition is really 'cyclic dust', a store of material on the ground which is resuspended into the atmosphere by wind during dry periods. A sampler which effectively traps this material will overestimate the net input of new material onto the catchment from external and point sources.

*Gross pollutant aspects*

The nutrient content of leaves and other vegetative debris (gross pollutants) can approach one tenth of nutrient loads measured downstream. Only a small proportion of this can be released in the short term by leaching, but in the longer term much of the gross pollutant load will eventually reach receiving waters and their sediments.

*Sewage overflows*

Sewage overflows contribute about 3% of phosphorus and 2% of nitrogen in urbanising areas, but less than 1% elsewhere. Overflows may be locally important when they occur, but averaged over time and space their total contribution is small.

Only a small fraction of treated sewage effluent is returned to streams in the selected catchments. Even so,

treated sewage effluent supplies almost one quarter of the watercourse load of phosphorus, and almost one tenth of the nitrogen, averaged over the whole Yarra catchment.

*Local watercourses*

Local watercourse loads of suspended solids, total phosphorus, and total nitrogen are similar to worldwide figures for comparable catchments. Local watercourse loads of lead, zinc, copper, cadmium, chromium, and nickel are all well below worldwide median levels for comparable catchments.

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PROGRAM 5
CLIMATE VARIABILITY

Program Leader
TOM McMAHON

## Report by Francis Chiew

## Seasonal streamflow forecasting and management of water resource systems

*El Nino/Southern Oscillation and streamflow*

The ability to forecast streamflow months in advance can be invaluable to the management of water resource systems. This is particularly so in Australia, where the evapotranspirative demand is high and where the interannual variability of streamflow is higher than in most parts of the world.

Streamflow in Australia can be forecast with some success from the serial correlation in streamflow and from indicators of El Nino/Southern Oscillation (ENSO). Serial correlations in streamflow have long been recognised and there is a clear link between streamflow and ENSO (see *Figure 1*).

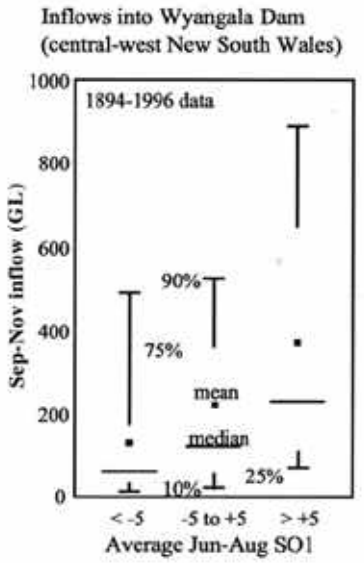


*Figure 1 Plot showing streamflow-ENSO teleconnection*

Chiew et al. (1998, 2000) discuss the teleconnection between ENSO and the Australian hydroclimate and show that the lag-correlations between streamflow and ENSO are statistically significant in many parts of Australia, particularly in spring and summer. The ENSO-streamflow correlation is stronger than the ENSO-rainfall correlation. At present, the Australian Bureau of Meteorology (like many other national meteorological agencies) publishes seasonal outlooks of rainfall and other climate variables based on ENSO indicators. These outlooks are used by

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farmers and various agencies to help manage climate variability. The Australian Rainman computer package (Clewett et al., 1994) is also a useful tool for exploring the links between Australian rainfall and ENSO. It is understood that a new Rainman computer package to be launched later this year will also include streamflow data across Australia.

*Seasonal climate forecasting*

Seasonal climate forecasts can be derived using either statistical models based on historical data, or physical models of the atmosphere-ocean-land systems. The physical models provide some good forecasts of equatorial Pacific sea surface temperature (SST) and large-scale atmospheric variables, but the routine use of such models for forecasting rainfall at a small local scale is still many years away. The climate models also do not represent the surface hydrology adequately enough for direct streamflow estimates. As part of CRC Project 5.1, CSIRO Land & Water are investigating the use of downscaling techniques to relate the large scale atmospheric variables estimated by the climate models to local scale catchment rainfall, initially for the Murrumbidgee River Basin (see Bates et al., 1998).

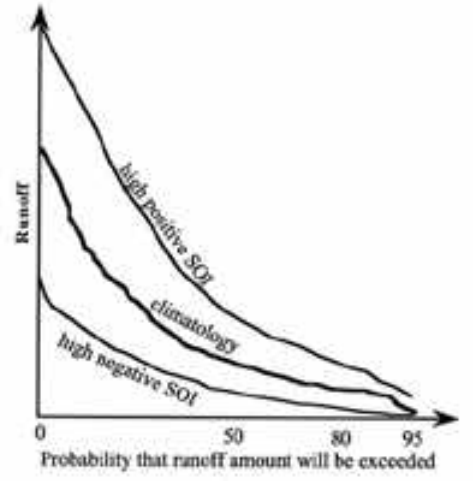


*Figure 2 An example of exceedance probability forecast of streamflow for different SOI values*

Practically all the statistical methods available today have been developed to provide categorical forecasts (e.g., high, medium and low rainfall). They range from simple methods that consider the conditional probabilities between pre-determined categories of hydroclimate and ENSO variables to sophisticated models that consider various lag-correlations and combinations of transformed variables (see Piechota et al., 1998).

*Probability of exceedance of streamflow approaches*

Although categorical forecasts are useful in many applications, including their use in water resources that are managed with very low risks, forecasts at the high end of probabilities of exceedances are required (see *Figure 2*). It is difficult to accurately forecast the low end and the high end of the probabilities of exceedances. This is because although there is a clear link between streamflow and ENSO, their correlation is not very high. As such, models that forecast continuous probabilities of exceedances of streamflow have to make some assumptions in handling the errors in the derived relationships.

The simplest method for estimating the probabilities of exceedances of streamflow is to subdivide the historical data into several categories based on the explanatory variable(s), and use the distribution of the streamflow data in the individual categories to provide a direct exceedance probability forecast. The method has an obvious limitation in that it assumes a discrete relationship between streamflow and the explanatory variables. Textbook regression methods cannot be used directly because the assumptions made in quantifying the errors to derive the regression model will invariably be violated due to the low correlation between the variables (in particular, increasing variance in the error term as the value of the dependent variable becomes larger, and the non-normal distribution of error terms due mainly to the zero bound of streamflow).

*Non-parametric method for forecasting exceedance probability of streamflow*

As part of a LWRRDC project, and in collaboration with researchers in the University of California, Los Angeles, we have developed a non-parametric method for forecasting exceedance probability of streamflow. The method uses linear discriminant analysis to empirically fit the data without making any prior assumption of the model structure (see *Figure 3* and Piechota et al. (2000)). The method has been tested on various Australian data sets, and is one of the best methods presently available to reliably forecast seasonal streamflow exceedance probabilities.

As part of CRC Project 5.1, the non-parametric method will be improved and tested on more streamflow data sets in Australia. A computer software of the method will also be produced (with Project 1.1).

*Use of seasonal streamflow forecast in water resource management*

Given the significant link between Australian streamflow and ENSO, it is likely that the use of seasonal streamflow forecasts can help improve the management of water resources systems and allow decisions on irrigation water allocation, water restriction rules and environmental flows

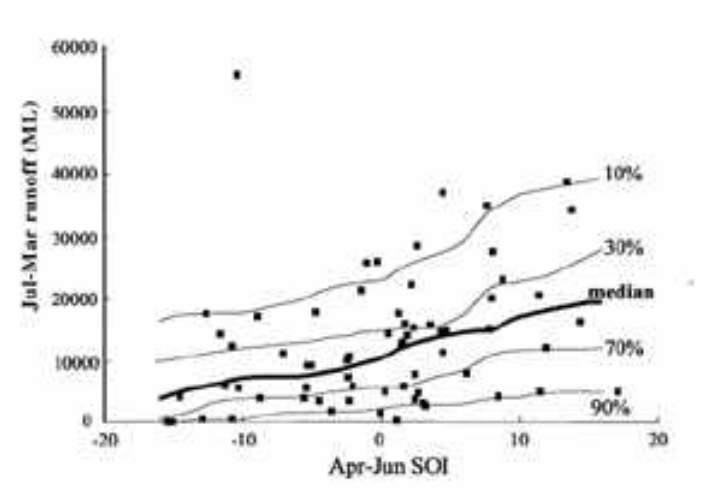


*Figure 3 A typical empirical fit derived using the non-parametric method*

to be more realistically based. Nevertheless, Australian water agencies at present take a very conservative approach in managing the water resources systems.

Several studies have clearly demonstrated the benefits of using streamflow forecasts to help manage water resources systems (see Chiew et al., 1999), and some of these studies will be described in future *Catchword* articles. As part of CRC Project 5.1, we hope to assess the benefits and risks of using seasonal streamflow forecasts in managing water resource systems in more detail. These studies will be opportunistic and will depend on the direct participation of water agencies and research in Project 3.1.

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# TECHNICAL REPORT

**GUIDELINES FOR STABILISING STREAMBANKS WITH RIPARIAN VEGETATION**

**by**
**Bruce Abernethy and Ian Rutherfurd**

**Report 99/10**

The Queensland Department of Natural Resources contracted the CRC for Catchment Hydrology to write technical guidelines to help specify the width and composition of vegetated riparian zones, for bank erosion control.

This report will guide and focus the practitioner's approach to planning riverbank stability works using vegetation.

**The report is available from the Centre Office for $25.**

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PROGRAM 6
RIVER RESTORATION

Program Leader
IAN RUTHERFURD

**Report by Rebecca Bartley**

***The dirty end of stream recovery – slug bums re-visited!***

***Case Study of the Ringarooma River***

*Sediment slugs - Background*

Sediment slugs are large pulses of sand and/or gravel that end up in waterways as a result of catchment disturbance such as erosion or mining. They have detrimental effects on our streams by reducing habitat availability, altering channel structure and reducing flood frequency. The purpose of my research is to use sediment slugs as an example of a large scale stream disturbance, and determine if the stream will recover once the disturbance is removed. Recovery in this case does not necessarily mean to its original condition, but to a state in which sediment erosion and aggradation is in equilibrium, the appropriate sediment size is present, and the appropriate geomorphic conditions are available. If the geomorphic and hydraulic conditions return, there will be a greater chance for the ecology of the river to be restored also.

*Case Study - Sediment slugs from tin mining*

The Ringarooma River, in north east Tasmania, has been disturbed by a sediment slug as a result of tin mining. An estimated total of (the answer is...!) 40 million $m^3$ of mining tailings were deposited in the river during the period between 1875-1984. There were a total of 52 mines scattered through-out the catchment. The majority of these, particularly the larger mines, deposited the overburden from the sluicing directly into the stream. Any sediment less than 5 inches (12.7 cm) was put directly into the channel and sediment greater than this was deposited on the bank. The introduced sediment was, however, dominated by sand/gravel sized sediment (1-4mm) which was considerably smaller than the natural gravel dominated (50mm) sediments of the un-slugged reaches.

*Sediment slugs movement*

The sediment slug has been progressively moving downstream blanketing the channel in the lower reaches and re-exposing the channel in the reaches upstream. A number of sections that were once totally smothered by the slug, are now returning to their former bed level ('slug-bum'), re-exposing the natural gravel bed and bedrock stream, re-creating the pool-riffle sequence and returning the natural heterogeneity indicative of the pre-disturbance condition.

*Geomorphic aspects of sediment slugs*

The objective of my visit to Tasmania was to (a) eat copious amounts of King Island Cheese (b) determine if the sediment slug has reduced the level of geomorphic variability in the stream and (c) determine if geomorphic variability is returning to the stream as the sediment moves through. To do this, we had to collect field data that would help describe the geomorphic variability at different points along the stream.

*Field data*

We collected data from ten 300 m reaches located along the river. Each reach was considered as either an impacted, recovering or control reach. In each reach we took ten cross-sectional surveys (0.5 m intervals), one thalweg (deepest thread of water) survey (2 m intervals), five sediment samples, flow readings to estimate the change in discharge and manually probed for the depth of sediment (at least 50 measurements in each reach). This data provided an estimate of the geomorphic structure of the stream at a variety of scales.

*Assessing data variability*

Techniques to assess the heterogeneity of data are now being applied to help quantify the impact and recovery process. Some of the tools being used to assess the cross-sectional and longitudinal variability include regression analysis, autocorrelation techniques and spectral analysis. The heterogeneity of the sediment is being assessed using skewness and kurtosis. The greater the variability or heterogeneity (compared to the control reaches) the greater the recovery.

*Some findings*

*Figure 1* shows the longitudinal bed level variation of three reaches along the Ringarooma. Reach 2 is a control reach containing no tailings, Reach 6 is a recovering reach at the back end of the slug, with an average sediment depth of 0.74 m and Reach 10 is downstream in the 'guts' of the slug where there is greater than 6 m of sediment in the vertical column. Assuming that thalweg variability is analogous to the health of the human heart, the reaches that contain the least sediment have a healthy (although variable) heart beat, the reaches that contain the greatest amount of sediment generally have a flat heart-rate,

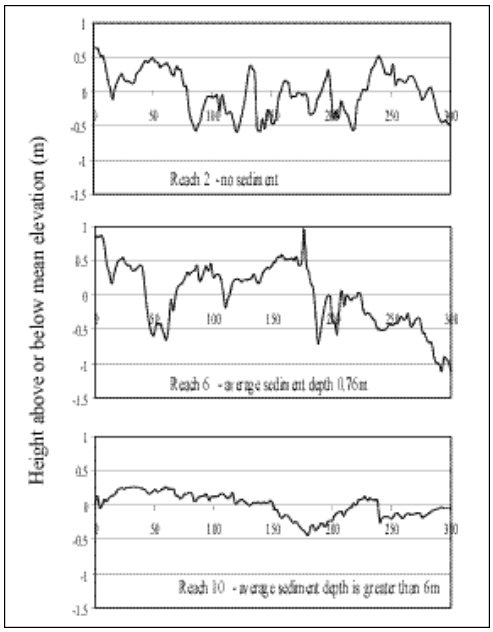


*Figure 1: Thalweg profiles for a control (Reach 2), recovering (Reach 6) and impact (Reach 10) section of the Ringarooma River. The greater the variation, the healthier the stream reach.*

indicative of a sick stream. It is important to note that Reach 6 appears to be re-creating its longitudinal variability well. Therefore, according to this measure of recovery the Ringarooma should pull through surgery!

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## COMMUNICATION AND ADOPTION PROGRAM

Program Leader
DAVID PERRY

### Report by David Perry

### The Flow on Effect – May 2000

***A site for sore eyes!***

**www.catchment.crc.org.au**

With great pride and fanfare, I can now formally announce that our new CRC website is open for browsing business. The initial CRC's web site was generally well regarded, but with the new CRC came an opportunity to review what our website should communicate to our virtual visitors. We have incorporated many of the features suggested over the last couple of years – thank you for your input.

*CRC Publications on-line*

Catchword and our Publications List have been available for downloading from our site for over a year now. The new site has a 'quick click' that takes you straight to the right page – there are quick clicks for CRC news, *Catchword*, publications, events, and models. All of our downloads can be read using Adobe Acrobat Reader. If you haven't already loaded this on your computer, it is well worthwhile. The Reader is fast becoming a software standard for reading large documents from web sites and is available free from the Adobe home page at http://www.adobe.com/products/acrobat/readstep.html The instructions are easy to follow and it doesn't take more than a few minutes. Version 4 of the reader will give the best results.

All of the CRC's publications since July 1999 are listed under the publications quick click. Each technical and industry report has a preface and abstract available and in some cases the conclusion. This gives an interested reader the opportunity to decide whether this report will be of value to them. There are also instructions on how to order our reports and you can also subscribe to *Catchword* on-line.

*What's on and when – CRC activities*

There is an event calender that is updated regularly. Details of CRC seminars, workshops, field trips and other forums are listed in a monthly format. For those early birds who would like to be notified by email of upcoming events and other activities as they are arranged, there is an event notification service. Over 300 people are currently registered. Click on the "subscribe" link, enter your name and email address and select which CRC programs are of

## NEW WORKING DOCUMENT

### DISAGGREGATION OF DAILY TO HOURLY RAINFALLS FOR FLOOD STUDIES

by
**Walter Boughton**

**Working Document 00/2**

This working document presents two models for disaggregating 9am to 9am daily rainfalls into temporal patterns of 24 hourly values. It is available from the Centre Office for $20

**Please contact Virginia Verrelli on tel 03 9905 2704 or email virginia.verrelli@eng.monash.edu.au.**

## NEW WORKING DOCUMENT

**DEVELOPMENT OF A REAL-TIME FLOOD FORECASTING MODEL**
**VOLUME 4: EVALUATION OF THE XINANJIANG-URBS MODEL**

**by**
**R. Srikanthan**
**M.H. Khan**
**P. Sooriyakumaran**
**J.F. Elliott**

**Working Document 00/1**

**This working document and the three others in this series are available from the Centre Office for $20 each.**

**Please contact**
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interest to you, then press the submit button. This sends us an email with your details, which we add to our communication database.

*Research and Researchers*

Details of the research programs from both the initial and current CRC are also on-line. The initial CRC achievements are listed by project (see the Research 1993-1999 link). In the next few weeks, detailed information on each new CRC project will be available for all CRC programs. The site also has a 'Models' page with details of CRC models, available for downloading directly from the site or from the Centre Office. Under links there are many valuable web addresses and email lists relevant to those in the land and water management industry. They are grouped in categories and have been updated over the last two months.

*Other Contacts*

The CRC Board, Executive, Program Leaders and research node contact details are available under 'Contacting the CRC' quick click. Contact details for all CRC staff are given in the CRC Phone Directory which can be downloaded from the site and read using the Adobe Reader.

*Focus Catchments*

Each of the five focus catchment coordinators have written a description and other information about their focus catchments. Details of the catchments, and contact details for the Coordinators is easily found under 'Focus Catchments'.

These are just some of the useful features of our new website.

*Thanks*

The success of the site is largely due to the determined efforts of Daniel 'grasshopper' Figucio at CSIRO Land and Water. Daniel's technical expertise and patience has created a site that provides a wide variety of information and will assist people in keeping in touch with the CRC's research progress. The site is not about to stand still either. More features will be added over the coming months as the site evolves. For example, a CRC on-line forum will be added to the site shortly. This will allow participants to post questions about the CRC's research on-line, and receive answers from a range of CRC researchers.

I recommend you have a look at our site and see for yourself! Any comments or suggestions will receive a warm welcome.

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## CRC PROFILE

**Report by André Taylor**

André Taylor is the Focus Catchment Coordinator for the Brisbane River in the CRC for Catchment Hydrology.

André was born in Alberta, Canada in 1969, but moved to Australia almost immediately. He spent the first 22 years of life living in Tasmania.

At the University of Tasmania, André completed a Bachelor of Science, focussing on physical sciences. André was fortunate enough to receive nine University awards and bursaries for his studies in geology, which encouraged him to undertake his Honours degree in Economic Geology with an emphasis on metasomatic petrology. André was fortunate enough to receive two scholarships to support this degree and received first class Honours in 1990.

A geological career in some desert, on an oil rig, or in a south east Asian jungle was looming until André decided to change career direction and become an environmental scientist. "The change in direction was a consequence of my desire to produce more than just profits for a mining company and the fact that I had just become engaged", he explains. "It was a difficult decision that didn't exactly please my Geology Professor at the time".

André worked with the Department of Environment in Hobart from 1991 to 1993 in the areas of waste management, and in particular, contaminated site assessment and management. Like many young professionals in Tasmania, the lack of career opportunities saw André move to the mainland. Lured to the sunshine state after years in Hobart, André moved to Brisbane.

André continued to undertake some consulting work advising on aspects of contaminated sites, but soon recognised the need to go back to University to improve his environmental management knowledge. He accepted an APA scholarship to study for a Masters of Environmental Management (MEM) on a full-time basis at University of Queensland from 1994 to 1995. "Although the degree was new at the time and had some weak areas, I found it be an excellent basis for future work in environmental management", he explains. "The course combined management elements from the University's MBA degree, technical subjects from a variety of faculties, and an applied thesis."

Although André achieved a grade point average of 7 for his MEM, he does have a skeleton in his closet. "Although I did pretty well, I have to admit there was one subject that I was lucky to scrape through with a non-graded pass - Hydrology and Groundwater. It is somewhat ironic that 5 years later I'm formally associated with Australia's premier research organisation in catchment hydrology. . . I may have to dust off the old course notes".

Since graduating from the University of Queensland in 1995, André has held four positions in Brisbane City Council, specialising in Environmental Management Systems, environmental management in Council's operational areas, and water quality management.

Currently, André is Brisbane City Council's Principal Waterways Program Officer (Water Quality). His duties include the development of Council's water quality management policy (e.g. as a part of the City's development assessment and planning processes) and ensuring that a variety of water quality management projects in Council's Urban Stormwater Management Strategy are delivered. André's Team in Council's Waterways Program manage over $3M of water quality-related projects every year.

André is proud to be associated with the CRC for Catchment Hydrology and especially, the Urban Stormwater Quality Program. "I have a penchant for high quality work, whether it is research, publications, or presentations – the CRC for Catchment Hydrology has already demonstrated that it can deliver in these areas and has the key personnel to continue to produce excellent products over the next 6 years."

Outside of work, André is a keen photographer, mediocre rock climber, avid movie-goer, fair weather bush walker and passionate Brisbane Bronco supporter.

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## WHERE ARE THEY NOW?

### Report by Bruce Abernethy

It feels as though it is almost cliché by now, but I've followed that well-worn path to Sinclair Knight Merz.

Happily ensconced at Armadale with panoramic views of the carpark, I find little time to ponder the twists and turns that have led me here. Thoughtful musings on the plight of the world over morning tea seem but a distant memory. Rather, my musings revolve around timelines and budgets. Of course the natural world is still as complex and as confusing as it always was, and applying the knowledge gained through my studies with the CRC to the gamut of problems that confront land and water managers around the country is proving a challenge. It appears that 'comfort zone' is not in the vocabulary of the consulting geomorphologist.

The odd bit of discomfort (probably character building) notwithstanding, I am learning a lot and I really enjoy the variety of work that crosses my desk. Projects that I'm currently working on include: the effects of hydro power station operations on channel morphology; investigating riverbank stability; drafting estuary management plans; exploring options for rehabilitating degraded hillslopes; and others. After four years of narrowly defining my expertise, the breadth of projects to which I can apply my skills is very rewarding.

It appears that the Australian water industry is increasingly recognising fluvial geomorphology as a legitimate component of natural resource/catchment planning projects. This is very reassuring, to me, both on a personal level (it pays the mortgage) and on a professional level. By considering longer tem landscape and channel forming processes, land-managers will be better equipped to make decisions that promote the sustainable use of the natural world.

**Bruce Abernethy**
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## NEW WORKING DOCUMENT

**An Integrated Dataset of Climate, Geomorphological and Flood Characteristics for 104 Catchments in South-East Australia**

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**by**
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**Russell Mein**
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CSIRO Land and Water
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